EXPLORING INTEGRATED KINETIC ENERGY OF POLAR MESOSCALE STORMS TO ESTIMATE SEA ICE FORMATION AND SALT FLUXES IN THE WEDDELL SEA

by

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A dissertation submitted to the Faculty of the University of Delaware in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Geography

Winter 2015

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ACKNOWLEDGMENTS

First and foremost, I would like to thank Dr. Cathleen Geiger and Dr. Tracy DeLiberty. They introduced me to sea ice research my first semester as a Master's student at the University of Delaware. They have included me on numerous projects throughout my time at the University, which have helped me to grow as a researcher. Their encouragement and direction will continue to inspire me throughout my career. I am grateful for thoughtful discussions and comments regarding this dissertation with my committee members, Dr. Sara Rauscher and Dr. Matthew Mazloff. The courses, seminars, education, and professional development opportunities available through the Department of Geography, and the help of the faculty and staff have been incredible resources. Additionally, I must thank Dr. Michael Harrison who introduced me to the field of geography and geographic research at the University of Richmond.

Thank you to my family and friends. I have learned as much from other graduate students and office mates in the Geography Department as I have through courses and my own research. I thank them for the dialogues which eventually led to organizing seminars, traveling abroad for conferences, and research presentations. I thank my parents, sisters, brothers, nieces, and nephews for their constant support. Finally, I thank my husband, Hal, for his confidence in me.

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ABSTRACT

This dissertation examines the relationship between polar cyclones and sea ice cover. Through this research, an archive of polar cyclones is created. The archive contains storms for the time period 01 January 1979 through 31 August 2014 for the Weddell Sea, a region east of the Antarctic Peninsula extending to where the Southern Ocean and Indian Ocean meet. The four defined properties of polar cyclones used in this work are: high wind speeds, low pressures, short duration, and small spatial scales. The storm strength is expressed specifically through the maximum wind speed and minimum sea level pressure. The archive additionally includes characteristics of individual storms including the storm date, duration, strength, and size which are analyzed and compared to changes in sea ice cover during each storm. Subsequently, this research quantifies linkages between polar cyclones and sea ice by computing each storm's integrated kinetic energy as a measure of the size, duration, and wind speeds. Specific linkages include the surface energy balance, sea ice growth rate, and the quantity of brine rejected to the top of the water column. The results show that the area of open water is the biggest contributor to sea ice growth and brine production through new ice formation. The ejected brine from the ice increases the density of sea water in the nearby upper ocean layers which contribute to the destabilization of the water column. Subsequently, the destabilization of the water column helps to form

Weddell Sea Bottom Water – the coldest and densest water mass on the planet and major contributor to the global ocean circulation. Hence, the storm climatology developed herein provides a new quantitative resource for establishing significant links between polar storms and Weddell Sea deep water formation.

Chapter 1

INTRODUCTION AND RESEARCH QUESTIONS

This dissertation examines how sea ice in the Weddell Sea varies with respect to mesoscale storms in the same region. The formation of sea ice in the Weddell Sea contributes to the formation of deep water masses which enhances global overturning circulation. The overturning circulation is strengthened at a few specific sites on the planet where surface cooling and brine contribution from freezing sea ice increase the density of the surface layer. Where the surface layer is sufficiently dense to destabilize the water column, layers of cold and high salinity water sink deep beneath the surface (Marshall and Schott 1999).

Sea ice forms throughout the year in the Weddell Sea. As seawater freezes, the brine rejected is denser than the surrounding water, and the high density brine plumes are entrained into deep water masses. Sea ice formation contributes to the formation of the cold and dense water masses. Deep water masses formed in the Weddell Sea have global implications because the deep water flows northward along the bottom of the basin to the Antarctic Circumpolar Current (ACC) and into other ocean basins where it becomes part of the global overturning circulation.

The genesis process of deep water in the Weddell Sea is closely linked to the sea ice formation, area, and extent. Figure 1.1 is an idealized cross section of the water mass formation processes in the Weddell Sea identified in Gordon (1998) combined with the surface flux and storm processes investigated in this dissertation. Katabatic winds (strong, density driven, southerly winds off the coast of Antarctica) lead to the formation of coastal polynyas where sea ice is pushed away from the coast. Surface seawater freezes and is subsequently pushed away by winds. Open ocean polynyas also form under the influence of winds and the upwelling of warm sea water. The sea ice cover is also marked by cracks and leads in the sea ice. High density seawater at the surface mixes with deeper water masses.

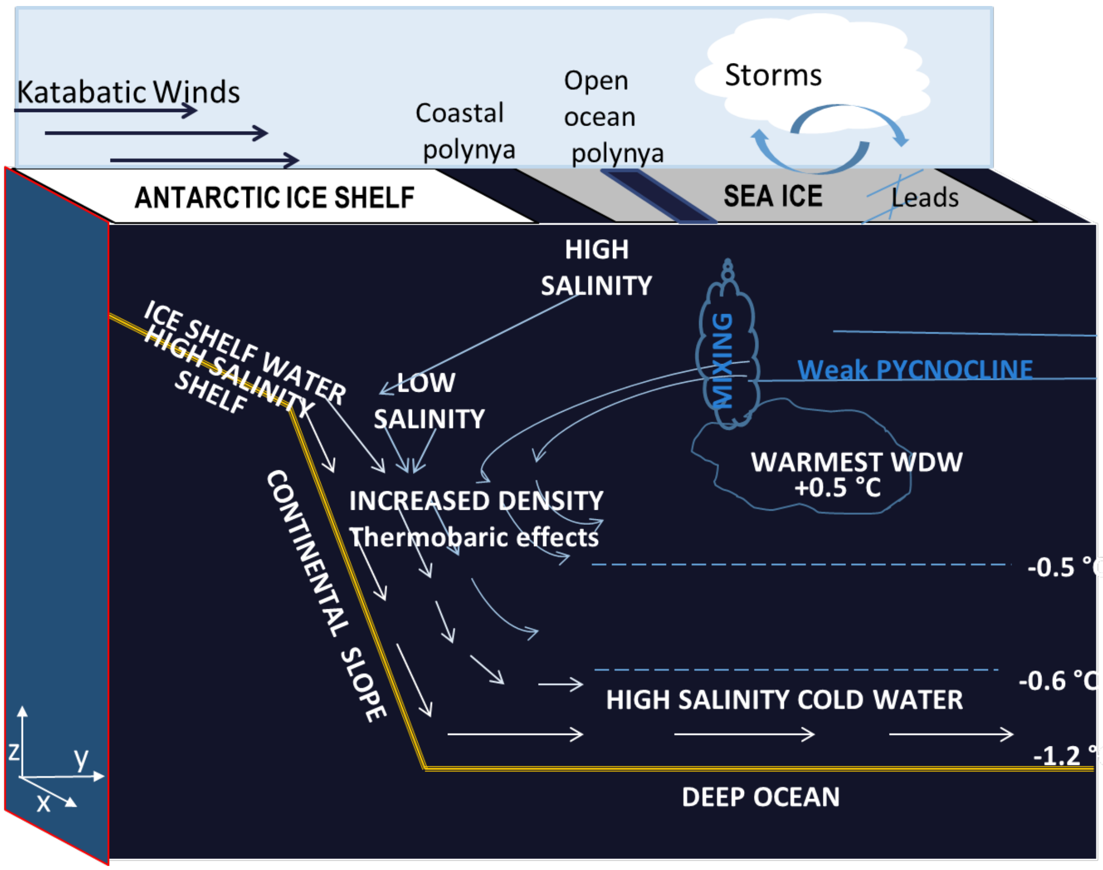


Figure 1.1 Idealized cross section of the Weddell Sea. This schematic provides an overview of air-ice-ocean interactions contributing to deep water formation.

This dissertation focuses on the top portion of Figure 1.1, specifically the cross section of Figure 1.2. The areas of open water within the ice pack and along the ice edge are the areas of interest. In the open water regions, new sea ice can form and contribute significantly to the destabilization of the surface layer.

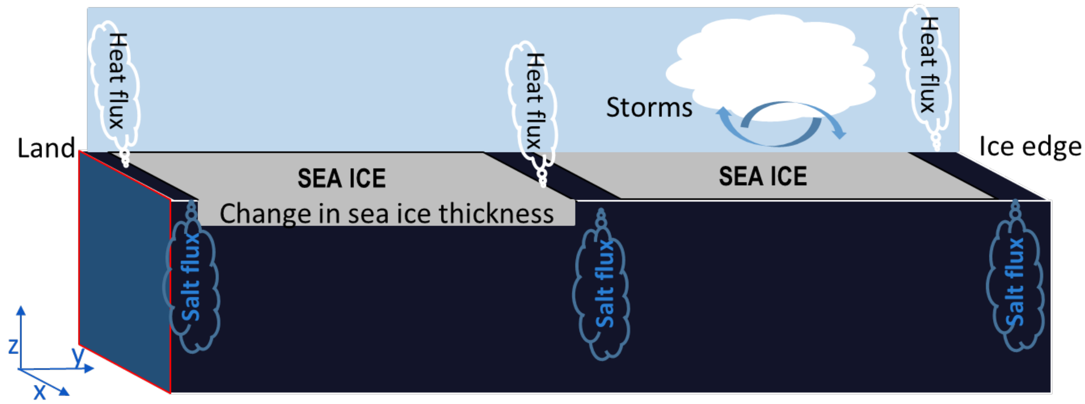


Figure 1.2 Idealized cross section of the Weddell Sea atmosphere - sea ice - ocean interactions. This figure represents the area of focus of this dissertation.

The research presented herein examines the relationships of certain weather events and the sea ice cover. The weather events of interest are polar mesoscale cyclones. Polar mesoscale cyclones are small scale, short term, intense weather events which typically form poleward of 60°S. Current literature indicates that the occurrences of polar mesoscale cyclones in the North Atlantic are decreasing as the climate in the North Atlantic warms (Zhan and von Storch 2010). Recent research (Condron and Renfew 2013) suggests that the existence of polar mesoscale cyclones positively impacts deep water formation in the regions of the North Atlantic. In the Southern Hemisphere, there is no consensus in the literature as to whether the pattern, frequency, and intensity of polar mesocyclones have changed significantly in the last 35 years.

1.1 Research Questions

Research on the effect of polar storms on sea ice formation has previously focused on the North Atlantic where there are distinct trends in the frequency of polar mesoscale storms (Zhan and von Storch 2010). Although no long term climate-related trends in polar mesoscale storms are known in the Southern Ocean, there is still a gap in the understanding of the pattern and characteristics of polar storms in the Weddell Sea. In addition, the sea ice extent since 1979 in the Southern Ocean has, on average, increased (Parkinson and Cavalieri 2012). The ice extent in the Weddell Sea has a slightly positive trend for the same period and a mixed trend on a monthly basis. The cause of the sea ice extent increase may be due to large scale circulation patterns more so than temperature changes (Parkinson and Cavalieri 2012). This dissertation explores the potential relationship of numerous small scale atmospheric events and sea ice by addressing the following specific questions.

1. What are the characteristics of mesoscale polar storms in the Weddell Sea over the last 36 years (01 January 1979 – 31 August 2014)? What storm characteristics are best correlated with changes in the sea ice cover?
2. How is the sea ice extent and area affected by the pattern of small scale storms in the Weddell Sea?
3. How is the sea ice growth rate affected by the occurrence and characteristics of a polar mesoscale storm?
4. How much can the occurrence of a storm affect the production of brine input to the water column?

1.2 Chapter Outline

The chapters in this dissertation include a literature review summarizing the supporting literature relevant to polar mesocyclones in the Weddell Sea, as well as the current understanding of Weddell Sea climate, weather patterns, sea ice conditions, and water masses. A description of the data used in this dissertation is provided (Chapter 3). Chapters 4, 5, and 6 are the methods, results, and discussion chapters, respectively. These three chapters are set up such that the first section of each refers to the climatology of polar storms in the Weddell Sea. The second section is a short section on sea ice edges in the Weddell Sea, and the third section refers to the calculation of the sea ice growth rate and salt production based on the calculation of the surface energy budget in the Weddell Sea under varying storm conditions. The overall conclusions and future research directions are presented in Chapter 7. Appendix A contains the methodology scripts, and Appendix B contains the full storm climatology.

Chapter 2

LITERATURE REVIEW

This chapter summarizes the literature that supports the proposed research topic. The first section emphasizes general polar cyclone research and predictions for polar cyclones in climate scenarios. The following sections review specific studies concerning the Weddell Sea, including the sea ice, water masses, and atmospheric conditions in the region. The goal of the summary is to highlight the connections between changing atmospheric patterns and the potential for those patterns to alter sea ice cover and therefore global ocean circulation.

2.1 Polar Cyclones and Warming Climate Scenarios

This section summarizes the impact of the winds and temperature changes associated with cyclones in the polar regions on sea ice and deep water formation. Any storms which are located entirely over the Weddell Sea are of interest. The term *polar low* is reserved for the specific set of strong storms which develop poleward of a polar front, over the ocean, with a diameter of less than 1000 km (mesoscale), and maximum wind speeds greater than 15 m s^{-1} (Carrasco et al. 2003, Ramussen and Turner 2003). Polar mesoscale cyclones are storms of the intensity of polar lows, but the storms may form northward of a Southern Hemisphere polar front. In the literature, occasionally the term polar low and polar mesoscale cyclone are used interchangeably. Because the Weddell Sea study area extends as far north as 55°S, this review includes research on both polar mesoscale cyclones and the specific storms known as polar lows.

Polar mesocyclones generally form as cold marine air masses move over warmer open ocean (Kolstad 2011). Low-level baroclinicity occurs where the atmospheric density is dependent on both pressure and temperature. It is related to the temperature gradients within marine cold air outbreaks and near the marginal ice zone. Low-level baroclinicity and high upper-level potential vorticity (curl of the velocity) initiate the first stage of development of polar mesoscale cyclones. Comma clouds develop in the initial baroclinic stage. The mesoscale features either dissipate after that stage or continue to develop (Kolstad 2011). Many polar lows continue into the convection stage characterized by spiral clouds. This generally occurs when the low pressure center of the storm moves over warmer water, decreasing low level stability (Kolstad 2011).

Polar lows are recorded less frequently in the Southern Ocean than in the Northern Hemisphere. The decreased frequency may be an artificial trend that reflects the more limited availability of small scale maximum wind observations in the Southern Ocean than in the Arctic (Irving et al. 2010). The Southern Ocean environment provides conditions favorable for mesoscale cyclogenesis (Yanase and Niino 2007, Heinemann 1990) where cold and strong katabatic winds blow off of the Antarctic continent. The contrast of the cold winds and relatively warm sea surface supplies the instability necessary for the first stage of polar cyclone development. Regions of strong baroclinicity have been identified near the Antarctic coast (Heinemann 1990, Yanase and Niino 2007). The winds may also cause a higher convergence zone over the ocean where continental air masses meet maritime masses (Heinemann 1990).

The Weddell Sea, like other regions surrounding Antarctica, experiences frequent mesoscale cyclones both near the coast and over ice-free regions (Heinemann 1990). In the Weddell Sea, subsynoptic scale (on the order of 1000 km) cyclones can form over Antarctica or the Antarctic coast, or northward of the polar front (Carrasco et al. 2003). There are some spatial and temporal patterns specific to Weddell Sea mesoscale cyclones. The diameter can be as small as 100 km, with an average diameter of approximately 380 km (Carrasco et al. 2003). They occur more frequently in the austral summer when the open water fraction is highest. The majority of mesoscale vortices coincide with the location of katabatic winds coming off the continent or at the sea ice and ocean margin (Carrasco et al. 2003).

Katabatic airflow supplies the cold air that interacts with the generally warmer and moist marine air masses creating temperature gradients. As the air moves over Weddell Sea, leads and polynyas in the ice cover provide open water where the sensible heat flux from the ocean decreases low level stability. Carrasco et al. (2003) identify two specific areas especially productive for mesocyclogenesis that include areas near the Filchner–Ronne Ice Shelf and 200 km north of the Southeastern shore of the Weddell Sea.

Identification of mesoscale cyclones is an active area of research because manual identification and classification of mesoscale cyclones is time consuming, and current automated detection algorithms may not identify the smallest storms. Most climatological studies of polar mesoscale cyclones rely on satellite data, but a recent report from the International Workshop on Polar Lows indicates that newer high-resolution reanalysis datasets are suitable for mesoscale cyclone detection (Heinemann 2013). Other data sources for storm identification, including meteorological data from weather stations, could be more reliable for areas with high concentrations of weather stations (Carrasco et al. 2003). Data from meteorological stations are accurate and are able to identify very small storms. However, these are prone to failure in cold regions, and the sampling interval and locations are irregularly spaced in the Southern Ocean. Polar cyclones are also identifiable using visible and infrared imagery from sensors on polar orbiting satellites. The distinct comma and spiral shapes of clouds associated with vortices indicate the presence and size of polar storms (Heinemann 1990).

Advanced Very High Resolution Radiometer (AVHRR) satellite imagery combined with microwave scatterometer wind speed data from the NASA QuickBird satellite (known as QuikSCAT) enable mesoscale cyclone detection for certain purposes because they have a finer spatial resolution (Condron et al. 2008). However, these are not always available multiple times a day. Additionally, the surface wind estimates from QuikSCAT are only available for ice-free oceans (Irving et al. 2010). Irving et al. (2010) use high resolution satellite data to identify and classify mesoscale storms in the Southern Hemisphere. Their 1999-2008 climatology, based on pressure and wind fields derived from scatterometer data, are able to identify smaller events than those identifiable based on coarse resolution reanalysis data. However, their methodology only identifies storms in the ice-free zone (Irving et al. 2010). The Weddell Sea contains high concentrations of sea ice year-round. For this study, ice-covered regions of the Weddell Sea must be included because deep water forms near ice covered areas and the Antarctic coast (Gordon 1998).

Reanalysis products can be used to identify storms, but the heterogeneity of the data assimilated over time, particularly in the polar regions where instrument and methodology bias are more problematic, can lead to uncertainty in the results (Trenberth et al. 2007). Due to the spatial resolution of global reanalysis datasets, larger storms are more likely to be detected with reanalysis data than smaller storms. Between October 1993 and September 1995 in the Northeast Atlantic, 80% of storms larger than 500 km in diameter detected from satellite imagery were also detected using the mean sea level pressure data from the ECMWF ERA-40 reanalysis dataset (Condron et al. 2006). With the same dataset, only 20% of cyclones smaller than 100 km were detected (Condron et al. 2006). Data from the ERA-40 also tend to underestimate wind speeds in cyclones (Condron et al. 2008). Although previous reanalysis data may not be ideal for storm detection because of the coarse spatial resolution (Irving et al. 2010), the newest ECMWF reanalysis product, ERA-Interim, with approximately a 79 km horizontal grid, may resolve more mesoscale cyclones. In the Southern Ocean, ERA-Interim may be the most accurate reanalysis for mesoscale cyclone tracking (Hodges et al. 2011).

The role of polar mesoscale cyclones in the global atmospheric circulation and atmosphere-sea ice-ocean interactions remains an active area of research (Rasmussen and Turner 2003). The sensible and latent heat fluxes at the ocean-atmosphere interface associated with mesoscale cyclones may interact with the surface wind stress during a cyclone and influence the thermohaline circulation (Condron et al. 2008). Condron et al. (2008) note that the high rates of ocean heat loss associated with vorticies in Nordic Seas are likely features in the Weddell Sea. In polar waters, there are two ways the surface layer becomes denser and contributes to deeper water masses: the first process is salt rejection due to sea ice formation, and the second is the cooling of surface waters. Surface water rejects salt as it freezes, thereby supplying the water beneath the sea ice with extra brine. Higher salinity water is denser, so it can sink to lower layers. The second process, surface cooling, occurs in cold regions where the air temperature is much cooler than the surface water or sea ice. Heat transfers to the atmosphere directly from the ocean, through the sea ice, or in open water areas within the ice cover. The ocean surface layer then becomes cooler and therefore denser. When the surface water temperature is near the temperature of the lower layers, ocean stratification is minimized and the surface waters can sink. Mesoscale cyclones influence this second process by supplying wind stress and heat fluxes from the ocean to the atmosphere.

Mesoscale cyclones can affect deep water formation in the North Atlantic (Condron et al. 2008, Condron and Renfrew 2013). Condron et al. (2008) ran an ocean general circulation model based on the Modular Ocean Model (MOM) forced with ERA-40 reanalysis fields in the Nordic Sea. The perturbed model run supplemented reanalysis data with vortices identified by satellite data. Wind speeds on average were higher in the perturbed run, and the higher wind speeds were associated with greater total (latent and sensible) heat flux. In the perturbed run, the surface of the ocean lost more heat to the atmosphere, there was increased deep water convection, and increased Greenland Deep Water outflow (Condron et al. 2008).

Polar mesoscale cyclone events are either too short in duration or too small in area to be simulated by most climate models (Condron and Renfrew 2006, Zahn and Storch 2010). Condron and Renfrew (2013) used a coupled ocean-sea ice general circulation model to further examine how polar cyclone forcing affects deep water formation, and found, similar to Condron et al. (2008), that increasing the number of polar storms in the model increased deep water volume. Marshall and Schott (1999) identify that deep water formation and global ocean circulation are linked. The results of Condron et al. (2008) and Condron and Renfrew (2013) highlight the necessity to investigate how polar cyclone events in other regions affect deep water formation and therefore global ocean circulation.

Although climate change tends to be associated with an increase in the frequency of extreme weather events, recent climate-model simulations predict fewer polar lows in the North Atlantic (Zahn and Storch 2010). This is likely because the mid-troposphere temperature is predicted to increase more quickly than the North Atlantic sea surface temperature which will increase regional atmospheric stability. In addition to the decreased frequency of storms, the simulations also indicate shifts in the spatial distribution of North Atlantic polar lows (Zahn and Storch 2010). Bengtsson et al. (2009) suggest that the number of mesoscale extratropical cyclones (not necessarily polar mesocyclones) will decrease possibly due to less of a temperature gradient between the sea surface and surface air temperature.

Currently, the impact of warming climate scenarios on cyclone patterns in the Weddell Sea is unknown. However, several studies support the suggestion that polar lows in the Southern Ocean are becoming more numerous and intense in contrast to the decreasing number of polar lows in the North Atlantic. Poleward of 60°S, Fyfe (2003) identifies a slight increase in the number of cyclones, and Pezza and Ambrizze (2003) show a significant increase in the number of intense (lower than 980 hPa) polar lows for the entire Southern Ocean. Sea level pressure data from 6-hourly ERA-40 reanalysis indicate that around the Antarctic coast, the number of strong polar cyclones per year increased between two time periods: 1958–77 and 1982–2001 (Wang et al. 2006). Over the same time period, the number of strong cyclones recorded north of the Antarctic coastal zone decreased. This is likely associated with a change in storm tracks in the region (Wang et al. 2006). Polar storm tracks in the Southern Ocean are projected to move to the south and increase the total cloud cover over the Southern Ocean (Bengtsson et al. 2013).

There are many studies examining how intense storms will change in the near future. However, the impact of climate change on mesoscale cyclones in the Southern Ocean and more specifically in the Weddell Sea remains unknown. The recent efforts to improve the detection and records of polar storms (Irving et al. 2010) may lead to further studies to investigate how the frequency and intensity of Southern Hemisphere polar lows will change under warming climate scenarios. Although the intensity and frequency of polar storms in the Southern Ocean in the future cannot be predicted, it is possible to investigate the potential local and global impacts of various possible polar cyclone scenarios.

2.2 Weddell Sea

The Weddell Sea in the Southern Ocean encompasses the region east of the Antarctic Peninsula to approximately 10°E (Deacon 1979). The Weddell Gyre is a large cyclonic subpolar gyre (Gordon 1998) that can reach as far to the east as 53°E (Park et al. 2001). The high sea ice concentration in the region makes field research difficult year round, so research expeditions are infrequent. This review notes findings from many models, remotely-sensed data studies, and a few field campaigns which focus on the Weddell Sea. Ice Station Weddell-1 (ISW-1) and Ice Station Polarstern (ISPOL) are two notable research expeditions dedicated to studying the

Weddell Sea. In 1992, an international effort of the United States and Russia established ISW-1, the first scientific drift station in the Southern Ocean. The ISW-1 camp started on an ice floe in the southwestern Weddell (71.4°S) on 12 February and gathered water column, sea ice, and atmospheric structure data in the western Weddell Sea as the floe drifted to the north (65.8°S) until 4 June. The multi-disciplinary study recorded hydrographic measurements, atmospheric boundary layer data, sea ice mechanics and dynamics, and biological characteristic of the sea ice and water column. The results of the studies of ISW-1 provide a comprehensive understanding of the state of the ocean, ice, and atmosphere during austral winter (Gordon 1993). The Weddell Sea field experiment, ISPOL, collected information between the austral spring and summer which complemented the austral autumn to early winter ISW-1 investigations. ISPOL anchored the German icebreaker *Polarstern* to an ice floe in the western Weddell Sea pack ice where it drifted between 27 November 2004 and 2 January 2005 (Hellmer et al. 2006).

The body of knowledge reported in the remainder of this chapter expresses the current state of understanding the location, formation processes and global importance of water masses in the Weddell Sea. The emphasis is on the lower atmosphere, sea ice, upper ocean, and interactions between the three that contribute to deep water mass formation in the Weddell Sea.

2.2.1 Weddell Sea Lower Atmosphere

The atmosphere is closely connected to the sea ice and surface ocean layer. Wind systems over the Weddell Sea drive the cyclonic surface circulation which creates the gyre (Schroder and Fahrbach 1999). The strength of the winds determines the strength of the gyre (McKee et al. 2011). In the Weddell Sea, surface winds are weak and generally around 2-3 m s^{-1} (Andreas et al. 2000). Atmospheric jets, defined as a local maximum with speeds 2 m s^{-1} higher than the winds below or above, are located primarily between 25 and 175 m above the sea surface in the Weddell Sea and usually below 425 m (Andreas et al. 2000). Here, faster wind velocities range between 3 and 13.6 m s^{-1}. The atmospheric boundary layer is stably stratified, and it is presumed that the stable stratification helps to generate low level jets, while unstable boundary layer activity erodes the jet through mixing (Andreas et al. 2000). At least in the austral autumn and early winter, low-level temperature inversions are common (96% of the time) in the western Weddell Sea over compact sea ice. Similar inversions are observed in the Arctic Ocean (Andreas et al. 2000). Stable conditions decrease the opportunities for cyclogenesis, as do warmer than average sea surface temperatures (Carrasco et al. 2003).

Indirect atmosphere and ice interactions also affect deep water formation. Anomalous winds, which occur during weather events, may change the ice-free or open water area within the ice pack (McKee et al. 2011). Deep water formation can occur at the ice shelf edge (Hellmer et al. 2006), so anomalous winds may create new areas for deep water formation by altering the location of the ice shelf edge.

The atmosphere is also connected indirectly to deeper water formation through winds. Ekman transport is to the left of the direction of the winds in the Southern Ocean. In the Weddell Sea gyre, where winds are generally clockwise, surface waters diverge and there is upwelling (Ekman pumping) in the center of the gyre and downwelling (Ekman suction) towards the edge of the gyre. Because Ekman transport is related to the speed of the surface winds, the wind speeds affect the volume of water transported horizontally and vertically. However, the Weddell Gyre responds to changes in the general atmospheric pattern slowly - after a lag time of three to four years (Venegas and Drinkwater 2001).

2.2.2 Weddell Sea Ice

The Weddell Sea is nearly completely covered by sea ice in the winter, and in the summer, the region has a higher sea ice concentration than any other area in the Southern Ocean (Gordon 1993). This section identifies the types, formation, extent, thickness, and climatic importance of sea ice in the Weddell Sea.

In the Weddell Sea, the sea ice drift and concentration exhibit a multi-year cycle that is coupled to the fluctuations of the atmosphere and upper ocean and feedbacks between the ocean, ice, and atmosphere (Venegas and Drinkwater 2001). The transport pattern of the ice is strongly influenced by the path of the Weddell Gyre. The Antarctic Peninsula, the western boundary of the Weddell Gyre, enhances the gyre circulation (Lange and Eicken 1991). Even where there is sea ice, angular momentum from winds gets transmitted to the ocean via the vorticity of the ice drift and the water stress. The stress beneath the ice contributes to Ekman pumping (downwelling) (Kottmeir and Sellmann 1996). Small scale oscillations with time scales of less than one day are also common (Geiger and Drinkwater 2005). These enhance bottom water production by providing vertical and horizontal mixing of surface layers (Geiger and Drinkwater 2005).

The ice extent is closely coupled to air temperature when the temperature change crosses the sea ice melt or freeze threshold. Seawater freezes at around -2 °C. The freezing point may be slightly cooler or warmer depending on the salinity of the seawater. Sea ice continually rejects salt, so it thaws at a temperature closer to the freezing point of freshwater, 0 °C (Geiger et al. 1997). The ice edge is difficult to define because there is a marginal ice zone in which the ice is distributed irregularly (Comiso and Sullivan 1986).

The Weddell Sea contains mainly first-year and second-year sea ice. The northwestern Weddell Sea contains the greatest variety of ice types (Lange and Eicken 1991). In the Weddell Sea, the differences in maximum thickness between first year and multiyear ice are fairly small (1.8 m versus 1.5 m). However, the multiyear ice has greater variability in surface height and thickness due to increased deformation. The multiyear ice also has lower salinity – 3 parts per thousand (ppt) as opposed to 15 ppt for first year ice (Gordon 1993).

Coastal polynas, ice-free areas in the ice pack, are common near ice shelves in the eastern Weddell Sea. Offshore winds create ice-free areas which close frequently when the wind direction changes from offshore to onshore (Lange et al. 1989). Polynyas can occur within the ice pack (Comiso and Sullivan 1986).

Sea ice forms as platelets that freeze within the water column as well as at the surface. The subsurface platelets rise to the surface. Frazil ice, newly formed ice with a granular texture (Lange et al. 1989), dominates ice types from 64°S to the northern ice edge of the Weddell Sea. Subsurface platelet congelation, where platelets freeze beneath the existing skin of sea ice, is a significant ice formation mechanism in the eastern Weddell Sea (Lange et al. 1989). In calm waters, congelation ice grows thermodynamically with a long columnar ice structure. Thick layers of up to five meters of loosely connected ice platelets beneath the surface consolidate (Lange et al. 1989).

In Weddell Sea, processes such as platelet growth, pancake ice growth, coastal polynas, rafting, and divergence significantly contribute to the overall sea ice cover and patterns (Lange et al. 1989). In rough waters, through wave and wind action, the crystals form together and eventually create circular disks which are several centimeters thick and tens of centimeters in diameter. This formation is known as pancake ice. The pancakes often amass and form a nearly continuous ice cover which can be tens of centimeters thick. Rafting of pancake ice due to wave action can create sea ice thicker than one meter. The sea ice cover in the Weddell Sea is mainly formed by consolidation of pancake ice (Lange et al. 1989). Wind and wave action can cause ice divergence, creating lines of open water (leads), and they can push ice floes back together, creating overlapping floes (rafts), and compressed floes (ridges) (Lange 1989, Kottmeir and Sellmann 1996). Where leads open, heat is lost to the atmosphere. The divergent winds which create leads are responsible for higher than average freezing rates because leads create new areas for freezing thin ice (Kottmeir and Sellmann 1996). Leads open and close within a few days (Kottmeir and Sellmann 1996). Due to tidal and inertial oscillations (where residual motion is only acted upon by gravity and the Coriolis force) in the Weddell Sea, they also open and close within a few hours (Geiger and Drinkwater, 2005).

The overall ice cover, which includes snow thickness, sea ice thickness, concentration, and ice type determines the albedo, or reflectivity, of the Weddell Sea (Geiger et al. 1997). The snow cover over the ice has an insulating capability (Comiso and Sullivan 1986). Comiso and Sullivan (1986) recorded a nearly constant snow-ice temperature of 4 °C while the air temperature varied between -20 °C and 5 °C. The insulating capability increases the heat storage, and the heat storage effect increases with thicker ice (Geiger et al. 1997). The sea ice cover reduces energy transfer between atmosphere and ocean (Lange et al. 1989). By insulating heat and reducing energy transfer, the sea ice affects the temperature of the mixed layer (Geiger et al. 1997). However, at the onset of freezing, or when a slush layer or flooded layer above the sea ice re-freezes, the insulating effect of the ice is reduced (Lytle and Ackley 1996).

As the seawater freezes, dense, salty brine moves through the underlying ice and surface water. Less dense, less salty seawater replaces the brine. This process initiates convection in regions of ice formation (Lyte and Ackley 1996). Convection will be described in more detail in the next section.

2.2.3 Weddell Sea Water Masses

Strong density gradients separate the deep ocean from the surface waters. However, in a few regions on the planet, open-ocean convection occurs where surface waters mix with water at depths. The dense water sinks and forms the deep and bottom water directly over the sea floor. The regions where deep convection occurs are in the North Atlantic, the Mediterranean Seas, and the Weddell Sea (Marshall and Schott 1999). These convection regions are of global importance because they sustain the global thermohaline circulation. This is basically the circulation driven by density gradients due to temperature (thermo) and salt (haline). The Weddell Sea is one of the most significant contributors to the formation of deep and bottom waters which affect the global overturning system (Farbach et al. 2011).

Before detailing water masses specific to the Weddell Sea, this section briefly explains seawater density and the relationship between density and water mass identification. Water density is not directly measured, but rather calculated based on temperature, salinity, and pressure. The distribution of salinity and temperature at the surface is affected by freezing and melting of sea ice, freshwater inputs from runoff, river inflow, heat fluxes, evaporation, and precipitation (Stewart 2008). Changes in temperature or salinity increase or decrease the water density. If a parcel of water at the surface becomes denser, it will sink to a position in the water column where it is stable, but it retains the same salinity and the potential temperature of the parcel at the surface. Water masses have distinct temperature and salinity properties. Temperature and salinity are conservative processes, only alterable if one water mass mixes with another water mass with different conservative properties or if the water mass freezes. Thus, an unfrozen water mass is identified based on the temperature and salinity properties of the source region.

The equation of state for the ocean expresses the dependency of density on temperature, salinity, and pressure. Colder water is denser than warmer water, and high salinity water is denser than low salinity water. However, the equation of state is complicated because the relationships of temperature, salinity, pressure, and density are nonlinear, and the nonlinear relationships become particularly interesting in deep water. When two water parcels mix, the density of the combined parcel is a function of the new temperature, salinity, and pressure properties. The new parcel will not necessarily have a density between the density of the two original parcels. In fact, if two parcels with the same density but different temperature and salinity properties mix, the new parcel will be denser than the original. The process of two water masses with the same density but different temperature and salinities mixing to form a denser water mass is called cabbelling (McDougall 1987). Another source of non-linearity in the equation of state is the thermobaric effect. Density is frequently visualized through the use of T-S (temperature-salinity) or θ-S (potential temperature-salinity) diagrams with temperature on the vertical axis and salinity on the horizontal axis. In T-S diagrams, the slope of the lines of constant density, termed isopycnals, becomes gentler as depth and pressure increase. This means that if two parcels of water have the same density but different salinities and temperatures at the surface, at depth, the colder parcel will be denser. The thermal expansion coefficient of sea water increases with pressure, so cold water is more compressible than warm water. This effect is called thermobaricity (McDougall 1987). Thermobaric effects may be particularly important in the Weddell Sea (Marshal and Schott 1999). Both caballing and thermobaricity produce vertical motion through downwelling in the water column (McDougall 1987). To examine water column stability, the density of a parcel of water is frequently referenced to the surface pressure. Due to nonlinearities in the equation of state the parcel at the surface will have a different density than in the water column at depth. Geiger (1990) provides several excellent examples of the effect of the nonlinearities in the equation of state on water parcel density at the surface.

The temperature and salinity are also important for density-driven ocean circulation. In the ocean, the seawater density varies only by a few percent, whereas in the atmosphere the density varies by several orders of magnitude. Although small, the density changes in the ocean are extremely important for driving circulation. Frequently, the coldest and highest salinity water is found at the bottom of the water column because seawater is densest at its freezing point, around -2 °C. Freshwater is densest at 4 °C. Sea ice is fresher and less dense than the sea water and floats at the surface. There are typically distinct layers of cold, less saline, and warm, more saline water found between the surface and benthic (ocean floor) layer in polar regions. The presence and transport of sea ice can change the temperature and salinity of surface waters, contributing to mixed layer instability and convection (Marshall and Schott 1999).

Water masses in the Weddell Sea are documented based on conductivity, temperature and depth (CTD) data which can be converted to potential temperature, salinity, and pressure via the equation of state for sea water. Although water mass names are not consistent throughout the literature, several distinct water masses are well accepted in the Weddell Sea. Weddell Sea Bottom Water (WSBW) is found at the bottom of the Weddell Sea, directly over the seafloor. The 1992 field experiment was the first to identify WSBW and distinguish it from other deep water masses in the Weddell Sea (Gordon, 1998). WSBW is a very cold thin layer – only 200 to 300 m thick. WSBW has a higher salinity than the cold bottom layer removed from the seafloor.

The fresher, removed layer is known as Weddell Sea Deep Water (WSDW). It is expected that the fresher water contains more water of glacial melt origin than the benthic layer. Away from the western edge of the Weddell Sea, the distinct, two layer structure of the bottom water disappears, and the water mixes into the water column (Gordon and Huber 1990). WSDW can be a mixture of other water masses. Warm deep water or modified warm deep water mix with water masses that form on the continental shelf or beneath the ice shelf to form WSDW. WSDW can also be a mixture of warm deep water and WSBW (Robertson et al. 2002).

In the winter, there is a thin surface mixed layer. A stable pycnocline (stable density gradient) in the western Weddell Sea limits vertical exchanges of heat and salt which explains why there is a greater perennial ice cover in the western Weddell than the rest of the Southern Ocean. Turbulent mixing occurs primarily in the subsurface layer and is stimulated by the stress of the ice-water interface (Gordon and Huber 1990).

ISPOL identified a thicker and fresher winter water layer in the upper 200 m of the Weddell Sea and cooler bottom water than ISW-1. The water column identified during ISPOL is more stable than earlier studies noted (Hellmer et al 2006). Although Gordon (1998) details how the continuous WSBW follows the continental shelf, Hellmer et al. (2006) identify a bottom water region containing water which does not appear to contain continental shelf origins. Deep water ventilation or deep transport occurs through a combination of processes including vertical shear in horizontal currents near the thermocline (Hellmer et al. 2006).

There is evidence that deep water formation changes on an annual or decadal cycle. Data from repeat hydrographic instruments on the Greenwich meridian starting in 1984 provide a record of climatic importance. These data show that the water mass properties vary (Farbach et al. 2011). The interannual WSDW variations are common and are largely driven by climate variability. The Southern Annular Mode (SAM) in particular may influence WSDW production because it changes wind patterns in the area. Additionally, variations in the influx of circumpolar deep water (CDC) may influence the volume of WSDW. The transfer of heat from one layer to the next is linked to the global overturning system (Farbach et al 2011). Weddell Sea water exports primarily via the western boundary current from the Weddell Sea into the Antarctic Circumpolar Current (ACC) (Muench and Gordon 1995). From there it travels as bottom water throughout the Southern Hemisphere where it affects the global thermohaline circulation (Robertson et al. 2002). Temperature and salinity ranges for the water masses in the Weddell Sea are listed in Table 2.1 with values based on Robertson et al. (2002).

Table 2.1 Weddell Sea Water Mass Properties

Name	Position	θ (°C) range	S (psu) range
Surface mixed layer	Surface	- 1.88* to 1.0	33.0 - 34.5
Winter water (WW)	Surface	- 1.88* to - 1.77	34.30 - 34.44
Low-salinity shelf water (LSSW)	Shelf waters	- 1.88* to - 1.78	34.3 - 34.4
High-salinity shelf water (HSSW)	Shelf waters	- 1.88* to - 1.79	34.56 - 34.84
Ice Shelf Water (ISW)	Shelf waters	< -1.9	34.2 - 34.7
Modified warm deep water (MWDW)	Transitional waters	- 0.7 to - 1.7	34.4 - 34.6
Warm deep water (WDW)	Deep waters	0.0 to 1.0	34.6 - 34.75
Weddell Sea Deep Water (WSDW)	Deep waters	- 0.6 to 0.0	34.62 - 34.68
Weddell Sea Bottom Water (WSBW)	Deep waters	< -0.6	34.62 - 34.69

*or surface freezing temperature depending on salinity

2.3 Chapter Summary

Chapter two provides literature to support that there are possible connections between water mass formation rates, the global overturning circulation, and the changing climate. It highlights that these connections are prevalent in the Weddell Sea, and the Weddell Sea is an ideal region to investigate specific sensitivities of sea ice formation to changing polar storms.

In the current climate, mesoscale cyclones are common in the Weddell Sea. In the northern hemisphere, which is the focus of most polar mesoscale cyclone research, fewer polar cyclones are predicted under warming climate scenarios. In the Southern

Hemisphere, storm tracks are expected to move poleward, but changes in storm frequency or intensity are unknown. The understanding of mesoscale cyclones in the Weddell Sea is limited by the small scale of the storms - they are too small to be resolved in many climate models and past reanalysis products. Temperature and wind changes can affect the volume of deep water created in regions of deep convection in the North Atlantic, but their effect on Southern Ocean waters has not been studied. The connections between polar storms and sea ice cover are important globally because of how the sea ice cover has the potential to destabilize the surface layer and affect the global overturning circulation. The processes described in this literature review point to the need for an original work to identify polar mesoscale storms and explore their relationship to sea ice and upper ocean layers. This chapter specifically justifies three points. First, polar cyclones are common weather features in the Weddell Sea, and the intensity or frequency of these storms may change in the future (Irving et al. 2010). Second, the winds associated with polar cyclones impact the volume of deep water formation by changing sea ice conditions (Condron et al. 2008). Finally, in the Weddell Sea, the volume of deep water formed affects the amount of deep water which exports to the global abyssal ocean (McKee et al. 2011).

Chapter 3

DATA

This chapter describes the data sets that are used throughout this dissertation. The two distinct data types are reanalysis output and satellite data. The reanalysis output are used as input for the long-term (01 January 2007 – 31 August 2014) Weddell Sea polar cyclone climatology analysis (Sections 4.1 and 5.1). The satellite data are used for analysis of sea ice area, extent, and edge (Sections 4.2 and 5.2) for a shorter term, but more detailed analysis between 01 January 2005 and 31 January 2005. Subsets of both the satellite and reanalysis data are analyzed together as part of the surface energy balance, sea ice growth rate, and brine production calculations over the same time period as the inputs for the ice edge study (Sections 5.3 and 5.4).

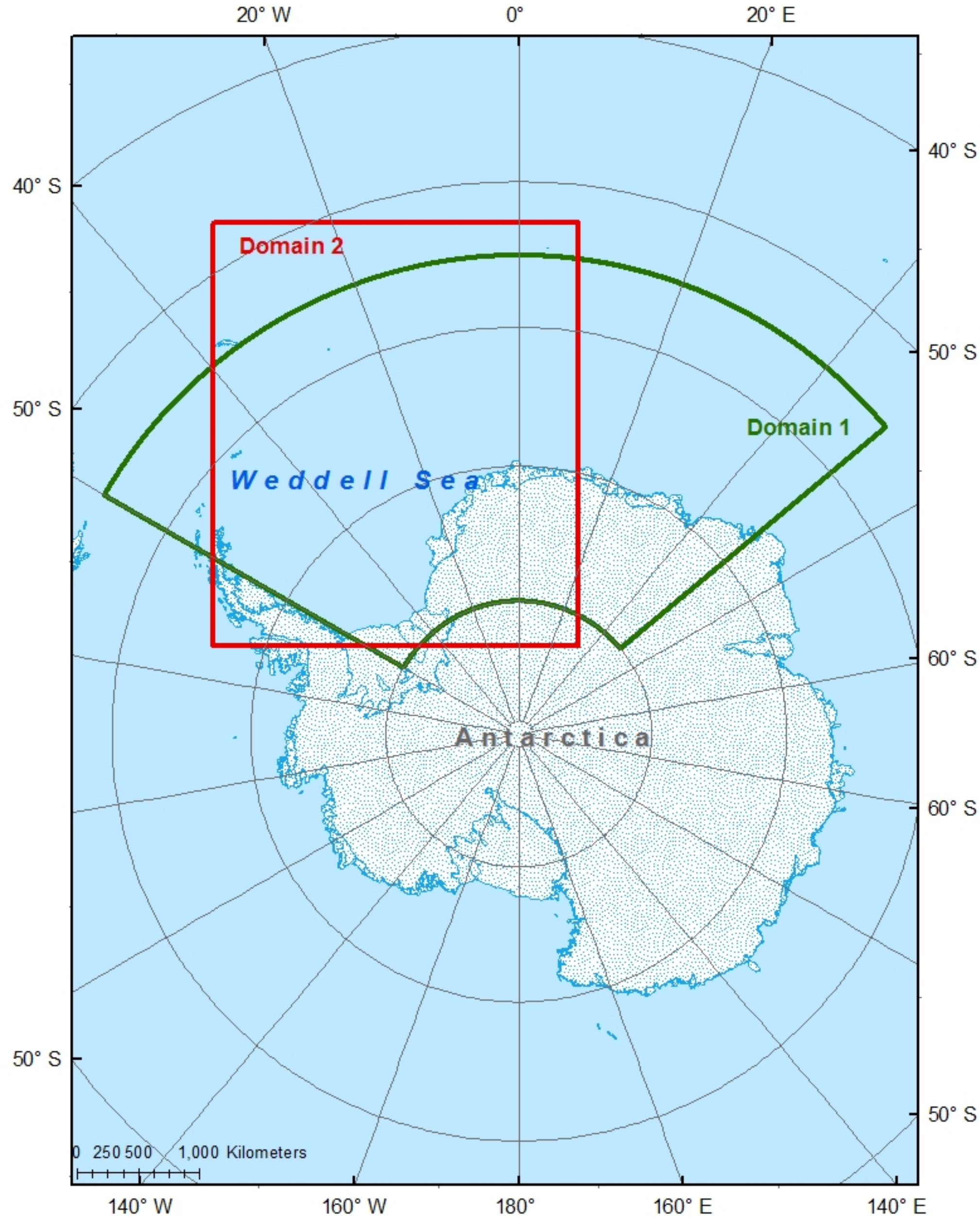


Figure 3.1 Study Areas. There are two study area domains in this research. Domain 1 (green) encompasses the entire Weddell Sea Gyre and is the domain of the storm climatology from 01 January 1979 – 08 August 2014. Domain 2 (red) is the area of the Weddell Sea which retains sea ice year round and is the domain of the ice edge and surface energy balance analysis. The base map of Antarctica includes ice shelves.

3.1 Reanalysis Output

Reanalysis fields are chosen for this study because the length and resolution of the reanalysis record provides a means to examine the characteristics of a large number of storms over time. The European Center for Medium-Range Weather Forecasts (ECMWF) ERA-Interim (ERA is the abbreviation for ECMWF Reanalysis) reanalysis field set is the primary source for atmospheric data in this dissertation. The ERA-Interim reanalysis set has been identified as a dataset suitable for tracking extratropical cyclones (Hodges et al. 2011).

The ERA-Interim is a global atmospheric dataset created with a progressive assimilation scheme. In each data assimilation cycle, available observations are combined with prior model forecasts. The final product gives the state of the atmosphere from the upper-levels to the surface (Dee et al. 2011). ERA-interim data are available for the study area from 01 January 1979 to 31 August 2014. The horizontal resolution of ERA-Interim data is T255 (~79 km) (Dee et al. 2011). The reanalysis fields retrieved from the ECMWF website (http://data-portal.ecmwf.int) are on a regular 0.75° by 0.75° grid and cover the geographic region bounded by -54.75°S to -80.25°S and-60°W to 50.25°E (Figure 3.1, Domain 1). A total of seven ERA-Interim reanalysis fields are used in this dissertation. The field names, units, and temporal resolution are listed in Table 3.1.

Table 3.1 Reanalysis fields

ERA-Interim Field	Units	Temporal Resolution (h)	Time Period (dd/mm/yy)
10 m winds	m s^{-1}	6	01/01/79 – 31/08/14
Sea ice concentration	%	6	01/01/79 – 31/08/14
2 m air temperature	K	6	01/01/79 – 31/08/14
2 m dew point temperature	K	6	01/01/05 – 31/12/09
Mean sea level pressure	Pa	6	01/01/05 – 31/12/09
Surface solar radiation downwards	J m^{-2}	12	01/01/05 – 31/12/09
Surface thermal radiation downwards	J m^{-2}	12	01/01/05 – 31/12/09

The input data for the climatology of polar cyclones (Sections 4.1, 5.1, and 6.1) are the zonal 10 m wind fields, meridional 10 m wind fields and mean sea level pressure fields over Domain 1 (Figure 3.1). Figure 3.2 provides an example of these fields from 09 April 2009. Reanalysis fields of sea ice concentration are also used as part of the polar cyclone analysis. The sea ice concentration field provides a percentage of the sea ice cover in every cell which is used to determine the sea ice extent and area from 01 January 1979 to 31 August 2014. The sum of the area of all cells with any sea ice concentration above zero is calculated to provide the sea ice extent. The sum of the areas of each grid cell multiplied by the concentration of sea ice in each grid cell is the ice area.

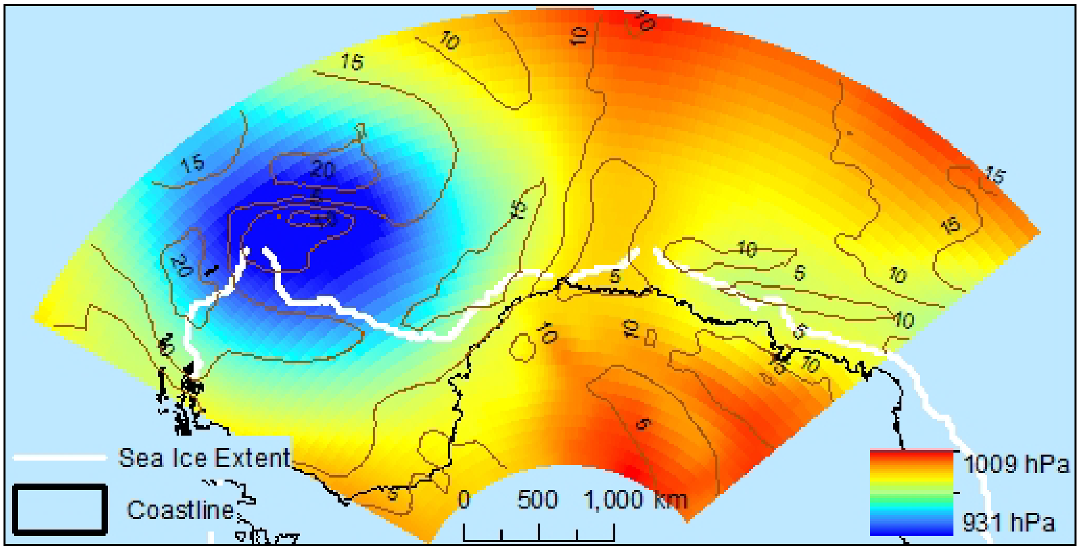


Figure 3.2 Reanalysis fields for 09 April 2005. Wind speed contours (m s^{-1}) calculated from 10 m zonal and meridional (m s^{-1}) components are overlaid on the mean sea level pressure field (hPa). The white line is the sea ice extent and the black line is the coastline of Antarctica including ice shelves.

Because reanalysis fields incorporate different data sources and assimilation methods, efforts have been made to understand whether reanalysis are appropriate inputs for calculating long-term climate trends. Bengtsson et al. (2004) compared several long-term fields from the previous ECMWF reanalysis (ERA-40) with other observational data and models and concluded that ERA-40 reanalysis fields require corrections if they are to be used in studies of long-term climate trends. Specifically, Bengtsson et al. (2004) considered the following trends based on ERA-40 output: temperature, integrated water vapor, and global kinetic energy. They found that the long term temperature trend from 1979 – 2001 reanalysis is artificially high and influenced by the incorporation of additional satellite observations for the last decade of the twentieth century into the reanalysis. The long-term positive trend in integrated water vapor is too high (~0.10 mm per decade higher than the estimated trend), likely due to observation system changes (Bengtsson et al. 2004). Although there is no trend in global kinetic energy from 1958 – 2004, ERA-40 reanalysis indicates a sharp increase in 1979 which coincides with the introduction of global satellite observation systems (Bengtsson et al. 2004). There are generally more available observations in more recent years (Dee and Uppala 2009).

Biases in models and reanalysis can cause changes in climate signals that do not reflect true climate (Dee and Uppala 2009). ERA-Interim is the successor of ERA-40, and both use the same input observations for years up to 2002. ERA-Interim is the first reanalysis to apply a variational bias correction which reduces the artificial shifts and trends in reanalysis (Dee and Uppala 2009). Although ERA-Interim is an improvement over ERA-40, it remains difficult to quantify the uncertainty in the reanalysis output (Dee and National Center for Atmospheric Research Staff 2014).

Although there are improvements in ERA-Interim over ERA-40, there are limitations for using the reanalysis output for climate trends. Because of this, the analysis of the storm climatology produced in this dissertation does not emphasize the changes of the trends over the entire study time period. Rather, the analysis focuses on the relationships of the characteristics within each storm period which are less than two weeks long.

All of the reanalysis fields in Table 3.1 are used in the surface energy balance calculations (Sections 4.3 and 5.3). The surface energy balance calculations are bounded by Domain 2 (Figure 3.1). Additional fields for fractional cloud cover, surface sensible heat flux, and surface latent heat flux were used to validate numbers determined as part of the surface energy balance calculations.

3.2 AMSR-E Satellite Concentration Maps

Both thermodynamic and dynamic processes contribute to the overall sea ice cover in a region. If all sea ice were stationary, it would be possible to calculate the annual cycle of ice growth and decay based on the history of regional air temperature, snowfall, and heat flux. However, ice motion and surface drag introduce stresses which pull ice apart and crush it together creating areas with thick ice and open water. Sea ice concentration describes the percentage of ice coverage in a given area. Areas of open water or low sea ice concentration are particularly important as regions for new ice production. Although long term records of sea ice thickness and ridge data are not available in the Southern Ocean, sea ice concentration data are available through the record of microwave satellite data starting in December 1972 with the Electrically Scanning Microwave Radiometer on Nimbus-5 (Cavalieri et al. 2003). Continuous passive microwave data from satellites are available from November 1978 to present (Parkinson and Cavalieri 2012).

Sea ice concentration from satellites is primarily derived from passive microwave. From November 1978 through August 1987, sea ice cover data were provided by Scanning Multichannel Microwave Radiometer (SSMR), which was succeeded in July 1987 by the Special Scanning Microwave/Imager (SSM/I) (Comiso and Nishio 2008). SSM/I remains the most commonly used source of large scale sea ice concentration data (Comiso and Nishio 2008). Sea ice concentration algorithms use the sea ice cover as input data and derive sea ice concentration based on observed brightness temperatures. The algorithms account for differences in radiances between the Arctic and Antarctic sea ice (Comiso and Nishio 2008).

In this dissertation, long-term sea ice concentration from ERA-Interim reanalysis is used to identify relationships between sea ice concentration and polar storms. Finer resolution sea ice concentration data are required to further understand how the relationship between polar storms and sea ice concentration impact the Weddell Sea surface layer. This research explores these storm relationships by applying a smaller subset of high resolution sea ice concentration data for example days as case studies. The case studies include 40 distinct days over the high extent sea ice period in the Weddell Sea from April through November. The surface energy balance from one day in each month over the years 2005 through 2009 is examined. The days are chosen to represent varying atmospheric conditions and sea ice concentration patterns.

The data chosen for the high resolution sea ice concentration used in the case studies are maps derived from Advanced Microwave Scanning Radiometer-EOS (AMSR-E) (Spreen et al. 2008). AMSR-E (launched in 2002) provides a much finer resolution than SSM/I. The gridded product resolution for AMSR-E sea ice concentration is 6.25 km by 6.25 km. The resolution of gridded standard products for ice concentration is 12.5 km by 12.5 km (Spreen et al. 2008). The finer resolution allows smaller open water areas to be distinguished than when using SSM/I ice concentration. AMSR-E ice concentration is available on a daily basis via the Antarctic Archive maintained by a joint effort among a program of the European Commission called Polar View and of the Arctic Regional Ocean Observing System (Spreen et al. 2008). The sea ice concentration algorithm came out of the Arctic Radiation and Turbulence Interaction STudy (ARTIST), a 1998 field campaign near Svalbard which considered both in situ and satellite data. The algorithm was originally used with the SSM/I, but this study uses the maps created from applications of the ARTIST sea ice (ASI) concentration algorithm to the newer, higher resolutions

AMSR-E (Spreen et al. 2008). An example AMSR-E sea ice concentration map from the earliest case study day, 09 April 2005, is provided (Figure 3.3).

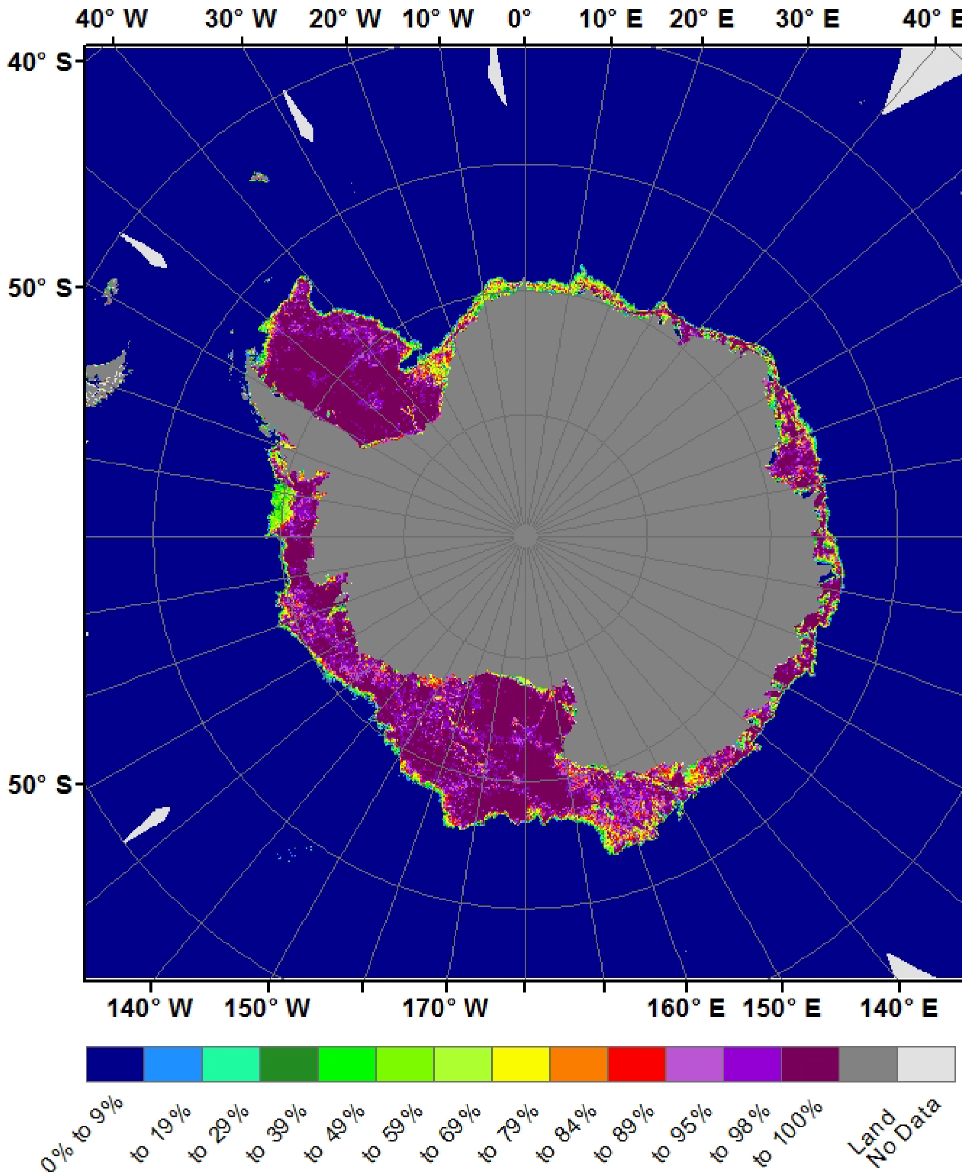


Figure 3.3 AMSR-E ice concentration map (% ice) example from 09 April 2005. The map shows the original format of the sea ice concentration based on the application of the ARTIST sea ice concentration algorithm to AMSR-E data.

Chapter 4

METHODS

This chapter describes the methods for the three sets of analysis. The first section details the process for identifying mesoscale storms in the Weddell Sea and the characteristics of those storms. The second section describes the step-by-step process for determining the ice edge based on sea ice concentration data. The third section explains how sea ice concentration data and the atmospheric conditions from reanalysis output are combined to examine the surface energy balance and the potential for sea ice growth and salt rejection.

4.1 Polar Mesoscale Storm Identification in the Weddell Sea

This section describes the methods for the long-term analysis of Weddell Sea polar cyclones identification and the relationship with sea ice area and extent. To the best of knowledge within the United States at the time of writing this dissertation, no archive of polar cyclones in the Weddell Sea currently exists. This dissertation first identifies and archives polar cyclones in the Weddell Sea (Domain 1, Figure 3.1) from 01 January 1979 to 31 August 2014. A total of six storm characteristics are recorded: storm date, duration, horizontal scale, minimum sea level pressure, maximum wind speed, and integrated kinetic energy. After the storms have been identified and characterized, the relationship with sea ice cover is explored.

High wind speed events in the Weddell Sea must meet certain criteria in order to be identified as a polar mesoscale cyclone of interest. For the purposes of this dissertation, polar mesoscale cyclone must contain a minimum mean sea level pressure below 960 hPa (Bengtsson et al. 2009), sustained winds greater than 15 m s^{-1}

(Carrasco et al. 2003, Ramussen et al. 2003) in the 10 m wind field, diameter smaller than 1000 km in horizontal scale, a cyclonic rotation (clockwise in the Southern Hemisphere), and duration long enough to be captured within the six hour temporal resolution of the reanalysis output.

Polar mesoscale cyclones are identified with an original script written for this research in MATLAB provided in Appendix A. Initially, the script reads the NetCDF files acquired from the ERA-interim data server for zonal 10 m winds, meridional 10 m winds, and the mean sea level pressure. The date field, time field, latitude, and longitude fields, are also read as input. The data are indexed in a 0.75° latitude by 0.75° longitude grid. The wind speeds for each cell are calculated from the *u* and *v* components of the 10 m winds. The *u* component is positive in the direction of west to east wind flow (westerly), and the *v* component is positive in the direction of south to north wind flow (southerly). Wind speed (magnitude), *U*, is calculated from the wind vector components with

$$U = \sqrt{u^2 + v^2}. \tag{4.1}$$

A query (the *find* command) is used to identify the time steps which contain cells which meet the wind speed and pressure criteria for a polar mesoscale cyclone. A new array is created which is the length of the number of time steps identified, and it contains the time index value for all time steps when the criteria are met. For these, another query is used to identify the latitudes and longitudes which meet the criteria for a polar mesoscale cyclone. For this query, for the minimum sea level pressure is relaxed to 975 hPa. Because the new array of time steps only includes storms with a sea level pressure under 960 hPa, the new query finds the range of low sea level pressures, from the minimum in the scene to 975 hPa. This new threshold, which indicates the external edge of the storm, is chosen based on a visual inspection of animations of the winds and sea level pressures of the storms. Winds vectors indicate clear cyclonic motion of the storm until between 970 hPa and 980 hPa. For each time step, the query produces an additional array of the latitudes and longitudes in which the conditions for a polar storm are met.

In addition to identifying if a storm exists at a given time, certain storm characteristics, which will be explained in the following paragraphs, are identified or calculated. These characteristics are the storm duration, the minimum sea level pressure, the maximum wind speed, the integrated kinetic energy, and the horizontal scale of the storm. Several of these characteristics require the area or the diameter of a grid cell. Because the grid cells are based on a geographic grid at varying latitudes, the area of a grid cell at each 0.75° latitude increment is calculated. The area of the cell, Equation 4.2, is based on a standard surface area of a sphere calculation (Santini et al. 2010). In the equation, *S* is the cell surface area, *R* is the average radius of the Earth (6371 km), λ_1 and λ_2 are the lowest and highest longitudes, respectively, in radians, and φ_1 and φ_2 are the lowest and highest latitudes, respectively, in radians.

$$S = R^2(\lambda_2 - \lambda_1)(\sin\varphi_2 - \sin\varphi_1) \quad (4.2)$$

The diameter of a storm, or characteristic called horizontal scale of the storm, is estimated from the area of the storm during each time step. The area of the storm is the sum of all of the surface areas of the cells of the storm. Because the storm area is assumed to be generally circular, the diameter of the storm is estimated based on the geometry of a circle as in Equation 4.3. The storm diameter at a time step, *D* is based on the storm area *A* such that

$$D = 2\sqrt{\frac{A}{\pi}} \quad (4.3)$$

Once a storm is identified in one time period, the grid cells in following periods are checked to see if the storm criteria continue to be met. The final storm characteristics are based on the duration of the storm. Storm duration is the number of time steps for which the criteria are met, multiplied by six hours for the length of each time period. The minimum sea level pressure of the storm is tracked at every time step and recorded. The average of the recorded minimum sea level pressure at each time step for the duration of the storm is the minimum sea level pressure characteristic retained. Similarly, the maximum wind speed of the storm at every time step is tracked for the duration of the storm. The average of the maximum wind speed for every time step is the maximum wind speed characteristic.

At the time of writing this dissertation, integrated kinetic energy is not a commonly used metric to identify the strength of a polar mesoscale storm. However, the integrated kinetic energy (IKE) has been suggested as a way to more accurately identify the destruction potential of tropical cyclones than simply quantifying the maximum wind speed or minimum sea level pressure (Powel and Reinhold 2007, Kozar and Misra 2013). Because the IKE calculation takes into account the size of the storm, the duration of the storm, and the high wind speeds of a storm, it is examined here for the possible relationships between the IKE of Weddell Sea polar storms and sea ice extent and area. IKE is calculated for every storm cell for every time step. The area of the cell is the surface area calculated in Equation 4.2, and the volume is based on a 1 meter depth (based on the convention in Powel and Reinhold 2007) for the domain of the storm. The equation for IKE is the one-half the product of the density of the air (ρ = 1 kg m^{-3}) and square of the 10 m wind speeds (U) during a storm integrated over the volume of the storm at a time step and for all the time steps of the storm.

$$IKE = \iint \frac{1}{2} \rho U^2 dV dt \tag{4.4}$$

An example of the storm identification based on the minimum sea level pressure and maximum wind speed criteria is provided in Figure 4.1. The complete archive of all storms identified between 01 January 1979 and 08 August 2014 and their characteristics is listed in Appendix B.

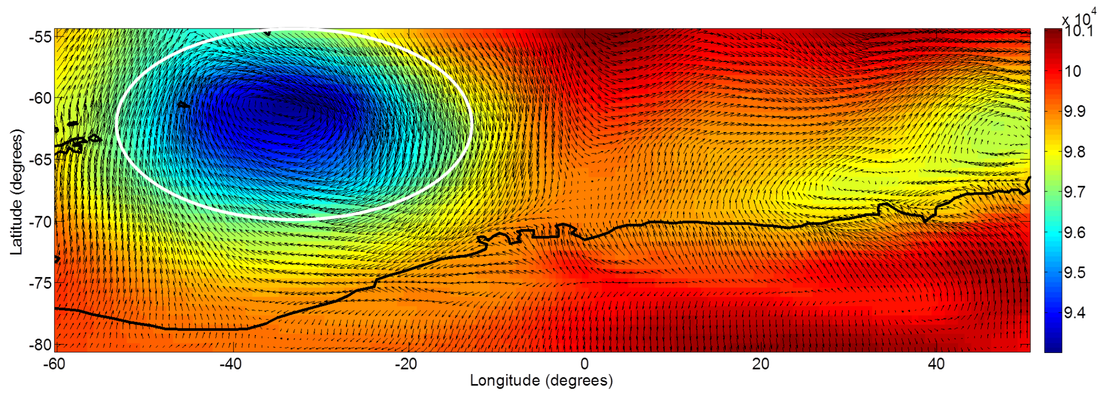


Figure 4.1 Polar low identification in the Weddell Sea. The circled area is a storm identified from ERA-interim reanalysis data as having pressure below 975 hPa with a minimum low pressure below 960 hPa in the center. Wind speeds are greater than 15 m s^{-1} in the circled region. The black line is the Coast of Antarctica.

The sea ice concentration data from reanalysis are read as input separately from the storm identification script. The ice extent is the area of all cells with any sea ice cover. Area of the cell is determined as in Equation 4.2. The sea ice area is the product of the concentration of sea ice in each cell and the cell area. The archived values of the storm date and duration are used to determine the sea ice extent and area on the initial date and time of the storm and the final date and time of the storm. Thus, two additional fields are available to characterize each storm: the change in sea ice extent over the storm and the change in sea ice area over the storm.

4.2 Ice Edge Detection from Sea Ice Concentration Maps

For higher-resolution case studies of the surface energy balance and the relationship to storms, sea ice concentration maps derived from AMSR-E images are used. As detailed in Section 3.2, representative maps are chosen for each of the months in austral autumn through spring (April – November) of 2005 through 2009. For sea ice concentration studies, it is customary to separate zero concentration regions based on whether or not the region is within the ice pack. Open water refers to areas without ice cover within the ice pack, and ice-free refers to the general area of ocean beyond the extent of the polar ice extent. In the AMSR-E sea ice concentration maps, the sea ice concentration is zero whether or not the region is within the ice pack. Because of this, the first step in data processing is to distinguish between the zero concentration area beyond the ice pack and the relevant ice concentration data within the ice pack. This is completed with a five step process using ENVI tools (Figure 4.2). One of the by-products of this method for separating the ice-free area from the open water within the ice pack is that it creates an ice edge product as an additional vector shapefile (line layer). This section describes how to separate ice-free areas from the ice pack and how to get the edge detection file in the process.

Ice concentration maps of the Southern Ocean obtained as geotiff files (Figure 3.3) from the AMSR-E with ARTIST Algorithim Sea Ice (ASI) concentration algorithm archive from the University of Bremen (Spreen et al. 2008). These files are constrained to the Weddell Sea Domain 2 (Figure 3.1) through a spatial subset command which limits the pixels to the area.

The first step to remove the pixels with zero concentration is to apply band math to the subset of the sea ice concentration image and use band math to reclassify pixels in the image to a value of either zero or one. A zero pixel value means the pixel contains no ice. A value of one means the pixel contains at least some ice. Then, the zero and one image is used as input for an ENVI classification tree operation. The classification tree is set to two classes and the number of endmembers is increased until all open water pixels within ice covered areas disappear. Increasing the number of endmembers effectively removes open water patches within the ice pack. The number of endmembers required to remove open water patches varies between 15 for images with no large open water features to 200 for images with polynyas and large leads. Increasing the number of endmembers does not affect the ice-free area, because the ice fee area consists of several hundreds of contiguous pixels at all times. The re-classified image is saved as a shapefile and the class vectors (polygon layer) are exported. The class vectors are then converted to regions of interest in ENVI. The regions of interest are saved to become the ice edge vectors. The region of interest file represents either the ice-free area or the area within the ice pack. The ice-free area is used as a mask on the AMSR-E sea ice concentration subset image from the first step. The ice-free area is given a no data value, and the sea ice within the ice pack is re-classified to sea ice concentration values between zero and 10.

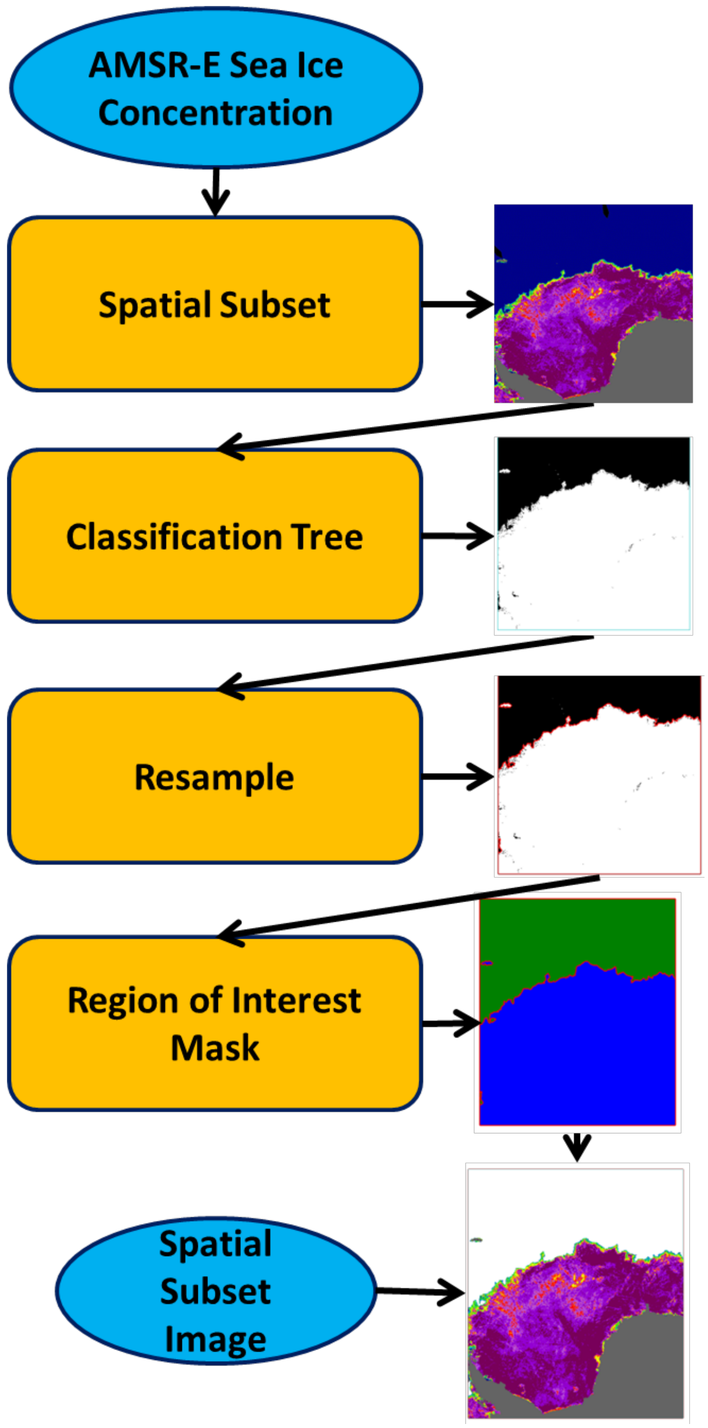


Figure 4.2 The steps to separate the ice-free area beyond the ice pack from the open water pixels within the ice pack.

4.3 The Surface Energy Budget, Sea Ice Growth Rate and Salt Rejection

The surface energy budget, sea ice growth rate, and salt rejection over the periods of ice growth from 2005 through 2009 are calculated based on the information in the ice concentration maps from AMSR-E data and reanalysis. The days for which the surface energy balance is calculated match dates for which the ice edge detection algorithm is demonstrated. The dates are chosen from the middle of the month unless the concentration image is not clear (Table 4.1). Because the reanalysis information is stored as NetCDF files, some data preparation is necessary in order to combine the information.

The NetCDF files are formatted with a Python and ArcGIS geoprocessing script. The script follows the basic model of Figure 4.3 and it is reproduced in Appendix A. For each reanalysis field, the NetCDF file for the field is the input. The ArcGIS tool to create raster layers from NetCDF data is applied. For the tool, the x and y dimensions are the longitude and latitude dimensions, respectively. The variable is the ECMWF field name, and the value for each raster is the date and time. The date and time are chosen by looping through a vector of the 40 dates which coincide with the ice concentration maps from 2005 through 2009. All 40 dates are listed in Table 4.1. Where coincident storms occur, storm characteristics are listed. The new raster created from the original NetCDF file is then re-projected to South Pole polar stereographic (conformal and angle preserving projection) to match the ice concentration maps. The re-projected raster is re-sampled and clipped to match the size and location of the ice concentration map grid cells. The result of the Python geoprocessing script is a set of 40 tiff files for each of the reanalysis fields listed in Table 3, each associated with the date of an ice concentration map.

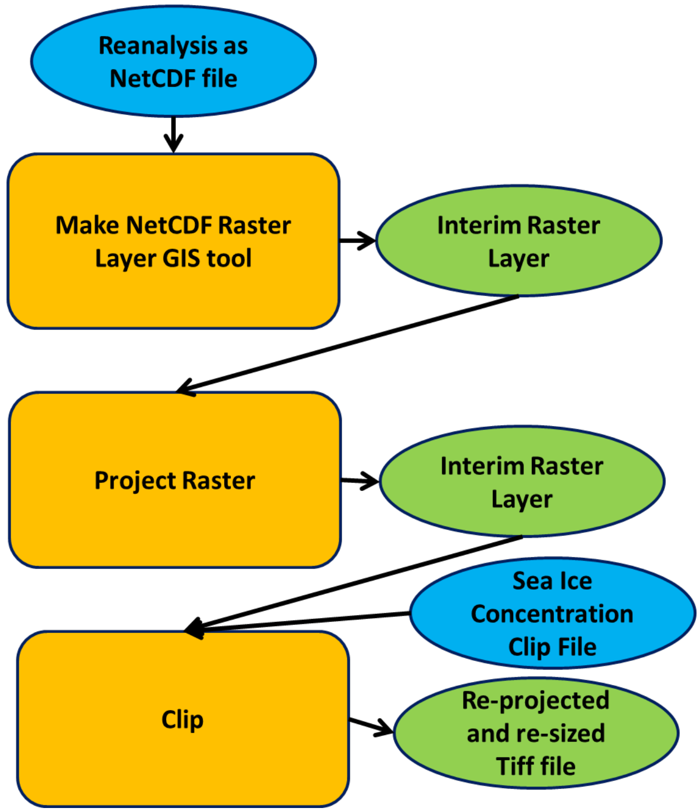


Figure 4.3 Schematic flowchart to transform NetCDF reanalysis fields to raster images in tiff file format using Python scripting and ArcGIS geoprocessing tools.

Table 4.1 40 Sea Ice Concentration Maps for Case Studies and Coincident Storms

Year	Month	Day	Coincident Storm Duration (h)	Coincident Storm IKE (J s)	Coincident Storm Scale (m)
2005	**April**	**9**	66	20364.54	910811.07
	May	**15**	30	5222.13	807474.91
	June	15			
	July	15			
	August	**15**	42	7440.71	855548.68
	September	15			
	October	15			
	November	**15**	12	577.41	744471.36
2006	**April**	**15**	30	4298.50	857666.92
	May	**15**	72	21141.75	734666.05
	June	15			
	July	**15**	144	82971.07	881836.17
	August	**15**	66	20600.44	834544.94
	September	15			
	October	15			
	November	**14**	66	17664.85	75884.09
2007	April	15			
	May	15			
	June	15			
	July	15			
	August	15			
	September	15			
	October	**15**	48	10802.94	643170.32
	November	**15**	30	1278.22	465820.43
2008	April	15			
	May	**15**	78	25025.58	832620.61
	June	15			
	July	15			
	August	**15**	132	72175.03	890591.05
	September	15			
	October	14			
	November	15			
2009	**April**	**15**	24	2662.58	844278.44
	May	15			
	June	**15**	72	21184.69	800457.34
	July	15			
	August	**15**	24	2737.19	718307.8
	September	15			
	October	**15**	6	2380.99	717397.31
	November	15			

*Bold dates coincide with storms

A script written in MATLAB is used to calculate the surface energy budget, the sea ice growth rate, and the sea ice salt production over areas of open water within the ice pack. The script is re-produced in Appendix A. For each day, the script reads the formatted ice concentration map with separate open water and ice-free areas. The script also reads the raster Tiff files formatted from reanalysis as described in section 4.3. The Tiff files include reanalysis fields for 10 meter winds, two meter air and dew point temperatures, mean sea level pressure, surface downward solar radiation, and surface thermal solar radiation. A mask is created for each time period to remove land, the ice-free area, and any areas missing data.

Specific atmospheric conditions influence the potential sea ice growth rate and the salt rejected from freezing ice (Geiger and Drinkwater 2005 and Markus et al. 1998). To test this, the energy balance at the air-sea interface over open water within the ice pack is calculated. The sea ice growth rate is estimated as the total heat flux divided by the product of the density of sea ice (estimated as (950 kg m^{-3}) and the latent heat of fusion (3.34x105 J kg^{-1}). Based on the sea ice growth rate, the total salt contribution is estimated as the product of the following terms: the density of the ice, the growth rate, the change in temperature, the area over which the growth rate applies, and the difference of the salinity of the water and the salinity of the ice (Geiger and Drinkwater 2005 and Markus et al. 1998).

Table 4.2 Variable Descriptions for Energy Balance Equations

Variable	Description	Units
H_i	Heat gained or lost at the air/sea interface	W m^{-2}
H_s	Sensible heat flux	W m^{-2}
H_l	Latent heat flux	W m^{-2}
Q_{ld}	Incoming longwave radiation	W m^{-2}
Q_{lu}	Outgoing longwave radiation (blackbody)	W m^{-2}
Q_s	Incoming Shortwave radiation in W m^{-2}	W m^{-2}
F_w	Ocean heat flux (7)***	W m^{-2}
F_{ri}	Radiation trapped or absorbed in ice (0)***	W m^{-2}
G_i	Rate of ice growth thickness (Geiger and Drinkwater 2005)	m s^{-1}
ρ_i	Density of the ice (~950)***	kg m^{-3}
α_w	Albedo of water (0.08) **	-
c_p	Specific heat of dry air (1004)	J $kg^{-1}K^{-1}$
C_H	Transfer coefficient for sensible heat (0.00175)*	-
C_E	Transfer coefficient for latent heat (0.00175)*	-
V_a	Wind speed	m s^{-1}
ε_w	Emissivity of water (0.98)**	-
σ	Stefan Boltzmann constant ($5.67\text{x}10^{-8}$)**	$Wm^{-2}K^{-4}$
ρ_a	Density of the air (1.3163)	kg m^{-3}
L	Latent heat of evaporation ($2.5\text{x}10^{6}$)*	J kg^{-1}
S_f	Amount of salt released	kg
t	Time	s
A	Area of open water	m^2
s_w	Salinity of the water column	ppt
s_i	Salinity of the sea ice such that ~$s_i = s_w(.31)$***	ppt
q_a	Specific humidity at 10m	g kg^{-1}
q_s	Specific humidity at the surface	g kg^{-1}
D_{bb}	Stephan-Boltzmann constant times surface emissivity	$Wm^{-2}K^{-4}$
p	Pressure	Pa
e	Vapor pressure	mb
e_s	Saturation vapor pressure	mb
ϵ	The ratio of the molecular weight of water to dry air	-
T_a	Air temperature	K
T_w	Water temperature	K
T_i	Ice temperature	K
	*constant based on Parkinson and Washington 1979 **constant based on Markus et al. 1998 *** constant based on Geiger and Drinkwater 2005	

The variables for the equations in this section are defined in Table 4. Geiger and Drinkwater (2005) clarify the surface energy balance described by Markus et al.

(1998). The amount of heat gained or lost at the air-sea interface is calculated as the sum of several inputs (Parkinson and Washington 1979, Markus et al. 1998, Geiger and Drinkwater 2005), such that

$$H_i = H_s + H_l + Q_{ld} - Q_{lu} + (1 - \alpha_w)Q_s + F_w + F_{ri} \tag{4.5}$$

The sensible heat, H_s, is estimated from the standard bulk formula as in Parkinson and Washington (1979).

$$H_s = \rho_a c_p C_H \left|\overrightarrow{V_a}\right| (T_a - T_w) \tag{4.6}$$

Although the bulk transfer coefficient included in the bulk sensible heat coefficient term does vary with wind speed, here the bulk transfer coefficient is assumed to be 2.28 $Jm^{-3}K^{-1}$. The wind speed, V_a, is the square root of the sum of the squares of the zonal and meridional components of the 10 meter wind. The air temperature is based on the reanalysis field for two meter air temperature, and the water temperature is assumed to be near the freezing point of sea water or 271.1 K.

The latent heat, H_l, is also calculated based on bulk formula (Parkinson and Washington 1979).

$$H_l = \rho_a L C_E \left|\overrightarrow{V_a}\right| (q_a[T_a] - q_i[T_i]) \tag{4.7}$$

Sensible heat and latent heat are calculated rather than input from reanalysis because the water temperature and sea ice temperature are set constant for this research. The reanalysis fields take into account additional variables.

The specific humidity at 10m is given by the following.

$$q_a = \frac{\epsilon e}{p - (1 - \epsilon)e} \tag{4.8}$$

The specific humidity at the surface formula is the same as the specific humidity at 10 m except the vapor pressure, e, is replaced by the saturation vapor pressure, e_s. The saturation vapor pressure formula is

$$e_s = 611 * 10^{7.5(T_d-273)/(237.16+(T_d-273))} \tag{4.9}$$

For the vapor pressure, the formula uses air temperature instead of dew point temperature. The next term in the surface energy flux equation is Q_l, the downward longwave radiation term. The surface thermal radiation downwards field from ERA-Interim reanalysis is used for downward longwave radiation after it is converted from units J m^{-2} to Wm^{-2}. The longwave radiation emitted outward at the surface is approximated as in Markus et al. (1998) by the Stefan Boltzmann law.

$$Q_{lu} = \sigma \varepsilon_w T_w^4 \tag{4.10}$$

The surface solar radiation downwards field from ECMWF-Interim reanalysis accounts for the cloud cover. The net solar radiation must also account for albedo. Because these calculations only consider open water, the albedo used is the albedo of water, 0.08, as Markus et al. (1998) reports based on Maykut (1986).

Because the calculations are over open water, the radiation trapped in the ice, F_{ri}, is set to zero. The oceanic heat flux, F_w, is set to 7 Wm^{-2} based on Geiger and Drinkwater (2005).

After the surface energy budget terms are combined, where H_i is positive, the downward fluxes are positive, and the surface is warming. To look at where ice may form, the next formulas for sea ice growth rate and salt production are constrained to where the downward surface heat flux is negative and the surface is cooling.

The growth rate in m s^{-1} is calculated where the surface heat flux is negative with the following relationship as expressed in Geiger and Drinkwater (2005).

$$G_i = \frac{-H_i}{\rho_i L_f} \tag{4.11}$$

The growth rate in sea ice volume per day is found by multiplying the growth rate by the seconds in a day and the area of each cell with ice growth. The potential salt production due to sea ice formation is then calculated based on Geiger and Drinkwater (2005) and the previous growth rate calculation.

$$S_f = \rho_i G_i \Delta t A(s_w - s_i) \tag{4.11}$$

4.4 Chapter 4 Summary

Chapter 4 outlined the methods required to address the research questions in the thesis. The storm identification script for identifying polar cyclones in the Weddell Sea based on reanalysis fields is an original tool designed for this research. The storms identified and the corresponding sea ice conditions are analyzed in Section 5.1. The ice edge detection algorithm is another original tool designed for this research. The method is used to limit the domain of the surface energy balance, sea ice growth rate, and salt rejection calculations. The use of high resolution AMSR-E sea ice concentration data for energy balance calculations over the time period is new for this dissertation.

Chapter 5

RESULTS

This chapter describes the results of the three method's sections. The first set of results identifies the mesoscale polar storm climatology for the Weddell Sea from 01 January 1979 – 31 August 2014. The storm characteristics defined in Section 4.1 are recorded in Appendix B. The relationships of the characteristics are described in Section 5.1. The second section provides the interannual variability of the ice edge in the high sea ice extent months between 2005 and 2009. The final section shows the surface energy balance, the sea ice growth rate, and the resulting salt rejection rate in the Weddell Sea for the same time period as the second section.

5.1 Mesoscale Storm Analysis: 1979 – 2014

Based on the methods listed in Section 4.1, 2,540 distinct storms are discernable based on the reanalysis output from 01 January 1979 – 31 August 2014. The storms are more likely to occur in April – November (Austral autumn and winter). Table 5.1 provides the mean of the characteristics from 1979 – 2013. The first column is the percentage of the number of storms which occur in each month. Bold values are where the percentage of storms in a month are high. Because the distribution is based on twelve months in the year, high values are those greater than one-twelfth of the total number of storms (greater than 8.3%). High storm duration (over 36 hours), low minimum sea level pressure (under 948 hPa), high IKE (over 9663 J s), and large horizontal scale (over 700 km) are listed in the table in bold.

Table 5.1 Mean of Storm Characteristics by Month (1979 – 2013)

	Frequency (%)	Duration (h)	SLP (hPa)	Wind (m s-1)	IKE (J s)	Scale (m)
January	4.76	21.08	951.69	22.86	2797	634240
February	6.22	23.97	950.13	24.11	3540	677660
March	7.83	30.62	949.16	23.96	6377	**704940**
April	**9.88**	33.07	948.40	24.74	7617	**732080**
May	**9.06**	**38.16**	**946.40**	**25.29**	**9663**	**728300**
June	**8.35**	**39.85**	**946.45**	**26.31**	**11400**	**728690**
July	**9.76**	**42.86**	**945.33**	**26.60**	**14614**	**723950**
August	**11.38**	**40.93**	**945.76**	**26.34**	**12288**	**703890**
September	**9.02**	**42.26**	**944.58**	**26.36**	**12254**	699990
October	**9.76**	**38.03**	**946.28**	24.74	**10632**	**703460**
November	**8.35**	32.10	948.42	**25.10**	7362	694120
December	5.63	27.08	**922.61**	23.35	4515	644850

Statistics of storm characteristics for the entire storm period are provided in Table 5.2. The storm characteristics are the storm duration in hours, the minimum sea level pressure for a storm (the average minimum sea level pressure for all of the time periods associated with the storm), the maximum wind speed (the average maximum wind speed for all time periods associated with the storm), the IKE, and the mean horizontal scale of the storms. The high end of the mean sea level pressure range is affected by the criteria for the storm identification, so it must fall under 960 hPa. As with the minimum sea level pressure, the range of maximum wind speeds is affected by the criteria for a storm because the wind speed must be higher than 15 m s^{-1}. Where annual or seasonal averages are reported, the time frame for averaged data is 01 January 1979 – 31 December 2013 because ECMWF-ERA interim reanalysis fields were not available through all of 2014 at the time of writing this dissertation.

Table 5.2 Storm Characteristic Mean, Standard Deviation and Range

	Mean	STD	Minimum	Maximum
Duration (h)	34.38	28.75	6.00	282.00
SLP (hPa)	947.54	7.60	916.30	959.86
IKE (J s)	8663.38	17819.62	114.59	338205.38
Wind (m s^{-1})	25.10	4.11	15.59	45.54
Scale (km)	701.34	157.01	62.16	970.30

The correlation matrices and P-value matrix for 95% confidence for the seasonal storm characteristics suggest that all of the characteristics may be correlated with the ice extent and the ice area as well as with each other (Table 5.3). The correlation value identifies whether or not two variables are associated. The Pearson's linear correlation coefficient value, between -1 and 1, expresses the strength and direction of the covariance of the variables. The P-value is the probability that the correlation is significantly (95% significance) different from zero. Values less than 0.05 indicate that the correlation coefficient is significant. The mean sea level pressure is negatively correlated with all of the other variables because a lower sea level pressure is associated with a stronger storm. All other variable correlations are positive. IKE is calculated from the duration and wind speed variables, so it is not independent from the other variables. However, there is a stronger correlation between IKE and the mean sea level pressure than between IKE and the wind speed. The ice area and the ice extent are positively correlated with all storm characteristics except storm scale. All variables – storm characteristics and sea ice cover – are included in the correlation matrix. However, the storm characteristics are calculated from the same reanalysis fields. Therefore they are not independent variables, and the relationship among the storm characteristics will not be considered in the analysis.

Only the relationships between each characteristic and the sea ice cover are examined further.

Table 5.3 Storm Characteristic and Sea Ice Correlation

Pearson's linear correlation coefficient

	Frequency	Duration	SLP	Wind	IKE	Scale	Ice Extent	Ice Area
Frequency	1							
Duration	**0.3240**	1						
SLP	**-0.3955**	**-0.8849**	1					
Wind	**0.3104**	**0.7398**	**-0.7161**	1				
IKE	**0.3177**	**0.9252**	**-0.7882**	**0.6789**	1			
Scale	**0.2870**	**0.5574**	**-0.5749**	**0.5721**	**0.4043**	1		
Ice Extent	**0.4445**	**0.4707**	**-0.5344**	**0.4853**	**0.4889**	0.1016	1	
Ice Area	**0.4992**	**0.5054**	**-0.5618**	**0.5240**	**0.5166**	0.1272	**0.9852**	1

P-value

	Frequency	Duration	SLP	Wind	IKE	Scale	Ice Extent	Ice Area
Frequency	1							
Duration	**0.0001**	1						
SLP	**0**	**0**	1					
Wind	**0.0002**	**0**	**0**	1				
IKE	**0.0001**	**0**	**0**	**0**	1			
Scale	**0.0006**	**0**	**0**	**0**	**0**	1		
Ice Extent	**0**	**0**	**0**	**0**	**0**	0.2322	1	
Ice Area	**0**	**0**	**0**	**0**	**0**	0.1342	**0**	1

To account for the differences in the units of measure for the storm characteristic and ice cover, the seasonal anomalies of the storm characteristics and ice extents and areas are normalized to fall between 0 and 1. The normalization is completed as in the following equation, where *Data* is the original data and subscripts denote the maximum of the field, minimum of the field and the normalized field.

$$Data_{Norm} = \frac{Data - Data_{Min}}{Data_{Max} - Data_{Min}} \tag{5.1}$$

The correlations and corresponding significance of the normalized anomalies (based on 1979 – 2013) provides a better understanding of the relationships of the variables than the correlation of the variables alone (Table 5.4).

Table 5.4 Storm Characteristics and Sea ice Cover: Normalized Anomalies

Pearson's linear correlation coefficient

	Frequency	Duration	SLP	Wind	IKE	Scale	Ice Extent	Ice Area
Frequency	1							
Duration	**-0.274**	1						
SLP	0.15	**-0.788**	1					
Wind	**-0.256**	**0.523**	**-0.485**	1				
IKE	**-0.237**	**0.87**	**-0.618**	**0.395**	1			
Scale	-0.067	**0.44**	**-0.493**	**0.507**	**0.235**	1		
Ice Extent	0.091	-0.092	0.01	-0.07	-0.082	-0.03	1	
Ice Area	**0.179**	**-0.169**	0.107	-0.061	**-0.174**	**-0.167**	**0.681**	1

P-value

	Frequency	Duration	SLP	Wind	IKE	Scale	Ice Extent	Ice Area
Frequency	1							
Duration	**0.001**	1						
SLP	0.078	**0**	1					
Wind	**0.002**	**0**	**0**	1				
IKE	**0.005**	**0**	**0**	**0**	1			
Scale	0.435	**0**	**0**	**0**	**0.005**	1		
Ice Extent	0.286	0.279	0.905	0.413	0.338	0.724	1	
Ice Area	**0.034**	**0.047**	0.21	0.472	**0.04**	**0.049**	**0**	1

The significant correlations among the anomalies of the storm characteristics and the sea ice cover are all linked to the sea ice area, not the extent. In particular, the sea ice area seasonal anomalies are significantly, but weakly, correlated with the mean frequency of the storms per season, the mean duration of the storms per season, and the mean IKE of the storms. This suggests the mean anomaly of ice area increases with anomalously high numbers of storms, and the mean anomaly of ice area decreases with anomalously high storm durations and wind speeds. The seasonal anomaly of the mean of ice area is positively correlated with storm duration and wind speeds, so the slopes of the changes in the ice area, duration, and wind speeds tend to be either positive or negative at the same time. Because the correlations are weak, the relationship of sea ice area and storms is further explored with the Figures 5.1.1 – 5.1.4.

The correlation coefficient matrix in Table 5.4 provides the relationship between sea ice area and storms on a seasonal basis. To explore the relationship of ice to IKE further, the change in storm area over the duration of a storm is determined. This is the difference of the area of sea ice at the last time of a storm relative to the area of ice at the beginning of a storm. A negative change in ice area means the storm period is associated with a decrease in ice area and an increase in open water fraction. A positive change in ice area means a specific storm is associated with decrease in open water fraction. The IKE of the storm and the change in open water fraction during a storm, for all 2,540 storms in the time period, is presented in Figure 5.1.1 a. Figure 5.1.1 b provides the absolute value of the change in ice area and IKE of a storm for all storms.

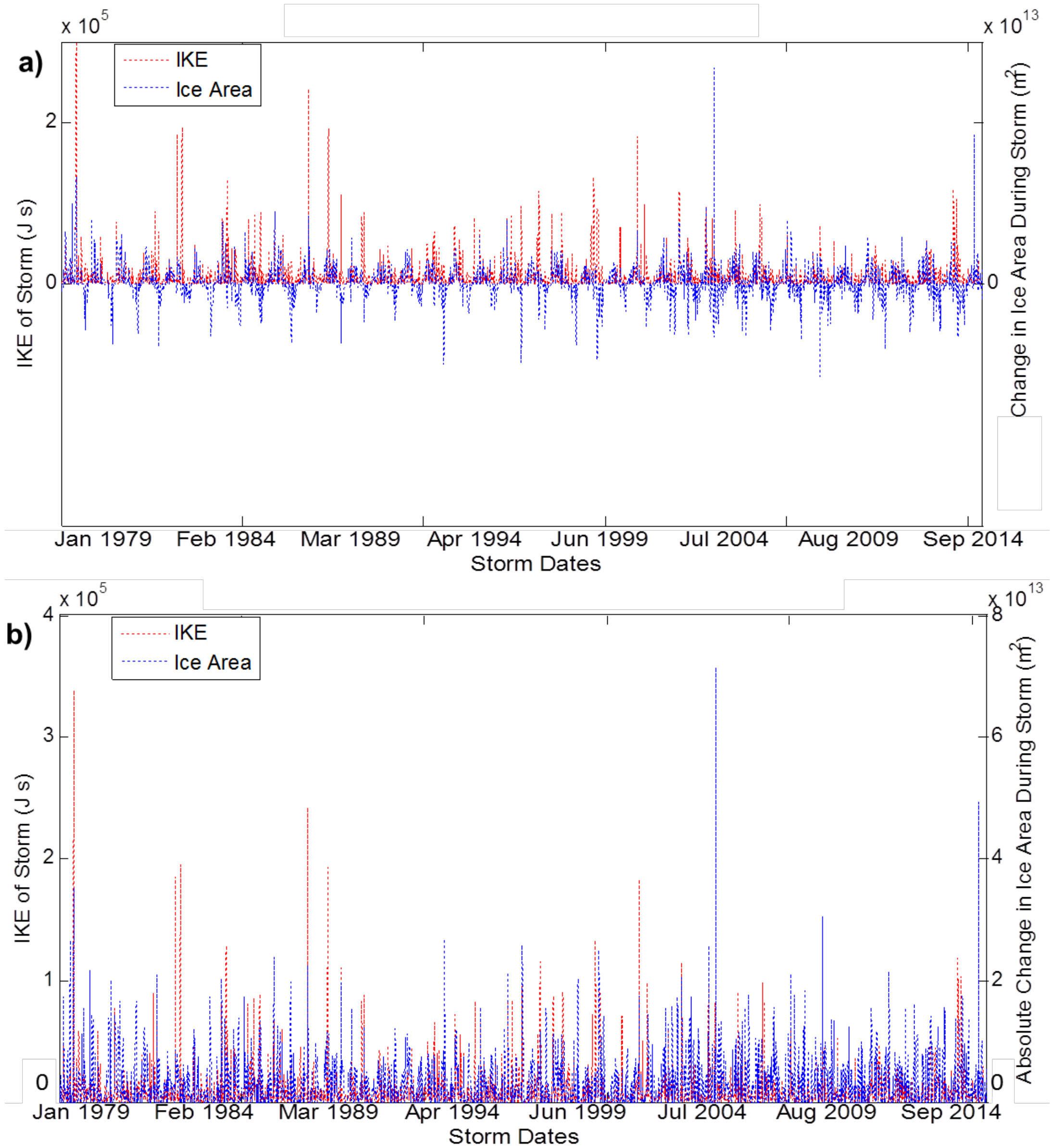


Figure 5.1 Mean IKE (J s) of each storm and the change in ice area (m^2) over the duration of the storm. a) Mean IKE and the positive and negative changes in sea ice area over the duration of a storm. b) Mean IKE and absolute value of the change in sea ice area during a storm.

From Figure 5.1, it appears the relationship between IKE and sea ice area change over a storm is strongest over extreme events, when the IKE is high. To test this, the IKE per storm is divided into quartiles. Additionally, the 90% quantile of IKE is separated to examine only the strongest storm events. Figure 5.2 shows the correlation between the lowest quartile of IKE and associated sea ice changes (a), the correlation between the interquartile range of IKE and associated sea ice changes (b), and the highest quartile of IKE and associated sea ice changes. The 75% quartile includes values of IKE over 9,697 J s. Figure 5.3, d shows the 90% (over 2.0035 J s) quantile of IKE and associated changes in sea ice area. The changes in ice area shown in Figure 5.2 all consider the absolute value of the change in sea ice area. For these plots, all data are normalized from zero to one as in Equation 5.1. The only exception is the change in sea ice values in Figure 5.4 c and d represent negative values, so the normalization for those values was scaled to between negative one and zero.

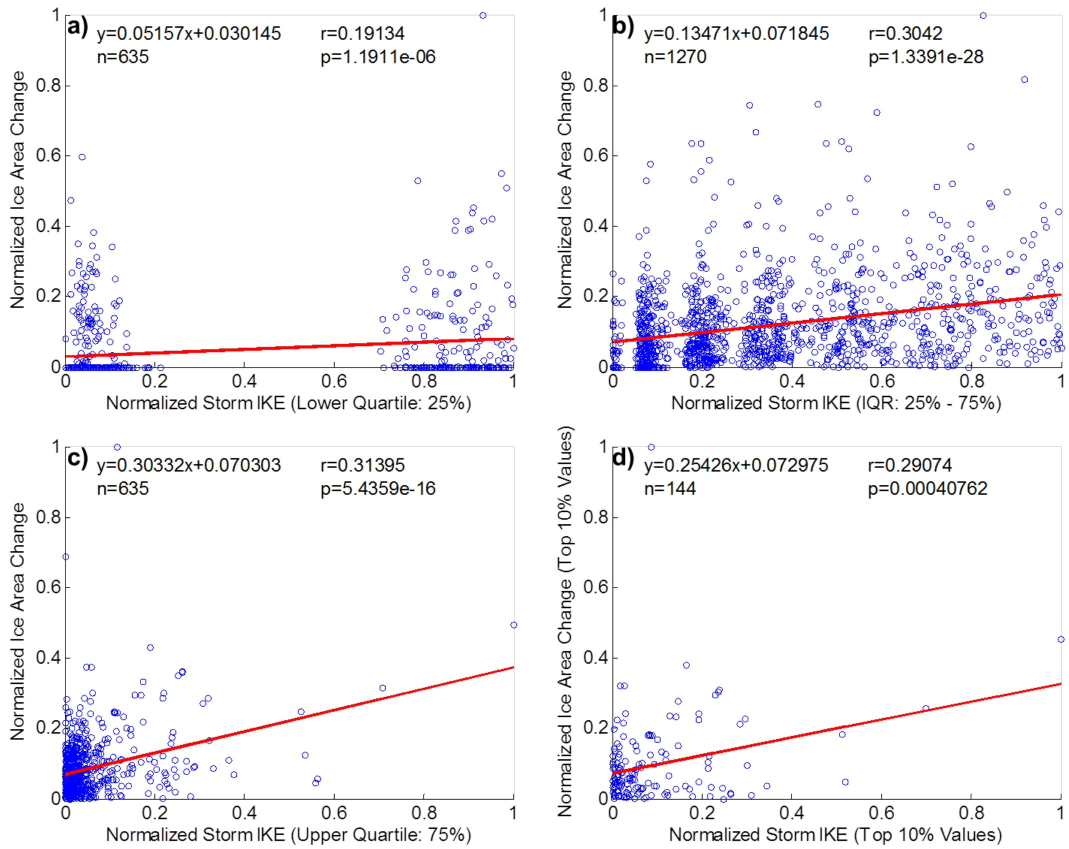


Figure 5.2 Scatterplots of IKE and change in ice area per storm. The lower quartile of storm IKE is plotted in a) with the associated change in sea ice area during a storm. The equation of the best fit line (red) is provided. The number of samples in the quartile, n, the correlation, r, and the P-value, p, are listed. P-values of less than 0.05 are considered significant. b) same as a) for the interquartile range of the storm IKE. c) same as a) and b) for the upper quartile. Data plotted in d) are in the 90% quantile for both storms and change in sea ice area. Values on d) are the same as in a), b), and c).

There are many instances where only small or no changes in sea ice area occur. Figures 5.3 and 5.4 contain subsets of data which eliminate storms associated with no change in sea ice area. The change in sea ice area can either be positive or negative. To remove the smoothing associated with positive values with positive and negative values, absolute value of the sea ice area change is compared to the actual change in sea ice area. Correlations among sea ice area and IKE with combinations including or removing zero ice values and using absolute value of the sea ice change or all changes as recorded are displayed in Figure 5.3.

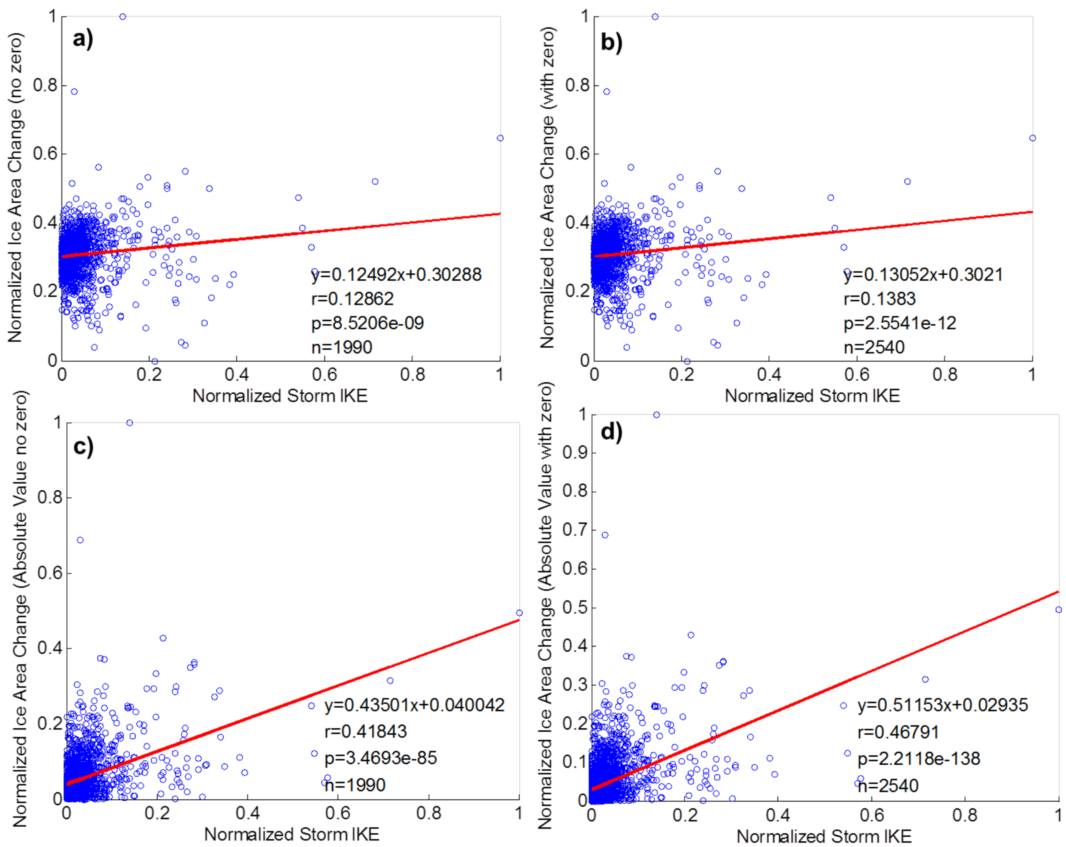


Figure 5.3 Scatterplots of IKE and change in ice area per storm. All changes in sea ice area during a storm that are positive or negative changes (no zero) are plotted with the IKE of the same storm in a). The equation of the best fit line (red) is provided. The number of storms plotted, n, the correlation, r, and the P-value, p, are written in the plot. b) same as a) for all storms including those associated with no change in sea ice area. c) same as a) for the absolute value of the change in sea ice area over a storm with no zeros included. d) same as b) for the absolute value of the change in sea ice area over the storm including zero change storms.

The extreme IKE events appear to be associated with a positive increase in sea ice area and a decrease in sea ice area. High wind speeds associated with storm events can either lead to ice convergence or ice divergence. Therefore it is possible for IKE to be associated with both positive and negative changes in ice area. To test this, the correlation between IKE and changes in sea ice area are examined by separating the events into storms associated with a positive change in area (either with or without zero values) and storm associated with a negative change in area (either with or without zero values. The results are displayed in Figure 5.4.   There is a significant, positive (negative) correlation between IKE and positive (negative) changes in sea ice area.

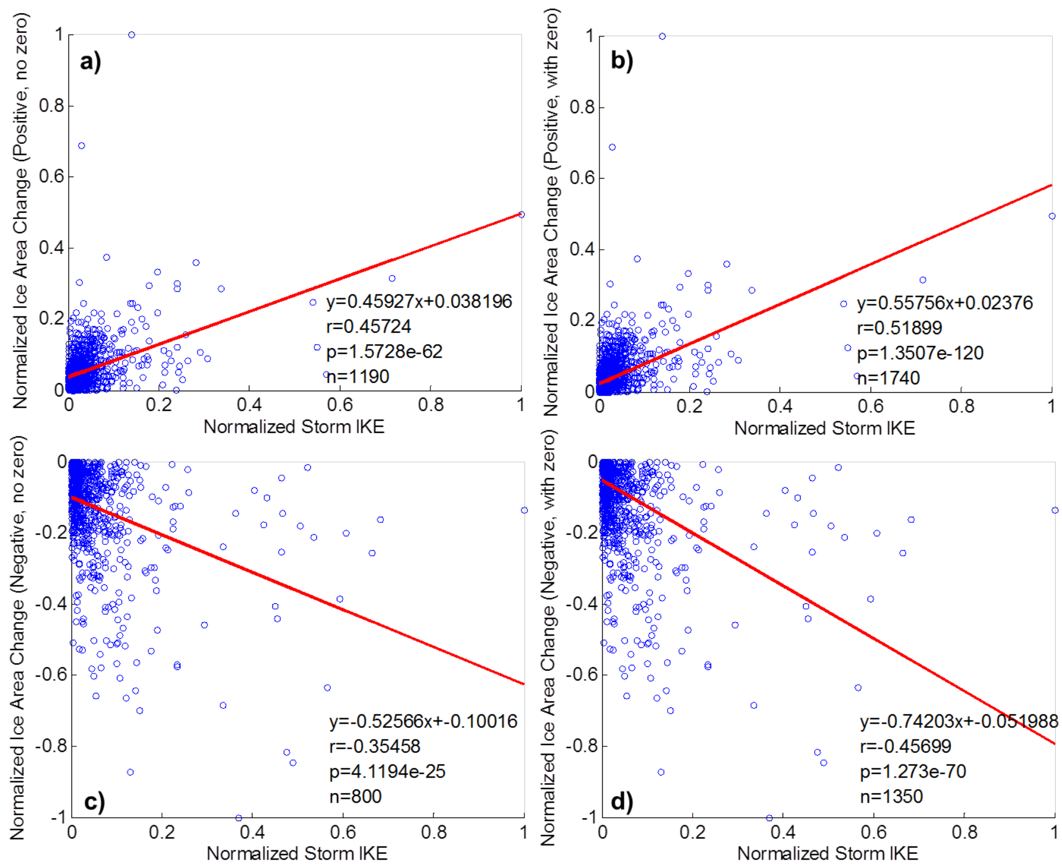


Figure 5.4 Scatterplots of IKE and change in ice area per storm. Positive changes (no zero) are plotted with the IKE of the same storm in a). The equation of the best fit line (red) is provided. The number of storms plotted, n, the correlation, r, and the P-value, p, are written in the plot. b) same as a) for storms associated with an increase in sea ice area or no change in sea ice area. c) same as a) only negative changes in sea ice area over a storm with no zeros included. d) same as b) for only negative changes or no change in sea ice area over the storm.

5.2 Ice Edge Detection from Sea Ice Concentration

The ice detection results display the shapefiles created from the separation of zero concentration pixels in the AMSR-E sea ice concentration files. The zero concentration pixels are masked and reclassified according to whether they are zero concentration pixels within the ice pack or zero concentration pixels outside of the ice pack (Section 4.2). The reclassification scheme is used to create maps of the ice edge for Domain 1 (Figure 3.1).

The ice edges for the month of April vary the most of all the months within 2005 through 2009 (Figure 5.5). In April 2005, the ice edge expands just north of 55°S at 40°W, but as far south as 73.5°S near 30°W. With this high latitude range, April 2005 has the most southern ice edge as well as nearly 11(with the exception of 2008 April) the most northern ice edge during the five years. The ice edge for the year 2006 also has a northern point of the ice edge in the western Weddell Sea and a southern tip to the east. There is less variability in the northern latitude of the ice edge in 2008 and 2009. The latitudes of the ice edge in 2007 are between the latitudes of the ice edge in the preceding and following years. The shape difference suggests a different predominant circulation pattern in 2005 and 2006 which changed before the start of the new sea ice growth season in 2008.

In May (Figure 5.6), the ice edge expands in response to the start of the sea ice growth season. The total ice extent is the lowest in 2006 for May. In May, differences between the low ice extents for 2005, 2006, and 2007 and the higher extents for 2008 and 2009 are lower than the differences for the same years in April. By June (Figure 5.7), the ice extends to between 77°S and 62°S for all years.

In July (Figure 5.8), August (Figure 5.9), and September (Figure 5.10), the ice edge continues to grow and expand northward, but the edges for the four years remain close together. The one exception is in September 2008, when the ice edge appears to already be in decline. In October (Figure 5.11), the sea ice edge for all years starts to decline. However, the rate of decline appears to be faster in 2009. In 2005, 2008 and 2009, the Weddell Sea ice edge in the west retreats before the ice edge to the east. By

November (Figure 5.12), the ice declines in all years. East of 30°W, the sea ice extent in 2009 is the farthest south. To the west, the ice extents in November 2005, 2006, and 2008 all retreat farther to the South. Because the sea ice in November 2005 and 2006 extends as far north as in 2007 and 2008, the differences in the sea ice edge in April must be due to the changes in the summer melt. The summers of 2005 through 2007 likely experience greater summer sea ice extent declines than the summers of 2008 and 2009. The winter ice edge extent for all years is not significantly impacted by the sea ice extent at the start of the growth period in April.

The variation in sea ice extent and area based on reanalysis output of sea ice concentration every four hours between 01 January 2005 and 31 December 2009 is plotted in Figure 5.13. The yearly cycles are overlaid to show the variations between the years and different months in which the sea ice extent and area peak.

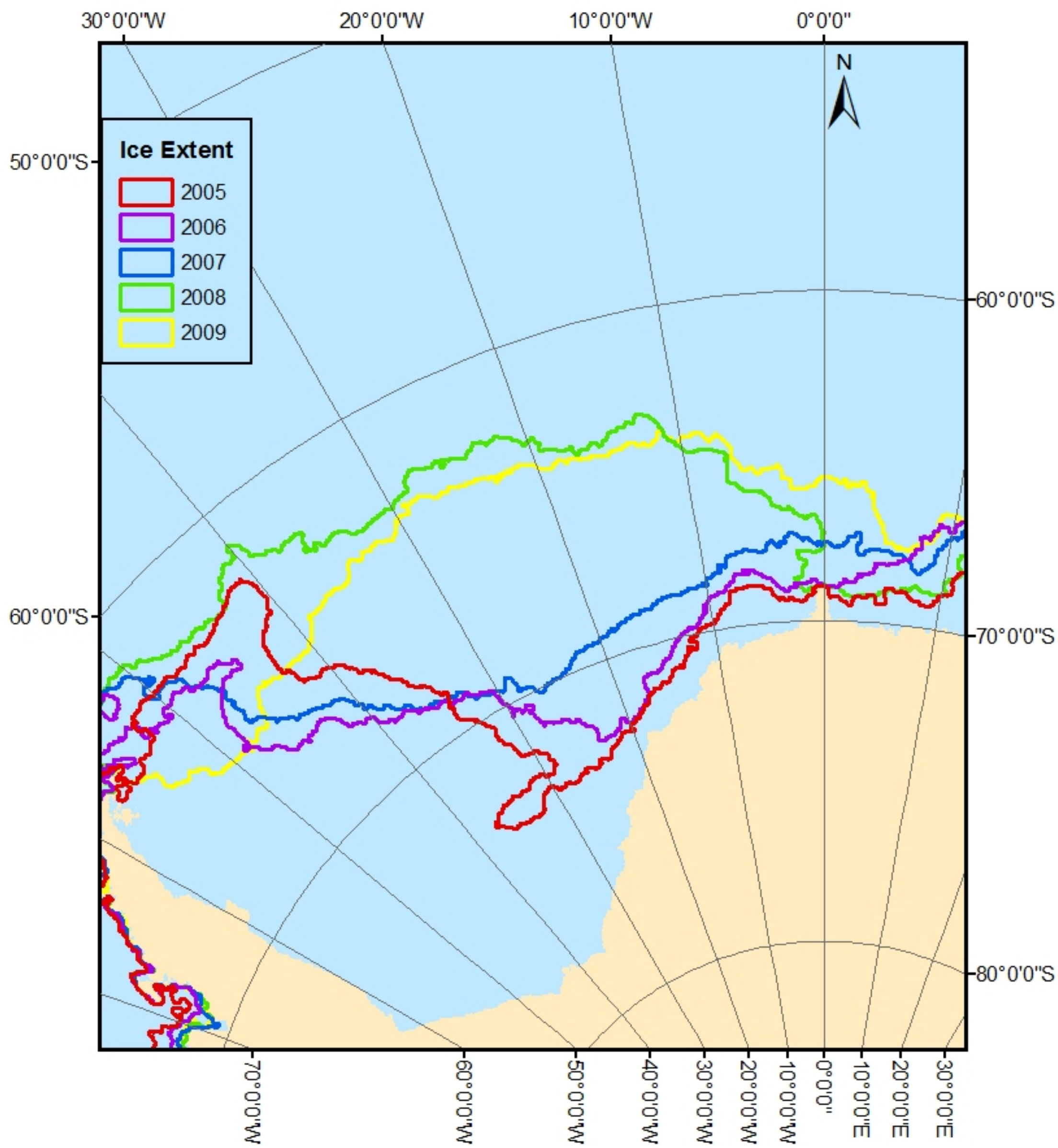


Figure 5.5 Ice edge for April 2005 – 2009 based on AMSR-E sea ice concentration maps.

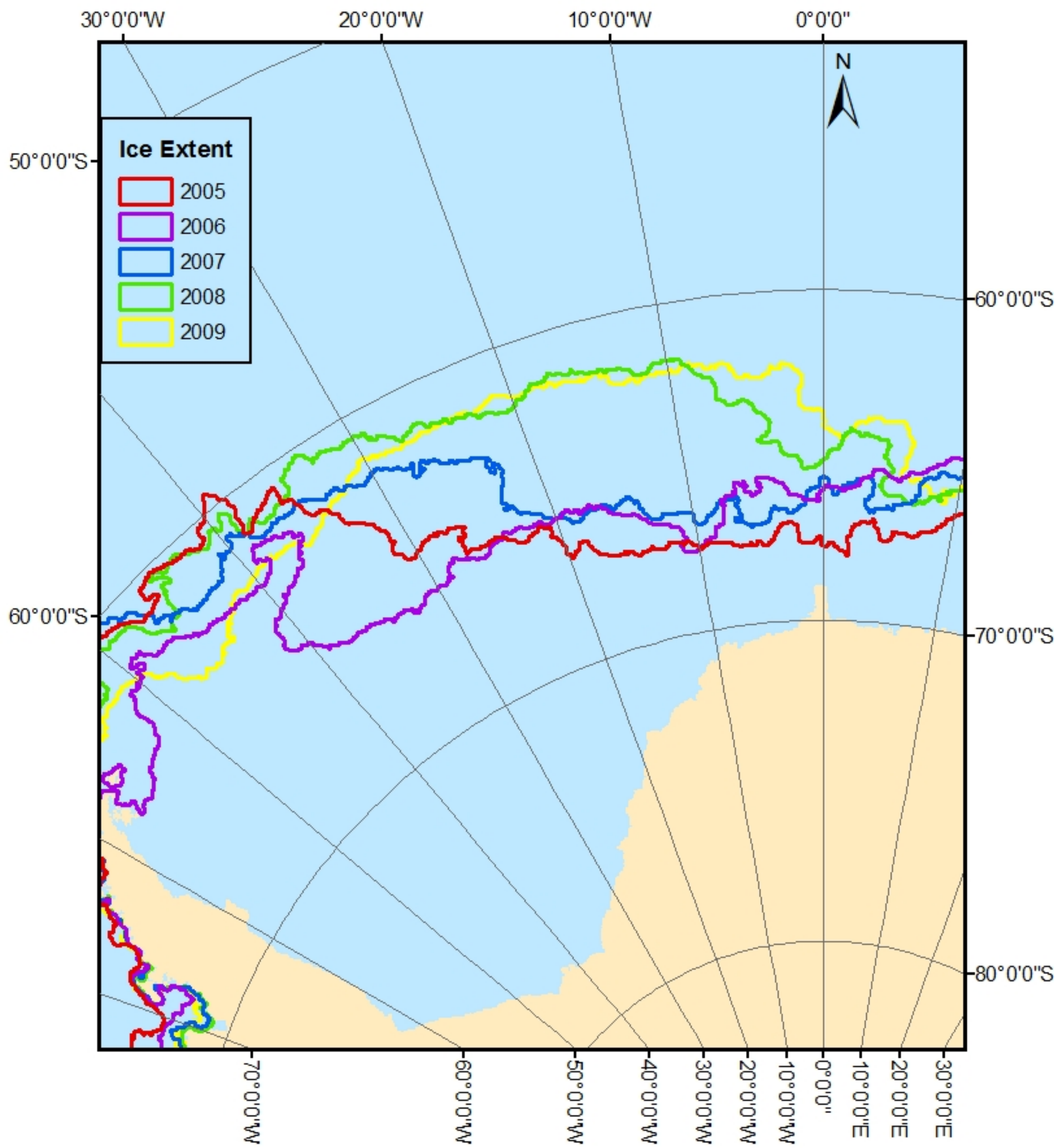


Figure 5.6 Ice edge for May 2005 – 2009 based on AMSR-E sea ice concentration maps.

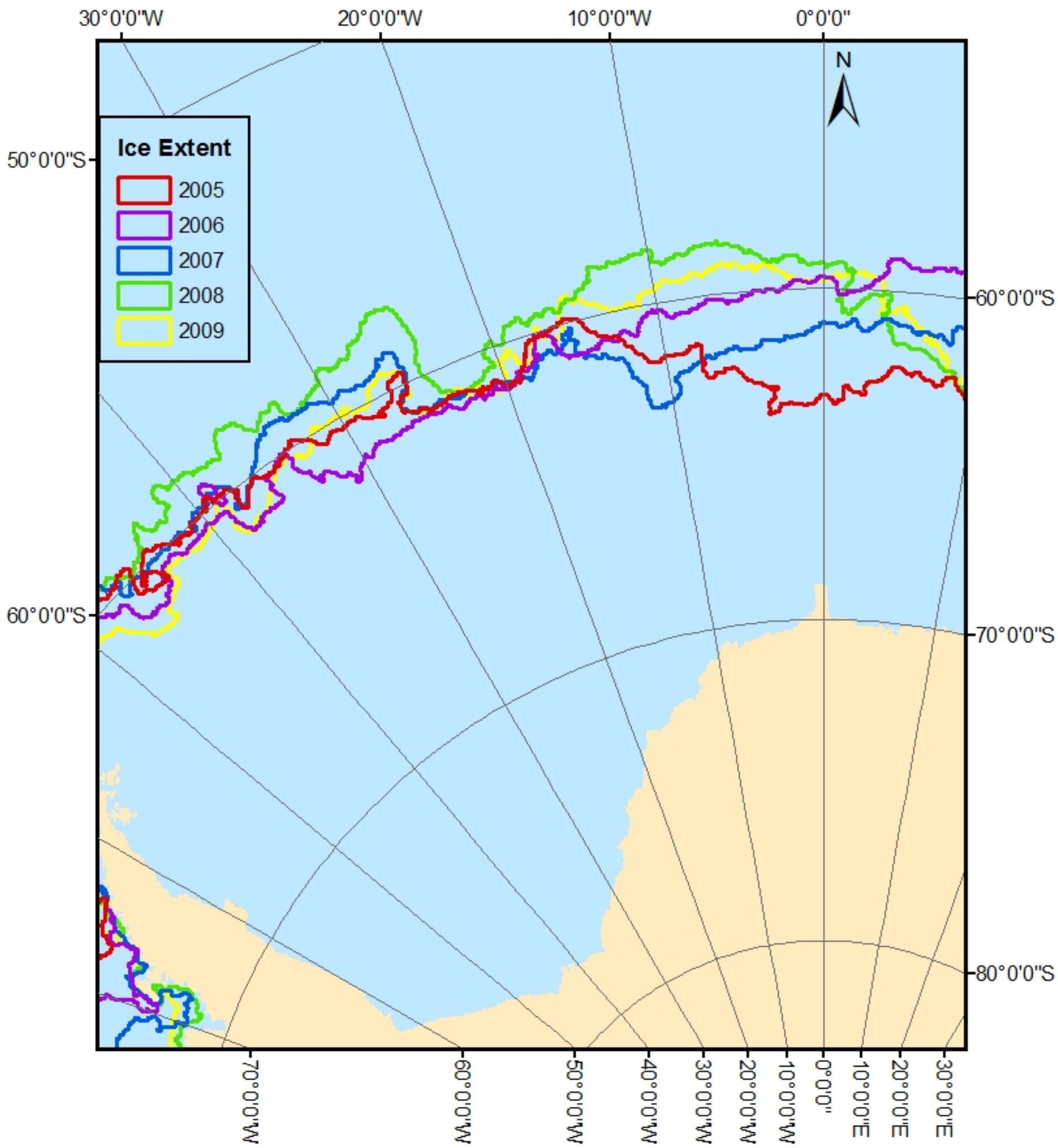


Figure 5.7 Ice edge for June 2005 – 2009 based on AMSR-E sea ice concentration maps.

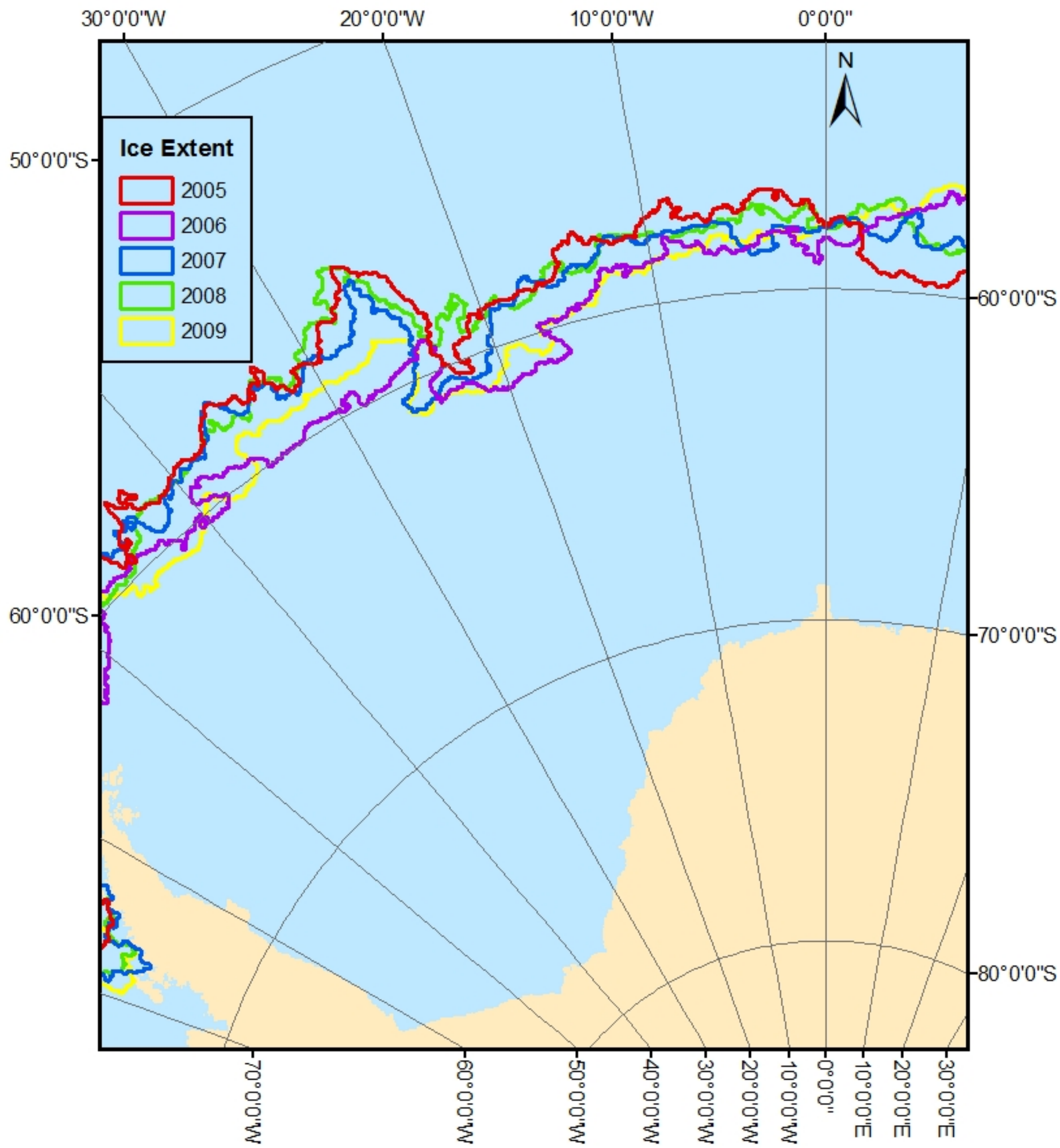


Figure 5.8 Ice edge for July 2005 – 2009 based on AMSR-E sea ice concentration maps.

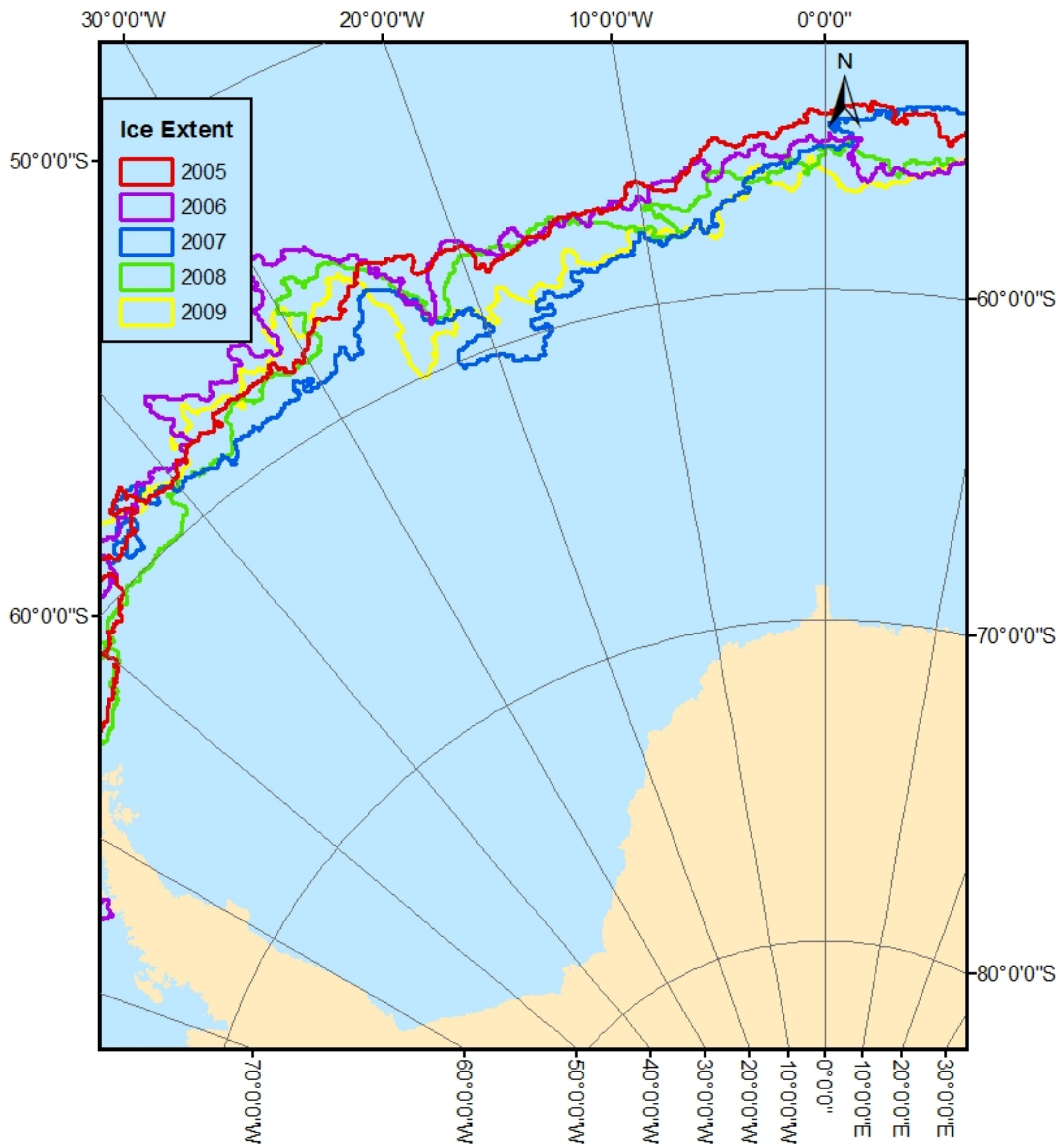


Figure 5.9 Ice edge for August 2005 – 2009 based on AMSR-E sea ice concentration maps.

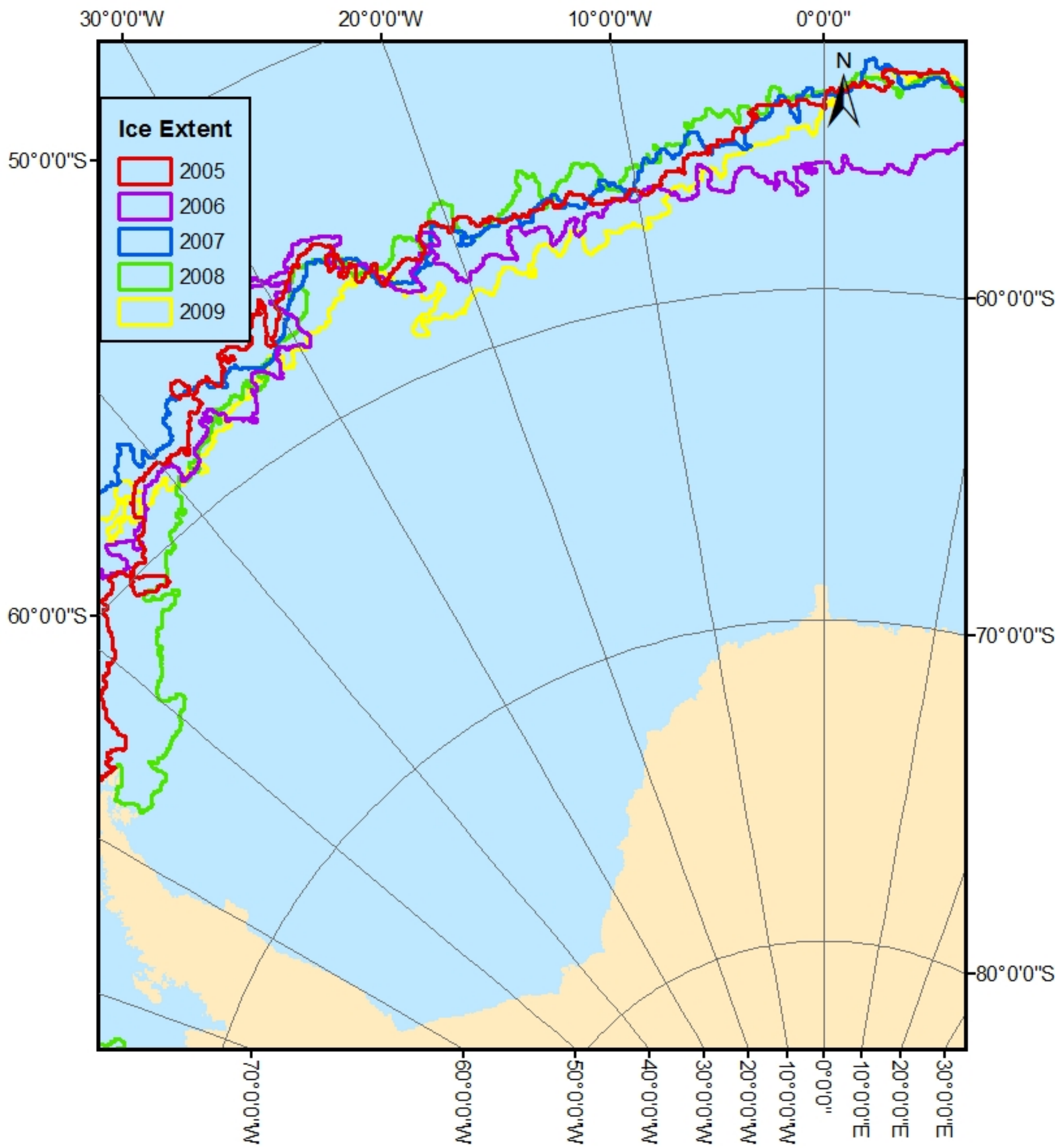


Figure 5.10 Ice edge for September 2005 – 2009 based on AMSR-E sea ice concentration maps.

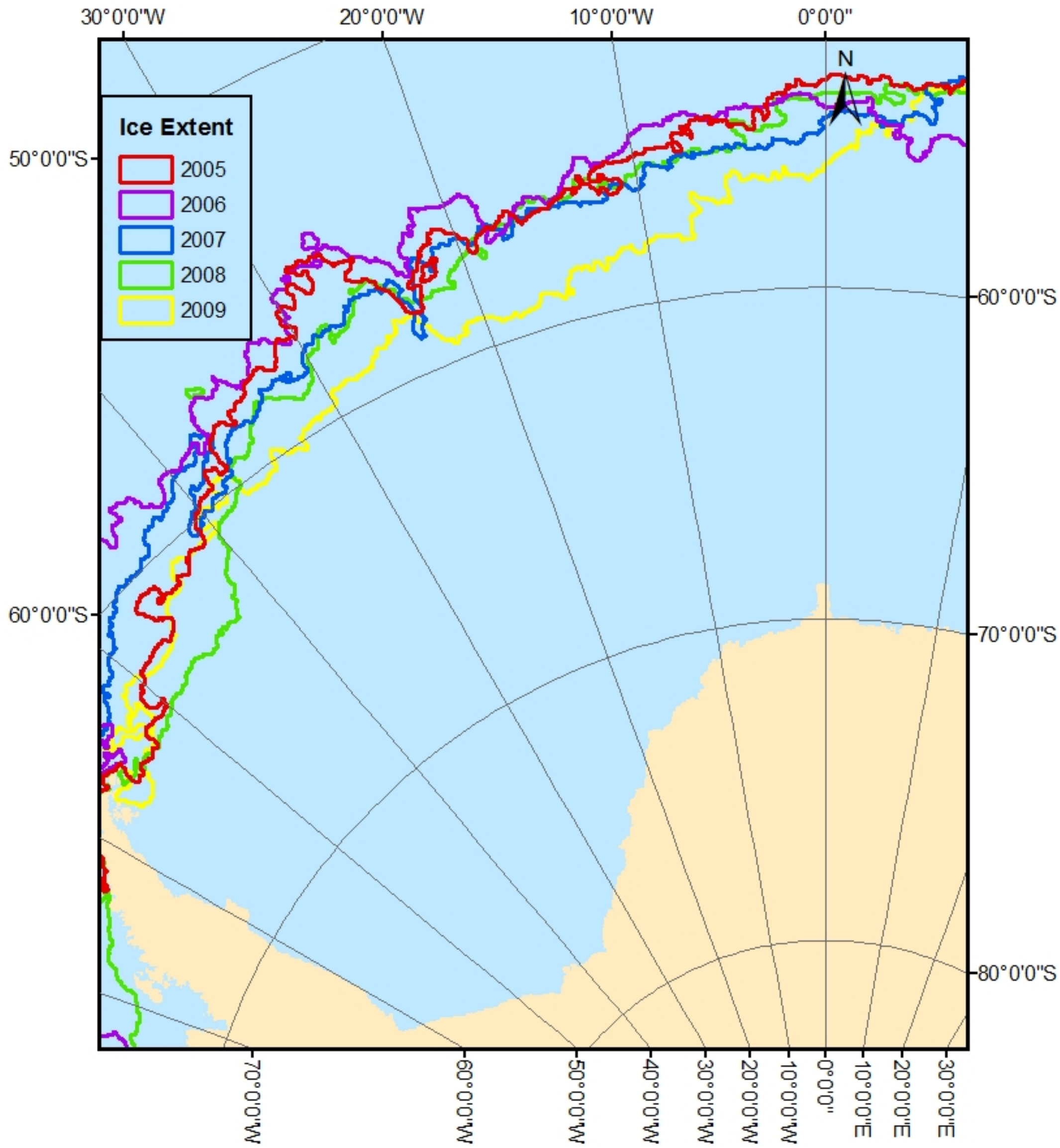


Figure 5.11 Ice edge for October 2005 – 2009 based on AMSR-E sea ice concentration maps.

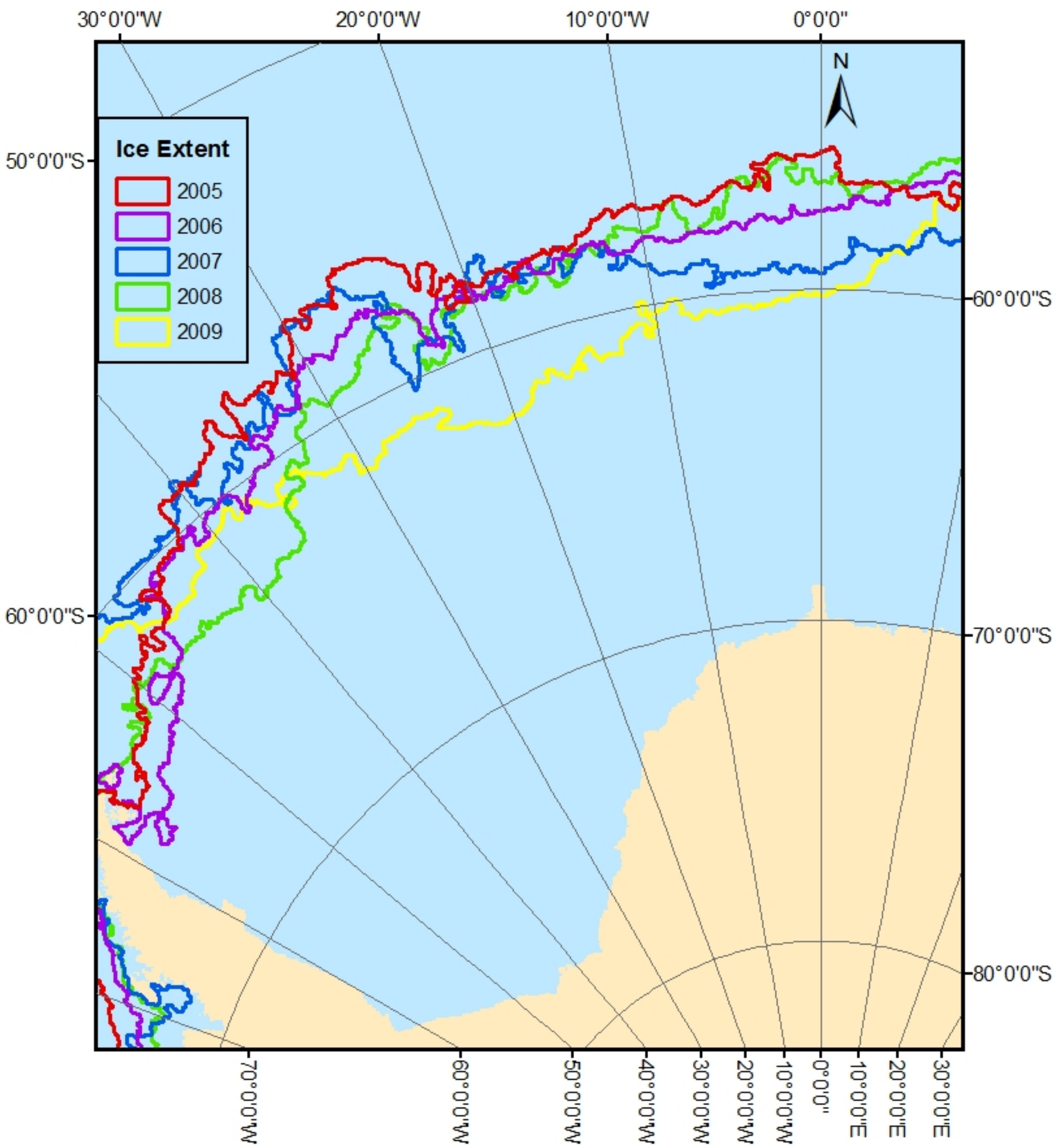


Figure 5.12 Ice edge for November 2005 – 2009 based on AMSR-E sea ice concentration maps.

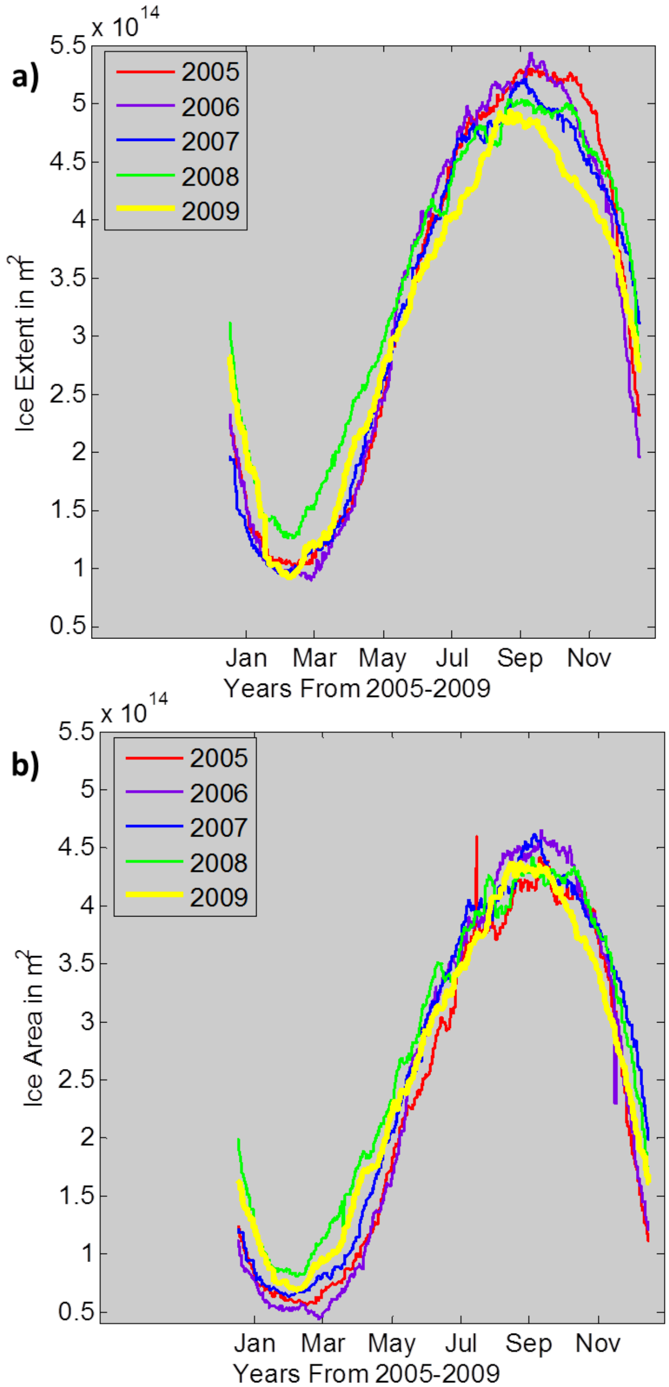


Figure 5.13 The ice extent (m^2) and ice area (m^2) cycle from 2005 through 2009 for the Weddell Sea based on sea ice concentration fields in reanalysis. a) Ice extent is the area of all ice-covered regions. b) Ice area is the area excluding open water within the ice pack.

5.3 The Sea Ice Growth Rate and Salt Production

Areas of open water within the ice pack during ice formation months are locations of high ice production. Where sea ice forms, cold and saline brine is released to the water column, which increases the density of the upper layer of the water column and increases the potential for destabilization of the water column (Markus et al. 1998). These results show where sea ice has the potential to grow, based on atmospheric conditions and the open water fraction within the ice pack for each of 40 scenes.

Sample input maps (Figure 5.14) and sample calculated fields used to determine the surface energy balance and sea ice growth rate (Figure 5.15) are provided as examples. The wind speed, two m air temperature, and mean sea level pressure are examples of the reanalysis fields used as inputs. A clear storm with a comma shape is visible in the upper right of the three images.

The dew point temperature, downwards thermal radiation and solar radiation are also inputs but not pictured here. Open water area is the fraction of the pixel that has open water. The latent heat flux ranges from -102 W m^{-2} to 25 W m^{-2}. Where the latent heat flux is negative, ice forms. When positive, water can be formed from ice. The sensible heat flux is also mostly negative. The negative sensible heat flux is where the heat is being drawn upwards and sea ice can form. The ice growth rate in cm day^{-1} is only dependent on where there is any open water fraction in a pixel and on the total surface heat flux at a point. Some coastal areas in the Weddell Sea and a few locations within the ice pack have high sea ice growth rates. The salt production in kg day^{-1} is based on the pixel ice area, the open water fraction, and the ice growth rate.

The maps of the potential amount of sea ice volume increase in one day are shown in figures 5.16 – 5.35. The sea ice volume is based on the sea ice growth rate, calculated from the surface energy budget, the latent heat of fusion, and the density of ice (Section 4.3). For most of the scenes, it is clear that the highest rate of sea ice growth occurs along the ice edge. This is especially true during the months with the greatest increase in ice extent: May through September. However, the sea ice growth rate spatial patterns in other locations in the Weddell Sea may explain some of the influence Weddell Sea Storms on the sea ice growth.

Significant sea ice growth is possible along the southern Weddell Sea Coast in October 2005, June 2006, July 2006, August 2006, September 2006, July 2007.August 2007, May 2008, November 2008 (major polynya), July 2009, and November 2009. Sea ice growth potential is concentrated along the 70°S parallel in August 2005, September 2005, October 2007, November 2007, August 2008, October 2008, and November 2008. Sea ice growth is seen along the western Weddell Sea near the Antarctic Peninsula in May 2006, June 2006, July 2006, and November 2006. Finally, Sea ice growth within the ice pack, away from the coastline and ice edge is most prevalent in the following scenes: July 2005, August 2005, September 2005, October 2005, September 2005, October 2005, November 2005, September 2007, July 2008, August 2008, September 2008, October 2009.

The salt production maps are not produced here because they follow the same basic spatial pattern as the sea ice growth rate maps. Instead, to show the magnitude of the salt production, the maximum salt production per day per ice concentration map is listed in Table 5.6. Table 5.5 provides the maximum sea ice growth rates calculated per scene.

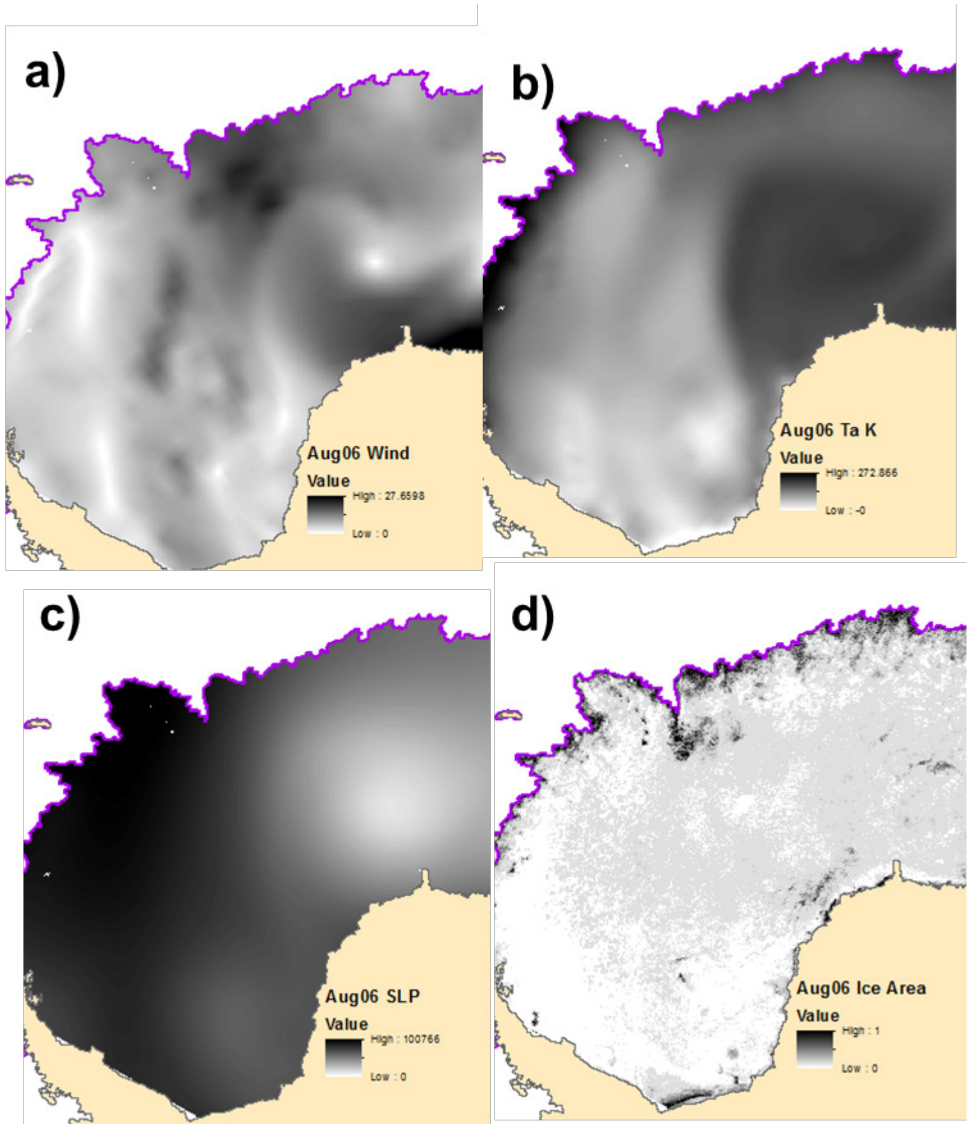


Figure 5.14 Sample input fields for surface energy balance calculations for 15 August 2006. The fields are a) 10 m wind speeds (m s^{-1}) from reanalysis, b) 2 m air temperature from reanalysis (K), c) mean sea level pressure from reanalysis (Pa), and d) ice area concentration from AMSR-E data (fraction from 0 to 1). For all fields dark shaded values are high.

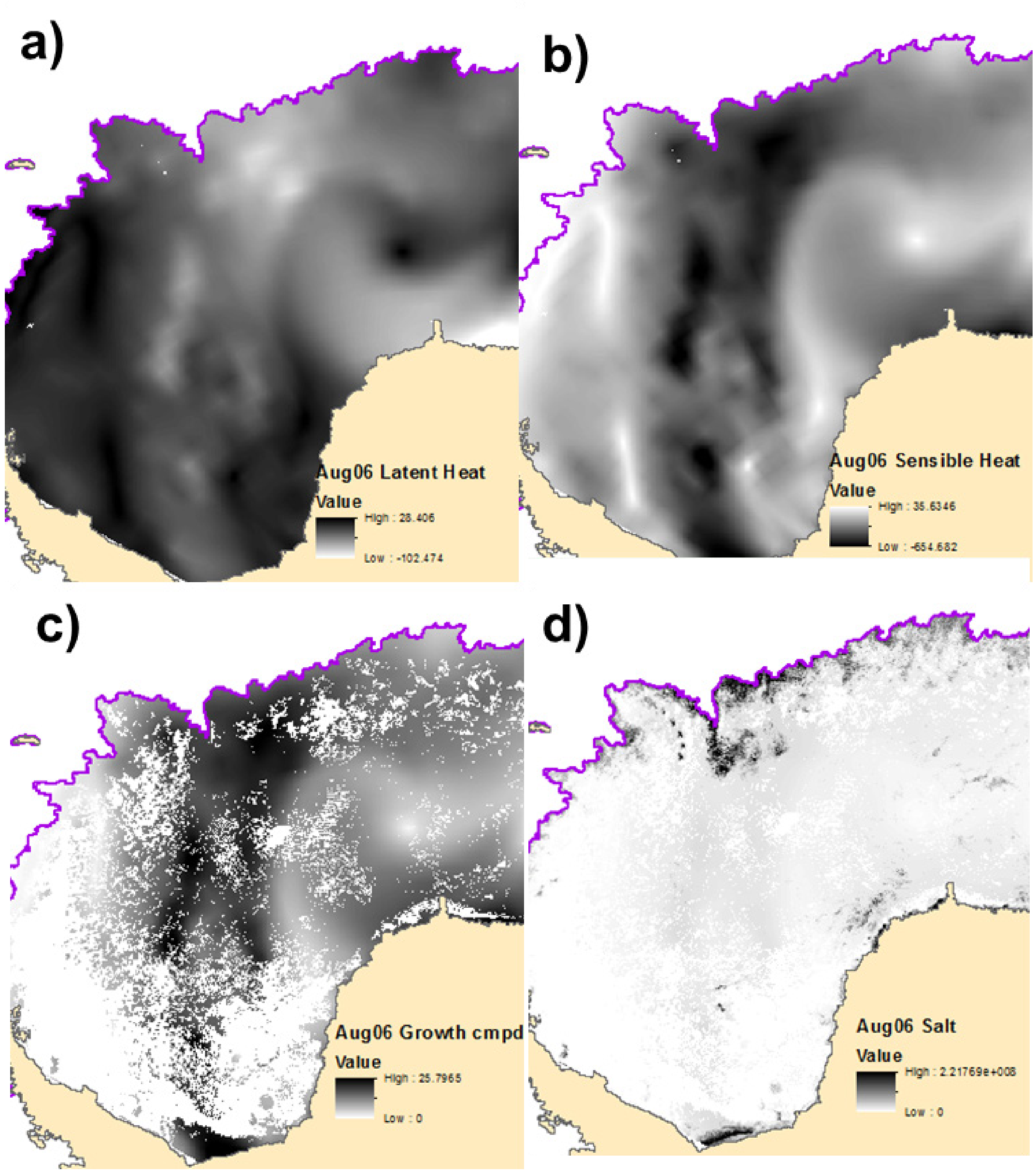


Figure 5.15 Sample calculated fields for surface energy balance calculations for 15 August 2006. The fields are a) latent heat flux (W m^{-2}), b) sensible heat flux (W m^{-2}), c) sea ice thickness growth in cm day^{-1}, and d) calculated salt flux in kg day^{-1}. For a), c) and d), dark shaded values are high. For b) dark shaded values are low.

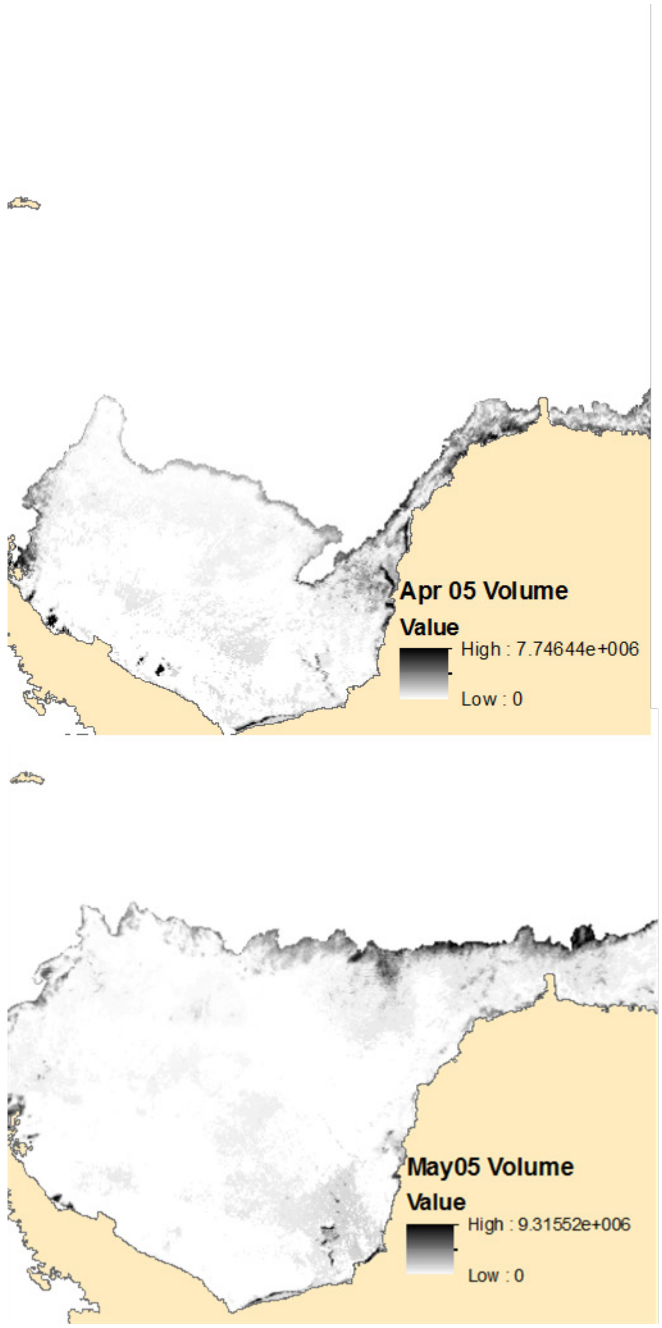


Figure 5.16 April (top) and May (bottom) 2005 sea ice potential volume growth per day in m^3.

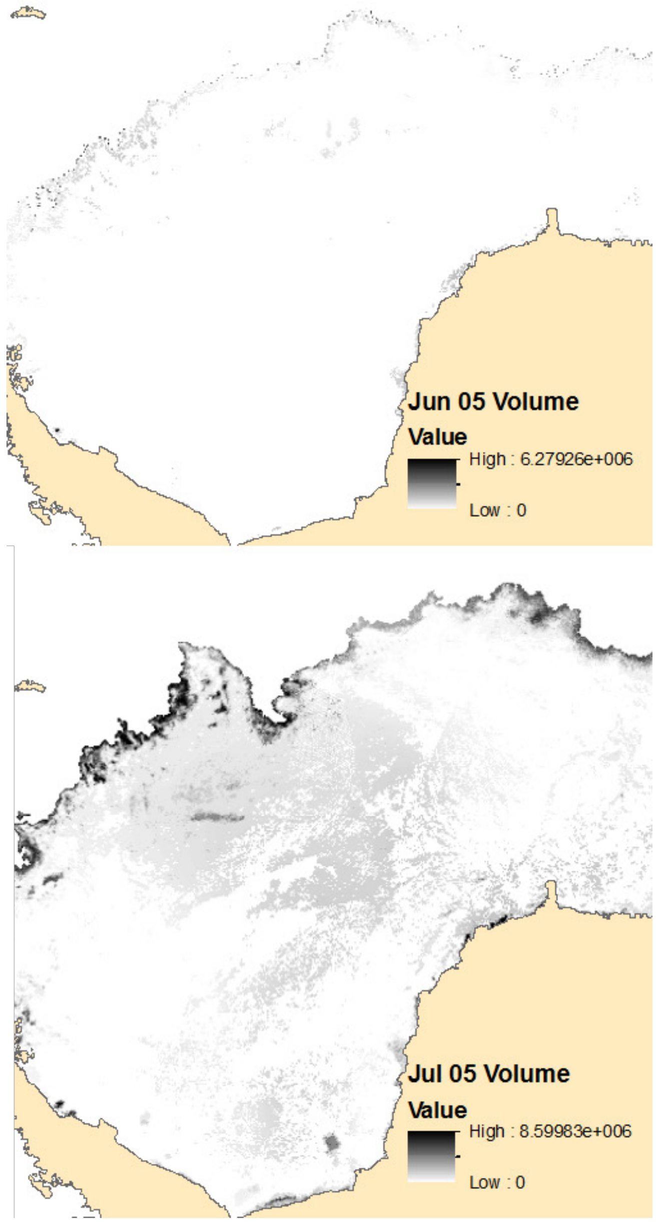


Figure 5.17 June (top) and July (bottom) 2005 sea ice potential volume growth per day in m^3.

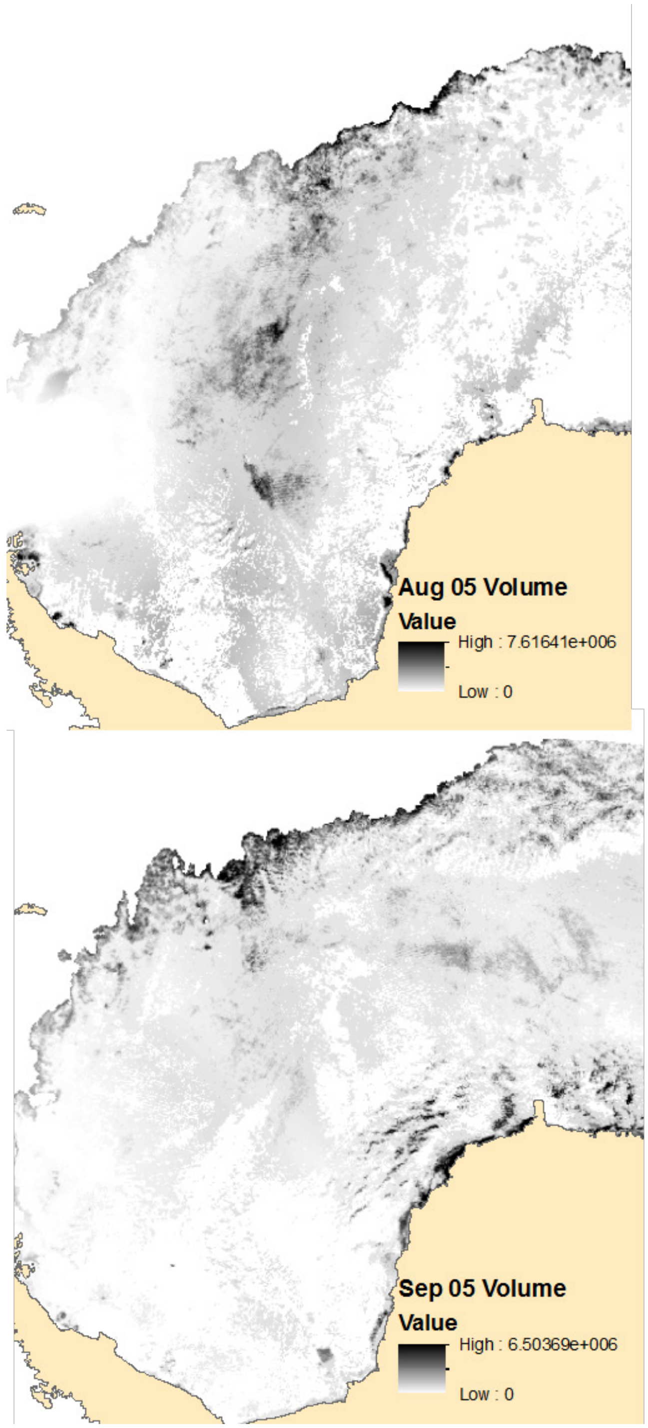


Figure 5.18 August (top) and September (bottom) 2005 sea ice potential volume growth per day in m^3.

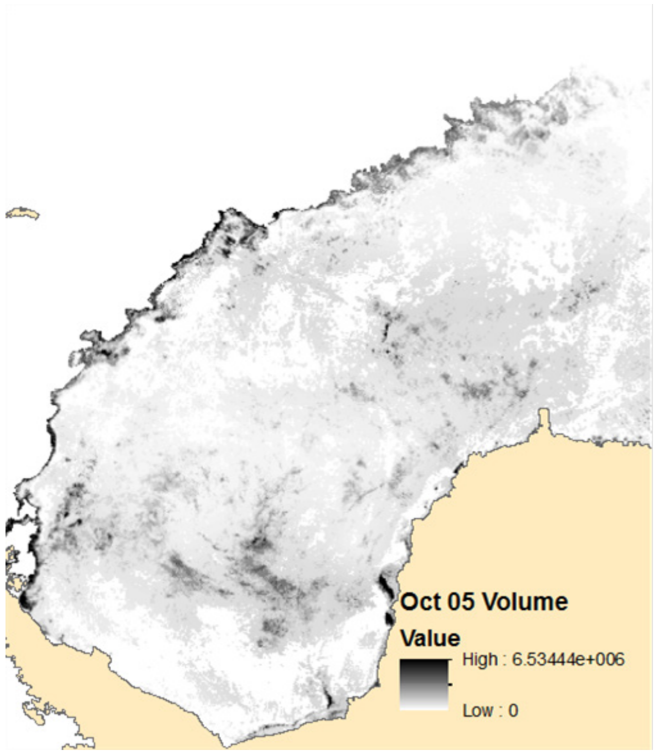
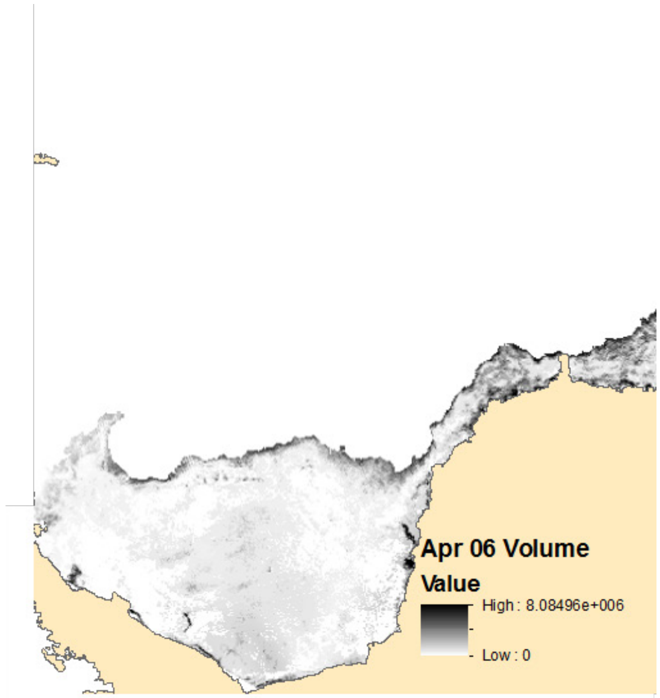


Figure 5.19 October 2005 sea ice potential volume growth per day in m^3. The November scene is not shown because of too many missing data pixels.



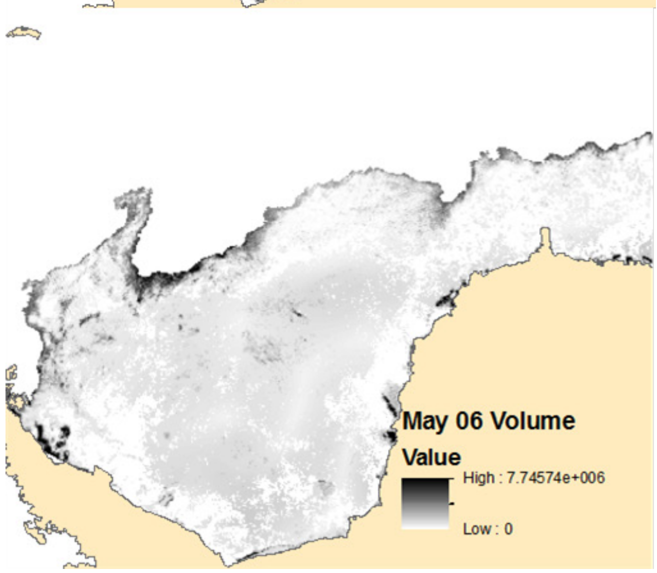


Figure 5.20 April (top) and May (bottom) 2006 sea ice potential volume growth per day in m^3.

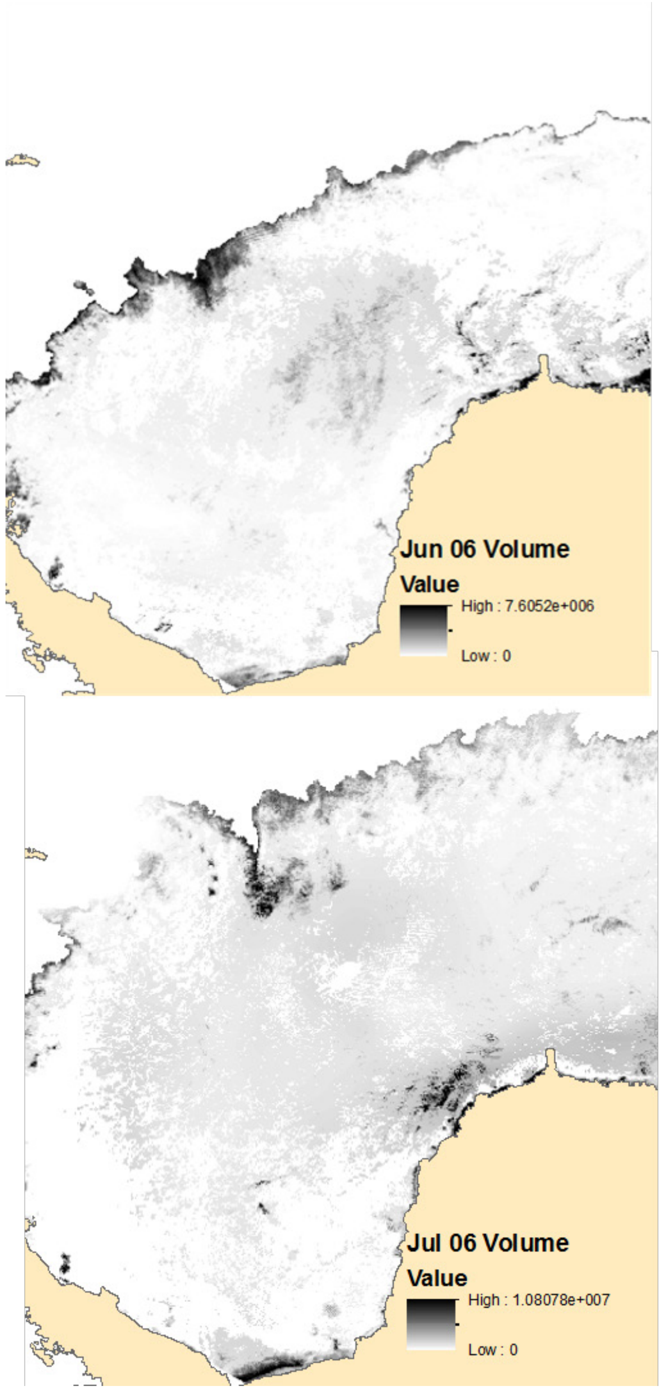


Figure 5.21 June (top) and July (bottom) 2006 sea ice potential volume growth per day in m^3.

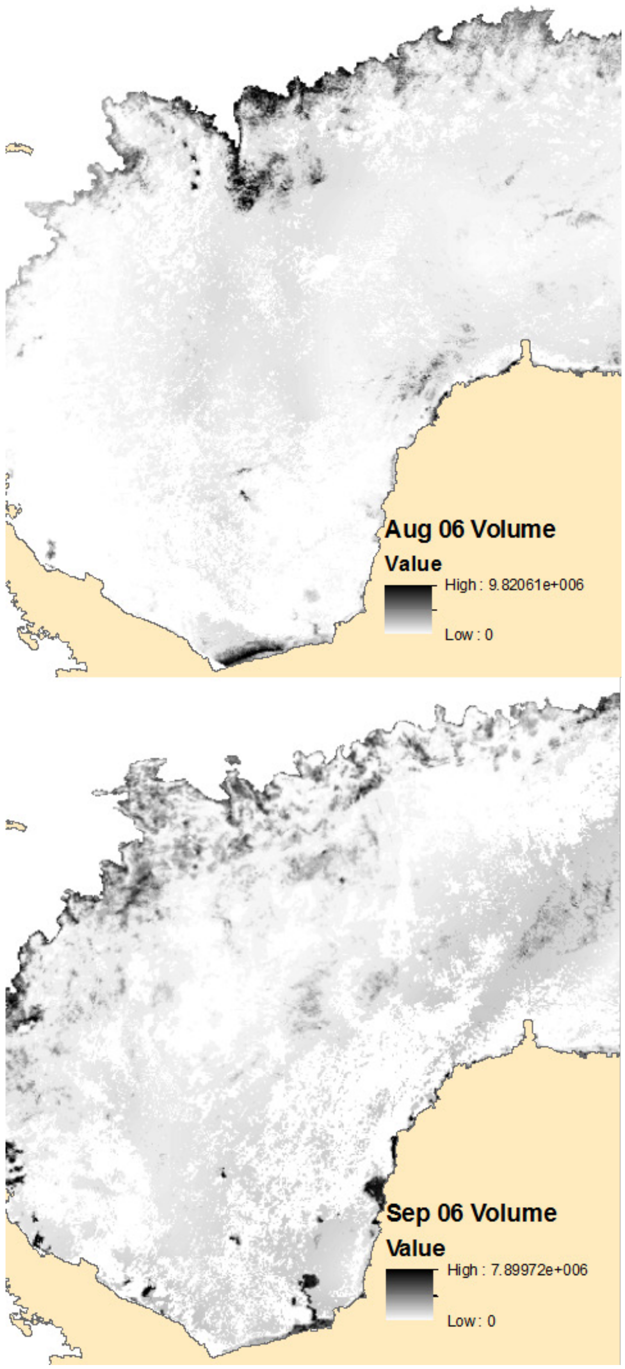


Figure 5.22 August (top) and September (bottom) 2006 sea ice potential volume growth per day in m^3.

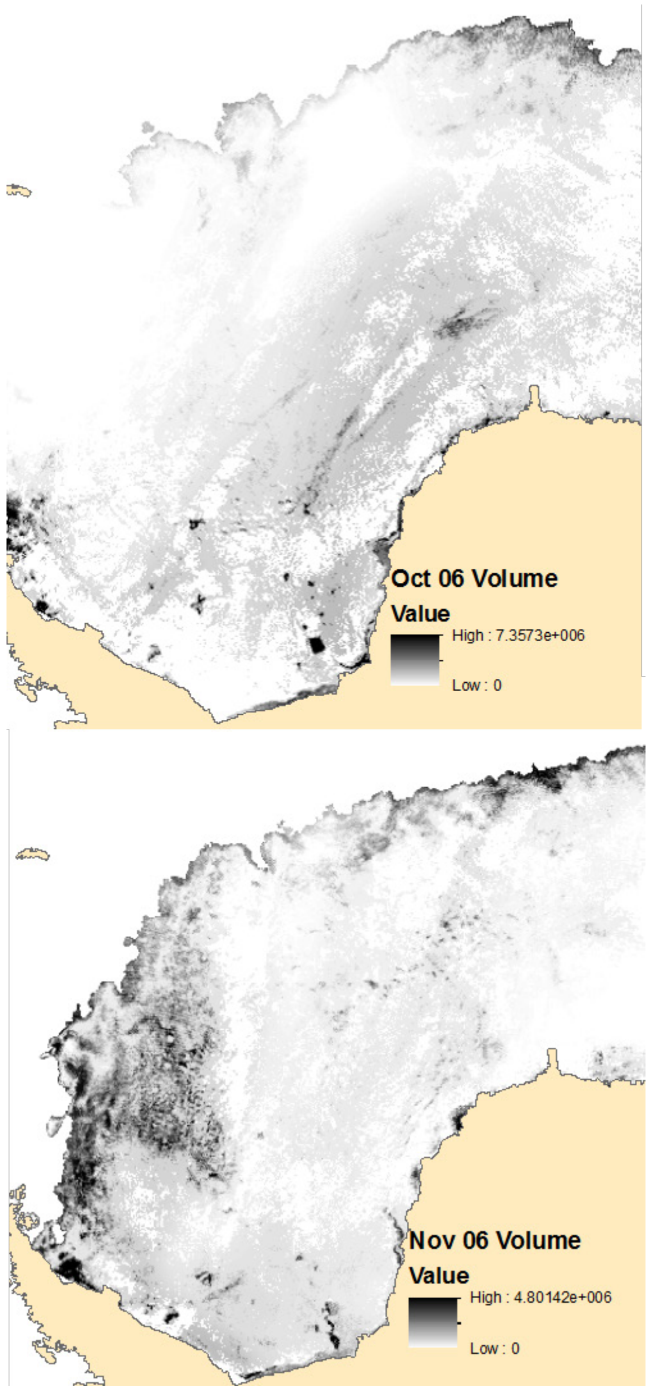


Figure 5.23 October (top) and November (bottom) 2006 sea ice potential volume growth per day in m^3.

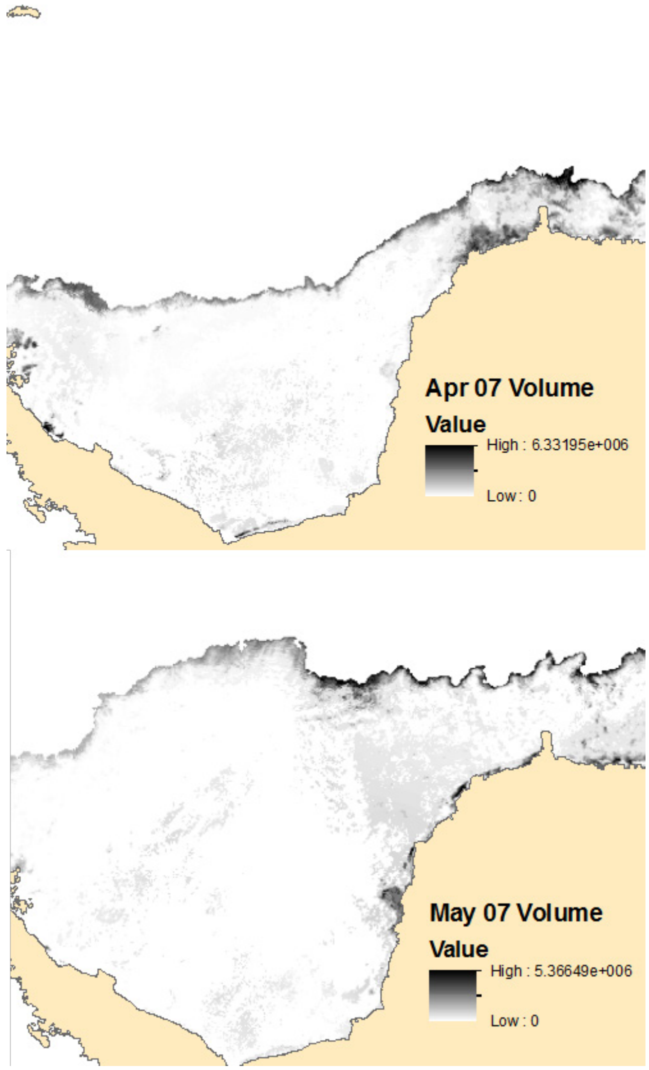


Figure 5.24 April (top) and May (bottom) 2007 sea ice potential volume growth per day in m^3.

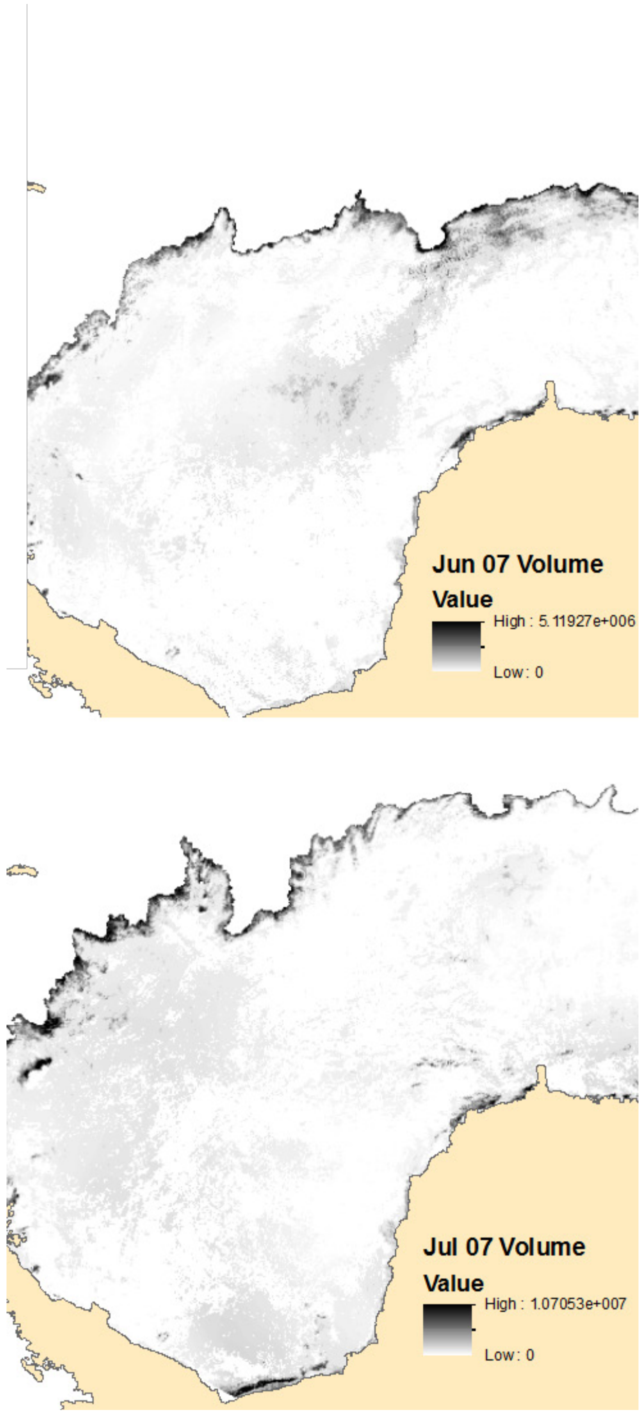


Figure 5.25 June (top) and July (bottom) 2007sea ice potential volume growth per day in m^3.

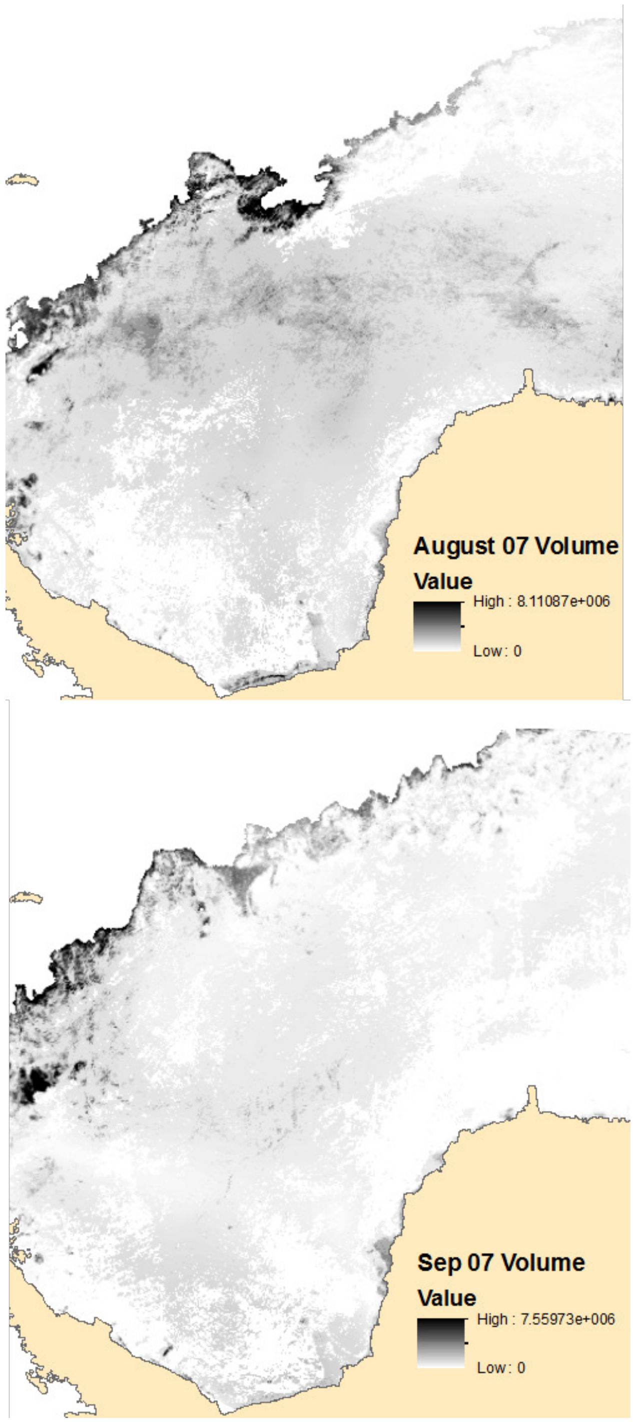


Figure 5.26 August (top) and September (bottom) 2007 sea ice potential volume growth per day in m^3.

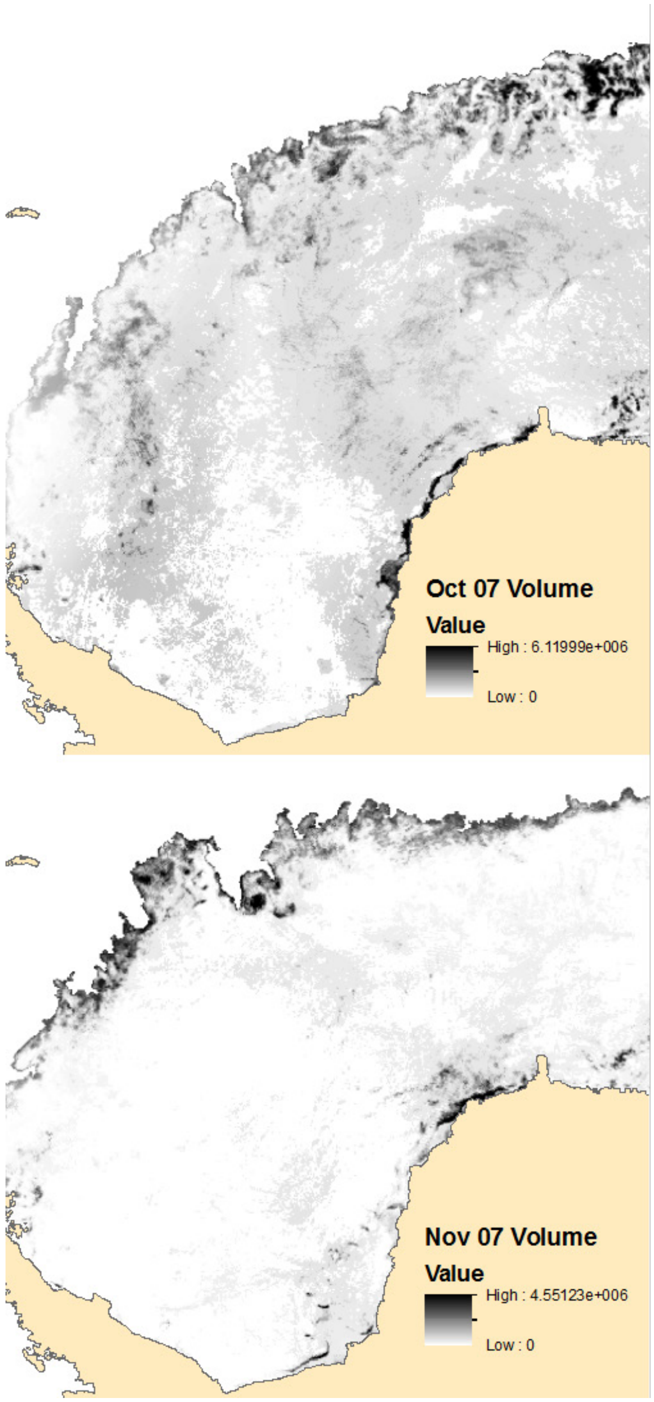


Figure 5.27 October (top) and November (bottom) 2007 sea ice potential volume growth per day in m^3.

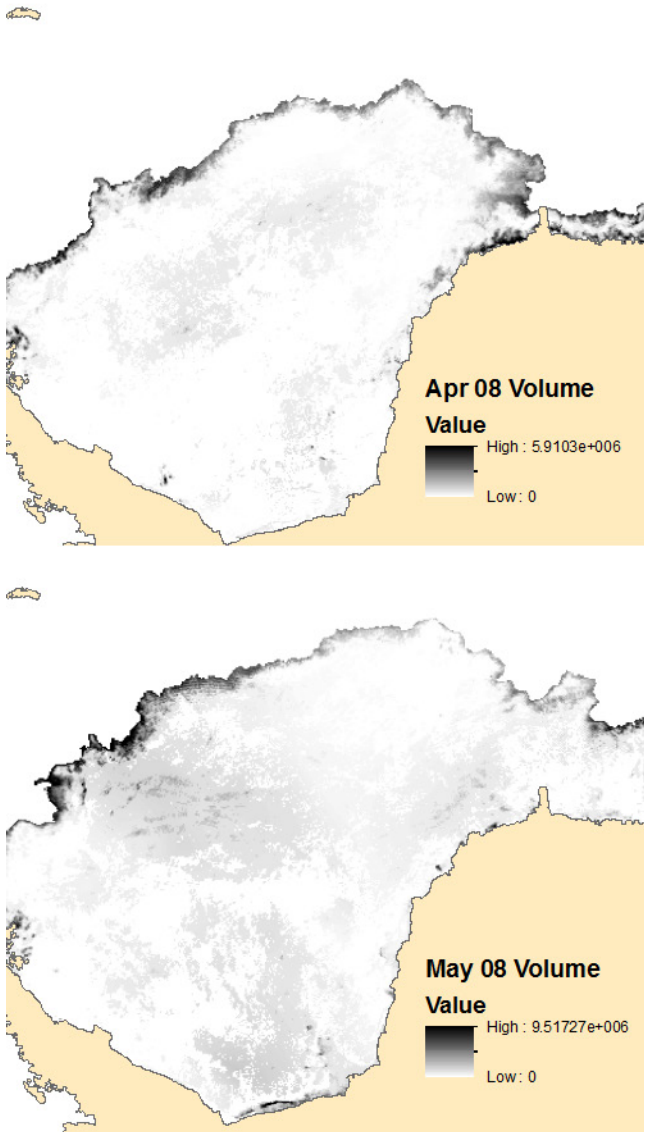


Figure 5.28 April (top) and May (bottom) 2008 sea ice potential volume growth per day in m^3.

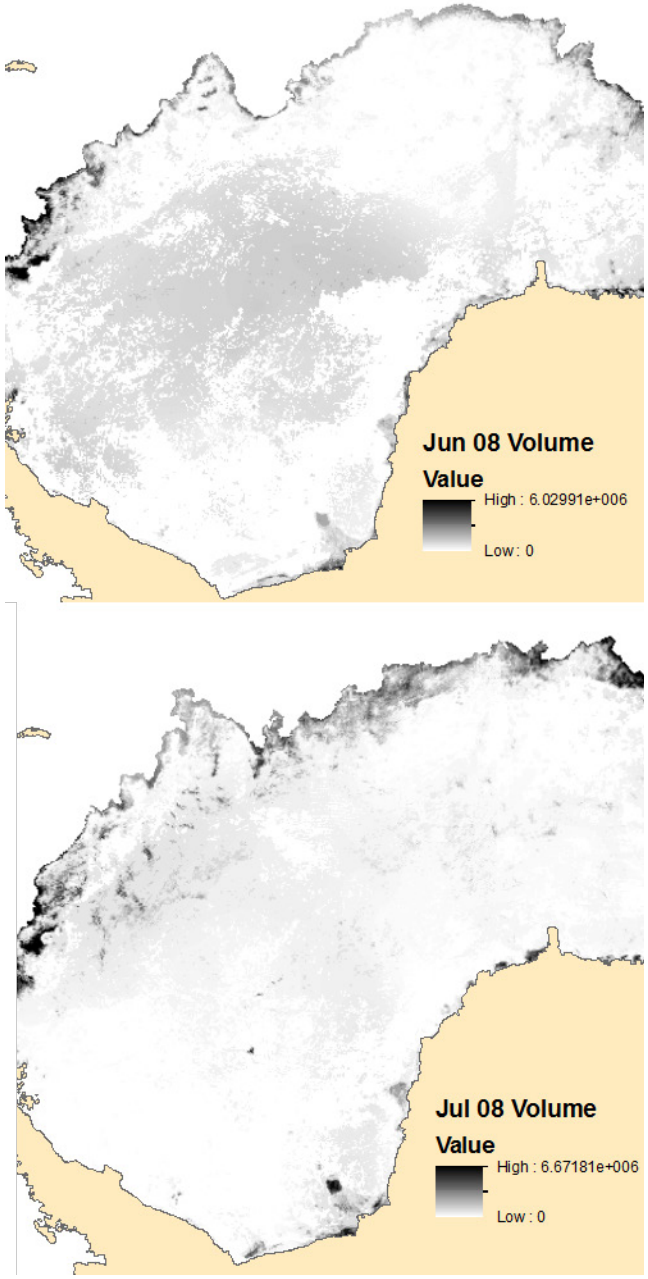


Figure 5.29 June (top) and July (bottom) 2008 sea ice potential volume growth per day in m^3.

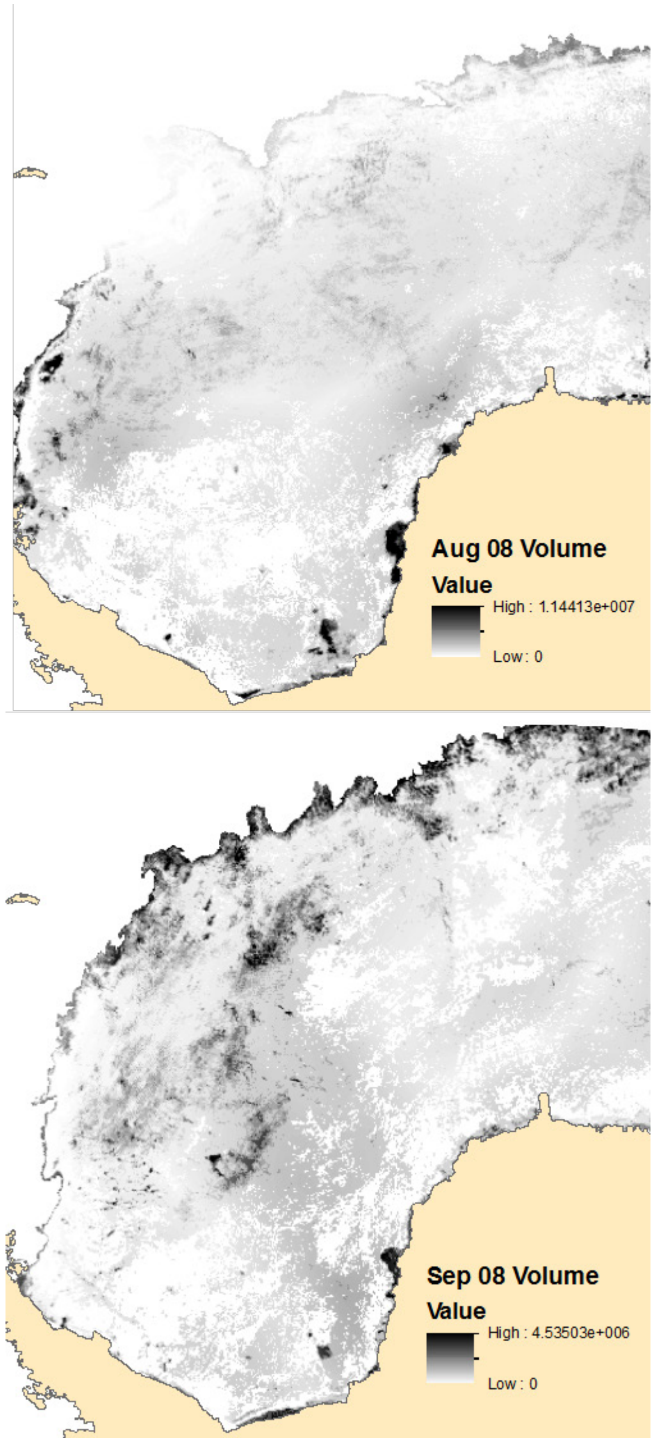
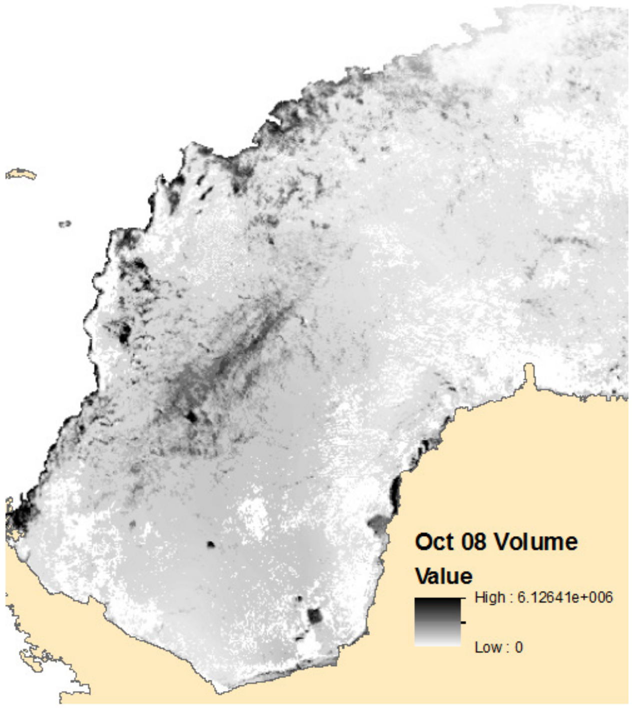


Figure 5.30 August (top) and September (bottom) 2008 sea ice potential volume growth per day in m^3.



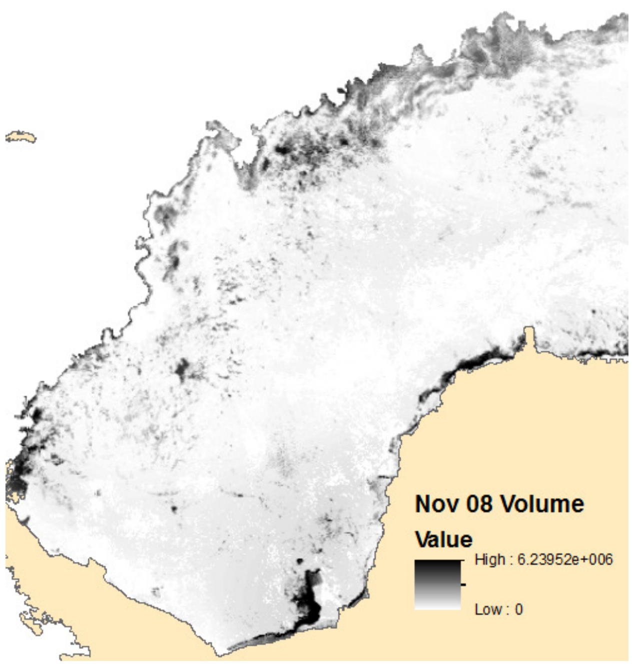


Figure 5.31 October (top) and November (bottom) 2008 sea ice potential volume growth per day in m^3.

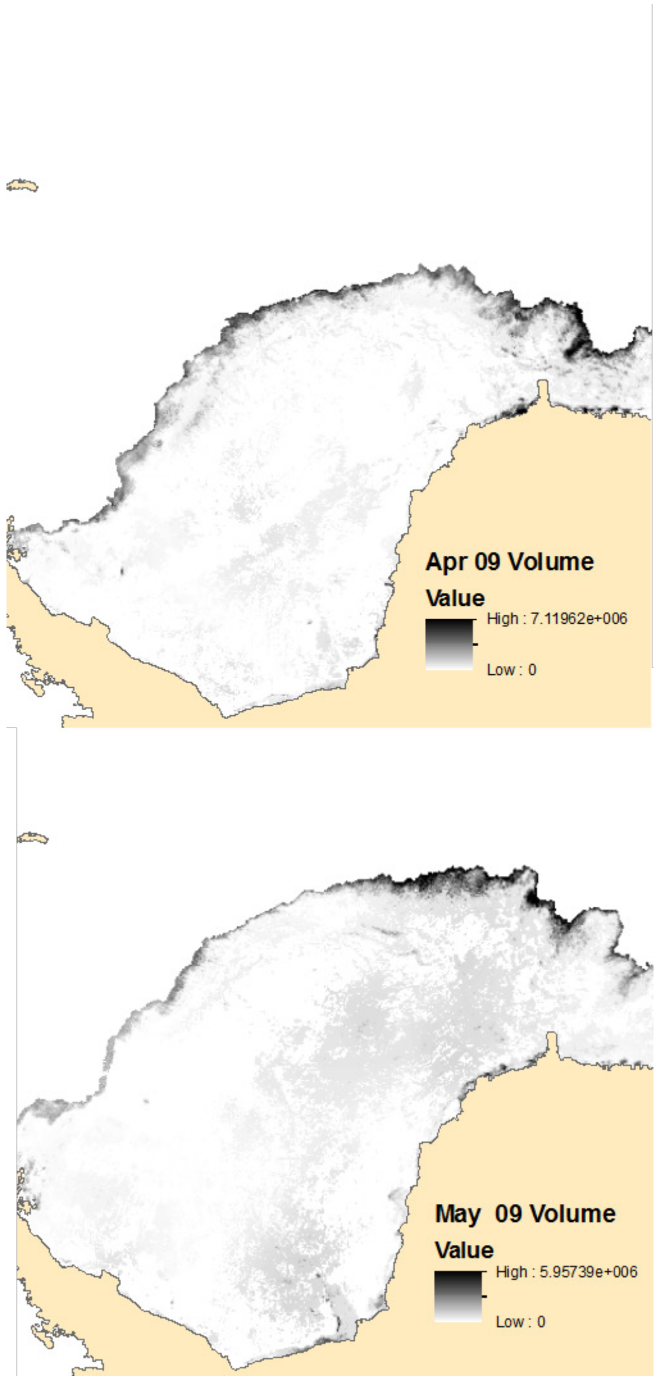


Figure 5.32 April (top) and May (bottom) 2009 sea ice potential volume growth per day in m^3.

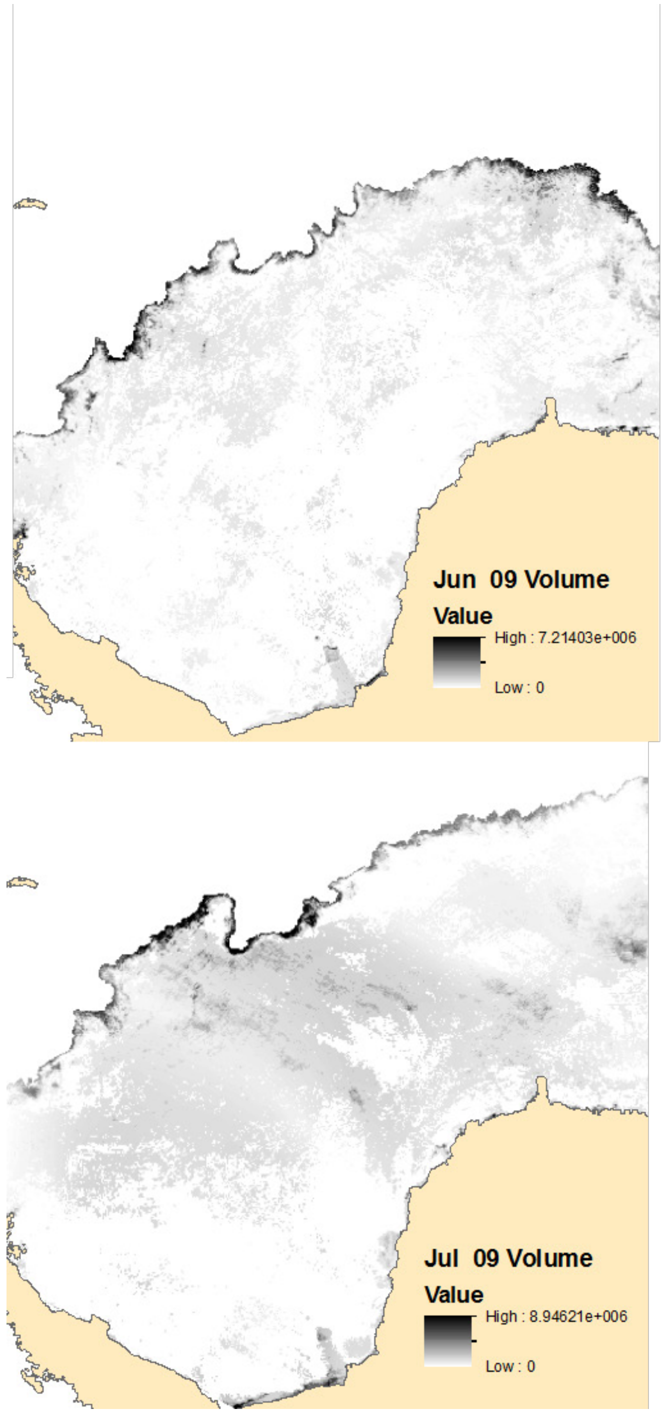


Figure 5.33 June (top) and July (bottom) 2009 sea ice potential volume growth per day in m^3.

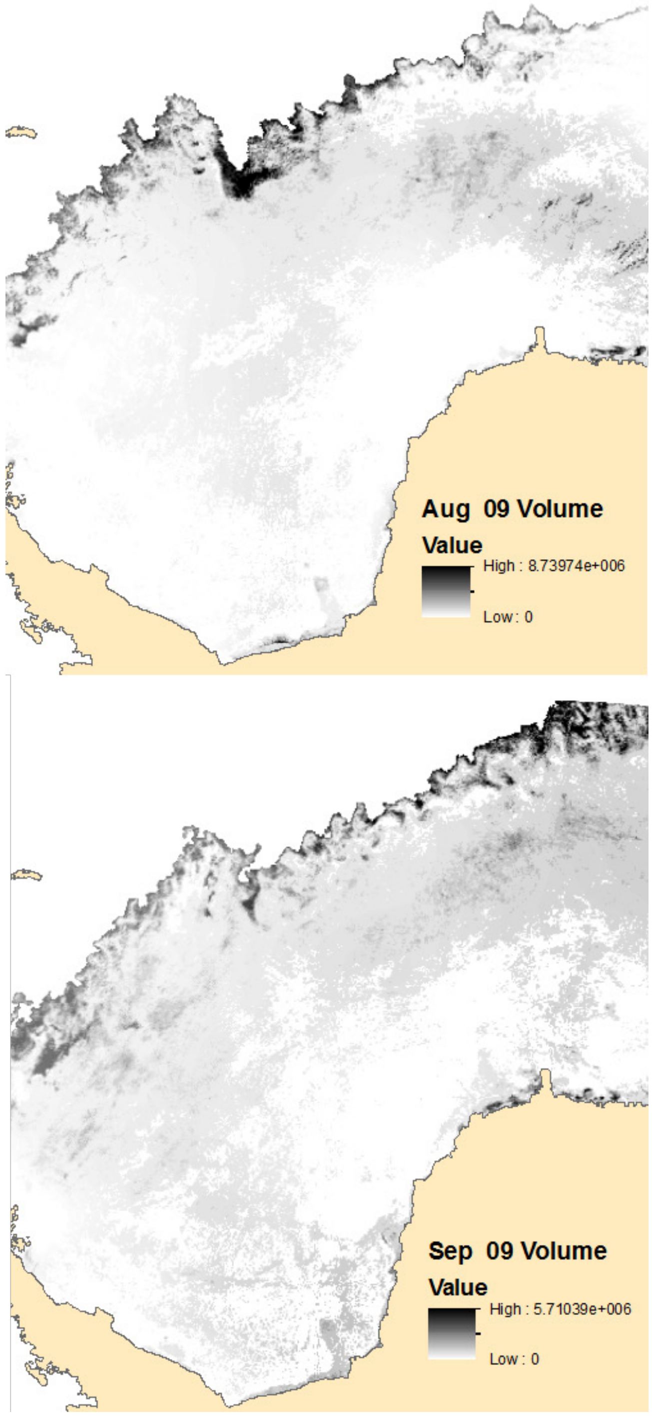


Figure 5.34 August (top) and September (bottom) 2009 sea ice potential volume growth per day in m^3.

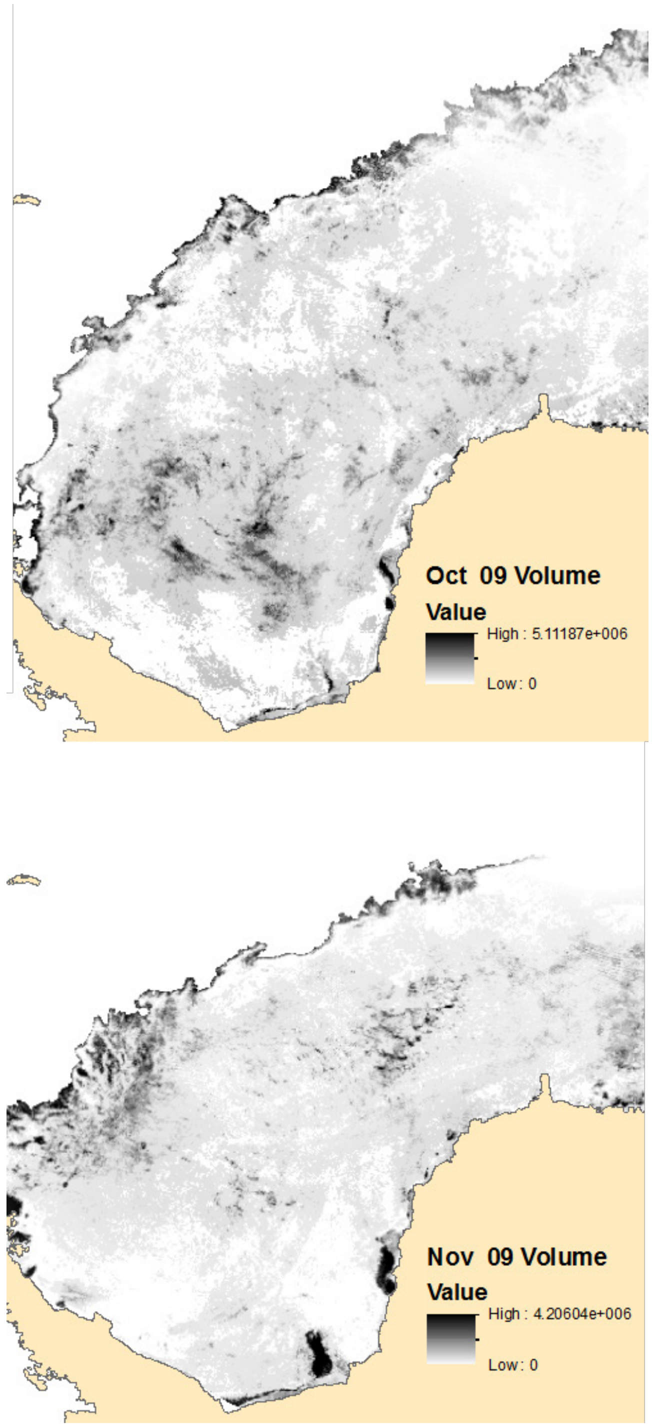


Figure 5.35 October (top) and November (bottom) 2009 sea ice potential volume growth per day in m^3.

The sea ice thickness growth rate in cm day^{-1} (Table 5.5) does not take into account the area of the ice forming. The sea ice growth in volume maps (Figures 5.14 – 5.35) take into account the area of the open water where sea ice can form. The sea ice salt production rates (Table 5.6) also consider the open water area. The spatial distribution of the highest salt production per day matches the spatial distribution of the sea ice volume growth maps. The salt production table is provided to display the quantities of salt production. The maximum ice growth rates (Table 5.5) are the highest in the fall and winter months. In the table, values over 25.5 cm day^{-1} (bold) appear in April, July and August of 2006; April, July and September of 2007; May of 2008; and June, July and August 2009. The highest salt production rates occur in late autumn and winter and coincide with the periods with the highest rates of sea ice volume growth. The months with maximum salt production over 200.0x10^{6} kg day^{-1} are May of 2005; July and August of 2006; July of 2007; May and August of 2008; and July of 2009. The months with the highest sea ice thickness growth rate and months with the highest volume growth rate and salt production occur in the same time of the year. However, the spatial pattern of the sea ice growth rate differs from the spatial pattern of the growth of sea ice volume. The difference is due to the influence of the area of open water. The areas where potential for sea ice growth are highest do not necessarily coincide with areas with a high percentage of open water area.

Table 5.5 Sea Ice Growth Rate Maximum

	2005	2006	2007	2008	2009
April	21.47	**27.01**	**27.46**	21.97	20.83
May	23.84	23.39	23.03	**29.65**	22.57
June	21.22	23.92	19.82	21.17	**26.43**
July	24.50	**33.00**	**28.20**	22.13	**25.62**
August	24.07	**25.79**	25.48	**33.70**	**30.38**
September	17.11	22.24	**30.04**	22.92	23.49
October	19.48	19.47	22.22	20.13	16.96
November	18.05	20.01	11.68	16.19	11.32

*units are cm day-1, **values over 25.5 cm day^{-1} are bold

Table 5.6 Salt Production Maximum

	2005	2006	2007	2008	2009
	1.0e+06 *				
April	174.93	182.57	142.99	133.47	160.78
May	**210.36**	174.91	121.19	**214.92**	134.53
June	141.80	171.74	115.60	136.17	162.91
July	194.20	**244.06**	**241.75**	150.66	**202.02**
August	171.99	**221.77**	183.16	**258.37**	197.36
September	146.87	178.39	170.71	102.41	128.95
October	147.56	166.14	138.20	138.35	115.44
November	153.17	108.43	102.78	140.90	94.98

*units are kg day-1 **values over 200x10^{6} kg day^{-1} are bold

The maximum salt production per day (Table 5.6) is a maximum per pixel, per day. The magnitude of the salt production in kg is a fraction of the mass of saline water available to freeze. The weight of seawater is the product of the density of the seawater and the volume of the seawater. To better understand the quantity of brine rejected, a sample calculation follows. If the density is assumed to be 1027 kg m^{-3}, and the volume is a 0.33 m deep region (the maximum depth of sea ice growth in this study) with the area of the sea ice concentration map pixels (6250*6260 m^2), the total weight of a unit of seawater in the example volume is 13.2x10^{10} kg. However, in this study, the majority of the pixels only have a small amount of open water area, so the area for each calculation will always contain less seawater than the amount given above. The mass of brine rejected due to sea ice formation will always be less than the mass of brine in the sample pixel. The amount of salt rejected is related to the amount of brine that is rejected as seawater freezes (assuming a small amount remains in the sea ice) and the difference between the density of seawater and the density of sea ice (sea ice density is approximately 910 kg m^{-3}). The potential mass of salt rejected by freezing in an idealized region with an area of 6250*6260 m^2 (1 pixel) and depth of maximum sea ice growth is 291x10^6 kg day^{-1}. However, the maximum salt rejected is always less than that amount because the area of open water rarely reaches 100% of the pixel area.

Chapter 6

DISCUSSION AND CONCLUSIONS

This dissertation examines polar cyclones and sea ice conditions in the Weddell Sea. The central research problems address how polar storms between 1979 and 2014 affect coincident changes in sea ice area and extent as well as how sea ice area affects the surface energy balance, sea ice growth rate, and brine rejection. The discussions in this chapter first focus on a corresponding results section. Sections 6.1, 6.2, and 6.3, discuss the results of Sections 5.1, 5.2, and 5.3, respectively.

6.1 Discussion of Polar Cyclone Climatology: 1979 - 2014

An archive of 2,540 polar mesoscale cyclones is identified in the Weddell Sea for the time period 01 January 1979 – 31 August 2014. The month with the highest frequency, on average, of polar storms is August. Similarly, storms which occur in the austral winter tend to be stronger with higher wind speeds, lower sea level pressures, and higher IKE (Table 5.1). Based on the monthly mean characteristics, it can be generalized that stronger and larger storms occur more frequently in the austral autumn through winter. Yuan et al. (2009) similarly identify lower frequency of cyclones in the season defined by January, February, and March over six years of polar cyclones. With a seasonal division of March-April-May and June-July-August of Yuan et al. (2009), Simmonds and Keay (2000) find the highest number of storms per season to be March-August with the minimum in December-October-November. Conversely, in a study of cyclones which includes a smaller region of the Weddell

Sea only in year 1991, Carrasco et al. (2003) identifies that the peak frequencies occur in January and December and frequency decreases by month until August when it rises. An examination of monthly data from this archive for only 1991 shows the year follows the pattern of monthly means identified for the entire archive. Differences between this study and Carrasco et al. (2003) are thus attributed to the difference in the study domains.

Results in the storm identification section of this dissertation focus primarily on the correlation between IKE and sea ice area. Values of IKE per storm range between 114 J s and 338,205 J s. The mesoscale cyclones identified in this research are not comparable to other storms for which IKE has been calculated because IKE is mainly used to categorize the strength of hurricanes and tropical storms. Hurricanes and tropical storms tend to have larger diameters and stronger wind speeds than the mesoscale polar storms recorded in this dissertation. As a reference, the IKE of a hurricane can be over 100 TJ (100×10^{12} J) (Powell and Reinhold 2007). Despite the relatively small IKE of the individual mesoscale storms in the Weddell Sea, findings from this research indicate that the storms are strong enough to significantly affect sea ice area.

Seasonal normalized anomaly correlations among the characteristics and the sea ice cover suggest the sea ice extent is not strongly correlated to the storms. However, storm frequency, duration, and integrated kinetic energy are correlated with sea ice area. The relationship of the change in sea ice area over the duration of a storm is considered based on the size of the IKE of the storm. The lower quartile of storms contains storms with an IKE of 647 J s or less. The interquartile range contains storms between 647 J s and 9797 J s. Neither the lower quartile nor the interquartile range exhibit a strong linear relationship with sea ice area. However, the storms with higher IKE values (the higher quartile and 90% quantile above 20,035 J s) exhibit a significant, positive relationship with change in sea ice area.

The removal of storms associated with zero ice change significantly affects the slope of the line of best fit of the absolute value sea ice area change and IKE. The y-intercept is not affected by inclusion of areas that do not change or change very little. Where storms are separated by positive or negative change in sea ice (Figure 5.1.4), all slopes are significant. The y-intercept does not vary significantly based on the inclusion of the storms with no change in ice area. The correlation between IKE and change in sea ice area is stronger when only negative changes in sea ice area are included, than when only positive changes are included. For both positive and negative changes in sea ice, the inclusion of no change in ice areas values strengthens the correlation.

The relationship between sea ice area and IKE is complicated. IKE is correlated with increases in sea ice area as well as decreases in sea ice area. Storms with high (over 9697 J s) IKE affect the ice area more than storms with lower IKE. Overall, the correlation between IKE and sea ice area is slightly positive; sea ice area increases with stronger storms. However, the strongest correlation between IKE and storms occurs when storms associated with decreases in sea ice are isolated. Fewer storms are associated with negative changes in sea ice than positive changes (800 versus 1190). The correlation between IKE and sea ice area is positive despite the stronger negative correlation with negative change in sea ice area values because of the higher sample size of positive values.

Several physical processes contribute to the simultaneously positive and negative correlation of IKE and sea ice area. The positive correlation is where sea ice area increases during a storm. High wind speeds increase the sensible heat flux from the ocean to the atmosphere and contribute to the freezing of ice. High wind speeds can also lead to divergence in the ice pack, which could be responsible for the decrease in sea ice area during a storm. For both relationships, the stronger storms tend to have more of an effect on the sea ice area.

6.2 Discussion of Ice Edge Detection 2005 – 2009

Sea ice edge detection is an ongoing area of research (Haarpaintner et al. 2004). The ice extent record is one of the most commonly used metrics to identify effects of climate change in the Arctic Ocean and Southern Ocean. It is also critical to be able to map the ice edge quickly for operations in polar regions because the ice edge changes quickly with time. One of the reasons it is difficult to identify the ice edge is because there is a marginal ice zone with very low sea ice concentration just seaward of the ice edge. Current operational ice edge detection algorithms use a sea ice concentration threshold (15% to 20%) to identify where the ice edge gives way to open ocean based on satellite imagery (Haarpaintner et al. 2004). The ice edge detection method provided in this dissertation is not a suitable replacement for operational because it requires sea ice concentration maps that have already been processed. However, the advantage of this method for research is that it removes any marginal ice zone from the ice edge. The edge is taken to be everywhere a sea ice concentration was identified from the AMSR-E image. The method also does not smooth variations in the ice edge.

Depending on the time of the year, the marginal ice edge can be more difficult to determine. In months when the marginal ice edge has low sea ice concentration, the area of all known ice is significantly different than the area in the 15% to 20% sea ice concentration range. Figure 6.1 is an example of the differences in the marginal ice edge. Figure 6.1 a is based on an April scene. By April, much of the low concentration or thin ice disappears due to austral summer melt (Bernstein et al. 2015). The red areas in the figure (0% to 20% sea ice concentration) essentially follow the area of all known ice. However, in November, as the ice starts to melt, the marginal ice zone exhibits greater variability. The red areas with 0% to 20% sea ice concentration are (Figure 6.1 b) have a greater range of ice extent than in April.

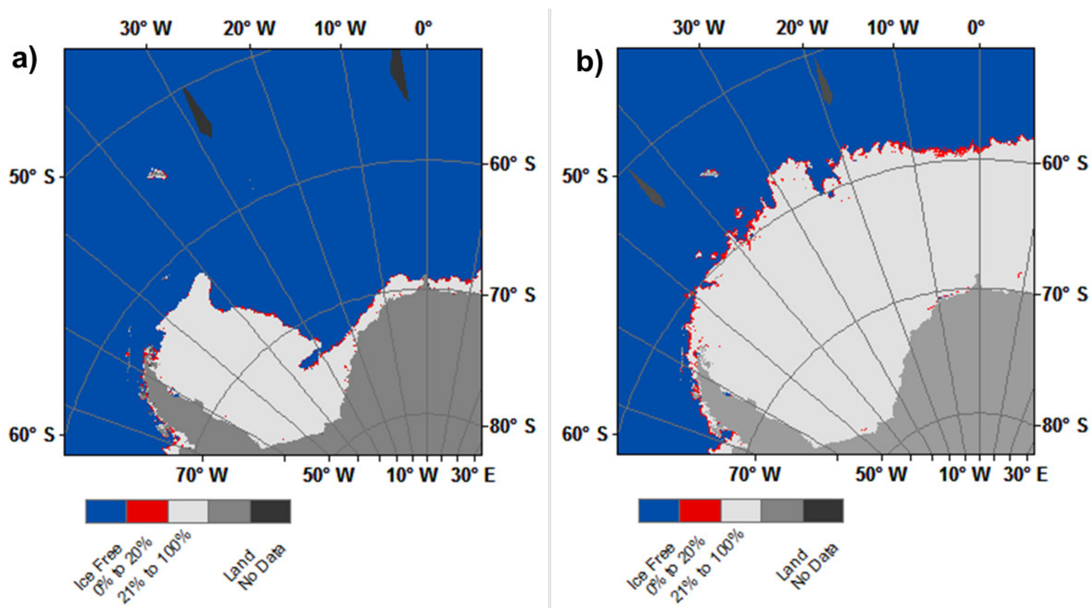


Figure 6.1 AMSR-E ice concentration (%) with ice edge 20% concentration threshold. a) Sea ice concentration for 09 April 2005. b) Sea ice concentration for 15 November 2007. The range of the ice edge based on a concentration threshold of up to 20% is in red.

The ice edges detected from 2005 through 2009 show that there is low interannual variability in months June through September. In April 2005, 2006, and 2007, the sea ice edge is farther to the south than in 2008 and 2009. Despite differences in sea ice extent in austral autumn, by the end of winter the extents reach the same latitude. The differences in April in May are likely due to more summer melt in the summer seasons leading to 2005, 2006, and 2007. .

6.3 Discussion of Sea Surface Energy Balance: 2005 - 2009

During 2005 – 2009, monthly averaged storm characteristics indicate storms are less strong than the mean of monthly storms between 1979 and 2013. Monthly anomalies show a lower than average storm frequency. The minimum sea level pressure anomalies are higher than the mean, while IKE and storm duration anomalies are lower than the mean. The horizontal scale, ice extent and maximum wind anomalies are positive and negative in the time period. Higher than normal sea ice extents for the 2005 through 2009 period agree with the findings of Parkinson and Cavalieri (2012). Fewer storms during the entire time period and higher minimum sea level pressures in the same time period indicate that there is a decrease in both the strength and frequency of small scale storms. The lower than average IKE per month for the 2005 through 2009 period supports the idea that the storms in the time period were shorter and less destructive overall despite occasional higher than normal wind speeds.

Most of the sea ice forms during the autumn and early winter months (MAM and JJA). The locations of the highest sea ice potential growth vary by time. The highest rate of sea ice growth tends to occur, for most scenes, at the ice edge. This is likely because the sea ice cover is generally increasing or stable in the months between

April and November. Other regions for high sea ice growth are along the edge of the ice shelf, likely due to low ice concentration from katabatic winds. After September, Antarctic sea ice extent starts to decrease, but in November, it is likely that the surface downward fluxes remain sufficiently negative for conditions to be favorable for ice growth.

The ice growth rate is dependent on where the latent heat flux and sensible heat flux are negative. Where the downward latent heat flux is negative, ice can form from seawater, and when positive, water can form from ice. The negative sensible heat flux is where the heat is being drawn upwards and sea ice can form. The ice growth rate is a measure of where ice can form, and the ice volume production is dependent on the existence of some open water fraction and the growth rate. Because of the large area, the sea ice volume is more dependent on the availability of open water to freeze than on the other terms in the energy balance equation. Similarly, the brine rejection per day is based on the pixel ice area, the open water fraction, and the ice growth rate. Because of the high influence of the open water fraction on sea ice volume growth and brine rejection, the spatial pattern of regions with high sea ice growth and high brine rejection are similar.

Chapter 7

CONCLUSIONS AND FUTURE RESEARCH

7.1 Overall Conclusions

This work addresses the primary research questions posed in Chapter 1. The first set of questions focus on the characteristics of mesoscale polar storms in the Weddell Sea over the last 36 years (01 January 1979 – 31 August 2014) and which storm characteristics are best correlated with changes in the sea ice cover. This dissertation identifies and characterizes 2540 storms in the Weddell Sea based on reanalysis fields from 01 January 1979 to 31 August 2014. The storm frequency, duration, lowest sea level pressure, and highest wind speeds are all correlated with the sea ice area. The second question asks how are the sea ice extent and area affected by small scale storms in the Weddell Sea? The strength of the storms and the ice area appear to be related via an integrated kinetic energy of the storm term. An increase in the total integrated kinetic energy of a storm is associated with a change in the sea ice area but not correlated with the sea ice extent.

The final set of questions considers the sea ice energy balance and the sea ice cover. The questions posed are how is the sea ice growth rate affected by the occurrence and characteristics of a polar mesoscale storm and how much can the occurrence of a storm affect the production of brine input to the water column? To examine the local variability of sea ice growth and the potential for brine to be rejected to the surface layer of the Weddell Sea, an ice edge detection algorithm is developed and applied to 40 case studies between 2005 and 2009. The ice edge detection is based on AMSR-E sea ice concentration. This dissertation notes that despite significant interannual variability at the beginning and end of the growth season, the ice edge maximum extent in winter reaches the same latitude in all five years. Using the ice edges detected to bound the domain for surface energy balance calculations, the surface energy balance, sea ice growth rate, and salt flux in the areas of open water within the ice pack are determined. The area of open water where there is a potential for freezing is more influential in the total sea ice salt input quantity than any single surface energy balance term

An increase in the area, duration, and strength of storms affects the open water fraction within the ice pack. The relationship is simplified by quantifying the integrate kinetic energy of the storm. This characteristic includes information about the size, duration, and strength of each storm. Storm IKE and sea ice area are correlated both positively and negatively. Depending on the location and direction, winds can cause sea ice convergence or divergence – decreasing or increasing the sea ice cover and concentration. Winds can also decrease the surface sensible heat flux which encourages sea ice formation.

The occurrence of storms and sea ice growth, area, and extent, is complicated because, although the storms influence the sea ice, the sea ice also influences the storm location and formation. The analysis in this dissertation focuses on the changes in the ice and storm characteristics which change concurrently.

Other factors besides sea ice formation contribute to the stability of the top of the water column by affecting the density. Fresh water inputs from precipitation and runoff lead to fresher surface water. An upward heat flux from lower layers in the ocean can warm this surface layer and increase stability (Martinson 1991). Although there are other contributing factors, sea ice formation has been found to be one of the most influential factors (Komuro and Hasumi 2003). Although sea ice growth in coastal polynyas contributes more to the deep water formation, Killworth (1983) shows ice growth in open ocean polynyas contribute to deep water formation as well. The area of open water available for sea ice growth is more influential on the volume of sea ice produced than the surface energy budget. This is because the highest potential rates of sea ice growth calculated during sea ice growth months 2005-2009 are less than 1 m day^{-1}. However, each additional pixel of open water in the AMSR-E sea ice concentration map adds another 39 km^2 of sea ice area for the volume growth and sea ice production. An entire pixel rarely is 100% ice free, but higher resolution sea ice concentration maps can resolve smaller regions with low ice concentration.

The polar storms identified throughout this dissertation may affect sea ice area by increasing the amount of open water within the ice pack available to freeze and form new sea ice. Determining how sea ice area varies with the strength of polar storms leads to a better understanding of the importance of one of the factors involved in determining the surface energy balance: open water area.

7.2 Future Considerations

The results presented in this dissertation naturally lead to new research questions. Additional areas of research include further investigation of the relationship of sea ice area and storm strength via the IKE term. The location of the storm as it moves through the Weddell Sea is likely to influence the amount of open water formed by sea ice divergence or convergence. Future efforts will need to focus on localized effects of polar storms. The impact of individual characteristics which are a part of the IKE calculation on sea ice area will also be determined. More research is needed to understand the relationship of storm duration and sea ice area.

Further research is needed to evaluate how destabilization of the surface of the water column through sea ice growth and brine rejection. The Sea Ice Research Group at the University of Delaware is exploring modeling the deep water formation based on changing polar storm forcing in the Weddell Sea using an ocean-sea ice general circulation model developed at the Massachusetts Institute of Technology.

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Appendix A

ANALYSIS SCRIPTS

This section contains three analysis scripts. The first is a Python script, ConvertNetCDFtoRaster.py, written with ArcGIS geoprocessing commands to convert the size, resolution, projection, and file type of NetCDF files with reanalysis fields to raster images compatible with the AMSR-E sea ice concentration maps. The second script, IDStormCharacteristics.m, is a MATLAB script which reads NetCDF reanalysis fields from January 1979 through August 2014 and identifies where and when storms occur within the Weddell Sea. The third script, SeaIceGrowth.m, uses the converted files from the first script and sea ice concentration maps as input. The script calculates the surface energy balance on the open water areas in the concentration images. On the same areas it calculates the sea ice thickness growth and the salt rejection from new sea ice.

```
# ConvertNetCDFtoRaster.py
# Import system modules
import arcpy, time
from arcpy import env       # Environment Variable Packagewhile in ArcGIS
#Set workspace environment
arcpy.env.workspace = "C:/Users/erbern/Documents/ArcGIS/Rasters/"
MatchRaster = "C:/Users/erbern/Documents/GISWork/OW20050409.tif"
# Set local variables - change for variable
#4 times daily fields
inNetCDFFile = ".../.../File.nc"
variable = "variablename"

XDimension = "longitude"
YDimension = "latitude"
```

```
#Monthlist for naming purposes only
monthlist=["Apr05", "May05","Jun05", "Jul05","Aug05", "Sep05","Oct05",
        "Nov05","Apr06", "May06","Jun06", "Jul06","Aug06", "Sep06","Oct06",
        "Nov06",  "Apr07", "May07","Jun07", "Jul07","Aug07", "Sep07","Oct07",
        "Nov07",        "Apr08", "May08","Jun08", "Jul08","Aug08",
        "Sep08","Oct08", "Nov08",  "Apr09", "May09","Jun09", "Jul09","Aug09",
        "Sep09","Oct09", "Nov09"]
timeindexlist=[395, 539, 663, 783, 907, 1031, 1151, 1275, 1879, 1999, 2123, 2243,
        2367, 2491, 2611, 2731, 3339, 3459, 3583, 3703, 3827, 3951, 4071, 4195,
        4803, 4923, 5047, 5167, 5291, 5415, 5531, 5659, 6263, 6383, 6507, 6627,
        6751, 6875, 6995, 7119]
datelist=[20050409, 20050515, 20050615, 20050715, 20050815, 20050915,
        20051015, 20051115,  20060415, 20060515, 20060615, 20060715, 20060815,
        20060915, 20061015, 20061114,  20070415, 20070515, 20070615, 20070715,
        20070815, 20070915, 20071015, 20071115,  20080415, 20080515, 20080615,
        20080715, 20080815, 20080915, 20081014, 20081115,  20090415, 20090515,
        20090615, 20090715, 20090815, 20090915, 20091015, 20091115]
for timeindex, date, month in zip(timeindexlist, datelist, monthlist):
   outRasterLayer =str(variable)+str(date)
   bandDimmension = ""
   dimensionValues = [["time", timeindex]]
   valueSelectionMethod = "BY_INDEX"
   # Execute Process MakeNetCDFRasterLayer
   arcpy.MakeNetCDFRasterLayer_md(inNetCDFFile, variable, XDimension,
        YDimension, outRasterLayer, bandDimmension,
        dimensionValues,valueSelectionMethod)
   ProjectRaster =
        "C:\\Users\\erbern\\Documents\\ArcGIS\\Default.gdb\\ProjRas1"+str(variable)
        + str(date)
   # Process: Project Raster
   tempEnvironment0 = arcpy.env.outputCoordinateSystem
   arcpy.env.outputCoordinateSystem =
        "PROJCS['Polar_Stereographic',GEOGCS['GCS_WGS_1984',DATUM['D_W
        GS_1984',SPHEROID['WGS_1984',6378137.0,298.257223563]],PRIMEM['G
        reenwich',0.0],UNIT['Degree',0.0174532925199433]],PROJECTION['Stereogr
        aphic_South_Pole'],PARAMETER['false_easting',0.0],PARAMETER['false_n
        orthing',0.0],PARAMETER['central_meridian',0.0],PARAMETER['standard_p
        arallel_1',-70.0],UNIT['Meter',1.0]]"
   tempEnvironment1 = arcpy.env.snapRaster
   arcpy.env.snapRaster = MatchRaster
   tempEnvironment2 = arcpy.env.extent
   arcpy.env.extent = "-2490625 715625 484375 4171875"
   tempEnvironment3 = arcpy.env.geographicTransformations
```

```
    arcpy.env.geographicTransformations = ""
    arcpy.ProjectRaster_management(outRasterLayer, ProjectRaster,
        "PROJCS['Polar_Stereographic',GEOGCS['GCS_WGS_1984',DATUM['D_W
        GS_1984',SPHEROID['WGS_1984',6378137.0,298.257223563]],PRIMEM['G
        reenwich',0.0],UNIT['Degree',0.0174532925199433]],PROJECTION['Stereogr
        aphic_South_Pole'],PARAMETER['false_easting',0.0],PARAMETER['false_n
        orthing',0.0],PARAMETER['central_meridian',0.0],PARAMETER['standard_p
        arallel_1',-70.0],UNIT['Meter',1.0]]", "BILINEAR", "6250", "", "", "")
    arcpy.env.outputCoordinateSystem = tempEnvironment0
    arcpy.env.snapRaster = tempEnvironment1
    arcpy.env.extent = tempEnvironment2
    arcpy.env.geographicTransformations = tempEnvironment3
OutRasterTif="../../"+str(variable)+ month +".tif"
    # Process: Clip
    arcpy.Clip_management(ProjectRaster, "-2490625 715625 484375 4171875",
        OutRasterTif, MatchRaster, "", "NONE", "MAINTAIN_EXTENT")
```

```
% IDStormCharacteristics.m
% Read Wind and Pressure files from Reanalysis
u10m = ncread('u10m.nc','u10');
v10m = ncread('v10m.nc','v10');
msl = ncread('msl.nc', 'msl');
seaice = ncread('seaice.nc', 'ci');
times = ncread('u10m.nc','time');
outfile='StormData.csv';
tt= size(times);
lats = ncread('u10m.nc','latitude');
longs = ncread('u10m.nc','longitude');
nlat = 35;
nlong = 148
%Calculate wind speeds (s=Root(u^2+v^2)
speed(:,:,:) = sqrt((u10m(:,:,:).^2)+(v10m(:,:,:).^2));
%Identify when criteria are met for storm conditions
timecount=0;
for t=1:tt;
   [findlong,findlat]=find((msl(:,:,t) <= 96000.0) & (speed(:,:,t) >= 15.0));
   if size(findlong) > 0
      timecount=timecount+1;
   end
end
counttimes=zeros(timecount,1);
timestepcount=0;
 for t=1:tt;
   [findlong,findlat]=find((msl(:,:,t) <= 96000.0) & (speed(:,:,t) >= 15.0));
   if size(findlong) > 0
      timestepcount=timestepcount+1; %New index for existing storms
      counttimes(timestepcount)=t;
   end
 end
 SurfaceArea=zeros(timestepcount,1); %create array for surface areas
 longitudes=zeros(200,timestepcount);
 latitudes=zeros(200,timestepcount);
 ncnt=0;
for t=1:timestepcount; % loop through the vector oftimes of storms
   step=counttimes(t);
   [findlong2,findlat2]=find((msl(:,:,step) <= 97500.0) & (speed(:,:,step) >= 15.0));
   ncnt=ncnt+1;
   %the following are the lat and longs of the storm
   longitudes(1:max(size(findlong2)),ncnt)=findlong2; %The INDEX of the lat/long
   latitudes(1:max(size(findlat2)),ncnt)=findlat2;
```

```
end
radiussquare=6371000^2;
%Calculate grid cell earth surface area and Integrated Kinetic Energy of a cell
CellArea=zeros(200,timestepcount);
UsquaredCell=zeros(200,timestepcount);
IKEcell=zeros(200,timestepcount,2);
IKETJcell=zeros(timestepcount,2);
IKETJTimeStamp=zeros(timestepcount,1);
StormAreaTimeStamp=zeros(timestepcount,1);
StormDiameterTimeStamp=zeros(timestepcount,1);
rho=1.; %1 kg m-3 air density
depth=1.; %1 meter depth for volume
timeinsec=60*60*6;%6 hours of seconds
for t=1:timestepcount;
   step=counttimes(t);
   for i=1:200;
      if latitudes(i,t)>0; %stop the area check when no values
         stoploop=i;
      end
   end
   stoploop;
   SurfaceArea(t)=0.;
   for j=1:stoploop;%ADD SUMMATION
      lambda2minuslambda1=(pi/180.)*(longs(longitudes(j,t))-(longs(longitudes(j,t))-
         .75));
      sinphi2=sind(lats(latitudes(j,t)));
      sinphi1=sind(lats(latitudes(j,t))-.75);
      CellArea(j,t)=(radiussquare*lambda2minuslambda1*(sinphi2-sinphi1));
      UsquaredCell(j,t)=(speed(longitudes(j,t),latitudes(j,t),step))^2;
      IKEcell(j,t)=.5*rho*UsquaredCell(j,t).*CellArea(j,t);
      IKETJcell(j,t)=.5*rho*UsquaredCell(j,t).*CellArea(j,t)*depth/timeinsec/(10^12);
   end
   StormAreaTimeStamp(t)=sum(CellArea(1:stoploop,t));
   % Estimate storm diameter from the area of the storm
   StormDiameterTimeStamp(t)=sqrt(StormAreaTimeStamp(t)/pi)*2.;
   IKETJTimeStamp(t)=sum(IKETJcell(1:stoploop,t))/(sum(CellArea(1:stoploop,t)));
end
stormindex = zeros(timestepcount,1);
stormtime=zeros(timestepcount,1);
initialdate=datenum('01-Jan-1900 00:00:00');
for t=1:timestepcount;
   step=counttimes(t);
   stormindex(t) = step;
```

```
    stormtime(t)=(addtodate(initialdate,times(stormindex(t)),'hour'));
end
 stormchardate=datestr(stormtime);
% Fastest wind speed and lowest mslp are below
lowmsl=zeros(timestepcount,1);
highwind=zeros(timestepcount,1);
for d=1:timestepcount;
    lowmsl(d)=min(min(msl(:,:,stormindex(d))));
    highwind(d)=max(max(speed(:,:,stormindex(d))));
end
%find storm durration
laststormtime=zeros(timestepcount,1);
stormduration=zeros(timestepcount,1);
countstormlength=0;
countstormnumber=0;
for d=1:timestepcount-1;
    if stormindex(d)==stormindex(d+1)-1;
        countstormlength=countstormlength+1; %length of storm
    else
        'next storm';
        countstormnumber=countstormnumber+1;
        timecnt=0;
        laststormtime(d)=stormindex(d);
        stormduration(d)=countstormlength+1;
        countstormlength=0;
    end
end
% If storm hasn't ended by end loop add another storm
if stormindex(timestepcount-1)==stormindex(timestepcount)-1;
    laststormtime(timestepcount)=stormindex(timestepcount);
    stormduration(timestepcount)=countstormlength+1;
    countstormnumber=countstormnumber+1;
end
% Get Storm Characteristics for storm duration
finaldateofstorm=zeros(countstormnumber,1);
finalstormindex=zeros(countstormnumber,1);
finaltimeofstorm=zeros(countstormnumber,1);
stormlength=zeros(countstormnumber,1);
stormmaxwind=zeros(countstormnumber,1);
stormminslp=zeros(countstormnumber,1);
stormIKETJ=zeros(countstormnumber,1);
MaxStormDiameter=zeros(countstormnumber,1);
ncnt=0;
```

```
for t=1:timestepcount;
        if laststormtime(t) > 0;
            ncnt=ncnt+1;
            finaltimeofstorm(ncnt)=laststormtime(t);
            finaldateofstorm(ncnt)=stormtime(t);
            stormlength(ncnt)=stormduration(t);
        end
end
ncnt=0;
for t=1:timestepcount;
        if laststormtime(t) > 0;
            ncnt=ncnt+1;
            highindex=t;
            lowindex=t-stormduration(t)+1;
            stormmaxwind(ncnt)=max(highwind(lowindex:highindex));
            stormminslp(ncnt)=min(lowmsl(lowindex:highindex));
            stormIKETJ(ncnt)=sum(IKETJTimeStamp(lowindex:highindex))*stormlength
            (ncnt)*timeinsec;
            finalstormindex(ncnt)=stormindex(t);
            MaxStormDiameter(ncnt)=max(StormDiameterTimeStamp(lowindex:highinde
            x));
        end
end
%Table storm characteristics and save data
Eventlength=stormlength*6;
datestringEvent=cellstr(datestr(finaldateofstorm));
TableDatabyEvent=table(datestringEvent,finalstormindex,Eventlength,storminslp,st
            ormmaxwind,stormIKETJ,MaxStormDiameter,...
'VariableNames',{'datestringEvent','finalstormindex', 'Eventlength','stormminslp',
            'stormmaxwind','stormIKETJ','MaxStormDiameter'})
writetable(TableDatabyEvent,outfile,'Delimiter',',');
```

```
%SeaIceGrowth.m
%Equations for the amount of salt rejected by sea ice
%Equation 6 from Geiger and Drinkwater 2005 for salt production requires equation 5
        (the new ice production) from the same paper and the surface energy balance
%Terms:
%Hi: Heat gained or lost at the air-sea interface in Wm-2
%Hi is the sum of the following 7 terms=>
%Hs: Sensible heat flux calculated based on Maykut 1998 and Geiger 2006
%Hl: Latent heat flux calculated based on Maykut 1998 and Geiger 2006
%Ql: Incoming longwave radiation from reanalysis
%Qbb: Outgoing longwave radiation (black body)
%Qs: Incoming Solar shortwave Radiation from reanalysis
%Fw: Ocean heat flux estimated value from Geiger 2006
%Fri: Radiation trapped or absorbed in ice
%list months for looping through file names
month = {'Apr05', 'May05','Jun05', 'Jul05','Aug05', 'Sep05','Oct05', 'Nov05', ...
    'Apr06', 'May06','Jun06', 'Jul06','Aug06', 'Sep06','Oct06', 'Nov06', ...
    'Apr07', 'May07','Jun07', 'Jul07','Aug07', 'Sep07','Oct07', 'Nov07', ...
    'Apr08', 'May08','Jun08', 'Jul08','Aug08', 'Sep08','Oct08', 'Nov08', ...
    'Apr09', 'May09','Jun09', 'Jul09','Aug09', 'Sep09','Oct09', 'Nov09'};
%outfile=strcat('VolDay',month(1),'.tif');
filenameH='Nov09Hi.tif';
filenameS='Nov09Sf.tif';
filenameV='Nov09Gi.tif';
for d=1:40
%read in all data files (ice from AMSRE, ECMWF inputs, Masks)
filename=strcat('OW',month(d));
openwateramount=imread(char(filename),'Tiff');
%Openwateramount has been classified from 0-100 so that 100 is 100%
%open water
filename=strcat('u10',month(d),'.tif');
uread=imread(char(filename),'Tiff'); %u wind in m s-1
filename=strcat('v10',month(d),'.tif');
vread=imread(char(filename),'Tiff'); %vwind in m s-1
filename=strcat('t2m',month(d),'.tif');
Tair=imread(char(filename),'Tiff');% Ta is Air temp in Kelvin
filename=strcat('d2m',month(d),'.tif');
Tdew=imread(char(filename),'Tiff'); %Dewpoint Temperature in K
filename=strcat('tcc',month(d),'.tif');
cloudcover=imread(char(filename),'Tiff'); %Cloud cover fraction
filename=strcat('msl',month(d),'.tif');
surfacepressure=imread(char(filename),'Tiff'); %Already in PA
```

```
filename=strcat('strd',month(d),'.tif');
strd=imread(char(filename), 'Tiff'); %Surface thermal radiation downwards in Jm-2
filename=strcat('ssrd',month(d),'.tif');
ssrd=imread(char(filename), 'Tiff'); %Surface solar radiation downwards in Jm-2
icearea=double(openwateramount(1:552,1:475));
landmask=imread('Landis0Mask01.enp.tif', 'Tiff');
%Land mask is in 0,3s, so convert to 0,1s and add the other part.
landmask=double(landmask(1:552,1:475)/3.);
%No data in Netcdf mask are set to -1000000.  Turn to a 0,1 image
NetcdfMask=imread('Netcdf1s.tif', 'Tiff');
for r=1:552
  for col=1:475
      if NetcdfMask(r,col)< 0
        NetcdfMask(r,col)=0;
      end
      if icearea(r,col) > 200
        icearea(r,col) = 0; %removes ice-free and land from calculation
      else
        icearea(r,col)=1;
      end
    end
 end
icearea(150:170,5:40)=0; %Remove island from calculations because of edges
%The ice area mask will change with each input file for open water
AllMask= landmask(1:552,1:475) .*double(NetcdfMask(1:552,1:475)) .* icearea;
Iceareanomask=double(openwateramount(1:552,1:475)) ;%.* AllMask ; %values are
      in 0-100
A=(Iceareanomask *.01 ).* AllMask;
for r=1:552
   for col=1:475
      if A(r,col)> 1
        A(r,col)=0;
      end
    end
end
%End mask section
 [findrow,findcol]=find((A(:,:) ==1)); %finds open water areas
i0=425;j0=150;
%Constants
 Lv=2.5*10^6; %from Markus et al 1998 and Parkinson and Washington
%From Parkinson and Washington 1979
Ds=1.3163*1004*.00175; %air density *cp*CH based on Parkinson and Washington
      1979; 2.28; %bulk sensible heat transfer coefficient in Jm-3K-1
```

```
%Dl=5.69*10^3; %bulk latent heat transfer coef over open water in Jm-3K-1
Dl=1.3163*Lv*.00175; %air density *L*CE based on Parkinson and Washington
        1979;%Dl= 6.45*10^3; %bulk latent heat transfer coef over ice in Jm-3K-1
Dsb=5.67*10^(-8); %Stefan-boltzmann constant * surface emisivity in Wm-2K-4
%Used in Geiger and Drinkwater 2005
emissivitywater=0.98;
rhoi=950.; %sea ice density in kg m-3 from Geiger and drinkwater
%Lf=3.34*10^5; %latent heat of fusion in J kg -1 for freezing salt
%water from GEIGER 2006
%Parameters to input from NETCDF data conversions
%V wind speed is calculated from u wind and v wind
u10=uread(1:552,1:475).* AllMask;
 for r=1:552
     for col=1:475
        if u10(r,col)< -1000
           u10(r,col)=-99;
        end
     end
  end
  v10=vread(1:552,1:475).* AllMask;
V=((u10.^2+v10.^2).^(1/2)); % in m s-1
for r=1:552
  for col=1:475
        if V(r,col) > 100
           V(r,col) = 0;
        end
     end
 end
%'Wind in m/s',V(i0,j0)
%Temperature, Dewpoint Temp, RH
Ta=Tair(1:552,1:475).* AllMask;% Ta is Air temp in Kelvin
Tw=273-1.9; %Water temp in Kelvin - ASSUME if there is ice T is -1.9 c,
Ti= 273-1.9; %Ice temp in Kelvin? - ASSUME
% RH= Relative humidity in percent and requires Ta & Td (both celcius), %saturation
        vapor pressure and vapor pressure
Td=Tdew(1:552,1:475).* AllMask; %Dewpoint Temperature in K
Espower=(7.5*(Ta-273) ./ (237.16+(Ta-273)));
Embpower=(7.5*(Td-273) ./ (237.16+(Td-273)));
Es=6.11*10.0 .^ Espower; %Saturation Vapor Pressure
Emb=6.11*10.0 .^ Embpower; %actual vapor pressure in MB
RH=(Emb./Es).* AllMask;
Lf=3.34e05;%3Jkg-1latent heat of fusion for growth rate
c=cloudcover(1:552,1:475).* AllMask;
```

```
%Following loop is to fill prime meridian data gap
for r=1:552
   for col=1:475
         if c(r,col)< -10
            c(r,col)= c(r,col+30);
         end
      end
   end
albedo=0.08; %Maykut
sw=34.45; %water salinity %Gordon 1998
si=sw*.31; %sea ice salinity from Geiger and Drinkwater 2005
an=17.2694;%empirical constants for conditions over open water
bn=35.86; %empirical constants for conditions over open water
P0=surfacepressure(1:552,1:475) .* AllMask; %in Pa
   for r=1:552
      for col=1:475
         if P0(r,col)< -10
            P0(r,col)= P0(r,col+30);
         end
      end
   end
E=0.622; %E is the ratio of dry air to vapor gas constants (no unit)
eai=611^((an*(Ti-273.16))/(Ti-bn)); %eai is the vapor pressure for qi calc
qi=E*eai ./ P0 ; %specific humidity at the ice surface
eaa=611.^((an*(Ta-273.16))./(Ta-bn)); %eaa is the vapor pressure for qa
qa= (E*eaa ./ P0) .* RH; %Specific humidity of the air
%Calculate each term
%Hs=rhoair*
Hs = Ds*V.*(Ta-Tw); %Sensible downward heat flux
Hl = Dl*V.*(qa.*Ta-qi.*Ti); %latent heat
%Surface thermal radiation downwards in Jm-2 is strd.It includes clouds
%ECMWF data are integrated over 12 hours, so we divide by 3600*12.
Qld=strd(1:552,1:475).* AllMask; % Data in Jm-2. 1watt=1joule/s.
Qld=Qld/(3600*12); %In Wm-2
Qlu = emissivitywater*Dsb*(Ti)^4; %(where Dsb is the stefan boltzman constant)
Qs=ssrd(1:552,1:475).* AllMask; %Jm-2
Qs=Qs/(3600*12); %now in Wm-2
Fw = 7; %From Geiger 2005, assume oceanic heatflux is 7wm-2
Fri = 0; %No heat is trapped because there is no ice cover
%Calculate Heat gained or lost at the air/sea interface in W m-2
Hi = Hs+Hl+Qld-Qlu+(1-albedo)*Qs+Fw+Fri;
%heat flux is valid only where new ice forms
%Calculate sea new ice production if there is open water
```

```
Gi=zeros(552,475);
Gicmps=zeros(552,475); %growth rate in cm/s
Sf=zeros(552,475);
Area=zeros(552,475);
VolIceDay=zeros(552,475);
for r=1:552
    for col=1:475
      if (Hi(r,col) <= 1) && (A(r,col) >= .09);% &&   (A(r,col) <= 1)&&
        Gi(r,col)=-Hi(r,col)/(rhoi*Lf); % Lf is the latent heat of fusion
        if Gi(r,col) < 0;
          Gi(r,col)=0;
        end
        Gicmps(r,col)=1000*(Gi(r,col)* AllMask(r,col));%cmps is in cm/s
        VolIceDay(r,col)=(Gi(r,col)* AllMask(r,col))*3600*24*
      A(r,col)*(6250*6250); %mperday
        %Calculate salt production
        dt=3600*24; %seconds in an hour times number of hours in day
        Area(r,col)= A(r,col)*(6250*6250); %open water fraction *
       %sf in kg per day below
        Sf(r,col)=(sw-si)*rhoi*(Gi(r,col)*dt)*Area(r,col);
      end
    end
end
```

Appendix B

STORM CHARACTERISTICS

A total of 2450 storms are identified from 01 January 2014 through 31 August 20114 (Section 5.1). The following characteristics of the storm are listed in the table in this appendix: final date and time of the storm, duration, minimum sea level pressure, maximum wind speed, integrated kinetic energy, and diameter.

Table B.1 Storm Dates and Characteristics

Final Date & Time	Duration (h)	Minimum MSLP (Pa)	Maximum Wind Speed (m s^{-1})	Total IKE (TJ)	Diameter (m)
1/3/1979 12:00	6.00	95685.49	21.17	162.37	574950.38
1/22/1979 18:00	24.00	95147.69	24.47	2283.60	594687.16
1/26/1979 12:00	6.00	95644.57	20.07	141.94	647080.71
2/9/1979 0:00	36.00	94680.51	26.02	5021.71	860056.05
2/15/1979 0:00	30.00	95159.94	24.86	3965.25	761633.51
3/3/1979 6:00	36.00	94747.40	22.23	5580.29	899640.54
3/7/1979 6:00	6.00	95575.81	17.06	118.61	405194.50
3/12/1979 12:00	12.00	95556.28	24.86	610.66	695467.44
3/22/1979 18:00	54.00	93901.75	26.64	12882.92	917396.18
3/23/1979 6:00	6.00	95411.92	19.02	122.37	524699.19
3/26/1979 12:00	48.00	94571.87	26.14	11257.23	816875.03
4/1/1979 18:00	24.00	95181.96	24.48	2287.17	442389.80
4/6/1979 18:00	108.00	94054.22	27.46	48183.59	826419.41
4/8/1979 0:00	24.00	95046.53	24.43	2673.05	709448.95
4/10/1979 18:00	54.00	94084.13	24.20	11774.98	904555.55
4/16/1979 0:00	48.00	93830.71	27.69	10926.25	829429.72
4/18/1979 0:00	42.00	94872.45	23.90	6847.73	923330.26
4/20/1979 18:00	30.00	95101.37	23.49	3598.90	829283.10
4/23/1979 6:00	42.00	94169.09	20.68	6835.51	776473.18

Final Date & Time	Duration (h)	Minimum MSLP (Pa)	Maximum Wind Speed ($m\ s^{-1}$)	Total IKE (TJ)	Diameter (m)
4/27/1979 6:00	6.00	95557.53	27.60	186.46	646756.06
4/29/1979 0:00	36.00	94664.73	29.76	6979.45	649512.92
5/5/1979 12:00	36.00	94754.46	22.59	5588.08	929147.97
5/8/1979 18:00	60.00	93729.34	28.68	16490.71	874432.06
5/9/1979 12:00	6.00	95670.12	22.60	169.50	659193.41
5/15/1979 12:00	60.00	94237.64	24.75	16574.26	787155.65
5/18/1979 6:00	60.00	92823.45	26.83	19060.84	903397.66
5/22/1979 12:00	12.00	95492.93	20.24	542.86	498865.88
5/24/1979 12:00	12.00	95395.09	24.69	605.22	638197.76
5/30/1979 6:00	12.00	95532.40	25.08	638.92	748512.86
6/3/1979 6:00	78.00	94093.07	27.22	28654.81	766758.23
6/7/1979 18:00	18.00	94993.97	27.89	1488.43	673107.71
6/13/1979 18:00	36.00	94049.24	29.26	6192.53	758728.86
6/15/1979 6:00	6.00	95560.23	20.13	151.36	546099.39
6/16/1979 18:00	12.00	95049.23	25.14	602.68	813149.93
6/19/1979 6:00	6.00	95300.57	21.69	153.02	531088.37
6/21/1979 0:00	24.00	95166.80	24.65	2327.61	612285.87
6/23/1979 0:00	36.00	94685.08	20.80	5222.33	690737.91
7/2/1979 12:00	6.00	95656.62	20.27	158.78	565752.51
7/5/1979 6:00	36.00	93644.17	31.45	5779.17	800559.50
7/17/1979 12:00	282.00	91979.88	36.98	338205.38	854224.15
7/21/1979 0:00	36.00	95250.10	21.93	5380.88	730825.34
7/21/1979 12:00	6.00	95129.41	22.26	146.15	790561.84
7/22/1979 6:00	12.00	94935.81	23.91	580.65	588287.14
7/22/1979 18:00	6.00	95485.66	28.02	166.30	820758.80
7/26/1979 12:00	72.00	94355.22	25.77	20662.07	847917.70
7/29/1979 6:00	18.00	94751.97	21.09	1342.38	538961.09
8/7/1979 12:00	90.00	93239.94	32.61	35810.25	842638.60
8/16/1979 12:00	72.00	94465.73	31.80	21506.87	700191.18
8/21/1979 6:00	66.00	92676.59	34.73	18358.13	808585.26
8/25/1979 0:00	60.00	93948.28	28.65	16714.56	895003.22
8/28/1979 18:00	6.00	95081.22	25.85	190.69	545055.89
8/30/1979 18:00	42.00	94575.20	25.17	7555.55	806851.21
9/3/1979 18:00	42.00	93933.53	32.80	8535.81	935020.20
9/6/1979 0:00	30.00	94339.22	31.29	4992.32	723829.01
9/14/1979 12:00	120.00	93234.12	27.80	58861.97	845007.82
9/17/1979 18:00	66.00	94020.36	25.37	17513.68	600665.44

Final Date & Time	Duration (h)	Minimum MSLP (Pa)	Maximum Wind Speed (m s^{-1})	Total IKE (TJ)	Diameter (m)
10/1/1979 0:00	6.00	95986.28	19.23	131.63	483586.20
10/3/1979 6:00	18.00	95078.31	23.53	1274.41	896432.48
10/5/1979 18:00	6.00	95616.32	22.21	142.13	502254.70
10/13/1979 0:00	24.00	95311.58	23.79	2212.07	526694.50
10/20/1979 18:00	36.00	94240.14	26.32	5607.61	771435.94
10/26/1979 0:00	24.00	95190.06	21.07	2527.73	659385.26
10/27/1979 12:00	30.00	95195.05	23.94	3547.84	742557.91
10/30/1979 18:00	72.00	93784.59	22.89	20351.53	882751.97
11/10/1979 12:00	60.00	94506.44	39.75	14860.60	856970.83
11/17/1979 12:00	78.00	94095.97	25.59	24943.86	881164.82
11/23/1979 6:00	48.00	94637.31	26.73	9711.58	817982.58
11/23/1979 18:00	6.00	95431.03	22.88	168.50	638885.65
11/26/1979 18:00	6.00	95603.85	25.31	177.93	514550.10
12/3/1979 6:00	12.00	95513.70	24.60	598.85	577396.28
1/24/1980 0:00	72.00	93828.22	24.62	19589.67	753994.93
1/27/1980 18:00	66.00	94842.54	24.28	19102.56	738272.75
2/13/1980 0:00	6.00	95659.94	24.53	187.35	506766.78
2/29/1980 6:00	48.00	93668.48	29.19	11167.55	775892.07
3/11/1980 12:00	12.00	95505.81	22.46	588.94	713395.22
3/18/1980 0:00	48.00	93524.73	28.97	11027.63	895034.55
3/23/1980 12:00	18.00	95470.29	21.76	1243.14	550207.99
4/3/1980 6:00	24.00	94893.02	21.89	2291.75	701069.22
4/13/1980 12:00	24.00	95270.45	20.98	2191.03	690369.88
4/16/1980 0:00	36.00	94516.83	29.19	5589.69	648698.29
4/21/1980 6:00	48.00	94662.86	27.25	9694.15	859292.39
4/26/1980 0:00	60.00	93960.33	30.31	16122.93	930788.80
5/4/1980 6:00	42.00	94346.49	24.22	8113.35	879076.43
5/11/1980 12:00	66.00	93745.54	28.07	19393.68	918867.20
5/15/1980 18:00	30.00	95493.34	20.84	3335.47	604529.12
5/19/1980 12:00	12.00	95528.66	22.69	643.02	658385.16
5/22/1980 6:00	54.00	94580.60	28.09	12351.37	801608.22
5/28/1980 6:00	60.00	94966.34	22.29	14107.60	805929.48
5/31/1980 12:00	18.00	95453.67	20.81	1341.70	570710.54
6/3/1980 12:00	24.00	95247.81	23.19	2423.86	803241.24
6/7/1980 0:00	30.00	94778.35	25.63	3526.70	733003.50
6/9/1980 12:00	12.00	95310.75	26.54	604.68	593985.85
6/13/1980 0:00	78.00	94022.44	23.93	25042.89	765401.93

Final Date & Time	Duration (h)	Minimum MSLP (Pa)	Maximum Wind Speed ($m\ s^{-1}$)	Total IKE (TJ)	Diameter (m)
6/17/1980 6:00	54.00	94470.50	29.07	12137.73	842432.68
6/20/1980 18:00	30.00	94864.35	27.72	3660.16	834595.57
6/22/1980 18:00	6.00	95497.08	23.10	174.54	679505.45
6/25/1980 12:00	60.00	94642.71	26.95	15145.03	892607.62
6/30/1980 12:00	18.00	95516.19	24.59	1443.88	448972.46
7/10/1980 0:00	30.00	94421.07	24.43	4678.40	917444.78
7/12/1980 0:00	42.00	93989.83	28.33	8789.42	792919.65
7/14/1980 6:00	24.00	95178.85	28.36	2451.32	902244.67
7/19/1980 0:00	6.00	95608.84	21.21	163.65	501231.71
7/24/1980 0:00	30.00	95214.78	21.57	3658.43	536222.59
7/26/1980 0:00	6.00	95501.86	23.30	154.69	531783.64
7/27/1980 18:00	18.00	95056.08	21.20	1325.18	588919.58
8/2/1980 0:00	114.00	93214.39	33.07	58781.03	812232.56
8/5/1980 6:00	36.00	94275.45	27.59	6370.42	834817.41
8/8/1980 12:00	48.00	93981.93	26.55	10293.27	861136.94
8/13/1980 6:00	48.00	93879.52	35.53	11314.35	795405.18
8/18/1980 0:00	78.00	93879.52	31.49	28663.51	858775.68
8/20/1980 12:00	6.00	95841.28	19.19	140.76	406234.77
8/30/1980 18:00	84.00	94033.24	28.37	32317.43	835233.08
9/2/1980 6:00	48.00	95018.48	25.55	9662.07	563549.02
9/2/1980 18:00	6.00	95366.63	20.21	135.41	694985.37
9/6/1980 0:00	12.00	95182.17	19.46	518.05	260371.81
9/10/1980 18:00	24.00	95244.28	22.58	2372.16	689993.37
9/15/1980 0:00	18.00	95195.88	27.12	1237.95	717902.02
9/16/1980 6:00	24.00	95155.79	23.77	2449.95	916705.12
9/16/1980 18:00	6.00	95746.35	20.35	133.58	596250.81
9/20/1980 0:00	18.00	94989.40	19.03	1209.98	530295.54
9/21/1980 6:00	24.00	94966.97	22.63	2193.83	647471.24
9/22/1980 18:00	24.00	94930.41	21.36	2198.72	811856.94
10/1/1980 18:00	12.00	95318.23	20.28	538.85	527679.56
10/3/1980 12:00	36.00	94941.00	22.07	4767.68	701239.27
10/5/1980 0:00	24.00	94476.11	25.31	2218.00	547213.01
10/6/1980 6:00	12.00	95420.64	26.36	575.84	460467.71
10/11/1980 18:00	60.00	93831.54	27.52	14119.33	850771.34
10/12/1980 6:00	6.00	95296.84	22.59	138.22	526251.84
10/15/1980 12:00	30.00	93504.58	25.19	3945.29	863647.90
10/19/1980 0:00	30.00	94700.25	20.40	3313.33	699623.84

Final Date & Time	Duration (h)	Minimum MSLP (Pa)	Maximum Wind Speed ($m\ s^{-1}$)	Total IKE (TJ)	Diameter (m)
10/20/1980 6:00	24.00	95261.31	28.02	2990.69	629333.70
10/22/1980 12:00	24.00	95142.70	22.38	2409.21	689930.99
10/26/1980 12:00	24.00	95234.93	24.89	2328.15	385542.36
10/28/1980 0:00	12.00	95295.59	18.36	527.94	312783.44
11/1/1980 0:00	48.00	94671.37	30.62	9772.98	844825.91
11/20/1980 12:00	30.00	94371.42	30.42	4196.22	844858.61
11/27/1980 12:00	36.00	95112.17	21.14	4957.76	750424.15
11/30/1980 6:00	24.00	95282.92	31.96	3041.68	656500.36
12/4/1980 0:00	36.00	94869.13	21.65	5006.19	874896.38
12/4/1980 18:00	6.00	95621.10	18.21	130.38	727899.69
12/22/1980 6:00	48.00	94664.10	24.27	10617.90	689260.39
1/5/1981 0:00	48.00	94910.88	21.82	8457.01	833794.70
1/19/1981 0:00	6.00	95773.15	17.51	127.68	374395.91
1/22/1981 18:00	12.00	95159.74	25.50	626.90	596296.16
2/7/1981 12:00	30.00	94044.25	32.43	4146.01	597397.74
2/21/1981 12:00	36.00	94490.65	27.65	6125.25	762133.04
3/2/1981 6:00	30.00	95223.72	23.76	4057.19	609509.16
3/4/1981 18:00	18.00	95601.78	23.71	1475.61	515844.42
3/9/1981 6:00	18.00	95239.30	22.87	1448.54	385316.35
3/15/1981 12:00	24.00	95276.48	27.52	2819.25	692532.65
4/11/1981 12:00	18.00	95211.05	22.79	1427.59	727137.10
4/27/1981 18:00	138.00	94508.31	26.08	76775.57	844534.42
5/1/1981 12:00	72.00	93493.57	25.61	24296.00	864317.47
5/5/1981 12:00	54.00	93583.52	26.02	14807.22	912923.42
5/7/1981 12:00	42.00	94674.28	22.99	7092.35	834129.86
5/10/1981 6:00	12.00	95714.78	20.50	553.42	744707.23
5/14/1981 0:00	6.00	95631.69	22.21	144.52	563175.72
5/15/1981 18:00	24.00	95341.91	25.13	2944.00	392233.62
5/19/1981 0:00	66.00	93841.72	25.77	18600.03	830113.88
5/22/1981 0:00	30.00	94029.50	26.49	3998.12	917694.71
5/24/1981 6:00	30.00	94827.17	24.97	3970.63	689850.30
5/28/1981 6:00	48.00	95116.74	25.06	9046.30	801569.08
6/4/1981 6:00	18.00	95538.21	24.64	1401.60	800902.02
6/7/1981 6:00	12.00	95413.99	23.17	598.03	494384.79
6/12/1981 18:00	108.00	93494.61	27.63	52168.45	798126.78
6/15/1981 12:00	36.00	94443.08	27.65	6498.94	784798.59
6/19/1981 0:00	48.00	93712.72	27.58	9532.02	843271.32

Final Date & Time	Duration (h)	Minimum MSLP (Pa)	Maximum Wind Speed (m s^{-1})	Total IKE (TJ)	Diameter (m)
6/21/1981 18:00	30.00	94890.52	28.79	3720.78	867474.82
6/24/1981 18:00	42.00	95108.01	21.27	7165.43	783937.81
6/28/1981 6:00	48.00	94189.87	22.57	9653.42	863396.20
7/2/1981 12:00	24.00	95180.09	28.41	2964.20	500159.87
7/3/1981 12:00	18.00	95272.53	25.23	1721.07	528581.26
7/5/1981 18:00	12.00	95642.70	22.12	640.05	540491.53
7/9/1981 0:00	60.00	92836.74	36.28	15706.37	904135.78
7/12/1981 6:00	42.00	94525.76	29.92	7889.26	826143.59
7/19/1981 18:00	30.00	94753.84	22.24	3484.17	790502.92
7/26/1981 6:00	48.00	94029.09	32.45	10845.40	864653.67
7/30/1981 18:00	78.00	93081.86	28.01	26519.24	883798.44
8/3/1981 0:00	6.00	95768.58	23.09	187.63	528515.85
8/6/1981 12:00	12.00	95171.37	31.28	708.93	640102.18
8/9/1981 12:00	12.00	95345.44	23.07	670.87	681327.11
8/11/1981 0:00	6.00	95476.10	21.28	146.10	759263.25
8/11/1981 12:00	6.00	95382.00	27.69	162.75	725215.72
8/23/1981 6:00	54.00	94800.58	28.32	12294.06	862951.21
9/1/1981 6:00	24.00	95458.86	29.21	2724.79	562494.69
9/6/1981 6:00	60.00	92813.27	32.39	17426.47	794935.17
9/12/1981 18:00	48.00	94510.18	24.96	11580.84	756436.62
9/17/1981 0:00	42.00	94605.73	25.99	6822.82	728987.02
9/20/1981 6:00	66.00	94811.80	23.07	17478.17	788761.51
9/23/1981 0:00	12.00	95395.71	24.57	611.71	486516.86
9/25/1981 18:00	48.00	93059.84	30.13	10339.16	785120.35
9/26/1981 6:00	6.00	95244.07	26.50	145.89	737568.42
9/27/1981 18:00	12.00	95228.29	33.96	752.45	592021.97
9/29/1981 12:00	24.00	95010.80	26.88	3062.47	493709.51
10/6/1981 18:00	66.00	93824.69	30.13	18547.18	808519.63
10/21/1981 12:00	12.00	95412.33	19.13	505.50	325891.55
10/25/1981 0:00	18.00	94699.62	19.75	1176.08	553851.29
10/27/1981 12:00	54.00	94823.43	20.41	10355.45	675361.94
10/28/1981 0:00	6.00	95357.28	17.57	123.32	427476.97
10/30/1981 12:00	30.00	94725.80	24.37	3999.23	810495.07
11/1/1981 6:00	24.00	94026.59	24.29	2395.45	572689.50
11/2/1981 18:00	24.00	95273.99	24.86	2466.91	549282.21
11/8/1981 18:00	12.00	95596.79	21.71	542.79	523239.57
11/10/1981 12:00	6.00	95636.05	23.45	184.20	418841.88

Final Date & Time	Duration (h)	Minimum MSLP (Pa)	Maximum Wind Speed (m s^{-1})	Total IKE (TJ)	Diameter (m)
11/21/1981 12:00	30.00	94581.22	24.64	4114.26	650856.41
11/24/1981 12:00	18.00	95326.13	25.58	1342.66	763386.22
11/27/1981 18:00	12.00	95334.23	21.44	559.21	643849.86
12/1/1981 6:00	12.00	95682.79	36.96	855.52	510412.69
12/4/1981 6:00	48.00	94848.56	23.85	9387.72	764236.76
12/10/1981 6:00	54.00	94478.81	38.01	12318.49	797958.08
12/22/1981 18:00	12.00	95030.53	18.33	537.61	450402.56
12/24/1981 12:00	30.00	94784.58	29.89	4817.87	678773.45
12/29/1981 18:00	42.00	94805.98	24.57	6682.75	555849.26
1/3/1982 12:00	36.00	94931.45	25.15	5504.88	720061.53
1/23/1982 18:00	6.00	95385.12	19.10	133.75	629686.10
2/3/1982 18:00	54.00	94183.63	30.48	13420.31	847947.36
2/12/1982 6:00	18.00	95073.74	24.92	1467.74	568073.28
2/24/1982 18:00	24.00	95387.82	23.99	2412.03	628162.90
3/6/1982 6:00	66.00	94734.73	23.75	18156.52	733088.45
3/10/1982 12:00	30.00	94657.87	23.07	4070.11	909310.91
3/16/1982 6:00	42.00	94517.03	24.74	6904.38	887589.33
3/18/1982 18:00	6.00	95630.86	23.62	169.15	372257.30
3/25/1982 18:00	30.00	95239.71	20.59	3328.40	649765.80
4/4/1982 18:00	54.00	94493.15	26.94	13585.34	788014.02
4/9/1982 18:00	66.00	94415.87	24.93	16985.85	811421.83
4/12/1982 12:00	60.00	94318.24	27.70	15867.41	890830.68
4/20/1982 6:00	96.00	94717.90	23.36	38488.30	880237.50
4/21/1982 18:00	18.00	95189.03	27.95	1546.49	753186.83
4/23/1982 12:00	36.00	95123.18	28.90	5614.17	804791.68
4/28/1982 12:00	36.00	94917.94	23.08	5291.97	892358.66
4/30/1982 12:00	18.00	95574.56	23.34	1234.83	530724.33
5/5/1982 0:00	54.00	93256.14	31.48	11907.18	837641.63
5/8/1982 6:00	72.00	93807.65	26.49	20248.55	722143.34
5/13/1982 0:00	60.00	94729.54	25.85	15731.92	838877.89
5/15/1982 12:00	42.00	94244.91	28.43	8665.49	860997.26
5/29/1982 12:00	48.00	93945.58	30.38	9275.25	846435.74
6/6/1982 6:00	18.00	95392.80	25.58	1531.58	608570.07
6/11/1982 12:00	24.00	94832.57	23.64	2631.18	854144.03
6/16/1982 0:00	48.00	93668.89	24.70	10185.59	850179.64
6/18/1982 6:00	36.00	95040.92	25.70	5527.95	606766.28
6/29/1982 6:00	12.00	95168.88	22.94	553.86	718386.61

Final Date & Time	Duration (h)	Minimum MSLP (Pa)	Maximum Wind Speed ($m\ s^{-1}$)	Total IKE (TJ)	Diameter (m)
7/4/1982 6:00	42.00	95016.61	35.43	7871.37	821037.29
7/10/1982 12:00	48.00	94453.05	24.49	10563.05	763969.40
7/13/1982 0:00	12.00	95563.56	21.99	617.00	582210.96
7/13/1982 18:00	12.00	95425.42	26.05	648.00	403702.65
7/16/1982 18:00	30.00	94866.22	28.12	3869.26	742676.69
7/21/1982 0:00	96.00	93135.04	30.02	40836.47	791165.45
7/25/1982 12:00	6.00	95373.28	19.51	134.20	491117.53
7/31/1982 18:00	54.00	93130.67	28.42	13923.57	817407.36
8/5/1982 12:00	30.00	94860.40	24.14	3567.30	650408.24
8/12/1982 18:00	18.00	95250.72	20.10	1187.93	450856.61
8/18/1982 12:00	60.00	93267.98	33.82	15956.67	877298.84
8/21/1982 12:00	24.00	94981.92	23.29	2593.21	729581.61
8/25/1982 12:00	90.00	92057.56	31.60	35355.54	807387.06
8/26/1982 18:00	24.00	94930.41	27.25	2379.82	749204.75
8/29/1982 6:00	24.00	95169.50	26.51	2454.71	859767.90
8/31/1982 12:00	30.00	95242.00	26.24	4614.46	654275.86
9/4/1982 6:00	24.00	95148.52	27.16	2926.98	661864.17
9/10/1982 18:00	144.00	93179.91	32.08	89548.42	856839.54
9/12/1982 6:00	6.00	95744.07	21.95	141.60	372341.99
9/22/1982 12:00	60.00	93162.66	31.93	14142.85	897512.75
9/28/1982 6:00	78.00	93969.47	27.48	27553.76	905012.62
10/2/1982 6:00	78.00	93140.23	25.84	28582.46	689132.71
10/8/1982 18:00	6.00	95693.38	26.46	152.09	625533.77
10/17/1982 12:00	42.00	93906.53	25.84	7666.83	631100.76
10/21/1982 0:00	24.00	95168.67	23.62	2610.50	567320.07
10/29/1982 18:00	132.00	94025.56	26.37	65360.22	521969.00
10/30/1982 6:00	6.00	95625.04	20.03	129.85	431933.14
11/3/1982 12:00	54.00	94286.67	26.95	13666.55	907825.72
11/11/1982 12:00	36.00	95038.01	28.76	6222.77	678699.37
11/15/1982 0:00	42.00	94490.03	25.79	6731.99	860626.73
11/22/1982 18:00	42.00	94328.00	24.06	7242.06	799635.05
11/23/1982 12:00	6.00	95125.05	17.39	124.66	462764.40
11/25/1982 12:00	6.00	94981.51	15.59	117.33	97162.92
11/26/1982 0:00	6.00	95204.40	16.00	120.75	292081.95
1/15/1983 12:00	24.00	95234.10	21.43	2136.55	668894.53
1/17/1983 18:00	18.00	95029.29	22.63	1525.46	586470.90
1/19/1983 12:00	6.00	95709.59	18.48	133.56	418214.06

Final Date & Time	Duration (h)	Minimum MSLP (Pa)	Maximum Wind Speed ($m\ s^{-1}$)	Total IKE (TJ)	Diameter (m)
1/29/1983 18:00	6.00	95545.48	26.34	154.15	431882.49
2/3/1983 6:00	30.00	95144.57	22.27	3670.20	780857.73
2/11/1983 6:00	36.00	95149.97	26.40	6232.66	723907.03
2/15/1983 6:00	24.00	94984.62	23.35	2555.53	687511.68
2/20/1983 6:00	36.00	94905.90	26.52	5649.07	791942.78
2/24/1983 12:00	6.00	95848.76	19.35	141.40	343354.09
2/27/1983 18:00	6.00	95542.78	23.32	159.08	595259.63
3/2/1983 0:00	6.00	95724.33	18.41	138.87	546669.00
3/7/1983 0:00	30.00	94606.77	24.12	3866.62	742323.74
3/13/1983 6:00	54.00	93901.96	24.41	11912.62	765950.44
3/17/1983 0:00	18.00	94601.79	23.55	1299.08	352688.26
3/19/1983 12:00	24.00	95066.05	23.51	2343.60	542526.64
3/30/1983 18:00	66.00	93352.11	27.32	19276.45	866025.39
4/7/1983 0:00	6.00	95506.43	19.61	125.32	386134.53
4/7/1983 12:00	6.00	95452.01	19.51	123.39	263793.44
4/16/1983 6:00	48.00	93774.83	29.70	9328.22	815072.90
4/19/1983 12:00	30.00	95067.71	26.68	3912.61	804728.84
4/24/1983 12:00	48.00	94170.55	28.38	10174.42	773769.33
4/25/1983 12:00	12.00	95555.45	22.08	600.14	811697.33
5/1/1983 0:00	84.00	93821.78	25.59	31066.50	850809.06
5/13/1983 12:00	54.00	94356.05	24.07	12519.61	879378.69
5/17/1983 6:00	24.00	95312.83	24.31	2377.50	599847.79
5/29/1983 0:00	42.00	94003.74	25.95	7879.63	736112.03
5/31/1983 18:00	36.00	94930.41	26.05	5105.71	829363.71
6/2/1983 18:00	24.00	94264.23	26.80	2729.67	681893.72
6/6/1983 12:00	48.00	94256.34	26.51	10997.51	791470.43
6/7/1983 6:00	12.00	95290.60	18.31	507.57	701999.42
6/9/1983 12:00	24.00	95290.40	24.38	2532.87	557728.85
6/12/1983 0:00	6.00	95855.62	24.04	172.90	724551.57
6/15/1983 18:00	36.00	93854.60	26.42	6358.60	789876.74
6/26/1983 12:00	54.00	94767.34	28.66	11941.16	842617.88
7/7/1983 0:00	60.00	93912.97	35.57	16098.45	893999.95
7/10/1983 12:00	60.00	94691.94	24.81	15360.18	722199.05
7/17/1983 0:00	18.00	95447.85	20.31	1342.14	493018.05
7/19/1983 0:00	36.00	94533.65	25.23	5802.59	931553.81
7/23/1983 12:00	30.00	94339.84	26.15	3695.33	608198.32
7/27/1983 18:00	18.00	94764.02	23.71	1378.12	509231.39

Final Date & Time	Duration (h)	Minimum MSLP (Pa)	Maximum Wind Speed (m s^{-1})	Total IKE (TJ)	Diameter (m)
8/2/1983 18:00	36.00	94751.97	21.93	4849.38	473279.08
8/4/1983 18:00	36.00	93228.10	27.51	5509.39	670351.17
8/6/1983 0:00	24.00	94196.31	26.78	2765.58	644985.45
8/7/1983 12:00	24.00	94996.46	22.70	2605.76	756747.61
8/16/1983 12:00	210.00	92692.79	35.82	185737.54	861879.60
8/22/1983 6:00	18.00	95487.32	25.73	1363.93	639889.77
8/24/1983 0:00	36.00	94717.70	20.53	4834.63	828619.88
8/25/1983 18:00	24.00	95168.46	25.33	2107.20	749430.09
8/29/1983 6:00	48.00	93741.59	28.94	9997.48	900898.30
9/2/1983 0:00	6.00	94820.11	16.58	115.78	317960.83
9/3/1983 0:00	12.00	95077.06	23.94	604.23	910219.06
9/7/1983 12:00	42.00	94793.52	23.51	6938.61	710055.68
9/8/1983 6:00	12.00	95417.94	25.11	665.39	303176.75
9/16/1983 12:00	6.00	95473.61	27.16	181.18	630067.18
9/21/1983 18:00	48.00	93706.90	27.82	12256.54	831048.93
9/25/1983 6:00	60.00	94561.07	23.13	15134.76	902882.69
10/6/1983 12:00	216.00	92810.57	30.25	195000.71	853075.52
10/7/1983 18:00	6.00	95526.16	19.88	147.80	567610.39
10/22/1983 12:00	78.00	93195.28	27.47	25549.74	873092.26
10/27/1983 0:00	60.00	93260.92	24.53	14567.80	773585.75
10/30/1983 12:00	24.00	94890.11	21.51	2206.57	700564.51
10/31/1983 12:00	6.00	95367.88	21.85	159.72	724912.88
11/3/1983 12:00	60.00	94225.80	26.69	16417.93	792093.26
11/6/1983 12:00	66.00	94337.77	22.76	17582.16	767989.18
11/8/1983 12:00	6.00	95278.35	21.91	146.04	694409.85
11/9/1983 0:00	6.00	95414.82	24.47	151.55	471239.49
11/10/1983 18:00	12.00	95060.65	18.98	491.89	466174.95
11/11/1983 18:00	18.00	94951.60	27.36	1280.61	741225.69
11/12/1983 12:00	6.00	95373.07	23.79	146.37	749497.00
11/13/1983 0:00	6.00	95261.11	17.82	128.40	594361.48
11/13/1983 12:00	6.00	95670.12	22.66	159.23	698498.49
11/14/1983 6:00	12.00	95236.60	20.22	586.27	591576.08
11/16/1983 12:00	48.00	94053.81	26.01	8858.75	862644.00
11/21/1983 12:00	24.00	95132.32	22.71	2247.72	712021.84
11/26/1983 12:00	36.00	94669.92	21.43	5166.29	779591.78
12/3/1983 6:00	12.00	94865.60	23.49	491.35	407746.66
12/3/1983 18:00	6.00	95339.83	25.69	146.63	564143.68

Final Date & Time	Duration (h)	Minimum MSLP (Pa)	Maximum Wind Speed (m s^{-1})	Total IKE (TJ)	Diameter (m)
12/23/1983 18:00	24.00	95299.12	22.88	2436.08	714553.90
12/25/1983 18:00	12.00	95440.79	18.09	505.87	525009.90
12/29/1983 18:00	42.00	95002.07	21.47	6790.59	762912.67
1/6/1984 6:00	30.00	95323.22	18.94	3135.66	593126.89
1/11/1984 0:00	36.00	94887.62	21.74	5312.98	715045.62
1/22/1984 18:00	6.00	95404.44	18.58	134.74	460077.73
2/7/1984 0:00	12.00	95431.86	22.59	666.83	510454.26
2/22/1984 6:00	12.00	95421.68	22.96	597.58	697153.25
2/26/1984 12:00	18.00	95386.78	24.11	1450.54	753911.52
3/6/1984 18:00	36.00	94817.20	29.15	5185.85	730681.89
3/8/1984 6:00	24.00	95016.41	22.22	2250.63	645226.72
3/14/1984 6:00	6.00	95767.54	25.19	140.66	587651.53
3/15/1984 18:00	30.00	94887.62	20.57	3502.98	421183.91
3/23/1984 18:00	36.00	94463.65	25.43	4904.17	758276.93
3/28/1984 0:00	30.00	94578.11	23.07	3716.65	847184.81
4/19/1984 18:00	108.00	93054.44	28.05	49716.67	859271.26
4/27/1984 0:00	24.00	95286.24	23.53	2374.63	837131.16
4/29/1984 12:00	12.00	95283.54	23.05	557.13	673295.20
5/1/1984 0:00	18.00	95252.59	23.13	1242.24	491181.29
5/6/1984 12:00	90.00	94352.72	26.50	33630.78	756671.95
5/7/1984 18:00	12.00	94998.13	22.29	615.36	570714.52
5/8/1984 18:00	18.00	95144.37	26.36	1221.24	632342.02
5/25/1984 12:00	6.00	95507.47	19.47	135.21	565354.56
5/26/1984 0:00	6.00	95684.87	21.28	155.64	709371.25
6/2/1984 0:00	18.00	95248.64	20.92	1329.47	365769.81
6/4/1984 6:00	12.00	95146.65	21.43	547.50	665581.72
6/6/1984 0:00	36.00	94513.30	25.29	5068.46	614929.66
6/30/1984 6:00	18.00	95138.13	24.44	1371.78	819594.87
7/3/1984 12:00	12.00	95394.67	25.49	594.30	648911.14
7/9/1984 6:00	66.00	93763.61	26.85	19977.12	908218.94
7/13/1984 0:00	18.00	95121.72	23.90	1360.29	477830.97
7/15/1984 6:00	12.00	95384.29	20.69	537.51	400845.10
7/18/1984 18:00	12.00	94717.90	28.82	744.68	606191.66
7/21/1984 12:00	48.00	94404.24	24.12	9790.55	773926.32
7/22/1984 12:00	18.00	95488.98	23.28	1243.84	494711.78
8/4/1984 12:00	66.00	92460.34	25.66	17188.13	747971.80
8/9/1984 0:00	24.00	95094.30	23.84	2682.09	716266.57

Final Date & Time	Duration (h)	Minimum MSLP (Pa)	Maximum Wind Speed (m s^{-1})	Total IKE (TJ)	Diameter (m)
8/21/1984 0:00	78.00	93843.38	28.66	24809.87	870650.67
8/27/1984 0:00	6.00	95414.20	19.22	133.67	464677.81
8/28/1984 6:00	24.00	94949.31	26.29	2304.91	770656.20
8/29/1984 0:00	12.00	95428.12	26.49	648.54	599018.89
9/1/1984 0:00	12.00	95326.96	22.96	646.00	459346.09
9/6/1984 0:00	24.00	95010.80	24.07	2254.39	720808.51
9/7/1984 18:00	12.00	95606.14	20.83	552.46	383898.73
9/8/1984 6:00	6.00	95461.56	18.66	123.94	420494.05
9/9/1984 18:00	18.00	95323.63	20.84	1188.28	483913.28
9/12/1984 12:00	48.00	92726.65	32.28	11507.32	857100.17
9/28/1984 0:00	30.00	94462.61	22.74	4312.14	754373.64
10/1/1984 12:00	18.00	95000.41	21.74	1394.70	640409.94
10/3/1984 12:00	36.00	94914.41	22.11	4957.60	599830.35
10/6/1984 12:00	24.00	94981.09	22.58	2533.99	821419.92
10/10/1984 6:00	66.00	93838.40	25.40	20897.68	848589.13
10/13/1984 0:00	36.00	95254.25	22.13	4836.25	545575.61
10/13/1984 18:00	12.00	95644.78	23.18	592.55	471219.15
10/15/1984 18:00	18.00	95491.68	21.74	1195.83	630977.99
10/21/1984 0:00	54.00	93677.82	31.35	13166.59	847821.45
10/23/1984 6:00	6.00	95650.59	19.62	142.02	448462.84
10/29/1984 0:00	24.00	94196.31	27.08	2768.52	759334.06
11/2/1984 12:00	18.00	95005.40	27.32	1765.58	547317.07
11/12/1984 18:00	30.00	95101.37	22.04	3599.64	863085.73
11/21/1984 0:00	72.00	94193.40	24.10	19773.18	799131.56
11/23/1984 6:00	48.00	94088.29	20.76	8590.40	768513.41
11/26/1984 12:00	42.00	94640.22	22.99	6627.80	813040.42
12/4/1984 18:00	36.00	94645.20	23.73	5344.35	862079.16
12/7/1984 18:00	36.00	94370.17	33.03	5405.52	840587.03
1/6/1985 12:00	6.00	95375.05	19.82	129.94	391425.63
1/7/1985 0:00	6.00	95568.70	20.69	142.41	402718.92
1/18/1985 12:00	18.00	95379.39	21.28	1405.40	576415.79
2/13/1985 18:00	6.00	95547.99	18.12	121.88	290131.34
2/17/1985 12:00	24.00	94851.17	25.23	2488.89	736981.23
2/20/1985 6:00	30.00	94688.35	27.12	3821.82	816338.24
3/2/1985 6:00	66.00	93687.08	25.89	16494.51	797782.17
3/5/1985 18:00	30.00	94712.68	31.52	3343.31	882779.24
3/6/1985 6:00	6.00	95530.65	17.51	126.70	601625.89

Final Date & Time	Duration (h)	Minimum MSLP (Pa)	Maximum Wind Speed ($m\ s^{-1}$)	Total IKE (TJ)	Diameter (m)
3/9/1985 12:00	30.00	95278.22	25.99	3695.67	622913.27
3/11/1985 0:00	24.00	95435.27	22.50	2615.78	621927.86
3/27/1985 18:00	36.00	94642.34	29.16	5597.89	799247.80
3/29/1985 0:00	18.00	95588.21	22.52	1290.59	776665.42
4/1/1985 18:00	48.00	95107.45	22.62	10103.48	834139.46
4/6/1985 6:00	48.00	94610.31	25.66	9091.74	843392.49
4/8/1985 12:00	12.00	95577.86	19.83	597.81	668546.18
4/12/1985 12:00	78.00	94625.24	26.79	27119.72	885371.65
4/15/1985 12:00	18.00	94896.70	19.25	1195.99	479771.03
4/21/1985 6:00	6.00	95634.70	21.94	140.41	743796.19
4/26/1985 0:00	18.00	95342.05	24.14	1390.91	843187.52
4/28/1985 18:00	48.00	94194.58	21.16	8971.68	799612.24
5/1/1985 6:00	6.00	95658.55	21.91	172.35	522565.46
5/13/1985 12:00	30.00	93969.85	27.52	4553.69	873401.41
5/20/1985 12:00	36.00	94675.82	23.16	5484.75	791992.54
5/23/1985 18:00	6.00	95716.35	25.56	200.02	672700.36
5/27/1985 12:00	84.00	94192.89	26.28	32723.63	863168.93
5/28/1985 0:00	6.00	95613.75	18.82	135.54	685221.41
6/4/1985 18:00	138.00	93553.40	27.85	81248.40	853528.60
6/14/1985 0:00	30.00	93295.20	24.63	3741.65	800887.11
6/15/1985 0:00	6.00	95461.52	18.71	122.39	194240.23
6/20/1985 18:00	24.00	95151.29	25.50	2429.82	706699.47
6/23/1985 12:00	42.00	94222.04	28.49	8220.69	836368.49
6/29/1985 0:00	6.00	95344.70	20.75	137.25	679119.00
7/1/1985 6:00	36.00	93960.94	30.75	5489.96	801277.32
7/3/1985 18:00	48.00	93534.13	27.21	9007.19	861961.30
7/7/1985 0:00	60.00	94071.98	32.15	15157.20	746776.03
7/12/1985 0:00	108.00	94515.41	28.68	46967.60	773147.29
7/13/1985 18:00	12.00	95127.20	19.07	554.39	527152.53
7/22/1985 6:00	174.00	92126.29	40.98	129493.46	815961.24
7/23/1985 6:00	18.00	95274.85	23.17	1379.83	478006.00
7/25/1985 0:00	24.00	94986.30	25.40	2636.88	572782.10
7/27/1985 0:00	24.00	94640.42	20.26	2173.41	805414.01
7/28/1985 12:00	12.00	94396.90	26.03	570.63	654736.16
8/2/1985 12:00	114.00	92741.93	29.75	59415.67	719734.35
8/6/1985 12:00	78.00	92998.93	27.01	26617.50	716871.68
8/8/1985 12:00	36.00	94670.04	24.30	5071.55	785945.44

Final Date & Time	Duration (h)	Minimum MSLP (Pa)	Maximum Wind Speed ($m\ s^{-1}$)	Total IKE (TJ)	Diameter (m)
8/9/1985 6:00	12.00	95349.76	21.03	600.22	571491.68
8/16/1985 0:00	12.00	95467.06	20.30	592.87	325560.74
8/20/1985 12:00	42.00	94826.60	27.49	7192.73	812861.89
8/26/1985 0:00	36.00	95003.64	24.72	5568.19	694745.83
8/29/1985 18:00	30.00	95008.22	21.63	3320.74	317306.12
9/5/1985 18:00	30.00	94750.25	23.64	3910.14	651643.98
9/13/1985 0:00	102.00	93827.50	36.31	44109.49	850027.09
9/15/1985 6:00	30.00	94633.91	24.41	3577.93	734174.69
9/17/1985 12:00	18.00	95205.96	19.38	1160.62	524317.79
9/22/1985 18:00	30.00	94365.59	22.56	3295.41	503608.42
9/24/1985 6:00	30.00	94961.49	21.34	3314.06	562515.02
9/26/1985 12:00	36.00	94683.53	24.42	5183.80	834836.75
9/28/1985 18:00	18.00	95246.67	26.82	1592.12	552562.65
10/4/1985 12:00	96.00	93616.51	24.71	39081.06	903459.99
10/8/1985 0:00	60.00	93774.03	25.50	15358.09	831330.48
10/15/1985 6:00	102.00	93492.22	27.78	43378.02	871405.39
10/16/1985 12:00	12.00	95329.29	18.73	542.52	777152.00
10/27/1985 0:00	96.00	92523.71	34.57	40693.05	894052.13
11/7/1985 0:00	6.00	95788.37	20.99	178.61	327170.67
11/11/1985 18:00	36.00	94338.37	25.92	6220.90	772659.12
11/13/1985 18:00	42.00	94761.09	29.61	7000.04	703923.99
11/19/1985 12:00	60.00	94759.16	39.14	15409.24	839762.62
11/28/1985 0:00	48.00	94328.50	33.31	12070.77	851761.82
12/1/1985 0:00	36.00	94560.93	23.91	5499.61	840533.42
12/7/1985 12:00	24.00	94247.33	19.15	2127.60	425246.09
12/9/1985 18:00	6.00	95355.30	21.10	148.51	471116.47
12/10/1985 18:00	18.00	95137.32	22.73	1242.87	656890.54
12/17/1985 12:00	24.00	94800.35	22.80	2427.42	916208.46
12/19/1985 18:00	24.00	95387.58	24.68	2242.90	883266.54
12/30/1985 12:00	48.00	94305.14	44.40	8942.14	727246.03
1/15/1986 6:00	36.00	94400.28	22.88	5642.87	745789.02
1/21/1986 18:00	18.00	95343.74	24.56	1459.80	777474.67
2/3/1986 0:00	42.00	95023.39	22.37	7054.63	784086.44
2/9/1986 12:00	24.00	95374.33	25.54	2570.61	767735.52
2/17/1986 0:00	12.00	95463.45	24.69	668.67	651674.66
3/4/1986 6:00	36.00	94967.03	25.23	5192.06	704432.31
3/18/1986 0:00	42.00	94782.77	26.41	7450.96	829615.71

Final Date & Time	Duration (h)	Minimum MSLP (Pa)	Maximum Wind Speed (m s^{-1})	Total IKE (TJ)	Diameter (m)
3/22/1986 18:00	42.00	94270.45	24.04	7216.39	843772.31
3/26/1986 18:00	24.00	94899.59	22.97	2522.73	890585.77
3/30/1986 6:00	48.00	94583.09	22.35	8605.57	724254.84
4/1/1986 6:00	24.00	95026.28	23.09	2494.26	713250.01
4/3/1986 6:00	36.00	94909.22	22.99	5411.64	821597.73
4/19/1986 6:00	108.00	91937.45	31.51	46734.52	910667.71
4/23/1986 6:00	60.00	95223.31	26.06	16076.51	786509.84
4/26/1986 12:00	36.00	94764.70	24.44	5848.21	726929.88
4/30/1986 18:00	60.00	94511.56	27.30	14759.12	862308.30
5/20/1986 18:00	6.00	95840.88	19.19	132.75	398828.39
5/22/1986 18:00	30.00	95058.80	26.04	4096.39	917142.02
5/29/1986 18:00	30.00	95063.61	26.79	3964.39	670687.18
6/4/1986 18:00	36.00	94415.69	28.65	5654.41	844450.68
6/6/1986 6:00	6.00	95542.45	30.08	177.64	851479.57
6/10/1986 0:00	36.00	93961.42	28.36	6062.57	815617.85
7/1/1986 0:00	54.00	93972.26	27.17	13026.53	777581.73
7/7/1986 6:00	126.00	91898.67	32.16	81065.57	945970.85
7/12/1986 18:00	60.00	93877.84	29.36	15077.75	741207.90
7/15/1986 0:00	30.00	94718.22	26.40	3583.51	662070.84
7/24/1986 12:00	60.00	92966.42	26.19	17372.45	937952.15
7/28/1986 12:00	42.00	94730.50	29.66	7034.27	706709.00
8/1/1986 12:00	90.00	92904.76	27.50	34966.06	840434.01
8/2/1986 12:00	12.00	95195.37	21.21	572.50	665362.87
8/4/1986 0:00	12.00	95429.97	25.37	618.50	745942.24
8/10/1986 18:00	42.00	94586.70	28.98	7320.30	797277.26
8/16/1986 0:00	90.00	94207.83	42.65	37725.53	823706.39
8/20/1986 0:00	78.00	94153.87	31.31	26815.45	914743.31
8/21/1986 18:00	18.00	95201.15	28.89	1446.72	767534.90
8/27/1986 18:00	12.00	95196.57	30.27	746.24	562472.62
9/1/1986 18:00	30.00	95175.37	27.92	3946.43	680514.08
9/4/1986 0:00	30.00	94315.97	24.23	3481.25	611067.02
9/9/1986 0:00	114.00	93206.32	33.66	55176.68	788085.18
9/15/1986 12:00	144.00	93065.89	36.79	85774.68	957373.85
9/19/1986 0:00	60.00	92795.64	28.49	15455.45	970307.32
9/21/1986 6:00	18.00	94133.40	22.27	1479.05	485643.12
9/24/1986 12:00	72.00	94021.64	24.73	21066.78	882855.98
9/28/1986 12:00	54.00	94248.77	24.21	11600.54	748529.61

Final Date & Time	Duration (h)	Minimum MSLP (Pa)	Maximum Wind Speed (m s^{-1})	Total IKE (TJ)	Diameter (m)
10/2/1986 0:00	60.00	94305.86	25.72	14801.37	916772.44
10/4/1986 18:00	12.00	95604.83	22.77	682.66	481201.94
10/6/1986 6:00	24.00	95130.33	25.29	2823.71	649343.25
10/10/1986 6:00	30.00	94975.94	27.81	4656.23	657348.80
10/21/1986 6:00	42.00	94464.11	20.10	6270.05	415783.50
10/27/1986 18:00	48.00	94236.49	27.20	9457.17	871975.52
10/28/1986 6:00	6.00	95744.78	21.42	172.57	571467.93
11/3/1986 0:00	72.00	94441.46	26.85	23210.43	684761.87
11/4/1986 12:00	12.00	95446.35	24.45	528.99	397969.78
11/7/1986 12:00	6.00	95313.63	22.84	114.59	62165.25
11/14/1986 6:00	144.00	93582.30	29.68	88799.42	843802.07
11/15/1986 12:00	6.00	95729.60	18.82	131.88	849613.12
11/20/1986 18:00	36.00	94434.48	22.03	4715.48	671900.39
11/23/1986 12:00	48.00	94732.91	23.23	9339.82	602878.27
11/30/1986 12:00	12.00	95576.89	21.02	569.22	818836.06
12/6/1986 18:00	66.00	94613.44	22.28	16246.20	534393.56
12/11/1986 6:00	18.00	95369.99	22.29	1338.72	758028.80
12/15/1986 12:00	18.00	95377.70	22.52	1284.79	827148.08
12/18/1986 12:00	12.00	95031.82	23.56	563.83	818941.67
12/27/1986 12:00	60.00	94612.48	22.29	13970.90	726510.37
12/31/1986 18:00	6.00	95285.45	19.18	138.10	392436.69
1/1/1987 18:00	18.00	94994.73	21.30	1237.32	734596.76
1/10/1987 12:00	18.00	95547.03	20.48	1356.77	480899.30
2/8/1987 18:00	6.00	95789.09	23.84	170.66	384911.02
2/10/1987 0:00	24.00	94901.03	24.60	2712.46	916650.91
2/12/1987 6:00	6.00	95633.74	19.34	130.45	316401.63
2/21/1987 6:00	54.00	94838.41	22.25	12663.15	779977.73
2/24/1987 18:00	36.00	94890.67	22.19	4991.15	494522.87
3/6/1987 6:00	36.00	94825.88	24.71	5130.77	699942.50
3/8/1987 6:00	18.00	94808.78	25.45	1211.98	766068.77
3/13/1987 0:00	18.00	94896.70	20.06	1184.64	550402.57
3/21/1987 18:00	42.00	93808.23	26.35	9424.03	913298.82
3/26/1987 18:00	60.00	94336.45	29.09	15286.47	907346.25
3/28/1987 12:00	24.00	94915.24	21.59	2195.10	721293.84
4/5/1987 12:00	96.00	92843.82	27.99	40733.95	843041.21
4/10/1987 18:00	6.00	95445.86	21.54	147.67	690357.97
4/12/1987 12:00	36.00	94595.38	28.89	5812.03	706888.02

Final Date & Time	Duration (h)	Minimum MSLP (Pa)	Maximum Wind Speed ($m\ s^{-1}$)	Total IKE (TJ)	Diameter (m)
4/20/1987 0:00	18.00	95034.95	23.41	1356.68	706038.57
4/26/1987 6:00	6.00	95727.43	21.06	153.63	905711.09
4/29/1987 18:00	54.00	93574.12	31.39	13764.98	945280.55
5/5/1987 12:00	6.00	95413.11	19.23	150.33	580465.17
5/12/1987 0:00	30.00	94855.27	23.36	4068.69	805582.28
5/27/1987 0:00	42.00	93620.60	25.25	8171.55	920280.79
5/27/1987 12:00	6.00	95676.37	18.26	123.95	523709.95
5/30/1987 12:00	6.00	95636.39	27.03	213.59	532474.67
5/31/1987 6:00	6.00	95686.25	24.33	209.88	347330.06
6/2/1987 18:00	36.00	94289.24	30.65	5350.05	846698.67
6/4/1987 12:00	24.00	95124.79	22.70	2304.12	512192.63
6/7/1987 18:00	30.00	94872.37	25.10	3628.59	668218.05
6/13/1987 18:00	126.00	94325.37	27.03	66958.81	889679.37
6/15/1987 6:00	24.00	93985.51	22.01	2288.58	523786.12
6/18/1987 12:00	24.00	94883.21	24.34	2736.97	632088.46
6/23/1987 0:00	30.00	94823.71	24.17	4110.67	728156.36
6/24/1987 12:00	24.00	95132.50	24.82	2363.38	804602.22
6/25/1987 6:00	12.00	95471.40	19.37	542.61	702115.54
6/27/1987 12:00	18.00	95092.04	21.43	1414.43	640782.91
6/29/1987 18:00	6.00	95705.03	27.34	178.85	589813.99
7/3/1987 18:00	60.00	92962.56	33.27	16311.91	932839.97
7/5/1987 6:00	6.00	95541.73	22.42	135.14	601339.77
7/8/1987 0:00	54.00	93350.83	30.96	14306.16	914138.24
7/8/1987 18:00	12.00	95326.16	21.00	589.47	707260.77
7/16/1987 18:00	18.00	95393.36	22.24	1270.55	853775.68
7/20/1987 0:00	66.00	92587.06	34.74	19952.81	775525.93
7/22/1987 0:00	30.00	94606.21	31.48	4038.52	677732.38
7/25/1987 0:00	18.00	95183.81	25.58	1346.95	631882.57
7/28/1987 0:00	42.00	94371.13	24.79	8062.63	773524.15
8/1/1987 12:00	102.00	94263.95	29.57	40606.85	593662.10
8/3/1987 12:00	36.00	94704.25	30.97	5812.39	792078.03
8/5/1987 6:00	24.00	95273.41	22.95	2237.59	720515.57
8/11/1987 6:00	18.00	95506.56	22.81	1496.06	691245.78
8/14/1987 0:00	12.00	95429.00	23.52	613.89	748189.82
8/15/1987 18:00	36.00	94189.76	23.51	5758.96	870259.86
8/18/1987 6:00	48.00	94395.22	27.53	11789.69	779727.85
8/22/1987 12:00	78.00	93782.22	41.80	28203.16	703714.20

Final Date & Time	Duration (h)	Minimum MSLP (Pa)	Maximum Wind Speed (m s^{-1})	Total IKE (TJ)	Diameter (m)
8/28/1987 12:00	120.00	93771.14	33.41	60139.30	860942.15
8/30/1987 0:00	30.00	94742.78	25.41	4332.44	648534.91
8/31/1987 0:00	12.00	95206.69	20.74	557.88	607887.00
9/4/1987 0:00	36.00	93763.19	27.97	6196.70	817849.67
9/11/1987 0:00	72.00	94356.44	27.56	22803.92	779548.25
9/13/1987 6:00	42.00	94287.55	26.90	7528.77	673266.30
9/14/1987 6:00	12.00	95336.99	27.16	560.35	718375.11
9/18/1987 18:00	54.00	92384.01	29.86	14845.47	942707.19
9/23/1987 0:00	60.00	93636.74	31.74	17507.75	876771.88
9/25/1987 18:00	42.00	95266.90	29.89	7633.01	530027.18
9/28/1987 6:00	48.00	93848.46	31.06	10323.73	884632.80
9/29/1987 0:00	12.00	95550.16	22.82	636.98	569917.06
10/2/1987 12:00	72.00	94341.51	33.85	25580.85	823966.36
10/5/1987 6:00	60.00	93592.66	28.73	18305.13	927605.66
10/16/1987 0:00	30.00	94504.09	21.46	3533.82	767024.96
10/19/1987 0:00	18.00	95112.03	20.24	1232.30	824847.80
10/25/1987 0:00	48.00	94055.36	29.10	10955.14	925853.46
10/25/1987 18:00	12.00	95029.89	20.55	564.70	719499.87
10/27/1987 0:00	18.00	95007.25	21.98	1358.87	731675.97
10/28/1987 12:00	24.00	94805.89	21.99	2400.66	828978.81
11/6/1987 6:00	72.00	92921.13	28.72	24319.20	892055.21
11/12/1987 0:00	84.00	93167.54	27.38	27885.44	767147.03
11/13/1987 18:00	12.00	95263.29	19.27	536.23	681249.71
11/16/1987 12:00	12.00	95052.53	19.88	547.93	620441.64
11/17/1987 18:00	24.00	94559.97	22.71	2258.25	846508.62
11/20/1987 12:00	48.00	95018.09	22.32	8940.08	729035.71
11/21/1987 18:00	18.00	95188.38	31.71	1483.65	827633.63
11/26/1987 12:00	6.00	95334.10	25.82	157.24	801780.32
11/27/1987 0:00	6.00	95527.04	20.93	131.16	724205.45
12/2/1987 18:00	12.00	95242.33	22.81	605.25	890834.27
12/20/1987 12:00	18.00	94874.78	18.39	1180.84	145165.95
12/25/1987 18:00	12.00	95186.70	22.74	584.17	383384.99
12/26/1987 12:00	6.00	95444.66	21.28	145.03	779538.96
12/29/1987 6:00	30.00	94585.50	25.44	4034.47	767123.02
1/8/1988 18:00	30.00	94524.08	21.73	3796.13	640254.81
1/11/1988 18:00	36.00	94805.89	25.90	5900.10	658626.46
1/21/1988 6:00	18.00	94864.66	27.44	1383.84	601338.57

Final Date & Time	Duration (h)	Minimum MSLP (Pa)	Maximum Wind Speed ($m\ s^{-1}$)	Total IKE (TJ)	Diameter (m)
1/31/1988 12:00	48.00	94436.17	24.91	9426.08	626979.82
2/16/1988 0:00	42.00	94063.55	28.61	8771.81	847999.65
2/20/1988 12:00	12.00	95650.36	24.73	678.80	747853.61
2/24/1988 12:00	18.00	95474.53	27.66	1522.18	757079.84
2/29/1988 12:00	72.00	94224.69	25.72	21152.67	876938.55
3/2/1988 0:00	18.00	95314.11	23.86	1422.07	539047.05
3/5/1988 0:00	6.00	95682.39	20.52	140.89	661959.87
3/5/1988 12:00	6.00	95650.84	23.68	147.87	856293.99
3/12/1988 12:00	30.00	94889.71	25.79	3963.50	715356.68
3/13/1988 18:00	24.00	94771.45	28.35	2418.45	688110.76
3/14/1988 12:00	6.00	95201.39	23.74	146.35	637859.90
3/20/1988 12:00	102.00	94371.37	28.72	45791.76	776638.65
3/22/1988 12:00	12.00	95500.54	23.60	679.42	580906.78
3/24/1988 6:00	30.00	94268.77	23.21	3764.32	535877.06
4/5/1988 0:00	36.00	94404.61	24.17	5885.43	892261.13
4/7/1988 0:00	18.00	95165.98	23.88	1487.81	682666.21
4/14/1988 0:00	18.00	95296.05	26.96	1692.32	761779.71
4/25/1988 12:00	36.00	94721.59	30.81	5295.16	820668.58
5/6/1988 18:00	6.00	95791.02	24.88	211.45	582389.63
5/7/1988 18:00	12.00	95370.23	25.25	655.18	801635.14
5/11/1988 18:00	84.00	93073.60	27.96	30643.54	883765.58
5/16/1988 12:00	12.00	95469.23	25.56	651.55	807541.62
5/23/1988 6:00	6.00	95336.27	21.49	162.48	495964.21
5/31/1988 0:00	30.00	94259.85	25.59	3718.52	672143.73
6/6/1988 0:00	36.00	94829.98	28.11	5255.78	791924.45
6/9/1988 0:00	54.00	93347.22	36.76	13351.59	903318.94
6/14/1988 6:00	30.00	95037.60	29.26	4472.43	591098.64
6/26/1988 0:00	18.00	95082.16	31.31	2367.83	511454.42
7/1/1988 0:00	24.00	95306.40	23.66	2809.93	859084.40
7/5/1988 12:00	42.00	94229.50	29.14	7511.97	802925.91
7/11/1988 6:00	42.00	95050.85	31.90	7824.89	815491.58
7/24/1988 0:00	240.00	92328.85	30.26	242228.65	864298.47
7/25/1988 18:00	12.00	95531.13	23.21	542.88	386869.10
7/28/1988 12:00	6.00	95680.22	19.29	124.07	201024.51
8/2/1988 6:00	60.00	93835.93	27.52	15030.48	734290.21
8/7/1988 12:00	96.00	94027.66	27.89	40734.99	850424.67
8/11/1988 18:00	6.00	94979.79	18.20	124.98	225742.65

Final Date & Time	Duration (h)	Minimum MSLP (Pa)	Maximum Wind Speed (m s^{-1})	Total IKE (TJ)	Diameter (m)
8/13/1988 18:00	12.00	95492.11	19.90	562.40	250007.28
8/18/1988 12:00	48.00	93980.69	38.11	10519.21	772713.72
8/20/1988 18:00	6.00	95602.18	20.41	124.46	291554.95
8/22/1988 0:00	24.00	95063.86	27.98	2690.87	775953.62
8/27/1988 12:00	54.00	94712.44	28.49	11674.13	731564.92
9/2/1988 6:00	48.00	93883.62	26.69	10533.83	847600.79
9/9/1988 18:00	54.00	94725.20	22.47	11748.46	538828.38
9/11/1988 0:00	6.00	95533.30	17.52	131.47	155443.19
9/12/1988 12:00	6.00	95600.50	20.50	150.50	343464.34
9/18/1988 18:00	48.00	94732.19	27.64	8359.75	509154.97
9/22/1988 12:00	84.00	94472.05	27.04	32545.86	751981.94
9/24/1988 12:00	18.00	95060.24	21.16	1409.38	677761.76
9/28/1988 6:00	72.00	94067.16	30.46	23427.65	818683.84
10/19/1988 0:00	24.00	94819.38	28.61	2741.46	692003.52
10/31/1988 0:00	30.00	94737.24	29.21	4348.51	659462.38
11/5/1988 6:00	30.00	94503.61	29.20	3882.89	660405.57
11/8/1988 6:00	18.00	95139.97	21.75	1345.94	897666.28
11/22/1988 0:00	54.00	94845.63	28.08	12445.70	877078.20
12/6/1988 12:00	18.00	95323.51	24.08	1439.35	626809.02
12/14/1988 18:00	42.00	95018.57	23.45	7669.95	511526.58
1/1/1989 0:00	6.00	95531.37	23.83	176.14	526582.51
1/12/1989 6:00	6.00	95645.06	21.92	159.51	662599.09
1/15/1989 6:00	12.00	95561.72	26.12	703.98	688613.59
1/21/1989 6:00	42.00	94034.65	24.65	8195.40	868950.79
1/24/1989 18:00	42.00	94363.18	26.08	7733.89	736778.50
2/2/1989 18:00	48.00	94271.66	30.67	9089.62	885029.83
2/4/1989 0:00	24.00	94722.79	27.63	2533.71	781109.20
2/7/1989 6:00	42.00	95152.73	21.97	6695.99	762543.58
2/10/1989 18:00	48.00	94161.82	24.41	11446.87	916622.57
2/15/1989 0:00	54.00	94189.04	25.11	11105.72	800622.68
2/17/1989 0:00	42.00	94319.11	26.06	6912.51	855857.30
2/21/1989 12:00	18.00	95164.54	22.02	1409.60	498477.68
2/25/1989 12:00	18.00	94796.02	22.27	1250.32	703316.30
2/28/1989 0:00	48.00	94847.80	25.47	10500.90	725311.62
3/6/1989 0:00	18.00	95328.32	22.33	1333.49	716389.96
3/9/1989 12:00	18.00	95456.46	20.74	1355.10	559909.41
3/16/1989 0:00	42.00	94569.84	26.77	7506.16	843249.43

Final Date & Time	Duration (h)	Minimum MSLP (Pa)	Maximum Wind Speed ($m\ s^{-1}$)	Total IKE (TJ)	Diameter (m)
3/27/1989 18:00	12.00	95488.74	21.29	588.84	610896.64
4/2/1989 12:00	24.00	94627.17	27.61	3312.28	707956.98
4/15/1989 12:00	24.00	95345.18	20.68	2193.94	826744.30
4/22/1989 0:00	48.00	94649.33	29.84	9668.04	847354.06
4/25/1989 18:00	24.00	94525.28	22.73	2572.98	652755.43
4/28/1989 6:00	36.00	94917.65	23.34	5476.25	949270.88
5/11/1989 6:00	42.00	94841.78	24.57	7385.66	742193.08
5/13/1989 0:00	18.00	95015.20	22.06	1170.26	228982.68
5/16/1989 18:00	36.00	95324.95	24.90	5455.83	654197.34
5/21/1989 0:00	72.00	93726.82	25.32	23826.68	890640.17
5/23/1989 12:00	30.00	94524.80	23.79	3865.74	481447.78
5/24/1989 0:00	6.00	95715.63	20.75	157.70	401890.48
6/3/1989 12:00	216.00	92007.54	30.97	193242.16	814817.19
6/5/1989 18:00	24.00	94835.52	31.10	2937.48	728412.53
6/6/1989 18:00	12.00	95253.41	28.11	597.79	800389.69
6/9/1989 18:00	24.00	95054.94	20.19	2280.77	579400.87
6/15/1989 6:00	42.00	94685.22	23.81	7486.61	909015.09
6/16/1989 12:00	18.00	95030.86	27.22	1747.48	707607.01
6/19/1989 18:00	6.00	95629.16	17.87	123.85	617654.13
6/21/1989 12:00	30.00	95223.79	24.54	3349.73	566631.57
6/25/1989 0:00	36.00	95141.17	22.40	5675.69	700968.59
6/28/1989 12:00	78.00	94338.13	25.24	24457.22	821336.81
6/30/1989 6:00	36.00	94659.20	28.86	5746.69	701349.71
7/3/1989 12:00	66.00	93908.19	22.14	16910.25	739351.54
7/5/1989 6:00	6.00	95553.53	22.03	164.72	576694.11
7/10/1989 6:00	96.00	92453.62	23.90	38403.36	807251.97
7/14/1989 12:00	66.00	93616.51	25.51	20201.93	689928.06
7/16/1989 12:00	12.00	95371.44	18.73	511.96	318115.71
7/21/1989 18:00	30.00	94954.50	22.80	3278.95	829635.96
7/30/1989 18:00	54.00	92696.41	31.25	12861.19	915377.70
8/1/1989 0:00	6.00	95447.31	17.50	128.69	255251.55
8/6/1989 0:00	6.00	95479.59	18.56	143.74	477271.67
8/11/1989 18:00	54.00	93107.56	24.80	14017.61	883799.65
8/16/1989 6:00	30.00	94585.26	27.13	4035.77	591061.51
8/20/1989 6:00	54.00	94501.44	21.38	11070.36	664414.98
8/24/1989 0:00	78.00	94215.53	24.26	25068.90	641913.86
9/14/1989 0:00	36.00	93966.72	27.34	6079.51	687201.22

Final Date & Time	Duration (h)	Minimum MSLP (Pa)	Maximum Wind Speed (m s^{-1})	Total IKE (TJ)	Diameter (m)
9/23/1989 0:00	30.00	94945.11	22.76	3580.50	613183.24
9/25/1989 12:00	18.00	94882.73	21.55	1357.04	307961.28
9/28/1989 18:00	30.00	93950.34	20.57	3618.62	680939.43
9/30/1989 6:00	18.00	94118.47	20.73	1304.41	474524.06
10/9/1989 12:00	24.00	95182.84	23.21	2179.86	606973.73
10/11/1989 18:00	6.00	95191.75	23.38	137.27	808817.14
10/16/1989 6:00	30.00	95324.47	23.12	3809.83	825874.47
10/19/1989 0:00	54.00	94502.40	25.74	12745.29	878207.60
10/20/1989 0:00	12.00	95455.26	20.58	508.89	432968.85
10/23/1989 12:00	36.00	94815.28	22.95	5638.21	948503.57
10/29/1989 0:00	60.00	93423.58	25.88	16345.95	934412.38
10/30/1989 6:00	18.00	94814.08	17.80	1152.18	589385.41
11/6/1989 6:00	162.00	93888.92	27.98	110382.50	828870.20
11/9/1989 12:00	60.00	92662.69	26.65	16608.62	886390.86
11/25/1989 6:00	42.00	94268.52	21.68	6650.50	429576.52
11/27/1989 12:00	18.00	95153.46	22.88	1414.25	885440.81
11/29/1989 0:00	18.00	95246.43	25.18	1404.05	863374.23
12/7/1989 0:00	6.00	95151.53	20.18	148.38	702972.75
12/19/1989 6:00	24.00	94872.37	23.59	2408.78	898426.26
12/25/1989 18:00	30.00	94658.72	24.23	3792.47	690839.40
1/21/1990 12:00	18.00	95175.62	26.85	1502.64	629562.14
1/29/1990 6:00	18.00	95295.08	18.70	1177.32	739077.54
2/2/1990 6:00	6.00	95674.93	22.70	177.08	506550.15
2/4/1990 6:00	6.00	95603.15	17.99	131.23	366587.55
2/4/1990 18:00	6.00	95642.17	18.79	129.44	433786.51
2/14/1990 0:00	24.00	94833.83	28.07	2341.93	547998.37
2/22/1990 12:00	36.00	94176.27	28.09	6748.92	889131.45
3/5/1990 18:00	42.00	94568.40	24.02	7061.72	804252.71
3/13/1990 12:00	24.00	94948.00	26.74	2870.71	781122.73
3/15/1990 12:00	18.00	95338.20	19.84	1254.39	706573.87
3/20/1990 12:00	24.00	95396.73	21.66	2681.19	759772.42
3/27/1990 18:00	36.00	94851.90	24.32	5577.90	797227.96
4/8/1990 0:00	30.00	94633.67	26.69	3808.08	706360.84
4/12/1990 0:00	18.00	95275.33	26.41	1401.04	669617.31
4/14/1990 12:00	18.00	95250.52	24.26	1556.55	691863.52
4/21/1990 0:00	60.00	93194.03	28.03	17176.00	923892.11
4/24/1990 0:00	12.00	95441.05	28.89	613.66	587184.33

Final Date & Time	Duration (h)	Minimum MSLP (Pa)	Maximum Wind Speed (m s^{-1})	Total IKE (TJ)	Diameter (m)
4/29/1990 18:00	72.00	93086.13	26.17	22143.15	846816.09
5/22/1990 12:00	24.00	95116.85	24.29	2311.20	851634.17
6/4/1990 0:00	6.00	95504.64	20.67	133.12	783295.85
6/4/1990 18:00	12.00	95285.93	22.22	567.88	644982.38
6/10/1990 0:00	90.00	94485.78	29.73	36253.27	834506.45
6/19/1990 18:00	30.00	95093.96	28.14	3602.63	829465.59
6/25/1990 0:00	36.00	94102.81	29.64	5425.21	741413.58
6/28/1990 18:00	72.00	93580.62	28.26	21975.31	814171.13
7/5/1990 18:00	42.00	94539.98	24.36	6965.08	880021.30
7/6/1990 18:00	12.00	95466.34	26.88	652.59	649575.62
7/7/1990 12:00	6.00	95476.45	24.52	136.91	576749.56
7/11/1990 0:00	18.00	95031.82	25.15	1648.75	600073.75
7/14/1990 12:00	48.00	94592.49	30.65	9610.01	705286.11
7/23/1990 12:00	30.00	94494.45	25.77	3985.04	802390.91
7/28/1990 0:00	24.00	95236.79	25.19	2462.14	588965.87
7/31/1990 12:00	60.00	92991.71	29.49	15463.50	889060.76
8/1/1990 0:00	6.00	95425.63	19.24	131.48	642383.00
8/7/1990 6:00	48.00	94658.48	21.88	9261.00	722724.06
8/11/1990 6:00	18.00	93983.34	27.24	1357.91	721565.48
8/13/1990 6:00	42.00	94545.52	27.02	7609.09	703949.50
8/16/1990 6:00	42.00	94764.94	24.85	7150.83	697923.56
8/17/1990 12:00	18.00	94975.70	20.31	1175.23	437670.12
8/19/1990 18:00	30.00	94809.02	28.31	3715.12	605063.01
8/20/1990 6:00	6.00	95634.94	24.48	155.14	642666.22
8/24/1990 0:00	12.00	95083.12	20.51	554.32	675699.85
8/26/1990 18:00	24.00	94962.21	24.87	2558.57	881868.50
8/28/1990 6:00	30.00	94623.08	25.32	3504.68	891143.57
9/2/1990 6:00	54.00	93401.42	37.17	12019.21	903237.17
9/5/1990 18:00	60.00	94032.72	23.29	15583.47	841059.42
9/10/1990 6:00	30.00	94824.92	36.16	3966.52	852670.86
9/12/1990 12:00	18.00	95093.48	22.26	1380.52	578167.21
9/13/1990 18:00	24.00	95041.21	27.99	2370.82	617536.61
9/22/1990 12:00	144.00	94138.70	25.54	83388.69	830112.31
9/26/1990 12:00	60.00	94630.30	23.91	17075.60	934353.02
10/1/1990 12:00	36.00	94540.70	23.57	5188.39	663257.68
10/3/1990 18:00	24.00	95067.95	22.63	2280.52	669526.91
10/8/1990 12:00	54.00	94743.03	22.23	10970.63	523969.54

Final Date & Time	Duration (h)	Minimum MSLP (Pa)	Maximum Wind Speed (m s^{-1})	Total IKE (TJ)	Diameter (m)
10/12/1990 12:00	78.00	94103.53	27.10	24562.67	877663.42
10/19/1990 12:00	138.00	93544.01	37.06	88071.68	834475.17
10/27/1990 12:00	96.00	92597.41	28.94	37702.15	888950.93
11/3/1990 12:00	18.00	95433.34	25.69	1546.23	583261.15
11/8/1990 0:00	18.00	95248.60	21.36	1201.60	717813.43
11/9/1990 12:00	6.00	95771.03	23.76	137.48	400961.79
11/18/1990 18:00	36.00	94296.46	36.97	6313.92	845936.11
11/22/1990 12:00	6.00	95419.13	23.45	147.69	610463.02
11/24/1990 18:00	42.00	94636.56	26.82	8259.40	731176.15
11/26/1990 12:00	12.00	95443.46	21.87	579.34	686288.39
12/1/1990 6:00	24.00	94879.11	22.43	2400.92	651206.36
12/3/1990 6:00	30.00	95338.68	23.73	3661.07	726760.72
12/5/1990 0:00	6.00	95228.12	20.57	139.74	795458.79
12/6/1990 6:00	24.00	95231.74	25.06	2631.10	857926.49
12/17/1990 18:00	24.00	94179.40	22.05	2250.07	675380.75
1/19/1991 0:00	54.00	92795.64	29.14	12137.95	926336.76
1/29/1991 6:00	18.00	95151.29	30.68	1324.91	771254.22
1/31/1991 6:00	6.00	95644.82	23.25	173.94	489095.48
2/1/1991 6:00	12.00	95686.97	22.91	648.08	805112.57
2/5/1991 18:00	24.00	95334.59	21.95	2288.30	772084.75
2/13/1991 0:00	12.00	95343.50	22.52	673.49	702364.40
2/13/1991 12:00	6.00	95306.40	23.85	157.07	888325.68
2/17/1991 6:00	6.00	95566.78	18.96	132.86	545562.29
2/18/1991 12:00	24.00	95114.44	25.26	2575.96	682823.85
3/7/1991 0:00	6.00	95595.92	20.24	153.09	612928.94
3/11/1991 6:00	36.00	95121.90	22.43	5019.39	525114.28
3/23/1991 12:00	36.00	94596.10	26.45	6002.77	831236.75
3/26/1991 18:00	66.00	93451.52	27.34	19401.57	830157.71
4/4/1991 0:00	36.00	95187.18	27.93	6715.26	703355.05
4/5/1991 12:00	18.00	95568.95	26.35	1584.01	714197.93
4/9/1991 6:00	24.00	95127.92	22.23	2518.58	551015.54
4/15/1991 6:00	30.00	95014.48	24.80	3692.64	853073.56
4/19/1991 12:00	42.00	94847.80	23.64	7817.35	892506.78
4/25/1991 6:00	18.00	95514.27	23.85	1526.72	556617.30
4/26/1991 12:00	12.00	95533.30	22.95	689.78	436409.58
4/29/1991 0:00	12.00	95576.41	23.03	597.24	747359.39
5/5/1991 12:00	36.00	95158.76	27.55	5143.06	713307.66

Final Date & Time	Duration (h)	Minimum MSLP (Pa)	Maximum Wind Speed ($m\ s^{-1}$)	Total IKE (TJ)	Diameter (m)
5/8/1991 6:00	54.00	94771.21	24.97	11144.65	656614.75
5/11/1991 18:00	42.00	93934.21	25.22	7818.28	772404.85
5/13/1991 0:00	24.00	94771.93	25.48	2755.35	872915.90
5/15/1991 12:00	42.00	94803.24	27.15	7685.60	877240.52
5/16/1991 0:00	6.00	95232.22	20.79	133.23	653464.57
5/17/1991 12:00	30.00	95059.04	22.98	3695.13	800306.61
5/22/1991 6:00	12.00	94578.27	26.81	648.42	769072.40
5/27/1991 18:00	102.00	93469.82	31.40	42328.17	785918.58
5/28/1991 6:00	6.00	95230.77	26.22	147.31	874936.22
6/1/1991 18:00	66.00	93027.60	27.92	18241.34	840990.67
6/6/1991 12:00	48.00	94256.96	30.57	10078.44	908543.15
6/8/1991 18:00	24.00	94920.78	22.97	2422.88	556345.50
6/13/1991 12:00	84.00	94789.51	30.69	28334.76	855931.17
6/16/1991 18:00	30.00	95014.00	29.03	4070.38	716264.13
6/21/1991 12:00	12.00	95658.07	22.52	683.58	543463.38
6/25/1991 6:00	12.00	95583.88	29.99	671.99	716538.07
6/28/1991 18:00	18.00	95228.85	23.95	1366.85	625217.05
7/5/1991 0:00	90.00	92982.07	28.48	36658.94	860610.86
7/7/1991 12:00	30.00	94575.87	29.64	3844.76	644914.35
7/10/1991 0:00	6.00	95562.20	24.67	174.58	650003.77
7/10/1991 18:00	6.00	95718.52	22.16	145.92	602573.21
7/13/1991 0:00	48.00	94911.63	26.09	9365.54	809661.97
7/17/1991 18:00	42.00	94404.13	25.76	6777.93	736197.55
7/28/1991 12:00	36.00	94539.50	24.14	5265.79	842548.08
8/2/1991 6:00	30.00	94216.74	28.32	4169.09	545237.85
8/4/1991 12:00	18.00	95275.33	26.97	1320.99	622465.09
8/10/1991 6:00	48.00	94257.20	26.36	9590.87	798600.88
8/11/1991 6:00	12.00	95177.78	28.29	744.59	496758.01
8/12/1991 0:00	12.00	95450.92	26.21	725.70	603756.44
8/18/1991 18:00	102.00	92925.23	30.84	47071.58	938526.51
8/21/1991 12:00	42.00	95074.45	28.33	7862.22	821894.72
8/23/1991 0:00	30.00	94216.98	27.37	4053.86	869244.93
8/29/1991 0:00	24.00	94695.82	19.66	2191.76	523727.59
9/2/1991 0:00	84.00	93947.21	24.42	30255.90	935410.95
9/8/1991 6:00	36.00	94385.34	25.87	5428.33	763144.28
9/12/1991 12:00	24.00	94941.26	23.40	2304.12	762322.57
9/16/1991 0:00	30.00	94389.20	24.01	3196.18	509909.17

Final Date & Time	Duration (h)	Minimum MSLP (Pa)	Maximum Wind Speed (m s^{-1})	Total IKE (TJ)	Diameter (m)
9/19/1991 12:00	6.00	95658.79	30.75	199.93	707227.45
9/23/1991 6:00	48.00	93493.91	30.58	10886.61	885144.91
9/24/1991 12:00	12.00	95452.85	26.04	685.19	788322.92
10/1/1991 12:00	12.00	95416.72	23.26	595.02	727849.64
10/11/1991 6:00	54.00	93657.21	25.98	12531.21	870849.45
10/17/1991 18:00	54.00	94007.43	22.62	11641.27	773351.35
10/22/1991 0:00	6.00	95908.08	18.34	131.18	381711.38
10/23/1991 12:00	12.00	94995.93	20.21	548.54	508143.41
10/27/1991 6:00	54.00	93999.24	25.14	14598.48	853267.21
10/30/1991 6:00	24.00	95212.95	24.55	2232.51	649662.18
11/4/1991 12:00	24.00	93674.07	22.89	2465.41	570890.29
11/7/1991 18:00	6.00	95590.38	20.63	138.84	685295.20
11/22/1991 18:00	48.00	93554.36	30.55	11027.28	874036.69
11/26/1991 6:00	66.00	93978.52	24.50	20456.30	857945.07
11/27/1991 0:00	12.00	95160.20	21.48	572.13	518575.07
12/8/1991 12:00	12.00	95538.12	20.33	560.61	459808.00
1/18/1992 0:00	36.00	95279.43	23.27	5138.31	806161.92
2/6/1992 0:00	12.00	95615.43	25.66	735.01	500614.76
2/7/1992 18:00	36.00	94707.86	21.44	5119.39	658468.47
2/10/1992 6:00	12.00	95633.74	23.82	631.45	622903.16
2/12/1992 6:00	42.00	93562.07	26.81	8375.52	944137.85
2/17/1992 12:00	12.00	95678.54	21.62	569.97	564882.41
2/22/1992 0:00	12.00	95813.18	31.15	727.49	673217.38
3/3/1992 6:00	30.00	94796.74	30.20	3885.67	824997.74
3/13/1992 6:00	18.00	94904.16	23.02	1398.14	598134.27
3/20/1992 12:00	18.00	95498.13	23.62	1348.92	754310.49
3/26/1992 12:00	36.00	94917.17	23.25	5259.09	759938.20
3/30/1992 12:00	60.00	93775.96	31.88	17331.07	809224.47
3/31/1992 18:00	6.00	95764.53	21.29	167.57	720532.09
4/1/1992 6:00	6.00	95625.79	22.25	167.30	706439.93
4/3/1992 6:00	18.00	95291.47	23.37	1393.68	591772.83
4/5/1992 12:00	18.00	94783.49	19.64	1239.38	535470.55
4/11/1992 6:00	36.00	94757.48	26.19	5681.75	760403.63
4/16/1992 0:00	24.00	95174.41	24.02	2537.10	524334.49
4/17/1992 0:00	18.00	95151.77	23.68	1259.57	542440.39
4/21/1992 0:00	42.00	95063.37	21.57	7226.81	859102.17
4/24/1992 18:00	36.00	94367.04	25.03	6256.42	844086.28

Final Date & Time	Duration (h)	Minimum MSLP (Pa)	Maximum Wind Speed (m s^{-1})	Total IKE (TJ)	Diameter (m)
5/4/1992 12:00	6.00	95740.68	21.46	160.61	525633.64
5/5/1992 12:00	12.00	95354.58	19.02	519.56	659327.88
5/6/1992 6:00	12.00	95215.60	21.16	579.10	583554.52
5/10/1992 0:00	60.00	94129.55	24.68	14345.19	779489.55
5/16/1992 12:00	48.00	94126.17	27.67	9531.74	834324.54
5/19/1992 6:00	42.00	94763.50	24.01	8000.83	718072.95
5/24/1992 0:00	18.00	95049.40	27.27	1484.75	702749.83
5/26/1992 6:00	42.00	93572.91	26.27	9171.62	905729.00
5/30/1992 12:00	78.00	94094.14	27.19	25277.65	790018.17
6/4/1992 18:00	60.00	94733.39	22.83	15397.90	850554.44
6/8/1992 0:00	72.00	93425.26	26.87	23731.56	909182.71
6/11/1992 18:00	60.00	93656.01	30.35	14973.57	793101.38
6/15/1992 0:00	48.00	94072.70	28.25	10905.27	821257.65
7/2/1992 6:00	30.00	94921.75	34.53	3888.85	887982.69
7/5/1992 6:00	18.00	95269.55	23.79	1501.56	568401.52
7/14/1992 18:00	54.00	94407.74	24.53	12095.98	812457.35
7/17/1992 0:00	36.00	94401.48	24.63	4844.15	775365.26
7/26/1992 0:00	54.00	94163.27	25.22	12008.74	821478.63
7/26/1992 18:00	6.00	95320.37	21.45	151.22	701112.18
8/2/1992 6:00	48.00	94407.26	27.73	10546.84	904918.94
8/8/1992 0:00	60.00	93383.59	27.39	17549.86	908960.15
8/12/1992 6:00	96.00	93318.56	37.11	43938.73	850032.32
8/17/1992 12:00	54.00	94347.05	24.79	11917.41	851487.88
8/20/1992 0:00	24.00	95138.28	20.93	2203.90	577892.52
8/29/1992 18:00	72.00	93433.93	28.03	21754.53	889992.47
8/30/1992 6:00	6.00	95236.07	30.46	178.17	531378.51
9/3/1992 0:00	36.00	94622.35	26.57	6303.61	830480.88
9/4/1992 0:00	12.00	95377.94	23.92	565.64	653125.83
9/6/1992 12:00	24.00	95182.84	22.21	2030.44	549956.89
9/11/1992 18:00	12.00	95506.56	23.01	635.99	670845.52
9/16/1992 12:00	24.00	94855.99	23.35	2304.85	682152.48
9/22/1992 18:00	24.00	94109.07	24.70	2197.92	600935.66
9/24/1992 12:00	6.00	95414.55	16.52	118.51	122079.16
9/26/1992 12:00	36.00	93999.00	34.07	5283.89	904039.01
10/3/1992 12:00	36.00	94479.28	23.87	6102.64	724015.55
10/9/1992 6:00	6.00	95560.76	23.95	160.09	681649.72
10/15/1992 12:00	42.00	94727.85	26.11	7158.68	550186.99

Final Date & Time	Duration (h)	Minimum MSLP (Pa)	Maximum Wind Speed ($m\ s^{-1}$)	Total IKE (TJ)	Diameter (m)
10/16/1992 18:00	24.00	94539.01	27.43	2879.35	513718.16
10/25/1992 12:00	18.00	95508.25	24.68	1544.36	746998.68
10/30/1992 0:00	54.00	93570.50	29.55	14677.38	898242.32
11/1/1992 12:00	54.00	92836.35	36.07	13184.55	724172.68
11/5/1992 18:00	6.00	95612.78	21.25	144.95	559048.37
11/9/1992 18:00	84.00	92709.42	35.42	30096.63	898182.57
11/17/1992 18:00	12.00	95520.29	23.07	615.81	417519.12
11/20/1992 12:00	18.00	95070.84	30.31	1616.91	541889.20
11/26/1992 12:00	6.00	95480.31	19.99	138.00	830357.43
11/27/1992 6:00	6.00	95741.64	22.15	161.46	635585.55
12/11/1992 0:00	24.00	94999.30	23.45	2382.80	700718.92
12/17/1992 12:00	30.00	94858.88	22.58	3532.51	704314.56
12/27/1992 18:00	12.00	95449.48	18.17	524.10	561978.13
1/12/1993 6:00	36.00	95213.19	22.94	5465.60	687474.09
2/17/1993 6:00	6.00	95513.07	20.54	130.20	561561.78
2/17/1993 18:00	6.00	95550.64	21.15	144.90	677512.30
2/26/1993 18:00	54.00	94957.88	26.08	11936.27	765394.11
3/2/1993 0:00	54.00	94864.18	20.73	11582.06	743858.91
3/5/1993 0:00	24.00	95159.48	24.28	2553.16	698912.15
3/10/1993 6:00	18.00	95382.76	25.28	1494.50	634197.41
3/13/1993 12:00	18.00	95267.38	20.89	1275.75	518640.20
3/23/1993 0:00	54.00	93626.86	28.27	14676.69	872652.71
4/8/1993 6:00	18.00	94161.34	28.50	1772.29	627156.22
4/18/1993 18:00	48.00	94027.66	24.13	9348.30	763985.63
4/22/1993 12:00	42.00	95047.96	26.04	6900.05	770876.40
4/25/1993 0:00	36.00	93941.43	28.97	7054.25	888887.63
5/4/1993 0:00	30.00	94840.09	25.07	4194.56	800606.04
5/9/1993 12:00	108.00	93457.78	34.38	49938.65	899967.24
5/19/1993 12:00	60.00	94063.07	22.28	15709.41	809797.85
5/23/1993 6:00	36.00	94129.06	24.43	5045.18	636591.23
5/25/1993 6:00	30.00	95093.48	29.14	4847.30	684054.44
5/29/1993 0:00	78.00	93963.83	28.65	26061.06	839315.63
5/31/1993 12:00	12.00	95212.95	25.44	678.22	608396.63
6/5/1993 6:00	18.00	95323.99	24.14	1348.53	502631.32
6/14/1993 6:00	72.00	91993.57	27.24	25130.65	909058.71
6/18/1993 6:00	18.00	94863.22	20.82	1207.50	601276.31
6/18/1993 18:00	6.00	95326.40	21.01	137.61	642126.91

Final Date & Time	Duration (h)	Minimum MSLP (Pa)	Maximum Wind Speed ($m\ s^{-1}$)	Total IKE (TJ)	Diameter (m)
6/25/1993 6:00	6.00	95575.93	20.95	132.34	367382.54
7/2/1993 0:00	54.00	93498.24	34.53	13354.48	894853.58
7/5/1993 12:00	48.00	92940.89	25.91	8521.70	889112.24
7/8/1993 0:00	18.00	95226.20	21.49	1392.49	652329.92
7/14/1993 18:00	42.00	94211.68	26.55	7854.55	804347.53
7/20/1993 6:00	114.00	94130.51	27.37	50984.37	693550.56
7/22/1993 18:00	48.00	94364.15	31.47	9231.74	803399.93
7/28/1993 6:00	30.00	95031.82	24.64	3494.94	750017.16
8/4/1993 12:00	126.00	93447.18	31.43	65306.50	882691.72
8/7/1993 12:00	6.00	95481.99	29.38	189.68	588933.18
8/16/1993 18:00	90.00	93884.35	28.48	31595.85	818246.13
8/18/1993 18:00	12.00	95290.51	19.74	531.67	734400.13
8/22/1993 18:00	12.00	95252.69	20.22	547.04	705398.61
8/27/1993 18:00	54.00	94583.57	23.21	12748.79	776760.33
8/29/1993 18:00	6.00	95359.64	31.44	186.31	765320.63
9/4/1993 6:00	96.00	93204.15	27.32	41016.47	847317.46
9/8/1993 6:00	72.00	94072.70	28.65	21331.02	890817.03
9/9/1993 6:00	18.00	95274.37	27.10	1428.02	599338.23
9/13/1993 18:00	66.00	93579.65	30.72	19734.36	735081.07
9/16/1993 12:00	60.00	94497.10	27.94	13792.72	563080.13
9/19/1993 12:00	66.00	94067.88	29.57	22078.45	734096.47
9/23/1993 18:00	78.00	91743.31	28.92	27330.82	895688.37
10/1/1993 18:00	102.00	93763.19	27.98	43773.55	882101.59
10/5/1993 12:00	12.00	95694.92	27.08	829.03	447687.35
10/8/1993 0:00	12.00	95324.23	17.49	488.66	278602.01
10/11/1993 0:00	66.00	94273.82	25.36	17625.66	792521.46
10/13/1993 6:00	36.00	94517.34	22.37	4920.15	763330.08
10/17/1993 0:00	48.00	94838.65	19.70	8676.68	620704.11
10/20/1993 6:00	48.00	93204.87	26.14	10645.49	776319.58
10/25/1993 0:00	18.00	95119.74	22.03	1263.92	838238.87
11/1/1993 12:00	78.00	94169.77	25.32	23990.72	883849.19
11/4/1993 18:00	48.00	94071.02	25.62	10707.72	819031.33
11/8/1993 6:00	60.00	93719.36	29.16	14816.20	883766.52
11/14/1993 18:00	18.00	95314.11	21.52	1257.08	578609.77
11/15/1993 12:00	12.00	95398.41	21.77	528.60	663547.66
11/24/1993 6:00	36.00	94213.37	31.79	5126.59	964894.21
12/9/1993 0:00	78.00	93856.65	30.10	25423.10	765051.26

Final Date & Time	Duration (h)	Minimum MSLP (Pa)	Maximum Wind Speed (m s^{-1})	Total IKE (TJ)	Diameter (m)
12/12/1993 18:00	6.00	95438.64	17.18	129.52	364394.98
12/14/1993 12:00	36.00	94728.33	19.65	4772.12	544955.80
12/19/1993 18:00	18.00	94873.33	18.50	1179.43	378512.83
12/23/1993 18:00	42.00	94383.90	23.51	7557.11	925848.18
12/27/1993 0:00	24.00	95036.64	22.92	2527.32	882289.99
1/14/1994 18:00	18.00	93359.75	25.41	1670.86	651019.78
1/19/1994 12:00	6.00	95613.99	23.69	153.52	682792.91
1/23/1994 0:00	24.00	95435.99	23.03	2502.27	688598.10
1/29/1994 12:00	24.00	94199.64	24.27	2316.68	781886.68
2/8/1994 6:00	18.00	95118.77	21.70	1334.27	913731.75
2/14/1994 0:00	24.00	95237.52	26.10	2857.15	735652.52
2/20/1994 6:00	48.00	94582.61	21.32	9416.72	858668.91
2/22/1994 0:00	12.00	95333.14	18.76	518.66	431051.49
3/2/1994 18:00	30.00	94845.87	26.77	4716.97	707818.06
3/4/1994 0:00	24.00	95055.18	25.40	2676.57	900305.97
3/7/1994 0:00	6.00	95271.48	20.77	146.75	485755.84
3/12/1994 0:00	42.00	94976.18	28.37	8835.10	687976.19
3/13/1994 18:00	6.00	95377.94	17.79	128.45	370671.50
3/19/1994 0:00	60.00	94186.15	26.61	13317.29	877239.25
3/19/1994 18:00	12.00	95458.39	23.25	596.20	739998.28
3/26/1994 0:00	30.00	95072.29	23.75	3804.65	725597.78
3/30/1994 12:00	6.00	95799.45	26.21	214.19	476026.65
4/11/1994 18:00	54.00	93545.93	28.28	12724.28	936244.93
4/24/1994 0:00	24.00	95052.78	23.71	2191.34	431227.81
4/27/1994 18:00	24.00	95251.73	24.56	2296.47	677635.96
4/30/1994 12:00	36.00	94752.18	22.62	4942.50	768518.84
5/6/1994 12:00	6.00	95504.88	22.44	151.37	469372.16
5/10/1994 0:00	66.00	93629.75	24.07	17453.50	814635.43
5/17/1994 0:00	66.00	93846.53	31.40	20264.68	866966.40
5/25/1994 0:00	126.00	93590.73	26.83	72060.93	811078.76
6/3/1994 0:00	60.00	94033.20	26.93	17094.82	892515.12
6/9/1994 6:00	48.00	94799.39	33.05	10659.30	828466.12
6/15/1994 0:00	60.00	94308.03	26.85	14893.65	833098.85
6/26/1994 6:00	54.00	95024.84	28.99	12901.74	760580.91
7/12/1994 18:00	84.00	94656.80	32.84	30012.81	806105.28
7/15/1994 12:00	36.00	94111.72	25.51	5443.35	776604.66
7/18/1994 12:00	30.00	94969.92	26.60	3638.15	856034.78

Final Date & Time	Duration (h)	Minimum MSLP (Pa)	Maximum Wind Speed ($m\ s^{-1}$)	Total IKE (TJ)	Diameter (m)
7/22/1994 0:00	72.00	93469.58	33.96	24999.96	914023.66
7/25/1994 6:00	42.00	93572.19	30.34	9266.96	915039.23
7/27/1994 0:00	24.00	95178.51	23.09	2356.89	789879.22
7/30/1994 0:00	42.00	93979.73	24.60	7807.86	920424.27
8/5/1994 0:00	114.00	94520.95	30.08	55883.91	800944.50
8/6/1994 12:00	24.00	94850.45	27.18	2234.38	884530.71
8/7/1994 18:00	6.00	95729.12	21.87	148.87	285350.54
8/8/1994 12:00	6.00	95653.49	19.66	124.77	508681.73
8/14/1994 0:00	96.00	92984.48	29.20	40735.09	779805.21
8/16/1994 12:00	30.00	95557.38	25.29	4250.26	671226.38
8/19/1994 0:00	42.00	94196.99	25.50	7469.08	791903.82
8/26/1994 0:00	18.00	95256.79	25.61	1730.07	754164.88
8/31/1994 0:00	12.00	95245.95	20.27	543.69	479973.42
9/2/1994 0:00	6.00	95414.79	19.09	142.22	452483.93
9/7/1994 0:00	90.00	93193.31	29.94	41529.95	805783.96
9/9/1994 6:00	24.00	95062.41	28.51	3499.91	604397.27
9/19/1994 18:00	42.00	94811.19	24.82	6985.81	602043.47
9/27/1994 12:00	6.00	95662.88	27.82	178.19	458811.13
10/4/1994 18:00	12.00	95538.36	20.00	565.46	675822.38
10/7/1994 12:00	24.00	94765.18	25.91	2524.42	823617.00
10/10/1994 6:00	6.00	95117.33	19.50	135.87	710139.82
10/10/1994 18:00	6.00	94962.69	21.65	142.01	777033.58
10/11/1994 6:00	6.00	95546.79	20.67	147.79	498536.19
10/15/1994 12:00	48.00	94600.67	23.86	11018.55	736903.85
10/19/1994 12:00	6.00	95412.63	22.43	141.27	725609.98
10/24/1994 12:00	54.00	94744.23	28.82	12378.65	854173.08
10/25/1994 0:00	6.00	95159.00	20.68	128.57	660290.63
11/1/1994 0:00	54.00	93300.01	24.29	12171.81	832026.97
11/5/1994 12:00	54.00	92974.85	28.43	14780.36	898611.29
11/28/1994 0:00	48.00	94533.47	22.13	9325.95	560810.19
12/4/1994 0:00	12.00	95302.55	27.24	595.63	670311.74
12/8/1994 6:00	30.00	94546.96	29.02	4004.99	766290.98
12/27/1994 12:00	36.00	94013.69	34.59	5559.20	838901.26
1/1/1995 18:00	6.00	95699.98	19.82	136.30	645556.93
1/8/1995 6:00	12.00	95513.07	21.91	574.22	623647.65
1/13/1995 6:00	42.00	94843.95	25.60	7480.25	732447.03
1/16/1995 18:00	42.00	94936.92	23.97	8530.22	641552.73

Final Date & Time	Duration (h)	Minimum MSLP (Pa)	Maximum Wind Speed ($m\ s^{-1}$)	Total IKE (TJ)	Diameter (m)
2/2/1995 6:00	24.00	94883.69	24.52	2562.08	706728.69
2/5/1995 0:00	24.00	95402.99	21.73	2341.04	513156.25
2/14/1995 18:00	12.00	95449.00	23.68	610.10	836338.25
2/16/1995 6:00	18.00	95380.11	25.50	1516.42	570491.34
3/9/1995 6:00	6.00	95461.04	21.97	144.11	650315.87
3/11/1995 18:00	30.00	94797.22	20.58	3476.04	663188.91
3/15/1995 6:00	6.00	95761.64	19.74	148.23	507346.13
3/16/1995 6:00	6.00	95648.19	20.60	147.27	500598.35
3/23/1995 12:00	144.00	93961.18	27.06	82588.42	844377.43
4/5/1995 12:00	24.00	94883.93	27.43	2442.06	868720.62
4/9/1995 12:00	30.00	94790.48	26.93	4460.92	704534.37
4/12/1995 6:00	6.00	95439.12	19.96	145.91	676407.85
4/15/1995 0:00	12.00	95383.72	23.19	595.38	460702.71
4/17/1995 0:00	18.00	94696.06	20.57	1225.40	651000.39
4/19/1995 6:00	48.00	94375.95	23.69	9339.46	800323.14
4/24/1995 6:00	42.00	94962.21	25.80	7220.04	823979.86
4/27/1995 18:00	24.00	95306.89	24.67	2441.02	726023.15
4/28/1995 18:00	12.00	95400.82	26.73	633.75	918107.63
4/29/1995 18:00	18.00	95319.41	24.60	1300.17	709495.76
5/3/1995 12:00	48.00	94023.08	27.91	11060.73	821130.29
5/20/1995 6:00	30.00	94771.45	23.23	3516.14	724334.39
5/21/1995 6:00	18.00	95107.93	28.63	1604.89	493047.53
5/24/1995 6:00	66.00	94094.62	26.24	17624.39	788554.59
5/25/1995 18:00	6.00	95586.05	19.62	135.23	699767.27
5/31/1995 6:00	126.00	93573.39	31.27	66533.79	879281.12
6/3/1995 18:00	18.00	94894.29	25.18	1499.75	676447.85
6/6/1995 6:00	18.00	95146.47	26.15	1646.33	466509.95
6/13/1995 0:00	54.00	94565.27	30.32	11471.60	853672.60
6/13/1995 18:00	6.00	95284.00	24.82	157.11	500056.46
6/15/1995 18:00	42.00	94373.30	24.15	8230.74	852751.02
6/21/1995 0:00	30.00	94629.82	24.77	4250.66	792751.52
6/23/1995 0:00	6.00	95642.17	23.80	171.59	584800.04
6/28/1995 0:00	84.00	94347.05	30.66	31411.05	831524.01
7/3/1995 0:00	18.00	95317.00	24.65	1336.64	521402.89
7/7/1995 0:00	30.00	95156.59	26.05	3903.63	881036.03
7/9/1995 12:00	30.00	94437.37	27.49	4159.57	629432.15
7/14/1995 6:00	42.00	95344.46	24.02	7984.50	645665.27

Final Date & Time	Duration (h)	Minimum MSLP (Pa)	Maximum Wind Speed ($m\ s^{-1}$)	Total IKE (TJ)	Diameter (m)
7/18/1995 0:00	42.00	94393.29	26.14	8122.80	844403.96
7/19/1995 0:00	6.00	95391.43	20.66	144.32	438880.46
7/19/1995 12:00	6.00	95611.58	17.83	128.32	317490.00
7/28/1995 18:00	48.00	94417.38	28.95	11369.75	460692.02
7/31/1995 6:00	6.00	95513.31	19.77	147.71	541942.69
8/4/1995 6:00	30.00	95136.35	26.09	3707.00	523095.51
8/7/1995 18:00	6.00	95125.28	20.66	152.06	492018.97
8/14/1995 0:00	72.00	93866.28	25.95	20853.65	737624.04
8/15/1995 12:00	24.00	94367.76	29.71	3192.95	623200.28
8/18/1995 0:00	36.00	94774.34	28.03	6623.45	729512.56
8/25/1995 18:00	54.00	93989.12	28.33	12518.53	867770.84
8/27/1995 6:00	18.00	94727.37	25.66	1323.88	655110.93
9/1/1995 0:00	18.00	94904.40	27.35	1408.76	653150.51
9/5/1995 6:00	60.00	94803.24	31.31	15004.85	633811.01
9/9/1995 6:00	78.00	93554.36	25.51	25314.31	850475.66
9/15/1995 0:00	60.00	92703.88	34.41	15892.49	903379.56
9/22/1995 18:00	60.00	93654.08	31.53	16031.76	867075.45
9/27/1995 6:00	12.00	95289.78	20.24	539.77	405458.59
10/2/1995 12:00	36.00	95020.98	25.27	5648.55	806756.01
10/5/1995 6:00	60.00	94387.75	33.22	15501.06	755139.52
10/7/1995 18:00	24.00	94943.18	27.13	2644.91	861153.48
10/8/1995 6:00	6.00	95396.49	21.10	126.65	416959.46
10/8/1995 18:00	6.00	95518.12	19.30	148.01	530843.16
10/14/1995 6:00	60.00	91992.61	35.98	15643.36	926135.88
10/18/1995 12:00	18.00	95222.34	22.56	1423.78	452636.45
10/27/1995 6:00	42.00	94859.12	25.46	7317.04	883939.15
11/1/1995 18:00	24.00	94952.58	23.94	2458.93	845401.06
11/6/1995 0:00	72.00	94286.11	24.36	21356.67	834338.94
11/11/1995 0:00	90.00	93845.09	25.06	34505.79	914509.48
11/13/1995 18:00	6.00	95638.31	18.80	135.16	722741.40
11/17/1995 12:00	30.00	94744.95	22.51	3418.34	903139.17
12/3/1995 12:00	36.00	95111.31	29.28	5499.60	873493.01
12/12/1995 6:00	24.00	94836.24	22.14	2533.10	665612.09
12/16/1995 18:00	36.00	94785.90	21.73	4809.36	725215.73
12/17/1995 18:00	12.00	94960.77	19.17	524.83	449163.09
12/22/1995 18:00	6.00	95529.68	20.07	151.61	606529.88
12/29/1995 12:00	6.00	95525.35	20.51	141.74	738417.16

Final Date & Time	Duration (h)	Minimum MSLP (Pa)	Maximum Wind Speed (m s^{-1})	Total IKE (TJ)	Diameter (m)
1/5/1996 12:00	18.00	95487.29	25.08	1609.81	574910.30
2/14/1996 12:00	18.00	94529.86	35.65	1327.14	820520.54
2/21/1996 0:00	12.00	95394.56	23.68	590.22	434133.78
2/26/1996 6:00	54.00	94402.20	27.69	11205.67	749291.92
2/26/1996 18:00	6.00	95181.16	21.94	146.24	623706.39
3/5/1996 0:00	42.00	94617.05	23.41	7218.55	851916.92
3/13/1996 6:00	18.00	95202.59	22.00	1387.02	600693.06
3/20/1996 6:00	18.00	94304.17	25.35	1645.94	663985.53
3/29/1996 12:00	102.00	93951.31	22.96	39649.46	882008.90
3/31/1996 0:00	18.00	95647.23	22.84	1419.06	510278.00
4/3/1996 18:00	12.00	95246.67	25.22	601.35	885148.52
4/9/1996 18:00	66.00	92908.13	26.01	19598.91	892545.12
4/11/1996 6:00	18.00	95554.98	19.55	1202.60	612580.47
4/12/1996 6:00	12.00	95428.52	23.64	639.20	685258.26
4/16/1996 12:00	12.00	95264.01	24.05	708.73	507589.10
4/21/1996 12:00	72.00	93836.17	29.62	23181.14	869387.60
4/28/1996 0:00	12.00	95388.54	22.43	671.92	521338.32
4/29/1996 18:00	30.00	95086.74	24.92	3836.06	634747.68
5/7/1996 18:00	6.00	95346.63	22.91	140.48	516788.56
5/15/1996 18:00	12.00	95527.52	26.54	728.23	498797.44
5/20/1996 6:00	24.00	95451.65	20.56	2157.82	445833.08
5/24/1996 18:00	18.00	95534.26	26.63	1549.19	782529.96
5/28/1996 0:00	42.00	93474.88	33.28	7784.07	826492.39
5/29/1996 6:00	24.00	94613.68	21.04	2210.88	515785.45
6/4/1996 6:00	138.00	94028.87	29.45	81657.44	837175.49
6/11/1996 12:00	66.00	94139.42	27.82	17234.22	842081.89
6/18/1996 18:00	66.00	94326.09	25.59	18496.21	682927.66
6/20/1996 0:00	18.00	95302.31	25.35	1357.20	836578.59
6/21/1996 18:00	30.00	93963.35	25.81	4479.87	605374.91
6/24/1996 0:00	12.00	95434.54	26.43	662.25	549185.66
6/28/1996 6:00	18.00	95335.55	20.21	1182.85	593721.90
6/29/1996 18:00	30.00	93944.32	28.33	3746.09	892657.11
7/5/1996 18:00	54.00	94131.71	25.54	12442.36	893948.48
7/8/1996 0:00	30.00	95255.58	24.66	3532.75	699275.20
7/21/1996 6:00	12.00	95639.52	22.18	560.48	613548.76
7/23/1996 18:00	36.00	93537.50	34.65	6377.63	901980.44
7/31/1996 18:00	138.00	93529.56	31.77	84204.94	820243.53

Final Date & Time	Duration (h)	Minimum MSLP (Pa)	Maximum Wind Speed ($m\ s^{-1}$)	Total IKE (TJ)	Diameter (m)
8/1/1996 6:00	6.00	95401.30	23.20	155.92	657601.67
8/4/1996 12:00	60.00	93394.91	28.56	16420.89	879455.52
8/7/1996 6:00	6.00	95605.80	19.66	145.08	683437.61
8/8/1996 18:00	24.00	94704.49	22.24	2351.60	814296.76
8/11/1996 6:00	12.00	95006.53	21.37	560.11	520659.17
8/18/1996 12:00	54.00	94060.90	35.12	13451.67	774292.93
8/22/1996 0:00	12.00	95413.11	23.74	635.90	666423.73
8/23/1996 18:00	30.00	95086.98	28.58	4079.33	718957.11
8/28/1996 12:00	36.00	94110.76	30.67	4984.75	845584.22
8/31/1996 18:00	54.00	94489.88	27.19	11515.69	706254.12
9/2/1996 12:00	36.00	94993.04	26.40	6076.27	757949.13
9/8/1996 12:00	96.00	93581.10	31.49	40211.85	746418.91
9/11/1996 0:00	12.00	95540.76	24.00	608.78	734674.27
9/16/1996 6:00	30.00	95000.03	23.17	4234.15	545600.00
9/20/1996 0:00	42.00	94208.79	27.20	8124.95	855859.43
9/24/1996 0:00	6.00	95486.33	23.27	170.22	630103.60
9/28/1996 6:00	12.00	95207.17	28.68	797.34	708289.13
10/6/1996 12:00	24.00	94873.57	20.52	2144.17	405644.60
10/10/1996 18:00	78.00	93260.03	30.44	26841.71	755057.39
10/13/1996 18:00	48.00	93504.75	21.06	8809.60	816938.02
10/17/1996 18:00	84.00	94218.18	32.75	30148.50	851952.91
10/19/1996 12:00	30.00	94704.49	23.14	3349.14	653913.25
10/22/1996 12:00	36.00	94154.11	23.77	5380.20	878312.82
10/23/1996 12:00	18.00	94892.36	20.95	1212.00	736211.85
10/27/1996 18:00	66.00	94351.86	23.63	17069.93	730792.34
11/4/1996 18:00	6.00	95467.54	18.98	133.19	365401.43
11/5/1996 18:00	18.00	94574.90	22.27	1267.15	238829.11
11/16/1996 6:00	150.00	93142.25	36.58	95639.58	864110.61
11/23/1996 0:00	48.00	94425.57	24.95	9987.11	891909.56
12/2/1996 12:00	42.00	94507.46	27.00	7865.00	720819.15
12/11/1996 18:00	6.00	95816.55	22.13	155.33	709777.27
12/16/1996 6:00	6.00	95612.06	21.53	168.27	453577.67
12/27/1996 18:00	18.00	95375.05	21.08	1299.85	619744.75
1/7/1997 6:00	24.00	95012.55	24.49	2686.80	724248.52
1/24/1997 12:00	6.00	95592.55	24.09	137.20	571939.77
2/6/1997 18:00	6.00	95773.44	19.33	144.19	543763.99
2/8/1997 12:00	6.00	95299.18	22.83	159.95	830519.50

Final Date & Time	Duration (h)	Minimum MSLP (Pa)	Maximum Wind Speed (m s^{-1})	Total IKE (TJ)	Diameter (m)
2/13/1997 6:00	30.00	94875.50	26.42	3685.56	908130.49
3/7/1997 6:00	24.00	95119.98	19.36	2156.32	593045.56
3/13/1997 6:00	66.00	93686.12	25.10	17893.84	937974.58
3/18/1997 0:00	18.00	95404.68	22.29	1351.53	499796.83
3/27/1997 18:00	18.00	95055.91	25.17	1282.02	484556.78
4/1/1997 6:00	36.00	94696.54	21.52	4808.06	604524.70
4/6/1997 18:00	12.00	95544.62	22.74	612.18	689476.73
4/7/1997 6:00	6.00	95630.12	21.39	154.75	624262.96
4/10/1997 12:00	72.00	93985.51	28.47	24887.52	939499.36
4/22/1997 18:00	72.00	93628.31	27.77	21787.00	884598.06
4/25/1997 6:00	6.00	95520.29	22.10	146.04	396354.45
4/27/1997 12:00	30.00	95073.97	28.30	3745.03	722302.95
4/30/1997 6:00	48.00	94729.05	24.19	10839.87	870100.24
5/5/1997 18:00	60.00	94404.85	26.96	16184.03	886339.06
5/8/1997 18:00	54.00	94209.75	25.94	13949.94	818785.50
5/15/1997 12:00	18.00	95053.02	22.54	1421.58	607789.01
5/18/1997 0:00	42.00	95147.92	25.13	7716.97	779983.03
5/18/1997 18:00	12.00	95517.64	23.36	664.08	690818.74
5/24/1997 0:00	42.00	93937.82	28.40	8654.04	857900.79
5/27/1997 6:00	66.00	94391.61	28.50	18899.32	814423.47
5/29/1997 0:00	30.00	94927.53	28.76	4020.28	869945.25
6/6/1997 18:00	54.00	95133.46	25.97	12416.10	894236.79
6/9/1997 18:00	36.00	94555.39	22.66	5513.34	624384.50
6/13/1997 0:00	30.00	94265.39	29.75	3906.53	867938.15
6/18/1997 18:00	66.00	93896.15	31.68	22245.22	812969.16
6/30/1997 6:00	18.00	94792.40	24.28	1633.87	755765.86
7/5/1997 18:00	6.00	95582.43	24.56	169.30	526389.05
7/7/1997 18:00	24.00	94864.42	24.78	2656.17	778775.20
7/9/1997 12:00	36.00	94272.62	27.38	5476.58	816716.34
7/12/1997 0:00	6.00	95541.25	20.92	156.13	696297.88
7/19/1997 12:00	18.00	95393.12	20.31	1320.66	694442.03
7/25/1997 12:00	54.00	94693.41	31.17	12808.18	807927.01
7/30/1997 18:00	114.00	93625.42	25.71	56897.36	796368.06
8/3/1997 18:00	90.00	94594.89	27.87	33542.62	859600.97
8/6/1997 0:00	42.00	94746.64	27.37	6903.57	742314.44
8/9/1997 12:00	24.00	95491.15	22.90	2464.37	667825.37
8/15/1997 12:00	78.00	94022.60	27.80	30347.41	791234.15

Final Date & Time	Duration (h)	Minimum MSLP (Pa)	Maximum Wind Speed ($m\ s^{-1}$)	Total IKE (TJ)	Diameter (m)
8/27/1997 0:00	156.00	93319.52	32.94	104326.80	845119.71
8/31/1997 0:00	42.00	93864.84	27.14	8326.38	800171.05
8/31/1997 18:00	6.00	95479.34	19.00	148.65	569062.77
9/17/1997 12:00	168.00	92252.26	33.35	115535.50	869615.89
9/20/1997 12:00	48.00	94046.69	28.68	11013.22	777762.95
9/23/1997 12:00	6.00	95533.06	25.72	129.38	593704.59
9/26/1997 6:00	18.00	95553.29	23.62	1516.65	673742.03
10/3/1997 12:00	6.00	95576.65	20.00	151.19	625396.65
10/4/1997 12:00	12.00	95416.72	25.48	633.31	740400.04
10/8/1997 0:00	42.00	94199.40	27.16	7701.10	807167.18
10/28/1997 18:00	24.00	95175.13	24.86	2393.97	697420.93
10/29/1997 12:00	12.00	95150.33	24.26	604.35	827558.11
11/1/1997 12:00	12.00	95422.74	20.59	564.87	315896.13
11/3/1997 18:00	42.00	94549.85	30.91	6928.28	774362.55
11/4/1997 12:00	6.00	95767.42	24.02	129.41	538137.49
11/5/1997 12:00	12.00	95377.22	26.62	720.17	540722.85
11/9/1997 12:00	6.00	95327.12	23.88	146.27	880973.72
11/10/1997 12:00	6.00	95514.51	24.76	177.97	891635.70
11/16/1997 0:00	18.00	95446.59	36.22	1248.01	435554.53
12/18/1997 18:00	60.00	94664.99	24.86	15290.61	807282.46
12/25/1997 18:00	12.00	95428.52	21.30	546.20	668397.15
12/26/1997 18:00	6.00	95732.01	20.84	150.18	712710.63
1/1/1998 0:00	18.00	95121.42	20.90	1126.46	626060.56
1/1/1998 18:00	12.00	95110.10	25.29	671.55	714085.72
1/2/1998 6:00	12.00	94951.35	20.26	580.82	603454.52
1/8/1998 18:00	30.00	94820.51	21.86	3530.10	829404.01
1/9/1998 12:00	6.00	95268.49	27.58	146.51	646102.20
1/13/1998 6:00	6.00	95828.31	21.63	169.19	594006.84
1/24/1998 18:00	42.00	94479.93	24.17	6977.09	794766.96
1/31/1998 0:00	24.00	94648.56	21.65	2323.35	852172.62
2/5/1998 0:00	12.00	95515.58	17.34	518.00	230171.79
2/13/1998 12:00	30.00	94859.63	31.02	3850.32	771860.68
2/15/1998 0:00	30.00	94572.98	23.61	3836.43	930497.77
2/17/1998 18:00	42.00	95285.95	21.46	6548.40	718021.23
3/4/1998 6:00	54.00	94428.44	29.15	12552.48	778520.35
3/6/1998 18:00	6.00	95301.42	22.88	149.74	842507.43
3/23/1998 0:00	144.00	93607.83	24.60	87650.95	753655.86

Final Date & Time	Duration (h)	Minimum MSLP (Pa)	Maximum Wind Speed (m s^{-1})	Total IKE (TJ)	Diameter (m)
4/2/1998 0:00	42.00	94043.00	22.79	6882.12	797202.90
4/7/1998 0:00	60.00	94056.04	26.40	14526.33	789395.84
4/10/1998 18:00	72.00	94999.30	22.88	20920.94	871680.52
4/17/1998 12:00	6.00	95584.54	22.29	140.40	607528.22
4/22/1998 0:00	18.00	95284.41	23.41	1205.16	650910.03
4/24/1998 6:00	24.00	95162.19	26.54	2816.71	653189.75
4/28/1998 6:00	42.00	94864.05	23.97	7129.01	743006.06
5/2/1998 6:00	60.00	94291.41	23.87	13551.07	848370.13
5/4/1998 12:00	42.00	95034.67	32.94	7797.26	666565.86
5/8/1998 18:00	42.00	94007.86	25.94	7591.92	690500.28
5/10/1998 18:00	12.00	95400.21	21.42	576.72	722087.67
5/18/1998 12:00	24.00	95070.47	21.02	2211.08	476595.85
5/23/1998 0:00	78.00	93902.22	29.24	26103.64	830359.88
5/25/1998 0:00	24.00	95228.49	22.94	2538.87	769641.76
5/26/1998 0:00	12.00	95656.36	23.26	656.31	606523.48
5/30/1998 12:00	42.00	92528.65	31.01	7998.35	955906.73
6/3/1998 6:00	30.00	94794.21	22.56	3479.95	740351.66
6/5/1998 12:00	48.00	93925.86	31.98	9633.34	849367.06
6/9/1998 12:00	84.00	93928.07	35.43	28250.84	959550.40
6/13/1998 18:00	66.00	93694.47	27.01	17423.73	881479.33
6/15/1998 6:00	18.00	94646.35	24.05	1271.27	612317.09
6/20/1998 0:00	6.00	95569.51	18.64	130.13	636547.38
6/20/1998 18:00	6.00	95665.65	18.59	129.34	589779.91
6/23/1998 0:00	42.00	93990.18	23.88	7184.87	719120.85
6/28/1998 18:00	18.00	95261.42	21.76	1162.54	609367.78
6/30/1998 18:00	6.00	95726.42	20.18	145.45	495853.06
7/6/1998 18:00	6.00	95571.72	20.27	135.70	620659.43
7/13/1998 6:00	132.00	93011.99	26.92	74941.22	866426.54
7/22/1998 18:00	150.00	91759.76	33.76	90566.02	779553.04
7/26/1998 0:00	12.00	95167.05	23.77	625.62	682513.24
7/30/1998 6:00	60.00	93277.65	28.45	16517.26	894138.27
8/9/1998 18:00	42.00	94033.05	23.44	7407.86	676216.88
8/10/1998 18:00	18.00	94661.38	22.98	1239.22	676902.40
8/13/1998 6:00	6.00	95594.04	17.96	127.54	285756.79
8/15/1998 12:00	36.00	94041.89	27.25	5926.58	686579.90
8/18/1998 12:00	24.00	94720.39	22.04	2117.90	524523.31
8/24/1998 12:00	66.00	92870.99	31.59	19043.62	856466.19

Final Date & Time	Duration (h)	Minimum MSLP (Pa)	Maximum Wind Speed ($m\ s^{-1}$)	Total IKE (TJ)	Diameter (m)
8/25/1998 6:00	6.00	95626.97	21.02	150.77	758652.06
8/30/1998 6:00	48.00	93481.64	26.48	11012.21	796507.00
9/4/1998 18:00	78.00	94504.47	25.72	25880.02	829311.10
9/6/1998 18:00	42.00	94217.15	22.30	6571.72	440500.24
9/10/1998 18:00	6.00	95607.96	32.12	159.33	587209.51
9/12/1998 6:00	30.00	95374.58	28.66	4204.90	594618.41
9/14/1998 18:00	24.00	94631.55	33.43	2899.96	890486.32
9/22/1998 0:00	84.00	93020.83	29.43	32364.56	834033.56
9/24/1998 12:00	48.00	94066.21	22.84	9175.25	620962.93
10/1/1998 18:00	6.00	95579.23	20.34	149.99	422669.83
10/10/1998 0:00	54.00	92593.18	29.99	12374.82	918907.94
10/13/1998 12:00	18.00	95371.26	24.57	1241.81	533205.97
10/15/1998 0:00	18.00	95420.77	32.91	1958.67	617692.05
10/18/1998 0:00	6.00	95438.89	20.80	167.36	436601.83
10/19/1998 18:00	6.00	95397.12	19.15	140.44	600301.86
10/22/1998 12:00	6.00	95265.40	19.40	137.81	455636.72
10/25/1998 18:00	60.00	93506.83	38.39	15830.89	905046.24
10/26/1998 6:00	6.00	95393.14	20.76	139.57	516595.84
10/27/1998 0:00	6.00	95585.42	19.44	141.76	359970.74
11/2/1998 12:00	84.00	93228.58	27.67	36151.63	844767.55
11/5/1998 6:00	30.00	95026.93	26.87	3478.30	764850.82
11/9/1998 6:00	24.00	95270.04	24.18	2882.32	586932.06
11/12/1998 12:00	36.00	93947.52	29.81	5697.80	847691.20
11/17/1998 0:00	12.00	95195.78	24.60	603.43	609962.03
11/18/1998 0:00	18.00	95264.52	22.14	1175.02	587515.21
11/18/1998 12:00	6.00	95543.65	18.21	123.44	595319.85
11/20/1998 18:00	36.00	94659.84	25.24	5384.25	846472.18
11/24/1998 18:00	24.00	95044.61	21.75	2261.23	324718.52
11/29/1998 18:00	42.00	94794.87	23.01	6883.50	864515.66
11/30/1998 6:00	6.00	95274.46	18.45	127.93	351227.23
12/3/1998 12:00	72.00	93637.67	40.92	20899.29	807558.50
12/7/1998 12:00	72.00	94381.14	26.40	23473.42	780420.21
12/9/1998 12:00	6.00	95659.46	19.52	138.98	563191.30
12/27/1998 6:00	18.00	95410.38	26.99	1548.35	491411.66
1/2/1999 18:00	6.00	95598.02	23.23	162.15	329296.94
1/28/1999 18:00	18.00	94887.03	26.93	1562.19	732531.90
2/2/1999 18:00	18.00	95352.48	25.01	1342.32	748807.95

Final Date & Time	Duration (h)	Minimum MSLP (Pa)	Maximum Wind Speed (m s^{-1})	Total IKE (TJ)	Diameter (m)
2/9/1999 18:00	6.00	95486.85	20.38	133.04	778196.84
2/10/1999 12:00	6.00	95441.54	20.17	130.00	624295.84
2/15/1999 0:00	24.00	94807.91	22.81	2305.10	852111.76
2/27/1999 18:00	18.00	95207.05	21.98	1335.19	915214.92
3/8/1999 18:00	12.00	94987.15	20.97	524.95	662644.98
3/9/1999 18:00	18.00	94943.39	18.52	1122.01	547693.53
3/26/1999 18:00	12.00	95305.62	20.85	525.43	578882.81
3/30/1999 18:00	54.00	94518.39	23.29	12420.13	870303.24
4/11/1999 6:00	18.00	95245.73	22.08	1282.00	885598.24
4/14/1999 6:00	18.00	95255.68	25.28	1634.60	535803.71
4/15/1999 6:00	6.00	95585.20	23.34	172.02	799415.78
4/16/1999 0:00	12.00	95458.78	22.31	601.93	787039.46
4/17/1999 12:00	18.00	95294.57	25.41	1423.37	792046.00
4/18/1999 0:00	6.00	95529.73	24.69	156.79	799769.92
4/21/1999 12:00	72.00	93957.03	27.03	19961.76	824607.75
4/24/1999 0:00	36.00	94615.19	20.95	4911.36	764495.48
4/25/1999 12:00	12.00	95346.07	23.59	660.13	509849.32
4/27/1999 6:00	36.00	95101.85	23.47	5660.63	757073.93
5/2/1999 18:00	30.00	94900.29	24.72	3400.14	816044.34
5/5/1999 18:00	60.00	94654.53	25.34	15052.28	829824.81
5/13/1999 12:00	12.00	95516.24	22.02	611.88	453124.75
5/18/1999 18:00	78.00	92605.78	27.71	31234.11	873011.09
5/19/1999 6:00	6.00	95513.81	19.15	138.73	758232.76
5/23/1999 18:00	48.00	93916.14	29.17	9008.14	750286.84
5/24/1999 18:00	6.00	95648.63	17.02	124.04	285523.80
6/3/1999 12:00	36.00	94677.07	23.91	5742.52	751765.81
6/12/1999 0:00	66.00	94037.92	29.72	19094.96	891404.64
6/16/1999 6:00	30.00	95093.45	23.41	4044.48	630664.96
6/30/1999 18:00	6.00	95496.35	26.88	172.40	596671.23
7/2/1999 0:00	24.00	95512.27	32.81	2936.85	743928.29
7/11/1999 12:00	6.00	95677.14	22.18	162.05	548762.68
7/15/1999 0:00	48.00	94305.78	26.11	10372.33	853202.63
7/16/1999 0:00	6.00	95384.97	20.58	144.18	723535.09
7/19/1999 12:00	54.00	93528.27	28.87	11214.13	883057.22
7/27/1999 18:00	132.00	93873.93	34.30	72291.31	871295.05
8/1/1999 0:00	54.00	94480.38	29.85	13143.68	766274.24
8/2/1999 6:00	24.00	94107.98	24.18	2130.86	376740.81

Final Date & Time	Duration (h)	Minimum MSLP (Pa)	Maximum Wind Speed ($m\ s^{-1}$)	Total IKE (TJ)	Diameter (m)
8/3/1999 0:00	12.00	95118.87	25.92	617.74	706043.02
8/8/1999 18:00	42.00	94072.84	33.10	7671.15	946092.26
8/11/1999 6:00	48.00	93546.17	24.32	9553.79	641244.28
8/15/1999 12:00	48.00	93062.16	29.87	11062.41	861167.82
8/16/1999 6:00	6.00	95678.24	21.08	129.28	316887.37
8/26/1999 12:00	174.00	93491.58	32.36	133188.05	796903.44
8/28/1999 18:00	42.00	95004.83	23.83	7075.02	743654.60
8/31/1999 18:00	48.00	93717.01	30.47	11156.33	763795.06
9/5/1999 0:00	36.00	94580.94	24.70	5418.98	657673.94
9/12/1999 0:00	60.00	92333.94	39.36	18034.27	824266.36
9/20/1999 0:00	60.00	93131.34	35.03	16079.29	819272.97
9/24/1999 0:00	24.00	94860.29	23.83	2884.58	491766.05
9/30/1999 0:00	24.00	95084.17	23.18	2342.32	875438.97
10/2/1999 18:00	42.00	93681.21	28.49	8219.53	845109.85
10/6/1999 18:00	60.00	91866.72	28.20	18477.73	896952.61
10/19/1999 12:00	150.00	93116.97	30.53	92717.20	818343.87
10/26/1999 12:00	150.00	93288.25	31.27	90410.00	876227.45
10/29/1999 0:00	36.00	93777.79	23.61	5264.63	671432.64
11/1/1999 18:00	6.00	95771.51	18.22	127.82	513404.79
11/4/1999 0:00	30.00	94967.26	23.47	3812.48	844494.11
11/8/1999 6:00	54.00	94155.49	27.47	13906.41	806742.93
11/17/1999 0:00	54.00	93702.65	24.89	14213.47	823002.76
11/19/1999 12:00	18.00	95458.78	21.24	1219.34	696214.40
12/1/1999 6:00	30.00	94818.74	23.49	3790.13	813085.36
12/2/1999 18:00	6.00	95541.66	22.02	150.46	794326.35
12/4/1999 12:00	30.00	94548.67	23.79	3806.66	916502.84
12/9/1999 6:00	72.00	93881.00	26.78	22172.46	848657.37
12/15/1999 12:00	36.00	95055.00	25.48	5704.29	783537.78
12/17/1999 12:00	12.00	95583.65	18.70	528.41	347630.48
12/20/1999 12:00	24.00	95000.19	33.58	3282.63	633269.20
1/6/2000 0:00	18.00	95355.13	19.62	1260.94	528023.87
1/18/2000 0:00	12.00	95653.71	25.16	678.03	536525.53
2/15/2000 18:00	30.00	94873.11	24.64	3647.31	826704.65
2/17/2000 18:00	36.00	93413.79	27.12	6151.03	802731.16
2/24/2000 0:00	24.00	94669.34	22.70	2645.55	794395.86
2/28/2000 0:00	18.00	94849.02	22.41	1329.51	770771.02
3/1/2000 6:00	24.00	95095.00	20.33	2114.37	668040.67

Final Date & Time	Duration (h)	Minimum MSLP (Pa)	Maximum Wind Speed (m s^{-1})	Total IKE (TJ)	Diameter (m)
3/7/2000 6:00	18.00	95325.73	24.09	1388.71	849605.84
3/20/2000 18:00	6.00	95672.72	19.98	145.69	677853.60
4/4/2000 0:00	6.00	95287.72	21.72	145.24	625444.88
4/6/2000 6:00	30.00	95052.79	27.15	4374.69	724438.53
4/12/2000 12:00	36.00	95013.01	24.83	5926.51	769869.67
4/13/2000 12:00	18.00	95376.35	20.93	1165.62	360279.22
4/14/2000 0:00	6.00	95502.32	20.10	140.70	883747.00
4/14/2000 12:00	6.00	95484.64	22.62	159.13	695625.66
4/23/2000 6:00	6.00	95655.26	25.79	170.04	615685.66
4/29/2000 12:00	6.00	95445.96	19.84	142.34	569795.31
5/2/2000 0:00	12.00	95178.76	22.83	571.04	608918.34
5/3/2000 0:00	12.00	95511.60	26.22	645.22	841344.88
5/6/2000 12:00	12.00	95323.97	23.05	595.03	468893.15
5/7/2000 0:00	6.00	95415.91	19.71	144.17	395429.79
5/9/2000 0:00	18.00	95264.07	20.85	1222.86	600241.87
5/10/2000 6:00	12.00	95435.36	21.46	617.23	698304.95
5/18/2000 0:00	18.00	95343.86	20.96	1221.79	428944.36
5/19/2000 12:00	24.00	95434.03	21.66	2122.49	706752.53
5/22/2000 0:00	24.00	94578.72	27.22	3087.70	693310.07
5/30/2000 18:00	6.00	95438.67	25.81	114.93	96195.10
6/1/2000 0:00	12.00	95493.48	32.55	815.69	443680.28
6/4/2000 0:00	48.00	94737.41	26.56	10248.25	706006.73
6/8/2000 0:00	48.00	95061.85	33.53	10971.44	800313.38
6/17/2000 12:00	42.00	94597.73	26.99	7527.84	742878.92
6/20/2000 6:00	36.00	94315.06	25.79	5958.36	602980.84
6/24/2000 12:00	6.00	95765.10	21.06	157.06	442637.14
6/28/2000 18:00	48.00	94375.18	24.01	9476.17	864738.64
7/2/2000 18:00	54.00	93529.37	29.72	12805.18	838640.63
7/5/2000 6:00	36.00	94403.69	25.30	5860.31	690078.00
7/9/2000 12:00	12.00	95264.74	20.15	538.41	535571.20
7/11/2000 12:00	36.00	94948.03	28.58	5443.47	728141.26
7/17/2000 0:00	30.00	94479.27	26.34	4745.20	802359.80
7/28/2000 0:00	72.00	92656.61	25.95	23406.15	909125.85
8/1/2000 0:00	24.00	94898.52	20.17	2291.25	563481.35
8/7/2000 18:00	18.00	95045.27	23.76	1309.54	590341.16
8/13/2000 6:00	30.00	94434.63	28.76	4197.47	844559.19
8/16/2000 0:00	6.00	95540.78	23.43	172.21	598818.42

Final Date & Time	Duration (h)	Minimum MSLP (Pa)	Maximum Wind Speed (m s^{-1})	Total IKE (TJ)	Diameter (m)
8/20/2000 0:00	6.00	95485.52	24.62	140.13	622434.02
8/22/2000 12:00	54.00	94420.26	24.67	11198.70	816353.76
8/28/2000 6:00	126.00	93566.73	27.79	70654.32	855282.64
8/30/2000 6:00	42.00	93978.91	29.95	8452.69	767167.23
9/2/2000 18:00	48.00	93551.25	25.75	10692.31	870303.81
9/10/2000 18:00	6.00	95605.09	25.25	167.44	469777.12
9/17/2000 6:00	126.00	93444.51	33.34	70977.69	885441.79
9/21/2000 0:00	48.00	94516.18	25.68	10296.85	792993.01
9/26/2000 18:00	12.00	95459.67	24.15	621.96	867770.37
9/28/2000 18:00	24.00	94959.08	22.73	2390.31	722841.13
10/6/2000 12:00	18.00	95342.31	18.47	1163.22	451128.76
10/8/2000 12:00	24.00	95158.87	20.63	2237.13	766320.21
10/15/2000 6:00	24.00	94879.52	23.17	2704.51	827108.09
10/24/2000 6:00	30.00	94868.69	24.00	3771.61	939584.63
10/30/2000 18:00	54.00	93321.85	29.02	12116.50	909309.24
11/18/2000 0:00	18.00	94889.46	33.12	1673.64	732745.15
11/19/2000 12:00	6.00	95551.39	34.60	163.34	593471.32
11/25/2000 12:00	24.00	95141.86	24.27	2359.98	641196.24
12/20/2000 12:00	48.00	94446.12	25.34	9702.00	519000.18
1/1/2001 18:00	18.00	95213.68	22.80	1285.94	551906.16
1/17/2001 18:00	6.00	95553.15	20.82	144.02	706131.52
2/4/2001 6:00	18.00	95186.50	24.57	1195.37	559471.82
2/12/2001 0:00	30.00	95008.59	23.18	3865.89	791208.27
2/15/2001 0:00	30.00	94277.49	27.23	4393.18	868705.51
2/19/2001 18:00	24.00	95028.48	23.71	2563.90	666015.92
2/27/2001 6:00	12.00	95375.46	22.03	626.70	583200.64
3/4/2001 18:00	12.00	95221.42	21.15	549.49	424355.35
3/13/2001 18:00	54.00	94990.02	24.75	11989.61	858984.26
3/20/2001 6:00	6.00	95908.76	24.39	186.05	492357.45
3/27/2001 18:00	36.00	94568.12	23.31	5316.75	709228.47
3/29/2001 0:00	18.00	95019.20	21.16	1228.88	675885.63
3/29/2001 12:00	6.00	95815.71	20.72	151.06	530458.10
4/4/2001 6:00	18.00	95289.05	21.71	1314.56	748967.51
4/7/2001 0:00	42.00	94378.93	23.57	7880.34	842301.54
4/12/2001 18:00	18.00	95441.10	26.34	1323.39	671191.31
4/15/2001 6:00	36.00	95403.75	23.62	5163.35	687193.32
4/16/2001 0:00	12.00	95392.48	23.12	653.45	816752.71

Final Date & Time	Duration (h)	Minimum MSLP (Pa)	Maximum Wind Speed ($m\ s^{-1}$)	Total IKE (TJ)	Diameter (m)
4/17/2001 12:00	6.00	95569.07	19.03	126.09	367740.49
4/22/2001 12:00	24.00	94973.23	23.45	2431.01	657736.66
4/27/2001 0:00	42.00	93790.61	25.24	6808.87	871124.73
5/1/2001 18:00	36.00	94171.41	24.66	6302.79	856033.37
5/7/2001 0:00	60.00	94323.90	25.97	16331.64	909554.62
5/9/2001 18:00	48.00	95107.60	28.97	9486.00	608787.67
5/18/2001 6:00	48.00	94458.28	27.18	11732.09	899535.68
5/28/2001 0:00	66.00	93392.79	25.34	19987.65	897545.36
5/31/2001 6:00	30.00	95067.60	20.61	3533.78	601030.20
6/4/2001 18:00	6.00	95520.22	18.40	130.50	407287.78
6/7/2001 6:00	18.00	95520.66	25.33	1463.02	542884.51
6/10/2001 6:00	48.00	95193.79	21.13	8418.46	588897.68
6/18/2001 18:00	54.00	93925.20	33.92	12942.78	888089.30
6/27/2001 6:00	114.00	93013.54	31.66	71520.34	830310.54
7/14/2001 0:00	204.00	92673.19	35.22	182876.68	900590.05
7/19/2001 0:00	48.00	94709.78	26.53	9491.42	789744.75
7/21/2001 12:00	24.00	95072.24	31.41	3506.74	475632.94
7/23/2001 0:00	6.00	95661.89	21.78	142.48	663202.56
7/30/2001 12:00	72.00	92986.36	30.10	24582.51	956124.14
8/2/2001 12:00	24.00	94763.71	20.80	2185.22	588312.33
8/4/2001 18:00	6.00	95260.76	21.46	138.89	701699.76
8/7/2001 12:00	30.00	94952.45	24.58	4039.28	510328.88
8/8/2001 18:00	12.00	95295.46	19.76	542.27	367580.64
8/12/2001 0:00	72.00	92560.69	29.48	21816.11	887775.43
8/18/2001 12:00	108.00	94175.16	26.44	50788.97	720199.96
8/24/2001 0:00	96.00	91955.35	33.81	41035.19	869168.80
8/24/2001 18:00	6.00	95487.07	19.63	141.82	525695.20
8/27/2001 12:00	18.00	95111.58	23.26	1320.19	744756.62
8/28/2001 12:00	6.00	95455.69	19.98	137.11	410737.34
8/30/2001 18:00	36.00	94972.78	25.56	5708.12	770658.68
9/3/2001 12:00	30.00	94939.85	23.65	3363.20	595829.06
9/11/2001 18:00	42.00	94357.50	24.26	7413.64	753582.74
9/14/2001 18:00	36.00	94102.67	24.61	5573.19	885272.58
9/20/2001 6:00	72.00	92834.74	28.32	20897.51	843784.34
10/2/2001 18:00	156.00	93816.02	28.25	98544.10	699399.30
10/10/2001 0:00	30.00	94583.59	21.72	3593.74	778291.37
10/12/2001 0:00	30.00	94999.97	21.73	3976.79	752262.06

Final Date & Time	Duration (h)	Minimum MSLP (Pa)	Maximum Wind Speed (m s^{-1})	Total IKE (TJ)	Diameter (m)
10/19/2001 12:00	48.00	94304.45	25.42	10788.03	790427.97
10/24/2001 12:00	96.00	94652.54	22.95	35667.43	655691.20
10/30/2001 18:00	96.00	93678.33	32.44	37339.44	840608.83
11/5/2001 6:00	60.00	94758.41	24.38	16456.02	816609.81
11/8/2001 18:00	36.00	95305.18	23.81	5379.93	717966.50
11/10/2001 6:00	24.00	95260.10	21.88	2247.91	594621.48
11/11/2001 6:00	12.00	95274.68	20.48	495.66	446619.21
11/20/2001 12:00	42.00	94996.21	27.39	7419.51	588135.22
11/27/2001 12:00	48.00	94064.00	23.87	10258.24	870405.69
11/28/2001 0:00	6.00	95307.83	20.11	133.04	703382.15
11/28/2001 12:00	6.00	95380.10	20.18	130.73	648810.19
11/29/2001 12:00	6.00	95263.19	26.81	161.25	705916.47
11/30/2001 12:00	18.00	95006.60	22.37	1279.10	808153.27
12/6/2001 0:00	42.00	95270.92	22.28	6547.25	484645.83
12/10/2001 18:00	12.00	95482.65	21.58	558.20	399446.28
12/13/2001 18:00	24.00	94987.37	30.51	2152.24	686050.80
12/15/2001 12:00	30.00	95230.04	25.99	3297.36	619843.60
12/18/2001 18:00	24.00	95188.05	20.82	2300.83	761686.86
12/20/2001 18:00	12.00	95393.81	23.79	596.06	537433.50
12/21/2001 12:00	6.00	95739.24	17.78	133.44	237742.35
1/22/2002 0:00	6.00	95676.70	20.39	147.69	594539.58
2/7/2002 12:00	30.00	95022.95	21.78	3565.30	692383.61
2/9/2002 6:00	30.00	95150.47	21.77	3530.55	820935.61
2/10/2002 12:00	24.00	95116.44	22.14	2556.31	642997.64
2/14/2002 12:00	48.00	93204.05	35.78	10512.98	753744.63
2/22/2002 12:00	24.00	94682.38	19.51	2245.56	799082.14
3/7/2002 12:00	30.00	94800.18	24.82	3826.29	809584.91
3/17/2002 18:00	12.00	95408.83	23.15	619.30	555220.37
3/18/2002 6:00	6.00	95823.89	20.06	139.56	486056.45
3/26/2002 18:00	30.00	94596.18	29.49	4916.49	846102.89
4/3/2002 6:00	54.00	92961.60	28.07	12607.14	881606.18
4/9/2002 6:00	30.00	95186.72	24.90	3565.54	849911.43
4/10/2002 12:00	18.00	95279.54	23.10	1269.78	689760.15
4/12/2002 12:00	18.00	95489.50	21.12	1303.79	649690.00
4/15/2002 12:00	42.00	94948.25	40.04	8414.10	645799.74
4/19/2002 0:00	24.00	95315.57	25.13	2747.64	654077.16
4/19/2002 18:00	12.00	95498.56	22.68	591.50	562725.14

Final Date & Time	Duration (h)	Minimum MSLP (Pa)	Maximum Wind Speed ($m\ s^{-1}$)	Total IKE (TJ)	Diameter (m)
4/21/2002 0:00	12.00	95171.25	24.17	628.78	660817.09
4/23/2002 12:00	54.00	94200.80	28.03	12563.74	831438.83
4/29/2002 18:00	30.00	95185.39	24.18	3516.97	876975.00
5/3/2002 18:00	30.00	95246.61	27.21	4097.13	825104.88
5/15/2002 12:00	66.00	93493.13	26.43	20253.14	918847.26
5/18/2002 12:00	42.00	93887.85	31.98	7238.89	887068.06
5/25/2002 18:00	42.00	94424.90	36.36	7836.03	865983.88
5/30/2002 0:00	36.00	94846.59	27.80	5977.54	901517.42
6/12/2002 12:00	42.00	94290.97	27.07	7413.94	768168.18
6/21/2002 12:00	72.00	94009.85	27.56	25919.48	846126.10
6/25/2002 0:00	60.00	93955.04	26.91	17840.98	927797.07
6/26/2002 6:00	24.00	95217.22	26.27	2665.23	630112.34
7/1/2002 6:00	78.00	94489.22	31.62	24616.65	830657.80
7/2/2002 18:00	12.00	95797.37	26.30	722.95	638658.26
7/4/2002 6:00	24.00	95094.56	24.38	2833.82	712634.98
7/14/2002 0:00	18.00	94988.03	22.56	1224.40	680327.95
7/16/2002 0:00	42.00	94300.47	30.74	8486.91	935370.11
7/19/2002 6:00	36.00	94673.32	26.50	6117.79	752010.44
7/22/2002 12:00	18.00	95128.82	24.43	1530.79	742471.56
7/29/2002 6:00	114.00	93678.78	30.13	58099.55	751818.93
7/30/2002 18:00	18.00	93992.39	28.35	1511.35	549311.06
8/4/2002 0:00	30.00	94504.91	22.67	3502.62	537289.62
8/6/2002 12:00	18.00	95017.21	22.36	1307.20	586299.19
8/11/2002 6:00	48.00	94536.95	27.10	10742.27	837662.65
8/15/2002 0:00	24.00	95112.68	24.20	2274.43	801064.10
8/17/2002 12:00	30.00	94731.22	22.94	3991.88	857329.95
8/21/2002 12:00	42.00	94555.08	25.90	7527.61	820406.03
8/25/2002 18:00	54.00	93920.56	27.51	15014.30	907750.49
8/27/2002 0:00	18.00	95501.22	19.91	1251.31	642453.54
9/3/2002 0:00	48.00	93667.51	30.11	12732.43	852717.32
9/11/2002 12:00	66.00	93078.30	38.85	23189.93	847870.13
9/18/2002 0:00	84.00	92306.53	33.87	30806.01	814248.35
10/4/2002 0:00	6.00	95772.39	21.88	131.55	573182.41
10/6/2002 18:00	60.00	94811.67	31.90	16307.33	762100.68
10/9/2002 18:00	54.00	93870.17	28.08	13191.99	878301.62
10/20/2002 6:00	42.00	94346.67	30.71	7075.07	798553.54
10/24/2002 18:00	48.00	93875.47	25.43	10229.35	871658.59

Final Date & Time	Duration (h)	Minimum MSLP (Pa)	Maximum Wind Speed (m s^{-1})	Total IKE (TJ)	Diameter (m)
10/25/2002 12:00	6.00	95593.82	22.68	140.72	890108.31
11/7/2002 6:00	24.00	95481.10	23.77	2324.19	845774.30
11/13/2002 18:00	48.00	94494.96	23.44	10240.02	842425.74
11/17/2002 0:00	24.00	95180.31	21.10	2344.17	605213.10
11/24/2002 12:00	30.00	95002.18	25.15	3791.05	681466.27
12/1/2002 12:00	84.00	93157.20	31.23	28115.02	916390.09
12/2/2002 6:00	6.00	94959.30	17.73	124.31	332372.71
12/4/2002 18:00	36.00	94446.12	23.97	4796.91	444664.78
12/10/2002 12:00	66.00	94514.85	21.55	16744.94	692879.75
12/15/2002 0:00	18.00	95205.29	22.10	1194.91	653281.24
12/19/2002 6:00	24.00	95123.95	25.85	2346.43	551891.52
1/21/2003 12:00	6.00	95449.06	27.73	173.83	776324.48
2/16/2003 12:00	6.00	95261.42	22.66	156.05	632682.96
3/7/2003 0:00	6.00	95512.49	24.85	156.62	393031.66
3/12/2003 0:00	18.00	95158.65	23.66	1561.24	929654.52
3/15/2003 12:00	36.00	94156.38	28.38	6318.49	682017.25
3/20/2003 6:00	48.00	94440.82	25.49	9457.65	762405.92
3/23/2003 12:00	54.00	94208.31	29.35	12791.49	864673.09
4/7/2003 6:00	18.00	94643.04	27.96	1826.53	531131.27
4/18/2003 6:00	162.00	94421.15	25.13	114417.87	890946.71
4/20/2003 12:00	12.00	95278.66	19.81	535.34	691553.86
4/27/2003 12:00	6.00	95616.80	18.53	126.81	673988.87
4/29/2003 6:00	30.00	94847.03	23.41	3601.63	760573.61
4/30/2003 12:00	24.00	94881.73	25.06	2481.99	844512.81
5/2/2003 18:00	24.00	95304.52	26.85	2829.51	708362.88
5/10/2003 6:00	12.00	95552.71	23.01	603.99	570296.72
5/13/2003 0:00	24.00	94742.49	24.06	2464.55	680386.72
5/15/2003 0:00	42.00	94235.94	24.66	7383.07	748905.32
5/17/2003 18:00	36.00	94944.05	26.33	6036.24	951285.51
5/25/2003 12:00	48.00	93882.77	37.93	10627.07	827570.99
5/31/2003 6:00	42.00	94231.74	26.26	8248.21	846862.48
6/5/2003 6:00	54.00	93505.28	27.28	12081.34	814128.95
6/10/2003 18:00	24.00	95192.47	24.26	2684.85	806402.41
6/14/2003 18:00	24.00	95082.40	30.30	2689.31	714738.56
6/15/2003 18:00	12.00	95064.28	23.00	660.81	369943.96
6/17/2003 6:00	12.00	95424.08	27.81	574.56	704928.59
6/23/2003 0:00	30.00	94332.96	27.69	3743.04	782081.45

Final Date & Time	Duration (h)	Minimum MSLP (Pa)	Maximum Wind Speed ($m\ s^{-1}$)	Total IKE (TJ)	Diameter (m)
7/6/2003 12:00	18.00	95154.67	23.70	1322.33	403592.42
7/12/2003 6:00	24.00	94996.87	24.17	2446.09	775567.53
7/17/2003 6:00	30.00	95020.30	34.57	3942.92	775505.80
7/18/2003 12:00	18.00	95532.38	25.26	1390.24	629674.35
7/24/2003 18:00	42.00	94167.87	27.31	7035.99	886707.46
8/3/2003 18:00	114.00	94297.60	32.26	57480.22	748078.90
8/4/2003 18:00	18.00	95117.10	24.64	1242.54	693342.53
8/7/2003 12:00	36.00	94968.36	25.61	5530.22	666965.21
8/14/2003 0:00	102.00	94132.73	33.40	45561.61	731148.86
8/18/2003 6:00	36.00	94197.04	23.23	5285.80	667170.75
8/20/2003 0:00	18.00	95363.31	24.03	1492.23	793178.14
8/25/2003 6:00	66.00	94019.13	26.49	18728.82	814317.06
8/27/2003 6:00	6.00	95681.56	25.25	138.17	629695.48
8/29/2003 12:00	48.00	94273.29	26.63	10405.35	524537.07
9/3/2003 18:00	84.00	93209.13	30.32	29202.93	751939.20
9/7/2003 6:00	48.00	93844.31	25.91	9803.21	811896.96
9/11/2003 0:00	84.00	94571.21	31.32	29697.01	881843.88
9/16/2003 12:00	36.00	94927.92	25.30	5176.08	702623.56
9/26/2003 0:00	18.00	95204.18	21.44	1212.38	308009.99
9/30/2003 0:00	48.00	93539.10	34.25	9874.52	758419.12
10/2/2003 6:00	24.00	95071.35	25.47	2501.97	684814.96
10/6/2003 18:00	6.00	95422.32	19.33	132.82	374999.13
10/11/2003 6:00	42.00	94912.89	25.02	6918.41	691771.66
10/17/2003 0:00	42.00	94854.77	25.76	7385.26	718345.88
10/17/2003 12:00	6.00	95413.70	19.56	139.67	791991.05
10/24/2003 12:00	30.00	94582.48	22.78	3236.20	488902.54
11/1/2003 0:00	66.00	94180.47	29.48	17885.23	888671.13
11/1/2003 18:00	6.00	95679.79	24.28	179.18	848741.74
11/13/2003 18:00	42.00	95033.34	24.62	6746.25	555944.96
11/16/2003 0:00	6.00	95488.84	21.00	154.63	225920.30
11/22/2003 18:00	54.00	94635.97	26.37	12035.44	858935.30
12/1/2003 6:00	18.00	94384.02	22.40	1200.77	486263.81
12/6/2003 6:00	12.00	95367.95	21.61	620.44	661597.83
1/3/2004 0:00	42.00	94571.65	25.28	7246.47	854212.40
1/11/2004 18:00	12.00	95500.77	20.27	599.12	636769.10
1/13/2004 12:00	6.00	95093.68	17.98	120.43	715672.55
1/14/2004 6:00	6.00	95293.69	22.37	149.10	632235.63

Final Date & Time	Duration (h)	Minimum MSLP (Pa)	Maximum Wind Speed ($m\ s^{-1}$)	Total IKE (TJ)	Diameter (m)
1/18/2004 18:00	42.00	93936.92	31.28	7843.23	612353.10
1/23/2004 12:00	42.00	95258.11	22.31	7287.78	620104.35
2/7/2004 12:00	6.00	95344.30	19.48	143.93	523176.62
2/16/2004 0:00	24.00	95377.89	25.19	2567.91	536873.98
3/3/2004 6:00	30.00	94150.19	27.17	4397.23	777069.92
3/8/2004 12:00	24.00	95386.95	23.92	2360.27	810584.24
3/9/2004 0:00	6.00	95610.84	20.94	132.57	768515.16
3/13/2004 18:00	36.00	94826.92	27.25	5032.48	894778.36
3/15/2004 6:00	24.00	94903.39	23.16	2109.22	574781.03
3/19/2004 0:00	30.00	94952.23	21.59	3679.63	774243.61
3/27/2004 0:00	24.00	94811.89	21.28	2268.60	726958.02
3/29/2004 18:00	30.00	94846.15	21.77	3693.53	857739.03
4/6/2004 12:00	36.00	94871.12	25.47	5320.34	682493.24
4/7/2004 6:00	12.00	95153.79	19.85	518.59	514175.93
4/10/2004 12:00	36.00	94995.77	22.53	5129.86	774959.21
4/25/2004 18:00	6.00	95752.95	22.95	178.76	644037.27
5/3/2004 18:00	66.00	93665.07	28.13	20895.23	883904.85
5/10/2004 12:00	138.00	93377.54	32.57	78889.12	860379.40
5/11/2004 0:00	6.00	95078.65	22.79	140.34	542192.14
5/16/2004 12:00	24.00	95153.35	27.35	2590.20	740681.39
5/24/2004 12:00	150.00	93810.28	28.83	95395.31	803939.39
6/1/2004 0:00	108.00	92596.28	33.03	50326.06	921746.74
6/1/2004 12:00	6.00	95428.95	18.98	121.51	168331.84
6/4/2004 12:00	6.00	95437.79	18.80	118.30	186164.66
6/9/2004 18:00	36.00	94350.86	25.19	5838.23	847829.45
6/12/2004 6:00	18.00	95277.11	22.49	1176.88	530654.59
6/18/2004 6:00	48.00	94717.74	24.54	9052.14	814686.01
6/21/2004 0:00	12.00	95629.84	21.71	621.86	886467.77
6/25/2004 18:00	78.00	92473.84	32.31	32161.39	934274.26
7/4/2004 6:00	6.00	95569.29	23.76	161.33	643462.67
7/14/2004 12:00	72.00	93468.38	28.52	23249.94	817872.10
7/19/2004 12:00	12.00	95455.69	25.61	590.27	603806.18
7/20/2004 12:00	18.00	94838.85	21.81	1461.98	612719.68
7/25/2004 12:00	72.00	94716.63	28.35	21068.02	896427.18
7/26/2004 12:00	12.00	95478.23	21.38	550.31	697015.79
8/2/2004 0:00	138.00	94090.30	30.57	81591.39	801201.65
8/3/2004 12:00	12.00	95226.28	26.47	665.48	829251.84

Final Date & Time	Duration (h)	Minimum MSLP (Pa)	Maximum Wind Speed (m s^{-1})	Total IKE (TJ)	Diameter (m)
8/8/2004 18:00	60.00	94269.98	41.26	17481.06	735817.59
8/12/2004 0:00	42.00	94715.97	32.10	8947.74	861337.67
8/18/2004 6:00	108.00	94121.46	30.24	47626.16	889184.02
8/19/2004 18:00	6.00	95689.52	23.08	140.27	457788.60
8/20/2004 6:00	6.00	95693.05	23.76	156.00	531078.99
8/21/2004 0:00	6.00	95655.70	23.81	176.28	741159.58
8/23/2004 12:00	42.00	94866.92	33.53	8657.11	841462.07
8/26/2004 6:00	60.00	93423.95	33.23	16979.29	933706.83
9/1/2004 6:00	30.00	94831.78	25.15	3665.95	614951.67
9/2/2004 18:00	24.00	94994.66	26.03	2559.78	909518.87
9/5/2004 12:00	60.00	94874.21	25.98	14689.58	848633.87
9/7/2004 18:00	30.00	95001.51	27.41	3984.07	684548.21
9/11/2004 0:00	60.00	95064.28	22.37	14639.52	829563.77
9/15/2004 0:00	6.00	95125.94	19.20	118.91	274212.20
9/20/2004 18:00	78.00	93798.78	23.83	24130.51	787755.70
9/21/2004 12:00	6.00	95345.85	19.74	137.96	340272.06
9/24/2004 12:00	18.00	95135.67	21.26	1386.94	555720.89
9/28/2004 12:00	54.00	94044.77	25.58	13605.71	913253.70
10/4/2004 12:00	48.00	94631.33	29.47	11622.23	737195.63
10/8/2004 0:00	24.00	95308.94	25.04	2560.64	845525.68
10/10/2004 6:00	42.00	93749.28	27.51	8278.78	869097.35
10/17/2004 18:00	30.00	93627.50	25.67	3915.21	774137.20
10/19/2004 12:00	24.00	95507.63	22.97	2571.26	782645.68
10/24/2004 12:00	72.00	93501.75	27.43	23176.57	841155.35
10/27/2004 6:00	24.00	95047.48	21.71	2390.26	543309.20
11/2/2004 12:00	18.00	95107.38	20.23	1203.89	683298.16
11/12/2004 18:00	24.00	95266.06	27.37	2891.38	592635.55
11/16/2004 6:00	54.00	94309.54	27.19	11982.55	761967.14
12/2/2004 6:00	36.00	95054.34	20.59	4652.35	483422.09
12/16/2004 12:00	24.00	94833.77	25.78	2378.94	714187.67
12/25/2004 12:00	18.00	95498.78	24.09	1388.93	639687.45
12/31/2004 6:00	24.00	94683.70	23.05	2432.02	841703.23
1/8/2005 12:00	30.00	95256.12	24.33	3665.04	756289.19
1/13/2005 12:00	18.00	95105.17	21.58	1214.70	544734.98
1/16/2005 6:00	42.00	94401.48	23.77	7568.24	845411.84
1/17/2005 18:00	24.00	95017.21	22.50	2200.95	609814.13
2/1/2005 12:00	12.00	95154.23	23.38	531.39	617513.42

Final Date & Time	Duration (h)	Minimum MSLP (Pa)	Maximum Wind Speed (m s^{-1})	Total IKE (TJ)	Diameter (m)
2/2/2005 6:00	6.00	95159.98	17.99	127.45	503793.45
2/9/2005 18:00	6.00	95652.17	18.94	135.52	628982.83
2/12/2005 0:00	24.00	94693.21	25.39	2410.52	555367.74
2/12/2005 18:00	12.00	95145.83	18.52	519.26	462256.44
2/16/2005 18:00	84.00	94265.56	27.01	29391.16	795675.16
2/19/2005 0:00	18.00	95146.28	18.14	1112.02	241679.29
2/26/2005 6:00	36.00	94306.00	38.13	5103.79	813368.09
3/5/2005 6:00	54.00	94451.20	26.80	14083.34	888542.78
3/15/2005 12:00	30.00	94834.43	20.83	3432.64	762425.22
3/22/2005 0:00	30.00	94682.16	23.57	3411.59	735893.77
4/7/2005 12:00	60.00	93835.91	24.54	15741.38	735603.87
4/11/2005 0:00	66.00	92762.69	26.75	20364.54	910811.08
4/15/2005 12:00	36.00	94128.75	26.38	6094.83	912408.22
4/17/2005 12:00	30.00	95168.38	21.46	3304.65	328252.35
4/21/2005 6:00	36.00	94426.67	24.50	5758.92	906608.06
4/27/2005 18:00	72.00	93913.27	27.31	21174.78	899222.35
5/4/2005 0:00	66.00	94243.01	26.36	20940.58	875226.04
5/6/2005 6:00	42.00	94934.55	25.37	7286.46	684605.97
5/15/2005 6:00	30.00	93477.44	34.84	5222.13	807474.91
5/18/2005 12:00	6.00	95346.29	18.05	134.97	428823.47
5/22/2005 0:00	30.00	94617.18	26.91	4376.50	822859.66
5/26/2005 6:00	66.00	92279.57	35.96	18658.20	875395.72
5/28/2005 12:00	24.00	95051.46	24.27	2742.86	767716.39
6/9/2005 18:00	42.00	95017.65	25.73	7804.51	670201.79
6/21/2005 0:00	12.00	95672.94	21.99	626.02	653128.12
6/27/2005 6:00	6.00	95609.07	20.75	149.14	606991.91
7/5/2005 18:00	138.00	92683.79	33.54	91102.00	902332.12
7/7/2005 12:00	24.00	94985.60	28.11	2301.31	643434.33
7/11/2005 12:00	66.00	93267.92	26.68	19194.35	933477.84
7/13/2005 18:00	18.00	94830.90	20.77	1320.10	445252.22
8/3/2005 18:00	54.00	93757.01	36.44	13890.62	840212.47
8/7/2005 0:00	6.00	95828.75	23.01	149.41	518822.71
8/11/2005 0:00	66.00	92590.75	28.13	19913.81	918740.09
8/15/2005 0:00	42.00	94309.98	23.95	7440.72	855548.69
8/21/2005 18:00	72.00	93183.05	28.17	23629.04	777083.82
8/25/2005 12:00	12.00	95427.84	25.06	602.46	650727.00
8/29/2005 0:00	54.00	94138.92	27.63	12953.26	837962.08

Final Date & Time	Duration (h)	Minimum MSLP (Pa)	Maximum Wind Speed ($m\ s^{-1}$)	Total IKE (TJ)	Diameter (m)
8/31/2005 18:00	18.00	95005.71	23.54	1358.55	739098.89
9/11/2005 12:00	102.00	91630.69	39.38	50661.11	902789.37
9/14/2005 18:00	72.00	94004.10	30.39	21302.33	902297.49
9/20/2005 12:00	12.00	95451.27	20.65	628.17	632105.19
9/21/2005 12:00	18.00	95166.61	20.85	1269.57	586834.50
9/23/2005 0:00	30.00	95023.62	21.15	3624.00	660103.22
9/27/2005 0:00	6.00	95643.77	22.86	147.25	439243.76
10/5/2005 6:00	66.00	93673.91	24.90	20014.14	633683.83
10/11/2005 6:00	96.00	93924.98	29.44	36672.96	710619.65
10/11/2005 18:00	6.00	95153.57	20.65	148.46	703575.85
10/17/2005 0:00	36.00	94342.25	22.95	5823.61	887243.99
10/28/2005 12:00	24.00	95243.52	24.49	2607.14	818098.18
11/6/2005 18:00	18.00	95112.90	22.73	1355.77	685492.45
11/11/2005 12:00	18.00	95295.24	23.03	1455.66	704316.48
11/15/2005 18:00	12.00	95119.53	24.07	577.41	744471.37
11/21/2005 12:00	12.00	95490.83	20.24	523.37	499570.69
11/23/2005 18:00	12.00	95132.35	23.25	726.09	425400.50
11/29/2005 0:00	54.00	94458.28	25.63	12870.60	614852.21
12/3/2005 12:00	30.00	94782.72	20.16	3415.67	729550.48
1/24/2006 0:00	18.00	94911.56	20.64	1224.23	389644.37
2/6/2006 6:00	18.00	95122.85	22.19	1277.84	913958.13
2/13/2006 12:00	6.00	95799.80	20.00	142.50	513566.00
2/17/2006 6:00	6.00	95287.72	19.40	138.85	396584.04
2/22/2006 12:00	48.00	94631.33	26.87	10550.21	640150.65
2/27/2006 0:00	12.00	95116.00	24.36	754.49	498774.42
3/4/2006 6:00	42.00	93950.40	29.17	8640.94	879121.44
3/9/2006 12:00	24.00	95163.29	25.47	2532.02	694321.26
3/10/2006 18:00	6.00	95508.51	20.05	134.43	337765.86
3/14/2006 0:00	24.00	94733.65	23.24	2427.14	852870.62
3/20/2006 12:00	24.00	94843.27	23.51	2518.56	895523.37
3/25/2006 6:00	24.00	94913.55	22.11	2552.71	881526.38
3/30/2006 12:00	36.00	94563.92	26.04	5524.23	755476.22
4/5/2006 0:00	18.00	95305.84	23.82	1392.33	668486.71
4/6/2006 18:00	6.00	95701.67	21.88	149.77	518791.85
4/7/2006 12:00	6.00	95859.03	21.32	149.67	513872.67
4/10/2006 0:00	24.00	95119.53	23.67	2383.24	914233.59
4/15/2006 6:00	30.00	95348.28	26.54	4298.51	857666.93

Final Date & Time	Duration (h)	Minimum MSLP (Pa)	Maximum Wind Speed ($m\ s^{-1}$)	Total IKE (TJ)	Diameter (m)
4/21/2006 6:00	66.00	94193.51	29.91	19386.21	714942.21
4/23/2006 0:00	24.00	95202.41	26.02	2691.48	745902.31
4/25/2006 0:00	24.00	94605.91	24.39	2673.99	647479.75
4/26/2006 0:00	6.00	95793.17	21.54	166.25	540567.81
5/3/2006 6:00	66.00	94598.39	25.73	18404.03	902560.18
5/5/2006 0:00	30.00	94669.78	22.77	3511.45	696379.07
5/9/2006 12:00	72.00	93543.52	26.18	21493.83	928164.00
5/10/2006 6:00	6.00	95285.73	20.18	135.79	753628.64
5/11/2006 12:00	24.00	95011.02	20.24	2055.67	741906.17
5/15/2006 0:00	72.00	93751.49	32.04	21141.75	734666.06
5/19/2006 0:00	90.00	94040.35	28.69	34665.03	744965.11
5/20/2006 0:00	6.00	95240.20	21.58	135.03	803361.79
5/20/2006 12:00	6.00	95102.74	22.88	151.11	703582.04
5/21/2006 12:00	12.00	95562.66	23.82	588.44	688462.84
5/27/2006 18:00	42.00	92744.57	29.55	8820.59	907767.57
5/31/2006 6:00	36.00	94756.64	25.34	5426.02	789342.32
6/6/2006 6:00	60.00	92550.31	31.85	20285.25	916938.63
6/22/2006 12:00	30.00	95352.48	28.96	3799.41	780632.18
6/30/2006 0:00	144.00	93284.94	32.97	98440.69	879305.92
7/1/2006 0:00	6.00	95540.78	19.88	123.66	410228.60
7/3/2006 6:00	30.00	94983.17	21.89	3364.37	781454.70
7/6/2006 12:00	24.00	95394.25	20.77	2121.53	441120.31
7/8/2006 6:00	12.00	95653.93	22.25	600.26	603773.29
7/16/2006 6:00	144.00	93488.27	31.05	82971.08	881836.18
7/16/2006 18:00	6.00	95425.85	19.40	125.88	460445.63
7/21/2006 18:00	30.00	94972.78	26.15	3416.30	693491.23
7/26/2006 12:00	30.00	94767.47	26.36	3326.05	469661.27
7/29/2006 6:00	30.00	94816.09	37.27	5383.94	719353.11
8/2/2006 6:00	72.00	93676.57	31.47	23882.23	854539.23
8/12/2006 12:00	30.00	95164.84	34.31	5270.14	579110.40
8/15/2006 18:00	66.00	94174.94	34.97	20600.45	834544.94
8/19/2006 18:00	12.00	95414.58	20.74	592.64	370454.07
8/23/2006 0:00	60.00	94407.66	31.03	18718.43	801652.54
8/27/2006 0:00	48.00	94500.05	26.84	9699.79	765501.52
8/31/2006 6:00	72.00	93973.82	26.78	24350.94	857694.20
9/2/2006 0:00	6.00	95105.83	19.80	130.28	632791.56
9/2/2006 18:00	12.00	95112.02	20.99	555.57	312901.22

Final Date & Time	Duration (h)	Minimum MSLP (Pa)	Maximum Wind Speed ($m\ s^{-1}$)	Total IKE (TJ)	Diameter (m)
9/7/2006 0:00	36.00	94351.97	25.88	5192.45	798643.96
9/10/2006 6:00	42.00	94812.33	25.38	6612.30	700820.07
9/14/2006 0:00	42.00	93994.16	25.18	6810.29	846759.03
9/14/2006 12:00	6.00	95163.07	19.60	136.49	720541.21
9/22/2006 6:00	42.00	94008.74	26.79	8469.49	864636.47
9/27/2006 0:00	48.00	94611.66	25.70	11026.82	763871.99
9/30/2006 18:00	18.00	95449.28	31.34	1918.08	626985.13
10/5/2006 6:00	30.00	93937.58	28.84	4663.23	864449.69
10/9/2006 12:00	48.00	93806.30	28.98	10430.77	783382.21
10/14/2006 18:00	24.00	95140.31	24.15	2827.18	531428.88
10/20/2006 6:00	18.00	95020.52	22.18	1541.46	579613.59
10/25/2006 12:00	72.00	94086.10	23.07	19583.65	688264.22
10/27/2006 6:00	24.00	94871.34	27.25	2377.61	493606.46
10/30/2006 6:00	24.00	94827.58	24.40	2593.90	490332.83
11/6/2006 0:00	60.00	94281.47	22.35	14685.68	723821.60
11/15/2006 6:00	66.00	94709.56	26.48	17664.85	758884.10
11/16/2006 18:00	12.00	95548.73	22.93	598.47	689559.58
11/19/2006 0:00	12.00	95531.72	21.44	629.71	643854.67
12/17/2006 18:00	48.00	94672.21	24.73	9642.54	774572.40
12/22/2006 18:00	30.00	94858.52	24.01	3572.52	871742.92
12/23/2006 18:00	6.00	95353.36	17.76	139.89	417313.06
12/25/2006 0:00	24.00	94994.44	20.60	2243.02	599919.69
12/30/2006 6:00	12.00	95050.58	24.89	654.46	378181.48
1/1/2007 18:00	18.00	95077.10	19.98	1192.41	787658.41
1/13/2007 0:00	18.00	95534.81	22.52	1307.05	430421.65
1/18/2007 0:00	12.00	95237.77	18.31	544.12	573173.84
1/22/2007 12:00	30.00	95237.55	25.32	3785.26	572910.23
2/1/2007 18:00	54.00	94034.16	24.29	12206.38	678032.10
2/3/2007 6:00	6.00	95550.72	19.45	140.36	556212.13
2/9/2007 0:00	18.00	94994.00	23.63	1241.25	866930.79
2/14/2007 6:00	6.00	95682.22	21.07	135.55	514910.09
2/19/2007 18:00	6.00	95616.14	18.18	119.83	135312.00
2/20/2007 6:00	6.00	95290.15	17.53	122.19	532490.28
2/26/2007 18:00	18.00	94787.14	24.13	1738.15	593987.75
3/5/2007 12:00	66.00	93648.94	27.78	17989.01	884119.61
3/7/2007 12:00	18.00	95534.37	18.72	1175.12	565012.06
3/9/2007 12:00	6.00	95628.30	22.99	152.30	671795.15

Final Date & Time	Duration (h)	Minimum MSLP (Pa)	Maximum Wind Speed (m s^{-1})	Total IKE (TJ)	Diameter (m)
3/15/2007 6:00	6.00	95551.16	22.49	144.93	749281.99
3/18/2007 6:00	18.00	95352.92	23.33	1536.88	927085.77
3/25/2007 18:00	18.00	95321.98	24.28	1637.66	540540.97
3/31/2007 18:00	18.00	95385.85	24.66	1355.74	626370.45
4/10/2007 6:00	48.00	94068.42	26.58	9629.66	795174.68
4/13/2007 6:00	36.00	94483.25	30.42	5683.60	814314.93
4/14/2007 12:00	12.00	95435.36	22.49	552.25	457401.42
4/18/2007 18:00	12.00	95077.98	23.77	637.76	560669.40
4/22/2007 18:00	36.00	93318.09	29.31	7057.49	868550.25
4/29/2007 18:00	18.00	95191.14	25.44	1700.52	487140.15
5/8/2007 6:00	12.00	95093.90	22.08	636.24	492483.29
5/9/2007 6:00	18.00	95192.91	21.76	1274.22	722961.22
5/16/2007 6:00	12.00	95123.29	22.84	691.50	373994.45
5/18/2007 18:00	30.00	94616.52	21.35	3563.06	510605.23
5/23/2007 6:00	18.00	95202.41	27.61	1597.28	693079.73
5/27/2007 12:00	54.00	93303.06	26.13	14265.12	946391.39
6/5/2007 0:00	36.00	94595.30	20.61	4649.54	514561.62
6/26/2007 18:00	42.00	94789.57	25.51	7318.77	800679.54
7/1/2007 6:00	6.00	95745.43	26.15	169.96	704317.07
7/10/2007 12:00	24.00	94037.03	24.15	2258.85	446724.43
7/14/2007 12:00	54.00	94318.82	25.80	11969.17	791561.06
7/22/2007 18:00	114.00	94498.28	33.55	60443.59	834159.83
7/25/2007 0:00	24.00	95033.56	26.06	2646.82	671694.54
8/5/2007 18:00	48.00	94498.28	26.44	10867.37	818379.51
8/8/2007 18:00	36.00	94822.06	26.19	6069.45	808040.61
8/12/2007 6:00	42.00	93830.39	25.20	8363.61	746120.50
8/14/2007 18:00	42.00	94646.57	25.45	7469.16	798200.19
8/17/2007 6:00	18.00	95330.82	19.97	1293.98	646438.53
8/22/2007 18:00	54.00	94096.04	29.84	13595.70	905373.33
8/27/2007 18:00	12.00	95397.56	27.43	798.57	491937.22
9/2/2007 0:00	12.00	95123.29	22.30	532.29	598883.92
9/3/2007 0:00	6.00	95323.75	25.17	160.00	829325.90
9/7/2007 12:00	54.00	94017.36	23.49	11687.90	813641.55
9/14/2007 0:00	48.00	93404.95	26.74	11771.65	856261.81
9/29/2007 0:00	18.00	94872.67	21.83	1279.57	903549.62
9/29/2007 18:00	6.00	95363.09	18.70	120.97	362321.43
10/2/2007 12:00	24.00	94589.33	25.01	2567.85	755568.83

Final Date & Time	Duration (h)	Minimum MSLP (Pa)	Maximum Wind Speed (m s^{-1})	Total IKE (TJ)	Diameter (m)
10/3/2007 6:00	6.00	95114.67	21.60	139.82	733713.49
10/5/2007 12:00	18.00	95051.02	23.69	1107.18	434157.33
10/6/2007 0:00	6.00	95343.86	17.27	122.26	454536.62
10/9/2007 18:00	72.00	93784.64	27.53	21103.66	787058.24
10/10/2007 6:00	6.00	95645.98	24.66	177.46	496123.00
10/11/2007 6:00	12.00	95382.98	23.46	603.28	570705.93
10/16/2007 0:00	48.00	95089.03	27.99	10802.94	643170.32
10/19/2007 6:00	72.00	94184.22	28.30	23753.40	908463.64
10/20/2007 12:00	24.00	94770.34	29.39	2852.96	862351.10
11/2/2007 18:00	30.00	95068.48	22.85	3715.84	688244.98
11/6/2007 6:00	18.00	95432.04	27.78	1278.23	465820.44
11/15/2007 12:00	30.00	94269.31	21.47	3446.24	348481.02
11/17/2007 12:00	6.00	95502.76	22.40	151.59	589321.77
11/19/2007 18:00	6.00	95677.36	25.69	181.86	645409.97
11/26/2007 18:00	12.00	95586.97	28.71	621.49	669854.44
11/27/2007 18:00	12.00	95476.68	27.41	529.25	884495.58
11/28/2007 18:00	18.00	95533.26	20.43	1258.47	836780.42
11/30/2007 18:00	12.00	95448.62	19.89	576.31	710520.56
12/6/2007 18:00	6.00	95677.14	19.02	132.29	330059.41
12/9/2007 18:00	66.00	94766.14	25.86	18751.80	732098.06
12/11/2007 6:00	24.00	95281.53	22.67	2435.51	549745.16
12/19/2007 12:00	12.00	95441.10	22.53	583.79	781335.03
12/23/2007 0:00	48.00	94525.46	23.49	9973.08	783037.23
1/28/2008 12:00	12.00	95524.79	17.78	519.42	515958.35
1/29/2008 6:00	12.00	95390.78	18.02	517.57	449406.37
1/31/2008 18:00	12.00	95402.41	22.25	606.70	310282.31
2/5/2008 6:00	30.00	94317.34	23.52	3878.22	733703.87
2/8/2008 18:00	6.00	95635.97	20.02	131.37	302736.29
2/11/2008 18:00	6.00	95568.96	21.90	162.64	466883.68
2/14/2008 0:00	48.00	94277.70	26.77	10957.06	878796.65
2/17/2008 0:00	36.00	94816.78	22.73	4854.45	595405.90
2/20/2008 18:00	42.00	94563.19	30.80	7479.37	615510.88
3/4/2008 0:00	66.00	93510.44	25.72	17176.61	875484.92
3/9/2008 18:00	6.00	95664.84	20.77	153.28	725679.13
3/11/2008 12:00	12.00	95073.83	22.98	565.11	631740.14
3/17/2008 6:00	42.00	94952.09	31.13	9628.55	693889.96
3/18/2008 6:00	18.00	95317.52	25.09	1289.80	907009.84

Final Date & Time	Duration (h)	Minimum MSLP (Pa)	Maximum Wind Speed ($m\ s^{-1}$)	Total IKE (TJ)	Diameter (m)
3/19/2008 0:00	12.00	95189.75	23.21	619.79	776482.91
3/20/2008 6:00	6.00	95446.80	20.80	165.64	561440.17
3/21/2008 6:00	12.00	95001.00	27.03	655.10	465586.11
3/26/2008 6:00	18.00	94895.43	26.51	1681.31	585007.56
3/31/2008 18:00	30.00	95136.75	32.56	4494.20	659078.15
4/2/2008 18:00	36.00	93829.11	29.85	5640.09	887649.87
4/8/2008 6:00	18.00	95070.38	25.58	1406.04	623875.04
4/11/2008 18:00	6.00	95503.46	18.38	130.53	922988.42
4/12/2008 6:00	6.00	95456.06	19.64	138.09	922517.16
4/21/2008 12:00	24.00	95347.25	25.19	2507.08	827398.00
4/27/2008 18:00	12.00	95288.86	28.63	574.54	733659.95
4/28/2008 18:00	18.00	95081.80	26.87	1341.27	594353.18
5/2/2008 18:00	54.00	94848.46	22.16	11235.75	816169.76
5/7/2008 12:00	30.00	95038.28	25.99	4325.58	596086.01
5/11/2008 12:00	18.00	94840.49	20.96	1311.56	360651.12
5/18/2008 12:00	78.00	94265.42	26.00	25028.59	832620.62
5/26/2008 6:00	42.00	94963.08	22.94	7270.37	806086.39
6/1/2008 6:00	96.00	93512.59	31.93	37951.32	753371.58
6/9/2008 6:00	78.00	94795.45	29.82	26167.91	765371.88
6/13/2008 12:00	42.00	94489.50	27.13	7875.43	824364.97
6/27/2008 12:00	66.00	93477.04	31.01	18542.02	757823.86
6/30/2008 18:00	60.00	93315.44	31.45	16104.51	845185.68
7/4/2008 12:00	12.00	95621.75	21.63	504.06	396057.62
7/7/2008 0:00	54.00	93188.11	38.16	13343.19	760612.25
7/8/2008 12:00	24.00	94810.32	27.64	2585.44	680122.59
7/9/2008 0:00	6.00	95448.52	21.89	139.68	640194.70
7/11/2008 12:00	54.00	93051.72	36.53	11868.51	927753.47
7/13/2008 6:00	24.00	95032.25	24.69	2714.99	456146.89
7/18/2008 6:00	48.00	92712.58	34.96	13803.37	792618.56
7/21/2008 6:00	54.00	94344.71	26.00	12774.36	730183.28
7/23/2008 0:00	30.00	94872.37	31.51	3879.60	823193.45
7/27/2008 0:00	66.00	92662.59	27.94	20762.34	859932.42
7/28/2008 12:00	12.00	95548.49	30.08	830.57	434100.10
8/4/2008 12:00	24.00	95472.87	24.61	2562.89	578619.15
8/9/2008 18:00	6.00	95827.09	21.36	166.77	495947.79
8/18/2008 6:00	132.00	93438.90	30.63	72175.04	890591.06
8/21/2008 0:00	60.00	91845.56	33.62	15717.54	866115.63

Final Date & Time	Duration (h)	Minimum MSLP (Pa)	Maximum Wind Speed ($m\ s^{-1}$)	Total IKE (TJ)	Diameter (m)
8/23/2008 6:00	48.00	93162.04	27.49	10267.80	644892.13
8/25/2008 0:00	30.00	94489.71	29.20	4225.22	603135.56
8/30/2008 18:00	6.00	95729.05	23.98	169.48	404145.97
9/5/2008 0:00	102.00	93940.50	26.34	45166.39	755919.84
9/6/2008 0:00	18.00	95579.52	21.59	1266.21	463878.34
9/9/2008 18:00	66.00	94124.94	24.97	19192.34	769876.96
9/20/2008 18:00	42.00	93290.24	33.68	8285.36	817389.28
9/28/2008 0:00	12.00	95288.22	20.59	578.57	640299.45
10/2/2008 12:00	12.00	95561.21	20.46	560.21	565642.54
10/6/2008 0:00	42.00	93569.47	24.49	8245.81	810754.44
10/11/2008 0:00	30.00	95058.96	22.70	3385.03	791207.88
10/13/2008 12:00	6.00	95599.56	25.18	147.26	479919.10
10/21/2008 18:00	48.00	94518.37	23.62	10256.52	846721.99
10/31/2008 18:00	24.00	94609.29	19.48	2036.24	597317.37
11/1/2008 6:00	6.00	95154.20	24.68	190.51	426964.80
11/2/2008 12:00	18.00	94922.79	27.26	1749.48	602158.80
11/3/2008 12:00	6.00	95494.20	29.52	173.16	701839.44
11/6/2008 6:00	36.00	95038.49	29.31	4741.84	555130.68
11/9/2008 6:00	24.00	95015.01	25.13	2440.49	579977.52
11/10/2008 0:00	12.00	95115.85	24.16	666.03	840516.69
11/24/2008 0:00	6.00	95527.16	21.45	163.83	574699.07
11/26/2008 18:00	48.00	94682.34	30.02	9088.26	877230.47
12/2/2008 6:00	72.00	93371.03	22.85	20089.15	864555.75
12/4/2008 18:00	36.00	95094.73	22.41	4970.79	833037.65
12/8/2008 12:00	30.00	94678.46	23.75	3356.12	915446.06
12/10/2008 0:00	18.00	95477.39	25.28	1333.44	727561.79
12/14/2008 0:00	12.00	95095.59	19.86	518.53	515568.13
12/23/2008 18:00	42.00	94120.41	24.40	7524.88	850488.35
12/28/2008 18:00	36.00	94888.10	33.80	5409.24	678722.14
1/12/2009 18:00	18.00	95486.22	24.25	1343.29	727064.30
1/23/2009 12:00	12.00	95483.42	23.87	660.62	627891.60
1/24/2009 12:00	18.00	95111.54	23.51	1398.63	794058.48
2/5/2009 12:00	48.00	94071.72	29.49	10792.54	831709.65
2/14/2009 0:00	24.00	94780.59	21.58	2396.58	915922.49
2/18/2009 6:00	30.00	94381.55	24.37	3663.23	529827.91
2/21/2009 12:00	54.00	93007.76	33.69	12524.29	791738.62
2/24/2009 0:00	42.00	94133.55	25.12	6649.43	734525.31

Final Date & Time	Duration (h)	Minimum MSLP (Pa)	Maximum Wind Speed ($m\ s^{-1}$)	Total IKE (TJ)	Diameter (m)
3/4/2009 0:00	114.00	94742.45	22.73	52610.77	893030.78
3/9/2009 0:00	48.00	94802.78	29.23	10193.63	862855.32
3/11/2009 12:00	42.00	94511.04	26.95	7904.32	783826.64
3/13/2009 0:00	12.00	95302.44	19.38	552.36	454383.00
3/14/2009 18:00	36.00	94267.14	22.85	5247.80	913471.73
3/16/2009 6:00	30.00	94292.35	27.30	4017.82	637646.42
3/29/2009 6:00	6.00	95572.19	19.15	132.23	719847.80
4/5/2009 0:00	12.00	95470.28	22.24	604.15	654122.62
4/7/2009 18:00	18.00	94357.42	25.23	1628.91	561805.26
4/10/2009 0:00	18.00	95229.39	20.63	1292.59	682207.82
4/13/2009 6:00	6.00	95627.57	25.34	169.96	711394.53
4/14/2009 0:00	12.00	95672.17	23.72	559.65	889322.65
4/15/2009 12:00	24.00	95006.61	24.15	2662.58	844278.44
4/18/2009 18:00	6.00	95490.10	20.22	146.19	649354.84
4/22/2009 0:00	48.00	93550.94	29.98	10796.83	894128.34
4/25/2009 6:00	42.00	94065.90	28.68	8059.86	762370.96
4/27/2009 18:00	18.00	95268.39	26.90	1811.80	518884.70
4/30/2009 0:00	48.00	94100.80	24.65	10204.93	796399.11
5/6/2009 6:00	42.00	94758.82	22.96	7400.75	609283.27
5/7/2009 18:00	12.00	95184.36	25.24	547.28	449180.50
5/10/2009 18:00	12.00	95699.53	25.24	729.13	592671.48
5/19/2009 6:00	42.00	94057.07	31.65	7598.74	932478.64
5/21/2009 6:00	36.00	94624.38	28.61	6664.39	684941.06
6/9/2009 0:00	18.00	95245.77	27.61	1568.61	565864.84
6/11/2009 0:00	6.00	95500.88	18.65	134.19	690055.26
6/16/2009 6:00	72.00	94544.87	27.77	21185.69	800457.34
6/18/2009 12:00	24.00	94963.73	30.21	2586.18	864018.36
6/21/2009 0:00	24.00	95319.46	23.48	2659.93	830901.74
6/25/2009 18:00	24.00	95187.81	28.30	2330.47	780466.76
7/4/2009 0:00	30.00	94790.93	30.51	4259.30	815065.52
7/6/2009 0:00	30.00	95184.79	29.27	3717.86	609688.99
7/13/2009 0:00	54.00	93738.18	26.01	12231.82	776402.97
7/20/2009 6:00	78.00	94575.90	37.43	25256.65	812989.80
7/26/2009 6:00	78.00	93206.85	26.95	29087.60	853393.72
7/31/2009 6:00	6.00	95319.46	21.57	138.64	577603.08
8/2/2009 6:00	6.00	95660.10	20.17	133.13	543928.18
8/4/2009 6:00	6.00	95332.82	20.36	140.78	680454.92

Final Date & Time	Duration (h)	Minimum MSLP (Pa)	Maximum Wind Speed ($m\ s^{-1}$)	Total IKE (TJ)	Diameter (m)
8/7/2009 6:00	48.00	93961.62	26.01	9973.18	858485.72
8/8/2009 0:00	6.00	95836.57	20.22	142.93	452894.95
8/15/2009 18:00	24.00	94944.34	26.75	2737.20	718307.87
8/19/2009 6:00	24.00	94981.83	24.99	2555.23	570030.00
8/22/2009 0:00	30.00	94208.10	31.27	3851.32	924583.49
8/25/2009 18:00	6.00	95690.91	22.45	147.16	495736.43
8/27/2009 0:00	18.00	95489.24	22.61	1482.91	541933.64
9/4/2009 6:00	30.00	94663.81	22.71	3653.20	668780.81
9/7/2009 6:00	18.00	95105.29	20.21	1352.19	579215.55
9/9/2009 12:00	12.00	95495.49	25.02	583.55	842012.53
9/12/2009 6:00	48.00	94890.90	32.65	9806.71	742006.48
9/19/2009 6:00	36.00	95140.84	22.15	5494.19	604584.74
9/19/2009 18:00	6.00	95558.19	21.84	157.39	437279.00
9/30/2009 0:00	96.00	93726.98	25.24	36293.42	765329.92
10/2/2009 0:00	18.00	95268.39	21.90	1175.28	635960.53
10/2/2009 12:00	6.00	95445.93	19.94	126.51	613427.33
10/3/2009 0:00	6.00	95414.05	17.66	122.52	264998.48
10/6/2009 6:00	24.00	94335.87	25.35	2357.12	742216.60
10/16/2009 0:00	24.00	95456.71	30.59	2381.00	717397.31
10/16/2009 12:00	6.00	95214.10	23.21	143.37	813753.83
10/17/2009 18:00	18.00	95173.59	22.21	1272.53	695238.58
10/26/2009 12:00	60.00	94211.12	29.72	14603.81	837154.47
10/29/2009 0:00	36.00	94850.83	22.79	5086.02	698704.78
10/30/2009 12:00	30.00	93449.46	27.06	4213.10	800776.96
11/2/2009 12:00	42.00	94699.57	25.12	7547.82	766533.61
11/11/2009 12:00	6.00	95760.94	18.18	125.09	526667.23
11/20/2009 12:00	24.00	95248.79	25.08	2230.74	799557.54
11/24/2009 12:00	48.00	95163.46	24.55	9872.05	533138.88
12/6/2009 18:00	30.00	95260.42	28.00	4381.94	809179.74
1/2/2010 6:00	36.00	95167.13	22.53	4992.74	491786.63
1/3/2010 18:00	12.00	95458.43	21.40	629.25	651356.14
1/4/2010 6:00	6.00	95646.53	20.91	143.48	443897.65
1/9/2010 6:00	54.00	94713.79	23.13	11615.25	638159.03
1/14/2010 18:00	6.00	95425.68	19.66	145.75	546987.22
1/16/2010 6:00	30.00	94892.20	25.72	3550.08	699994.10
1/23/2010 12:00	12.00	95507.77	19.83	564.99	628697.59
2/1/2010 6:00	42.00	95165.83	23.30	7443.18	723028.35

Final Date & Time	Duration (h)	Minimum MSLP (Pa)	Maximum Wind Speed ($m\ s^{-1}$)	Total IKE (TJ)	Diameter (m)
2/4/2010 18:00	12.00	95385.60	28.88	765.78	673036.62
2/10/2010 18:00	18.00	95104.00	22.73	1272.77	472876.84
3/6/2010 12:00	66.00	94894.14	26.26	17594.10	680822.46
3/14/2010 18:00	42.00	94804.72	23.53	7150.83	796916.23
3/16/2010 12:00	12.00	95303.30	22.22	642.75	650132.97
3/19/2010 18:00	6.00	95653.64	19.54	149.93	696805.94
3/20/2010 18:00	18.00	95382.16	24.22	1325.41	729917.82
3/21/2010 18:00	18.00	95059.61	20.65	1229.63	710351.64
3/25/2010 12:00	30.00	95130.28	23.71	3978.62	834719.77
3/29/2010 0:00	6.00	95833.98	20.14	143.88	589582.08
4/3/2010 12:00	24.00	95086.33	22.99	2638.04	797121.29
4/5/2010 6:00	6.00	95852.73	22.47	184.74	447902.07
4/7/2010 12:00	36.00	94765.94	20.21	4838.07	702069.38
4/10/2010 18:00	30.00	93932.74	23.16	4126.01	673200.87
4/17/2010 18:00	42.00	95177.04	26.18	8172.98	742111.85
4/23/2010 0:00	54.00	94864.62	30.46	12682.61	834208.13
4/23/2010 18:00	12.00	95533.84	27.30	742.79	491594.62
4/27/2010 12:00	66.00	92678.75	31.61	19074.60	966811.40
5/2/2010 0:00	54.00	94732.54	24.40	12412.98	749104.27
5/16/2010 0:00	66.00	93464.54	27.20	19555.75	939115.30
5/20/2010 0:00	60.00	92638.89	32.47	18171.73	883132.74
5/25/2010 6:00	36.00	93832.77	27.27	6530.43	858462.95
5/30/2010 0:00	90.00	92673.58	26.18	33343.47	913369.04
6/3/2010 12:00	42.00	94446.84	26.49	9336.25	808387.93
6/10/2010 6:00	6.00	95378.49	21.79	135.55	615455.91
6/12/2010 6:00	24.00	94615.11	24.56	2483.23	837296.71
6/13/2010 12:00	18.00	94860.09	21.57	1293.18	542418.42
6/17/2010 18:00	36.00	94375.52	26.47	6866.29	686105.09
6/22/2010 12:00	24.00	95390.34	26.86	2449.83	823570.88
7/2/2010 0:00	66.00	94148.42	22.67	17544.20	695358.24
7/3/2010 0:00	6.00	95713.11	22.28	177.88	489078.17
7/5/2010 6:00	6.00	95661.18	20.56	134.85	803839.23
7/7/2010 18:00	36.00	94978.60	26.23	4949.88	739648.77
7/11/2010 0:00	72.00	94775.20	28.02	22135.58	669756.24
7/17/2010 0:00	48.00	93528.54	26.06	9736.47	872286.49
7/19/2010 18:00	24.00	94860.95	19.08	2113.13	568336.67
7/23/2010 18:00	84.00	93786.44	27.46	26016.42	878496.32

Final Date & Time	Duration (h)	Minimum MSLP (Pa)	Maximum Wind Speed (m s^{-1})	Total IKE (TJ)	Diameter (m)
7/28/2010 6:00	90.00	93601.79	28.65	34744.17	946258.41
8/1/2010 12:00	6.00	95589.43	21.96	149.80	719664.47
8/5/2010 12:00	6.00	95267.96	20.40	144.39	619020.65
8/8/2010 6:00	54.00	93682.16	30.98	12098.46	833981.42
8/10/2010 6:00	36.00	93670.31	29.38	5797.62	885325.88
8/17/2010 0:00	102.00	93024.57	30.54	47844.79	882654.56
8/20/2010 12:00	72.00	94318.42	33.01	21587.44	758368.87
8/22/2010 18:00	30.00	94419.90	26.21	4452.14	682977.91
8/28/2010 18:00	12.00	95759.22	22.81	633.87	642557.36
8/31/2010 12:00	6.00	95471.14	21.41	156.78	732427.82
9/5/2010 12:00	36.00	94411.72	23.07	5731.18	828764.38
9/9/2010 6:00	72.00	94215.43	25.23	24192.03	812649.16
9/11/2010 0:00	24.00	94094.56	25.65	2820.15	671399.46
9/13/2010 0:00	30.00	93758.87	27.44	3776.89	767780.63
9/15/2010 0:00	12.00	95364.92	19.25	540.18	492023.77
9/19/2010 0:00	24.00	95384.53	26.94	2869.91	748885.44
9/29/2010 6:00	30.00	94607.36	22.44	3666.05	492653.28
10/9/2010 0:00	6.00	95105.07	20.47	166.82	490417.80
10/12/2010 0:00	54.00	94294.29	30.62	14346.17	678905.87
10/13/2010 6:00	24.00	94721.55	28.97	2410.24	618951.60
10/14/2010 0:00	6.00	95493.98	18.75	128.87	354372.03
10/14/2010 12:00	6.00	95602.79	19.69	127.87	446615.43
10/18/2010 0:00	72.00	93514.10	30.23	21440.06	858438.53
10/22/2010 18:00	42.00	94604.77	24.97	8651.43	705676.78
10/31/2010 0:00	78.00	93256.41	35.40	24710.40	802082.54
11/10/2010 12:00	30.00	93918.09	27.14	3935.71	676169.30
11/14/2010 6:00	6.00	95855.74	20.60	146.46	343474.50
11/17/2010 12:00	18.00	95313.86	21.55	1192.58	595490.24
11/18/2010 12:00	12.00	95087.84	20.57	532.22	679891.32
11/27/2010 18:00	6.00	95624.34	19.71	121.37	569426.33
11/28/2010 6:00	6.00	95607.10	26.05	175.39	643684.62
12/3/2010 0:00	24.00	95098.18	22.36	2293.91	549009.79
12/16/2010 12:00	84.00	94425.51	38.23	29547.14	711732.73
1/2/2011 18:00	24.00	95383.02	22.52	2105.53	535047.94
1/12/2011 0:00	54.00	94728.88	21.57	11411.52	760992.13
1/18/2011 0:00	36.00	95171.65	26.07	5186.14	759025.43
1/25/2011 18:00	6.00	95570.90	18.74	129.31	655387.99

Final Date & Time	Duration (h)	Minimum MSLP (Pa)	Maximum Wind Speed ($m\ s^{-1}$)	Total IKE (TJ)	Diameter (m)
2/13/2011 18:00	6.00	95387.54	21.26	130.98	490259.92
2/19/2011 12:00	24.00	95225.73	23.65	2579.73	796542.42
2/23/2011 0:00	24.00	95242.11	19.31	2160.88	502674.76
3/3/2011 18:00	6.00	95630.37	24.64	186.17	383325.61
3/7/2011 18:00	30.00	95203.32	25.83	4126.23	804752.99
3/9/2011 0:00	12.00	95415.98	24.88	538.71	630708.93
3/16/2011 18:00	60.00	94192.81	30.56	14526.54	688071.65
4/7/2011 12:00	18.00	95467.48	24.67	1366.78	547544.58
4/8/2011 6:00	6.00	95535.35	21.64	150.21	785354.69
4/13/2011 12:00	48.00	94409.78	26.46	9117.95	886523.51
4/17/2011 6:00	42.00	93418.22	33.09	6871.00	878248.58
4/23/2011 6:00	54.00	94907.71	24.26	12044.41	756344.38
4/28/2011 6:00	66.00	94667.47	27.44	20056.31	840486.88
5/1/2011 6:00	6.00	95607.53	21.62	151.27	697524.42
5/2/2011 18:00	30.00	94295.80	22.27	4092.57	932182.19
5/7/2011 18:00	84.00	94254.43	24.97	29252.27	850240.43
5/9/2011 18:00	6.00	95647.61	22.25	180.83	511931.96
5/18/2011 0:00	24.00	94729.09	24.98	2448.75	685271.33
5/20/2011 18:00	24.00	94762.92	25.03	2416.08	640815.77
5/23/2011 6:00	6.00	95548.28	19.88	131.01	546179.68
5/26/2011 12:00	48.00	93547.07	27.97	9381.98	830794.33
6/4/2011 0:00	66.00	93561.07	32.64	19612.70	828883.08
6/6/2011 18:00	12.00	95316.44	23.22	658.52	786505.00
6/11/2011 18:00	54.00	93839.66	29.35	12994.21	920530.91
6/16/2011 0:00	60.00	94062.67	31.60	19162.12	779955.17
6/24/2011 12:00	12.00	95107.44	31.17	783.74	746401.36
6/26/2011 6:00	12.00	95433.22	24.12	644.23	730454.38
6/29/2011 12:00	48.00	94774.34	26.58	9199.39	537050.31
7/6/2011 18:00	84.00	93718.36	25.14	28351.52	799844.96
7/12/2011 0:00	30.00	95324.20	26.84	3596.61	642836.89
7/13/2011 6:00	24.00	95165.62	28.56	2537.70	837106.61
7/22/2011 6:00	30.00	94756.24	26.11	3841.92	874103.10
7/30/2011 0:00	42.00	94345.57	26.21	8333.23	920976.71
8/8/2011 0:00	60.00	94545.09	30.73	16698.54	827738.48
8/9/2011 18:00	18.00	95298.56	21.93	1457.63	638513.45
8/16/2011 18:00	60.00	93768.56	28.08	14236.09	844021.50
8/21/2011 18:00	18.00	95323.98	24.03	1666.13	733562.58

Final Date & Time	Duration (h)	Minimum MSLP (Pa)	Maximum Wind Speed (m s^{-1})	Total IKE (TJ)	Diameter (m)
8/26/2011 0:00	18.00	95225.73	23.92	1661.82	628735.96
8/28/2011 0:00	42.00	94636.01	24.53	7332.81	895753.82
9/1/2011 12:00	36.00	94112.65	31.53	5978.45	846834.73
9/5/2011 12:00	60.00	92693.62	25.54	14873.45	807884.32
9/11/2011 6:00	6.00	95506.69	22.57	134.01	646205.48
9/19/2011 18:00	12.00	95378.92	22.31	612.31	583660.41
9/20/2011 6:00	6.00	95437.96	21.46	137.80	558983.67
9/20/2011 18:00	6.00	95199.44	21.95	137.07	582558.20
9/23/2011 18:00	54.00	94305.71	29.98	12403.96	838788.96
9/25/2011 18:00	30.00	95120.80	28.75	4000.97	646207.87
10/3/2011 0:00	54.00	92867.07	29.05	13556.53	913307.73
10/3/2011 12:00	6.00	95156.14	25.14	131.70	630856.86
10/7/2011 12:00	48.00	93940.28	23.42	9463.55	803533.18
10/11/2011 18:00	18.00	94612.10	22.45	1391.16	549145.80
10/15/2011 0:00	18.00	95265.81	22.79	1308.85	792630.61
10/23/2011 12:00	48.00	95270.55	23.11	9419.61	534022.27
10/24/2011 12:00	18.00	95373.75	25.38	1305.06	525116.49
11/1/2011 18:00	42.00	94464.50	45.54	8940.53	730977.69
11/8/2011 18:00	12.00	95568.75	27.16	612.92	669741.31
11/12/2011 18:00	36.00	95067.58	22.36	5147.09	553700.24
11/21/2011 18:00	66.00	93499.02	26.60	19687.88	849373.64
11/22/2011 12:00	6.00	95657.30	25.14	140.81	508653.35
11/30/2011 12:00	48.00	94042.20	27.51	10999.09	910392.88
12/8/2011 6:00	6.00	95554.96	27.67	172.32	680464.60
12/9/2011 18:00	30.00	95230.26	22.24	3550.12	735771.01
12/12/2011 0:00	6.00	95596.97	20.37	151.20	563274.59
12/16/2011 0:00	30.00	95006.18	30.31	4784.20	657370.25
12/17/2011 12:00	12.00	95445.50	23.80	610.62	792584.04
12/18/2011 12:00	12.00	95067.15	20.71	544.61	595700.40
12/24/2011 12:00	24.00	94989.58	22.21	2413.01	701032.70
12/26/2011 0:00	30.00	94770.24	22.00	3508.67	786845.98
1/3/2012 18:00	6.00	95486.66	19.15	137.96	323400.82
1/6/2012 18:00	6.00	95741.98	20.78	146.24	916414.43
1/10/2012 12:00	48.00	93128.85	25.66	11002.59	833290.65
1/14/2012 12:00	48.00	94111.58	24.11	10110.25	815826.21
1/16/2012 0:00	6.00	95105.29	20.03	126.75	487539.34
1/16/2012 12:00	6.00	95370.95	19.06	132.70	718275.62

Final Date & Time	Duration (h)	Minimum MSLP (Pa)	Maximum Wind Speed ($m\ s^{-1}$)	Total IKE (TJ)	Diameter (m)
1/19/2012 0:00	6.00	95607.10	20.70	150.97	484082.40
1/19/2012 18:00	12.00	95418.57	24.94	693.62	690701.67
1/22/2012 12:00	30.00	94367.33	28.88	3991.48	752127.16
1/25/2012 6:00	6.00	95582.32	18.40	128.83	609255.33
1/28/2012 12:00	36.00	94444.47	23.21	5588.49	781865.71
1/30/2012 12:00	18.00	94894.57	20.11	1187.10	582579.49
2/2/2012 18:00	12.00	95356.95	18.41	532.84	335406.83
2/7/2012 0:00	12.00	95121.66	20.93	540.84	840486.49
2/7/2012 18:00	12.00	95453.04	22.56	555.17	615565.52
2/10/2012 12:00	24.00	95361.69	33.45	2510.98	843126.90
2/15/2012 12:00	60.00	93875.43	28.53	17182.22	843861.70
2/21/2012 12:00	24.00	95506.91	22.43	2587.66	841216.46
2/28/2012 6:00	60.00	94602.83	25.25	15491.94	760383.94
3/9/2012 0:00	42.00	94760.76	22.42	6886.34	793914.33
3/14/2012 18:00	60.00	94094.34	27.52	15378.02	895789.82
3/19/2012 18:00	54.00	94410.64	24.90	11560.70	458113.82
3/29/2012 6:00	36.00	94248.40	28.56	5684.21	940102.18
4/1/2012 12:00	18.00	95163.89	22.99	1216.34	574453.03
4/5/2012 0:00	6.00	95498.72	21.37	134.51	771441.43
4/10/2012 18:00	6.00	95571.12	18.35	125.17	579334.77
4/13/2012 0:00	12.00	95633.60	22.29	592.47	679004.24
4/17/2012 6:00	54.00	93845.70	30.08	12824.90	854302.69
4/20/2012 12:00	42.00	94830.36	26.41	7824.97	759239.64
4/21/2012 6:00	6.00	95726.90	25.43	194.45	552251.11
4/27/2012 0:00	30.00	94673.29	22.86	4032.61	755269.70
4/29/2012 6:00	30.00	94872.59	23.12	4085.60	707712.09
5/4/2012 6:00	60.00	94012.03	25.55	16238.20	819727.40
5/12/2012 0:00	48.00	94904.05	28.29	11019.76	571943.43
5/15/2012 6:00	48.00	93896.11	26.78	11160.83	831331.85
5/19/2012 0:00	12.00	94266.71	20.28	555.27	361624.55
5/28/2012 18:00	42.00	94997.56	24.92	8058.23	886119.24
6/2/2012 6:00	18.00	95089.34	23.17	1434.66	673934.54
6/12/2012 0:00	72.00	94261.11	31.69	22063.34	728383.57
6/19/2012 6:00	114.00	94154.67	27.43	55083.29	916906.72
7/3/2012 18:00	6.00	95726.25	23.14	131.53	456748.96
7/5/2012 6:00	18.00	94905.34	24.38	1272.55	603401.71
7/7/2012 0:00	18.00	94894.35	24.82	1357.71	540843.54

Final Date & Time	Duration (h)	Minimum MSLP (Pa)	Maximum Wind Speed ($m\ s^{-1}$)	Total IKE (TJ)	Diameter (m)
7/10/2012 18:00	36.00	94521.82	22.46	5446.51	599160.01
7/15/2012 12:00	48.00	94812.48	37.22	10554.63	854090.24
7/18/2012 12:00	66.00	94108.99	27.63	17686.04	837861.08
7/21/2012 12:00	36.00	93658.24	24.86	6117.61	836677.02
7/23/2012 6:00	18.00	95033.32	27.96	1463.13	585328.57
7/28/2012 18:00	96.00	93888.14	31.10	41420.50	827173.51
8/3/2012 12:00	96.00	94062.02	33.77	38711.21	784128.62
8/8/2012 6:00	54.00	93449.89	33.42	12538.98	782814.85
8/14/2012 18:00	12.00	95372.46	27.13	665.94	743756.62
8/18/2012 12:00	66.00	94932.92	29.71	19348.84	836266.30
8/20/2012 18:00	30.00	94608.43	24.44	3969.46	585852.31
8/25/2012 12:00	102.00	93672.47	29.97	44954.13	862017.40
8/28/2012 0:00	18.00	95162.60	22.76	1410.70	408391.52
8/29/2012 0:00	12.00	95467.48	24.45	657.05	514677.25
8/30/2012 6:00	12.00	95503.68	22.56	632.41	814834.88
9/16/2012 18:00	54.00	94739.22	27.94	11874.25	777168.41
9/22/2012 12:00	60.00	94323.16	22.87	14568.17	809781.35
9/25/2012 18:00	66.00	93954.29	29.84	17883.04	832333.48
9/29/2012 6:00	66.00	93517.55	34.71	21105.05	818446.63
10/2/2012 18:00	54.00	93463.25	25.57	11651.47	616156.71
10/9/2012 6:00	24.00	94803.21	19.75	2194.39	633718.43
10/13/2012 12:00	66.00	93289.59	25.14	18789.95	919913.78
10/14/2012 0:00	6.00	95442.70	20.34	142.72	588769.11
10/15/2012 18:00	24.00	95274.86	27.39	2526.65	724282.00
10/19/2012 12:00	66.00	93612.57	28.23	18494.17	885175.81
10/20/2012 18:00	18.00	95389.70	24.60	1412.74	766206.55
10/25/2012 6:00	6.00	95778.82	22.67	145.42	487348.79
10/28/2012 0:00	30.00	94216.51	29.73	3829.02	649530.34
10/29/2012 0:00	18.00	95200.31	24.65	1282.90	492501.95
11/11/2012 18:00	60.00	94335.66	25.36	15461.85	791060.07
11/20/2012 0:00	30.00	94691.17	22.83	3560.67	792205.48
11/21/2012 12:00	30.00	95316.66	20.89	3385.49	744846.37
11/27/2012 18:00	66.00	93981.44	31.63	17809.55	776988.57
11/28/2012 18:00	6.00	95570.47	18.99	140.20	359781.55
11/29/2012 12:00	12.00	95537.50	25.68	609.39	654518.29
12/5/2012 18:00	42.00	94612.53	23.85	7034.27	690558.93
12/11/2012 18:00	72.00	93850.65	23.64	21223.35	730948.45

Final Date & Time	Duration (h)	Minimum MSLP (Pa)	Maximum Wind Speed ($m\ s^{-1}$)	Total IKE (TJ)	Diameter (m)
12/17/2012 6:00	18.00	95466.40	20.48	1197.49	615360.55
12/29/2012 12:00	30.00	94979.67	26.13	4052.02	786805.88
1/5/2013 0:00	6.00	95103.78	23.53	153.30	586990.01
1/7/2013 18:00	18.00	95015.01	20.89	1383.64	530274.61
1/13/2013 0:00	18.00	95415.12	23.77	1271.85	713000.82
1/25/2013 0:00	6.00	95600.64	21.81	139.13	356204.69
1/29/2013 18:00	30.00	94959.85	22.34	3701.65	899940.74
1/30/2013 6:00	6.00	95478.04	20.41	151.87	621842.38
2/6/2013 12:00	30.00	95090.85	25.51	3802.57	694570.13
2/9/2013 12:00	48.00	94512.77	23.30	8998.30	841532.97
2/11/2013 12:00	24.00	95306.31	23.89	2639.76	722488.53
2/16/2013 18:00	54.00	93475.96	26.75	13090.39	918823.89
2/19/2013 18:00	18.00	94977.95	24.32	1532.02	826568.30
3/10/2013 12:00	18.00	95215.82	24.23	1289.89	647631.64
3/12/2013 0:00	6.00	95930.51	26.51	227.51	518941.60
3/17/2013 0:00	42.00	94342.77	23.08	6940.61	833321.47
3/26/2013 12:00	78.00	93010.35	26.42	26267.51	886344.91
4/1/2013 0:00	24.00	94779.51	24.72	2605.23	662168.65
4/3/2013 18:00	12.00	95601.28	19.04	541.67	670886.63
4/4/2013 12:00	12.00	95005.96	19.58	582.13	866256.01
4/7/2013 18:00	12.00	95432.57	21.27	582.86	415327.99
4/8/2013 12:00	6.00	95242.32	24.76	171.13	706110.08
4/12/2013 18:00	30.00	95342.94	24.82	3992.61	774647.59
4/16/2013 12:00	18.00	95282.83	24.55	1493.80	402280.58
4/19/2013 0:00	54.00	93207.71	25.86	13967.58	894245.88
4/25/2013 6:00	66.00	93803.68	23.83	17715.38	842777.76
4/26/2013 0:00	12.00	95744.78	24.49	579.47	327991.92
5/8/2013 18:00	84.00	93694.01	23.91	30025.92	828514.21
5/18/2013 18:00	48.00	93999.97	25.36	10137.86	850453.22
5/28/2013 18:00	42.00	94225.56	27.76	8786.23	770918.40
6/2/2013 12:00	48.00	93244.99	42.40	11690.49	762803.69
6/11/2013 12:00	42.00	94579.78	25.00	7089.21	859492.69
6/16/2013 12:00	12.00	95405.00	22.14	561.65	617369.66
6/25/2013 18:00	162.00	93246.71	31.72	118589.07	917754.80
7/6/2013 12:00	6.00	95337.56	24.18	149.85	752164.85
7/8/2013 6:00	36.00	94639.46	30.67	6204.90	797565.14
7/28/2013 0:00	78.00	94175.35	30.78	24929.50	784521.96

Final Date & Time	Duration (h)	Minimum MSLP (Pa)	Maximum Wind Speed (m s^{-1})	Total IKE (TJ)	Diameter (m)
8/5/2013 6:00	156.00	92045.94	43.18	101921.39	911595.18
8/6/2013 6:00	6.00	95491.40	18.01	135.87	340630.16
8/25/2013 6:00	42.00	93941.36	26.19	7864.66	734529.13
8/26/2013 18:00	30.00	95163.89	19.60	3210.48	461184.99
8/31/2013 0:00	24.00	95019.10	24.62	2968.48	587686.90
9/4/2013 6:00	42.00	94452.22	27.85	8218.08	674119.80
9/15/2013 12:00	156.00	93814.67	33.65	104083.54	800785.41
9/17/2013 6:00	24.00	95200.52	29.06	2743.92	516880.22
9/28/2013 12:00	18.00	95139.55	22.10	1343.23	487434.67
10/2/2013 0:00	36.00	94473.34	26.18	6141.76	753078.31
10/18/2013 12:00	102.00	94302.91	26.89	45872.65	836809.42
10/23/2013 12:00	84.00	93821.13	37.93	34333.50	920598.16
10/27/2013 12:00	24.00	95341.22	23.62	2760.05	665380.25
10/28/2013 0:00	6.00	95397.02	20.21	149.23	889342.82
11/6/2013 12:00	90.00	94039.83	31.88	31897.17	761950.76
11/9/2013 18:00	54.00	94190.22	42.87	12712.98	817600.32
11/16/2013 12:00	54.00	93971.53	26.94	11895.67	710905.60
11/22/2013 12:00	36.00	94337.81	25.77	5846.36	821789.90
11/24/2013 12:00	30.00	94120.41	26.23	4071.26	741379.19
11/26/2013 12:00	6.00	95734.01	19.97	135.78	909237.46
11/28/2013 12:00	6.00	95334.97	21.01	135.42	645769.85
12/1/2013 18:00	54.00	93821.57	27.55	11402.11	806042.79
12/2/2013 12:00	6.00	95072.32	19.75	128.72	463326.63
12/6/2013 12:00	48.00	94523.54	25.28	9046.85	810406.07
12/9/2013 0:00	30.00	94948.86	24.81	3652.91	731425.01
12/9/2013 12:00	6.00	95260.85	21.25	136.51	624814.56
12/18/2013 18:00	54.00	94858.37	24.28	11639.83	758406.87
12/21/2013 12:00	36.00	94423.57	26.34	5272.75	800222.93
12/30/2013 0:00	24.00	95254.60	33.28	2598.88	558682.23
1/5/2014 12:00	30.00	94768.95	23.66	3383.59	495608.24
1/14/2014 0:00	24.00	95465.97	24.70	2527.94	633553.09
1/14/2014 18:00	12.00	95540.31	19.38	562.46	626345.26
1/27/2014 18:00	36.00	94533.02	22.87	5195.43	544836.53
2/2/2014 18:00	18.00	95498.51	23.51	1491.29	795236.98
2/7/2014 6:00	30.00	94740.73	24.78	4034.63	838726.97
2/14/2014 6:00	6.00	95349.41	22.74	171.89	716939.18
2/21/2014 6:00	18.00	95370.09	22.26	1369.48	834542.00

Final Date & Time	Duration (h)	Minimum MSLP (Pa)	Maximum Wind Speed ($m\ s^{-1}$)	Total IKE (TJ)	Diameter (m)
2/24/2014 18:00	24.00	95398.53	20.22	2132.50	653060.70
2/28/2014 6:00	60.00	92497.55	27.00	18665.20	935867.17
3/6/2014 12:00	54.00	93948.47	27.18	13310.32	841484.08
3/11/2014 0:00	36.00	94735.56	23.33	5635.10	826455.54
3/18/2014 0:00	30.00	95092.14	21.12	3650.98	518860.73
3/20/2014 12:00	48.00	94640.97	25.51	9852.45	861647.34
3/23/2014 6:00	30.00	95176.82	24.42	3965.15	543346.99
3/24/2014 18:00	24.00	95240.60	23.68	2502.36	798990.61
3/28/2014 0:00	24.00	95391.42	26.23	2479.04	787815.83
3/30/2014 12:00	54.00	94717.46	23.18	11575.31	686615.75
4/3/2014 6:00	48.00	94298.17	24.94	9907.88	913892.48
4/8/2014 12:00	18.00	95384.10	27.12	1736.88	707600.03
4/10/2014 6:00	6.00	95385.82	21.90	143.65	754818.57
4/14/2014 6:00	24.00	94895.86	24.15	2458.17	845054.99
4/18/2014 6:00	30.00	94614.68	22.15	3765.86	863676.68
4/25/2014 0:00	30.00	95123.60	23.99	3618.51	847819.71
4/25/2014 18:00	6.00	95929.86	31.88	189.15	541823.67
5/1/2014 0:00	36.00	95161.95	24.25	4926.75	648595.88
5/13/2014 18:00	48.00	93148.46	26.43	10199.24	904010.84
5/21/2014 0:00	18.00	95558.19	23.96	1530.43	231397.20
5/23/2014 6:00	6.00	95541.17	20.41	147.47	841241.48
5/25/2014 6:00	30.00	95089.99	23.36	4102.57	599718.10
5/29/2014 12:00	18.00	95285.20	24.88	1565.87	641298.50
6/6/2014 12:00	42.00	94866.34	28.31	7057.86	899323.75
6/13/2014 6:00	48.00	95102.92	29.58	10941.00	764680.40
6/18/2014 0:00	48.00	95125.33	25.85	9142.12	823034.75
6/22/2014 18:00	66.00	93532.63	23.32	18079.22	725531.93
6/27/2014 0:00	12.00	95461.88	21.17	616.85	502503.62
7/4/2014 12:00	18.00	95021.26	24.81	1392.52	635594.66
7/6/2014 18:00	24.00	95042.16	22.17	2376.57	784669.96
7/11/2014 6:00	78.00	94268.22	27.89	30189.76	937636.17
7/15/2014 6:00	54.00	94147.99	30.44	12796.01	703276.29
7/17/2014 0:00	36.00	94970.41	29.85	6693.91	752842.33
7/29/2014 18:00	30.00	94829.28	26.67	4238.72	842248.01
8/7/2014 0:00	6.00	95754.91	23.17	163.85	611234.88
8/9/2014 6:00	6.00	95465.54	25.48	131.86	571843.57
8/15/2014 0:00	6.00	95484.29	19.78	131.22	585950.90

8/18/2014 0:00	6.00	95398.96	28.26	146.31	509201.46
8/19/2014 0:00	12.00	95325.92	26.61	573.20	572621.64
8/22/2014 12:00	30.00	94825.83	26.28	3789.65	727675.96
8/24/2014 18:00	36.00	94826.05	26.37	5285.63	601677.79
8/31/2014 12:00	30.00	94698.28	30.21	4604.85	762667.16