Creation of a Control Dataset and Forecast System for Global OSSEs

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Motivation

Every 6 hours, roughly 4 million observations are assimilated into the operational NCEP/Global Forecast System (GFS) model, using Gridpoint Statistical Interpolation (GSI).

When conducting global Observing System Simulation Experiments (OSSEs), we cannot assess the global impacts of potential new observing systems without first creating a control dataset, mirroring these roughly 4 million observations.

This globally-simulated control dataset should
- use geolocation similar to that in the real world
- have similar error statistics to the real-world observations
- yield similar forecast skill to control observations in the real world

This poster describes the methods used to create such a dataset for use in global OSSEs conducted with GFS and simulated from the NASA GEOS-5 7-km Nature Run (G5NR).

Observations

More detail on the simulation of control observations can be found in Boukabara et al. (2016).

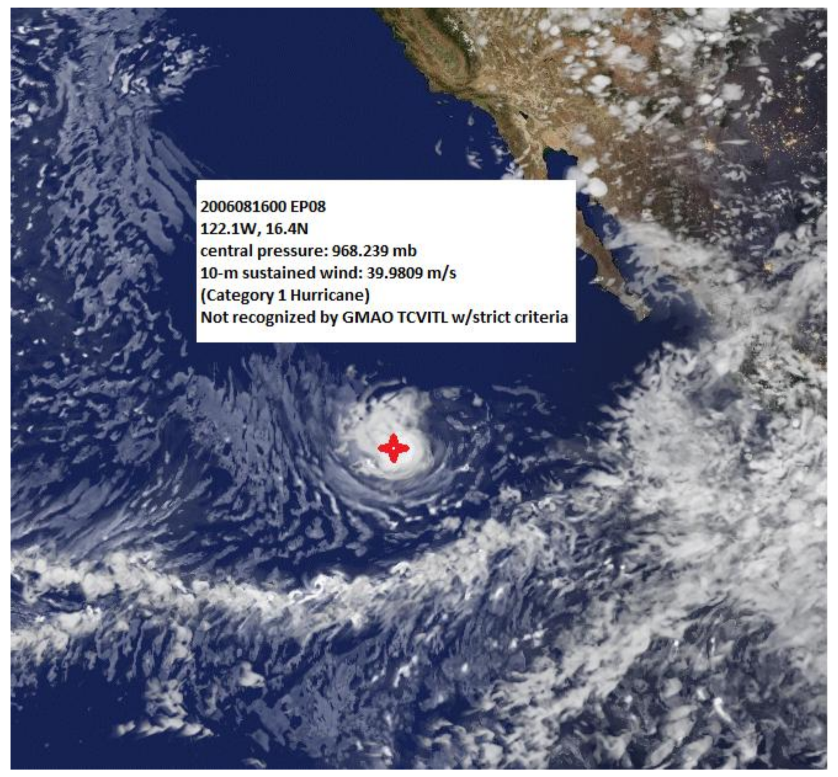
The experiment period chosen for this study was August-September 2006 of the G5NR simulated atmosphere. In order for our global OSSE results to better reflect potential impacts in the current observational system, we must use a more complete and recent observation system (here chosen to be 2014), rather than observations available in 2006.

Locations from August/September 2014 were used to simulate observations from August/September 2006 in the G5NR.

- **Surface Pressure Types (IDs)**
  - Rawinsonde (120)
  - Dropsonde (132, 182)
  - Surface Marine (180)
  - Surface Land (181)
  - Surface METAR (187)
- **Conventional Wind Types (IDs)**
  - Rawinsonde (220)
  - PIBAL (221)
  - NPN Wind Profiler (223)
  - NEXRAD (224)
  - Wind Profiler – PIBAL Decoded (229)
  - Aircraft (230, 231, 233)
  - Dropsonde (232)
  - Surface Marine (280)
- **Moisture Types (IDs)**
  - Rawinsonde (120)
  - Dropsonde (132, 182)
  - Surface Marine (180)
- **Satellite Wind Sources (IDs)**
  - JMA (242, 250, 252)
  - EUMETSAT (Meteo-Sat) (243, 253)
  - NESDIS-GOES (245, 246)
  - MODIS/POES (Aqua) (257, 258, 259)
  - ASCAT (290)
- **Temperature Types (IDs)**
  - Radiosonde (120)
  - Aircraft (130, 131, 133)
  - Dropsonde (132, 182)
  - Surface Marine (180)
- **Radiance Instruments (Satellites)**
  - Aqua (AIRS, AMSU-A)
  - F17 (SSMIS)
  - F18 (SSMIS)
  - GOES 15 [GOES Sounder (4 detectors)]
  - M10 (SEVIRI)
  - Metop-A (AMSU-A, HIRS4, IASI, MHS)
  - Metop-B (AMSU-A, IASI, MHS)
  - N15 (AMSU-A)
  - N18 (AMSU-A, MHS)
  - N19 (AMSU-A, MHS)
  - NPP (ATMS/CrIS)
- **GPS Bending Angle (IDs)**
  - Metop-B (003)
  - Metop-A (004)
  - TSX (042)
  - COSMIC (740-745)

Observations (cont.)

Special Case: Tropical Cyclone Pressure Observations

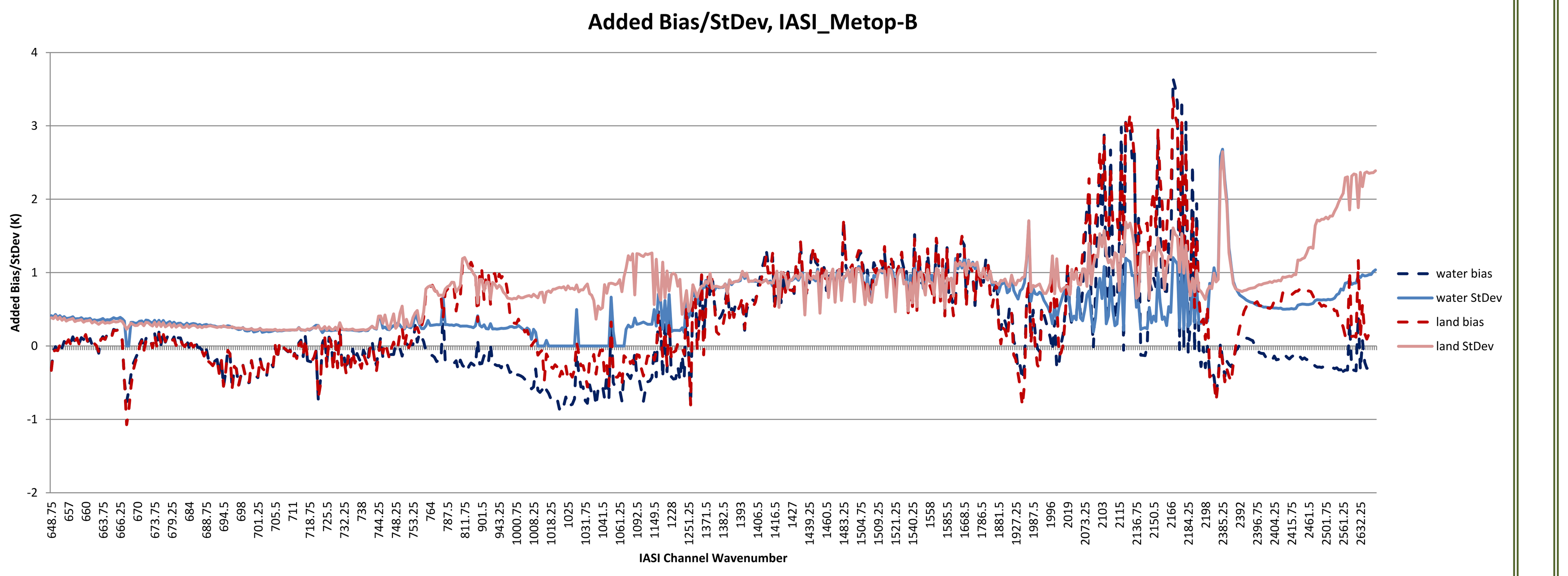


- Initially simulated by GMAO from G5NR using Putman (2015), Reale et al. (2017)
- Four strict criteria were used to identify storms
  - Alignment
  - Vorticity
  - Presence of a Warm Core
  - Wind Speed
- Tracks strong storms effectively, but misses genesis and lysis stages
- Left: Cat 1 hurricane missed by algorithm (during lysis stage)
- Here we developed an algorithm to expand tracks through genesis/lysis
  - Only works on storms identified by Reale/Putman algorithm
  - Considers only central pressure, maximum 10-m wind speed

Added Errors

GSI identifies obs innovation (O-B) for each ob type, separating by height (for conventional and GPSRO observations) and channel (for radiances).

Most observations types will show significant differences in RMSE between real and simulated "perfect" observations.



Above: Bias/RMSE added to IASI/Metop-B simulated radiances (clear-sky) in order to match error characteristics noted in real observations [similar to Errico et al. (2013)]

Similar methodology applied to all observation types, with the exception of tropical cyclones.

Basin/Metric	Tropical Storms	Category 1-2	Category 3-5
Atlantic west of 60°			
-pressure (mb)	3.8	4.4	4.9
-location (n mi)	27.5	18.6	14.0
All other observations			
-pressure (mb)	7.3	9.6	11.9
-location (n mi)	43.1	29.0	15.4

TC Random Errors

- Many more TCs in G5NR than in real-world comparison period
- Small number of observations in real-world comparison period renders direct comparison/calibration ineffective
- Instead, adding central pressure, location errors based on Landsea/Franklin 2013 (left)
- Numbers converted from Mean Absolute Error to 1-sigma (above)
- Chi-squared distribution used for position magnitude errors (2 degrees of freedom)

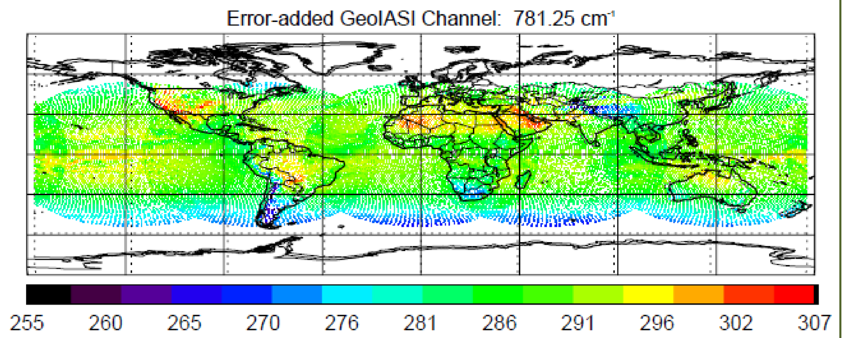
Model Configurations

NWS/NCEP Global Forecast System (GFS) used for experiments
- NWPROD_2015_Q1 configuration (previous operational set-up)
- Run at research resolution:
  - Spectral truncation T670 for Global Spectral Model (GSM) forecasts
  - T254 Global Statistical Interpolation (GSI) analysis
  - T254 3D Ensemble Variation (3DEnVar)

Changes made to assimilation/model system for OSSE usage:
- Removal of spatial averaging for ATMS, SSMIS in GSI; not necessary given simulation of radiances at same geolocation regardless of channel
- Parameter changes for GSM forecasts:
  - Raising mountain block/orographic drag coefficients from '0.75,3.00' to '1.50,6.00'
  - Raising vertical momentum diffusion coefficient from 3.0 to 6.0
  - Why?
    - Running forecasts with standard research-version coefficients created a "fraternal-twin" problem, with GFS forecast skill with respect to G5NR much higher than observed in the real world
    - Increasing these coefficients reduced forecast skill, better approximating real-world forecast skill in the OSSE system.

Test Observations

With the control dataset simulated, with errors added, and with the model configuration set, we can now begin the process of simulating prospective new observations and running forecasts to test these.



Right: Example test observations (with added errors) for five Geostationary Hyper-Spectral Sounders (GeoHSS), located at 0°E, 60°E, 120°E, 185°E, and 225°E longitude (see IOAS/AOLS presentation 3.6, slides/extended abstract available upon request)

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