Potential Impacts of ATMS and MIS Data in NCEP Global Forecast System

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Advanced Technique Microwave Sounder (ATMS) Characteristics

- 22 microwave sounding channels
- Cross-track scanning geometry
- 96 footprints across and covers ± 52.7°

which include AMSU-A & MHS capability

Table ATMS Channel Characteristics

<table>
<thead>
<tr>
<th>Channel</th>
<th>Center Frequency (GHz)</th>
<th>Temperature Sensitivity (NEAT)</th>
<th>Static Beam Bandwidth $\theta_b$ (degrees)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>23.8</td>
<td>0.9</td>
<td>5.2</td>
</tr>
<tr>
<td>2</td>
<td>31.4</td>
<td>0.9</td>
<td>5.2</td>
</tr>
<tr>
<td>3</td>
<td>50.3</td>
<td>1.2</td>
<td>2.2</td>
</tr>
<tr>
<td>4</td>
<td>51.76</td>
<td>0.75</td>
<td>2.2</td>
</tr>
<tr>
<td>5</td>
<td>52.8</td>
<td>0.75</td>
<td>2.2</td>
</tr>
<tr>
<td>6</td>
<td>53.596±0.115</td>
<td>0.75</td>
<td>2.2</td>
</tr>
<tr>
<td>7</td>
<td>54.40</td>
<td>0.75</td>
<td>2.2</td>
</tr>
<tr>
<td>8</td>
<td>54.94</td>
<td>0.75</td>
<td>2.2</td>
</tr>
<tr>
<td>9</td>
<td>55.50</td>
<td>0.75</td>
<td>2.2</td>
</tr>
<tr>
<td>10</td>
<td>57.2903</td>
<td>0.75</td>
<td>2.2</td>
</tr>
<tr>
<td>11</td>
<td>57.2903±0.217</td>
<td>1.20</td>
<td>2.2</td>
</tr>
<tr>
<td>12</td>
<td>57.2903±0.322±0.048</td>
<td>1.20</td>
<td>2.2</td>
</tr>
<tr>
<td>13</td>
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<td>14</td>
<td>57.2903±0.322±0.010</td>
<td>2.40</td>
<td>2.2</td>
</tr>
<tr>
<td>15</td>
<td>57.2903±0.322±0.0045</td>
<td>3.60</td>
<td>2.2</td>
</tr>
<tr>
<td>16</td>
<td>87-91(88.20)</td>
<td>0.5</td>
<td>2.2</td>
</tr>
<tr>
<td>17</td>
<td>164-167</td>
<td>0.6</td>
<td>1.1</td>
</tr>
<tr>
<td>18</td>
<td>183.31±7</td>
<td>0.8</td>
<td>1.1</td>
</tr>
<tr>
<td>19</td>
<td>183.31±4.5</td>
<td>0.8</td>
<td>1.1</td>
</tr>
<tr>
<td>20</td>
<td>183.31±3</td>
<td>0.8</td>
<td>1.1</td>
</tr>
<tr>
<td>21</td>
<td>183.31±1.8</td>
<td>0.8</td>
<td>1.1</td>
</tr>
<tr>
<td>22</td>
<td>183.31±1.0</td>
<td>0.9</td>
<td>1.1</td>
</tr>
</tbody>
</table>

(reference: GSFC 429-00-06-03 CF15-50674-433)
Microwave Imager/Sounder (MIS) Characteristics

- Conical scanning geometry
- Atmospheric sounding: 50.3 – 57 GHz; 150/166.7 183.31 GHz
- Upper air sounding (60 – 63 GHz)
- Core imaging channels: 10 VH; 23V; 18VH; 89 VH
- Low frequency: 6.8 VH (with RFI mitigation)
- Polarimetric channels: 10 PM or LR; 18 PMLR; 37 PM

SSMIS Capability

(Reference: http://www.ipo.noaa.gov/instruments/MIS.pdf)
F 16 SSMIS Recalibration Algorithms

- **NRL/UK MetOffice SSMIS Unified Pre-processor (UPP data)**
  - NRL/UK MetOffice SSMIS Unified Pre-processor (UPP data) (Bell et al. 2008)
    - Correction of antenna emission for LAS
    - Correction of warm load anomaly
    - Linear mapping of SSMIS imager to its predecessor (SSM/I)
    - Doppler shift correction for UAS
    - Spatial averaging to reduce to the sub-Kelvin levels

- **NOAA/NESDIS SSMIS Pre-processor (NESDIS Data)**
  - NOAA/NESDIS SSMIS Pre-processor (NESDIS Data) (Yan and Weng 2009)
    - Correction of antenna emission for LAS
    - Correction of warm load anomaly
    - UAS bias removal using SABER (Sounding of the Atmosphere using Broadband Emission Radiometry) measurements simulated as truth
    - Spatial filter for noise reduction
    - Linear mapping of SSMIS imager to its predecessor (SSM/I) using the F15 and F16 Simultaneous Conical Overpass observations
    - Inter-sensor calibration for SSMIS imager non-linearity (for climate reprocessing)
F16 SSMIS Biases (O-B) in GFS

Note the same bias correction is applied to both data sets. Clearly, UPP data at this channel has bias more depending on satellite local passing time.
Bias Correction Algorithms

• **Current (EMC) Bias Correction Algorithm** (Derber and Wu 1998)
  - Correct angle dependent bias (cross-track scanning sensor)
  - Correct beam dependent bias (conical scanning sensor)
  - Remove systematic bias

• **New Bias Correction Algorithm** (Yan and Weng 2010)
  - Correct residual calibration bias at LAS channels in UPP data
  - Correct beam dependent bias (NESDIS SSMIS data)
Comparison of Longitudinal-Mean Bias in TB
w/wo New Bias Correction
Impacts of AMSU-A and SSMIS LAS Data on Forecast Scores

- For northern hemispheric forecasts, impacts from both data sets are similar.
- For southern hemispheric forecasts, the score from UPP data is much lower compared to that from NESDIS data.
Impact of UPP LAS Data with New BC

- A new bias correction is developed which is a function of latitude and node.
- Bias correction coefficients are generated based on weekly mean results.
- New bias correction makes the UPP data produce much improved assimilation impact.
- Conical scanning sensor SSMIS LAS (UPP) can produce impact similar to cross-track scanning sensor (AMSU-A).
Assimilation Impact of MHS WV Channel Data Using Current GFS QC Scheme

Southern Hemisphere 500mb Height

MHS data has a smaller impact
Current GFS Quality Control for MHS (AMSU-B) Channels

• Use an index from MHS 89 and 157 (150) GHz to check clouds/rain-affected data for each channel

• Use an index defined according to the TB biases at two window channels to check the data where RTM simulations are not accurate for each channel

• The index thresholds for gross error check are different for each channel, ranging from 2.5 to 3.5 K
New Quality Control Scheme in MHS and SSMIS WV Channels

- Use new index from three WV channels to determine corresponding cloud/rain-affected data.
- Use new index thresholds (2 K) for the gross error check at all five MHS channels (SSMIS WV channels).
- Detect ice clouds for three WV channels (Sun and Weng IWP algorithm) (to be done).

More high quality data

Cloud-affected data is gone!
Impacts of METOP-A MHS Data (New QCs)

Southern Hemisphere 500mb Height

ANOMALY CORRELATION vs. FORECAST DAY

- **Cntrl Exp. (No MW Data)**
- **Metop-a AMSU-A Exp**
- **Metop-a AMSU-A&MHS Exp. (Old QC)**
- **Metop-a AMSU-A&MHS Exp. (New QC)**

More positive Impact!

(35 days of exp.)
Impacts of UPP WV Data (New QCs)

Southern Hemisphere 500mb Height

ANOMALY CORRELATION

FORECAST DAY

1 2 3 4 5 6 7

Cntrl Exp (no mw.).
UPP3LASH20 Exp.
UPP3LAS Exp. (ND)

Positive impact

(45 days of exp.)
Summary and Conclusions

- More positive impacts of the MIS LAS-like data are observed using the new bias correction scheme.

- More positive impacts of the ATMS and MIS WV-like data are observed by using the new quality control scheme.

- Impacts of MIS LAS-like data (conical scanning) on forecast skill can be similar to that of ATMS AMSU-A-like data (cross-track scanning).