NOAA-20 ATMS TDR/SDR Validated Maturity Status Report

June 15, 2018

ATMS SDR Team

With contributions from NOAA STAR, NASA/GSFC, UMD/CICS, MIT/LL, CSU/CIRA, and Northrop Grumman

Outline

- ATMS TDR/SDR Cal/Val Team
- Progresses since Provisional Maturity
- Highlighted Performance
- NOAA-20 ATMS TDR/SDR in Operations
- Documentation
- Criteria for Validated Maturity
- Rationales for Validated Maturity
- Conclusion/Recommendation
- Path Forward

ATMS Cal/Val Team Members

PI	Organization	Team Members	Roles and Responsibilities
Quanhua (Mark) Liu	NOAA/STAR	Ninghai Sun (technical lead), Hu Yang, Xiaolei Zou, Lin Lin	Project management, SDR team coordination and algorithm test in IDPS, ATMS calibration/validation and geolocation science support, ATMS TDR/SDR data quality and monitoring
Edward Kim	NASA	Craig Smith, Joseph Lyu, Lisa McCormick	Liaison NASA flight team and NG Azusa, and independent SDR assessments
Vince Leslie	MIT/LL	Idahosa Osaretin, Mark Tolman	ATMS instrument performance and data quality assessments
Wesley Berg	CSU/CIRA		ATMS and GPM WG band cross-calibration
Deirdre Bolen	JPSS/JAM		ADR/PCR support
Wael Ibrahim (?)	RAYTHEON		IDPS support

ATMS Instrument Specifications

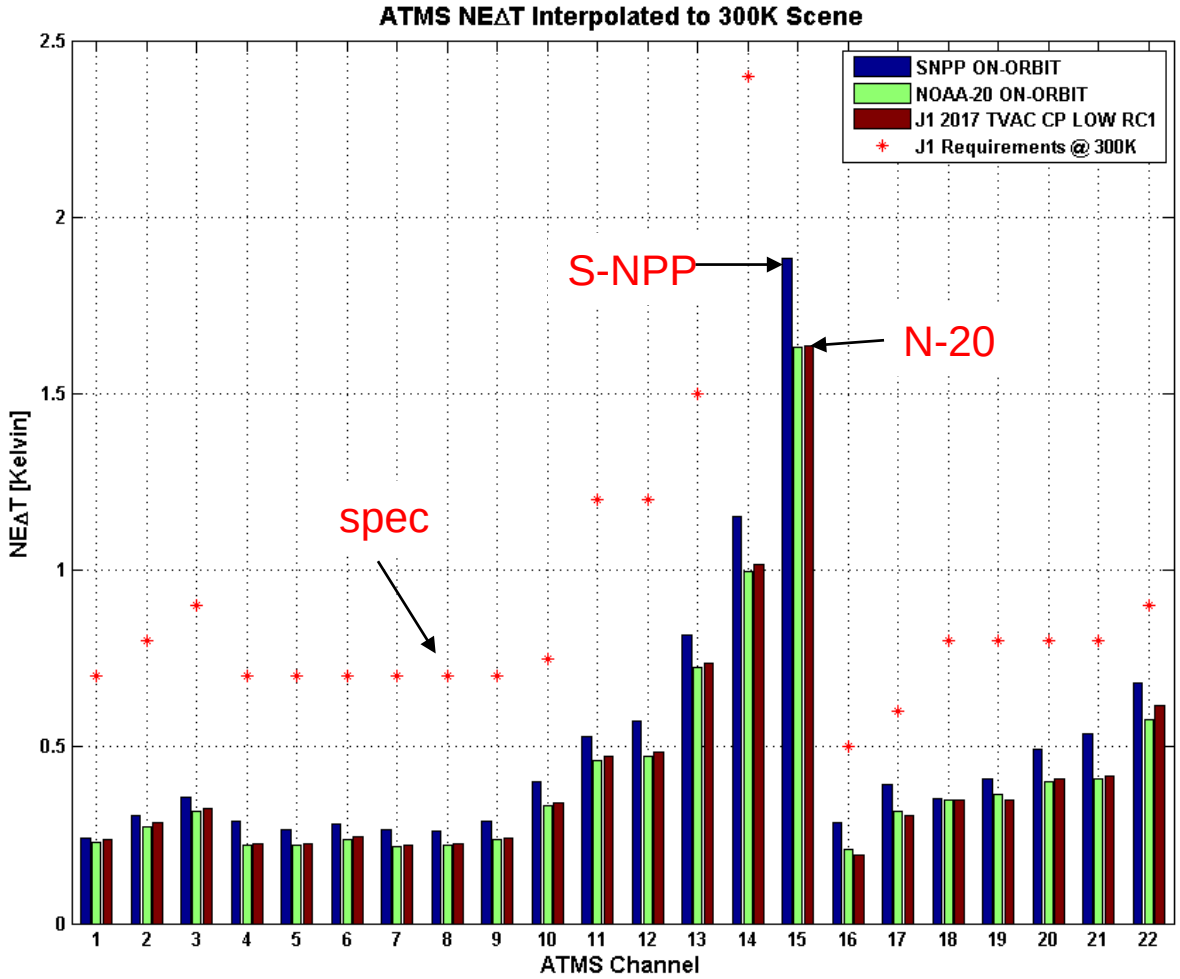
Ch.	Center Freq.(MHz)	POL	Bandwidth Max. (MHz)	Frequency Stability (MHz)	Calibration Accuracy (K)	NEΔT (K)	3-dB Bandwidth (deg)	Remarks	Characterization at Nadir
1	23800	QV	270	10	1.0	0.7	5.2	AMSU-A2	Window-water vapor 100 mm
2	31400	QV	180	10	1.0	0.8	5.2	AMSU-A2	Window-water vapor 500 mm
3	50300	QH	180	10	0.75	0.9	2.2	AMSU-A1-2	Window-surface emissivity
4	51760	QH	400	5	0.75	0.7	2.2		Window-surface emissivity
5	52800	QH	400	5	0.75	0.7	2.2	AMSU-A1-2	Surface air
6	53596±115	QH	170	5	0.75	0.7	2.2	AMSU-A1-2	4 km ~ 700 mb
7	54400	QH	400	5	0.75	0.7	2.2	AMSU-A1-1	9 km ~ 400 mb
8	54940	QH	400	10	0.75	0.7	2.2	AMSU-A1-1	11 km ~ 250 mb
9	55500	QH	330	10	0.75	0.7	2.2	AMSU-A1-2	13 km ~ 180 mb
10	57290.344(f_o)	QH	330	0.5	0.75	0.75	2.2	AMSU-A1-1	17 km ~ 90 mb
11	f_o± 217	QH	78	0.5	0.75	1.2	2.2	AMSU-A1-1	19 km ~ 50 mb
12	f_o±322.2±48	QH	36	1.2	0.75	1.2	2.2	AMSU-A1-1	25 km ~ 25 mb
13	f_o±322.2±22	QH	16	1.6	0.75	1.5	2.2	AMSU-A1-1	29 km ~ 10 mb
14	f_o±322.2±10	QH	8	0.5	0.75	2.4	2.2	AMSU-A1-1	32 km ~ 6 mb
15	f_o±322.2±4.5	QH	3	0.5	0.75	3.6	2.2	AMSU-A1-1	37 km ~ 3 mb
16	88200	QV	2000	200	1.0	0.5	2.2	89000	Window H_2O 150 mm
17	165500	QH	3000	200	1.0	0.6	1.1	157000	H_2O 18 mm
18	183310±7000	QH	2000	30	1.0	0.8	1.1	AMSU-B	H_2O 8 mm
19	183310±4500	QH	2000	30	1.0	0.8	1.1		H_2O 4.5 mm
20	183310±3000	QH	1000	30	1.0	0.8	1.1	AMSU-B/MHS	H_2O 2.5 mm
21	183310±1800	QH	1000	30	1.0	0.8	1.1		H_2O 1.2 mm
22	183310±1000	QH	500	30	1.0	0.9	1.1	AMSU-B/MHS	H_2O 0.5 mm

Progresses since Provisional Maturity

1. PCT 007 completed and approved; improved TDR to SDR conversion and QC for monitoring
2. Ch. 18 and 19 count/gain subtle downward drift flatted out
3. Cross satellites and sensors comparisons (N20 vs SNPP; ATMS vs GMI)
4. Measurements vs RT simulations (CRTM, NWP data; RO data)
5. NOAA-20 ATMS TDR in operations @NCEP/NOAA; NOAA-20 ATMS TDR in operations @ECMWF; NOAA-20 ATMS SDR cross scan asymmetry is way better (Simon and Swadley @NRL; Peter Weston and Niels Bormann)
6. MiRS ATMS EDR achieved provisional maturity

ATMS Sensitivity (NEDT)

Comparison of J1 Pre-Launch, NOAA-20 on-orbit, SNPP on-orbit

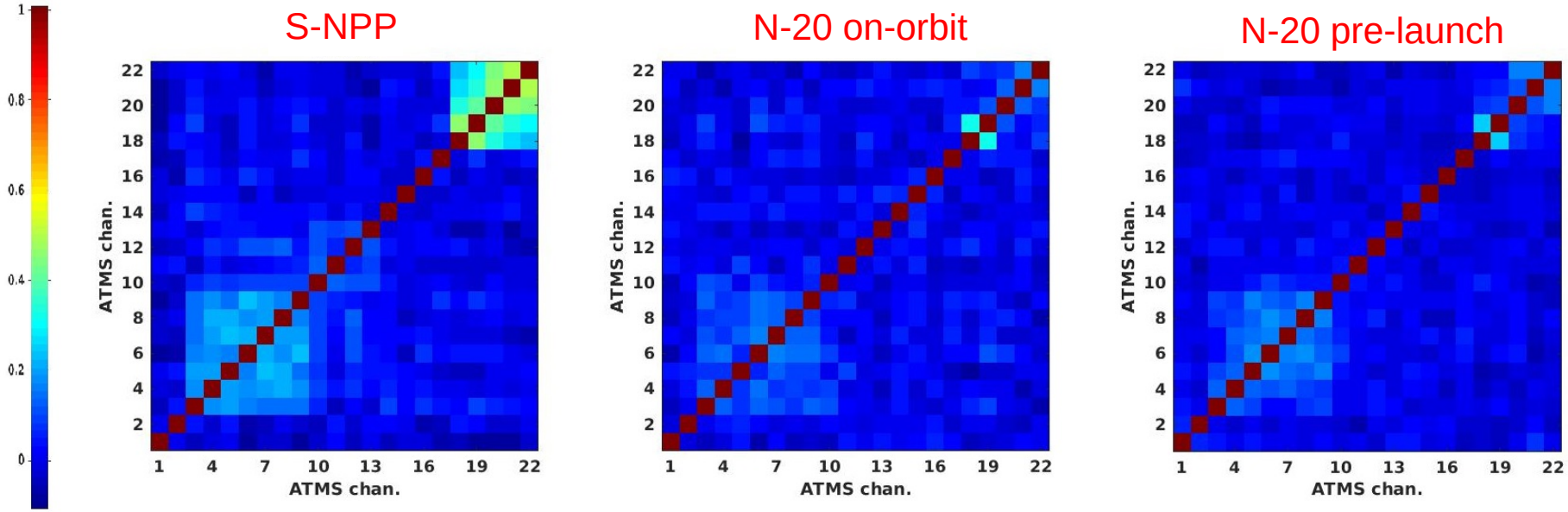


V. Leslie & I.Osaretin, MIT LL

N-20 NEDT on-orbit ~ same as pre-launch and better than S-NPP

ATMS Inter-Channel Correlation

Comparison of J1 Pre-Launch, NOAA-20 on-orbit, SNPP on-orbit



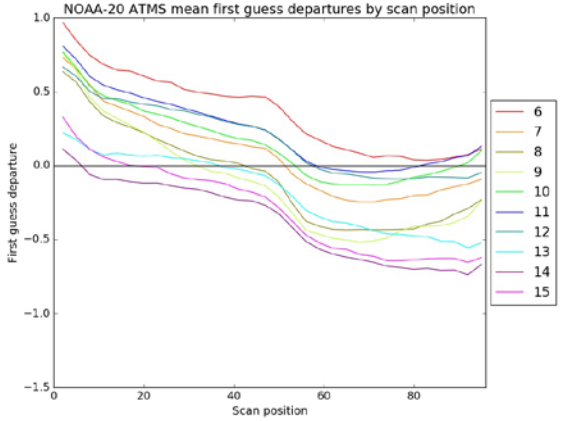
V. Leslie & I.Osaretin, MIT LL

N-20 Noise Correlation Much Better than S-NPP for all Channels

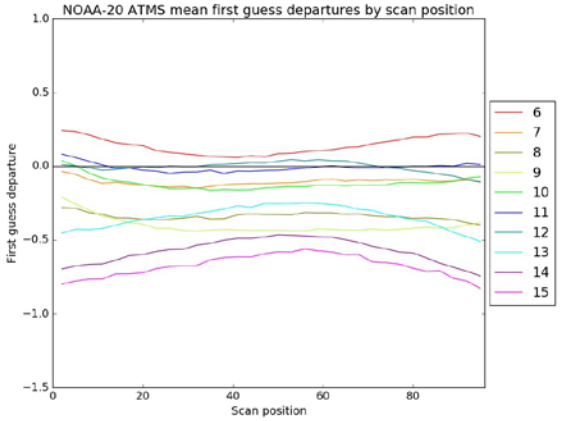
Scan biases (cloud screened data before bias correction)

- NOAA-20 updated SDRs have much more symmetric scan biases than NOAA-20 original SDRs
- NOAA-20 updated SDRs have more symmetric and smaller magnitude scan biases than NOAA-20 TDRs
- NOAA-20 updated SDRs have more symmetric and smaller magnitude scan biases than Suomi-NPP SDRs

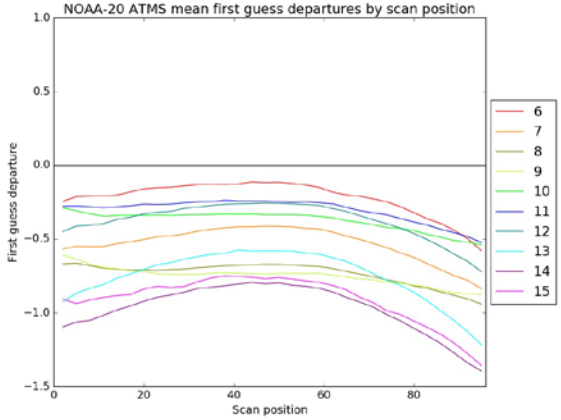
NOAA-20 original SDRs



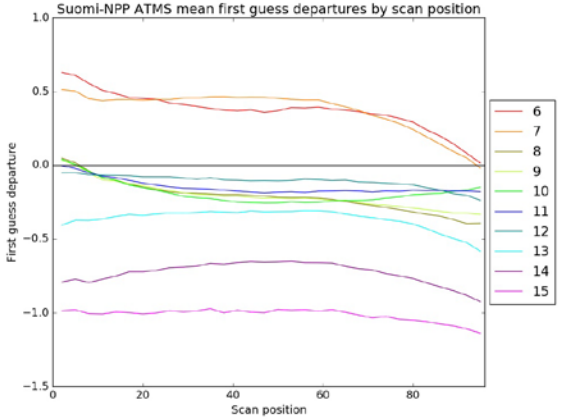
NOAA-20 updated SDRs



NOAA-20 TDRs

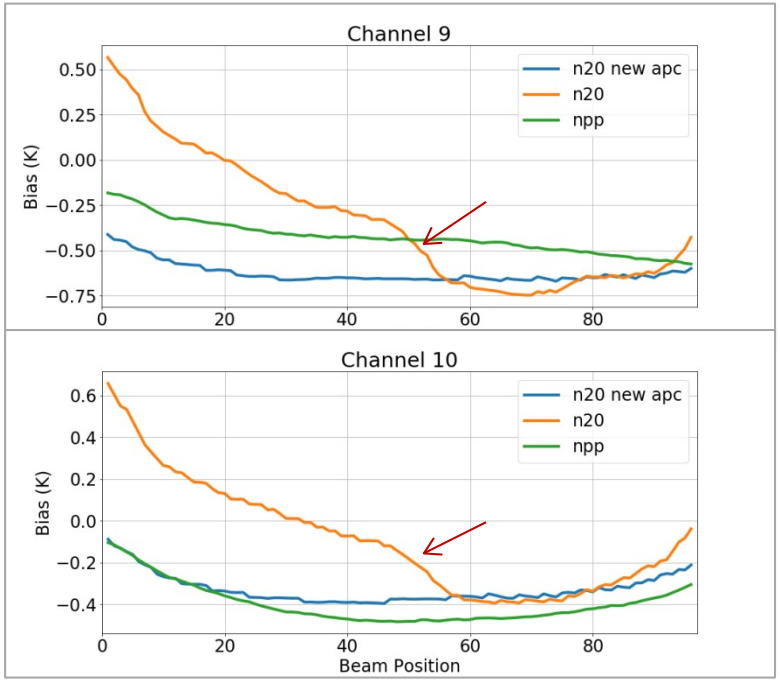


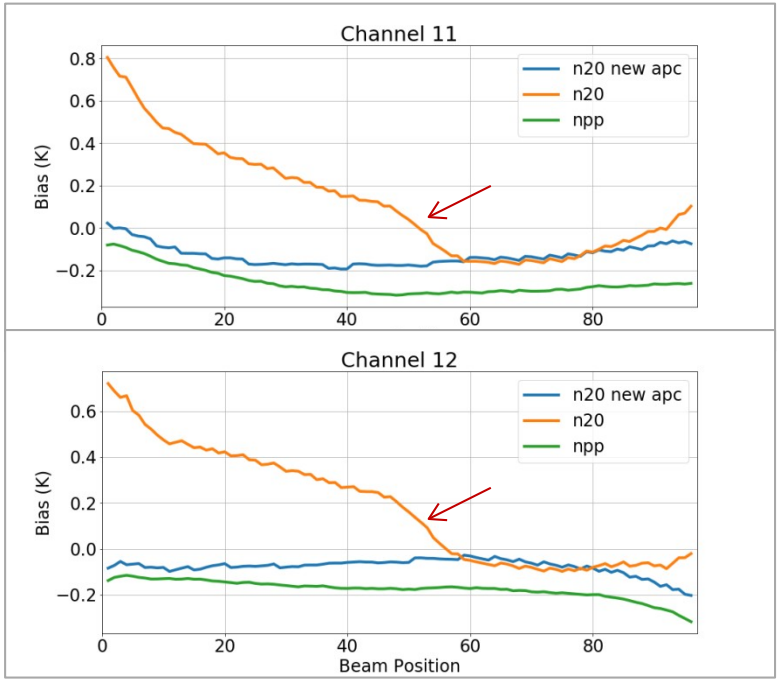
Suomi-NPP SDRs



New TDR-to-SDR coefficients used the pitchup-maneuver data that wasn't available at provisional date.

N20 ATMS Channels 9-12
Scan Asymmetry Largely Removed along with Steep Gradient Near Center of Swath

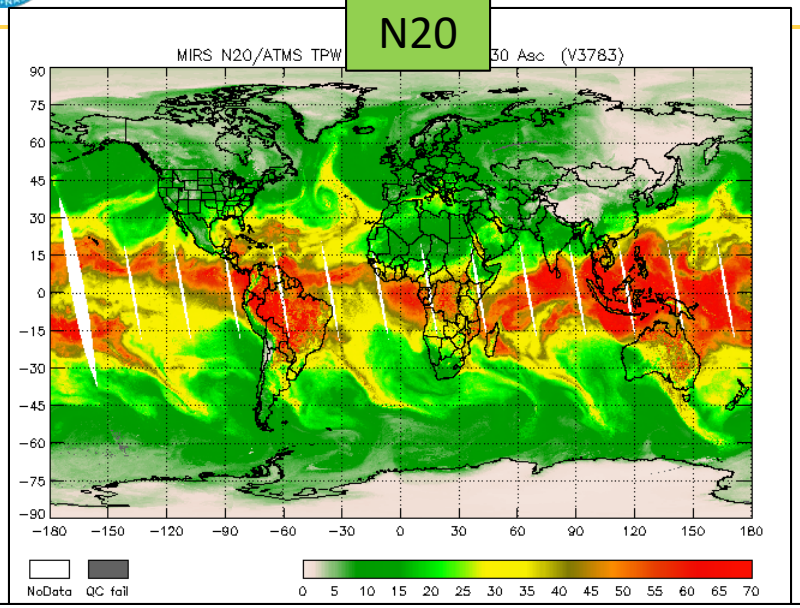




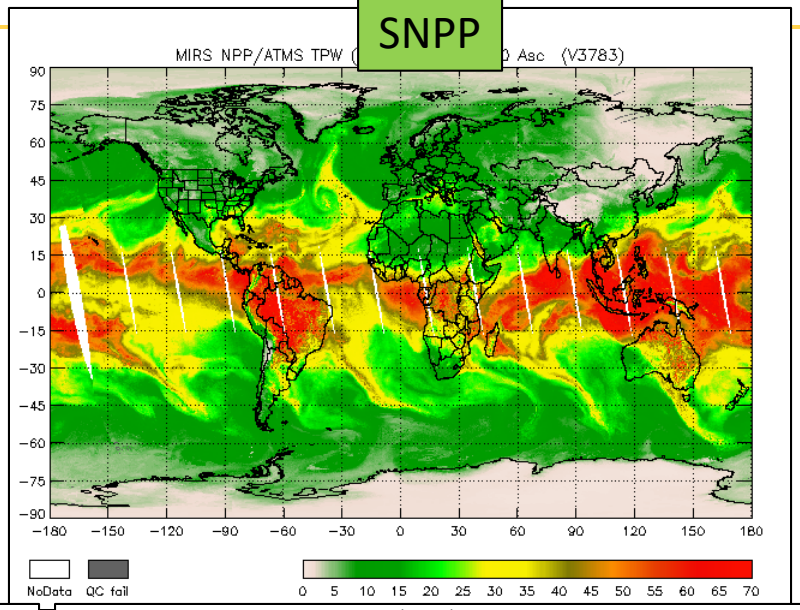
Eric Simon and Steve Swadley @NRL Monterey

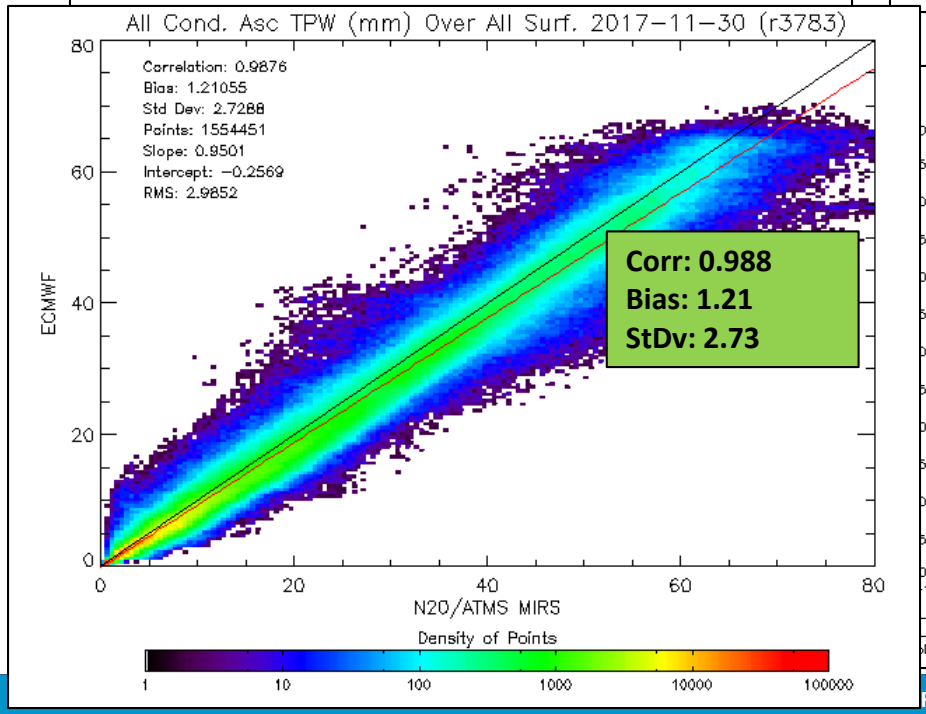
Total Precipitable Water (2017-11-30)

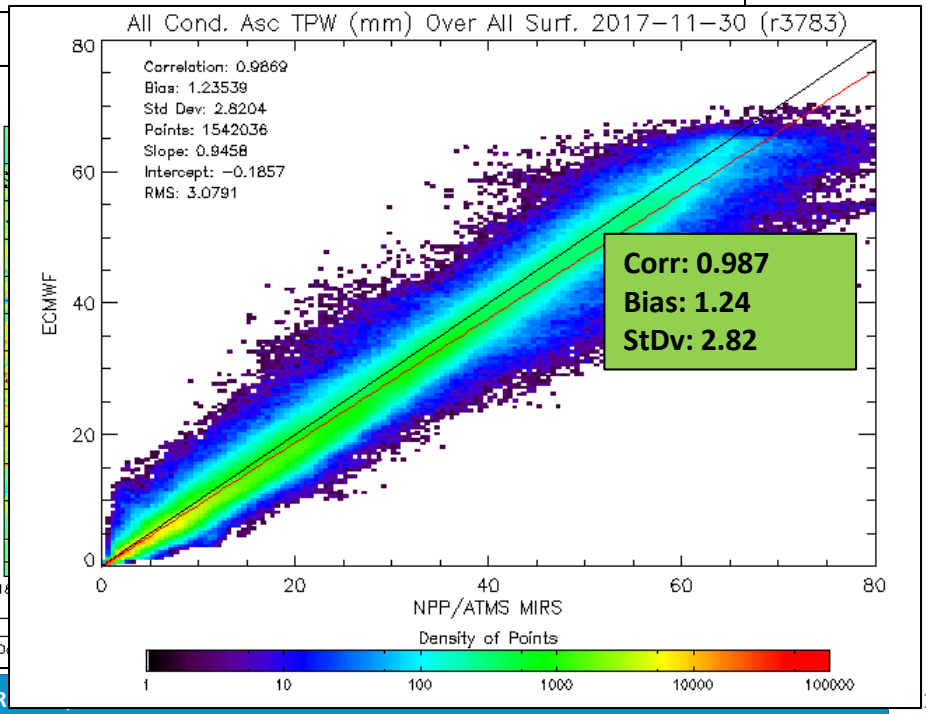
N20



SNPP



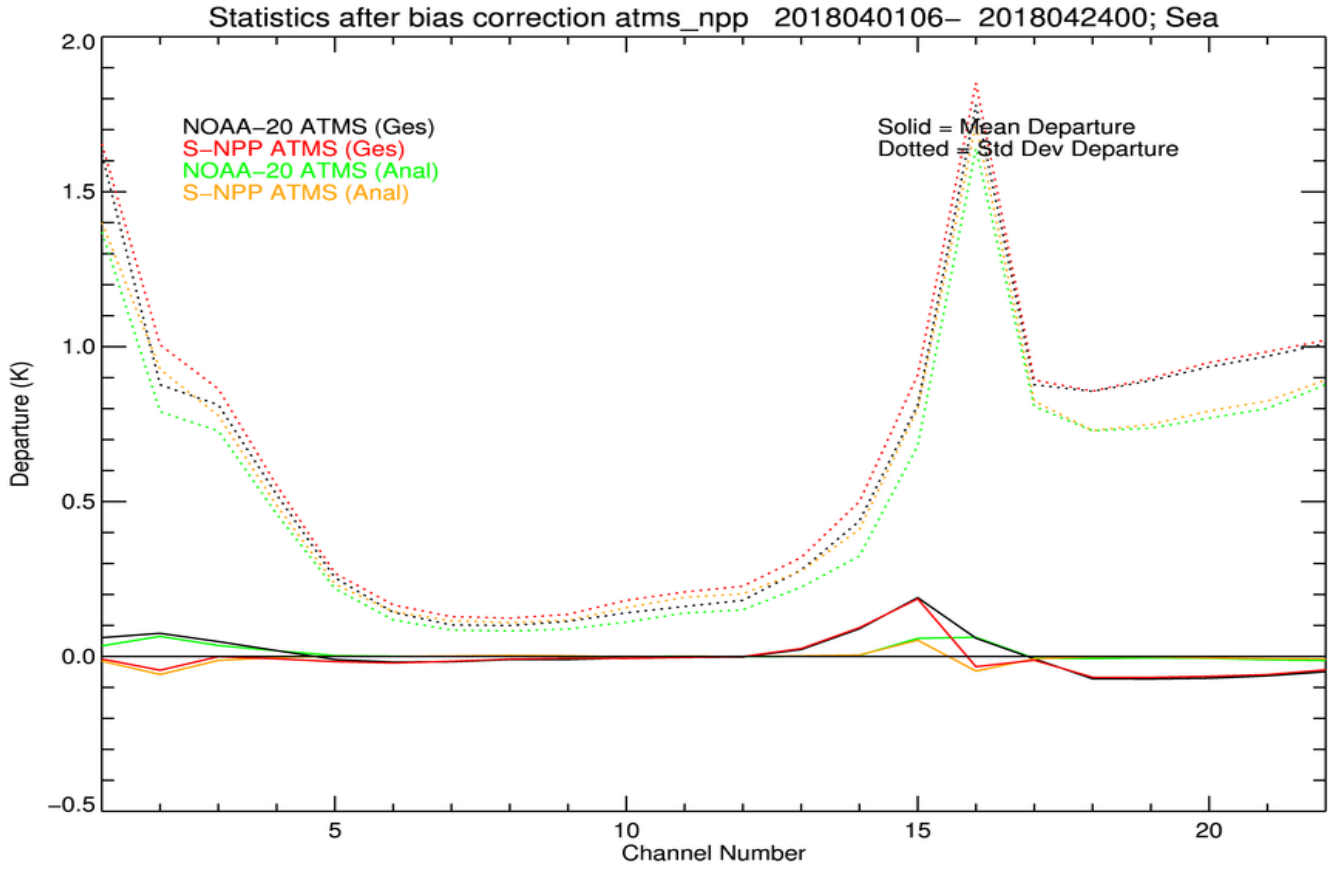




NOAA/EMC NOAA-20 ATMS Radiance Assimilation

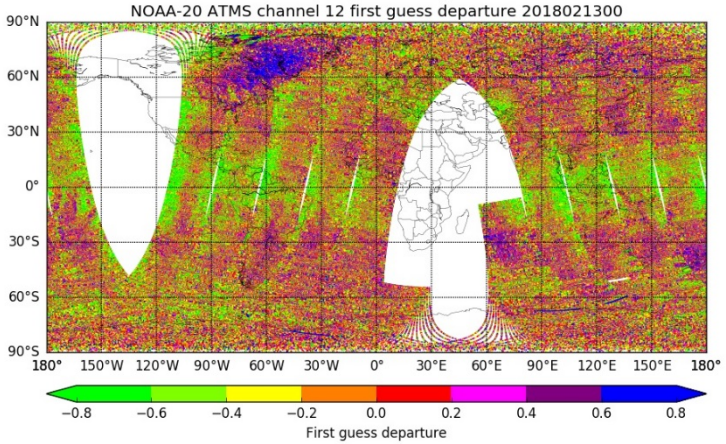
N20 ATMS TDR data look good;
Striping appears to be less of an issue compared to S-NPP
Number of observations between N20 and S-NPP passing QC is comparable.

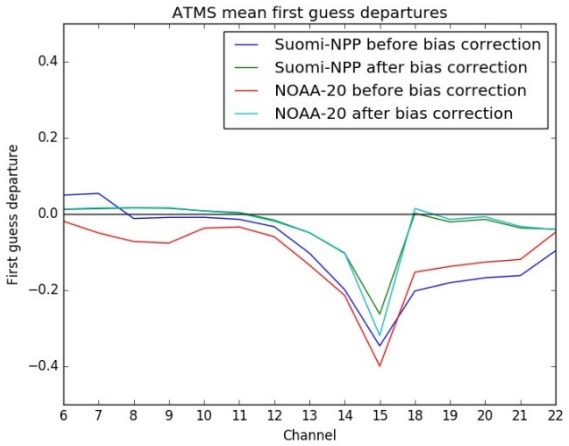
NOAA-20 ATMS bias-corrected departure is comparable/slightly less than that of SNPP ATMS

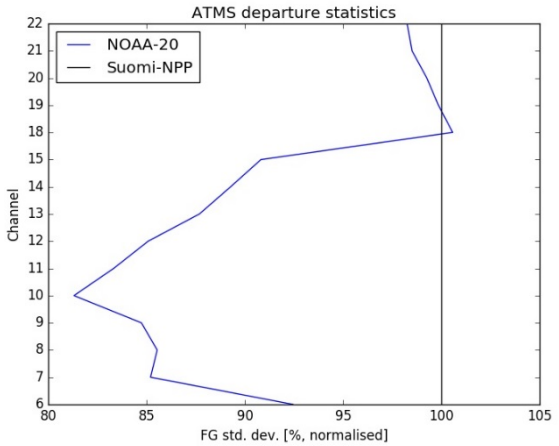


NOAA-20 ATMS

- Satellite launched 18/11/2017, sample data 19/12/2017, NRT stream from 25/02/2018
- We are using TDRs (antenna temperatures) currently
- Data quality looks better than Suomi-NPP:
  - Similar biases
  - Smaller standard deviation of first guess departures and diagnosed observation errors
  - Weaker striping signal than Suomi-NPP ATMS



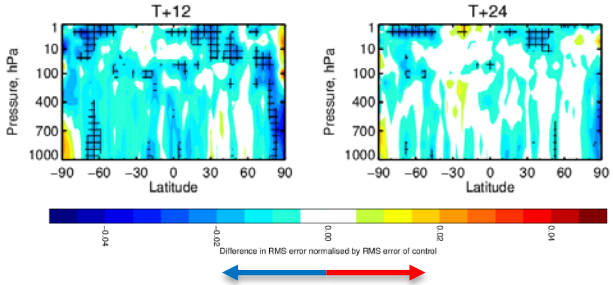




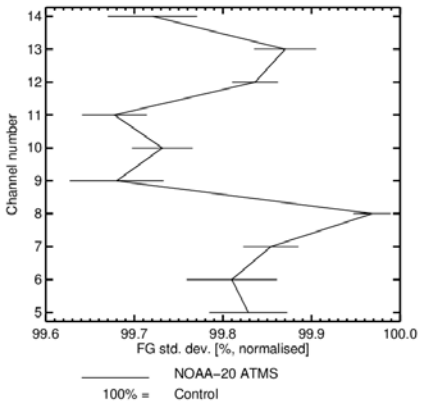
Assimilation experiment results – From two and half months

- **Improved first guess fits to:**
  - Temperature observations (AMSU-A, CrIS, GPSRO)
  - Humidity observations (MHS, GEO CSRs)
- **Indicates improved accuracy of short range temperature and humidity forecasts**
- Neutral to slightly positive forecast scores:
  - Smaller geopotential height analysis increments

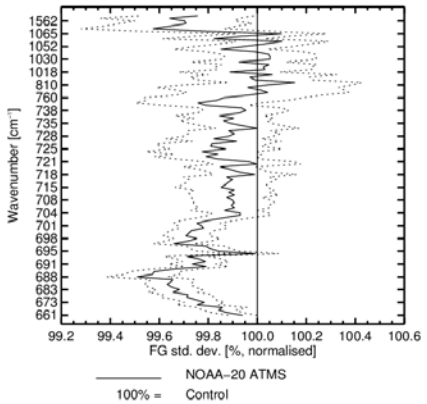
Change in RMSE of geopotential height forecasts



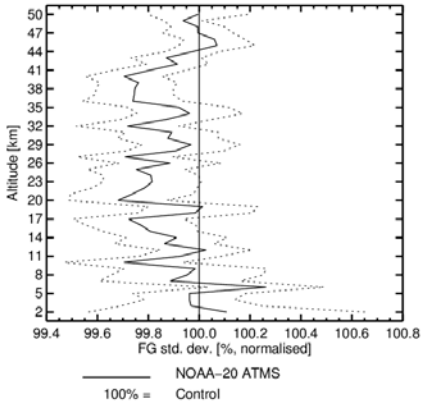
AMSU-A



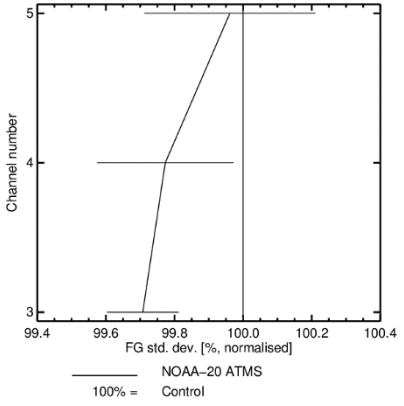
CrIS



GPSRO



MHS



Peter Weston and Niels Bormann

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	Same as SNPP, ReadME file, ATBD, OAD serve for "user manual".
Operational Algorithm Description Document (OAD)	Yes
Peer Reviewed Publications (Demonstrates algorithm is independently reviewed)	S-NPP
Regular Validation Reports (at least. annually) (Demonstrates long-term performance of the algorithm)	ICVS report, STAR JPSS Annual Meeting

Validated Maturity Definition (3)

JPSS/GOES-R Data Product Validation Maturity Stages – COMMON DEFINITIONS (Nominal Mission)

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.

Rationales for Validated Maturity

1. Product performance has been demonstrated over a large and wide range of representative conditions

ATMS TDR/SDR performance has been demonstrated globally for months

2. 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

ICVS reports, ATBD, OAD, ReadME file, Cal/Val plan, regular validation report, journal papers for SNPP ATMS

3. Product analyses are sufficient for full qualitative and quantitative determination of product fitness-for-purpose

Meet or exceed specification requirements; comparable or better than SNPP ATMS

4. Product is ready for operational use based on documented validation findings and user feedback

In operations at NOAA/NCEP and ECMWF, MiRS provisional maturity achieved

5. Product validation, quality assurance, and algorithm stewardship continue through lifetime of the instrument

ATMS team maintains the algorithm and product validation, continue to improve algorithm performance, and with ICVS team to monitor the product.

Conclusion

- NOAA-20 ATMS working well since activation
- NOAA-20 ATMS post-launch performance is comparable to pre-launch performance
- All PLTs successfully executed, no go-backs, all reports completed
  - space view profile #1 declared optimal
  - Maneuver-related activities successful
- NOAA-20 ATMS compares well to S-NPP ATMS
  - NEΔTs stable since activation and slightly lower than S-NPP
  - Inter-channel noise correlation much lower than S-NPP
  - Less striping than S-NPP
  - No Ka-band transmitter RFI so far
  - No heater induced EMI observed
- NOAA-20 ATMS MiRS EDRs achieved provisional maturity
- NOAA-20 ATMS TDR/SDR are in operations at NOAA/NCEP and ECMWF

ATMS team recommends NOAA-20 ATMS TDR/SDR for “validated” maturity!

Path Forward

- ✓ Keep analyzing PLT data, such as pitch maneuver, active geolocation, lunar intrusion, and so on, to better characterize NOAA-20 ATMS on orbit performance
- ✓ Implement key instrument performance and data quality monitoring packages for long term stability trending
- ✓ Improve calibration algorithm, remove reflector emission in TDR, hybrid antenna pattern correction, better TDR to SDR conversion (code change, PCT change)
- ✓ Improve geolocation accuracy
- ✓ Update the SNPP ATMS calibration algorithm and PCT for consistency and better cross verification
- ✓ Support data product end users, antenna pattern model for radiance assimilation
- ✓ Write users manual
- ✓ NOAA-20 and SNPP ATMS reprocessing
- ✓ J2 ATMS assessment and preparation to operation

ATMS Radiometric Accuracy

Table 10-20b Radiometric Temperature Compared to Physical Temperature, CP +7.7°C, RC1 (continued)

	230K			280K			330K		
Ch	Scene Physical Temp (Tv)	Scene Rad. Temp (Ts)	Delta (Ts-Tv)	Scene Physical Temp (Tv)	Scene Rad. Temp (Ts)	Delta (Ts-Tv)	Scene Physical Temp (Tv)	Scene Rad. Temp (Ts)	Delta (Ts-Tv)
1	229.983	230.035	0.052	279.806	279.731	-0.075	329.962	329.557	-0.405
2	229.983	230.077	0.094	279.806	279.727	-0.079	329.962	329.489	-0.473
3	229.983	229.966	-0.017	279.806	279.759	-0.047	329.962	329.750	-0.212
4	229.983	229.874	-0.109	279.806	279.754	-0.052	329.962	329.922	-0.039
5	229.983	229.924	-0.059	279.806	279.749	-0.057	329.962	329.861	-0.101
6	229.983	229.893	-0.090	279.806	279.748	-0.058	329.962	329.919	-0.042
7	229.983	229.998	0.015	279.806	279.754	-0.052	329.962	329.720	-0.242
8	229.983	230.011	0.028	279.806	279.734	-0.072	329.962	329.668	-0.293
9	229.983	230.004	0.021	279.806	279.747	-0.059	329.962	329.699	-0.263
10	229.983	230.169	0.186	279.806	279.724	-0.082	329.962	329.466	-0.496
11	229.983	230.160	0.177	279.806	279.709	-0.097	329.962	329.445	-0.517
12	229.983	230.164	0.181	279.806	279.706	-0.100	329.962	329.422	-0.540
13	229.983	230.225	0.242	279.806	279.715	-0.091	329.962	329.370	-0.592
14	229.983	230.204	0.221	279.806	279.760	-0.046	329.962	329.335	-0.627
15	229.983	230.217	0.234	279.806	279.798	-0.008	329.962	329.334	-0.627
16	229.641	229.586	-0.055	279.894	279.888	-0.006	329.943	329.785	-0.158
17	229.641	229.785	0.144	279.894	279.850	-0.044	329.943	329.526	-0.417
18	229.641	229.695	0.054	279.894	279.852	-0.041	329.943	329.678	-0.266
19	229.641	229.726	0.084	279.894	279.870	-0.024	329.943	329.671	-0.272
20	229.641	229.696	0.054	279.894	279.867	-0.026	329.943	329.632	-0.311
21	229.641	229.703	0.061	279.894	279.841	-0.053	329.943	329.624	-0.319
22	229.641	229.778	0.136	279.894	279.836	-0.057	329.943	329.497	-0.446

Calibration Data Book JPSS1 ATMS P/N 1362460-1, S/N 303, October 16 2017