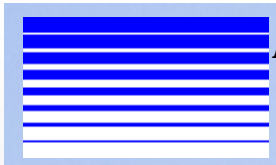

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Development and Testing of Polar WRF*

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***Supported by NSF, NOAA, and NASA**

Vesker

Outline

- Polar Modeling Lessons from Polar MM5 work
- WRF development simulations for Greenland
  - Test vs. AWS and Polar MM5
  - December 2002 (winter)
  - June 2001 (summer)
- WRF development in the Arctic
  - SHEBA 1997/98

Work with Polar MM5

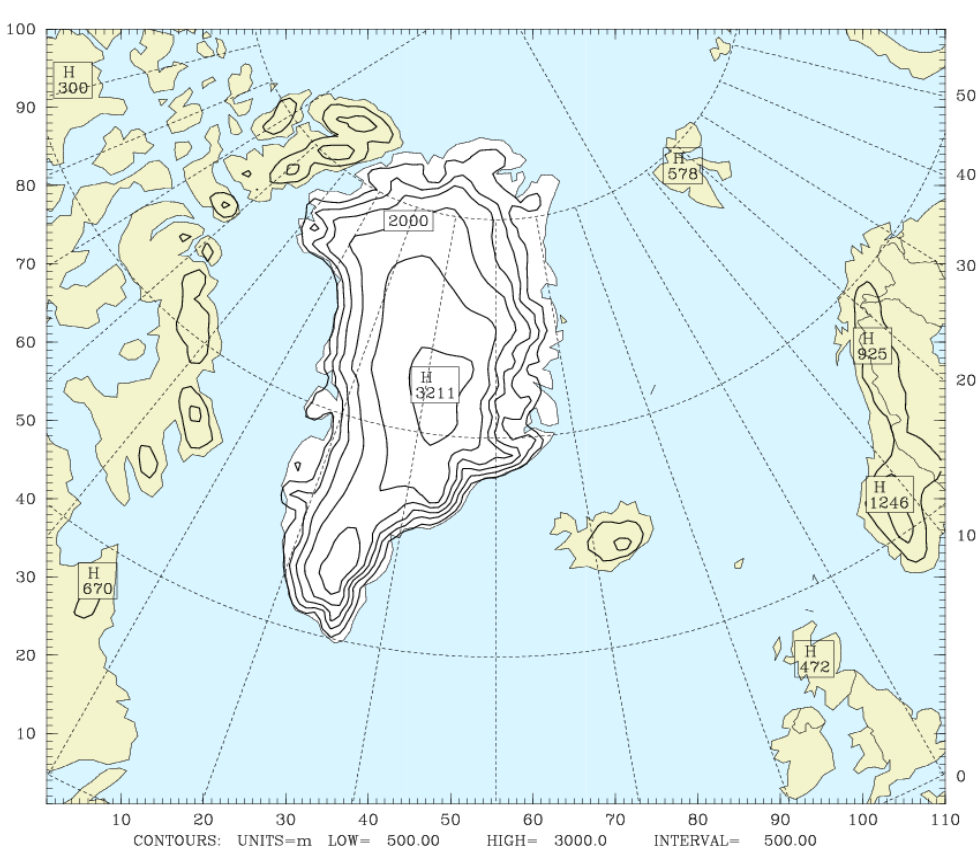
1. Begin with Greenland Testing
2. MM5 was also adapted for polar applications
   - (1) Real-time forecasting/Operational uses - AMPS
   - (2) Synoptic studies
   - (3) Regional Climate studies
   - (4) Paleoclimate studies

3. Polar Optimizations to MM5 physics

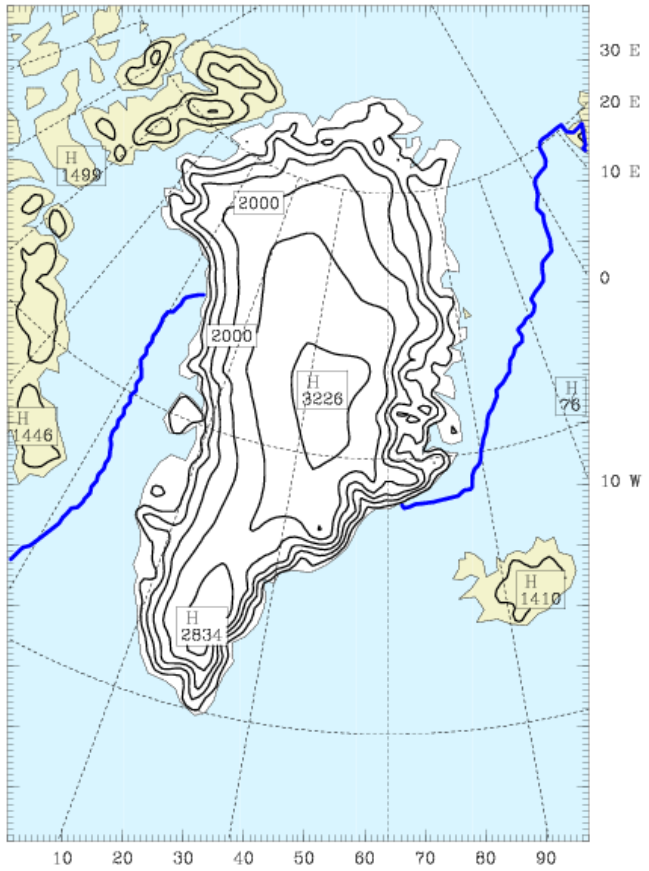
- (1) Revised cloud / radiation interaction
- (2) Modified explicit ice phase microphysics
- (3) Optimized turbulence (boundary layer) parameterization
- (4) Implementation of a sea ice surface type
- (5) Improved treatment of heat transfer through snow/ice surfaces
- (6) Improved upper boundary treatment

Greenland as a Microcosm for Antarctica

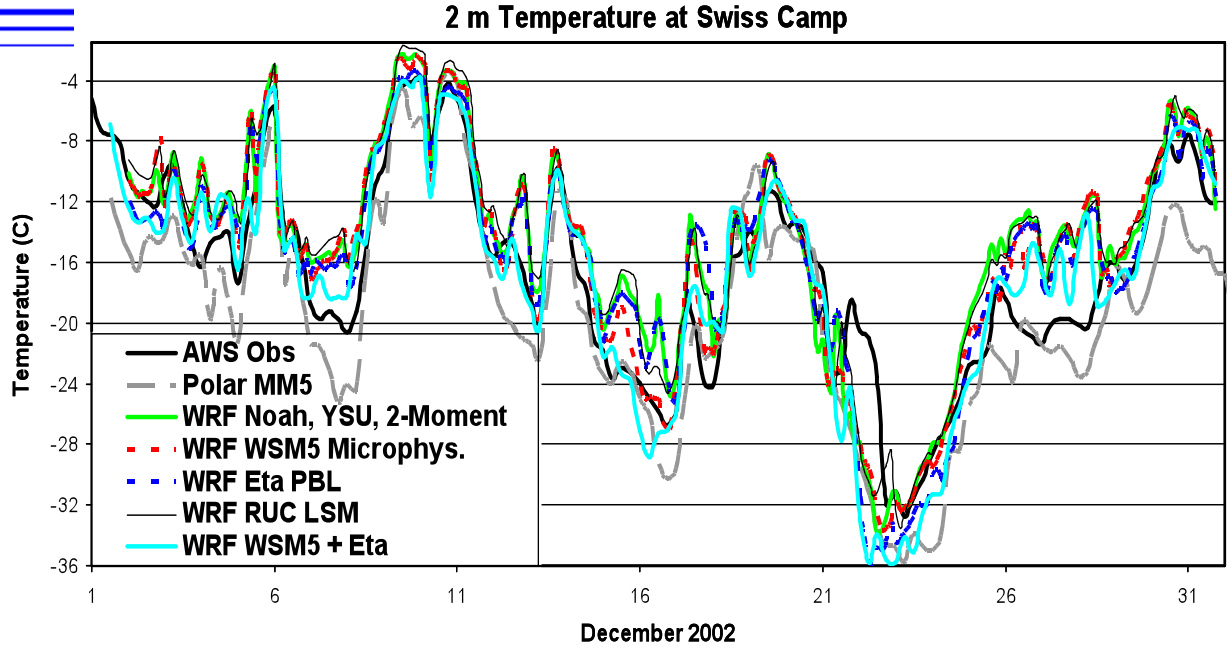
North Atlantic Grids for Greenland Polar WRF Simulations



110 x 100 40 km spacing
28 levels



97 x 139 24 km spacing
28 levels

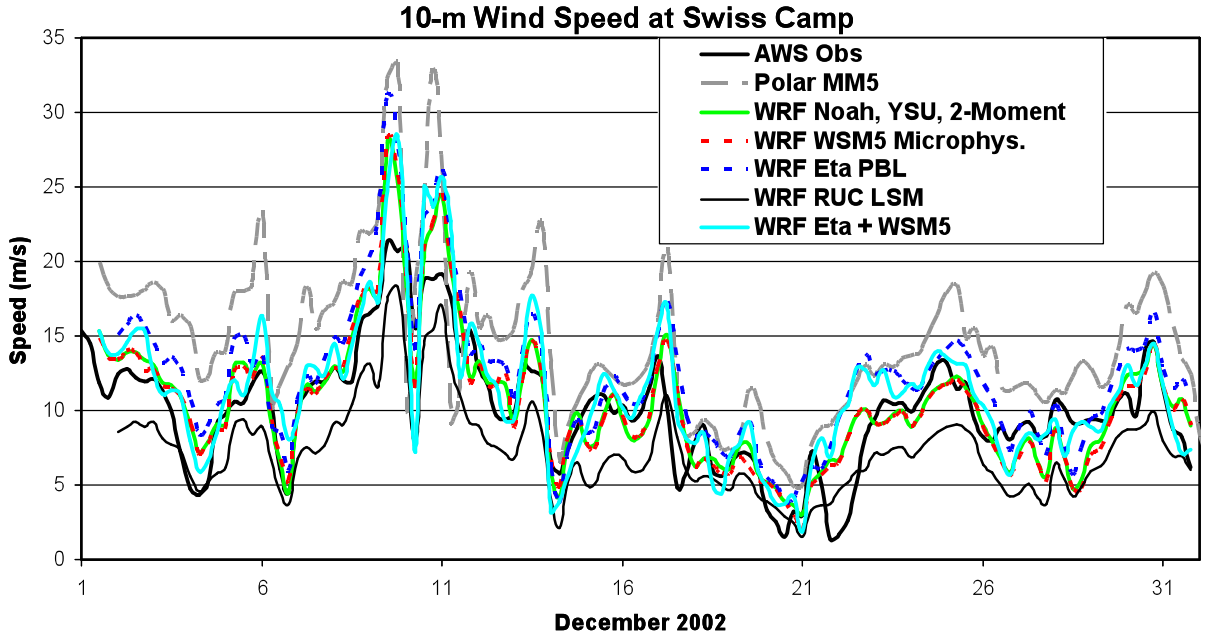


Polar MM5

Correlation	0.93
Bias	-2.6
RMSE	3.7

Polar WRF (Noah LSM + Eta PBL + WSM5 Microphys)

Correlation	0.92
Bias	-0.1
RMSE	3.1

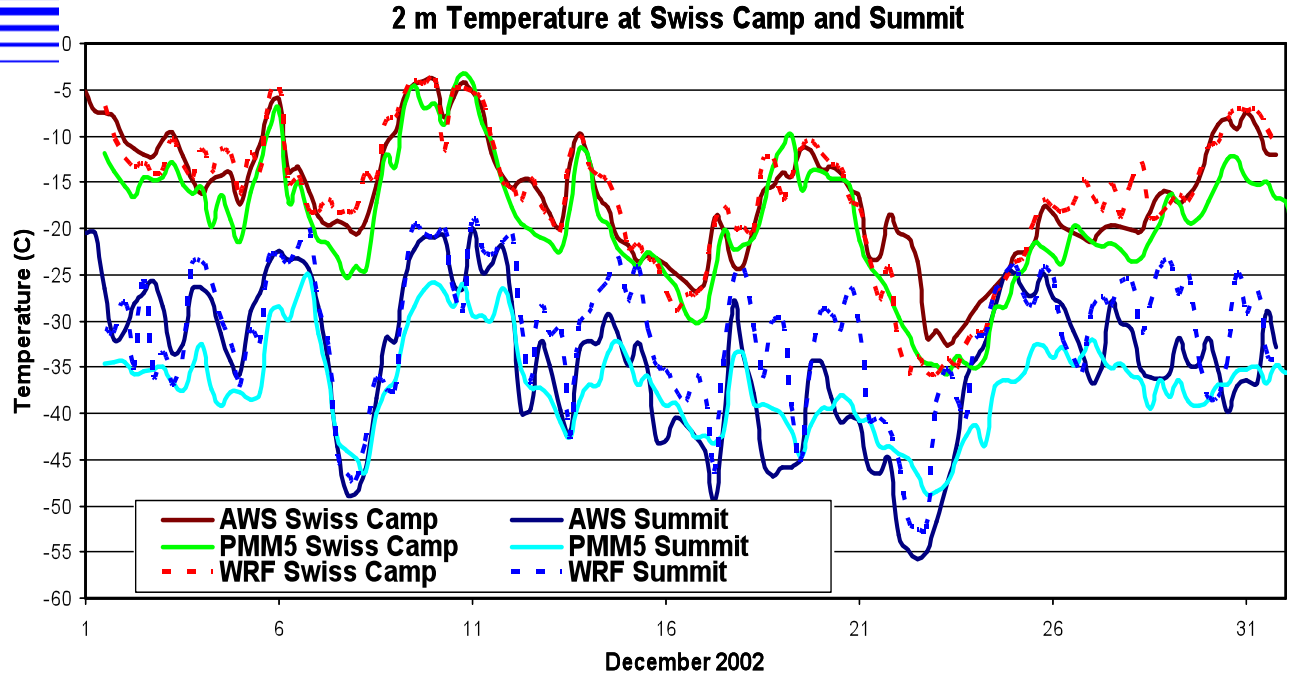


Polar MM5

Correlation	0.75
Bias	4.4
RMSE	5.5

Polar WRF

Correlation	0.92
Bias	1.2
RMSE	2.8



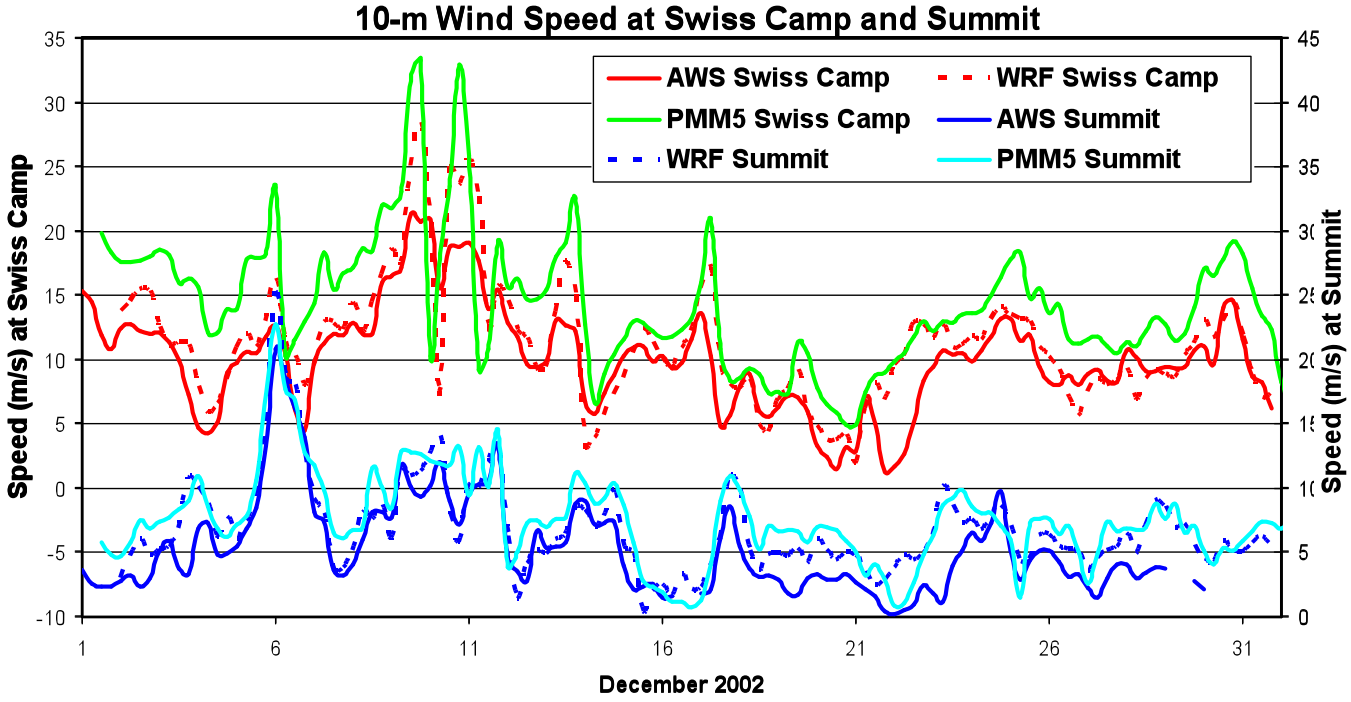
Polar MM5 (Summit)

Correlation	0.84
Bias	-2.3
RMSE	5.6

Polar WRF (Summit)

Noah + MYJ + WSM5

Correlation	0.80
Bias	3.0
RMSE	6.0

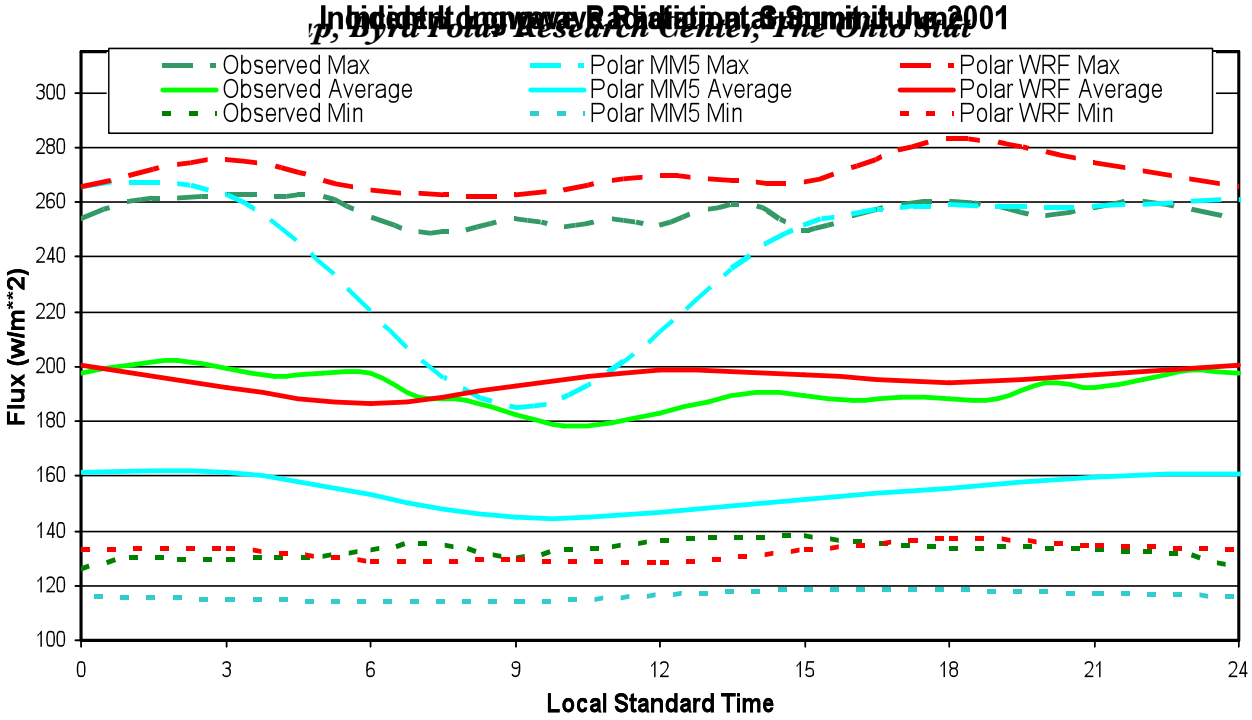


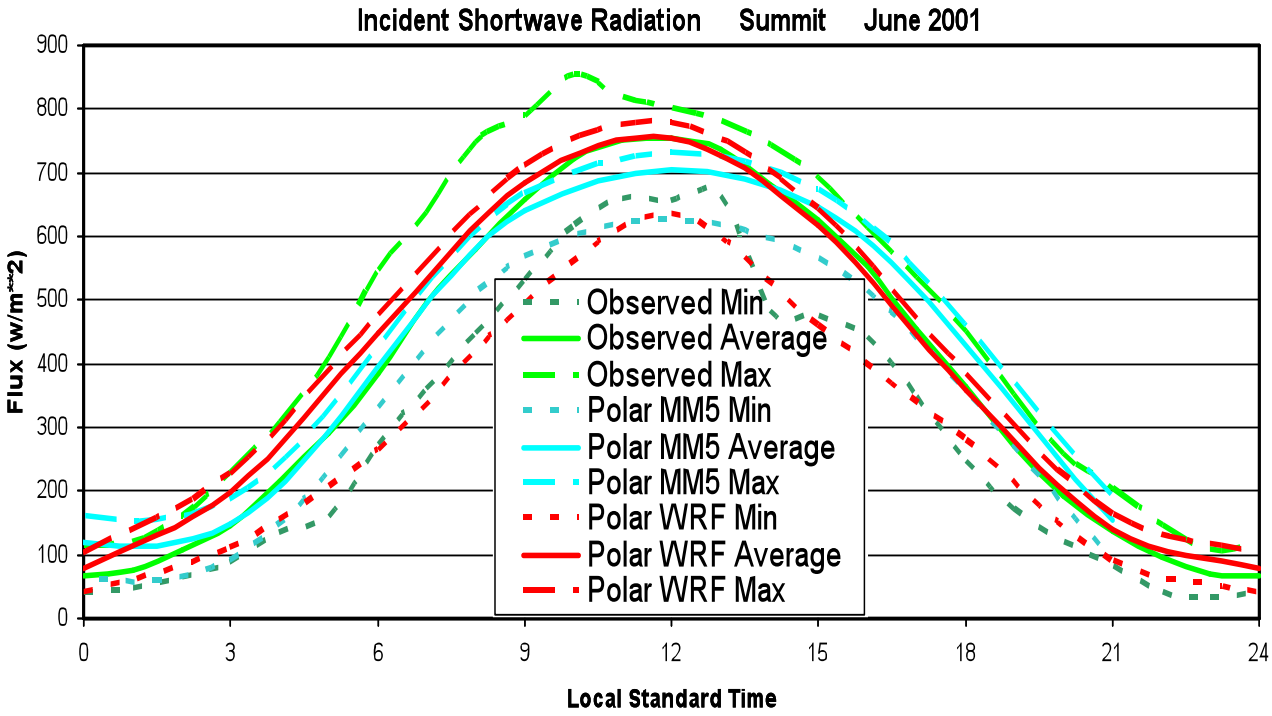
Polar MM5 (Summit)

Correlation	0.87
Bias	2.5
RMSE	3.1

Polar WRF (Summit)

Correlation	0.85
Bias	1.5
RMSE	2.4


Incident Longwave Radiation at Summit, June 2001
Observed Max
Observed Average
Observed Min
Polar MM5 Max
Polar MM5 Average
Polar MM5 Min
Polar WRF Max
Polar WRF Average
Polar WRF Min
Flux (w/m**2)
Local Standard Time

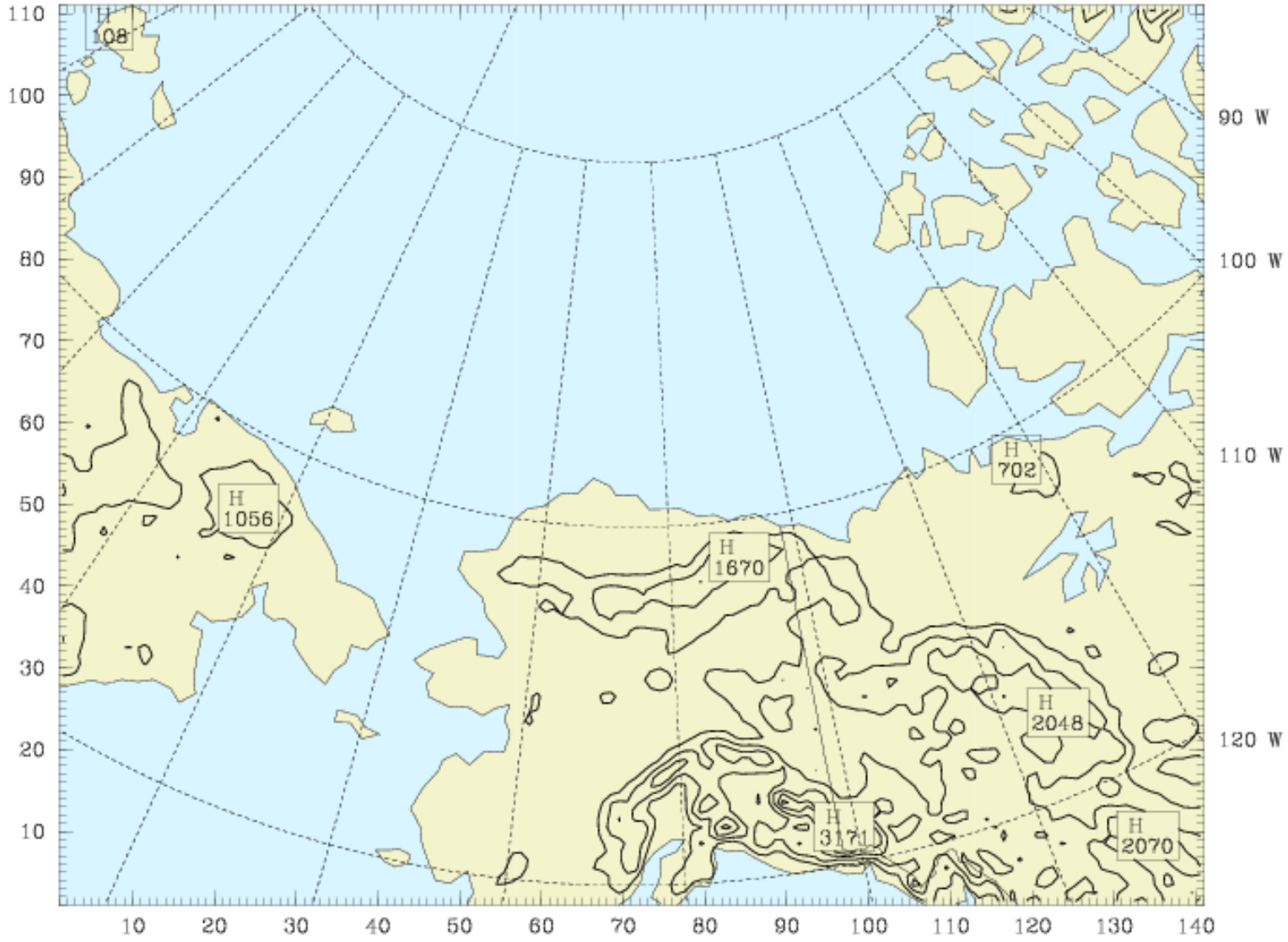

Incident Shortwave Radiation Summit June 2001
Observed Min
Observed Average
Observed Max
Polar MM5 Min
Polar MM5 Average
Polar MM5 Max
Polar WRF Min
Polar WRF Average
Polar WRF Max
Flux (w/m**2)
Local Standard Time

Summary of Greenland Simulations

- Following the path of development for Polar MM5, WRF is being optimized for polar applications beginning with Greenland domains.
- Best results for WRF are achieved with the Noah LSM, the MYJ PBL, and the WRF-single moment 5-class microphysics.
- Polar WRF is at least as successful as Polar MM5 for simulations of the Greenland winter surface layer.
- Polar WRF simulations of the Greenland summer surface layer are comparable to those of Polar MM5 when verified with AWS observations, and surface energy balance for Polar WRF is better.

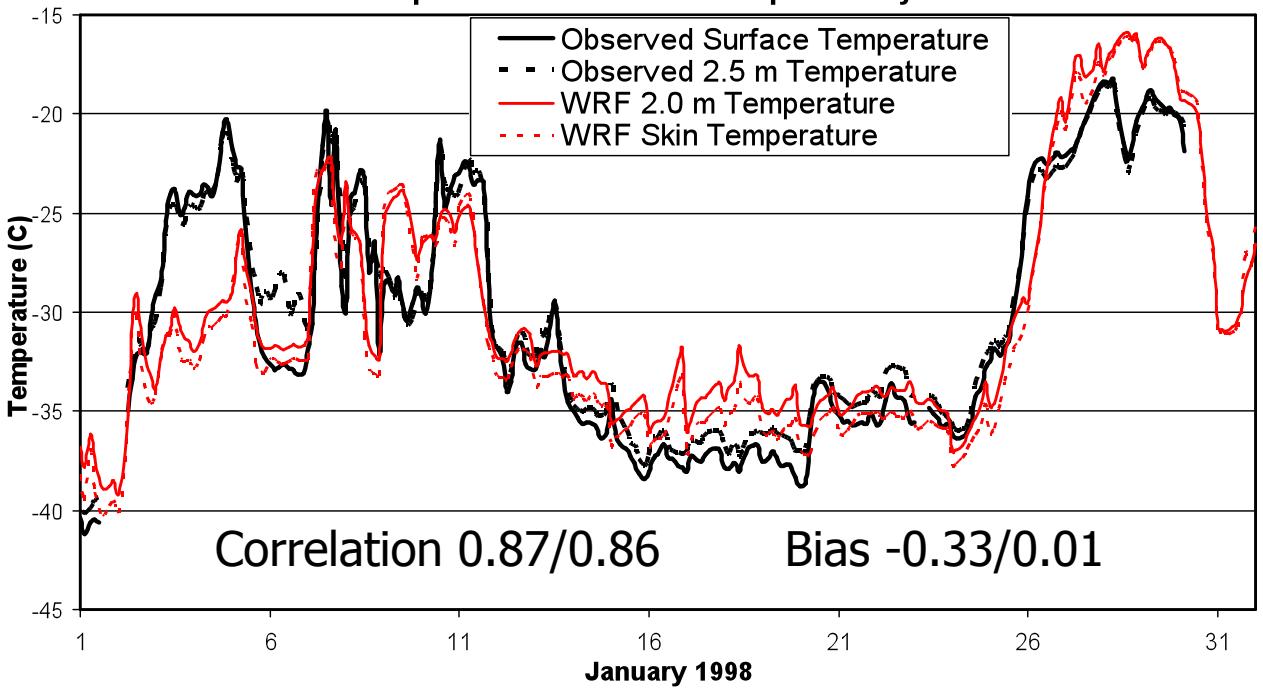
Noah LSM + YSU PBL + Thompson et al. microphysics

Western Arctic Domain for Comparison with SHEBA observations

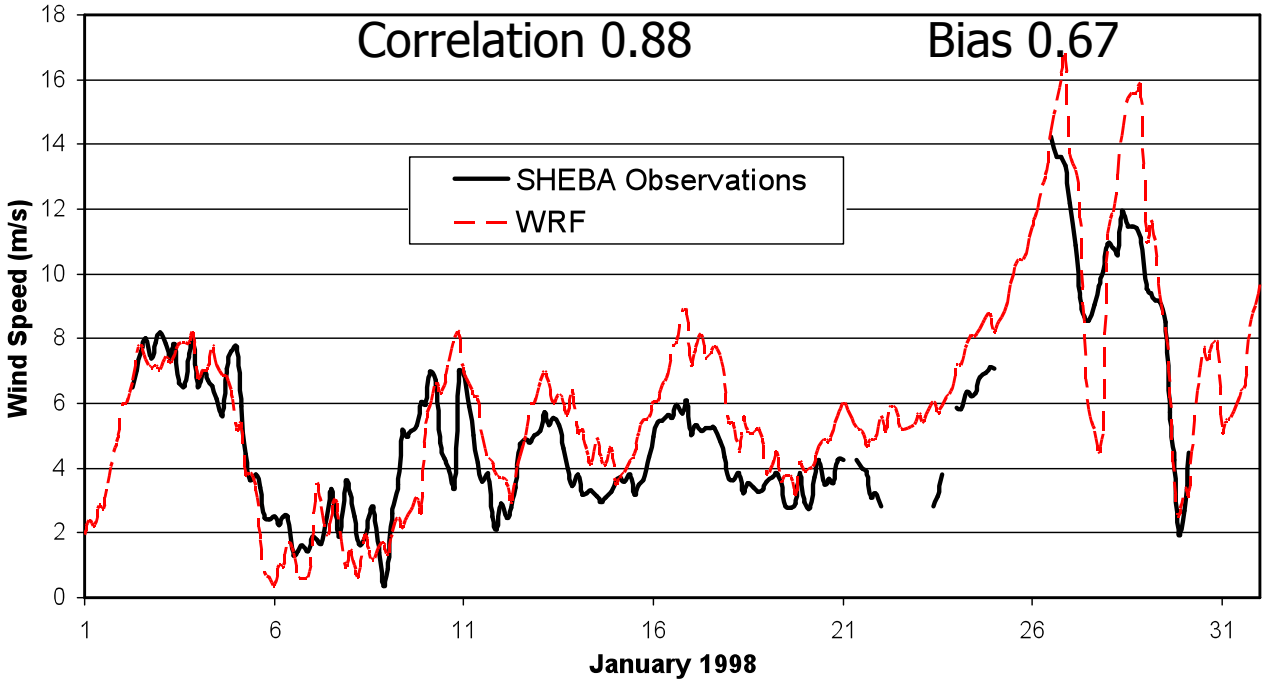


141 x 111 25 km spacing 28 levels

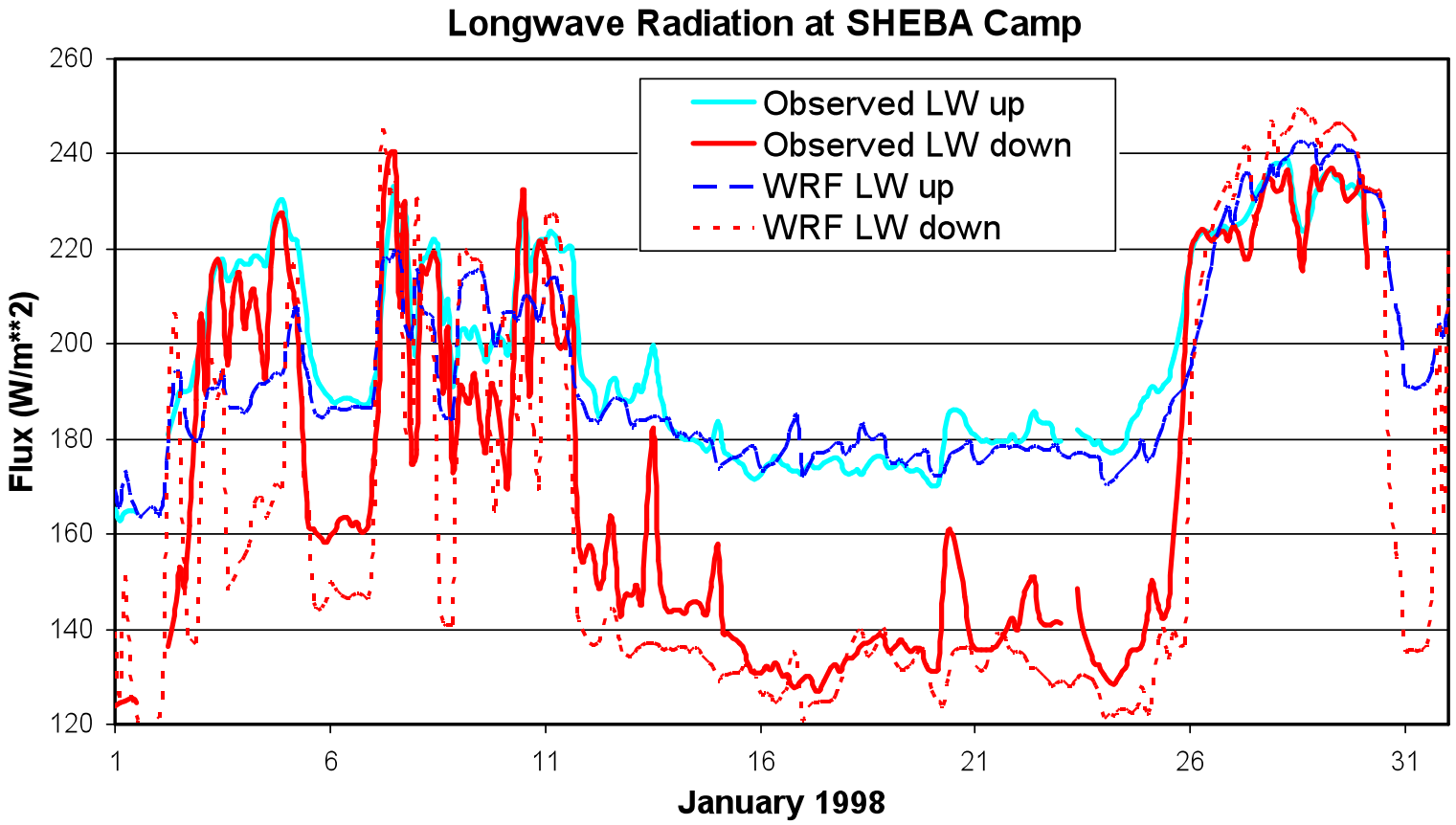
Temperature at SHEBA Camp January 1998

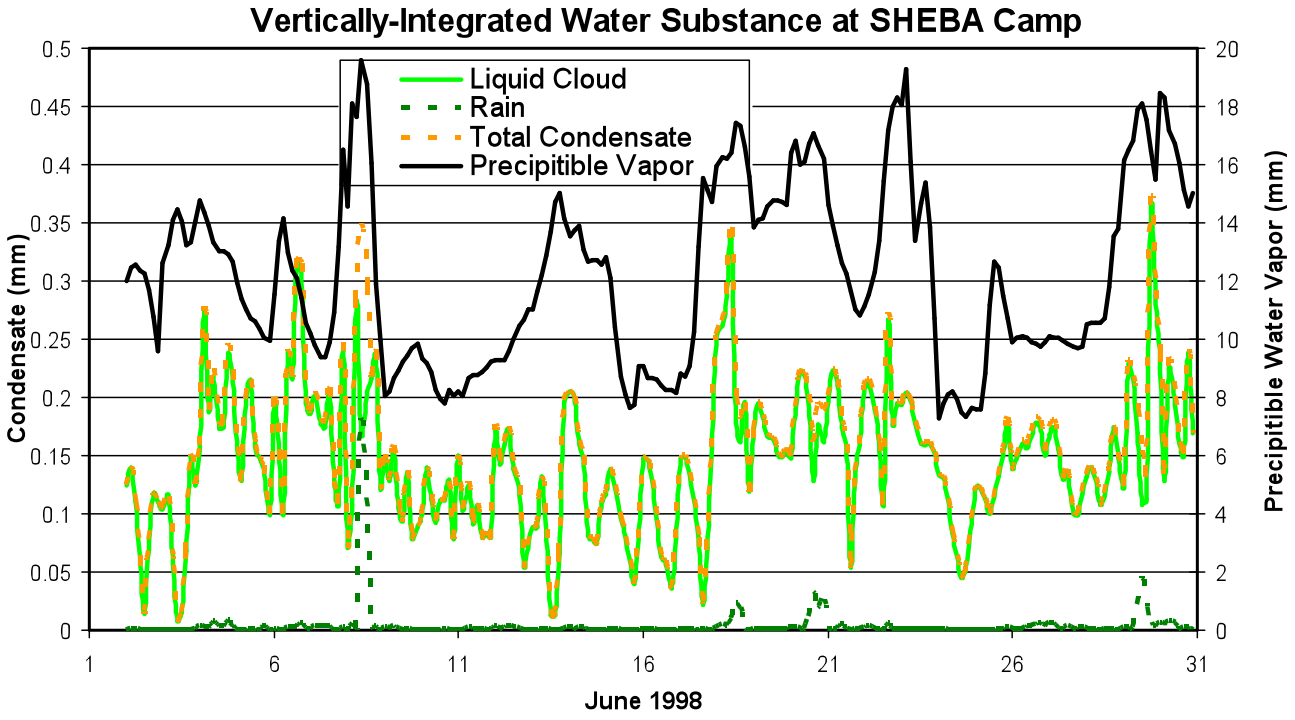


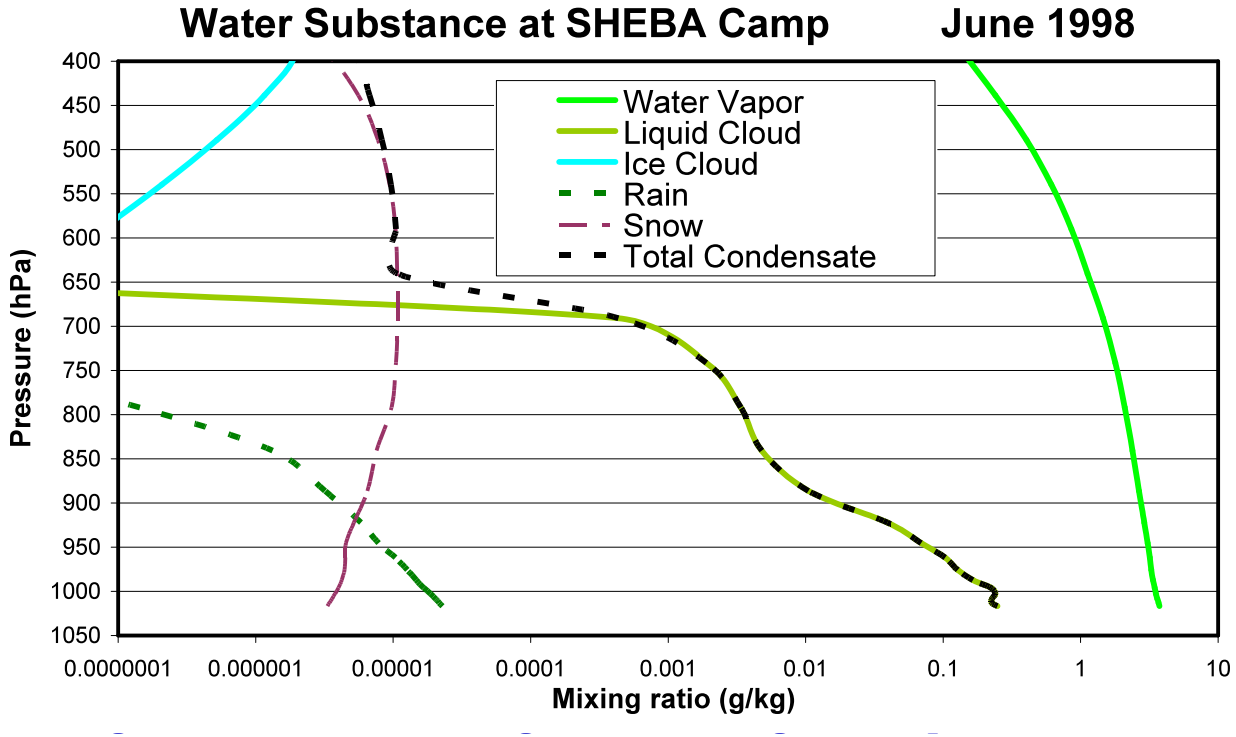
10-mWind Speed At Sheba Camp January 1998



Good Results for January 1998




Vertically-Integrated Water Substance at SHEBA Camp
Liquid Cloud
Rain
Total Condensate
Precipitible Vapor
Condensate (mm)
Precipitible Water Vapor (mm)
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
20
18
16
14
12
10
8
6
4
2
0
1
6
11
16
21
26
31
June 1998

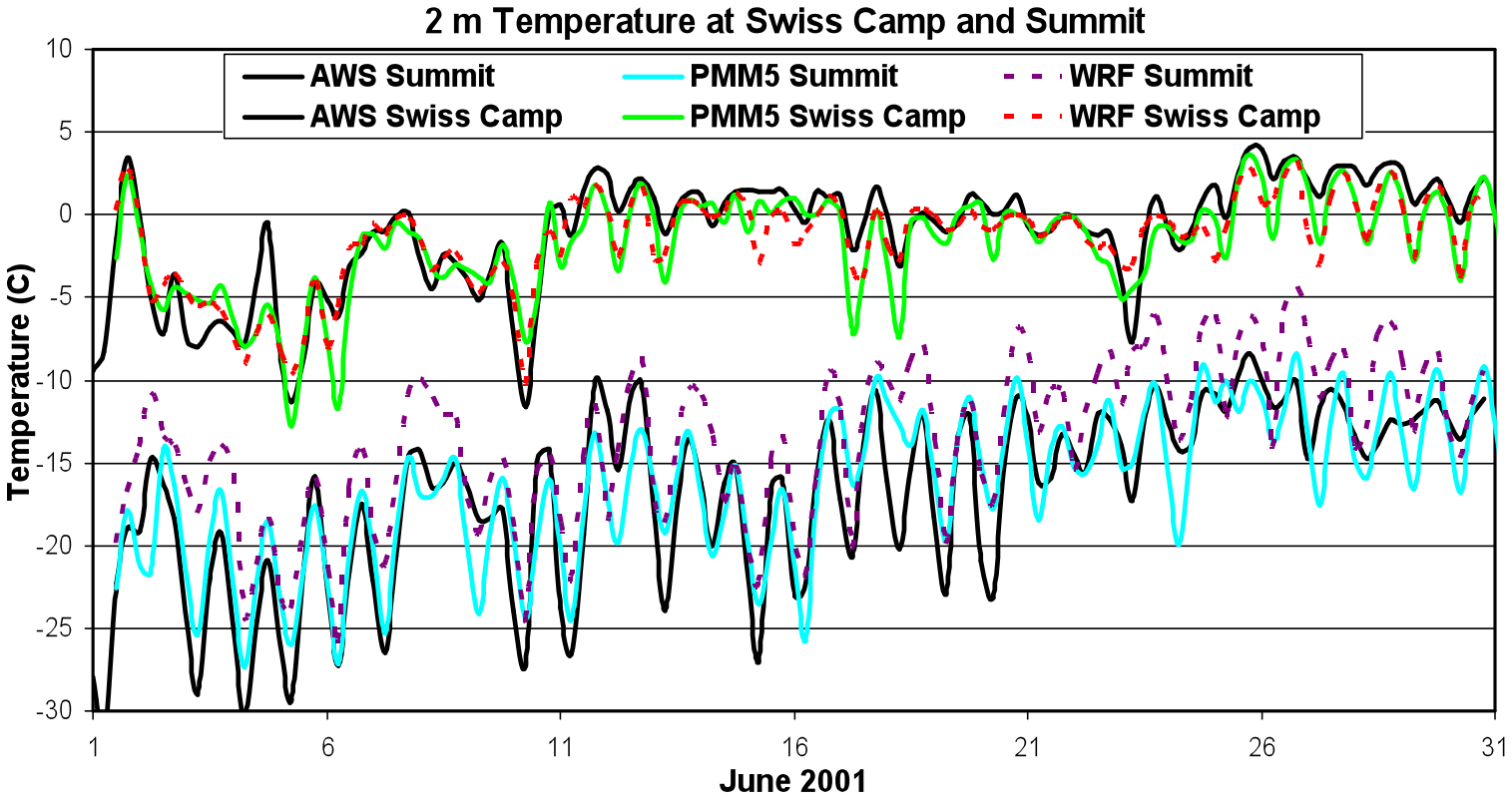

Water Substance at SHEBA Camp
June 1998
Water Vapor
Liquid Cloud
Ice Cloud
Rain
Snow
Total Condensate
Pressure (hPa)
400
450
500
550
600
650
700
750
800
850
900
950
1000
1050
0.0000001
0.000001
0.00001
0.0001
0.001
0.01
0.1
1
10
Mixing ratio (g/kg)

Needs for Polar WRF

- Test for Arctic land surfaces
- Test fractional sea ice treatment
- More tests needed for cloud microphysics
- Testing and improvements of subsurface treatment for soil and ice
- More testing with AMPS Antarctic forecasts

Summer Greenland Case: June 2001

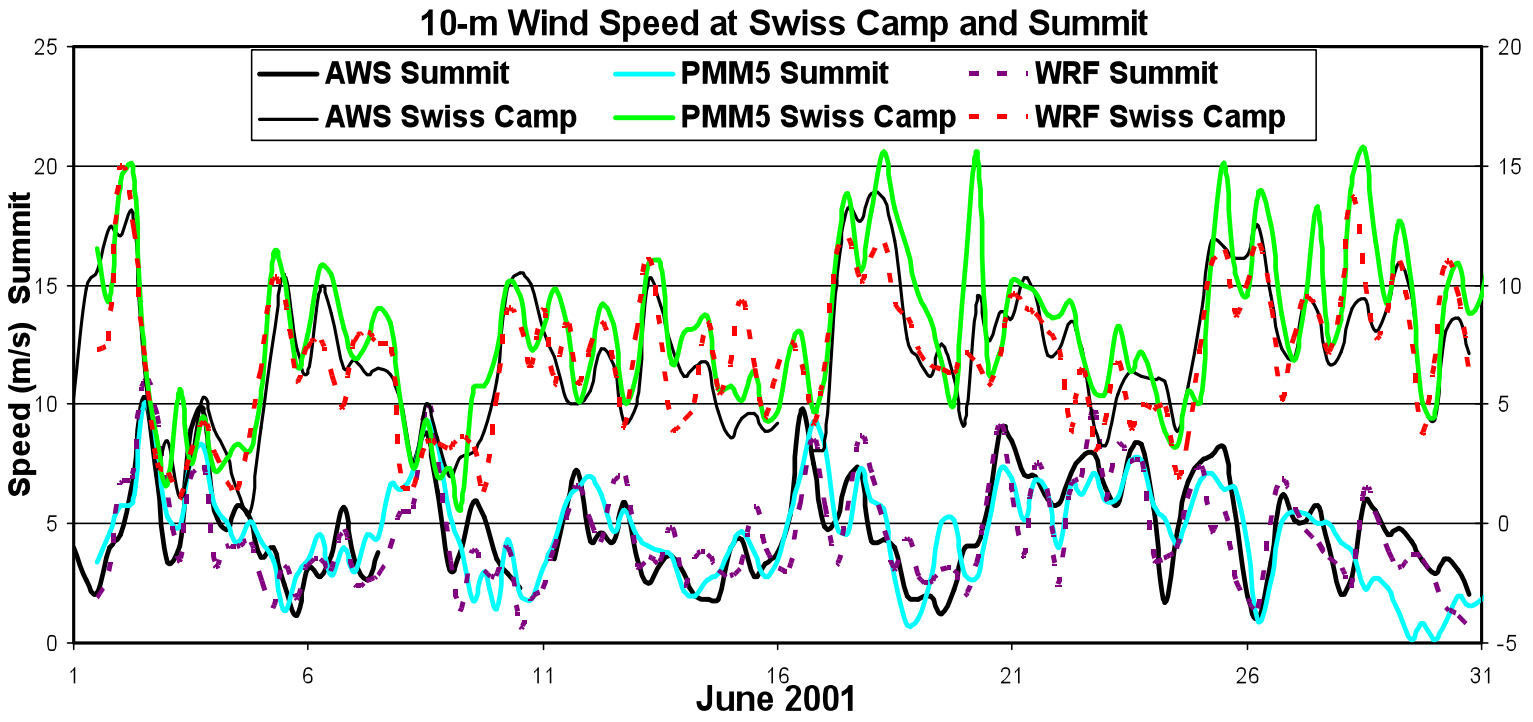
97 x 139 grid 24 km spacing



Run	Correlation	Bias	RMSE
Polar WRF - Swiss Camp	0.87	-0.6	1.8
Polar MM5 – Swiss Camp	0.86	-0.7	1.9
Polar WRF - Summit	0.76	2.6	4.8
Polar MM5 – Summit	0.79	-0.1	3.8

Summer Greenland Case: June 2001

97 x 139 grid 24 km spacing



Run	Correlation	Bias	RMSE
Polar WRF - Swiss Camp	0.77	-0.3	2.0
Polar MM5 – Swiss Camp	0.83	1.0	2.1
Polar WRF - Summit	0.75	-0.3	1.5
Polar MM5 – Summit	0.72	-0.1	1.6