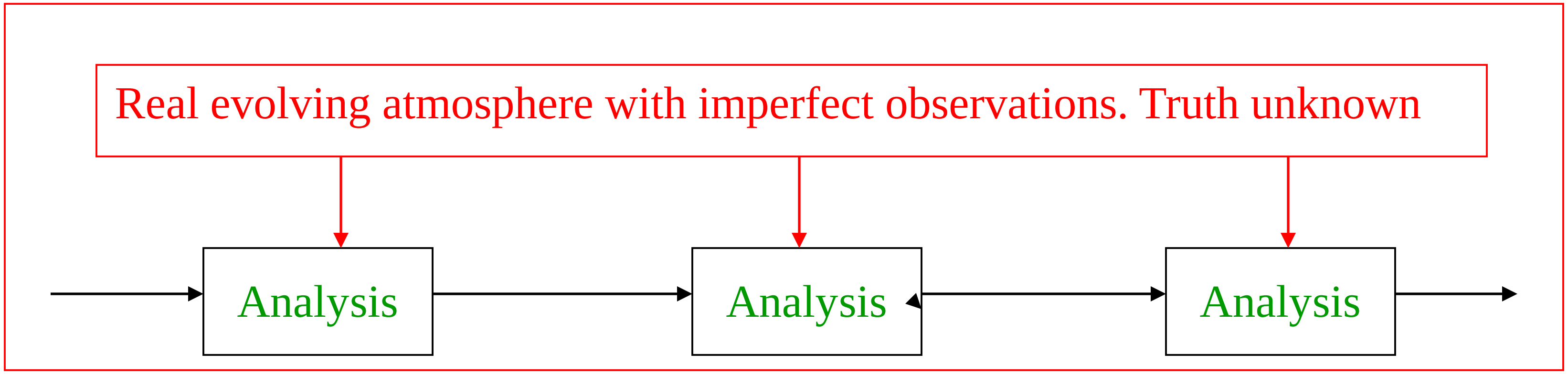
Some General and Fundamental Requirements for Designing Observing System Simulation Experiments (OSSEs)

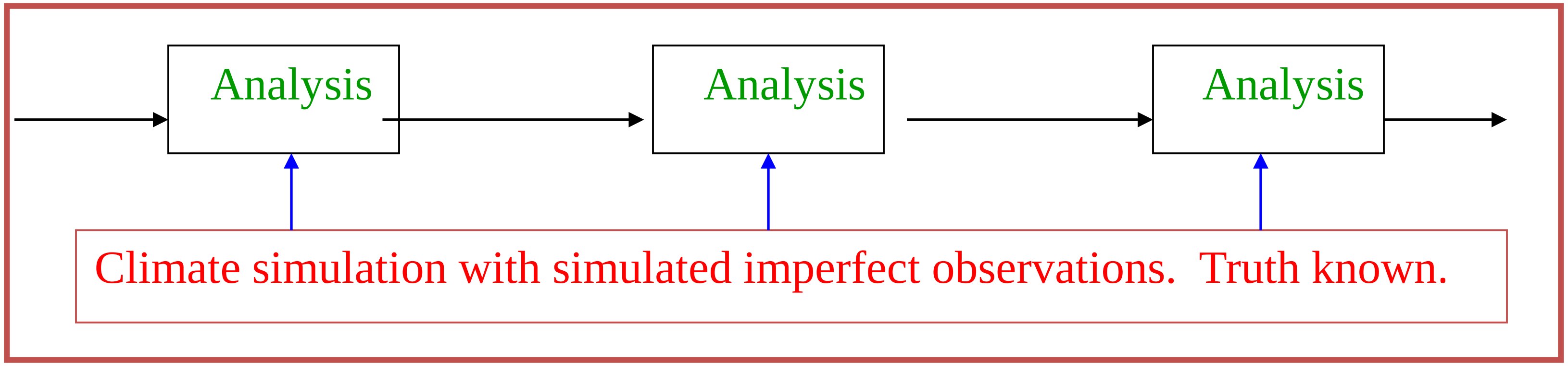
Ronald M. Errico and Nikki C. Privé

Goddard Earth Sciences, Technology and Research Center, Morgan State University
and
Global Modeling and Assimilation Office, NASA Goddard Space Flight Center

Data Assimilation of Real Data



Time ⟶



Observing System Simulation Experiment

Common Short-cuts

1. Observation locations inconsistent with characteristics of real observations.
2. Ignoring important characteristics of the observations (e.g., by treating radiance observations as radiosondes)
3. Instrument or representativeness error absent
4. Inadequate validation of the NR or DAS control is performed.
5. The statistical nature of the DAS problem is ignored.
6. Error correlations not considered.
7. The control DAS uses no or very few observations.
8. The work is harmfully expedited at the demands of an administrator or customer.

Validation of the NR

1. The usual “climate statistics” should be examined.
2. Matches of all such statistics are neither necessary or sufficient
3. Requirements depend on questions explored.

Required properties of simulated observation

1. Counts
2. Spatial and temporal distributions
3. Instrument and representativeness error
4. Error biases?
5. Error variances?
6. Error correlations?
7. Relationships of observation locations and atmospheric state
8. Relationships of observation errors and atmospheric state
9. Distinction between analyzed and discarded observations

Importance of system errors

1. The values of most metrics used to assess real atmospheric data assimilation or forecast systems are determined by the various types of errors inherent in those systems and how the modeling and data assimilation modifies them.

2. These types include observation instrument errors, observation representativeness errors, forecast model formulation errors, and errors introduced by the data assimilation algorithm itself.

Representativeness error in the OSSE context

In the context of data assimilation with real observations,
as a more realistic forward model is introduced,
the representativeness error bias and variance tends to decrease.

In the context of an OSSE with a fixed data assimilation system,
with fixed forward models,
as a more realistic observation simulation model is introduced,
making it more unlike the DAS forward model,
the representativeness error bias and variance tends to increase.

Some general issues

1. Sufficient sampling is an issue.
2. DA results depend on how observations are used, not simply how good they might potentially be
3. Augmentation of the existing network with a new observation set will likely only make modest improvements to accuracy.
4. As long as forecast model error remains significant, assimilation of new observations will only modestly improve accuracy.
5. Assimilating only poor observations is better than assimilating none.
6. The DAS and observing system is likely to change before an OSSE-tested observation is deployed.
7. Poor OSSEs may be preferred by customers.

NR space and time data set truncation

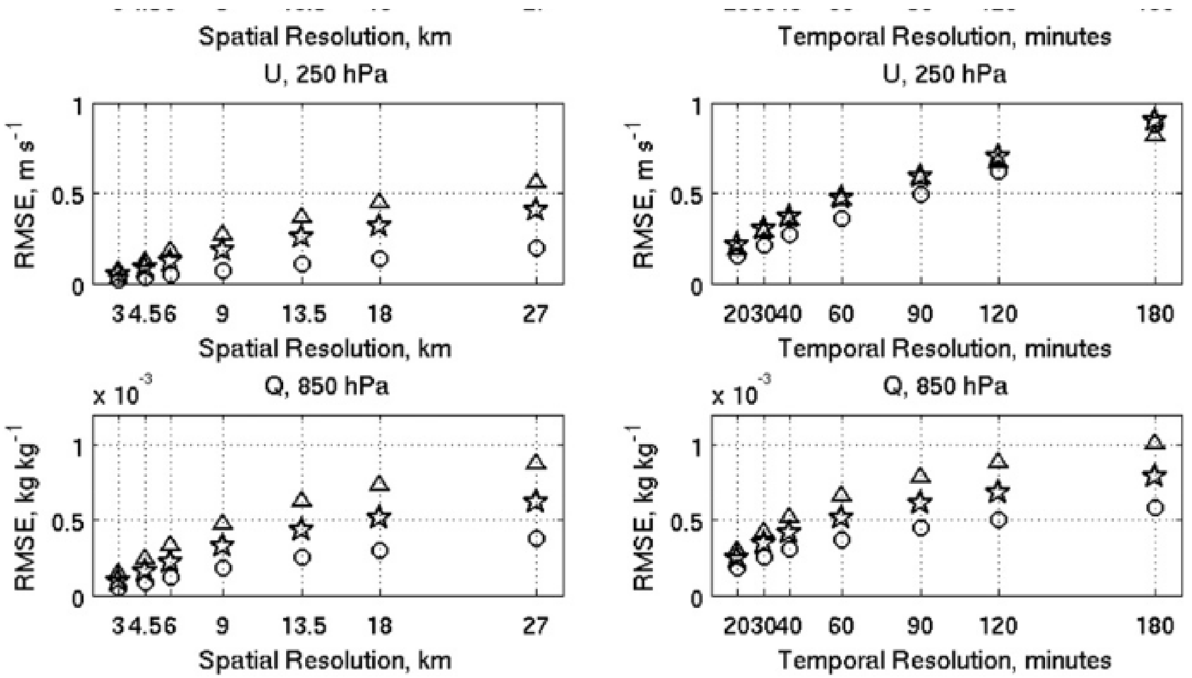


FIG. 1. RMSE for temporal and spatial interpolations calculated for NHEX (star), SHEX (circle), and tropics (triangle) at various resolutions (abscissa) for temperature (K), zonal wind ($m\ s^{-1}$), and specific humidity ($kg\ kg^{-1}$) at 250 and 850 hPa. (left) Spatial interpolation error and (right) temporal interpolation error.

Privé and Errico 2016

Challenges

1. Validation must be performed.
2. OSSEs must be timely.
3. Plug and play OSSE capability has a drawback.
4. System errors need to be identified and validated.
5. Conflicts of interest must be avoided.

Recommendations

The Community should

1. provide input and assessment for OSSE applications
2. provide educational opportunities for OSSE practitioners
3. encourage collaboration and sharing
4. encourage greater consideration of system errors
5. encourage thinking rather than following of recipes
6. create opportunities for critical reviews

The entire community may be affected by OSSE results.

DAOS-WWRP-WMO White Paper

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A White Paper prepared by
Ronald M. Errico[1] and Nikki C. Privé

Goddard Earth Sciences, Technology and Research Center, Morgan State University
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Global Modeling and Assimilation Office, NASA Goddard Space Flight Center

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Executive Summary

The intent of this white paper is to inform WMO projects and working groups, together with the broader weather research and general meteorology and oceanography communities, regarding the use of Observing System Simulation Experiments (OSSEs). This paper is not intended to be either a critical or cursory review of past OSSE efforts. Instead, it describes some fundamental, but often neglected, aspects of OSSEs and prescribes important caveats regarding their design, validation, and application.

Well designed, properly validated, and carefully conducted OSSEs can be invaluable for examining, understanding, and estimating impacts of proposed observing systems and new data assimilation techniques. Although significant imperfections and limitations should be expected, OSSEs either profoundly complement or uniquely provide both qualitative and quantitative characterizations of potential analysis of components of the earth system.