Assimilation of GOES-R Atmospheric Motion Vectors in the NCEP Global Forecast System

Sharon Nebuda¹, Jim Jung¹,², Dave Santek¹, Jaime Daniels³, Wayne Bresky⁴

¹Cooperative Institute for Meteorological Studies, University of Madison-Wisconsin, WI ²Joint Center for Satellite Data Assimilation, College Park, MD ³NOAA/NESDIS, Center for Satellite Applications and Research, College Park, MD ⁴I.M. Systems Group (IMS), Rockville, MD

Purpose:

Evaluate proxy AMVs for GOES-R Advanced Baseline Imager (ABI) within the NCEP GFS to support the successful, timely use of the new data when available.
Proxy GOES-R AMV Data Uses
- Meteosat-9 & 10 SEVIRI imagery
- GOES-R ABI Nested Tracking Algorithm
- GOES-R ABI Cloud Height Algorithm

4 AMV types represent ABI Channels:
- 2 visible (VIS)
- 7 infrared (NIR)
- 8 cloud top water vapor (CTWV) – Tb height assignment
- 14 infrared (IR)

Proxy data is created on an hourly frequency. Results are shown using the 6 hour synoptic frequency data. Future work is examining best use of hourly GOES-R data in the GFS.

How to best assimilate this data? Need to consider:

- Quality Control
- Observation Error
- Departure Check
- Departure Statistics
- Impact on GFS Forecast Skill
Quality Control

QI - Quality Indicator without the forecast component
Used QIFN > 80

June 2012 – All data

Mean Normalized Speed departure

RMSE of the Vector Difference

[VIS] [NIR] [CTWV] [IR Below 700hPa] [IR Above 700hPa]
Quality Control

**NEE** – Normalized Expected Error
Used NEE < 0.9

June 2012 – All data

**Mean Normalized Speed departure**

**RMSE of the Vector Difference**
Quality Control

PCT1 – Cluster standard deviation / distance traveled
Used 0.04 < PCT1 < 0.5

June 2012 – IR data

**Speed departure Obs – GFS Background (m/s)**
Black lines mark mean and standard deviation for each pct1 bin along the x axis
Quality Control

**PERR** – Cluster median of the measure of uncertainty in cloud top height (hPa)
Did not use this parameter.

June 2012 – IR data
Observation Error
Analysis response to varying the GOES-R AMV observation error through a range of multipliers to the current GOES AMV error settings.

Fit to obs (GFS Analysis – AMV)
Speed Bias (left) Vector Difference RMSE (right)

Blue – Original GOES Error
Green – 75% GOES Error
Log Normal Vector Departure Check

\[ \sqrt{ \left( U_{AMV} - U_{GFS} \right)^2 + \left( V_{AMV} - V_{GFS} \right)^2 } / \log(\text{Speed}_{AMV}) < 3 \]

Top row: after QC before departure check

Bottom row: after QC and departure check
Data Count – June 2012

Percent removed due to QC, Departure Check, and GSI checks.

<table>
<thead>
<tr>
<th>Condition</th>
<th>Visible</th>
<th>Near IR</th>
<th>CTWV</th>
<th>IR</th>
</tr>
</thead>
<tbody>
<tr>
<td>QI &gt; 80</td>
<td>16</td>
<td>17</td>
<td>26</td>
<td>26</td>
</tr>
<tr>
<td>+ NEE&lt;0.9</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>+ 0.04&lt;PCT1&lt;0.5</td>
<td></td>
<td></td>
<td></td>
<td>7</td>
</tr>
<tr>
<td>+ LNVD &lt; 3</td>
<td>1</td>
<td>1</td>
<td>14</td>
<td>7</td>
</tr>
<tr>
<td>Rejected by GSI</td>
<td>10</td>
<td>3</td>
<td>0.2</td>
<td>2</td>
</tr>
<tr>
<td>% Used</td>
<td>70</td>
<td>77</td>
<td>58</td>
<td>56</td>
</tr>
</tbody>
</table>
Data Count and Fit to Obs as a function of Pressure for 3 regions

Fit to obs (GFS – AMV)
Speed Bias (left) Vector Difference RMSE (right)

June 2012
Data Count and Fit to Obs IR AMVs as a function of Pressure for 3 regions divided into dominant cloud type in target box

- 25-60N
- 20S-25N
- 60-20S
Speed departure as a function of Zenith Angle
20S-25N June 2012
AMV speed – GFS Background speed
Data Count and Fit to Obs

GFS Background - AMV
1x1 deg grid box average from 100-700hPa for June 2012

GFS Speed (m/s)

AMV-GFS Speed/ AMV Speed

CTWV

IR
1x1 deg grid box average from 100-700hPa for June 2012

GFS U Comp (m/s)

AMV-GFS U Comp (m/s)
1x1 deg grid box average from 100-700hPa for June 2012

GFS V Comp (m/s)

CTWV

IR

AMV-GFS V Comp (m/s)
Forecast Skill Impact
500 hPa Height Anomaly Correlation Coefficient

Die-off curves

24 May – 23 July, 2014
AMVE6 – GFS simulation using GOES-R AMVs
AMVC1 – GFS simulation using no AMVs from SEVIRI
Forecast Skill Impact
Tropical Wind RMSE

WIND: RMSE
20120524–20120723 Mean, G2/TRO 00Z

AMVC1

AMVEG–AMVC1

Difference w.r.t. AMVC1

The differences outside of outline bars are significant at the 95% confidence level

Forecast Hour

0 48 96 144

-3.5 -2.6 -2.1 -1.4 -0.7 0 0.7 1.4 2.1 2.8 3.5

200 hPa

850 hPa
Forecast Skill Impact
Global Wind Pattern Correlation

WIND: Pattern Correlation
20120524-20120723 Mean, G2 00Z

AMVC1
AMVE6-AMVC1

Forecast Hour

Difference w.r.t. AMVC1

200 hPa

WIND: Pattern Correlation
P850 G2 00Z, 20120524-20120723 Mean

AMVC1 81
AMVE6 81

Difference w.r.t. AMVC1

850 hPa

poor differences outside of outline bars are significant at the 95% confidence level
Radiosonde Fit to Obs
Solid – AMVC1 no SEVIRI AMVs
Dots – AMVE6 GOES-R AMVs

0Z

12Z
Summary

Selected Quality Control Settings
QIFN < 80
EE/Ob Speed < 0.9
0.04 < PCT1 < 0.5

Reduced Observation Error for synoptic frequency data by 25%

Applied Log Normal Vector Departure Check

Forecast Skill Impact is neutral to slightly positive in the Southern Hemisphere.

Next: Examine impact of hourly GOES-R AMV data with consideration given to observation error settings and use of off synoptic time data.