Potential NASA contributions to advancing atmospheric modeling in the Arctic and Antarctic

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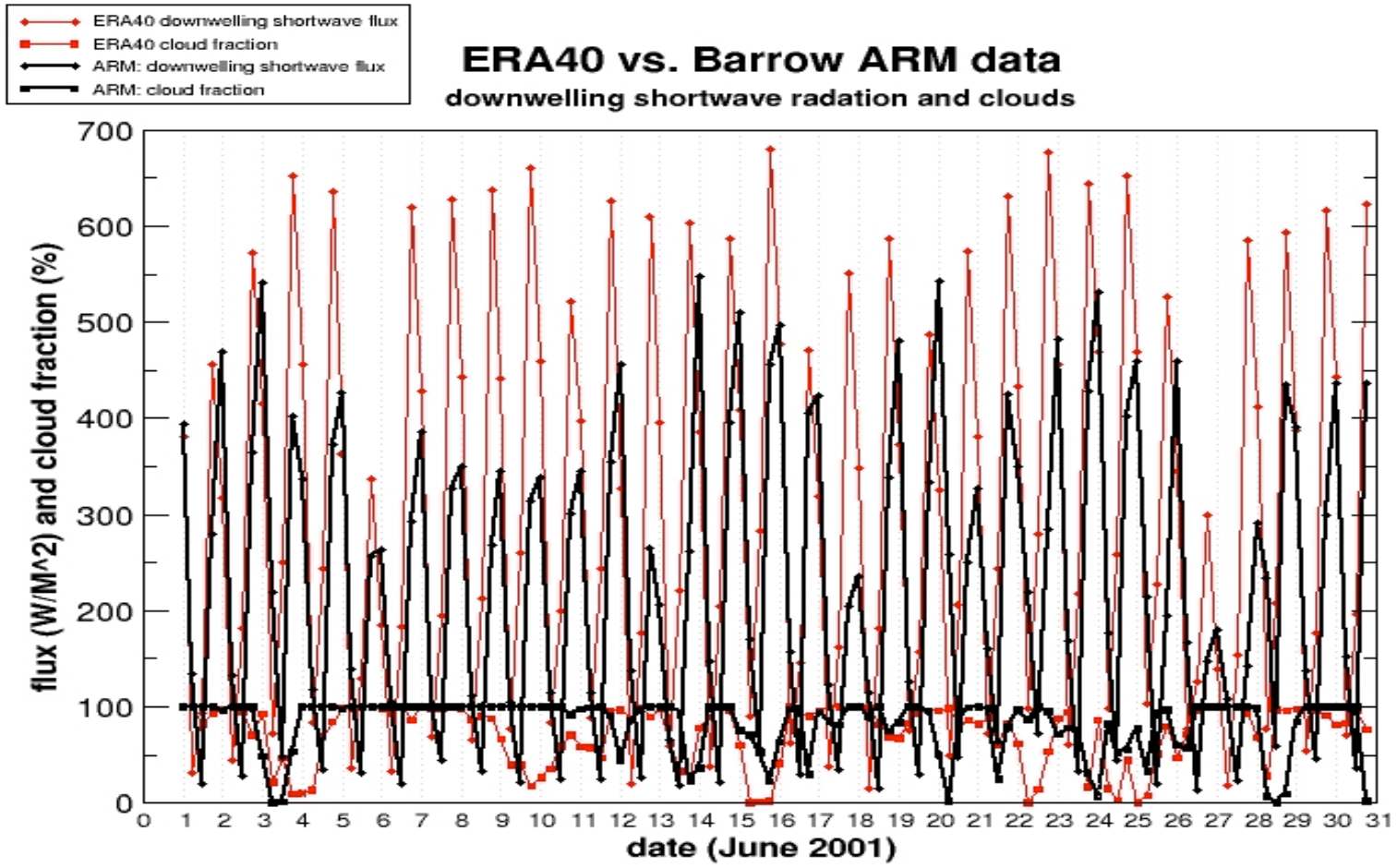
Outline

1. Issues with global reanalyses in the Arctic and Antarctic
2. Arctic System Reanalysis (ASR)
3. Antarctic Regional Reanalysis (AR^2)
4. Assimilation of new satellite data sources
5. Conclusions

Radiation and Cloud Differences in the Arctic

↓ solar and cloud fraction at Barrow (June 2001):
ERA40 (red) vs ARM/NSA (black)



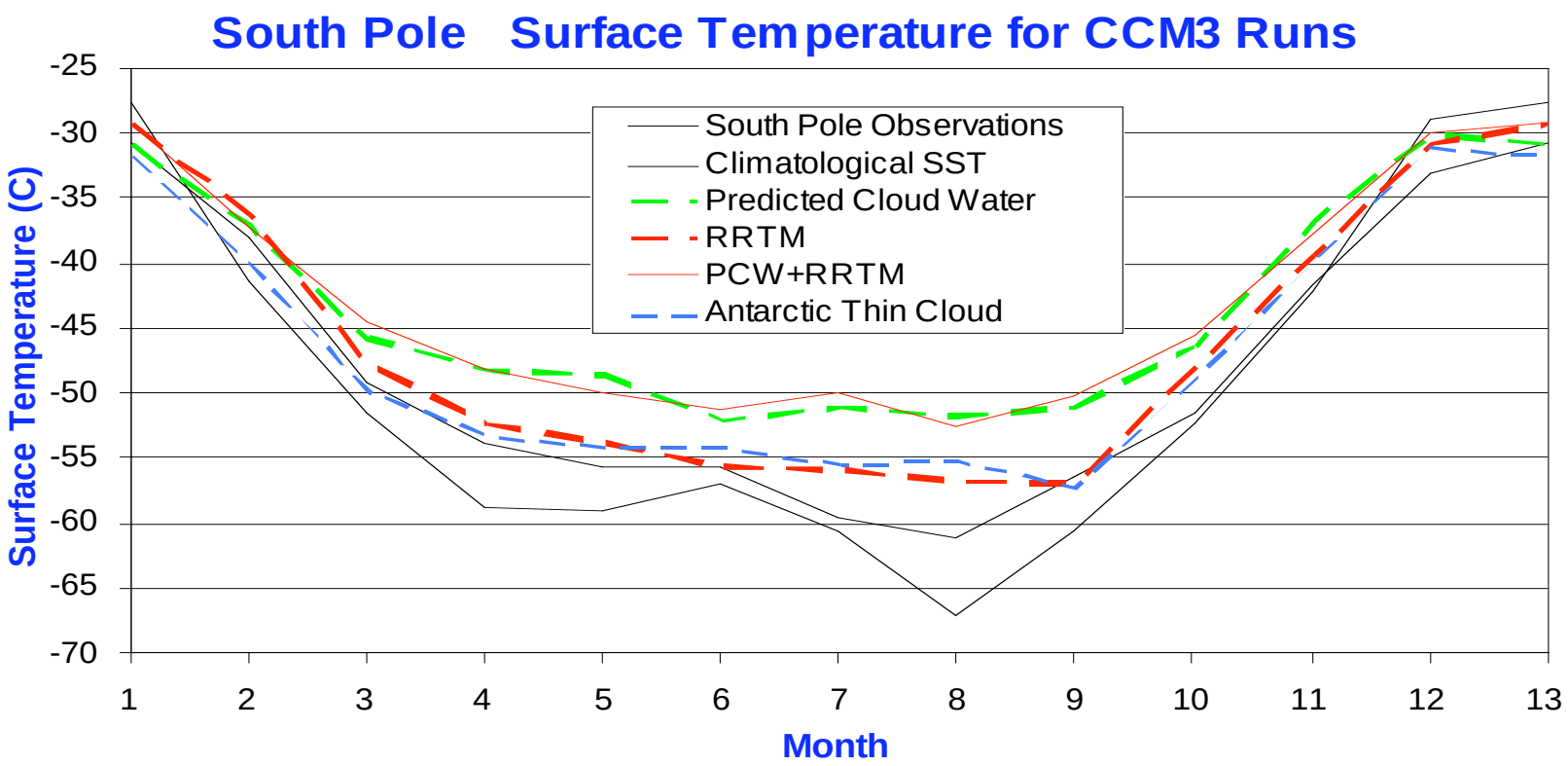
Global reanalysis tropospheric temperature trends in the Antarctic

Table 1. Wintertime tropospheric trends (K/decade) from radiosonde, MSU and two reanalysis datasets between Jan. 1979 and Aug. 2002. The end year (2002) corresponds to the last available year of ERA-40 data.

	Radiosonde	MSU	NCEP	ERA-40
Halley Bay	0.039	0.259	0.895	0.697
Novolazarevskaja	0.434	0.588	1.031	0.815
Syowa	0.591	0.536	0.855	0.955
Mawson	0.775	0.562	0.998	0.936
Davis	0.572	0.523	0.793	0.901
Mirny	0.404	0.333	0.669	0.708
Casey	0.267	0.166	0.815	0.629
Dumont d'Urville	0.023	0.059	0.498	0.408
All	0.376	0.357	0.795	0.760

(Johanson and Fu in press)

Global Climate Model Challenges in Antarctica



Hines et al. (2004)

Arctic System Reanalysis (ASR)

1. Rapid climate change appears to be happening in the Arctic. A more comprehensive picture of the coupled atmosphere/land surface/ ocean interactions is needed.

2. Global reanalyses encounter many problems at high latitudes. The ASR would use the best available description for Arctic processes and would enhance the existing database of Arctic observations. The ASR will be produced at improved temporal resolution and much higher spatial resolution.

3. The ASR would provide fields for which direct observation are sparse or problematic (precipitation, radiation, cloud, ...) at higher resolution than from existing reanalyses.

4. The system-oriented approach would provide a community focus including the atmosphere, land surface and sea ice communities.

5. The ASR would provide a convenient synthesis of Arctic field programs (SHEBA, LAII/ATLAS, ARM, ...)

ASR: Characteristics

Numerical modeling with WRF ARW

ASR grid 600x600 with 60 levels and 20 km horizontal resolution

Much higher resolution than previous reanalyses

Model is being optimized for the Polar Regions

-Greenland

-Western Arctic – SHEBA and Alaska ARM sites

Assimilation of surface conditions

Snow cover and sea ice

Surface temperature

Soil moisture

Surface albedo

Time-variation of surface type

(Climate change impacts)

Additional assimilation

Cloud track winds

Retrieved profiles of T, q

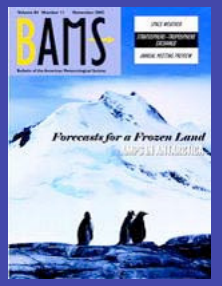
New satellites/COSMIC/…

Antarctic Regional Reanalysis (AR^2)

1. One of the foci of the global climate change debate, but perplexing events are occurring
2. Global reanalyses are most challenged for Antarctica.
3. Accurate description of the air-sea interaction over the Southern Ocean
4. Inline simulation of the surface mass balance of the ice sheet
5. Remote sensing information makes the greatest impact for this data sparse region

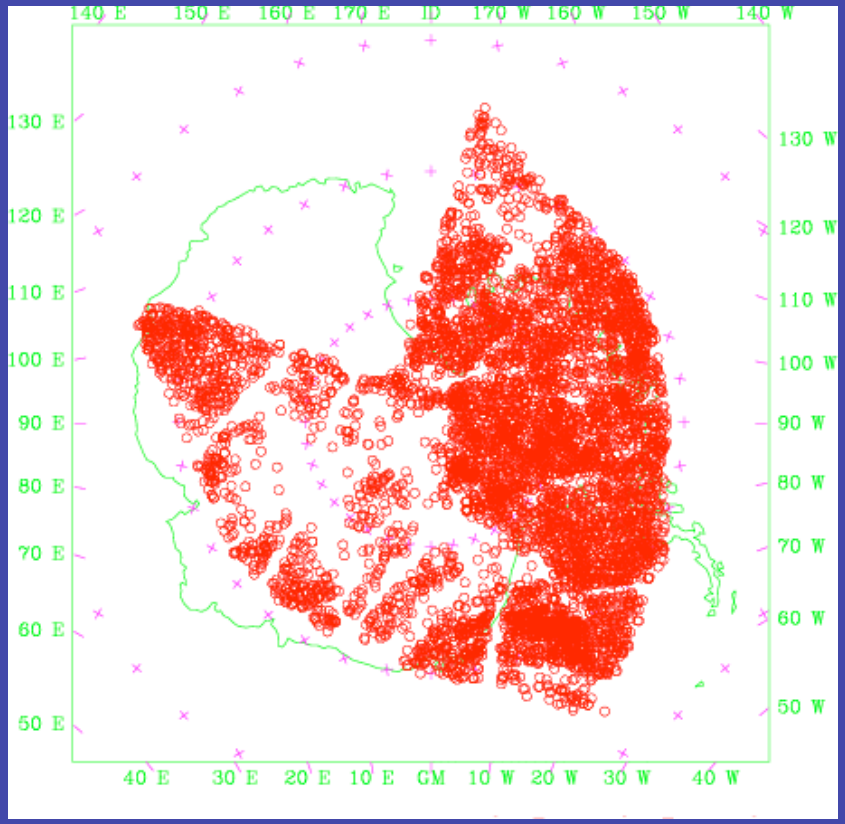
Assimilation of satellite data into atmospheric models.

- Example: AMPS (The Antarctic Mesoscale Prediction System)
- Nested NWP system dedicated to supporting the operations of the U.S. Antarctic Program and International programs.

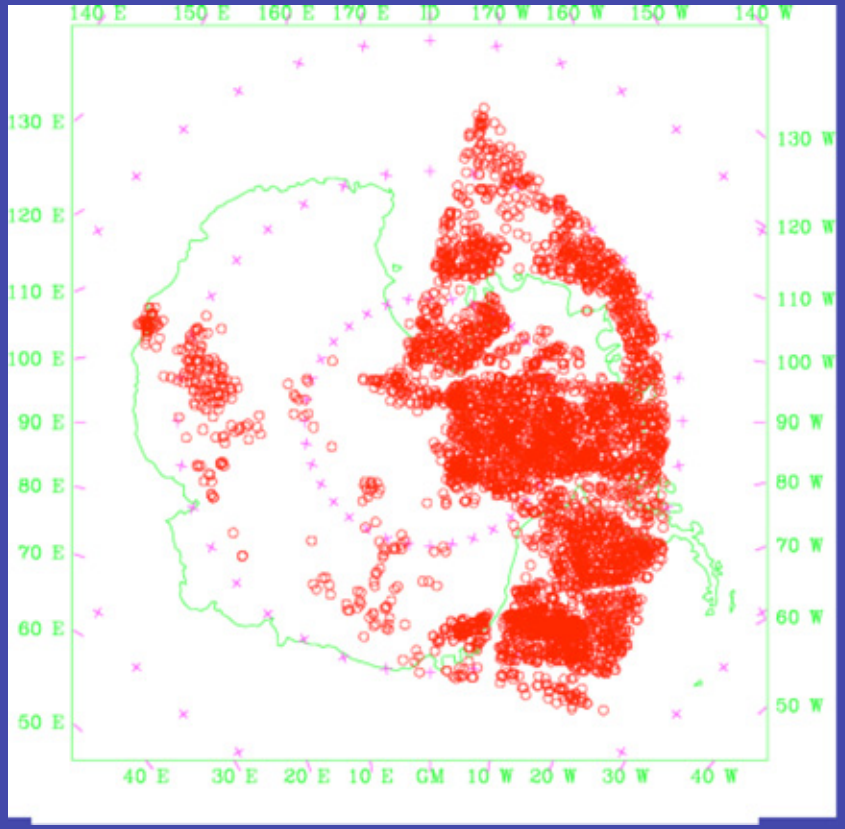


- Employs “Polar MM5”, a limited-area atmospheric model adapted for high-latitude applications by Ohio State University’s Polar Meteorology Group.
- Project began in October 2000 as a small collaboration between 2 U.S. institutions, and since has grown into an international program.
- Other nations are developing similar systems (Aust., Italy)

Impact of MODIS Winds on Antarctic Forecasts:



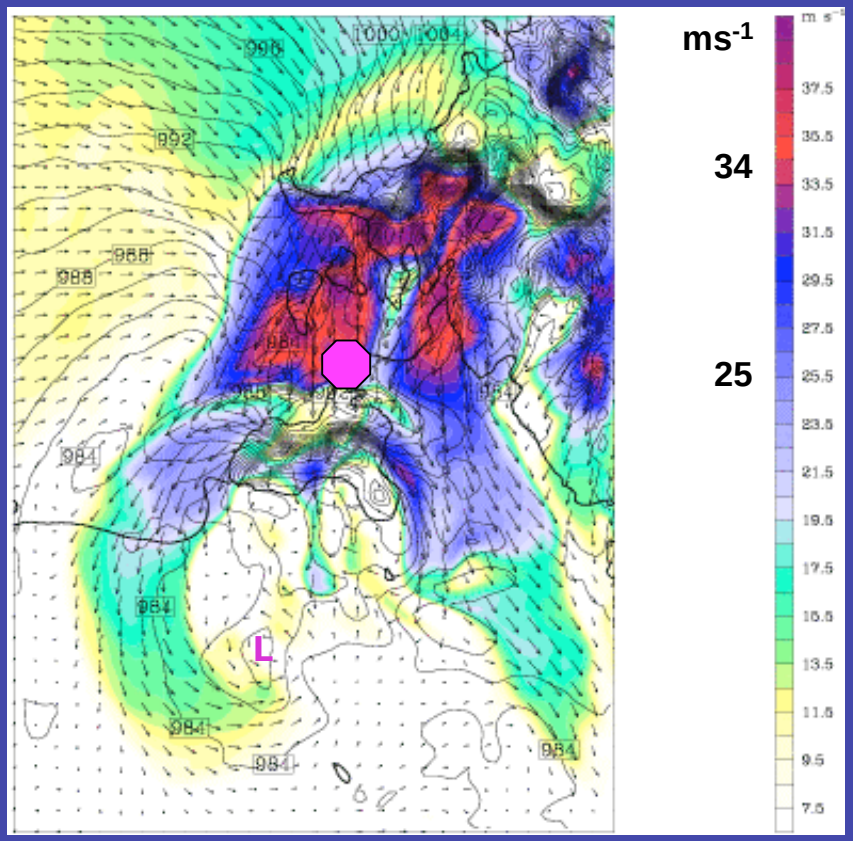
Unfiltered— ALL



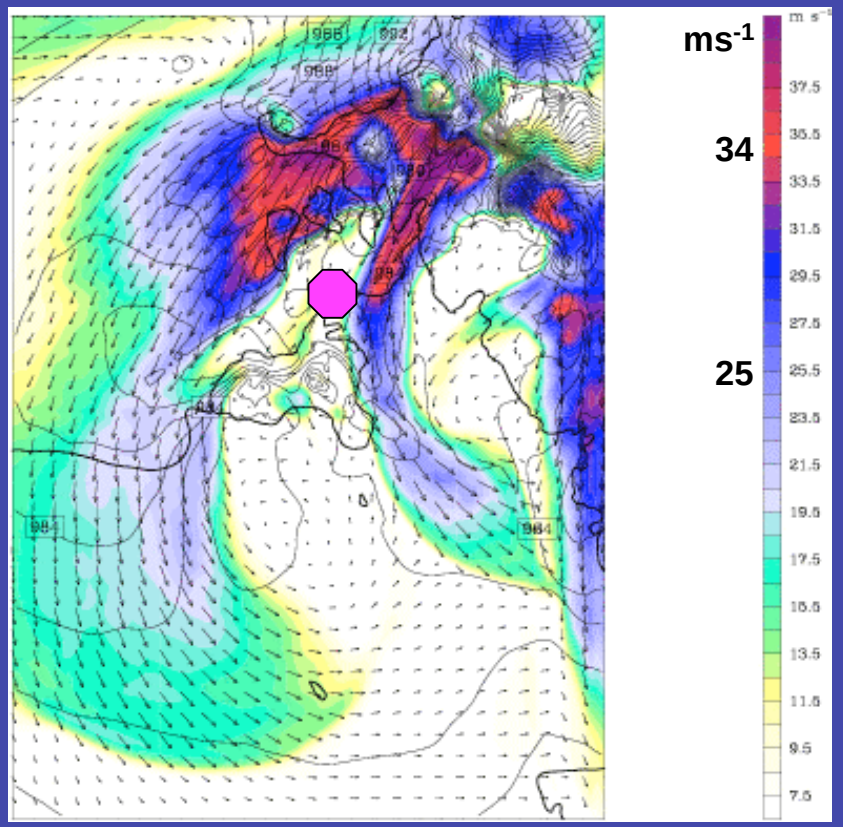
Filtered— MOD1

0000 UTC 15 May 2004 Init

WRF Sfc Winds 2300 UTC 15 May (Hr 23)



MOD1 3.3 km

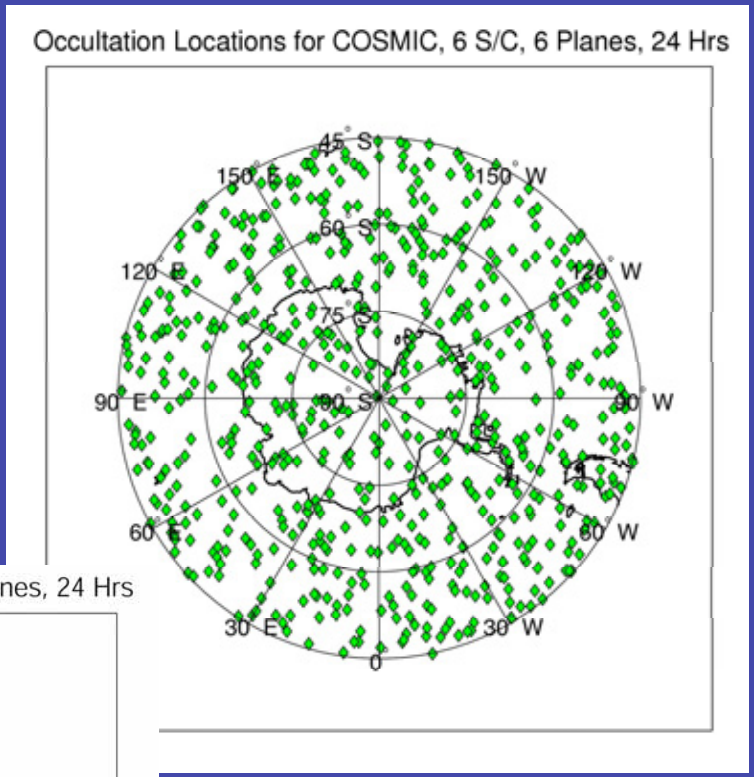


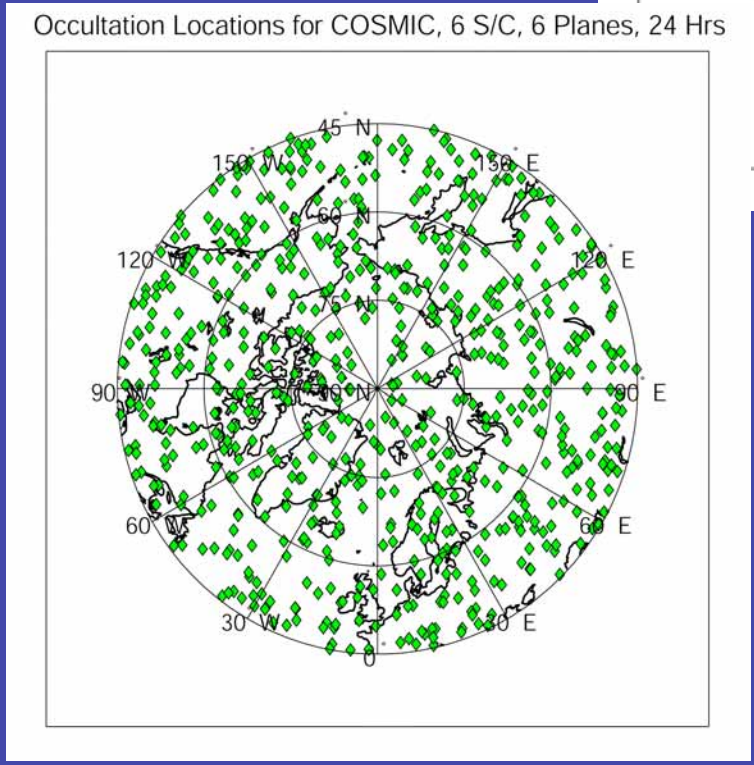
CONTROL 3.3 km

Sfc Winds (ms^{-1})
SLP (hPa)

COSMIC

Typical distribution of COSMIC GPS radio occultation soundings (green dots) over a 24-hour period over the Antarctic and Arctic





Summary

1. Many challenges remain for atmospheric modeling in the Arctic and Antarctic, especially with respect to clouds

2. Satellite remote sensing provides observations with extensive spatial and temporal coverage for the otherwise data sparse polar regions

3. Much research is necessary to learn how to effectively exploit the diversity of satellite data available