Observation uncertainty

Or... “There is no Such Thing as TRUTH”

Barbara Brown
NCAR

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The monster(s) in the closet...

- What are we losing/risking by ignoring observation uncertainty?
- What can we gain by considering it?
- (Confusion?)
- What methods are currently available?
  - What else can we do?
Outline

- What are the issues? Why do we care?
- What are some approaches for quantifying and dealing with observation errors and uncertainties?
Sources of error and uncertainty

- Biases in frequency or value
- Instrument error
- Random error or noise
- Reporting errors
- Reporting of errors
- Subjective obs (e.g., STORM data)

- Representativeness error
- Precision error
- Conversion error
- Analysis error
- Other?
Issue: Obs uncertainty leads to underestimation of forecast performance

From Bowler 2008 (Met. Apps)

850 mb Wind speed forecasts
Assumed error = 1.6 ms$^{-1}$
Issues: Analysis errors and variations

Thanks to E. Tollerud, H. Yuan, et al.
Issues: Analysis definitions

- Many new analyses under development
- How have they been verified? Compared?
- What do we know about analysis uncertainty?
  - RTMA uncertainty field

RTMA 2 m temperature
Issue – Data filtering for assimilation and QC

700 hPa analysis; Environment Canada; 1200 UTC, 17Jan 2008

From L. Wilson
Issues: Observation selection

Verification with different datasets leads to different results

From E. Tollerud
Approaches for coping with observational uncertainty

- Indirect estimation of obs uncertainties through verification approaches
- Incorporation of uncertainty information into verification metrics
- Treat observations as probabilistic
- Assimilation approaches
Indirect approaches for coping with observational uncertainty

- Neighborhood or fuzzy verification approaches
- Other spatial methods

(Atger, 2001)
Direct approaches for coping with observational uncertainty

☐ Compare forecast error to known observation error
  ■ If forecast error is smaller, then
    ☑ A good forecast
  ■ If forecast error is larger, then
    ☑ A bad forecast
Direct approaches for coping with observational uncertainty

- Bowler, 2008 (MWR)
  - Methods for reconstructing contingency table statistics, taking into account errors in classification of observations

- Ciach and Krajewski (1999)
  - Decomposition of RMSE into components due to “true” forecast errors and observation errors

\[
\text{RMSE}_o = \sqrt{\text{RMSE}_t^2 + \text{RMSE}_e^2}
\]

Where \( \text{RMSE}_e \) is the RMSE of the observed values vs. the true values.
Direct approaches for taking uncertainty into account

- Candille and Talagrand
  - Treat observations as probabilities (new Brier score decomposition)
  - Perturb the ensemble members with observation error
- Briggs et al. (MWR, 2005)
  - Incorporating mis-classification errors using a “gold standard”
- B. Casati
  - Wavelet reconstruction
- Roberts and Lean (MWR, 2008)
  - Perturb pixels in the observed field to obtain error bars
- Hamill (2001)
  - Rank histogram perturbations
- Hot before the press: Mittermaier (2008)
  - Incorporation of uncertainty in radar-rainfall estimates
- Others?
Issues

- Obtaining meaningful estimates of observational error
- Developing “standard” approaches for incorporating this information in verification
Evaluation and intercomparisons of analyses

- Establish base-level knowledge of analysis uncertainties
- Ongoing estimation of uncertainties is desirable
- Intercomparisons of obs-based analyses are needed to understand their capabilities and differences, as well as their variability