Microwave Integrated Retrieval System for NPOESS Preparatory Project:

MiRS NPP/ATMS Integration into NDE

System Readiness Review

April 19, 2012

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Review Agenda

1. Introduction	10:00 – 10:10	**K. Garrett**
2. CUTR Report	10:10 – 10:30	**C. Grassotti**
3. System Requirements • Requirements Allocation • Deliverable Status • Success Criteria	10:30 – 10:50	**C. Grassotti**
4. System Readiness	10:50 – 12:00	
• System Configuration: External and Internal Interfaces, System Tests for MiRS and QC DAP		**K. Garrett**
• System Test Results: IT Benchmarks, Product Assessment and QC		**C. Grassotti, K . Garrett, F. Iturbide, D. Powell**
• Readiness for Users, Operations and Maintenance		**C. Grassotti**
5. Risks/Actions	12:00 – 12:15	**K. Garrett**
6. Summary and Conclusions	12:15 – 12:25	**K. Garrett**
Discussion	12:25 – 1:00	**All**

- **INTRODUCTION**
- CUTR Report
- System Requirements
  - » Requirements Allocation
  - » Deliverable Status
  - » Success Criteria
- System Readiness
  - » System Configuration: External and Internal Interfaces, System tests for MiRS and QC DAPs
  - » System Test Results: MiRS IT, Product Assessment and QC
  - » Readiness for Users, Operations and Maintenance
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Section 1 – Introduction

Presented by

K. Garrett

Project Objectives

- Technical Objective
  - **Adaptation of MiRS to NPP ATMS and integration within NDE (MiRS Science and QC)**
  - **High priority to implement MiRS in high-resolution going forward (NPP, Metop-B, etc.)**

- Science Objectives
  - Improved temperature and moisture profile retrievals
  - 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

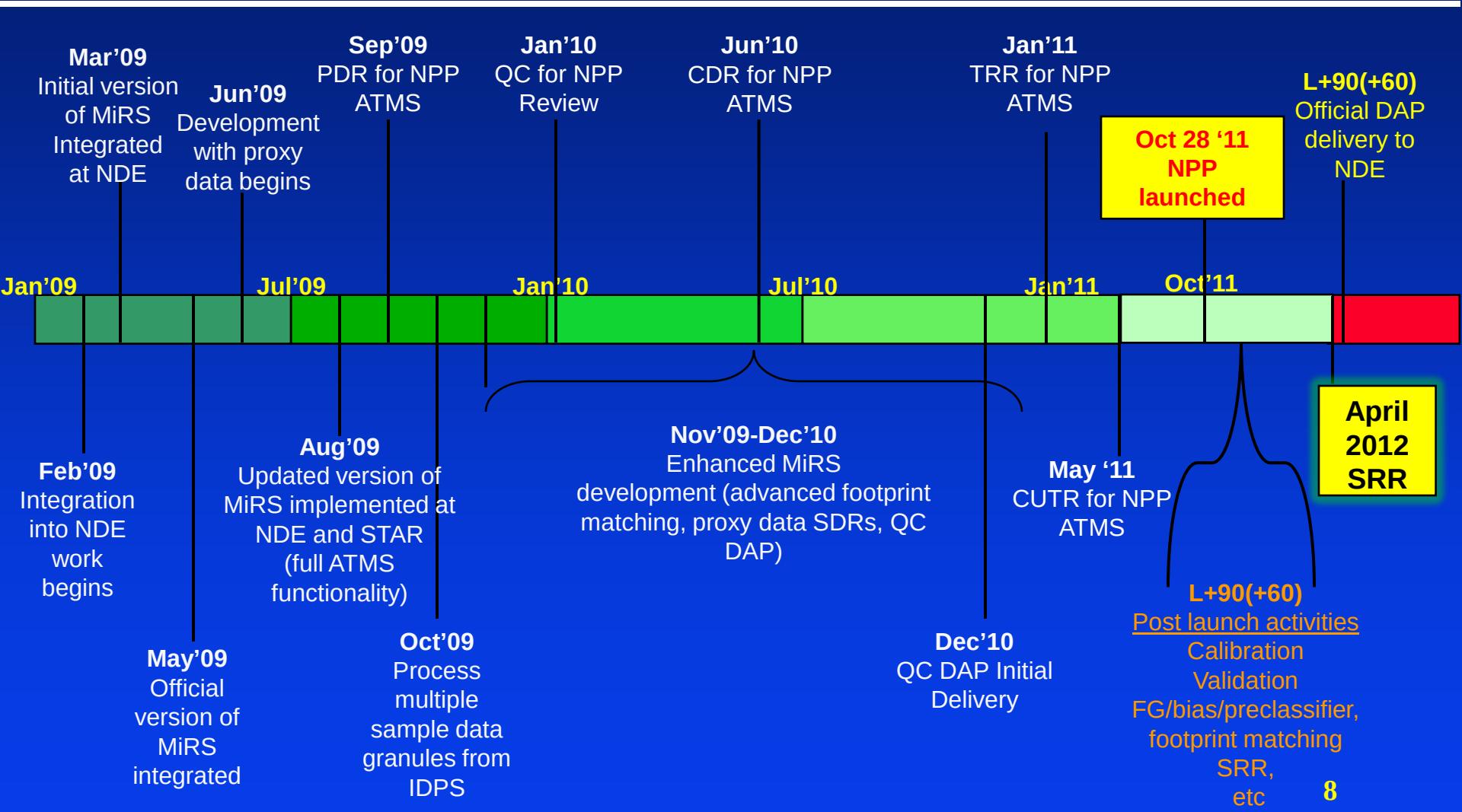
SRR Objectives

- Objectives of the System Readiness Review
  - » Goal #1: Gather all MiRS stakeholders to review the overall system integration of MiRS into the NPOESS Data Exploitation (NDE) environment
  - » Goal #2: Review of system requirements and requirements allocation
  - » Goal #3: Review of system readiness (incl. system test, readiness for users and maintenance/operations)
  - » Goal #4: Review of CUTR action items and actions taken
  - » Goal #5: Identify new or outstanding risks w/mitigation strategies
- Follow the STAR EPL Guidelines for SRR

MiRS Stakeholders

- Development Team
  - S.-A. Boukabara, K. Garrett, F. Iturbide-Sanchez, C. Grassotti, W. Chen, L. Moy, **T. Clough (part-time consultant since March 2012)**
- OSPO Partners
  - L. Zhao, J. Zhao, J. Wang
- NDE Partners
  - P. MacHarrie, L. Fenichel, D. Powell, J. Silva, G. Goodrum
- MiRS Oversight Board
  - F. Weng (chair), R. Ferraro (STAR), L. Zhao (OSPO), J. Silva (NDE), T. Schott (OSD)
- Oversight Panels
  - SPOP, PREPOP, ICAPOP, LSPOP
- MiRS Users
  - Dan Pisut (NOAA EVL), Tony Reale (STAR), Joe Turk (JPL), Ben Ruston (NRL), Sheldon Kusselson (SAB), Stan Kidder (CIRA), Kevin Schrab and Andy Adman (NWS), Denise Hobson (AFWA), M. Kim (JCSDA), G. Huffman and W. McCarty (NASA/GSFC), J. Tesmar (FNMOC), P. Wang, M-H. Liao (Taiwan Weather Bureau), J. Janowiak (UMD), Paul Field (UKMET), K. Okamoto (JMA), M. V. Engel (IAO SB), B. Lambrigtsen (JPL), Peiming Dong, Qui Hong and Hu Yang (CMA), Universities (Graduate School of Chinese Academy of Sciences, Universia degli studi di Roma), Franklin Robertson and Clay Blankenship (NASA/MSFC), Tom Auligne (NCAR), D. Vila (CPTEC, Brazil), W. Han (Chinese Met. Admin.), D. Cimini (IMAA/CNR), M. Itkin (MPI-M, Hamburg), T. Greenwald (SSEC), L. Chen (CNES)

MiRS in NDE Timeline



- Introduction
- **CUTR REPORT**
- System Requirements
  - » Requirements Allocation
  - » Deliverable Status
  - » Success Criteria
- System Readiness
  - » System Configuration: External and Internal Interfaces, System tests for MiRS and QC DAPs
  - » System Test Results: MiRS IT, Product Assessment and QC
  - » Readiness for Users, Operations and Maintenance
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Section 2 – CUTR Report

- Review of CUTR Action Items
- SRR Entry Criteria
- SRR Exit Criteria
- CUTR Summary

Presented by

C. Grassotti

CUTR Action Items

- Total of 3 Action Items
- For each AI, response was drafted (when available) describing the item, the action(s) (to be) taken, and status
- Response sent to AI author(s)
- At present:
  - 3 Items Closed

CUTR Action Items

Action Item	Description	Author	Lead Org	Status
1	Share upgraded netCDF converter with OSPO	L. Zhao	STAR	Closed
2	STAR/OSPO Meeting to Discuss Scaling and Precision Requirements for netCDF data	C. Grassotti	STAR/OSPO	Closed
3	OSPO/NDE Meeting to Discuss QC DAP Requirements	K. Garrett	OSPO/NDE	Closed

Action Item # 1: Sharing of Upgraded STAR netCDF Converter with OSPO

Submitted by: L. Zhao

Description: STAR upgrades to mirs2nc encoder (now supports netCDF4) to be shared with OSPO

Lead Organization: STAR

Response: New version of mirs2nc provided to OSPO on 31 May 2011

Status: CLOSED

Action Item # 2: Meet with OSPO to Discuss Scaling and Precision Requirements in netCDF Outputs

Submitted by: C. Grassotti

Description: MiRS IPT to meet with OSPO to discuss requirements for scaling, precision, and storage for data contained in netCDF output files.

Lead Organization: STAR/OSPO

Response: Meeting held in September, 2011 to discuss requirements, and a set of scaling and storage parameters for output netCDF4 files was agreed upon. All changes to file contents, scaling, storage parameters have been updated and tested, and are now reflected in the mirs2nc software.

Status: CLOSED

Action Item # 3: OSPO/NDE Meeting to Discuss Requirements for QC DAP

Submitted by: K. Garrett

Description: OSPO to meet with NDE to discuss OSPO requirements and runtime scenarios for QC DAP. OSPO to define what outputs are required. MiRS IPT can provide information as needed.

Lead Organization: OSPO/NDE

Response: Several meetings between OSPO/NDE/STAR held. Requirements and responsibilities between NDE and OSPO were discussed, and conclusion was for NDE to run QC DAP and provide all outputs to OSPO, including plots.

Status: CLOSED

CUTR Action Items

Action Item	Description	Author	Lead Org	Status
1	Share upgraded netCDF converter with OSPO	L. Zhao	STAR	Closed
2	STAR/OSPO Meeting to Discuss Scaling and Precision Requirements for netCDF data	C. Grassotti	STAR/OSPO	Closed
3	OSPO/NDE Meeting to Discuss QC DAP Requirements	K. Garrett	OSPO/NDE	Closed

MiRS for NPP/ATMS SRR Entry Criteria

- Entry # 1 – Review of CUTR Report with Action Items, Responses, Status
- Entry # 2 – Review of the SRR for MiRS NPP/ATMS in NDE
  - » System Requirements and requirements allocation
  - » System Readiness (incl. system test, readiness for users and maintenance/operations)
  - » Risks/Actions

MiRS for NPP/ATMS SRR Exit Criteria

- Exit # 1 – System Readiness Review Report
  - » SRR Report will be compiled and delivered after SRR
  - » SRR Report to contain:
    - – SRR Presentation
    - – Actions
    - – Comments

CUTR Report Summary

- This CUTR Report closes the CUTR
- Total of 3 Action Items:
  - » At present, all 3 items have been closed
- 2 SRR Entry Criteria have been established
- 1 SRR Exit Criterion has been established

- Introduction
- CUTR Report
- **SYSTEM REQUIREMENTS**
  - » **Requirements Allocation**
  - » **Deliverable Status**
  - » **Success Criteria**
- System Readiness
  - » System Configuration: External and Internal Interfaces, System tests for MiRS and QC DAPs
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Section 3 –
System Requirements

Presented by

C. Grassotti

Requirements

- Research to Operations Level 1 Requirements Document
  - » Final approved in April 2010
  - » Developed, reviewed, approved by NDE, OSD, OSPO, and STAR
  - » Establishes requirements and allocation of responsibilities between MiRS IPT, NDE, OSPO
  - » Performance (NPP/ATMS, Implementation, Interface, QC and Monitoring); Project Management (coding standards, version control, etc.); Funding; Schedule
  - » STAR to deliver QC DAP to NDE: Based on Tier-1 and Tier-2 MiRS operational QC
  - » MiRS IPT: Assist With Integration into NDE environment
  - » Minimal and Fully Successful Criteria
- Requirements Changes Since CUTR: ESPDS Standards for Algorithm Delivery and Integration Using Delivered Algorithm Packages (DAPs)
  - » Approved September 2011
  - » Specifies roles, responsibilities and requirements for Science Algorithm DAPs to NDE: delivery memo, readme, documentation, test data, etc.
- **System readiness for MiRS and QC DAPs in STAR is complete; System readiness in NDE is complete for MiRS DAP and will be complete for QC DAP by time of DAP delivery.**

Requirements: Deliverable Status

	Deliverable	Comment	Delivery Status
Prior Docs	MiRS System Description Doc	Developed for POES, DMSP; Avail on MiRS website	Delivered ✓
	MiRS Interface Control Doc	Developed for POES, DMSP; Avail on MiRS website	Delivered ✓
	MiRS Users Manual	Developed for POES, DMSP; Avail on MiRS website	Delivered ✓
Current Docs	PDR + Document	PDR Slides and Action Items w/Status	Delivered ✓
	CDR + Document	CDR Slides and Action Items w/Status	Delivered ✓
	Level 1 Requirements Doc	Document approved	Delivered ✓
	TRR + Document	TRR Slides and Action Items w/Status	Delivered ✓
	CUTR + Document	CUTR Slides and Action Items w/Status	Delivered ✓
Future Docs	IUM, EUM, SMM, ATBD	SPSRB Required Docs	To be delivered with final DAP✓
Software (Integration/Testing)	MiRS Algorithm DAP	Level1b ingest and preproc., core retrievals, derived products	Delivered ✓ Final IOC* Delivered with final DAP
	MiRS QC DAP	Tier-1 and Tier-2 QC	Delivered ✓ Final IOC* Delivered with final DAP
Reviews	Preliminary Design Review	Completed: 9/2009	Delivered ✓
	Critical Design Review	Completed: 6/2010	Delivered ✓
	Test Readiness Review	Completed: 1/2011	Delivered ✓
	Code Unit Review	Completed: 5/2011	Delivered ✓
	System Readiness Review	To be completed: 4/2012	To be delivered ✓

*** Note: Final IOC will also include Delivery Memo, README, and all other required DAP docs**

System Success Criteria

Success Status	Criteria	Steps
Minimally Successful **MIRS DAP**✓ **QC DAP**✓	End-to-End Processing of **Sample or Proxy** Data:	Read HDF5 TDRs or SDRs
		Run MiRS algorithms
		Output products to NetCDF4 (CF convention)
		Integration into NDE Processing System
Fully Successful **MIRS DAP**✓ **QC DAP**✓	End-to-End Processing of **Live** Data:	Read HDF5 TDRs or SDRs
		Run MiRS algorithms
		Output products to NetCDF4 (CF convention)
		Integration into NDE Processing System *

- MiRS and QC DAP have been "fully successful" since shortly post-launch (* Note: initial MiRS DAP integrated and tested at NDE; QC DAP end-to-end integration at NDE is expected by Final DAP delivery; this will be listed as an SRR risk item)

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  - » **System Test Results: MiRS IT, Product Assessment and QC**
  - » **Readiness for Users, Operations and Maintenance**
- Risks/Actions
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Section 4 –
System Readiness

- System Configuration: External and Internal Interfaces, System tests for MiRS and QC DAPs
- System Test Results: MiRS IT, Product Assessment and QC
- Quick note on plans for enhanced MiRS diagnostics and processing
- Readiness for Users, Operations and Maintenance

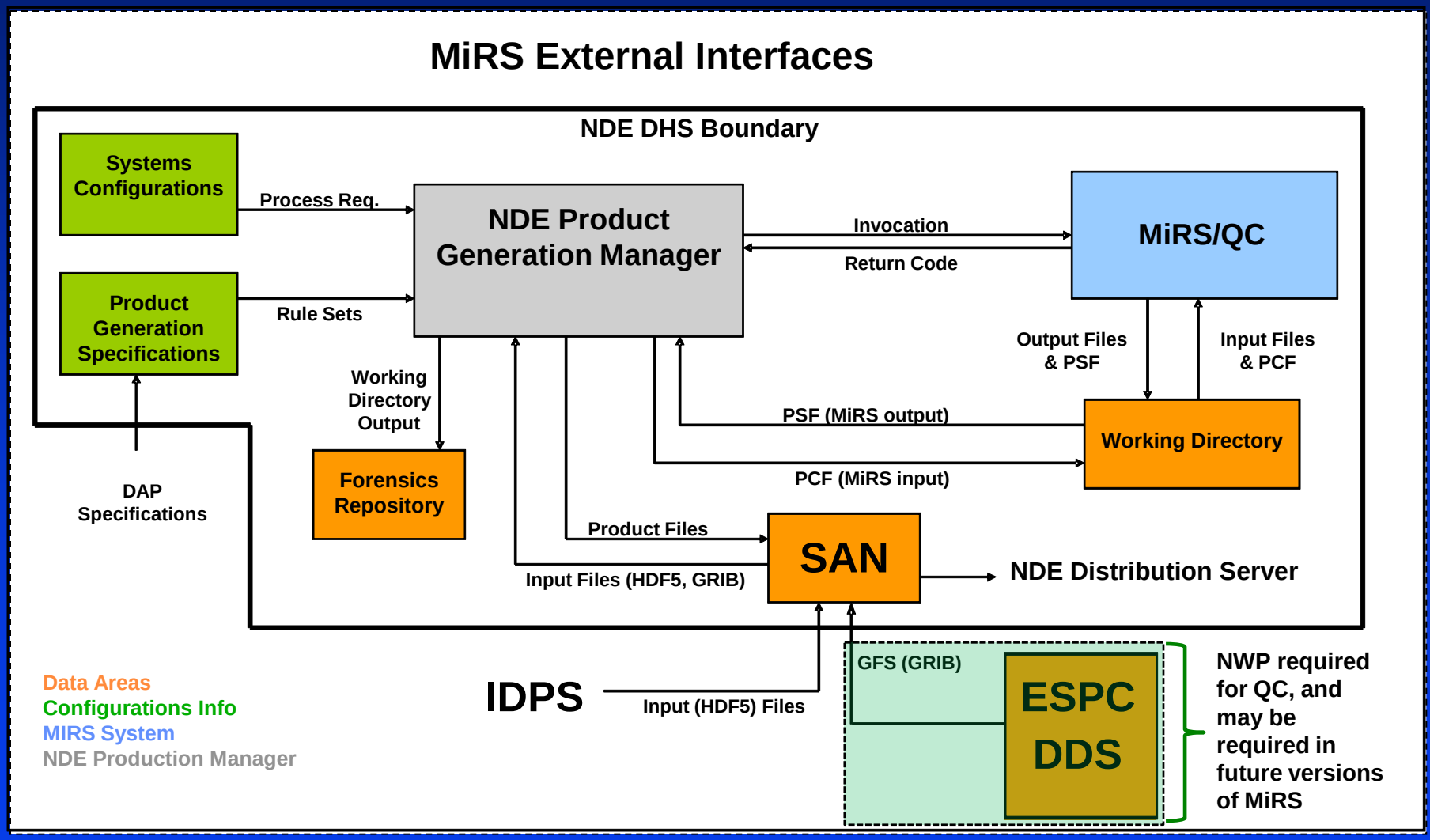
Presented by

C. Grassotti, K. Garrett, F. Iturbide, D. Powell

Software Architecture: Overview

- The software architecture describes the structure of the system software elements and the external and internal data flows between software elements.
- 3 Layers of design (STAR EPL Guidelines):
  - Context Layer - 0: External Interfaces
  - System Layer - 1: Flow Between Units
  - Unit Layer - 2: Flow Within Units

MiRS in NDE: External Interfaces



MiRS External Interfaces

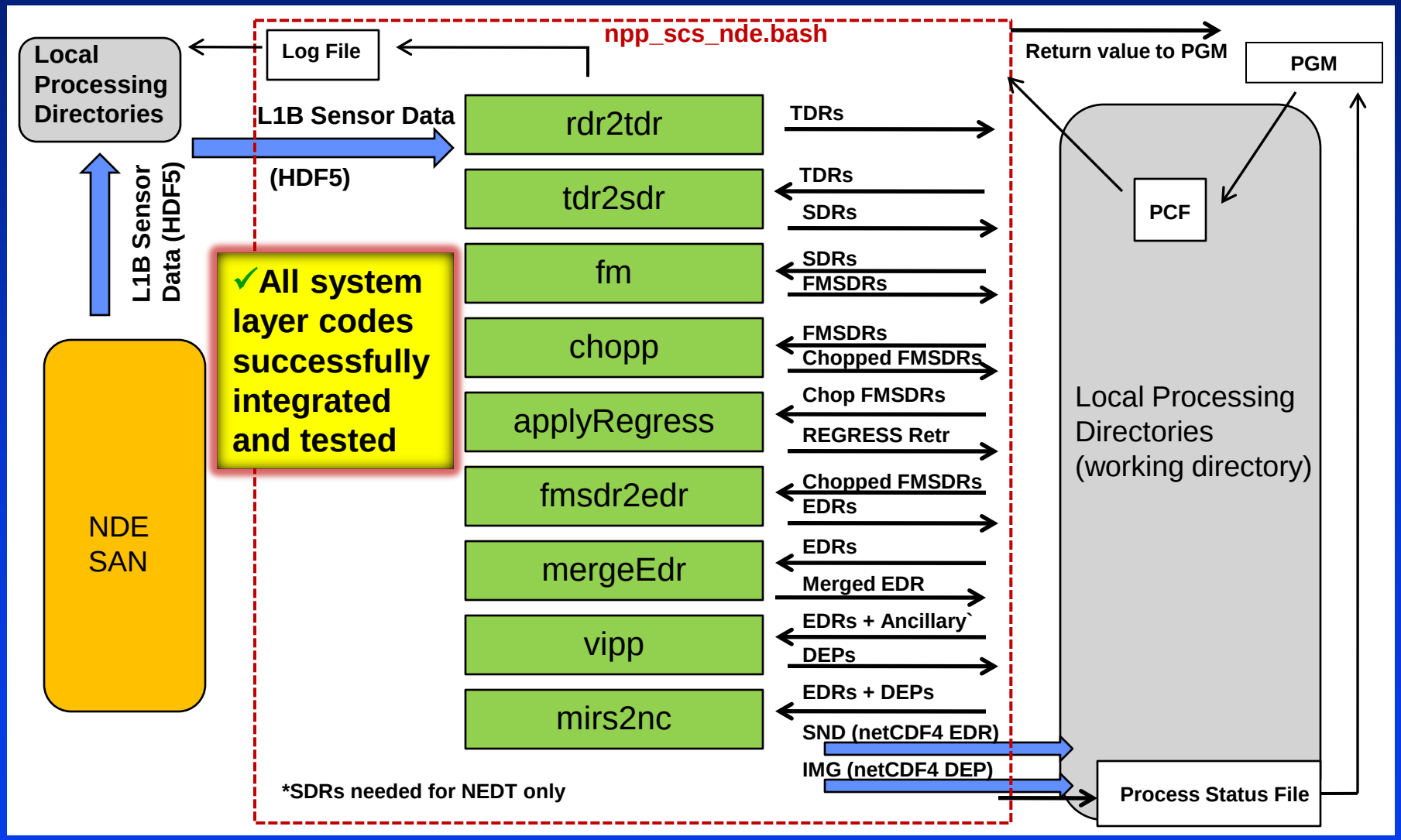
- File format requirements for NPP ATMS
  - » ATMS level 1b granules/geo formatted in HDF5
  - » PCF ascii file generated by NDE DHS
  - » MiRS product outputs formatted in netCDF4 (CF conventions)
  - » MiRS output PSF ascii file listing output files
  - » All MiRS readers and encoders support these formats and have been running with live data in NDE
- Metadata:
  - » Current MiRS Collection Level metadata available in ISO 19115 at CLASS (for POES/Metop/DMSP)
  - » Similar Collection Level file for MIRS NPP ATMS products to be stored at CLASS
  - » Metadata requirements for MiRS NPP ATMS are outlined by updated Submission Agreement
  - » MiRS NPP ATMS Granule Level metadata to be contained inside the MiRS netCDF4 output header (following STAR metadata template finalized 5/18/2011)

MiRS DAP Processing Units

- Each major step in the MiRS processing sequence is a stand-alone bash script and a corresponding Fortran 95 or C++ executable and namelist file and constitutes a Layer-2 Test Unit

Code Unit	Purpose	Ready
r2r2tdr	**Convert raw data records to temperature data records (antenna temperatures); generate sensor NEDT files**	✓
tdr2sdr	**Convert temperature data record to sensor data record (TBs or radiances)**	✓
fm	**Footprint matching**	✓
chopp	**Chop fm files into sub-files**	✓
applyRegress	**First guess generation using TB-based regression (applied on chopped fm files)**	✓
fmsdr2edr	**1dvar: converts footprint matched SDRs to EDRs**	✓
mergeEdr	**Merge EDR files into 1 file**	✓
vipp	**Postprocessing converts EDRs to derived environmental parameters (DEPs)**	✓
convertMirs2nc	**Converts files from MiRS binary to netCDF4**	✓

MiRS System-Layer Process Flow: NDE Environment



MiRS QC Overview

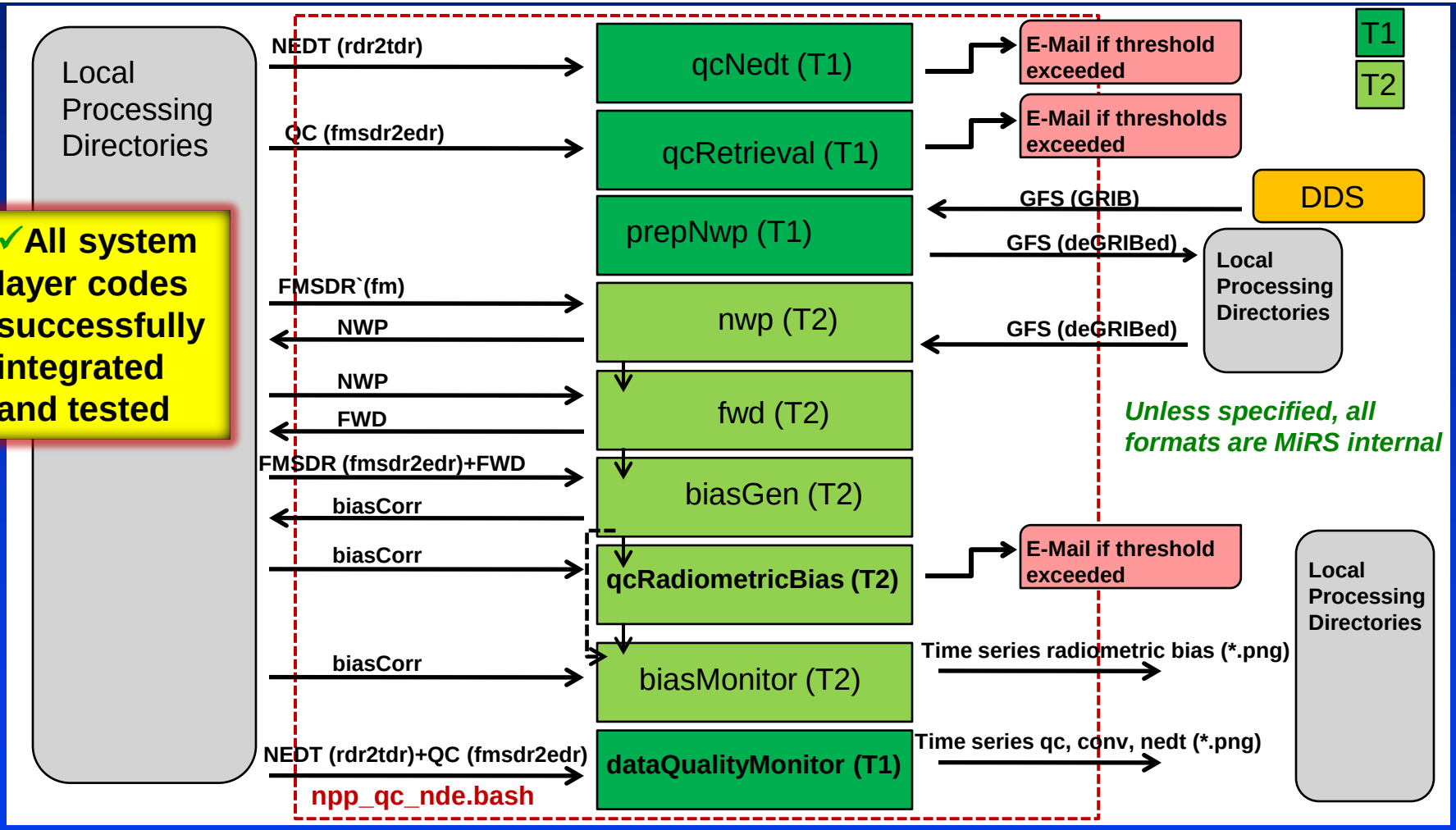
- **Overall Objective:** Comprehensive real-time monitoring at various stages of MIRS data processing; selective flagging and notification of anomalies via e-mail
- Run daily in STAR environment; Applied to N-18, N-19, Metop-A, NPP/ATMS, DMSP
- **Tier-1 ("Autonomous") QC:** Easily implemented in operations
  - » NEDT monitoring (time series, **e-mail alerts**)
  - » QC flag monitoring (time series, **e-mail alerts**)
  - » Convergence monitoring (1dVAR) (time series, **e-mail alerts**)
- **Tier-2 ("Intermediate") QC:**
  - » Radiometric performance (time series, **e-mail alerts** for dynamic biases)

QC DAP System Layer : Processing Units

- **Each step in the MiRS Tier-1 and Tier-2 QC processing sequence is a stand-alone bash script and one or more corresponding Fortran 95 executables, or IDL procedures (v6) driven by namelist files**

Code Unit	Purpose	Tier	Comment	Ready
qcNedt	Parses NEDT files (generated by rdr2tdr) and generates an **e-mail** if thresholds exceeded	1	**Autonomous**	✓
qcRetrieval	Parses DEP files (generated by fmsdr2edr) and generates an **e-mail** if thresholds of QC or conv rate exceeded	1	**Autonomous**	✓
prepNwp	Check for required NWP data, convert NWP files from GRIB to binary if needed	1	**NWP required**	✓
nwp	Interpolates NWP fields to FMSDR location and time	2	**NWP required**	✓
fwd	Runs CRTM forward model on NWP output (generated by nwp) to simulate TBs at each FMSDR location	2	**NWP required**	✓
biasGen	Compares FWD to FMSDR TBs and generates bias files	2	**NWP required**	✓
qcRadiometricBias	Parses bias files (generated by biasGen) and generates an **e-mail** if thresholds exceeded	2	**NWP required**	✓
biasMonitor	Produces time series of radiometric bias from bias files (generated by biasGen)	2	**NWP+product retention**	✓
dataQualityMonitor	Produces time series of nedt, qc, convergence from NEDT and QC files (generated by rdr2tdr and fmsdr2edr)	1	**Product retention required**	✓

MiRS Tier-1 and 2 QC System-Layer Process Flow: NDE Environment



NB: Time series require archiving biasCorr, NEDT and QC files

MiRS Tests: STAR Environment
MiRS DAP and QC DAP

- Run on standard Linux machine (e.g. orbit272L)
- **Codes:** (F95, C++) precompiled using Linux compiler (ifort, g++, HDF5, netCDF4) + IDL for QC DAP
- **Required**: Working directory (in NDE this will be created at run time by the PGM): this is where all file input/output takes place. **For MiRS QC, MiRS DAP must have already been run.**
- **MiRS DAP** Working directory contents (3 files + PCF):
  - » Single ATMS granule: 3 HDF5 files containing geolocation (GATMO_*.h5) and radiometric data (SATMS_*.h5, TATMS_*.h5)
  - » PCF: contains directory, variable specifications, flags to control execution of MiRS script (npp_scs_nde.bash), which steps to run, etc.
- **MiRS QC DAP** Working directory contents (19 files +PCF):
  - » Previous granule(s): Bias file, Nedt file, QC file (for time series)
  - » Current granule: Nedt, FMSDR, EDR, DEP,SATMS
  - » Nominal Bias file (copied from MiRS SemiStaticData)
  - » GFS forecast files deGRIBed by prepNWP (normally 5 atm + 5 sfc)
  - » PCF: contains directory, variable specifications, flags to control execution of MiRS script (npp_qc_nde.bash), which steps to run, etc.

MiRS System Tests: MiRS IT, Product Assessment, QC

- MiRS IT Benchmarking
  - » IT benchmarks in STAR (C. Grassotti)
  - » IT benchmarks and System Integration at NDE (D. Powell, ESPDS/NDE)
- MIRS Science Quality Assessment
  - » Footprint matching (K Garrett)
  - » MiRS QC (K. Garrett)
  - » Sounding products (K. Garrett)
  - » Hydrometeors (F. Iturbide)
  - » Surface products (C. Grassotti)
  - » New Diagnostic and Assessment Tools for MiRS (C. Grassotti)

MiRS IT Benchmarks in STAR Environment: Processing steps High Res RDR -> DEP -> netCDF4

Machine	Single CPU (core)	Number of CPUs	Total Memory
orbit272L	2.67 GHz	24	132 GB

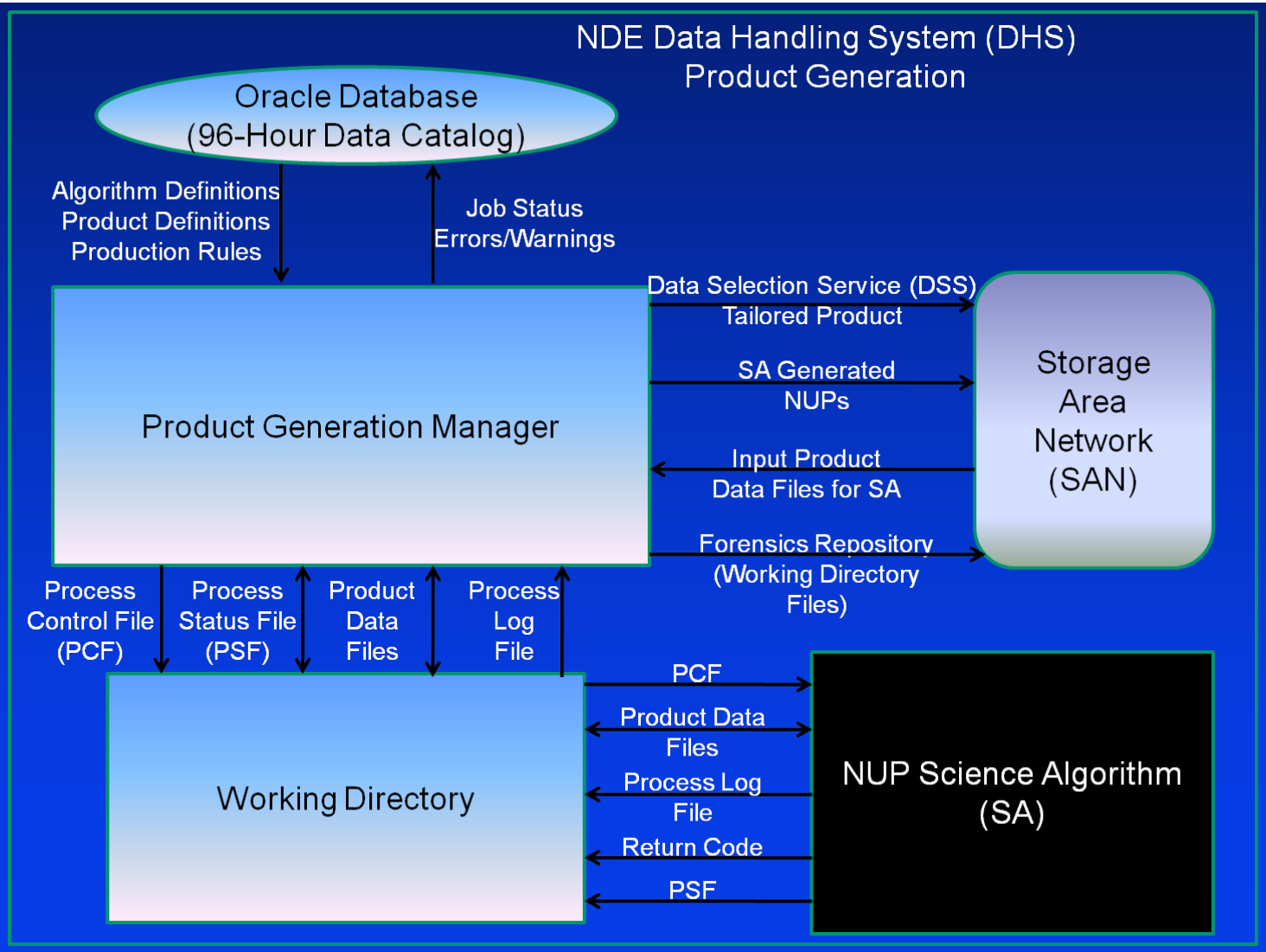
- 1 granule = 1152 profiles
- 1 orbit = 195 granules
- 1 day= 2700 granules

Single granule Chop factor=9	Number of profiles per processor=1152/9=128		
MiRS Step	**CPU Time (sec)**	**Real Time (sec)**	**Remarks**
rdr2tdr	0.13	0.55	
mergeNedt	0.08	0.28	
tdr2sdr	0.06	0.29	
fm	0.06	0.31	
chopp	0.06	0.28	
fmsdr2edr	60.8	8.59	•56% of real time •96% of CPU time • ~ 50% of time spent in CRTM
mergeEdr	0.06	0.36	
vipp	0.12	0.40	
mirs2nc	1.91	4.22	•27% of real time •3% of CPU time
Total	**63.3**	**15.28**	IMG+SND= 3.7 MB

- Total real time < 32 sec (represented in 1 granule)
- Processing speed sufficient to keep up with data flow

Single granule No chopping	Number of profiles per processor=1152		
MiRS Step	**CPU Time (sec)**	**Real Time (sec)**	**Remarks**
rdr2tdr	0.14	0.67	
mergeNedt	0.06	0.11	
tdr2sdr	0.07	0.26	
fm	0.07	0.18	
chopp	NA	NA	
fmsdr2edr	40.60	41.61	•87% of real time •94% of CPU time • ~ 50% of time spent in CRTM
mergeEdr	NA	NA	
vipp	0.17	0.43	
mirs2nc	2.11	4.36	•9% of real time •5% of CPU time
Total	**43.22**	**47.62**	IMG+SND= 3.7 MB Memory = 56 MB

MiRS Integration into NDE



MiRS Integration in NDE

- NDE Data Handling System controls the flow of data from ingest of xDRs through product generation and distribution
  - » MiRS to NDE interface defined by the Algorithm Delivery Standards, Integration, and Test V1.3 (DAP) document
  - » MiRS must be capable of command line execution from any directory using a Process Control File (PCF) – text file listing all MiRS job execution parameters (working directory, input data, execution flags, etc.)
  - » MiRS writes output file names to a Process Status File (PSF) and any output messages (e.g. errors or warnings) to a log file
  - » MiRS issues a return code to NDE DHS indicating success or failure
- NDE database (Oracle) contains all the information necessary for MiRS execution
  - » Algorithm definitions
  - » Production rules
  - » Product descriptions (output and input data files)
  - » Error/Warning messages
  - » System parameters
- Storage Area Network (SAN) stores all input/output data

MiRS IT Benchmarking in NDE Test Environment

- Performance testing with NDE DHS Build 3.0.4, xmlDefinitionsPop_1.0_20120309, and MiRS DAP Release 7.5 v2701 (Aug 8 2011)
- Run on PowerPC_P6 (64 bit) with OS AIX 6.1
- No chopping of granules

Machine	Single CPU (core)	Number of CPUs (cores)	Total Memory
n06apn5	4.20 GHz	16 (8 dual-core)	64 GB

Processing volume	CPU Time (user)	Wall Clock Time (real)	NDE Job Latency	Memory	IMG + SND File Size	Remarks
1 Granule (04/10/2012) (1 CPU)	**63.3 sec**	64.5 sec	65.8 sec	79 MB	4.2 MB	• 3 job boxes (granule/job box) required to keep up orbit-to-orbit
191 Granules (04/10/2012) (16 CPUs) = 1 full orbit = 102 min of real data			48 min (69.4sec/granule)	~1 GB	802 MB	• Assigned 5 job boxes for back-log processing • NDE latency includes ingest, production, and overhead

Based on:
- 1 granule = 1152 profiles
- 1 orbit = 191 granules
- Input data is from ATMS granules ingested from IDPS on 04/10/2012

NDE Production Environment (Product Generation)

- IBM BladeCenter P7 series (64 bit)
- 8 cores (3.0 GHz) with 4 multi-threads per core (32 effective CPUs)
- 64 GB memory
- AIX 6.1 OS
- 7 nodes for production

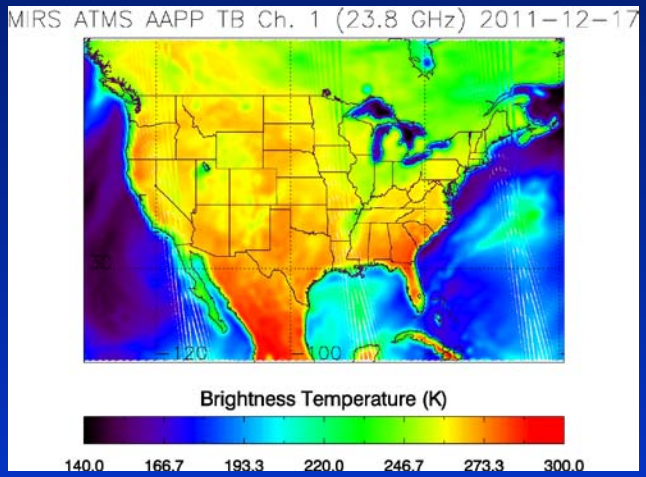
MiRS System Tests: Product Assessment, QC

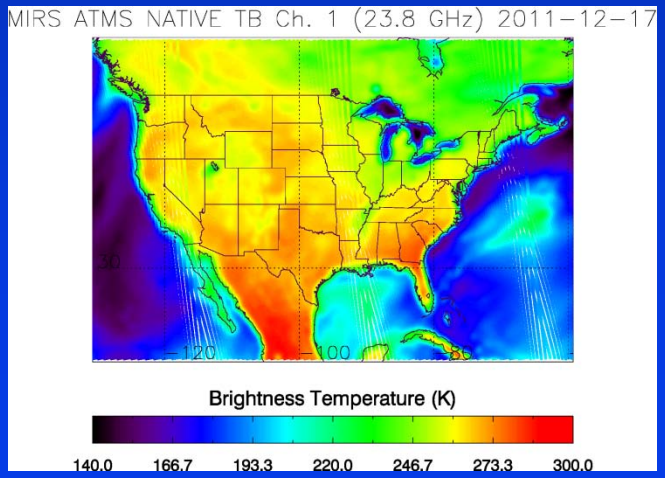
- MIRS Science Quality Assessment
  - Footprint matching and Bias Correction (K. Garrett)
  - MiRS QC (K. Garrett)
  - Sounding products (K. Garrett)
  - Hydrometeors (F. Iturbide)
  - Surface products (C. Grassotti)
  - New Diagnostic and Assessment Tools for MiRS (C. Grassotti)

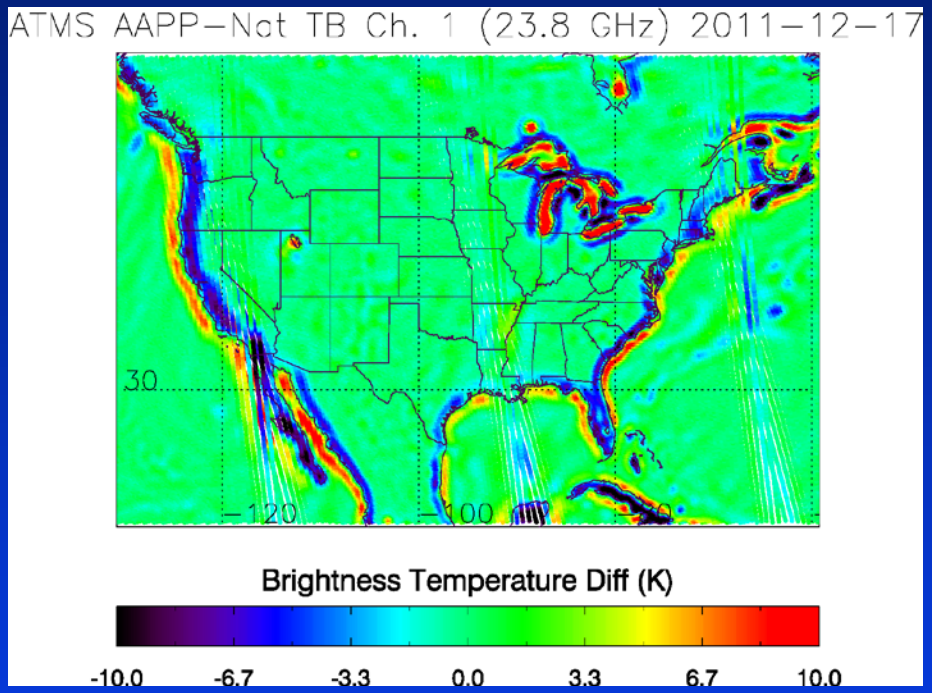
MiRS Product Assessments: Footprint Matching

- Varying spatial resolution by ATMS channel may require increasing resolution of the low spatial resolution channels (since all channels used in retrieval)
- Modification from past TRR/CUTR is the spatial averaging code for ATMS
  - » Utilize the Advanced ATOVS Preprocessor Package (AAPP)
  - » Allows for increased resolution for ATMS channels 1, 2 (5.2° to 3.3°) and channels 3-15 (2.2° to 1.1°)
  - » Integrated within current fm_npp.f90 module
- Current implementation increases channels 1 and 2 from 5.2° to 3.3°. All other channels remain native

MiRS Product Assessments: Footprint Matching

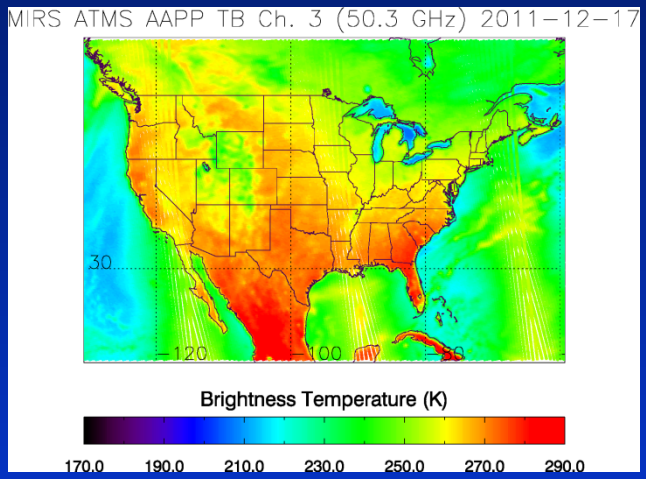


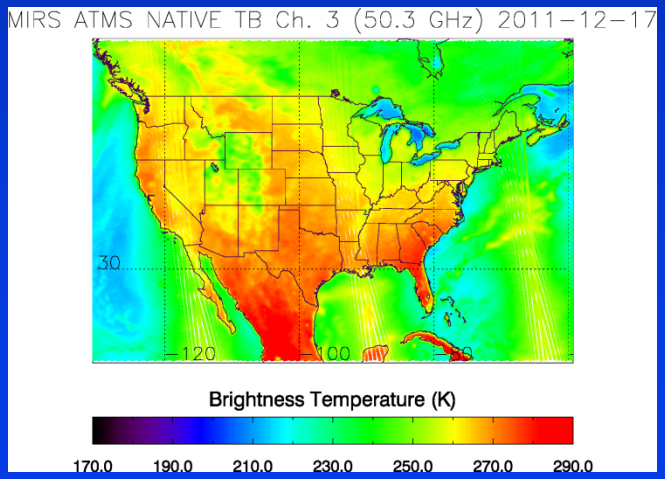


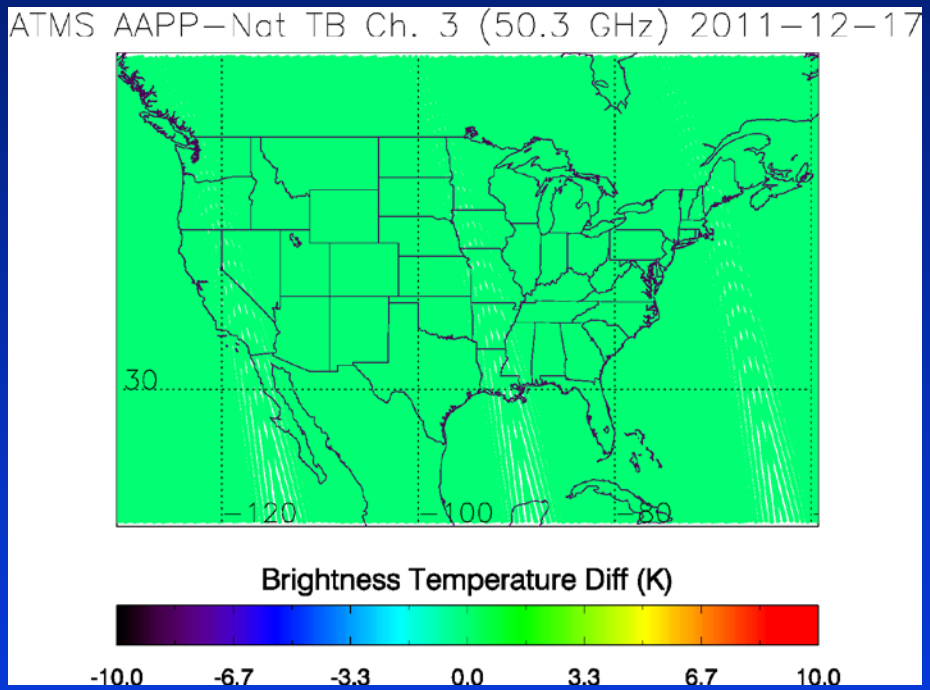


Channel 1 3.3° – 5.2°

MiRS Product Assessments: Footprint Matching

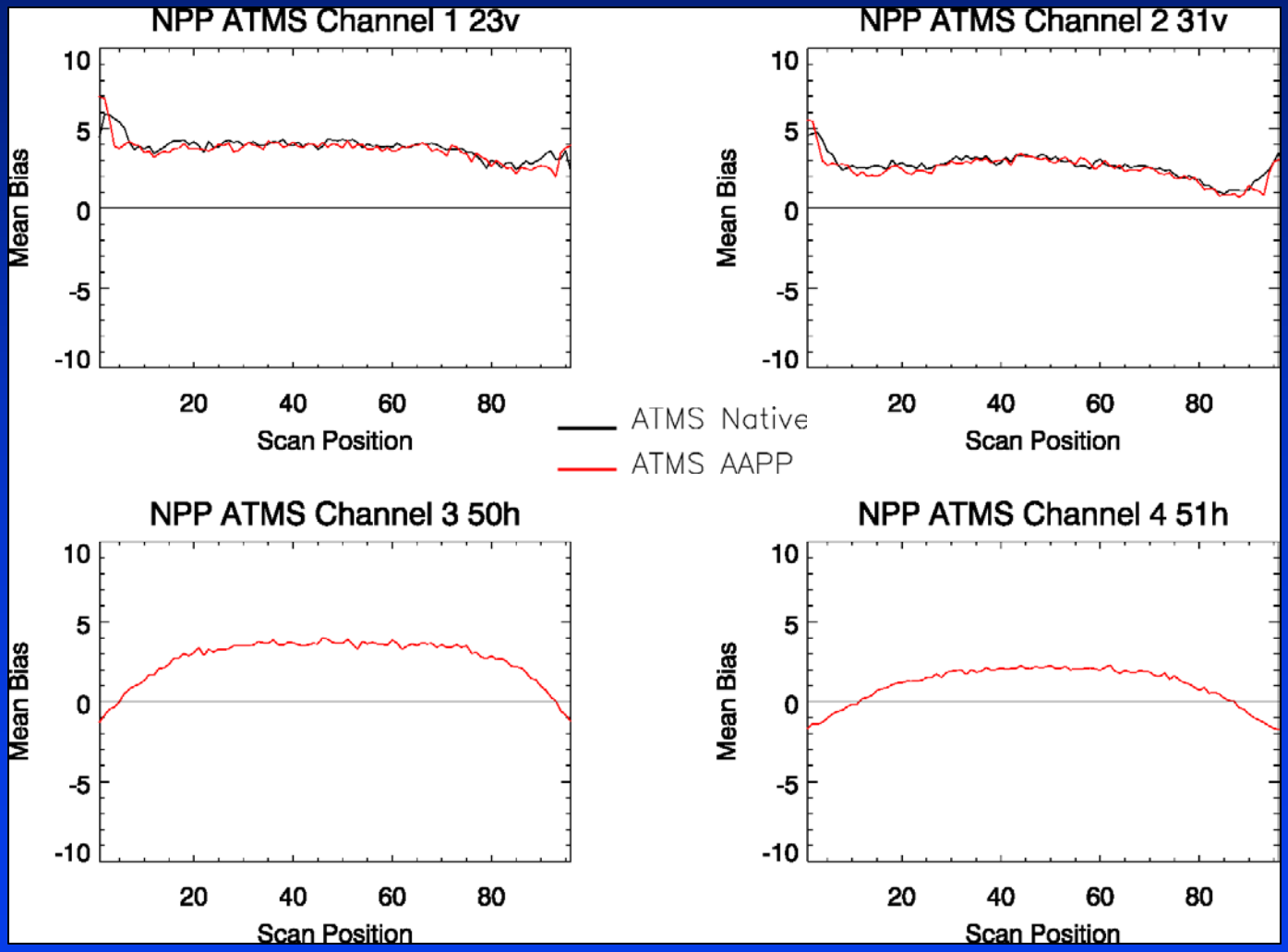






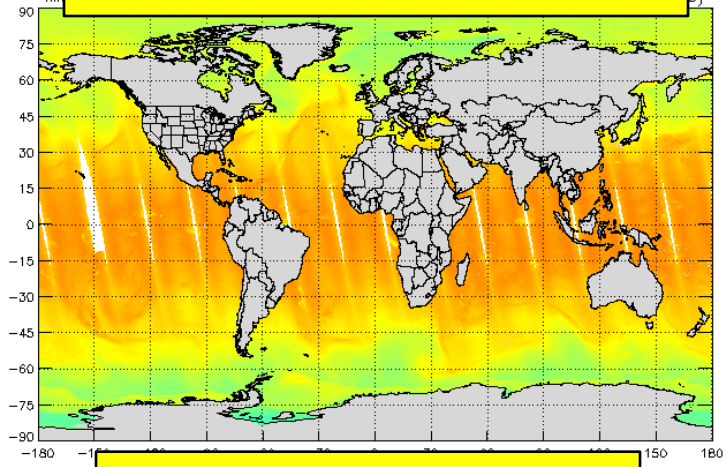
Channel 3 2.2° – 2.2°

MiRS Product Assessments: Bias Correction

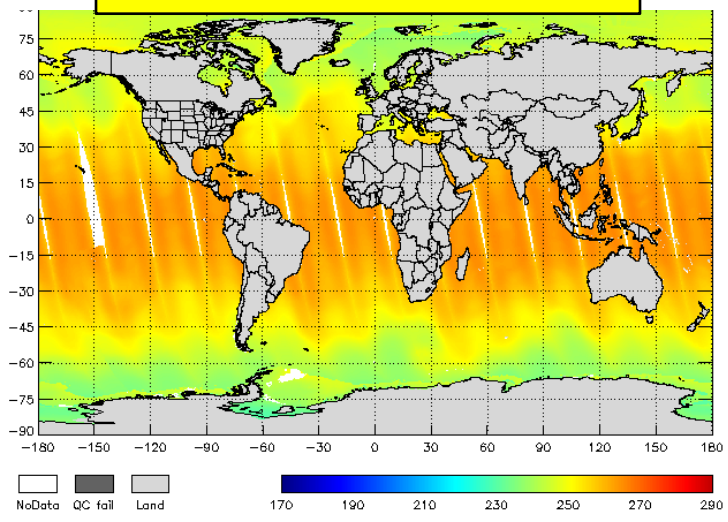


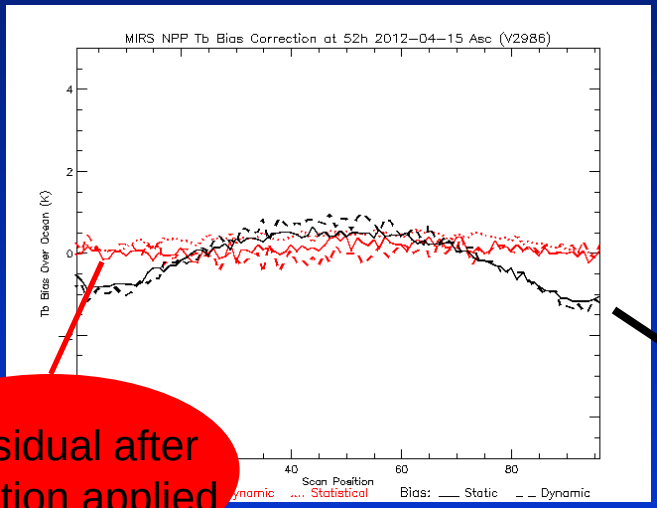
MiRS Product Assessments: Bias Correction

ATMS 52 GHz Measurement

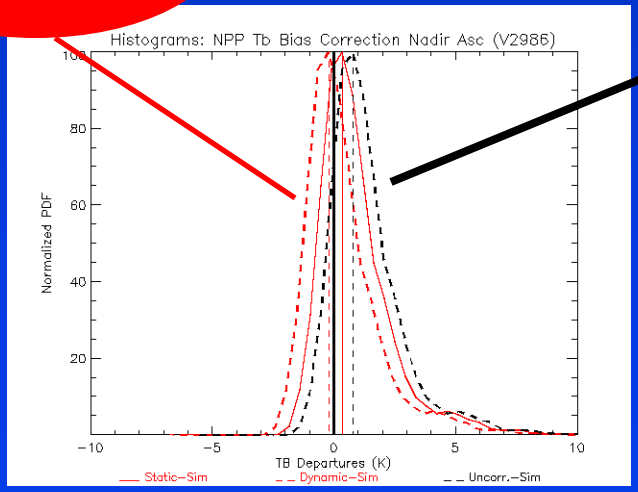


Simulated 52 GHz





Residual after correction applied

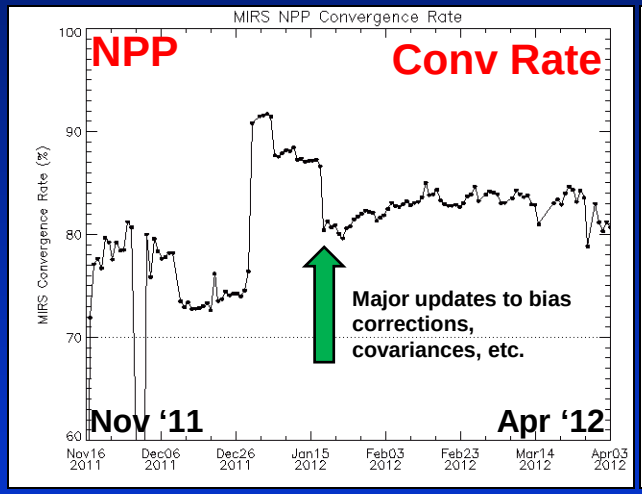


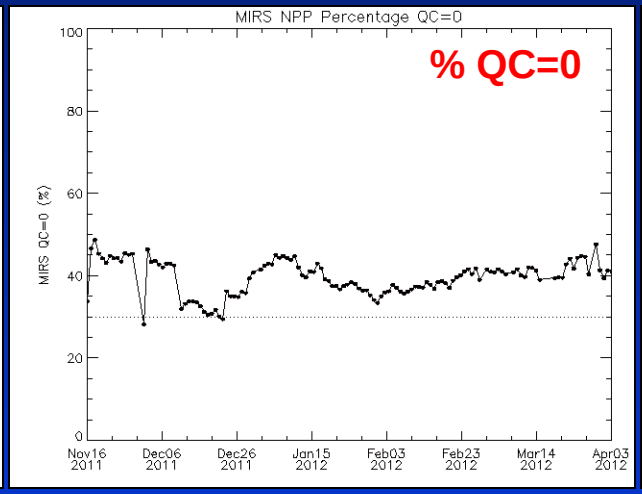
ATMS TDR 52 GHz bias (Obs-Sim)

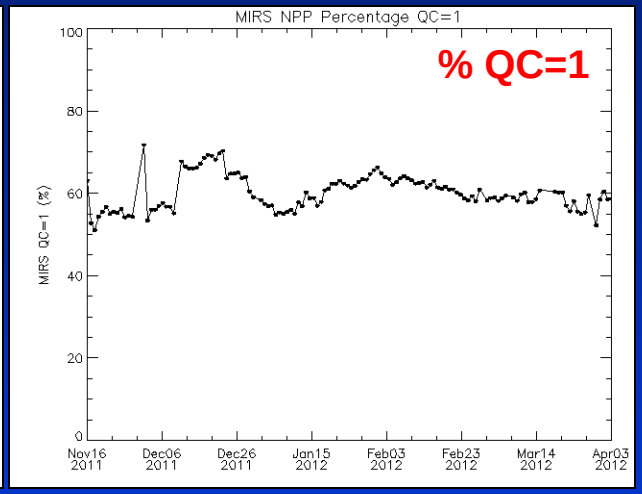
MiRS Product Assessments: QC

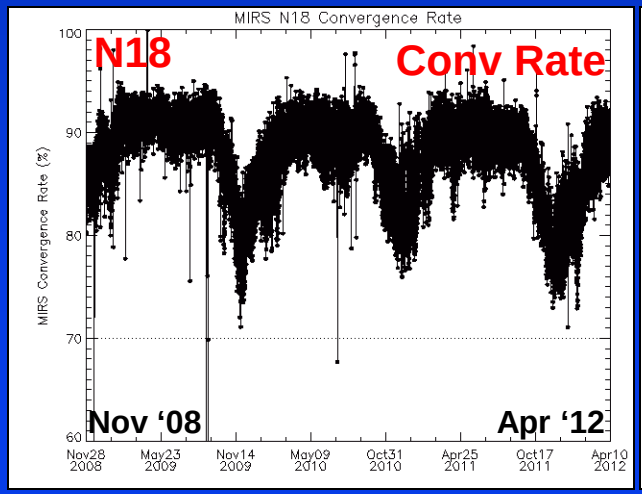
- QC Elements
  - » Percentage QC=1,2,3
  - » Convergence Rate
  - » NEDT monitoring
  - » Radiometric monitoring

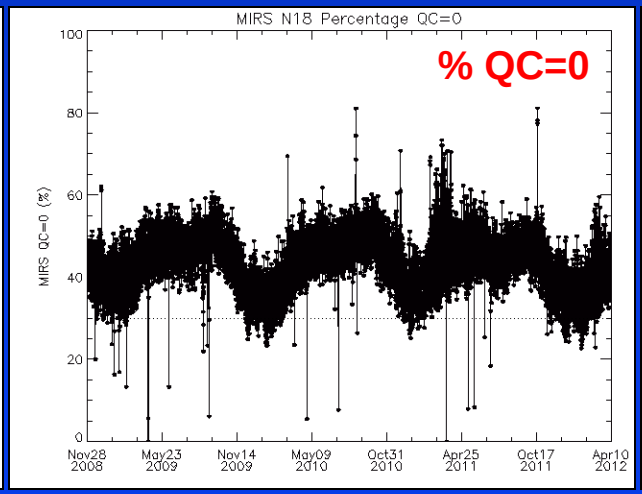
MiRS Product Assessments: Convergence Rate and QC flags

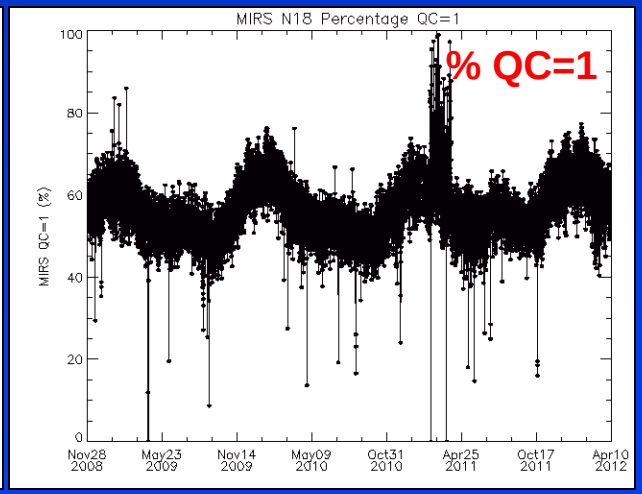




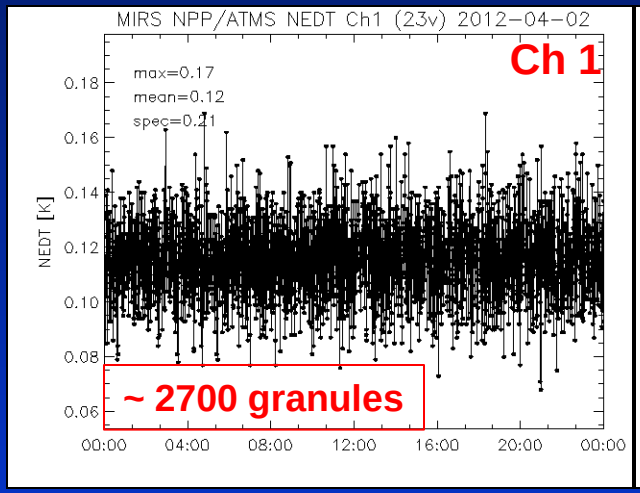


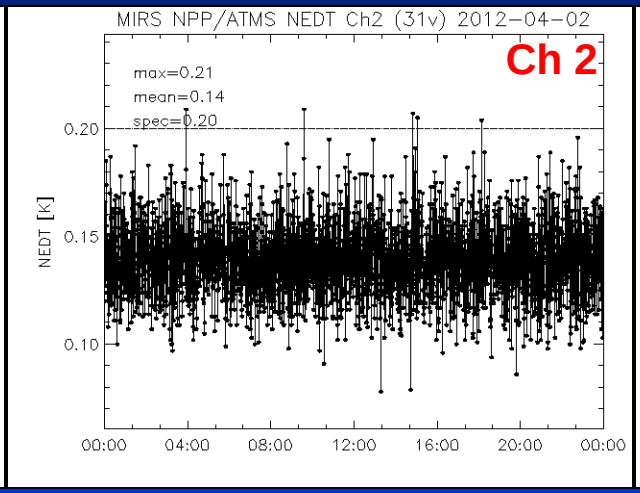


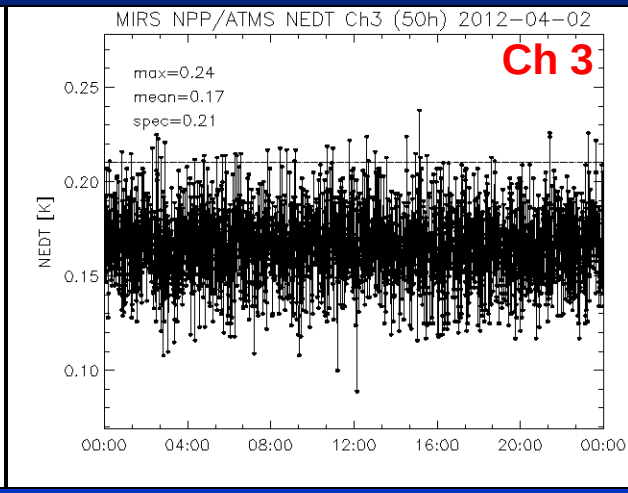


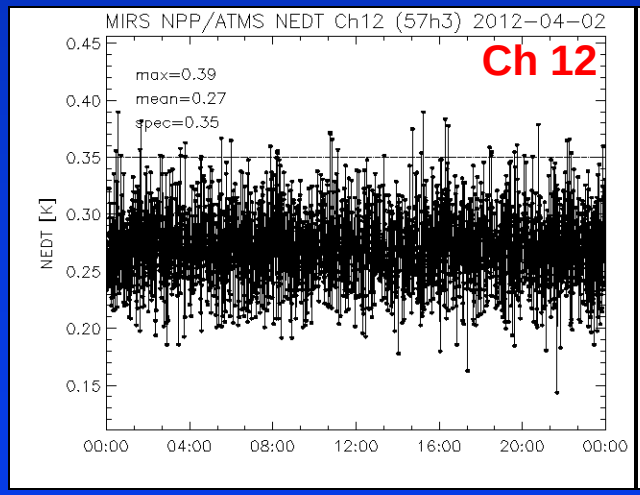


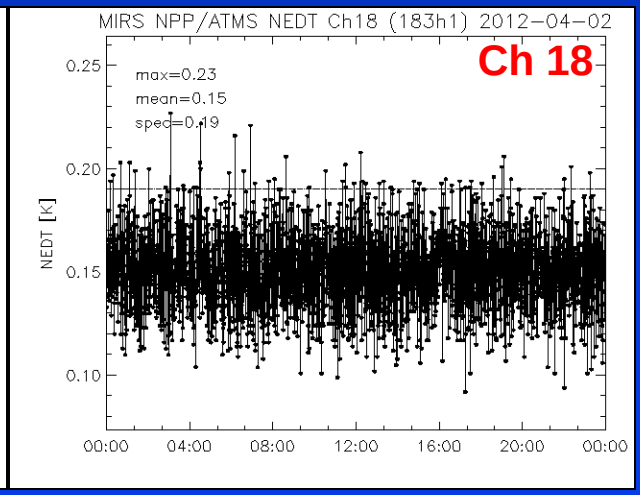
MiRS Product Assessments: NEDT Monitoring – Single Day





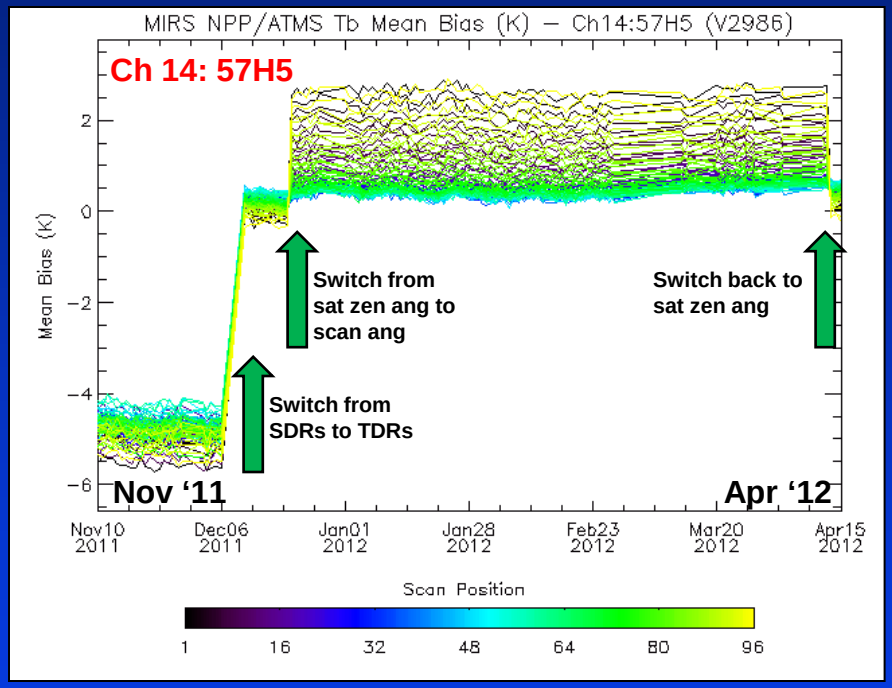


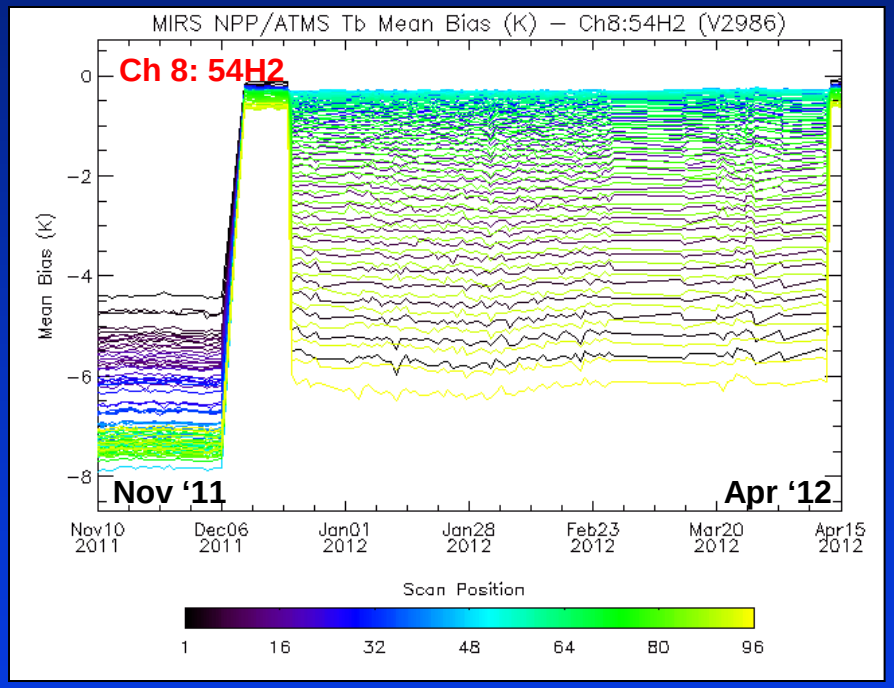




Most channels at or below spec
Exceptions are upper air chans 13-15 (57h4-h6)

MiRS Product Assessments: Tier -2 Radiometric Monitoring





MiRS Official Products: SND and IMG files

Observational Parameter	Imagery Product	Sounding Product Package
Atmospheric Temperature profile		X
Atmospheric Water Vapor profile		X
Total Precipitable Water	X	
Land Surface Temperature	X	
Surface Emissivity Spectrum	X	
Sea-ice Concentration	X	
Snow Cover Extent	X	
Snow-Water Equivalent	X	
Integrated Cloud Liquid Water	X	
Integrated Ice Water Path	X	
Integrated Rain Water Path	X	
Rainfall Rate	X	

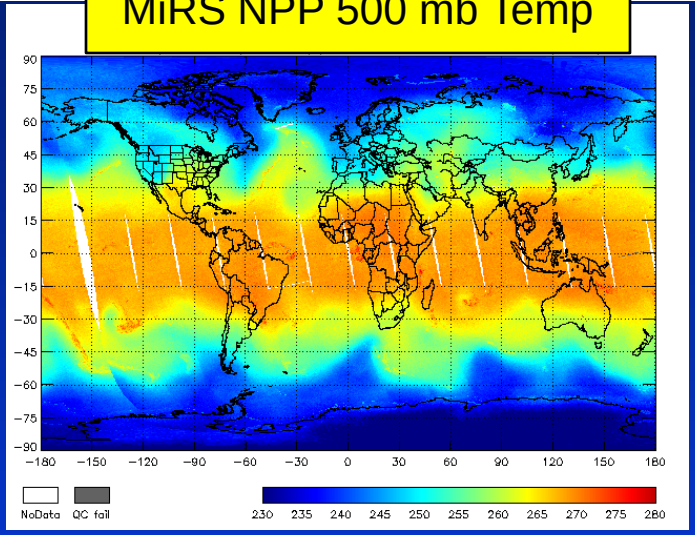
NB: IMG and SND products stored in netCDF4 files

MiRS Product Assessments: Sounding Products

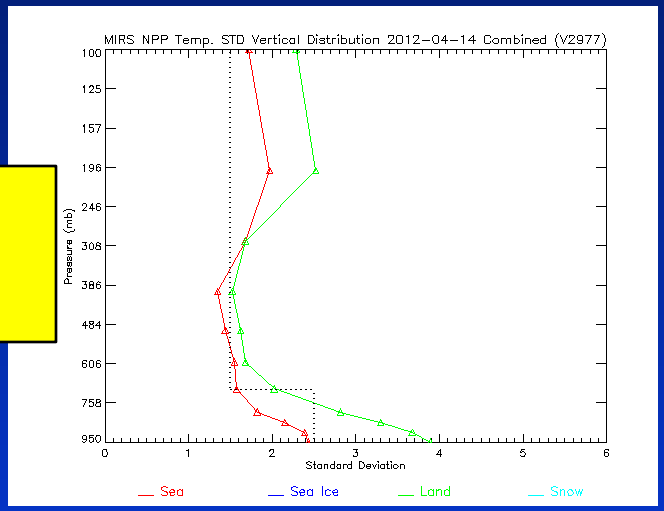
- Sounding Products
  - » Temp profile
  - » WV Profile
  - » TPW

MiRS Product Assessments: Temperature Sounding

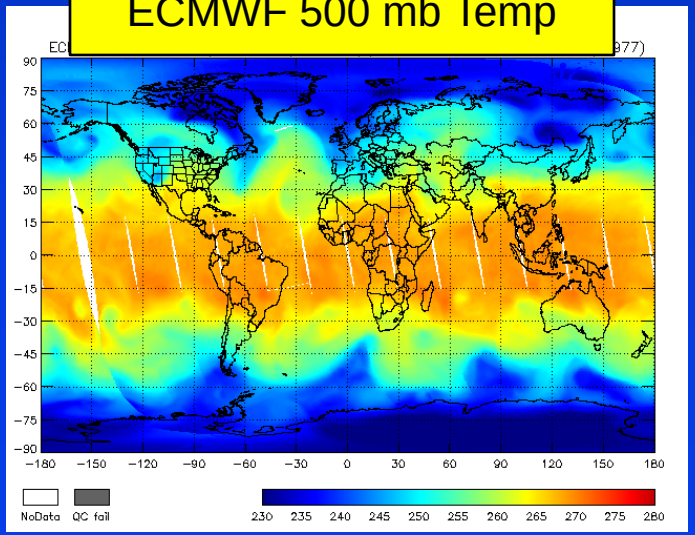
MiRS NPP 500 mb Temp



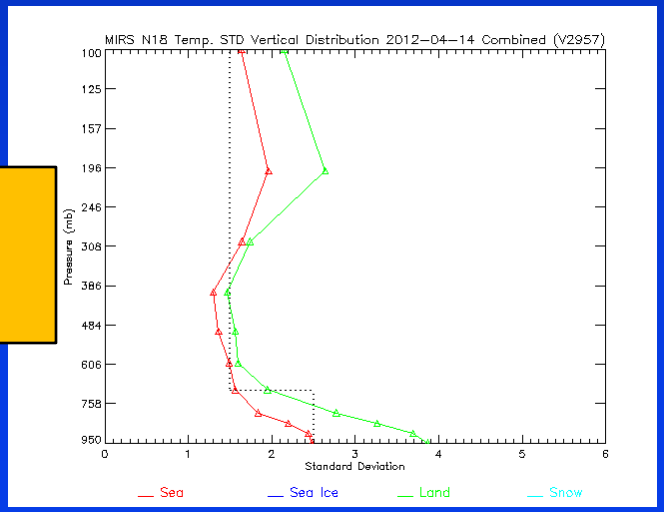
MiRS NPP Temperature Std Dev.



ECMWF 500 mb Temp

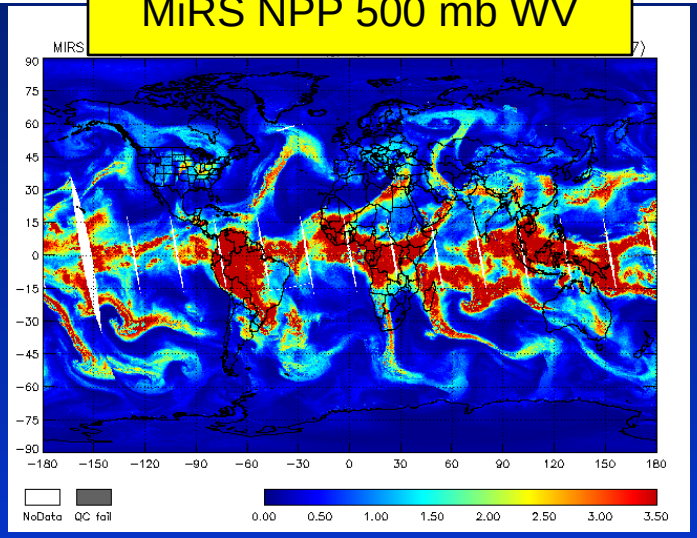


MiRS N18 Temperature Std Dev.

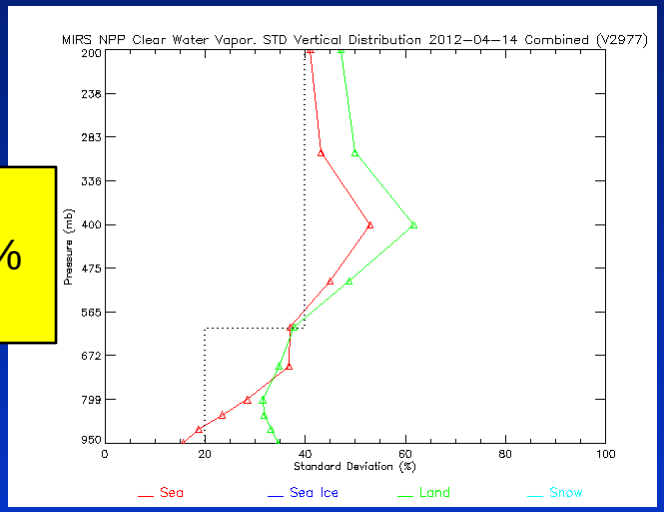


MiRS Product Assessments: Water Vapor Sounding

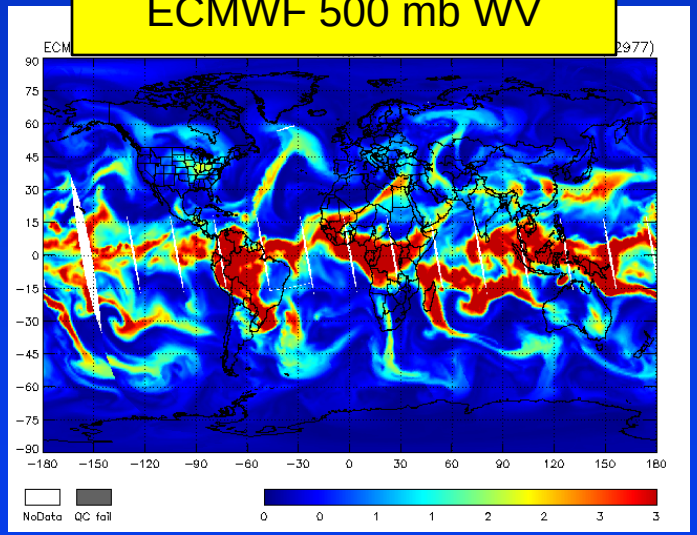
MiRS NPP 500 mb WV



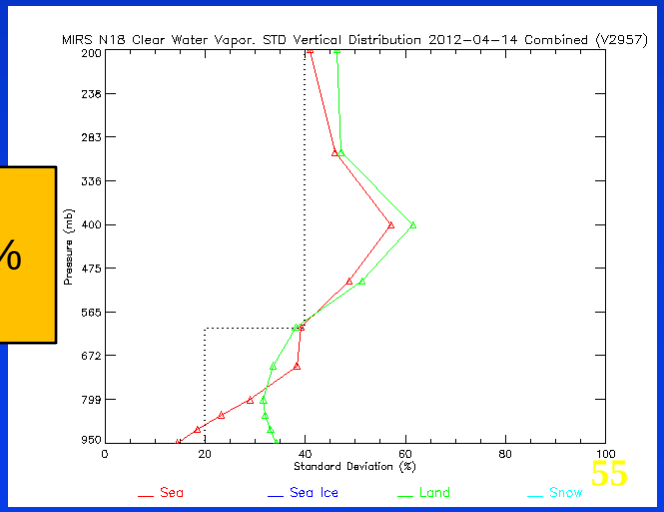
MiRS NPP Water Vapor % Std Dev.



ECMWF 500 mb WV

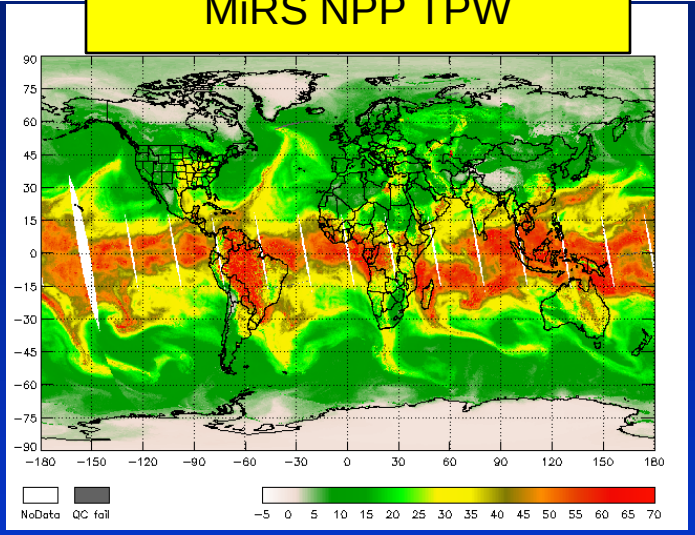


MiRS N18 Water Vapor % Std Dev.

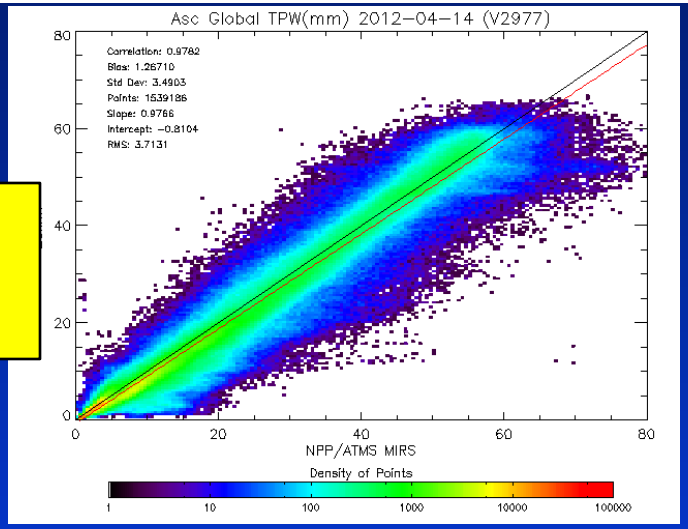


MiRS Product Assessments: TPW

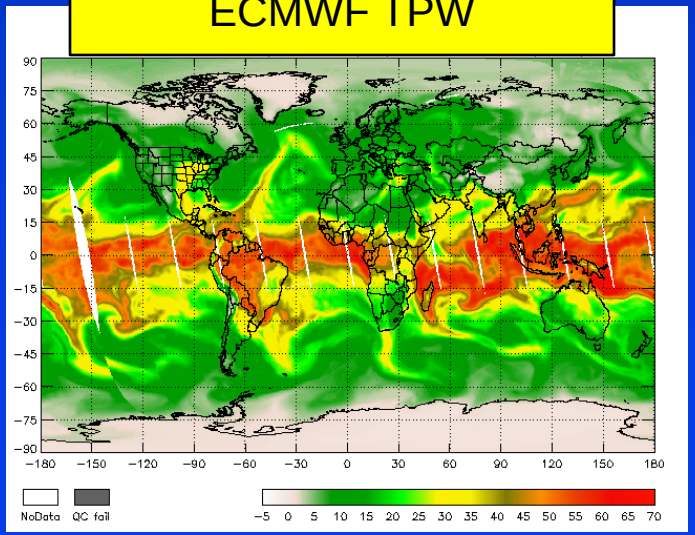
MiRS NPP TPW



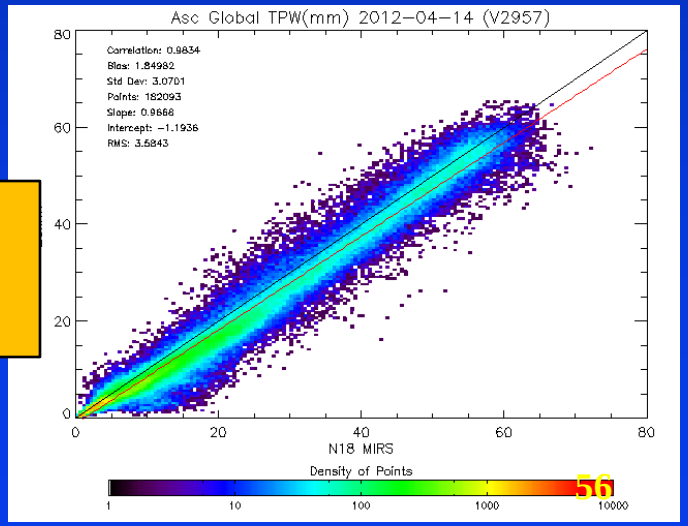
MiRS NPP TPW vs. ECMWF



ECMWF TPW



MiRS N18 TPW vs. ECMWF

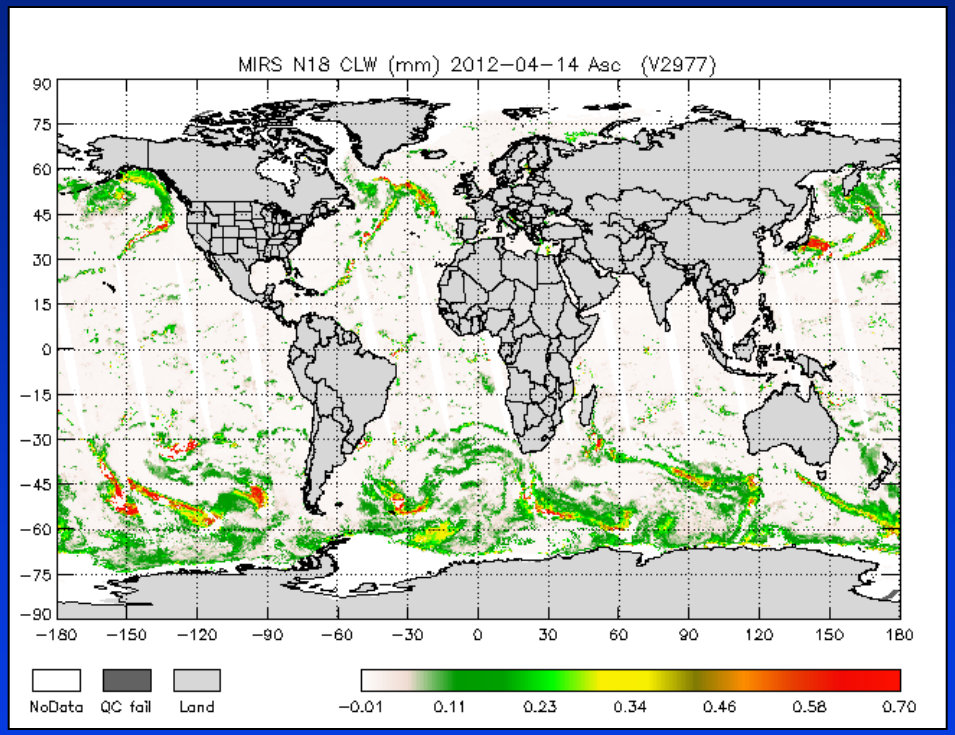


MiRS Product Assessments: Hydrometeors

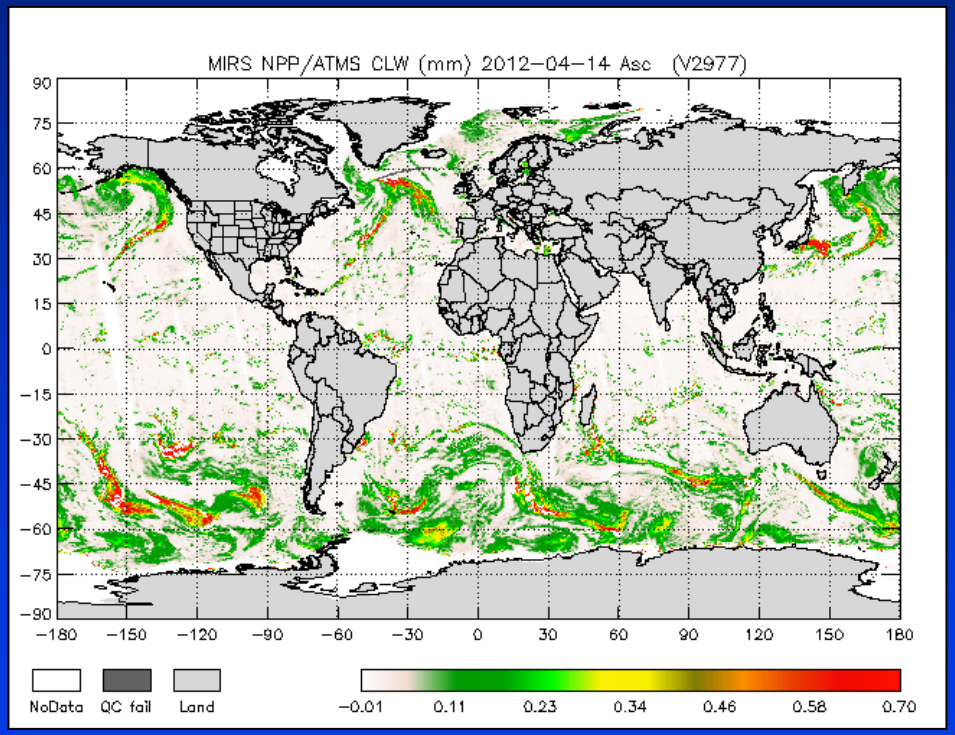
- CLWP
- IWP
- RWP
- Rain Rate

MiRS Product Assessments: Cloud Liquid Water

MiRS N18/AMSUA-MHS CLWP HR



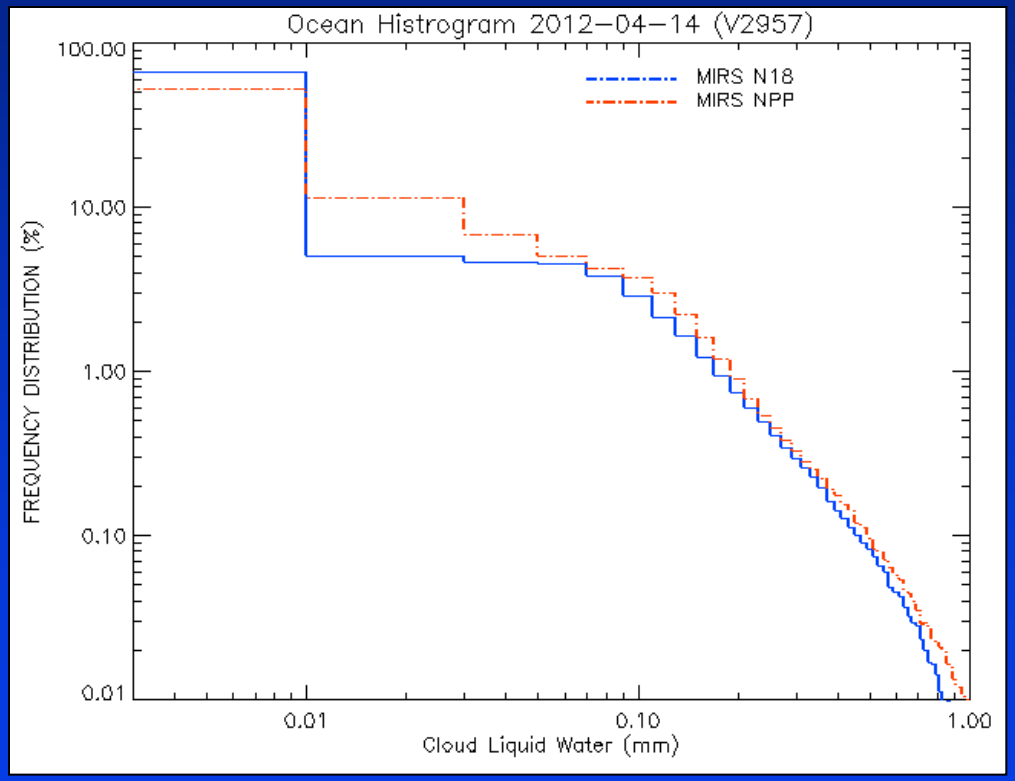
MiRS NPP/ATMS CLWP HR



Very similar patterns, NPP CLW slightly more extensive than N18 (RT model uncertainty tuning)

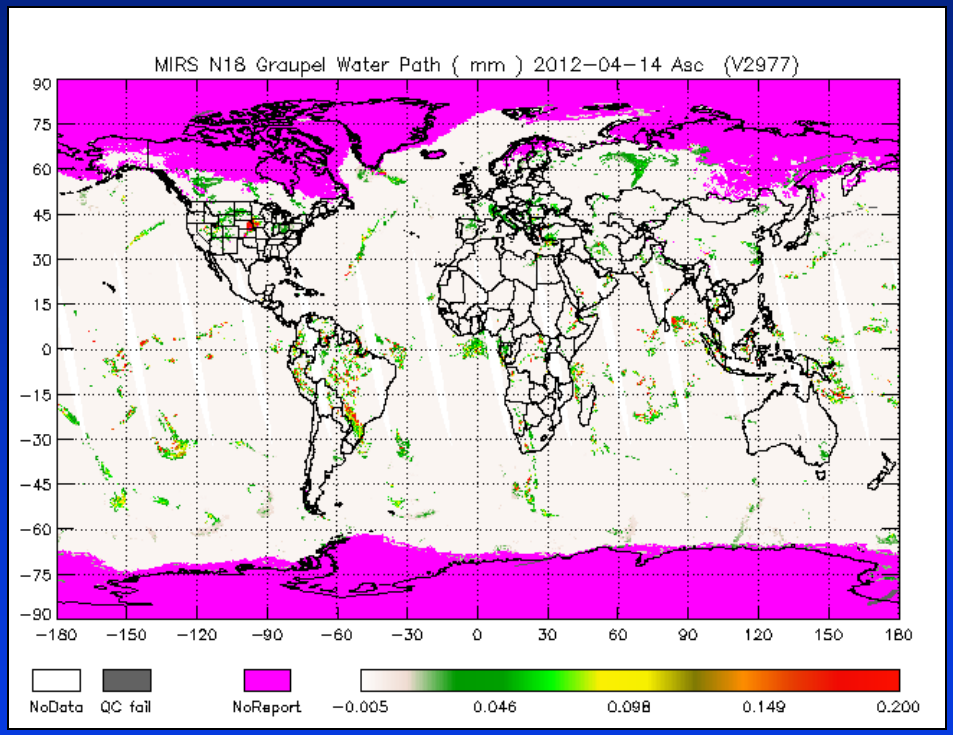
Inter-comparison MiRS N18 vs NPP CLWP

Over Ocean

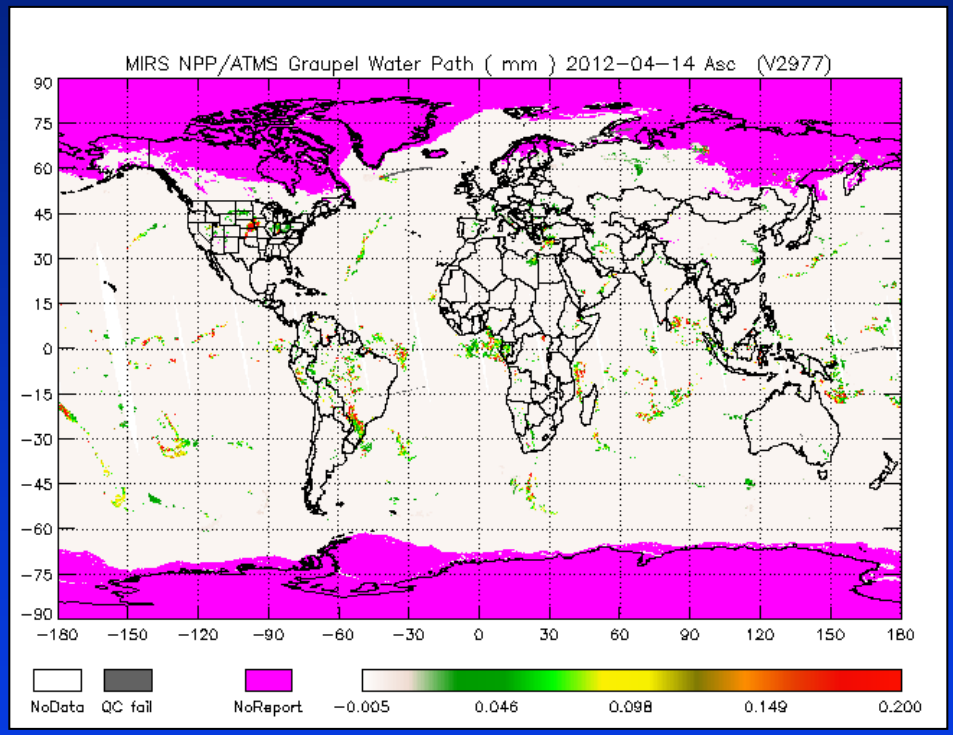


MiRS Product Assessments: Ice Water Path

MiRS N18/AMSUA-MHS IWP HR



MiRS NPP/ATMS IWP HR

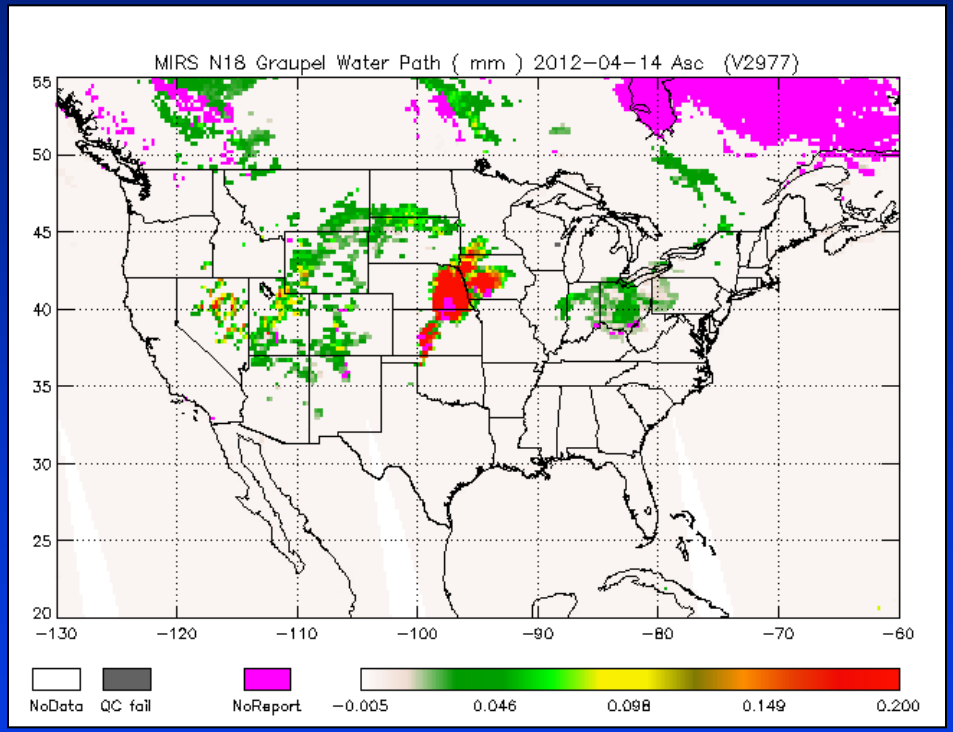


Very similar patterns, NPP IWP slightly less extensive than N18 (RT model uncertainty tuning)

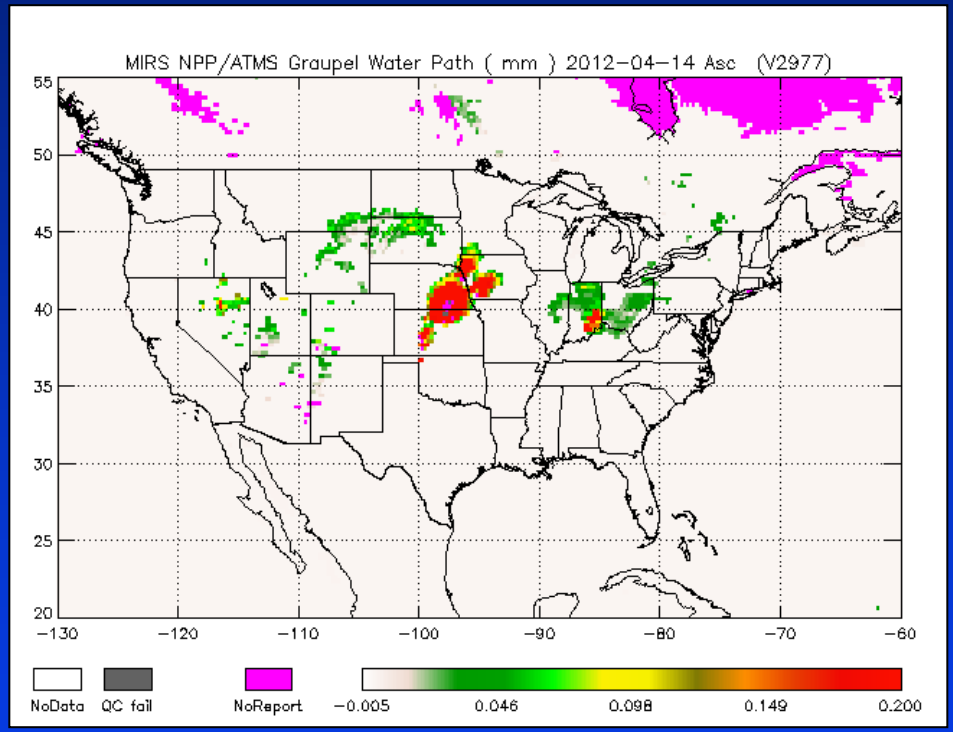
IWP is screened out over snow cover and sea ice.

MiRS Product Assessments: Ice Water Path

MiRS N18/AMSUA-MHS IWP HR



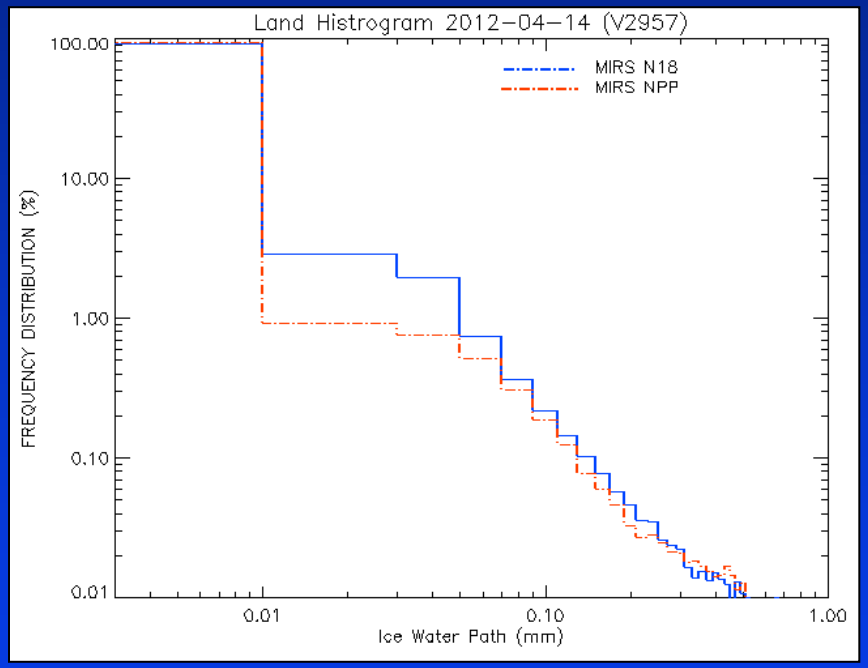
MiRS NPP/ATMS IWP HR



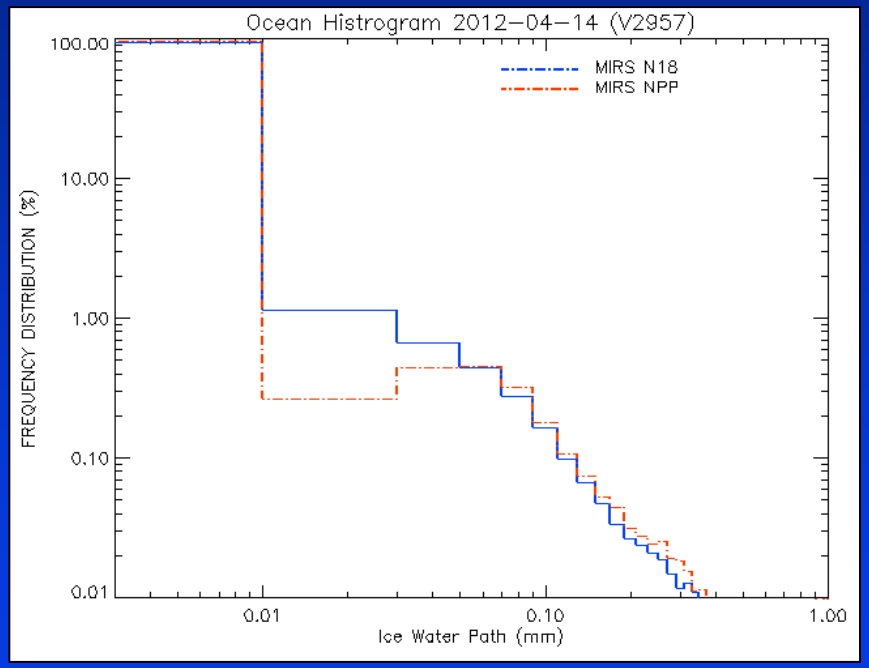
IWP is screened out over snow cover and sea ice.

Inter-comparison MiRS N18 vs NPP IWP

Over Land

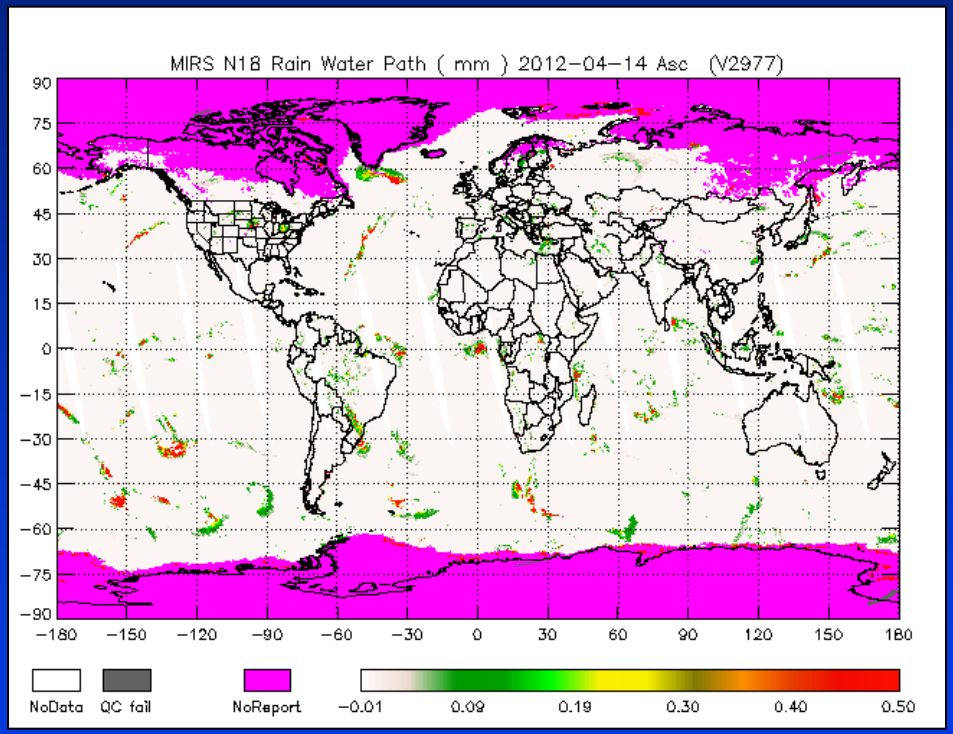


Over Ocean

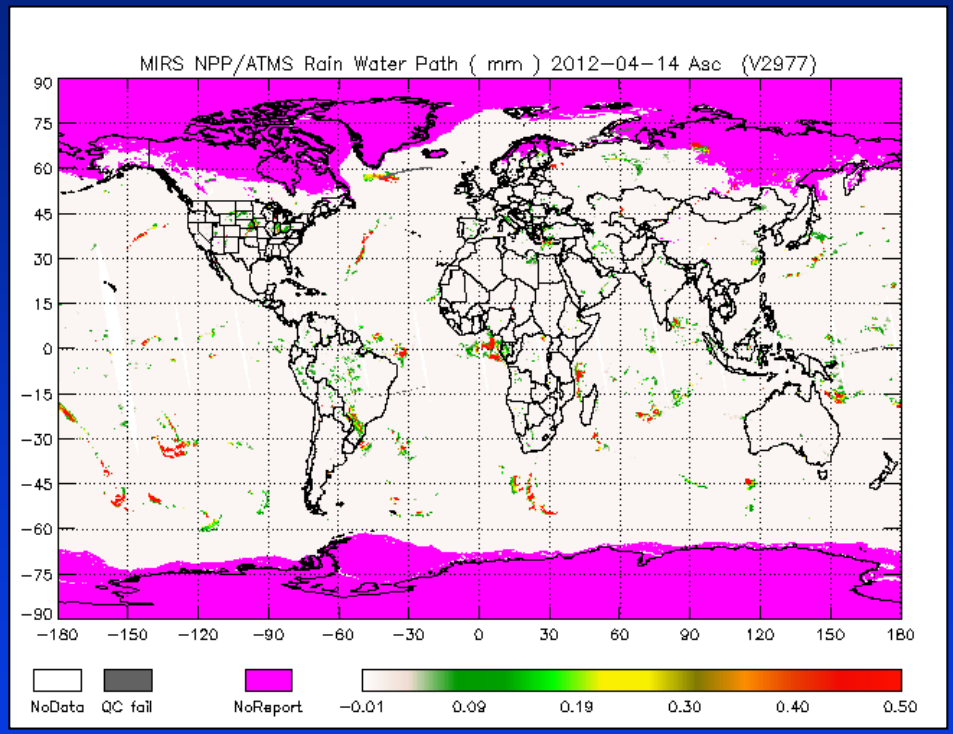


MiRS Product Assessments: Rain Water Path

MiRS N18/AMSUA-MHS RWP HR



MiRS NPP/ATMS RWP HR

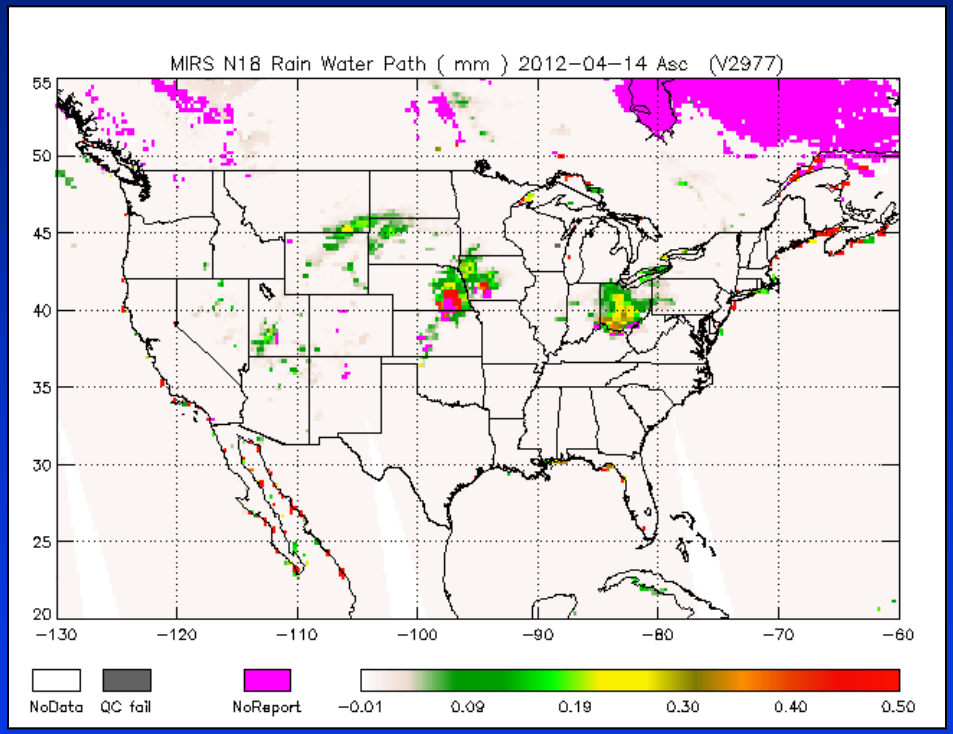


Very similar patterns, NPP RWP slightly less extensive than N18 (RT model uncertainty tuning)

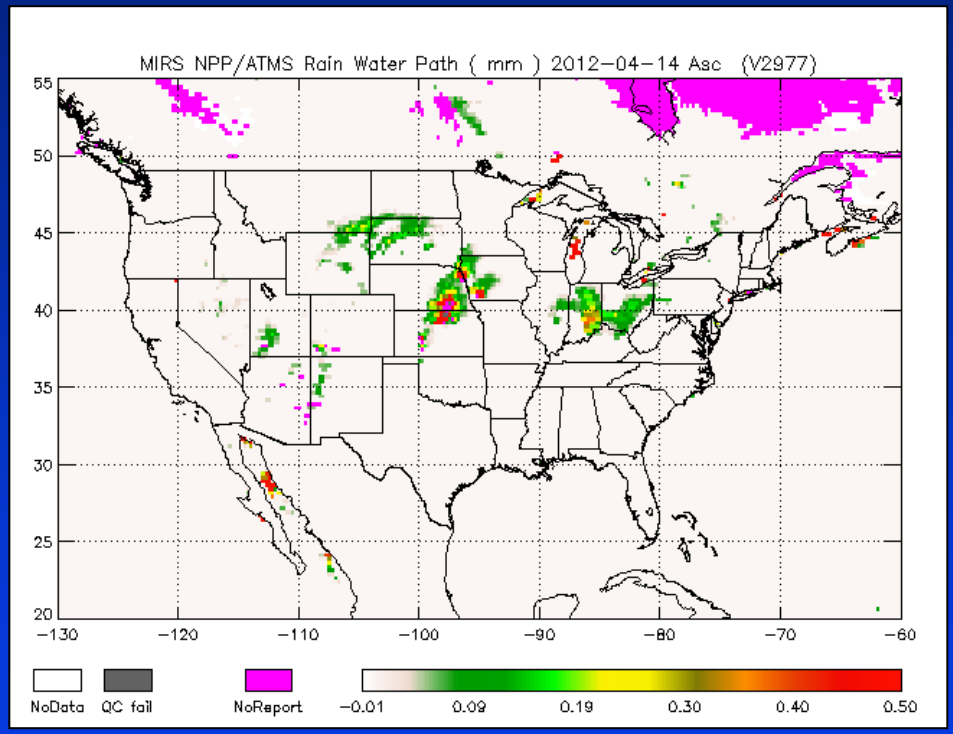
RWP is screened out over snow cover and sea ice.

MiRS Product Assessments: Rain Water Path

MiRS N18/AMSUA-MHS RWP HR



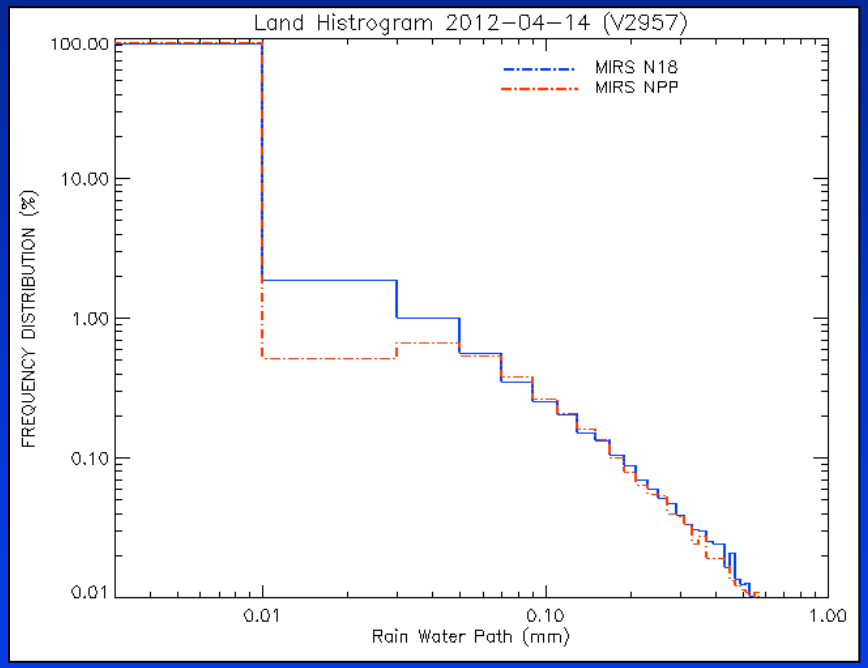
MiRS NPP/ATMS RWP HR



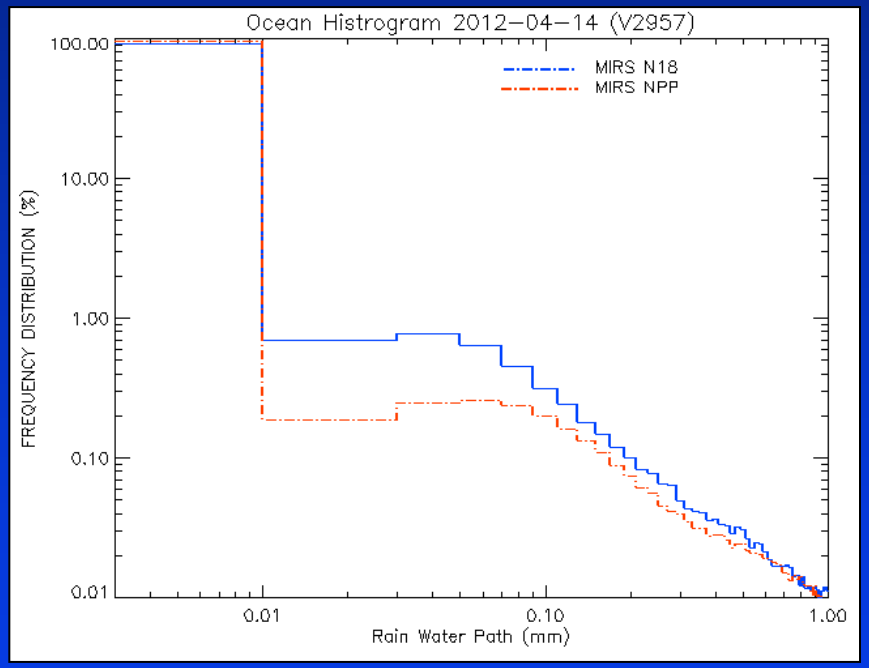
RWP is screened out over snow cover and sea ice.

Inter-comparison MiRS N18 vs NPP RWP

Over Land

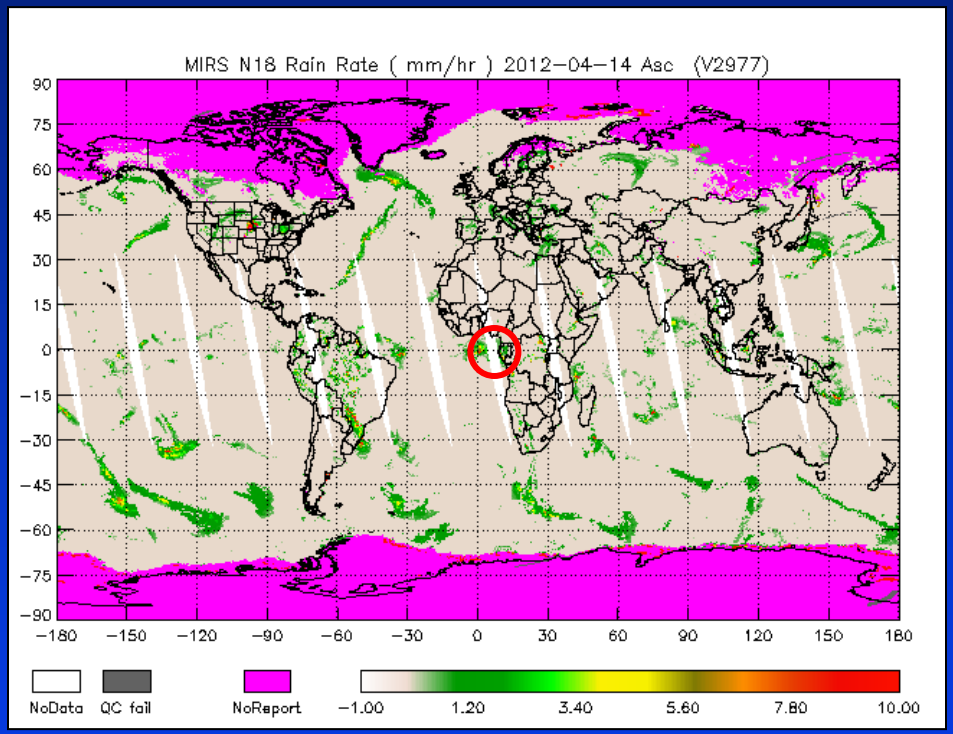


Over Ocean

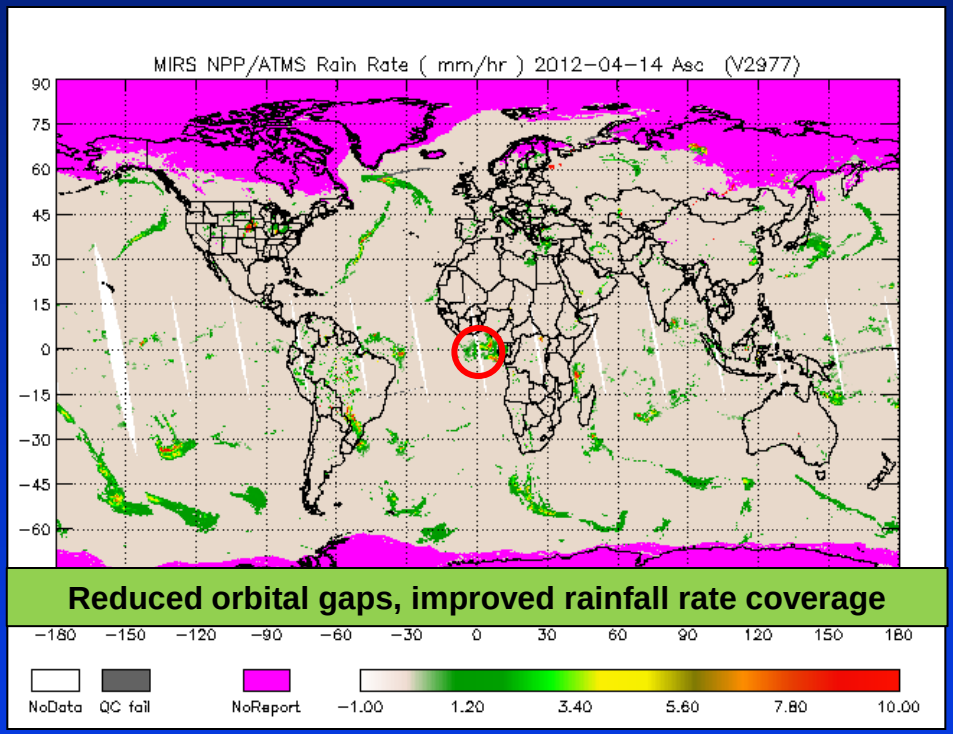


MiRS Product Assessments: Rain Rate

MiRS N18/AMSUA-MHS RR HR



MiRS NPP/ATMS RR HR



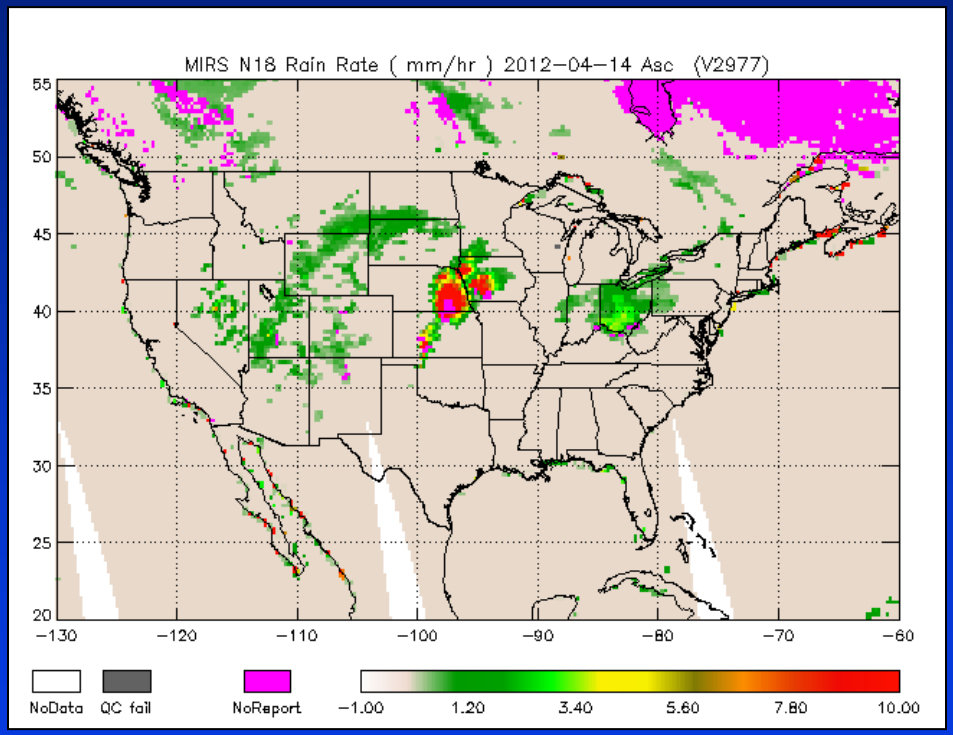
Reduced orbital gaps, improved rainfall rate coverage

Very similar patterns, NPP RR slightly less extensive than N18 (RT model uncertainty tuning)

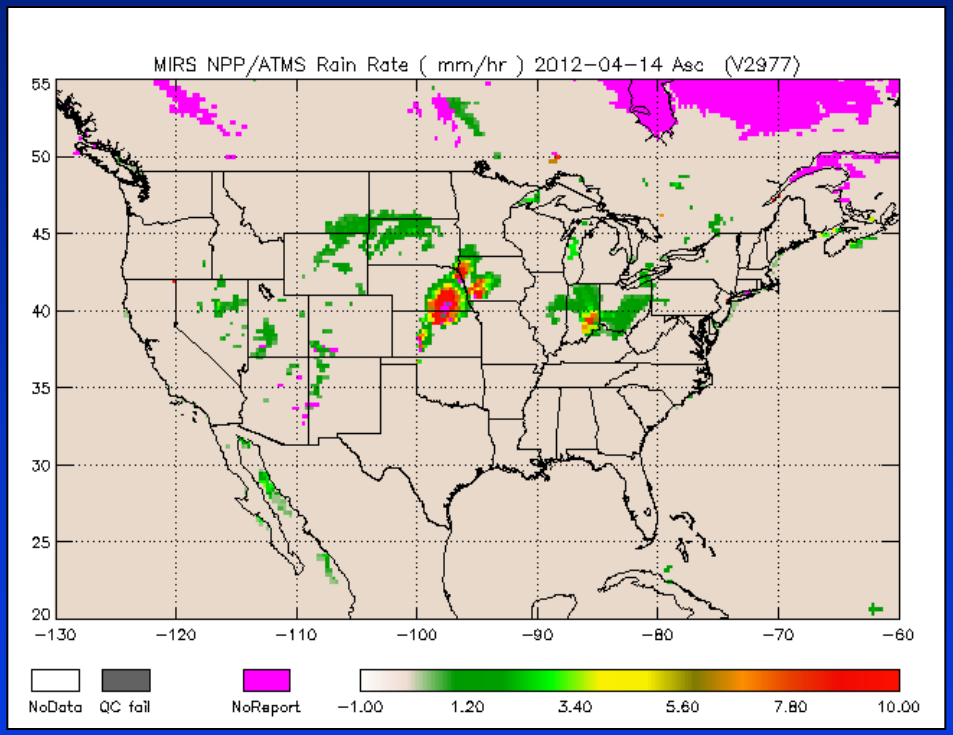
RR is screened out over snow cover and sea ice.

MiRS Product Assessments: Rain Rate

MiRS N18/AMSUA-MHS RR HR



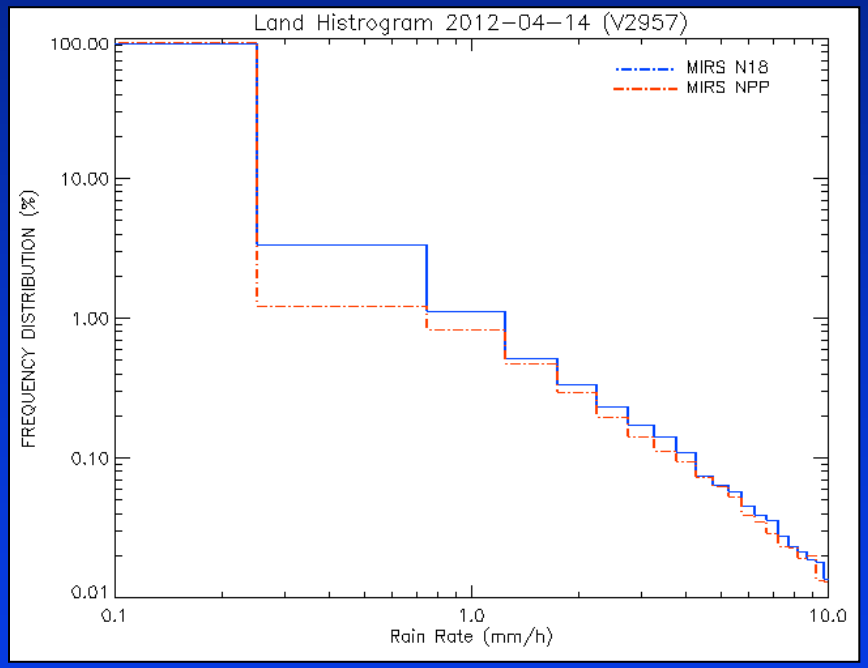
MiRS NPP/ATMS RR HR



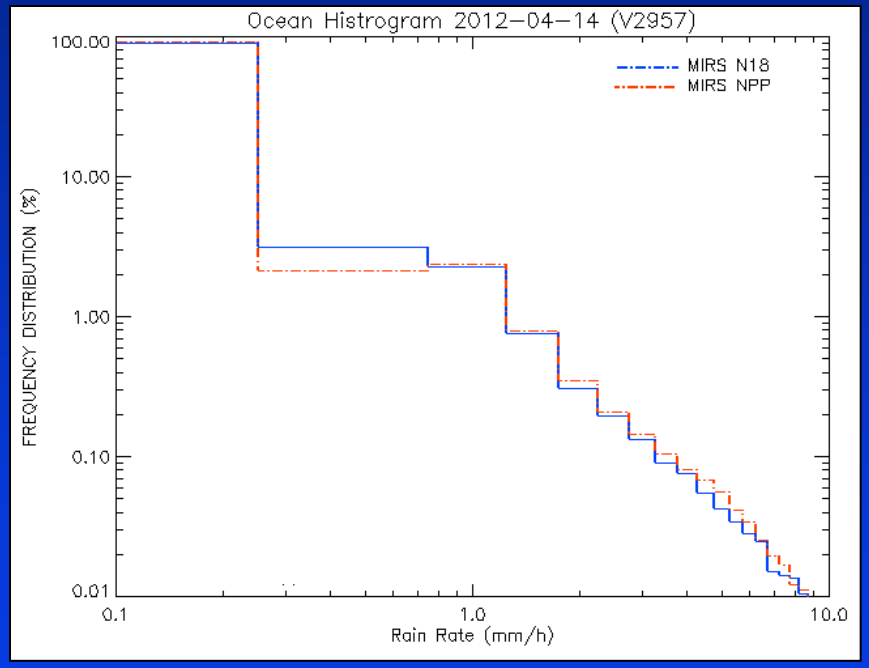
RR is screened out over snow cover and sea ice.

Inter-comparison MiRS N18 vs NPP RR

Over Land

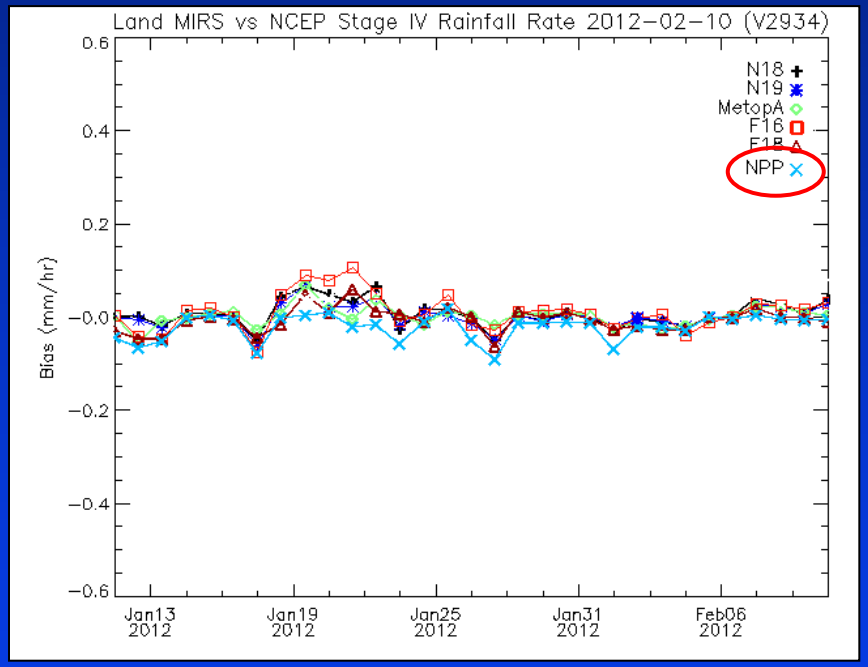


Over Ocean

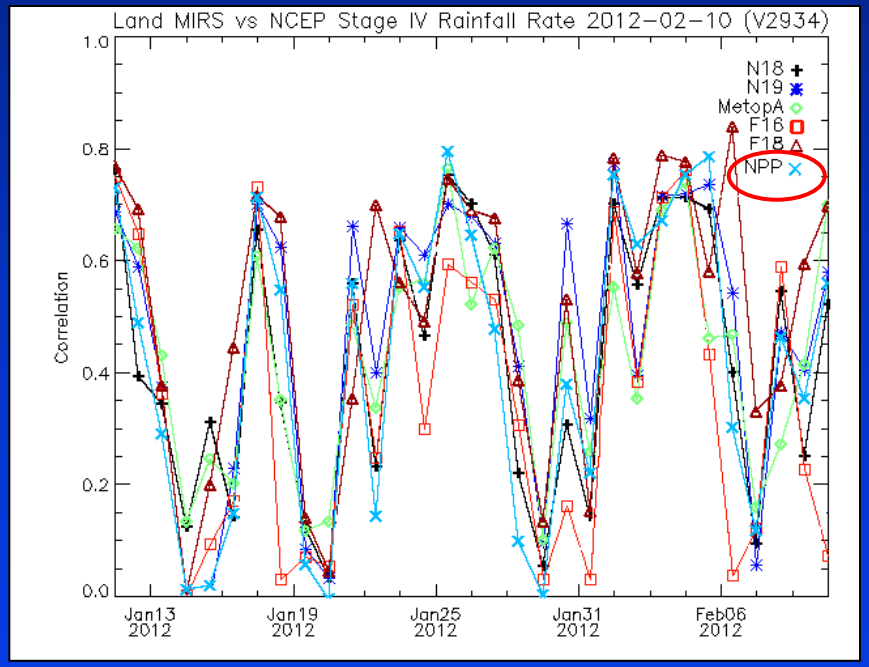


Rainfall Rate Assessment Using NCEP Stage IV Precipitation (1/3)

Bias

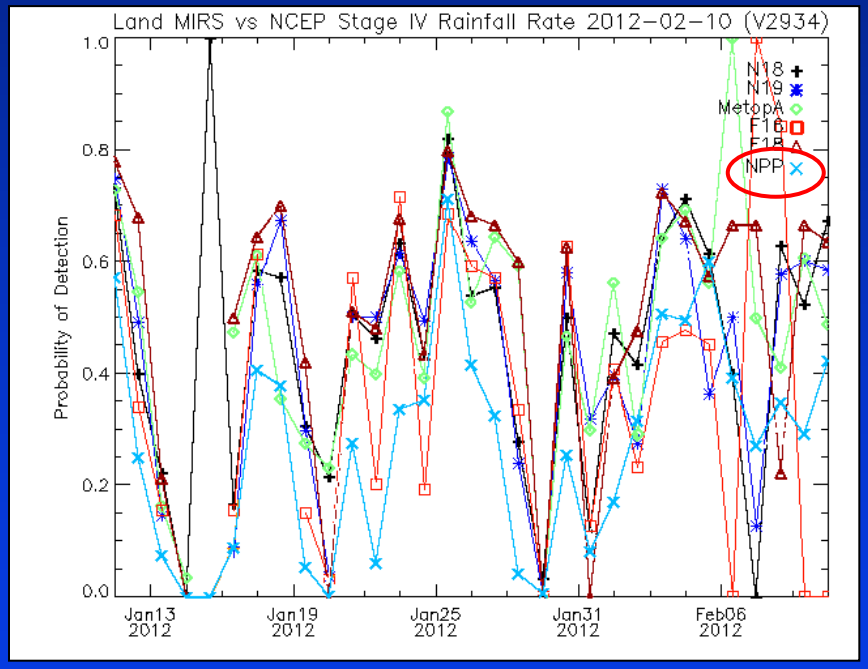


Correlation

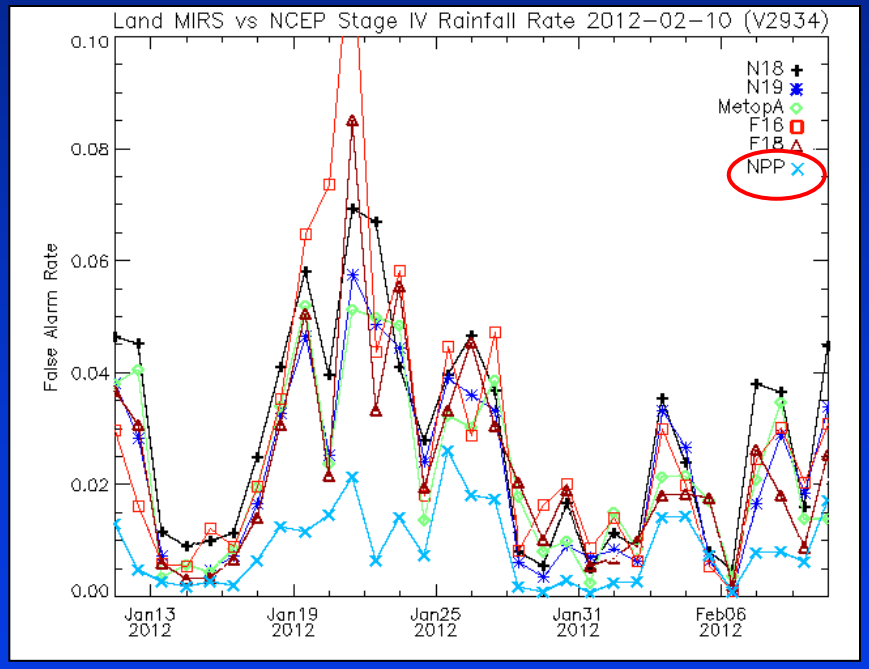


Rainfall Rate Assessment Using NCEP Stage IV Precipitation (2/3)

Probability of Detection

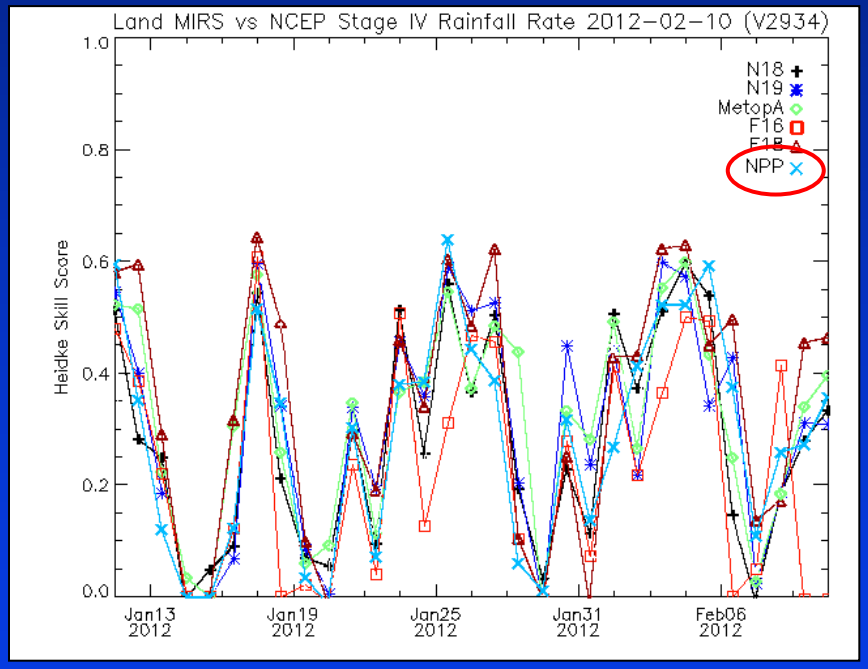


False Alarm Rate

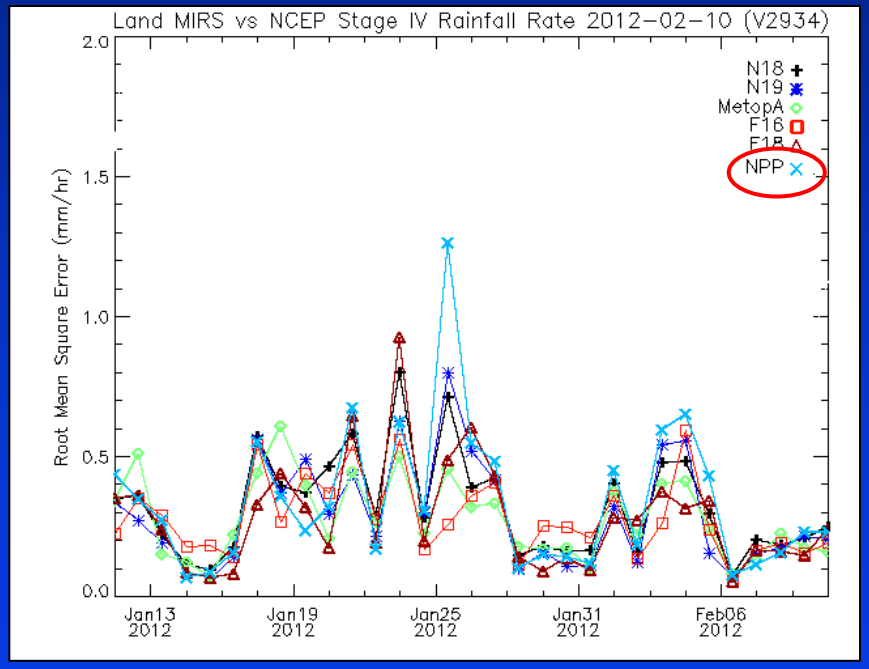


Rainfall Rate Assessment Using NCEP Stage IV Precipitation (3/3)

Heidke Skill Score



RMSE

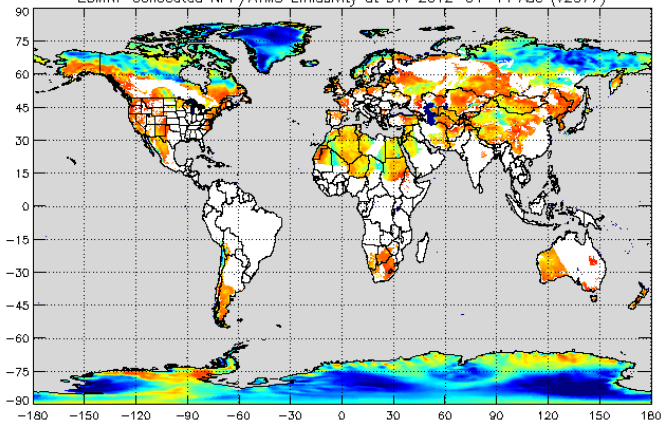


MiRS Product Assessments: Surface Products

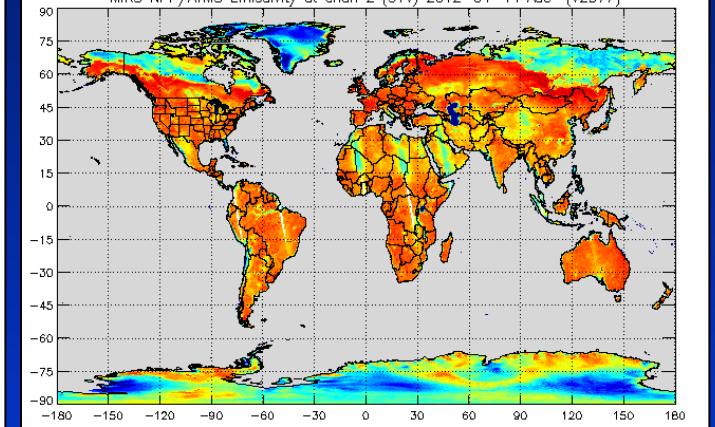
- Emissivity
- Sea Ice Concentration
- Sfc Type/Snow Cover Extent
- Snow Water Equivalent
- Tskin

MiRS Product Assessments: Sfc Emissivity – 31 GHz Vpol Land and Ice

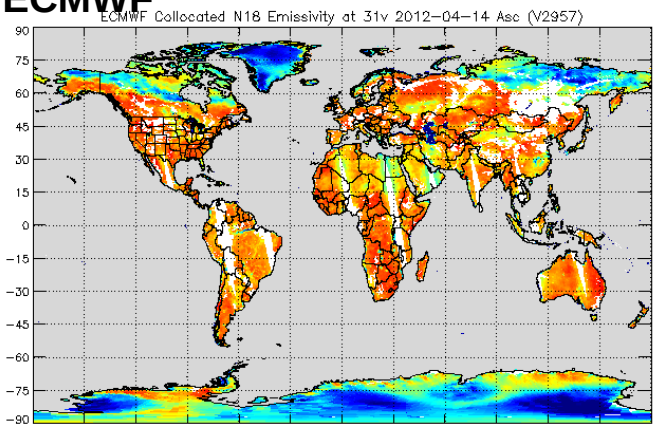
ECMWF



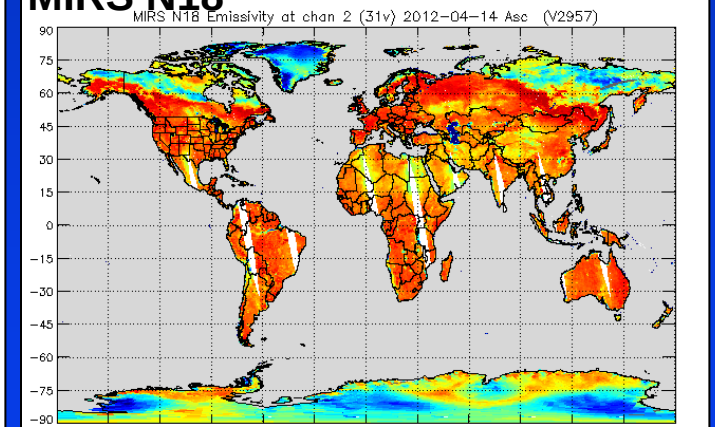
MIRS NPP



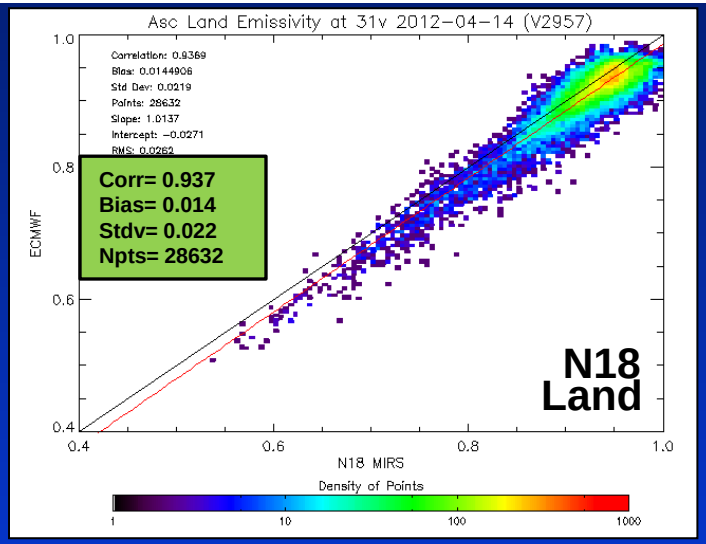
ECMWF

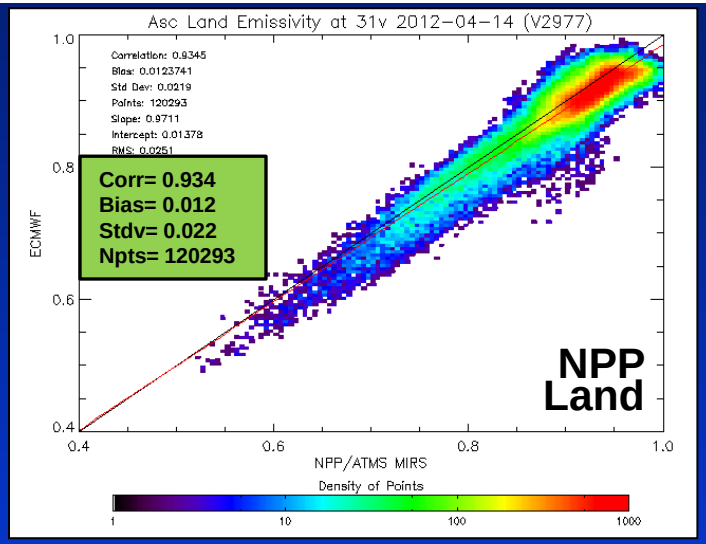


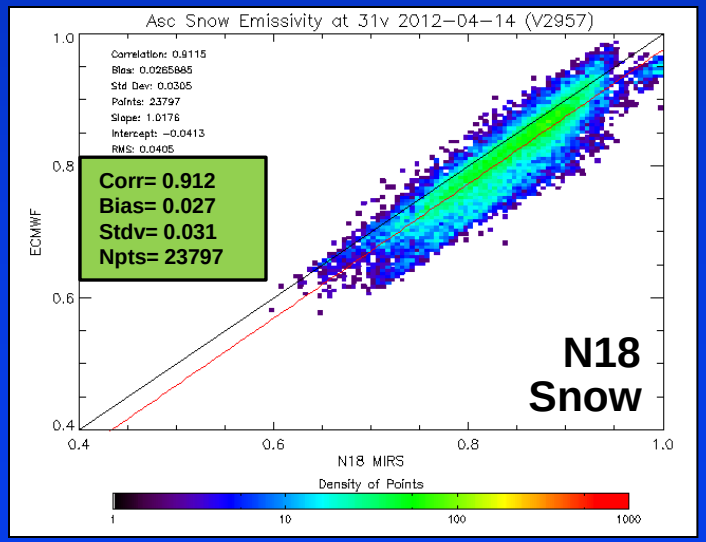
MIRS N18

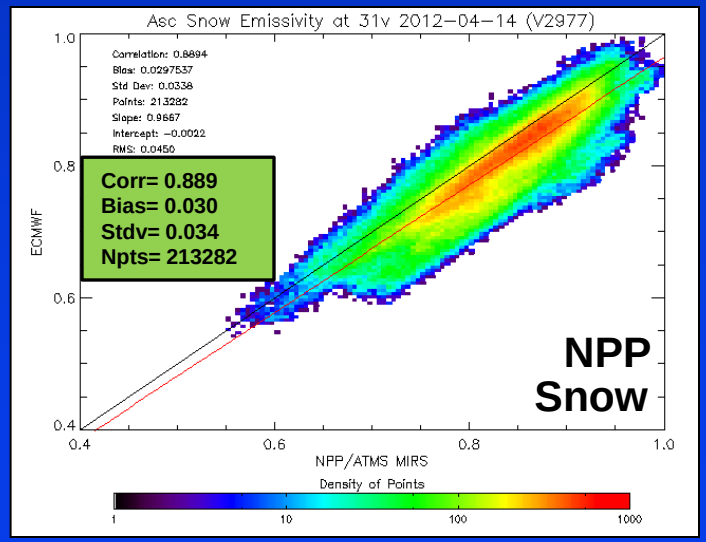


MiRS Product Assessments: Sfc Emissivity – 31 GHz Vpol Land and Snow





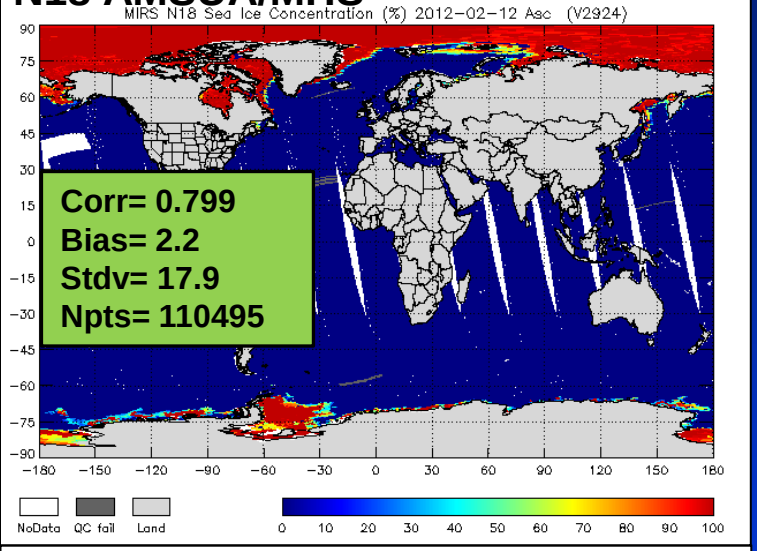




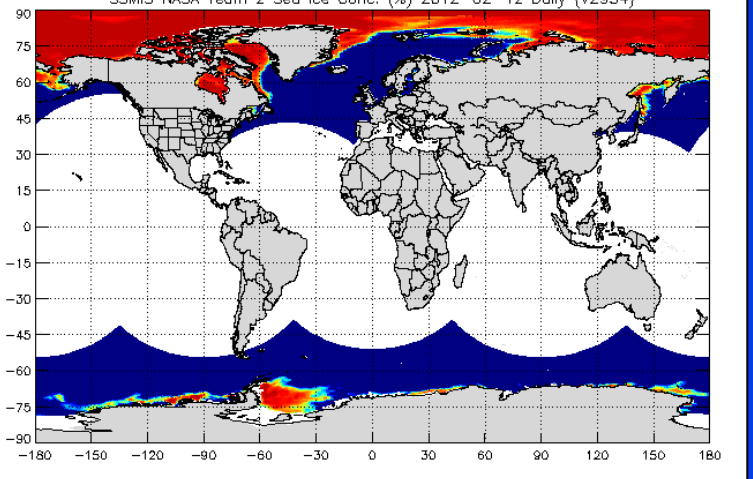
Other channels show similar behavior

MiRS Product Assessments: Sea Ice Concentration compared against SSMIS NASA Team Algorithm

N18 AMSUA/MHS

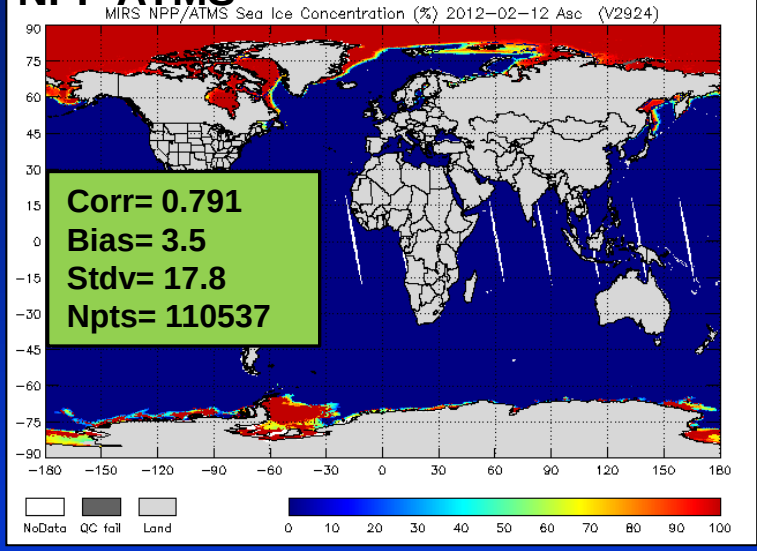


F17 SSMIS NASA Team



Assessments vs. F17 SSMIS NASA Team

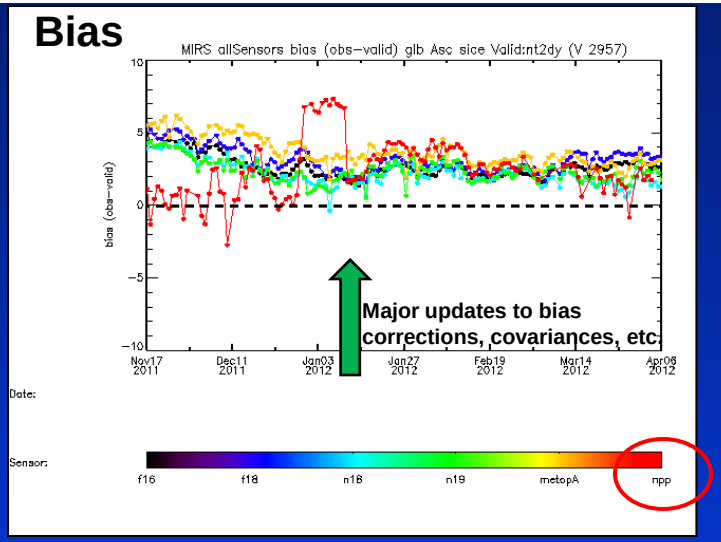
NPP ATMS



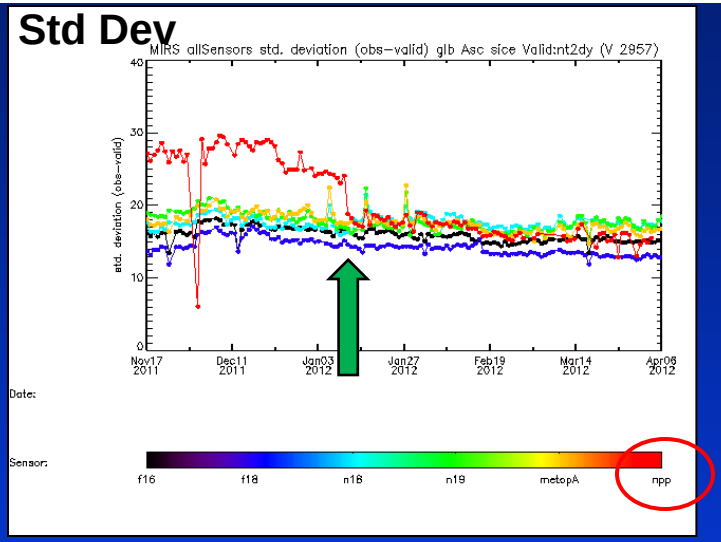
Time series of other skill metrics show ATMS performance consistent with other sensors

MiRS Product Assessments: Sea Ice Concentration

Bias

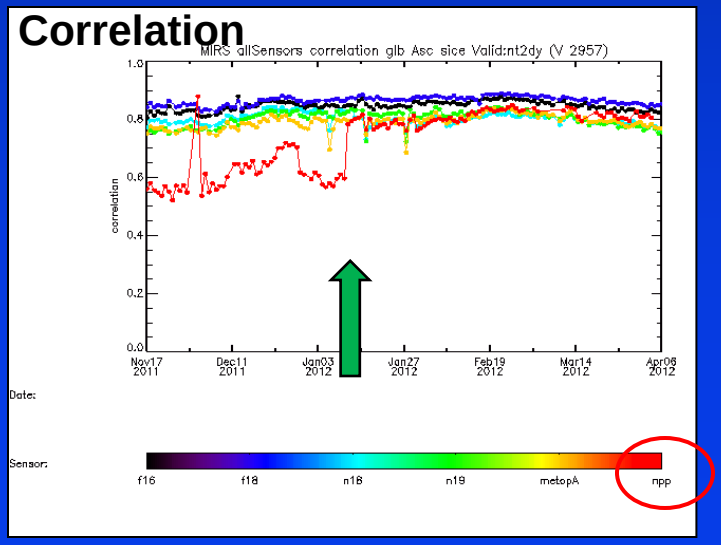


Std Dev

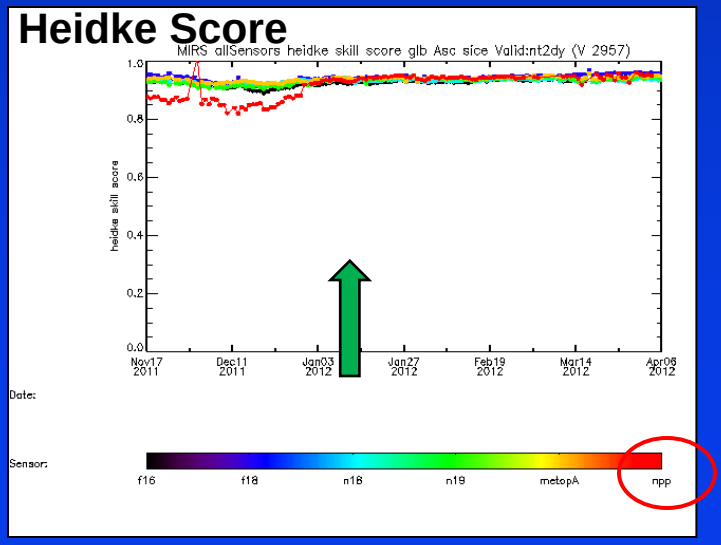


Assessments vs. F17 SSMIS NASA Team

Correlation

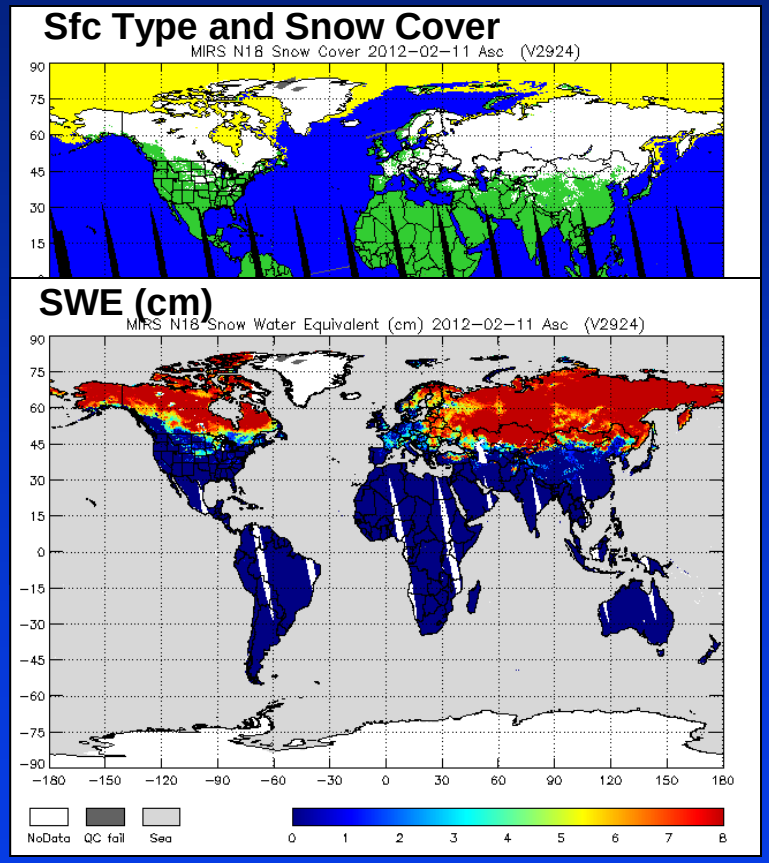


Heidke Score

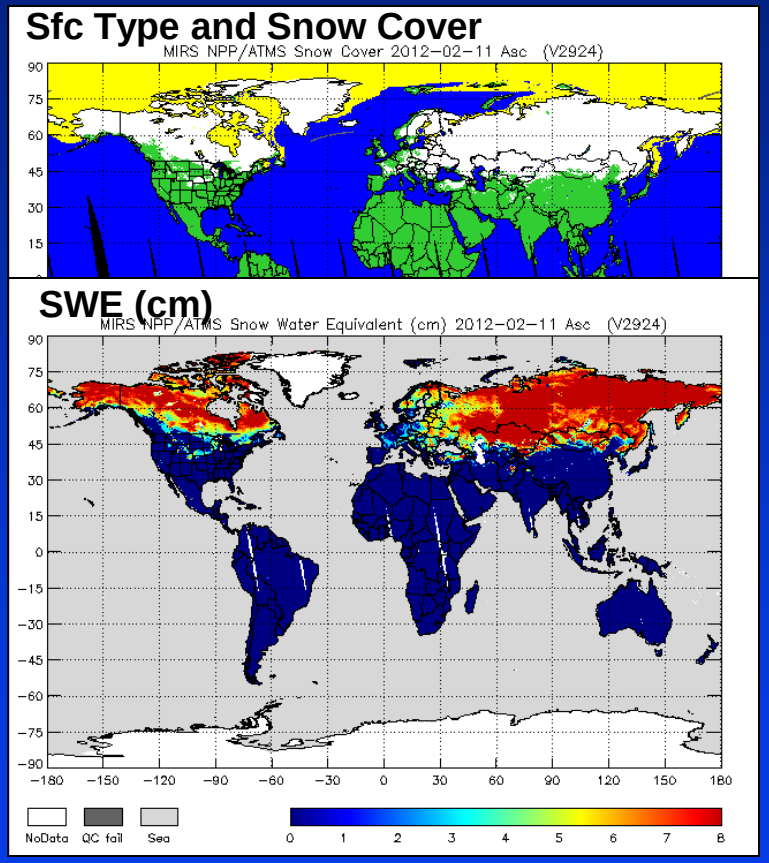


MiRS Product Assessments: Snow Cover and Snow Water Equivalent

N18 AMSUA/MHS

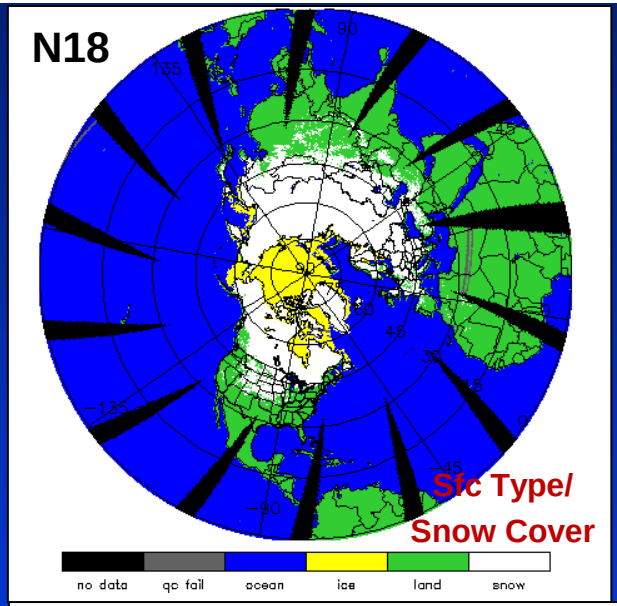


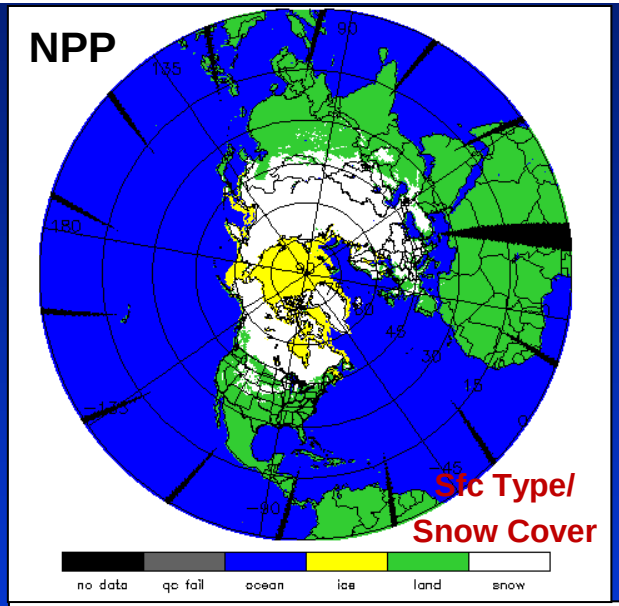
NPP ATMS

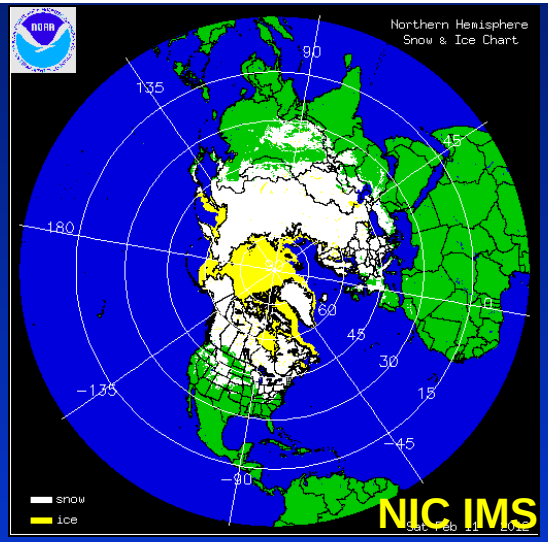


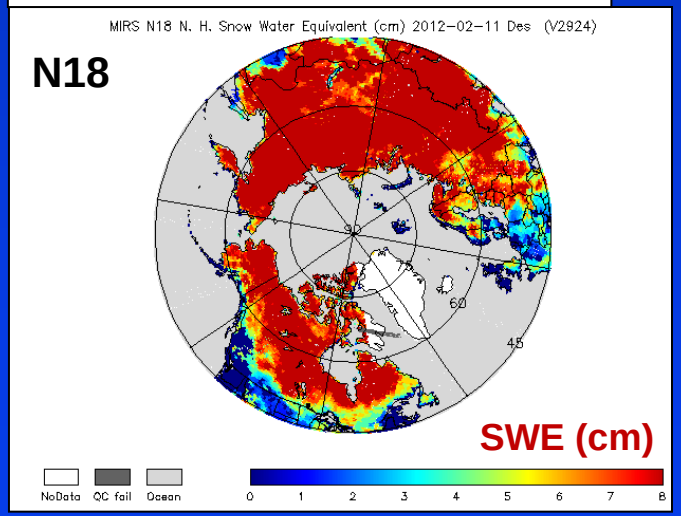
N18 and NPP global patterns of surface type, snow coverage and snow water equivalent are very consistent

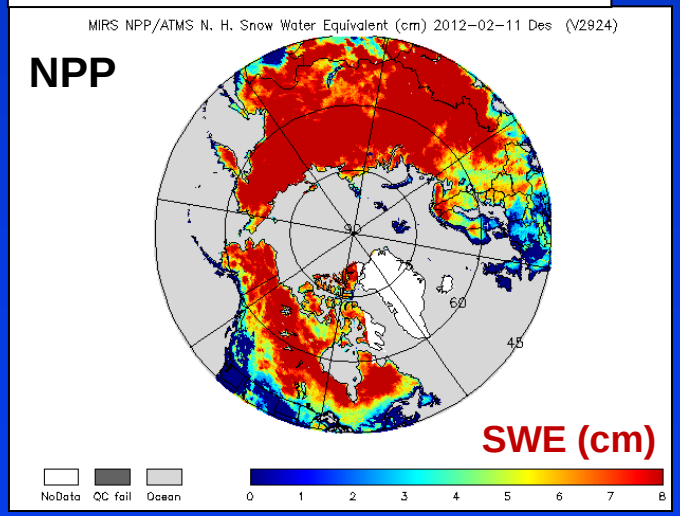
MiRS Product Assessments: Snow Cover and Snow Water Equivalent







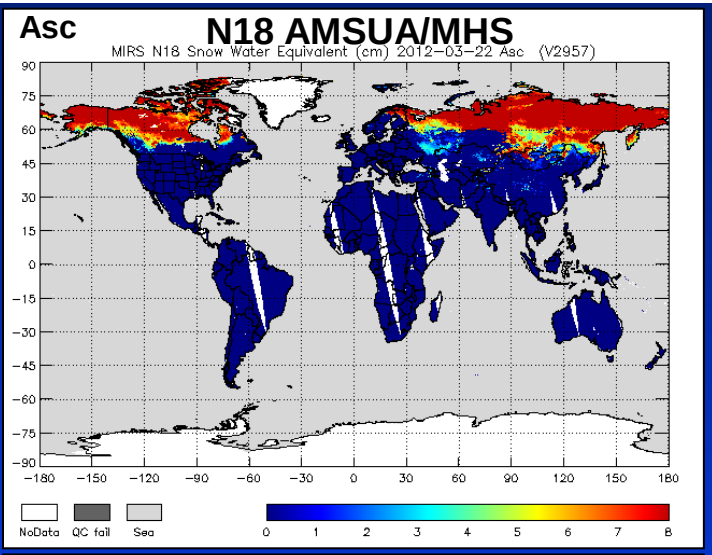




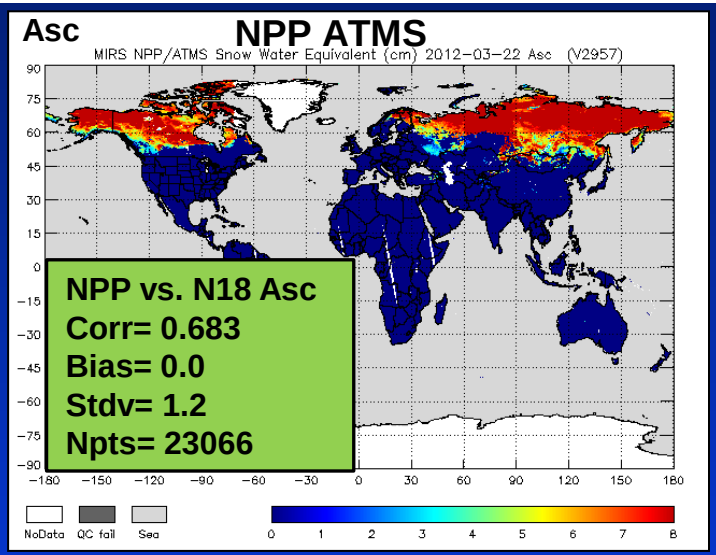
N18 and NPP global patterns of surface type, snow coverage and snow water equivalent are very consistent and compare well with NIC analysis

MiRS Product Assessments: Snow Water Equivalent

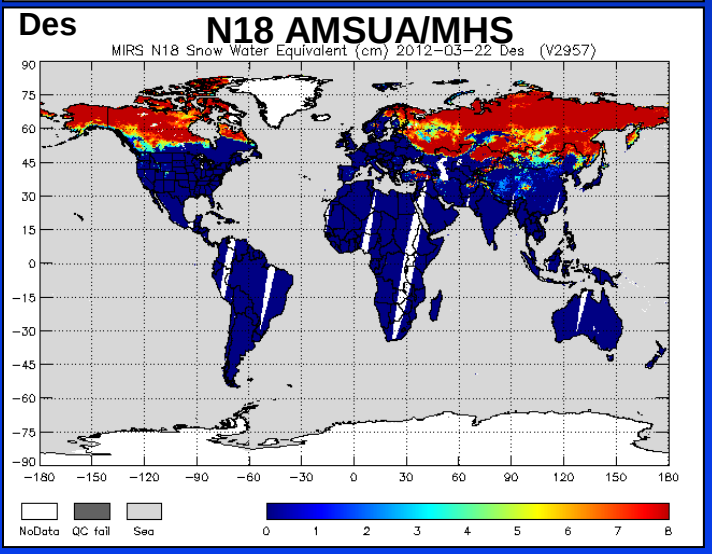
Asc



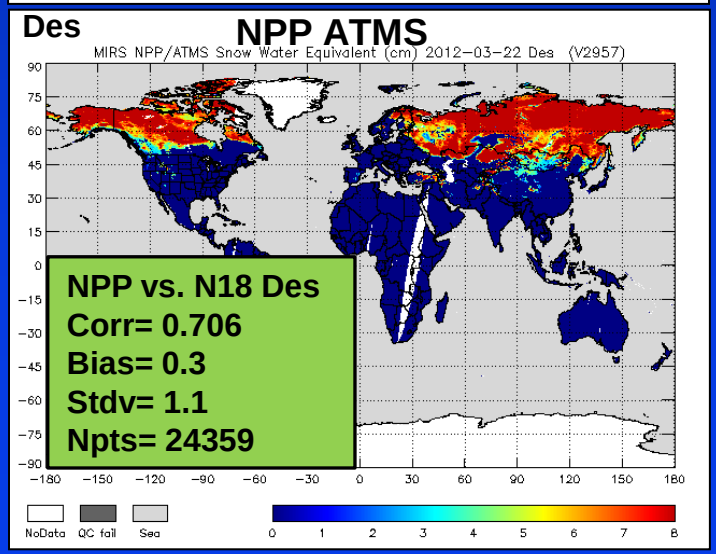
Asc



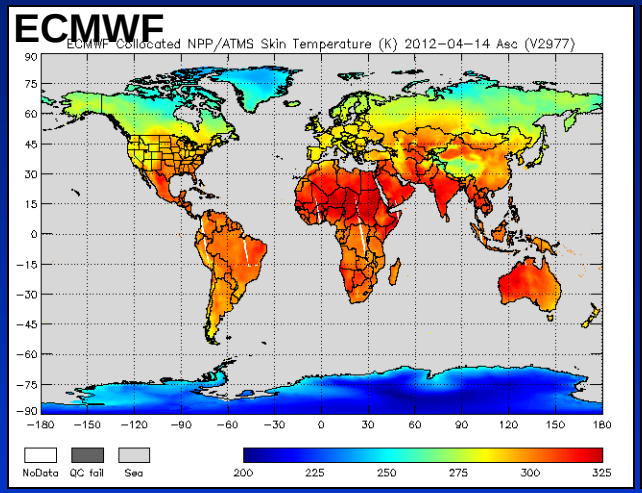
Des

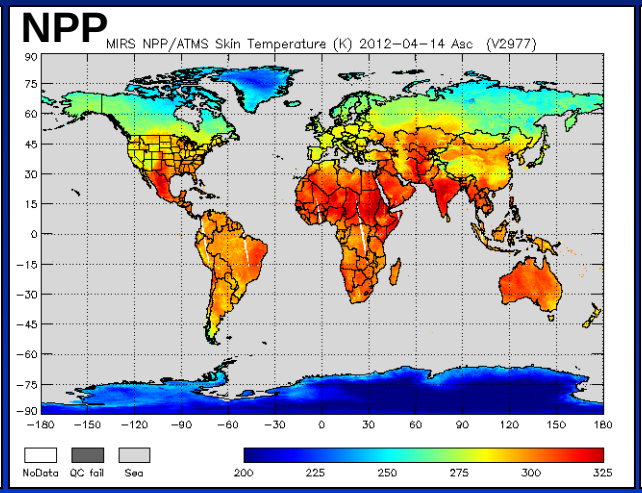


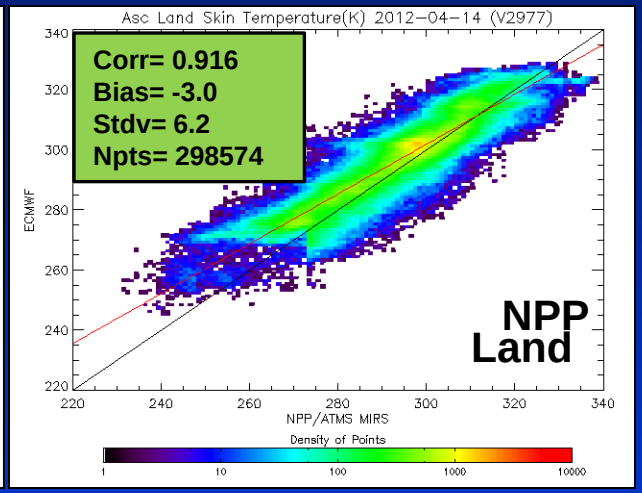
Des

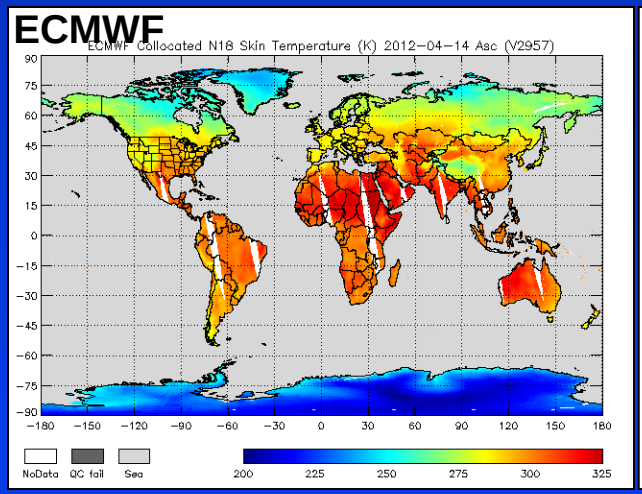


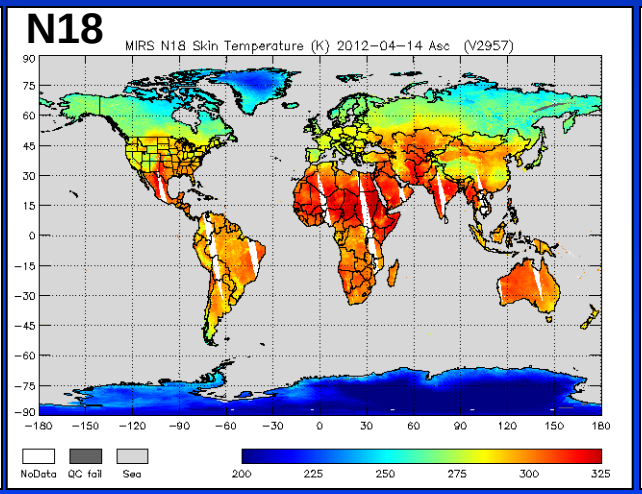
MiRS Product Assessments: Tskin Land

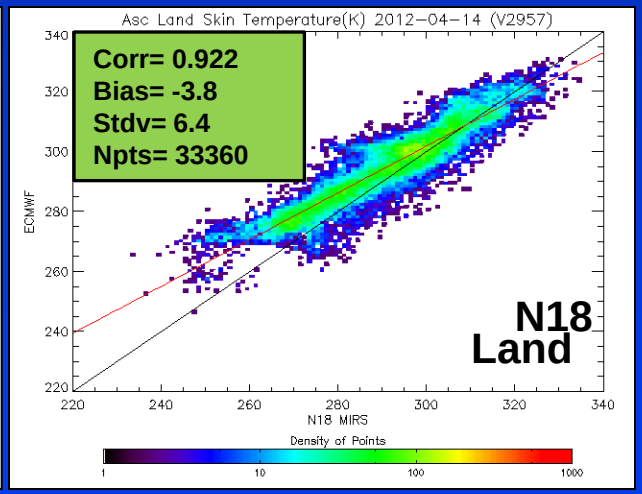












MIRS ATMS
Science Product Assessment Summary

- IT Benchmarks
  - » All integration and testing results (STAR, NDE) show adequate resources for operations
- QC Monitoring
  - » Convergence rates, QC Flags, NEDTs all satisfactory
- Sounding Products
  - » T, WV, TPW performances all comparable to AMSUA/MHS
- Hydrometeors
  - » CLW, IWP, RWP, RR performances comparable to AMSUA/MHS
  - » Slight overestimation of CLW, and underestimation of other hydrometeors will be addressed with tuning of RT modeling error by channel (as done for AMSUA/MHS and SSMIS) prior to final DAP delivery. Current RT modeling errors to be lowered for consistency with N18
- Surface parameters
  - » SIC, SWE and SCE and Tskin all comparable to N18
- Remaining tuning and testing:
  - » AAPP resolution optimization, bias corrections, RT modeling error
- Edge of scan artifacts in some retrieval products may require QC flagging
  - » Added as SRR risk

MiRS Official Products Readiness

Observational Parameter	Imagery Product	Sounding Product Package	Ready	Remarks
Atmospheric Temperature profile		X	✓	All products satisfactory; Tune FM, Bias correction to reduce edge of scan impacts in Sounding and Sfc prods
Atmospheric Water Vapor profile		X	✓	
Total Precipitable Water	X		✓	
Land Surface Temperature	X		✓	
Surface Emissivity Spectrum	X		✓	
Sea-ice Concentration	X		✓	
Snow Cover Extent	X		✓	
Snow-Water Equivalent	X		✓	
Integrated Cloud Liquid Water	X		✓	Tune of RT model uncertainty for overestimation
Integrated Ice Water Path	X		✓	Tune of RT model uncertainty for underestimation
Integrated Rain Water Path	X		✓	SAME AS IWP
Rainfall Rate	X		✓	SAME AS IWP, RWP

Plans for Enhanced MiRS Retrieval Evaluations and Improvements

- Development of New Objective Tools to Evaluate MiRS Retrievals
  - » Based on 1dVAR Formalism; Goal is better evaluation of MiRS performance, especially in difficult situations
- Evolution toward improved a priori background state vector specification
- No effect on MiRS ATMS Integration into NDE

MiRS New Diagnostic and Assessment Tools

- MiRS 1dVAR methodology utilizes information coming from BOTH radiometric measurements (TBs) and an assumed *a priori* state (along with associated error covariances) to minimize an objective function using the non-linear least squares method
- A rigorous analysis of the dependence of the retrievals on both measurements and the *a priori* state (and associated error characteristics) is critical to the evaluation and improvement of the MiRS products
- **MiRS Team is in the process of developing a set of diagnostic tools** that will facilitate rapid and precise analysis of individual retrievals (scenes) produced by the core 1dvar algorithms; Code development will emphasize generality, and extensibility. Initial tool will be an offline module, but codes will allow future integration directly within the MiRS 1dvar modules.
- Advantages:
  - » Rapid analysis of individual or multiple retrieval performance from an information content perspective;
  - » Graphical output of diagnostic metrics: **averaging kernel** (independent information content from measurements), **contribution functions** (sensitivity of retrieved state to measurement channels), **degrees of freedom** (information content contained in the measurements);
  - » Ability to conduct sensitivity tests: dependence on *a priori*, first guess, constraint matrix functional form (e.g. optimal estimation (MiRS), 1st or 2nd derivative constraints, etc.)

Expected initial implementation within next 1-2 months; will be applicable to all satellite/sensor suites

Result will be better quantification of dependence on a priori state (next slide)

The Plan for an Improved MiRS *a Priori* State

- **The *a priori* state plays a critical role in MiRS retrievals:**
  1. Limited number of radiometric measurements (ATMS nchans=22 with redundancy between channels)
  2. Large number of retrieved parameters (T (100), WV(100), Hydrometeors(100), Tskin, Em(22))

- **MiRS currently utilizes a priori state vectors and error covariances based on a global climatology;**
  - » Potential for sub-optimal results in conditions far from climatology

- **MiRS has initiated new effort to develop a spatially and temporally dependent *a priori***
  - » T, WV, Tskin and Em
  - » Spatial: 1 x 1 degree (Coastlines may require special handling)
  - » Temporal: Seasonal (or Monthly)
  - » Source: NWP Reanalysis (NCEP / ECMWF) or NCEP Ensemble forecast error covariances

- Applicable to all satellite/sensor suites
- Expected initial implementation: Sept 2012
- **No immediate impact on current MiRS ATMS integration for NDE**

System Readiness for Users, Operations and Maintenance

- MIRS DAP
  - » **Algorithm run in STAR (regular daily processing) and NDE (integrated and tested)** environments since shortly post-launch; assessments done daily in STAR environment
  - » Algorithm stable, quality of products comparable to heritage sensors
  - » Final MiRS DAP for IOC at NDE to be delivered by July 2012
- QC DAP
  - » **Algorithm running in STAR** since shortly post-launch; assessments done daily in STAR environment: convergence rates and QC percentages comparable to AMSUA/MHS
  - » Algorithm tested at NDE, but full integration with NDE DHS has not yet taken place (NDE/STAR collaboration)
  - » Final QC DAP for IOC at NDE to be delivered by July 2012
- **Overall System Readiness: Both MiRS DAP and QC DAP are ready for operations**

- Introduction
- CUTR Report
- System Requirements
  - » Requirements Allocation
  - » Deliverable Status
  - » Success Criteria
- System Readiness
  - » System Configuration: External and Internal Interfaces, System tests for MiRS and QC DAPs
  - » System Test Results: MiRS IT, Product Assessment and QC
  - » Readiness for Users, Operations and Maintenance
- **RISKS/ACTIONS**
- Summary and Conclusions
- Discussion

Section 5 –
Risks and Actions

Presented by

K. Garrett

Open CDR Risks

- **Risk #1:** Unclear if resources available to run MiRS QC DAP in high-resolution mode.
  - » **Risk Mitigation:** If necessary, AAPP spatial averaging (FM) code which is now implemented can be used to reduce resolution to manageable size; OSPO and NDE indicate testing shows resources are sufficient
  - » Status: Closed

- **Risk #2:** NPP launch date may be postponed beyond Oct 2011; Budget planning assumes minimal schedule slippage.
  - » **Risk Mitigation:** NPP launched in October 2011!
  - » Status: Closed

Open CDR Risks

- **Risk #3:** Footprint Matching (FM) codes not integrated
  - » **Risk Mitigation:** AAPP spatial averaging code now implemented within MIRS; can be tuned to trade off spatial resolution vs. noise amplification
  - » Status: Closed

- **Risk #4:** Proxy data fidelity; Preclassifier and post-processing algorithms partially dependent on calibration with proxy (or real) data.
  - » **Risk Mitigation:** Real data assessments show only minor issues (related to large scan-dependence in SDRs)
  - » Status: Closed

Open CDR Risks

- **Risk #5:** SciTech Renewal
  - **Risk Mitigation:** SciTech contract modifications and bridge contract ensure continuity through end 2012.
  - Status: Closed

Open TRR Risks

- **Risk #1:** Coefficient files require real data for training and algorithm tuning (bias, covariances, first-guess, catalogs) (also a CDR risk)
  - » **Risk Mitigation:** Post-launch efforts have focused on cal/val; software and correction coefficients based on real data, and results show only minor issues.
  - » Status: Closed

Open TRR Risks

- **Risk #2:** Available resources in STAR and NDE environments are not consistent (IDL versions, compiler versions, etc.)
  - » **Risk Mitigation:** Identified and addressed issues during the code unit testing. MiRS software is compatible with a variety of operating environments (Linux, AIX, multiple compilers). NDE integration and testing post-launch has reduced risk.
  - » Status: Open with reduced risk

- **Risk #3:** QC DAP lacks ability to monitor radiometric bias for upper-atmospheric ATMS temperature sounding channels using GFS at input. GFS model profiles only extend to 10 mb, below the sensitivity of ATMS channels 14 and 15 (57 GHz).
  - » **Risk Mitigation:** Broader instrument issues will be captured through NEDT, QC, or radiometric monitoring of other ATMS channels. **STAR will also perform radiometric monitoring using other data sources which extend to the upper atmosphere where ATMS channels 14 and 15 are sensitive (e.g. ECMWF analysis).**
  - » Status: Open with reduced risk

Open CUTR Risks

- **Risk #1: NO RISKS IDENTIFIED**
  - **Risk Mitigation:**
  - Status:

CUTR Action Items

Action Item	Description	Author	Lead Org	Status
1	Share upgraded netCDF converter with OSPO	L. Zhao	STAR	Closed
2	STAR/OSPO Meeting to Discuss Scaling and Precision Requirements for netCDF data	C. Grassotti	STAR/OSPO	Closed
3	OSPO/NDE Meeting to Discuss QC DAP Requirements	K. Garrett	OSPO/NDE	Closed

New SRR Risks

- **Risk #1:** SDR calibration still not finalized by STAR cal/val team; currently running with TDRs which require some footprint matching especially low frequencies (23v, 31v) with large FOVs
  - » **Risk Likelihood: Moderate**. Cal/Val teams still working on improving calibration for SDRs
  - » **Risk Impact: Low**. MiRS currently processing TDRs with good performance
  - » **Risk Mitigation:** AAPP footprint matching should reduce side lobe artifacts.
  - » Status: Open

- **Risk #2:** Footprint matching not adequately tuned or may amplify noise
  - » **Risk Likelihood: Low**. Extensive testing will ensure low noise amplification
  - » **Risk Impact: Low**. Only chans 1-2 (23v, 31v) likely to be impacted since other channels have much smaller beam width
  - » **Risk Mitigation:** Continued testing through to operational declaration will reduce risk
  - » Status: Open

New SRR Risks

- **Risk #3:** Edge of scan retrievals (1-3; 94-96) may need to be flagged/removed if TDR biases can not be reduced and retrieval products are affected
  - **Risk Likelihood: Moderate**. Results to date show that using AAPP increases edge of scan biases in channels 1-2 only.
  - **Risk Impact: Moderate**. Removal of edge of scan retrievals will slightly reduce spatial coverage of NPP data
  - **Risk Mitigation:** Applying bias corrections based on native resolution data may reduce impact; Better characterization of radiometric biases (e.g. cloud, rain filtering, latitudinal sampling, etc.)
  - Status: Open

New SRR Risks

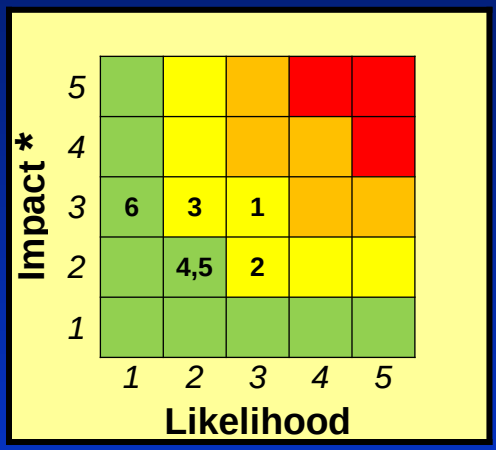
- **Risk #4:** Residual retrieval artifacts may be present along coastlines and other surface discontinuities due to differences in spatial resolution between chans 1-2 and higher frequency channels
  - » **Risk Likelihood: Low**. Results to date show that AAPP FM will increase effective resolution without artifacts for all scan positions away from edge of scan
  - » **Risk Impact: Moderate**. Removal of some retrieval products at edge of scan in some conditions (coastlines, etc.) will reduce spatial coverage.
  - » **Risk Mitigation:** Running AAPP FM should reduce artifacts in retrieval products; edge of scan retrievals may need to be flagged
  - » Status: Open

New SRR Risks

- **Risk #5:** NDE production rule changes to accommodate AAPP (require granules before and after current granule to do spatial averaging)
  - **Risk Likelihood:** **Very Low**. NDE will be able to accommodate this change
  - **Risk Impact:** **Moderate**. If neighboring granules not available, then some fraction of each granule would not be able to be processed by FM code.
  - **Risk Mitigation:** Communications with NDE indicate this is not a major change and is already being done for NUCAPS algorithms
  - Status: Open
- **Risk #6:** QC DAP not fully integrated and tested at NDE
  - **Risk Likelihood:** **Low**. NDE will have resources to integrate before going operational.
  - **Risk Impact:** **Low**. QC metrics will allow better monitoring of MiRS performance.
  - **Risk Mitigation:** NDE can integrate and test with current version prior to delivery of final QC DAP (NDE/STAR collaboration)
  - Status: Open

MiRS SRR Risk Summary

Risk No. (Rank)	Risk	*Risk Likelihood*	*Risk Impact*	*Risk Index*
1	Edge of scan retrieval quality due to TDR biases	Moderate	Moderate	9.00
2	SDR calibration still not finalized; Using TDRs	Moderate	Low	6.00
3	Retrieval artifacts near surface discontinuities due to interchannel spatial resolution differences	Low	Moderate	6.00
4	QC DAP not integrated/tested at NDE	Low	Low	4.00
5	AAPS FM not adequately tuned	Low	Low	4.00
6	AAPS requires change in NDE production rules	Very Low	Moderate	3.00



***Risk Impact may be on schedule, cost, and/or science product quality and availability.**

Risk Level		*Likelihood*
1	Very Low	P < 10%
2	Low	10% ≤ P < 30%
3	Moderate	30% ≤ P < 70%
4	High	70% ≤ P < 90%
5	Very High	P ≥ 90%

Risk Impact		*Description*
1	Very Low	Negligible
2	Low	Minor
3	Moderate	Major
4	High	Critical
5	Very High	Catastrophic

Review Items Summary

- 5 Risk Items from the CDR were reviewed, 5 are closed
- 3 TRR Risk Items were reviewed, 2 remain open
- 3 Action Items from the CUTR were identified, 3 are closed; There were no CUTR Risk Items
- 6 SRR Risk Items were identified

- Introduction
- CUTR Report
- System Requirements
  - » Requirements Allocation
  - » Deliverable Status
  - » Success Criteria
- System Readiness
  - » System Configuration: External and Internal Interfaces, System tests for MiRS and QC DAPs
  - » System Test Results: MiRS IT, Product Assessment and QC
  - » Readiness for Users, Operations and Maintenance
- Risks/Actions
- **SUMMARY AND CONCLUSIONS**
- Discussion

Section 6
Summary and Conclusions

Presented by

K. Garrett

Summary and Conclusions

- Following have been reviewed:
  - CUTR Report
  - System Requirements
  - System Readiness
  - Risks and Actions
- Based on all testing and integration results:
  - **MiRS DAP and QC DAP are ready for operations** (pending response to any Action Items from SRR)

Next Steps

- Prepare SRR Report (including action items)
- Reviews:
  - » No official EPL reviews remain; SRR satisifies requirement 9.1.5 in Level 1 Reqs Doc
  - » June/July: Briefings to POPs and SPSRB on product status
- Update Documentation following SPSRB Guidelines
- Build MiRS DAP and QC DAP following ESPDS Guidelines (e.g. documentation, software, test data)
- Address action items identified in SRR

- Introduction
- CUTR Report
- System Requirements
  - » Requirements Allocation
  - » Deliverable Status
  - » Success Criteria
- System Readiness
  - » System Configuration: External and Internal Interfaces, System tests for MiRS and QC DAPs
  - » System Test Results: MiRS IT, Product Assessment and QC
  - » Readiness for Users, Operations and Maintenance
- Risks/Actions
- Summary and Conclusions
- **DISCUSSION**

Open Discussion

- The review is now open for discussion

SRR Action Item # 1: Deliver MiRS DAP and QC DAP to OSPO for testing

Submitted by: L. Zhao

Description: Deliver MiRS DAP and QC DAP to OSPO for testing prior to final DAP delivery to NDE in July.

Lead Organization: STAR

Response: Once remaining issues with ATMS processing are resolved, MiRS IPT will deliver the MiRS DAP and QC DAP to OSPO for testing prior to final DAP delivery to NDE in July.

Status: OPEN

Back-up Slides