

***Provisional Maturity Science Review
For Microwave Integrated Retrieval System (MiRS)
NOAA-21 ATMS***



***Presented by C. Grassotti, Y.-K. Lee, S. Liu, Q. Liu
Date: 6/22/23***

Outline

- MiRS validation team
- Product maturity definitions
- Algorithm background
- Verification of STAR vs. NCCF outputs
- Validation results
- Documentation
- Summary/Path forward



MiRS Team



Algorithm Validation Team Members

Team Member	Organization	Roles and Responsibilities
Q. Liu (Project Manager)	NESDIS/STAR/SMCD	Project management
C. Grassotti (Technical Lead)	NESDIS/STAR/SMCD (U. MD./ESSIC/CISESS)	Coordination of technical activities; review/deliverable planning
S. Liu, Y.-K. Lee, Y. Zhou, J. Yang, X. Liang	NESDIS/STAR/SMCD (U. MD./ESSIC/CISESS, CSU/CIRA)	Precipitation product development and val, SFR integration, AI applications, DAP preparation, sounding, emissivity, and cryosphere product val, sounding improvements, new sensor extension, JPSS mission reprocessing, SmallSat evaluation, Imagery product development.
L. Ma	NESDIS/OSPO	Operational Product Area Lead



JPSS Data Products Maturity Definition



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.

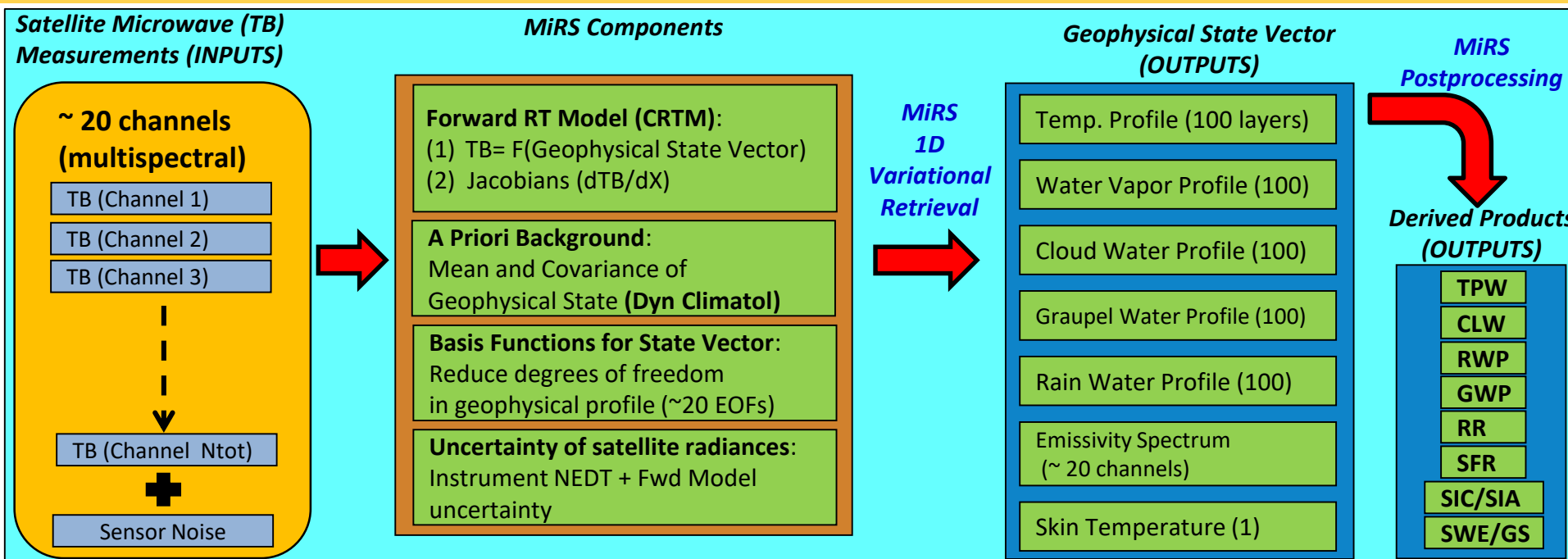
2. Provisional

- 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.

Algorithm Background

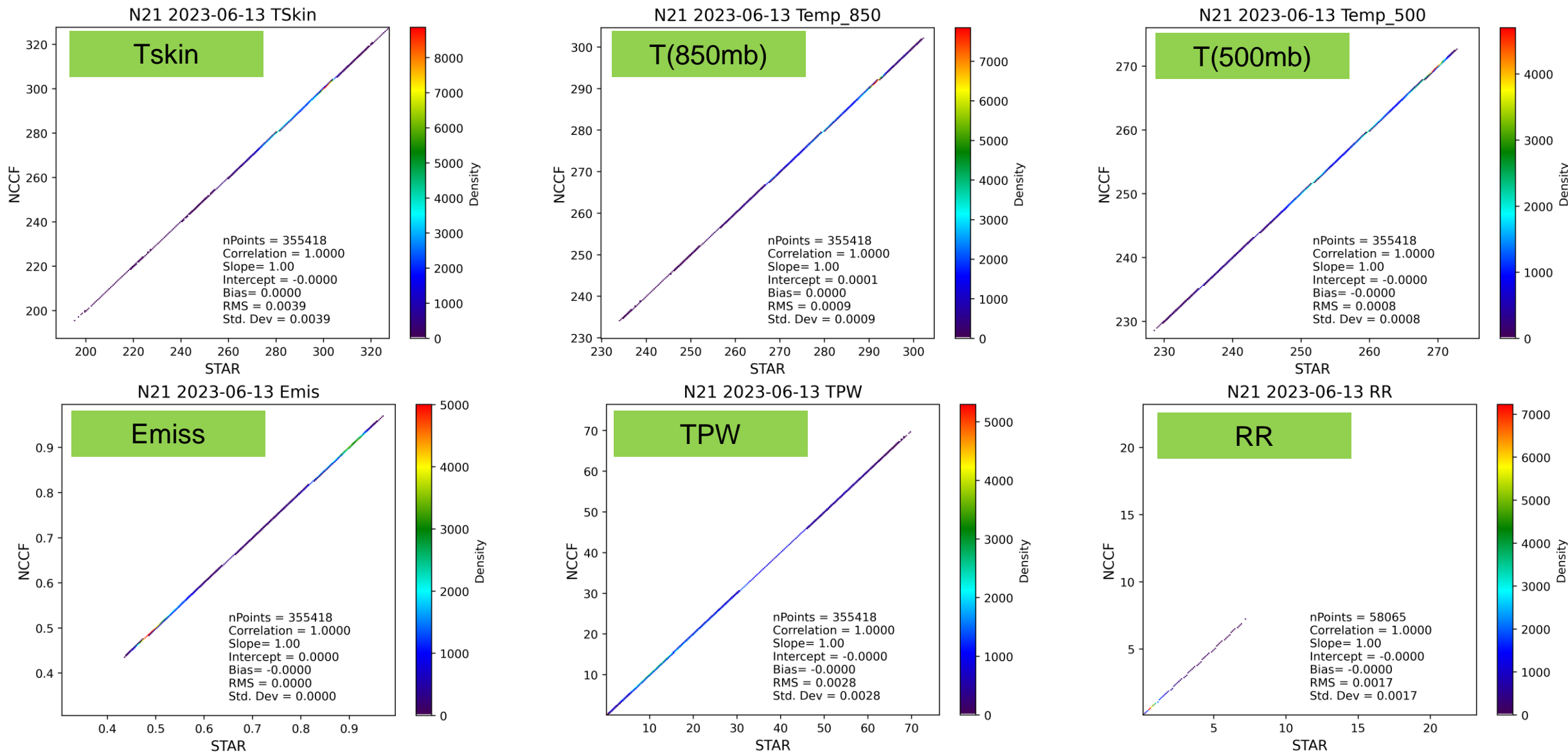


- MW Only, Variational Approach: Find the “most likely” atm/sfc state that: (1) best matches the satellite measurements, and (2) is still close to an a priori estimate of the atm/sfc conditions.
- **ATMS processing uses TDR data (SDR files used to extract sensor NEDT).**
- **Does not use any real-time ancillary data, e.g. from NWP, etc.**
- **“Enterprise” Algorithm: Same core software runs on all satellites/sensors; facilitates science improvements and extension to new sensors.**
- Initial capability delivered in 2007. Can run on SNPP, N20, N21/ATMS, N18, N19, MetopA, MetopB, MetopC F17, F18, GPM/GMI, (experimentally on AMSR2, TROPICS).
- V11.9 delivered in 2022, planned operational in June 2023.



MiRS N21 STAR vs. NCCF Output Verification

Date: 2023-06-13, Number of granules: 798

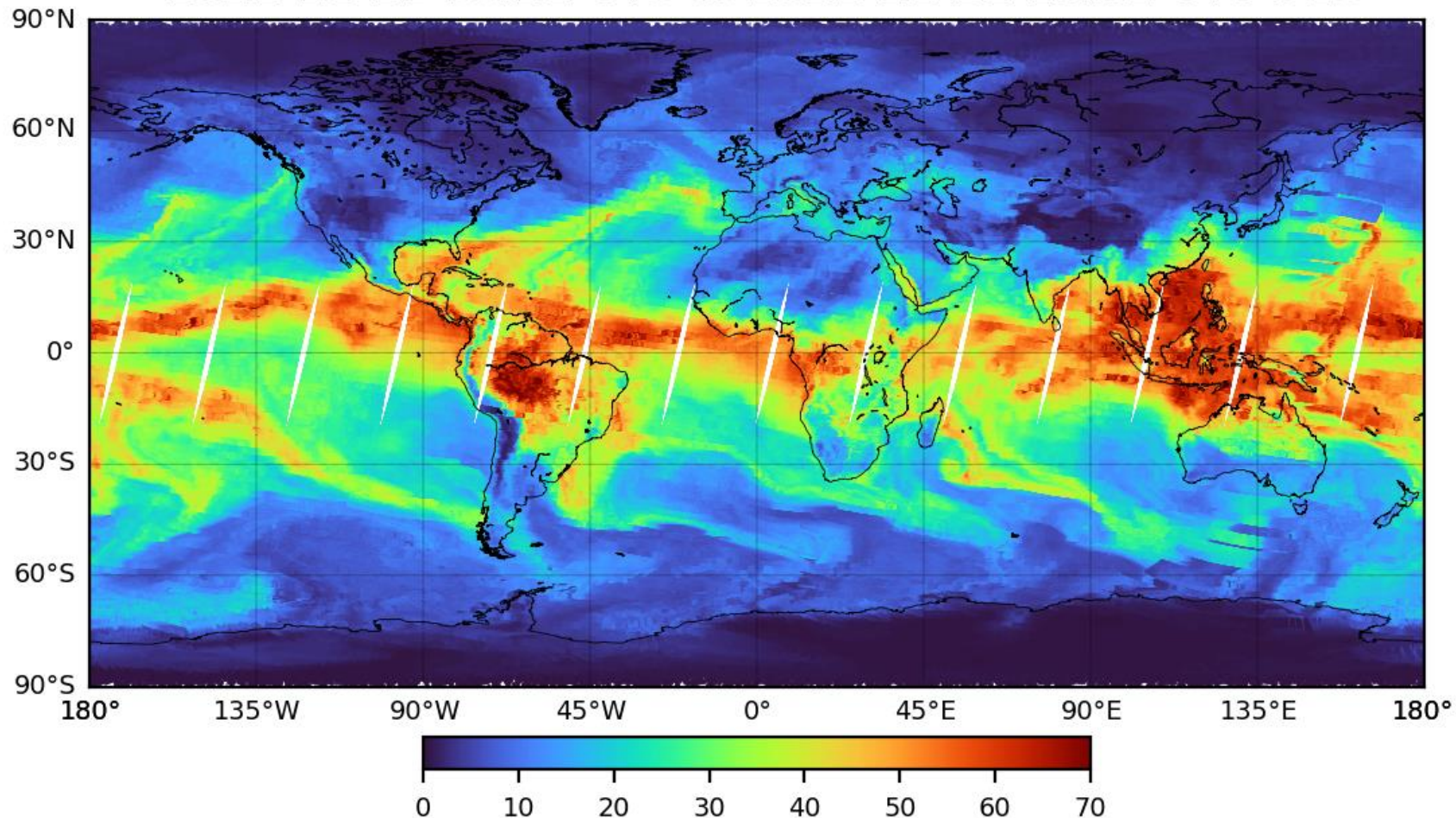


Validation approach summary

- MiRS ATMS processing began with first light data at 15:22 UTC on 21 November.
- Daily processing in STAR, with routine comparisons to GDAS and ECMWF.
- Preliminary validation of 10 different products: T(p), q(p), TPW, RR, LST, LSE, CLW, SIC, SWE/SCE.
- For T(p), q(p), TPW, LST, **LSE**, **CLW**: direct global comparisons to ECMWF analyses.
- For **RR**: direct comparison to NWS Stage IV radar/gauge analysis.
- For SIC, SWE: direct comparison of N21 to N20 to determine agreement, combined with knowledge of N20 performance to estimate likely N21 performance when compared with independent reference.
- All NOAA-21 results are preliminary, non-operational.

MIRS NOAA-21 ATMS First Light

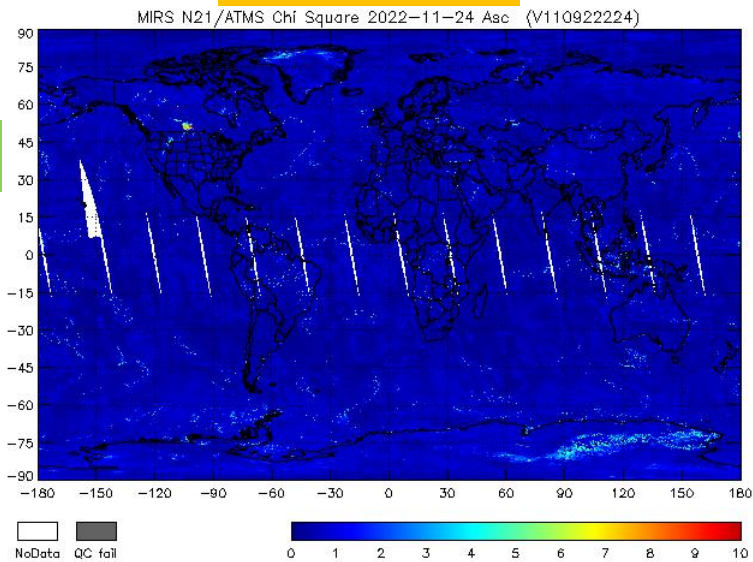
MIRS NOAA-21 ATMS TPW (mm)
2022-11-21 15:22 UTC to 2022-11-22 15:52 UTC DES



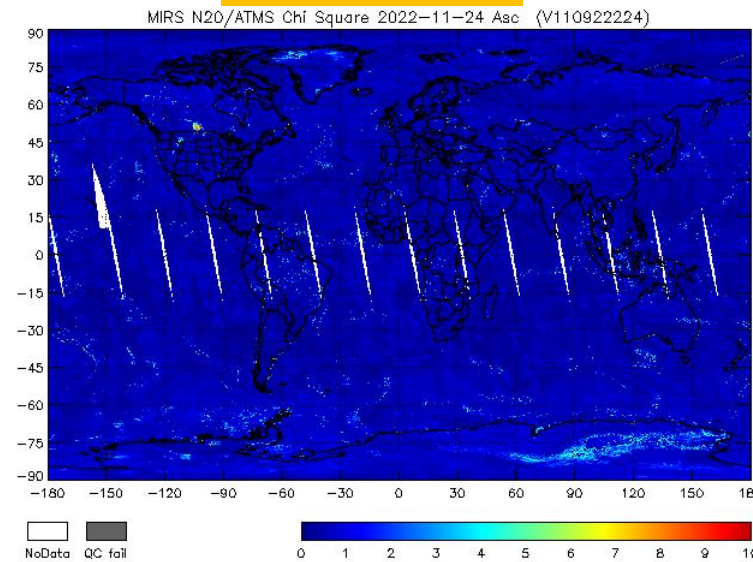
MiRS N21 and N20 Retrieval Diagnostics

Chi squared

N21

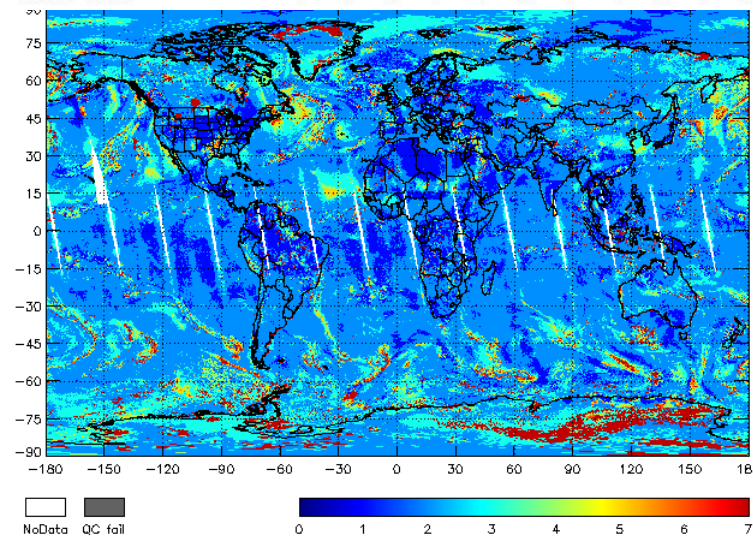
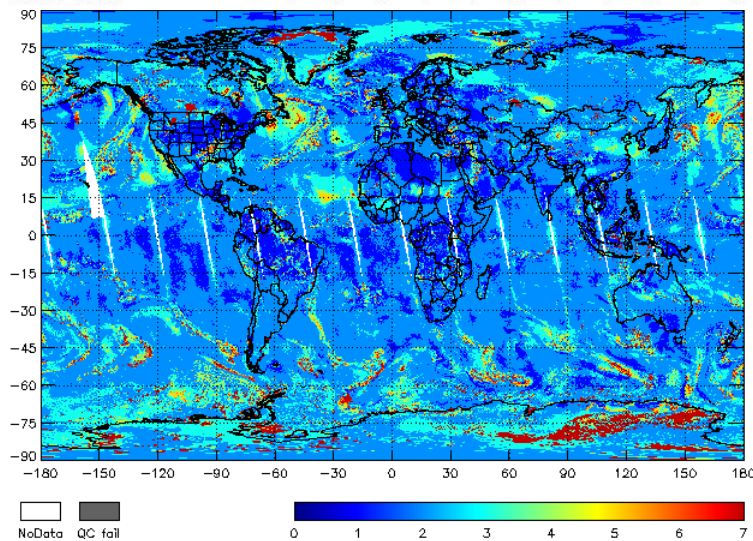


N20



2022-11-24

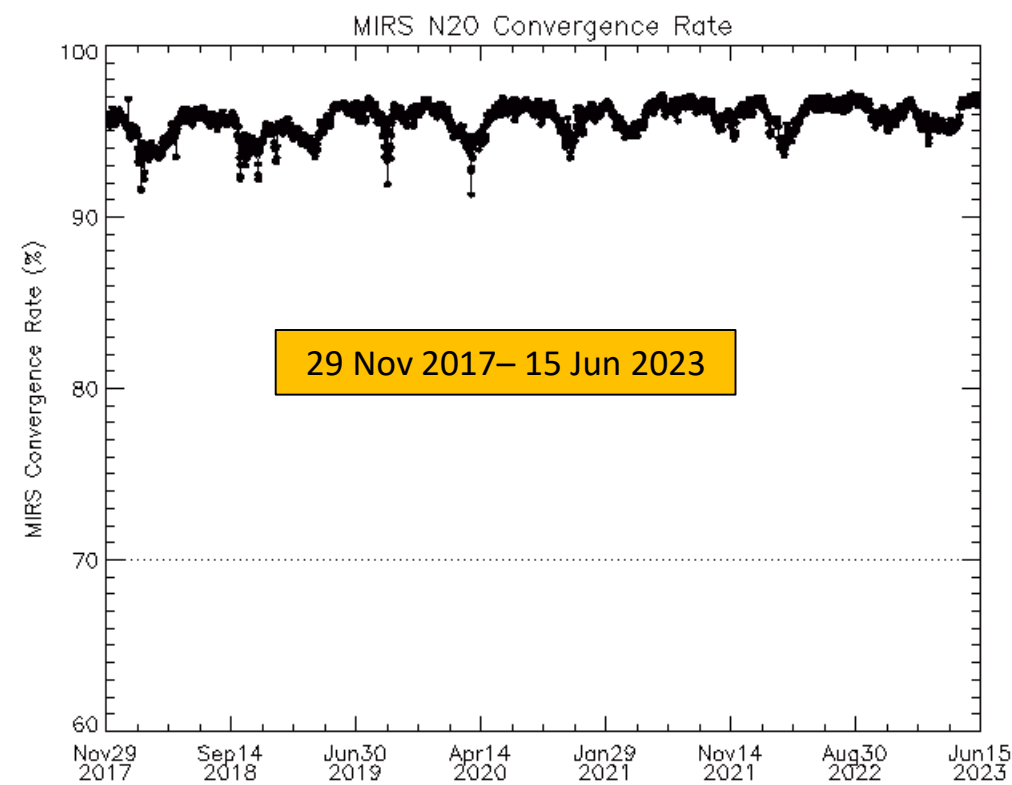
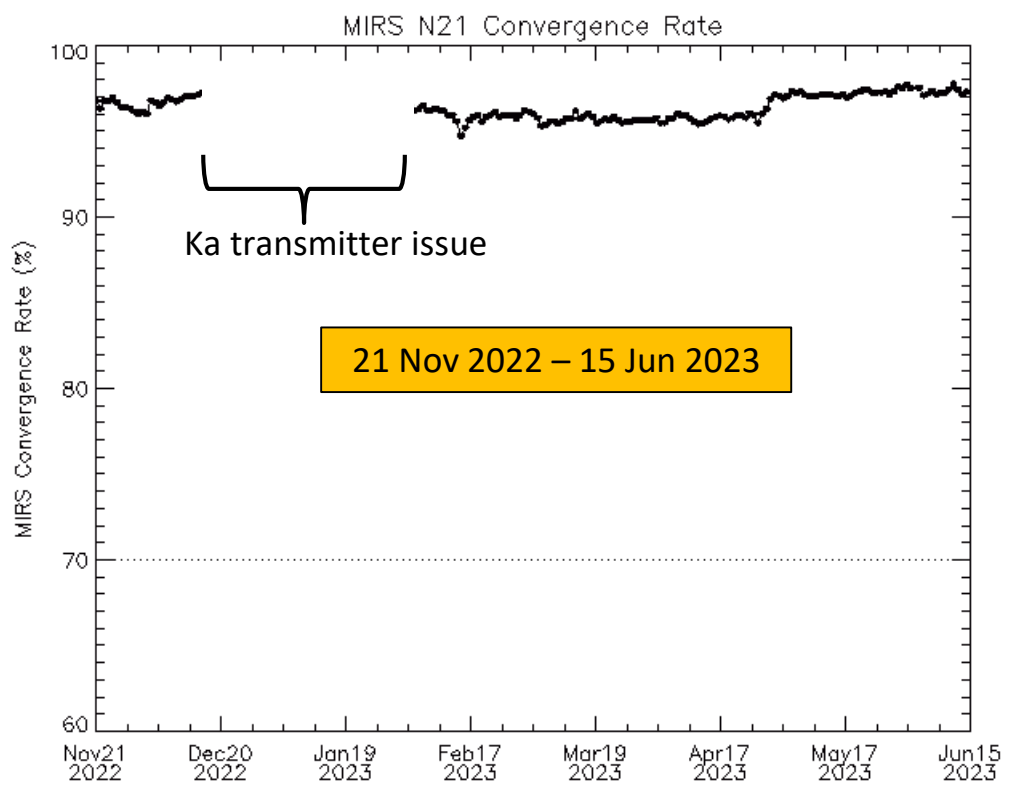
N. Iterations



Retrieval Convergence Rate

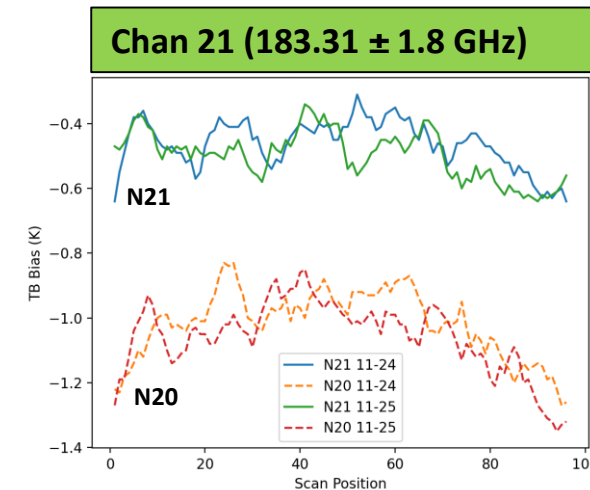
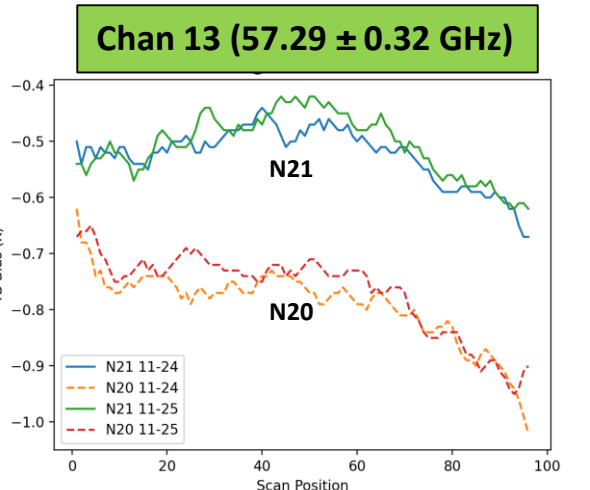
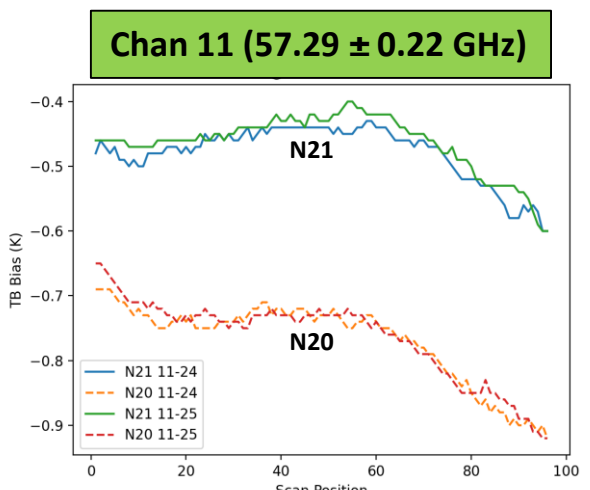
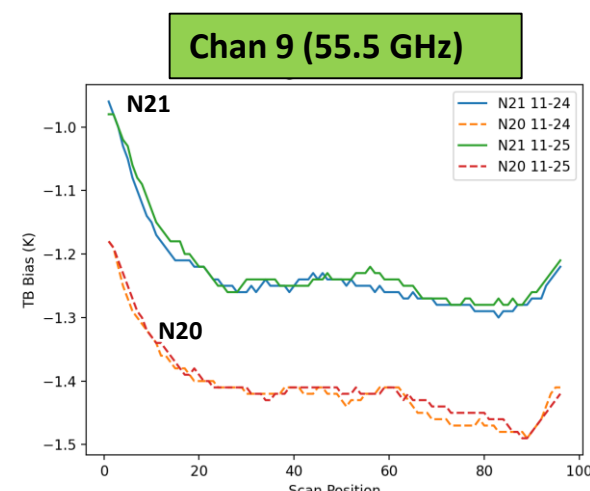
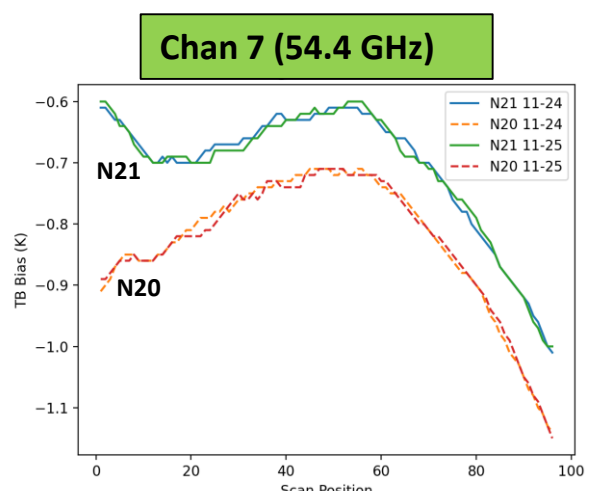
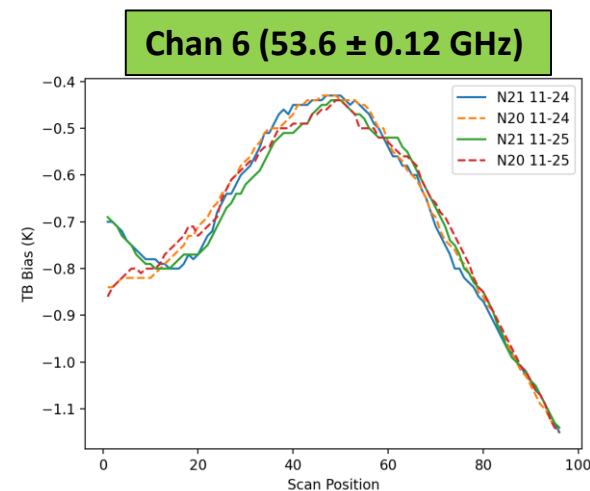
N21

N20

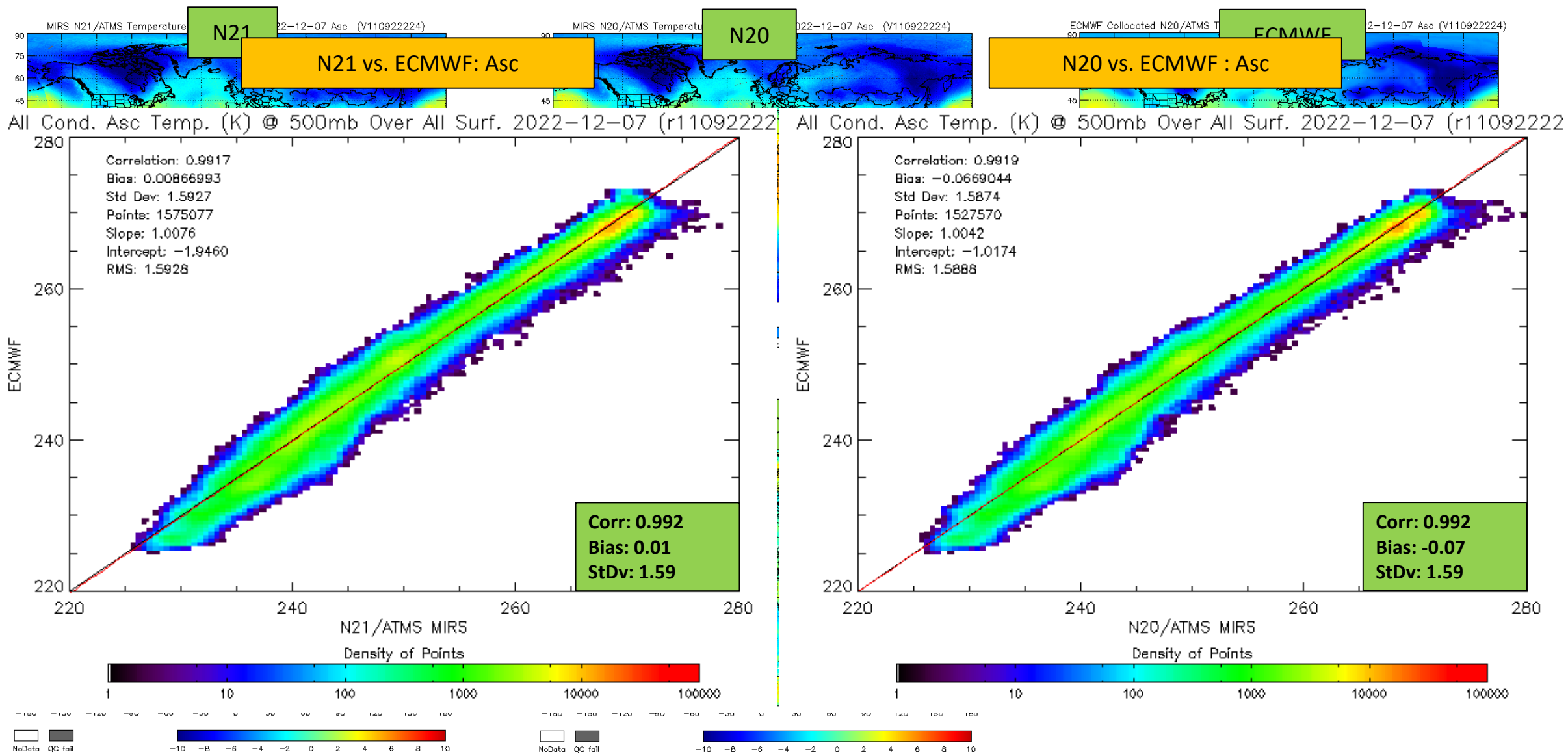


NOAA-21 and NOAA-20 ATMS Radiometric Biases (Obs-Sim)

- N21 (blue, green) and N20 (orange, red) biases on 2022-11-24 and 2022-11-25
- ECMWF + CRTM, clear ocean

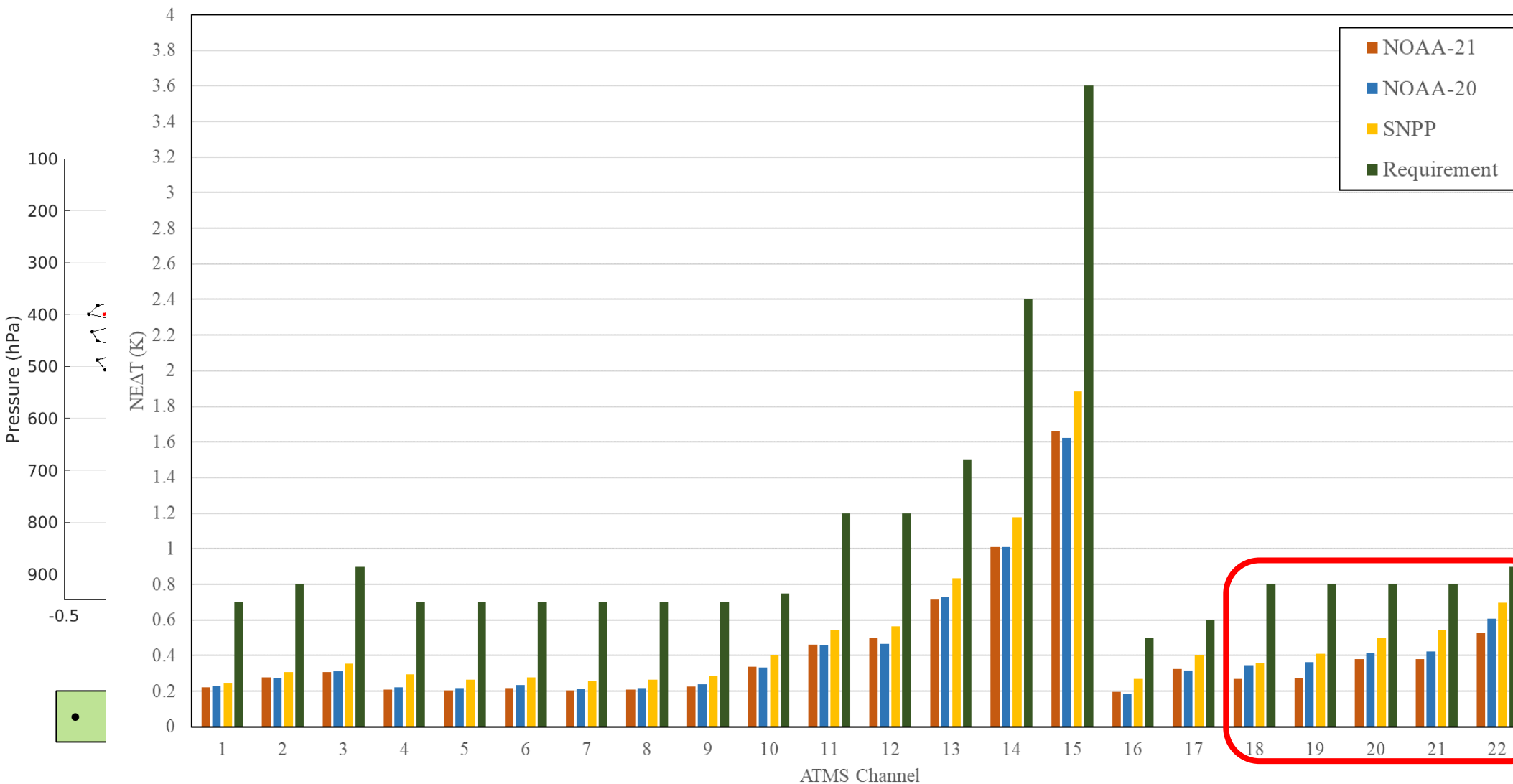


Temperature profile (500 hPa)



Temperature/Water Vapor profile

JPSS ATMS On-orbit Channel Noise Equivalent Differential Temperature (NEAT)



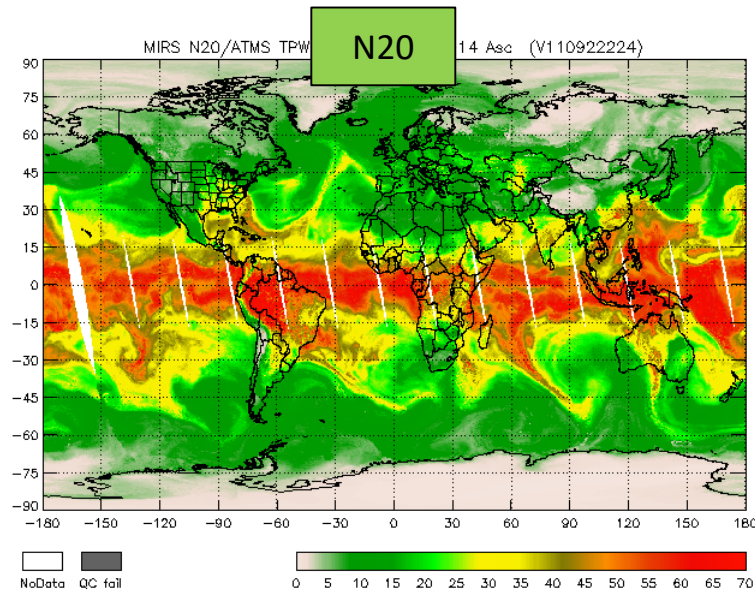
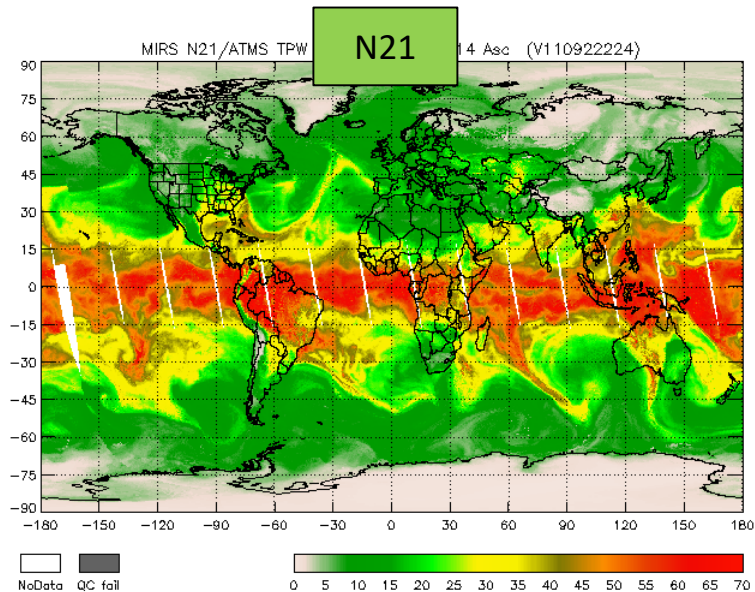
Requirement, Cloudy, Average (Ocean+Land)

Accuracy (%)	Precision (%)
30	65
20	63
15	55
20	40

Courtesy of N. Sun and M. Liu

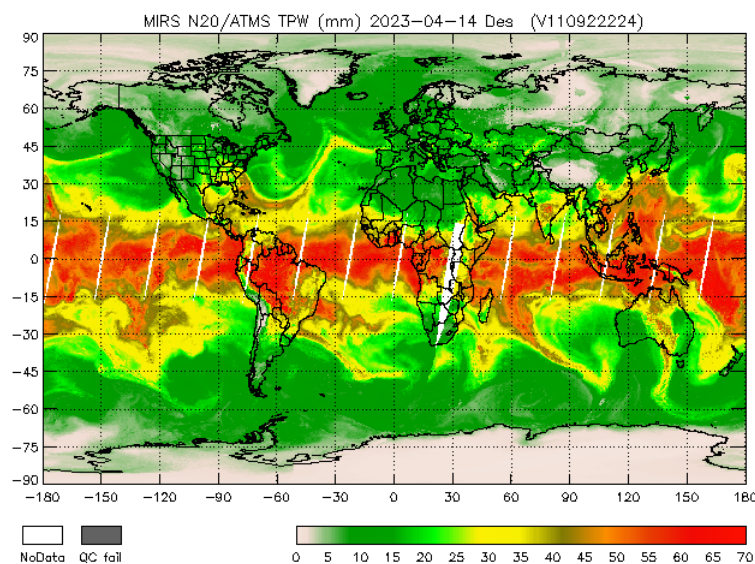
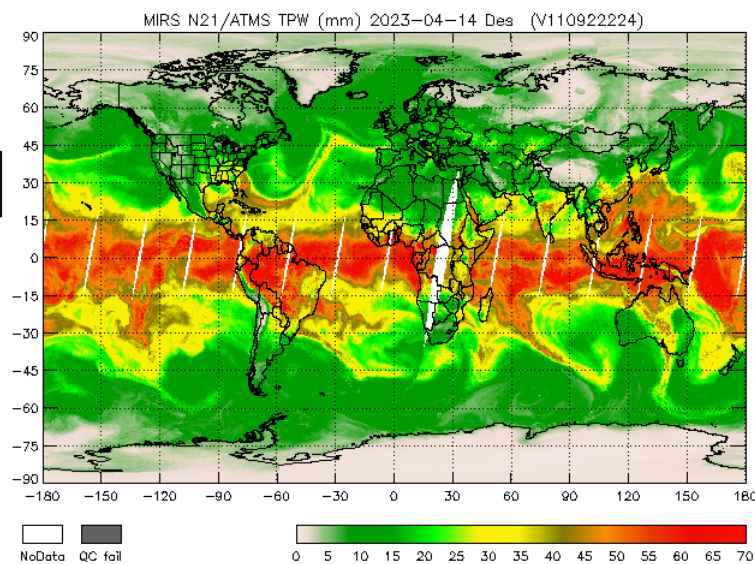
Total Precipitable Water: Ascending and Descending Data

Ascending

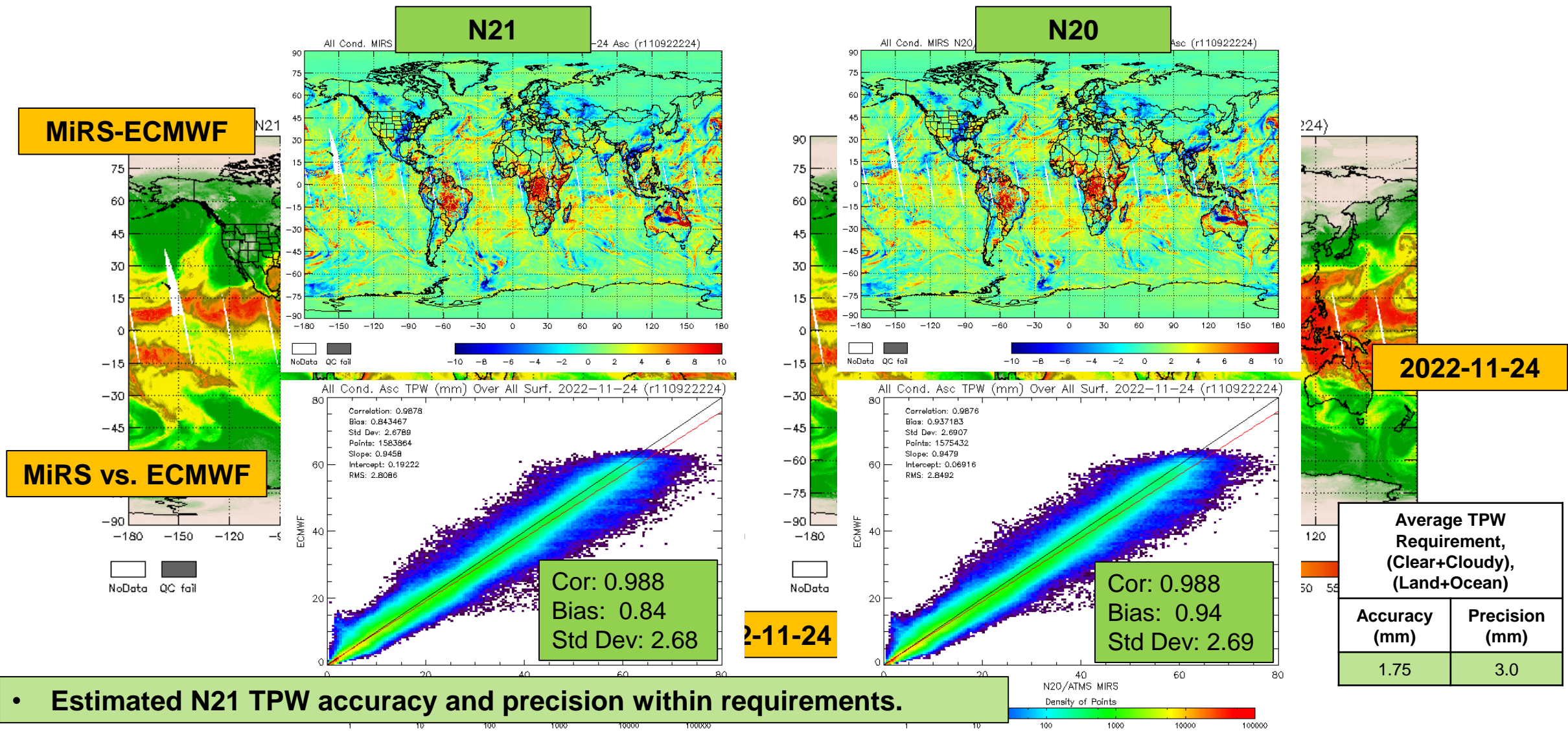


2023-04-14

Descending



Total Precipitable Water (TPW): Comparison with ECMWF



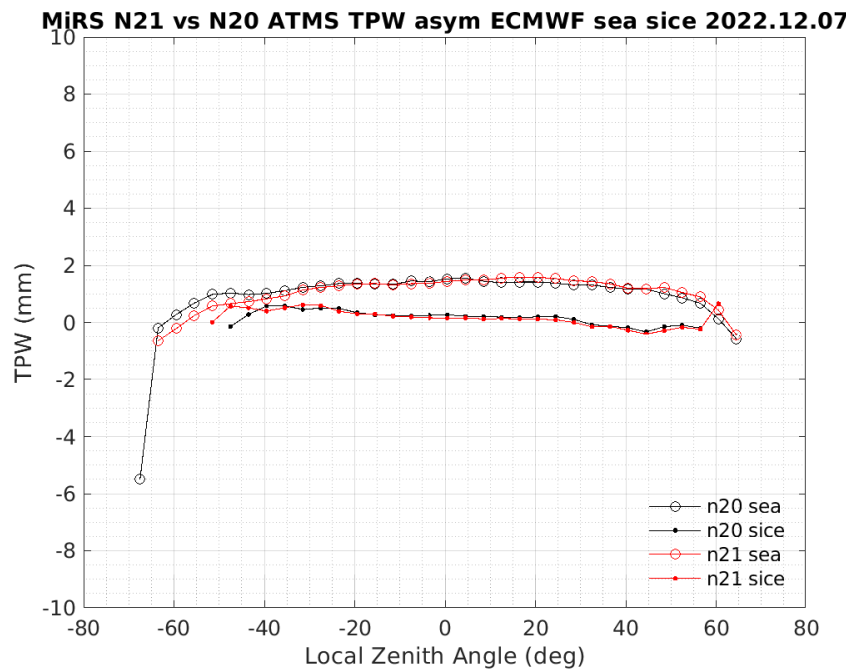
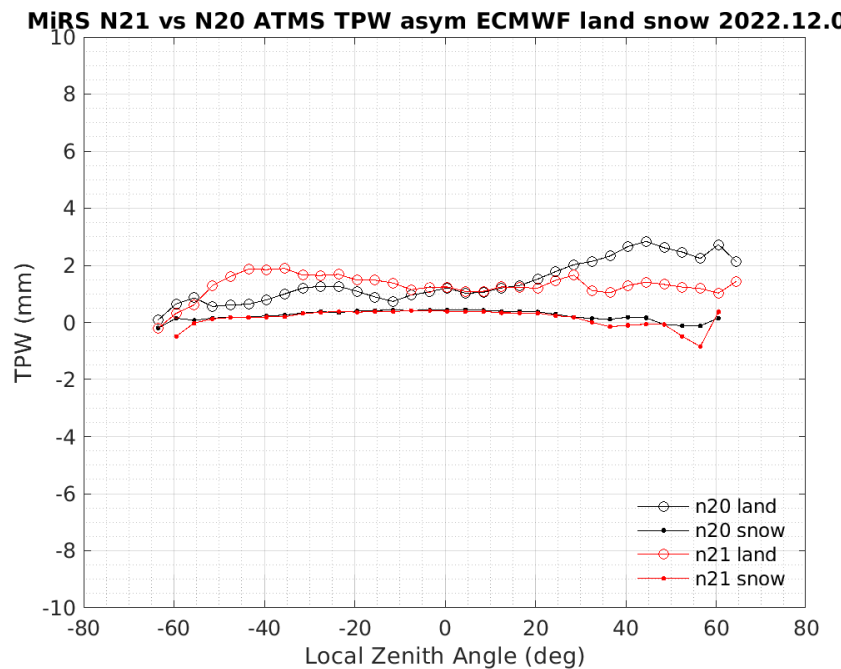
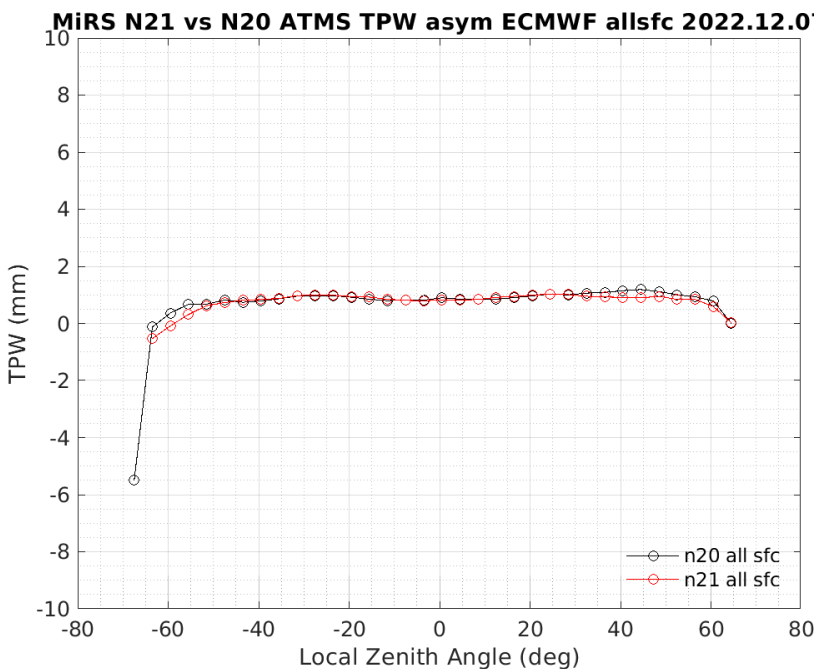
- Estimated N21 TPW accuracy and precision within requirements.

Global Collocation w/ ECMWF

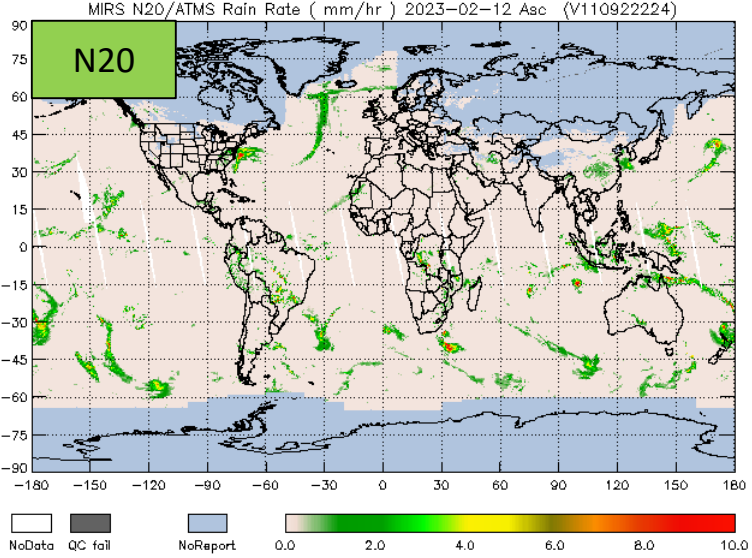
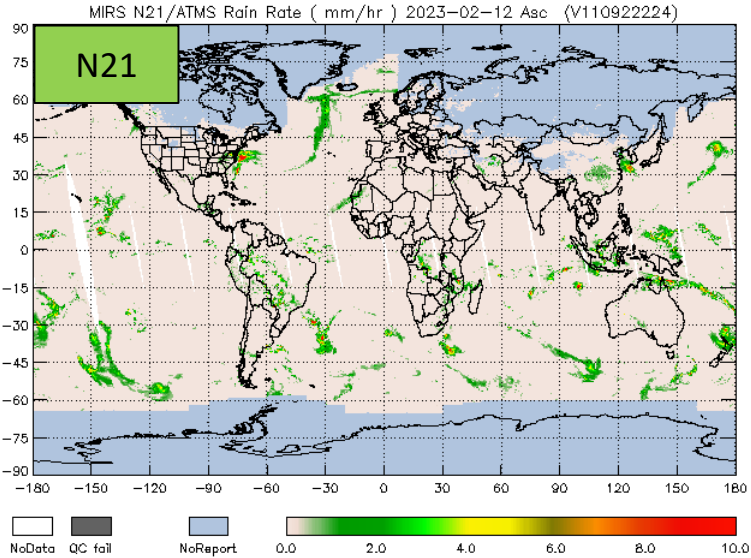
All surfaces ascending

Land/snow ascending

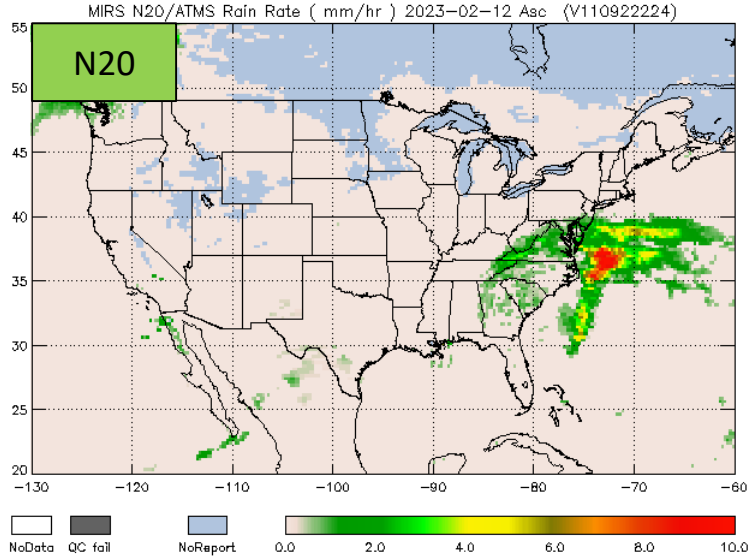
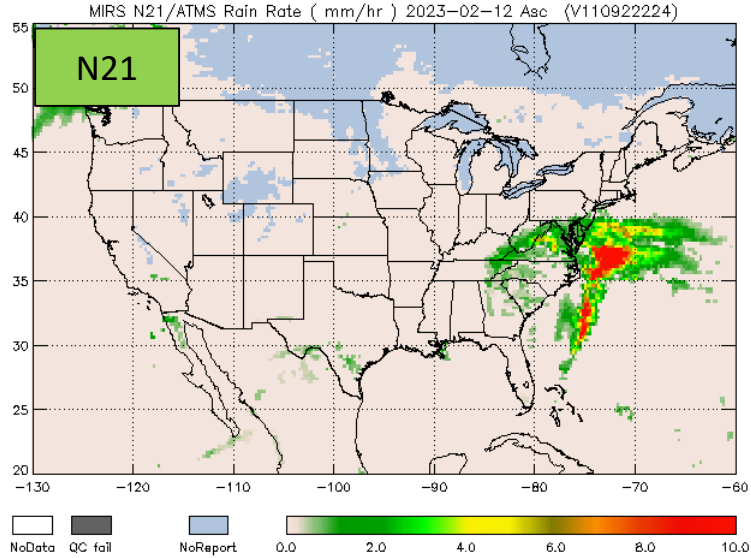
Ocean/Sea ice ascending



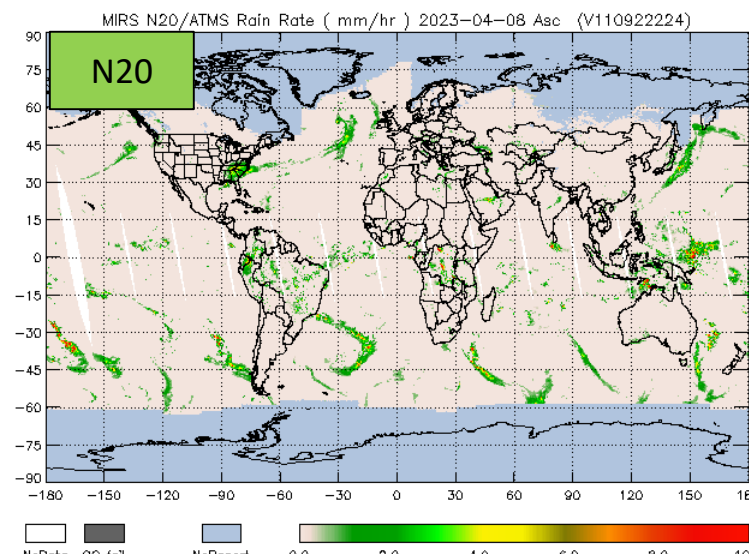
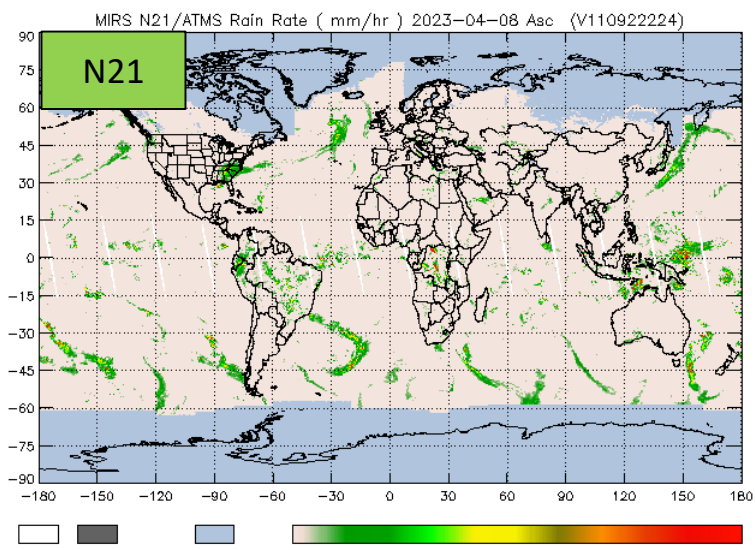
Rain rate



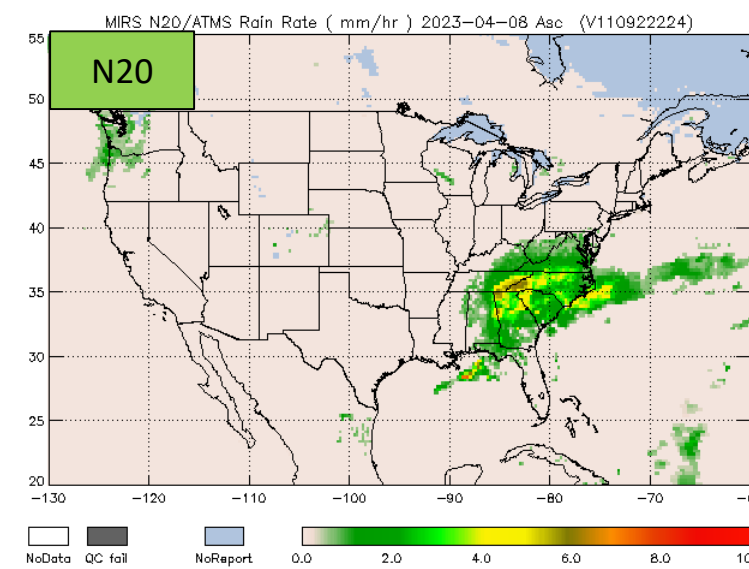
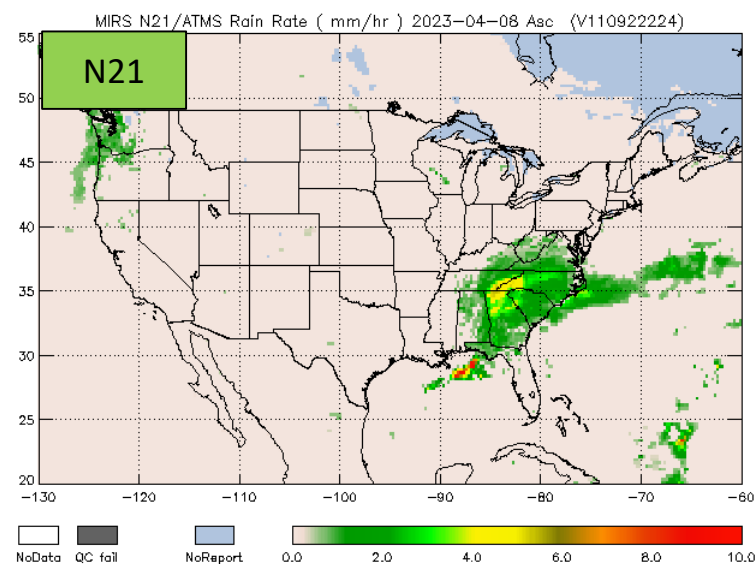
2023-02-12



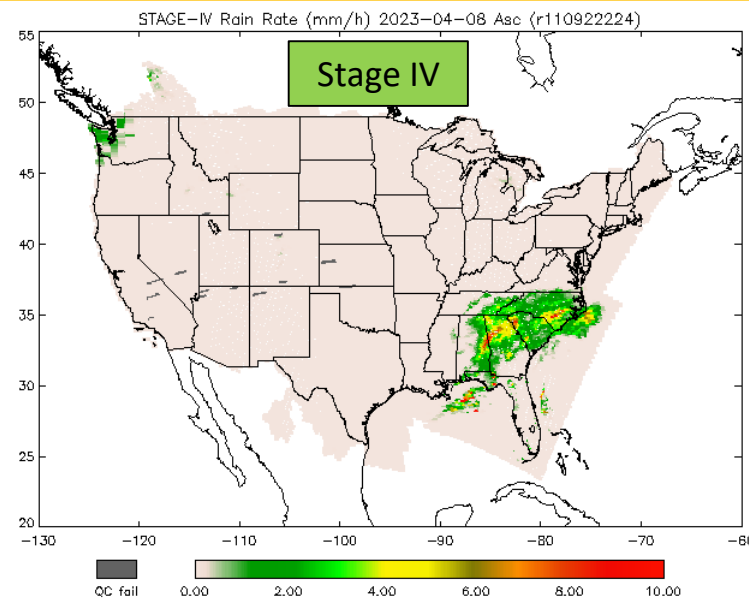
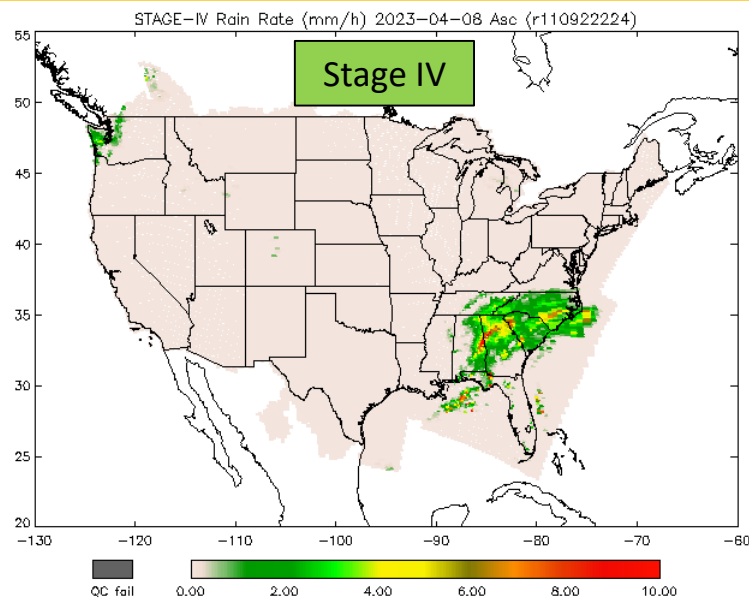
Rain rate



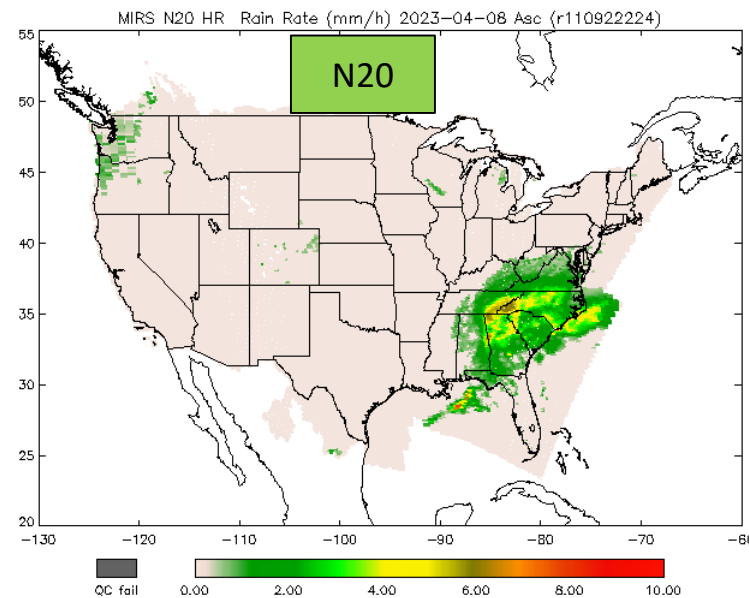
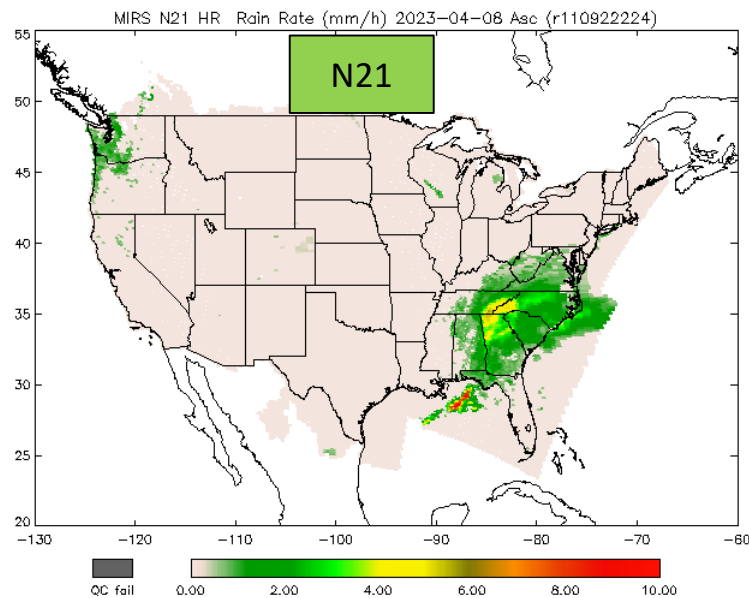
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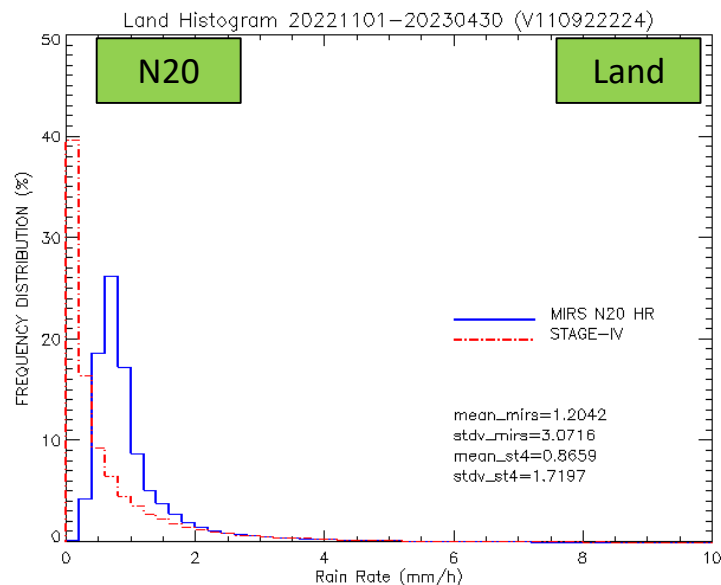
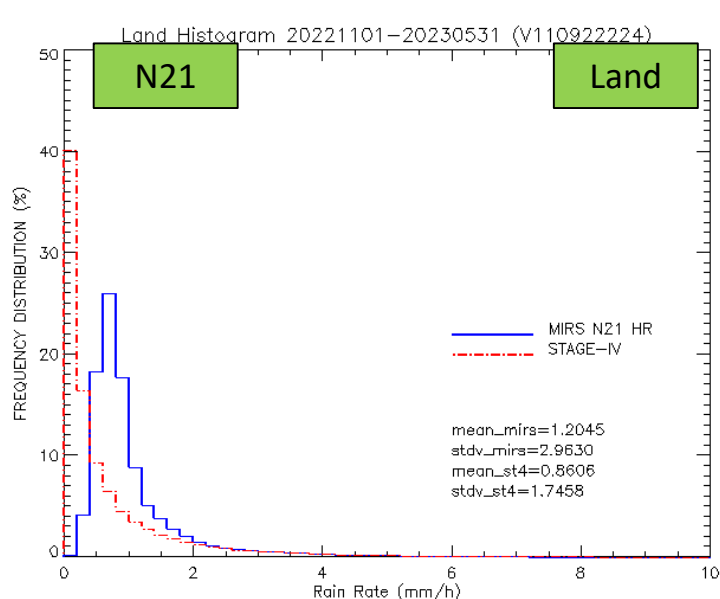
Rain rate



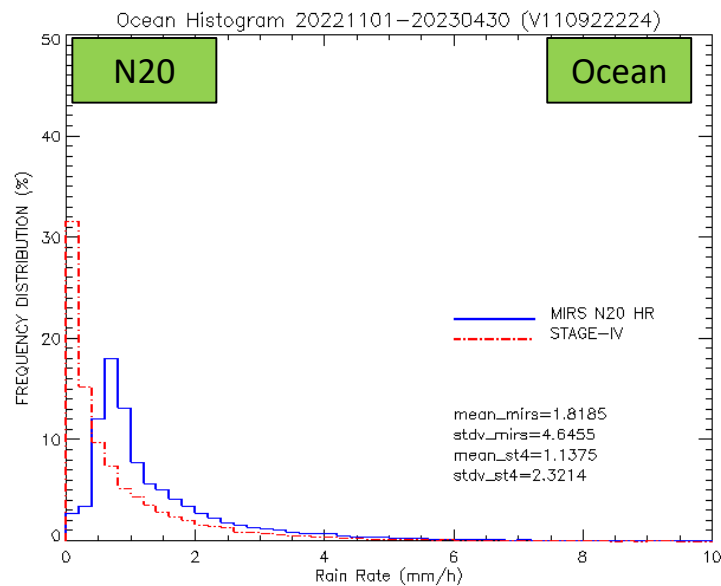
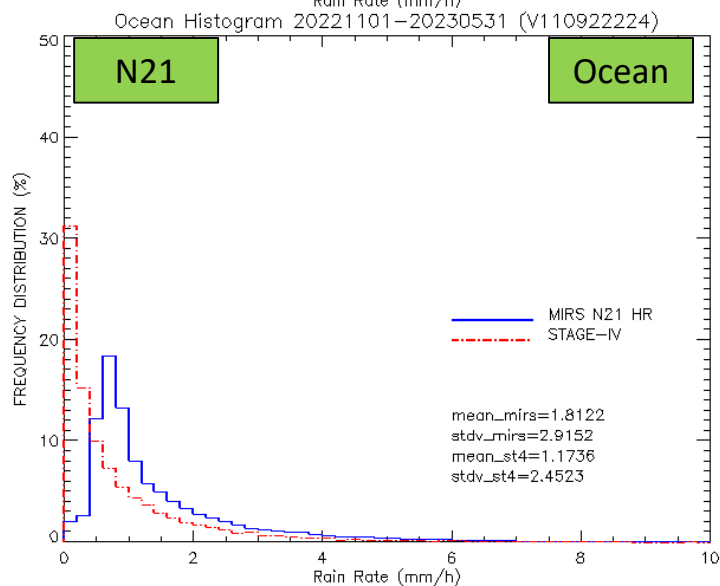
2023-04-08



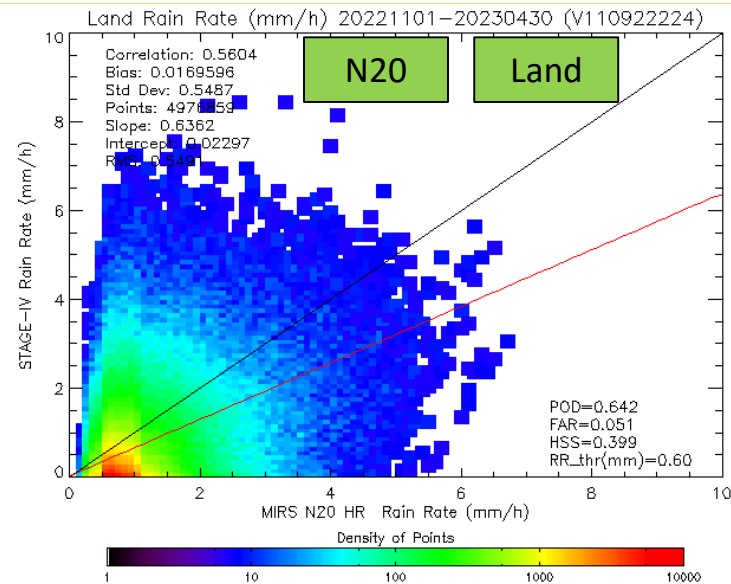
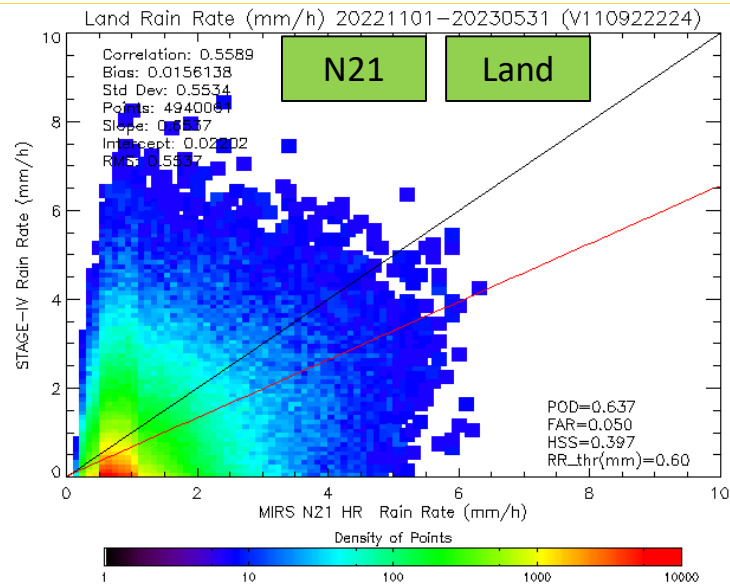
Rain rate



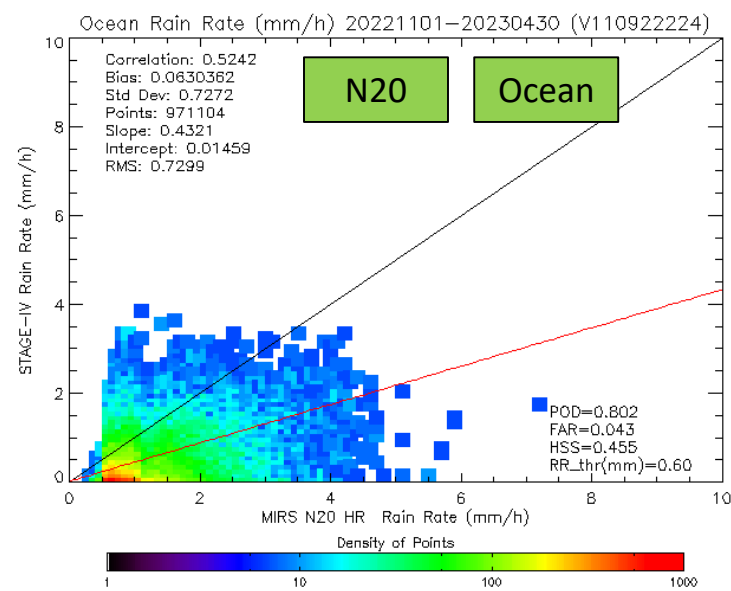
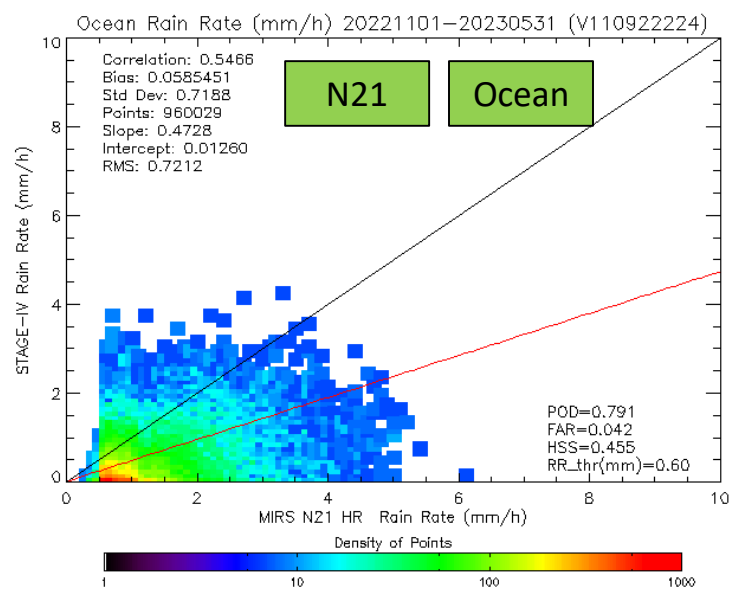
November 2022 – May 2023



Rain rate



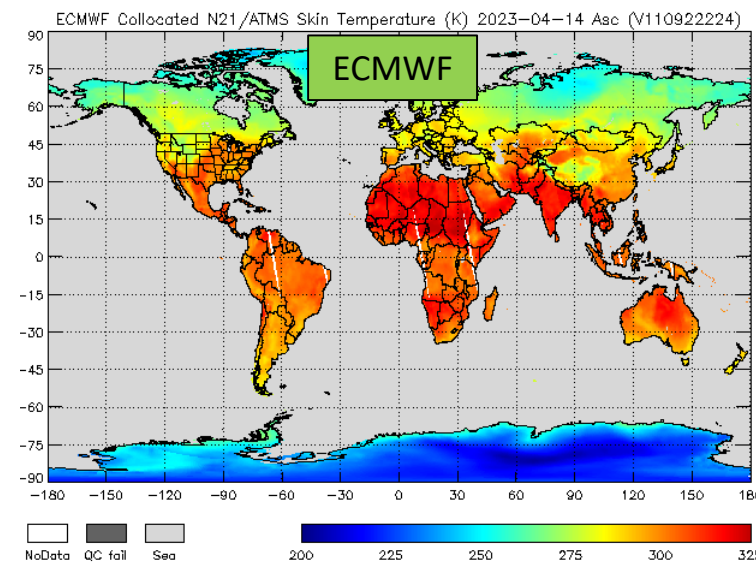
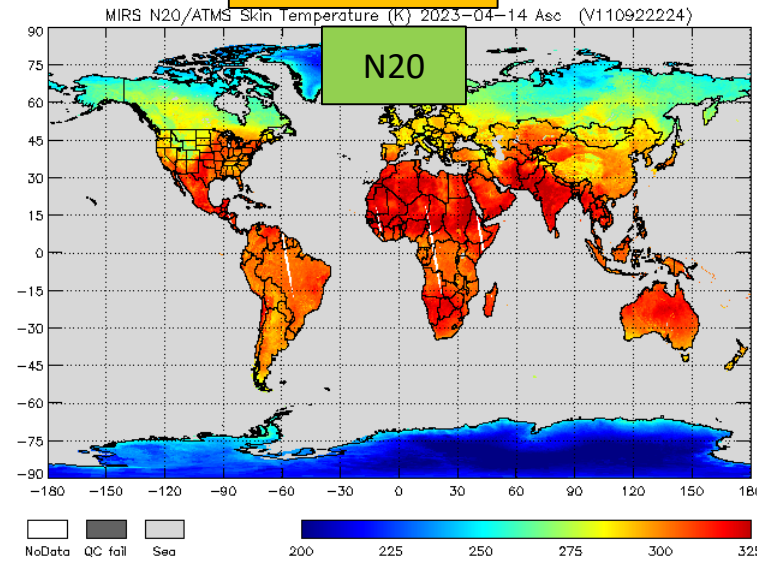
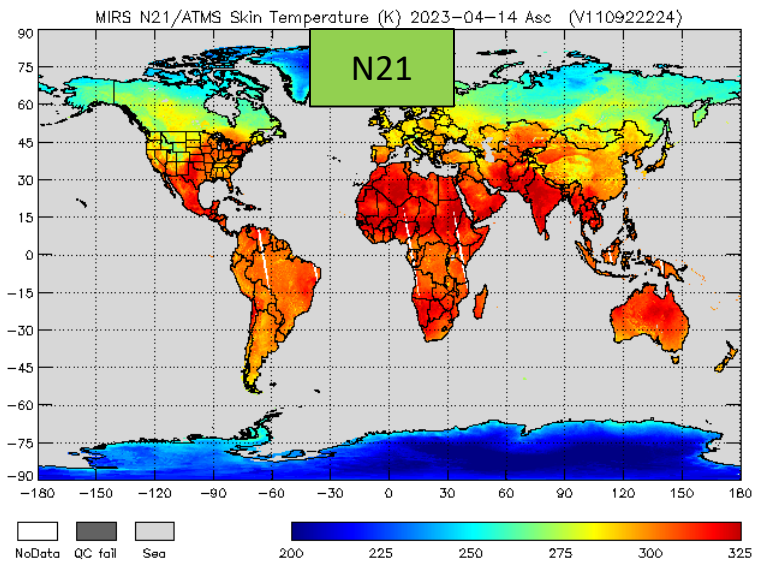
November 2022 – May 2023



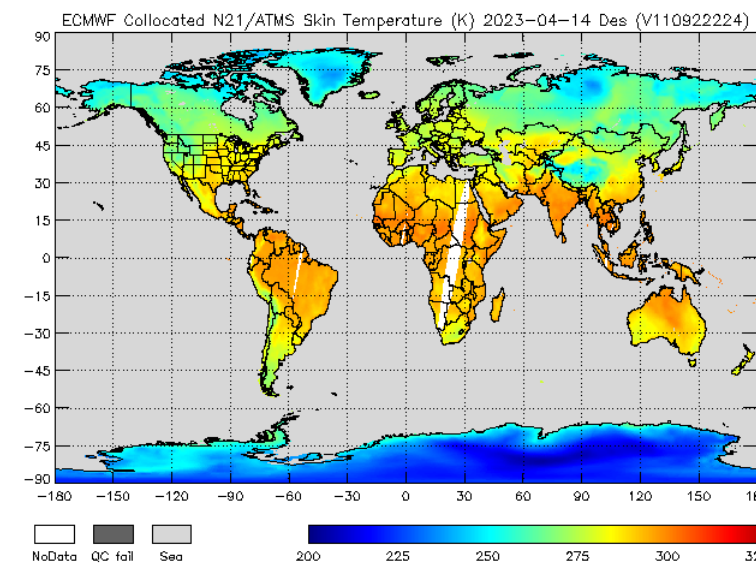
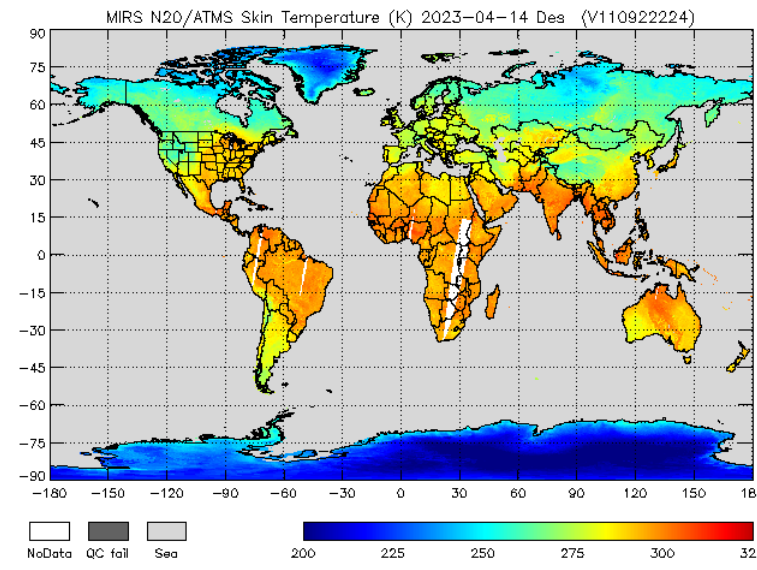
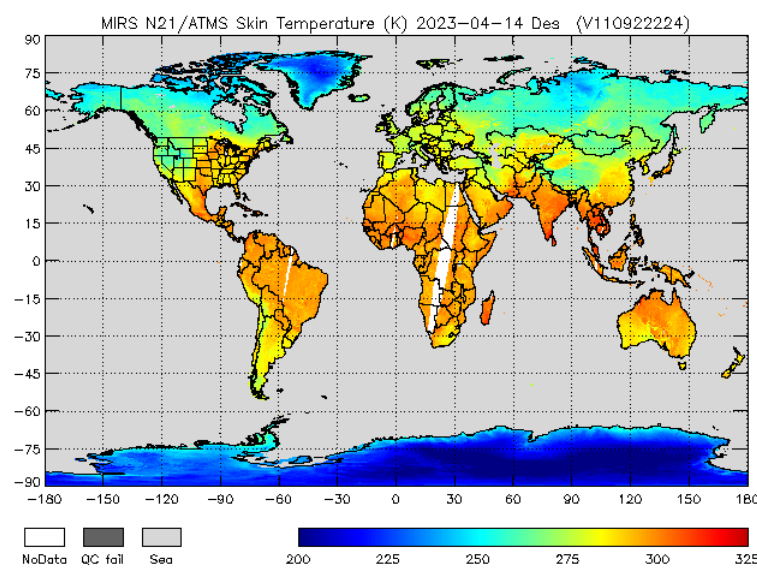
Land Surface Temperature

2023-04-14

Asc

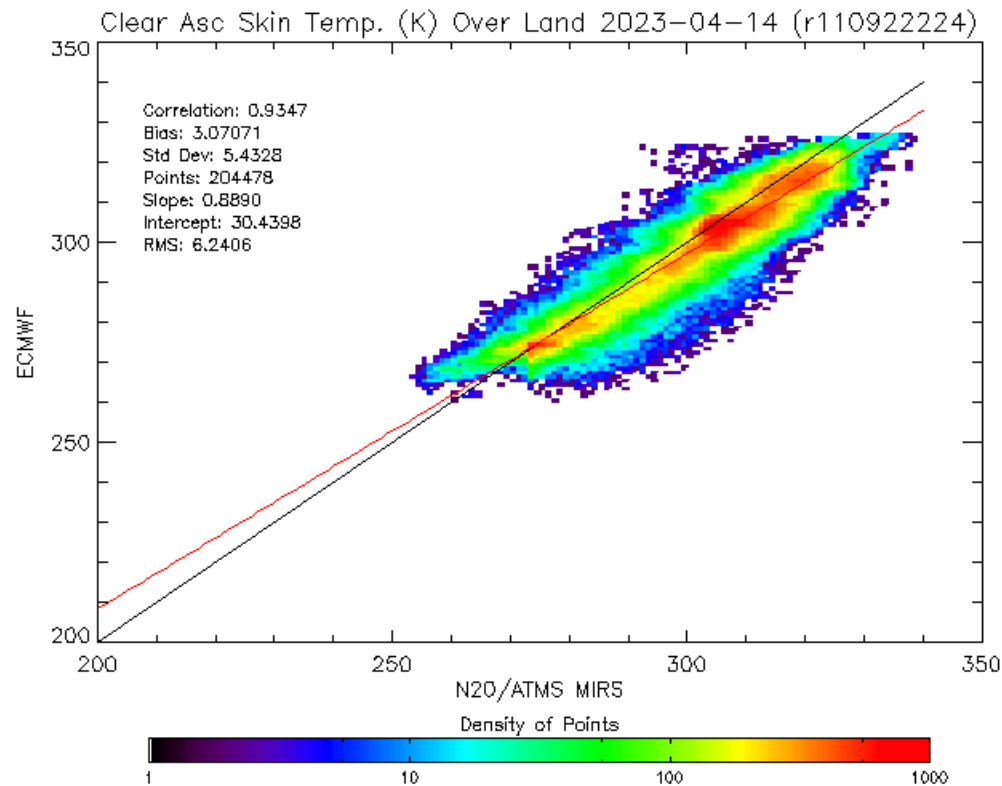
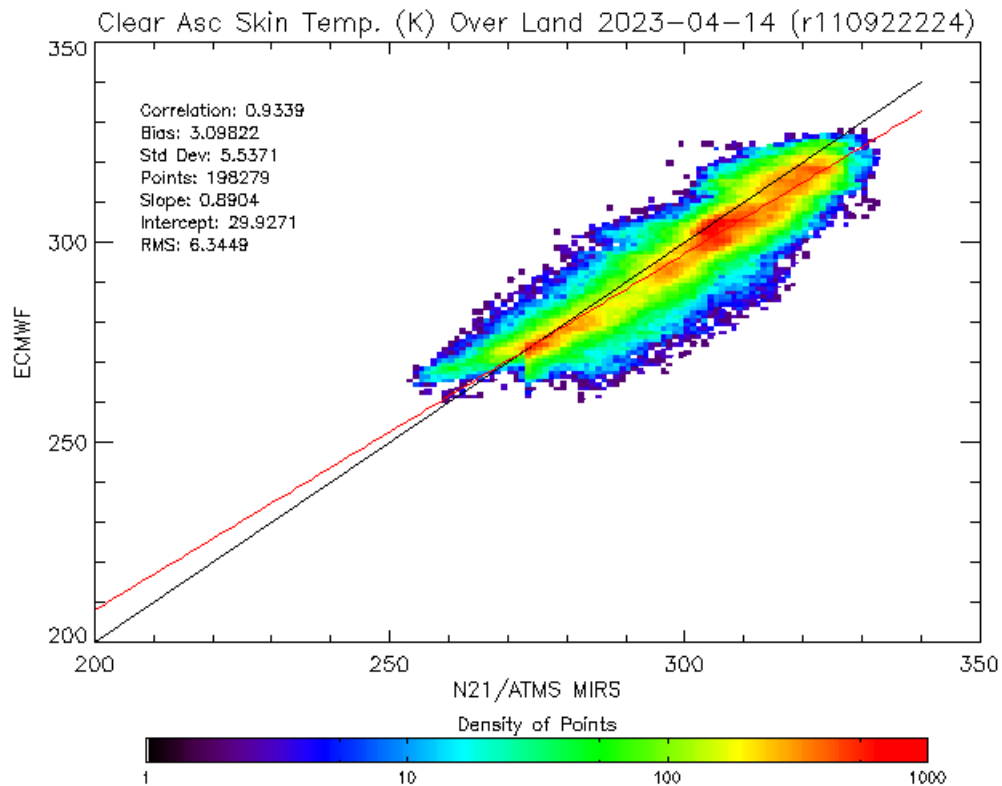


Des



N21

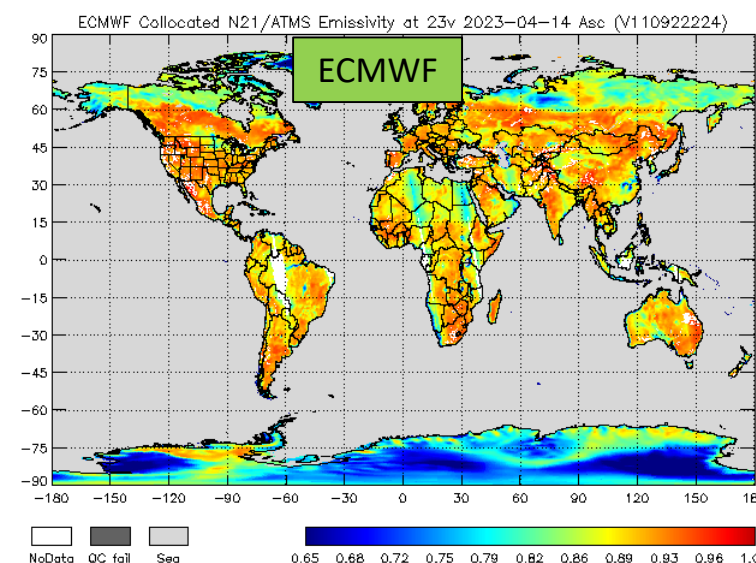
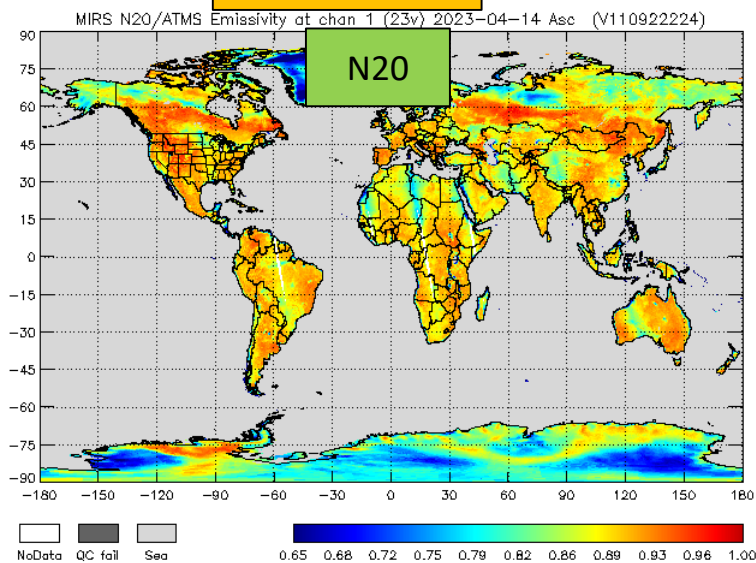
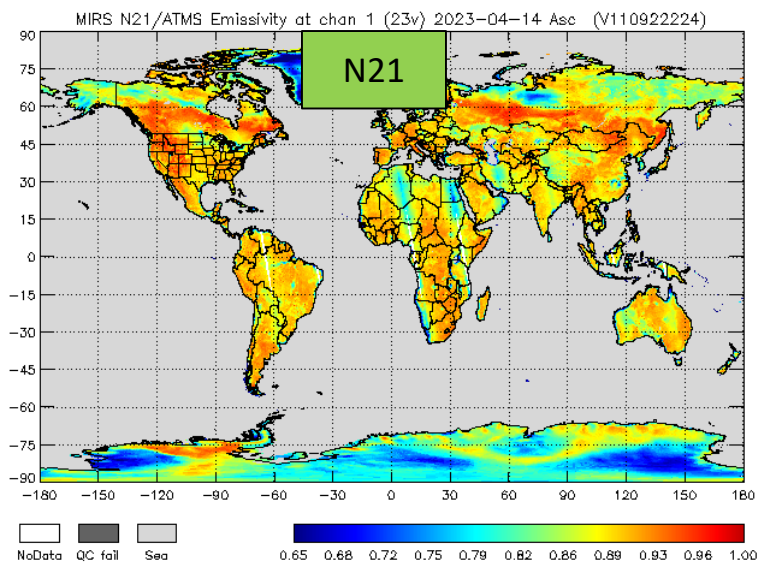
N20



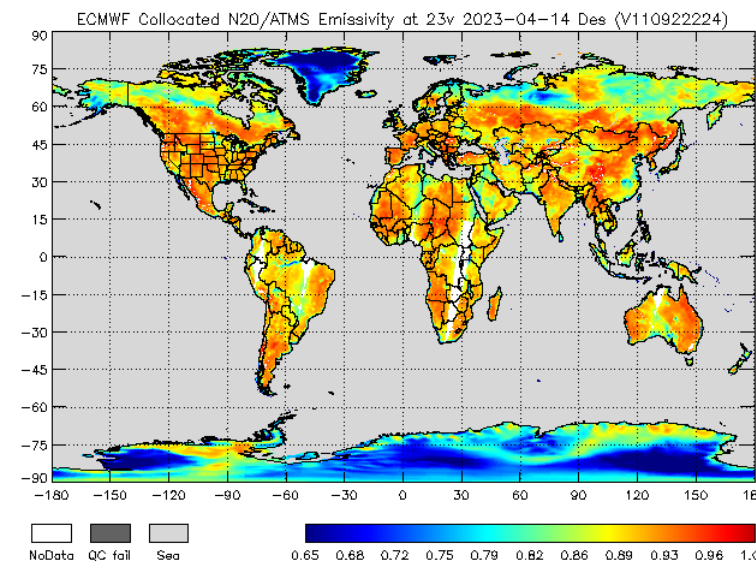
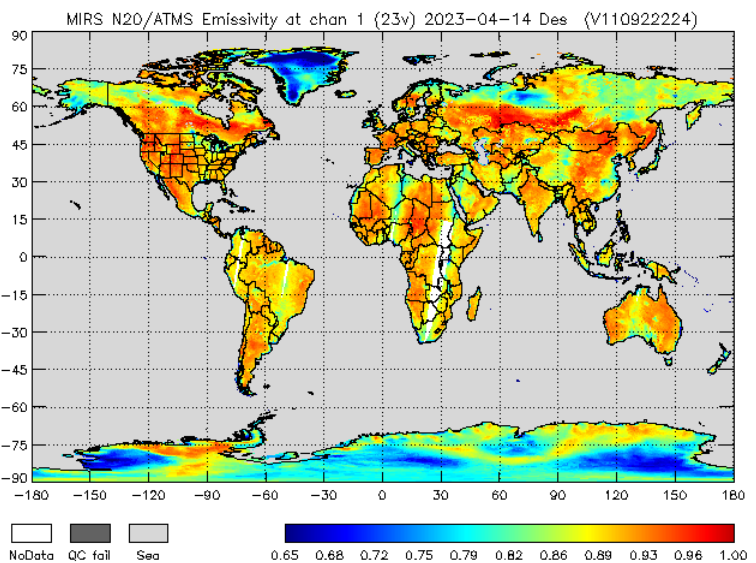
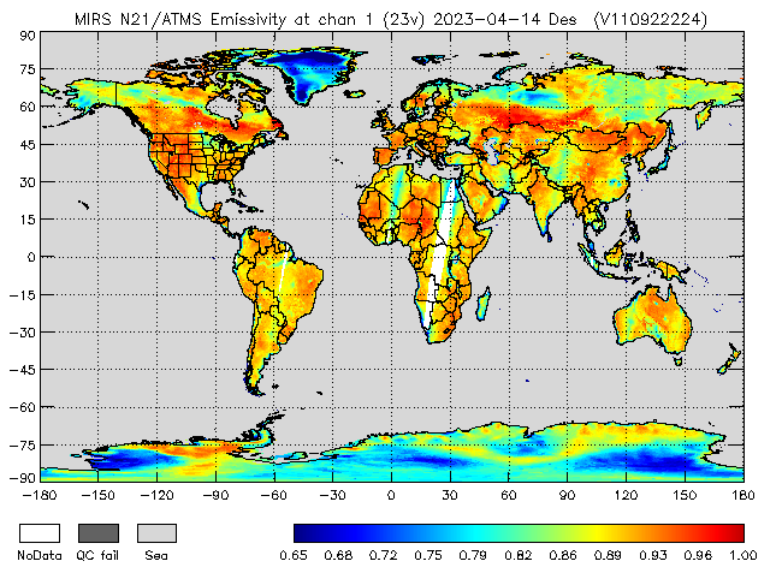
Land Surface Emissivity (23 GHz)

2023-04-14

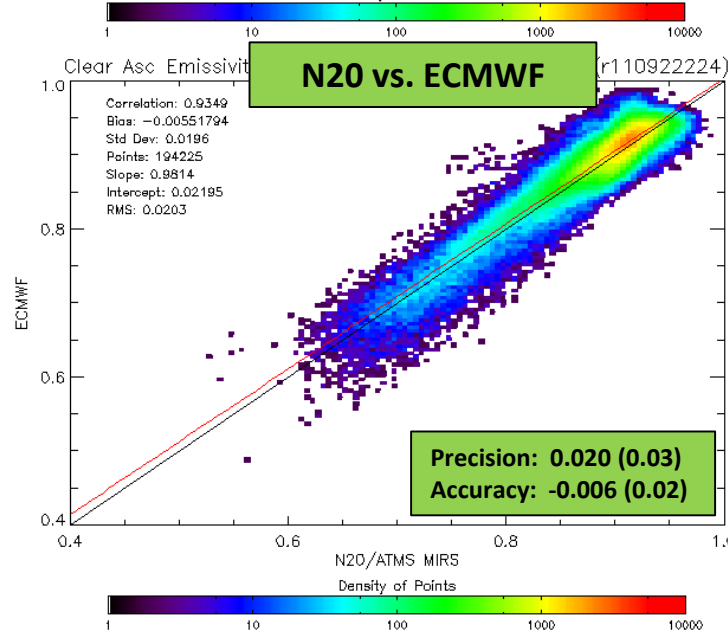
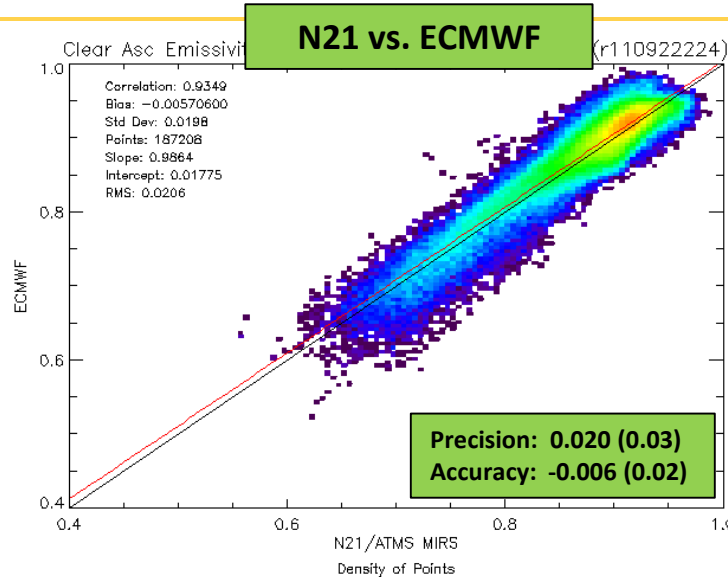
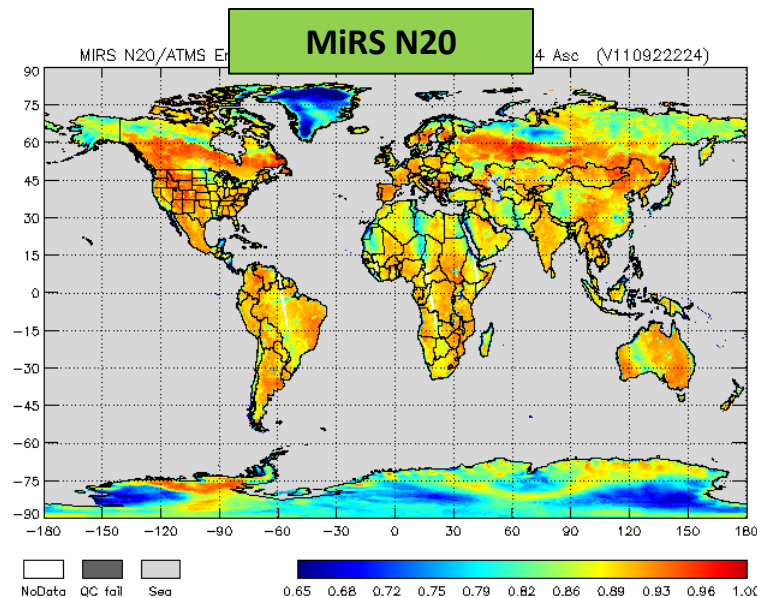
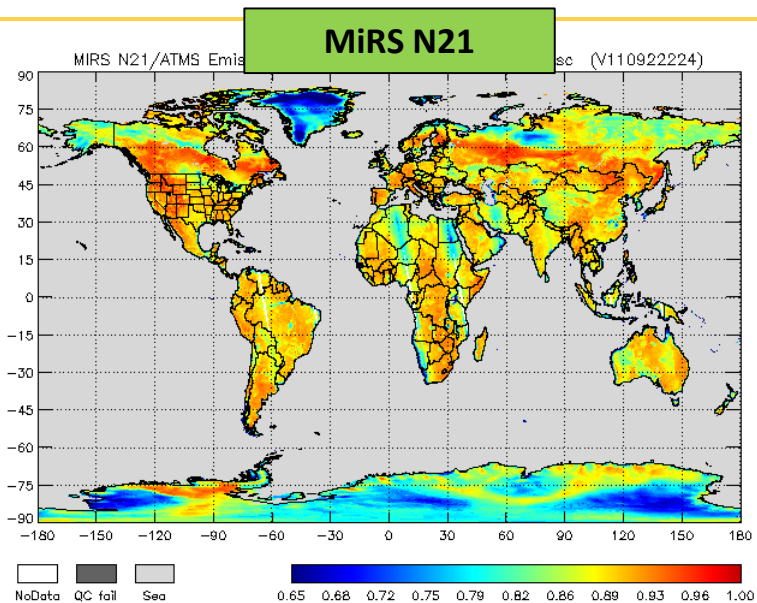
Asc



Des



Land Surface Emissivity (23 GHz)



2023-04-14

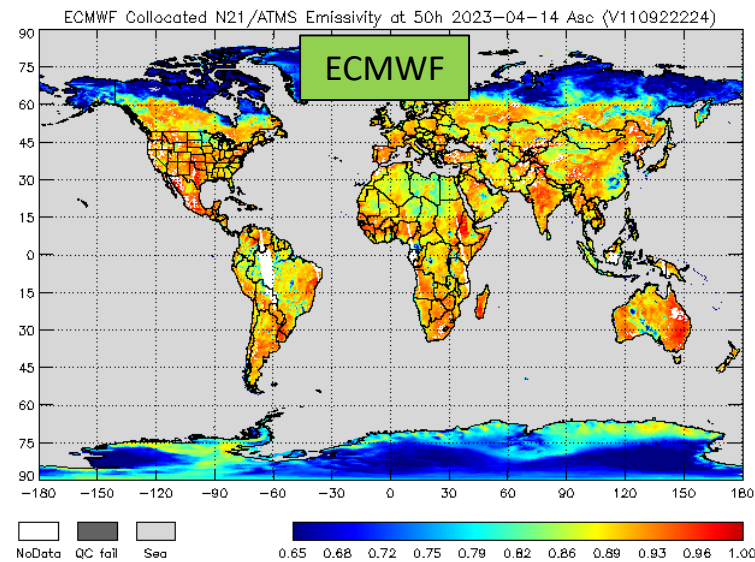
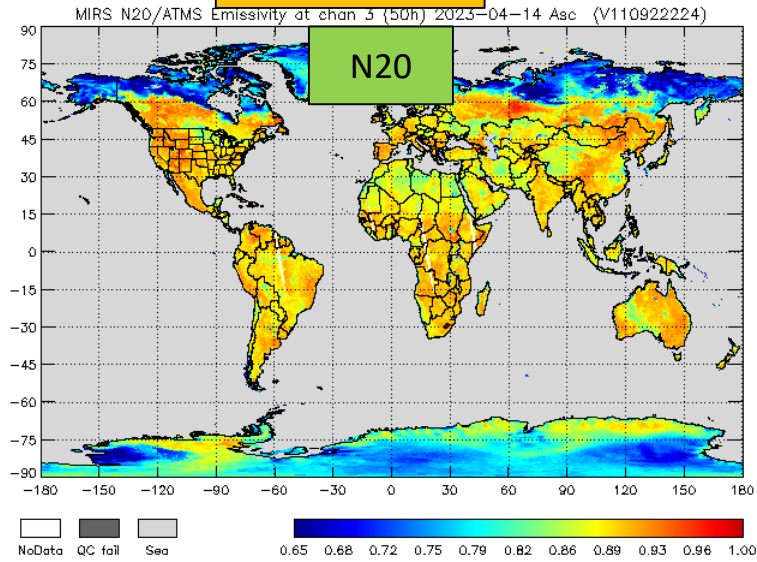
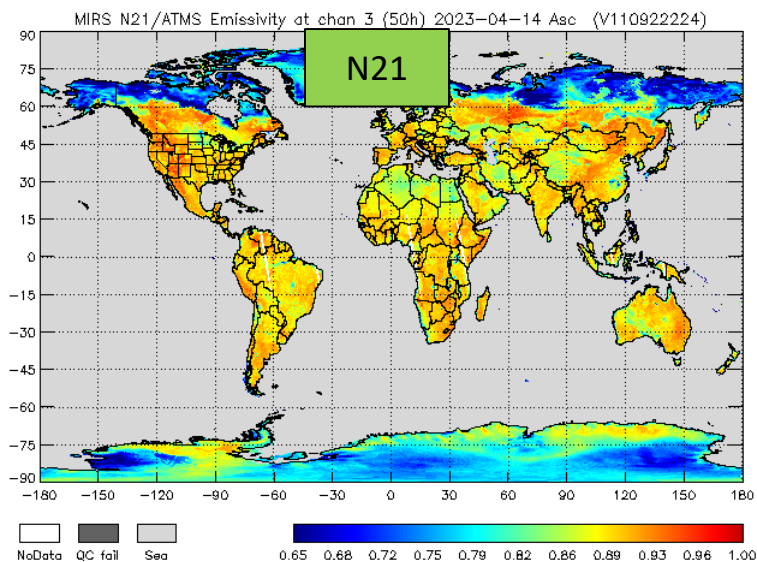
23 QV

Asc

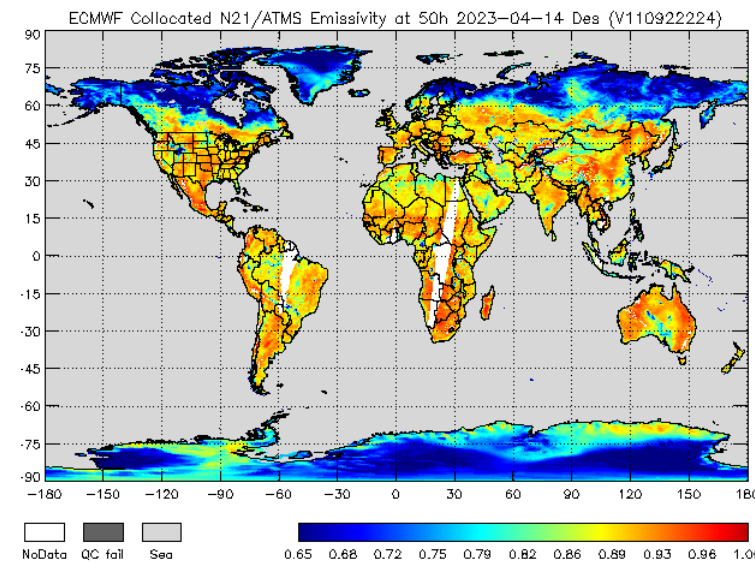
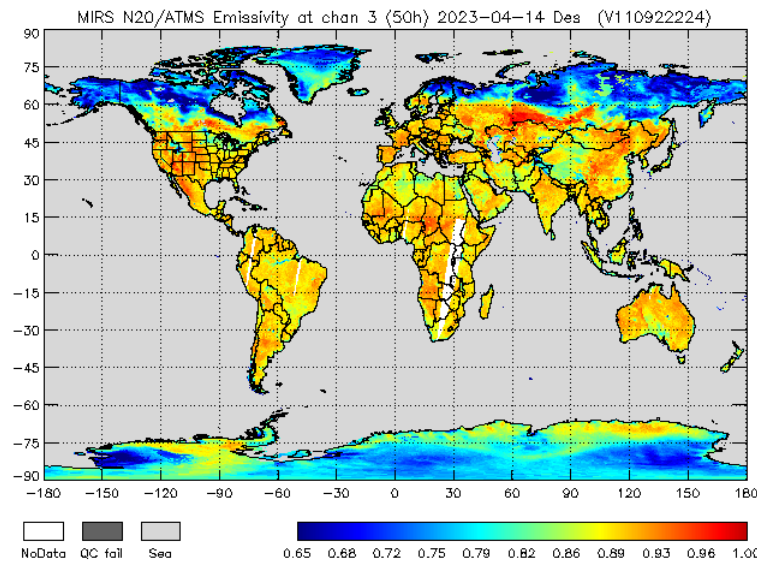
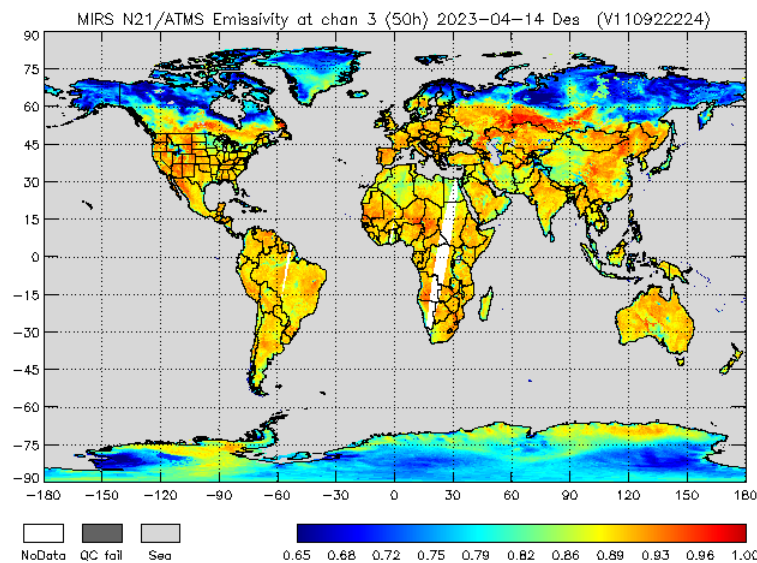
Land Surface Emissivity (50 GHz)

2023-04-14

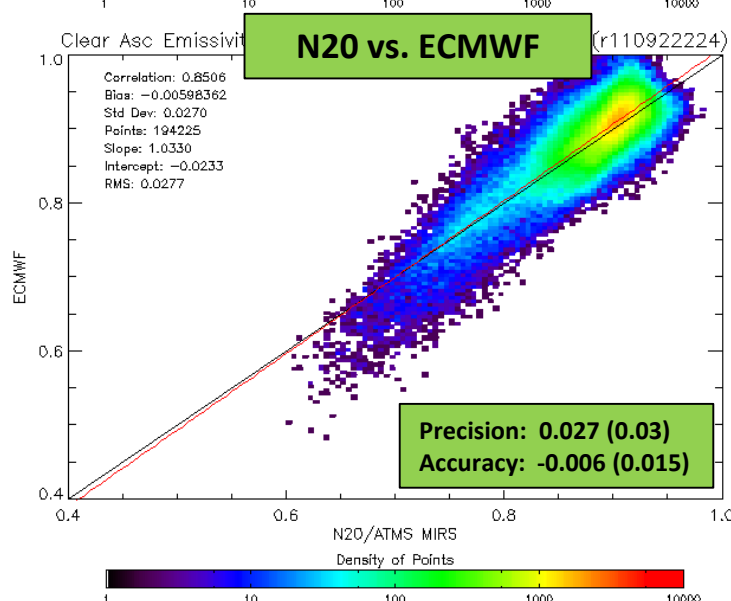
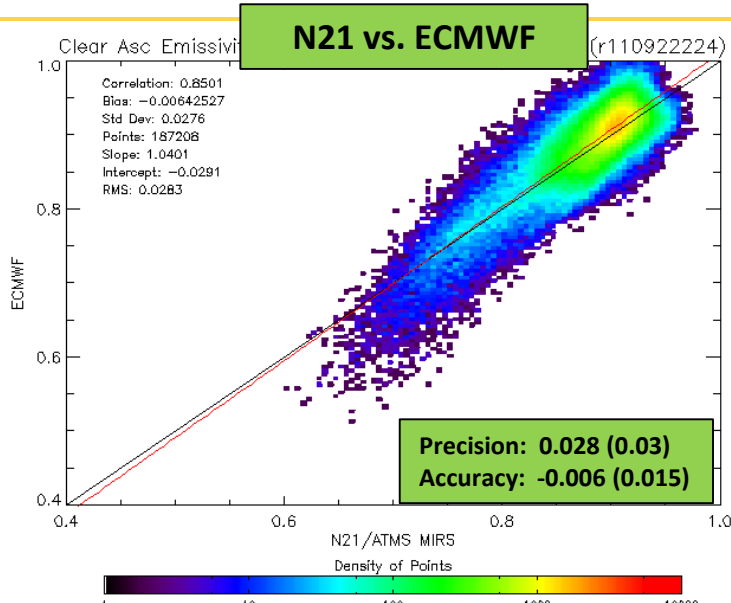
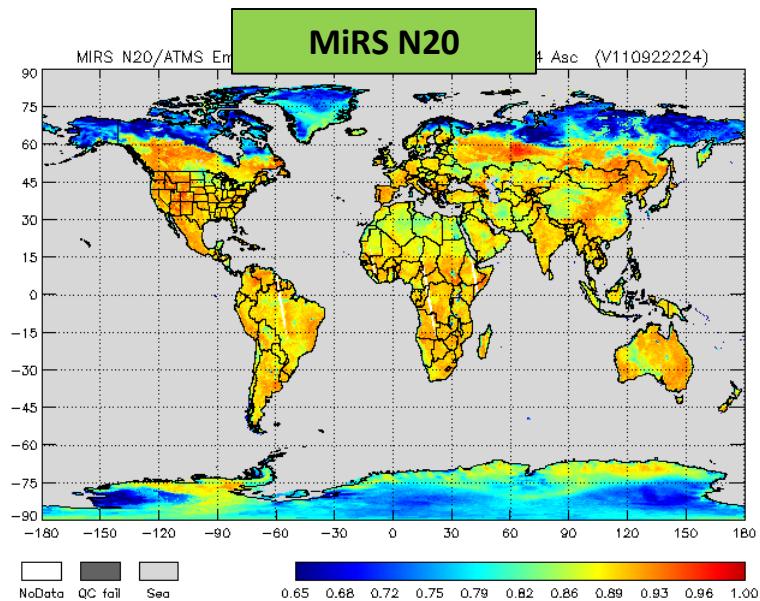
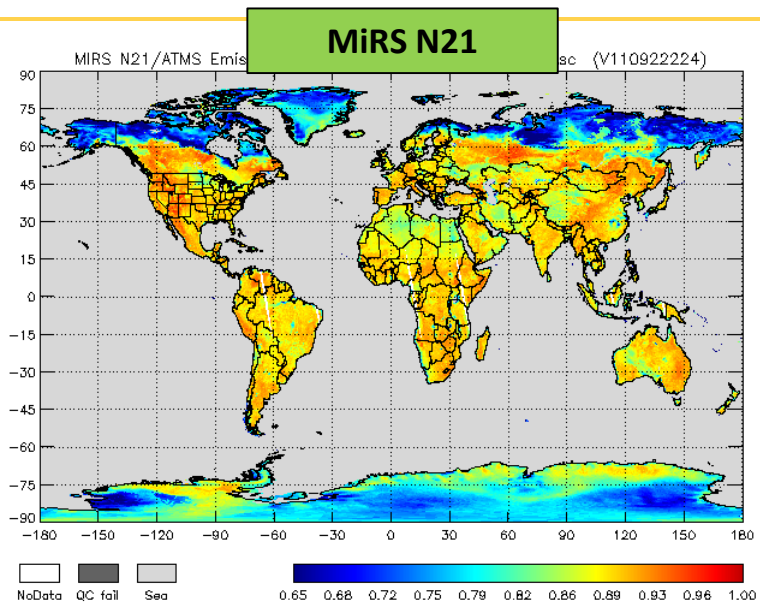
Asc



Des



Land Surface Emissivity (50 GHz)



2023-04-14

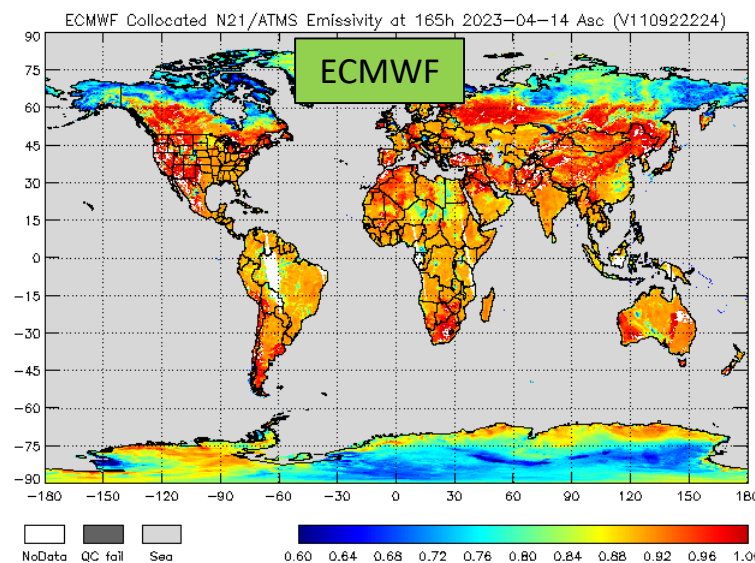
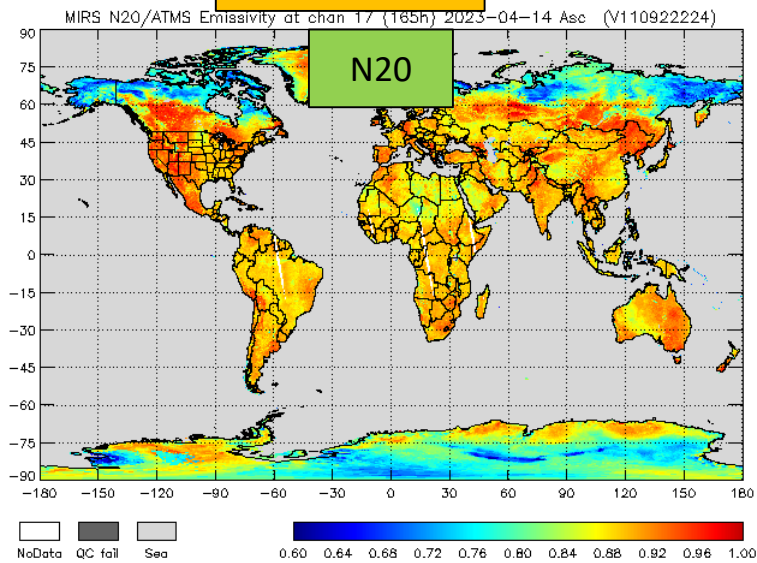
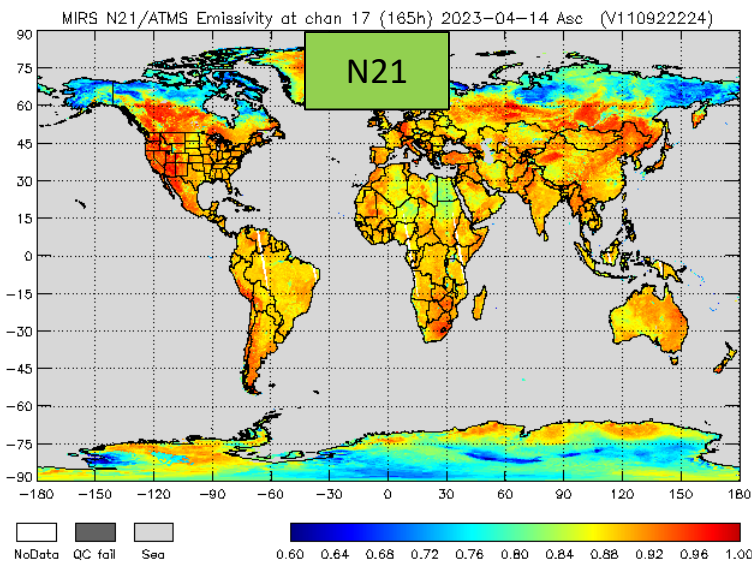
50 QH

Asc

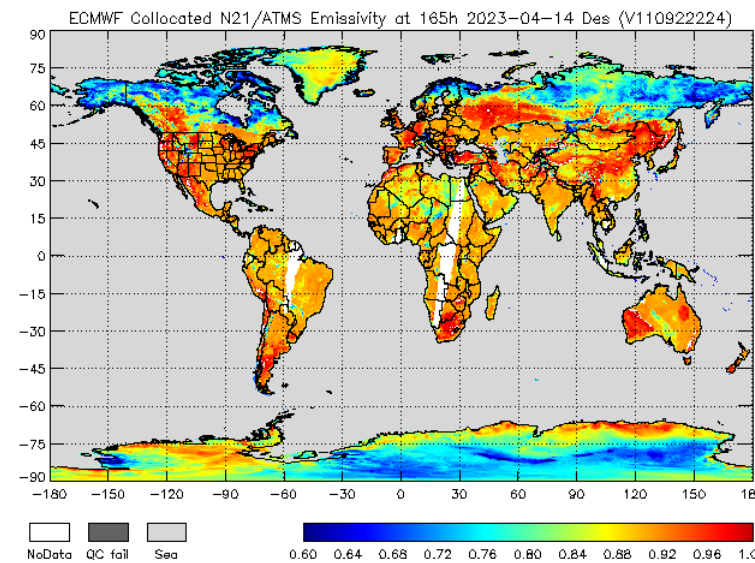
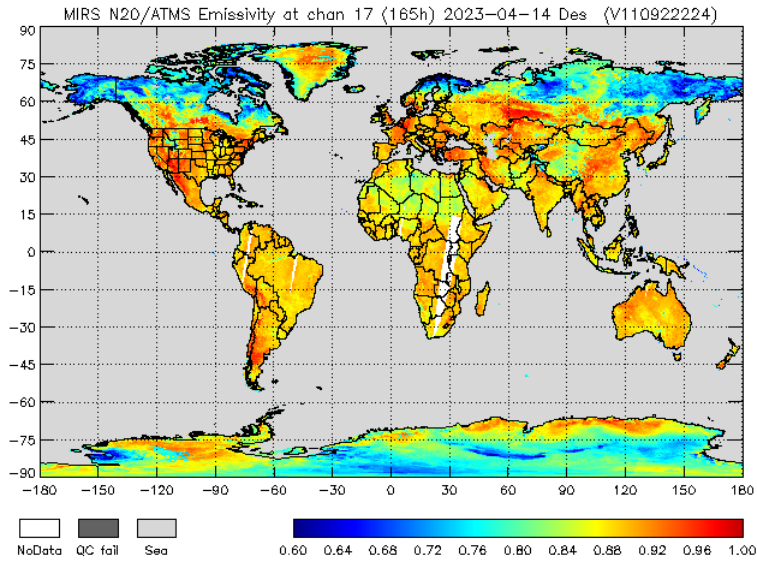
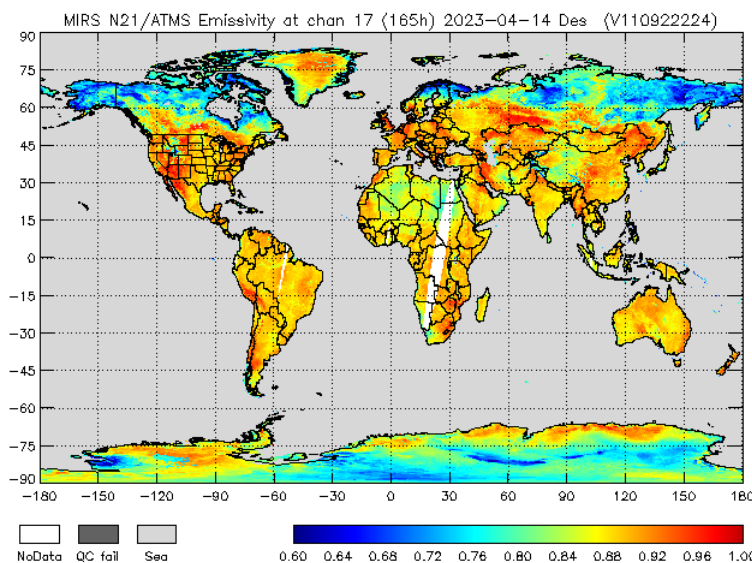
Land Surface Emissivity (165 GHz)

2023-04-14

Asc



Des

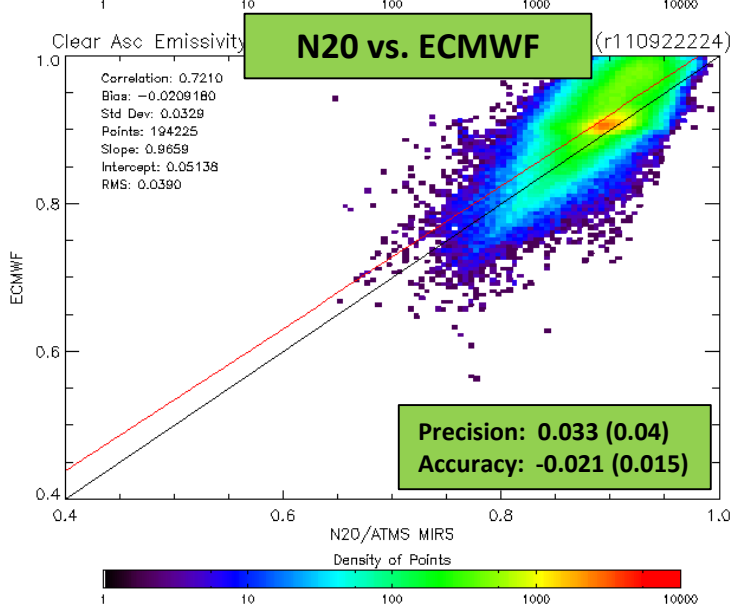
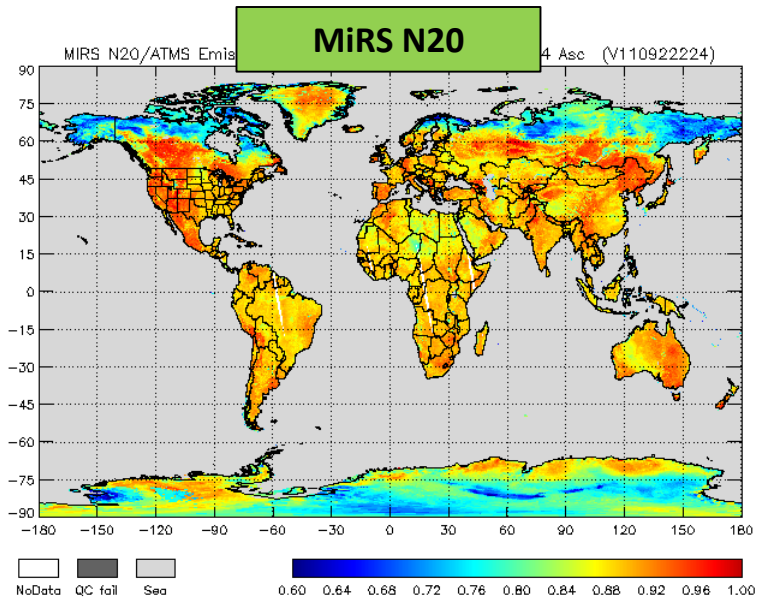
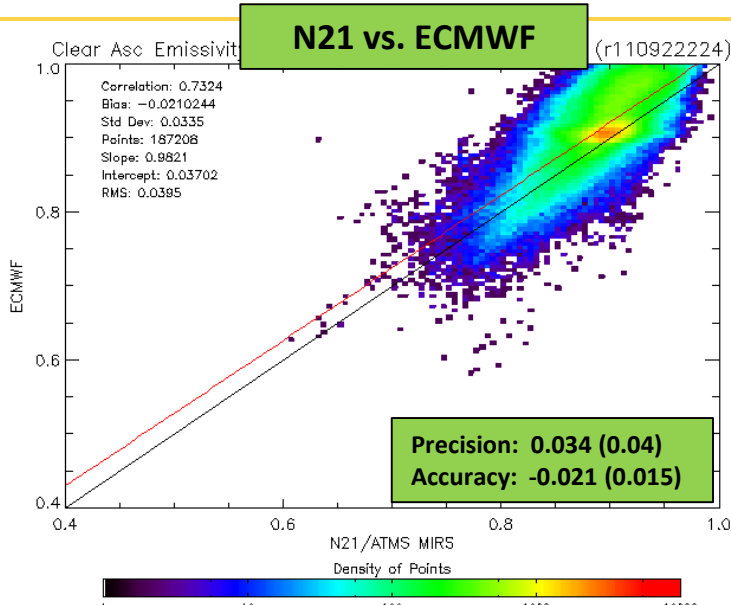
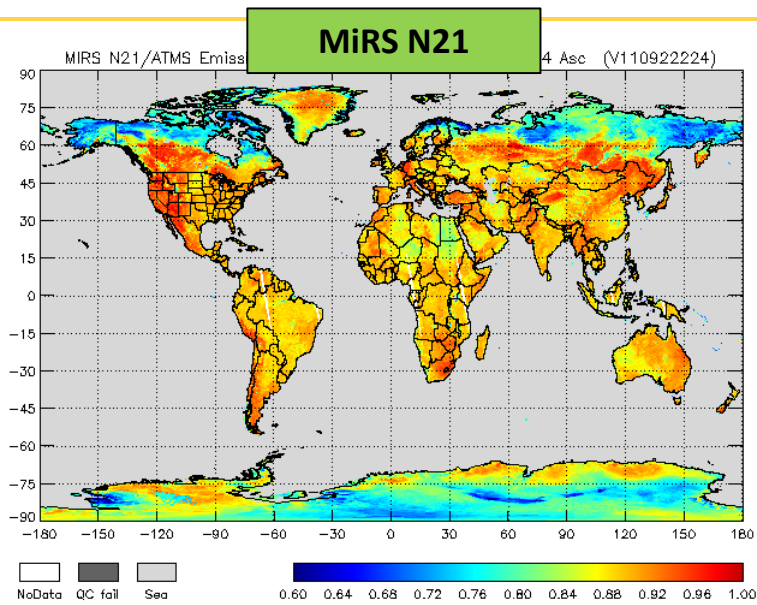


Land Surface Emissivity (165 GHz)

2023-04-14

165 QH

Asc



Sea Ice Concentration/Age

Total SIC

First-Year SIC

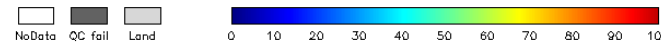
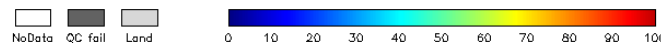
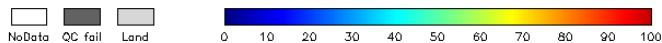
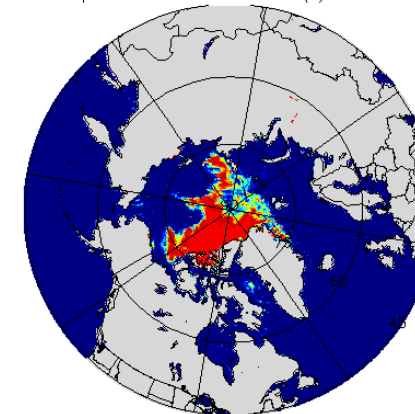
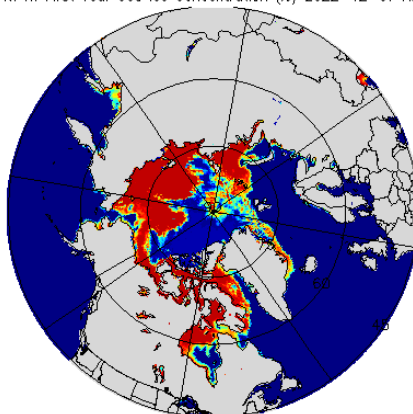
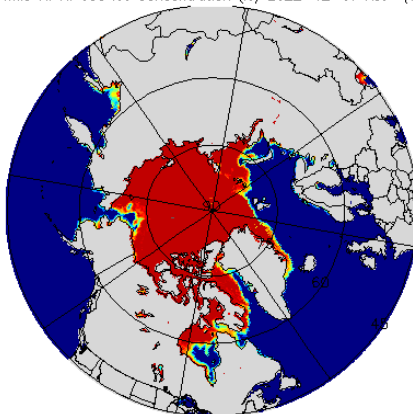
Multi-Year SIC

MIRS N21/ATMS N. H. Sea Ice Concentration (%) 2022-12-07 Asc (V110922224)

MIRS N21/ATMS N. H. First Year Sea Ice Concentration (%) 2022-12-07 Asc (V110922224)

MIRS N21/ATMS N. H. Multiple Year Sea Ice Concentration (%) 2022-12-07 Asc (V110922224)

N21



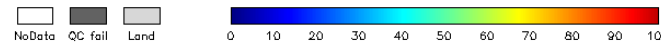
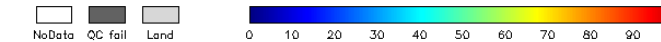
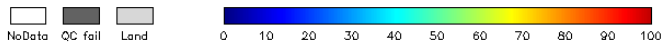
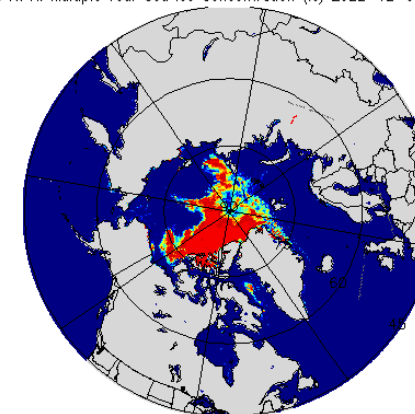
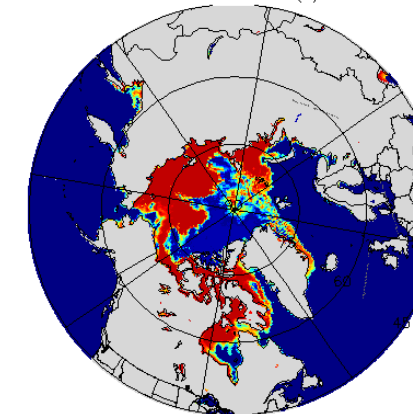
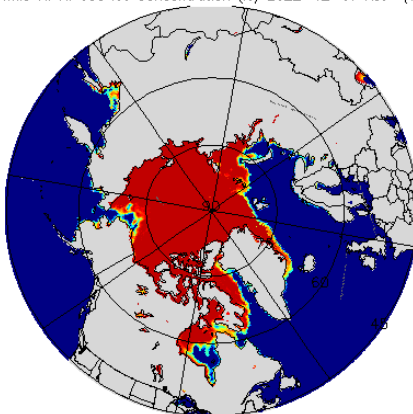
2022-12-07

MIRS N20/ATMS N. H. Sea Ice Concentration (%) 2022-12-07 Asc (V110922224)

MIRS N20/ATMS N. H. First Year Sea Ice Concentration (%) 2022-12-07 Asc (V110922224)

MIRS N20/ATMS N. H. Multiple Year Sea Ice Concentration (%) 2022-12-07 Asc (V110922224)

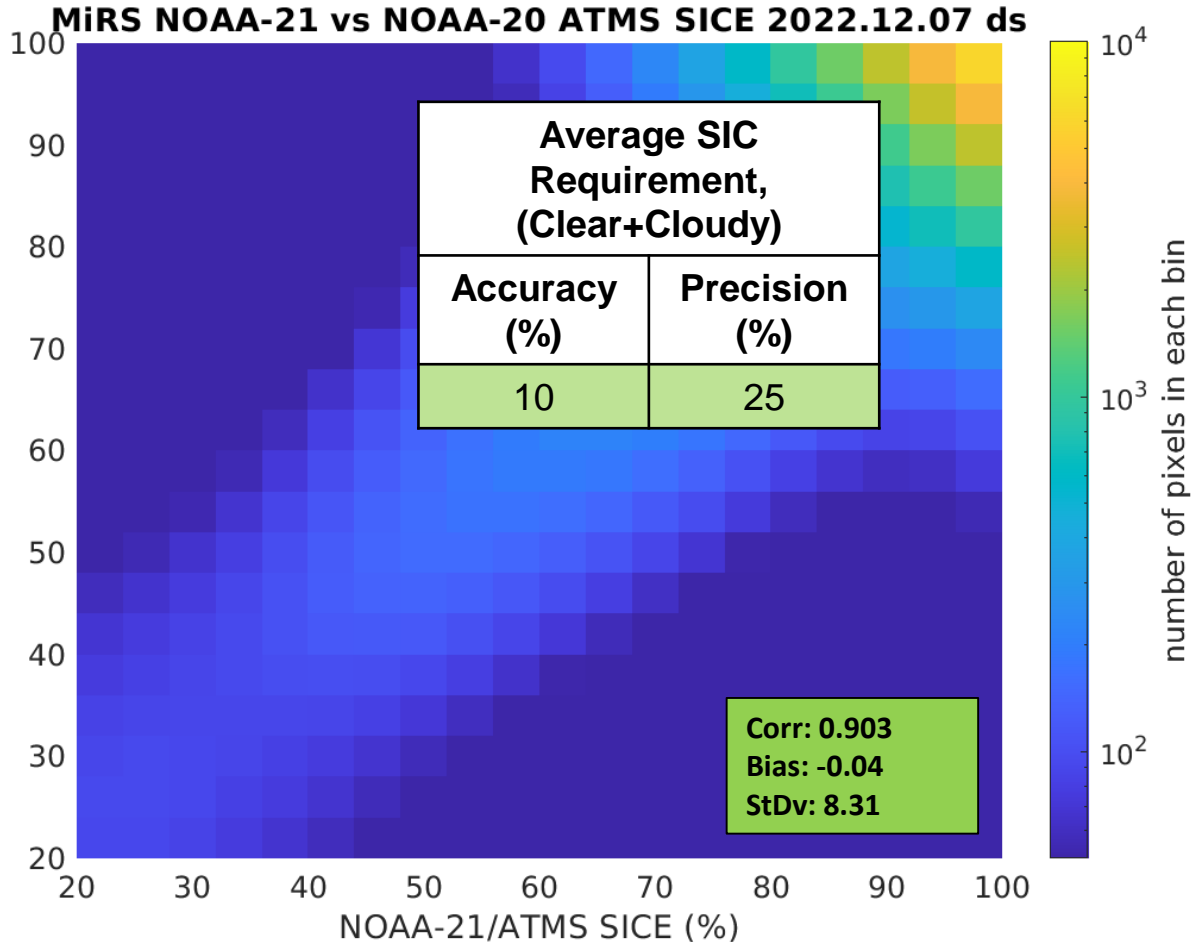
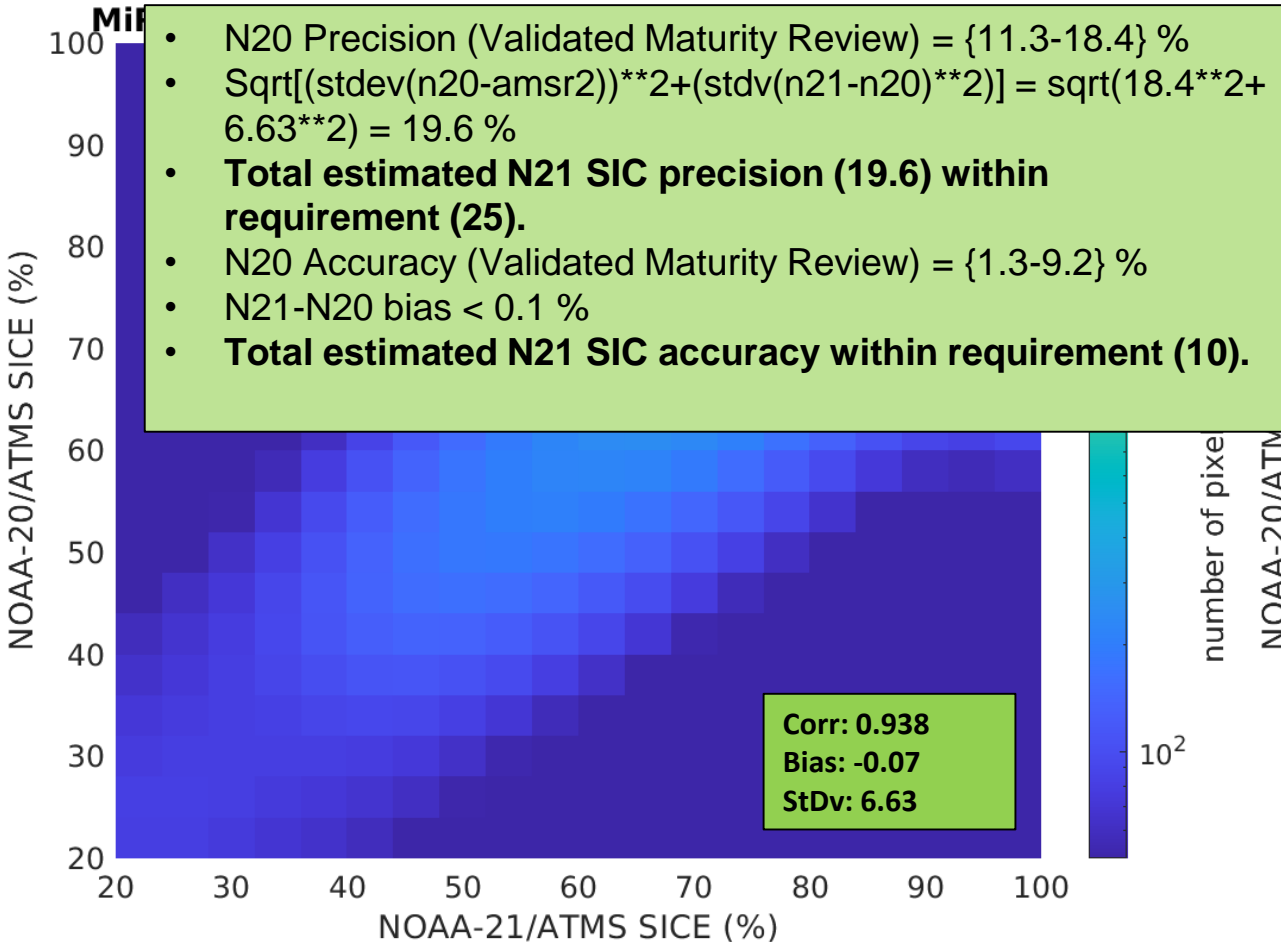
N20



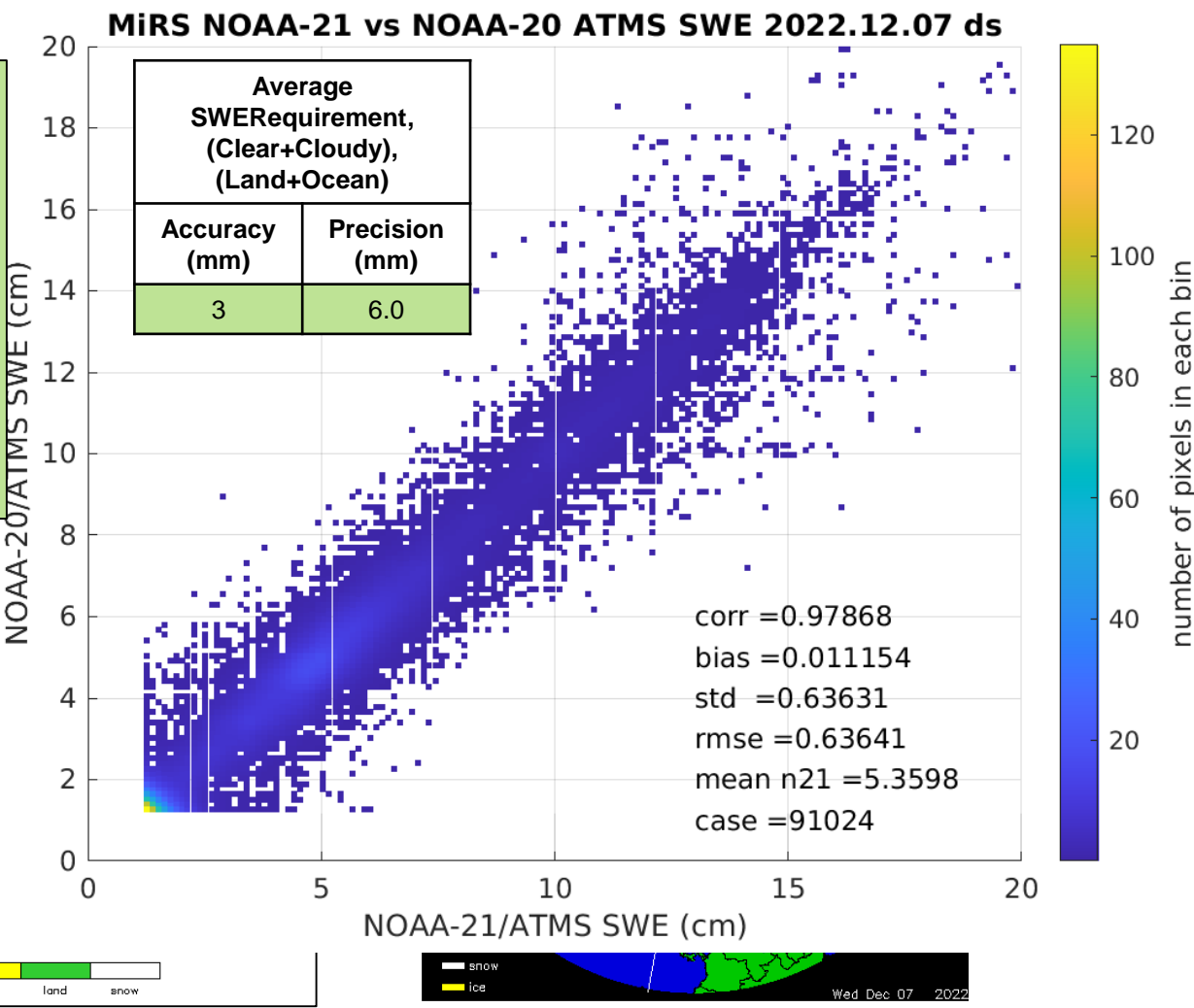
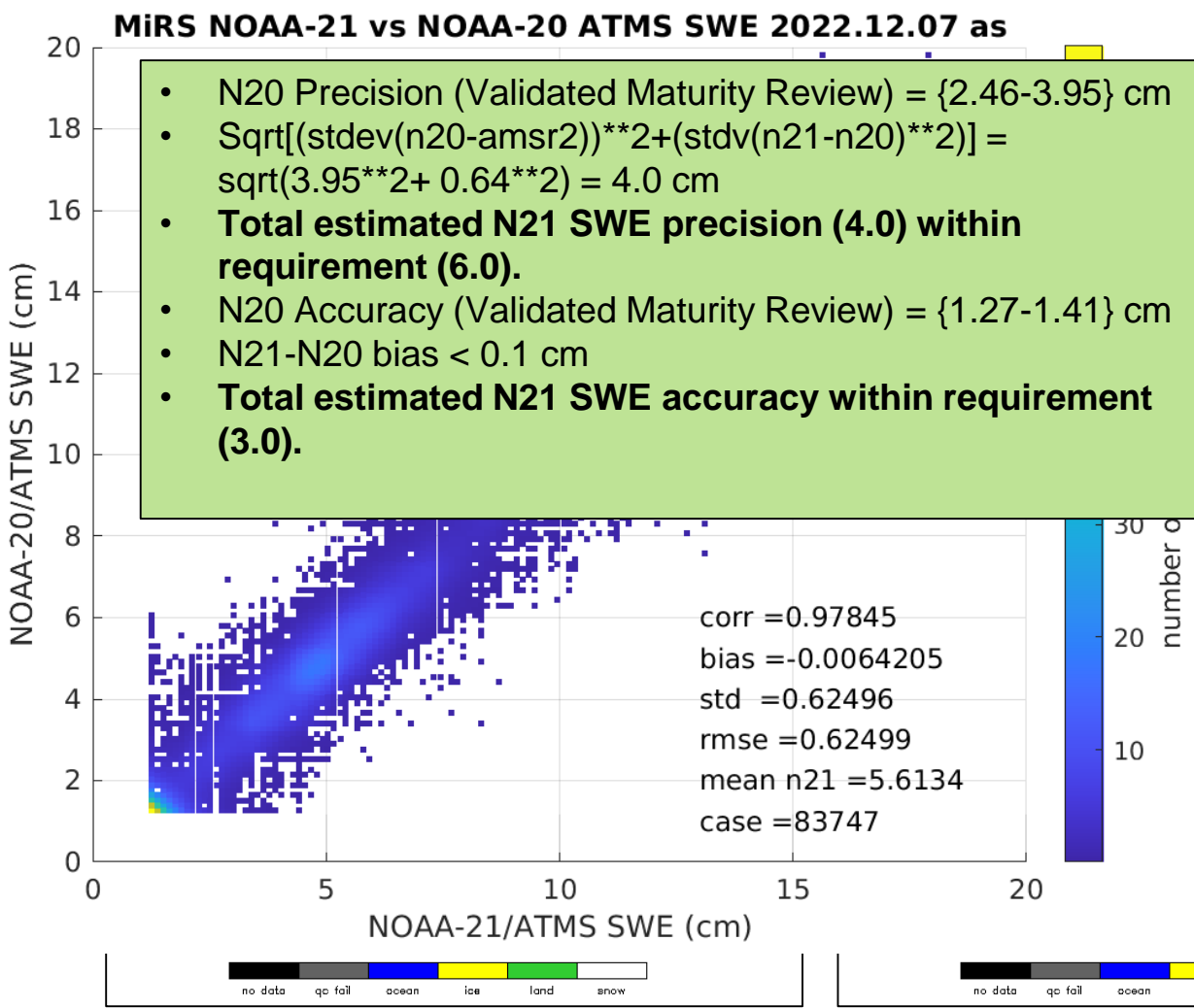
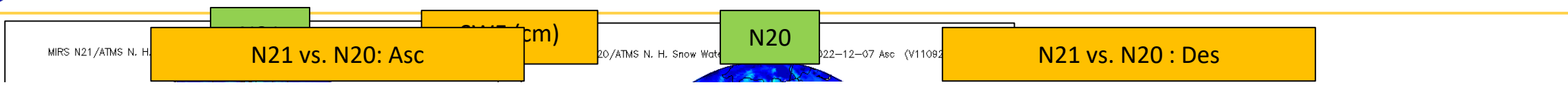
Sea Ice Concentration

N21 vs. N20: Asc

N21 vs. N20 : Des

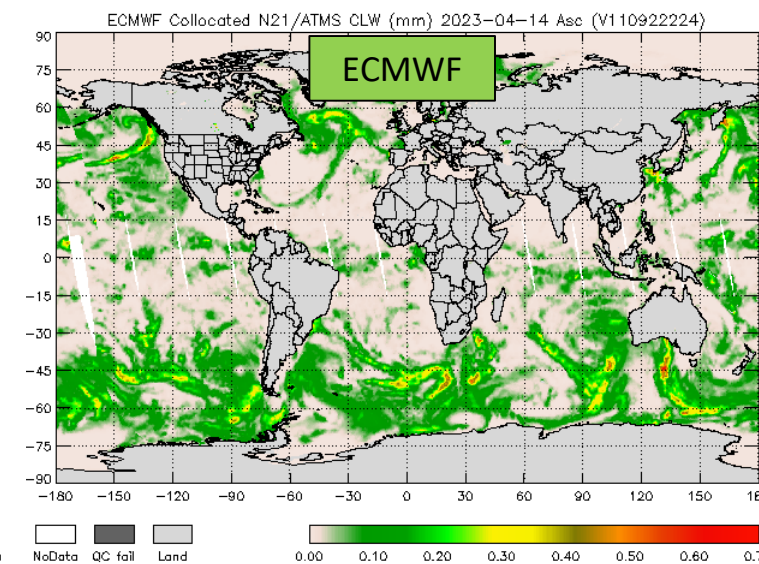
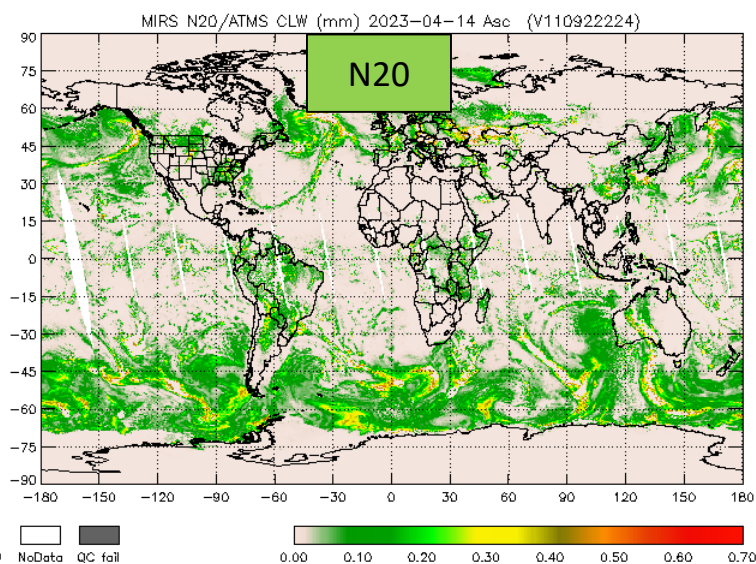
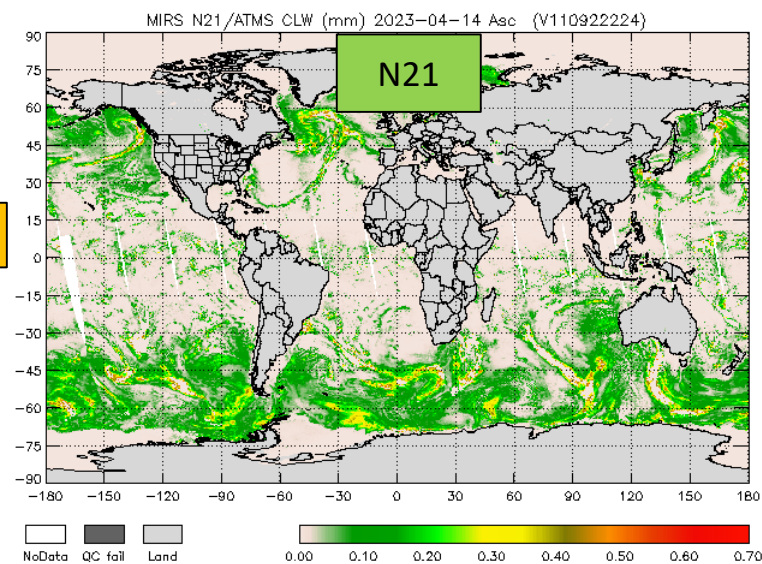


Snow Water Equivalent/Snow Cover

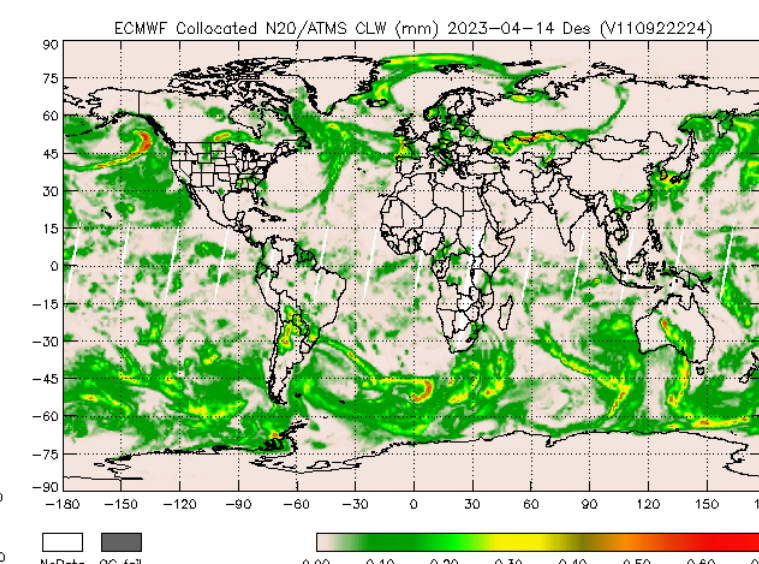
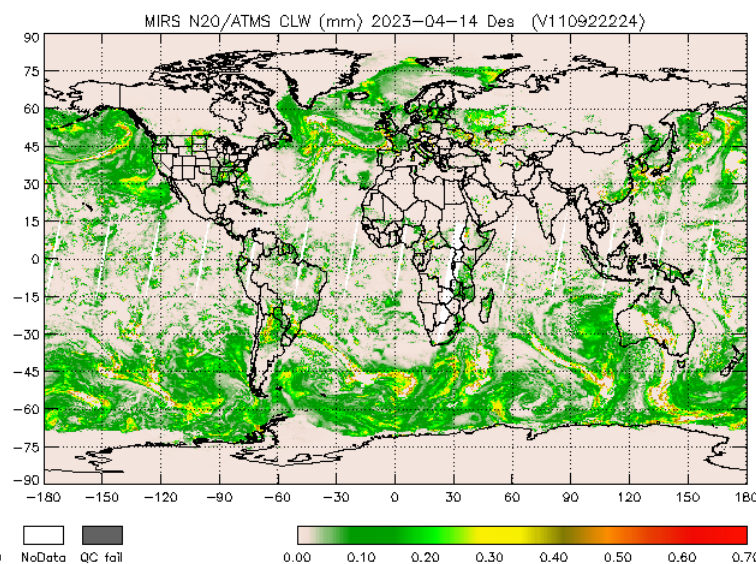
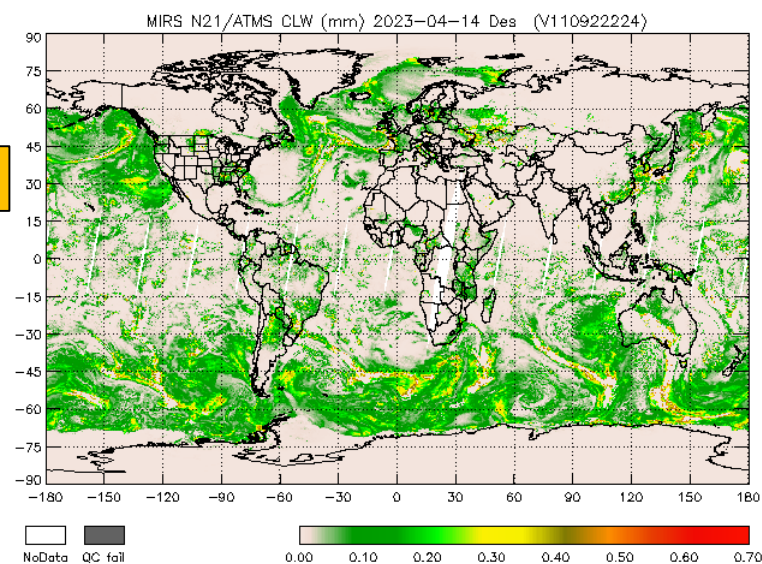


Cloud Liquid Water

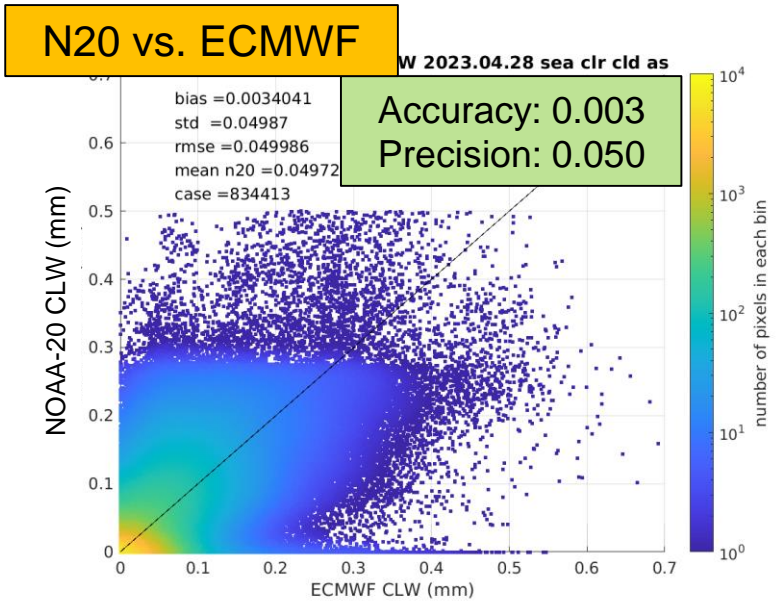
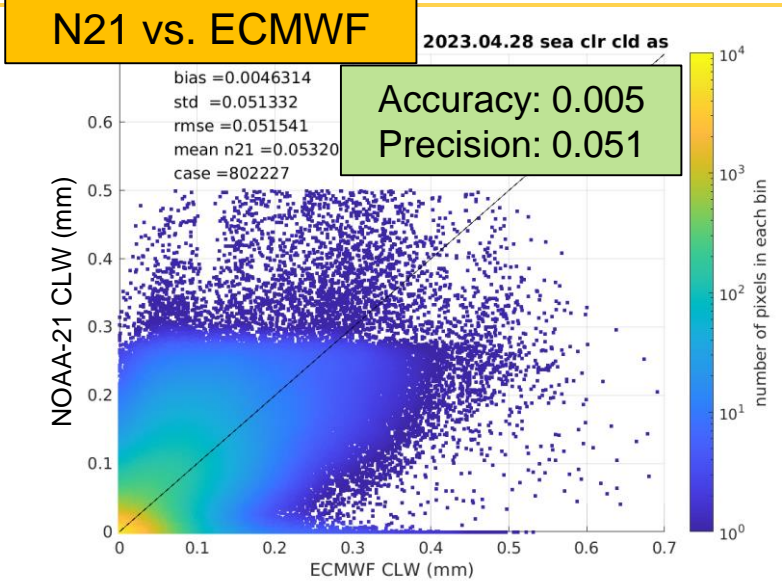
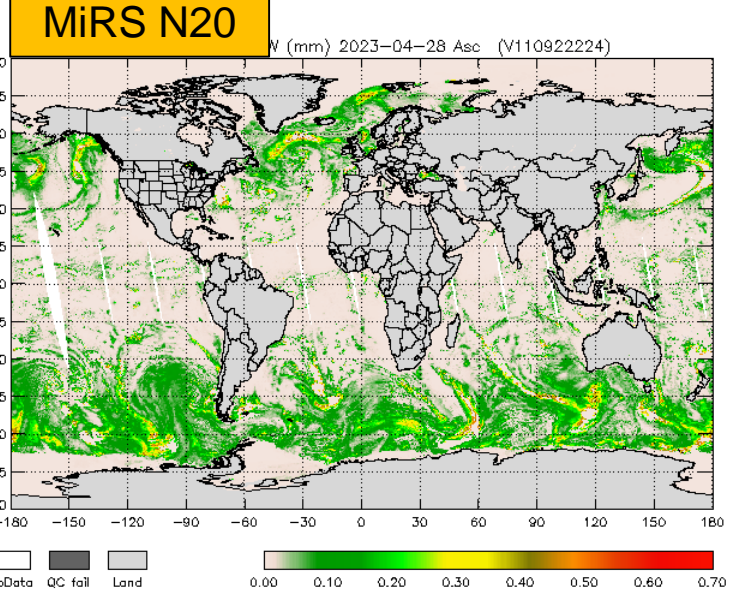
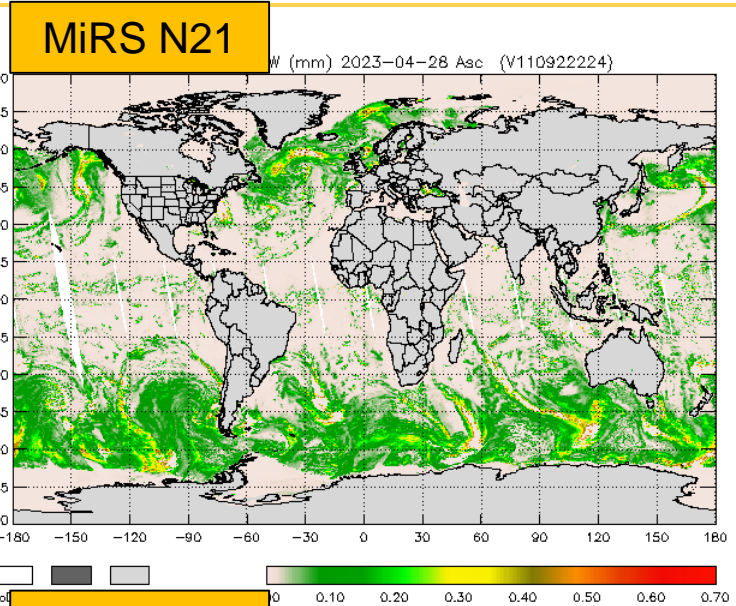
Asc



Des



Cloud Liquid Water



Requirements:
Accuracy: 0.03 mm
Precision: 0.08 mm



Documentation



Science Maturity Check List	Yes ?
ReadMe for Data Product Users	Yes
Algorithm Theoretical Basis Document (ATBD)	Yes
Algorithm Calibration/Validation Plan	Yes
(External/Internal) Users Manual	Yes
System Maintenance Manual (for ESPC products)	Yes
Peer Reviewed Publications (Demonstrates algorithm is independently reviewed)	Yes https://www.star.nesdis.noaa.gov/mirs/publications.php
Regular Validation Reports (at least annually) (Demonstrates long-term performance of the algorithm)	



ReadMe for Provisional Maturity (original as MS Word doc)



MEMORANDUM FOR: The JPSS Program Record

SUBMITTED BY: JPSS MiRS Team Lead, Quanhua (Mark) Liu

CONCURRED BY: JPSS Algorithm Management Project Lead Lihang Zhou

JPSS STAR Program Manager Ingrid Guch

APPROVED BY: JPSS Program Scientist Satya Kalluri

SUBJECT: NOAA-21 MiRS Provisional maturity status

DATE: 06/22/2023

Provisional maturity status declaration for MiRS EDR Products

Maturity Review Date: 06/22/2023

Effective Date: 05/12/2023

Operational System: MiRS, Version 11.9

1. Maturity stage definition (reference to the AMM webpage for maturity definition: <http://www.star.nesdis.noaa.gov/jpss/AlgorithmMaturity.php>)

2. Algorithm Description:

List of Products (Collection Short Name (CSN)): NDE_L2_MIRS

Product requirements/Exclusions (DPS): See artifact at TBD

Quality flags (Table): See artifact at TBD

Product evaluation/validation: See artifact at TBD

Product availability/reliability:

N21 EDR data have been produced with V11.9 since 11/2022, qualitative comparisons of all EDR products with N20 products show extremely good agreement.

Limited quantitative comparisons of all EDR products with independent references also show very good agreement.

Algorithm performance dependence: None

Known errors/issues/limitations: SWE daytime estimates have higher uncertainty than nighttime estimates. Sea ice concentration estimates have higher uncertainty in each hemisphere's summer season.

3. Changes since last maturity stage: Additional quantitative validation of RR, LSE, CLW; all products now have some quantitative validation

4. Review board recommendations: TBD

5. Path Forward/Future Plan: Continue qualitative and quantitative validation using independent references for all EDR products either locally, or in some cases, globally.

6. Additional Items to note

Additional information is available in the MiRS algorithm theoretical basis document (ATBD) and validation maturity review briefing, which can be accessed at:

<http://www.star.nesdis.noaa.gov/jpss/Docs.php>

Point of Contact:

Name: Quanhua (Mark) Liu

Email: quanhua.liu@noaa.gov

Phone: 301-683-3661

Summary/Path Forward

- All 10 official products validated either by direct comparison to ECMWF, ground based radar/gauges and/or qualitative and direct N21 vs. N20 comparisons. Most validation global.
- Initial results show very good performance and high agreement with N20 products, **consistent with Provisional Maturity. All products meeting requirements.** Criteria (slide 4) below:
 - *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: e.g. Slides 12-34*
 - *Product analyses are sufficient for qualitative, and limited quantitative, determination of product fitness-for-purpose: e.g. Slides 12-34*
 - *Documentation of product performance, testing involving product fixes, identified product performance anomalies, including recommended remediation strategies, exists: **No significant anomalies found***
 - *Product is recommended for potential operational use (user decision) and in scientific publications after consulting product status documents*
- Path forward:
 - Continue daily processing of NOAA-21.
 - Continue validation using additional independent references. E.g. radiosondes (T, WV, TPW), SURFRAD (LST), N21/VIIRS LSR (LSE), AMSR2 (SIC, SWE/SCE, CLW), IMS (SIC, SWE), Stage IV, MRMS (RR)
 - Eventually regenerate/evaluate NOAA-21 radiometric bias corrections (normally after one annual cycle).