Impacts of Ocean Observing Systems in NCEP GODAS in the Tropical Pacific

Hyun-Chul Lee[1] and Daryl Kleist[2]
([1]IMSG at NOAA/NWS/NCEP/EMC, [2]NOAA/NWS/NCEP/EMC)
email : hyun-chul.lee@noaa.gov

The currently operational Global Ocean Data Assimilation System (GODAS, Behringer, 2007) assimilates in situ profile data from EXpendable BathyThermograph (XBT) and Conductivity Temperature Depth (CTD), stationary fixed moorings, autonomous Argo floats, and remotely sensed sea surface temperature. With GODAS, these ocean observing systems are fundamental to NCEP's operational efforts not only for monitoring the ocean state but also for forecasting multi-week to seasonal variability in the NCEP CFSv2. In order to evaluate the impact of the observation system on NCEP operational products, a series of observing system experiments (tOSE; Lee, et al. 2020) have been carried out, and the observational innovations and the analysis increments associated with individual ocean observations in NCEP's GODAS are monitored and evaluated.

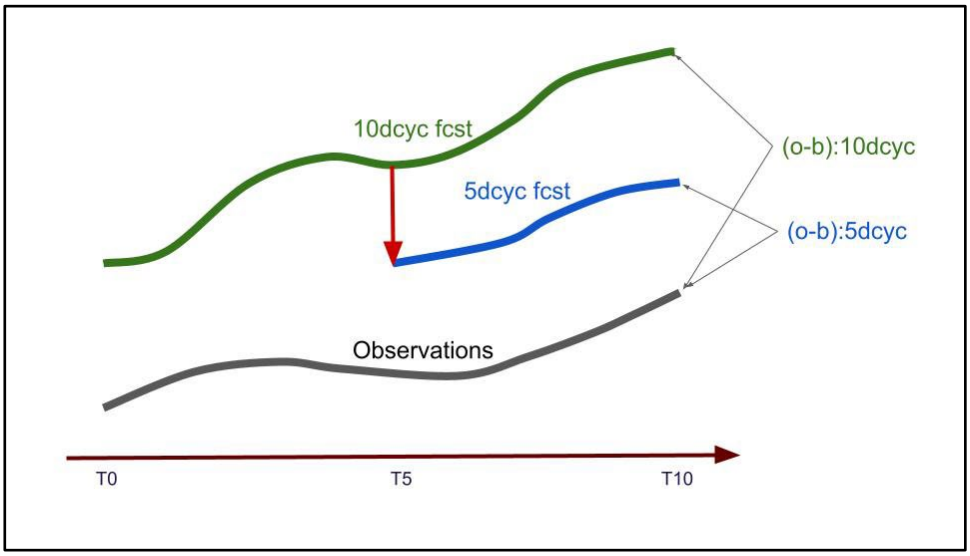

Figure 1. Schematic diagram showing trajectories of 10 day (green) and 5 day (blue) cycled runs, and real observations (black) in time. 10 day and 5 day cycled runs start at the same time, and the restart of 5day cycled runs from the analysis field (red arrow).

In the tOSE, the impacts of the observing systems on the GODAS are defined from the differences of absolute values of observation innovations between 5 day and 10 day cycle runs. Figure 1 shows a schematic diagram of the tOSE for 5 day/10 day cycle runs. At the end of the two runs, the differences are due to the updated initial states of the 5 day run. From the results of these differences, it is possible to estimate the impacts of each observing system on the GODAS, which is traceable at each observation in space and time.

In order to evaluate the impacts of the observing systems, the assimilation impacts of observing systems (AIOS) and the forecast impacts of observing systems (FIOS) are defined as

$$AIOS = \sum_{i=1}^{N} |o-b|_i \, , i \in regions \quad \text{and}$$

$$FIOS = AIOS_{10day} - AIOS_{5day}$$

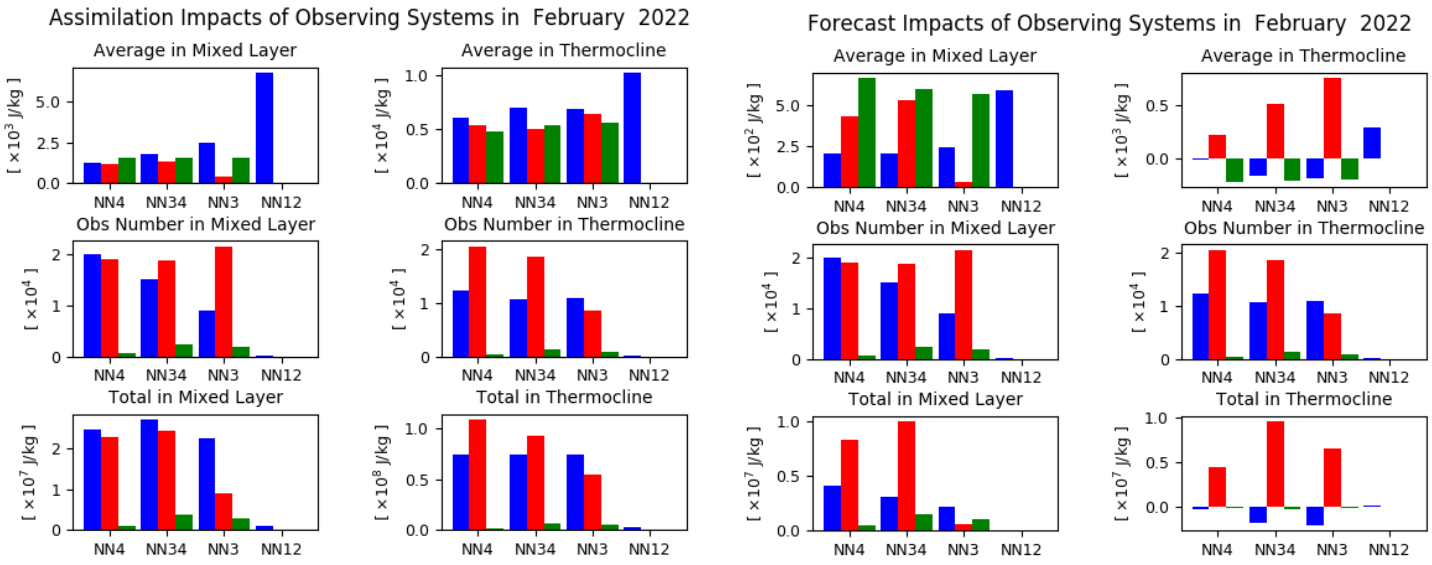

Figure 2 Regional averaged AIOS (left) and FIOS (right) in February 2022 tropical Pacific oceans (right) from the observations of the Argo floats (blue), moored buoys (red) and CTD profiles (green), averaged over the NINO1+2 (NN12), NINO3 (NN3), NINO3.4 (NN34) and NINO4 (NN4) regions. Vertically, 'Mixed Layer' is the layer of temperature difference from SST that is less than 0.5ºC, and 'Thermocline' is the layer in the temperature range of 18 - 22ºC.

Figure 2 shows the energy-weighted AIOS and FIOS in February 2022, which are averaged in the regions of the tropical Pacific. During February 2022, the Argo (blue) and moored buoy (red) data are the main sources of in situ profile data in the tropical Pacific (middle row in Fig. 2). During this period, the relatively small amount of profile data from ships is also assimilated (green). The total AISO shows that the GODAS have been assimilated mainly from the Argo and moored buoy data. In the mixed layer, the profile data from Argo has larger impacts in the whole tropical Pacific. In the thermocline layer, the moored buoy data have larger impacts than Argo data. In February 2022, the Argo data induced more AIOS in the thermocline layer at NN3.

In the mixed layer, the FIOS of moored buoy data are two to three times larger than the FIOS from Argo in the NN4 and NN34 regions. In the thermocline layer, the moored buoy plays an essential role in FIOS for the whole tropical Pacific. The FIOS from Argo and ship data in the thermocline layer have the negative values. This means that actually FIOS in GODAS are degraded by these data in the regions in February 2022. This degradation of FIOS would be due to the dynamical mismatch between the real ocean and GODAS. The patterns and intensity of observational impacts in AIOS and FIOS change regionally and monthly, and the impacts of AIOS/FIOS in the NCEP GODAS have been monitored in near-real time. The tOSE's and monitoring systems of AIOS/FIOS are being developed for the application to the next version of GODAS.

Acknowledgements: This study was supported by NOAA's Global Ocean Monitoring and Observing Program.

References:

Behringer, D. W., 2007: The Global Ocean Data Assimilation System(GODAS) at NCEP. *Proc. 11th Symp. Integr. Obs. Assim. Systems*, San Antonio, TX, Amer. Meteor. Soc. 3.3.

Lee, H.-C., D. Behringer, D. Kleist, 2020, A traceable Observing System Experiment in NCEP GODAS, Research activities in Earth system modelling. Working Group on Numerical Experimentation. Report No. 50. WCRP Report No.6/2020. WMO, Geneva (http://bluebook.meteoinfo.ru/index.php?year=2020&ch_=2), pp.1-11--1-12.