1. Introduction

This report details my visit to McMurdo Station, Antarctica, to work with weather forecasters at the McMurdo forecast office (“Mac Weather”). The goal of my visit was to discuss the performance of the Antarctic Mesoscale Prediction System (AMPS) during the current field season with the weather forecasters. I also gauged model performance by following AMPS forecasts and observations real-time during my visit. This visit was especially important for the AMPS effort, as it is the first season that the Weather Research and Forecasting (WRF) model has been used within the AMPS framework operationally. AMPS WRF forecasts have been available over the internet for several years without all of the polar modifications, but forecasters have not analyzed these runs extensively.

I arrived at McMurdo 22 January on a RNZAF C-130 from Christchurch. The weather during my visit was generally quiet and devoid of any significant weather events. Only one intracontinental flight was cancelled due to weather in the McMurdo area, and no intercontinental flights were impacted by weather at McMurdo. There was only light snow a few days, and nothing from any organized system. However, during times of weak forcing there are situations involving low-level moisture in the region that can impact flight operations. It has been noted previously that these situations can be difficult for AMPS to resolve, so observing model performance during such events is beneficial. In addition to the primary goal of assessing AMPS performance real-time, our research group and myself are interested in strong wind events in the McMurdo area. Future research efforts may be directed towards study of such wind events and the
general flow regime of the McMurdo area. In anticipation of these efforts, some exploratory work was done with the extensive weather observing network data provided through Mac Weather, along with discussing such events with forecasters who have experienced them.

Section 2 presents some general comments about AMPS performance and features provided by the forecasters and obtained from my own experiences here. Section 3 contains analysis of several weather events encountered during my stay. As can be seen, there were a good variety of weather events during my three weeks at McMurdo. Section 4 contains some miscellaneous information regarding lesser-impact weather events and my visits to several AWS sites on servicing missions. Section 5 includes some conclusions from my visit.

2. General Information

Overall, forecasters are pleased with AMPS WRF, and have noticed improvement with the switch to WRF and the recent increased resolution. There were not a lot of negative comments towards model performance. An issue known by those involved with the AMPS effort is a low-level warm temperature bias over the continental interior. The forecasters are well aware of this problem, and a work-around has been developed on the AMPS webpage for South Pole forecasts. A “corrected” temperature is presented, obtained by averaging recent observed temperature values in an attempt to correct for the warm bias. I am not sure of the exact calculation of this quantity, but it is hoped that it is a temporary product until a permanent fix is implemented. The remote forecasting office in Charleston generally handles South Pole forecasts, so I did not have the opportunity to discuss this problem extensively with forecasters.

One of the major issues with AMPS noted during previous visits by myself and others involved with AMPS is how it handles low-level moisture. This is especially important due to the prevalence of low-level moisture in summer, and the impact on flight operations. For example, C-17 flights need 1500 ft or greater ceilings and at least 3 miles visibility, and C-130 flights need at least 300 ft or greater ceilings and at least 1-
mile visibility to land at Pegasus airfield. My feeling is that AMPS WRF is handling low-level moisture better during this visit than AMPS MM5 did during my visit in 2006. AMPS MM5 had numerous cases of moisture advection down McMurdo Sound towards McMurdo that was grossly overestimated. This does not seem to be an issue with AMPS WRF. Prominent examples of low-level moisture advection towards McMurdo are presented in section 3, but for other weaker and/or tenuous events, AMPS WRF handled moisture advection fairly well. Forecasters noted that the number of “false positive” moisture advection events have decreased with AMPS WRF. Although, forecasters have noticed that for inland locations, AMPS has problems differentiating between fog and stratus clouds inland. This can be an issue for transport to and from field camps. The problem may be related to the temperature biases inland mentioned earlier. Also, forecasting supervisor Al Hay noted that AMPS often underestimates precipitation amounts at McMurdo during “overrunning” events to the south. None such events were encountered during my stay here, so further comment is not possible.

Another issue I was concerned with here, in regards to low-level moisture, is the sea-ice representation in AMPS. Due to docile conditions most of the summer, there was more ice in McMurdo Sound just north of McMurdo than most years. Stronger (15-30 kts) southerly winds 31 January to 2 February cleared out ice, leaving open water near Cape Royds, north of McMurdo. Figure 1a and b show visible satellite imagery from 3 February illustrating the recently opened water, and the 1.7 km resolution sea ice representation in AMPS from the 0000 UTC 3 February model run, respectively. Sea ice ingested from SSM/I data is at 25 km resolution, which is insufficient to represent the relatively small area of open water being discussed. AMPS does get a reduction in sea ice fraction associated with the wind event, from 90% on 28 January to 60% on 3 February, but not the region of open water. It is unclear if this discrepancy in sea conditions led to any model biases in regards to temperature and low-level moisture – no egregious errors were noted during periods of northerly flow. It is unlikely that this open water would have significant influence on precipitation processes. It might enhance some precipitation amounts, but would probably not be involved in precipitation generation, due to insufficient wind fetch, similar to lake-effect snowfall. Additionally, moisture and heat fluxes generated over the open water could potentially lead to fog as
air is advected over the colder ice surface to the south. But again, no such effects were noted at McMurdo, as a southerly or easterly wind regime kept low levels clear during moisture advection events. Also, mid-level stratus blanketed the area during these events, preventing observation of low-level cloud features on satellite imagery. The mesoscale sea ice issue requires further study to determine if it is of significance towards forecasting efforts at McMurdo.

Below are other issues brought up by forecasters or noted by myself, in bullet-point format:

• Forecasts are now disseminated exclusively from the AMPS website at http://www.mmm.ucar.edu/rt/wrf/amps/index.html. During my last visit, AMPS data was downloaded off of the Antarctic-Internet data distribution system (Ant-IDD) using LDM software. With bandwidth restrictions being less of an issue now, and with the Ant-IDD not always providing full forecasts, the AMPS website has become the more attractive option at this time.

• Similar to my last visit, AMPS often backs off the timing of synoptic-scale systems within the 36-72 hour forecast timeframe. Forecasters have found that AMPS tends to lock onto systems well within the 36 hour forecast window. Forecasts past 72 hours are generally disregarded.

• The “H and L” labels that are often stamped over Ross Island in AMPS plots annoy one forecaster. For many quantities, the high/low distribution can be implied from the contours, and these labels could be safely removed in the interest of clarity.

• This is not an AMPS issue, but several forecasters have mentioned how useful radar would be at McMurdo. Properly placed, radar would aid in identifying low-level moisture and snowfall (which impacts visibility) being advected into the region. Additionally, Doppler velocities would be useful for determining lower-tropospheric wind patterns for the area runways, in support of flight operations.

The SPAWAR Charleston Remote Operations Facility (ROF) handles forecasting for South Pole and remote field camps. I contacted Rolf Hennig, Senior Weather Forecaster at ROF, regarding the performance of AMPS WRF during the field season.
Rolf replied on behalf of the entire forecast staff at ROF. The biggest issues are ceiling and visibility at South Pole and AGAP-South (East Antarctic Ice Sheet), which are important for Terminal Aerodrome Forecasts (TAFs). With a strong high pressure system over interior East Antarctica, setting up grid northerly flow (from the 0°-40°E sector) that advects moisture inland, AMPS over-predicts the areal coverage of cloudiness (represented by the AMPS cloud ceiling product). However, the cloud base levels predicted by AMPS are found to be reasonable. During such events, with observed wind speeds under 10 kts at AGAP-South, AMPS typically over-forecasts wind speeds at 15-17 kts. This impacts visibility forecasts, as the saltation threshold is 6-7 kts. Hence, wind speeds exceeding this threshold by 7-8 kts would reduce visibility to less than 1 statute mile, below minimum landing requirements for LC-130 aircraft at South Pole and AGAP-South. Additional concerns were raised about fog at Siple Dome, where AMPS surface relative humidity (RH) with respect to ice is used for guidance. AMPS tends to under-forecast the occurrence of advection fog from the true northwest-north sector. Radiation fog is better predicted by AMPS.

3. Event Descriptions

January 25th Ross Ice Shelf synoptic-scale cyclone

Over the period 22nd January to 26th January a small synoptic-scale cyclone propagated northward across the Ross Ice Shelf. The system formed around 1200 UTC 22 January near the Siple Coast, and tracked around the western portion of the Ross Ice Shelf to the east of McMurdo by 25 January. The system is barotropic, with weak temperature gradients and vertical stacking. The cyclone had little if any impact on flight operations at McMurdo, but the representation of such weather systems in AMPS is of interest. A sequence of infrared satellite images from approximately 1800 UTC 24 January to 0800 UTC 25 January is shown in Fig. 2a-c. Figure 2a shows the comma cloud centered over the northern portion of the Ross Ice Shelf. Just outside of the storm center is a region of lower cloud, which appears to originate as dry air off of East Antarctica over the Ross Sea is advected over the ice shelf. Higher clouds can be seen in
the western sector of the system, along the Transantarctic Mountains. Figure 2a shows scattered cloud coverage over the McMurdo area. Pegasus airfield observations indicate scattered upper level cloud at and around 1800 UTC 24 January. Subsequent images (Fig. 2b and c) show a greater concentration of cloud cover into the McMurdo area, and Pegasus airfield observations show upper level cloud categorization increase to “broken” after 20 UTC 24 January.

The AMPS representations of geopotential height and relative humidity for 850 hPa and 700 hPa are shown for 0000 UTC 25 January in Fig. 3a-b. At 850 hPa, the relative humidity values over the central Ross Ice Shelf matches up well with satellite imagery near the time of this event (Fig. 2a and b). A dry tract of air extends along the Transantarctic Mountains, as a result of the northward propagation of a barrier wind. This airstream undergoes adiabatic warming and associated drying upstream as it descends from the Transantarctic Mountains and West Antarctica. At 700 hPa (Fig. 3b), relative humidity values of 90% or greater exist along the Transantarctic Mountains, northwest of 180°. The presence of only upper level clouds along the western Ross Ice Shelf, into the McMurdo area, in AMPS is supported by the Pegasus airfield observations. AMPS correctly simulates the vertical cloud distribution for the system, having only high cloud over the McMurdo area with lower cloud just to the east. The moisture distribution within the system evolves from earlier forecasts (1200 UTC 23 January and 0000 UTC 24 January simulations, not shown), as the system becomes more coherent and the relative humidity values increase at 700 hPa.

January 26th fog event

A radiation fog event occurred on the evening of January 26th-27th local time. Light winds and the decreasing sun angle resulted in air temperatures approaching the dewpoint temperatures at Pegasus and Williams airfields by 0900 UTC 26 January. Figure 4a shows the surface relative humidity and wind barbs from the 1.7 km resolution domain at 0900 UTC. Black Island wind speeds of 10 m s⁻¹ do not reach Pegasus or Williams airfields in Fig. 4a or in the AWS observations. This implies that strong
inversion conditions lead to flow separation in the lee of Black Island. Figure 4b shows the AMPS model sounding from Pegasus South AWS site at 1200 UTC 26 January. An inversion of about 4°C exists at the surface. Similarly, the AMPS model sounding from McMurdo, shown in Fig. 4c, also has a surface inversion, but conditions remain warm enough at the surface to prevent fog formation in the model. The actual 1200 UTC 26 January sounding from McMurdo, shown in Fig. 4d, does not have a surface inversion. It appears that the complex terrain in the immediate vicinity of McMurdo station prevents development of a surface inversion. AMPS does not completely capture the near-surface temperature and moisture profiles, but is correct in not generating fog at McMurdo.

Further cooling by 1500 UTC 26 January results in fog formation at Williams Field and Pegasus in AMPS, shown in Fig. 4e. METAR observations from Williams field indicate fog from 15 UTC to 20 UTC 26 January 2009. AMPS explicitly predicts fog at Williams Field (zero dewpoint depression and surface cloud formation) between 1300 UTC and 1500 UTC 26 January 2009, and has a dewpoint depression within 2°C from 1200 UTC to about 1800 UTC. This provides forecasters with sufficient warning that fog formation is likely. AMPS clearly identifies the sharp temperature contrast between McMurdo (-4°C) and Williams Field (-15°C) around 1500 UTC 26 January (Fig. 4f).

January 31-February 1 wind event

As early as the 0000 UTC 27 January model run, AMPS depicted a synoptic-scale cyclone spiraling into the Ross Sea from the northeast before pulling out to the northwest. The magnitude of impact on the McMurdo area varied between each forecast. Several of the runs (mainly the 0000 UTC 29 January run) had snowfall of several inches, but all of the runs had at least wind speeds upward of 20 kts as the pressure gradient associated with the approaching system set up southerly geostrophic winds along the western Ross Ice Shelf. AMPS simulations between 27 and 29 January had strengthening winds late on 31 January. Simulations improved once the bulk of the event was within the 36-hour nesting simulation, with the 0000 UTC 30 January simulation having winds around 12
kts. Wind speeds increased at McMurdo and Williams Field after 1200 UTC 30 January, with wind speeds 10-15 kts with gusts to 25-30 kts at McMurdo, and around 20 kts at Williams Field. Throughout the event, AMPS reasonably captures wind speeds at McMurdo, with wind speeds generally between 15-20 kts. This falls between the sustained and gust speeds. AMPS also captures Williams Field winds speeds during the event, between 5 and 15 kts. In the observations, several surges in wind speed can be seen, primarily around 1800 UTC 30 January, between 1200 UTC 31 January and 0000 UTC 1 February, and around 1200 UTC 2 February.

For the first surge around 1800 UTC 30 January, AMPS captures the increase in wind speed associated with a southeasterly wind at McMurdo, but misses the strong southeasterly winds at Williams Field. Figure 5 shows the AMPS 1.7 km wind speed and barb plot at 1800 UTC 30 January from the 0000 UTC 30 January forecast. AMPS is not getting the southeasterly flow off of White Island, which is likely the source of the strong winds in the observations. Instead, there is a stagnant flow region extending outward from Windless Bight, associated with the mesoscale high-pressure region formed there as mass accumulates in front of Ross Island. Obviously, there are sharp gradients in wind speed and direction with the moderate southerly flow regime in the Ross Island area. Slight upstream differences in wind speed and/or direction can lead to differences between the AMPS simulations and observations. It is difficult to pinpoint the exact cause of the discrepancy in wind regime between AMPS and that observed. The synoptic flow appears to be properly oriented in AMPS, so the primary factor is likely differences in wind speed. AMPS underestimates wind speeds for the surge around 1200 UTC 31 January, with wind speeds around 15 kts at McMurdo and 10 kts at Williams Field when observations were around 20 kts (gusting to 30 kts) at McMurdo and around 18 kts at Williams Field. AMPS does not simulate the change to southeasterly flow at McMurdo, which may account for the differences, as southeasterly flow regimes tend to be inherently stronger than northeasterly flow forced by topographic influences of Ross Island. AMPS does a better job of capturing wind speeds around 1200 UTC 2 February, with east-northeasterly flow and wind speeds around 18 kts.
Changes in orientation and strength of the Windless Bight high-pressure region leads to variable flow conditions at Williams Field and McMurdo. Aloft, even up to just 1000 ft., flow is primarily southeasterly, as this regime is stronger above the surface with less frictional dissipation. Even though the event illustrated above is of moderate operational impact at most, the local Ross Island wind regime warrants further study. At times, slight differences in wind regime for moderate wind events like this may mean the difference between dry conditions associated with southeasterly flow and fog associated with the Windless Bight stagnation zone. Additionally, the sharp low-level vertical wind shear that often accompanies wind events may adversely impact flight operations in the McMurdo area.

February 6-8 weather events

Interesting weather began for McMurdo during the local daytime of 6 February, with overcast skies most of the day and spotty snow showers during the afternoon. These were most prevalent at Williams Field, and appeared to be influenced by the Ross Island topography. The snow showers became more widespread throughout the area and stronger into the early evening, leading to visibility being reduced to 1600 m and ceilings of 2000 ft at Williams Field, grounding a South Pole-bound flight. In Fig. 6, the IR imagery at 0836 UTC 6 February 2009 shows a wide swath of scattered higher cloud tops extending zonally between Terra Nova Bay and Minna Bluff. The clouds are associated with a cyclone centered just northeast of Ross Island at 850 hPa (Fig. 7a). This system formed primarily as a Terra Nova Bay (TNB) low earlier in the day, appearing to merge with a system moving offshore to the north, which likely formed as a result of vortex stretching from an upper-level trough moving offshore. However, these features could not be easily confirmed with satellite imagery. Upper-level forcing for the cloud development can be seen with the 300 hPa relative vorticity in Fig. 7b. Cyclonic vorticity advection is present in the regions of cloud in Fig. 6. AMPS is correctly representing this cloud development, as shown by the pseudosatellite image in Fig. 7c. AMPS did not explicitly represent the precipitation that fell over the McMurdo area in the local evening of 6 February, but there are hints of this wrap-around moisture in the
3000 ft relative humidity plot from the 1.7 km resolution grid in Fig. 8. It is unclear why the model underestimates the amount of moisture associated with the TNB low, but the errors are minor. Ceilings at the airfields returned to operational levels later in the evening.

With AMPS not explicitly representing the lowered ceilings and snow at Williams Field that evening, concern was raised for conditions for the inbound C-17 and LC-130 flights for the next day (Saturday, 7 February). The C-17 had already been delayed one day due to mechanical issues, and the LC-130 was returning to McMurdo after flying north to Christchurch on Friday for a medevac. AMPS depicts the TNB low propagating southeast across the Ross Ice Shelf overnight into Saturday morning, ending up east of Ross Island by 0000 UTC (Fig. 9a). At this time, the 1.7 km AMPS 3000 ft. relative humidity shows some moisture wrapping around the eastern side of Ross Island into the McMurdo area (Fig. 9b). Ceilings for McMurdo and Pegasus Field were forecasted to be around 3000 ft with the 1200 UTC 6 February forecast. With AMPS overestimating ceiling heights on the evening of 6 February, it was feared that actual ceilings would be lower, jeopardizing the intercontinental flights for the day. Late evening Friday, the TAF was written to reflect this concern. However, AMPS depicts strong southerly flow to the south of McMurdo, drawing from drier air along the Transantarctic Mountains, that would dry out the lower levels (under 3000 feet). The 0000 UTC 6 February AMPS forecast had ceilings increasing from about 7000 ft up past 9000 ft between 1200 UTC 6 February and 0600 UTC 7 February. Similarly, observed ceilings at Pegasus Field were 9000 ft from 1900 UTC 6 February until 0000 UTC 7 February (observations are only taken during flight operations at Pegasus airfield). The LC-130 was grounded for mechanical issues, and the C-17 was also grounded, but for weather enroute back to New Zealand on return. A SIGMET was issued just south of New Zealand, for severe turbulence associated with a 200 kt jet aloft (Fig. 10).

During the afternoon of 7 February local time, a mesoscale cyclone was spotted on satellite imagery northwest of Ross Island, just east of Mackay Glacier. Figures 11a-d show a time series of the mesoscale cyclone on visible satellite imagery between 2025 UTC 6 February to 0603 UTC 7 February. The system begins to lose definition after
about 0500 UTC in the imagery. Incidentally, the system was barely decipherable on infrared imagery throughout the time period. This shows the benefit of having visible imagery for identification of mesoscale cyclones in the summer. The 1200 UTC 6 February AMPS simulation has the mesoscale cyclone development, and in this model run the system propagates southward down McMurdo Sound, bringing low-level moisture into the McMurdo area around 0000 UTC 8 February (Fig. 12). The C-17 was scheduled to arrive at Pegasus airfield around 1530 local time (2.5 hours later), so it was of concern to the forecasters on the afternoon of 7 February. The 1.7 km resolution AMPS grid runs out 36 hours, and AMPS had areas of > 80% RH down to about 2000 ft at Pegasus field by 0000 UTC 8 February. However, the system begins to weaken in the satellite imagery in the evening local time 7 February. Correspondingly, the 0000 UTC 7 February AMPS simulation, which completed soon after the mesoscale cyclone began weakening, showed the mesoscale cyclone being in a weaker state, and not propagating southward towards McMurdo, but instead moving north of Ross Island and dissipating. With low-level stratus blanketing the area, it is difficult to discern exactly what became of the mesoscale cyclone. However, AMPS correctly initialized that the mesoscale cyclone was weakening and did not have it remaining at strength and propagating towards McMurdo.

A key feature of the 0000 UTC 7 February AMPS simulation is the development of the Terra Nova Bay katabatic wind regime around 1800 UTC 7 February. This airstream feeds into a mesoscale high-pressure region located to the east, and the dry airstream is directed southward. This pushes an area of low-level moisture southward towards McMurdo after 0000 UTC 8 February (Fig. 13a and b). Again, this is of concern to forecasters due to the scheduled C-17 arrival that afternoon local time. The AMPS meteogram for Pegasus airfield showed RH values > 80%, at times > 90%, down to about 2000 ft between 0000 UTC and 0600 UTC 8 February, the window that the C-17 would be arriving and departing Pegasus (Fig. 14). However, the model showed an easterly wind regime in the lowest levels that would bring dry conditions for the lowest 2000 ft or so. Indeed, observations from Pegasus airfield early UTC 8 February shows an easterly wind of around 10 kts, with a dewpoint depression of at least 4°C. The McMurdo sounding at 0000 UTC 8 February (Fig. 15) confirms this vertical profile of dry air in
low-levels from the easterly wind regime, becoming northwesterly aloft in the cloud layer. The minimum ceiling requirement for C-17s to land at Pegasus airfield is 1500 ft, so conditions remained acceptable throughout the afternoon of 8 February, and the C-17 landed and returned to Christchurch without incident or delay.

4. Miscellaneous

a. AWS site visits to Pegasus North and Williams Field

I made several visits to nearby Pegasus North and Williams Field AWS sites with Shelley Knuth (University of Wisconsin AMRC) and Melissa Richards (University of Colorado). On the evening of 4 February, Shelley, Melissa, and myself went to Pegasus North to service the antenna. On 5 February, Melissa and myself went to Williams Field to replace the electronics box, antenna, acoustic depth gauge, and part of the aerovane. A return trip to Pegasus North was made to replace the electronics box and install a lower temperature sensor. On 6 February, Melissa and myself once again visited Pegasus North in an attempt to fix an electronics problem that was causing wind speed and humidity to not transmit properly. Unfortunately, the procedure did not fix the problem. Figure 16 shows a picture from the AWS visit to Williams Field on 5 February.

b. Visit to Ford Rock

On 7 February I went with two of the Mac Weather technicians and an observer to Ford Rock to service the SPAWAR AWS site there. This site is located just past Castle Rock on the Hut Point Peninsula. The ride in a pickup truck with tracked wheels was just under an hour each way. The met techs needed to replace the temperature sensor there. The trip was of a sightseeing nature for me, with views of the open water to the north.
c. Wind Event Data Processing

A secondary goal of my visit was to analyze any strong wind events that might have occurred during the season. The forecasters and observers have detailed knowledge of such events, including spatial and temporal patterns associated with the strong winds. No strong wind events have occurred during this field season at McMurdo, with nothing of notoriety occurring even at WINFLY or early in the season. I went through 2007 surface wind speed observations for the local University of Wisconsin AWS sites (Minna Bluff, Pegasus North/South, and Williams Field), SPAWAR AWS sites (all five MWS sites around McMurdo, Herbie Alley North, Cape Spencer, and Whiteout), and the manual airfield METARs (Pegasus and Williams Field hourly observations when taken, and McMurdo town 3-hourly observations). Data were compiled for each station for each month of 2007, which was found to have good data availability, especially compared to 2008. Data was sorted according to wind speed, with an attempt to filter out bad data by determining the change in wind speed compared to the previous observation. If the change was especially large, or the observation was preceded by a missing data value, it is likely that the data contain errors. With several stations being analyzed, it is clear which events are legitimate and occur at multiple sites. From this analysis it is clear that some events only occur at some of the sites, while not occurring at others. It is not unusual to have high winds south of McMurdo, with winds dying off in town. I talked with two of the forecasters that have wintered over at McMurdo, and both acknowledged that they often observe what they perceive to be hydraulic jumps associated with the strongest wind events. With features that are perceived to be hydraulic jumps, the high winds cease in town, with a large increase in pressure, while sensors at Black Island and other AWS sites to the south continue to record strong wind speeds. The data processed and organized during my visit, along with the knowledge gained about the SPAWAR AWS sites and about the wind events from forecasters, will be beneficial towards a better understanding of the McMurdo area wind regime.
5. Conclusions

This report presents a wide variety of meteorological situations encountered by AMPS. The most glaring issue for AMPS is the low-level temperature bias over the interior plateau. However, the forecasters currently have a work-around, and work continues to fix this issue. The most substantial improvement noted between my last visit and 2006 and this visit is how AMPS handles low-level moisture, especially southward moisture advection down McMurdo Sound. For two different events (a mesoscale cyclone north of McMurdo, and low-level moisture forced southward towards McMurdo by katabatic winds), AMPS handles ceiling forecasts well. As a result, flight operations were not unnecessarily impacted. It is also shown here that AMPS effectively handles radiation fog, which can be a common occurrence during the summer nighttime hours. Some discrepancies were found between model forecasts and wind observations at McMurdo and the nearby runways for moderate wind events. However, such errors are generally minor, and increased resolution would be necessary in order to better represent the localized influence of topography. Finally, the sea ice representation used in the model is shown to overestimate sea ice fraction for a localized area just north of McMurdo where ice is “blown out” by strong winds. It is unclear at this time what impact the sea ice representation has on model forecasts of temperature and moisture at McMurdo.

The 2008-09 field season visit was again beneficial for the Polar Meteorology Group at Ohio State and for the AMPS project. The first operational season for AMPS WRF appears to be going smoothly, and the forecasters are pleased with the output they are getting from the model. Additionally, with the increased resolution and higher-order numerics of WRF, more detail is present in the high-resolution model representation of winds in the McMurdo area. The high-resolution Ross Island grid forecasts are more realistic than during my previous visit in 2006, and even more so than during R. Fogt’s last McMurdo Weather visit during 2005-06, where he noted that the high-resolution forecast was often not used. Even though the weather was quiet and of weak forcing during my stay, I got to see AMPS performance in a variety of weather situations. Finally, just like in 2006, the visit is a good learning experience for me with Antarctic
meteorology and weather forecasting in general. The forecasters are all seasoned current or ex-military weather forecasters. I gain a lot of knowledge about meteorology that is more practical and often not present in university coursework. In working with numerical weather prediction models, it is good to interact with the people actually using the product for a real-world application.
Figure 1. a) Visible imagery from 0726 UTC 3 February 2009.
b) AMPS 1.7 km resolution sea ice fraction from 0000 UTC 3 February 2009 simulation.
Figure 2. a) Infrared satellite image from 1848 UTC 24 January 2009.
b) Visible satellite imagery from 0358 UTC 25 January 2009.
c) Visible satellite imagery from 0757 UTC 25 January 2009.
Figure 3. a) AMPS 15-km 850 hPa geopotential height (gpm, blue contours), temperature (°C, red contours), relative humidity (w.r.t ice, %, color shaded), and wind barbs from 0000 UTC 25 January 2009, from forecast initialized at 1200 UTC 24 January 2009.
b) AMPS 15-km 700 hPa geopotential height (gpm, blue contours), temperature (°C, red contours), relative humidity (w.r.t ice, %, color shaded), and wind barbs from 0000 UTC 25 January 2009, from forecast initialized at 1200 UTC 24 January 2009.
Figure 4. a) AMPS 1.7-km surface temperature (°C, red contours), relative humidity (w.r.t ice, %, color shaded), and wind barbs from 0900 UTC 26 January 2009, from forecast initialized at 0000 UTC 26 January 2009. “PS” magenta point represents Pegasus South, “BI” magenta point represents Black Island.
b) AMPS 1.7 km sounding from Pegasus South AWS site at 1200 UTC 26 January 2009.
c) AMPS 1.7 km sounding from McMurdo at 1200 UTC 26 January 2009.
d) McMurdo sounding from 1200 UTC 26 January 2009.
e) AMPS 1.7-km surface temperature (°C, red contours), relative humidity (w.r.t ice, %, color shaded), and wind barbs from 1500 UTC 26 January 2009, from forecast initialized at 0000 UTC 26 January 2009. “PS” light blue point represents Pegasus South, “BI” light blue point represents Black Island.
f) AMPS 1.7-km surface temperature (°C, color shaded) and wind barbs from 1500 UTC 26 January 2009, from forecast initialized at 0000 UTC 26 January 2009. “PS” orange point represents Pegasus South, “BI” orange point represents Black Island.
Figure 5. AMPS 1.7-km wind speed (m s$^{-1}$, color shaded) and wind barbs from 1800 UTC 30 January 2009, from forecast initialized at 0000 UTC 30 January 2009.
Figure 6. IR imagery from 0836 UTC 6 February 2009.
Figure 7. a) AMPS 15-km resolution 850 hPa geopotential height (gpm, blue contours), temperature (°C, red contours), relative humidity (w.r.t ice, %, color shaded), and wind barbs from 0900 UTC 6 February 2009, from forecast initialized at 1200 UTC 5 February 2009.
b) AMPS 15-km resolution 300 hPa wind speed (m s\(^{-1}\), green contours), relative vorticity (10\(^{-5}\) s\(^{-1}\), color shaded), and wind barbs from 0900 UTC 6 February 2009, from forecast initialized at 1200 UTC 5 February 2009.
c) AMPS 15-km resolution pseudosat (column-integrated cloud liquid water, mm) from 0900 UTC 6 February 2009, from forecast initialized at 1200 UTC 5 February 2009.
Figure 8. AMPS 1.7-km 3000 feet relative humidity (w.r.t ice, %, color shaded), and wind barbs from 0800 UTC 6 February 2009, from forecast initialized at 1200 UTC 5 February 2009.
Figure 9. a) AMPS 15-km resolution 925 hPa geopotential height (gpm, blue contours), temperature (°C, red contours), relative humidity (w.r.t ice, %, color shaded), and wind barbs from 0000 UTC 7 February 2009, from forecast initialized at 0000 UTC 6 February 2009.
b) AMPS 1.7-km 3000 feet relative humidity (w.r.t ice, %, color shaded), and wind barbs from 0000 UTC 7 February 2009, from forecast initialized at 0000 UTC 6 February 2009.
Figure 10. SIGMET chart from the U.S. Aviation Weather Center valid 1200 UTC 7 February 2009.
Figure 11. a) Visible satellite imagery from 2025 UTC 6 February 2009.
b) Same as a) except for at 2206 UTC.
c) Same as a) except for at 0322 UTC 7 February.
d) Same as a) except for at 0603 UTC 7 February.
Figure 12. AMPS 15-km resolution 925 hPa geopotential height (gpm, blue contours), temperature (°C, red contours), relative humidity (w.r.t ice, %, color shaded), and wind barbs at 1200 UTC 7 February 2009, from forecast initialized at 1200 UTC 6 February 2009.
Figure 13. a) AMPS 5-km 3000 feet relative humidity (w.r.t ice, %, color shaded), and wind barbs at 2100 UTC 7 February 2009, from forecast initialized at 0000 UTC 7 February 2009.
b) Same as a) except for at 0300 UTC 8 February 2009.
Figure 14. AMPS 1.7 km resolution grid meteogram for Pegasus airfield from forecast initialized at 0000 UTC 7 February 2009.
Figure 15. McMurdo sounding from 0000 UTC 8 February 2009.
Figure 16. Picture of Williams Field AWS and Mt. Erebus in background, taken 5 February 2009.