

# Quantifying Uncertainty and Improvements in Prediction

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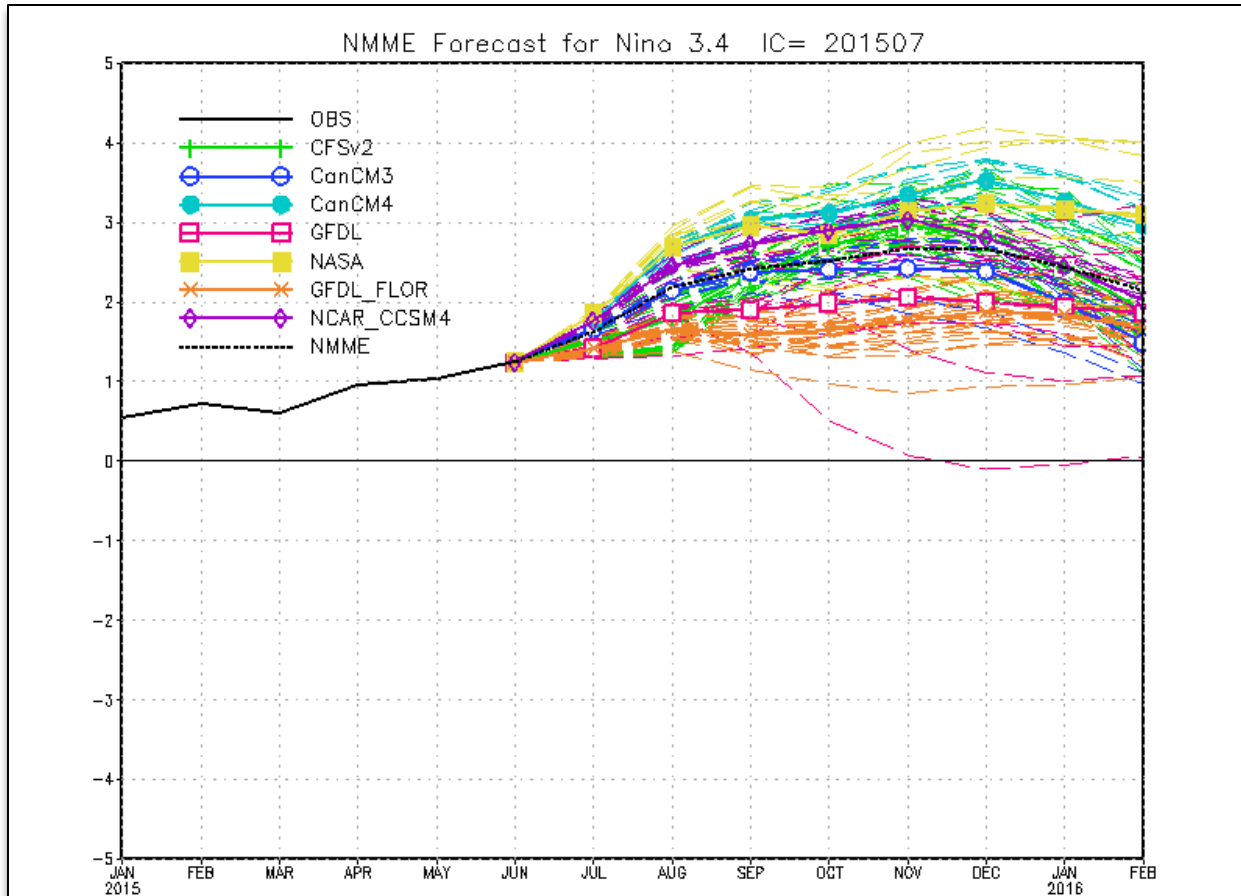
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# Forecast Uncertainty

- Forecast uncertainty (or divergence of forecasts) from small initial perturbations is a fundamental fact of forecast enterprise
- The level of forecast uncertainty controls host of consequences
  - Average skill of forecast
  - Confidence (or probabilities) associated with forecasts for particular events
- For individual forecast events, forecast uncertainty is one of the hardest aspects to communicate and incorporate in decision making process

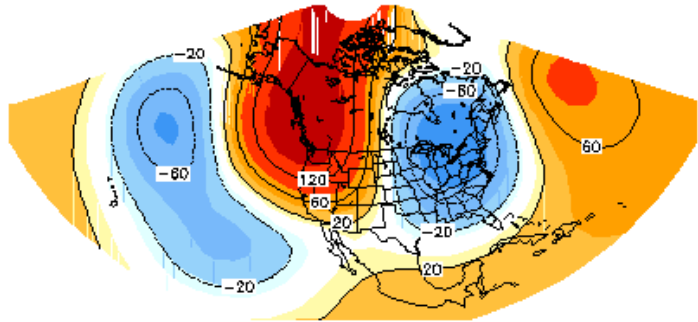
# An example...Nino 3.4



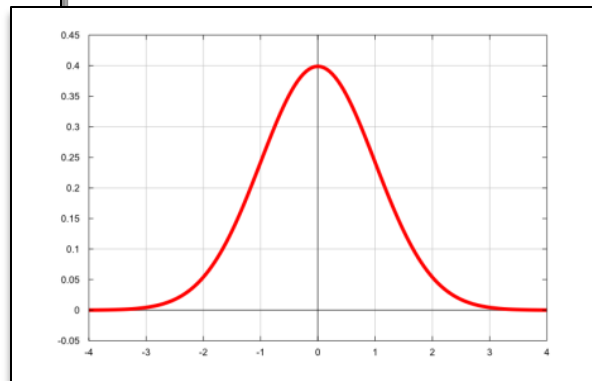
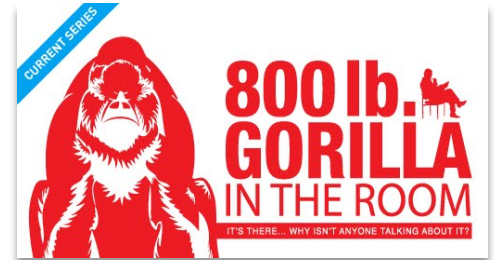
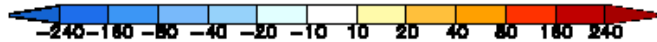
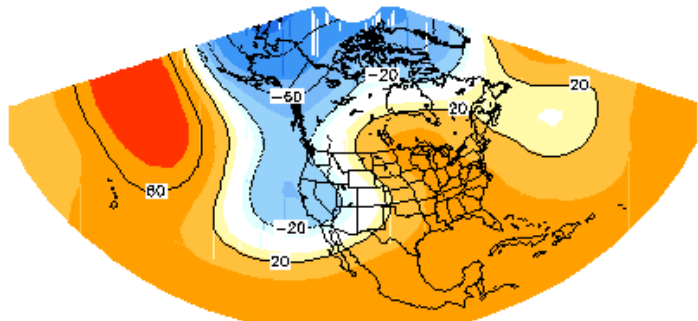
# Forecast Uncertainty

DJF 04/05 200 mb height

(a) NCEP run1



(b) NCEP run5



...outcome of two model runs with identical boundary and external forcings but different ICs

- One should not aim for developing forecast systems with smaller noise (→ deterministic forecasts) but forecast systems that have right level of noise
- This leads to the question – What is the right level of noise? or what level of forecast divergence mimics nature?
- How do we know forecasts have correct level of uncertainty?
- How can the right level of forecast divergence be determined?

# Forecast verifications...

- ...can inform about whether forecasts have less (under-dispersive) or more (over-dispersive) uncertainty
- Forecast reliability

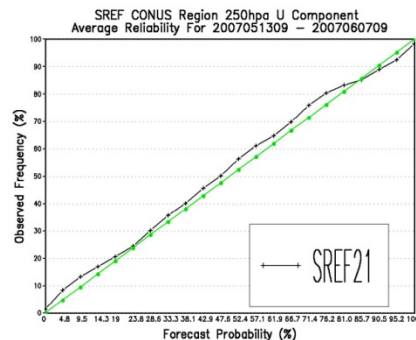
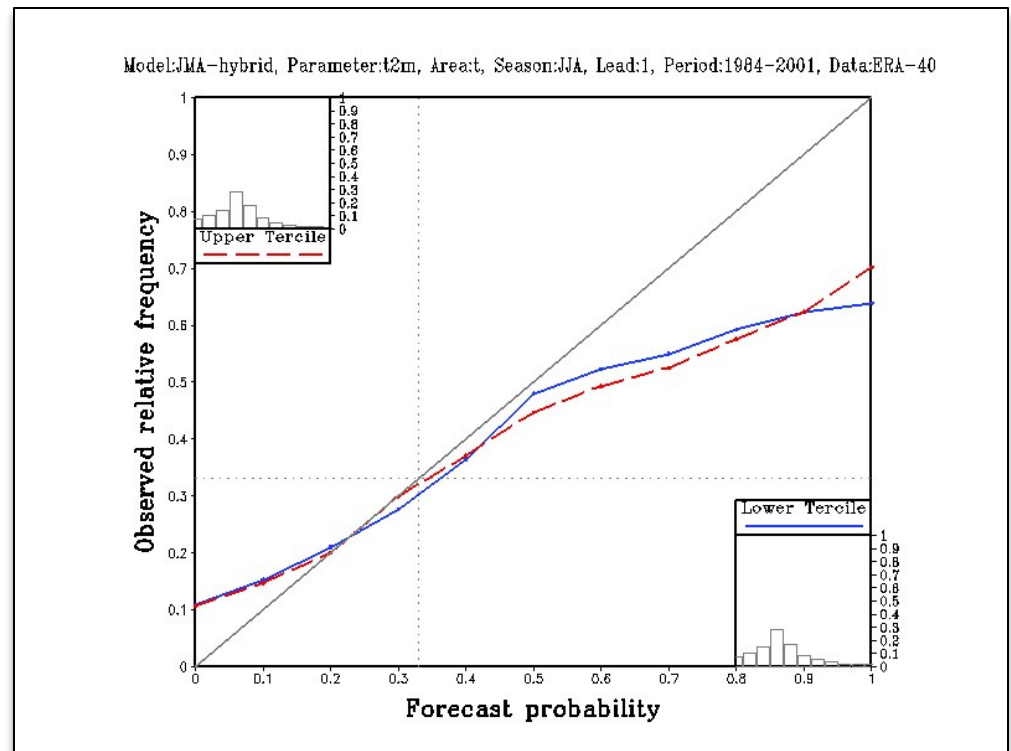
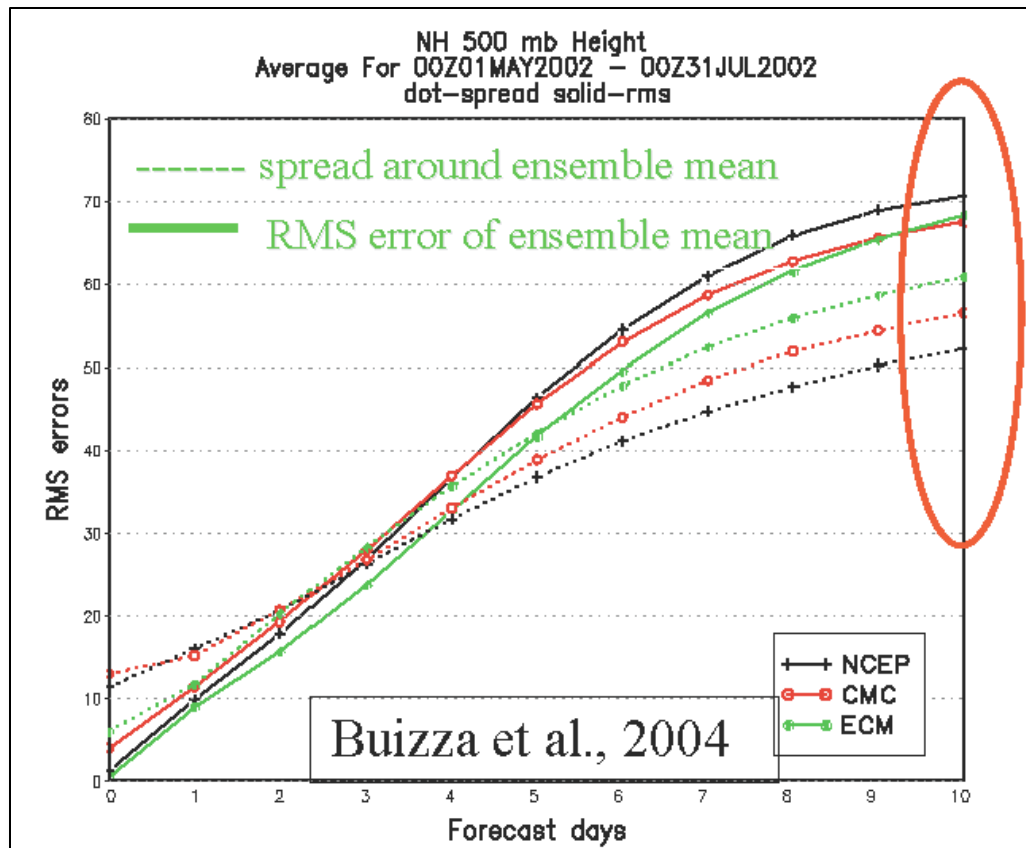


Fig. 10: Reliability score of U-component of 250-hpa wind speed probability  $\geq 20$  m/s at 45h lead time averaged over a period from May 13, 2007 to June 7, 2007, based on NCEP SREF data.



# Forecast verifications...

- Root mean square error



# Other methods to estimate forecast uncertainty

- Observational
  - Analogs – Divergence among two similar observed states
  - Auto-correlation estimates based on daily data
  - Other statistical approaches
  - ...but always limited by the length of observational data that is not long enough
- Models
  - ...influenced by model biases



# Summary

- Having the correct level of uncertainty is important in the decision making context...either under- or over-confident forecasts have economical consequences, and on the credibility of forecast producers
- There are certain ways to judge whether forecasts have correct level of uncertainty, and models should be put to test
- Forecast models have biases and assessment of forecast uncertainty should be one of metrics in the model development process