

**CoastWatch/OceanWatch Proving Ground:  
VIIRS Ocean Color**

User Engagement, Quality Assessment,  
Product Development, Data Distribution Portal,  
and  
Chesapeake Bay Ecosystem Modeling

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NOAA/NMFS Chesapeake Bay Office

June 26, 2013  
JPSS Proving Ground Science Seminar

# Outline

Overview of VIIRS Ocean Color Proving Ground  
(Hughes)

VIIRS Ocean Color Independent Quality Assessment  
(Ramachandran)

Ocean Color Data Usage  
in the Atlantis Ecosystem Model  
(Ihde, Townsend)

# CoastWatch/OceanWatch VIIRS Ocean Color: Proving Ground Overview

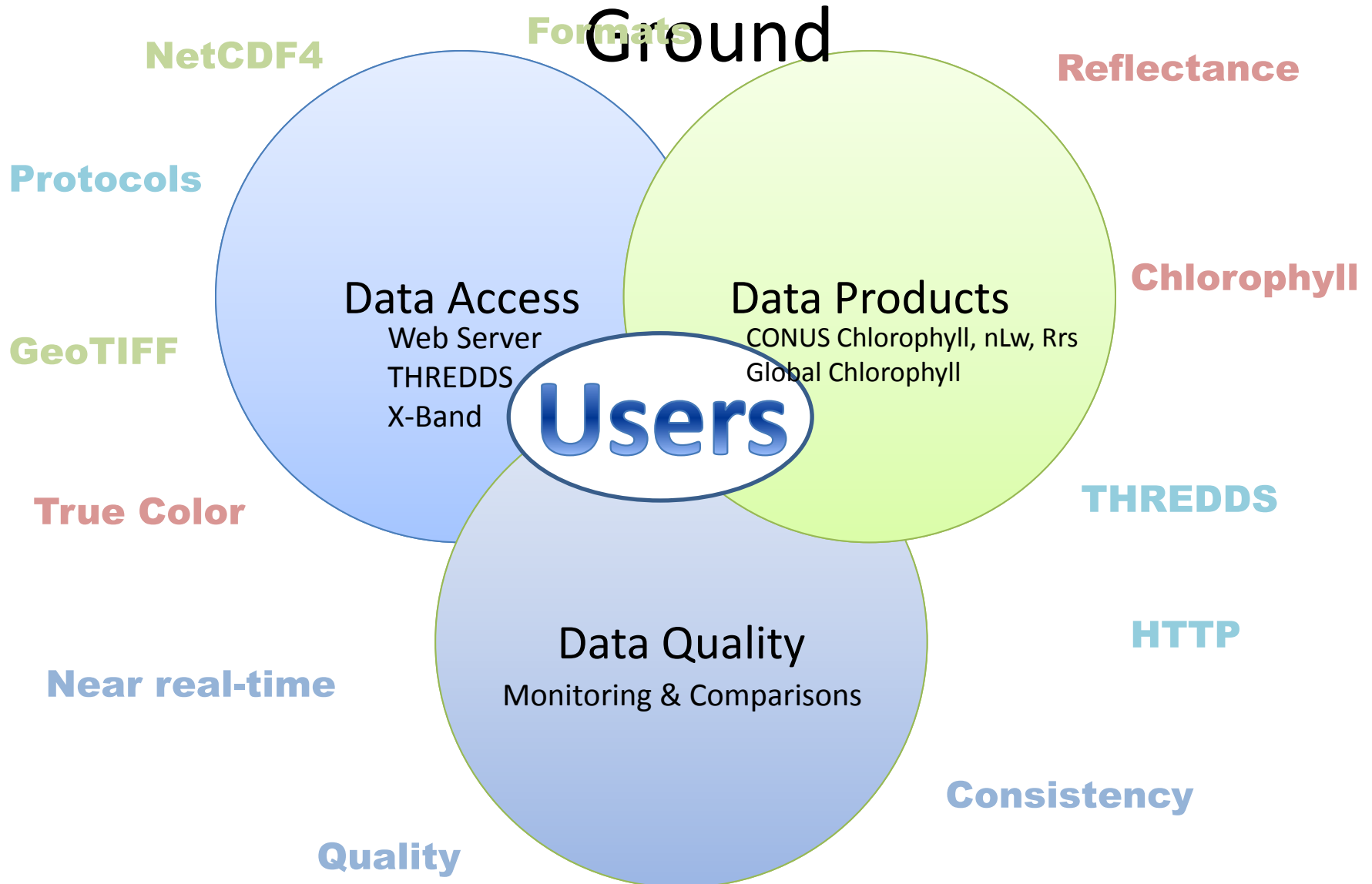
Kent H. Hughes

# Proving Ground Overview

## Outline

- User Engagement
- Product Development to support user needs
- Data Distribution Portal

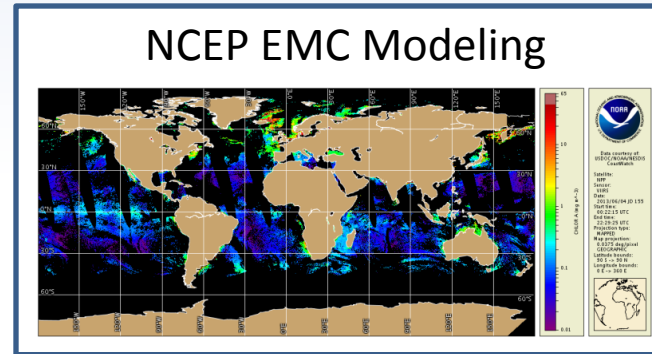
# CoastWatch VIIRS Ocean Color Proving Ground



# VIIRS OCEAN COLOR USE

## Operational HAB Forecasts

## NCEP EMC Modeling



## Ecological Forecast Modeling

VIIRS satellite chlorophyll → Georeferenced grid → Ecosystem model

S-NPP VIIRS chlorophyll  
CoastWatch 2-day avg (Dec 3-4, 2012)  
Raster data: UTM coordinates

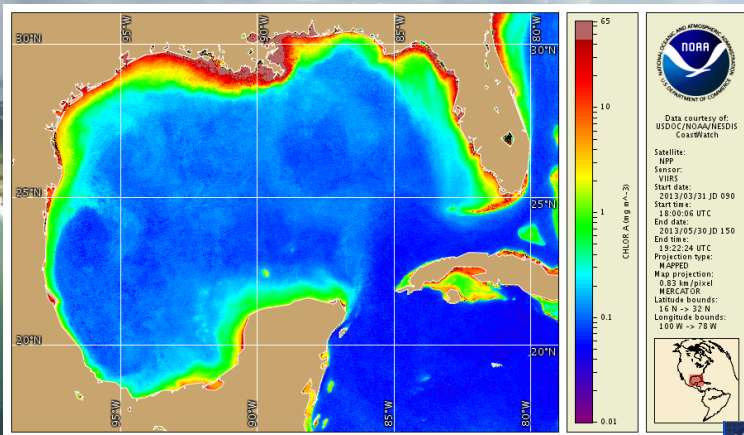
Chesapeake Bay Program  
Georeferenced polygonal grid  
8,282 polygons

NOAA/NMFS/NCBO  
Atlantis Ecosystem Model  
97 polygons  
Aggregated from 8,282

## Commercial

# VIIRS Operational Ocean Color User: NOS & NWS/OPC

Harmful Algal Bloom Monitoring and Forecasting  
NOS issues twice-weekly HAB Bulletins



A screenshot of the NOAA Harmful Algal Bloom Operational Forecast System (HAB-OFS) website. The website features a navigation menu with links to Home, Products, Programs, Partnerships, Education, and Help. The main content area displays a search bar, a navigation menu for HAB (Harmful Algal Bloom), and a section for Public Conditions Reports by Region. The reports are categorized by region: Southwest Florida, Northwest Florida, and East Florida. A specific report for Southwest Florida, dated Monday, June 3, 2013, is highlighted, stating that background concentrations of *Karenia brevis* (commonly known as Florida red tide) are present alongshore southwest Florida. The website also includes a section for HAB Bulletins (for Coastal Resource Managers) and a link to Other Gulf of Mexico HAB Status Info.

NOAA  
TIDES & CURRENTS

Home Products Programs Partnerships Education Help

HAB  
Harmful Algal Bloom Operational Forecast System (HAB-OFS)  
Local Beach Conditions  
HAB Health Information  
HAB-OFS Bulletin Archive  
HAB News and Updates  
HAB-OFS Contributors & Data Providers  
Developmental HAB Forecast Projects  
Links to Other HAB Resources

Public Conditions Reports by Region (including Impact Forecasts):  
Southwest Florida Northwest Florida East Florida Texas

View Frequently Asked Questions about the Conditions Reports.

HAB Bulletins (for Coastal Resource Managers):  
About the Bulletins Archived Bulletins

Other Gulf of Mexico HAB Status Info [here](#)

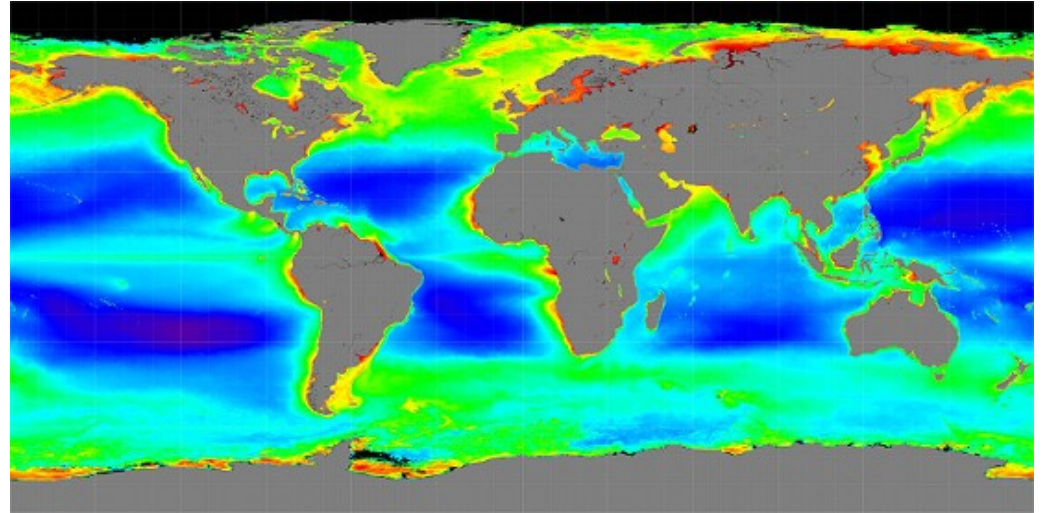
Operational Conditions Reports

Southwest Florida  
Monday, June 3, 2013

Background concentrations of *Karenia brevis* (commonly known as Florida red tide) are present alongshore southwest Florida. No respiratory impacts are expected alongshore southwest Florida, including the Florida Keys, today through Monday, June 10.

# VIIRS Operational Ocean Color User: NWS/EMC

- Phytoplankton alter the penetration of solar radiation in the upper layers of the ocean, affecting:
  - vertical distribution of heat
  - near surface heat content
  - surface heat flux
- Current NCEP ocean models use a very limited climatology of SeaWiFS chlorophyll (1998-2001)



Chlorophyll Global Distribution (SeaWiFS, NASA)

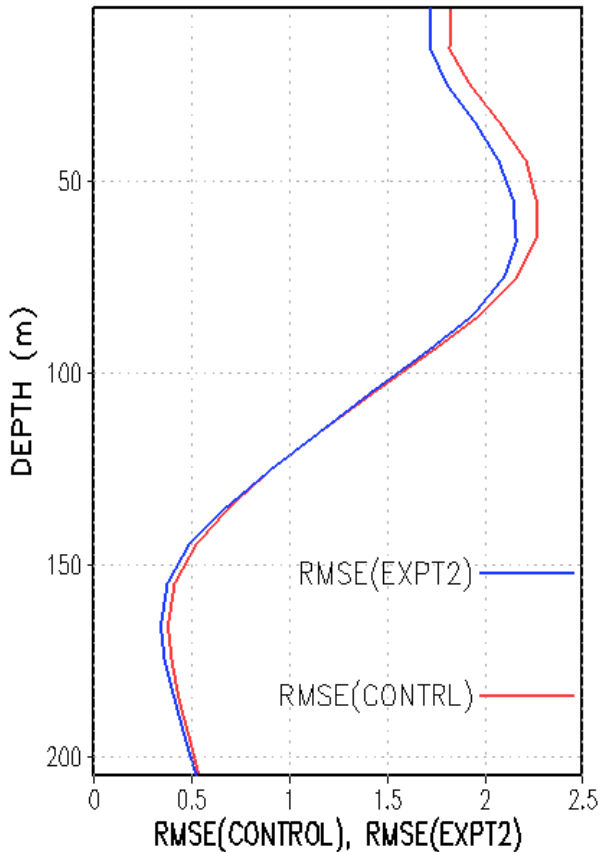
- Operational near real-time use of VIIRS chlorophyll will properly represent temporal change of upper ocean heat distribution
- Improvements to:
  - Ocean forecasts:  
**Real-time Ocean Forecast System (RTOFS)**
  - Coupled ocean-atmosphere forecasts:  
**Global Ocean Data Assimilation System / Coupled Forecast System (GODAS / CFS)**



# NWS/EMC Results: GODAS/CFS Improvement (MOM4 Ocean Model, currently with SeaWiFS climatology)

**Near-surface ocean temperature  
error reduction of ~10% (~0.2 C)**  
(Equatorial Pacific “Cold Tongue” 2S – 2N)

RMSE (2S-2N,120W)



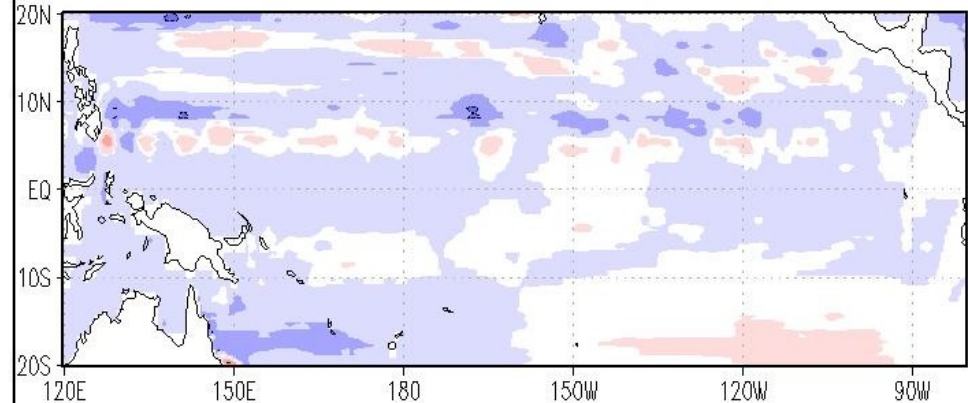
**Expt2** =  
SeaWiFS  
monthly chl  
1998- 2010

**Control** =  
SeaWiFS chl  
climatology  
(1998-2001)

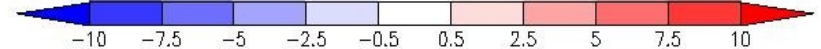
**Reference** =  
CFS  
Reanalysis

**Sea Surface Height  
percent error reduction of ~5-10%**  
(Equatorial Pacific Basin 20S – 20N)

SSH: NORM RMSE(EXPT1)-RMSE(CONTROL) in Percent



**Percent**



**Expt1** = SeaWiFS chl climatology (1998- 2010)  
**Control** = SeaWiFS chl climatology (1998-2001)  
**Reference** = CFS Reanalysis

**Source: E. Bayler, S. Nadiga, A. Mehra, D. Behringer**

## CoastWatch NPP/VIIRS User Engagement: User Interviews and Outcomes

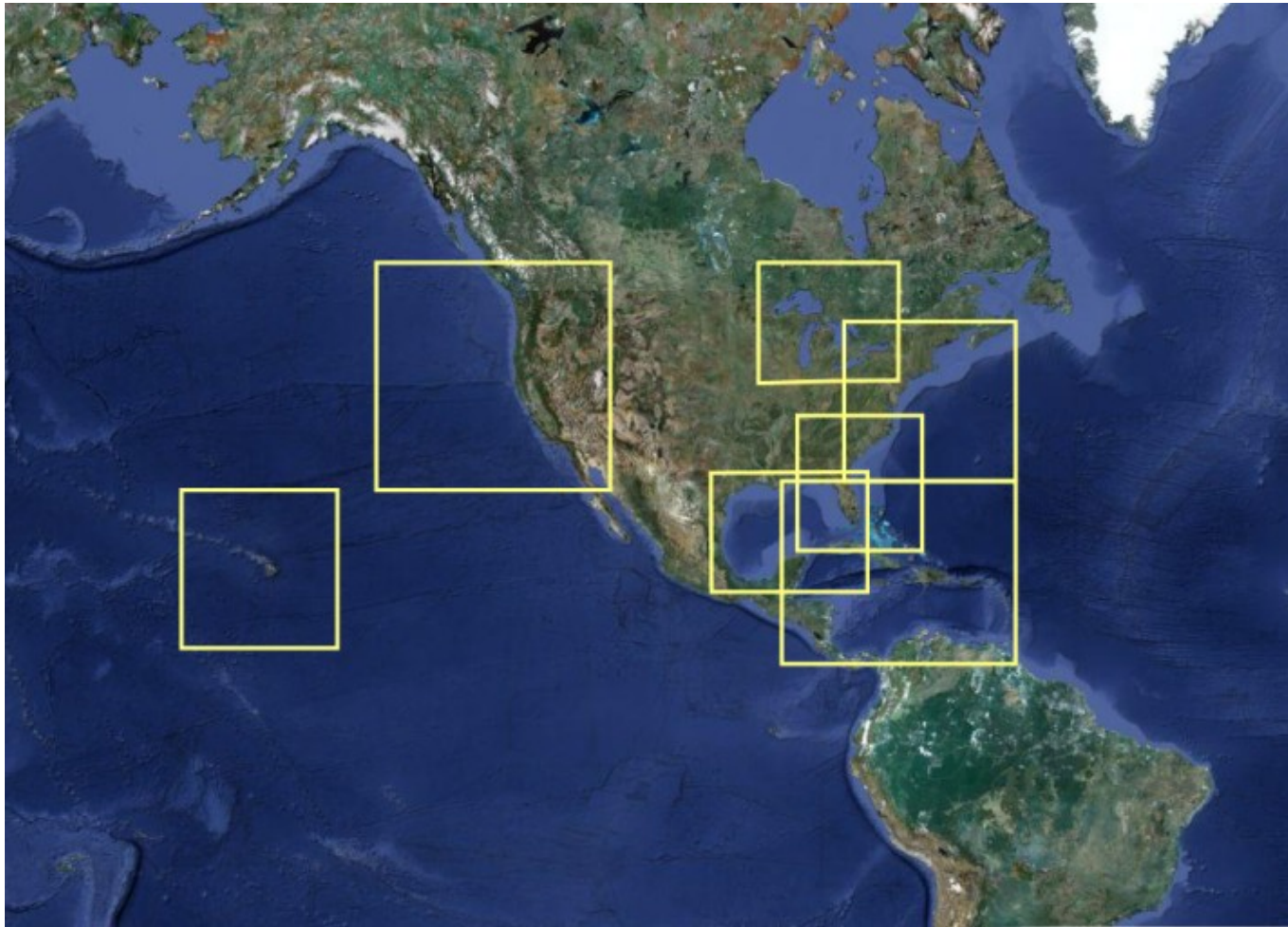
Line Office	Sub-Element	Program Area/Products	Interviewees and Date(s)	Outcome
National Ocean Service (NOS)	NCCOS	Imagery support for operational product: Harmful Algal Bloom Forecasts and Warnings	Stumpf and Tomlinson February 26, 2013	<ol style="list-style-type: none"> <li>1. Major concern re masking of West Florida shelf area during major HAB. L2gen renders area satisfactorily.</li> <li>2. Do not shut down MODIS until end of life, but VIIRS should be ready.</li> <li>3. Parallel operations: MODIS and VIIRS</li> <li>4. Require at least one back up platform</li> <li>5. Continue independent quality assessment.</li> <li>6. Desire regeneration of HAB products using NASA science quality data.</li> <li>7. Lack of inland waters (lakes) makes IDPS product unacceptable.</li> </ol>
National Weather Service (NWS)	EMC and OPC	Incorporation of near realtime chl a into regional and global models. Input of chl into AWIPS to support Ecological Forecast System	Avichal Mehra and Dave Behringer. Anthony Siebers	<ol style="list-style-type: none"> <li>1. Lack of Great Lakes data makes IDPS product unacceptable.</li> <li>2. Consistency AND quality are important. In that order.</li> <li>3. Difference between science quality (NASA) and NOAA of 10% is acceptable. Parallel operations with science quality is important.</li> <li>4. Consistent delivery of data, i.e., from constellations is important.</li> </ol>
National Marine Fisheries Service (NMFS)	Honolulu Laboratory / Pacific Island Fisheries Science Center	Basin scale resource management on decadal / interdecadal timescales and cruise support – Pacific Basin	Polovina and Moxey March 21, 2013	<ol style="list-style-type: none"> <li>1. Require NRT high resolution for cruise support as well as long time period basin scale for resource management.</li> <li>2. Desire data from various missions “stitched” together.</li> <li>3. Historically relied on OBPG but would use NOAA data if quality were assessed, sustained and conveniently delivered.</li> </ol>

# CoastWatch Data Processing (STAR/Tethys) to support users' requirements

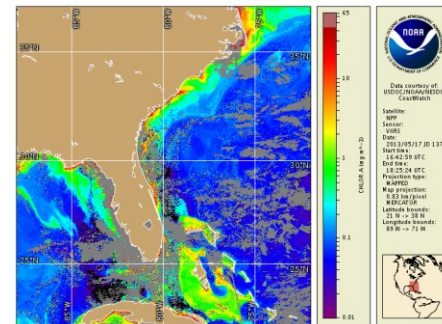
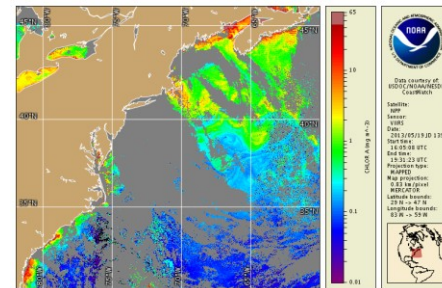
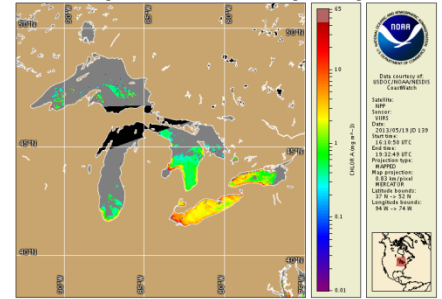
- VIIRS Ocean Color Processing from IDPS EDR
  - EDR swath mapped to CONUS Regions and Full-Resolution Global 'Sectors'
  - Reformat as CW-HDF
- Separate processing instances for Global and CONUS
  - Global (to support NWS/EMC)
    - Chlorophyll only
    - Globe is divided into 24 sectors at full resolution (750m)
    - Sector daily composites are assembled into a 4 km global product
  - CONUS (to support NOS & NWS/OPC)
    - Chlorophyll
    - Normalized Water-Leaving Radiance, nLw (QA, NOS evaluation)
    - Suspended Matter Reflectance, Rrs\_672 (correction to HAB for resuspended chl)
    - Regions processed are Hawaii (HI05), Gulf of Mexico (GM03 and GM05), Northeast (NE05), Great Lakes (GL05), Caribbean (CB05), Southeast (SE05) and West Coast (WC05)
    - Mapped granules, daily composite, 61-day median composite, and HAB anomaly products.

# CONUS regions processed for VIIRS

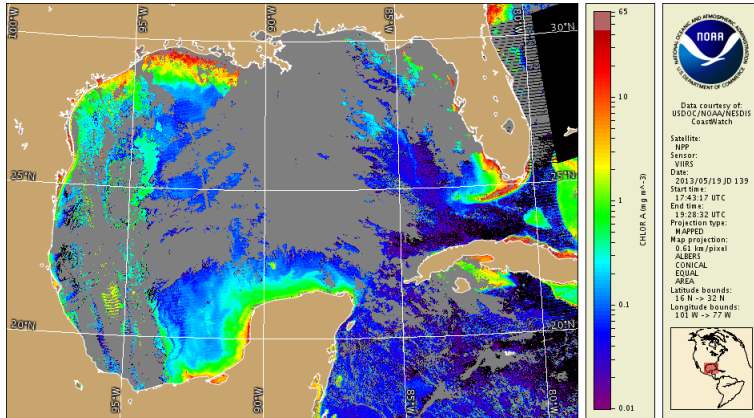
750m resolution



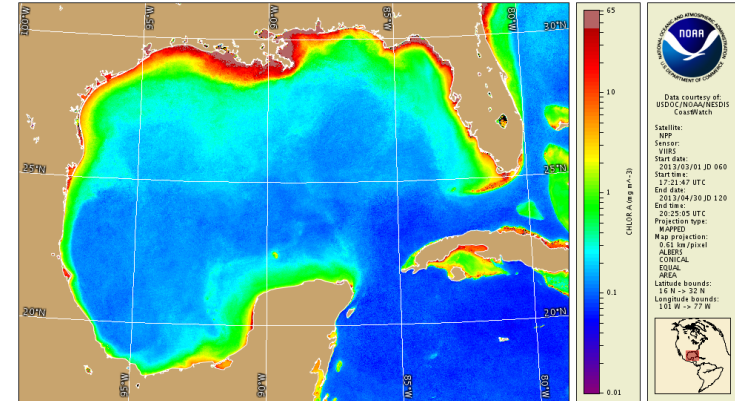
Example Regions:  
daily chlorophyll



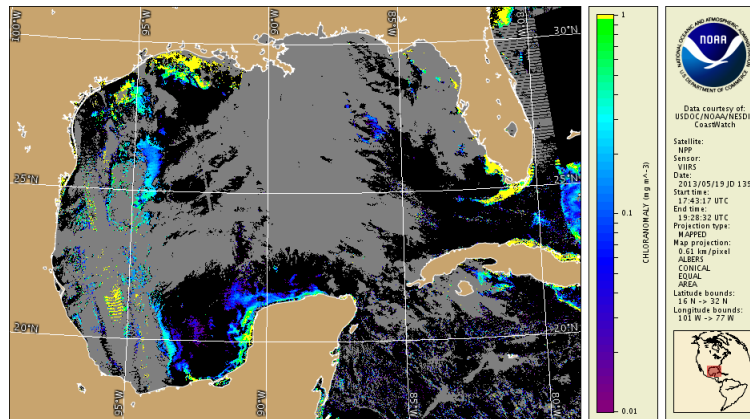
# Gulf of Mexico HAB Products for NOS



Daily Image



61-Day Baseline

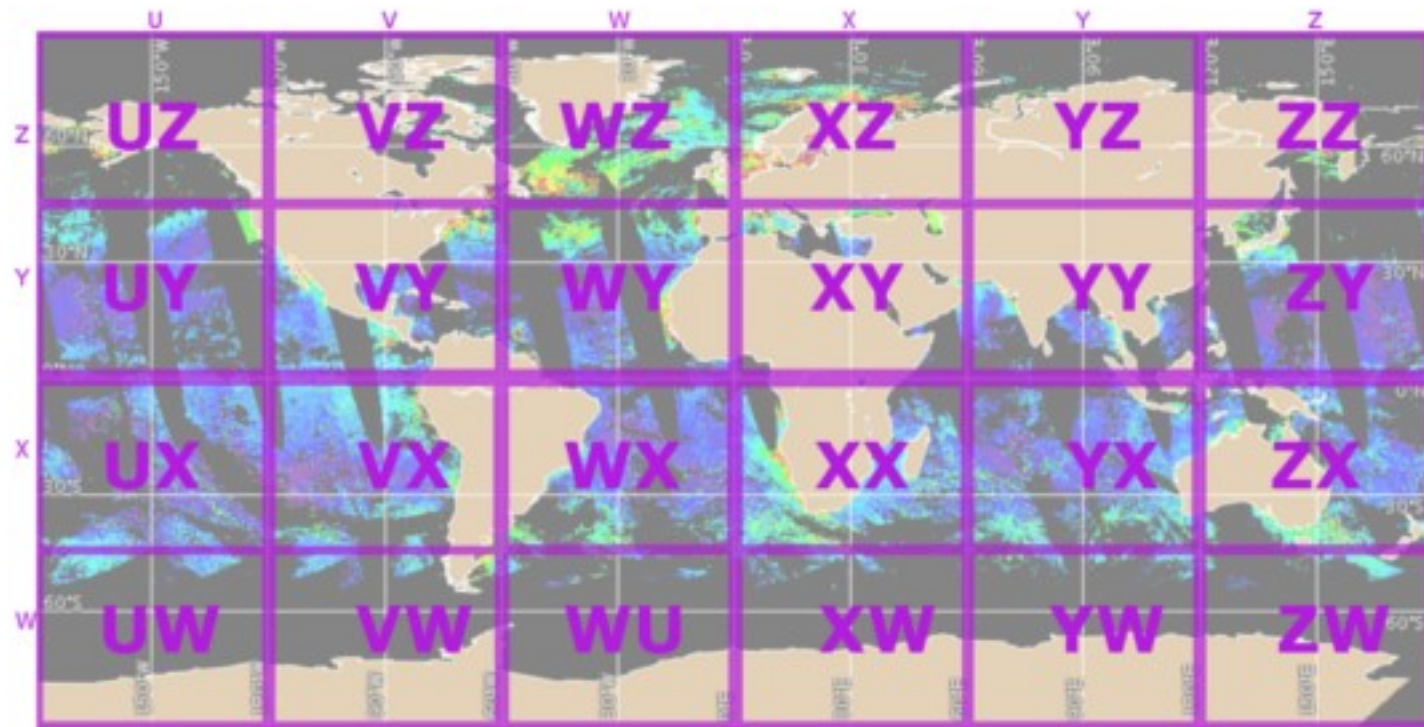


Anomaly

All CONUS regions are being generated to support **NWS/OPC** operational HAB detection and forecasting

# Full-Resolution (750m) Global Sectors

first time full-res global ocean color available to the user community

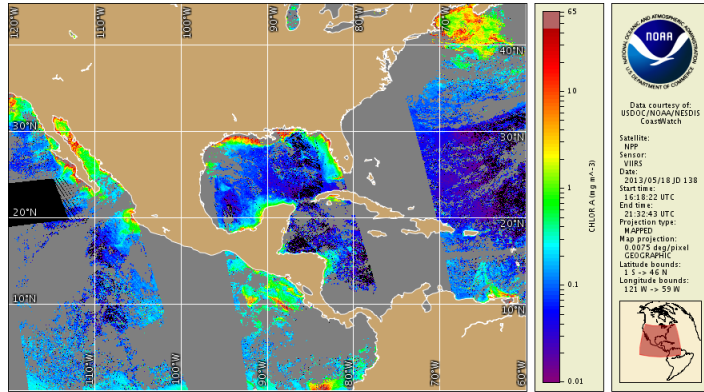


U – Z in longitude

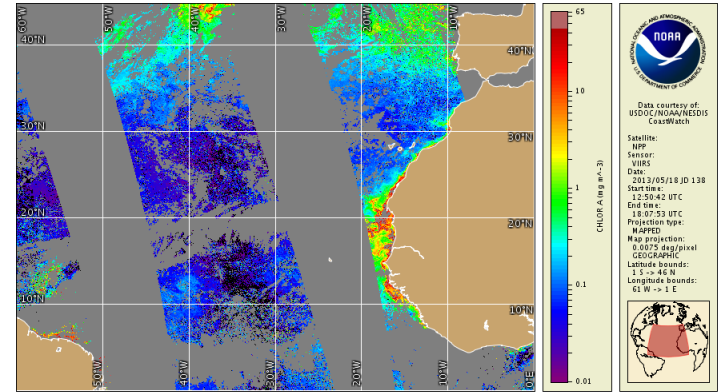
W – Z in latitude

WU is used instead of WW

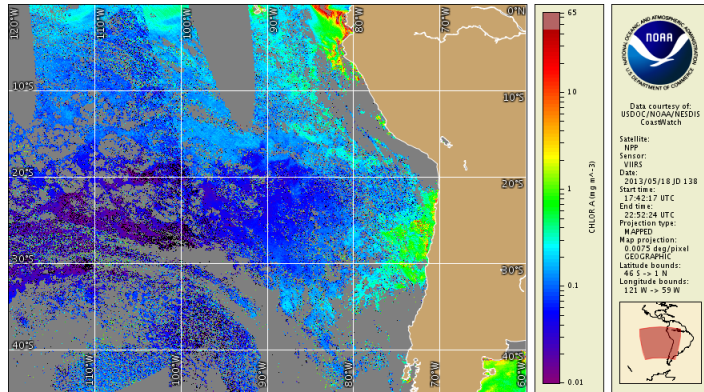
# 750m Sectors: Daily Composite chlorophyll



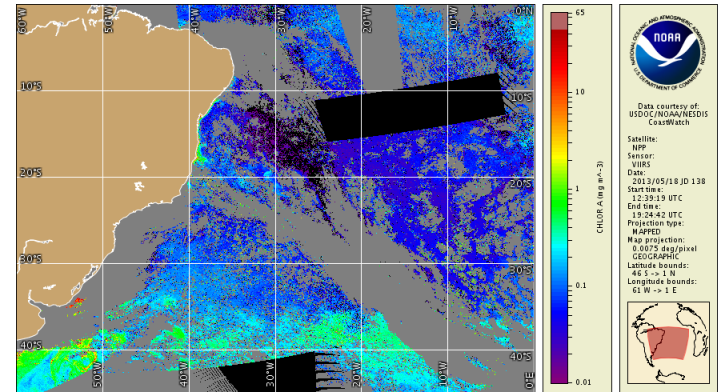
VY



WY

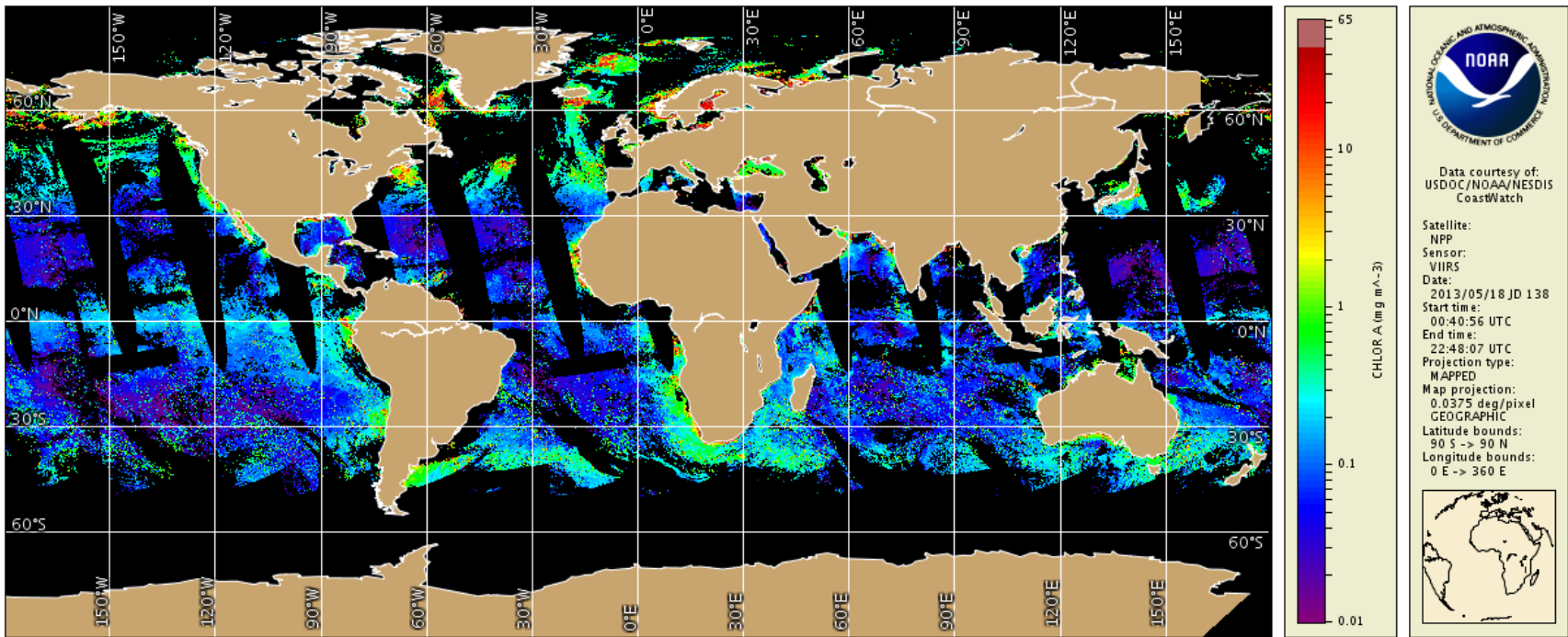


VX



WX

# Global Daily Composite (4km)



VIIRS Chlorophyll, May 18, 2013



# Data Distribution Portal

- CoastWatch webserver
  - Product/Region search for all CW products
    - VIIRS CONUS 750m
    - VIIRS Global 4km
  - VIIRS Granule Selector
  - Data available for 7 days (images available longer)
  - CW-HDF, NetCDF, GeoTIFF, PNG formats
- THREDDS data server
  - VIIRS Global 750m sectors
  - VIIRS Global 4km
  - NetCDF format
  - THREDDS services for mapping, spatial subsetting, data visualization

NOAA

## Recent Data - VIIRS

- Home
- History
- Regional Nodes
- Data Products
- Data Access
- Applications
- Science
- Image Gallery
- OceanWatch
- Reports
- Resources

Search

CoastWatch  NOAA

NOAA CoastWatch  
NCWCP E/RA3  
College Park, MD 20740  
301.683.3335  
coastwatch.info@noaa.gov

Jun 6 2013 17:05:59 GMT (57)  
Caribbean  
C-Morphology (P35 IIPF5)  
VIIRS / NPP

Jun 6 2013 18:40:59 GMT (57)  
Caribbean  
C-Morphology (P35 IIPF5)  
VIIRS / NPP

Jun 6 2013 18:40:59 GMT (57)  
Caribbean  
C-Morphology (P35 IIPF5)  
VIIRS / NPP

Jun 6 2013 18:40:59 GMT (57)  
Caribbean  
C-Morphology (P35 IIPF5)  
VIIRS / NPP

Jun 6 2013 09:04:59 GMT (57)  
Great Lakes  
C-Morphology (P35 IIPF5)  
VIIRS / NPP

Jun 6 2013 17:15:49 GMT (57)  
Great Lakes  
C-Morphology (P35 IIPF5)  
VIIRS / NPP

Jun 6 2013 17:08:59 GMT (57)  
Gulf of Mexico  
C-Morphology (P35 IIPF5)  
VIIRS / NPP

Jun 6 2013 18:40:59 GMT (57)  
Gulf of Mexico  
C-Morphology (P35 IIPF5)  
VIIRS / NPP

Jun 6 2013 18:40:59 GMT (57)  
Gulf of Mexico  
C-Morphology (P35 IIPF5)  
VIIRS / NPP

Jun 6 2013 20:26:16 GMT (57)  
Gulf of Mexico  
C-Morphology (P35 IIPF5)  
VIIRS / NPP

Jun 6 2013 20:26:16 GMT (57)  
Gulf of Mexico  
C-Morphology (P35 IIPF5)  
VIIRS / NPP

Jun 6 2013 20:26:16 GMT (57)  
Gulf of Mexico  
C-Morphology (P35 IIPF5)  
VIIRS / NPP

Jun 6 2013 20:26:16 GMT (57)  
Gulf of Mexico  
C-Morphology (P35 IIPF5)  
VIIRS / NPP

Jun 6 2013 00:05:49 GMT (57)  
Hawaii  
C-Morphology (P35 IIPF5)  
VIIRS / NPP

Jun 6 2013 00:07:10 GMT (57)  
Hawaii  
C-Morphology (P35 IIPF5)  
VIIRS / NPP

Jun 6 2013 22:07:14 GMT (57)  
Hawaii  
C-Morphology (P35 IIPF5)  
VIIRS / NPP

Jun 6 2013 22:08:40 GMT (57)  
Hawaii  
C-Morphology (P35 IIPF5)  
VIIRS / NPP

Use the Product Search to find older data.

NOAA Satellites and Information  
National Environmental Satellite, Data, and Information Service

Department of Commerce  
National Oceanic & Atmospheric Administration  
Center for Satellite Applications and Research  
Satellite Oceanography & Climatology Division

Web site owner: Satellite Oceanography & Climatology Division

# Data Portal Enhancements

- VIIRS Granule Selector
  - Select granules from a Google map
- Product search results of “No Results” augmented with date range of actual data holdings
- Operational vs. experimental search

**VIIRS Granule Selector**

Home

VIIRS daytime granules are available in near real-time and retrospective days. Using the map interface, select the granule of interest for a true color thumbnail and links to the HDF dataset. The map is updated every 3 hours.

Available granules for Fri, 07 Jun 2013 18:41:19 GMT DoY: 158

June, 2013

Mon Tue Wed Thu Fri Sat Sun

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

Google Imagery ©2013 NASA - Terra of Us

CoastWatch Regions  Current Weather

NOAA CoastWatch VIIRS Data  
 VIIRS Granule Date: 2013-06-07 Time: 0633  
 Coordinates (Lat, Lon):  
 Upper Left: 12.236500, 36.112297  
 Upper Right: 16.581100, 114.166996  
 Lower Right: 11.548400, 113.032002  
 Lower Left: 7.269200, 87.484200

Download Data:  
[True Color Image \(PNG\)](#)  
[VIIRS Ocean Color Data \(CW HDE, IDPS\)](#)

Note: Data products are processed from the JPSS VIIRS IDPS. The following products are included in the IDPS dataset:  
 Chlorophyll-a, nLw\_[412,445,488,555,672], sst, skinsst, Rrs\_[412,445,488,555,672].

NOAA Satellites and Information  
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Web site owner: Satellite Oceanography & Climatology Division

Google-Map zoom into granules

View granule true color image and download data files

Near real-time processing status shown on map

Calendar to select data for any date

**VIIRS Granule Selector**

Home

VIIRS daytime granules are available in near real-time and retrospective days. Using the map interface, select the granule of interest for a true color thumbnail and links to the HDF dataset. The map is updated every 3 hours.

Available granules for Fri, 05-21-2013 (Day of Year:141)

May, 2013

Mon Tue Wed Thu Fri Sat Sun

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

Google Imagery ©2013 NASA, TerraMetrics - Terra of Us

CoastWatch Regions  Current Weather

NOAA CoastWatch VIIRS Data  
 VIIRS Granule Date: 2013-05-21 Time: 1515  
 Coordinates (Lat, Lon):  
 Upper Left: -2.115770, -41.885809  
 Upper Right: 1.982210, -14.625200  
 Lower Right: -3.008130, -13.438000  
 Lower Left: -7.166310, -40.862701

Download Data:  
[True Color Image \(PNG\)](#)  
[VIIRS Ocean Color Data \(CW HDE, IDPS\)](#)

Note: Data products are processed from the JPSS VIIRS IDPS. The following products are included in the IDPS dataset:  
 Chlorophyll-a, nLw\_[412,445,488,555,672], sst, skinsst, Rrs\_[412,445,488,555,672].

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Department of Commerce  
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 Center for Satellite Applications and Research  
 Satellite Oceanography & Climatology Division

Web site owner: Satellite Oceanography & Climatology Division

# Plans for 2<sup>nd</sup> Year

- Support for NWS/EMC
  - EMC conduct ocean model experiments with near real-time VIIRS chlorophyll (funded externally)
  - Establish requirement for VIIRS chlorophyll temporal composite and spatial interpolation (to address data gaps in NRT global product)
  - NRT QA comparison with NASA global product
- Support for NOS & NWS/OPC
  - Unique flagging/masking to support HAB
  - Anomaly from daily minus monthly climatology (in addition to anomaly from daily minus 61-day running mean)
  - NRT QA comparison with NASA product for all CONUS regions
- Distribution Portal
  - Geographic search capability
  - Database redesign to support additional search criteria, data cart, data subscriptions, etc.

# Other Future Work

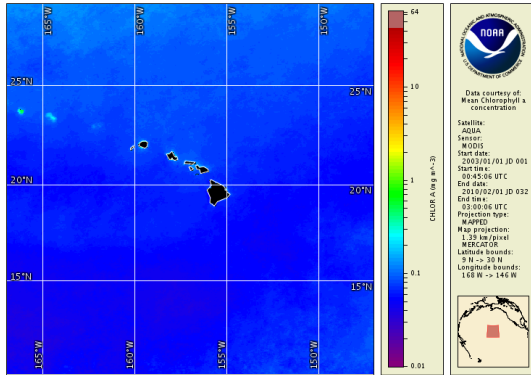
- For NWS/EMC:
  - VIIRS K-490 and/or K-PAR light penetration products
    - Products not included in JPSS Level-1 Requirements... Will need to be produced outside of IDPS?
  - Implement VIIRS chlorophyll temporal composite and spatial interpolation to address data gaps in NRT global product
- X-band plans at AOML

# CoastWatch NPP/VIIRS Ocean Color: Independent Quality Assessment and Algorithm Recommendation

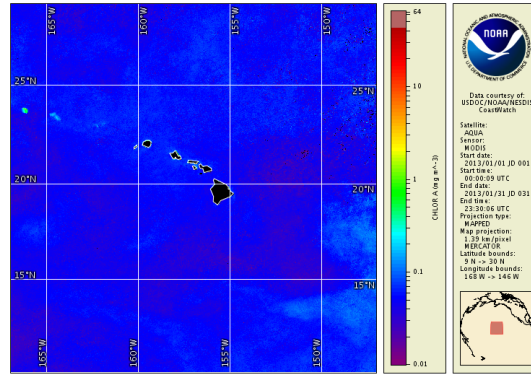
Sathya Ramachandran

# Monthly Chlorophyll

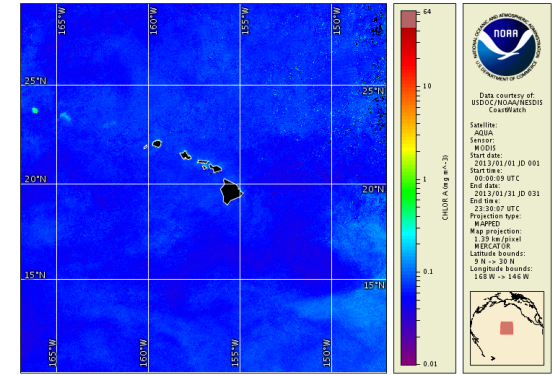
MODIS **Climatology** for January



MODIS (L2gen) NRT for January



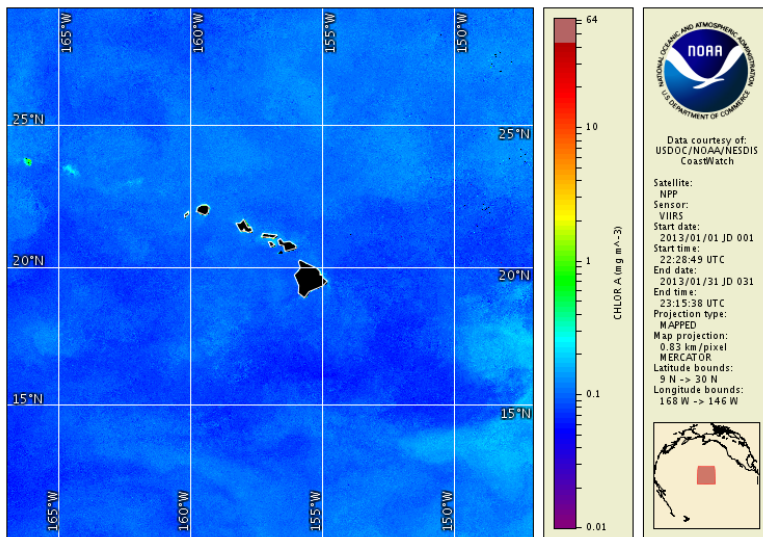
MODIS (SWIR) NRT for January



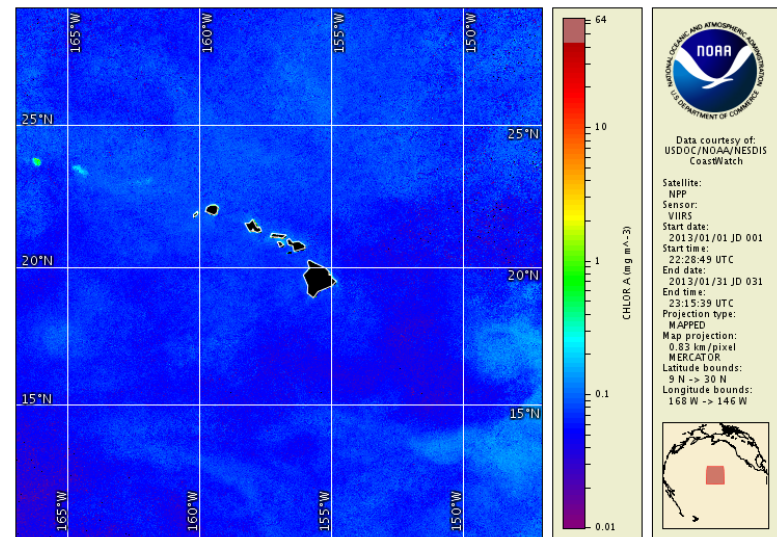
- VIIRS Flavors

- IDPS (Ingest IDPS EDRs and create CWhdf L3 files; **VRSCW**)
- L2gen (Ingest IDPS SDR, use L2gen to create EDR and then L3 CWhdf; **VRSSCW**)

VIIRS(L2gen) for January

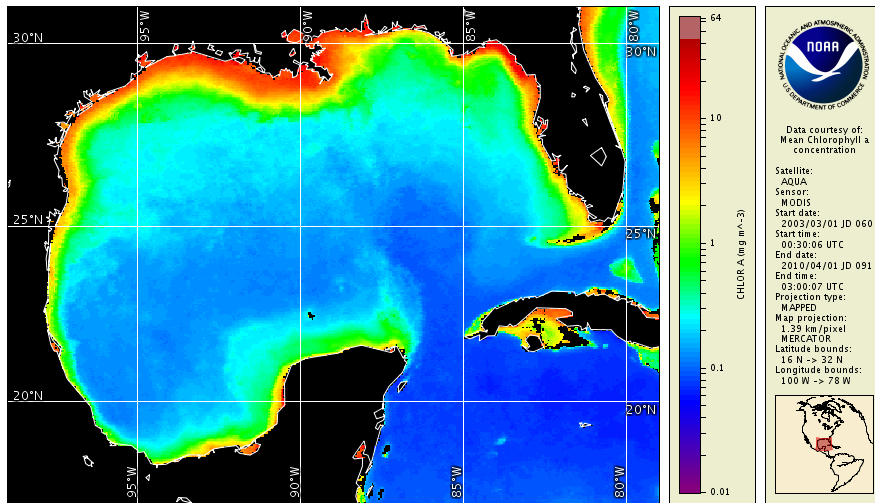


VIIRS(IDPS) for January

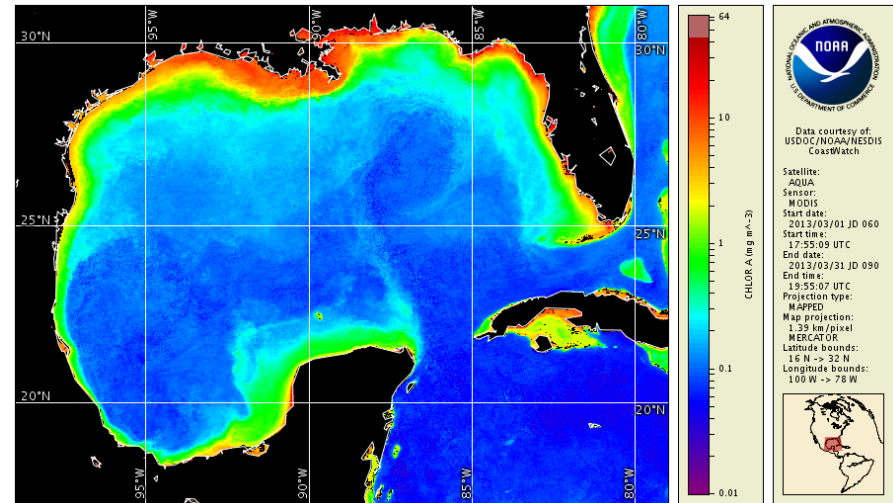


# Chlorophyll Images from various algorithms

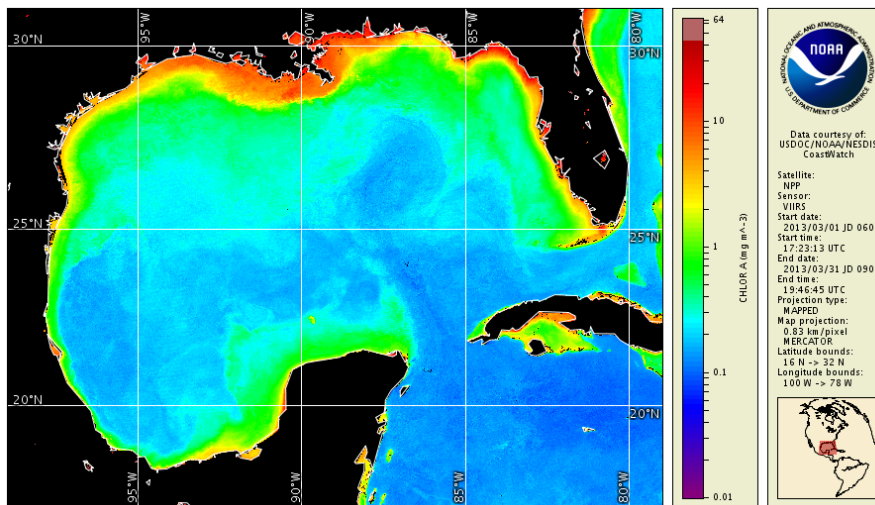
## MODIS Climatology For March



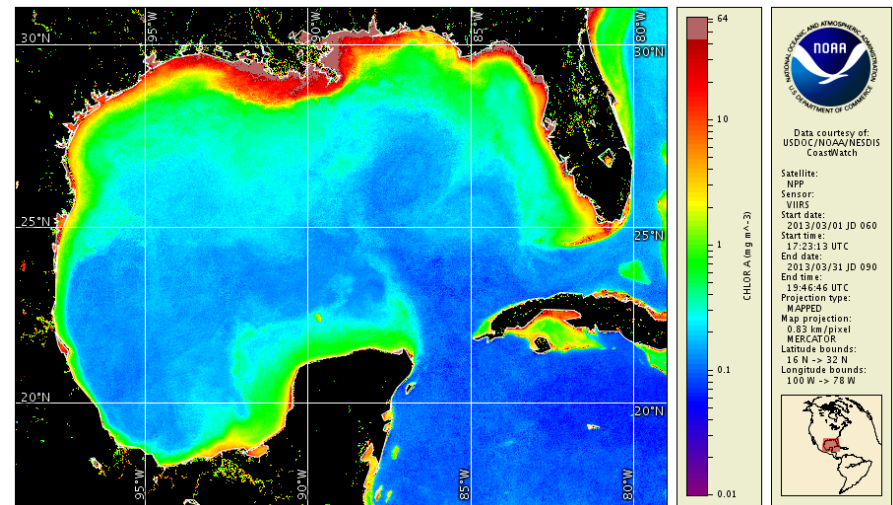
## MODIS (L2gen) Monthly for Mar 2013



## VIIRS (L2gen) monthly for Mar 2013

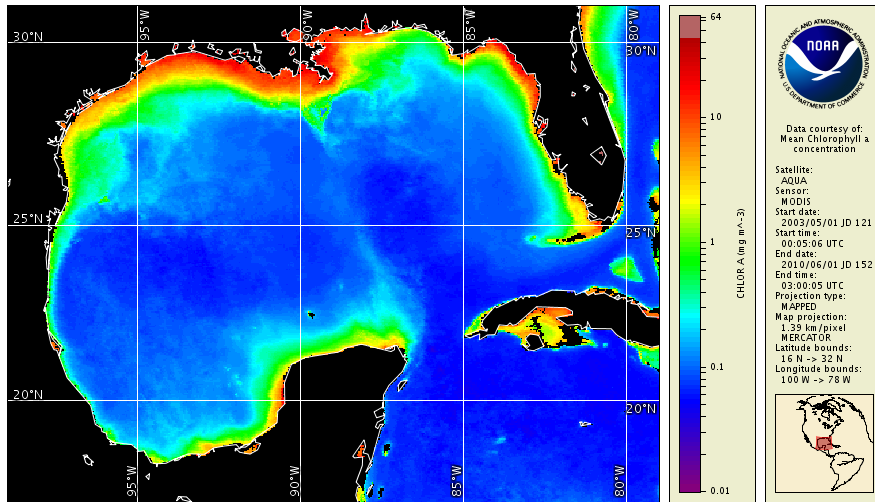


## VIIRS (IDPS) monthly for Mar 2013

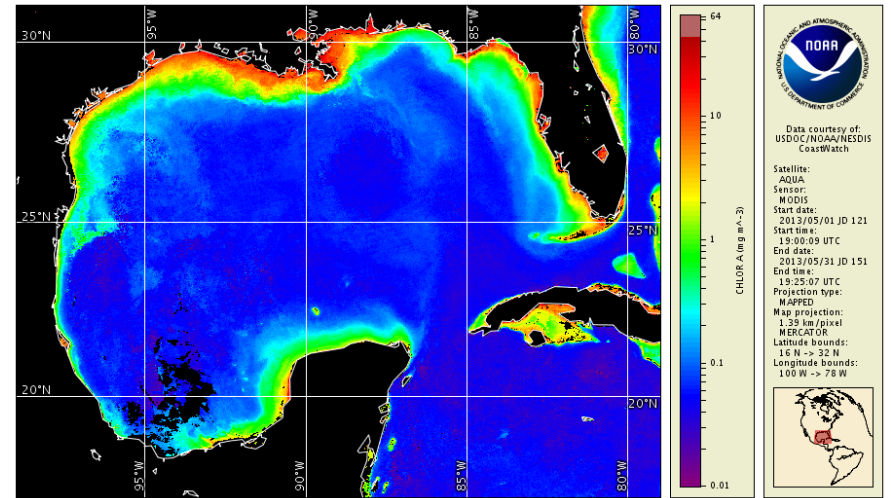


# Chlorophyll Images from various algorithms

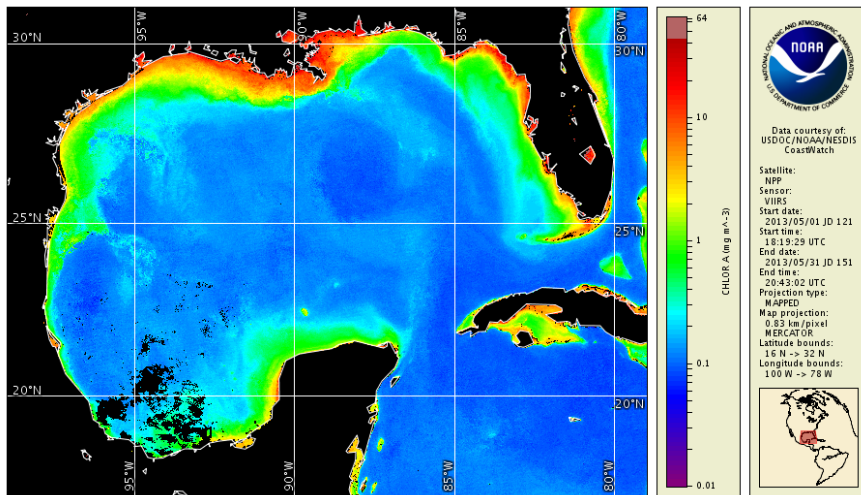
## MODIS Climatology For May



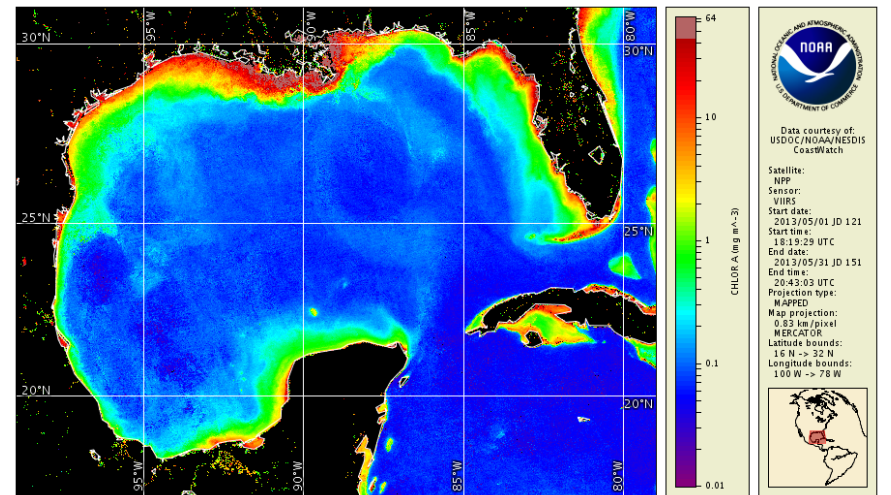
## MODIS (L2gen) Monthly for May 2013



## VIIRS (L2gen) monthly for May 2013

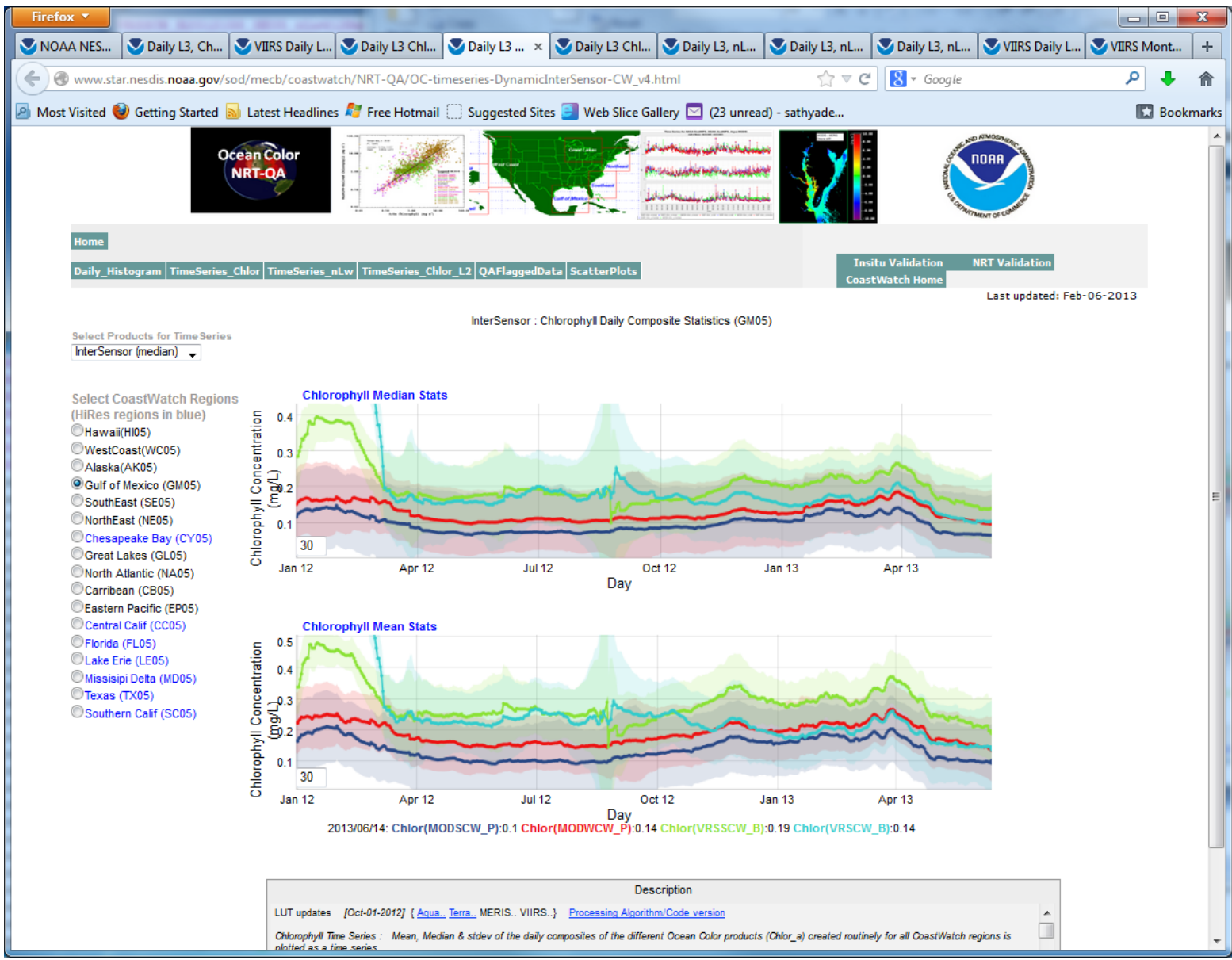


## VIIRS (IDPS) monthly for May 2013





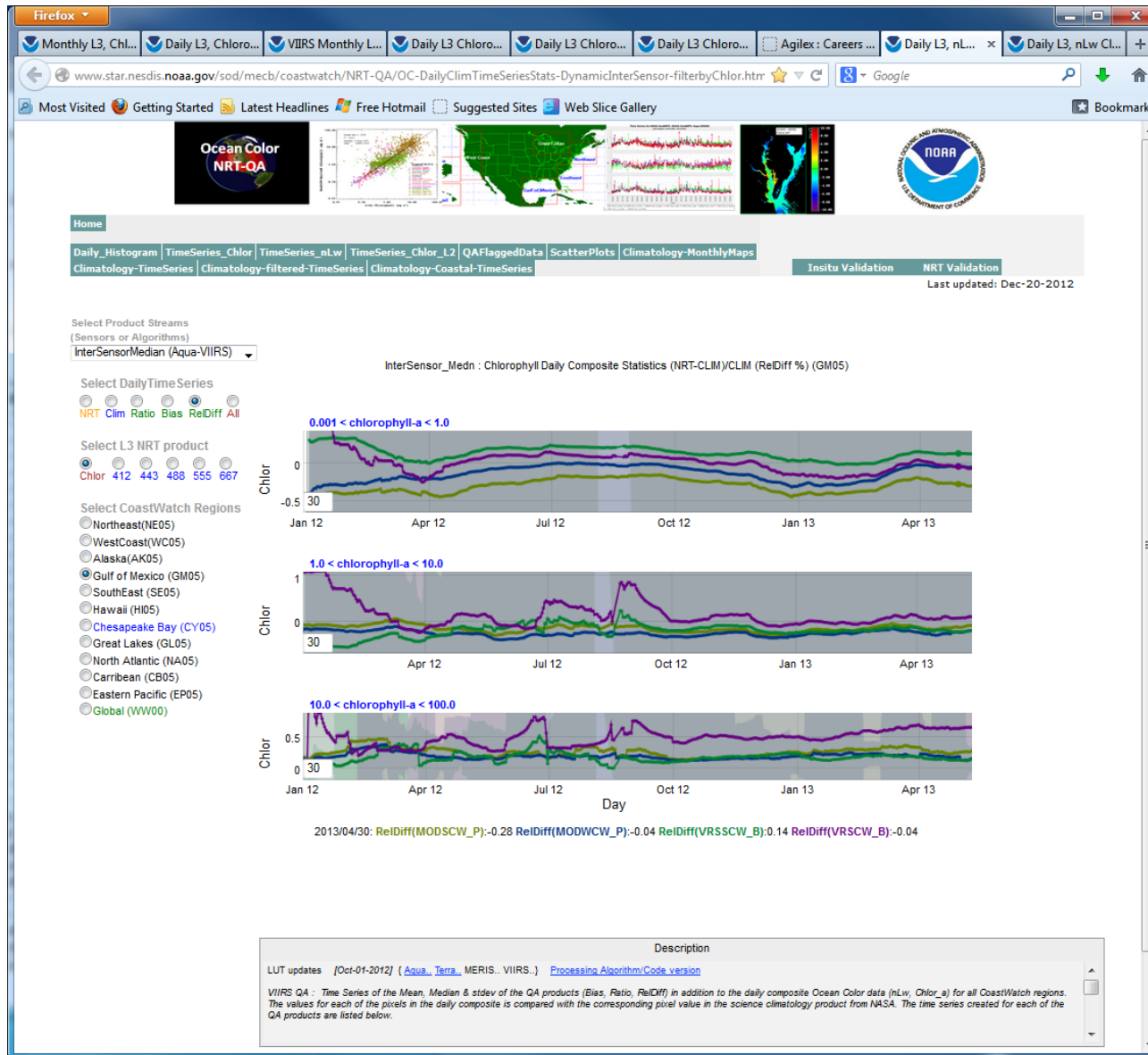
# CoastWatch region Chlorophyll averages (Mean & Median) for GM05



VIIRS  
L2gen  
IDPS

MODIS  
SWIR  
L2gen

# Relative Difference with Climatology GM05 Stratified by Chlorophyll values

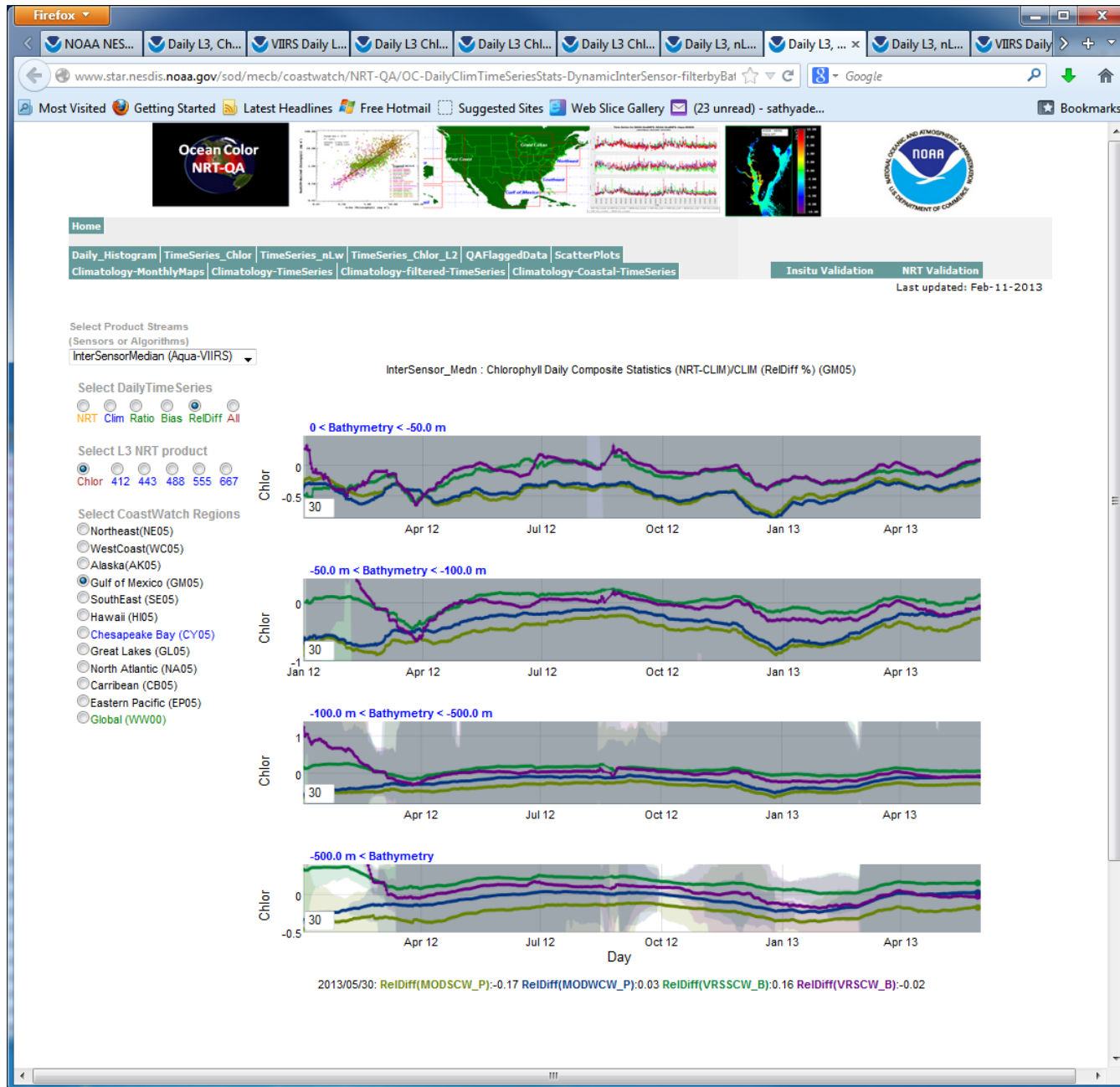


VIIRS  
L2gen  
IDPS

MODIS  
SWIR  
L2gen

Note: L2gen(NOAA) returns higher values for Chlorophyll in open ocean and IDPS does the same for high (coastal) values compared to MODIS multi-year Climatology

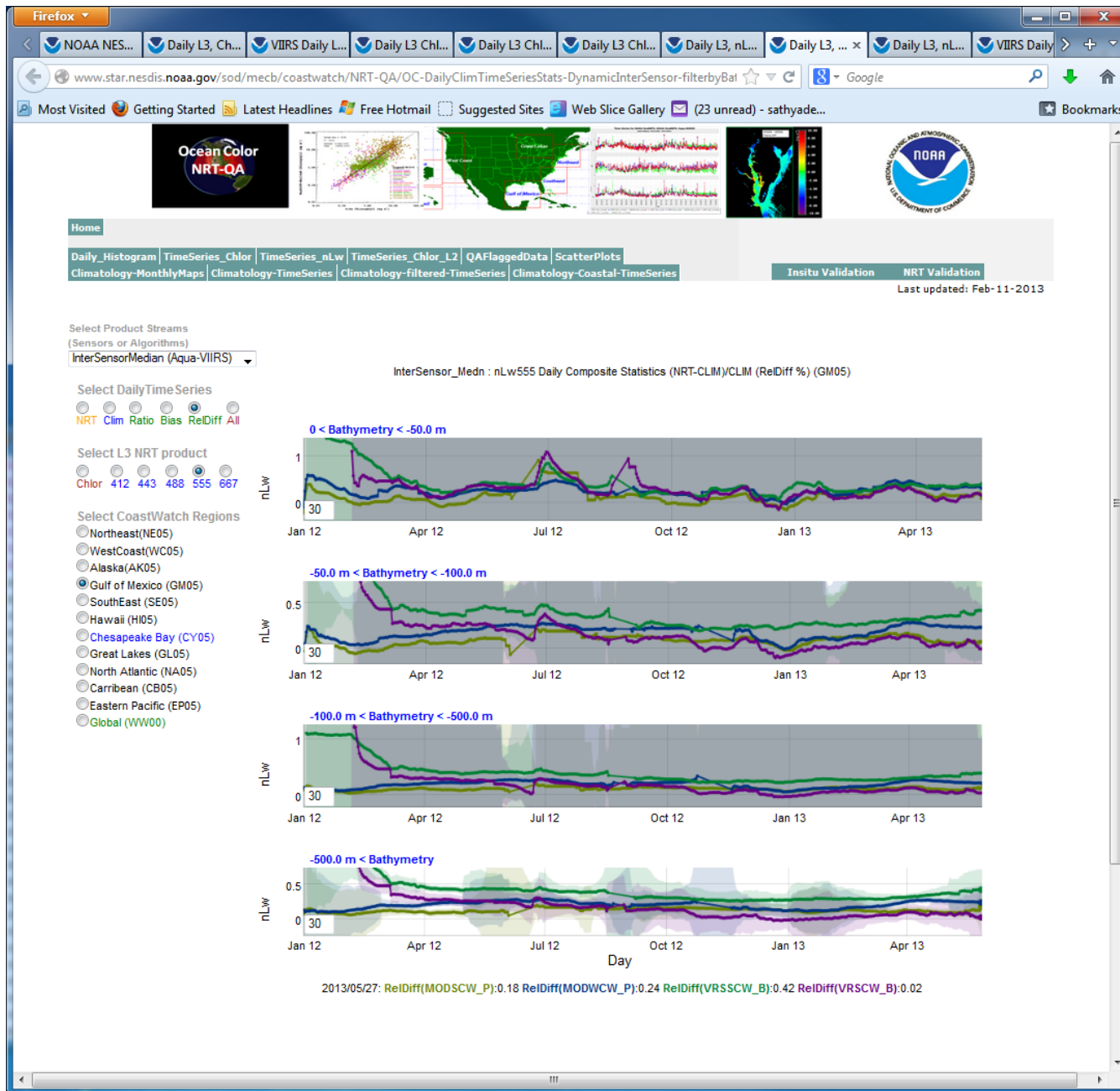
# Chlorophyll Relative Difference GM05 Stratified by Bathymetry



VIIRS  
 L2gen  
 IDPS

MODIS  
 SWIR  
 L2gen

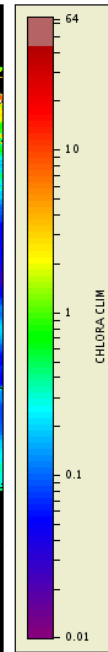
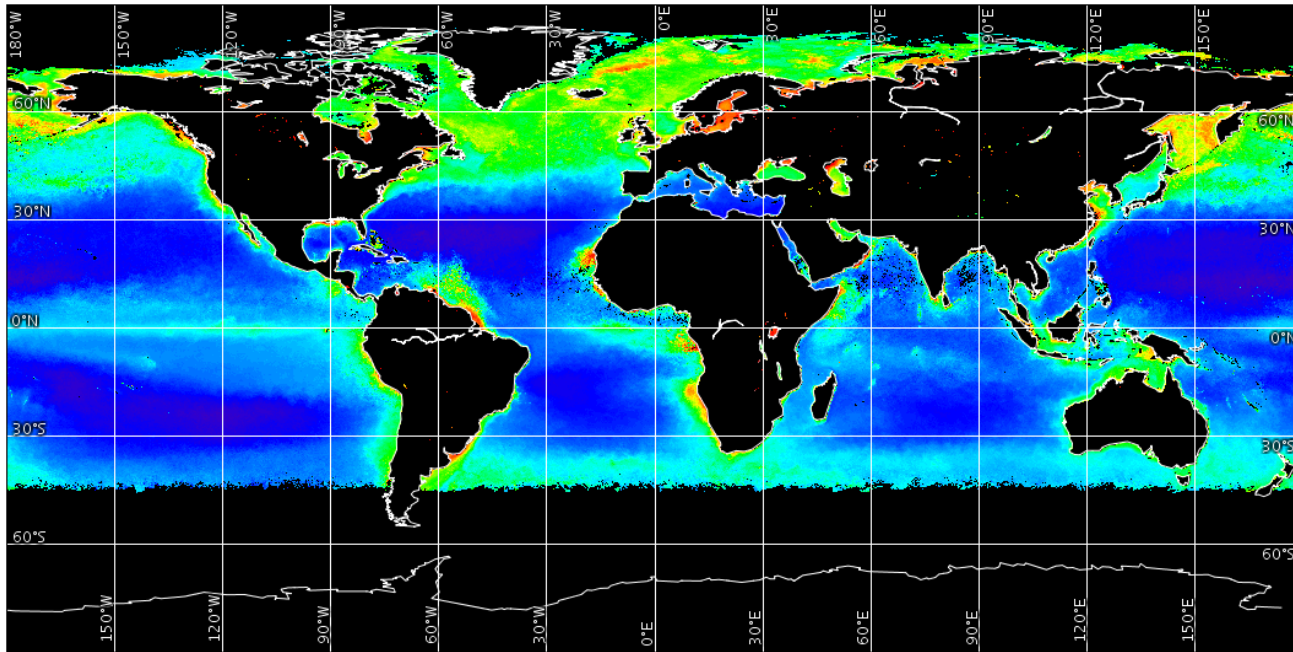

# nlw555 Relative Difference GM05 stratified by Bathymetry



VIIRS  
L2gen  
IDPS


MODIS  
SWIR  
L2gen

## AQUA MODIS NASA-OBPG multi-year CLIMATOLOGY for June

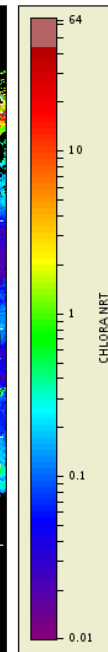
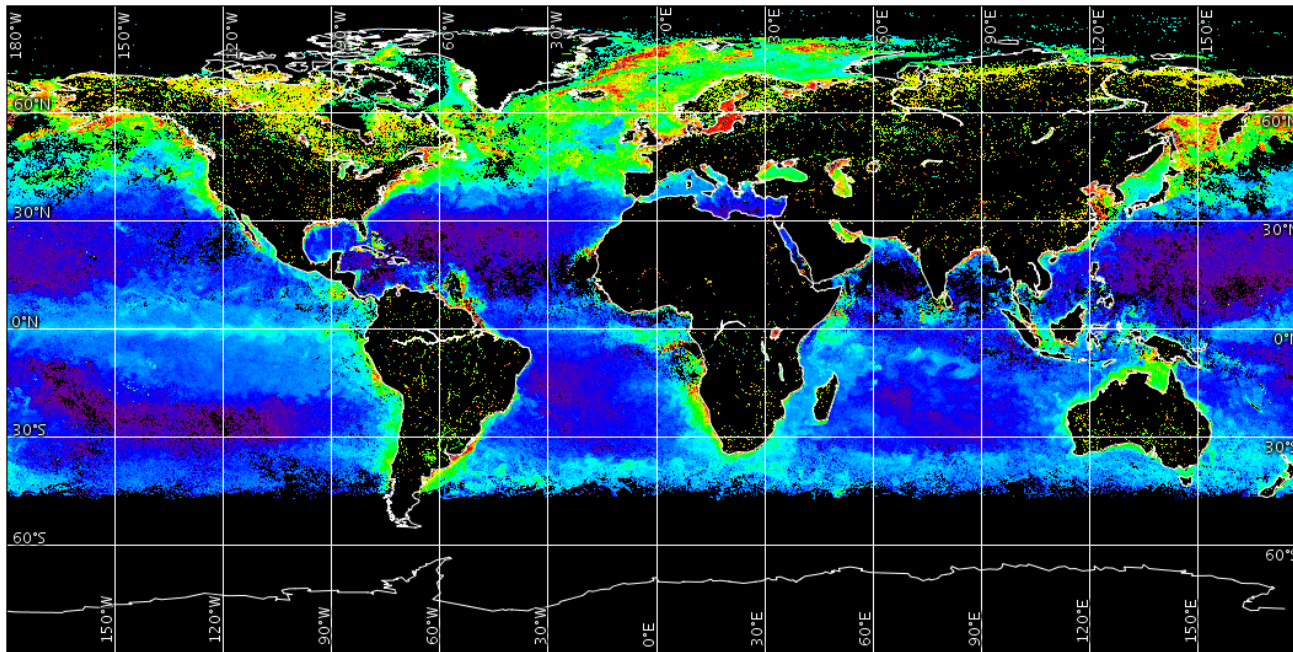




Data courtesy of:  
USDOC/NOAA/NESDIS  
CoastWatch Mean  
Chlorophyll a  
concentration

Satellite:  
NPP, AQUA  
Sensor:  
VIIRS, MODIS  
Start date:  
2013/06/01 JD 152  
Start time:  
01:13:02 UTC  
End date:  
2013/06/14 JD 165  
End time:  
21:01:12 UTC  
Projection type:  
MAPPED  
Map projection:  
0.0375 deg/pixel  
GEOGRAPHIC  
Latitude bounds:  
90 S -> 90 N  
Longitude bounds:  
0 E -> 360 E




## VIIRS IDPS 14-day Median Composite: June 1–14, 2013

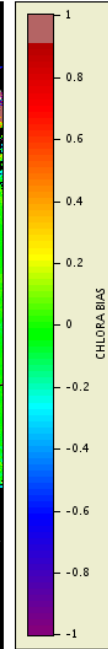
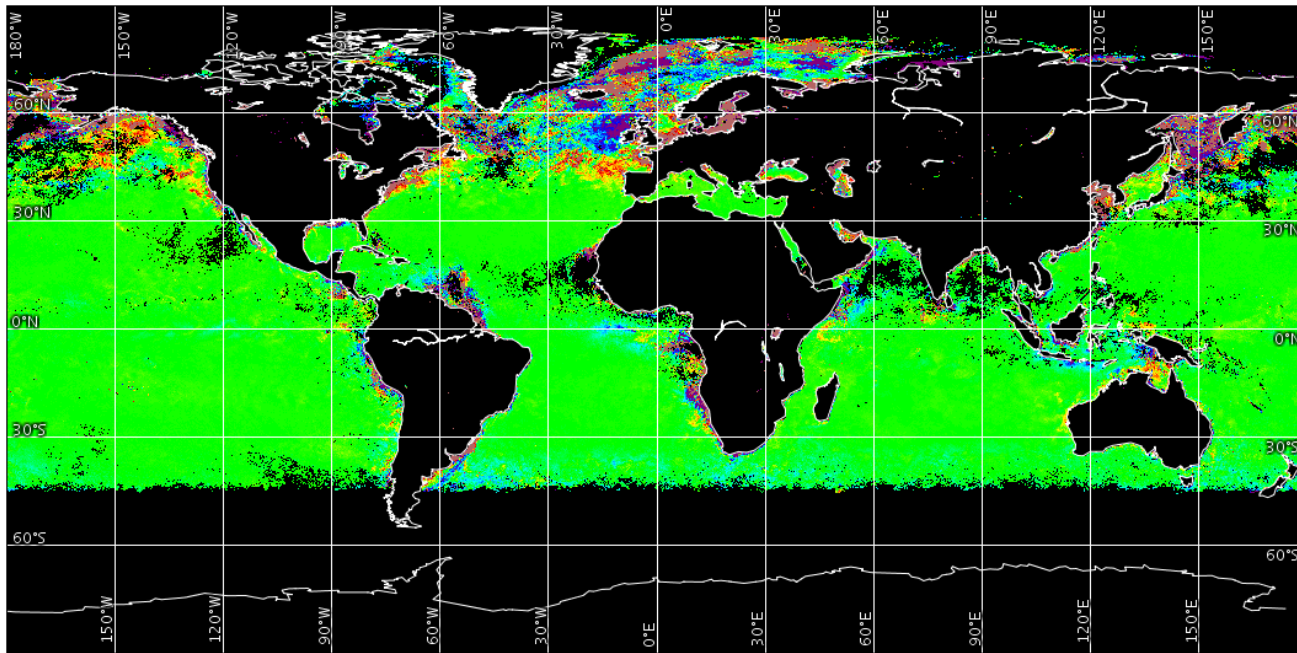




Data courtesy of:  
USDOC/NOAA/NESDIS  
CoastWatch Mean  
Chlorophyll a  
concentration

Satellite:  
NPP, AQUA  
Sensor:  
VIIRS, MODIS  
Start date:  
2013/06/01 JD 152  
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01:13:02 UTC  
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2013/06/14 JD 165  
End time:  
21:01:12 UTC  
Projection type:  
MAPPED  
Map projection:  
0.0375 deg/pixel  
GEOGRAPHIC  
Latitude bounds:  
90 S -> 90 N  
Longitude bounds:  
0 E -> 360 E




## Chlorophyll Bias (mg/L) to Climatology

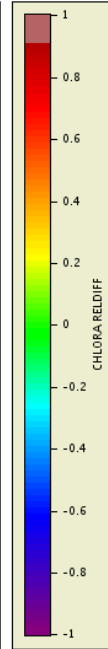
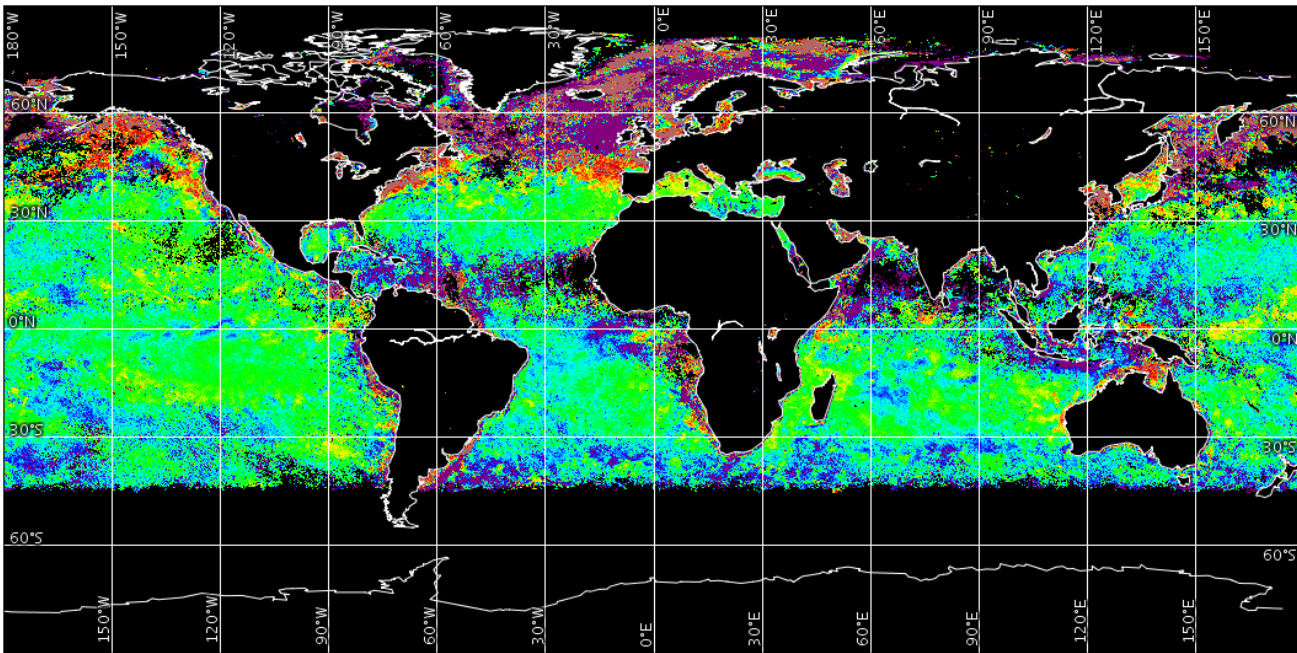




Data courtesy of:  
USDOC/NOAA/NESDIS  
CoastWatch Mean  
Chlorophyll a  
concentration

Satellite:  
NPP, AQUA  
Sensor:  
VIIRS, MODIS  
Start date:  
2013/06/01 JD 152  
Start time:  
01:19:02 UTC  
End date:  
2013/06/14 JD 165  
End time:  
21:01:12 UTC  
Projection type:  
MAPPED  
Map projection:  
0.0375 deg/pixel  
GEOGRAPHIC  
Latitude bounds:  
90 S -> 90 N  
Longitude bounds:  
0 E -> 360 E




## Chlorophyll relative difference (%) with Climatology

Data courtesy of:  
USDOC/NOAA/NESDIS  
CoastWatch Mean  
Chlorophyll a  
concentration

Satellite:  
NPP, AQUA  
Sensor:  
VIIRS, MODIS  
Start date:  
2013/06/01 JD 152  
Start time:  
01:19:02 UTC  
End date:  
2013/06/14 JD 165  
End time:  
21:01:12 UTC  
Projection type:  
MAPPED  
Map projection:  
0.0375 deg/pixel  
GEOGRAPHIC  
Latitude bounds:  
90 S -> 90 N  
Longitude bounds:  
0 E -> 360 E



# Results

- Chlorophyll
  - IDPS looks good in comparison with heritage and Climatology for open ocean waters.
  - L2gen is doing better than IDPS for high chlorophyll coastal waters.
- nLw
  - 443 & 488 bands are closer to corresponding Climatology values for L2gen (< 5%), it is more like 10-15% for IDPS
  - However 551 band is sitting with a large bias (~ 30%) for L2gen when compared to IDPS product (<10%) at this time.

# NRT-QA links

## Inter-sensor plots :

[http://www.star.nesdis.noaa.gov/sod/mecb/coastwatch/NRT-QA/OC-timeseries-DynamicInterSensor-CW\\_v4.html](http://www.star.nesdis.noaa.gov/sod/mecb/coastwatch/NRT-QA/OC-timeseries-DynamicInterSensor-CW_v4.html)

## Comparison with MODIS Climatology

Filter by Chlorophyll value:

<http://www.star.nesdis.noaa.gov/sod/mecb/coastwatch/NRT-QA/OC-DailyClimTimeSeriesStats-DynamicInterSensor-filterbyChlor.html>

Filter by distance from Coast:

<http://www.star.nesdis.noaa.gov/sod/mecb/coastwatch/NRT-QA/OC-DailyClimTimeSeriesStats-DynamicInterSensor-filterbyCoastal.html>

Filter by Bathymetry:

<http://www.star.nesdis.noaa.gov/sod/mecb/coastwatch/NRT-QA/OC-DailyClimTimeSeriesStats-DynamicInterSensor-filterbyBathy.html>



Satellite Data Usage  
in the Atlantis Ecosystem Model  
for Chesapeake Bay Fish Stock Management

Howard Townsend, Tom Ihde, Mejs Hasan, Ron Vogel

# The Chesapeake Atlantis Model



Tom Ihde – Versar, Inc. /NMFS

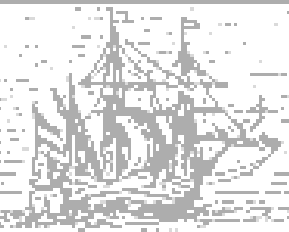
Howard Townsend – NMFS

Mejs Hasan – Chesapeake Research Consortium /NMFS

Ron Vogel – S.M. Resources Corp. /NESDIS

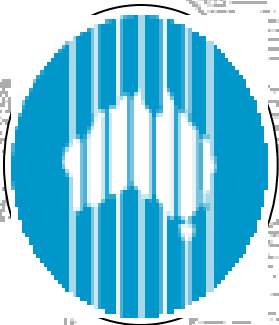
NOAA Chesapeake Bay Office

Situs  
Insule Atlantidis, à  
Mori olim absorptæ ex  
mente Egyptianum et  
Platonis descriptis.

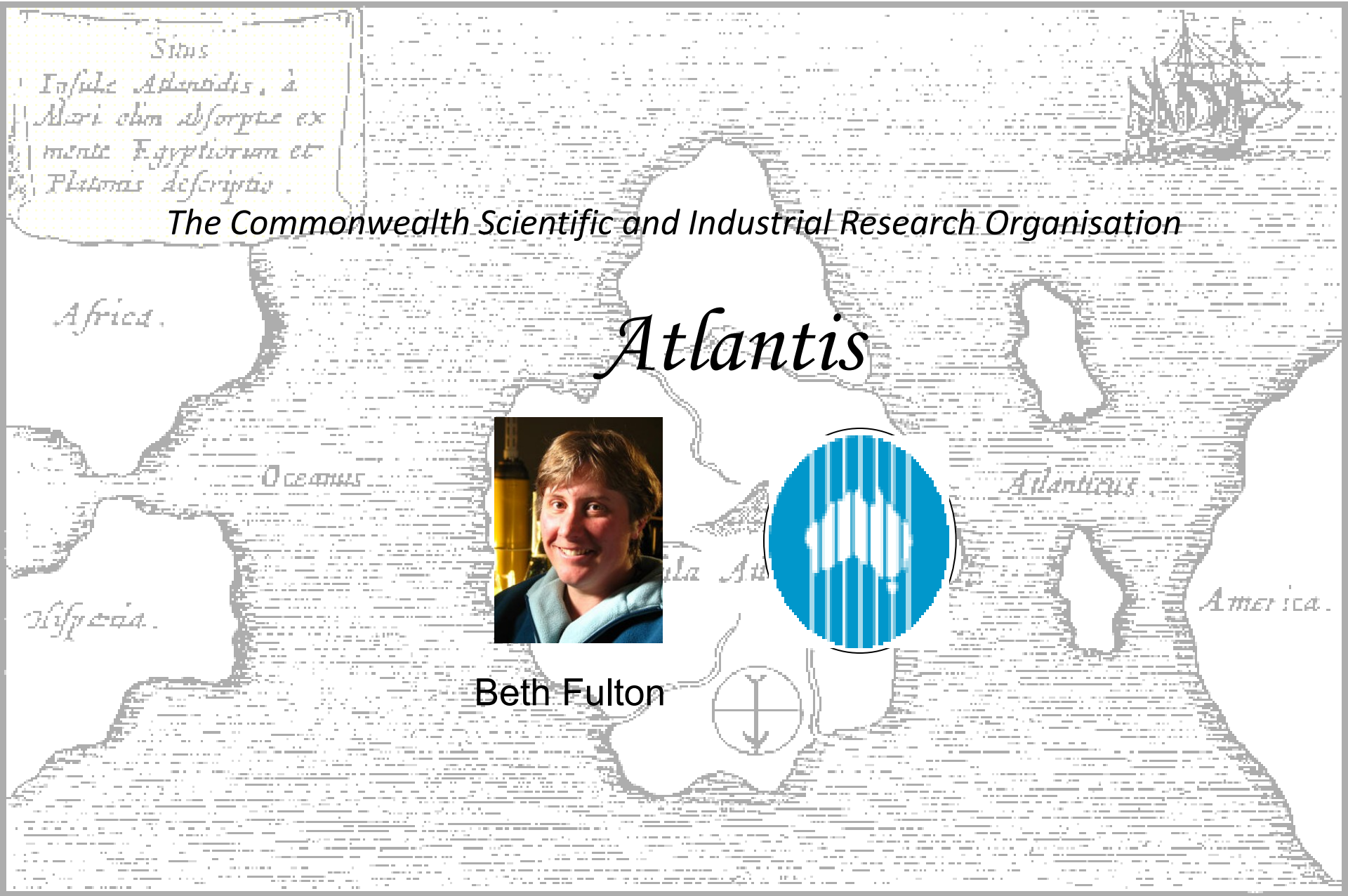


The Commonwealth Scientific and Industrial Research Organisation

# Atlantis



Beth Fulton



# The Atlantis Model

## A Holistic Ecosystem Model

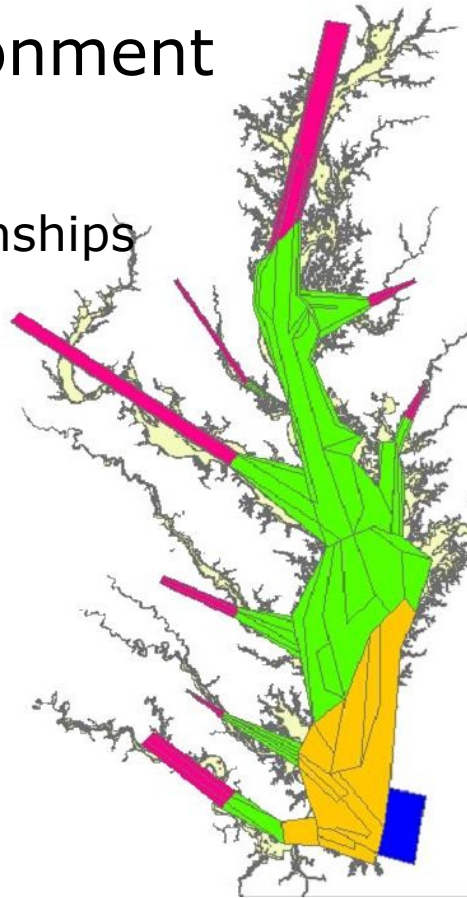
*Incorporating:*

### Biological environment

- ✓ Primary production
- ✓ Trophic interactions
- ✓ Recruitment relationships
- ✓ Age structure
- ✓ Size structure
- ✓ Life History

### Fisheries

- ✓ Multiple sectors
- ✓ Gears
- ✓ Seasons
- ✓ Spatially explicit



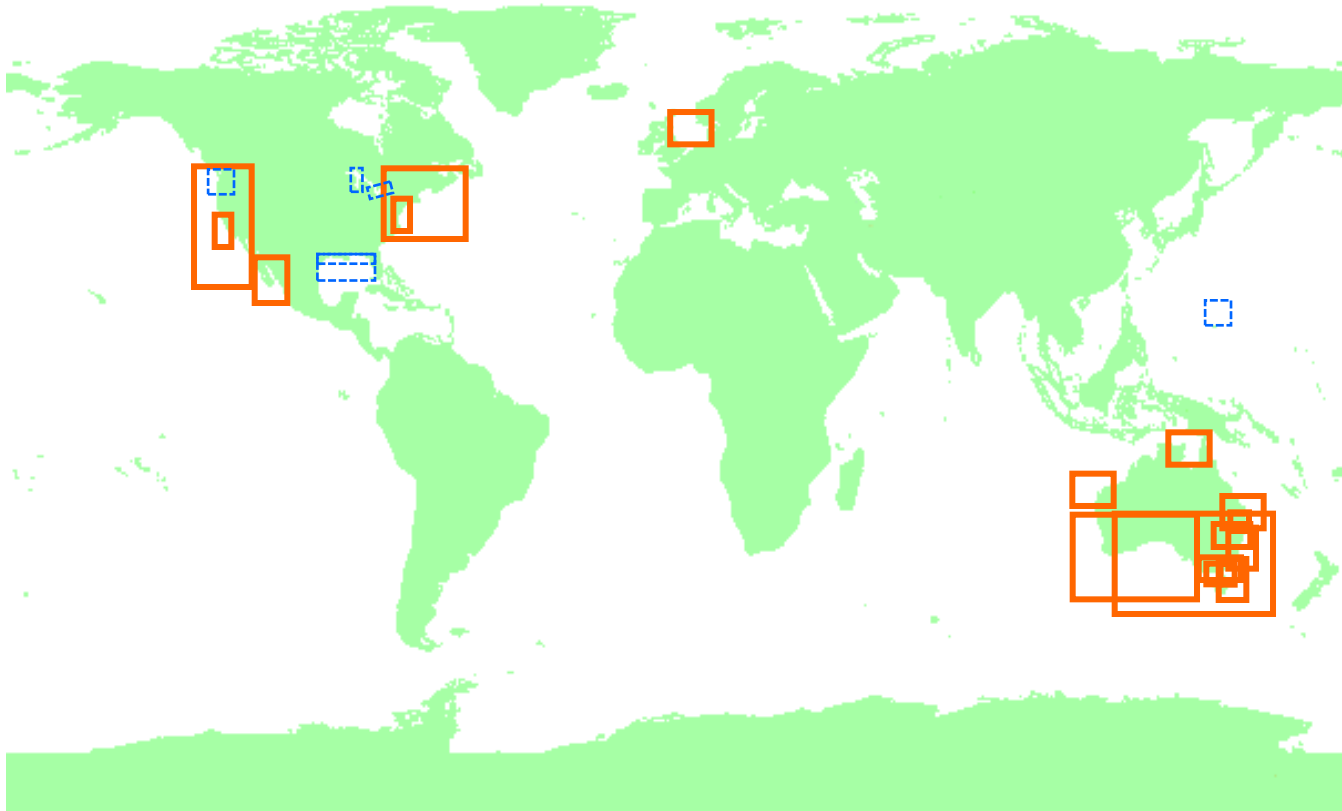
### Physical environment

- ✓ Geology
- ✓ Chemistry
- ✓ Circulation & currents
- ✓ Temperature
- ✓ Salinity
- ✓ Water clarity
- ✓ Climate variability

### Nutrient Inputs

- ✓ Currency is Nitrogen
- ✓ Oxygen
- ✓ Silica
- ✓ 3 Detrital forms
- ✓ Bacteria-mediated recycling

# Implementations



- ~20 systems established simulations
- 6 new NOAA models begun

# How Model is Used

- Provides integrated system information on trade-offs to decision makers (Integrated Ecosystem Assessment approach)
  - Levels the playing field for system stressors
- Management strategies – Socioeconomic effects
  - Gear choice effects
  - MPA design
  - Catch Shares
- Ecological understanding
  - Harvest impacts
  - Nutrient effects
  - Inshore production (forage species & habitat) effects on offshore fisheries production
  - Climate impacts
  - Ecosystem health indicators/metrics

An underwater photograph showing a vast, dense bed of mussels covering the seabed. The mussels are dark brown and grey, with some showing their characteristic shape. In the background, the water is clear and blue, with several small fish swimming near the surface.

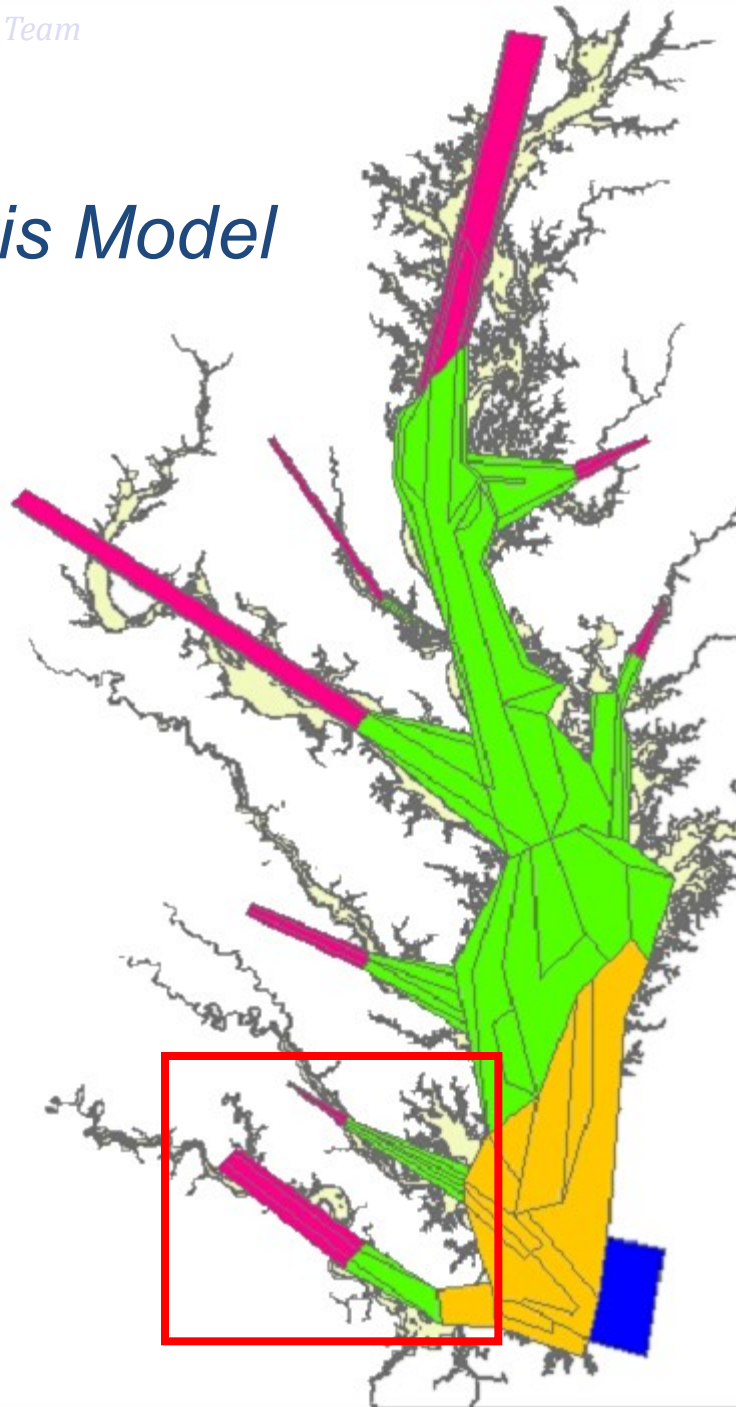
# The Chesapeake Atlantis Model

(CAM)

## Design

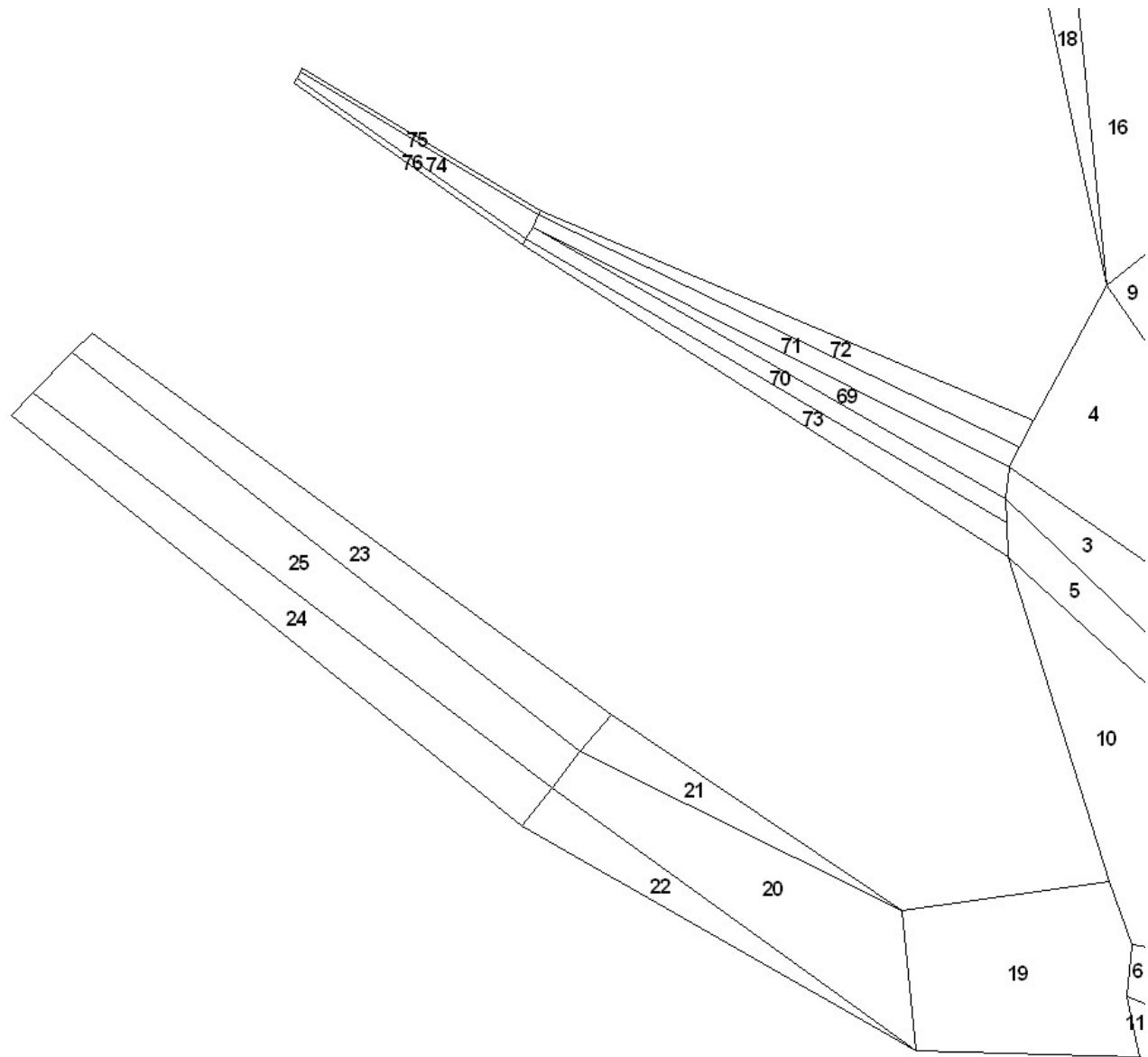
# Chesapeake Atlantis Model

## Salinity





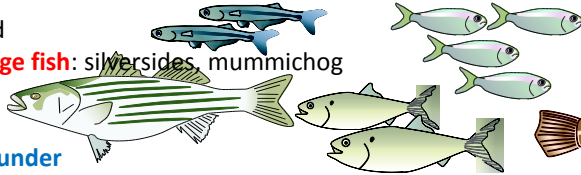
# CAM: River Box Structure



# Ecological Groups: Federal fisheries, Forage, Protected, Habitat

## Finfish

- **Alosines** (Amer. Shad, Hickory Shad, Alewife & Herring)
- Atlantic Croaker
- **Bay anchovy**
- Black drum
- **Bluefish**
- **Butterfish**, harvestfish ("Jellivores")
- Catfish
- Gizzard shad
- **Littoral forage fish**: silversides, mummichog
- **Menhaden**
- Striped bass
- **Summer flounder**
- Other flatfish (hogchoker, tonguefish, window pane, winter flounder)
- **Panfish**:  
Euryhaline: Spot, silver perch; FW to 10ppt: yellow perch, bluegill
- **Reef assoc. fish**: spadefish, tautog, **black seabass**, toadfish
- Spotted hake, lizard fish, northern searobin
- Weakfish
- White perch



## Elasmobranchs

- Cownose ray
- Dogfish, smooth
- **Dogfish, spiny**
- Sandbar shark



## Birds

- **Bald Eagle**
- Piscivorous birds (osprey, great blue heron, brown pelican, cormorant)
- Benthic predators (diving ducks)
- Herbivorous seabirds (mallard, redhead, Canada goose, & swans)



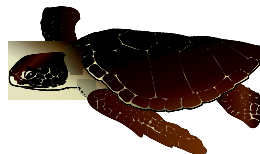
## Mammals

- **Bottlenose dolphin**



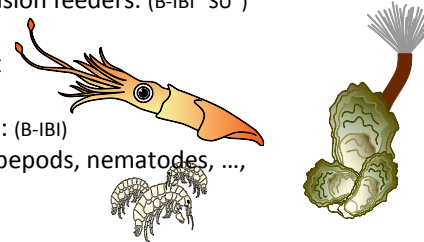
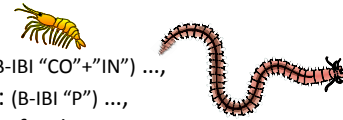
## Reptiles

- **Diamond-back Terrapin**
- **Seaturtles**



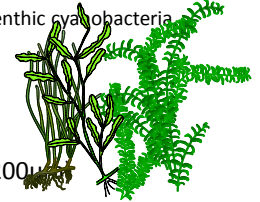
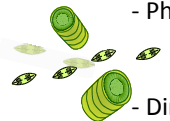
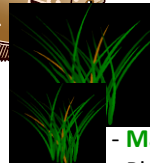
## Invertebrates

- Benthic feeders: (B-IBI "CO"+"IN") ...,
- Benthic predators: (B-IBI "P") ...,
- Benthic suspension feeders: (B-IBI "SU")
- Blue crab YOY
- Blue crab adult
- **Brief squid**
- Macoma clams: (B-IBI)
- Meiofauna: copepods, nematodes, ...,
- **Oysters**



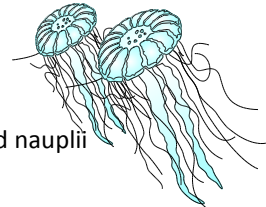
## Primary Producers

- Benthic microalgae ("microphytobenthos" benthic diatoms, benthic cyanobacteria & flagellates)
- **Grasses:**  
**SAV** – type varies with salinity
- **Marsh grass**
- Phytoplankton – Large: diatoms & silicoflagellates (2-200um)
- Phytoplankton – Small: nanoplankton, ultraplankton, aka "picoplankton" or "picoalgae" (0.2-2um), cyanobacteria included (2um)
- Dinoflagellates (mixotrophs) (5-2,000um)



## ZooPlankton

- Ctenophores
- Sea nettles
- Microzooplankton (.02-.2mm): rotifers, ciliates, copepod nauplii
- Mesozooplankton (.2-20mm): copepods, etc.



## Detritus

- Carrion
- Carrion (sediment)
- Labile
- Labile (sediment)
- Refractory
- Refractory (sediment)

## Bacteria (.2-2 um [.002 mm] - feed microzooplankton food chain)

- Benthic Bacteria (sediment)
- Pelagic Bacteria: (free-living)

# Benefits of NESDIS data for science questions addressed in the Chesapeake Atlantis Model

- Verify/tune current model
- Develop new improved model:
  - ✓ Test effects of vastly improved spatial & temporal resolution of chla & tss data on model predictions
  - ✓ Capture/ model system effects of episodic events
  - ✓ Minimize lower trophic-level errors & consequently, limit error propagation

# Initial Design – Experimental Outline

- Format data for Atlantis
- Compare results for various Chl\_a data sources:
  - EPA – base model
  - MODIS(std)
  - MODIS(tunedCB)
  - SeaWiFS(2002)
  - VIIRS(untuned)
- Metrics
  - Run length
  - Biomass
- Refine Comparison
  - Lessons learned

# Conversion of VIIRS data to Atlantis Ecosystem Model Grid

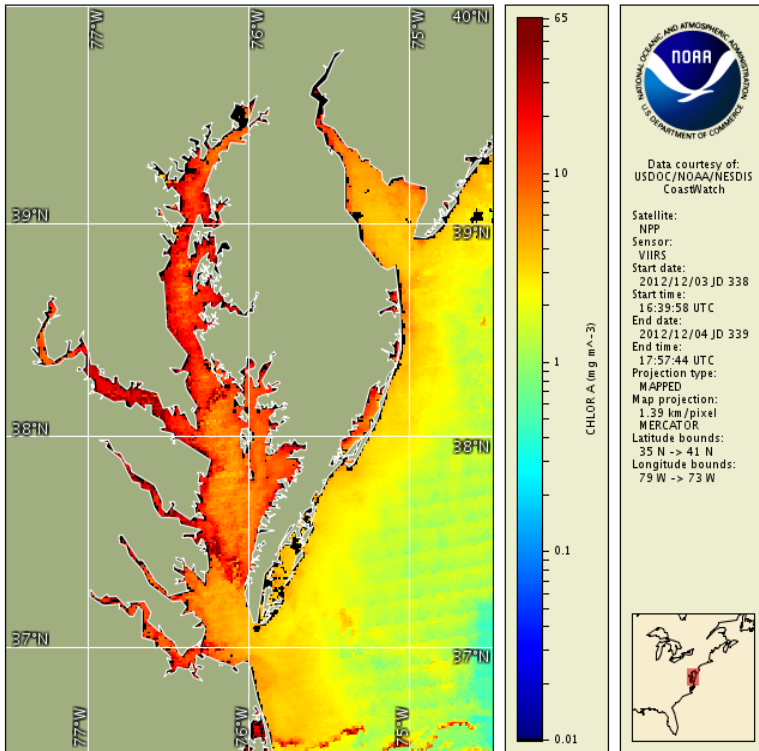
VIIRS satellite chlorophyll



Georeferenced grid



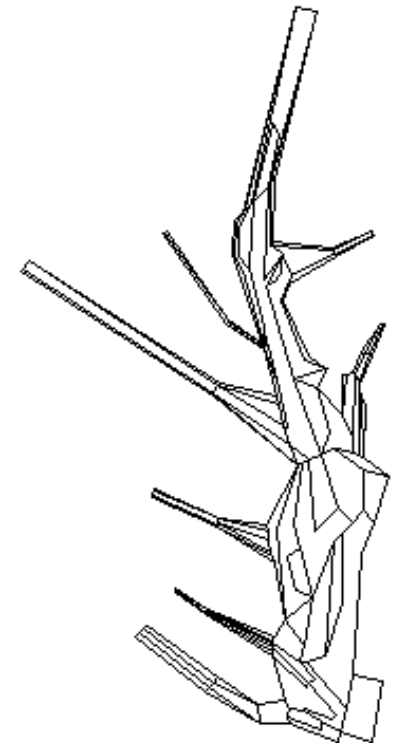
Ecosystem model grid



S-NPP VIIRS chlorophyll  
CoastWatch 2-day avg (Dec 3-4, 2012)  
Raster data: UTM coordinates

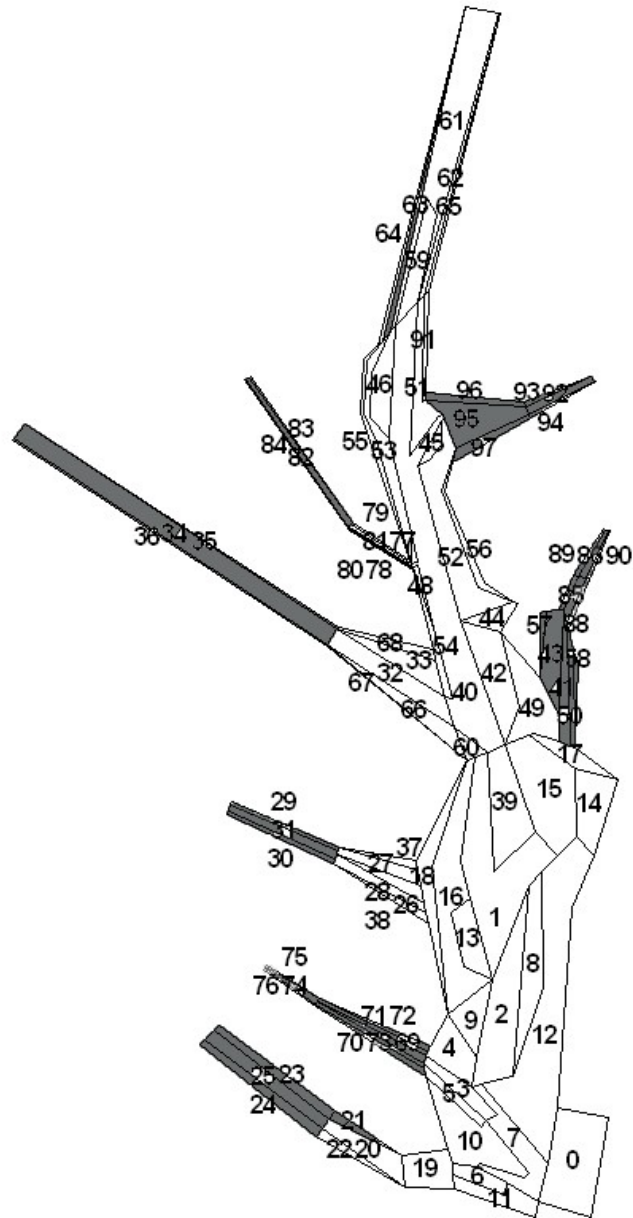


Chesapeake Bay Program  
Georeferenced polygonal grid  
8,282 polygons



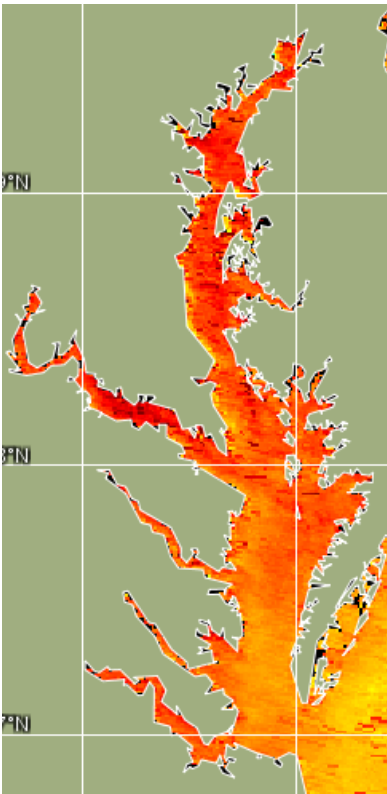
NOAA/NMFS/NCBO  
Atlantis Ecosystem Model  
97 polygons  
Aggregated from 8,282

# EPA Chlorophyll Inputs to Atlantis Model



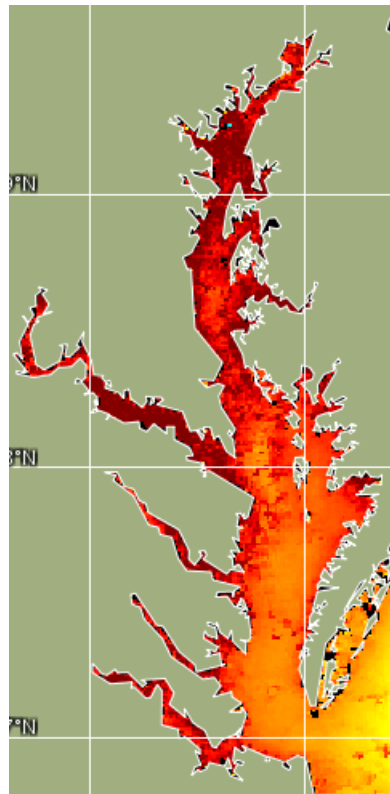
# Satellite Chlorophyll Inputs to Atlantis Model

**SeaWiFS**



Two-month average  
Dec 2001 – Jan 2002

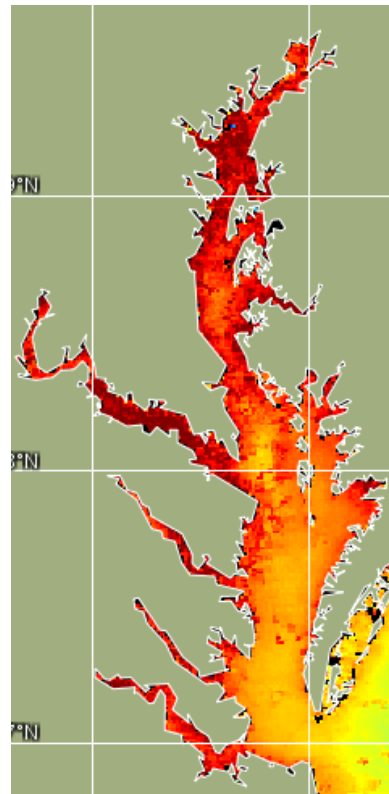
**MODIS standard**



Two-month average  
Dec 2012 – Jan 2013

**High bias for  
coastal regions**

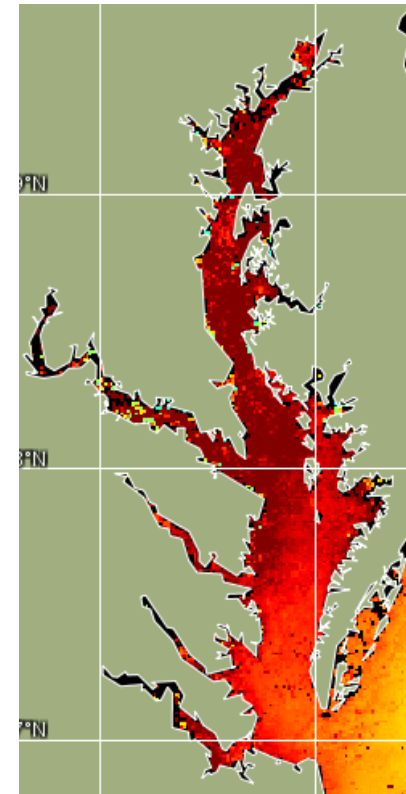
**MODIS Bay-tuned**



Two-month average  
Dec 2012 – Jan 2013

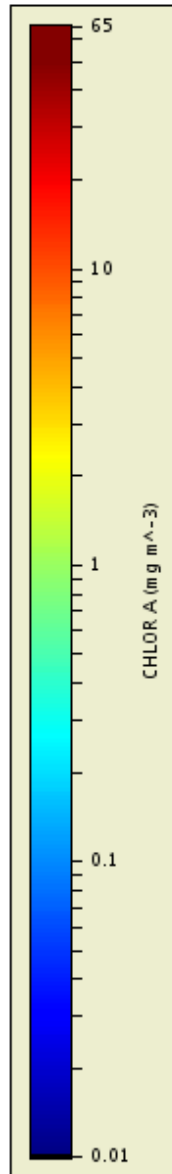
**Tuning reduces  
high bias for Bay**

**VIIRS**



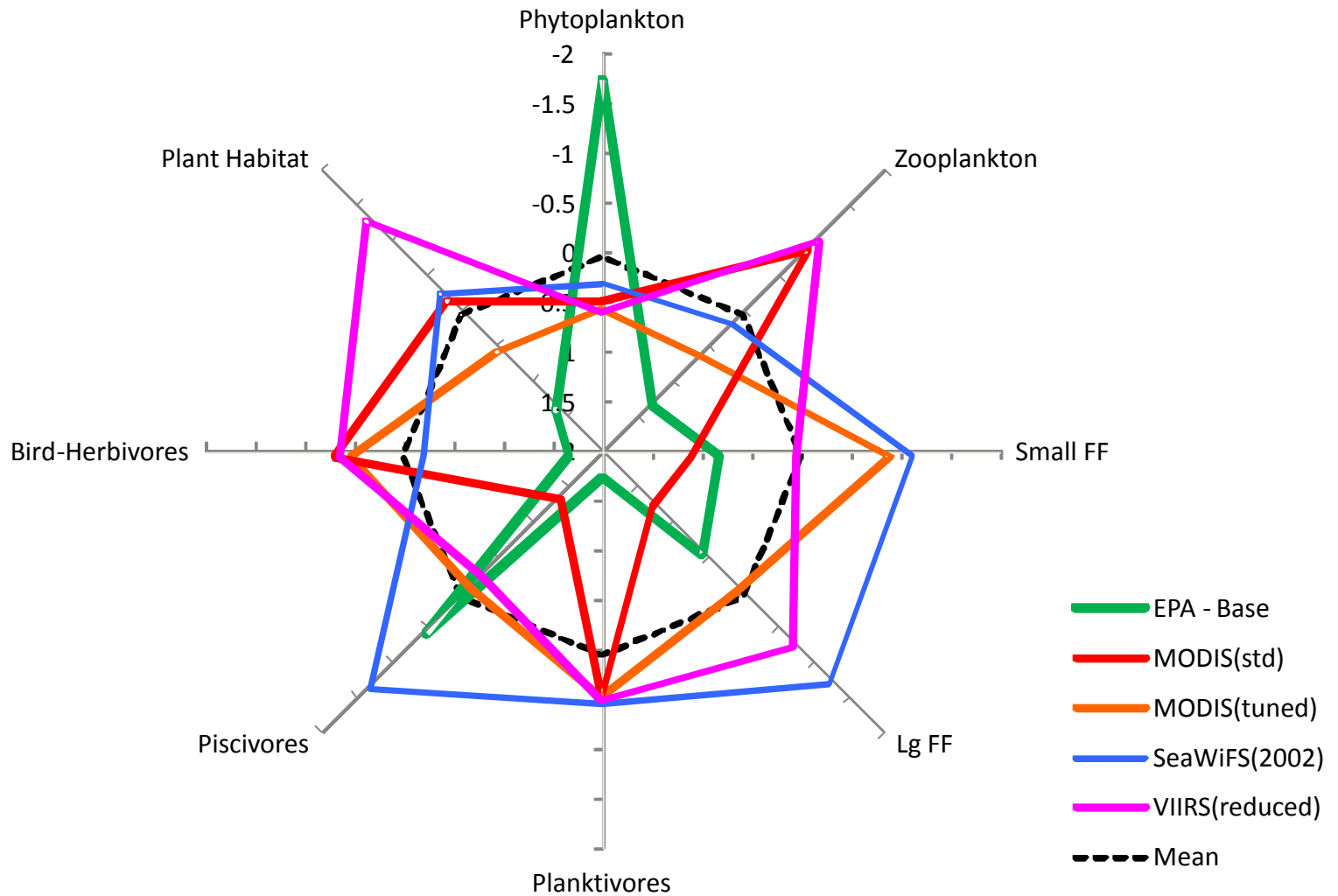
Two-month average  
Dec 2012 – Jan 2013

**High chl mask not  
implemented**



# Initial Results

## Aggregate Biomass Z-scores





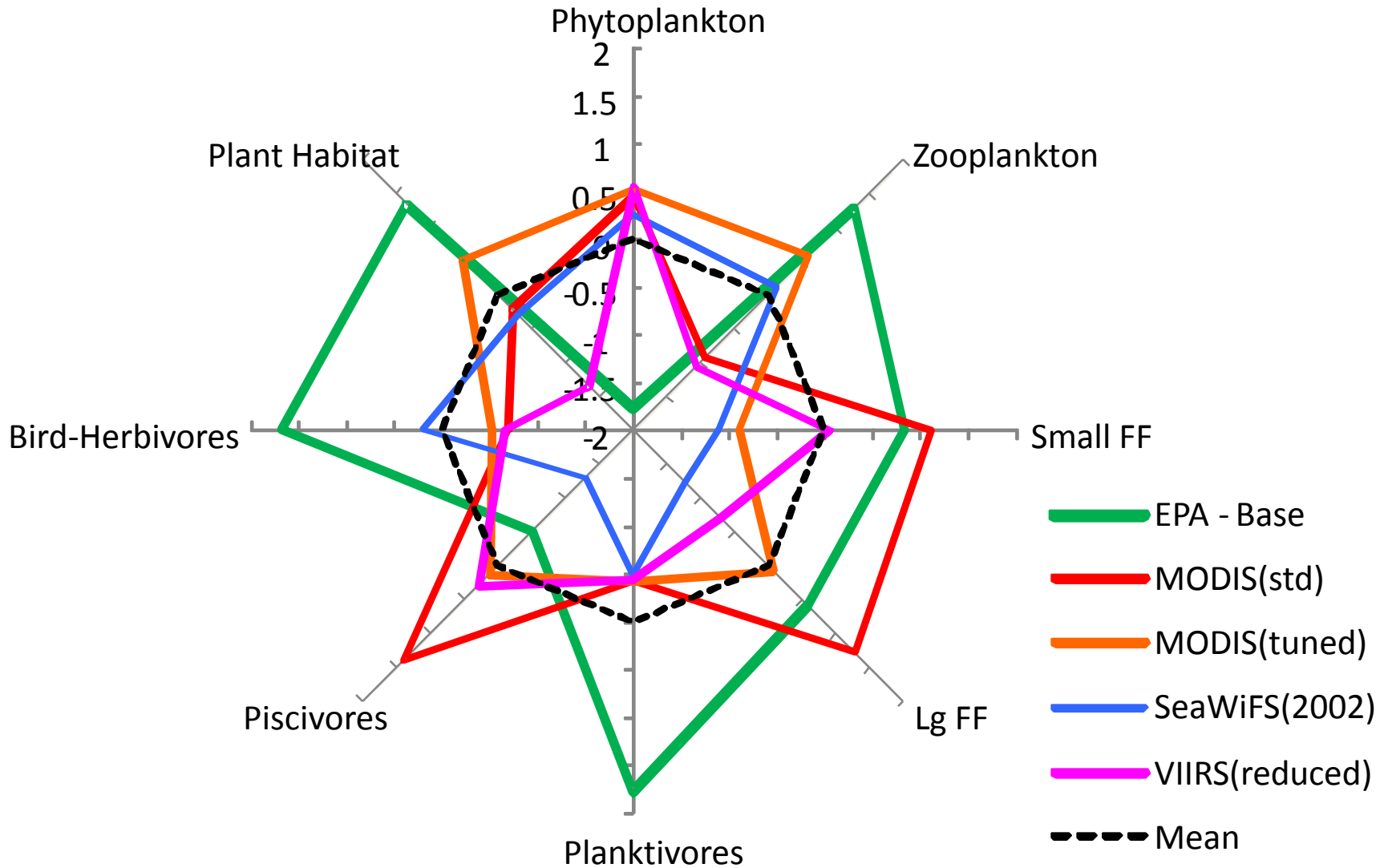
# Future Directions

- Further refine data input, make better use of satellite resolution
- Develop methods for verifying the model's simulation output
- Test alternative model configurations; e.g., satellite/EPA hybrid model
- Data assimilation
- Apply Satellite data to other Atlantis efforts

A large school of fish, possibly sardines or anchovies, is swimming in clear blue water. The fish are densely packed and appear to be moving in a coordinated pattern. The water is a vibrant blue, and the fish are silvery with some darker spots. The overall scene is dynamic and captures a moment of intense activity in the ocean.

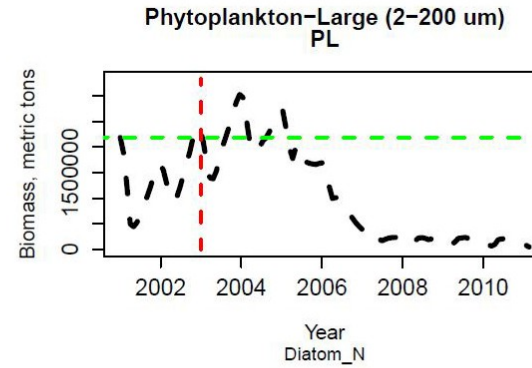
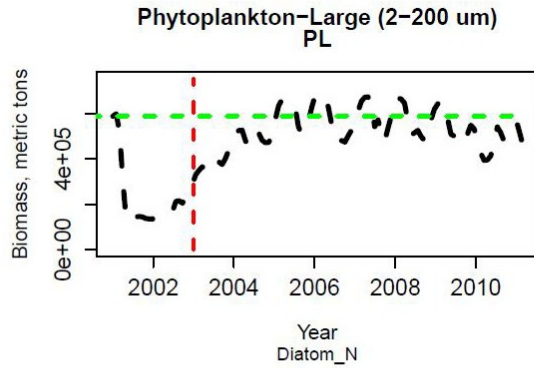
**EXTRA SLIDES**

# Aggregate Biomass Z-scores

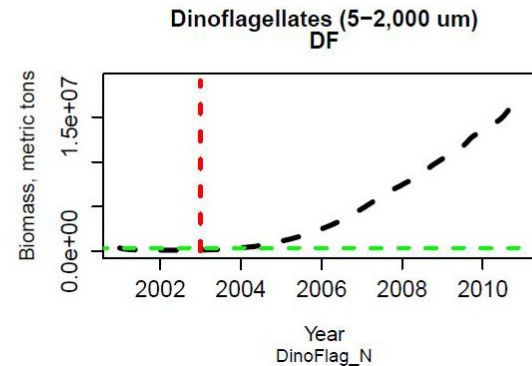
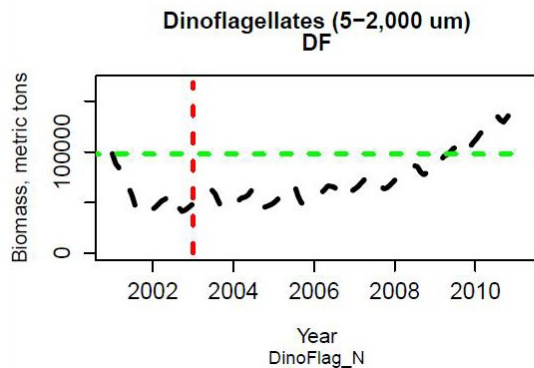
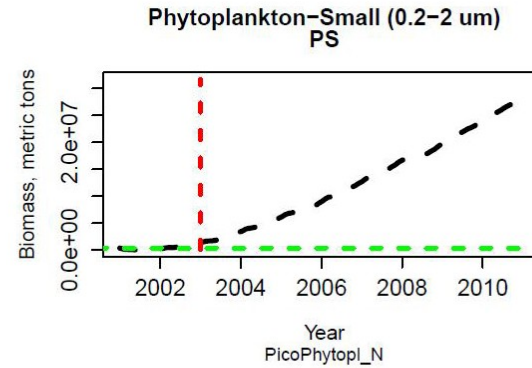
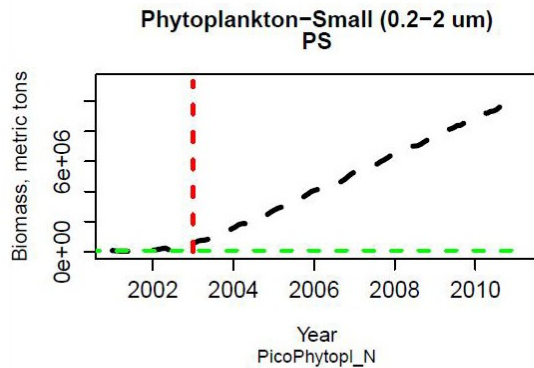


# Phytoplankton Trends

EPA

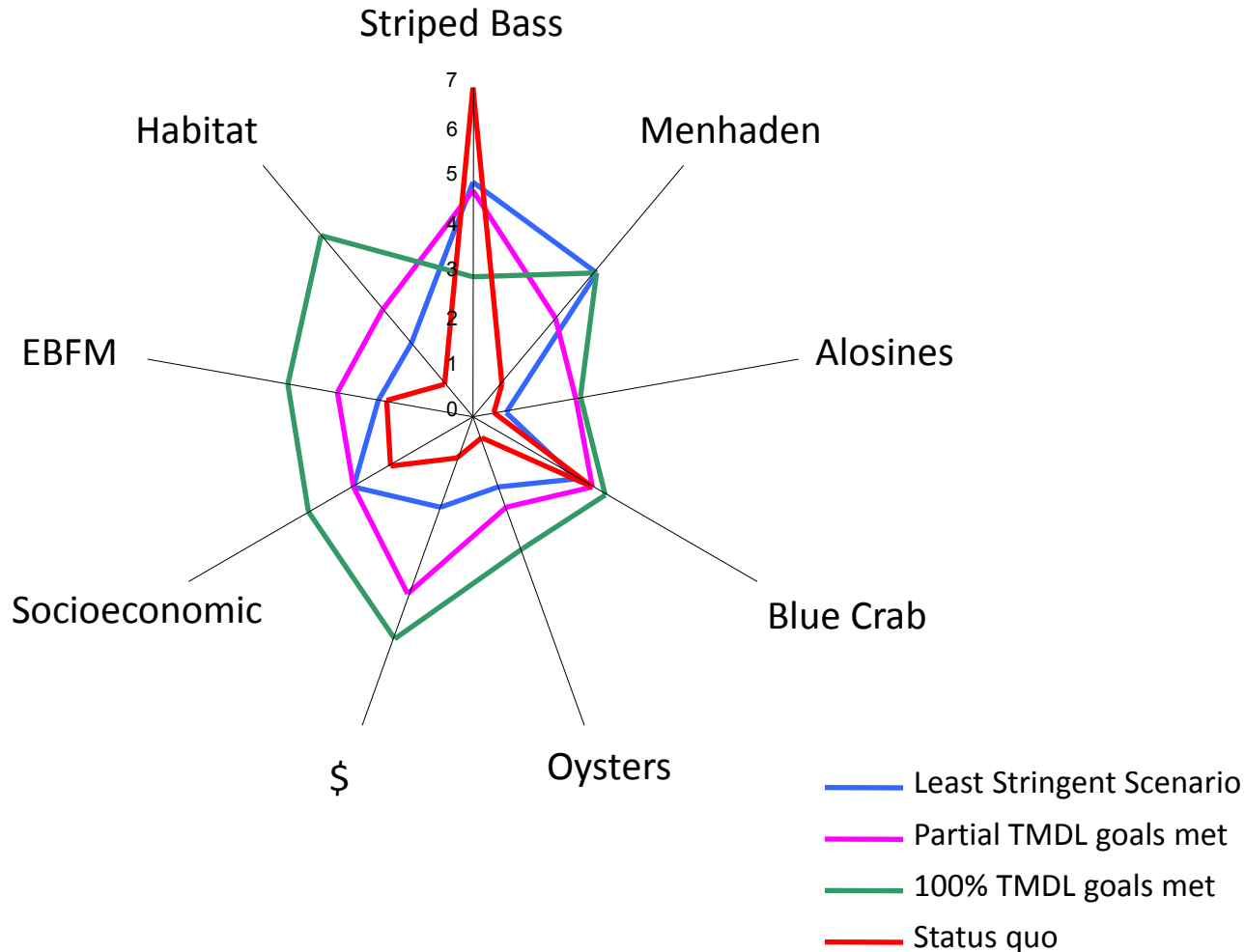


Satellite  
(MODIS tuned)



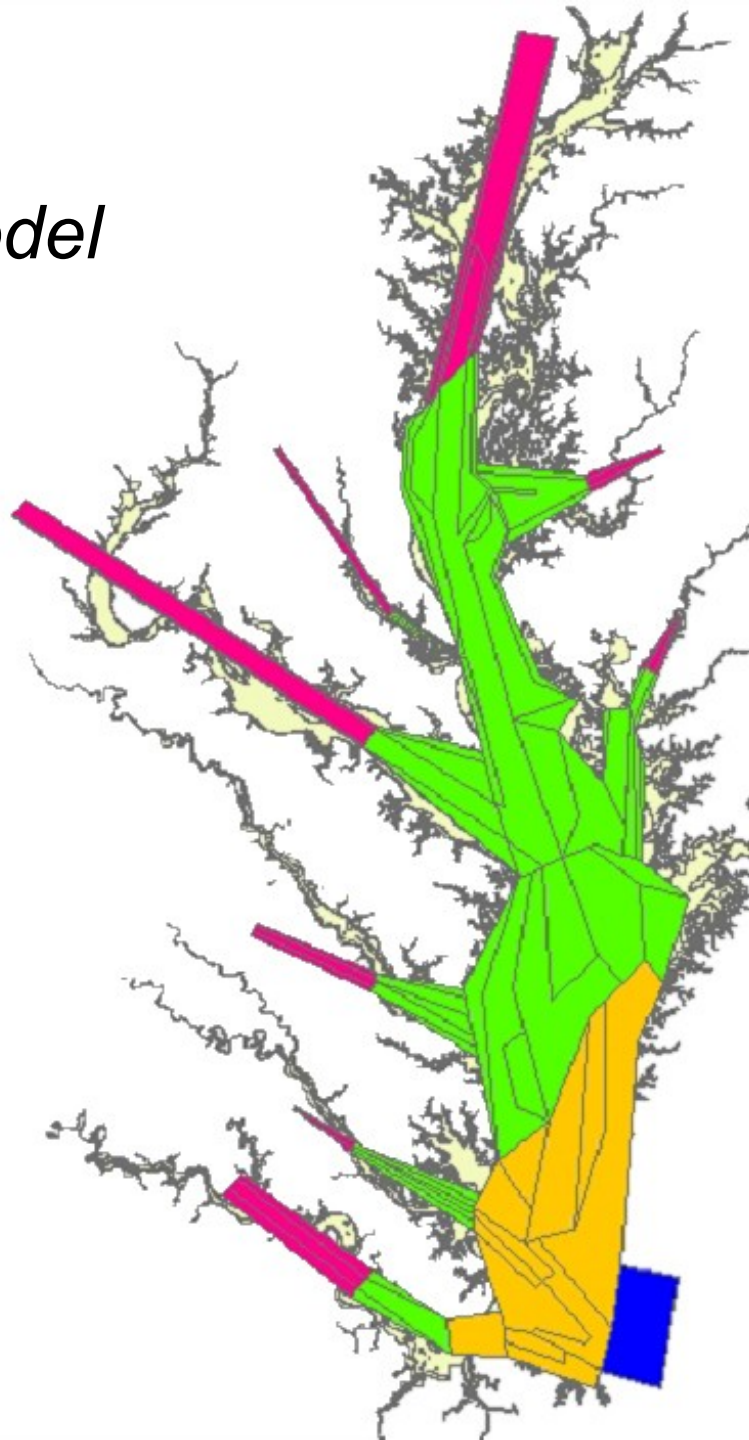
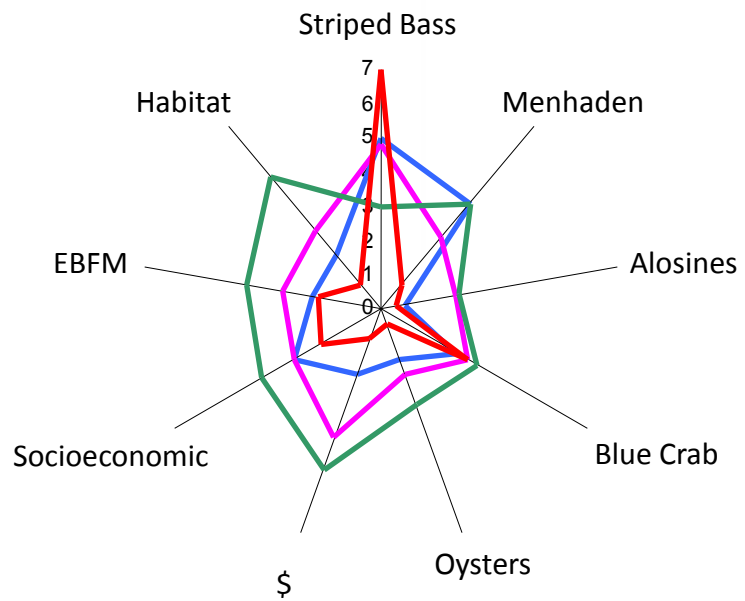
# Tradeoffs - Hypothetical

CAM Output  
20 year Simulation



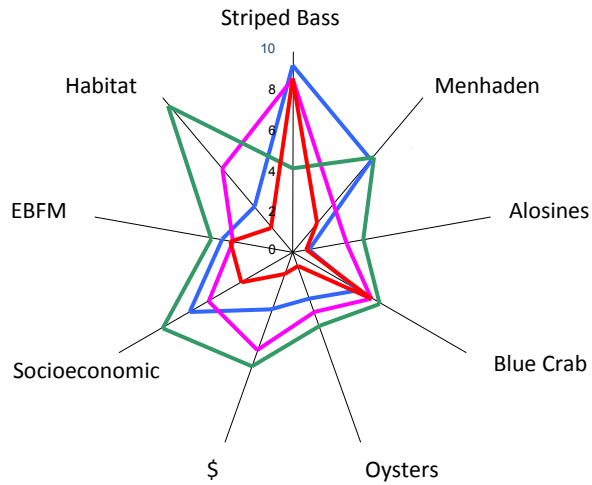
For Illustrative Purposes Only -- Not Based on Actual Modeling Results

# Chesapeake Atlantis Model



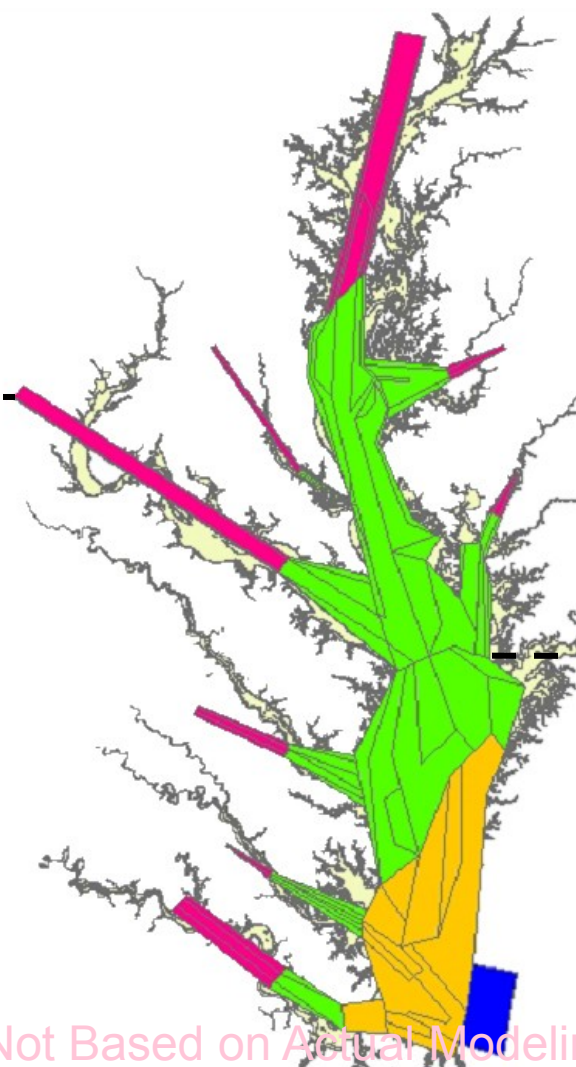
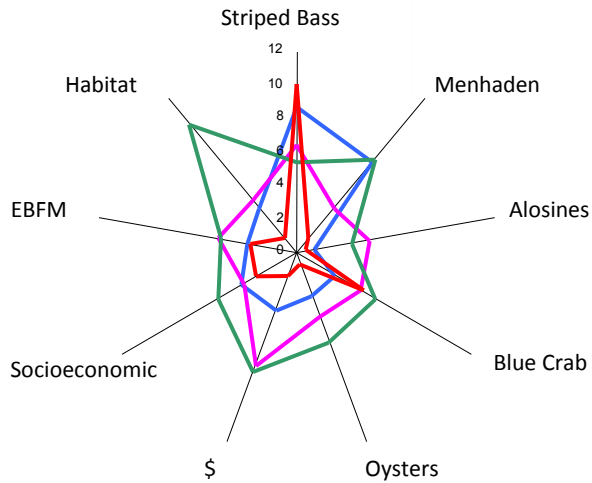
# Tradeoffs

CAM Output  
20 year Simulation



MD

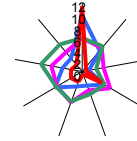
VA



For Illustrative Purposes Only -- Not Based on Actual Modeling Results

# Tradeoffs

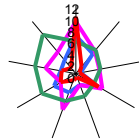
CAM Output  
20 year Simulation



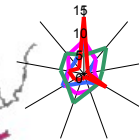
Susquehanna/  
Upper-Bay

*Focus areas:*

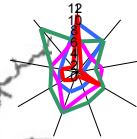
Potomac



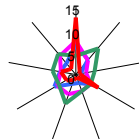
Choptank



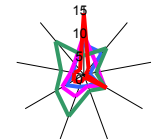
Nanticoke



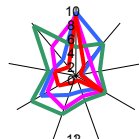
Rappahannock



Mid-Bay

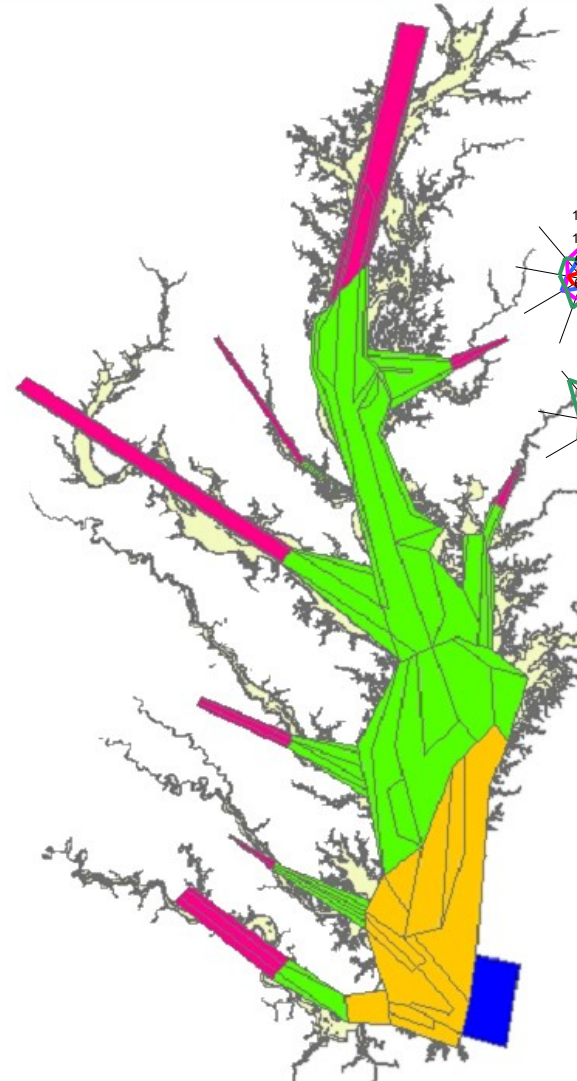
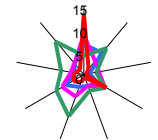
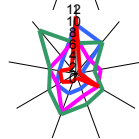


York



Lower-Bay

James



For Illustrative Purposes Only -- Not Based on Actual Modeling Results

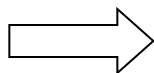


# Atlantis

## Management Strategy Evaluation (MSE)

### Manager Roles

DEFINE OBJECTIVES

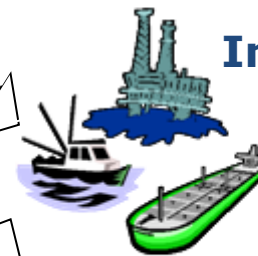


PERFORMANCE MEASURES

### Simulation Cycle



**Biophysical**



**Industry**



**Implementation**



**Management**

**Monitoring**



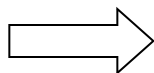
**Assessment**

# Atlantis

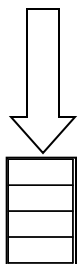
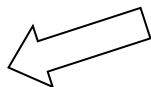
## Management Strategy Evaluation (MSE)

### Manager Roles

DEFINE OBJECTIVES



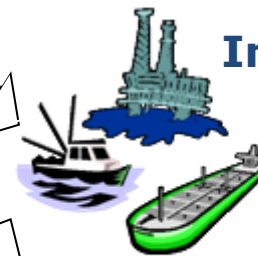
PERFORMANCE MEASURES



### Simulation Cycle



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**Industry**



**Implementation**



**Management**

**Monitoring**



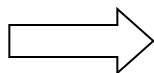
**Assessment**

# Atlantis

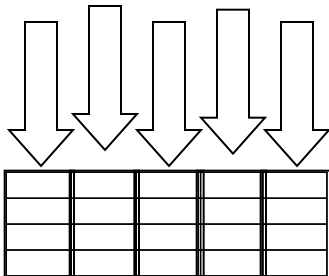
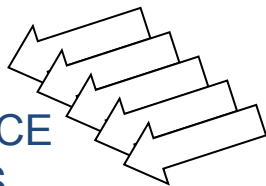
## Management Strategy Evaluation (MSE)

### Manager Roles

DEFINE OBJECTIVES



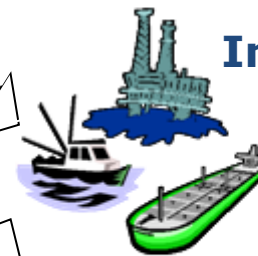
PERFORMANCE MEASURES



### Simulation Cycle



**Biophysical**



**Industry**



**Implementation**



**Management**

**Monitoring**



**Assessment**

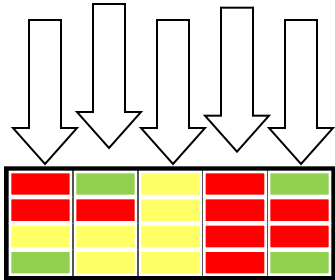
# Atlantis

## Management Strategy Evaluation (MSE)

### Manager Roles

DEFINE OBJECTIVES →

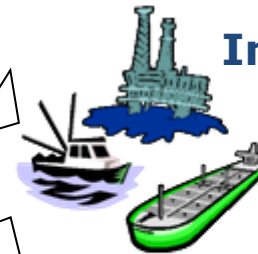
PERFORMANCE MEASURES



### Simulation Cycle



**Biophysical**



**Industry**

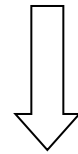


**Implementation**



**Management**

**Monitoring**



**Assessment**

# SUMMARY

- CoastWatch / OceanWatch Proving Ground Year 1: August 23, 2012 – August 24, 2013.
- Existing NOAA Program Users (NOS and NMFS) interviewed and New NOAA Users engaged (NWS/NCEP, and Commercial). Expanded and strengthened user requests.
- Independent user driven quality assessment and recommendation favors IDPS product for global ocean operations. Coastal quality issues remain. Issue to be revisited April 2014.
- New users and new uses being explored and developed. New product needs emerging. Development process not defined.
- Experimental global ocean color production and distribution sustained in STAR. Transition to operations on track for September 2013 (external funding) via Okeanos.
- Data distribution portal enhancements are rolling out. More to come.
- Significant development expected in Years 2 and 3 for utilization in NWS/NCEP and NMFS application areas.
- Nationwide X-band direct broadcast station(s) being planned by NJO for S-NPP and JPSS. Significant back up capability and as well as locally enhanced quality and product opportunities. CoastWatch / OceanWatch will operate Miami station at AOML.