Review of Some Cloud and Precipitation Data Assimilation Issues

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What can I add ?

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1. Errico, Bauer, Mahfouf 2007 JAS
2. Errico, Bauer, Mahfouf 2008 JAS
3. Continued questions and warnings
   a. Philosophy
   b. Predictability
   c. Representativeness (forward model) error
   d. Non-Gaussianity and non-linearity
   e. Continued fundamental flaws
   f. Acceleration of progress

Philosophy

1. Science vs. Engineering
   somewhat distinct goals but not distinct activities

2. Correctness vs. Utility
   almost nothing in data assimilation has been correct

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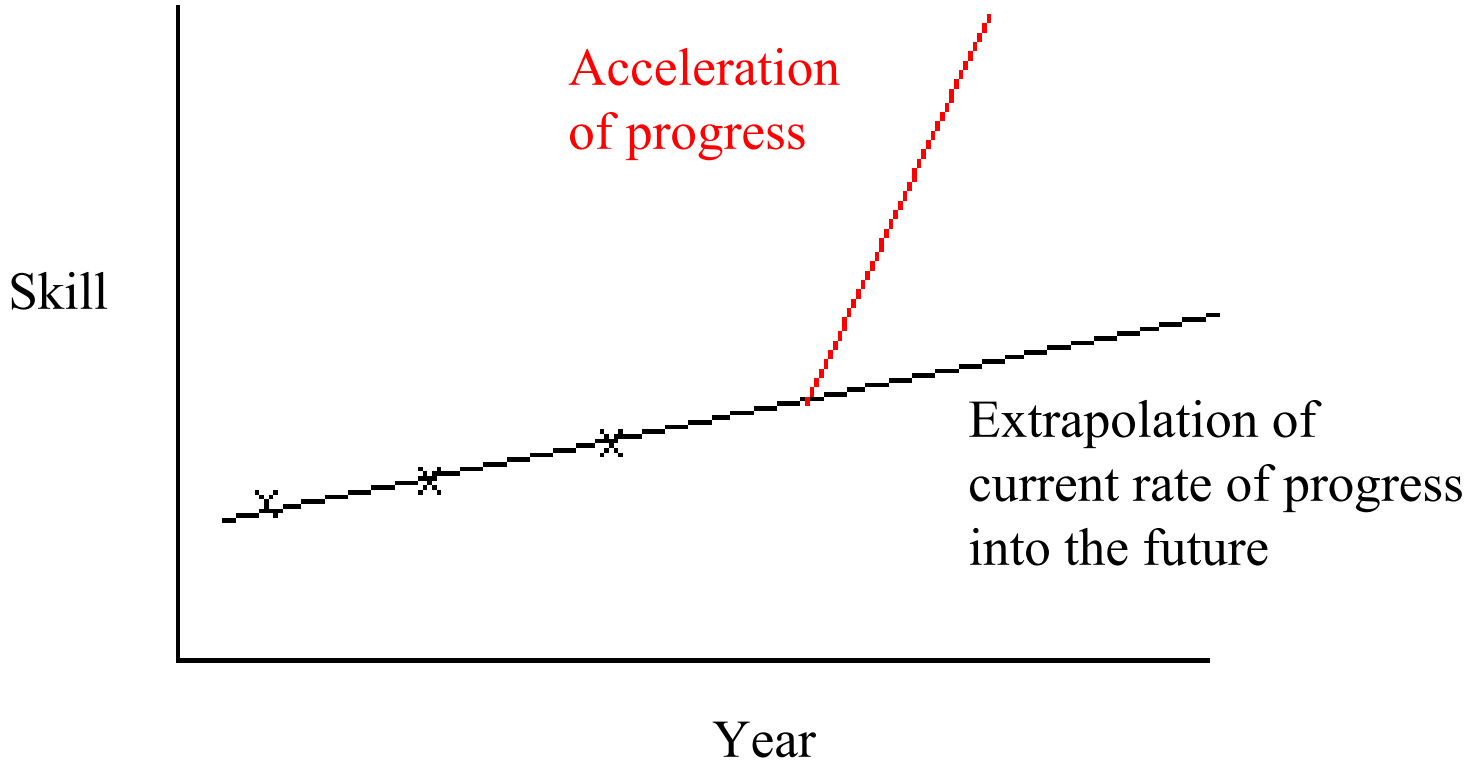
Background error statistics treated as isotropic and homogeneous
Observation errors treated as uncorrelated in time and space
Background and observation errors treated as unbiased
Errors treated as Gaussian
Models treated as linear
Etc.

The Skill of Quantitative Precipitation Forecasts as described by a US national program

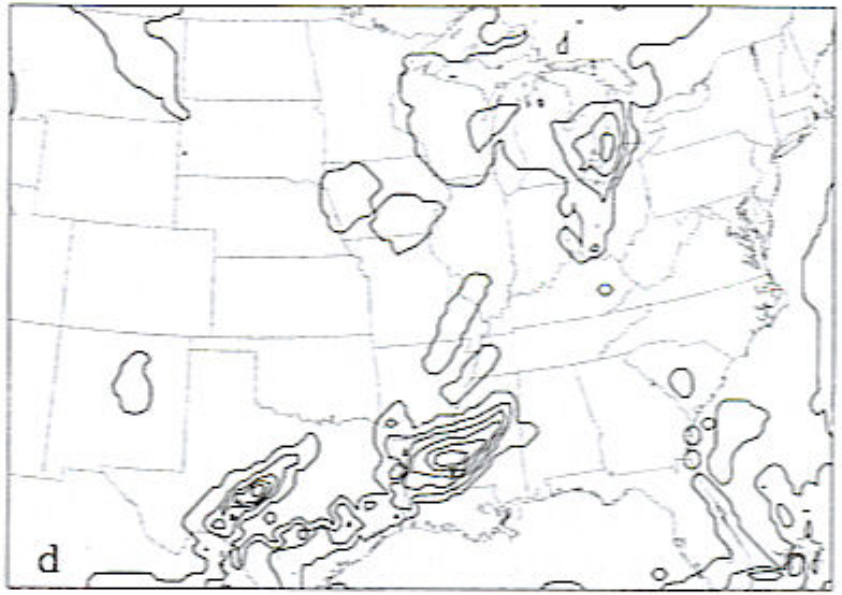


Why basic predictability studies are important

"Between the extremes of theory and practice lies the problem of detecting when the development of more and more general, complicated, and costly methods of dynamical prediction, and more refined computing techniques will not produce a significant increase in the overall accuracy of prediction [without further improvements in initial conditions]." (Thompson, 1957 *Tellus*)

"Until one can quantitatively predict the predictability that would result from increased data coverage, it is impossible to establish the point of rapidly diminishing returns, beyond which further outlays would be unprofitable. That of course is the real problem." (Thompson 1957, *Tellus*)

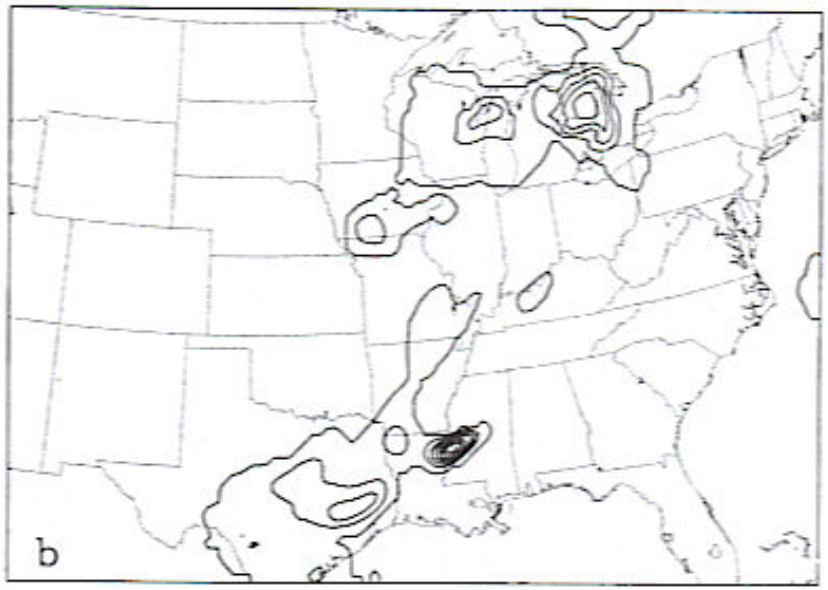
"Well-designed predictability studies not only will reveal what is reasonably feasible, but also will indicate what is required to achieve such forecast skill improvement." (Errico et al., 2002 *BAMS*).



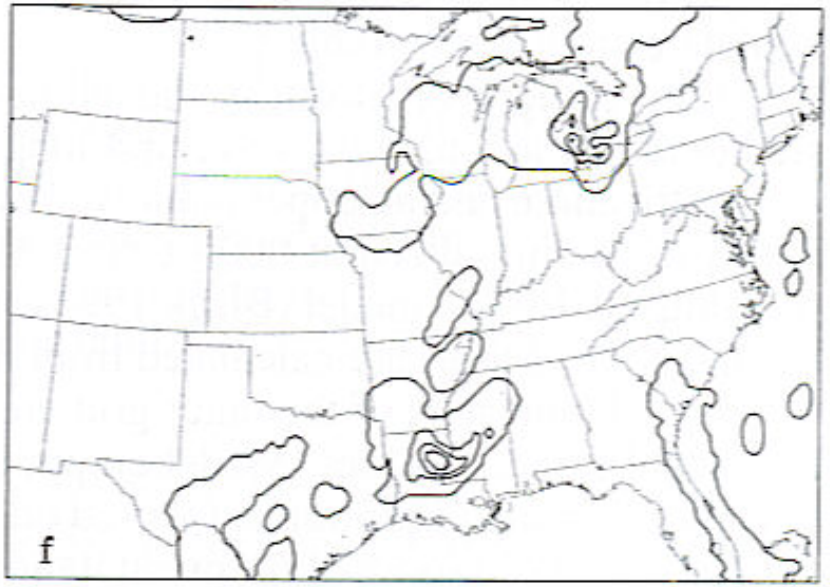
Kain - Fritsch

Are the errors of current forward models of precipitation so large as to render them unsuitable for useful data assimilation?

Errico et al. *QJRMS* 2001:
6-hour accumulated precip.
With 3 versions of MM5
Contour interval 1/3 cm



Betts - Miller



Grell

Thanks to Dave Stensrud

Non-Gaussianity

Consideration of different error distributions changes the metric

$$J_o = \sum_i \sigma_i^{-2} \left[y_i - H_i(\mathbf{x}) \right]^2$$

verses

$$J_o = \sum_i \gamma_i^{-2} \left[\ln\left(y_i\right) - \ln\left(H_i(\mathbf{x})\right) \right]^2$$

Nonlinearity

If a model is linear for state space of dimension N, an ensemble of N linearly independent members is sufficient to completely describe the response of the system to perturbations. If the model is not linear, this is not true.

Reply

To comment by T. Vukicevic

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ABSTRACT

This is a reply to a set of criticisms regarding a previously published work. It briefly addresses the main criticisms. In particular, it explains why some papers identified as having some fundamental flaws were referenced in the original work without detailed exposition of those flaws. It also explains why parts of the conclusions criticized as being contradictory are, in fact, not. It further highlights the need for more publishing of scientific criticisms.

A more recent example of (unpublished) flawed work

(The following is not the way to review such work)

1. A problem of replacement of usual ensembles with ones composed of time-lagged members.

2. Uninformative measures of success: The demonstration that a data assimilation algorithm can draw towards observations does not indicate its suitability.

Some Frequent Problems

1. Lack of statistical considerations (Modern DAS is fundamentally statistical).

2. Many published techniques for "assimilating" precipitation are essentially algorithms for adjusting precipitation.

3. Several comparisons are inappropriate (e.g., those against analysis products generated without consideration of precipitation-related observations, or those against the NCEP/NCAR reanalysis products.)

4. No examination or discussion of the effects of "compromises."

Acceleration of progress

1. Do not assume that most work is fundamentally correct.
2. Do not assume that all works with apparent major flaws are totally without merit.
3. Do not quickly dismiss fundamentals (but take the time to learn them).

4. Recognize that public review is
   a. critical
   b. stimulating
   c. challenging

5. Design formats that permit and encourage serious review