Observing Systems Simulation Experiments (OSSEs) (EK, SAB)

- Good to explore the impact of future instruments, and to test different instrument designs.
- It has a "Nature" (truth) run, e.g., a high resolution 1 year run with the ECMWF model.
- It has a Data Assimilation (DA) similar to the operational system (e.g., GDAS+GFS).
- All observations in the current system are simulated using the Nature run.
- A control DA is created with all the current simulated observations.
- Control forecasts are run from the control data assimilation and verified against Nature.
- "Observations" with the future instrument are created from Nature.
- An experiment DA is performed adding the future observations.
- The forecasts from the control and the experiment are verified against Nature.
- If the forecasts from the experiment are better than the forecasts from the control, we conclude that the new instrument will have a positive impact on the forecasts.

Advantages of OSSEs

- OSSEs allow to test the forecast impact of future instruments and find their optimal design before investing billions of dollars in constructing them.
- In an OSSE you know the complete truth (Nature) so you can test anything you want.

Disadvantages of OSSEs

- They are computationally very expensive and inefficient, requiring a year or more to get forecast impacts that are statistically significant.
- This is because there are already many observations and the new observing system has to compete with the others. It is very difficult to prove the new instrument improves the forecast in a statistically significant way, with very long experiments.

Proposed Solution: Proactive Quality Control (PQC)

- Ensemble Forecast Sensitivity Observations (EFSO) allows to estimate for each observation how much it improves or makes worse the analysis. If EFSO<0 for an observation, the observation is beneficial, because it reduces the analysis error. If EFSO>0, the observation is detrimental, because it increases the error. PQC then deletes the most detrimental observations and modifies the analysis appropriately.
- This is done before the forecast mixes the impacts of all the observations, so it is very precise. The results with lower resolution GDAS/GFS are astonishing: deleting the most detrimental 10-20% observations at every analysis cycle has a beneficial effect that accumulates with time and improves the forecasts substantially by more than 5%.
- All the observations are evaluated, and a few days of EFSO values plotted at every cycle are enough to identify which observations are frequently detrimental, even if they have been used for many years, (e.g., a HIRS channel and MODIS winds).
- Dr. Robert Atlas, Director of AOML, is supporting Dr. Sean Casey to combine PQC with the AOML OSSE system to get the advantages of both systems, under the guidance of Dr. Tse-Chun Chen who in his thesis developed and tested PQC strategies.
References:
Kalnay et al., 2012, Tellus A
Ota et al., 2013, Tellus A
Hotta et al., 2017a, MWR
Hotta et al., 2017b, MWR
Chen and Kalnay, 2018, MWR under revision.

Please write to me for a copy of Dr. Chen's presentation (ekalnay@umd.edu).