

# AMPS Real-time Forecasts – 2009 Update

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## 1) INTRODUCTION

The Antarctic Mesoscale Prediction System (AMPS) is an experimental real-time forecasting system offering high-resolution numerical weather prediction (NWP) products for Antarctic forecasters. The mission for AMPS is specifically to support United States Antarctic Program (USAP) flight logistics in and around McMurdo Station, but the coverage of AMPS products is continental in scope. Since October of 2000, AMPS has made its real-time NWP products freely available to the Antarctic community, through the AMPS web page (<http://www.mmm.ucar.edu/rt/amps>).

AMPS is a collaboration among investigators at the National Center for Atmospheric Research (NCAR), the Ohio State University (OSU), and the University of Colorado (CU), supported by funding and resources from the National Science Foundation (NSF). In addition to these formal collaborations, over its multiple cycles of NSF funding, AMPS has fostered informal collaborations and interactions with many other researchers, research groups, and forecasters worldwide.

## 2) THE END OF THE MM5 ERA

AMPS began in 2000, using the Pennsylvania State University/NCAR Mesoscale Model, version 5 (MM5). In more recent years, AMPS has added a second model, the Weather Research and Forecasting model (WRF), to its production runs. AMPS has been running WRF in parallel with MM5, with the goal of evaluating WRF, improving WRF for the Antarctic environment, and eventually replacing MM5 with WRF. Researchers at the OSU Byrd Polar Research Center (BPRC; work by Keith Hines, David Bromwich, and others) have built upon their experiences from adapting MM5 to the polar environment, applying that

expertise to WRF. Testing these polar improvements to WRF within AMPS has been ongoing. After several cycles of improvements and evaluations, WRF was determined to be a viable replacement for MM5 in AMPS. Following the 2008 workshop in Madison, WI, we turned off the MM5 AMPS forecasts for good. WRF is now the sole model running in AMPS.

## 3) NEW COMPUTING PLATFORM

Thanks to continued generous support from the NSF, AMPS received a significant increase in its computing capacity in the autumn of 2008. Three nodes of NCAR's primary supercomputer, *bluefire*, have been dedicated for AMPS usage. Three nodes of a similar architecture were purchased and configured as a stand-alone machine to serve as a test platform for development work at NCAR's Computational and Information Systems Laboratory (CISL), the division that operates NCAR's supercomputers. This stand-alone machine also serves as a backup platform for AMPS when the primary platform is down.

Bluefire is an IBM Power 575 supercomputer. The machine as a whole has 128 nodes with 32-processors on each node, for a total of 4096 IBM Power6 processors running at 4.7 GHz.

In October 2008, AMPS began running on three nodes (96 processors) of bluefire. This amounts to an estimated 2- to 3-fold increase in computing power over the old Linux cluster. This increased capacity has gone primarily toward increasing the horizontal resolution and vertical extent of the AMPS model grids, as discussed below.

## 4) UPGRADE TO WRF VERSION 3.0.1.1

In October 2008, we upgraded the WRF model used in AMPS from WRFv2.2 to WRFv3.0.1.1. This version of

WRF offers several features over earlier versions of WRF, such as adaptive timesteps, more advanced diffusion options, better treatment of the model lid. Keith Hines of OSU/BPRC has adapted his polar modifications from WRFv2.2 to this newer version.

#### 5) CHANGES TO MODEL CONFIGURATION:

Along with the update to the WRF version, several changes to the model configuration have been implemented.

##### *Increased resolution; raised model top*

The increased processing power made available by the new computing platform has allowed us to significantly enhance our model configuration. We have increased the resolution of all grids, moving from a 60/20/6.7/2.2-km setup to a 45/15/5/1.7-km setup. We have raised the model top from 50 to 10 hPa, and increased the number of vertical levels from 31 to 44. We have enhanced the vertical resolution of the model, especially below about 1 km.

##### *Vertical damping*

The extended model top necessitated applying a damping term to the vertical velocity near the model top. Weak damping is applied over the top 7 km of the grid. Without this damping, reflections of vertically propagating energy eventually contaminate the model integration leading to numerical instability and model crashes.

##### *Diffusion*

With the higher resolution grids, and the shallower model levels near the surface, instances of small-scale numerical noise near the surface became common. These did not appear to adversely affect the model results, but did look unphysical. Applying the new 6<sup>th</sup>-order diffusion option in WRF removed this noise.

##### *Adaptive time step*

Even on the new machine, the higher-resolution configuration proved to be too expensive to run within a target wallclock time of 4 to 5 hours. To reduce the cost, we have activated the new adaptive timestep option in WRF. This option increases the model time step (faster model integration) when the numerical stability of the integration allows it, and reduces the model time step (slower model integration) to keep solutions stable when the situation demands it. With this option, we are able to complete the model run within about 5 hours.

#### 6) ADDITIONAL PRODUCTS

A few new sets of products have been implemented this year in support of certain field programs. In support of forecasting for the Antarctica Gamburtsev Province (AGAP) project, we have implemented a zoomed-in plotting window of our 15-km grid over the region of interest on the East Antarctic plateau.

Two new plotting windows have also been implemented in support of an upcoming project using uninhabited aerial vehicles (UAVs) to study interactions among the atmosphere, the ocean, and sea ice. These windows from the 15-km grid and from the 5-km Western Ross Sea grid offer zoomed-in views which should be useful in planning and executing the UAV missions.

A new capability that we've implemented on an experimental basis is our "Meteogram-On-Demand" feature. This feature allows users to submit a form specifying the location at which a meteogram chart is desired. Within approximately 5 to 7 minutes, the requested meteogram appears in a specific directory of the AMPS web site.

#### 7) PLANS

A new version of WRF, version 3.1, was released in the spring of 2009. We are currently evaluating this version of WRF for use in AMPS.

One attractive enhancement of WRFv3.1 is the inclusion of some polar modifications: specifically, a fractional sea-ice treatment, and adaptations to the land-surface model to better represent thermal properties of glacial ice. These polar modifications are based on an amalgamation of approaches developed by modelers at BPRC, NCAR, and the National Centers for Environmental Prediction (NCEP).

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