Polar WRF*

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Testing of Polar WRF

1. **Permanent ice sheets**
   - Start with Greenland (Follow Polar MM5 path)
     - January 2002 (winter) and June 2001 (summer)
   - Hines and Bromwich (June 2008, MWR)
   - Also Antarctic AMPS forecasts (NCAR MMM Division)
   - Antarctic climate simulations (Elad Shilo at BPRC)

2. **Polar pack ice**
   - Use 1997/1998 Surface Heat Budget of the Arctic (SHEBA) observations on drifting sea ice
   - Selected months: January, June, and August
   - Bromwich et al. (2008, JGR)

3. **Arctic land**
   - Underway
Modifications to Noah LSM in WRF versions 2 and 3

1. Snow/ice emissivity set at 0.98
2. Permanent ice albedo set at 0.8
3. If snowpack depth > 0.05 m treat snow within the prognostic “soil” layers of Noah
4. Direct summation of surface energy balance terms in diagnostic calculation of surface temperature for snow/ice
5. Penman Equation evapotranspiration calculations updated for ice sublimation (now standard in version 3.0)

Fractional sea ice for versions 2.2 and 3.0

1. Fractional sea ice not an “additional” landuse type as in Polar MM5
2. Noah or other LSMs can be used
3. Can specify sea ice albedo
4. Surface boundary layer routine called separately for ice and liquid
Antarctic Domain
WRF 3.0

Western Arctic Domain
for Comparison with SHEBA observations
WRF 2.2

Greenland Domain
WRF 2.1.1

121 x 121
60 km spacing
28 levels

141 x 111
25 km spacing
28 levels

97 x 139
24 km spacing
28 levels
Temporal and spatial variability of sea ice surface

May
Spring has snow cover

How do we treat the sea ice surface over the course of an ASR year?
Must account for snow cover, leads, bare ice, melt ponds, and ice thickness.

June
Snow melt and pond formation

July
Pond development

August
Freeze and thaw

September
Refreeze and snowfall
Sea Ice Fraction in the Arctic

Fractional area of the ocean surface covered by ice as a function of latitude within the domain for the January, June and August 1998 simulations. Data is from National Snow and Ice Data Center (NSIDC) Special Sensor Microwave Imager (SSM/I) bootstrap retrievals.

Sea ice fraction during August 1998
Agreement between simulated and observed surface pressure demonstrates that Polar WRF is capturing the synoptic variability at Ice Station SHEBA during January 1998.

Similar results are seen for June and August 1998.
Surface Temperature at Ice Station SHEBA

January 1998

Correlation: 0.83
Bias: -2.20°C
RMSE: 4.29°C

June 1998

Correlation: 0.38
Bias: 0.42°C
RMSE: 1.05°C

August 1998

Correlation: 0.46
Bias: 0.20°C
RMSE: 1.15°C
Figure 9 10-m Wind speed (m s\(^{-1}\)) from observations and the Polar WRF simulation at Ice Station SHEBA for January, June and August 1998
Impact of open water fraction: Consider Ice Station SHEBA and point (51,59)

Surface Temperature at SHEBA/PT(51,59) January 1998

At Ice Station SHEBA the temperature difference is very small as open-water fraction is very small.

At point (51,59) the temperature difference becomes very large as open-water fraction becomes significant.
Summary/ What is next?

- Polar WRF works well over the Greenland Ice Sheet
- Polar WRF captures the synoptic variability over the Arctic pack ice
  small bias
  high-frequency errors due to clouds
- Testing over Arctic land underway
  snow cover
  initial soil temperature and moisture
  stable boundary layer + topography
- Antarctic climate tests underway
- AMPS Antarctic real-time forecasts at NCAR
- Arctic System Reanalysis ongoing work
- Polar changes for V 3.0 are available
ASR High Resolution Domain

http://polarmet.mps.ohio-state.edu/PolarMet/ASR.html

Outer Grid:
~30 km resolution

Inner Grid:
~10 km resolution

Vertical Grid:
~60 levels

Inner Grid includes Arctic river basins