AMSR-E Validation and Comparison Studies at UW-Madison

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Outline

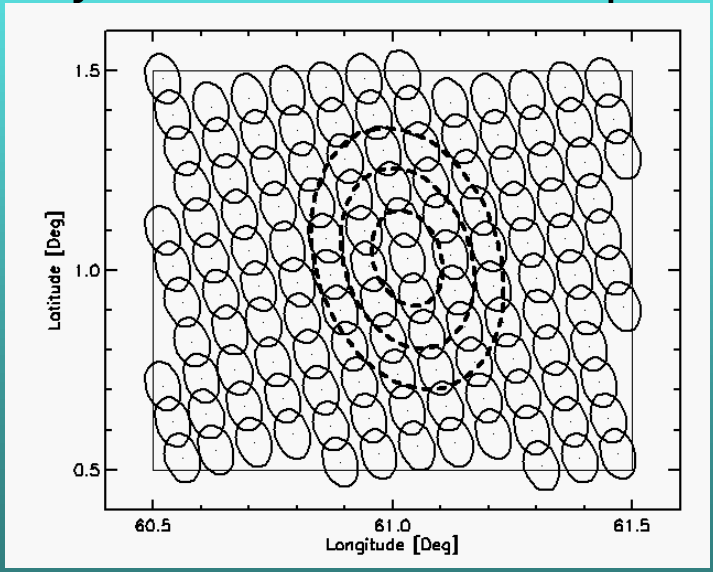
- Global-Scale comparisons with GFS:
  - Discovered low-level problems with surface emissivity model.
  - Discuss global clear and cloudy TB biases.
  - Look at biases in retrieved quantities.
  - Assess some regional biases.
- Regional Comparison of wintertime light snow cases with ground radar in BALTEX region.
- Grant Petty update.
- Side studies: Amazon River Basin Flooding and Baltic Sea Ice.

Methodology of GFS/AMSR Comparison

- GFS: 12 hr forecast files. FASTEM-2 surface emissivity model. Simple no-scattering radiative transfer model to produce TOA TBs. No pixels allowed beyond 55° (to further exclude sea-ice).

- AMSR : +/- 90 min within forecast. No rain, sea ice, or land allowed (from L3 ocean product).

- Select one “cloudy” and one “clear” sample for each GFS 1° x 1° pixel:



- Performed comparisons monthly or over 5 months: Dec 2003 to April 2004. Gives ability to test AMSR-E data and all models used.

Surface Emissivity Model: FASTEM-2

Bug found that affects most frequencies (should be corrected in RTTOV-8*)

Error involves absence of electrical conductivity term in computation of permittivity of seawater.

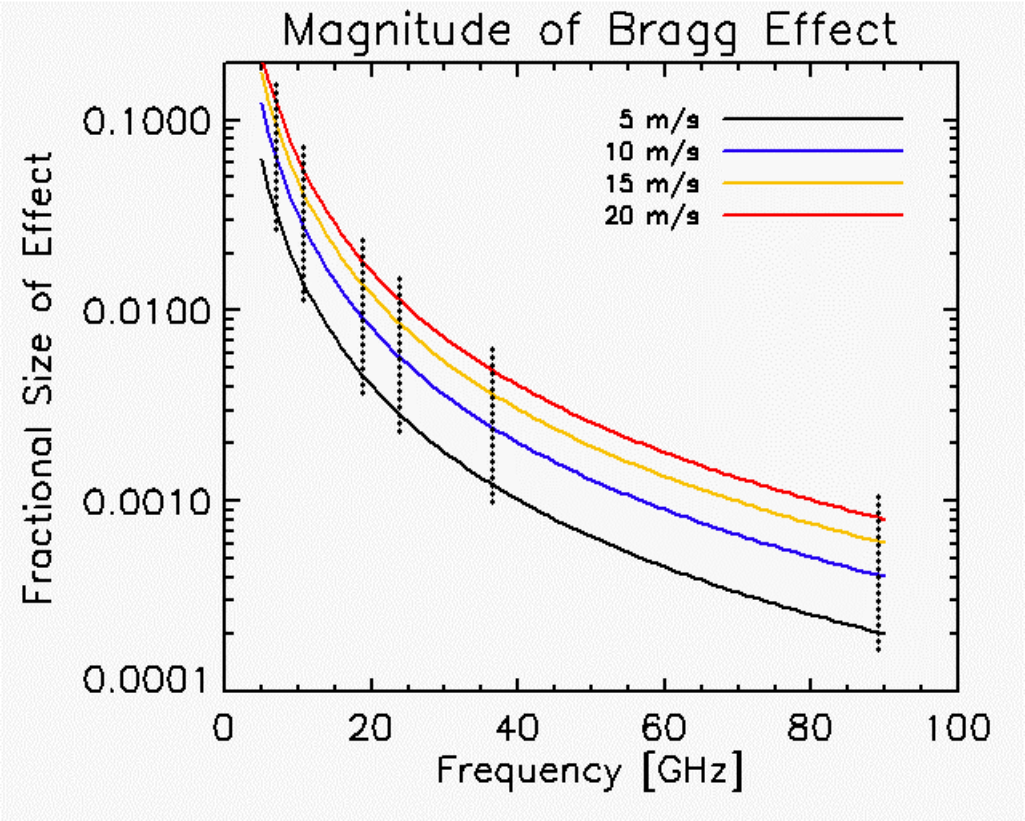
Channel	ΔTB_V	ΔTB_H
6.9	5.6 K	3.2 K
10.7	5.0 K	2.8 K
18.7	4.0 K	2.4 K
23.8	2.8 K	1.7 K
36.5	3.3 K	2.2 K
89.0	1.5 K	1.3 K

* Steve English, personal communication

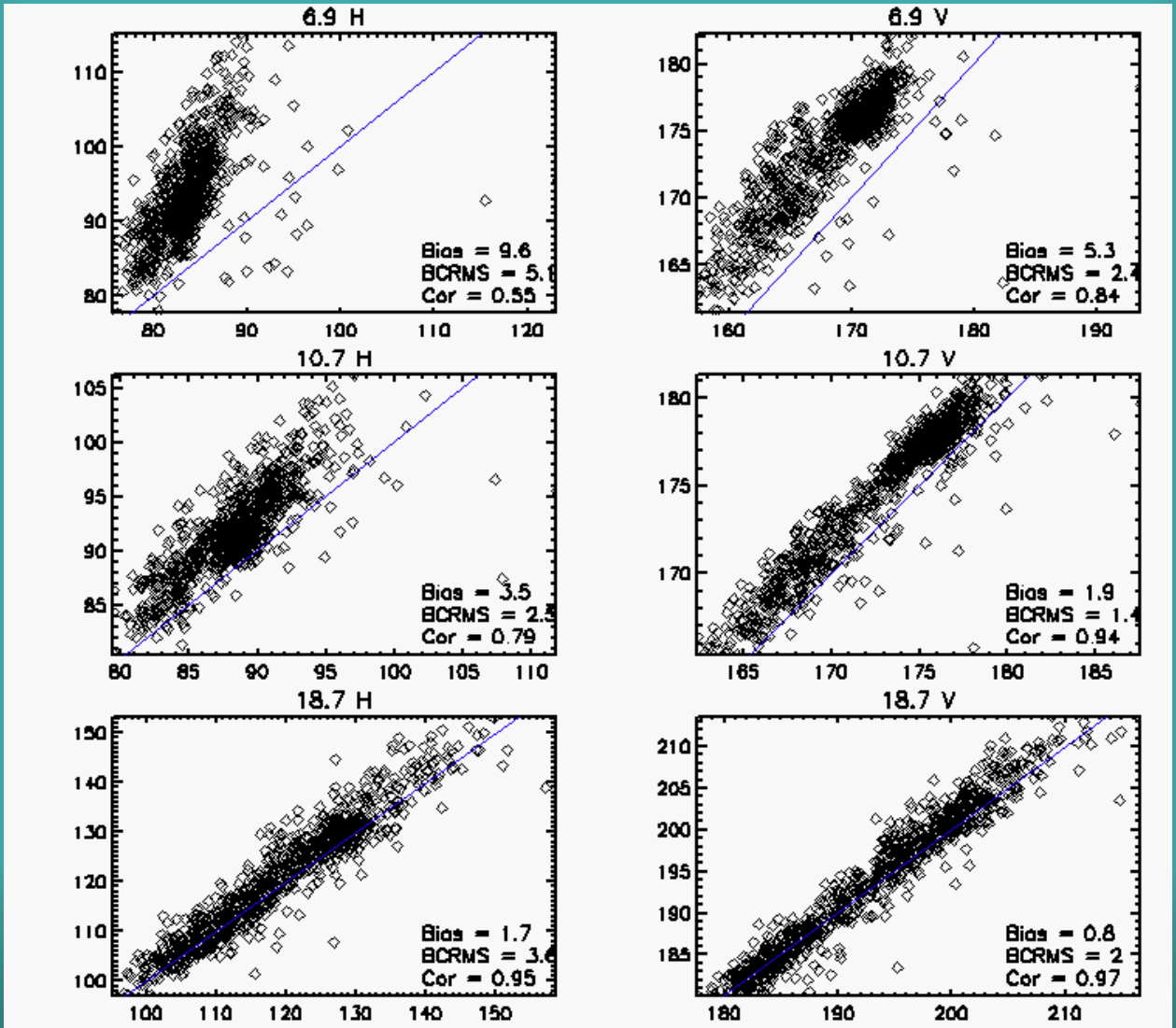
FASTEM-2 Issues Continued:

Problem with parametrization of small-scale capillary waves on ocean surface: “Bragg Scattering” (English and Hewison, 1998)

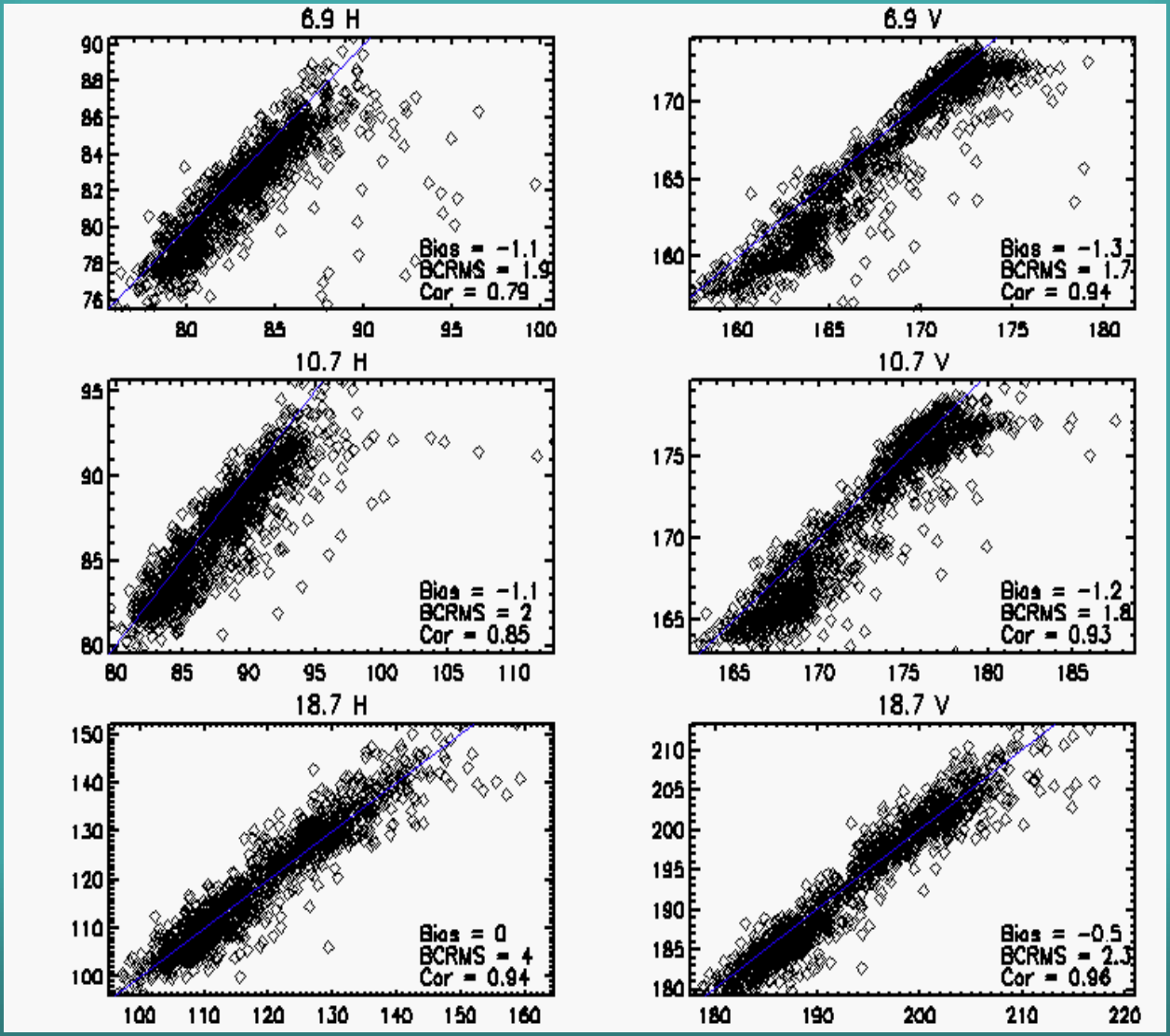
$$B = e^{-\frac{WS \cos^2 \theta}{\nu^2}}$$



MODEL vs. AMSR-E low frequency Scatter Plots, with the Bragg Term:

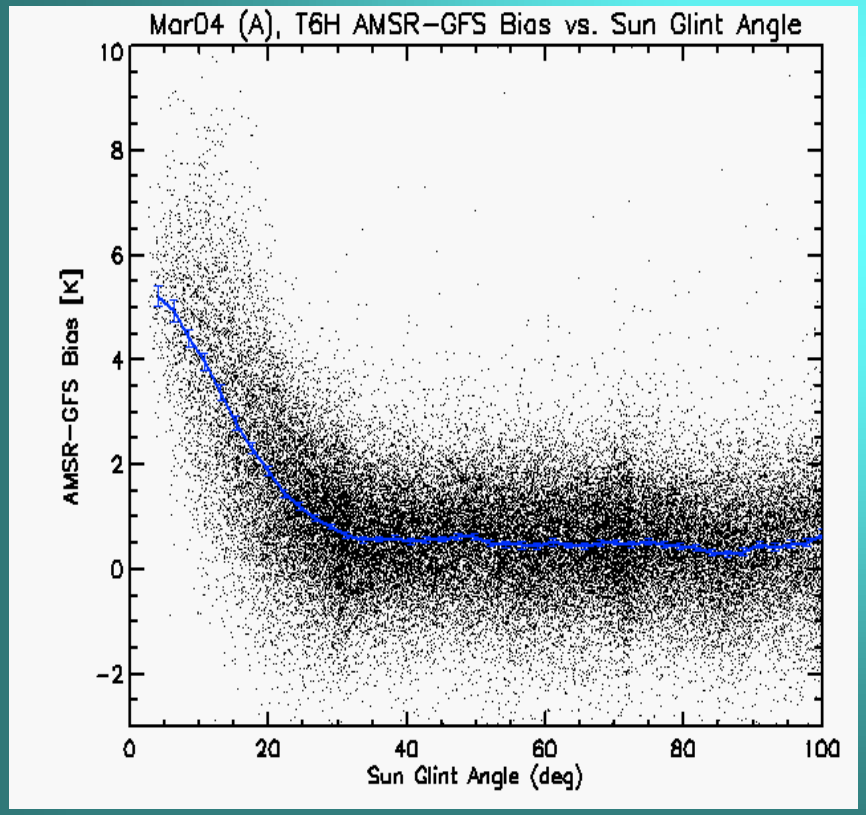


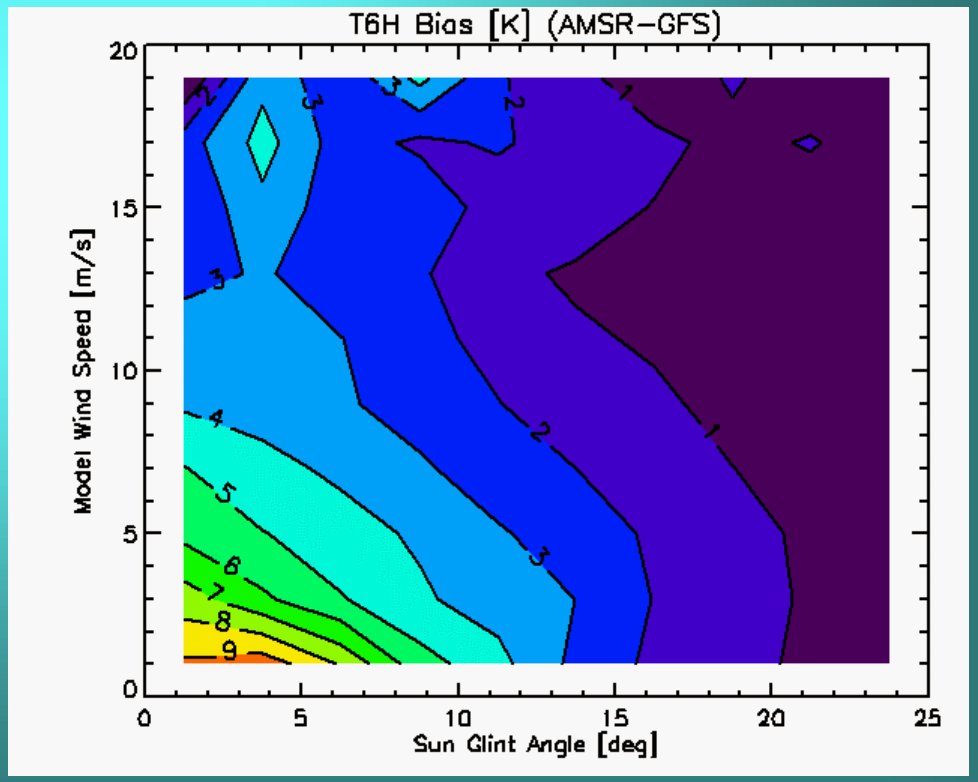
MODEL vs. AMSR-E low frequency Scatter Plots, without the Bragg Term:



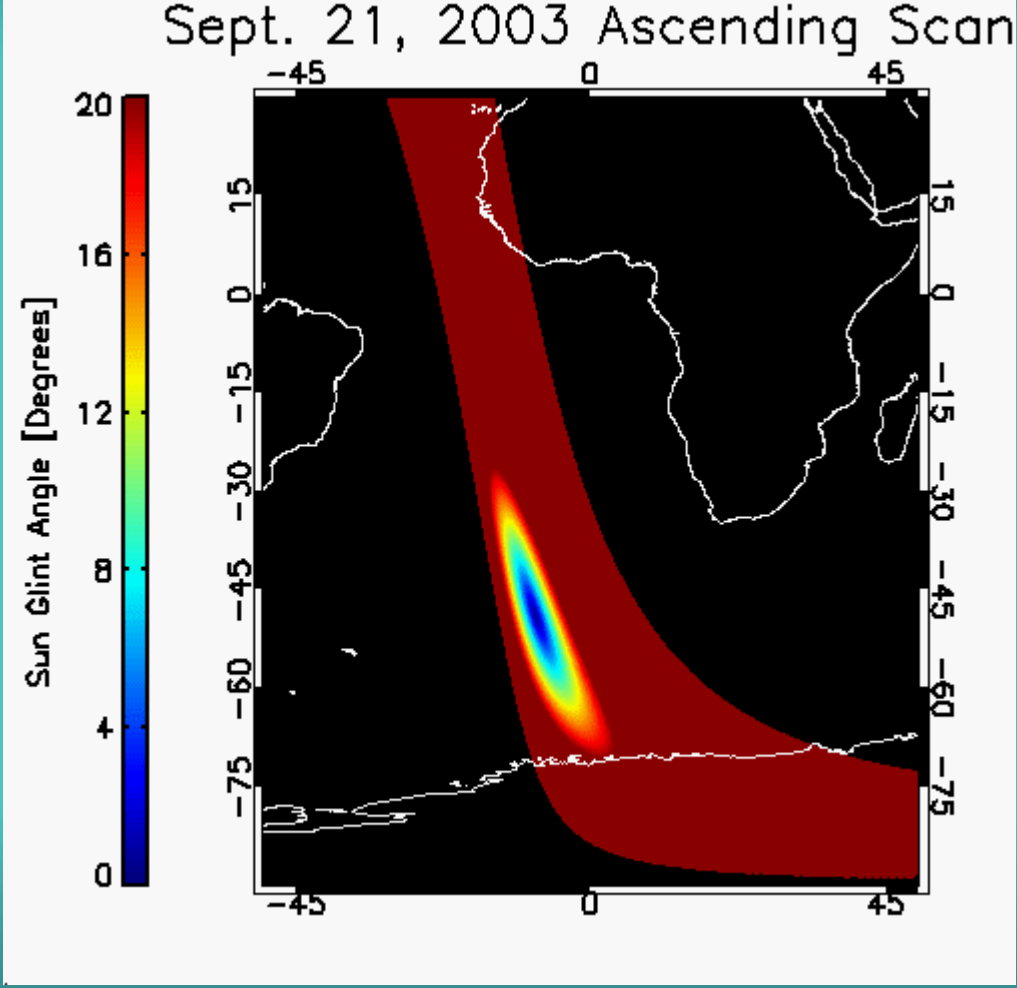
Sun Glint Clearly Observed!

- Most pronounced at low frequencies due both to higher reflectivity and wider sensor beam width.
- Only affects southern hemisphere (ocean). Affects 7-8% of any ascending overpass (< 20° sunglint angle).
- Can be greater than 10 K effect. Effect mitigated with higher wind speeds.

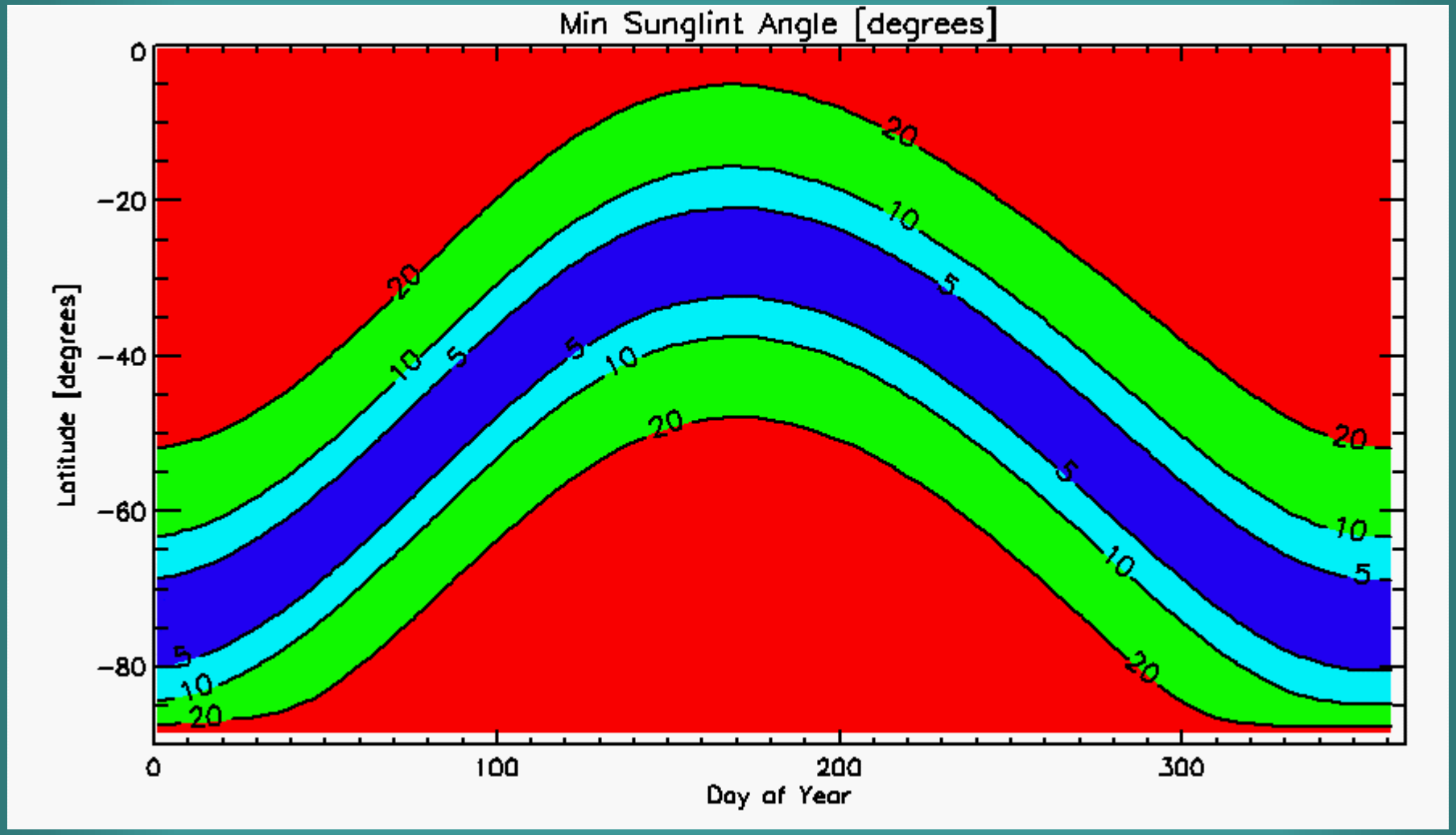




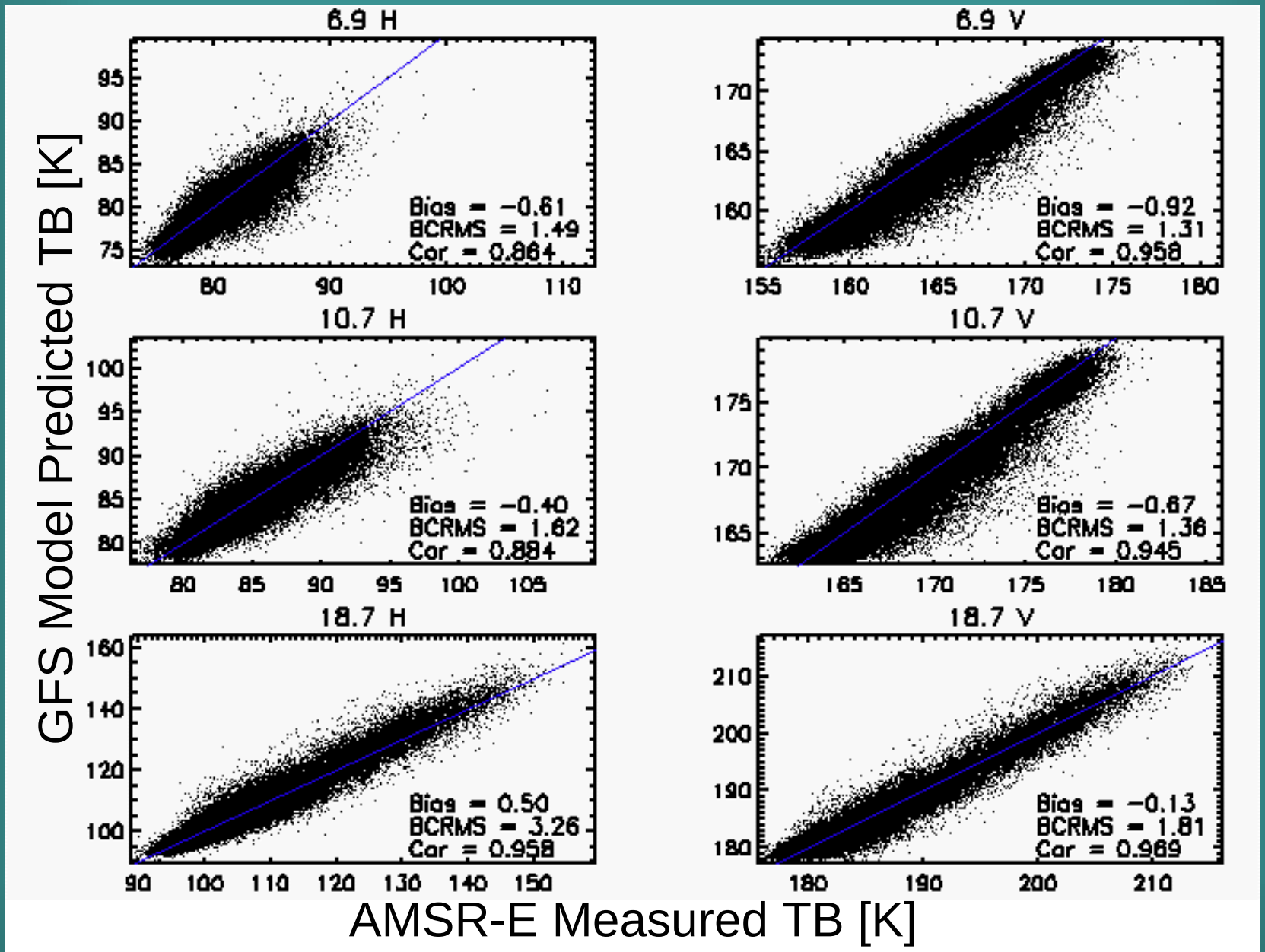
Sun Glint Problem Exists Entirely in Southern Hemisphere:



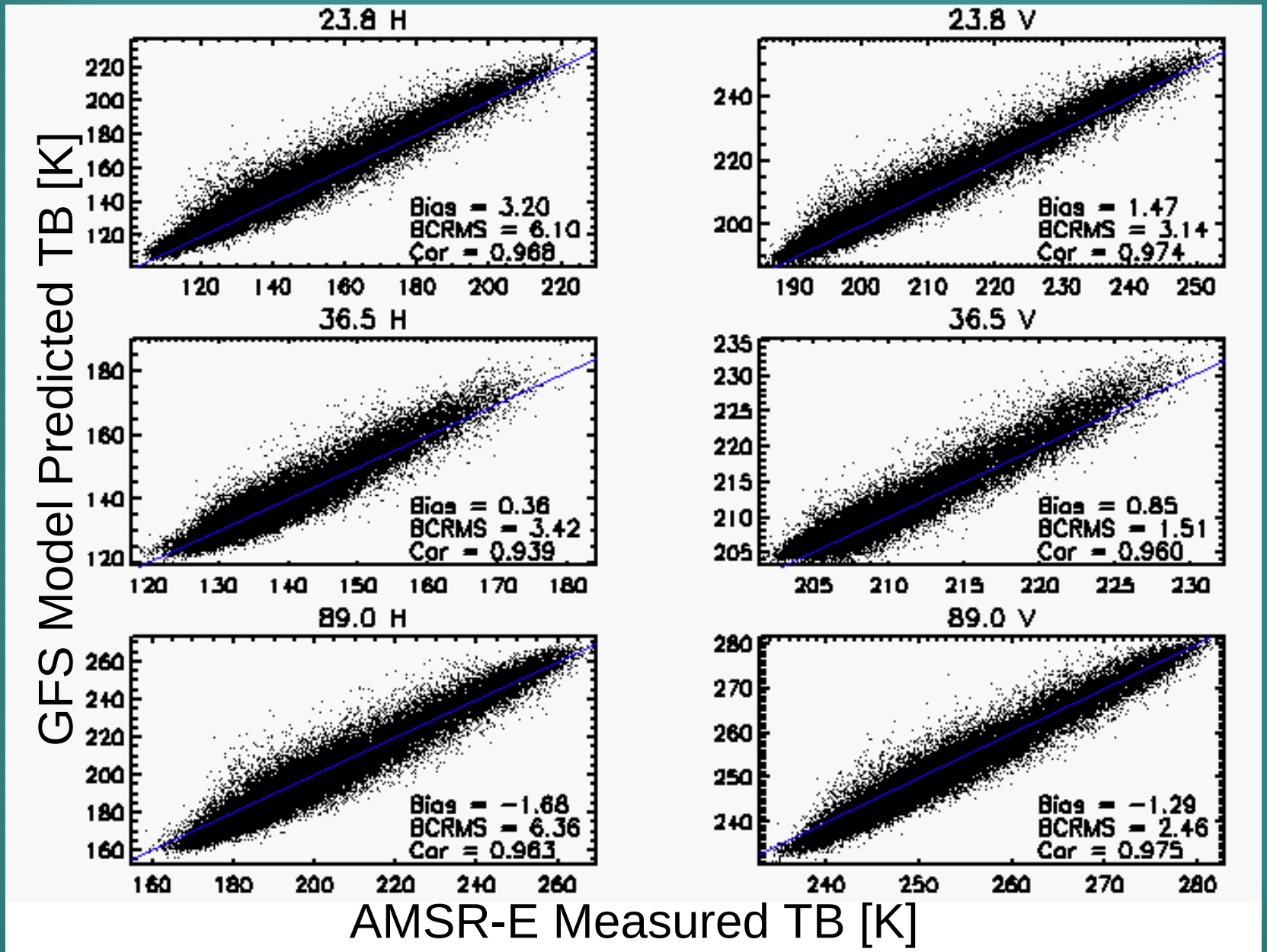
Sun Glint Problem Areas in S.H. vary throughout the year



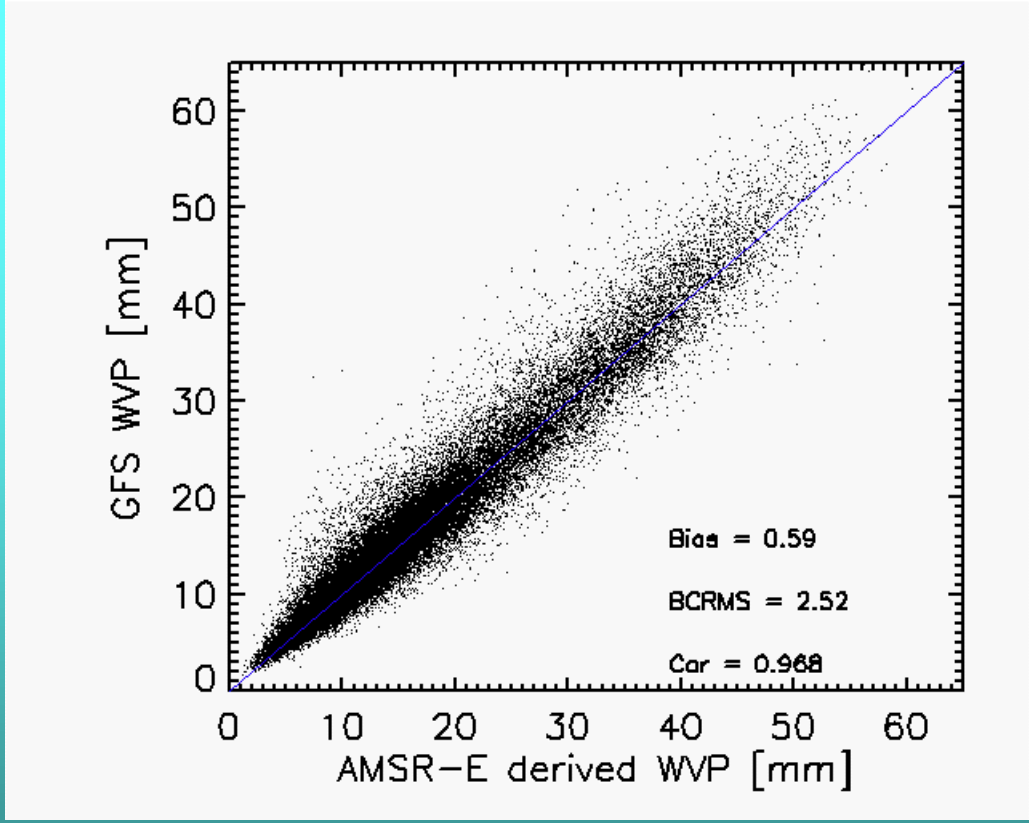
Clear-sky Biases (low frequencies)



Clear-sky Biases (high frequencies)

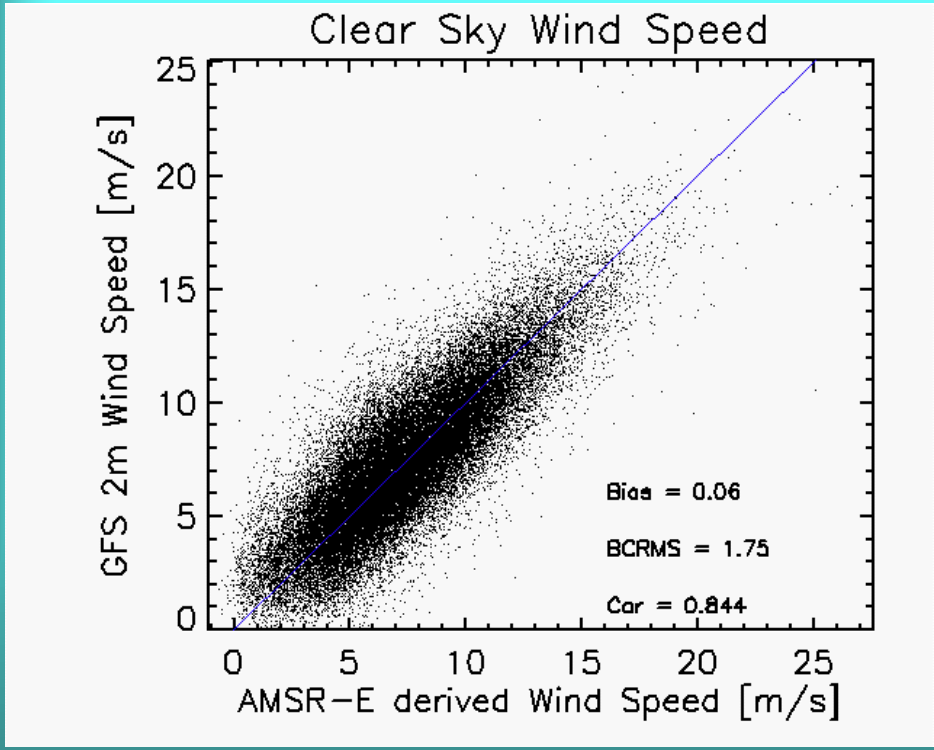


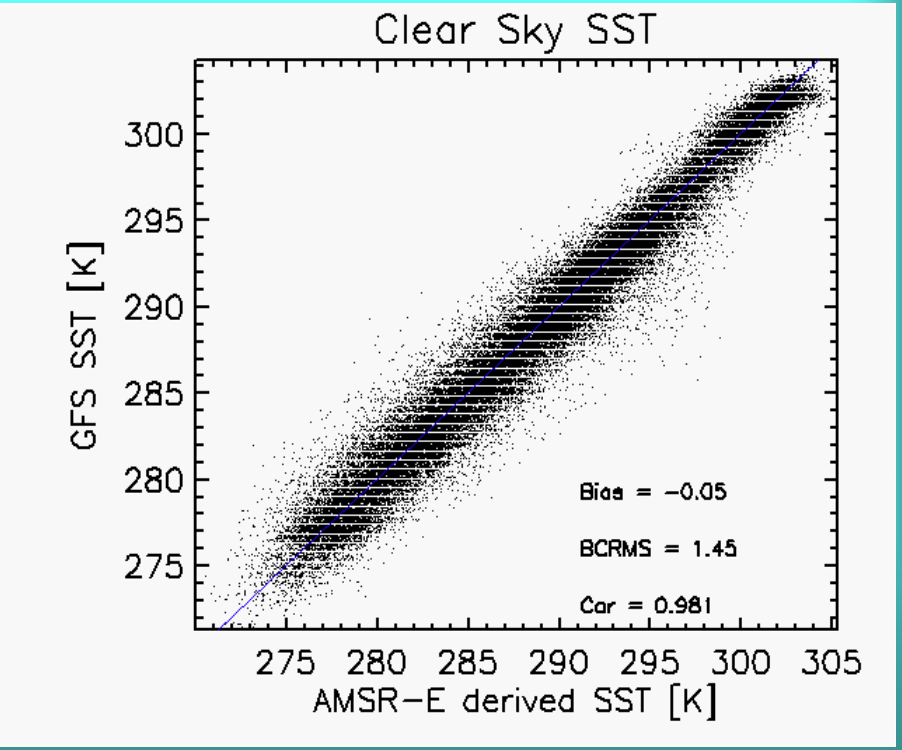
Slight PWV bias in GFS model?



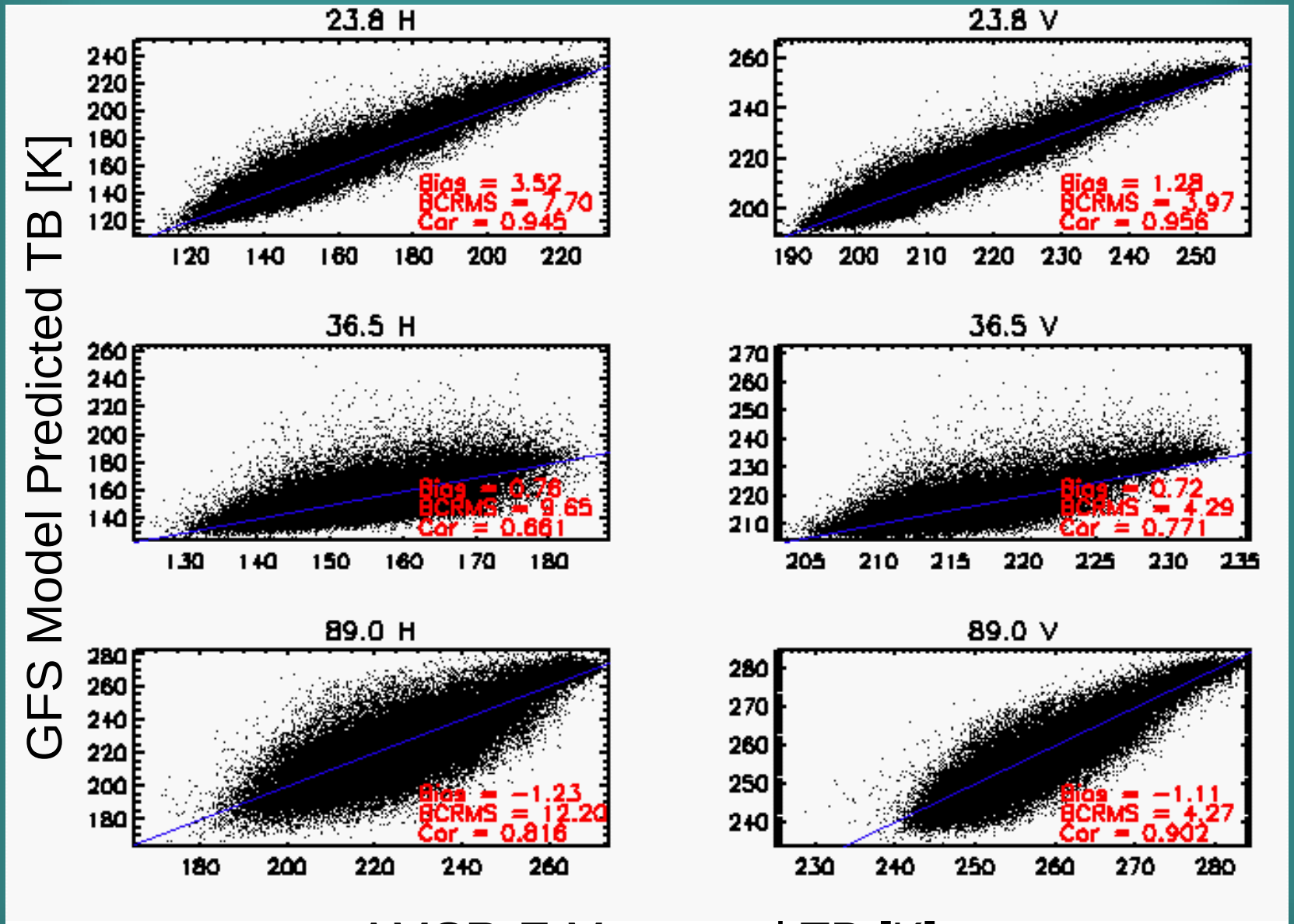
→ A ~1 mm GFS water vapor bias vs. AMSR-E is consistent with 23.8 GHz biases.

Excellent Clear-Sky Wind Speed and SST Comparisons:

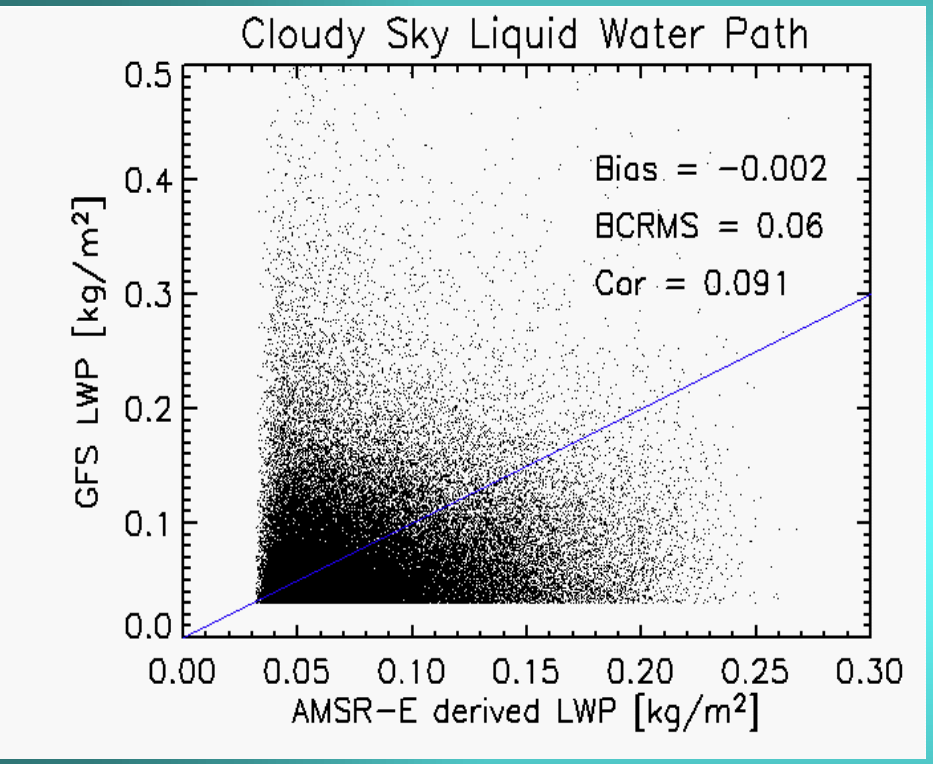




Cloudy-sky Biases (high frequencies)



Cloudy Comparisons



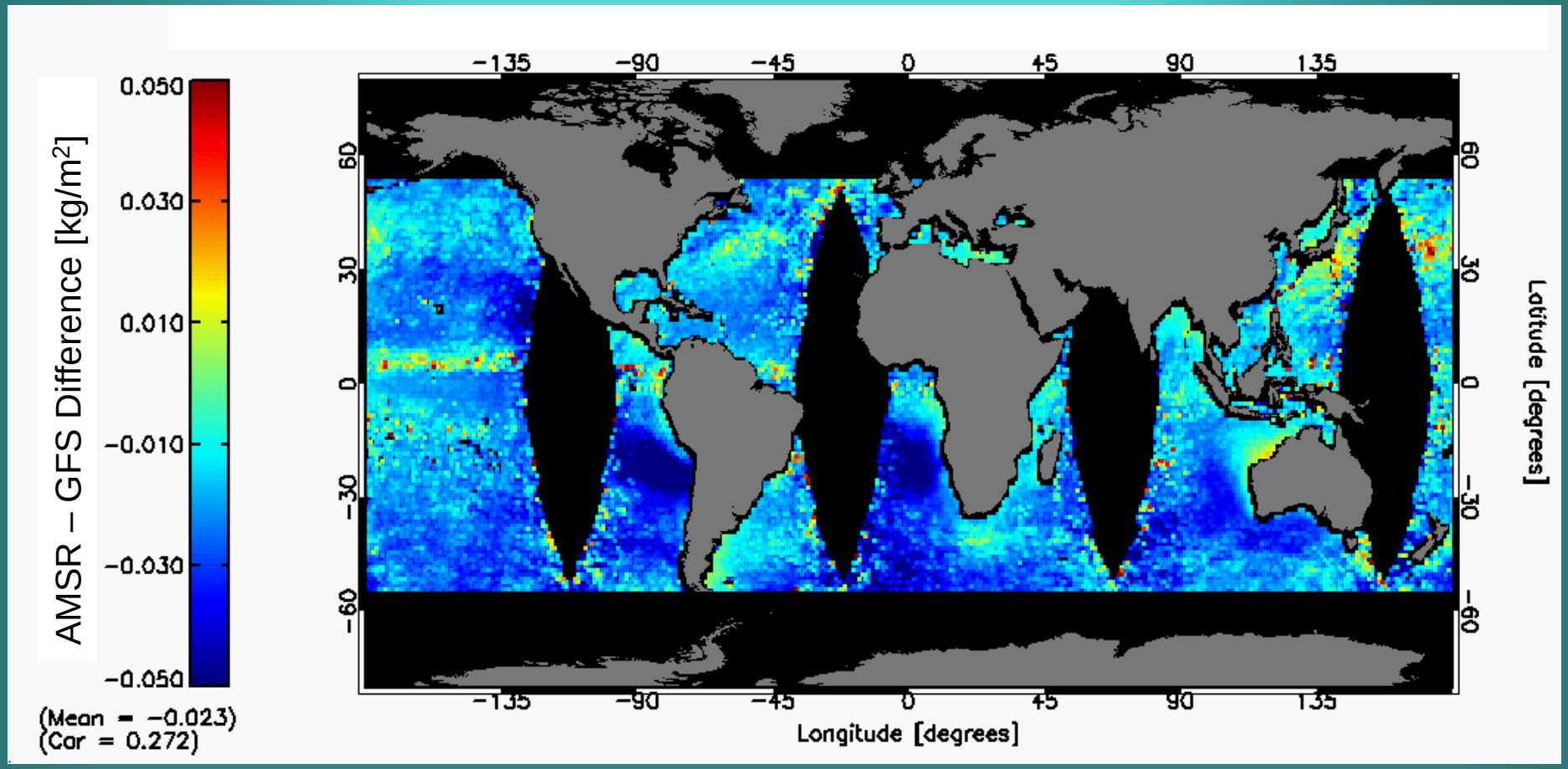
Channel	Bias		Correlation	
	Clear	Cloudy	Clear	Cloudy
23.8 V	1.5	1.3	0.97	0.96
23.8 H	3.2	3.5	0.97	0.95
36.5 V	0.9	0.7	0.96	0.77
36.5 H	0.4	0.8	0.94	0.66
89 V	-1.3	-1.1	0.97	0.90
89 H	-1.7	-1.2	0.96	0.82

The GFS model might benefit from LWP or cloudy radiance assimilation.

** Cloudy = Cloudy Data only, in model and observations*

Regional Biases Studies :

Example: Liquid Water Path



Summary of project objectives for Grant Petty (new PI)

1. Support ongoing GPROF development/refinement, in cooperation with C. Kummerow et al.

2. Liaison with Japanese AMSR precipitation algorithm development and validation teams.

3. Continued development of AMSR simulation testbed and community modeling tools (http://rain.aos.wisc.edu/MW)
   - Fully polarized backward Monte Carlo model
   - Improved microwave models of frozen and melting hydrometeors
   - Improved surface models
   - Realistic spatial averaging and sampling

4. Improved theoretical and empirical foundations for retrieval of high-latitude/cold-season precipitation (in cooperation with R. Bennartz, C. O'Dell et al.).
   - Analysis of Wakasa Bay EDOP and PMW data
   - In situ measurements of microwave attenuation in melting zone

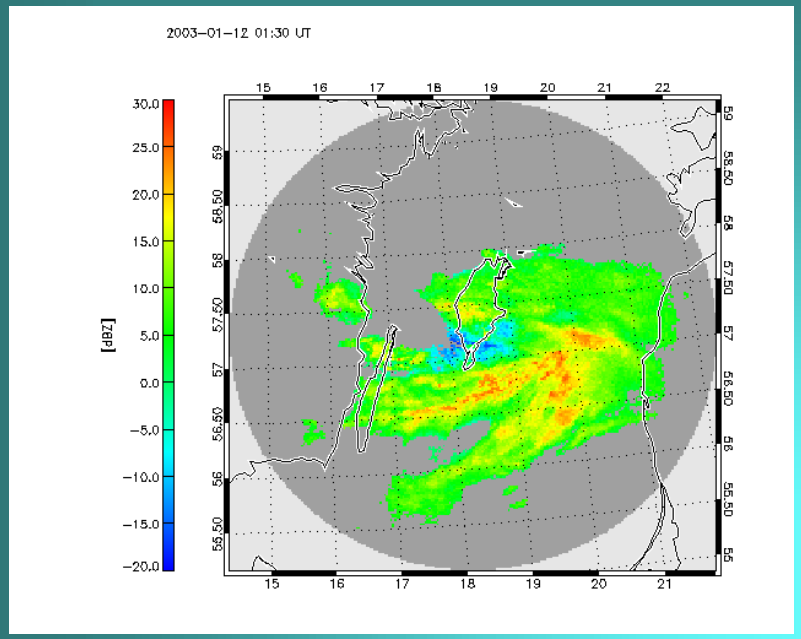
BALTEX region RADAR/AMSR-E Comparison at 89 GHz

Light Snow Case, 2003-01-12

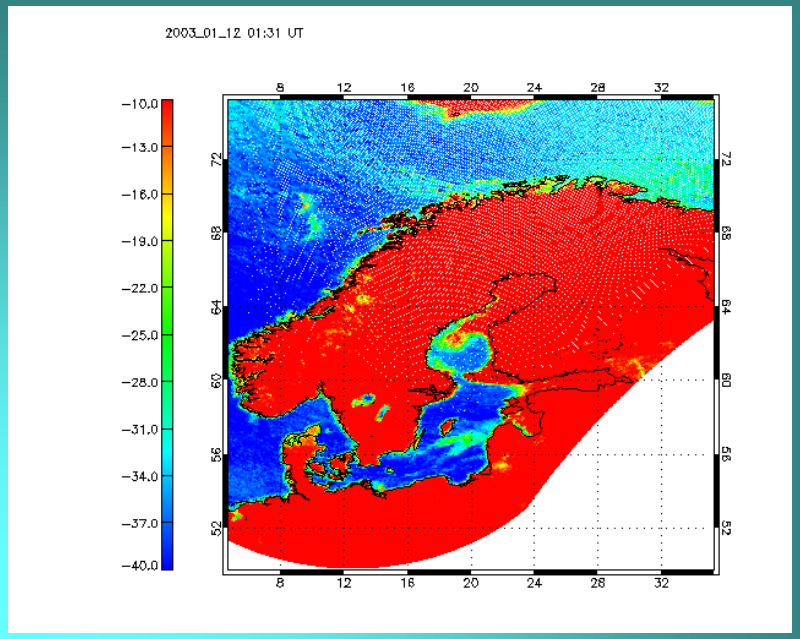
- Winter frontal event with light precipitation
- Radar time: 0130 UT
- AMSR overpass time: 0131 UT
- AMSU overpass time: 0107 UT
- Freezing level[1]: ~400 m
- Radar echo top: ~ 4 km

[1] Derived from AMSR data near Gotland Island

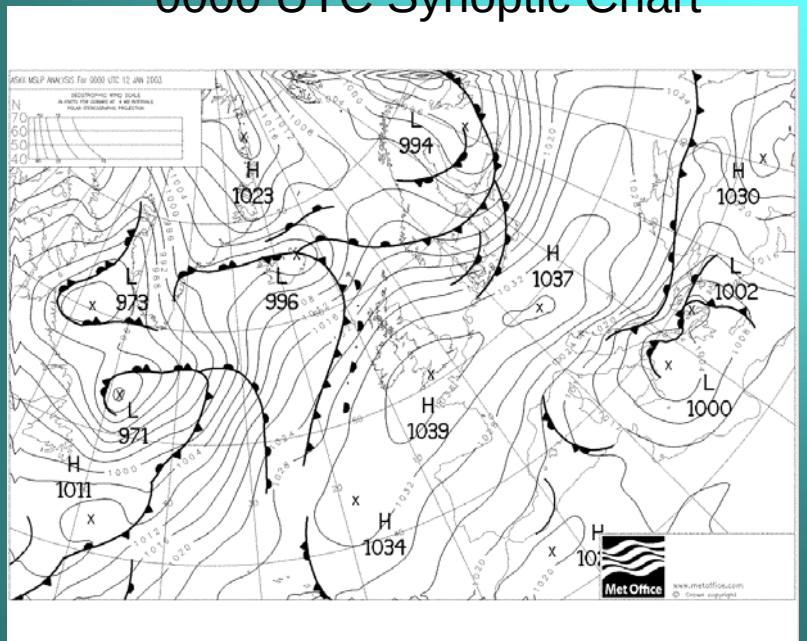
Gotland Radar



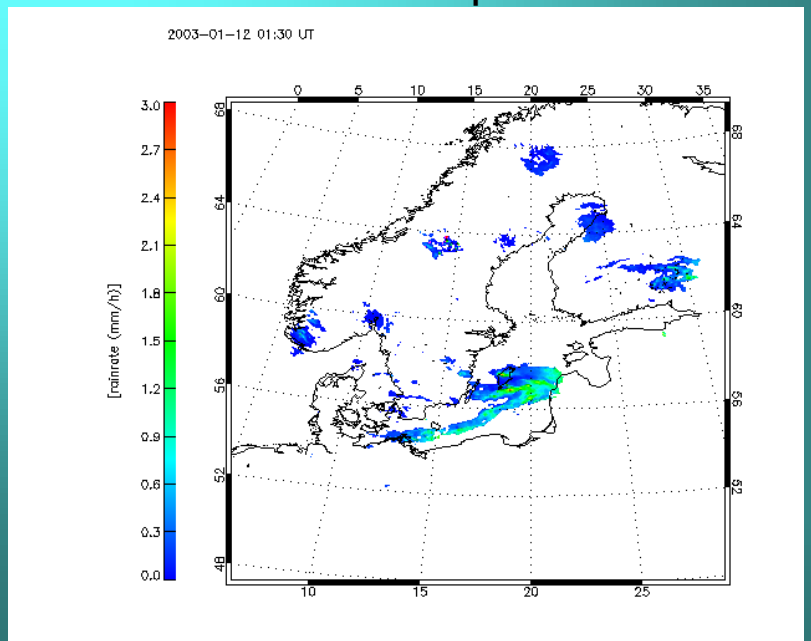
AMSR-E T_B(36V-89V)



0000 UTC Synoptic Chart



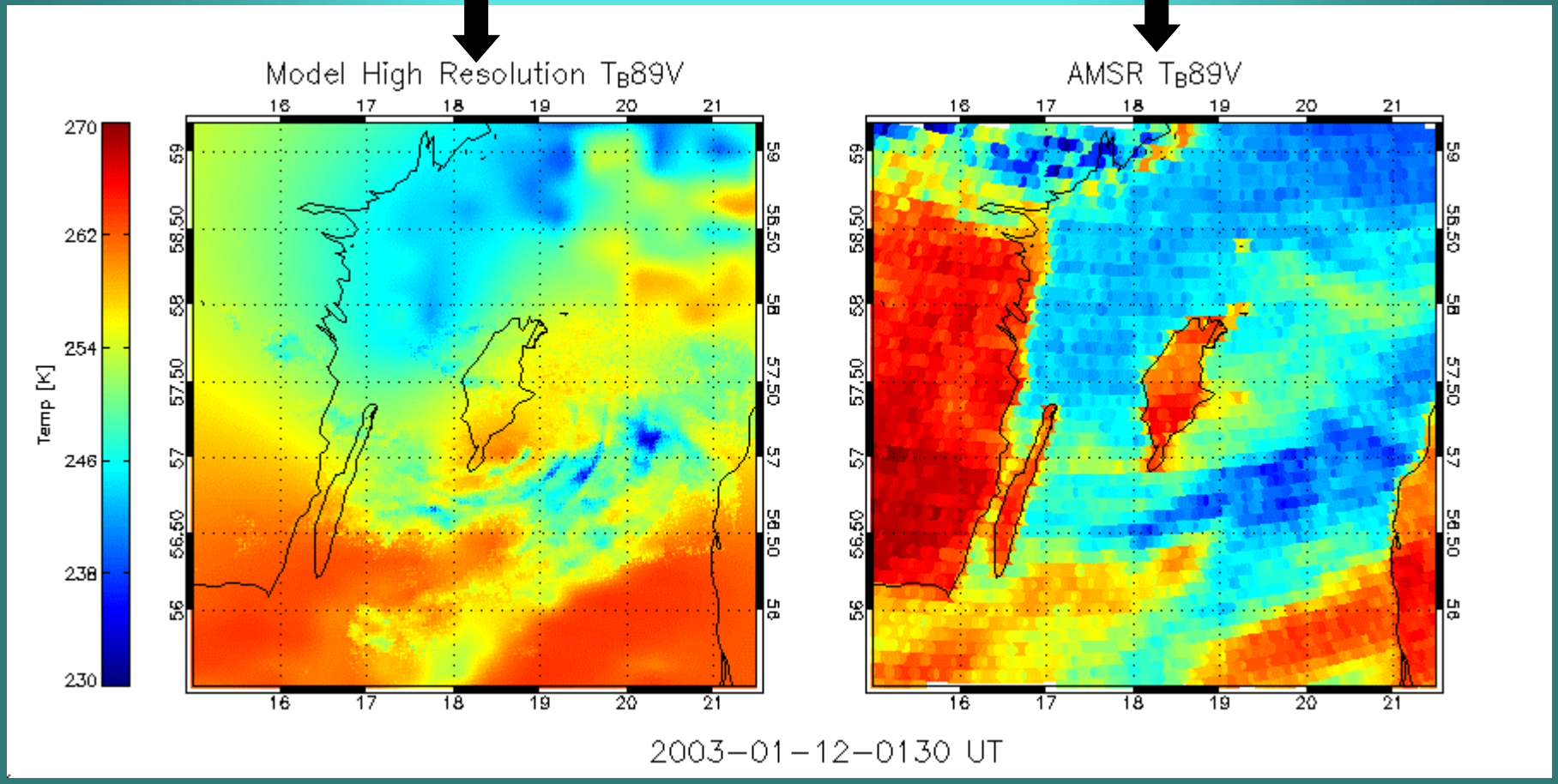
Baltrad Composite Rainrate



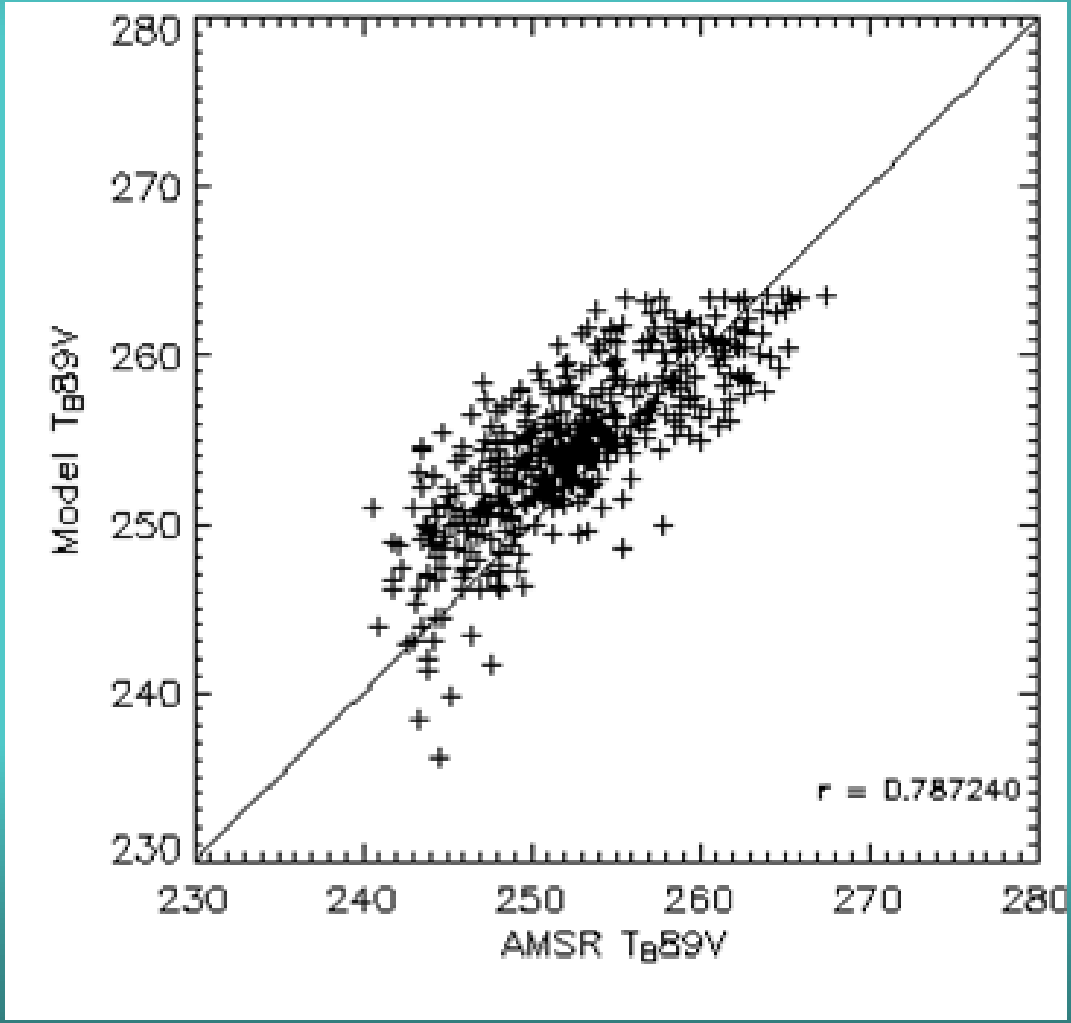
Optical Properties: Bennartz and Petty (2001)
Marshall-Palmer DSD, match reflectivities.

RT : Reverse 3D Monte-Carlo with Henyey-Greenstein Phase Function, on a 2 km x 2 km x 1 km grid with 10 vertical levels. FASTEM-2 Ocean emissivity model, everywhere.

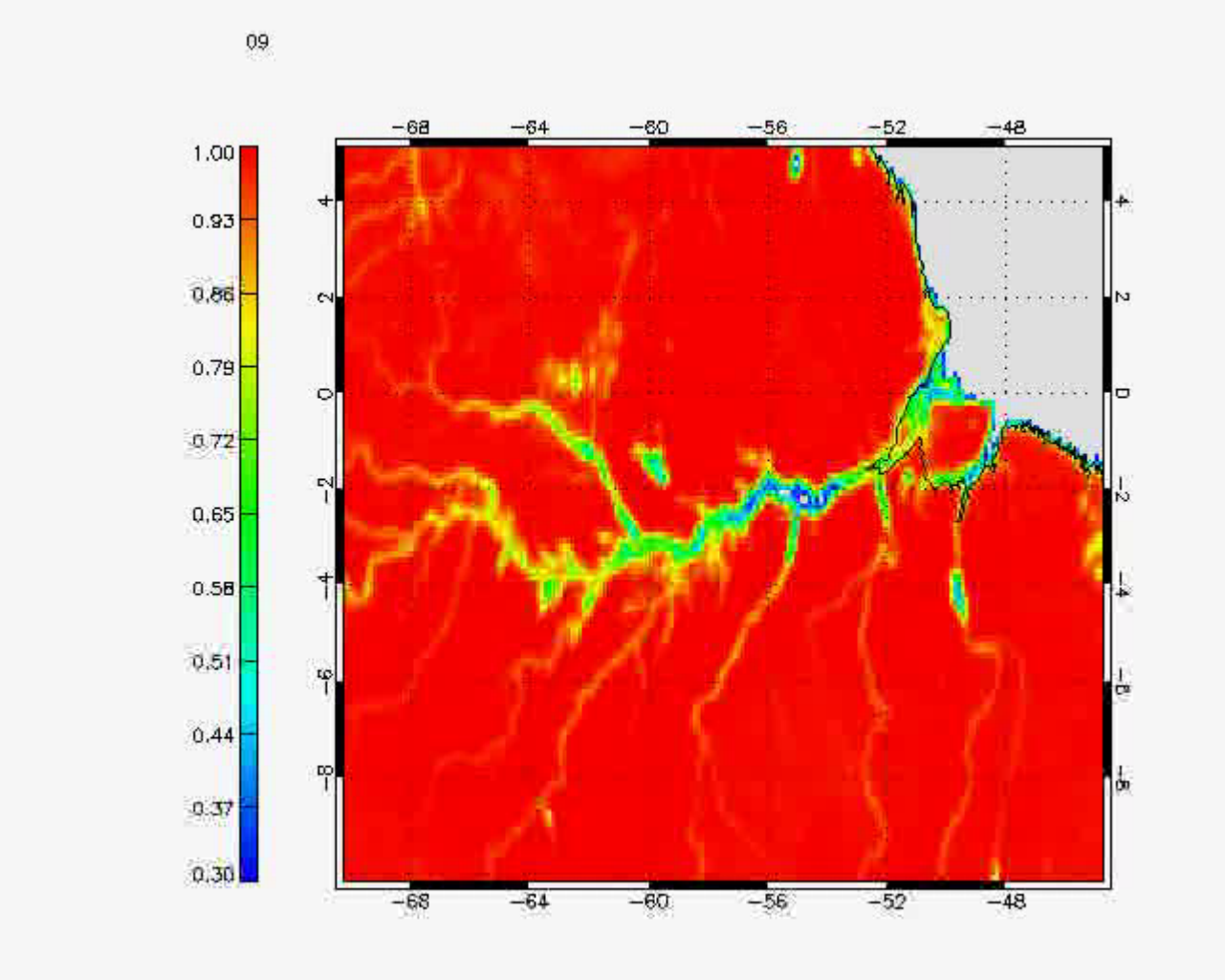
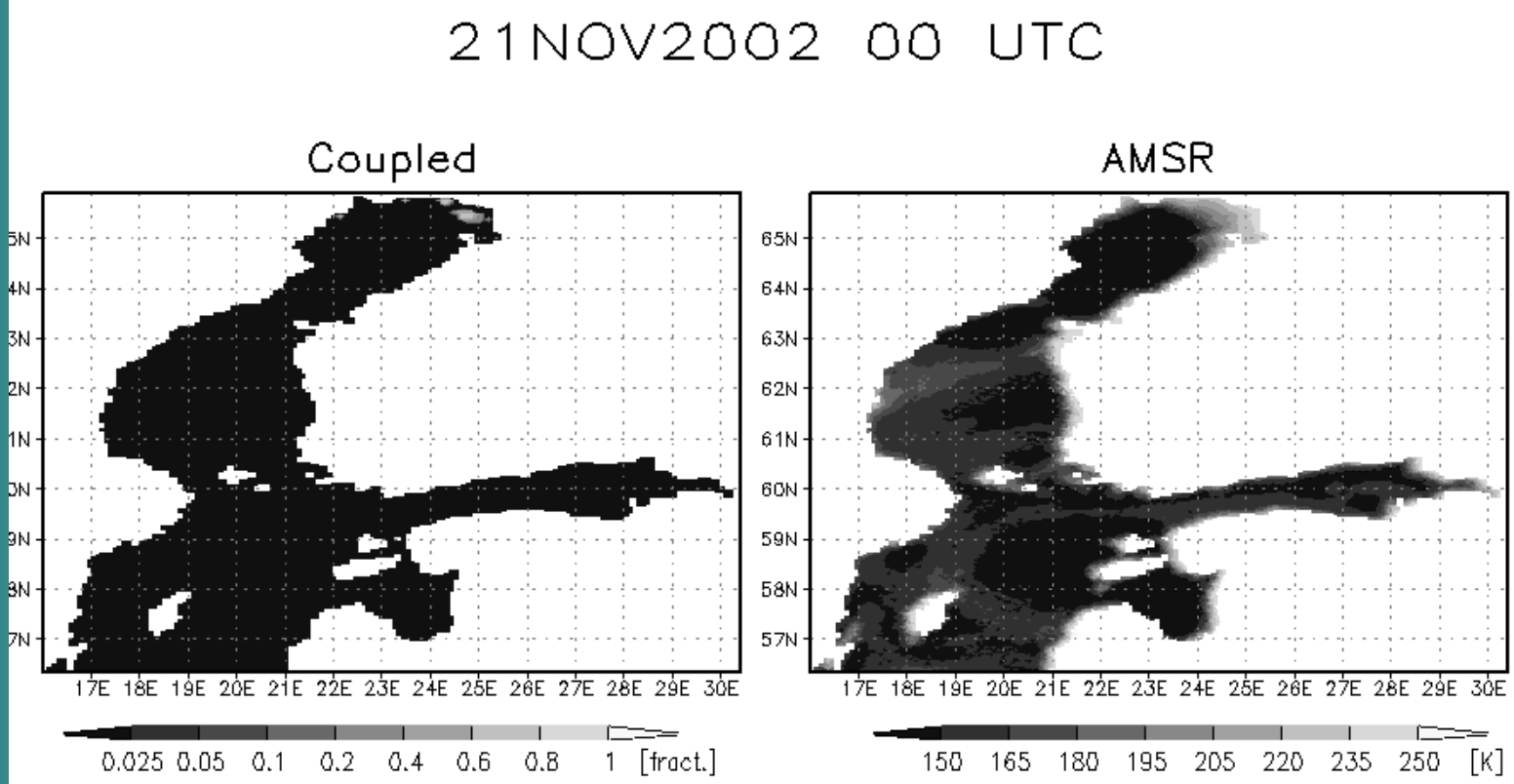
89 GHz (a) channel, at 36 GHz resolution



Model vs. Observation Comparison: Little bias, reasonably good correlation.



Brazil at 18 GHz -- Flooding of the Amazon River Basin



Sea Ice in the Baltic Region