Calibration of the Observing Simulation System Experiment (OSSE) use to assess the Impact of Geostationary Hyperspectral Data

Agnes Lim, James Jung, Allen Huang and Zhenglong Li
Cooperative Institute for Meteorological Satellite Studies

Motivation

To demonstrate and access the impact of high temporal, high spatial and high spectral satellite infrared radiances on regional; NWP analyses and forecasts.

1. Observing Simulation System Experiment (OSSE)

- Aim to assess the impact of a hypothetical data type on a forecast system.
- Methodology (Figure 1)
  - Nature run Simulate existing observations.
  - Control run assimilating simulated existing observations.
  - Simulate candidate observations.
  - Perturbation run with the addition of simulated candidate observations.
  - Comparison of forecast skill between the control and perturbation run.

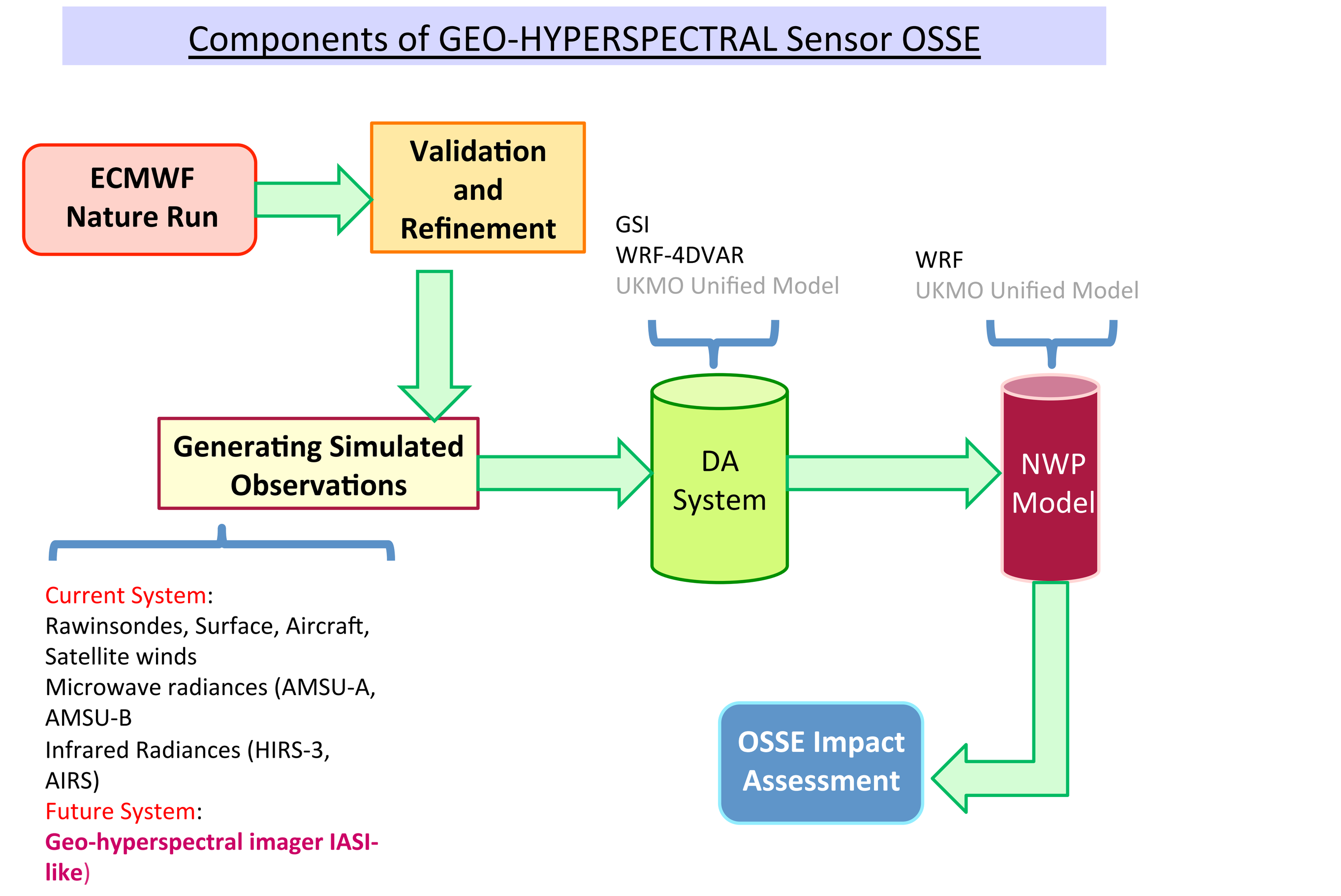

Figure 1 Elements of the GEO-Hyperspectral OSSE

2. Nature Run (NR)

- A long, uninterrupted forecast generated by state of the art numerical weather prediction (NWP) model at the highest resolution possible.
- ECMWF Nature Run (NR)
  - Horizontal resolution: T511 (40km).
  - Number of vertical levels: 91.
  - Period covers 20050510-20060531 (3-hour write ups).

3. Simulation of observations for existing observing systems

- Noise free conventional and existing satellite sensors based on the NR time period were provided by NOAA/NCEP.
- Conventional data
  - Rawinsonde : vertically correlated Gaussian errors added to T, q, u and v component of winds.
  - Other datasets – Non-correlated Gaussian random errors with standard deviation based on GSI observational error table.
- Satellite Data – sum of Gaussian random error with standard deviation based on sensor NEDT and forward model error. No spatial and spectral correlations.

4. Geostationary Hyperspectral Data

- An IASi-like sensor placed in the geostationary orbit.
- Simulated sensor will have observations every 3 hours.
- Simulated geo hyperspectral data treated as a thinned dataset.
- Clear sky RT model - SARTA V1.07 (Strow et al. 2003)
- Cloudy sky RT model (Wei et al. 2004) - Input: cloud-top pressure, cloud optical thickness, cloud phase, particle radius, Single layer model.

5. Assimilation System, NWP model and its configuration

- GSI-3D-VAR, DTC version 3.2.
- WRF-ARW version 3.2.1.
- 250 by 200 by 75 gridpoints with a horizontal resolution of 80km.
- Model top at 1hPa.
- Initial and boundary conditions from GFS T254 from GDAS analyses or OSSE T126 analyses.

6. Experimental Design

- Experiment time period : 15 – 28 September 2005
- 5 weeks of bias coefficients spin up for REAL and OSSE from 5 August – 14 September 2005.
- Data assimilated : Conventional data, AMSU-A from NOAA-15 and AQUA, AMSU-B and HIRS-3 from NOAA-17 and AIRS from AQUA.

7. Calibration

- Verifies that the simulated data impact is comparable to that of real observations.
- Innovations (O-B) and analysis errors (O-A) of observation type from OSSE should be statistically similar to that of real world assimilation.
- Standard deviation of O-B and O-A for radwinsode (T and q) show largest difference between REAL and OSSE occurs near the surface (Figure 2).
- Standard deviation of O-B and O-A for non-surface sensitive channels were pretty similar between REAL and OSSE (Figure 3).
- Statistical properties of analysis increments for OSSE and real world should match.
- Largest differences in analysis increments over land surface and these locations are approximate locations of rawinsondes (Figure 4).

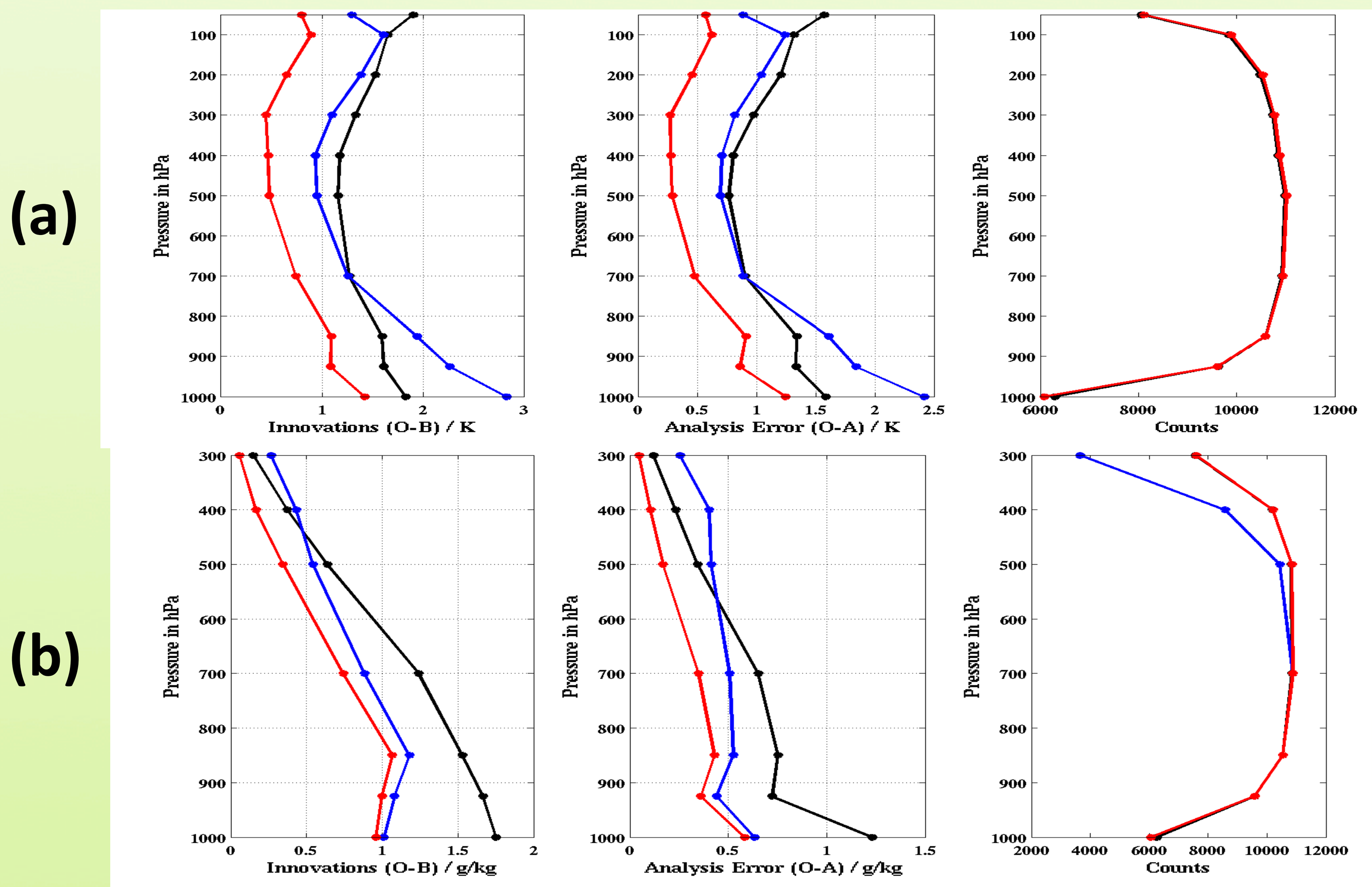

Figure 2 Standard deviation of (a) temperature [K] and (b) moisture)g/kg) for rawinsondes as a function of pressure for REAL (black), OSSE observations with no errors added (red) and OSSE observations with errors added (blue).

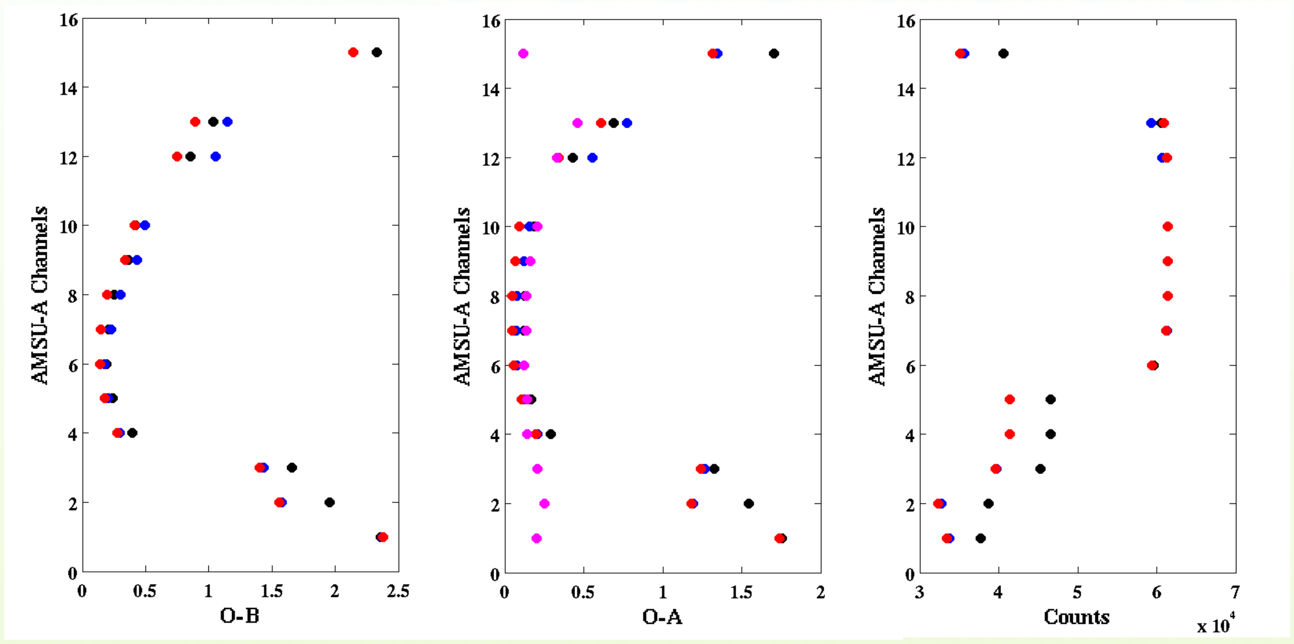

Figure 3 Standard deviation of O-B [K] and O-A [K] for different channels on NOAA-15 AMSU-A for REAL (black), OSSE observations with no errors added (red), OSSE observations with errors added (blue) and NEDT (magenta).

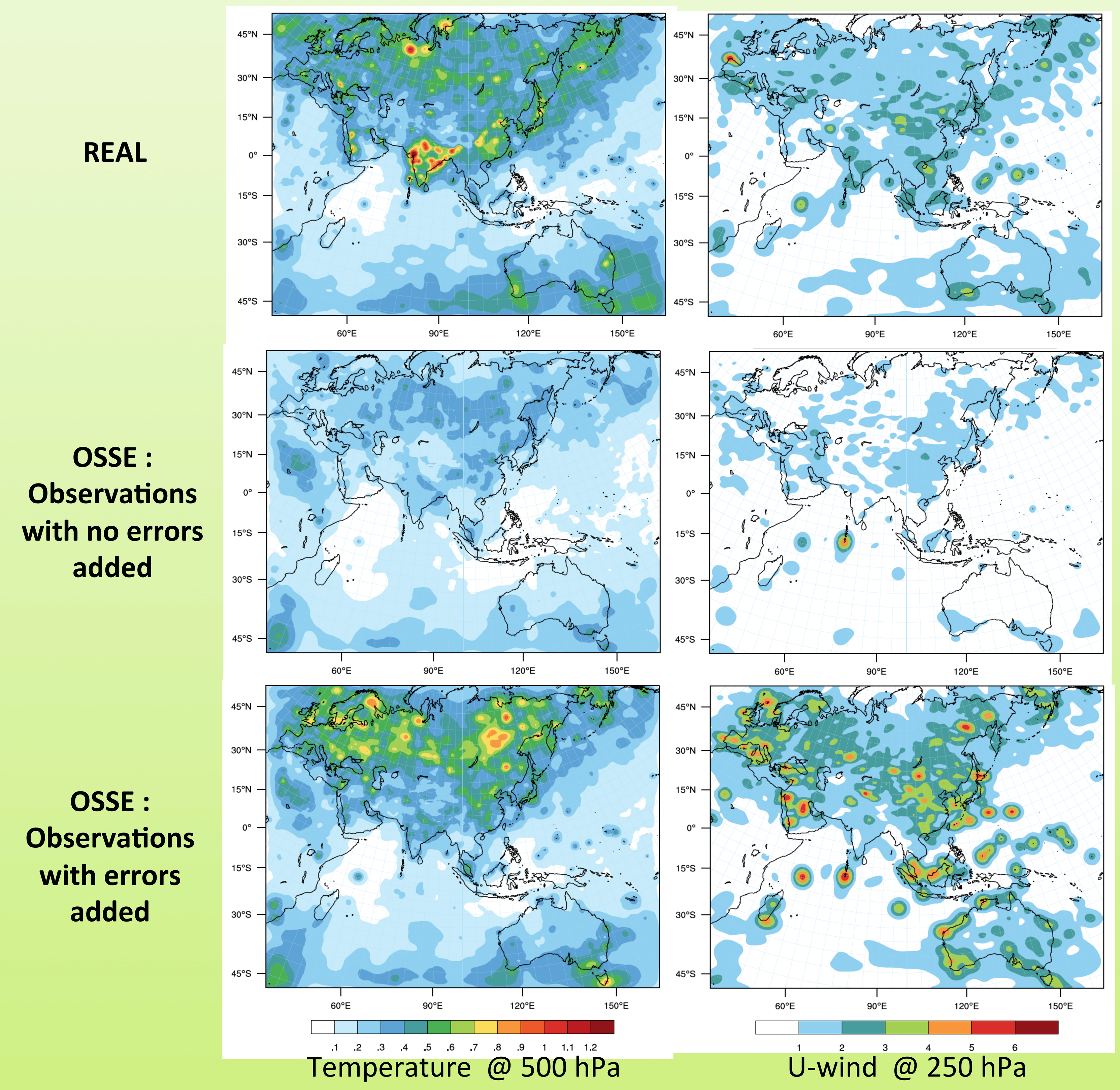

Figure 4 Temporal standard deviation of analysis increments for temperature [K] and u-component wind [m/s].

8. Next step

- As the performance of assimilating existing observing network in the OSSE does not match the REAL.
- Adjustments of synthetic errors added to simulated observations, starting from rawinsondes.
- Longer calibration time period and other verification statistics.
- Single case study with the addition of geostationary hyperspectral infrared data.

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Email : alim@ssec.wisc.edu