Coastal Ocean Data Assimilation and Forecasting Using a Multi-Scale Three-Dimensional Variational Data Assimilation Scheme

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Coastal ocean flows are often characterized by multiple spatial and temporal scales, and mesoscale and sub-mesoscale features, such as eddies and filaments, are energetic. A multi-scale three-dimensional variational data assimilation (MS-3DVAR) scheme has been formulated for high resolution coastal ocean models that represent a wide range of spatial scales, and implemented in real-time forecasting systems in support of a few operational coastal ocean observing systems and field campaigns. This MS-3DVAR scheme uses partitioned cost functions and thus background error covariances of multi-decorrelation length scales. MS-3DVAR improves the effectiveness of the assimilation of both very sparse and high resolution observations. A variety of data assimilation experiments, known as Observing System Experiments (OSEs), is performed to illustrate MS-3DVAR. These OSEs are also used to assess the relative impacts of different types of observations. The observations assimilated primarily includes satellite altimetry data and sea surface temperatures, High Frequency (HF) radar surface velocities, and vertical profiles of temperature/salinity (T/S) measured by ships, moorings, Autonomous Underwater Vehicles and gliders. The combination of high resolution HF radar surface velocities and sparse T/S profiles allows representing meso-scale systems and producing analyses and forecasts with skill. It is suggested that a potentially promising observing network may be based on satellite altimetry data and SSTs along with sparse T/S profiles, but future satellite SSHs with wide swath coverage and higher resolution may be needed.