NOAA-20 and SNPP ATMS Retrievals and Applications from the Microwave Integrated Retrieval System (MiRS)

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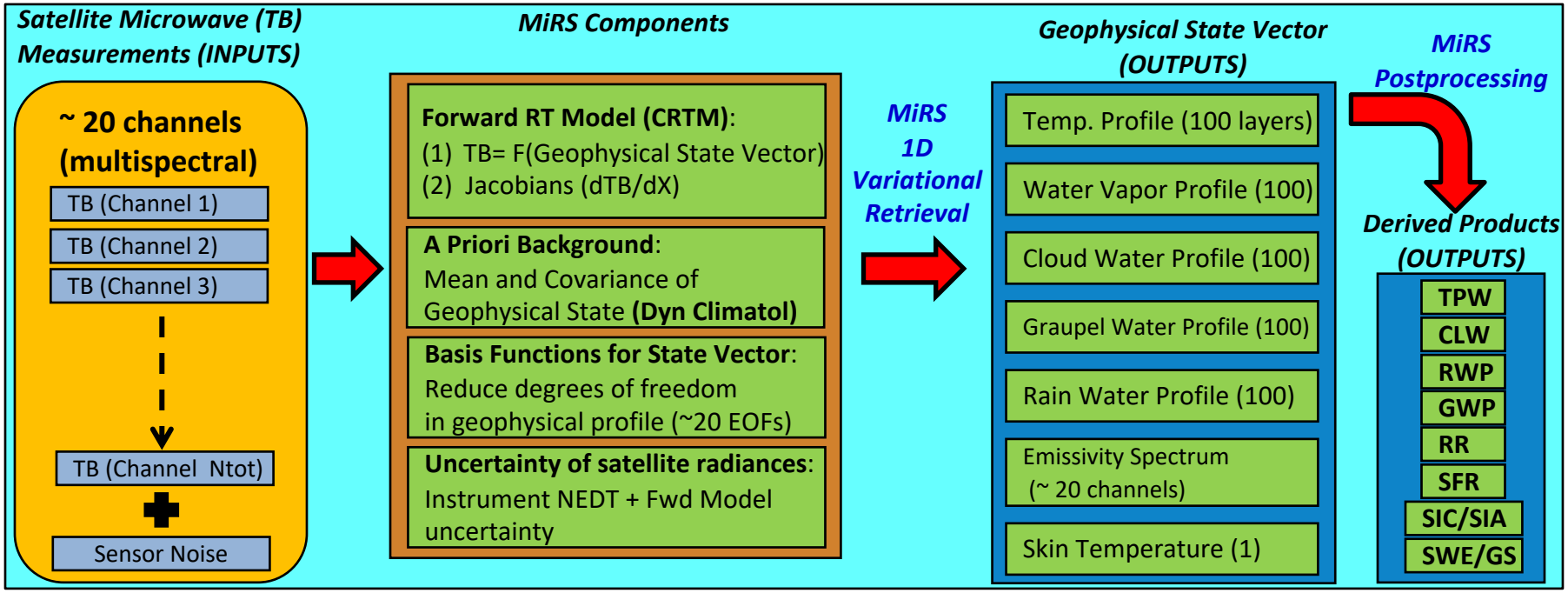
MiRS N20/ATMS Validation/Delivery Status

- **JPSS-1 Launch**: 18 Nov 2017, 0147 PT
- **Beta Maturity** since 29 Nov 2017 (L+11 days)
- **Provisional Maturity** declared on 29 March 2018
- **V11.3 preliminary algorithm package delivered to NDE/OSPO on 8 June**
  - Operational in Fall 2018
- **Also delivered to CSPP/DB in July (CSPP_MIRS 2.1)**
  - Officially released on 10 Sept
- Additional validation ongoing, e.g. RR, cryosphere, T and WV vs. raobs, LST, and LSE, etc.
- **An updated algorithm package will be delivered in early 2019**

MiRS Version 11.3 Changes

- Extension to NOAA-20/ATMS
- Addition of snowfall rate (SFR) to SNPP and N20 (not fully validated); SFR already implemented for AMSU-MHS
- Implementation of forest fraction emissivity correction in SWE algorithm for ATMS and AMSU-MHS (improved estimation in forested regions, e.g. eastern CONUS)
- Incorporation of cloud liquid water over land in RR algorithm for all satellites (improved detection/estimation of light rain)
- Miscellaneous fixes, changes to nc metadata,…

Algorithm Overview

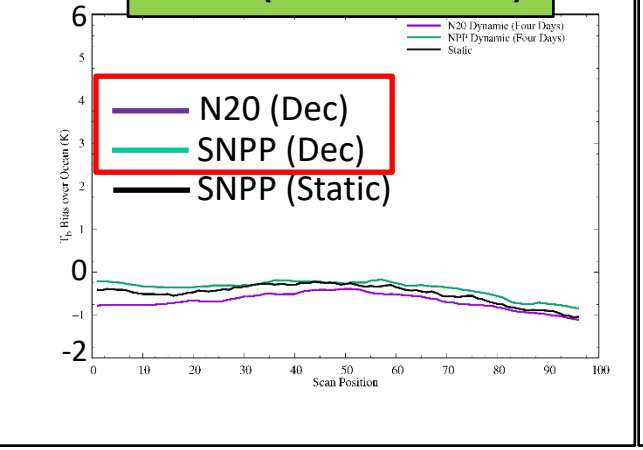


- MW Only, Variational Approach: Find the "most likely" atm/sfc state that: (1) best matches the satellite measurements, and (2) is still close to an a priori estimate of the atm/sfc conditions.
- **"Enterprise" Algorithm: Same core software runs on all satellites/sensors; facilitates science improvements and extension to new sensors.**
- Initial capability delivered in 2007. Running v11.2 since Jan 2017 on SNPP/ATMS, N18, N19, MetopA, MetopB, F17, F18, GPM/GMI, Megha-Tropiques/SAPHIR. (eventually MetopC…)
- Delivery of v11.3 (extended to NOAA-20/ATMS) to operations on **8 June**.
- External Users/Applications: TC Analysis/Forecasting at NHC, Blended Total/Layer PW Animations at NHC and WPC Animations (CSU/CIRA, U. Wisconsin/CIMSS), CSPP Direct Broadcast (U. Wisconsin), NFLUX model (NRL, Stennis), Global blended precipitation analysis at NOAA/CPC (CMORPH),…
- **All N20 results here are generated with MiRS v11.3 (offline processing in STAR), and TDR data generated in IDPS (Block 2 processing).**

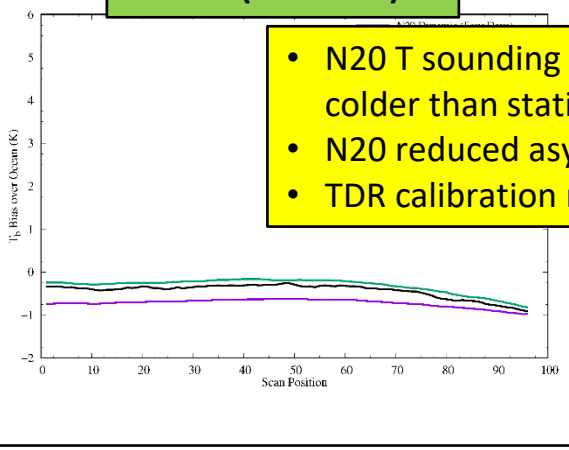
Radiometric Biases (Observed TDR-Simulated)

- N20 and NPP Biases based on 4 days: Dec 10, 13, 16, 18
- Static Bias (oper) based on 4 days NPP 2015 Block 2 calibrated data
- ECMWF + CRTM, clear ocean

Chan 6 (53.6 ± 0.12 GHz)

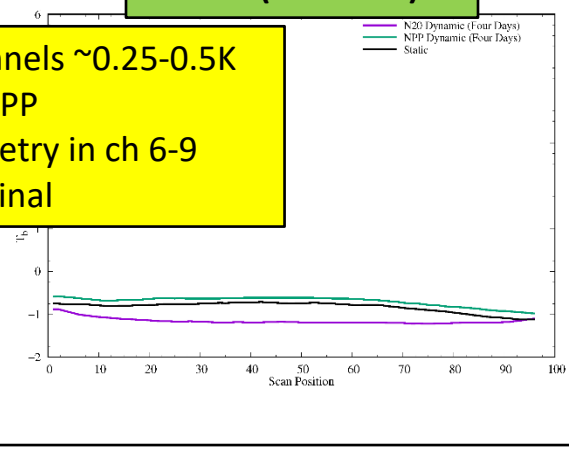


Chan 7 (54.4 GHz)

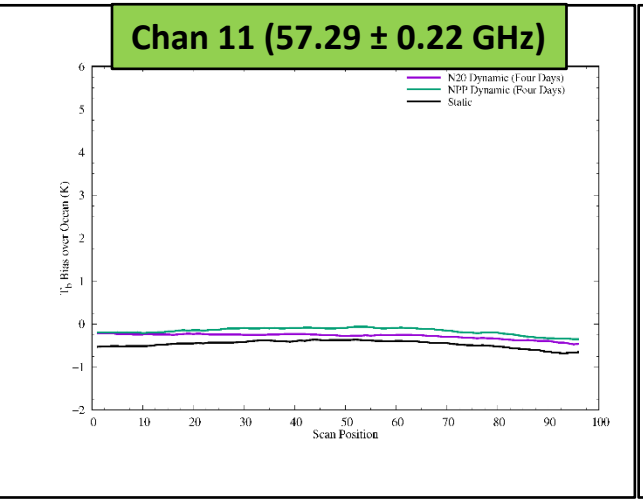


- N20 T sounding channels ~0.25-0.5K colder than static SNPP
- N20 reduced asymmetry in ch 6-9
- TDR calibration not final

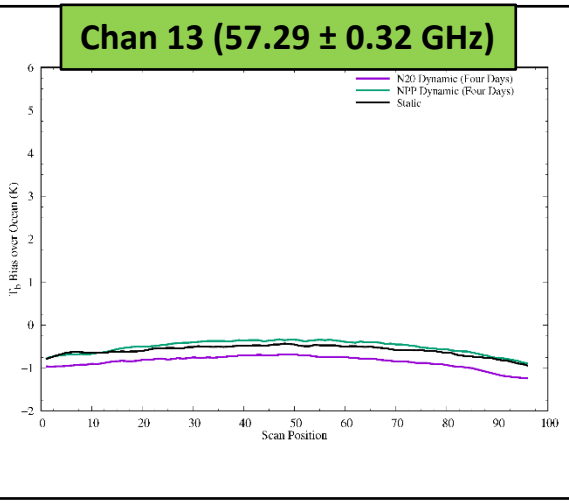
Chan 9 (55.5 GHz)



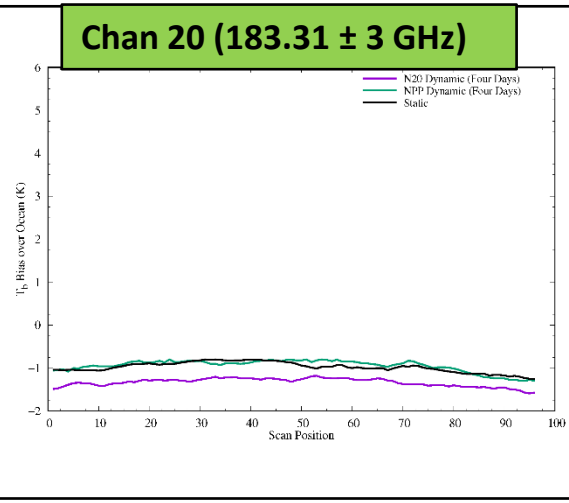
Chan 11 (57.29 ± 0.22 GHz)



Chan 13 (57.29 ± 0.32 GHz)

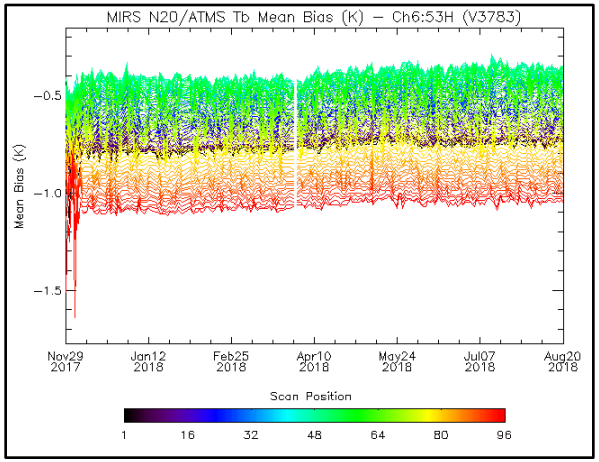


Chan 20 (183.31 ± 3 GHz)

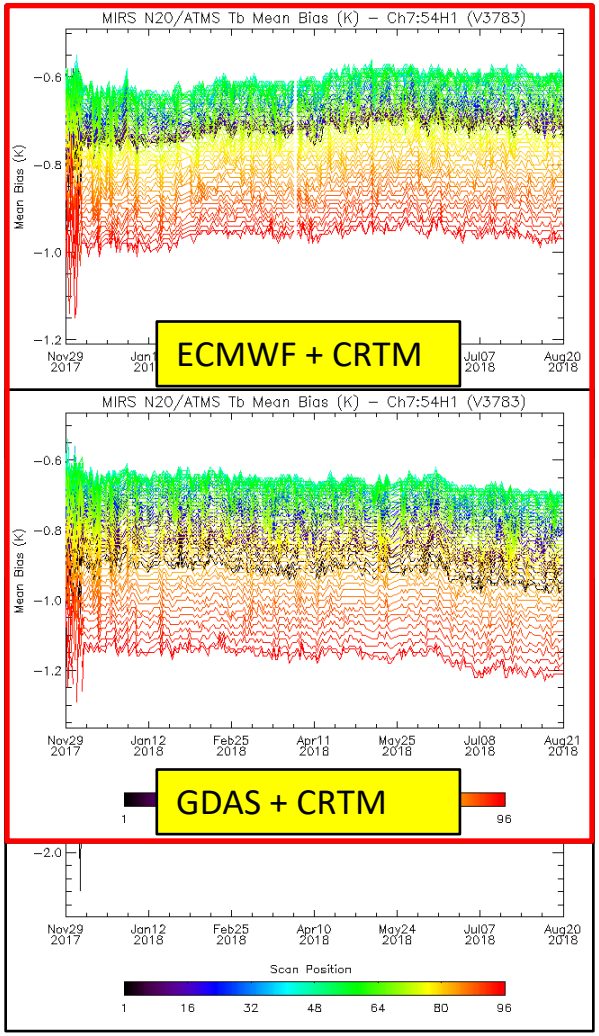


Radiometric Biases: Time Series
TDR Obs-Sim (29 Nov – 20 Aug)

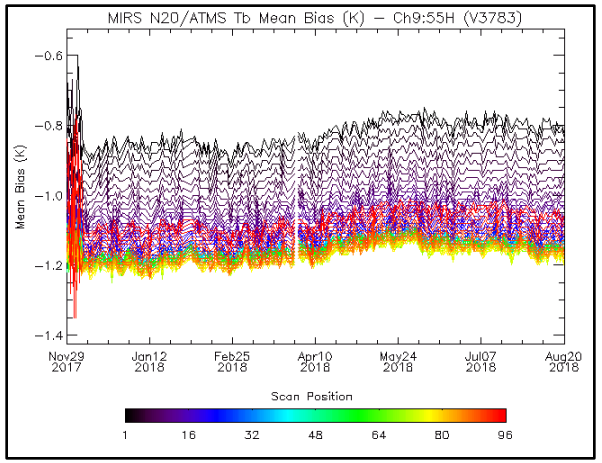
Chan 6 (53.6 ± 0.12 GHz)



Chan 7 (54.4 GHz)



Chan 9 (55.5 GHz)



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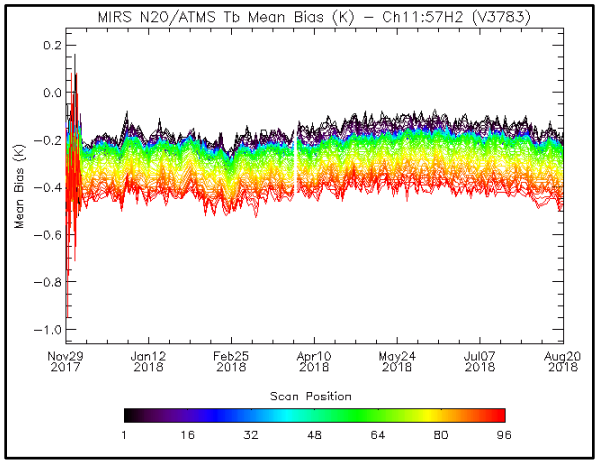

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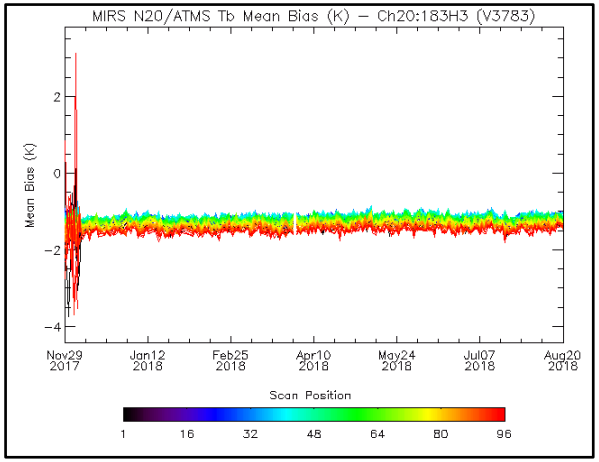
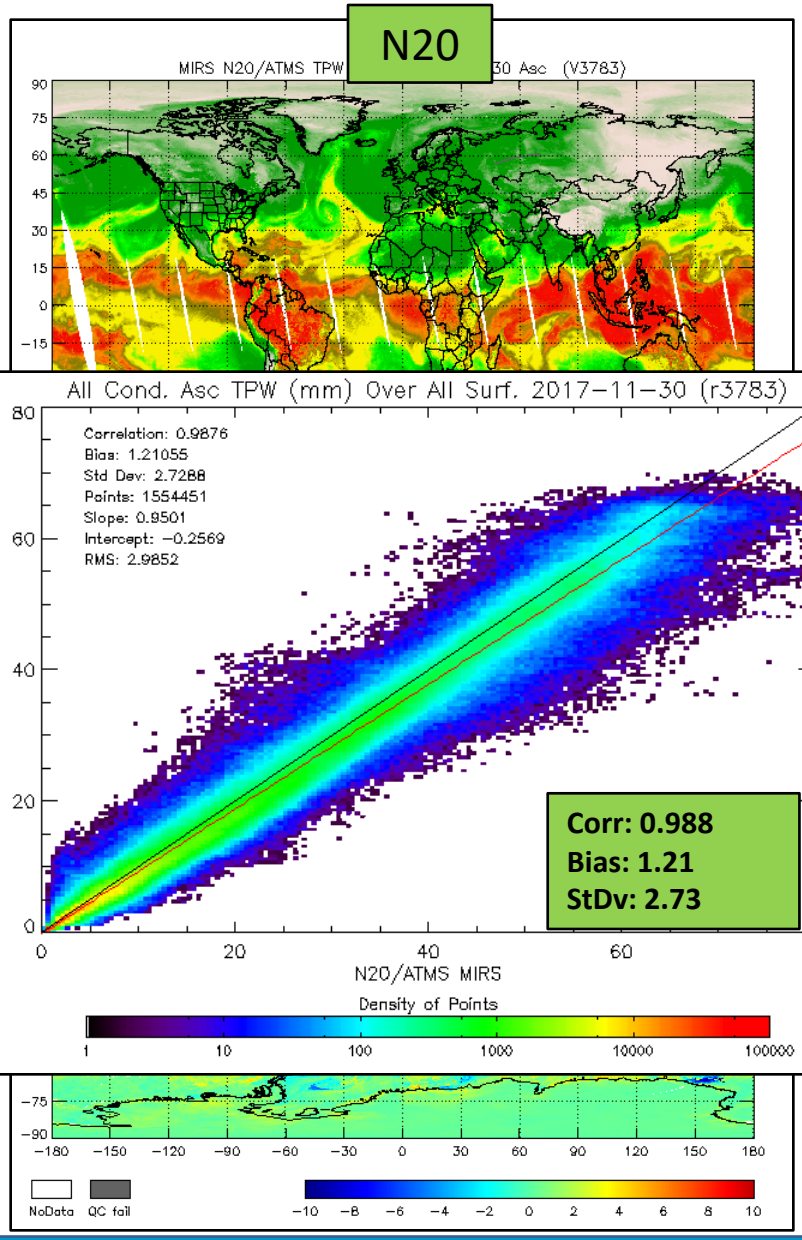


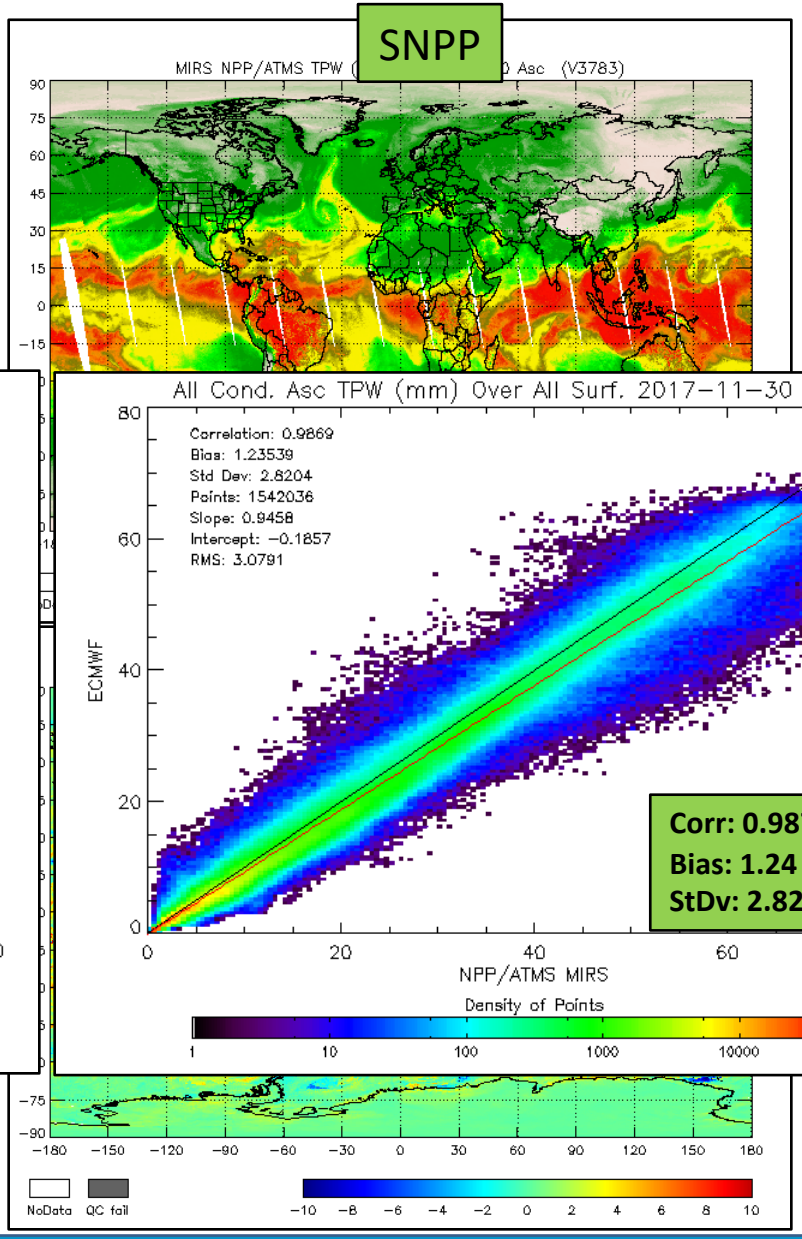
- Simulated TBs: ECMWF + CRTM (v2.1.1), clear ocean

Total Precipitable Water (2017-11-30)

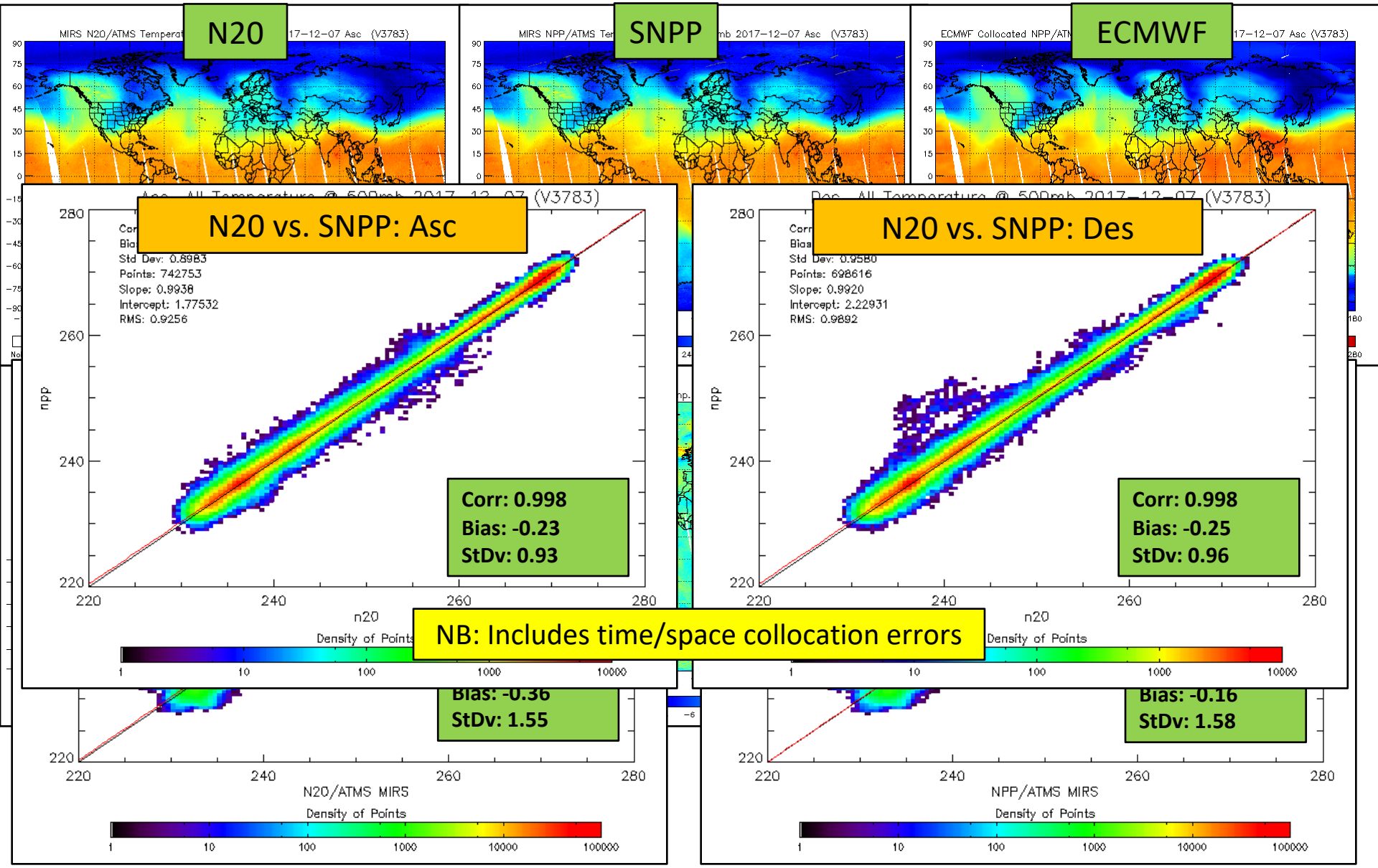
N20



SNPP



500 hPaTemperature (2017-12-07)



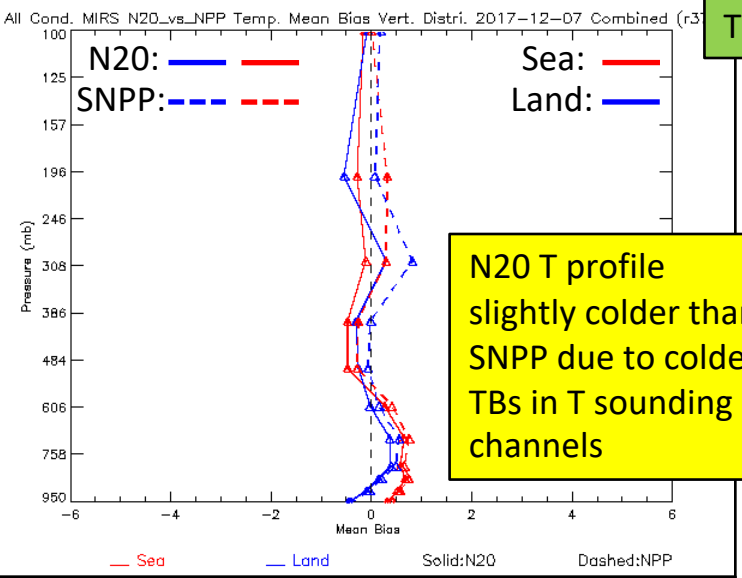
Temperature and Water Vapor Profile (2017-12-07)

Global collocation w/ECMWF

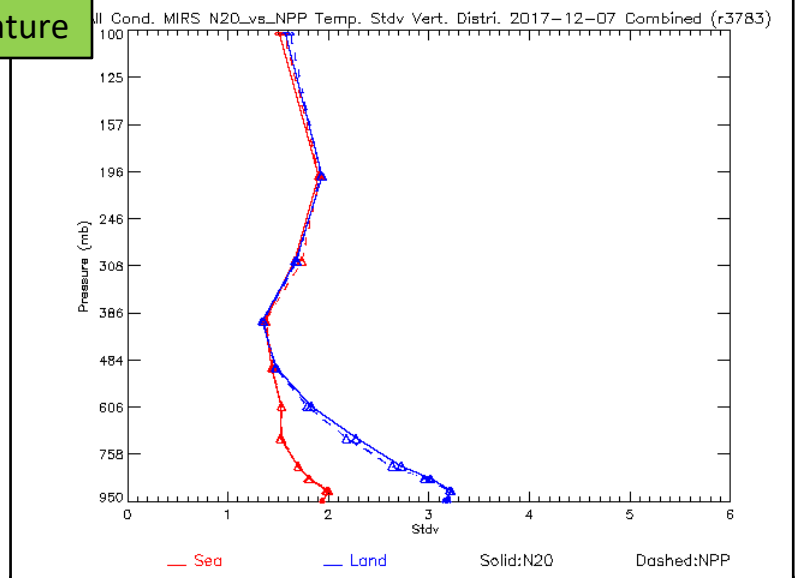
Bias

StDv

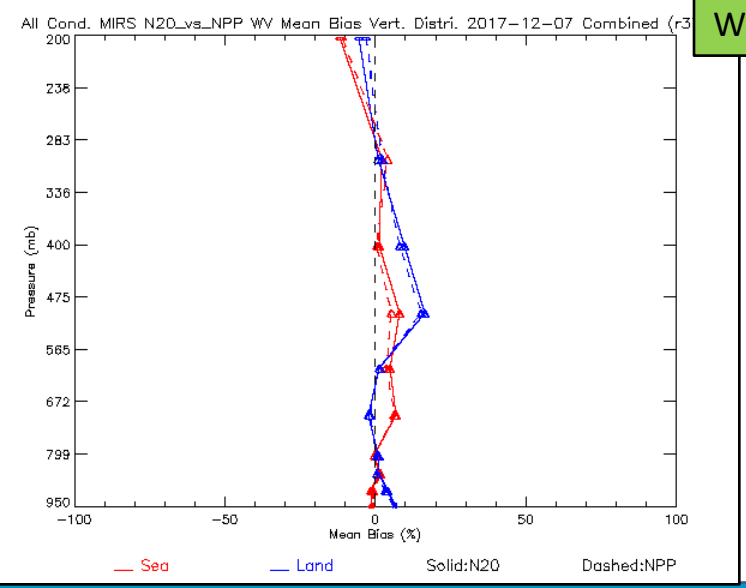
Temperature

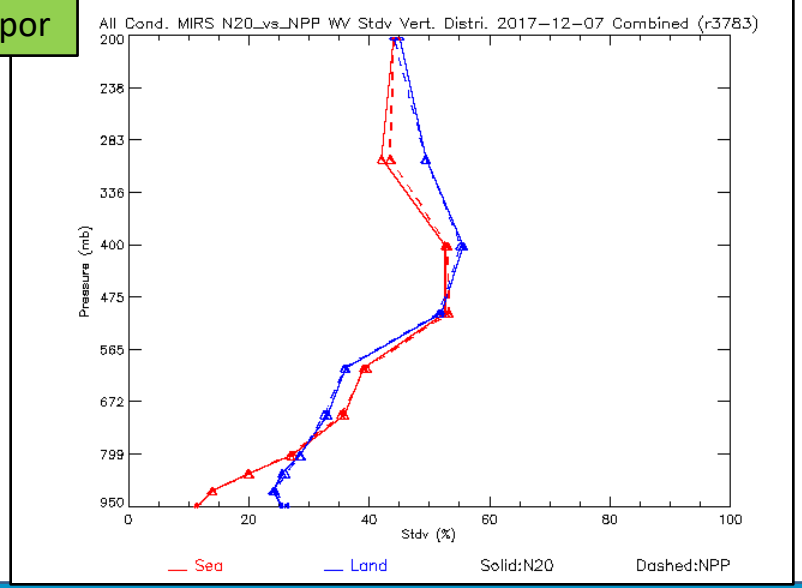


N20 T profile slightly colder than SNPP due to colder TBs in T sounding channels



Water Vapor

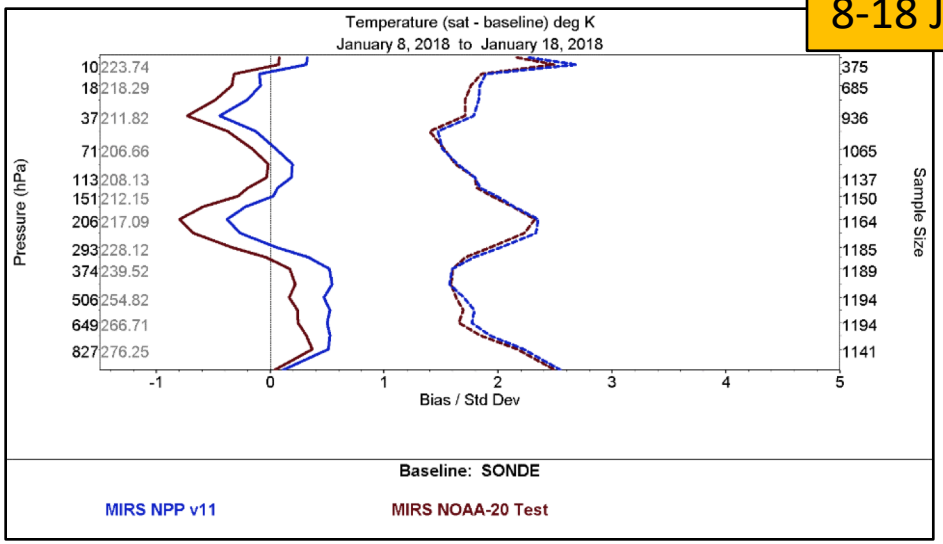


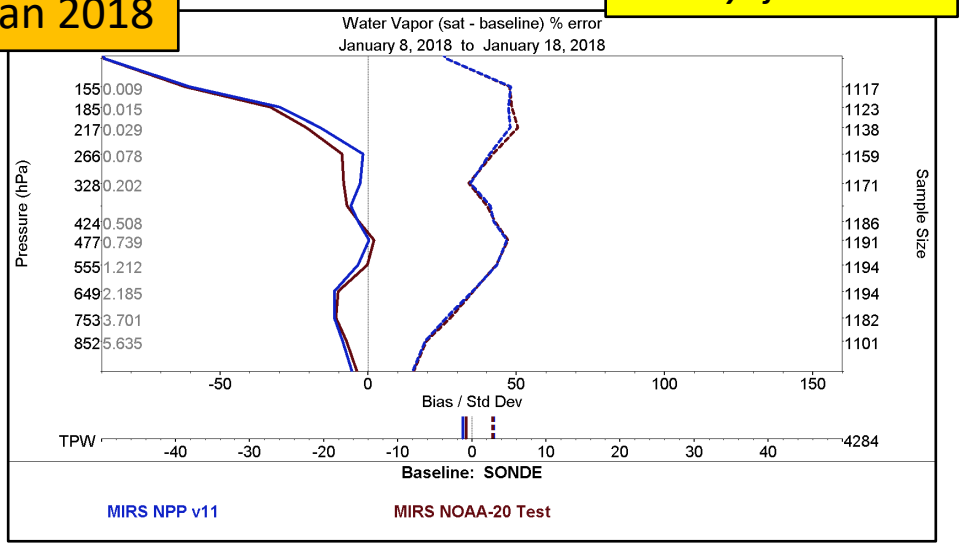


Temperature and WV Bias and Std Dev: Global (Land+Ocean) Comparison with Raobs

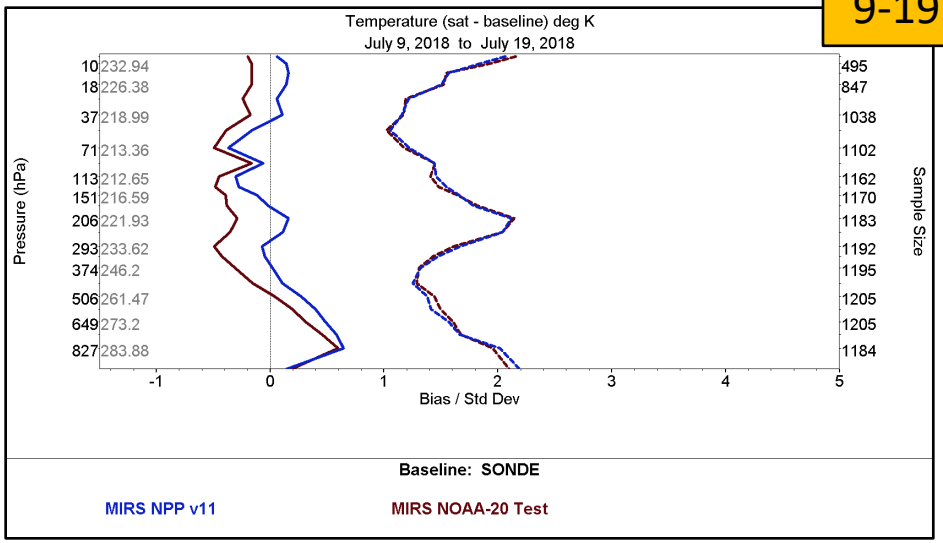
Courtesy of Bomin Sun

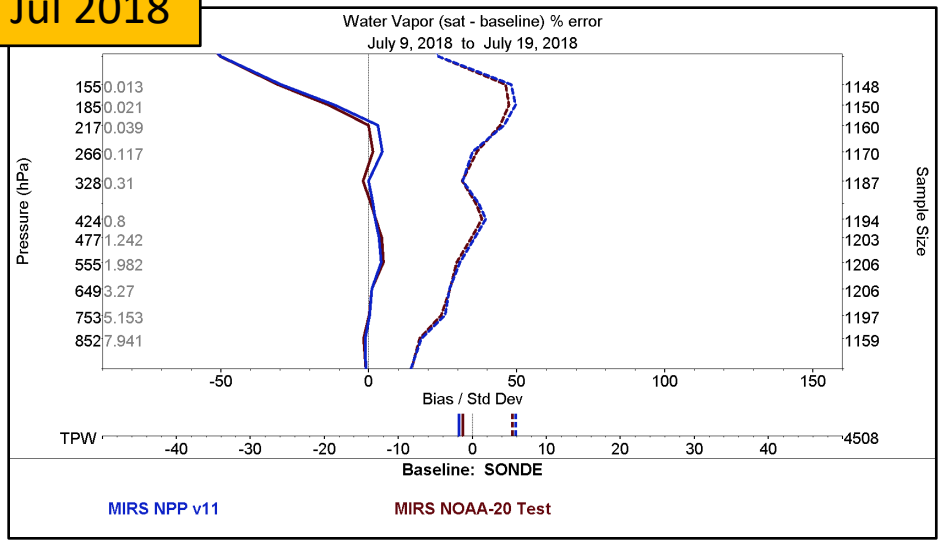
8-18 Jan 2018





9-19 Jul 2018





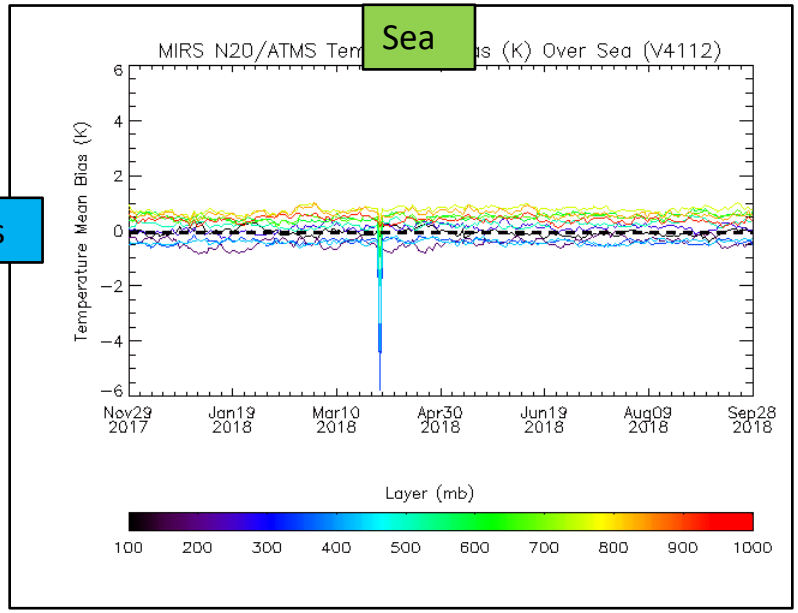
N20/ATMS Temperature Bias and Std Dev: Time Series (29 Nov – 28 Sep)

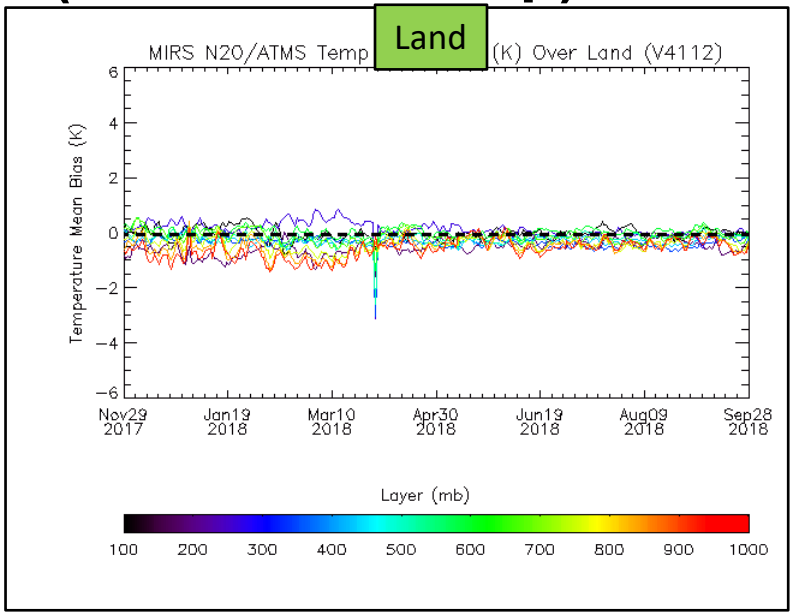
Sea

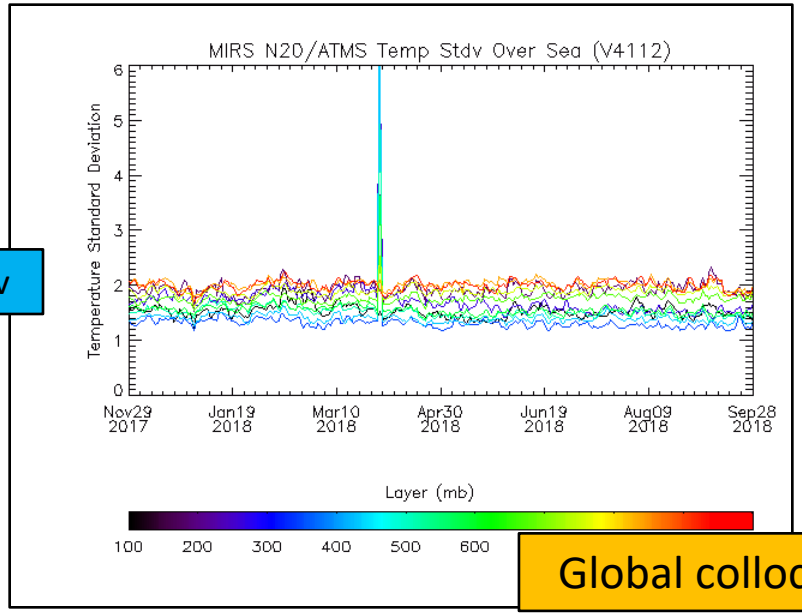
Land

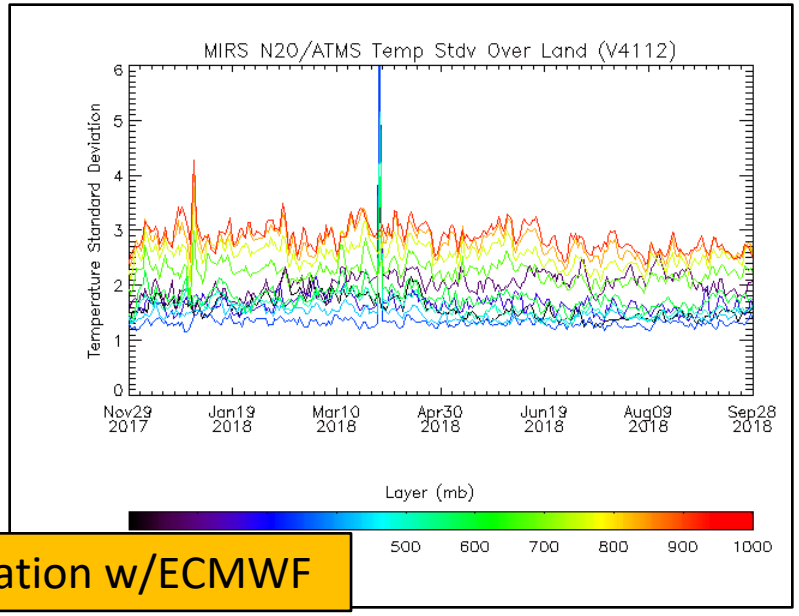
Bias

StDv









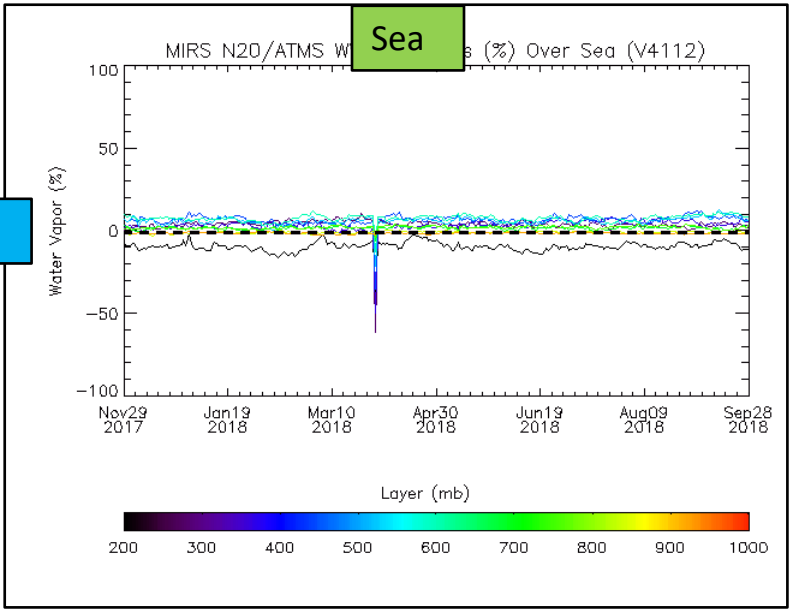
Global collocation w/ECMWF

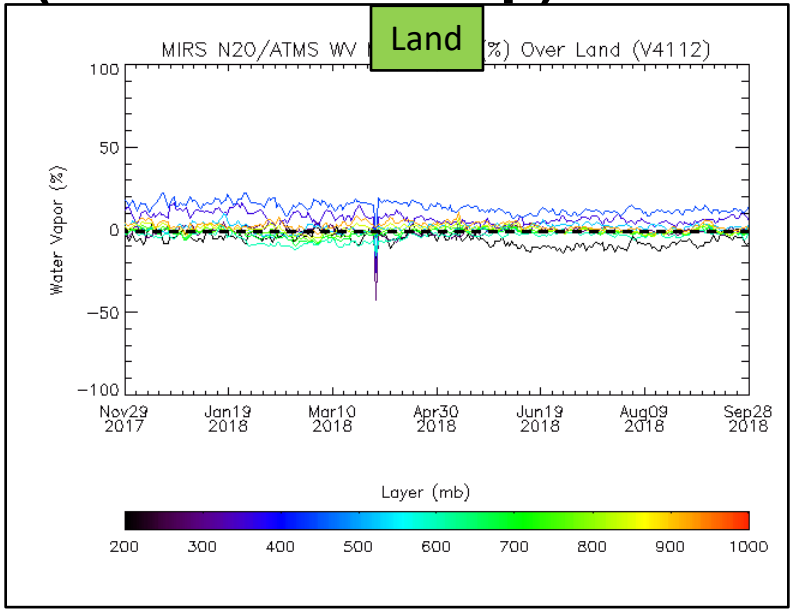
N20/ATMS Water Vapor Bias and Std Dev: Time Series (29 Nov – 28 Sep)

Sea

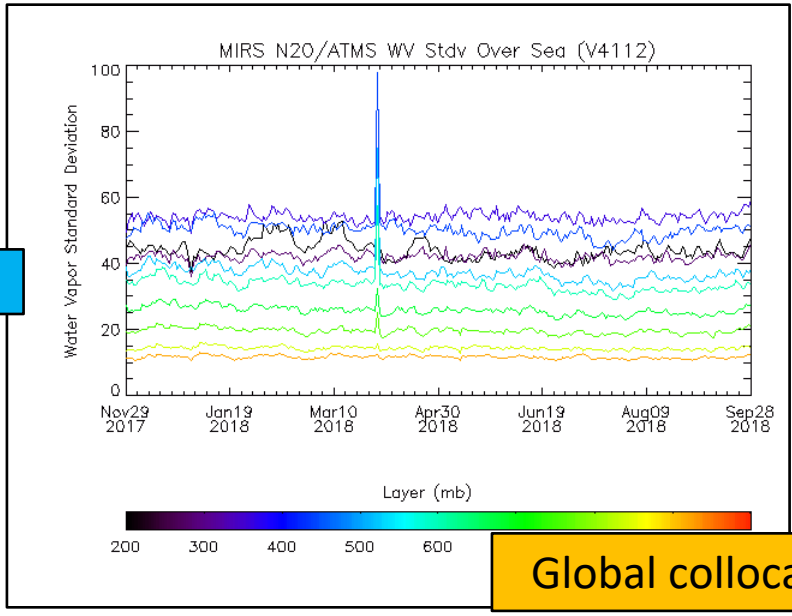
Land

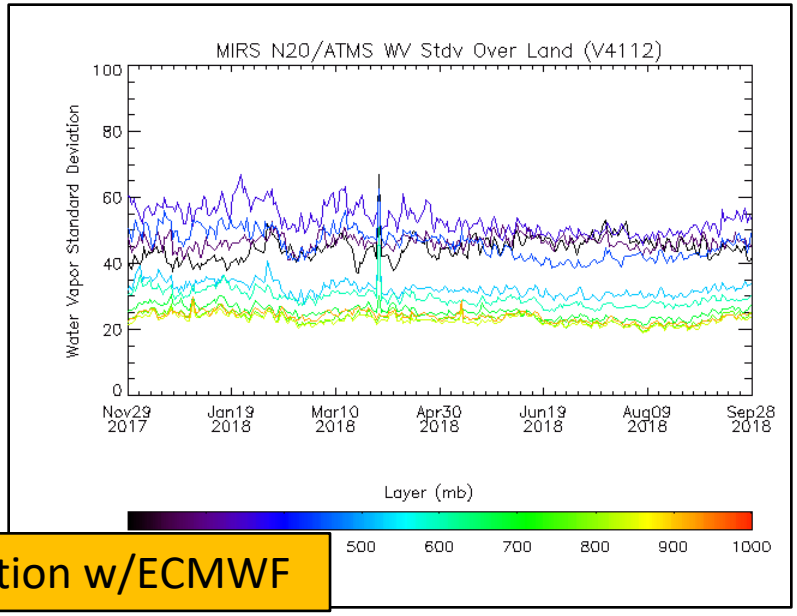
Bias





StDv





Global collocation w/ECMWF

Application Using MiRS Data: Hurricane Intensity and Structure Algorithm (HISA)

HISA provides MW-based TC Intensity estimates:

- Global
- Objective
- Independent of Dvorak

Input:

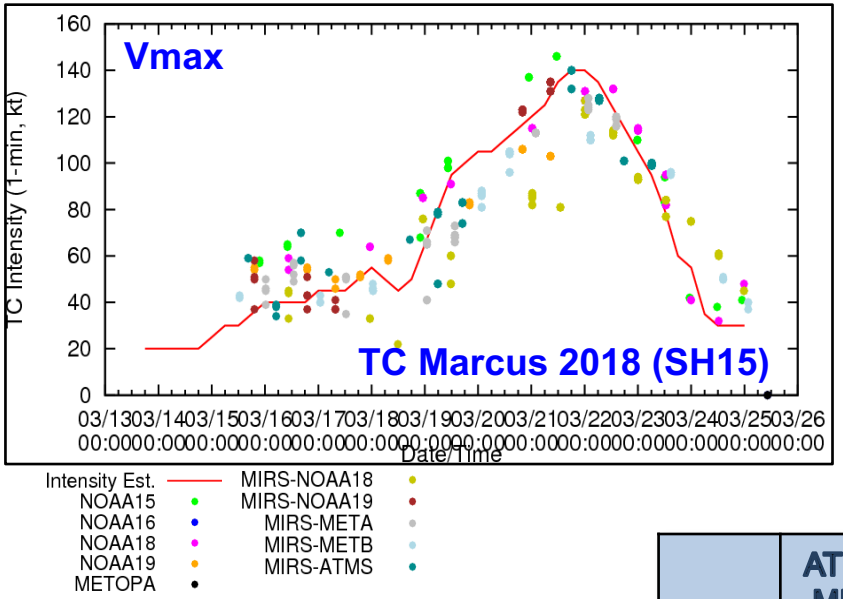
- Temperature profile, CLW from **AMSU/ATMS-MiRS** or statistical retrievals
- GFS boundary conditions
- ATCF TC track data

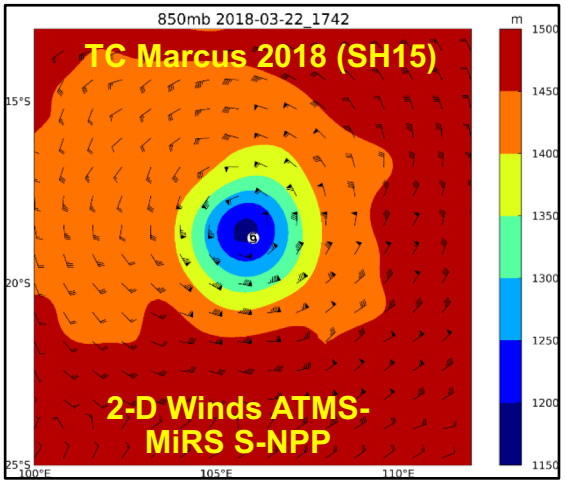
Output:

1) Intensity estimates, provided via f-deck
   - Maximum sustained wind (Vmax, kt)
   - Minimum Sea Level Pressure (MSLP, hPa)
2) Surface Wind Radii Estimates (nmi), provided via f-deck
   - R34, R50, R64 for NE, NW, SE, and SW TC quadrants
3) Azimuthally-averaged gradient winds as a function of geopotential height and distance from TC center.
4) Horizontal 2-D balanced winds (kt) for the local TC environment

Operational on ATMS and AMSU on 7 satellites, is upgraded to work with NOAA20 ATMS

Users: NHC, CPHC, JTWC





	ATMS-MIRS MAE	AMSU-MIRS MAE
Vmax (kts)	11.1 (1565)	13.2 (4346)
Pmin (hPa)	7.0 (1565)	8.4 (4347)
R34 (nmi)	20.0 (344)	24.9 (1044)
R50 (nmi)	12.0 (215)	10.6 (601)
R64 (nmi)	12.0 (134)	8.9 (336)

Galina Chirokova (CIRA), John Knaff (NOAA/NESDIS), Scott Longmore (CIRA), Mark DeMaria (NOAA/NWS/NHC), Jack Dostalek (CIRA)

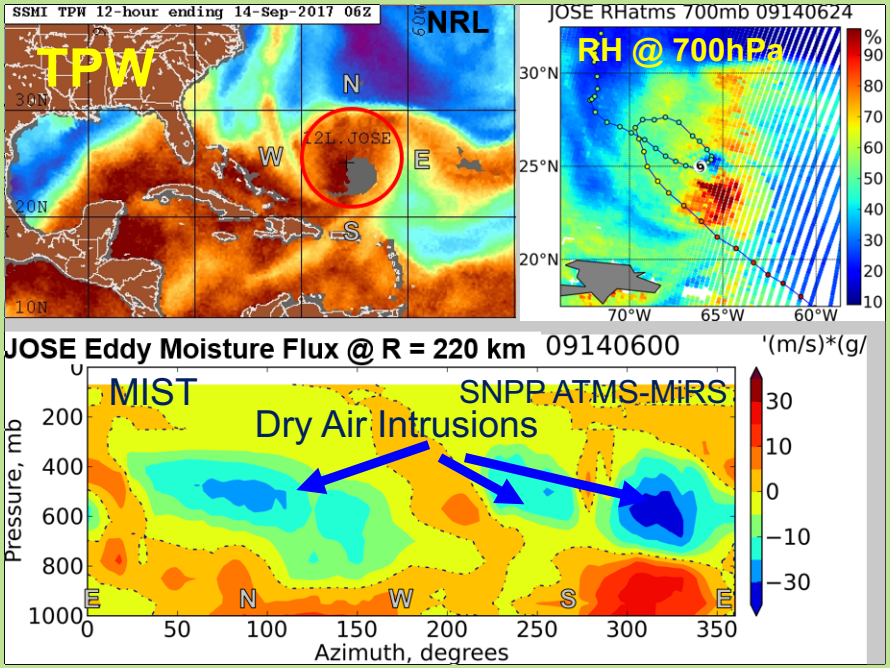
Application Using MiRS Data: Moisture In-Flux Storm Tool (MIST) (under development)

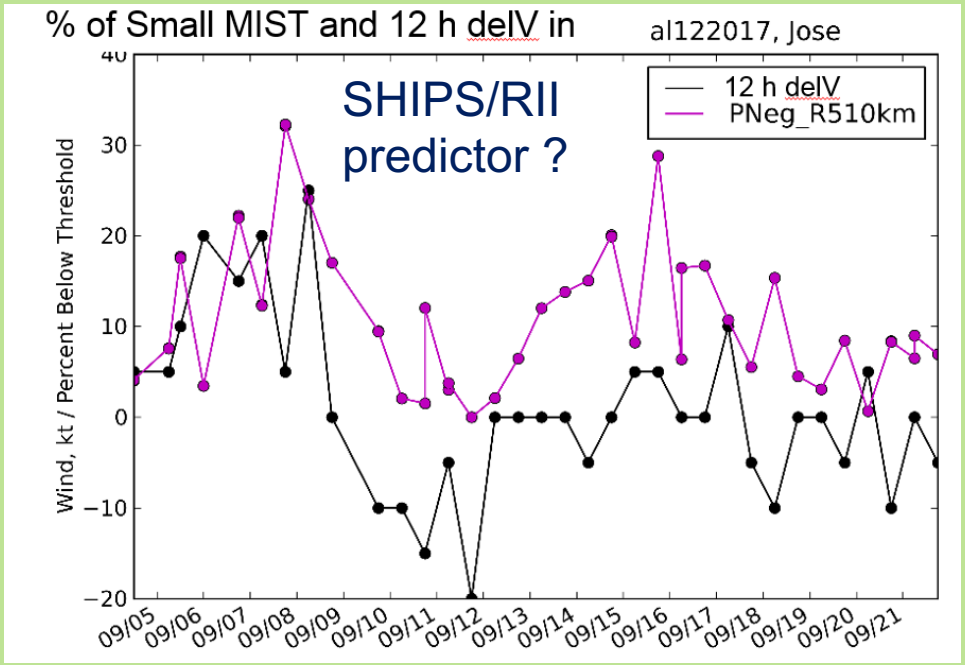
Dry-air intrusions:

- adversely affect TCs: inhibit convection, enhance cold downdrafts, contribute to storm asymmetry
- detected with TPW, LPW, WV imagery which do not provide quantitative information and do not always reflect moisture changes at mid-levels

MIST:

- detects and quantifies dry-air intrusions
- potential predictor for statistical TC intensity forecast models (SHIPS, LGEM, RII)





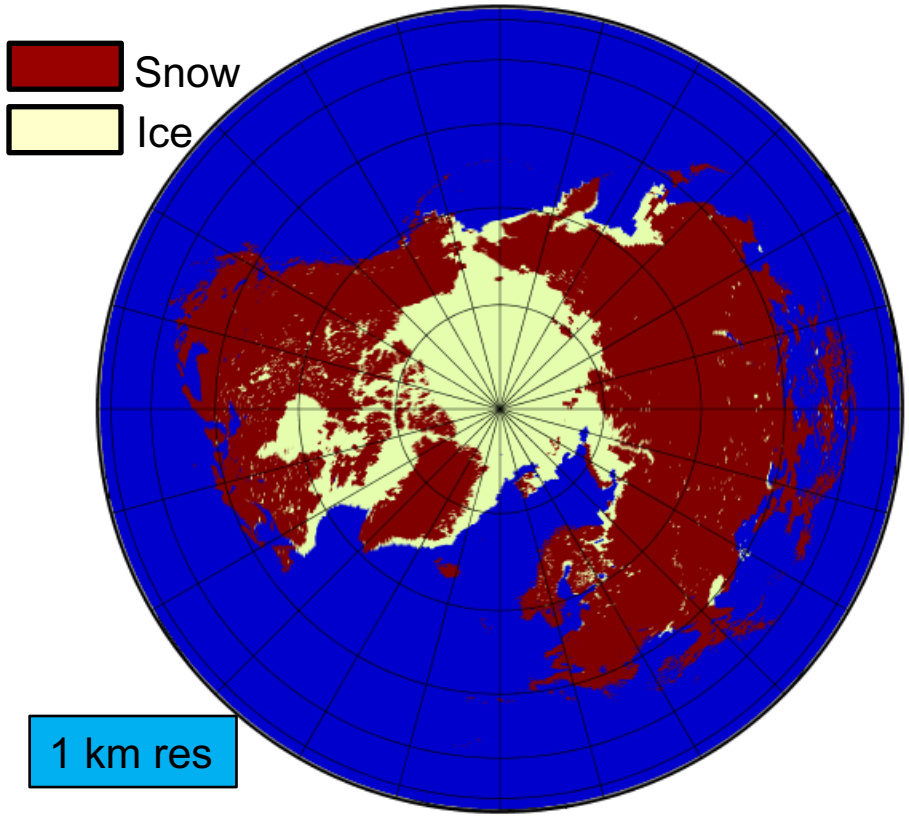
MIST shows moisture flux at R = 220 km from the storm center as a function of azimuth

Galina Chirokova (CIRA), Mark DeMaria (NOAA/NWS/NHC), John Knaff (NOAA/NESDIS)

Future Development: Surface Classifier Using Machine Learning

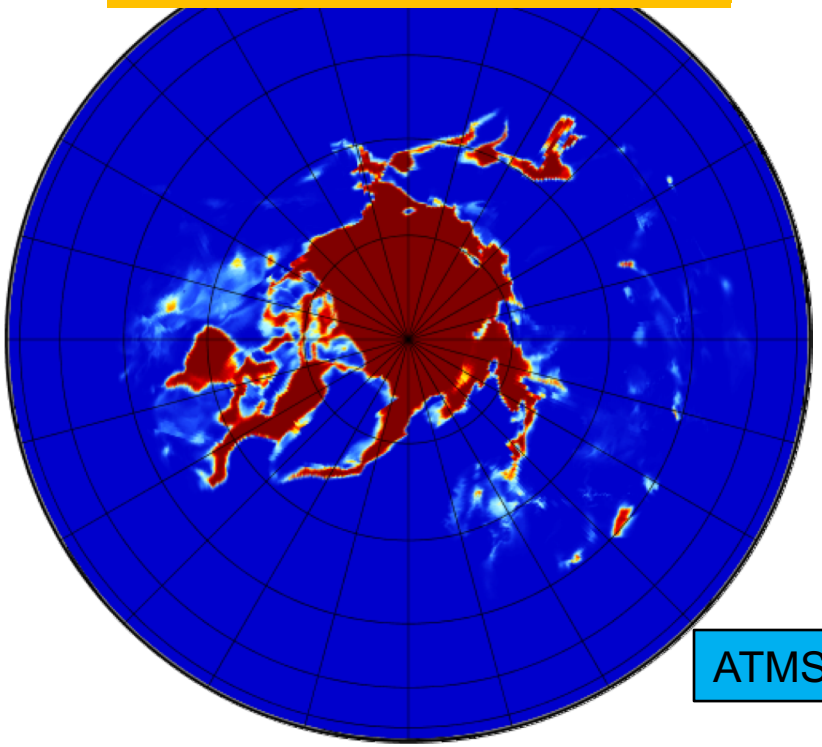
- Current MiRS surface type classifier is categorical (no mixed types): ocean, land, snow, ice
- Using TensorFlow to train a neural network to probabilistically classify surface types with IMS operational analyses as truth data
- Probabilistic surface type can be used to condition the a priori conditions for mixed surface types (e.g. emissivity) with potential impact on retrievals (e.g. ice concentration, snow water, T, WV profiles)

IMS (Observed)

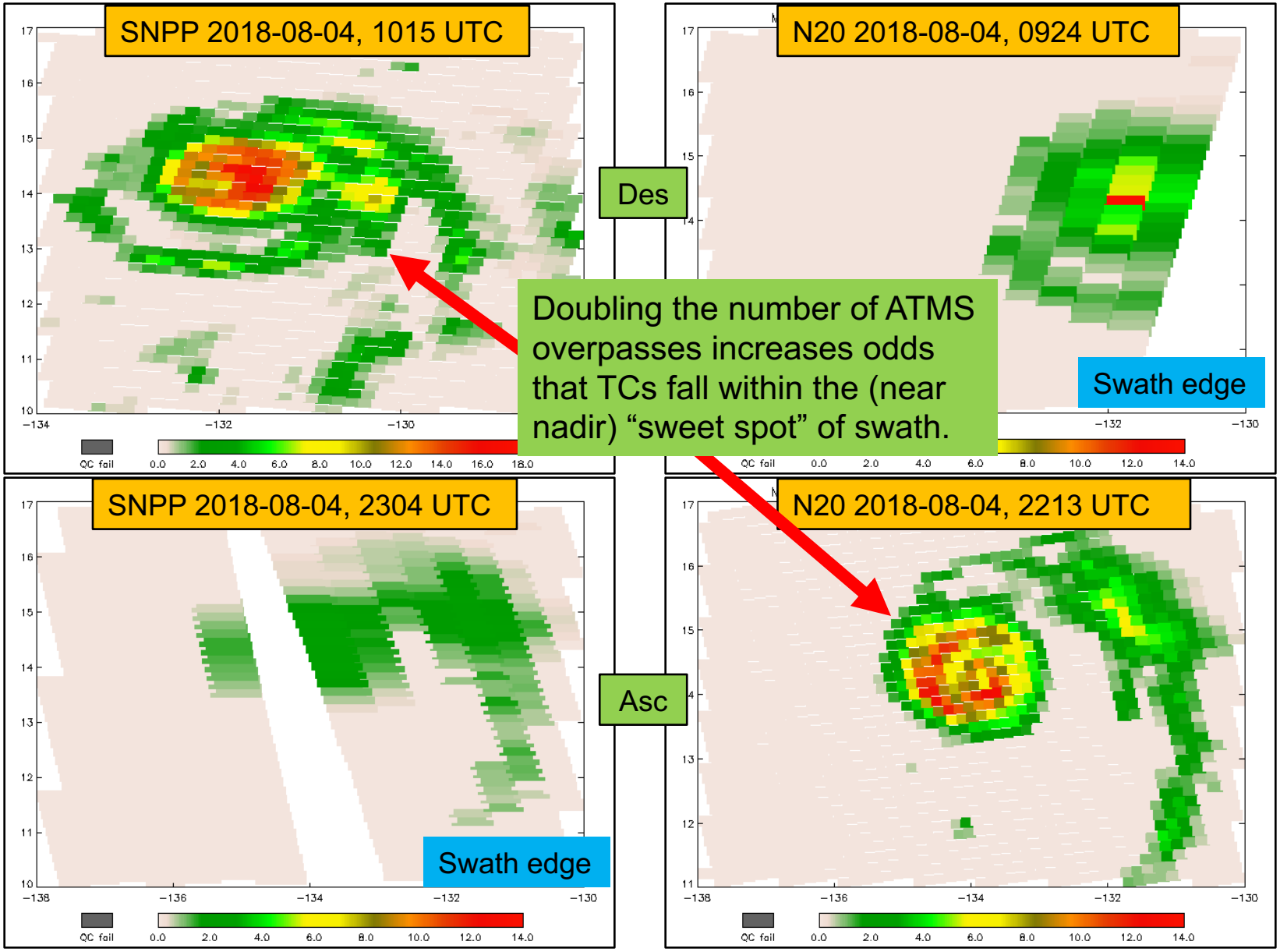


9 Jan 2016

Neural Net (Predicted) Probability of Ice

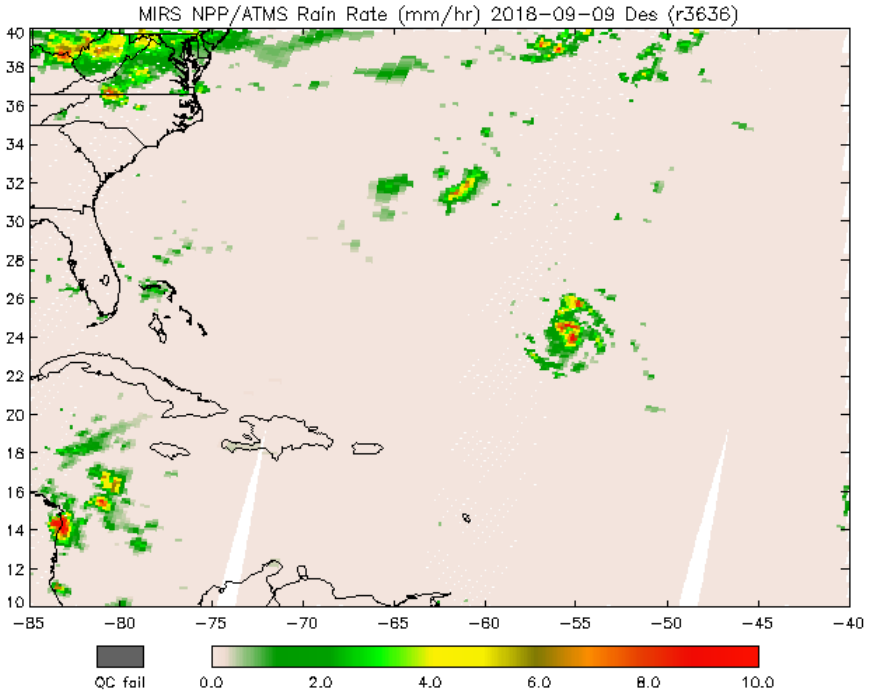


Two Operational ATMS Better Than One: MiRS Rain Rate for Hurricane Hector

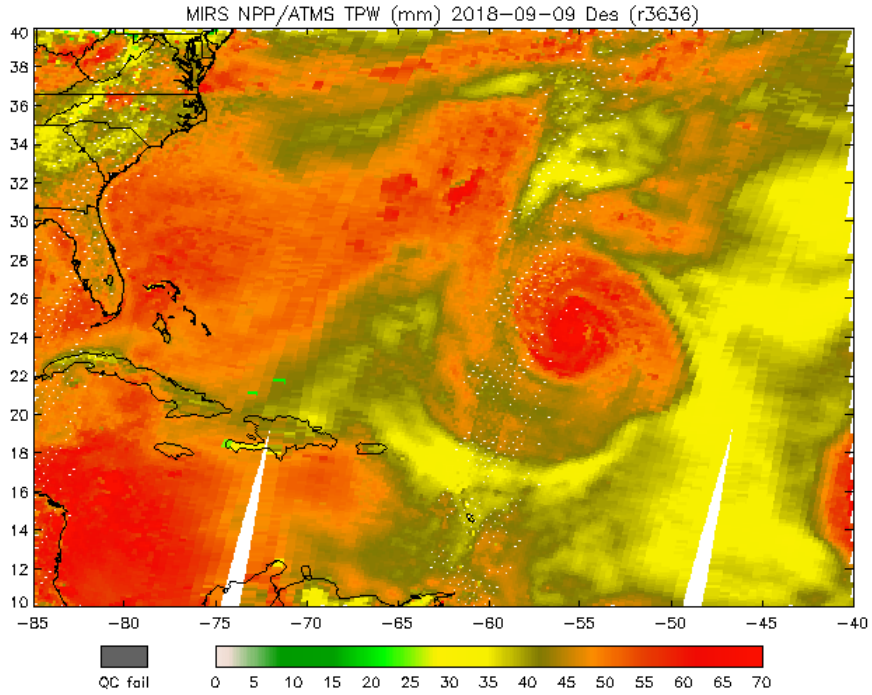


Hurricane Florence: 9-14 September 2018

MiRS Rain Rate (mm/hr)



MiRS TPW (mm)



Summary

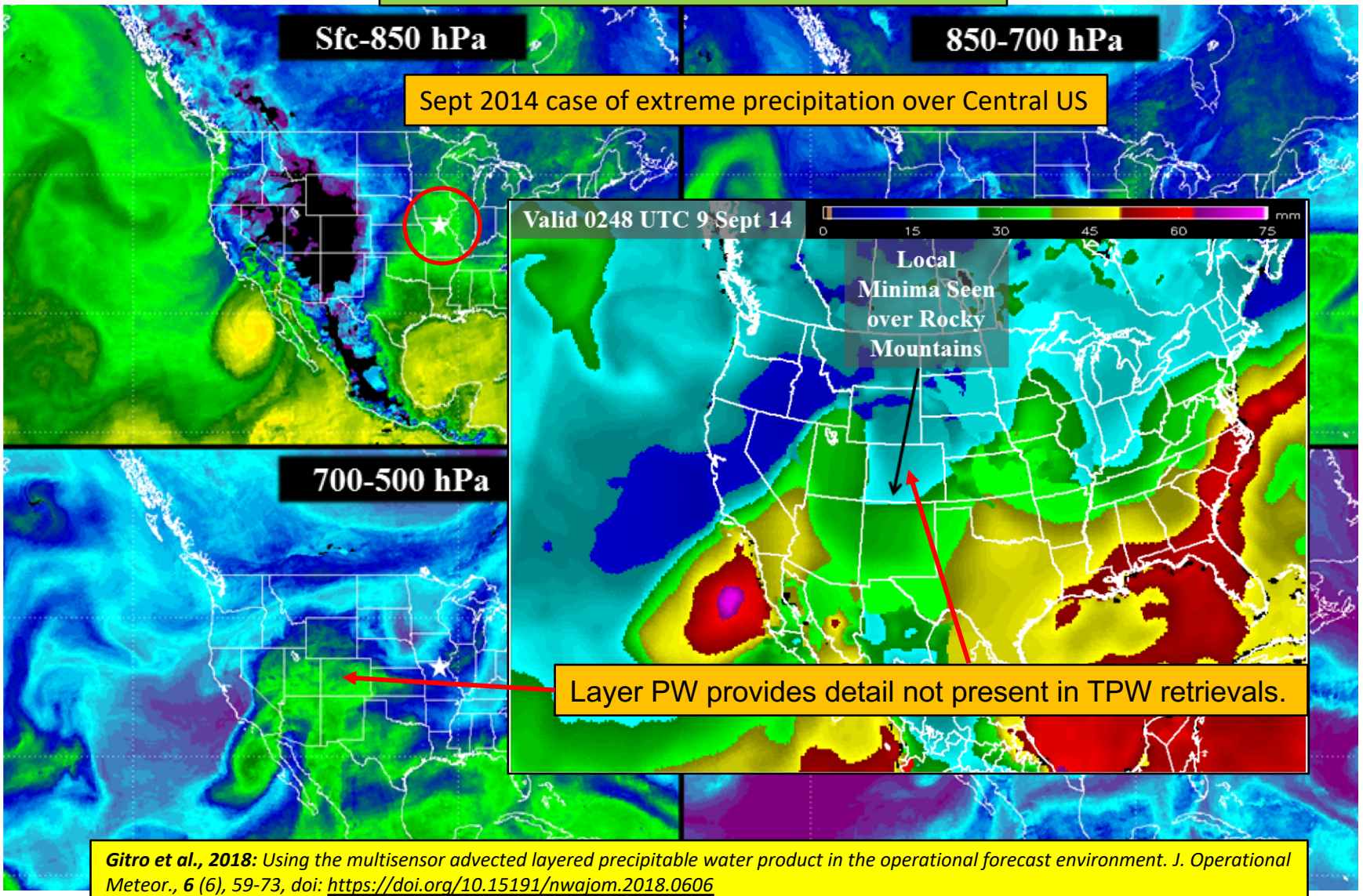
- Continued N20 validation indicates **extremely good agreement** with SNPP, and performance against external references very similar to SNPP; additional validation necessary
- Validation maturity status: Provisional maturity
- MiRS v11.3: Extension to N20 ATMS processing, delivered to OSPO/NDE on 8 June
- Path Forward
  - Continued validation, e.g. rain rate, cryosphere, T, WV, CLW,…
  - Additional DAP delivery in late 2018 (updated radiometric bias corrections, possible science improvements)
  - Extend to MetopC in 2019, JPSS-2, etc.
  - Science improvements (e.g. surface classification, bias correction, rainy sounding)
  - Longer term: EON-MW (SmallSats), Metop-SG (sounding, surface, and ice cloud missions)
  - Stakeholders/user needs; continue collaboration with applications developers and users…
- MiRS data available at CLASS (all satellites), and STAR ftp (S-NPP/ATMS, NOAA-20/ATMS, GPM/GMI)
- Software package available for download **https://www.star.nesdis.noaa.gov/mirs**

Extra Slides

Application: Blended Layer Precipitable Water
Combines MiRS WV from up to 7 Polar Satellites for Rapid Refresh and Advection (NWP-based winds)

To be implemented at NHC and WPC

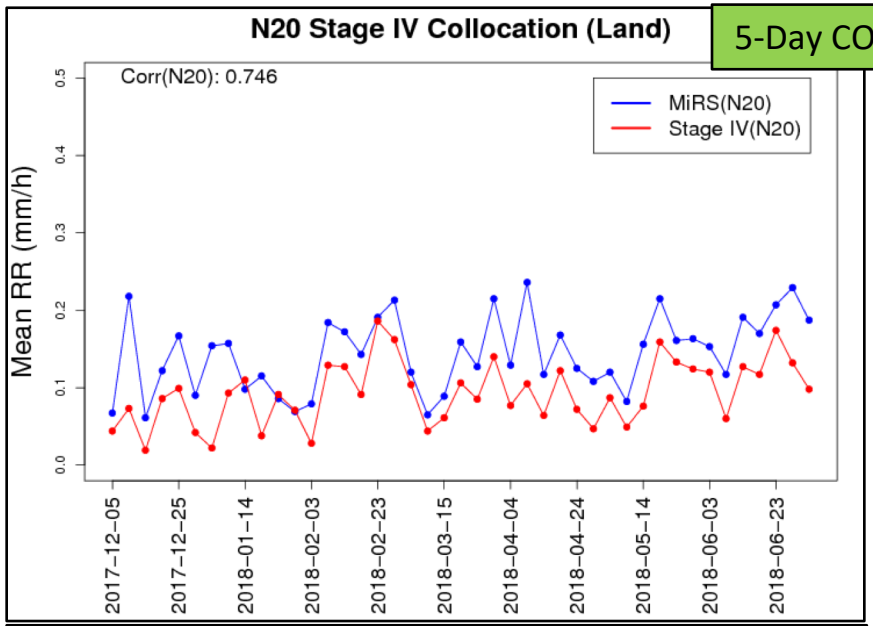
Courtesy of John Forsythe

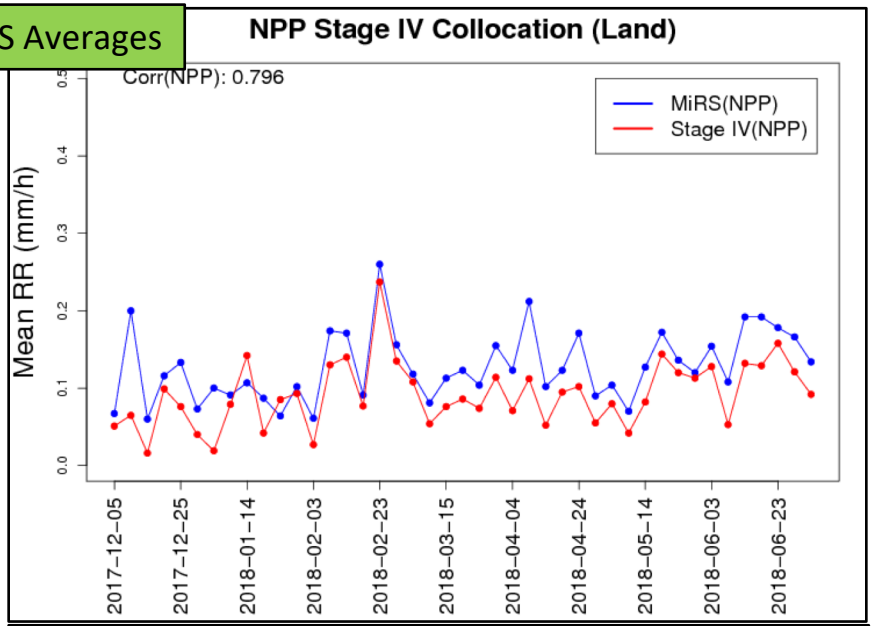


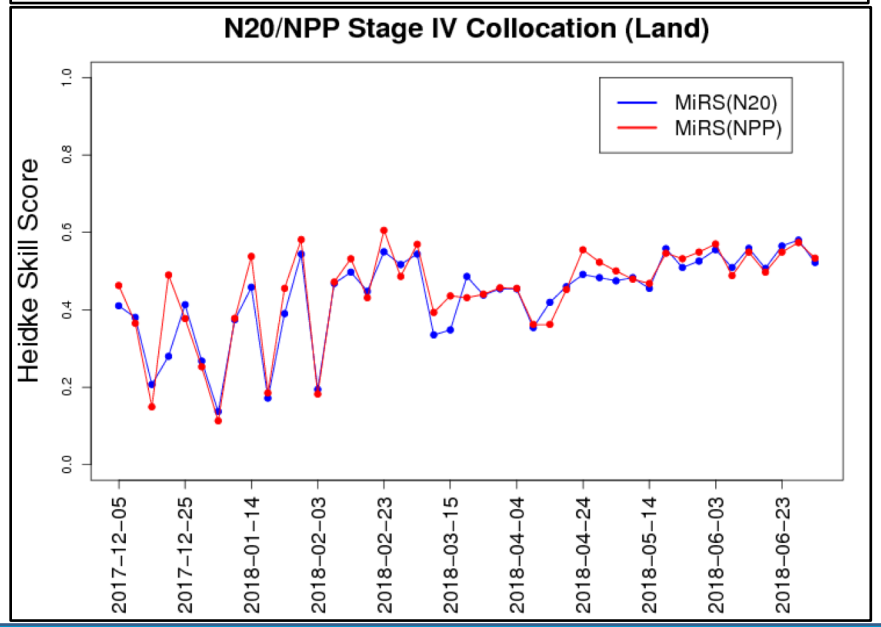
Gitro et al., 2018: *Using the multisensor advected layered precipitable water product in the operational forecast environment. J. Operational Meteor.,* ***6*** *(6), 59-73, doi: https://doi.org/10.15191/nwajom.2018.0606*

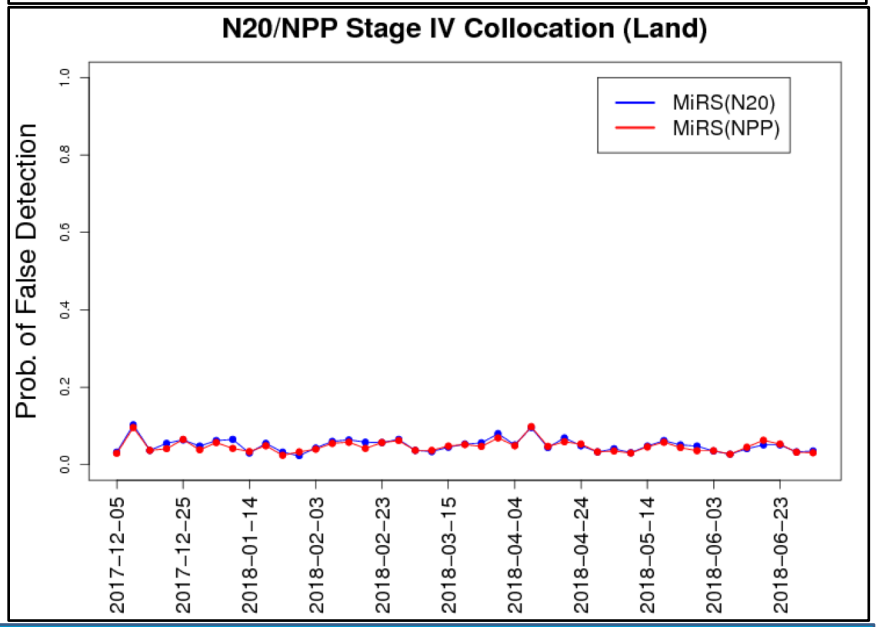
RR validation: N20 and SNPP vs. Stage IV (Dec 2017 – Jul 2018)

5-Day CONUS Averages









SNPP/ATMS Sea Ice Concentration and Age: Comparisons with VIIRS

- Collocations of VIIRS pixels that fall within each ATMS FOV
- Example from one day of global data: 29 Jan 2018