2018 JPSS Annual Meeting
Sounding Session Opening Remarks

Chairs:
Antonia Gambacorta, Chris Grassotti, Larry Flynn

NCWCP August 28, 2018
Topics of this session

**Part I: NUCAPS Session**
Co-Chair: A. Gambacorta
1. Status of the NOAA Unique Combined Atmospheric Processing System (NUCAPS) – A. Gambacorta
2. Validation status of the NOAA Unique Combined Atmospheric Processing System (NUCAPS) - N. Nalli
3. How NUCAPS addresses the mesoscale challenge in now-casting applications – N. Smith

**Part II: MiRS Session**
Co-Chair: C. Grassotti

**Part III: OMPS Session**
Co-Chair: L. Flynn
1. NO2 and HCHO plans – P. Lee
2. Near Real Time Ozone EDR applications – C. Long
3. NOAA-20 OMPS ozone products – L. Flynn
Status of the NOAA Unique Combined Atmospheric Processing System (NUCAPS)

Antonia Gambacorta (1), Nick Nalli (1), Changyi Tan (1), Mike Wilson (1), Juying Warner (6), Callyn Bloch (1), Tish Suillard (2), Tom King (1), Flavio Iturbide Sanchez (3), Lihang Zhou (3)

With contributions from:
Larrabee Strow (4), Chris Barnet (7), Tony Reale (3), Bomin Sun (1), Mark Liu (3), AK Sharma (3), Walter Wolf (3), Mitch Goldberg (5)

2018 JPSS Annual Meeting – NUCAPS Session

1 IMSG; 2 GAMMA; 3 NOAA/NESDIS/STAR; 4 UMBC; 5 NOAA JPSS; 6 U. Maryland; 7 STC
Outline of this talk

• Introduction to the NUCAPS system
• Overview of the past year’s activities
• Current activities
• Future directions
NOAA Long term strategy of hyperspectral sounding

- Aqua (2002)
- NPP (2011)
- JPSS 1, 2, 3, 4 (2017–2025)
- EPS SG (2020, 2040)

Same exact executable
Same underlying Spectroscopy
Same look up table methodology for all platforms
# Summary of current NUCAPS retrieval products

<table>
<thead>
<tr>
<th>gas</th>
<th>Range (cm(^{-1}))</th>
<th>Precision</th>
<th>d.o.f.</th>
<th>Interfering Gases</th>
</tr>
</thead>
<tbody>
<tr>
<td>T</td>
<td>650-800</td>
<td>1K/km</td>
<td>6-10</td>
<td>H2O,O3,N2O emissivity</td>
</tr>
<tr>
<td></td>
<td>2375-2395</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H(_2)O</td>
<td>1200-1600</td>
<td>15%</td>
<td>4-6</td>
<td>CH4, HNO3</td>
</tr>
<tr>
<td>O(_3)</td>
<td>1025-1050</td>
<td>10%</td>
<td>1+</td>
<td>H2O, emissivity</td>
</tr>
<tr>
<td>CO</td>
<td>2080-2200</td>
<td>15%</td>
<td>≈ 1</td>
<td>H2O,N2O</td>
</tr>
<tr>
<td>CH(_4)</td>
<td>1250-1370</td>
<td>1.5%</td>
<td>≈ 1</td>
<td>H2O,HNO3,N2O</td>
</tr>
<tr>
<td>CO(_2)</td>
<td>680-795, 2375-2395</td>
<td>0.5%</td>
<td>≈ 1</td>
<td>H2O,O3 T(_p)</td>
</tr>
<tr>
<td>Volcanic SO(_2)</td>
<td>1340-1380</td>
<td>50% ??</td>
<td>&lt; 1</td>
<td>H2O,HNO3</td>
</tr>
<tr>
<td>HNO(_3)</td>
<td>860-920, 1320-1330</td>
<td>50% ??</td>
<td>&lt; 1</td>
<td>emissivity H2O,CH4,N2O</td>
</tr>
<tr>
<td>N(_2)O</td>
<td>1250-1315, 2180-2250</td>
<td>5% ??</td>
<td>&lt; 1</td>
<td>H2O H2O,CO</td>
</tr>
</tbody>
</table>

http://www.class.ngdc.noaa.gov
Status of NUCAPS

Validated maturity status:
✓ SNPP NUCAPS Temperature, water vapor, ozone, OLR

Provisional maturity status:
✓ SNPP NUCAPS carbon trace gases
✓ NOAA-20 NUCAPS Temperature and water vapor

Beta maturity status:
✓ NOAA-20 NUCAPS OLR, ozone, carbon trace gases
One year has gone by...

August 7th, 2018
NUCAPS MetOp goes live in CSPP

June 22nd, 2018
Updated Enterprise NUCAPS Delivery of Algorithm Package (DAP) to ASSISTT
NUCAPS Enterprise algorithm delivery to UW for implementation in CSPP

June 15th, 2018
NUCAPS NOAA-20 Temperature and Water Vapor Provisional Maturity review

April 27th, 2018
First NOAA-20 NUCAPS Delivery of Algorithm Package (DAP) to ASSISTT

April 4th, 2018
Implementation of NUCAPS Enterprise Algorithm (SNPP, NOAA-20, MetOp) in the HEAP

January 5th, 2018
NUCAPS NOAA-20 first Light results

August 31st, 2017
NUCAPS Phase 4 delivered to UW for implementation in CSPP

July 7th, 2017
NUCAPS Phase 4 Algorithm Readiness Review
NUCAPS Phase 4 Delivery of Algorithm Package (DAP) to ASSISTT
CrIS signal processors and detectors powered up on **January 4th, 2018 at 23:47 UTC**. First Light NUCAPS NOAA-20 results were generated on **January 5th, 2018 at 21:00 UTC**.
April 4th, 2018:
NUCAPS is implemented in the Hyperspectral Enterprise Algorithm Package (HEAP)
First global, multi focus days statistics results showing SNPP and NOAA-20 NUCAPS temperature (left), water vapor (center), ozone (right) remarkably consistent since first light, qualifying NOAA-20 NUCAPS temperature, water vapor and ozone for preliminary DAP to ASSISTT and reaching provisional maturity status.
NUCAPS Version 2.1.12d (June 2018):
✓ NOAA-20 CrIS and ATMS instrument noise files.
✓ Optimized temperature, water vapor, cloud clearing and carbon monoxide channel selection.
✓ An improved RTA bias correction in the carbon monoxide band.
✓ An improved carbon monoxide a priori climatology.
✓ An improved carbon monoxide quality control methodology.

Work in progress towards NUCAPS validated maturity status:
  ... improve methane, nitrous oxide and carbon dioxide retrieval modules.
  ... improve training methodology of statistical regression by removing cloud contamination and supersaturation cases.
  ... improve surface emissivity regression algorithm.
Towards NUCAPS validated maturity: what’s needed?

• Inter-consistency of NUCAPS SNPP, NOAA-20 (and MetOp): no requirement specified but inter-consistency is key to several applications of NUCAPS products
  – NUCAPS is in AWIPS and RealEarth: diurnal variability for regional weather forecasting
  – NUCAPS is in IDEA-I: diurnal transport and variability of species for air quality monitoring
  – NUCAPS data record is being reprocessed
  – NUCAPS is in several DA experiments (CO, CH4, CO2, SAL)

• We have built a robust framework, the HEAP, to provide consistency in the processing (same machine, same executable)
• We employ the same underlying spectroscopy, forward model and LUT methodologies to provide consistency in the scientific retrieval code
• We need very well inter-calibrated SDRs to fulfill NUCAPS mandate: NOAA’s operational enterprise algorithm for hyper spectral sounding.
• Next step: fine tuning of the NOAA-20 CrIS and ATMS related LUTs.
A game changer: NUCAPS version 2.1.12d Carbon Monoxide
A game changer: NUCAPS version 2.1.12d Carbon Monoxide (cont’d)

Top
NUCAPS 2.1.12d new CO A priori (ppbv) developed from NCAR MOZART-GEOS5 model
Linear transition between 15N and 15S;
Monthly varying, but no year-to-year variations;
Same approach as for previous version, but using a more updated time period.

Bottom
NUCAPS New - Old CO A priori
A game changer: NUCAPS \textit{version 2.1.12d} Carbon Monoxide (cont’d)

NUCAPS 2.1.12d new CO QC reduces cloud contamination, but yield is penalized

<table>
<thead>
<tr>
<th>Module</th>
<th>Lower Limit</th>
<th>Upper Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chi-square</td>
<td>0.0</td>
<td>1.0</td>
</tr>
<tr>
<td>DOFS</td>
<td>0.3</td>
<td>9.9</td>
</tr>
<tr>
<td>CO Retrievals</td>
<td>0.0</td>
<td>1.1</td>
</tr>
<tr>
<td>Cloud Amplifier Limit</td>
<td>0.3</td>
<td>1.8</td>
</tr>
<tr>
<td>Cloud-clearing residual</td>
<td>0.0</td>
<td>0.7</td>
</tr>
<tr>
<td>Number of iteration</td>
<td>0.0</td>
<td>5.0</td>
</tr>
<tr>
<td>Total cloud fraction</td>
<td>0.0</td>
<td>0.7</td>
</tr>
</tbody>
</table>

npp v2.1.11a 506hPa 20180515, QA=0, Y=52%
Significance to users applications

Figure courtesy of Shobha Kondragunta

CA Thomas Fire, Dec. 5th, 2017

- CO chn selection and tailored QC remove spurious spikes in CO due to poor cloud clearing while preserving the real signal of interest
- CO new a priori and forward model bias correction remove consistent bias observed in previous version (see next talk by Nick Nalli).
Coming next…

- MetOp C, J2, EPS-SG activities are on the way
- NUCAPS validated maturity review: September 2019

<table>
<thead>
<tr>
<th></th>
<th>S-NPP</th>
<th>JPSS-1</th>
<th>JPSS-2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FY18</strong></td>
<td>CO, CO2, and CH4 products validation</td>
<td>algorithm tuning for J1/SNPP CO, CO2, and CH4 products</td>
<td></td>
</tr>
<tr>
<td><strong>FY19</strong></td>
<td>Maintenance and monitoring</td>
<td>SNPP and J1 EDRs comparisons; AVTP, AVMP, O3, and OLR validation</td>
<td></td>
</tr>
<tr>
<td><strong>FY20</strong></td>
<td>Maintenance and monitoring</td>
<td>CO, CO2, CH4 validation</td>
<td></td>
</tr>
<tr>
<td><strong>FY21</strong></td>
<td>Maintenance and monitoring</td>
<td>Algorithm implementation for new trace gases: ammonia (NH₃)</td>
<td>algorithm preparation for AVTP, AVMP, O3, OLR, CO, CO2, CH4</td>
</tr>
<tr>
<td><strong>FY22</strong></td>
<td>Maintenance and monitoring</td>
<td>Maintenance and monitoring</td>
<td>algorithm optimization for AVTP, AVMP, O3, OLR, CO, CO2, CH4</td>
</tr>
</tbody>
</table>
Where to find us

https://www.star.nesdis.noaa.gov/jpss/mapper