GPM's Passive Microwave Retrieval Algorithm

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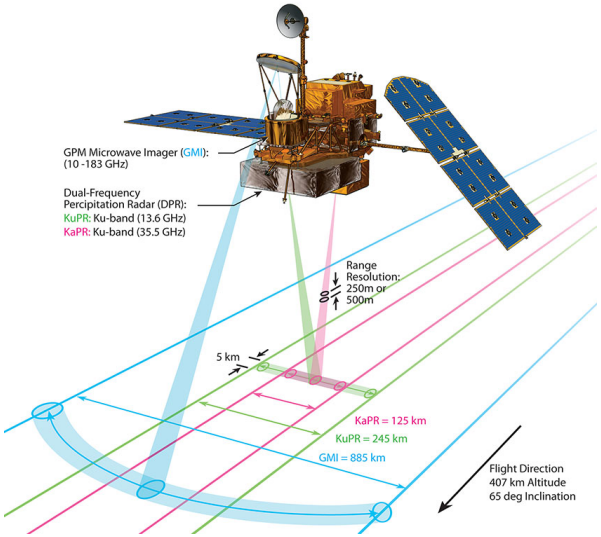
and

Passive Microwave Team

Outline

- ☆ *Algorithm Outline and Philosophy*
- ☆ *Algorithm General Structure*
- ☆ *Code evolution pre- and post-launch*
- ☆ *Validation*
- ☆ *ATBD outline and status*
- ☆ *Summary*

The GPM Concept



Everyone contributes constellation of dedicated and operational PMW radiometers for frequent sampling

- *NASA/JAXA contribute Core Satellite Precipitation Physics*

GPM Core Satellite carries:

- *a dual-frequency radar &*
- *a passive microwave imager with high frequency capabilities*

Radiometer Algorithm Outline

☆ *Use a Bayesian approach for retrieving surface precipitation and its vertical structure.*

- *A-priori databases of cloud and precipitation profiles are initially built from existing sources but transition immediately to the GPM core satellite after launch*
- *Surface characteristics (over land) are added incrementally as they are understood*
- *Channels are used dynamically based upon information content.*

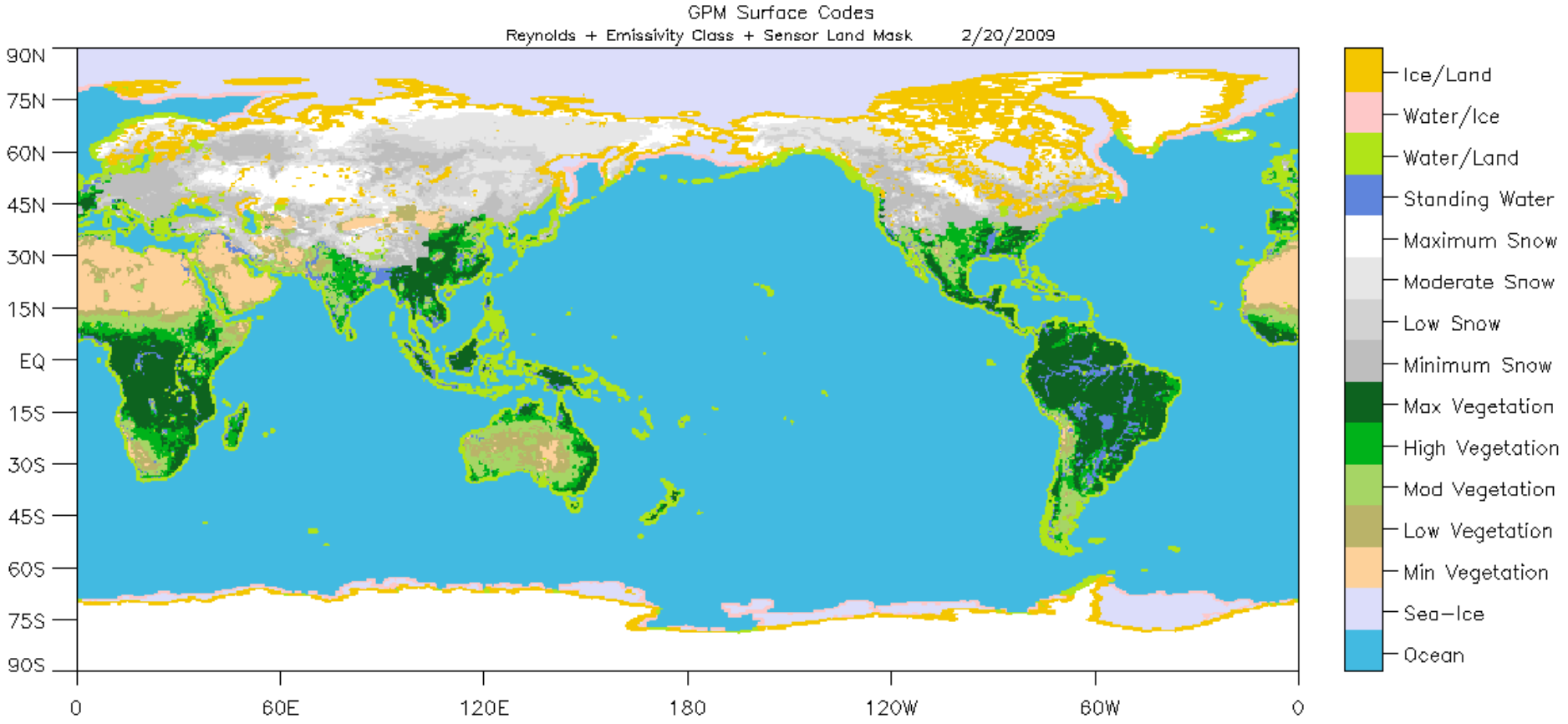
The A-priori Database

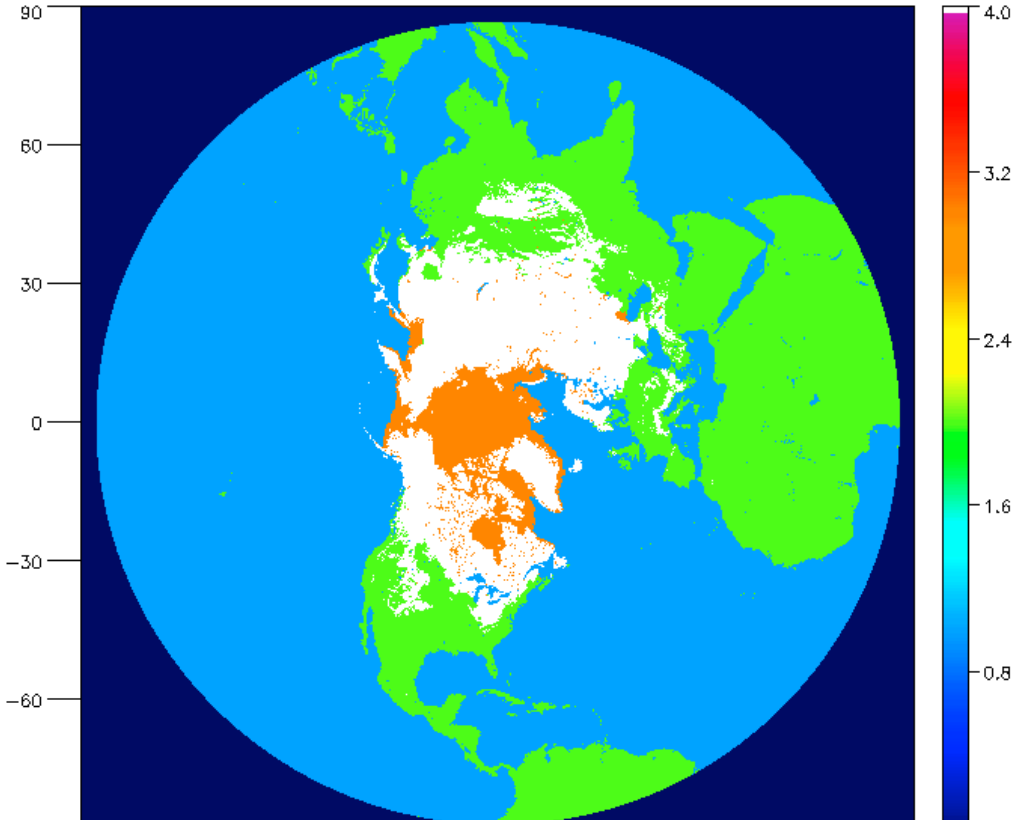
- *Have existing databases of TRMM PR rainfall with coincident TMI observations in tropics (land and ocean)*
- *Created databases of CloudSat rainfall with coincident AMSR-E and MHS observation globally for land and ocean (Kulie/Bennartz, UW)*
- *Created Databases of NMQ Surface rainfall with coincident SSMIS observation over CONUS and adjacent waters (Wang/Ferraro)*

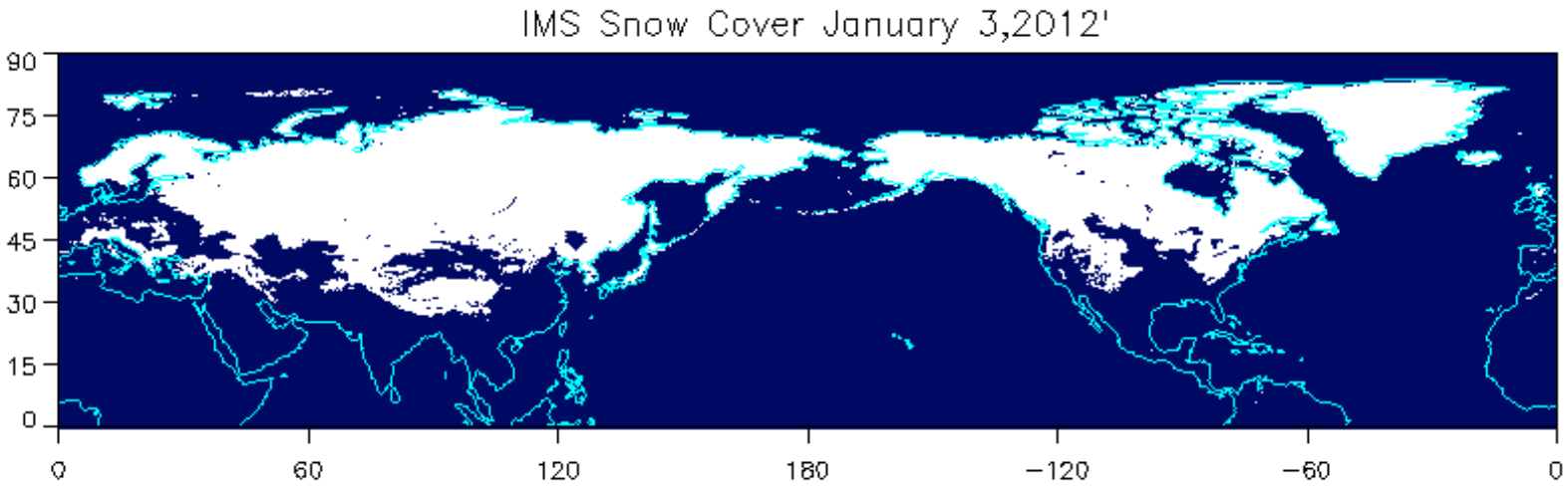
In each case, observed rainfall, available Tb, Land_stc_type, T_{sfc} and TPW are matched to a set of 50,000,000 profiles Goddard MMF and Satellite Simulator (Mohr, Matsui).

Final database is assembled from NMQ/SSMIS; PR/TMI and CloudSat/ AMSR-E+MHS in that order. Each Land_stc_type, T_{sfc} and TPW bin is filled until it has 10,000 profiles.

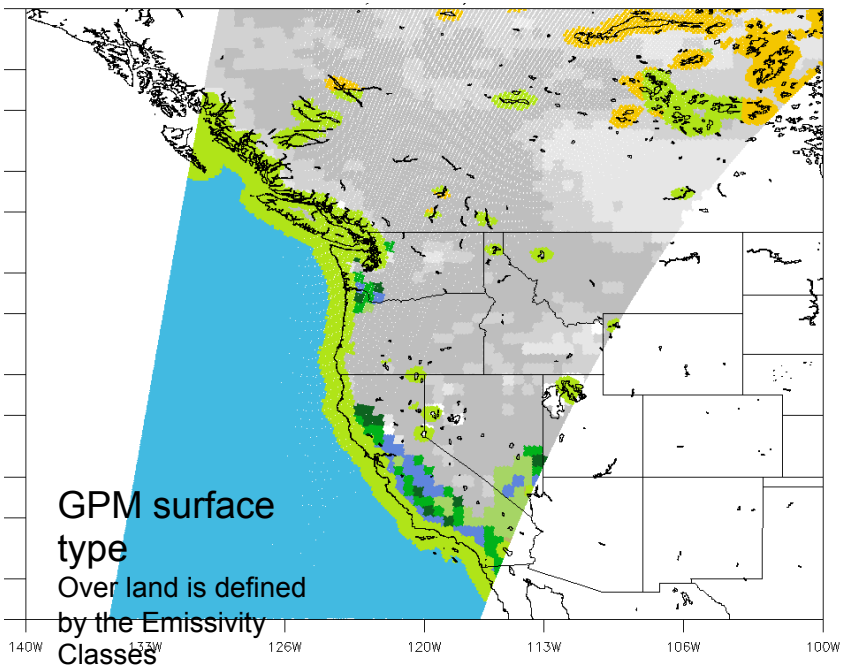
These profile, with Tb computed for each constellation sensor, serves as the basic entry for each GPM constellation radiometer database.

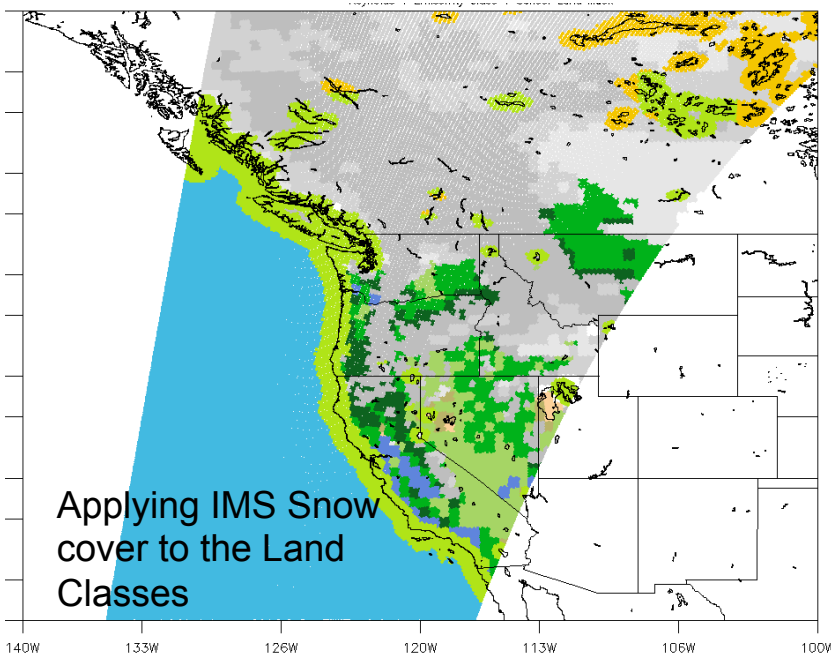

GPM Surface Codes
Reynolds + Emissivity Class + Sensor Land Mask 2/20/2009
90N
75N
60N
45N
30N
15N
EQ
15S
30S
45S
60S
75S
90S
0
60E
120E
180
120W
60W
0
Ice/Land
Water/Ice
Water/Land
Standing Water
Maximum Snow
Moderate Snow
Low Snow
Minimum Snow
Max Vegetation
High Vegetation
Mod Vegetation
Low Vegetation
Min Vegetation
Sea-Ice
Ocean


90
60
30
0
−30
−60
4.0
3.2
2.4
1.6
0.8


IMS Snow Cover January 3,2012'
90
75
60
45
30
15
0
0
60
120
180
−120
−60
0

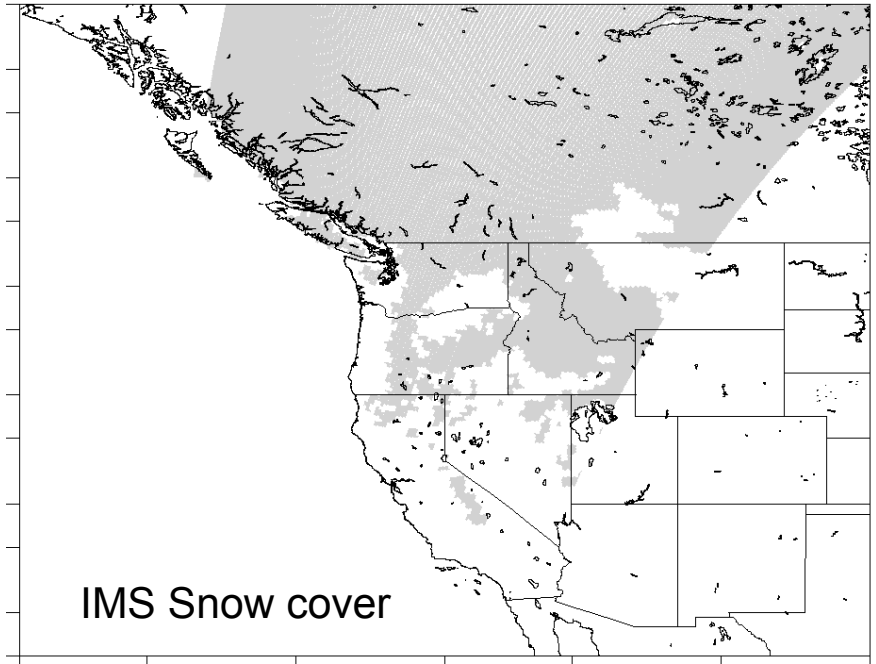
January 4th,





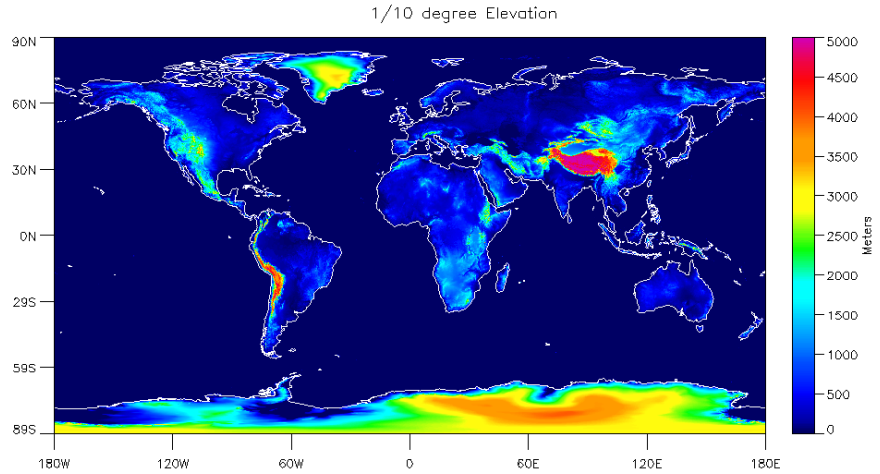
IMS : Interactive Multi-sensor Snow and Ice Mapping System

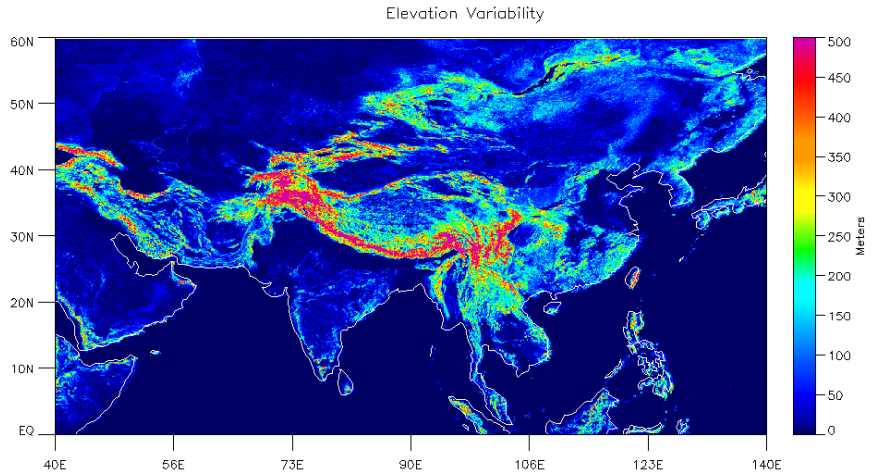
- available daily from NSIDC

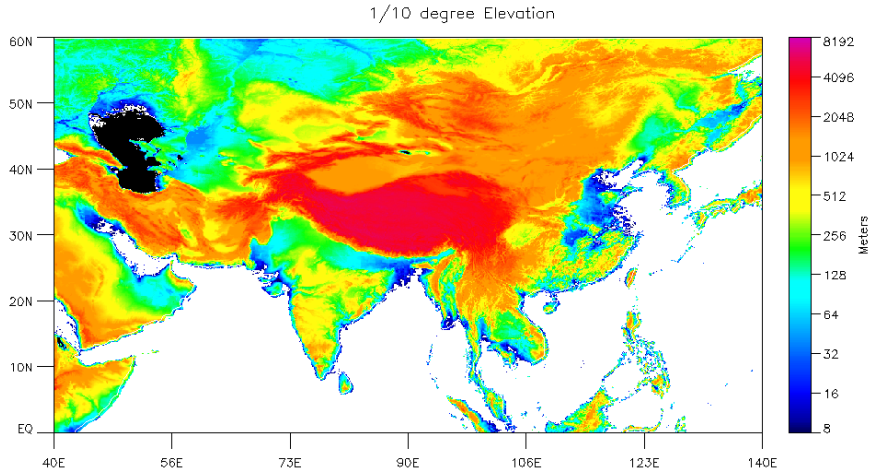


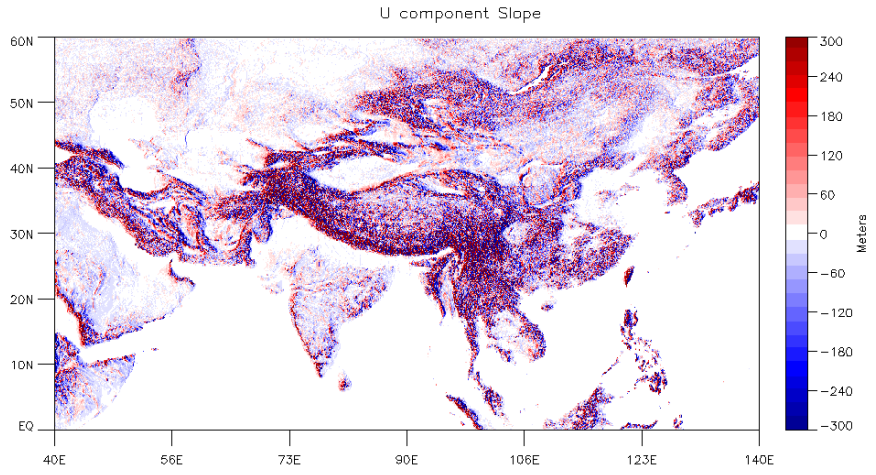
Ancillary Data - Topography

Elevation
1 km global elevation from GLOBE, Sampled to 1/10 of a degree (12 km).
Includes standard deviation of elevation within the sampled 10X10 footprint.





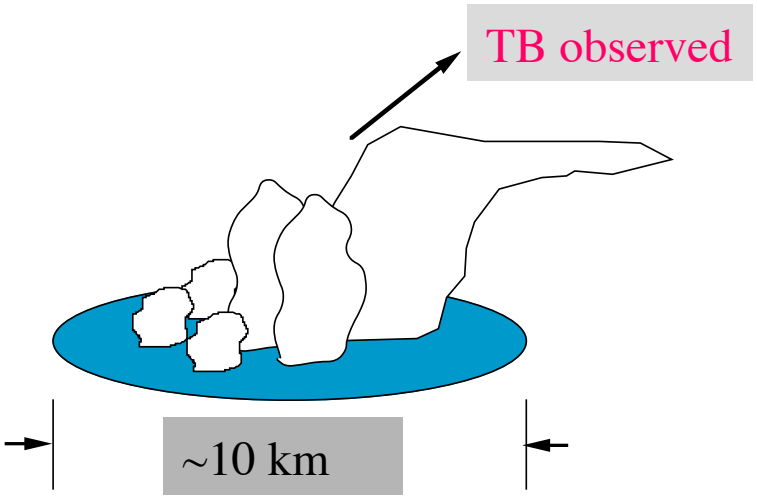


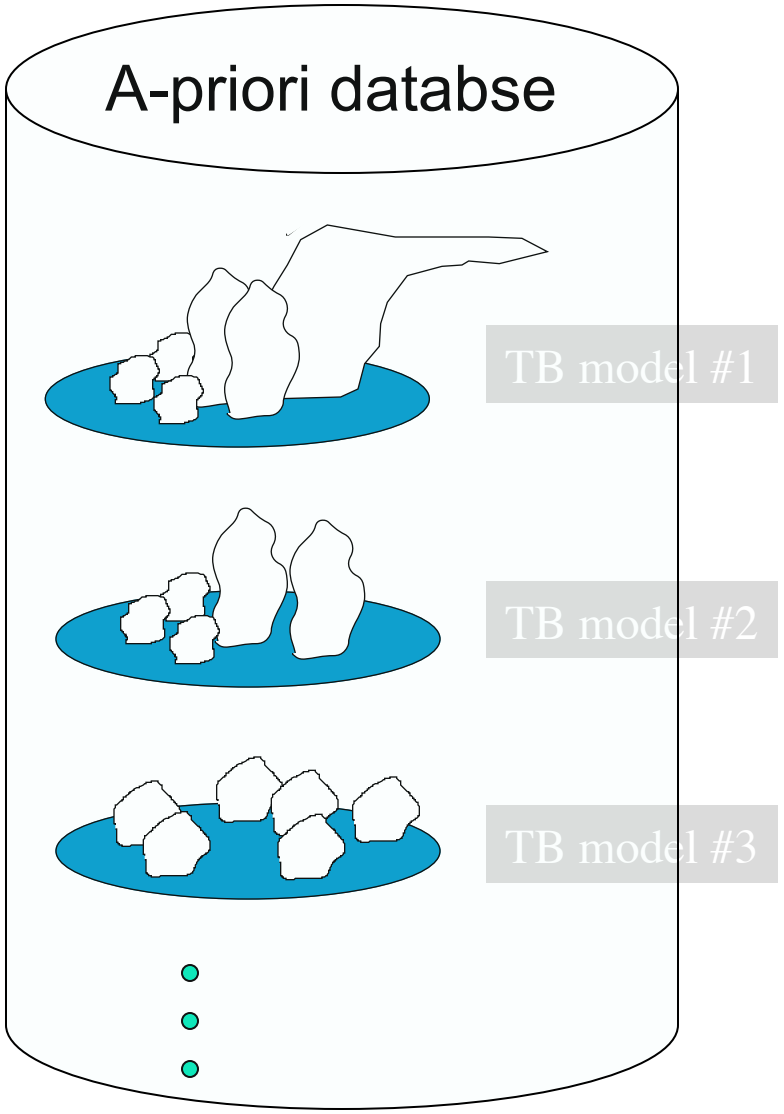


Radiometer Retrievals trained with observed data

Bayesian Inversion

Bayes, T. and R. Prices, 1763: An Essay towards solving a problem in the Doctrine of Chance. By the late Rev. Mr. Bayes, communicated by Mr. Price, in a letter to John Canton, M.A. and F.R.S. Philos. Trans. R. Soc. London, **53,** 370-418.

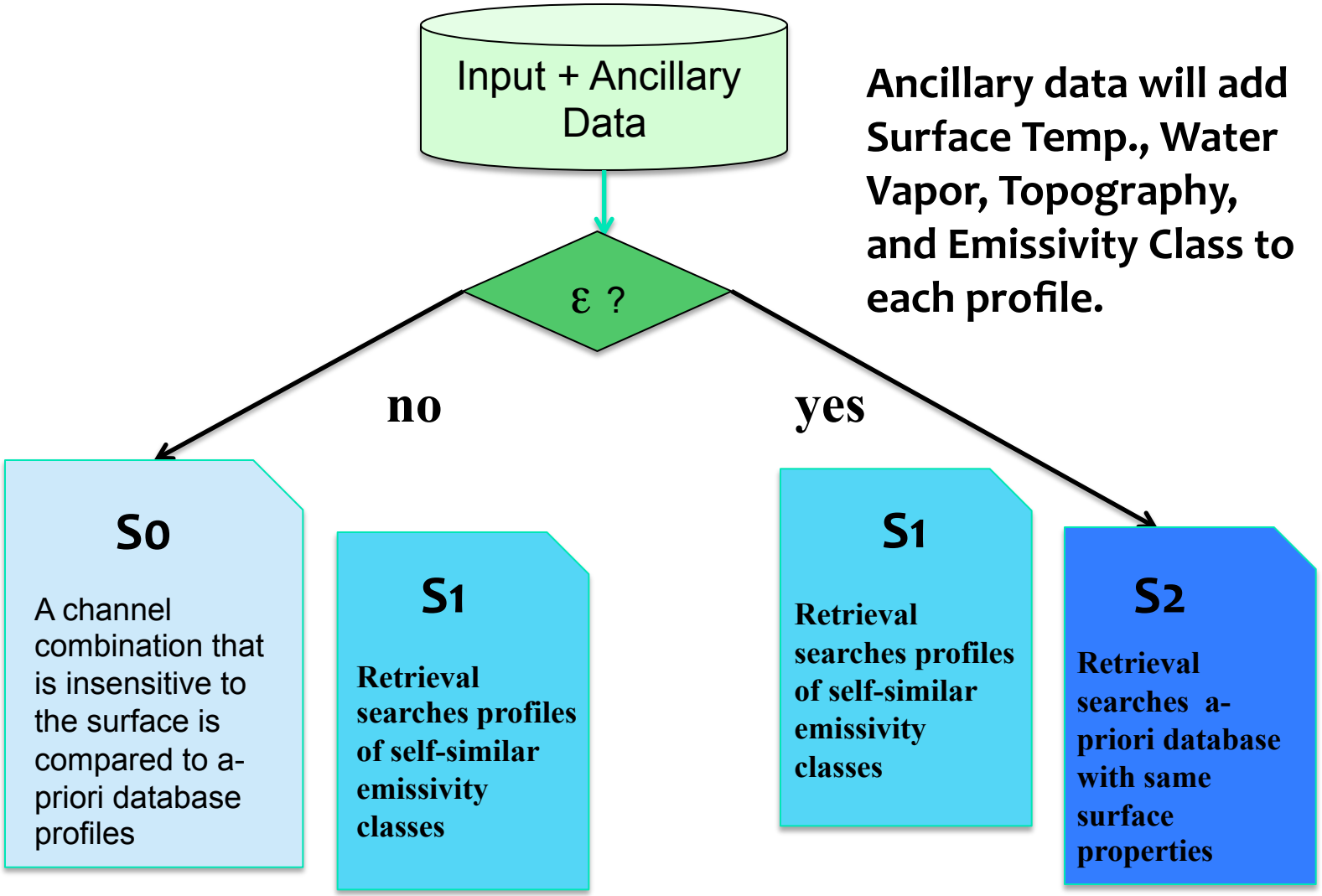




$$P(\mathbf{R} \mid \mathbf{T_b}) \propto P(\mathbf{R}) \times P(\mathbf{T_b} \mid \mathbf{R})$$

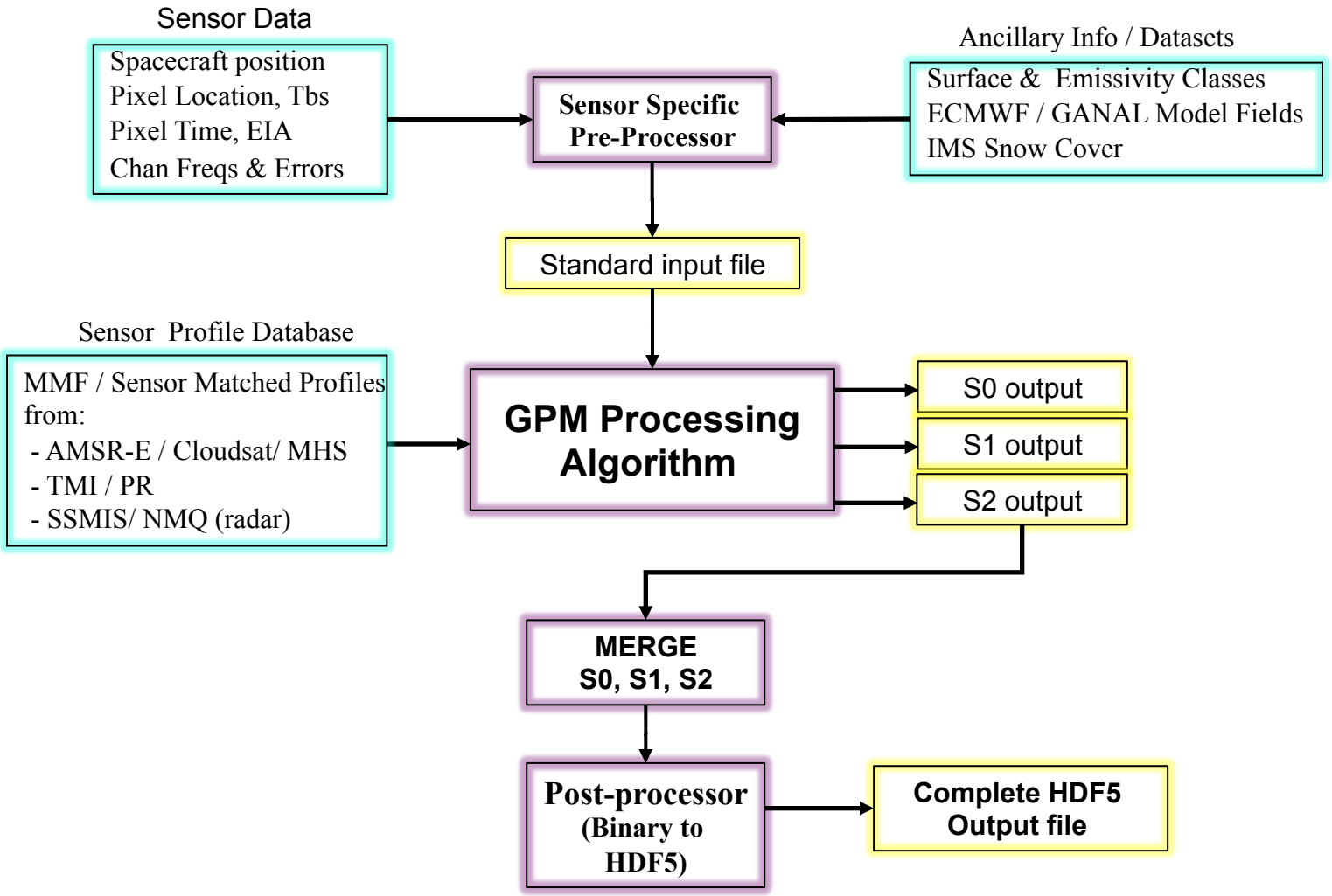
The Retrieval Algorithm

Retrievals to search only subset of database with similar ancillary values



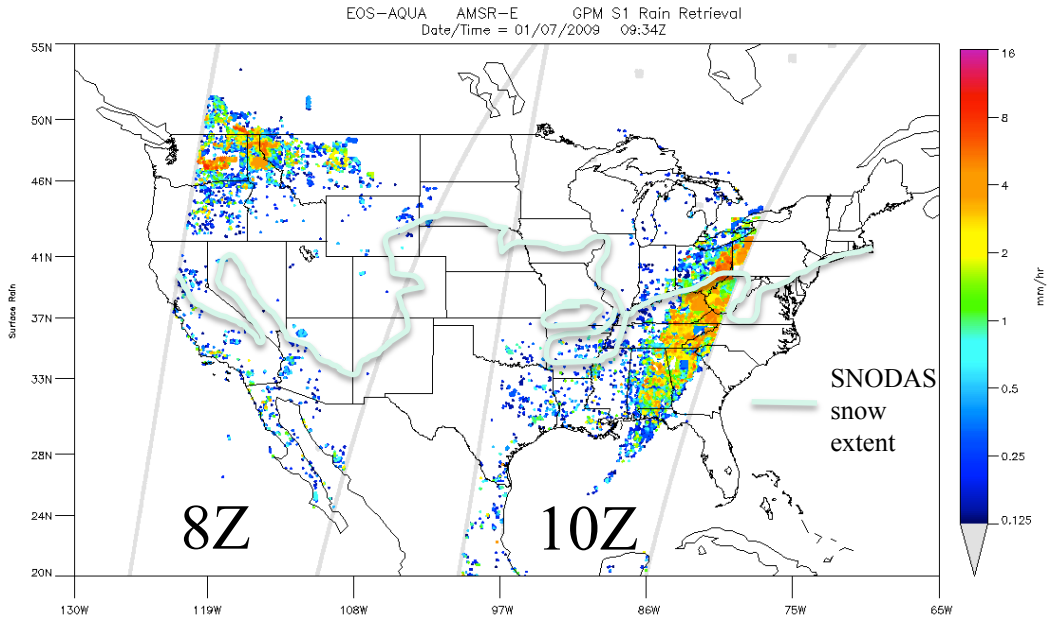
Ancillary data will add Surface Temp., Water Vapor, Topography, and Emissivity Class to each profile.

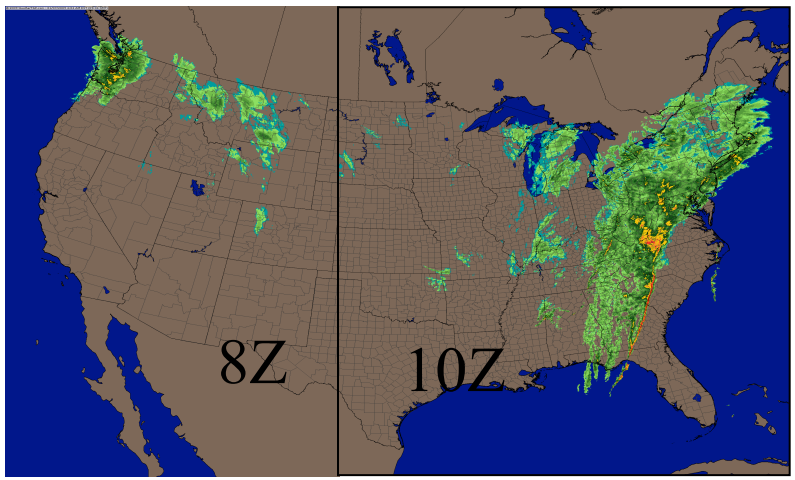
GPROF 2014 Algorithm Structure

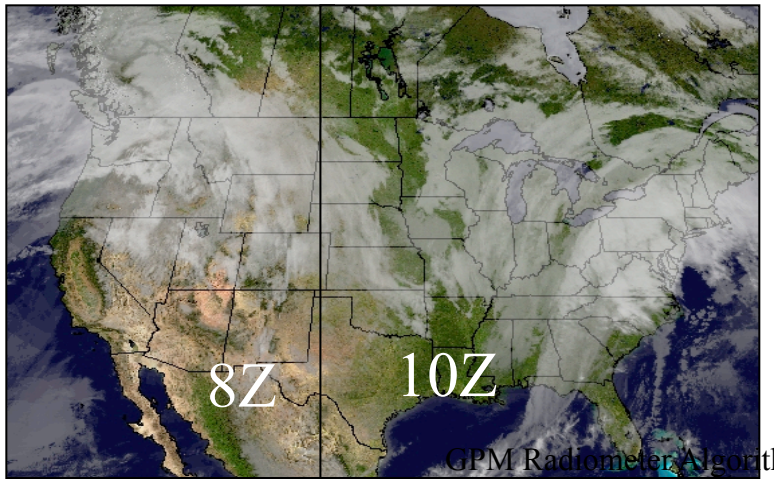


AMSR-E Tbs with AMSR-E/CloudSat Database S1 Retrieval

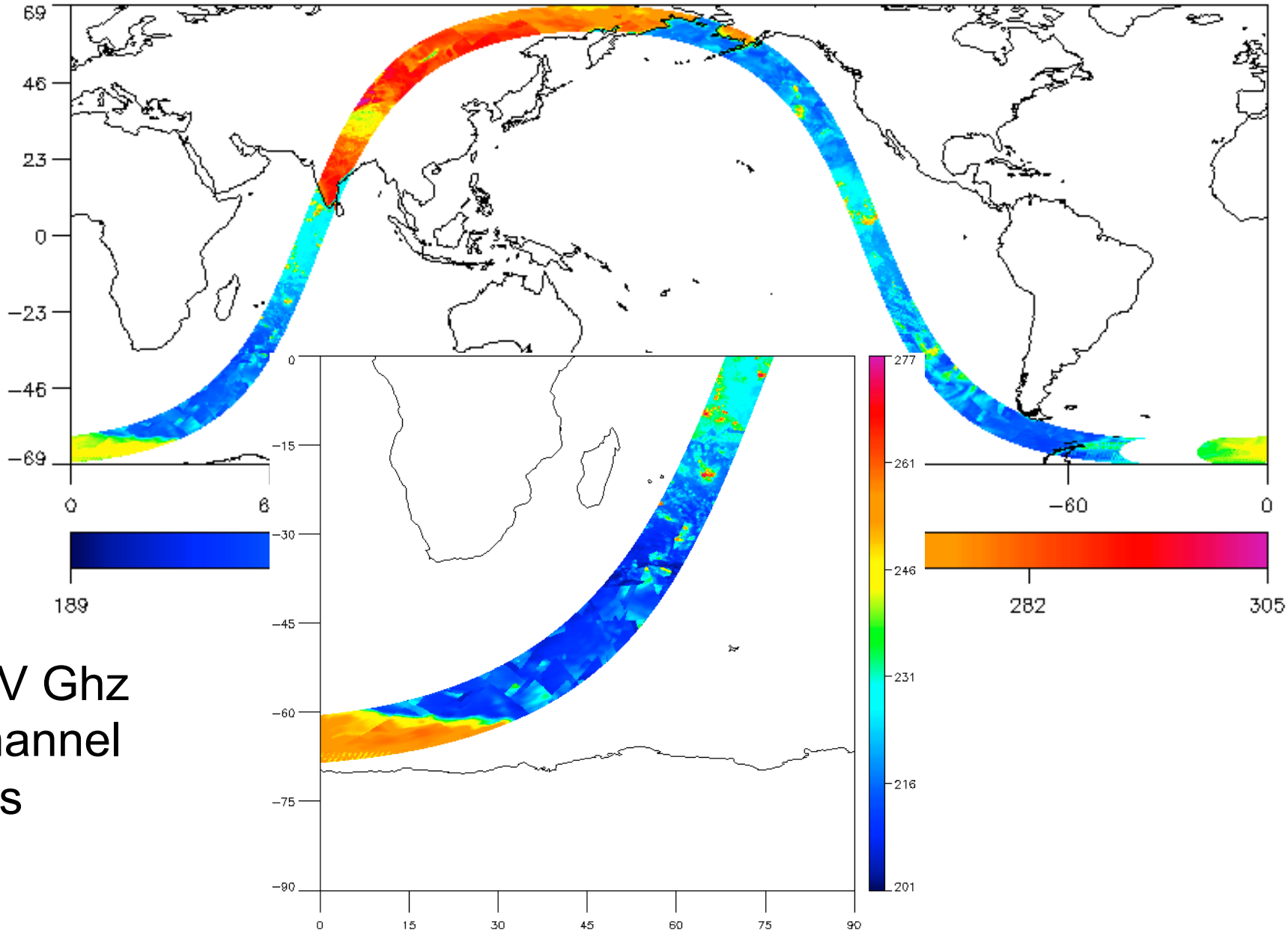
January 7th, 2009



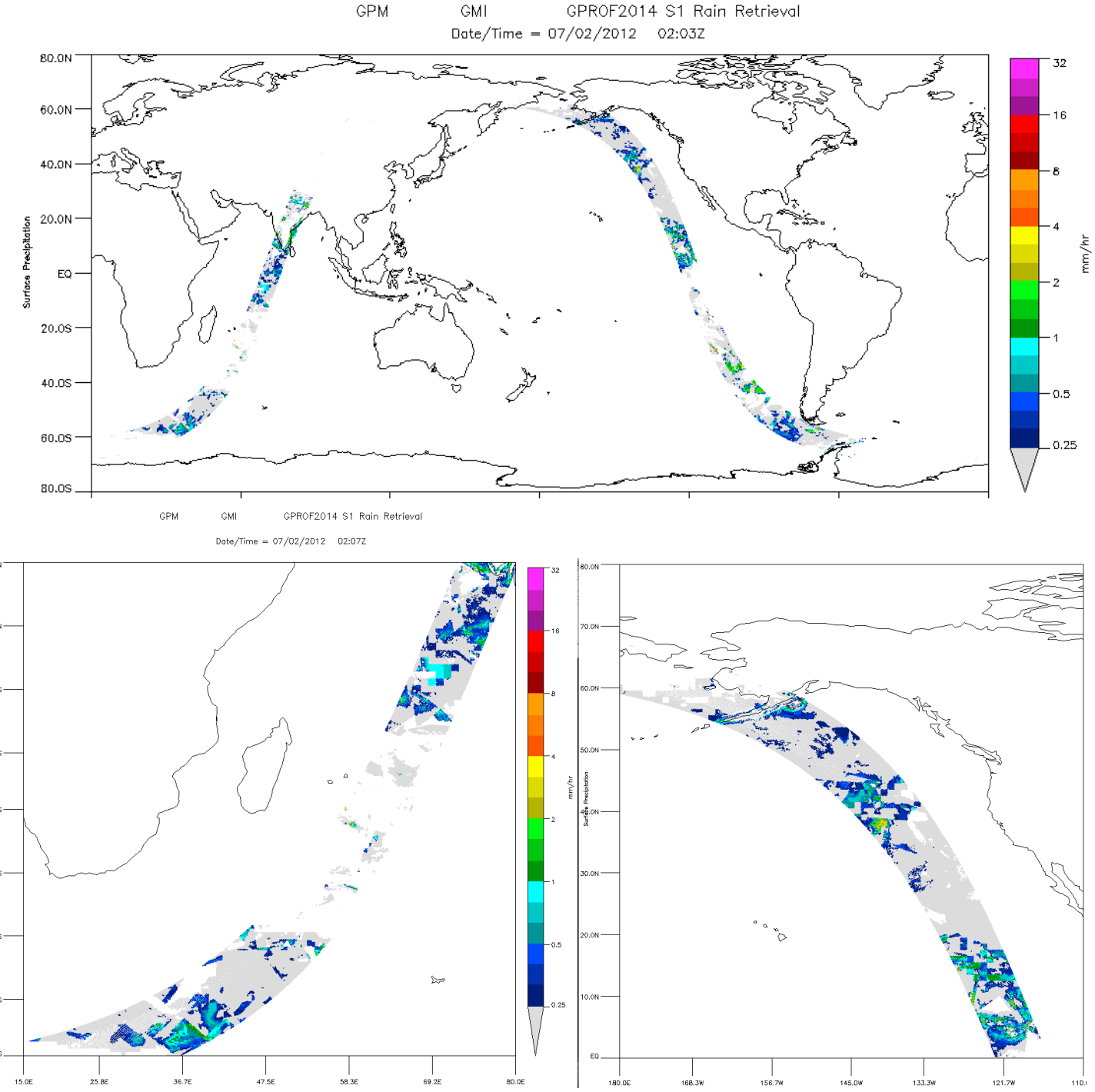


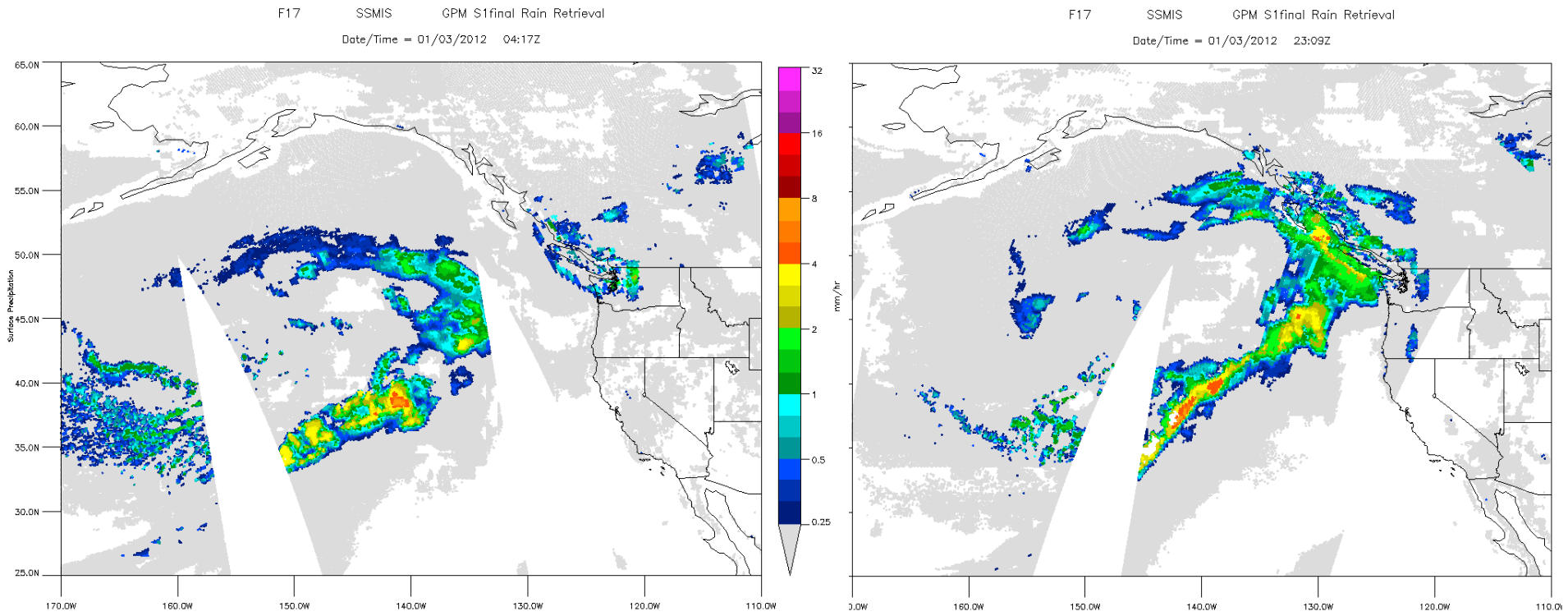


1C.GPM.GMI.XCAL2012-N.20120702-S020330-
E033606.000914.V00A.HDF5



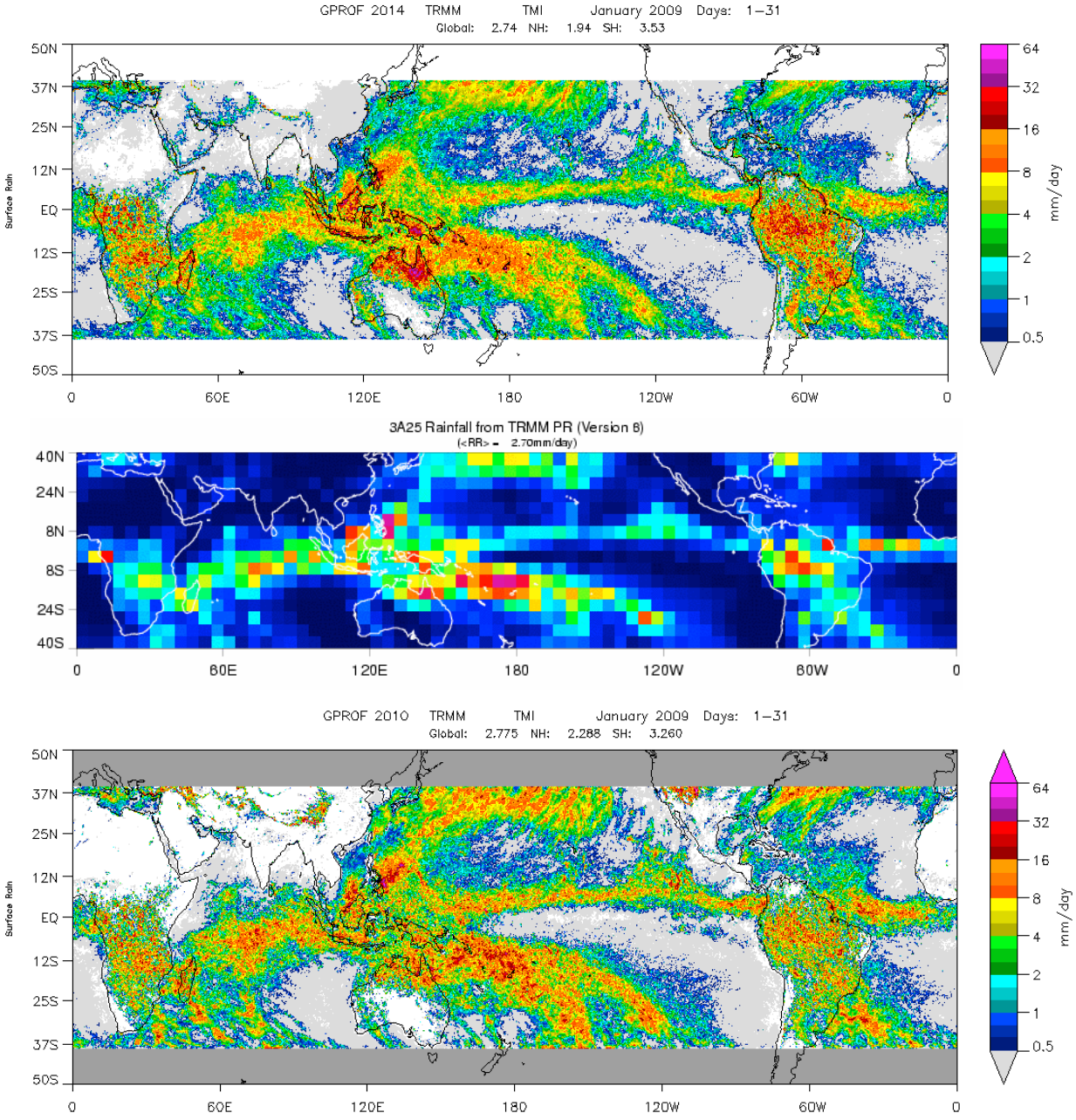
37V Ghz
Channel
Tbs


GPM GMI GPROF2014 S1 Rain Retrieval
Date/Time = 07/02/2012 02:03Z
Surface Precipitation
mm/hr
32
16
8
4
2
1
0.5
0.25
80.0N
60.0N
40.0N
20.0N
EQ
20.0S
40.0S
60.0S
80.0S
GPM GMI GPROF2014 S1 Rain Retrieval
Date/Time = 07/02/2012 02:07Z


F17 SSMIS GPM S1final Rain Retrieval
Date/Time = 01/03/2012 04:17Z
F17 SSMIS GPM S1final Rain Retrieval
Date/Time = 01/03/2012 23:09Z
Surface Precipitation
mm/hr
32
16
8
4
2
1
0.5
0.25
65.0N
60.0N
55.0N
50.0N
45.0N
40.0N
35.0N
30.0N
25.0N
170.0W
160.0W
150.0W
140.0W
130.0W
120.0W
110.0W

This is a comparison of GPROF2014 (top) and GPROF2010 (bottom) for TMI. The center panal is the PR for the same month (Jan 2009).

This plot of 2014 is from Version B1, released in November, 2012.



Validation

Pre-launch

- ☆ *Mainly agaisnt TRMM PR and NMQ*

Post-launch

- ☆ *Use use primarily the DPR and Combined algorithm to validate constellation radiometer precipitation by comparing statistics of coincident overpasses to draw out error statistics*

- ☆ *Team members to engage in PI-based research of algorithm deficiencies, error characterization and improvements.*

ATBD

- Will develop algorithm for 3 months
- Will use month 4 to document, distribute, and update ATBD

http://rain.atmos.colostate.edu/ATBD

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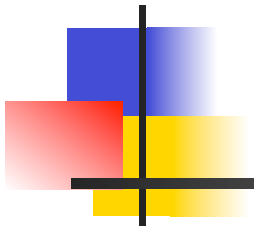

Summary