Evaluating the tradeoff between ensemble size and ensemble resolution in an Ensemble-Var DA system

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Motivation

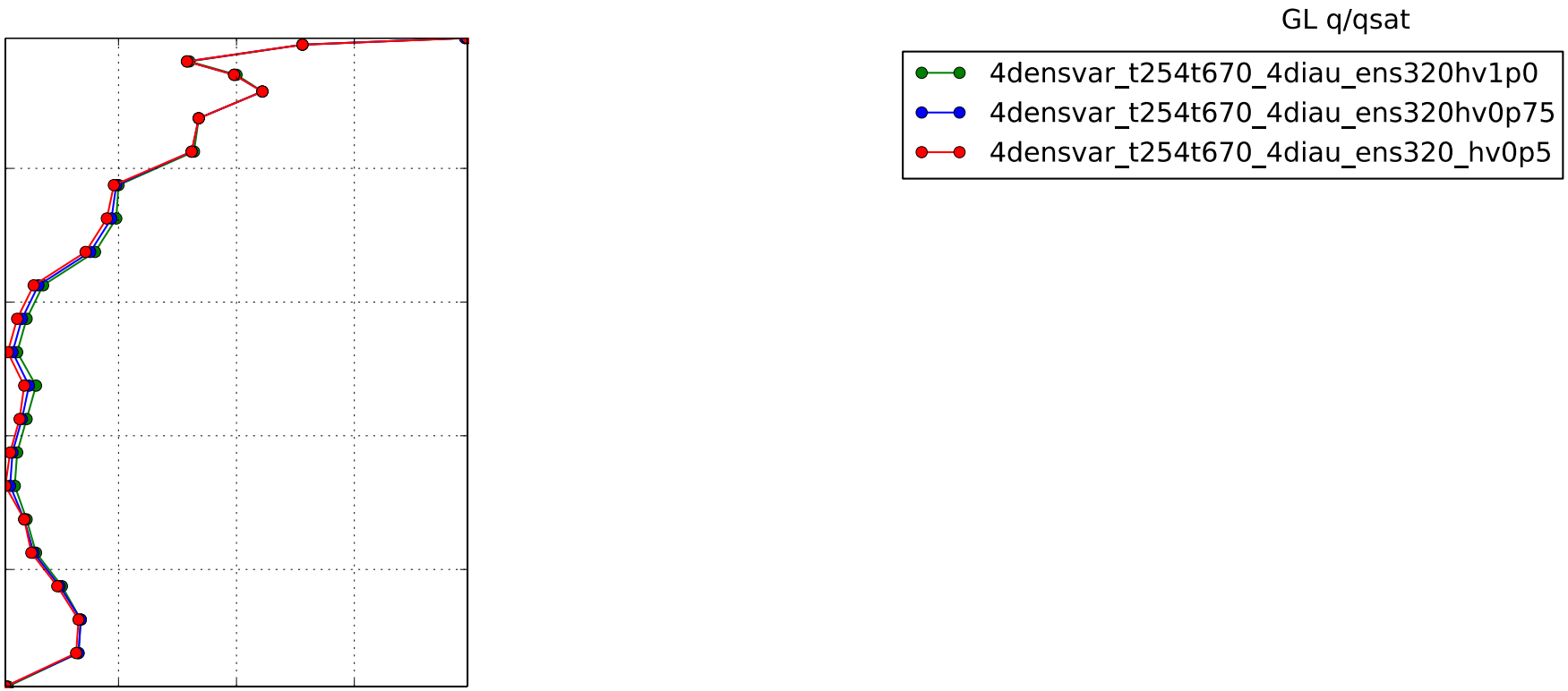
- Current NCEP operational system uses 80 member T574 ensemble, T1534 control.
- Given an increase in computer resources, and assuming the control resolution is not going to change, is it better to
  - keep the ensemble size the same, and increase the ensemble resolution, or
  - increase the ensemble size and keep the ensemble resolution the same?

Experimental design

- Control experiment (T254/T670): 80 member T254 ensemble and T670 control (cannot afford to experiment with full operational resolution).
- Two sets of new experiment that cost approximately 4 times more than the control experiment:
  - ***T254T670Ens320***: dual resolution T254/T670 with 320 ensemble members.
  - ***T670T670***: single resolution T670 with 80 ensemble members.
- For all experiments:
  - 4DIAU is used for both the control and the ensembles (no digital filter, TLNM balance constraint enabled);
  - Results of tuning the data assimilation parameters are based on 5-day expts from which the last 4 days are used for verification, and the other results are based on 24-day expts from which the last 20 days are used for verification.

Tuning localization, and weight of static B for T254T670Ens320

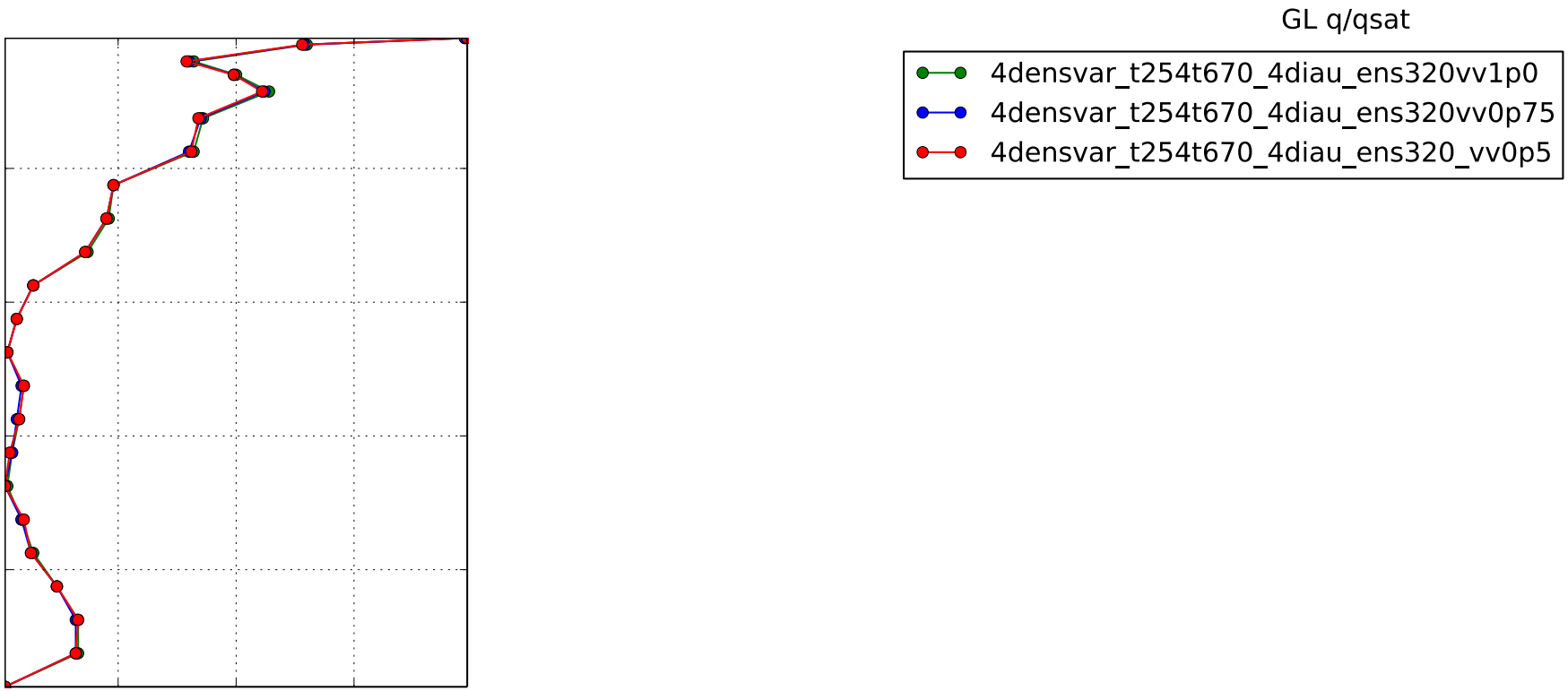
Effect of varying horizontal localization



With 320 ensemble members, there is little sensitivity to changes in the horizontal localization scale.

Tuning localization, and weight of static B for T254T670Ens320

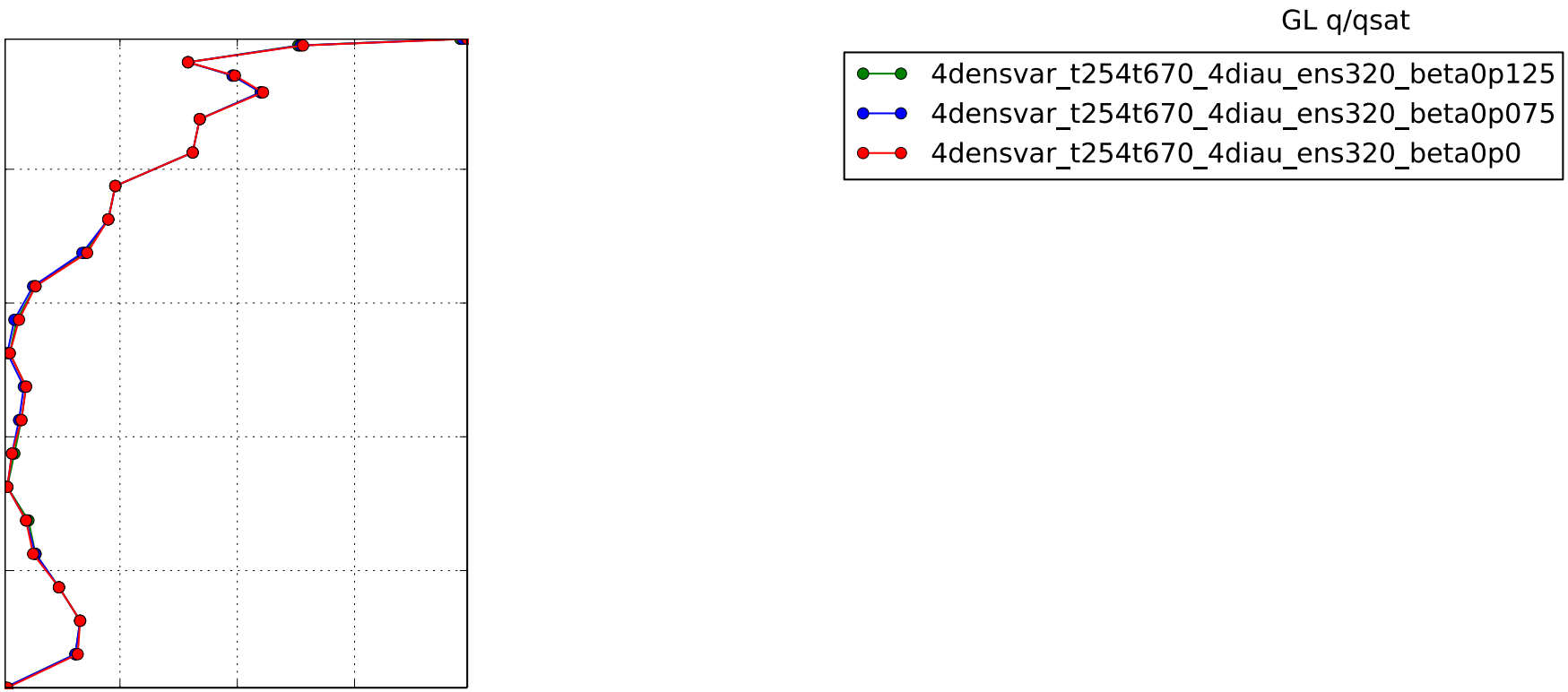
Effect of varying vertical localization



With 320 members, there is no sensitivity to changes in the vertical localization scale.

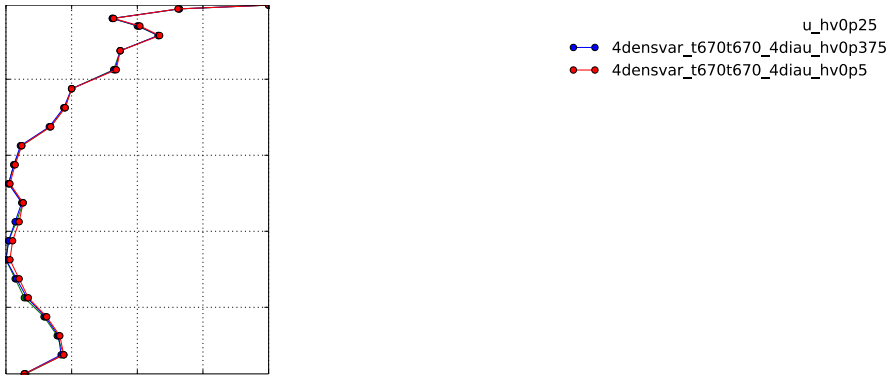
Tuning localization, and weight of static B for T254T670Ens320

Effect of static **B** *weighting*

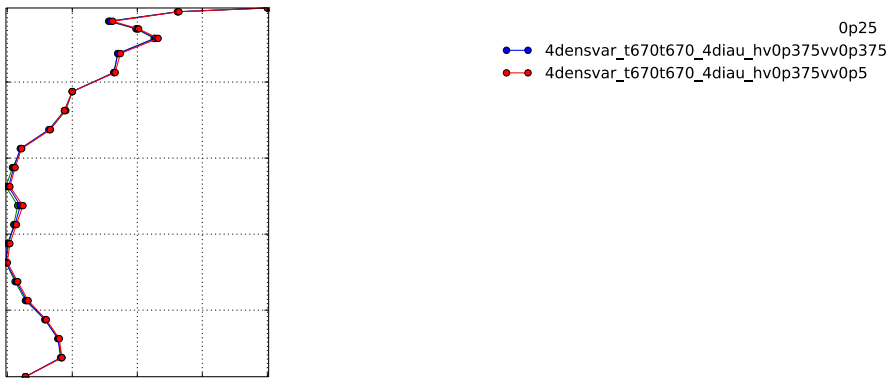


With 320 ensemble members, turning off the static **B** *has no impact.*

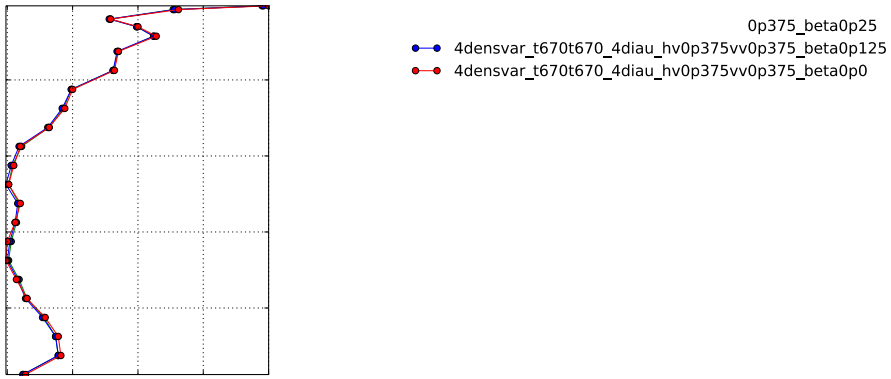
Tuning localization, and weight of static B for T670T670



When ens resolution increases, slightly decreasing the horizontal localization results slightly smaller error. Thus 75% of current horizontal localization is chosen.

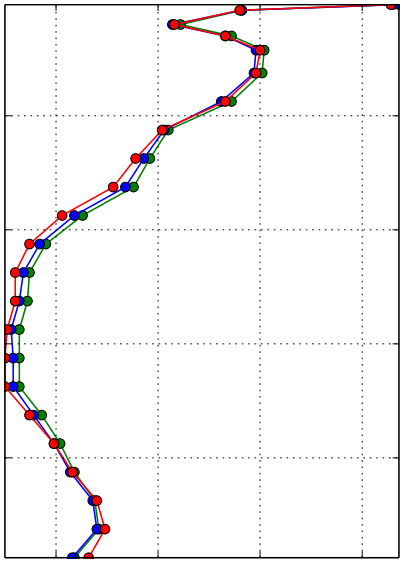


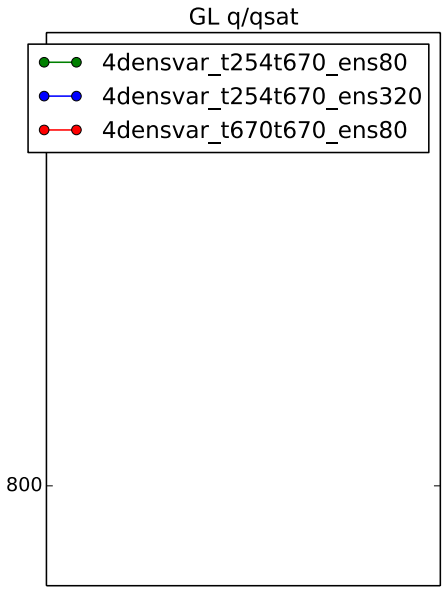
There is very little sensitivity to the vertical localization scale. To be consistent with horizontal localization, 75% of current vertical localization is chosen.



There is very little sensitivity to the static **B** weighting (much less than the dual resolution T254T670 80 member configuration). The weighting is left the same as in the control configuration (0.125)

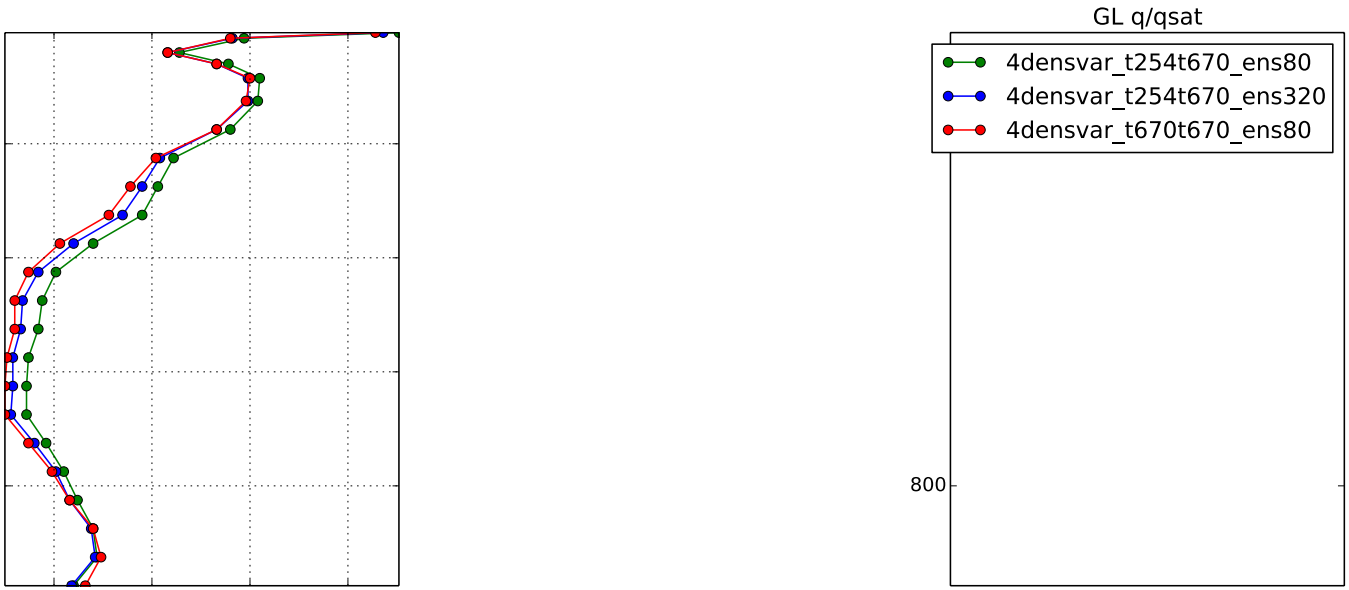
Increasing model resolution is better than increasing ensemble size





Exp. Name	Horiz. localization	Vert. localization	Weight of static B
T254T670	Operational localization table	-0.5	0.125
T254T670Ens320	Operational localization table	-0.5	0.0
T670T670	75% of the operational localization table	-0.375	0.125

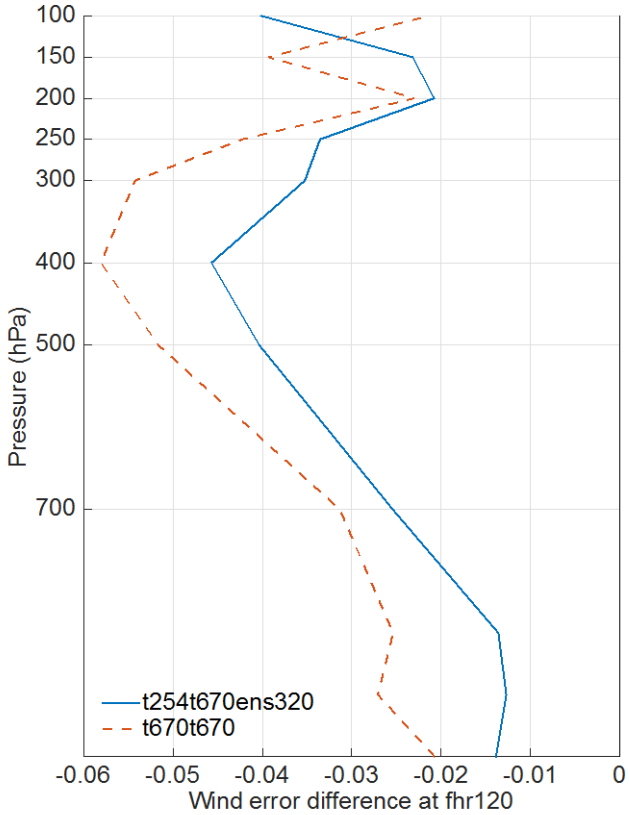
Increasing model resolution is better than increasing ensemble size

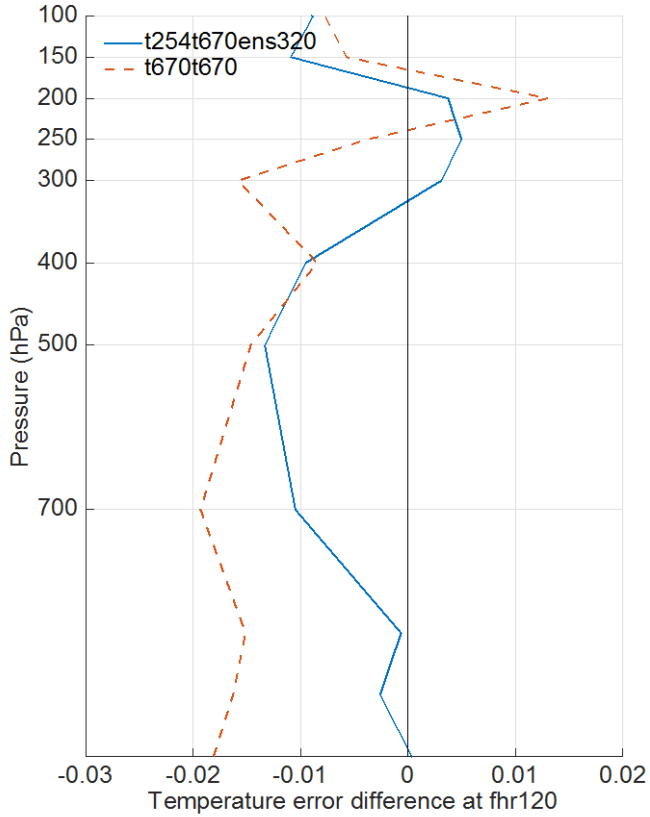


The differences among the three experiments are larger, when the TLNMC is disabled.

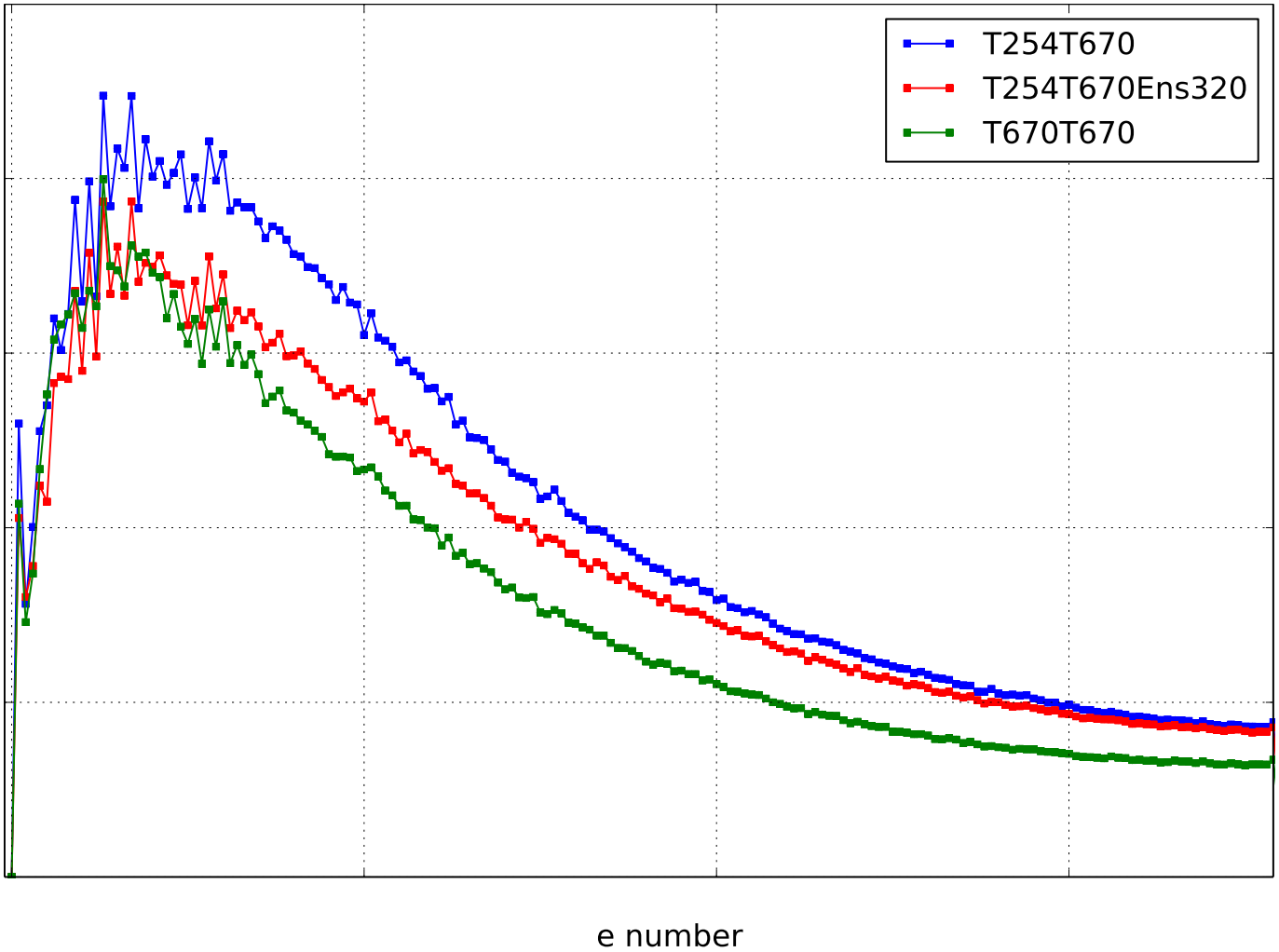
Impact on 5-day forecast error

% improvement in RMS error relative to ECMWF analyses





Spectrum of 6-h forecast wind error (relative to EC analyses)



- Increasing ensemble size or resolution decreases error at all scales.
- Increasing resolution has a larger impact, esp. at smaller scales.

Conclusions

- Sensitivities to data assimilation parameters including the horizontal and vertical localization and weight of static **B** are small when either ensemble size or ensemble resolution increases.
  - Static **B** can probably be eliminated if ensemble size increases to 320, or ensemble resolution is the same as the control resolution.
- At resolutions of T254 and T670, increasing ensemble resolution yields a larger improvement than increasing ensemble size.
- Do these results apply to higher resolution (T574T1534)?