Estimates of AMVs Errors using MISR CMVs and Data Assimilation Diagnostics in GRAPES

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Estimates of AMVs obs. Error

- **Using MISR**
  - Height Assignment
  - Wind(u,v) Differences
- **Using DA Diagnosis**
  - Desroziers diagnostics: Monitoring of Obs. Error
  - *FSO: Forecast sensitivity to observation*
- **Impact of AMVs on NWP in GRAPES**
  - Height Adjustment : best fit pressure
  - Impacts
- **Conclusions and discussions**

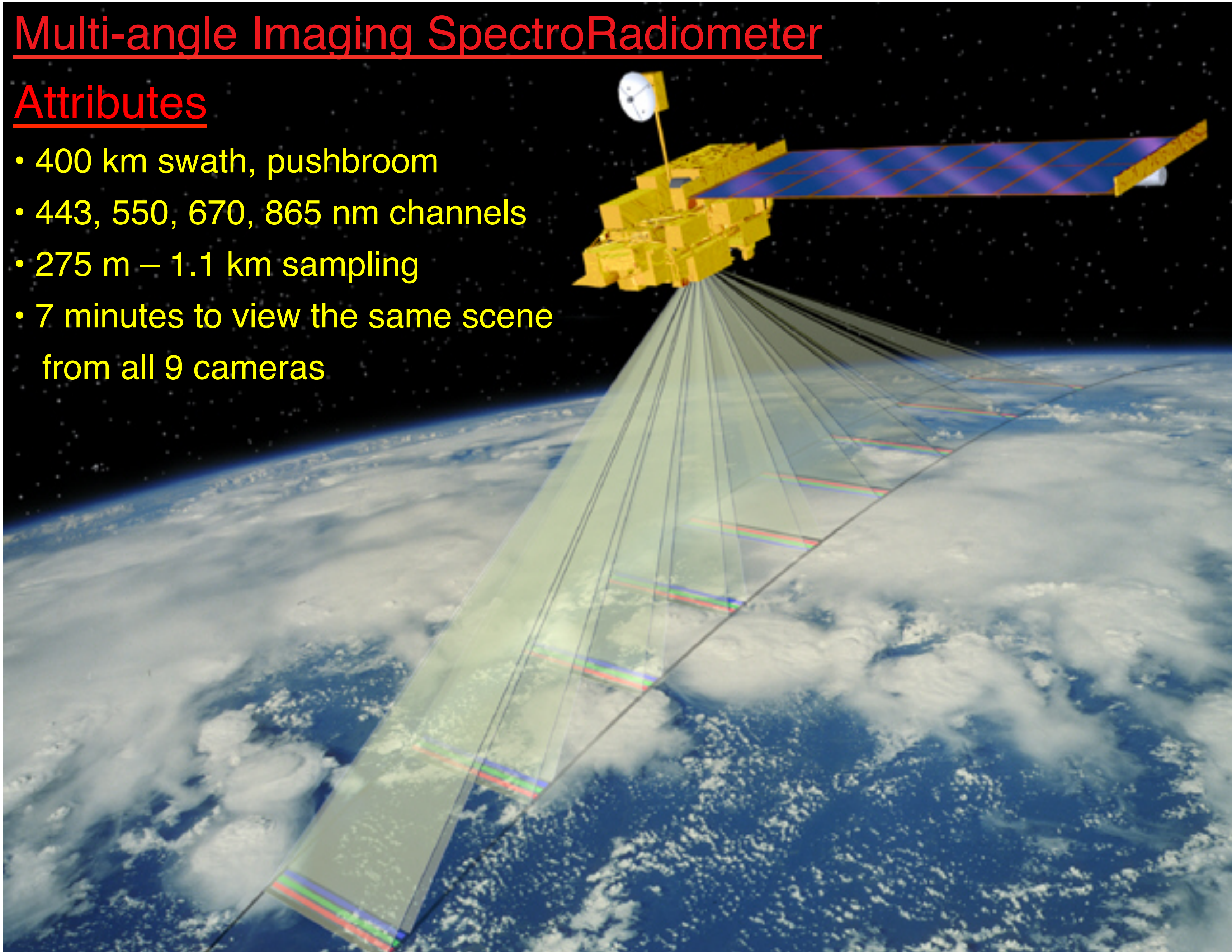
$E(\boldsymbol{\varepsilon}^b) = 0 \quad E(\boldsymbol{\varepsilon}^o) = 0$
$\mathbf{B} = E(\boldsymbol{\varepsilon}^b \boldsymbol{\varepsilon}^{b^T}) \quad \mathbf{R} = E(\boldsymbol{\varepsilon}^o \boldsymbol{\varepsilon}^{o^T})$
$E(\mathbf{d}_b^o \mathbf{d}_b^{oT}) = \mathbf{R} + \mathbf{HBH}^T \quad E(J\min) = p/2$

$$\delta J = \left\langle \frac{\partial J}{\partial \mathbf{y}}, \mathbf{y} - \mathbf{H}\mathbf{x}_b \right\rangle$$

Multi-angle Imaging SpectroRadiometer

Attributes

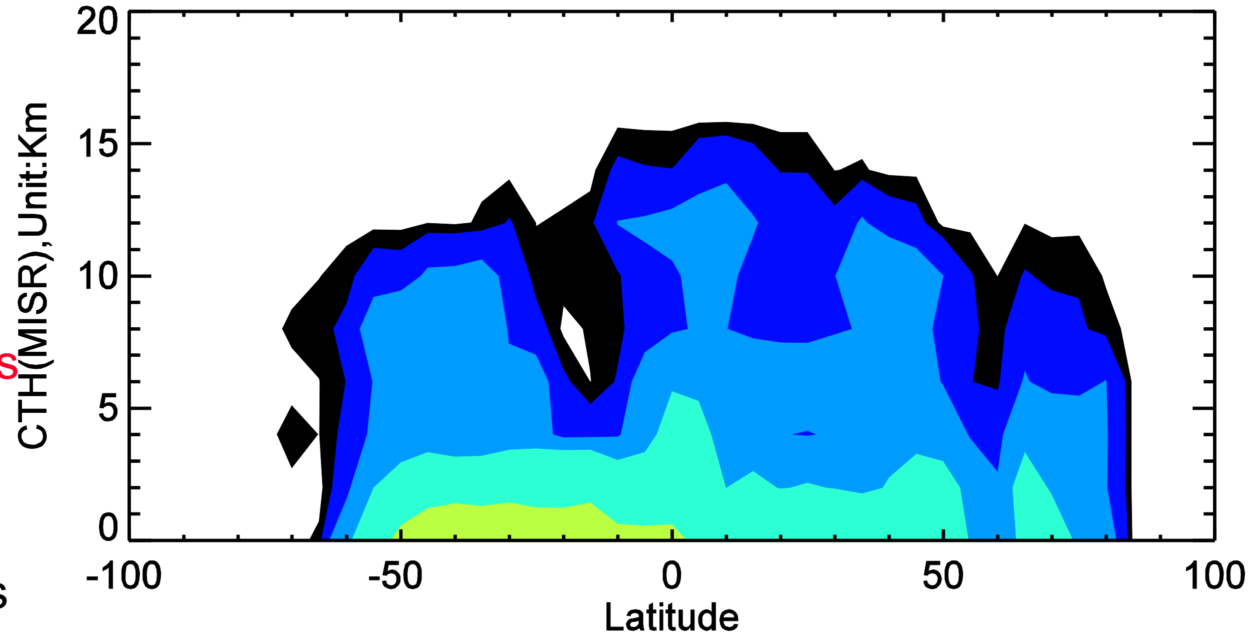
- 400 km swath, pushbroom
- 443, 550, 670, 865 nm channels
- 275 m – 1.1 km sampling
- 7 minutes to view the same scene from all 9 cameras

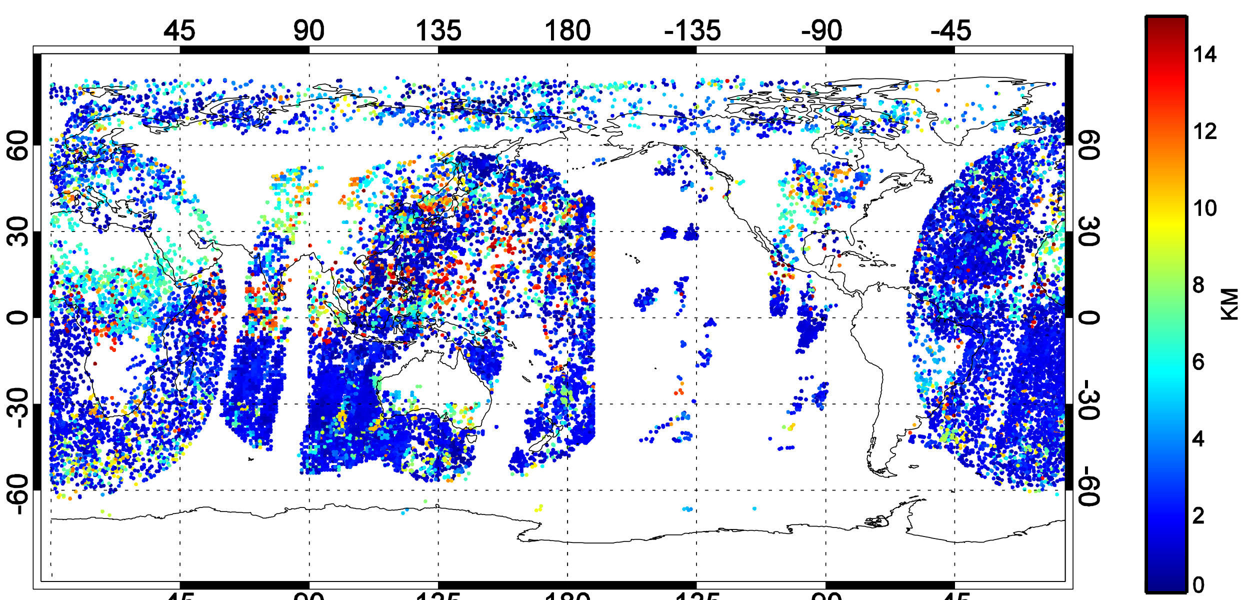


CTH(MISR)

- **201108**

Collocation of MISR and AMVs
Dlat and Dlon ≤ 0.5°
Dtime ≤ 15 min
Closest in height
Filter out MISR clearsky winds
(*Katrin Lonitz and Akos Horvath,2010)

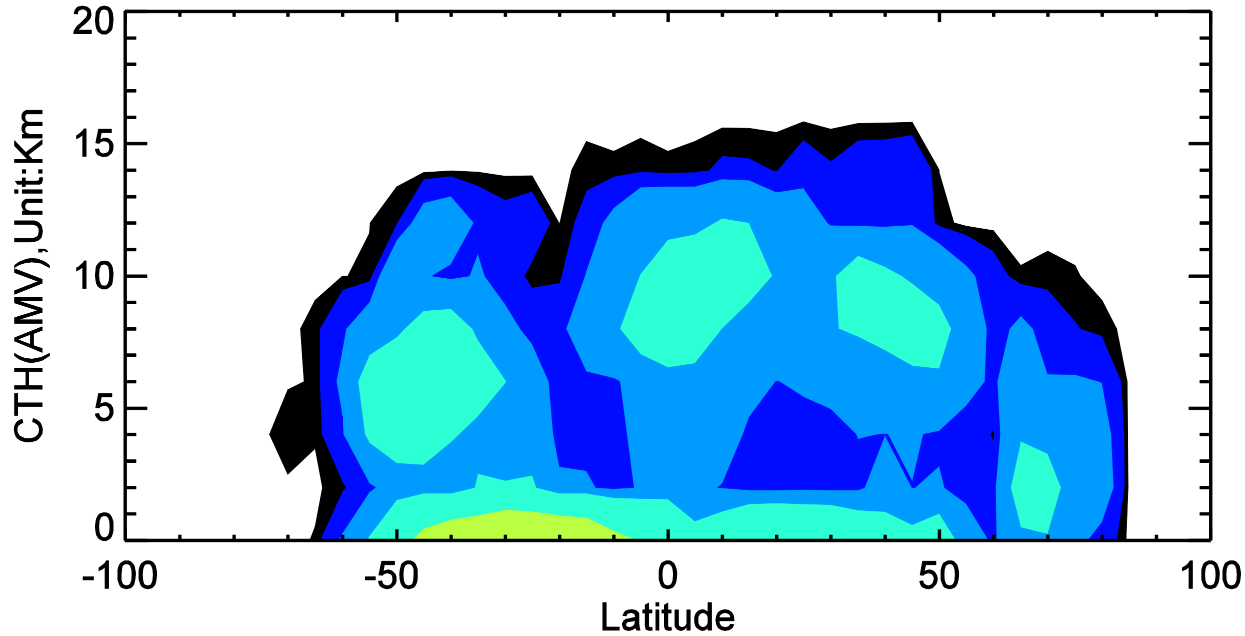


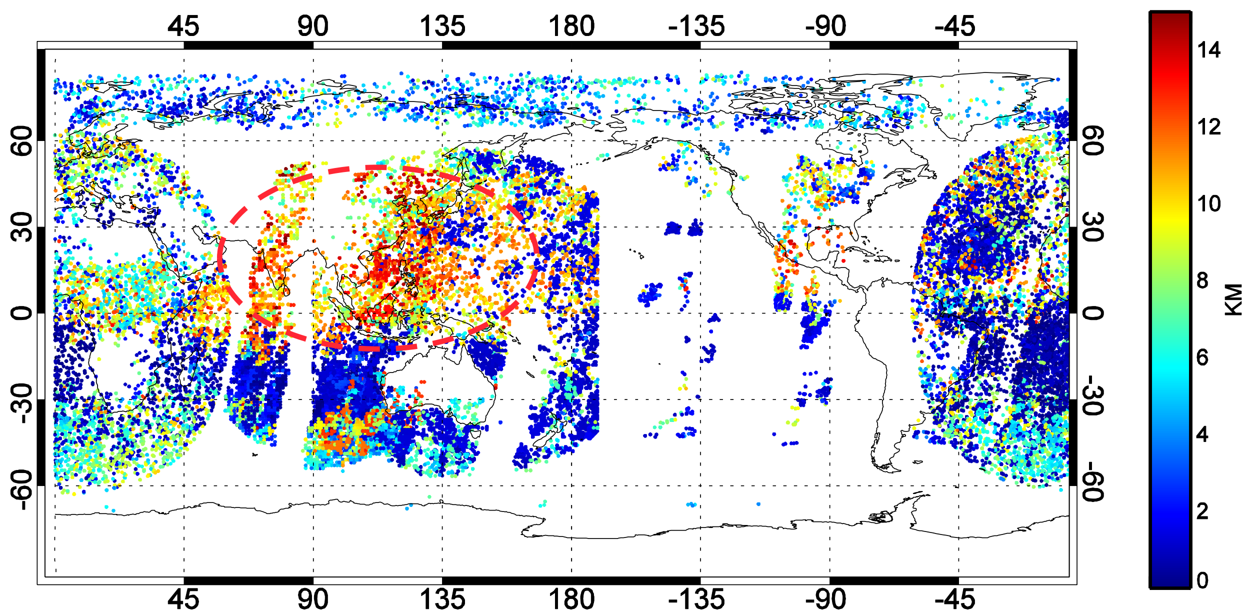


IR winds only

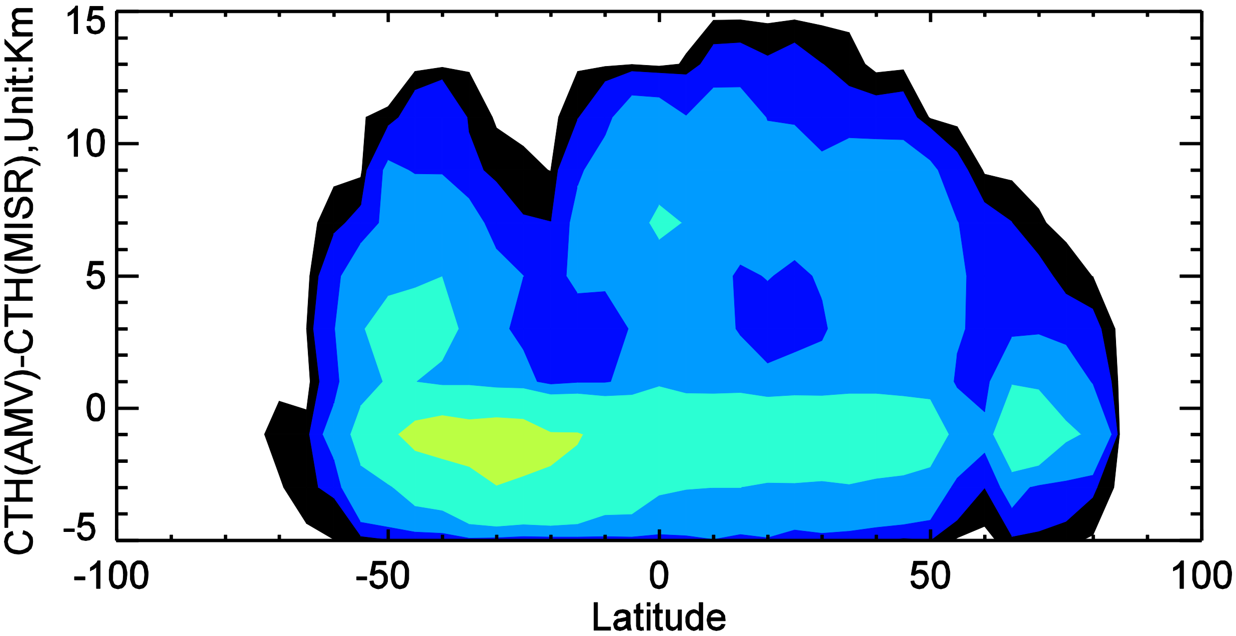
CTH(AMV)

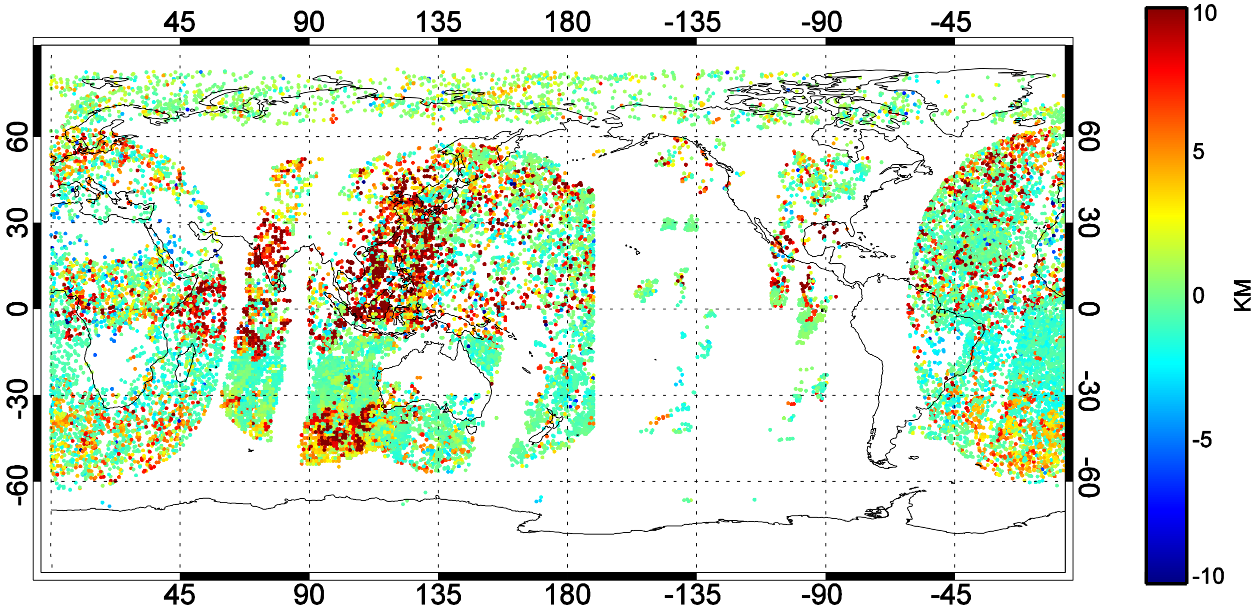
- **Height of AMVs**

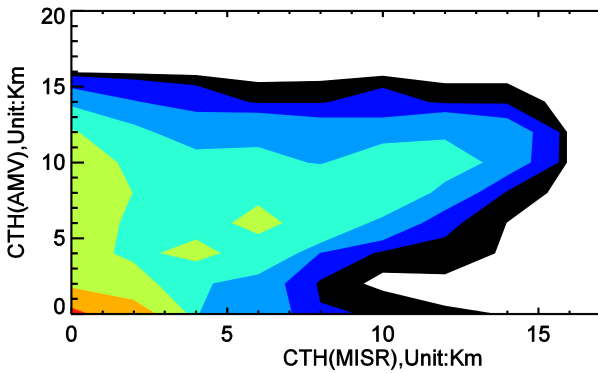




CTH(AMV) -CTH(MISR)

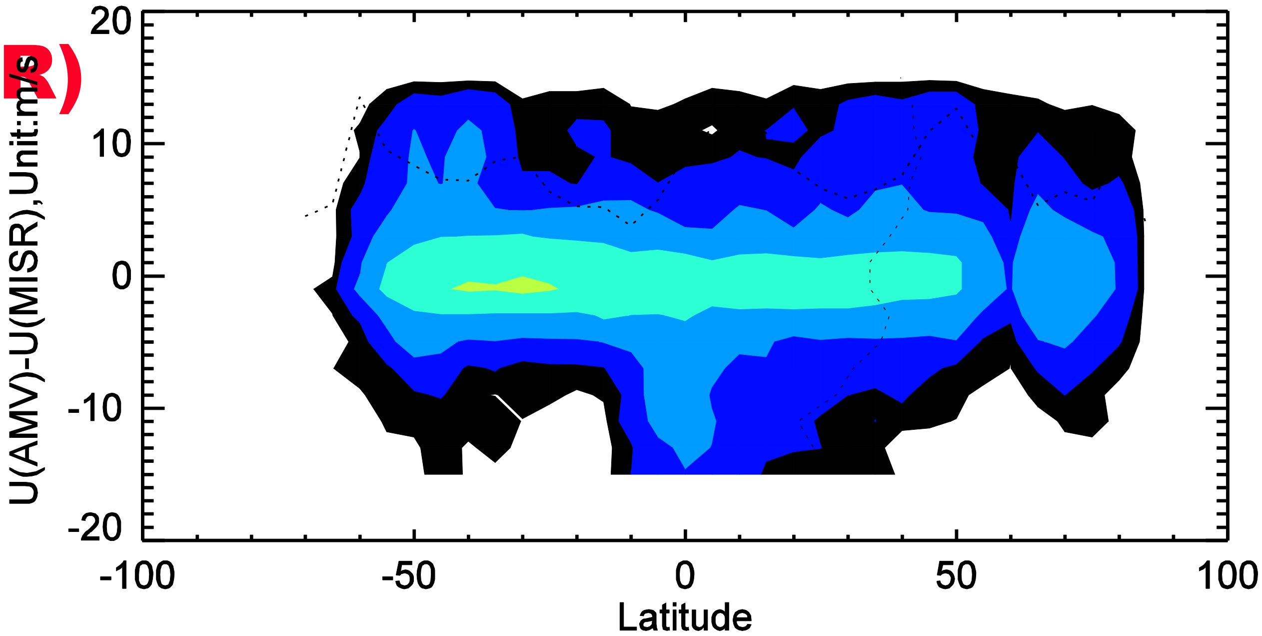


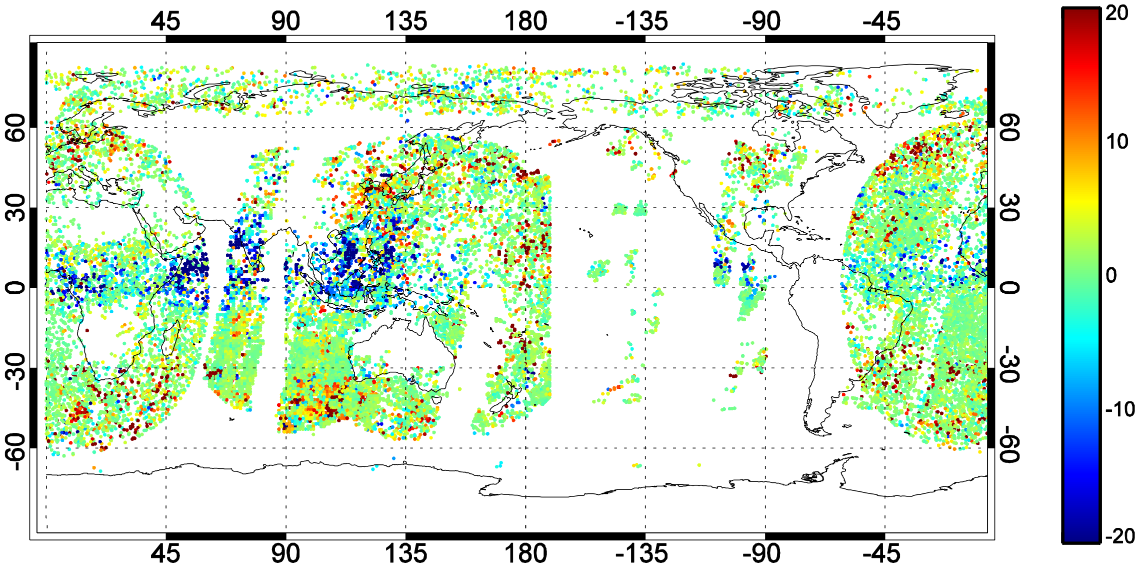


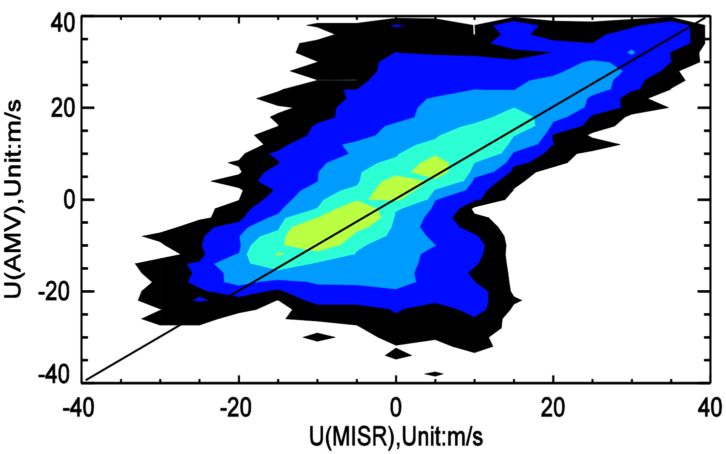


U(AMV)-U(MISR)

- U difference

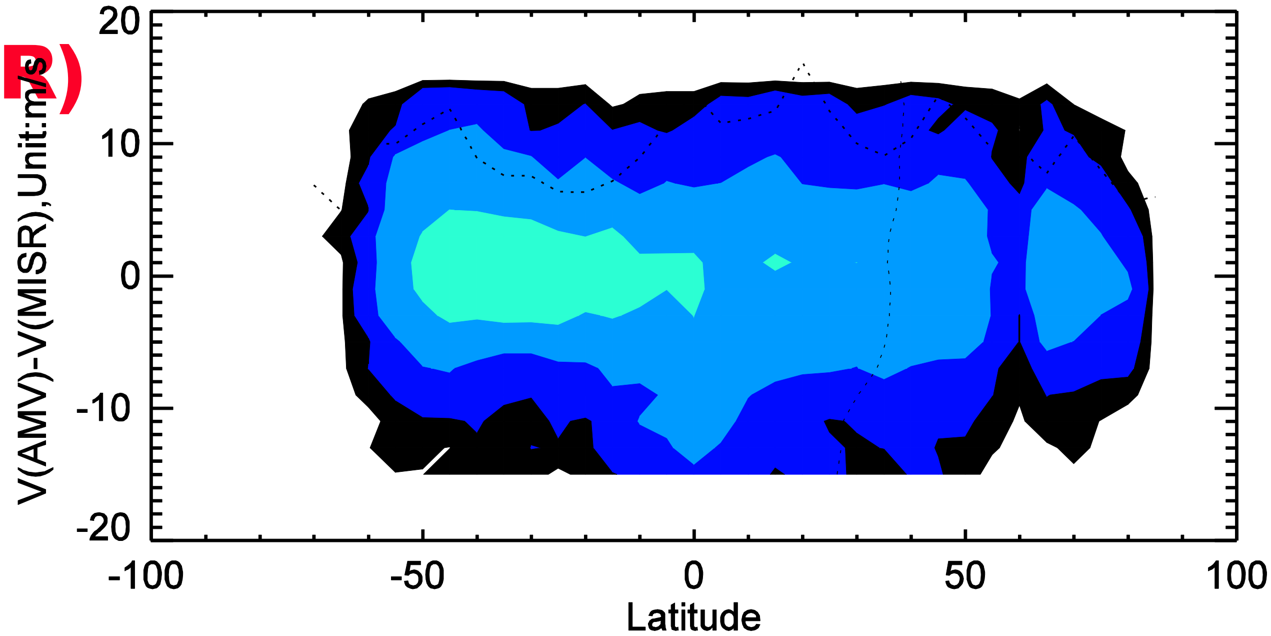


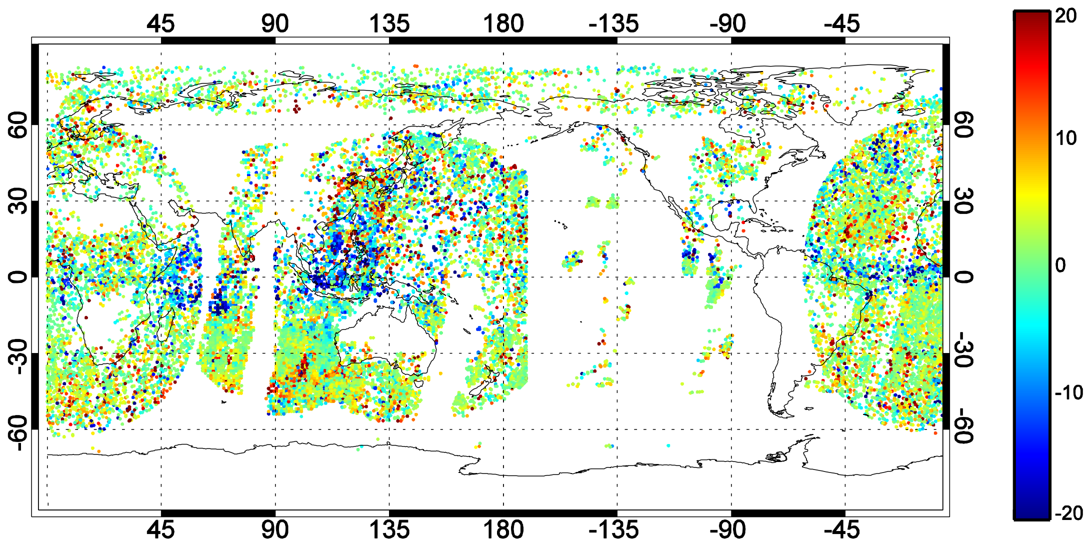


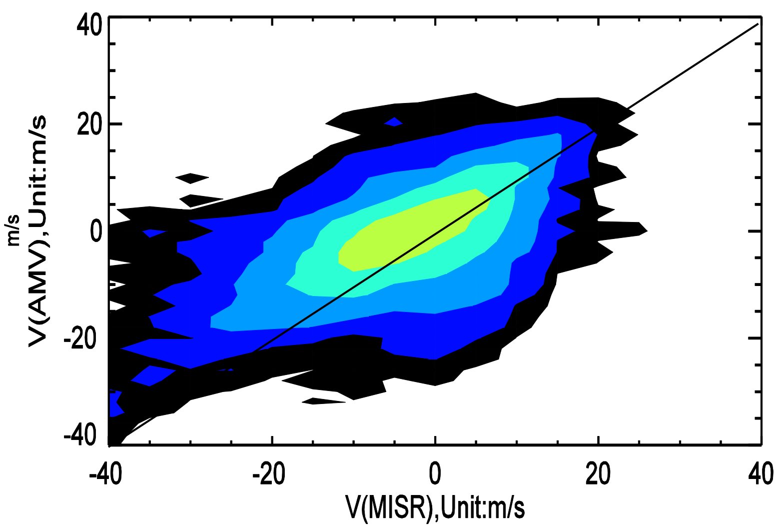


V(AMV)-V(MISR)

- V difference







Height correction: the best fit pressure

- **Height(pessure) Correction of Observed AMVs to Minimize the following Cost Function:**

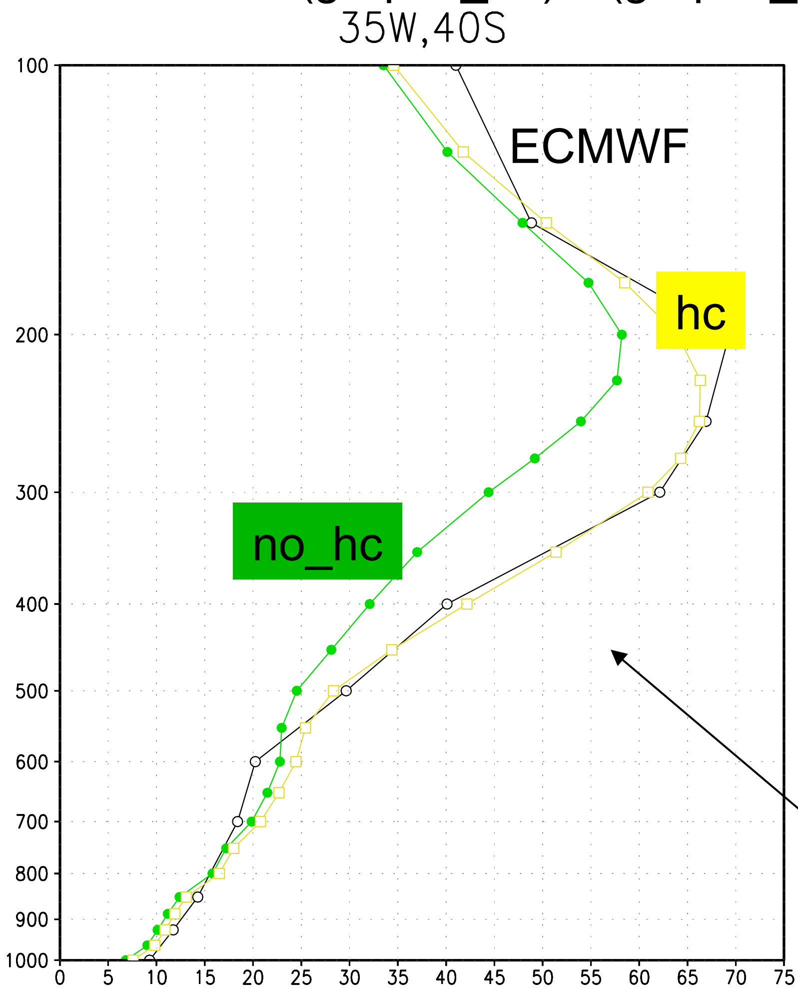
$$J(p) = \frac{1}{2}\left[\left(\frac{u_o - u_b(p)}{U_e}\right)^2 + \left(\frac{v_o - v_b(p)}{V_e}\right)^2 + \left(\frac{p - p_o}{P_e}\right)^2\right]$$

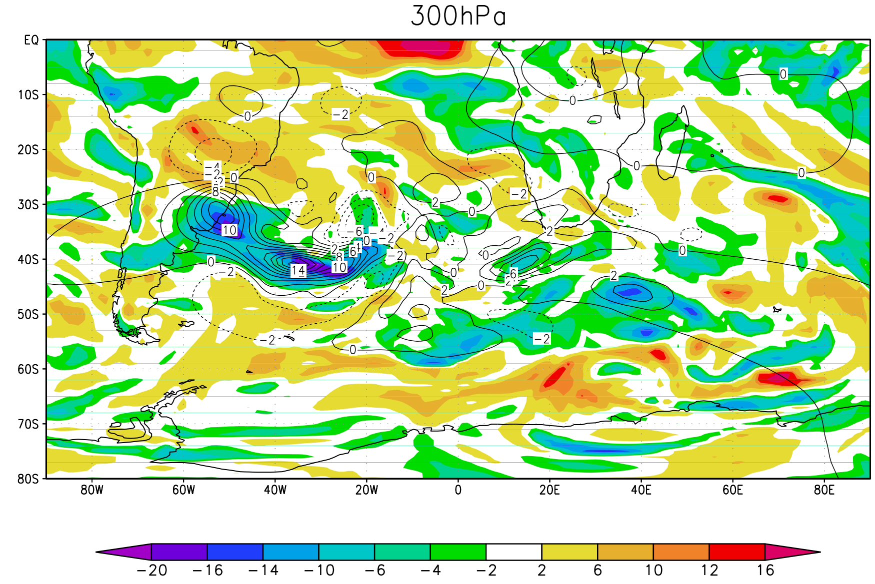
- **Parameter:**

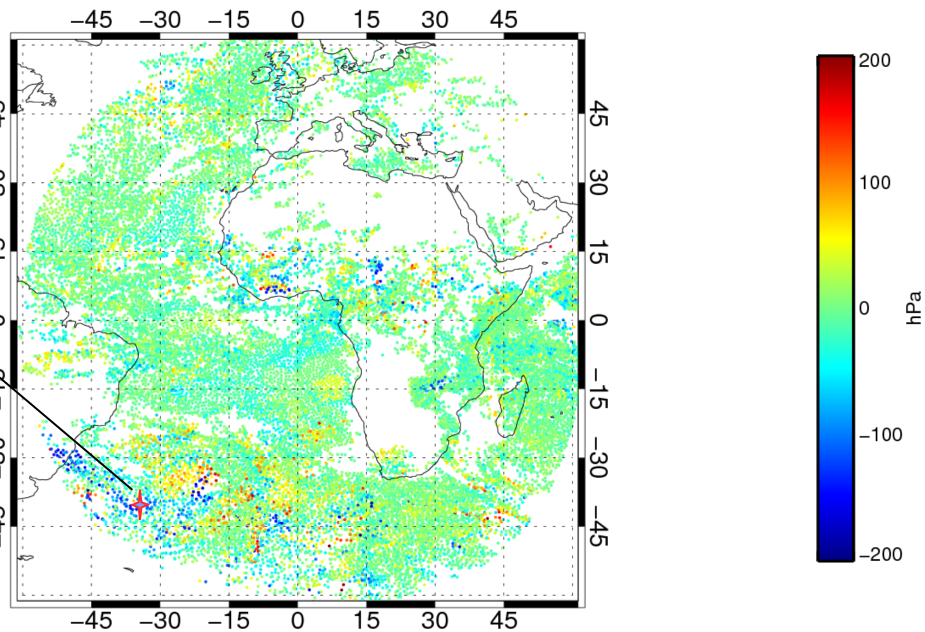
  - ♦ **Ue=Ve=3.0m/s,   Pe=50hPa**

Impact of Height correction of METEOSAT AMVs on Analysis, A CASE: 2009080612

Shaded: U(grapes_xa)-U(EC)
Contour: U(grapes_ha)-U(grapes_xa)

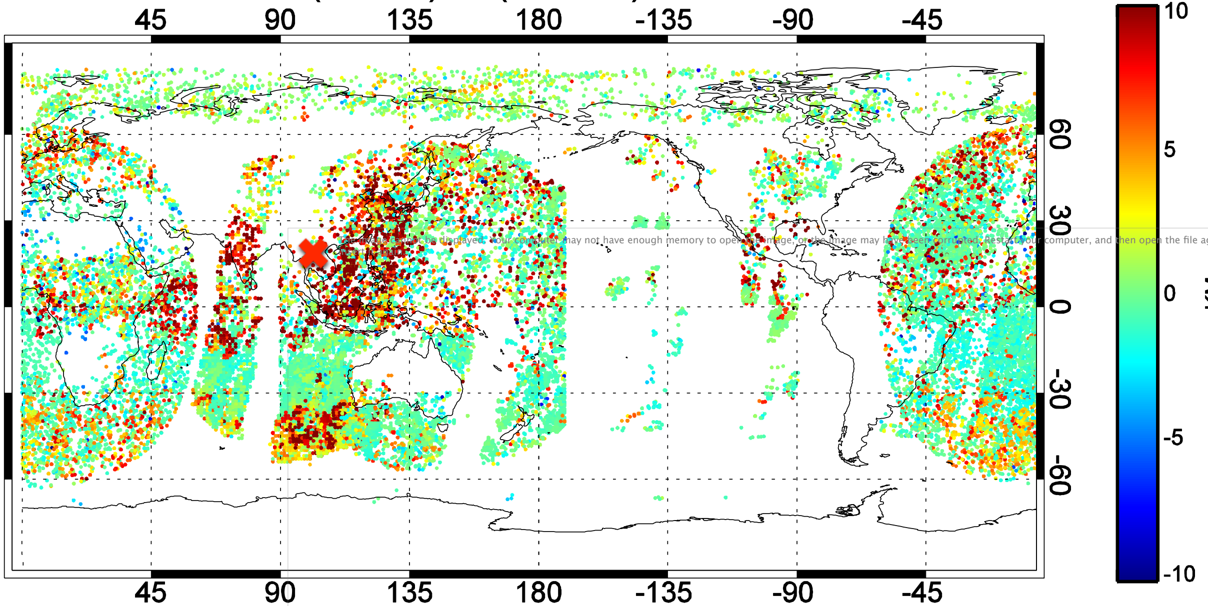




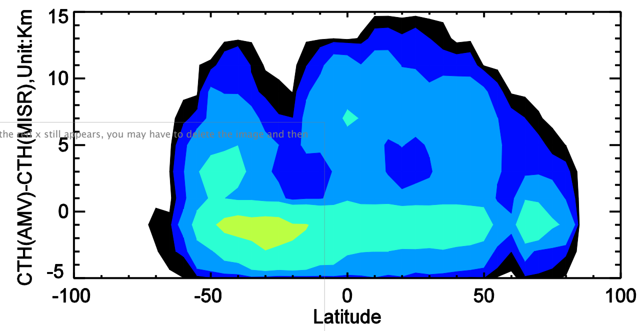


$$J(p) = \frac{1}{2}\left[\left(\frac{u_o - u_b(p)}{U_e}\right)^2 + \left(\frac{v_o - v_b(p)}{V_e}\right)^2 + \left(\frac{p - p_o}{P_e}\right)^2\right]$$

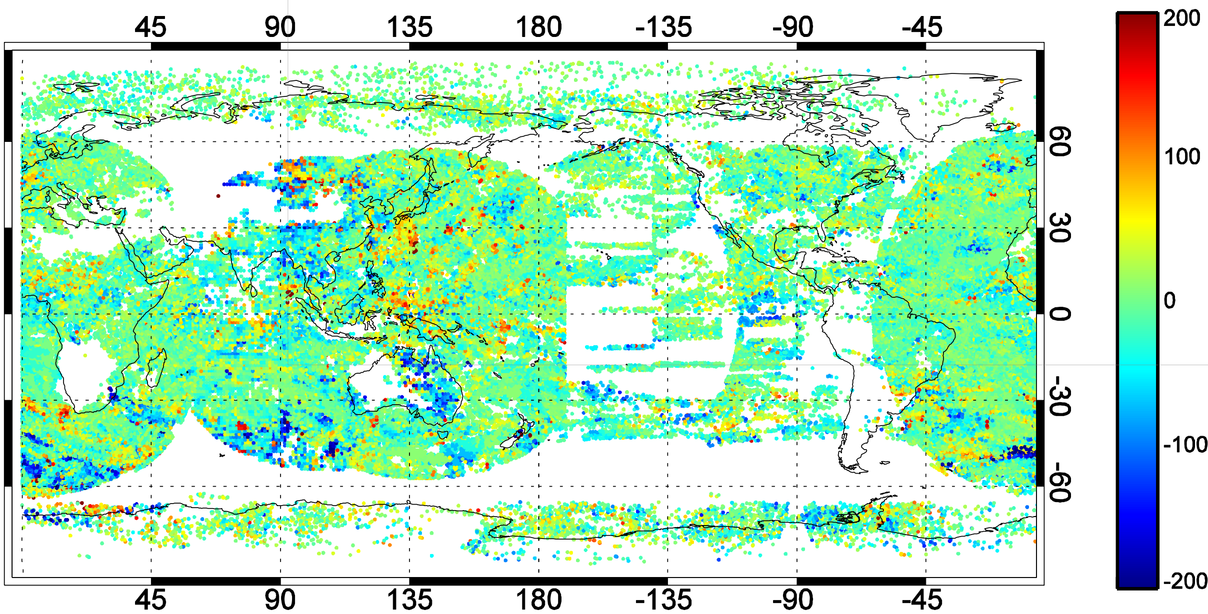
201108, CTH(AMV)-H(MISR)



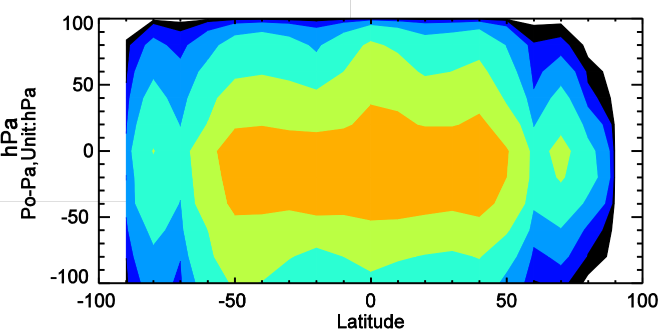
201108, CTH(AMV)-H(MISR)



20110801,Po(AMV)-Pa(AMV)



20110801~20110807
Po(AMV)-Pa(AMV)



Geometrical interpretation of analysis

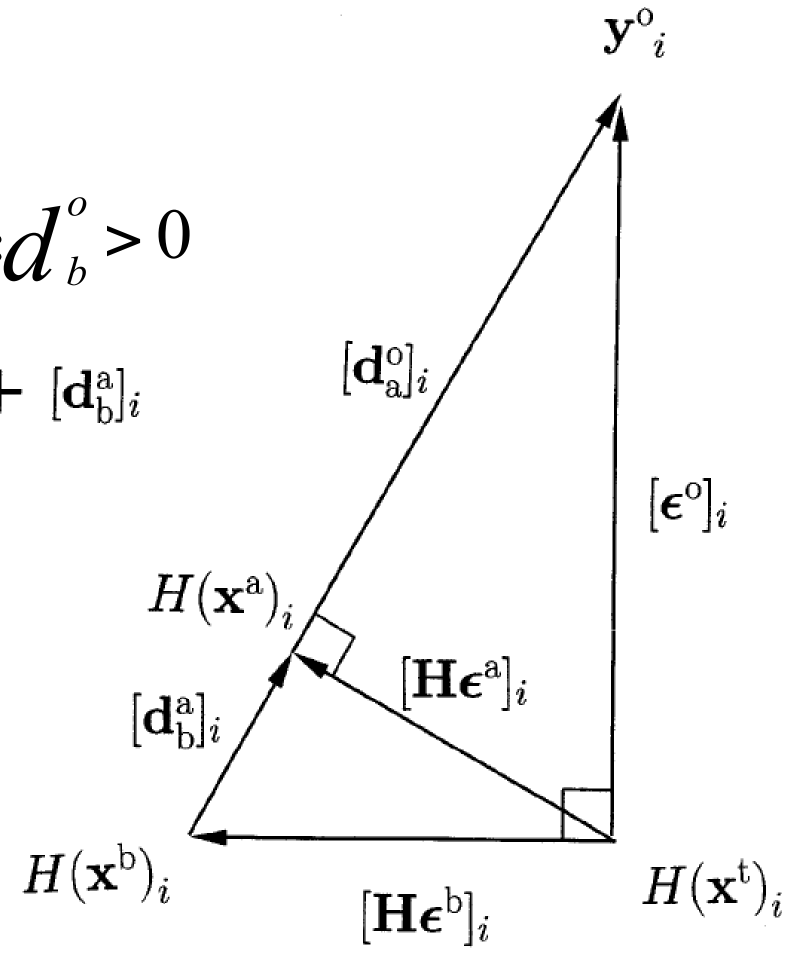
- Practical Implementation
  - Multi. Variable and Obs.
  - QC
- Monitoring of Obs. Error
  - based on O-B and O-A
  - Easy to use

$$(\varepsilon^o)^2 = d_a^o * d_b^o > 0$$

$$[\mathbf{d}_\mathrm{b}^\mathrm{o}]_i = [\mathbf{d}_\mathrm{a}^\mathrm{o}]_i + [\mathbf{d}_\mathrm{b}^\mathrm{a}]_i$$

$$E[d_a^o (d_b^o)^T] = R$$

The diag. of R: $(\varepsilon^o)^2 = d_a^o * d_b^o$

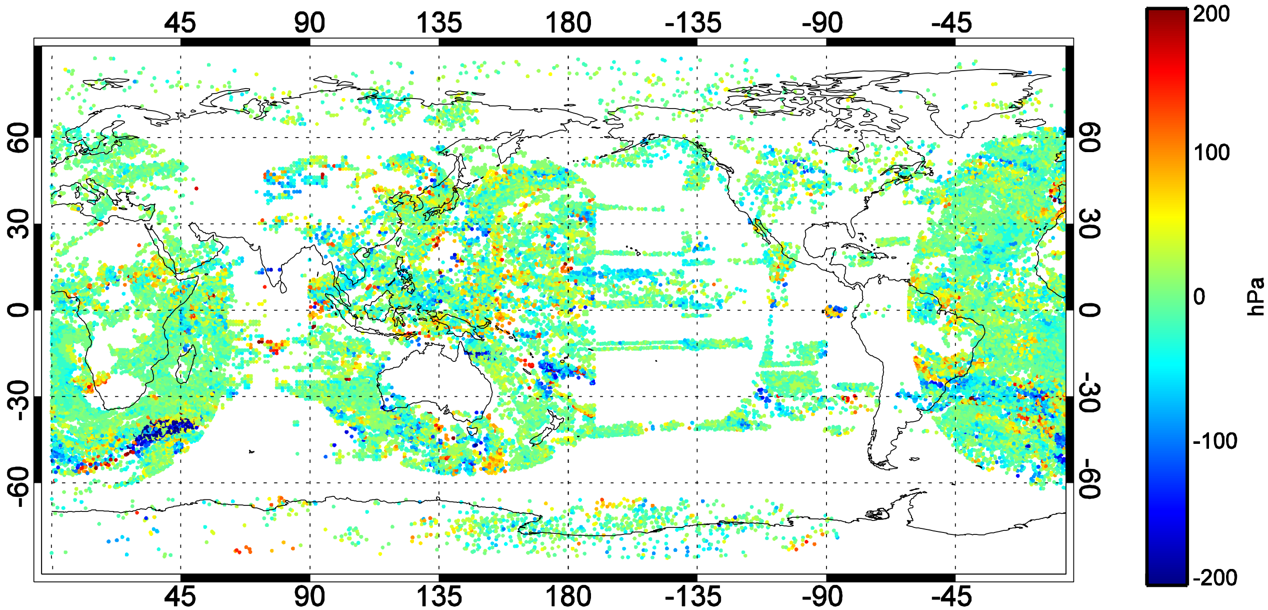


Desroziers, G. et.al,Diagnosis of observation, background and analysis-error statistics in observation space, *Q. J. R. Meteorol. Soc.* (2005), **131**, pp. 3385–3396

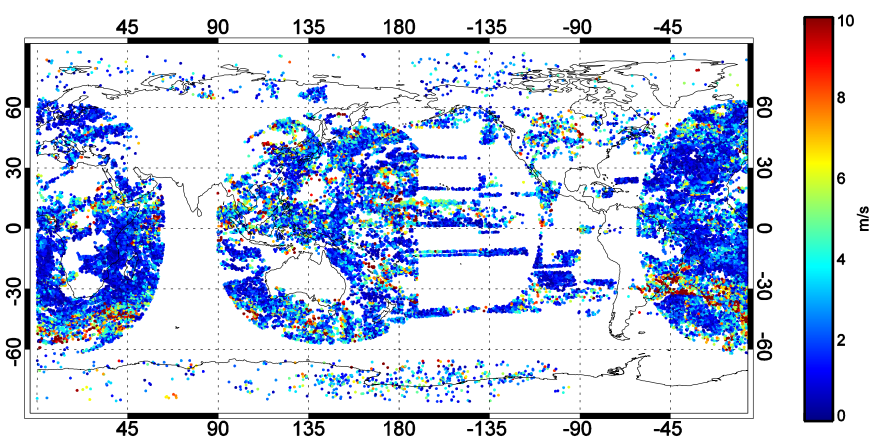
2011080112

H(P0)-H(P1)
P0: assigned height
P1: corrected height

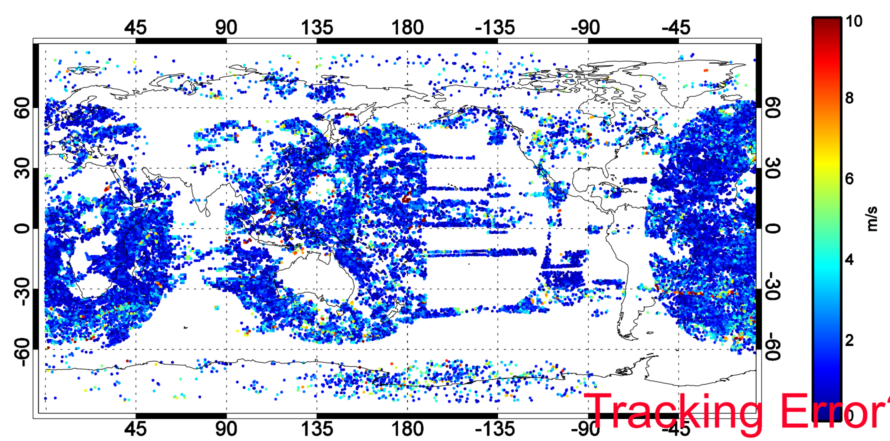
HC:Height Correction



Before HC:U_obs_Error



After HC: U_obs_Error

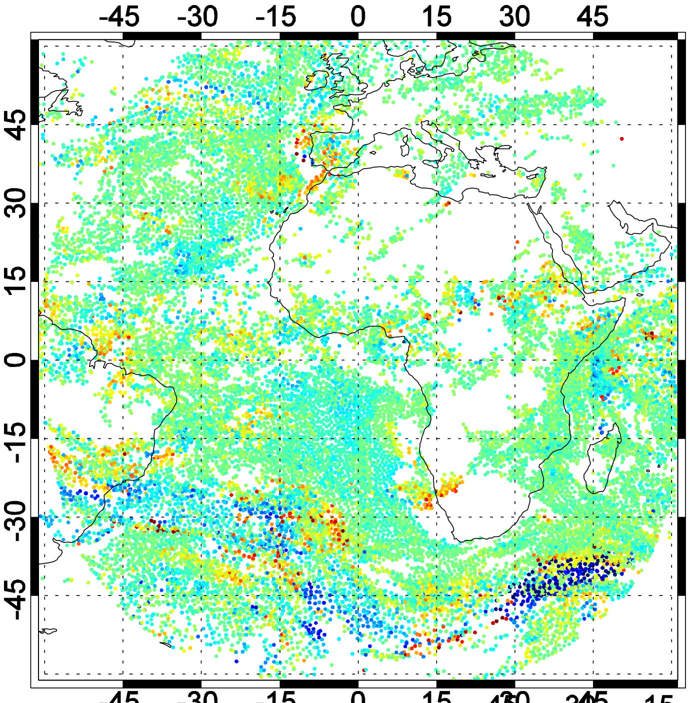


Tracking Error?

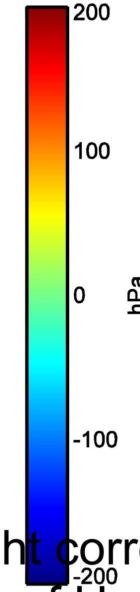
Height Correction 2009080112

- **With DA diagnosis:**

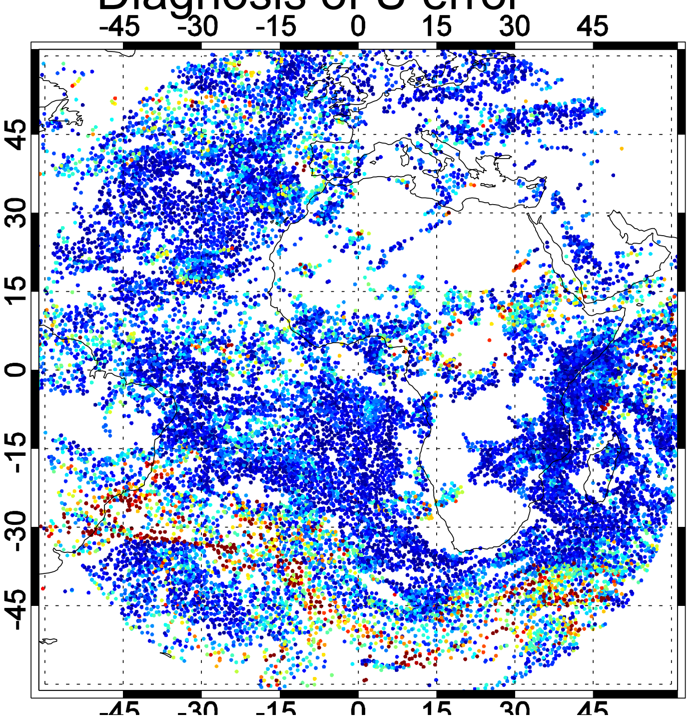
Larger Ue→ O-B, O-A

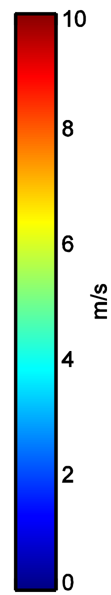


H(P0)-H(P1)

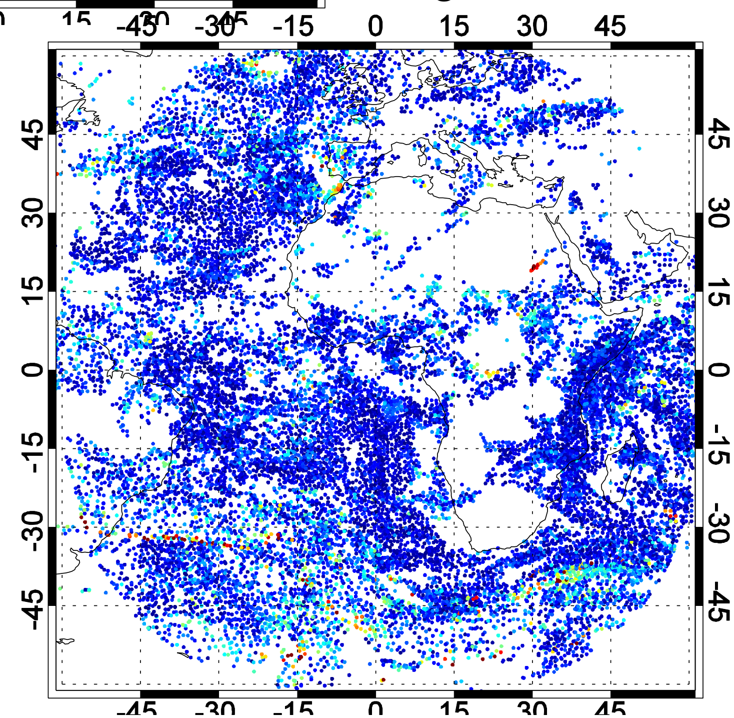


Before height correction
Diagnosis of U error





After height correction
Diagnosis of U error



AMVs obs. Error

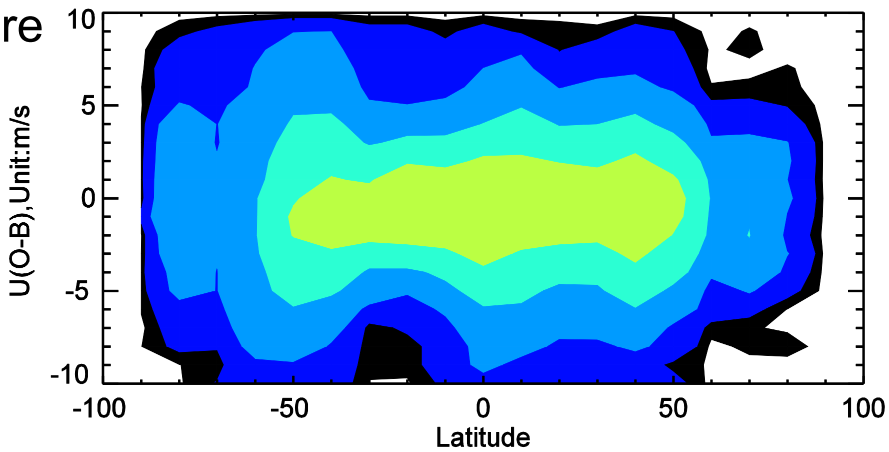
2011080112

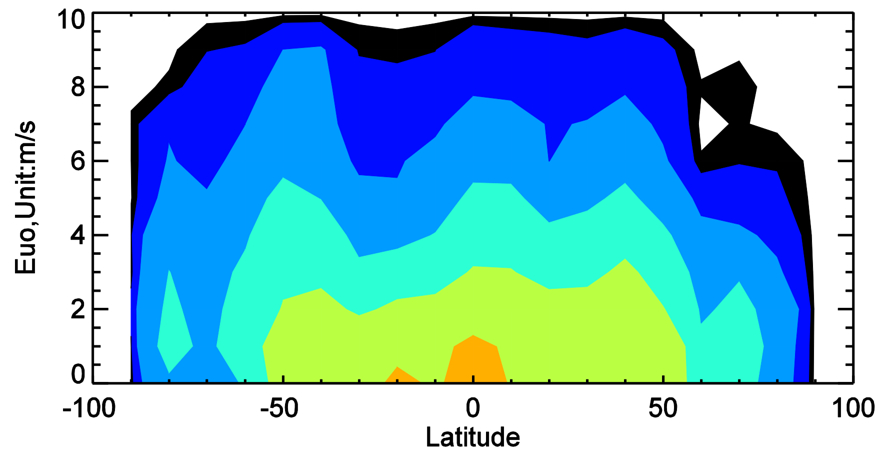
Reduction of Error in the Height Assignment?
By the best fit height?

O-B

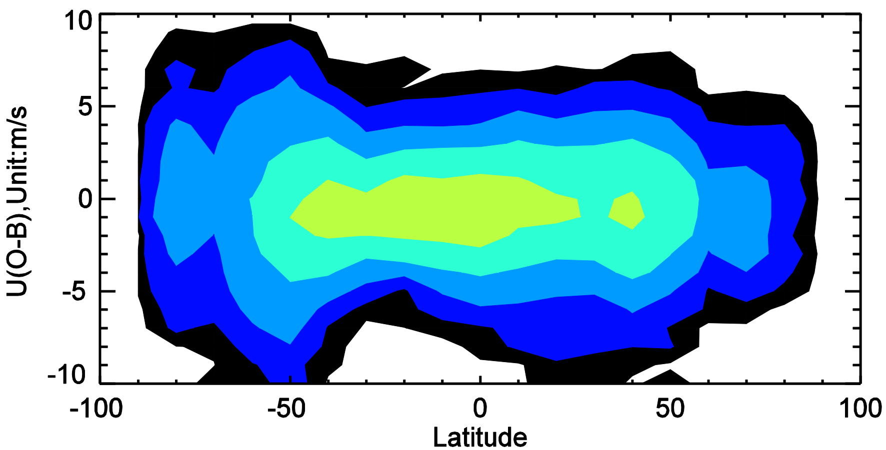
Obs. Error

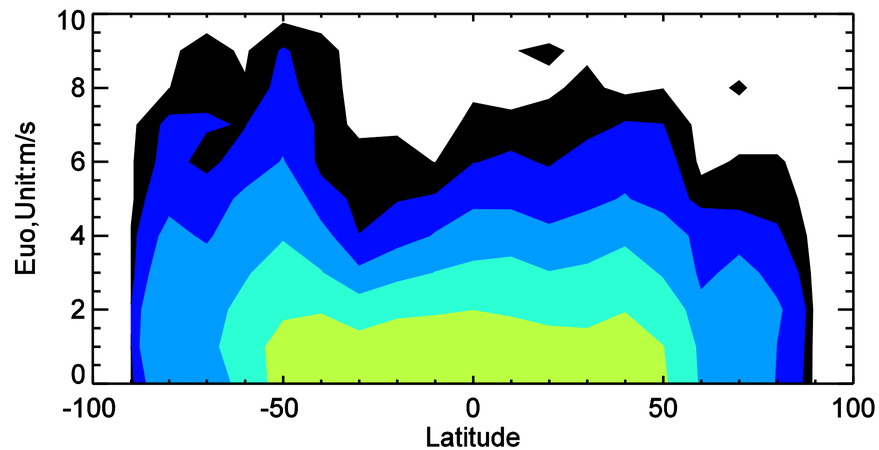
Before HC



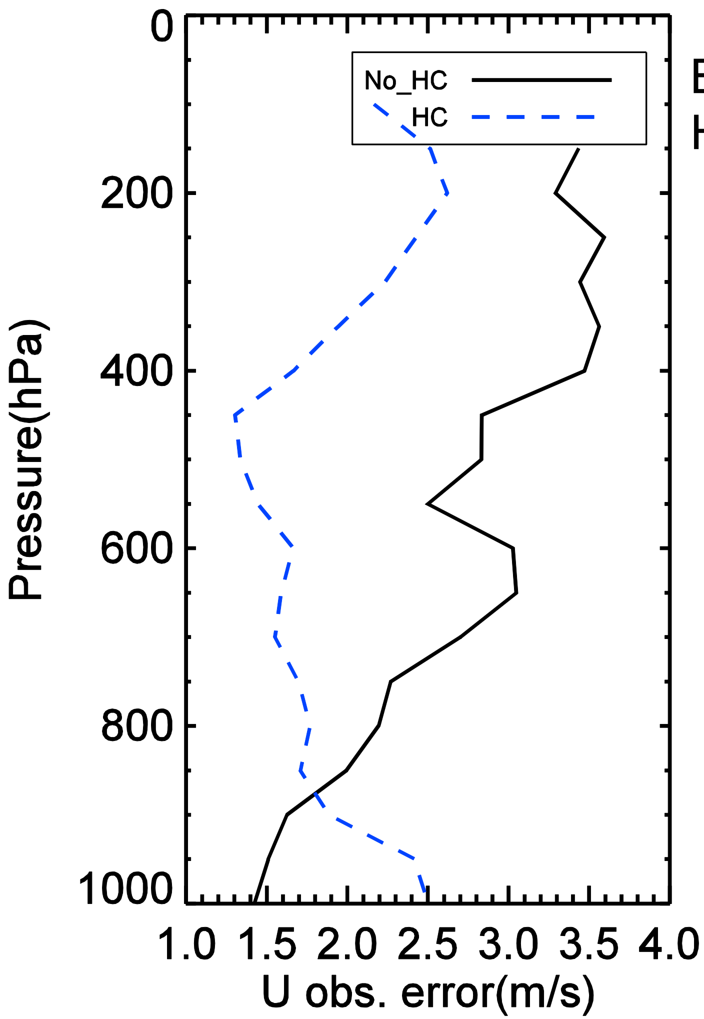


After HC

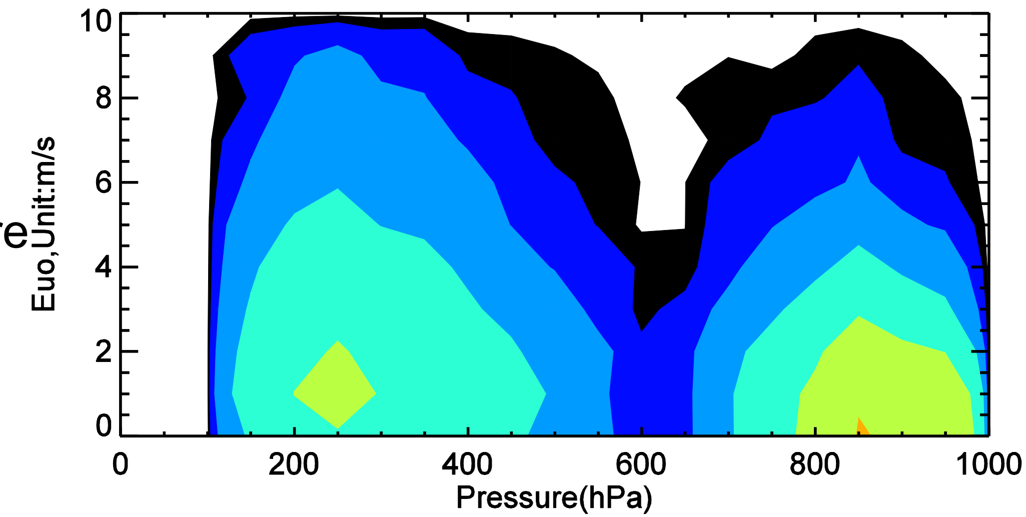




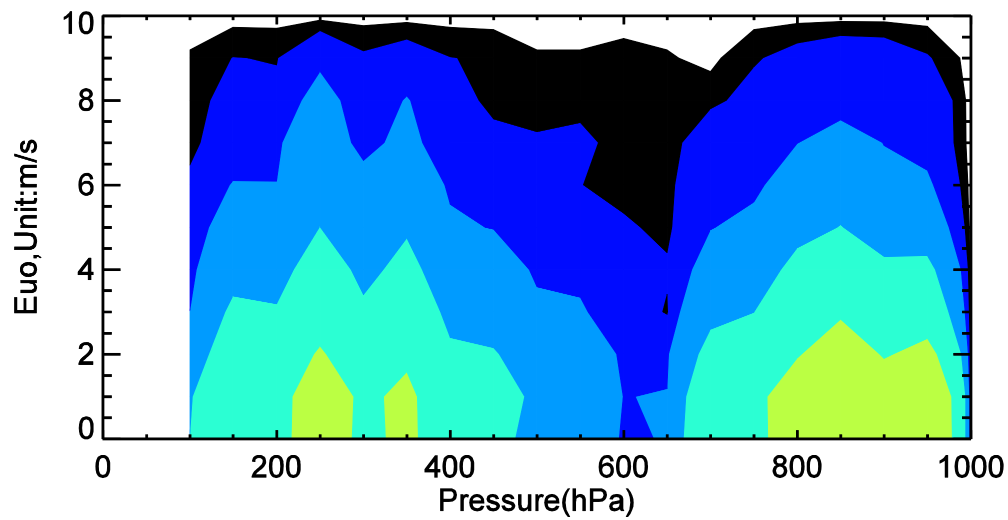
AMVs obs. error



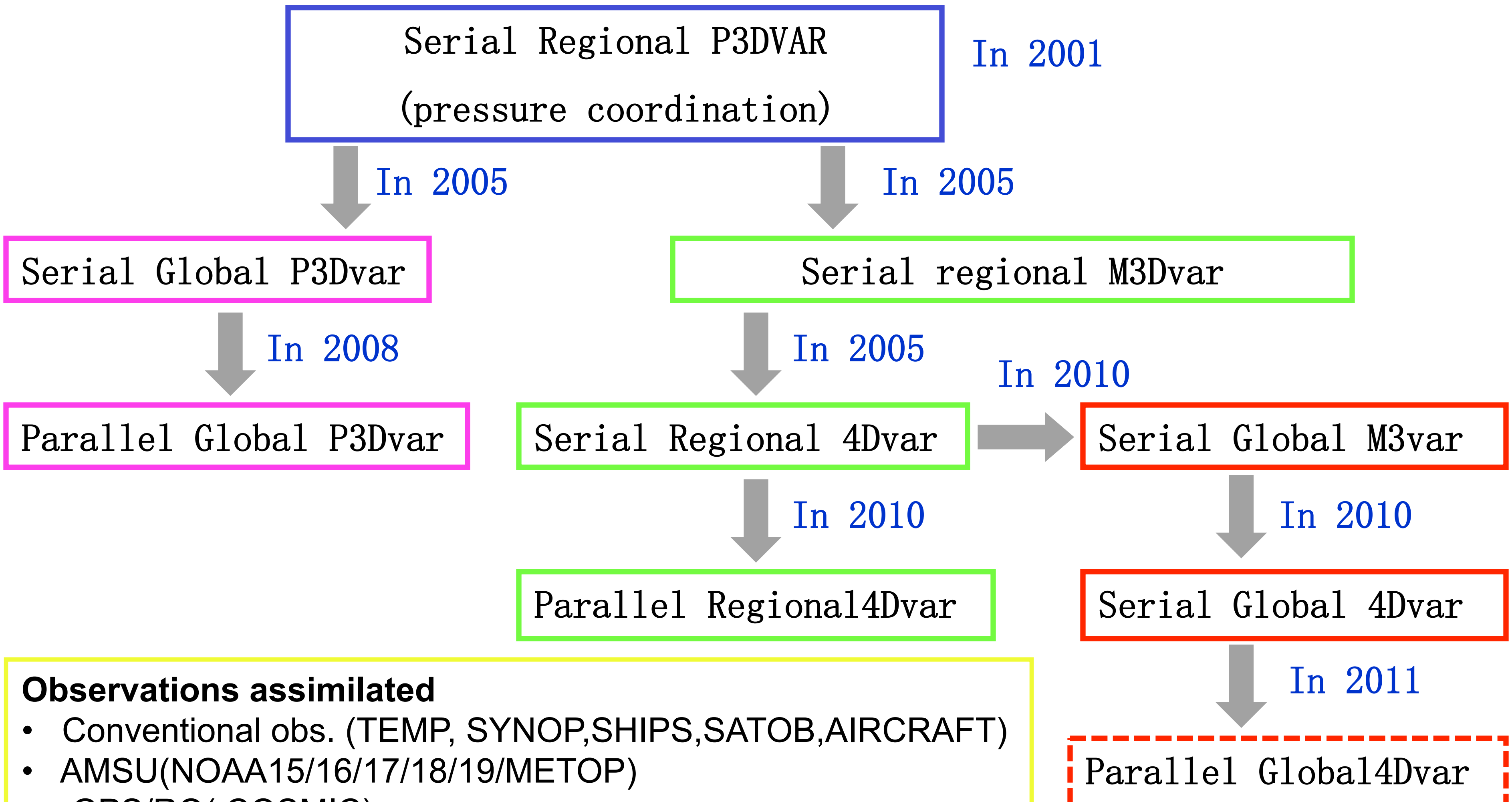
Before HC



After HC



Milestone of GRAPES-Var



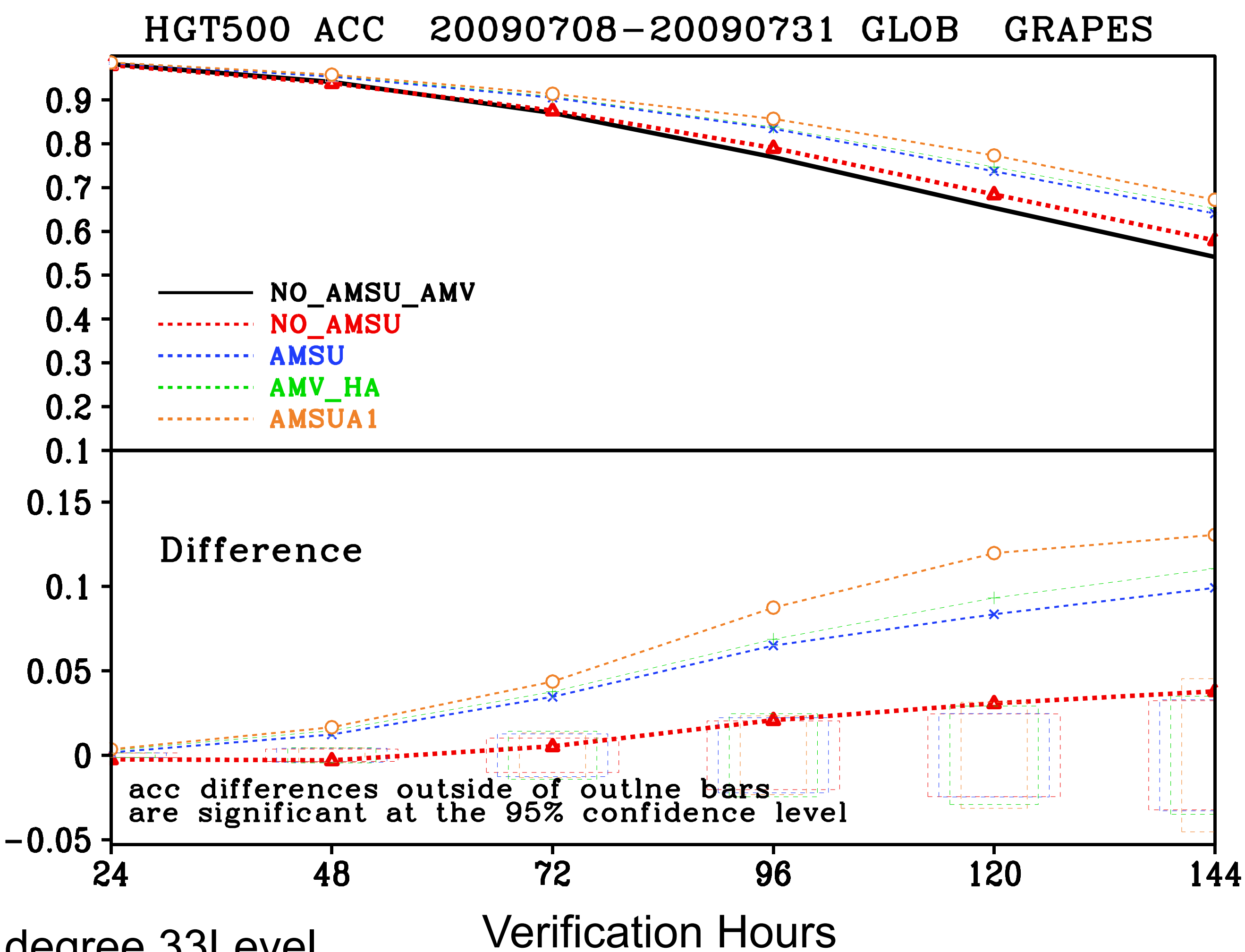
Observations assimilated

- Conventional obs. (TEMP, SYNOP,SHIPS,SATOB,AIRCRAFT)
- AMSU(NOAA15/16/17/18/19/METOP)
- GPS/RO(COSMIC)
- RADAR(wind and refractivity)
- GPS/PW
- TC Bogus

Impact of AMVs on Forecast in GRAPES

■Baseline+AMVs: positive
■Control+AMV_HA: positive

Baseline:Sonde+Airep+Synop+ships+COSMIC
Control: Baseline+AMVs+AMSUs

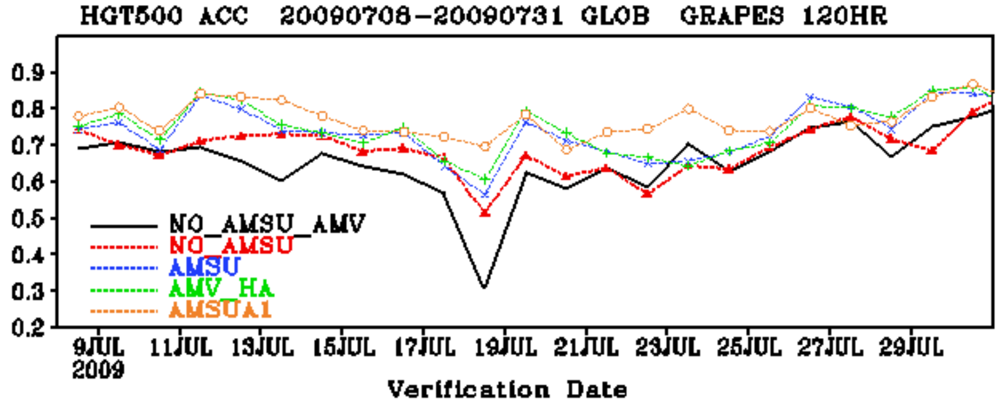


Resolution:1 degree,33Level

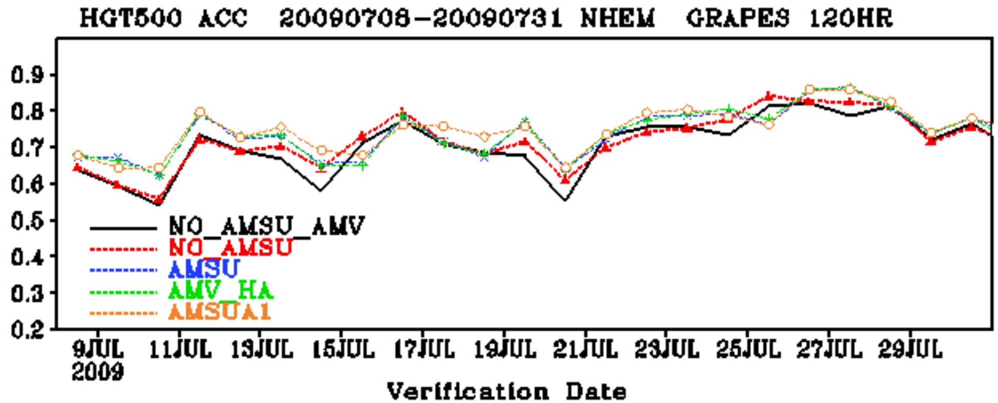
5 day ACC

- Baseline+AMVs: positive
- Control+AMV_HA: positive

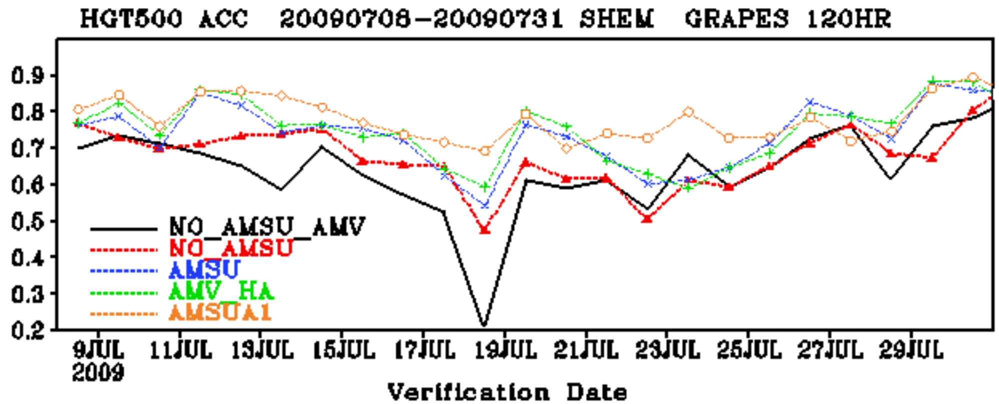
GLOBAL



N.H.

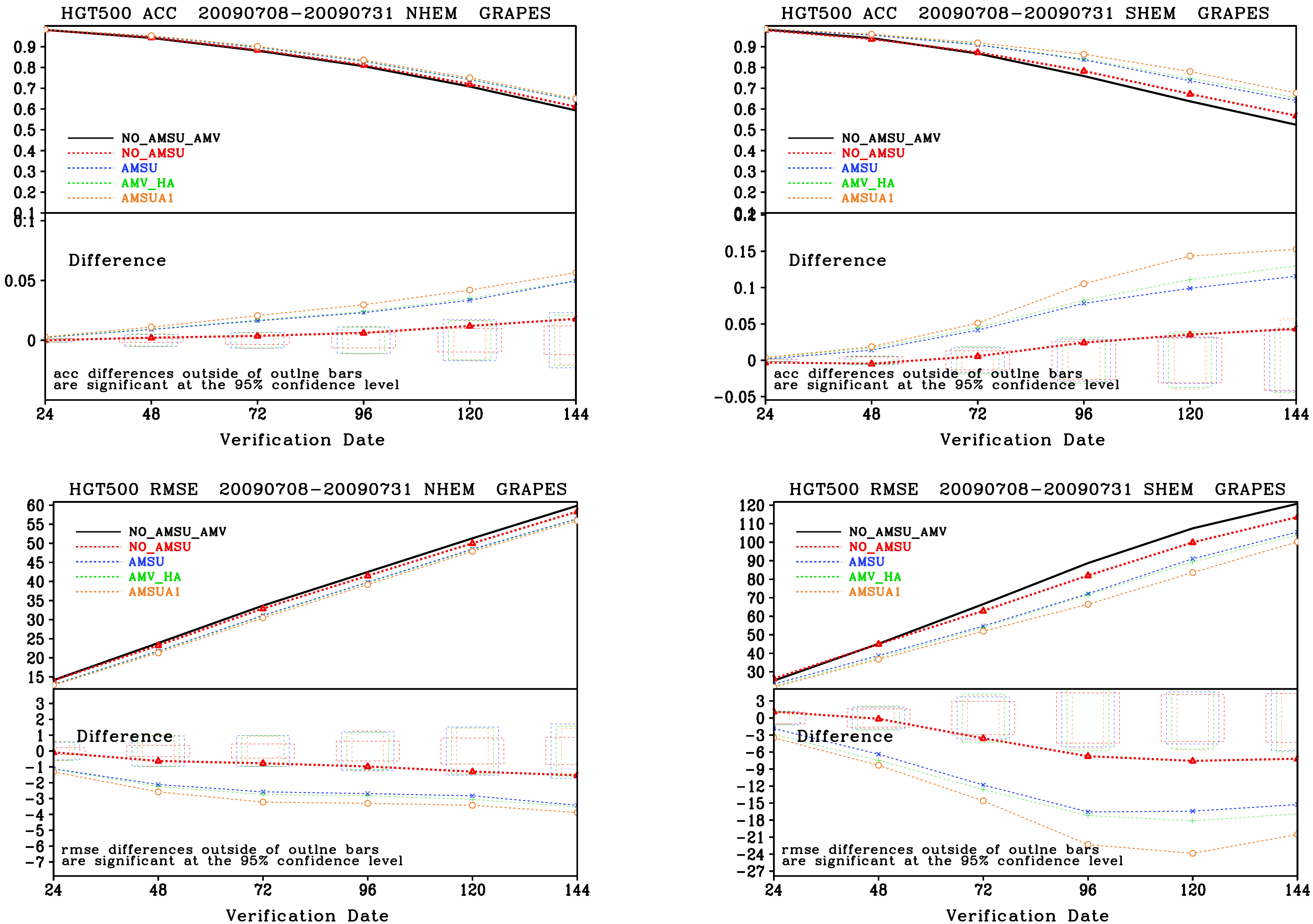


S.H.



Impacts of AMVs on Forecast

N.H. S.H.



Conclusions and Discussions

- **Comparisons of MISR and AMVs**
  - ♦ **CTH: more information about the FOV needed**
  - ♦ **Samples are limited**
- **Evaluate the quality of AMVs using data assimilation diagnosis**
  - ♦ **Reasonable results**
  - ♦ **Monitoring: find out the questionable AMVs**
- **The best fit height: height correction**
  - ♦ **Positive on forecast**
  - ♦ **Reduce the obs. error**
- ***Forecast sensitivity to observation, ongoing work***
  - ♦ ***Adjoint based monitoring of the quality of AMVs***