



Impacts of flow-dependent background-error covariances in the NCEP Global Forecast System

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*(with help from Tom Hamill, Gil Compo,
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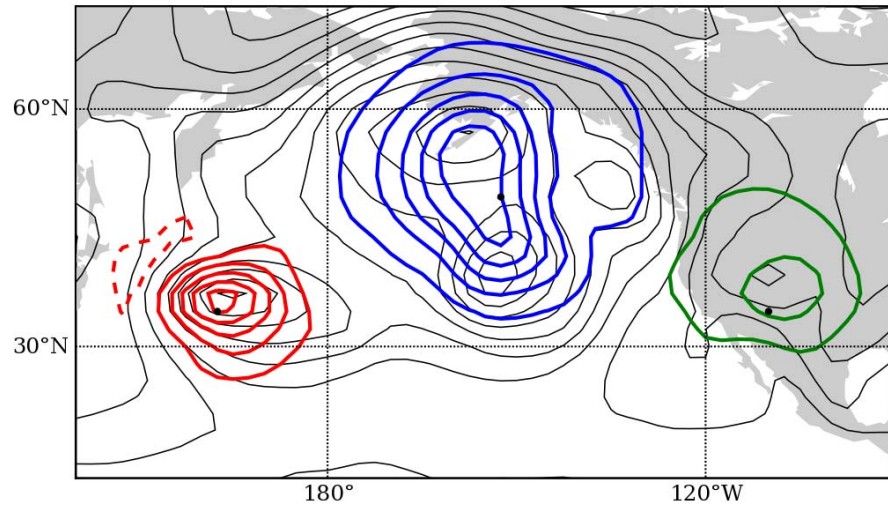
- How much impact is there?
- What might be limiting the impact?

Pros/Cons of Ensemble DA

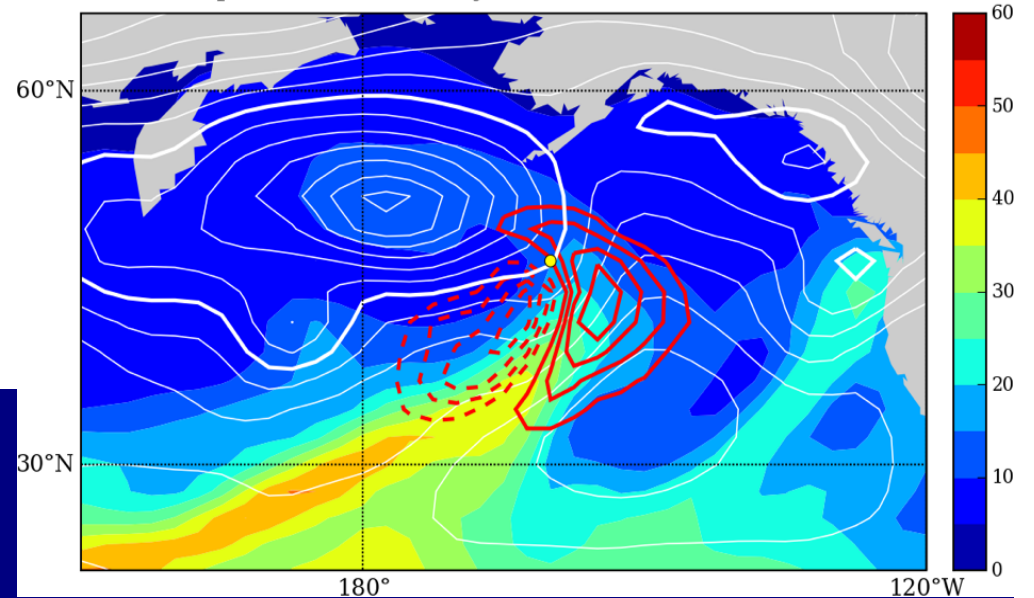
- + Flow-dependent background-errors
- + Automatic initialization of ensembles.
- + No adjoint needed, no need to specify **B**.
- Sampling error (cov localization).
- Must run ensemble.
- Interactive covariances - specification errors can feedback.

Examples of Flow-Dependent Analysis Increments

Analysis Increments for 3 Different Surface Pressure Obs



Precipitable Water Analysis Increment 2004013000



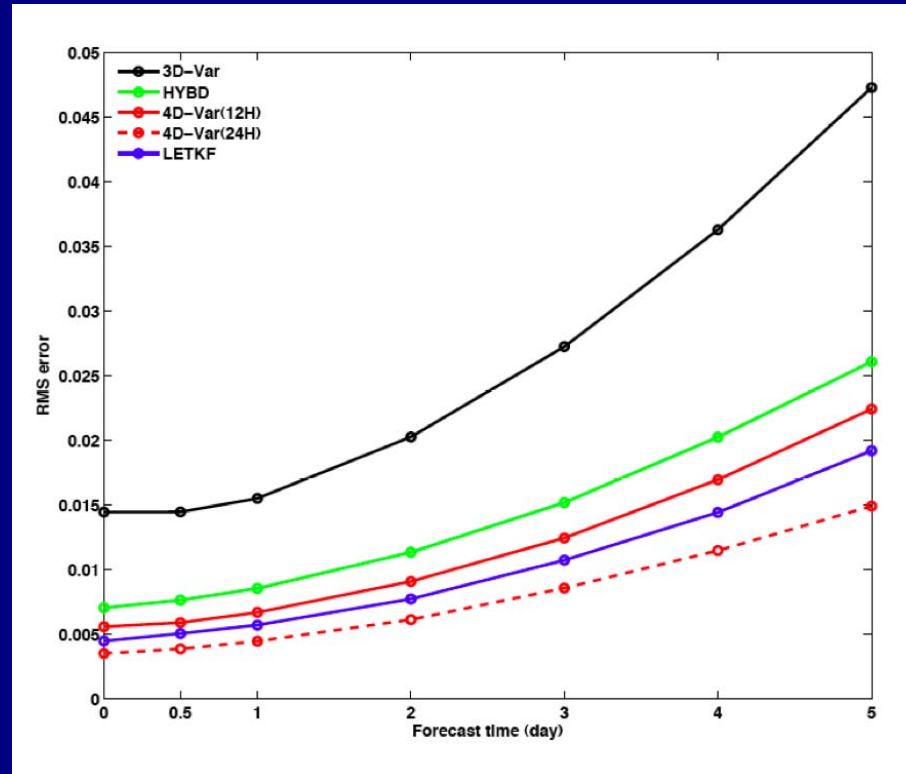
Ensemble DA with NCEP GFS

- Developed via collaborative THORPEX project.
- Uses existing 3D-Var for forward operator, LETKF (Hunt et al, *Physica D*, June 2007, 112-126) to compute increment.
- Outperforms existing 3D-Var when only p_s observations assimilated (Whitaker et al, *MWR*, 2004, p. 1190) and when all non-radiance obs assimilated (Whitaker et al, 2007, *MWR*, accepted, <http://tinyurl.com/293vnu>).

EnKF/Var comparisons in a perfect (QG) model

Shu-Chih Yang et al., submitted to MWR

<http://tinyurl.com/3dpzqd>

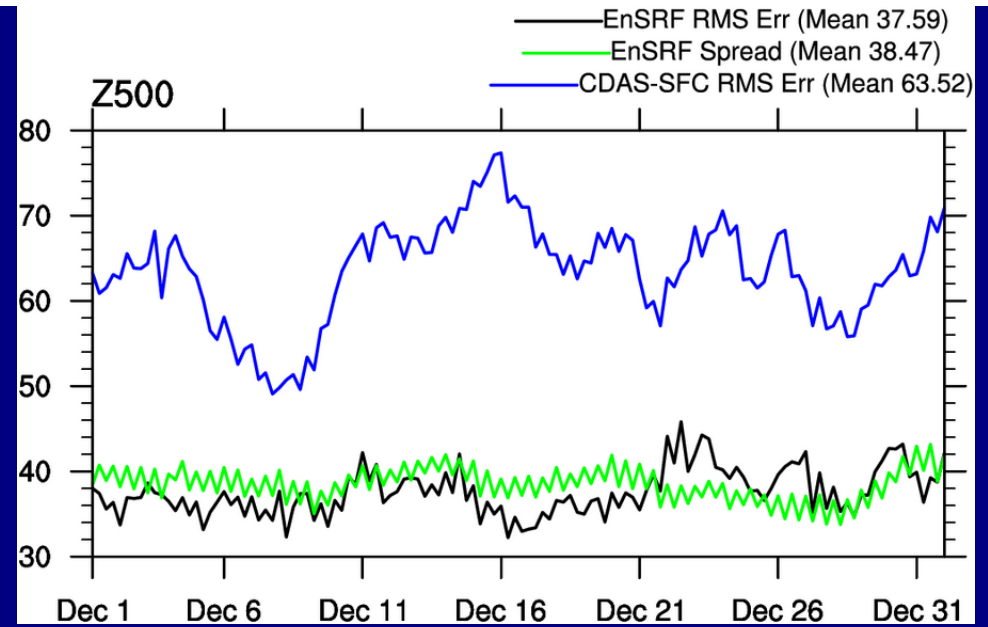


	3D-Var	HYBD	4D-Var		LETKF			
			12hr	24 hr	l=3	l=5	l=7	l=9
RMS error	1.44	0.70	0.56	0.35	0.67	0.48	0.44	0.44

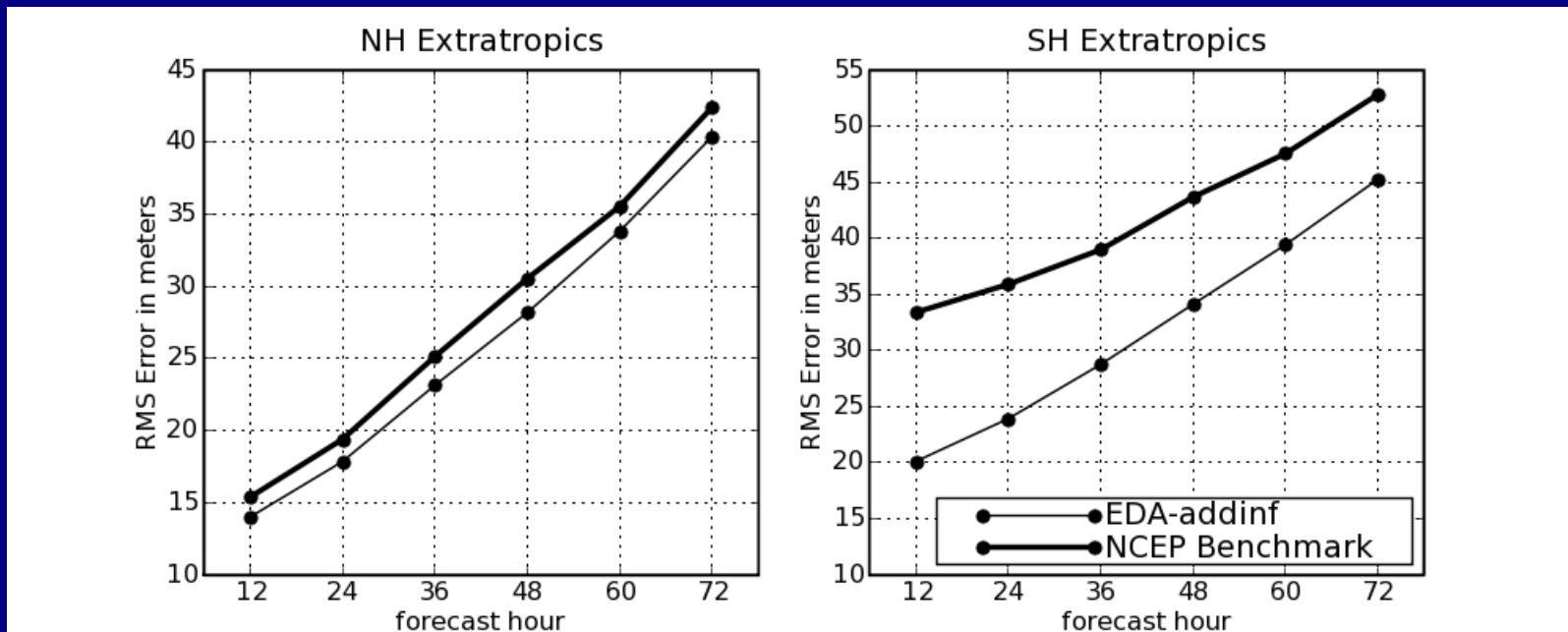
EnsDA/3D-Var comparisons - real obs

modern network
(without
radiances)

p_s only
(1915)



From *Whitaker et al, MWR, 2004, p. 1190*



From *Whitaker et al, 2007 (accepted) - <http://tinyurl.com/293vnu>*

Questions

- *What is limiting impact of flow-dependent covariances?*
 - *Observational density? Model error?*

Experiments

- T62L28, 54-member LETKF with NCEP GFS.
- Vary observing network (everything, or only surface pressure).
- Limit impact of model error by using “perfect” model (ensemble mean first guess from all-obs assimilation == ‘truth’).
- Static vs. flow-dependent ensemble.

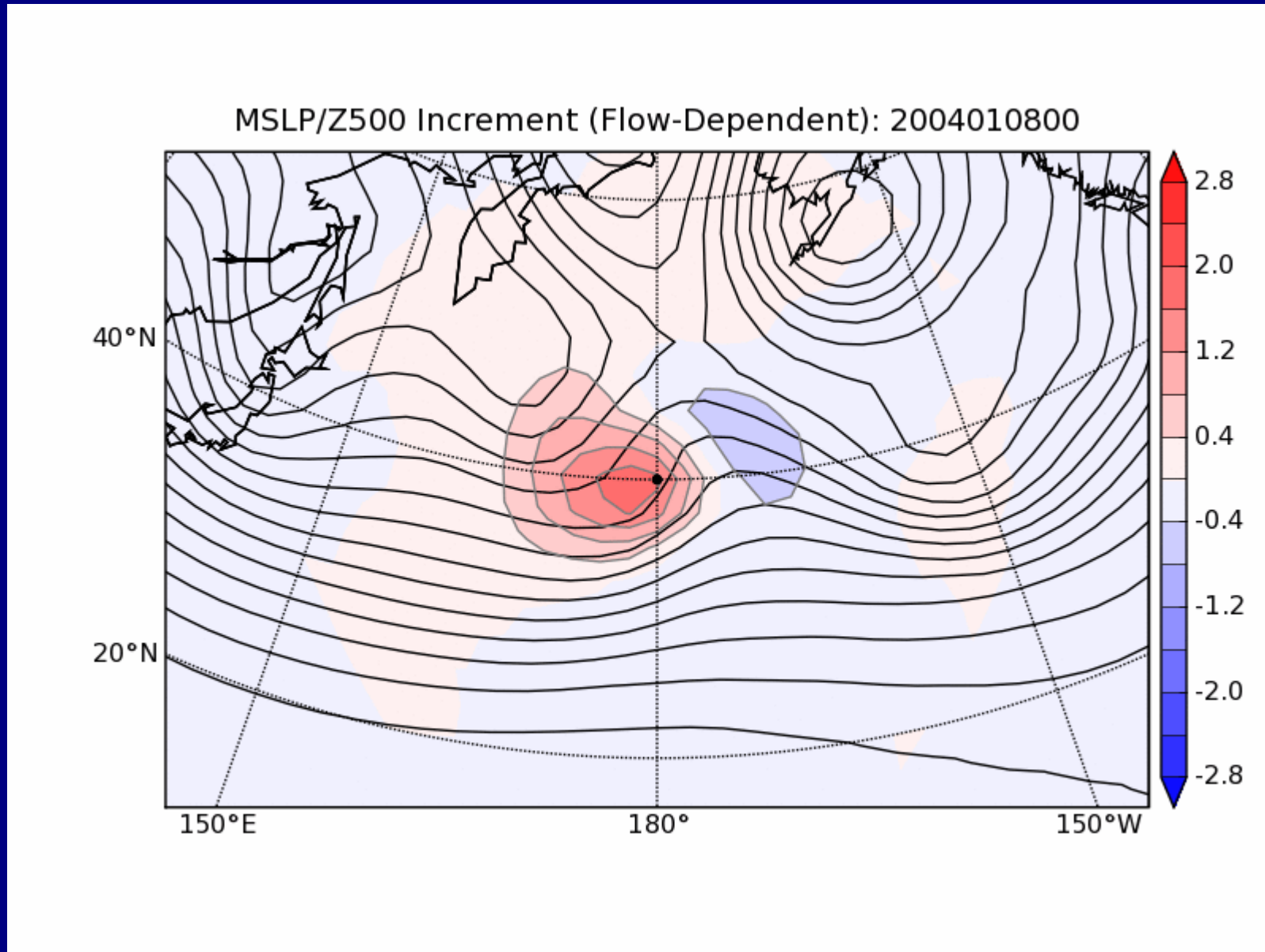
Experiments (more details)

- ‘ob-error localization’ - limits impact of obs. with distance from state variable.
- Obs for Jan and Feb 2004 (full set, and surface-pressure only subset).
- Vertical level of radiance == maximum of weighting function.
- Model error parameterized with additive inflation (random samples from NCEP/NCAR reanalysis tendencies).

Experiments (yet more details)

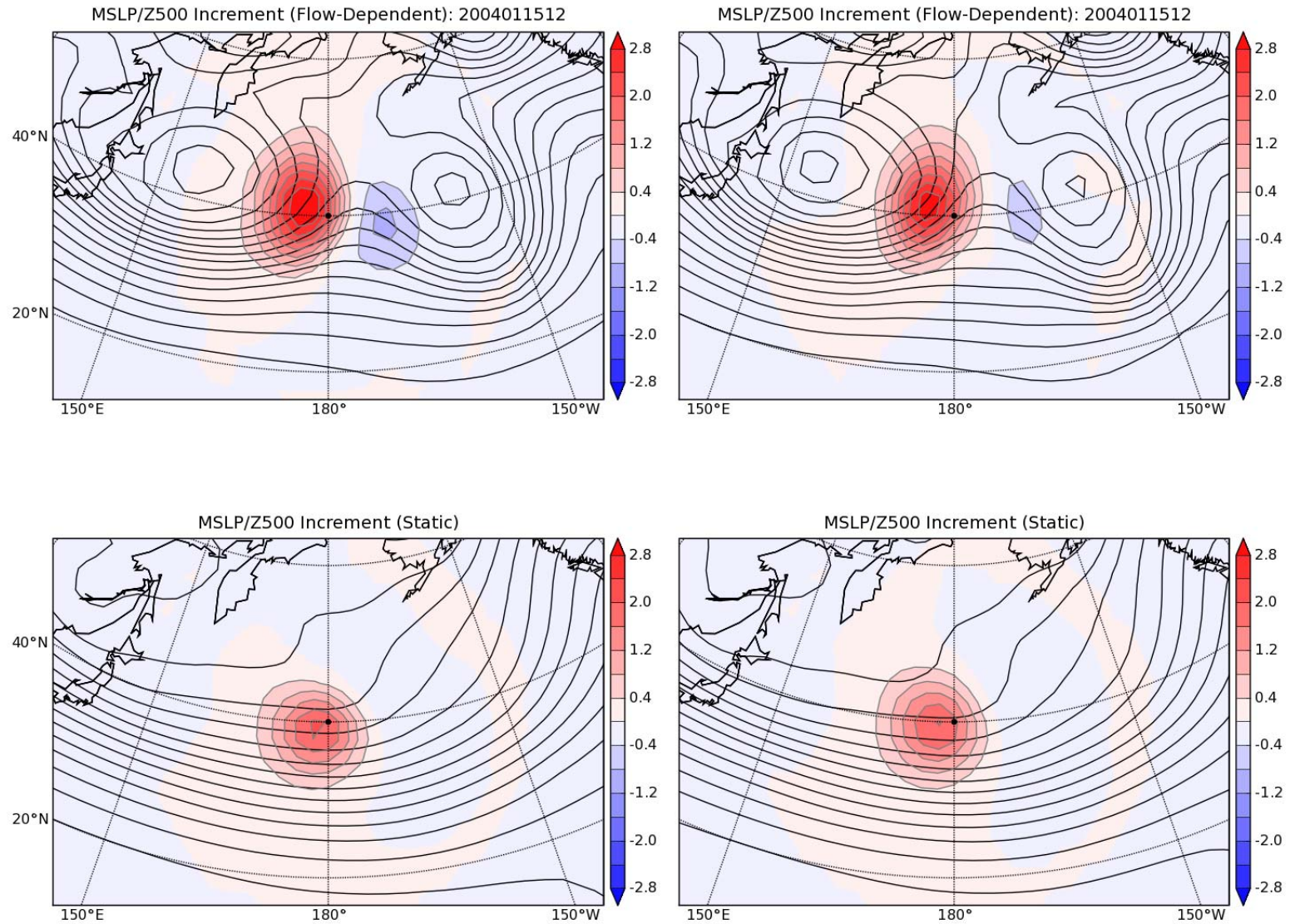
1. **'Flow-dependent' B** - full LETKF as described.
2. **'Flow-independent' B** - ensemble perturbations constructed from a random sample from one month run of (1). Prior from full ensemble mean, or single run from ensemble mean analysis.
3. **'Perfect model' B** - substitute $N(Hx^b, R)$ from (1) for real observations.

Flow-Dependence of Analysis Increments - p_s obs only

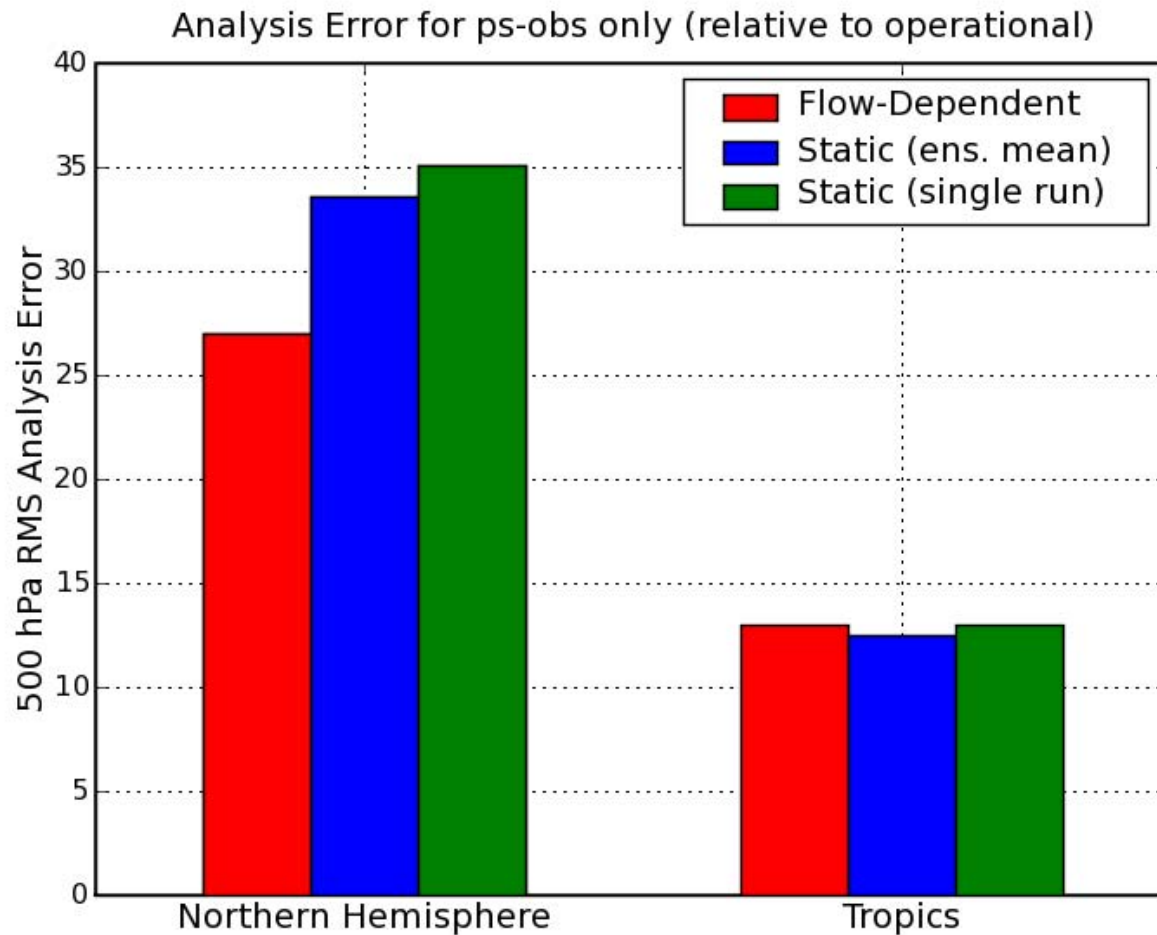


Only p_s obs

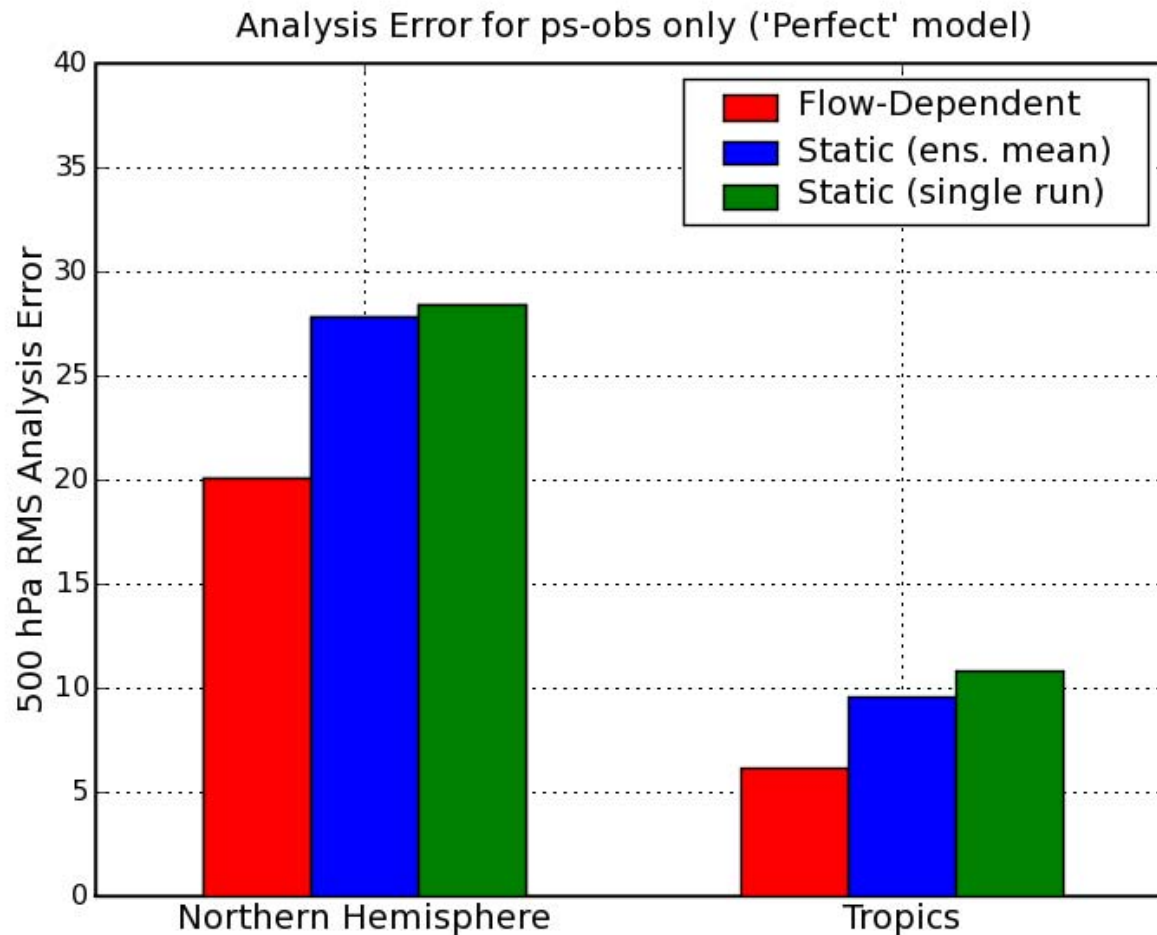
All obs



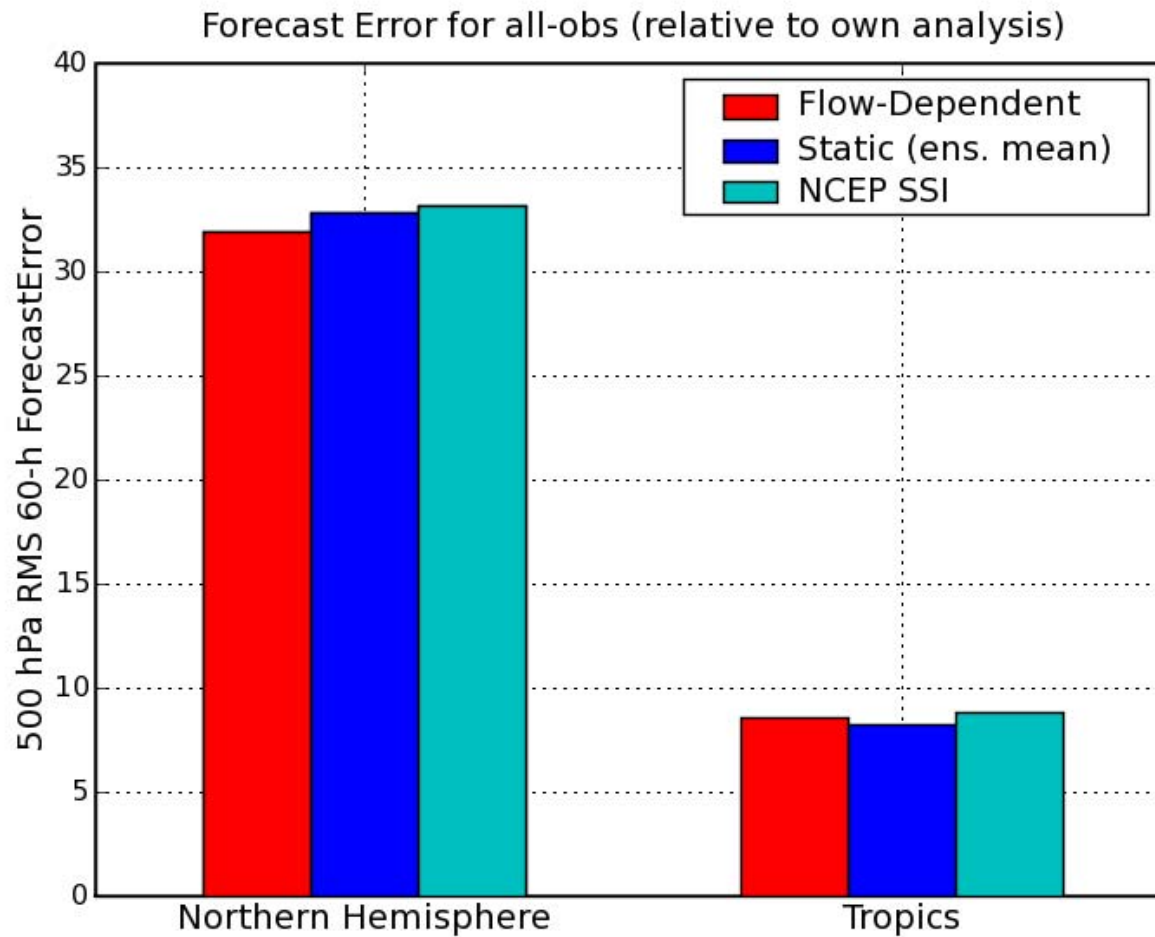
Effect of Flow-Dependent Covariances (p_s -only)



Effect of Flow-Dependent Covariances (p_s -only - “Perfect” model)



Effect of Flow-Dependent Covariances (all obs)



Conclusions

- In EDA systems, impact of flow-dependent **B** depends on how well observed the phenomena of interest is.
- Impact is limited by model error (especially in tropics). Situation should improve as models are improved and/or better representations of model error are developed.