Representing Model Error in the AFWA Joint Mesoscale Ensemble by a Stochastic Kinetic Backscatter Scheme

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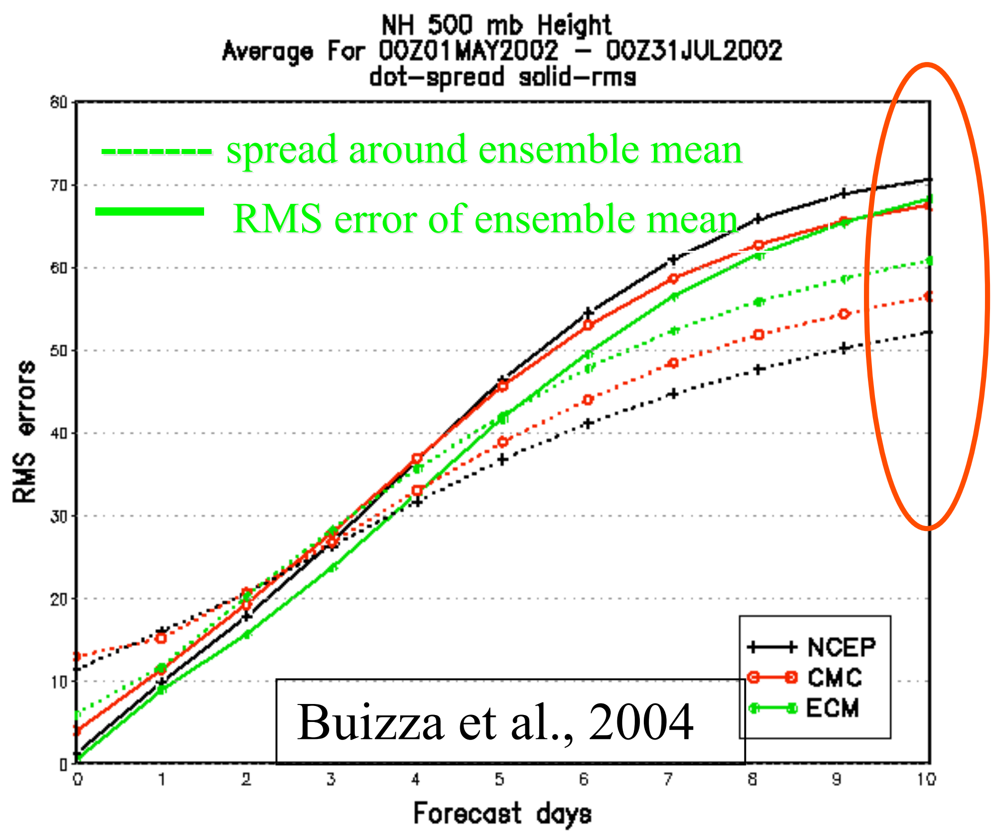
Underdispersivness of ensemble systems



The RMS error grows faster than the spread

- Ensemble is underdispersive
- Ensemble forecast is **overconfident**
- Underdispersion is a form of **model error**

- All sources of forecast error must be accounted for:

Forecast error = initial condition error + model error + boundary condition error

Representing model error in ensemble systems

- The multi-model approach: each ensemble member is a different model
- The multi-parameterization approach: each ensemble member uses a different set of parameterizations (e.g. for cumulus convection, planetary boundary layer, microphysics, short-wave/long-wave radiation, land use, land surface)
- The multi-parameter approach: each ensemble member uses the control physics, but the parameters are varied from one ensemble member to the next
- Stochastic parameterizations: each ensemble member is perturbed by a stochastic forcing term that represents the statistical fluctuations in the subgrid-scale fluxes as well as altogether unrepresented interactions between the resolved and unresolved scale

Representing model error in ensemble systems

- The multi-model approach: each … ber is a different model
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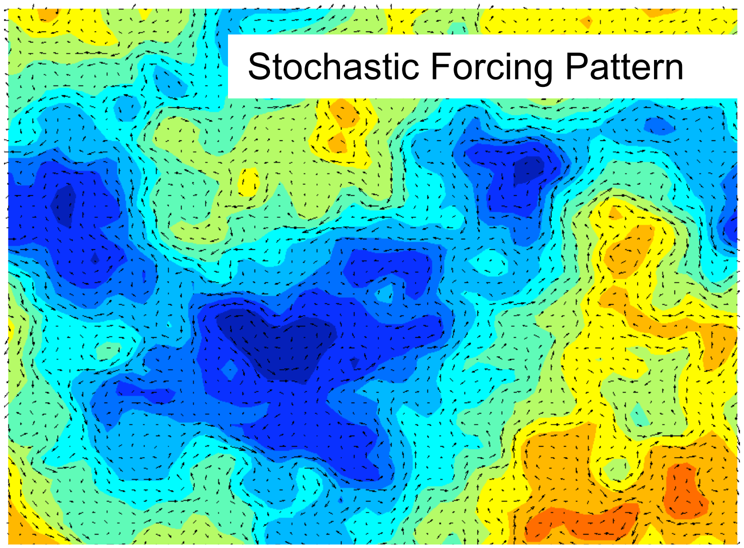
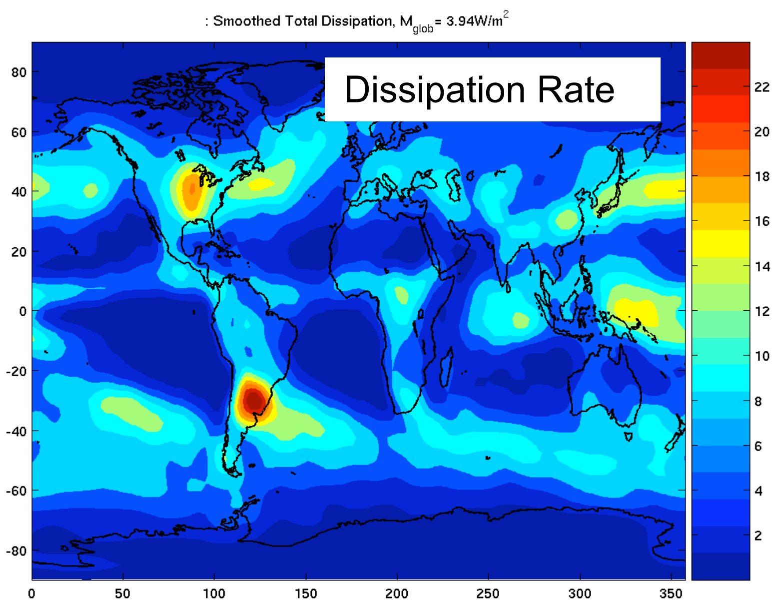
Each ensemble member has different bias

Each ensemble is from the same underlying distribution

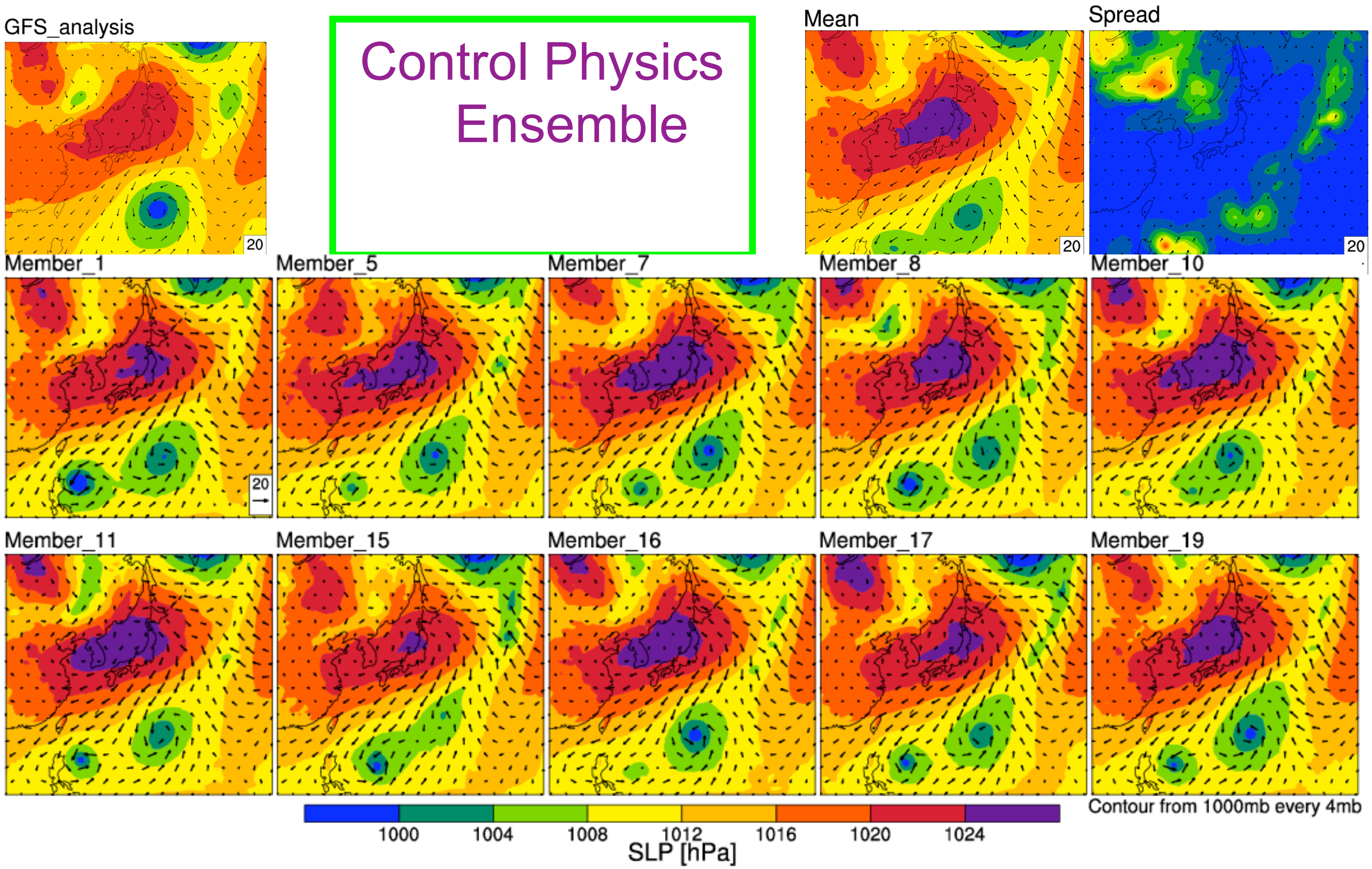
A spectral stochastic kinetic backscatter scheme





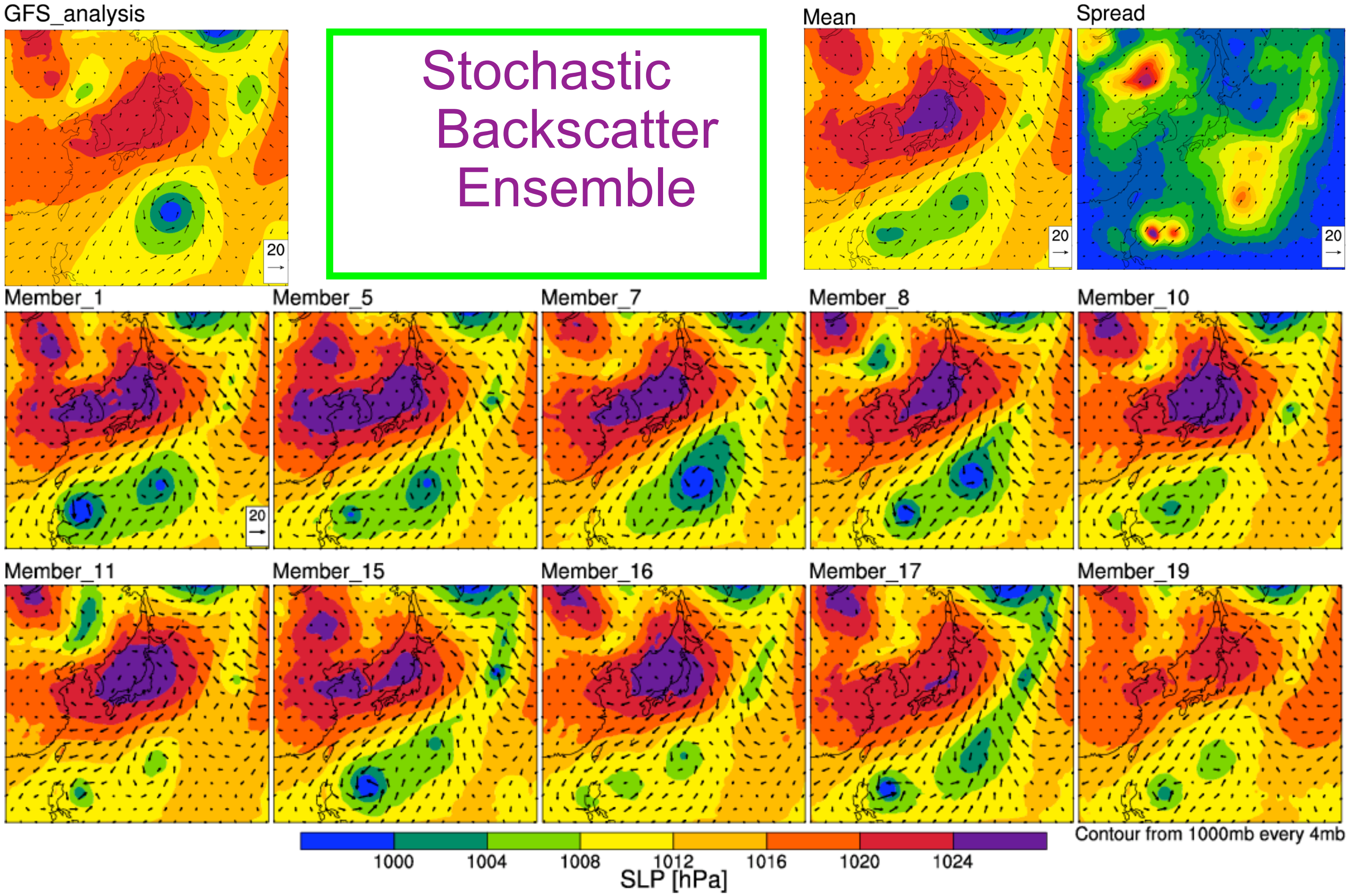
- ❖Rationale: A fraction of the dissipated energy is scattered upscale and acts as streamfunction and temperature forcing for the resolved-scale flow.
- ❖ Implementation into ECMWF global ensemble system ongoing (Shutts (2005), Berner et al. (2009))
- ❖Adjusted into AFWA limited-area ensemble with appropriate planar 2D-basis functions and constant dissipation rate
- ❖Future work: Extend to include a flow-dependent dissipation rate (currently flow-independent)

60h-forecast for Oct 13, 2006: SLP and surface $\vec{u}$



➢ All very similar, two typhoons

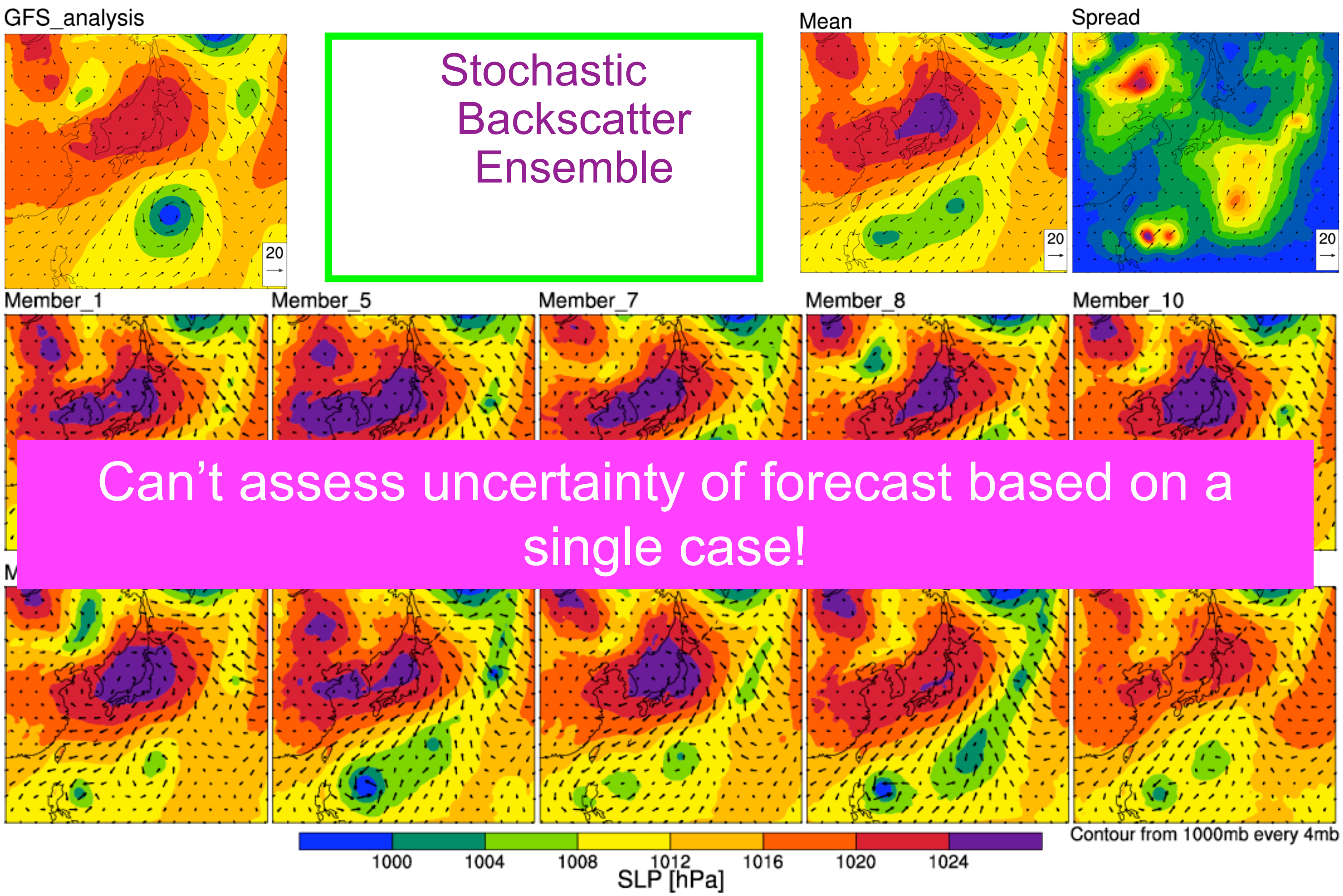
60h-forecast for Oct 13, 2006: SLP and surface $\vec{u}$



- More spread, member 7 gives best forecast

60h-forecast for Oct 13, 2006: SLP and surface $\vec{u}$

Stochastic Backscatter Ensemble

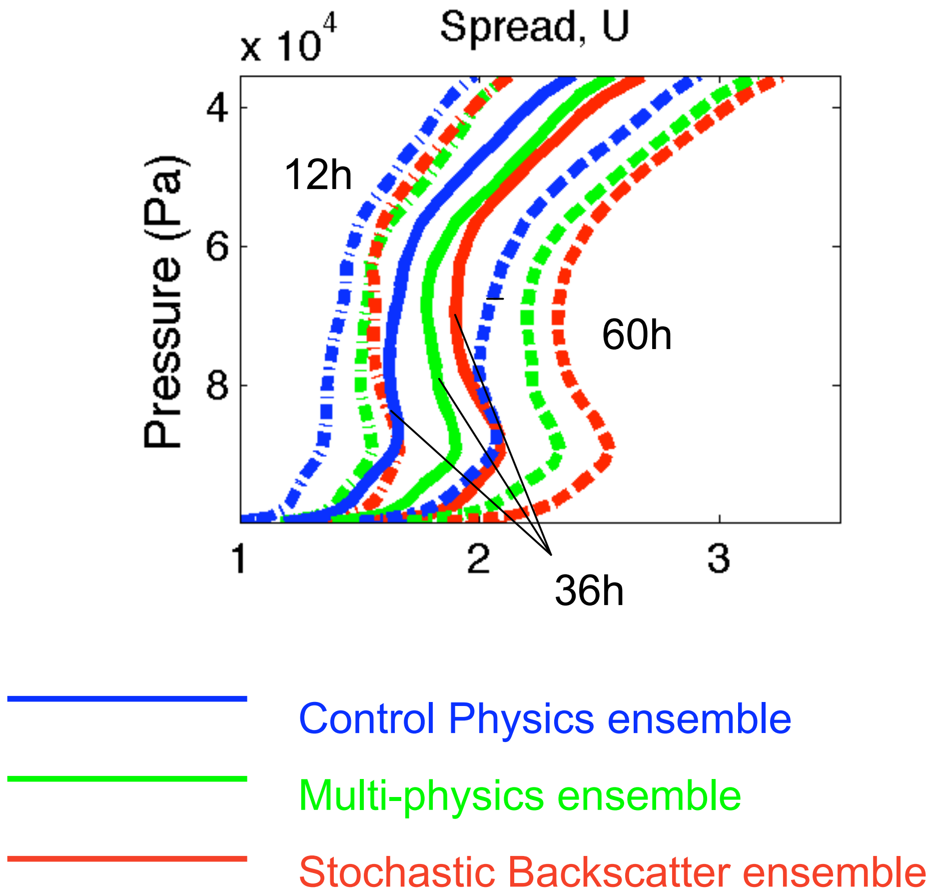


Can’t assess uncertainty of forecast based on a single case!

Experimental Design for Ensemble Runs

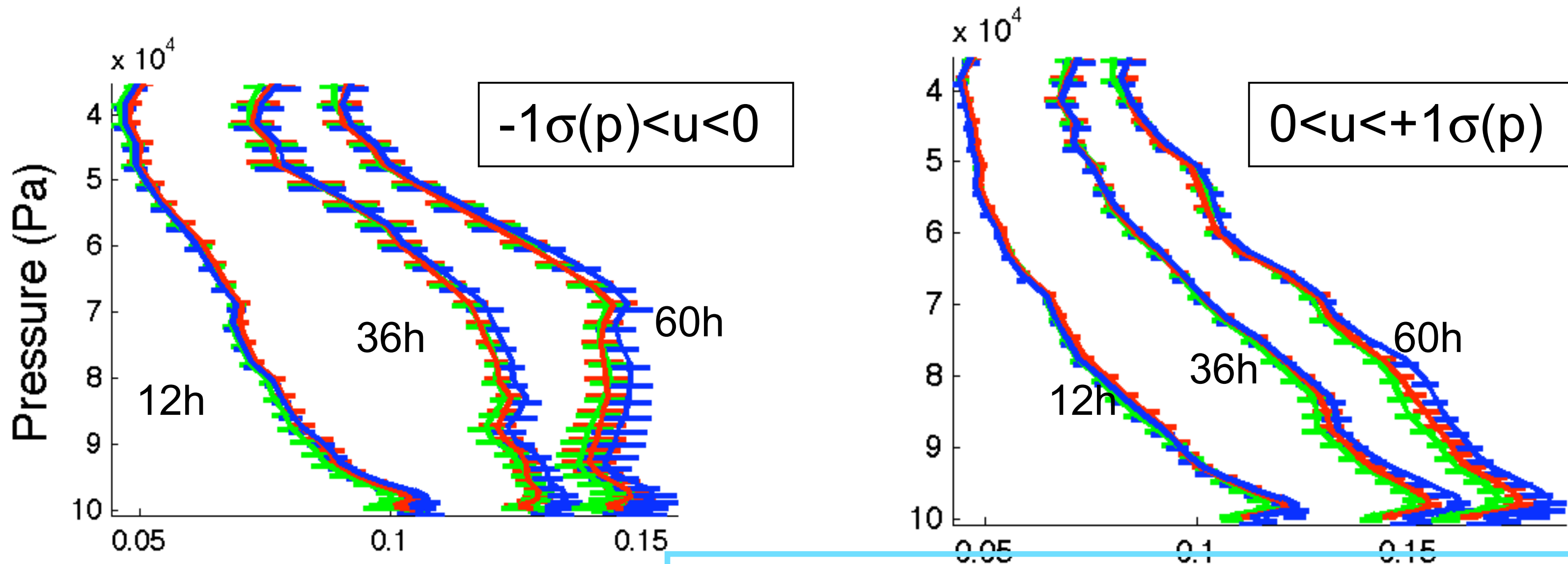
- AWFA ensemble run every 2nd day for Oct 2006 (13 cases)
- Korean Domain
- 40km resolution
- 10 ensemble members initialized from GFS global ensemble and forced by GFS boundary conditions
- Three ensemble systems: control physics, multi-physics, stochastic backscatter

Spread and RMS Error around ensemble mean



- ❖ Stochastic backscatter introduced most spread
  - ➢ Good spread-error relationship
- ❖ Multi-physics ensemble reduces RMS error

Brier score for u



Control Physics ensemble

Multi-physics ensemble

Stochastic Backscatter ensemble

❖Stochastic Backscatter better than control physics

❖Multi-physics ensemble better than stochastic backscatter

❖Errorbars are overlapping

➢Not statistically significant, more dates needed

Summary and Conclusions

- Both, the multi-physics ensemble and the ensemble with simplified stochastic backscatter scheme improve the AFWA mesoscale ensemble system over the ensemble with control physics, in terms of spread-error relationship and Brier score.
- This study should be extended to more dates, so that the results become statistically significant.
- Although the multi-physics ensemble is characterized by an increased mean bias in some levels, it reduces the root-mean-square error of the ensemble mean for wind and temperature.

Summary and Conclusions (cont)

- Given the theoretical and practical advantages of the stochastic backscatter scheme (all ensemble members have the same climatological distribution; one does not need to check the validity of multiple parameterizations if the domain is moved to a new region) it should be considered as alternative to the multi-physics.
- Future work: Include flow-dependent dissipation rates and see if this leads to improved skill.

Extras

Mean Bias for U and T