NOAA-20 SDR OVERVIEW

20 August, 2018

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NOAA/NESDIS/STAR

SDR Team Lead

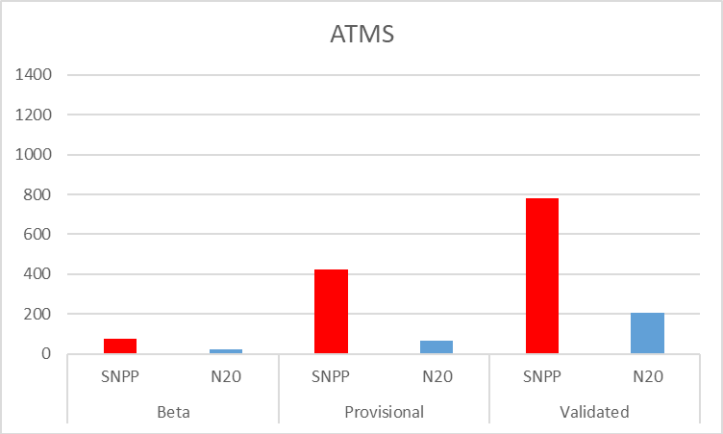
With contributions from SDR Team

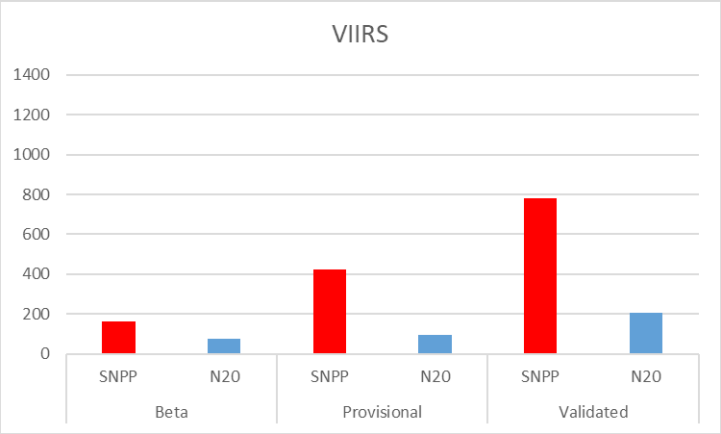
NOAA 20 SDR Maturity Status

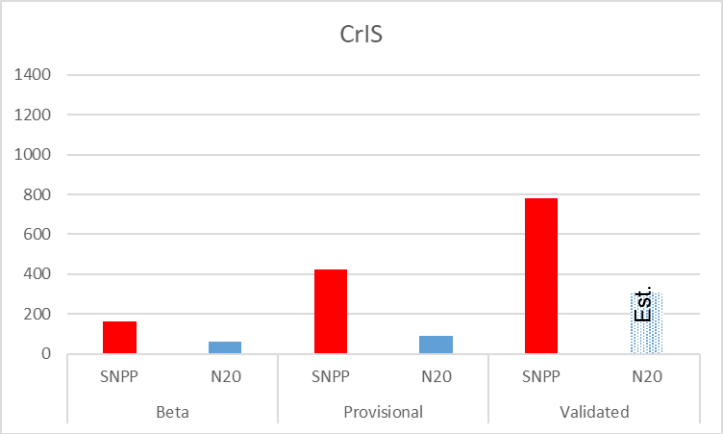
- ATMS – Validated
- VIIRS – Validated
- CrIS – Provisional
- OMPS Nadir Mapper- Provisional

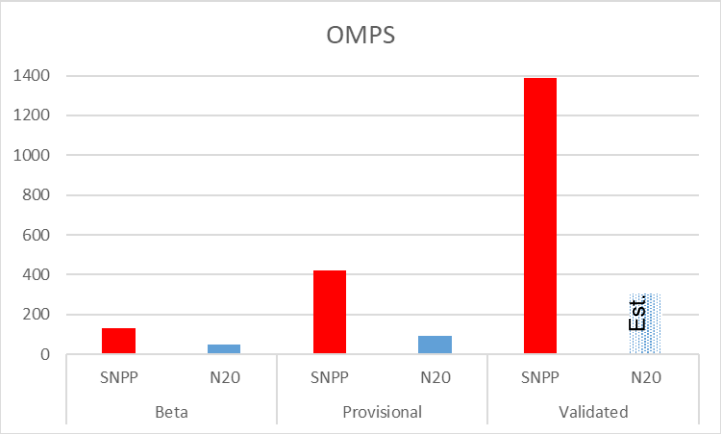
Suomi NPP vs NOAA-20 SDR Maturity Review Timeline Comparison

NOAA-20 SDR Maturity Achieved in Record Time!







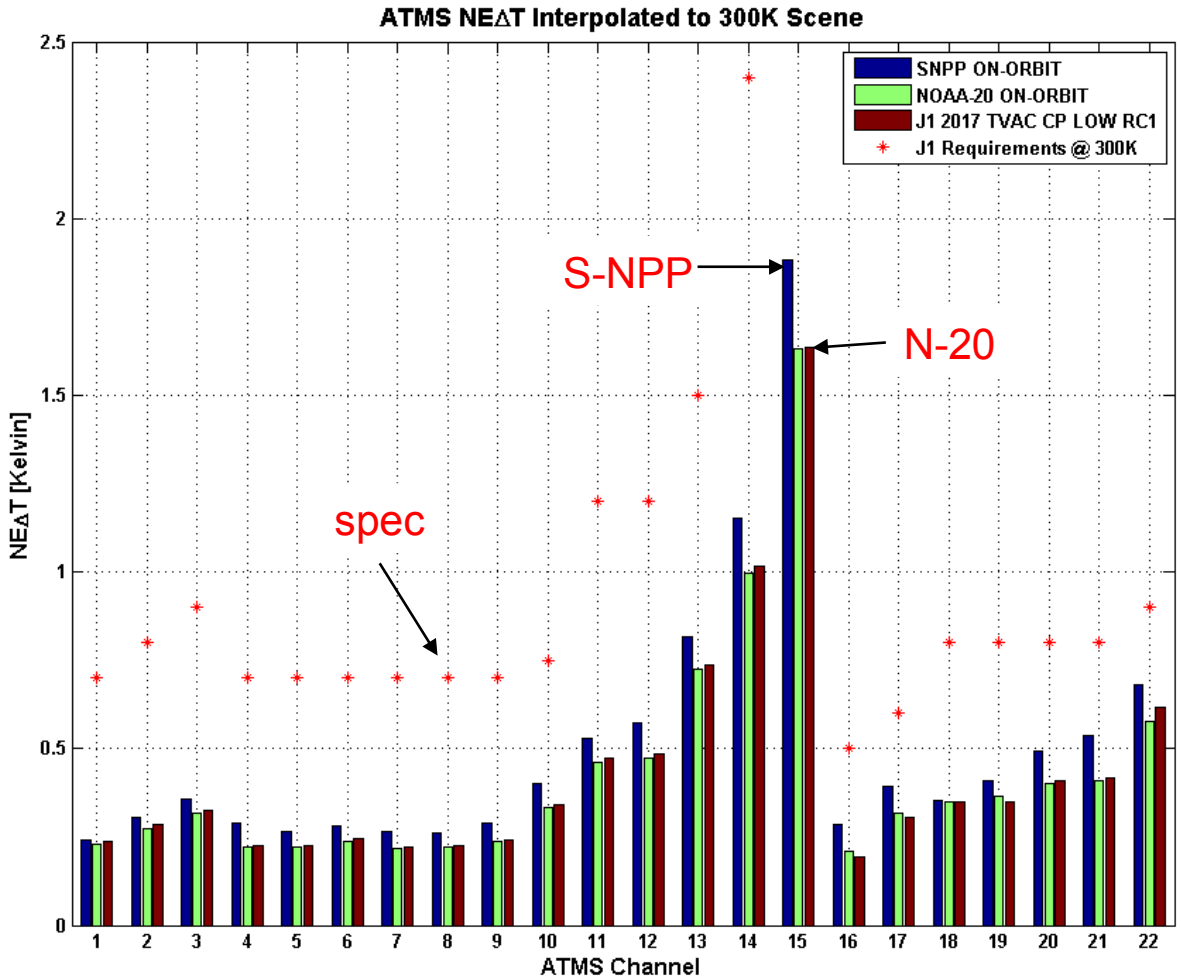


NOAA 20 ATMS Progress Since Launch

- ATMS TDR/SDR performance has been demonstrated globally for months
- Cross satellites and sensors comparisons (N20 vs SNPP; ATMS vs GMI)
- Measurements vs RT simulations (CRTM, NWP data; RO data)
- 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)
- Delivered 6 Processing Coefficient Tables (PCTs) and updated 8692 (4346*2) coefficients right before launch, 8448 coefficients for Provisional and 8448 coefficients for Validated maturities.

ATMS Sensitivity (NEDT)

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



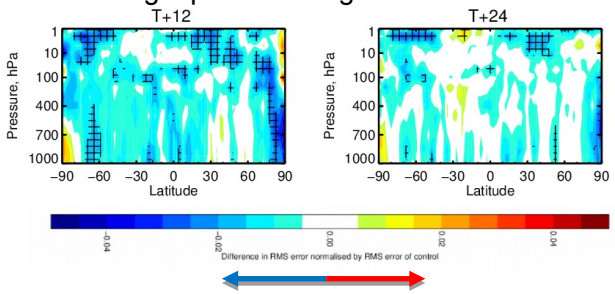
V. Leslie & I.Osaretin, MIT LL

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

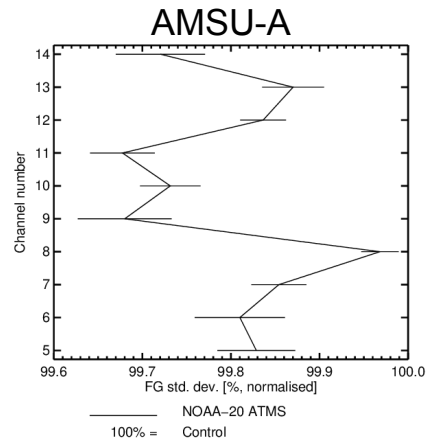
Assimilation experiment results – From two and half months

- **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



Good Bad



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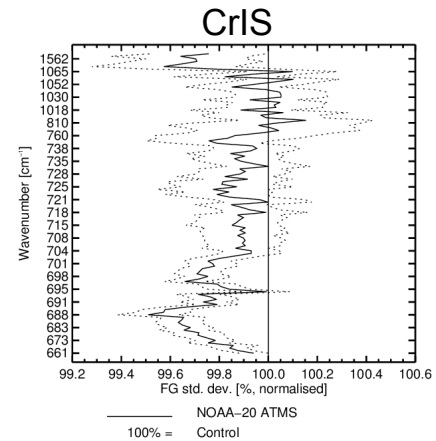

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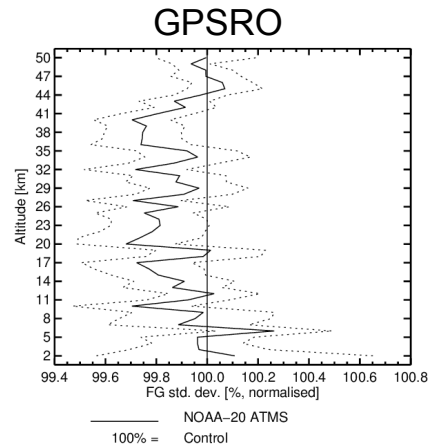

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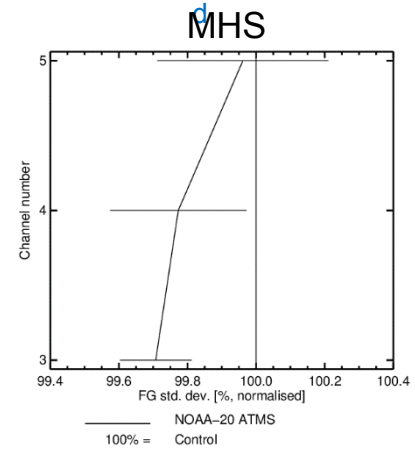


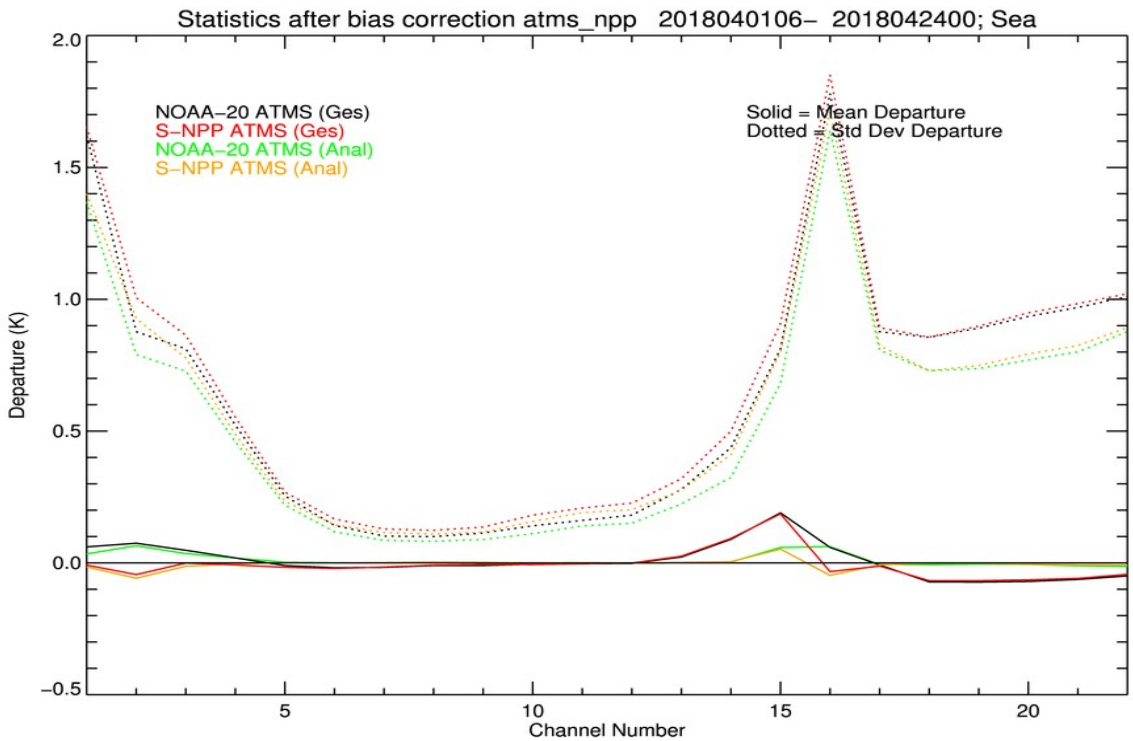
Good Bad

Courtesy: Peter Weston and Niels Bormann

NOAA/EMC NOAA-20 ATMS Radiance Assimilation

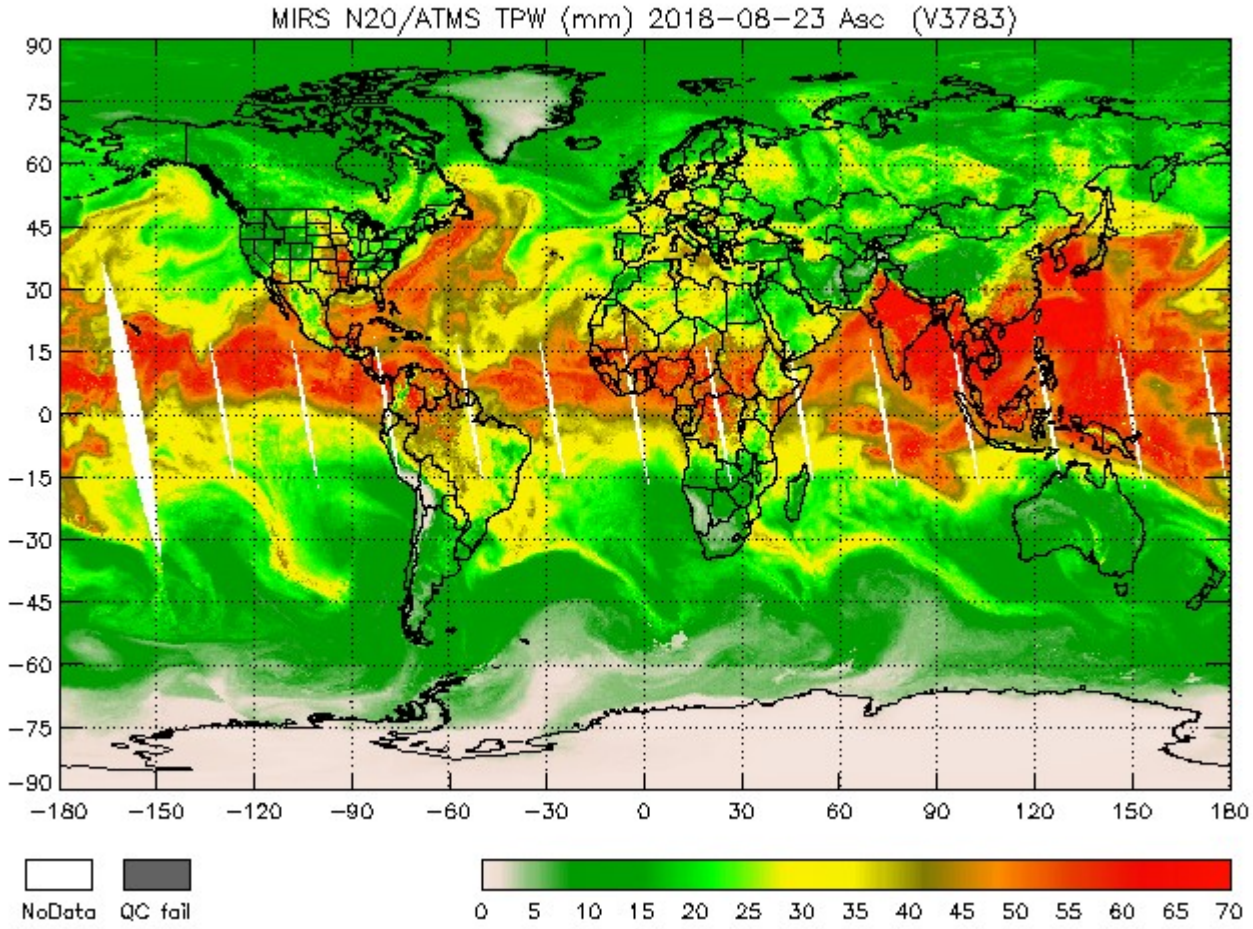
N20 ATMS TDR data look good;
Striping appears to be less of an issue compared to S-NPP
Number of observations between N20 and S-NPP passing QC is comparable.

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



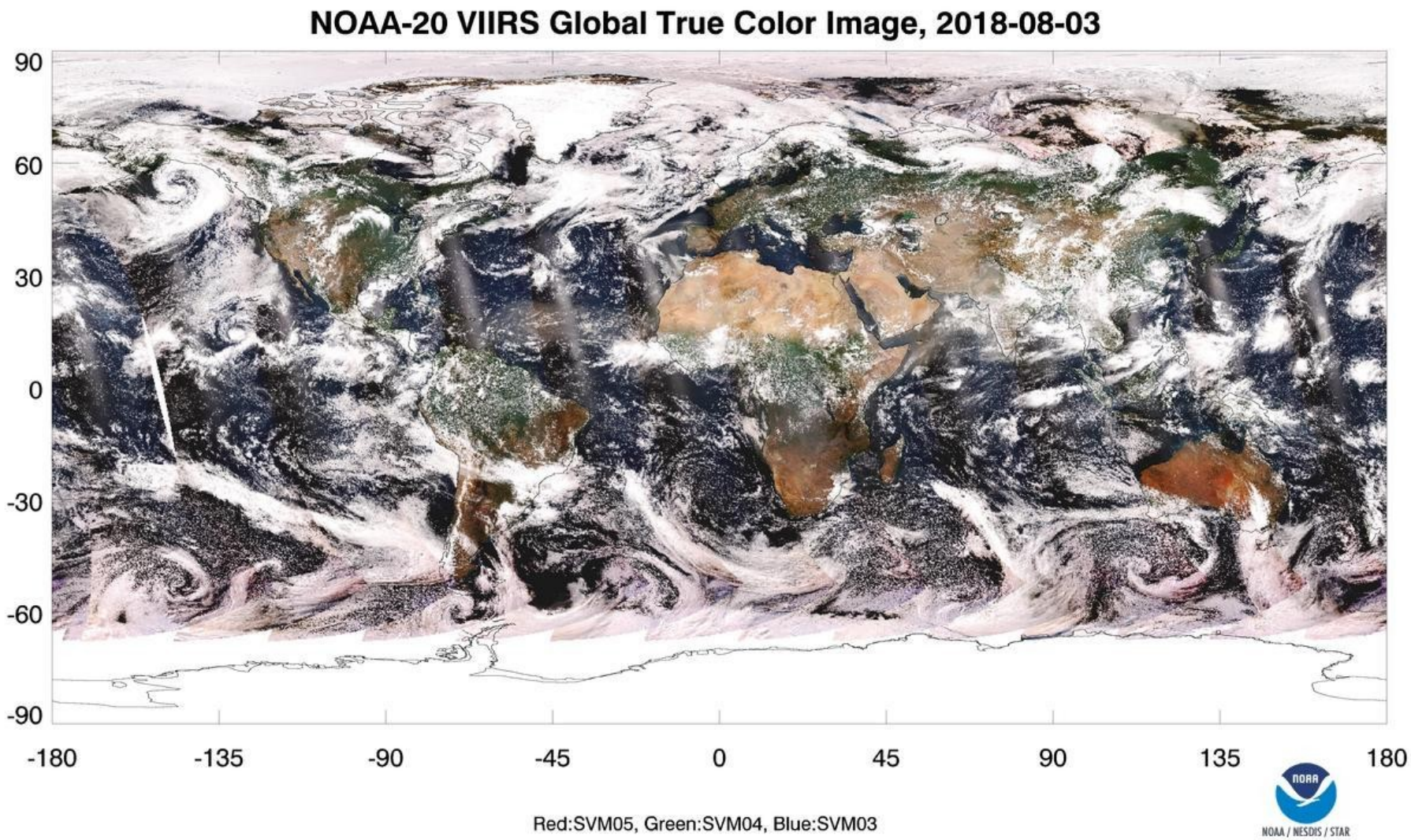
Courtesy: Andrew Collard, John Derber, Yangrong Ling

Total Precipitable Water (2018-08-23)



NOAA20 VIIRS - Progress Since Launch

- Code and LUT corrections to enable the IDPS production of VIIRS First Light Image
- Developed and delivered updated LUTs (> 40) to operations to achieve Validated Maturity of NOAA-20 VIIRS SDR as scheduled
- Completed all major Post Launch Test (PLT) tasks to ensure the quality of SDR produced by IDPS
- Developed and delivered monthly precision lunar position predictions for operational lunar calibration maneuver (ongoing)
- Developed and delivered monthly DNB, RSB LUT calibration updates, and DNB straylight correction (ongoing)
- Developed and delivered postlaunch mounting matrix updates to IDPS and improved the geolocation uncertainty from a few kilometers to <200m.


NOAA-20 VIIRS Global True Color Image, 2018-08-03
90
60
30
0
-30
-60
-90
-180
-135
-90
-45
0
45
90
135
180
Red:SVM05, Green:SVM04, Blue:SVM03
NOAA / NESDIS / STAR

NOAA-20 VIIRS SNR/NEDT Performance (May 2018)

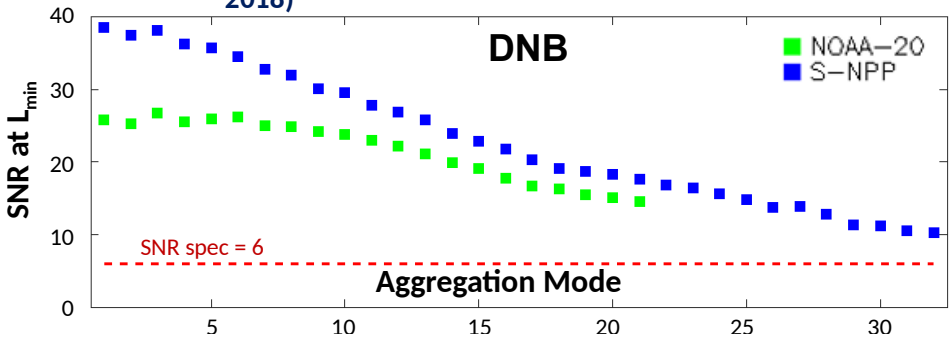
Band	L_typ	SNR Spec	NOAA-20 (on-orbit)	S-NPP (on-orbit)
M1 LG	155	316	1115	1045
M1 HG	44.9	352	644	588
M2 LG	146	409	1012	1010
M2 HG	40	380	573	572
M3 LG	123	414	1057	988
M3 HG	32	416	686	628
M4 LG	90	315	857	856
M4 HG	21	362	551	534
M5 LG	68	360	762	631
M5 HG	10	242	383	336
M6	9.6	199	413	368
M7 LG	33.4	340	708	631
M7 HG	6.4	215	523	457
M8	5.4	74	319	221
M9	6	83	297	227
M10	7.3	342	653	586
M11	1	90	198	22*
I1	22	119	224	214
I2	25	150	285	264
I3	7.3	6	174	149

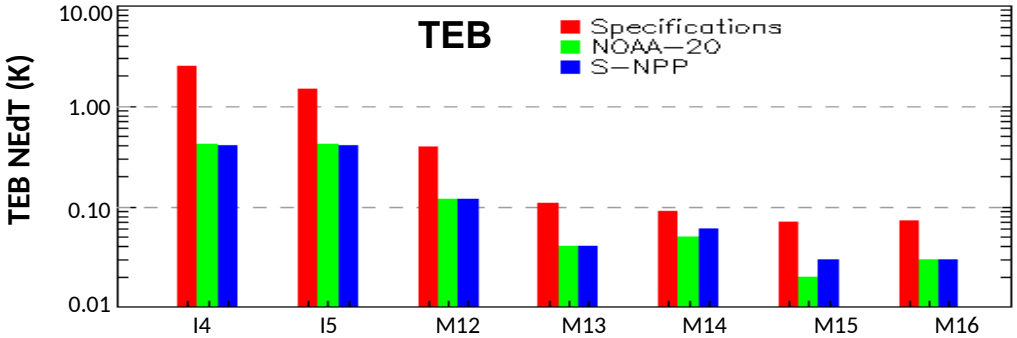
Band	T_typ	NEDT Spec	NOAA-20 (on-orbit)	S-NPP (on-orbit)
M12	270	0.396	0.12	0.12
M13	300	0.107	0.04	0.04
M14	270	0.091	0.05	0.06
M15	300	0.07	0.02	0.03
M16	300	0.072	0.03	0.03
I4	270	2.5	0.42	0.4
I5	210	1.5	0.42	0.4

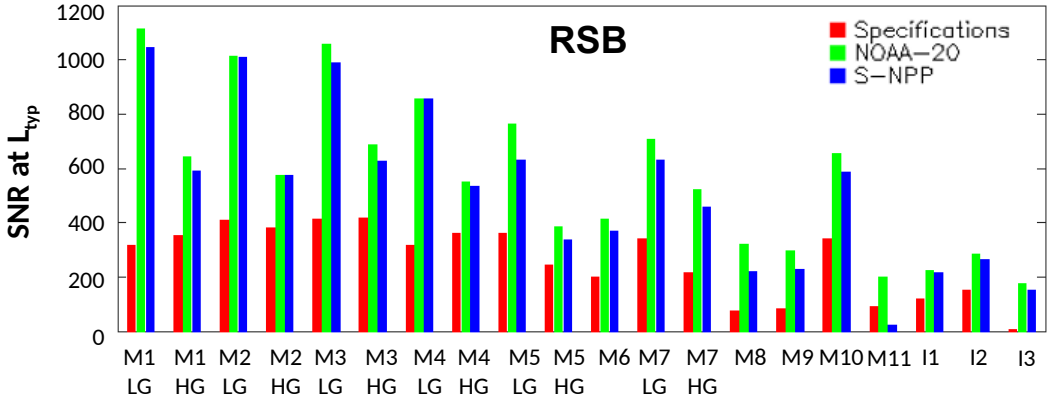
Band	L_min	SNR Spec	NOAA-20 (on-orbit)	S-NPP (on-orbit)
DNB**	3	6	>10	>10

* For S-NPP M11, L_{typ} = 0.12 W/m^2-sr-µm

** On-orbit SNR of DNB at L_{min} was evaluated by using the DNB OBC-BB data







All channel noise performance meet specification, comparable to SNPP (I3 bad detector excluded)

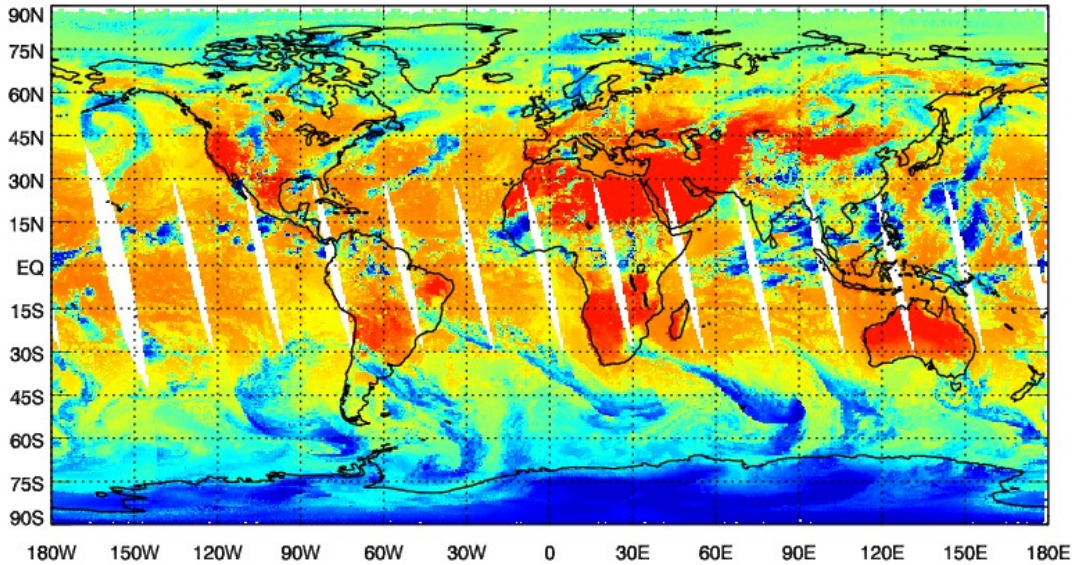

NOAA20 4 August 2018

NOAA 20 CrIS SDR Progress Since Launch

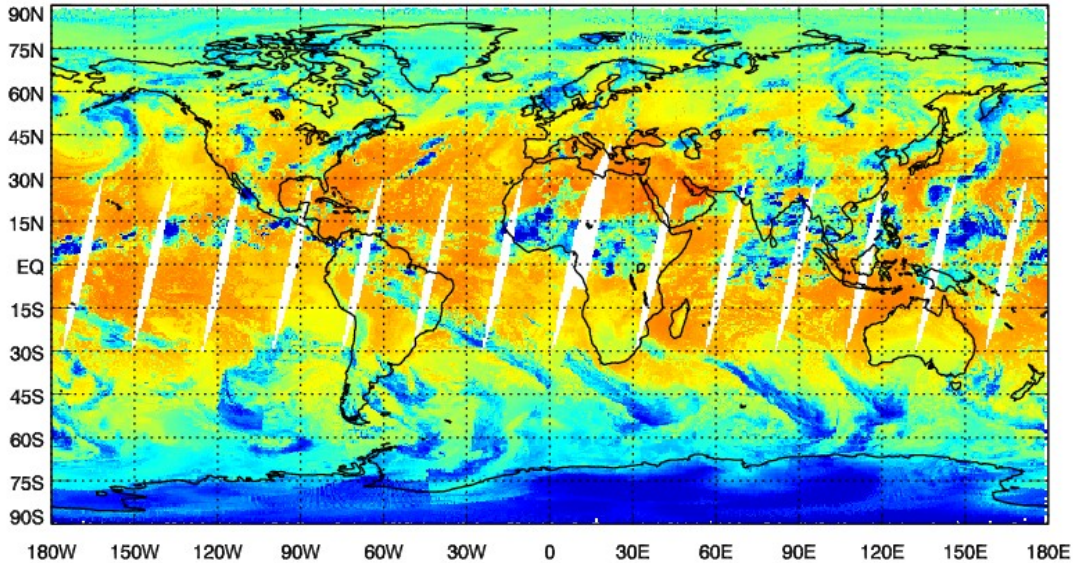
- NOAA-20 CrIS SDR products have been reliably produced by IDPS since detectors first went cold on 01/04/2018.
- Delivered 5 DAPs to IDPS
- RDR generator software package development: (1) STAR NL correction coefficient generator; (2) STAR ILS parameter generator; (3) STAR CITS unpacker to generate level 1a product; (4) STAR CITS geolocation to generate geolocation data; (5) STAR RDR generator

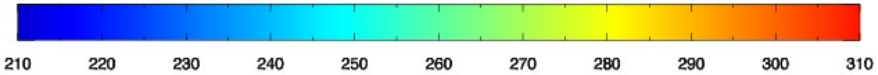
N20 CrIS Brightness Temperature, 11 μm (900 cm^{-1}), Mapped, Ascending, 08/18/2018

Updated at Aug 19 12:38:46 2018 UTC



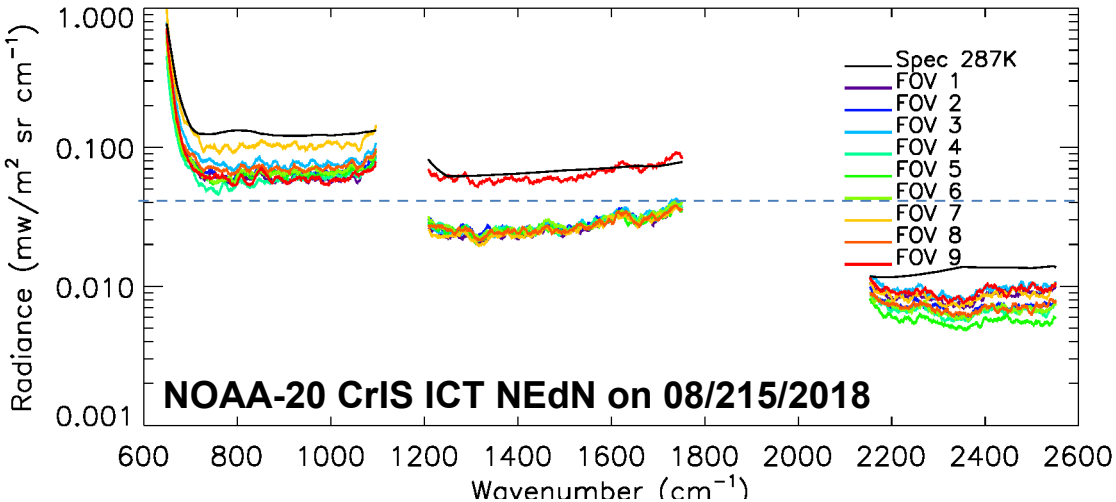
N20 CrIS Brightness Temperature, 11 μm (900 cm^{-1}), Mapped, Descending, 08/18/2018

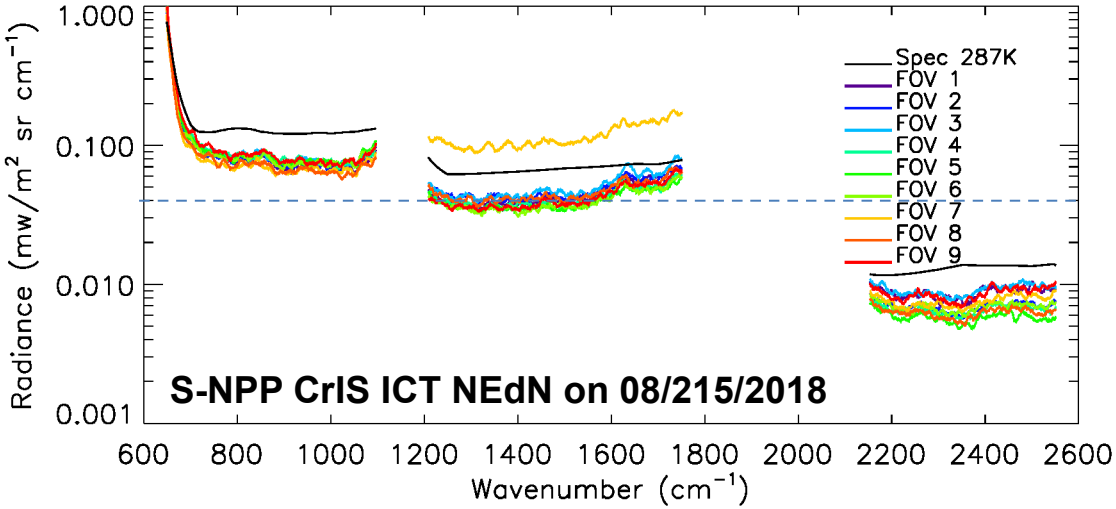




Comparison Between S-NPP and NOAA-20 CrIS NEdN

NOAA-20 CrIS MWIR NEdN shows better performance than S-NPP for FOVs 1-8

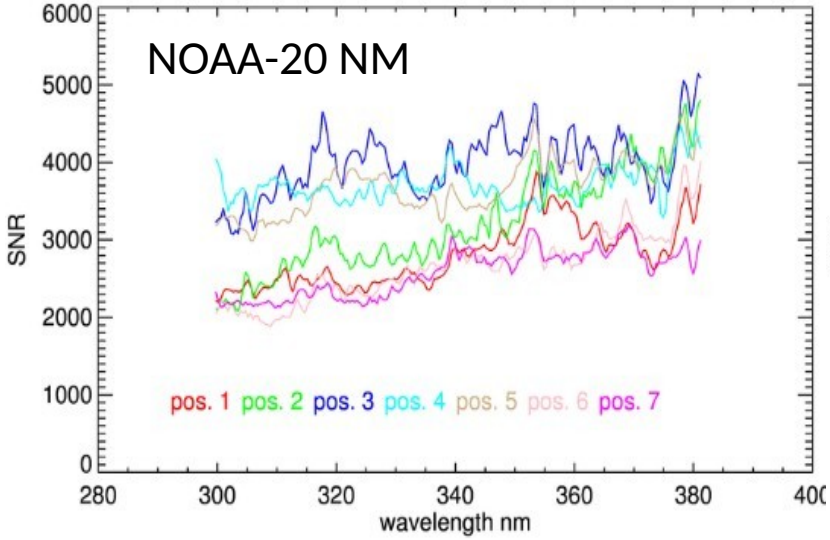


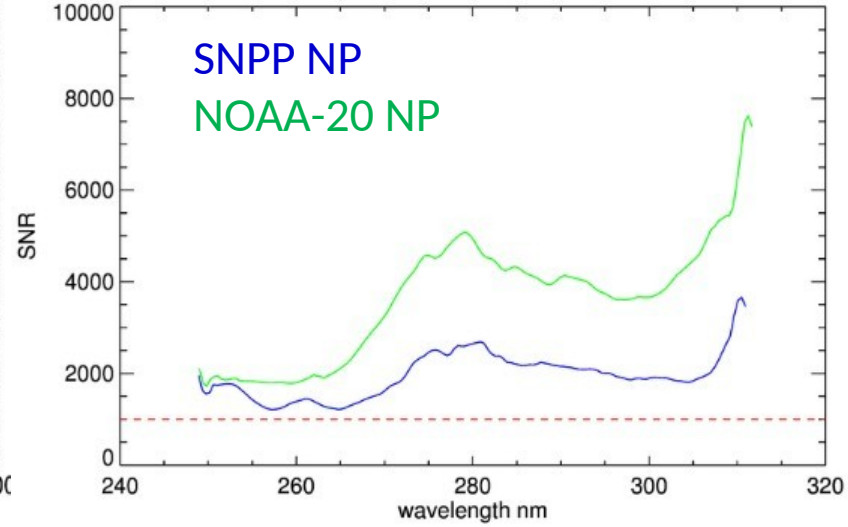


NOAA20 OMPS Progress Since launch

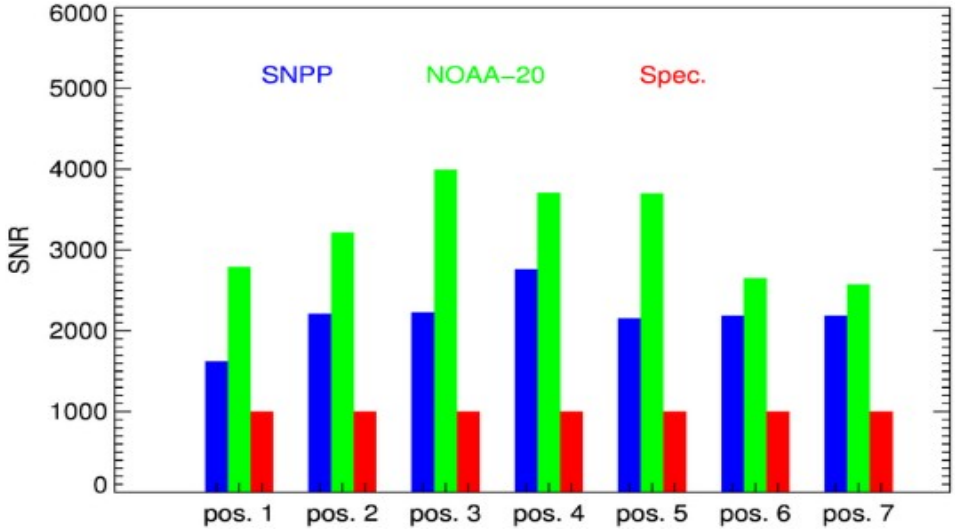
- Delivered 66 tables
- Code Change Deliveries: 4
- EDRs are being successfully retrieved from the SDRs/ GEOs.

Solar View Noise Meets Requirements

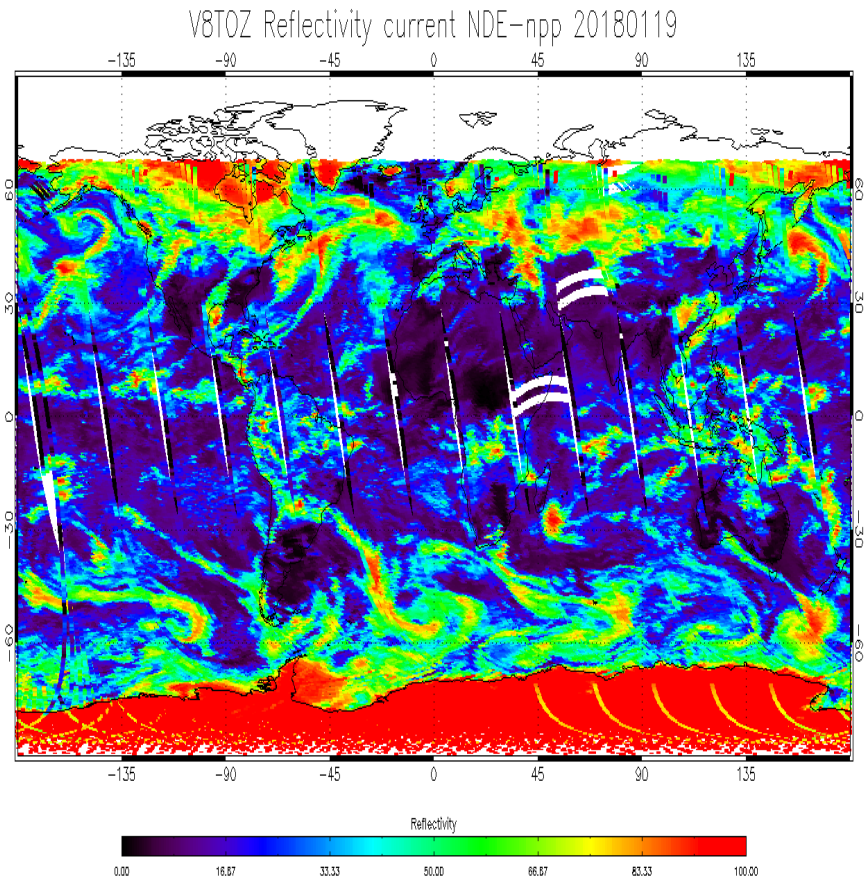


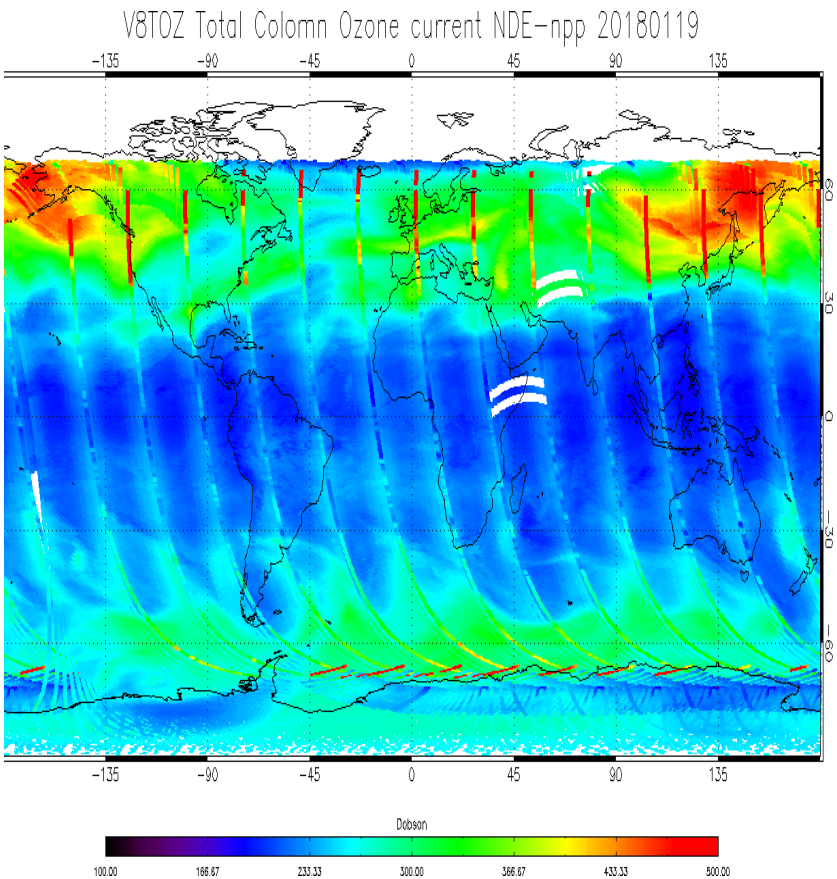


- Sensor SNR comparison with SNPP and Spec.
- Spec. SNR = 1000
- NOAA-20 shows a better performance

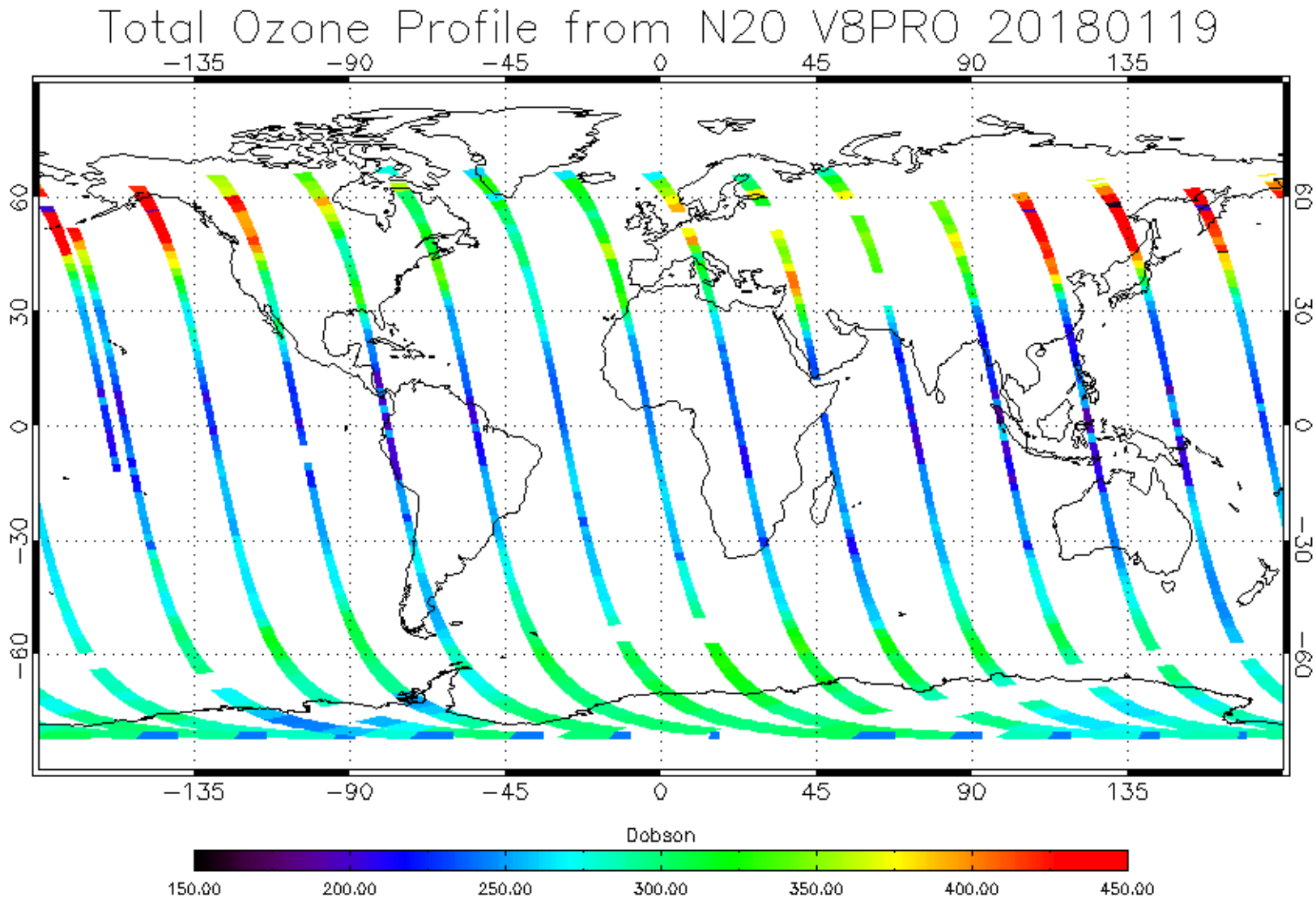


NOAA 20 OMPS NM Retrieval Prodcuts





NOAA-20 NP Retrieval Products



NOAA 20 OMPS Summary

- At the current stage, the NOAA-20 OMPS on-orbit performances are doing well. Main performance parameters were compared for before and after launch, as well as between SNPP and N-20. The results are consistent and are expected.
- CCD performance, in terms of electronic bias, readout noise, LED signal drifting, nonlinearity and change in dark currents are all normal.

- Big thanks for the dedicated and hard work of each of the contributing organizations
- Team work has been and continues to be exceptional

NOAA-20 VIIRS SDR Cal/Val Team

PI	Organization	Team Members	Roles and Responsibilities
C. Cao	STAR		Team lead, calibration/validation, SDR science, coordination, oversight
S. Blonski / W. Wang	STAR/ERT	J. Choi, Y. Gu, B. Zhang, A. Wald	Flight & operations interface; maneuver support; VIIRS SDR cal/val (prelaunch studies; software code changes and ADL tests; postlaunch analysis, monitoring and LUT update; operations support; anomaly resolution); postlaunch cal/val tasks.
X. Shao$_{(1/2)}$	UMD/CICS	S. Uprety, Y. Bai, E. Lynch, and students	DNB operational calibration, straylight correction, geolocation validation, intercomparisons, solar/lunar calibration; image analysis& quality assurance; postlaunch cal/val tasks, documentation.
I. Guch	Aerospace	G. Moy, E. Haas, S. Farrar, F. Sun, and many others	Postlaunch cal/val tasks; independent analysis.
J. Xiong	NASA/VCST	G. Lin, N. Lei, J. McIntire, and others	Flight support, geolocation, postlaunch cal/val tasks; independent analysis,
C. Moeller	U. Wisconsin	C. Moeller, J. Li	VIIRS RSR, CrIS comparison, DCC calibration
JPSS	JPSS	R. Marley, C. Rossiter B. Guenther	Collaboration

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, manage PLT and data analyze
Vince Leslie	MIT/LL	Idahosa Osaretin, Mark Tolman	ATMS instrument performance and data quality assessments, PLT data evaluation
Wesley Berg	CSU/CIRA		ATMS and GPM WG band cross-calibration
Deirdre Bolen	JPSS/JAM		ADR/PCR support

CrIS Cal/Val Team Members

PI	Organization	Major Task
Flavio Iturbide-Sanchez	NOAA/STAR	Project management, SDR team coordination and algorithm test in IDPS, calibration and geolocation science support, inter-comparison, CrIS SDR data quality and monitoring
Changyong Cao (was acting)		
Yong Chen	CICS/UMD	Project management, SDR team coordination and algorithm test in IDPS
Dave Tobin	U. of Wisconsin (UW)	Radiometric calibration, non-linearity coefficients, polarization, inter-comparison, simulation
Larrabee Strow	U. of Maryland Baltimore County (UMBC)	Spectral calibration, ILS parameters, inter-comparison, simulation
Deron Scott	Space Dynamic Lab (SDL)	Noise characterization, bit trim and impulse noise mask, anomaly analysis
Dan Mooney	MIT/LL	Correlated/uncorrelated noise characterization, residual analysis and ringing, simulation
Dave Johnson	NASA Langley	NASA flight support, instrument science
Lawrence Suwinski	Harris	PLT tests, on-orbit instrument performance
Joe Predina	Logistikos	Optimal laser wavelength setting, noise, calibration algorithm
Deirdre Bolen	JPSS/JAM	DR support

OMPS Cal/Val Team Members

PI	Organization	Team Members	Roles and Responsibilities
Trevor Beck, Chunhui Pan	NOAA, UMD-CICS	Eve-Marie Devaliere, Shouguo Ding, Sri Madhavan, Ding Liang	Coordination; instrument and product performance monitoring.
Glen Jaross	NASA	Tom Kelly, Rama. Mundakkara, Mike Haken, Colin Seftor	Instrument scientist; TVAC data acquisition and analysis; SDR algorithms
Laura Dunlap	STC/AMP		Algorithm Changes; DR and issues tracking
Sarah Lipscy	BATC		Instrument Scientist; prelaunch test

JPSS VIIRS SENSOR DATA RECORD (SDR)

Changyong Cao
VIIRS SDR team lead
NOAA/NESDIS/STAR

Hurricane Lane
8/23/2018 23:48UTC

Outline

- Cal/Val Team Members
- Sensor/Algorithm Overview
- S-NPP/N-20 Product(s) Performance
- Major Risks/Issues and Mitigation
- Milestones and Deliverables
- Future Plans/Improvements
- Summary

VIIRS SDR Cal/Val Team

PI	Organization	Team Members	Roles and Responsibilities
C. Cao	STAR		Team lead, calibration/validation, SDR science, coordination, oversight
S. Blonski / W. Wang	STAR contractor team	J. Choi, Y. Gu, B. Zhang, A. Wald	Flight & operations interface; maneuver support; VIIRS SDR cal/val (prelaunch studies; software code changes and ADL tests; postlaunch analysis, monitoring and LUT update; operations support; anomaly resolution); postlaunch cal/val tasks.
X. Shao/E. Lynch	UMD/CICS team	S. Uprety, Y. Bai, E. Lynch, and students	Precision lunar position for maneuver, DNB operational calibration, straylight correction, geolocation validation, intercomparisons, solar/lunar calibration; image analysis& quality assurance; postlaunch cal/val tasks, documentation.
I. Guch	Aerospace team	G. Moy, E. Haas, S. Farrar, F. Sun, and many others	Prelaunch/Postlaunch connection at vendor facility; independent analysis of special tasks.
J. Xiong	NASA/VCST team	G. Lin, N. Lei, J. McIntire, and others	Flight support, geolocation, postlaunch cal/val tasks; independent analysis,
C. Moeller	U. Wisconsin team	C. Moeller, J. Li	VIIRS RSR, CrIS comparison, DCC calibration
JPSS	JPSS team	R. Marley, C. Rossiter B. Guenther	Operations, collaboration

VIIRS SNR/NEDT Performance

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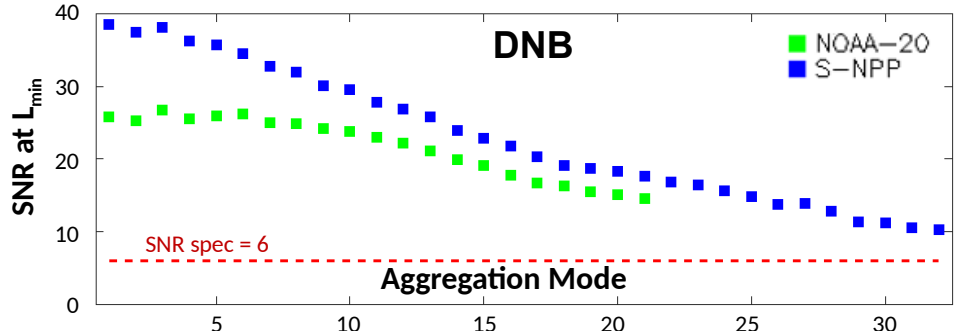
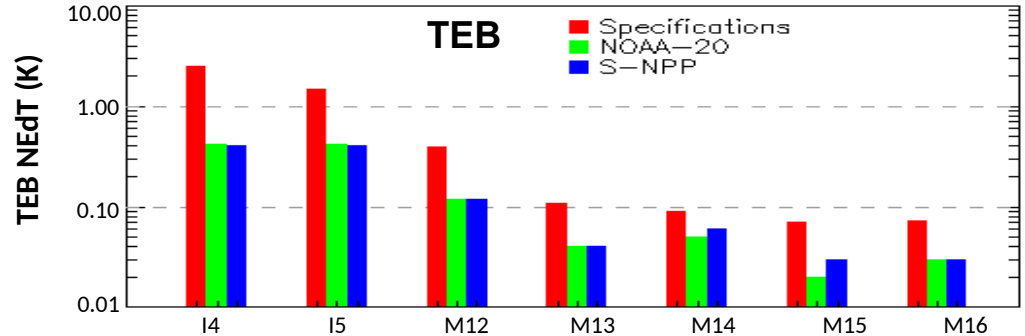
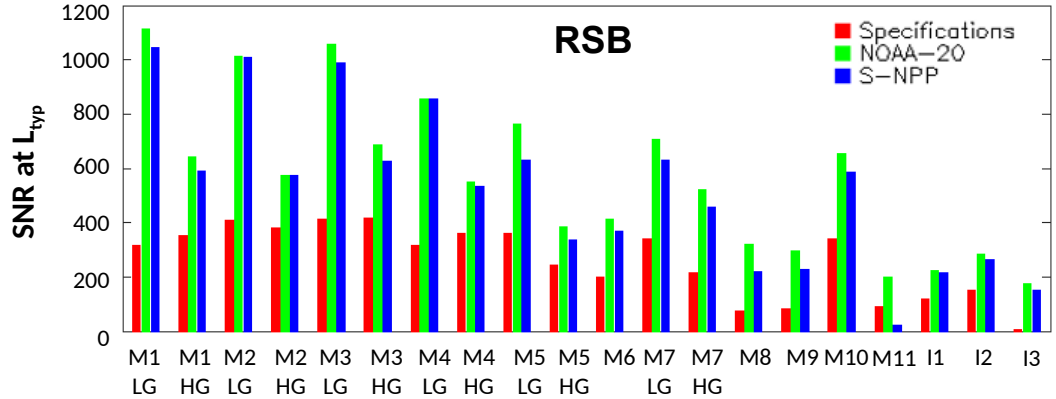
Band	L_min	SNR Spec	NOAA-20 (on-orbit)	S-NPP (on-orbit)
DNB**	3	6	>10	>10

* For S-NPP M11, L_{typ} = 0.12 W/m^2-sr-µm

** On-orbit SNR of DNB at L_{min} was evaluated by using the DNB OBC-BB data



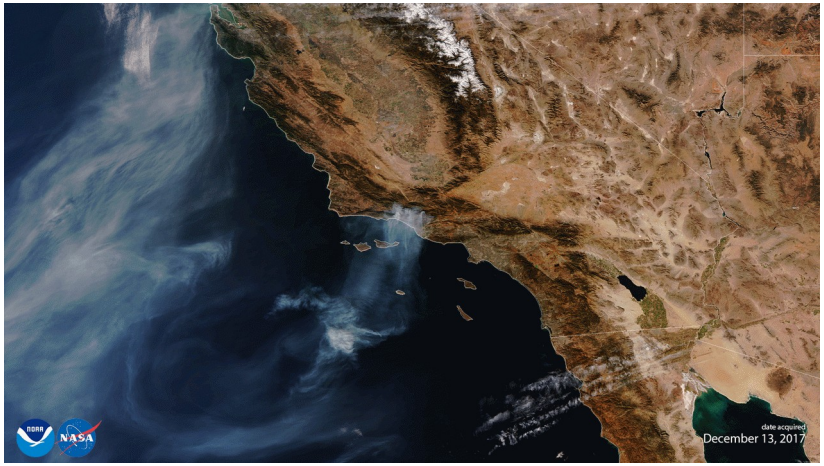




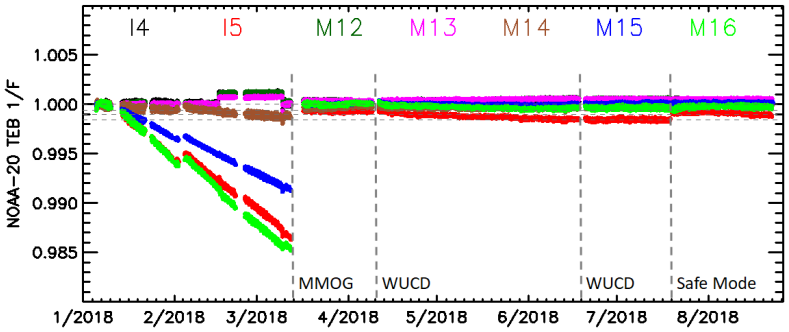
All channel noise performance meet specification, comparable to SNPP (I3 bad detector excluded)

FY18 Top Accomplishments

- NOAA-20 postlaunch investigation and mitigation of initial production of VIIRS SDR; Timely diagnosed and resolved ground processing anomaly to support the mission critical First Light Image.
- Prepared and performed NOAA-20 VIIRS Post Launch Test (PLT) tasks to ensure the quality of SDR; Development and deployment of updated LUTs to achieve Provisional and Validated Maturity of NOAA-20 VIIRS SDR as scheduled.
- Support monthly operational lunar calibration with precision lunar position predictions.
- Closely monitored NOAA-20 TEB performance and successfully supported LWIR degradation investigations.
- Post-launch evaluation and significant improvements of NOAA-20 VIIRS geolocation accuracy
- S-NPP VIIRS version 2 OnDemand reprocessing with the latest methodologies (annual oscillation mitigation in SD F-factors, Kalman filtering using DCC, SNO and Lunar F-factors).

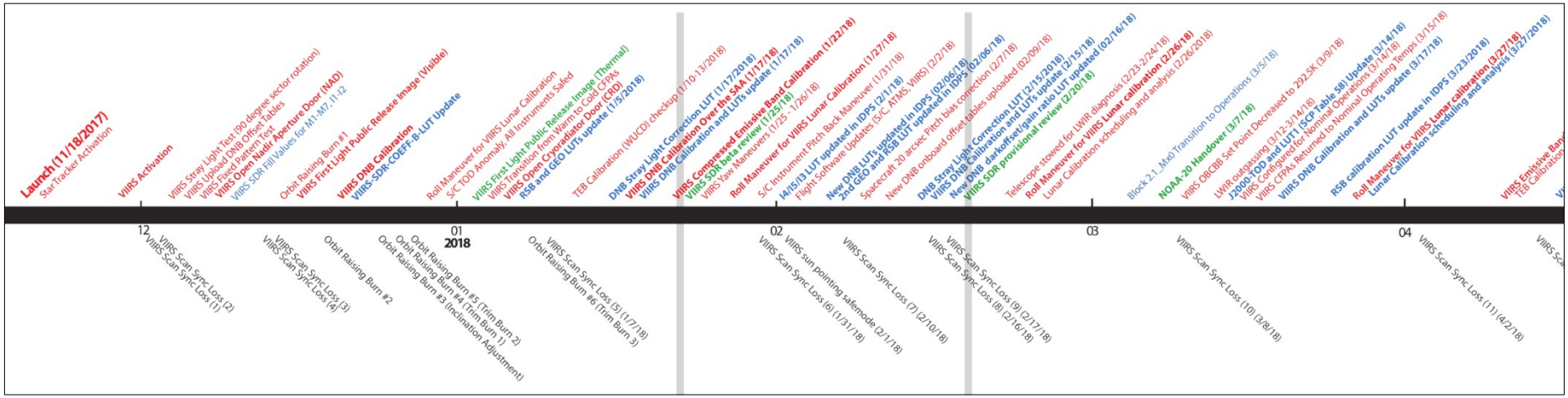


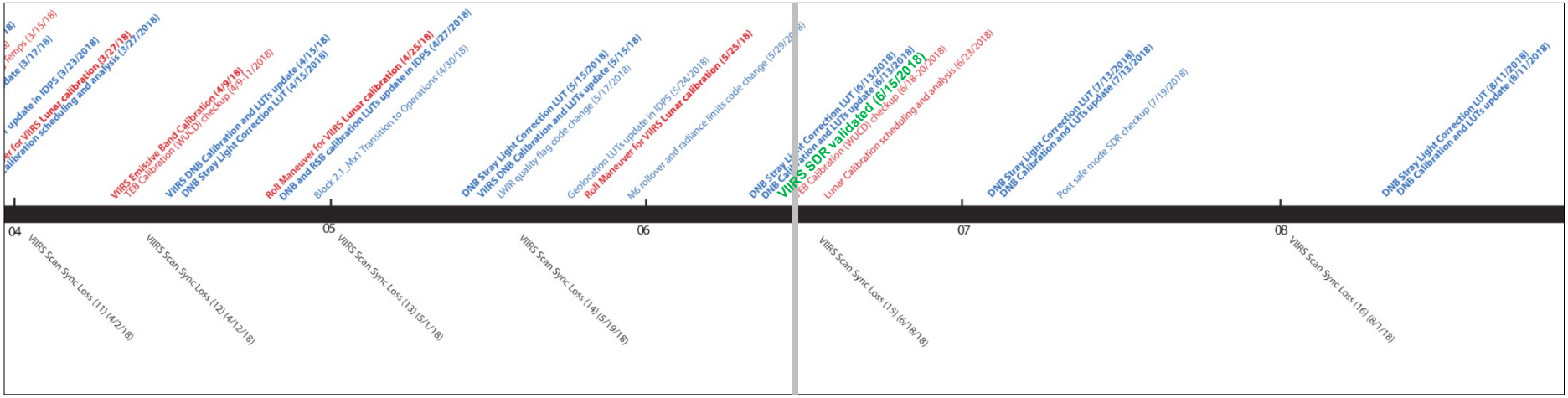
NOAA-20 VIIRS First Light Image



NOAA-20 VIIRS TEB LWIR Degradation

NOAA-20 VIIRS Events





Red= mission operation **Green= major milestone** **Blue= IDPS update**

VIIRS Performance and Error Budget

Attribute Analyzed	L1RD Threshold	Pre-Launch Performance	On-orbit Performance	Meet Requirement?	Latest results
RSB Bias	2%	2%	Most bands within 2% relative to SNPP (@Low latitude SNOs)	Yes, meet the +/- 2% requirement; Exceptions: M5, M7 (I2), (M4 atyp)	-N20 biased low by 2% for most bands compared to SNPP -N20 M5/M7 calibration are more consistent with other radiometers such as MODIS
TEB Bias	0.1K @ OBCBB	0.1K	<0.1K compared to CrIS during nominal operations	Yes.	-Bias during WUCD up to 0.05K. Recommended to reduce WUCD to annual. -Scan angle dependent bias under investigation (splinter meeting)
DNB Bias	5-10% (LGS) 10-30% (MGS) 30-100% (HGS)	4.4-6.5% (LGS) 7.6-9.0% (MGS) 10.5-54.2% (HGS)	4%±1.4% compared to SNPP DNB (LGS) 3.5%±5% compared to SNPP DNB (HGS)	Yes.	Calibration consistent with Suomi NPP

Note: DNB L1RD threshold and prelaunch performance are for aggregation modes 1-21, provided for 3 gain stages, at 0.5 *Lmax and low radiance for LGS, at high and low radiance levels for MGS and HGS.

Major Risks/Issues and Mitigation

Risk/Issue	Description	Impact	Action/Mitigation
N20 VIIRS RSB constant bias relative to S-NPP	NOAA-20 RSB calibration has a constant bias (2%) lower than that of S-NPP due to prelaunch characterization	Consistency for products requiring absolute calibration may be affected	- SMEs at Aerospace and NASA to investigate prelaunch characterization issues and recommend fundamental solutions (splinter session) - Closely monitor biases between NOAA-20 and S-NPP using multiple methods
M15/16 bias	M15/16 scan angle, and scene temperature dependent bias relative to CrIS	Affects accuracy at high scan angle and low temperatures	Further comparison and investigation
Sync loss	The loss of synchronization between the RTA and HAM occasionally	Loss of ~2 mins of data periodically	No fix except for future model improvements
N20 VIIRS RSB H-factor stability	Instability in H-factor due to uncertainties in SDSM may lead to calibration issues	Products requiring time series analysis may be impacted due to instability in early products	- Ideally more yaw maneuvers will be needed but that plan was not supported by operations. - VIIRS SDR team developed a new algorithm to reduce the uncertainties and it will further improve as more data collected over time.
LWIR degradation	NOAA-20 LWIR degradation unexpected due to water vapor	Longterm impact on noise performance	- Mid mission outgassing resolved this issue - Will closely monitor the performance

FY19 Milestones and Deliverables

Task	Description	Deliverables	Scheduled Date
Monthly Lunar, DNB calibration &straylight correction	Precision lunar position calculation for lunar maneuver; DNB VROP support, monthly; complete DNB straylight correction LUT development (monthly based)	Precision lunar position and DNB monthly calibration	Monthly
Geolocation LUT & code change to support J2	The encoder data was hardcoded in the operational code. This needs to be changed in both the LUT and code to make it work for J2	Operational code and LUT for all VIIRS	12/2018
TEB cal during lunar intrusion	Moon in VIIRS spaceview corrupts the calibration. The new algorithm fixes this problem.	Algorithm and code to operations	3/2019
Remove Obsolete LUTs	Some of the VIIRS operational LUTs are obsolete and need to be removed after an impact assessment	Updated operational codes &LUTs	3/2019
J2 TVAC RDR	Convert J2 TVAC data to RDR for testing	RDR data based on TVAC data	3/2019
J2 VIIRS LUT development	Develop VIIRS LUT based on prelaunch calibration	Initial version of J2 VIIRS LUT	6/2019
Intercal web site	Develop a website for intercal between VIIRS and ABI following GSICS standard	Website	9/2019

User Feedback and Summary

Name	Organization	Application	User Feedback - User readiness dates for ingest of data and bringing data to operations
Andy Heidinger	STAR/UW	Cloud Mask	Positive feedback on NOAA20 M5/M7
Menghua Wang	STAR	Ocean Color	Ocean view website: https://www.star.nesdis.noaa.gov/sod/mecb/color/ocview/ocview.html#date=20180607/zoom=2/lat=0/lon=0/tc=true/l2=true/sens=VIIRSJ1/proj=4326/algo=noaa_msl12_nrt/prod=chl/ave=daily/cbar=false/gran=false/coast=true/grid=false
Tom Atkins/Lihang Zhou	STAR	Alaska Watch	Alaska watch website: https://www.star.nesdis.noaa.gov/jpss/alaskawatch/
Alex Ignantov	STAR	SST	SST website: https://www.star.nesdis.noaa.gov/sod/sst/micros/#
Ivan Cisiszar	STAR	Fire	Fire website: http://viirsfire.geog.umd.edu/map/map_v2.php
Don Hillger	STAR/CIRA	Imagery	Presentation later
Eric Steven	Alaska/GINA	Operational user	http://feeder.gina.alaska.edu/
Shobha Kondragunta	STAR	Aerosol	IDEA website: https://www.star.nesdis.noaa.gov/smcd/spb/aq/index.php

VIIRS Reprocessing

S-NPP VIIRS V1

- **Consistent IDPS baseline calibration using the latest algorithms and LUTs**
- Introduced "bias correction" term to produce OC equivalent SDR as an option; also correct M5&M7 biases
- Thermal band improvements to address saturation and WUCD bias for selected bands
- DNB consistent calibration for all gain stages, less negative radiances, consistent terrain correction
- Geolocation improvements with consistency

S-NPP VIIRS V2 (supersedes V1)

- **VIIRS SDR final baseline calibration**
- Future improvements only require bias correction, instead of reprocessing
- Calibration oscillation correction based on SDSM and BRF physics, instead of smoothing
- Calibration based on STAR VIIRS SDR team's Kalman filter model F-factors, which reconciled Lunar, DCC, SNO calibrations.
- Other improvements (IDPS code correction)
- Official version for NECI archinve

On-Demand Reprocessing

Why?

- VIIRS data volume is large (~1 PB/7 years) There is not enough storage space; NCEI is not yet ready to take the data
- SDR volume is 10x of RDR
- Generating SDR files on the fly is faster than transmitting over the network
- Most users don't need all the data (few have the storage capacity

How?

- Work with specific users to define needs
- Generate the required SDRs only when needed
- User can define spatial and temporal criteria
- SDR can be either generated at STAR or user site
- Will provide fully reprocessed SDR to NCEI when they are ready to accept
- Demonstrating for N20 DNB, and Calibration site data for GSICS

For more details, attend three reprocessing talks at this annual meeting

Future Plans/Improvements

1. Continued monthly Lunar calibration support
2. Continued DNB straylight LUT development
3. Continued vicarious monitoring using DCC, cal/val sites, and geolocation
4. Collaborate with GRAVITE reprocessing early NOAA-20 data; continue developing the OnDemand reprocessing capabilities; establish interface with NCEI/CLASS
5. Contribute to the NASA technical book Volume VIII
6. Possible field campaign: VIIRS DNB SI traceable calibration in collaboration with SDSU and USGS calibration center. Leverage light source developed under NOAA SBIR
7. J2 prelaunch calibration support; LUT and test data development

VIIRS Science Team will continue providing operational cal/val support.

Summary

- STAR VIIRS SDR team has developed full capabilities to support VIIRS calibration/validation, as demonstrated in the NOAA-20 VIIRS postlaunch support.
- Precision lunar prediction is the latest addition to the STAR capability supporting monthly lunar maneuver for mission operations
- Both NOAA-20 and Suomi NPP VIIRS are performing well as expected; the team has identified and will address remaining issues, working closely with users, vendors, and the flight project
- As reprocessing is becoming more mature, more efficient strategies are being developed to meet user needs while optimizing computing power and storage
- In addition to the continued NOAA-20 and Suomi NPP VIIRS support, the VIIRS SDR team is ready to support J2 VIIRS

Backup Slides

- Backup slides

NOAA-20 VIIRS Major Events

- Nov 28, 2017: instrument turn on
- Nov 30, 2017: first SDSM operation
- Dec 08, 2017: first electronics self-test (Ecal)
- Dec 13, 2017: nadir aperture door (NAD) open
- Dec 18, 2018: first DNB calibration (VROP)
- Dec 29, 2017: first lunar calibration (roll maneuver)
- Jan 03, 2018: cryoradiator door open
- Jan 10, 2018: first BB WUCD
- Jan 25, 2018: calibration yaw maneuvers
- Jan 31, 2018: calibration pitch maneuver
- Feb 21, 2018: rotating telescope stow (3 days)
- Mar 12, 2018: mid-mission outgassing.

NOAA-20 ATMS PERFORMANCE HIGHLIGHTS

ATMS SDR Team

Mark Liu, Ninghai Sun, Tiger Yang, Lin Lin, Ed Kim, Lisa McCormick, Joseph Lyu, Craig Smith, Vince Leslie, Idahosa Osaretin, Wes Berg, Kent Anderson, James Fuentes

NOAA STAR, NASA/GSFC, MIT/LL, CIRA/CSU, Northrop Grumman

Presented by Ed Kim and Mark Liu

August 27, 2018

NOAA-20 ATMS First Light Image
(First Light Image for the Entire JPSS Series)

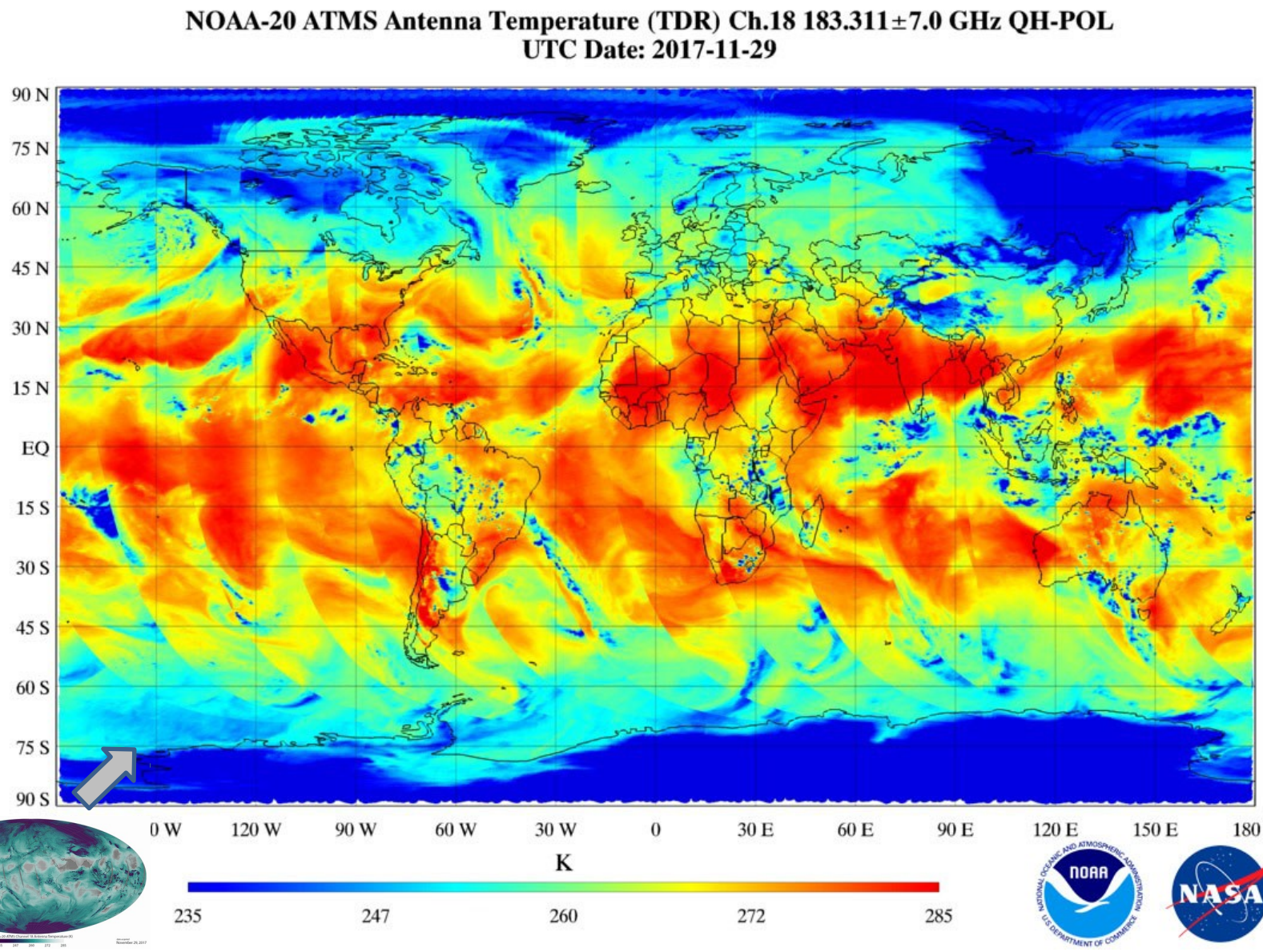
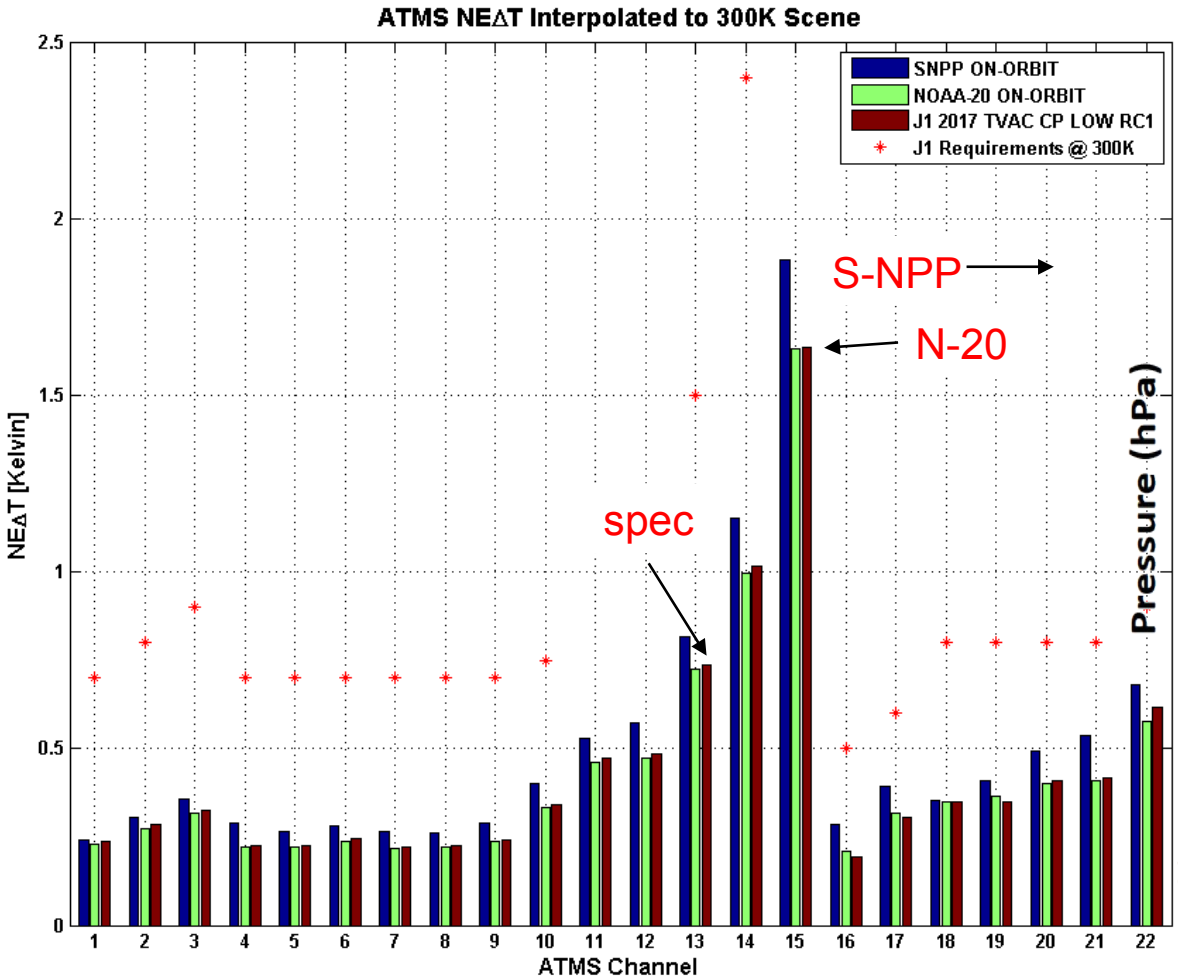


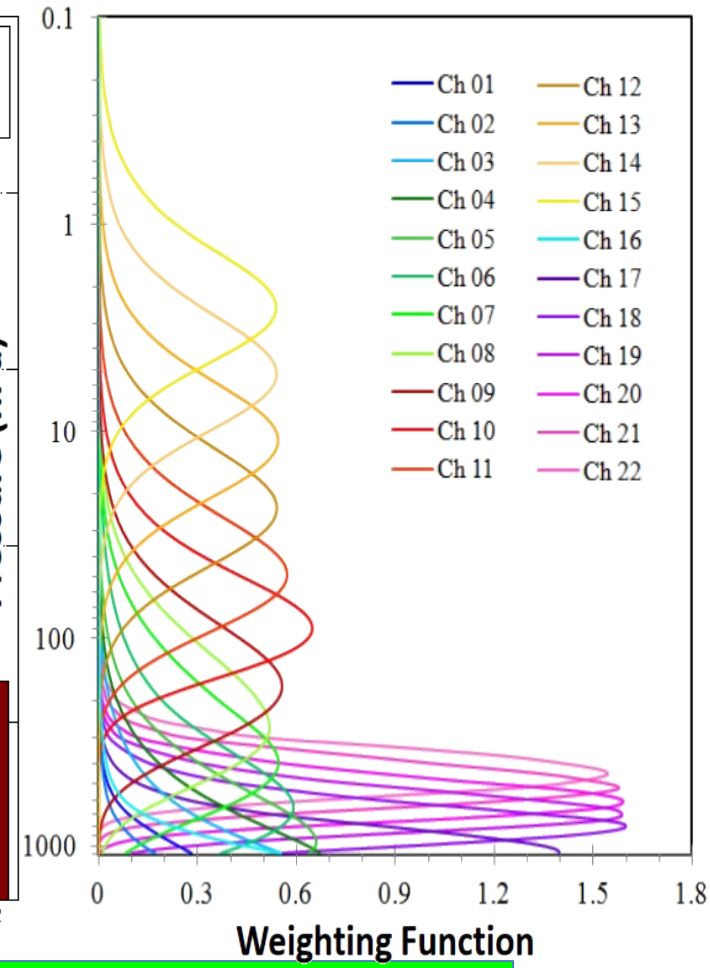
Image from NOAA STAR

ATMS Sensitivity (NEDT)

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

V. Leslie & I.Osaretin, MIT LL

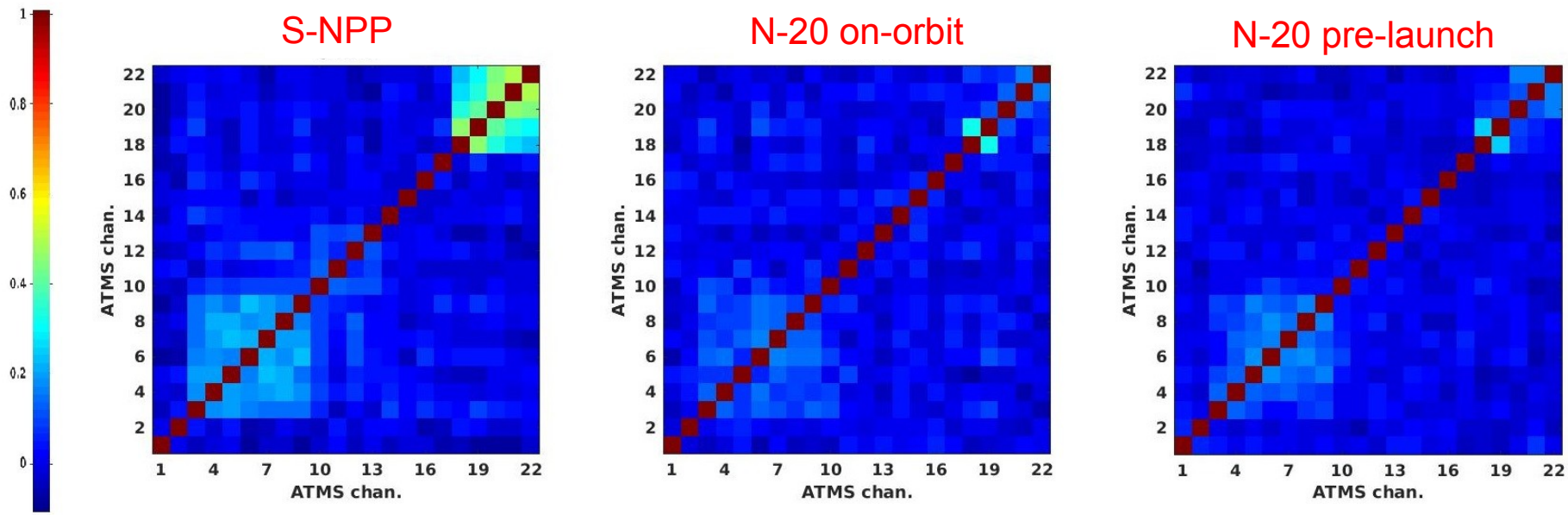




N-20 NEDT on-orbit ~ same as pre-launch and better than S-NPP

ATMS Inter-Channel Correlation

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

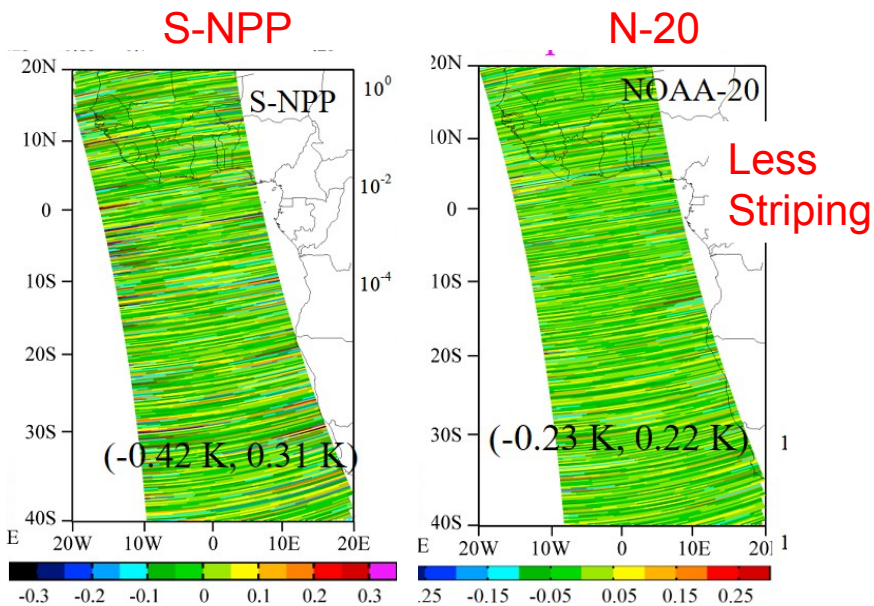


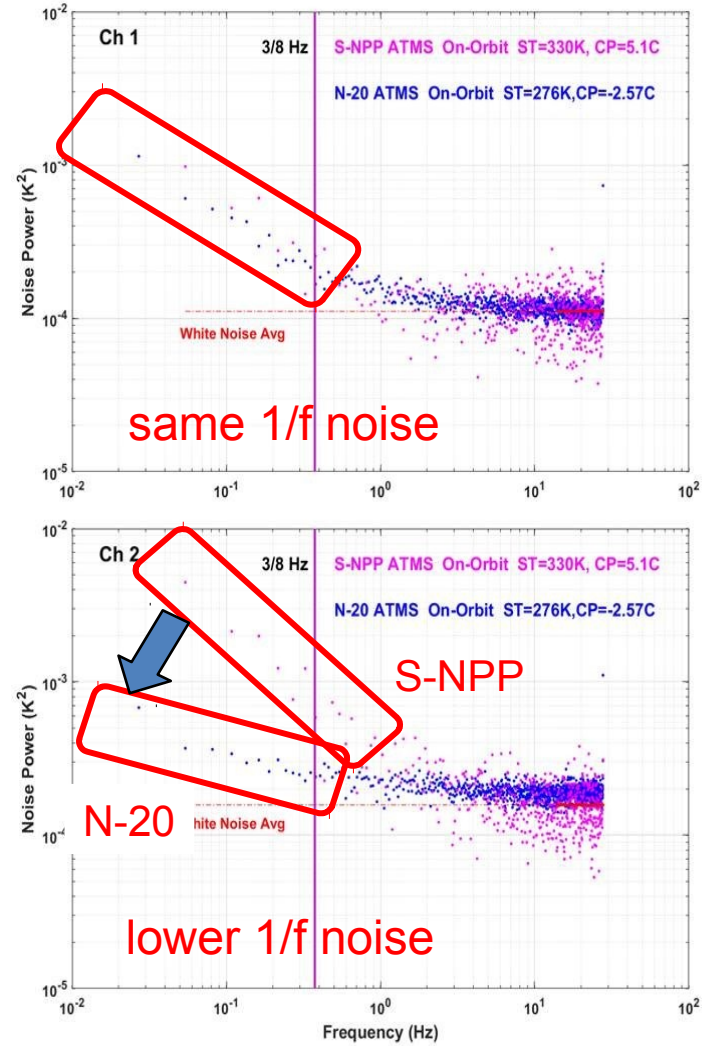
V. Leslie & I.Osaretin, MIT LL

N-20 Noise Correlation <u>Much Better</u> than S-NPP for all Channels

ATMS Noise Power Spectra

NOAA STAR





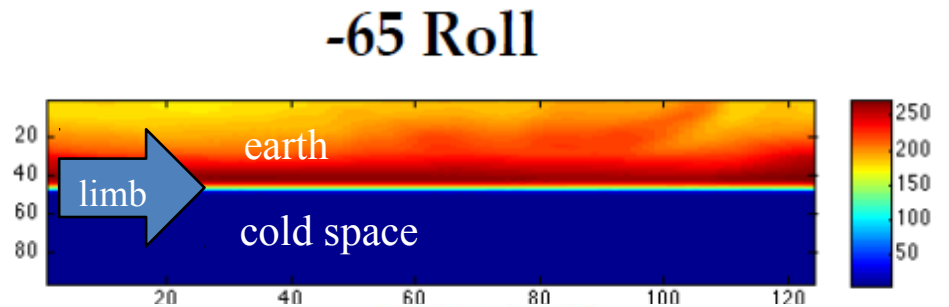
- On-orbit noise power spectra match well with Instrument TVAC results
- Same or better for most channels compared to S-NPP
- Channels with < 1/f noise will have less striping

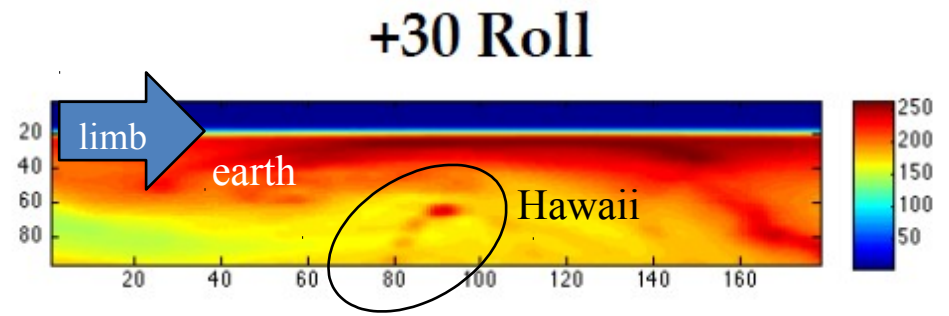
J.Lyu/ NASA GSFC

NOAA-20 Maneuvers

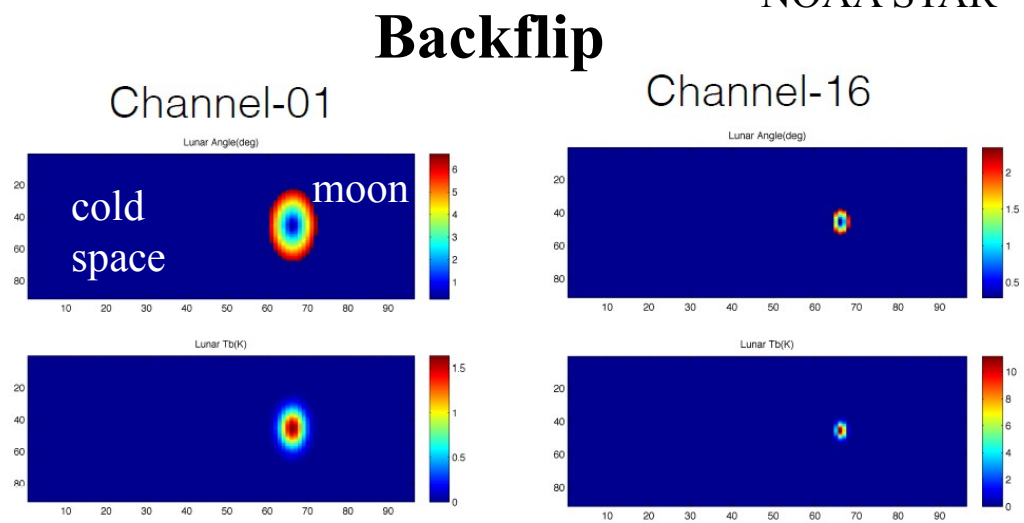
- **Rolls -65deg & +30deg**
  - Antenna pattern/sidelobe check
- **Backflip Maneuver**
  - Antenna pattern/sidelobe check
  - Sidelobe contamination characterized
  - Scan Bias (flat field) determined
  - Reflector Emissivity much better than SNPP
  - Minor lunar intrusion; no significant impact

Maneuver results good





NOAA STAR



Results from Commissioning

- ✓ Space view profile #1 declared optimal
- ✓ Channel NEΔTs stable and lower than S-NPP
- ✓ Noise power spectra same or better for most channels vs. S-NPP
- ✓ Image striping slightly less than S-NPP
- ✓ Inter-channel noise correlation << S-NPP
- ✓ Channel on-orbit effective field-of-view (EFOV), earth sidelobes effects, and antenna pattern derived maneuvers ≅ nominal
- ✓ No *significant* RFI from Ka transmitters so far
- ✓ Passive lunar intrusion coefficients derived (currently off-line fixed); evaluating alternative active mitigation technique
- ✓ No heater activation EMI observed
- ✓ Active geolocation tested for first time; faster determination of pointing accuracy appears achievable

Lessons Learned for J2+

- **#1 lesson: be willing to delay launch in order to address known hardware issues that affect science performance. The decision will pay off.**

- #2 lesson: perform full pre-launch calibration in TVAC: all 3 cold plate temps x 11 scene temps---this is the baseline for J2

- #3 lesson: perform detailed SRF measurements—already planned

- Measure reflector emissivity & adjust SDR algorithm

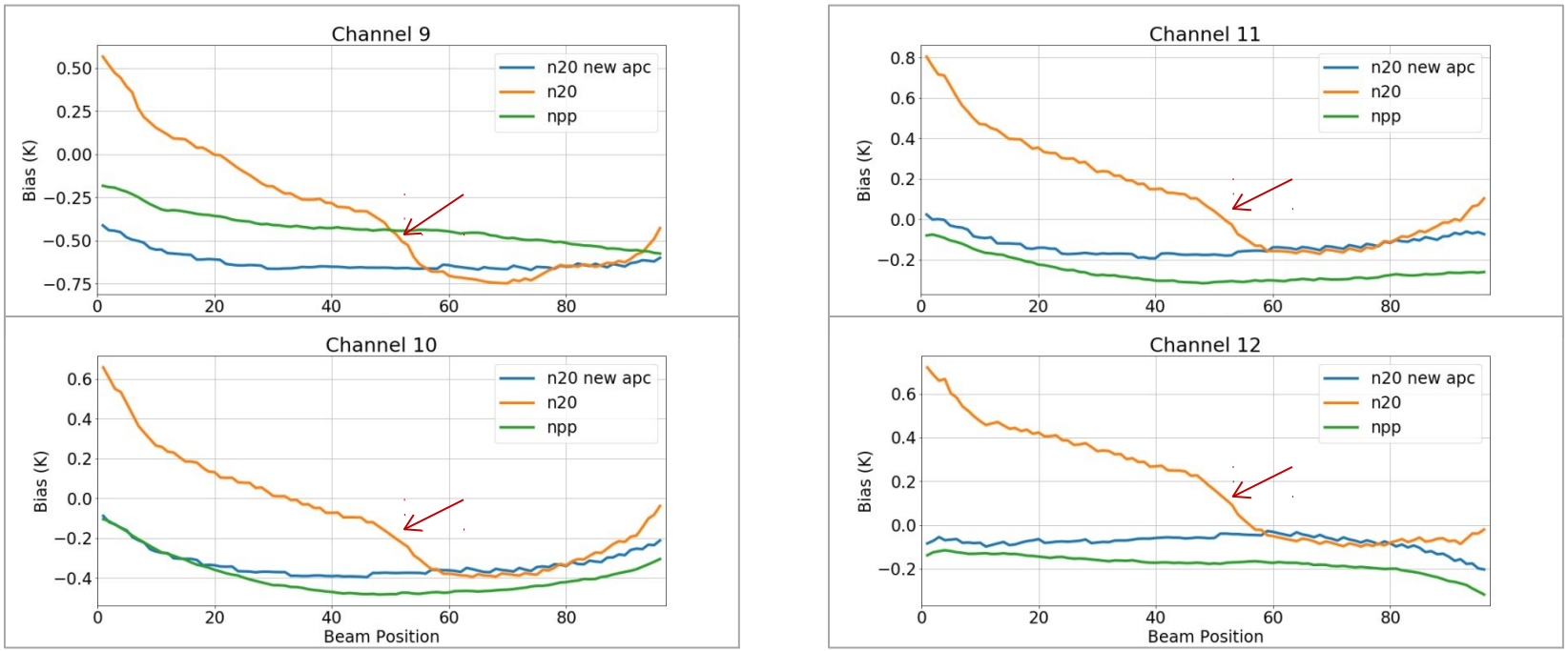
ATMS Cal/Val Team Members

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, manage PLT and data analyze
Vince Leslie	MIT/LL	Idahosa Osaretin, Mark Tolman	ATMS instrument performance and data quality assessments, PLT data evaluation
Wesley Berg	CSU/CIRA		ATMS and GPM WG band cross-calibration
Deirdre Bolen	JPSS/JAM		ADR/PCR 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

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



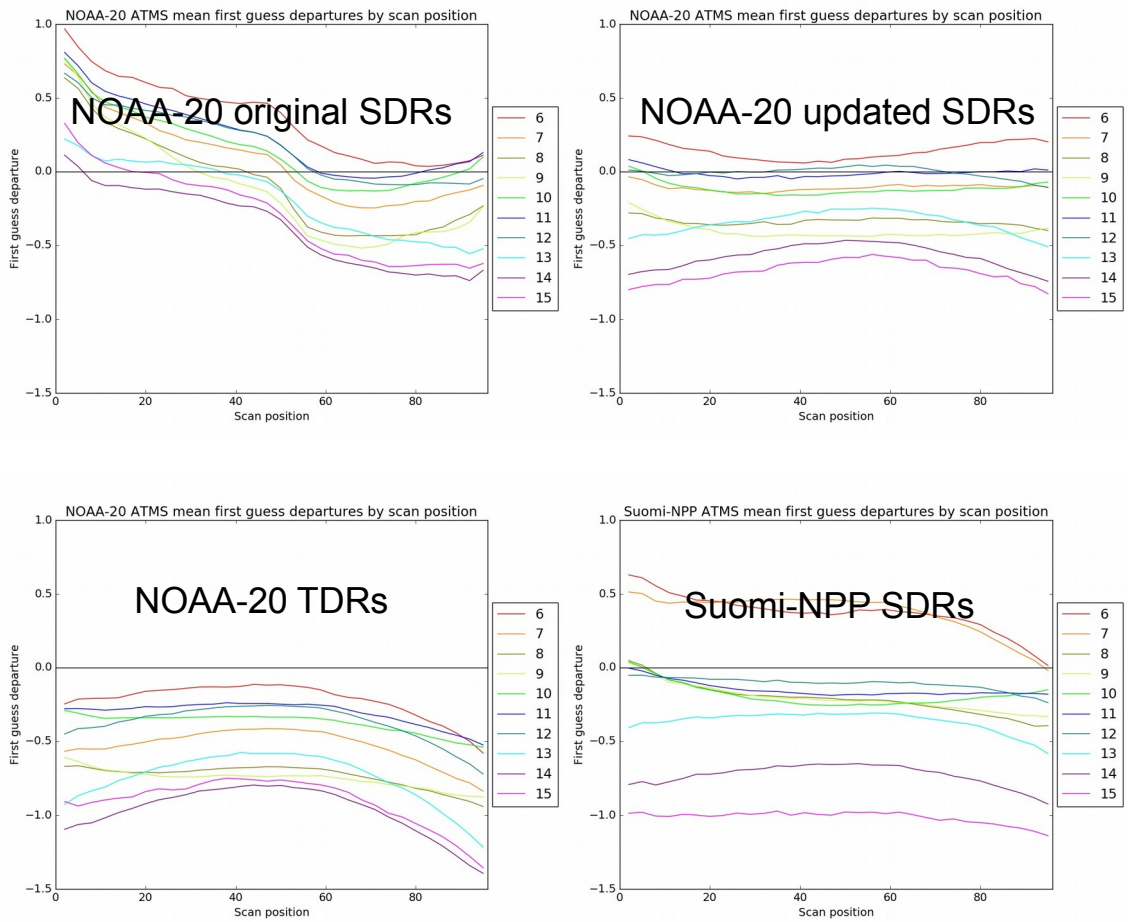
Eric Simon and Steve Swadley @NRL Monterey

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



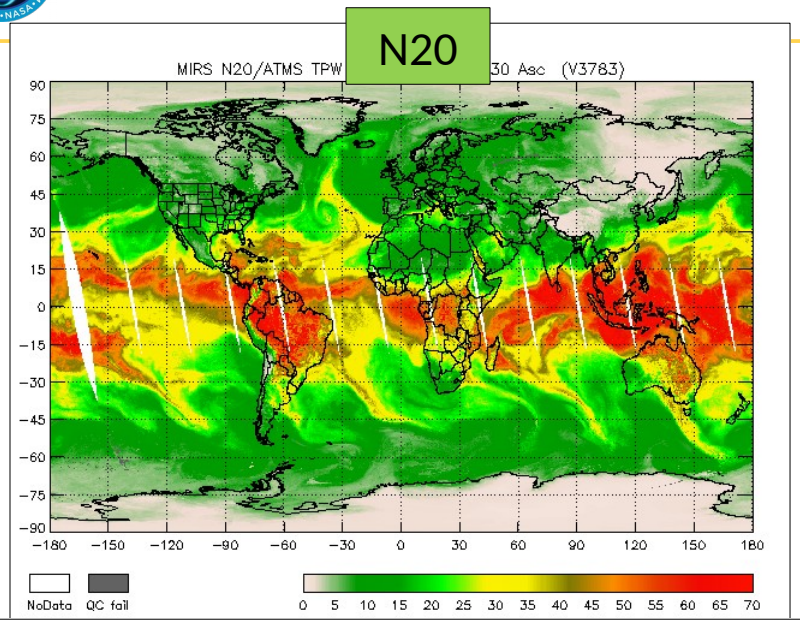
SDR data improved because
1. Improved antenna pattern measurements for J01, especially in W and G bands
2. Improved antenna pattern correction algorithm based on On-orbit environment test data
3. More accurate antenna reflector emission correction model

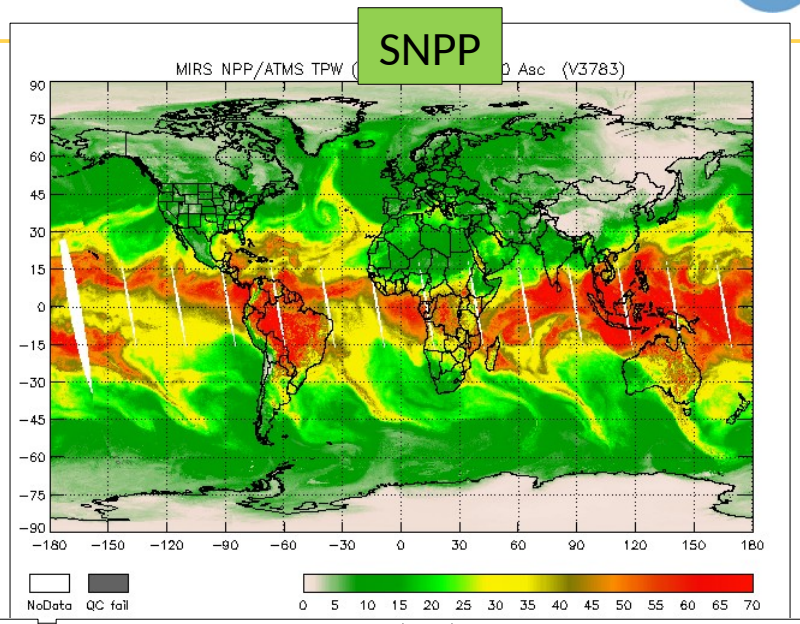
Selected ATMS Comments from ECMWF

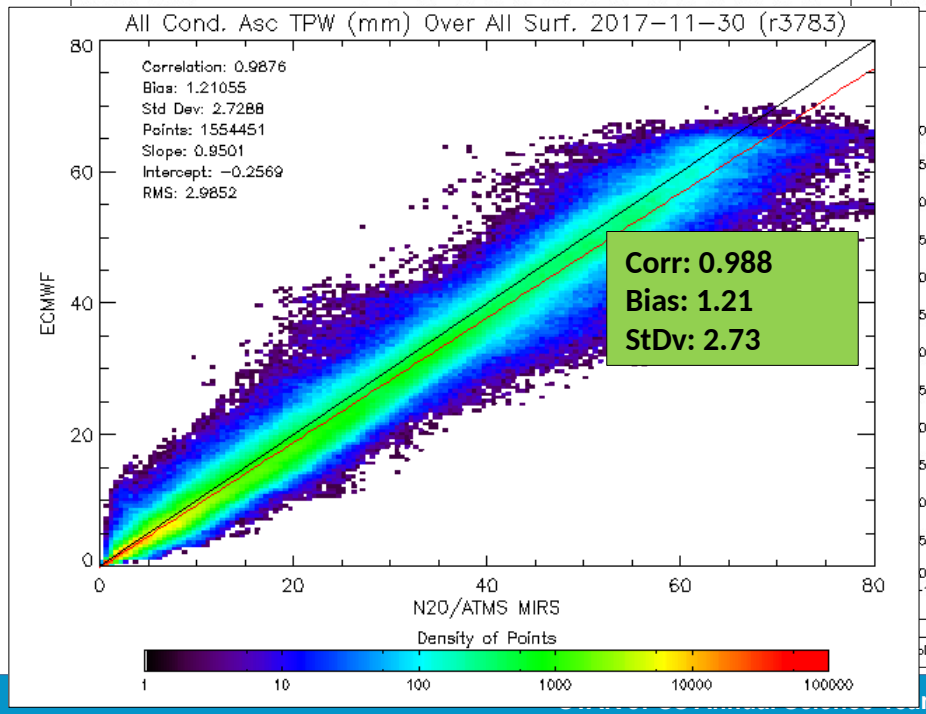
- Data quality looks better than Suomi-NPP:
  - Similar biases
  - Smaller standard deviation of first guess departures and diagnosed observation errors
  - Weaker striping signal than Suomi-NPP ATMS
- Improved first guess fits to:
  - Temperature observations (AMSU-A, CrIS, GPSRO)
  - Humidity observations (MHS, GEO CSRs)
- Indicates improved accuracy of short range temperature and humidity forecasts
- Neutral to slightly positive forecast scores

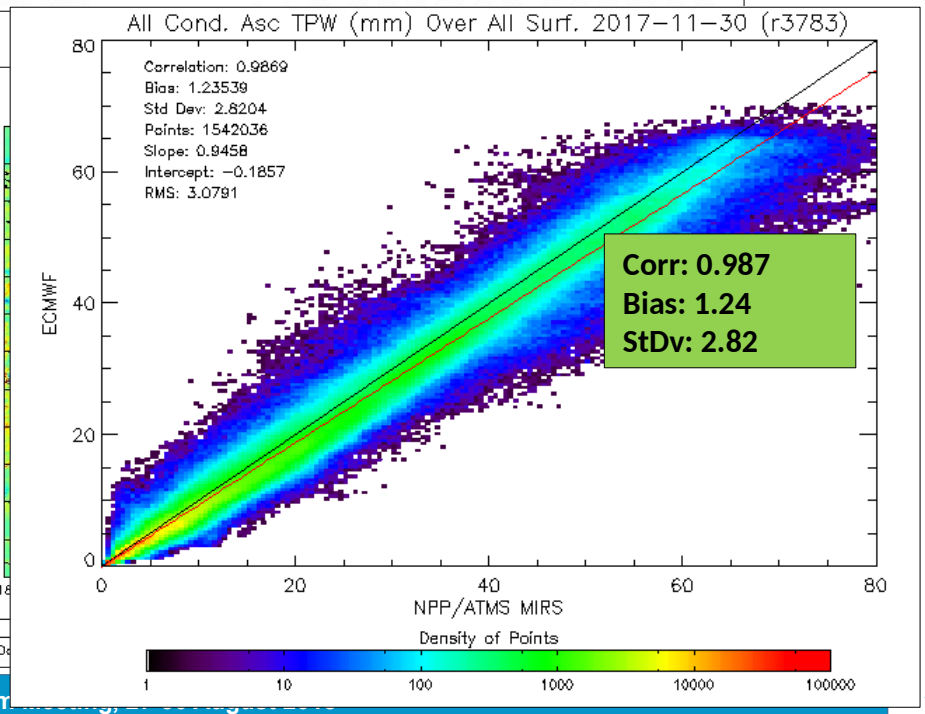
Generally positive feedback from ECMWF

Total Precipitable Water (2017-11-30), beta maturity at day-1









Conclusion

- NOAA-20 ATMS working well since activation
- NOAA-20 ATMS post-launch performance is comparable to pre-launch performance; No Ka-band transmitter RFI and heater induced EMI observed so far
- All PLTs successfully executed, no go-backs, reports nearly complete
  - space view profile #1 declared optimal
  - Maneuver-related activities successful
- NOAA-20 ATMS TDR/SDR compare well to S-NPP ATMS
  - NEΔTs stable since activation and slightly lower than S-NPP
  - Inter-channel noise correlation much lower than S-NPP
- ATMS SDR is significantly improved. MiRS products achieved beta maturity at day-1. TDR/SDR products are operational at major NWP centers. Some centers are working on the ATMS RDR data for climate studies.

NOAA-20 ATMS on-orbit performance compares well with S-NPP ATMS.
NOAA-20 ATMS TDR and SDR products look better.
The decision to re-work & delay launch (twice) has paid off.

JPSS Radiance Timeline

S-NPP Launch 28-Oct-2011
N-20 Launch 18-Nov-2017

Sensor-Spacecraft	Algorithm	Activation	Beta	Provisional	Validated
ATMS-SNPP	SDR-L1b	08-Nov-2011	Jan-2012 (2 m)	Oct-2012 (1 yr)	Dec-2013 (2 yr 2 m)
ATMS-N20	SDR-L1b	29-Nov-2017	11-Dec-2017 (2 wk)	23-Jan-2018 (2 m)	June-2018 (8 m)
CrIS-SNPP	SDR-L1b	14-Dec-2011	Apr-2012 (5 m)	Oct-2012 (11 m)	Dec-2013 (2 yr)
CrIS-N20	SDR-L1b	3-Jan-2018	17-Jan-18 (2 m)	16-Feb-18 (3 m)	Aug-2018 (10 m)

Maturity milestones reached earlier for N20!

JPSS Retrieval Timeline

S-NPP Launch 28-Oct-2011
N-20 Launch 18-Nov-2017

Sensor-Spacecraft	Algorithm	Activation	Beta	Provisional	Validated
MIRS SNPP (ATMS only)	Temperature/ Water Vapor	08-Nov-2011	Apr-2012 (6 m)	Aug-2014 (2 yr 10 m)	Oct-2016 (5 yr)
MIRS N20 (ATMS only)	Temperature/ Water Vapor	29-Nov-2017	21-Mar-2018 (5 m)	Sep-2018 (1 yr)	Sep-2019 (2 yr)
NUCAPS SNPP (ATMS + CrIS)	Temperature/ Water Vapor	14-Dec-2011	Aug-2012 (9 m)	Jan-2013 (1 yr 1 m)	Sep-2014 (2 yr 10 m)
NUCAPS N20 (ATMS + CrIS)	Temperature/ Water Vapor	3-Jan-2018	Jun-2018 (6 m)	Sep-2018 (9 m)	Sep-2019 (1 yr 9 m)

Maturity milestones reached earlier for N20!

JPSS Anomaly Reporting

https://www.star.nesdis.noaa.gov/icvs/SNPP_Anomalies.php

STAR ICVS Integrated Calibration / Validation System Long-Term Monitoring

Monitoring and characterizing satellite instrument performance for weather, climate and environmental applications

ICVS Home > S-NPP On-orbit Events & Anomalies Table

S-NPP On-orbit Events & Anomalies Table

Cumulative Zip file of all MX Releases, (ZIP, 1.57 MB, 6/30/2016)

Click column headings to sort; Type in the "Search" box to query table contents.

Updated: 8/3/2018

All events | ATMS | CrIS | VIIRS | OMPS

Show 30 entries Search:

Event	Date	Time (UTC)	End (UTC)	Instrument(s)	Retrieved From	CCR	Notes
Drag Make-Up Maneuver (DMU) (28)	7/17/18	16:10	16:23	ACOV	OSPO Planning Calendar	---	Slew: 16:10:00-16:23:04z, 0.7s Burn: 16:16:00:00-16:16:00:70z, OMPS Decon: 16:00-16:27:06z
Block 2.1_Mx2 Transition to Operations	7/2/18	14:50	-:--	ACOV	C/V Leads Archive	---	---
Roll Maneuver for VIIRS Lunar Calibration	5/25/18	4:59	5:07	ACOV	OSPO Planning Calendar	---	04:59:34-05:06:33z, Center of Dwell 05:03:04, -2.13 degrees
Block 2.1_Mx1 Transition to Operations	4/30/18	14:35	-:--	ACOV	C/V Leads Archive	---	---
Roll Maneuver for VIIRS Lunar Calibration	4/25/18	19:25	19:37	ACOV	OSPO Planning Calendar	---	19:25:34-19:37:34z, Center of Dwell 19:30:34z, -3.06 degrees
Block 2.1_Mx0 Transition to Operations	3/5/18	17:00	-:--	ACOV	C/V Leads Archive	---	---
Drag Make-up Maneuver (DMU) (27)	2/28/18	17:49	18:02	ACOV	C/V Leads Archive	---	No Slew, 17:48:59-18:02:03, Burn: 17:54:59-17:55:01, OMPS Decon 17:38:59-18:06:03
Roll Maneuver for VIIRS Lunar Calibration	2/26/18	5:34	5:40	ACOV	C/V Leads Archive	---	-1.13 degrees
Roll Maneuver for VIIRS Lunar Calibration	1/27/18	20:08	20:20	ACOV	C/V Leads Archive	---	Center of Dwell at 20:13:15, -4.223 degrees
SCC Clock Slope Update	1/24/18	-:--	-:--	ACOV	NPP ATR	---	---

Easy to find anomalies from STAR ICVS

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—switch to active geolocation?
- ✓ 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

OVERVIEW OF THE CrIS SDR: S-NPP AND NOAA-20

Flavio Iturbide-Sanchez, NOAA/NESDIS/STAR
CrIS SDR Team Lead
On behalf of the CrIS SDR Team

Outline

- Cal/Val Team Members
- Sensor/Algorithm Overview
- S-NPP/N-20 CrIS SDR Performance
- Major Risks/Issues and Mitigation
- Milestones and Deliverables
- Future Plans/Improvements
- Summary

Team Members

PI	Organization
Flavio Iturbide-Sanchez	NOAA/STAR (Contractors: Yong Chen, Denis Tremblay, Likun Wang and Adrew Wald)
Dave Tobin	U. of Wisconsin (UW)
Larrabee Strow	U. of Maryland Baltimore County (UMBC)
Deron Scott	Space Dynamics Lab (SDL)
Dan Mooney	MIT/LL
Dave Johnson	NASA Langley
Lawrence Suwinski	Harris
Joe Predina	Logistikos
Deirdre Bolen	JPSS/JAM

CrIS SDR Maturity Level Timeline

S-NPP CrIS SDR

Beta → ~9.5 mos. → **Provisional** → ~10.8 mos. → **Validated**

04/19/2012 — 01/31/2013 — 12/20/2013

S-NPP Launch:10/28/2011.
First Science Data:01/18/2012.
Transition to FSR mode:12/04/2014

~20 mos.

NOAA-20 CrIS SDR

Beta → 1 mos. → **Provisional** → 6 mos. → **Validated**

01/17/2018 — 02/16/2018 — 08/14/2018

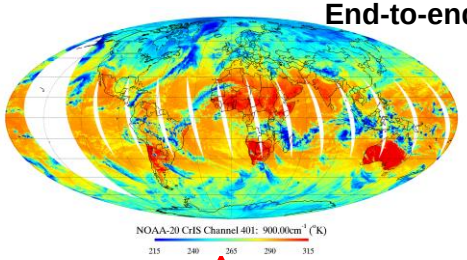
Expected Effective Date

NOAA-20 Launch:11/18/2017
First Science Data:01/04/2018

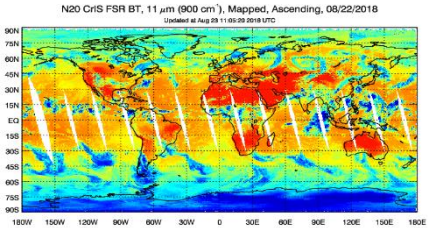
7 mos.

NOAA-20 CrIS Major Events and Milestones

End-to-end System (Flight/Ground) demonstration



Optimally Calibrated and Validated Observations



1/5/2018
FIRST LIGHT GLOBAL IMAGES

1/17/2018
BETA MATURITY ENGPKT V113

2/16/2018
PROVISIONAL MATURITY ENGPKT V114

2/2/2018 - 2/16/2018
BIAS TILTS ANOMALY

3/5/2018
IDPS BLOCK 2.1 MX0
DR 8399: CRIS ICT PRT3, TELEMETRY

4/30/2018
IDPS BLOCK 2.1 MX1
DR 8444: USING EXTENDED INTERFEROGRAMS
DR 8361: ENGPKT OUTPUT FREQUENCY
DR 8445: FSR LONGWAVE RADIANCE ANOMALY (FOLDING INDEX)

5/24/2018
DR 8653: N-20 SDR ANOMALIES RELATED TO MISSING RDR PACKETS

7/2/2018
IDPS BLOCK 2.1 MX2
DR 8489: MISSING DS CAL PACKETS
DR 8490: OVERALL QUALITY FLAG FOR NAN
DR 8491: METROLOGY LASER WAVELENGTH AS NAN

8/14/2018
VALIDATED MATURITY ENGPKT V115

7/19/2018 - 7/26/2018
BIAS TILTS ANOMALY

11/18/2017 - 1/3/2018
OUTGASSING PHASE

1/4/2018 - 1/17/2018
EARLY CHECK

1/17/2018 - 2/16/2018
INTENSIVE CAL/VAL

2/16/2018 - 8/14/2018
CONTINUING INTENSIVE CAL/VAL

1/1/2018

18 November 2017

14 August 2018

Planned Improvements

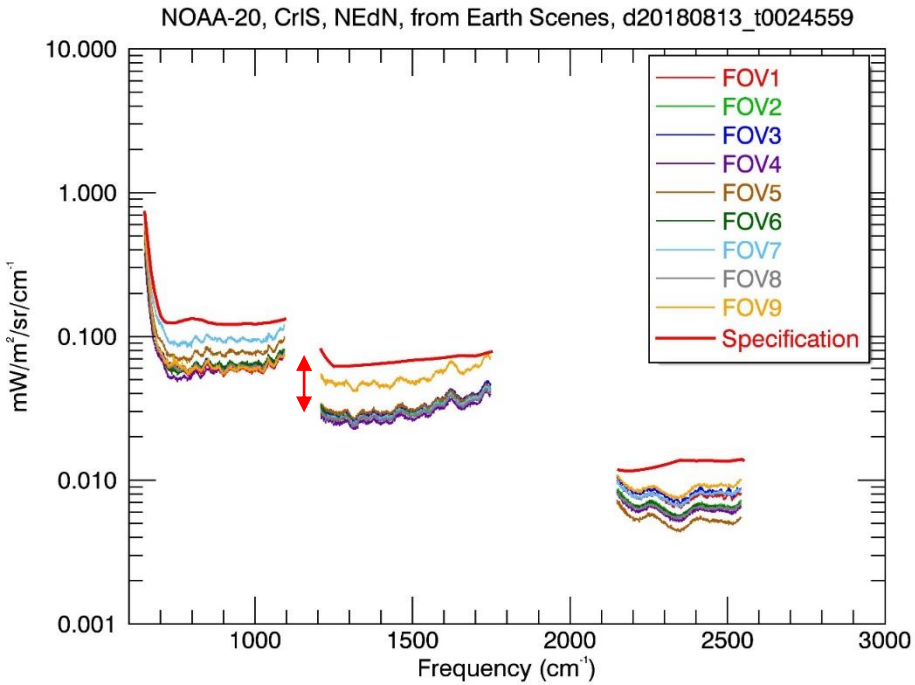
9/24/2018
IDPS BLOCK 2.1 MX3
DR 8013: CRIS INTERFEROGRAMS SPIKES DETECTION AND CORRECTION
DR 8629: N-20 SWEEP DIRECTION INDICATORS AND QUALITY FLAGS

12/17/2018
IDPS BLOCK 2.1 MX4
DR 8631: CRIS LUNAR INTRUSION DETECTION ALGORITHM UPDATE AND PCT UPDATE

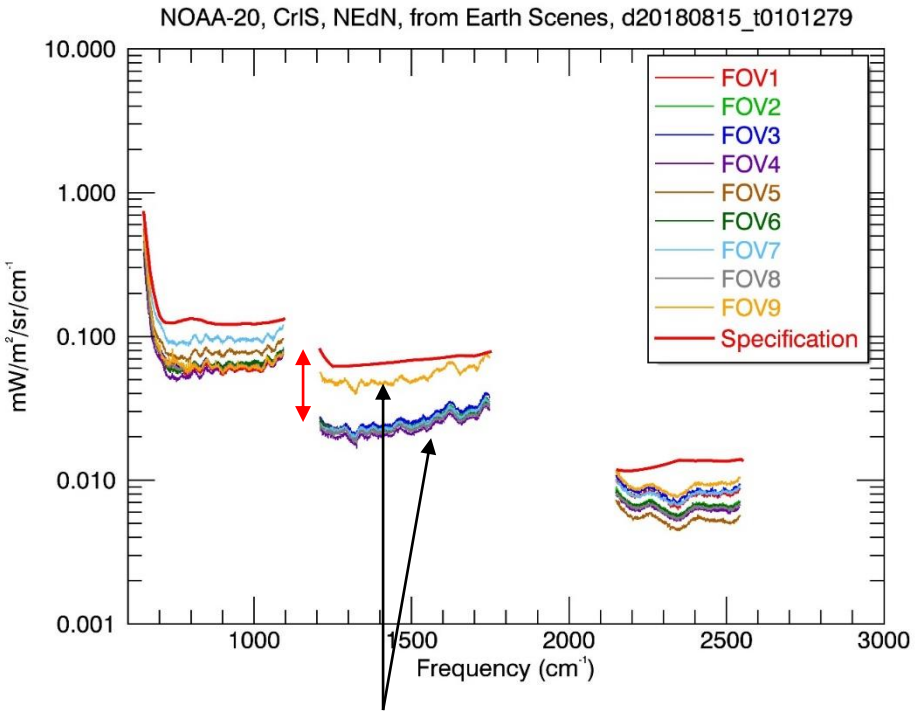
Provided by Yong Chen

NOAA-20 CrIS NEdN: After EP v115 Upload on Aug 14, 2018

NEdN on 8/13/2018 (EP v114)



NEdN on 8/15/2018 (EP v115) For Validated Maturity Level

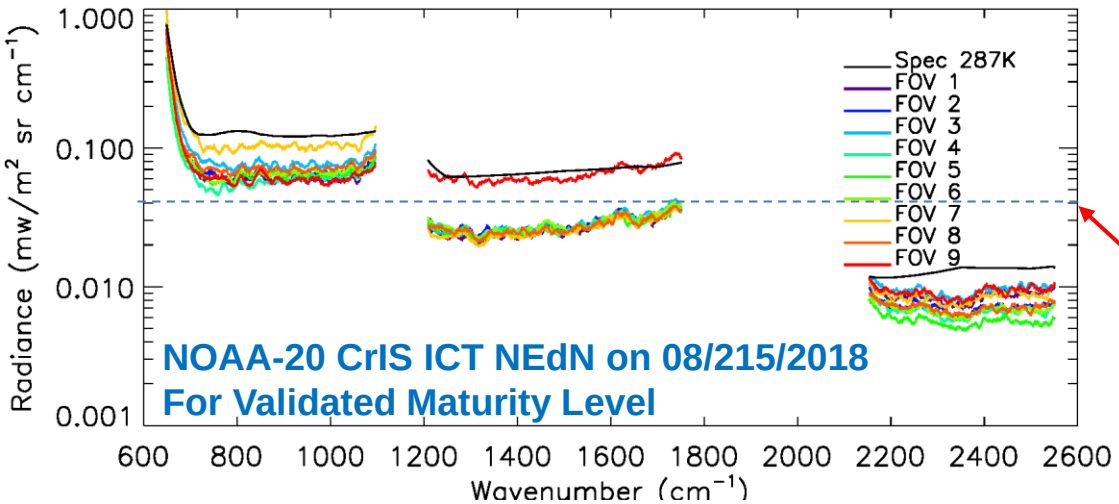


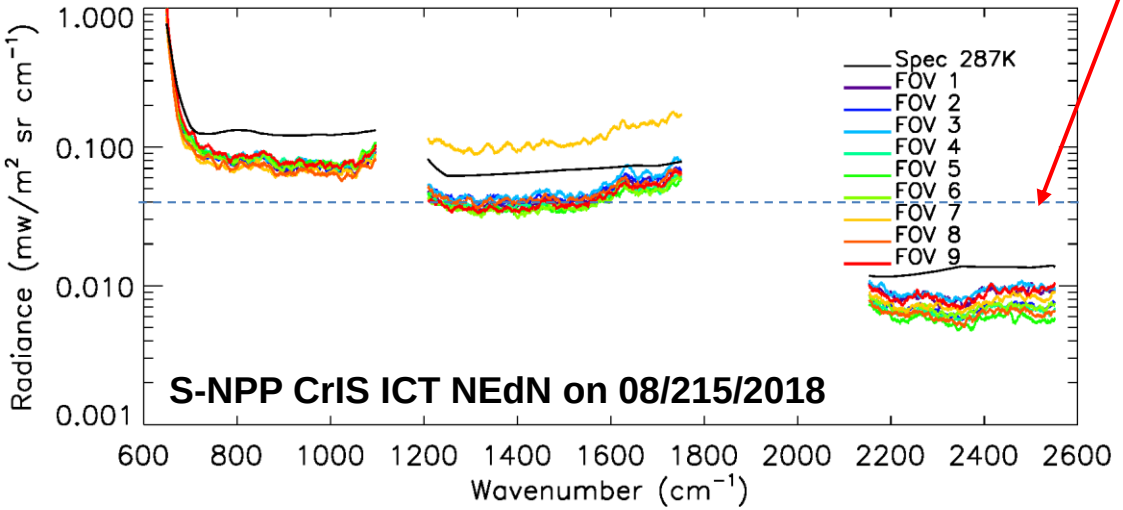
- MWIR NEdN has decreased ~15% due to PGA gain increase (FOV9 stays the same due to no gain change).
- All FOVs are below the specification.

Provided by Denis Tremblay

NEdN Performance: S-NPP vs NOAA-20

S-NPP and NOAA-20 are meeting the NEdN specifications (except NPP FOV7)





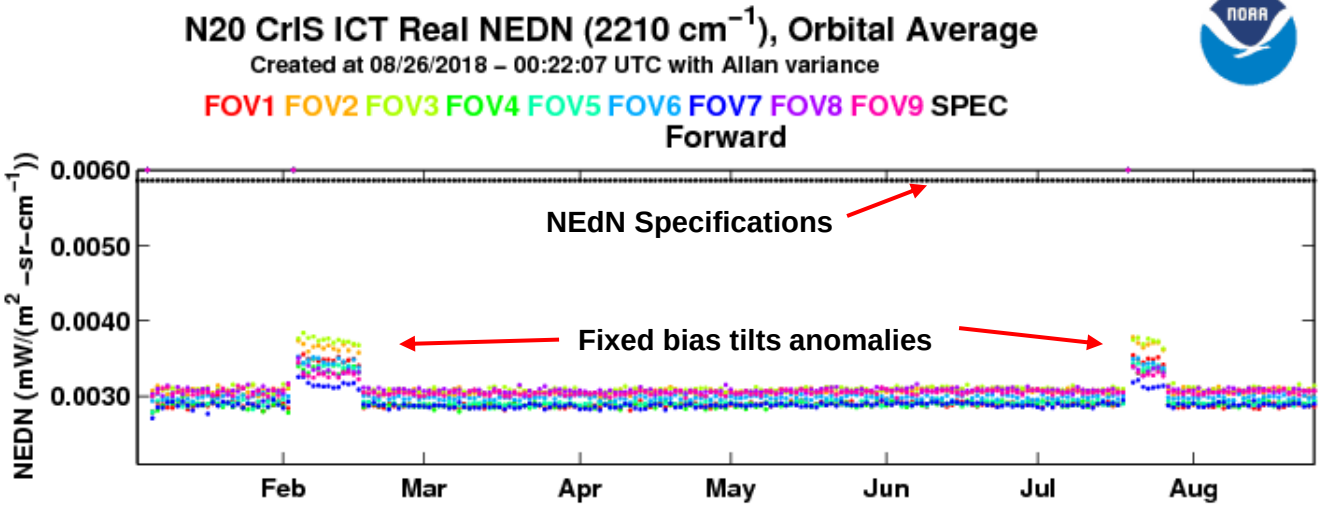
NOAA-20 CrIS MWIR NEdN shows better performance than S-NPP for FOVs 1-8

Provided by Yong Chen

Noise Performance Trending: S-NPP and NOAA-20

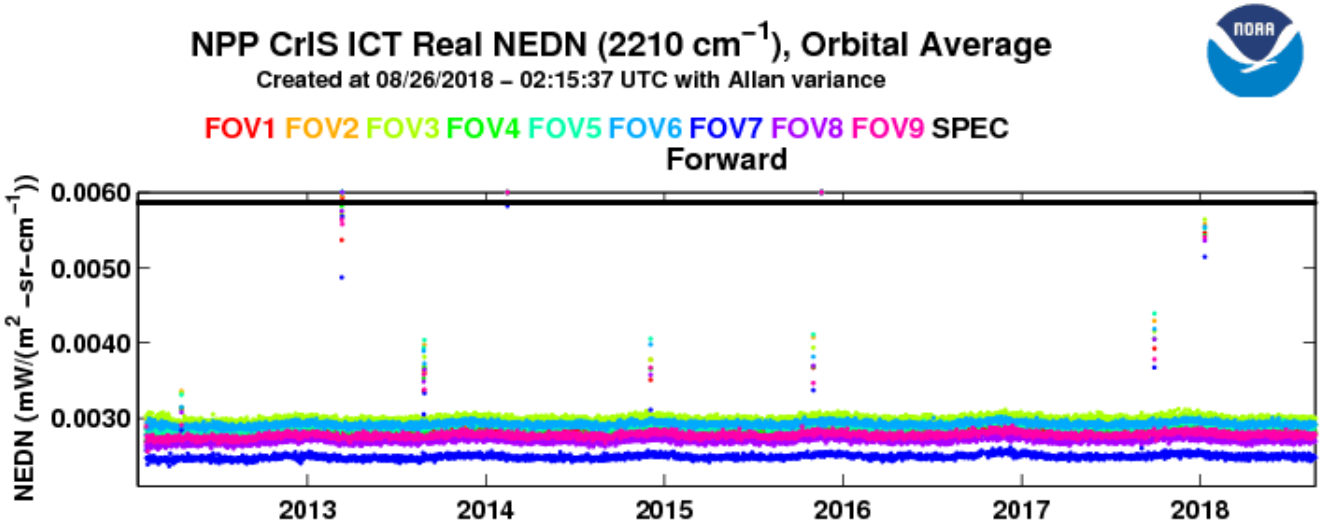
NOAA-20

From STAR/ICVS



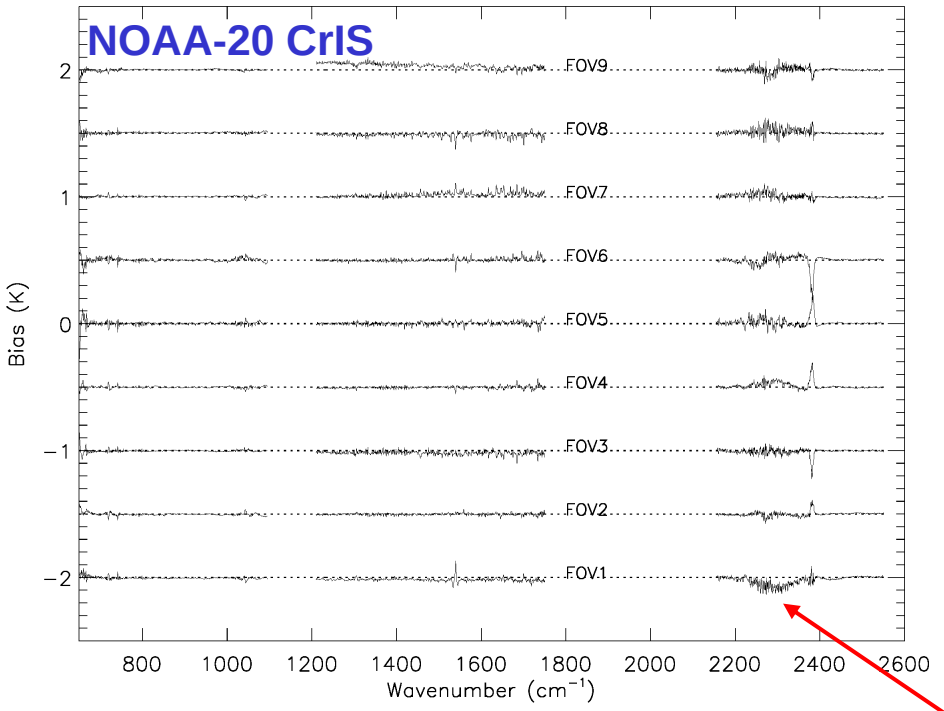
S-NPP and NOAA-20 are showing long term noise stability

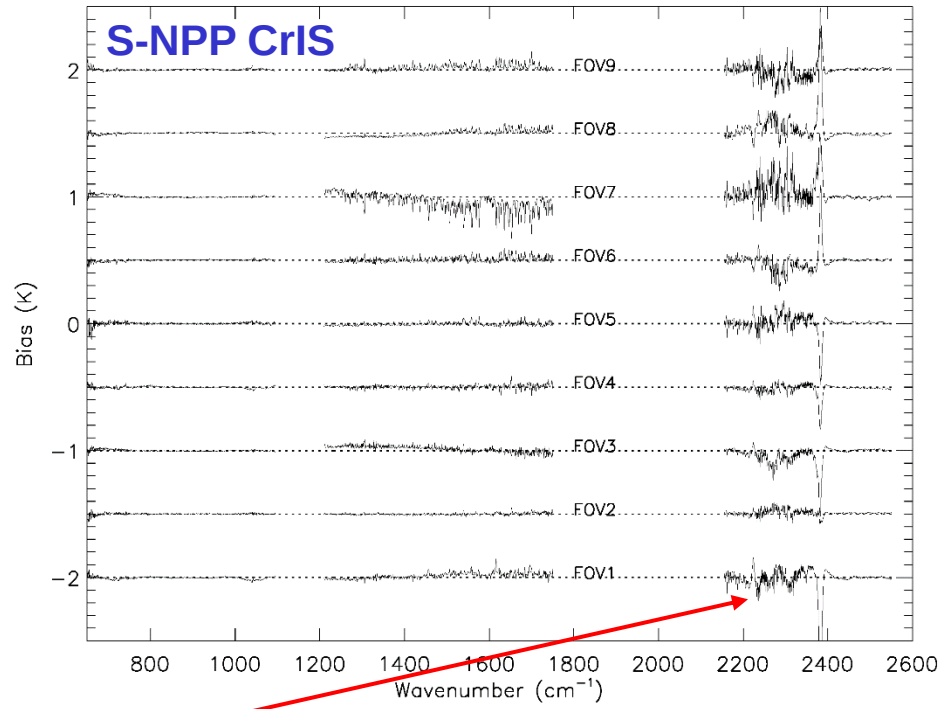
S-NPP



FOV-to-FOV Radiometric Consistency

Mean Difference of Observed and Simulated (CRTM) Hamming Apodized Spectra (removed O-B bias for each FOV)





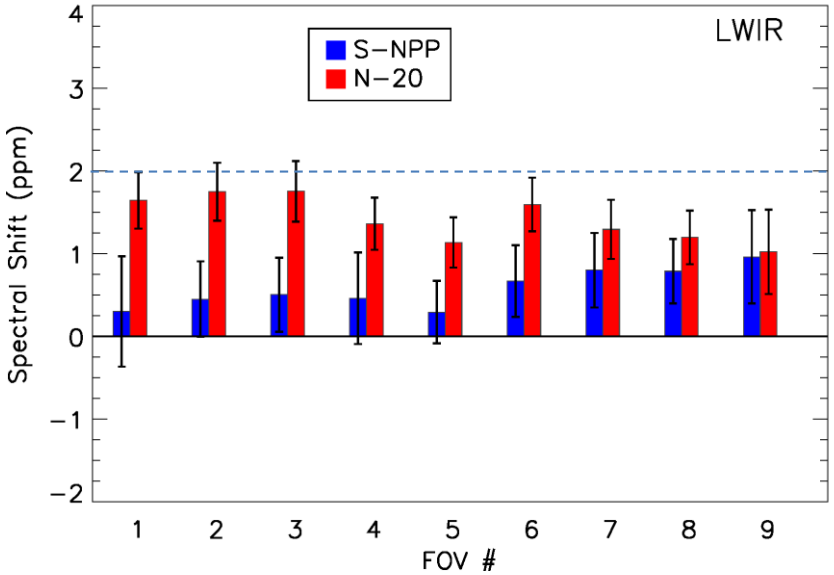
Over Clear-Sky/Ocean/No Sea Ice Surfaces

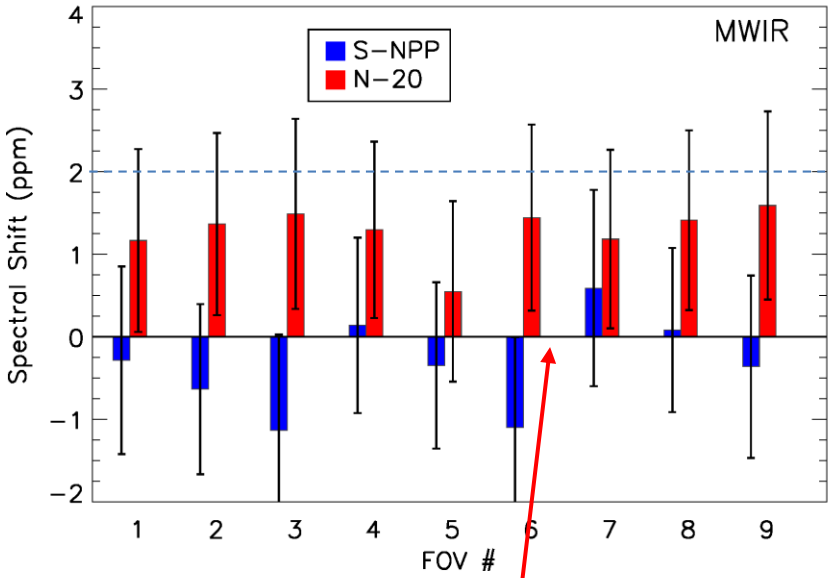
NOAA-20 shows better FOV2FOV Radiometric Consistency than SNPP for MW and SW bands mainly associate to better detectors linearity characteristics

Uniformity of FOV-to-FOV radiometric and spectral performances allows the assimilation of all FOVs without special treatment for particular FOVs

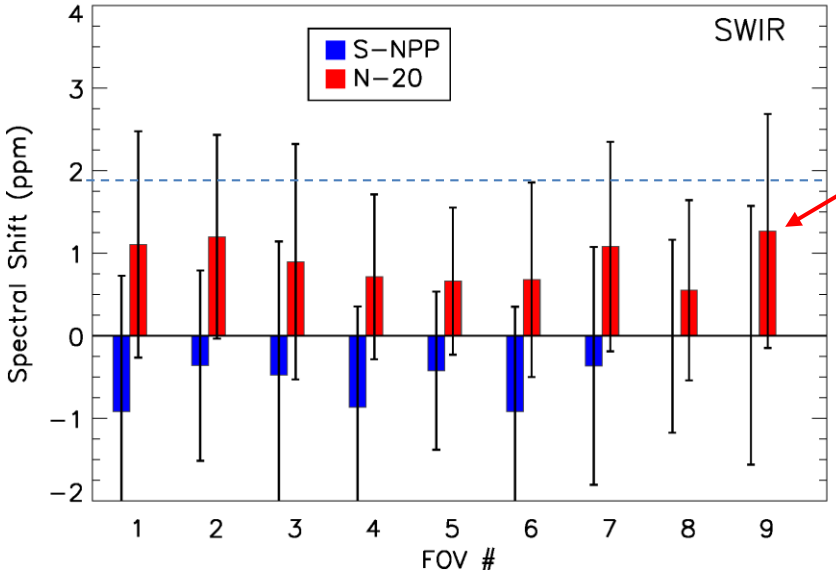
Provided by Yong Chen

Absolute Spectral Accuracy: S-NPP and NOAA-20





S-NPP and NOAA-20 are ~5 times below the Spectral Uncertainty Requirement (10 ppm)



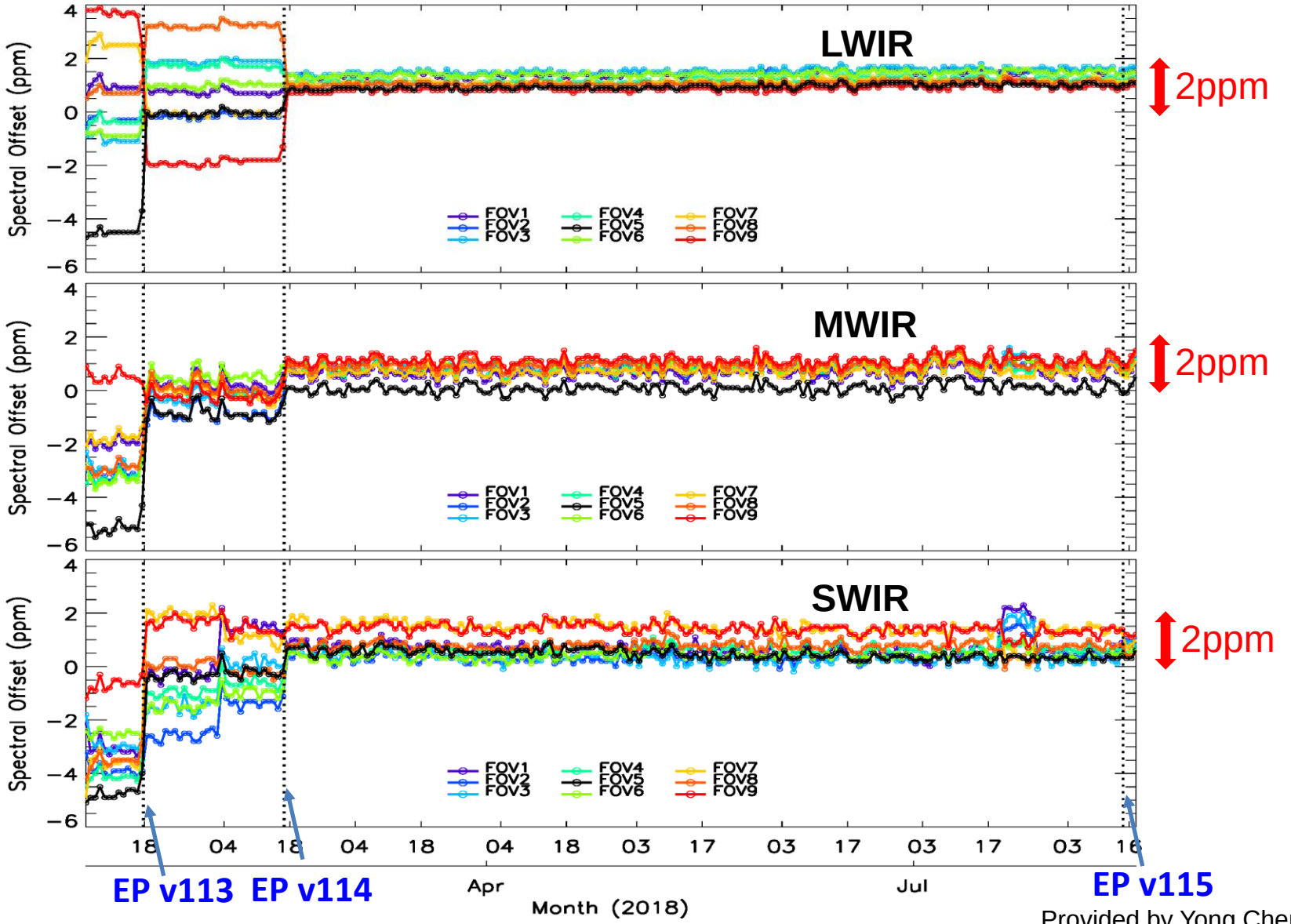
NOAA-20 shows similar performance over all FOVs and IR bands

SDR data from 08/17/2018

CRTM is used as reference.

Provided by Yong Chen

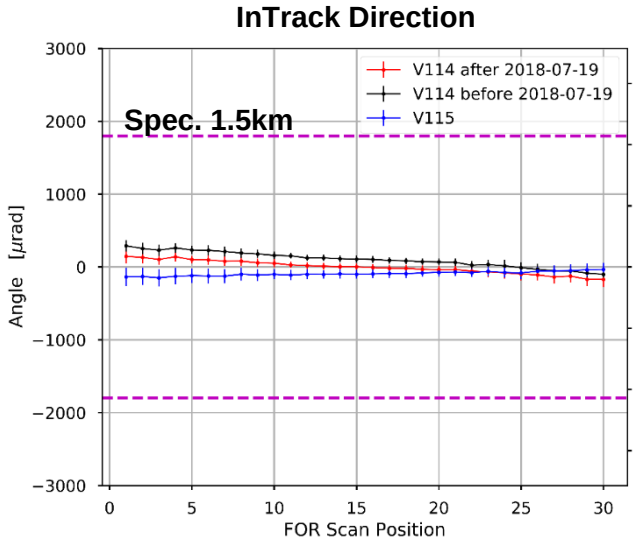
NOAA-20 Spectral Calibration: Absolute Accuracy Trending

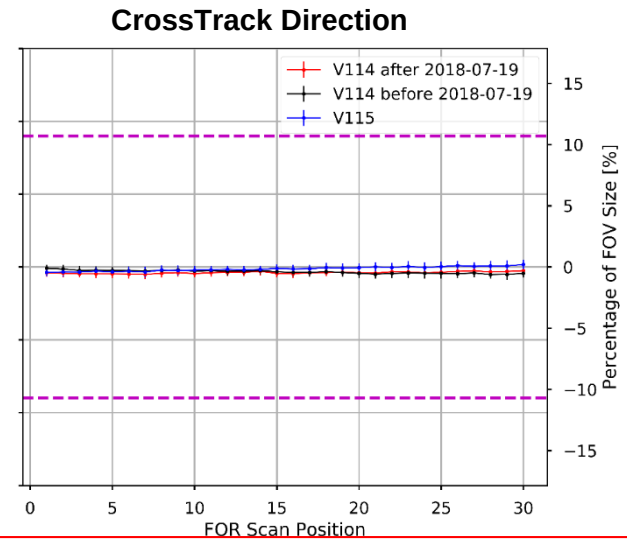


Provided by Yong Chen

Geolocation Uncertainty: S-NPP and NOAA-20

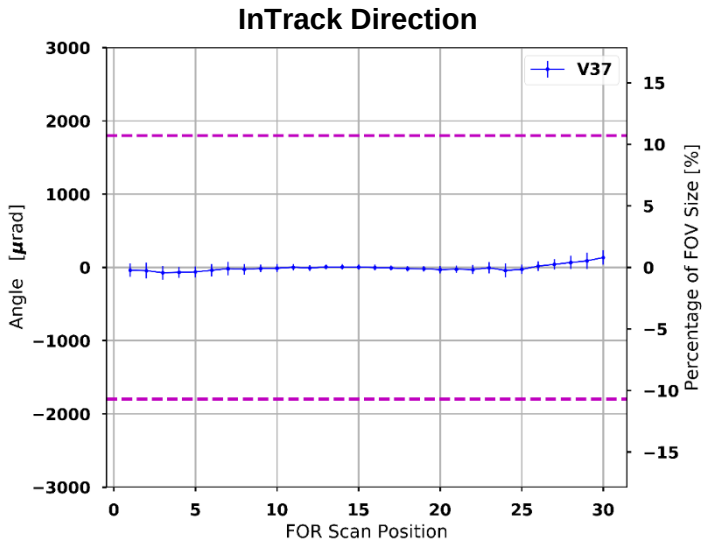
NOAA-20

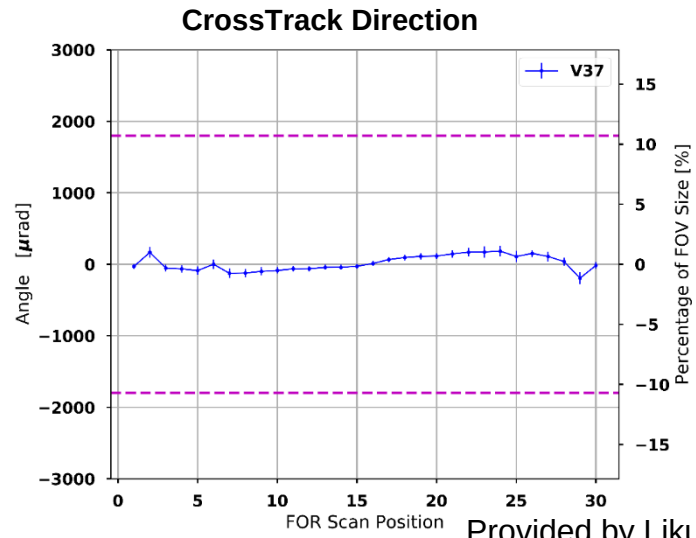




NOAA-20 shows better geolocation uncertainty due to an improvement performed in the method to derived the mapping angles defined in the engineering packet

S-NPP

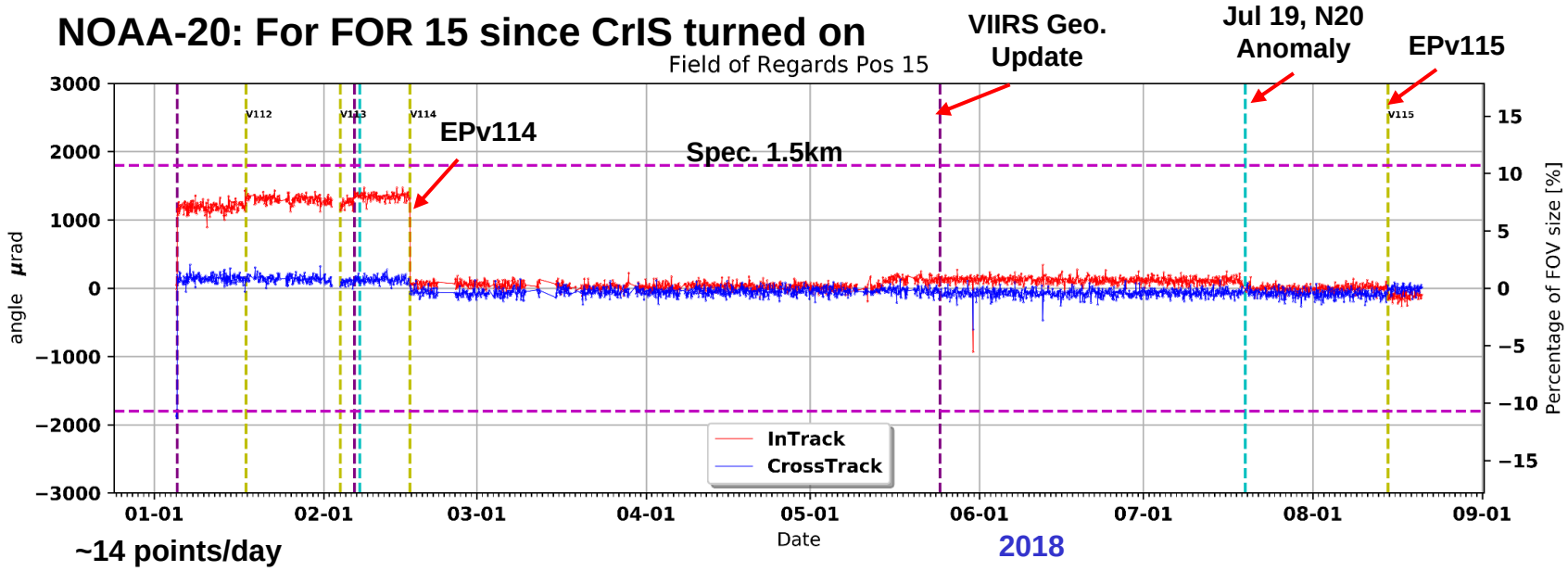




Provided by Likun Wang

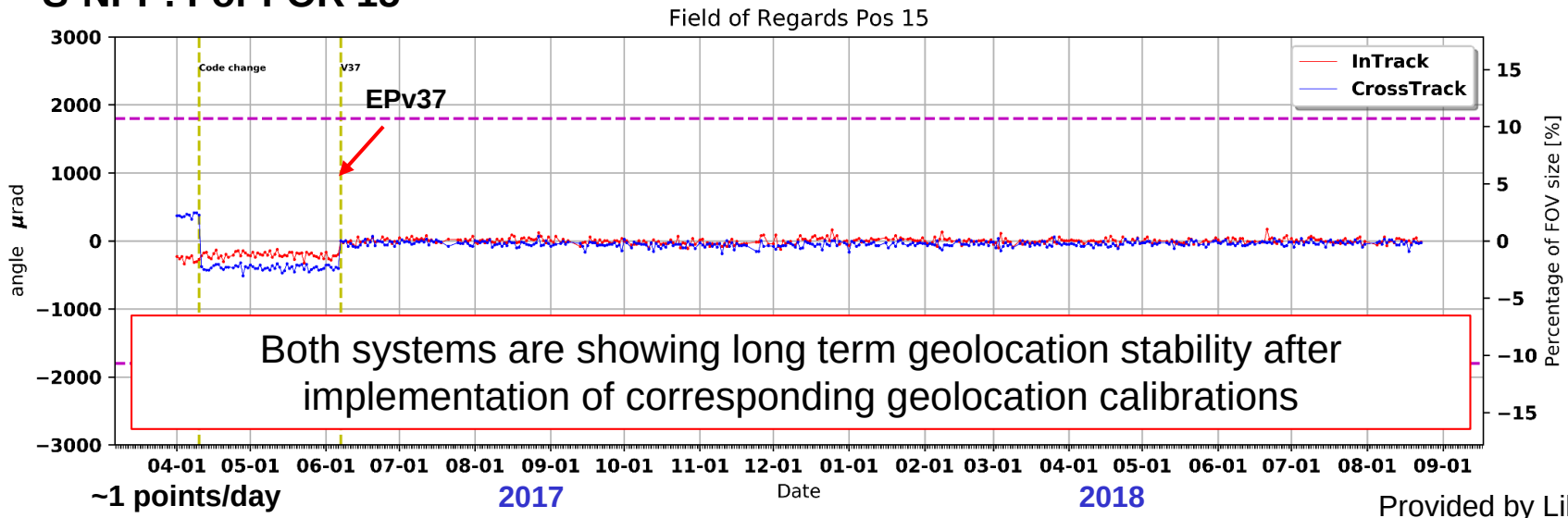
Geolocation Uncertainty Trending: S-NPP and NOAA-20

NOAA-20: For FOR 15 since CrIS turned on



~14 points/day

S-NPP: For FOR 15



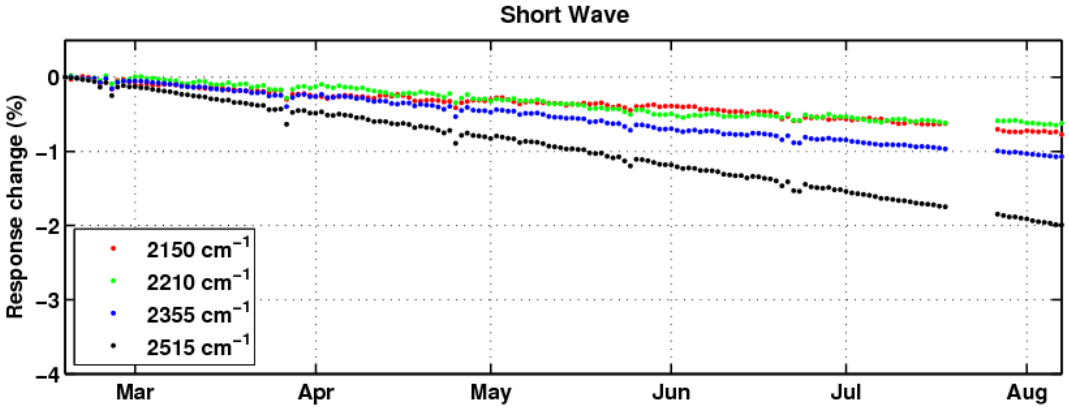
Both systems are showing long term geolocation stability after implementation of corresponding geolocation calibrations

~1 points/day

Provided by Likun Wang

CrIS Responsivity (Gain): S-NPP and NOAA-20

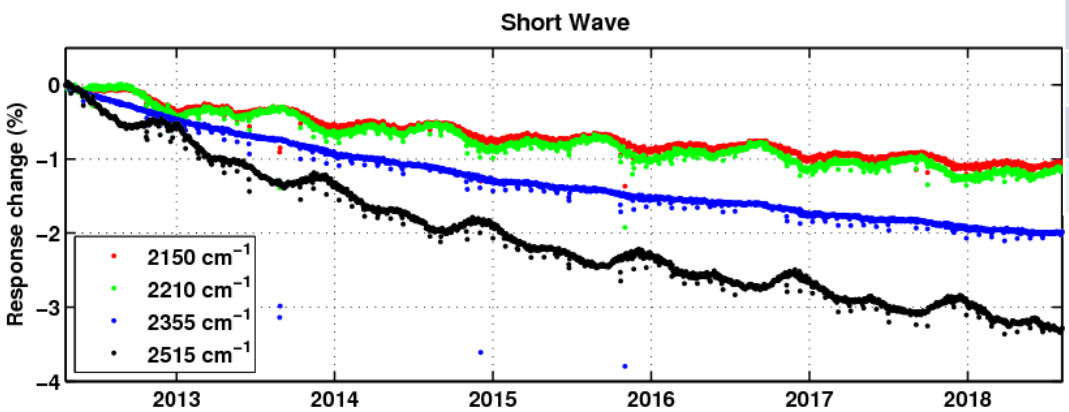
NOAA-20



- These changes are calibrated out.
- Interesting to know if other NOAA-20 instruments are experiencing similar responsivity degradation.
- This could be related to contamination (molecular, particulate) of the optical surface.

Platform/ Band	Wavelength (cm $^{-1}$)	Degradation (%)	Time (months)
N20/SW	2515	-2%	6
NPP/SW	2515	-2%	26
N20 /MW	1710	-1%	3.5
NPP/MW	1710	-1%	54
N20 /LW	1050	-0.4%	6
NPP/LW	1050	-0.4%	24

NPP



- Recommend to monitor the responsivity performance.
- A gain change of 50% caused a 15% change in MW NEdN.
- An initial estimate of a 6% increase in NEdN could be expected in 5 years for SW.

From STAR/ICVS

CrIS SDR Performance: S-NPP and NOAA-20

NOAA-20 CrIS FSR SDR uncertainties (**blue**) vs. specifications (black)

Band	Spectral Range (cm^{-1})	Resolution (cm^{-1})	Number of Channels	NEdN* ($mW/m^2/sr/cm^{-1}$)	Frequency Uncertainty (ppm)	Geolocation Uncertainty** (km)
LWIR	650-1095	0.625	713	0.086 (0.14)	2 (10)	0.22 (1.5)
MWIR	1210-1750	0.625	865	0.0315 (0.084)	2 (10)	0.22 (1.5)
SWIR	2155-2550	0.625	633	0.00766 (0.014)	2 (10)	0.22 (1.5)

* Mean value averaged over 9 FOVs and over all band.
** Using worst case within 30° scan angles.

S-NPP CrIS FSR SDR uncertainties (**blue**) vs. specifications (black)

Band	Spectral Range (cm^{-1})	Resolution (cm^{-1})	Number of Channels	NEdN ($mW/m^2/sr/cm^{-1}$)	Frequency Uncertainty (ppm)	Geolocation Uncertainty** (km)
LWIR	650-1095	0.625	713	0.101 (0.14)	2 (10)	0.25 (1.5)
MWIR	1210-1750	0.625	865	0.0522 (0.084)	2 (10)	0.25 (1.5)
SWIR	2155-2550	0.625	633	0.00741 (0.014)	2 (10)	0.25 (1.5)

CrIS SDR Team Milestones (FY18)

- Successfully achieved the NOAA-20 CrIS SDR products Beta, Provisional Maturity milestones, working toward reaching the *Validated Maturity Level*.
- Successfully and reliably produced NOAA-20 CrIS SDR products in both nominal and full spectral resolution in IDPS operational system.
- Made significant progress and delivered code for 1) Interferogram Spike Detection and Correction and 2) Lunar Intrusion Algorithm.
- Improved SDR calibration by using extended interferogram data points.
- Addressed all NOAA-20 and S-NPP CrIS anomaly events.
- Performed and discussed a trade study about reducing the CrIS field of view size from 14 km to 7 km.

CrIS SDR Team Future Plans and Improvements

- Implement a CrIS polarization correction algorithm.
- Prepare for the J2/CrIS TVAC activities.
- Implement future improvements in the CrIS SDR Calibration Algorithm and perform proper integration into the ADL Builder.
- Enhance the radiometric, spectral and geolocation validations of the S-NPP and NOAA-20 CrIS SDR.
  - The S-NPP CrIS is approaching 7-years of continued observations and requires performance monitoring.
- Support the STAR/ICVS to implement new and improved capabilities for the LTM of S-NPP/NOAA-20 CrIS.
- Look for new research activities and applications of the CrIS observations.

Users Feedback

Name	Organization	Application	User Feedback
Nick Nally	STAR	Soundings	**Positive Feedback** The similar performance found between the AVTP and AVMP EDR products of NUCAPS S-NPP and NOAA-20 is a testament to the comparable calibration accuracy of the CrIS and ATMS observations made by S-NPP and NOAA-20
Jim Jung/Andrew Collard	NCEP	NWP	**Positive Feedback** Initial quality of the CrIS data from NOAA-20 is comparable with that from NPP

Summary

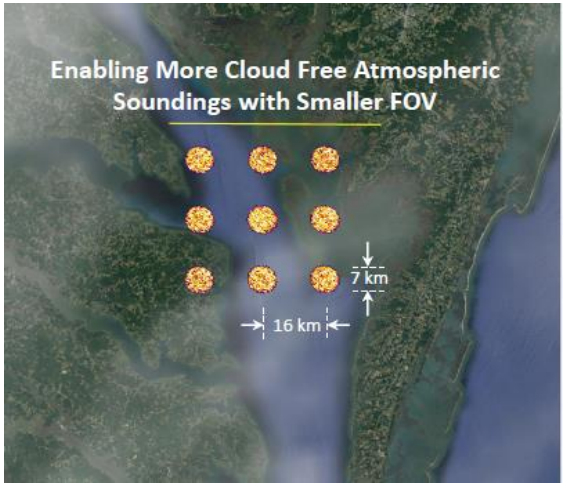
- The CrIS SDR Team has developed and demonstrated capabilities to support the Calibration, Validation and Monitoring of the S-NPP and NOAA-20 CrIS instruments, ensuring the quality of the CrIS SDR data.
- The NPP and NOAA-20 CrIS SDRs are meeting the requirements and are showing long term stability.
- No major risks have been identified for the NPP and NOAA-20 CrIS.
- Lessons learned from S-NPP have contribute to reach the Validated Level for NOAA-20 CrIS SDR in 7 months (3 times faster than S-NPP).
- The CrIS SDR Team is performing activities toward reaching Validated Maturity Level for NOAA-20 CrIS. Presented results show that NOAA-20 is meeting the requirements and is expecting August 14, 2018 as the effective date to achieved the Validate Maturity Level.
- The CrIS SDR Team is moving toward future higher spatial resolution IR hyperspertral observations by discussing the implementation of a 7 km CrIS FOV size for J4.

The CrIS SDR Side Meeting
August 28, 2017 from 9:00AM to 3:00PM

Time	Topic Title	Presenter
9:00-9:15	CrIS Polarization Corrections and Radiometric Uncertainty Estimates	Joe Taylor
9:15-9:30	NOAA-20 Satellite Intercalibration: CrIS/AIRS/IASI SNOs and CrIS/CrIS Double Difference Comparisons	Bob Knutson
9:30-9:45	NOAA20 a2 Progression and Summary of UW Efforts/Issues	David Tobin
9:45-10:00	Suggestions for New Research for the CrIS SDR Team	Larrabee Strow/Howard Motteler
10:00-10:15	Toward NOAA-20 CrIS SDR Validated Maturity Status: Radiometric and Spectral Performances	Yong Chen
10:15-10:30	*Break*	
10:30-10:45	Inter-Comparison of SNPP and NOAA-20 CrIS Toward Long-term Consistent Data Records	Likun Wang
10:45-11:00	Status of the J2/CrIS Pre-environmental TVAC Test	Lawrence Suwinski
11:00-11:15	Feedbacks from the NUCAPS Team on the Use of SNPP and NOAA-20 SDRs	Antonia Gambacorta
11:15-11:45	Study on Reducing the CrIS FOV Size from 14 km to 7 km for Implementation on J3 & J4	Joe Predina
11:45-12:00	Investigation of Noise Impact of 7km FOV on Nonlinearity Estimate from Diagnostic Mode Data	Dave Tobin
12:00-13:00	*Lunch*	
13:00-13:15	CrIS On-Orbit Noise and Relative Responsivity Trending from both SNPP and NOAA20	Kori Moore
13:15-3:00	*Open Discussion Session*	

Discussing the FOV size reduction for J4:

- **Small FOV approach shall be low risk, low cost for J4 implementation**
- **No optical design changes other than x2 field stop aperture reduction.**
- **Assess performance impacts associated with change.**
- **Cloud-free FOR Observations increases from 18% to 27%.**



Provided by Joe Predina

OMPS SDR OVERVIEW

NOAA STAR
(301)683-3613 Trevor.Beck@noaa.gov
Trevor Beck

Outline

- Cal/Val Team Members
- Sensor Overview
- Algorithm Overview
- S-NPP/N-20 Products Performance
- Major Risks/Issues
- Mitigation
- Milestones and Deliverables
- Future Plans and Improvements
- Summary

Cal/Val Team Members

PI	Organization	Team Members	Roles and Responsibilities
Trevor Beck, Chunhui Pan	NOAA, UMD-CICS	Eve-Marie Devaliere, Xiaozhen Xiong, Ding Liang-ICVS	Coordination; instrument and product performance monitoring.
Glen Jaross	NASA	Tom Kelly, Rama. Mundakkara, Mike Haken, Colin Seftor	Instrument scientist; TVAC data acquisition and analysis; SDR algorithms
Laura Dunlap	STC/AMP		Algorithm Changes; DR and issues tracking
Sarah Lipscy	BATC		Instrument Scientist; prelaunch test
Daniel Cumpton	Raytheon	Derek Stuhmer	IDPS Operations

Sensor Overview

- Configuration
  - Two grating Spectrometers:
    - NM 300-380nm, 420nm
    - NP 250-310nm
  - Actively cooled CCD detectors
    - 780x364 pixels OMPS-TC
    - 390x364 pixels OMPS-NP

- Onboard Calibration
  - LED provides non-linearity calibration
  - Reference Solar Diffuser and working Solar diffuser together provide method to track degradation.
  - Orbital Dark current measurements.

- SDR Products
  - Nadir Mapper has Global coverage every 24 hours. 2800km swath
  - Nadir Profiler has 250km swath, Viewing angle +-8°
  - Biweekly solar measurements for Nadir Mapper and Profiler.

- Sensor Differences S-NPP and NOAA-20

  N20 has increased downlink bandwidth and FSW data compression.
  - N20 OMPS-TC capable of 10Km^2 ground pixel size
  - N20 OMPS-NP measurements have 25 times the number of ground pixels.

  N20 has improved Solar diffuser material

Limb Profiler not present on NOAA-20, returns on JPSS-2.

Algorithm Overview

- CCD detector measurements are spatially binned according to a sample table in the flight software(FSW).
- Binning reduces the required bandwidth and increases the SNR.
- The FSW does co-adding and applies gain and non-linearity corrections.
- For NOAA-20 the measurement counts are compresed.
- The ground processor corrects for dark current, smear, and straylight.
- Wavelength registration is corrected

  OMPS-NP has seasonal temperature variation, biweekly updates.

  OMPS-NM has orbital temperature variations
- S-NPP SDR reached Validated Maturity in September 2015
- NOAA-20 reached provisional Maturity July, 2018

OMPS-NM Product Overview

Product	L1RDS APU Thresholds	S-NPP Performance	N-20 Performance
Non-linearity Accuracy	<0.2%	<0.2%	<0.2%
SNR	1000	>1000	>1000@50km^2
Straylight Out-of-band & Out-of-Field response	<2%	<2%	Analysis Pending New Tables
Orbital thermal wavelength shift	0.02nm	~0.006nm	~0.01nm
Absolute irradiance cal accuracy	<7%	<7% for most channels	<7%
Absolute radiance Cal accuracy	<8%	<8%	<8%
Albedo calibration accuracy	<2%	<2% For most channels	~2%

OMPS-NP Product Overview

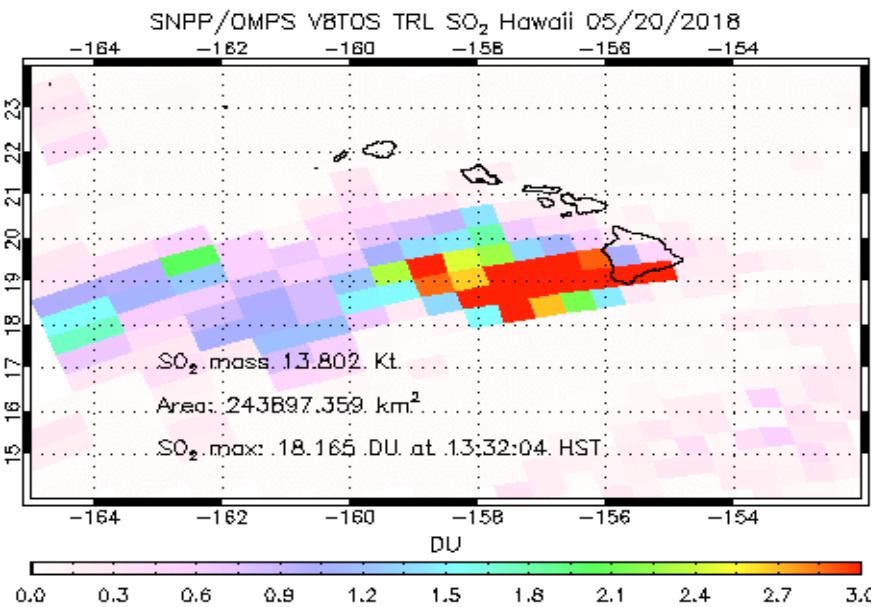
Product	L1RDS APU Thresholds	S-NPP Performance	N-20 Performance
Non-linearity Accuracy	<0.2%	<0.2%	>.2% in some channels
SNR	45-400 channel dependent	>1000	Meets Spec
Straylight Out-of-band & Out-of-Field response	<2%	<2%	>2%, but Analysis Pending New tables
Orbital thermal wavelength shift	0.02nm	~0.006nm	>.02nm, intra-orbit
Absolute irradiance cal accuracy	<7%	<7% for most channels	<7% for most channels
Absolute radiance Cal accuracy	<8%	<8%	<8%
Albedo calibration accuracy	<2%	<2% For most channels	Analysis Pending

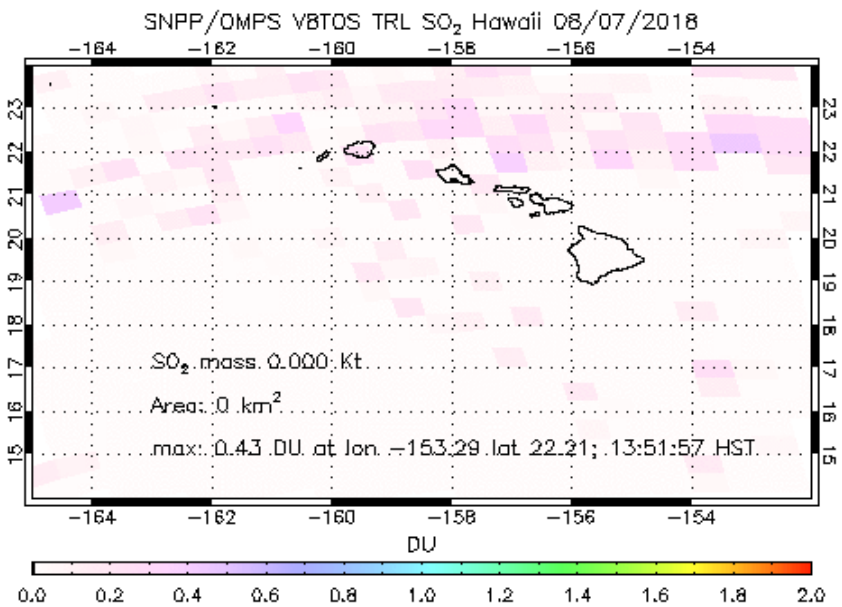
OMPS EDR Products

There are three EDR algorithms for JPSS-1 OMPS in NDE

- SO2, Linear Fit SO_2 method(LFSO2)
- Total Ozone, using the version 8 algorithm
- Ozone profile, using the version 8 algorithm.

Below: Estimated SO_2 over active Kilauea, HI on a very active day and the more recent quiet day. Courtesy of Jianguo Niu, OMPS EDR team.



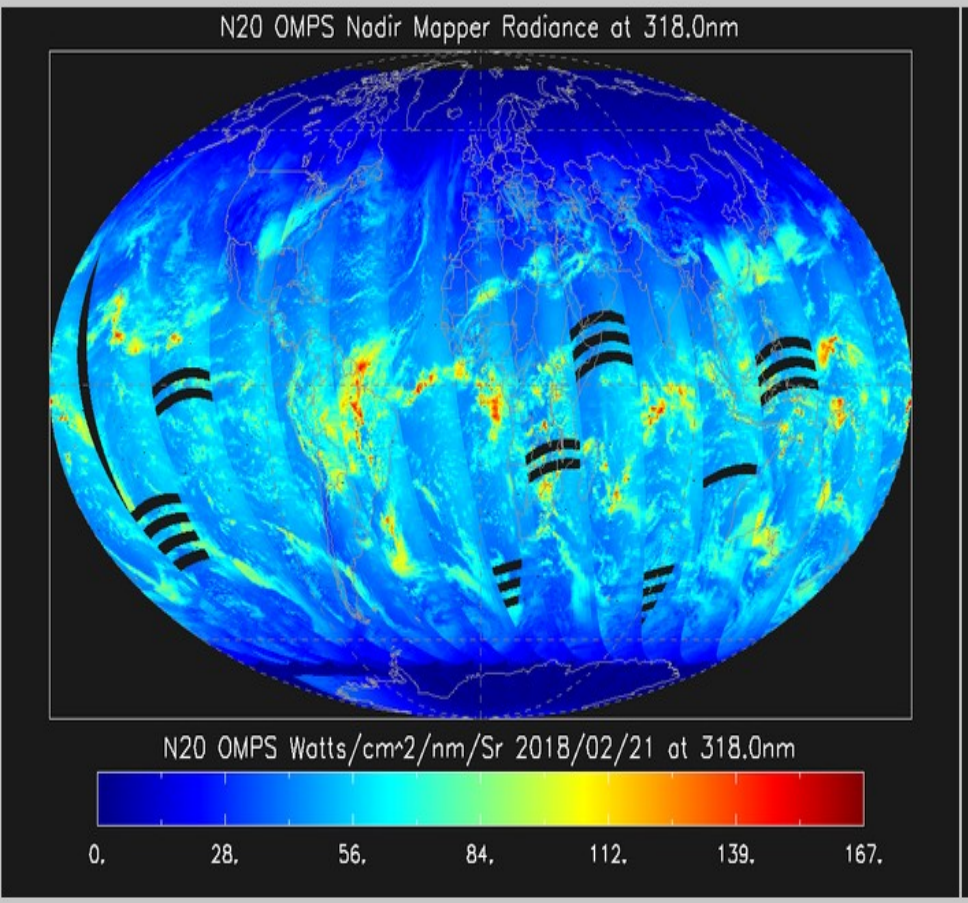


NOAA-20 Major Issues and Mitigation

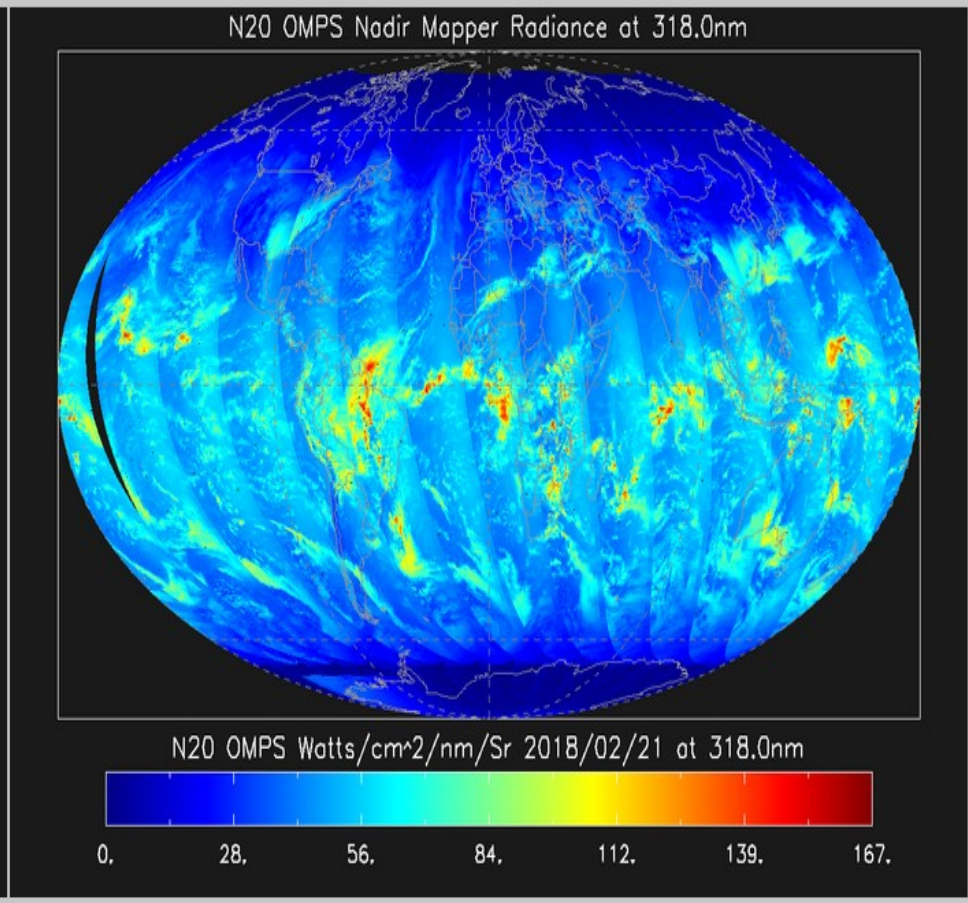
Risk/Issue	Description	Impact	Action/Mitigation
DR_8616 N20	16 Scan RDR, unexpected variance in CCSDS packet times. Result of Data Compression in NOAA-20.	Up to 20 Missing Granules per day	Fixed in MX03 IDPS Build
DR_8594 N20	OMPS Provisional Tables, poorly chosen at-launch sample tables	Striping in lowRes mode	OMPS-TC switched to MedRes Mode in Feb. 8, 2018. IDPS SDR is 50km cross and 17km along Ground pixels size at nadir.
DR_8617 N20	The Field of View for OMPS-TC and OMPS-NP large difference spatially in scene.	Ozone Profile retrieval, EDR errors.	New flight tables tested. Special collections. Set of twelve IDPS tables being delivered.
DR_8730 N20	Unexpected Outliers / Discretization error in Non-Linearity correction for OMPS-NP	Non-linearity requirement not met	Flight table and ground tables need to be delivered: OMPS-NP-CALCONST_j01 and OMPS-NP-NONLINEARITY-LUT

Data Quality Issues, Missing Granules from IDPS

- The 16 scan RDR problem. The unexpected variance in packet times used in Ingest to create the RDR caused a missing granule problem. This is ongoing in IDPS until Sept. 24, the MX03 TTO.



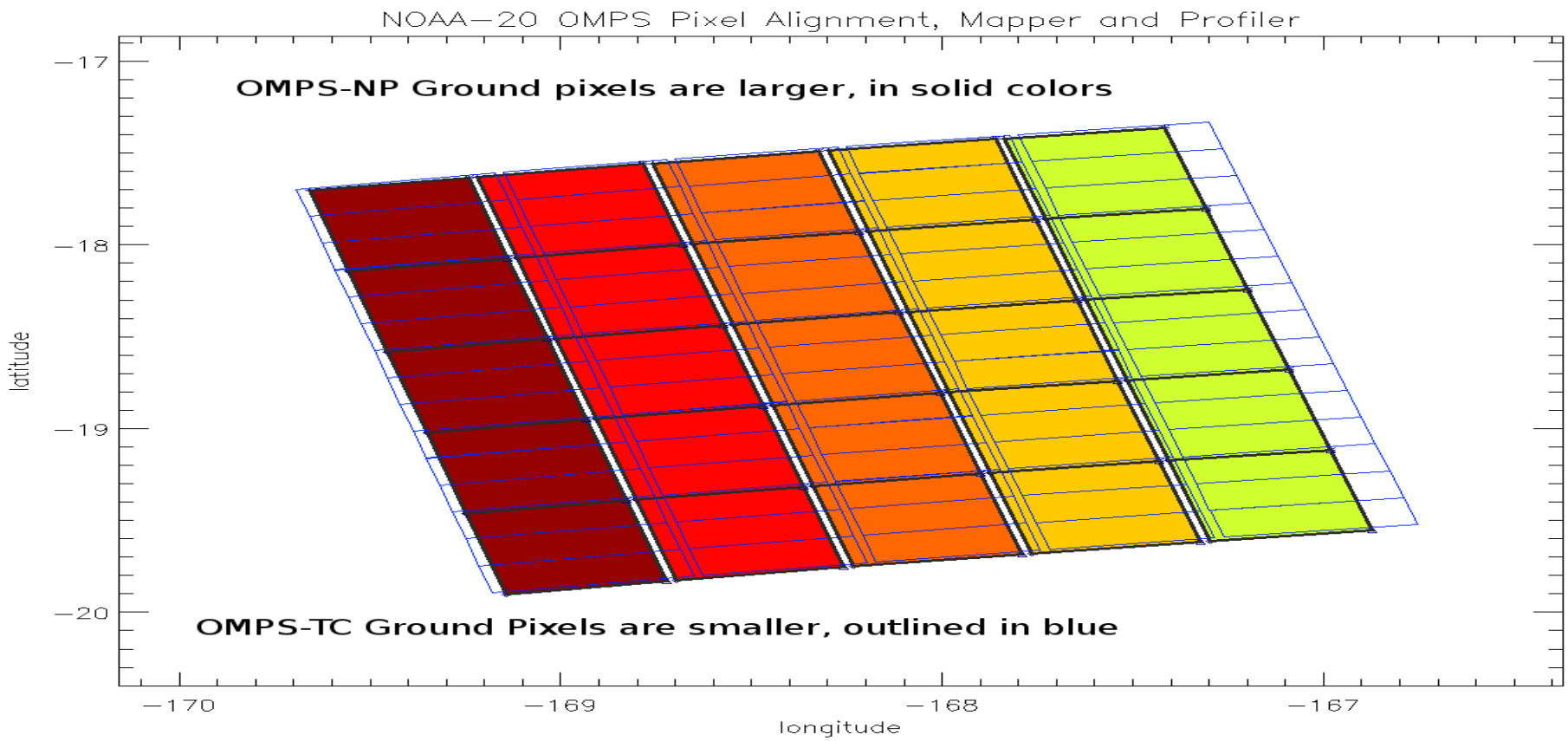
before_xGran_2018-02-21.png



with_xGran_DR_8616_2018_02_21.png

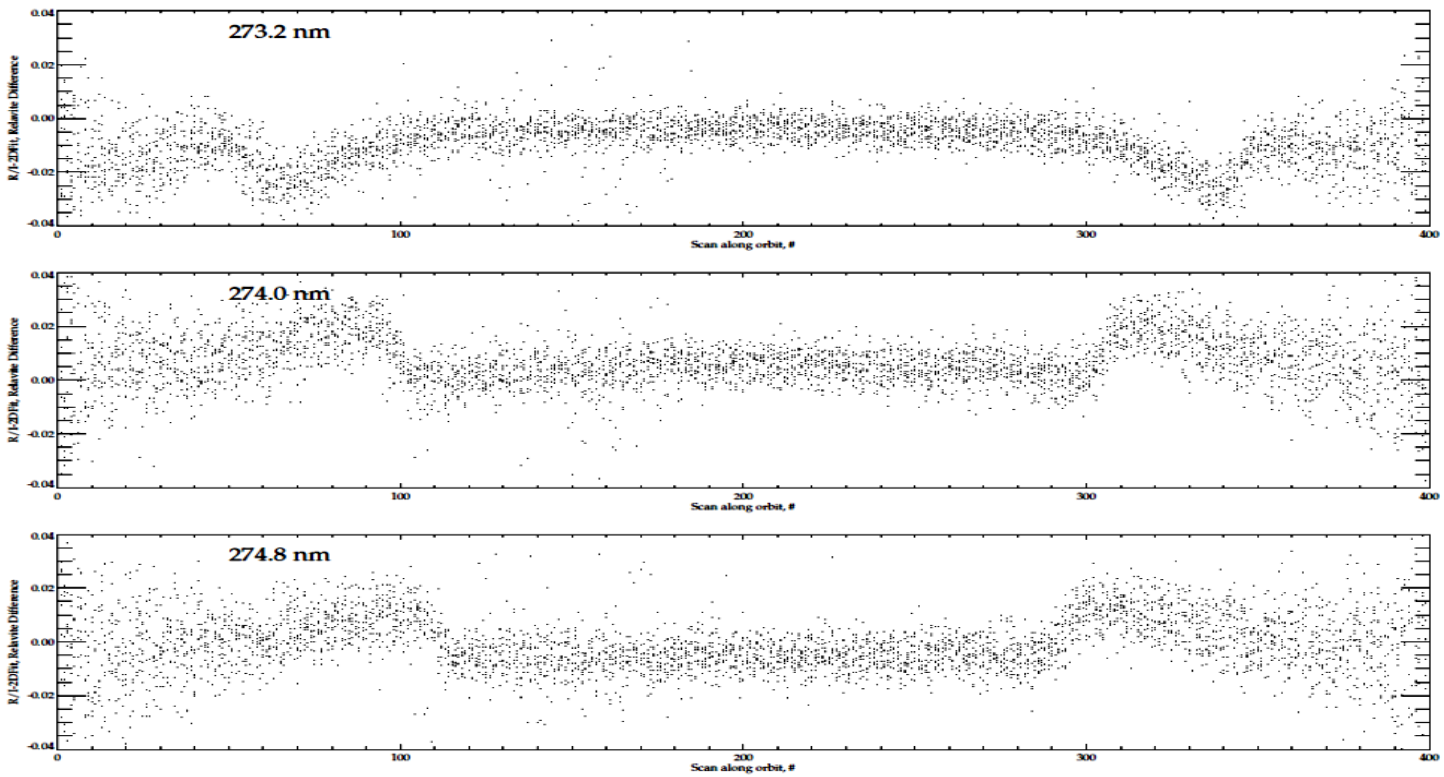
Data Quality Issues Field of View, OMPS-NP,TC

- The Field of View for OMPS-TC and OMPS-NP difference is large. In the EDR ozone profile retrieval the radiances from both the OMPS-NP and OMPS-TC Nadir are combined to form one scene with spectral sampling from 252nm to 380nm. If the fields of view are not aligned between the two sensors this will cause significant retrieval errors over inhomogeneous scenes.



Remaining Challenge, Non-Linearity correction

- Non-Linearity problems were discovered in NOAA-20 OMPS-NP. The OMPS EDR team found up to 2% errors in some low signal channels. Not all channels are affected. The OMPS-NP non-linearity correction flight table will be changed in the near future. The image below shows signal level dependent errors as a function of along track for one orbit. The expected behavior is noise distributed about the zero line.



FY19 Milestones and Deliverables

Task	Description	Deliverables	Scheduled Date
DR_8684,8685	OMPS SDR Quality Flag Implementation	Code Change	TTO Q2 2019
DR_8730	Non-Linearity table Update	Table Delivery	TTO Q1 2019
DR_8709	OMPS Smear Transient Detection and Correction	Code change	2019
	Validated Radiance Requirements		Q1 2019

Future Plans/Improvements

- Algorithm Improvements
  - Smear Transient Detection and Correction
  - Bi-weekly solar flux and wavelength deliveries for N20-OMPS-NP.
  - Possibility to increase spatial resolution from current 17km by 50km to 17km by 17km.
  - OMPS-NP wavelength intra-orbital correction
- J2 OMPS and Beyond
  - J2 OMPS Nadir Instruments substantially similar to NOAA-20.
  - J2 Limb Instrument will return. J2 Limb SDR and EDR NOAA operational products will be made at NDE.
  - J2 Limb will measure radiance from 290nm to 1000nm.
  - J2 NOAA operational EDR will produce ozone profile with a vertical resolution of ~1.5km.

OMPS Reprocessing

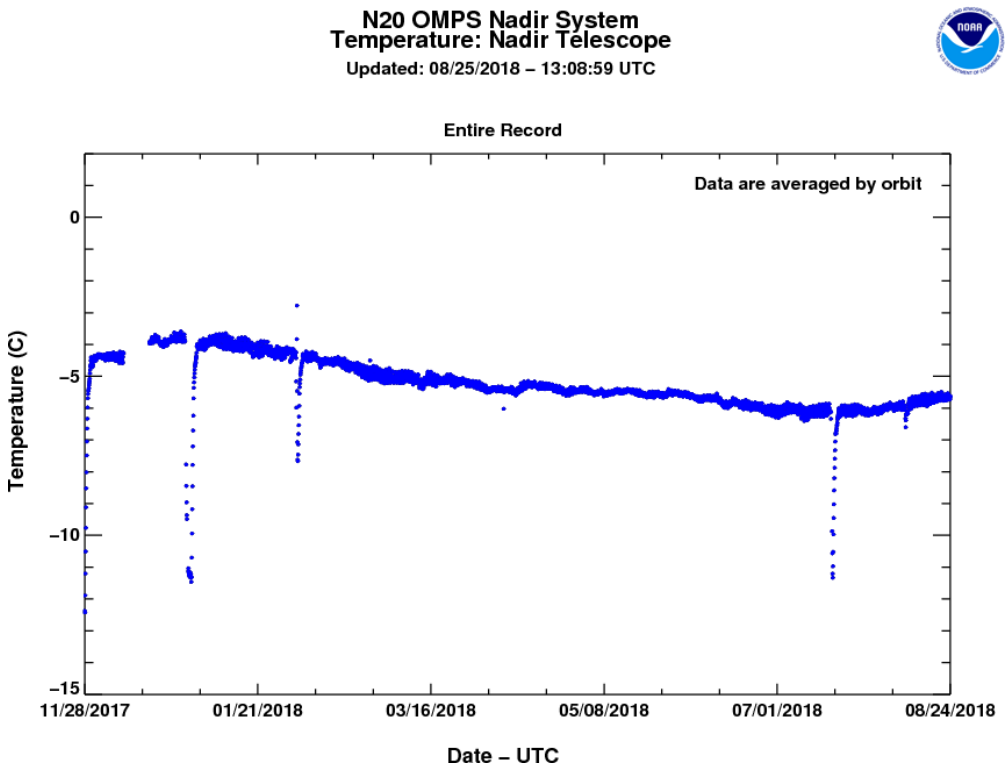
- Reprocessing was completed for January 2012 to March 2017.
- The S-NPP reprocessing will be redone. A new OMPS-TC straylight table went into operations July 8, 2018. The SDR data record needs to be reprocessed prior to the new straylight table change.
- The purpose of the reprocessing is to create a consistent SDR set using the best set of input LUTs and a consistent algorithm.
- The OMPS EDR team at NOAA has reprocessed the total ozone and ozone profile datasets and will repeat the EDR reprocessing once the most recent SDR reprocessed datasets are available.
- The NOAA-20 SDR reprocessing will begin in 2019.
- NOAA-20 SDR reprocessing will need to address several problems
  - Different sets of sample tables from Feb 8, 2018 to Oct. 2018.
  - Non-linearity correction coefficient changes in late 2018.

Long Term Monitoring with ICVS

http://www.star.nesdis.noaa.gov/icvs/status_NPP_OMPS_NM.php
http://www.star.nesdis.noaa.gov/icvs/status_NPP_OMPS_NP.php
http://www.star.nesdis.noaa.gov/icvs/status_NPP_OMPS_LP.php
http://www.star.nesdis.noaa.gov/icvs/status_J01_OMPS_NM.php
http://www.star.nesdis.noaa.gov/icvs/status_J01_OMPS_NP.php

The NOAA/STAR ICVS provides long term monitoring of key parameters

- Instrument Health and
- Sensor Performance
- SDR Product Monitoring
- Data Quality Assessment
- Anomaly Detection
- Anomaly Notification



ICVS OMPS Monitoring Presentation on Wednesday by Ding Liang

Summary

- NOAA-20 OMPS reached provisional Maturity in July, 2018. The team is working towards Validated Maturity.
- NOAA-20 OMPS had problems with the at-launch tables. There have been delays.
- NOAA-20 OMPS has advantages over S-NPP OMPS in spatial resolution.
- NOAA-21 OMPS will have the Limb and Nadir instruments.
- The SDR team work very closely with the OMPS EDR team, feedback has been positive.
- There will be an OMPS SDR session on Wednesday, August 29 at 1pm in Room 2554. More details will be presented by the SDR team.

Evaluation and Assimilation of ATMS and CrIS at NCEP

Andrew Collard[1], John Derber[2],
Yangrong Ling[1], Jim Jung[3], Yanqiu Zhu[1],
Li Bi[1], Emily Liu[4], Kristen Bathmann[1]

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[3]Univ. of Wisconsin [4]SRG@NOAA/NCEP/EMC

Introduction

- Assimilation Configuration
- Data Quality
- Impact on Analysis
- Impact on Forecasts
- Summary and Next Steps

Assimilation Configuration

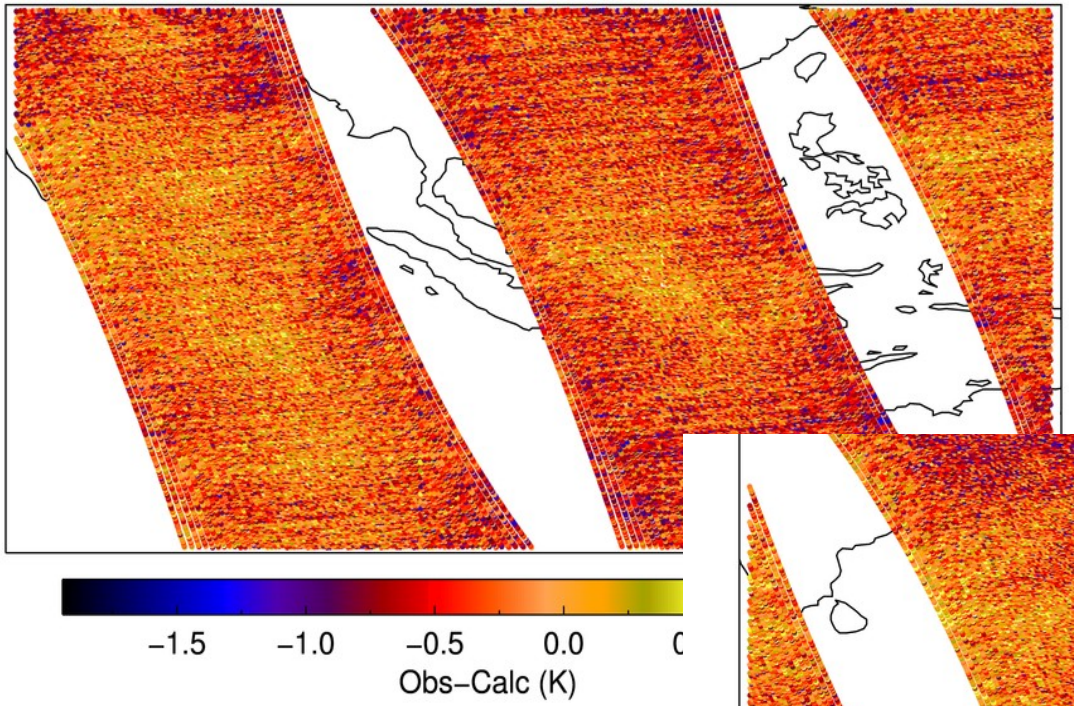
Assimilation Configuration

- For testing purposes, experiments were run at reduced resolution using the operational 4DEns-Var Hybrid GSI.
- Deterministic model resolution is T670 (operations is T1574).
- EnKF and analysis resolution is T254 (T574)
- The default (box-car ISRF) CRTM radiative transfer coefficients for ATMS are being used in this implementation.
  - Testing with coefficients using the measured ISRF is underway.
- After testing implementation was both in the operational global GFS and the pre-operational FV3-GFS parallel.

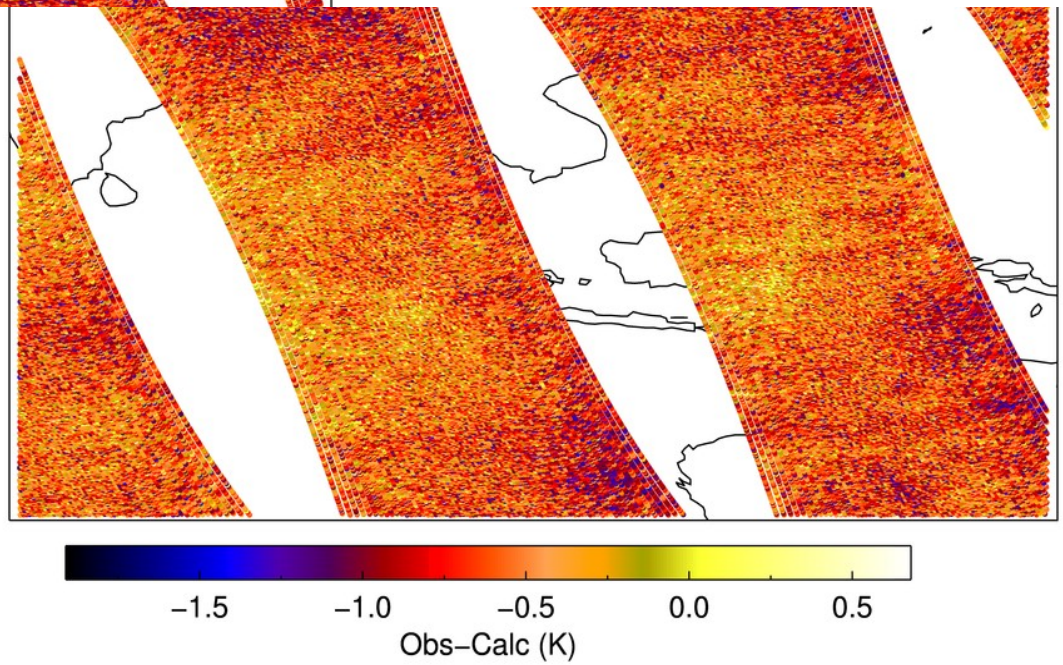
ATMS

Striping Seems to be better

S-NPP Channel 10



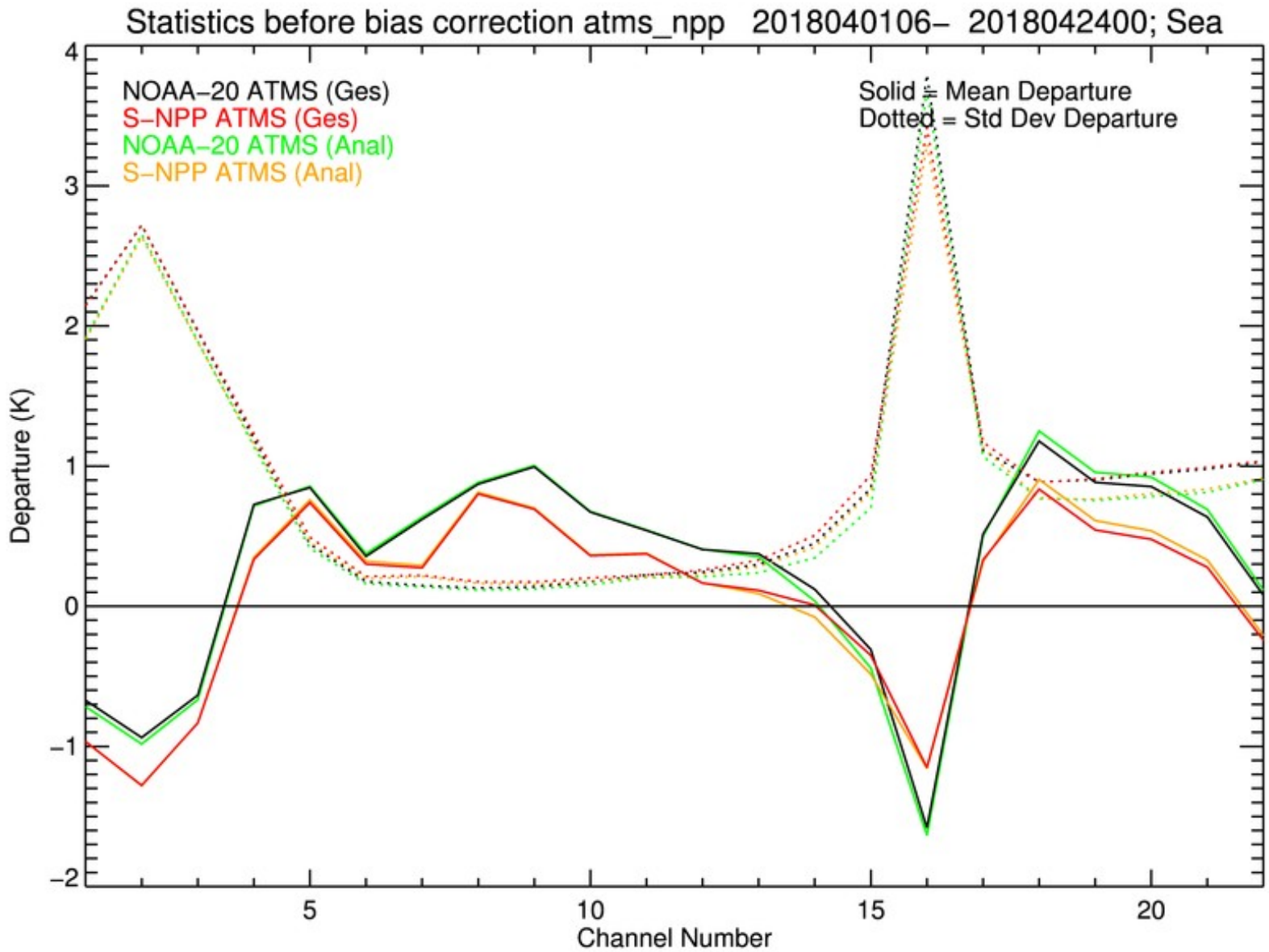
NOAA-20 Channel 10



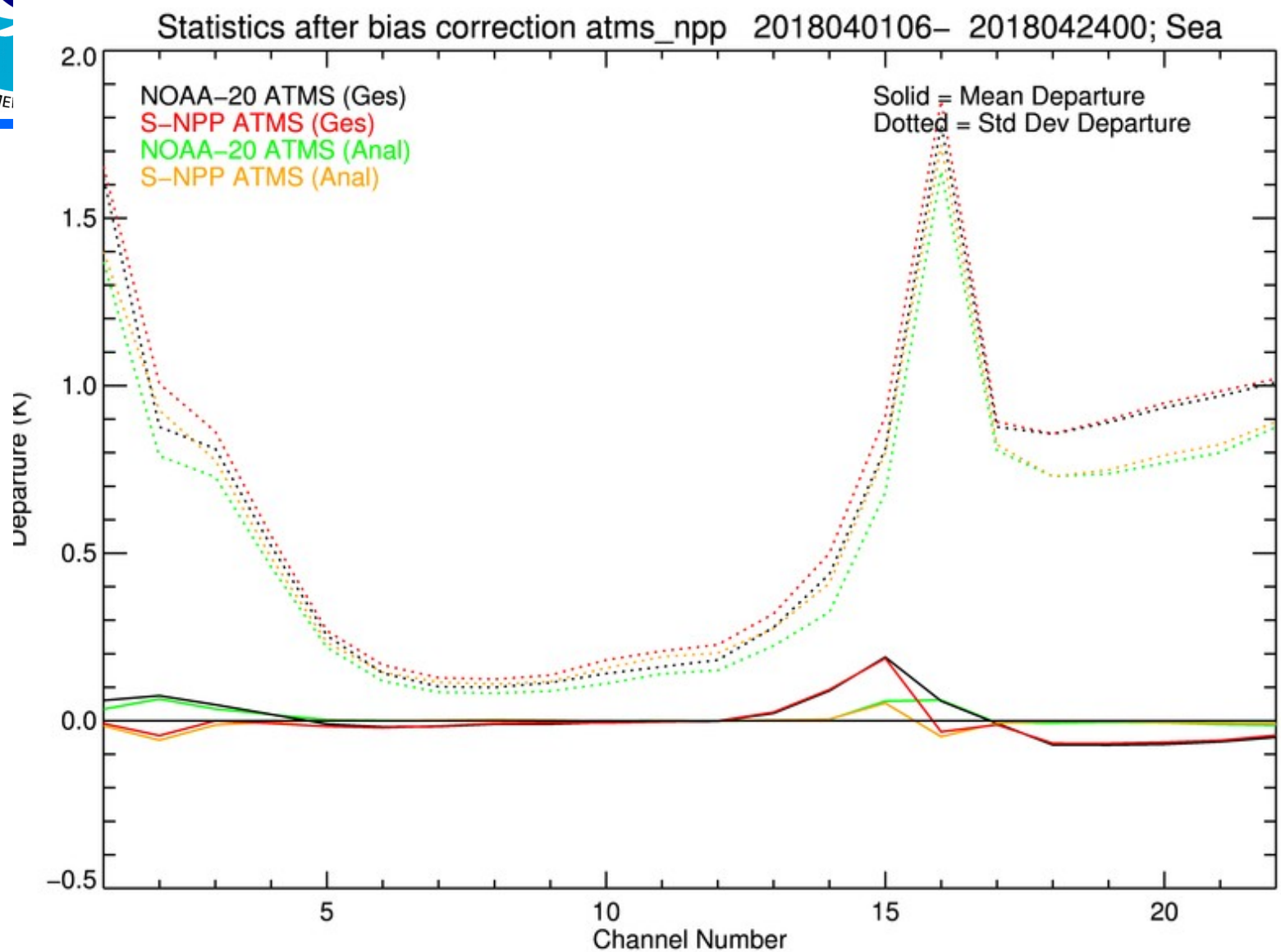
Spatial Averaging / Re-Mapping

- We use the AAPP FFT-based remapping code (described by Nigel Atkinson) to re-map (and in the process spatially average) the AMSU-A like ATMS channels to a common field of view (3.3°).
- This is to reduce the noise on the temperature sounding channels and also to allow the 5.2° FOV channels 1 and 2 to be consistent with the other AMSU-A like channels (as these are used for cloud-detection).
- Special attention has to be paid to missing and bad data as this will affect surrounding points in the re-mapped product.

Uncorrected Departure Stats



Bias-corrected Departure Stats

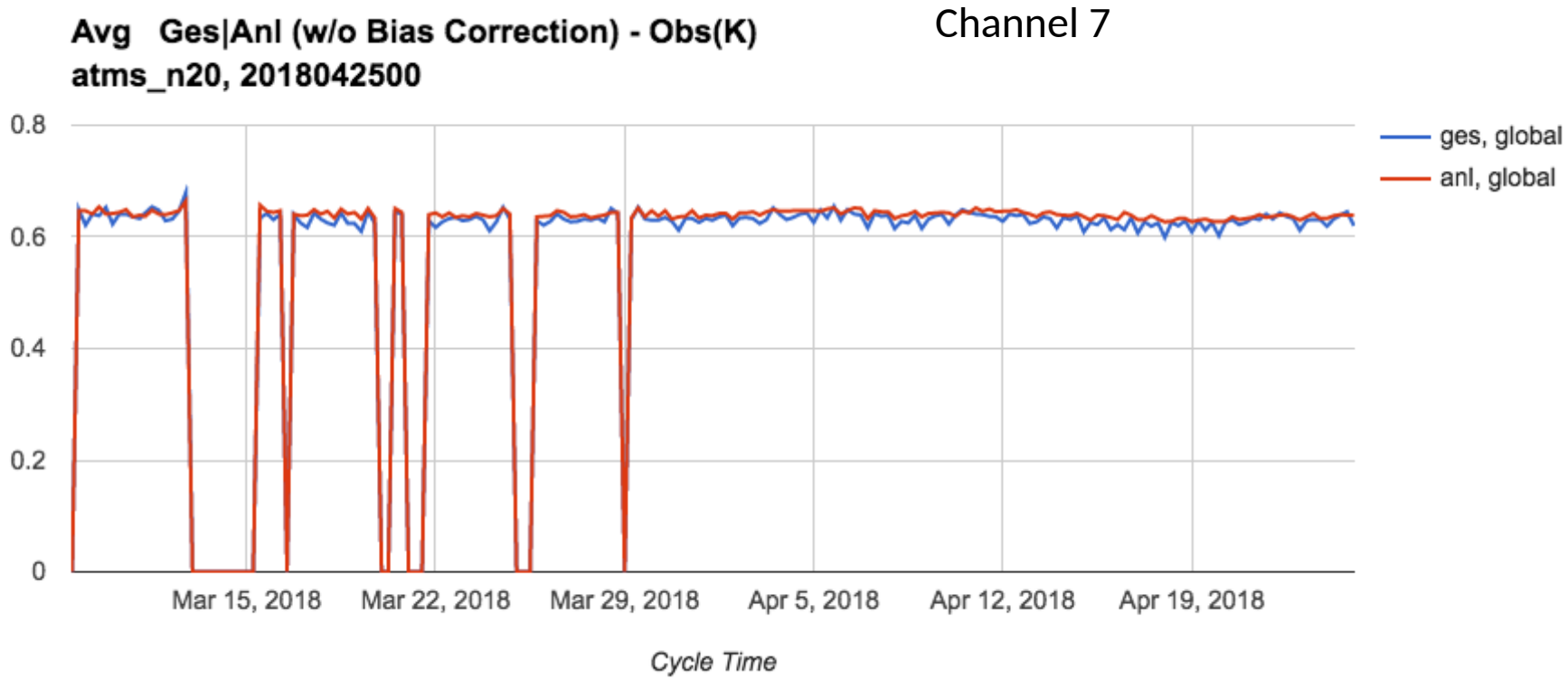


Monitoring Instrument Performance in the GSI

Our evaluation experiments start on 3rd March 2018.

Since that date observed-calculated statistics appear to be stable

Channel 7



Observation Errors

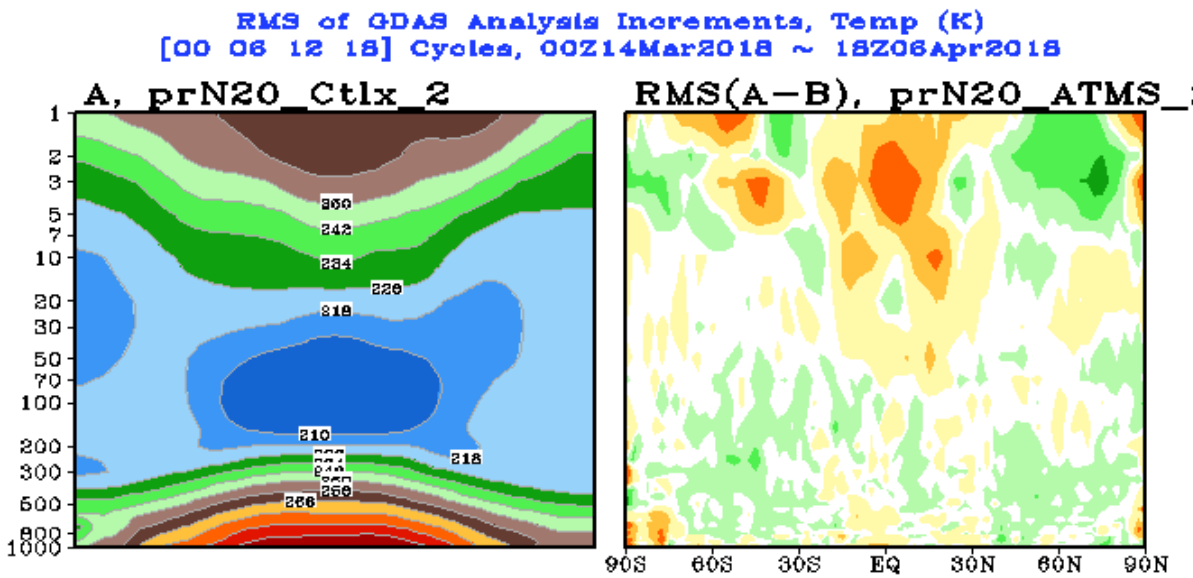
ATMS Channel	AMSU-A/MHS NOAA-19 Obs Error (K)	ATMS Obs Error (K)
1	2.50	5.00
2	2.00	5.00
3†	2.00	5.00
4		3.00
5†	0.55	0.55
6	0.30	0.40
7	0.23	0.40
8†	0.23	0.40
9	*0.25	0.40
10	0.25	0.40
11	0.35	0.45
12	0.40	0.45
13	0.55	0.55
14	0.80	0.80
15	*3.00	*3.00
16-22	2.50	2.50

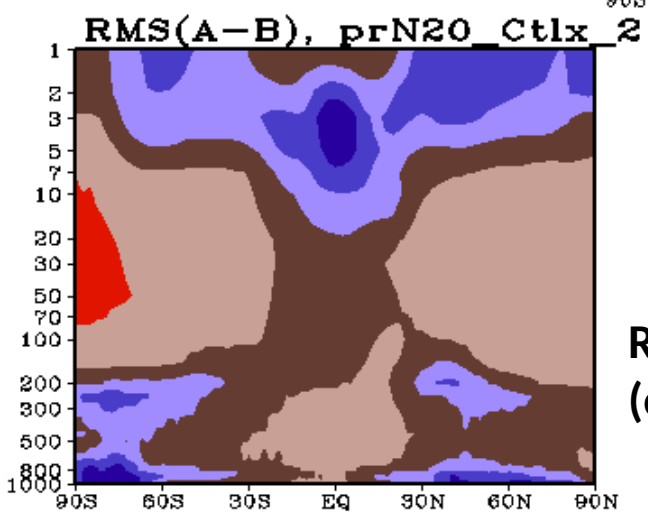
†ATMS and AMSU-A have different polarizations.

*Channel not used

Temperature Analysis Increments

Analysis

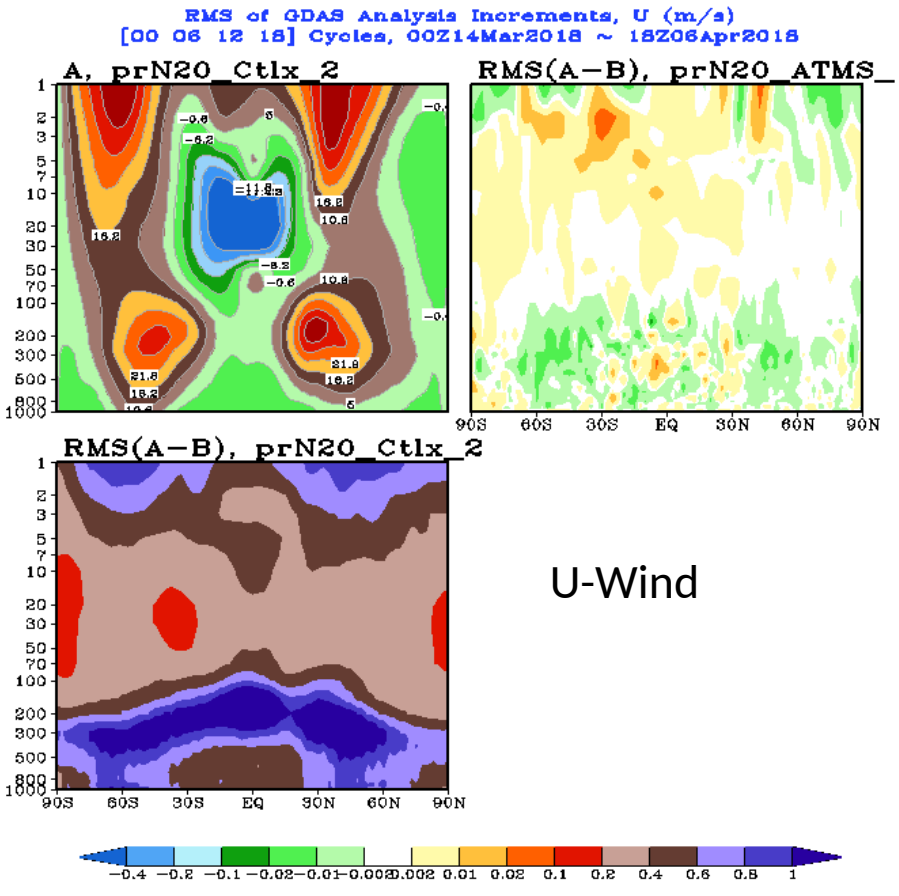




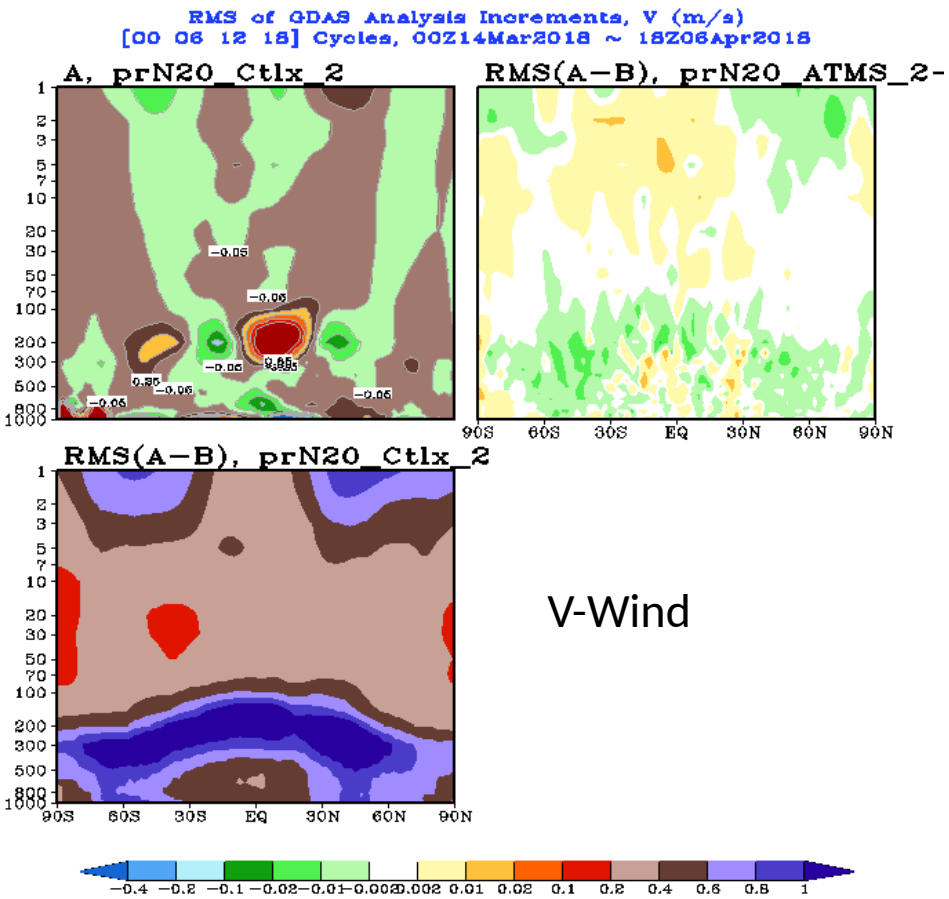
Difference in RMS Analysis Increment (experiment - control)

RMS Analysis Increment (control)

Wind Analysis Increments



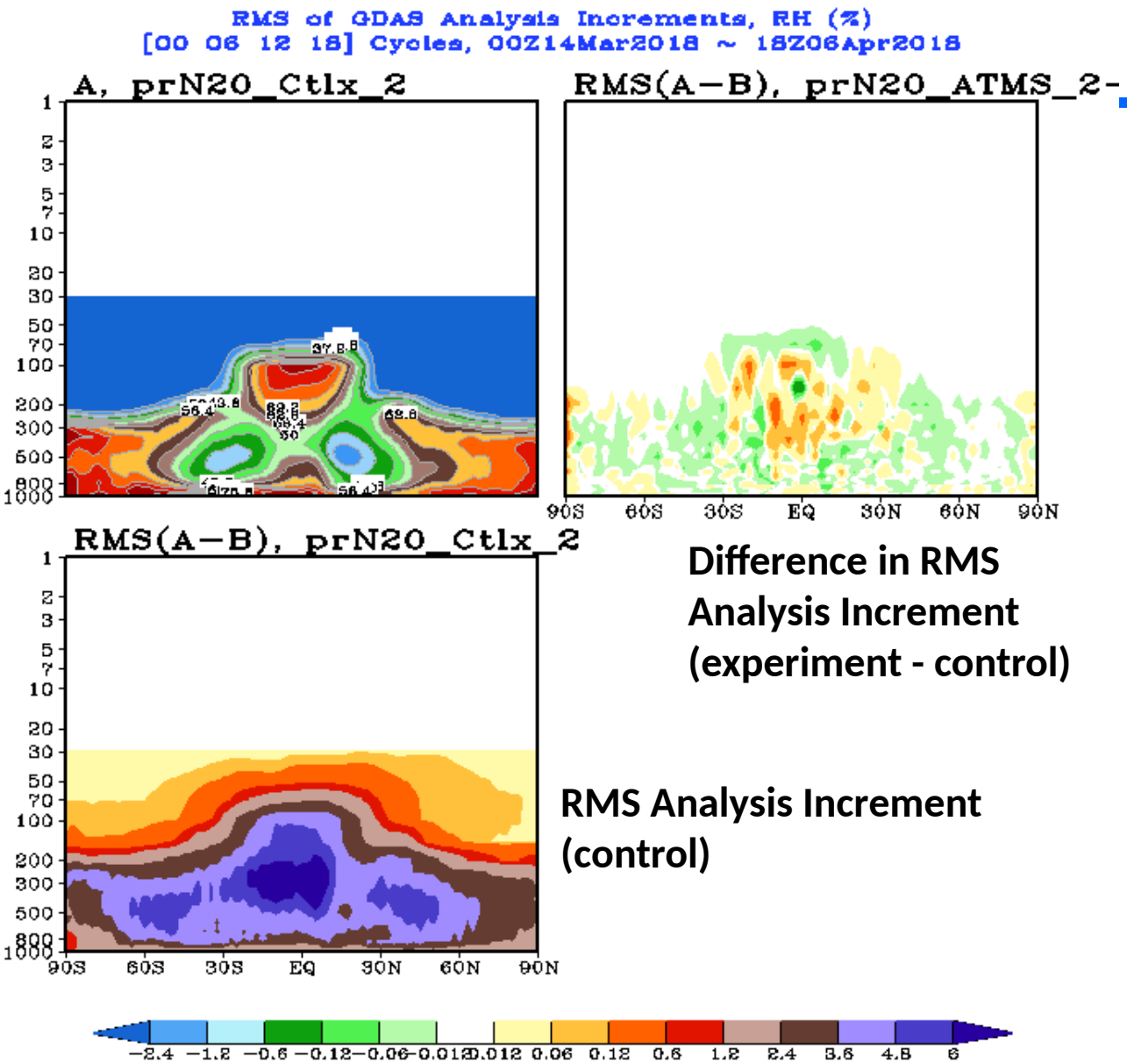
U-Wind



V-Wind

Relative Humidity Analysis Increments

Analysis



Difference in RMS Analysis Increment (experiment - control)

RMS Analysis Increment (control)

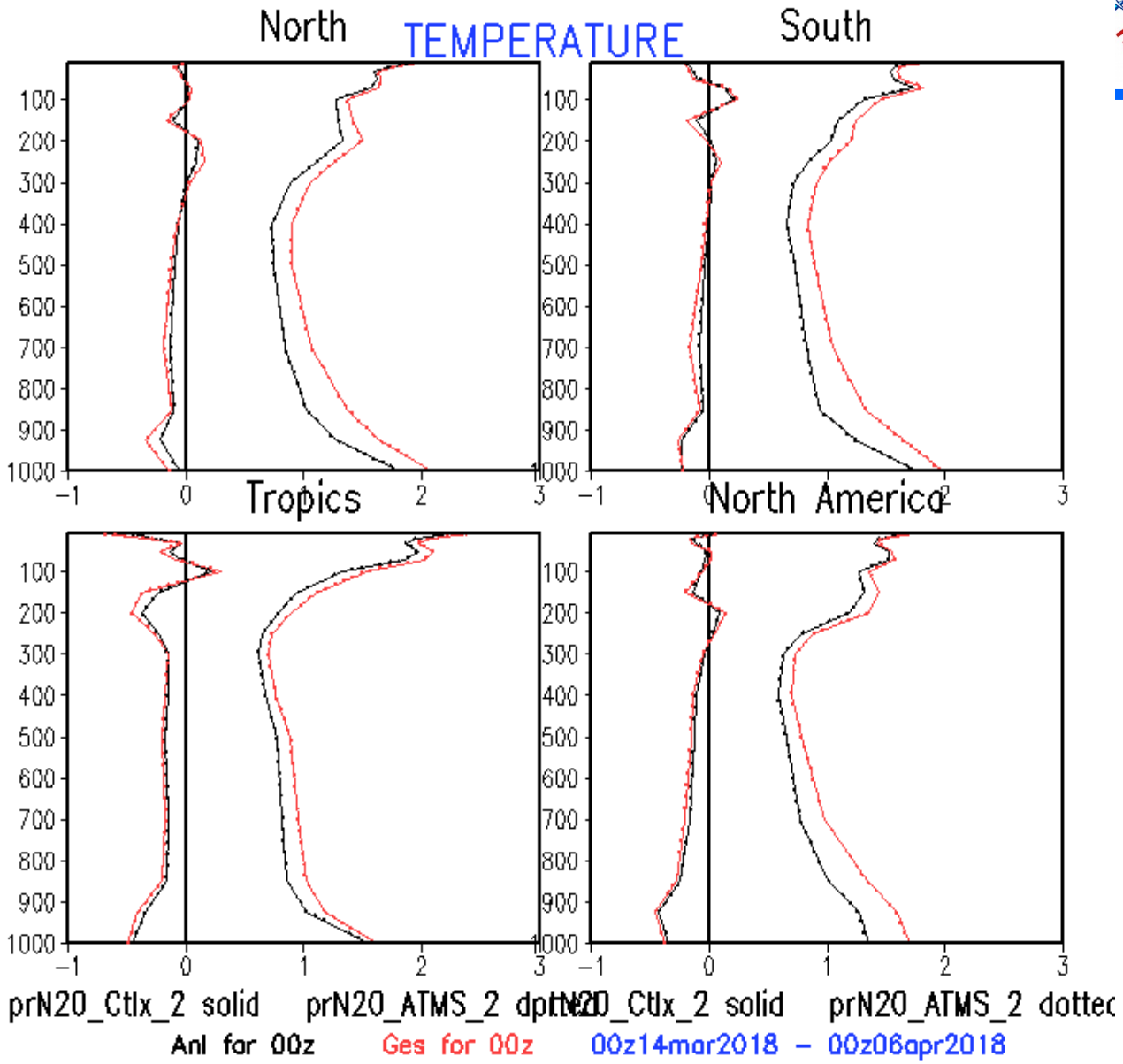
Background and Analysis Fit to Sondes

Temperature

Guess
Analysis

Solid=Control
Dotted=Control
+ATMS_N20

LH Curves=Bias
RH Curves=RMS



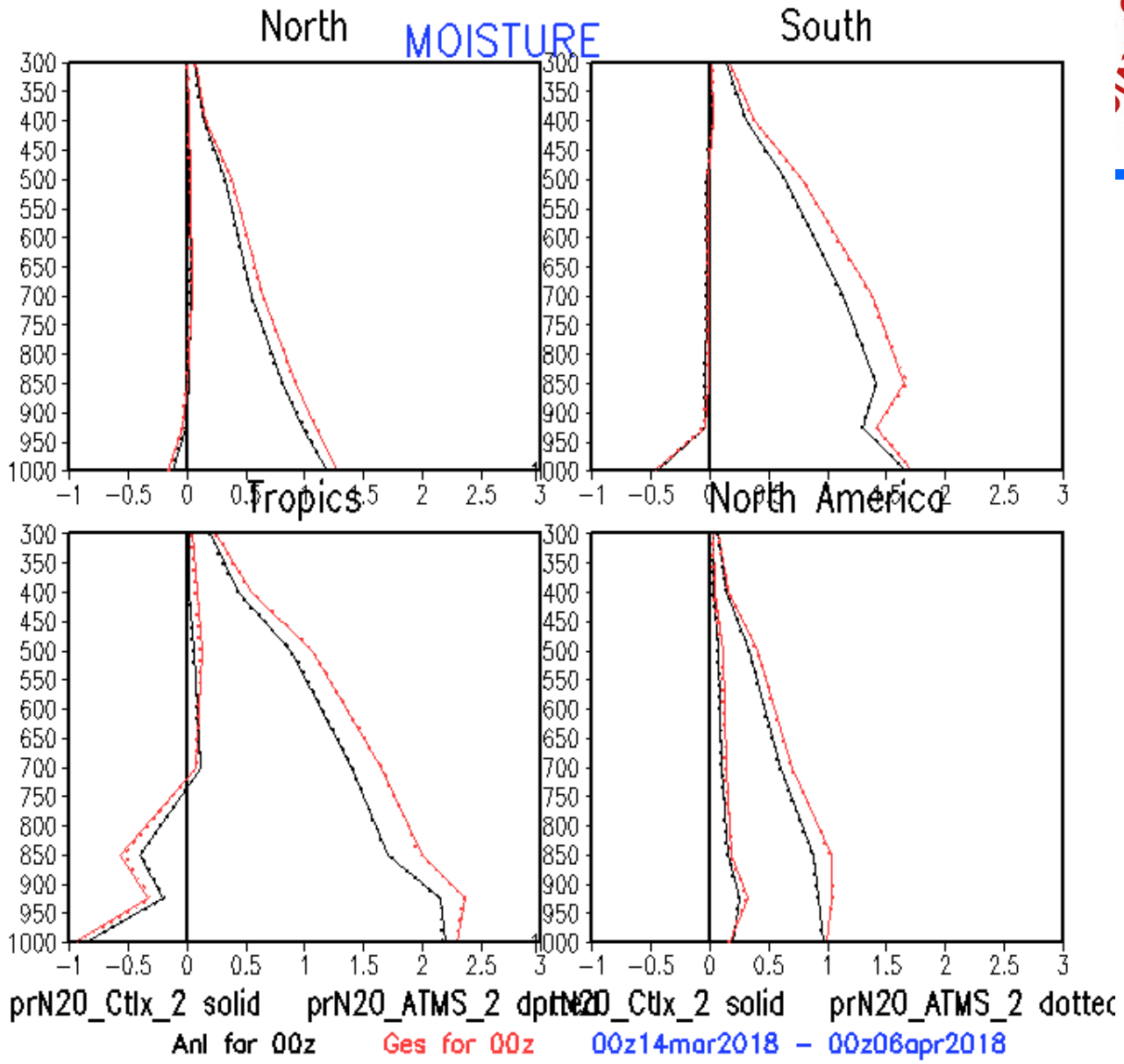
Background and Analysis Fit to Sondes

Specific Humidity

Guess
Analysis

Solid=Control
Dotted=Control +ATMS_N20

LH Curves=Bias
RH Curves=RMS



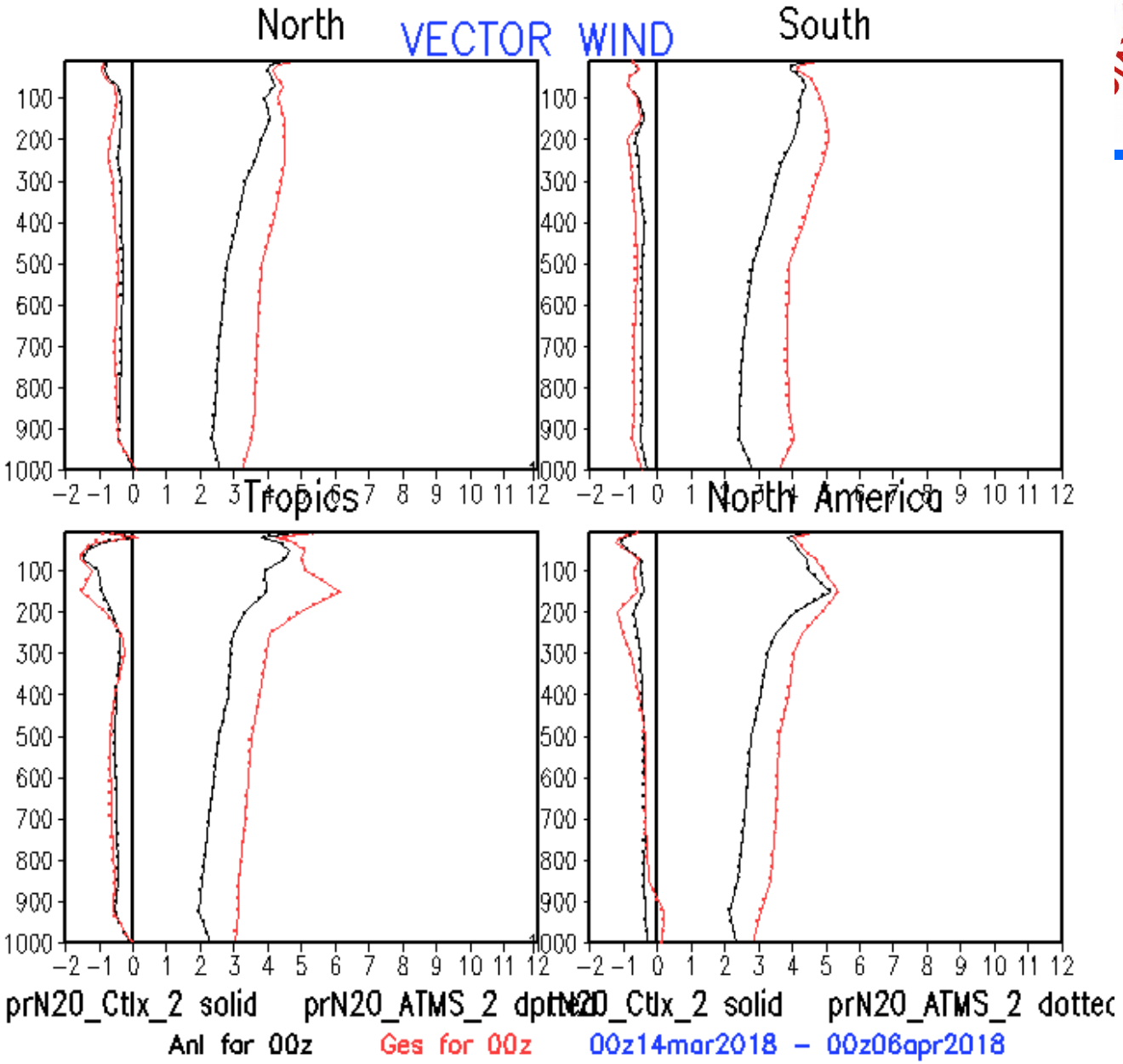
Background and Analysis Fit to Sondes

Vector Wind

Guess
Analysis

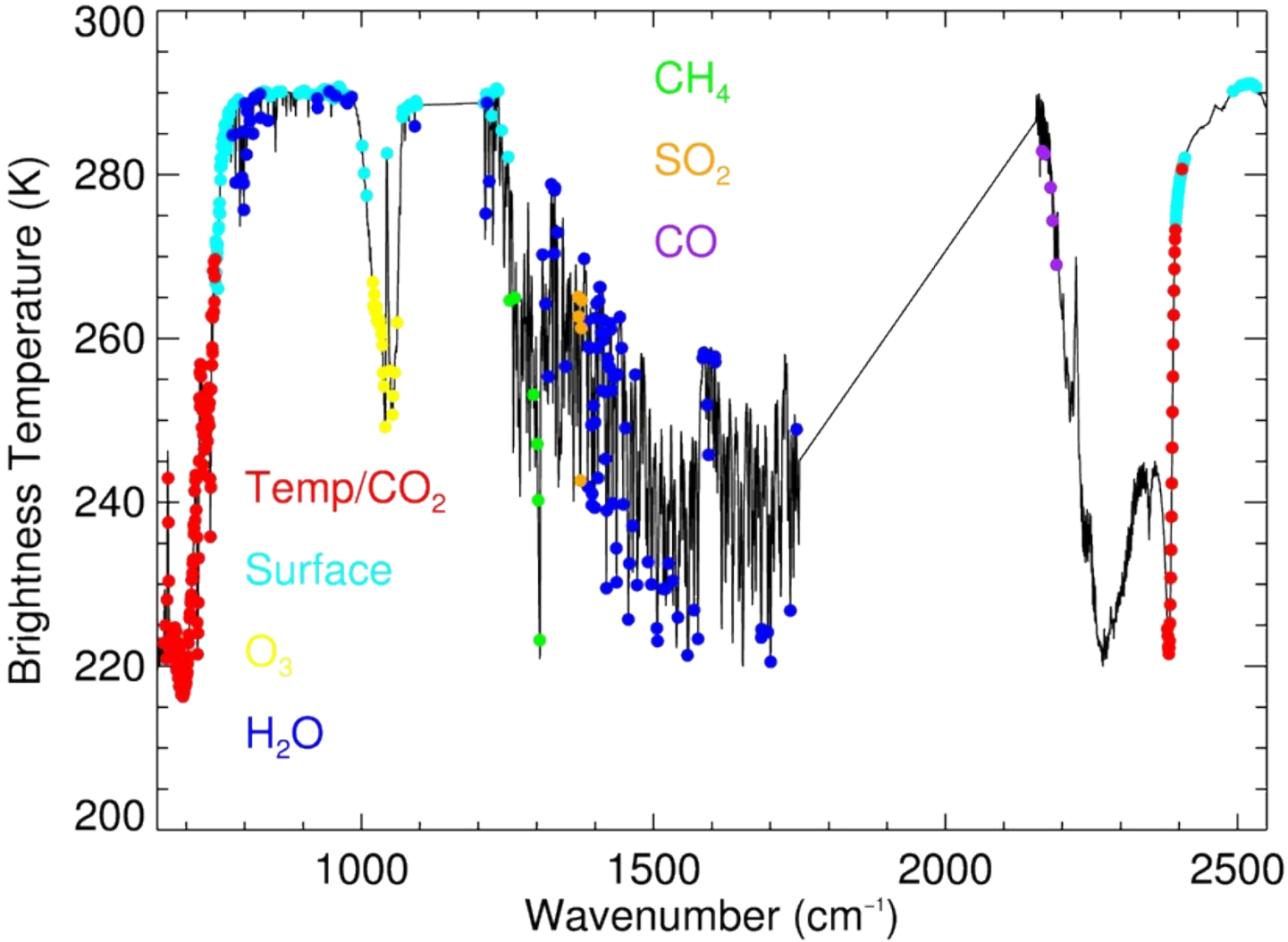
Solid=Control
Dotted=Control
+ATMS_N20

LH Curves=Bias
RH Curves=RMS

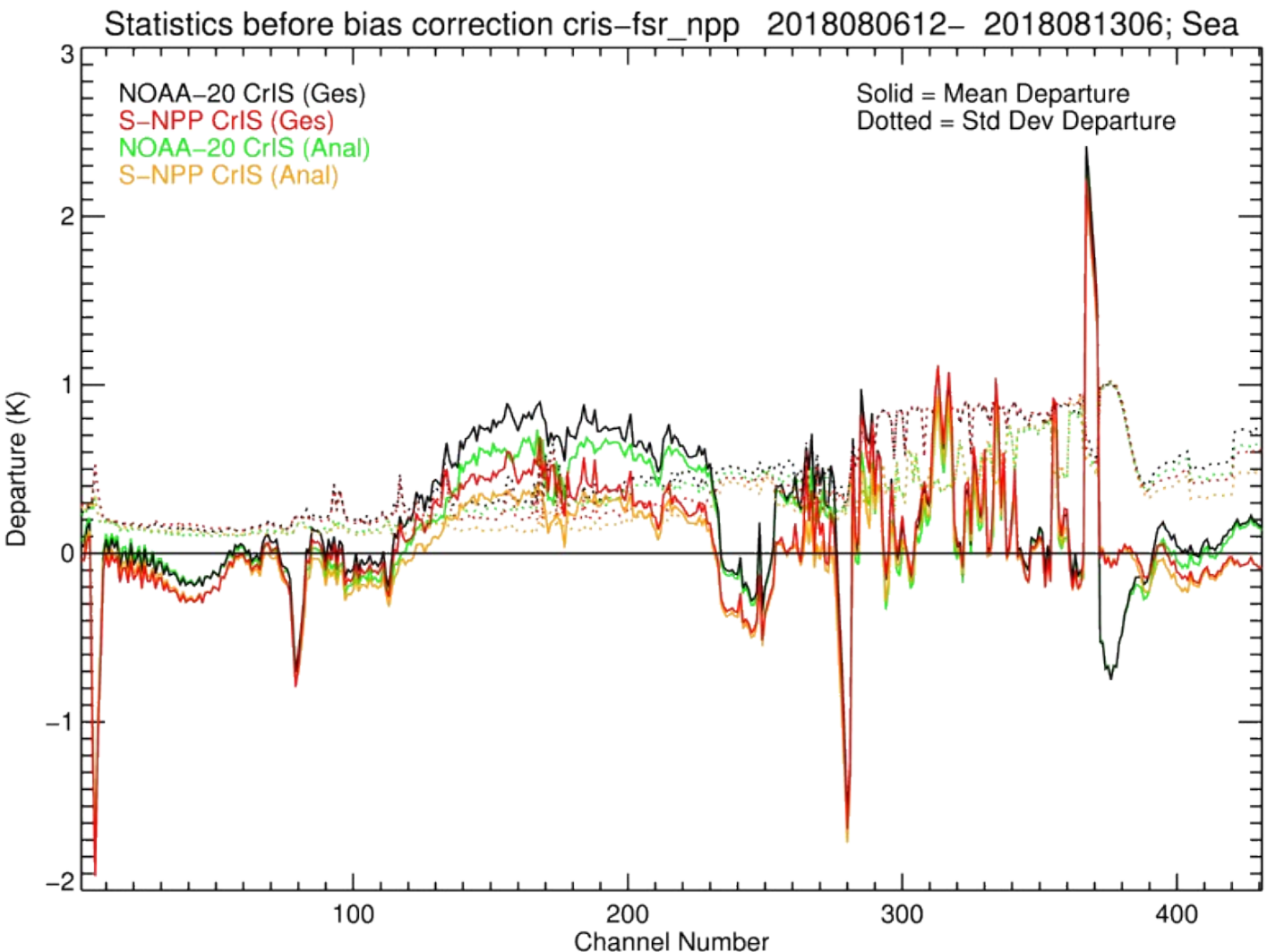


CrIS

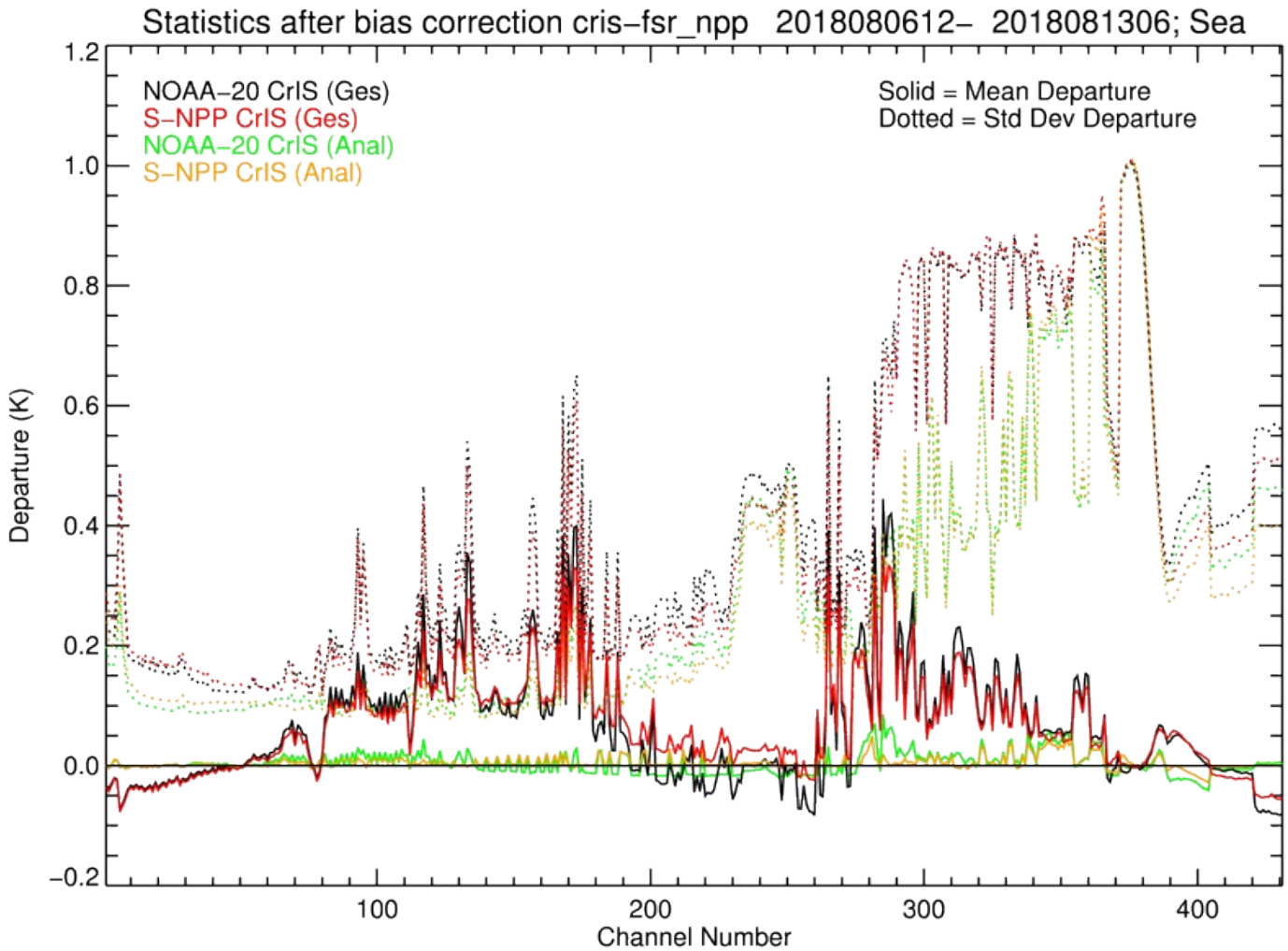
CrIS FSR 431
Channel Selection



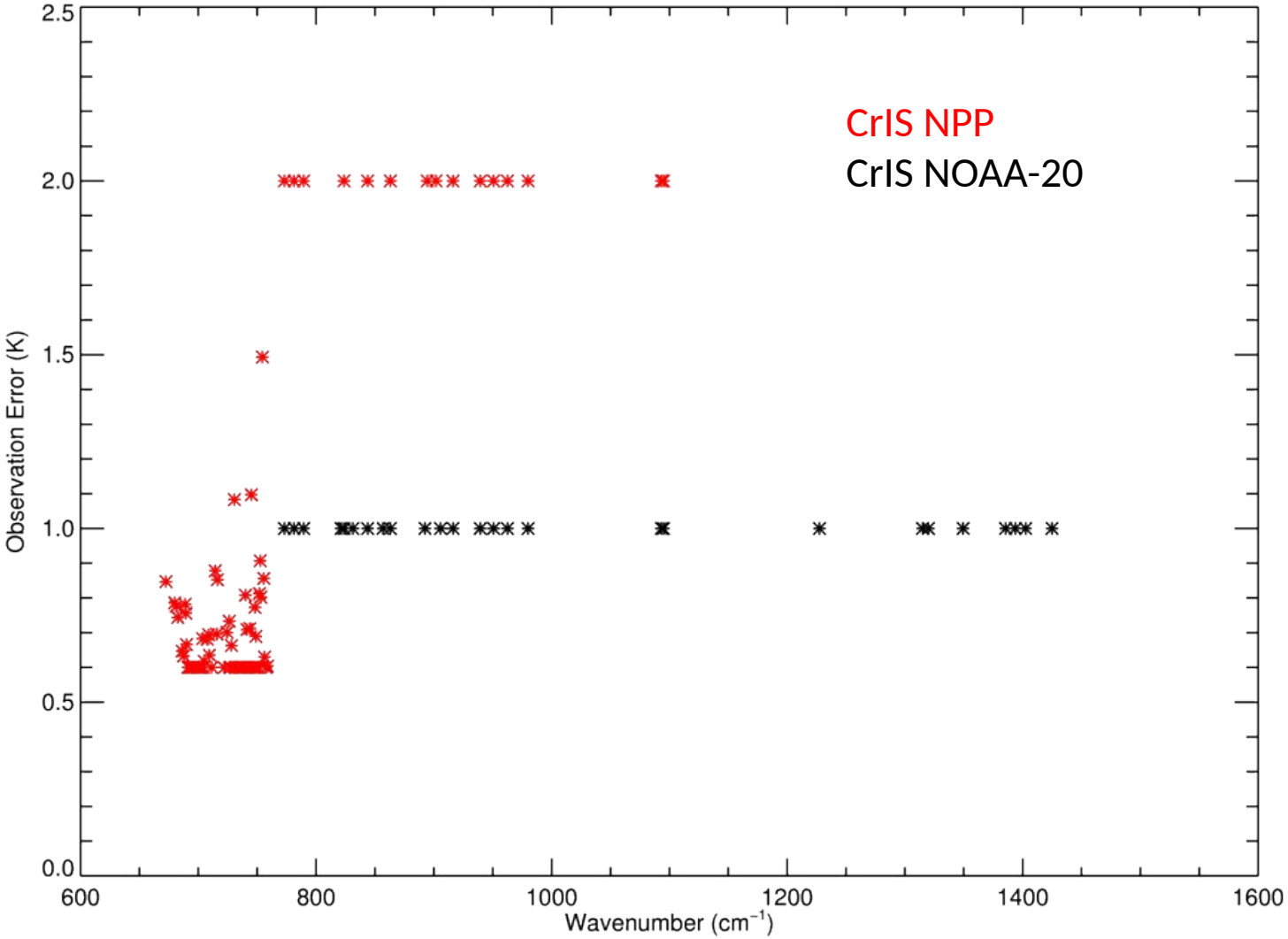
Uncorrected Departure Stats



Bias-corrected Departure Stats

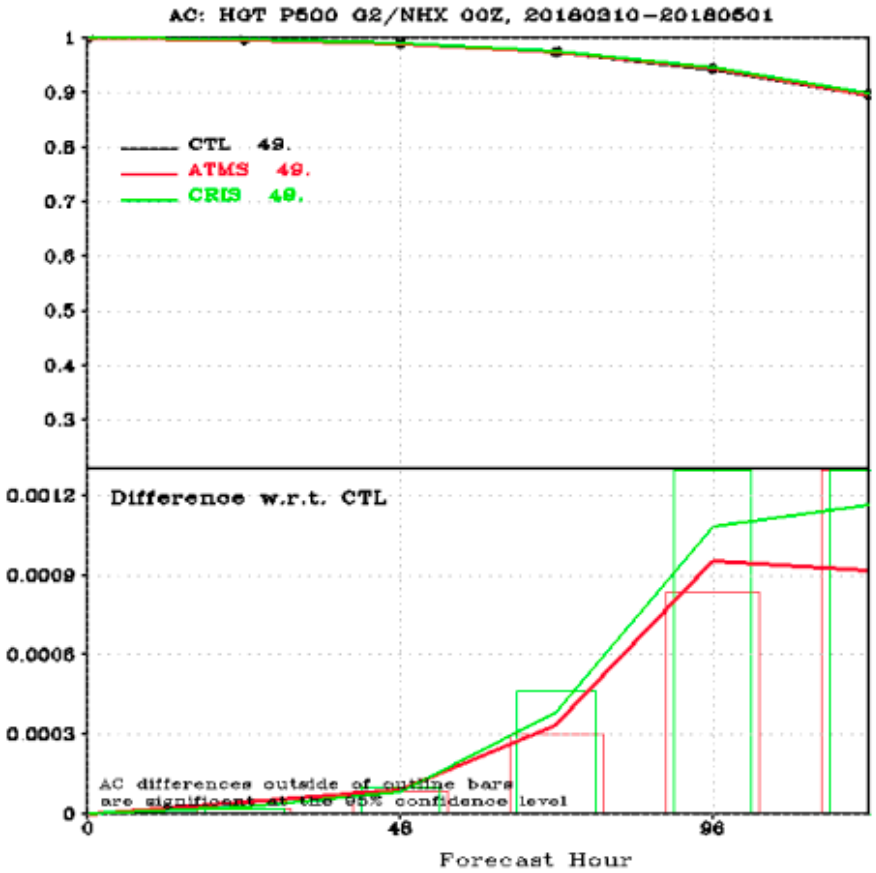


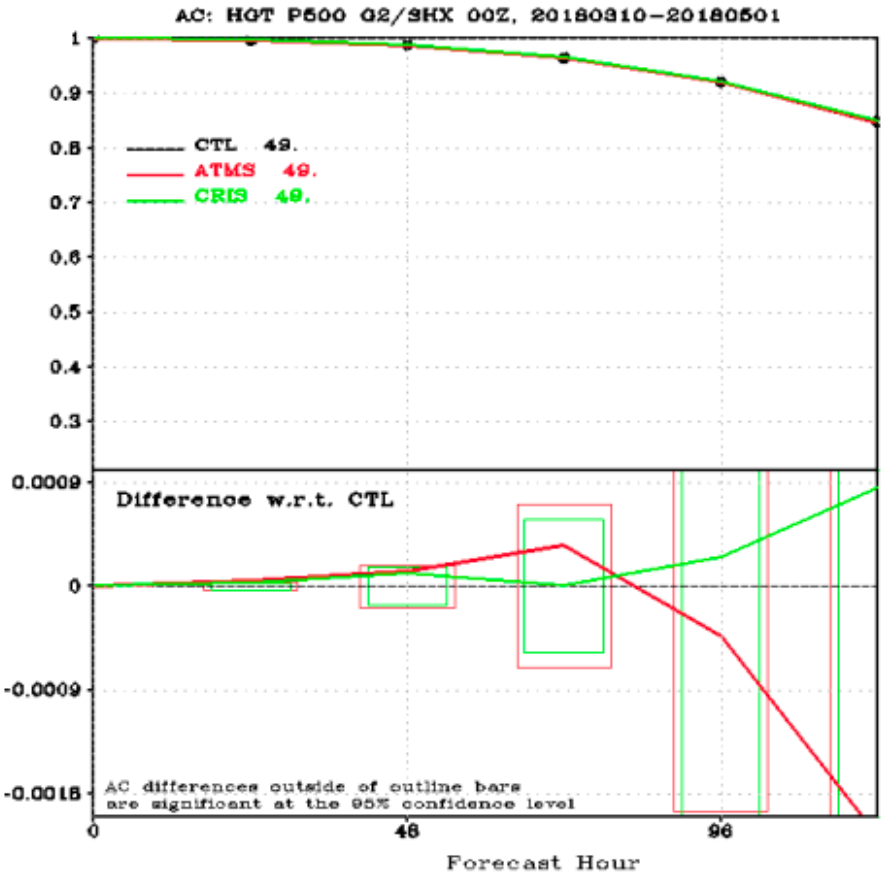
Changes to observation errors and channel usage in FV3



Forecast Impacts

500hPa Geopotential Height Anomaly Correlation Scores

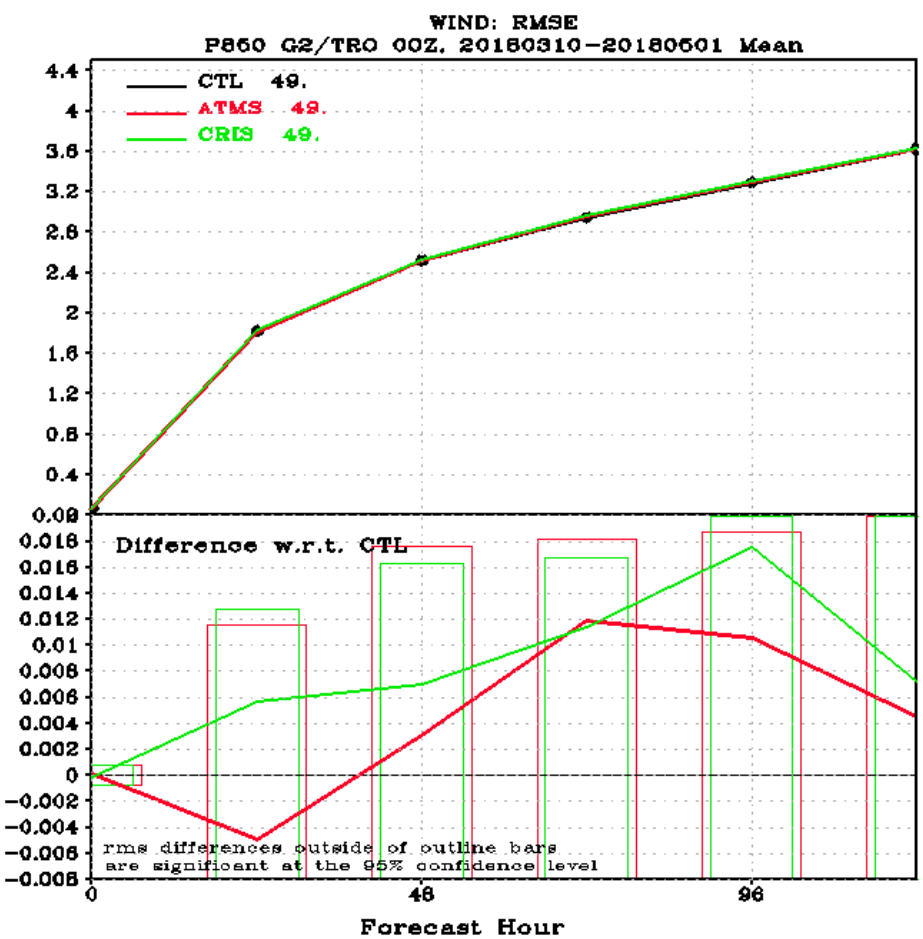


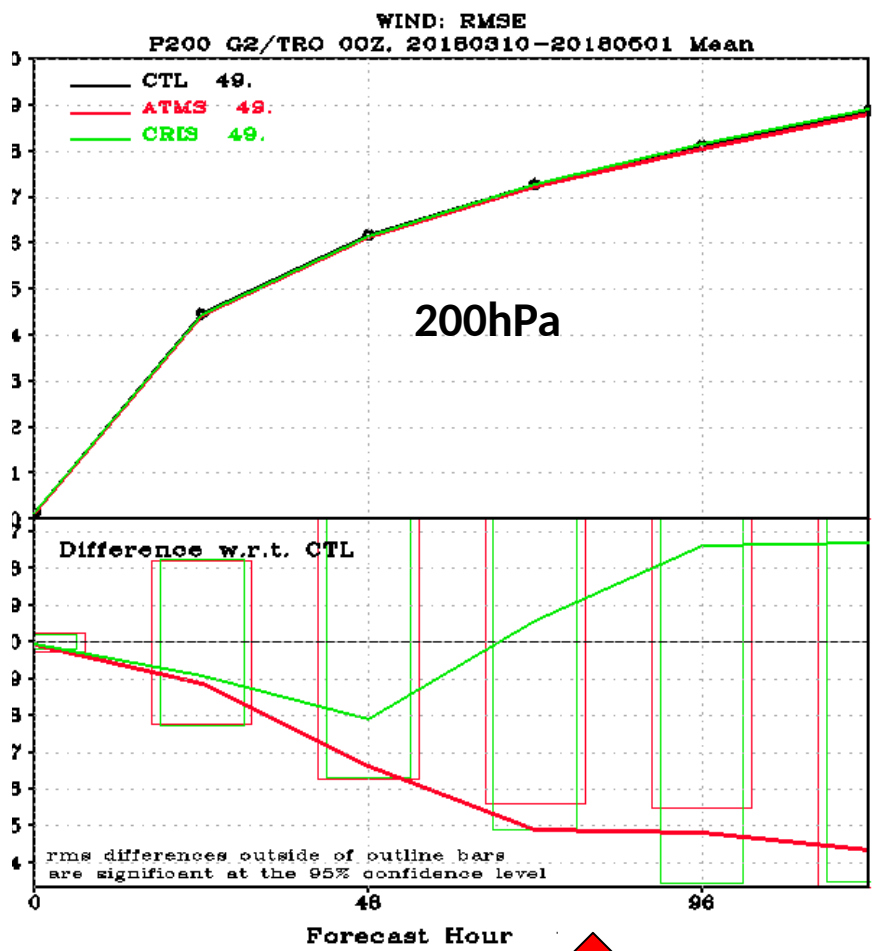


NOAA-20 Improves

NOAA-20 Degrades

Tropical Vector Wind RMS Error Scores





NOAA-20 Improves

NOAA-20 Degrades

ATMS Summary and steps forward

- The initial quality of the ATMS data from NOAA-20 is comparable with/slightly improved relative to that from NPP.
- Small bias differences are removed through bias correction.
- Striping appears to be less of an issue compared to S-NPP.
- In assimilation experiments, analysis increments and fit-to-observations appear reasonable.
- Forecast impacts are neutral to slightly positive.
- For operational implementations, there are two configurations:
  - The current configuration (clear sky) was put into the global operational system on 30th May 2018
  - **Cloudy radiance assimilation** (affecting channels 1-6 and 16-22) is implemented in the FV3-Beta GFS to be run in parallel with the operational system

CrIS Summary and steps forward

- The initial quality of the CrIS data from NOAA-20 is comparable or slightly better that from NPP.
- In assimilation experiments, analysis increments and fit-to-observations appear reasonable.
- Forecast impacts are mostly neutral.
- For operational implementations, there are two configurations:
  - The current configuration was put into the global operational system on 30th May 2018
  - The FV3-Beta GFS being run in parallel with the operational system has slightly more aggressive observation errors.
- Future work includes the introduction of cloudy radiances and correlated observation errors.