AMPS Update – June 2016

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The Antarctic Mesoscale Prediction System

• Funded by the National Science Foundation to support US Antarctic Program (USAP) forecasters and activities
• Provides customized NWP support for Antarctic forecasters
• Forecast model is the Weather Research and Forecasting Model (WRF-ARW), tuned for the Antarctic environment
  – Taking advantage of the Polar WRF effort at BPCRC
• Real-time forecasts running at NCAR since October 2000
• Real-time NWP products disseminated primarily through the AMPS web page and the Antarctic-IDD network
• Archive of AMPS forecasts back to 2001
  – Many, many model updates, configuration changes, etc. through this period
• AMPS runs WRF with five two-way interactive nests

• Two forecasts per day
  – 00Z and 12Z forecast cycles
  – 30 and 10-km grids over all of Antarctica and environs
    • 3-hourly output to forecast hour 120
  – 3.3 and 1.1-km grids over areas of particular interest to USAP
    • Hourly output to forecast hour 39
http://www2.mmm.ucar.edu/rt/amps

http://amps-backup.ucar.edu
What’s New
AMPS Ensemble

- 2-domain 30km/10km configuration out to 5 days
- ~14 members
- 10 members initialized from NCEP GEFS (0.5 degree dataset)
- ~4 members initialized with various data assimilation strategies
- Variety of graphical products available on 30-km, 10-km and Ross/Beardmore (10km) windows
- Provide information on forecast uncertainty
  – “Probabilistic” NWP products
Ensemble Time Series
(surface, selected stations)
Ensemble Extremes and Frequencies

Example: ceiling

Minimum ceiling among all ensemble members

Frequency of ceiling below 1000 m

Dataset: rt.d2  RIP: rip ens f045
Fcast: 45.00 h
CIG: Ensemble minimum value

Init: 0000 UTC Sat 14 May 16
Valid: 2100 UTC Sun 15 May 16
sm = 1

Dataset: rt.d2  RIP: rip ens f045
Fcast: 45.00 h
CIG: Ens. freq'cy below 1000 ft

Init: 0000 UTC Sat 14 May 16
Valid: 2100 UTC Sun 15 May 16
sm = 1
AMPS Ensemble

• From the main AMPS web page
  – Look for “Experimental Ensemble Products” in the menus for the 30-km and 10-km grids

• Caveats regarding AMPS Ensemble
  – Experimental
  – Runs after the main AMPS forecast has completed
  – Small ensemble (~14 members)
    • May have to cut back further
  – Under-dispersive
    • Ensemble members are too similar to each other
    • Variability exhibited among ensemble members does not adequately reflect true atmospheric variability
Hybrid (ensemble/variational) Data Assimilation

• Variational data assimilation (Var) uses Background Error Covariance statistics (BE)
  – Spreads the influence of an observation appropriately over a greater region than the immediate vicinity of the observation

• Variational data assimilation as used in AMPS uses a static estimate of BE
  – updated monthly by the “NMC Method”
    • difference between 24-hr forecasts and 12-hr forecasts over a 1-month period
    • “Static BE”

• Ensemble data assimilation uses an ensemble to estimate BE
  – BE will vary forecast-to-forecast depending on the particular characteristics of the atmospheric state/predictability/uncertainty
    • “Flow-dependent BE”
  – Larger ensembles (perhaps O(100) members advisable) will have more reliable statistics

• Hybrid method weights between the static BE and ensemble-estimated BE
  – Even a small ensemble can offer some flow-dependent information to supplement the static BE

• AMPS does not use “cycled” data assimilation in which the AMPS forecast would be used as first guess to the next DA cycle
  – Each DA cycle uses NCEP GFS analysis as first guess
Forecast Statistics
Hybrid vs. Conventional Var DA

Station Pressure Bias Comparison
Average bias over forecast hours 0 – 120

00Z forecasts between 01 Mar 2016 and 05 May 2016

Blue Circles represent stations where Conventional DA has smaller absolute bias than Hybrid DA

Red Circles represent stations where Hybrid DA has smaller absolute bias than Conventional DA

Size of circle reflects the magnitude of the difference in scores

Thanks to AMRC for much of the data used for model verification
Station Pressure RMSE Comparison
Average RMSE over forecast hours 0 – 120

00Z forecasts between 01 Mar 2016 and 05 May 2016
Surface Wind Speed statistics comparison

**BIAS (m s⁻¹)**
- Conventional better
- Hybrid better

**RMSE (m s⁻¹)**
- Hybrid better
Surface Temperature statistics comparison

Conventional better  Hybrid better

BIAS (K)

RMSE (K)

AMOMFW 2016
Station Pressure RMSE at various forecast lead times

Forecast Hours 0-24  “Day 1”
Forecast Hours 48-72  “Day 3”
Forecast Hours 96-120  “Day 5”

Conventional better  Hybrid better
Surface Wind Speed RMSE at various forecast lead times

Forecast Hours 0-24 “Day 1”
Forecast Hours 48-72 “Day 3”
Forecast Hours 96-120 “Day 5”

Conventional better
Hybrid better
Surface Temperature RMSE at various forecast lead times

Forecast Hours 0-24 “Day 1”
Forecast Hours 48-72 “Day 3”
Forecast Hours 96-120 “Day 5”

Conventional better
Hybrid better
Hybrid DA summary

• Overall, Hybrid DA offers improved forecast skill over conventional variational DA
  – Despite small, under-dispersive ensemble
• Implemented in AMPS beginning 25 May 2016
WRF Version Update

• Keep AMPS current with WRF community
  – v3.3.1 released to WRF community ~Sep 2011
  – v3.7.1 released to WRF community ~Sep 2015
Station Pressure Comparison
(06 Nov – 24 Dec 2015)

BIAS

RMSE

WRF-v3.3.1 better
WRF-v3.7.1 better
Surface Temperature Comparison
(06 Nov – 24 Dec 2015)

WRF-v3.3.1 better
WRF-v3.7.1 better
Surface Wind Speed Comparison
(06 Nov – 24 Dec 2015)

BIAS

RMSE

WRF-v3.3.1 better

WRF-v3.7.1 better
WRF Version Update

• WRF-v3.7.1 implemented in AMPS beginning 19 January 2016

• WRF-v3.7.1 ran somewhat slower than v3.3.1
  – Overhead costs of nest communications
    • AMPS has a lot of nests
  – Some code adjustments implemented in AMPS to speed up execution
    • merged into WRF-v3.8 release
  – Some AMPS configuration adjustments to speed up execution
    • parallel-processing domain decomposition

• AMPS with v3.7.1 runs about as fast as with v3.3.1
Streamline Visualization

• Animated visualizations of static surface streamlines
  – Not trajectories, despite depiction of motion
  – Presented as animated GIF

• Temporary URL
  – http://www2.mmm.ucar.edu/rt/amps/test/strm/
  – Will try to merge into the AMPS web pages
AMPS Init Time: 2016-05-24 / 12 UTC    Forecast Lead Time: 12 Hours
Forecast Valid Time: 2016-05-25 / 00 UTC

Surface Wind Streamlines

Wind Speed (kts)
Coming Soon – New computing resources

• AMPS “Erebus” computer (2012), residing at the NCAR/Wyoming Supercomputing Center (NWSC), is nearing end-of-life
  – Along with NWSC “Yellowstone” community computer

• New community computer “Cheyenne” being installed at NWSC
  – Cheyenne will offer ~2.5 × computing power of Yellowstone
  – AMPS will run on Cheyenne beginning in 2017
    • Working estimate is that AMPS usage of Cheyenne will be ~2.5 × computing power of Erebus
    • Use of community platform for AMPS has its advantages and disadvantages
AMPS Update
Questions / Comments / Discussion

www2.mmm.ucar.edu/rt/amps
amps-backup.ucar.edu
www2.mmm.ucar.edu/rt/amps/test/strm