REVISED WORK PLAN

PROJECT TITLE: SFP2006: Simulations of Circulation and Nutrient Transport Around Florida Bay and the Florida Keys with the South Florida Regional SoFLA-HYCOM Model

Institutions: **U. of Miami/Rosenstiel School of Marine and Atmospheric Science (RSMAS)**
NOAA/Atlantic Oceanographic and Meteorological Laboratory (AOML)

Principal Investigator: **Dr. Vassiliki H. Kourafalou, RSMAS/UM**
Co-Principal Investigator: **Dr. Peter Ortner AOML/NOAA**
Total 2-year Proposed Cost to NOAA: **$ 450,000**

Project Period: **June 1, 2006 – May 31, 2008**

This is the revised plan for work initially proposed on October 2005, in response to the Funding opportunity NOS-NCCOS-2006-2000322. The changes reflect a 40% reduction from the originally requested budget and according modification of research tasks. All tasks related to further development of the South Florida Hybrid Coordinate Ocean Model (SoFLA-HYCOM) have been maintained and changes primarily affect the nutrient transport module.

This project will be conducted through CIMAS, Task 3, Theme 3: Coastal Ocean Ecosystem Processes and is linked to the NOAA Strategic Goal 1: Protect, Restore, and Manage the Use of Coastal and Ocean Resources Through Ecosystem-based Management..

The **main study objective** is:
To further develop the NOAA/UMiami regional hydrodynamic model of the Southwest Florida shelf, Florida Straits and Gulf Stream (SoFLA-HYCOM) that encompasses Florida Bay and the Florida Keys, in order to perform simulations that include all relevant coastal processes that affect circulation around the South Florida ecosystems with implications on nutrient transport.

The model simulations will help other interdisciplinary efforts in the SFP, such as the study of recruitment pathways of pink shrimp and the investigation of the downstream effects of Everglades restoration on the ecologically fragile Florida Keys Marine Sanctuary, by providing transport pathways that can be utilized by ancillary projects. The modeling activities will be closely linked to SFP observational efforts, by employing data for model calibration and validation.

The revised Work Plan follows. All References were given in the original text and are not repeated here.

SECTION D: PROPOSED RESEARCH (Year 1)

D1.1. SoFLA-HYCOM hydrodynamic model improvements

Vertical resolution and turbulence closure scheme: The hybrid vertical coordinate system in SoFLA-HYCOM (Bleck, 2002) allows flexibility in the resolution of flows in the shallow shelf areas. Furthermore, a hierarchy of schemes for the parameterization of vertical mixing processes exist, ranging from traditional turbulence closure schemes to more sophisticated schemes, such as the K-Profile Parameterization (KPP), which computes the vertical mixing coefficient over the entire water column, taking into account the effect of wind stirring induced mixed layer turbulence and additional mixing parameterization for processes like internal wave breaking, Richardson dependent vertical current shear and double diffusion. Other turbulence closure submodels include the NASA Goddard Institute for Space Studies level 2 (GISS; Canuto *et al.*, 2002), the Mellor-Yamada level 2.5 (MY; Mellor and Yamada, 1982), and the Price-Weller-Pinkel dynamical instability (PWP; Price *et al.*, 1986) submodels. Sensitivity tests with different specifications of vertical resolution and turbulence closure schemes will be performed with the HYCOM model to determine the optimal adaptation.

Tides: A key improvement over the previous implementation of SoFLA-HYCOM will be the inclusion of tidal boundary forcing. The tidal constituents will come from the Oregon State tidal model (Egbert and Erofeeva, 2002) and will be implemented in the larger scale Gulf of Mexico HYCOM through an ancillary NOPP project with NRL. Thus, the boundary conditions imposed at the SOFLA nested domain will incorporate tidal forcing.

Data assimilation: Our long term modeling strategy with the SoFLA-HYCOM model is to attain pre-operational capabilities by assimilating remote sensing and near real time in-situ data. As a first step, we will improve our boundary conditions by obtaining fields from larger scale Gulf of Mexico HYCOM simulations that include data assimilation. Two schemes are currently being tested in the Gulf of Mexico region (through ancillary NOPP funds). The Reduced Order Information Filter (ROIF) assimilation scheme is a version of the extended Kalman Filter that parameterizes the covariance function using a second-order Gaussian Markov Random Field model, which is a multi-dimensional generalization of regression over space. The Coupled Ocean Data Assimilation (NCODA) system is a fully three-dimensional multivariate optimum interpolation system (Cummings, 2003); it uses a volume formulation that permits several thousand observations located in the same region to be processed simultaneously. NCODA makes full use of all sources of operational ocean observations, and new ocean observing systems can be added as they become available. NCODA is designed to run in real-time and cycle with an ocean forecast model in a sequential incremental update cycle. In addition, an ocean data quality control system has been developed that is tightly integrated with the NCODA analysis system.

D1.2. Preparation of hydrodynamic and atmospheric data for model input

The SoFLA-HYCOM will receive lateral inputs from a larger scale hydrodynamic HYCOM that covers the Gulf of Mexico; air-sea interaction parameters will be supplied by the Coupled Ocean Atmosphere Prediction System (COAMPS) that has higher resolution than the

NOGAPS (Navy Global Atmospheric Prediction System) used before. The lateral boundary forcing consists of currents, temperature, salinity and sea elevation. The atmospheric forcing functions include wind stress and heat and salt fluxes. In addition, river input data will be prepared from the available USGS west Florida shelf data gauges and from the flows computed through the USGS TIME model for the Everglades region (we are already collaborating with J. Wang and C. Hittle).

SECTION D: PROPOSED RESEARCH (Year 2)

D2.1 Hydrodynamic model simulations for the 2000-2005 year period

The SoFLA-HYCOM model simulations will concentrate on the period 2000-2005, as this is the only period for which regional physical data and detailed transport measurements within Florida Bay are both available. Therefore, the regional SoFLA model will be run for 2000-2005 with all improvements described above to provide reliable boundary conditions that will allow realistic simulations within Florida Bay (EFDC model of the South Florida Water Management District) and establish subsequent predictive scenario evaluation.

The expected results include improved parameterization of shelf currents and salinity distributions, due to the addition of tides and the higher frequency of atmospheric forcing and riverine inputs, as compared to the previous SoFLA simulations; this has been elaborated in Kourafalou *et al.* (1996b). The position and extension in the Gulf of Mexico of the Loop Current (LC), the proximity of the Florida Current (FC) to the Keys and the passage of mesoscale and frontal eddies will improve, due to the data assimilative boundary conditions. This will also influence the sea elevation changes near the western boundary of Florida Bay (Hetland *et al.*, 1999) and through the Keys passages (Lee and Smith, 2002), as these are closely linked to LC/FC variability and the eddy passages.

D2.2 Model validation

During the 2000-20005 simulation period, observational data have been collected linking Florida Bay with the adjacent southwest Florida shelf and Florida Straits. Observational methods consist of a combination of bi-monthly interdisciplinary surveys over the complete South Florida region, high-resolution monthly surveys within Florida Bay, in-situ moorings in the southwest and Florida Keys coastal zones, shipboard Acoustic Doppler Current Profiler (ADCP) transport transects in the major Keys flow passages, and bi-monthly deployments of Lagrangian surface drifters in the Shark River discharge plume. These measurements are part of the data in the comprehensive Standard Data Set for South Florida coastal waters made available through the Interagency Florida Bay Science Program, in accordance with the requirements (http://www.aoml.noaa.gov/flbay/standard_dataset_wkshp.html) provided by the overseeing Physical Science Team. A few near Real-Time moorings or inlet stations have also been maintained by the NOAA SFP.

Particular processes and events will be targeted for model validation. An example is the advection of low salinity, high chlorophyll waters that originate from the Mississippi River but reach the South Florida region (Kourafalou *et al.*, 2005c). It is presently unknown how frequent this process is and how much of these waters reach the Florida Straits via the Loop Current and Florida Current, or from the southwest Florida shelf through Florida Keys passages. The impacts on the Florida Bay and Florida Keys ecosystems are critical (Hu *et al.*, 2005) and such predictions will receive great attention by scientists, policy makers and managers.