NOAA-20 ATMS PERFORMANCE HIGHLIGHTS

ATMS SDR Team


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

Presented by Ed Kim and Mark Liu
August 27, 2018
NOAA-20 ATMS Antenna Temperature (TDR) Ch.18 183.311 ± 7.0 GHz QH-POL
UTC Date: 2017-11-29

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

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

V. Leslie & I. Osaretin, MIT LL
ATMS Noise Power Spectra

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

<table>
<thead>
<tr>
<th>Ch.</th>
<th>Center Freq. (MHz)</th>
<th>POL</th>
<th>Bandwidth Max. (MHz)</th>
<th>Frequency Stability (MHz)</th>
<th>Calibration Accuracy (K)</th>
<th>NEΔT (K)</th>
<th>3-dB Bandwidth (deg)</th>
<th>Remarks</th>
<th>Characterization at Nadir</th>
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<tr>
<td>1</td>
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<td>QV</td>
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<td>Window-water vapor 100 mm</td>
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<td>QV</td>
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<td>Window-surface emissivity</td>
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<td>5</td>
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<td>0.6</td>
<td>1.1</td>
<td>157000</td>
<td>H2O 18 mm</td>
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<td>1.1</td>
<td>AMSU-B</td>
<td>H2O 8 mm</td>
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<td>QH</td>
<td>2000</td>
<td>30</td>
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<td>H2O 4.5 mm</td>
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<td>30</td>
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<td>0.8</td>
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<td>AMSU-B/MHS</td>
<td>H2O 2.5 mm</td>
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<td>H2O 1.2 mm</td>
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<td>QH</td>
<td>500</td>
<td>30</td>
<td>1.0</td>
<td>0.9</td>
<td>1.1</td>
<td>AMSU-B/MHS</td>
<td>H2O 0.5 mm</td>
</tr>
</tbody>
</table>
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
· 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

N20

SNPP

Corr: 0.988
Bias: 1.21
StDv: 2.73

Corr: 0.987
Bias: 1.24
StDv: 2.82
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**

<table>
<thead>
<tr>
<th>Sensor-Spacecraft</th>
<th>Algorithm</th>
<th>Activation</th>
<th>Beta</th>
<th>Provisional</th>
<th>Validated</th>
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</thead>
<tbody>
<tr>
<td>ATMS-SNPP</td>
<td>SDR-L1b</td>
<td>08-Nov-2011</td>
<td>Jan-2012 (2 m)</td>
<td>Oct-2012 (1 yr)</td>
<td>Dec-2013 (2 yr 2 m)</td>
</tr>
<tr>
<td>CrIS-SNPP</td>
<td>SDR-L1b</td>
<td>14-Dec-2011</td>
<td>Apr-2012 (5 m)</td>
<td>Oct-2012 (11 m)</td>
<td>Dec-2013 (2 yr)</td>
</tr>
<tr>
<td>CrIS-N20</td>
<td>SDR-L1b</td>
<td>3-Jan-2018</td>
<td>17-Jan-18 (2 m)</td>
<td>16-Feb-18 (3 m)</td>
<td>Aug-2018 (10 m)</td>
</tr>
</tbody>
</table>

Maturity milestones reached earlier for N20!
## JPSS Retrieval Timeline

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

<table>
<thead>
<tr>
<th>Sensor-Spacecraft</th>
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<th>Activation</th>
<th>Beta</th>
<th>Provisional</th>
<th>Validated</th>
</tr>
</thead>
<tbody>
<tr>
<td>MIRS SNPP (ATMS only)</td>
<td>Temperature/</td>
<td>08-Nov-2011</td>
<td>Apr-2012</td>
<td>Aug-2014</td>
<td>Oct-2016</td>
</tr>
<tr>
<td></td>
<td>Water Vapor</td>
<td></td>
<td>(6 m)</td>
<td>(2 yr 10 m)</td>
<td>(5 yr)</td>
</tr>
<tr>
<td></td>
<td>Water Vapor</td>
<td></td>
<td>(5 m)</td>
<td>(1 yr)</td>
<td>(2 yr)</td>
</tr>
<tr>
<td>NUCAPS SNPP (ATMS + CrIS)</td>
<td>Temperature/</td>
<td>14-Dec-2011</td>
<td>Aug-2012</td>
<td>Jan-2013</td>
<td>Sep-2014</td>
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<tr>
<td></td>
<td>Water Vapor</td>
<td></td>
<td>(9 m)</td>
<td>(1 yr 1 m)</td>
<td>(2 yr 10 m)</td>
</tr>
<tr>
<td>NUCAPS N20 (ATMS + CrIS)</td>
<td>Temperature/</td>
<td>3-Jan-2018</td>
<td>Jun-2018</td>
<td>Sep-2018</td>
<td>Sep-2019</td>
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<td></td>
<td>Water Vapor</td>
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<td>(6 m)</td>
<td>(9 m)</td>
<td>(1 yr 9 m)</td>
</tr>
</tbody>
</table>

Maturity milestones reached earlier for N20!
JPSS Anomaly Reporting

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

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