AMPS Update – June 2013

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1. Introduction

The Antarctic Mesoscale Prediction System (AMPS) is a numerical weather prediction (NWP) system for Antarctica, sponsored by the National Science Foundation Office of Polar Programs to provide high-resolution NWP guidance to weather forecasters of the United States Antarctic Program (USAP). A joint project of the National Center for Atmospheric Research (NCAR) and the Ohio State University – Byrd Polar Research Center, AMPS uses NCAR's Weather Research and Forecasting model (WRF), tuned for the Antarctic environment, to produce graphical and tabular products for forecasters. Though specifically charged to support USAP interests, AMPS products are used as well by many Antarctic forecasters from programs around the world.

AMPS products are openly available on its web site: http://www.mmm.ucar.edu/rt/amps. In addition, NCAR maintains an archive of past AMPS model output files back to 2001.

This annual update summarizes some of the major changes to AMPS over the past year.

2. New computing platform – Erebus

The major change over the past year has been the porting of AMPS to a new computing platform, "Erebus". Erebus has approximately 15 to 20 times the computing capacity of the former platform (three nodes of NCAR's "Bluefire" supercomputer allocated to AMPS); this increased capacity allows us to enhance the AMPS system and its configuration in various ways, including increased vertical resolution, increased horizontal resolution, and greater coverage of high-resolution grids.

Erebus was made available for testing in early fall, 2012. After a few months of porting scripts and program, experimentation and reconfiguration of AMPS, real-time forecasts on Erebus began in January 2013. On 14 January, AMPS was completely migrated off of the old (and now decommissioned) Bluefire machine, and began running exclusively on Erebus.

Table 1. AMPS grid specifications

Grid ID	Region	Dimensions	Grid cell size
1	Antarctica and Southern Ocean	330 x 436	30 km
2	Antarctica	667 x 628	10 km
3	Ross Sea and Ice Shelf	538 x 826	3.3 km
5	Ross Island	325 x 346	1.1 km
6	Antarctica Peninsula	520 x 454	3.3km

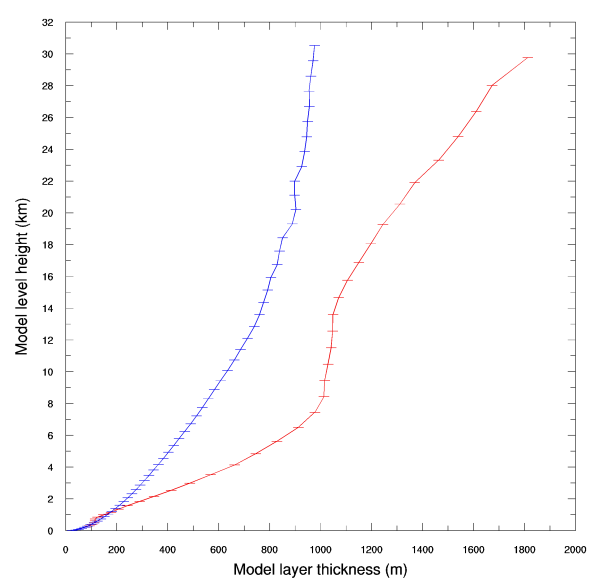

Fig. 1. Approximate model-layer thicknesses in the old 43-layer configuration (red) and the new 60-layer configuration (blue).

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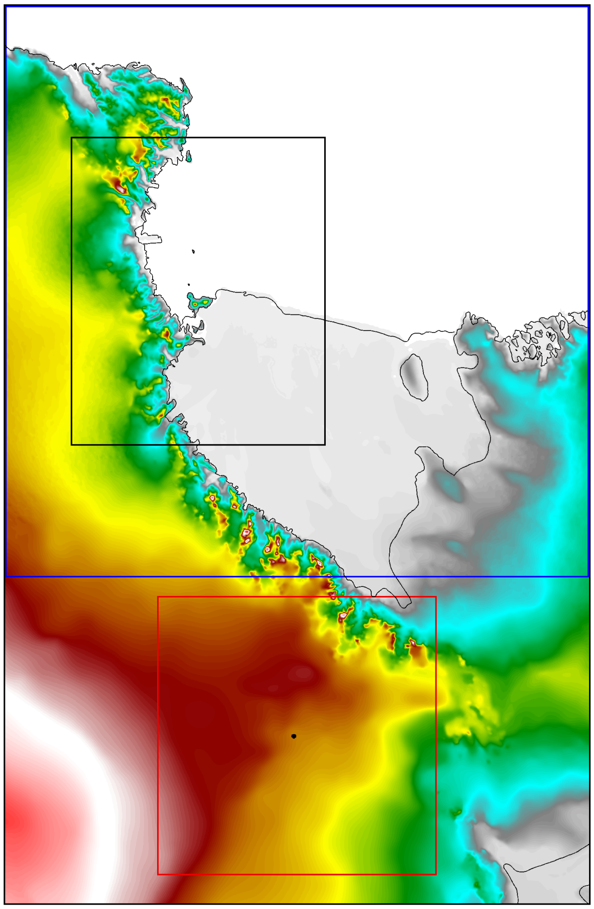

Fig. 2. AMPS domain 3, with 3.3-km grid spacing. The position of domain 3 in last year's AMPS configuration is shown as the black box (Ross Island and the Western Ross Sea). The initial expansion of domain 3 is shown as the blue box (top two-thirds of the figure). The retired S. Pole grid, shown as the red box, has been superseded by the expanded domain 3.

3. Increased resolution

When AMPS began running on Erebus, we immediately made use of the computing capacity to increase resolution all around: horizontal, vertical, and temporal. The number of vertical layers was increased from 43 to 60 (Fig. 1), increasing the vertical resolution throughout the model column. Horizontal grid spacing on all domains was reduced by one third (Table 1). Time steps consequently had to be decreased as well.

4. Larger high-resolution grids

Following the increase in resolution, we began experimenting with larger nests. We increased the coverage of domain 3, the "Western Ross Sea" grid, to cover the full Ross Sea and Ross Ice Shelf. Subsequently, we extended this grid to cover the South Pole (Fig. 2), and were thus able to eliminate a separate South Pole grid (AMPS domain 4). One goals of this southern extension were to better resolve the katabatic flows feeding onto the Ross Ice Shelf, without the artificial discontinuities imposed by internal nest boundaries.

We also increased the size of the Ross Island grid, domain 5 (Fig.3), extending this grid on all sides, but particularly to the south, in order to include the Byrd Glacier and the strong katabatic flows associated with the glacier.

In addition, at the request of SPAWAR forecasters, we extended the high-resolution nest duration from 36 to 39 hours.

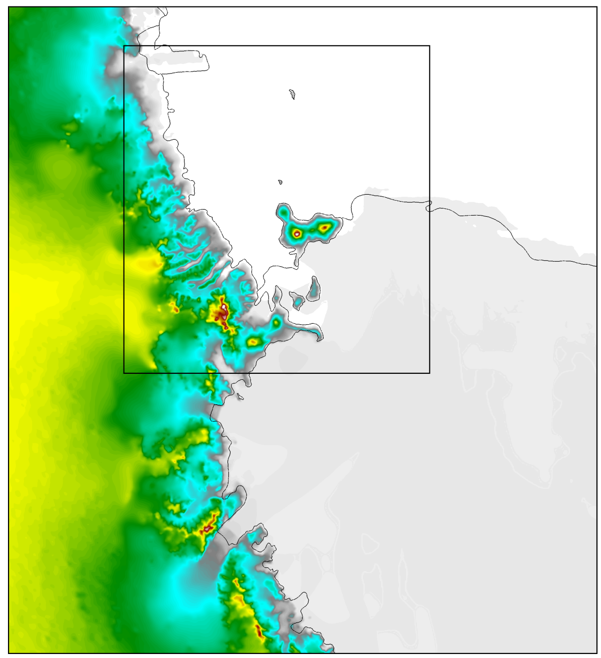

Fig. 3. AMPS domain 5, with 1.1-km grid spacing. The position of domain 5 in last year's AMPS configuration is shown as the black box around Ross Island and vicinity.

5. Grid reconfiguration

We reconfigured the AMPS domains in other ways. The "Palmer" one-way nest, covering the tip of South America, the Drake Passage, and the Antarctic Peninsula with 10-km grid spacing now runs as a two-way nest (with 9-km grid) driven by an additional WRF simulation, the coarse domain of which is similar to the traditional AMPS domain 1. In addition, this new coarse grid now drives a second two-way nest over New Zealand, a nest that had been requested by USAP forecasters.

This strategy has several benefits: 1) We can run these two-way nests in parallel with the regular

AMPS grids, not needing to wait for model output to drive a one-way nest. This consideration means less of a wait for forecasters to get the data. 2) We can configure the coarse domain independently from the traditional AMPS grids. This run uses a 27-km grid spacing (rather than 30-km) for slightly higher resolution. The grid has also been shifted slightly to better position the nests within it. 3) The nests benefit from full two-way nesting with the parent grid. 4) We can dispense with the considerable computational overhead and wallclock time needed to generate the one-way nest initial and boundary conditions.

This strategy is feasible for the New Zealand grid and the Palmer grid, since these regions are nested within a large low-resolution grid which is of almost negligible cost as compared to the nests. It is not feasible for the higher-resolution one-way nests that are driven by the considerably more expensive AMPS domain 2.

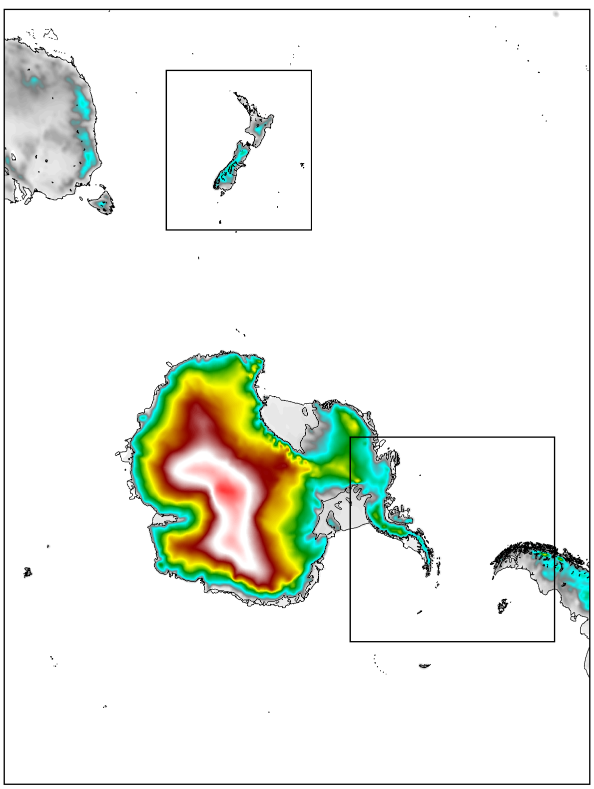

Fig. 4. 27-km grid driving two-way nests, with 9-km grid spacing, over New Zealand and the Drake Passage.

These higher-resolution one-way nests, driven by output from AMPS domain 2, include a 3.3-km grid over WAIS Divide and a 3.3-km grid around the Pine Island Glacier region.

6. Other updates

The version of WRF used for AMPS was updated from WRF v3.2.1 to WRF v3.3.1 when we made the switch to the Erebus computer. Results between the two versions, when the same polar modifications had been applied, were very similar.

A long-standing bug was discovered and fixed in August 2012. This bug, caused by confusion between the logic of adaptive timesteps and that of radiation timestep frequency, meant that the radiation physics routines were not called as often as requested. While radiation physics was supposed to be called every 15 minutes, the interval between radiation calls could vary unpredictably, but usually seemed to fall somewhere between a half hour and a few hours.