This work is funded by the Applied Sciences Program of the Earth Science Division in the NASA Science Mission through NASA's Research Opportunities in Space and Earth Sciences (ROSES) solicitation:

“Earth Science Applications: Ecological Forecasting for Conservation and Natural Resource Management”

Partner/End-User Organizations:

NOAA National Centers for Environmental Information
NOAA Atlantic Oceanographic and Meteorological Laboratory
NOAA Southeast Fisheries Science Center
EPA Gulf Ecology Division
BOEM Gulf of Mexico Region
Adaptive Ecosystem Climatology - Purpose

Aid the decision-making process for conservation and natural resource management, which often relies upon:

**Historical in-situ measurements/climatological products**

- Expensive and time consuming to collect
- Gaps and temporal/spatial aliasing
- Spatially and temporally coarse (monthly or seasonal)

**Earth Observations**

- Surface only (2D)
- Data gaps (clouds, etc.)
- Near-shore signal contamination

**Models**

- Assumptions and simplifications
- Require specialized skill
- Require high-performance computing resources
- Require initialization and boundary conditions
Product: An on-line decision support tool for ecological forecasting:

- gridded, 3-D fields
  - temperature, salinity
  - currents, sea-surface height
  - chlorophyll, phytoplankton
  - zooplankton
  - nitrate, ammonium, silicate, phosphate, oxygen
  - organic detritus
  - underwater photosynthetically available radiation (PAR)
- incorporate both climatological variability and real-time observations

The AEC is based upon four elements:

1) a long-term, coupled biological-optical-physical simulation model run
2) Earth Observation (EO) time-series (remote sensing)
3) historical in-situ data
4) real-time remote sensing data and in-situ observations from government, academia, and the public (via a crowdsourcing ‘app’ for iOS and Android)
Adaptive Ecosystem Climatology - Development

Long-term Earth Observations (MODIS aqua)
- MMDDYYYY

Long-term Coupled Bio-physical Simulation Model Run
- (biological, chemical, optical, and physical variables)
- MMDDYYYY

Static Climatology
- Jan01-Dec31 (366 days)
- MMDD
- Jan Feb Mar Apr May Jun Jul Aug Sep Nov Dec

- New observational data (remote-sensing and/or in situ)
  one or more variables
- MMDDYYYY
- Aug 31, 2015

- Initial approximation “first guess”
- MMDD
- Aug 31

- Forecast/nowcast/hindcast
- AEC product
- MMDDYYYY
- Aug 31, 2015
Adaptive Ecosystem Climatology - Concept

High-Frequency Climatology

Biomass Optical-Physical Model Ensembles

Historical Data

Observational Data

Climatological first guess (if no data)

As observational data increases, more skill is achieved

more data variables, more inference for higher level diagnostics

(Time) Increased, but quantified, uncertainty

Initial/Boundary Conditions

Analysis & Visualization Tools

Special Needs Systems or Models

Decision Making
Adapting Earth System Climate Knowledge Concept

AEC Analysis for November 16, 2011
ACE – CONUS (3 aggregate regions)
ACE – CONUS (3 aggregate regions)

**Gulf of Mexico** (available) 18-30°N x 79-98°W
- MODIS Aqua (2003-2013)
  - 1 km resolution
  - Chlorophyll
  - Sea Surface Temperature
- NCOM-COSINE Model (1980-2012)
  - 4 km resolution
  - Chlorophyll
  - Plankton groups
  - Physics

**USWEST** (available fall 2018) 29-53°N x 115-135°W
- MODIS Aqua (2003 – 2016)
  - 1 km resolution
  - Chlorophyll
  - Sea Surface Temperature
- NCOM-COSINE Model (1999-2006)
  - 9 km resolution (4 km in prep)
  - Chlorophyll
  - Plankton groups
  - Physics

**USEAST** (satellite only) 24-46°N x 64-82°W
- MODIS Aqua (2003 – 2016)
  - 1 km resolution
  - Chlorophyll
  - Sea Surface Temperature
Adaptive Ecosystem Climatology - CONUS

SST Satellite Climatology

SST Climatology Jan 1
Adaptive Ecosystem Climatology - CONUS

Chlorophyll Satellite Climatology

Chlorophyll Climatology Jan 1

Latitude

Longitude

Chlorophyll (mg/m³)
Chlorophyll Satellite Climatology
Domain-averaged timeseries

NE Atlantic Spring Bloom

California Current Upwelling
Adaptive Ecosystem Climatology - USWEST

Chlorophyll Monthly Climatology

Satellite

MODIS Aqua CHL Climatology Jan

Model

Model CHL Climatology Jan

Longitude (°W)

Latitude (°N)

2003-2016

1999-2006

Will continue to 2018
AEC OceanNOMADS
Production server at NOAA Data Center (now NCEI)
Nashville, TN

https://www.ncdc.noaa.gov/data-access/model-data/model-datasets/nrl-aec

AEC Real Time OI (Gulf of Mexico)
Development server at NRL
Stennis Space Center, MS

https://www7330.nrlssc.navy.mil/derada/AEC/
AEC – OSKit

OSKit App
On the Apple App Store

OSKit RoV
Delivered to 2 high-schools
Crowdsourcing:
Adaptive Ecosystem Climatology – Thanks!

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