Combining Polar Hyper-spectral and Geostationary Multi-spectral Sounding Data – A Method to Optimize Sounding Spatial and Temporal Resolution

W. L. Smith¹², E. Weisz¹, and J. McNabb²

¹University of Wisconsin, Madison WI, USA ; ²Hampton University, Hampton VA, USA

ABI: Vertical Res. 5-10 km
Horizontal Res. 2-km
Time Res. 5-15 min.

AIRS, IASI, CrIS: Vertical Res. 1-4 km
Horizontal Res. 14-km
Time Res. 1-7 hr.
## Direct Broadcast Processing Server Quicklook

### Archive of Previous Images

<table>
<thead>
<tr>
<th>Satellite Directory</th>
<th>File Type</th>
<th>Generation Date (UTC)</th>
<th>Image</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Directories</td>
<td>All File Types</td>
<td>All Dates</td>
<td></td>
</tr>
</tbody>
</table>

20 files match of 20 images

- **current_CRIS_f3.jpg**
  - Generation Time (UTC): 2017-12-01 07:37:33

- **current_CRIS_f2.jpg**
  - Generation Time (UTC): 2017-12-01 07:37:22

- **current_CRIS_f1.jpg**
  - Generation Time (UTC): 2017-12-01 07:37:10

### Images

- **SAT Negative Lifted Index**
  - CriS 2017-12-01 (065503 UTC)
  - Coordinates: 80°W-76°W, 38°N-36°N
  - Color scale: -5 to 0

- **SAT-RAP Negative Lifted Index**
  - CriS 2017-12-01 (065503 UTC)
  - Coordinates: 80°W-76°W, 38°N-36°N
  - Color scale: -5 to 0

- **SAT 700 hPa Temp (K)**
  - Coordinates: 80°W-76°W, 38°N-36°N
  - Color scale: 268 to 276

- **SAT-RAP 700 hPa Temp (K)**
  - Coordinates: 80°W-76°W, 38°N-36°N
  - Color scale: 268 to 276
### Polar-Orbiting Ultra-Spectral & Geostationary Sounders

#### Instrument

<table>
<thead>
<tr>
<th>Satellite</th>
<th>IASI</th>
<th>CrIS</th>
<th>ABI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metop-A, Metop-B</td>
<td>Metop-A, Metop-B</td>
<td>Suomi-NPP</td>
<td>GOES-16</td>
</tr>
<tr>
<td>Michelson Interferometer</td>
<td>Michelson Interferometer</td>
<td>Radiometer</td>
<td>GOES-16</td>
</tr>
<tr>
<td>0.25 cm⁻¹</td>
<td>0.625 (LW), 1.25 (MW), 2.5 cm⁻¹ (SW)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>645 – 2760 cm⁻¹ (15.5 – 3.62 μm)</td>
<td>650 – 2550 cm⁻¹ (15.4 – 3.9 μm)</td>
<td>751.9 – 21276 cm⁻¹ (0.47 – 13.3 μm)</td>
<td></td>
</tr>
<tr>
<td>12 / 8461</td>
<td>27 / 1305</td>
<td>16 / 16</td>
<td></td>
</tr>
<tr>
<td>0.1 – 0.75 K</td>
<td>0.05 – 0.5 K</td>
<td>0.01 / 0.07</td>
<td></td>
</tr>
<tr>
<td>12 km</td>
<td>14 km</td>
<td>2 km</td>
<td></td>
</tr>
</tbody>
</table>
**PHS (CrIS/IASI) + ABI Sounding**

\[
\text{ABI/PHS} = \text{ABI} (x,y,t) + \\
[\text{PHS} (x_o,y_o,t_o) - \text{ABI} (x_o,y_o,t_o)]
\]

**ABI** \((x,y,t)\): ABI retrieval value at location and time \((x, y, t)\)

**PHS** \((x_o,y_o,t_o)\): Mean of 5 reference PHS values closest to ABI location and time \((x, y, t)\)

**ABI** \((x_o,y_o,t_o)\): Mean of 5 reference PHS Field-of-View average ABI retrieval values closest to the ABI location and time \((x, y, t)\)

**Implicit Assumption:** The vertical resolution induced error of multi-spectral ABI retrievals is persistent over the time interval between the acquisition times of the high vertical resolution polar hyperspectral soundings and over the spatial scale (i.e., 14-km) of the hyperspectral sounding data.
Combining 500 hPa ABI with PHS (IASI) @ 15:00 UTC
Combining ABI with PHS (CrIS) @ 17:55 UTC
CrIS + ABI Vs Radiosondes (May 19, 2017)
PHS+ABI Time Series (MOVIE)
PHS+ABI 2017-5-19 (14:57:18)
Humidity [g/kg] at 496.6 hPa
Humidity [g/kg] at 496.6 hPa
PHS+ABI 2017-5-19 (15:57:18)
Humidity [g/kg] at 496.6 hPa
PHS+ABI 2017-5-19 (16:57:18)
Humidity [g/kg] at 496.6 hPa

IASI-B +ABI
Humidity [g/kg] at 496.6 hPa

CrIS + ABI
Atmospheric Stability Change
HR Severe Weather Not Predicted by NWS (May 19, 2017)

Day 1 Risk

Area (sq. mi.)

Area Pop.

Some Larger Population Centers in Risk Area

ENHANCED

48,447

7,656,120

Dallas, TX...Fort Worth, TX...Arlington, TX...Plano, TX...Garland, TX...

SLIGHT

194,795

19,485,383

Columbus, OH...Oklahoma City, OK...Kansas City, MO...Tulsa, OK...Wichita, KS...

MARGINAL

294,539

67,316,656

New York, NY...Philadelphia, PA...Indianapolis, IN...Austin, TX...Baltimore, MD...
HR Severe Weather Predicted by NWS (May 22, 2017)
Summary and Conclusions

• Profile Retrievals from Polar Hyperspectral Sounders and Geostationary Multi-spectral Instruments to Optimize the Vertical, Horizontal, and Temporal resolution of the Satellite Sounding Product
  — Improving low altitude sounding coverage in partly cloudy areas
  — Observe spatial mesoscale details important for intense weather prediction
  — Provide high temporal resolution for predicting the onset of severe convection
  — Provide altitude-resolved water vapor imagery time sequences potentially useful for estimating 4-d wind profiles for NWP applications

• Technique Can Provide Near-Global Coverage Using be Polar Satellite Hyperspectral Sounders (e.g., IASI, CrIS, HIRAS) Data Obtained Using the International Network of Direct Broadcast Systems (e.g., DBnet) and Geostationary Satellite Multi-spectral Instruments (e.g., ABI, AHI, AMI, and SEVIRI)

• PHS + ABI is NOT a replacement for the Geo-Hyperspectral Sounder