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Ocean surface current from Space: Advancing the understanding of upper layer dynamics and fluxes

Johnny A. Johannessen (1), Bertrand Chapron (2), Vladimir Kudryavtsev (3), and Fabrice Collard (4)
(1) Nansen Environmental and Remote Sensing Center, Bergen, Norway (johnny.johannessen@nersc.no), (2) Ifremer, Plouzane, Brest, France, (3) RSHU, St. Petersburg, Russia, (4) OceanDataLab, Plouzane, Brest, France

This paper discusses the establishment of a new framework for synergetic use of satellite data. The motivation is to advance the understanding and ability to more consistently transfer the 2-dimensional (2D) satellite observations of the surface expressions of mesoscale to submesoscale features in the upper ocean to 3D upper ocean dynamics. This strongly capitalizes on both existing and approved high resolution and coarser resolution satellite data in synergy with high quality in-situ data and reliable ocean models.

A synergetic approach for quantitative analysis of high-resolution ocean synthetic aperture radar (SAR) and imaging spectrometer data, including the infrared (IR) channels, has recently emerged. This approach first clearly demonstrates that sea surface roughness anomalies derived from sun glitter imagery compare very well to SAR roughness anomalies. As further revealed using these fine-resolution (from about 1-10 km) observations, the derived roughness anomaly fields are spatially correlated with sharp gradients of the sea surface temperature (SST) field. To quantitatively interpret SAR and optical (in visible and IR ranges) images, equations are derived to relate the "surface roughness" signatures to the upper ocean flow characteristics. As developed, a direct link between surface observations and divergence of the sea surface current field is anticipated. From these satellite observations, intense cross-frontal dynamics and vertical motions are then found to occur near sharp horizontal gradients of the SST field. As a plausible mechanism, it is suggested that interactions of the wind-driven upper layer with the quasi-geostrophic current field (via Ekman advective and mixing mechanisms) result in the generation of secondary ageostrophic circulation, producing convergence and divergence of the surface currents. Combined with the larger scale (30-50 km) regular estimation of the surface geostrophic currents this new framework will thus provide new and innovative information products of ocean surface current from space.

The proposed synergetic approach combining SST, sun glitter brightness- and radar backscatter anomalies, augmented by other satellite data (e.g., altimetry, scatterometry, ocean color), can thus provide consistent and quantitative determination of the location and intensity of the surface current meandering fronts and eddies including the strength of convergence/divergence (upwelling/downwelling) zones. This, in turn, establishes an important new framework toward quantitative understanding of the ocean surface currents and the upper ocean dynamics and fluxes from new interpretation of the two-dimensional surface expressions in the range from km to several tens of km as derived from satellite sensor synergy.