Preprocessing and Assimilation of Imaging Channels from SSMI/S and AMSR2

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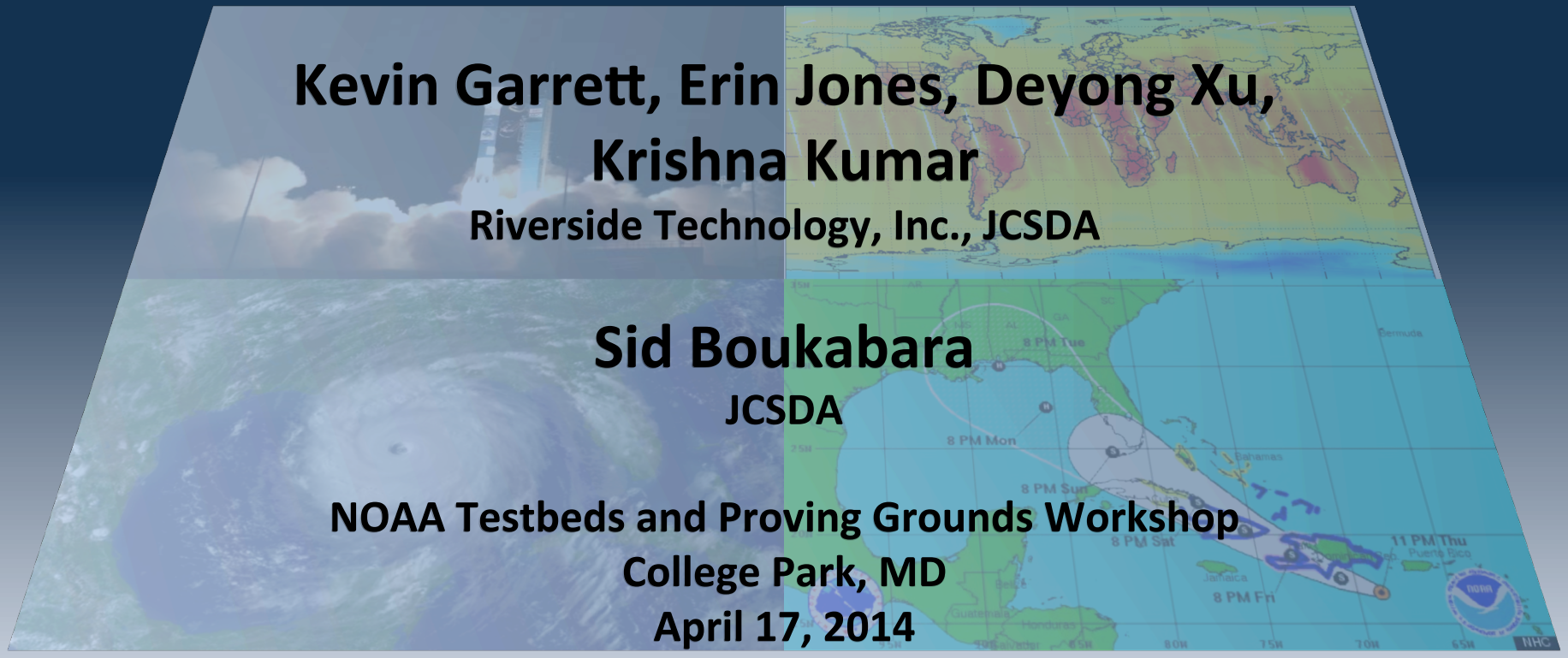

NOAA Testbeds and Proving Grounds Workshop

College Park, MD

April 17, 2014

Motivation

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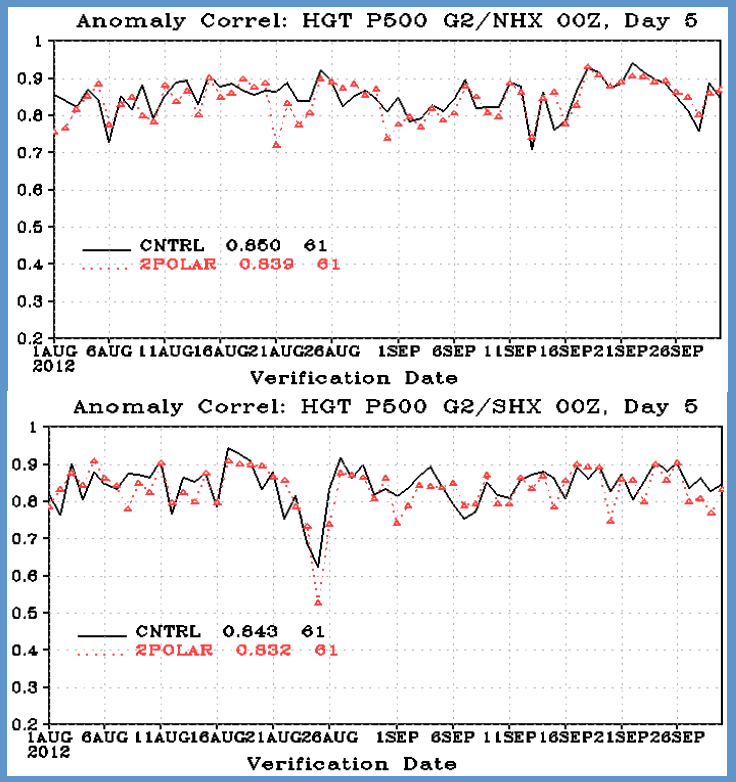
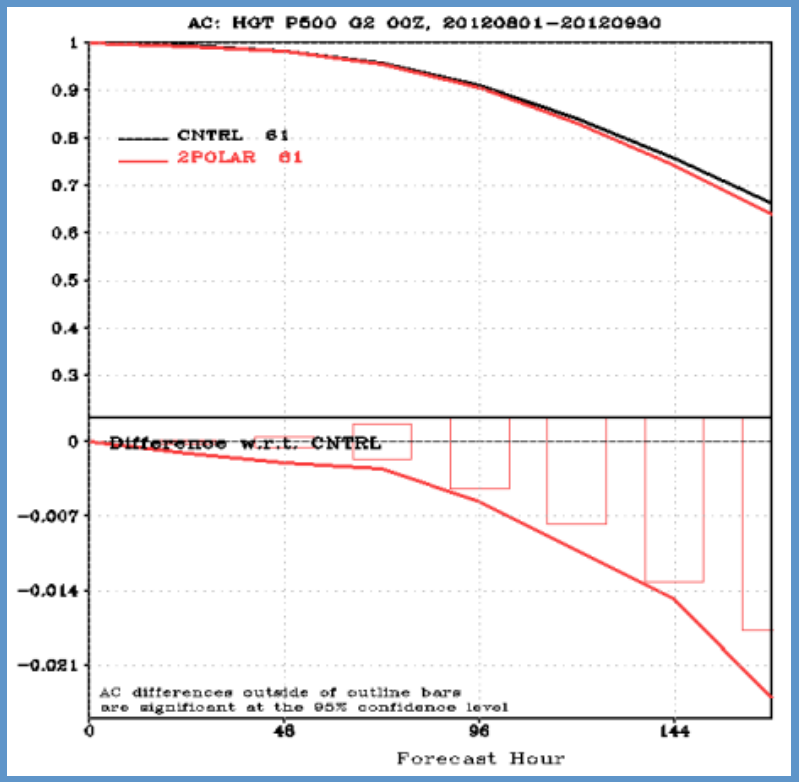




Day 5 500 mb Anomaly Correlation for NH, SH, and dieoff curves for early AM, mid-AM and PM orbits (CNTRL) and early AM and mid-AM only (2POLAR). Experiments run using T574 GDAS/GFS (2012 Operational Version)

SSMI/S, AMSR2 Status

- A 1DVAR preprocessor has been integrated into the GSI
- SSMI/S sounding channels are assimilated in the GSI, with capability to assess/ assimilate imaging channels
- Radiance quality assessment for SSMI/S and AMSR2 is in process
- GSI is currently being extended to assimilate AMSR2
  - Data is available in BUFR ad-hoc

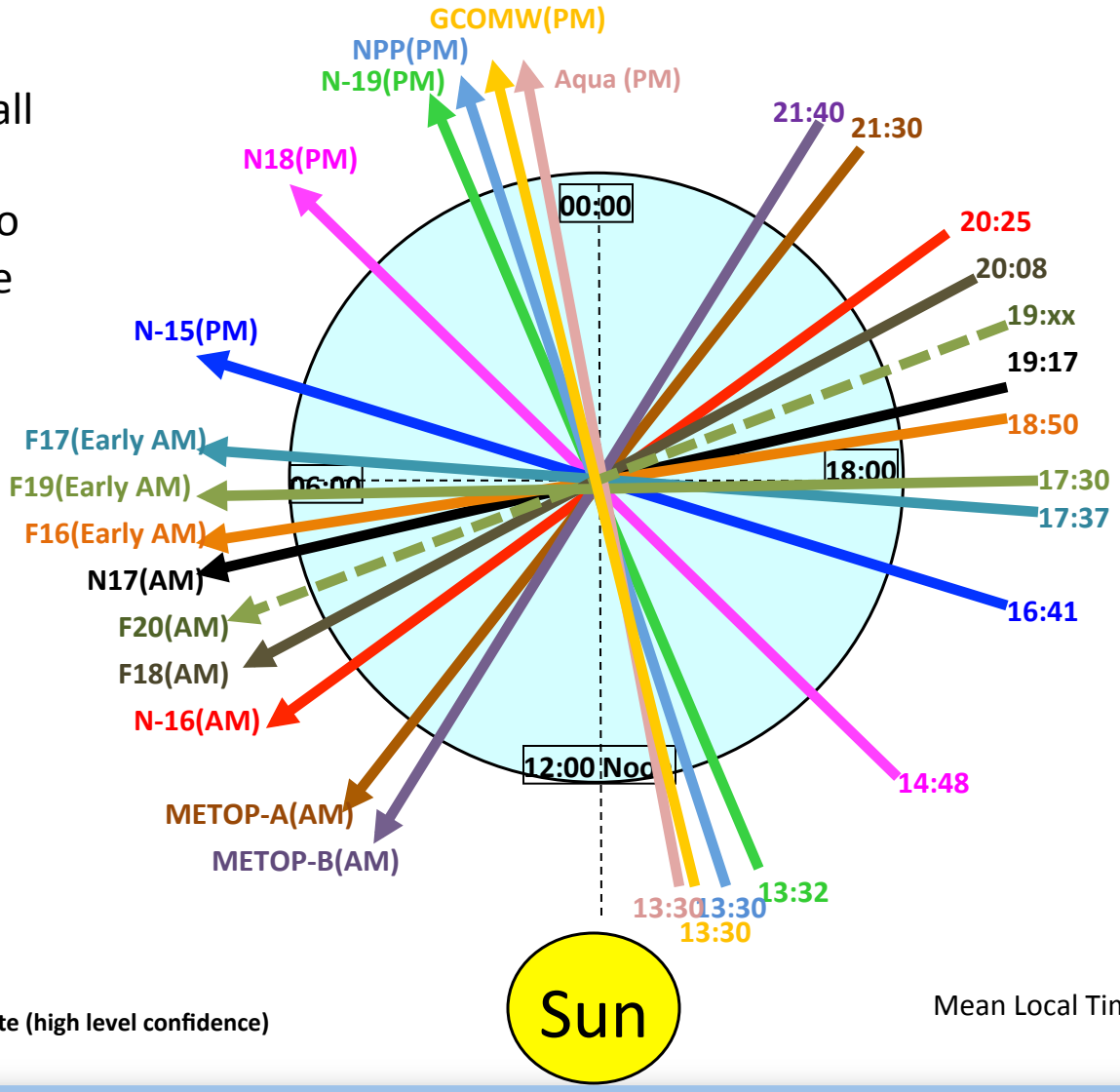
Outline

- Overview of passive microwave (PMW) sensors and information content
- Current baseline SSMI/S imaging channel radiance monitoring
- GSI 1DVAR preprocessing – application to SSMI/S
- Future work

Passive Microwave Imager Overview

Current Polar Constellation Passive Microwave Platforms

Note that currently not all satellites are assimilated (no need given the redundancy)



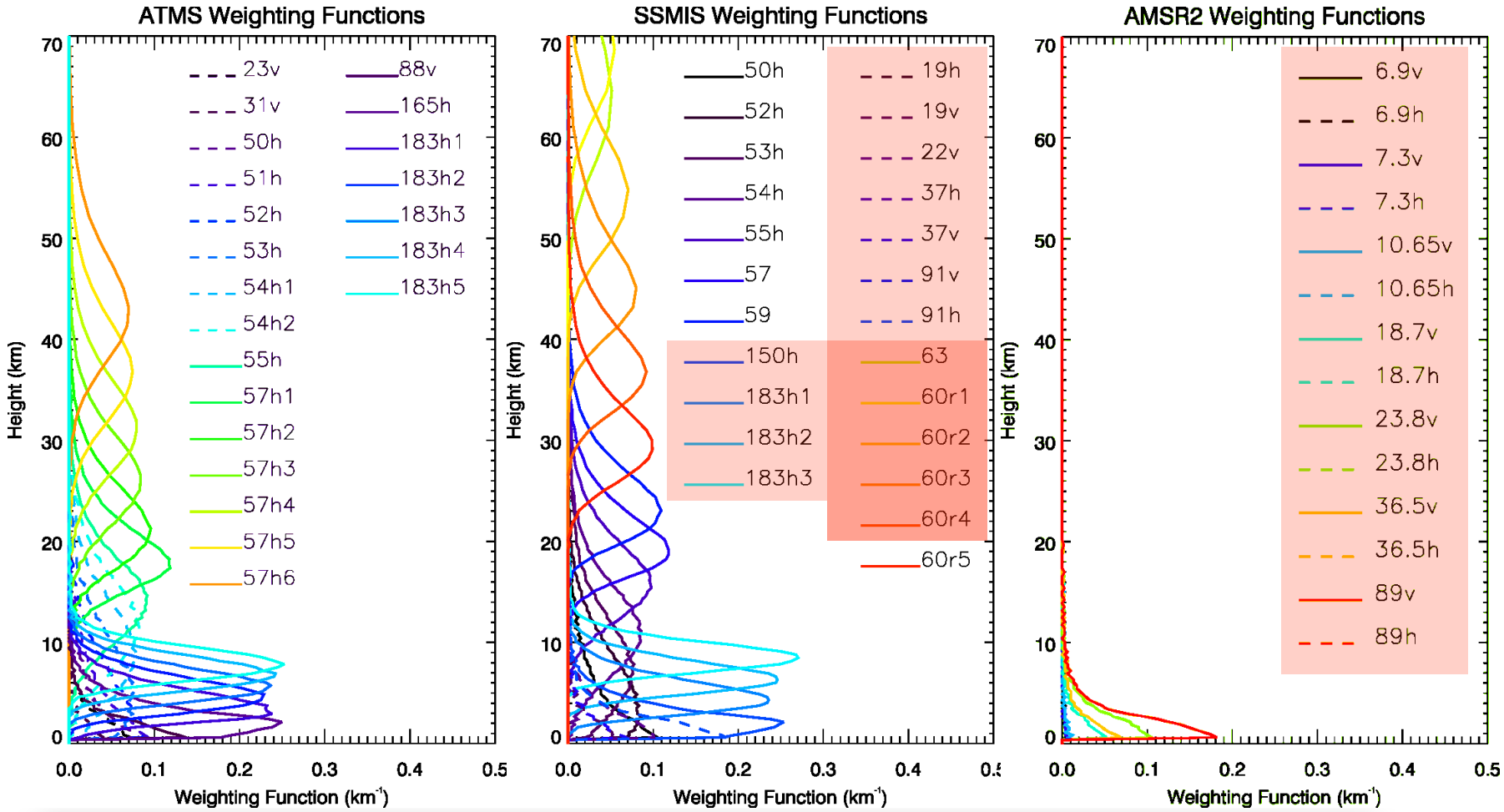
Future satellite (high level confidence)

Mean Local Times at the Ascending Node (hh:mm)

PMW Information Content

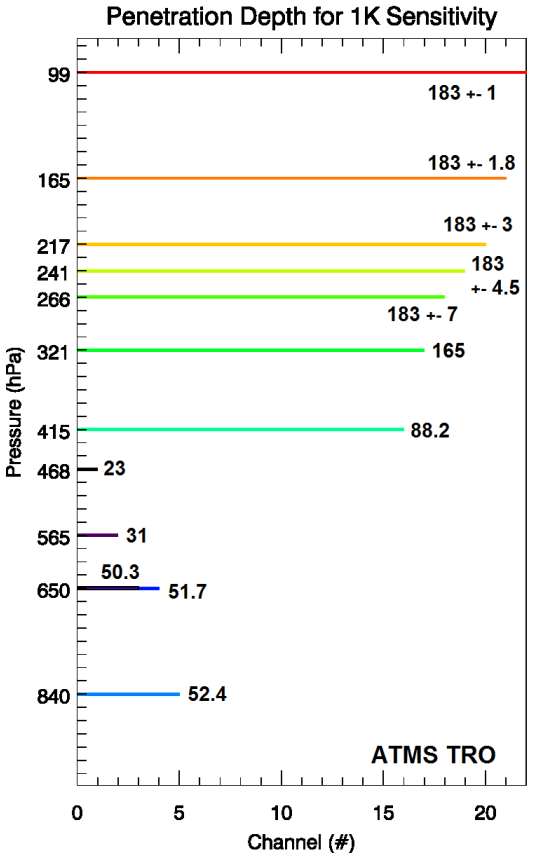
Not currently assimilated

Will not be assimilated

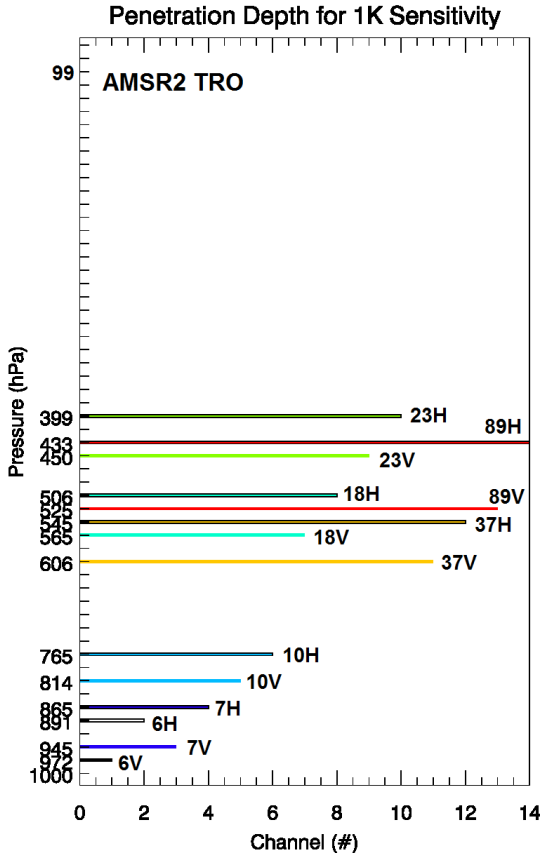


PMW Imager Information Content

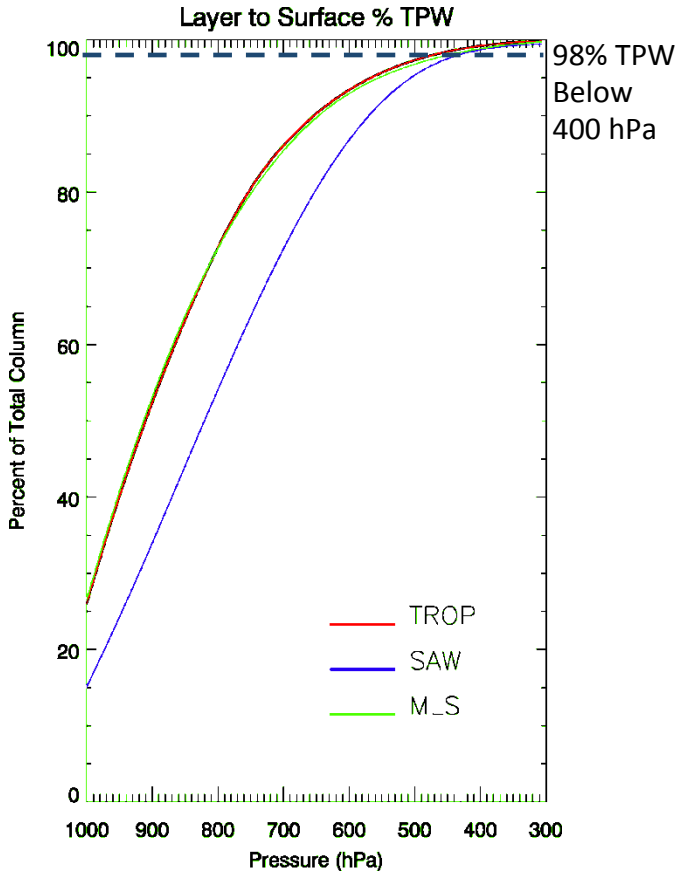
Layer at which dTb for each channel reaches 1 K due to addition of water vapor, from top-of-atmosphere to surface, in a standard tropical atmosphere.



ATMS



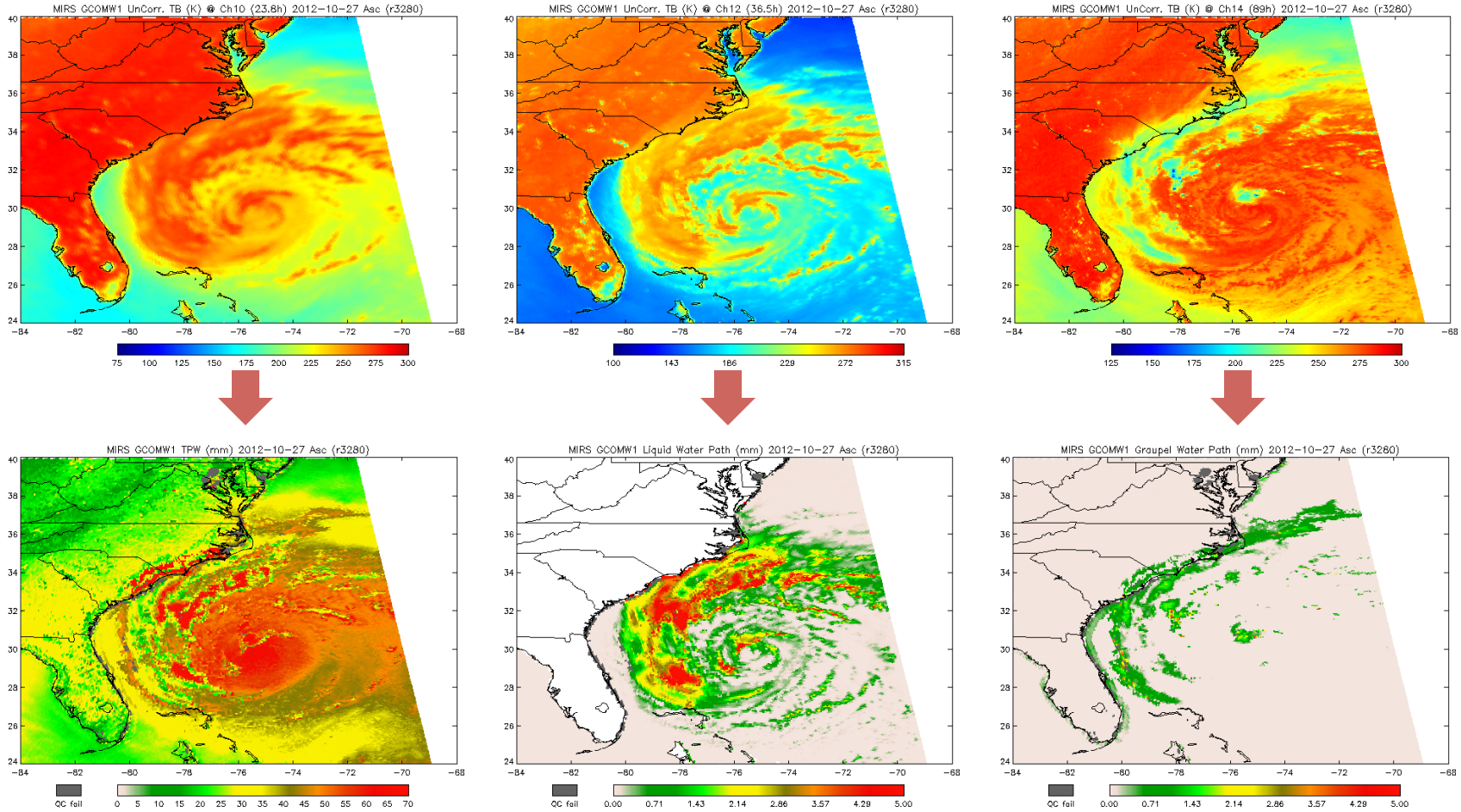
AMSR2



Percent of total column water vapor (TPW) below a given pressure level for tropical, arctic, and mid-latitude atmospheres.

PMW Imager Information Content

Hurricane Sandy case – October 27, 2012

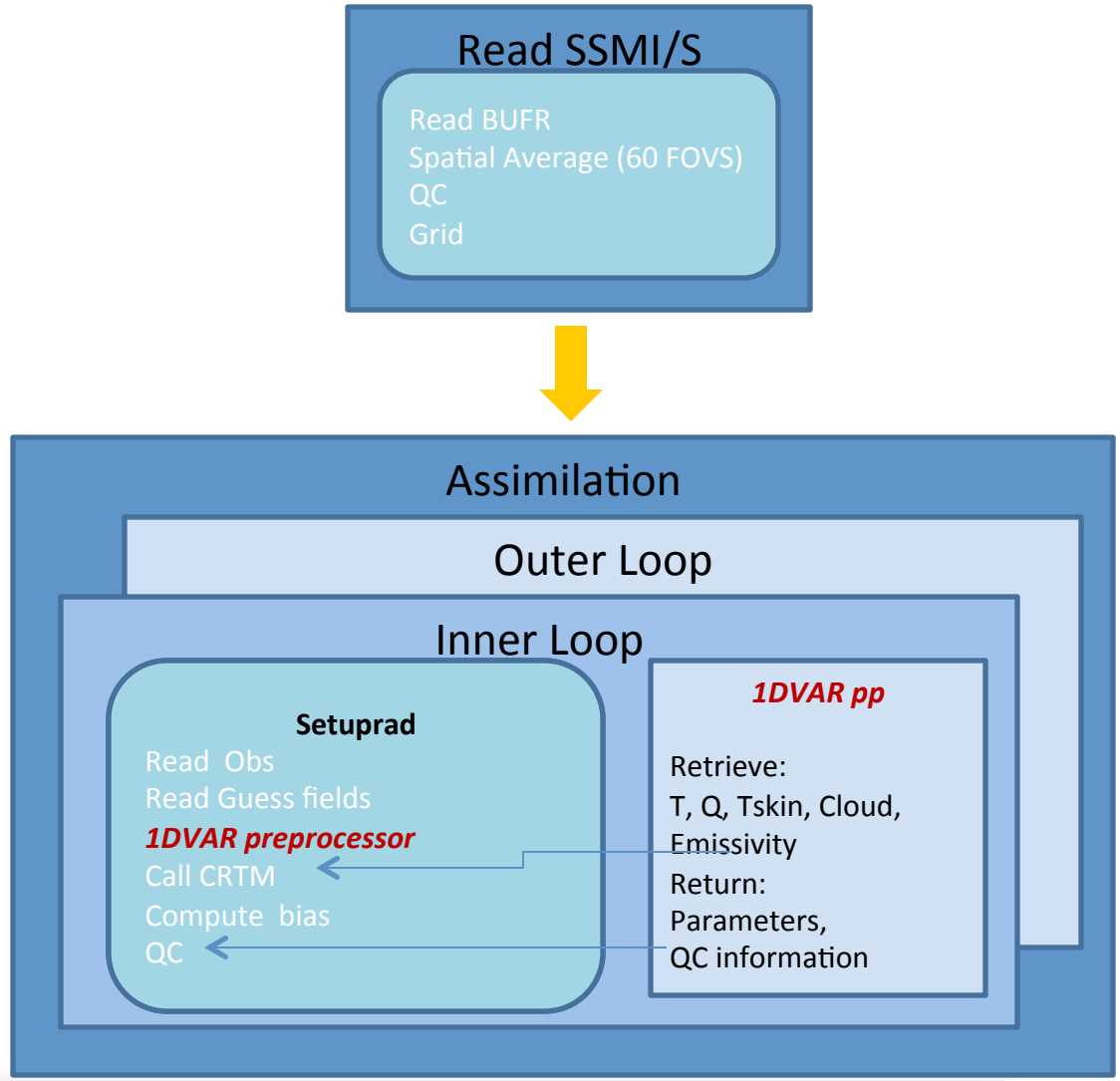


SSMI/S Preprocessing and Assimilation

GSI SSMI/S Overview

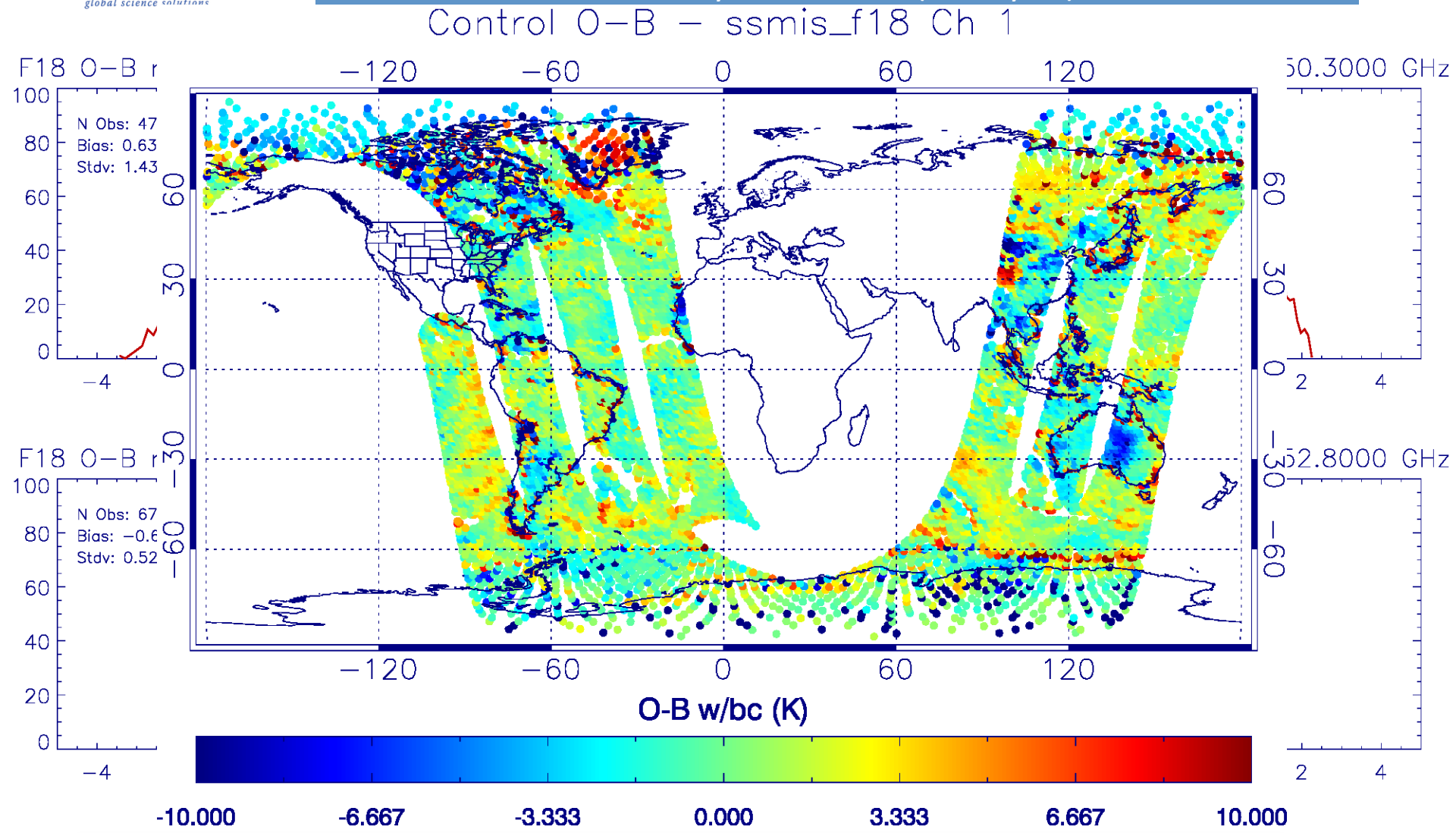
F18 SSMI/S		
	Frequency (GHZ)	Error (K)
1.	50.3	1.4
2.	52.8	0.9
3.	53.6	0.47
4.	54.4	0.22
5.	55.5	0.34
6.	57.2	0.38
7.	59.4	0.31
8.	150.0	2.78
9.	183.3 ± 6.6	1.75
10.	183.3 ± 3	1.5
11.	183.3 ± 1	1.3
12.	19.3 H	1.81
13.	19.3 V	1.34
14.	22.2 V	1.37
15.	37.0 H	2.16
16.	37.0 V	1.58
17.	91.6 H	1.43
18.	91.6 V	2.44
24.	60.7	0.7

Assimilated | **To Be Assimilated** / Not Assimilated



SSMI/S Current Status

Case day 2013-08-23 (00Z Cycle)



SSMI/S Current Status

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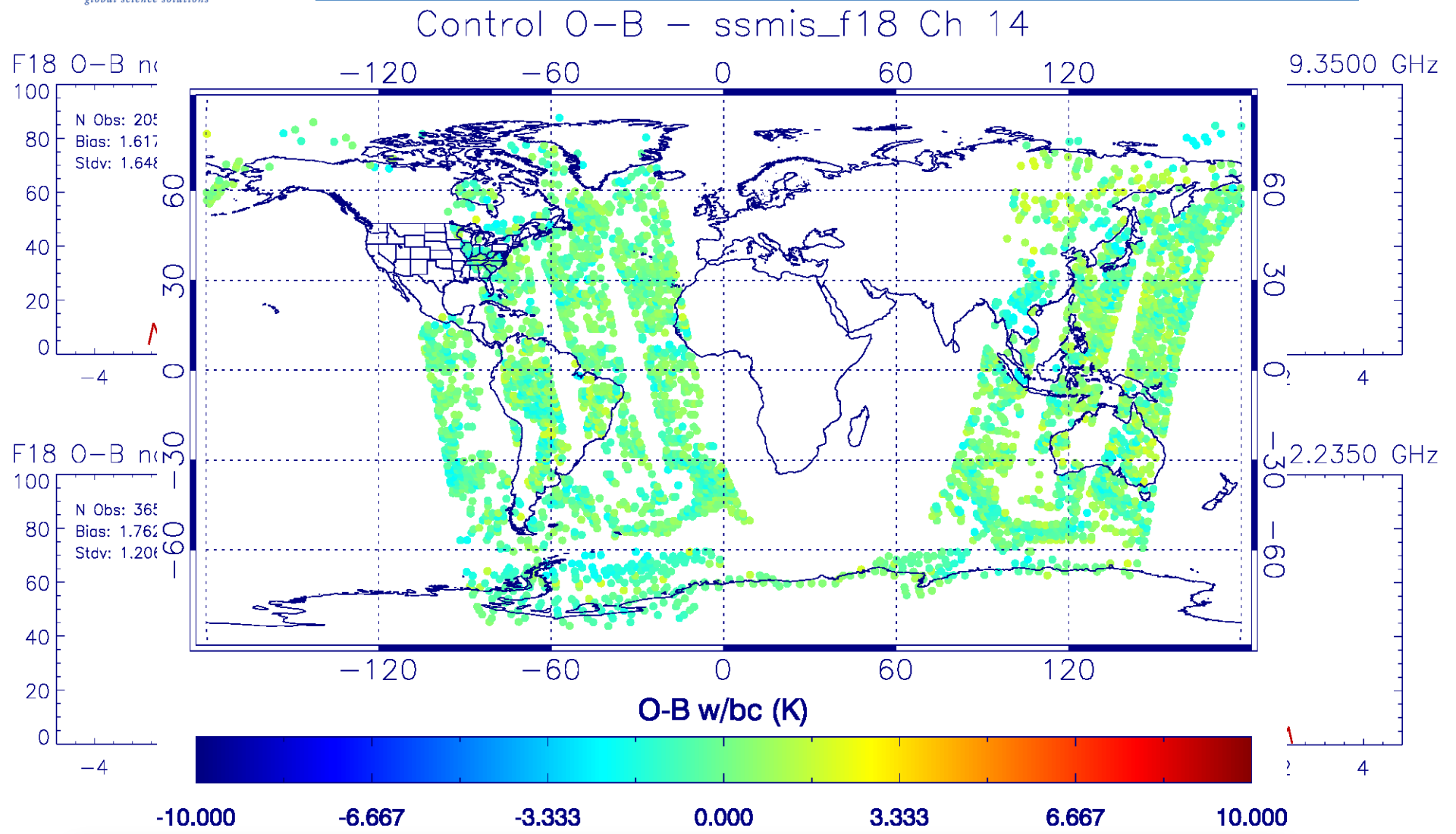


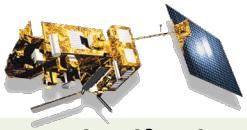
1DVAR Preprocessor

Multi-Instrument Inversion and Data Assimilation Preprocessing System

RIVERSIDE
global science solutions

S-NPP ATMS

Megha-Tropiques
SAPHIR/MADRAS



MetOp-A AMSU/MHS
MetOp-B AMSU/MHS

NOAA-18 AMSU/MHS
NOAA-19 AMSU/MHS

Inversion Process

- Consistent algorithm across all sensors
- Uses CRTM for forward and Jacobian operators
- Use forecast, fast regression or climatology as first guess/background

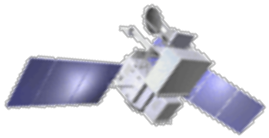
MIIDAPS

Assimilation/Retrieval

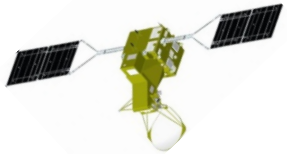
- All parameters retrieved simultaneously
- Valid globally over all surface types
- Valid in all weather conditions
- Retrieved parameters depend on information content from sensor frequencies

DMSP F16 SSMI/S
DMSP F17 SSMI/S
DMSP F18 SSMI/S

TRMM TMI



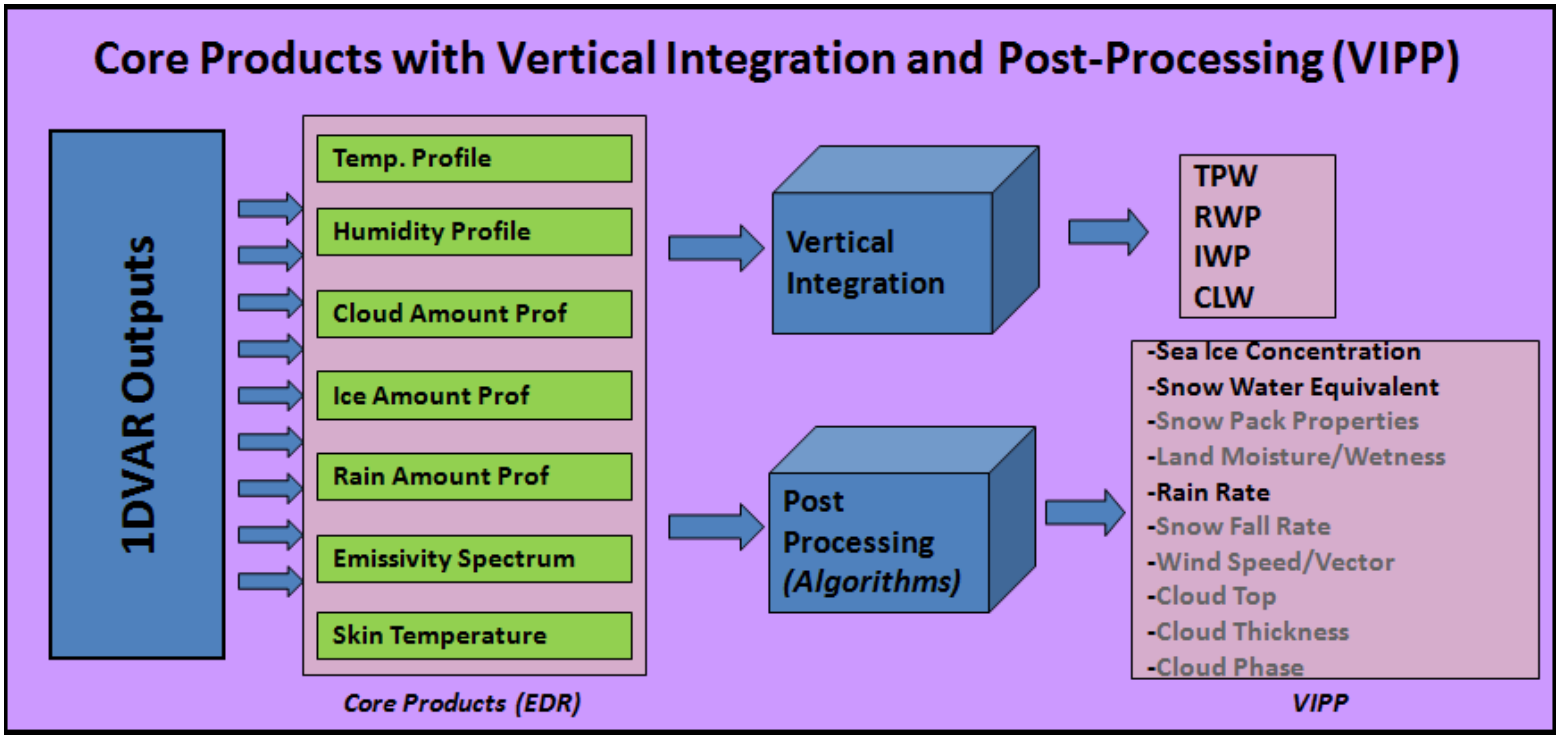
GPM GMI



GCOM-W1 AMSR2

Benefit of the 1DVAR preprocessor is to enhance QC, as well as increase the number and types of observations assimilated (e.g. imager data)

1DVAR Preprocessor Outputs



Quality Control Outputs

Useful for Radiance Assimilation

- QC Summary (Good, Bad, Rain, Cloud)
- Cloud Amount
- Surface Emissivity
- Chi-squared (< 1 Convergence reached)

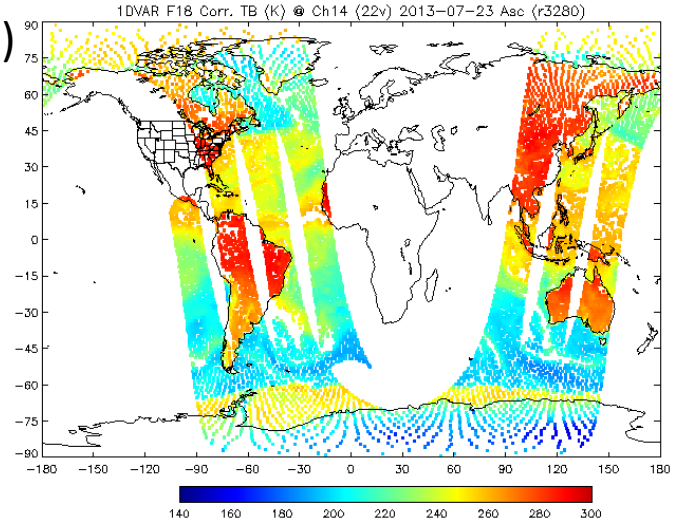
Useful for Product Assimilation

- Averaging Kernel
- Contribution Function
- Uncertainty Matrix

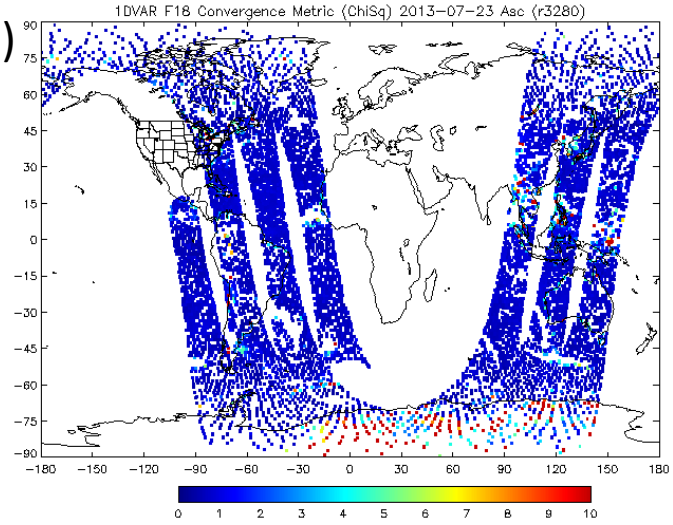
1DVAR Preprocessor – SSMI/S

Case day 2013-08-23 (00Z Cycle)

a)



b)



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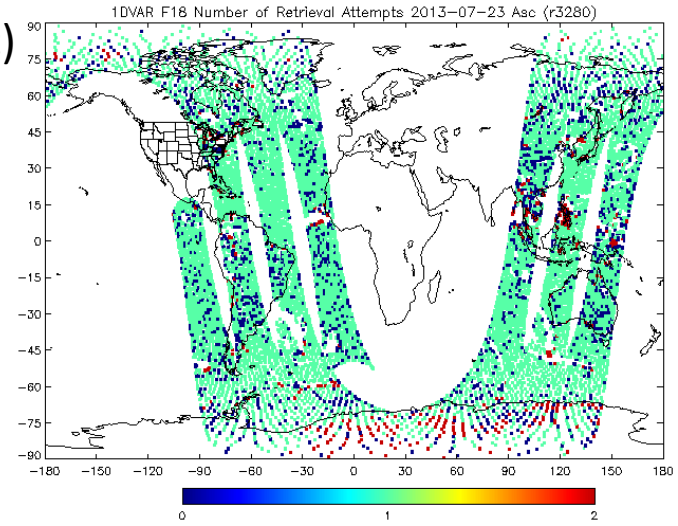
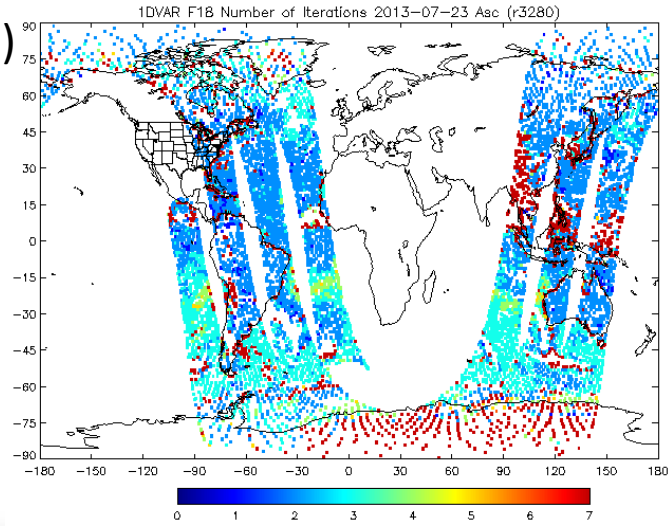


d)



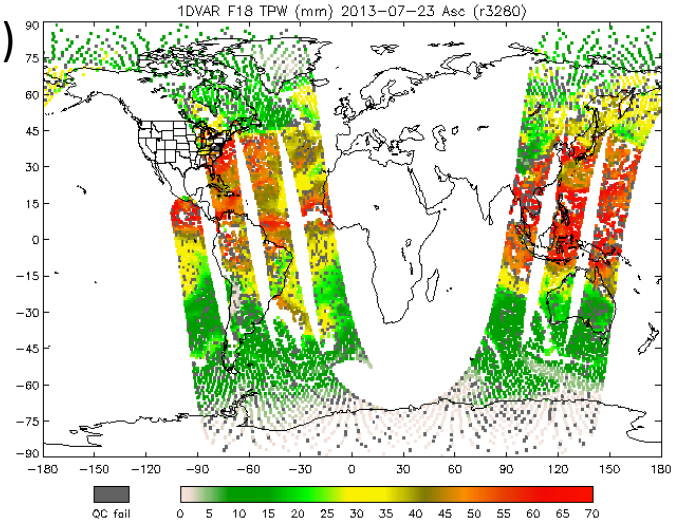
(a) F18 SSMI/S 22 GHz Corrected Brightness Temperature, and 1DVAR QC outputs including **(b)** ChiSq, **(c)** Number of Retrieval Attempts (max 2), and **(d)** Number of iterations for minimization (max 7)

Many points in (c) show zero retrieval attempts which needs to be investigated.

1DVAR Preprocessor – SSMI/S

Case day 2013-08-23 (00Z Cycle)

a)



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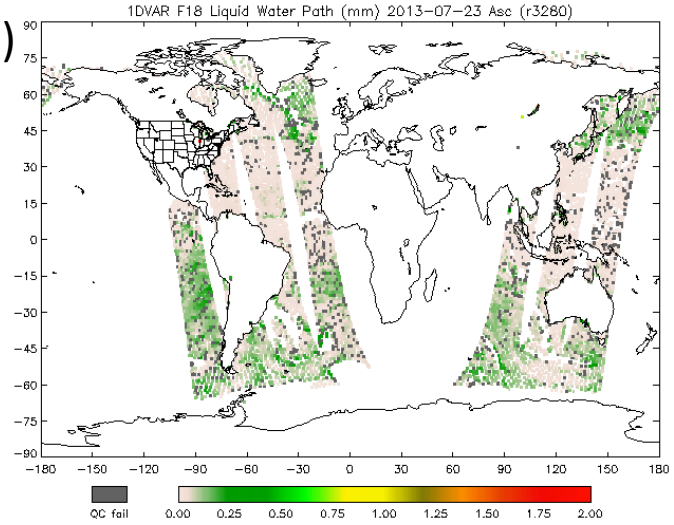
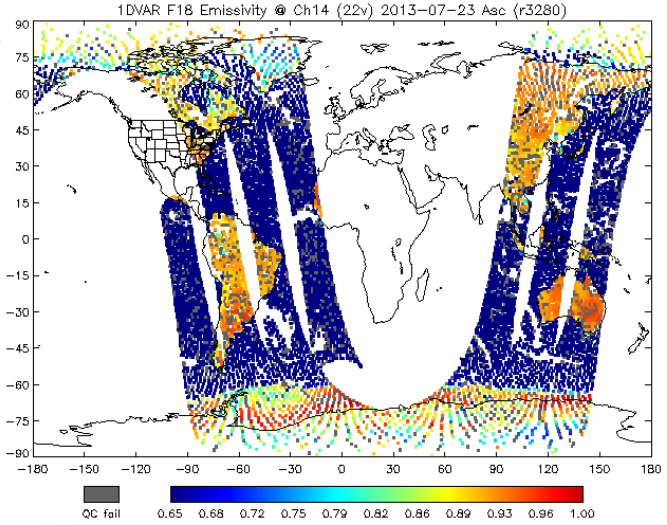
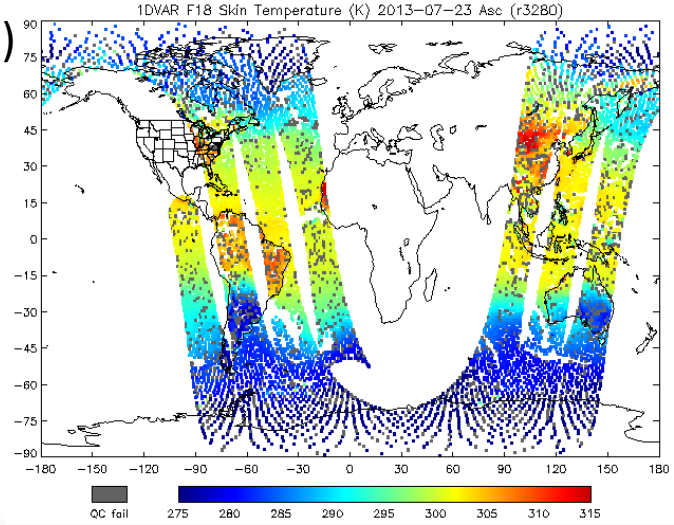


c)



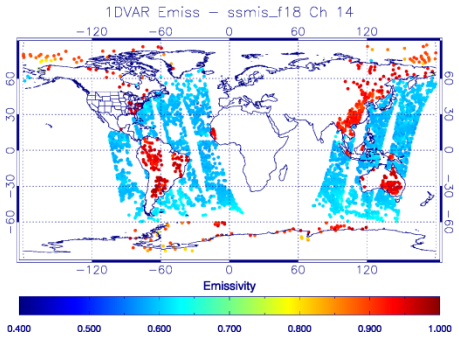
d)

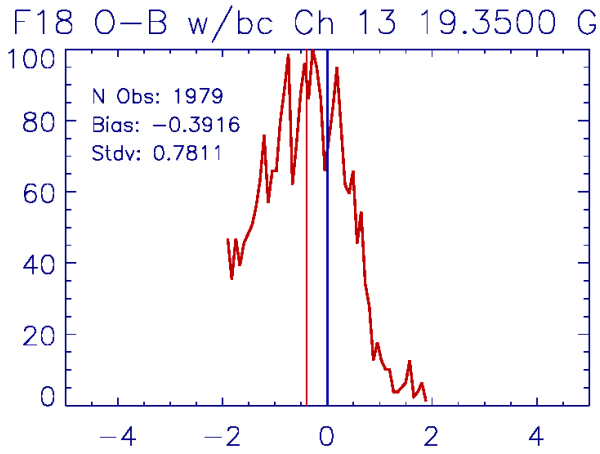


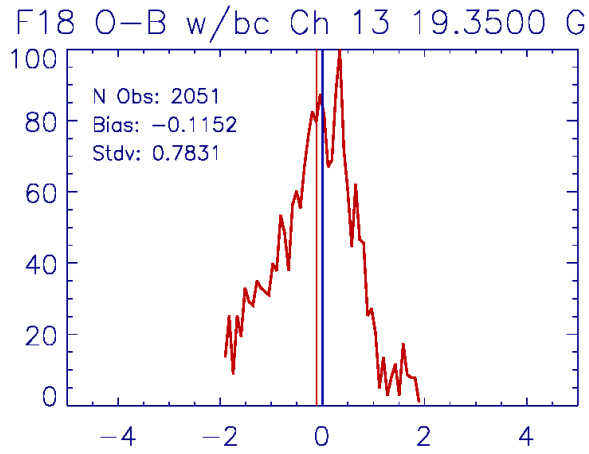
(a) 1DVAR retrieved TPW **(b)** Liquid Water Path, **(c)** 22 GHz surface emissivity, and **(d)** skin temperature

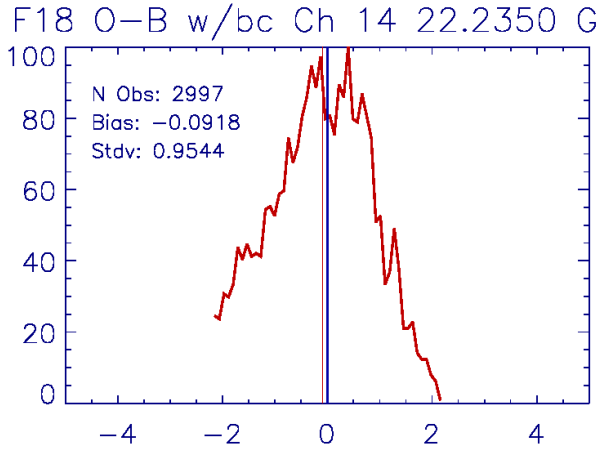
1DVAR Impact on Assimilation

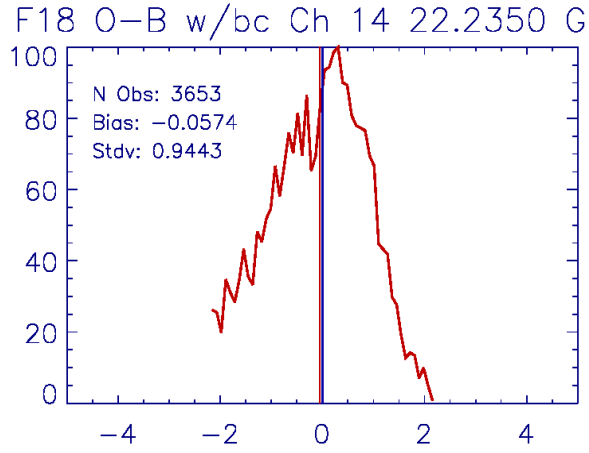
Case day 2013-08-23 (00Z Cycle)











O-B using 1DVAR Dynamic Emissivity as input to simulation

O-B using Emissivity from model as input to simulation (default)

Future Work

- Preliminary integration of the 1DVAR preprocessor has been completed
- SSMI/S
  - Perform SSMI/S radiance quality assessment (including F19)
  - Optimize 1DVAR retrieval and use of outputs in GSI (QC, emissivity, hydrometeors) to increase use of surface and hydrometeor affected observations
  - Assess forecast impact of imaging channels (global and regional)
- AMSR2
  - Finish GSI plumbing
  - Follow tasks from SSMI/S work