Observing and assimilating total surface velocities: Challenges and perspectives with the ODYSEA mission

Ocean surface currents are critical for a large diversity of short-term real-time ocean prediction applications such as transport of pollutants and harmful algae, navigation, and search and rescue. Today, only moored current meters, fixed and ship-based ADCPs, High-Frequency Radars (HFR) provide ocean total current information, but each in a very few locations, and often close to the shore. Geostrophic currents can be deduced from altimetric observations, except in the tropics. The evaluation of the quality of the surface current estimates from multi-observation-based products and from analyses and forecasts produced by ocean monitoring and prediction systems is also very limited due to the absence of global direct surface current observations. The ODYSEA (Ocean Dynamics and Surface Exchange with the Atmosphere) satellite mission is a NASA/JPL and CNES proposal that will fill this gap by providing colocalized ocean and wind observations with a doppler scatterometer. ODYSEA has been selected for Phase A in NASA's Earth System Explorers program, and final selection of Earth System Explorers will take place in mid-2025. Having satellite measurements at the interface between the ocean and the atmosphere will help to advance our understanding of the mechanisms that drive ocean-atmosphere interaction, on scales extending from global down to few kilometers, and will improve the coupled ocean/atmosphere systems that are coming to be more commonly used. The potential benefit of assimilating surface currents in operational ocean forecasting system was assessed using the so-called OSSE approach in two different systems: Mercator Ocean (MO) and the UK Met Office. The first OSSEs in the MO global system at ¼° show a very significant improvement of the surface current estimation with impacts that remain over several days in the forecast. The assimilation experiments also highlight the importance of the model background covariance matrix to properly project the information into the ocean interior and onto other model variables to avoid spurious signals, especially at depth below the thermocline. These OSSE experiments will be updated with an improved assimilation system and with simulated ODYSEA-like observations. The sensitivity to the observation accuracy will be assessed, and the complementarity of ODYSEA observations will be evaluated with respect to other observing systems such as altimetry observations.

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