



NOAA GCOM-W1 PROJECT

Global Change Observation Mission 1st – Water “SHIZUKU”
(GCOM-W1)

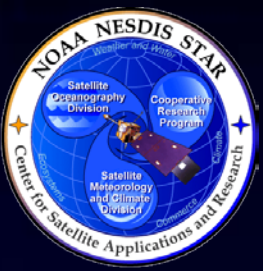
STAR GCOM-W1/AMSR2 Product Development and
Validation Project

Presented by Paul S. Chang



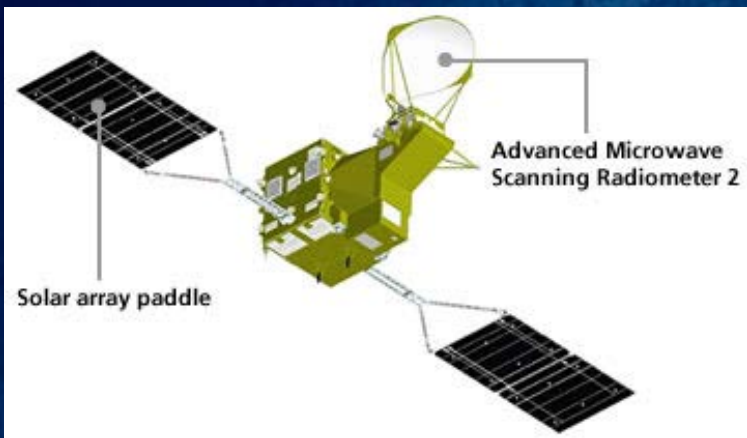
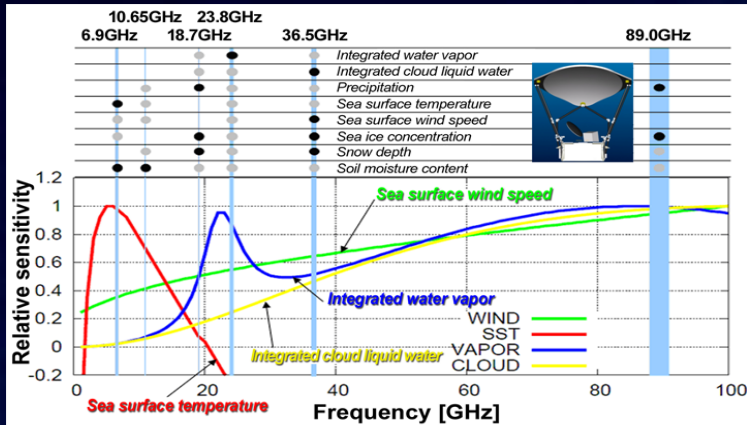
Ralph Ferraro, Zorana Jelenak, Suleiman Alsweiss, Patrick Meyers, Jun Park, Qi Zhu, Micah Baker, Xiwu Zhan, Jicheng Liu, Eileen Maturi, Fuzhong Weng, Andy Harris, Jeff Key, Cezar Kongoli, Walt Meier, Yong-Keun Lee, Walter Wolf, Tom King, Letitia Soullaird, Peter Keehn, Mike Wilson ...





GCOM-W1 AMSR2

- The "Global Change Observation Mission" (GCOM) was envisioned as a series of JAXA Earth observation missions spanning 10-15 years.
- GCOM is part of Japan's contribution to GEOSS (Global Earth Observation System of Systems)
- The GCOM program is comprised of two series of satellites:
 - » GCOM-W for water cycle observations
 - » GCOM-C for climate observations
- The GCOM-W1 was launched at 1:39am (JST) on May 18, 2012 and is the first satellite in the GCOM-W series.
- GCOM-W1 is part of the "A-Train" in a sun-synchronous orbit (~700 km altitude) with an ascending node equator crossing time of 13:30 UTC providing continuity of AMSRE





NOAA GCOM-W1 Project Responsibilities

The NOAA JPSS Office (NJO) is providing funding to OSD, STAR, and OSPO to operationally generate and make available AMSR2 SDR and EDR products to support NOAA's user needs.

OSD will develop a system called the GCOM-W1 Processing and Distribution System (GPDS) to perform the following tasks.

- » Ingest AMSR2 RDRs and ancillary data; Run the JAXA RDR-to-SDR software; Run the STAR GCOM-W1 AMSR2 Algorithm Software Processor (GAASP); Transfer products for distribution; Interact with OSPO monitoring and control systems.

STAR will:

- » Develop a software package, called the GCOM-W1 AMSR2 Algorithm Software Processor (GAASP), to generate the AMSR2 EDRs and perform product reformatting to netCDF4.
- » Develop operational documentation for the GAASP package and the EDR algorithms following existing SPSRB templates.
- » Deliver the GAASP and documentation to the OSD contractor for integration into their GPDS.

OSPO will:

- » Receive the GPDS (with JAXA and GAASP packages integrated into it) from the OSD contractor.
- » Operationally run and maintain the GPDS for the lifecycle of the project.



STAR GAASP Development

(Four Planned Deliveries)

Delivery 1:

- » Day 1 GAASP Product Capability
 - Microwave Brightness Temperature (MBT)
 - Cloud Liquid Water (CLW)
 - Sea Surface Temperature (SST)
 - » GAASP netCDF4 Reformatting Capability
 - » SPSRB documentation
- | |
|--------------------------------|
| Total Precipitable Water (TPW) |
| Precipitation Type/Rate (PT/R) |
| Sea Surface Wind Speed (SSW) |

Delivery 2

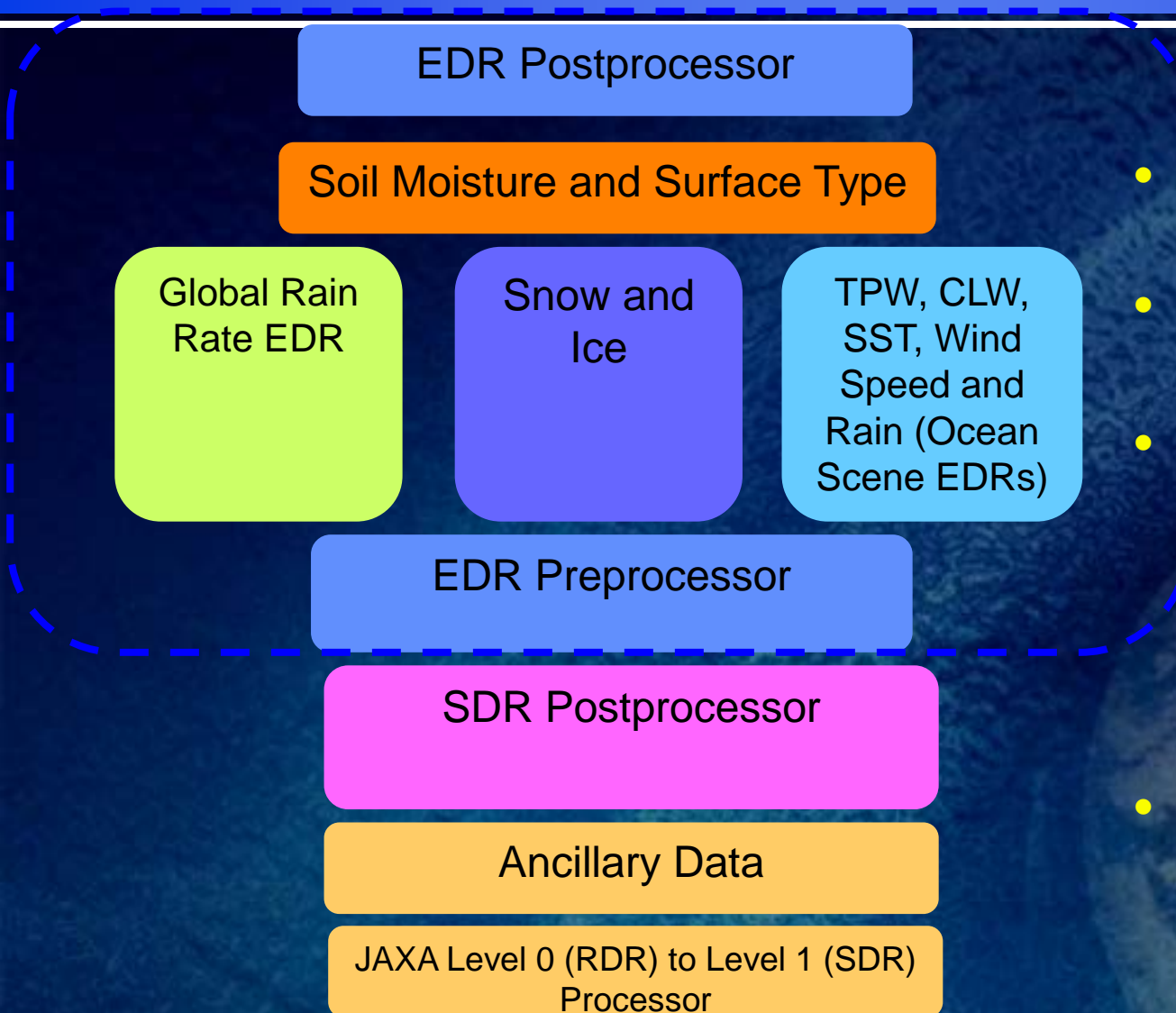
- » Day 2 GAASP Product Capability
 - Soil Moisture (SM)
 - Snow Cover/Depth (SC/D)
 - » Updated GAASP netCDF4 Reformatting Capability
 - » Updated SPSRB Documentation
- | |
|--------------------------------|
| Sea Ice Characterization (SIC) |
| Snow Water Equivalent (SWE) |

Delivery 3 and 4

- » Updates and enhancements to existing EDRs



NOAA AMSR-2 Processor Modular Approach



- SDR Postprocessor
 - » Address any AMSR2 residual calibration issues
- EDR Preprocessor
 - » Reformatting & flagging
 - » Prepare ancillary data
- EDR Modules
 - Ocean Scene EDRs (SST, SSW, TPW, CLW)
 - Global Rain Rate (Ocean, Land and Coastal Region)
 - Snow and Sea Ice
 - Soil Moisture
- EDR Postprocessor



AMSR2 On Orbit Calibration

- Well calibrated AMSR2 Tbs significantly improve the performance and accuracy of geophysical retrieval algorithms
 - » Identifying and correcting residual calibration biases in AMSR2 Tbs reduce retrievals errors

Double difference analysis utilized to characterize the brightness temperature performance

Data

AMSR2: L1B 2013 release (V1.1)

TMI: 1B11 V7 calibrated Tbs

AMSR2/TMI collocations

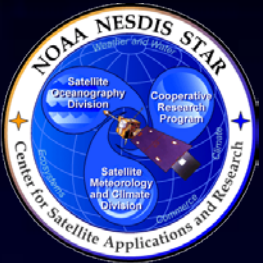
30 minutes time difference & 10 km spatial difference

Separated by channel & ascending/descending

Bad pixels excluded

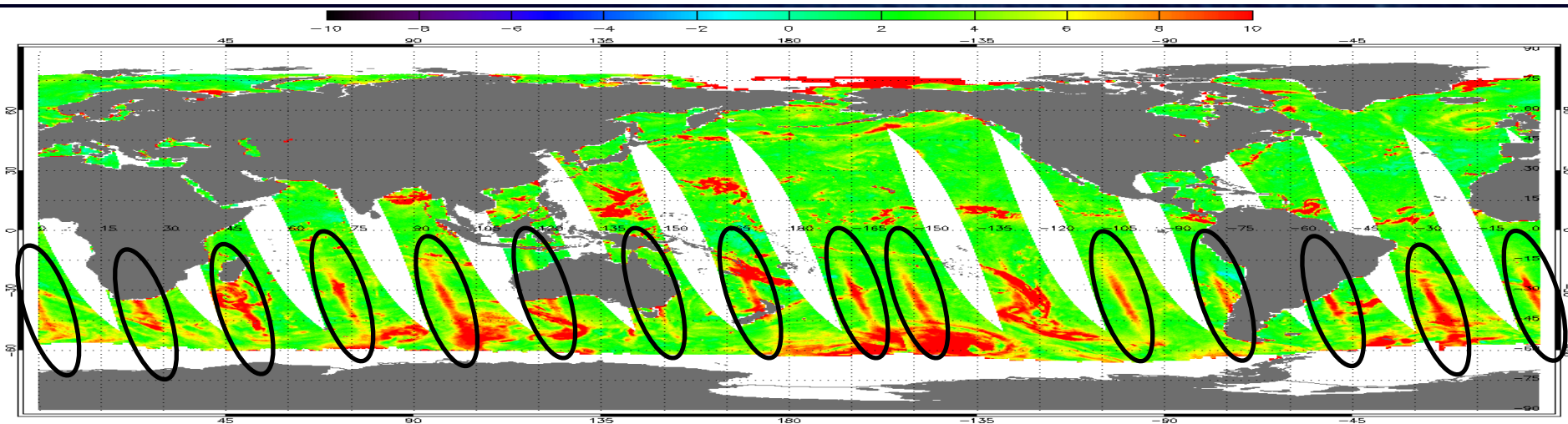
Rain & clouds using TMI EDR maps (Remote Sensing Sys.)

Sun glint & RFI

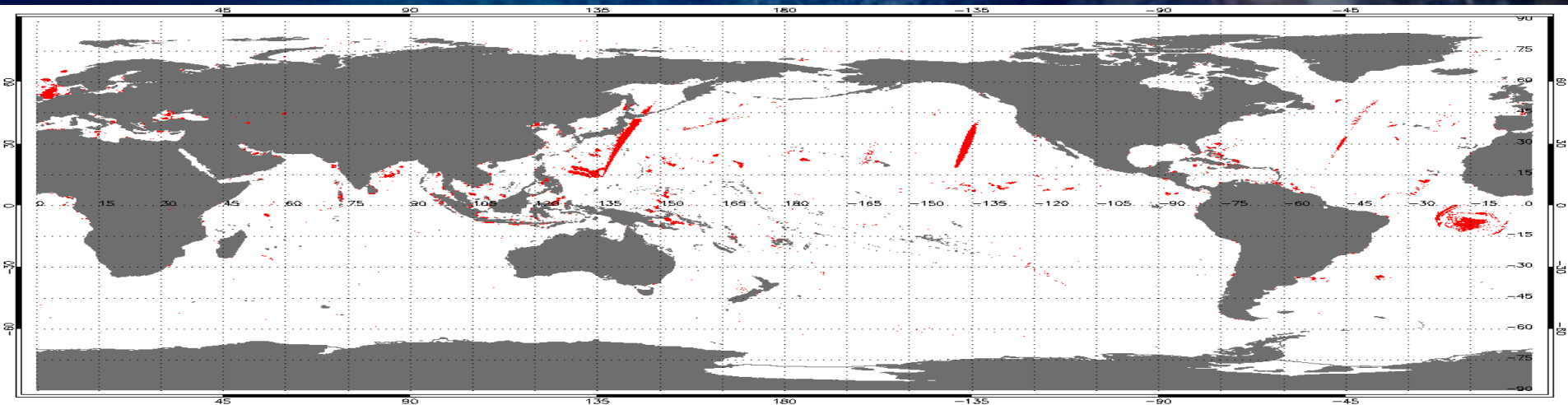


Sun Glint & RFI

Sun Glint: [Tbh6_L1B – Tbh6_sim.], 08/02/2012



C-band RFI: Abs(Tbv6_L1B – Tbv7_L1B.) > 3, 08/02/2012



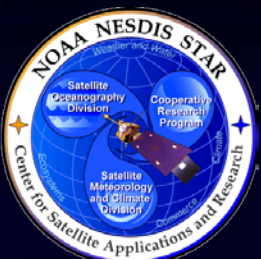


Oceanic Mean Calibration Biases

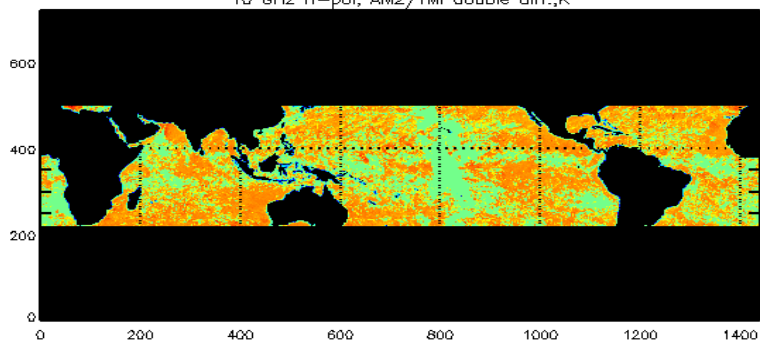
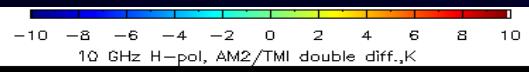
■ → After applying corrections

Channel	AMSR2 –TMI (ascending)		AMSR2 –TMI (descending)		AMSR2 –TMI (all)	
10V	4.4	-0.3	4.4	0.05	4.4	-0.23
10H	5.1	-0.2	4.9	0.22	5.0	-0.1
18V	3.8	-0.32	4.0	0.05	3.9	-0.2
18H	2.5	-0.33	2.2	0.14	2.4	-0.17
23V	4.0	-0.2	4.3	0.14	4.1	-0.18
23H	- -	- -	- -	- -	- -	- -
36V	4.4	0	4.9	0.09	4.6	0.03
36H	5.2	0.05	5.7	0.06	5.4	0.05
89V	2.8	-0.1	3.1	-0.02	2.9	-0.08
89H	3.5	0.03	4.0	0.03	3.6	0.03

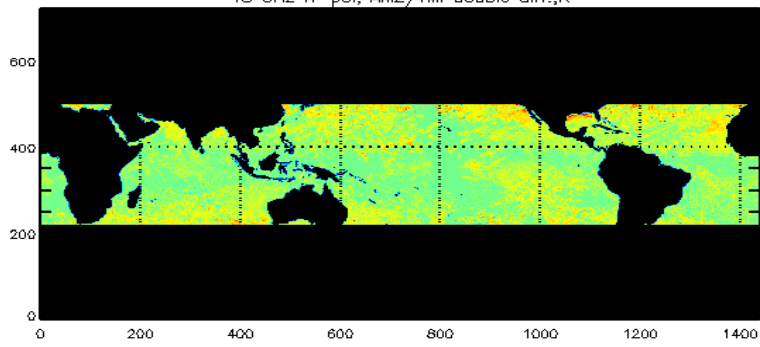
Actual biases are modeled as functions of AMSR2 Tb, so they are not just one number 8



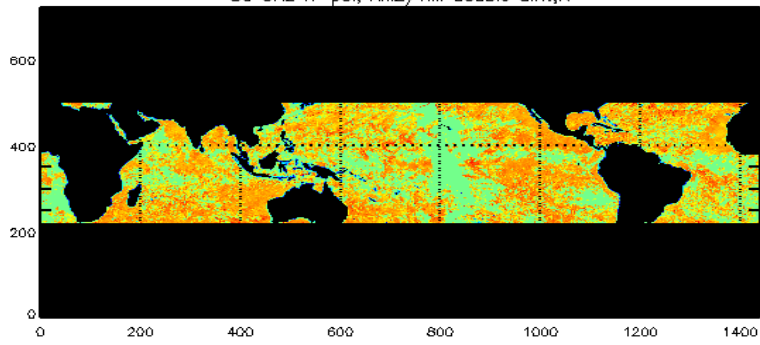
Double Difference Map Bias H-Pol



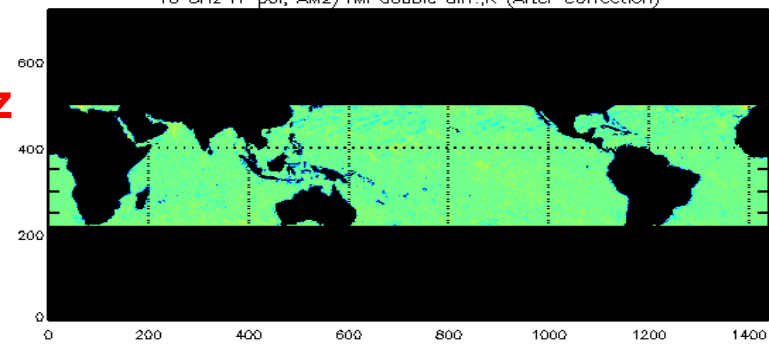
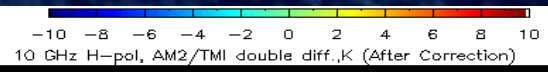
10 GHz H-pol, AM2/TMI double diff.,K



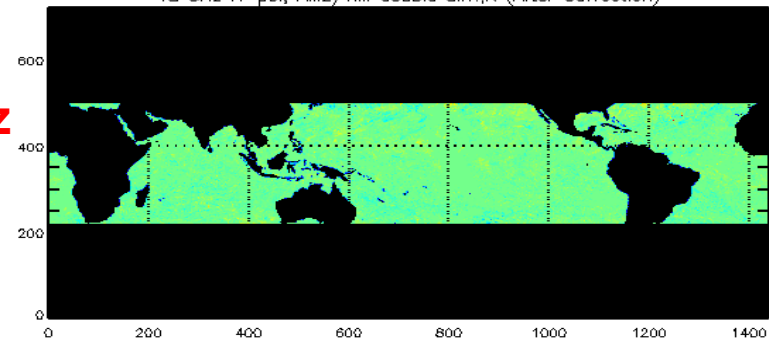
18 GHz H-pol, AM2/TMI double diff.,K



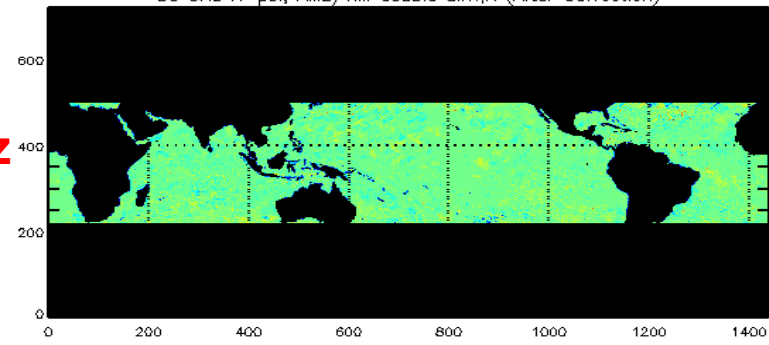
36 GHz H-pol, AM2/TMI double diff.,K



10 GHz H-pol, AM2/TMI double diff.,K (After Correction)



18 GHz H-pol, AM2/TMI double diff.,K (After Correction)

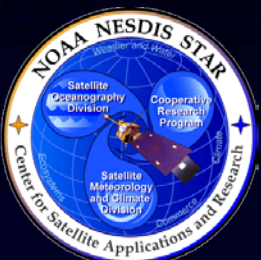


36 GHz H-pol, AM2/TMI double diff.,K (After Correction)

10Ghz

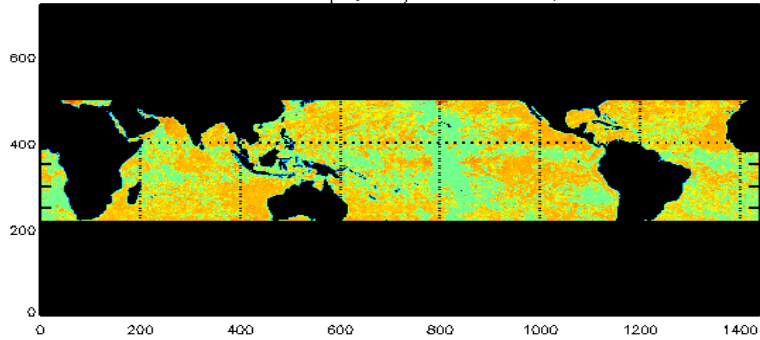
18Ghz

36Ghz

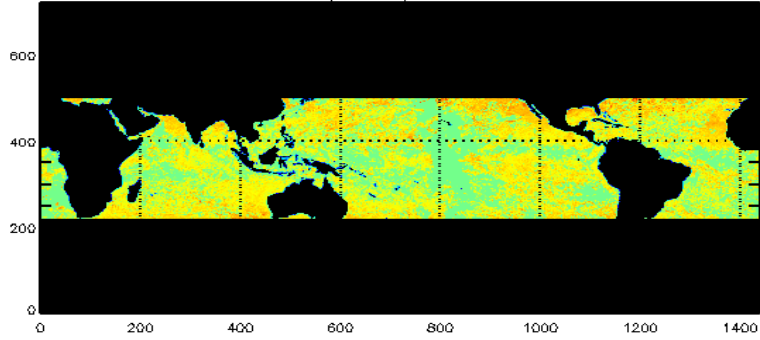


Double Difference Map Bias V-Pol

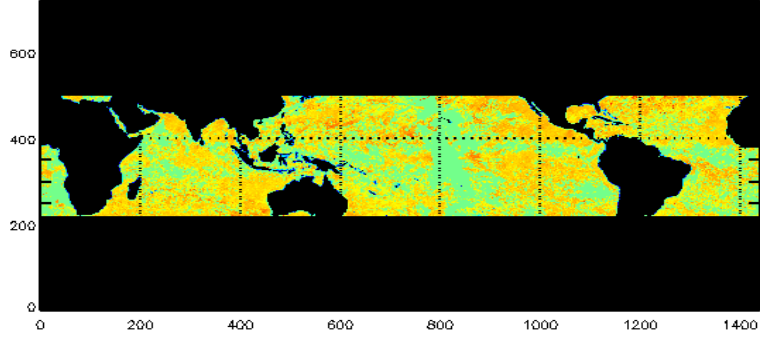
-10 -8 -6 -4 -2 0 2 4 6 8 10
10 GHz V-pol, AM2/TMI double diff.,K



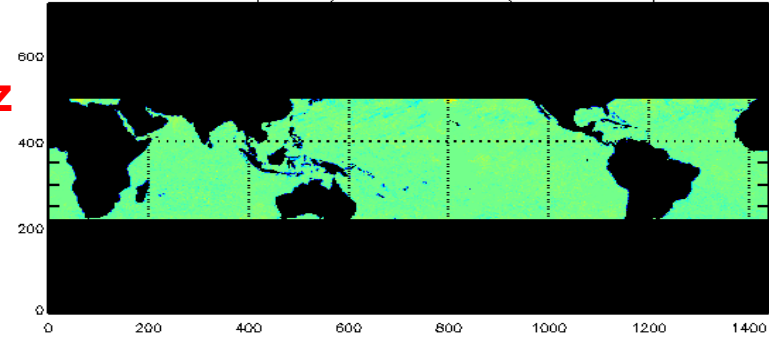
18 GHz V-pol, AM2/TMI double diff.,K



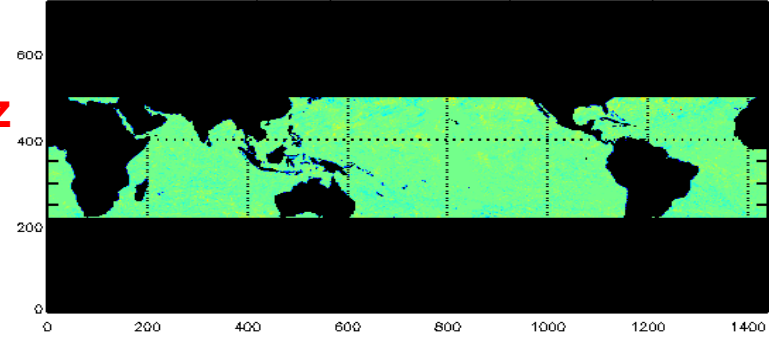
36 GHz V-pol, AM2/TMI double diff.,K



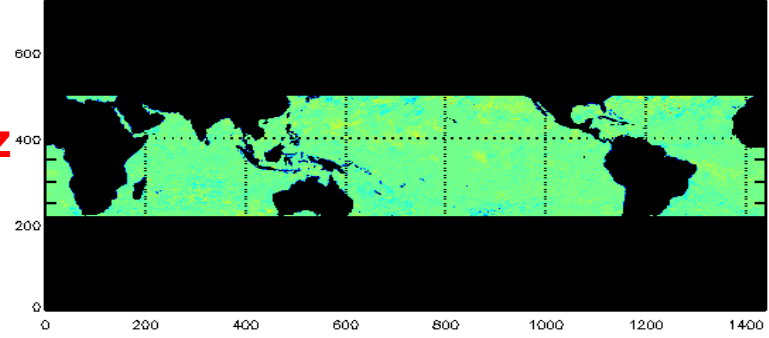
-10 -8 -6 -4 -2 0 2 4 6 8 10
10 GHz V-pol, AM2/TMI double diff.,K (After Correction)



18 GHz V-pol, AM2/TMI double diff.,K (After Correction)



36 GHz V-pol, AM2/TMI double diff.,K (After Correction)



10Ghz

18Ghz

36Ghz

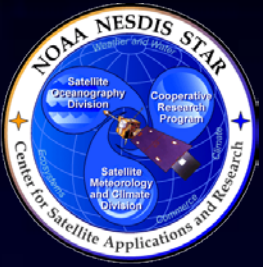


AMSR2 Oceanic EDR Validation



NOAA AMSR2 Ocean EDR Products

- Ocean Scene EDRs include
 - » Total Precipitable Water (TPW)
 - » Cloud Liquid Water (CLW)
 - » Sea Surface Wind Speed (SSW)
 - » Sea Surface Temperature (SST)
- **1st Delivery**
 - » **Multi stage regression ocean EDR algorithms**
- **2nd Delivery**
 - » Iterative multistage regression & Bayesian probability



Validation Data Set

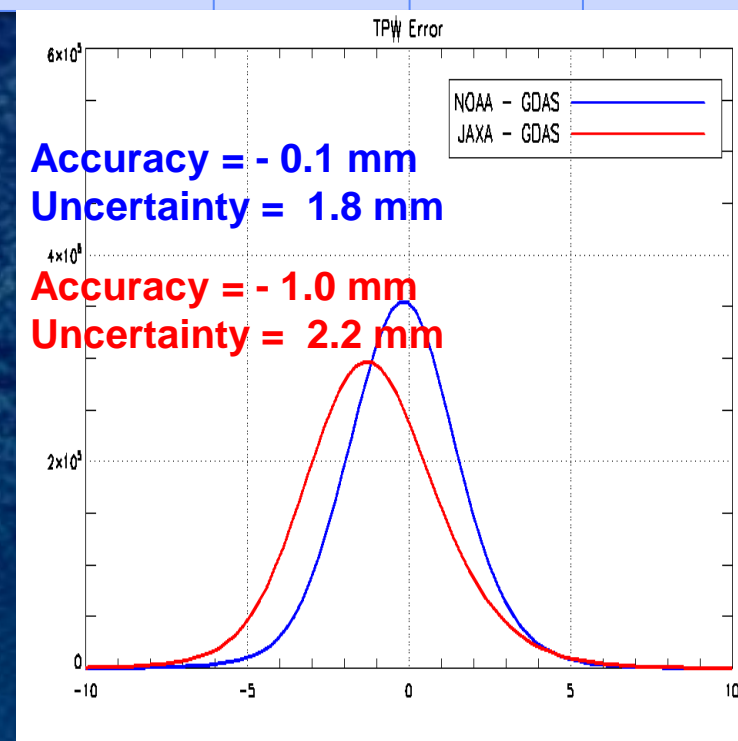
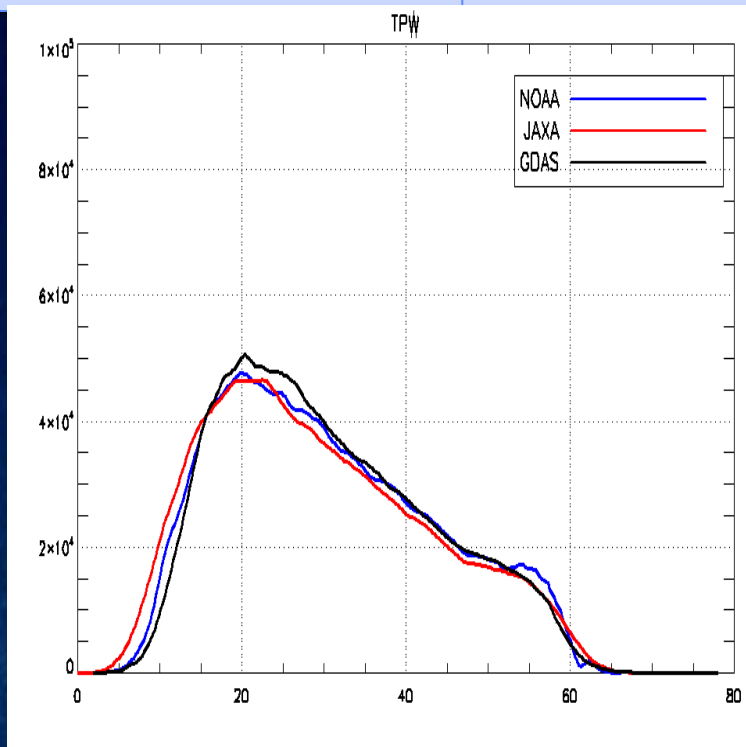
- Validation data set consists of one year worth of data
 - » Year 2013
 - » Several Data Sources
 - Models: GDAS, Reynolds SST
 - Data were spatially & temporally interpolated to AMSR2 observation time & location
 - Satellite measurements: TMI & NOAA-19
 - Collocation criteria: 10 km maximum distance & 30 minutes maximum time difference
 - Buoys: NCDC
 - Collocation criteria: 10 km maximum distance & 30 minutes maximum time difference



TPW Validation

GCOM Total Precipitable Water Requirements

EDR Attribute	Requirement	Status		
		GDAS	TMI	NOAA-19
<i>Measurement range</i>	1 – 75 mm			
<i>Measurement uncertainty</i>	2mm or 10% whichever is greater	1.8	1.1	1.4
<i>Measurement accuracy</i>	1 mm	0.1	0.0	0.7



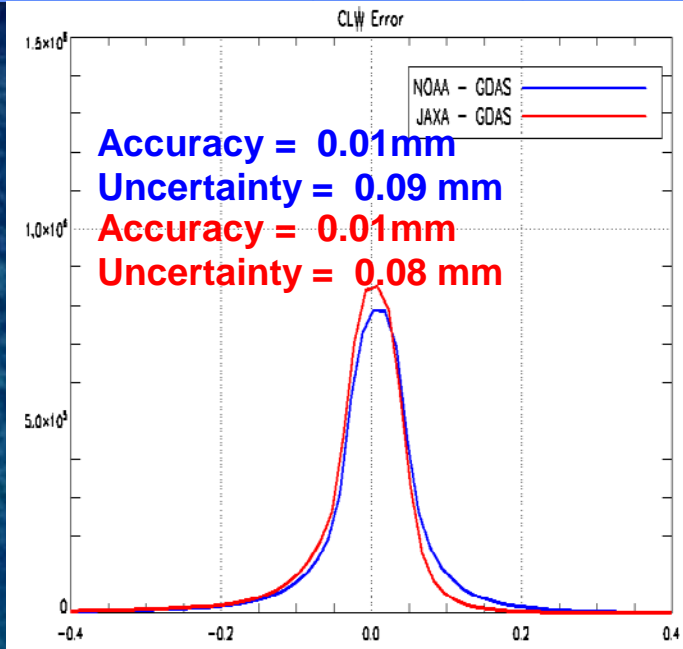
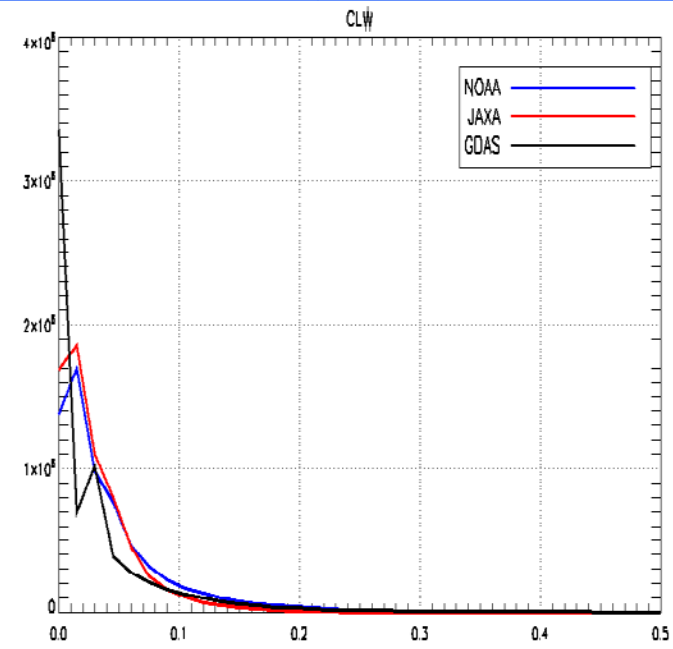


CLW Validation

* CLW changes fastest of all other parameters. Interpolated 6H models are not expected to agree well with instantaneous measurements from AMSR2

GCOM Cloud Liquid Water Requirements

EDR Attribute	Requirement	Status		
		GDAS	TMI	NOAA-19
<i>Measurement range</i>	0.005 – 1 mm			
<i>Measurement uncertainty</i>	0.05 mm over ocean	0.09 *	0.04	0.03
<i>Measurement accuracy</i>	0.01 mm	0.01	0.01	0.01

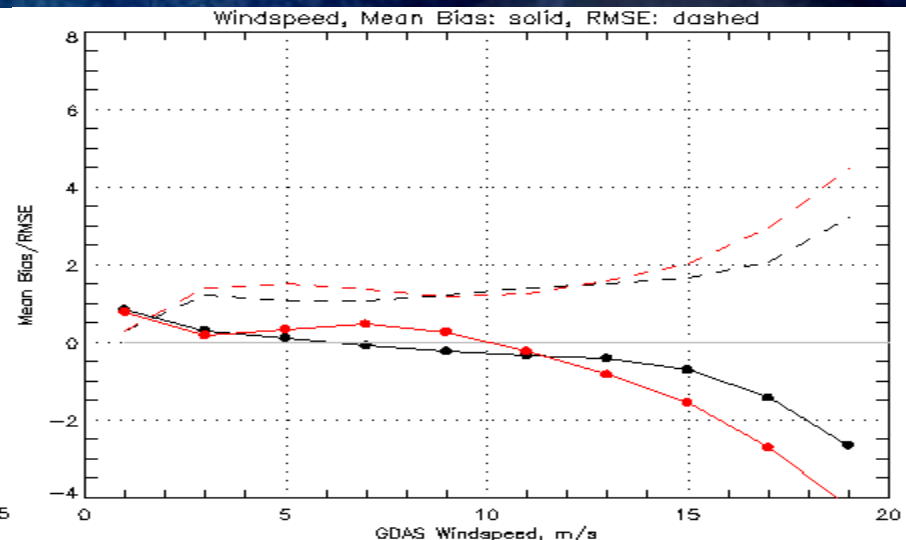
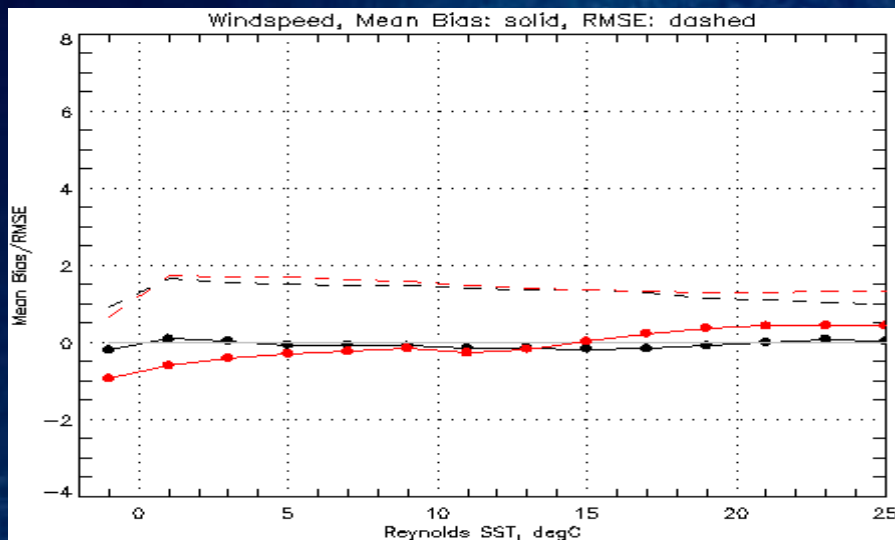




SSW Validation

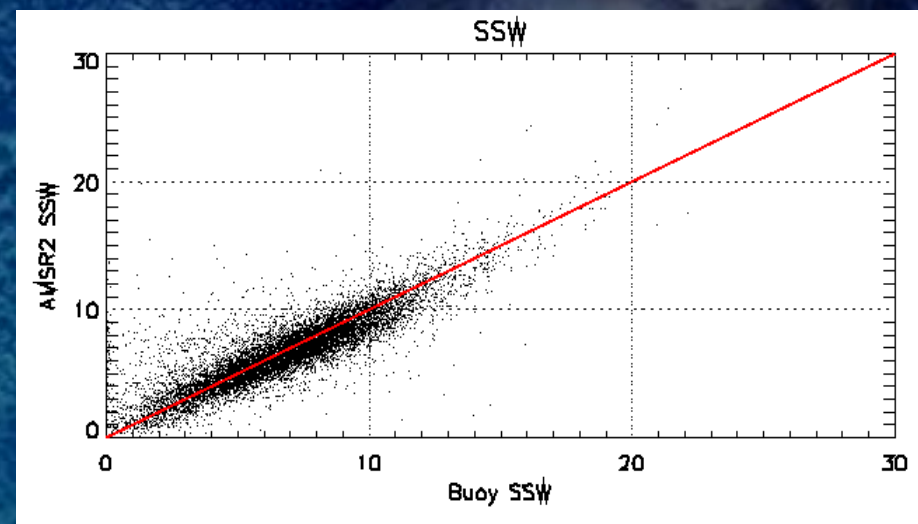
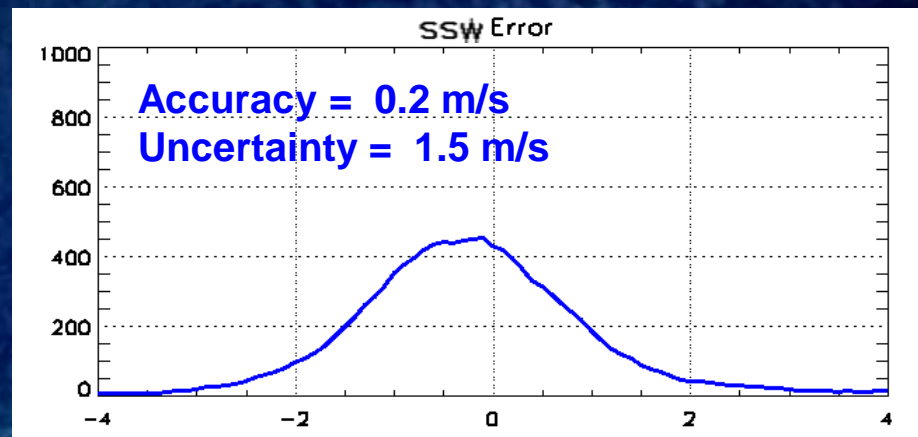
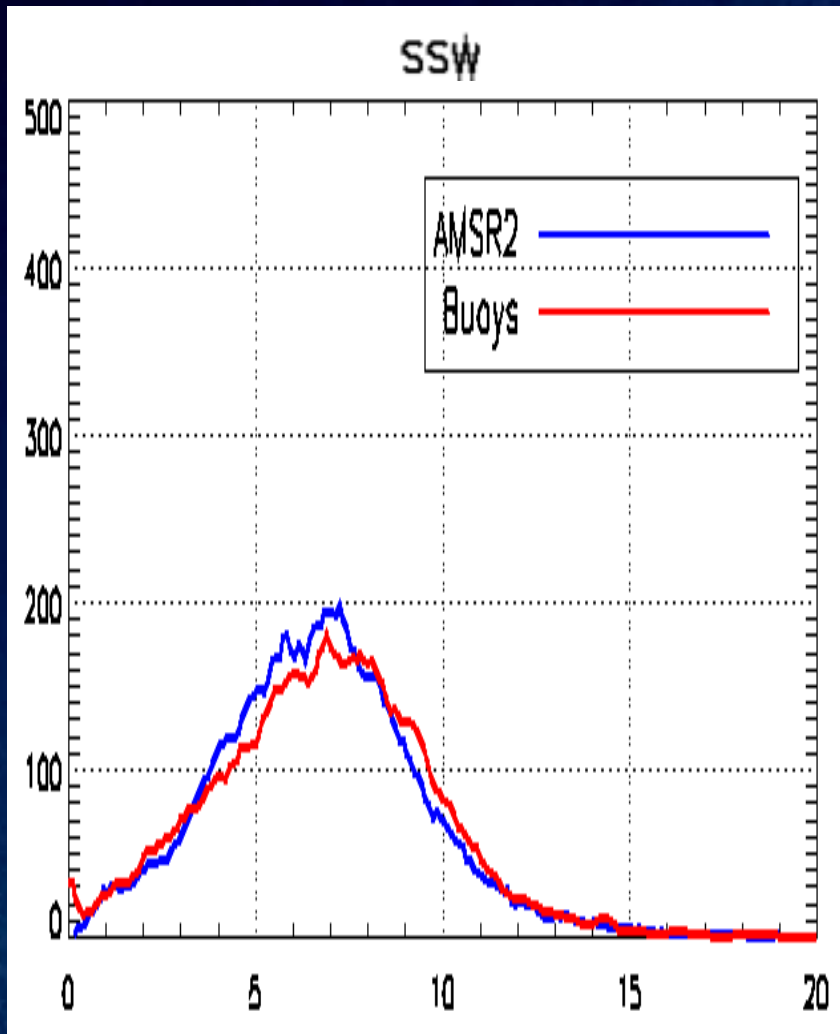
GCOM Sea Surface Wind Speed Requirements

EDR Attribute	Requirement	Status		
		GDAS	TMI	Buoys
<i>Measurement range</i>	2 – 30 m/s			
<i>Measurement uncertainty</i>	2 m/s or 10 % whichever is greater	1.3	0.9	1.5
<i>Measurement accuracy</i>	0.5 m/s	0.1	0.3	0.2





SSW Validation / GDAS

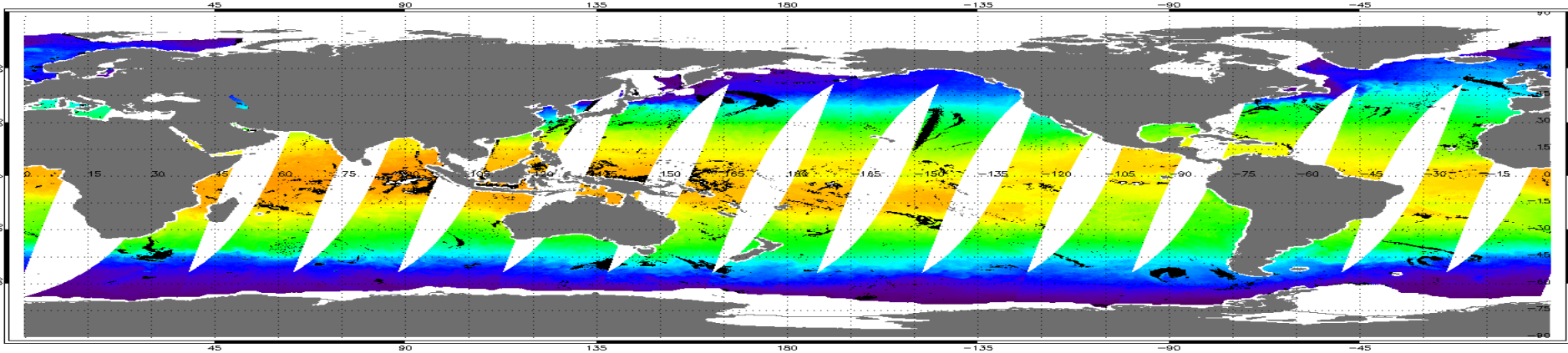




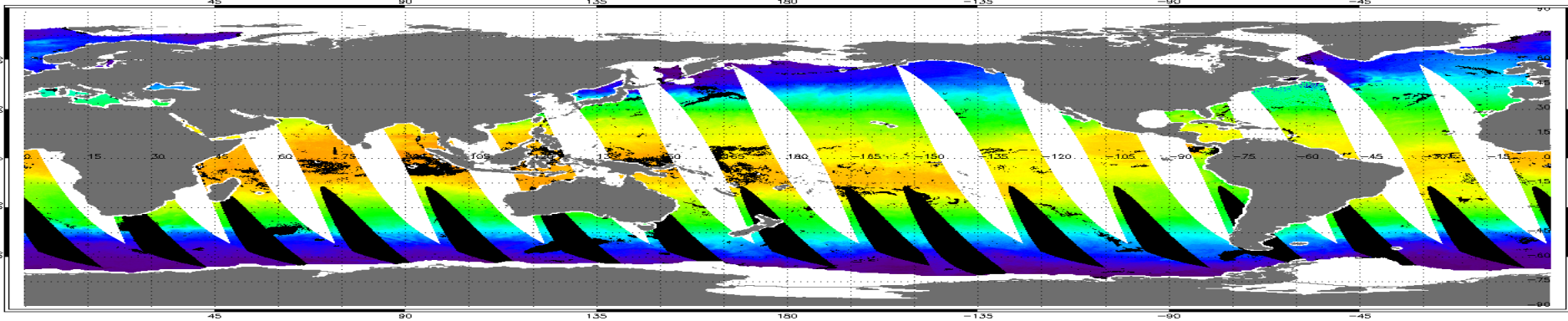
NOAA SST Example (04/01/2014)

% of flagged points (NOAA): ~ 11%

NOAA SST Des.



NOAA SST Asc.



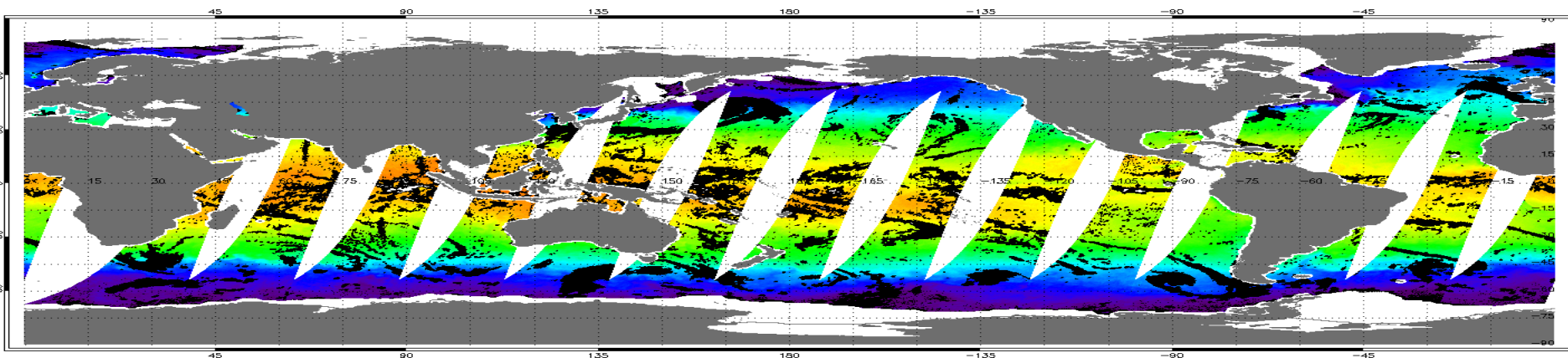


JAXA SST Example (04/01/2014)

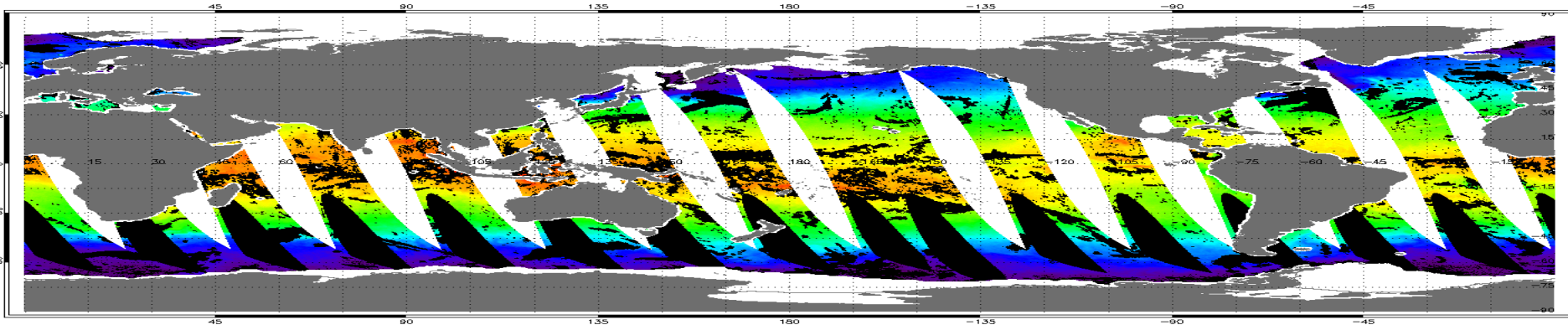
% of flagged points (JAXA): ~ 30%



JAXA SST Des.



JAXA SST Asc.





SST Validation

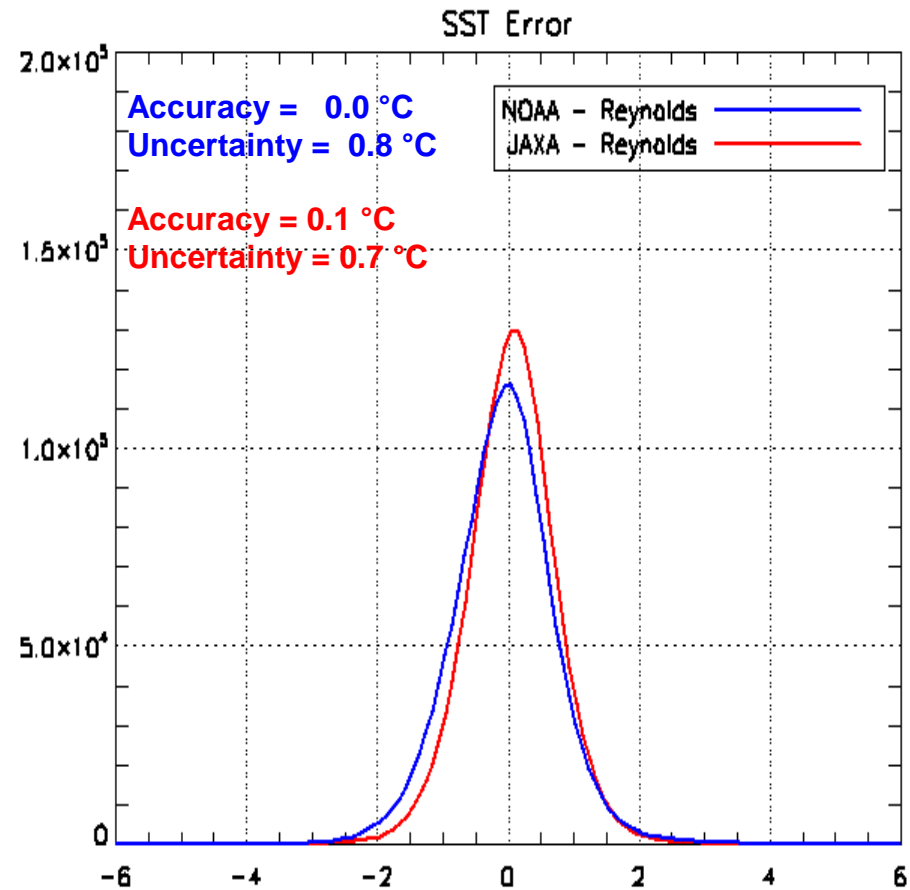
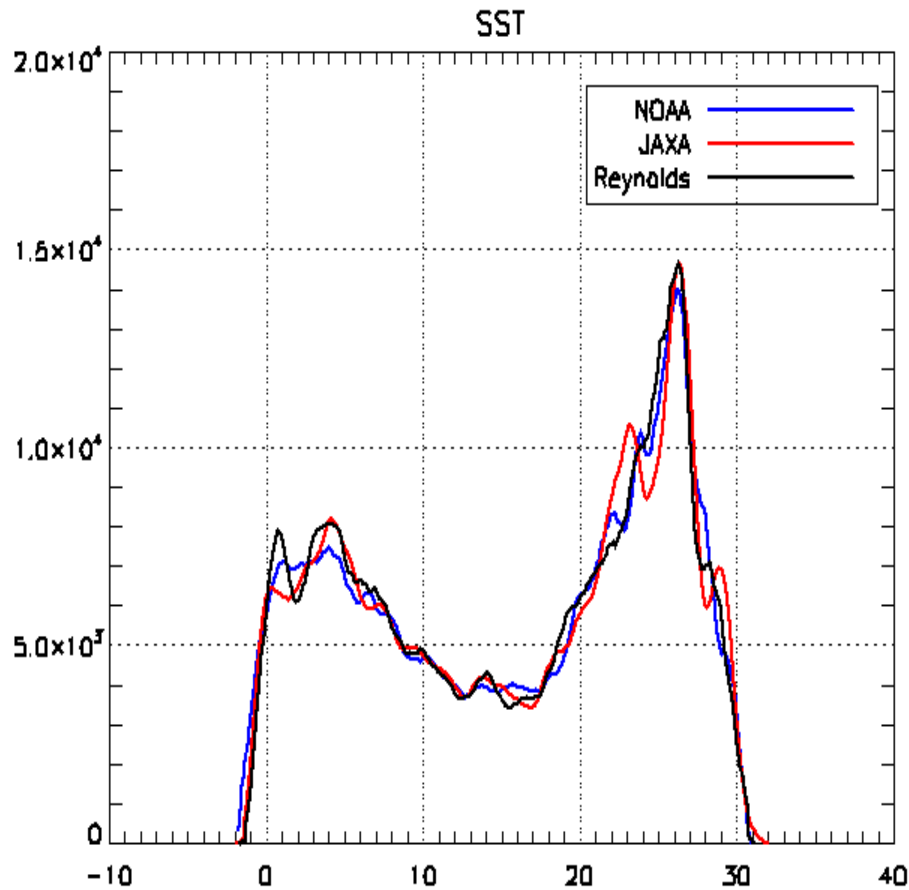
- Ancillary data for AMSR2 SST validation
 - » Models : Reynolds
 - » Measurements : TMI, Buoy

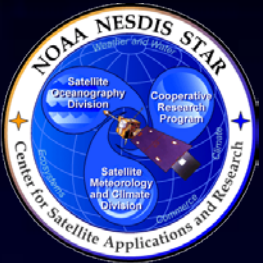
GCOM Sea Surface Temperature Requirements

EDR Attribute	Requirement	Status		
		Reynolds	TMI	Buoys
Measurement range	271 – 313 k			
Measurement uncertainty	1.0 k	0.8	0.9	0.8
Measurement accuracy	0.5 k	0.0	0.1	0.1

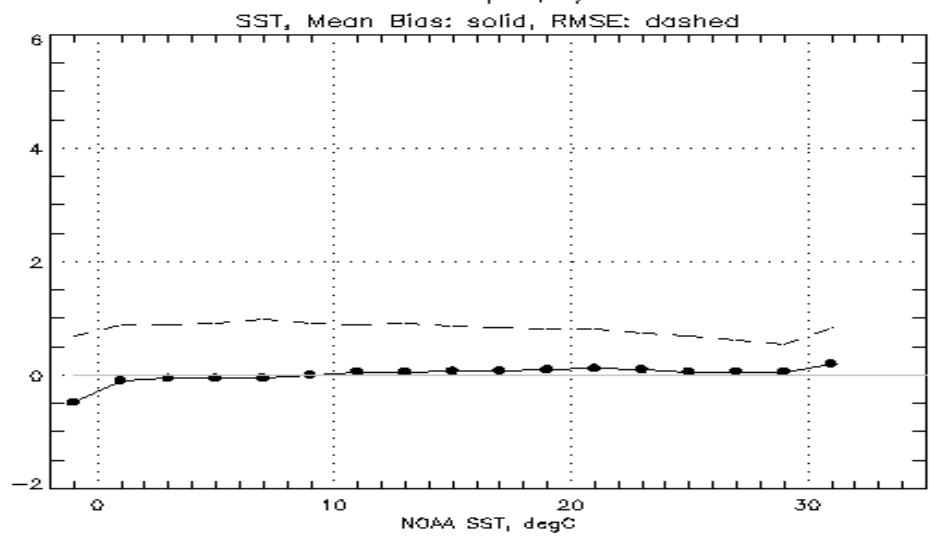
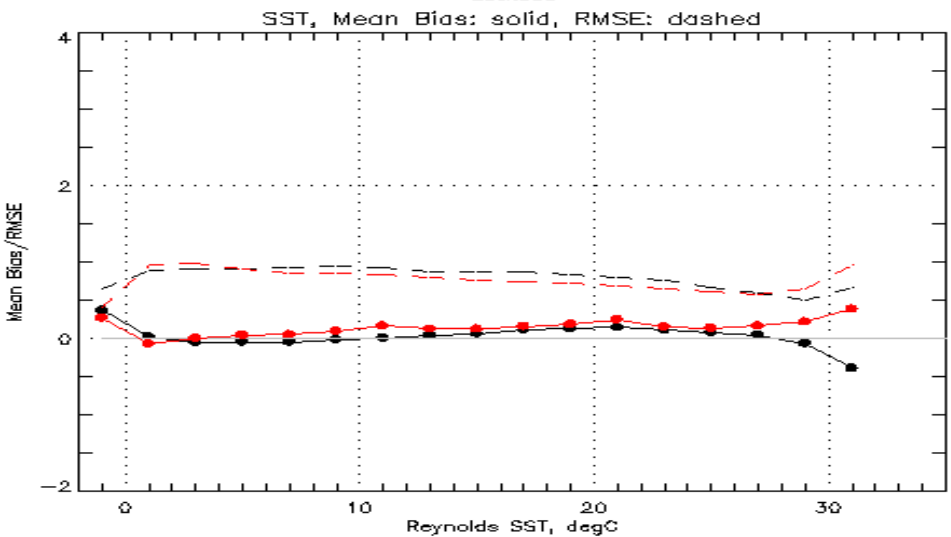
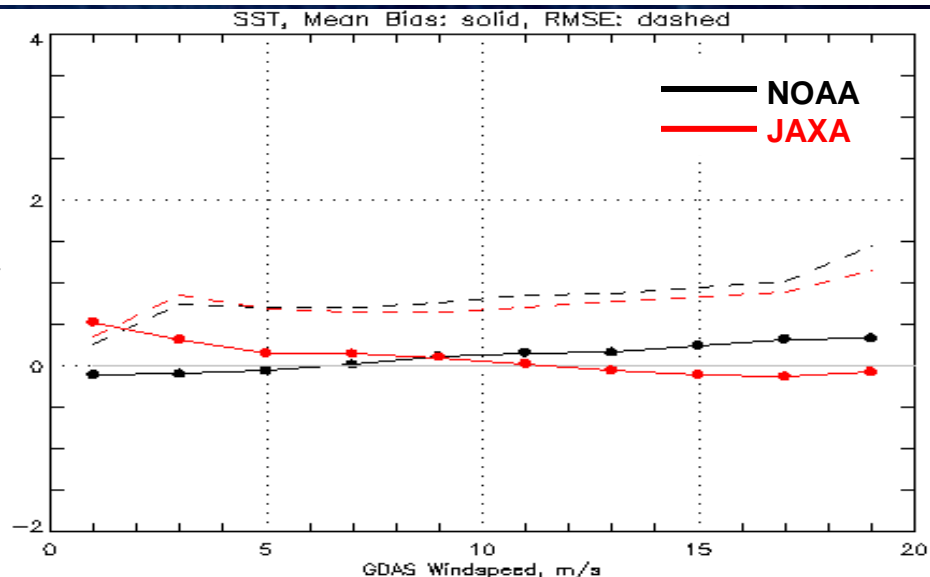
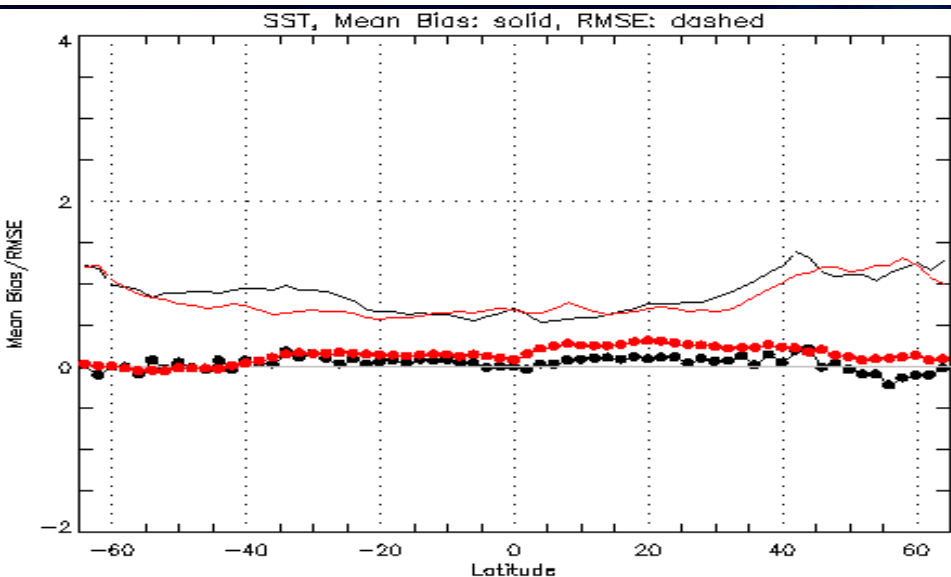


SST Validation / Reynold



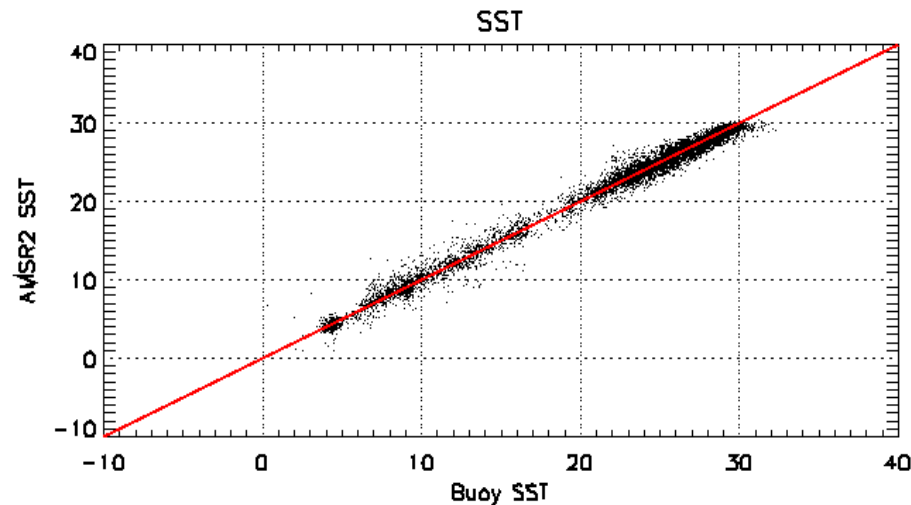
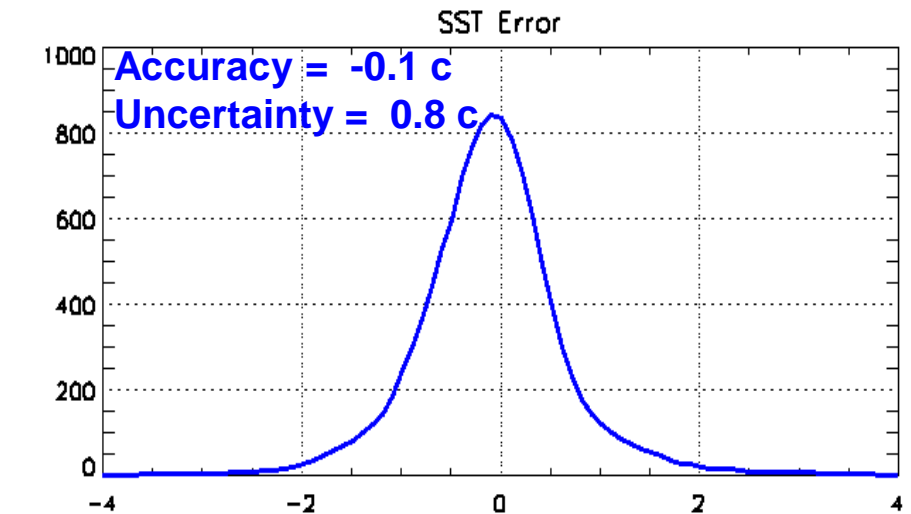
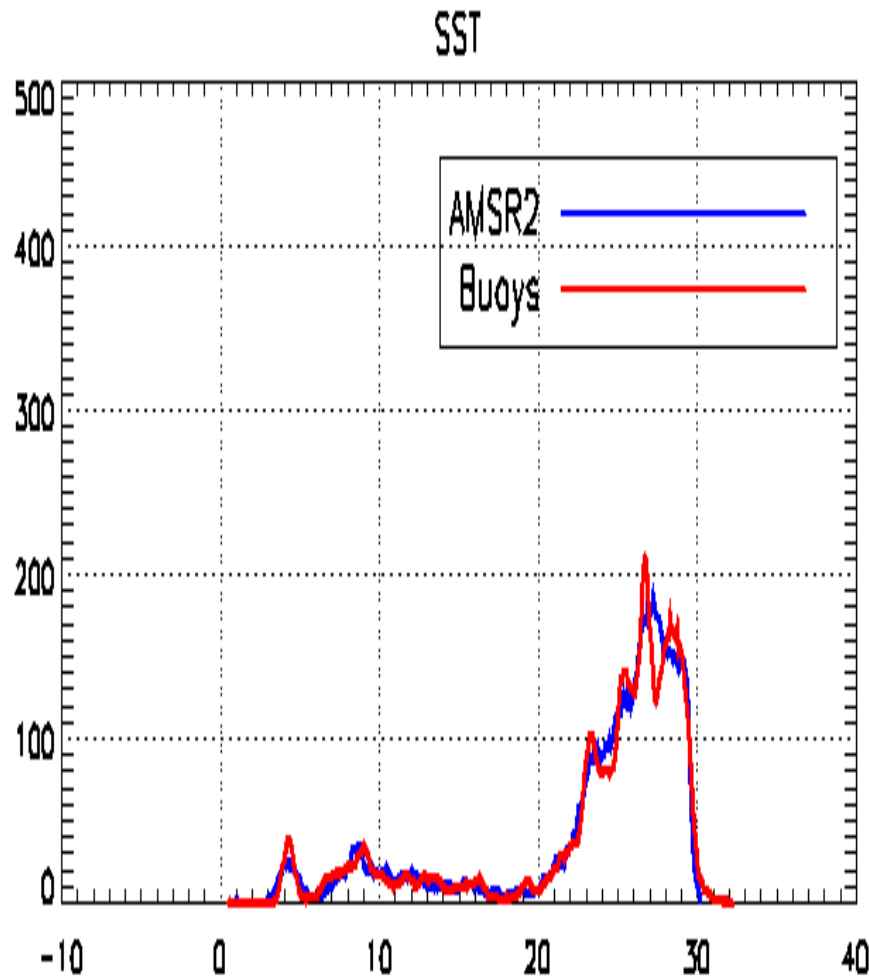


SST Validation / Reynold - cont.





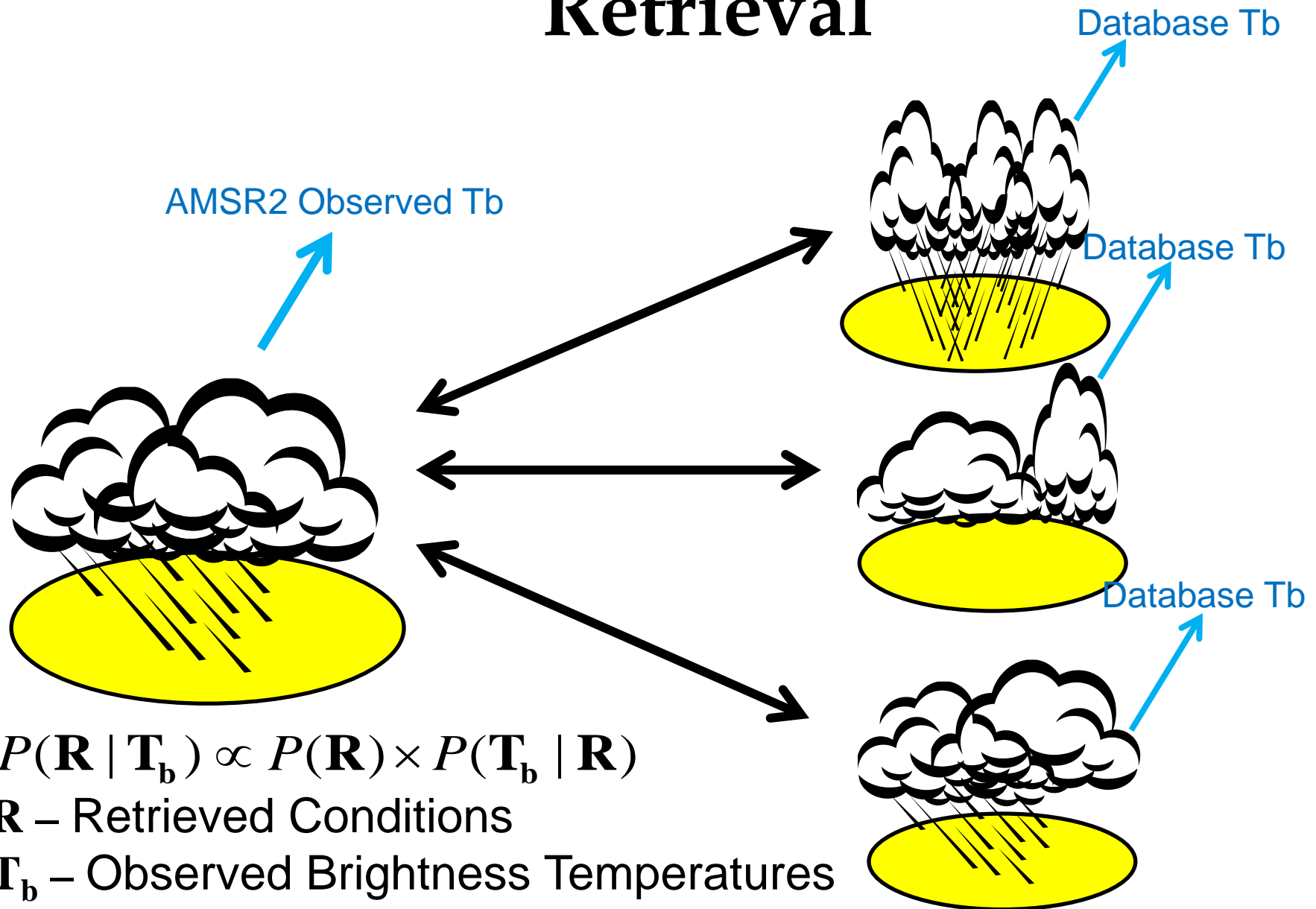
SST Validation / Buoys





AMSR2 Precipitation EDR Validation

Ocean Segment: Bayesian Retrieval





Land Segment: Semi-Empirical Calculation

- Developed for TRMM with training dataset from PR & TMI
 - » Requires adjustment from TMI to AMSR2 frequencies
- Separated into Convective/Stratiform rain rates

$$RR = RR_{Conv}P(C) + RR_{Strat}[1 - P(C)]$$

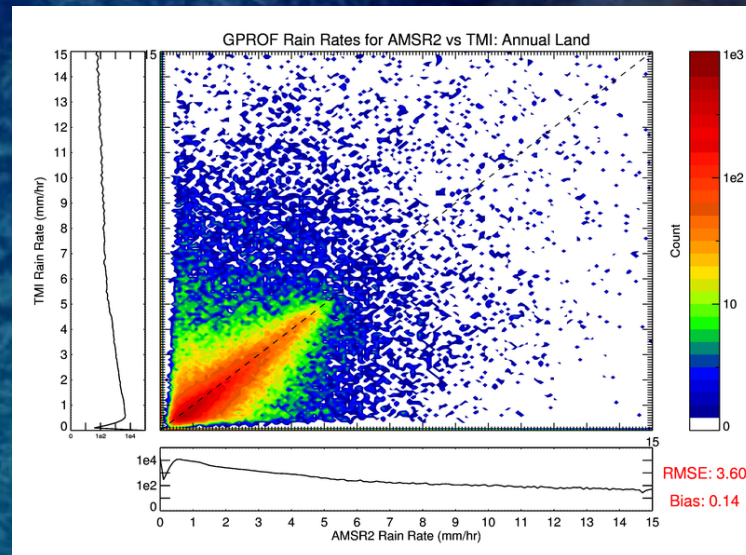
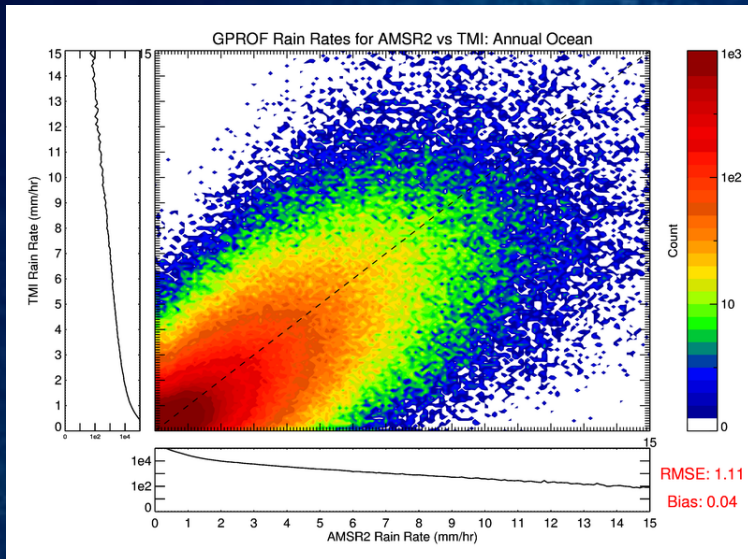
- $RR_{Conv} = (O_3(T89V))$; $RR_{Strat} = O_1(T89V)$
- $P(C[TbV(10, 37, 89), \sigma(T89V), \text{Minima of } T89V, [T89V-T89H]])$



AM2/TMI Validation: Precipitation Land and Ocean

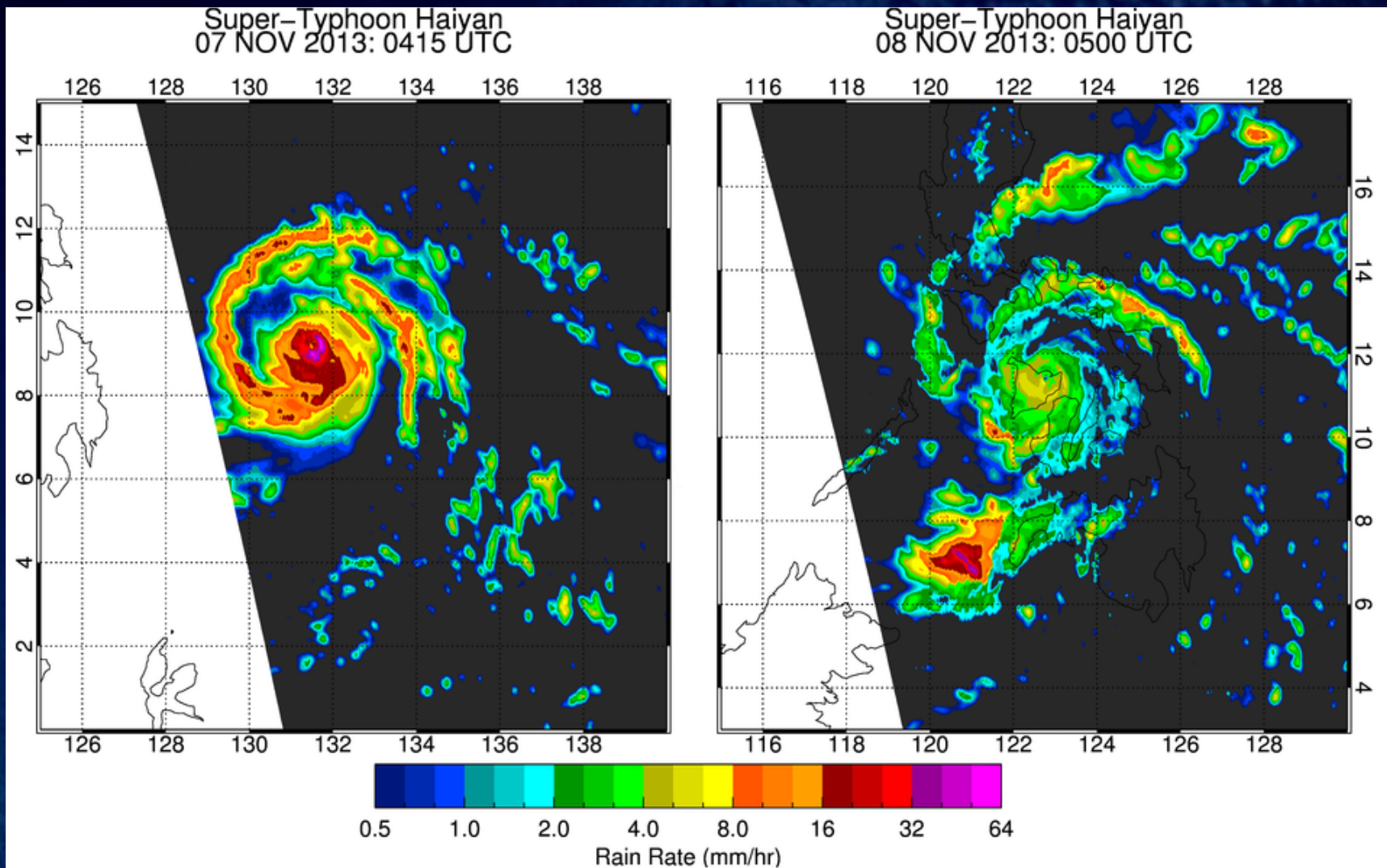
RMSD (mm/hr)	Land	Ocean	Overall
Requirements	5.0	2.0	—
TMI & TMPA	3.1	1.2	1.6
AMSR2 & TMI	3.6	1.2	1.8
AMSR2 & TMPA	3.1	1.4	1.9

- TMI: Similar sensor; Similar algorithm
- Collocation within 30 minutes and 10 km
- High quality retrieval for both instruments
 - » Land Flags: Snow/semi-arid/arid land
 - » Ocean Flags: Non-convergence of Bayesian retrieval, low-quality SST/TPW
- Validation for Jan-Dec 2013



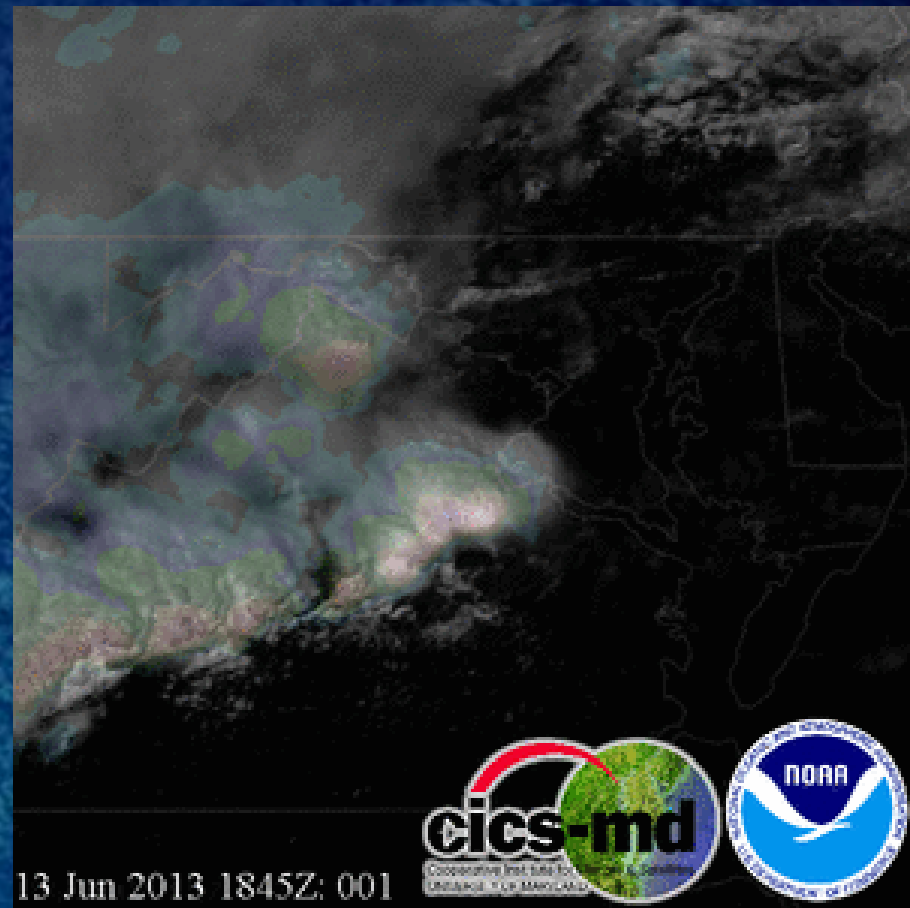
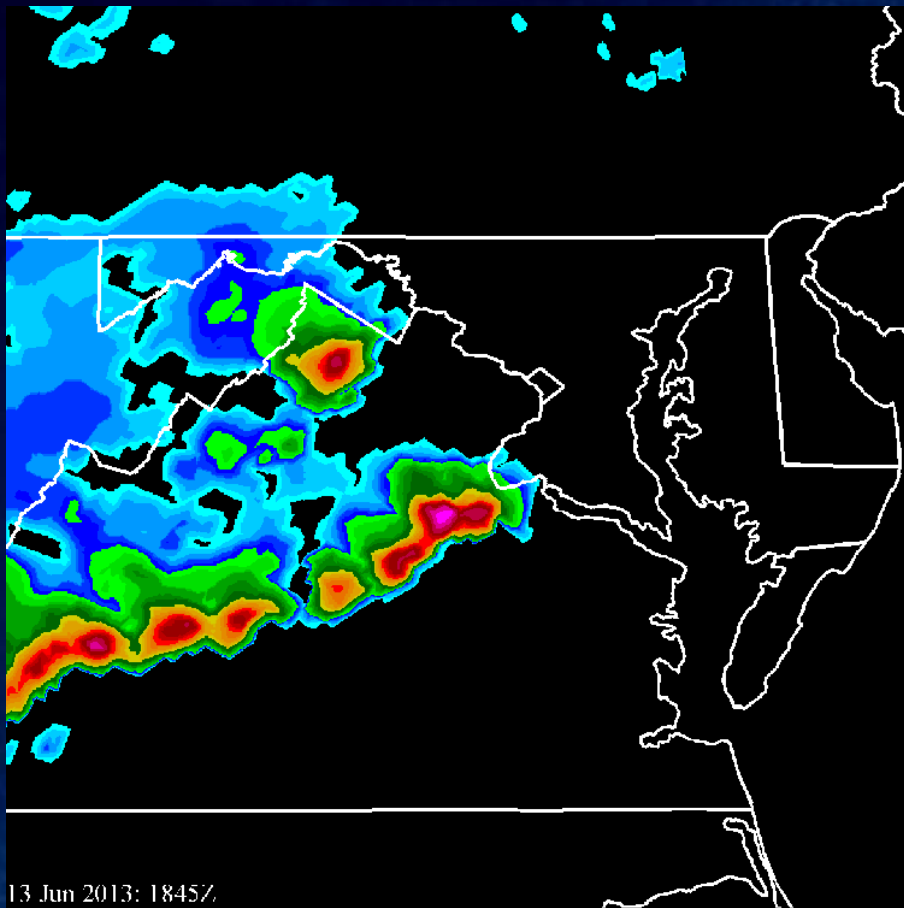


Super-Typhoon Haiyan





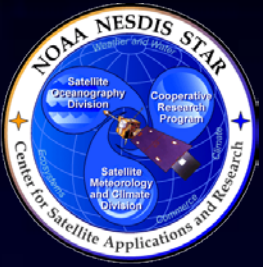
Tornado Outbreak 13 June 2013





Summary

- Double difference approach used to inter-calibrate AMSR2 residual biases in observed Tbs
- AMSR2 measures warmer Tbs when compared to TMI
 - » AMSR2 L1B V1.1
 - » TMI 1B11 V7
- Corrected AMSR2 Tbs were used in EDR products
 - » TPW, CLW, SST, SSW and Precipitation

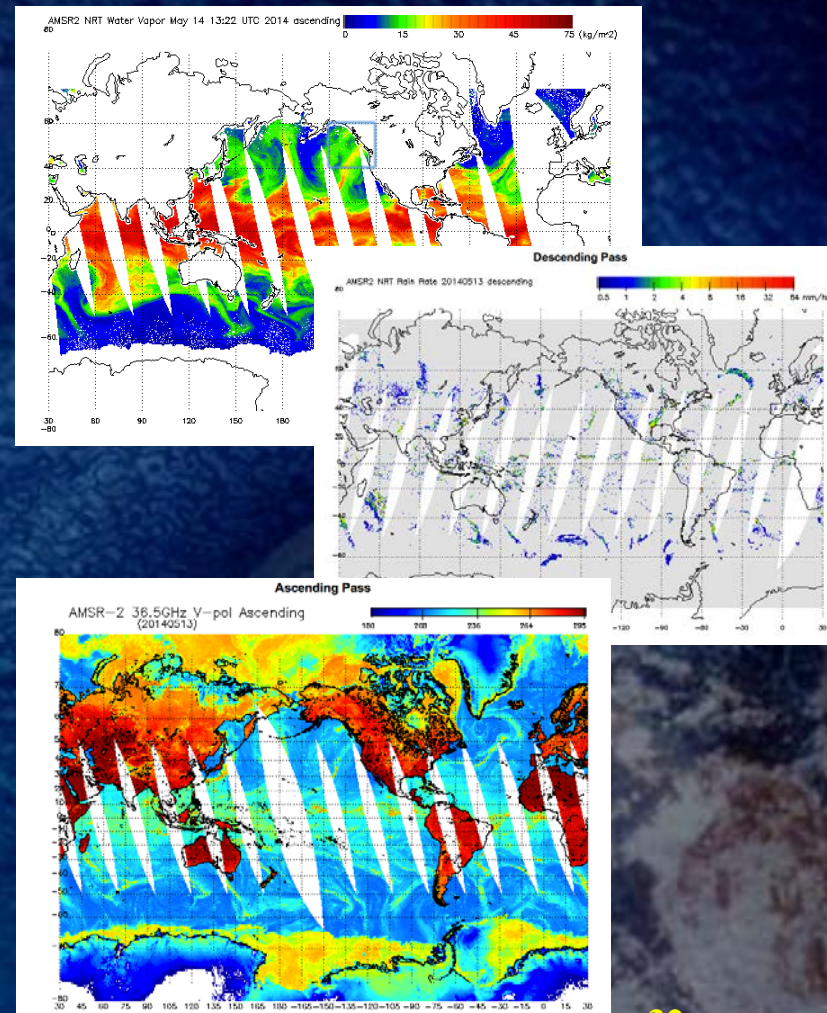
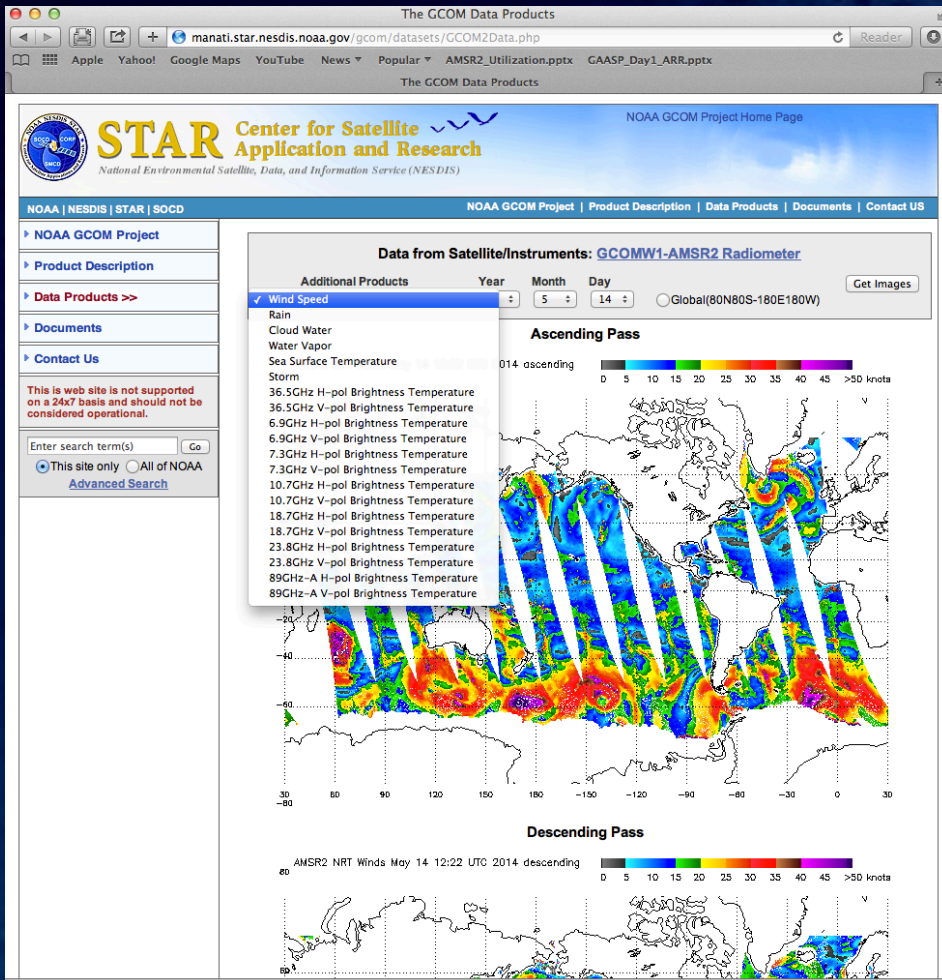


Summary – cont.

- 1st delivery EDR products were validated against several other products
 - » Models
 - GDAS
 - Reynolds
 - » Measurements
 - NOAA-19
 - TMI
- Validations results show that AMSR2 1st delivery EDRs meet accuracy requirements



STAR GCOM-W1 AMSR2 Web Page



<http://manati.star.nesdis.noaa.gov/gcom>