ATMS SDR SCIENCE REPORT

Fuzhong Weng and Ninghai Sun

NOAAA/STAR
Outline

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• Sensor/Algorithm Overview
• S-NPP Product(s) Overview
• JPSS-1 Readiness
• Summary and Path Forward
## Cal/Val Team Members

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<tbody>
<tr>
<td>Fuzhong Weng</td>
<td>NOAA/STAR</td>
<td>Neal Baker, Lin Lin, Wanchun Chen</td>
<td>ATMS SDR Lead: Budget and execution, strategic science direction, and oversight the SDR teamCal/Val tasks, reprocessing</td>
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<tr>
<td>Ninghai Sun</td>
<td>NOAA/STAR</td>
<td>Khalil Ahmad</td>
<td>ATMS SDR technical lead for science coordination, research to operation transition, ICVS monitoring</td>
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<tr>
<td>Xiaolei Zou</td>
<td>UMD/ESSIC</td>
<td>Yuan Ma, Xiao Xu Tian</td>
<td>ATMS SDR destriping, RFI interference</td>
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<td>Hu Yang</td>
<td>UMD/ESSIC</td>
<td>Jun Zhou, Xu Yang</td>
<td>ATMS SDR calibration algorithm development, improvement, and validation</td>
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<tr>
<td>Ed Kim</td>
<td>NASA/GSFC</td>
<td>Craig Smith, Joseph Lyu</td>
<td>ATMS instrument team for sensor pre- and post-launch characterization</td>
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<td>Vince Leslie</td>
<td>MIT/LL</td>
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<td>Prelaunch ATMS sensor characterization</td>
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<td>Wael Ibrahim</td>
<td>Raytheon</td>
<td></td>
<td>IDPS operational ground processing system</td>
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<td>Kent Anderson</td>
<td>NGES</td>
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<td>NGES ATMS instrument calibration</td>
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<td>Wesley Berg</td>
<td>CSU</td>
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<td>ATMMS cross calibration</td>
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</table>

STAR JPSS Annual Science Team Meeting, 8-12 August 2016
# ATMS Sensor Overview

<table>
<thead>
<tr>
<th>Ch</th>
<th>Channel Central Freq. (MHz)</th>
<th>Polarization</th>
<th>Bandwidth Max. (MHz)</th>
<th>Frequency Stability (MHz)</th>
<th>Calibration Accuracy (K)</th>
<th>Nonlinearity Max. (K)</th>
<th>NEAT (K)</th>
<th>3-dB Bandwidth (deg)</th>
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<th>Nadir Weighting Function Peak &amp; Primary Applications 1</th>
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<td>157000</td>
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<td>950 mb &amp; Vapor, Cloud, Precip</td>
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<td>AMSU-B/MHS</td>
<td>300 mb &amp; Atmos Vapor</td>
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</table>

1. Weighting function peak is computed from the standard atmosphere, 2. TPW: Total Precipitable Water, CLW: Cloud Liquid Water, Ts: Land Surface Temp, Es: Land Surface Emissivity.
ATMS Sensor Overview

- 22 channels measuring from surface to upper atmosphere for temperature and water vapor profiling
- Scan swath: 2700 km
- Earth FOVs per scan: 98
- Scan angle range: 52.3 degree
Suomi NPP ATMS all channel noise meets the requirement with margins
Suomi NPP ATMS On-orbit Performance

S-NPP ATMS On-orbit O-B Bias (ECMWF) for Selected V-Band Channels

Suomi NPP ATMS on-orbit absolute bias (OBS-RTM) meet the requirement
suomi npp atms on-orbit performance

<table>
<thead>
<tr>
<th>Channel</th>
<th>Euler Angles (degree)</th>
<th>Ground Geolocation Error (km)</th>
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<tbody>
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<td>Roll</td>
<td>Pitch</td>
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<td></td>
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</tr>
<tr>
<td>16</td>
<td>-0.065</td>
<td>-0.098</td>
</tr>
</tbody>
</table>

Ch.1 Ground Geolocation Error
ATMS scan drive main motor current major spikes detected
- Instrument temperature increased
- Scan angle shift observed after SD motor current spikes but still well below requirements
- Once per day scan reversal implemented from August 24, 2015
- Once per orbit scan reversal implemented from July 25, 2016 (staggering configuration among consecutive orbits)
- ATMS put in safe mode due to 1553 issue during once per day reversal
- Twice per orbit reversal (staggering configuration near north and south pole) to be implemented soon
ATMS Scan Reversal Scheme Study

S-NPP ATMS Scan Reversal Missing Granule Map
2016-07-25 Total Number of Reversal Events: 7

- B24573 09:26:08~09:26:24 UTC
- B24577 16:10:45~16:11:01 UTC
- B24579 19:37:26~19:37:43 UTC
- B24581 23:01:53~23:02:09 UTC

B24576 14:32:10~14:32:26 UTC
B24578 17:53:53~17:54:09 UTC
B24580 21:18:45~21:19:01 UTC

S-NPP ATMS Scan Reversal Coverage Map
Daily Orbital Reversal (24 Scans per Orbit) Centered at 75N

S-NPP ATMS Scan Reversal Coverage Map
Daily Orbital Reversal (24 Scans per Orbit) Centered at 70N, 75N, and 80N
ATMS Algorithm Overview

- Radiation from calibration targets are calculated as radiance instead of brightness temperature.
- Lunar contamination correction is included in space view radiance correction.
- Nonlinearity correction is based on “μ” parameter derived from TVAC.
- Brightness temperature is computed from full Planck function in radiance space.
- Error budget in calibration are traceable.
ATMS Algorithm Overview

SNPP Launch
Since Oct. 28, 2011
- Mx5.0
  2011-10-28
- Mx5.1
  2011-12-09
  • Updated ATMS PCT on data range

Beta
Since Apr. 19, 2012
- Mx6.0(6.1/6.2)
  2012-08-09
- Mx6.3(6.4)
  2012-10-15
  • Updated ATMS PCT on TDR to SDR conversion

Provisional
Since Jan. 31, 2013
- Mx6.6
  2013-02-28
- Mx6.7
  2013-03-14
- Mx7.0(7.1)
  2013-07-10
- Mx7.2
  2013-08-20
- Mx8.0
  2013-11-14

Validated
Since Feb. 20, 2014
- Mx8.1(8.2)
  2014-02-20
  • Fixed 1958 issue
- Mx8.3
  2014-03-18
  • Updated lunar intrusion correction
- Mx8.4
  2014-05-22
  • Updated ATMS PCT on warm target range
- Mx8.5
  2014-08-13
- Mx8.6
  2014-11-21
  • Updated CMN Geo on lunar intrusion flag
- Mx8.7
  2014-12-17
- Mx8.8
  2015-03-06
- Mx8.10
  2015-06-22
- Mx8.11
  2015-12-17
  • Updated data gap QF
ATMS Algorithm Overview

- Full radiance process has been tested in Advanced Radiance Transformation System (ARTS)
- FRP code update for IDPS, as well as associated PCT, has been approved for operational implementation

ATMS TDR-RTM Bias using FRP (Red) and using IDPS OPS (Blue)
ATMS Algorithm Overview

- Channel noise reduced after applying striping mitigation algorithm
- 45-day de-striping BUFR data generated for NWP impact study

<table>
<thead>
<tr>
<th>Channel</th>
<th>NEDT (K)</th>
<th>Allan Deviation (K)</th>
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Major updates in S-NPP ATMS Reprocessing

- Calibration algorithm upgraded from R-J approximation based to radiance based
  - Update non-linearity correction coefficients using radiance calibration algorithm
  - Reduce TDR values systematically

- Calibration target smoothing method unified to boxcar
  - Change striping pattern for OPS data using triangular smoothing method prior to October 2012

- Degraded TDR regenerated using updated processing coefficients table

- Lunar intrusion correction applied to life time ATMS TDR
  - Quality flag triggered locations
  - TDR correction updated
Suomi NPP ATMS Reprocessing

Striping pattern is caused by different smoothing methods, triangular v.s. boxcar
Suomi NPP ATMS Reprocessing

No striping after October 2012 due to the same smoothing method (boxcar) applied.
Suomi NPP ATMS Reprocessing

S-NPP ATMS TDR Bias (Rep - OPS)

Temperature Bias (K)

Channels

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Suomi NPP ATMS Reprocessing

Quality flag triggered before PCT update

Quality flag off after update of PCT

TDR bias before and after PCT update
JPSS-1 ATMS Readiness

• Radiance based ATMS SDR calibration algorithm and associated PCT have been approved for operational implementation
• J1 ATMS pre-launch instrument characterization was completed
• J1 ATMS post-rework TVAC data analysis and coefficients generation were performed successfully
• J1 ATMS instrument to spacecraft mounting matrix was generated and updated in J1 PCT
• J1 ATMS channel 17 anomaly in flight unit was observed during EMI testing. Further investigation is ongoing. Now, J1 ATMS EDU is put back to the spacecraft for EMI testing
JPSS-1 ATMS Readiness

- Overall lower channel correlation observed in JPSS-1 ATMS
- Relatively large channel correlation at channel 18 and 19 is possibly due to the shared harmonics
JPSS-1 ATMS Readiness

JPSS-1 ATMS presents lower striping noise
JPSS-1 ATMS Readiness

- ATMS reflector emissivity was retrieved from TVAC test when scene target temperature is close to cold target temperature.
- On-orbit emissivity may be changed due to the uncertainty in cold and scene target temperature measurements.
JPSS-1 ATMS Readiness

Channel 18: 183.31 ± 7 GHz
- Imbalance = 4.537

Channel 19: 183.31 ± 4.5 GHz
- Imbalance = 1.997

Channel 20: 183.31 ± 3 GHz
- Imbalance = 2.419

Channel 21: 183.31 ± 1.8 GHz
- Imbalance = -0.482

Channel 22: 183.31 ± 1 GHz
- Imbalance = 0.205

<table>
<thead>
<tr>
<th>Channel</th>
<th>18</th>
<th>19</th>
<th>20</th>
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STAR’s imbalance value is comparable with NASA’s result.
Summary & Path Forward

• Summary
  – S-NPP ATMS scan drive motor current increased during the last year. More frequent scan reversal activities can help to reduce motor current
  – S-NPP ATMS on-orbit channel performance meets the requirement with margins
  – JPSSS-1 ATMS post-rework characterization was performed and ground processing system PCT has been updated using newly derived coefficients
  – Radiance based ATMS SDR calibration algorithm has been approved and is waiting for IDPS operational implementation
  – JPSS-1 ATMS flight unit anomalies observed in spacecraft EMI testing are under investigation
Summary & Path Forward

• Path Forward
  – Implement reflector emissivity correction algorithm
  – Revisit JPSS-1 ATMS PCT for launch readiness
  – Work with ATMS SDR team members to support JPSS-1 ATMS post-launch characterization
  – Work with STAR ICVS team for JPSS-1 ATMS health status and performance monitoring
  – Perform additional S-NPP ATMS reverse scan data analysis
Re-construct normal scan FOVs from reverse scan to minimize impact to data users

- Current scan profile and reversal scan profile are used for the study
- Reverse scan antenna pattern is used as source and normal scan antenna pattern as target function, calculate coefficients for each channel at every normal scan FOV
- Apply the coefficients to reversal scan observations, reconstruct normal observations with 96 FOVs at target FOV size