The Adaptive Ecosystem Climatology (AEC)*

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U.S. NAVAL RESEARCH LABORATORY

NASA Biodiversity and Ecological Forecasting Team Meeting May 23-25, 2017

*Patent Pending

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

Decision-making needs and tools

NOAA

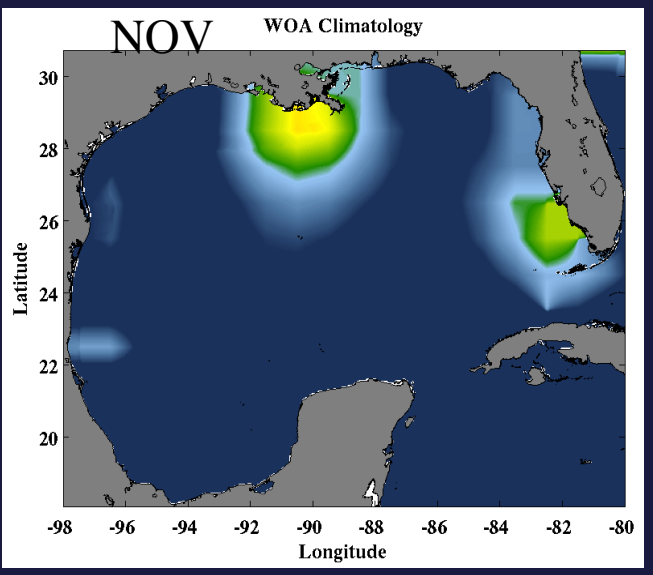
- ecosystem based management tools – models need temperature, salinity, plankton fields for initial conditions

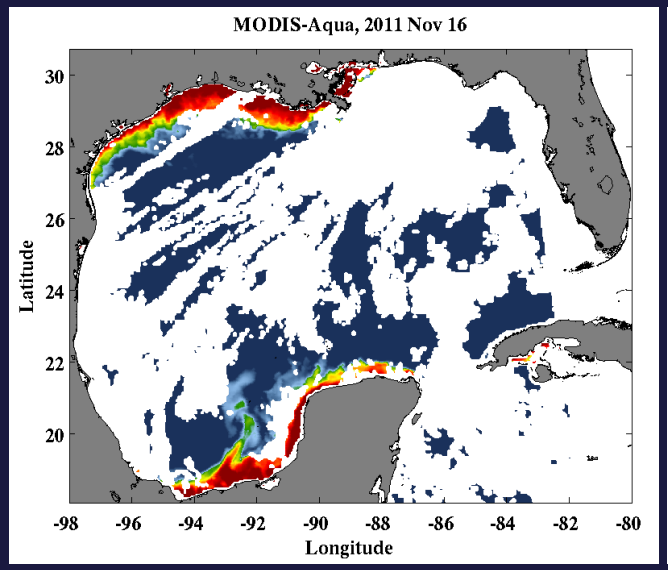
EPA

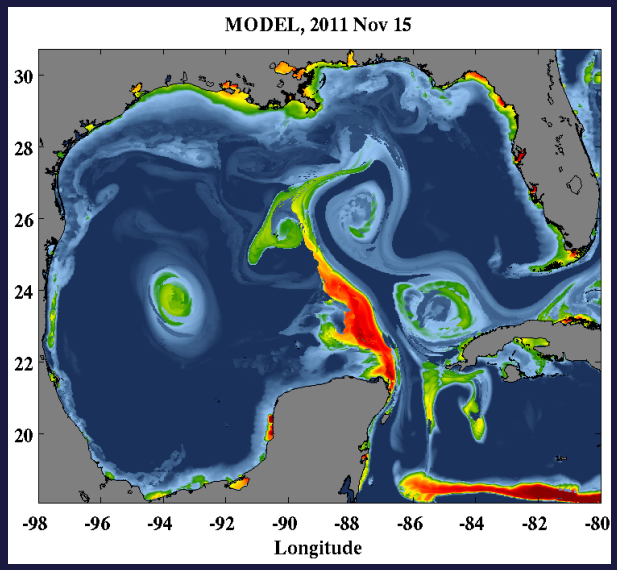
- GoM hypoxia model – needs open boundary conditions

BOEM

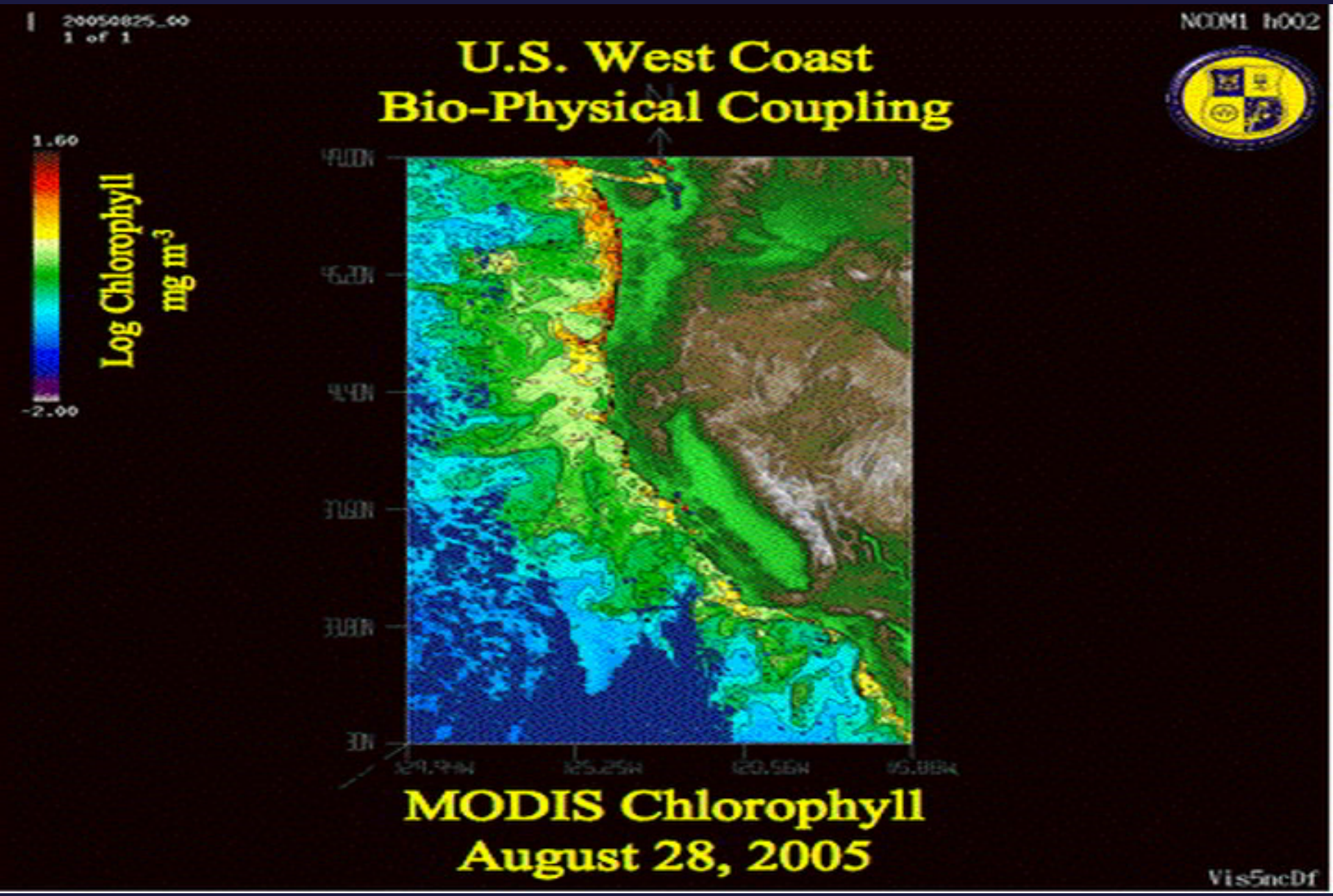
- environmental sensitivity and marine productivity assessments in relation to potential impacts of offshore energy development



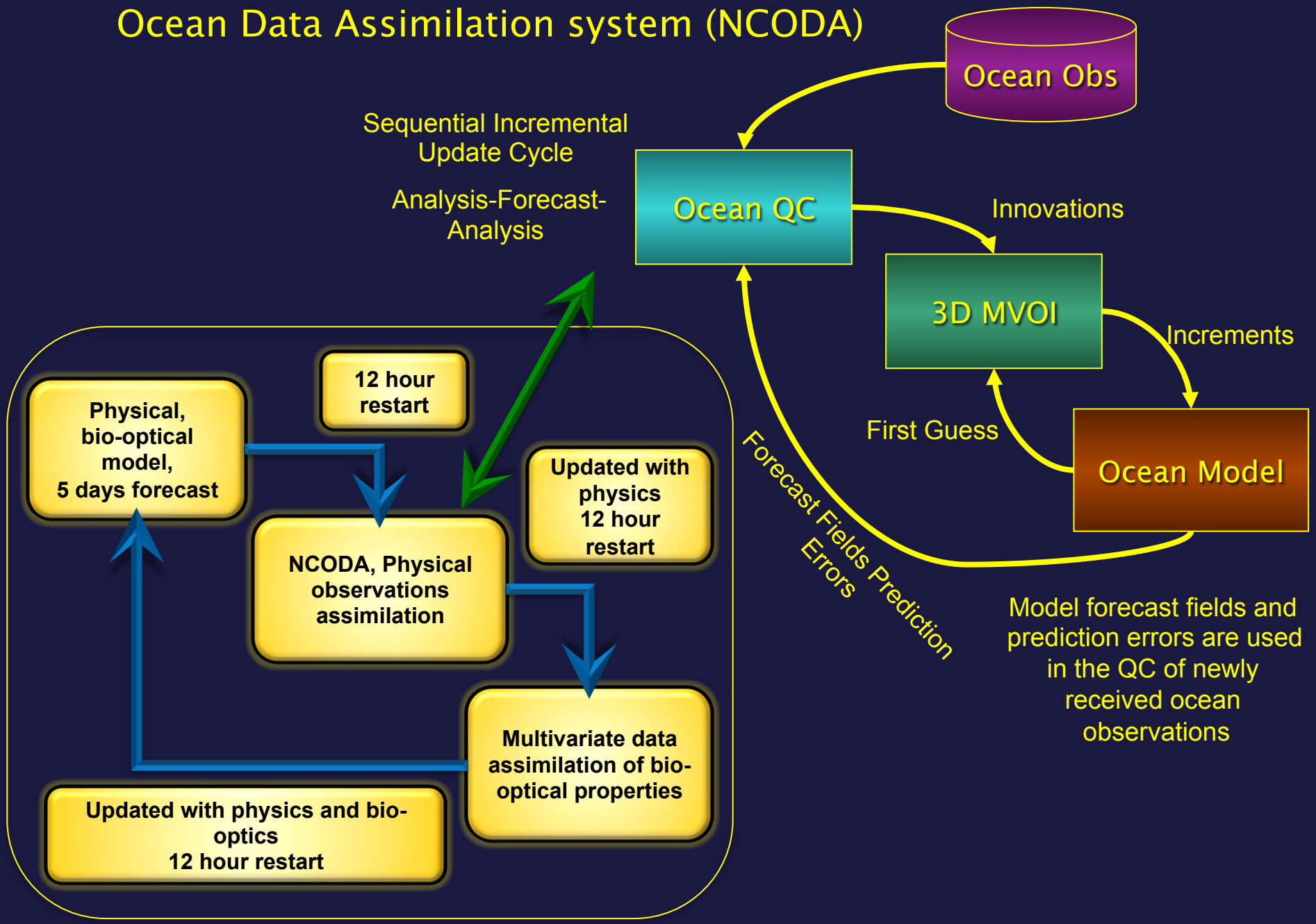


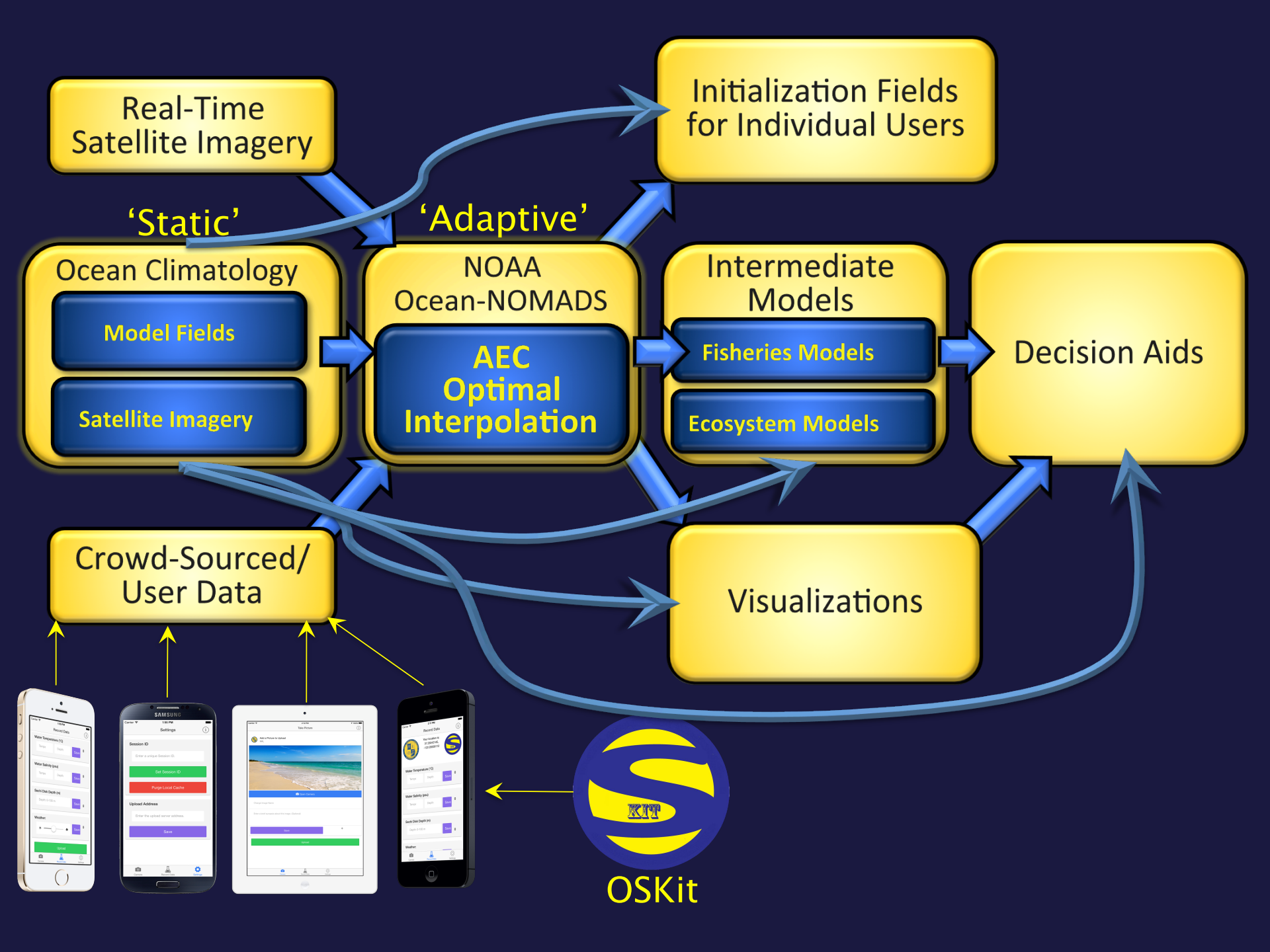


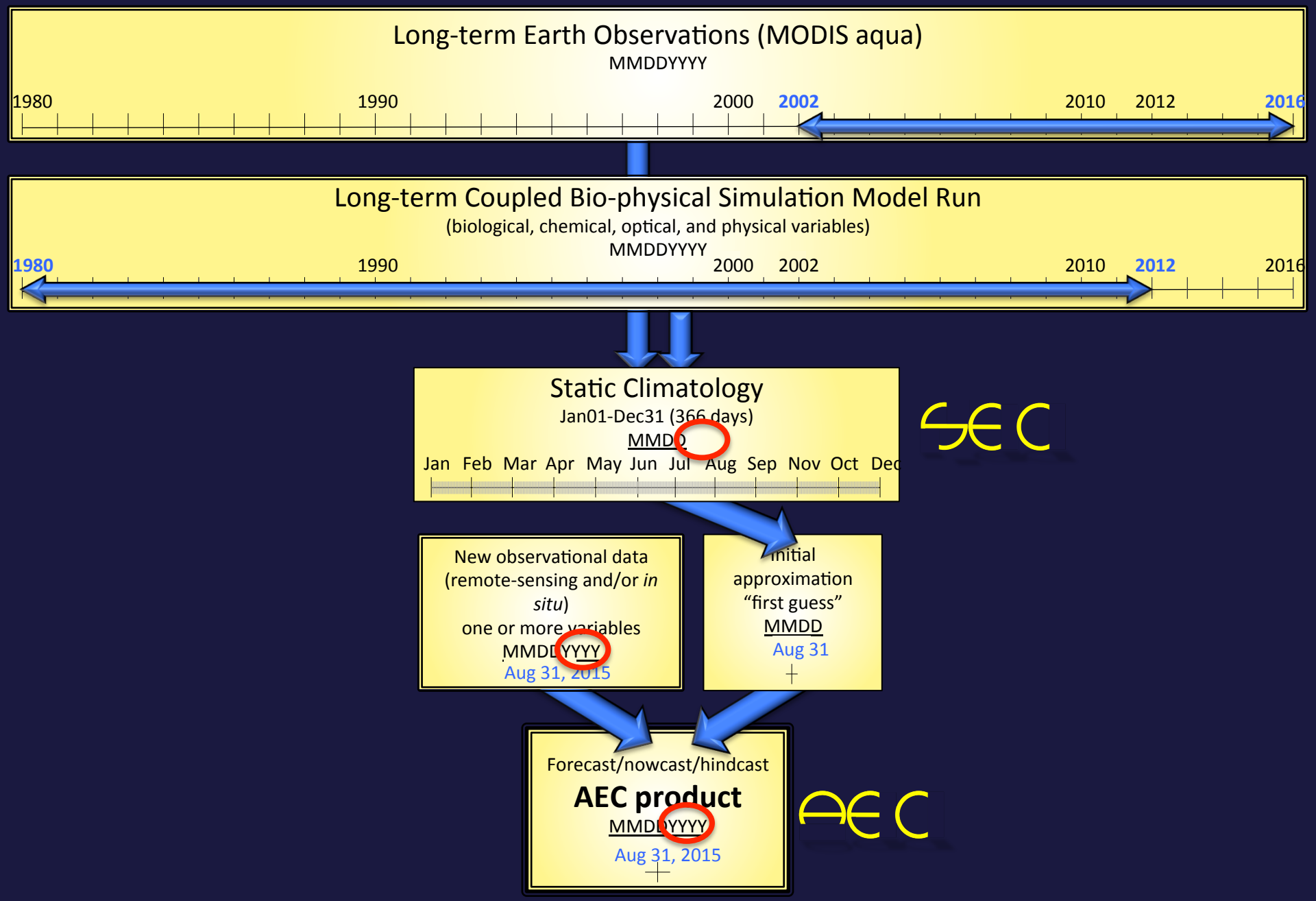
in-situ climatologies Earth Observations Models


20050825_00
1 of 1
NOAA1 h002
U.S. West Coast
Bio-Physical Coupling
1.60
-2.00
Log Chlorophyll
mg m-3
MODIS Chlorophyll
August 28, 2005
VisSmcDf

Data Assimilation example using NRL's Coupled Ocean Data Assimilation system (NCODA)




Real-Time Satellite Imagery
Initialization Fields for Individual Users
'Static'
'Adaptive'
Ocean Climatology
Model Fields
Satellite Imagery
NOAA Ocean-NOMADS
AEC Optimal Interpolation
Intermediate Models
Fisheries Models
Ecosystem Models
Decision Aids
Crowd-Sourced/ User Data
Visualizations
KIT
OSKit


Long-term Earth Observations (MODIS aqua)
MMDDYYYY
1980
1990
2000
2002
2010
2012
2016
Long-term Coupled Bio-physical Simulation Model Run
(biological, chemical, optical, and physical variables)
MMDDYYYY
1980
1990
2000
2002
2010
2012
2016
Static Climatology
Jan01-Dec31 (366 days)
MMDD
Jan Feb Mar Apr May Jun Jul Aug Sep Nov Oct Dec
SEC
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
AEC

tatic

cosystem

limatology

SEC

Gulf of Mexico (available)

18-30ºN x 79-98ºW

MODIS Aqua (2003-2013)

1 km resolution

- Chlorophyll
- Sea Surface Temperature

NCOM-COSINE Model (1980-2012)

4 km resolution

- Chlorophyll
- Phytoplankton groups
- Zooplankton groups
- Temperature
- Salinity
- Water velocity (U,V)

Blended EO/Model in prep.

USWEST (available soon)

29–53ºN x 115-135ºW

MODIS Aqua (2003 – 2016)

1 km resolution

- Chlorophyll
- Sea Surface Temperature

NCOM-COSINE Model (1999-2006)

9 km resolution (4 km in prep)

- Chlorophyll
- Phytoplankton groups
- Zooplankton groups

USEAST

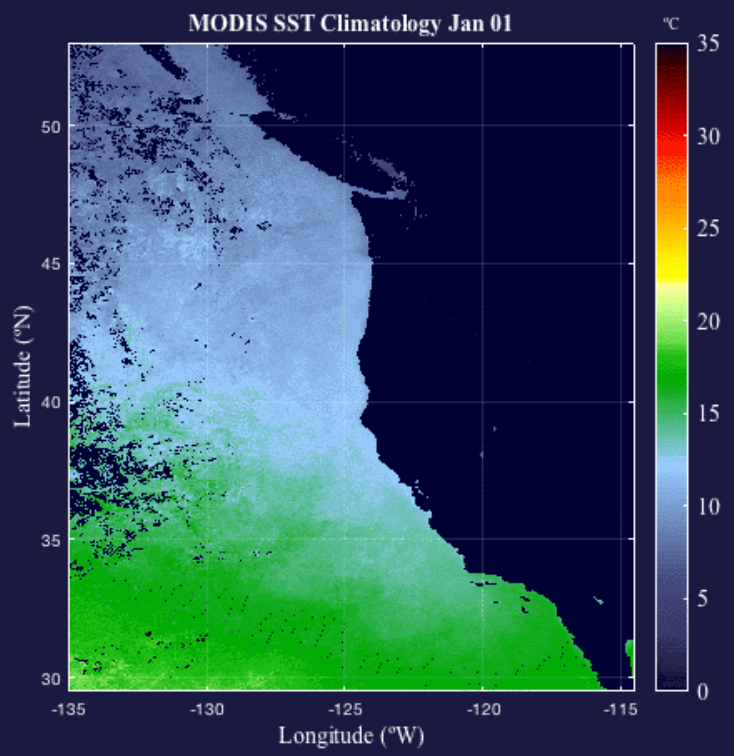
24-46ºN x 64-82ºW

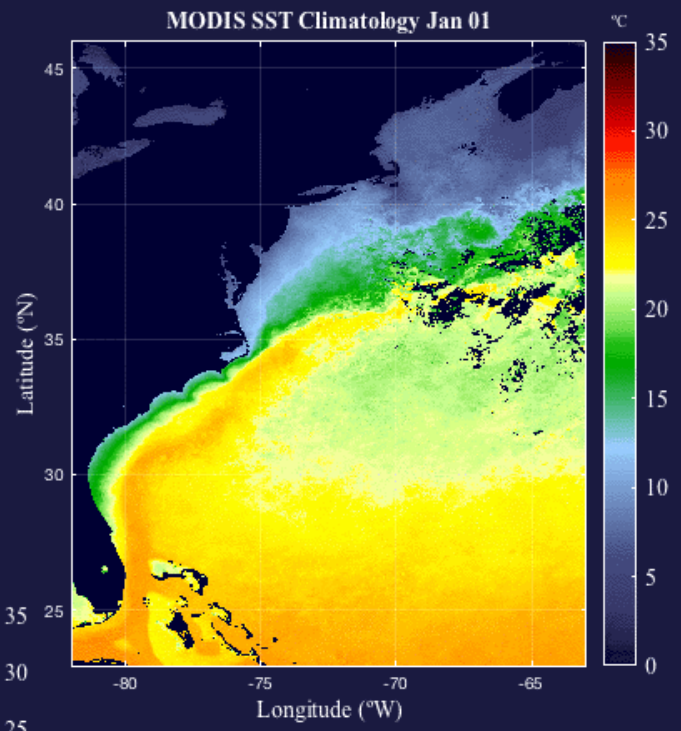
MODIS Aqua (2003 – 2016)

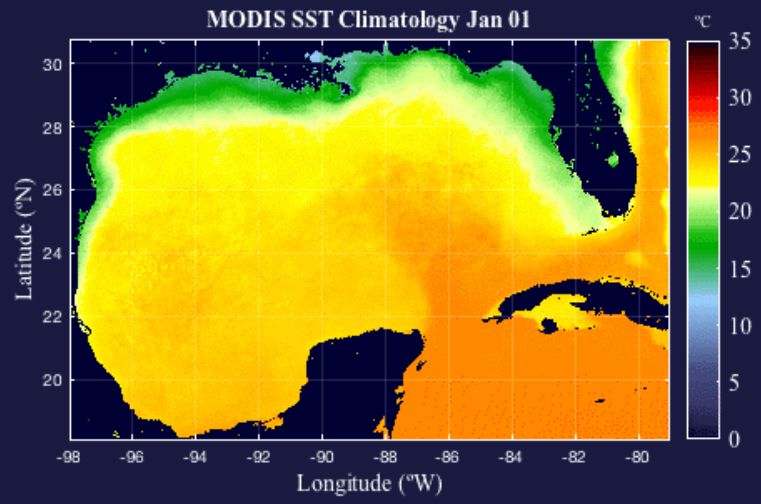
1 km resolution

- Chlorophyll
- Sea Surface Temperature

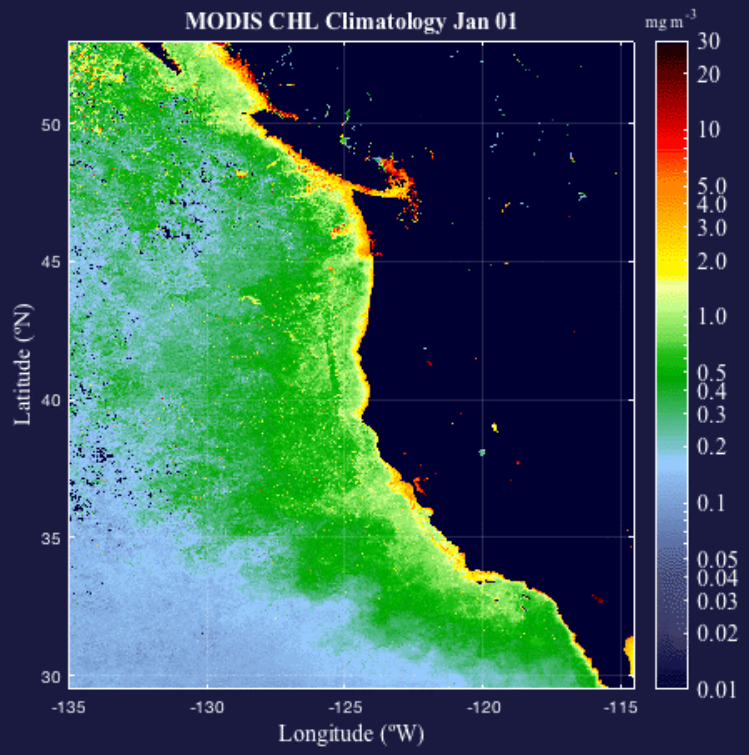
EO SST Climatology

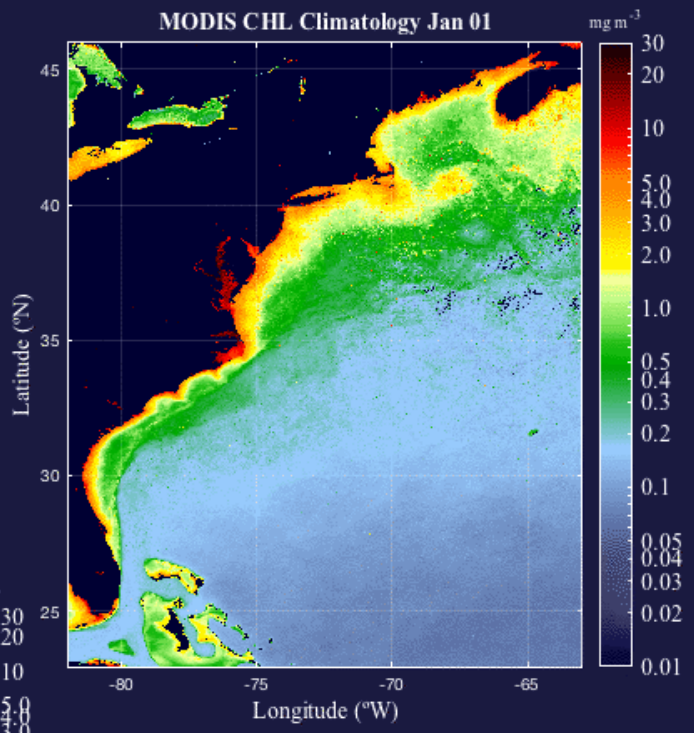


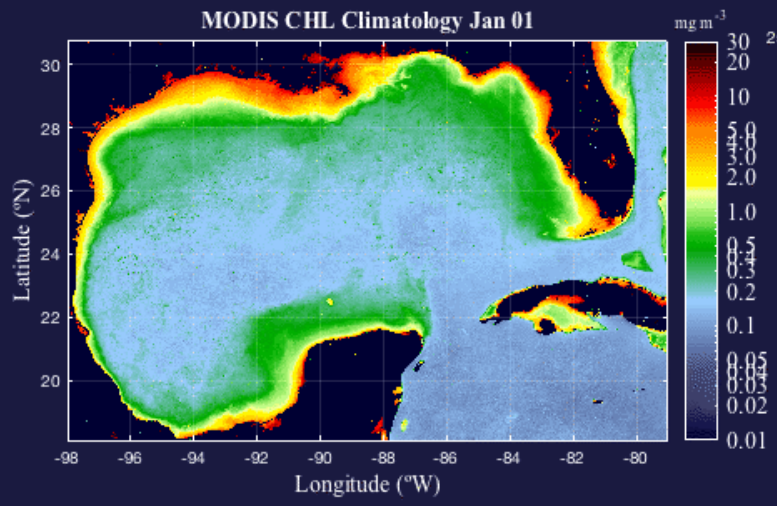




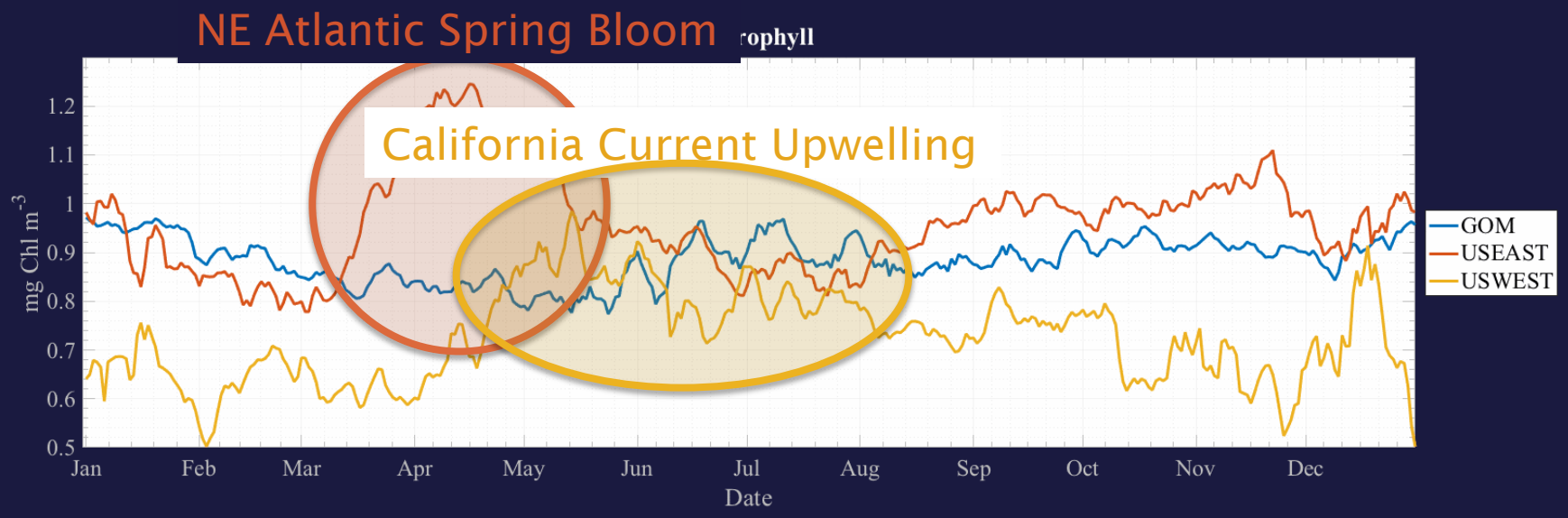
EO Chlorophyll Climatology



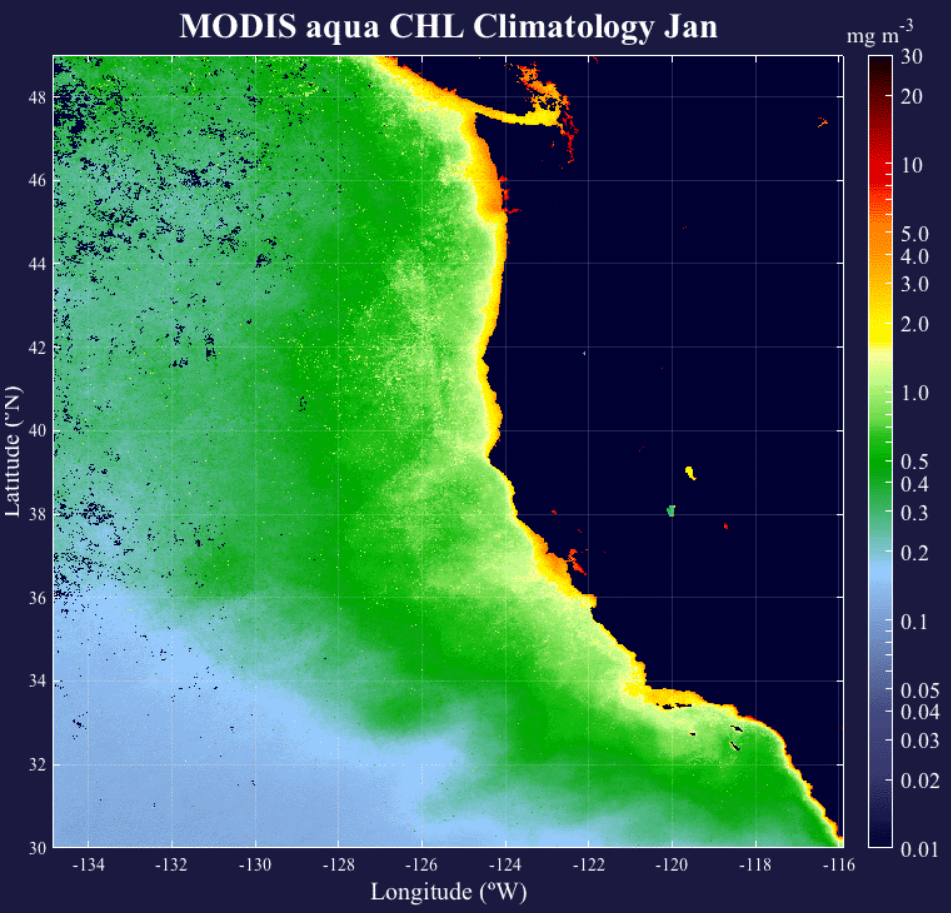




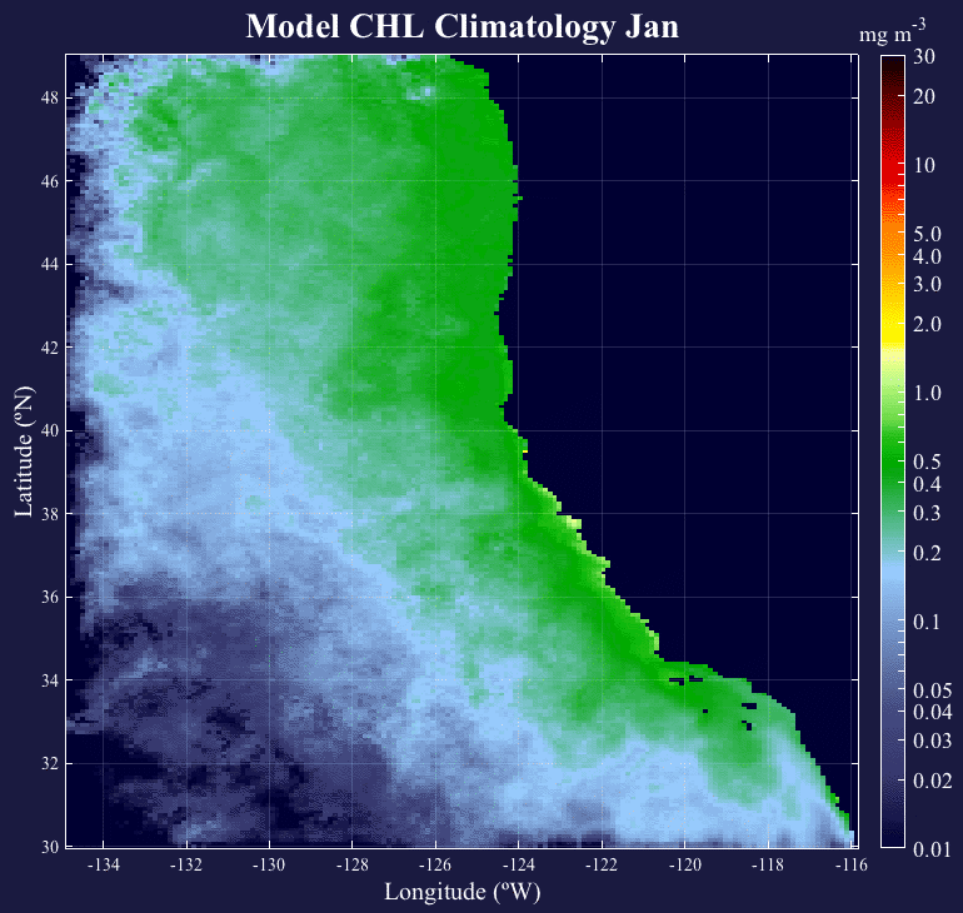
EO Whole Domain Climatology



Model and EO
Monthly Chlorophyll Climatologies

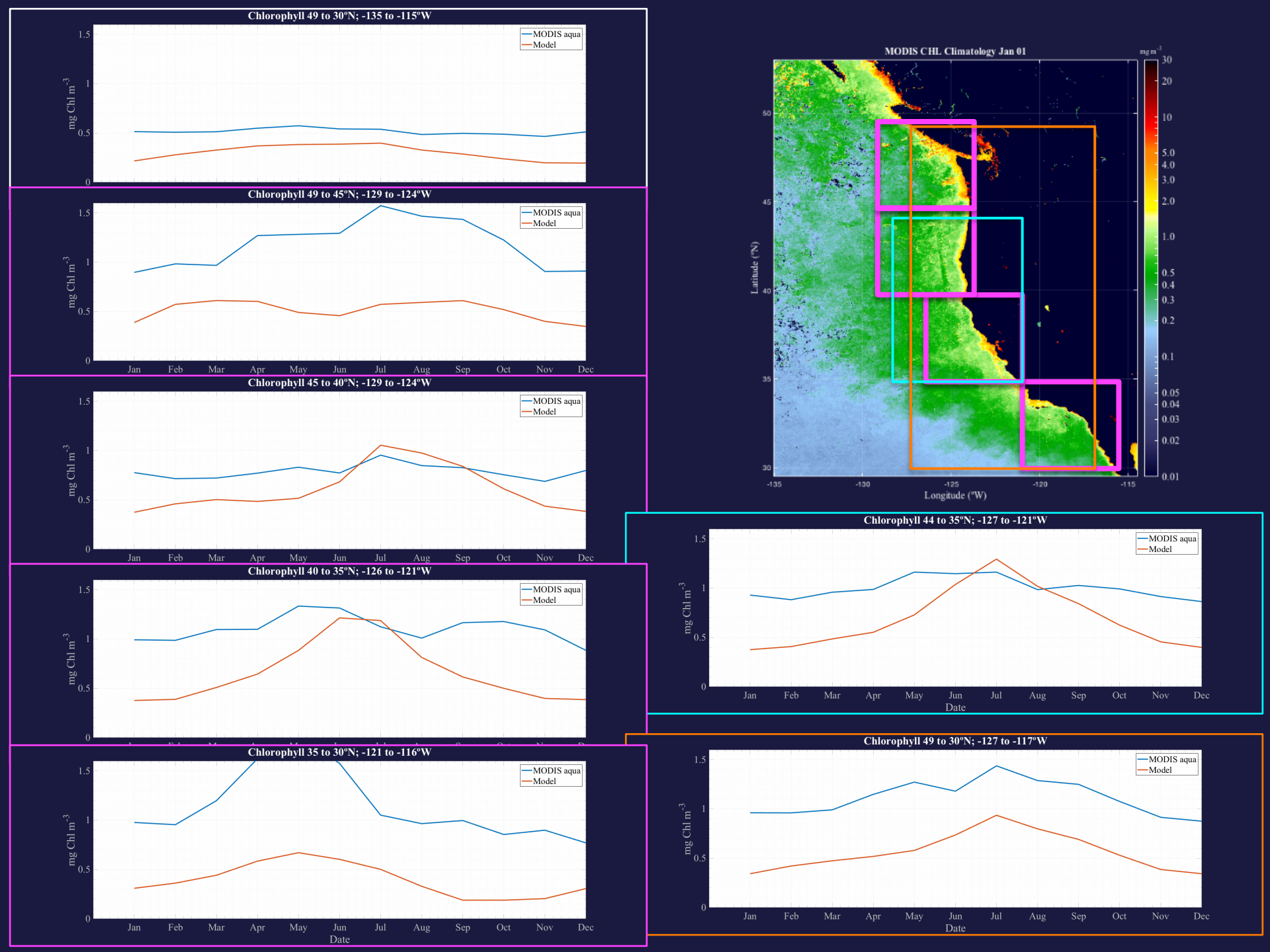


2003-2016



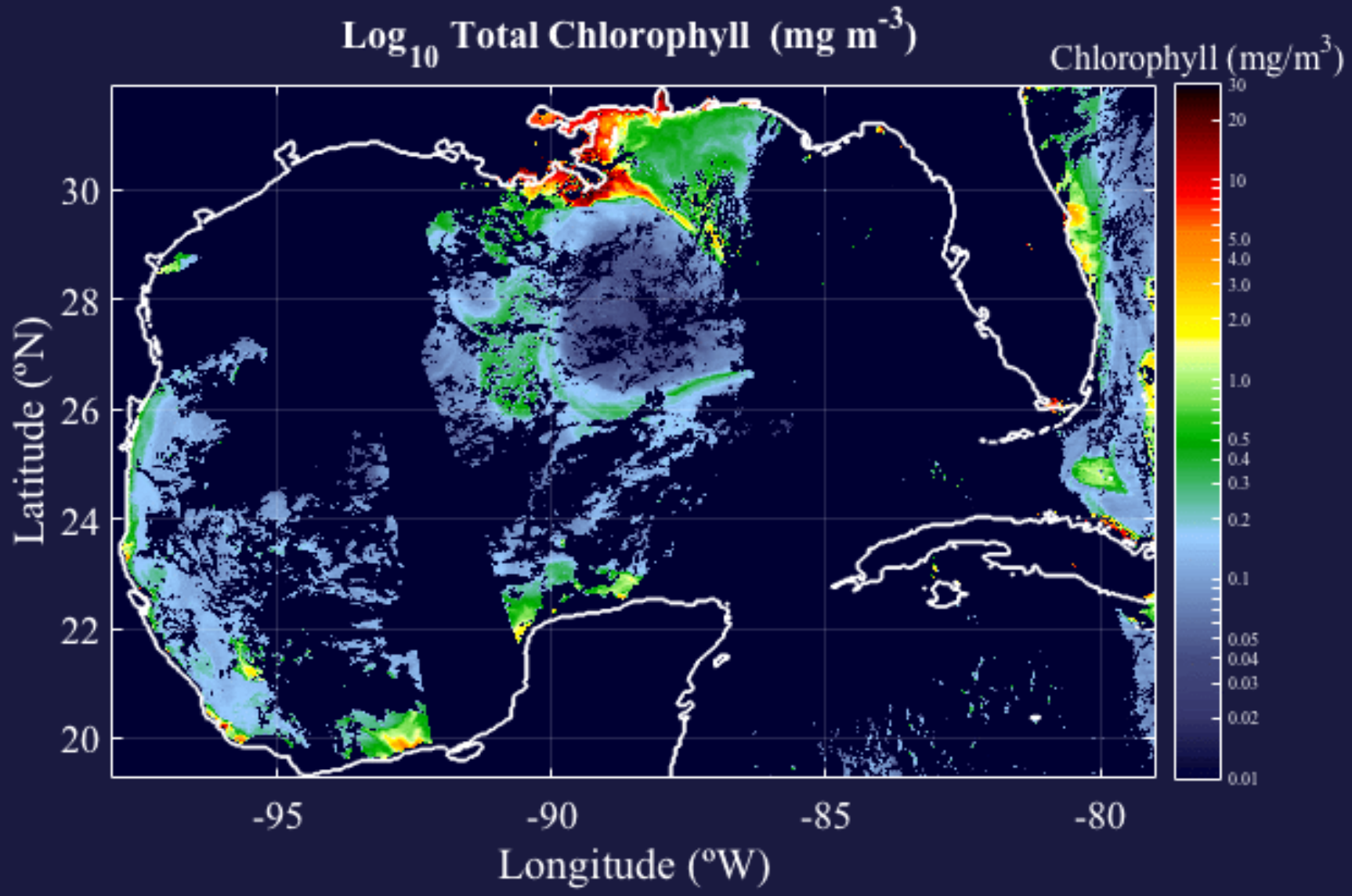
1999-2006

Will continue to 2018

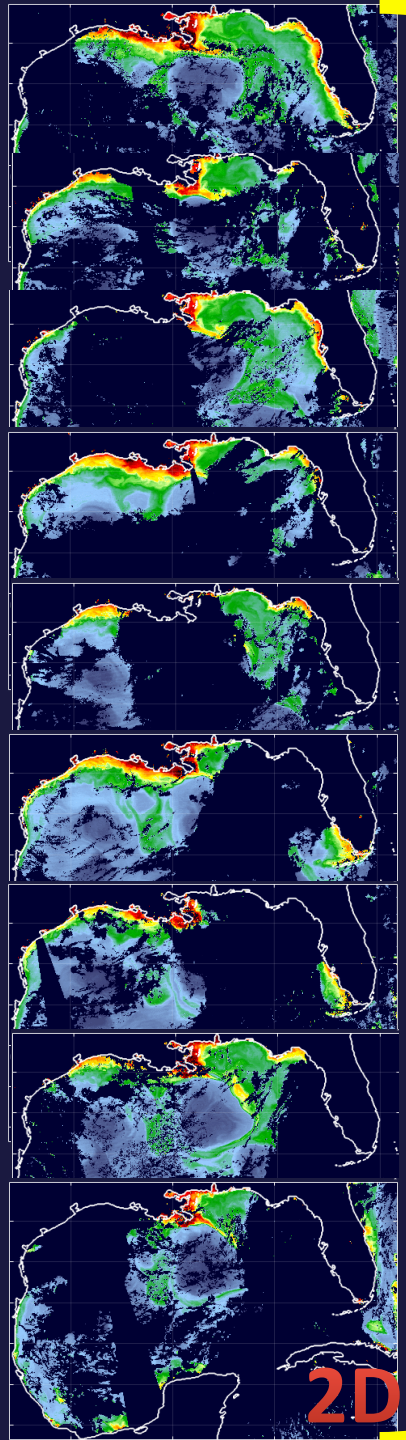

Chlorophyll 49 to 30ºN; -135 to -115ºW
Chlorophyll 49 to 45ºN; -129 to -124ºW
Chlorophyll 45 to 40ºN; -129 to -124ºW
Chlorophyll 40 to 35ºN; -126 to -121ºW
Chlorophyll 35 to 30ºN; -121 to -116ºW
Chlorophyll 44 to 35ºN; -127 to -121ºW
Chlorophyll 49 to 30ºN; -127 to -117ºW
MODIS aqua
Model
mg Chl m-3
Date
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
MODIS CHL Climatology Jan 01
Latitude (ºN)
Longitude (ºW)
mg m-3

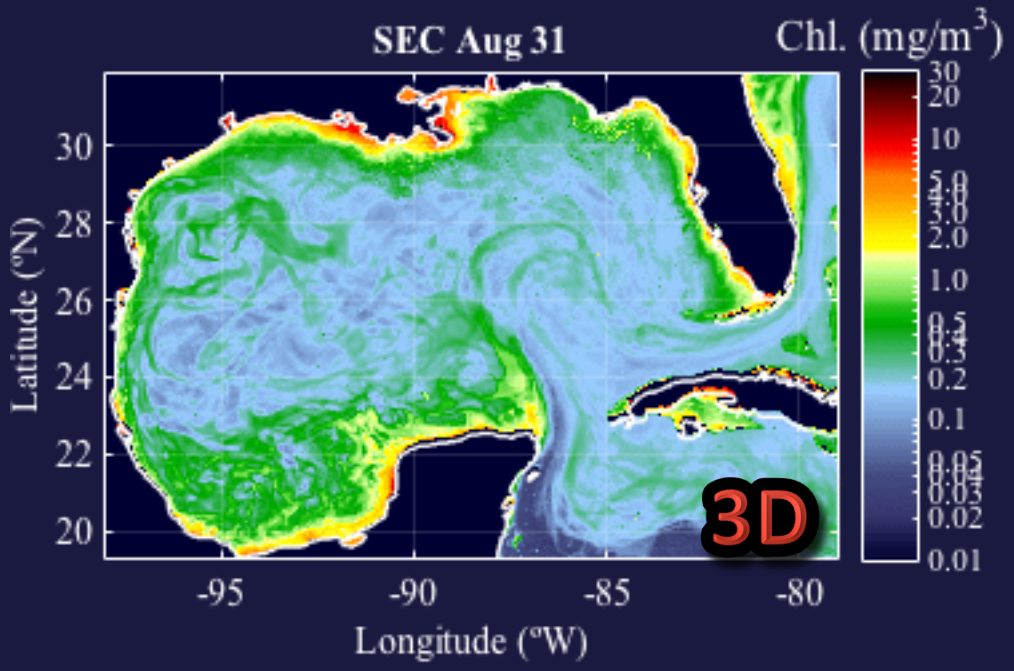
daptive
cosystem
limatology

Daily EO Aug 31, 2015

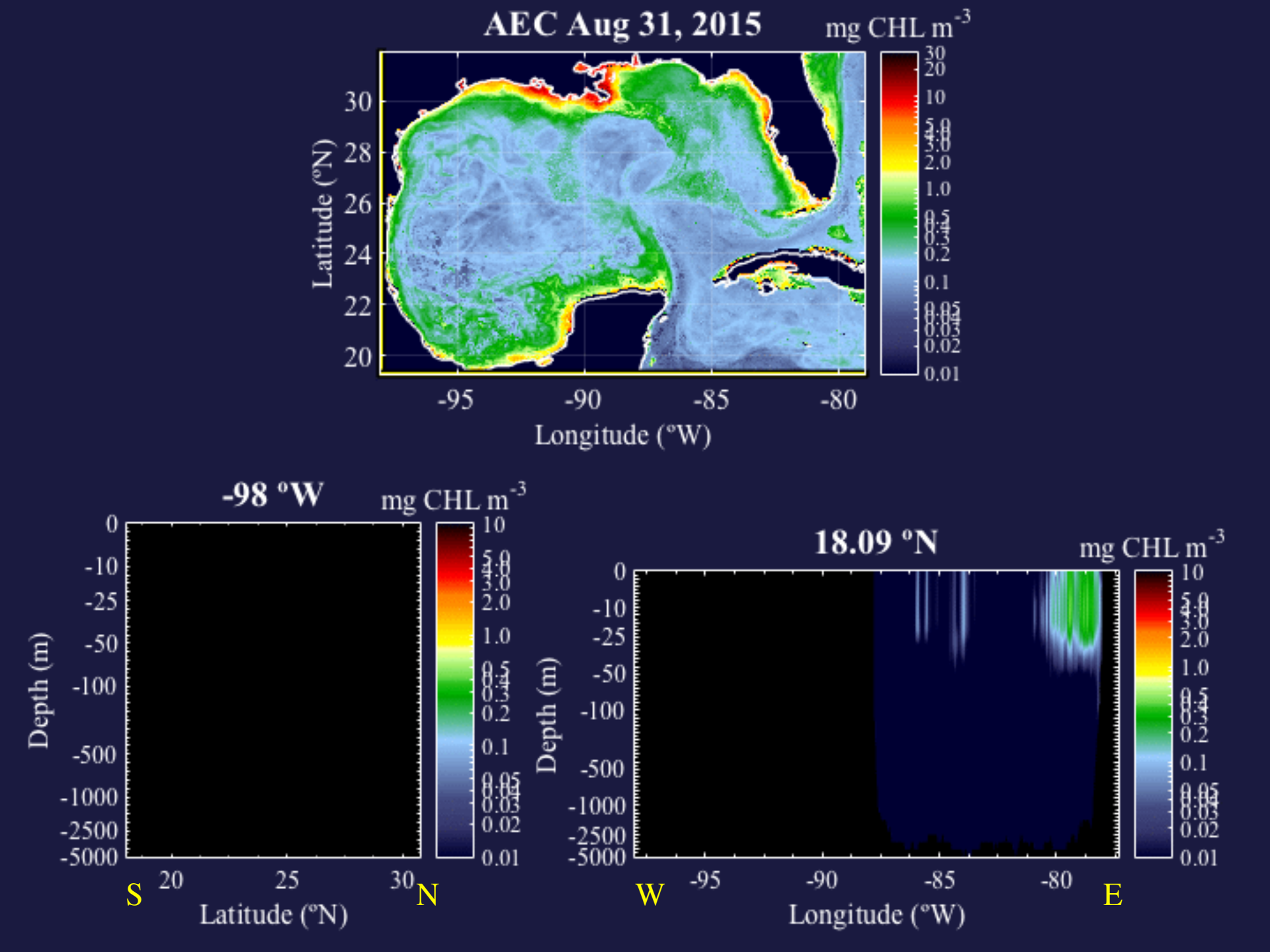


Daily EO (Chlorophyll) Aug 23-31, 2015



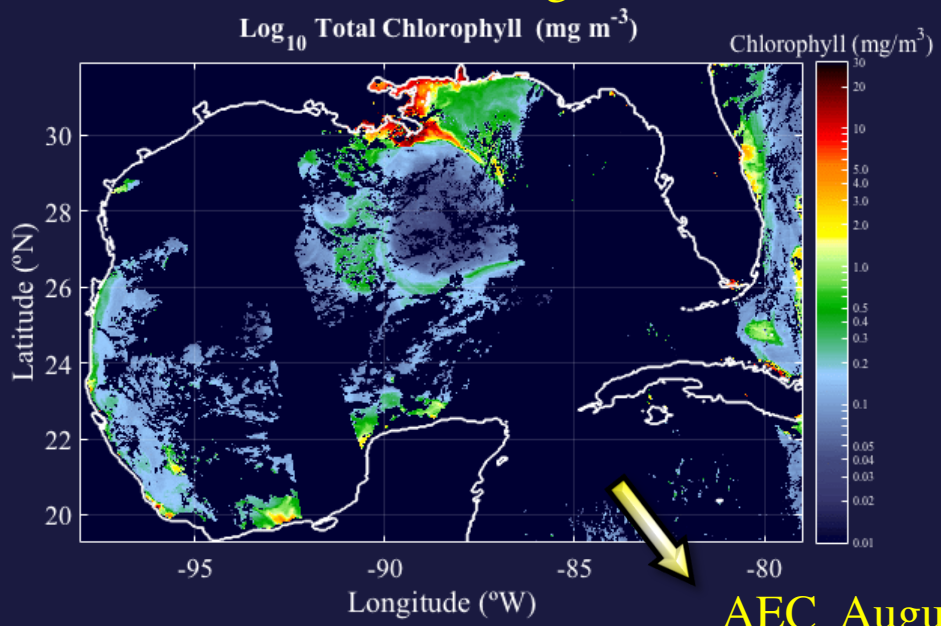


AEC

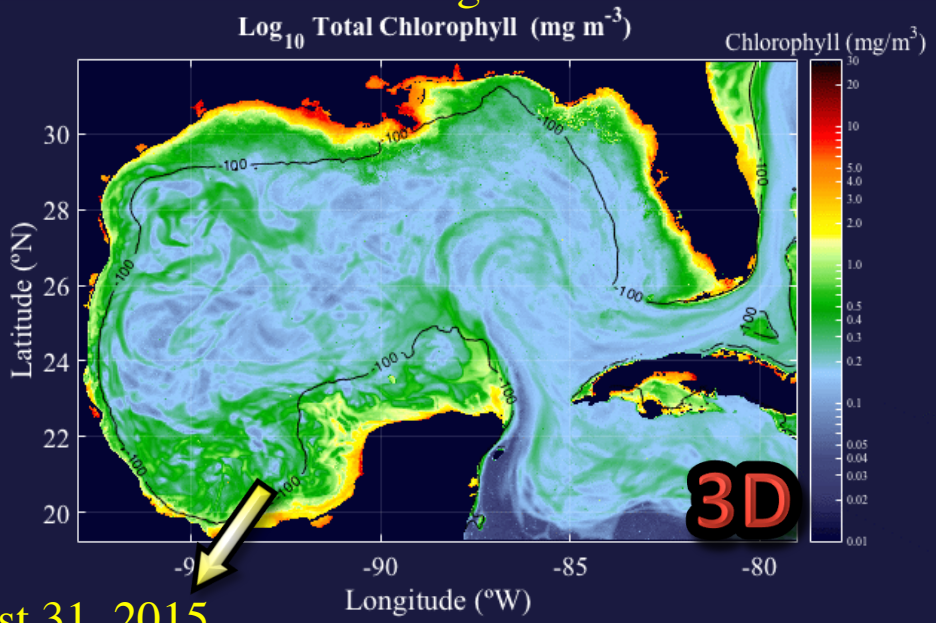

AEC Aug 31, 2015
mg CHL m-3
Latitude (°N)
Longitude (°W)
-98 °W
Depth (m)
Latitude (°N)
S
N
18.09 °N
Longitude (°W)
W
E

Summary

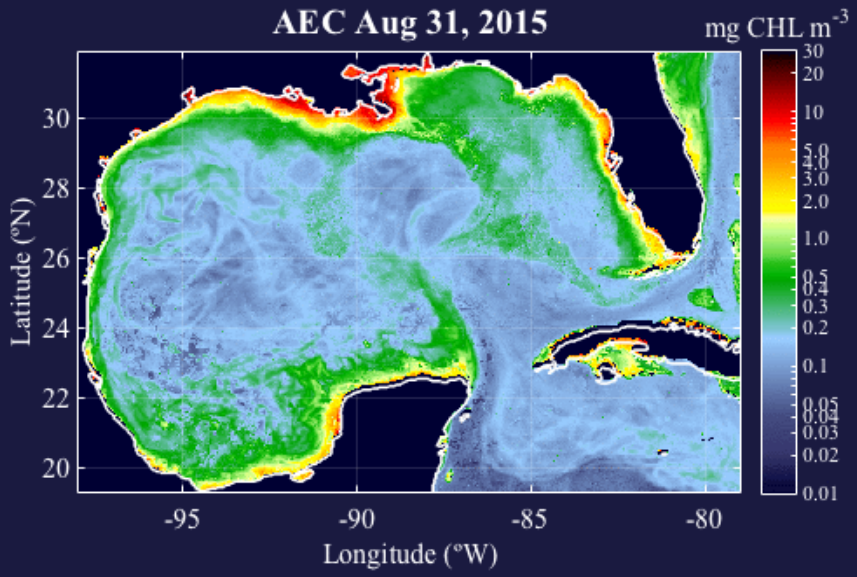
Earth Observation August 31, 2015



SEC August 31



AEC August 31, 2015



AEC Web portal current status:

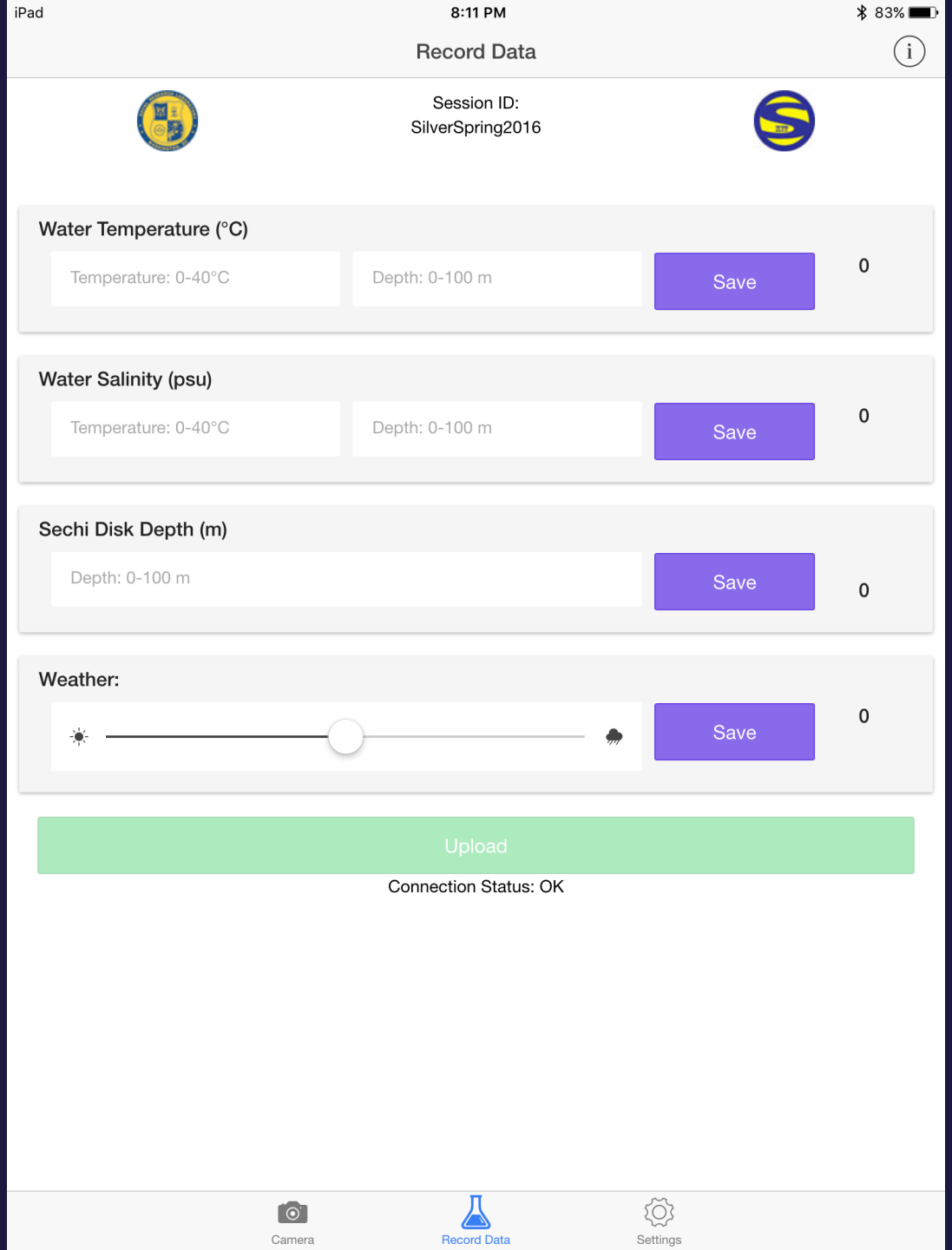
- Change in the physical location of the OceanNOMADS server and data storage from Stennis Space Center, MS to Nashville, TN

- Automated AEC tools are being converted from fortran/Matlab to python scripts

Crowdsourcing:

iPad
9:37 PM
77%
AEC
Secchi
HydroColor
Phyto
Deep Sea ID
GoPro
World Regist...
EyeOnWater
OSKit

Oskit App:


iPad
8:11 PM
83%
Record Data
Session ID:
SilverSpring2016
Water Temperature (°C)
Temperature: 0-40°C
Depth: 0-100 m
Save
0
Water Salinity (psu)
Temperature: 0-40°C
Depth: 0-100 m
Save
0
Sechi Disk Depth (m)
Depth: 0-100 m
Save
0
Weather:
Save
0
Upload
Connection Status: OK
Camera
Record Data
Settings

Thanks:

NASA: **Maury Estes, Woody Turner**.

BOEM: Joseph Christopher, Rebecca Green.

EPA: Richard Greene, John Leherter.

NOAA: Rebecca Allee, Russ Beard, Scott Cross, Christopher Gledhill, Arnaud Grüss, George Halliwell, Christopher Kelble, Steve Morton, Woody Nero, Rost Parsons, Angela Sallis, Michael Schirripa.

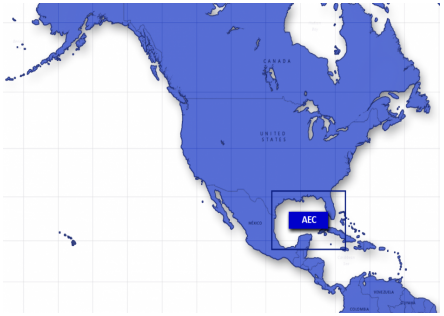
NRL: Adam Lawson

NRL/ONR Summer Interns: Rachel Holliday, Sam Holliday, Francis Prikasky, Suhaas Yerramreddy

U.S. NAVAL RESEARCH LABORATORY

Quick Links
Land-Based Station
Satellite
Radar
Model
Datasets
AEC
CFS
CM2.X
CMIP5
GDAS
GEFS
GFS
HYCOM
NAM
NARR
NCOM
NCOM-Regional
NDFD
NDGD
NGM
R1 / R2
RAP
RTOFS
SRRS
Ocean Models
Reanalysis
Numerical Weather Prediction
Climate Prediction
Derived / Other Model Data
NOMADS

Naval Research Laboratory Gulf of Mexico Adaptive Ecosystem Climatology (AEC)



Coverage area for the Naval Research Laboratory's Gulf of Mexico Adaptive Ecosystem Climatology.

The Naval Research Laboratory Adaptive Ecosystem Climatology (AEC) combines an ocean model with Earth observations to provide a synoptic view of the typical (climatic) state of the ocean for every day of the year. The current version of AEC (beta4) is a research-quality product constructed for the Gulf of Mexico. The AEC comprises two sets of climatological mean fields: one derived from a coupled biophysical model simulation and one derived from satellite observations. The model-based daily climatology is derived from a 33-year simulation (1980–2012) of a 4-km resolution, coupled biophysical ocean model that uses the Navy Coastal Ocean Model (NCOM) hydrodynamics and the Carbon Silicate Nitrogen Ecosystem (COSINE) marine biochemistry. The model assimilates altimetry data and satellite sea surface temperature from the Advanced Very High Resolution Radiometer (AVHRR). It is forced by boundary conditions prescribed by the 1/8° Global NCOM, and by atmospheric fluxes prescribed by NASA's Modern Era Retrospective-Analysis for Research and Applications (MERRA). The satellite daily climatology provides chlorophyll concentration and sea surface temperature derived from the Moderate Resolution Imaging Spectroradiometer (MODIS) level-1 data processed at 1-km resolution and spanning the period 2003–2013. Each calendar day in the climatology represents a 5-day rolling average centered on that day, with data from all 11 years included. Thus, the value at each pixel is an average of up to 55 individual data values.

AEC beta4 netCDF files contain (Model): sea surface elevation, ocean temperature, salinity, eastward and northward currents, along with phytoplankton, diatoms, micro-zooplankton, and meso-zooplankton distributions at standard depths through the water column; (Satellite): sea surface temperature and sea surface chlorophyll.

Product	Grid/Scale	POR	Model Cycle	Output Time Step	Access
Model-based climatology	1/25°	1 year climatology	1 day	1 day	TDS agg, TDS files, ERDDAP 2D, ERDDAP 3D
Satellite-based climatology	1/100°	1 year climatology	1 day	1 day	TDS agg, TDS files, ERDDAP

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NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

ERDDAP

Brought to you by NOAA NMFS SWFSC ERD

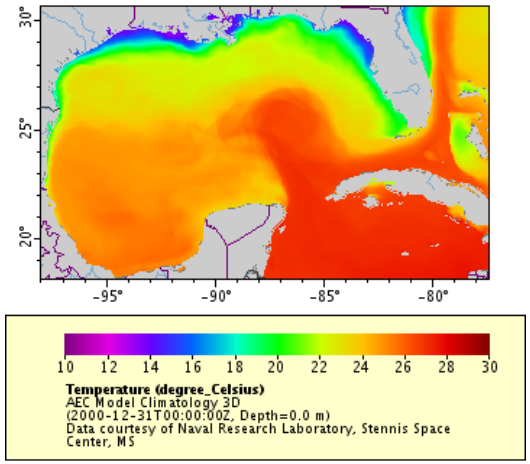
ERDDAP > griddap > Make A Graph

Dataset Title: **AEC Model Climatology 3D** RSS
Institution: Naval Research Laboratory, Stennis Space Center, MS (Dataset ID: AEC_gomex_model_climo_3d)
Information: Summary | License | FGDC | ISO 19115 | Metadata | Background | Data Access Form

Graph Type: surface
X Axis: longitude
Y Axis: latitude
Color: water_temp

Dimensions	**Start**	**Stop**
time (UTC)	specify just 1 value →	2000-12-31T00:00:00Z
depth (m)	specify just 1 value →	0.0
latitude (degrees_north)	18.09165	30.73087
longitude (degrees_east)	-98.0	-77.36

Click on the map to specify a new center point.
Zoom: Data Out 8x Out 2x Out In In 2x In 8x



Graph Settings
Color Bar: Continuity: Scale:
Min: Max: N Sections:
Draw the land mask:

Redraw the Graph (Please be patient. It may take a while to get the data.)

Optional:
Then set the File Type: .htmlTable and Download the Data or an Image
or view the URL: http://ecowatch.ncddc.noaa.gov/erddap/griddap/AEC_gomex_model_climo_3d.htmlTable
(Documentation / Bypass this form) (File Type information)

Things You Can Do With Your Graphs

Well, you can do anything you want with your graphs, of course. But some things you might not have considered are:

- Web page authors can embed a graph of the latest data in a web page using HTML <img> tags.
- Anyone can use ERDDAPs Slide Sorter to build a personal web page that displays graphs with the latest data (or other images or HTML content), each in its own, draggable slide.

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ERDDAP

Brought to you by NOAA NMFS SWFSC ERD

ERDDAP > griddap > Data Access Form

Dataset Title: **AEC Model Climatology 3D** RSS
Institution: Naval Research Laboratory, Stennis Space Center, MS (Dataset ID: AEC_gomex_model_climo_3d)
Information: Summary | License | FGDC | ISO 19115 | Metadata | Background | Make a graph

Dimensions	Start	Stride	Stop	Size	Spacing
☑ time (Forecast time for ForecastModelRunCollection, UTC)	2000-12-31T00:00:00Z	1	2000-12-31T00:00:00Z	366	1 day (even)
☑ depth (m)	0.0	1	-2.0	40	-128.2051 (uneven)
☑ latitude (degrees_north)	30.73087	1	30.73087	349	0.0363196 (uneven)
☑ longitude (degrees_east)	-77.36	1	-77.36	517	0.04 (even)

Grid Variables (which always also download all of the dimension variables)
- ☑ water_temp (Temperature, degree_Celsius)
- ☐ water_u (U Velocity, m/s)
- ☐ water_v (V Velocity, m/s)
- ☐ salinity (psu)
- ☐ sphy (Small Phytoplankton, micromoles N/L)
- ☐ diatoms (micromoles N/L)
- ☐ mezoo (Mesozooplankton, micromoles N/L)
- ☐ mizoo (Microzooplankton, micromoles N/L)

File type: .htmlTable - View a .html web page with the data in a table. Times are ISO 8601 strings. more info
Just generate the URL: Documentation / Bypass this form

Submit (Please be patient. It may take a while to get the data.)

.asc - View OPeNDAP-style comma-separated ASCII text.
.csv - Download a comma-separated ASCII text table (line 1: names; line 2: units; ISO 8601 times).
.csvp - Download a .csv file with line 1: name (units). Times are ISO 8601 strings.
.csv0 - Download a .csv file without column names or units. Times are ISO 8601 strings.
.das - View the dataset's metadata via an OPeNDAP Dataset Attribute Structure (DAS).
.dds - View the dataset's structure via an OPeNDAP Dataset Descriptor Structure (DDS).
.dods - OPeNDAP clients use this to download the data in the DODS binary format.
.esriAscii - Download an ESRI ASCII file (lat lon data only; lon must be all below or all above 180).
.fgdc - View the dataset's FGDC .xml metadata.
.graph - View a Make A Graph web page.
.help - View a web page with a description of griddap.
.html - View an OPeNDAP-style HTML Data Access Form.
✓ .htmlTable - View a .html web page with the data in a table. Times are ISO 8601 strings.
.iso19115 - View the dataset's ISO 19115-2/19139 .xml metadata.
.json - View a table-like JSON file (missing value = 'null'; times are ISO 8601 strings).
.mat - Download a MATLAB binary file.
.nc - Download a NetCDF-3 binary file with COARDS/CF/ACDD metadata.
.ncHeader - View the header (the metadata) for the .nc file.
.ncml - View the dataset's structure and metadata as an NCML .xml file.
.odvTxt - Download time,lat,lon,otherVariables as an ODV Generic Spreadsheet File (.txt).
.tsv - Download a tab-separated ASCII text table (line 1: names; line 2: units; ISO 8601 times).
.tsvp - Download a .tsv file with line 1: name (units). Times are ISO 8601 strings.
.tsv0 - Download a .tsv file without column names or units. Times are ISO 8601 strings.
.xhtml - View an XHTML (XML) file with the data in a table. Times are ISO 8601 strings.
.geotif - View a grayscale GeoTIFF .tif file (for lat lon data; lon must be all below or all above 180).
.kml - View a Google Earth .kml file (for lat, lon data only).
.smallPdf - View a small .pdf image file with a graph or map.
.pdf - View a standard, medium-sized .pdf image file with a graph or map.
.largePdf - View a large .pdf image file with a graph or map.
.smallPng - View a small .png image file with a graph or map.
.png - View a standard, medium-sized .png image file with a graph or map.
.largePng - View a large .png image file with a graph or map.
.transparentPng - View a .png image file (just the data, without axes, landmask, or legend).

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NCEI Ocean NOMADS

THREDDS Data Server

Catalog http://ecowatch.ncddc.noaa.gov/thredds/catalog/aec_model/catalog.html

Dataset: AEC Model/AEC.beta4.GOM5i0.04.0000123100.nc

- *Data size:* 231.6 Mbytes
- *ID:* AEC_model/AEC.beta4.GOM5i0.04.0000123100.nc

Access:

1. **OPENDAP:** /thredds/dodsC/aec_model/AEC.beta4.GOM5i0.04.0000123100.nc
2. **HTTPServer:** /thredds/fileServer/aec_model/AEC.beta4.GOM5i0.04.0000123100.nc
3. **WCS:** /thredds/wcs/aec_model/AEC.beta4.GOM5i0.04.0000123100.nc
4. **WMS:** /thredds/wms/aec_model/AEC.beta4.GOM5i0.04.0000123100.nc
5. **NCML:** /thredds/ncml/aec_model/AEC.beta4.GOM5i0.04.0000123100.nc
6. **UDDC:** /thredds/uddc/aec_model/AEC.beta4.GOM5i0.04.0000123100.nc
7. **ISO:** /thredds/iso/aec_model/AEC.beta4.GOM5i0.04.0000123100.nc

Dates:

- 2014-09-23T18:33:02Z **(modified)**

Viewers:

- Godiva2 (browser-based)
- NetCDF-Java ToolsUI (webstart)

Auto-zoom on select Refresh

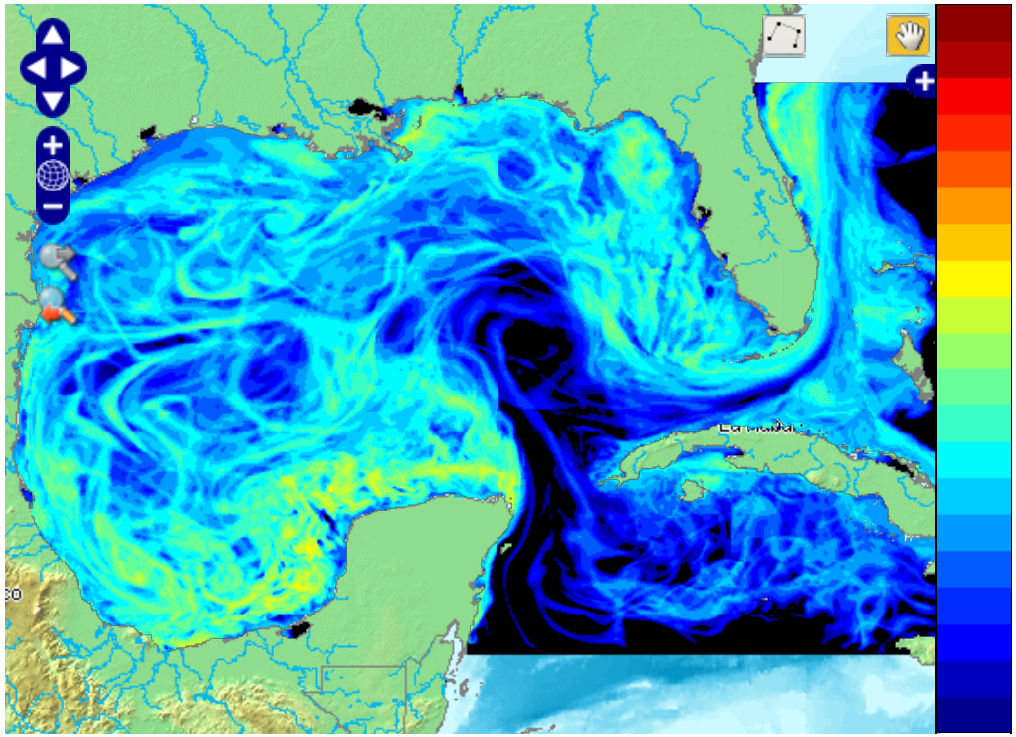
- NCEI Ocean NOMADS
  - AEC.beta4.GOM5i0.04.0000123100.nc
    - Sea Surface Elevation
    - Salinity
    - Temperature
    - U Velocity
    - V Velocity
    - Small Phytoplankton
    - Diatoms
    - Mesozooplankton
    - Microzooplankton

Layer: NCEI Ocean NOMADS > AEC.beta4.GOM5i0.04.0000123100.nc > Small Phytoplankton
Units: micromoles N/L
Height (m): 0
Date/time: 31 Dec 2000 00:00:00 UTC first frame last frame

?	December, 2000					
«	‹	Today			›	»
Sun	Mon	Tue	Wed	Thu	Fri	Sat
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

Select date

Fit layer to window



50
2.924
boxfill
log
auto
lock
0.1710
0.01

User guide

Reading e-Science Centre

test image

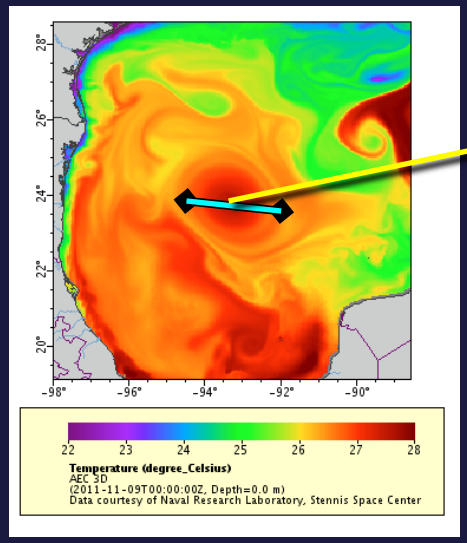
Overlay opacity: 100%

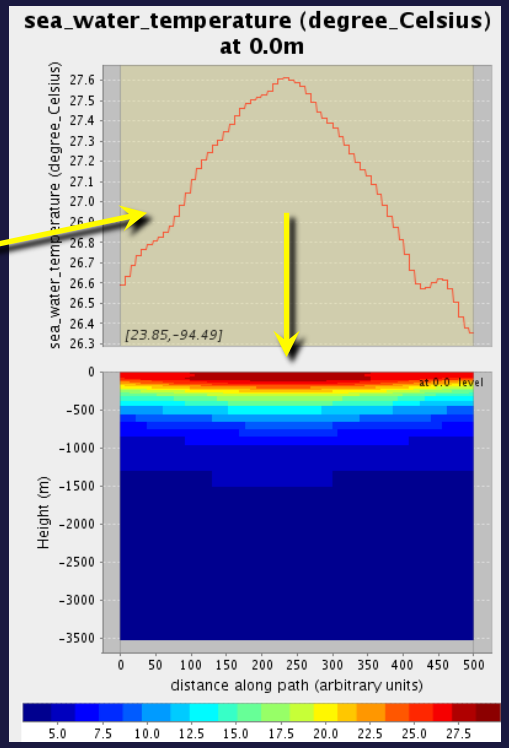
Powered by OpenLayers and OGC standards

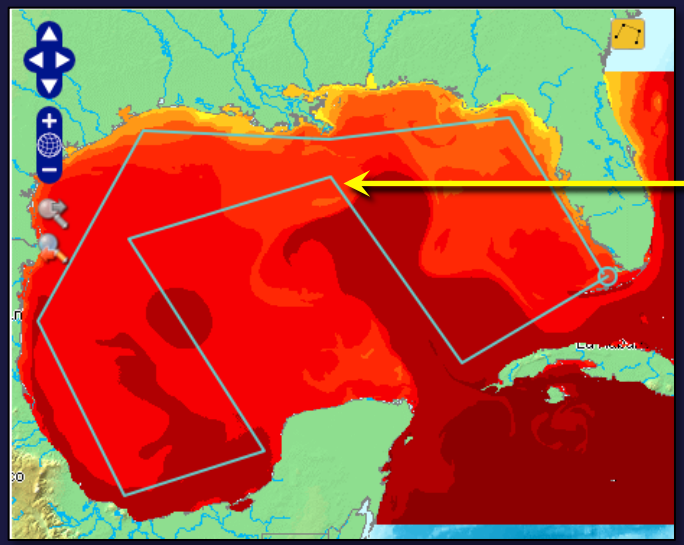
Permalink | email

November 9, 2011

SST







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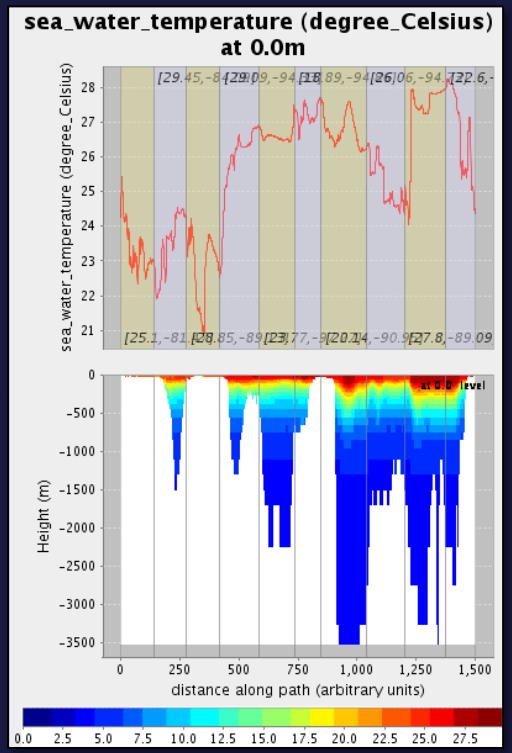
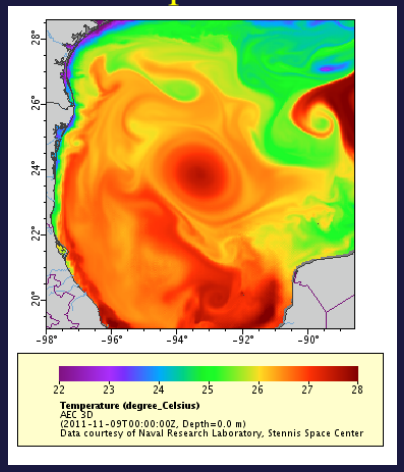
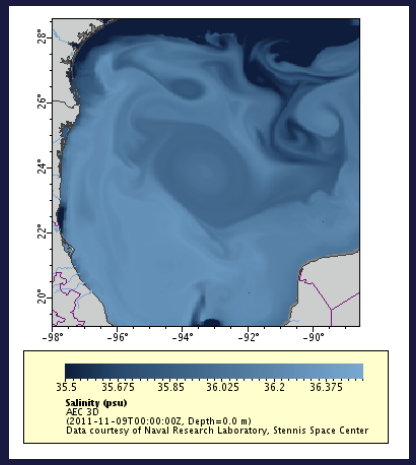


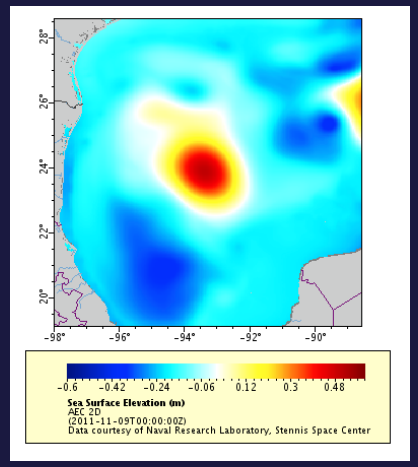
Temperature



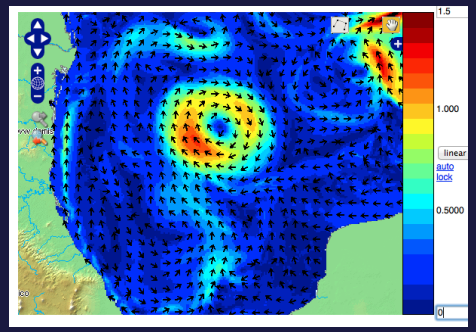
Salinity



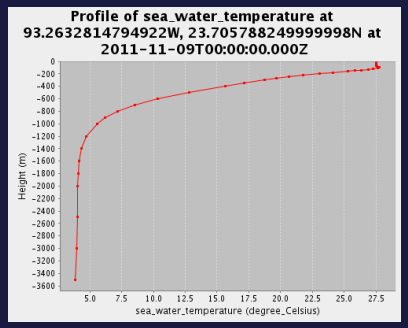
Sea Surface Height

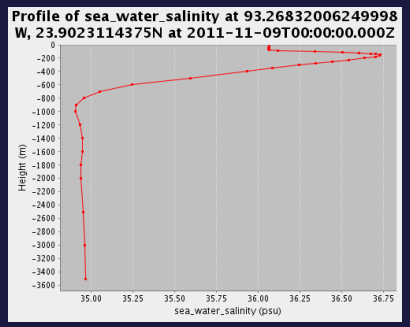


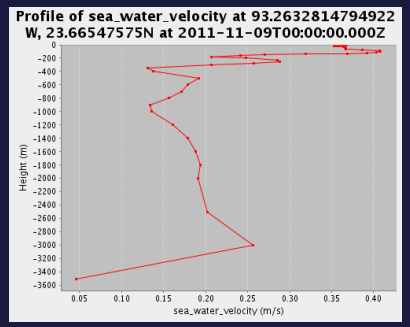
Currents



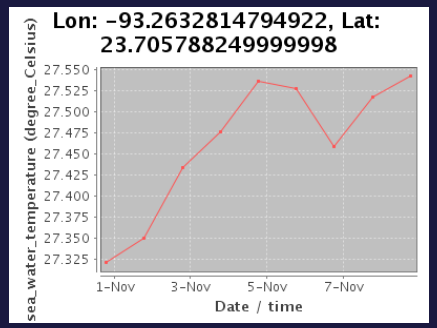
Profiles:

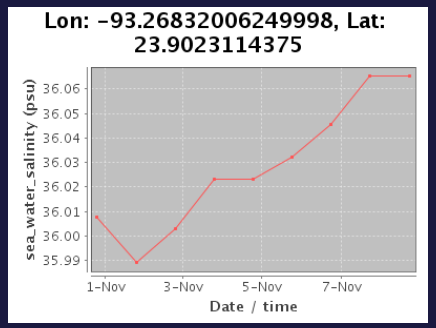


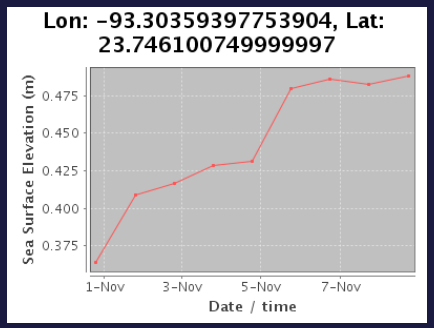


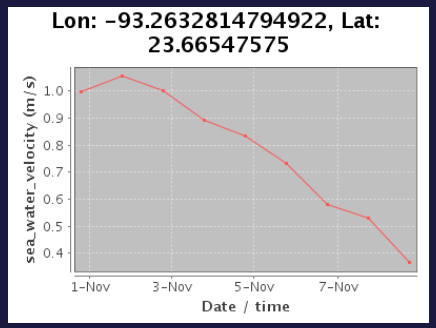


Timeseries:

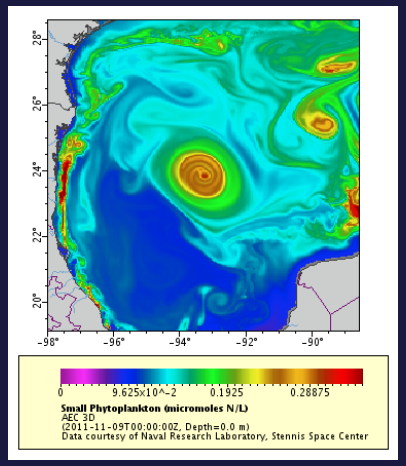




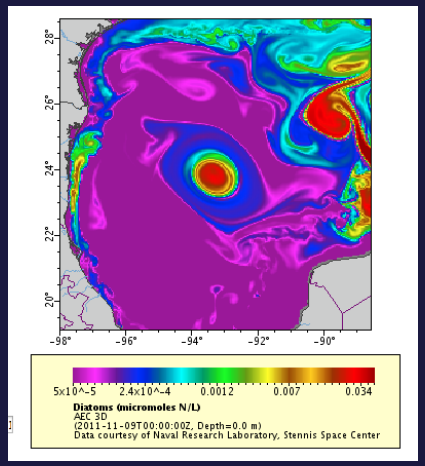




Small Phytoplankton



Diatoms



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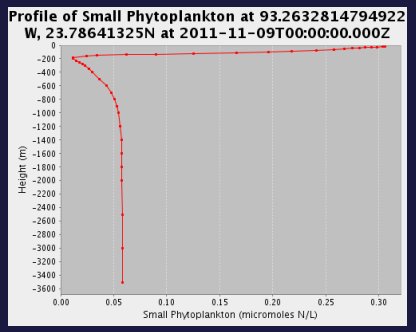

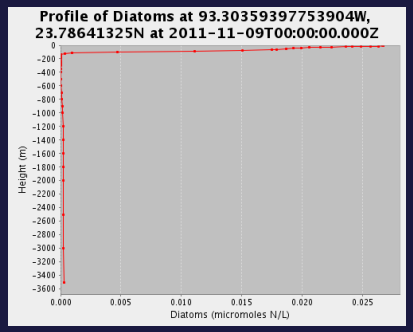
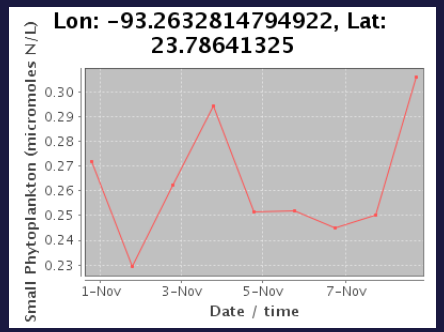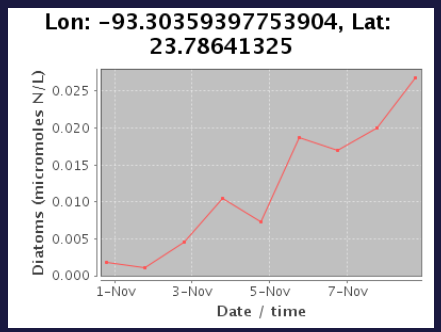
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