Simulation of AMVs for OSSEs

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GMAO
Global Modeling & Assimilation O ffice

Goals: Synthetic Atmospheric Motion Vectors (AMVs)

- Obtain realistic observation counts in space and time
- Obtain realistic observation separation distances
- Obtain realistic relationships between location and weather
- Avoid reliance on image processing of Nature Run data
- Avoid necessity of extensive tuning of the algorithm

Simulation Algorithm

1. Consider sets of points at times and regions viewed by each imager
2. Determine cloud field or IPW at each location
3. Consider values f of either cloud fraction or scaled IPW gradient magnitude
4. For each point and level seen, an observation exists if r<P(f)

Parameters and form of P depend on observation type, p-layer, geographic region, and surface type.

$$P_1(f) = \alpha(1 - |f - \frac{1}{2}|)^m ,$$

$$P_2(f) = \alpha f^m ,$$

$$P_3(f) = \begin{cases} 1 & \text{if } f_1 \le f \le f_2, \\ 0 & \text{otherwise.} \end{cases}$$

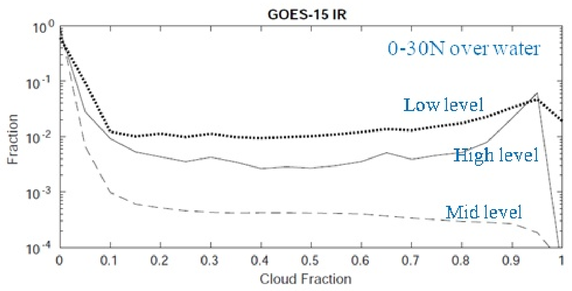


Figure 1. Histograms of numbers of cloud fraction values falling within each of 21 bins, presented as fractions of the total number of locations considered over water or ice. G5NR is used during the June-August period for 2006.

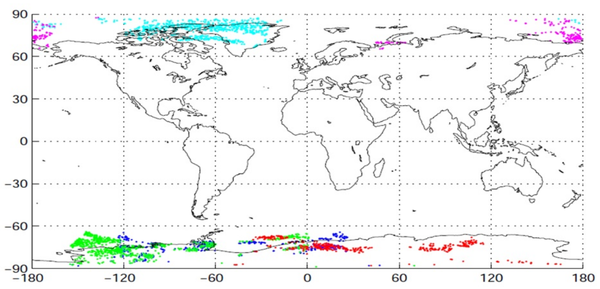


Figure 2. Locations of real (top) and simulated (bottom) MODIS AMVs assimilated at 0000 UTC 1 July (2015, top; 2006, bottom). Colors indicate observation times.

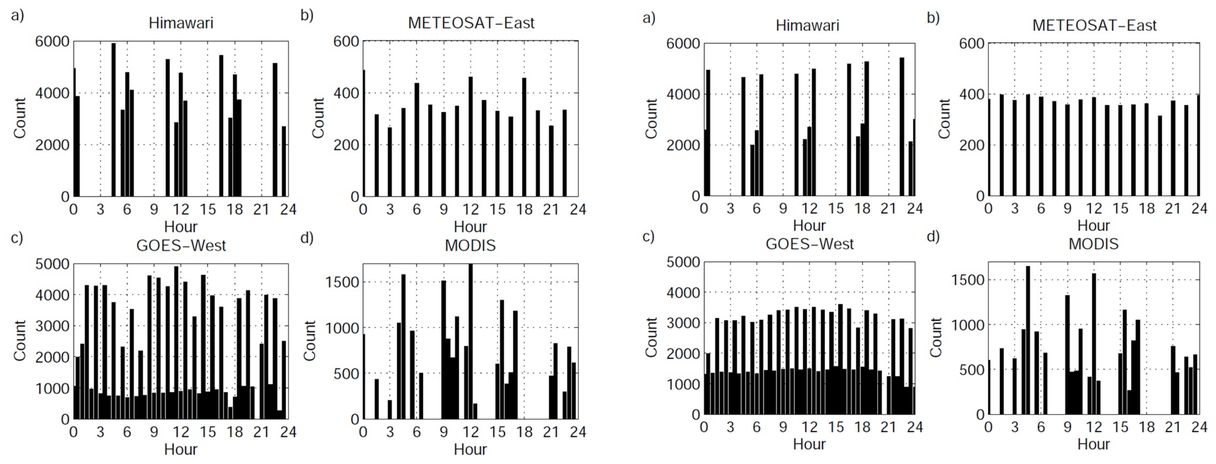


Figure 3. Numbers of locations of real (left) and simulated (right) observations within 30-min temporal bins centered at the indicated times (UTC) during 1 July (2015, left; 2006, right), produced from IR images of selected instruments.

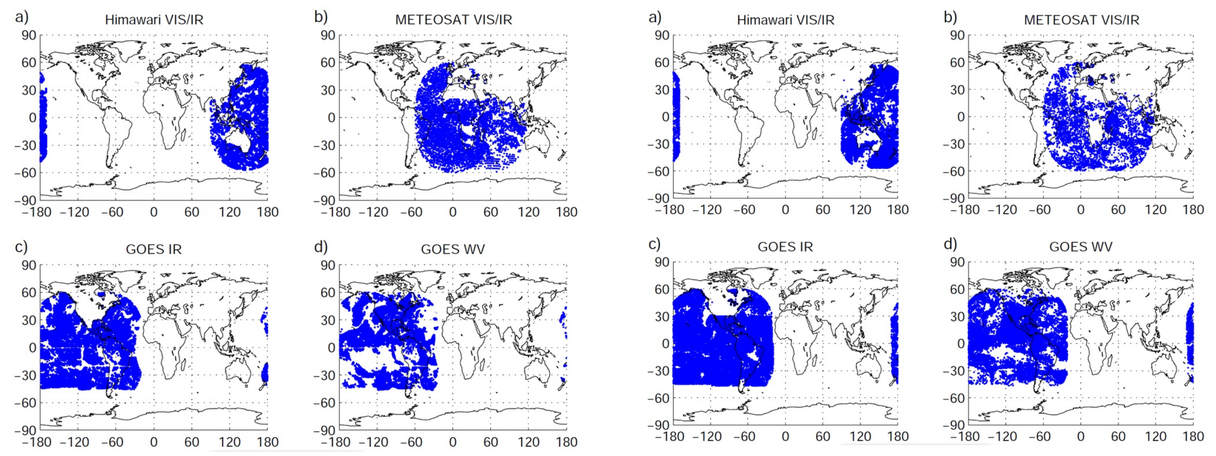


Figure 4. Locations of real (left) and simulated (right) AMV observations centered on 0000 UTC 1 July (2015, left; 2006, right), produced from selected instruments.

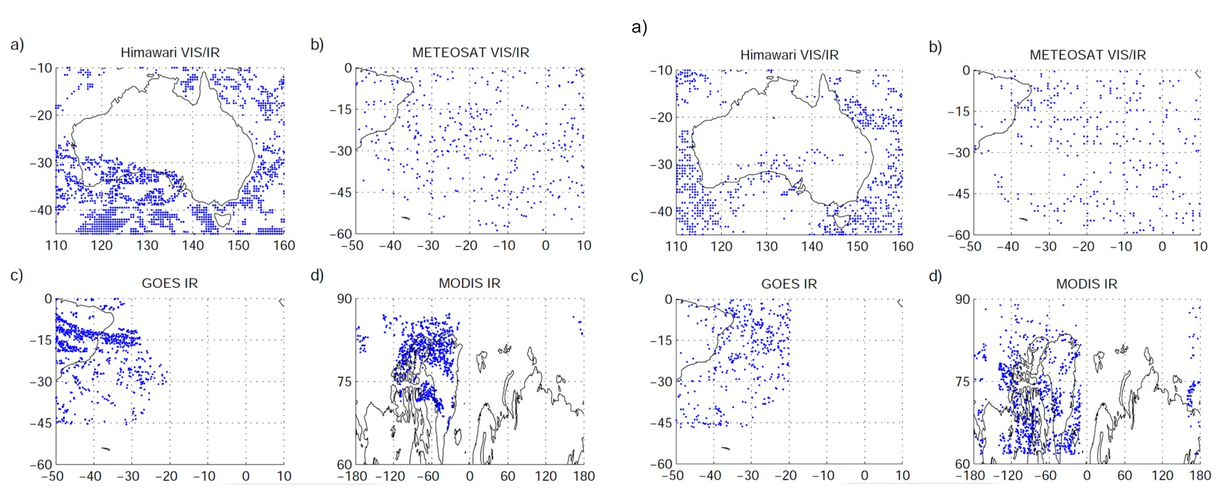


Figure 5. Spacing of real (left) and simulated (right) AMV observations for 30 minute periods on 1 July (2015, left; 2006, right), produced from selected instruments.

Tuning of Algorithm

First, for each AMV type, determine the time-mean counts C of assimilated real observations within various p-layers and geographic regions over some period.

Next, divide the values of f derived from the NR fields into discrete sets.

For each AMV type, p-layer, geographic region, and set of viewing times, determine histograms H of the counts of f-values.

For the appropriate form of P and a range of values of m, determine the coefficients α required to render

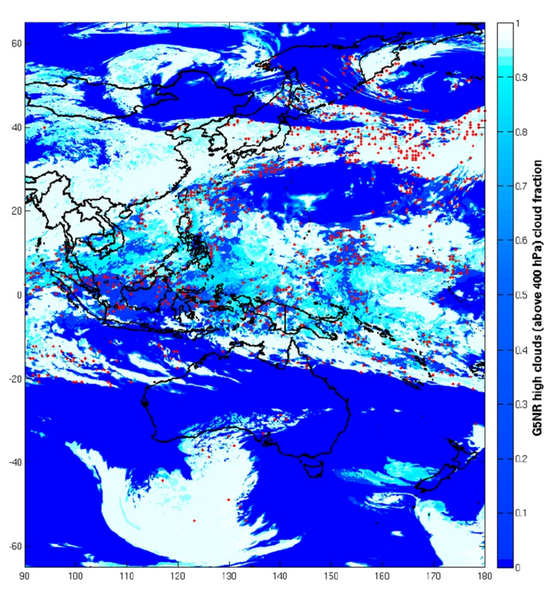
$$C_t = \sum_i P_{j,i} H_i ,$$

If P(f) > 1 for any f, then consider a smaller value of m, but if no suitable m is found, use option 3 for P(f).

Figure 6. HIMAWARI-7 observation locations created for the Nature Run time 2230 UTC 30 June 2006 at levels 100 < p < 300 hPa superimposed on the field of high level cloud fractions at that same time.

Summary

1. Separation distances are realistic
2. Geographic locations are realistic
3. Temporal distributions are realistic
4. Vertical distributions are realistic
5. Land vs. Sea distributions are realistic
6. Associations with cloud and water vapor fields are realistic
7. Algorithm is very flexible
8. Tuning is very quick



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