Determining optimal conditions for meso-scale AMV

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EUMETSAT
Korea plans to launch our first meteorological imager at April THIS YEAR (Wish us luck!!)

It has four IR and one VIS channel
- central wavelengths are almost same with MTSAT

We’ve developed AMV algorithm with MTSAT data
- results are comparable to GTS AMVs (in accuracy and impact to forecast)
Attempts to observe smaller scale winds

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Fig. 2.2. Vertical and horizontal scales of some extra-tropic atmospheric motion systems. The straight line separating the open and shaded areas is defined by the Rossby radius of deformation (\(R\)) for a latitude of 45° as a function of the vertical scale (\(h\)). The open area denotes the range within which the wind field dominates the atmospheric dynamics and three-dimensional wind measurements are important. The shaded area denotes the range where mass information dominates.

Table 1. AMV Steps

<table>
<thead>
<tr>
<th>AMV Producer</th>
<th>EUMESAT</th>
<th>CIMSS/NESDIS</th>
<th>Brazil</th>
<th>JMA</th>
<th>KMA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steps</td>
<td>target, track,</td>
<td>target, height</td>
<td>target, track,</td>
<td>target, track,</td>
<td>target, track,</td>
</tr>
<tr>
<td>subsequence</td>
<td>height assign.</td>
<td>assign., track</td>
<td>height assign.</td>
<td>height assign.</td>
<td>height assign.</td>
</tr>
<tr>
<td>Target box</td>
<td>24x24 pix</td>
<td>15x15 pix</td>
<td>32x32 pix</td>
<td>32x32 pix</td>
<td>32x32 pix</td>
</tr>
<tr>
<td>Search box</td>
<td>80x80 pix</td>
<td>21x37 pix</td>
<td>50x50 pix</td>
<td>64x64 pix</td>
<td>64x64 pix</td>
</tr>
<tr>
<td>Target</td>
<td>no threshold</td>
<td>7 bright units</td>
<td>no threshold</td>
<td>no threshold</td>
<td>5 Kelvin</td>
</tr>
</tbody>
</table>

\(~72\) km \(\sim 60\) km \(\sim 128\) km
What controls **SCALE** of AMV?

1. **time interval of images**
   - 15 minutes
   - 30 minutes

2. **horizontal resolution of image**
   - 4 km (IR channels)
   - 1 km (HR-Visible channel)

3. **target size**
   - 128 to 16 km

4. **scale of NWP**
   - larger than 35 km (UM/KMA)
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<td>Steps subsequence</td>
<td>~72 km</td>
<td>~60 km</td>
<td>~128 km</td>
<td></td>
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</table>

**size of TARGET:**

128 km?
reducing Target Size

size of target: $64 \times 64$ km$^2$
solution: **Time Interval between images?**

**IRW-channel**: res. = 4 km

<table>
<thead>
<tr>
<th>Time Interval</th>
<th>Wind Speed corresponding one pixel displacement</th>
</tr>
</thead>
<tbody>
<tr>
<td>30 min.</td>
<td>2.2 ms⁻¹</td>
</tr>
<tr>
<td>15 min.</td>
<td>4.4 ms⁻¹</td>
</tr>
</tbody>
</table>

**HRV-channel**: res. = 1 km

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<th>Time Interval</th>
<th>Wind Speed corresponding one pixel displacement</th>
</tr>
</thead>
<tbody>
<tr>
<td>30 min.</td>
<td>0.6 ms⁻¹</td>
</tr>
<tr>
<td>15 min.</td>
<td>1.1 ms⁻¹</td>
</tr>
</tbody>
</table>
solution: **Sub-pixel determination of target displacement?**
Figure 3: Lower troposphere rapid scan AMVs around Tropical Storm Gabrielle, 14 September, 2001.
What controls SCALE of AMV?

assuming we can ignore the effects of
2. horizontal resolution of image
4. scale of NWP

can we determine the OPTIMAL
3. target size
   - 128 to 16 km

for GIVEN
1. time interval of images
   - 15 minutes
   - 30 minutes
Determining optimal target size for given time interval of images

**ACCURACY** (to Rawinsonde)
- Data: IRW (10.8 μm) AMV
- Period: 17 Oct – 10 Nov 2009
- Filters:
  - Horizontal dist < 150 km
  - Vertical dist < 25 hPa
  - Quality >= 0.8
  - Speed diff. < 30 m/s
  - Dir. diff. < 90 degree

**QI** (Quality Indicator) Histogram
- Period: (same)
- Filter: (none)
- X-axis: QI
- Y-axis: Number density

Must consider not only ACCURACY also QUALITY
time interval of images: 30 minutes

QI histogram

17oct-10nov 2009
IRW (10.8μm) AMV
time interval of images: 15 minutes

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<tr>
<th></th>
<th>30 min.</th>
<th>15 min.</th>
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<tr>
<td>IRW (4 km)</td>
<td>96~48 km</td>
<td>32 km</td>
</tr>
<tr>
<td>HRV (1 km)</td>
<td>64 km</td>
<td>64~32 km</td>
</tr>
</tbody>
</table>

QI histogram
- Optimal target size varies with time interval of images
- It is determined mainly by time interval, not image resolution
- For AMV whose time scale is more than 15 minutes, target size is a matter of PHYSICAL scale of cloud deformation, NOT the number of pixels within target
DISCUSSION

◆ Rapid scan AMV
  – optimal target must be smaller than 30 km
  – for that scale, 4km resolution image might be a problem
    (1) precision can be poorer than tens of m/s
    (2) number of pixels is too few (in sense of corr. calculation)
  – optimum can be determined also by dynamic range of cloud

◆ After the MTSAT-1R will be changed to rapid scan mode ...