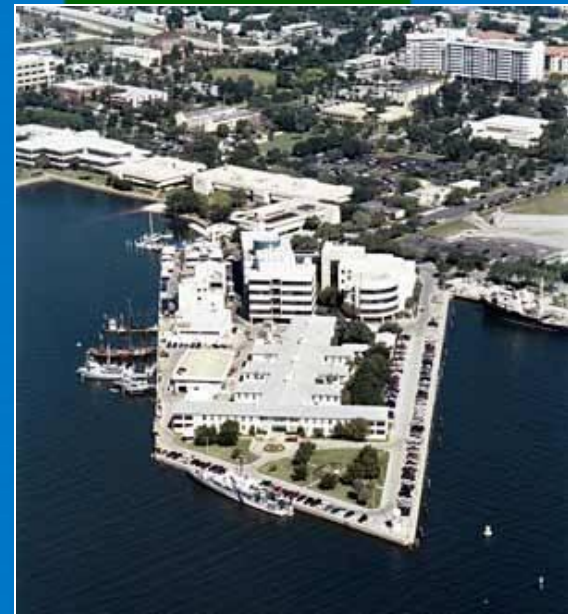


# College of Marine Science

*The Society of Military  
Engineers*

*August 8, 2012*

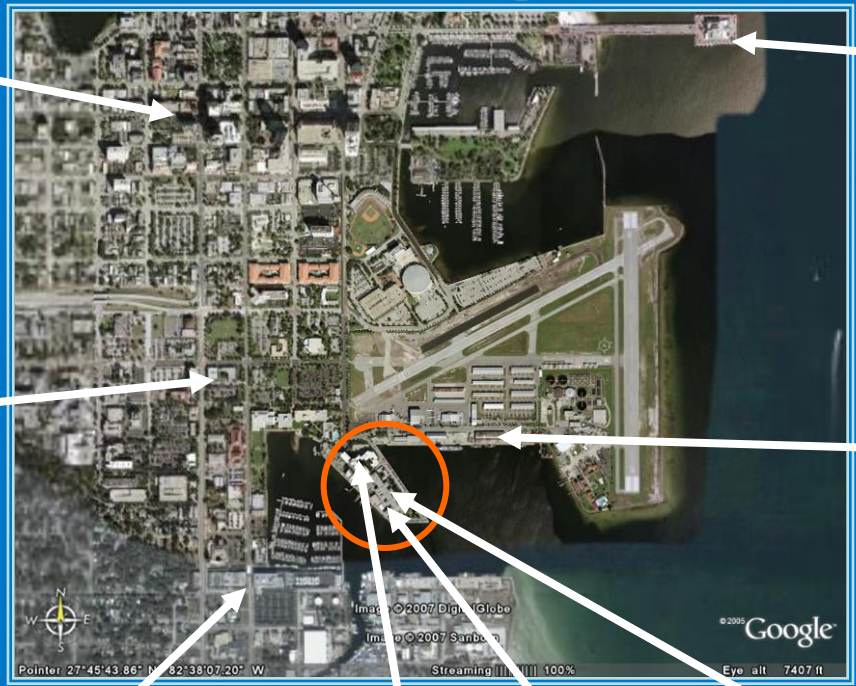
*<http://www.marine.usf.edu>*



**St. Petersburg Ocean Team**  
**Largest cluster in the Southeast**  
**1,620+ employees**  
**\$143 million in payroll**



~ Saint Petersburg, Florida ~



**International Oceans Institute (IOI)**



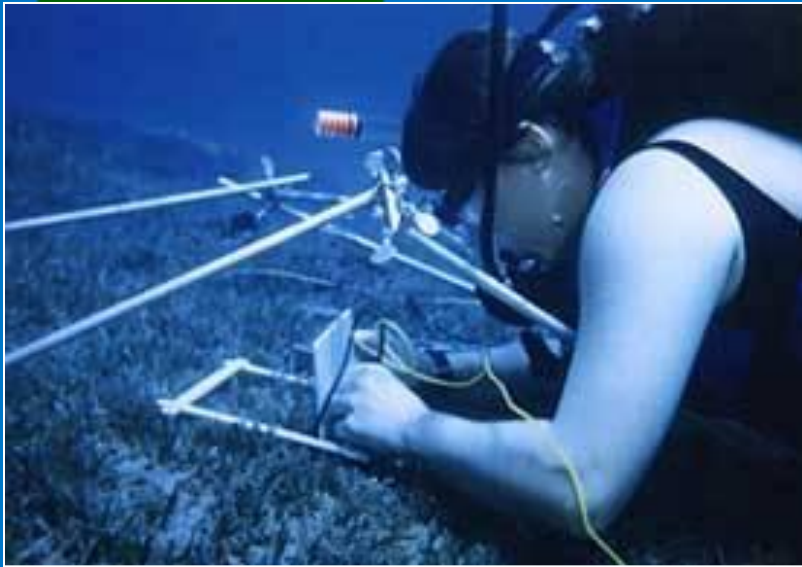
2011-2012



- C.W. Young Marine Science Complex:  
Knight Oceanographic Research Center, MSL building, COT
- 28 Tenure-track Faculty
- 112 graduate students (M.S. and Ph.D.)
- ~\$12 Million in research funding



## ***Academics***



- Degrees offered:
  - Master of Science (MS)
  - Doctor of Philosophy (PhD)
- Areas of Study:
  - Biological Oceanography
  - Chemical Oceanography
  - Geological Oceanography
  - Physical Oceanography
  - Marine Resource Assessment

## *Education and Outreach*

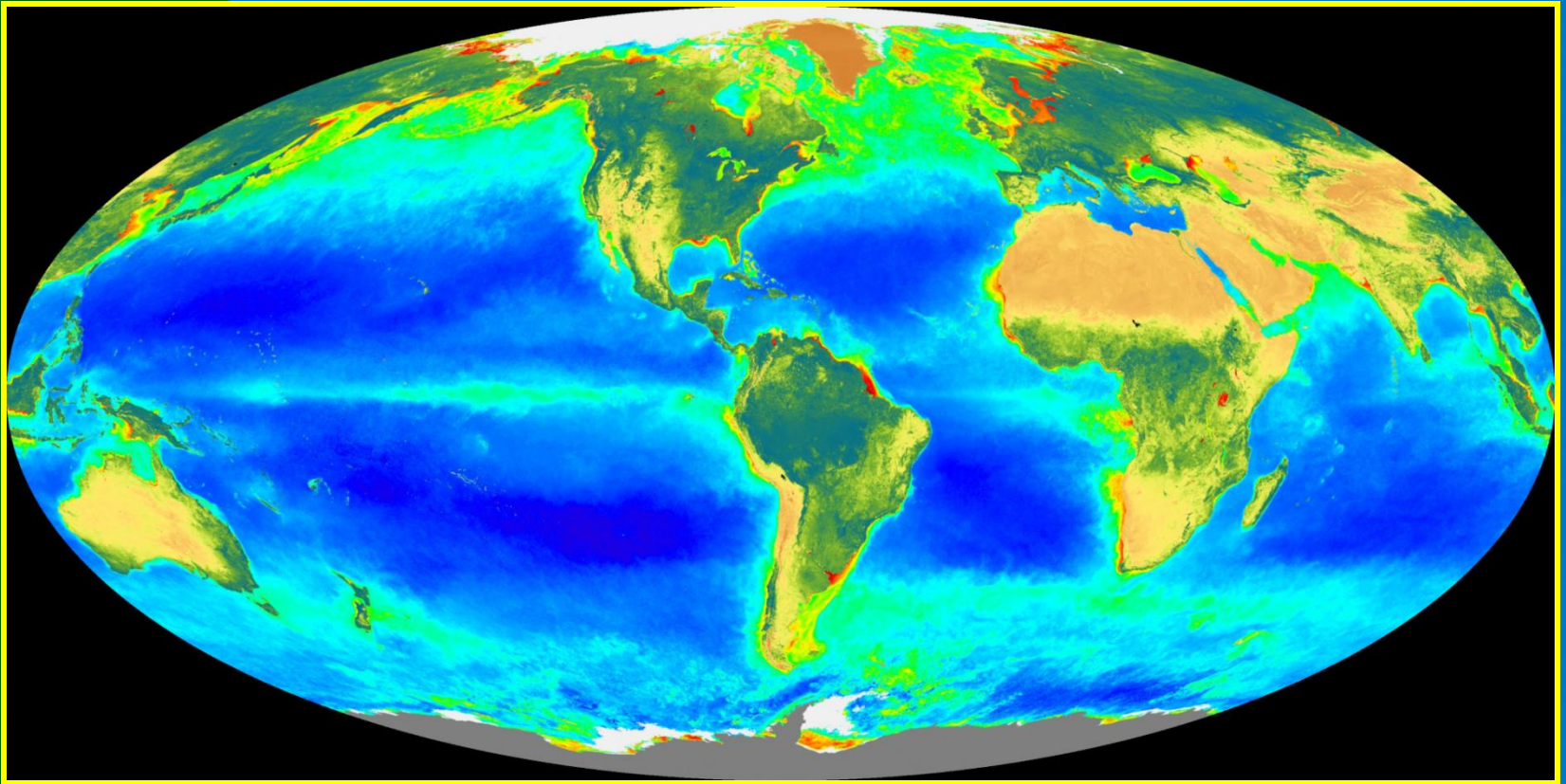


- Oceanography Camp for Girls
- Teacher at Sea
- Partnership with Secret of the Seas Marine Exploration Center
- Partnerships with Cousteau Divers and Canterbury Schools

## *Fellowships*



- Bridge to the Doctorate Fellowship
- Elsie and William Knight, Jr. Endowed Fellowship
- St. Petersburg Progress Endowed Fellowship in Coastal Science
- John and Katharine Ann Lake Endowed Fellowship
- Gulf Oceanic Trust Fellowship
- Paul Getting Memorial Endowed Fellowship
- C.W. Bill Young Fellowship
- Robert M. Garrells Fellowship
- Sanibel-Captiva Shell Club Endowed Fellowship
- Von Rosenstiel Fellowships
- Wachovia Bank Fellowship
- Carl Riggs Endowed Fellowship
- Tampa Bay Parrot Head Endowment





UNIVERSITY OF  
SOUTH FLORIDA  
COLLEGE OF MARINE SCIENCE



with a  
strength in  
local issues



**On April 20, 2010  
Explosion and Fire on Transocean Ltd's  
Drilling Rig - Deepwater Horizon  
Explosion**



- ***Research Highlights:***
  - Continued response to Deepwater Horizon blowout
  - Shortly after the DWH tragedy, BP announced **\$500 million over 10 years** to fund an independent research program to study the impact of the oil spill on the environment and public health in the Gulf of Mexico.

# Research Themes

- **1** Physical distribution, dispersion, and dilution of petroleum (oil and gas), its constituents, and associated contaminants (e.g., dispersants) under the action of physical oceanographic processes, air–sea interactions, and tropical storms.
- **2** Chemical evolution and biological degradation of the petroleum/ ocean, and deep-water ecosystems.
- **3** Environmental effects of the petroleum/dispersant system on the marshes, and organisms; and the science of ecosystem recovery.
- **4** Technology developments for improved response, mitigation, detection, characterization, and remediation associated with oil spills and gas releases.
- **5** Impact of oil spills on public health.

**RFP-I: \$121 M to fund 8 Centers  
80 research institutions involved  
77 submitted center proposals**

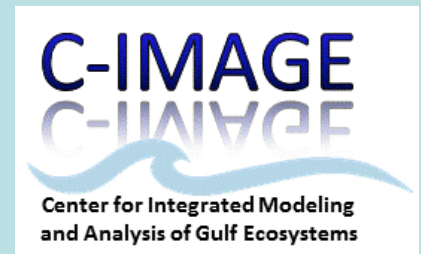
- **Impact of Physical, Chemical, and Biological Processes on the Fate of Oil Spills –**  
**U Texas – Ed Buskey**
- **GISR – Gulf Integrated Spill Research – TAMU – Piers Chapman**
- **Deep-C - Deepsea to Coast Connectivity in the Eastern GoM – FSU – Eric Chassignet**
- **Effects of the Macondo Oil Spill on Coastal Ecosystems – LUMCON – Nancy Rabalais**
- **C-IMAGE – Center for Integrated Modeling and Analysis of Gulf Ecosystems – USF – Steve Murawski**
- **CARTHE – Consortium for Advanced Research of Hydrocarbon Transport in the Environment – UMiami - Tamay Ozgokmen**
- **C-MED - The Consortium for Molecularly Engineered Dispersants– Tulane – Vijay John**
- **ECOGIG – Ecosystem Impacts of Oil and Gas Inputs to the Gulf – UMississippi - Ray Highsmith**



# Overview of the Center for Integrated Modeling and Analysis of Gulf Ecosystems (C-IMAGE) Consortium

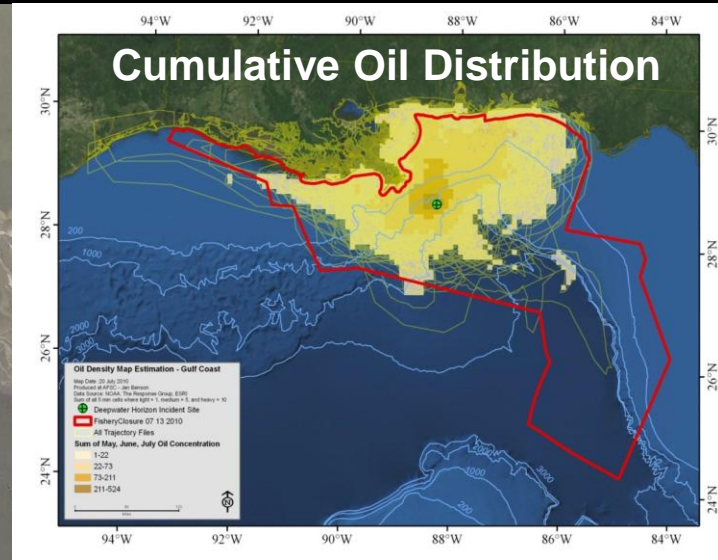
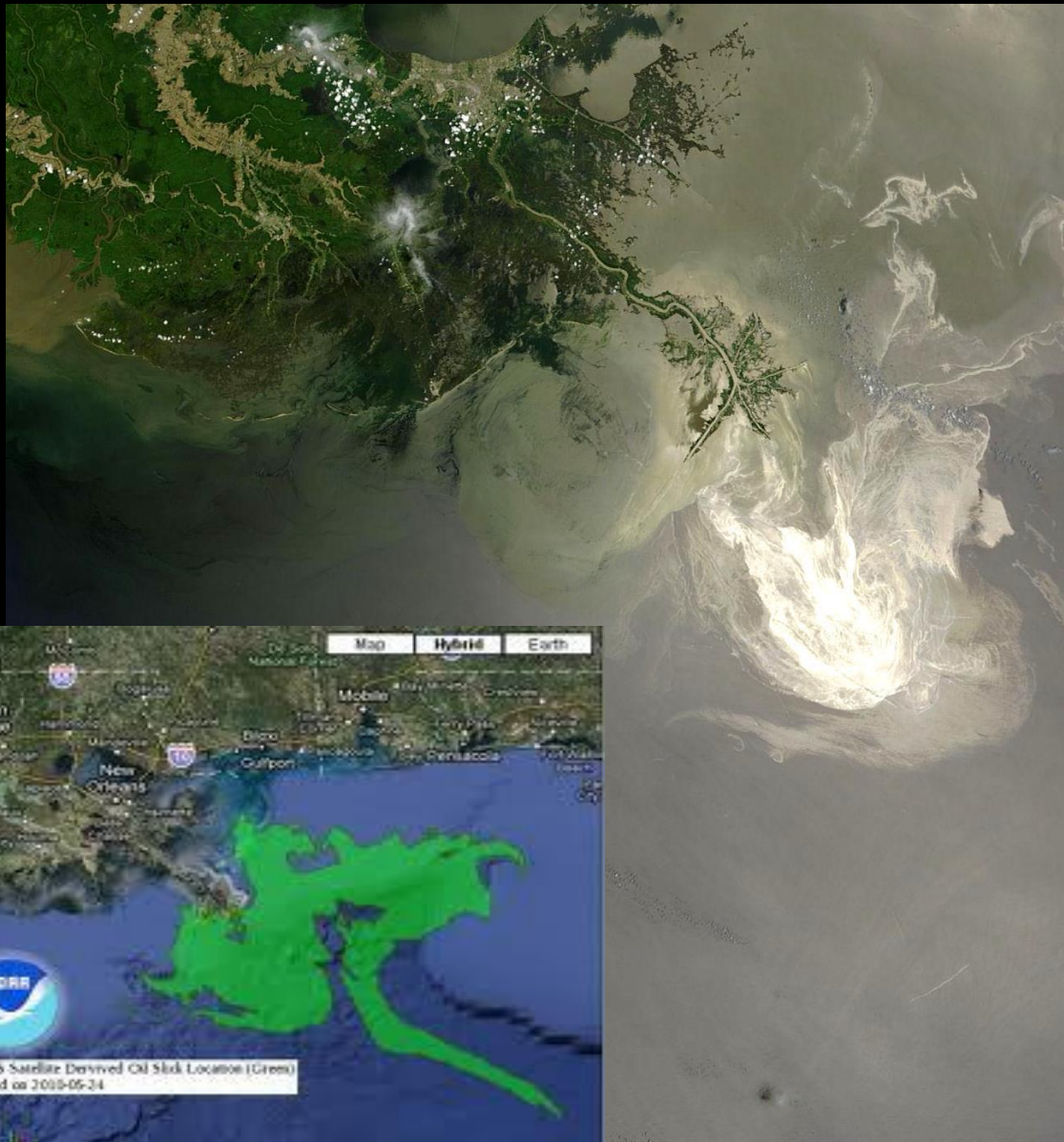
**Steven Murawski - Principal Investigator**

**David Hollander - Co-Principal Investigator**

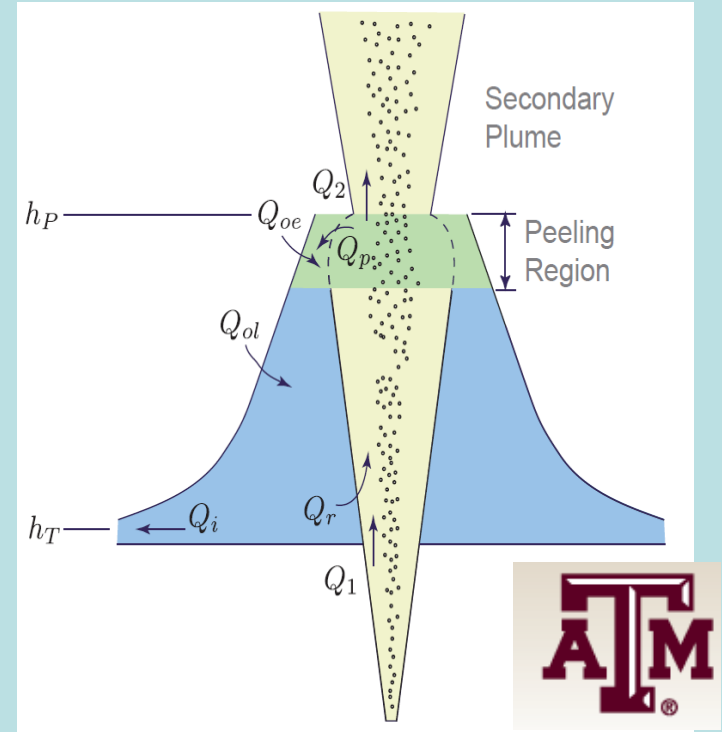
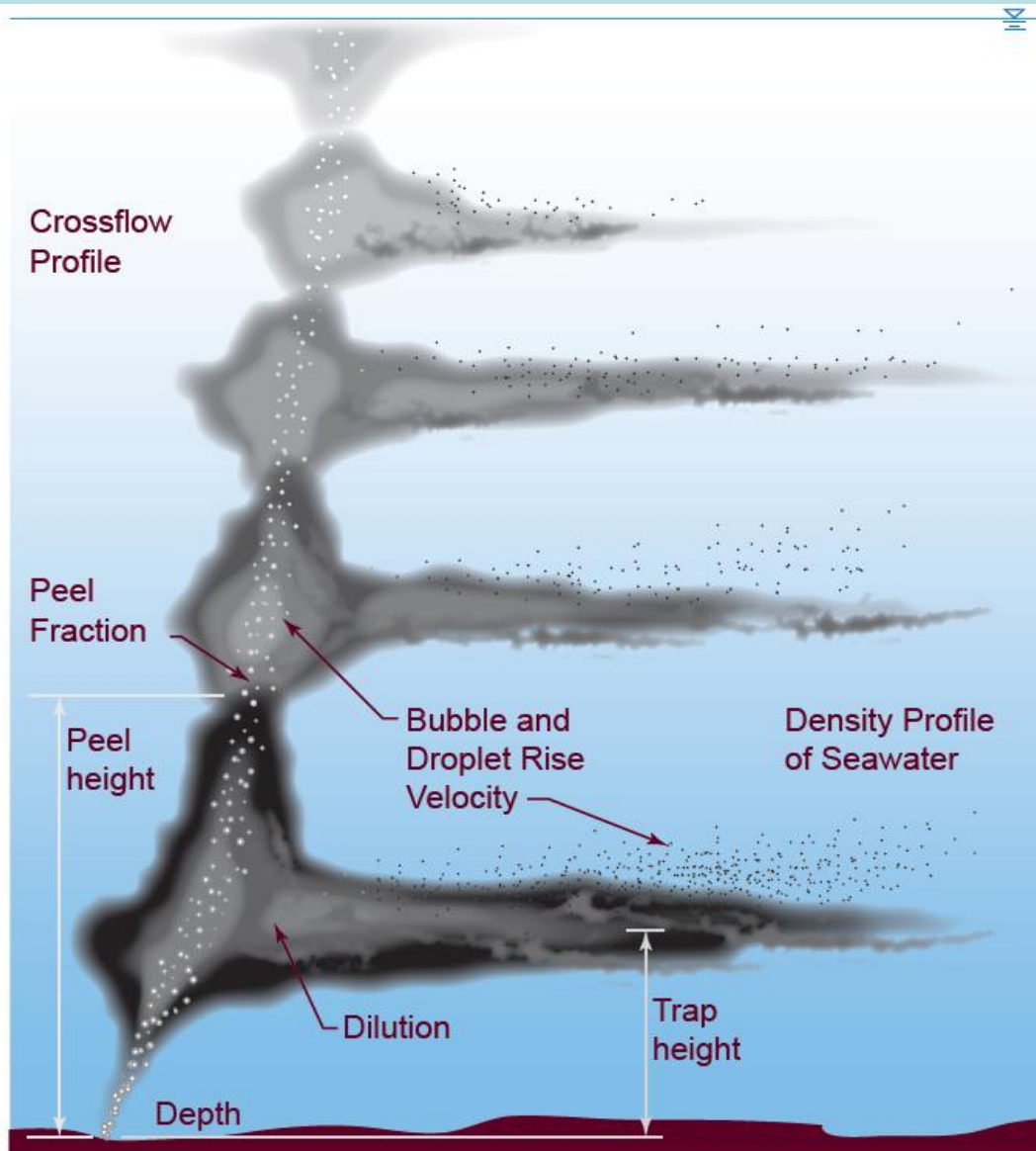


# Oil Spill from Space—May 24, 2010

## A 2-Dimensional Disaster

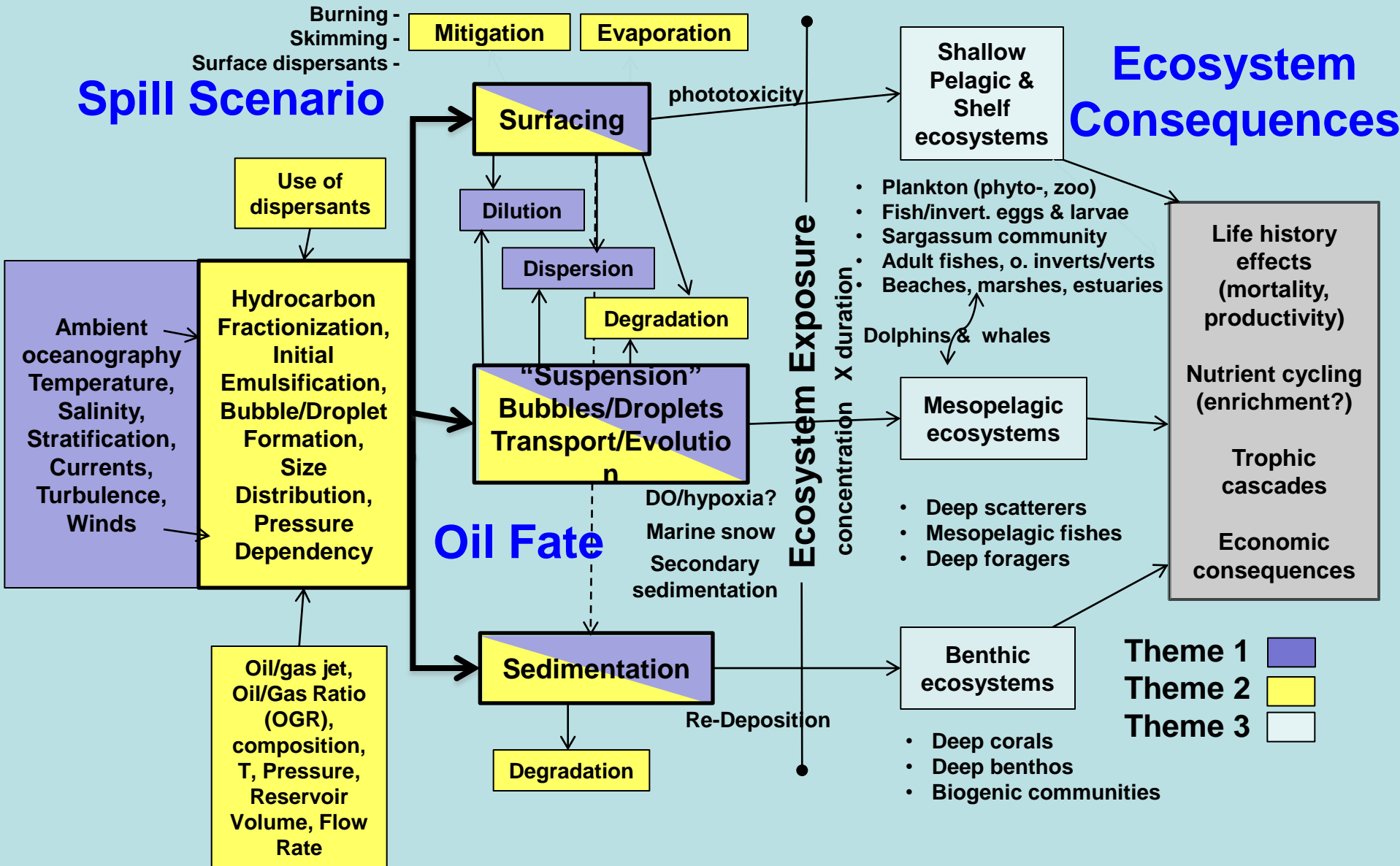


# But it is a 4-D problem



- Model multiphase plume flow
- Coupled to GoM circulation models
- Improve near-field modeling w/better constraints behavior of oil/gas/seawater mixture at high-pressure

# C-IMAGE: Integrated Understanding of Oil Spill Dynamics

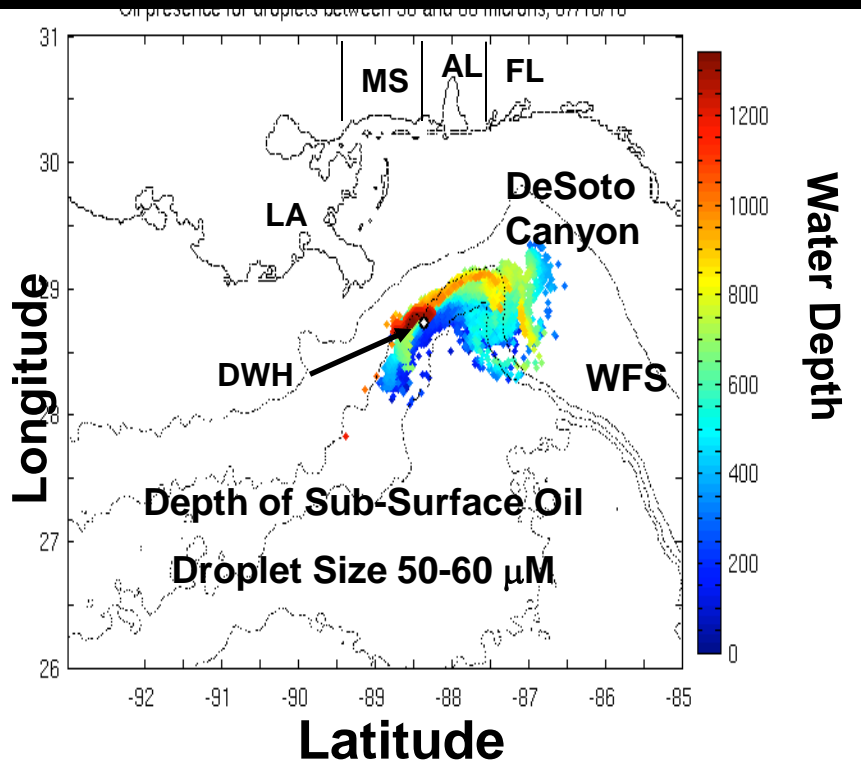




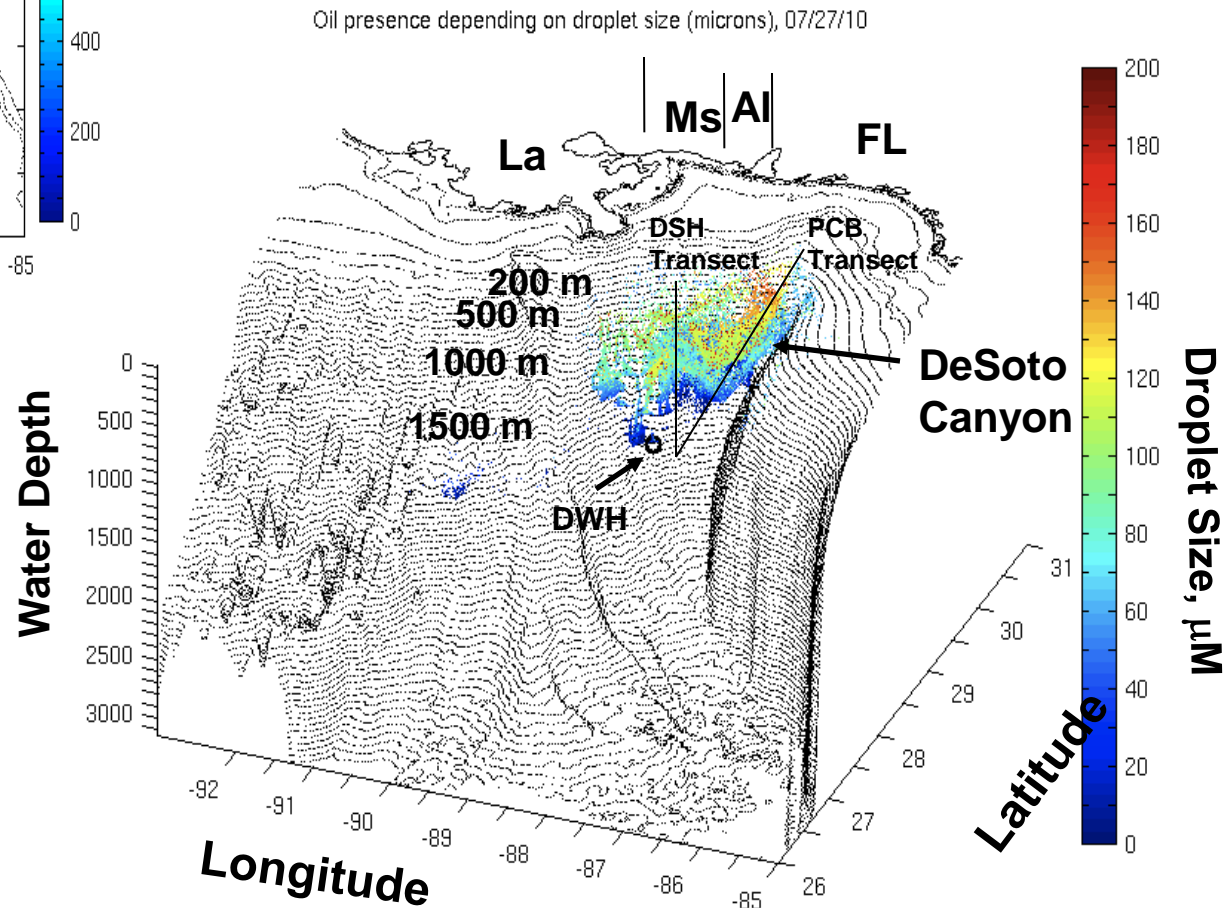
# C-IMAGE Consortium Partners: assembling the world's experts

- **University of South Florida** – *lead, IT, education, various science*
- **Florida Institute of Oceanography** – *Research vessels*
- **Hamburg Technical University** – *High-P lab studies, velocity*
- **Texas A&M University** – *Oil physics and chemistry*
- **University of Calgary** – *HMW environmental exposure, partitioning*
- **Wageningen University & NHL – Netherlands** – *Decision support tool*
- **Eckerd College** - *Benthic stratigraphic studies*
- **University of West Florida** - *Microbial studies*
- **Pennsylvania State University** – *Degrading enzymes,  $^{13}\text{C}$ ,  $^{14}\text{C}$  studies*
- **University of Miami** – *Modeling oil distribution & concentration*
- **University of South Alabama** – *Fish community analyses*
- **Mote Marine Laboratory** - *Biomarkers -vertebrate exposure*
- **Scripps Institution of Oceanography** – *Marine mammals*

# 3-Dimensional Oil Fate and Trajectory Model



- Models suggests oil transport and deposition east of the wellhead in the DeSoto Canyon
- Models are consistent with field observations and chemical analyses

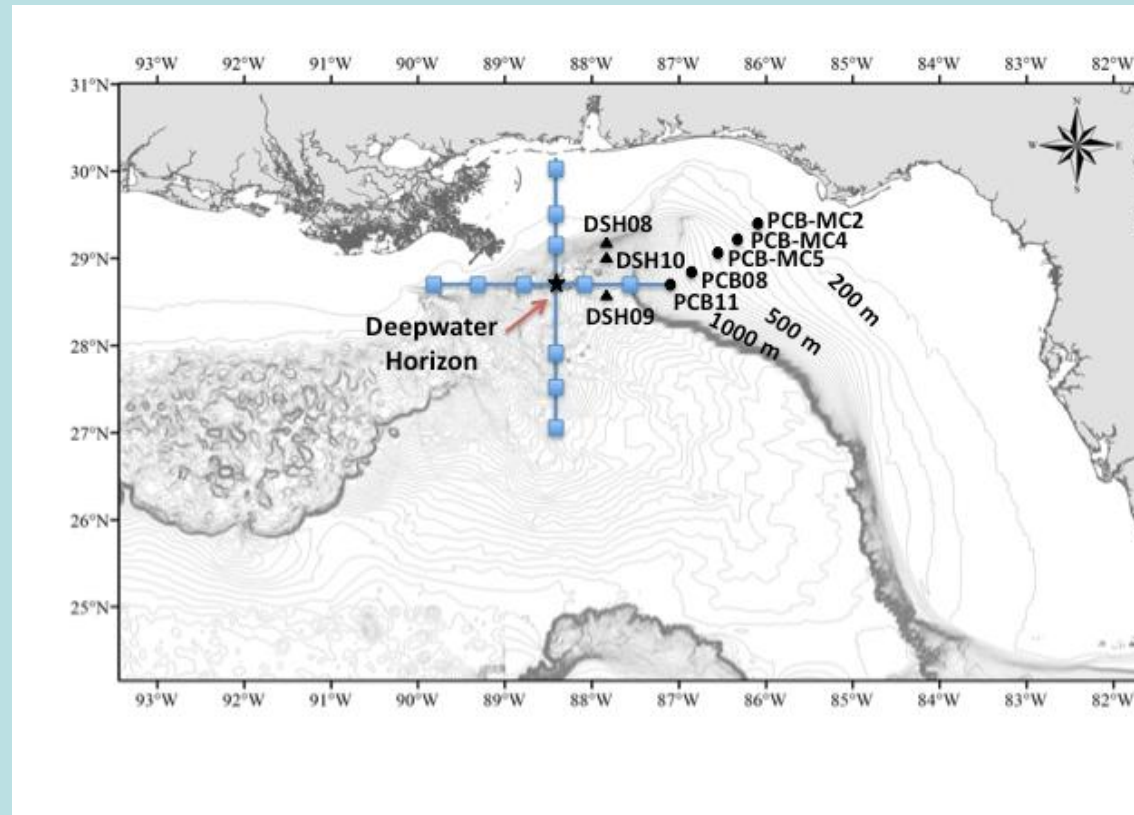


# Where did the oil go?

## Sediment Studies, Northern GoM

Reconstruction of Conditions: Pre- to Post-Blowout  
Oil Deposition and Microbial Degradations

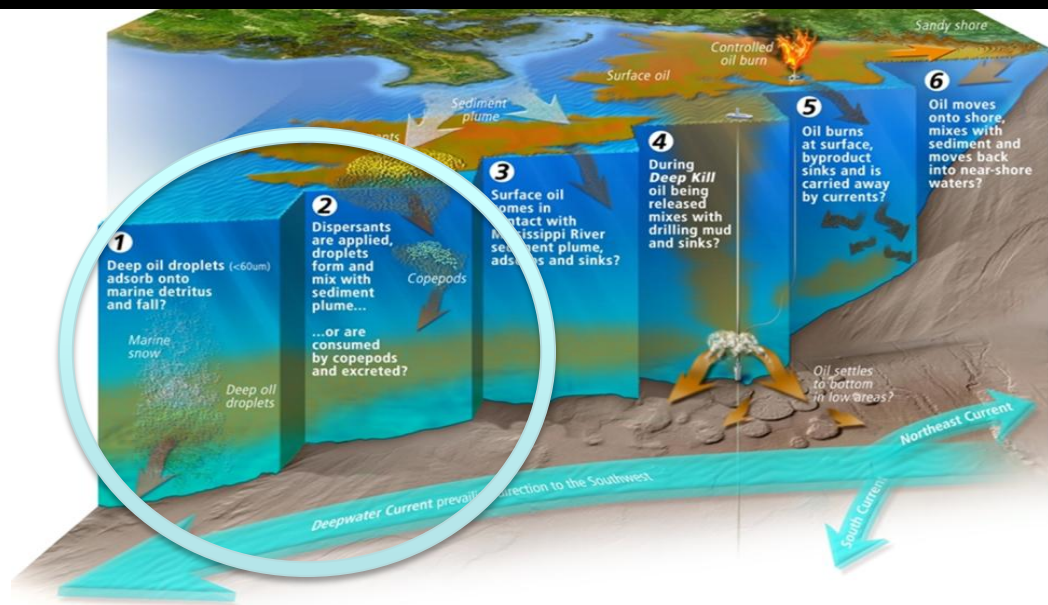
- Validation of far-field oil fate and transport models
- Testing hypotheses of oil-sediment deposition
- Short-lived radioisotope
- Microbial degradation of oil
- Metal composition
- Microbial community structure
- Novel analytical approach to analysis and oil fingerprinting



(Hollander & Flower- U. South Florida, Freeman & Macallady- Penn State, Brooks & Hastings- Eckerd College , Oldenburg & Larter U. Calgary)

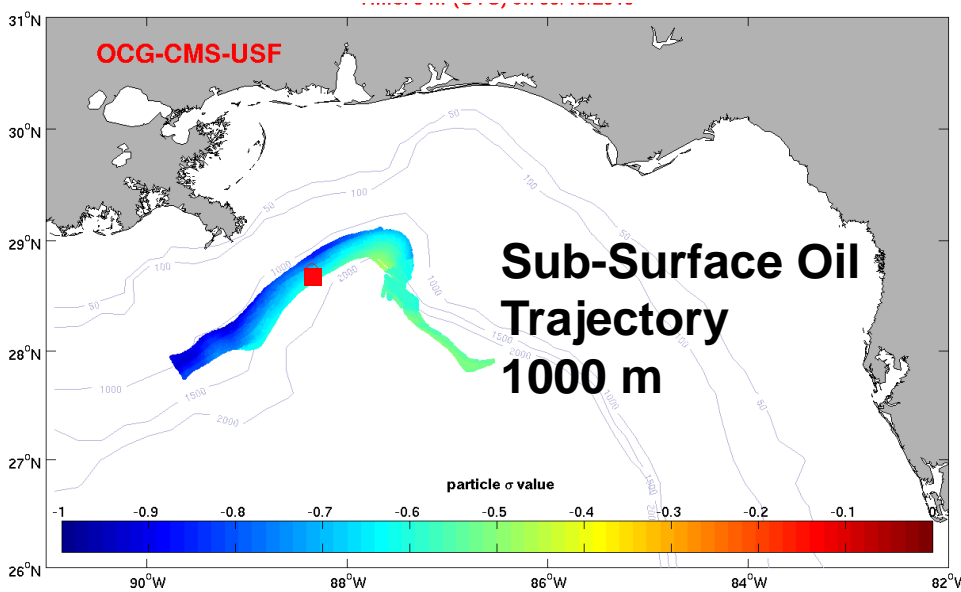
# Next... Assessing Ecosystem Impacts in Sediments

## How can oil get to the sediments?



### “The Flocculent Blizzard Hypothesis”

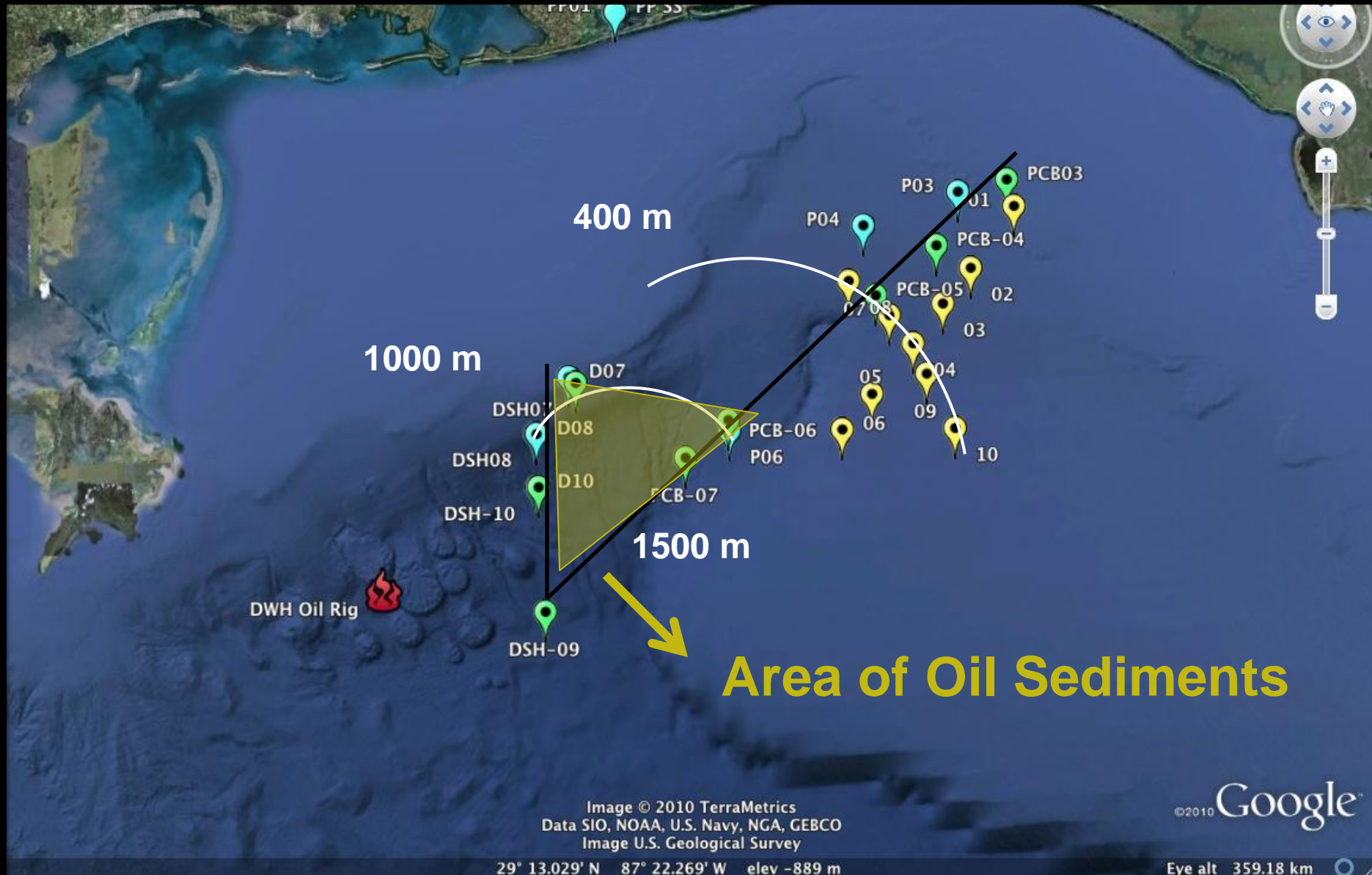
- Aggregation-flocculation of hydrocarbon particles with biological and lithogenic particles increases sedimentation,
- Suffocates Organisms



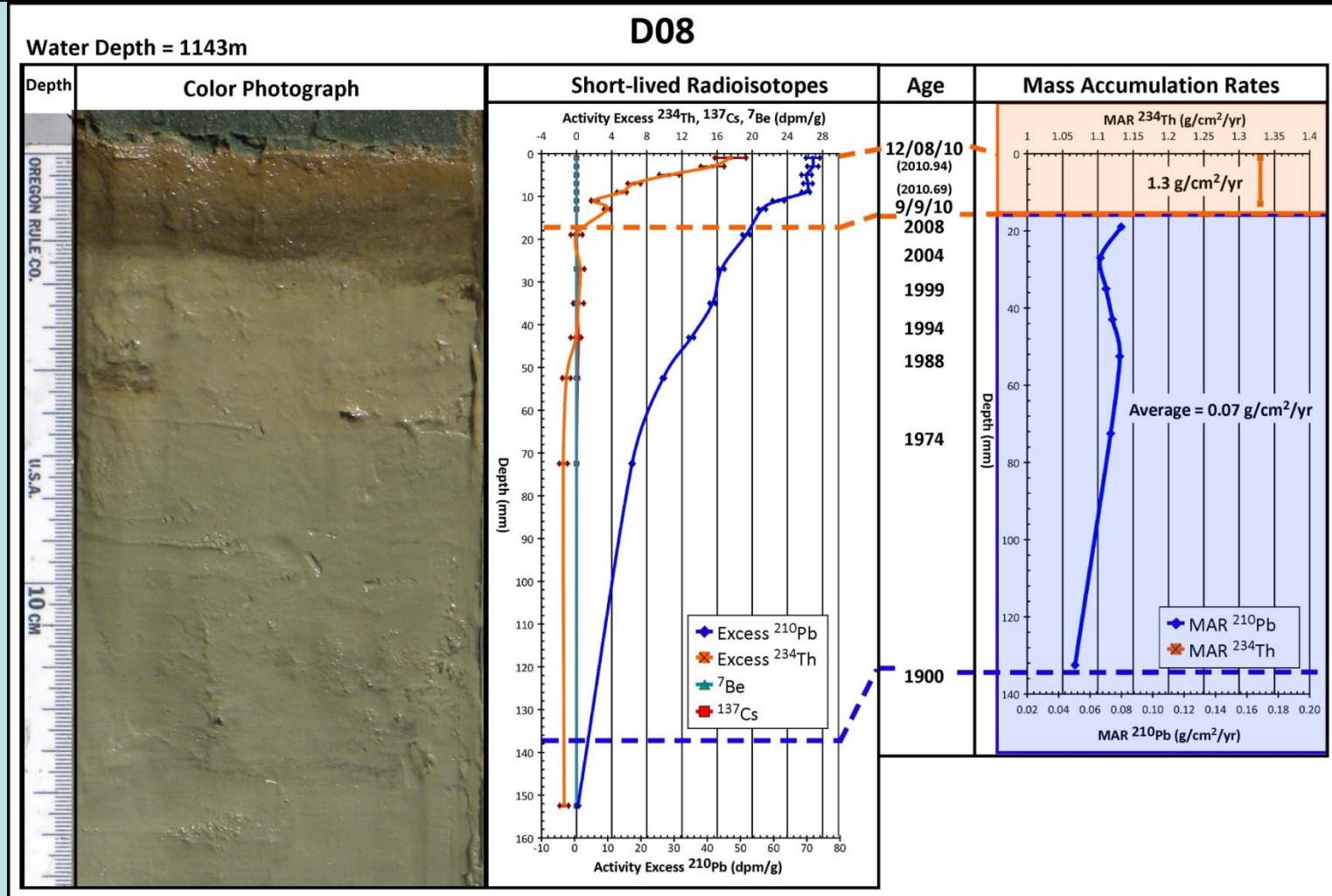
### “The Toxic Bathtub Ring Hypothesis”

- Sub-surface oil is moving along bathymetric contours and impinging on the sediment surface,
- Lethal & sub-lethal effects

# Toxic Bathtub Ring Hypothesis: December 2010 Sediment Coring Sites



# Event Stratigraphy and Short-lived Radioisotope Geochronology (Brooks and Larson, Eckerd College)



- Short-lived radioisotope <sup>234</sup>Th has a half-life of 22.4 days & activity for 120 days
- 100-fold increases in sedimentation rates: Pre-blowout (0.07 g/cm<sup>2</sup>/yr) versus post-blowout (1.3 g/cm<sup>2</sup>/yr)
- X-radiographs, sedimentology & grain size all indicate event & no bioturbation

# Effect on benthic biota: DSH-10 core top



*Cibicidoides wuellerstorfi* (normal)  
Brown and Flower, preliminary data



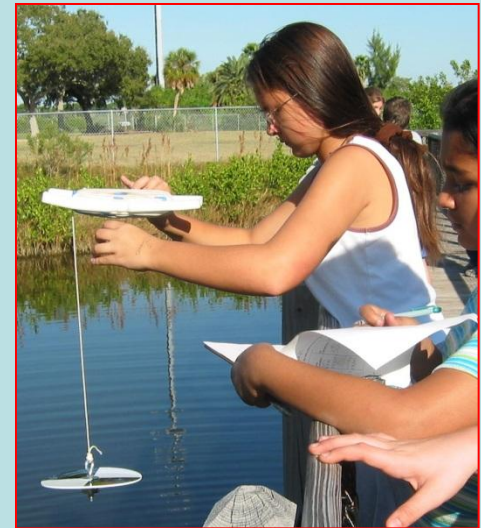
*Cibicidoides wuellerstorfi* (deformed)  
• 8 of 42 specimens deformed  
(hydrocarbon impact?)

# C-IMAGE Consortium Education & Outreach

## *Formal Education: Engaging teachers & students*

- **PD of living resources coastal & deep waters**
  - GLOBE environmental monitoring (Y1-2)
  - SENSE IT water sensor development (Y2-3)
- **Teachers At Sea in GOM (Y1-3)**
  - Blogs, teaching modules, new science
- **K-12 Students as citizen scientists (Y1-3)**
  - hydrology, atmosphere & soil measurements
- **PD for Scientists: Research & Storytelling (Y1)**

*Anticipated impact 4,500 teachers & students*



College of Marine Science

8/16/2012

**USF**  
UNIVERSITY OF  
SOUTH FLORIDA



## *Informal Education: Engaging citizens & scientists*

- **Public Media via WUSF (Years 1-3)**
  - Radio segments & Podcasts
  - Audio Slideshows for website & exhibits
- **Science Cafes (Years 1-3)**
  - Scientists explain research @ sea & in labs
- **Aquaria Exhibit: Secrets of Sea Mystery Station**
  - living resources, data integration, track R/V (Y3)



**Teresa Greely ->**

*Anticipated 500,000 listeners & visitors*

# Major Scientific Questions?

- **If a similar accident happened today (Cuba drilling??) would we be better equipped to advise government decision makers & the public?**
- **What are the processes at work that result in the observed phenomena that were revealed over the course of the spill (e.g., sub-surface plumes, grounded oil, transport dynamics, disease frequency in fishes, increased primary productivity in the vicinity of the surface oil?)**
- **How can science aid the recovery of the Gulf from the effects of the spill and in a broader context help make it more resilient to multiple threats? (its not just about the oil.....)**

# A Survey of Gulf of Mexico Reef Fishes to Determine Disease Frequency

Steve Murawski PI, Ernst Peebles, Bill Hogarth

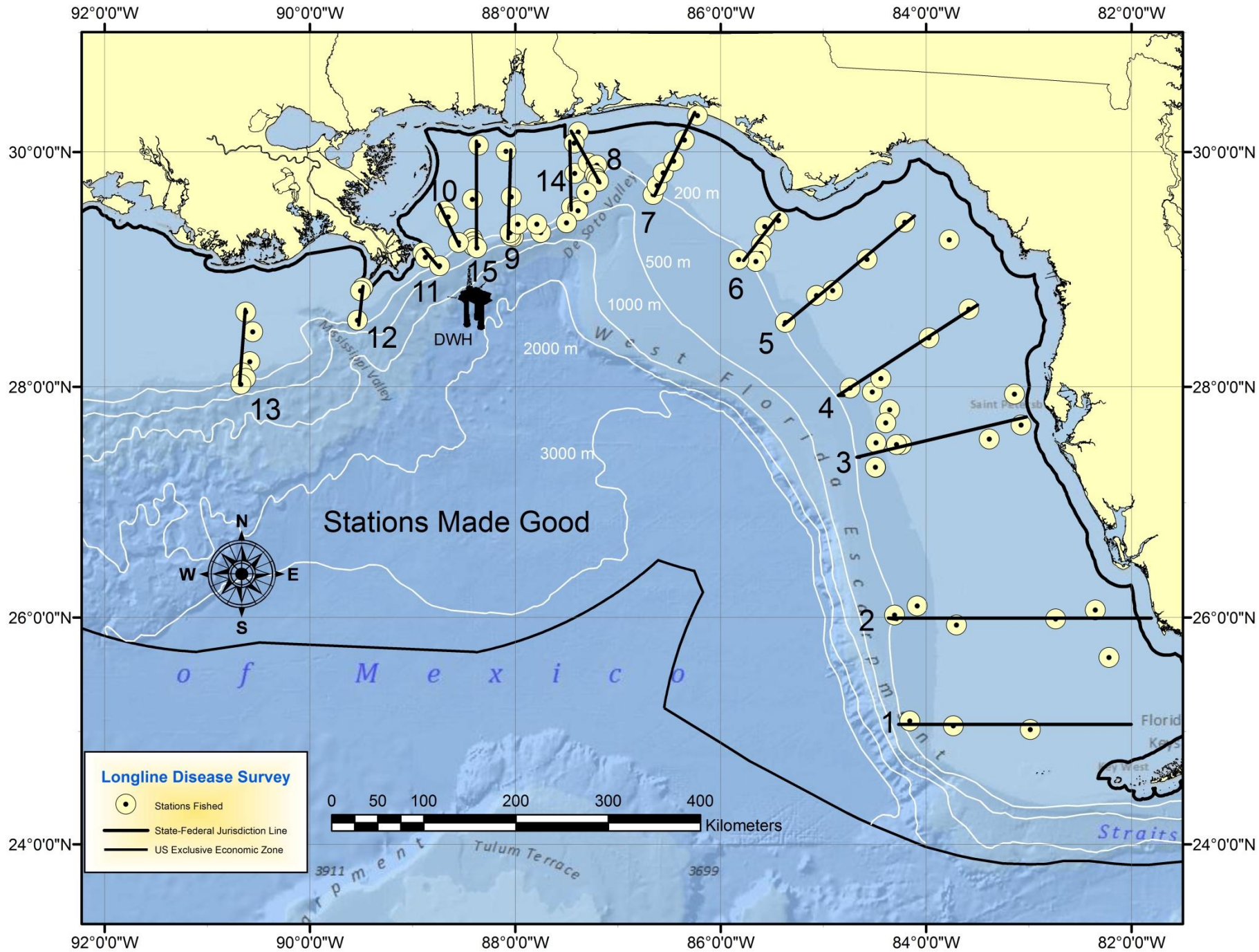
## Objectives

- (1) Conduct a broad-scale survey from the Florida Keys to Central Louisiana to determine the frequency of abnormal looking reef fishes, with emphasis on ulcers, fin rot and other external lesions
- (2) Compare the frequency of disease types across target species, by region and by depth
- (3) Determine the “background” level of disease incidence by surveying broadly in the Gulf
- (4) Provide data on the age, length, weight and internal organ weights of fishes sampled to determine fish condition
- (5) Provide fish samples for a broad array of laboratory testing including pathology

**Partners: University of South Florida, College of Marine Science, National Marine Fisheries Service (NMFS), Florida Wildlife Research Institute (FWRI), Commercial fishing industry**



**F/V PISCES**  
**Panama City, Florida**  
**Capt. John Anderson**  
**St. Andrews Marina**

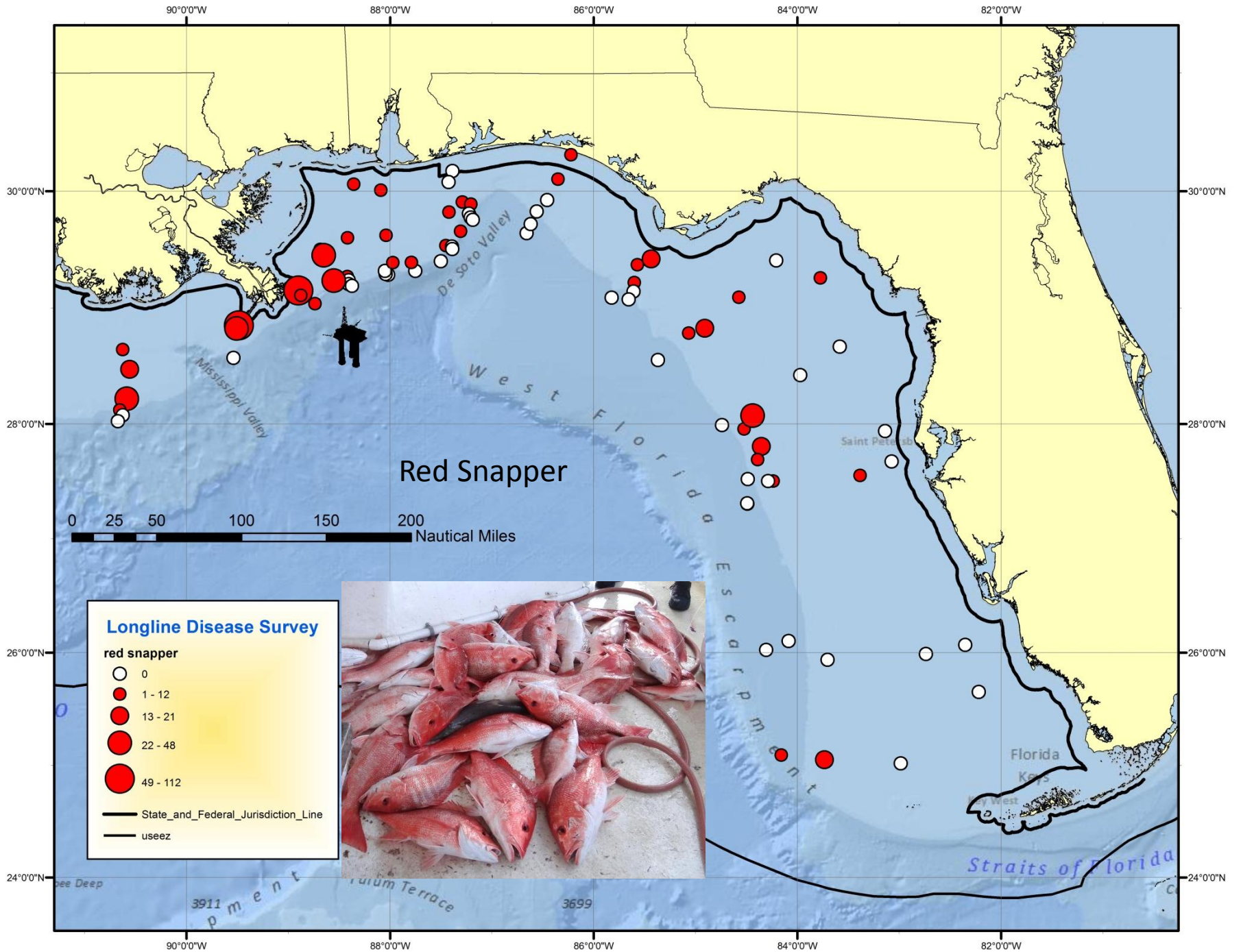




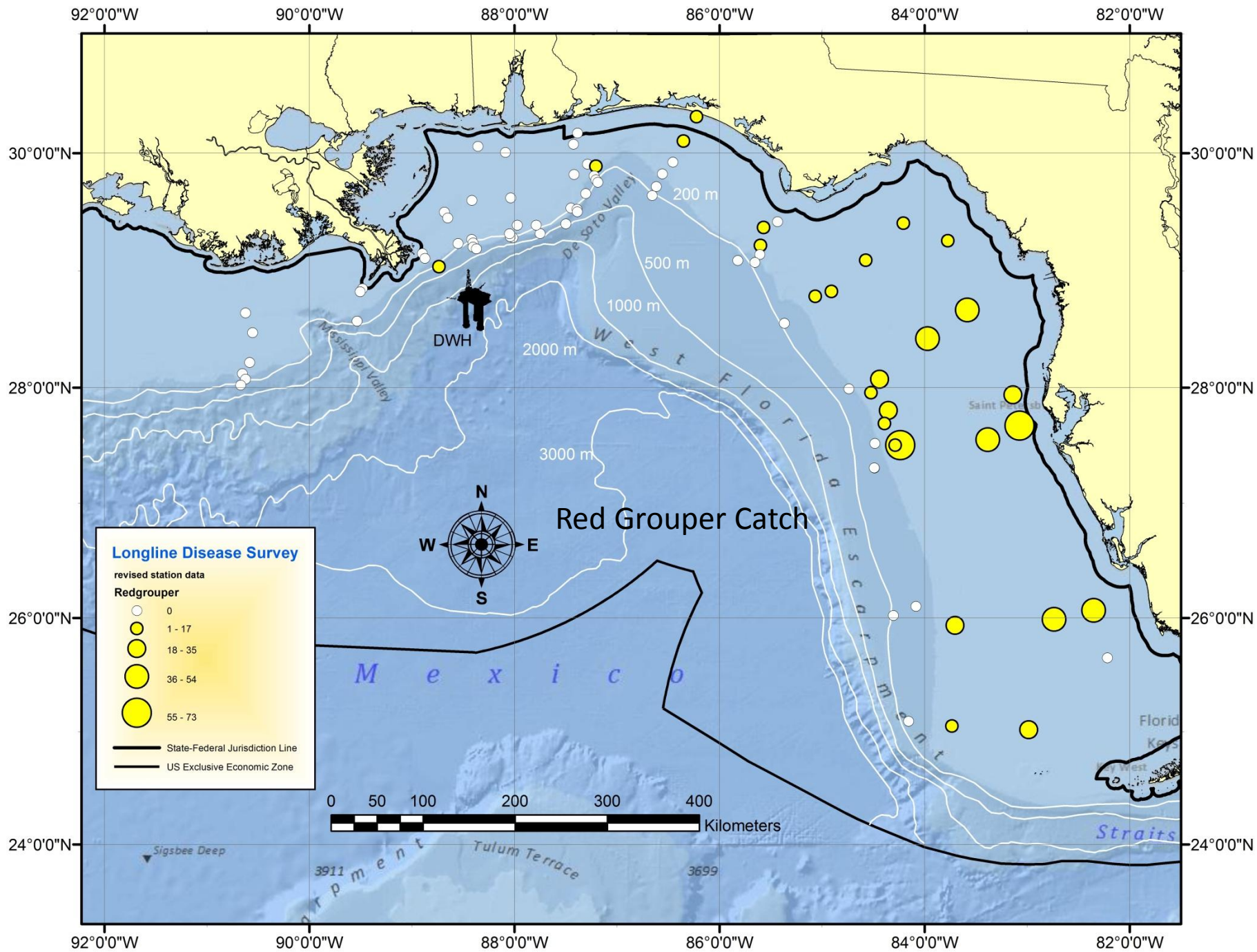
**Sampling fishes using commercial fishing gears**

# A quick autopsy.... (necropsy)



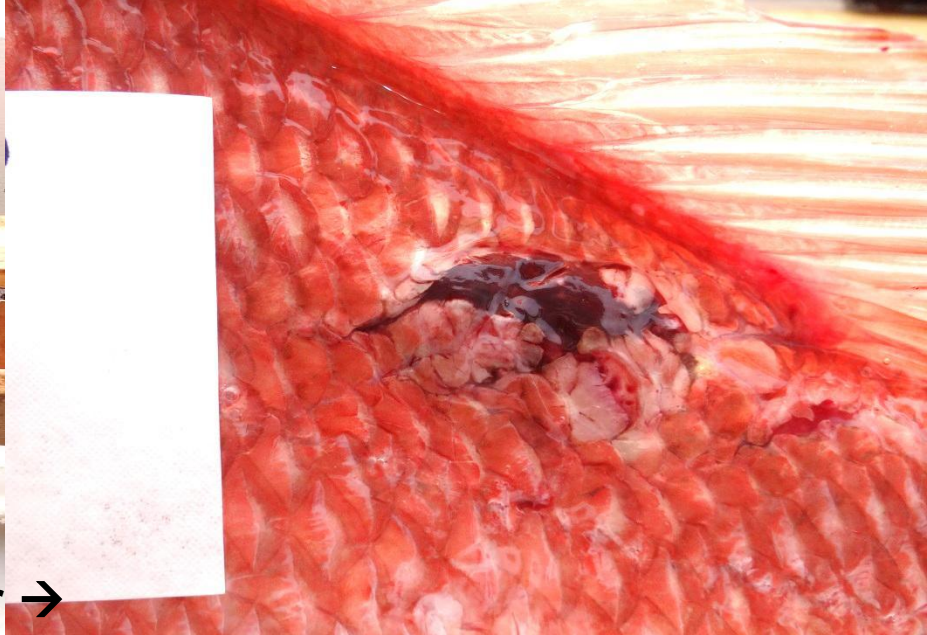








**Skin Ulcers on Red Snapper →**



**Conger eel**



**tilefish**



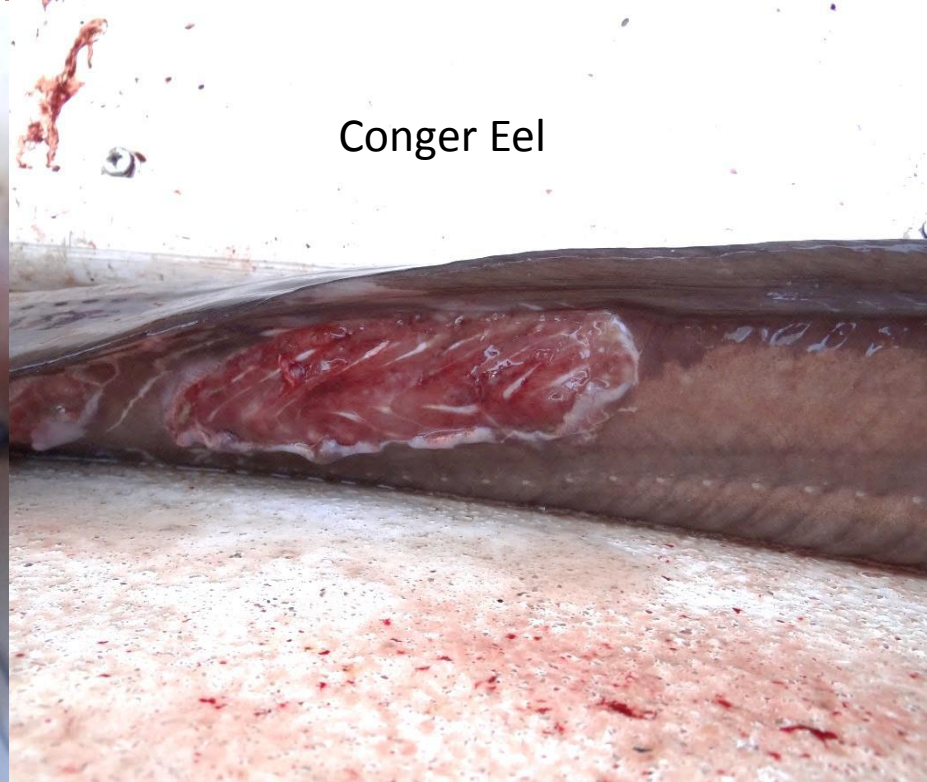
**Southern hake**

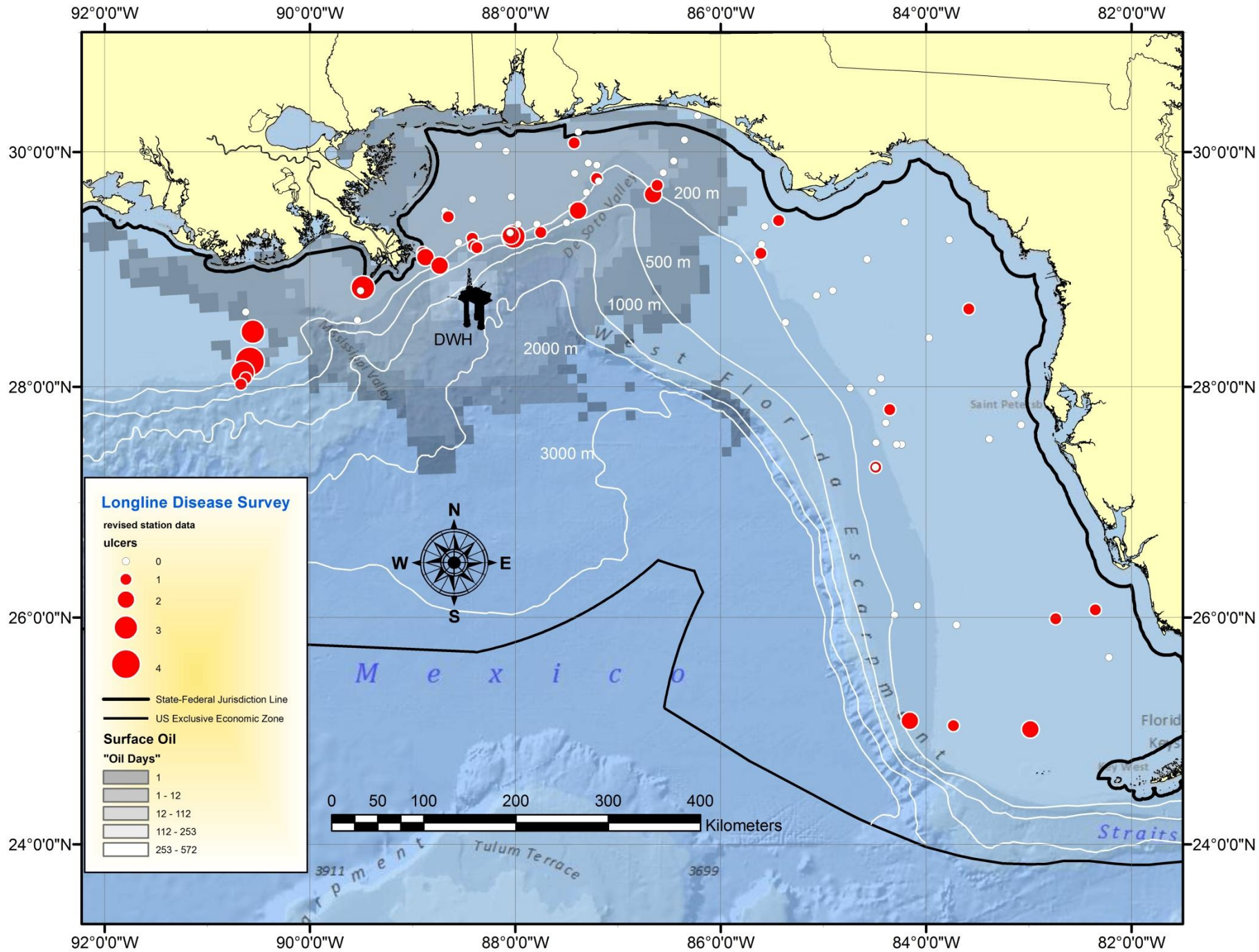


Southern Hake



Conger Eel





## **2011 surveys complete**

### **Fish diseases surveyed:**

**External skin ulcers (lesions)**

**Didymozoid digenean parasites in gills**

**Intestinal parasites**

**Fin rot high of the Florida Coast (likely not spill-related)**

**Disease more frequent near oil spill**

**Levels of three PAHs in bile samples similar to polluted urban estuaries**

## **Work in progress**

**Histology of all tissue from leasoned fish & liver histology from diseased and healthy fish**

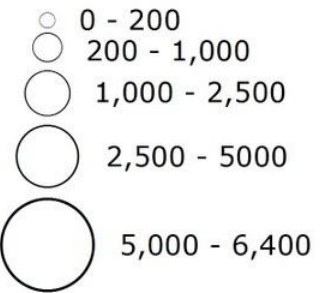
**Trace metals (V & Ni) in otoliths**

**Analysis of PAHs in flesh, bile, livers**

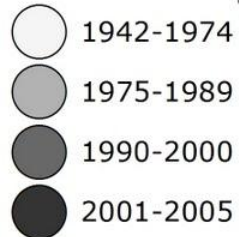
**More surveys in 2012 to see if diseases declining**

**Deeper and farther west than previous surveys**

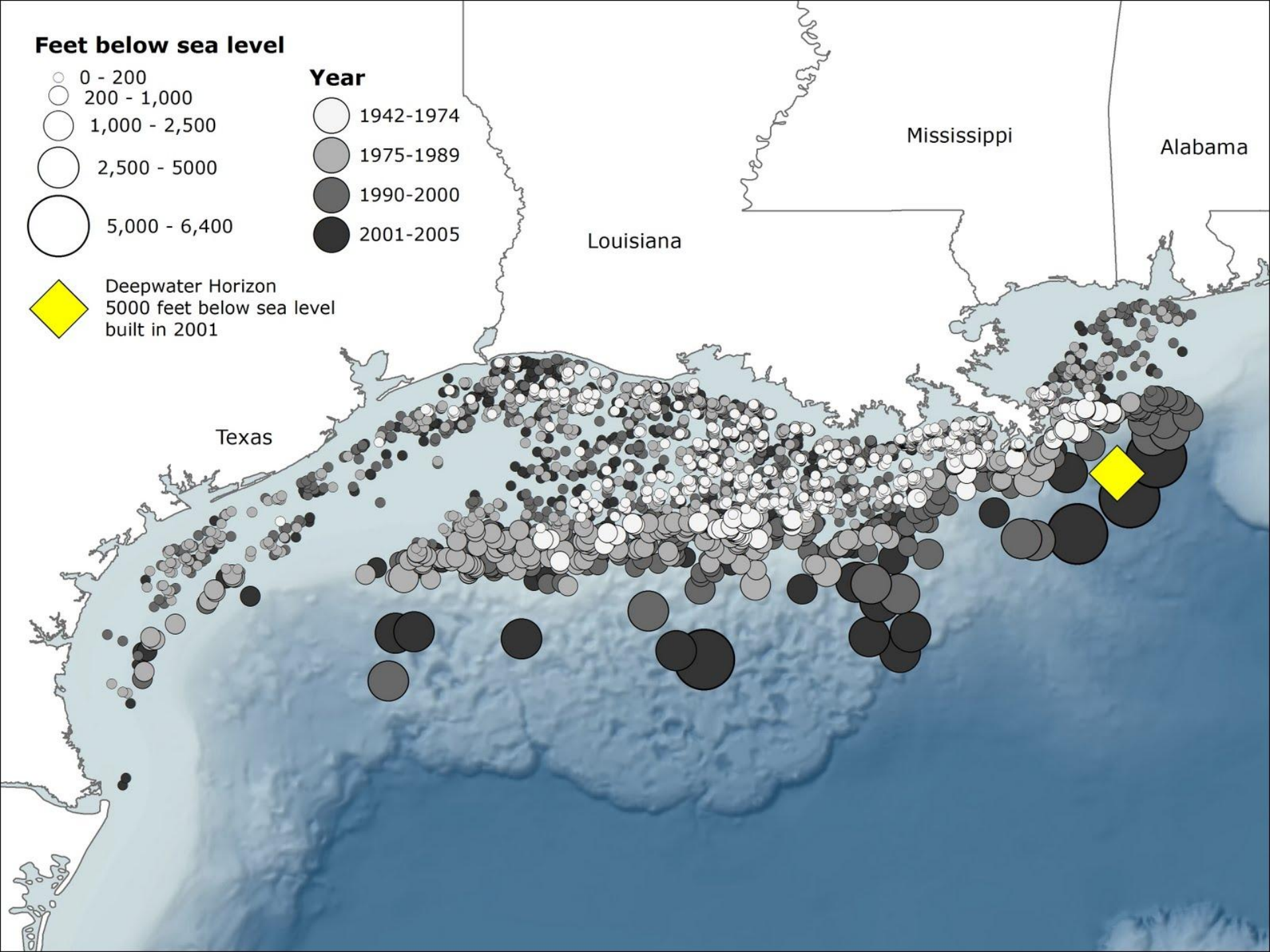
### Feet below sea level



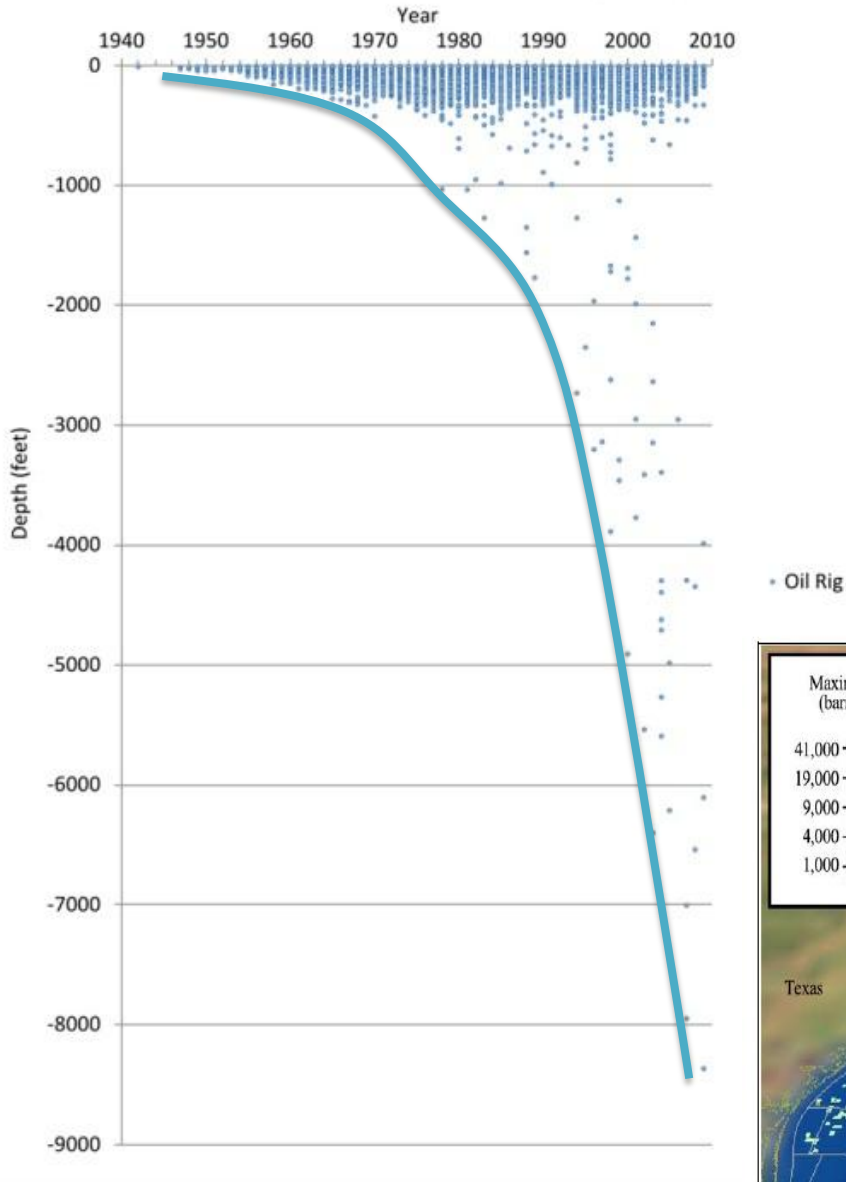
### Year



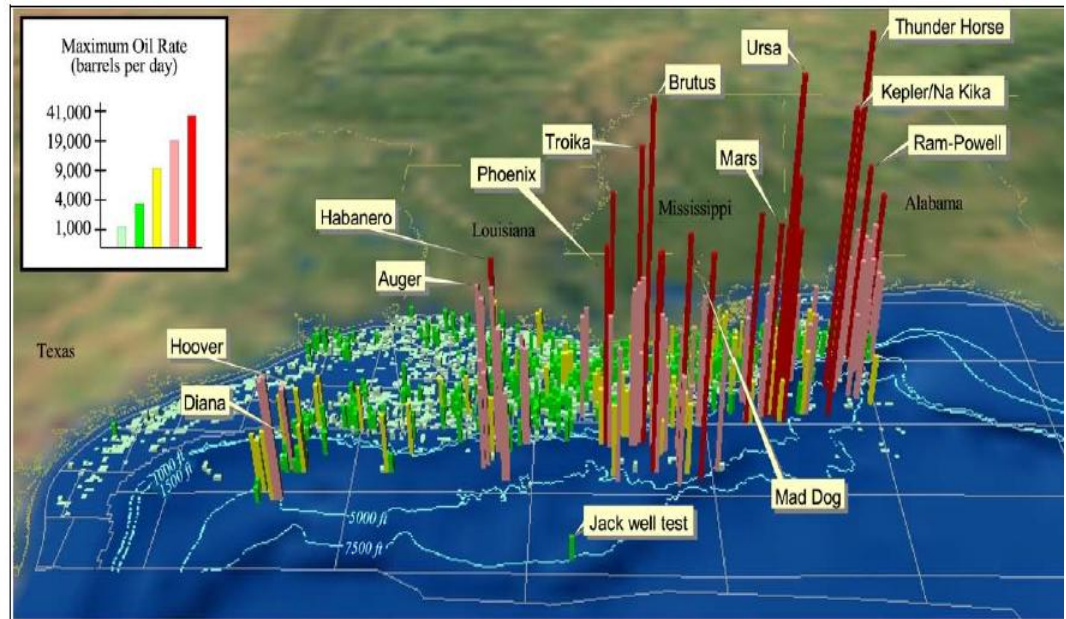
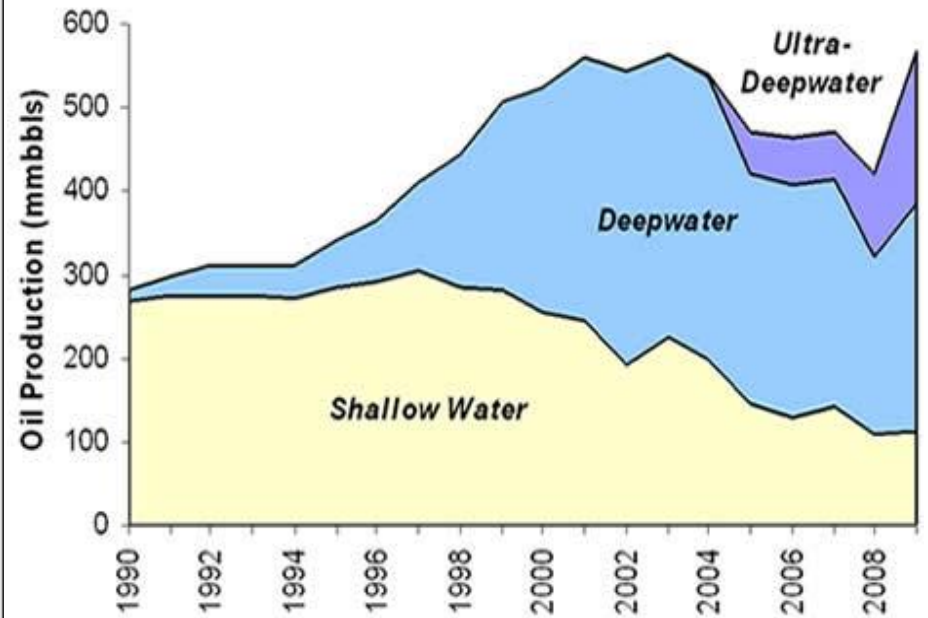
Deepwater Horizon  
5000 feet below sea level  
built in 2001



**Gulf of Mexico Oil Rig Installation Depths by Year**



**Figure 2. Gulf of Mexico Federal Offshore Oil Production**

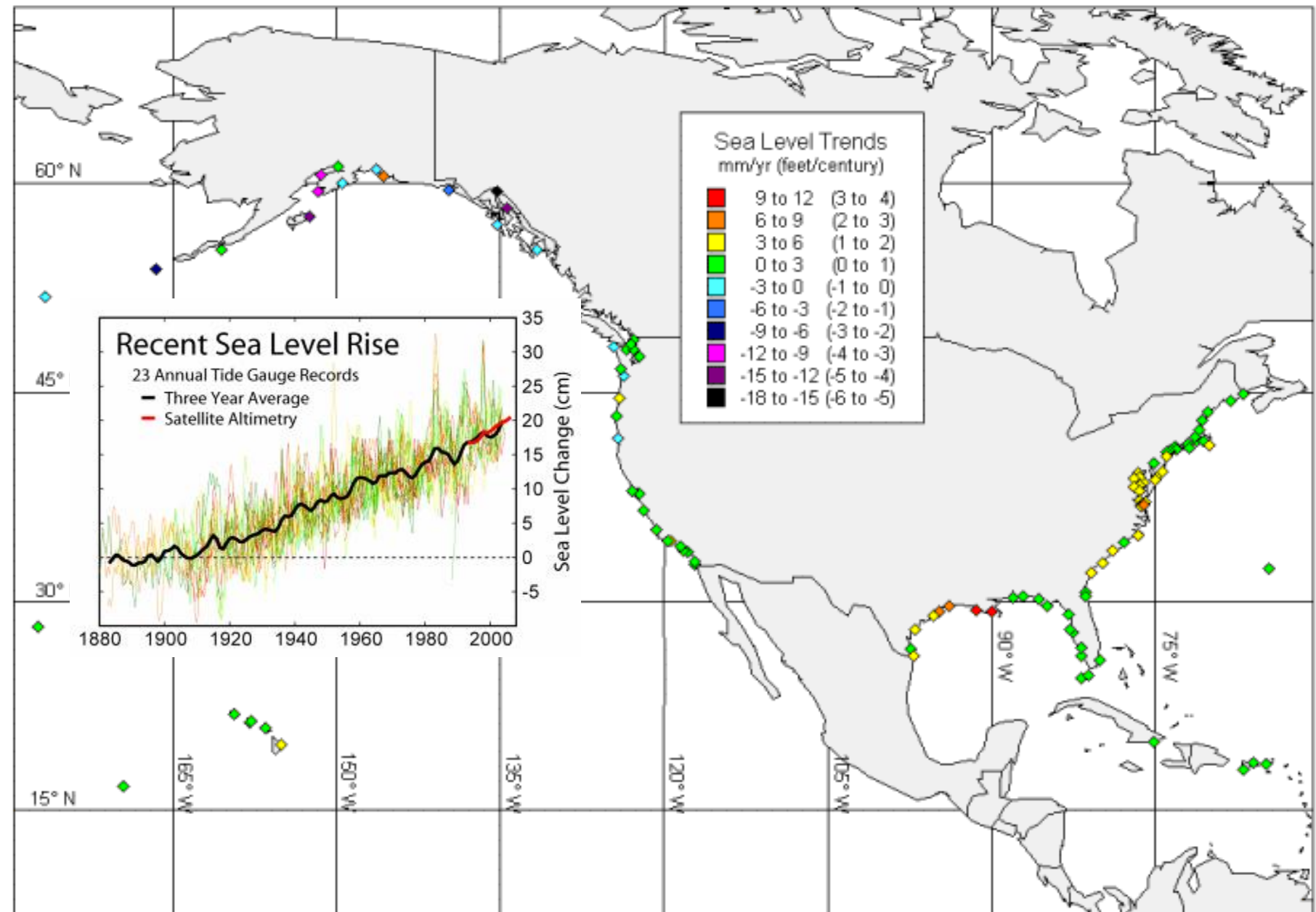


- **Mexican Drilling in DW**
- **Cuban Drilling in DW**
- **Push to open up the Eastern Gulf and North Atlantic**





# Trends in Sea Level Rise & Resource Impacts



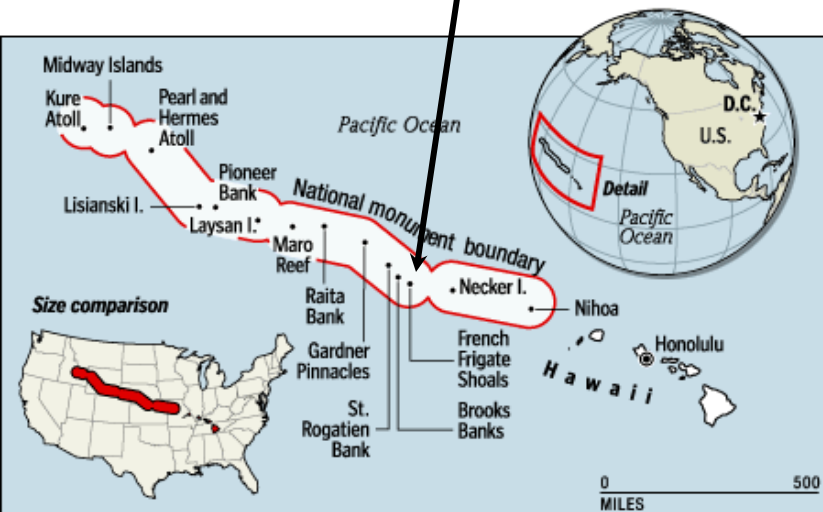
# SLR Example: How will Protected Species critical habitats change with SLR in the NWHI Monument?

## Example Whaleskate Island French Frigate Shoals, NWHI

- Once an important nesting island for Hawaiian green sea turtles and a primary pupping site for endangered Hawaiian monk seals
- Few feet above sea level; what would be the impacts of observed rates of SLR on Protected Species breeding and nesting habitat?
- 2006 study published by scientists in the journal Biological Conservation (Baker et al. 2006)



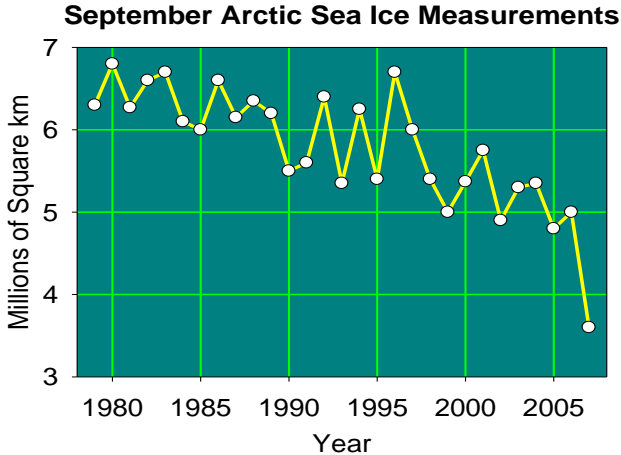
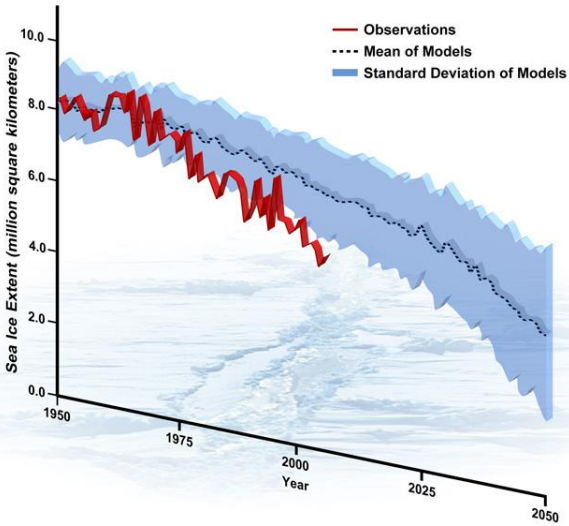
1963



# Loss of Arctic Sea Ice – Ecological Implications for Society



Arctic September Sea Ice Extent: Observations and Model Runs



Trust Resources  
MMPA + ESA



Petition  
To List



Ringed, Ribbon,  
Spotted, Bearded  
Seals

+Arctic FMP

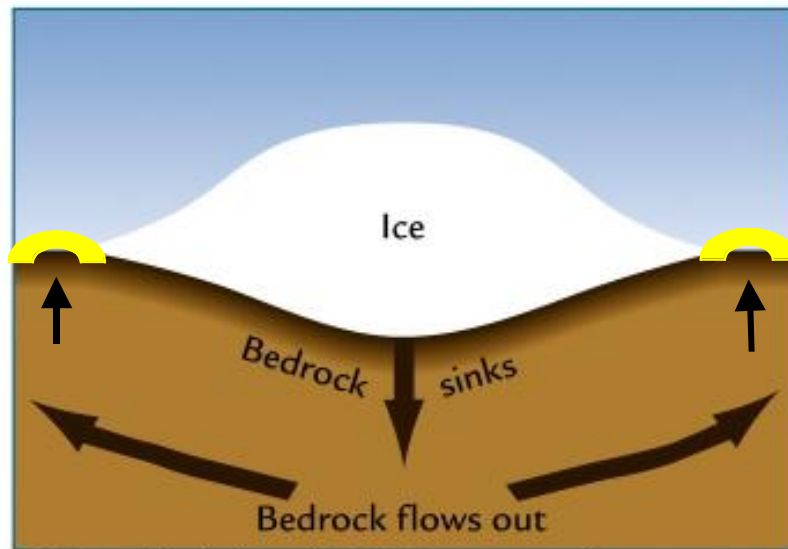
***Research  
Highlights:  
Global  
Issues***

- Greenland Ice Sheet Melting  
Don Chambers (CMS) & Tim Dixon  
(Geology)
  - Rate of melting is major uncertainty in global mean sea level rise models
  - Measured using GRACE and GPS
  - 15-30% mass loss over last decade
  - Rate has doubled in last 5 years
  - Will be major contributor to global sea level rise in next decade

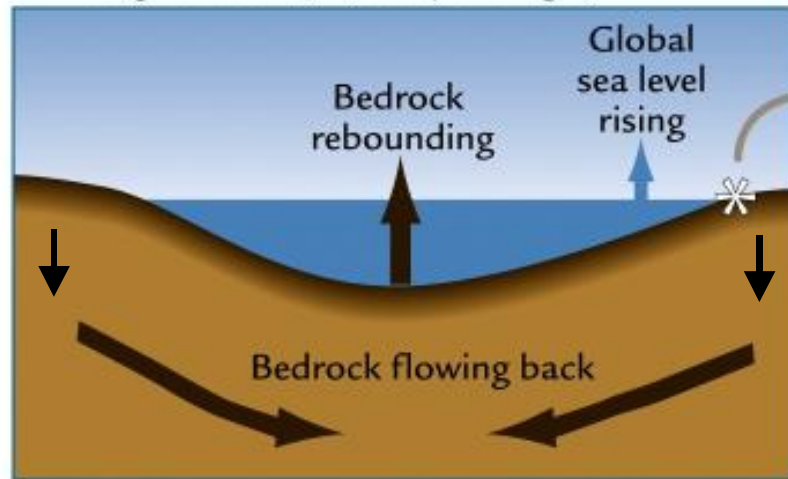
# GPS as a Tool for Monitoring Greenland

- Restricted to rocky coast (where loss is concentrated)
- Other studies indicate interior in approximate mass balance (outflow to edges balanced by new snow)
- Need to deal with Glacial Isostatic Adjustment (GIA)
- Most GIA models predict that Greenland is subsiding due to peripheral bulge collapse from Laurentide glaciation

# What is a Peripheral Bulge? Why does it collapse?



A Last glaciation (21,000 years ago)



B Today

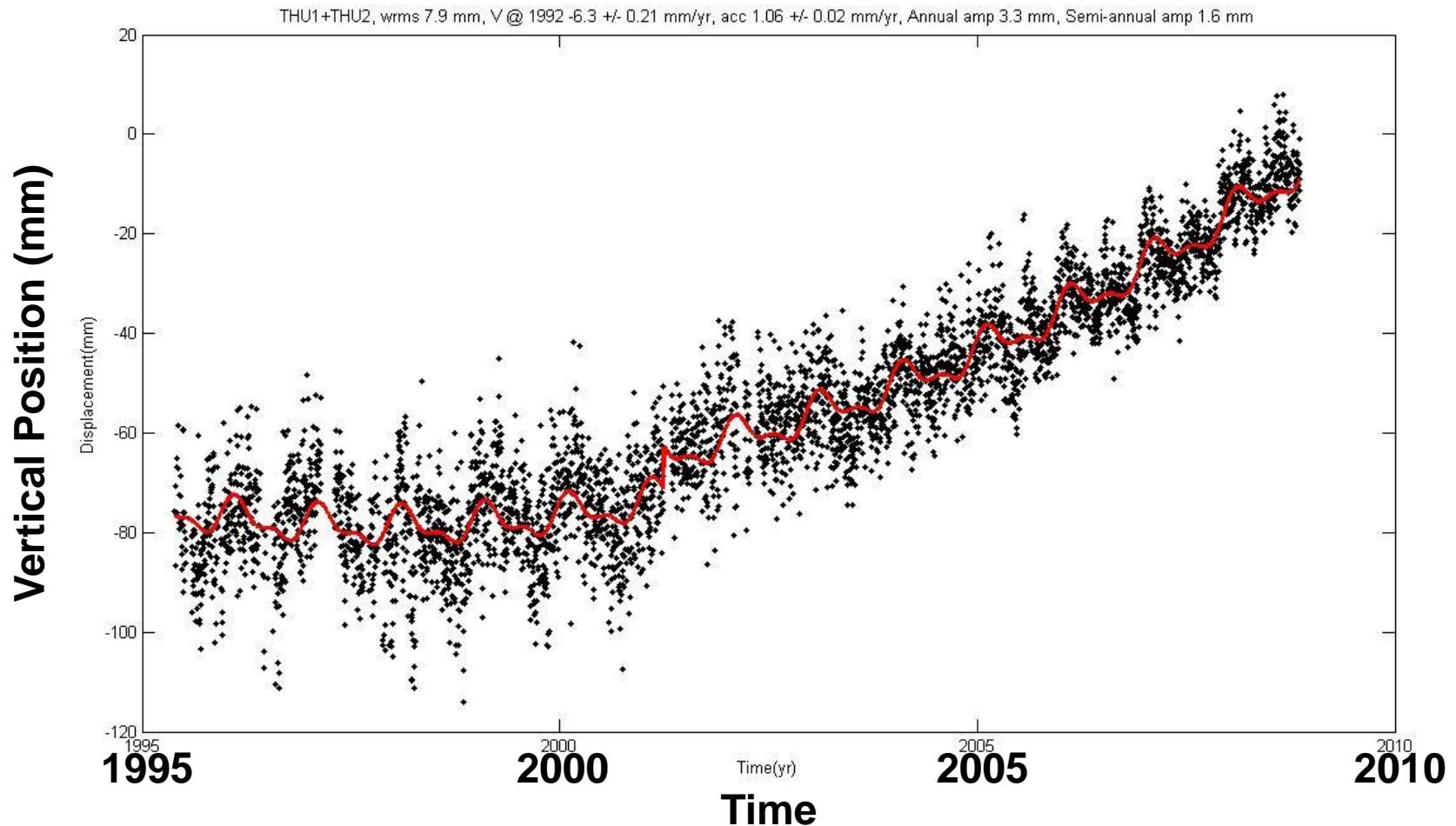
Glacier loads continent, depressing land beneath, but lifting side areas

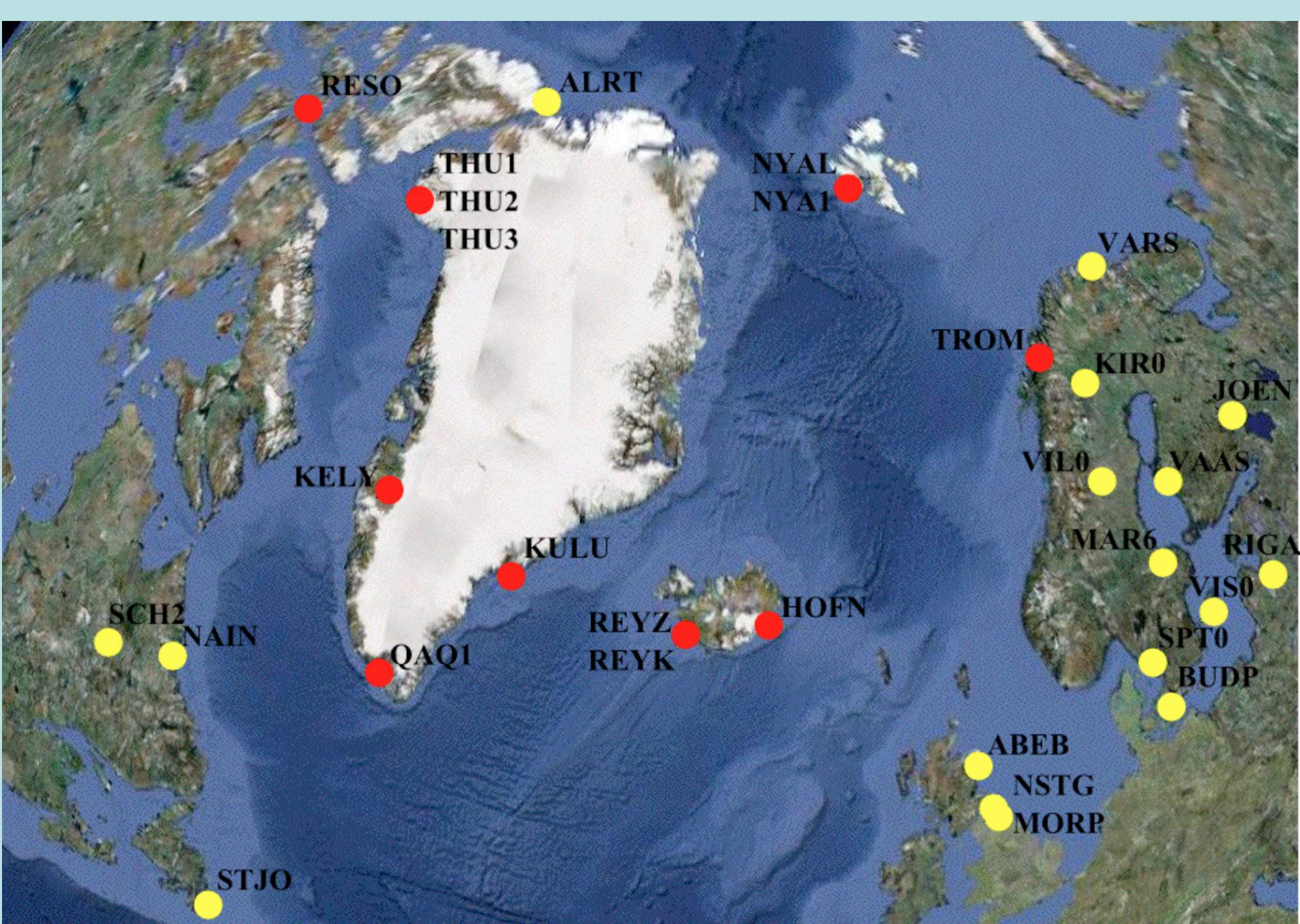
When glacier melts, land beneath rebounds, side areas subside

➤ Hinge line, separating rising ground north of about 43° latitude, from subsiding areas

**Rate of rebound sensitive to viscosity of mantle**

# GPS Position Time Series: All Greenland sites show upward acceleration





RESO

ALRT

THU1

THU2

THU3

NYAL

NYA1

VARS

TROM

KIR0

JOEN

KELY

KULU

VIL0

VAAS

MAR6

RIGA

SCH2

NAIN

REYZ

REYK

HOFN

VIS0

SPT0

BUDP

QAQ1

ABEB

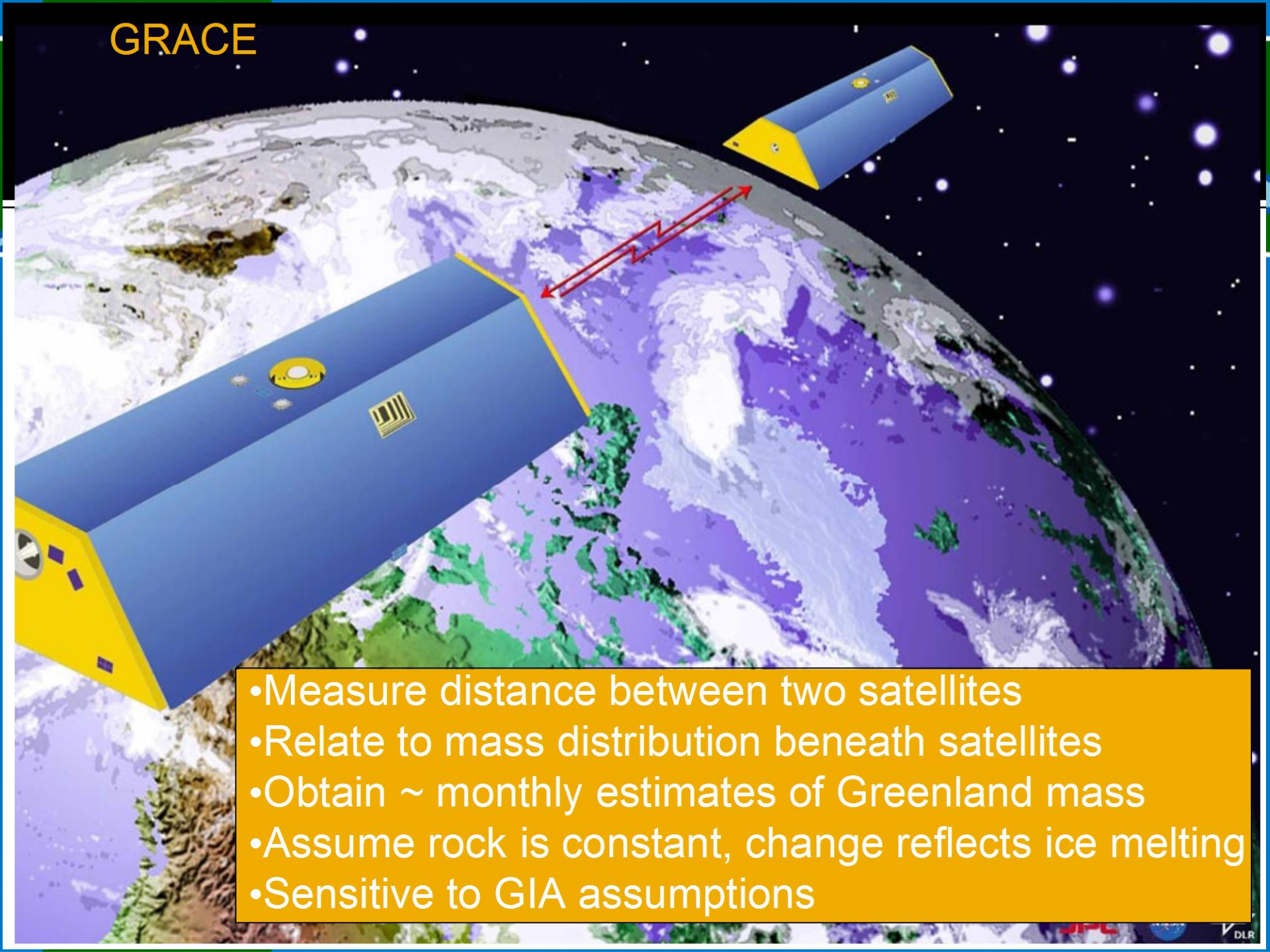
NSTG

MORP

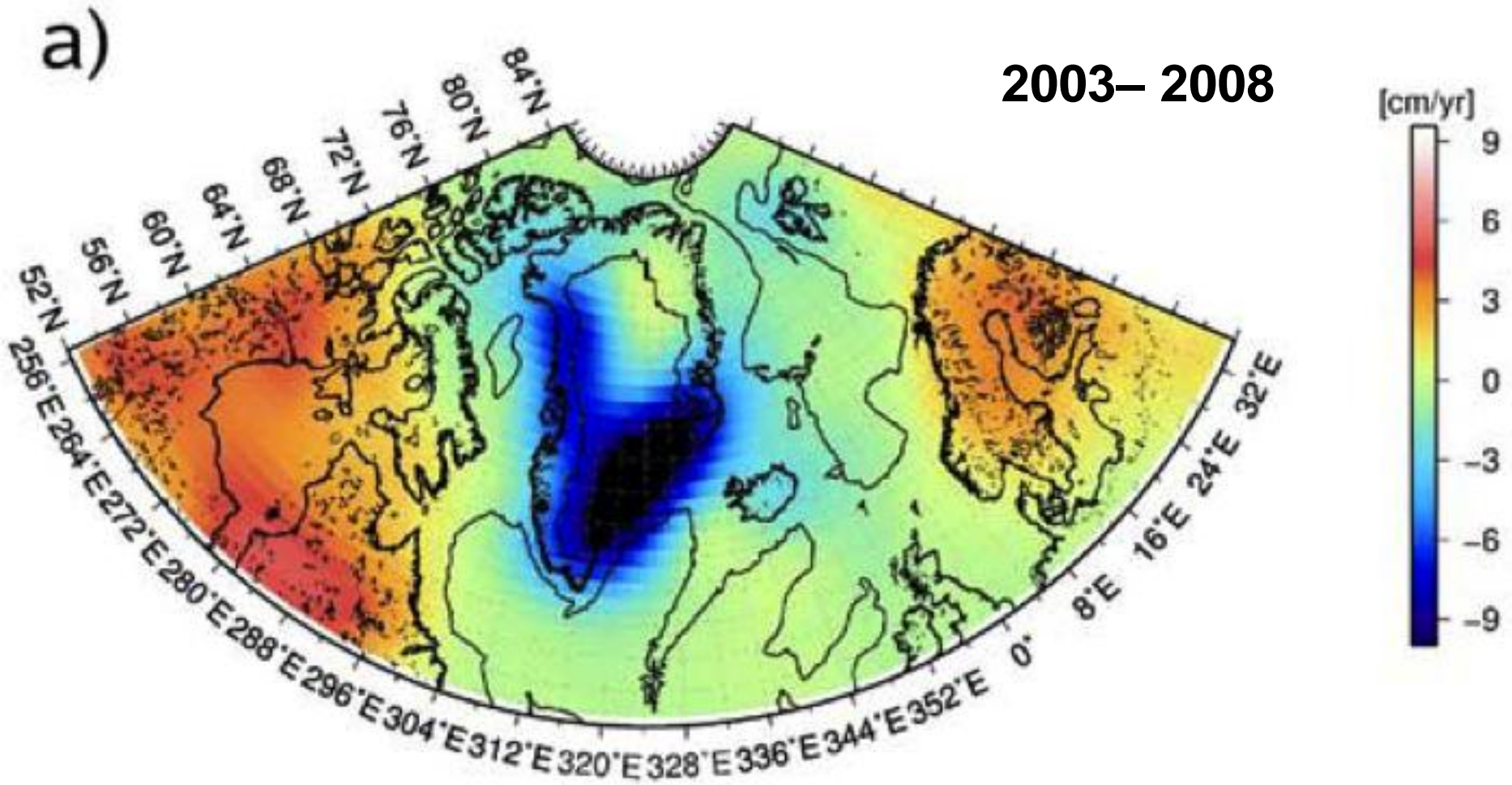
STJO



# GRACE

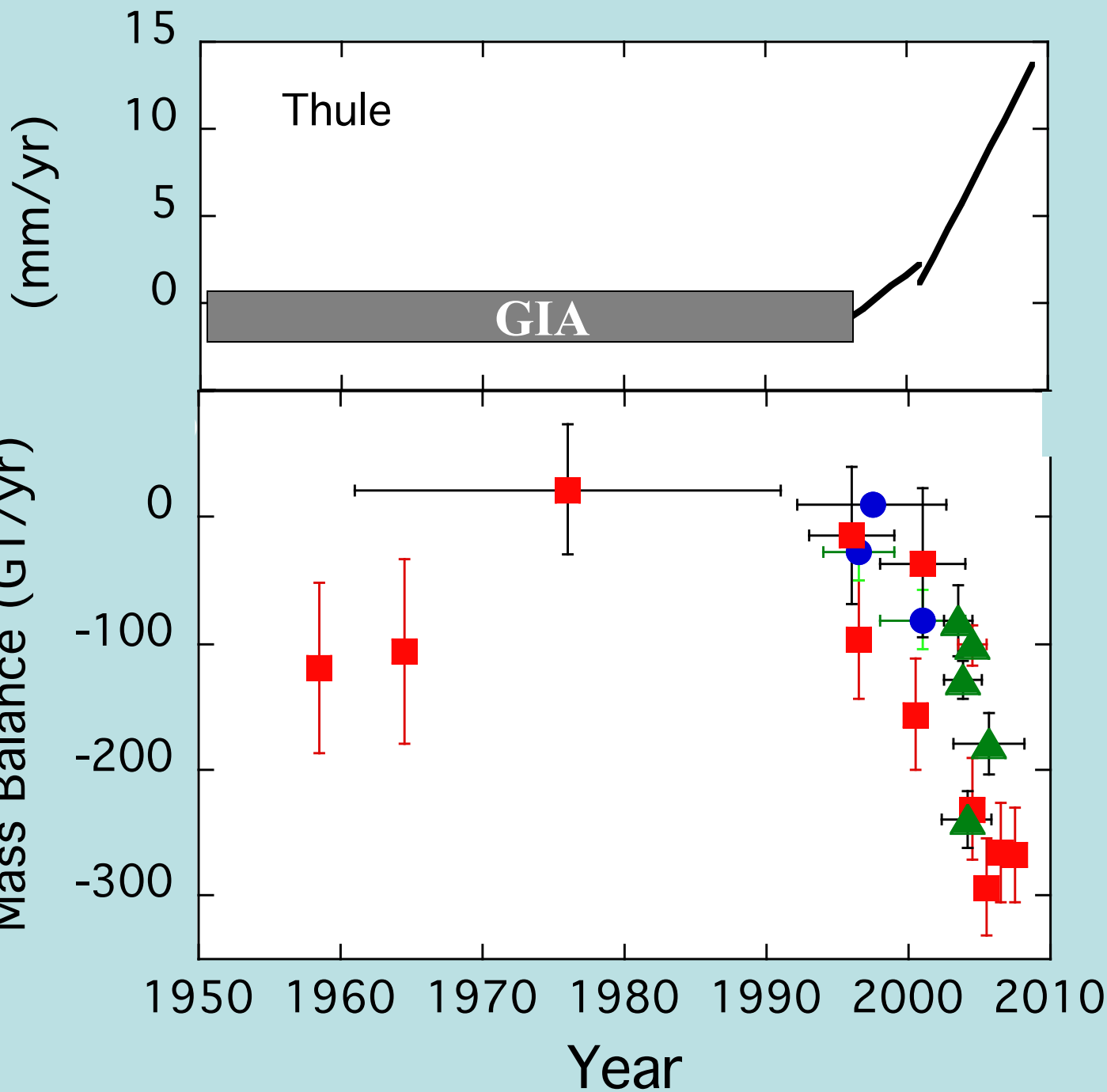
- 
- Measure distance between two satellites
  - Relate to mass distribution beneath satellites
  - Obtain ~ monthly estimates of Greenland mass
  - Assume rock is constant, change reflects ice melting
  - Sensitive to GIA assumptions

# Significant mass loss concentrated in coastal areas



Wouters et al (2008)

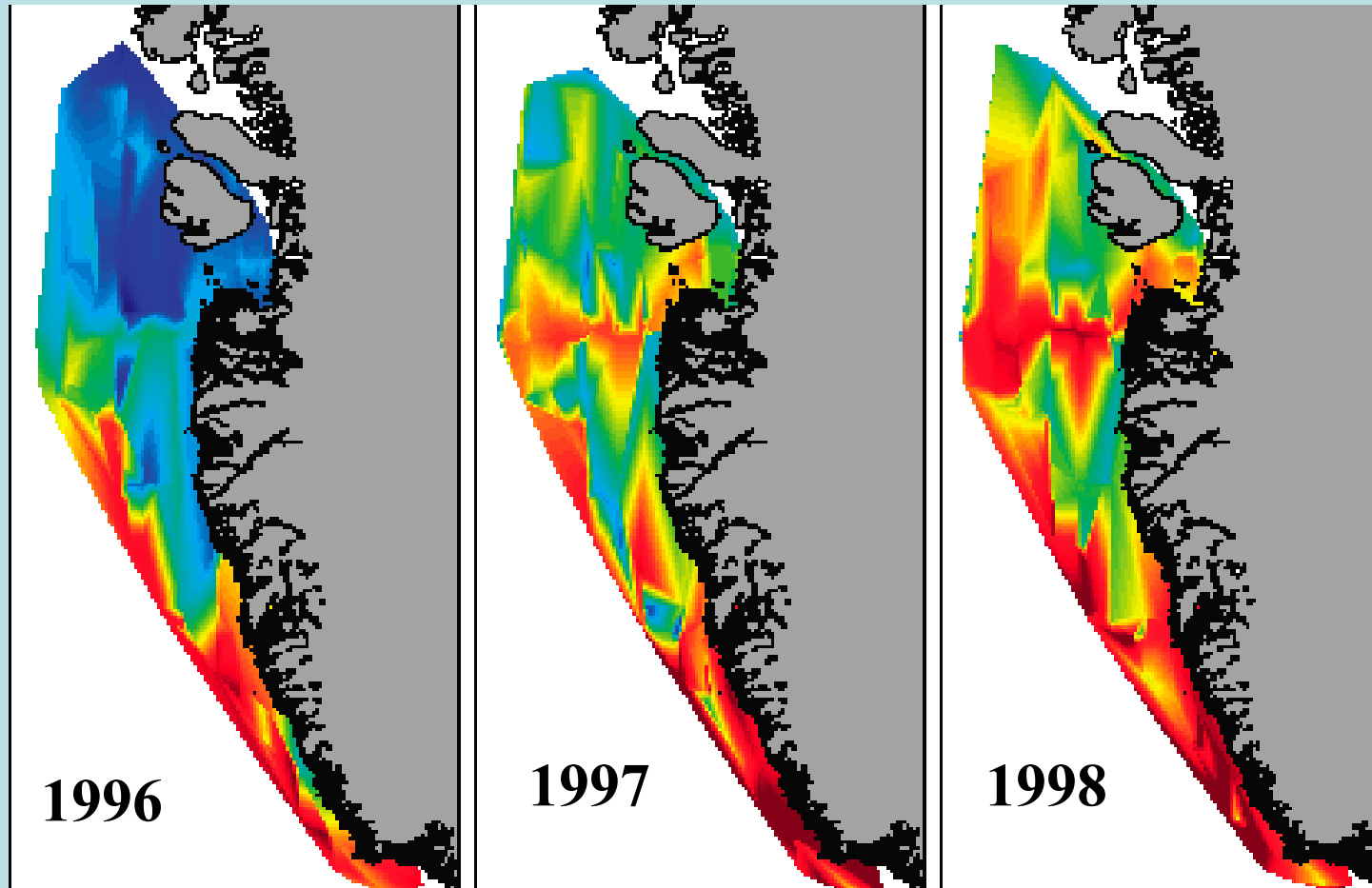
**Uplift**  
|  
**Rates**



# Constraints on Timing

- Only two GPS stations operating in 1995, both on west coast
- Suggests accelerated uplift and coastal melting began in late-90' s (based on departure from GIA model)
- GRACE measurements began in 2002, confirm post-2000 acceleration
- What happened in late 1990' s? (air temp ~ constant)

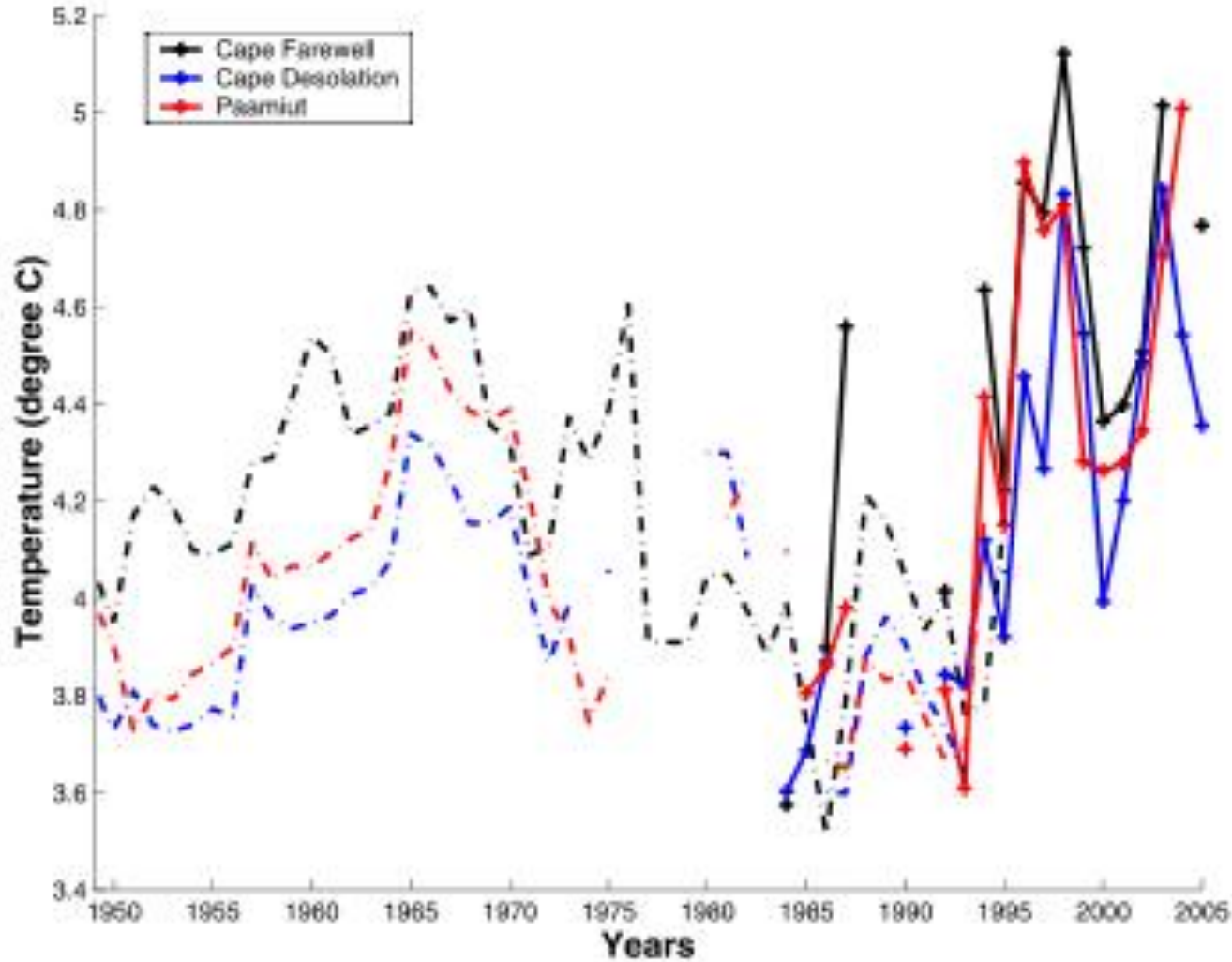
**This is where oceanography comes in:  
Sub-Surface Water Temperature, Western Greenland  
150-600 m depth**



**Holland et al. 2008-data recorded by trawl fisheries**

# D: IRMINGER WATER VARIABILITY

## Southwest Greenland



Myers et al., 2007: data from ctd casts

# Conclusions

- Perturbations to the vertical velocity field measured by GPS are sensitive to recent land ice melting
- Uplift of Greenland, Iceland and Svalbard is accelerating
- Two stations in western Greenland began accelerating in late 1990's, when water temperatures increased
- A simple elastic model for coastal ice loss in Greenland gives estimates in approximate agreement with other techniques
- Longer time-series of integrated space, geologic, and oceanographic data are needed!

- Thank You!