GCOM-W1 AMSR2 Algorithm Software Processor (GAASP)

Day 2 Products Algorithm Readiness Review

May 9, 2016

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[1]IMSG
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[4]NASA
[5]GST

Review Agenda

Section	Time	Presenter
Introduction	1:00 – 1:10	Tom King
Day 1 ORR Report	1:10 – 1:15	Tom King
Requirements	1:15 – 1:20	Tom King
Software Architecture	1:20 – 1:35	Letitia Soulliard
Validation: Soil Moisture EDR	1:35 – 2:00	Jicheng Liu
Validation: Sea Ice EDR	2:00 – 2:25	Walter Meier
Validation: Snow EDR	2:25 – 2:50	Jeff Key
Validation: Ocean EDR	2:50 – 3:50	Suleiman Alsweiss
Validation: Unit Tests and Final DAP	3:50 – 4:15	Letitia Soulliard
Risk Summary	4:15 – 4:25	Tom King
Summary and Conclusions	4:25 – 4:30	Tom King

Review Outline

- Introduction
- Day 1 ORR Report
- Requirements
- Software Architecture
- Validation
- Risk Summary
- Summary and Conclusions

Introduction

Presented by

Tom King

GCOM

- The "Global Change Observation Mission" (GCOM) is a series of JAXA Earth missions lasting 10-15 years designed to obtain observations related to water and climate.
- The GCOM-W1 platform was launched May 18, 2012 and is the first satellite of the GCOM-W series.
- GCOM-W1 is in a sun-synchronus orbit (~700 km altitude) and part of the “A-Train” with an ascending node equator crossing time of 13:30 UTC.
- The AMSR2 (Advanced Microwave Scanning Radiometer 2) instrument onboard the GCOM-W1 satellite will continue Aqua/AMSR-E observations of water vapor, cloud liquid water, precipitation, SST, sea surface wind speed, sea ice concentration, snow depth, and soil moisture..

Stakeholder Roles

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

- OSGS/NDE
  - » Develop the NDE system
    - – Ingest AMSR2 RDRs and ancillary data.
    - – Run the GRAC (RDR-to-ASD converter).
    - – 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.
  - » Integrate science algorithm packages received from STAR
  - » Conduct system tests and deliver the system to OSPO

Stakeholder Roles

- 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 NDE for integration into their system.
  - » Develop and deliver tailoring capabilities for BUFR and/or GRIB2 in the Tailoring Toolkit.

- OSPO will:
  - » Receive the NDE system (with JAXA and GAASP packages integrated into it).
  - » Operationally run and maintain the NDE system for the lifecycle of the project.
  - » Conduct product quality monitoring through the OSPO Product Monitoring System.

GCOM-W1 Project Organization

Customers/Users
NWS (CPC, OPC, CPC, NHC), NAVO, NIC, STAR, NCEI/CLASS

NJO
Harry Cikanek (Director)
Ajay Mehta (Deputy Director)
Mitch Goldberg (Program Scientist)
Stephen Walters (Ground Systems)

Data Providers
JAXA, KSAT

Project Manager - Kirk Liang
Project Scientist – Paul Chang

OSGS/ESPDS
Rick Vizbulis (ESPDS PM)
Kirk Liang (GCOM PM)
Tom Schott (System Requirements)
Arron Layns (System Requirements)
Geoff Goodrum (System Interface - NDE)

STAR
Paul Chang (STAR Project Lead)
Ralph Ferraro (STAR Project Deputy)
Walter Wolf (Integration Lead)
Zorana Jelenak (EDR lead)

OSPO
Limin Zhao (OSPO GCOM-W1 Project Lead, PAL)
Donna McNamara (ESPC Distribution)
Paul Haggerty (ESPC Operations Team Lead)
Zhaohui Cheng (Quality Monitoring)

NDE Team
Peter MacHarrie (Integration)
Dylan Powell (Integration)

SDR Validation & Monitoring
Zorana Jelenak (Lead)
Suleiman Alsweiss – Support

EDR Development and Validation
Zorana Jelenak (Lead)
Jun Park - EDR Science Support
Patrick Meyers – EDR/Precipitation Science Support
Suleiman Alsweiss – SDR/EDR Science Support
Qi Zhu – Scientific Programming Support
Mark Romer – IT support
Jeff Key – Science Lead (ice/snow)
Walt Meir – Science Support (ice)
Cezar Kongoli – Science Support (snow)
Eileen Maturi/Andy Harris – Science Support (SST)
Xiwu 'Jerry' Zhan – Science Lead (soil moisture)
Jicheng Liu – Science Support (soil moisture)

GAASP Development
Tom King (Development Lead)
Letitia Soulliard (Development)
Michael Wilson (Algorithm Integration)
Peter Keehn (Algorithm Integration)
Yunhui Zhao (CM)
Larisa Koval (Documentation)
Yi Song (BUFR/GRIB2)

STAR GAASP Development

- GAASP development will result in 4 deliveries:

- Day 1 Delivery:
  - Products
    - Microwave Brightness Temperature (MBT)
    - Total Precipitable Water (TPW)
    - Cloud Liquid Water (CLW)
    - Sea Surface Temperature (SST)
    - Sea Surface Wind Speed (SSW)
    - Precipitation Type/Rate (PT/R)
  - Reformatting Capability for MBT and SST into BUFR
  - SPSRB documentation

STAR GAASP Development

- Day 2 Delivery:
  - » Products
    - – Snow Cover/Depth (SC/D)
    - – Snow Water Equivalent (SWE)
    - – Sea Ice Characterization (SIC)
    - – Soil Moisture (SM)
    - – Surface Type (ST)
  - » Reformatting Capability for Sea Ice into GRIB2
  - » Updated SPSRB Documentation

- Day 3 and 4 Delivery:
  - » Updates and enhancements to existing EDRs

Project Timeline

- Preliminary Design Review – 11/08/2012
- Critical Design Review – 5/1/2013
- Code Test Review – 8/1/2013
- Software Code Review – 9/18/2013
- Day 1 Algorithm Readiness Review – 4/10/2014
- Day 1 Preliminary DAP delivery – 12/09/2014
- Day 1 Operational Readiness Review – 8/21/2015
- Day 1 Final DAP delivery – 4/28/2015
- Day 2 Preliminary DAP delivery – 10/5/2015
- Day 1 SPSRB briefing – 10/21/2015
- Day 2 Final DAP delivery – 3/22/2016
- Day 2 Algorithm Readiness Review – 5/9/2016
- Day 2 Software Code Review – 5/TBD/2016
- Day 2 Operational Readiness Review –TBD 2016
- Day 2 SPSRB briefing – TBD 2016

GAASP Day 2 ARR Entry Criteria

- Updated Requirements Allocation Document (RAD)
- Updated Review Item Disposition (RID)
- Updated Day 1 ARR slide package
- Day 2 Final DAP
- Day 2 ARR (slide package)
- Updated SPSRB documents

GAASP Day 2 ARR Exit Criteria

- Updated RAD, if necessary
- Updated Review Item Disposition (RID)
- Updated Day 2 ARR slide package

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Day 1 ORR Report

Presented by

Tom King

Day 1 ORR Report

- The GAASP Day 1 ORR Report is available as the Review Item Disposition (RID) shared on Google Docs (GAASP_Review_Item_Disposition).
- The RID covers all open and closed risks, actions, issues, and mitigations throughout the lifecycle of the project.
- Risks closed in previous reviews are not shown here, but are located in the RID.
- Risks shown here that are marked as “closed” will be closed with the approval of this review.

CDR Risk

- **Risk #12:** The allocated latency thresholds for processing orbital (as opposed to granule) products still need to be identified and approved. There is a CCR to adjust these allocations (JPSS CCR (NJO-2015- 032, Rev A)), but it has not been approved because of pushback from NWS.
- **Risk Assessment:** Low
- **Impact:** Low
- **Likelihood:** Low
- **Risk Mitigation:**
  - End to end testing within the NDE system will demonstrate the actual run times. Based on these, NJO will need to work with NWS or request a waiver.
- **Status:** Open

CONSEQUENCES

LIKELIHOOD	1	2	3	4	5
5					
4					
3					
2					
1				X	

Day 1 ORR Risk

- **Risk #22:** There are some significant differences between the rain rate product generated at NDE versus that from STAR. Current thinking is that the algorithm is unstable when presented with small perturbations. The PAL considers this to be unacceptable for operational implementation to move forward.
- **Risk Assessment:** High
- **Impact:** High
- **Likelihood:** High
- **Risk Mitigation:**
  - GCOM science team needs to identify and fix the source of the instability in the algorithm. Prior to the fix, the algorithm can be switched off so that its absence does not impact any of the other products.
- **Status:** Closed (This was easily resolved by adjusting a compiler flag)

CONSEQUENCES

LIKELIHOOD	1	2	3	4	5
5					
4					
3					X
2					
1					

Day 1 ORR Risk

- **Risk #23:** The GCOM SST product cannot be used for as input to the GHRSST blended product because of quality issues.
- **Risk Assessment:** Medium
- **Impact:** Medium
- **Likelihood:** High
- **Risk Mitigation:**
  - The GHRSST team will work with the GCOM ocean products team to improve quality. In the meantime, the GHRSST team will use the GCOM RSS product.
  - Ocean Products Oversight Panel will host a review meeting to further discuss the quality issue and provide recommendation for operation.
- **Status:** Closed (See validation of updated Day 1 ocean products)

CONSEQUENCES

LIKELIHOOD	1	2	3	4	5
5					
4			X		
3					
2					
1					

Day 1 ORR Risk

- **Risk #24:** The OI SST files come from a non-operational NCEI website. Files are not available several times a year. Please make sure code can choose the latest file of those available. Please make sure NDE xml is set accordingly. Ensure successful operation with a missing file is tested on NDE PE2 before promotion to PE1.
- **Risk Assessment:** Medium
- **Impact:** Medium
- **Likelihood:** High
- **Risk Mitigation:**
  - Tish and Dylan will make the updates to the NDE and GAASP systems.
- **Status:** Closed (GAASP can handle a file that is up to 14 days old. Otherwise, and error message is sent to the NDE system.)

CONSEQUENCES

LIKELIHOOD

	1	2	3	4	5
5					
4		X			
3					
2					
1					

Day 1 ORR Report Summary

- 4 Risks Total:
  - » 1 Low
  - » 2 Medium
  - » 1 High

- With the approval of the ARR reviewers all 3 risks can be closed.

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Requirements

Presented by

Tom King

GAASP Requirements

- All requirements presented here are contained within the GAASP Requirements Allocation Document (RAD) made available in Google Docs (GAASP_RAD_1.5.docx).

- Requirements were obtained from the following:
  - » Project Office Requirements (JPSS L1RD Supplement)
  - » ESPDS SOW
  - » Project Plan
  - » Contacting users
  - » SPSRB process (coding/security standards and documentation requirements for OSPO).
  - » NDE DAP Standards Version 1.5

GAASP Requirements

- The requirements have already been presented in the previous reviews so we won't cover them all again.

- Since Day 1, the only updates are:
  - » Updated the allocated latency (25 min) for the product generation.
  - » Added the GHRSST generation/reformatting requirement (15.0).
  - » Updated requirement 14.2 to specify the need and details for the Product Quality Monitoring metadata.

AMSR2 Products and Users

Product	Format	User
Microwave Brightness Temperatures	netCDF4	EMC (NCEP) for SMOPS - Michael Ek OSPO (SAB) need 36.5 and 89 GHz channels...both H and V polarities - Sheldon Kusselson, Michael Turk NWS/NHC - Michael Brennan NAVOCEAN – Bruce McKenzie
Total Precipitable Water	netCDF4	NWS (CPC, NWSFO, NHC) for use in blended products - Jim Heil, Mike Johnson, Michael Brennan OSPO (SAB) - Sheldon Kusselson, Michael Turk
Cloud Liquid Water	netCDF4	NCEP/EMC - Brad Ferrier
Precipitation Type/Rate	netCDF4	NWS (CPC, NWSFO, NESDIS, NHC) - Pingping Xie, Jim Heil, Michael Brennan OSPO (SAB) - Sheldon Kusselson, Michael Turk NCEP/EMC - Brad Ferrier
Sea Surface Temperature	netCDF4	EMC (NCEP) - Bert Katz NWS/NHC - Michael Brennan CoastWatch/OceanWatch - Kent Hughes Coral Reef Watch - Mark Eakin Global High Resolution Sea Surface Temperature Group (International) - Peter Minnette NWS/NCEP/EMC/MMAB - Robert Grumbine NWS/NCEP/OPC - Joe Sienkiewicz - Ming Ji, NWS/NHC - Jiann-Gwo Jing NWS/NCEP/CPC - Pingping Xie NMFS/Pacific Marine Lab - Cara Wilson JCSDA - Eric Bayler NWS/NCEP/EMC/MMAB - Avichal Mehra Navy - Bruce McKenzie NASA/SPoRT - Gary Jedlevoc OAR/AOML - Gustavo Goni OAR/ESRL - Gary Wick

AMSR2 Products and Users

Product	Format	User
Sea Surface Winds	netCDF4	OSPO (SAB) - Sheldon Kusselson, Michael Turk NWS/NHC - Michael Brennan
Soil Moisture	netCDF4	EMC (NCEP) via SMOPS - Michael Ek
Sea Ice Characterization	netCDF4	NIC - Sean Helfrich NAVOCEAN – Bruce McKenzie
Snow Cover/Depth	netCDF4	NIC - Sean Helfrich
Snow Water Equivalent	netCDF4	NIC - Sean Helfrich
Surface Type	netCDF4	NWS (CPC, NWSFO) for use in blended hydro products - Jim Heil EMC – SMOPS Mike Ek

Basic Requirement 1.0

- **Requirement 1.0:** *The STAR GCOM processing system shall produce a GCOM imagery product.*

Table 1.0 GCOM Imagery		
EDR Attribute	Threshold	Objective
Applicable conditions		1. Delivered under "all weather" conditions. 2. Each channel shall be provided at its highest native resolution. 3. All channels shall be Vertically and Horizontally polarized. 4. All channels sampled at 10 km except 89 GHz, which is at 5 km.
Horizontal sampling interval	10 km, except 89 GHz which is at 5 km	Same as threshold
Mapping uncertainty, 3 sigma	5 km	3 km
Refresh	At least 90% coverage of the globe about every 20 hours (monthly average)	Not Specified
Latency	25 minutes	

Basic Requirement 2.0

- **Requirement 2.0:** *The STAR GCOM processing system shall produce a total precipitable water (TPW) product.*

Table 2.0 GCOM Total Precipitable Water

EDR Attribute	Threshold	Objective
Horizontal cell size	10km (21 GHz FOV sampling)	5 km
Mapping uncertainty, 3 sigma	5 km	1 km
Measurement range	1 – 75 mm	1 - 100 mm
Measurement uncertainty	2mm or 10% whichever is greater	1 mm or 4% whichever is greater
Measurement accuracy	1 mm	0.2mm
Refresh	At least 90% coverage of the globe about every 20 hours (monthly average)	Not Specified
Coverage	Ice-free global ocean	Ice-free global ocean
Latency	25 minutes	

Basic Requirement 3.0

- **Requirement 3.0:** *The STAR GCOM processing system shall produce a cloud liquid water (CLW) product.*

Table 3.0 GCOM Cloud Liquid Water		
EDR Attribute	Threshold	Objective
Applicable conditions		Delivered under "all weather" conditions
Horizontal cell size	10 km (37 GHz FOV size); 10 km sampling	5 km
Vertical reporting interval	Total Column	Total Column
Mapping uncertainty, 3 sigma	5 km	1 km
Measurement uncertainty (1 kg/m^2 = 1 mm)	0.05 mm over ocean; Best efforts over land	0.02 mm
Measurement Accuracy	0.01 mm	Not Specified
Coverage	Global Ice-free Oceans	Global
Refresh	At least 90% coverage of the globe about every 20 hours (monthly average)	Not Specified
Range (1 kg/m^2 = 1 mm)	0.005 – 1 mm	0 - 2 mm
Latency	25 minutes	

Basic Requirement 4.0

- **Requirement 4.0:** *The STAR GCOM processing system shall produce a precipitation type/rate (PT/R) product.*

Table 4.0 GCOM Precipitation Type/Rate

EDR Attribute	Threshold	Objective
Applicable conditions		Delivered under "all weather" conditions
Horizontal cell size	5 km land (89 GHz FOV); 5 km ocean (37 GHz FOV size); 5-10 km sampling	5.0 km
Mapping uncertainty, 3 sigma	< 5 km	3.0 km
Measurement range	0 – 50 mm/hr	Not Specified
Measurement precision	0.05 mm/hr	0.05 mm/hr
Measurement uncertainty	2 mm/hr over ocean; 5 mm/hr over land	2 mm/hr
Refresh	At least 90% coverage of the globe about every 20 hours (monthly average)	Not Specified
Precipitation type	Stratiform or convective	Not Specified
Latency	25 minutes	

Basic Requirement 5.0

- **Requirement 5.0:** *The STAR GCOM processing system shall produce a snow cover/depth (SC/D) product.*

Table 5.0 GCOM Snow Cover/Depth

EDR Attribute	Threshold	Objective
Applicable conditions		Delivered under "all weather" conditions
Sensing depth	0 – 60 cm	1 m
Horizontal cell size	10 km	5 km
Mapping uncertainty, 3 sigma	5 km	1 km
Snow depth ranges	5 – 60 cm	> 8 cm; > 15 cm; > 30 cm; > 51 cm; > 76 cm
Measurement uncertainty		
-- Clear	80% probability of correct snow/no snow classification; Snow Depth: 20 cm (30 cm if forest cover exceeds 30%)	10% for snow depth
-- Cloudy	80% probability of correct snow/no snow classification; Snow Depth: 20 cm	Not Specified
Refresh	At least 90% coverage of the globe about every 20 hours (monthly average)	Not Specified
Latency	25 minutes	

Basic Requirement 6.0

- **Requirement 6.0:** *The STAR GCOM processing system shall produce a surface type (ST) product.*

Table 6.0 - Surface Type (AMSR-2)		
EDR Attribute	Threshold (1)	Objective
Applicable conditions	Delivered under “all weather” conditions	Delivered under “all weather” conditions
Horizontal cell size	25 km	1 km
Mapping uncertainty, 3σ	5 km	1 km
Measurement Range	8 hydrological classes(2)	13 classes of land types listed in Note (3)
Measurement Precision	5%	2%
Measurement Accuracy	70% for 17 types	80%
Refresh	>90% coverage of globe every 20 hrs (4)	n/s
Latency	25 minutes	

Basic Requirement 7.0

- **Requirement 7.0:** *The STAR GCOM processing system shall produce a soil moisture (SM) product.*

Table 7.0 - GCOM-W Soil Moisture

EDR Attribute	Threshold	Objective
Applicable conditions	Delivered under "all weather" conditions	Delivered under "all weather" conditions
Sensing depth	Surface to -0.1 cm (skin layer)	Surface to -80 cm
Horizontal cell size	40km (1)	20 km
Mapping uncertainty, 3 sigma	5 km	1 km
Measurement Uncertainty	6% volumetric RMSE (goal) with VWC < 1.5 kg/m^2 or GVF < 0.5 and < 2 mm/hr precip rate	Surface: 5% 80 cm column: 5%
Measurement range	0 – 50%(2)	0 – 50%
Refresh	At least 90% coverage of the globe about every 20 hours (monthly average)(3)	n/s
Latency	25 minutes	

Note:
(1) Per AMSR-E legacy and user convenience, 25km can be obtained.
(2) Absolution soil moisture unit (m^3/m^3 volume %) is preferred by most users of NWP community
(3) This Refresh requirement is consistent with the AMSR-2 Cross-track Swath Width design of 1450 km for a single orbit plane

Basic Requirement 8.0

- **Requirement 8.0:** *The STAR GCOM processing system shall produce a sea ice characterization (SIC) product.*

Table 8.0.1 GCOM Sea Ice Characterization

EDR Attribute	Threshold	Objective
Applicable conditions		Delivered under “all weather” conditions
Vertical coverage	Ice surface	Ice surface
Horizontal cell size	10 km	5 km
Mapping uncertainty, 3 sigma	5 km	3 km
Measurement range		
-- Ice concentration	1/10 – 10/10	0 – 100%
-- Ice age classes	Ice free, first-year, multiyear ice	Ice free, nilas, grey white, grey, white, first year medium, first year thick, second year, and multiyear; smooth and deformed ice

Basic Requirement 8.0 Cont.

Table 8.0.2 GCOM Sea Ice Characterization		
EDR Attribute	Threshold	Objective
Measurement uncertainty		
-- Ice concentration	10%	5%
Probability of correct typing of ice age classes	70%	90%
Refresh	At least 90% coverage of the globe about every 20 hours (monthly average)	Not Specified
Geographic coverage	All ice-covered regions of the global ocean	All ice-covered regions of the global ocean
Latency	25 minutes	
Note: This is a global product updated every orbit using the previous 24 hours of orbital data.		

Basic Requirement 8.0 Cont.

- **Requirement 8.1:** *The GAASP Sea Ice product will be produced every orbit using the last 24 hours of data.*

- *Note: This is a request from Robert Grumbine at EMC. He has requested this product be in GRIB2.*

Tom (10/1/14):

We're working on integrating the AMSR2 sea ice code. I see that this is normally generated as a daily global product which is sent out once a day.

It is, however, possible to have a daily global product that is updated with each new orbital dump. Therefore, it would still be a global sea ice product, but it would be generated and distributed every ~100 minutes each time using the most recent 24 hours of orbital data as input. Would you want that or would you just rather get a daily product generated and sent to you once a day? Does sea ice change quickly enough for that to even matter?

Bob (11/10/14):
I waffled some on how to manage the every orbit vs. once per day. I've settled on requesting the every orbit update of the last 24 hours (as of the time of transmission). That sits better with how we do our processing, and is more amenable to us working towards having more than once cycle per day ourselves.

Basic Requirement 9.0

- **Requirement 9.0:** *The STAR GCOM processing system shall produce a sea surface temperature (SST) product.*

Table 9.0 GCOM Sea Surface Temperature

EDR Attribute	Threshold	Objective
Applicable conditions		Delivered under "all weather" conditions
Horizontal cell size	40 km	20 km
Mapping uncertainty, 3 sigma	5 km	3 km
Measurement range	271 – 313 K	271 – 313 K
Measurement accuracy, skin & bulk	0.5 K	0.1 K
Measurement uncertainty	1.0 K	0.5 K
Refresh	At least 90% coverage of the globe about every 20 hours (monthly average)	Not Specified
Geographic coverage	Global oceans	Global oceans
Latency	25 minutes	

Basic Requirement 10.0

- **Requirement 10.0:** *The STAR GCOM processing system shall produce a sea surface wind (SSW) product.*

Table 10.0.1 GCOM Sea Surface Wind – Speed

EDR Attribute	Threshold	Objective
Applicable conditions: Delivered under "all weather" conditions		
Horizontal cell size (Wind speed)	33 km (10.7 GHz FOV size); 10 km sampling	1km
Mapping uncertainty, 3 sigma	TBS-11	1 km
Measurement range (Speed)	2 – 30 m/sec	1 – 50 m/sec
Measurement uncertainty (Speed)	Greater of 2.0 m/sec or 10%	Not Specified
Measurement Accuracy	0.5 m/sec	0.2 m/sec
Refresh	At least 90% coverage of the globe about every 20 hours (monthly average)	Not Specified
Geographic Coverage	Global Ice-free Oceans	Global Ice-free Oceans
Latency	25 minutes	

Basic Requirement 11.0

- **Requirement 11.0:** *The STAR GCOM processing system shall produce a snow water equivalent (SWE) product.*

Table 11.0 GCOM Snow Water Equivalent		
EDR Attribute	Threshold	Objective
Applicable conditions		Delivered under "all weather“ conditions
Horizontal cell size	10 km	5 km
Mapping uncertainty, 3 sigma	5 km	1 km
Measurement range	10 – 200 mm	Not Specified
Measurement uncertainty		Not Specified
-- Shallow to moderate snow packs (10 – 100 mm)	20 mm or 50%	Not Specified
-- High snow accumulation (above 100 mm)	70%	Not Specified
Refresh	At least 90% coverage of the globe about every 20 hours (monthly average)	Not Specified
Latency	25 minutes	

Basic Requirement 12.0

- **Requirement 12.0:** *The STAR GCOM-W1 AMSR2 Algorithm Software Processor (GAASP) development team shall deliver the GAASP software package to NDE for integration into their data handling and scheduling system.*
  - *It is our understanding that the OSGS contractor-built system will, in turn, be delivered to OSPO where it will run operationally.*
- **Requirement 12.1:** *The GAASP package shall be delivered to NDE as a Delivered Algorithm Package (DAP). The DAP shall contain all the code (programs and scripts), test data, and SPSRB-required documentation.*
  - *The DAP is defined in the NDE DAP standards document.*

Basic Requirement 12.0

- **Requirement 12.2:** *The STAR GCOM-W1 GAASP code contained within the DAP shall adhere to SPSRB coding standards and ESPC security standards.*

- **Requirement 12.3:** *The STAR GAASP development team shall deliver to the NDE the following SPSRB-required documentation as part of the DAP:*
  - » *A System Maintenance Manual (SMM)*
  - » *An External Users Manual (EUM)*
  - » *An Algorithm Theoretical Basis Document (ATBD)*

Basic Requirement 12.0

- **Requirement 12.4:** *The GAASP software shall consist of the STAR EDR algorithm code wrapped in Perl scripts. These will be run within the NDE system.*
  - » *These scripts shall also drive the additional front and back end data format tailoring programs to assist the science code. This approach will minimize modification of the science code while providing users with the required format and providing a common interface to NDE.*

Basic Requirement 12.0

- **Requirement 12.5:** *The GAASP software shall be able to compile and run on the NDE integration, test, and production platforms.*
  - *Details about target platform such as available memory, disk space, CPUs, and compilers are to be determined.*
- **Requirement 12.6:** *The GAASP code shall be able to compile such that it does not require access to compiler libraries at run time (compilers not allowed on OSPO production machines).*

Basic Requirement 13.0

- **Requirement 13.0:** *The GAASP software shall be able to generate all the required GCOM EDR products.*

- **Requirement 13.1:** *The GAASP software shall read and use the AMSR2 SDR (native and remapped) HDF5 files produced by the JAXA code. The data from these HDF5 files will be read in by the GAASP preprocessor code, RFI and bias corrections will be applied, and the output passed to the actual EDR programs will be HDF5.*

- **Requirement 13.2:** *The GAASP postprocessor software shall tailor the STAR EDR program output files for delivery into netCDF4.*

Basic Requirement 13.0

- **Requirement 13.3:** *The GAASP software shall perform error checking, handling, and logging.*
  - *The GAASP software shall check the return value of all system-level and script level commands within the driver scripts. Success or failure of a given run shall be returned to the data handling and scheduling system (NDE). All exits shall be graceful.*
  - *The GAASP software shall generate detailed human-comprehensible error messages; these shall be directed to log files in the local working directory.*
- **Requirement 13.4:** *The GAASP software shall produce flags that indicate "degradation" and "exclusion" conditions for products as defined in section 3.3 of the JPSS L1RD Supplement.*

Basic Requirement 13.0

- **Requirement 13.5:** *All GAASP output files made available to the distribution interface shall adhere to ~~a slightly modified version of~~ the NDE file naming convention.*
  - » *Note: Date/Time strings will be in YYYYMMDDhhmmss instead of YYYYMMDDhhmmsss (no tenths of second as this was an IDPS convention).*

- **Requirement 13.6:** *The GAASP software shall be able to read a Production Control File (PCF) produced by the NDE and it will produce a Production Status File (PSF) containing the names of the successfully generated output files. The contents of these files shall adhere to existing NDE standards.*
  - » *Note: Production rules associated with invocation of the algorithms (PCF generation) shall be negotiated with the OSGS contractors and documented in the System Maintenance Manual.*

Basic Requirement 14.0

- **Requirement 14.0:** *The GAASP development team shall perform quality assurance on the software package and data products as well as assist with product quality monitoring activities at OSPO.*

- **Requirement 14.1:** *The GAASP developers shall conduct unit tests of the GAASP software. The unit tests shall be conducted, documented and then presented in a Code Test Review. This will validate the software functionality and the product quality.*

Basic Requirement 14.0

- **Requirement 14.2:** *The GAASP software shall produce quality metadata within the netCDF4 output files. These metadata will be used by the OSPO Product Quality Monitoring Tool.*

- **Requirement 14.3:** *The GAASP software shall be submitted to OSPO for a Software Code Review to verify that the software meets SPSRB coding standards and ESPC security standards.*

Basic Requirement 15.0

- **Requirement 15.0:** *The GAASP software will output GHRSST files for the blended product users.*

- **Requirement 15.1:** *The GAASP software read the Ocean products netCDF4 EDR file, run the GHRSST processing code to generate error characteristics, and output a GHRSST compliant netCDF4 file.*

- *Note: This will be performed in the GAASP postprocessor code. Andy Harris will deliver GHRSST processing code to the GAASP developers for integration.*

GAASP Requirements Summary

- The GAASP Day 1 and 2 Requirements have been established.
- These have been documented in the Requirements Allocation Document (RAD).
- The Requirements are traceable to drivers (customer needs or expectations) and other requirements.

Review Outline

- Introduction
- Day 1 ORR Report
- Requirements
- Software Architecture
- Validation
- Risk and Actions
- Summary and Conclusions

Software Architecture

Presented by

Letitia Soulliard

GAASP Processing Architecture

- The GAASP Day 1 software architecture has already presented in the previous reviews (PDR, CDR, CTR).
- There have been some adjustments to the architecture since Day 1 ARR. Only the updates made since then will be presented. These are highlighted in green.

GAASP Processing Architecture

- Hardware Environment
  - » STAR Science/System Development and Test
  - » Integration/Test and Production
- Software Description
  - » System Level Flow
  - » Unit Level Flow

GAASP Processing Architecture

- Data Files
  - » Input Files
  - » Ancillary Files (Dynamic/Static)
  - » Output Files
  - » Log/Monitoring Files
  - » Resource Files
  - » File Formats

GAASP Production and Development Hardware

- STAR Development Hardware (rhs8142.star1.nesids.noaa.gov)
  - » Architecture: 64-bit Intel® Xeon™ X5680
  - » OS Version: Red Hat Enterprise Linux 6
  - » Diskspace: 72TB raw disk, ~30TB unallocated to logical volumes.
  - » Number of Processors: 12
    - – dual 6-core processors
  - » Total Memory: 96GB RAM, DDR3
  - » Processor Clockspeed: 3.33GHz
  - » Fortran Compiler: Intel Fortran Composer XE (Version 12.1.3)

NDE/GAASP Integration Hardware

- Integration Hardware
  - » 7 servers with 189 GB of RAM
  - » 21 servers with 94 GB RAM
  - » 6 cores
  - » 64-bit Intel Xeon E5-2640 @ 2.5 GHz
  - » 24 CPUs per server
  - » RHEL 6
  - » 1.5 TB of local storage
  - » NAS (formerly the SAN): 500 TB storage

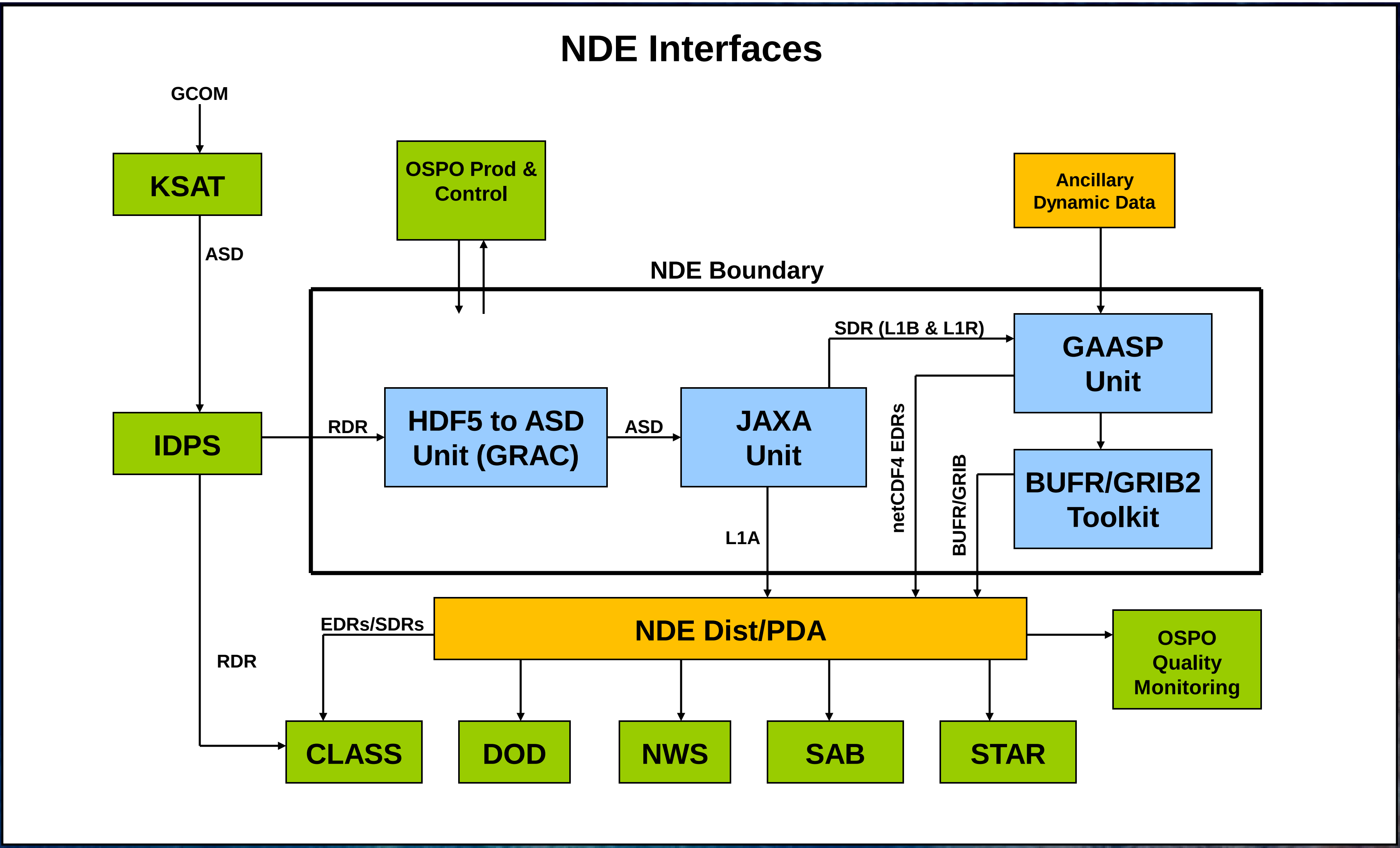
NDE/GAASP Production Hardware

- Production Hardware
  - » 7 servers with 189 GB of RAM
  - » 21 servers with 94 GB RAM
  - » 6 cores
  - » 64-bit Intel Xeon E5-2640 @ 2.5 GHz
  - » 24 CPUs per server
  - » RHEL 6
  - » 1.5 TB of local storage
  - » NAS (formerly the SAN): 500 TB storage

NDE Processing and Distribution System

- The following slide shows a high-level chart of how GAASP runs within NDE and its interfaces.
- The blue boxes in the figure represent the 3 delivered software components that need to run within the NDE.

NDE Interfaces



GAASP External Interfaces

- External input and output files are identified in the tables on the following 2 slides, respectively.
  - » Input files include both input data files and ancillary data.
  - » The tables indentify the file name patterns, formats, and sources (for input files).
  - » Files needed/produced for Day 1 and Day 2 products are identified.
  - » GAASP follows the NDE output file naming convention for products.
  - » netCDF4 output files contain the NDE-compliant metadata and metadata for the OSPO Product Monitoring.
  - » The transfers of external files to and from GAASP will be automated by the NDE.

GAASP External Dynamic Input Data

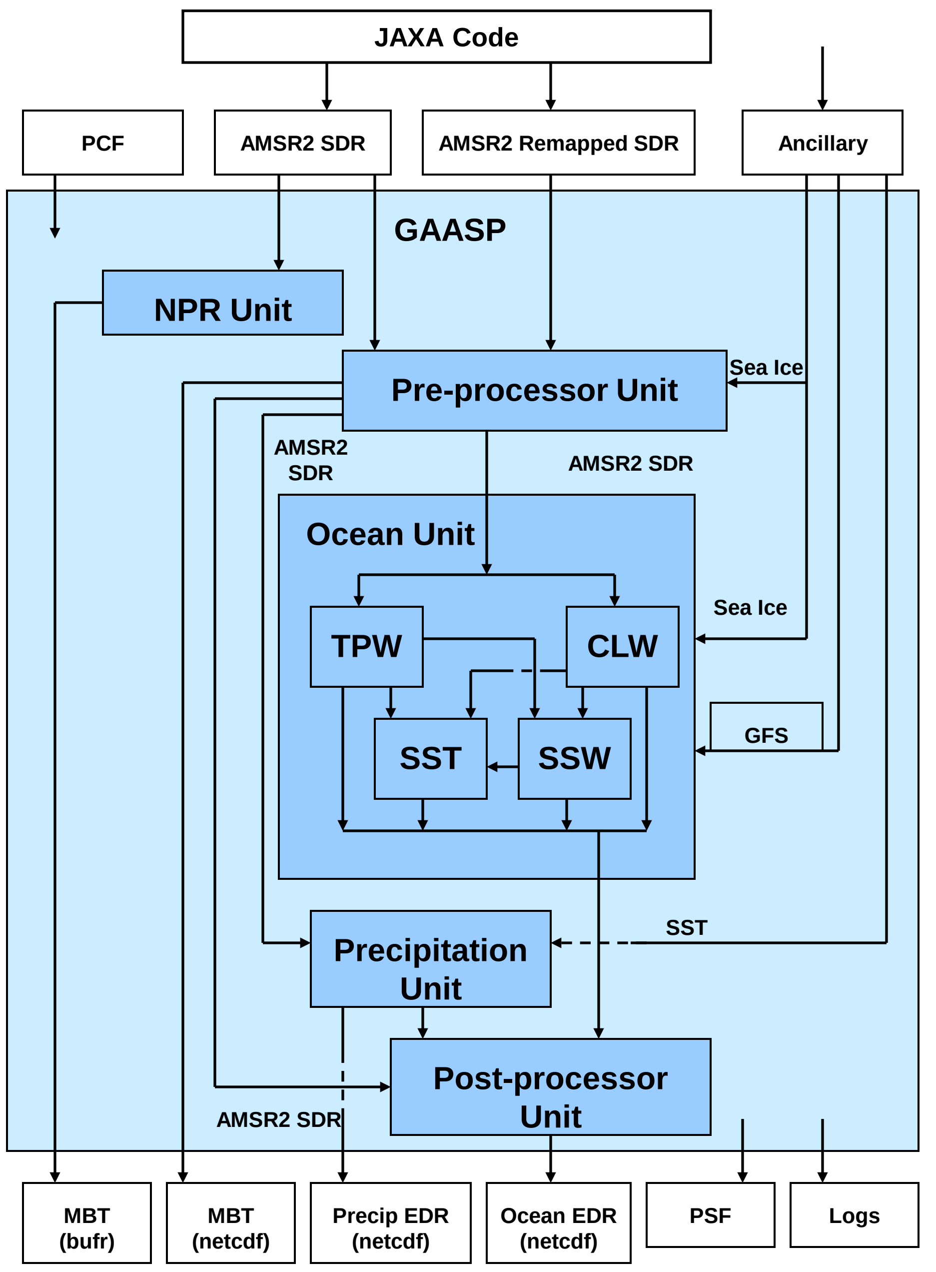
External Dynamic Input Data								
Input File	**Name Pattern**	**Source**	**Update Frequency**	**When**	**EDR**	**Type**	**Format**	**Size**
AMSR2 SDR Native Res	GW1AM2_????????????_????_L1SGBTBR_1110110.h5	IDPS via NDE	~100 minutes	Day 1	MBT, SST, SSW, TPW, CLW, PR, SM, ST, SC, SD, SWE	Input	HDF5	9.2 MB
AMSR2 SDR Remapped	GW1AM2_????????????_????_L1SGRTBR_1110110.h5	IDPS via NDE	~100 minutes	Day 1	SST, SSW, TPW, CLW, SIC	Input	HDF5	12.7 MB
GFS Forecast (0.5 degree)	gfs.t??z.pgrb2f??.????????	DDS	6 hours	Day 1	SST, SSW, TPW, CLW	Ancillary	GRIB2	18.5 MB
Daily OI SST	avhrr-only-v2.????????_preliminary	DDS	Daily	Day 1	PR, SST, SSW, TPW, CLW	Ancillary	Binary	1.8 MB
Sea Ice	seaice.t00z.5min.grb.grib2.????????	DDS	Daily	Day 1	RFI	Ancillary	GRIB2	0.5 MB

GAASP External Output Data

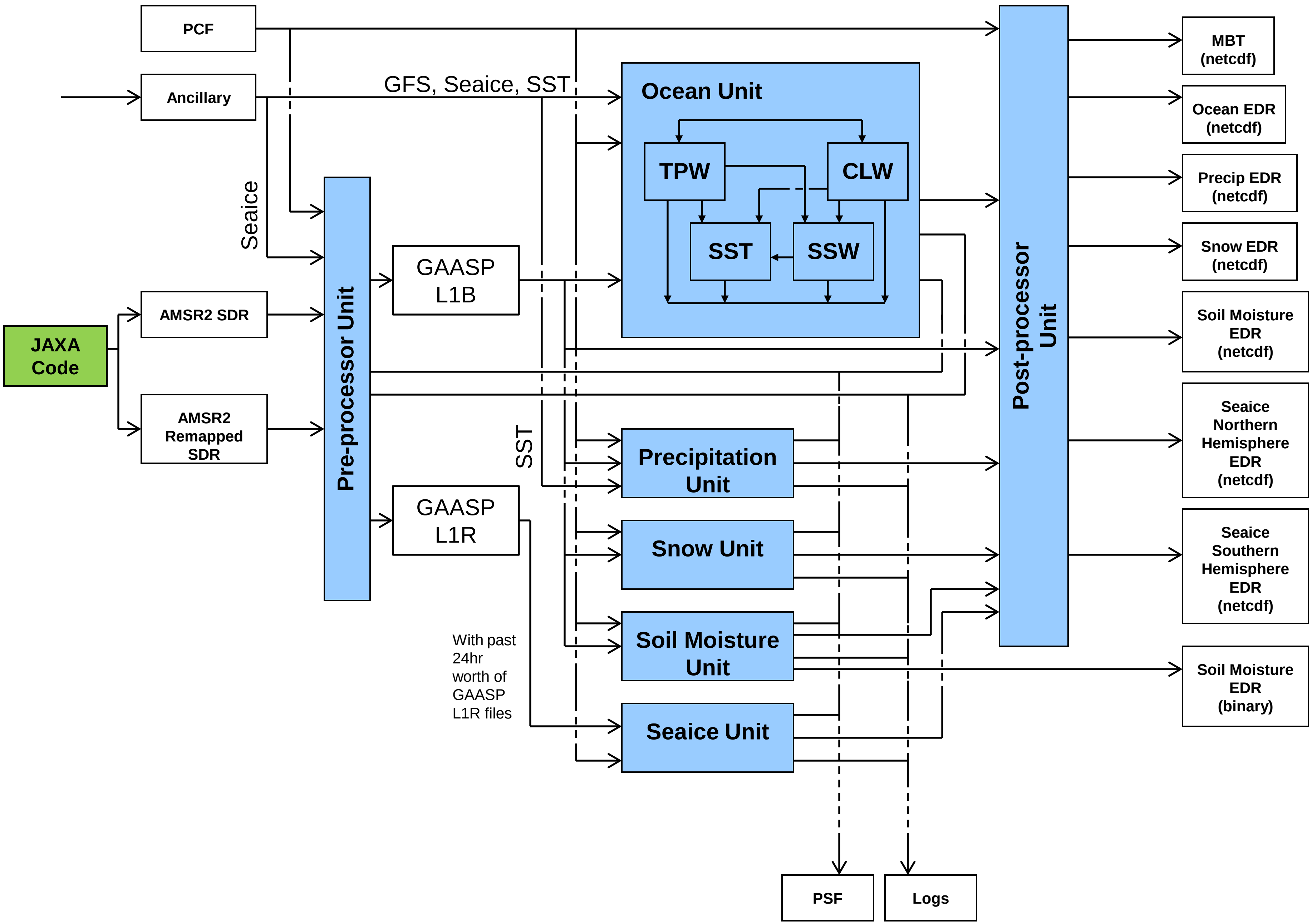
External Output Data (Day1)

Output File	Name Pattern	Update Frequency	When	Format	Size
AMSR2 SDR Native Res	AMSR2-MBT_v2r0_GW1_sYYYYMMDDhhmmsss_eYYYYMMDDhhmmsss_cYYYYMMDDhhmmsss.nc	~100 minutes	Day 1	netCDF4	244 MB
Ocean (CLW, TPW, SST, SSW)	AMSR2-OCEAN_v2r0_GW1_sYYYYMMDDhhmmsss_eYYYYMMDDhhmmsss_cYYYYMMDDhhmmsss.nc	~100 minutes	Day 1	netCDF4	160 MB
Precip (PT/R)	AMSR2-PRECIP_v2r0_GW1_sYYYYMMDDhhmmsss_eYYYYMMDDhhmmsss_cYYYYMMDDhhmmsss.nc	~100 minutes	Day 1	netCDF4	60 MB
SST	AMSR2-GHRSST_v2r0_GW1_sYYYYMMDDhhmmsss_eYYYYMMDDhhmmsss_cYYYYMMDDhhmmsss.nc	~100 minutes	Day 1	netCDF4	TBD MB
Land (SM & ST)	AMSR2-SOIL_v2r0_GW1_sYYYYMMDDhhmmsss_eYYYYMMDDhhmmsss_cYYYYMMDDhhmmsss.nc	~100 minutes	Day 2	netCDF4	31 MB
Land (SM & ST)	AMSR2-SOIL_v2r0_GW1_sYYYYMMDDhhmmsss_eYYYYMMDDhhmmsss_cYYYYMMDDhhmmsss.bin	~100 minutes	Day 2	Binary	4.9 MB
Snow (SC/D & SWE)	AMSR2-SNOW_v2r0_GW1_sYYYYMMDDhhmmsss_eYYYYMMDDhhmmsss_cYYYYMMDDhhmmsss.nc	~100 minutes	Day 2	netCDF4	37 MB
Sea Ice (SIC) – Northern Hemisphere	AMSR2-SEAICE-NH_v2r0_GW1_sYYYYMMDDhhmmsss_eYYYYMMDDhhmmsss_cYYYYMMDDhhmmsss.nc	~100 minutes	Day 2	netCDF4	64 MB
Sea Ice (SIC) – Southern Hemisphere	AMSR2-SEAICE-SH_v2r0_GW1_sYYYYMMDDhhmmsss_eYYYYMMDDhhmmsss_cYYYYMMDDhhmmsss.nc	~100 minutes	Day 2	netCDF4	24 MB

GAASP Software Unit Data Flow: Day 1



GAASP Software Unit Data Flow: Day 2



GAASP System Design

- The Day 2 GAASP consists of seven Perl driver scripts that wrap the individual FORTRAN codes.
  - These scripts are run by the NDE system and in turn run the entire GAASP processing for a single input orbit (i.e. SDR to EDR) for each unit respectively.
  - Within each driver script everything is run serially (no forking of processes)
  - These units scripts handle direct interfaces and arguments for individual algorithm executables (science code)
  - The driver and its unit scripts:
    - Conduct local file management (e.g. creating, removing, and renaming) in the local working directory (only)
    - Perform of error handling and generate higher-level error logs for NDE/OSPO production monitoring
  - All science code is written Fortran 90 (Compiled using the Intel Compiler). There is no science code written in an interpreted or high-level language like IDL and Matlab.

GAASP System Design

- The Day 2 GAASP driver scripts are invoked by the NDE system and may be run in parallel by the NDE system, provided the necessary files are available.
  - » The production rules for the driver scripts are documented in the System Maintenance Manual and will be delivered as part of the DAP.
  - » Interfaces between NDE and GAASP consist of PCF and PSF files.
  - » The Postprocessor may be run for each individual product separately or combined into one run as necessary for meeting latency.

- GAASP does NOT do the following as these tasks are understood to be tasks performed by NDE:
  - » Schedule jobs
  - » Invoke its own driver scripts
  - » Fork processes or load manage jobs
  - » Set up and manage system directories
  - » Ingest, distribute, or transfer files
  - » Interact directly with the OSPO production or quality monitoring

GAASP System Design

- Preprocessor unit:
  - » Perform brightness temperature bias correction
  - » Assign the RFI flag
  - » Output the HDF5 intermediate files (L1B and L1R) to be used by all downstream EDRs
- Ocean unit:
  - » Generate all ocean EDRs (TPW, CLW, SST, SSW)
  - » Generate QA metadata or products for OSPO monitoring.
- Precipitation unit:
  - » Generate land/ocean precipitation EDR
  - » Generate QA metadata or products for OSPO monitoring.
- Snow unit:
  - » Generates snow EDRs
  - » Generate QA metadata or products for OSPO monitoring.
- Soil Moisture unit:
  - » Generates Land Soil Moisture EDRs
  - » Creates Binary output file
  - » Generate QA metadata or products for OSPO monitoring.

GAASP System Design

- Sea Ice unit:
  - Generates Sea Ice EDRs
  - Generate QA metadata or products for OSPO monitoring.
- Postprocessor unit:
  - Converts all HDF5 files to netCDF4 format for distribution for each algorithm
  - Will handle the tailoring of the Ocean EDR to GHRSST.
- NOAA Product Reformatter (NPR) Runs outside of GAASP. However, it has been updated to perform the following:
  - Tailor L1B hdf5 output to BUFR
  - Tailor SST netCDF output to BUFR
  - Tailor Sea Ice netCDF4 to GRIB2

GAASP System Design

- The internal file format for files within the driver script will be HDF5.
- Ancillary data is obtained by the NDE system from DDS/PDA (see table) and made available to the Day 2 GAASP driver scripts as necessary.

GAASP System Design: NDE Interfaces

- The interface between the NDE system and the GAASP driver script consists of an Production Control File (PCF) and Production Status File (PSF) files.
  - » PCF contains:
    - – All the required input files to process an orbit, including paths if they're located outside the working directory. This includes input instrument and ancillary data, static files such as templates and lookup tables.
    - – Any run parameters or flags
  - » PSF contains all successfully generated output files

- During production, a PCF for a given run is produced by the NDE and made available to an instance of the GAASP driver in a local working directory.
  - » The contents of the PCF are based on the production rules defined in the System Maintenance Manual.

- The GAASP driver runs and produces its output and a PSF file in the same working directory. The NDE then reads this file, determines the output file name(s) from it, and distributes it to DDS.

GAASP System Design: NDE Interfaces

- Here’s an example of a GAASP PCF from the Preprocessor Unit:

```
working_directory=/home/GAASP/SATELLITE_DATA/GCOM-W1/day2/2015/10/02/201510020858_036B/Preprocessor
PSF_FILE=/home/GAASP/SATELLITE_DATA/GCOM-W1/day2/PSF/
GAASP_Preprocessor_201510020858_036B_20151002.PSF
L1B_FILE=GW1AM2_201510020858_036B_L1SNBTBR_2210210.h5
L1R_FILE=GW1AM2_201510020858_036B_L1SNRTBR_2210210.h5
EMAIL_ERROR_FLAG=YES
OPS_MACHINE=letitias@rhs8142.star1.nesdis.noaa.gov
OPS_MAIL=letitia.soulliard@noaa.gov
LOG_FILE=/home/GAASP/SATELLITE_DATA/GCOM-W1/day2/2015/10/02/201510020858_036B/Preprocessor/GAASP.log
PERL_LOC=/usr/bin/perl
SCRIPT_OPS=/home/GAASP/OPS/scripts
H5DUMP_LOC=/usr/local/bin/h5dump
WGRIB2_LOC=/usr/local/bin/wgrib2
OPS_BIN=/home/GAASP/OPS/Common_Bin
SEAICE_FILE=/home/GAASP/DATA/seaice/seaice.t00z.5min.grb.grib2.20151001.nc
RUN_L1R_CORRECTION_FLAG=YES
```

  - » An example for each unit can be found in the System Maintenance Manual

GAASP System Design: NDE Interfaces

- And here is an example of the PSF file from the Soil Moisture Unit:

```
/home/GAASP/SATELLITE_DATA/GCOM-W1/day2/2015/10/02/201510020858_036B/Soil/AMSR2-
SOIL_v2r0_GW1_s201510020858520_e201510021037500_c201510021131150.bin
/home/GAASP/SATELLITE_DATA/GCOM-W1/day2/2015/10/02/201510020858_036B/Soil/GAASP-
SOIL_v2r0_GW1_s201510020858520_e201510021037500_c201510021131150.h5
```

  - » All files that will be distributed via DDS have a AMSR2 prefix.
  - » All files that are output from one GAASP unit to be used by another GAASP unit will have a GAASP prefix.

GAASP System Design: Error Handling and Monitoring

- All system calls within scripts and all functions and statements in the compiled code will have their return values and/or returned content checked where applicable to allow for graceful exits in the event of an error.

- All standard output and standard error from scripts and programs is logged so it can be made available to the NDE and OSPO monitoring efforts.

- Contents of logs were shown in the Code Test Review held on 8/1/2013 and the code was checked for security and coding standards in the Software Code Review held on 9/18/2013.

- The GAASP driver script produces a single high-level log file that the NDE can parse in the event of an error. If there is an error:
  - Perl driver returns to the NDE a non-zero value
  - There may be no output file(s) written in the PSF depending upon at what stage the error occurred

GAASP System Design: Error Handling and Monitoring

- All error conditions and messages written into the log files are identified and described in the System Maintenance Manual.
- The NDE system can obtain these error codes and messages and use them for its system production monitoring.
- GAASP science quality monitoring is a separate effort handled by the OSPO Product Monitoring System. This latest GAASP delivery includes the metadata required to support this monitoring effort downstream outside of NDE.
- Additional OSPO GCOM monitoring is handled by the PAL (Limin Zhao) and is accessible via the following website:

  http://www.ospo.noaa.gov/Products/atmosphere/gpds/maps.html?GPTPW#gpdsMaps

Unit Level Input/Output

- The following slides contain tables showing all the GAASP Day 2 unit level input and output.
- Required input data fields are identified for each unit.
- Output data fields are identified for the products coming out of each unit. These also show:
  - Variable names
  - Variable size (bytes)
  - Resolution
  - Dimensionality
  - Total file size

Microwave Brightness Temperature SDR

Microwave Brightness Temperature					
Paramter	**Size**	**Scans**	**FOV**	**Other Dimensions**	**Total**
Across_Scan_High_Resolution	2		486		972
Across_Scan_Low_Resolution	2		243		486
Along_Scan	2	3960			7,920
Brightness_Temperature_10_GHzV	4	3960	243		3,849,120
Brightness_Temperature_10_GHzH	4	3960	243		3,849,120
Brightness_Temperature_18_GHzV	4	3960	243		3,849,120
Brightness_Temperature_18_GHzH	4	3960	243		3,849,120
Brightness_Temperature_23_GHzV	4	3960	243		3,849,120
Brightness_Temperature_23_GHzH	4	3960	243		3,849,120
Brightness_Temperature_36_GHzV	4	3960	243		3,849,120
Brightness_Temperature_36_GHzH	4	3960	243		3,849,120
Brightness_Temperature_6_GHzV	4	3960	243		3,849,120
Brightness_Temperature_6_GHzH	4	3960	243		3,849,120
Brightness_Temperature_7_GHzV	4	3960	243		3,849,120
Brightness_Temperature_7_GHzH	4	3960	243		3,849,120
Brightness_Temperature_89_GHz-AV	4	3960	486		7,698,240
Brightness_Temperature_89_GHz-AH	4	3960	486		7,698,240
Brightness_Temperature_89_GHz-BV	4	3960	486		7,698,240
Brightness_Temperature_89_GHz-BH	4	3960	486		7,698,240
C_Band_Ocean_RFI_Flag	2	3960	243		1,924,560
Earth_Azimuth_Angle	4	3960	243		3,849,120
Earth_Incidence_Angle	4	3960	243		3,849,120
Land_Ocean_Flag_6_to_36	2	3960	243	6	11,547,360
Land_Ocean_Flag_89	2	3960	486	2	7,698,240

Microwave Brightness Temperature SDR

Microwave Brightness Temperature					
Paramter	Size	Scans	FOV	Other Dimensions	Total
Latitude_ for_10	4	3960	243		3,849,120
Latitude_ for_18	4	3960	243		3,849,120
Latitude_ for_23	4	3960	243		3,849,120
Latitude_ for_36	4	3960	243		3,849,120
Latitude_ for_6	4	3960	243		3,849,120
Latitude_ for_7	4	3960	243		3,849,120
Latitude_ for_89A	4	3960	486		7,698,240
Latitude_ for_89B	4	3960	486		7,698,240
Latitude_ for_High_Resolution	4	3960	486		7,698,240
Latitude_ for_Low_Resolution	4	3960	243		3,849,120
Longitude_ for_10	4	3960	243		3,849,120
Longitude_ for_18	4	3960	243		3,849,120
Longitude_ for_23	4	3960	243		3,849,120
Longitude_ for_36	4	3960	243		3,849,120
Longitude_ for_6	4	3960	243		3,849,120
Longitude_ for_7	4	3960	243		3,849,120
Longitude_ for_89A	4	3960	486		7,698,240
Longitude_ for_89B	4	3960	486		7,698,240
Longitude_ for_High_Resolution	4	3960	486		7,698,240
Longitude_ for_Low_Resolution	4	3960	243		3,849,120
Pixel_Data_Quality_6_to_36	2	3960	486		3,849,120
Pixel_Data_Quality_89	2	3960	486		3,849,120
RFI_NOAA_LAND_06v	4	3960	243		3,849,120

Microwave Brightness Temperature SDR

Microwave Brightness Temperature					
Paramter	Size	Scans	FOV	Other Dimensions	Total
RFI_NOAA_LAND_06h	4	3960	243		3,849,120
RFI_NOAA_LAND_07v	4	3960	243		3,849,120
RFI_NOAA_LAND_07h	4	3960	243		3,849,120
RFI_NOAA_LAND_10v	4	3960	243		3,849,120
RFI_NOAA_LAND_10h	4	3960	243		3,849,120
RFI_NOAA_OCEAN_10v	4	3960	243		3,849,120
RFI_NOAA_OCEAN_10h	4	3960	243		3,849,120
RFI_NOAA_OCEAN_18v	4	3960	243		3,849,120
RFI_NOAA_OCEAN_18h	4	3960	243		3,849,120
Scan_Angle	4	3960	243		3,849,120
Scan_Time	4	3960		6	95,040
Sun_Azimuth_Angle	4	3960	243		3,849,120
Sun_Elevation	4	3960	243		3,849,120
Sun_Glint_Flag	2	3960	243		1,924,560
					265,693,698

Ocean EDR Inputs

Table 15.0 GCOM Ocean Unit Inputs		
Parameter	Source	Status
Brightness Temperatures	From AMSR2 SDR (L1B) and From AMSR2 SDR (L1R)	Dynamic
Geo location information	From AMSR2 SDR (L1B) and From AMSR2 SDR (L1R)	Dynamic
Land/Coastal mask	From AMSR2 SDR (L1B) and From AMSR2 SDR (L1R)	Dynamic
Model Wind Direction	From GFS Forecast Model	Dynamic
Model Sea Surface Temp	From GFS Forecast Model	Dynamic
Model Sea/Land Flag	From GFS Forecast Model	Dynamic
Seaice Filter File	From DDS	Dynamic
SST (Sea Ice data)	From daily IEEE OI-SST from AVHRR	Dynamic
CLW Coefficient files	From STAR algorithm development	Static
TPW Coefficient files	From STAR algorithm development	Static
WS and SST Coefficient files	From STAR algorithm development	Static

Ocean EDR Output

Ocean/Precip Products					
Paramter	**Size**	**Scans**	**FOV**	**Other Dimensions**	**Total**
Across_Scan_High_Resolution	2		486		972
Across_Scan_Low_Resolution	2		243		486
Aggressive_Land_mask	4	3960	243		3849120
Along_Scan	2	3960			7920
CLW	8	3960	243		7698240
Descending_Flag	2	3960			7920
EDR_QC_Flag	4	3960	243		3849120
Earth_Azimuth_Angle	4	3960	243		3849120
Earth_Incidence_Angle	4	3960	243		3849120
GFS_Model_SST	4	3960	243		3849120
GFS_Model_WDIR	4	3960	243		3849120
GFS_Model_WSPD	4	3960	243		3849120
Land_mask	4	3960	243		3849120
Latitude_ for_High_Resolution	4	3960	486		7698240
Latitude_ for_Low_Resolution	4	3960	243		3849120
Longitude_ for_High_Resolution	4	3960	486		7698240
Longitude_ for_Low_Resolution	4	3960	243		3849120
Pixel_Data_Quality_6_to_36	4	3960	486		7698240
Prelim_Reynolds_SST	4	3960	243		3849120
QM_max_EIA	4			1	4
QM_max_SST_diff	4			1	4
QM_max_WSPD_diff	4			1	4

Ocean EDR Output

Ocean/Precip Products					
Paramter	**Size**	**Scans**	**FOV**	**Other Dimensions**	**Total**
QM_mean_EIA	4			1	4
QM_mean_SST_diff	4			1	4
QM_mean_WSPD_diff	4			1	4
QM_min_EIA	4			1	4
QM_min_SST_diff	4			1	4
QM_min_WSPD_diff	4			1	4
Rain_Rate	4	3960	486		7698240
Rain_Rate_QC_Flag	1	3960	486		1924560
SST	8	3960	243		7698240
SST_QC	4	3960	243		3849120
Scan_Angle	4	3960	243		3849120
Scan_Time	4	3960		6	95040
Sun_Azimuth_Angle	4	3960	243		3849120
Sun_Elevation	4	3960	243		3849120
Sun_Glint_Flag	2	3960	243		1924560
TPW	8	3960	243		7698240
WSPD	8	3960	243		7698240
					123284214

Precipitation Unit Inputs

Table 16.0 GCOM Precipitation Unit Inputs		
Parameter	**Source**	**Status**
Brightness Temperatures	From AMSR2 SDR (L1B)	Dynamic
Geo location information	From AMSR2 SDR (L1B)	Dynamic
SST	From daily IEEE OI-SST from AVHRR	Dynamic
Profile database	Compiled TRMM's Precipitation Radar by Dave Randel at Colorado State University	Static
Caspian Sea Ice Climo	Developed from RSS Weekly AMSRE	Static
Desert/Ice Climo	IGBP (Desert) IMS & AMSRE (Snow)	Static
Elevation		Static
Land Mask		Static
Forward Model coefficient file	From STAR algorithm development	Static
TMI Correction files	From STAR algorithm development	Static

Precipitation EDR Output

Precip Products					
Paramter	Size	Scans	FOV	Other Dimensions	Total
Across_Scan_High_Resolution	2	1	486	1	972
Across_Scan_Low_Resolution	2	1	243	1	486
Along_Scan	2	3960	1	1	7920
Earth_Azimuth_Angle	4	3960	243	1	3849120
Earth_Incidence_Angle	4	3960	243	1	3849120
Latitude_ for_High_Resolution	4	3960	486	1	7698240
Latitude_ for_Low_Resolution	4	3960	243	1	3849120
Longitude_ for_High_Resolution	4	3960	486	1	7698240
Longitude_ for_Low_Resolution	4	3960	243	1	3849120
Probability_of_Precip	4	3960	486	1	7698240
QM_Avg_Rain_Land_Amt	4	1	1	1	4
QM_Avg_Rain_Ocean_Amt	4	1	1	1	4
QM_Cond_Rain_Land_Amt	4	1	1	1	4
QM_Cond_Rain_Ocean_Amt	4	1	1	1	4
QM_Num_Ambig_Land	4	1	1	1	4
QM_Num_Ambig_Ocean	4	1	1	1	4
QM_Num_Flagged_Land	4	1	1	1	4
QM_Num_Flagged_Ocean	4	1	1	1	4

Precipitation EDR Output

Precip Products					
Paramter	**Size**	**Scans**	**FOV**	**Other Dimensions**	**Total**
QM_Num_Good_Land	4	1	1	1	4
QM_Num_Good_Ocean	4	1	1	1	4
QM_Num_Land_Pixels	4	1	1	1	4
QM_Num_Missing	4	1	1	1	4
QM_Num_Ocean_Pixels	4	1	1	1	4
QM_Num_Rain_Land_Pixels	4	1	1	1	4
QM_Num_Rain_Ocean_Pixels	4	1	1	1	4
QM_Sum_Rain_Land_Pixels	4	1	1	1	4
QM_Sum_Rain_Ocean_Pixels	4	1	1	1	4
Rain_Rate	4	3960	486	1	7698240
Rain_Rate_QC_Flag	1	3960	486	1	1924560
Scan_Angle	4	3960	243	1	3849120
Scan_Time	4	3960	1	6	95040
convectPrecipitation	4	3960	486	1	7698240
surfaceType	1	3960	486	1	1924560
					61690406

Snow Unit Inputs

Table 17.0 GCOM Snow Unit Inputs		
Parameter	Source	Status
Brightness Temperatures	From AMSR2 SDR (L1B)	Dynamic
Geo location information	From AMSR2 SDR (L1B)	Dynamic
new_sclass.txt	From STAR algorithm development	Static
sn_freq_latlon_wk_??.dat	From STAR algorithm development	Static
snow_freq_sh_week-??_24km	From STAR algorithm development	Static
max_min_lat_lon_h??v??_qkm.dat	From STAR algorithm development	Static
max_min_lat_lon_qkm_merge.list	From STAR algorithm development	Static
averaged_7km_vcf_h??v??.bin	From STAR algorithm development	Static
averaged_7km_veg_h??v??.bin	From STAR algorithm development	Static

Snow EDR Output

Snow Products					
Paramter	Size	Scans	FOV	Other Dimensions	Total
Across_Scan_Low_Resolution	2		243		486
Along_Scan	2	3960			7920
Earth_Azimuth_Angle	4	3960	243		3849120
Earth_Incidence_Angle	4	3960	243		3849120
Latitude_ for_Low_Resolution	4	3960	243		3849120
Longitude_ for_Low_Resolution	4	3960	243		3849120
QM_Total_Pixels	4			1	4
QM_Total_Pixels_SCI_3	4			1	4
QM_Total_Pixels_SDI_0	4			1	4
QM_Total_Pixels_SDI_1	4			1	4
QM_Total_Pixels_SDI_2	4			1	4
QM_Total_Pixels_SDI_3	4			1	4
QM_Total_Pixels_SSI_9	4			1	4
SWE	4	3960	486		7698240
Scan_Angle	4	3960	243		3849120
Scan_Time	4	3960		6	95040

Snow EDR Output

Snow Products					
Paramter	**Size**	**Scans**	**FOV**	**Other Dimensions**	**Total**
Scan_Time	4	3960		6	95040
Scattering_Surface_Index	2	3960	243		1924560
Snow_Climatology_Index	2	3960	243		1924560
Snow_Cover	2	3960	243		1924560
Snow_Depth	4	3960	243		3849120
Snow_Depth_Index	2	3960	243		1924560
					38594674

Soil Moisture Unit Inputs

Table 17.0 GCOM Soil Moisture Unit Inputs		
Parameter	Source	Status
Brightness Temperatures	From AMSR2 SDR (L1B)	Dynamic
Geo location information	From AMSR2 SDR (L1B)	Dynamic
LandCover_8km.bin	From STAR algorithm development	Static
CLAY_TOP_fp.IMG	From STAR algorithm development	Static
PORO_TOP_fp.IMG	From STAR algorithm development	Static
SAND_TOP_fp.IMG	From STAR algorithm development	Static
TAU_CDF_LPRM.bin	From STAR algorithm development	Static
TAU_CDF_Reference.bin	From STAR algorithm development	Static

Soil Moisture EDR Output

Soil Moisture Products					
Parameter	**Size**	**Scans**	**FOV**	**Other Dimensions**	**Total**
Across_Scan_Low_Resolution	2		243		486
Along_Scan	2	3960			7920
Earth_Azimuth_Angle	4	3960	243		3849120
Earth_Incidence_Angle	4	3960	243		3849120
Land_Cover_Type	2	3960	243		1924560
Latitude_ for_Low_Resolution	4	3960	243		3849120
Longitude_ for_Low_Resolution	4	3960	243		3849120
QM_Total_BT_Problems	4			1	4
QM_Total_Bad_Retrievals	4			1	4
QM_Total_Cold_Desert	4			1	4
QM_Total_Frozen_Ground	4			1	4
QM_Total_Good_Quality	4			1	4
QM_Total_No_Retrieval	4			1	4
QM_Total_Num_Pixels	4			1	4
QM_Total_SM_GT_Porosity	4			1	4
QM_Total_Snow_Rain	4			1	4

Soil Moisture EDR Output

Soil Moisture Products					
Parameter	**Size**	**Scans**	**FOV**	**Other Dimensions**	**Total**
Scan_Angle	4	3960	243		3849120
Scan_Time	4	3960		6	95040
Soil_Moisture	4	3960	243		3849120
Soil_Moisture_QA	4	3960	243		3849120
					28971882

Sea Ice Unit Inputs

Table 17.0 GCOM Seaice Unit Inputs		
Parameter	Source	Status
Brightness Temperatures	From AMSR2 SDR (L1R)	Dynamic
Geo location information	From AMSR2 SDR (L1R)	Dynamic
e2_mask_north.dat	From STAR algorithm development	Static
e2_mask_south.dat	From STAR algorithm development	Static
e2_sst_n_??.dat	From STAR algorithm development	Static
e2_sst_s_??.dat	From STAR algorithm development	Static
EASE2_NPolar.gpd	From STAR algorithm development	Static
EASE2_NPolar_lat.bin	From STAR algorithm development	Static
EASE2_NPolar_lon.bin	From STAR algorithm development	Static
EASE2_SPolar.gpd	From STAR algorithm development	Static
EASE2_SPolar_lat.bin	From STAR algorithm development	Static
EASE2_SPolar_lon.bin	From STAR algorithm development	Static

Sea Ice – Northern Hemisphere EDR Output

Seaice – Northern Hemisphere - Products					
Parameter	**Size**	**X-Dimension**	**Y-Dimension**	**Other Dimensions**	**Total**
Across_X_Dimension	2	1050			2100
Along_Y_Dimension	2		1050		2100
Bootstrap_Ice_Concentation	4	1050	1050		4410000
Flags	2	1050	1050		2205000
Latency	4	1050	1050		4410000
Latitude	4	1050	1050		4410000
Longitude	4	1050	1050		4410000
NASA_Team_2_Ice_Concentration	4	1050	1050		4410000
NASA_Team_2_Multiyear_Ice	4	1050	1050		4410000
NT2_minus_Bootstrap	4	1050	1050		4410000
QM_Num_Grid_Range_25	4			1	4
QM_Num_Grid_Range_50	4			1	4
QM_Total_Ice	4			1	4
QM_Total_Pixels	4			1	4
Range_of_Ice_Concentation	4	1050	1050		4410000
Scan_Time	4	1050	1050	6	26460000
					63949216

Sea Ice – Southern Hemisphere EDR Output

Seaice – Northern Hemisphere - Products					
Parameter	**Size**	**X-Dimension**	**Y-Dimension**	**Other Dimensions**	**Total**
Across_X_Dimension	2	840			1680
Along_Y_Dimension	2		840		1680
Bootstrap_Ice_Concentation	4	840	840		2822400
Flags	2	840	840		1411200
Latency	4	840	840		2822400
Latitude	4	840	840		2822400
Longitude	4	840	840		2822400
NASA_Team_2_Ice_Concentration	4	840	840		2822400
NASA_Team_2_Multiyear_Ice	4	840	840		2822400
NT2_minus_Bootstrap	4	840	840		2822400
QM_Num_Grid_Range_25	4			1	4
QM_Num_Grid_Range_50	4			1	4
QM_Total_Ice	4			1	4
QM_Total_Pixels	4			1	4
Range_of_Ice_Concentation	4	840	840		2822400
Scan_Time	4	840	840	6	16934400
					40928176

GAASP Architecture Summary

- Hardware
  - » Development, Integration, and Production hardware are defined
- Software Architecture
  - » A high-level system and unit-level designed are defined.
  - » GAASP external interfaces are set up for working with the NDE system.
- Data Files (Input/Outputs)
  - » Input, output, and ancillary data types are defined
  - » All dynamic ancillary data types and their sources have been identified

Review Outline

- Introduction
- Day 1 ORR Report
- Requirements
- Software Architecture
- Validation
- Risk Summary
- Summary and Conclusions

Validation: Ocean EDR

Presented by

Suleiman Alsweiss

Ocean EDR Validation

2nd Delivery of SST & TPW

NOAA GCOM-W1 Project Goal

- Goal of NOAA GCOM-W1 product processing system is to provide validated operational Level-2 products from AMSR2 measurements
  - » Meets scientific accuracy requirements
  - » Meets GCOM-W1 distribution to operational users requirements
  - » Easily maintainable over the life of the mission
  - » Adaptable to handle any required modifications

NOAA GCOM-W1 Processing System

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

AMSR-2 In-orbit Calibration

AMSR2 In-Orbit Calibration

- AMSR2 observed brightness temperatures (Tbs) will be used to infer several geophysical parameters over land and ocean
- Calibrated AMSR2 Tbs significantly improve performance and accuracy of geophysical retrieval algorithms
  - » Identifying and correcting residual calibration biases in AMSR2 Tbs reduce retrievals errors

Calibration Methodology

- The double difference (DD) approach was used to inter-calibrate AMSR2 Tbs
  - » Two instruments are needed (A & B) with one being the reference sensor

$$DD_{AB} = SD_A - SD_B$$

SD= Tb_obs. – Tb_sim.

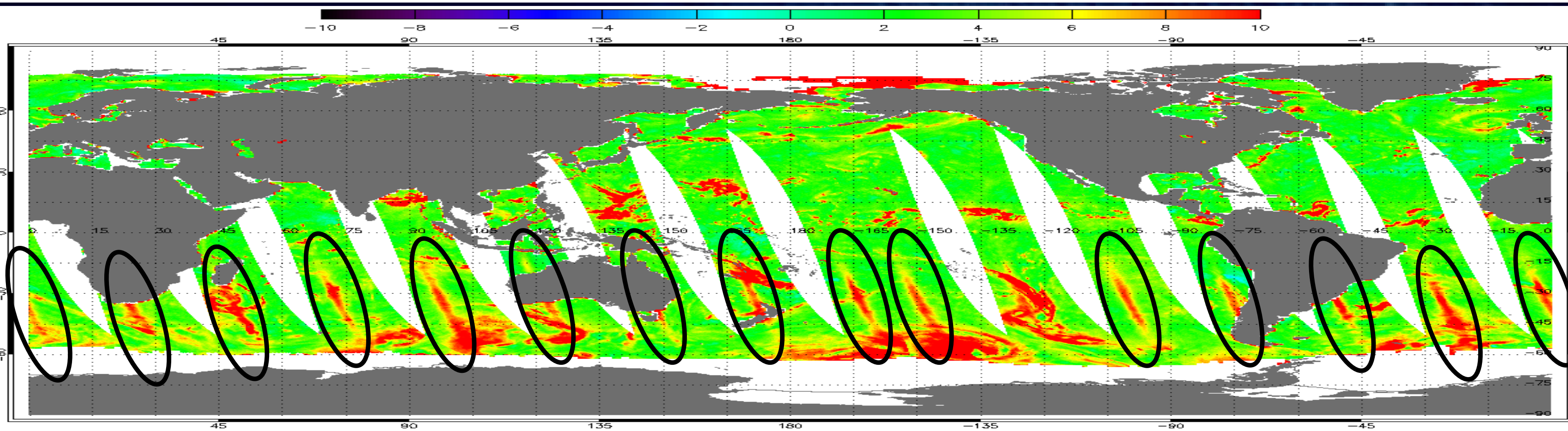
- TRMM microwave imager (TMI) chosen as reference radiometer

Calibration Methodology – cont.

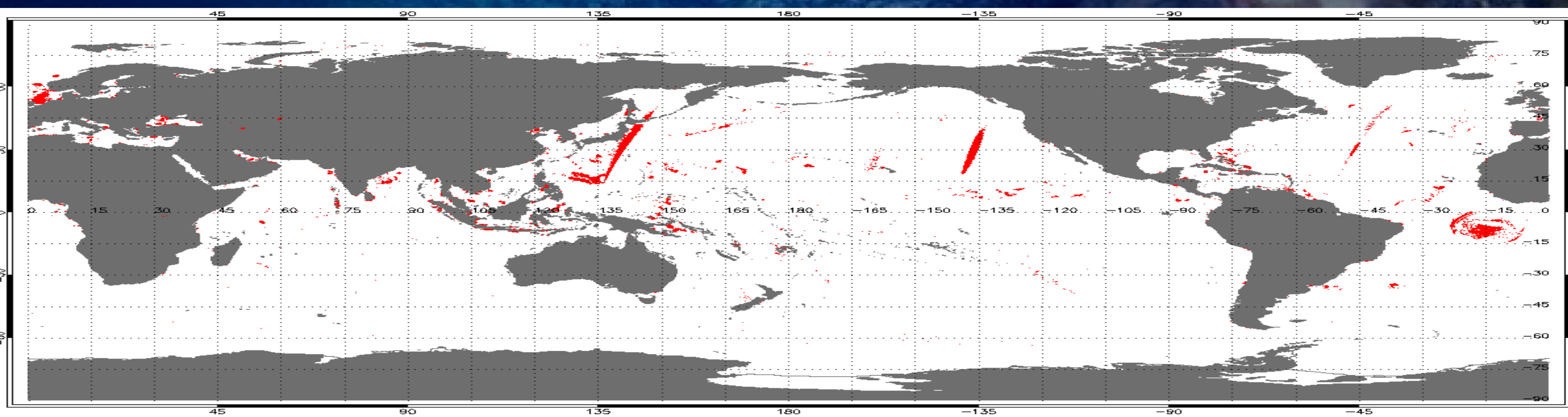
- Data
  - » AMSR2: L1B 2015 release (V2.1)
  - » TMI: 1B11 V7 calibrated Tbs
- AMSR2/TMI collocations
  - » 30 minutes time difference & 10 km spatial difference
  - » Separated by channel & ascending/descending
- Bad pixels excluded
  - » Rain & clouds using TMI EDR maps (Remote Sensing Sys.)
  - » 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



AMSR2 Tb Bias Corrections

- Corrections developed based on double difference relation with AMSR2 Tbs
  - Correction = *f(AMSR2_L1B Tbs)*
  - Different correction applied for each channel

Input Data
- **Brightness temperatures (TB) for 6.9 V/H, 7.3 V/H, 10.7 V/H,18.7 V/H 23.8 V, 36.5 H/V,89 H/V**

6.925h/V Ghz channel correction

7.3H/V Ghz channel correction

10.7H/V Ghz channel correction

18.7H/V Ghz channel correction

23.8 H/V Ghz channel correction

36.5 H/V Ghz channel correction

89a H/V Ghz channel correction

89b H/V Ghz channel correction

Correction Function

$$\Delta T_{Bi} = \frac{\sum_{n} a_{in} T_{Bi}^{n}}{\sum_{m} b_{i} T_{Bi}^{m}}$$

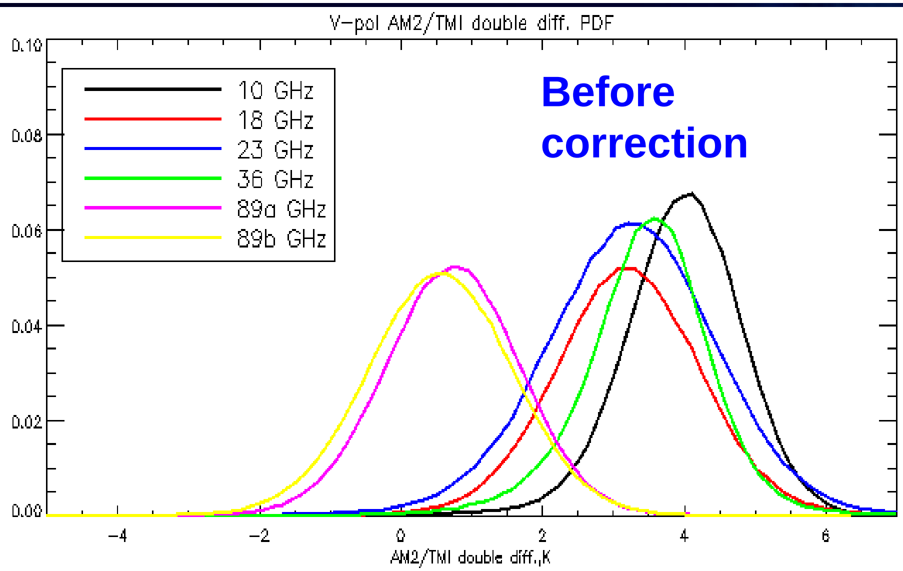
$$T_{Bi} = T_{Bi} - \Delta T_{Bi}$$

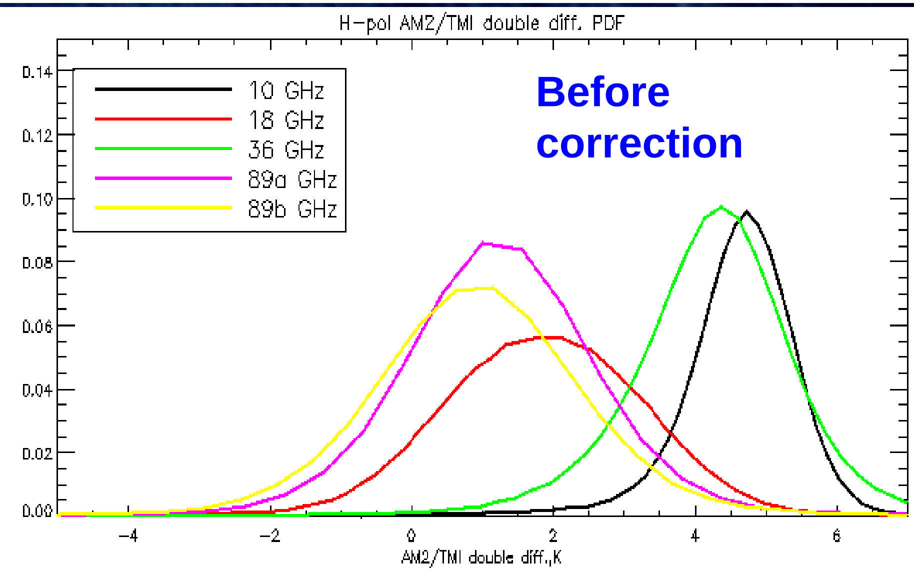
$$i = AMSR2channel$$

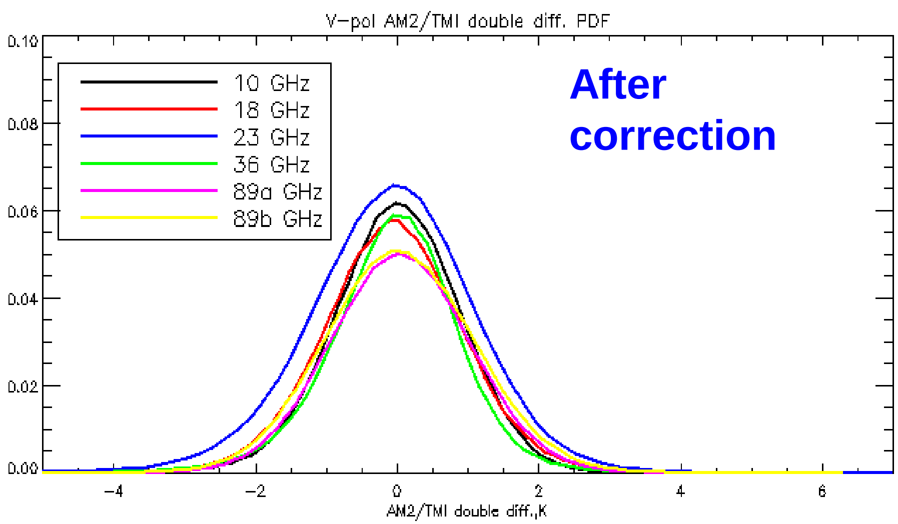
Output Data
- **Corrected ocean brightness temperatures**

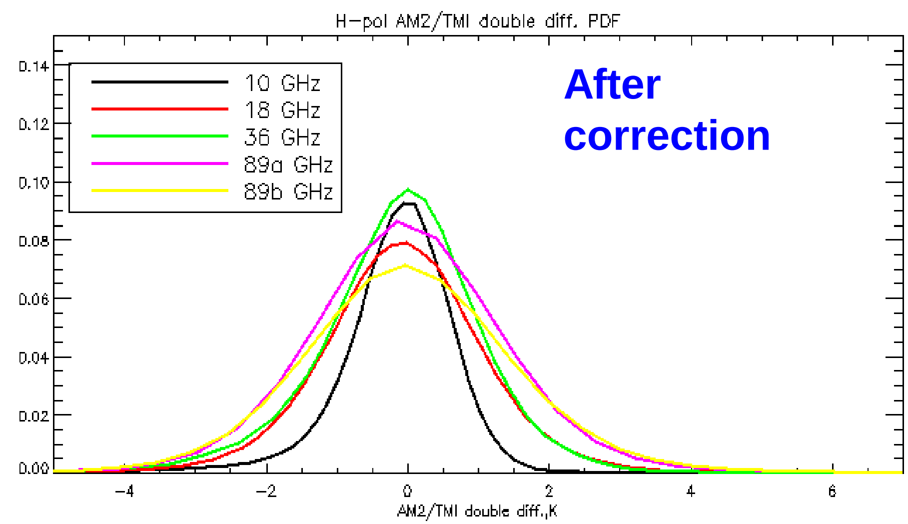
Double Difference PDFs

V-Pol **H-Pol**









AMSR2 Oceanic EDR Validation

2nd Delivery

NOAA AMSR2 Ocean EDR Products

- AMSR2 Ocean 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
  - » Improved SST & TPW from previous delivery based on users feedback

Validation Data Set

- Six months worth of data used in validation
  - » Year 2014
  - » Several Data Sources
    - – Models: Reynolds
      - Data were spatially & temporally interpolated to AMSR2 observation time & location
    - – Satellite measurements: TMI EDRs from RSS
      - Collocation criteria: 10 km maximum distance & 30 minutes maximum time difference
    - – Buoys: NCDC
      - Collocation criteria: 10 km maximum distance & 30 minutes maximum time difference

SST V2.0 Ret. Algorithm

12 AMSR2 channels: 6-36 GHz, H/V pol → 3 deg. latitude bins with 2.75 deg. overlap between 65N and 65S → Wind speed & direction signal correction → Iterative spatial CDF matching & median filter → QC

- SST V2.0 retrieval algorithm utilizes corrected AMSR2 brightness temperatures (Tbs)
  - » 6, 7, 10, 18, 23 & 36 GHz V- & H-pol

SST V2.0 Ret. Algorithm Description – Cont.

- **Stage 1:**
  - » Utilizes stepwise latitude-based localized regressions
    - – Coefficients were interpolated between latitude bins to avoid discontinuity
    - – Separate asc/des coefficients
- **Stage 2:**
  - » Accounts for SST dependence on wind speed, wind direction, total precipitable water and cross track index
- **Stage 3:**
  - » Sliding window for CDF matching & median filtering
    - – Pre-op Reynolds SST used for initialization

SST V2.0 Ret. Algorithm Description – Cont.

- $SST=\Sigma(ai*Tbi)+f(ws,\varphi,tpw,xid)$
- $f(ws, \varphi,tpw,xid)= b0(ws,tpw,xid) + b1(ws)*\cos(\varphi) + b1(ws)*\cos(\varphi) + b2(ws)*\cos(2\varphi) + b3(ws)*\sin(\varphi) + b4*\sin(2\varphi)$
  - » *Xid: Cross track location*
  - » *Ws: GFS wind Speed*
  - » *Φ: Relative azimuth direction*
  - » *TPW: Total precipitable water*

SST V2.0 Ret. Algorithm Description – Cont.

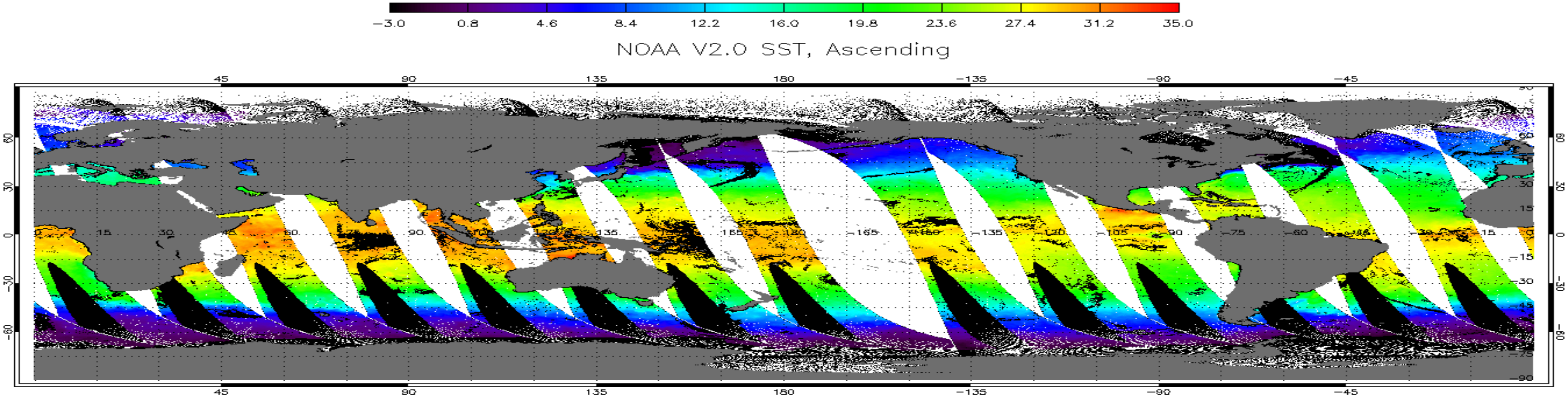
- Some issues found in 1st delivery products were addressed in 2nd delivery
  - » Retrieved SST values match models in daytime (ascending AMSR2 passes)
    - – Models tend to underestimate SST by ~ 2-3 K at low winds
  - » Occasionally horizontal lines (artifacts) appear in some 1st delivery of SST
    - – Latitude stepwise regressions coefficients were interpolated between bins

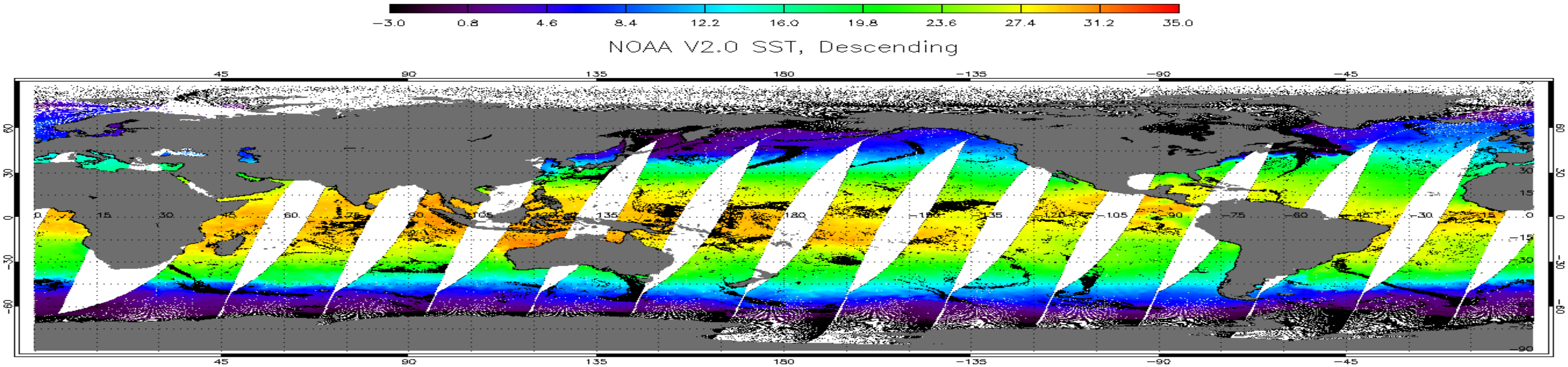
SST V2.0 Quality Control

- Retrieved SST V2.0 products are QC'd using several parameters
  - » Sun glint
    - – Ascending revs only
  - » C-band RFI over ocean
    - – Difference between 6 & 7 GHz channels
  - » 36 GHz polarization ratio
  - » 6/36 GHz gradient
  - » Out of range retrieved values
  - » Edges of the swath

NOAA SST Example (04/01/2014)

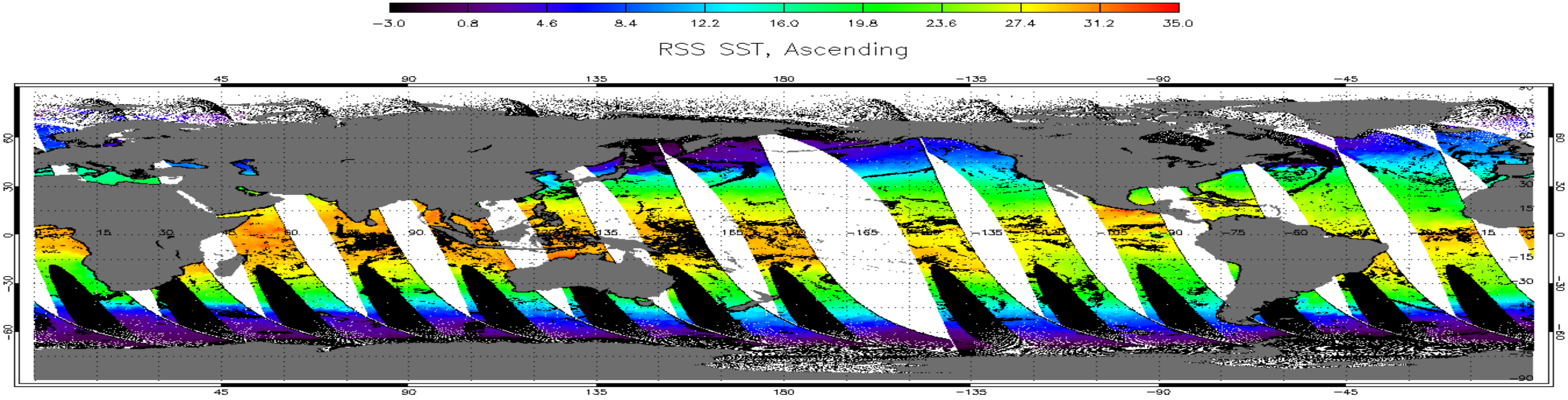
% of flagged points (NOAA): ~ 27%

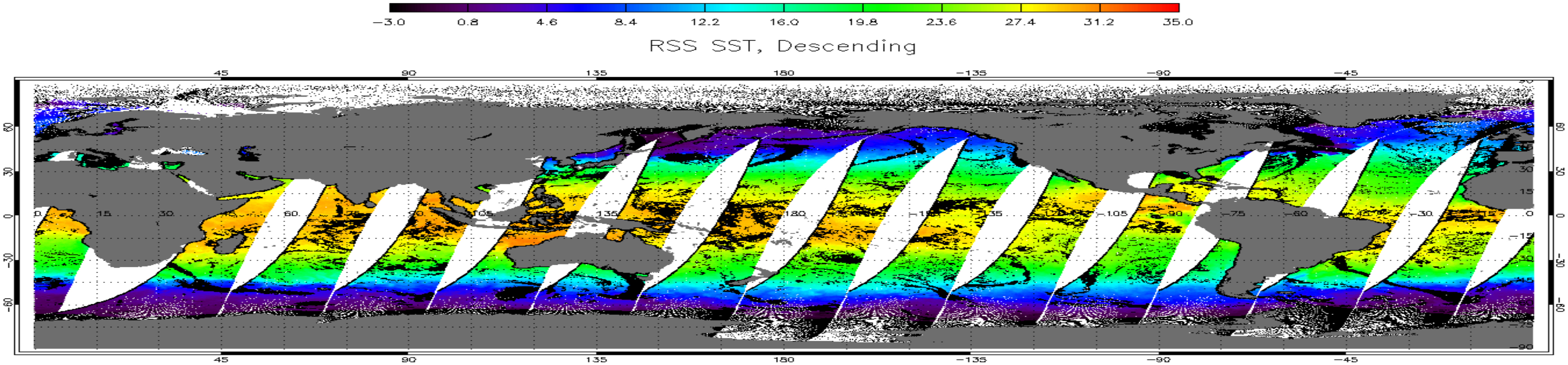




RSS SST Example (04/01/2014)

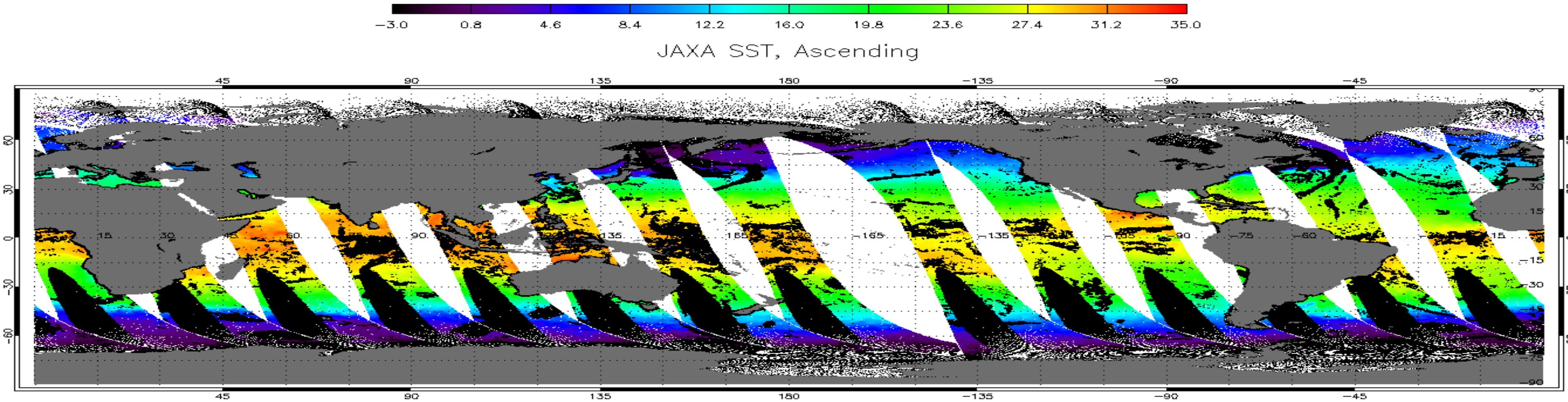
% of flagged points (RSS): ~ 33%

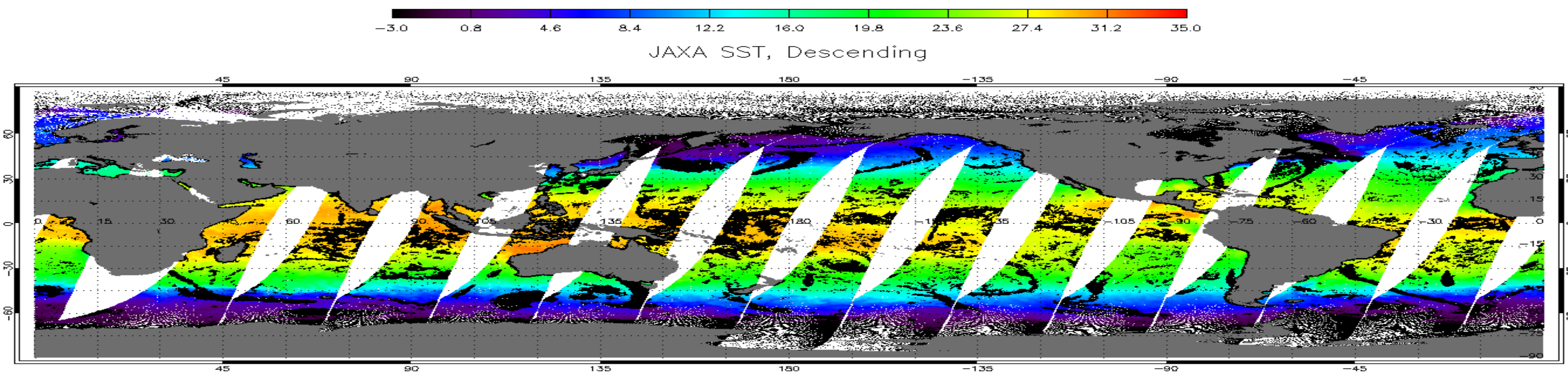




JAXA SST Example (04/01/2014)

% of flagged points (JAXA): ~ 38%





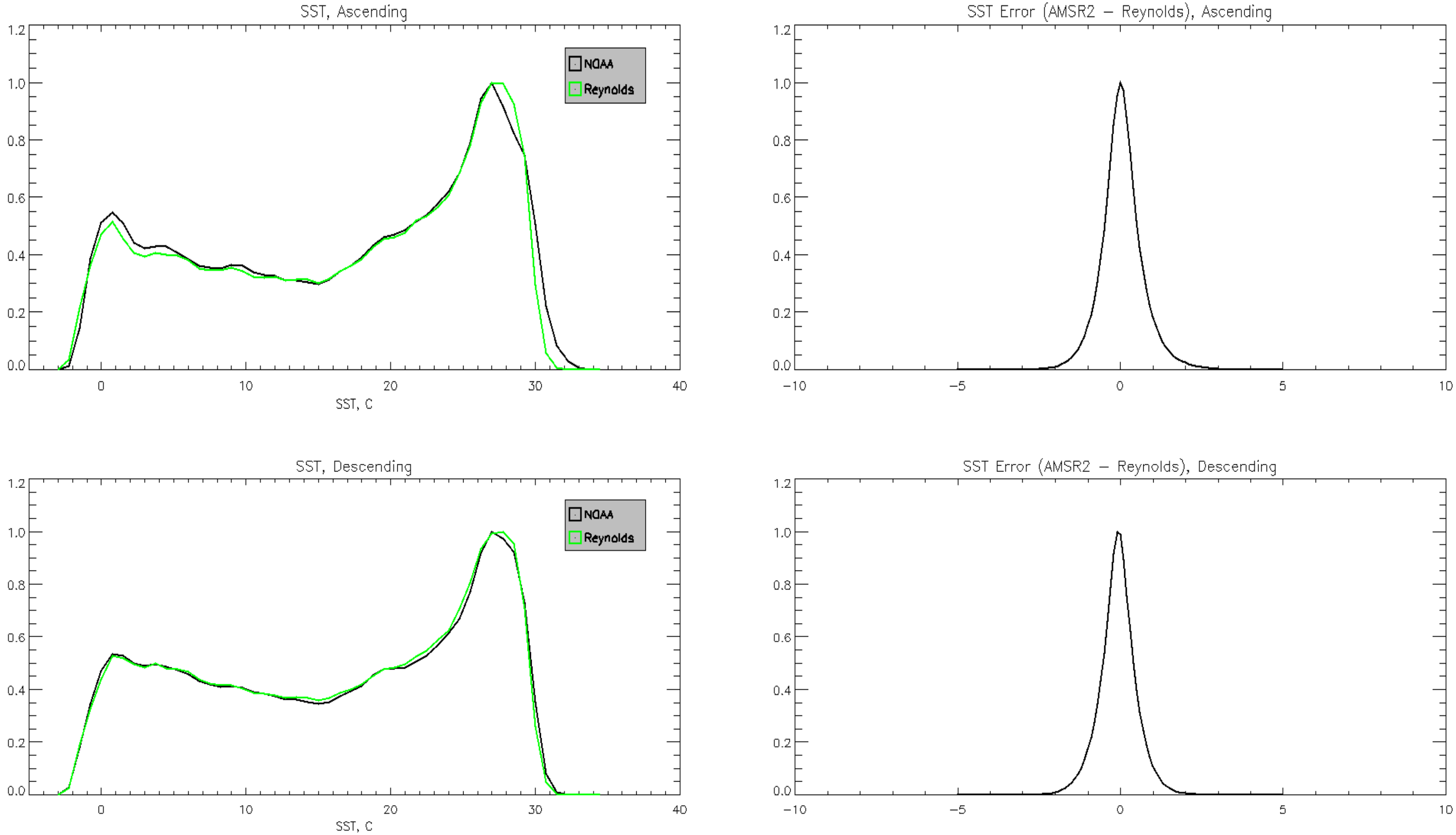
SST Validation

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

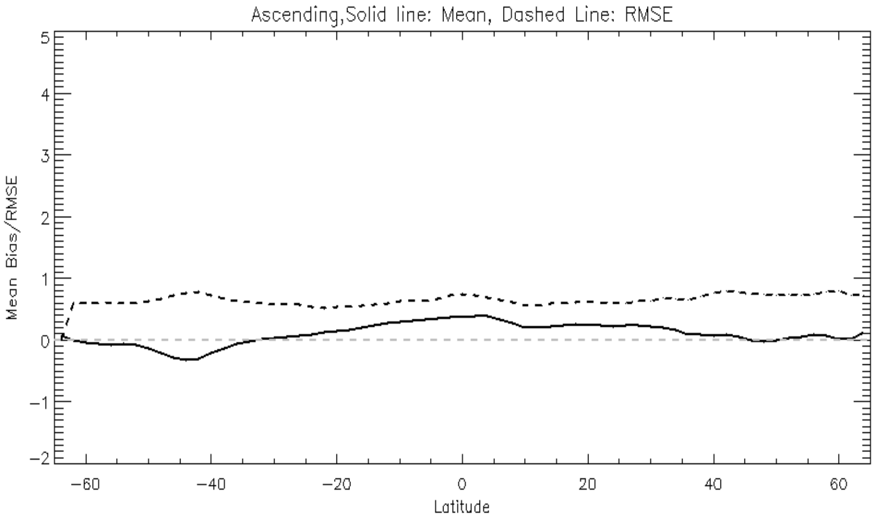
GCOM Sea Surface Temperature Requirements

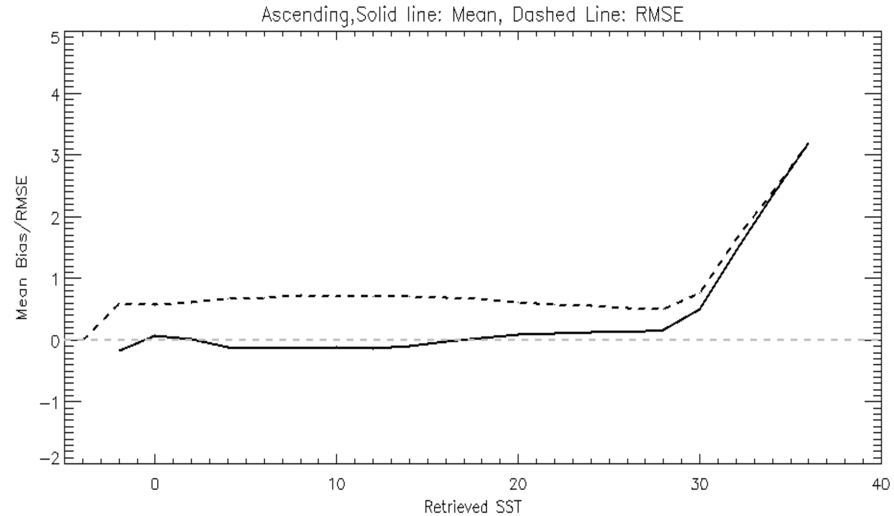
EDR Attribute	Requirement	Status		
		Reynolds	TMI	Buoys
Measurement range	271 – 313 k			
Measurement uncertainty	1.0 k	0.6	0.5	0.7
Measurement accuracy	0.5 k	0.0	-0.2	0.2

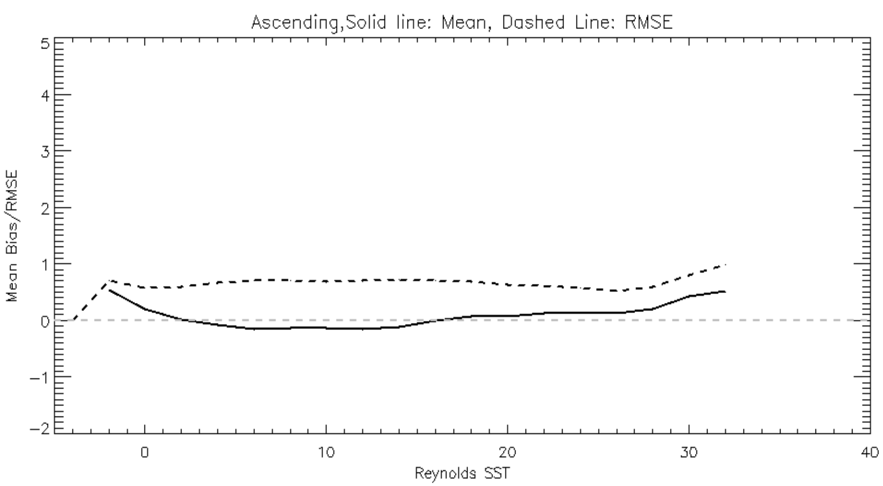
SST Validation / Reynolds

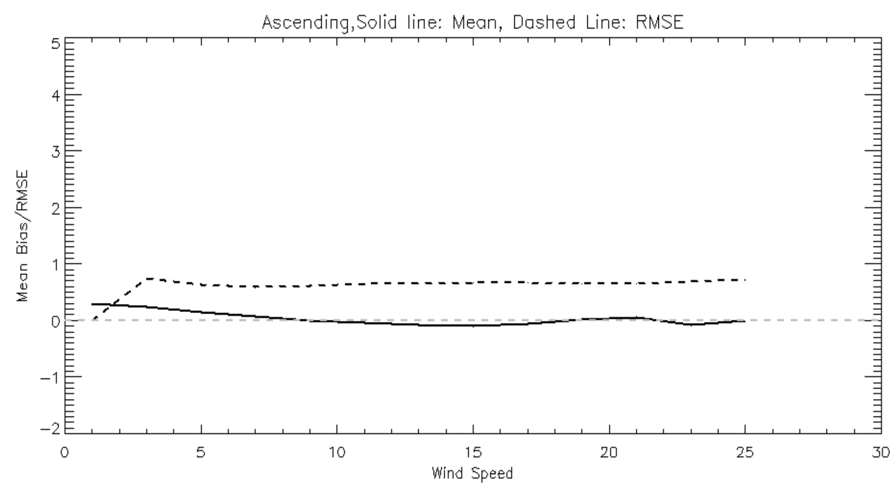


SST Validation / Reynolds – cont.

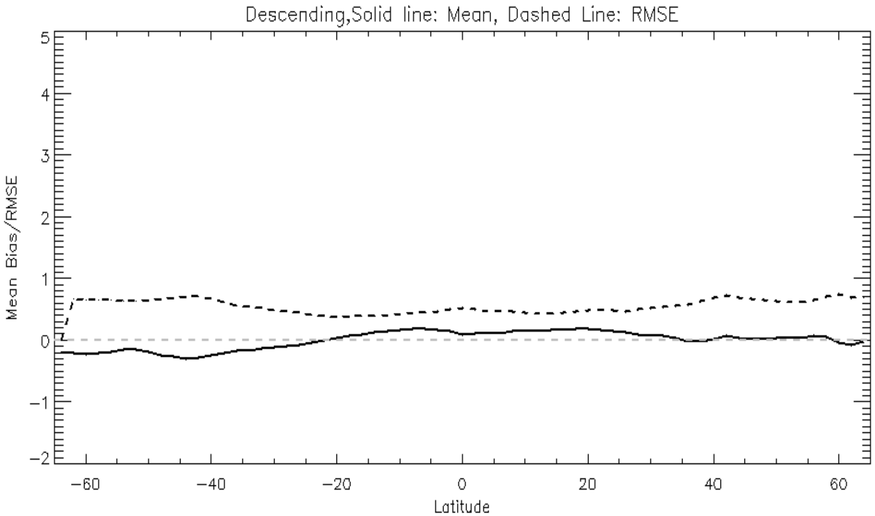


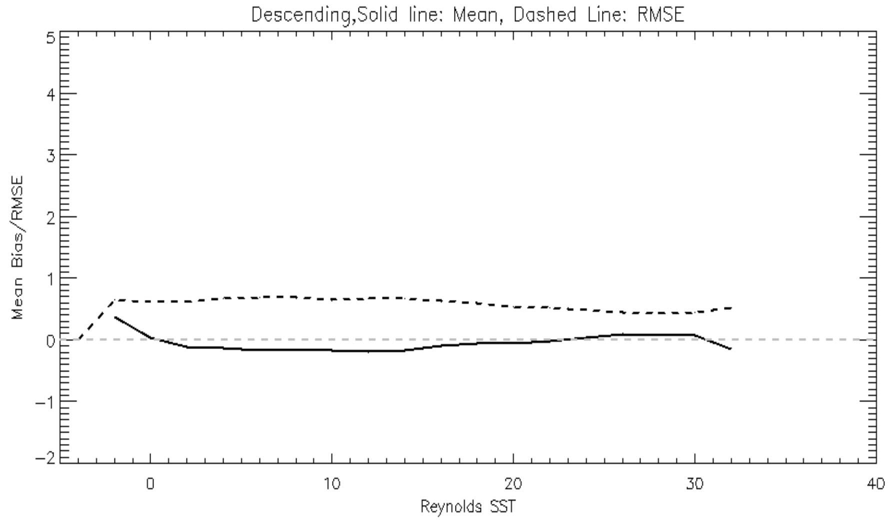


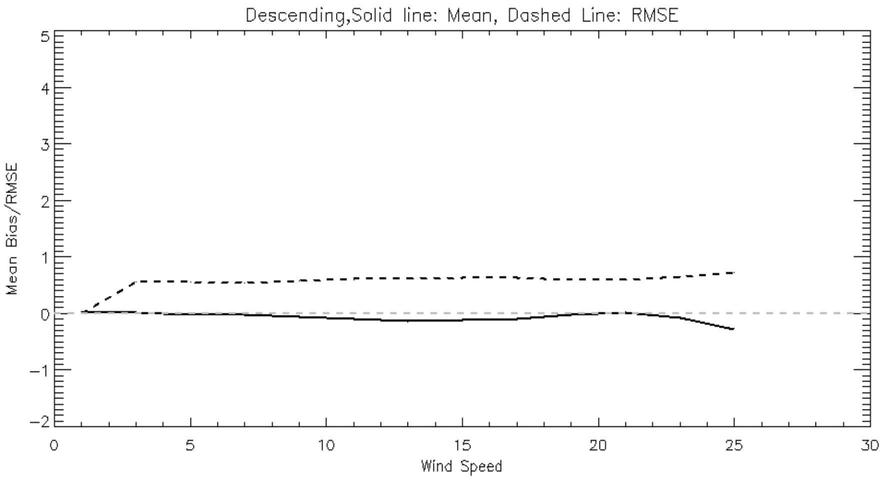


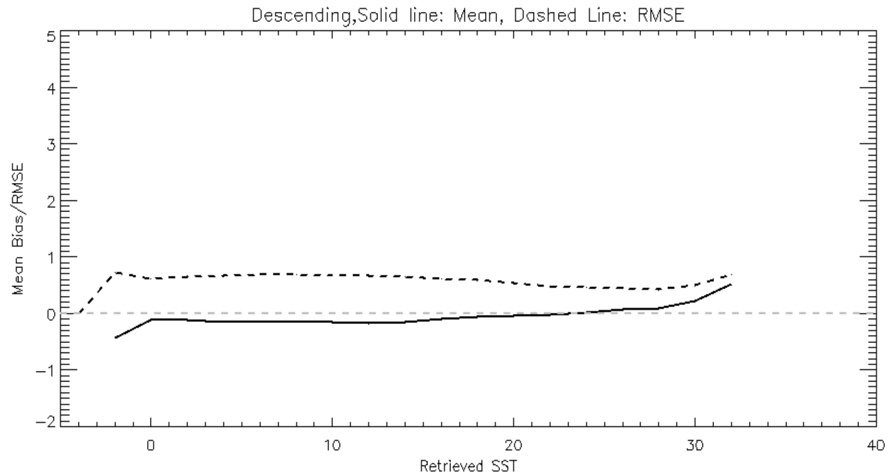


SST Validation / Reynolds – cont.

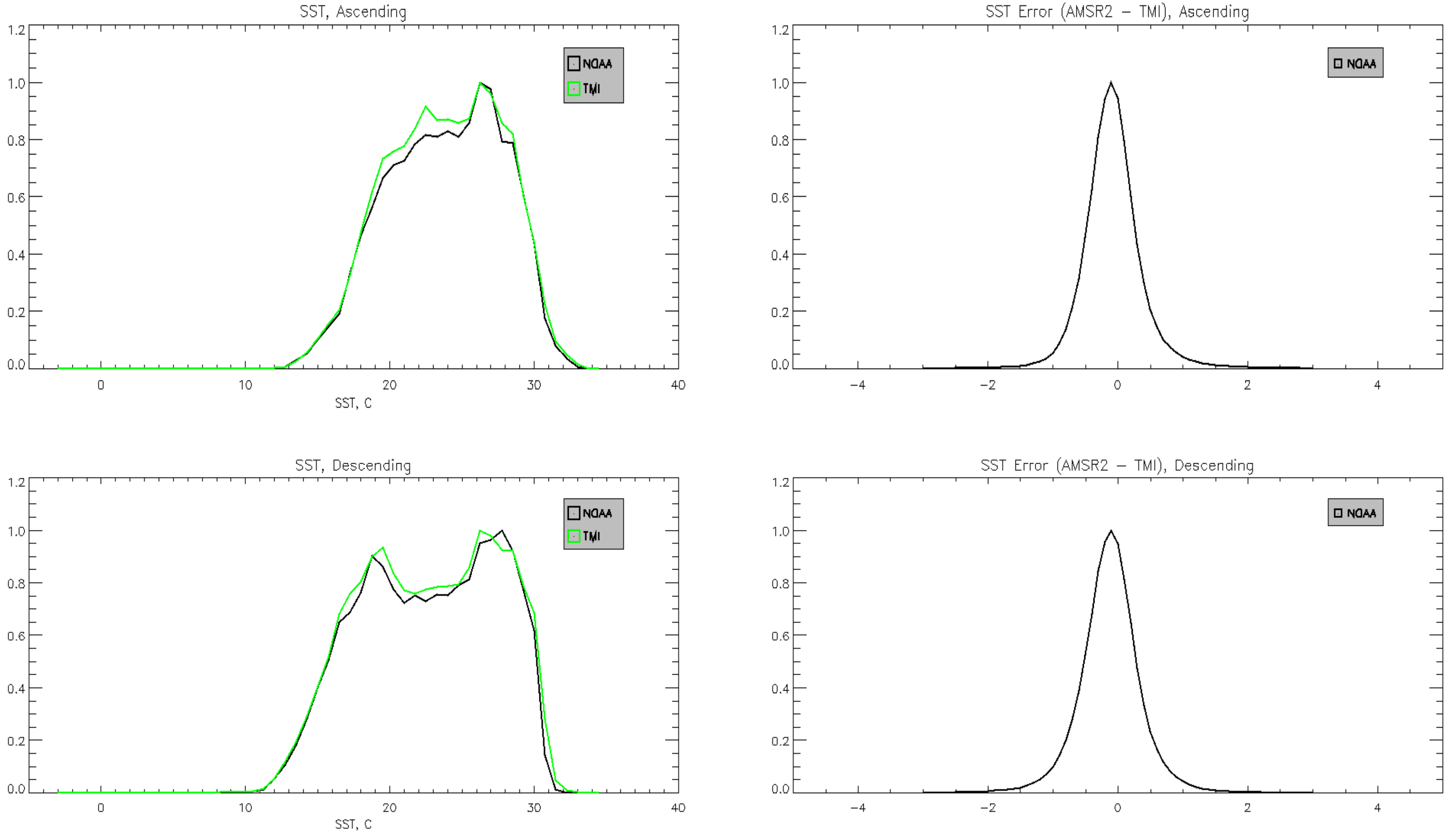




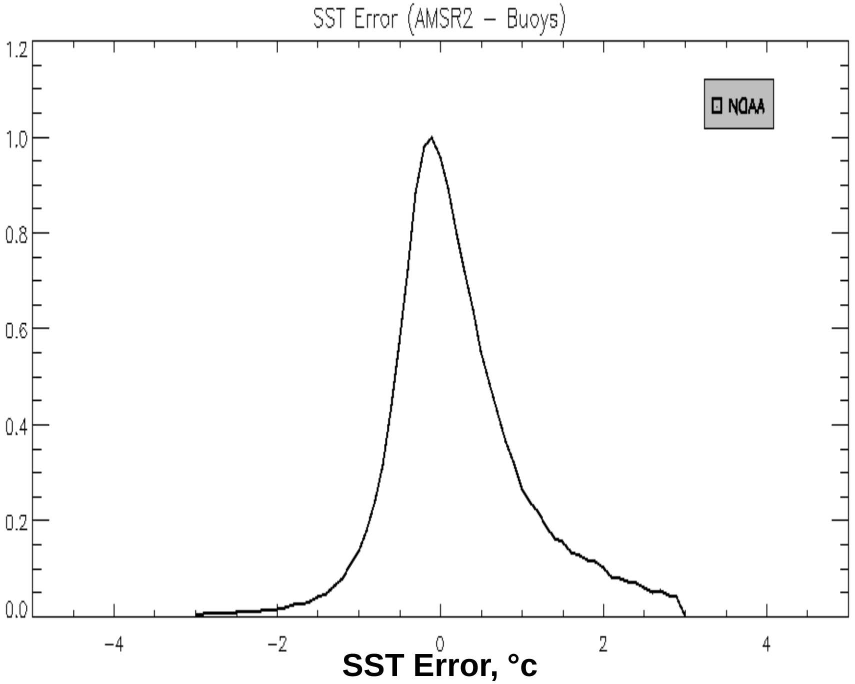


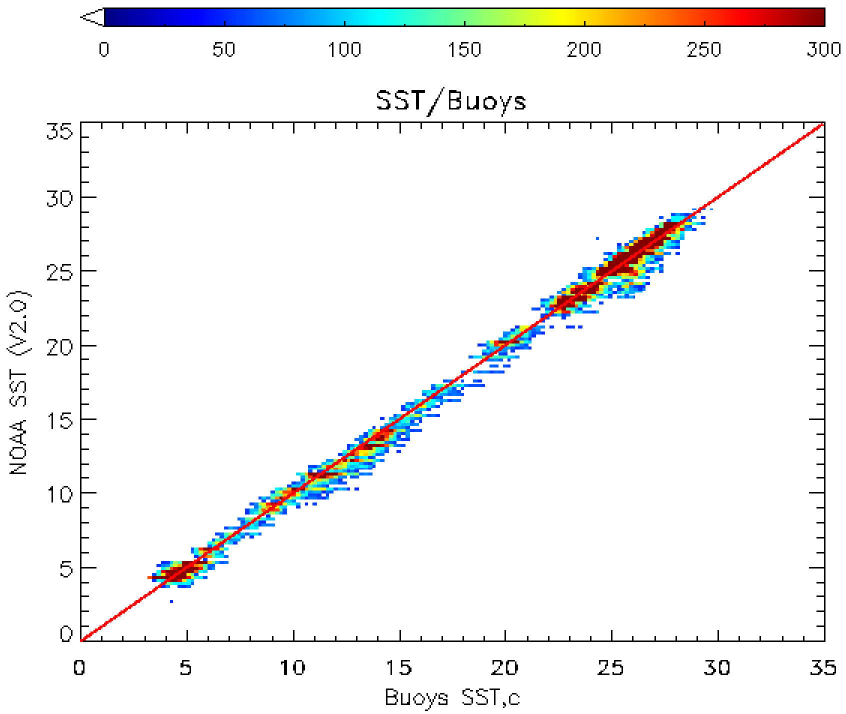


SST Validation / TMI



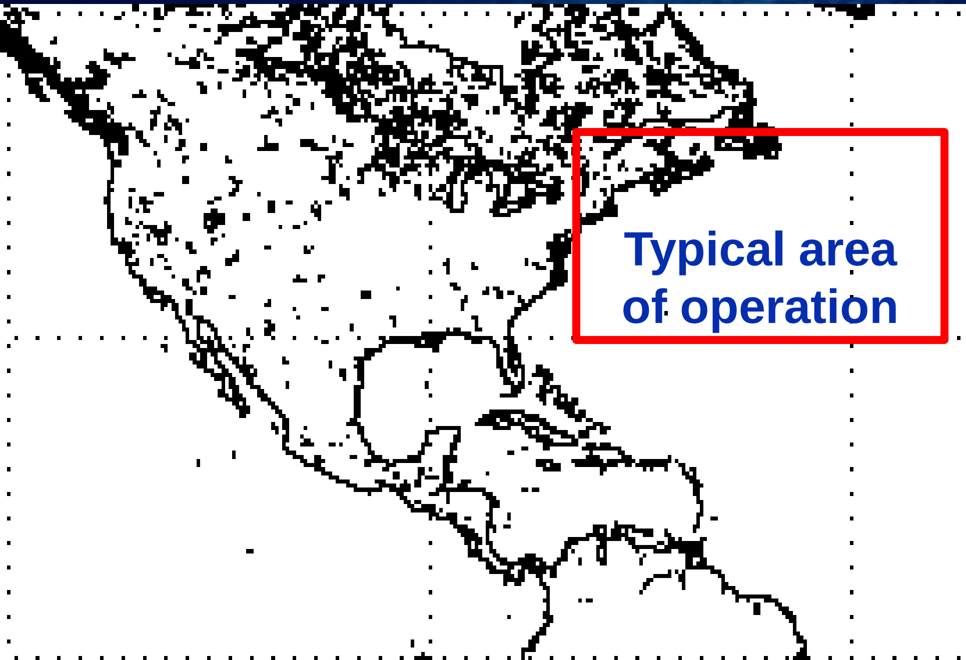
SST Validation / Buoys

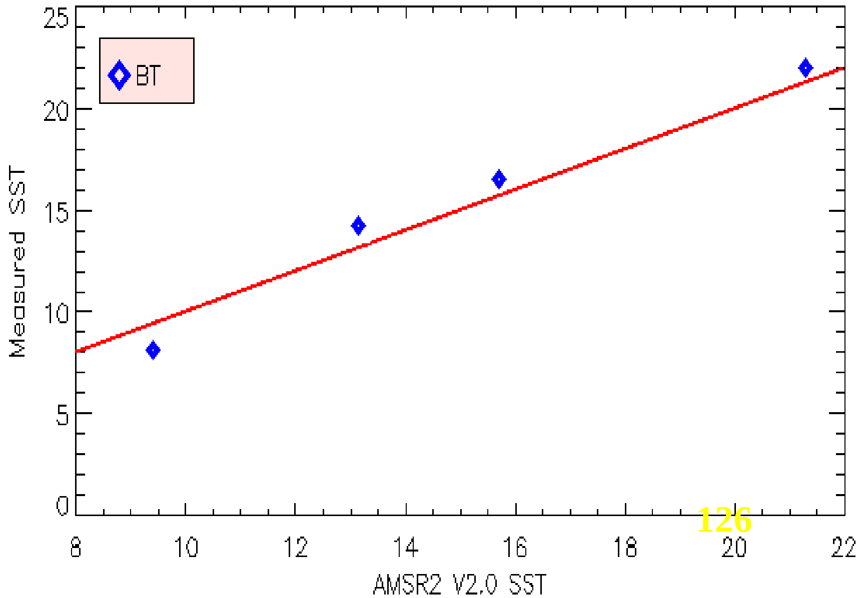




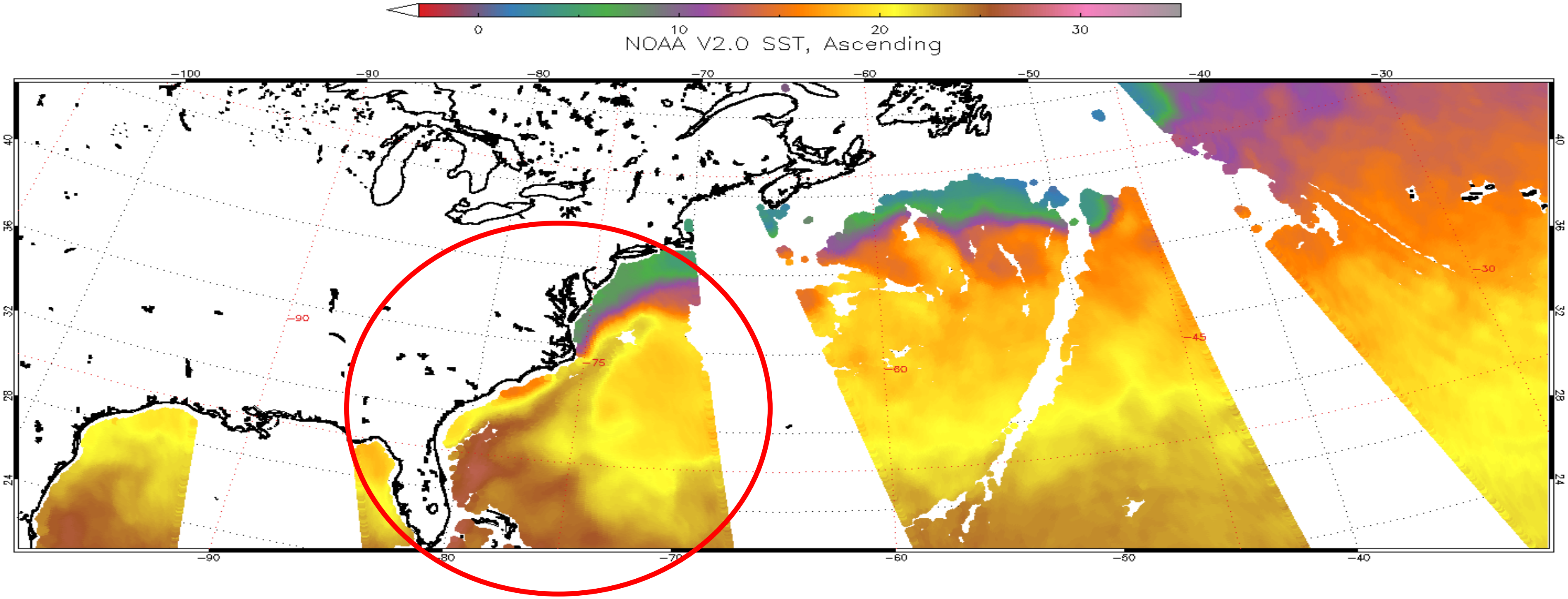
SST Validation / Field Experiments

- During 2016 winter season field experiments we dropped several Airborne eXpendable Bathy Thermograph (AXBT) to measure SST
  - » Collocated with AMSR2 overpass

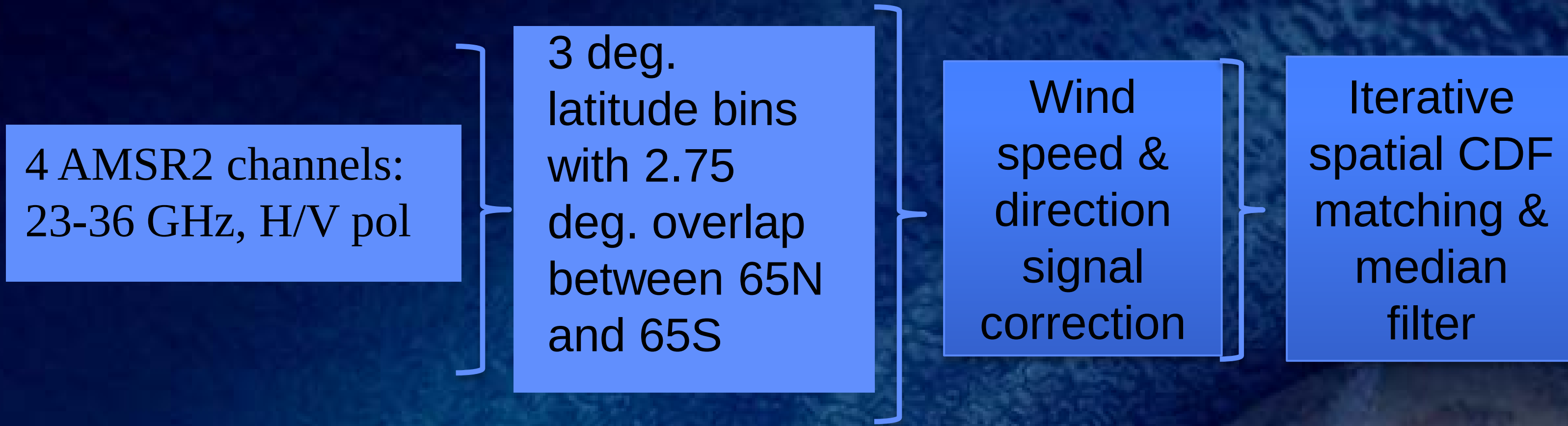




Gulf Stream Example (04/01/2014)



TPW V2.0 Ret. Algorithm



- SST V2.0 retrieval algorithm utilizes corrected AMSR2 brightness temperatures (Tbs)
  - » 23 & 36 GHz V- & H-pol

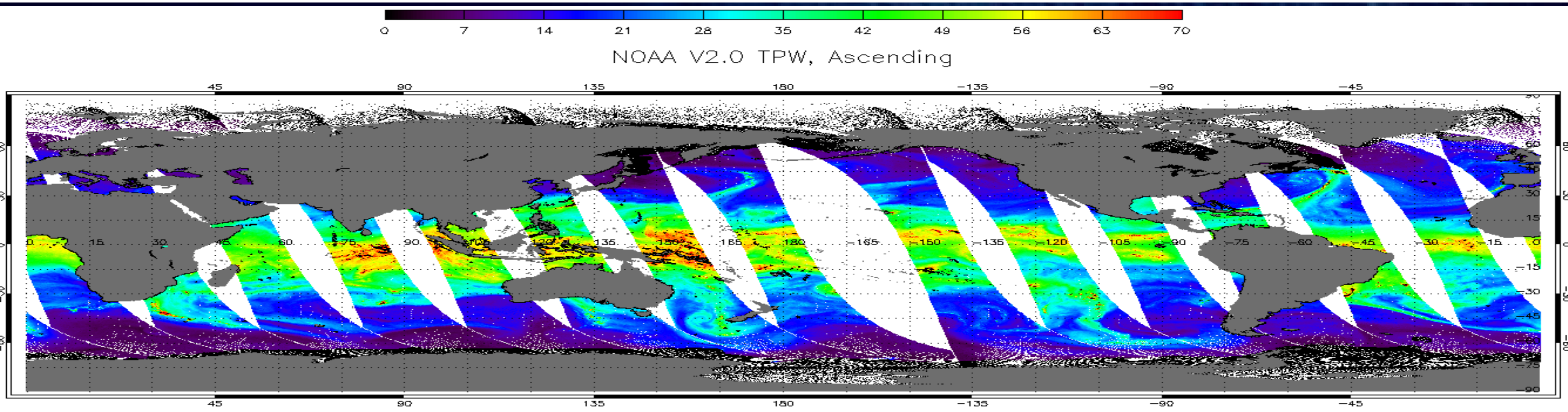
TPW V2.0 Ret. Algorithm Description – Cont.

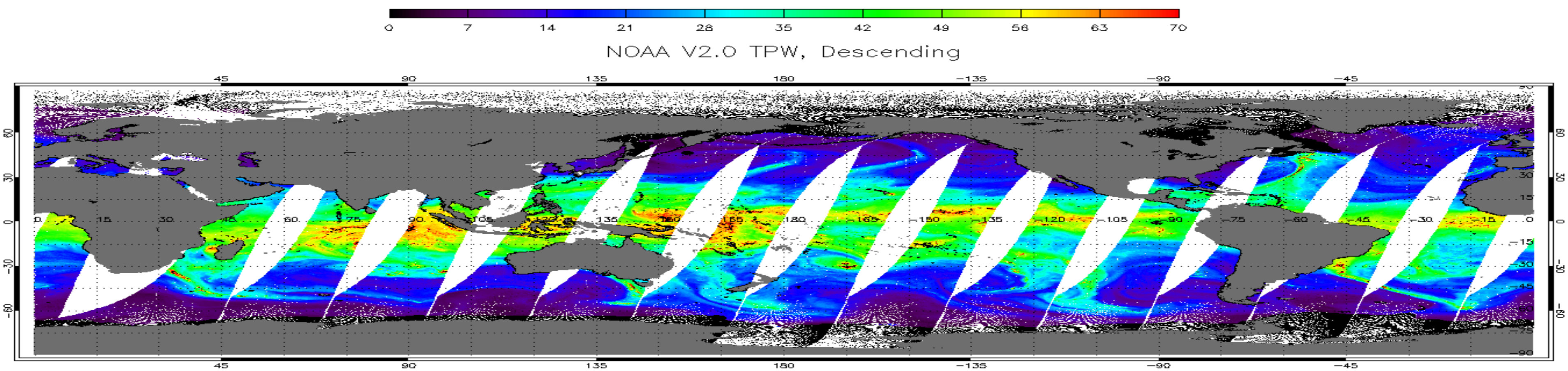
- **Stage 1:**
  - » TPW retrieval algorithm utilizes stepwise latitude-based localized regressions
    - – Coefficients were interpolated between latitude bins to avoid discontinuity
- **Stage 2:**
  - » Accounts for TPW dependence on wind speed and direction
- **Stage 3:**
  - » Spatial sliding median filtering

TPW V2.0 Ret. Algorithm Description – Cont.

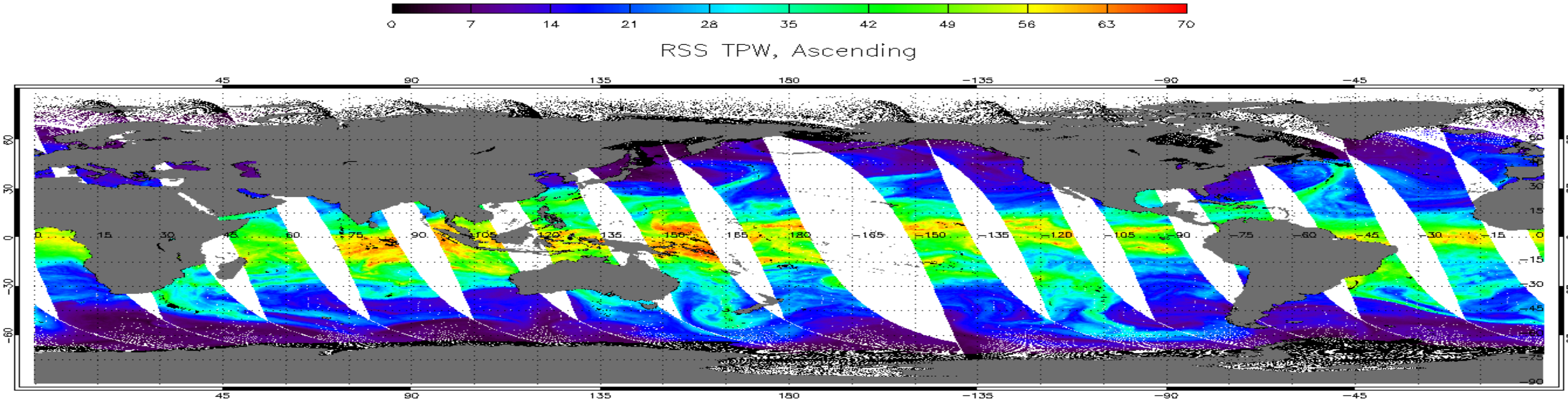
- Some issues found in 1st delivery products were addressed in 2nd delivery
  - » TPW retrievals uses all AMSR-2 channels including 6 & 7 GHz
    - – Affected by sun glint
    - – Not able to get close to coast line due to bigger IFOV of low frequency channels
  - » 2nd delivery of TPW utilizes 23 & 36 GHz channels only
    - – No sun glint contamination
    - – Can get close to coast line

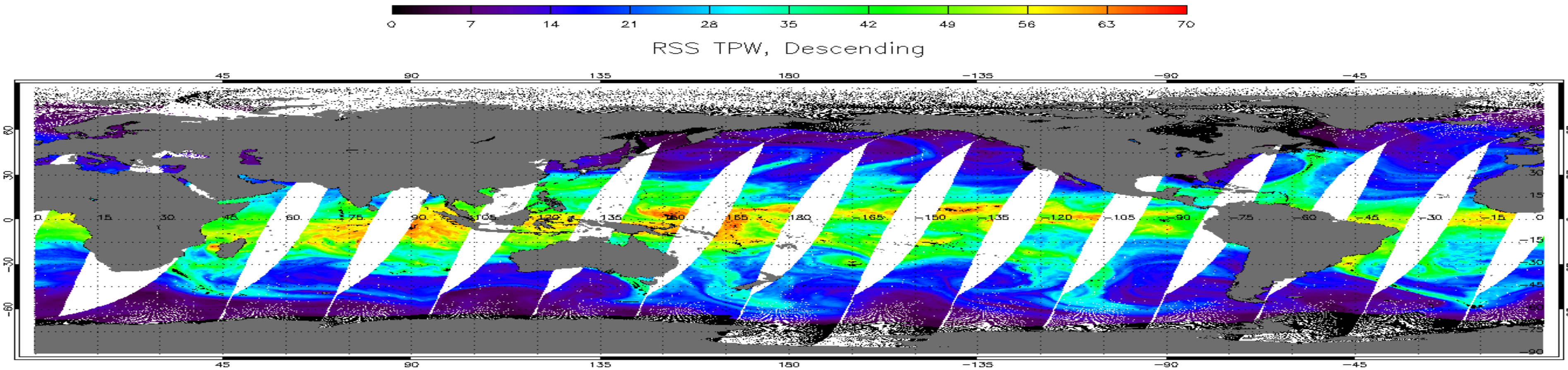
NOAA TPW Example (04/01/2014)



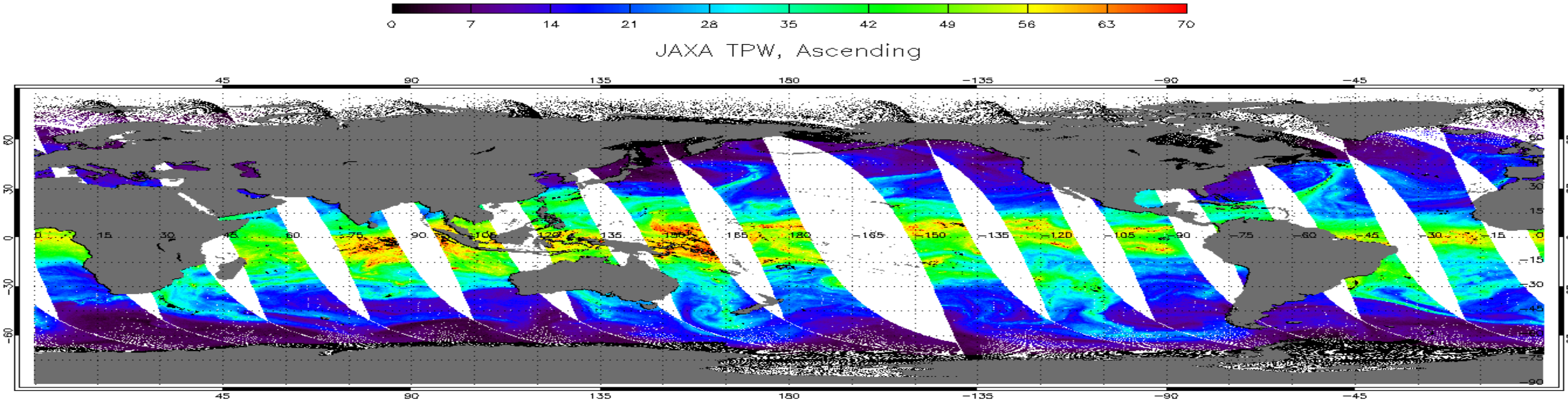


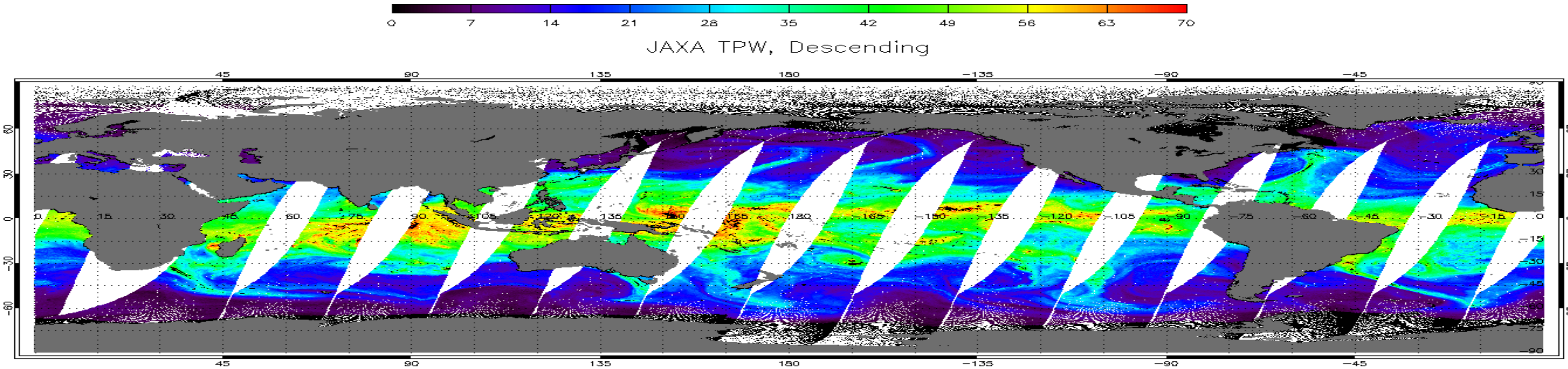
RSS TPW Example (04/01/2014)





JAXA TPW Example (04/01/2014)





TPW Validation

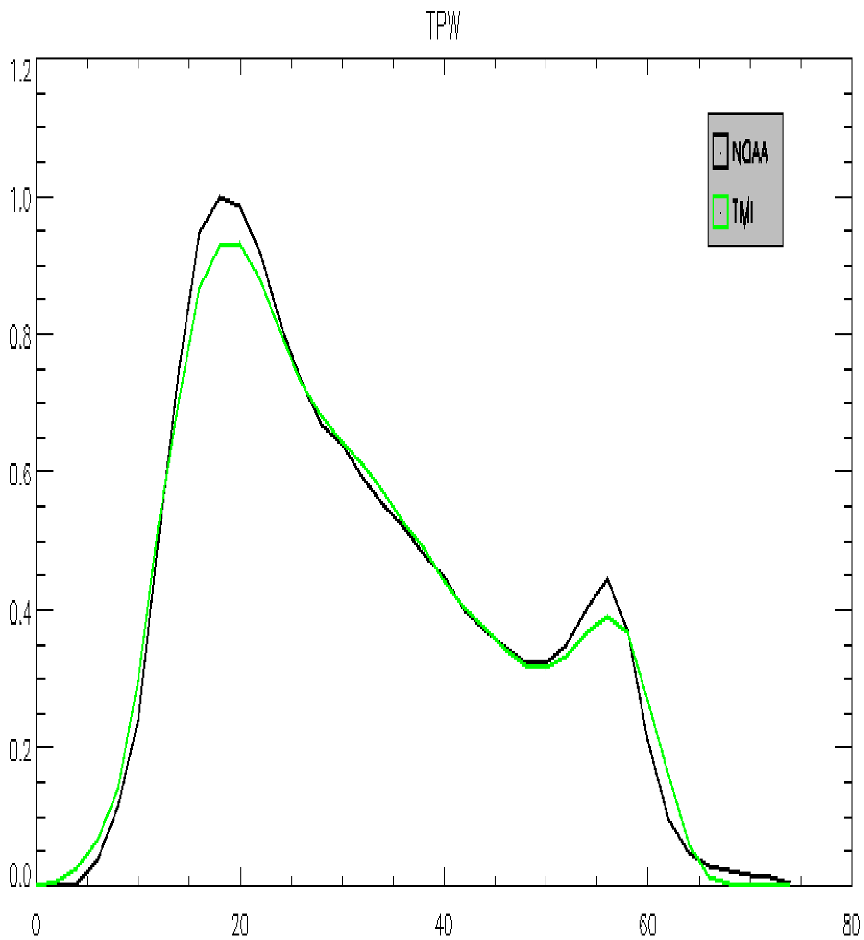
- Ancillary data for AMSR2 TPW validation
  - TMI & AMSR2 EDRs from RSS
  - NOAA-19 EDRs from NOAA's Microwave Integrated Retrieval System (MIRS)

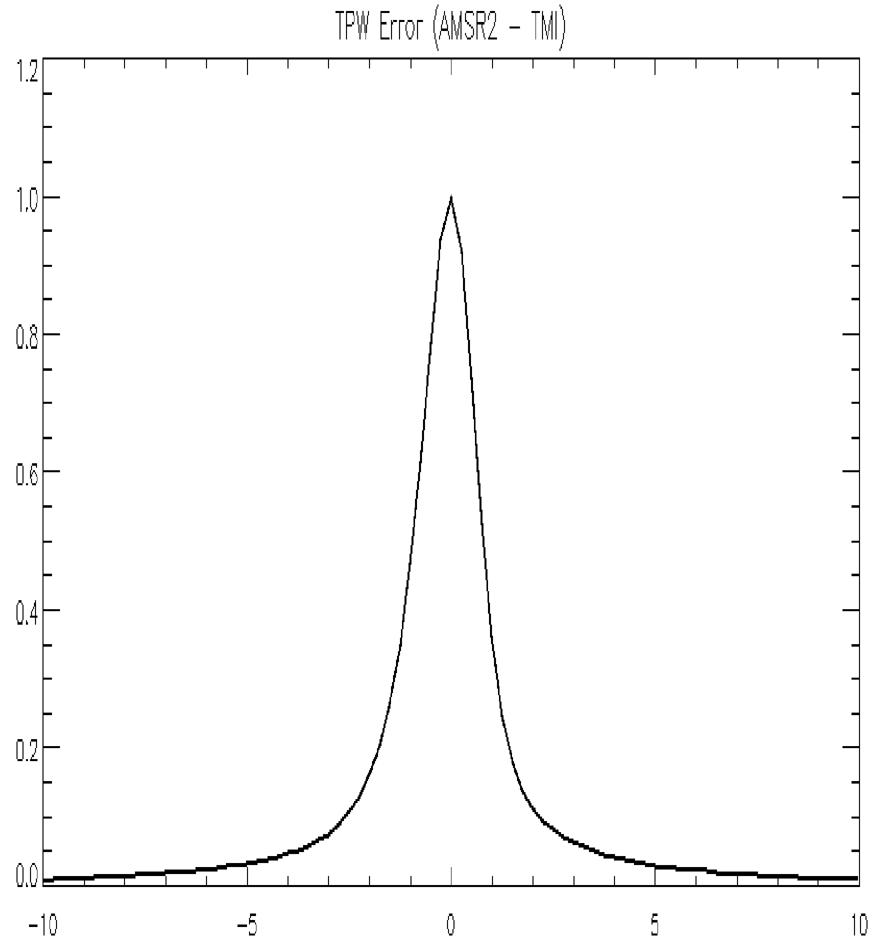
GCOM Total Precipitable Water Requirements

EDR Attribute	Requirement	Status
		TMI
Measurement range	1 – 75 mm	
Measurement uncertainty	2mm or 10% whichever is greater	1.2
Measurement accuracy	1 mm	0.0

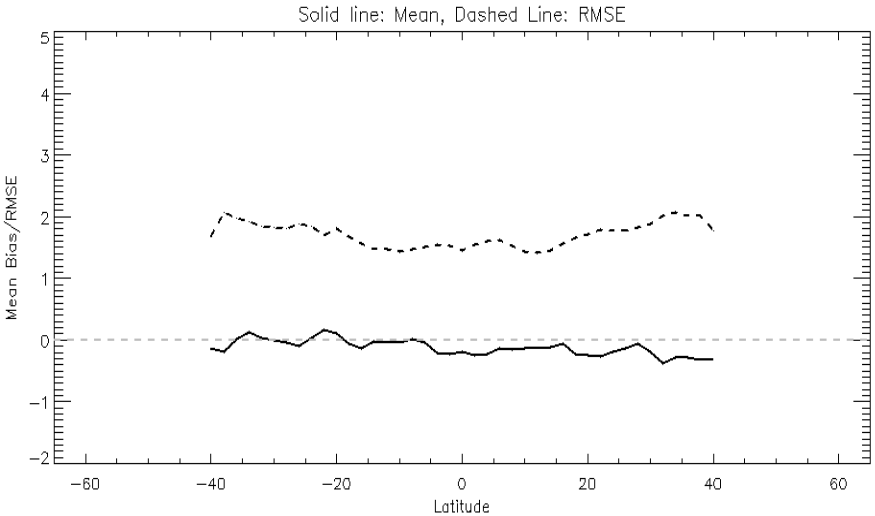
*** TPW & CLW changes are fastest of all other parameters. Interpolated 6H models are not expected to agree well with instantaneous measurements from AMSR2**

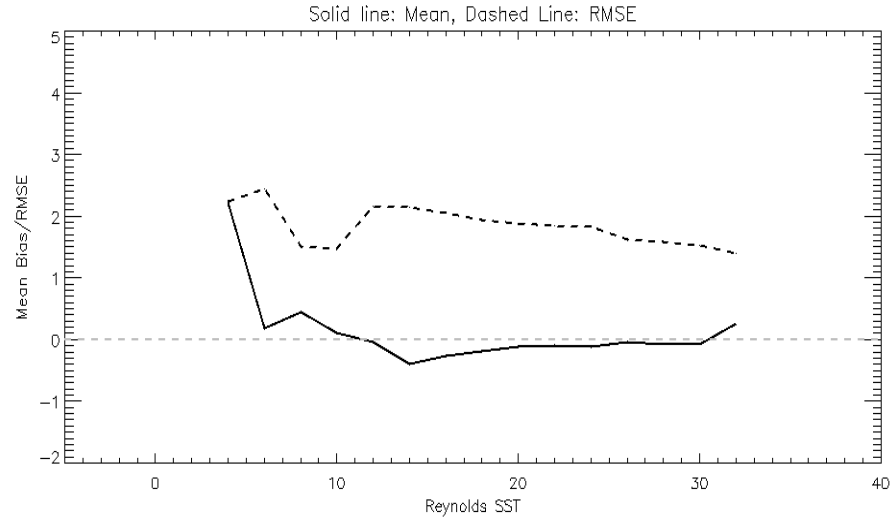
TPW Validation / TMI

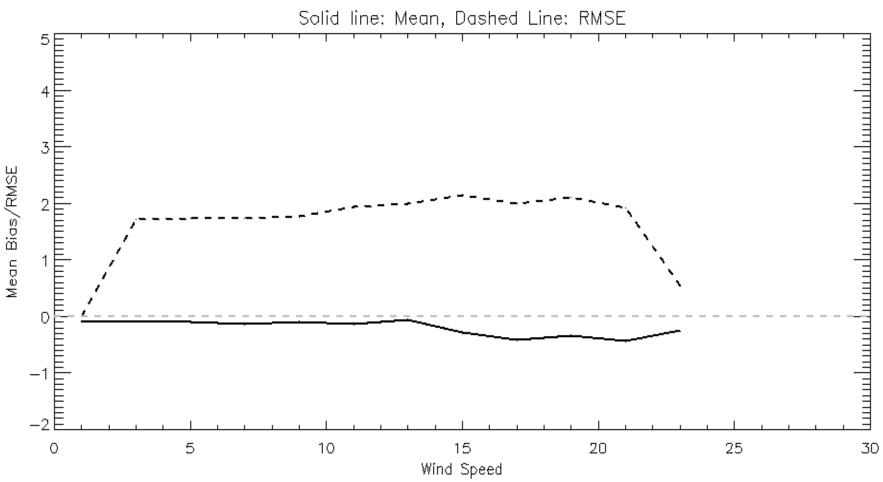


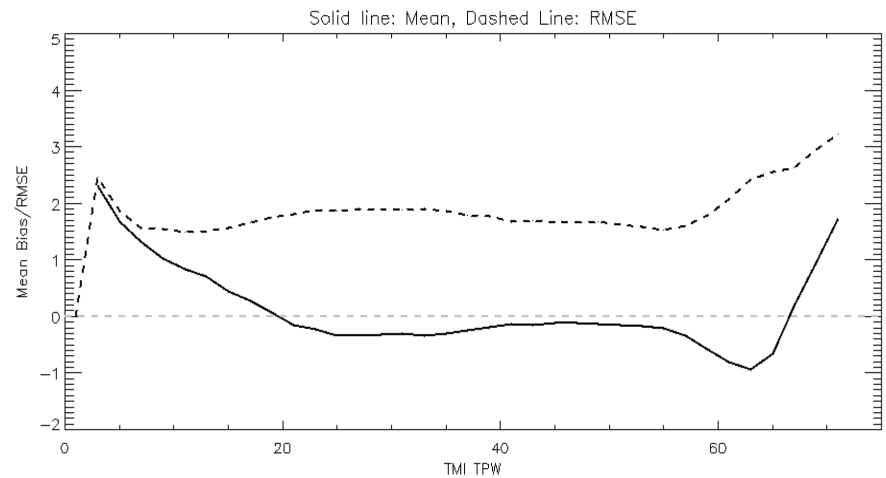


TPW Validation / TMI

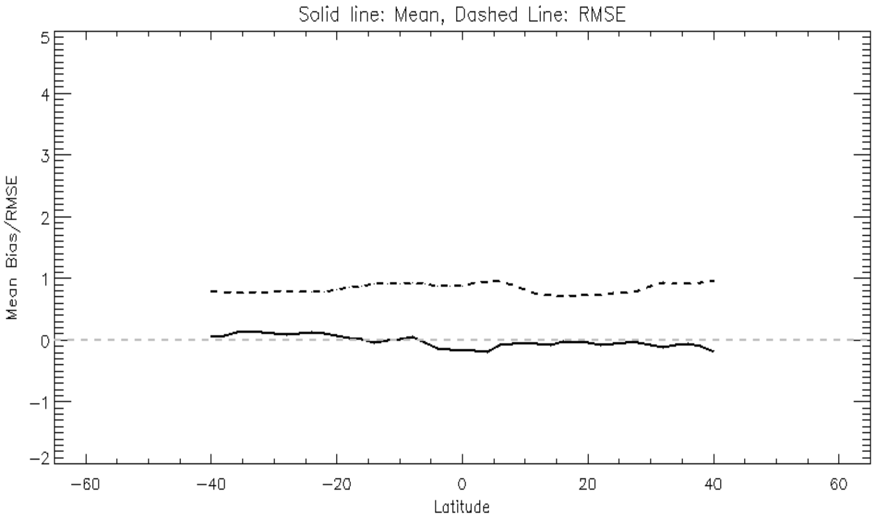


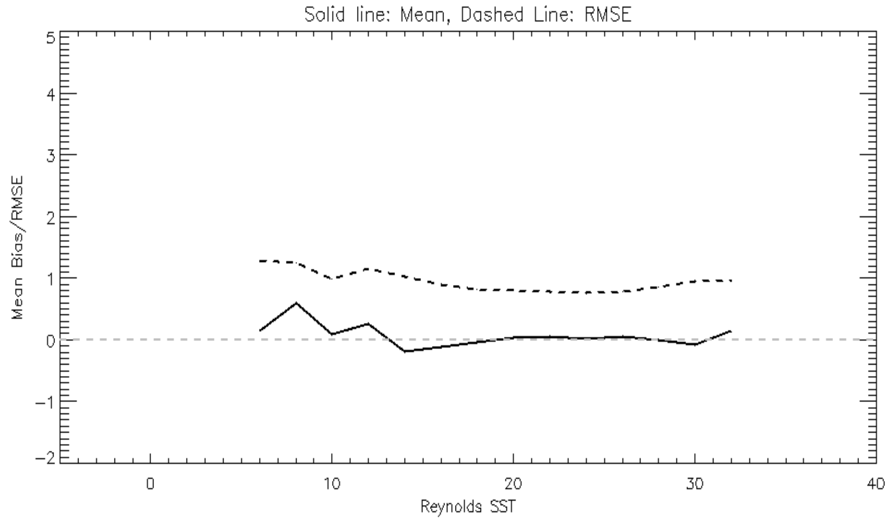


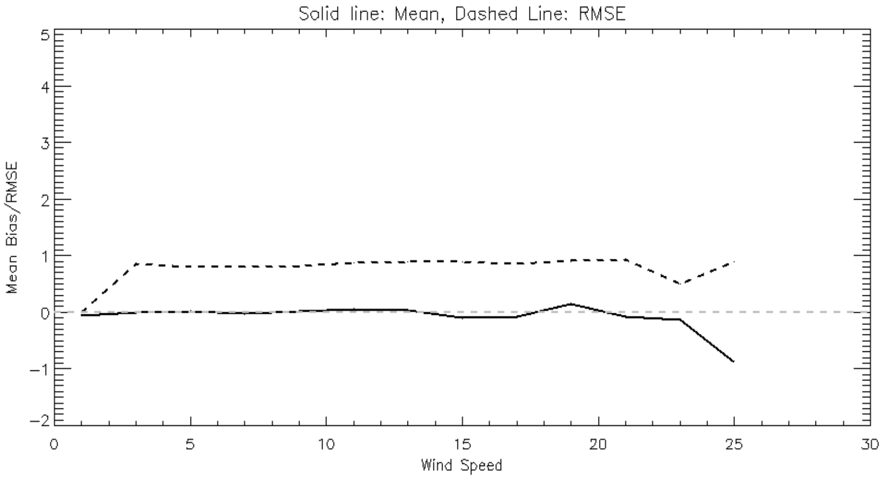


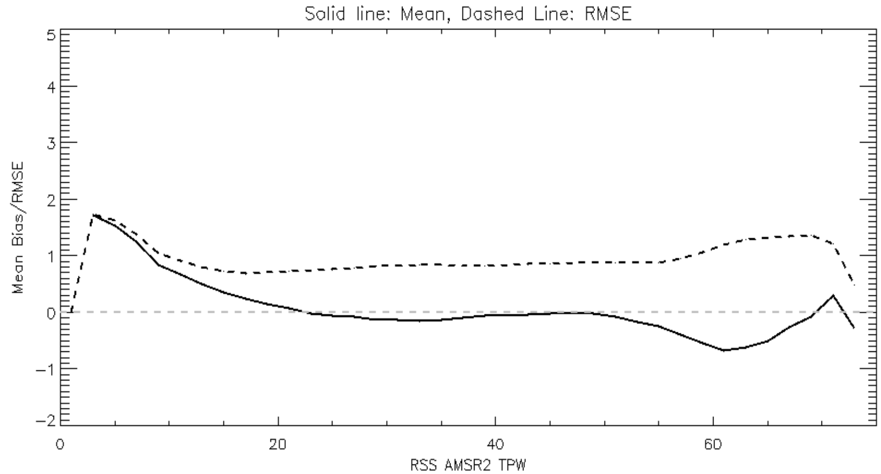


TPW Validation / RSS AMSR2

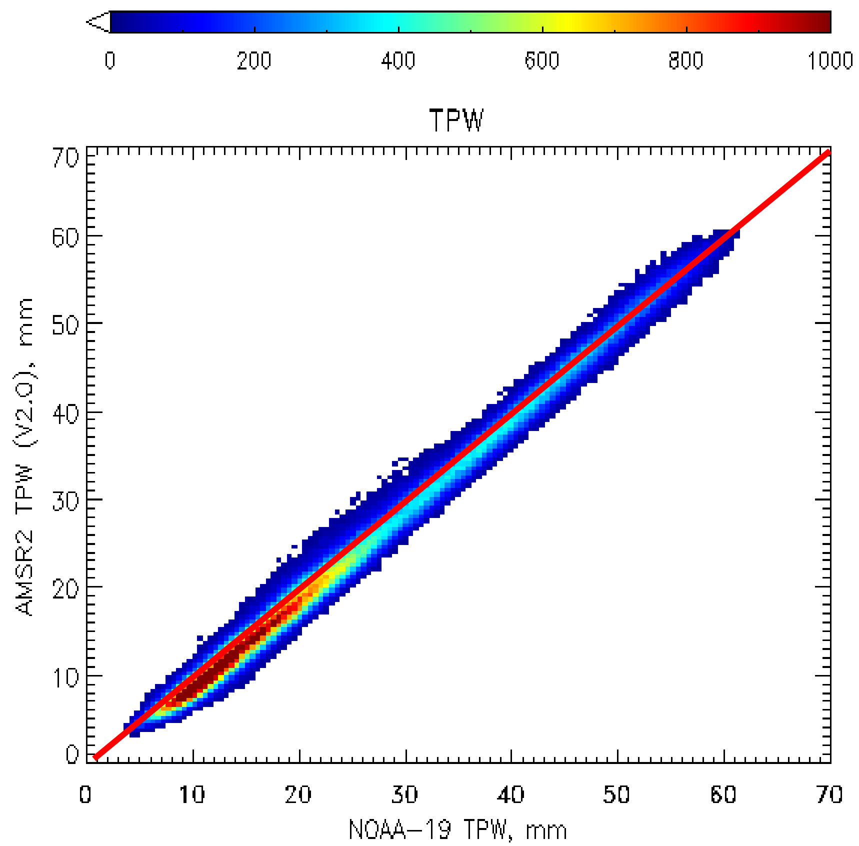


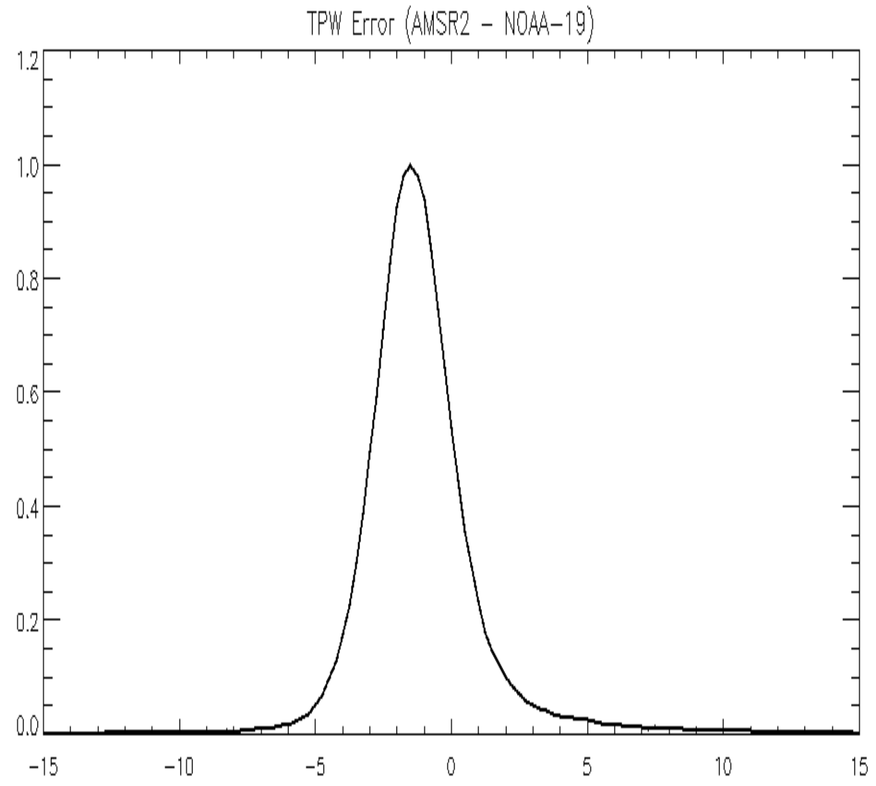




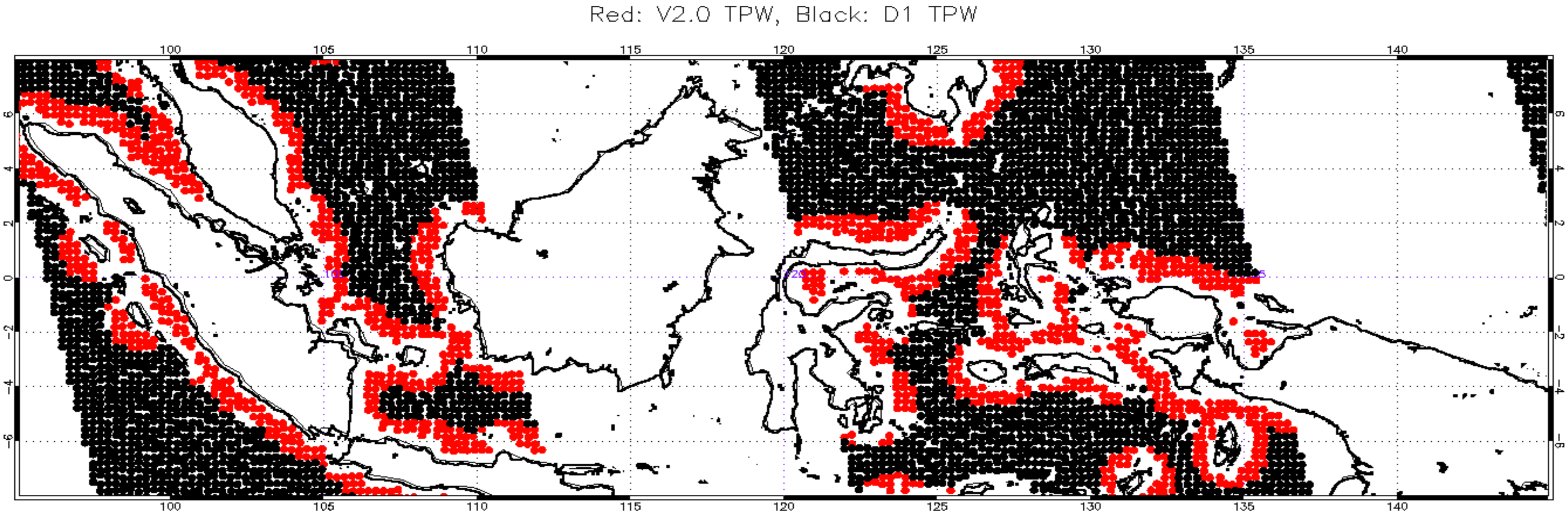


TPW Validation / MIRS





TPW Closer to Coast Line



Red areas show additional retrievals using our V2.0 TPW that were not available in Day1

Summary

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

Summary – cont.

- 2^{nd} delivery ocean EDR SST and TPW products were validated against several other products
  - » Models
    - – Reynolds
  - » Measurements
    - – TMI EDRs, Buoys
- Validation results show that AMSR2 2^{nd} delivery ocean EDRs meet accuracy requirements

Validation: Snow EDR

Presented by

Jeff Key

AMSR2 Snow Ice Product Algorithm Readiness:

1. Snow Cover, Snow Depth, and Snow Water Equivalent (SWE)
2. Ice Characterization (concentration and type)

Outline

- Product Overview and Requirements
- Product Examples
- Validation Strategy
- Validation Results

<u>Goal:</u> Demonstrate science quality of the AMSR2 snow and ice products.

AMSR2 Snow Cover Algorithm Readiness

Presented by

Yong-Keun Lee[1], Cezar Kongoli[2], and Jeff Key[3]

[1]Cooperative Institute for Meteorological Satellite Studies (CIMSS)
[2]Cooperative Institute for Climate Studies (CICS)
[3]NOAA/NESDIS/STAR

AMSR2 Snow Cover Overview

- **The AMRS2 snow cover product provides the presence/absence of snow cover for every pixel.**
- **The algorithm is a brightness temperature (TB)-based decision-tree approach**
  - Most operational algorithms have applied this methodology: Identify snow from non-snow surfaces by its brightness temperature scattering signal and filter out known confounding factors such as cold deserts, frozen soil and precipitation

AMSR2 Snow Depth Overview

- **The AMRS2 snow depth product provides the depth of the snow cover (cm). The snow water equivalent (SWE) product provides the water equivalent (mm) of the snow cover.**

- **Most recent NASA AMSR-E SWE approach**
  - Dynamic algorithm for regional to global applications
  - Has evolved over the course of 40-some years
  - This is a NASA signature product regarded as an international industry standard
  - Utilizes lower frequency channels (10 GHz) not available in SSMI
  - Explicit sub-pixel forest cover and forest-free SWE estimates, potentially beneficial for downscaling applications

AMSR2 Snow Cover and Depth Requirements

Table 5.0 GCOM Snow Cover/Depth		
EDR Attribute	Threshold	Objective
Applicable conditions		Delivered under "all weather" conditions
Sensing depth	0 – 60 cm	1 m
Horizontal cell size	10 km	5 km
Mapping uncertainty, 3 sigma	5 km	1 km
Snow depth ranges	5 – 60 cm	> 8 cm; > 15 cm; > 30 cm; > 51 cm; > 76 cm
Measurement uncertainty		
-- Clear	80% probability of correct snow/no snow classification; Snow Depth: 20 cm (30 cm if forest cover exceeds 30%)	10% for snow depth
-- Cloudy	80% probability of correct snow/no snow classification; Snow Depth: 20 cm	Not Specified
Refresh	At least 90% coverage of the globe about every 20 hours (monthly average)	Not Specified

AMSR2 Snow Water Equivalent Requirements

Table 11.0 GCOM Snow Water Equivalent		
EDR Attribute	Threshold	Objective
Applicable conditions		Delivered under "all weather“ conditions
Horizontal cell size	10 km	5 km
Mapping uncertainty, 3 sigma	5 km	1 km
Measurement range	10 – 200 mm	Not Specified
Measurement uncertainty		Not Specified
-- Shallow to moderate snow packs (10 – 100 mm)	20 mm or 50%	Not Specified
-- High snow accumulation (above 100 mm)	70%	Not Specified
Refresh	At least 90% coverage of the globe about every 20 hours (monthly average)	Not Specified

Algorithm Output: Snow Cover

- Output Data:
  - Snow cover detected by this algorithm

Name	Type	Description	Dimension
Snow cover	output	Output contains snow cover information (4: snow, 2: no snow, 1:water, 0:missing) for each pixel	Scan grid (xsize, ysize)

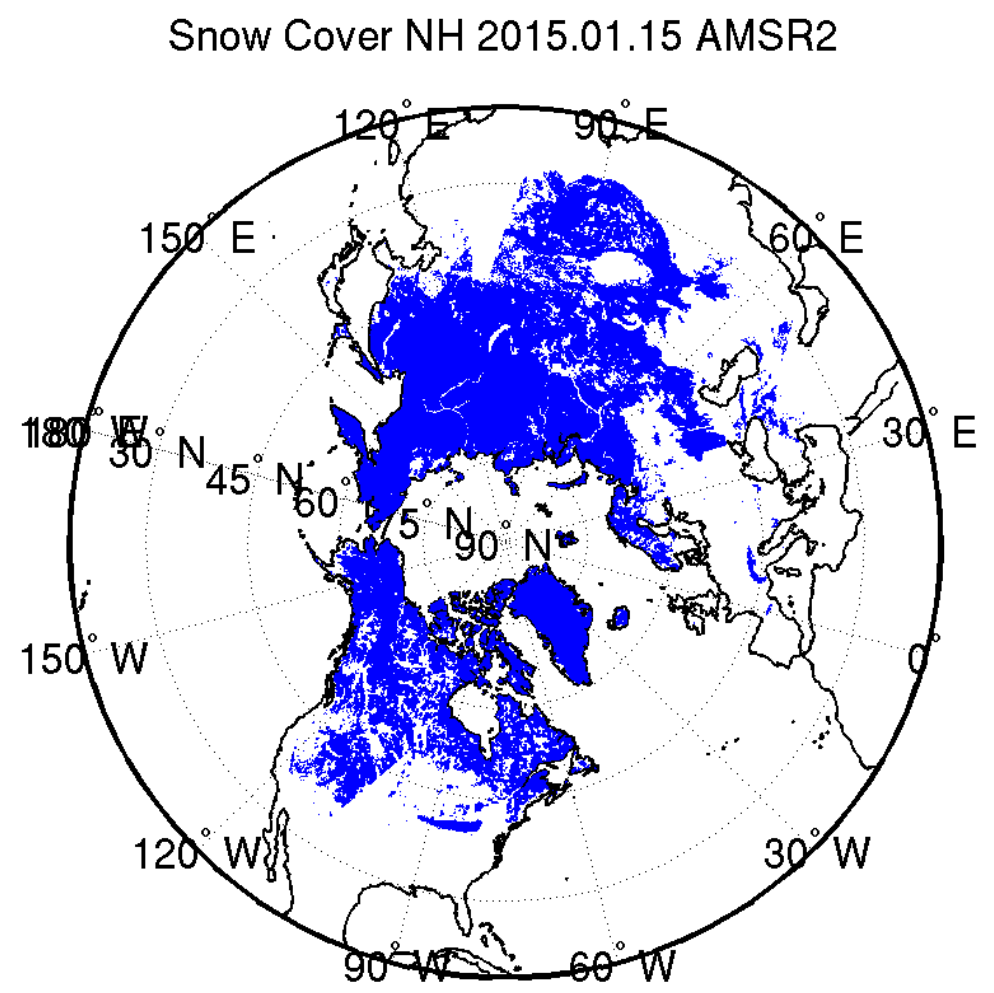
Algorithm Output: Snow Depth and SWE

- Output Data:
  - Snow depth
  - Snow water equivalent (SWE)

Name	Type	Description	Dimension
Snow depth	Output	Output contains snow depth for each pixel where the snow cover is detected	Scan grid (xsize, ysize)
SWE	Output	Output contains SWE for each pixel where snow depth and snow density are available	Scan grid (xsize, ysize)

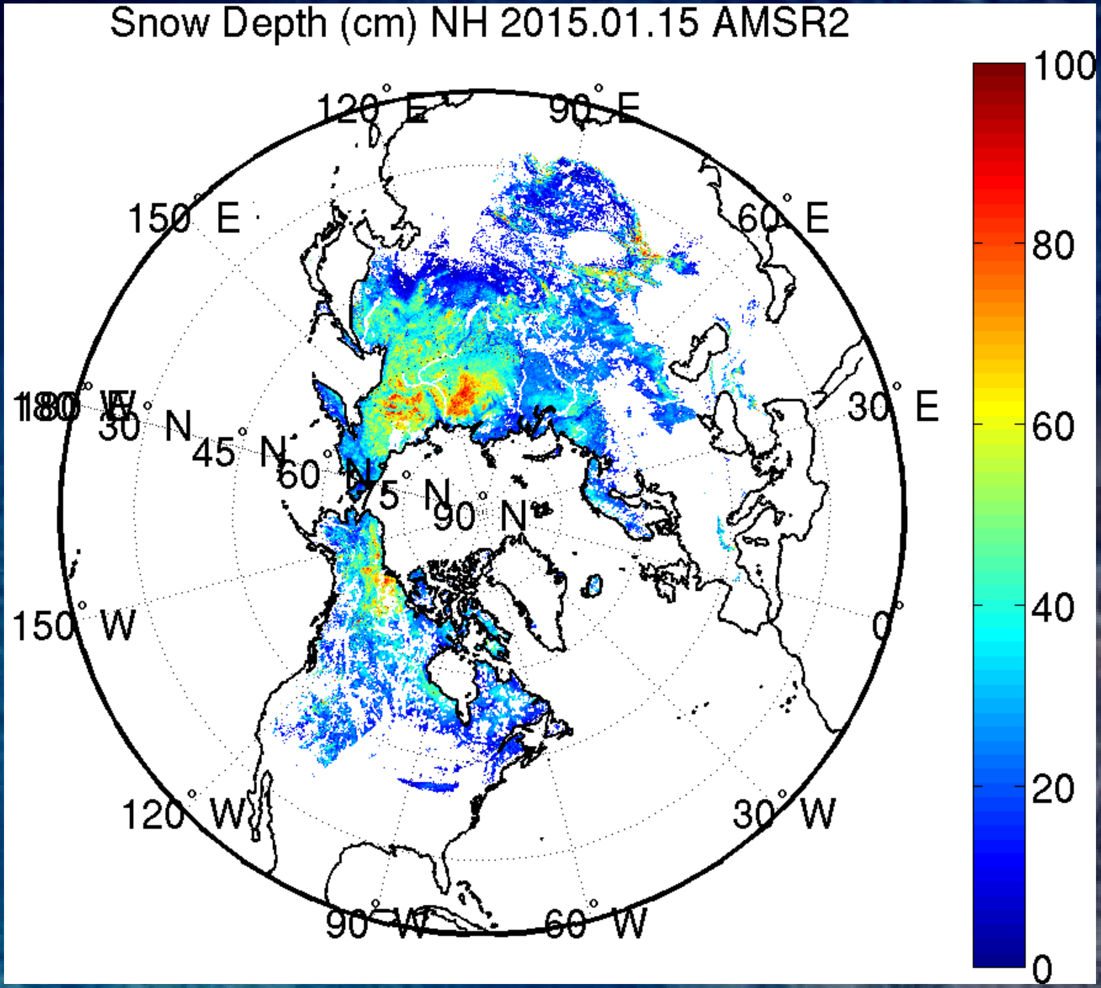
Algorithm Output

Example of AMSR2 snow cover over the Northern Hemisphere on January 15, 2015



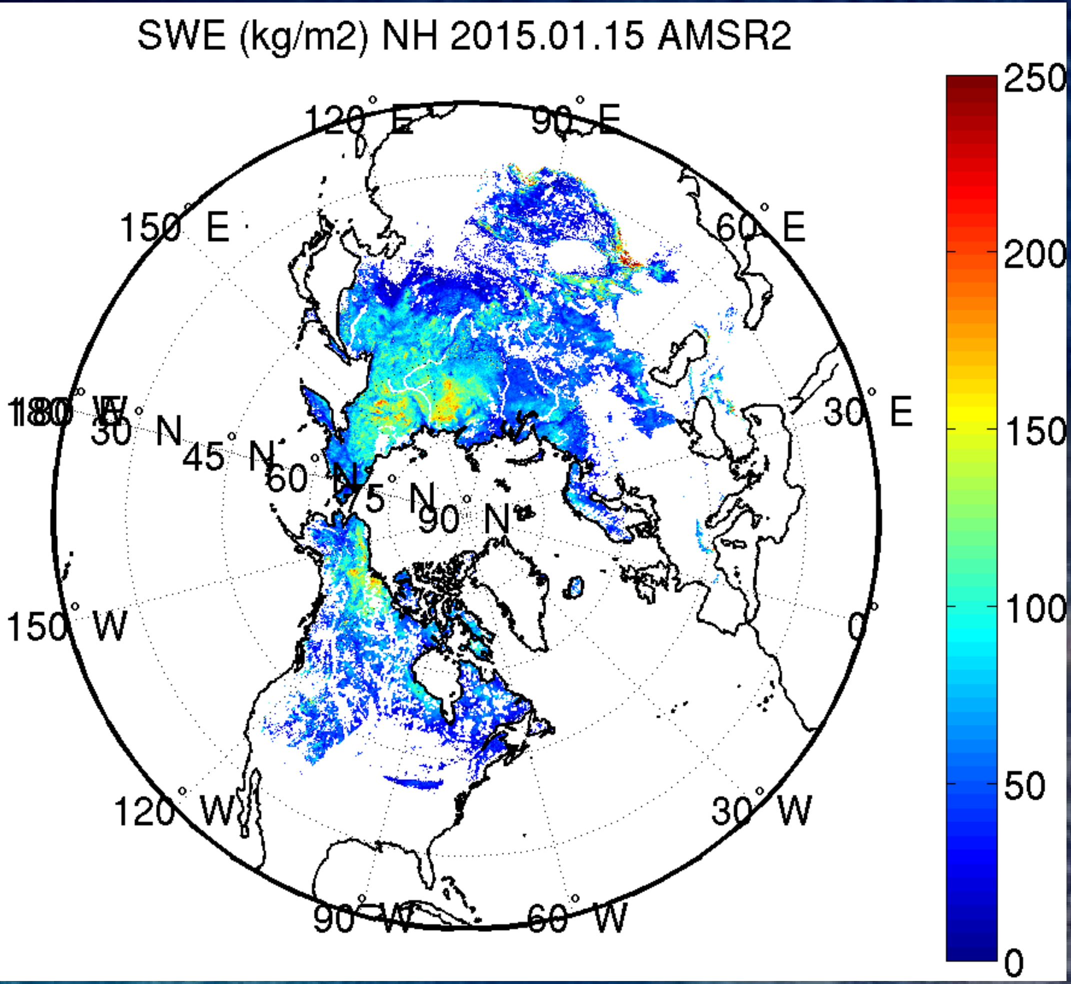
Algorithm Output

Example of AMSR2 snow depth over the Northern Hemisphere on January 15, 2015



Algorithm Output

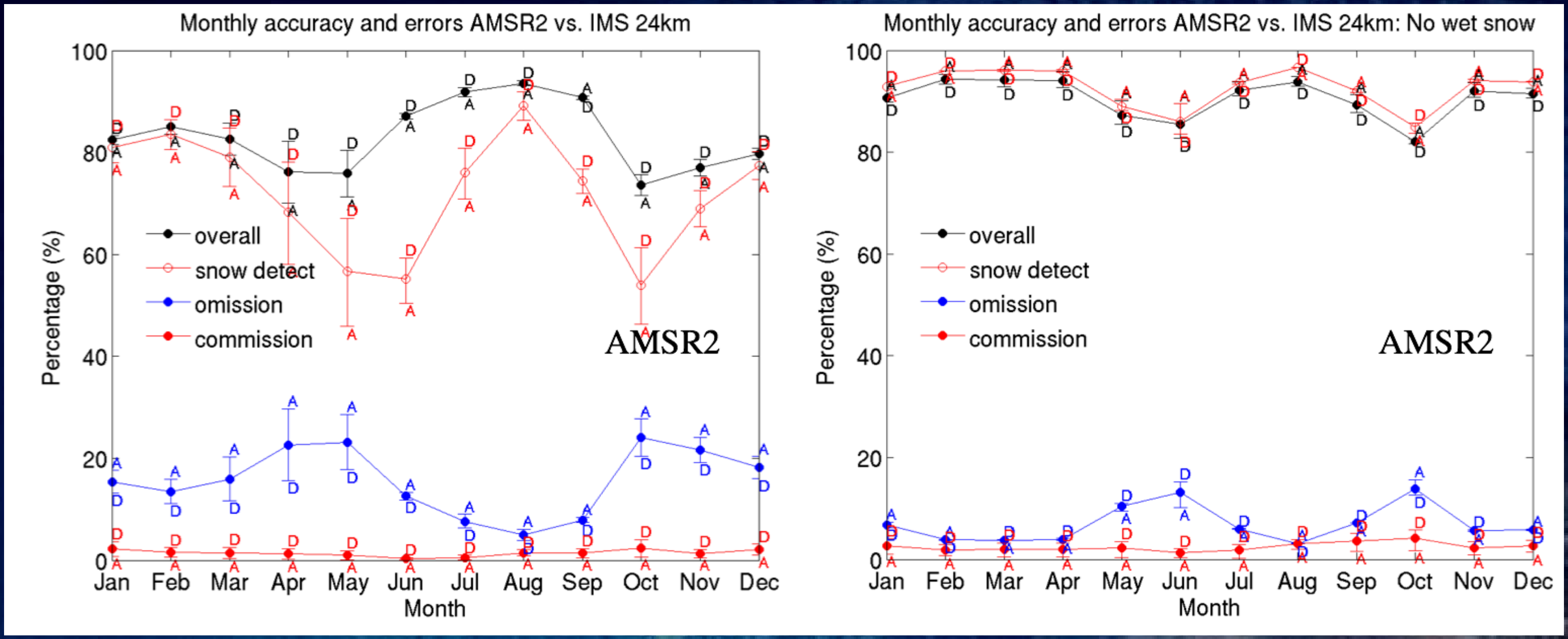
Example of AMSR2 snow water equivalent over the Northern Hemisphere on January 15, 2015



Validation Strategy

- Snow cover: daily comparison with the Interactive Multisensor Snow and Ice Mapping System (IMS) 24 km.
- Snow depth: daily comparison with ground station measurements including the World Meteorological Organization (WMO) and the US National Weather Service (NWS) Cooperative Observer Program (COOP) Network.
- Snow Water Equivalent (SWE): comparison with the National Operational Hydrologic Remote Sensing Center (NOHRSC) Snow Data Assimilation System (SNODAS).

Validation Results – Snow Cover



Monthly comparison between AMSR2 and IMS snow cover area (SCA) and corresponding number of AMSR2 pixels: the bars above and below each point indicate descending ("D") and ascending ("A") orbits. Left panels are with wet snow and right panels are after wet snow exclusion.

Validation Results – Snow Cover

	Overall accuracy
Tundra	94.6%
Taiga	97.4%
Maritime	80.9%
Ephemeral	71.7%
Prairie	74.0%
Alpine	86.9%

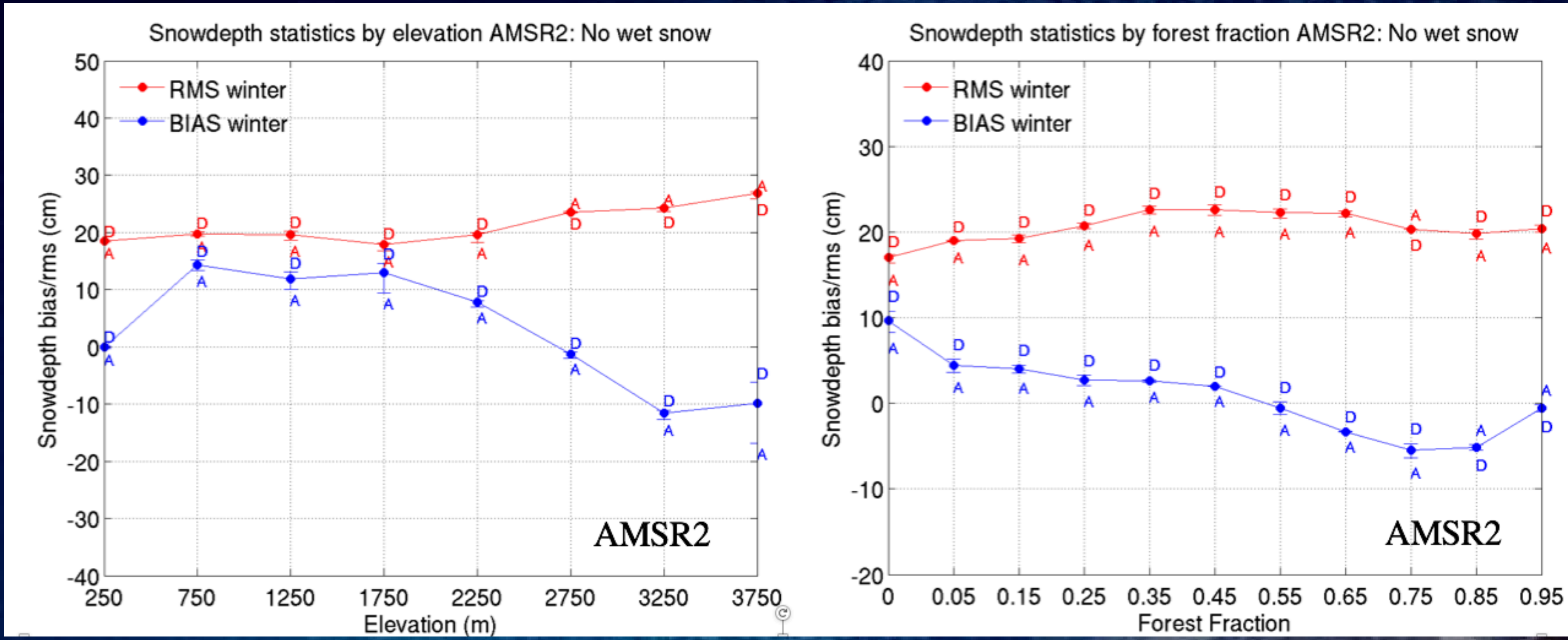
Overall accuracy of global, multi-year snow cover detection (AMSR-E) for different snow cover classes.

Validation Results – STAR vs CIMSS Snow Cover

Snow cover	GAASP : corrected BT	GAASP : uncorrected BT	CIMSS : uncorrected BT
Overall accuracy	81.17 %	79.84 %	79.75 %
Snow detection rate	78.34 %	76.40 %	76.35 %
Commission	1.78 %	1.59 %	1.57 %
Omission	17.05 %	18.57 %	18.68 %
Number of pixels	1504245	1504245	1524368

Valid for the January 15, 2015

Validation Results – Snow Depth



Statistics AMSR2 snow depth compared to ground site snow depth as a function of elevation (left) and forest fraction (right). The bars above and below each point indicate descending ("D") and ascending ("A") orbits. Winter months (January, February, and December) are included.

Validation Results – Snow Depth

	RMSE (cm)	Bias (cm)	mean (cm) of in-situ obs.
Tundra	18.77	4.51	25.10
Taiga	20.96	3.77	29.18
Maritime	19.37	-5.34	20.20
Ephemeral	14.95	6.05	8.40
Prairie	18.93	2.75	18.49
Alpine	21.97	-4.45	25.14

Bias and root mean square error (RMSE) of global, multi-year snow depth comparison between AMSR-E and in-situ data (AMSR-E – in-situ observation) for each snow cover class. Statistical values are based on AMSR-E measurements for the winter months (December, January, and February).

Validation Results – STAR vs CIMSS Snow Depth

Valid for the January 15, 2015

Snow depth	GAASP : corrected BT	GAASP : uncorrected BT	CIMSS : uncorrected BT
bias	-0.50 cm	-0.46 cm	-0.48 cm (-1.39 cm*)
RMSE	18.7 cm	19.40 cm	19.23 cm (21.95 cm*)
Number of pixels	2432	2144	2162 (770*)

*valid for pixels with forest fraction above 30%

Validation Results – Snow Water Equivalent

Overall, AMSR2 SWE slightly underestimates SNODAS SWE by 0.02 mm. The RMSE is 29.10 mm.

STAR vs CIMSS:

SWE	GAASP : corrected BT	GAASP : uncorrected BT	CIMSS : uncorrected BT
bias	-0.22 mm	-0.16 mm	-0.17 mm
RMSE	31.35 mm	31.61 mm	31.62 mm
Number of pixels	26639	22279	21609
Mean (AMSR2)	62.06 mm	61.68 mm	61.68 mm

Valid for the January 15, 2015

Validation Results – STAR vs CIMSS

Extensive snow cover and snow depth validation results are available in the ATBD and in:

Lee, K.-L., C. Kongoli, and J. Key, 2015, An in-depth evaluation of heritage algorithms for snow cover and snow depth using AMSR-E and AMSR2 measurements, J. Atmos. Oceanic Tech., 32, 2319-2336, doi: 10.1175/JTECH-D-15-0100.1.

Summary of Validation Results for AMSR2 Snow Products

- The AMSR snow product samples generated by the AIT are nearly identical to those generated locally at CIMSS.
- The AMSR2 snow products have been validated against IMS SCA products, ground measured snow depth (WMO, COOP), and SNODAS SWE data.
- The AMSR2 snow cover product meets the accuracy and precision specifications, though for the single case study it is marginal.
- The AMSR2 snow depth product meets the accuracy and precision specifications.
- The AMSR2 snow water equivalent product meets the accuracy and precision specifications (50% of average amount), though it is marginal for the single case study.

Validation: Sea Ice EDR

Presented by

Walt Meier

Outline

- Product Overview and Requirements
- Product Examples
- Validation Strategy
- Validation Results

Goal: Demonstrate science quality of the AMSR2 snow and ice products.

AMSR2 Sea Ice Characterization Algorithm Readiness

Presented by

Walt Meier[1] and Julienne Stroeve[2]
with input from Rich Dworak[3] and Yong-Keun Lee[3]

[1]NASA Goddard Space Flight Center (GSFC)
[2]National Snow and Ice Data Center (NSIDC)
[3]Cooperative Institute for Meteorological Satellite Studies (CIMSS)

AMSR2 Sea Ice Characterization Overview

- The AMRS2 sea ice characterization product provides sea ice concentration and an age class (first-year or multiyear concentration)
- NASA Team 2 (NT2) as primary; Bootstrap (BT) as secondary
  - » Allows known errors from each to be considered
    - – NASA Team 2: atmospheric emission
    - – Bootstrap: low (cold) temperatures and melt
  - » Difference in concentrations between algorithms provides a confidence indicator
  - » Concentration range estimate (max – min) for each day of NT2 concentration provides uncertainty estimate due to temporal sampling
  - » Iteration for NASA Team 2 atmospheric correction provides a potential quantitative error estimate
  - » Takes advantage of higher frequency channels for better spatial resolution, up to 5 km – initial implementation will be at 10 km resolution

AMSR2 Sea Ice Characterization Requirements

Table 8.0.1 GCOM Sea Ice Characterization		
EDR Attribute	Threshold	Objective
Applicable conditions		Delivered under “all weather” conditions
Vertical coverage	Ice surface	Ice surface
Horizontal cell size	10 km	5 km
Mapping uncertainty, 3 sigma	5 km	3 km
Measurement range		
-- Ice concentration	1/10 – 10/10	0 – 100%
-- Ice age classes	Ice free, first-year, multiyear ice	Ice free, nilas, grey white, grey, white, first year medium, first year thick, second year, and multiyear; smooth and deformed ice

AMSR2 Sea Ice Characterization Requirements, cont.

Table 8.0.2 GCOM Sea Ice Characterization		
EDR Attribute	Threshold	Objective
Measurement uncertainty*		
-- Ice concentration	10%	5%
Probability of correct typing of ice age classes	70%	90%
Refresh	At least 90% coverage of the globe about every 20 hours (monthly average)	Not Specified
Geographic coverage	All ice-covered regions of the global ocean	All ice-covered regions of the global ocean

*"Uncertainty" above may be incorrect. Using the term "accuracy" (absolute value of mean bias) and the same value (10%) would be consistent with ice concentration requirements for GOES-R ABI (accuracy: 10%) and JPSS VIIRS (accuracy: 10%; uncertainty: 25%). Perhaps accuracy is what was intended.

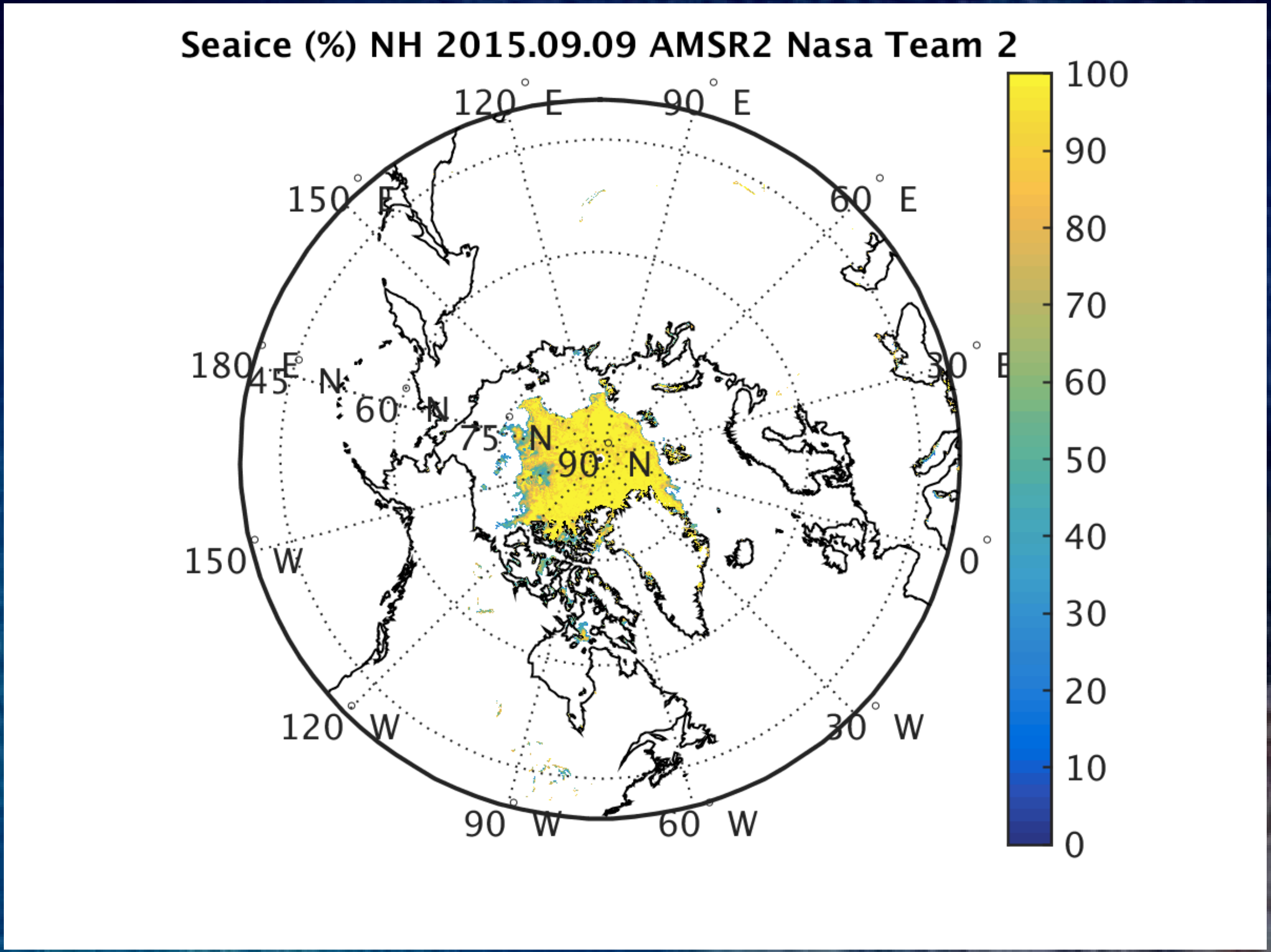
Algorithm Output: Ice Char.

- Output Data:
  - Ice concentration and ice age class

Name	Type	Description	Dimension
Ice concentration	output	Output contains ice concentration for each pixel identified as ice	Scan grid (xsize, ysize)
Ice age	Output	Multiyear and first-year ice fraction	Scan grid (xsize, ysize)
Concentration uncertainty	output	Concentration uncertainty for each pixel from NASA Team 2 iteration	Scan grid (xsize, ysize)
QC flags for Ice Concentration/cover	output	Quality Control Flags for every pixel	Scan grid (xsize, ysize)

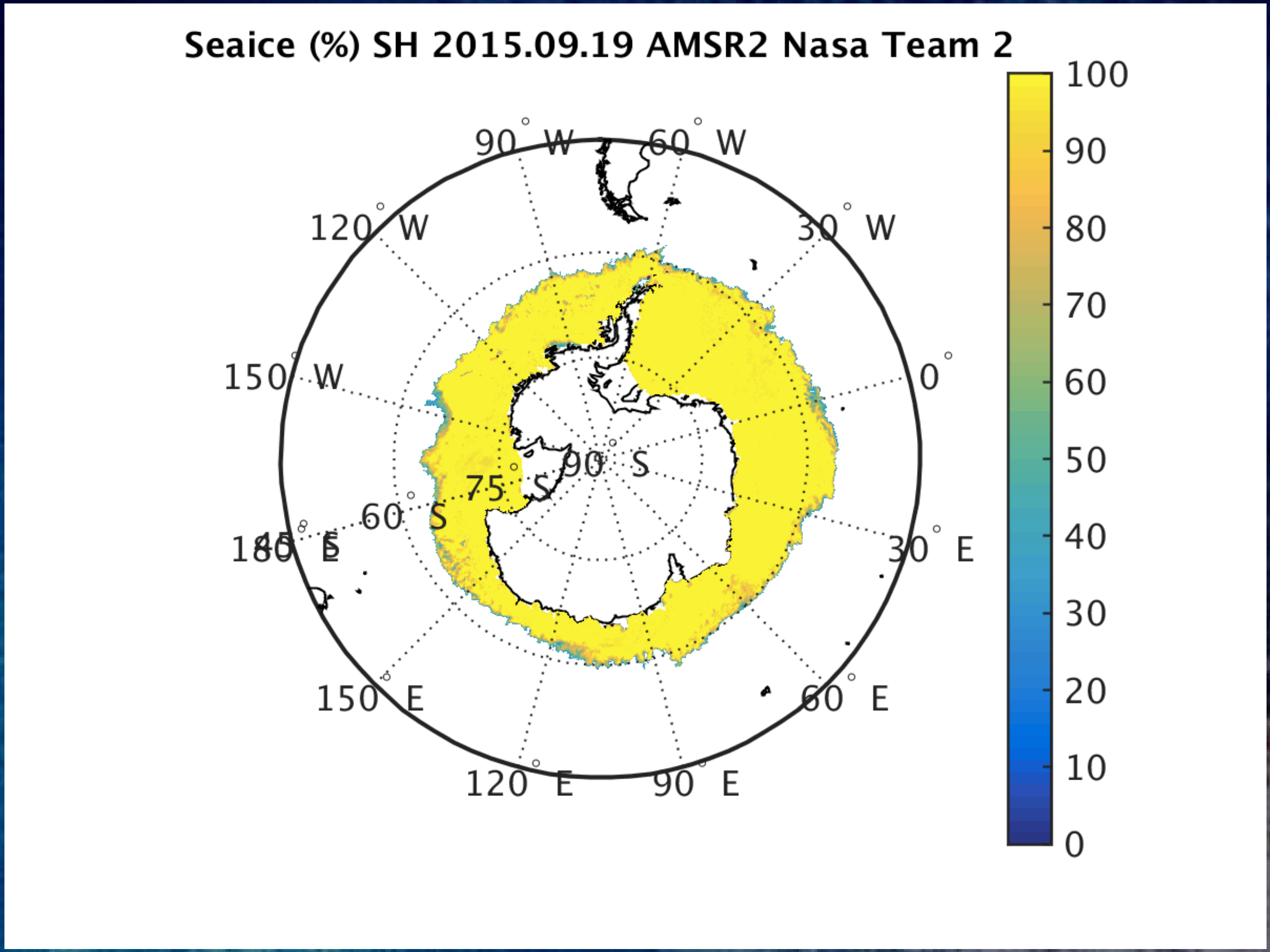
Algorithm Output

Example of AMSR2 sea ice concentration over the Arctic on 9 September 2015.



Algorithm Output

Example of AMSR2 sea ice concentration over the Antarctic on 19 September 2015.



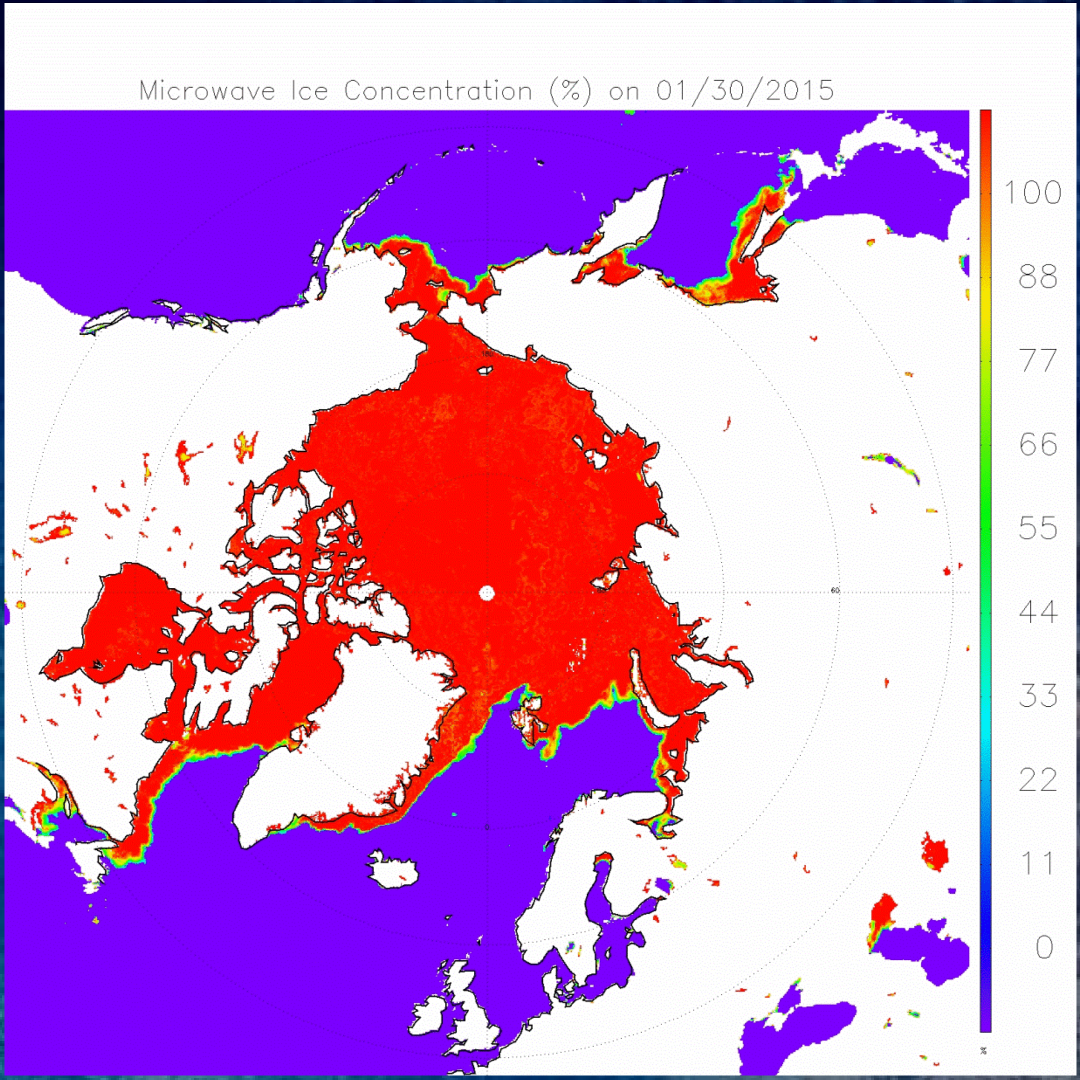
Validation Strategy

- Numerous validation studies have been done on BT and NT2 algorithms via comparisons with aircraft and other satellite (vis/IR, SAR) imagery
  - » e.g., Cavalieri et al., 2006; Meier, 2005; Comiso et al., 1997; Comiso and Nishio, 2008; Andersen et al., 2007; Ivanova et al., 2014
  - » Concentration errors for the central ice pack during cold, winter periods are <5%
  - » Errors for melting ice, thin ice, and near the ice edge may be higher
  - » Precision of the ice edge limited by spatial resolution of the channel with the largest footprint (IFOV), ~25 km for AMSR2
- AIT test cases were validated through a comparison of the AMSR2 ice concentration results to S-NPP VIIRS sea ice concentration. Differences are expected due to:
  - » Cloud cover – VIIRS retrievals are clear-sky only
  - » Spatial resolution – VIIRS is < 1 km

Validation Results

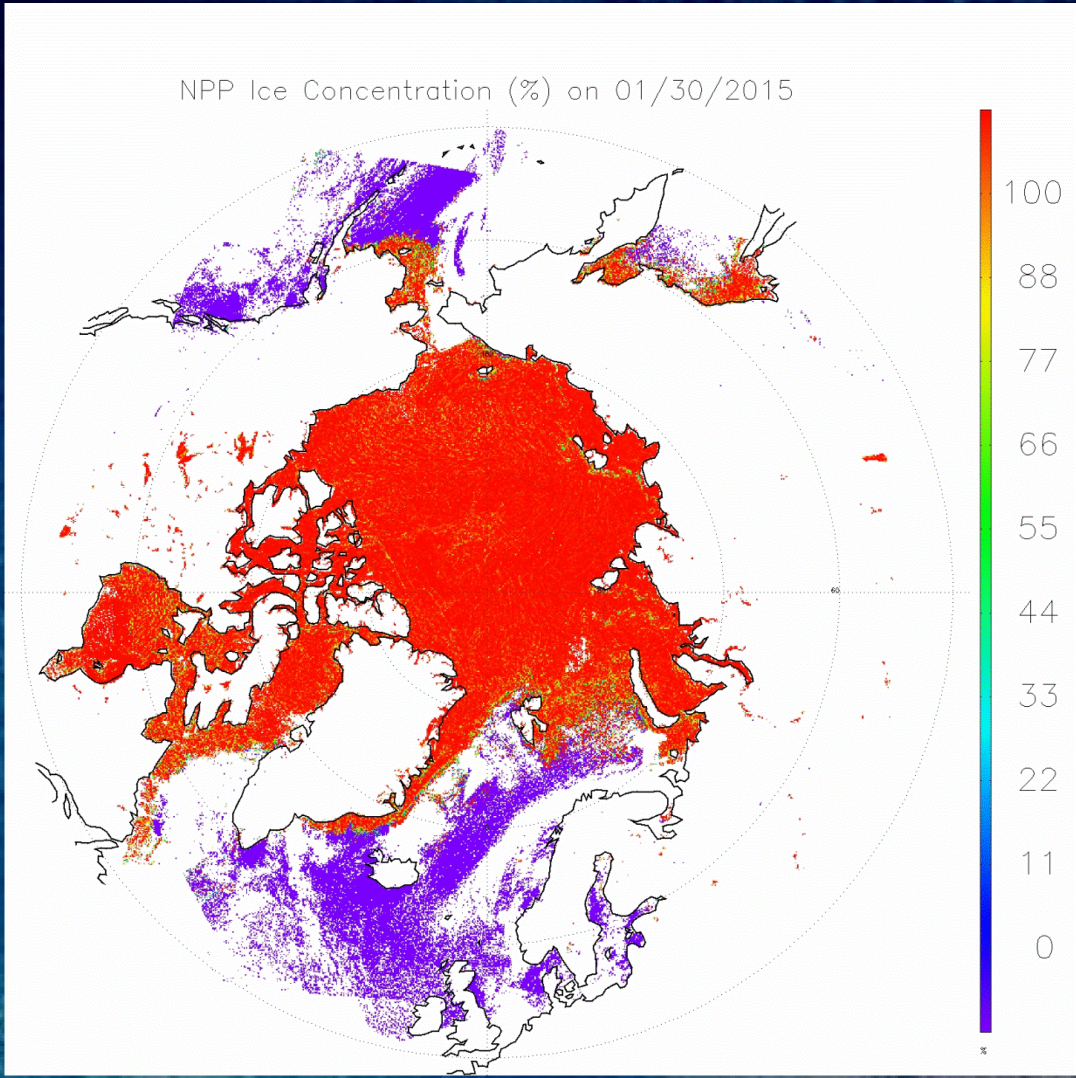
Comparison of AMSR2 and VIIRS sea ice concentration over the Arctic on 31 January 2015.

(To compare toggle between this slide and the next)



Validation Results

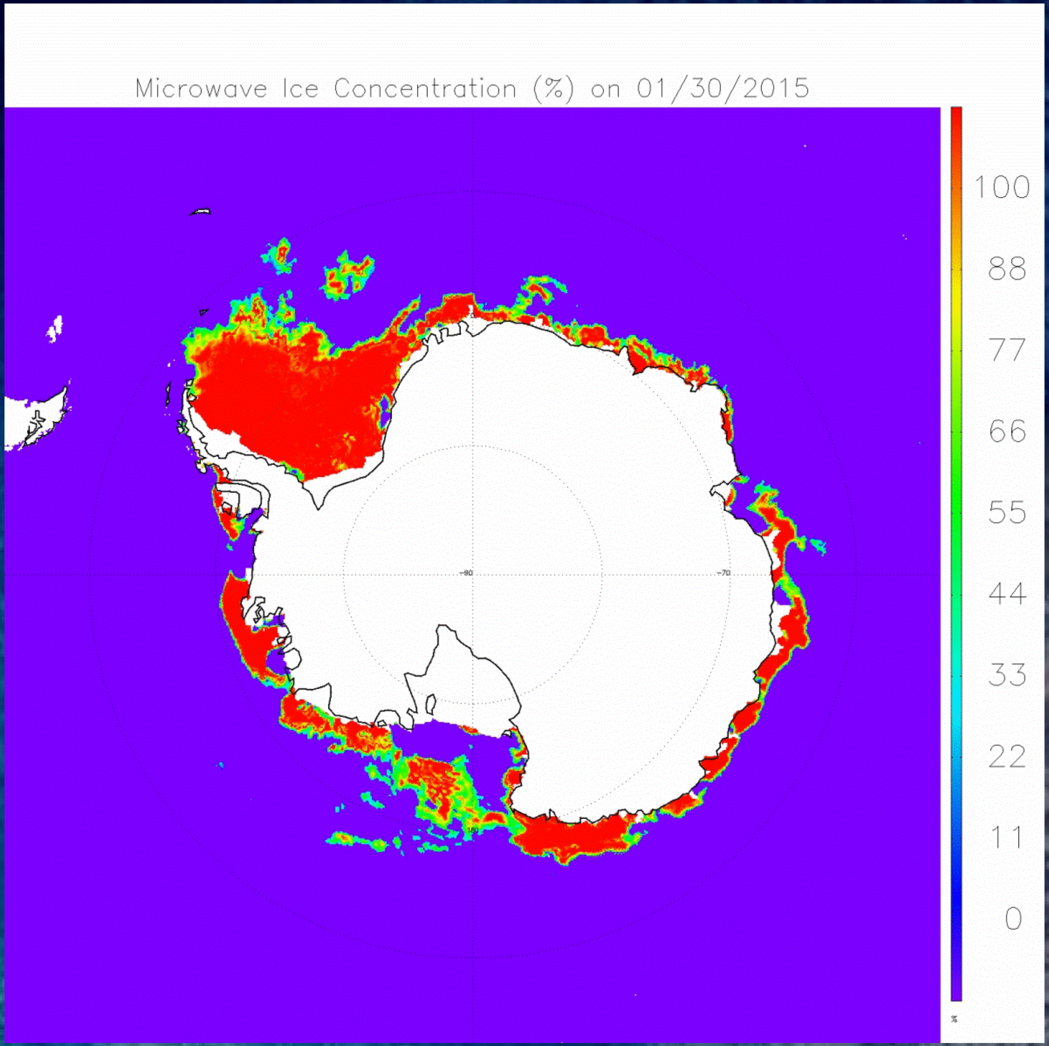
Comparison of AMSR2 and VIIRS sea ice concentration over the Arctic on 31 January 2015.



Validation Results

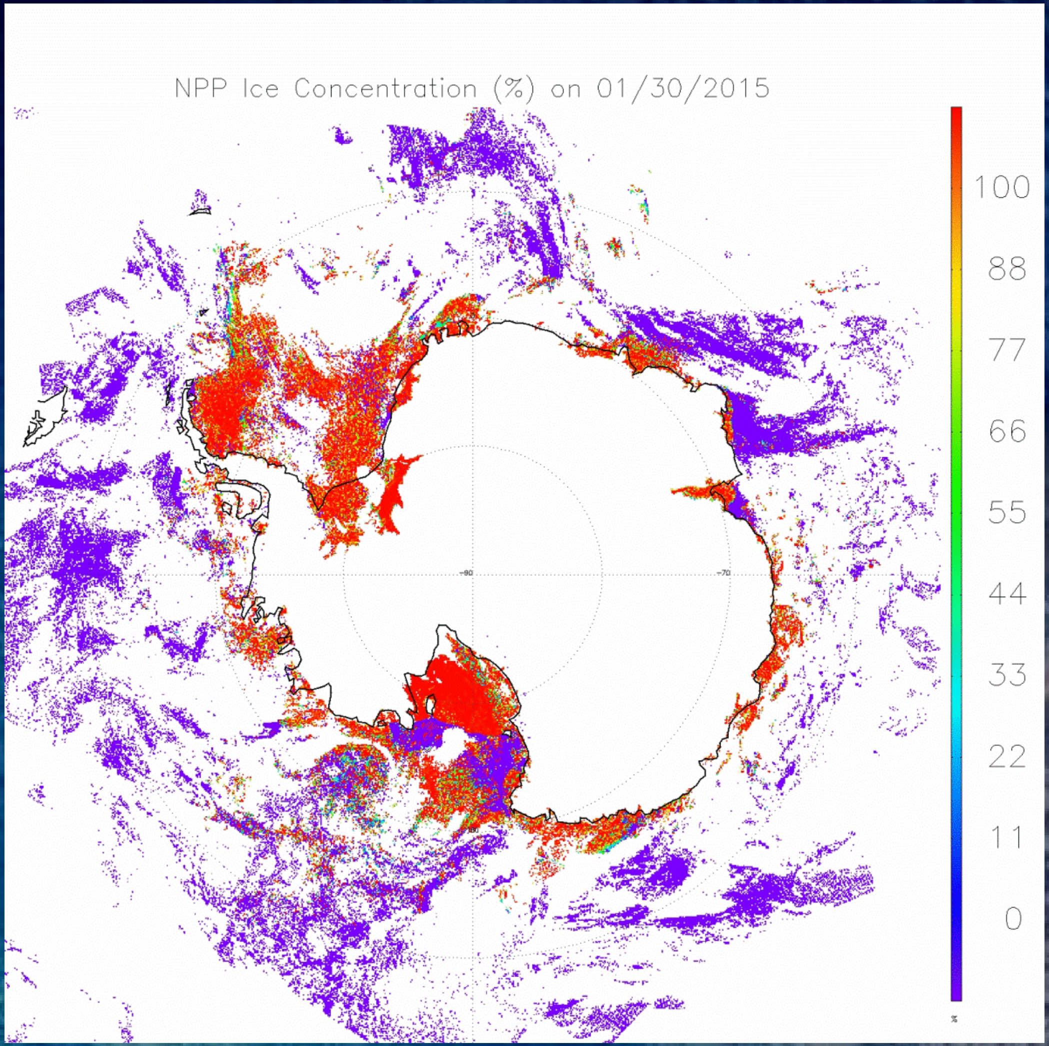
Comparison of AMSR2 and VIIRS sea ice concentration over the Antarctic on 31 January 2015.

(To compare toggle between this slide and the next)

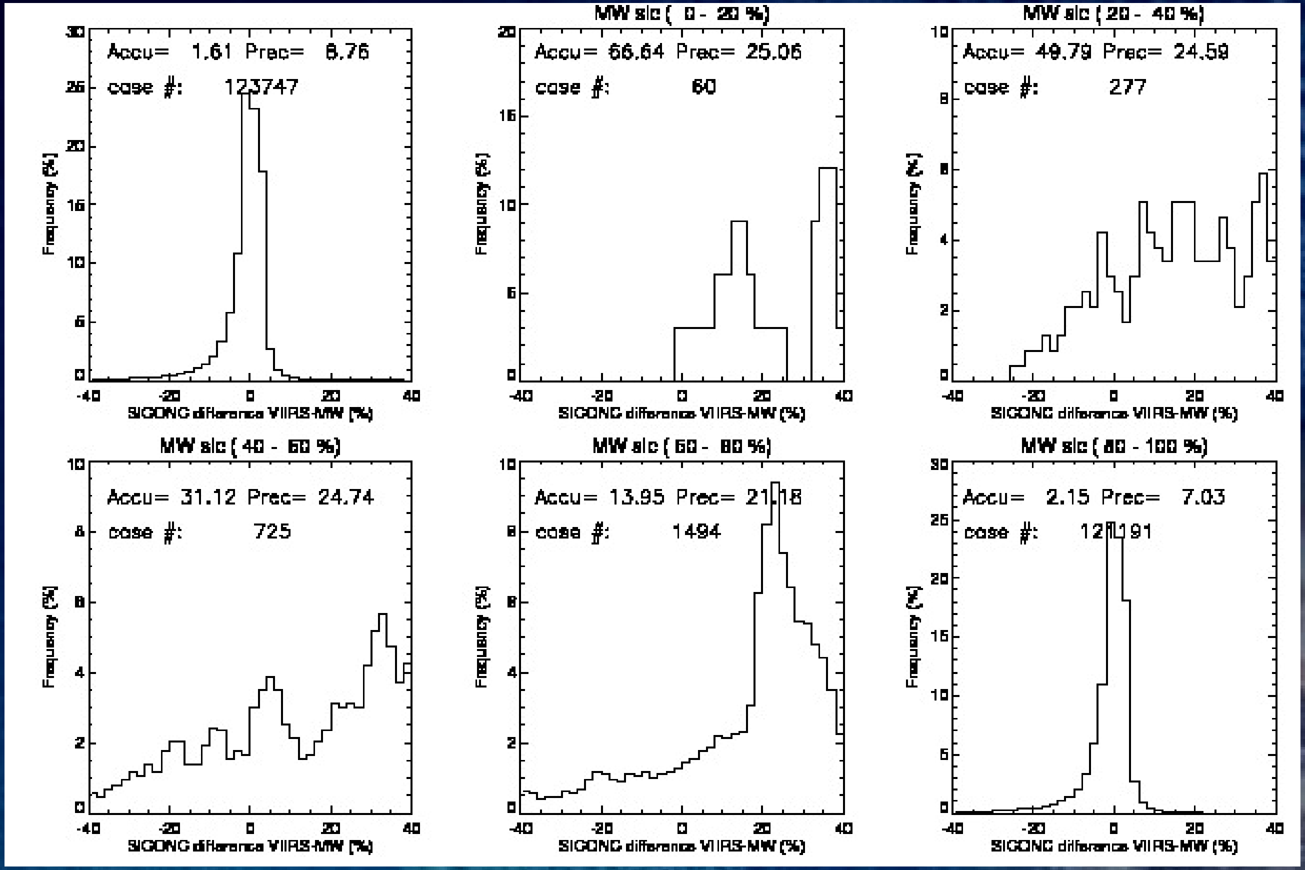


Validation Results

Comparison of AMSR2 and VIIRS sea ice concentration over the Antarctic on 31 January 2015.

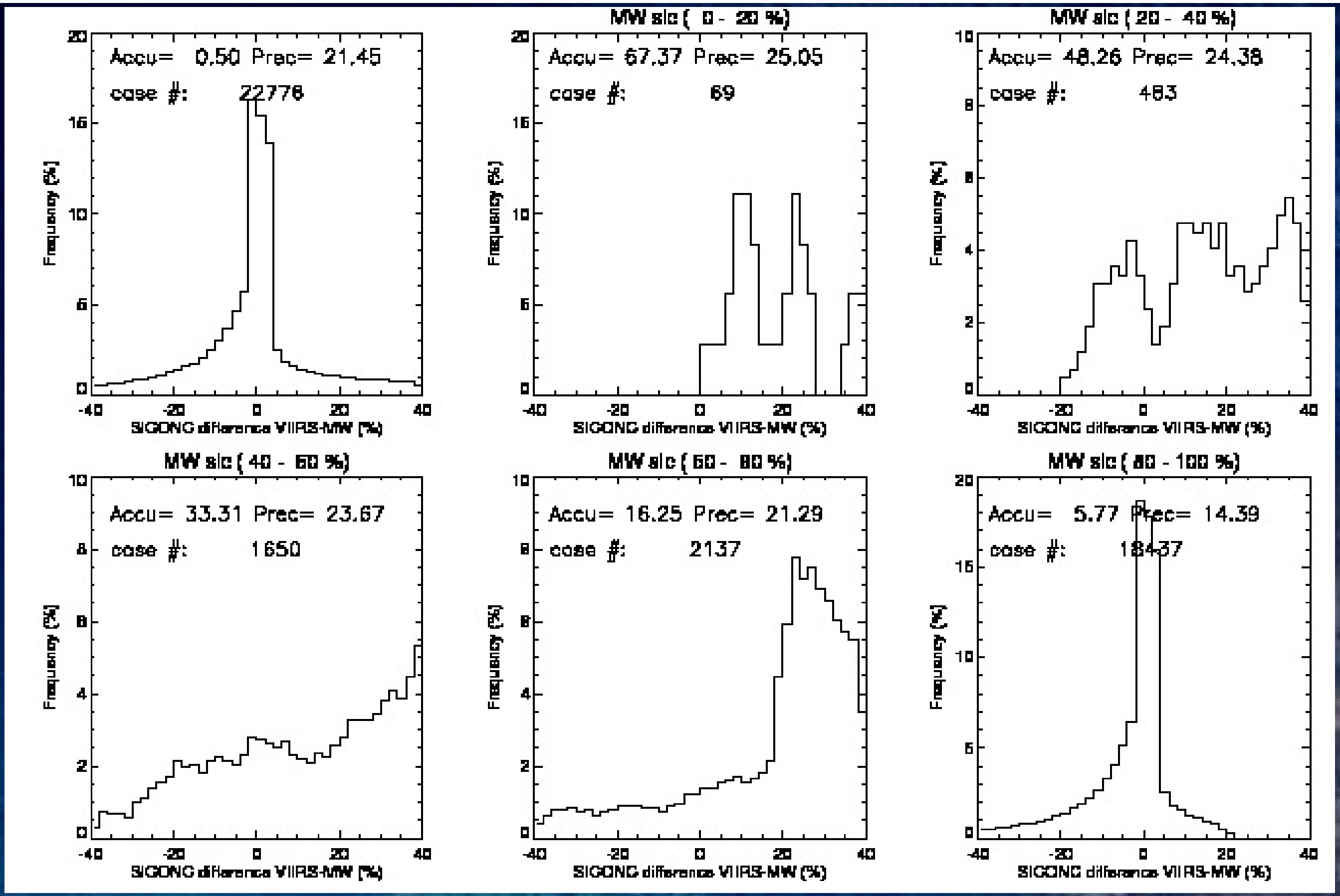


Validation Results



Histograms of the diffferences between AMSR2 and VIIRS sea ice concentration over the Arctic on 31 January 2015. Results are given for different ice concentration bins. The upper left is for the entire concentration range.

Validation Results



Histograms of the diffferences between AMSR2 and VIIRS sea ice concentration over the Antarctic on 31 January 2015. Results are given for different ice concentration bins. The upper left is for the entire concentration range.

Validation Results Summary

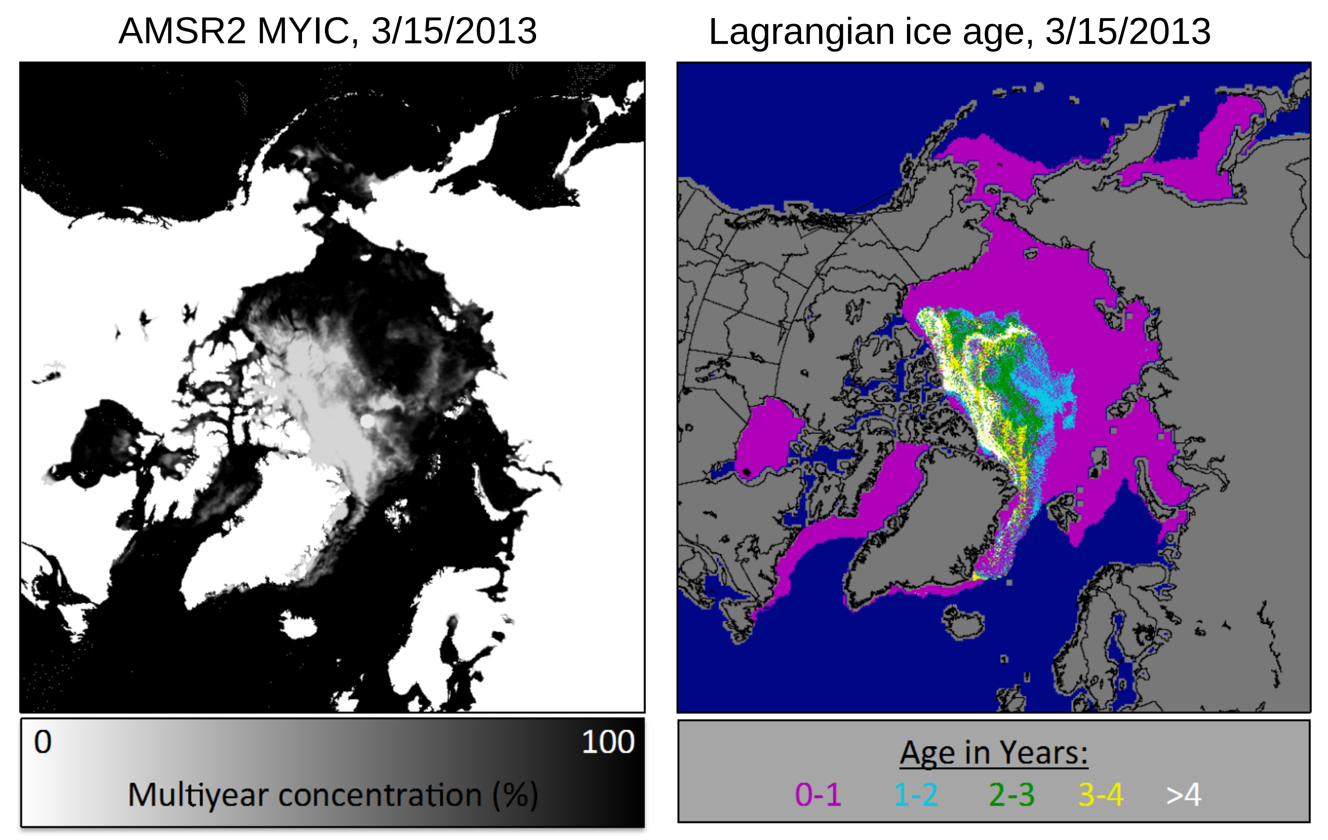
Statistical results of the comparison in sea ice concentration between AMSR2 (AIT) and VIIRS.

Maximum (red) and minimum (blue) values in each column are highlighted.

	Arctic			Antarctic		
	Accu	Prec	Cases	Accu	Prec	Cases
01/30	1.61	***8.76***	123747	0.50	21.45	22776
01/31	1.62	9.10	***124514***	1.53	***22.03***	***19556***
02/27	2.05	9.91	122376	1.04	20.19	20101
02/28	2.03	9.35	120343	***0.21***	20.88	22256
03/30	2.45	10.01	122108	1.52	14.90	48343
03/31	2.12	9.39	118841	2.48	15.24	43737
04/30	3.02	11.98	88959	1.85	12.64	79228
04/31	3.01	11.87	79756	2.24	12.62	82094
05/30	3.20	11.46	65418	2.19	13.03	99093
05/31	***3.22***	11.92	70990	1.80	12.97	104142
06/30	2.19	14.05	56864	1.55	***11.08***	121964
06/31	1.89	14.41	55580	1.56	11.78	123805
07/30	1.89	18.33	35577	2.43	12.62	***142350***
07/31	2.53	18.20	38069	2.58	12.34	138524
08/30	***0.25***	***18.48***	28727	2.79	11.87	133027
08/31	0.61	17.19	***27315***	***2.95***	12.71	142208

Multiyear ice validation

The multi-year ice concentration (MYIC) parameter has not been thoroughly validated and is still considered to be experimental. Initial comparison with independent ice age fields (using Lagrangian tracking of ice parcels) indicates good agreement in terms of spatial distribution of multi-year ice cover.



Summary of Validation Results for AMSR2 Ice Characterization

- The AMSR sea ice characterization product samples generated by the AIT are essentially the same as those generated locally at CIMSS.
- The AMSR2 ice concentration has been validated against the VIIRS sea ice concentration product.
- The AMSR2 ice characterization product meets the accuracy requirements, though "uncertainty" in the requirements documents should be changed to "accuracy".

Validation: Soil Moisture EDR

Presented by

Jicheng Liu
Xiwu (Jerry) Zhan

Basic Requirement 7.0

- **Requirement 7.0:** *The STAR GCOM processing system shall produce a soil moisture (SM) product.*

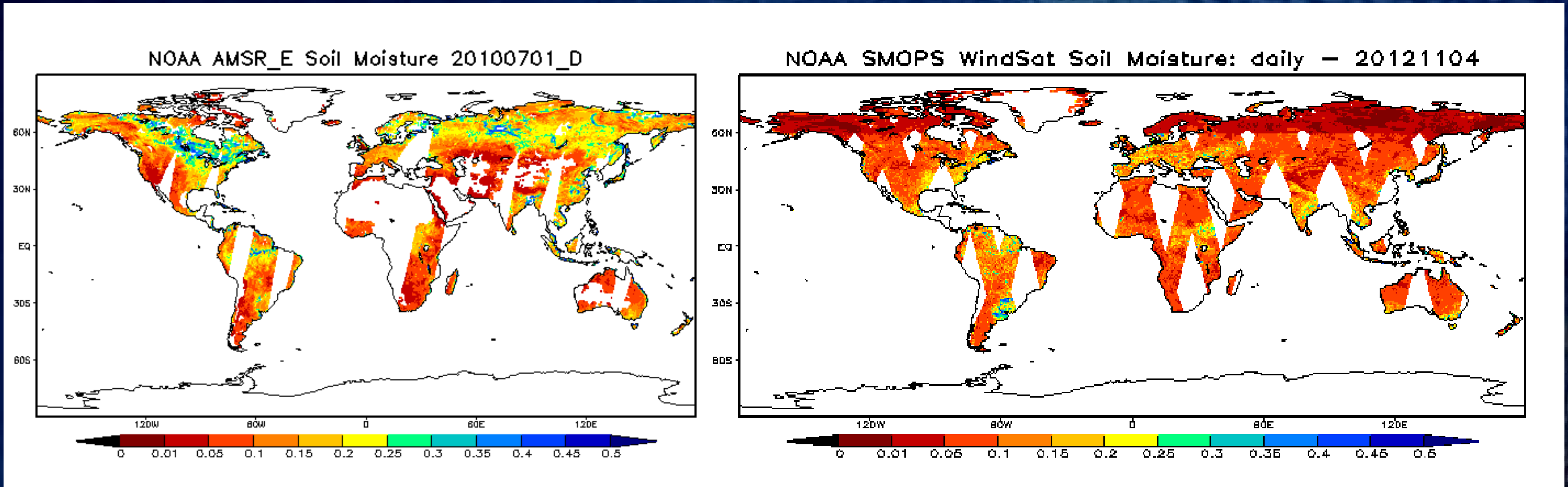
Table 7.0 - GCOM-W Soil Moisture

EDR Attribute	Threshold	Objective
Applicable conditions	Delivered under “all weather” conditions	Delivered under “all weather” conditions
Sensing depth	Surface to -0.1 cm (skin layer)	Surface to -80 cm
Horizontal cell size	40km (1)	20 km
Mapping uncertainty, 3 sigma	5 km	1 km
Measurement Uncertainty	6% volumetric RMSE (goal) with VWC < 1.5 kg/m^2 or GVF < 0.5 and < 2 mm/hr precip rate	Surface: 5% 80 cm column: 5%
Measurement range	0 – 50%(2)	0 – 50%
Refresh	At least 90% coverage of the globe about every 20 hours (monthly average)(3)	n/s
Latency	25 minutes	

Note:
(1) Per AMSR-E legacy and user convenience, 25km can be obtained.
(2) Absolution soil moisture unit (m^3/m^3 volume %) is preferred by most users of NWP community
(3) This Refresh requirement is consistent with the AMSR-2 Cross-track Swath Width design of 1450 km for a single orbit plane

Single Channel Retrieval (SCR) Algorithm

- Currently used in NOAA Soil Moisture Operational Product System (SMOPS) for retrieving soil moisture from observations of WindSat and AMSR-E (before AMSR-E was down).



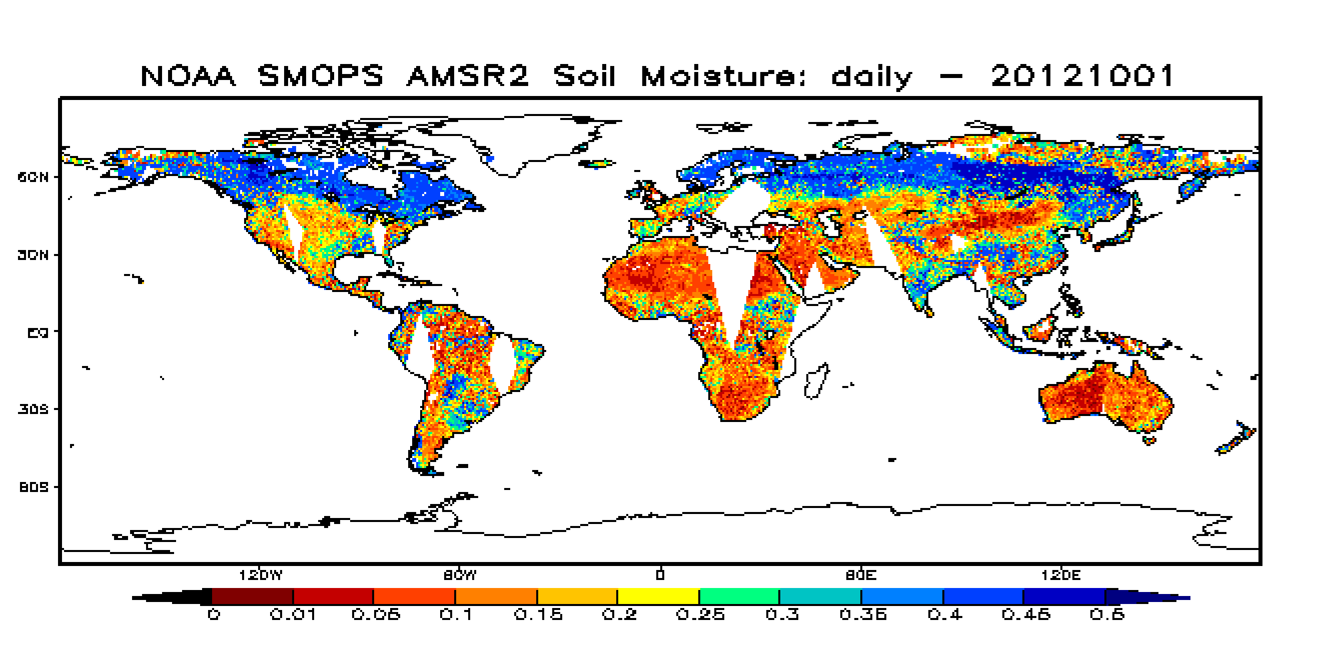
- Good spatial/temporal dynamics and reasonable patterns.
- Main issue: Sensitive to NDVI.

Land Parameter Retrieval Model (LPRM)

By VUA and NASA

- Capable of retrieving both SM and Vegetation Optical Depth (tau).

Original Soil Moisture Map



- Problem: SM too high.

AMSR-2 Soil Moisture EDR Algorithm

Algorithm applied to AMSR2 EDR:

SCR: Inverse tau-omega equation of a TBh (C/X-band) for SM with tau from NDVI and Ts from TB36v. Used in SMOPS

LPRM: Inverse tau-omega equations of TBh and TBv (C/X-band) for tau and SM with Ts from TB36v

Hybrid: Use LPRM inversed tau in SCR

Theoretical Basis of the SCR Algorithm

- Introduced by Jackson (1993).
- TB_h (C/X-band) is the most sensitive to SM
- *Simplified* τ-ω equation is used to inverse *e* while τ & T_s are estimated from *NDVI* and TB_{36v}

$$T_{Bp} = T_s e_{r,p} \exp(-\tau_p / \cos\theta) + T_s [1 - \exp(-\tau_p / \cos\theta)][1 + R_{r,p} \exp(-\tau_p / \cos\theta)]$$

- The Fresnel equation is then used to determine the dielectric constant from *e* and a dielectric mixing model is used to inverse *SM*
- Results were too sensitive to *NDVI* errors

Theoretical Basis of the LPRM Algorithm

- Introduced by Owe et al (2001).
- Relate τ to $MPDI = (T_{Bv} - T_{Bh})/(T_{Bv} + T_{Bh})$
- The τ-ω equation is used to inverse *e* while T_s is estimated from TB_{36v}

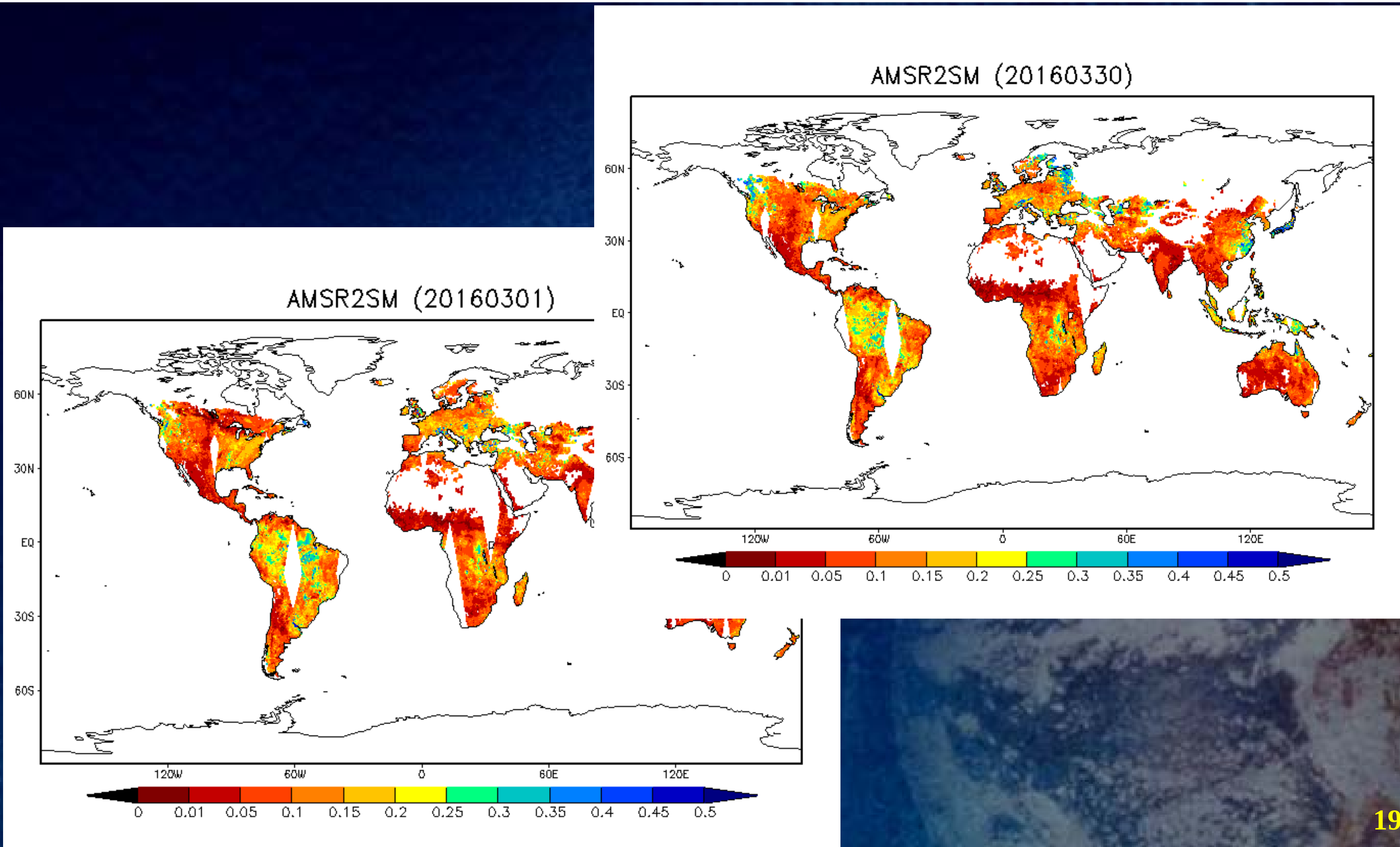
$$T_{Bp} = T_s e_{r,p} \exp(-\tau_p / \cos\theta) + T_s (1 - \omega_p) [1 - \exp(-\tau_p / \cos\theta)][1 + R_{r,p} \exp(-\tau_p / \cos\theta)]$$

- The Fresnel equation is then used to determine the dielectric constant from *e* and a dielectric mixing model is used to inverse *SM*
- Results were too high for some areas

Combining the SCR and LPRM Algorithms

- τ inversion from LPRM
- Apply τ to simplified τ-ω equation to solve for *e*
- Use Fresnel equation to determine the dielectric constant from *e*
- Use a dielectric mixing model to inverse *SM*

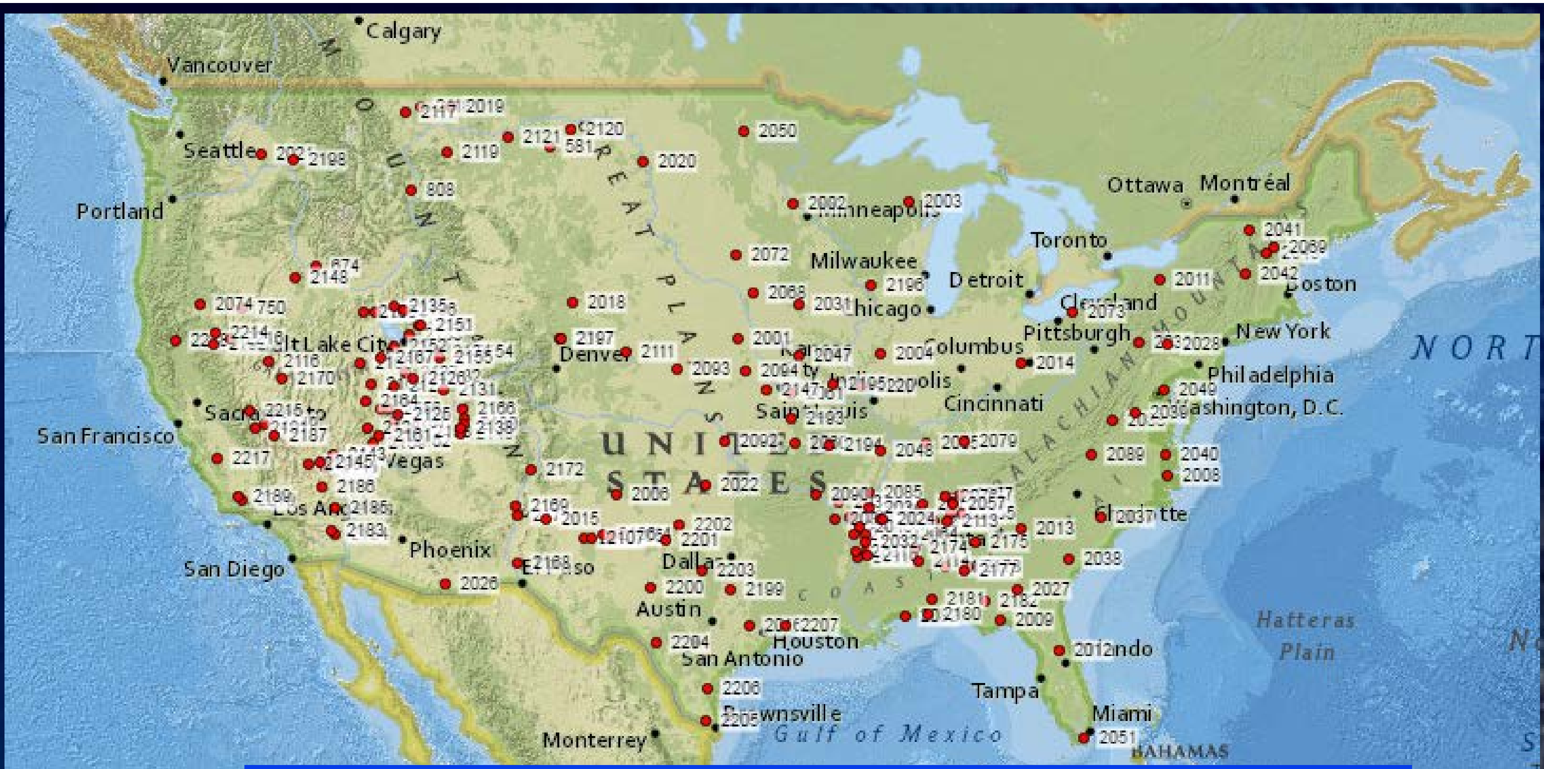
AMSR2 SM EDR


AMSR2SM (20160330)
AMSR2SM (20160301)
60N
30N
EQ
30S
60S
120W
60W
0
60E
120E
0
0.01
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
0.5

SM EDR Validation: In-situ Data Collection

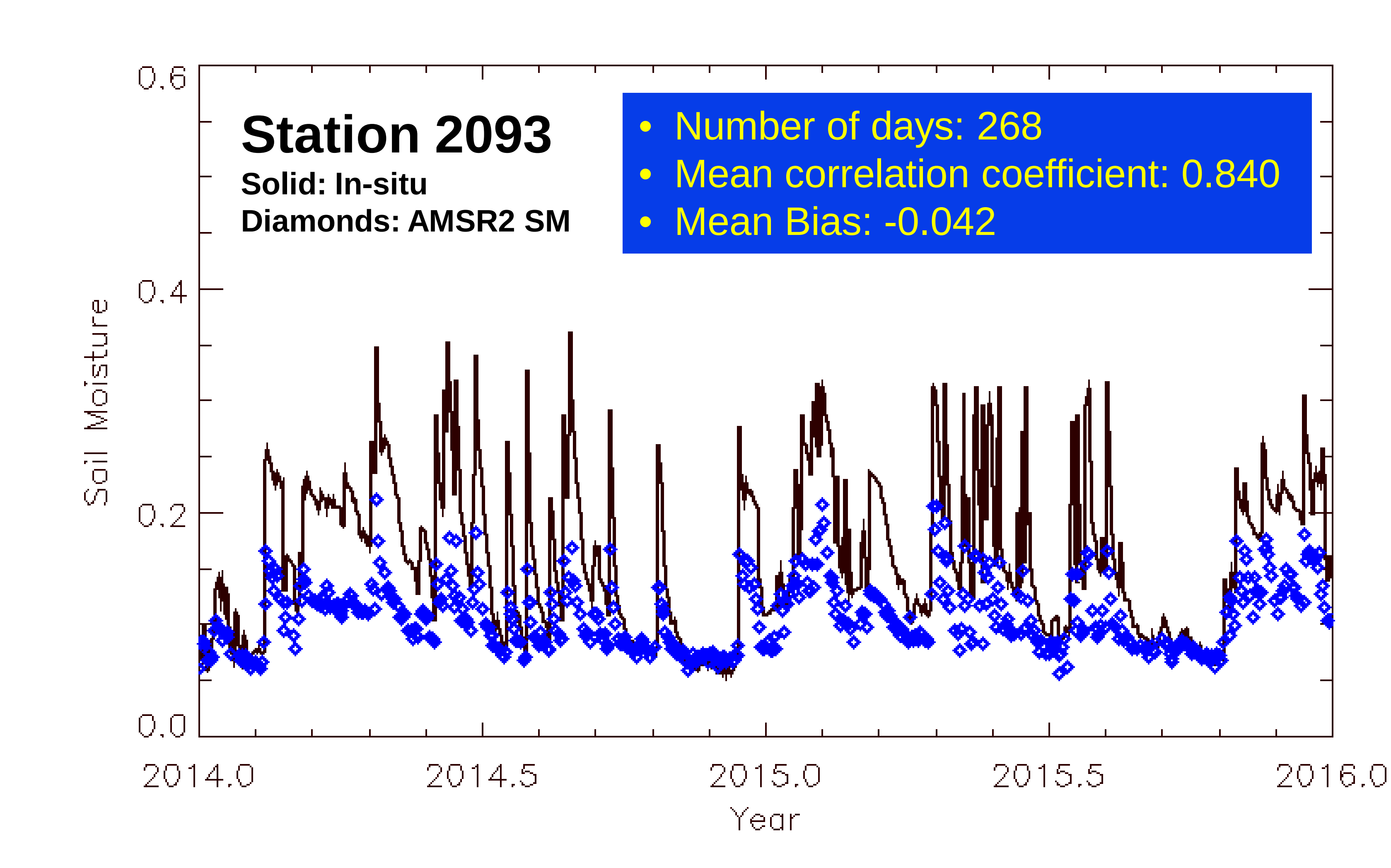
- All *in-situ* soil moisture measurements from USDA SCAN sites are collected and reprocessed.

AMSR2 SM vs SCAN: Overall Statistics

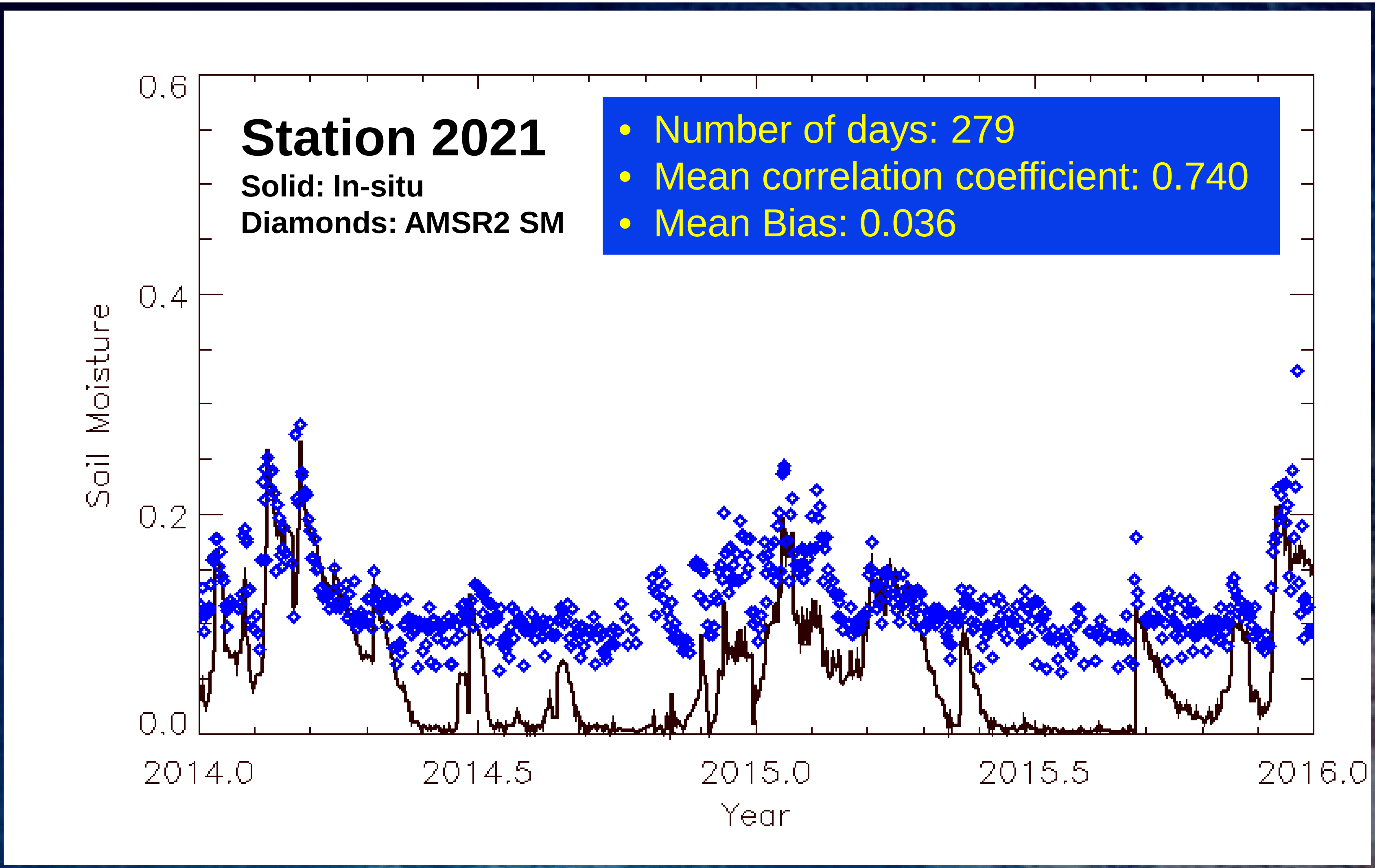


- Number of Stations: 150
- Mean correlation coefficient: 0.545
- Mean Bias: 0.021
- Mean RMSE: 0.038

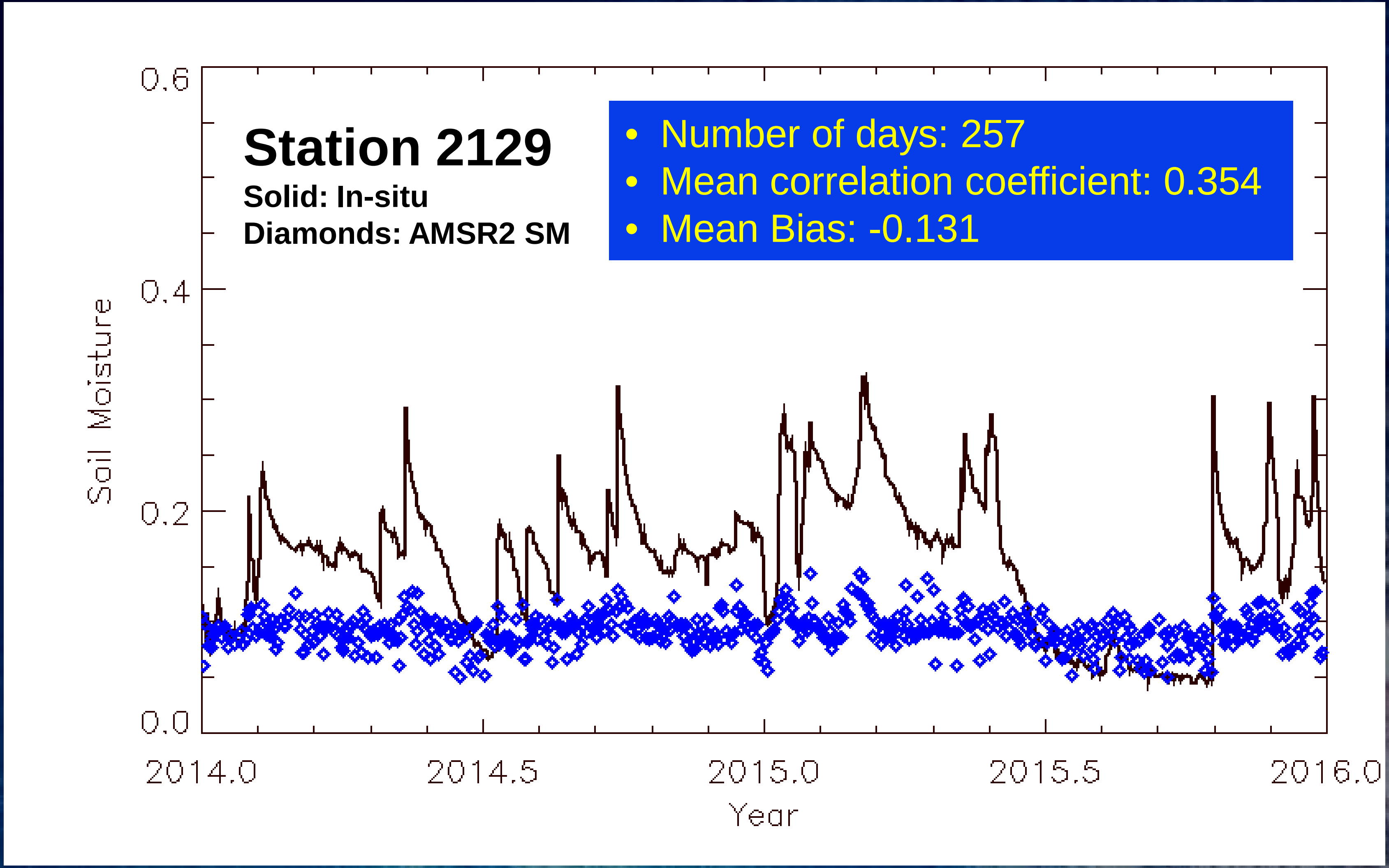
AMSR2 SM vs SCAN: Sample time series



AMSR2 SM vs SCAN: Sample time series



AMSR2 SM vs SCAN: Sample time series



AMSR2 SM EDR Validation: Summary

The preliminary validation using SCAN field data show that:

1. The overall RMSE is within four percent.
2. AMSR2 SM is mainly overestimating.
3. The time series shows good correlation.
4. Results are good for some stations while they are bad for some others.
5. Further investigation is needed to determine the source of error and, therefore, to improve the algorithm.
6. Further validation work is need with more in-situ data and inter-comparison with other satellite SM products.

Validation: Unit Tests & Final DAP

Presented by

Letitia Soulliard

GAASP Day 2 Testing

- The STAR GAASP development team has been running the system via CRON on rhs8142 and distributing pre-operational data to users for about 2 years
  - » Demonstrates that each unit can run error free over long periods
  - » Provides output files to users via http://manati.star.nesdis.noaa.gov/gcom/data_gaasp_day2/
- Preliminary DAP was delivered to NDE on 10/5/2015 to assist with early integration efforts
- Final DAP was delivered to NDE on 03/22/2016

GAASP – Run Times

- GAASP product generation within ESPC (NDE) is allocated 25 minutes per orbit. Below are the average run times at STAR running on rhs8142.

Process	Average Clock Time	In Minutes
GAASP_Preprocessor.pl	**64 seconds**	**1.1**
GAASP_Ocean.pl	96 seconds	1.6
GAASP_Precipitation.pl	617 seconds	10.3
GAASP_Snow.pl	**640 seconds**	**10.7**
GAASP_SoilMoisture.pl	15 seconds	0.25
GAASP_Seaice.pl	160 seconds	2.7
GAASP_Postprocessor.pl	**14 seconds**	**0.23**
MAX Latency	**718 seconds**	**12.0**

GAASP – NetCDF CF1.5 Compliance

- Testing each netCDF Template file at http://puma.nerc.ac.uk/cgi-bin/cf-checker.pl

- Scan Time always causes an error due to it being 6 dimensions.
  - » Scan_Time:long_name = "Scan line Start Time 6-D for (YYYY, MM, DD, HH, MM, SS.S) in GMT“
  - » ERROR (5): Dimensions of Scan_Time must be a subset of dimensions of [each variable that list Scan_Time as a coordinate]

- All “Information Messages” are along the lines of
  - » INFO: attribute 'comment' is being used in a non-standard way
  - » INFO: attribute '_FillValue' is being used in a non-standard way

GAASP – NetCDF CF1.5 Compliance

NetCDF Template File	Errors	Warning	Information
gaasp_mbt.nc	1	0	41
gaasp_ocean.nc	1	0	9
gaasp_precip.nc	1	0	9
gaasp_snow.nc	1	0	5
gaasp_soil.nc	1	0	5
gaasp_seaice-nh.nc	1	0	3
gaasp_seaice-sh.nc	1	0	3

GAASP Sea ICE GRIB2 Formatting Test Results

- AMSR2 Sea Ice North Hemisphere GRIB2 file can be produced successfully. Here is GAASP Sea Ice GRIB2 run at 11:47 on March 18, 2016:

```
pwdrhs8142(ysong):/net/orbit247l/disk1/pub/ysong/intel/AMSR2/run/AMSR2-ICE-NH>pwd
/net/orbit247l/disk1/pub/ysong/intel/AMSR2/run/AMSR2-ICE-NH
rhs8142(ysong):/net/orbit247l/disk1/pub/ysong/intel/AMSR2/run/AMSR2-ICE-NH>ls -lrt
total 72332
-rw-r-----. 1 ysong star 66159696 Mar 16 12:15 GAASP-SEAICE-
NH_v2r0_GW1_s201603161140230_e201603161319220_c201603161507370.h5
-rw-r--r--. 1 ysong star      190 Mar 16 12:17 NPR.pl.PCF
-rw-r--r--. 1 ysong star      194 Mar 18 11:47 npr.filenames
-rwxr-xr-x. 1 ysong star  7804636 Mar 18 11:47 AMSR2-SEAICE-
NH_v2r0_GW1_s201603161140230_e201603161319220_c201603181547260.grib2
-rw-r--r--. 1 ysong star       82 Mar 18 11:47 NPR.pl.PSF
-rw-r--r--. 1 ysong star     1784 Mar 18 11:47 NPR.pl.log
rhs8142(ysong):/net/orbit247l/disk1/pub/ysong/intel/AMSR2/run/AMSR2-ICE-NH>
```

GAASP Sea ICE GRIB2 Formatting Test Results

- Dumped the contents of the log file (NPR.pl.log) to show that everything ran correctly. There were no error in the script itself, any of the system calls, the main program, its subroutines and GRIB2 library calls. This log file contained the starting and ending times indicating everything completed in 13 seconds of clock time. The CPU for the main program is 0.4 seconds for one day North Pole Sea Ice data.

```
Starting at Fri Mar 18 11:47:26 EDT 2016
 main_npr is now starting.
 Starting AMSR2_ICE_H5_to_grib2
GRIB2_FileName=
 AMSR2-SEAICE-NH_v2r0_GW1_s201603161140230_e201603161319220_c201603181547260.grib2
 Total_Allocation =      24255000
 CPU TIME for read NetCDF4 files is:  0.154976000000000
 Starting AMSR2_ice_write_grib2
lengrib returned from gribend=      7804636
 lcgrib=     44100000
 Closing GRIB2 file.
 Finishing AMSR2_ice_write_grib2
 CPU TIME for wrting GRIB2 files is:  0.245964000000000
 Finishing AMSR2_ICE_H5_to_grib2
 main_npr is now finished.
 CPU time for the whole program is:  0.401939000000000
Total_time=3
Ending at Fri Mar 18 11:47:29 EDT 2016
```

GAASP Sea ICE GRIB2 Formatting Test Results

- The created AMSR2 Sea Ice GRIB2 file can also be dumped with the NCEP WGRIB2 utility. It indicates that the product is readable among user communities.
  - » Message from the WGRIB2 utility for the North Hemisphere GRIB2 file.

```
rhw1044(ysong):/net/orbit247l/disk1/pub/ysong/intel/AMSR2/run/AMSR2-ICE-NH>wgrib2 -V AMSR2-SEAICE-NH_v2r0_GW1_s201603161140230_e201603161319220_c201603181547260.grib2

1.1:0:vt=2016031611:reserved:anl:ICEC Ice Cover [Proportion]:
    ndata=1102500:undef=528883:mean=25.1539:min=0:max=100
    grid_template=140:winds(N/S):no other grid info

1.2:0:vt=2016031611:reserved:anl:ICEC Ice Cover [Proportion]:climatological
    ndata=1102500:undef=526076:mean=9.68636:min=0:max=100
    grid_template=140:winds(N/S):no other grid info

1.3:0:vt=2016031611:reserved:anl:ICEC Ice Cover [Proportion]:
    ndata=1102500:undef=528883:mean=25.0192:min=0:max=100
    grid_template=140:winds(N/S):no other grid info

1.4:0:vt=2016031611:reserved:anl:TSEC Seconds Prior To Initial Reference Time (Defined In Section 1) [s]:
    ndata=1102500:undef=791496:mean=425.829:min=0:max=1488
    grid_template=140:winds(N/S):no other grid info

rhw1044(ysong):/net/orbit247l/disk1/pub/ysong/intel/AMSR2/run/AMSR2-ICE-NH>
```

GAASP Sea ICE GRIB2 Formatting Test Results

- AMSR2 Sea Ice South Hemisphere GRIB2 file can also be produced successfully. Here is GAASP Sea Ice GRIB2 run at 14:21 on March 18, 2016:

```
rhs8142(ysong):/net/orbit247l/disk1/pub/ysong/intel/AMSR2/run/AMSR2-ICE-SH>pwd
/net/orbit247l/disk1/pub/ysong/intel/AMSR2/run/AMSR2-ICE-SH
rhs8142(ysong):/net/orbit247l/disk1/pub/ysong/intel/AMSR2/run/AMSR2-ICE-SH>ls -lrt
total 46160
-rw-r-----. 1 ysong star 42345696 Mar 18 12:15 GAASP-SEAICE-
SH_v2r0_GW1_s201603181307220_e201603181443210_c201603181531130.h5
-rw-r--r--. 1 ysong star      190 Mar 18 14:19 NPR.pl.PCF
-rw-r--r--. 1 ysong star      194 Mar 18 14:21 npr.filenames
-rw-r--r--. 1 ysong star       82 Mar 18 14:21 NPR.pl.PSF
-rw-r--r--. 1 ysong star     1784 Mar 18 14:21 NPR.pl.log
-rwxr-xr-x. 1 ysong star  4839597 Mar 18 14:21 AMSR2-SEAICE-
SH_v2r0_GW1_s201603181307220_e201603181443210_c201603181821060.grib2
rhs8142(ysong):/net/orbit247l/disk1/pub/ysong/intel/AMSR2/run/AMSR2-ICE-SH>
```

GAASP Sea ICE GRIB2 Formatting Test Results

- Dumped the contents of the log file (NPR.pl.log) to show that everything ran correctly. There were no error in the script itself, any of the system calls, the main program, its subroutines and GRIB2 library calls. This log file contained the starting and ending times indicating everything completed in 2 seconds of clock time. The CPU for the main program is 0.2 seconds for one day North Pole Sea Ice data.

```
Starting at Fri Mar 18 14:21:06 EDT 2016
 main_npr is now starting.
 Starting AMSR2_ICE_H5_to_grib2
 GRIB2_FileName=
 AMSR2-SEAICE-SH_v2r0_GW1_s201603181307220_e201603181443210_c201603181821060.grib2
 Total_Allocation =      15523200
 CPU TIME for read NetCDF4 files is:  0.100985000000000
 Starting AMSR2_ice_write_grib2
  lengrib returned from gribend=      4839597
 lcgrib=     28224000
 Closing GRIB2 file.
 Finishing AMSR2_ice_write_grib2
 CPU TIME for wrting GRIB2 files is:  0.158976000000000
 Finishing AMSR2_ICE_H5_to_grib2
 main_npr is now finished.
 CPU time for the whole program is:  0.260961000000000
Total_time=2
Ending at Fri Mar 18 14:21:08 EDT 2016
```

GAASP Sea ICE GRIB2 Formatting Test Results

- The created AMSR2 Sea Ice GRIB2 file can also be dumped with the NCEP WGRIB2 utility. It indicates that the product is readable among user communities.
  - » Message from the WGRIB2 utility for the South Hemisphere GRIB2 file.

```
rhw1044(ysong):/net/orbit247l/disk1/pub/ysong/intel/AMSR2/run/AMSR2-ICE-SH>wgrib2 -V AMSR2-SEAICE-SH_v2r0_GW1_s201603181307220_e201603181443210_c201603181821060.grib2
1.1:0:vt=2016031813:reserved:anl:ICEC Ice Cover [Proportion]:
    ndata=705600:undef=143336:mean=6.80837:min=0:max=100
    grid_template=140:winds(N/S):no other grid info

1.2:0:vt=2016031813:reserved:anl:ICEC Ice Cover [Proportion]:climatological
    ndata=705600:undef=143336:mean=1.66624:min=0:max=100
    grid_template=140:winds(N/S):no other grid info

1.3:0:vt=2016031813:reserved:anl:ICEC Ice Cover [Proportion]:
    ndata=705600:undef=143336:mean=6.11652:min=0:max=100
    grid_template=140:winds(N/S):no other grid info

1.4:0:vt=2016031813:reserved:anl:TSEC Seconds Prior To Initial Reference Time (Defined In Section 1) [s]:
    ndata=705600:undef=402063:mean=348.784:min=34:max=1442
    grid_template=140:winds(N/S):no other grid info

rhw1044(ysong):/net/orbit247l/disk1/pub/ysong/intel/AMSR2/run/AMSR2-ICE-SH>
```

GAASP Sea ICE GRIB2 Formatting Test Results

- Rober Grumbine, the user at NCEP/EMC, test the sample GRIB2 files and approved this GRIB2 product. Here is his email on 3/2/2016.

> I think I've replied before, but for certainty: Yes, looks ok. I particularly like that latency field being added.
>
> Thanks,
>
> Bob

- Boi Vuong, the NCEP GRIB2 library developer, decoded the sample GRIB2 files and approved them. Here is his email on 10/15/2016.

> Hi Yi,
> I decoded your sample files and they look fine in GRIB2 format. There is one file I could not decode SEAICE_NH_201502152336.h5 (not GRIB2). All of your GRIB2 files are in simple packing. Note: There are some options in GRIB2 that allow you to pack the grib message in the following packing:
> -p0 simple packing
> -p2 complex packing
> -p31 complex pack with 1st order diffs
> -p32 complex pack with 2nd order diffs
> -p40 JPEG2000 encoding
> -p41 PNG encoding
>
> Thanks,
> Boi

GAASP: GRAC Testing

- GRAC = GCOM RDR to ASD Converter
- Takes an HDF5 RDR double-contact file and the GPS time in seconds of the last RDR packet read in
- Uses that value to cut the double contact RDR at the location of the new orbital information
- Creates an ASD file with just the new data for use by the JAXA code
- Filenames use GPS seconds time instead of standard UTC. (NDE Approved)

GAASP: GRAC Testing

- PCF file

```
EMAIL_ERROR_FLAG=NO
working_directory=/home/letitias/RDR_splitter/TEST/2
GPS_TIME_FILE=/home/letitias/RDR_splitter/TEST/1/LAST_GPS_s1081207756_e1081219633.txt
RDR_INPUT_FILE=RAM2M_gw1_d20140411_t0107461_e0425599_b00002_c20150724164252855696_advu_dev.
h5
OPS_BIN=/home/letitias/RDR_splitter/bin
PSF_FILE=GCOM.PSF
```

- Log file

```
Processing file:
 RAM2M_gw1_d20140411_t0107461_e0425599_b00002_c20150724164252855696_advu_dev.h5
 Reading: All_Data/AMSR2-MISSIONDATA-RDR_All/RawApplicationPackets_0
 Writing AMSR2 RAP            1 into asd.tmp
 Writing to = GCOM_1476_s1081219635_e1081225574.ASD
```

GAASP: GRAC Testing

- PSF file

```
/home/letitias/RDR_splitter/TEST/2/GCOM_1476_s1081219635_e1081225574.ASD
/home/letitias/RDR_splitter/TEST/2/LAST_GPS_s1081219635_e1081225574.txt
```

- ASD file ~ half the size of the RDR file

```
64897024 Sep 22  2015 GCOM_1476_s1081219635_e1081225574.ASD
129934236 Sep 10  2015
RAM2M_gw1_d20140411_t0107461_e0425599_b00002_c20150724164252855696_advu_dev.h5
```

- LAST_GPS time file contains GPS time for next run of GRAC

```
cat LAST_GPS_s1081219635_e1081225574.txt
            1081225574
```

GAASP: GRAC Testing

- Received LG2 RDR files for a period of 2 days
- Ran them through the GRAC
- Ran them through the JAXA 2.1 code on rhs8142
- Compared the outputs to the L1B files we receive directly from Japan and currently use in our development system

Comparison of JAXA vs STAR produced granules

	NumberOfScans		ObservationStartDateTime		ObservationEndDateTime		NumberMissingPackets	
granule id	***JAXA***	***STAR***	***JAXA***	***STAR***	***JAXA***	***STAR***	***JAXA***	***STAR***
201604110407_221	3961	3960	2016-04-11 T04:07:31.476Z	2016-04-11 T04:07:31.476Z	2016-04-11 T05:46:30.905Z	2016-04-11 T05:46:29.405Z	1	0
201604110546_004	3840	3841	2016-04-11 T05:46:32.405Z	2016-04-11 T05:46:30.905Z	2016-04-11 T07:22:30.340Z	2016-04-11 T07:22:30.340Z	0	0
201604110722_020	3961	3960	2016-04-11 T07:22:31.840Z	2016-04-11 T 07:22:31.840Z	2016-04-11 T09:01:31.267Z	2016-04-11 T09:01:29.767Z	2	0
201604110901_036	3960	3961	2016-04-11 T09:01:32.767Z	2016-04-11 T09:01:31.267Z	2016-04-11 T10:40:30.697Z	2016-04-11 T10:40:30.697Z	0	0
201604111040_052	3840	3840	2016-04-11 T10:40:32.197Z	2016-04-11 T10:40:32.197Z	2016-04-11 T12:16:30.140Z	2016-04-11 T12:16:30.140Z	0	0
201604111216_068	3961	3960	2016-04-11 T12:16:31.640Z	2016-04-11 T12:16:31.640Z	2016-04-11 T13:55:31.070Z	2016-04-11 T13:55:29.571Z	1	0

GAASP: GRAC Testing

- GRAC is designed to only output full scan lines which are 16 packets each.
  - » Accounts for occasional miss-alignments
- When the granules lined up exactly there were no differences for all BTs. There were differences for Land/Ocean Mask.
  - » STAR probably has an old copy of the SeaFlag files.

GAASP: GRAC Testing

- When the granules are off by one scan line, the first 10 scan lines or the last 10 scan lines (depending on where the miss-alignment occurs) are slightly different (< 0.1 K)

GAASP – NDE DAP Standards V1.5 Compliance

- Updated netCDF4 metadata to follow Algorithm Delivery Standards, Integration, and Test_V1.5-DRAFT_03042015.docx

- MBT, Ocean, Precip, Snow, Soil Moisture are all SWATH files and have the same metadata structure

- Sea ice is on a grid and has a different metadata structure

GAASP – NDE DAP Standards V1.5 Compliance

- Swath example

```
// global attributes:
		:Conventions = "CF-1.5" ;
		:Metadata_Conventions = "CF-1.5, Unidata Datasset Discovery v1.0" ;
		:standard_name_vocabulary = "CF Standard Name Table (version 17, 24 March 2011)" ;
		:project = "NPP Data Exploitation: NOAA GCOM-W1 AMSR2" ;
		:title = "AMSR2_MBT" ;
		:summary = "GCOM Microwave Brightness Temperatures" ;
		:institution = "DOC/NOAA/NESDIS/OSPO > Office of Satellite and Product 
Operations,     NESDIS, NOAA, U.S. Department of Commerce" ;
		:naming_authority = "gov.noaa.nesdis.nde" ;
		:platform_name = "GCOM-W1" ;
		:instrument_name = "AMSR2" ;
		:creator_name = "DOC/NOAA/NESDIS/STAR > IOSSPDT Algorithm Team, Center for 
Satellite   Applications and Research, NESDIS, NOAA, U.S. Department of Commerce" ;
		:creator_email = "espcoperations@noaa.gov" ;
		:creator_url = "http://www.star.nesdis.noaa.gov" ;
		:publisher_name = "DOC/NOAA/NESDIS/NDE > NPP Data Exploitation, Center for 
Satellite Applications and Research, NESDIS, NOAA, U.S. Department of Commerce" ;
		:publisher_email = "espcoperations@noaa.gov" ;
		:publisher_url = "http://www.ospo.noaa.gov/" ;
		:references = "Contact the OSPO PAL to request the ATBD." ;
		:history = "Created by GAASP version 2.0, Release 0.0" ;
		:processing_level = "NOAA Level 1 data" ;
		:production_site = "" ;
		:production_environment = "" ;
```

GAASP – NDE DAP Standards V1.5 Compliance

- Swath example (cont.)

```
      :cdm_data_type = "Swath" ;
      :geospatial_lat_units = "degrees_north" ;
      :geospatial_lon_units = "degrees_east" ;
      :date_created = "2016-03-11T05:28:12Z" ;
      :id = "ba3ee3d3-def0-4813-817a-7c6ed8c2e9cc" ;
      :Metadata_Link = "AMSR2-
MBT_v2r0_GW1_s201603110134210_e201603110313190_c201603110528120.nc" ;
      :source = "GW1AM2_201603110134_196B_L1SNBTBR_2210210.h5,
seaice.t00z.5min.grb.grib2.20160310.nc" ;
      :start_orbit_number = 20292 ;
      :end_orbit_number = 20293 ;
      :day_night_data_flag = 2 ;
      :ascend_descend_data_flag = 2 ;
      :time_coverage_start = "2016-03-11T01:34:21.666Z" ;
      :time_coverage_end = "2016-03-11T03:13:19.593Z" ;
      :geospatial_first_scanline_first_fov_lat = 72.86f ;
      :geospatial_first_scanline_last_fov_lat = 66.89f ;
      :geospatial_first_scanline_first_fov_lon = 0.91f ;
      :geospatial_first_scanline_last_fov_lon = 40.73f ;
      :geospatial_last_scanline_first_fov_lat = 72.56f ;
      :geospatial_last_scanline_last_fov_lat = 66.68f ;
      :geospatial_last_scanline_first_fov_lon = -23.89f ;
      :geospatial_last_scanline_last_fov_lon = 15.55f ;
      :geospatial_bounds = "POLYGON((0.91, 72.86, 40.73, 66.89, 15.55, 66.68, -23.89, 72. 56))" ;
```

GAASP – NDE DAP Standards V1.5 Compliance

- Grid example

```
// global attributes:
      :Conventions = "CF-1.5" ;
      :Metadata_Conventions = "CF-1.5, Unidata Datasset Discovery v1.0" ;
      :standard_name_vocabulary = "CF Standard Name Table (version 17, 24 March 2011)" ;
      :project = "NPP Data Exploitation: NOAA GCOM-W1 AMSR2" ;
      :title = "AMSR2_SEAICE" ;
      :summary = "GCOM Seaice Products" ;
      :institution = "DOC/NOAA/NESDIS/OSPO > Office of Satellite and Product
Operations,     NESDIS, NOAA, U.S. Department of Commerce" ;
      :naming_authority = "gov.noaa.nesdis.nde" ;
      :platform_name = "GCOM-W1" ;
      :instrument_name = "AMSR2" ;
      :creator_name = "DOC/NOAA/NESDIS/STAR > IOSSPDT Algorithm Team, Center for
Satellite   Applications and Research, NESDIS, NOAA, U.S. Department of Commerce" ;
      :creator_email = "espcoperations@noaa.gov" ;
      :creator_url = "http://www.star.nesdis.noaa.gov" ;
      :publisher_name = "DOC/NOAA/NESDIS/NDE > NPP Data Exploitation, Center for
Satellite Applications and Research, NESDIS, NOAA, U.S. Department of Commerce" ;
      :publisher_email = "espcoperations@noaa.gov" ;
      :publisher_url = "http://www.ospo.noaa.gov/" ;
      :references = "Contact the OSPO PAL to request the ATBD." ;
      :history = "Created by GAASP version 2.0, Release 0.0" ;
:processing_level = "NOAA Level 2 data" ;
      :production_site = "" ;
:production_environment = "" ;
```

GAASP – NDE DAP Standards V1.5 Compliance

- Grid example

```
:cdm_data_type = "Grid" ;
      :geospatial_lat_min = 18.87699f ;
:geospatial_lat_max = 89.9367f ;
      :geospatial_lon_min = -179.945f ;
      :geospatial_lon_max = 179.945f ;
      :geospatial_lat_units = "degrees_north" ;
:geospatial_lon_units = "degrees_east" ;
      :date_created = "2016-03-11T05:28:12Z" ;
      :id = "5608c7c1-8e80-453e-b471-0de4eae70467" ;
      :Metadata_Link = "AMSR2-SEAICE-
NH_v2r0_GW1_s201603110134210_e201603110313190_c201603110528120.nc" ;
      :source = "GAASP-L1R_v2r0_GW1_s201603110134210_e201603110313190_c201603110507110.   h5,
GAASP-L1R_v2r0_GW1_s201603102355200_e201603110134200_c201603110216110.h5, GAASP-
L1R_v2r0_GW1_s201603102216210_e201603102355190_c201603110037100.h5, GAASP-
L1R_v2r0_GW1_s201603102034200_e201603102216190_c201603102255110.h5, GAASP-
L1R_v2r0_GW1_s201603101852210_e201603102034180_c201603102116100.h5, GAASP-
L1R_v2r0_GW1_s201603101713210_e201603101852190_c201603101934130.h5, GAASP-
L1R_v2r0_GW1_s201603101534200_e201603101713200_c201603101755120.h5, GAASP-
L1R_v2r0_GW1_s201603101355210_e201603101534190_c201603101616110.h5, GAASP-
L1R_v2r0_GW1_s201603101216210_e201603101355190_c201603101446130.h5, GAASP-
L1R_v2r0_GW1_s201603101037200_e201603101216200_c201603101307110.h5, GAASP-
L1R_v2r0_GW1_s201603100901210_e201603101037190_c201603101125140.h5, GAASP-
L1R_v2r0_GW1_s201603100722210_e201603100901190_c201603100946110.h5, GAASP-
L1R_v2r0_GW1_s201603100546210_e201603100722200_c201603100807130.h5, GAASP-
L1R_v2r0_GW1_s201603100407210_e201603100546190_c201603100625150.h5, GAASP-
L1R_v2r0_GW1_s201603100228200_e201603100407200_c201603100507110.h5" ;
```

GAASP – NDE DAP Standards V1.5 Compliance

- Grid example

```
:start_orbit_number = 20292 ;
      :end_orbit_number = 20293 ;
      :day_night_data_flag = 2 ;
      :ascend_descend_data_flag = 2 ;
      :time_coverage_start = "2016-03-11T01:34:21.666Z" ;
      :time_coverage_end = "2016-03-11T03:13:19.593Z" ;
```

Final GAASP DAP Checklist

- The final Day 2 DAP was delivered to sadie:
  - /utilraid/data/users/lsoullia/DAP/GAASP_v2-0_20160322.tar.gz
- The package contains:
  - Code
    - GAASP code
    - Reformatter Toolkit (updated for the Sea Ice GRIB2 tailoring)
    - mapx-0.10 code
  - Documentation:
    - README
    - SMM, EUM, ATBD documents
    - PDR, CDR, CTR, and ARR slide packages
  - Data
    - Sample data
    - Static ancillary data

GAASP Code Details

Language	Line Count
Fortran 90	107,275
Fortran 77	0
C	1748
Perl	6614

Validation Unit Tests & Final DAP Summary

- GCOM Day 2 validation has demonstrated that:
  - GAASP is meeting latency requirements
  - GAASP output is CF compliant
  - GRIB2 tailoring by the Reformatter Toolkit is being performed correctly
  - The GAASP DAP is meeting NDE DAP 1.5 standards
  - GRAC updates are able to handle the double contact RDRs from IDPS block 2.0

- DAP Checklist has verified that the DAP contents are complete and ready for integration and implementation in NDE

Review Outline

- Introduction
- Day 1 ORR Report
- Requirements
- Software Architecture
- Validation
- Risk Summary
- Summary and Conclusions

Risk Summary

Presented by

Tom King

CDR Risk

- **Risk #12:** The allocated latency thresholds for processing orbital (as opposed to granule) products still need to be identified and approved. There is a CCR to adjust these allocations (JPSS CCR (NJO-2015- 032, Rev A)), but it has not been approved because of pushback from NWS.
- **Risk Assessment:** Low
- **Impact:** Low
- **Likelihood:** Low
- **Risk Mitigation:**
  - End to end testing within the NDE system will demonstrate the actual run times. Based on these, NJO will need to work with NWS or request a waiver.
- **Status:** Open

CONSEQUENCES

LIKELIHOOD	1	2	3	4	5
5					
4					
3					
2					
1				X	

Day 2 ARR Risk

- **Risk #25:** The delivery of GAASP Day 2 has likely missed the opportunity to run in NDE 1.0 because of the freeze.
- **Risk Assessment:** Medium
- **Impact:** Medium
- **Likelihood:** High
- **Risk Mitigation:**
  - STAR will make Day 2 products available from its ftp server until GAASP Day 2 can be declared operational at OSPO. If a new build of NDE 1.0 can be authorized, GAASP Day 2 products can then be generated operationally at OSPO, except for Sea Ice which requires L1R files. Sea Ice will have to be generated at STAR until NDE 2.0 is running (NDE 2.0 will get GCOM RDRs from IDPS block 2.0).
- **Status:** Open

CONSEQUENCES

LIKELIHOOD	1	2	3	4	5
5		X			
4					
3					
2					
1					

Day 2 ARR Risk

- **Risk #26:** IDPS block 2.0 is labeling the AMSR2 RDR double orbit full-contact RDR HDF5 files as "repairs" because there is temporal overlap. This overlap is necessary to obtain all the data, however, NDE doesn't subscribe to repairs so these files will not be available to NDE product generation.
- **Risk Assessment:** Low
- **Impact:** Low
- **Likelihood:** Low
- **Risk Mitigation:**
  - There is a CCR to have this fixed in the IDPS by the time block 2.0 is delivered. For now, NDE can also allow repairs for just GCOM RDRs as mitigation.
- **Status:** Open

CONSEQUENCES

LIKELIHOOD	1	2	3	4	5
5					
4					
3					
2		X			
1					

Day 2 ARR Risk

- **Risk #27:** The GHRSST reformatting capability is not yet complete.
- **Risk Assessment:** Low
- **Impact:** Low
- **Likelihood:** Medium
- **Risk Mitigation:**
  - Andy Harris is working on this. When it's ready he will give the STAR GAASP developers the code to add to into the GAASP postprocessor. This should happen sometime in May 2016. Tish will redeliver an update of the DAP to NDE.
  - STAR GCOM developers will update the existing DSR to include these GHRSST files once the file sizes and other details are better known.
- **Status:** Open

CONSEQUENCES

LIKELIHOOD	1	2	3	4	5
5					
4					
3	X				
2					
1					

Day 2 ARR Risk

- **Risk #28:** The ATBD for Soil Moisture is still not yet complete and the SMM and EUM will need to be updated for GHRSST.
- **Risk Assessment:** Low
- **Impact:** Low
- **Likelihood:** Low
- **Risk Mitigation:**
  - This work is in progress and will be completed within the next month by the STAR GCOM developers and science team.
- **Status:** Open

CONSEQUENCES

LIKELIHOOD

	1	2	3	4	5
5					
4					
3					
2					
1		X			

Day 2 ARR Risk

- **Risk #29:** The LG2 GCOM evaluation of the L1B/L1R files indicated that the NDE version of the JAXA code is not using the latest version of the JAXA code. The observation times were off by 1 second. This is likely due to the last version not having been updated to include the leap second that was added on June 30, 2015.
- **Risk Assessment:** Low
- **Impact:** Low
- **Likelihood:** Low
- **Risk Mitigation:**
  - NDE developers will need to obtain and implement the latest version of the JAXA code.
- **Status:** Open

CONSEQUENCES

LIKELIHOOD

	1	2	3	4	5
5					
4					
3					
2					
1			X		

Day 2 ARR Risk

- **Risk #30:** Need to have a Software Code Review for the Day 2 DAP.
- **Risk Assessment:** Low
- **Impact:** Low
- **Likelihood:** Low
- **Risk Mitigation:**
  - Code was submitted for review on 4/28/2016. This is in progress, but has not been completed.
- **Status:** Open

CONSEQUENCES

LIKELIHOOD

	1	2	3	4	5
5					
4					
3					
2					
1	X				

Day 2 ARR Risk

- **Risk #31:** Some minor updates are needed for Soil Moisture. (1) A LUT change will be needed and (2) we can turn off the production of the binary soil moisture file since SMOPS is now set up to use the netCDF4 instead.
- **Risk Assessment:** Low
- **Impact:** Low
- **Likelihood:** Low
- **Risk Mitigation:**
  - Jicheng and Tish will work together to implement these updates in the code, production rules, and documentation.
- **Status:** Open

CONSEQUENCES

LIKELIHOOD

	1	2	3	4	5
5					
4					
3					
2					
1	X				

Day 2 ARR Risk

- **Risk #32:** The JPSS Requirements need to be updated to remove the Surface Type EDR as a requirement.
- **Risk Assessment:** Low
- **Impact:** Low
- **Likelihood:** Low
- **Risk Mitigation:**
  - The GCOM Science team leads will submit a CCR to the NOAA Engineering Review Board (ERB) to have this requirement removed from the L1RD Supplement.
- **Status:** Open

CONSEQUENCES

LIKELIHOOD	1	2	3	4	5
5					
4					
3					
2					
1	X				

Risk Summary

- 7 Risks Total
  - » 1 Old Risks
  - » 6 New Risks
    - – 6 Low
    - – 1 Medium

Review Outline

- Introduction
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- Validation
- Risk Summary
- Summary and Conclusions

Summary and Conclusions

Presented by

Tom King

Review Objectives Have Been Addressed

- The following have been reviewed
  - » Project Schedule
  - » Project Requirements
  - » Software Architecture
  - » Validation
  - » Risks and Actions

Next Steps for GAASP

- Gather reviewer feedback, make necessary updates to the ARR and the Review Item Disposition, and make these updates available to the review team.
- Receive, integrate, and deliver to NDE the GHRSST generation capability and make final updates to documentation.
- Assist NCEI with any information required to assist archive of EDRs.
- Assist NDE and OSPO with system test validation and troubleshooting.

Open Discussion

- The review is now open for free discussion

Acronyms

AFWA	Air Force Weather Agency
AMSR2	Advanced Microwave Scanning Radiometer 2
AMSR-E	Advanced Microwave Scanning Radiometer – Earth Observing System
AMSU	Advanced Microwave Sounder Unit
APID	Application Package IDentifier
ARR	Algorithm Readiness Review
ASCII	American Standard Code for Information Interchange
ASD	APID Sorted Data
ASI	Arctic Sea Ice
ATBD	Algorithm Theoretical Basis Document
BT	Bootstrap
BUFR	Binary Universal Form for the Representation of meteorological data
CDR	Critical Design Review
CICS	Cooperative Institute for Climate and Satellites
CIRES	Cooperative Institute for Research in Environmental Sciences
CLASS	Comprehensive Large Array-data Stewardship System
CLW	Cloud Liquid Water

Acronyms

CM	Configuration Management
CMC	Canadian Meteorological Center
COSMOS	COsmic-ray Soil Moisture Observing System
CPC	Climate Prediction Center
CPU	Central Processing Unit
CRTM	Community Radiative Transfer Model
CTR	Code Test Review
DAP	Delivered Algorithm Package
DDS	Data Distribution Server
DPCA	Double Principal Components Analysis
ECMWF	European Center for Medium-Range Weather Forecasts
EDR	Environmental Data Record
EIA	Earth Incidence Angle
EMC	Environmental Modeling Center
EPL	Enterprise Product Lifecycle
ESPC	Environmental Satellite Processing Center
ESPDS	Environmental Satellite Processing and Distribution Services
ESRL	Earth System Research Laboratory

Acronyms

EUM	External Users Manual
EUMETSAT	European Organization for the Exploitation Meteorological Satellites
FNMOC	Fleet Numerical Meteorology and Oceanography Center
FOV	Field of View
GAASP	GCOM-W1 AMSR2 Algorithm Software Processor
GB	Gigabyte
GCOM	Global Change Observation Mission
GDAS	Global Data Assimilation System
GEOSS	Global Earth Observation System of Systems
GFS	Global Forecast System
GHRSST	Group for High Resolution Sea Surface Temperature
GMAO	Global Modeling and Assimilation Office
GMT	Greenwich Mean Time
GPROF	Goddard Profiling algorithm
GRIB	Gridded Binary format
GRIB2	Gridded Binary format (version 2)

Acronyms

HCS	Horizontal Cell Size
IASI	Infrared Atmospheric Sounding Interferometer
IDPS	Interface Data Processing Segment
IGBP	International Geosphere-Biosphere Programme
IMS	Interactive Multisensor Snow and Ice Mapping System
IPT	Integrated Product Team
JAXA	Japan Aerospace Exploration Agency
JCSDA	Joint Center for Satellite Data Assimilation
JPSS	Joint Polar Satellite System
KSAT	Kongsberg Satellite Services
MBT	Microwave Brightness Temperature
MIRS	Microwave Integrated Retrieval System
MMAB	Marine Modeling and Analysis Branch
MODIS	Moderate-resolution Imaging Spectroradiometer
N4RT	NetCDF4 Reformatting Toolkit
NDE	NPOESS Data Exploitation

Acronyms

NDVI	Normalized Difference Vegetation Index
NGDC	National Geophysical Data Center
NCEI	National Centers for Environmental Information
NCEP	National Center for Environmental Prediction
NESDIS	National Environmental Satellite, Data, and Information Service
netCDF4	network Common Data Format version 4
NHC	National Hurricane Center
NIC	National Ice Center
NJO	NOAA JPSS Office
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPOESS	National Polar-orbiting Operational Environmental Satellite System
NRL	Naval Research Lab
NRT	Near Real-Time
NSIDC	National Snow and Ice Data Center
NSOF	NOAA Satellite Operations Facility
NT2	NASA Team 2

Acronyms

NUCAPS	NOAA Unique CrIS/ATMS Product System
NWP	Numerical Weather Prediction
NWS	National Weather Service
NWSFO	National Weather Service Forecast Office
OAR	Office of Oceanic and Atmospheric Research
OSGS	Office of Satellite Ground Services
OSPO	Office of Satellite and Product Operations
OSTIA	Operational Sea Surface Temperature and Sea Ice Analysis
PCF	Production Control File
PDF	Probability Density Function
PDR	Preliminary Design Review
PSF	Production Status File
PT/R	Precipitation Type/Rate
QA	Quality Assurance
QC	Quality Control
RAD	Requirements Allocation Document

Acronyms

RDR	Raw Data Record
RFI	Radio Frequency Interference
RID	Review Item Disposition
RSS	Remote Sensing Systems
RTM	Radiative Transfer Model
SA	Submission Agreement
SAB	Satellite Analysis Branch
SAN	Storage Area Network
SAR	Synthetic Aperture Radar
SCAN	Soil Climate Analysis Network
SC/D	Snow Cover/Depth
SCR	Software Code Review
SDR	Sensor Data Record
SIC	Sea Ice Characterization
SM	Soil Moisture

Acronyms

SMCD	Satellite Meteorology and Climate Division
SMM	System Maintenance Manual
SMOPS	Soil Moisture Operational Products System
SOW	Statement of Work
SPSRB	Satellite Products and Services Review Board
SSMI	Special Sensor Microwave/Imager
SSMI/S	Special Sensor Microwave Imager/Sounder
SSS	Sea Surface Salinity
SST	Sea Surface Temperature
SSW	Sea Surface Winds
STAR	Center for Satellite Applications and Research
SWE	Snow Water Equivalent
Tb	Temperature brightness
TB	Terabyte
TBD	To Be Determined
TMI	TRMM Microwave Imager
TPW	Total Precipitable Water

Acronyms

TRMM	Tropical Rainfall Measuring Mission
UCAR	University Corporation for Atmospheric Research
USCRN	U.S. Climate Reference Network
UTC	Universal Time Coordinated
VIIRS	Visible Infrared Imager Radiometer Suite
V & V	Validation and Verification
WMO	World Meteorological Organization
WSPD	Wind Speed