Hawai'i Ocean Observing System: The Role of ROMS

Hsu, M.T., B.S. Powell, D. Matthews, Y. Chen, A. Natarov, and I. Janekovic
School of Ocean and Earth Science and Technology, University of Hawai'i at Manoa

Abstract

The NOAA-funded, Hawai'i Ocean Observing System (HiOOS) focuses on ecosystem monitoring and prediction in the Hawaiian Islands with an emphasis on the south shore of Oahu. HiOOS is part of the larger Pacific Islands Ocean Observing System (PacIOOS). The School of Ocean and Earth Science and Technology at the University of Hawai'i Manoa (SOEST) works with various governmental agencies and organizations to provide both nowcasts and forecasts for Hawaiian coastal and open ocean conditions. ROMS plays an integral role within HiOOS, and we present a brief overview of the ROMS modeling component in the Hawai'i Ocean Observing System (HiOOS).

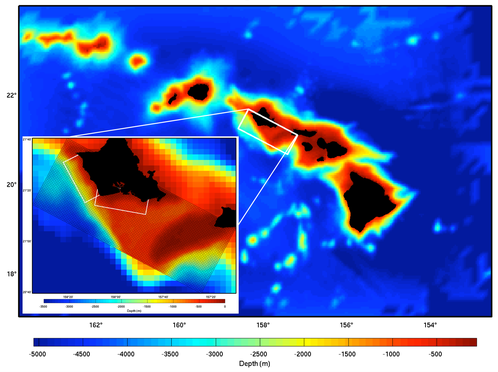
Introduction

ROMS Modeling goals for HiOOS

- Create an extensive database of Hawai'i Island observational and model data for future endeavors
- Growth in understanding the ocean circulation and dynamic patterns for the Hawaiian Islands
- Support research and development of the ROMS model; a focus on sensitivity experiments and data assimilation

Regions of Modeling Interest

Shown in the figure below. The outer most grid consists of the Hawaiian Island chain, the white boxed area shows the region of the Oahu grid. The inset is a closer view of the four different grid regions; only the results of the Hawaiian Island chain and Oahu grids are currently available to the public.



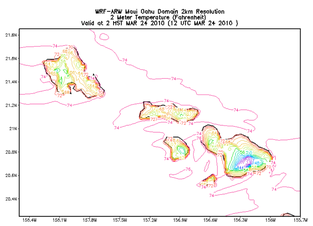
Input Forcing for ROMS

Before the start of the ROMS daily HiOOS simulation, information for the ocean and atmospheric conditions must be imported.

For the ocean, the Navy Coastal Ocean Model (NCOM) daily global ocean forecast, with 1/8° resolution, is used to generate boundary conditions for the ROMS Hawaiian Islands grid

WRF-ARW Simulations at SOEST

The operational atmospheric modeling component of HiOOS is led by Yi-Leng Chen in the Department of Meteorology. The WRF-ARW model is initiated at 00:00 UTC (14:00 HST), and provides daily atmospheric forecasts available for three different grids; the Hawaiian Islands (6 km resolution, run for 84 hours), Maui-Oahu (2 km, 84 hours), and Oahu (1.5 km, 48 hours) grids.
The variables extracted from the WRF-ARW simulations to be used as atmospheric forcing in ROMS are surface air temperature, rain fall rate, surface air pressure, surface wind components at 10m, net longwave radiation flux, solar shortwave radiation flux, surface air relative humidity, and atmospheric guess for SST.



Regional Ocean Modeling System: Daily Routine

Observations and Data Input

- Satellite Data and Products: AVHRR, MODIS, AVISO, OSTIA
- In-situ: ARGO, Glider
- Forecasts for boundary conditions and atmospheric forcing

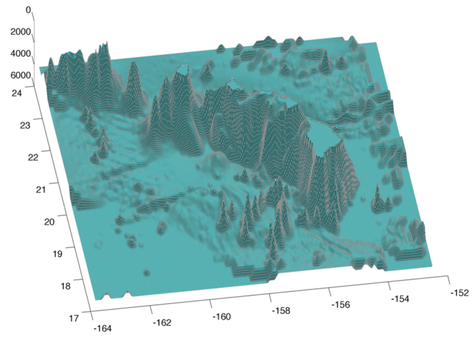
Outer Grid: Hawai'i Islands Grid (HIIG)

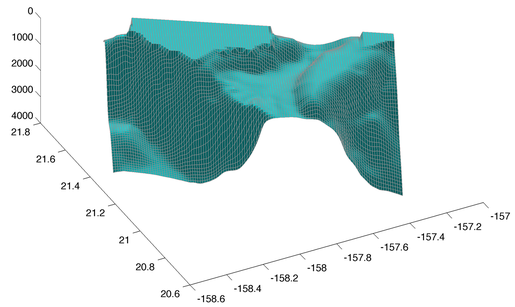
- 4 km horizontal resolution
- 30 vertical layers (max depth ~ 5060 m)

Data reorganization onto the grids

Nested Grid: Oahu Grid (HIOG)

- 1.2 km horizontal resolution
- 30 vertical layers (max depth ~ 3240 m)





Assimilation Model

- IS4DVAR
- Run for 3 days, ending on current day
- History recorded every 6 hours

Forecast Model

- Nonlinear Forward Model
- Run for 3 days, starting on current day
- History file recorded every 6 hours
- Average file recorded every 24 hours

Model Output Data

- Nowcast and Forecast charts
- Available for download online
- Variables from forecast model: ocean potential temperature, salinity, ubar, vbar, u, v, w, and free-surface height

Model output used for creating new climatology, boundary, and initial condition files

Assimilation Model

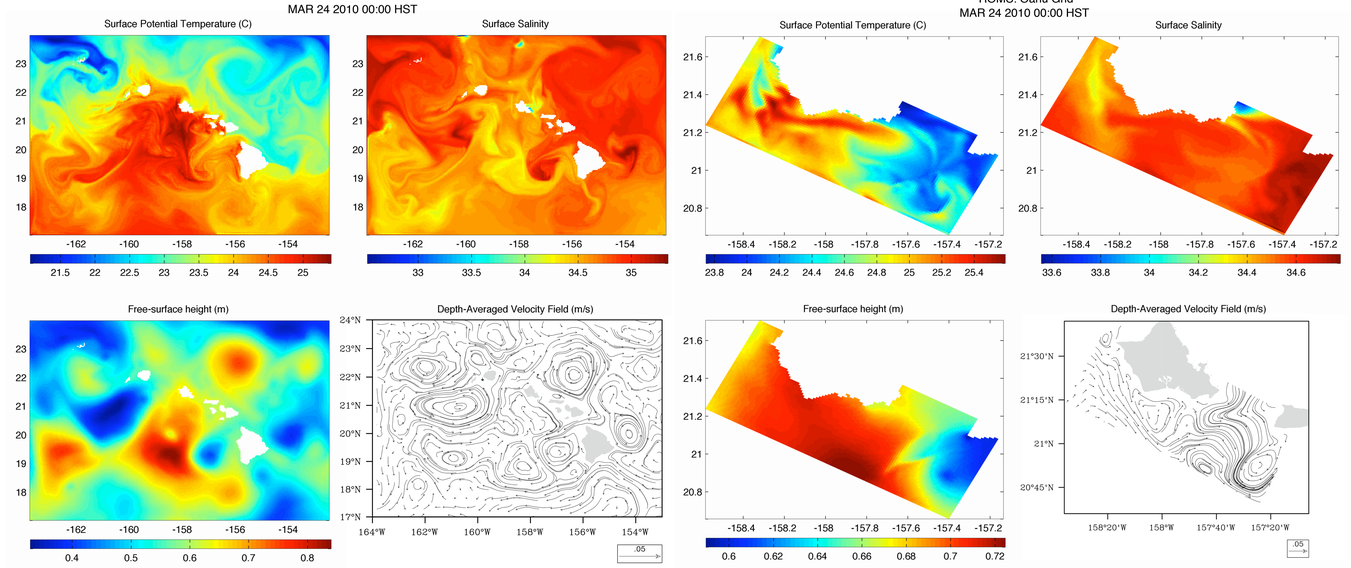
- IS4DVAR
- Run for 2 days, ending on current day
- History recorded every 3 hours

Forecast Model

- Nonlinear Forward Model
- Run for 2 days, starting on current day
- History recorded every 3 hours
- Average file recorded every 24 hours

Model Output Data

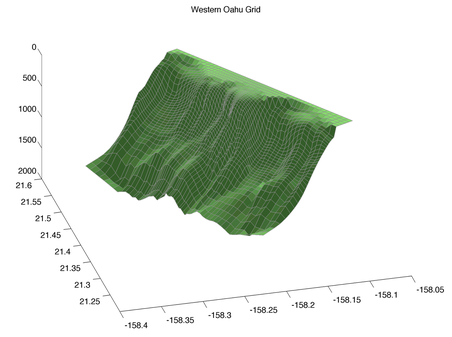
- Nowcast and Forecast charts
- Available for download online
- Variables from forecast model: ocean potential temperature, salinity, ubar, vbar, u, v, w, free-surface height, time-averaged surface net heat/salt fluxes, and time-averaged u/v momentum stress

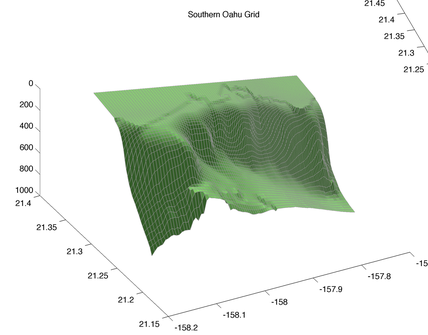


In Development: Grids

Two additional nested grids, the Western and Southern Oahu grids, are currently in working development. These grids were first shown in the inset Oahu graph in the Introduction section.

On the right and below, the two images illustrate the complex three-dimensional topography of the Western and Southern Oahu grids.





The Western Oahu Grid (Above)
- 0.2 to 1.0 km horizontal resolution
- 20 vertical layers (max depth ~ 1590 m)

The Southern Oahu Grid (Left)
- 0.2 to 0.5 km horizontal resolution
- 20 vertical layers (max depth ~ 860 m)
- Daily observations are currently reorganized onto the grid for future use

Southern Grid Observations

The implementation of three additional observation sources for the Southern Oahu Grid are in development.

1. High Frequency Radar
- Calculates surface velocity and direction of ocean currents
- Maximum transmission distance of 125 km offshore
- Measures every 15 minutes
- Location of the two radars are shown below by the red stars

2. Kilo-Nalu Cabled Laboratory
- Location shown above as the blue star
- One central sensor node (10 m depth), Four optional remote sensor nodes (10 m, 20 m, 30 m depths)
- Sensors have the ability to record wave height, wave period, wave direction, current speed and direction, water temperature, salinity, fluorescence, optical backscatter (turbidity)
- Data recorded every 20 minutes

3. REMUS AUV (Remote Environmental Monitoring UnitS)
- The Autonomous Underwater Vehicle (AUV) collects data on currents, temperature, salinity, and fluorescence while
- Acoustic and optical backscattering are used for measuring particulate matter
- Produces images of the ocean bottom using its side scan sonar.
- Can dive a maximum depth of 100 m below the surface and therefore is best suited for near and inshore regions
- Battery-power can last up to 15 hours, and communication with the vehicle is available when it rises from the surface

For ROMS data acquisition or more information on the HiOOS project, go to:
http://www.soest.hawaii.edu/hioos