Observations of Local Seychelles Circulation

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LONG-TERM GOALS

The overarching goal for the proposed work is to develop predictive capabilities for physical oceanography for the Seychelles region in support of locally relevant marine applications while providing context for larger scale NASCar efforts. A key objective for the project is to establish local capacity for ocean observations in the Seychelles region that will lead to long-term data collection efforts. In collaboration with local partnerships, we will carry out an observational program that will provide a foundational data set for regional and local scale modeling efforts. The work will also include development of a preliminary 3D numerical model for the region. The observational and modeling efforts will be critical in identifying primary forcing mechanisms for local oceanography in a complex and relatively undersampled environment.

OBJECTIVES

The specific science objectives for the project will include:

- Identification of dominant contributions to variability in waves, currents and water properties on the Mascarene Plateau.
- Identification of physical oceanographic controls on mass and momentum transport on scales that are relevant to local ecology and fisheries and that determine biological connectivity amongst the Seychelles' multiple islands.
- Collection of observational data that will provide validation and forcing input for local scale numerical modeling.
- Development of local ocean-observing capabilities including in situ and autonomous methods.
- Development of basic regional modeling capacity that Seychelles managers and fisheries can use to guide decisions and improve community outreach and education.

The initial phase of the work will include identification and establishment of local partners. In collaboration with these local partnerships, we aim to further carry out an observational program that will provide a foundational data set for regional and local scale modeling efforts. The data set will be

critical in identifying primary forcing mechanisms for local oceanography in a complex and relatively undersampled environment.

Broader and longer term objectives for extended observations will also include collection of time series data that can resolve interseasonal variability along with interactions of larger scale ocean forcing with variations in local dynamics.

APPROACH

The physical oceanography of the Seychelles is dominated by two distinctive features: strong seasonal forcing that drives significant changes in regional circulation; and its unique geographic location atop a broad shallow shelf bordered on all sides by deep ocean (Figure 1). These two components represent significant challenges for predictive modeling at local scales. The islands thus present a valuable venue for development of analytical and numerical modeling capabilities for flow in complex environments.

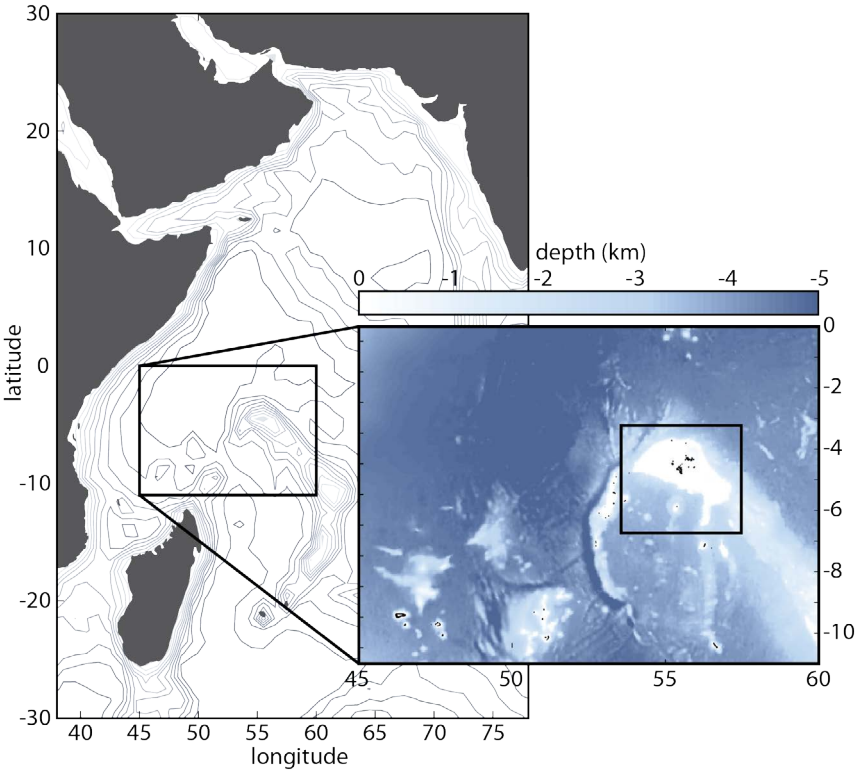

Figure 1. Region of interest and proposed model grid. Regional map includes the coastlines of Madagascar, eastern Africa, the Arabian Peninsula, and southern Asia. The Mascarene Plateau forms a backwards-C north east of Madagascar. The outer model grid at 5km resolution extends ~1700 x 1200km around the Republic of Seychelles (color map). A higher resolution grid (~1 km) will be nested around the inner Seychelles islands as indicated. Colors indicate depth in km.

To achieve the objectives outlined above, we are designing an observational program along with a local outreach effort that will take place in parallel. The primary focus for the field observational data is to provide appropriate boundary condition and validation data for a numerical modeling effort. The work will be closely coordinated with other ONR funded researchers to maximize the value of observations towards modeling efforts. Dynamical prcoesses of interest to be evaluated include

variability in surface waves, currents, stratification and internal wave climate over the seasonal cycle from the data time series described above.

The basic field campaign will feature time-series observations at a set of locations determined based on their potential impact for resolving locally relevant dynamics and on their value for numerical modeling. A nominal observational array is illustrated in Figure 2. Available components will include:

- ADCP + thermistor chain (star, 2 locations): bottom-mounted 600 kHz ADCP with a nearby thermistor chain (8-10 SBE 56s with 1 SBE37 CT) to enable resolution of currents, stratification and internal wave energy fluxes.
- Thermistor chain (circles, 2 locations): thermistor chains to resolve variations in stratification and internal wave activity.
- Wirewalkers: A newly funded DURIP will support short term deployment of two profiling moorings (Wirewalkers) at two locations with bottom moored ADCPs to resolve currents, stratification and internal wave energy fluxes.
- PUV array (triangles, 2 location): bottom mounted ADVs to resolve wave fields and near-bed currents and turbulence at shallower sites closer to shore.
- ADCP (hexagon, 1 location): One bottom mounted 1200 kHz ADCP (hexagon), nearshore currents, waves
- Vessel-based measurements: surveys using handheld CTDs and an over-the-side 1200kHz or 300kHz ADCP can also be carried out during field deployment/recovery campaigns.

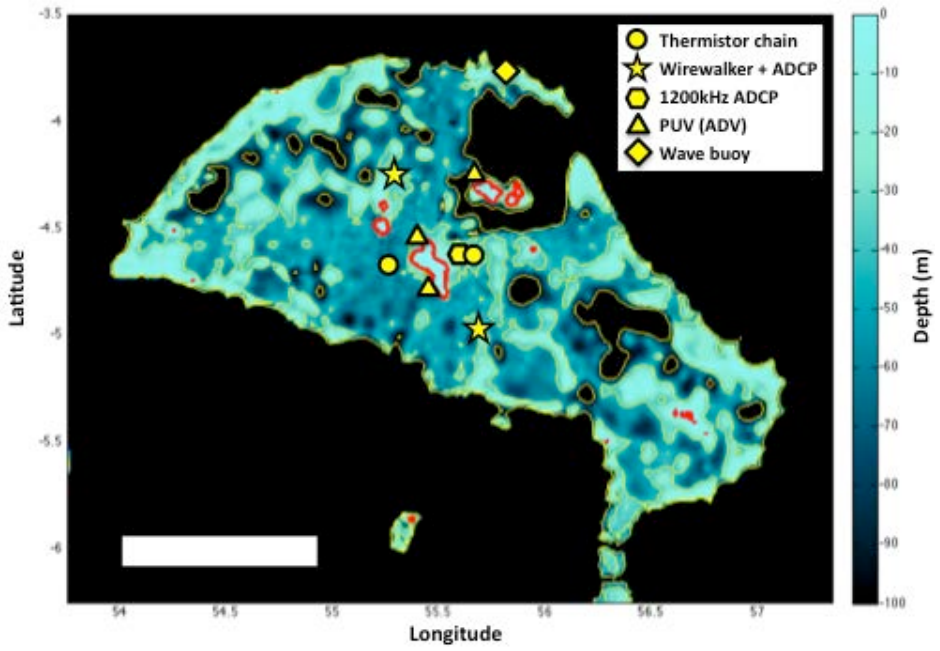

Figure 2. Nominal observational array with bathymetry on Mascarane Plateau, highlighting areas with <100 m depth. Contours are at 40 m and 100 m depths. Red contours indicate island coastlines including the primary and largest island of Mahé in the center. Tentative instrument locations are shown by yellow symbols as indicated in the legend. Deployment locations are subject to change based on local knowledge, features of interest, and on-site reconassaince dives.

We will also develop a nested, high-resolution 3D hydrodynamic numerical model of the region and run multi-year realistic hindcast simulations (see Figure 1). This model will utilize existing bathymetry; a global tidal model to set tidal constituents at the open boundaries; and coupled atmospheric/oceanic models (such as HYCOM) to set temperature, salinity, currents, and wave forcing at the open boundaries. Importantly, the larger scale models these simulations are nested within need to properly represent the seasonal and spatial structure of the Indian Ocean and Arabian Sea basins.

WORK COMPLETED

Thus far, we have started conversations with the Better Life Foundation (BLF) and Scott Katz (UCSD) regarding transit to, accomodations, and logistics in the Seychelles. After a couple month hold on these conversations, we have just re-initated communication with BLF. We have aquired most of the instrumentation for the long term deployments. Addtitionally, we have been in touch with Julie MacClean and Tommy Jenson regarding model output, both for use as boundary conditions for the regional model and for guidance for our field deployment locations. MacClean has provided us movies of SSH, SST, and currents to help guide regional model boundary condition placement while Tommy is in the process of extracting numerical mooring outputs near the locations of our planned deployments. A new postdoc, Hugo Ulloa, will begin work in November with partial support on the SLOMO project.

RESULTS

No major results are yet to be reported.

IMPACT/APPLICATIONS

The work proposed here will provide critical observational data in an otherwise undersampled region. The observational program will be essential for development of predictive model capabilities at local scales in a complex ocean environment. In particular, the observations and associated modeling efforts will provide important local scale context for larger scale NASCar DRI observations and will enable validation of downscaling modeling efforts within a hierarchy of ocean models and coupled ocean-atmosphere models. Beyond the direct scientific goals for the work, the outreach components of the project, which aim to establish local ocean-observing capacity, also represent an important component in the success of the larger DRI effort and in longer-term naval efforts in the Indian Ocean region.

RELATED PROJECTS

The work is being coordinated closely with other NASCar efforts. We have already begun discussions with the NASCar team and formed the SLO-MO working group based on researchers with an interest in the SLO-MO efforts. Specifically, we anticipate initializing good relationships with Seychelles officials in collaboration with Scott Katz, Eric Terrill, and Joe Fernando (ASIRI) whom already have established relationships with locals. Our relationships and identification of resources will help pave the way for other Seychelles-based deployments including glider deployments (Lee), drifter deployments (Centurioni & Hormann), and drifting WireWalker test deployments (Lucas). We will work closely with modelers (Jensen, McClean & Scotti) to determine the most appropriate boundary conditions for our local model and aid in model development. We will collaborate with Send and Terrill who also have interest in local deployments in the region, including the addition of biological measurements (Send). Lermusiaux will help determine optimal instrument deployment strategies. Beal

will provide invaluable guidance as to how to interpret the local circulation in the context of the larger scale circulation. Finally, many (Beal, Lucas, Riser, Shcherbina, and others) have expressed great interest in participating in a local outreach/workshop capacity and providing general guidance for dynamics and logistics of doing work in the region.