Ensemble Data Assimilation

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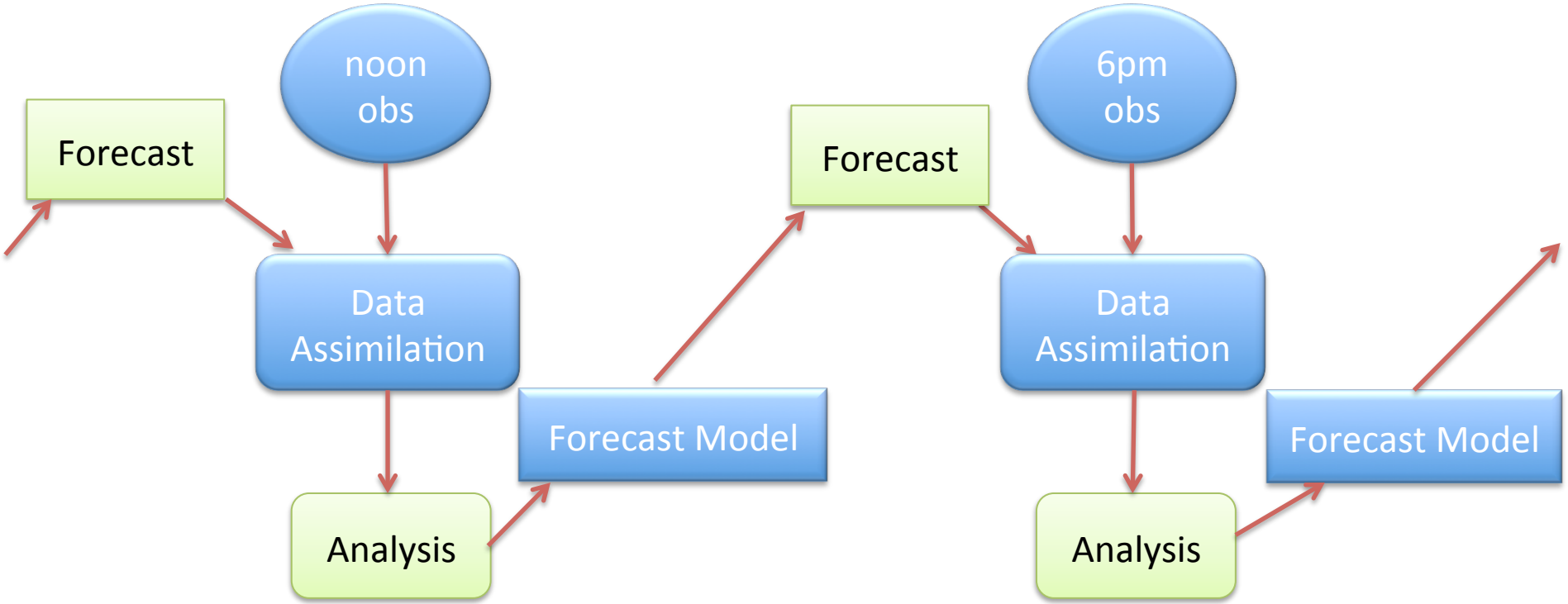
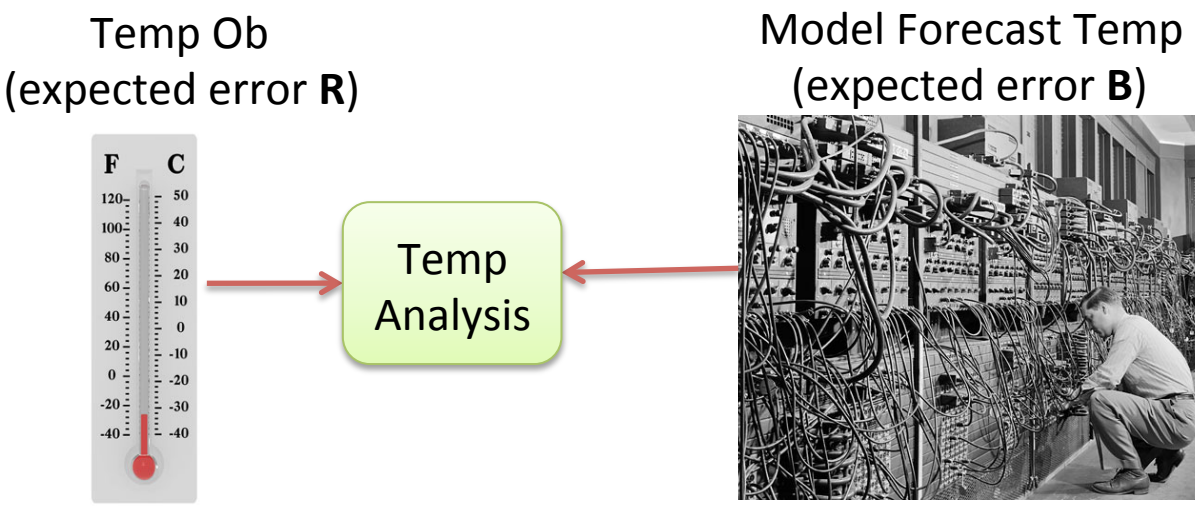
The Numerical Weather Prediction Process



Analyses and forecasts become more accurate when:

- Observations, forecast model and/or data assimilation (DA) components improve.
- Forecast model carries information from past observations.

Data Assimilation *is the process of combining prior knowledge of the state of the atmosphere (a previous model forecast) with new observations.*



If we have equal confidence in prior forecast and new observation (**R** = **B**), analysis is half-way between (equal weight given to each).

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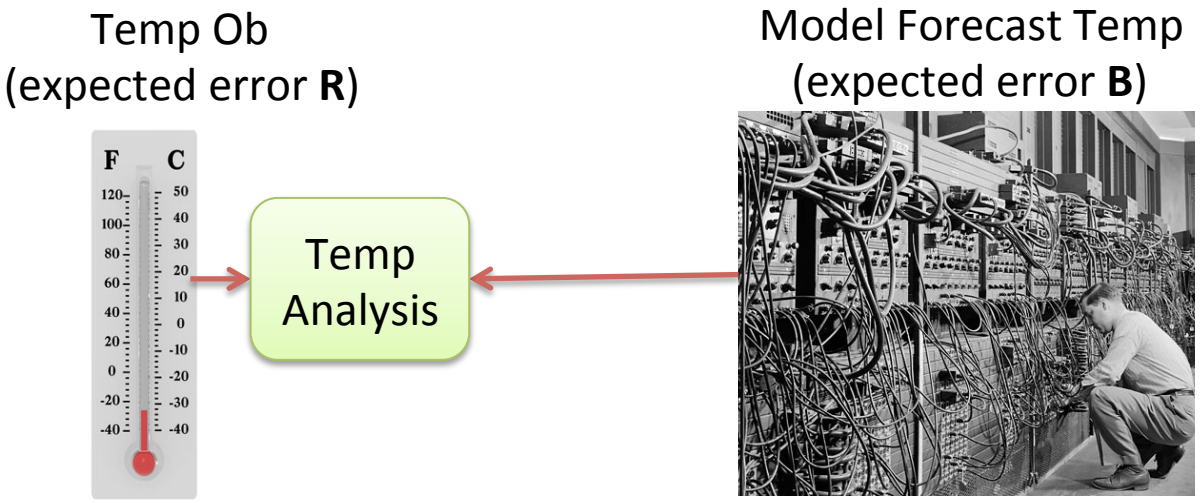
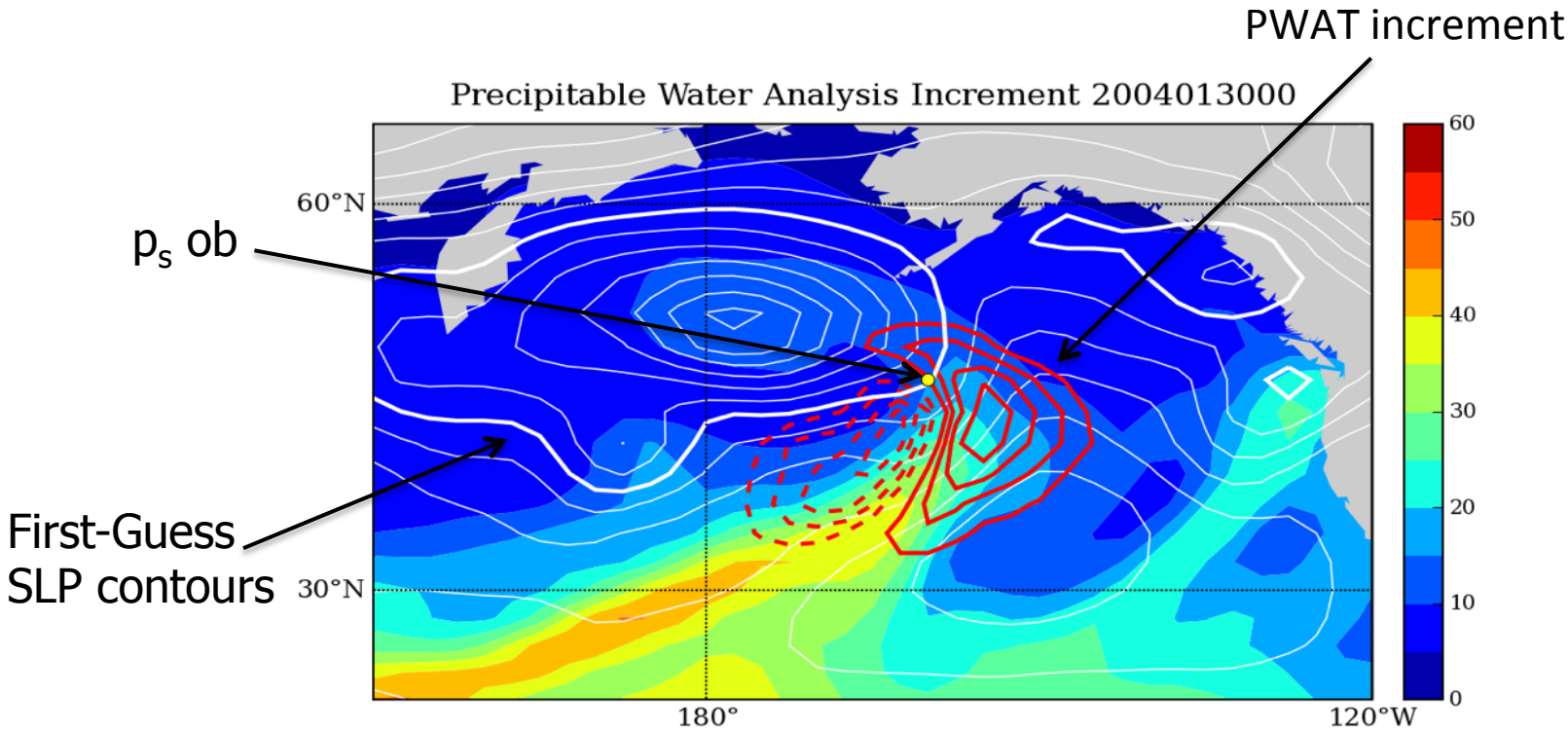


If we less confidence in prior forecast (**B** > **R**), analysis closer to observation. *The job of DA is to compute the weights that optimally blend the observations and the model forecast.*

What is the role of ensembles in DA?

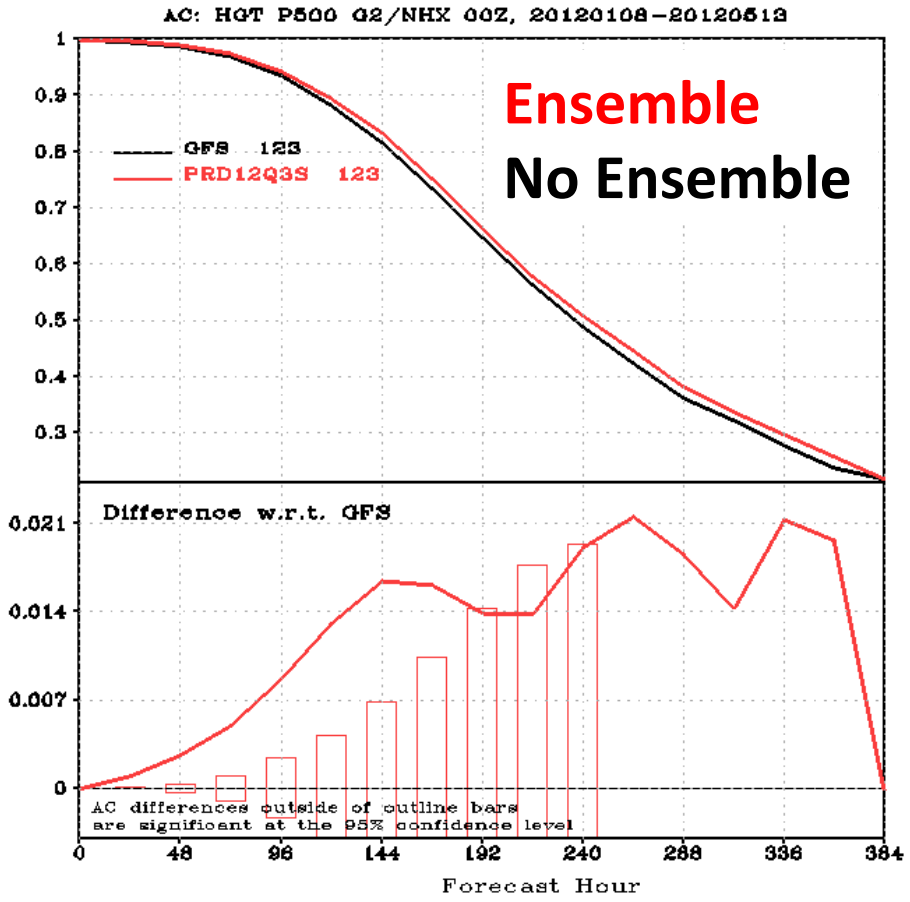
The sample covariance estimated from an ensemble of first-guess forecasts is used to define the forecast uncertainty.



The Ensemble Kalman Filter (EnKF) algorithm integrates ensemble forecasts with DA

R2O

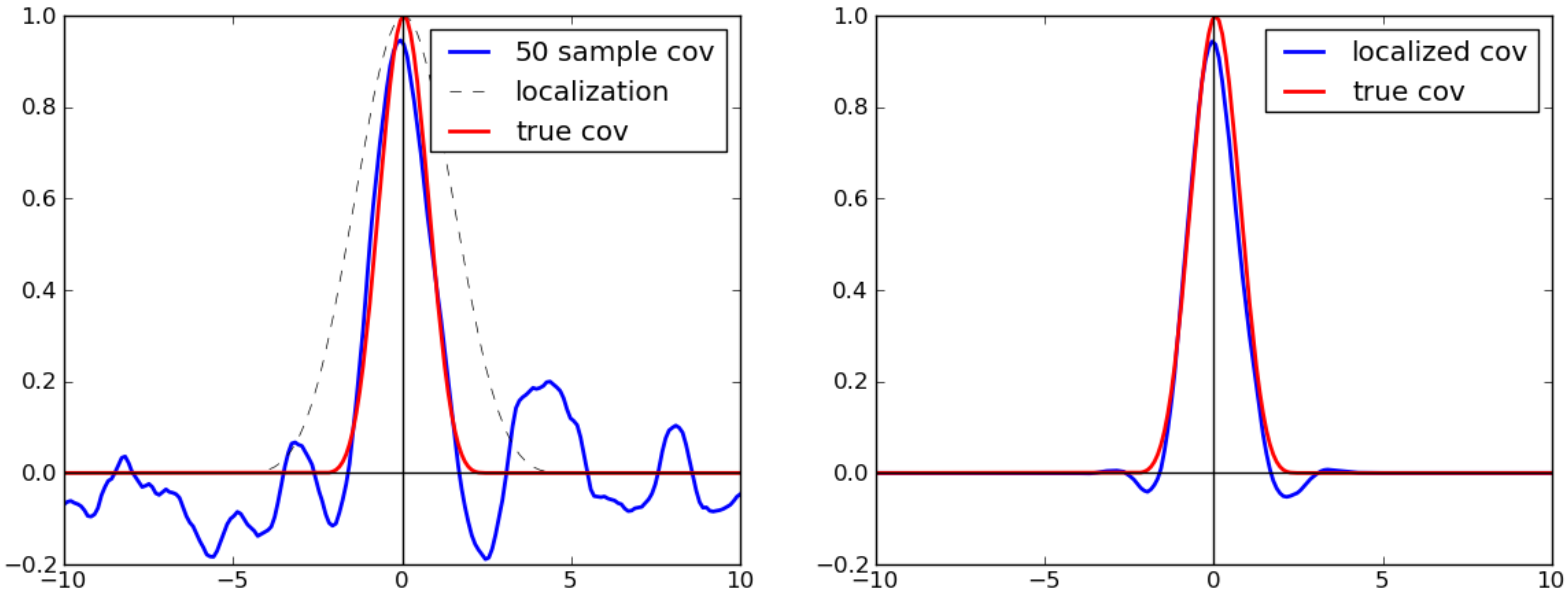
- PSD scientists developed EnKF software which became operational at NCEP in May 2012 as part of the 3D Ensemble-Var upgrade to the Global Forecast System (GFS).
- Work is ongoing to improve the algorithms (4D EnVar upgrade coming Q1FY16), apply to new applications (e.g. hurricane forecasting, see H. Winterbottom poster).



Key factors limiting performance

Sampling Error: ensemble size << model dimension.

Need for ***Covariance Localization***



Key factors limiting performance

Model Error: If every ensemble member run with the same model, uncertainty due to model formulation not accounted for. Need for ***Stochastic Parameterization*** (next talk)

Summary and Conclusions

- Ensembles allow a better characterization of forecast uncertainty – more information can be extracted from observations, improving analyses and forecasts.
  - Especially important when observations are sparse (20th Century Reanalysis)
- Improved treatments of sampling and model error are crucial for further progress.
- PSD research has directly benefited NOAA operations via partnership with NWS/NCEP.