AMPS 2011 Update

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Introduction

The Antarctic Mesoscale Prediction System (AMPS) is an experimental numerical weather prediction (NWP) system which provides real-time, high-resolution NWP products to Antarctic weather forecasters and to researchers in Antarctic meteorology and modeling. Sponsored by the National Science Foundation (NSF) Office of Polar Programs and the NSF UCAR and Lower Atmosphere Facilities Oversight Section, the priority mission of AMPS is to support the forecasting efforts for United States Antarctic Program (USAP) logistics and operations. However, the easy availability of AMPS products on-line, and the continent-wide coverage of AMPS model grids, have given AMPS a broader user base in the international Antarctic weather research and forecasting community. This year, AMPS has completed its tenth season of support for the USAP, and of informal interactions with Antarctic programs around the world.

The numerical model used in AMPS is the Weather Research and Forecasting model (WRF), or more specifically, the Advanced Research WRF. WRF was developed by the National Center for Atmospheric Research (NCAR) in collaboration with a number of U.S. government agencies and university programs. For better depiction of Antarctic weather conditions, AMPS uses a version of WRF that includes adaptations developed by AMPS collaborators at the Byrd Polar Research Center (BPRC) of the Ohio State University.

AMPS runs the WRF model twice each day, initialized at 00 UTC and 12 UTC, with six two-way interactive grids (Fig. 1). A grid with 45-km grid spacing covers Antarctica and much of the surrounding southern oceans, extending out to Australia, South Africa, and South America. A 15-km grid covers the Antarctic Continent. Higher resolution grids (5-km spacing) cover regions of specific interest: the South Pole, the Antarctic Peninsula, and the Western Ross Sea. The highest resolution grid, with 1.67-km grid spacing, is centered over Ross Island and McMurdo Station, the hub for much of the USAP activity in Antarctica. The outer two grids run out to 120 hours of forecast time; the inner four grids run to 36 hours.

In addition to this forecast simulation, other forecast runs may be made over specific parts of the continent as need arises and as resources allow.

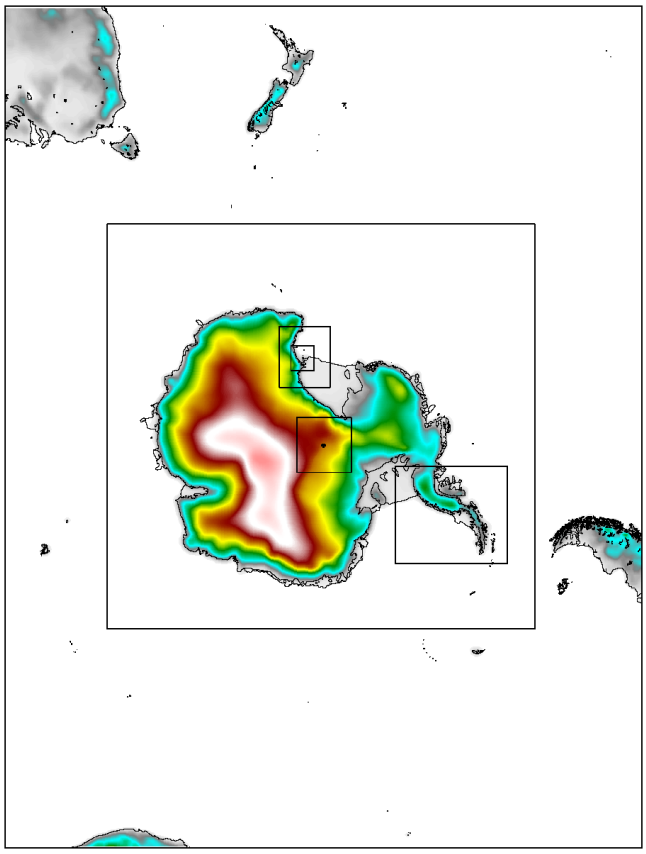

Fig. 1: AMPS grid 1 terrain field, showing locations of two-way interactive grids.

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AMPS products are available to forecasters through the AMPS web page:

http://www.mmm.ucar.edu/rt/amps.

A variety of textual and graphical products may be selected through the menu interface. These products include zoomed-in views of various parts of the continent (Fig. 2). Most of these views have been requested by forecasters in these regions. In addition to the graphical products, a subset of AMPS model output is available in GRIB format. All products are also distributed over the Antarctic Internet Data Distribution system (Antarctic-IDD).

Updates

As usual, many requests for changes or additions to AMPS products have been implemented this year. In addition, the following new features are highlighted.

a) Nathaniel B. Palmer Window

In January 2011, NSF requested, as an experimental AMPS product, a plotting window of our AMPS grid 2 (15-km continental grid) which would follow the research vessel Nathaniel B. Palmer in its Antarctic cruise this season. To produce this, the updated location of the Palmer is downloaded from the web for each forecast, and plotting-window coordinates are generated based on the updated location. A minimal set of plots is emailed directly to the meteorological officer aboard ship as the AMPS simulation progresses.

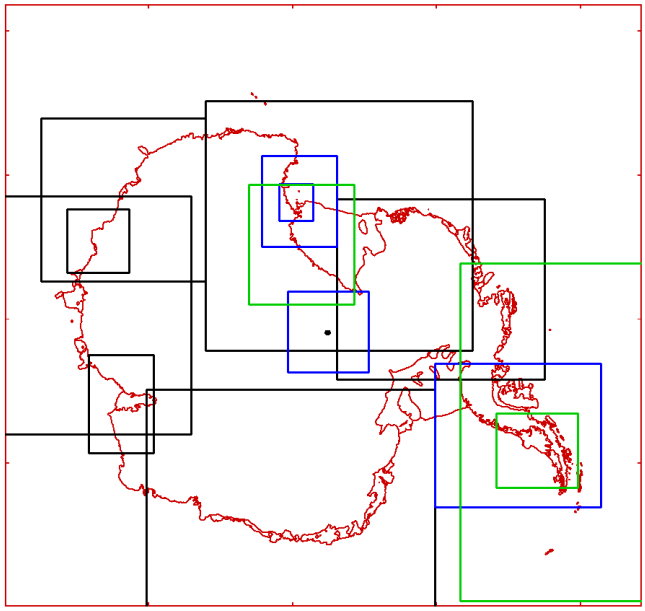

Fig. 2: AMPS grid 2, showing locations of two-way nests (blue), plotting windows (black), and one-way nests (green) run during the 2010/2011 season.

Response from the Palmer has been positive. In March 2011 it wrote: "The forecasts from AMPS and the weather station in Charleston [SPAWAR-SYSCEN] have been the perfect combination."

b) Partial Meteograms

The popular AMPS meteogram depiction of the AMPS forecast at specific stations has been adapted this year. In the past, the AMPS meteograms were the final graphics produced for a given forecast initialization. Because they depict the model weather conditions as they change over time, we had waited for the WRF simulation to complete before producing the meteograms. However, it was recognized that early hours of the meteograms might be useful to forecasters before the later forecast hours become available three to four hours later. To address this, we have implemented meteograms that are updated as the forecast progresses. At early forecast hours, the meteogram figure will be only partially filled. Later forecast hours of the image will be progressively filled in as the forecast proceeds. Note that this new feature is not available for meteograms available through our on-demand web form.

c) One-Way Nests

AMPS has the capability to quickly implement one-way nests, model grids run after the main AMPS forecast simulation, focused over relatively small areas, and driven by initial and boundary conditions from one of the primary AMPS grids. This season, we had three one-way nests running (Fig. 2, green boxes): 1) the Palmer grid, our ongoing nest from the 45-km grid over the Drake Passage, with grid spacing of 11.25 km; 2) the LARISSA grid (for the LARISSA (Larsen Ice Shelf System, Antarctica) campaign), with 2.5-km grid spacing over the Antarctic Peninsula, first implemented in the 2009/10 season and activated again for the 2010/11 season; and 3) the CTAM grid, a new grid with 5-km grid spacing, in support of USAP activities in the Central Trans-Antarctic Mountains.

d) Update of AMPS to WRF Version 3.2.1

In April 2011, we updated the version of WRF used in AMPS, from version 3.0.1.1 (in use in AMPS since October 2008) to WRF version 3.2.1. Both of these versions were adapted for use in AMPS by including polar modifications developed by BPRC. The newer version of WRF keeps AMPS more up-to-date with the large WRF modeling community, and offers a full set of fixes and improvements. We now make use of the RRTMG longwave radiation scheme, an improved

version of the RRTM scheme that AMPS has used for some time. Tests for the period of January 2010 suggested improvement in forecast results at the majority of sites examined.

Pegasus Relocation — AMPS Analysis

At the 5th Antarctic Meteorological, Observations, Modeling, and Forecasting Workshop (2010) in Columbus, OH, SPAWAR meteorology managers approached the AMPS team with a request for an analysis of past AMPS forecasts. USAP was considering moving the Pegasus runway closer in to McMurdo Station, and the SPAWAR met managers suggested that AMPS forecast results at the two sites under consideration might be useful for the decision makers.

We considered three seasons of data for AMPS grid 5, the 1.67-km grid over McMurdo Station and Ross Island, producing AMPS forecast statistics at four specific sites: the current Pegasus runway, Williams Field, and two alternate locations situated between Pegasus and Williams (Fig. 3, denoted "Alt 1" and "Alt 2"). Statistics for temperature, relative humidity, wind events, wind chill, and precipitation were compiled based on the 2008/09, 2009/10, and 2010/11 seasons (e.g., Fig. 4).

For the most part, statistics do not show major differences among the sites. This result is not surprising, considering that the sites are close together. In the average, some of the meteorological fields (e.g., temperature, humidity) show a distinct axis along the line connecting the four sites, leading to minimal variation among the sites. A major exception to this is the precipitation field, which shows twice as much precipitation at Williams Field than at Pegasus (Fig. 5).

Summary

After a decade of forecasts, AMPS continues to be a valuable tool for Antarctic weather forecasting and meteorological research. Enhancements to the NWP model and to the products available to forecasters keep AMPS up-to-date with current research and with the changing demands of weather forecasting across the continent.

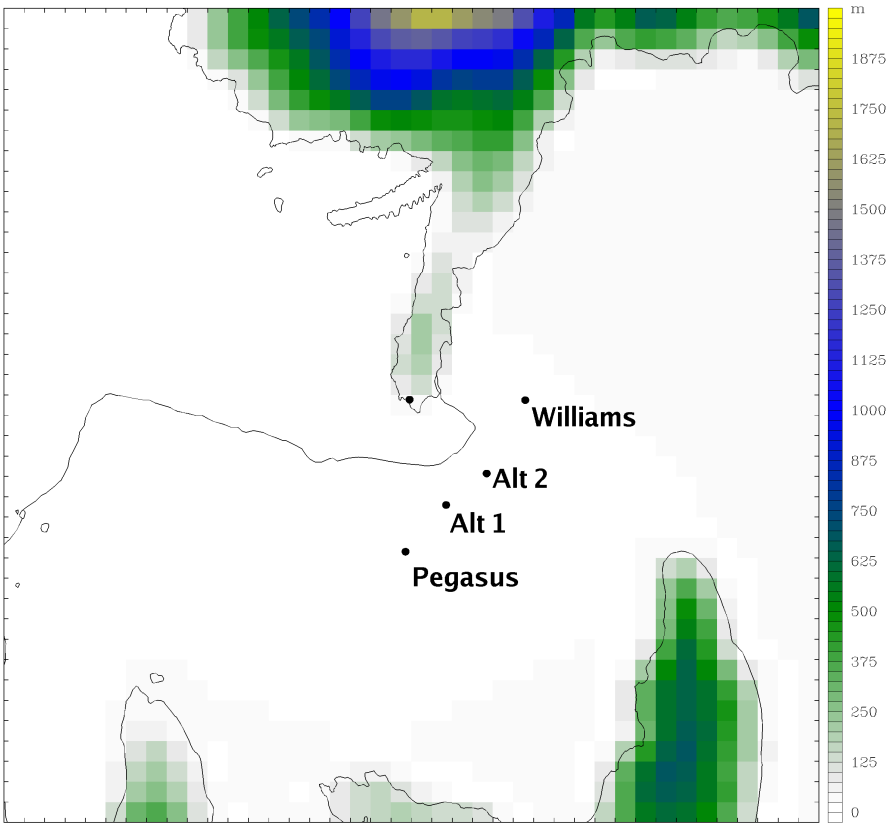

Fig. 3: AMPS terrain field near Hut Point peninsula, showing locations of the four sites for our analysis.

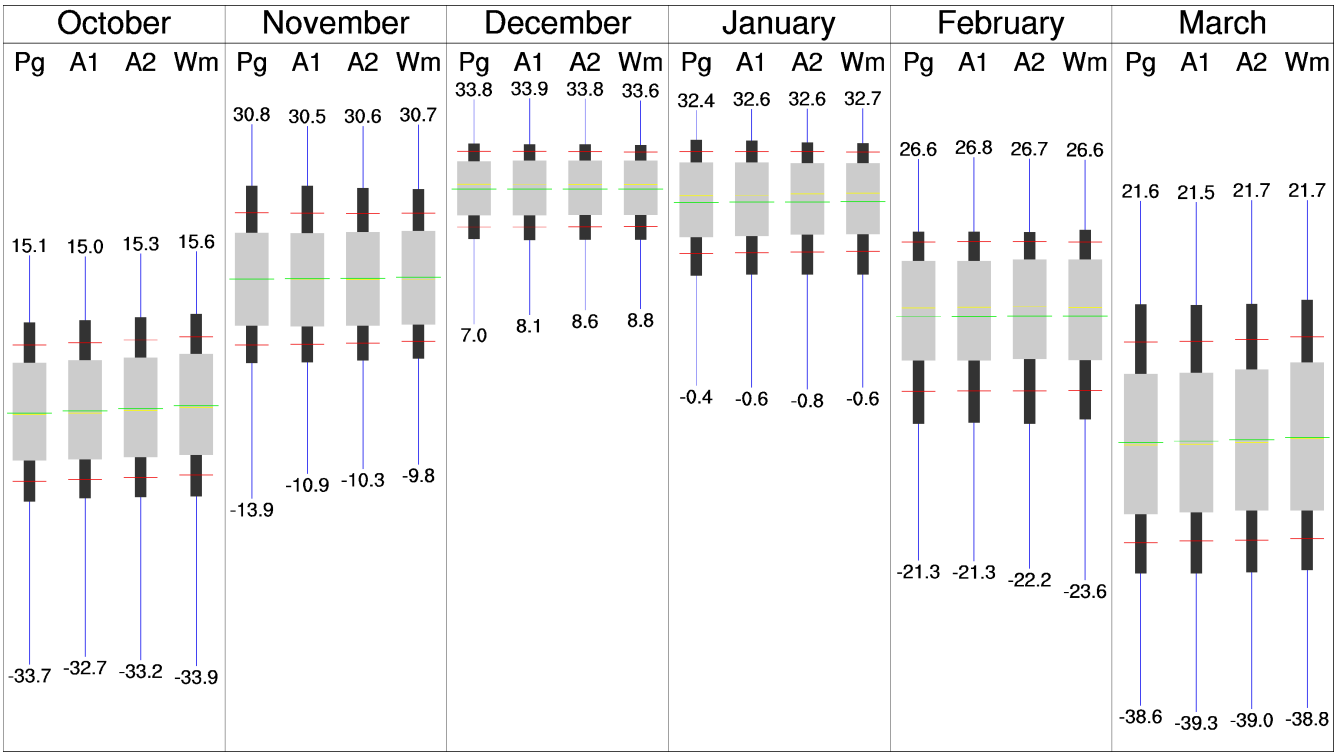

Fig. 4: Box/whisker plots for temperature statistics (°F) from three seasons of AMPS forecasts, at the four sites of interest, for six different months. The vertical blue line represents the range of the data, from minimum to maximum. Minimum and maximum values are printed to show the scale of the diagram. The vertical extent of the black block represents the range of the data from the 10th through 90th percentile. The vertical extent of the gray block represents the range of the data from the 25th through 75th percentile. The horizontal green line indicates the mean. The horizontal yellow line indicates the median. The horizontal red lines indicate the mean +/- the standard deviation.

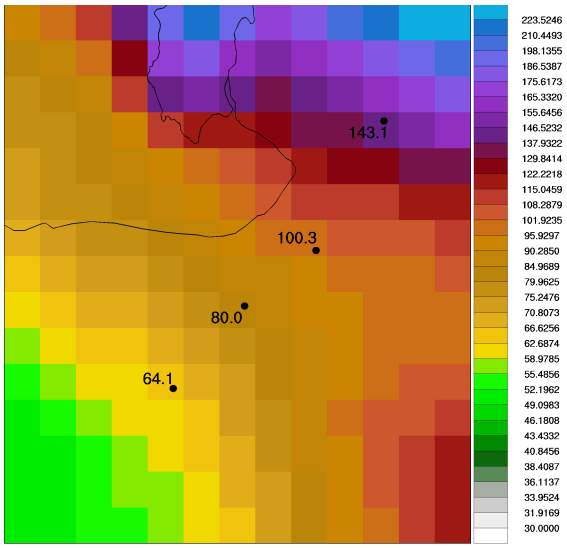

Fig. 5: Total March through October precipitation accumulation (water equivalent, mm) from the AMPS 12–24-hr forecasts, for three seasons. Note that the color scale is logarithmic, not linear.