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

- Good to **explore the impact of <u>future</u> 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 t**here 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.
Chen, Tse-Chun, 2018, UMD Doctoral thesis and presentation. 28 June 2018.
Please write to me for a copy of Dr. Chen's presentation (ekalnay@umd.edu).