Earth System Prediction Capability (ESPC)

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ESPC Overview

Introduction

- ESPC is an **interagency collaboration** (DoD, NOAA, DoE, NASA, NSF) to coordinate R2O for an extended range earth system analysis and prediction capability at the **weather to climate interface**.
- Common **prediction requirements and forecast model standards** enable agencies to improve leverage and collaboration.
- Cooperative five-year **demonstration projects** inform S&T and R&D efforts.
- Integrate of atmosphere-ocean-land-ice and space predictions into a **fully coupled global prediction** capability.

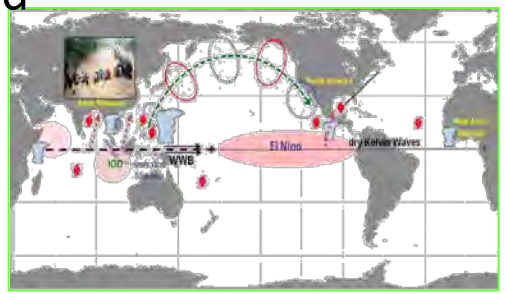
Sources of Predictability:

- Improve Model Physics through:
  - Coupled global modeling
  - Improved resolution & parameterization
- Improve Initial Value Problem through
  - Joint observational retrievals
  - New hybrid DA approaches
- Increase Forecast Information through
  - Stochastic prediction and post-model processing
  - National Multi-model ensembles
  - Seamless prediction
- Increase System Resolution affordably through
  - Efficient Computational Architectures
  - Efficient Numerics/Discretization

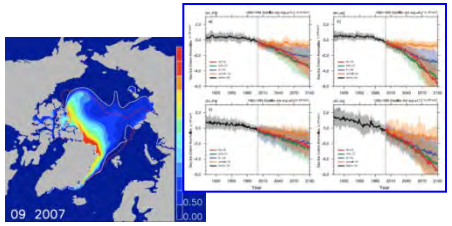
ESPC Demonstrations

(10 days to 1-2 years)

- Extreme Weather Events: Predictability of Blocking Events and Related High Impact Weather at Leads of 1-6 Weeks (Stan Benjamin, ESRL)

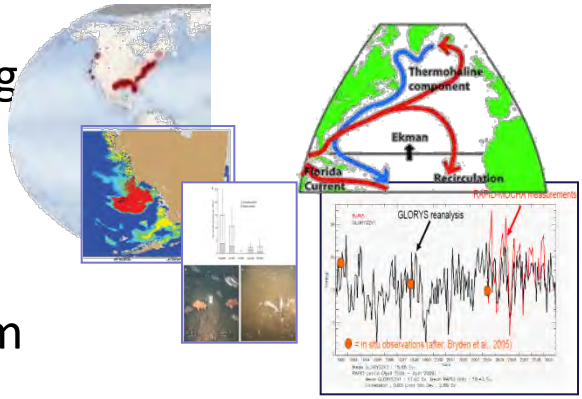


- Seasonal Tropical Cyclone Threat: Predictability of Tropical Cyclone Likelihood, Mean Track, and Intensity from Weekly to Seasonal Timescales (Melinda Peng, NRL MRY)



- Arctic Sea Ice Extent and Seasonal Ice Free Dates: Predictability from Weekly to Seasonal Timescales (Phil Jones, LANL)

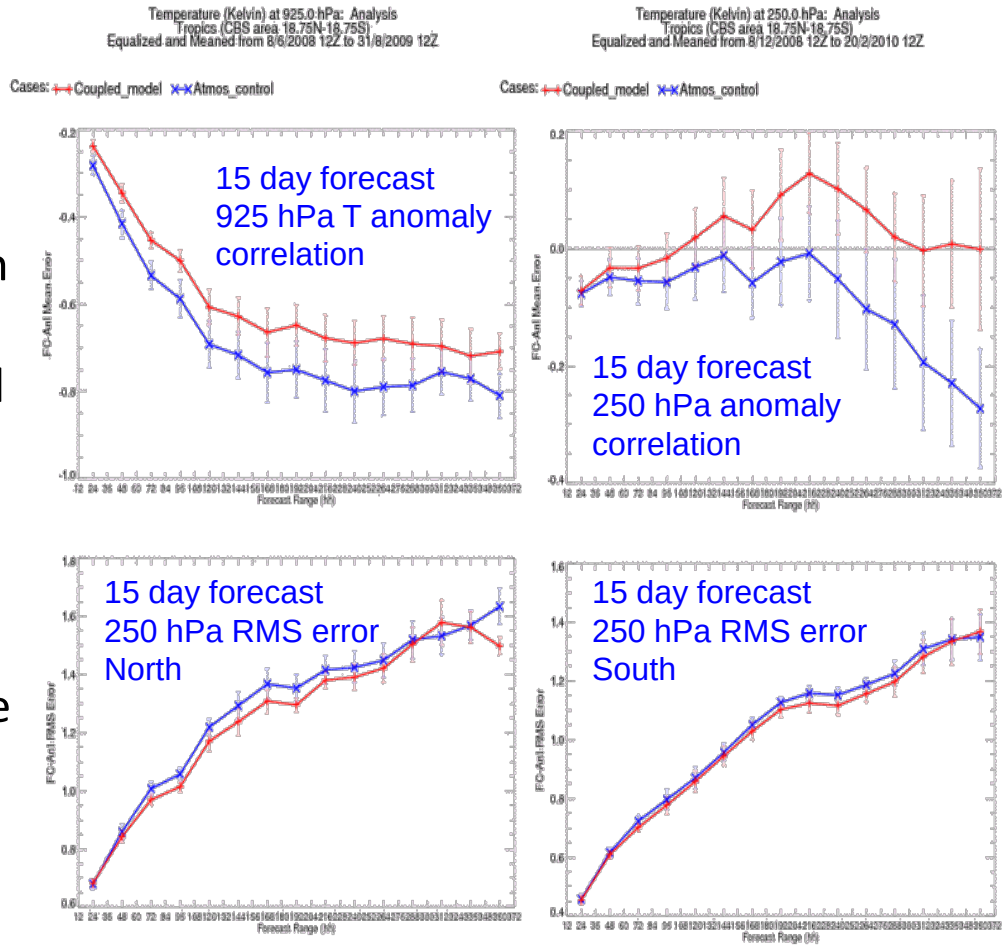
- Coastal Seas: Predictability of Circulation, Hypoxia, and Harmful Algal Blooms at Lead Times of 1-3 months (Greg Jacobs, NRL SSC)



- Open Ocean: Predictability of the Atlantic Meridional Overturning Circulation (AMOC) from Monthly to Decadal Timescales for Improved Weather and Climate Forecasts (Jim Richman, NRL SSC)

Global Coupled Models (ocn/atm/wav/ice/land)

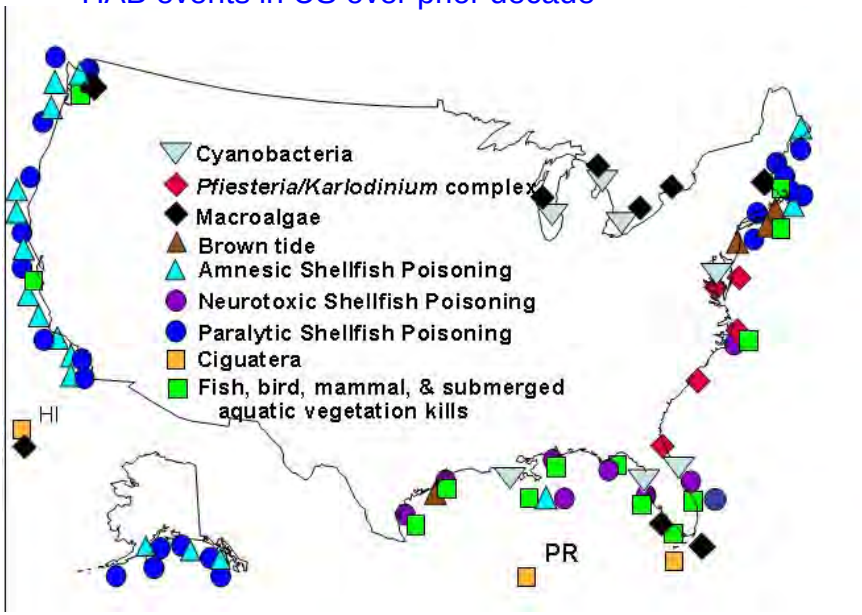
- Global air-sea coupled models were first implemented for climate applications but are increasingly being used at subseasonal to ISI timescales.
- Benefit is seen especially in the tropics in both atmospheric and oceanic verification with largely comparable skill in extra-tropics and some benefit still seen at higher latitudes from coupling in the Southern Hemisphere.
- At week two and beyond, coupling produces skill improvements comparable to doubling resolution in some research cases.



NOAA operational forecast zones reflect differentiation in local biology and physics leading to local Hypoxia / HABS

NOAA's Marine Forecast Zones

HAB events in US over prior decade



ESPC demonstration follows this approach, which allows

- Natural concentration of expertise to local biological processes
- Natural application of focused research to local physics
- Natural leveraging of developed knowledge and skills
- Natural integration into operational environment

ESPC “Demo 4” Coastal Seas: Predictability of Circulation, Hypoxia, and Harmful Algal Blooms

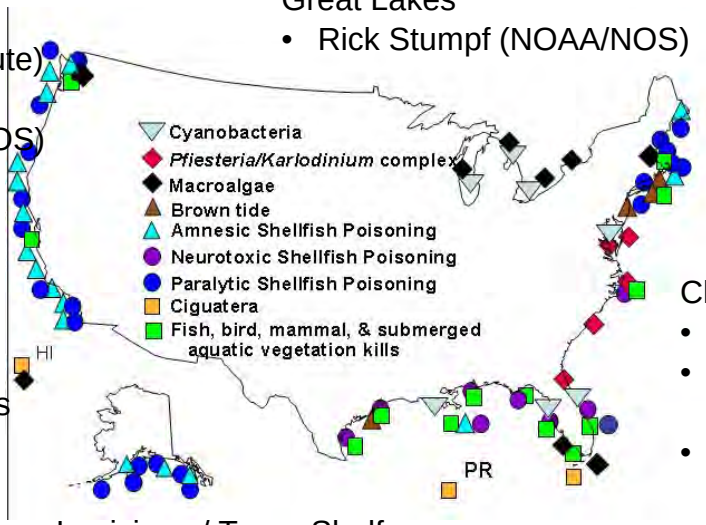
Participants in Science Team

Management need and requirements
- Frank Aikman (NOAA/NOS)
- Allison Allen (NOAA/NOS)
- John Harding (Gulf Research Institute)
- Alan Lewitus (NOAA/CSCOR)
- Richard Patchen (Retired NOAA/NOS)
- Hendrik Tolman (NOAA/NCEP)

Great Lakes
- Rick Stumpf (NOAA/NOS)

Gulf of Maine
- Dennis McGillicuddy (Woods Hole Oceanographic Institute)
- Ruoying He (North Carolina State University)
- Donald Anderson (Woods Hole Oceanographic Institute)

West Coast
- Neil Banas (University of Washington)
- Enrique Curchitser (Rutgers University)



Chesapeake Bay
- Robert Chant (Rutgers University)
- Marjorie Friedrichs (Virginia Institute of Marine Sciences)
- Oscar Schofield (Rutgers University)

Louisiana / Texas Shelf
- Steve DiMarco (Texas A&M)
- Katja Fennel (Dalhausie University)
- Steve Ashby (Gulf Research Institute)
- Nancy Rabalais (LUMCON)
- Rob Hetland (Texas A&M)

Additional expertise on global modeling
- Scott Peckham (University of Colorado)
- Michael Ek (NOAA/NCEP)
- John Dunne (NOAA/GFDL)
- Frank Bryan (UCAR)

West Florida Shelf
- Bob Weisberg (University of South Florida)
- John Walsh (University of South Florida)
- Jason Lenes (University of South Florida)
- Luanyuan Zheng (University of South Florida)

Coordinated direction from Hypoxia management

Management need and requirements plan development by:

- Alan Lewitus (NOAA Center for Sponsored Coastal Ocean Research)
- Frank Aikman (NOAA National Ocean Service)
- John Harding (Gulf Research Institute)
- Richard Patchen (Retired NOAA/NOS)
- Hendrik Tolman (NOAA/NCEP)

Examples of management needs from long-term forecasts include:

- Determine whether problem is getting worse as trigger for regulatory action (Water Quality Regulators)
- Determine safest area for locating facility (Aquaculture Managers)
- Differentiate natural and anthropogenic factors (Water Quality Regulators)
- Determine harvesting seasonal strategy and target sampling (Shellfishery Managers)
- Determine when and where to release rehabilitated species (Bird and Mammal Centers)
- Determine whether fisheries and protected species populations are at risk (Resource Managers)

Four concepts relative to Hypoxia / HABS demo

1. **An interconnection of processes is necessary, and several basic processes are in the overlap with ESPC**
2. **Prior work indicates a complex interaction between physical processes and biological. No one factor has dominance, but statistical studies have shown skill.**
3. **Not all ESPC inputs will result in greater predictability in all areas under all situations. Equally, a null result is just as unlikely. Not all ESPC inputs will result in no greater predictability in all areas under all situations.**
4. **Downscaling will be a critical factor in the demonstration. Connecting physical and biological understating requires local expertise**

ESPC Roadmap

2010-2011

- Planning, First ESPC scientific workshop (Boulder, CO Sep 2010)

2012-2013

- Interim Scientific Steering Committee formed, ISSC workshop (Silver Spring, MD, Mar 2012)
- Proposed demonstration systems for IOC at 2018, Demo workshop (Nov 2012)

2013-2017

- Construct implementation plan for each demonstration project
- Develop a better understanding of the bounds on prediction skill at various time and space scales in the current “skill nadir”
- Implement systematic improvements in Research towards Operations
- Conduct verification and validation with common metrics

2018

- Initial Operational Capability (IOC) towards a FOC by 2025

FY13	FY14	FY15	FY16	FY17	FY 18
Ensure agency and academic integration with ecological operational roadmap					
Improve upon existing tactical scale (3-5 day) forecasts to guidance (7-30 day)					
Quantify guidance forecast (7-30 days) errors					
Demonstrate extended forcing connections related to atm,ocn,land variables					
Quantify errors in atm,ocn,land variables					
Development of extended biological components					
Identify obs gaps to correct for spatial sensitivity vs. errors in long term forecasts					
Integrate ensemble forecast inputs (atm, ocn, initial biological distribution, …)					
Estimate errors through demonstration of ensemble forecast (preoperational assessment)					
Metrics development					

Implementation Plan, ongoing and planned work

Implementation of an operational model for prediction of Alexandrium fundyense blooms in the Gulf of Maine

Modeling Hypoxia and Ecological Responses to Climate and Nutrients

Mechanism of harmful algal bloom initiation in the western Gulf of Mexico

The Columbia River plume and the HABs in the Pacific Northwest: bioreactor, barrier or conduit?

A Regional Comparison of Upwelling and Coastal Land Use Patterns on the Development of HAB Hotspots Along the California Coast

Mechanisms Controlling Hypoxia: Integrated Causal Modeling

Integrated Ecosystem Modeling of the Causes of Hypoxia

Implementation Plan

Coordinate with NOAA Ecological Forecast Roadmap

Bring present related work into ESPC demo implementation plan

- **Long term forecast development**
- **Observations necessary to demonstrate skill**

Add identified development not presently addressed

Brief plan and 'holes' to ESPC Executive Steering Group

Advocate advancements through

- **PCMHABS (Prevention, Control , Mitigation of HABS)**
- **MERHABS (Monitoring and Event Response of HABs)**
- **CHRP (Coastal Hypoxia Research Program)**
- **NGOMEX (Northern Gulf of Mexico Hypoxia and Ecosystem Assessment Program)**
- **IOOS Coastal Ocean Modeling Testbed**

Discussion