SWOT satellite sea level observations: validation and integration with high-resolution regional simulations

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Based on an innovative interferometric technology, the SWOT (Surface Water and Ocean Topography) satellite mission has been mapping the sea surface topography with an unprecedented spatial resolution for the last two years, providing new insights into the two-dimensional sea level signature of small mesoscale ocean features. Combining in-situ measurement campaigns and high-resolution regional modelling, the FaSt-SWOT and SWINT projects aim at both validating SWOT measurements and improving our understanding of the small-scale regional ocean variability through the integration of these new observations with multiplatform in-situ measurements and regional modelling. These projects take advantage of the availability of daily-repetitive observations collected by the satellite over specific tracks in the Western Mediterranean Sea during the initial 3-month fast-sampling phase of the mission.

Two sea trial experiments were conducted in the Balearic Sea in April-May 2023, leading to the collection of observations from ship-based instruments (CTD, Moving Vessel Profiler, thermosalinograph, ADCP) and autonomous platforms (surface drifters and gliders). These measurements allowed us to characterize the thermohaline and kinematic properties of a ~20-25km-radius intrathermocline anticyclonic eddy detected under the swath of the satellite, approximately 60km from the coast of Mallorca and Ibiza Islands. In addition, numerical simulations were developed to support the cruise planning, help data analysis and provide a complementary view of the small-scale ocean variability. These include the 2-km resolution data-assimilative predictive model WMOP, as well as 650m-resolution nested simulations.

We evaluate both SWOT observations and high-resolution regional simulations using this valuable in-situ dataset. On the one hand, SWOT is found to significantly improve the representation of the signature of this small-scale eddy with respect to conventional altimetry, both in terms of observed sea level and derived geostrophic currents. SWOT, together with glider observations, also reveal a significant temporal variability at a daily timescale. On the other hand, the simulations represent a small-scale anticyclonic eddy in the study area showing similarities with the observed eddy in terms of dimension and vertical structure, yet with a 25km spatial offset.

This good agreement between SWOT and in-situ observations opens the door for their integration into numerical models through data asssimilation. We provide here initial results about the contribution of SWOT observations to the improvement of the representation of ocean variables in these high-resolution regional simulations.