The May 2013 SNPP Cal/Val Campaign – Validation of Satellite Soundings

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May 2013 Suomi-NPP Aircraft Campaign
SHIS, NAST-I, NAST-M, MASTER/AVIRIS on ER-2
The ER-2 Aircraft Interferometers

- **NAST-I/SHIS-I** infrared Michelson interferometer
  - (9000/4500 spectral channels)
  - 3.5 – 16 microns @ 0.25 /0.5 cm⁻¹

- **Aircraft Accommodation**
  - NAST-I: ER-2 Super pod
  - SHIS: ER-2 Underbelly pod

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Spatial resolution</th>
<th>Spectral Resolution</th>
<th>Useful Spectral Range</th>
<th>Spatial Sampling</th>
</tr>
</thead>
<tbody>
<tr>
<td>NAST-I</td>
<td>2.6 Km @ 20 Km</td>
<td>0.25 (cm⁻¹)</td>
<td>600-2800 (cm⁻¹)</td>
<td>~ Contiguous Cross-track scan</td>
</tr>
<tr>
<td>SHIS</td>
<td>2.0 Km @ 20 Km</td>
<td>0.50 (cm⁻¹)</td>
<td>600-2800 (cm⁻¹)</td>
<td>~ Contiguous Cross-track Scan</td>
</tr>
</tbody>
</table>
## The Satellite Instruments

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Spatial resolution</th>
<th>spectral res. (cm(^{-1}))</th>
<th>spectral rng. (cm(^{-1}))</th>
<th>spatial sampling</th>
</tr>
</thead>
<tbody>
<tr>
<td>AIRS (2002 -)</td>
<td>3x3 13.5-km (50 km)</td>
<td>~1200 resolving power</td>
<td>645-2700</td>
<td>Contiguous Cross-track scan</td>
</tr>
<tr>
<td>IASI-A (2006 -)</td>
<td>2x2 12.0-km (50 km)</td>
<td>0.25</td>
<td>645-2760</td>
<td>Contiguous Cross-track Scan</td>
</tr>
<tr>
<td>IASI-B (2012 -)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CrIS (2011 -)</td>
<td>3 x 3 13-km (50 km)</td>
<td>0.6</td>
<td>645-2700</td>
<td>Contiguous Cross-track</td>
</tr>
</tbody>
</table>
Suomi-NPP Cal/Val Flight Tracks

Today’s Focus

• 10 SNPP science flights
• 3 HyspIRI ‘piggy-back’ flights
The Dual Regression Retrieval Algorithm

Global Clear Soundings

Radiances (calculated with clear FM)

Clear trained EOF regression results

Global Cloudy Soundings

Radiances (calculated with cloudy FM)

8 cloud height classes (100-900 hPa)

Cloud trained EOF regression results

Cloud Top Altitude level where \( T(\text{cloudy}) > T(\text{clear}) \) for \( p > p_{cld} \)

Final Profile

- clear-trained above,
- cloud-trained below cloud level

To be discussed by Nadia Smith of Friday Morning
**Physical Correction Using Forecast Model Profile**

**Problem:** DR method uses a statistical training data set. Imperfect skill, due to lack of vertical resolution in radiances, leads to local statistical bias.

**Solution:** Calculate radiances from forecast profile (FP) and perform DR retrieval using simulated “Truth” radiances. Retrieval Error = Statistical Bias.

\[
\text{Statistical Bias} = \text{FP} - \text{FP radiance Retrieval}
\]
The 2013 Moore tornado was an EF5 Tornado that struck Moore, Oklahoma, and adjacent areas on the afternoon of May 20, 2013, with peak winds estimated at 210 miles per hour (340 km/h), killing 23 people (+2 indirectly) and injuring 377 others. The tornado touched down west of Moore at 2:56 PM CDT (19:56 UTC), staying on the ground for 39 minutes over a 17-mile (27 km) path, crossing through a heavily populated section of Moore. The tornado was 1.3 miles (2.1 km) wide at its peak.
ER-2 Flight Track
Cloud Pressure Altitude
Aircraft Track and Satellite Orbits

- **SGP ARM-site**
- **Moore OK (20 UTC)**
- **Aqua 1935 UTC**
- **SNPP 1908 UTC**
- **Metop B 1653 UTC**
- **Metop A 1556 UTC**
Satellite Retrievals (raw) Vs ARM-site Radiosondes
Satellite Retrievals Vs ARM-site Radiosondes
Lifted Index Stability Parameter

The **lifted index** (LI) is the temperature difference between an air parcel lifted adiabatically $T_p(p)$ and the temperature of the environment $T_e(p)$ at a pressure height in the troposphere of 500 hPa (mb). When the value is positive, the atmosphere (at the respective height) is stable and when the value is negative, the atmosphere is unstable.

**Thunderstorm Potential:**

- $< -5$: Very Unstable: Strong Thunderstorm Potential
- -3 to -5: Unstable: Thunderstorm Probable
- 0 to -2: Marginally Unstable: Thunderstorms Possible
- $> 0$: Stable: Thunderstorms Unlikely
ER-2 Aircraft Soundings Are Used to Validate Satellite Sounding Time Variations

High spatial resolution (1 – km) ER-2 aircraft soundings are used to validate 35 minute time changes in relative humidity indicated by consecutive CrIS and AIRS humidity soundings.
Summary and Conclusions

• AIRS, IASI, and CrIS retrievals provide comparable accuracy and spatial resolution
• ER-2 SHIS and NAST retrievals can be used to validate high spatial resolution features diagnosed from satellite data
• Satellite soundings provide mesoscale features not yet resolved by the highest spatial resolution NWP models (i.e., RAP/WRF)
• Next step is to validate mesoscale features of Chemistry retrievals obtained with the thermodynamic retrievals shown here.

Thank You for Your Attention