"No-cost" Proactive Quality Control (PQC) by the use of linearly approximated analysis

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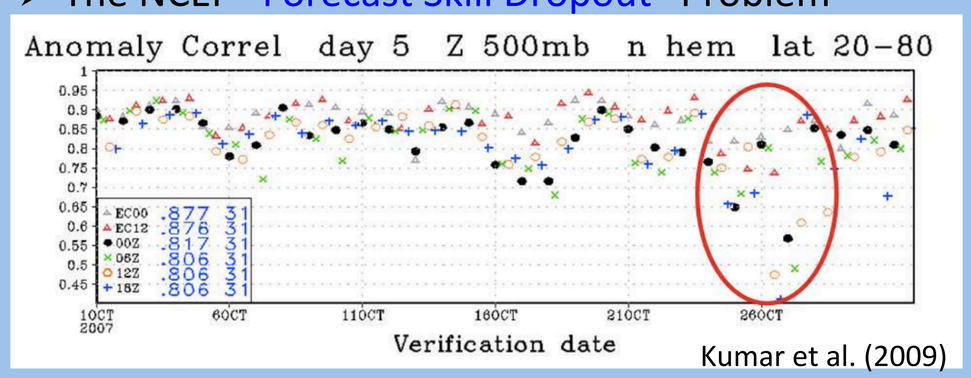
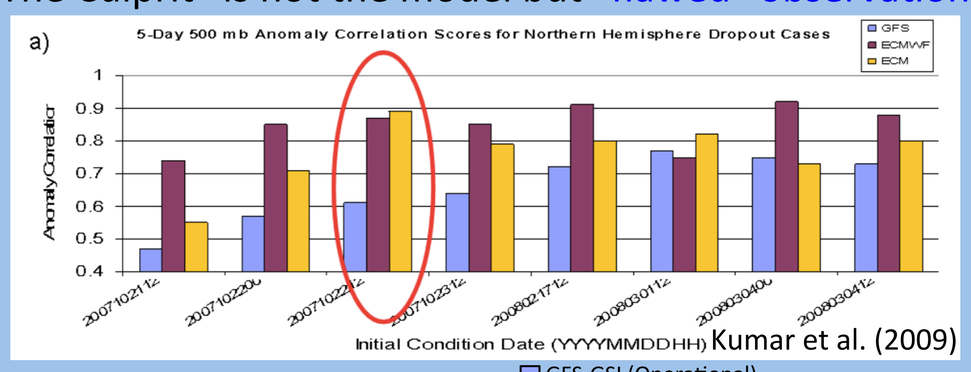
Motivation

➢ The NCEP "Forecast Skill Dropout" Problem



Kumar et al. (2009)

"The Culprit" is not the model but "flawed" observations

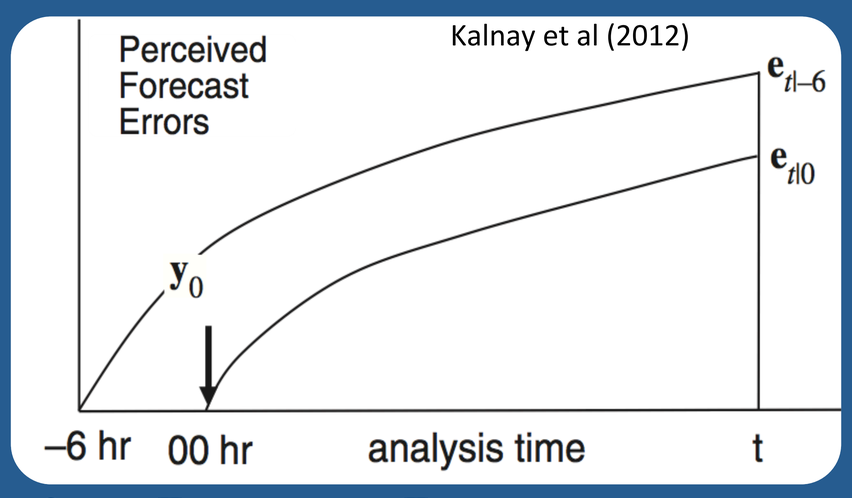


Kumar et al. (2009)

- GFS-GSI (Operational)
- ECMWF
- GFS-GSI which assimilates "Pseudo-Obs" generated from ECMWF analysis

EFSO Formulation

➢ Quantifies how much each observation Improved/degraded the forecast



Kalnay et al (2012)

$$\Delta e^2 = \mathbf{e}_{t|0}^T C \mathbf{e}_{t|0} - \mathbf{e}_{t|-6}^T C \mathbf{e}_{t|-6}$$
$$\approx \frac{1}{K-1} \delta \mathbf{y}_0^T \mathbf{R}^{-1} \mathbf{Y}_0^a \mathbf{X}_{t|0}^{fT} C (\mathbf{e}_{t|0} + \mathbf{e}_{t|-6})$$

Proactive QC Experiments

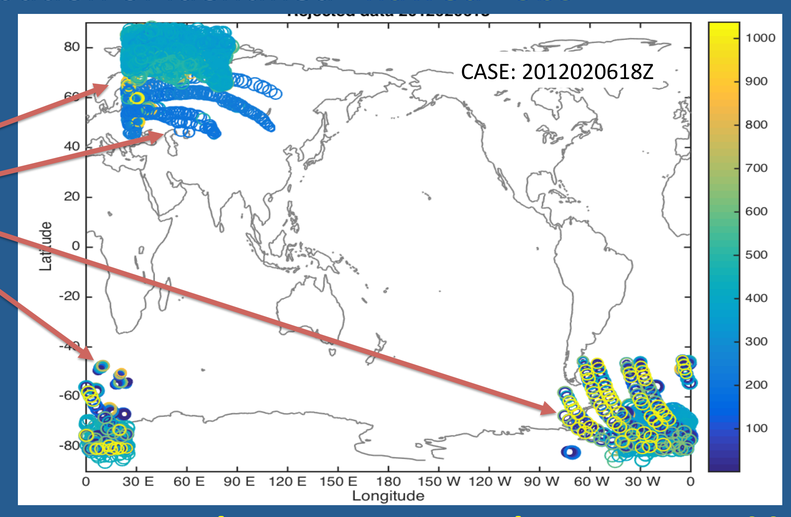
- Forecast Model: NCEP GFS model
- Resolution: T254L64 (deterministic)
  T126L64 (ensemble)
- DA system: hybrid GSI (LETKF)
- Observations: NCEP operational system

1. Run regular DA cycle from -06h to 00h.
2. Run regular DA cycle from 00h to 06h.
3. Detect "regional dropouts" using step 1., 2.
4. Perform 6-hour EFSO to identify "flawed" obs.
5. If "flawed" obs. are identified, repeat 00h analysis without using the detected "flawed" obs.

Results

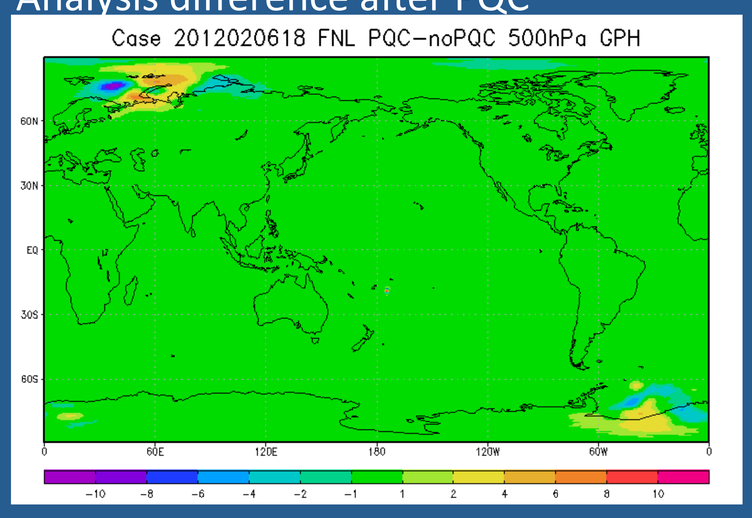
➢ Spatial distribution of identified "flawed" obs

MODIS_WIND
Aircraft
Ozone
GPSRO



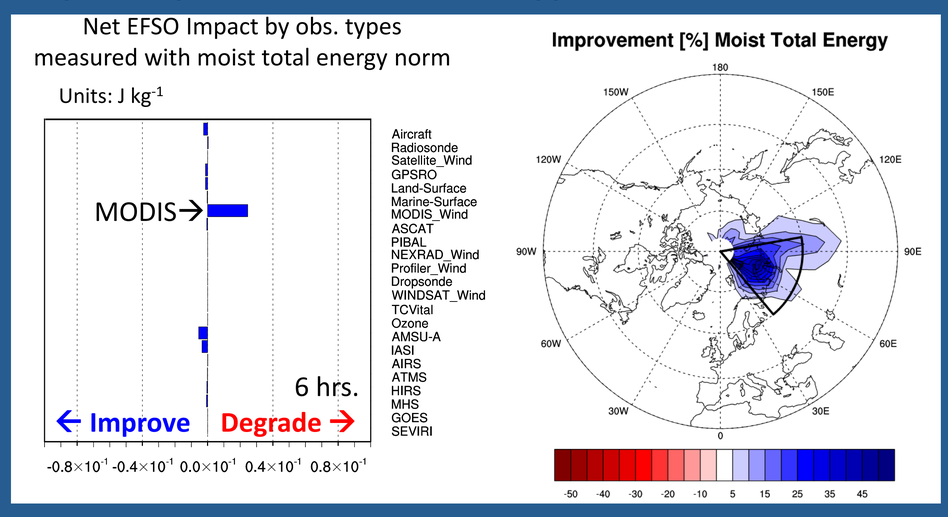
We could improve observation by EFSO !!

➢ Analysis difference after PQC



500 hPa Geopotential Height NonPQC-PQC

➢ Impact by each observation type

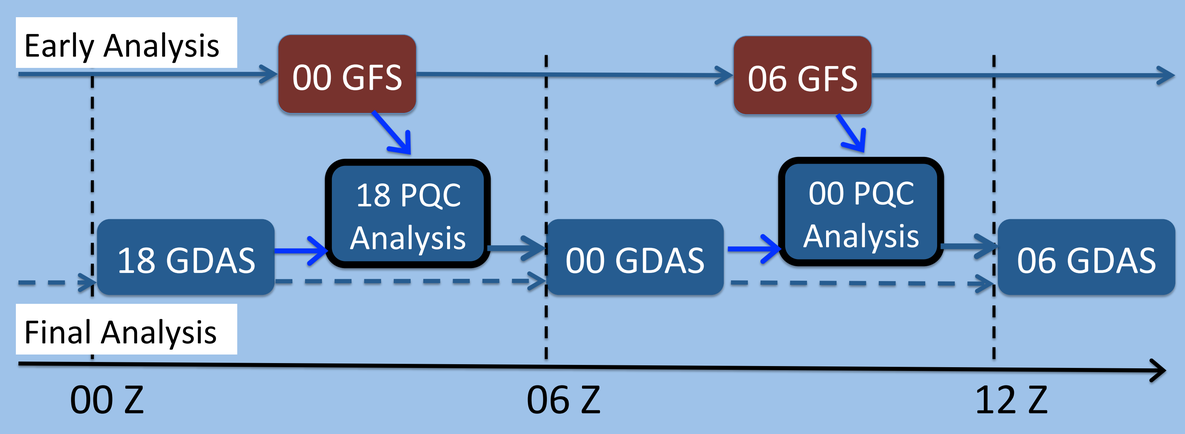


We could improve forecast by PQC !!

Linear Approximation

➢ To make it affordable in operational implementation

$$\mathbf{K} \approx \frac{1}{K-1} \mathbf{X}_0^a \mathbf{X}_0^{aT} \mathbf{H}^T \mathbf{R}^{-1} \qquad \bar{\mathbf{x}}_0^{a,\mathrm{deny}} - \bar{\mathbf{x}}_0^a \approx -\mathbf{K} \delta \bar{\mathbf{y}}_0^{ob,\mathrm{deny}}$$
$$\approx \frac{1}{K-1} \mathbf{X}_0^a \mathbf{Y}_0^{aT} \mathbf{R}^{-1} \qquad \approx -\frac{1}{K-1} \mathbf{X}_0^a \mathbf{Y}_0^{aT} \mathbf{R}^{-1} \delta \bar{\mathbf{y}}_0^{ob,\mathrm{deny}}$$



Approximate the analysis after PQC
No need to repeat analysis!!