Innovative Methods for Global Ocean Currents Verification

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Introduction

Operationalisation of verification of ocean current forecasts is under active development by the Australian Bureau of Meteorology (ABoM), Mercator Océan International (MOi), Environment and Climate Change Canada (ECCC), and the UK Met Office. To achieve this, we have explored innovative methods of consensus filtering of observations, inclusion of wave-driven Stokes drift, and Lagrangian diagnostics in global ocean currents verification. We have further evaluated drifting fish-aggregating-devices (FADs) to expand the temporal and spatial observational coverage for global ocean currents verification. A preliminary analysis against SWOT has shown good agreement with ABoM model analysis data.

Eulerian currents verification and intercomparison

We have shown that filtering observations from the global drifter program (GDP) buoys to daily-averages that correspond to daily-averaged model outputs and including Stokes drift from global wave models scaled to the depth of observations significantly improves model representation with the observations by 10-15% (Aijaz et al., 2023). Verification analysis leveraging the CLASS4 data convention established by the OceanPredict task team for Intercomparison and Validation (IV-TT) has been applied to participating global models, ABoM Ocean Model, Analysis and Prediction System (OMAPS), Mercator Océan International (MOi) ocean forecast system, the UK Met office operational models, Forecast Ocean Assimilation (FOAM), and the Canadian Global Ice Ocean Prediction System (GDPS), and Global Ensemble Prediction System (GEPS). Figure 1a presents the overall mean absolute error (MAE) for analysis for each current component for all models while time-series of MAE of selected models for zonal currents is shown in Figure 1b. Comparison of filtered SWOT and OMAPS geostrophic currents shows a high correlation of 0.8 in areas, such as southern Africa, where geostrophic balance is dominant (Figure 1c), and reasonable correlations (0.5-0.6) where it is weak (not shown) or in areas of high frequency motions. The MAE for the forecast lead times is displayed in Figure 2. Although there are significant differences in the model configurations of various models, all models are shown to be statistically similar with consistent temporal and spatial patterns (not shown) for both analysis and forecast.

Lagrangian modelling

As drifting buoys are the primary source of observations for the verification of ocean currents, we have also employed Lagrangian diagnostics using OceanParcels (https://oceanparcels.org/) tracker model for verification of virtual and observed Lagrangian trajectories. We compare the Lagrangian trajectories of simulated particles released in the Western and Central Pacific Ocean (WCPO) with those of GDP drifters using current fields from OMAPS over a period of one year. We further evaluate the simulated trajectories in the WCPO with the trajectories of FADs over 28-day time-period by computing separation distances and skill scores following Liu and Weisberg (2011).

A one-year analysis shows that the FADs currents are highly correlated with the GDP currents (Figure 3a). The distribution of separation distances (Figure 3b,3c) and skill scores (Figure 3d) of virtual trajectories against observations from GDP versus FADs are remarkably similar. Although FADs are not designed as an ocean observing platform, the autonomous propagation of FADs provides viable information on ocean currents and ocean circulation features. In addition, FADs can be used for in-situ validation of satellite observations, and maritime safety including oil spills and search and rescue operations. The results from this study demonstrate that FADs are a valuable observation source for verifying ocean currents in global ocean forecast models.

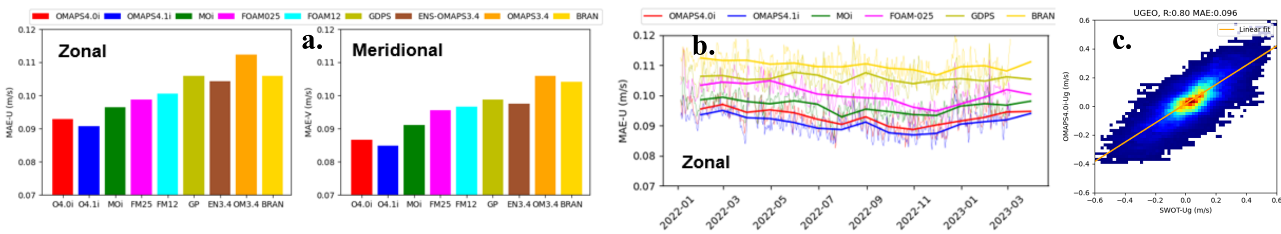

Figure 1a: Overall MAE for zonal and meridional currents for global analysis for OMAPS (orange), ENS-OMAPS (sienna): 21May2021–20May2022 (364 days); OMAPS4.0i (red), OMAPS 4.1i (blue): 1Jan2024–30Jun2024 (182 days); MOi (green), FOAM025 (magenta), FOAM12 (cyan), ECCC (olive), BRAN (OMAPS Reanalysis) (yellow): 1Jan2022–10Mar2023 (432 days); b. Time-series of daily and monthly MAE for zonal currents (dark solid lines represent monthly means, and light lines represent daily means); and c. Correlation of filtered SWOT (21-day orbit) and OMAPS 4.0i geostrophic zonal velocities over 24-hours (23Oct2023).

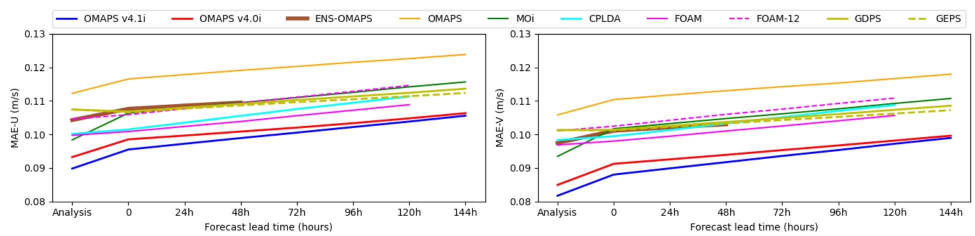

Figure 2: Overall MAE for zonal (left) and meridional (right) currents for forecast lead times of 0 to144 hours (seven days). Timeframes are the same as for Figure 1a.

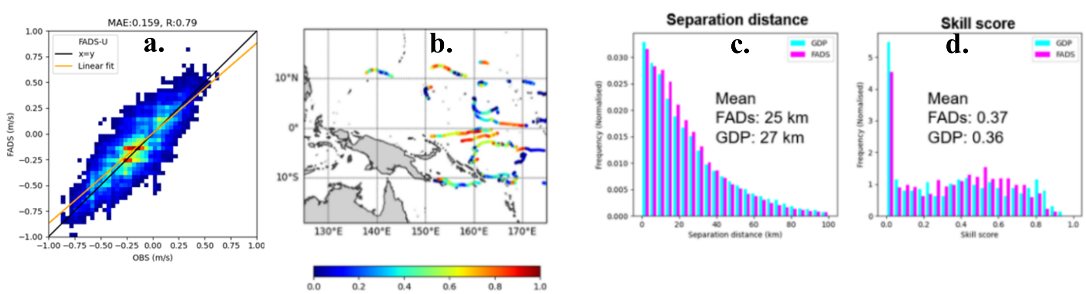

Figure 3a. Correlation of FADs with GDP (OBS) zonal currents; b. Map of OMAPS skill score vs GDP after 72 hours of drifting for total of 28 days' simulations; c. Distribution of separation distances; d. distribution of skill scores between virtual OMAPS Lagrangian particles versus GDP (cyan)/FADs (magenta).

References

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