Microwave Integrated Retrieval System Release v. 4

System Readiness Review

November 17, 2008

Prepared by: K. Garrett[1], S.-A. Boukabara[2], F. Iturbide-Sanchez[1],
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[2] NOAA/NESDIS/STAR
[3] Q.S.S. Group
[4] NOAA/NESDIS/OSDPD

Review Agenda

Introduction	<2:00-2:10>	Sid-Ahmed Boukabara
MIRS Description & Requirements	<2:10-2:25>	Kevin Garrett
System Operational Readiness	<2:25-2:35>	Limin Zhao
New Products for this Release	<2:35-3:25>	
Rainfall Rate		Flavio Iturbide-Sanchez
Sea Ice Concentration		Chris Grassotti
Snow Water Equivalent		Cezar Kongoli
Core Products/Cloud Liquid Water		Kevin Garrett
MIRS Code Unit Review	<3:25-3:35>	Wanchun Chen
Risks and Actions	<3:35-3:45>	Kevin Garrett
Summary and Conclusions	<3:45-3:50>	Sid-Ahmed Boukabara
Open Discussion	<3:50-4:00>	All

1. **INTRODUCTION**
2. MIRS DESCRIPTION & REQUIREMENTS
3. SYSTEM OPERATIONAL READINESS
4. NEW PRODUCTS FOR THIS RELEASE
5. MIRS CODE UNIT REVIEW
6. RISKS AND ACTIONS
7. SUMMARY AND CONCLUSIONS

Section 1 – Introduction

Presented by

Sid-Ahmed Boukabara
Physical Scientist
NOAA/NESDIS/STAR

MIRS Status

- MIRS is Ready for operations?
  - » MIRS ready for operations because the system is already operational
  - » The next delivery we are reviewing is an update to the previous release
- Why a System Readiness Review then?
  - » MIRS is not an EPL project (it started in 2005 and operational since 2007)
  - » Goal #1: Gather all POPs and MIRS stakeholders to go over the scientific and IT system readiness
  - » Goal #2: Perform a code review (new requirement)
  - » Goal #3: Brief oversight board, OSDPD
  - » Goal #4: Be proactive in communicating MIRS status, ahead of SPSRB meeting to have time to act on potential corrective measures and/or address concerns
- In a sense, this is a review of several aspects of the system to ensure we have maintained operational requirements/readiness with this update

Project Objectives (1/2)

- Overarching Objective
  - » The overarching objective of the Microwave Integrated Retrieval System (MIRS) is to contribute to the execution of the NOAA elements in the Integrated Earth Observation System (IEOS), which is a NOAA priority (Mission Support).
- Mission Objective
  - » MIRS aims at providing timely and effective acquisition and delivery of satellite-derived information that supports requirements from the Mission goal. The integrated and generic natures of MIRS make it possible to reduce significantly the amount of time spent developing retrieval algorithms for new sensors, which in turn reduces dramatically the time needed to transition to operations.

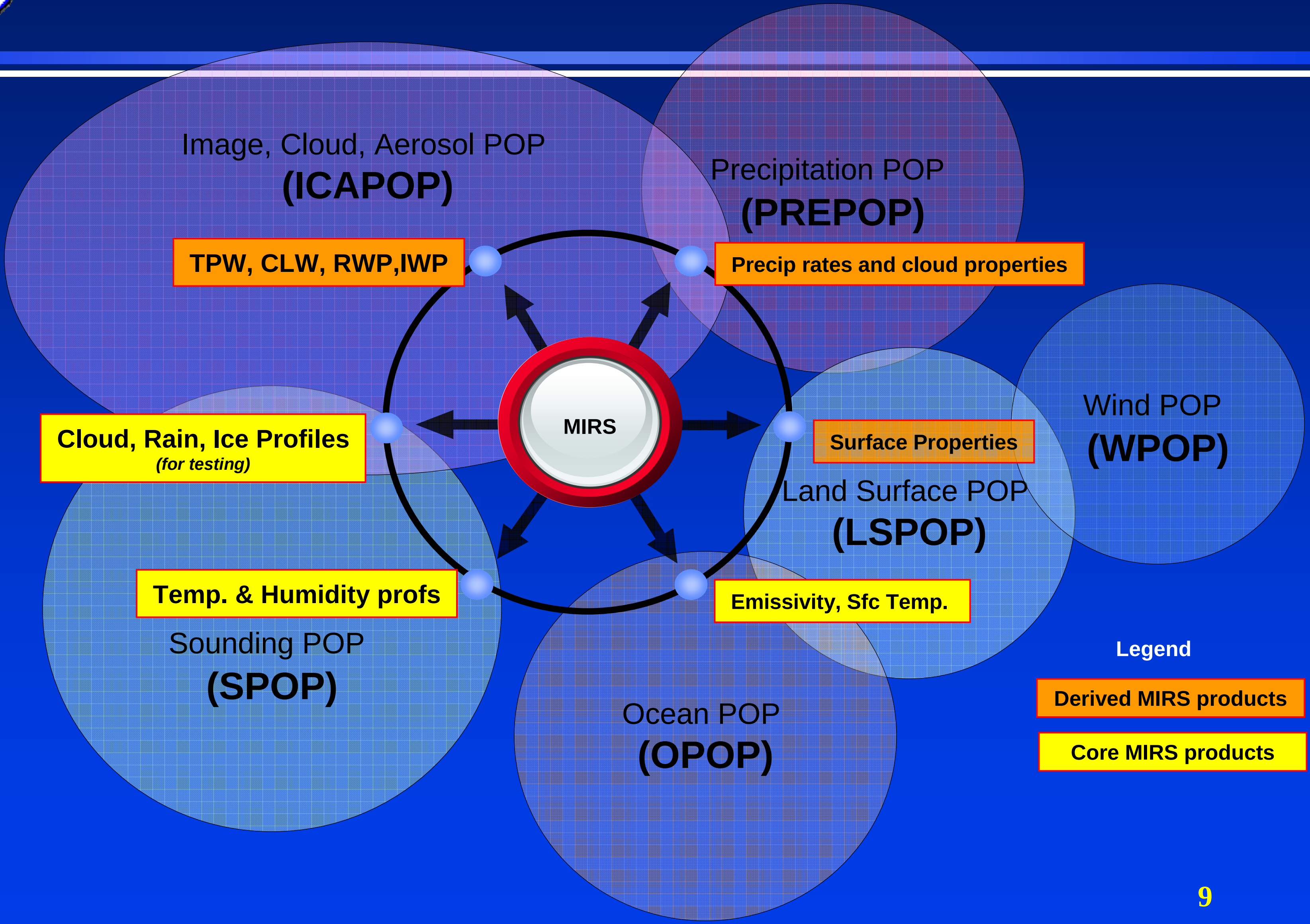
Project Objectives (2/2)

- Science Objectives
  - An improved temperature and moisture profiles retrieval
  - The extension of the retrieved products to non-standard surfaces including sea-ice and snow-covered land
  - The retrieval in all-weather conditions including cloudy and precipitating conditions
  - An improved set of retrieved surface properties whose derivation is based on the retrieved emissivities instead of directly from the brightness temperatures

MIRS Stakeholders

- Development Team
  - S.-A. Boukabara, K. Garrett, F. Iturbide-Sanchez, C. Grassotti, W. Chen, C. Kongoli, S. Stegall
- OSDPD Partners
  - L. Zhao, A. Li, J. Zhao
- MIRS Oversight Board
  - F. Weng (chair), R. Ferraro (STAR), L. Zhao (OSDPD), J. Silva (NDE), T. Schott (OSD)
- Oversight Panels
  - SPOP, PREPOP, ICAPOP, LSPOP
- MIRS Users
  - J. Derber, B. Yan, M. Kim (JCSDA), K. Mitchell and J. Janowiak (NCEP/CPC), G. Serafino (NESDIS/SAB), J. Turk and B. Ruston (NRL), G. Huffman (NASA/GSFC), AFWA, J. Tesmar (FNMOC), P. Wang (Taiwan Weather Bureau), S. Kidder (CIRA), and Universities
  - Additional users of the MIRS package include a dozen users around the world, including CMA and NASA/JPL.

MIRS in the context of SPSRB



Image, Cloud, Aerosol POP

(ICAPOP)

Precipitation POP

(PREPOP)

TPW, CLW, RWP,IWP

Precip rates and cloud properties

MIRS

Cloud, Rain, Ice Profiles
(for testing)

Surface Properties

Wind POP

(WPOP)

Land Surface POP

(LSPOP)

Temp. & Humidity profs

Emissivity, Sfc Temp.

Sounding POP

(SPOP)

Ocean POP

(OPOP)

Legend

Derived MIRS products

Core MIRS products

MIRS Timeline/History(1/4)

- Development Phase Begins (Sep. ’05-Sep. ‘06)
  - Go-ahead with product development (Sep. ’05)
  - Preliminary Design Review (Oct. ’05)
  - Critical Design Review (Sep. ’06)
- Pre-Operational Phase Begins (Jul. ’07)
  - Operational/backup processing capabilities in place.
  - SPSRB approves product to go operational
- Operational Phase Begins (Aug. ’07)
  - Operational/backup processing capabilities reach ops status
  - Code transitions to operations (MIRS Release I)
  - SPSRB updates product metrics web pages
  - OSD updates Satellite Products database

MIRS Timeline/History (2/4)
List of Products

MIRS	Products	N18	Metop-A	DMSP F16
Phase I	-Atmospheric Temperature Profiles (T) -Quality Control (QC) based on convergence metic (Chi-sq) –optional-	Sep 2006	Jun 2007	Jun 2008
Phase I & II	-Water Vapor Profiles (Q) –over ocean- -Total Precipitable Water –over ocean- -Land Surface Temperature -SST –optional- -IST –optional- -Emissivity –all surfaces- -Surface Type	Jun 2007	Jun 2007	Jun 2008
Phase II	Em.-based Snow-Water Equivalent Em.-based Snow-Cover Extent Em-based Sea-Ice Concentration Soil Wetness –optional- Integrated Cloud Liquid Water –ocean- TPW and Q to non-ocean surfaces	Dec 2007	Dec 2007	Dec 2008

🟩 Transitioned to OPS 🟧 Dec 2008

MIRS Timeline/History (3/4)
List of Products

MIRS	Products	N18	Metop-A	DMSP F16
Phase II & III	-Ice profile & Ice Water Path (IWP) -Rain profile & Rain Water Path (RWP) -Rain Flag (RF) –optional- -Precipitation Type (Water Phase) (PT) –optional-	Jun 2008	Jun 2008	Jun 2009
Phase III	-Rain Rate (RR) -Snow Fall Rate (SFR) –optional- -Cloud Top Pressure –optional- -Cloud thickness –optional- -Cloud base –optional- -Advance Quality Control Products: Average Kernal, Hessian, Contribution Functions -optional- -Extension to cloud retrieval over non-ocean -optional-	Dec 2008	Dec 2008	Nov 2009

🟩 Transitioned to OPS 🟧 Dec 2008 🟪 Jun 2009 🟥 Nov 2009

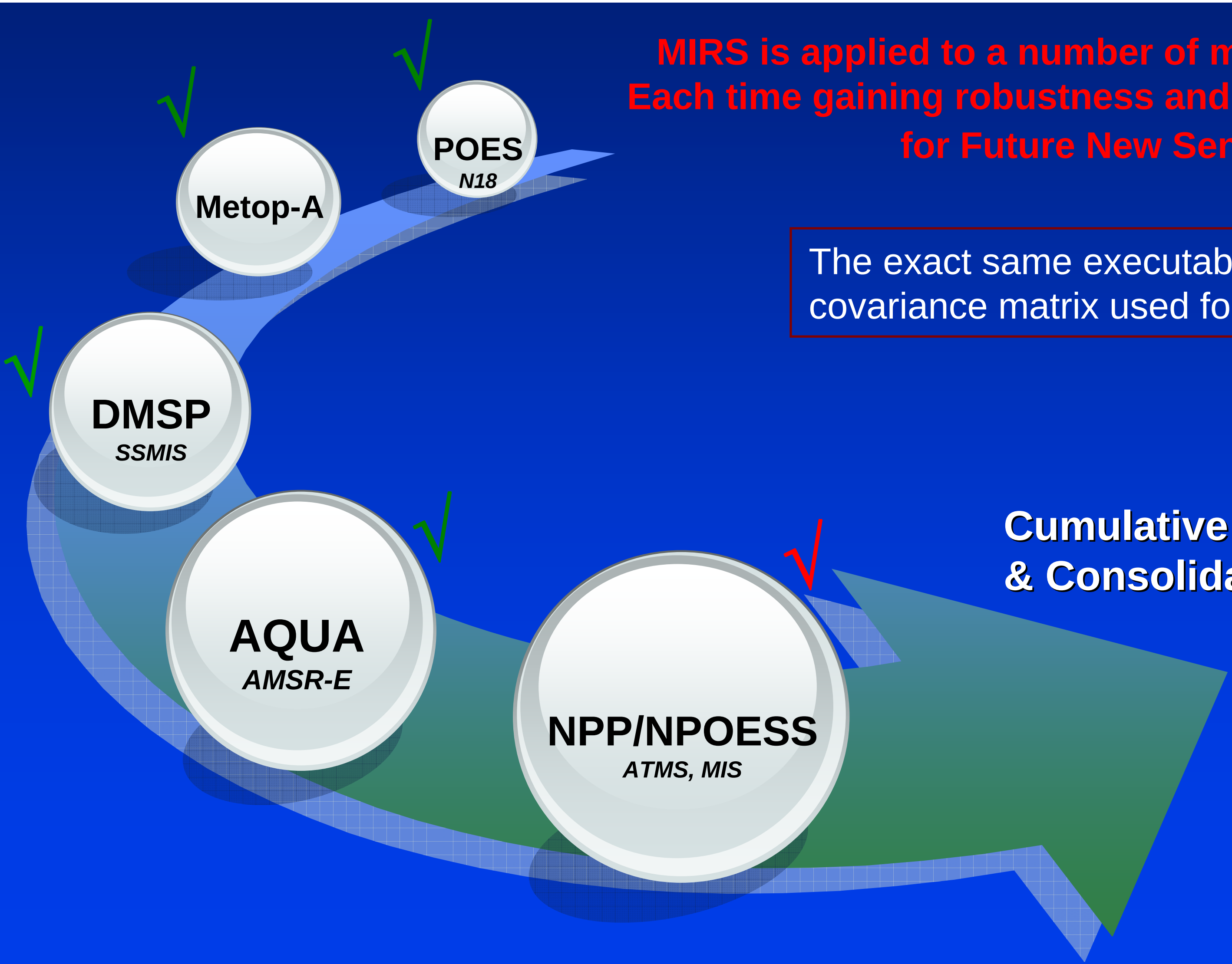
MIRS Timeline/History (4/4)

- MIRS is in Phase II for F16 products
- MIRS is in Phase III for N18/Metop-A products
- In the near future, MIRS will be tested/applied to NOAA-N’, F18 SSMIS and NPP/ATMS
- The focus of this SRR will be:
  - » Overview of MIRS readiness (for this release):
    - – Science performances
    - – IT system (this new release does not impact IT)
    - – Operational readiness
  - » Highlight of new products to become operational with this release of MIRS

Getting ready for NPP and NPOESS

MIRS is applied to a number of microwave sensors, Each time gaining robustness and improving validation for Future New Sensors

The exact same executable, forward operator, covariance matrix used for all sensors



√ **POES** *N18*

√ **Metop-A**

√ **DMSP** *SSMIS*

√ **AQUA** *AMSR-E*

√ **NPP/NPOESS** *ATMS, MIS*

Cumulative Validation & Consolidation of MIRS

√: Applied Daily

√: Applied occasionally

√: Tested in Simulation

Section 2 –

MIRS Description & Requirements

Presented by

Kevin Garrett (STAR Contractor)

MIRS Requirements

MIRS System Requirements can be divided into two categories

- Requirements to meet scientific (user) needs
- Requirements to meet needs of the system underpinnings

While MIRS is operational and baseline requirements have been met, we strive to extend beyond the requirements with each successive update to the algorithm package

MIRS System Requirements (Science)

- SPSRB and other Requirements
  - » Enhancement to MSPPS Day-2 Products
  - » Improvement to ITOVS System
  - » IJPS Product List
  - » NPOESS IORD-II
- Added value from MIRS *(in addition to meeting requirements):*
  - » Emissivity for all channels and for all surface types
  - » TPW extended over land, sea ice and snow areas
  - » Surface temperature extended to ocean, ice, snow
  - » Sounding in All-Weather Conditions
  - » Generic algorithm (can be applied to multiple sensors)

MIRS Description (Documentation)

- The MIRS is described in three documents (written by STAR):
  - **The User's Manual (UM)** outlines the hardware and software requirements, system directory structure, levels of user interaction, and product generation. http://mirs.nesdis.noaa.gov/download/MIRS_Users-Manual.pdf
  - **The System Description Document (SDD)** describes subsystem functions and capabilities, key interfaces, system input and output, procedures for the scheduling of operational jobs, and monitoring and maintenance procedures. http://mirs.nesdis.noaa.gov/download/MIRS_System_Discription_Document.pdf
  - **The Interface Control Document (ICD)** contains a detailed description of the MIRS input, intermediate, and output datasets including details on function, type, format, naming convention, and content.

    http://mirs.nesdis.noaa.gov/download/MIRS_Interface-Control-Document.pdf
- The MIRS is also described in operational documents (held by OSDPD): Operations Manual, System Maintenance Manual, Metadata Document.

MIRS Description (IT Requirements)

Hardware Requirements

	Minimum* # of CPUs	Minimum RAM	Min. Hard Disk Space	Platform Type
MIRS Requirements	1	1GB	3GB	Any

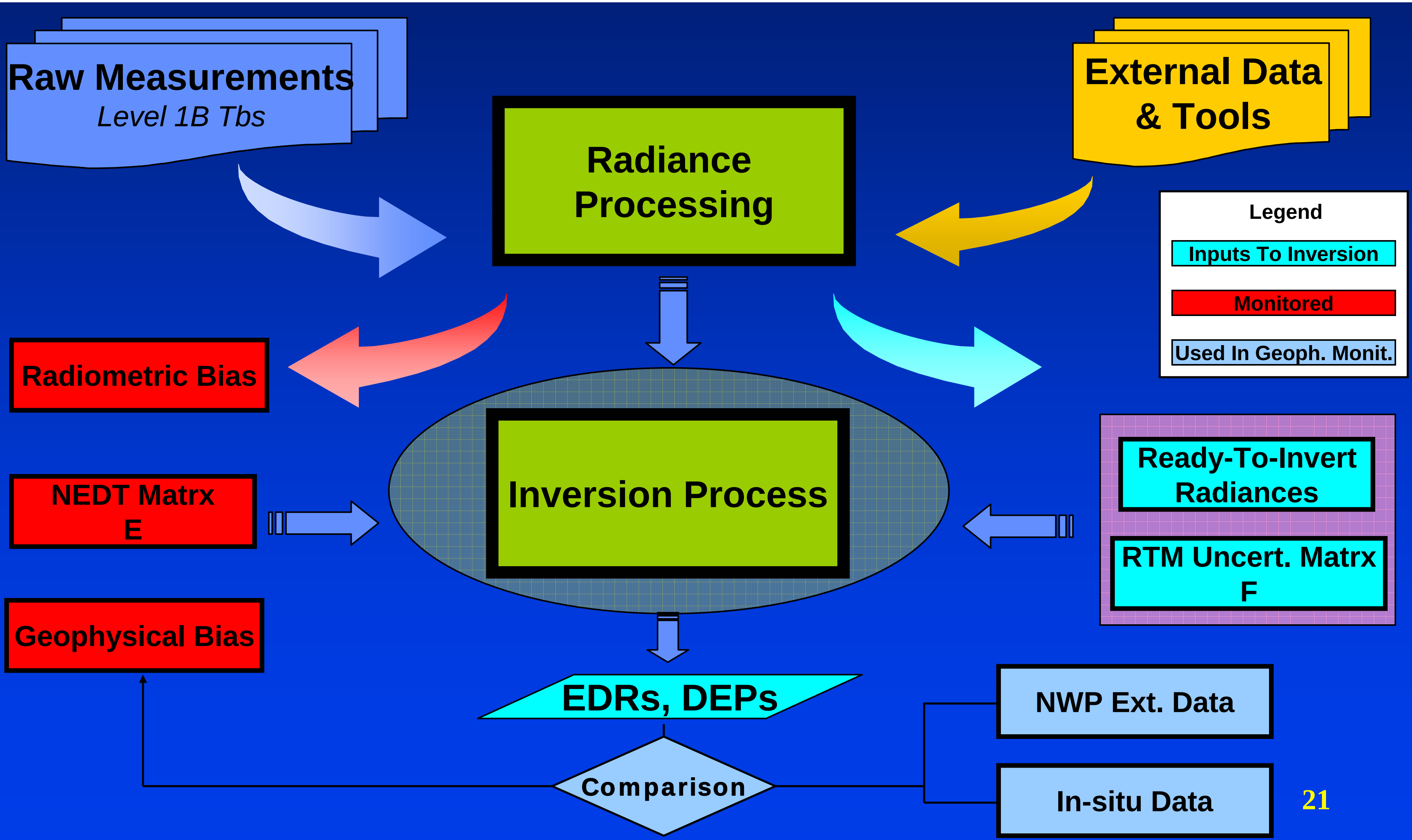
Software Requirements

Not necessary for producing the outputs

	Operating System	F95 Compiler	Commercial Software(s)	Freeware(s)
MIRS Requirements	Linux or IBM AIX	ifort or pgf95 or xlf95	IDL v5 and Up	BASH

**This is minimum required. Number of CPUs will affect the speed of execution. 14 CPUs are used in STAR to run three sensors daily.*

MIRS Description (Processing Flow 1/2)



Raw Measurements
Level 1B Tbs

External Data & Tools

Radiance Processing

Legend

Inputs To Inversion

Monitored

Used In Geoph. Monit.

Radiometric Bias

NEDT Matrx E

Inversion Process

Ready-To-Invert Radiances

RTM Uncert. Matrx F

Geophysical Bias

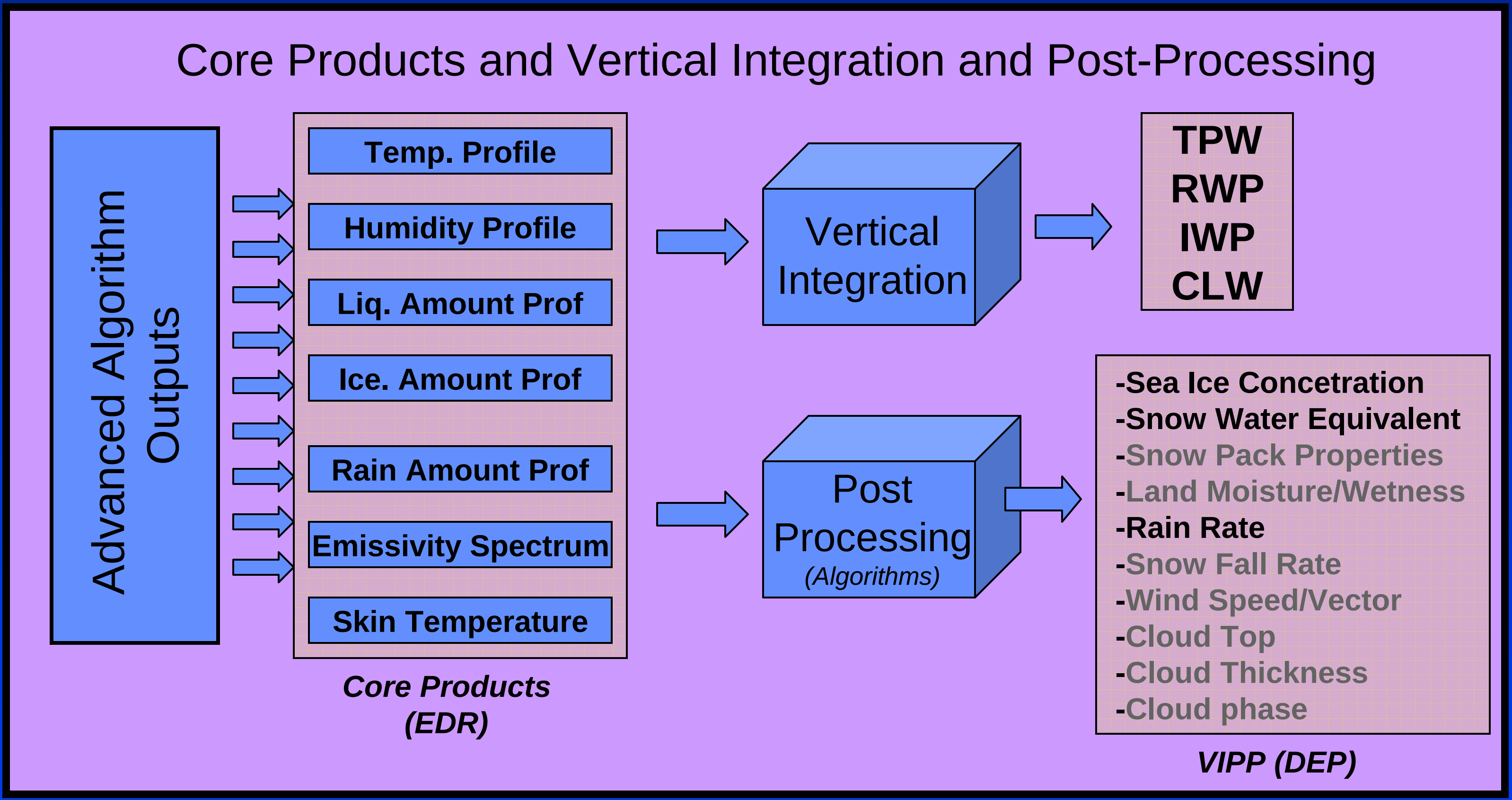
EDRs, DEPs

NWP Ext. Data

Comparison

In-situ Data

MIRS Description (Processing Flow 2/2)



Core Products and Vertical Integration and Post-Processing

Advanced Algorithm Outputs

- Temp. Profile
- Humidity Profile
- Liq. Amount Prof
- Ice. Amount Prof
- Rain Amount Prof
- Emissivity Spectrum
- Skin Temperature

Core Products (EDR)

Vertical Integration

TPW
RWP
IWP
CLW

Post Processing *(Algorithms)*

- **Sea Ice Concetration**
- **Snow Water Equivalent**
- **Snow Pack Properties**
- **Land Moisture/Wetness**
- **Rain Rate**
- **Snow Fall Rate**
- **Wind Speed/Vector**
- **Cloud Top**
- **Cloud Thickness**
- **Cloud phase**

VIPP (DEP)

MIRS Description (Processing Chain 1/2)

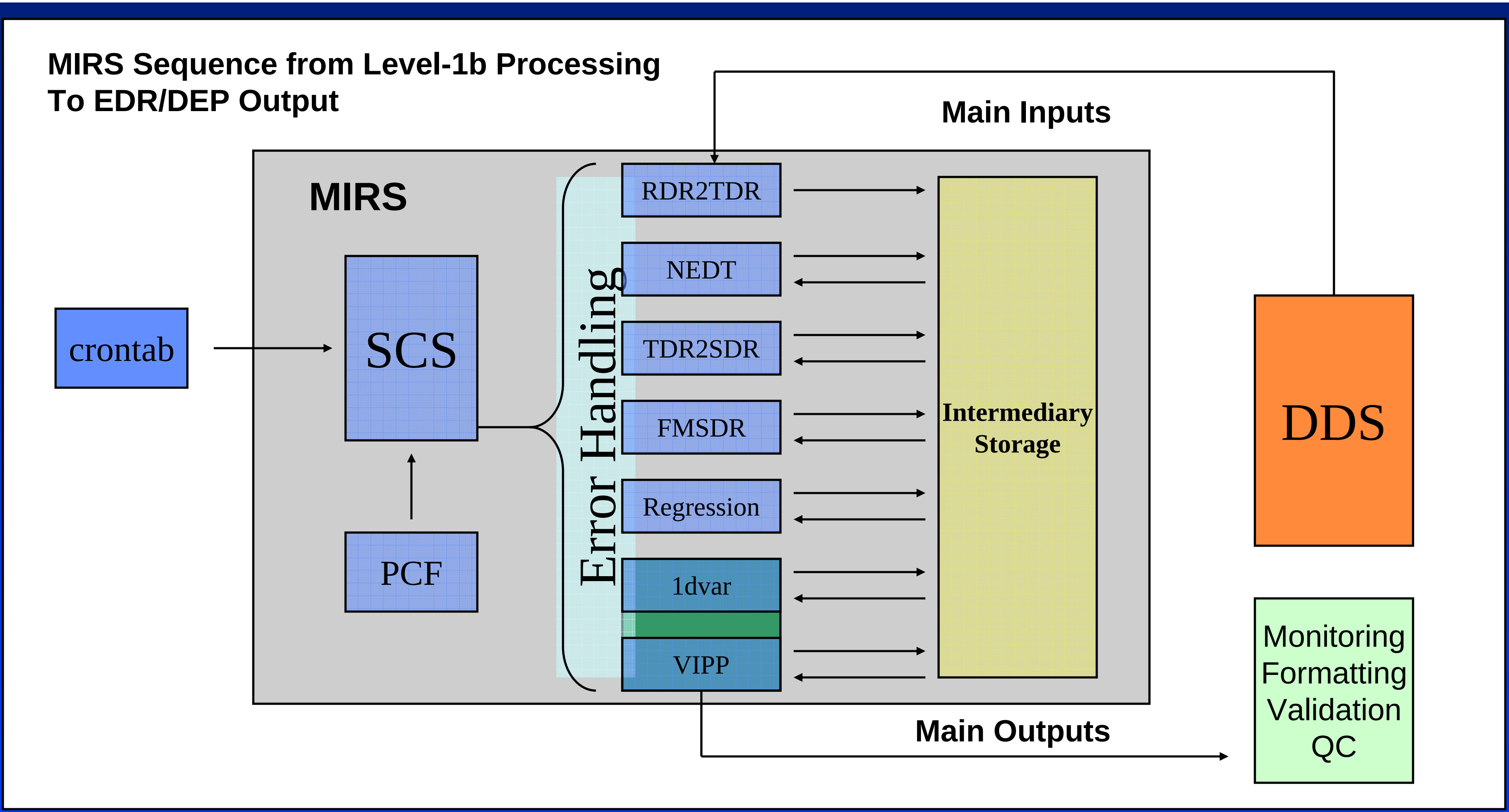
STEP	FUNCTION
RDR2TDR	convert RDR data to TDR data (**level-1b Input**)
NEDT	compute NEDT
TDR2SDR	convert TDR data to SDR data
FMSDR	perform footprint matching at desired resolution
NWP	ingest GDAS or ECMWF data and collocate
FWD	run NWP data through the forward model to produce TBs
Bias Generation	calculate bias between model TBs and measurements
Apply Regression	generate first-guess for retrieval
1DVAR	perform the retrieval (**generate EDR Output**)
VIPP	generate derived products (**generate DEP Output**)
gridData	grid EDR and DEP output
gridBias	grid difference between EDR/DEP and NWP parameters
Figures Generation	produce maps/figures of EDR/DEP
Bias Figures Generation	produce maps/figures of MIRS-NWP bias
NEDT Monitoring	produce figures to monitor NEDT trend
Cleaning	remove intermediate files, data, binaries, etc.

🟥 **Steps run in STAR environment only**

MIRS Description (Processing Chain 2/2)

- Each step is initiated by an associated function written in .bash, which generates the required namelist and calls the related Fortran or IDL program (IDL is not used in operations)
  - » A process control file (PCF) defines all variables for namelist input, and which steps should be executed
  - » A master sequence control script (SCS) reads the PCF and calls the desired script functions (with arguments) that ultimately execute the step (program)
- All namelists, SCS, PCF for all sensors are easily generated by the central GUI tool

MIRS Description (Processing Sequence)

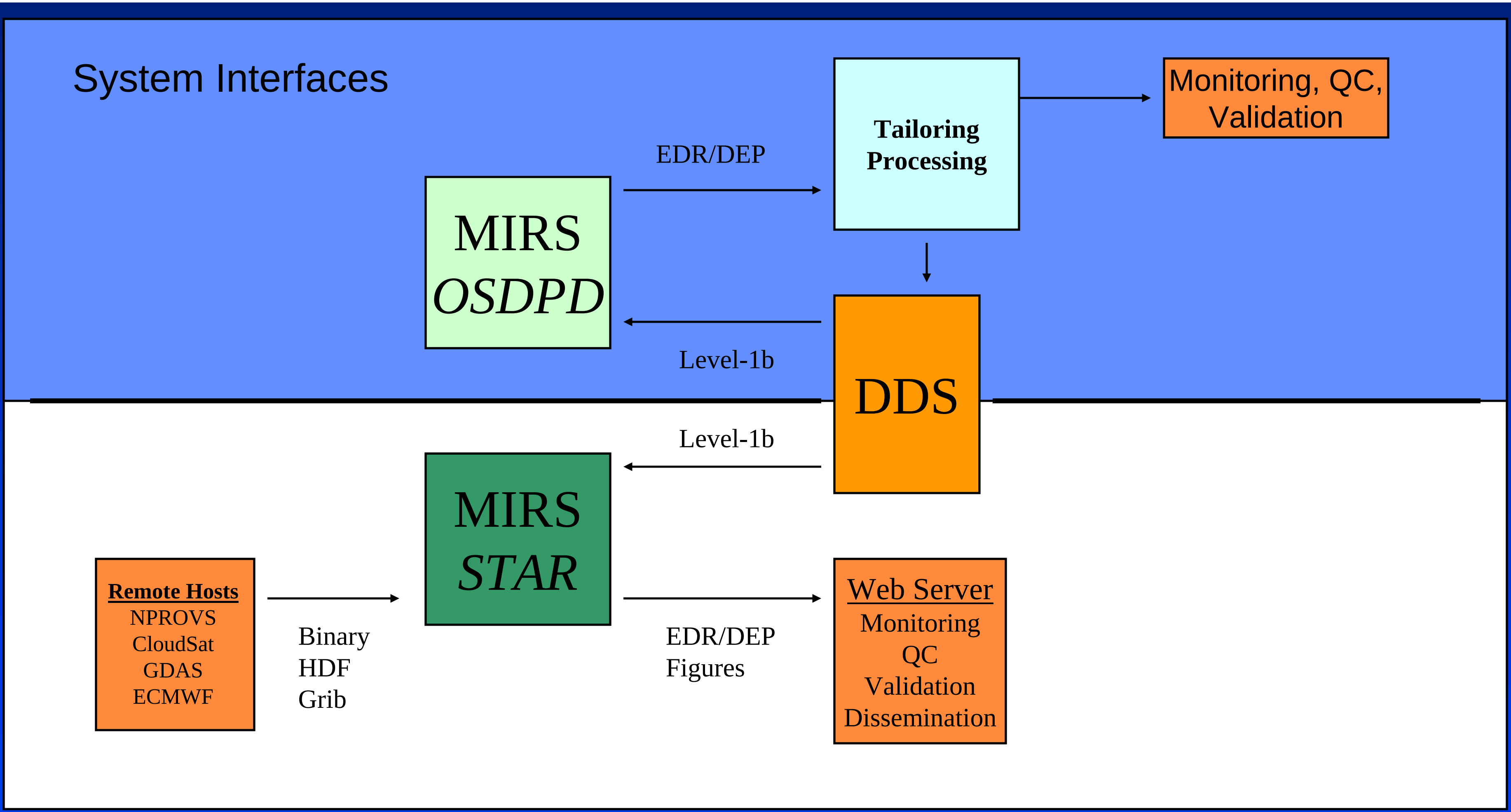


MIRS Description (Environments and Functions)

The MIRS is currently running in two environments in parallel

- Run in development/test mode at STAR for monitoring and performance assessment
  - » Data processed from level-1b to EDR/DEP
  - » EDR/DEP gridded
  - » NWP data used for radiometric/geophysical performance assessment
  - » Figures generated for science monitoring
  - » Automatic validation performed (comparison to GDAS, ECMWF, RAOBs, COSMIC, CLOUDSAT, Rain gauges, radars, AMSR-E, ATOVS, GFS)
- Run in pre-operational and operational modes at OSDPD, for operational production
  - » Data processed from level-1b to EDR/DEP
  - » Products are tailored to fit user’s need

MIRS Description (Flow Diagram)


System Interfaces

MIRS *OSDPD*

EDR/DEP

Tailoring Processing

Monitoring, QC, Validation

Level-1b

DDS

Level-1b

MIRS *STAR*

Remote Hosts
NPROVS
CloudSat
GDAS
ECMWF

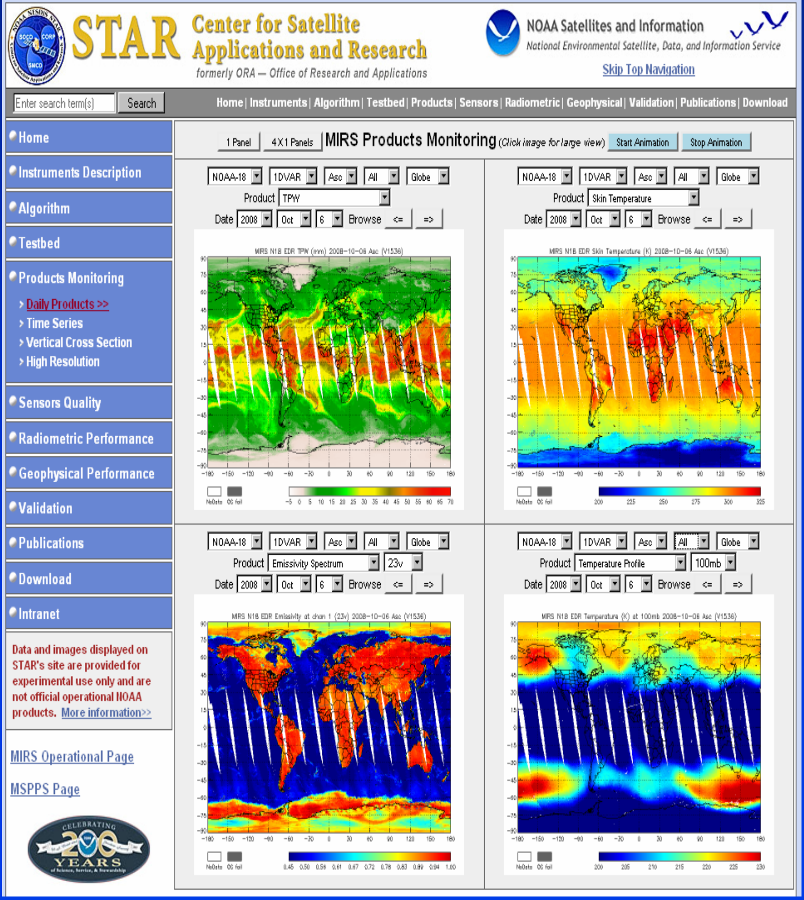
Binary
HDF
Grib

EDR/DEP
Figures

Web Server
Monitoring
QC
Validation
Dissemination

MIRS Description (Science Monitoring 1/4)

- Primary monitoring system is web-based on STAR web server: mirs.nesdis.noaa.gov
- Provides figures for
  - All retrieved/derived products including QC
    - Global and over specific regions (high-res.)
  - NEDT and footprint matching monitoring
  - TBs and radiometric bias monitoring
  - Product comparisons and validation
  - Documentations
  - Meetings minutes and slides



STAR Center for Satellite Applications and Research

formerly ORA — Office of Research and Applications

NOAA Satellites and Information

National Environmental Satellite, Data, and Information Service

MIRS Products Monitoring (Click image for large view)

NOAA-18, 1DVAR, Asc, All, Globe; Product: TPW; Date: 2008 Oct 6

MIRS N18 EDR TPW (mm) 2008-10-06 Asc (V1536)

NOAA-18, 1DVAR, Asc, All, Globe; Product: Skin Temperature; Date: 2008 Oct 6

MIRS N18 EDR Skin Temperature (K) 2008-10-06 Asc (V1536)

NOAA-18, 1DVAR, Asc, All, Globe; Product: Emissivity Spectrum, 23v; Date: 2008 Oct 6

MIRS N18 EDR Emissivity at chan 1 (23v) 2008-10-06 Asc (V1536)

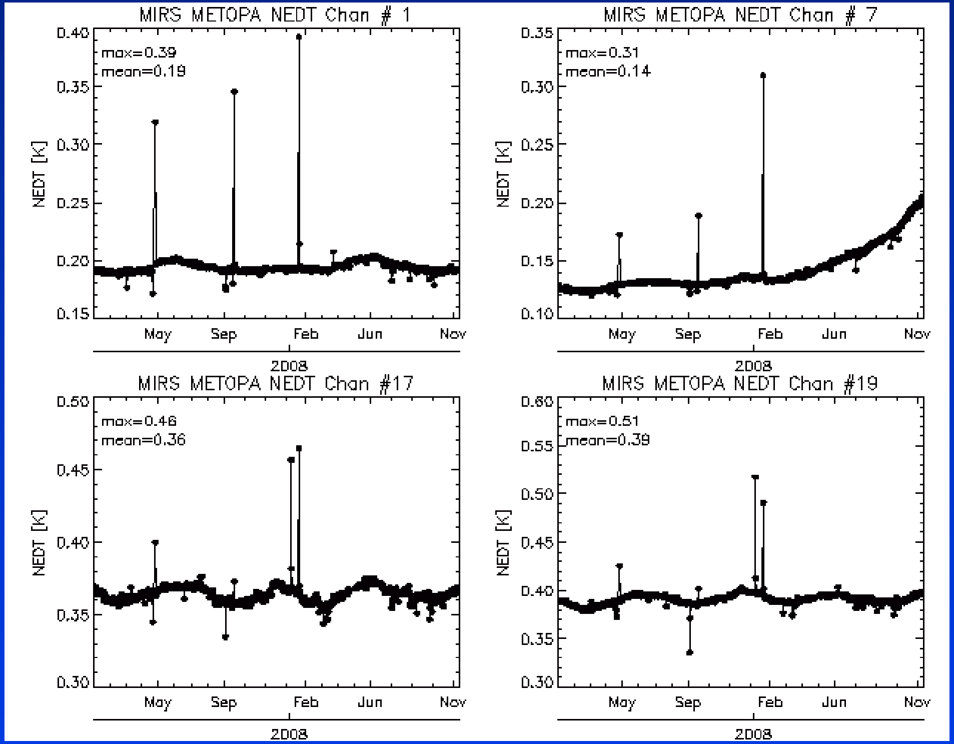
NOAA-18, 1DVAR, Asc, All, Globe; Product: Temperature Profile, 100mb; Date: 2008 Oct 6

MIRS N18 EDR Temperature (K) at 100mb 2008-10-06 Asc (V1536)

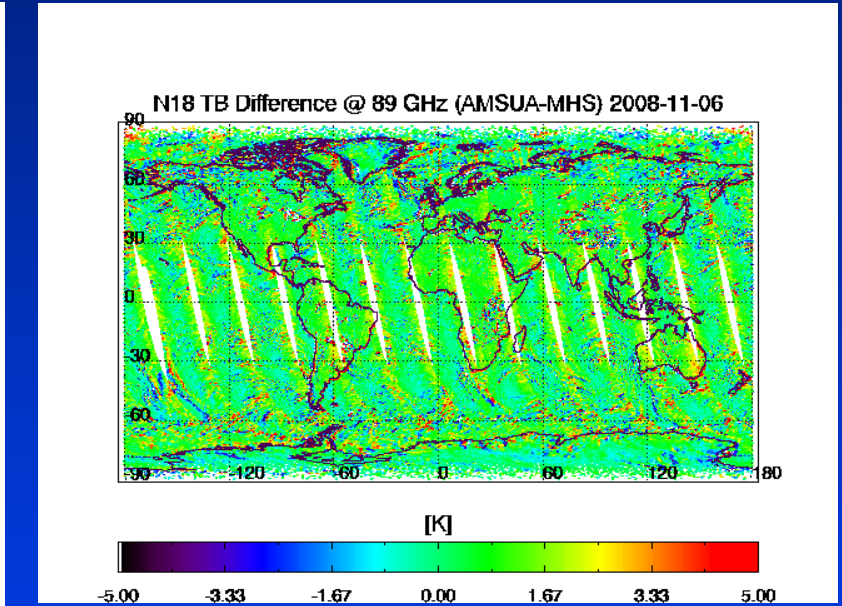
Data and images displayed on STAR's site are provided for experimental use only and are not official operational NOAA products. More information>>

MIRS Description
(Science Monitoring 2/4)

Radiometric monitoring and sensor quality

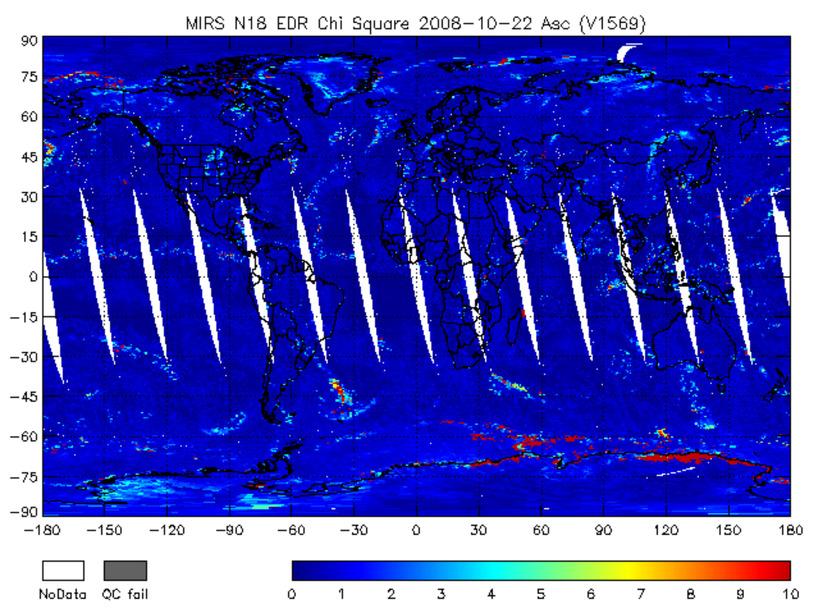


NEDT for MetopA AMSU-A Channels 1, 7 and MHS channels 17 and 19

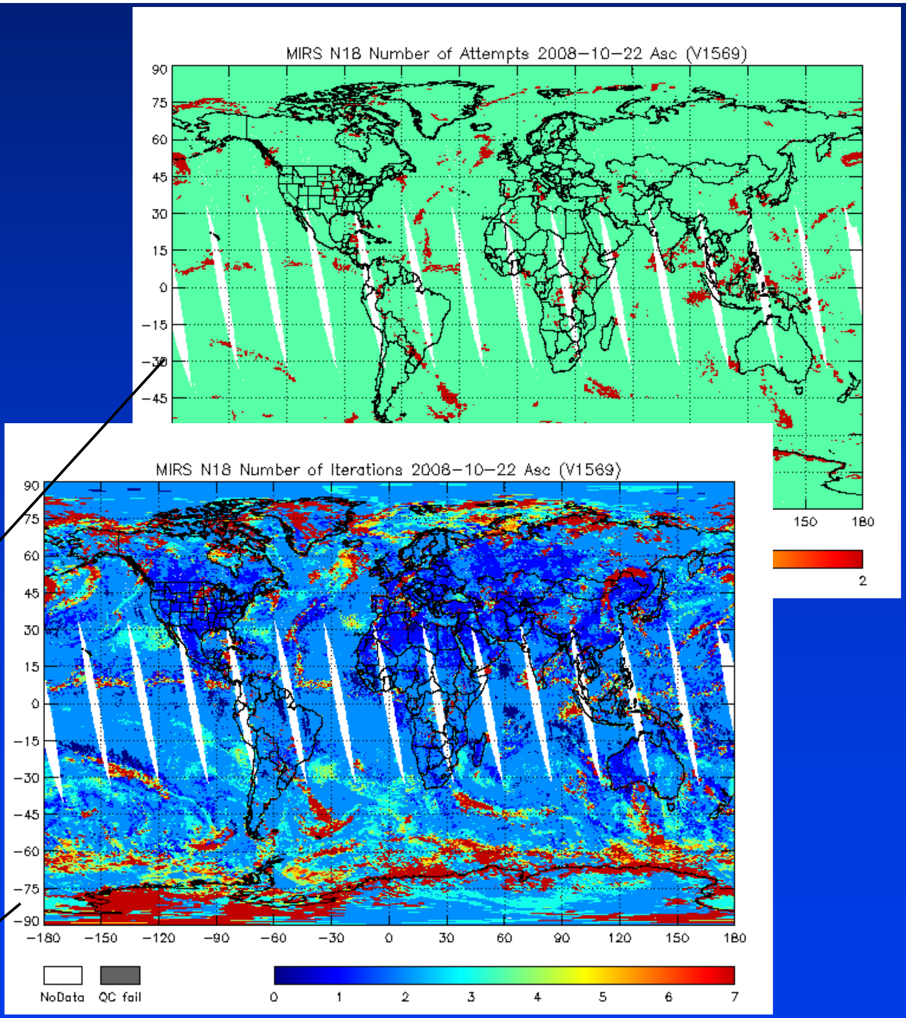


AMSUA-MHS 89 GHz After Footprint Matching

MIRS Description (Science Monitoring 3/4)



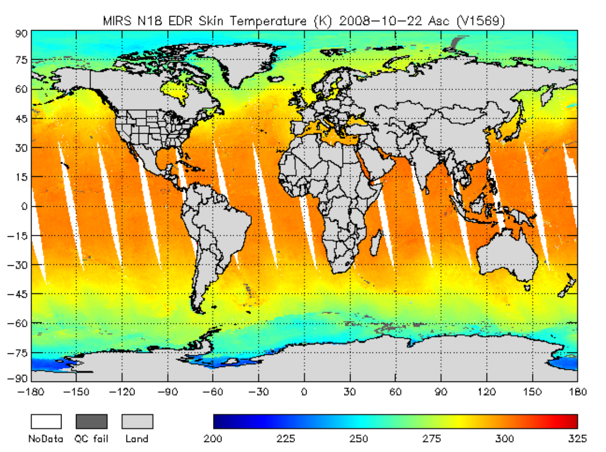
MIRS Convergence metric Chi-Sq



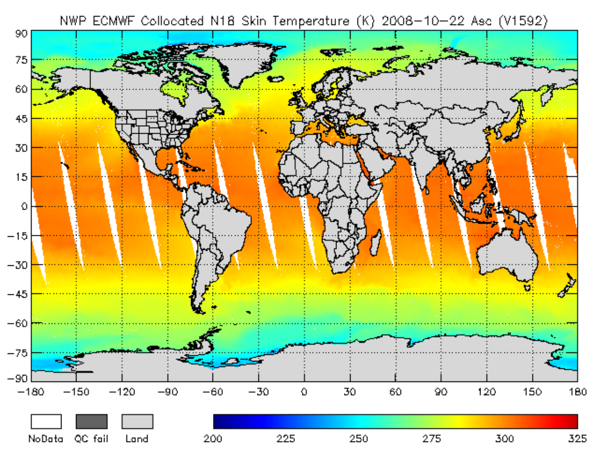
Number of Attempts (upper right)
Number of Iterations (lower right)

MIRS Description (Science Monitoring 4/4) –Example-

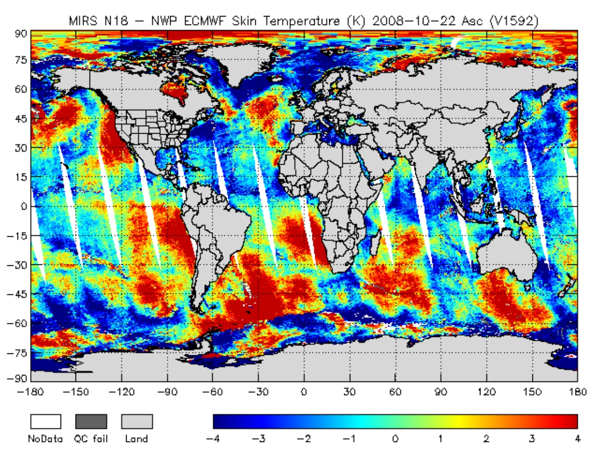
N18 MIRS TSKIN



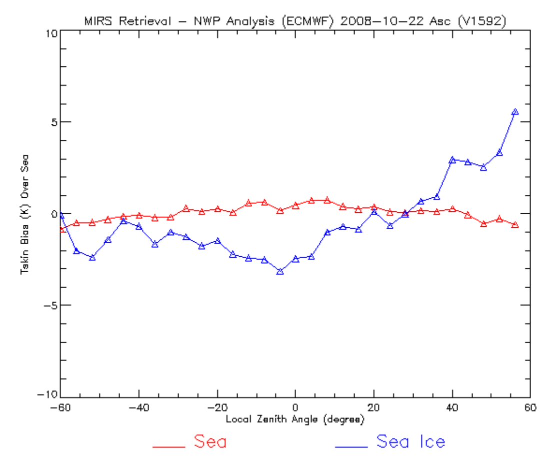
ECMWF TSKIN

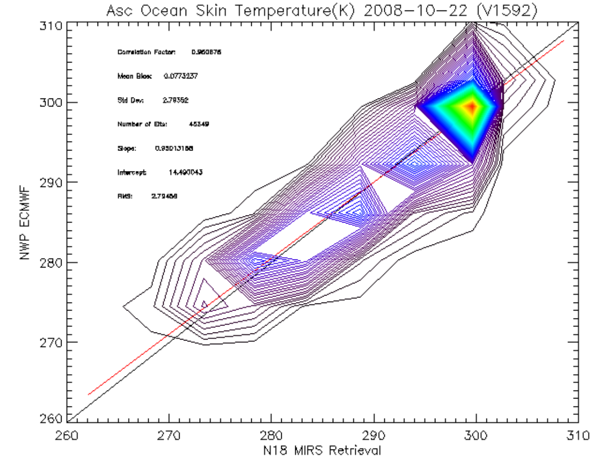


MIRS - ECMWF



Bias
Vs.
Scan Pos





ECMWF
Vs.
MIRS

MIRS Description (Summary)

- The MIRS is running operationally at OSDPD
- The MIRS is running daily in STAR environment
- Procedures for operation, monitoring (QC, Validation, Troubleshooting), and updating are in execution mode (operational)
- Each release of MIRS does not alter these procedures, but may extend these procedures (i.e. extension to other products/sensors)

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Section 3 –

System Operational Readiness

Presented by

Limin Zhao (OSDPD)

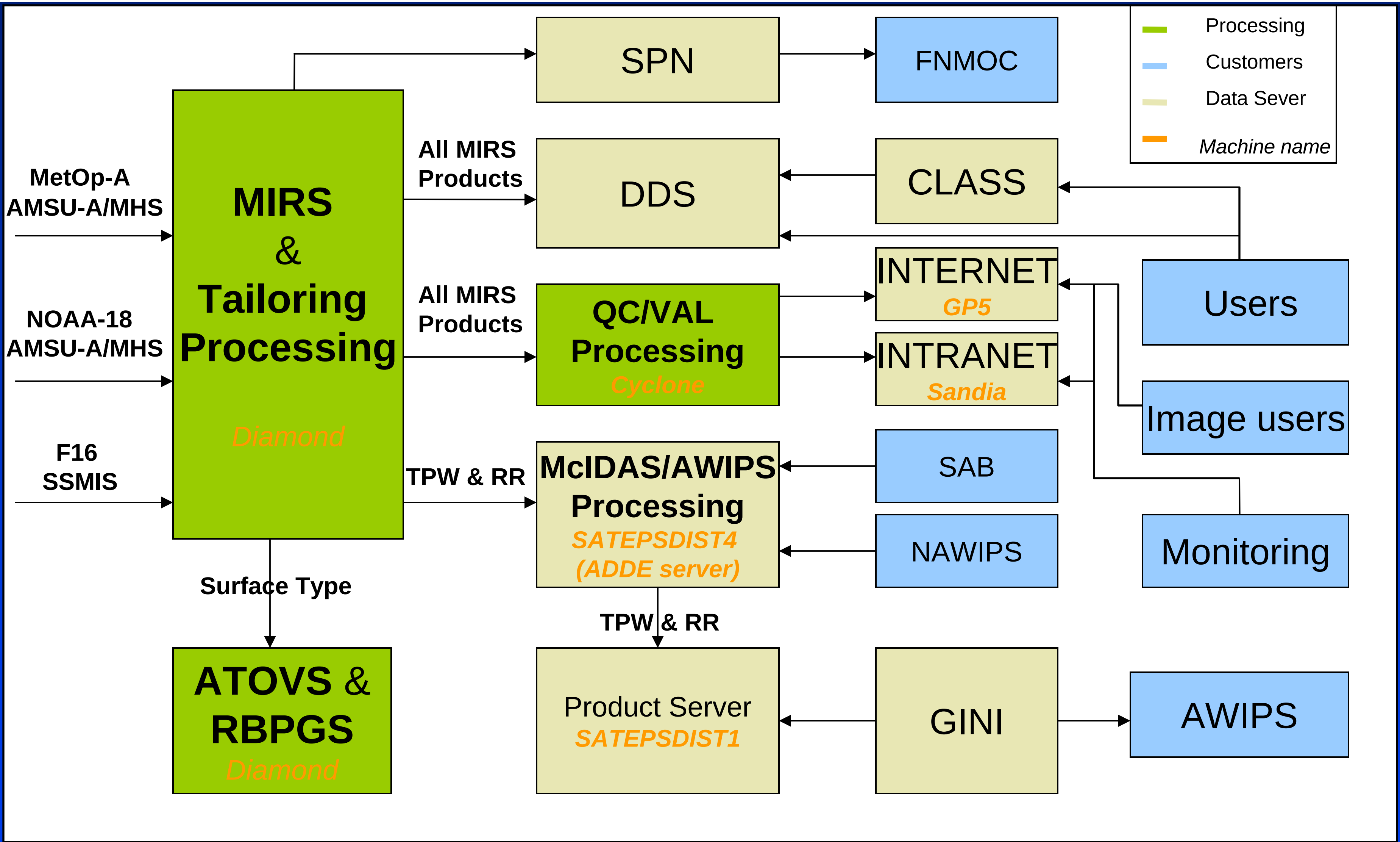
SYSTEM OPERATIONAL READINESS (General Status)

- The previous versions of MIRS have been tested and run in the ESPC operation at OSDPD
  - » The first version MIRS v1.0 was implemented into operation on August 30, 2007
  - » The latest version MIRS v3.0 was implemented into operation on Oct 27, 2008

- The MIRS operational team has been working with the development team to ensure that the MIRS follows the ESPC operational requirements/guidance
  - » Directory structures
  - » File/directory naming conventions
  - » Operational log file content
  - » Error tracking and handling

- For any errors/unexpected result caughted in the real-time data flows, the MIRS operational and development teams have worked together to develop and implement the appropriate remedies. i.e.,
  - » Added the capability for detecting and handling of the unsynchronized AMSU-A and MHS data
  - » Improved approaches to deal with bad and/or missing scanlines

SYSTEM OPERATIONAL READINESS
(IT Architecture and Data Flow)



🟩 Processing
🟦 Customers
🟨 Data Sever
🟧 *Machine name*

MetOp-A AMSU-A/MHS

NOAA-18 AMSU-A/MHS

F16 SSMIS

MIRS & Tailoring Processing
Diamond

All MIRS Products

All MIRS Products

TPW & RR

SPN

FNMOC

DDS

CLASS

QC/VAL Processing
Cyclone

INTERNET
GP5

INTRANET
Sandia

Users

Image users

McIDAS/AWIPS Processing
SATEPSDIST4 (ADDE server)

SAB

NAWIPS

Monitoring

Surface Type

ATOVS & RBPGS
Diamond

TPW & RR

Product Server
SATEPSDIST1

GINI

AWIPS

SYSTEM OPERATIONAL READINESS (MIRS/MSPPS Users)

User	POCs	Products	Dissemination
CLASS	Constantino Cremidis	T(z), q(z), TPW, CLW, SIC, Snow Cover, SWE, IWP, RWP, Rain Rate, LST, LSE, surface type	ESPC data Distribution Sever
CPC	Pingping Xie Robert Joyce	Rain Rate	ESPC data Distribution Sever
FNMOC	Yiping Wang James Vermeulen	Rain Rate	Shared Processing Network (SPN)
NRL	Joe Turk	Rain Rate	DDS
NASA	George Huffman	Rain Rate	DDS
CIRA	Stan Kidder Andy Jones	TPW, Rain Rate and LSE	DDS

SYSTEM OPERATIONAL READINESS
(MIRS/MSPPS Users)

User	POCs	Products	Dissemination
STAR	Tony Reale	T(z) and q(z)	DDS
NCEP	John Derber, Banghua Yan, Min-Jeong Kim	T(z), q(z), CLW, IWP, LSE, TPW, RWP	DDS
NESDIS/SAB	Sheldon Kusselson	TPW, Rain Rate, CLW and Sea Ice, T(z), q(z)	ADDE server
NWS/NAWIPS	Paula Freeman	TPW	ADDE server
NWS/SPC	Steven J Weiss	TPW, T(z), q(z)	ADDE server and GINI/AWIPS
NWS/WFOs	Andy Edman	TPW, RR	GINI/AWIPS
NESDIS/TRaP	Matthew Seybold Michael Turk	Rain Rate	ESPC internal

SYSTEM OPERATIONAL READINESS (MIRS/MSPPS Users)

User	POCs	Products	Dissemination
NESDIS/ATOVS and RBPGS	Awdhesh Sharma Hanjun Ding	surface type	ESPC internal
NIC	Sean Helfrich	SWE, Sea Ice Concentration, Snowfall rate	DDS
NCEP/EMC	Kenneth Mitchell	SWE	IMS
CMA, JMA, MSC, CNRS, RAS, IRSA, Peking University, NASA/GPL, etc.	Peiming Dong, Kozo Okamoto, Peter Wang, U. Jaya Prakash Raju, Marina Engel, Yingying Chen, Xiaoyang Liu, etc.	The MIRS retrieval package	STAR - MIRS user agreement
Non operational users	N/A	N/A	CLASS

SYSTEM OPERATIONAL READINESS
(Documentation)

- OM and SMM are developed to support O&M needs at OSDPD, which include:
  - » Procedures for installation and build
  - » Run procedures (includes normal and special (emergency) operations)
  - » Input, output, and intermediate file specifications
  - » Monitoring, diagnosis, and recovery procedures
  - » Product distribution procedures
  - » Interpretation of error messages
  - » System shutdown and startup procedures
  - » Backup Procedures

- *Metadata is developed jointly with NGDC (Anna Milan) for the MIRS products*

- Other three documents: ICD, UM, SSD, are from STAR and have been updated to reflect the changes in the ESPC operational environment.

- All these five documents are being updated to reflect the changes in each delivery.

SYSTEM OPERATIONAL READINESS (Monitoring)

- Multi-level monitoring tools are set-up and used at the ESPC operation, including:
  - » Operators' monitoring of the job flow and processing status through OPUS GUI interface under 24/7
  - » Automated email notification for product generation and distribution anomalies
  - » Web-based monitoring of the products generation, timeliness and distribution status (http://www.ssd.noaa.gov/PS/TROP/MIRS/MIRS_monitor.html)
  - » Web-based imagery QC monitoring (http://www.osdpd.noaa.gov/PSB/mirs/mirs.html)

SYSTEM OPERATIONAL READINESS (Archive)

- A Data Submission Agreement was developed with CLASS and OSDPD: Producer Archive Submission Agreement for MIRS Products (NESDIS/OSDPD/CLASS, updated 2008):
  - Content (Products and Metadata)
  - Data formats
  - Size requirements
  - Name structure and convention
  - Search requirements
  - Frequency of transfer
  - Product quality information
  - Server and protocol of transfer (ftp pull to CLASS from DDS)
  - Technical/management points of contact for all stakeholders

SYSTEM OPERATIONAL READINESS (Operation and Maintenance)

- MIRS is supported under the ESPC operation
  - » The production machines are maintained by the ESPC IT team under 24/7
  - » OM and SMM are in place to support O&M needs
  - » Aiwu Li and Jiang Zhao are identified as the primary and backup maintenance personnel to cover normal maintenance needs
  - » The ESPC CM procedures are followed for any codes and documents changes
  - » Multi-level monitoring capability is in place as shown in the previous slide
  - » The PAL will work with STAR MIRS scientists for any science maintenance needs when identified
- Emergency Recovery Capability
  - » MIRS is set-up on the CIP (Critical Infrastructure Protection) facility
  - » Any promotions and changes in the ESPC operation will be being made in the CIP at the same time
  - » MIRS products can be continued in the event of an unexpected and sustained loss of service at the NSOF ESPC

SYSTEM OPERATIONAL READINESS
(Next Release)

- The MIRS operational team will test and implement the MIRS v4.0 into operation following the established rules and procedures.
  - November 15, 2008 – *pre-release*
  - December 15, 2008 – *official release*

1. INTRODUCTION
2. MIRS DESCRIPTION & REQUIREMENTS
3. SYSTEM OPERATIONAL READINESS
4. **NEW PRODUCTS FOR THIS RELEASE**

▪ **Rainfall Rate**	**Flavio Iturbide-Sanchez**
▪ **Sea Ice Concentration**	**Chris Grassotti**
▪ **Snow Water Equivalent**	**Cezar Kongoli**
▪ **Core Products/Cloud Liquid Water**	**Kevin Garrett**

5. MIRS CODE UNIT REVIEW
6. RISKS AND ACTIONS
7. SUMMARY AND CONCLUSIONS

Section 4 –

New Products for this Release

Presented by

Flavio Iturbide-Sanchez (STAR Contractor)
Cezar Kongoli (STAR Contractor)
Chris Grassotti (STAR Contractor)
Kevin Garrett (STAR Contractor)

List of New Products

- N18 and Metop-A (AMSUA/MHS)
    - » Rainfall Rate (mm/hr)

- F16 (SSMI/S)
    - » Sea-Ice Concentration (%)
    - » Snow-Water Equivalent (cm)
    - » Snow Cover Extent
    - » Extending F16 Total Precipitable Water (mm) over non-Ocean
    - » Integrated Cloud Liquid Water (mm) over Ocean

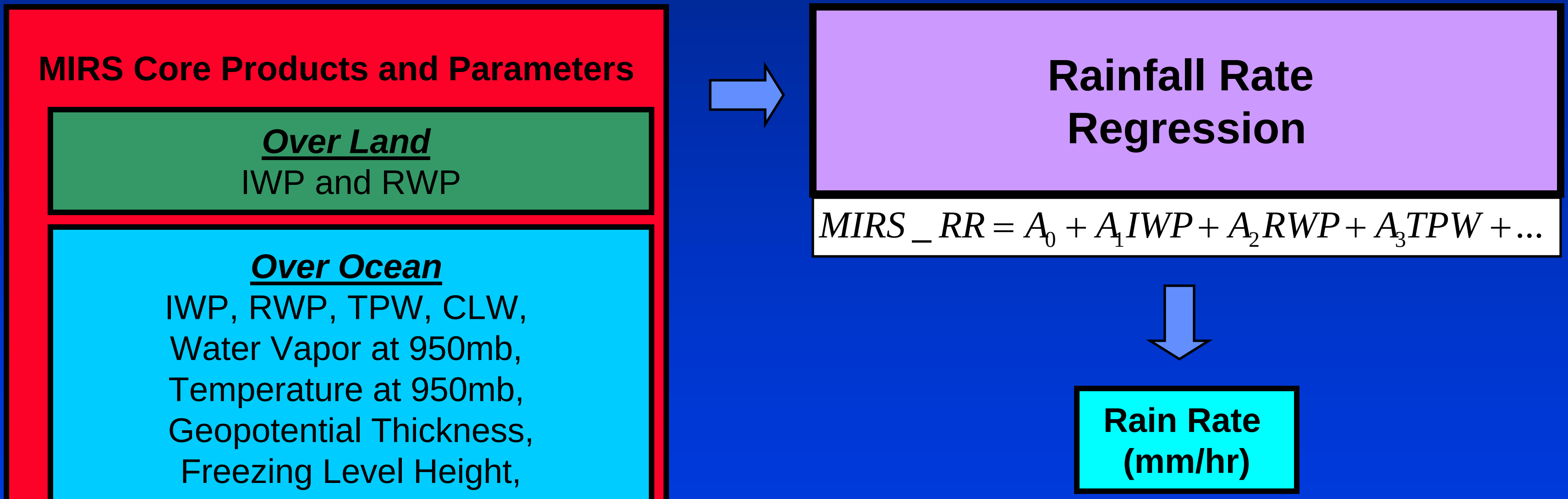
- Core Product Updates
    - » First-Guess retrieval

N18/Metop-A Rainfall rate

Flavio Iturbide-Sanchez (STAR Contractor)

N18/Metop-A Rainfall Rate (Algorithm Description)

The MIRS Rain Rate computation is *sensor independent* and based on the MIRS core products. It uses the MIRS core products that have shown the highest correlation with a well- known reference rain rates (MSPPS Rain rate in this phase).



MIRS Core Products and Parameters

Over Land
IWP and RWP

Over Ocean
IWP, RWP, TPW, CLW,
Water Vapor at 950mb,
Temperature at 950mb,
Geopotential Thickness,
Freezing Level Height,
Skin Temperature

Rainfall Rate Regression

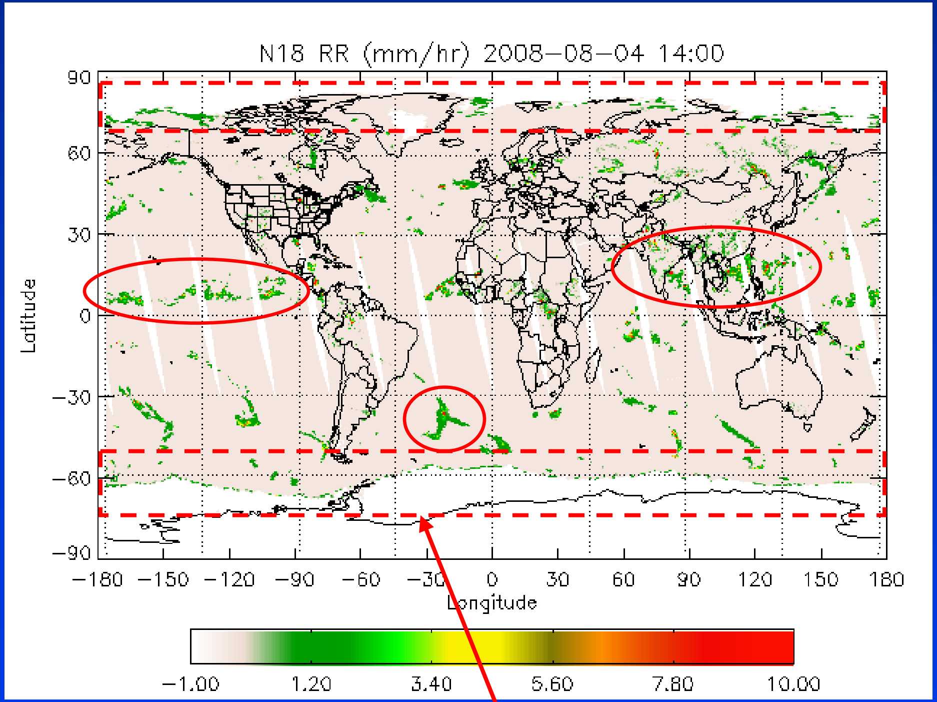
$$MIRS\_RR = A_0 + A_1 IWP + A_2 RWP + A_3 TPW + \ldots$$

Rain Rate (mm/hr)

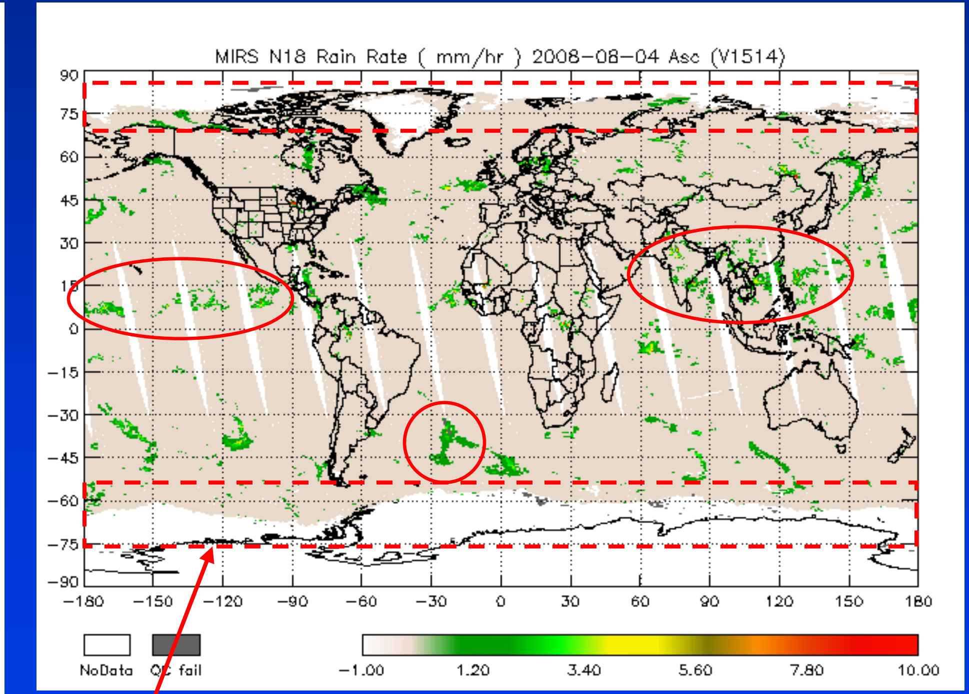
A_i are coefficients generated by a multi-linear regression approach using the MIRS products and a reference rain rate.

Rainfall Rate (N18)

Operational MSPPS
RR (mm/hr)



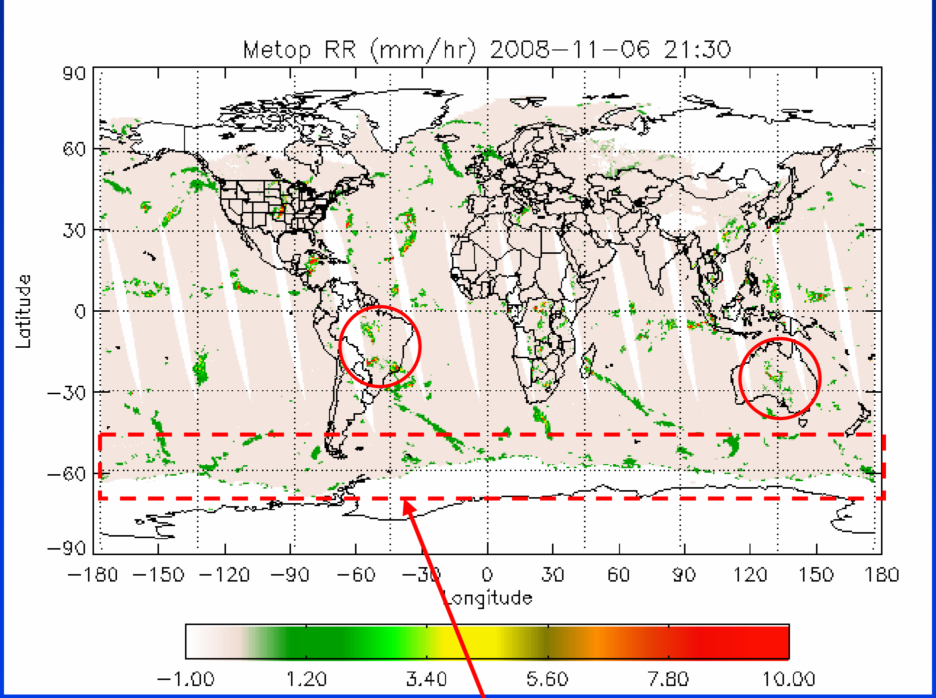
MIRS N18
RR (mm/hr)



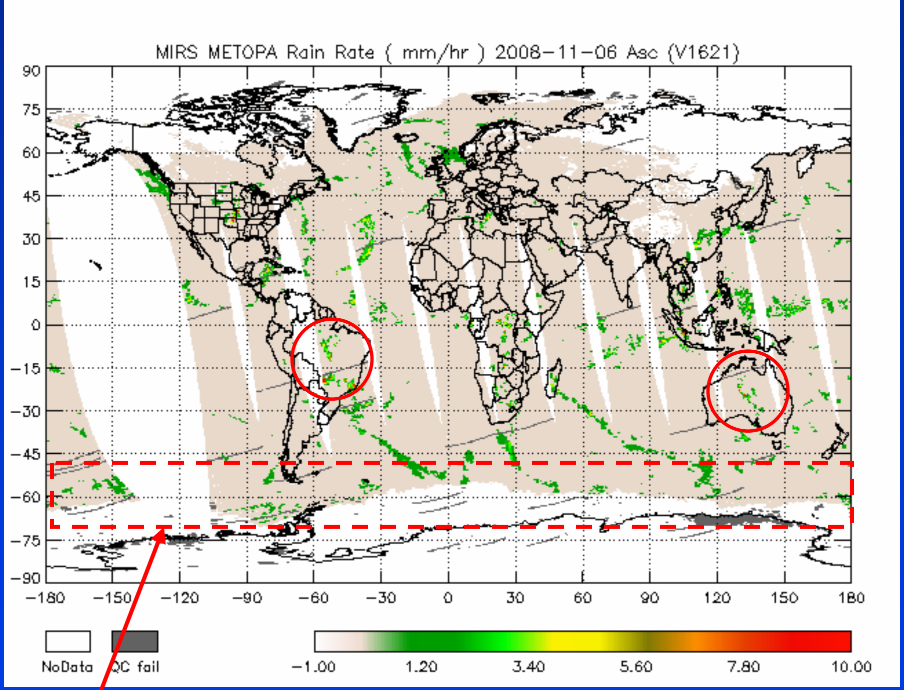
Reduction in coastal false alarms

Rainfall Rate (Metop-A)

Operational MSPPS
RR (mm/hr)



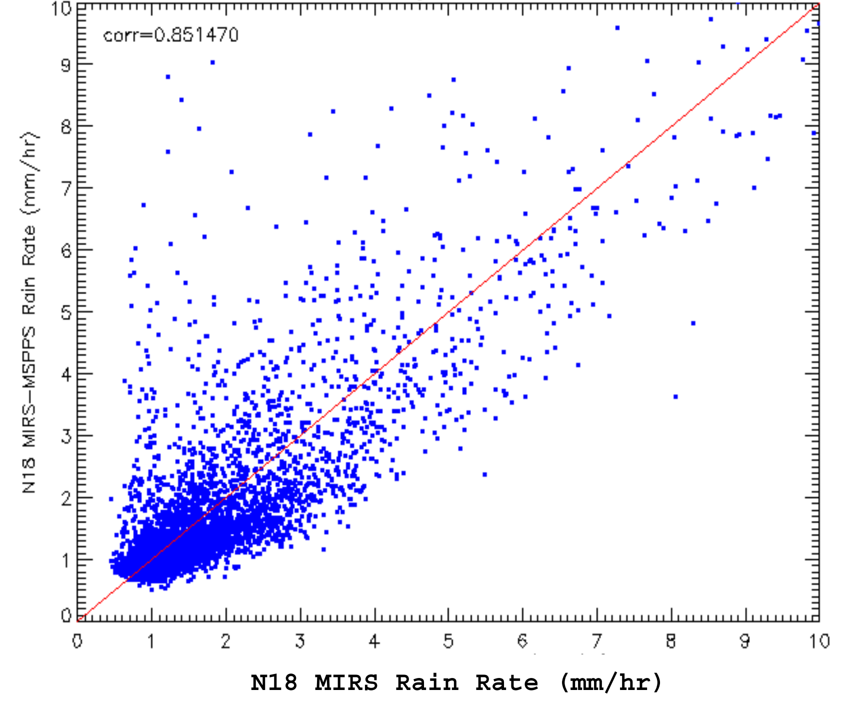
MIRS Metop-A
RR (mm/hr)



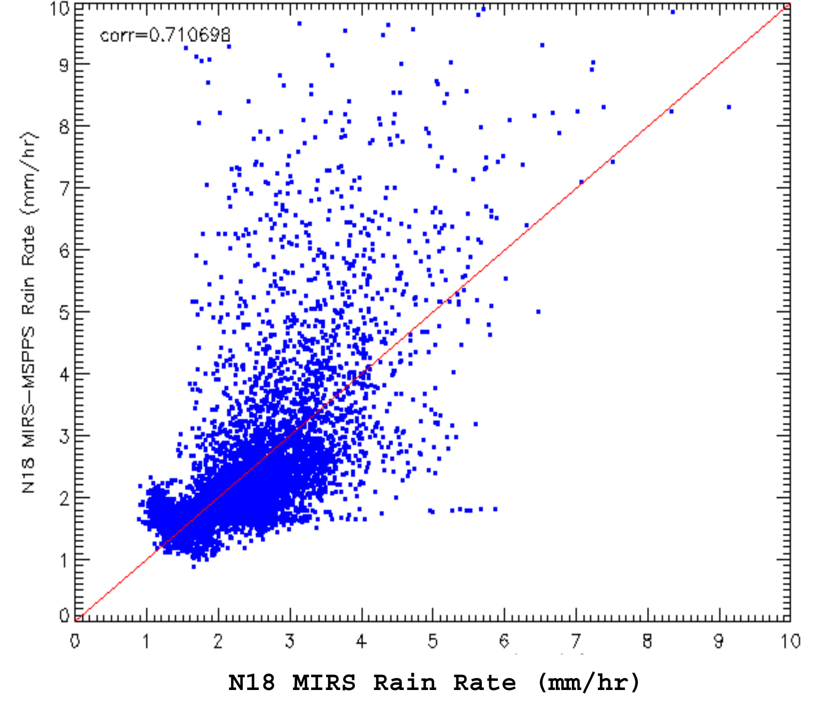
Reduction in coastal false alarms

Rainfall Rate Comparisons (MSPPS vs MIRS)

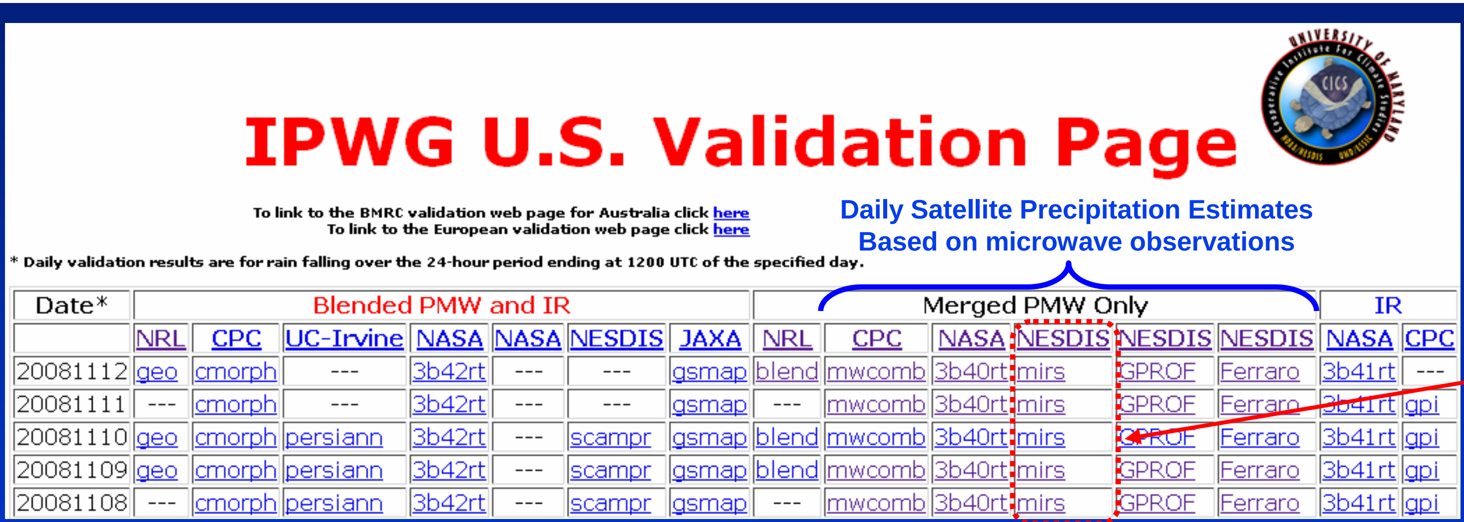
MSPPS vs MIRS N18
Land



MSPPS vs MIRS N18
Ocean



Satellite Rainfall Rate Comparisons (Leverage of International Precipitation Working Group (IPWG) assessment system)



IPWG U.S. Validation Page

To link to the BMRC validation web page for Australia click here
To link to the European validation web page click here

* Daily validation results are for rain falling over the 24-hour period ending at 1200 UTC of the specified day.

Daily Satellite Precipitation Estimates Based on microwave observations

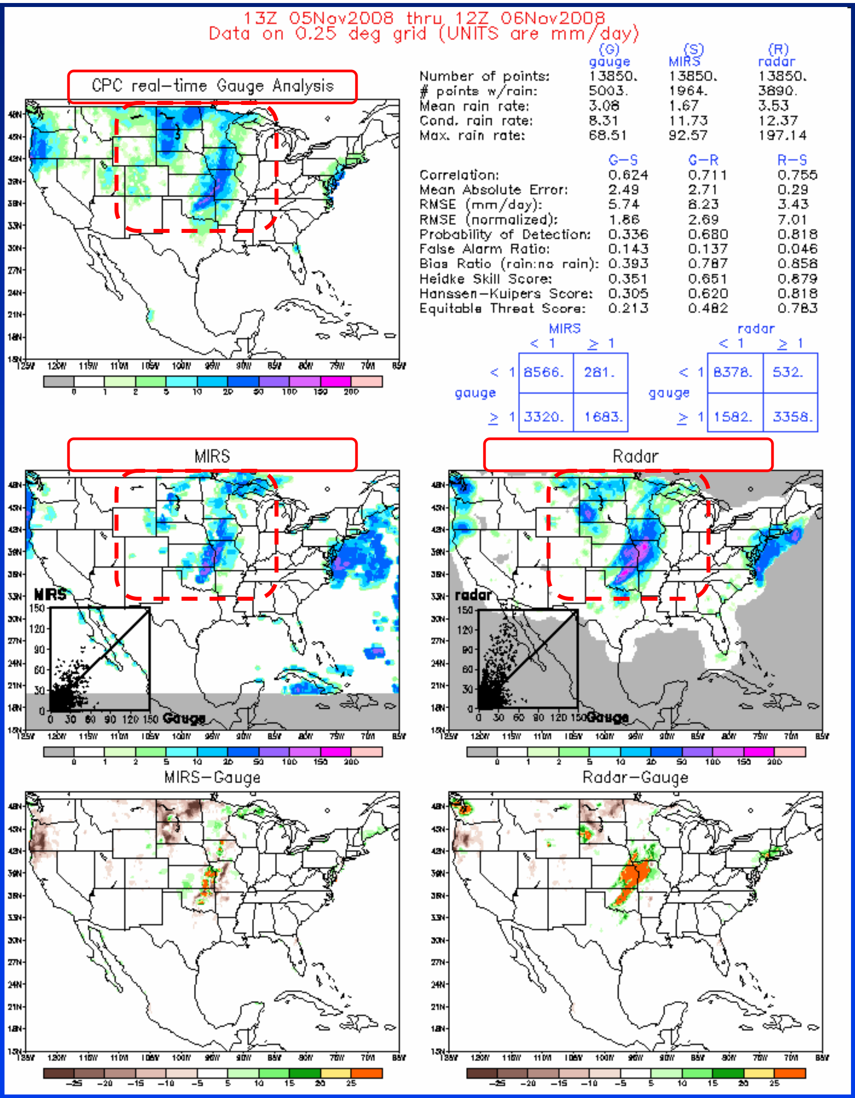
Date*	Blended PMW and IR							Merged PMW Only						IR	
	NRL	CPC	UC-Irvine	NASA	NASA	NESDIS	JAXA	NRL	CPC	NASA	NESDIS	NESDIS	NESDIS	NASA	CPC
20081112	geo	cmorph	---	3b42rt	---	---	gsmap	blend	mwcomb	3b40rt	mirs	GPROF	Ferraro	3b41rt	---
20081111	---	cmorph	---	3b42rt	---	---	gsmap	---	mwcomb	3b40rt	mirs	GPROF	Ferraro	3b41rt	gpi
20081110	geo	cmorph	persiann	3b42rt	---	scampr	gsmap	blend	mwcomb	3b40rt	mirs	GPROF	Ferraro	3b41rt	gpi
20081109	geo	cmorph	persiann	3b42rt	---	scampr	gsmap	blend	mwcomb	3b40rt	mirs	GPROF	Ferraro	3b41rt	gpi
20081108	---	cmorph	persiann	3b42rt	---	scampr	gsmap	---	mwcomb	3b40rt	mirs	GPROF	Ferraro	3b41rt	gpi

MIRS Precipitation Estimate at the IPWG project

An overview of the Precipitation Estimate algorithms compared to Rain Gauge and Radar precipitation estimates (mm/day) over U.S. at the IPWG

Satellite Precipitation Estimate Algorithm	Responsible Organization	No. of Suites	Satellites/Instruments	Description
MIRS	NOAA/NESDIS/STAR	2	NOAA-18 and Metop-A (AMSU-A and MHS)	Sensor independent algorithm.
3B40RT	NASA	4	TRMM (TMI), F13, F14 and F15 (SSM/I)	Provides a merger of all available SSM/I and TMI microwave precipitation estimates into a high-quality estimate.
MWCOMB	CPC	8	TRMM (TMI), F13, 14, 15 (SSM/I), NOAA-15, 16, 17 (AMSU-B) and 18 (MHS)	Precipitation estimates are daily composites of precipitation estimates from SSM/I, AMSU-B and TMI.
NESDIS-GPROF	NESDIS	3	F13 , 14, 15 (SSM/I)	Based on the Goddard profiling algorithm.
NESDIS-FERRARO	NOAA/NESDIS/STAR	3	F13 , 14, 15 (SSM/I)	Precipitation estimates are daily composites of precipitation estimates from SSM/I.

Rainfall Rate Comparisons (Leverage of IPWG assessment system)



13Z 05Nov2008 thru 12Z 06Nov2008
Data on 0.25 deg grid (UNITS are mm/day)

	(G) gauge	(S) MIRS	(R) radar
Number of points:	13850.	13850.	13850.
# points w/rain:	5003.	1964.	3890.
Mean rain rate:	3.08	1.67	3.53
Cond. rain rate:	8.31	11.73	12.37
Max. rain rate:	68.51	92.57	197.14

	G−S	G−R	R−S
Correlation:	0.624	0.711	0.755
Mean Absolute Error:	2.49	2.71	0.29
RMSE (mm/day):	5.74	8.23	3.43
RMSE (normalized):	1.86	2.69	7.01
Probability of Detection:	0.336	0.680	0.818
False Alarm Ratio:	0.143	0.137	0.046
Bias Ratio (rain:no rain):	0.393	0.787	0.858
Heidke Skill Score:	0.351	0.651	0.879
Hanssen−Kuipers Score:	0.305	0.620	0.818
Equitable Threat Score:	0.213	0.482	0.783

		MIRS	
		< 1	≥ 1
gauge	< 1	8566.	281.
	≥ 1	3320.	1683.

		radar	
		< 1	≥ 1
gauge	< 1	8378.	532.
	≥ 1	1582.	3358.

MIRS Precipitation Estimate vs Rain Gauge data and Radar observations over U.S. from IPWG project
Nov. 5-6, 2008

MIRS Rainfall Rate (*mm/hr*) from NOAA-18 and Metop-A sensors are integrated over 24 hrs to determine the rainfall in *mm/day*.

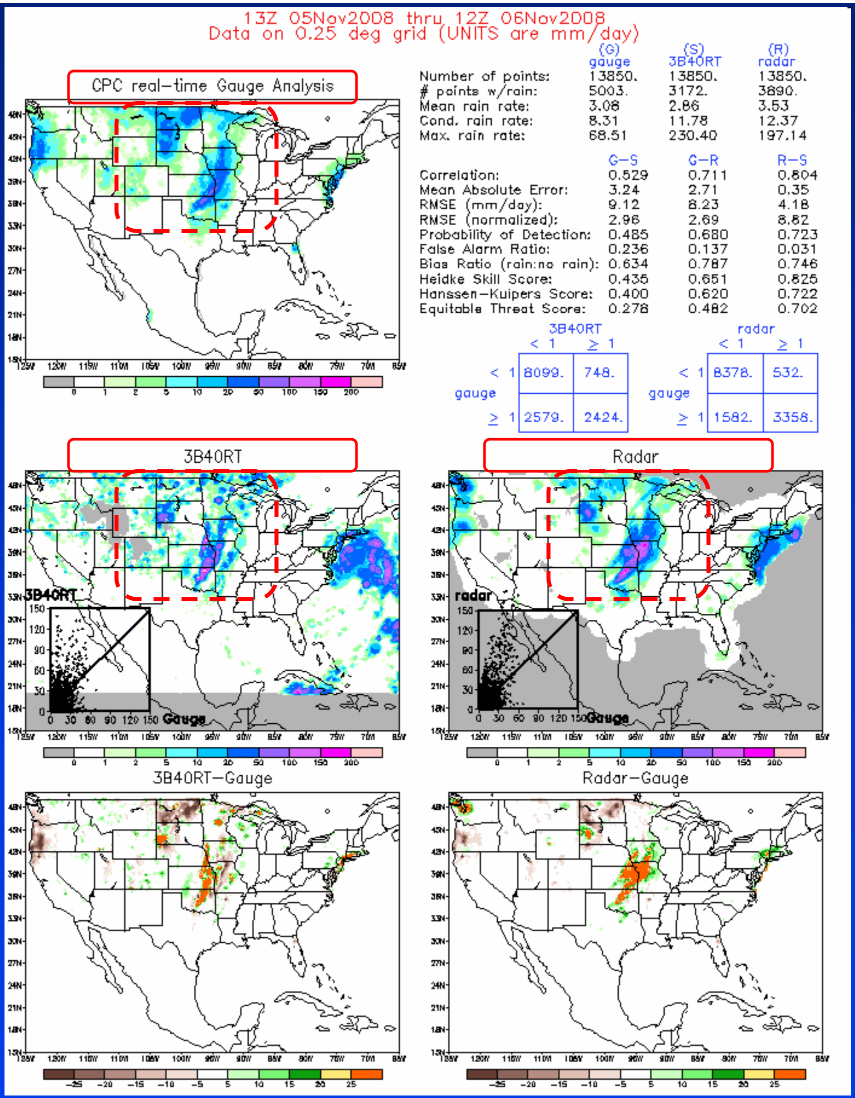
The rainfall amount is then compared to rain gauge measurements along with other remote precipitation estimate observations (radar/satellite)

Correlation: 0.62 (wrt gauges)
0.75 (wrt radar)

Figures provided by
John Janowiak

http://www.cpc.ncep.noaa.gov/products/janowiak/us_web.shtml

Rainfall Rate Comparisons
(Leverage of IPWG assessment system)



13Z 05Nov2008 thru 12Z 06Nov2008
Data on 0.25 deg grid (UNITS are mm/day)

	(G) gauge	(S) 3B40RT	(R) radar
Number of points:	13850.	13850.	13850.
# points w/rain:	5003.	3172.	3890.
Mean rain rate:	3.08	2.86	3.53
Cond. rain rate:	8.31	11.78	12.37
Max. rain rate:	68.51	230.40	197.14

	G–S	G–R	R–S
Correlation:	0.529	0.711	0.804
Mean Absolute Error:	3.24	2.71	0.35
RMSE (mm/day):	9.12	8.23	4.18
RMSE (normalized):	2.96	2.69	8.82
Probability of Detection:	0.485	0.680	0.723
False Alarm Ratio:	0.236	0.137	0.031
Bias Ratio (rain:no rain):	0.634	0.787	0.746
Heidke Skill Score:	0.435	0.651	0.825
Hanssen–Kuipers Score:	0.400	0.620	0.722
Equitable Threat Score:	0.278	0.482	0.702

		3B40RT	
		< 1	≥ 1
gauge	< 1	8099.	748.
	≥ 1	2579.	2424.

		radar	
		< 1	≥ 1
gauge	< 1	8378.	532.
	≥ 1	1582.	3358.

3B40RT vs Rain Gauge data and Radar observations over U.S. from IPWG project
Nov. 5-6, 2008

The NASA-3B40RT algorithms provides a merger of all available SSM/I and TMI microwave precipitation estimates into a "high-quality" (HQ) precipitation estimate

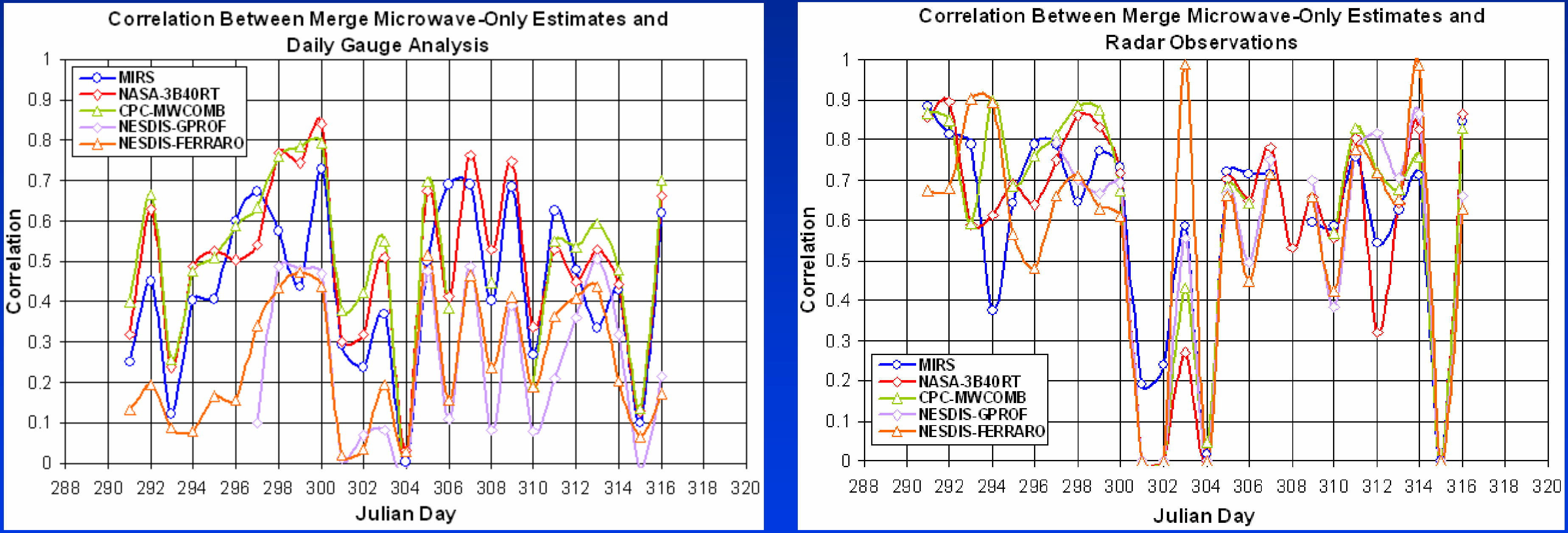
Correlation: 0.52 (wrt gauges)
0.80 (wrt radar)

Figures provided by
John Janowiak

http://www.cpc.ncep.noaa.gov/products/janowiak/us_web.shtml

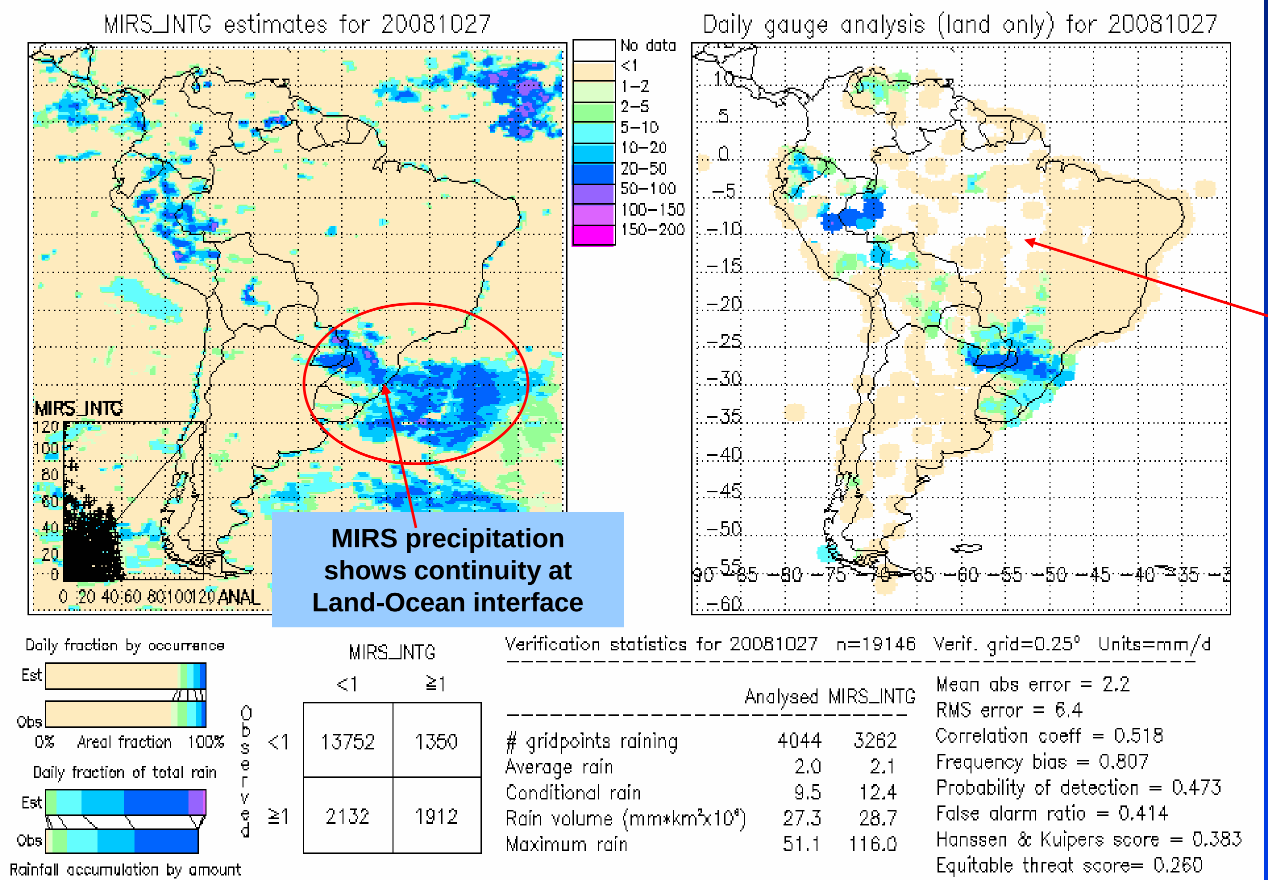
Rainfall Rate Comparisons (Leverage of IPWG assessment system)

Over about one month, the MIRS has shown comparable performance to well-known precipitation estimate algorithms.



Time-series of correlations between Microwave-Only Estimates and Daily Gauge Analysis (left) and Radar Observations (right). The MIRS Precipitation Estimate is the blue line.

Rainfall Rate Comparisons (Leverage of IPWG assessment system)



MIRS precipitation shows continuity at Land-Ocean interface

		MIRS_INTG	
		<1	≥1
Observed	<1	13752	1350
	≥1	2132	1912

Verification statistics for 20081027 n=19146 Verif. grid=0.25° Units=mm/d

	Analysed	MIRS_INTG
# gridpoints raining	4044	3262
Average rain	2.0	2.1
Conditional rain	9.5	12.4
Rain volume (mm*km^{2}x10^6)	27.3	28.7
Maximum rain	51.1	116.0

Mean abs error = 2.2
RMS error = 6.4
Correlation coeff = 0.518
Frequency bias = 0.807
Probability of detection = 0.473
False alarm ratio = 0.414
Hanssen & Kuipers score = 0.383
Equitable threat score= 0.260

MIRS Precipitation Estimate vs. Rain Gauge Analysis over South America Oct. 27, 2008

Not a dense network of rain gauges over South America

Correlation: 0.52 (wrt gauges)

Figures provided by Daniel Vila

Summary

- MIRS Rain Rate is computed from a set of MIRS core product outputs (*sensor independent*). This property simplifies significantly its extension to new sensors.

- MIRS precipitation is being validated with Rain Gauge and Radar observations at the IPWG project where it has demonstrated comparable performance to well-known satellite precipitation estimate algorithms.

- MIRS validation will be extended to other regions (Europe, Australia, Japan, etc) and to other available resources.

F16 Products

-Sea-Ice Concentration

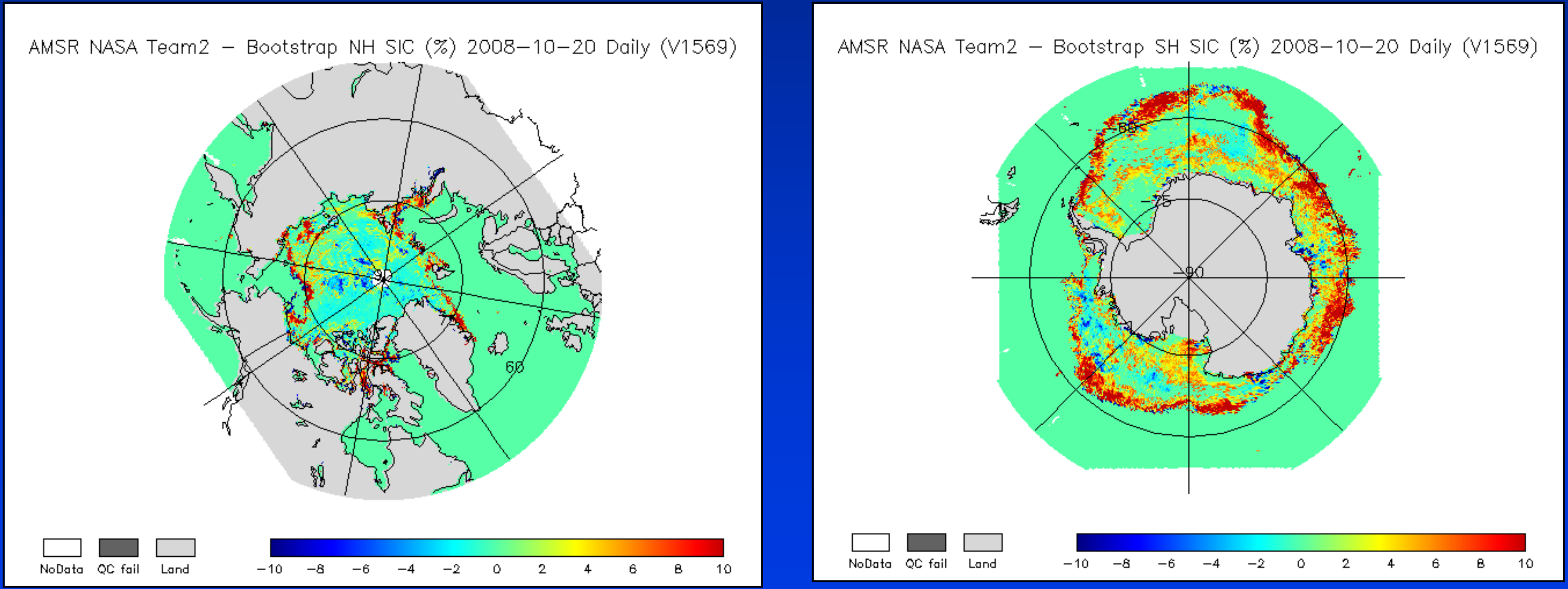
Chris Grassotti (STAR Contractor)

F16 Products (SIC Algorithm Description)

- **Inputs**
  - » **Scene emissivities at 19, 22, 37 and 91 GHz V+H (retrieved from MIRS)**
  - » **Library of sfc emissivity spectra for range of sea ice fractions**
    - – Computed from known pure (100 %) FY ice, MY ice, and ocean sfc emissivity spectra; Linear mixing model
- **General Retrieval Strategy**
  - » **Closest match by minimization of Euclidian distance between a-priori (stored in library) and posteriori (retrieved from MIRS) emissivities**
- **Technique Applied to SSMI/S**
  - » **MY ice, closest match between normalized values of emissivity gradients and V-H pol difference for channels up to 37 GHz; Otherwise, closest match between emissivity spectrum (19-91 GHz)**
- **Outputs**
  - » **First-year, Multi-year and Total ice concentration (12-100 %)**
- **Validation/Monitoring using AMSR-E sea ice products**
  - » **Daily, Ascending, Descending; NASA Team 2, Bootstrap**
  - » **Incorporated into daily monitoring**

F16 Products (SIC Reference Comparison)

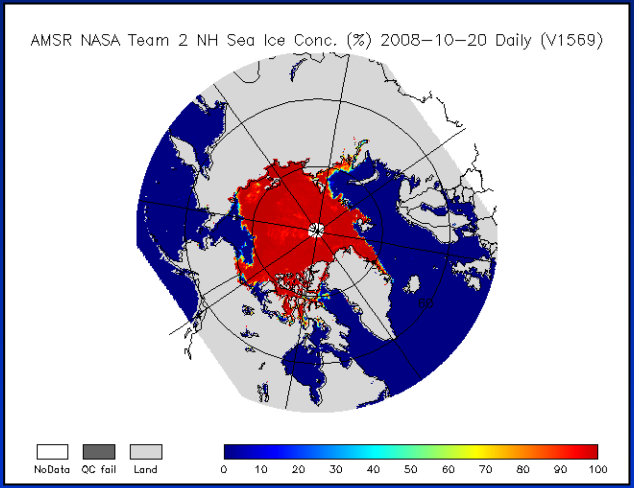
- Difference among reference algorithms
  - » AMSR SIC: NASA Team 2 vs. Bootstrap



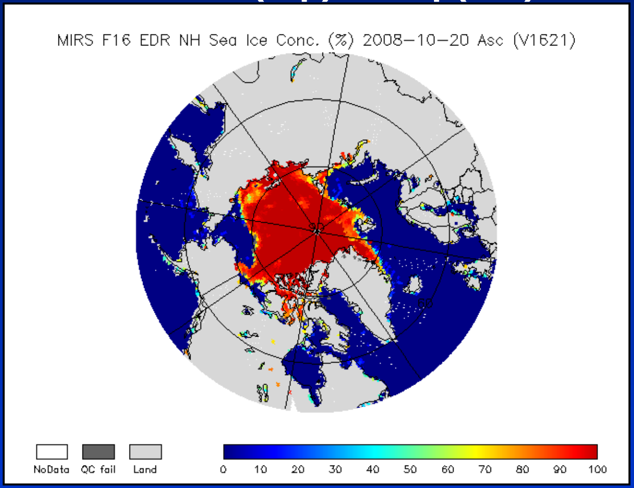
Daily SIC composite NASA Team 2 SIC – Bootstrap SIC (%) for Northern (left) and Southern (right) Polar regions

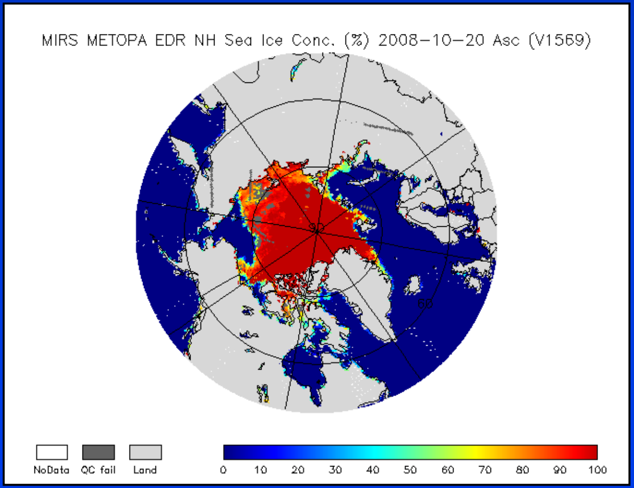
F16 Products
(SIC Results NH – F16/Metop/AMSR)

AMSR

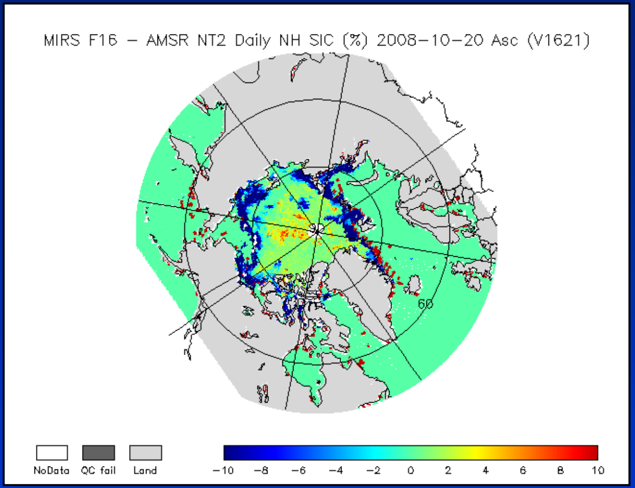


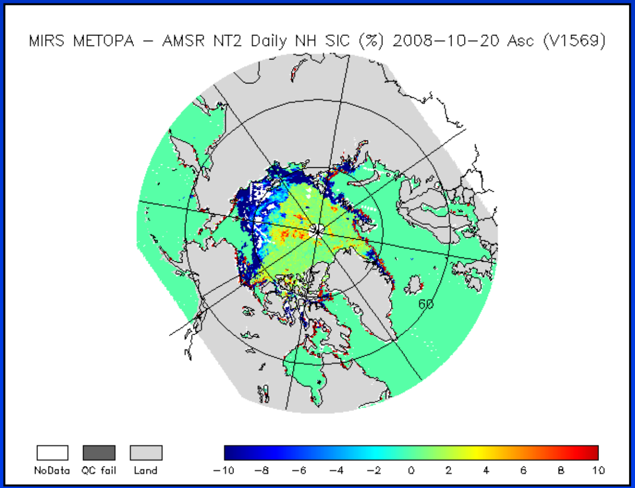
MIRS: F16(top) Metop(bot)





MIRS - AMSR

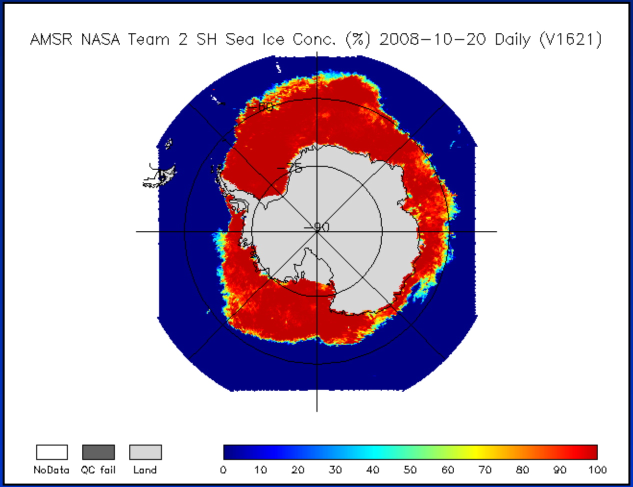




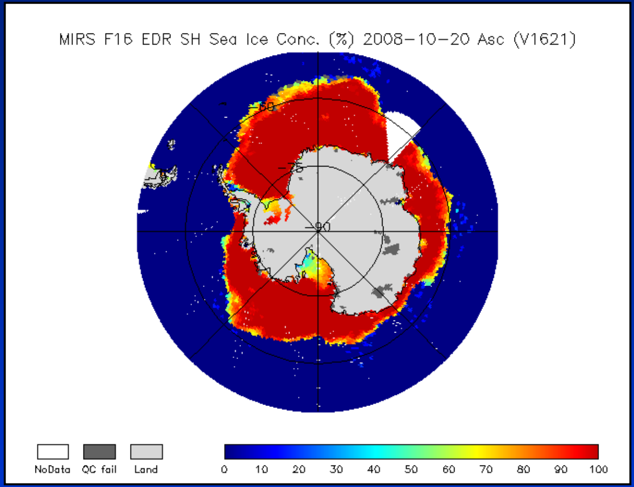
- Example on 20 Oct 08
- Good agreement between F16 and Metop
- Same agreement found with N18 (not shown)
- Largest differences with AMSR near ice edge and off N. Siberia

F16 Products
(SIC Results SH – F16/Metop/AMSR)

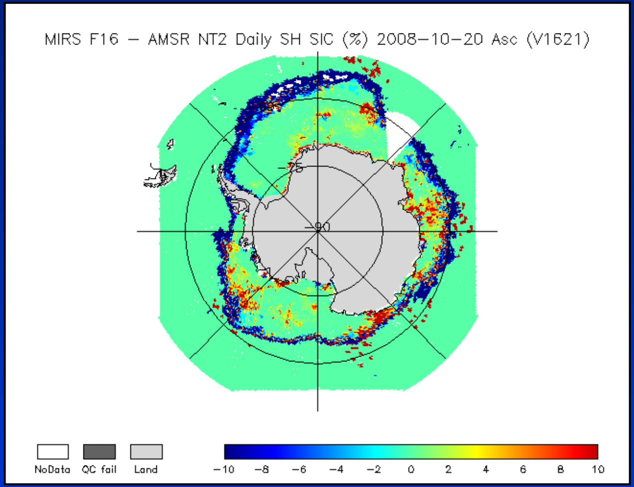
AMSR

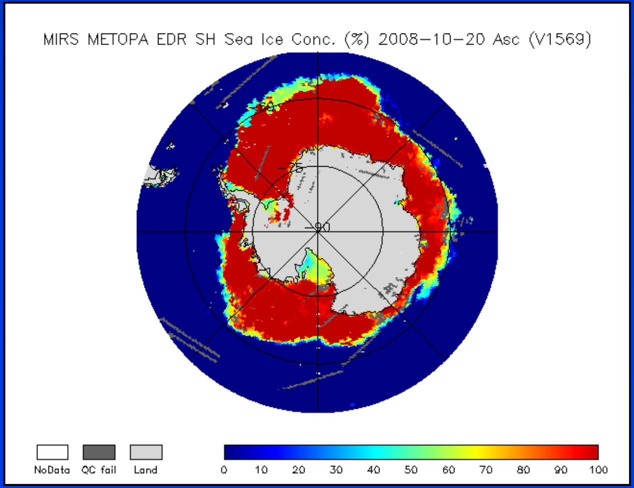

AMSR NASA Team 2 SH Sea Ice Conc. (%) 2008–10–20 Daily (V1621)

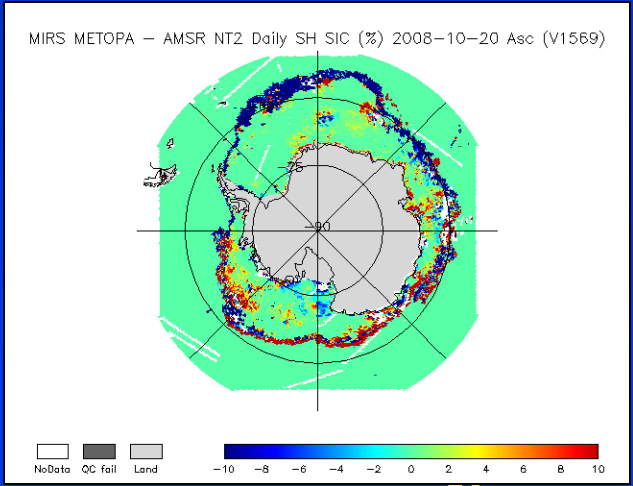
MIRS: F16(top) Metop(bot)


MIRS F16 EDR SH Sea Ice Conc. (%) 2008–10–20 Asc (V1621)

MIRS - AMSR


MIRS F16 – AMSR NT2 Daily SH SIC (%) 2008–10–20 Asc (V1621)

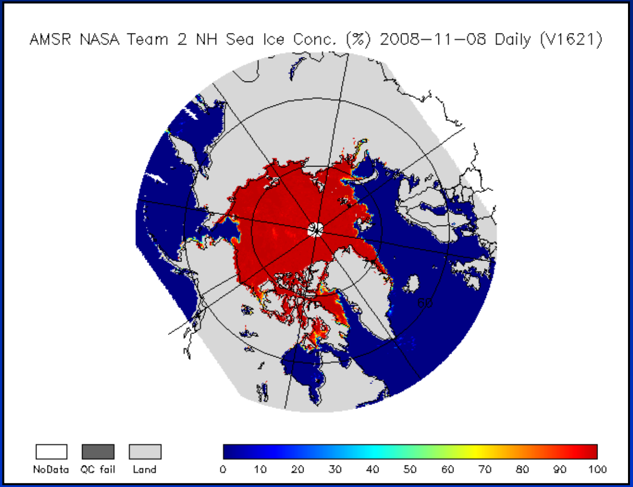

MIRS METOPA EDR SH Sea Ice Conc. (%) 2008–10–20 Asc (V1569)


MIRS METOPA – AMSR NT2 Daily SH SIC (%) 2008–10–20 Asc (V1569)

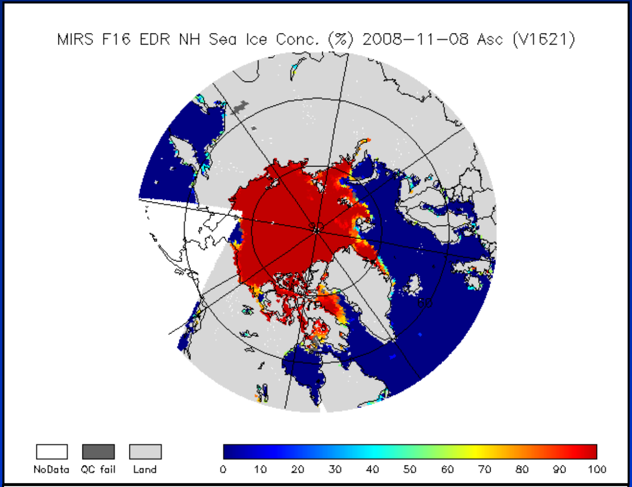
- Example on 20 Oct 08
- Good agreement between F16 and Metop
- Same agreement found with N18 (not shown)
- Largest differences with AMSR near ice edge

F16 Products
(SIC Results NH – F16/Metop/AMSR)

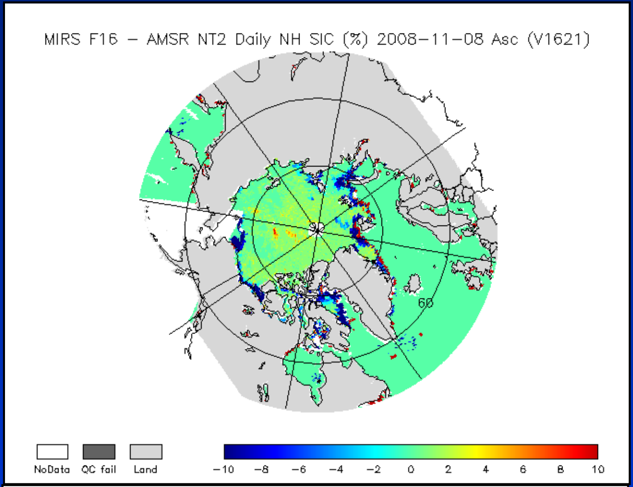
AMSR


AMSR NASA Team 2 NH Sea Ice Conc. (%) 2008–11–08 Daily (V1621)

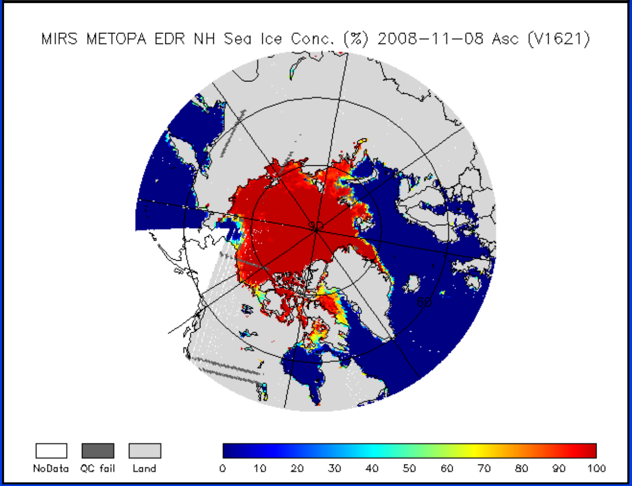
MIRS: F16(top) Metop(bot)

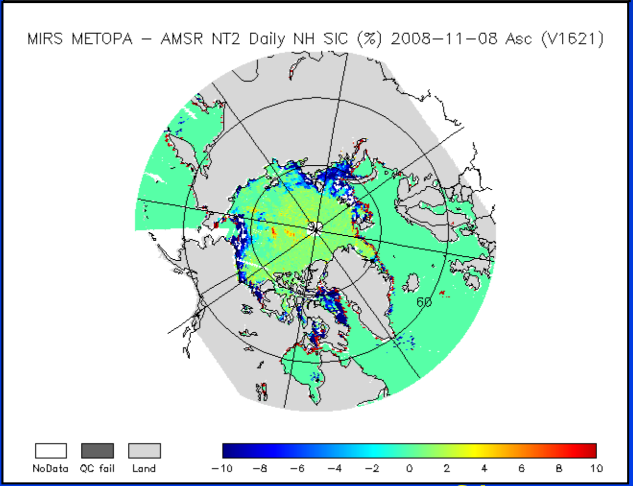

MIRS F16 EDR NH Sea Ice Conc. (%) 2008–11–08 Asc (V1621)

MIRS - AMSR


MIRS F16 – AMSR NT2 Daily NH SIC (%) 2008–11–08 Asc (V1621)

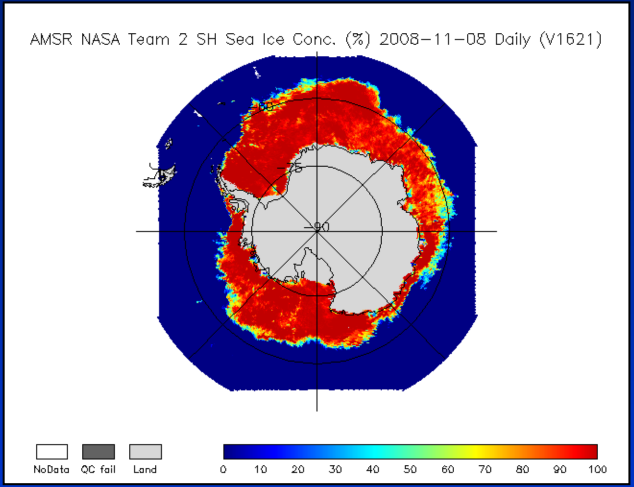
- **Example on 8 Nov 08**
- **Good agreement between F16 and Metop**
- **Largest differences with AMSR near ice edge**


MIRS METOPA EDR NH Sea Ice Conc. (%) 2008–11–08 Asc (V1621)

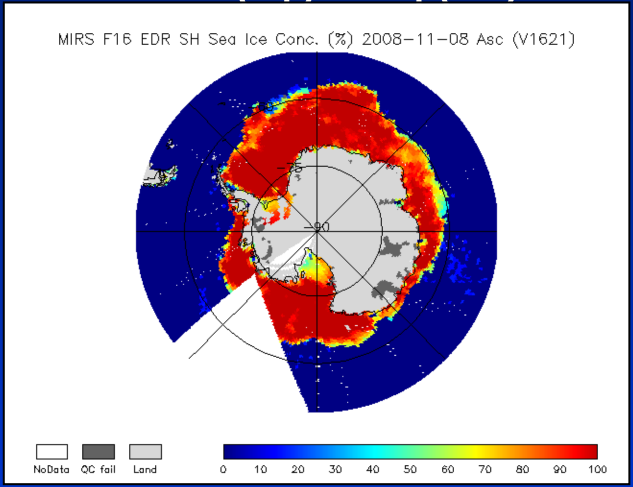

MIRS METOPA – AMSR NT2 Daily NH SIC (%) 2008–11–08 Asc (V1621)

F16 Products
(SIC Results SH – F16/Metop/AMSR)

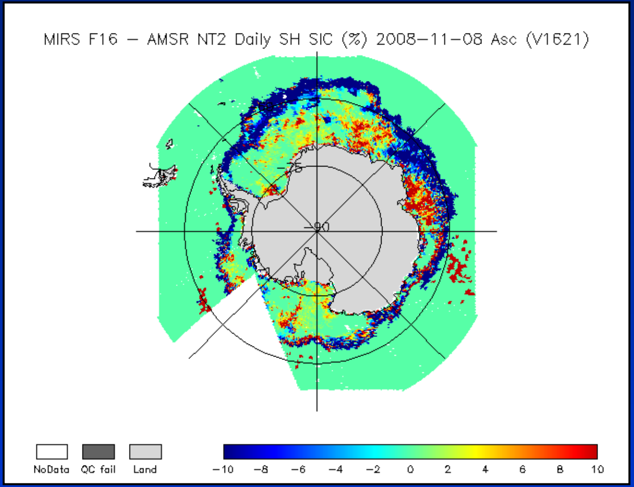
AMSR



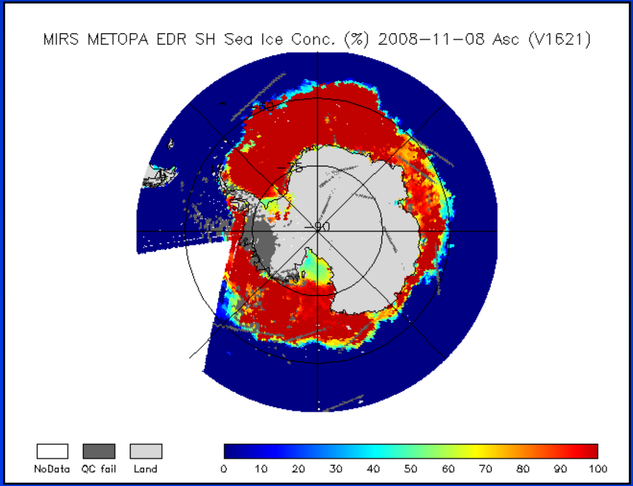
MIRS: F16(top) Metop(bot)

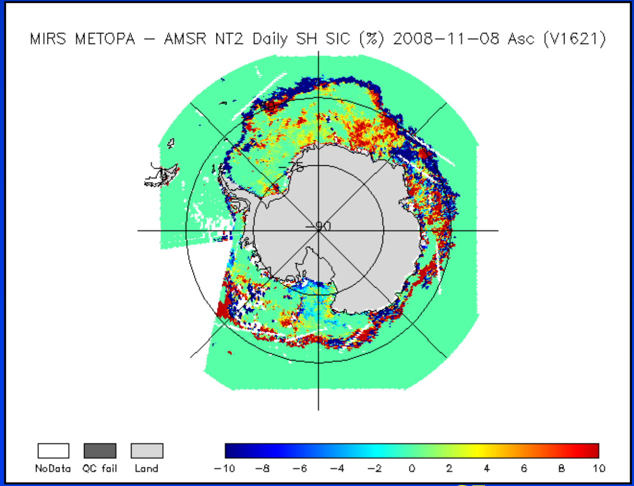


MIRS - AMSR



- Example on 8 Nov 08
- Good agreement between F16 and Metop
- Largest differences with AMSR near ice edge





F16 Products

Snow Cover Extent &
Snow-Water Equivalent

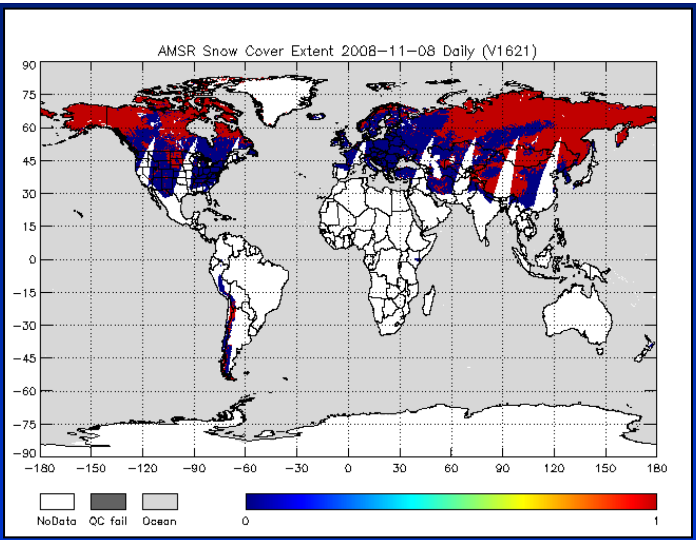
Cezar Kongoli (STAR Contractor)

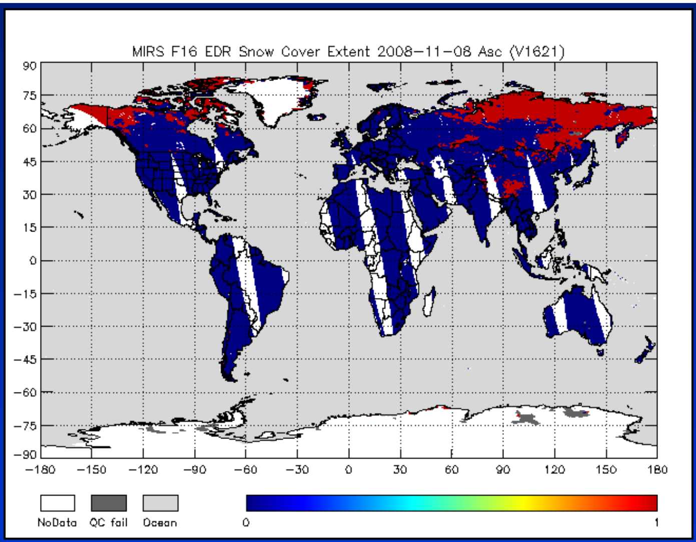
F16 Products (SWE Algorithm Description)

- Inputs
  - Scene emissivities at 19, 22, 37 and 91 GHz V+H (retrieved from MIRS)
  - Library of sfc emissivity spectra for range of snow params
    - Computed from a microwave snow emissivity model for realistic ranges of snow depth and grain size, with fixed snow volume fraction
- General Retrieval Strategy
  - Closest match by minimization of Euclidian distance between a-priori (stored in library) and posteriori (retrieved from MIRS) emissivities
- Technique Applied to SSMI/S
  - Compute emissivity differences at 22, 37 and 91 GHz with respect to 19 GHz to reduce uncertainties in absolute emissivities
- Outputs
  - Snow Water Equivalent and Grain Size
- Validation/Monitoring using AMSR-E SWE product
  - Incorporated into daily monitoring

F16 Products
(SCE Results - F16/Metop/AMSR)

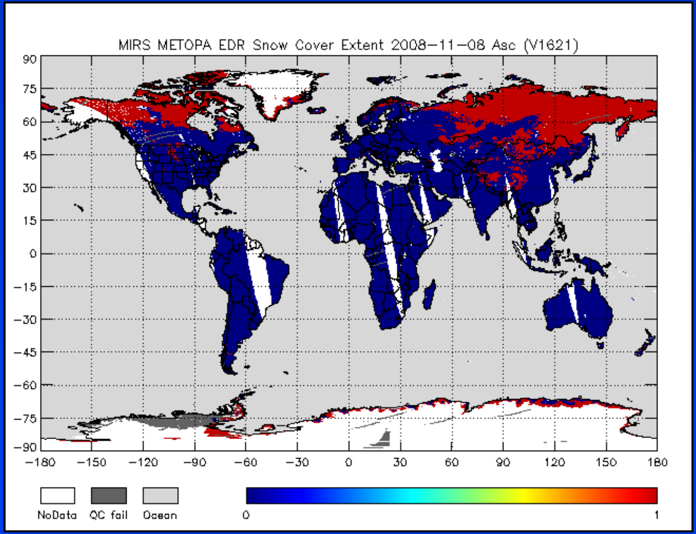
AMSR





MIRS: F16

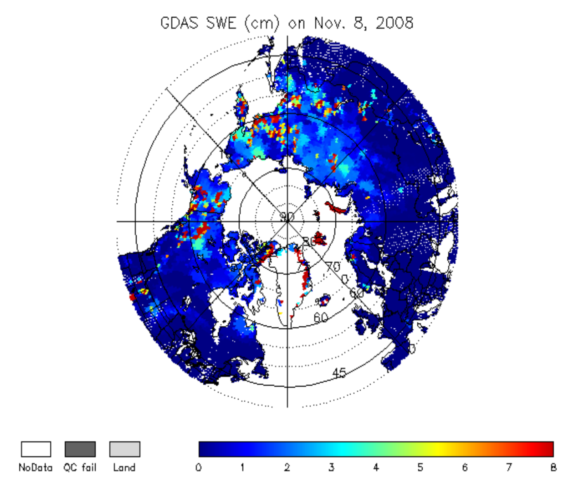
- Example on 8 Nov 08
- F16 snow extent slightly less than Metop
- AMSR snow extent greater than F16 and Metop
- N18 results similar to Metop



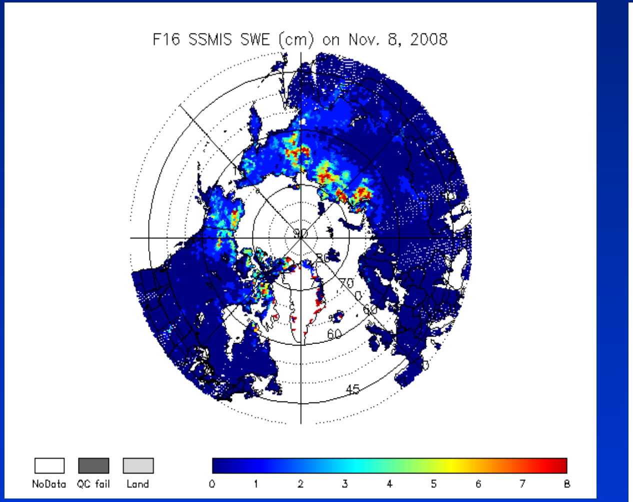
MIRS: Metop

F16 Products
(SWE Results – SSMIS/GDAS)

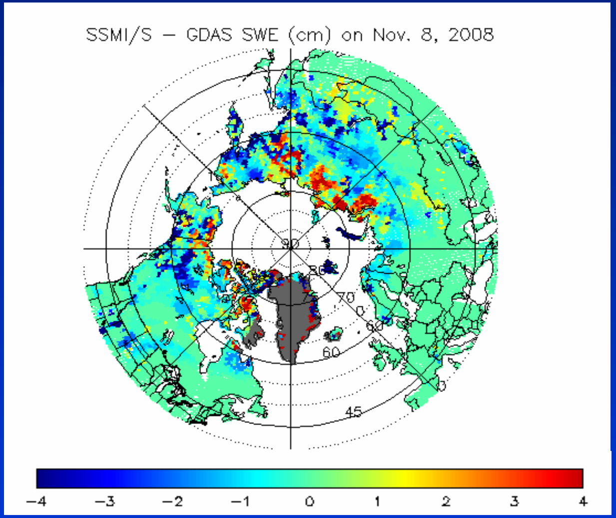
GDAS



MIRS F16 SSMIS



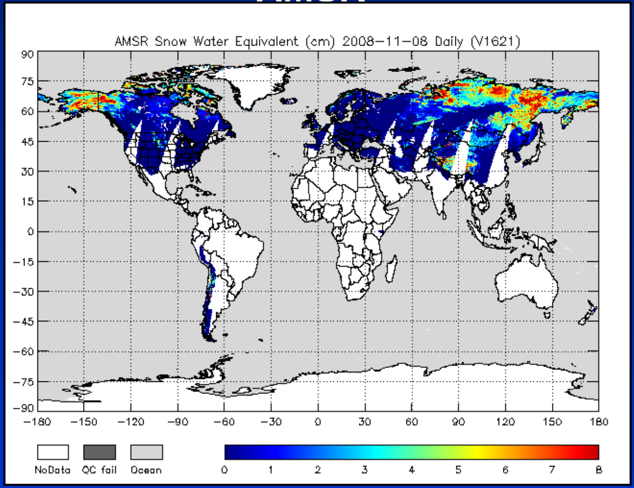
MIRS - GDAS



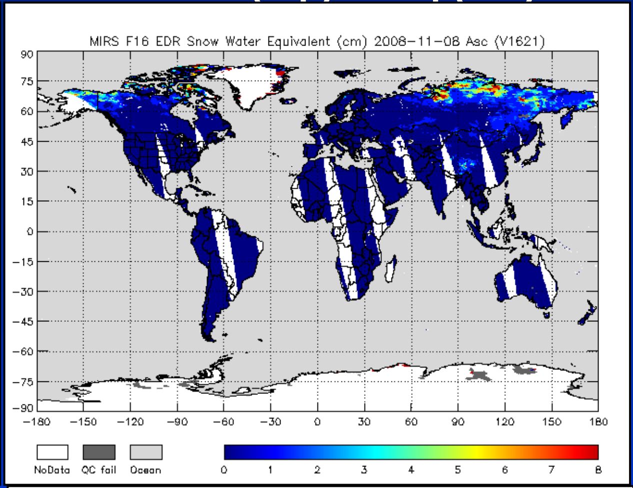
- Example on 8 Nov 08
- F16 SSMIS SWE overestimated:
  - » over Eurasia by 0.9 cm and over Alaska by 0.2 cm
- Global bias = +0.6 cm and RMSE = 3.1. cm

F16 Products
(SWE Results - F16/Metop/AMSR)

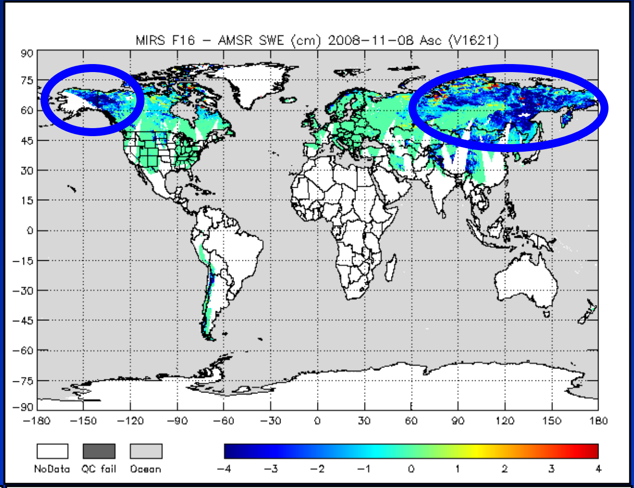
AMSR

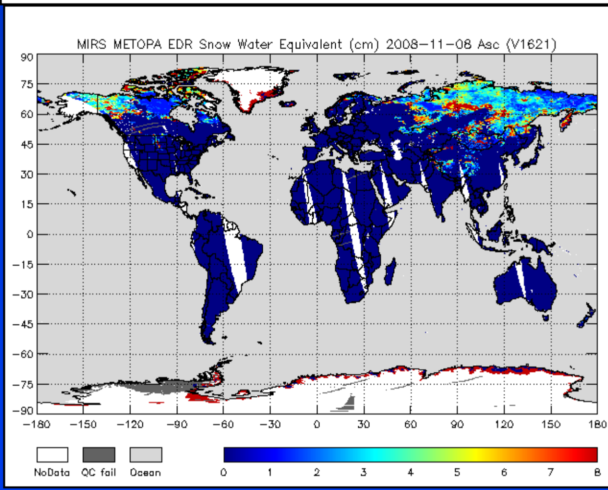


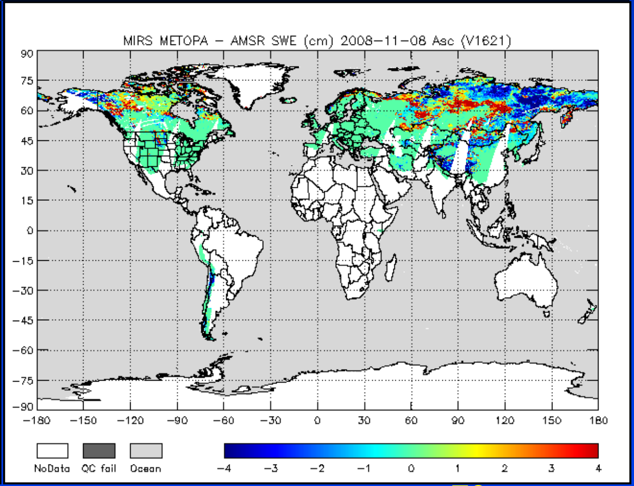
MIRS: F16(top) Metop(bot)



MIRS - AMSR







- Example on 8 Nov 08
- F16 snow extent reasonable
- F16 SWE underestimated, e.g., Eurasia and Alaska
- Global bias = -1.4 cm and RMSE = 3.3. cm

Conclusive Remarks

- *Most recent* inter-comparisons of F16 SSMIS SWE with two independent products (AMSR and GDAS) show different results, with the SSMI/S SWE product positioned in the middle: underestimations with respect to AMSR SWE and overestimations with respect to GDAS SWE. Bias and RMSE statistics with respect to GDAS is smaller.

- *Most recent* snow cover extent inter-comparisons show consistency, with slight underestimations with respect to AMSR product

MIRS Core Products Updates

-Science Improvements
-F16 - Total Precipitable Water over non-Ocean
-F16 - Integrated Cloud Liquid Water over Ocean

Kevin Garrett (STAR Contractor)

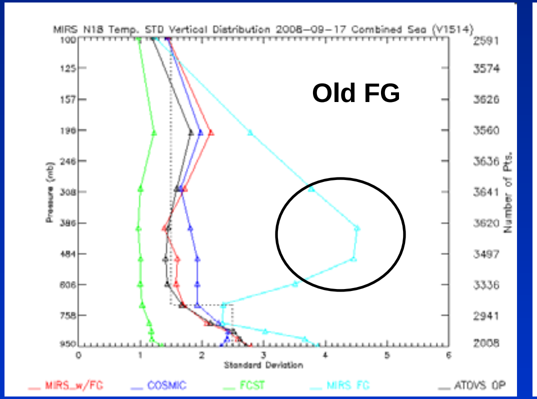
MIRS Core Products (Science Improvements)

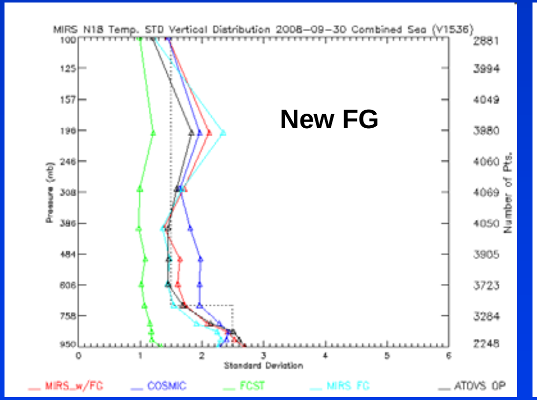
- This release contains new first-guess algorithms for most parameters (regression approach)
  - First-guess training algorithm re-coded with many refinements
  - First-guess now includes CLW
  - First-guess of all parameters available to N18/Metop-A/F16

Algorithm	TBs Trained On	Geophys. Src Trained On
CLW	Fwd simulated TBs of high/low freq. window channels	2 Days, ECMWF analysis
TSKIN	Uncorrected, collocated FMSDRs, all #s	2 Days, ECMWF analysis
TPW	Uncorrected, collocated FMSDRs, all #s	2 Days, ECMWF analysis
Emissivity	Uncorrected, collocated FMSDRs, all #s	2 Days, ECMWF analysis
Water Vapor Prof.	Uncorrected, collocated FMSDRs, all #s	2 Days, ECMWF analysis
Temperature Prof.	Uncorrected, collocated FMSDRs, all #s	2 Days, ECMWF analysis

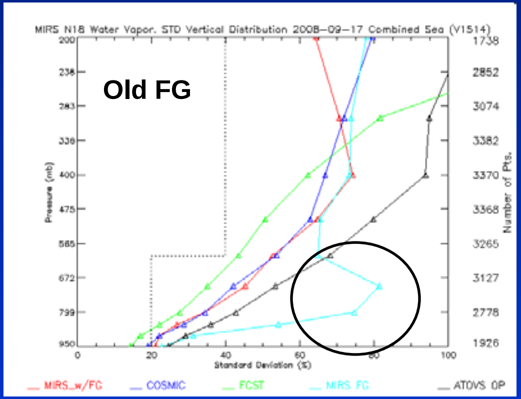
MIRS Core Products
(Science Improvements)

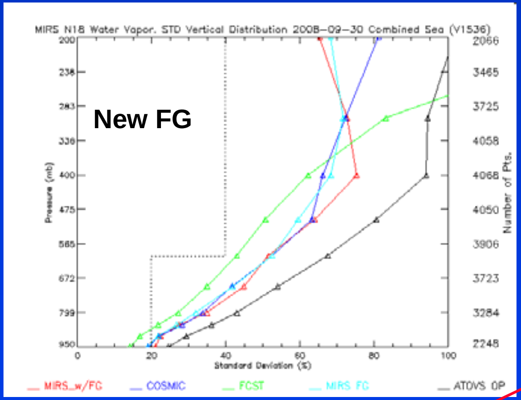
Temp vs. RAOB
Standard Dev. (K)





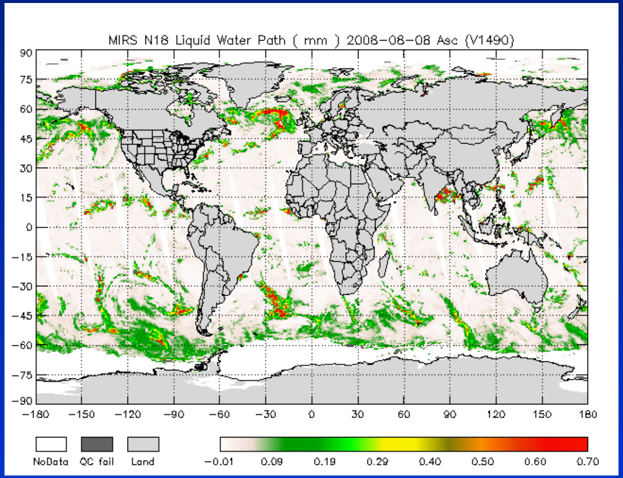
WV vs. RAOB
Standard Dev. (%)



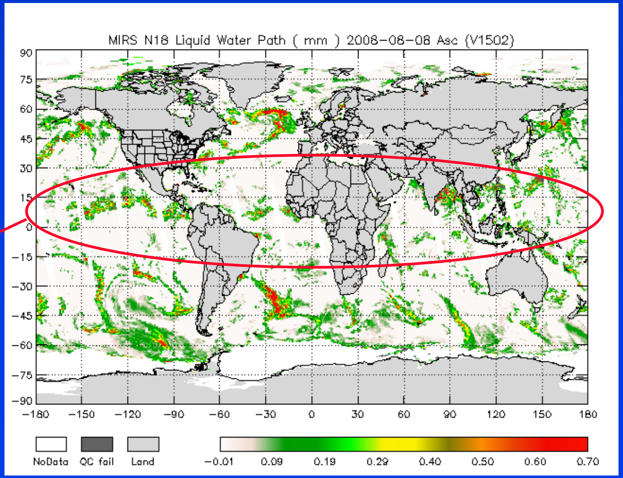


First-Guess	MIRS
🟦	🟥

MIRS OLD LWP



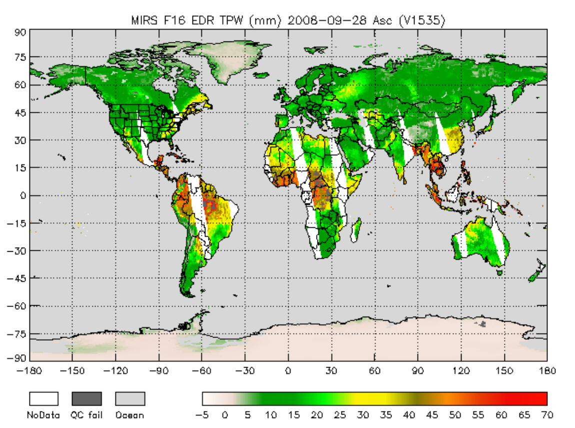
MIRS NEW LWP



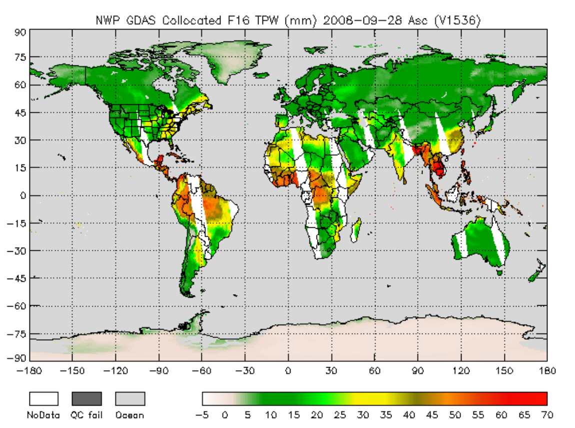
Increased CLW over ITCZ

MIRS Core Products (F16 Non-ocean TPW)

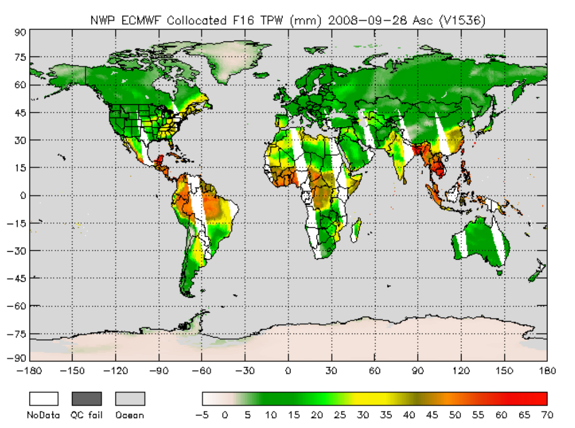
F16 MIRS TPW

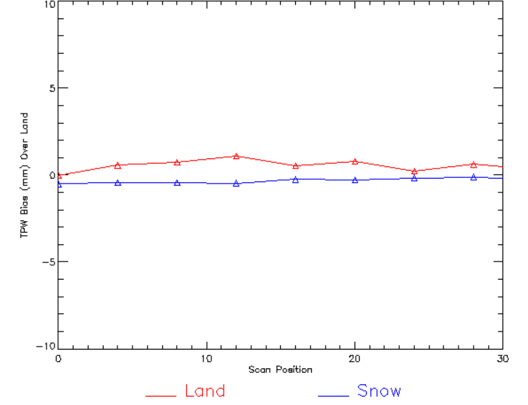


GDAS TPW

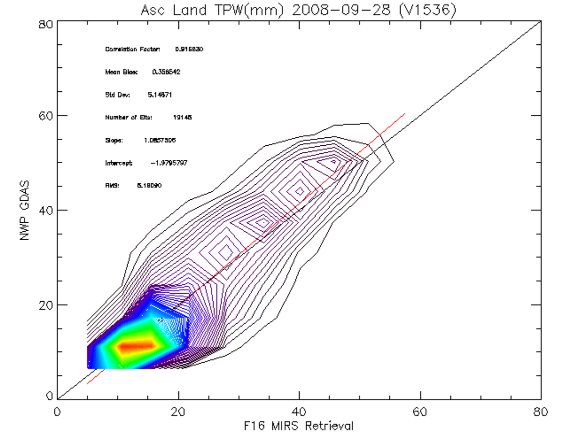


ECMWF TPW

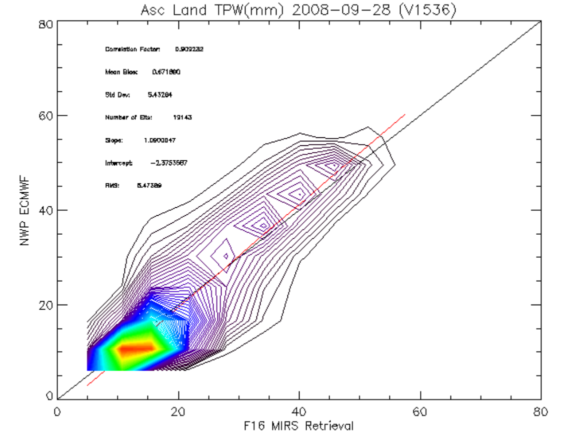




GDAS vs. MIRS
Bias vs. Scan Pos



GDAS vs. MIRS
Bias: 0.36, Std: 5.15



ECMWF vs. MIRS
Bias: 0.47, Std: 5.43

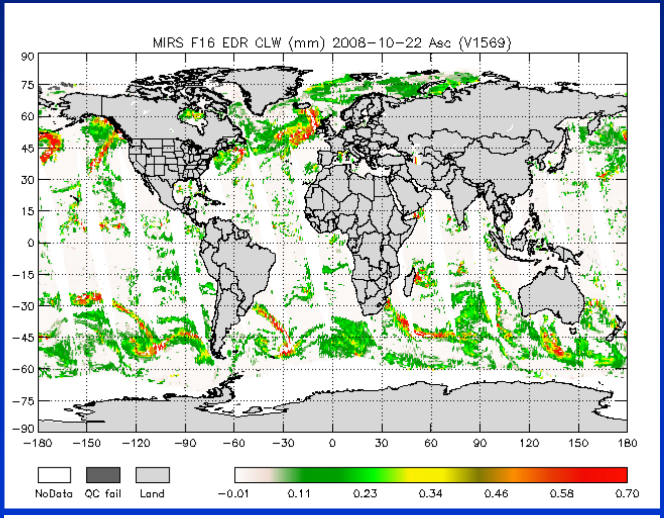
MIRS Core Products (F16 CLW)

- Integrated Cloud Liquid Water already operational product for N18/Metop-A (over Ocean surface only)
- Switched ON retrieval of CLW with SSMI/S data:
  - » Modification to “tuning” file
  - » Generate algorithm first-guess for CLW (not required but implemented with this version)
  - » Turn OFF SSMI/S channels 8,17,18*
  - » Extend validation/monitoring to SSMI/S

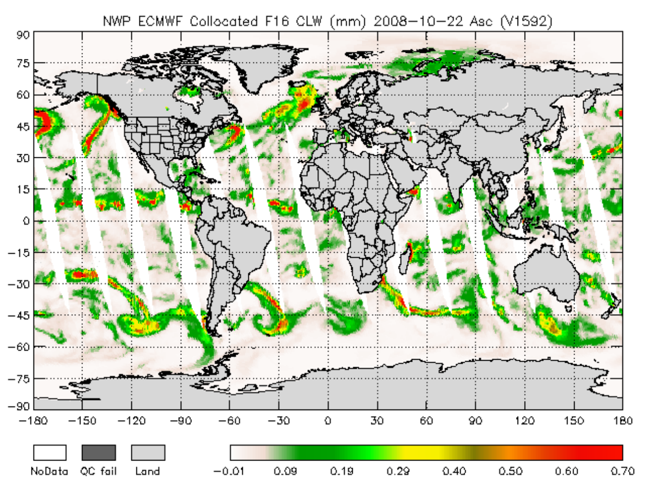
** 150, 91v, 91h (GHz)*

MIRS Core Products
(F16 CLW)

F16 MIRS CLW

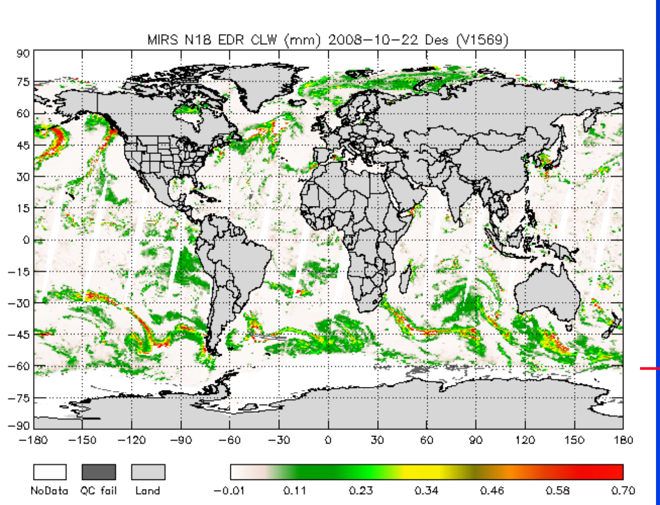


ECMWF CLW



Correlation: 0.57

**ECMWF CLW includes rain*



N18 MIRS CLW for reference

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5. **MIRS CODE UNIT REVIEW**
6. RISKS AND ACTIONS
7. SUMMARY AND CONCLUSIONS

Section 5 –
MIRS Unit Code Review

Presented by

Wanchun Chen (STAR Contractor)

MIRS Unit Code Review

- The MIRS Unit Code Review is to ensure that all MIRS codes meet operational requirements
  - » Follow Fortran 95 coding standards
  - » Programs/Subroutines efficient and robust (no memory leaks, etc)
  - » Modular design
  - » Centralized error handling
  - » Baseline profiling of the code
- All code changes are managed by Subversion: a source version control system

Code Review
Standards Compliance (1/3)

- ISO Fortran 95 standards adherence is assessed using the Forcheck utility
- Manual Verification that SPSRB F95 coding standards are adhered to as well (standards and guidelines)
- Standards upheld:
  - » Use Implicit None in all modules and main programs.
  - » Documented well enough. All modules/main programs/subroutines/functions have a header:
    - – Description of the code
    - – Modules used
    - – Subroutines or functions contained
    - – Data types included
    - – Intrinsic functions used
    - – Argument description (input/output)
    - – Code history
  - » In the code, major sections have their own comments to describe what the section of the code is doing.
  - » No hard coded numbers. All Constants are defined in module Const.

Code Review
Standards Compliance (2/3)

- Standards upheld (continued)
  - » All variables are initialized.
  - » Use free format syntax but the maximum length in each line is less than 128 (g95 will cut off any line longer than 128 characters).
  - » No tab characters in all Fortran codes.
  - » No GOTO statements in all codes.
  - » All unused variables are removed.
  - » Use private to ensure proper encapsulation.
  - » No conditional statements using == or /= with floating points.
  - » No numbered DO loops. Labeled DO loops are used.
  - » All intrinsic functions are declared before using them.

Code Review
Standards Compliance (3/3)

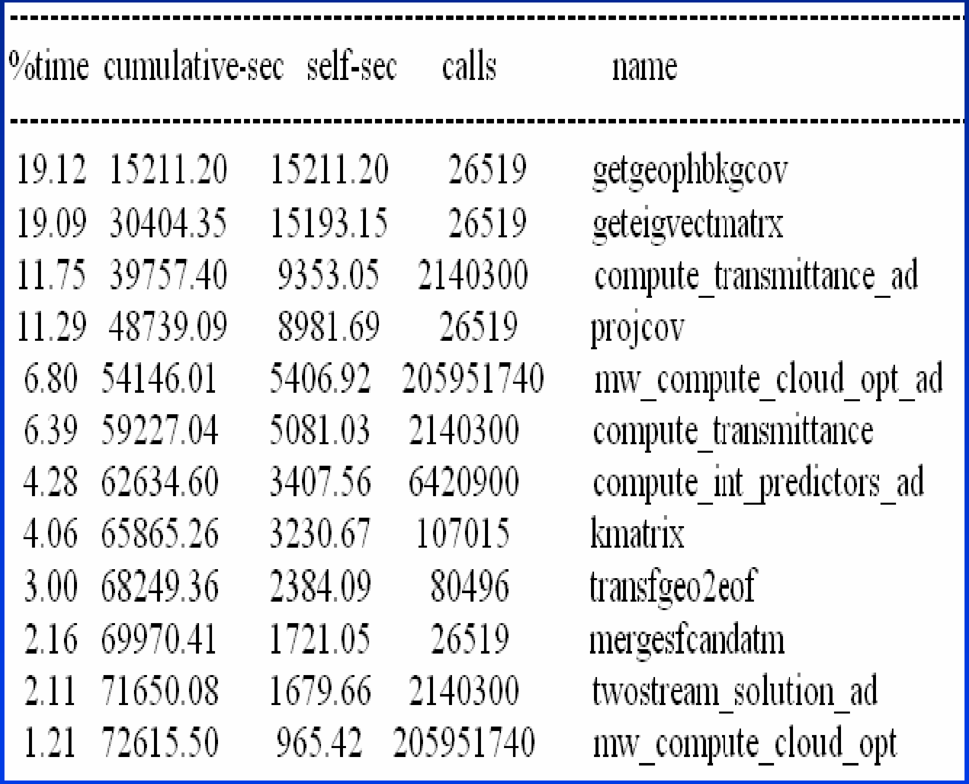
Module Name	implicit none	document	no hard coded num	initialization	no tabs	free format	no goto	remove unused var	no fp eq/ne	no numbered loop	same as file name
FwdOperator	done	done	done	done	done	done	done	done	done	done	done
GeophCovBkg	done	done	done	done	done	done	done	done	done	done	done
SeFeErrCov	done	done	done	done	done	done	done	done	done	done	done
VarOprs	done	done	done	done	done	done	done	done	done	done	done
IO_Colocate	done	done	done	done	done	done	done	done	done	done	done
IO_DEP	done	done	done	done	done	done	done	done	done	done	done
IO_DropSonde	done	done	done	done	done	done	done	done	done	done	done
IO_InstrConfig	done	done	done	done	done	done	done	done	done	done	done
IO_MeasurData	done	done	done	done	done	done	done	done	done	done	done
IO_Misc	done	done	done	done	done	done	done	done	done	done	done
IO_Misc_LE	done	done	done	done	done	done	done	done	done	done	done
IO_Monitor	done	done	done	done	done	done	done	done	done	done	done
IO_Noise	done	done	done	done	done	done	done	done	done	done	done
IO_Regress	done	done	done	done	done	done	done	done	done	done	done
IO_Scene	done	done	done	done	done	done	done	done	done	done	done
IO_SSMIS	done	done	done	done	done	done	done	done	done	done	done
MathFcts	done	done	done	done	done	done	done	done	done	done	done
CntrlParams	done	done	done	done	done	done	done	done	done	done	done
Consts	done	done	done	done	done	done	done	done	done	done	done
misc	done	done	done	done	done	done	done	done	done	done	done
TuningParams	done	done	done	done	done	done	done	done	done	done	done
Noise	done	done	done	done	done	done	done	done	done	done	done
Preclassif	done	done	done	done	done	done	done	done	done	done	done
ErrorHandling	done	done	done	done	done	done	done	done	done	done	done
QCchecking	done	done	done	done	done	done	done	done	done	done	done
utils	done	done	done	done	done	done	done	done	done	done	done

Spread sheet summarizing all tests/checks performed on MIRS (to be independently validated by OSDPD)

Code Review
Profiling

- Main results from profiling the code
  - » 80% of time is spent in 1DVar step
  - » 60% of 1DVAR time is consumed by CRTM
  - » Efforts on-going by CRTM team to improve efficiency.

1DVAR Step Profiling



```
-------------------------------------------------------------------------------
%time  cumulative-sec  self-sec    calls        name
-------------------------------------------------------------------------------
19.12  15211.20    15211.20     26519      getgeophbkgcov
19.09  30404.35    15193.15     26519      geteigvectmatrx
11.75  39757.40     9353.05   2140300      compute_transmittance_ad
11.29  48739.09     8981.69     26519      projcov
 6.80  54146.01     5406.92  205951740     mw_compute_cloud_opt_ad
 6.39  59227.04     5081.03   2140300      compute_transmittance
 4.28  62634.60     3407.56   6420900      compute_int_predictors_ad
 4.06  65865.26     3230.67    107015      kmatrix
 3.00  68249.36     2384.09     80496      transfgeo2eof
 2.16  69970.41     1721.05     26519      mergesfcandatm
 2.11  71650.08     1679.66   2140300      twostream_solution_ad
 1.21  72615.50      965.42  205951740     mw_compute_cloud_opt
```

Code Review
Robustness and Efficiency

- Use valgrind to help detect any memory leaks. Valgrind is a Linux program used to "*detect many memory management and threading bugs, avoiding hours of frustrating bug-hunting, making your programs more stable*". Valgrind detailed information and usage:

  http://www.valgrind.org/
- Since last version, no memory leaks in MIRS
  - All dynamically allocated memories are deallocated when they are not used anymore.
  - No array index out of bounds. Array index out of bounds will usually cause "segmentation fault".

Code Review
What is Supported?

- Platforms
  - » MIRS has been tested on Linux and IBM AIX
- Compilers
  - » ifort on Linux 64-bit machine
  - » g95 on Linux 32 bit machine
  - » Xlf95 on IBM AIX
- IDL for figures generation (not operational requirement)
  - » Radiance quality monitoring
  - » Scientific monitoring
  - » Daily science validation system
- MIRS daily product monitoring and comparisons: http://mirs.nesdis.noaa.gov
- MIRS in operations at OSDPD: http://www.osdpd.noaa.gov/PSB/mirs/

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Section 6 –
Risks and Actions

Presented by

Kevin Garrett (STAR Contractor)

MIRS
Risks at SRR

- There are 3 risks identified
- The following slides contain, for each risk item:
  - » A risk statement
  - » Risk assessment (Severity and Likelihood)
  - » Risk mitigation recommendation
  - » Status of actions identified to mitigate the risk

Risk # 1

- Risk #1 - Running MIRS in high resolution mode
  - » Running MIRS at the MHS (for N18/Metop-A) or higher than UAS resolution (for SSMI/S) is computationally expensive. Increase in required CPU resources proportional to increase in resolution.
  - » Risk only if we decommission MSPPS (planned for FY10-11).
- Risk Mitigation
  - » Set all default configurations to use lowest resolution per sensor
  - » Keep running MSPPS
  - » Upgrade resources
- Status:
  - » MIRS is run at low-resolution in OSDPD and STAR environments
  - » MIRS is run also at high-resolution in STAR environment daily in dynamic regions (currently Gulf-of-Mexico) for all sensors

Risk #2

- Risk #2: Geolocation of SSMI/S is inconsistent between UAS and other channels
  - » If MIRS is applied to SSMI/S data, and the UAS resolution is selected, the corresponding UAS lat/lon are shifted from the IMG, ENV, and LAS lat/lon
- Risk Mitigation
  - » In the footprint matching code for SSMI/S, an average lat/lon of the two center ENV footprints within the UAS field-of-view is used in place of the UAS lat/lon
- Status
  - » The footprint matching code for SSMI/S has been modified and fully tested. Results have shown improvement in MIRS retrievals, especially in coastal areas

Risk # 3

- Risk #3: Snow-Water Equivalent algorithm for SSMI/S not tested over all seasons
  - » SWE has been tested over a limited time period.
- Risk Mitigation
  - » Continuous on-line monitoring with respect to AMSR and off-line inter-comparisons with respect to GDAS and other ancillary data will continue for a more thorough assessment of results, in all seasons.
- Status
  - » The SWE for F16-SSMIS is being monitored

Summary of Risks and Actions

- There are currently 3 Risks with this release of the MIRS DAP
  - » 3 risks have been mitigated and are low risks
    - – Running MIRS in high resolution
    - – Geolocation of SSMI/S UAS resolution
    - – SWE not tested in all seasons

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Section 7 –
Summary and Conclusions

Presented by

Sid-Ahmed Boukabara (STAR)

Summary and Conclusions

- The MIRS has been running operationally since Aug ’07 at OSPDP, incrementally adding new products and expanding to three satellites (N18, Metop-A and F16 SSMIS)
- All major changes with MIRS release 4 (this release) uphold and enhance the system’s operational readiness and capabilities
- Code robustness and standards have been improved
  - » All codes verified/checked with Forcheck, Valgrind
  - » Codes profiled to analyze where efficiency could be gained
- MIRS documentation has been updated to reflect modified system requirements and descriptions
- New MIRS products and Science Improvements have been reviewed
- Risks associated with this release have been identified and mitigated

Keeping up to date with MIRS

- MIRS daily products, daily science monitoring, daily validation (wrt RAOB, AMSR-E, CLOUDSAT, COSMIC) could be found under: mirs.nesdis.noaa.gov
- Minutes of the regular MIRS meetings could also be found under the same site
- MIRS package is available to scientific community at large.

Open Discussion

The review is now open for discussion

BACKUP SLIDES

Review Objectives Have Been Addressed

- Code Unit has been Reviewed
  - » All codes have passed standards compliance and debugging
- System requirements have been reviewed
  - » Requirements have been outlined and needs met
- System description has been reviewed
  - » Overview of system and new product updates given
- System readiness has been reviewed
  - » Reaffirmed MIRS operational status
- Risks and Actions have been reviewed
  - » New and outstanding risks have been reviewed

MIRS Capabilities

SDR/EDR	POES/METOP AMSU-A/B; MHS	DMSP SSMIS	NPP ATMS	NPOESS ATMS
Radiances	✓	✓	✓	✓
Temp. profile	✓	✓	✓	✓
Moist. profile	✓	✓	✓	✓
Total precipitable water[1]	✓	✓	✓	✓
Precipitation rate[1]	✓	✓	✓	✓
Snow cover[1]	✓	✓	✓	✓
Snow water equivalent[1]	✓	✓	✓	✓
Sea ice [1]	✓	✓	✓	✓
Cloud water[1]	✓	✓	✓	✓
Ice water[1]	✓	✓	✓	✓
Land temp[1]	✓	✓	✓	✓
Land emis[1]	✓	✓	✓	✓
Hydrometeor Profile[2]	✓	✓	✓	✓
Sea Surface Temperature[3]	✓	✓	✓	✓
Snow & Ice Temperature[3]	✓	✓	✓	✓
Advanced QC Params (Average Kernel, Contrib Fcts,..)[4]	✓	✓	✓	✓
Flooding Index[4]	✓	✓	✓	✓
Sea Surface Wind Speed[4]	✓	✓	✓	✓
Soil moisture/wetness[4]	✓	✓	✓	✓
Snow Fall Rate [5]	✓	✓	✓	✓
Precipitation Type (water Phase)[5]	✓	✓	✓	✓
Cloud Water over Non-ocean Surfaces[5]	✓	✓	✓	✓
Cloud Thickness[5]	✓	✓	✓	✓
Cloud Top[5]	✓	✓	✓	✓

MIRS Description
(IT Requirements)

- Hardware Requirements (sensor/day, low-res)
  - » CPU Processing Time (based on 1.6 GHz)
    - – 1 CPU/EDR-DEP with intermediary data: 2.25 hrs
    - – Above plus gridded data and figures: 3 hrs
    - – 14 CPUs/EDR-DEP with intermediary data: 15 min
    - – Above plus gridded data and figures: 45 min
  - » Memory
    - – 1 GB minimum (serial data processing)
  - » Storage
    - – EDR/DEP with intermediary data: 3 GB
    - – Above plus gridded data and figures: 10 GB

** Excludes NWP steps for performance assessment*

MIRS System Requirements (IT)

In addition, MIRS must have requirements to meet Operational and User needs at the System level

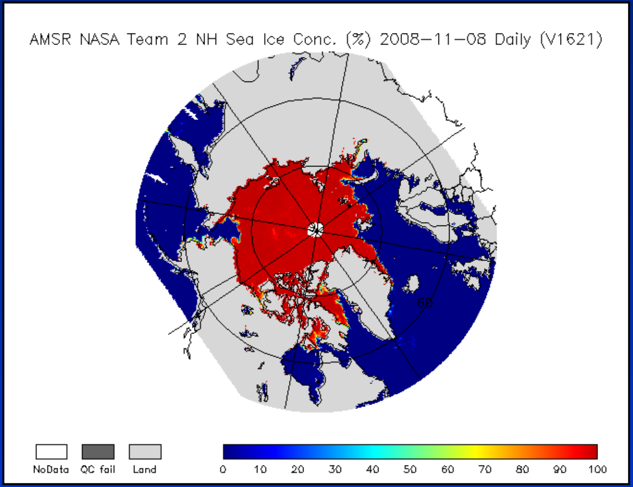
- Provide source codes, libraries, and ancillary files
  - » F90/F95 code, IDL code (not op. requirement), makefiles
  - » Libraries: CRTM, HDF5
  - » Compilation with multiple compilers/platforms
    - – Platforms: Linux, IBM AIX
    - – Compilers: ifort, f95, xlf95
  - » Documentation and Support
  - » GUI for enhanced user functionality and customization (requires JAVA 6)
- Provide updated MIRS algorithm package to users
- License agreements where applicable

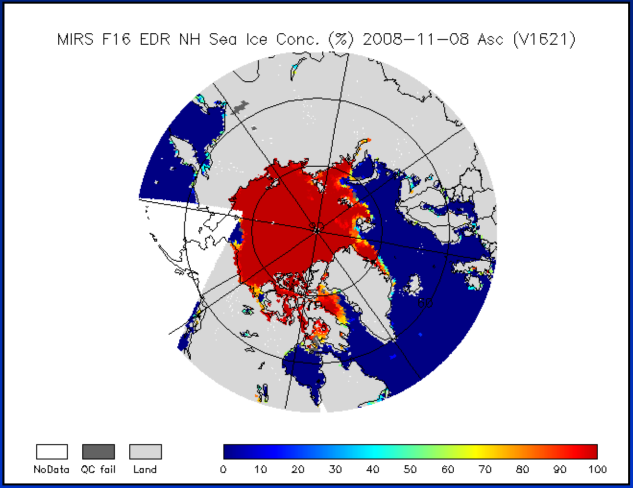
F16 Products
(SIC Results NH – F16/N18/AMSR)

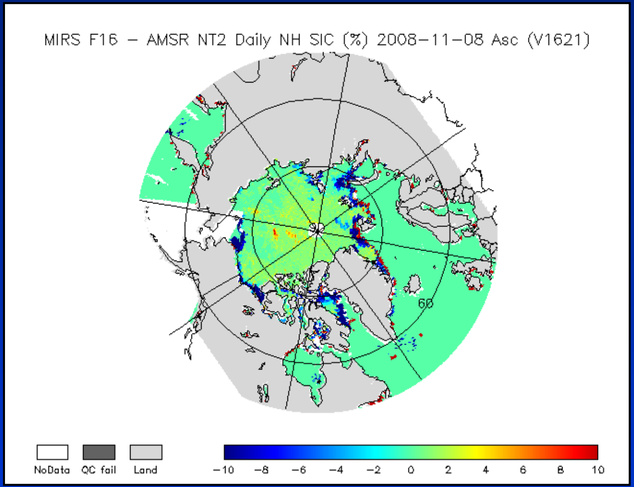
AMSR

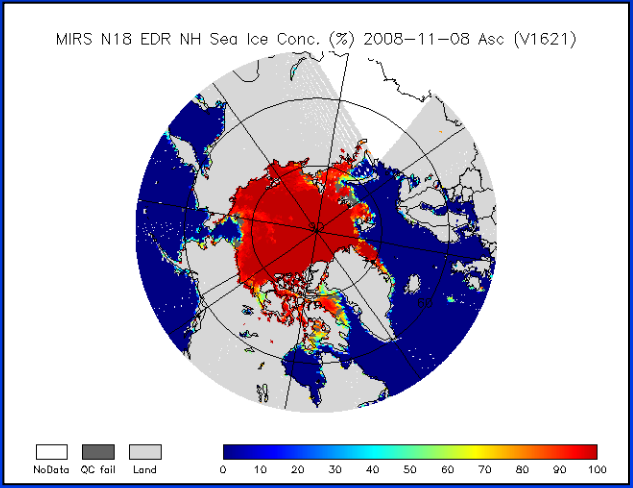
MIRS: F16(top) N18(bot)

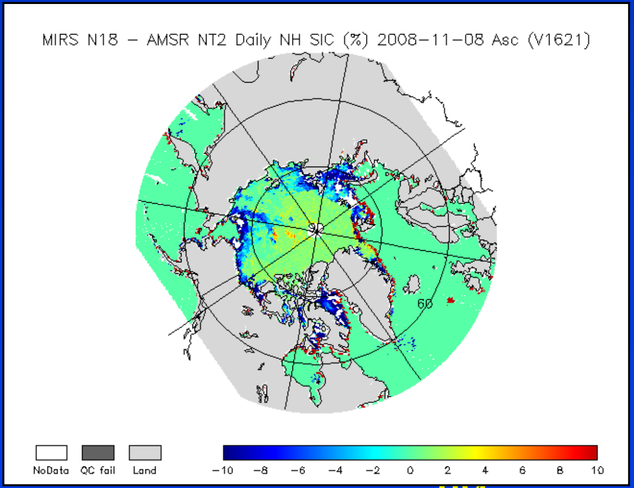
MIRS - AMSR







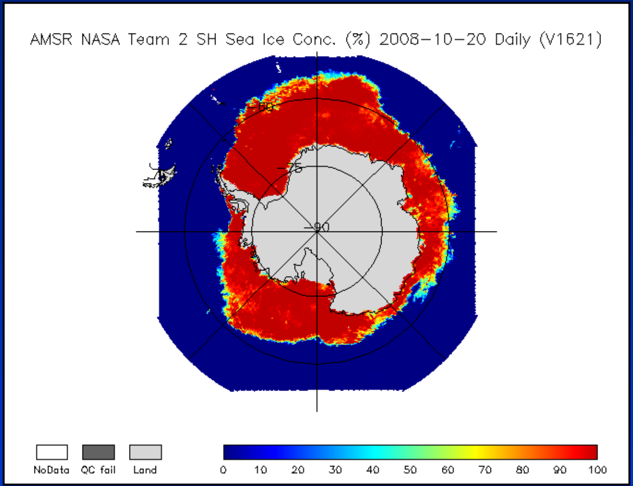


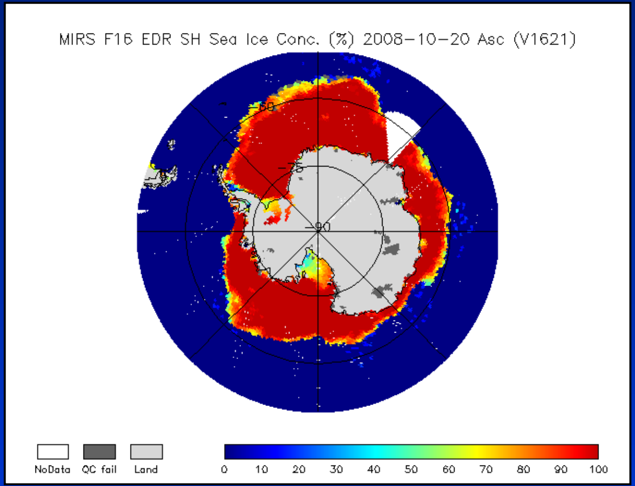


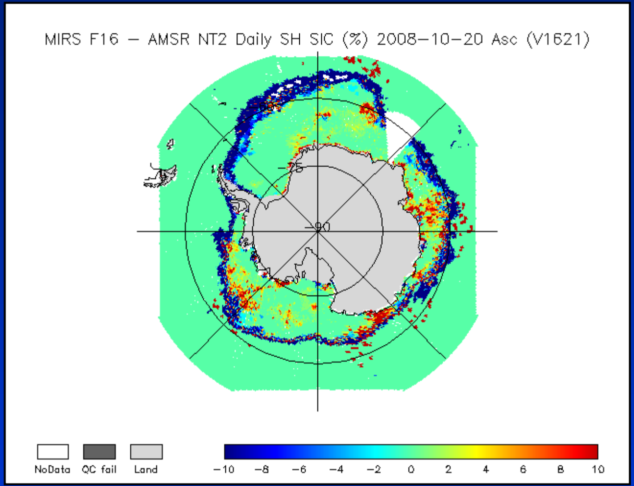
- Example on 20 Oct 08
- Good agreement between F16 and N18
- Largest differences with AMSR near ice edge

F16 Products
(SIC Results SH – F16/N18/AMSR)

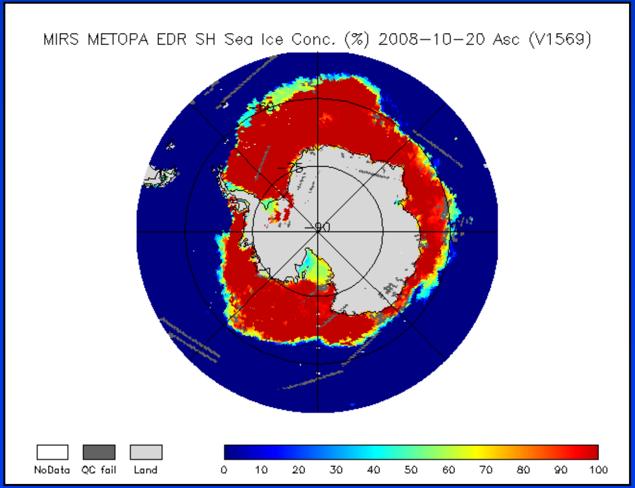
AMSR | **MIRS: F16(top) N18(bot)** | **MIRS - AMSR**

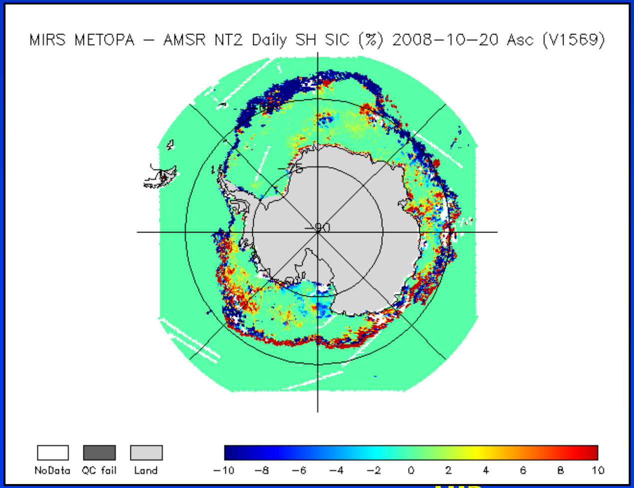

AMSR NASA Team 2 SH Sea Ice Conc. (%) 2008–10–20 Daily (V1621)


MIRS F16 EDR SH Sea Ice Conc. (%) 2008–10–20 Asc (V1621)


MIRS F16 – AMSR NT2 Daily SH SIC (%) 2008–10–20 Asc (V1621)

- Example on 20 Oct 08
- Good agreement between F16 and N18
- Largest differences with AMSR near ice edge


MIRS METOPA EDR SH Sea Ice Conc. (%) 2008–10–20 Asc (V1569)


MIRS METOPA – AMSR NT2 Daily SH SIC (%) 2008–10–20 Asc (V1569)

MIRS Core Products (Science Improvements)

- Three primary components to 1DVar
  - » Bias Correction: Correction applied to measured TBs to make consistent with the forward model
  - » Covariance Matrix: Provides a set of covariances to the 1DVar to determine the variational interdependence of retrieved parameters
  - » First-Guess: An initial value give to parameters in the state-vector to begin the retrieval closer to the truth (as opposed to starting from climatology)