**Forecast Ecosystem Conditions in Gulf of Mexico OCS Habitats Using Coupled Modeling and Climate Scenarios**

**Quarterly Report (Y2Q4 – Jul 1-Sep 30, 2018)**
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This quarterly report is filed per requirements of BOEM-NRL IAA # M16PG00027 with respect to our research project focused on climate-scale ocean model simulations for the Gulf of Mexico. The focus of this study is to forecast, through year 2050, marine ecosystem conditions in the Gulf of Mexico (GoM) using RCP climate scenarios prescribed by the NCAR CESM Large Ensemble (LE) atmospheric forcing.

## 1. WORK ACCOMPLISHED

We have completed an initial assessment of two long term climatological simulations, one using NCOM, and the other one using HYCOM. While both models' numerical integration takes about 7 years to spin up, at the end of the 23 year simulation, both models are in a steady state solution and depict a similar ocean physical environment as illustrated in Fig. 1, Y2Q3 Report, where the temperature seasonal variability for the domain-averaged surface layer is well represented by both models.

Given that the geometry and the configuration of the models is the same, HYCOM was 2.2 times more expensive than NCOM, and given that NCOM produces better biochemistry results, NCOM was selected as the more suitable model to run the climate simulations. Further sensitivity analysis will be done with NCOM-COSINE to assess the susceptibility of the models to the atmospheric fluxes.

A Gant chart, shown in Figure 2 (and in high resolution on page 3), provides a summary to the various model simulations planned for this project. This "roadmap" and any revisions thereof will be published on the project web which will be available starting the next quarter.

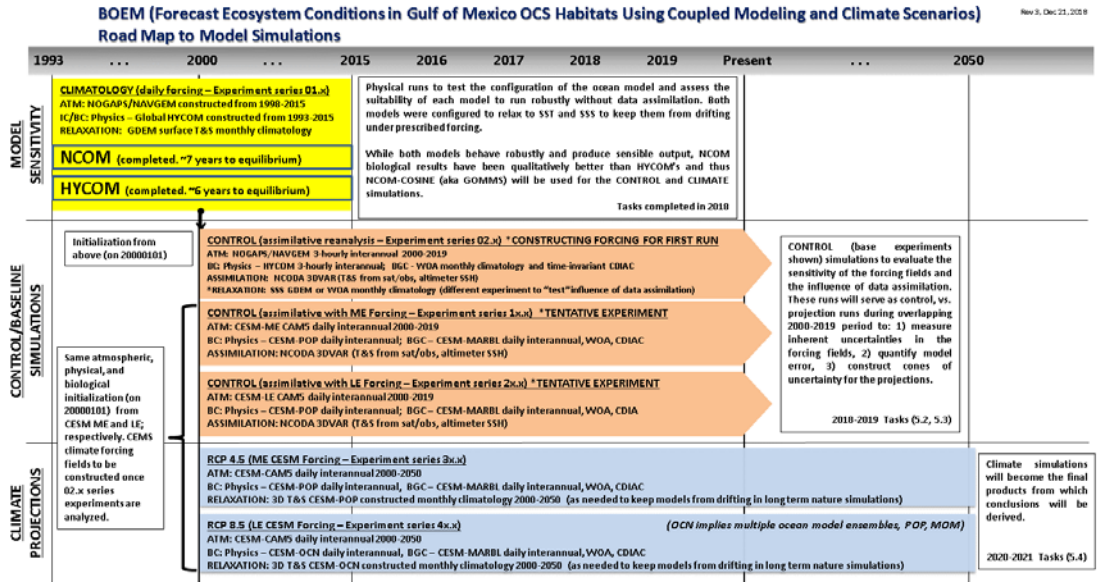


**Figure 1. Gantt chart (Road Map) summarizing the ocean model simulations completed and planned.**

## 2. PROBLEMS

None to report.

## 3. PLANNED ACTIONS FOR NEXT QUARTER

Complete generation of input forcing fields to run CONTROL experiment series 01.x (Figure 1). Two simulations are planned that will take about 3-4 months to run and post process. One with full data assimilation and one without data assimilation or minimal relaxation to Sea Surface Salinity (SSS) to keep the simulation as close to a “nature” run as possible.

## 4. BUDGET

$280K has been received (Y1:$80K, Y2:$80K, Y3:$120K).

Expenditures: ~$35K year to date.

# BOEM (Forecast Ecosystem Conditions in Gulf of Mexico OCS Habitats Using Coupled Modeling and Climate Scenarios)
# Road Map to Model Simulations

Rev 3, Dec 21, 2018

1993 . . . 2000 . . . 2015 2016 2017 2018 2019 Present . . . 2050

## MODEL SENSITIVITY

**CLIMATOLOGY (daily forcing – Experiment series 01.x)**
ATM: NOGAPS/NAVGEM constructed from 1998-2015
IC/BC: Physics – Global HYCOM constructed from 1993-2015
RELAXATION: GDEM surface T&S monthly climatology

**NCOM** (completed. ~7 years to equilibrium)

**HYCOM** (completed. ~6 years to equilibrium)

Physical runs to test the configuration of the ocean model and assess the suitability of each model to run robustly without data assimilation. Both models were configured to relax to SST and SSS to keep them from drifting under prescribed forcing.

While both models behave robustly and produce sensible output, NCOM biological results have been qualitatively better than HYCOM's and thus NCOM-COSINE (aka GOMMS) will be used for the CONTROL and CLIMATE simulations.

Tasks completed in 2018

## CONTROL/BASELINE SIMULATIONS

Initialization from above (on 20000101)

**CONTROL (assimilative reanalysis – Experiment series 02.x) *CONSTRUCTING FORCING FOR FIRST RUN**
ATM: NOGAPS/NAVGEM 3-hourly interannual 2000-2019
BC: Physics – HYCOM 3-hourly interannual; BGC - WOA monthly climatology and time-invariant CDIAC
ASSIMILATION: NCODA 3DVAR (T&S from sat/obs, altimeter SSH)
*RELAXATION: SSS GDEM or WOA monthly climatology (different experiment to "test" influence of data assimilation)

**CONTROL (assimilative with ME Forcing – Experiment series 1x.x) *TENTATIVE EXPERIMENT**
ATM: CESM-ME CAM5 daily interannual 2000-2019
BC: Physics – CESM-POP daily interannual; BGC – CESM-MARBL daily interannual, WOA, CDIAC
ASSIMILATION: NCODA 3DVAR (T&S from sat/obs, altimeter SSH)

**CONTROL (assimilative with LE Forcing – Experiment series 2x.x) *TENTATIVE EXPERIMENT**
ATM: CESM-LE CAM5 daily interannual 2000-2019
BC: Physics – CESM-POP daily interannual; BGC – CESM-MARBL daily interannual, WOA, CDIA
ASSIMILATION: NCODA 3DVAR (T&S from sat/obs, altimeter SSH)

CONTROL (base experiments shown) simulations to evaluate the sensitivity of the forcing fields and the influence of data assimilation. These runs will serve as control, vs. projection runs during overlapping 2000-2019 period to: 1) measure inherent uncertainties in the forcing fields, 2) quantify model error, 3) construct cones of uncertainty for the projections.

2018-2019 Tasks (5.2, 5.3)

## CLIMATE PROJECTIONS

Same atmospheric, physical, and biological initialization (on 20000101) from CESM ME and LE; respectively. CEMS climate forcing fields to be constructed once 02.x series experiments are analyzed.

**RCP 4.5 (ME CESM Forcing – Experiment series 3x.x)**
ATM: CESM-CAM5 daily interannual 2000-2050
BC: Physics – CESM-POP daily interannual, BGC – CESM-MARBL daily interannual, WOA, CDIAC
RELAXATION: 3D T&S CESM-POP constructed monthly climatology 2000-2050 (as needed to keep models from drifting in long term nature simulations)

**RCP 8.5 (LE CESM Forcing – Experiment series 4x.x)** *(OCN implies multiple ocean model ensembles, POP, MOM)*
ATM: CESM-CAM5 daily interannual 2000-2050
BC: Physics – CESM-OCN daily interannual, BGC – CESM-MARBL daily interannual, WOA, CDIAC
RELAXATION: 3D T&S CESM-OCN constructed monthly climatology 2000-2050 (as needed to keep models from drifting in long term nature simulations)

Climate simulations will become the final products from which conclusions will be derived.

2020-2021 Tasks (5.4)