

Assimilation in the PBL

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Outline

- DAI in my world
- Why ensemble approaches?
- Data assimilation in the PBL
- Research with a column model
- DART and assimilation in the PBL
- Summary and future DAI interaction

DAI and me

- No formal relationship
- Collaborative opportunity
- Collection of expertise

Predictability Lessons

- The forecast problem, particularly at small scales, is inherently probabilistic.
- We are **obligated** to include estimates of uncertainty in observations, analyses, and forecasts and how they relate to the “flow of the day.”
- The only way we know how to do this is to combine ensemble forecasts with a data assimilation system, using our best dynamic models.

PBL characteristics and assimilation

- Transient strong coupling with the Earth's surface and the free atmosphere.
- Unknown and highly variable (space and time) error growth that is probably not well represented in mesoscale models.
- Irreversible processes.
- Nonhydrostatic processes and lack of dependable "balances."

Column model experiments

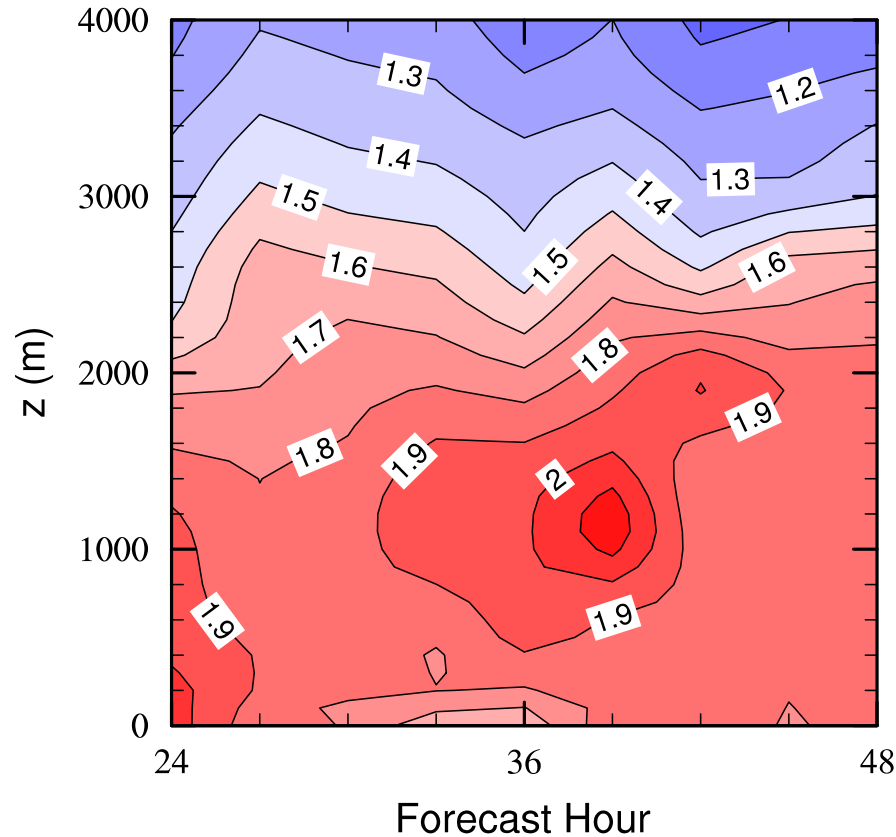
Hacker/Snyder

- Variance-covariance structures in a current mesoscale model.
- An off-line 1-D PBL modeling framework.
- Application of the EnKF to fixed surface (screen-height) observations.
- Conclusions and future work.

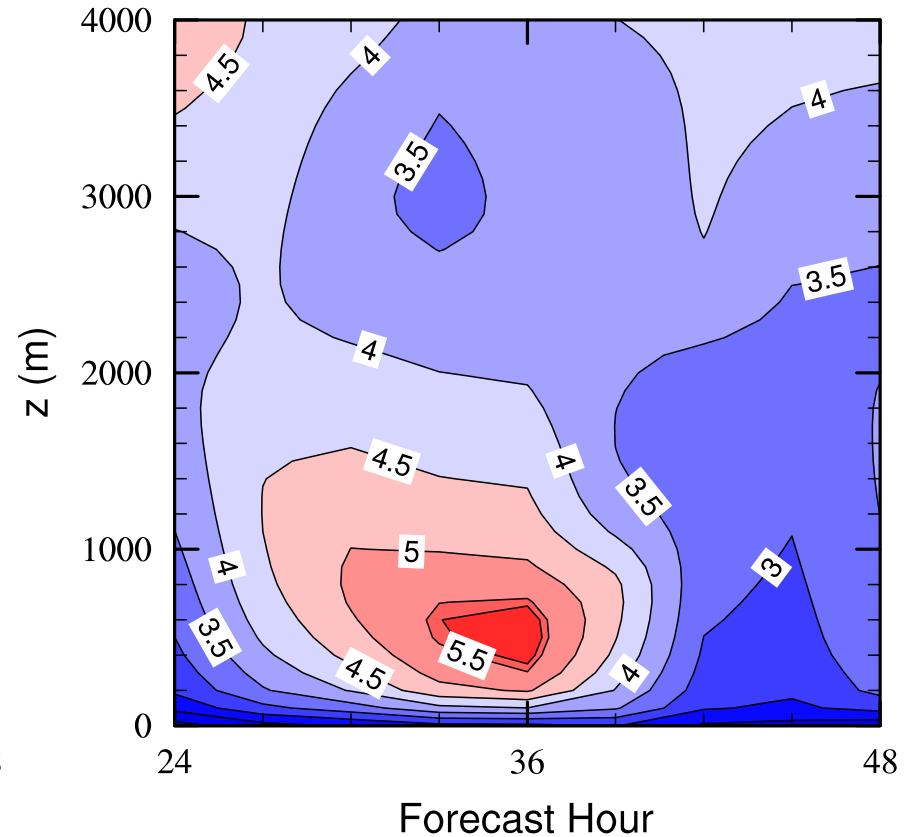
WRF Climatology

Summer southern great plains variance in the column

Variance of T (K^2)

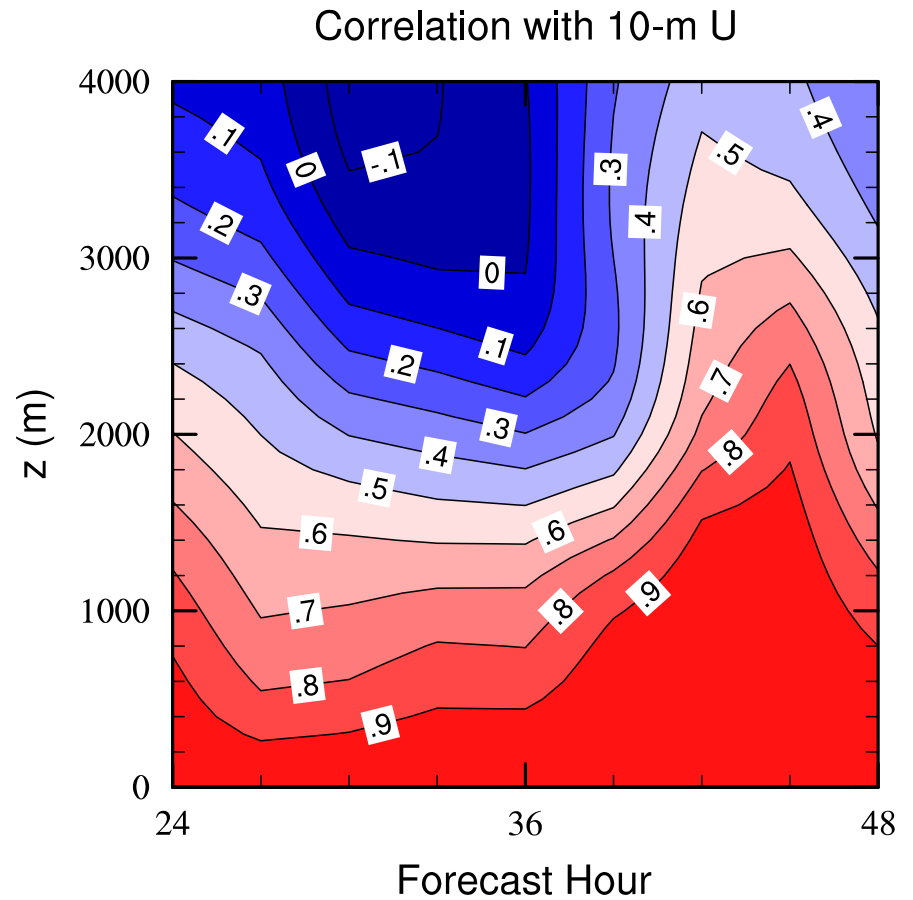
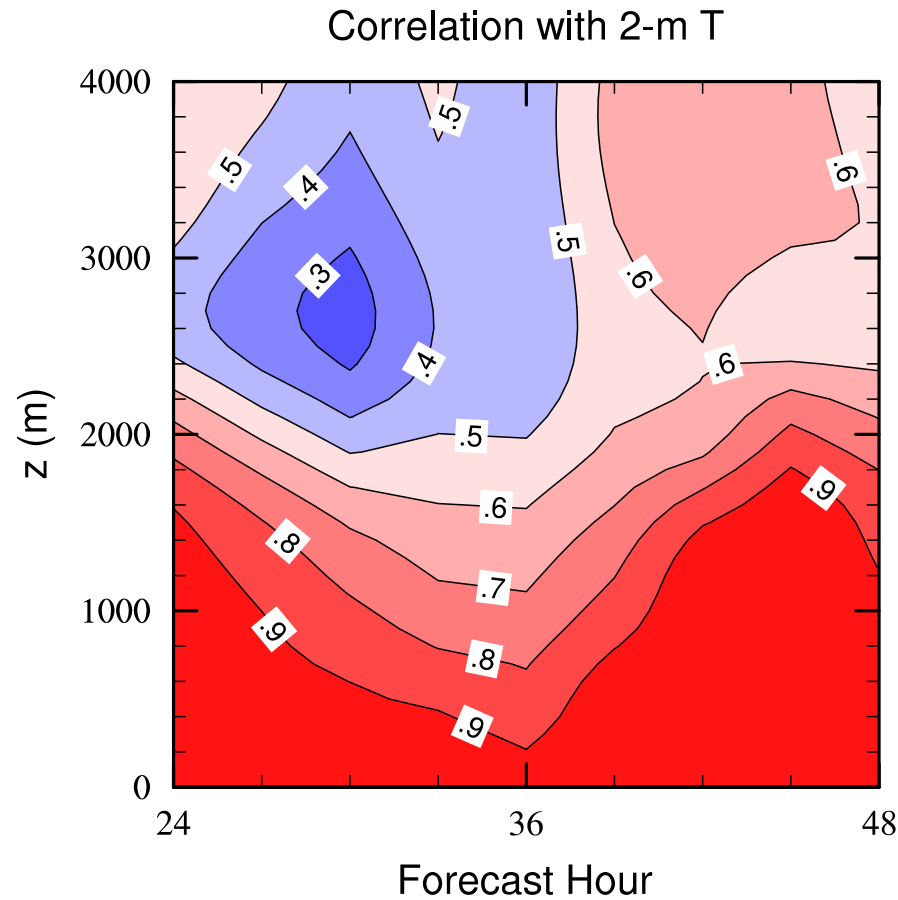


Variance of U ($m^2 s^{-2}$)

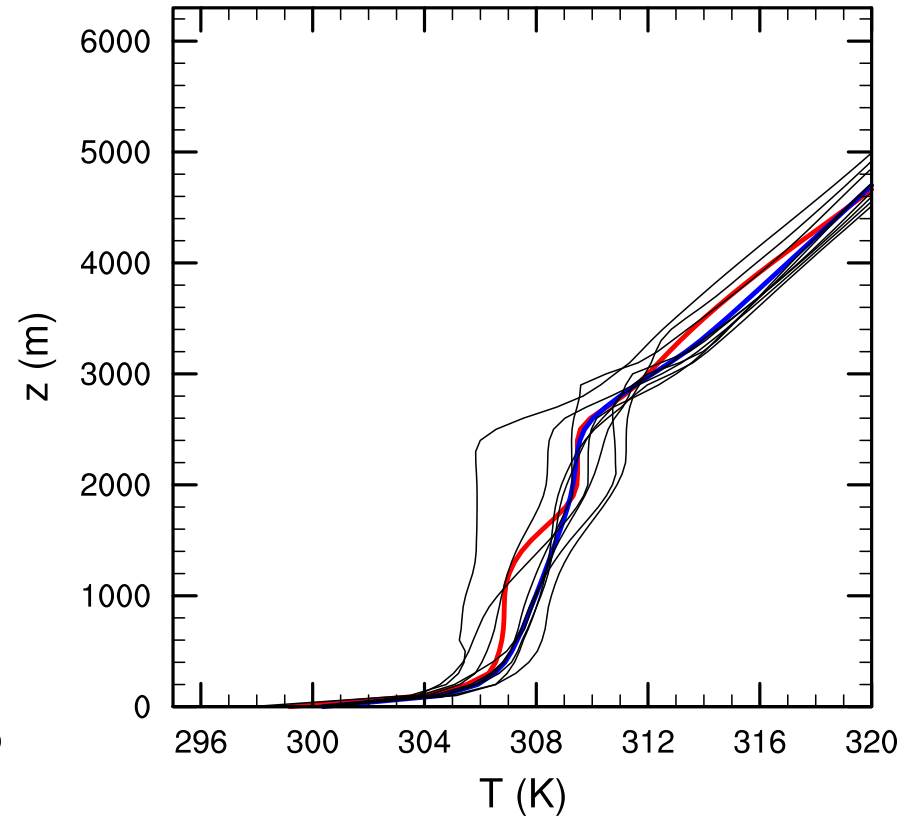
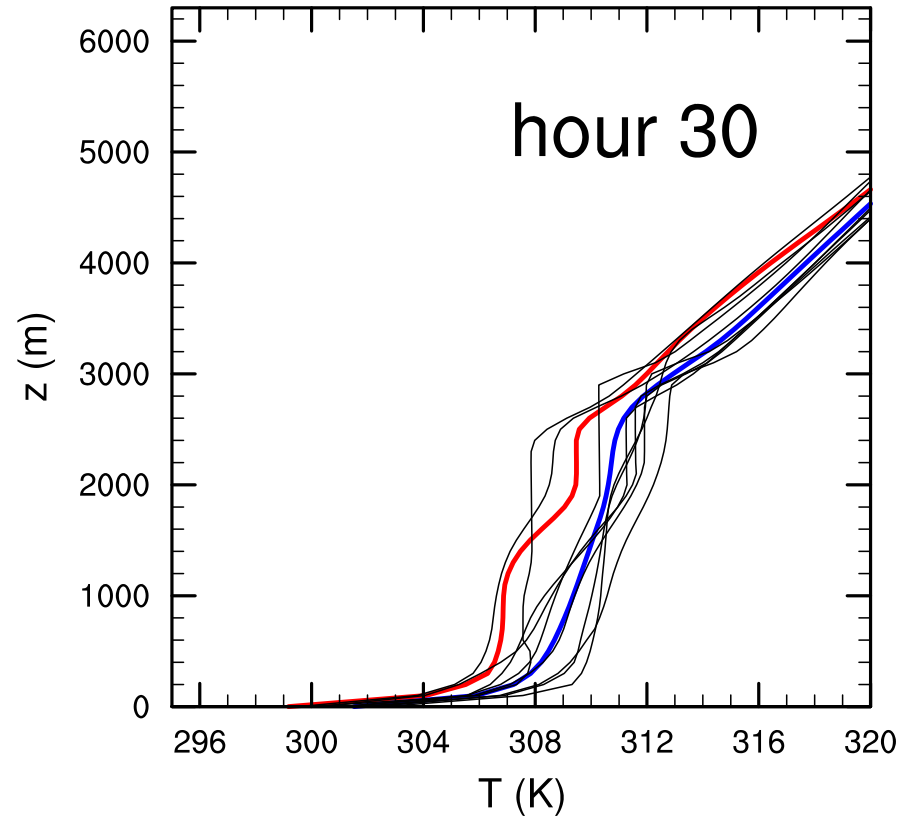


WRF Climatology

Summer southern great plains correlation with near-surface state.

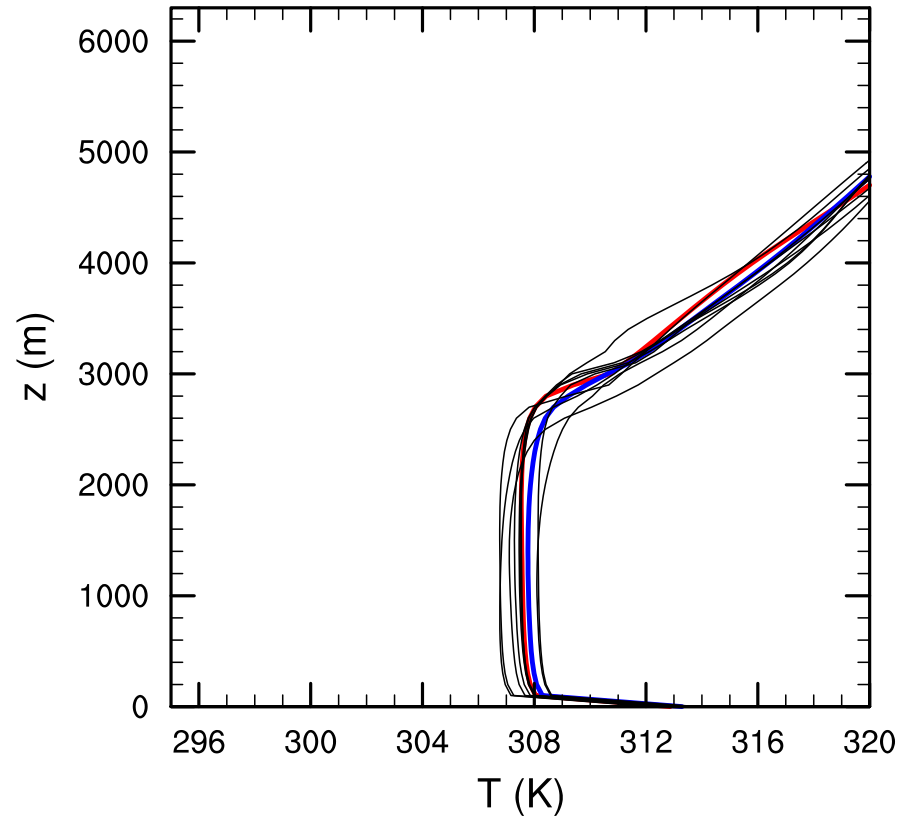
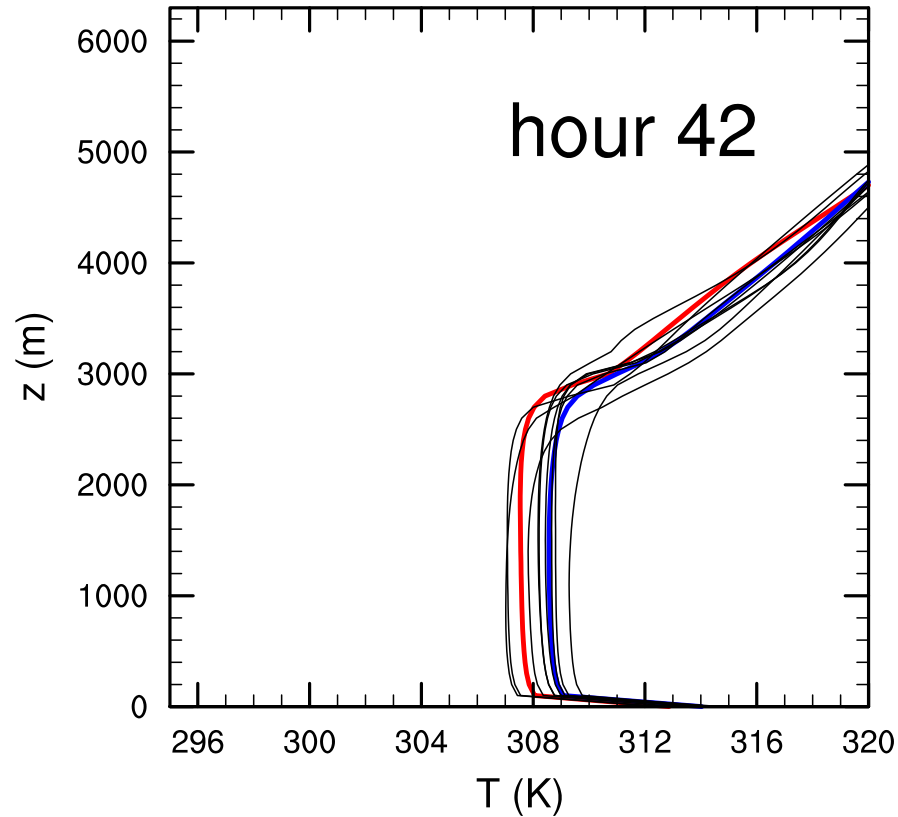


Assimilation Example: Nighttime



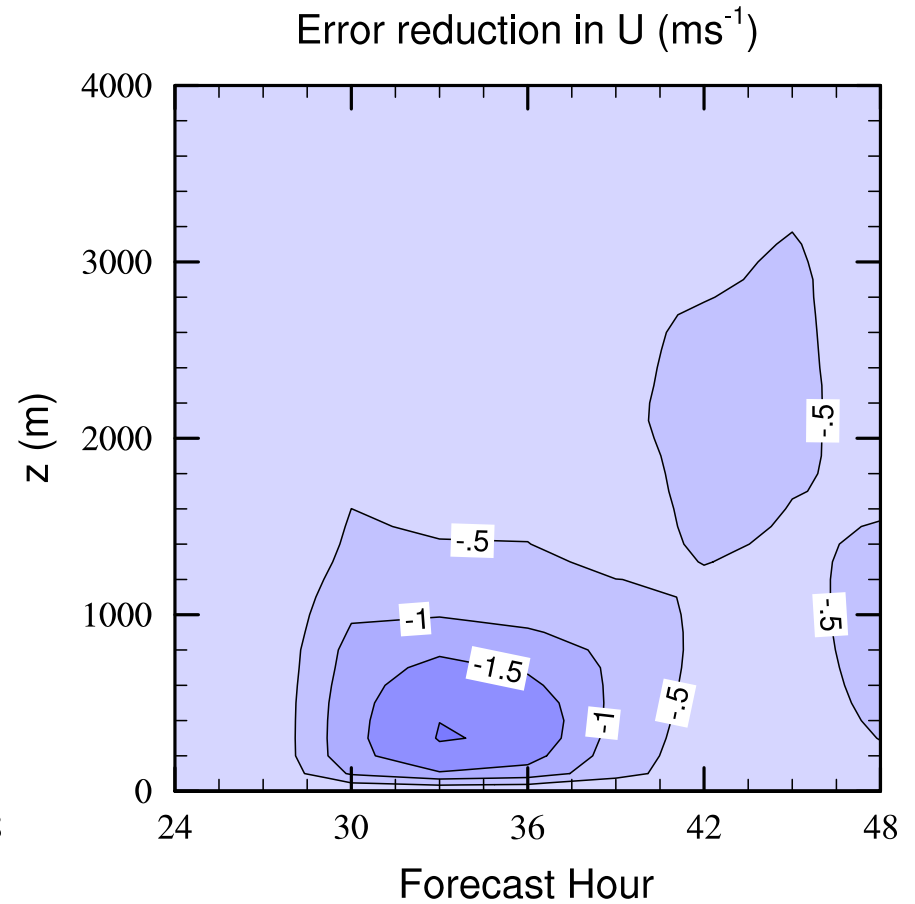
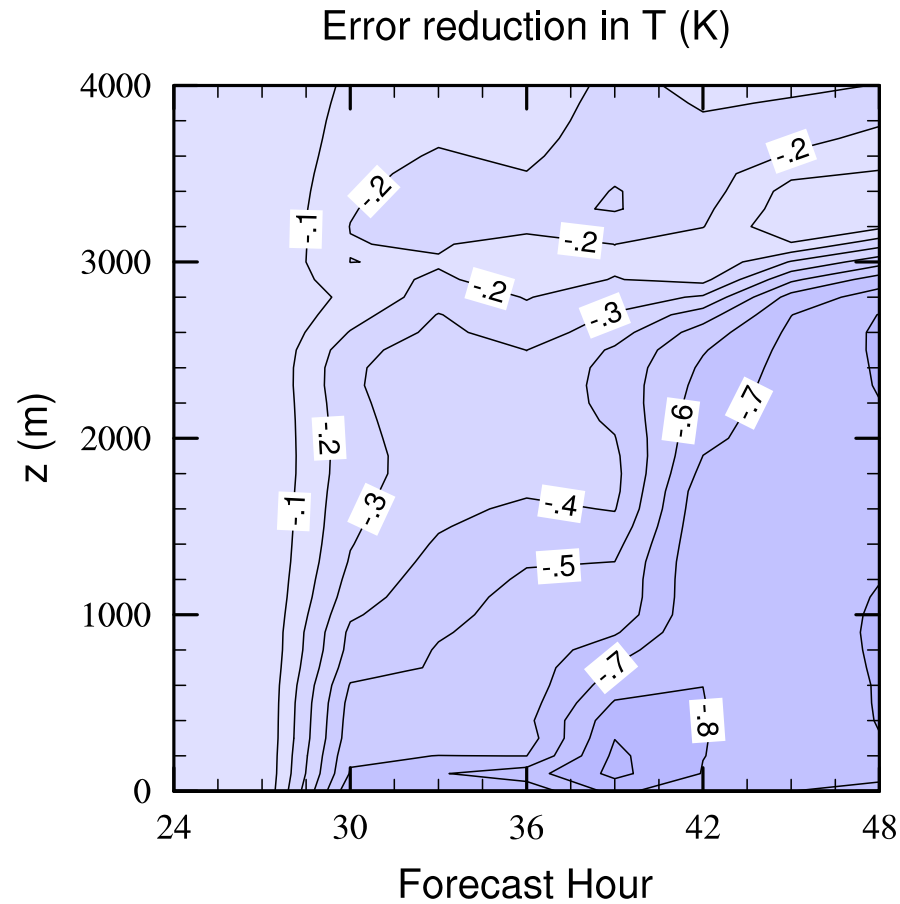
TRUTH and **ENSEMBLE MEAN**

Assimilation Example: Daytime



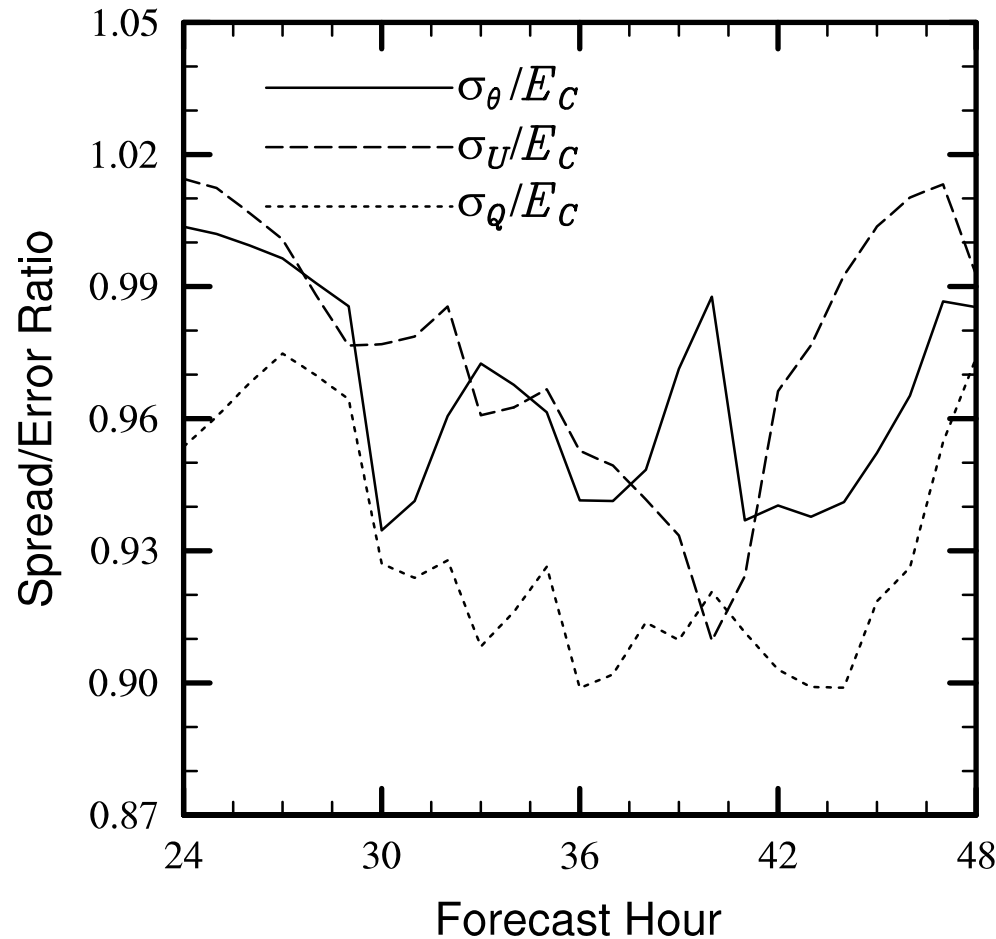
TRUTH and **ENSEMBLE MEAN**

Average Error Reduction for Assimilation



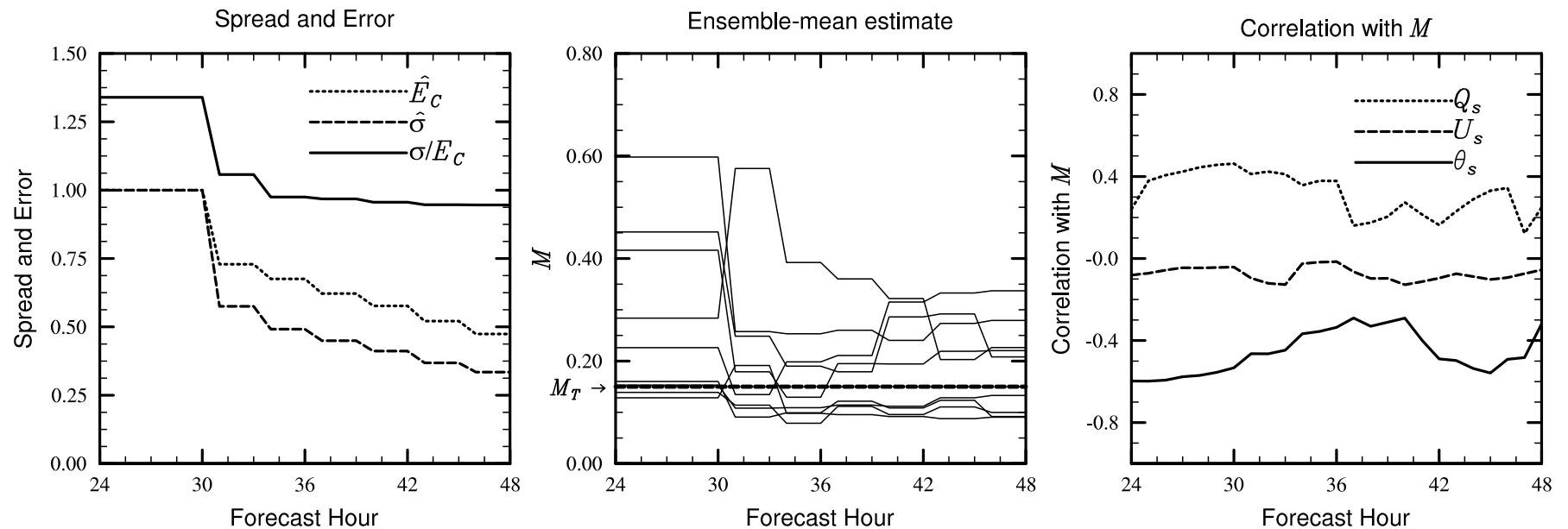
Can the ensemble quantify skill?

- Compare spread and error at $z = 500$ m



Add Model Error and Estimate M

- Augment the state vector with the “moisture availability” M and allow the observations to modify the distribution.



Summary of results

- The state near the surface is strongly coupled to the PBL through most of the diurnal cycle.
- The covariances can be exploited to determine the structure of the PBL with surface observations.
- Model error can be mitigated by augmenting the state vector with model parameters, and estimating their distributions.

Future column-model plans

- Install more sophisticated column model into DART.
- Investigate forward operator error and more parameter estimates.
- Attempt real-data experiments for augmenting profiler networks.

DART and PBL assimilation research

Toward 3D

- Multiple ways to localize ensemble covariances.
- Ease of adding state variables or parameters to the state vector.
- Ease of adding new observation types.
- Natural transition to real-data assimilation experiments.
- The ability to use both GCMs and mesoscale models.

Primary challenge to DAI

General: data assimilation issues

1. Strongly-forced, highly dissipative
2. Inappropriate closure assumptions (model error)
3. Extremely variable representativeness error

WRF: implementation issues

1. Boundary conditions
2. Cold-start initialization