Assessing the Health of Coastal Ecosystem

The Role of the U.S. Integrated Ocean Observing System

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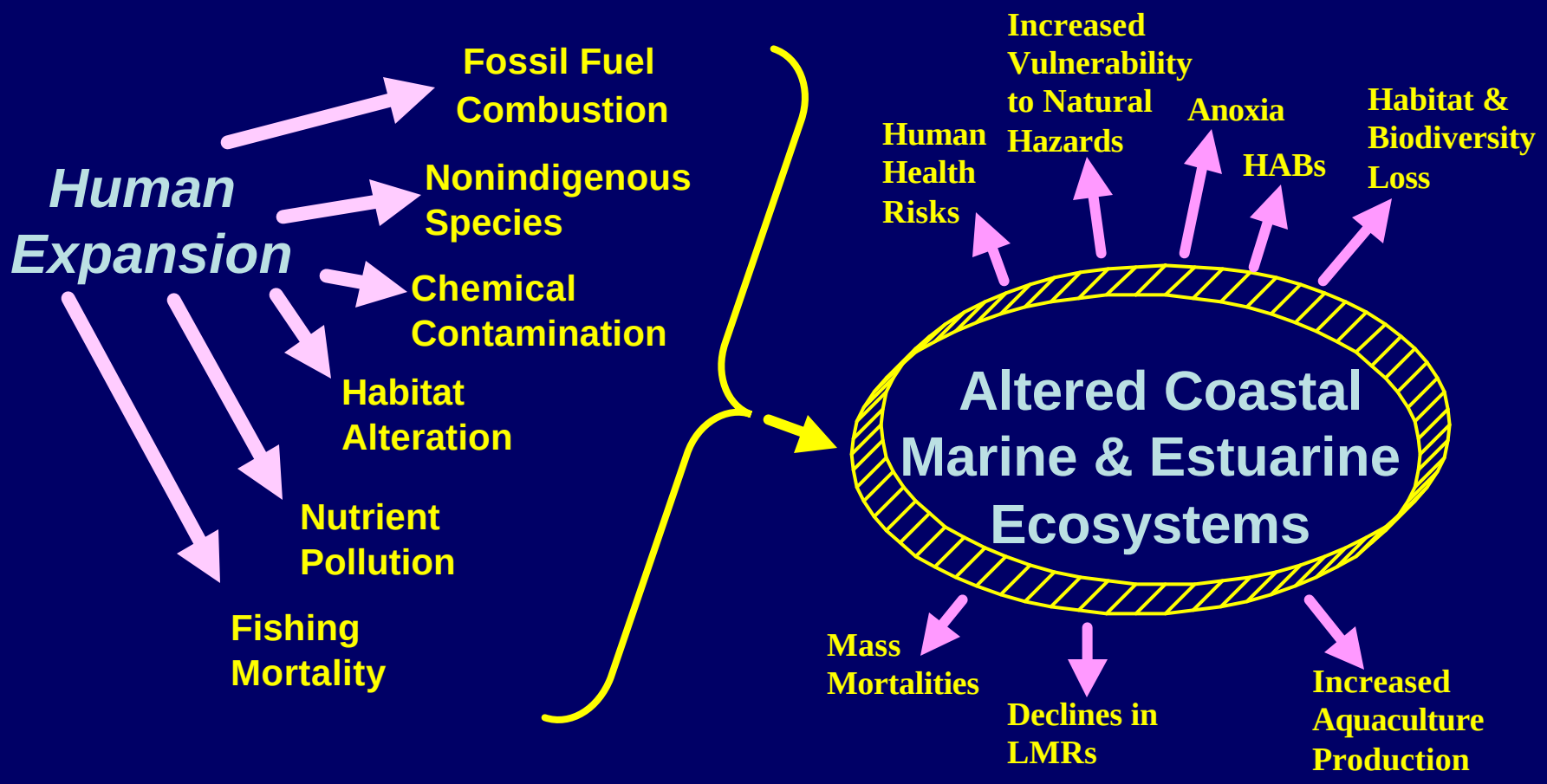
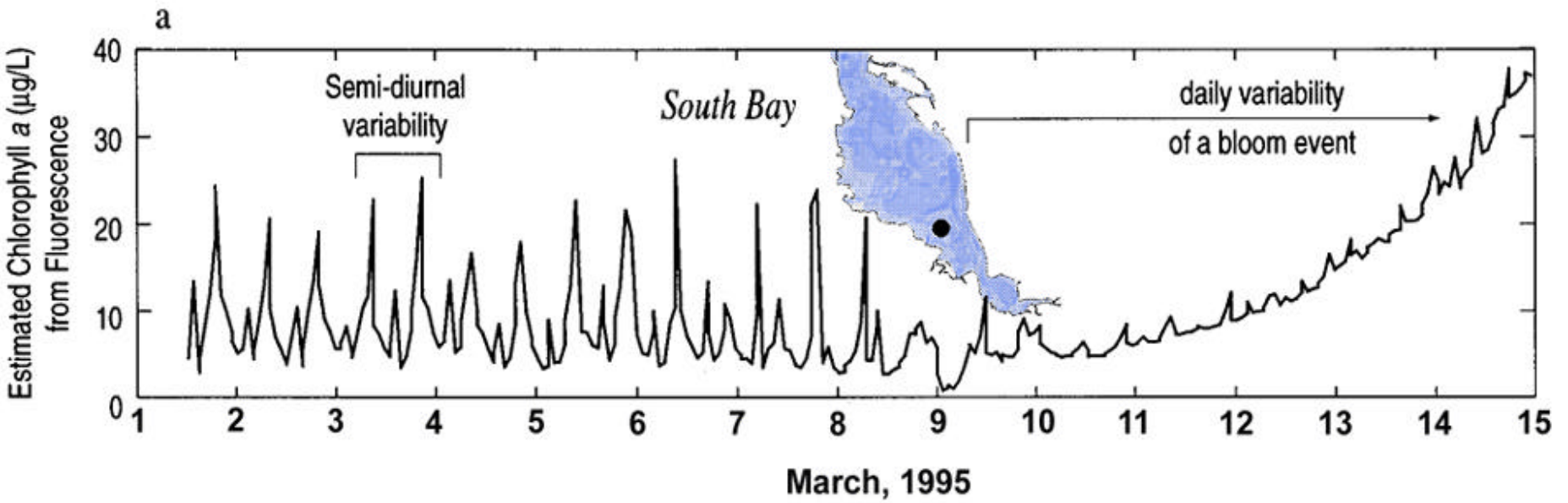
- **Drivers of change in coastal marine & estuarine ecosystems & associated scales of variability**
- **Requirements for Ecosystem–Based, Adaptive Management**
- **Development of the U.S. IOOS & EMAP**

Human Alterations of Coastal Ecosystem Condition, Integrity & Sustainability

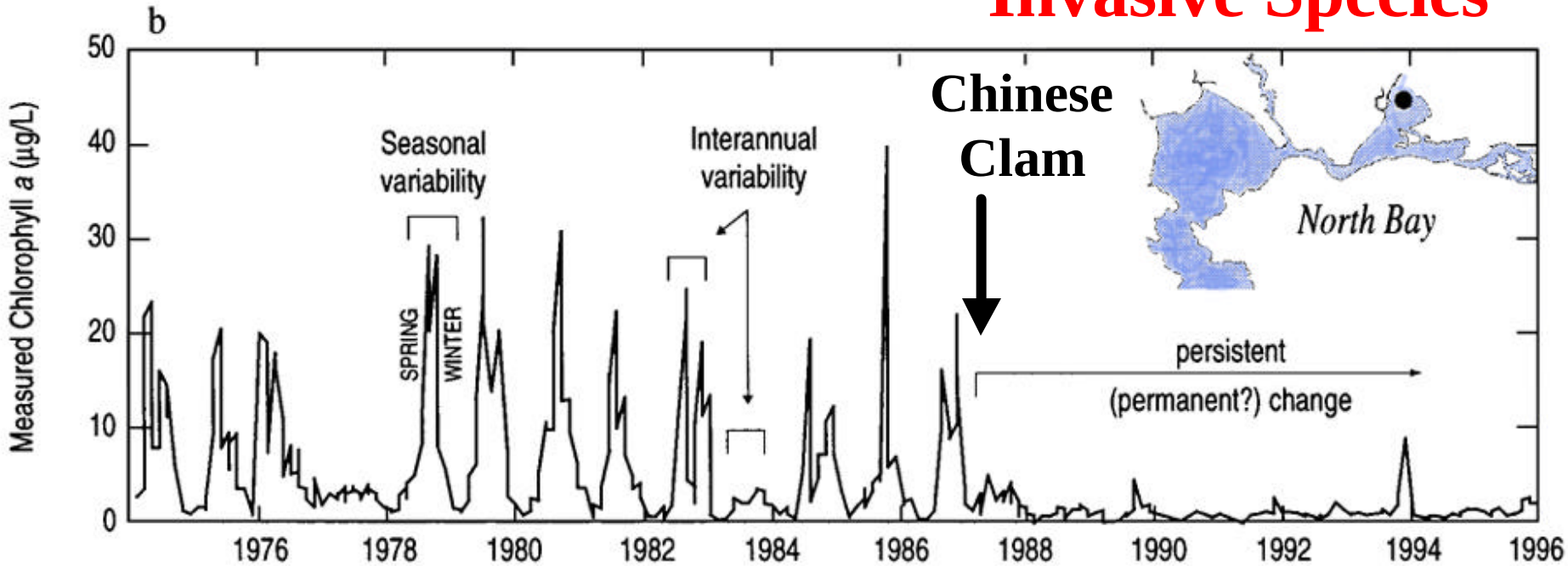


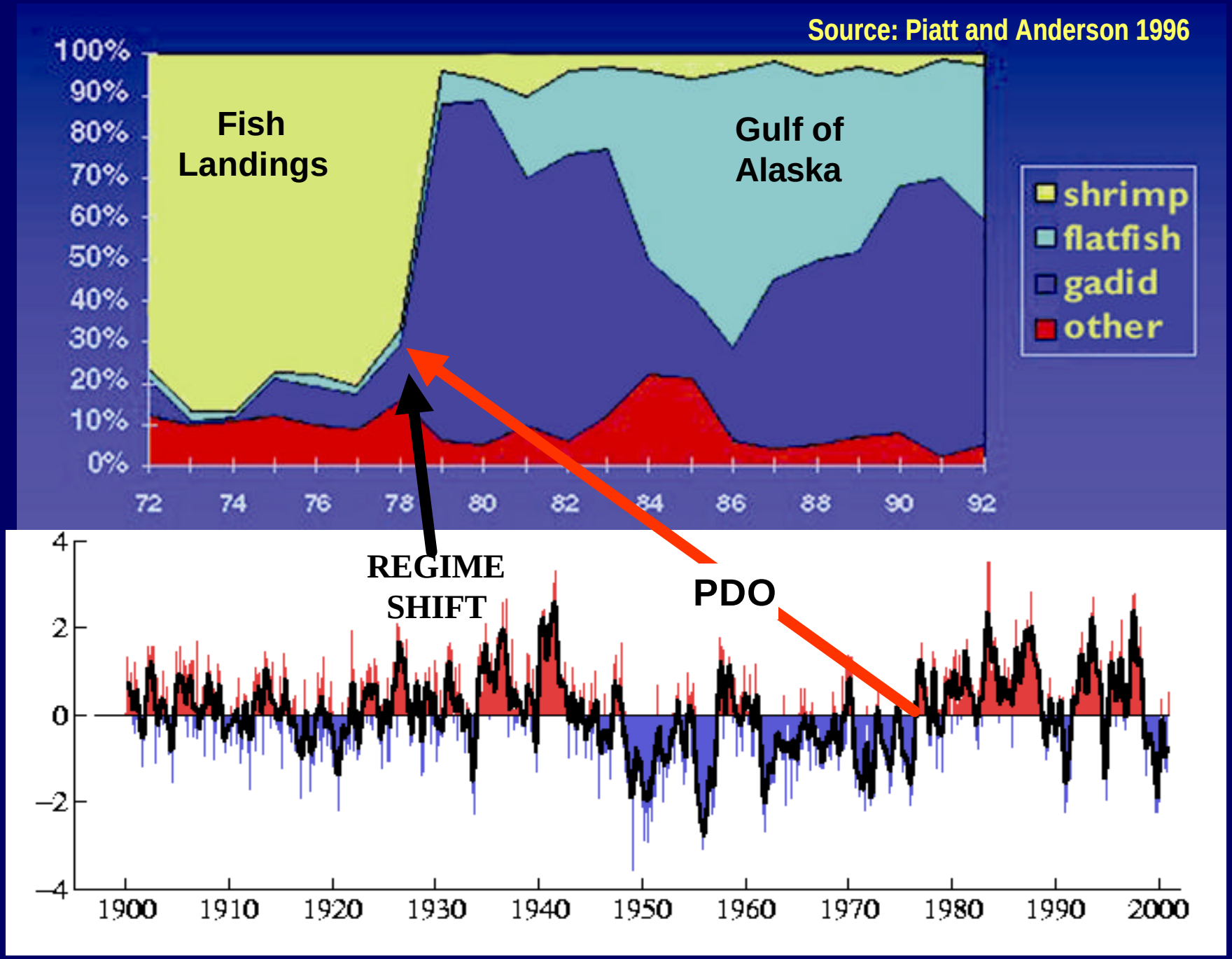
Jackson et al., 2001



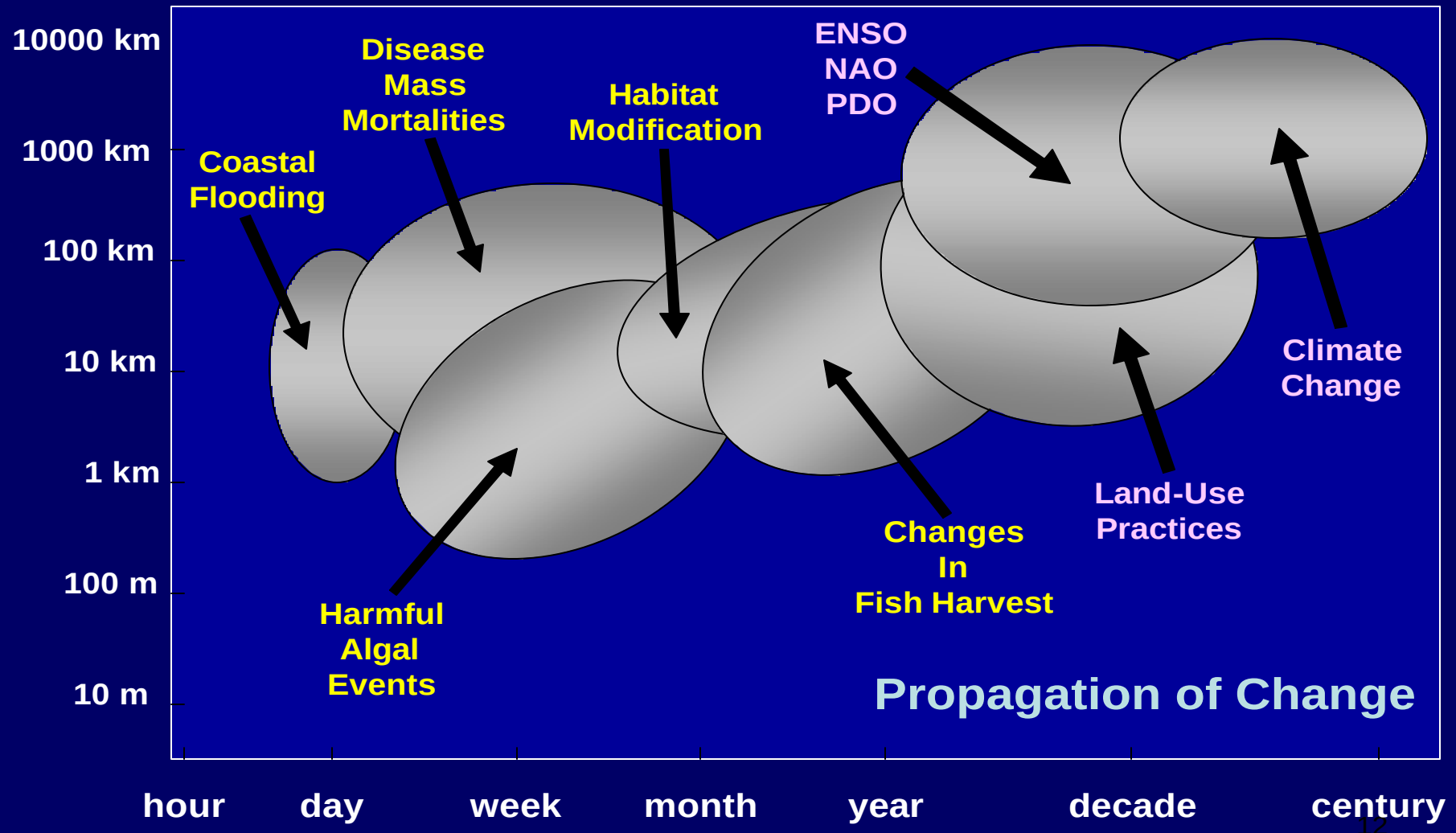
Jim Cloern

Invasive Species




Source: Piatt and Anderson 1996
Fish Landings
Gulf of Alaska
shrimp
flatfish
gadid
other
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
72
74
76
78
80
82
84
86
88
90
92
REGIME SHIFT
PDO
4
2
0
−2
−4
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000

Condition of Coastal Marine & Estuarine Ecosystems
Varies Over a Broad Spectrum of Time – Space Scales



Message 1

- **Successful management & mitigation of the effects of human activities, natural hazards & climate change depend on**
  - **The capacity to detect changes rapidly on time scales of days – decades &**
  - **The capacity to "anticipate changes with sufficient lead time to make informed decisions with desired outcomes"**

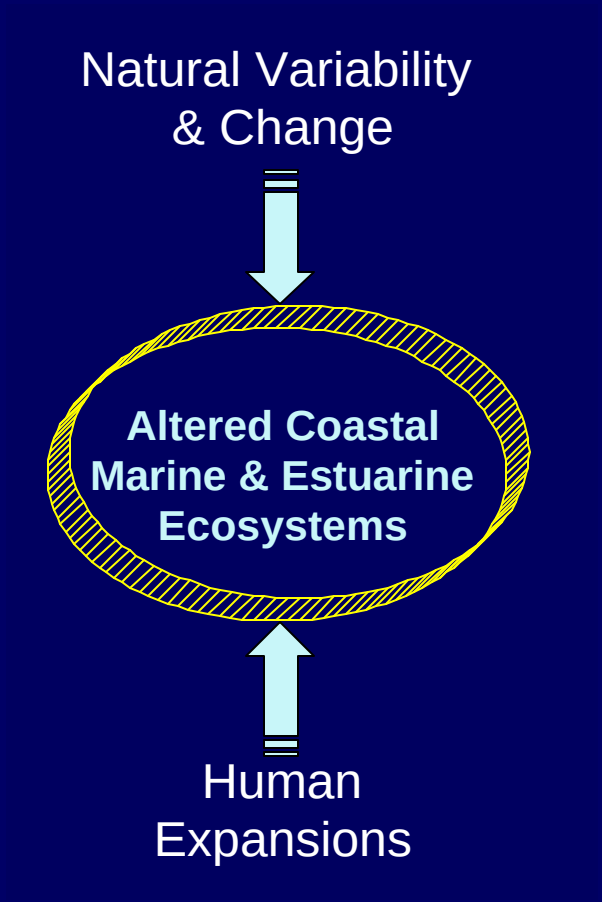
Clark et al. 2001. Ecological forecasts: an emerging imperative. *Science*, 293: 657 – 660

Message 2

Achieving these goals requires

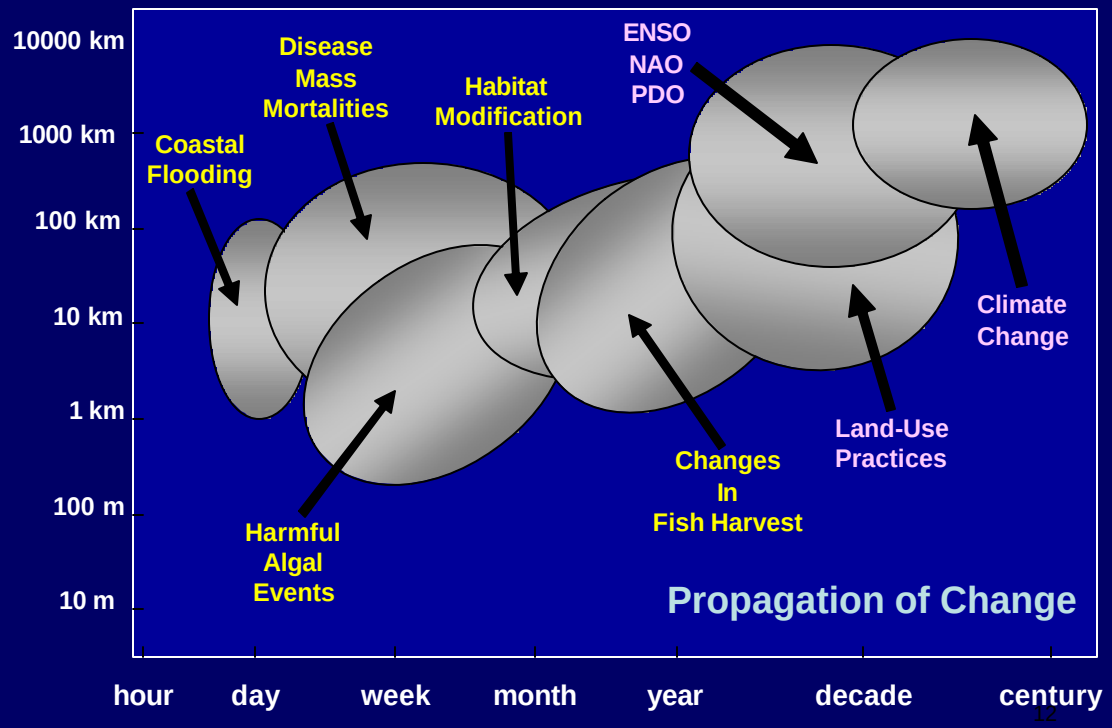
- A more comprehensive approach to
  - environmental protection,
  - management of living resources,
  - coastal zone management &
  - coastal engineering
- An integrated observing system that serves data & information
  - repeatedly
  - at rates on which management decision CAN & SHOULD be made

An Approach



- **That considers the effects of human activities in terms of**
  - **Multi – species interactions**
  - **Ecosystem dynamics &**
  - **The forces of nature**

Ecosystem-Based, Adaptive Management



- **<u>Rapid & Repeated Detection</u> of changes**
  - **over a broad spectrum of time-space scales**
- **<u>Timely Predictions of</u> such changes**

WE DO NOT HAVE THIS CAPABILITY TODAY

WHY?

- **Inefficient, ineffective data management**
  - **Data lost or not accessible**
  - **Time required to acquire, process & analyze diverse data from many sources (data fusion)**
- **Under sampling in time, space & ecological complexity**
  - **Inputs to coastal ecosystems poorly quantified**
  - **Lack of long term, high resolution time series**
  - **Lack of synoptic measurements of physical, chemical & biological properties & processes**
- **Research & Monitoring needs transcend traditional boundaries between**
  - **Government agencies**
  - **Private & public sectors**
  - **Research & Management**

1998 Congress called for Integrated Ocean Observing System (IOOS)

Provide Data/Info Required for More Rapid Detection & Timely Prediction of State Changes

- **Improve the safety & efficiency of marine operations**
- **Improve homeland security**
- **Mitigate effects of natural hazards more effectively**
- **Improve predictions of climate change & their effects**
- **Minimize public health risks**
- **Protect & restore healthy coastal marine ecosystems more effectively**
- **Sustain living marine resources**

1 System, 7 Goals

Commission on Ocean Policy
Governor's Draft
20 April, 2004

- **Implement an Integrated Ocean Observing System**
  - Makes more effective use of existing assets
  - Enhanced over time as new technologies, knowledge & user groups develop
- **Authorize & appropriate**
  - $138 M for FY 2006
  - $600 M by FY 2010
- **Interagency program funded through NOAA as the lead agency**
- **Codify OceanUS as the Planning Office for the IOOS**

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What is an Integrated Ocean Observing System (IOOS)?

- A sustained system that repeatedly & routinely provides data & information required by groups & the public that
  - use, depend on, manage, or study marine systems from waves to whales
- An "end-to-end" system
  - Multiple applications are efficiently linked to observations via integrated data management & analysis
- A data management & communications subsystem that provides rapid access to diverse data from many sources – data fusion
- An interdisciplinary system that provides data required to rapidly detect & predict changes in the state of
  - Physical, Chemical, Biological & Ecological systems
- A system that makes more effective use of the collective assets of federal & state agencies, academia & private enterprise

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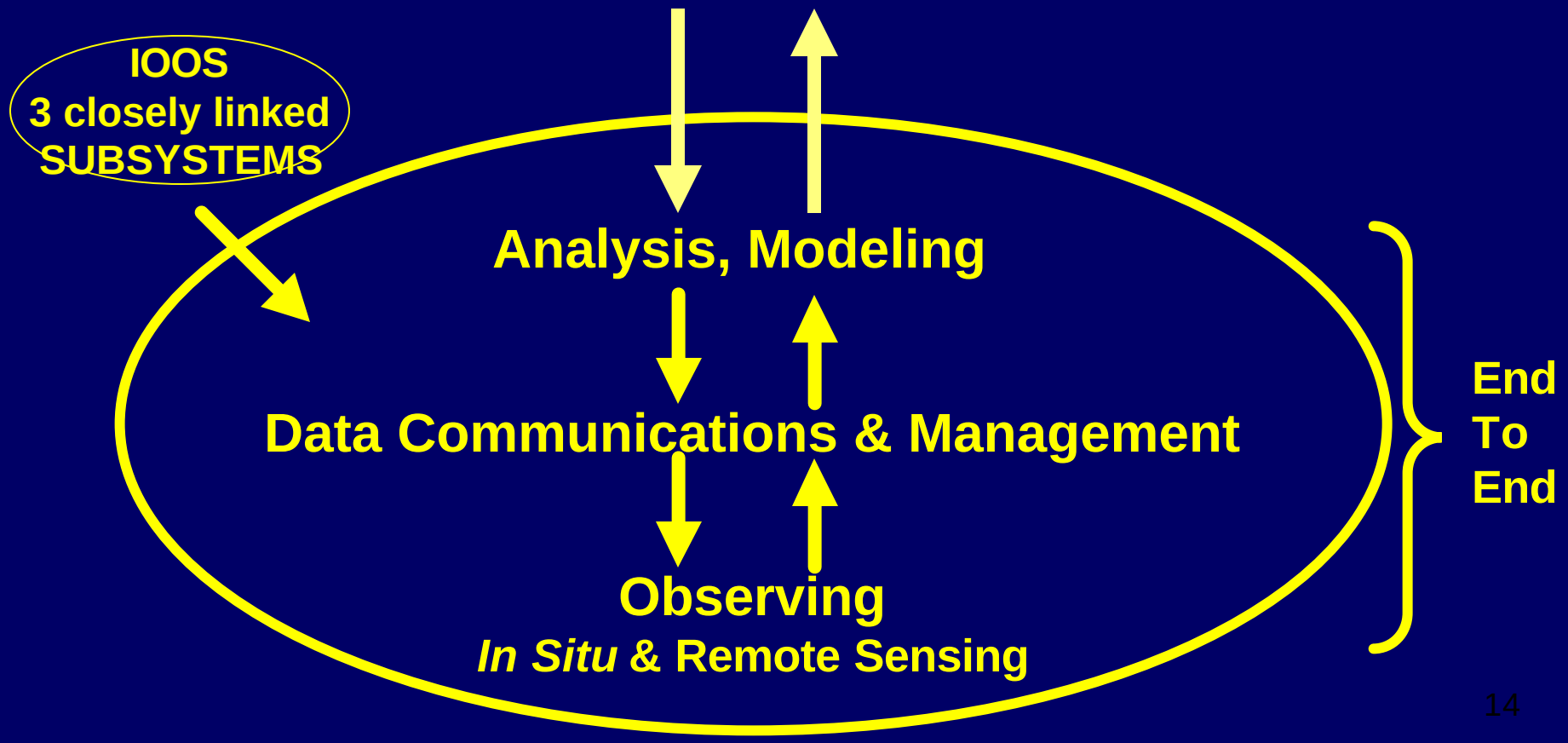
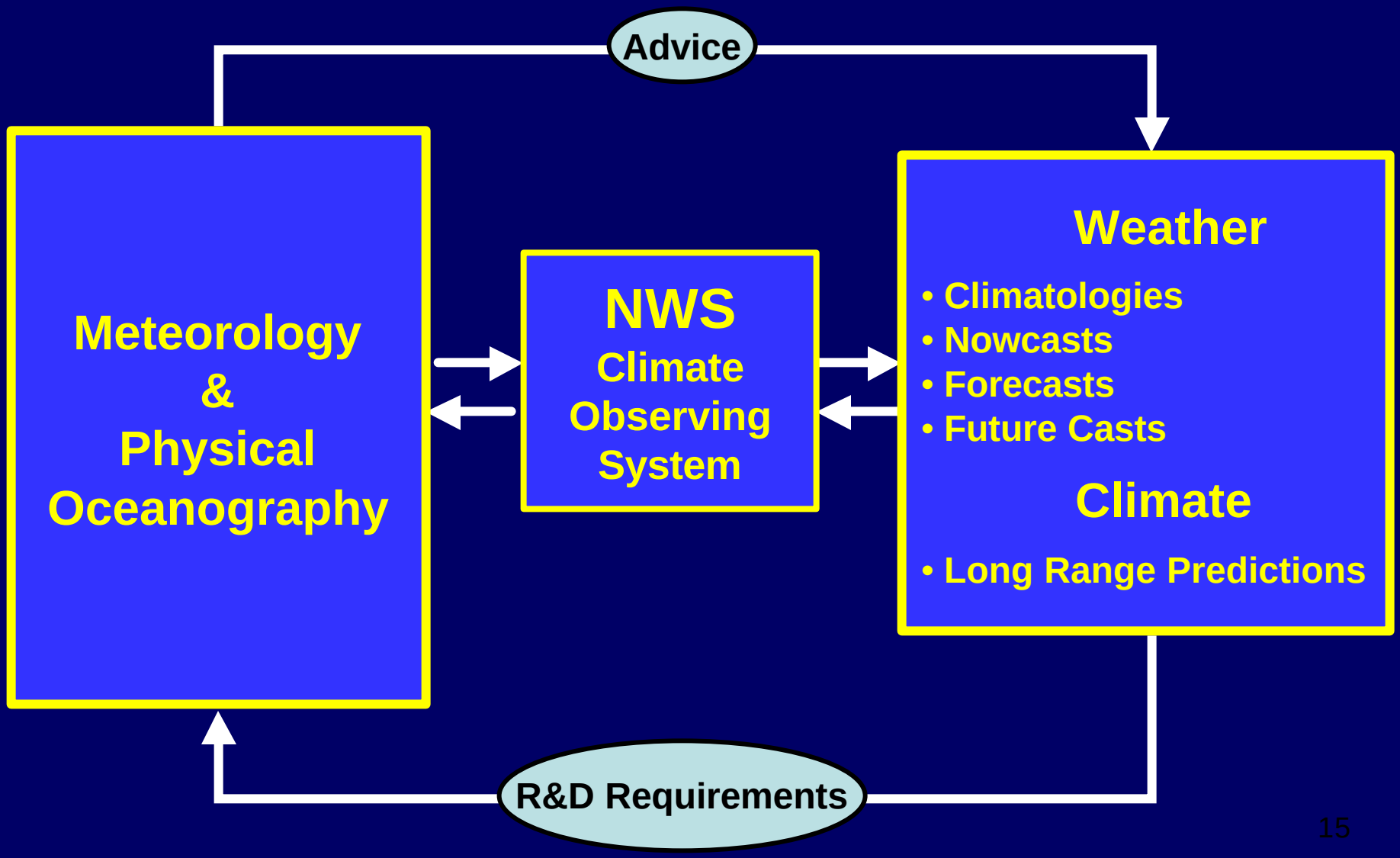
User–Driven, End–to–End

Continuously, routinely & repeatedly
Provides Data & Information
Specified by Multiple User Groups



National Weather Service

A Model for an Operational, End to End Observing System



Detecting & Predicting Change in Oceans & Coasts

Advice

Multi-D Foundation

- Marine Meteorology
- Oceanography
- Marine & Estuarine Ecology
- Landscape Ecology
- Medical Research

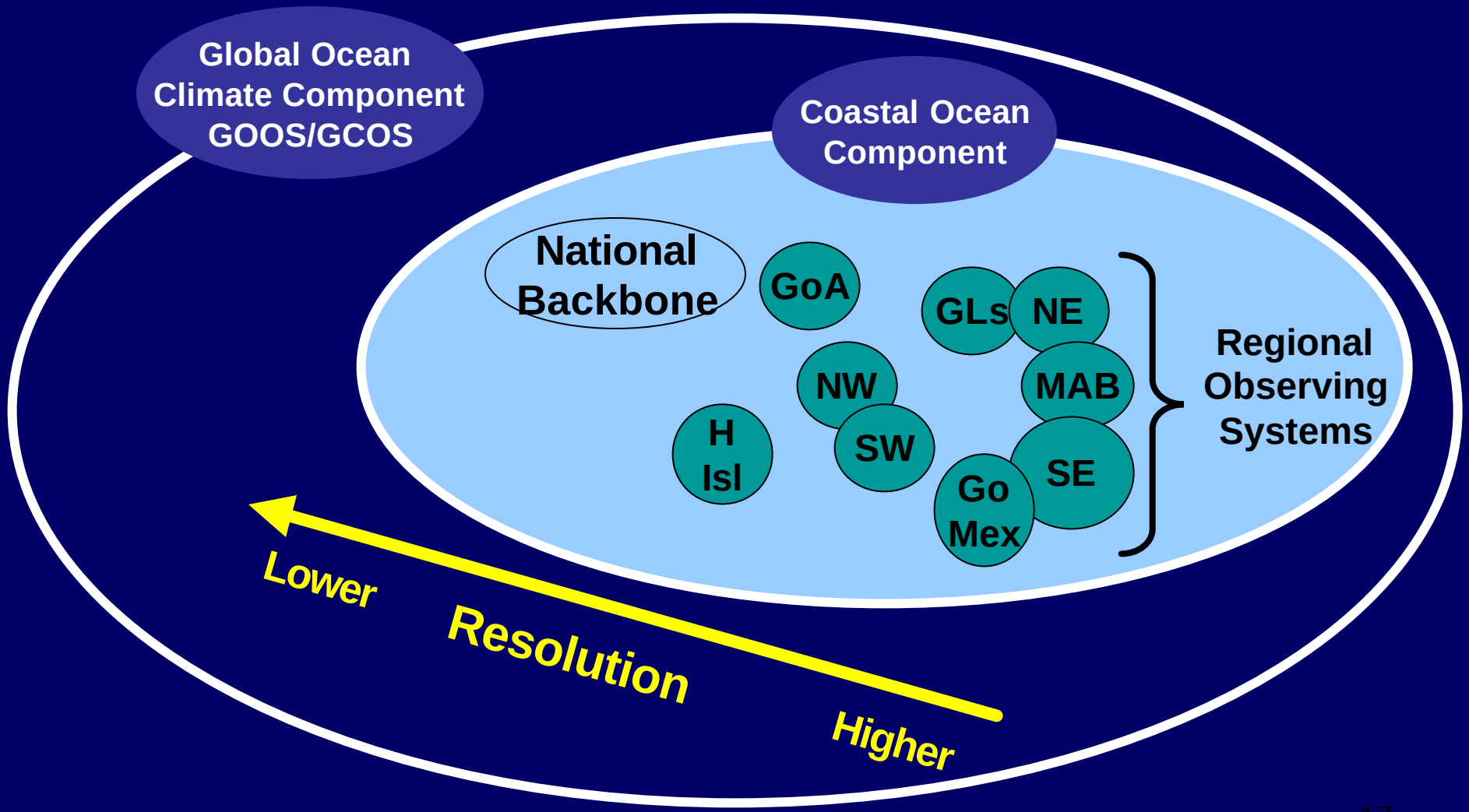
IOOS

Multiple Applications

- Environmental protection
- Public health & safety
- LMR management
- ICZM management
- Safe, efficient marine operations
- Coastal engineering

R&D Requirements

IOOS: Hierarchy of Observations



U.S. Coastal Component

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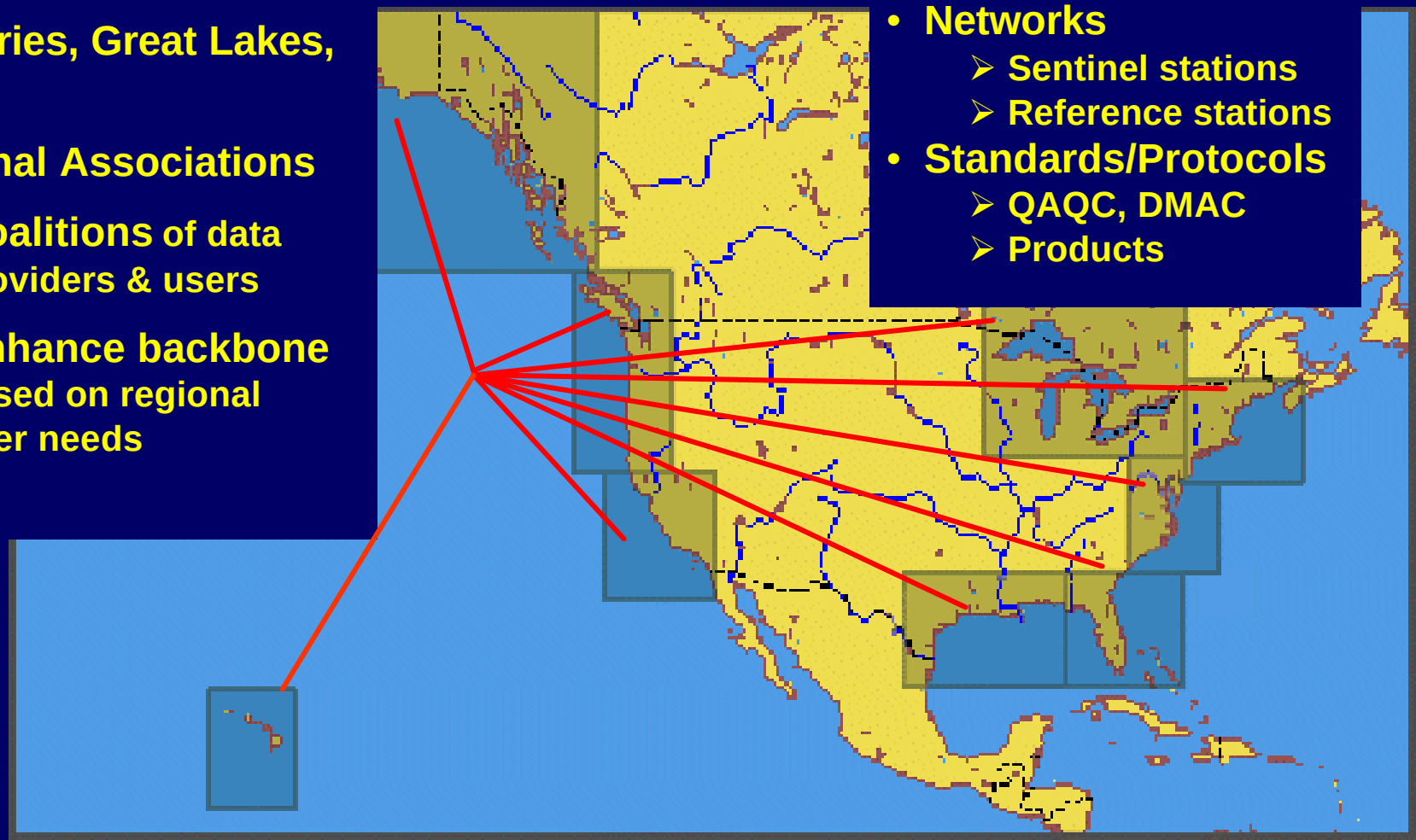
National Backbone

- EEZ & Great Lakes
- Federal Agencies
  - Design
  - Operate
- Core variables
  - Required by regions
- Networks
  - Sentinel stations
  - Reference stations
- Standards/Protocols
  - QAQC, DMAC
  - Products

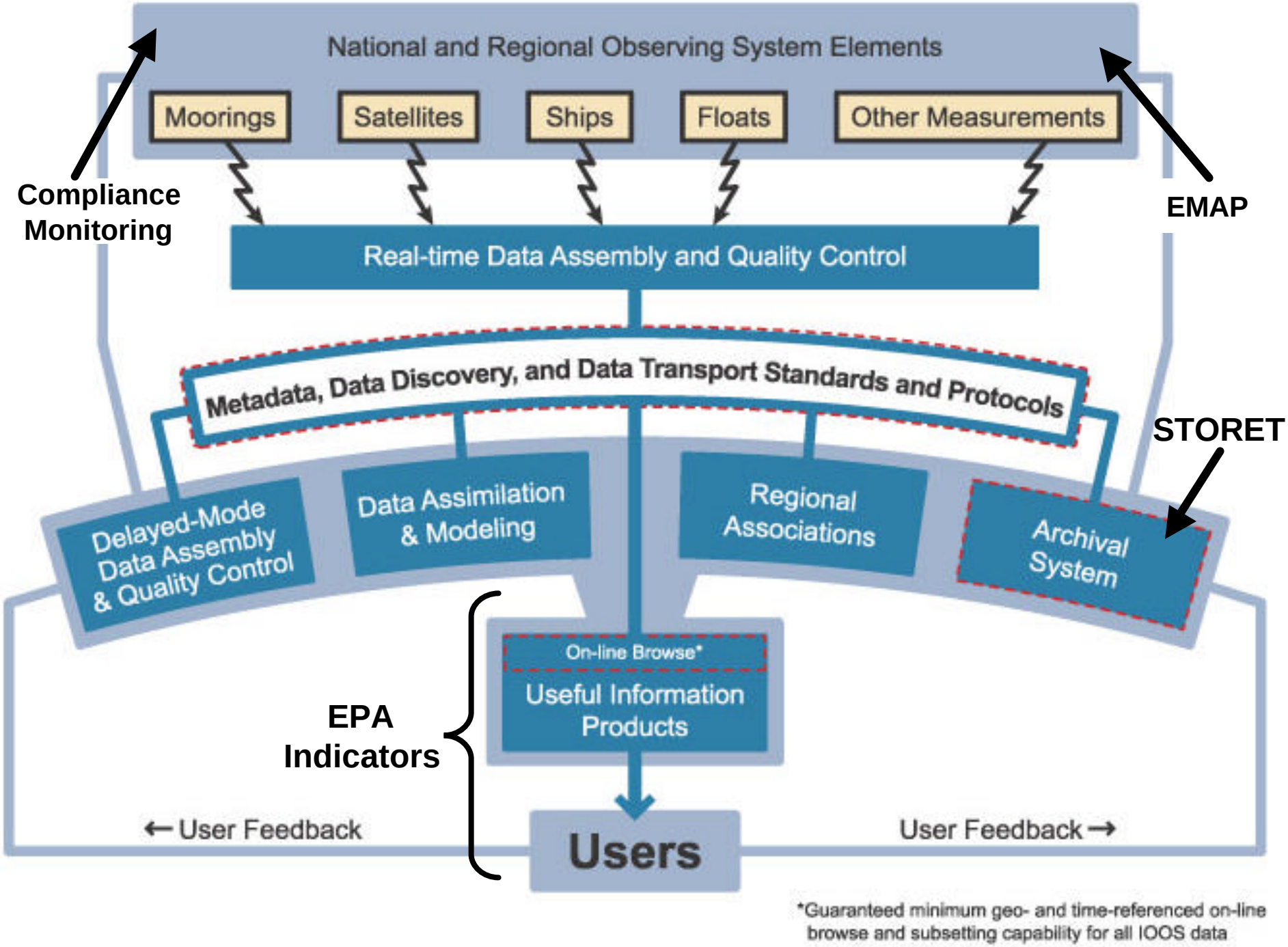
Regional COOS's

- Estuaries, Great Lakes, EEZ
- Regional Associations
  - Coalitions of data providers & users
  - Enhance backbone based on regional user needs



Developing Operational Ecology for Environmental Protection

- **EMAP is a research program to**
  - **"develop the tools necessary to monitor & assess the status & trends of national ecological resources"**
- **A major objective of the STAR Program**
  - **develop indicators of ecological condition, integrity & sustainability**
- **If indicators are to be used for management purposes,**
  - **they must be determined routinely & repeatedly at rates specified by decision makers, e.g., daily, monthly, yearly.**
- **Requires a sustained & integrated observing system for coastal ecosystems**
  - **that EPA can benefit from & contribute to**
  - **as both a user & a provider of data & information generated by the IOOS**


National and Regional Observing System Elements
Moorings
Satellites
Ships
Floats
Other Measurements
Compliance Monitoring
EMAP
Real-time Data Assembly and Quality Control
Metadata, Data Discovery, and Data Transport Standards and Protocols
STORET
Delayed-Mode Data Assembly & Quality Control
Data Assimilation & Modeling
Regional Associations
Archival System
On-line Browse*
Useful Information Products
EPA Indicators
← User Feedback
User Feedback →
Users
*Guaranteed minimum geo- and time-referenced on-line browse and subsetting capability for all IOOS data

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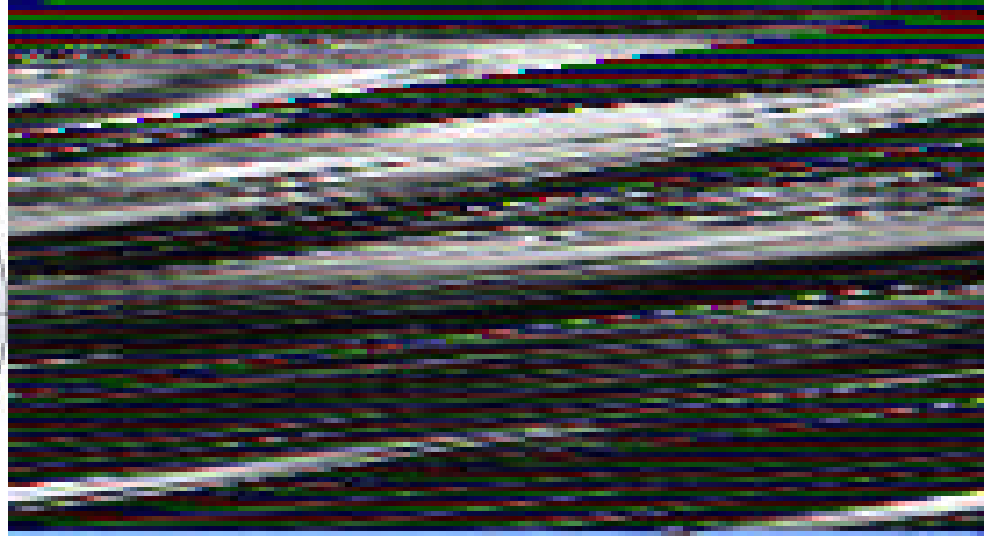
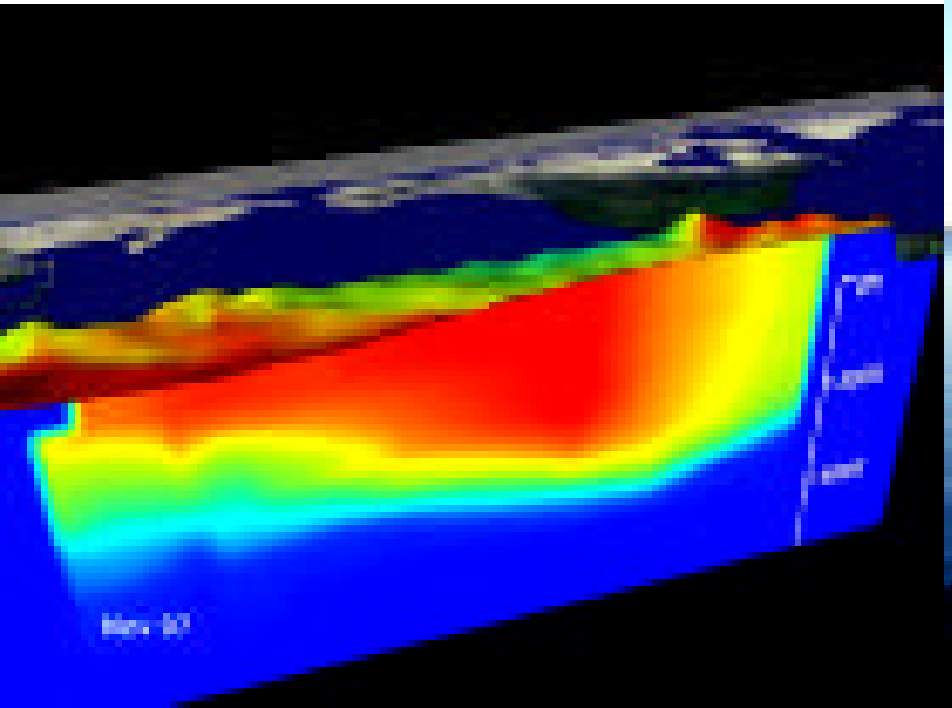


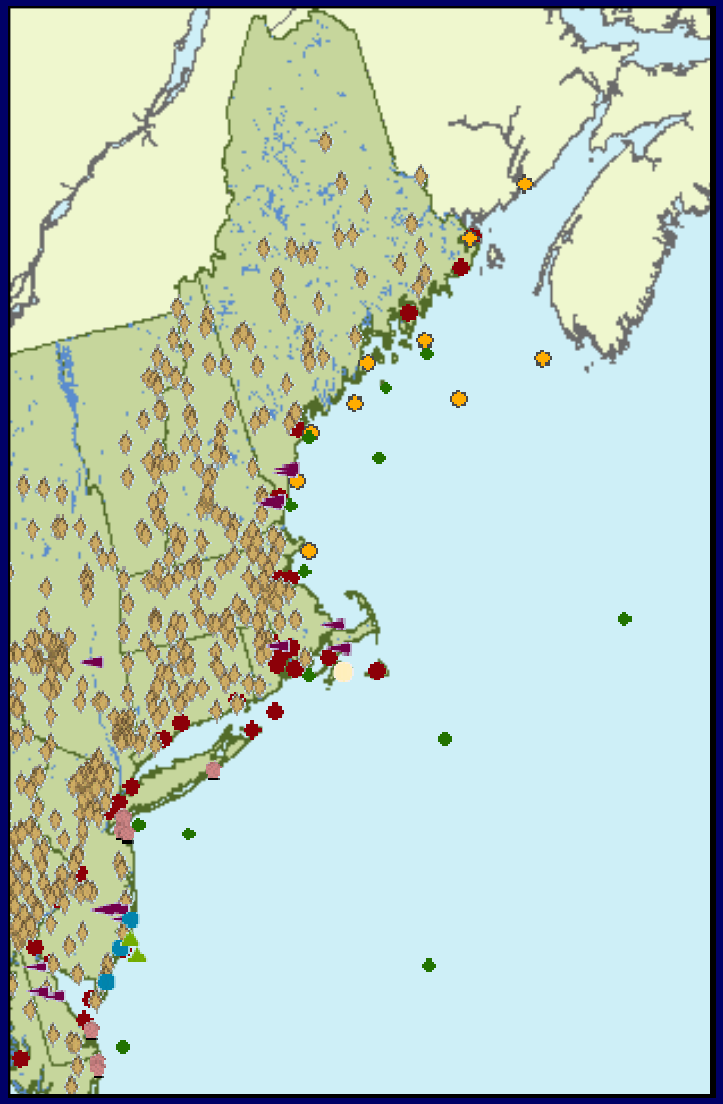


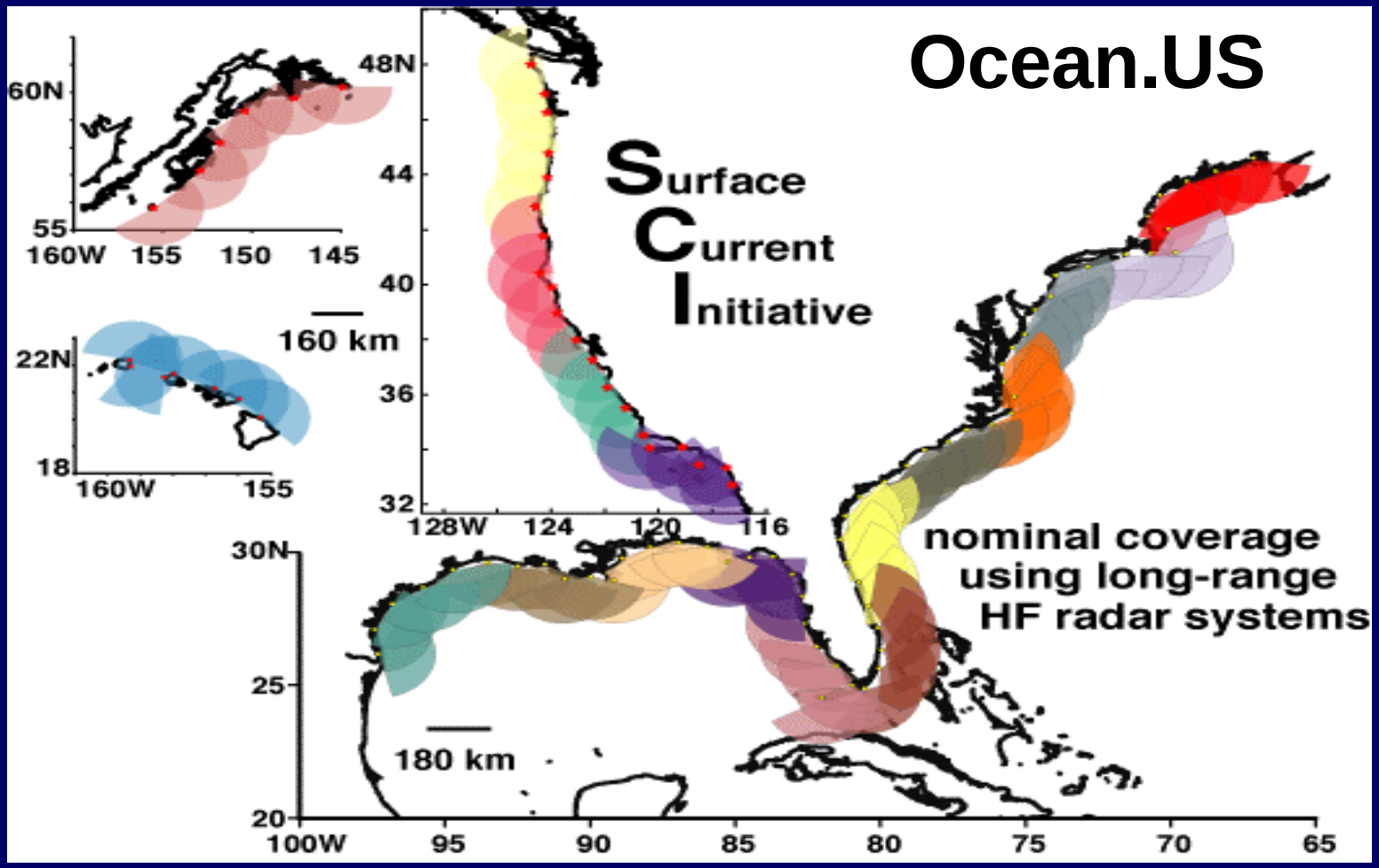
THANK YOU

Northeast Atlantic Region

Observing Systems

- COOL
- NJ CMN
- Marthas Vineyard
- NERR
- GOMOOS
- NDBC
- COE Waves
- NWLON
- USGS Stream





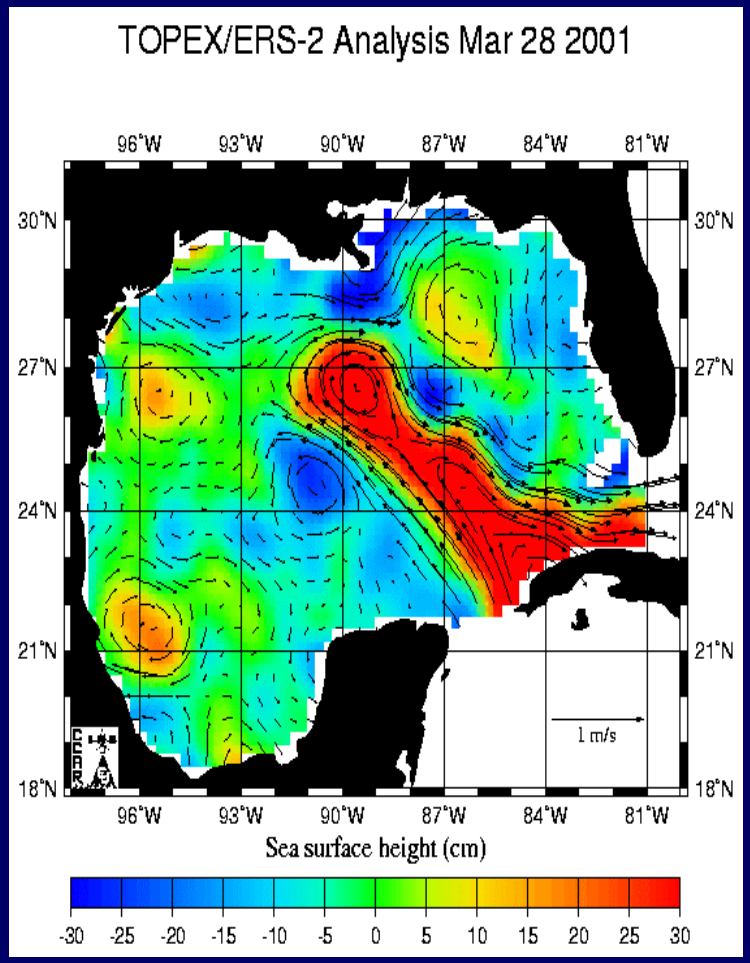
<u>Goal</u>: Serve surface current velocity maps in real – time

<u>Challenges</u>:

Establish coastal network of HF Radar systems &

Rapidly integrate data from HF Radars, Satellites, & *In situ* instruments

Surface Current Mapping: Multiple Applications



- **Search & Rescue**
  - More rapid recovery
- **Ship Routing & Detection**
  - Improved fuel efficiency, safety
- **Mitigate effects of oil spills, point source plumes & HABs**
  - More accurate forecasts of trajectories
- **Sustainable Fisheries**
  - More accurate estimates of recruitment
- **Ocean Science**
  - Improved understanding of marine & estuarine ecosystems

A Sampling of Federal Agencies & Programs Engaged in Coastal Research & Monitoring

~$ 650 M year^{-1}

Earth Science Enterprise

CWAP: Coastal Research and Monitoring Strategy

National Estuary Program

National Marine Sanctuary Program

National Coastal Assessment – Coastal 2000

NOAA's National Estuarine Research Reserve System

NOAA National Status and Trends

U.S. Fish and Wildlife Service Coastal Program

Coastal Zone Management Act

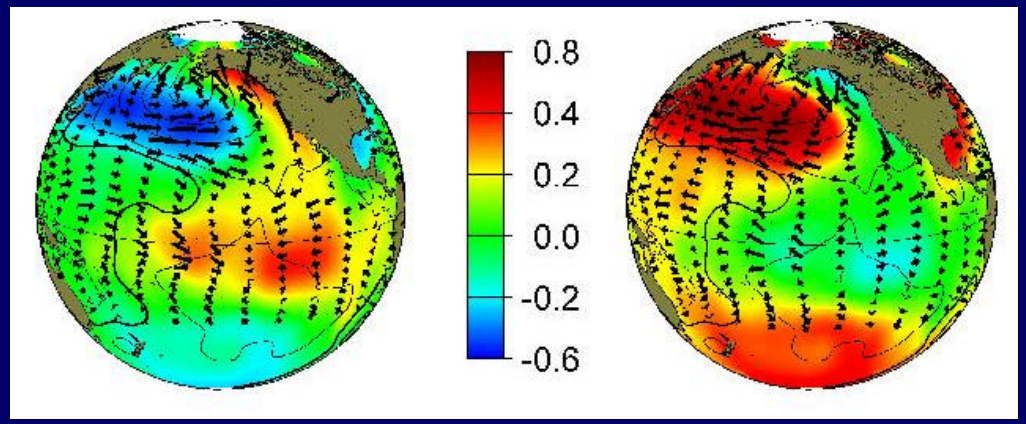
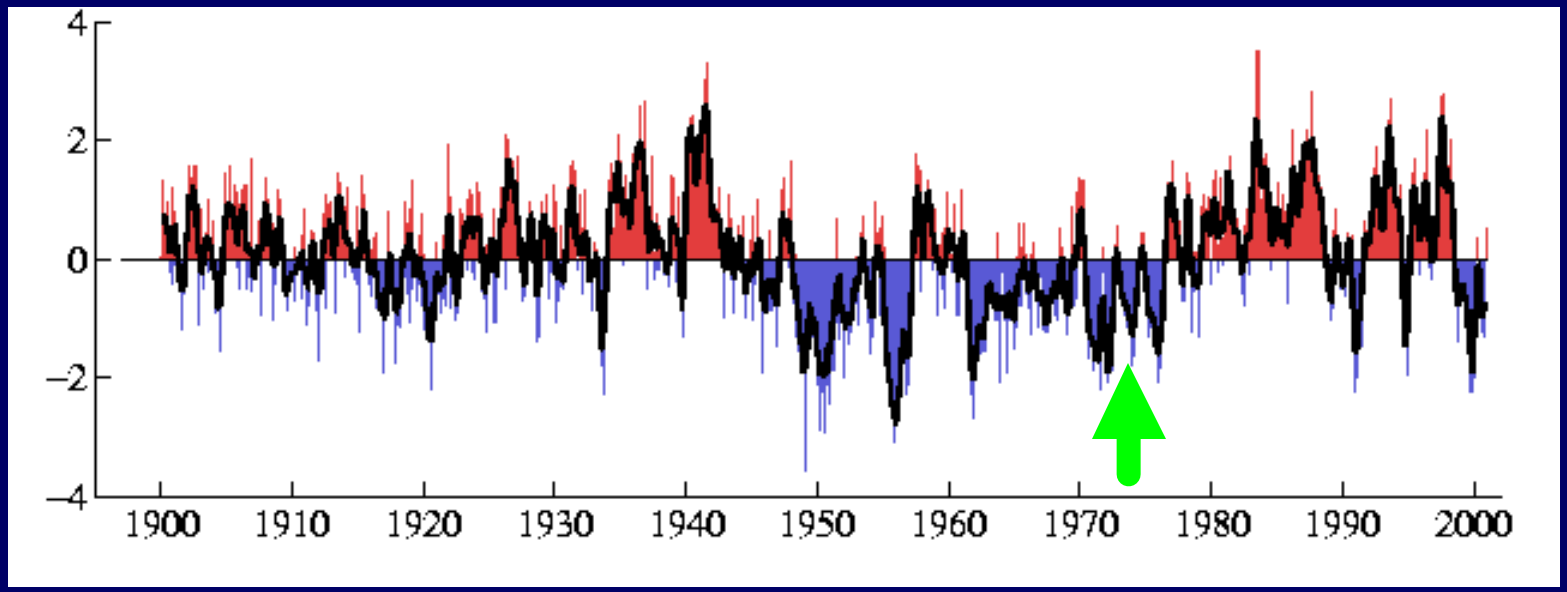
Environmental Monitoring and Assessment Program

National Streamgauging Program

EPA's BEACH Watch Program

EPA Great Waters Program

Pacific Decadal Oscillation



Warm Cool Warm