

# Downscaling to Study Interactions between the Coastal Ocean and Bay/Estuary

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## Modeling San Francisco Bay/Estuary with SELFE (Semi-implicit Eulerian-Lagrangian Finite Element):

The San Francisco Estuary is the largest estuary on the Pacific coast of the United States and the largest wetland habitat in the western U.S. We are modeling San Francisco Bay/Estuary with SELFE (Zhang, Y., and A. M. Baptista, SELFE: A semi-implicit Eulerian-Lagrangian finite-element model for cross-scale ocean circulation, *Ocean Modelling*, 21:3-4, 71-96, 2008), a state-of-the-art open-source community-supported modeling system, based on unstructured grids in the horizontal and hybrid terrain-following coordinates S-Z coordinates in the vertical, designed for the effective simulation of 3D baroclinic circulations across river-to-ocean scales. SELFE has been successfully applied to model the Columbia River estuary and plume circulation.

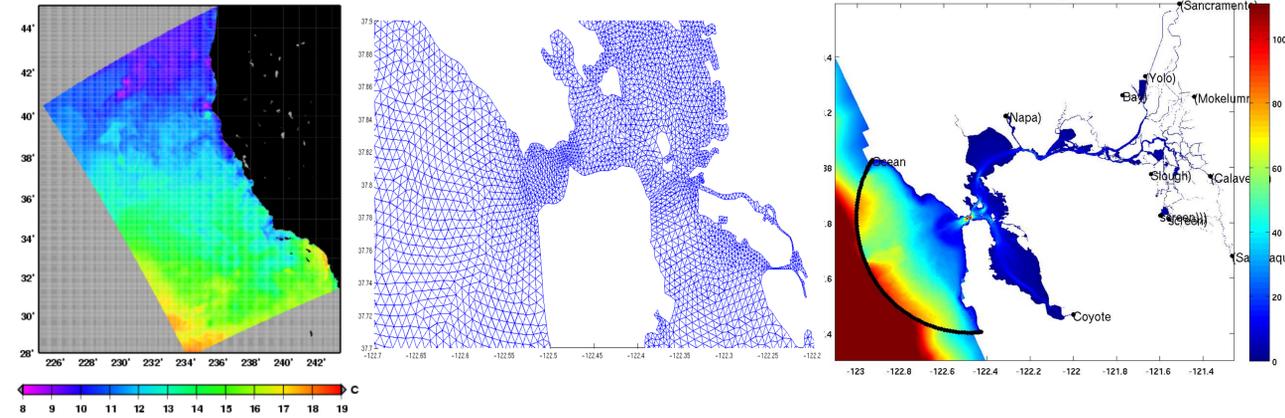


Figure 1. The ROMS model simulated sea surface temperature (left) and the SELFE model domain showing the bathymetry (right). The black line shows the boundary of the SELFE model domain, where the lateral boundary conditions are exchanged with ROMS. The zoom-in of the SELFE model grid near the Golden Gate showing the unstructured triangle grid (middle).

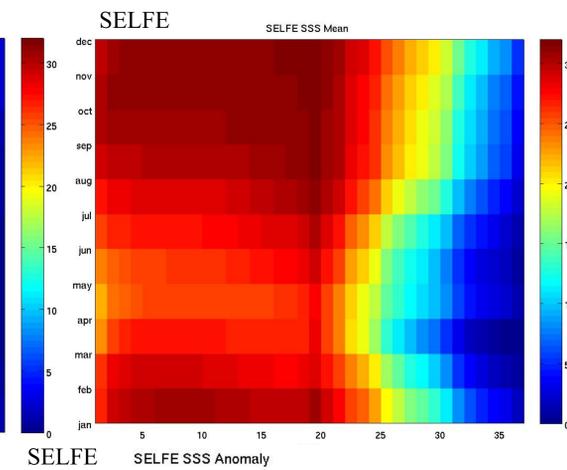
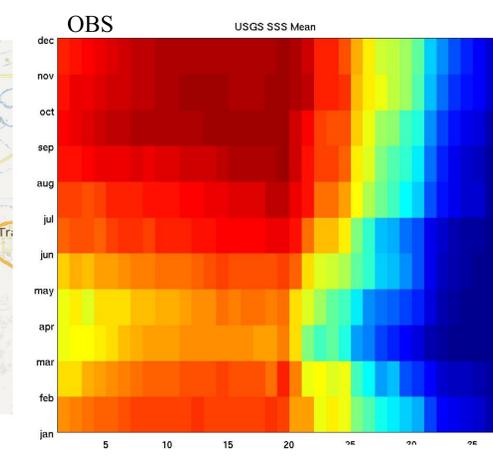
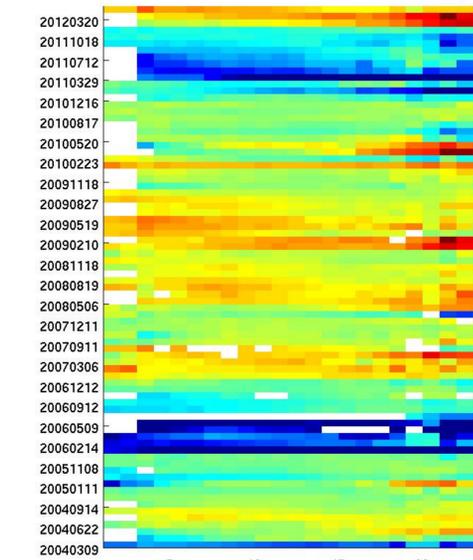
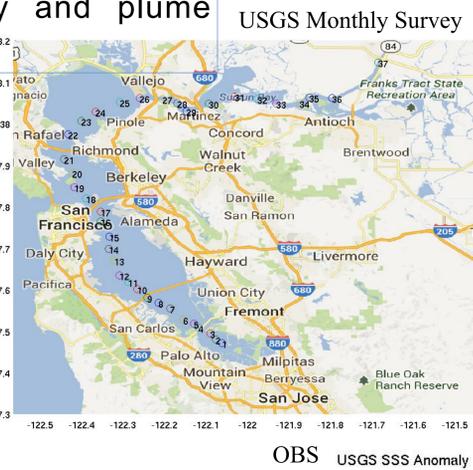
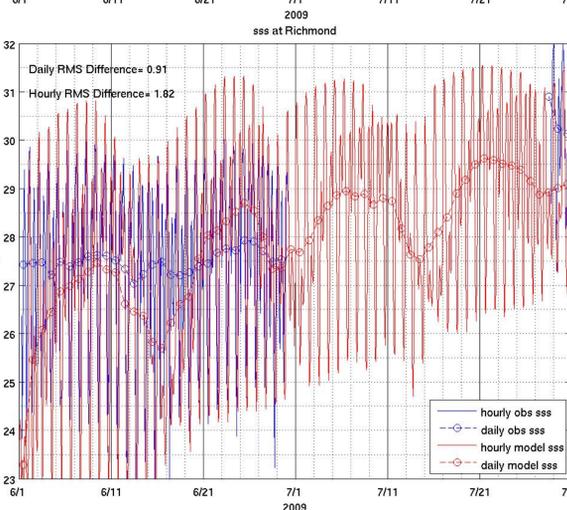
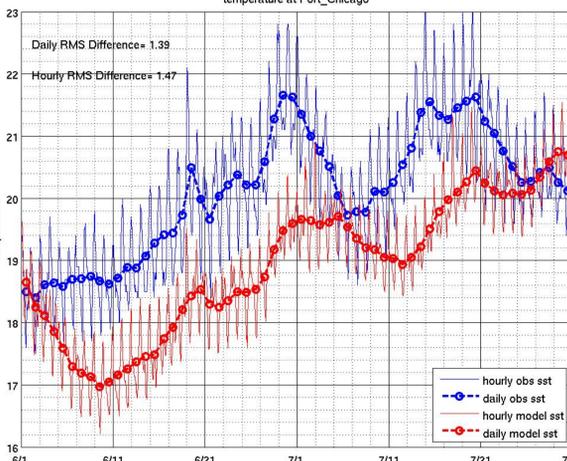
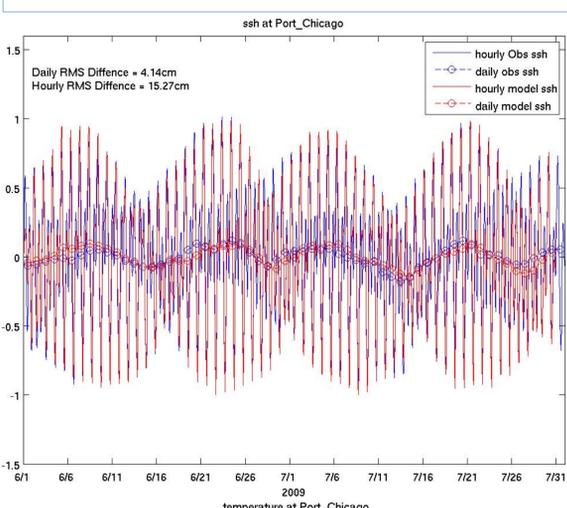


Figure 3. The USGS station locations (upper left). The seasonal (upper panels) and interannual (lower panels) salinity variations as observed by the USGS ship surveys (left) and SELFE simulations (right) during 2004-2013.

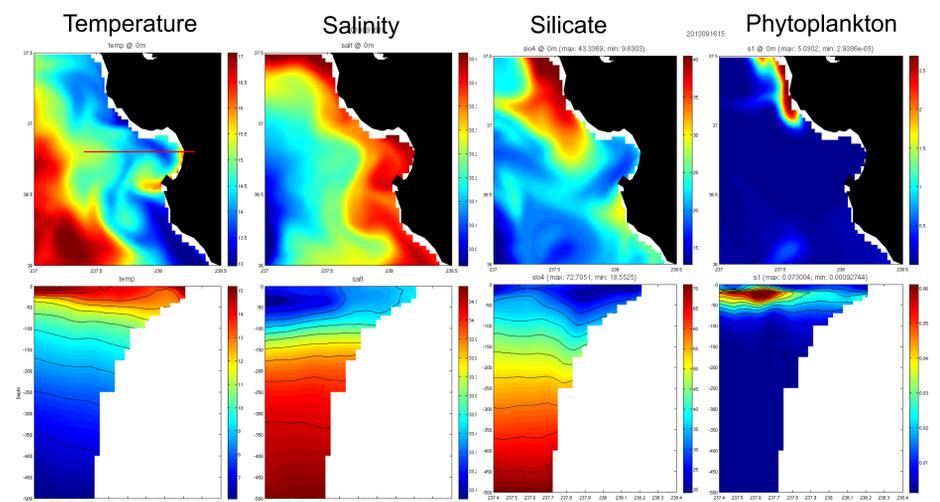
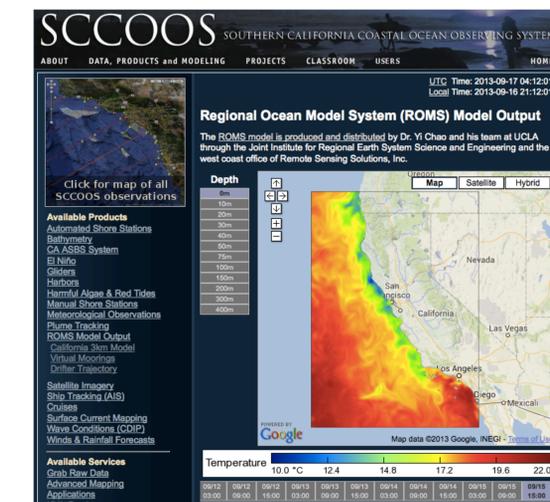


Figure 4. The California coastal ocean model is modeled by ROMS in real-time with 3-km resolution using the multi-scale 3DVAR method to assimilate satellite SST, HF radar surface current and vertical profiles available in real-time. ROMS has been coupled with CoSINE in collaboration with Dr. Fei Chai at University of Maine.

**Summary:** SELFE model has been applied to the San Francisco Bay and Estuary and lower Sacramento River forced by the coastal ROMS model and atmospheric COAMPS model; Satisfactory skill has been obtained using SELFE to reproduce water level, temperature and salinity during the June-July 2009 and for a 10-year (2004-2013) hindcast. The California coastal ocean ROMS with 3DVAR data assimilation has been running in real-time to produce nowcast/forecast, and coupled with the CoSINE biogeochemical model.

**Future Work:** To couple SELFE hydrodynamic model with a biogeochemical (e.g., CoSINE) model; To improve decision making of Salmon fishery management coupling the California coastal ocean ROMS with San Francisco Bay/Estuary SELFE.