Overview of NOAA Unique CrIS ATMS Processing System (NUCAPS)

*AVTP, AVMP, OLR, IR Ozone, CO, CO₂, and CH₄ Products*


*Sounding EDR Team*
August 25, 2015
Outline

- Soundings Cal/Val Team Members
- S-NPP Sounding Products Overview
- Products Online Monitoring, LTM
- JPSS-1 Readiness
- Major Accomplishments
- USERS
- Moving Forwards J1
- Summary
- FY16 Milestone
- J2 and Beyond: Future Improvements
# Algorithm Cal/Val Team Members

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<th>PI</th>
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<th>Team Members</th>
<th>Roles and Responsibilities</th>
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<tr>
<td>Quanhua (Mark) Liu</td>
<td>STAR</td>
<td>N. Nalli, C. Tan, F. Iturbide-Sanchez, K. Zhang, J. Smith</td>
<td>Maintain, validation, J1 algorithm development</td>
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<tr>
<td>Chris Barnet</td>
<td>STC</td>
<td>A. Gambacorta</td>
<td>Algorithm improvement, direct broadcast,</td>
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<tr>
<td>Xu Liu</td>
<td>NASA/LaRC</td>
<td>S. Kizer</td>
<td>Science support, independent assessment</td>
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<tr>
<td>Tony Reale</td>
<td>STAR</td>
<td>Bomin Sun, M. Pettcy, F. Tilley, C. Brown</td>
<td>NROVS support for NUCAPS EDR validations</td>
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<tr>
<td>P. J. Mather</td>
<td>DOE</td>
<td>D. Holdrige</td>
<td>Dedicated radiosonde launch</td>
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<tr>
<td>D. Tobin</td>
<td>U. Wisconsin</td>
<td>L. Borg, R. Knuteson</td>
<td>Radiosonde launch schedule, radiosonde data analyze</td>
</tr>
<tr>
<td>A. Sharma</td>
<td>OSPO</td>
<td>O. Roytburd and W. O'Connor</td>
<td>POC, Interact with users and data quality monitoring</td>
</tr>
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</table>
S-NPP Product Overview

- AVMP (L1RD Sup. Table 5.2.3.1) from NDE
- AVTP (L1RD Sup. Table 5.2.4.1) from NDE
- CO (L1RD Sup. Table 5.2.5) from NDE
- CO$_2$ (L1RD Sup. Table 5.2.6) from NDE
- CH$_4$ (L1RD Sup. Table 5.2.7) from NDE
- IR ozone (L1RD Sup. Table 5.2.8) from NDE
- OLR (L1RD Sup. Table 5.4.2)
- S-NPP Cal/Val Status
  - AVMP and AVTP Stage-1 Validated Maturity;
  - OLR meets an objective requirement;
  - IR Ozone to reach Validated Maturity;
  - CO, CO$_2$, and CH$_4$ cannot achieve good accuracy for SNPP.
Online LTM

• OSPO

OSPO has developed websites for: NUCAPS Sounding Products, Global Granules Composite Images, Global Gridded Products, and Retrieval Statistics:

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• STAR

http://www.star.nesdis.noaa.gov/jpss/EDRs/products_Soundings.php

NDCAPS IR/MW Temperature at 850mb 2015-08-19 Asc
• J1 Algorithm Summary

  o CrIS SDR data will change to the full-spectral resolution, which requires changes in NUCAPS
    ➢ codes,
    ➢ radiative transfer model (SARTA),
    ➢ channel selections,
    ➢ new noise characteristics,
    ➢ new tuning parameters,
    ➢ testing,
    ➢ validation

  o New J1 EDRs CO, CO₂, and CH₄ require
    ➢ accurate trace gas retrieval algorithms,
    ➢ channel optimization,
    ➢ validation data (MLS, OCO-2, aircraft and surface In-situ),
    ➢ validation
**JPSS-1 Readiness (2)**

- **J1 Cal/Val Overview**
  - AVMP, AVTP: L+12 months (assuming validated ATMS and CrIS SDR).
  - OLR and IR ozone: L+18 months (assuming validated ATMS and CrIS SDR).
  - CO, CO$_2$, and CH$_4$: L+24 months (assuming validated ATMS and CrIS SDR).

- **Pre-Launch Calibration/Validation Plans**
  - Validation Archive (VALAR) and NOAA Products Validation System (NPROVS) enhancement.
  - Radiative Transfer Model (SARTA) for CrIS full-spectral radiance simulation and assessment.
  - NUCAPS code change for CrIS full-spectral data.
  - Channel selection for each stepwise retrievals in NUCAPS.
  - J1 sensor characteristics and tuning data.
  - J1 NUCAPS system level testing using synthetic radiance.

- **Post-Launch Calibration/Validation Plans**
  - Validation data (dedicated radiosonde, GFS data, ECMWF data).
  - Noise file (including RT modeling error), bias correction coeff, regression coeff.
  - Data collocation, analyze, and validation.
Major Accomplishments

• AVTP and AVMP achieved validated maturity
• First comparison of SNPP CrIS OLR and CERES OLR
• NUCAPS parallel offline processing at STAR
• Migration of NUCAPS codes for GFORTRAN and IFORT by OSPO/NDE requirement
• Integrated ozonesonde truth dataset for validation of the CrIS ozone profile
• Supported 2015 CalWater/ACAPEX campaign onboard the NOAA Ship Ronald H. Brown
• Developed/implemented versatile ATMS/CrIS mapping algorithms
• EDR quality significantly improved after fixed bugs and used new regression coefficients
• Interactions with users: AWIPS, NOAA/CPC, NOAA/ARL

Significant Improvement of RET

Improved Stdev of RET
10-day sample collocated with NUCAPS IR+MW pass QC including newly deployed NUCAPS parallel (test) system.
NOAA Products Validation System (NPROVS)

Temp
IR+MW pass QC
10-day

Baseline: Radiosonde Radiosonde

NUCAPS
NUCAPS Test
CERES S-NPP FM5 online

CrIS SDR has quality before June 2012 (see figure below)
STAR AIT team re-process CrIS SDR data using current calibration method.
Users

- AWIPS-II (Soundings)
  - Atmospheric stability condition for severe storms
  - Nowcasting
  - Alaska (cold core)
  - Monthly telecon with AWIPS forecasters (Bill Sjoberg)

- NOAA/CPC (OLR)

- NOAA/ARL (IR ozone and trace gases)

- TOAST (IR ozone)

- Support CrIS future missions: close spectral gaps between bands, and improve spatial resolution.

- Basic and applied geophysical science research/investigation
  - Users via NOAA CLASS
  - Universities and peer-review publications
Moving Towards J1

1. Radiative transfer assessment for CrIS full-spectral data
2. NUCAPS upgrade for CrIS full-spectral data
3. Channel selections/subsets
4. Regression coefficient generation
5. Error/uncertainty characterization
6. Product tuning
7. NUCAPS ozone retrieval algorithm improvement and validation
8. Trace gas (CO, CO$_2$, and CH$_4$) algorithm development for JPSS CrIS
9. J1 product validation (soundings, OLR, trace gases...)
10. Dedicated testbed(s) and intensive field campaigns data for validation
Summary

• The accuracy of the offline NUCAPS EDRs has been improved.
• NUCAPS development, maintenance, and delivery are on track.
• Unified algorithm is now used for ATMS/CrIS and IASI/AMSU/MHS.
• First comparison between SNPP CrIS OLR and CERES OLR is conducted.
• NUCAPS parallel offline processing at STAR

Issues:

• Few validation data for trace gas EDRs.
FY16 SNPP Milestone

- Outgoing long-wave radiation (OLR) EDR validation review
- CrIS ozone algorithm improvement
- IR ozone validation review (provisional)
- NUCAPS upgrades including CrIS full-spectral data
- Trace gas EDRs (CO, CO$_2$, CH$_4$) algorithm development/improvement
- Aircraft, satellite, dedicated radiosonde campaign for NUCAPS validation
- Maintain dedicated radiosonde for NUCAPS validation
J2 and Beyond: Future Improvements

• We support CrIS SDR team and the SDR team studying
  ➢ Close spectral gap: more information for trace gas retrievals
  ➢ More FOVs (6x6 vs 3x3): increase homogeneous observations, significantly increase clear-sky hunting and overcast hunting.

• ATMS/CrIS/VIIRS Retrieval
  ➢ Add cloud information to improve EDRs over cloudy areas
  ➢ High spatial resolution for small-scale severe weather

• Customized Retrievals
  ➢ Better trace gas EDR for air quality studies
  ➢ Fine spatial resolution for small-scale severe weather
  ➢ Selected super retrievals
Aircraft NAST-I / S-HIS and dropsonde for SNPP EDR Validation

- SNPP-2 Field Validation Campaign conducted from March 7 to March 31, 2015 over Iceland and Greenland
  - NUCAPS EDR products
  - METOP-A IASI/AMSU/MHS Level 1 products
  - METOP-B IASI/AMSU/MHS Level 1 products
  - NAST-I hyperspectral IR radiance spectra
  - ECMWF reanalysis data interpolated to CrIS/ATMS, IASI, and NAST footprints
  - Sondes collected for the overpass days

- SNPP-1 Field Cal/Val Campaign campaign was conducted during May 2013
  D. Zhou, X. Liu et al., 2015: First Suomi NPP Cal/Val Campaign: Inter-comparison of Satellite and Aircraft Sounding Retrievals.

- Single FOV all-sky Retrieval
<table>
<thead>
<tr>
<th>Time</th>
<th>Session Title</th>
<th>Speaker(s)</th>
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| 1550 - 1730 | **Session 7b: Soundings Breakout**  
  **Chairs: Mark Liu and Tony Reale**  
  **Conference Room B/C** |                     |                 |
| 1550 - 1610 | **JPSS Soundings Product Program and Future Development** | Mitch Goldberg | JPSS Program |
| 1610 - 1630 | **NPROVS Utility in a Variety of Meteorological Cal/Val Scenarios** | Tony Reale | STAR          |
| 1630 - 1650 | **Recent Algorithm Enhancements to NUCAPS** | Antonia Gambacorta | STC           |
| 1650 - 1710 | **MiRS ATMS Retrievals: Algorithm Updates, Product Assessment, and Preparations for JPSS-1** | Chris Grassotti | UMD/ESSIC (STAR) |
| 1710 - 1730 | **Current SNPP Sounding Products from the Operational System and Way Forward for the JPSS-1 CrIS/ATMS Product** | Awdhesh Sharma | OSPO          |
| 0830 - 0850 | **Atmospheric Soundings from JPSS - Retrievals for NWP Data Assimilation** | Bill Smith | UW, NASA SSAT |
| 0850 - 0910 | **Status and Plans for the Processing of CrIS/ATMS at the GSFC SRT** | Joel Susskind | NASA GSFC     |
| 0910 - 0930 | **The MTG-IRS Level 2 Processor: Physical Basis, Selected Results, and Planned Evolution** | Stephen A. Tjemkes | EUMETSAT      |
| 0930 - 0950 | **An Overview of NASA’s Orbiting Carbon Observatory-2 (OCO-2)** | Lesley Ott | NASA GSFC     |
| 0950 - 1010 | **NUCAPS Product Validation** | Nick Nalli | IMSG (STAR)   |
| 1010 - 1030 | **Break**                                                                   |                     |                |
| 1030 - 1050 | **Evaluation of NUCAPS within high impact mesoscale events: overview of the CalWater-2015 field campaign** | Chris Barnet | STC           |
| 1050 - 1110 | **Applications Using Satellite Sounder Products at the NASA SPoRT Center** | Emily Berndt | NASA SPoRT    |
| 1110 - 1130 | **NUCAPS Demonstration at the HWT 2015 Spring Experiment** | Bill Line | SPC           |
| 1130 - 1150 | **The Utility of NUCAPS in Operational Forecasting** | Dan Nietfeld | NWS           |
| 1150 - 1210 | **OLR for NOAA Precipitation Verification** | Pingping Xie | CPC           |
| 1210 - 1230 | **Trace Gas Applications to Air Quality Forecasting** | Pius Lee | ARL           |