Evaluation of Quality Control Methods and their influence on HYCOM model Background

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Observations are an integral part of any data assimilation system. Measured ocean observations are available from various sources, e.g., SST from satellites, SSH anomalies from altimeters, T&S from profiles, XBT's, moorings etc. Quality control (QC) of observations is required to make a decision on the validity of newly received data and requires information about the data. For profile observations the possible collocated products are climatology (e.g., GDEM), cross-validation (xval), analysis and forecast. The main purpose of the QC is to bring data validation information into the analysis process. While QC of observations is done at the data release time, real-time operational QC methods are also required to improve consistency of the data with simulated ocean states used in the data assimilation procedures (e.g., Navy Coupled Ocean Data Assimilation System – NCODA; Cummings and Smedstad, 2013). NCODA has a built-in QC that works in conjunction with its 3D variational algorithm (Cummings, 2011). At NCEP, 24-hr forecast fields are generated from the 1/12 deg global Real-Time Ocean Forecasting System (RTOFS). In this study, the influence of additional automated QC methods for real-time applications and the importance and consequences of using model background fields for QC in real-time operational ocean analysis and forecast is presented.

A few days of QC'ed profile data provided by the US Navy consisted of daily profile temperature (^{o}C) and salinity (psu) measured from Fixed Buoys, Drifting Buoys, Marine Mammals, Argo Floats, TESAC (Temperature, Salinity and Currents) and Expendable BTs. The QC'ed profile data was reformatted to obtain the pre-QC'ed incoming files. These files were input into the NCODA QC algorithm with the NCEP global HYCOM+CICE+NCODA (HYCOM; Bleck, 2002) generated forecast as background field.

The probability of error (E) for an observation w.r.t a background field can be computed from the normalized innovations as, I=(Obs-background)/σ, where σ is the error estimate of the background field. The error probability E that the observation contains a random error I is obtained from the normal distribution (Cummings, 2011). The US Navy profile data included xval information. The xval method computes corrections to climatology using observations against other nearby data. It is analogous to checking observations against a dynamic, time-dependent climatology. The error probability E for GDEM climatology and for the HYCOM 24-hr forecast was computed in addition to the error probability E for xval.

The total number of profiles available for March 01, 2017 are 7452 (Fig. 1), of which 2265 profiles have overall error probability values of less than 1.0 (Fig. 2a and Fig. 2b). The profile locations where HYCOM probabilities are smaller than climate are plotted in Fig. 2, indicating than HYCOM is a better predictor of profile temperature at ~68% of locations. The xval probabilities are also compared to the probabilities from GDEM in Fig. 3. The xval is found to be a better predictor of profile temperature than GDEM at ~44% of locations. However, in comparison to HYCOM, the profile locations where xval is a better predictor than GDEM climatology are more spread out. The profile temperature from three locations near equatorial Pacific are also compared to HYCOM and GDEM temperatures in Fig 3, where HYCOM is a better predictor of profile temperature than GDEM (blue circles: Fig 3 top panel) and GDEM is better predictor of profile temperature than HYCOM (red circles: Fig 3 top panel). Replacing GDEM climatology with HYCOM forecasts as background field would on average improve the QC of the profile data more than xval, but this occurs in regions where there is repetition in measurements (e.g., TAO/TRITON buoys; glider transects off the California coast; Mediterranean moorings; Japan Meteorological Agency's repeat hydrography, etc). Extended regions containing different sources of profile data, where error probability E for HYCOM is large, indicate regions with low forecast skills. The same analysis was repeated for March 10, 2017 with similar results. As an additional by-product, including the HYCOM forecast in the QC will give an indication of HYCOM forecast skill. This experiment is the first step in testing the use of including ocean forecasts to QC ocean observations and is being further investigated.

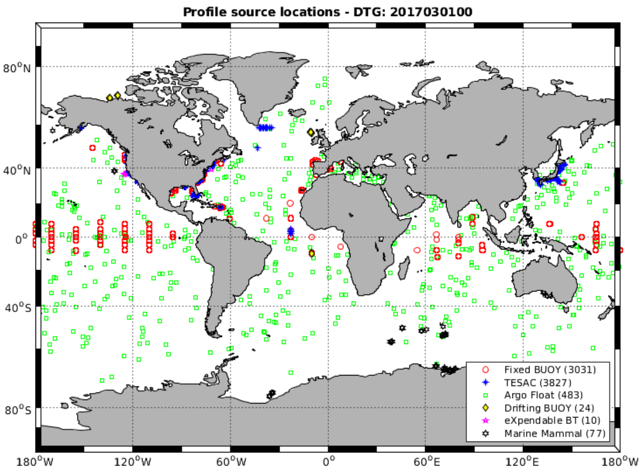

Figure 1. Locations of profile data – March 01, 2017.

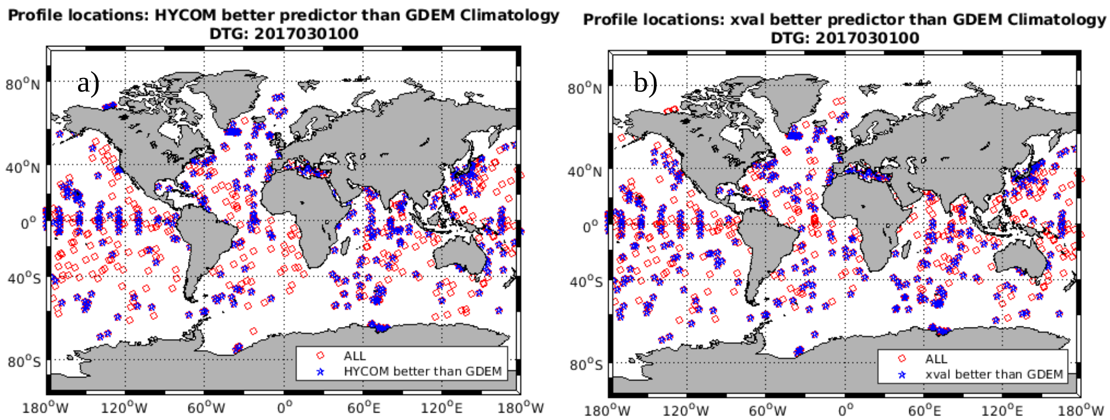

Fig 2. Locations of profiles where (a) HYCOM is a better predictor than GDEM and (b) xval is a better predictor than GDEM.

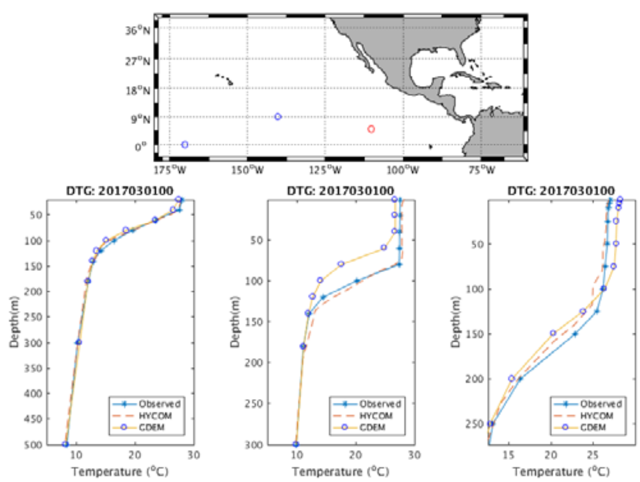

Figure 3. Profile Temperature comparison with HYCOM and GDEM climatology at three locations, where HYCOM is a better predictor of profile temperature than GDEM (blue circles-top panel) and GDEM is better predictor of profile temperature than HYCOM (red circle-top panel). Profile figures left to right correspond to profile locations from west to east.

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