S-NPP Snowfall Rate

Critical Design Review

Algorithm Readiness Review

Provisional Maturity Review

&

NOAA-20 Snowfall Rate

Beta Maturity Review

June 20, 2018

Presented by:

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Review Agenda

Section	Time	Presenter
Introduction	1:00 – 1:05	Huan Meng
Requirements	1:05 – 1:15	Limin Zhao
Operations Concept	1:15 – 1:25	Limin Zhao
Algorithms: Snowfall Detection and Snowfall Rate	1:25 – 1:40	Huan Meng
Software Architecture and Interfaces	1:40 – 1:50	Huan Meng
Validation: Snowfall Detection	1:50 – 2:00	Cezar Kongoli
Validation: Snowfall Rate	2:00 – 2:10	Jun Dong
NOAA-20 SFR Performance	2:10 – 2:15	Huan Meng
Risk Summary	2:15 – 2:20	Huan Meng
Summary and Conclusions	2:20 – 2:30	Ralph Ferraro

Review Outline

- **Introduction**
- Requirements
- Operations Concept
- Algorithms: Snowfall Detection and Snowfall Rate
- Software Architecture and Interfaces
- Validation: Snowfall Detection
- Validation: Snowfall Rate
- NOAA-20 SFR Performance
- Risk Summary
- Summary and Conclusions

Introduction

Presented by

Huan Meng
NOAA/NESDIS/STAR

Background

- This project builds on the operational AMSU/MHS Snowfall Rate (SFR) product
  - ✓ SFR is water equivalent snowfall rate
    - Current SFR max is 5 mm/hr (0.2 in/hr), equivalent to 5 cm/hr (2 in/hr) solid snow with 10:1 snow to liquid ratio
  - ✓ Four POES and Metop satellites: NOAA-18/-19, Metop-A/-B
  - ✓ Implemented in operation in 2012
- Future implementations
  - ✓ Extension to S-NPP and NOAA-20 ATMS (PSDI-funded)
  - ✓ Extension to Metop-C AMSU/MHS (PSDI-funded)
  - ✓ Extension to NASA GPM GMI (not yet funded)
  - ✓ Extension to DMSP F16/F17/F18 SSMIS (not yet funded)
- This review will focus on the extension to S-NPP and NOAA-20 beta maturity review

Background

- JPSS PGRR Program supported the development of S-NPP SFR algorithm
- The product has been produced at near real-time in experimental mode since 2014
- S-NPP SFR and POES/Metop SFR were evaluated at several NWS Forecast Offices (WFOs) in operational environment
  - ✓ Forecasters feedback indicates that SFR is useful in operation, especially in regions with no or limited radar coverage
- POES and Metop SFR is produced inside MiRS; S-NPP and NOAA-20 SFR will follow the same production scheme
- ATMS SFR was added to JPSS Baseline Requirements
  - ✓ Approvals by ERB, SPSRB, LORWG,PCB, NOSC, and DUSO
  - ✓ SPSRB approval on April 19, 2017

Stakeholders – Integrated Product Team and Users

- IPT Lead: Huan Meng (STAR)
- IPT Backup Lead: Limin Zhao (OSPO)
- NESDIS Team:
  - ✓ STAR: H. Meng, R. Ferraro, M. Liu, B. Yan
  - ✓ OSPO: L. Zhao
  - ✓ JPSS: A. Layns
  - ✓ JPSS-STAR: L. Zhou
  - ✓ NCEI: A. Graumann
  - ✓ Others: J. Dong, C. Kongoli, C. Grassotti, S. Liu, R. Honeyager
- User Team
  - ✓ Lead: P. Xie (NCEP/CPC)
  - ✓ Others: NWS WFOs, NWS WPC, NWS/OWP, NASA/SPoRT
- Oversight Panel (OP) lead: PREPOP
- Other OPs involved: NONE

Stakeholders – Development Team

- STAR
  - ✓ Huan Meng, Ralph Ferraro, Quanhua Liu, Banghua Yan
- CICS-MD
  - ✓ Jun Dong, Cezar Kongoli, Chris Grossotti
- CIRA
  - ✓ Shuyan Liu
- IMSG
  - ✓ Ryan Honeyager
- Responsibilities
  - ✓ Develop SFR algorithm including snowfall detection and rate
  - ✓ Validate SFR product including snowfall detection and rate
  - ✓ Build SFR near real-time processing system
  - ✓ Integrate SFR processing into the MiRS system
  - ✓ Develop SFR ATBD and maturity README files
  - ✓ Deliver MiRS DAP including S-NPP and NOAA-20 SFR to NDE

Project Plan – Task and Milestones

- Tasks
  - ✓ Prepare ATMS SFR for transition to operation
  - ✓ S-NPP SFR reaches provisional maturity
  - ✓ NOAA-20 SFR reaches beta maturity
  - ✓ Implement S-NPP ATMS SFR in operation
- S-NPP SFR Milestones
  - ✓ Critical Design Review – June 2018
  - ✓ Algorithm Readiness Review – June 2018
  - ✓ Software Code Review – June 2018
  - ✓ Final DAP – June 2018
  - ✓ Operational Readiness Review – August 2018
  - ✓ SPSRB Briefing – September 2018
  - ✓ Operations Commence – September 2018
- NOAA-20 SFR Milestones
  - ✓ Preliminary DAP – June 2018
  - ✓ Critical Design Review – September 2018
  - ✓ Algorithm Readiness Review – September 2018
  - ✓ Final DAP – December 2018
  - ✓ Software Code Review – January 2019
  - ✓ Operational Readiness Review – February 2019
  - ✓ SPSRB Briefing – March 2019
  - ✓ Operations Commence – March 2019

CDR and ARR Entry Criteria

- S-NPP SFR Final DAP, NOAA-20 Preliminary DAP
- Review Item Disposition (RID)
- Software Code Review (SCR)
- SPSRB and JPSS documents
- Review of the S-NPP and NOAA-20 SFR
  - ✓ Requirements
  - ✓ Operations Concept
  - ✓ Algorithms
  - ✓ Software Architecture and Interfaces
  - ✓ Validation
  - ✓ Risk Summary

CDR and ARR Exit Criteria

- CDR and ARR Review Report
  - ✓ Updated slide package
  - ✓ Actions
  - ✓ Comments

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Requirements

Presented by

Limin Zhao
NOAA/NESDIS/OSPO

Requirements

- **SPSRB User Requests**
  - ✓ 1611-0008 - Extension of passive microwave (PMW) satellite Snowfall Rate (SFR) retrievals to be extended/improved by including ATMS data
    - – Extend the existing PMW snowfall rate product to ATMS
  - ✓ 1208-0020 - Requests for Satellite PMW Snowfall Rate Retrievals
    - – The request has been fulfilled with AMSU/MHS SFR
    - – The capability has been integrated into MIRS

- **JPSS Requirement**
  - ✓ NJO-2016-018: Approved as an addition to JPSS L1RD, L1RD-S, JRED, etc.

- **Continuity of Operation**
  - ✓ Need SFR from new satellites, including S-NPP, JPSS-20 and beyond

Requirements

- All requirements presented here are obtained from the following documents:
  - ✓ SPSRB user requests
  - ✓ SPSRB process
  - ✓ Continuity of Operation
  - ✓ JPSS L1RD
  - ✓ MiRS Requirements
- Basic requirements are shown in orange
- The requirements documented here mainly focus on the updates required for generating SFR within MiRS from S-NPP and NOAA-20, which are highlighted in red
  - ✓ MiRS has been running on both NDE and MGT servers operationally for many years

Basic Requirement 0.0

- SFR-R 0.0: *The SFR development project shall adopt the standard practices of the Satellite Product and Services Review Board (SPSRB)*
  - ✓ **Driver**: The SPSRB process has been updated by incorporating aspects of the STAR EPL Process.

Basic Requirement 0.0

- SFR-R 0.1: *The SFR development project practices shall be compatible with the SPSRB process.*
  - ✓ This requirement should be met by following the SPSRB process, as long as the tailoring does not introduce an incompatibility.

- SFR-R 0.2: *There shall be a combined Project Requirements Review (PRR) and Preliminary Design Review (PDR) and Critical Design Review (CDR) and Algorithm Readiness Review (ARR)*
  - ✓ This derived requirement has been adopted to eliminate the overhead of preparing PRR, PDR, CDR slide packages and responding to review reports.

Basic Requirement 1.0

- SFR-R 1.0: *The Integrated Product Team (IPT) shall design and build SFR to run within MIRS in near real time.*
  - ✓ **Driver:** This basic requirement is traced to users' need for near real-time data and products

Basic Requirement 1.0

- SFR/MiRS-R 1.1: *The SFR shall run within MiRS in the ESPS/NDE operational environment*
  - ✓ SFR/MiRS-R 1.1.1: *The MIRS shall be hosted on the NDE and MGT servers that are built following the ESPC requirements for OS, security and network.*
- SFR/MiRS-R 1.2: *The NDE and MGT servers shall have required capacity to process the MIRS products, including SFR*
  - ✓ SFR/MiRS-R 1.2.1: *The NDE/MGT servers shall have the IT capacity required to run the MiRS at high resolution (10~ 15km)*
    - SFR/MiRS-R 1.2.1.1: *The NDE and MGT servers shall have at least 64 GB of memory and 2TB of data storage*
    - SFR/MIRS-R 1.2.1.2: *The NDE and MGT servers shall be connected to ESPC SAN for storage*

Basic Requirement 1.0

- SFR/MiRS-R 1.2.2 *The NDE and MGT servers shall provide required IT capacity to run MiRS within time latency less than 30 mins. The following is minimal IT capacity required.*
  - ✓ 80 processors
  - ✓ 64 GB RAM per node
  - ✓ 1.0 TB of Disk Space for Development Environment
  - ✓ 2.0 TB of Disk Space on Test and Operational Environments

Basic Requirement 1.0

- SFR/MiRS-R 1.2.3 *The NDE and MGT shall establish the network connections with the following machines*
  - ✓ PDA/PDAtest
  - ✓ GP50/GP5
  - ✓ Geodist4
  - ✓ Cyclone/Tornado
  - ✓ SATEPSANONE

Basic Requirement 1.0

- SFR/MiRS-R 1.2.4: *The NDE and MGT shall provide the operational system with the following features*
  - ✓ RedHat Linux OS
  - ✓ Intel FORTRAN compiler (preferred)
  - ✓ gcc compiler package (gcc, gfortran)
- SFR/MiRS-R *1.2.5:* *The NDE and MGT shall provide the shell script listed below*
  - ✓ Bash shell
- SFR/MiRS-R 1.2.6: *The NDE and MGT shall provide the Tools/Libs listed below*
  - ✓ Perl
  - ✓ IDL
  - ✓ McIDAS
  - ✓ HDF4/HDF5 and netCDF4 libraries
  - ✓ jpeg, zlib, szip, hdfeos2
- SFR/MiRS-R 1.2.7: *The NDE and MGT shall provide the CM tool listed below*
  - ✓ Subversion

Basic Requirement 1.0

- SFR/MiRS-R 1.3: *The NDE and MGT shall establish the interface/network connection for MiRS to access the ATMS, AMSU L1b, MHS L1b, SSMIS TDR, GMI L1C-R, IMS and NCEP GFS/GDAS data from ESPC PDA/SFS*
  - ✓ SFR/MiRS-R 1.3.1: The NDE shall setup the required firewall rules to allow access from NDE to PDA
  - ✓ SFR/MiRS-R 1.3.2: The MGT shall setup the required firewall rules to allow access from MGT to PDA/SFS
- SFR/MiRS-R 1.4: *The NDE and MGT shall make the ATMS, AMSU L1b, MHS L1b, SSMIS TDR, GMI L1C-R, IMS and NCEP GFS/GDAS data available to MiRS. Files are identified in the following slide*
  - ✓ SFR/MiRS-R 1.3.3: The NDE shall *setup sftp/ftp pull/push access from NDE to PDA*
  - ✓ SFR/MiRS-R 1.3.4: The MGT shall *setup sftp/ftp pull/push access from MGT to PDA/SFS*

External Input Data Required

Dynamic Input File	Filename	Format
ATMS SDR – SNPP, N20	SATMS_???_d????????_t???????_e???????_b?????_c?????? ????????????????_noac_ops.h5	HDF5
ATMS TDR – SNPP, N20	TATMS_???_d????????_t???????_e???????_b?????_c?????? ????????????????_noac_ops.h5	HDF5
ATMS Geo – SNPP, N20	GATMO_???_d????????_t???????_e???????_b?????_c?????? ????????????????_noac_ops.h5	HDF5
AMSU-A L1B – MetOp-B and C	NSS.AMAX.??.D?????.S????.E????.B???????.SV	L1B binary
MHS L1B – MetOp-B and C	NSS.MHSX.??. D?????.S????.E????.B???????.SV	L1B binary
GMI GPM L1CR	1C-R.GPM.GMI.XCAL2016-C.20180128-S155140-E155638.V05A	HDF5
GMI GPM L1B	1B.GPM.GMI.TB2016.20180128-S155640-E160138.V05A	HDF5
SAPHIR M-T	MT1SAPSL1A2_1.07_000_1_17_I_2016_08_10_19_26_01_2016 _08_10_21_23_25_24930_24931_258_02_03_BL4_00.h5	HDF5
GFS	0.5 degrees resolution	GRIB2

Basic Requirement 1.0

- SFR/MIRS-R 1.4.1: *The MIRS shall have access to the real-time satellite data*
  - ✓ *SFR/MIRS-R 1.4.1.1: The MIRS shall establish the interface to pull the satellite data*
    - *SFR/MIRS-R 1.4.1.1.1: The SFR shall establish the interface with MiRS to ingest the satellite data*
  - ✓ *SFR/MIRS-R 1.4.1.2: The MIRS shall have an ingest module to read and decode the satellite data in either netCDF4 or HDF5 formats*
- SFR/MIRS-R 1.4.2: *The MIRS shall have access to the NCEP GFS/GDAS data*
  - ✓ SFR/MIRS-R 1.4.2.1: *The MIRS shall establish the interface to get the GFS/GDAS data from the ESPC DDS*
    - *SFR/MIRS-R 1.4.2.1.1: The SFR shall establish the interface with MiRS to ingest the GFS data*
- SFR/MIRS-R 1.4.3: *The MIRS shall have access to the IMS data*
  - ✓ SFR/MIRS-R 1.4.3.1: *The MIRS shall establish the interface to get the IMS data from the ESPC DDS*

Basic Requirement 1.0

- SFR/MIRS-R 1.5: *The NDE and MGT shall be capable of providing the MIRS products to users. Files are identified in the following slide.*
  - ✓ SFR/MiRS-R 1.5.1: *The SFR shall establish the interface to merge the snowfall rate into the MiRS data file*
  - ✓ SFR/MiRS-R 1.5.2: *The NDE/MGT shall establish the interface to distribute the MiRS data to users through PDA*
  - ✓ SFR/MiRS-R 1.5.3: *The MGT shall establish the interface to distribute the MiRS data to users through DAPE*
  - ✓ SFR/MiRS-R 1.5.4: *The MGT shall establish the interface to distribute the MiRS data to users through the ESPC ADDE server (Geodist)*
  - ✓ SFR/MiRS-R 1.5.5: *The MGT shall establish the interface to distribute the MiRS data to users through the ESPC QC/QA server (Cyclone/Tornado)*
  - ✓ SFR/MiRS-R 1.5.6: *The MGT shall establish the interface to distribute the MiRS data to users through the ESPC Web server (gp5/gp50)*
  - ✓ SFR/MiRS-R 1.5.7: *The MGT shall establish the interface to distribute the MiRS data to users through the ESPC FTP server (satepsanone)*

MiRS Output Data Files

Output File	Filename	Format
SND Products	NPR-MIRS-IMG_v??r??_<SatID>_s????????????_e????????????_c????????????.nc	netCDF4
IMG Products	NPR-MIRS-SND_v??r?_<SatID>_s????????????_e????????????_c????????????.nc	netCDF4

Basic Requirement 2.0

- SFR/MIRS-R 2.0: *The MIRS products shall include Total Precipitable Water (TPW), Cloud Liquid Water (CLW), Ice Water Path(IWP),* Graupel-size ice Water Path (GWP), *Rain Water Path (RWP), Rain Rate(RR), Snowfall Rate(SFR), Snow Cover, Sea Ice Concentration, Snow Water Equivalent, Land Surface Emissivity, Land Surface Temperature, Temperature profile, Moisture profile*

  ✓ **Driver:** This basic requirement is traced to user needs.

Basic Requirement 2.0

- SFR/MIRS-R 2.1: *The MIRS* shall provide the products from NOAA-18, NOAA-19, Metop-A, Metop-B, DMSP F17, DMSP F18, GPM and S-NPP, NOAA-20
  - ✓ SFR/MIRS-R 2.1.1: SFR shall be added to the MiRS S-NPP and NOAA-20 products file
    - SFR/MIRS-R 2.1.1.1: SFR shall have an interface with MiRS
- SFR/MIRS-R 2.2: *The MIRS shall provide the products to users within 0.5 ~ 3 hours after observation under the condition that the real-time data is available*
  - ✓ SFR/MIRS-R 2.2.1: SFR shall meet the time latency requirement
- SFR/MIRS-R 2.3: *The MIRS products shall be provided in netCDF4 format*
- SFR/MIRS-R 2.3: *The MIRS products shall be provided in McIDAS format*

Basic Requirement 3.0

- MIRS-R 3.0: *The MIRS shall have the QC monitoring capability.*

  - ✓ **Driver:** This basic requirement is traced to user's needs for product quality.

Basic Requirement 3.0

- SFR/MIRS-R 3.1: *The MIRS product files shall include overall quality control flags.*
  - ✓ SFR/MIRS-R 3.1.1: *The SFR shall output its quality check as part of the MiRS quality flags*
- SFR/MIRS-R 3.2: *The MIRS shall be capable of monitoring input data latency and overall quality.*
- SFR/MIRS-R 3.3: *The MIRS shall be capable of monitoring product generation status to ensure that the MIRS data and products are successfully generated*
- SFR/MIRS-R 3.4: *The MIRS shall be capable of monitoring product latency.*

Basic Requirement 3.0

- SFR/MIRS-R 3.5: *The MIRS shall be capable of monitoring product distribution status to ensure that the data/products are successfully transfer to the user community.*
- SFR/MIRS-R 3.6: *The MIRS* shall *be capable of monitoring product quality*
  - ✓ SFR/MIRS-R 3.6.1: *The MIRS shall be able to generate images for the M-T data and products*
  - ✓ SFR/MIRS-R 3.6.2: *The MIRS shall be able to generate statistics for trend plots*
  - ✓ SFR/MIRS-R 3.6.3: *The MIRS shall be able to generate daily and monthly means for trend plots*
  - ✓ SFR/MIRS-R 3.6.4: The MIRS shall be able to setup some real-time validation capability with TRMM, Radar, etc.

Basic Requirement 3.0

- SFR/MIRS-R 3.7: *The IPT shall develop software to build the web-based monitoring tool*
  - ✓ SFR/MIRS-R 3.7.1: *The MIRS shall establish the interface to push data to the ESPC web servers.*
  - ✓ SFR/MIRS-R 3.7.2: *The web-based monitoring tool shall have capability of displaying the imagery products.*
    - SFR/MIRS-R 3.7.2.1: The web-based monitoring shall have query capability for display the image at specified time
    - SFR/MIRS-R 3.7.2.2: The web-based monitoring shall have animation capability for display the image at a specified time duration
    - SFR/MIRS-R 3.7.2.3: The web-based monitoring shall be updated to include S-NPP and NOAA-20 SFR
  - ✓ SFR/MIRS-R 3.7.3: *The web-based monitoring tool shall have capability of monitoring the system performance, product time latency, etc.*

Basic Requirement 4.0

- SFR/MIRS-R 4.0: *The IPT shall deliver the MIRS document package to OSPO.*

  - ✓ **Driver:** SPSRB process

Basic Requirement 4.0

- SFR/MIRS-R 4.1: *The document package shall include an Algorithm Theoretical Basis Document (ATBD).*
  - ✓ *SFR-R 4.1.2: The document package shall include an ATBD for SFR*
- SFR/MIRS-R 4.2: *The document package shall include a System Maintenance Manual (SMM).*
- SFR/MIRS-R 4.3: *The document package shall include an User Manual (UM).*

Basic Requirement 5.0

- SFR/MIRS 5.0: *The MIRS output files shall be archived* (product, functional)

  ✓ **Driver:** This basic requirement is traced to user's needs.

Basic Requirement 5.0

- SFR/MIRS-R 5.1: The MIRS *shall output the products in netCDF4 format, which should be CF compliant.*

- SFR/MIRS-R 5.2: *The MIRS IPT shall create a Data Submission Agreement (DSA) with CLASS. The DSA shall include all information regarding the archival of product files.*

Basic Requirement 6.0

- SFR/MIRS-R 6.0 : *Programming and scripting languages shall follow the OSPO Technical Reference Model (TRM) Programming Language/Scripting.*

  - Driver: SPSRB process - code standards

Basic Requirement 7.0

- SFR/MIRS-R 7.0: *The MIRS shall comply with OSPO Code Review Security check lists.*

Driver: OSPO Security

Basic Requirement 7.0

- SFR/MIRS-R 7.1: *The MIRS shall comply with OSPO data integrity check list.*
  - ✓ Driver: OSPO data integrity check list is part of the OSPO Code Review Security check lists
- SFR/MIRS-R 7.2: *The MIRS shall comply with OSPO development security check list.*
  - ✓ Driver: OSPO development security check list is part of the OSPO Code Review Security check lists
- SFR/MIRS-R 7.3: *The MIRS shall comply with OSPO code check list.*
  - ✓ Driver: OSPO code standard check list is part of the OSPO Code Review Security check lists

Basic Requirement 8.0

- SFR/MIRS-R 8.0: *The IPT shall deliver the MIRS products and documentations to the OSPO in the form of Algorithm Packages (APs).*

Driver: This basic requirement is traced to user's needs.

Basic Requirement 8.0

- SFR/MIRS-R 8.1: *The MIRS development team shall set up an internal FTP site for transferring the pre-operational algorithm to OSPO as a Delivered Algorithm Package (DAP)*
  - ✓ SFR/MIRS-R 8.1.1: The MIRS development team shall ensure that the OSPO PAL has the information needed to acquire the DAP from the internal FTP site
- SFR/MIRS-R 8.2: *The DAP shall include all processing codes and ancillary files needed to reproduce the benchmark results*
- SFR/MIRS-R 8.3: *The DAP shall include all input test data needed to reproduce the benchmark results*
- SFR/MIRS-R 8.4: *The DAP shall include all benchmark output data*

Basic Requirement 8.0

- SFR/MIRS-R 8.5: *The DAP shall include the following items:*
  - ✓ All codes and system files
  - ✓ Benchmark test data
  - ✓ Error messaging/handling
  - ✓ Configuration files
  - ✓ Production rules
  - ✓ Delivery memo

Basic Requirement 9.0

- SFR/MIRS-R 9.0: *The SFR product shall meet the JPSS requirements*

EDR Attribute	Threshold	Objective
Snowfall Rate applicable conditions: Limb-corrected TB53.6 GHz ≥ 240 K		
Geographic coverage	Global land	Global
Vertical Coverage	Single Layer in lower atmosphere	Single Layer in lower atmosphere
Horizontal Cell Size	15 km at nadir	15 km at nadir
Mapping Uncertainty	N/A (reflects SDR characteristics)	N/A (reflects SDR characteristics)
Measurement Range	N/A	N/A
Measurement Accuracy	0.3 mm/hr	0.15 mm/hr
Measurement Precision	1 mm/hr	0.7 mm/hr
Probability of Detection	40% over land and 30% over water	50% over land and 40% over water
False Alarm Rate	15% over land and water	10% over land and water
Refresh	Orbital	Orbital

Basic Requirement 10.0

- SFR/MIRS-R 10.0: *The SFR product shall meet the JPSS data products maturity requirements*

1. Beta
- Product is minimally validated, and may still contain significant identified and unidentified errors.
- Information/data from validation efforts can be used to make initial qualitative or very limited quantitative assessments regarding product fitness-for-purpose.
- Documentation of product performance and identified product performance anomalies, including recommended remediation strategies, exists.

2. Provisional
- Product performance has been demonstrated through analysis of a large, but still limited (i.e., not necessarily globally or seasonally representative) number of independent measurements obtained from selected locations, time periods, or field campaign efforts.
- Product analyses are sufficient for qualitative, and limited quantitative, determination of product fitness-for-purpose.
- Documentation of product performance, testing involving product fixes, identified product performance anomalies, including recommended remediation strategies, exists.
- Product is recommended for potential operational use (user decision) and in scientific publications after consulting product status documents.

3. Validated
- Product performance has been demonstrated over a large and wide range of representative conditions (i.e., global, seasonal).
- Comprehensive documentation of product performance exists that includes all known product anomalies and their recommended remediation strategies for a full range of retrieval conditions and severity level.
- Product analyses are sufficient for full qualitative and quantitative determination of product fitness-for-purpose.
- Product is ready for operational use based on documented validation findings and user feedback.
- Product validation, quality assurance, and algorithm stewardship continue through the lifetime of the instrument.

Requirements – Summary

- The requirements have been documented in this presentation as Requirements Allocation Document (RAD).
- The SFR requirements are traceable to drivers (customer needs or expectations) and other requirements, including JPSS requirements for quality and maturnity.
- The SFR requirements have been allocated to the system design.
- The MiRS requirements have been updated to reflect the changes for SFR from S-NPP and NOAA-20

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Operations Concept

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NOAA/NESDIS/OSPO

Operations Concepts - Overview

- Review the answers to the following questions based on customer/user needs and expectations and production constraints
  - ✓ What are the products?
  - ✓ Why are the products being produced?
  - ✓ How will the products be used?
  - ✓ How should the products be produced (operational scenario)

What are the Products?

Parameters	Specifications
Environmental parameter	Snowfall Rate
Geographical Coverage	Global Land
Horizontal Resolution/grid spacing	Original satellite footprint (15 km x 15 km to 31 km x 71 km depending on scan position)
Mapping Uncertainty	N/A
Measurement Range	0.05 – 5 mm/hr
Measurement Accuracy	0.3 mm/hr
Latency	0.5 ~ 3 hours (30 mins after all input data received)
Refresh	Orbital

Why Are The Products Being Produced?

- The SFR products are required through the SPSRB user requests by NWS
  - ✓ SPSRB User Requests: 1208-0020 (AMSU/MHS); 1611-0008(ATMS)
- The SFR products from S-NPP and NOAA-20 beyond are also included in the JPSS requirement
  - ✓ Addition to JPSS L1RD, JRED, etc: NJO-2016-018; JPSS-L1RDS-13230
- The SFR from S-NPP and NOAA-20 are also required for supporting the Continuity of Operation

How Will The Products Be Used?

- The SFR products are currently used for satellite precipitation analyses, and for supporting satellite analysts and weather forecasters in operation
- The required extension and enhancement of the SFR products with S-NPP and NOAA-20 are expected to be used in the same fashion
- The SFR user community includes: NCEP/CPC, NESDIS/SAB, NWS/WFOs, NWS/WPC, NWS/OWP, NASA

SFR Production: *Input data*

- Satellite data used in product generation:
  - ✓ S-NPP ATMS
  - ✓ NOAA-20 ATMS
- Ancillary data used in product generation and validation:
  - ✓ GFS
  - ✓ Radar precipitation analyses
  - ✓ Gauge observations

SFR Production: *Production Environments*

- There are four distinct environments
  - ✓ Development Environments (CICS-MD, STAR and NDE Dev)
    - Development and testing of SFR algorithm
    - Integration of SFR into MiRS for the DAP delivery
    - Unit test of pre-operational code at NDE
  - ✓ Test environment (NDE I&T)
    - Pre-operational MiRS DAP received from STAR will be integrated and tested by Solers and validated by OSPO
  - ✓ Operation Environment (NDE OPS)
    - Operational MiRS codes run and generate the products on NDE by OSPO and the products will be distributed to user through PDA

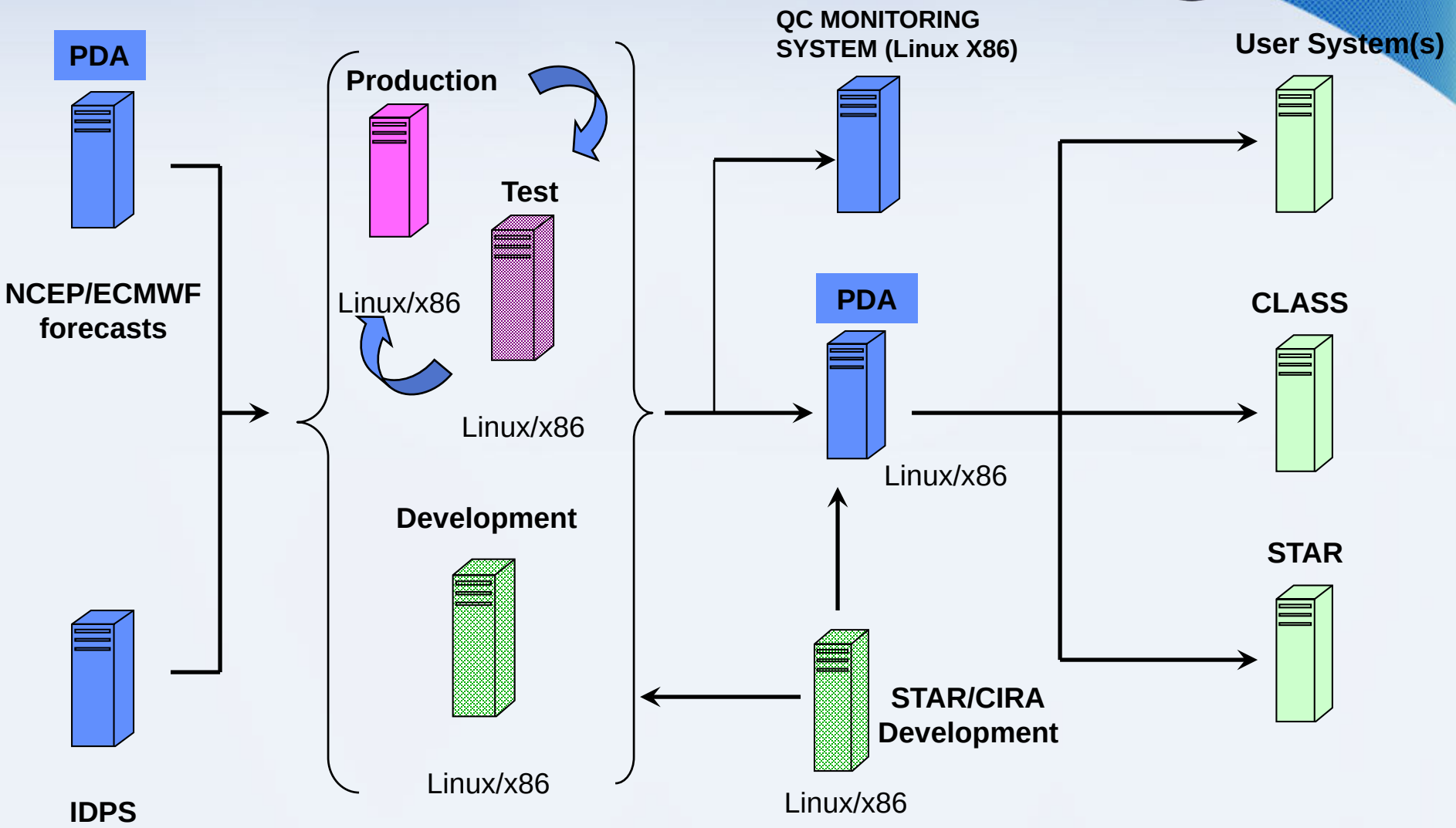
SFR Production: *Requirements*

- **Coverage**
  - ✓ Global Land
- **Formats**
  - ✓ netCDF4
  - ✓ GIF Imagery
- **Latency**
  - ✓ 30 mins after all inputs received
- **Products**
  - ✓ SFR

SFR Production: *Production Scenarios*

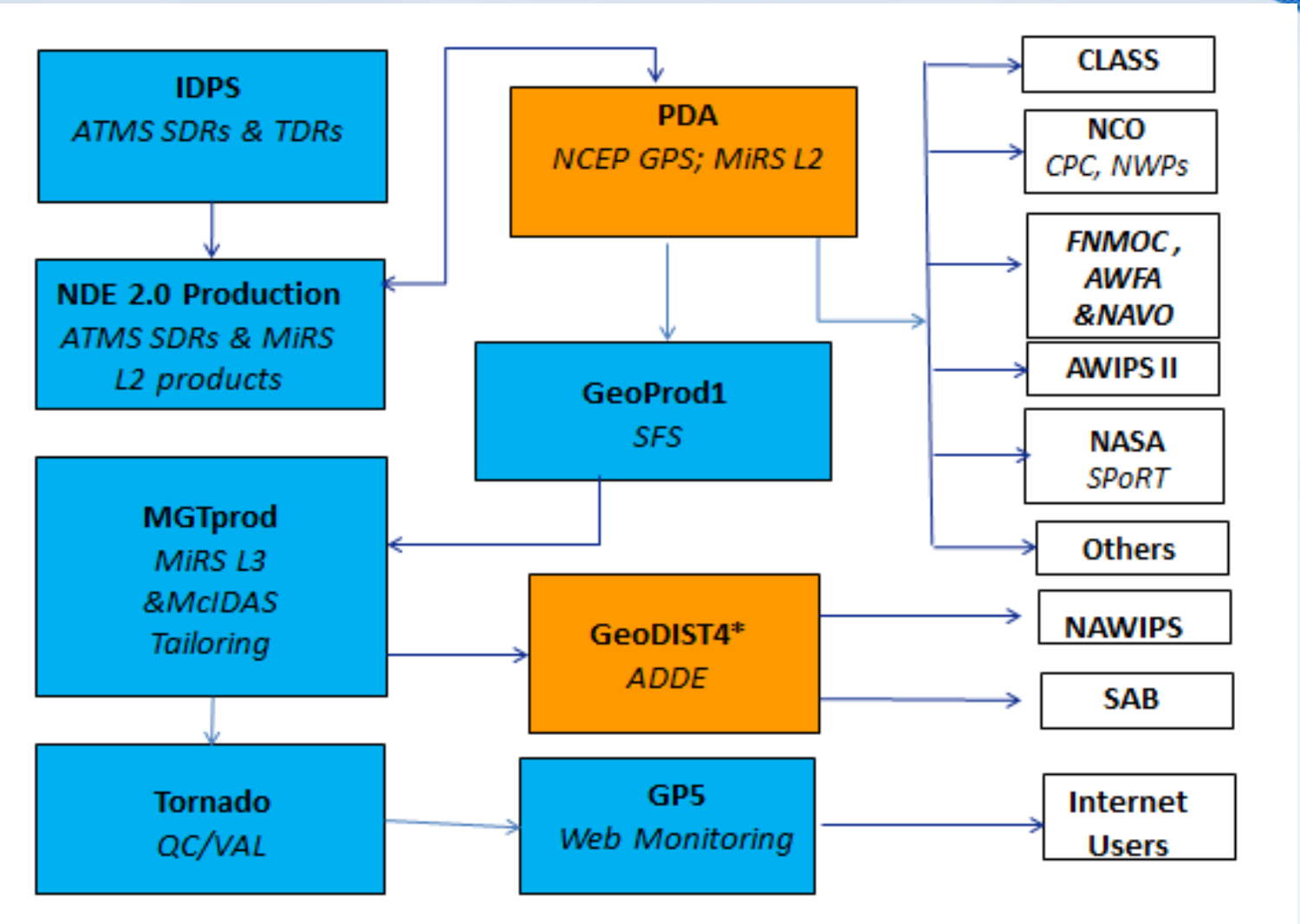
- The SFR will be integrated into MiRS as a sub-system
- The SFR product will be integrated into the NDE MIRS IMG file
- The NDE will handle all required satellite data and ancillary data
- The MiRS system will query the satellite inputs and required ancillary data to run the SFR algorithms within MiRS
- The SFR product will be distributed through PDA as part of the MiRS IMG data file in netCDF4 format
- The SFR imagery product will be generated for QC monitoring
- The current MiRS users will have access to the SFR product after it is declared operational, and new users will be granted access through the data access request submission process

IT System Architecture – NDE at ESPC Product System for All Products



Input Data Includes: **XDRs, NCEP GFS and GDAS forecasts and analysis, ATCF TC positions, and radiosonde data**

IT System Architecture



Input Data Includes: S-NPP/JPSS ATMS SDRs & TDRs, NCEP GFS

SFR Production: *Products Monitoring*

- **Multi-level monitoring tools will be extended to cover S-NPP and NOAA-20 SFR capability, and used at the ESPC operation**
  - ✓ Operator's monitoring of the MiRS job flow and processing status through NDE portal for data and product generation and distribution anomalies under 24/7
  - ✓ Web-based monitoring of the products generation, timeliness and distribution status
  - ✓ Web-based product quality monitoring, including imagery, anomaly detection, etc
- **Product Quality Monitoring**
  - ✓ The Precipitation PAL and maintenance personnel at OSPO will monitor the product quality and coordinate with the STAR scientists for any product quality issue
  - ✓ Offline statistical comparison with radar precipitation analyses can be generated for product quality validation when needed

SFR Production: *Products Maintenance (1/2)*

- **Operation Support**
  - ✓ No change on the operation maintenance support for adding SFR to the MIRS system.
    - The ESPC provides 24/7 support for the real-time MiRS job failure, anomaly and data outage
    - The MiRS monitoring tools will be extended to include SFR
    - The MiRS PAL and O&M personnel will perform the routine monitoring on the quality of SFR

- **Products Maintenance**
  - ✓ No change on the products maintenance support for adding SFR to the MIRS system.
    - The MiRS PAL and O&M personnel will cover normal maintenance needs for products generation, dissemination and quality anomaly

SFR Production: *Products Maintenance (2/2)*

- **Products Maintenance (cont's)**
  - ✓ No change to the products maintenance support for adding SFR to the MIRS system.
    - The MiRS PAL and O&M personnel will cover normal maintenance needs for products generation, dissemination and quality anomaly
    - The PAL will work with STAR scientists for any science maintenance needs when identified.

- **Emergency Maintenance**
  - ✓ No change to the emergency maintenance support for adding SFR to the MIRS system.
    - ATMS SFR will not be run at the CIP (Critical Infrastructure Protection) facility when it is operational.
    - The ATM SFR products can be continued in the event of an unexpected and sustained loss of service at the NSOF ESPC when MiRS is supported at CBU

SFR Production: *Products Archive*

- **Short Term Archive**
  - ✓ 96 hours time retention requirement for all data associated with the MiRS processing on the NDE operational machines
  - ✓ SFR is part of MiRS IMG data file, so no additional requirement for the NDE operation
  - ✓ Automatic Shell/Perl scripts used to clean up the old files.
- **Long Term Archive**
  - ✓ SFR will be archived as part of the MiRS IMG products
  - ✓ MIRS IMG file already has a SFR data field place holder with ‘fill values’ and will be populated with real retrievals once S-NPP SFR transitions to operation
  - ✓ No additional effort is required

SFR Production: *Documentation*

- **Algorithm Theoretical Basis Document**
  - ✓ SFR ATBD v1.0
- **User Manual**
  - ✓ MiRS UM will be updated to include SFR
- **System Maintenance Manual**
  - ✓ MiRS SMM will be updated to include SFR

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- Validation: Snowfall Rate
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- Summary and Conclusions

Algorithms:
Snowfall Detection and Snowfall Rate

Presented by

Huan Meng
NOAA/NESDIS/STAR

Snowfall Detection (SD) Algorithm

- Snowfall detection – statistical algorithm
  - ✓ Satellite-based module
  - ✓ NWP model-based module
  - ✓ Optimal combination of the two modules
  - ✓ NWP model-based screening

SD – Satellite Module

- Coupled principal components and logistic regression model (Kongoli et al., 2015)

$$P = \frac{\exp(\beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots. \beta_n X_n)}{1 + \exp(\beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots. \beta_n X_n))}$$

- Input data: seven high frequency channels above 88.2 GHz
- Three principal components
- Model output is the probability of snowfall; preset thresholds for snowfall
- Training data sets are composed of 2-year of matching satellite and ground snowfall observation data (QCLCD)

SD – Satellite Module

- Two temperature regimes: warm and cold
  - ✓ Defined with limb-corrected T_B53.6 GHz data
  - ✓ Satellite measurements exhibit different characteristics depending on atmospheric conditions: scattering signal dominates in relatively warm and moist atmosphere, emission signal dominates in cold and dry atmosphere or atmosphere with abundant supercooled cloud liquid droplets
  - ✓ No retrieval if limb corrected T_B53.6 GHz < 240 K; not enough water vapor to mask surface
- Two cloud thickness regimes
  - ✓ CT derived from NWP model data
  - ✓ Shallow (low and thin cloud layer) snowfall is much more challenging to detect than snowfall from thick clouds

Combined SD Algorithm

- Numerical Weather Prediction (NWP) model-based weather SD module
  - ✓ Logistic regression model
  - ✓ Input data: RH, T, V-Vel, CT
- The SD algorithm is an optimal combination of the satellite module and weather module (Kongoli et al., 2018)

$$P = W_s * P_s + W_w * P_w$$

$$W_s + W_w = 1$$

P: probability of snowfall
W: weight
s: satellite module
w: weather module

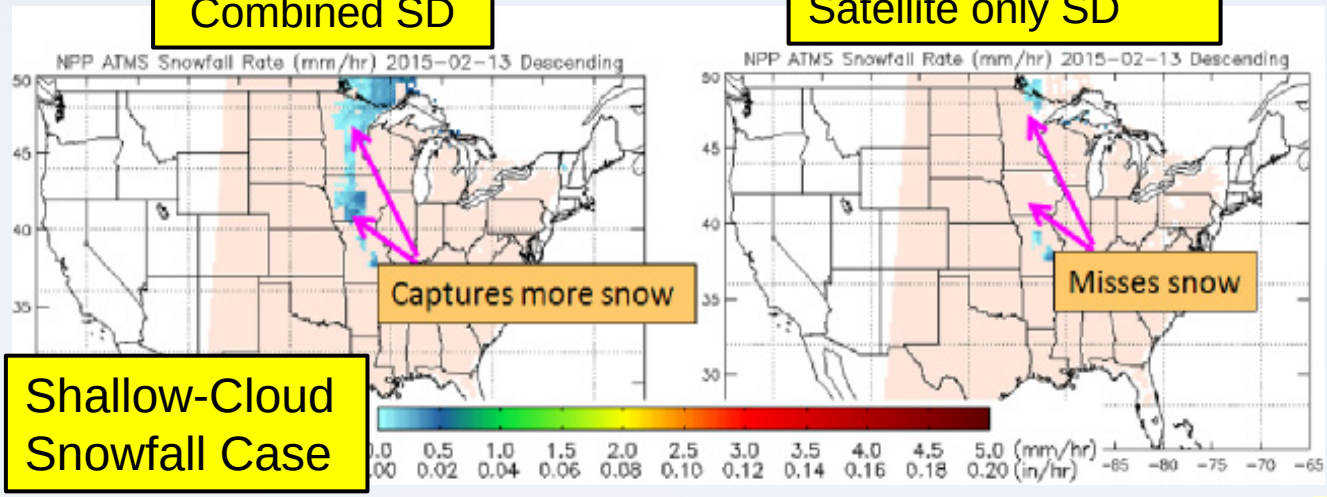
Combined SD Algorithm

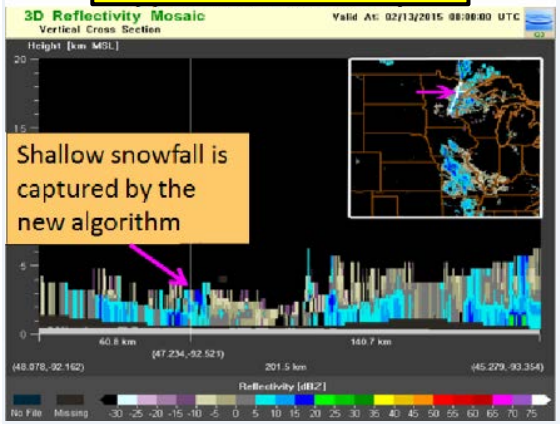
- The combined SD algorithm improves detection of both shallow- and deep-cloud snowfalls

Combined SD

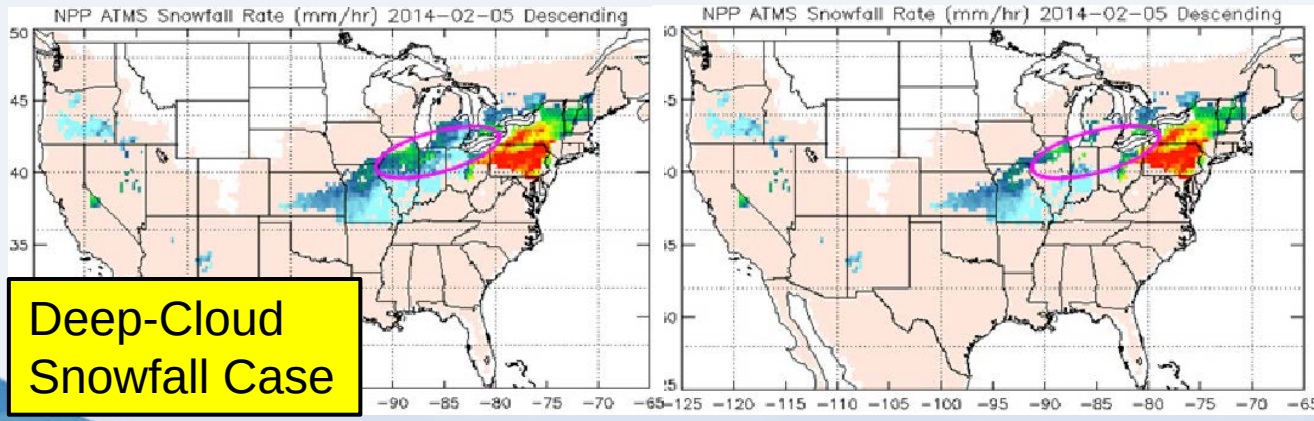
Satellite only SD

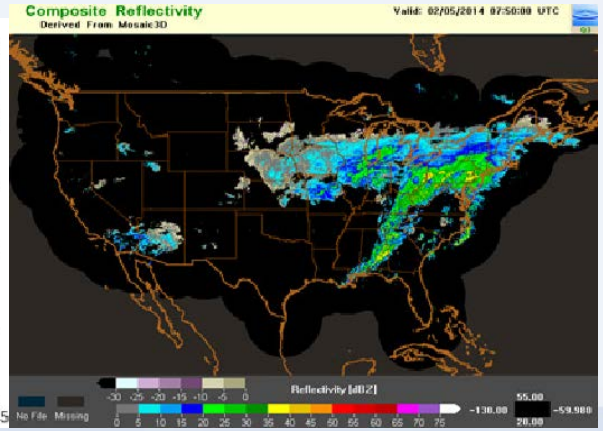
Radar Reflectivity





Shallow-Cloud Snowfall Case





Deep-Cloud Snowfall Case

Snowfall Rate Algorithm

- SFR – physical algorithm
  - ✓ Retrieve cloud properties with 1DVAR
  - ✓ Derive ice water content (IWC)
  - ✓ Compute ice particle fall velocity
  - ✓ Derive SFR

SFR Algorithm

- 1D variational method
  - ✓ Forward simulation of TB's with a radiative transfer model (RTM) (Yan *et al.*, 2008)

$$\begin{vmatrix} \Delta I_w \\ \Delta D_e \\ \Delta \varepsilon_{23} \\ \Delta \varepsilon_{31} \\ \Delta \varepsilon_{88} \\ \Delta \varepsilon_{165} \\ \Delta \varepsilon_{176} \end{vmatrix} = \left| (A^T A + E)^{-1} A^T \right| \begin{vmatrix} \Delta T_{B23} \\ \Delta T_{B31} \\ \Delta T_{B88} \\ \Delta T_{B165} \\ \Delta T_{B176} \end{vmatrix}$$

I_w: ice water path

D_e: ice particle effective diameter

ε_i: emissivity at 23.8, 31.4, 88.2, 165.5, and 183±7 GHz

T_{Bi}: brightness temperature at 23.8, 31.4, 88.2, 165.5, and 183±7 GHz

A: Jacobian matrix, derivatives of T_{Bi} *over* I_w, D_e, *and* ε_i

E: error matrix

- ✓ Iteration scheme with ΔT_{Bi} thresholds
- ✓ I_w and D_e are retrieved when iteration stops

SFR Algorithm

- Terminal velocity is a function of atmospheric conditions and ice particle properties, Heymsfield and Westbrook (2010):

$$v(D) = \frac{\eta R_e}{\rho_a D}$$

- Uncalibrated SFR (Meng et al., 2017):

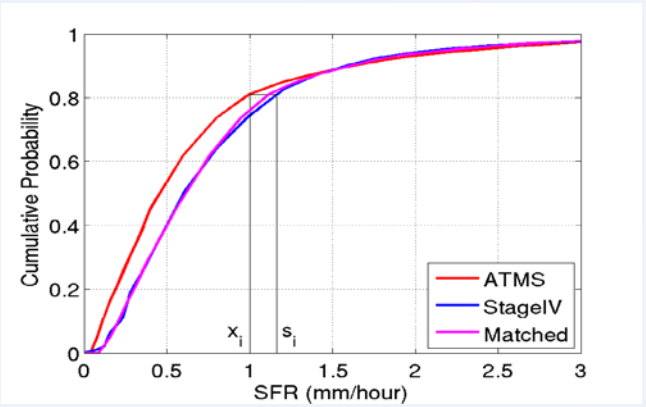
$$SFR_u = A \int_{D_{min}}^{D_{max}} D^2 e^{-D/D_e} \left[\left(1 + BD^{3/2}\right)^{1/2} - 1 \right]^2 dD$$

$$A = \frac{I_c \delta_0^2 \eta}{24 \rho_w \rho_a D_e^4} \qquad B = \frac{8}{\delta_0^2 \eta} \sqrt{\frac{g \rho_a \rho_I}{3 C_0}}$$

- Equation solved numerically

SFR Calibration

- Calibration data is Stage IV precipitation analyses
  - ✓ Best snowfall rate data available: uses MRMS radar precipitation data as input, incorporates gauge/model/satellite data, and applies human quality controls
  - ✓ Large snowstorms from two winter seasons (2015-2016)
  - ✓ CONUS coverage
- Histogram matching (Kidder and Jones, 2007):
  - ✓ CDF adjustment
  - ✓ Lease square method to achieve optimal overall agreement between SFR and StageIV CDFs



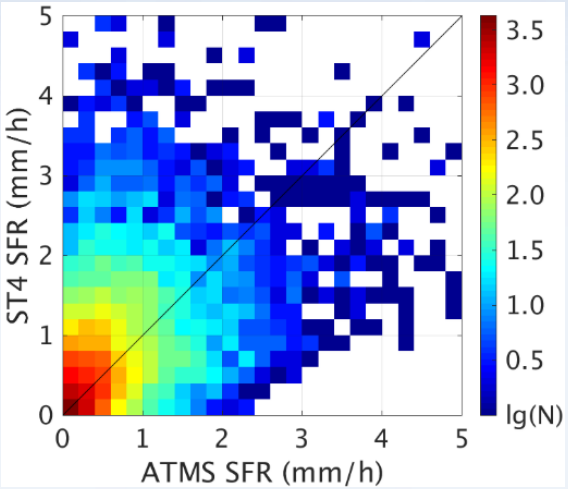
- SFR:

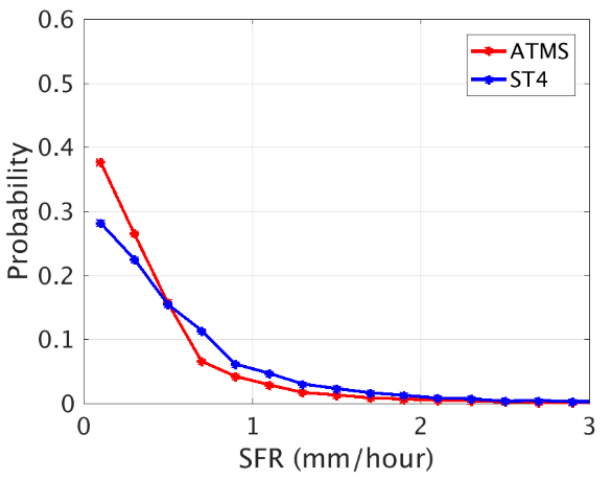
$$SFR = 1.5813\ SFR_u - 0.2236\ SFR_u^2 + 0.0216\ SFR_u^3$$

SFR Calibration

- **Before calibration**

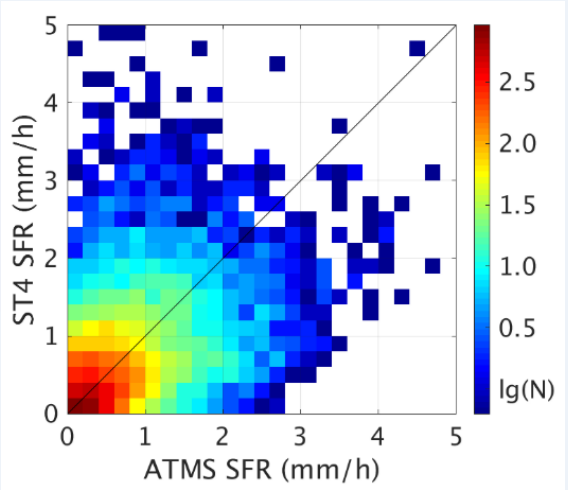
Corr. Coeff.	0.52
Accuracy (mm/hr)	-0.15
Precision (mm/hr)	0.63

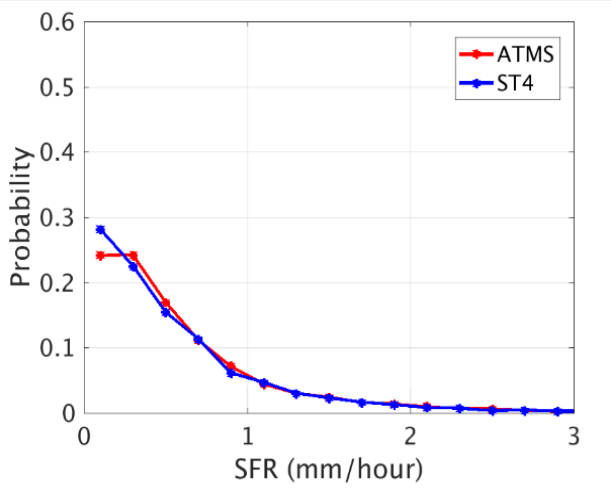




- **After calibration**

Corr. Coeff.	0.51
Accuracy (mm/hr)	-0.02
Precision (mm/hr)	0.64





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Software Architecture and Interfaces

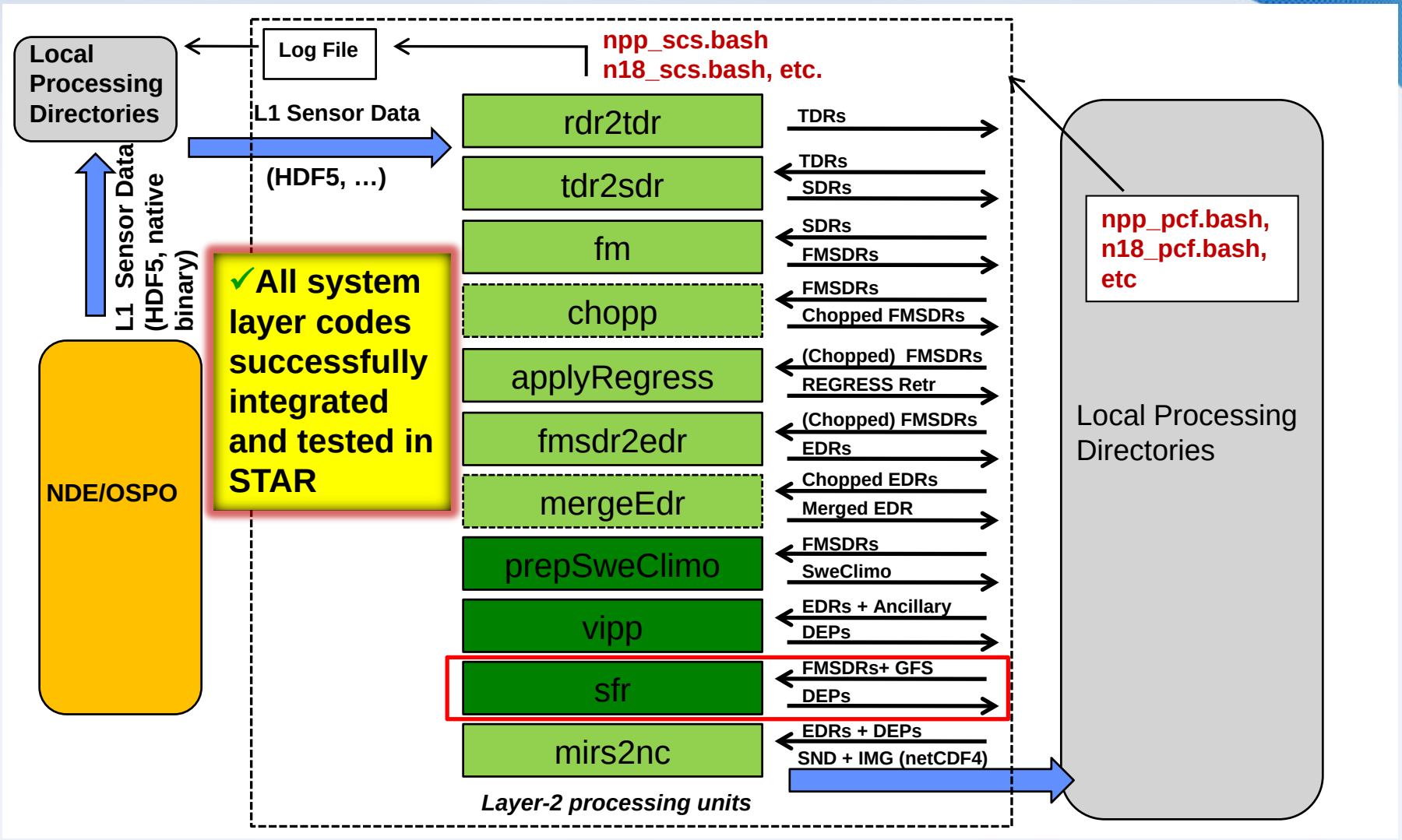
Presented by

Huan Meng
NOAA/NESDIS/STAR

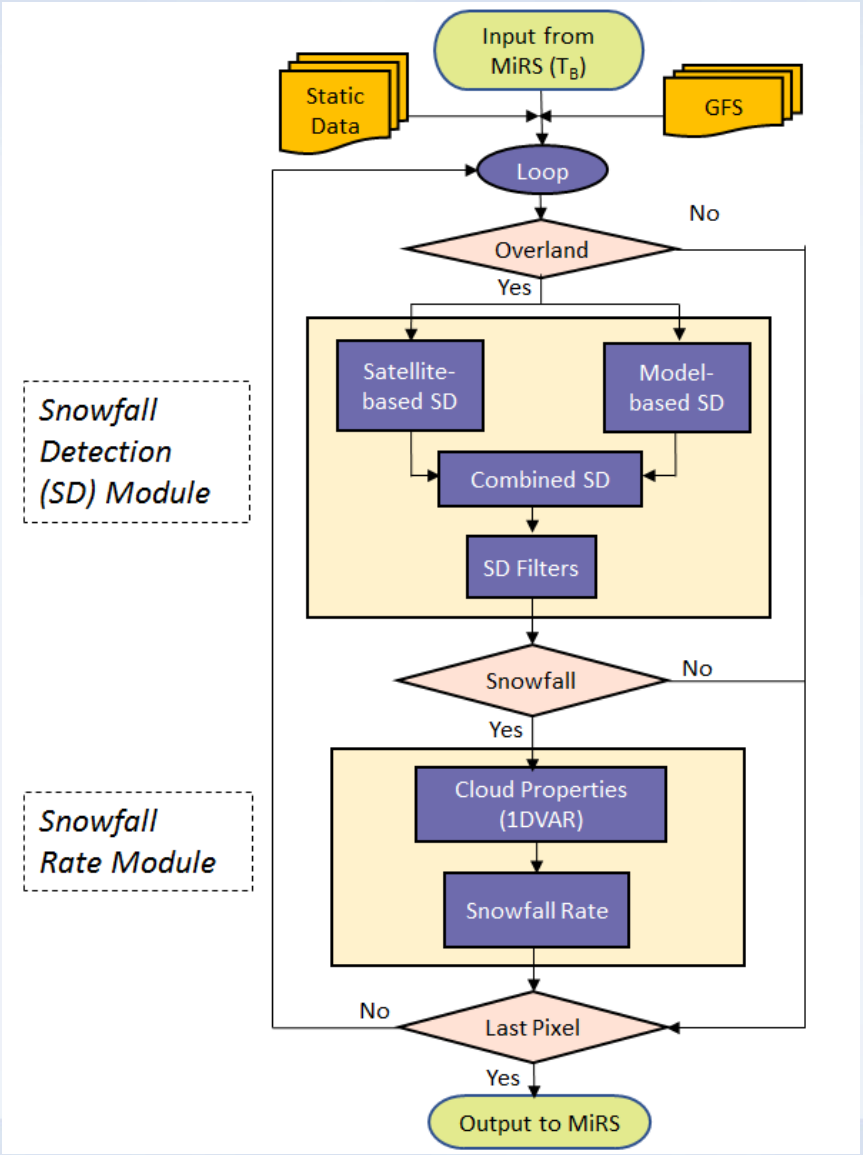
Software Architecture and Interfaces

- SFR product is generated inside MiRS
- SFR processing is a sub-system within MiRS
- MiRS calls SFR processing on script level
- SFR processing interfaces with MiRS through input and output

MiRS System-Layer Process Flow



SFR Processing Flowchart



Dynamic Data Interface

Input Data

Interface Item	Source	Interface Type	Description
ATMS FMSDR	IDPS via NDE	Input	Footprint-matched brightness temperatures and geolocation data
GFS	PDA	Input	GFS forecast fields (temperature/relative humidity profiles etc.)

Output Data

Interface Item	Source	Interface Type	Description
Final DEP		Output	MiRS binary output file including MiRS EDRs and SFR; the Final DEP file is used to generate the netCDF4 MiRS IMG file

MiRS SFR Run Schedule

Daily Run at STAR:

- get_npp_atms.bash
  - ✓ Daily at 02:00 am
- get_gfs_data.bash
  - ✓ Daily at 21:30 pm
- npp_scs_product.bash (including step to run SFR processing)
  - ✓ Daily at 04:30 am
- daily_cleanup.bash
  - ✓ Daily at 18:53 pm

Near Real-Time Run at NDE:

- Fixed schedule to retrieve GFS data
- MiRS (including SFR) processing when a new ATMS granule arrives

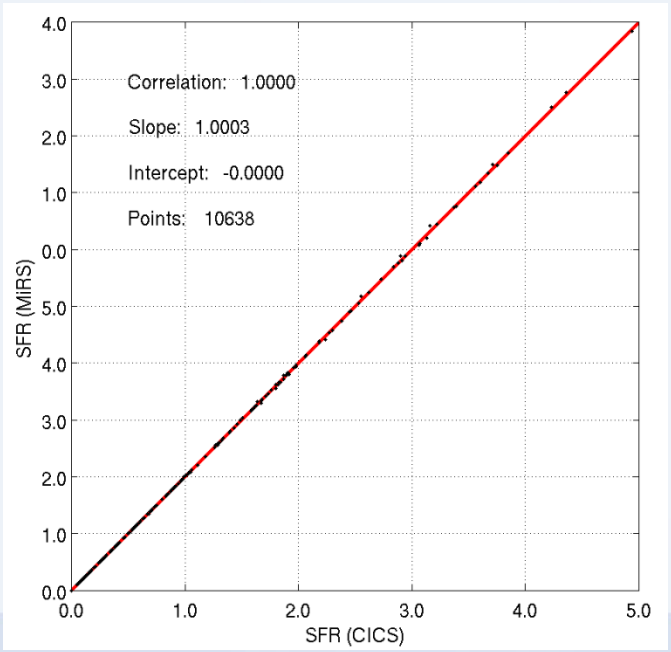
SFR Integration and Test in MiRS

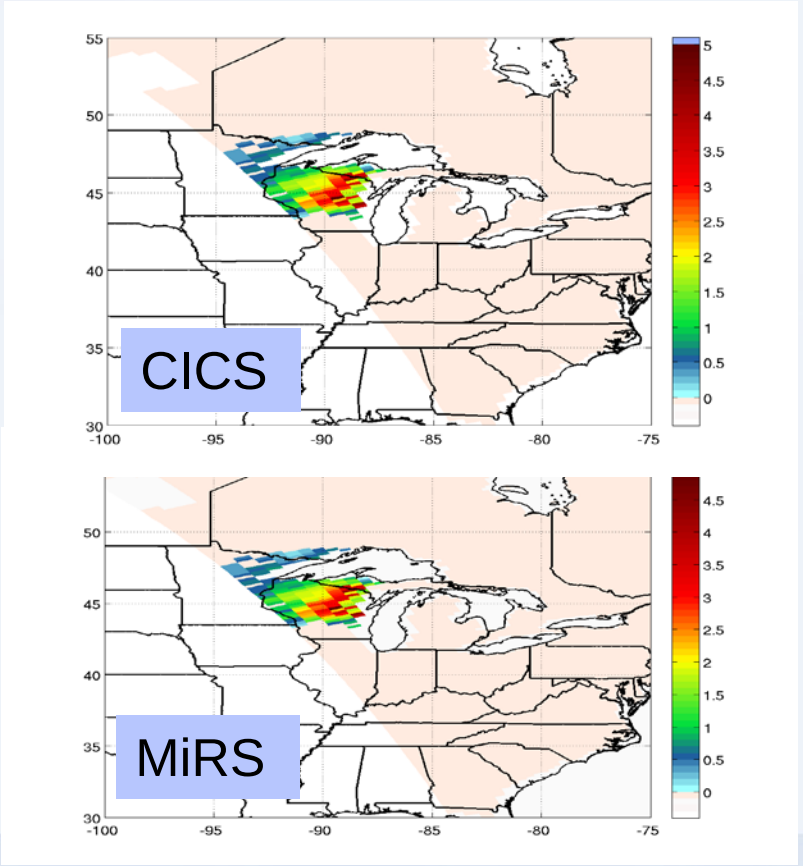
- ATMS SFR package developed and delivered to STAR MiRS team
  - ✓ package included C and Fortran 90 code, scripts, static ancillary data files, test data, and README
- MiRS team performed SFR integration in collaboration with the SFR developers at CICS-MD
  - ✓ First ran the package as a stand-alone system and produced the same SFR result as the test data
  - ✓ Modified the SFR code following operational standards
  - ✓ Modified the ATMS MiRS code to integrate SFR into the system

Consistency Study

- MiRS SFR and CICS SFR comparison using the same input data
- Results show high consistency between the two data sets and indicate the SFR processing system in MiRS functions as expected

Standard Deviation	Bias	# of Points
1.2E-3	9.4E-7	10638

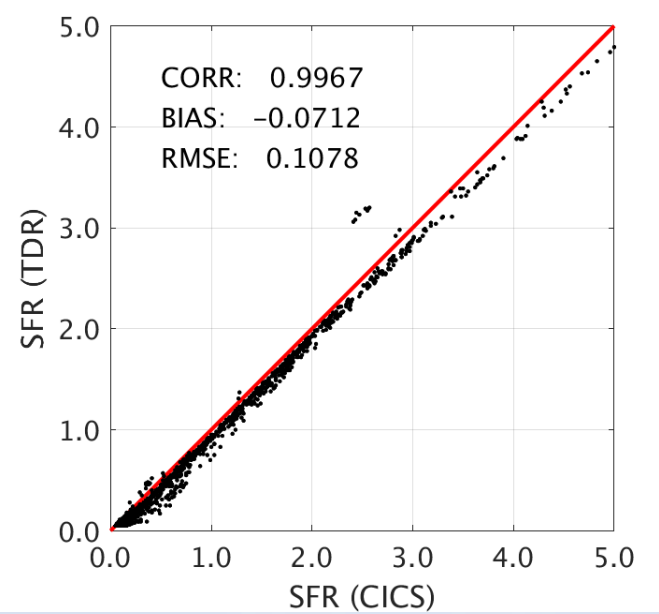


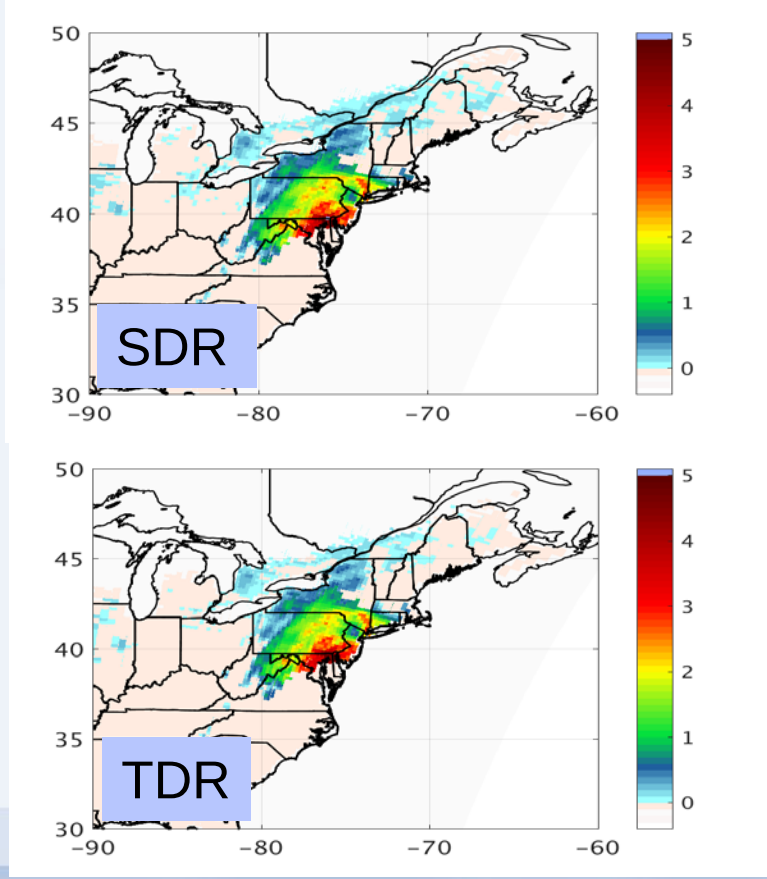


Consistency Study

- MiRS uses ATMS TDR as input (currently investigating using TDR vs. SDR); the original ATMS SFR uses ATMS SDR as input
- Comparison between SFR derived from SDR and TDR shows good consistency with bias and RMS well within the range of the requirements

Corr Coeff	Bias (mm/hr)	RMS (mm/hr)
1.00	-0.07	0.11





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Validation: Snowfall Detection

Presented by

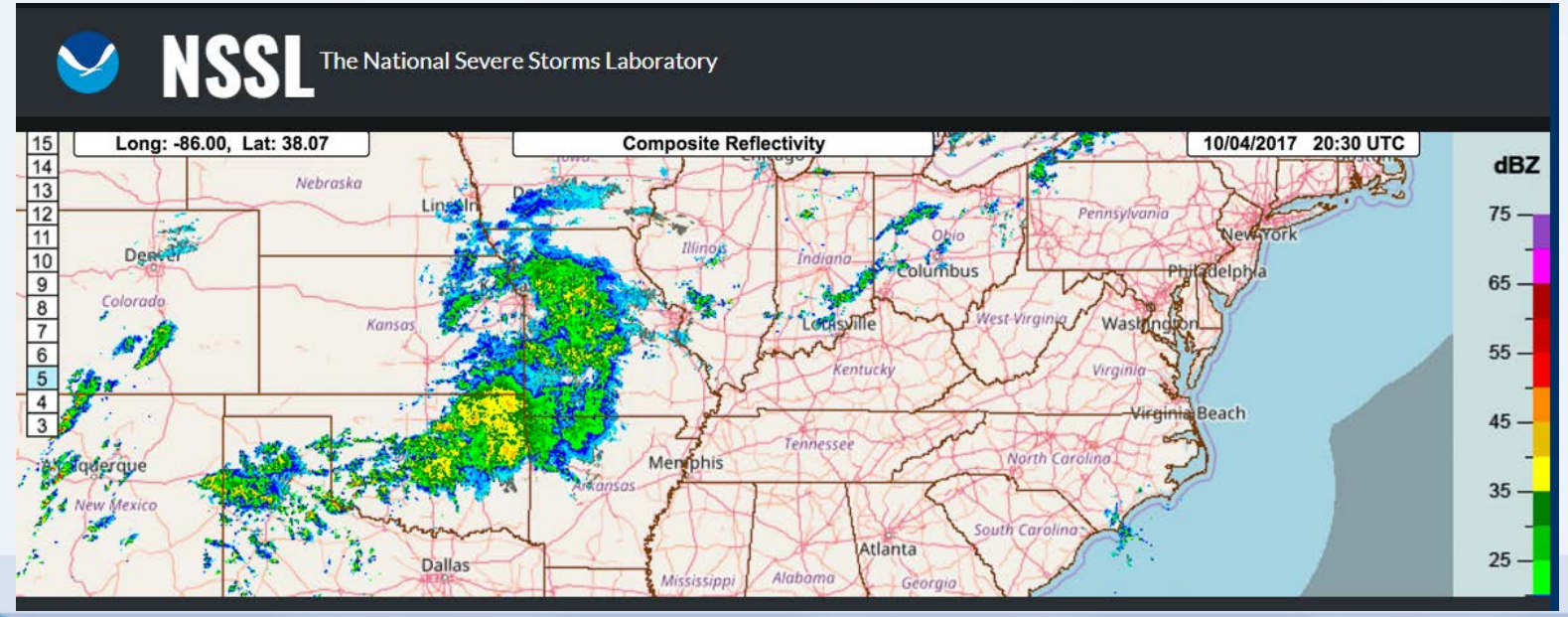
Cezar Kongoli
University of Maryland/CICS-MD

SD Validation: Methodology

- Three-year validation dataset (2015-2017)
- Multi-Radar Multi-Sensor (MRMS) – ATMS Match-up
- In-situ – ATMS Match-up
- Validation Metrics:
  - ✓ Accuracy Rate
  - ✓ Probability of Detection (POD)
  - ✓ False Alarm Rate (FAR)
  - ✓ Heidke Skill Score (HSS)
- Over Continental US (MRMS and in-situ)
- Over Alaska (in-situ only)

MRMS – ATMS Match-up

MRMS is a system with automated algorithms that quickly and intelligently integrate data streams from multiple radars, surface and upper air observations, lightning detection systems, and satellite and forecast models.



MRMS – ATMS Match-up

MRMS pixels were collocated with ATMS FOVs. Calculated were fraction of precipitating ATMS FOV, fraction of snowing and raining FOV and an effective FOV snowfall rate (SFR). An ATMS FOV was classified as “snowing” for positive values of effective SFR and no-snowing for zero SFR values.

In-situ – ATMS Match-up

- Obtained from Quality Controlled Local Climatological Data (QCLCD) data available from NOAA National Centers for Environmental Information (NCEI)
- Measurements include surface temperature, humidity, measured surface liquid precipitation and present weather
- Present weather flag indicates if it is snowing, raining or no-precipitation

In-situ – ATMS Match-up

Hourly weather observations were collocated with ATMS SFR/SD product. The nearest in-situ observation within 15 km to the FOV center and 30 minutes time off-set was selected. An ATMS FOV was classified as snowing if the present weather was flagged as “snowfall” and no-snowing if the present weather was flagged as other than snowfall and accumulated gauge precipitation was equal to zero.

SD Validation Metrics

- POD is the fraction of true snowfall retrieved
- FAR is the fraction of false snowfall retrieved
- Accuracy is the fraction of correct snowfall and no-snowfall retrieved
- HSS is the correct forecast relative to the chance forecast. A zero score indicates no skill. A negative score indicates forecast does worse than a chance forecast

Results: vs MSMR (CONUS)

Year	Accuracy	POD (%)	FAR (%)	HSS
2015	0.92	53	4	0.47
2016	0.90	55	7	0.43
2017	0.88	51	8	0.40
Combined	**0.90**	**53**	**6**	**0.43**
Threshold (over land)	N/A	40	15	N/A
Objective (over land)	N/A	50	10	N/A

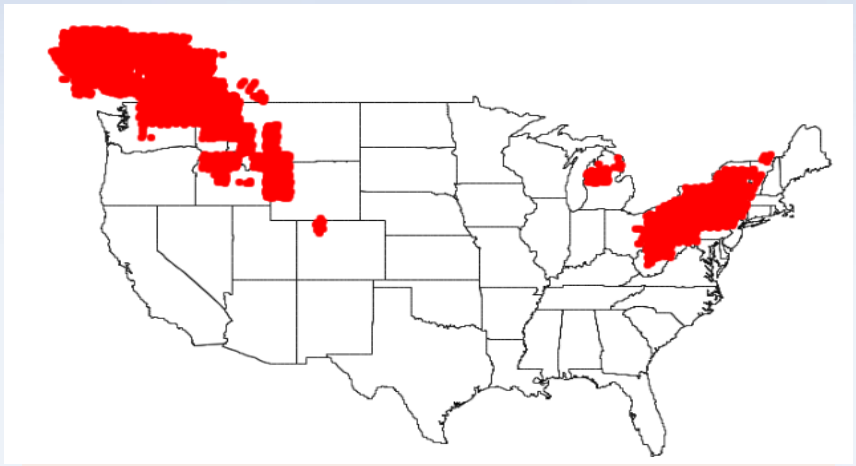
Results: vs in-situ (CONUS)

Year	Accuracy	POD (%)	FAR (%)	HSS
2015	0.90	50	7	0.42
2016	0.89	53	8	0.42
2017	0.88	50	8	0.40
Combined	**0.88**	**51**	**8**	**0.40**
Threshold (over land)	N/A	40	15	N/A
Objective (over land)	N/A	50	10	N/A

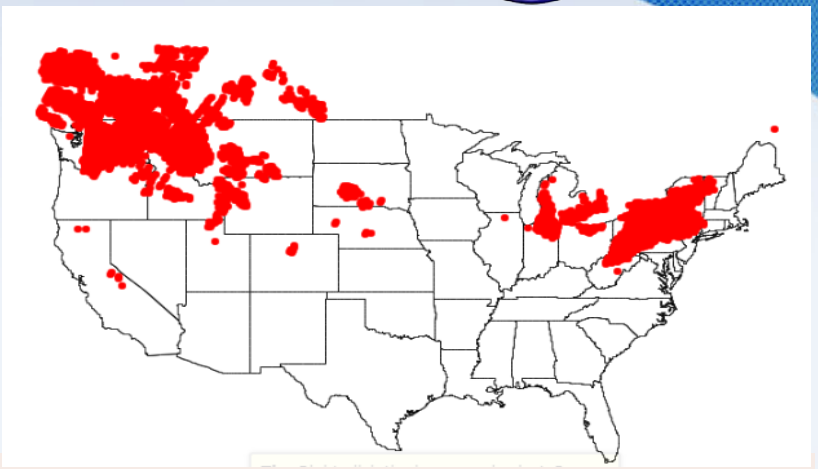
Results: vs in-situ (Alaska)

Year	Accuracy	POD (%)	FAR (%)	HSS
2015	0.85	45	9	0.39
2016	0.87	47	10	0.38
2017	0.85	47	11	0.35
Combined	**0.86**	**46**	**10**	**0.37**
Threshold (over land)	N/A	40	15	N/A
Objective (over land)	N/A	50	10	N/A

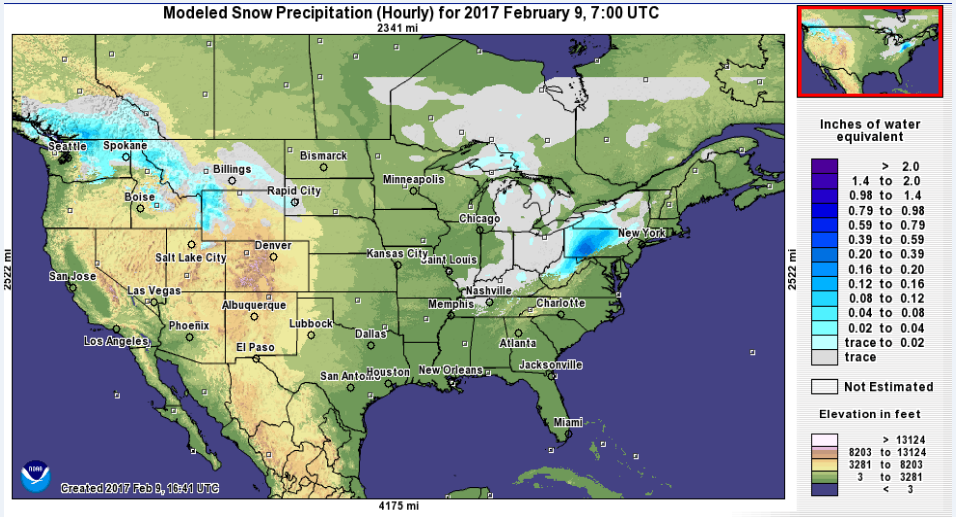
Comparisons with MRMS and NOHRSC



ATMS – 20170209: Descending



MRMS – 20170209: Descending



NOAA's NOHRSC Snow Analysis

National Operational Hydrologic Remote Sensing Center (NOHRSC) Snowfall Analysis is a unified snowfall analysis from several high-resolution operational forecast model precipitation data sets

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Validation: Snowfall Rate

Presented by

Jun Dong
University of Maryland/CICS-MD

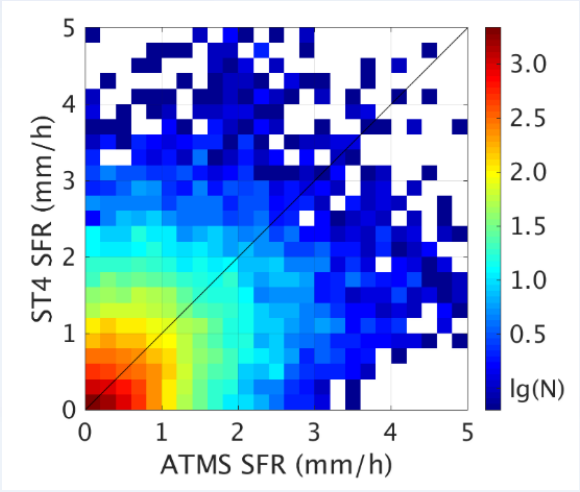
SFR Validation: Methodology

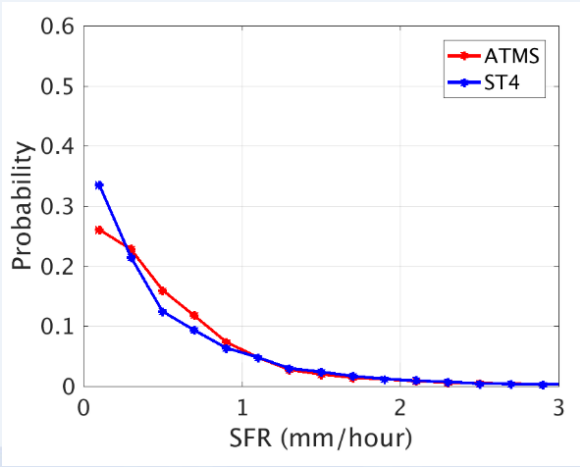
- **Validation data**
  - ✓ Stage IV (hourly, 4 km) data from winter 2016-2017, over 92K points, CONUS
  - ✓ MRMS (instantaneous, 0.01 degree) data from winter 2016-2017, over 160K points, CONUS
- **Validation method**
  - ✓ Statistics from collocated instantaneous SFR and validation data
  - ✓ Statistics from collocated seasonal-average SFR and validation data
- **Validation metrics**
  - ✓ Correlation coefficient
  - ✓ Accuracy
  - ✓ Precision
  - ✓ Histogram comparison
  - ✓ Scatter plot

SFR Validation: vs. Stage IV

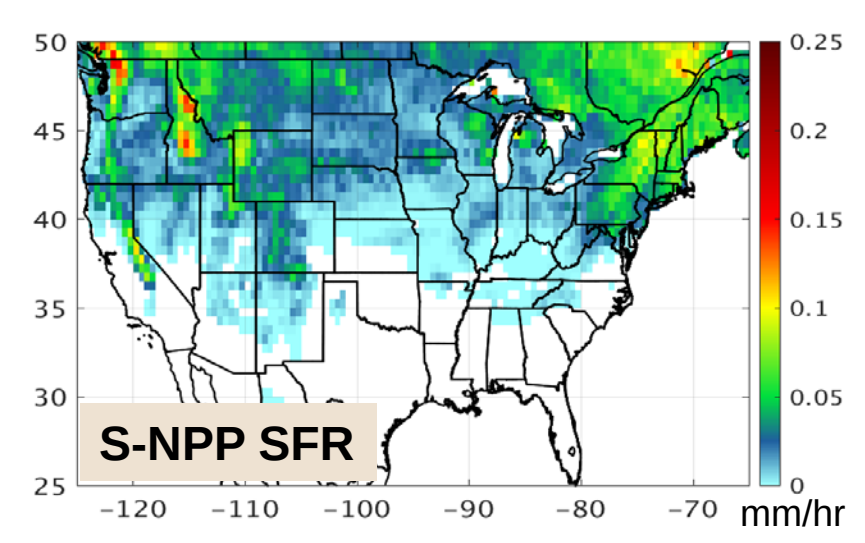
- Collocate Stage IV with S-NPP ATMS SFR through convolution to ATMS footprint

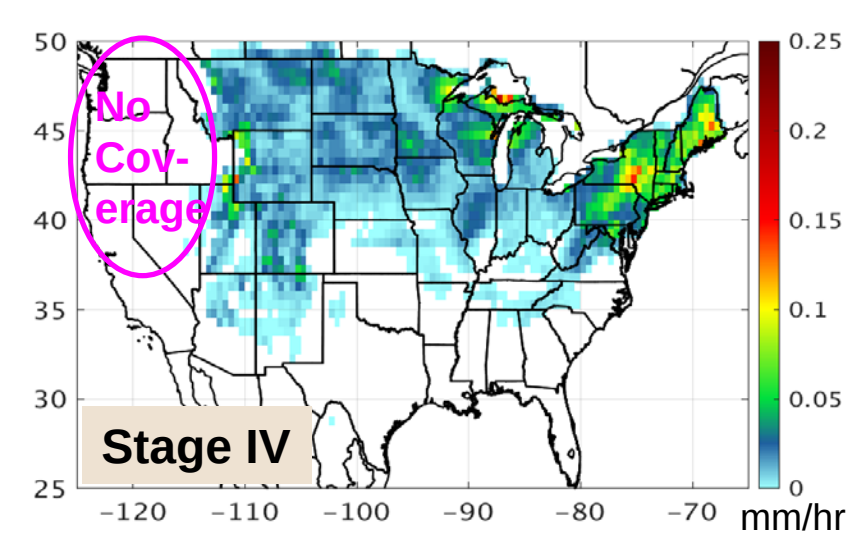
Metrics	S-NPP SFR	Threshold	Objective
Corr. Coeff.	0.50	N/A	N/A
Accuracy (mm/hr)	0.06	0.30	0.15
Precision (mm/hr)	0.74	1.00	0.70

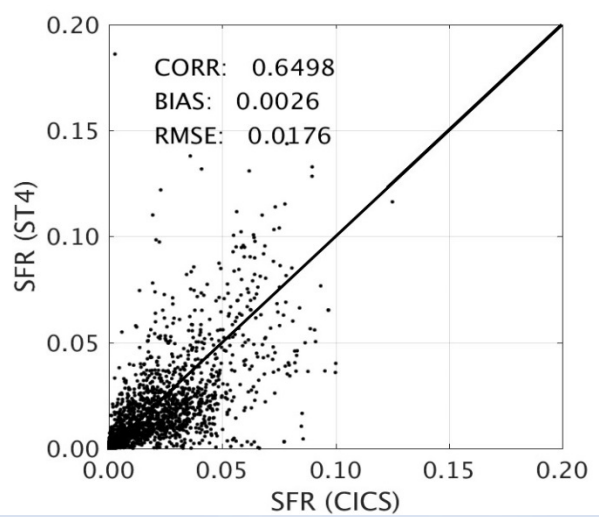




Seasonal Average (Jan – Mar, 2017)





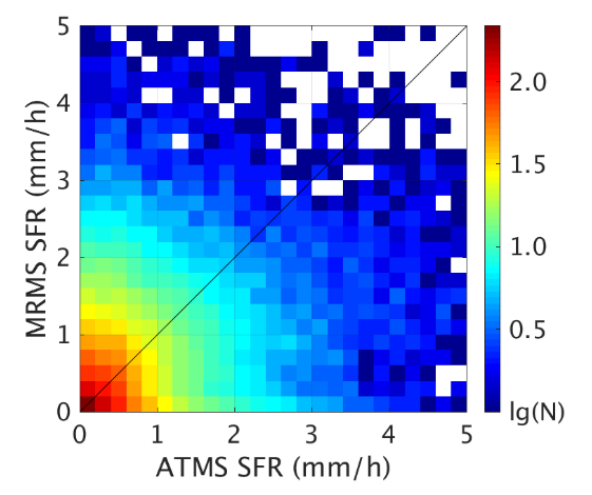


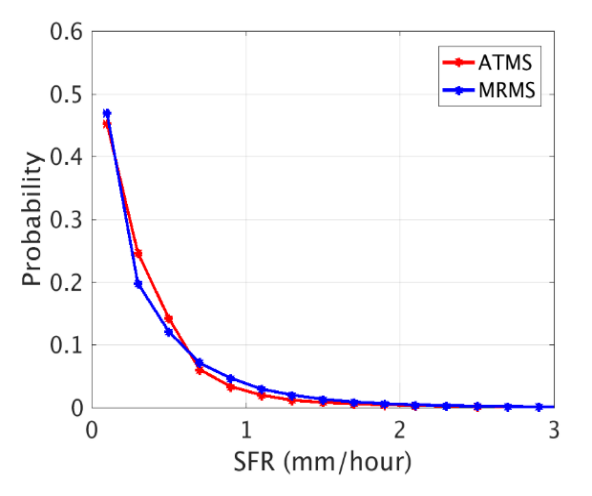
Corr. Coeff.	Accuracy (mm/hr)	Precision (mm/hr)
0.65	0.00	0.02

SFR Validation: vs. MRMS

- Collocate MRMS with S-NPP ATMS SFR through convolution to ATMS footprint

Metrics	S-NPP SFR	Threshold	Objective
Corr. Coeff.	0.43	N/A	N/A
Accuracy (mm/hr)	-0.01	0.30	0.15
Precision (mm/hr)	0.55	1.00	0.70





Check List - Provisional Maturity

Provisional Maturity End State	Assessment
Product performance has been demonstrated through analysis of a large, but still limited (i.e., not necessarily globally or seasonally representative) number of independent measurements obtained from select locations, periods, and associated ground truth or field campaign efforts.	The S-NPP SFR product has been validated against radar precipitation analyses and in-situ observations over CONUS (and SD over Alaska). Results indicate that the product meets JPSS Threshold Requirements and most Objective Requirements.
Product analysis is sufficient to communicate product performance to users relative to expectations (Performance Baseline).	The S-NPP SFR product meets this requirement.
Documentation of product performance exists that includes recommended remediation strategies for all anomalies and weaknesses. Any algorithm changes associated with severe anomalies have been documented, implemented, tested, and shared with the user community.	The ATMS ATBD v1.0 meets the requirements.
Product is ready for operational use and for use in comprehensive cal/val activities and product optimization.	The S-NPP SFR product meets this requirement.

Review Outline

- Introduction
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- **NOAA-20 SFR Performance**
- Risk Summary
- Summary and Conclusions

NOAA-20 SFR Performance

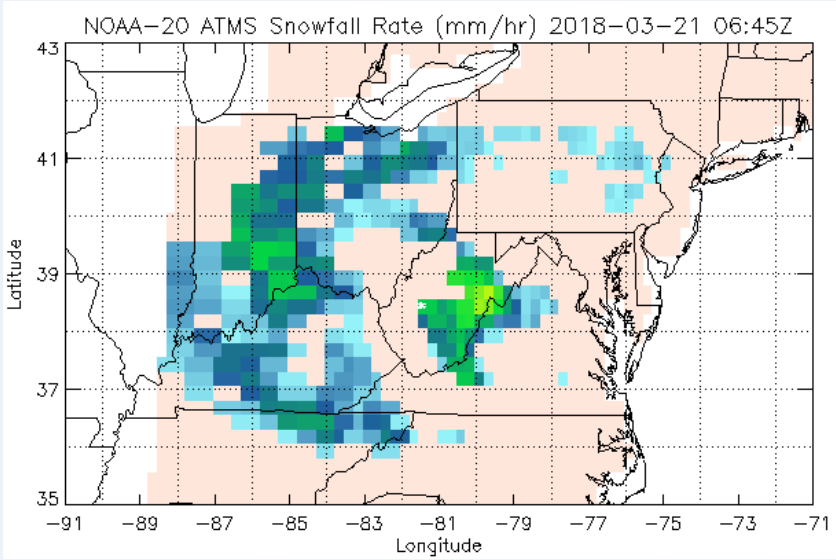
Presented by

Huan Meng
NOAA/NESDIS/STAR

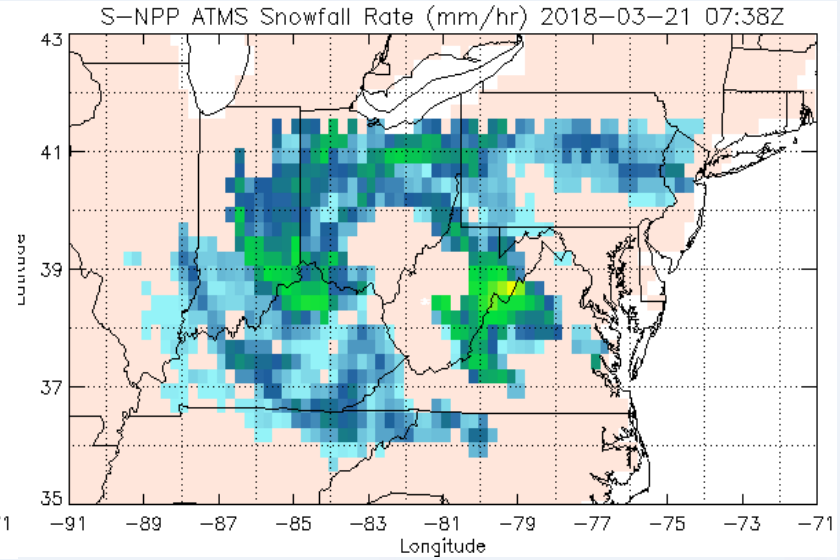
NOAA-20 SFR Performance

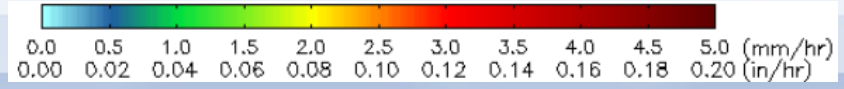
- NOAA-20 ATMS observations were tested on three snowstorms using the S-NPP SFR algorithm
- **Case 1**: Nor'easter on March 21, 2018
  - ✓ NOAA-20 SFR captured the spiral structure of the cyclone
  - ✓ Has less coherent snowfall structures than S-NPP SFR

NOAA-20 SFR, 06:46Z



S-NPP SFR, 07:38Z

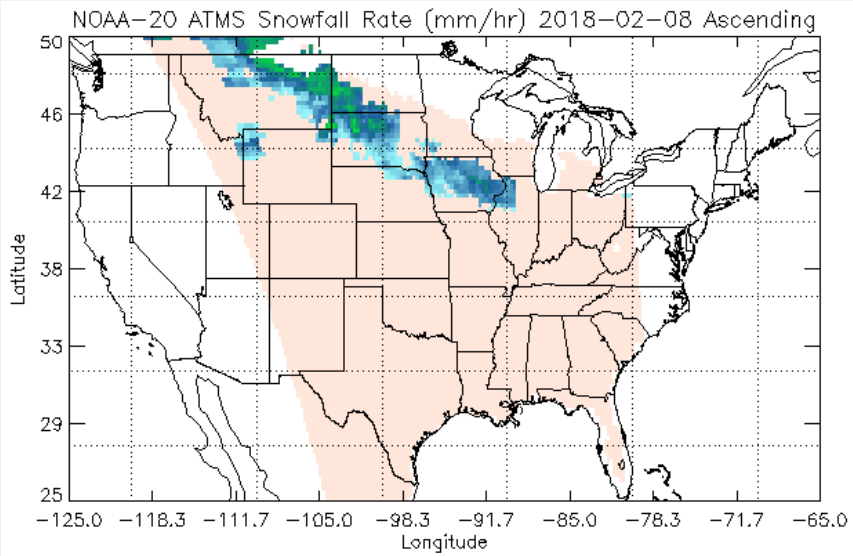




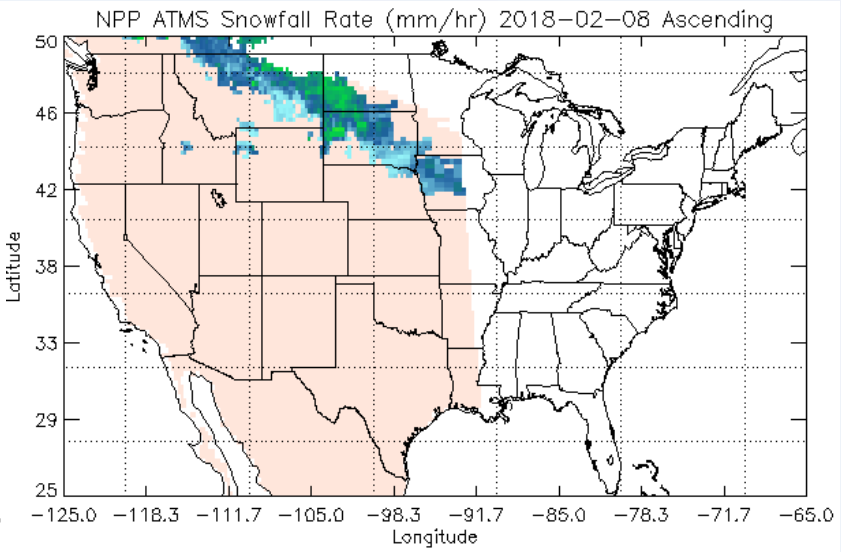
NOAA-20 SFR Performance

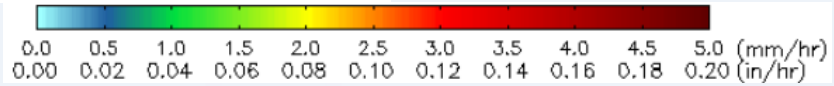
- **Case 2**: Snowstorm in the Northern Plains on February 8, 2018
  - ✓ Similar snowfall extent
  - ✓ Visually comparable rates

NOAA-20 SFR, 19:20Z



S-NPP SFR, 20:10Z

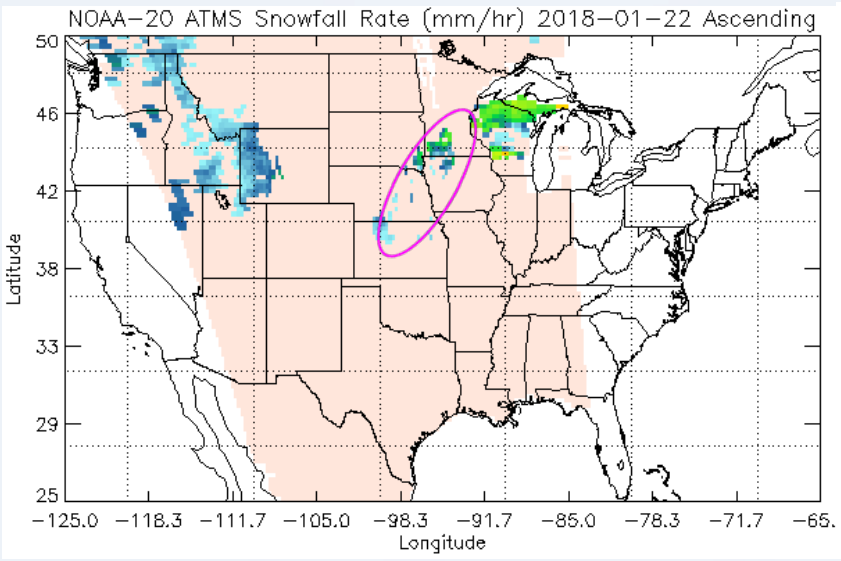




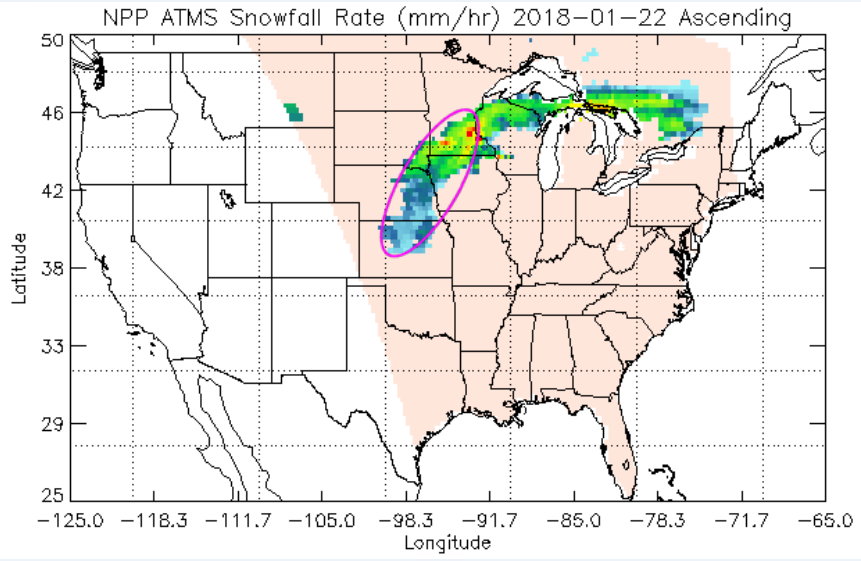
NOAA-20 SFR Performance

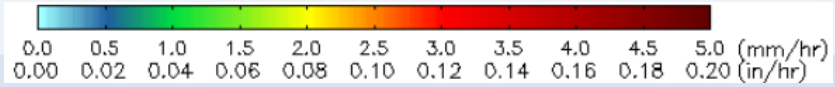
- **Case 3**: Snowstorm in the Midwestern US on January 22, 2018
  - ✓ NOAA-20 SFR captured the snowfall in Wisconsin and Michigan but missed most snowfall in the states to the west
  - ✓ Visually comparable rates where snowfall is detected

NOAA-20 SFR, 19:37Z



S-NPP SFR, 18:47Z





NOAA-20 SFR Performance

- NOAA-20 SFR can capture various percentage of the snowfall detected by the S-NPP SFR depending on the snow event
- NOAA-20 SFR has visually comparable rates as S-NPP SFR
- NOAA-20 SFR still requires following development and cal/val:
  - ✓ Training SD model
  - ✓ Radiometric bias correction
  - ✓ SFR calibration and validation
  - ✓ SD validation

Check List - Beta Maturity

Beta Maturity End State	Assessment
Product is minimally validated, and may still contain significant identified and unidentified errors	Some case studies have been conducted where the NOAA-20 ATMS SFR product was compared to the S-NPP ATMS SFR. The results indicate that NOAA-20 SFR has some skills but still contains significant errors that require algorithm development and cal/val
Information/data from validation efforts can only be used to make initial qualitative or very limited quantitative assessments regarding product fitness-for-purpose	The NOAA-20 SFR product meets this requirement
Documentation of product performance and identified product performance anomalies, including recommended remediation strategies, exists	NOAA-20 SFR Readme for Data Users

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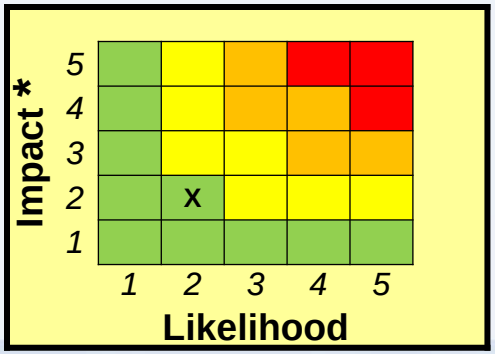
Risk Summary

Presented by

Huan Meng
NOAA/NESDIS/STAR

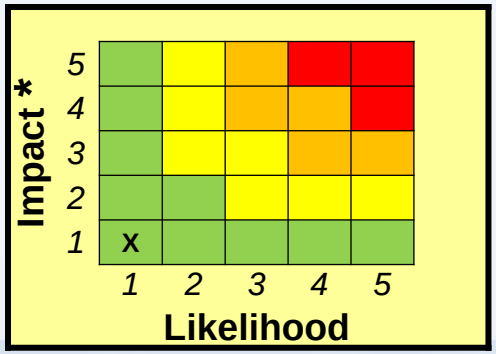
Risk

- Risk 1: Potential complication caused by adding GFS ingestion to MiRS processing in NDE.
- Risk Assessment: Low
- Impact:
  - ✓ Delayed MiRS DAP implementation
- Likelihood: Low
- Mitigation:
  - ✓ Collaborations among NDE, MiRS team, and the algorithm developers to ensure the proper and timely implementation of the MiRS DAP (SFR) including GFS ingestion
- Status: Open



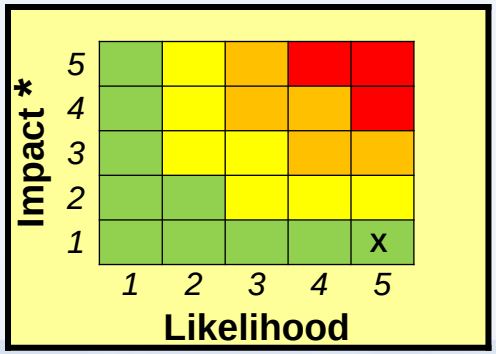
Risk

- Risk 2: SCR reported a potential memory leak in one of the SFR processing subroutines
- Risk Assessment: Low
- Impact: Low
- Likelihood: Low
- Mitigation:
  - ✓ The subroutine was examined and it was determined that the variables with dynamically allocated memory are properly freed so there is no memory leak.
- Status: Closed



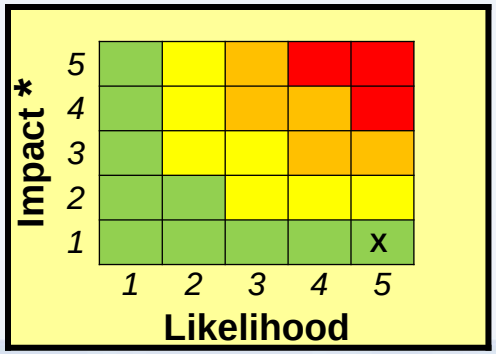
Risk

- Risk 3: SCR identified a few instances where code does now follow prudent coding practice
- Risk Assessment: Low
- Impact: Low
- Likelihood: High
- Mitigation:
  - ✓ All identified code issues are related to AMSU/MHS SFR rather than ATMS SFR. The Precipitation PAL has agreed to defer the correction to the next DAP delivery in December 2018
- Status: Open



Risk

- Risk 4: SFR quality check is not part of the MiRS quality flags (Requirement SFR/MIRS-R 3.1.1)
- Risk Assessment: Low
- Impact: Low
- Likelihood: High
- Mitigation:
  - ✓ Coordinate with MiRS team about adding SFR 1DVAR convergence status to MiRS quality flags.
- Status: Open



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Summary and Conclusions

Presented by

Ralph Ferraro
NOAA/NESDIS/STAR

Review Objectives Have Been Addressed

- The following have been reviewed
  - ✓ Project Schedule
  - ✓ Operations Concept
  - ✓ Algorithms – Snowfall Detection and Snowfall Rate
  - ✓ Software Architecture and Interfaces
  - ✓ Validation – Snowfall Detection and Snowfall Rate
  - ✓ NOAA-20 SFR Performance
  - ✓ Risks

Next Steps

- Gather reviewer feedback, make necessary updates to the ARR, and make these updates available to the review team
- Perform the Operational Readiness Review (ORR)
- Brief SPSRB the capability is ready for operation
- Assist NDE and OSPO with system test validation and troubleshooting

Open Discussion

- The review is now open for free discussion