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

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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.
Hampton University

Center for Atmospheric Research and Education

Direct Broadcast Processing Server Quicklook

Archive of Previous Images

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<th>Generation Date (UTC)</th>
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<th>Generation Time (UTC)</th>
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Cris 2017-12-01 (065503 UTC)

SAT Negative Lifted Index

SAT-RAP Negative Lifted Index

Cris 2017-12-01 (065503 UTC)

SAT 700 hPa Temp (K)

SAT-RAP 700 hPa Temp (K)
# Polar-Orbiting Ultra-Spectral & Geostationary Sounders

<table>
<thead>
<tr>
<th>Instrument</th>
<th>IASI</th>
<th>CrIS</th>
<th>ABI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Satellite</td>
<td>Metop-A, Metop-B</td>
<td>Suomi-NPP</td>
<td>GOES-16</td>
</tr>
<tr>
<td>Type</td>
<td>Michelson Interferometer</td>
<td>Michelson Interferometer</td>
<td>Radiometer</td>
</tr>
<tr>
<td>Spectral resolution</td>
<td>0.25 cm⁻¹</td>
<td>0.625 (LW), 1.25 (MW), 2.5 cm⁻¹ (SW)</td>
<td>GOES-16</td>
</tr>
<tr>
<td>Spectral range</td>
<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>
</tr>
<tr>
<td>Number of Detectors/Channels</td>
<td>12 / 8461</td>
<td>27 / 1305</td>
<td>16 / 16</td>
</tr>
<tr>
<td>NEDT range</td>
<td>0.1 – 0.75 K</td>
<td>0.05 – 0.5 K</td>
<td>0.01 / 0.07</td>
</tr>
<tr>
<td>Spatial Resolution (at nadir)</td>
<td>12 km</td>
<td>14 km</td>
<td>2 km</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

Averaged ABI 2017-5-19 (145718)
Humidity [g/kg] at 496.6 hPa

IASI 2017-5-19 (150259)
Humidity [g/kg] at 496.6 hPa

ABI 2017-5-19 (14:57:18)
Humidity [g/kg] at 496.6 hPa

PHS+ABI 2017-5-19 (14:57:18)
Humidity [g/kg] at 496.6 hPa
Combining ABI with PHS (CrIS) @ 17:55 UTC

Averaged ABI 2017-5-19 (17:57:18) Humidity [g/kg] at 496.6 hPa

CrIS 2017-05-19 (175119) Humidity [g/kg] at 496.6 hPa

ABI 2017-5-19 (17:57:18) Humidity [g/kg] at 496.6 hPa

PHS+ABI 2017-5-19 (17:57:18) Humidity [g/kg] at 496.6 hPa
CrIS + ABI Vs Radiosondes (May 19, 2017)
IASI + ABI

Predicted

CrIS + ABI

Humidity [g/kg] at 496.6 hPa

Humidity [g/kg] at 852.8 hPa

Latitude

Longitude
PHS+ABI Time Series (MOVIE)
Humidity [g/kg] at 496.6 hPa

IASI-A + ABI
Humidity [g/kg] at 496.6 hPa
PHS+ABI 2017-5-19 (17:57:18)
Humidity [g/kg] at 496.6 hPa

IASI-B +ABI
Atmospheric Stability Change

RAP 2017-05-19 (145718)
Lifted Index [°C]

RAP 2017-05-19 (175718)
Lifted Index [°C]

PHS+ABI 2017-5-19 (14:57:18)
Lifted Index [°C]

PHS+ABI 2017-5-19 (17:57:18)
Lifted Index [°C]
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...
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