Observing System Simulation Experiments and their Requirements

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What is an OSSE?

An OSSE is a modeling experiment used to evaluate the impact of new observing systems on operational forecasts when actual observational data is not available.

- A long free model run is used as the “truth” - the Nature Run
- The Nature Run fields are used to back out “synthetic observations” from all current and new observing systems.
- Suitable errors are added to the synthetic observations
- The synthetic observations are assimilated into a different operational model
- Forecasts are made with the second model and compared with the Nature Run to quantify improvements due to the new observing system

Synthetic Observations

- ‘Synthetic’ observations are intended to mimic a realistic suite of global observations as if the Nature Run was the real world
- Based (mostly) on metadata from real archived observations
- Nature Run fields are interpolated/processed with observation operators to generate synthetic observations with realistic spatial and temporal distribution
- Simulated observation errors added to synthetic obs
- Synthetic observations are then ingested into DAS just like real data

Observations Types

- Conventional: raob, profilers, aircraft, ships, surface, etc
- Infrared radiance: HIRS4, AIRS, IASI, CrIS
- Microwave radiance: AMSU-A, MHS, ATMS, SSMIS, GMI
- Atmospheric wind vectors
- GPSRO bending angles

Conventional Synthetic Obs

- PREPBUFR temporal/spatial metadata is used as a basis for interpolating the Nature Run fields
- GPSRO uses 2-D operator from ECMWF
- AMVs only use satellite footprints from archived data, not specific obs metadata
- RAOBs/ dropsondes are advected in NR wind fields and use different metadata after launch
- Synthetic obs are placed in PREPBUFR or similar original format
- Simulated errors, including spatial/vertically correlated errors, are added to synthetic observation in BUFR file

Synthetic Radiance Obs

- Read metadata from BUFR files and consolidate needed information in secondary files
- Observations are partially thinned
- Reads secondary files and extracts/saves column data at times/locations from the Nature Run
- NR cloud field used to determine if ob is cloud affected
- CRTM applied to column data for each observation subtype (different operator would be optimal)
- Observations merged back into BUFR files
- Simulated errors (channel correlated) added to observations

Synthetic Obs Issues: Obs Data

- Files contain some information that we don't need (flags, id #s, etc) but that DAS may or may not use
- Helpful for observations to be grouped by type and in temporal order
  - i/o with NR very expensive
  - NR output files as temporal fields – high spatial and temporal resolution = memory intensive and frequent i/o
- Need to be able to mismatch observation type and NR date – ex. Using IASI and GMI for "2005"
- Thinning may be handled differently in the OSSE, so pre-thinned data should be available

Synthetic Obs Issues: Operators

- May want to use different obs operator to generate synthetic ob than is used by DAS
  - OSSE operator may need different input fields from NR, such as clouds/WV for radiances
  - Local/regional fields may be needed for individual obs: RAOB drift; AMV gradients; radiance footprints
  - QC values may also require other fields

Synthetic Obs Issues: Operators

- Some metadata may need to be preserved not normally used by operator, ex. Quality flags
- NR input fields may be much higher spatial and temporal resolution compared to regular output
- Flexibility in using the DAS diagnostic output or raw obs data is desired