AMPS Update – July 2018

Kevin W. Manning

Jordan G. Powers

Mesoscale and Microscale Meteorology Laboratory

*National Center for Atmospheric Research**

Boulder, Colorado

1. Introduction

The Antarctic Mesoscale Prediction system (AMPS) is an experimental, real-time, high-resolution numerical weather prediction (NWP) system in support of Antarctic weather forecasting needs for the United States Antarctic Program (USAP). Sponsored by the National Science Foundation, AMPS has been producing real-time NWP guidance for Antarctic forecasts since October of 2000. AMPS charts and data are openly available on the AMPS web page, http://www2.mmm.ucar.edu/rt/amps. While specifically funded to support USAP forecasting needs (i.e., flight support for transports to McMurdo Station and Pole; weather support for USAP field camps, etc.), the continent-wide coverage of AMPS make its products useful for a variety of international Antarctic programs as well.

AMPS uses the WRF model (currently WRF-ARW version 3.9.1.1), modified with a number of adaptations from the Polar WRF effort of the Ohio State University/Byrd Polar and Climate Research Center. AMPS runs WRF twice daily (initialized at 00 UTC and 12 UTC) with five two-way interactive nests (Fig. 1) ranging from a grid with 24-km grid spacing over a significant portion of the Southern Hemisphere, an 8-km grid over the entire Antarctic continent, telescoping down to 0.89-km grid spacing in the Ross Island vicinity. In addition, AMPS runs a small ensemble of forecasts at the continental scale. AMPS is also testing the newer Model for Prediction Across Scales (MPAS) for Antarctic applications.

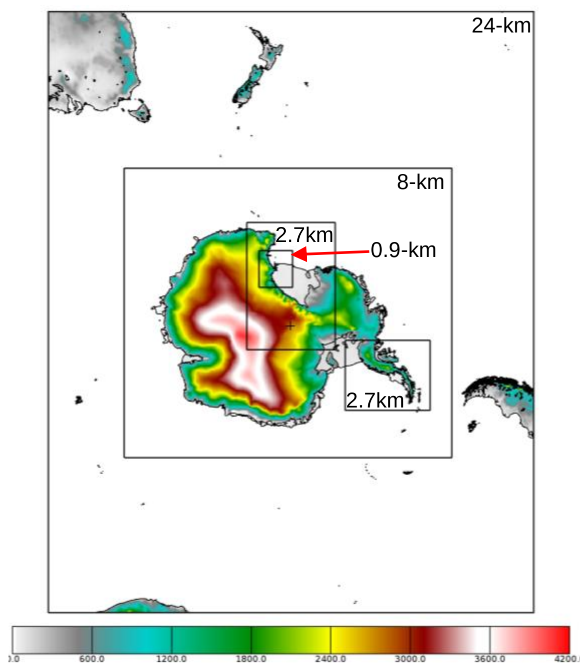

Fig.1. The five two-way interactive AMPS grids. Model terrain-elevation field is shaded. Labels indicate grid cell size.

NCAR is sponsored by the National Science Foundation.

2. New computing

Since June 2017, AMPS has been running on the NCAR/Wyoming Supercomputing Center's (NWSC) principal supercomputer, “Cheyenne”. Cheyenne is a resource shared by a large NWSC user base; AMPS is just one user that shares this resource. Cheyenne is a cluster of 4032 compute nodes with 36 processor cores per node, for a total of 145,152 processors. AMPS runs on a small portion of this cluster; AMPS allocation on Cheyenne represents approximately 2.5 times the computing capacity previously available to AMPS.

The first year on Cheyenne has been a challenge, a break-in period during which many serious issues with the computer and with AMPS use of Cheyenne were encountered. Thanks to the efforts of NCAR's Computational and Information Systems Lab (CISL) staff, major issues have been solved and Cheyenne should be a more stable system for AMPS in coming seasons.

CISL management has also recognized the importance of AMPS for real-time support of USAP efforts, and has arranged for AMPS to use cloud computing services for times when the Cheyenne computer is undergoing maintenance or is otherwise unavailable.

3. Increased resolution and updated WRF

The increased computing power available on the Cheyenne supercomputer has allowed AMPS to increase resolution, beginning in September 2017. This increased resolution reduces the grid spacing from 30/10/3.3/1.1-km grid spacing in prior seasons, to 24/8/2.67/0.89-km grid spacing in the current configuration. This takes AMPS to 8-km grid spacing over the entire Antarctic continent; 2.67-km over the Ross Sea, Ross Ice Shelf, and Antarctic Peninsula; and 0.89-km for Ross Island and vicinity (Fig.1).

At the same time as the increased resolution, AMPS was upgraded to use WRF version 3.9.1.1 (previously using version 3.7.1). This version of WRF introduces an option for the hybrid vertical coordinate, which AMPS now uses, to reduce spurious generation of vertically-propagating waves, particularly in areas of complex topography and steep terrain gradients (i.e., much of the AMPS forecast regions).

4. New AMPS products

A new experimental product has been developed, in conjuction with USAP forecasters, to depict the changing weather in AMPS along a flight route. The product is similar to the traditional (instantaneous) AMPS vertical cross sections, except that it accounts for the travel time along the flight route between waypoints (Fig. 2). This is an “on-demand” product, where a user submits a web form detailing flight times and waypoints, and a finished product shows up a little while later in an AMPS web page directory.

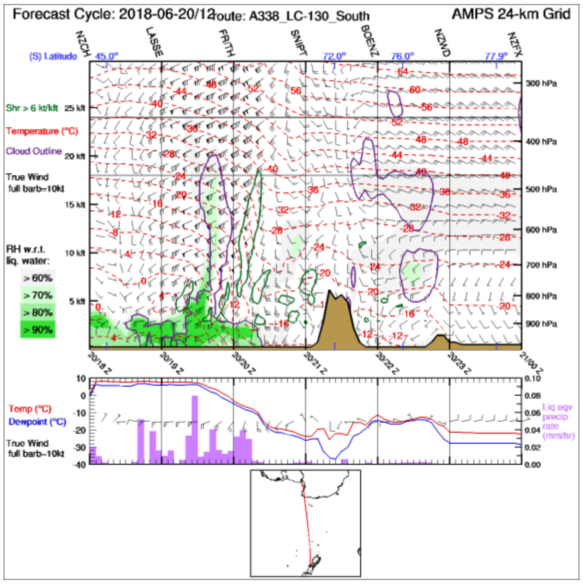

Fig.2. Example of AMPS weather-along-flight-route on-demand product.

In light of recent interest in “atmospheric river” features (i.e., distinct bands of enhanced horizontal transport of moisture) affecting Antarctica, AMPS has added a chart for the vertically-integrated horizontal vapor transport (IVT). These charts are available on the AMPS 24-km grid (Southern Oceans and Antarctica).

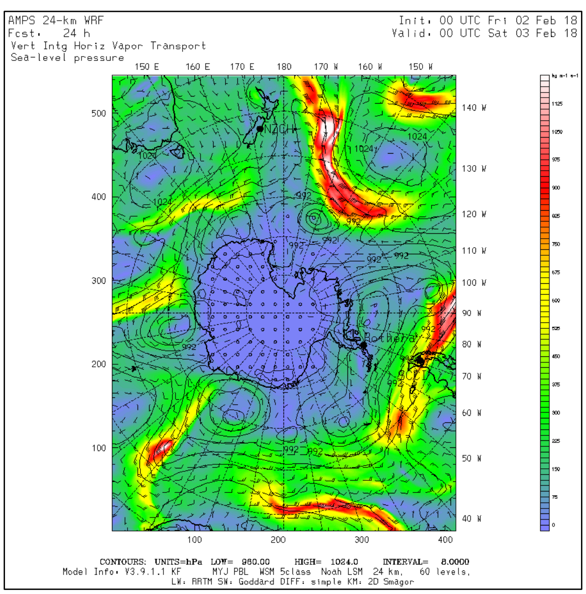

Fig.3. Example of AMPS integrated vapor transport (IVT) graphics.

5. MPAS updates

The MPAS model continues to be run as a component of AMPS. The AMPS MPAS mesh is a smoothly-varying global lattice of irregular cells, mostly hexagons, varying from 60-km scale on the globe to 10-km scale over the Antarctic (Fig.4). This smooth variation of the grid cell size significantly mitigates the effects of varying model resolution over different regions of model integration, and effectively eliminates nest-boundary computational artifacts inherent in the traditional grid nesting strategy used in WRF.

This year, AMPS has upgraded its version to MPAS-5.3, which particularly corrects some issues in initializing moisture fields. In addition, AMPS now makes use of an MPAS extension to the RIP graphics package for WRF, which allows RIP to interpolate and plot MPAS fields on a regular cartesian grid. The MPAS graphics in AMPS now have a capability and a look very similar to those of the traditional RIP graphics used in AMPS since its inception.

An upcoming release of MPAS is expected to support regional (as opposed to global) meshes. AMPS will likely investigate that regional capability, as the cost savings (from not having to run globally) may make higher resolution MPAS runs practicable in terms of the computing power needed.

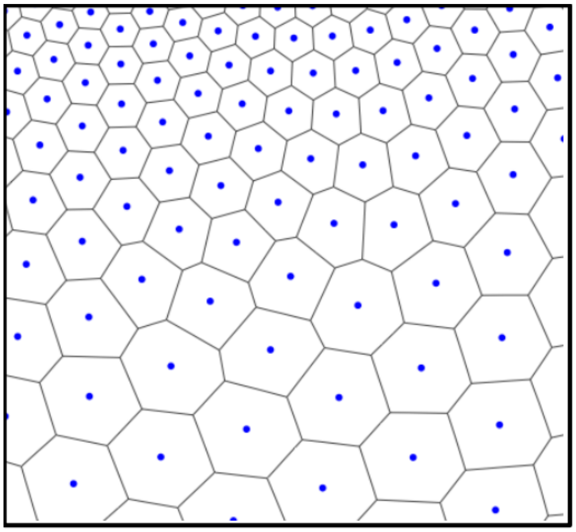

Fig.4. Schematic of a portion of an MPAS smoothly-varying mesh.

6. Plans for upcoming seasons

AMPS will support forecasting for the International Thwaites Glacier Collaboration, a three-year field campaign to collect data on the region in West Antarctica. AMPS will likely be able to offer a one-way nest over this region, with grid spacing perhaps as high as 2.67 km, and forecast products tuned as needed for the project.