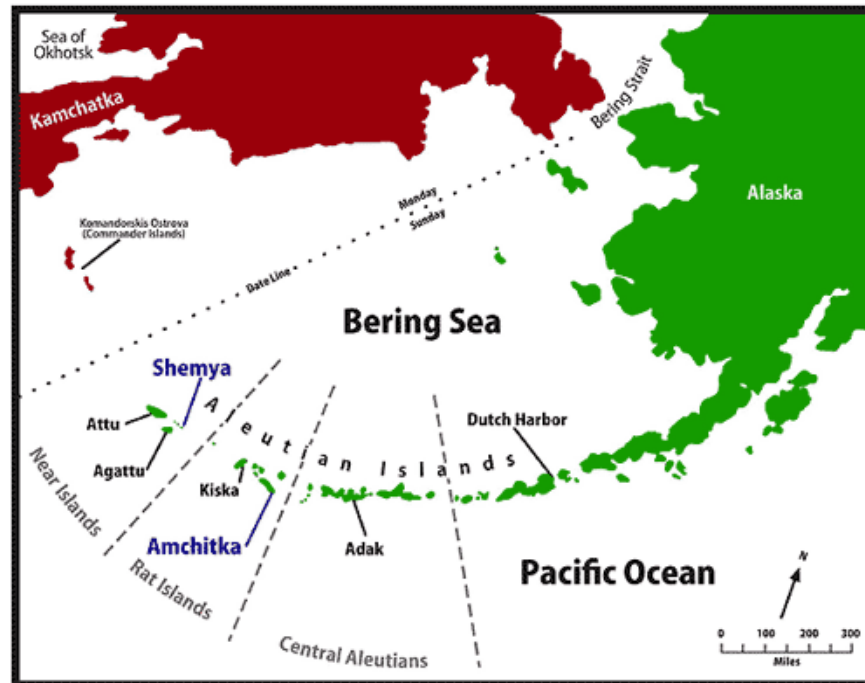


Downscaling Climate Model Projections for Marine Ecosystem Applications

Nick Bond, University of Washington/JISAO and NOAA/PMEL



Collaborations featuring ABSILCC, UAF (J. Walsh)

Topics

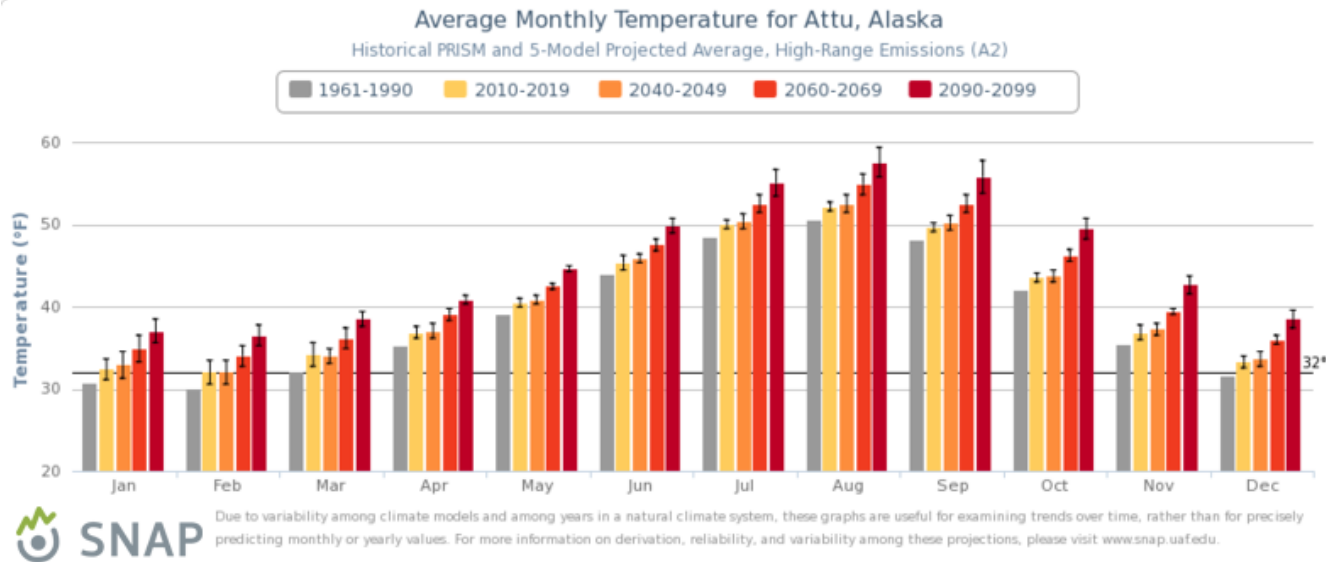
- Long-term projections from Scenarios Network for Alaska and Arctic Planning (SNAP) and the Bering Sea project
- Seasonal predictions from J-SCOPE for the Pacific Northwest coast

Downscaling of global climate models by SNAP (Scenarios Network for Alaska and Arctic Planning)

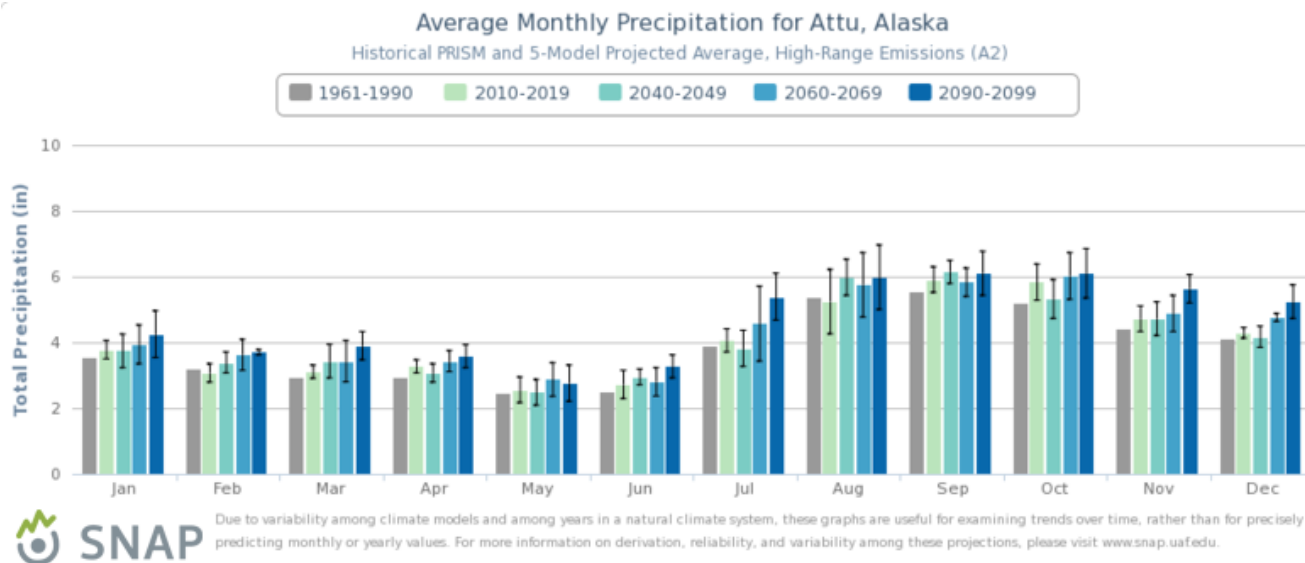
- **A set of 20+ models were compared with data (1958-2000) for surface air temperature, sea level pressure, and precipitation**
- **Models that perform best over Alaska have been selected**
- ***Two statistical downscaling methods:***
one for monthly means by decade,
one for changes in extremes



Decadal temperature and precipitation, A2 scenario: Attu, AK

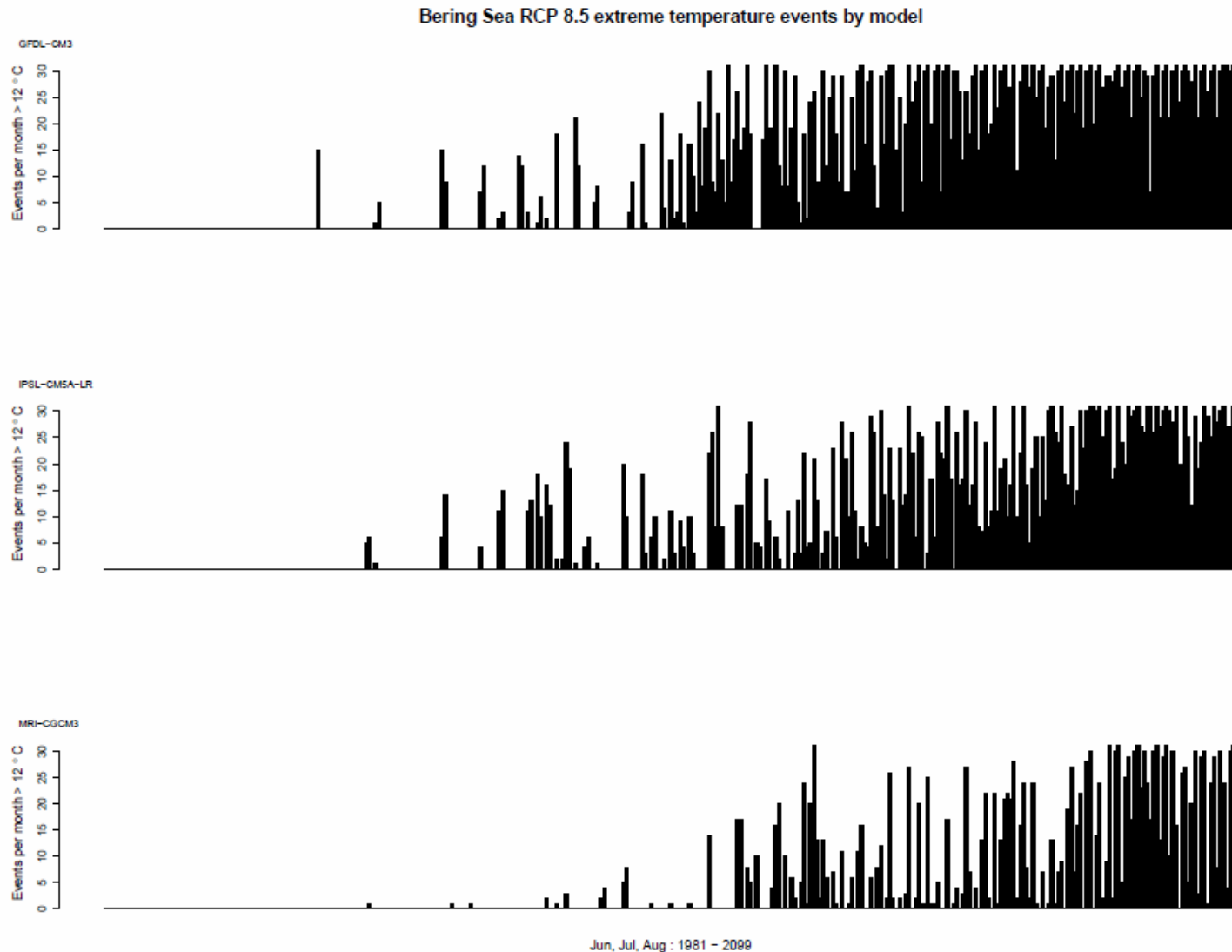


Temperature



Precipitation

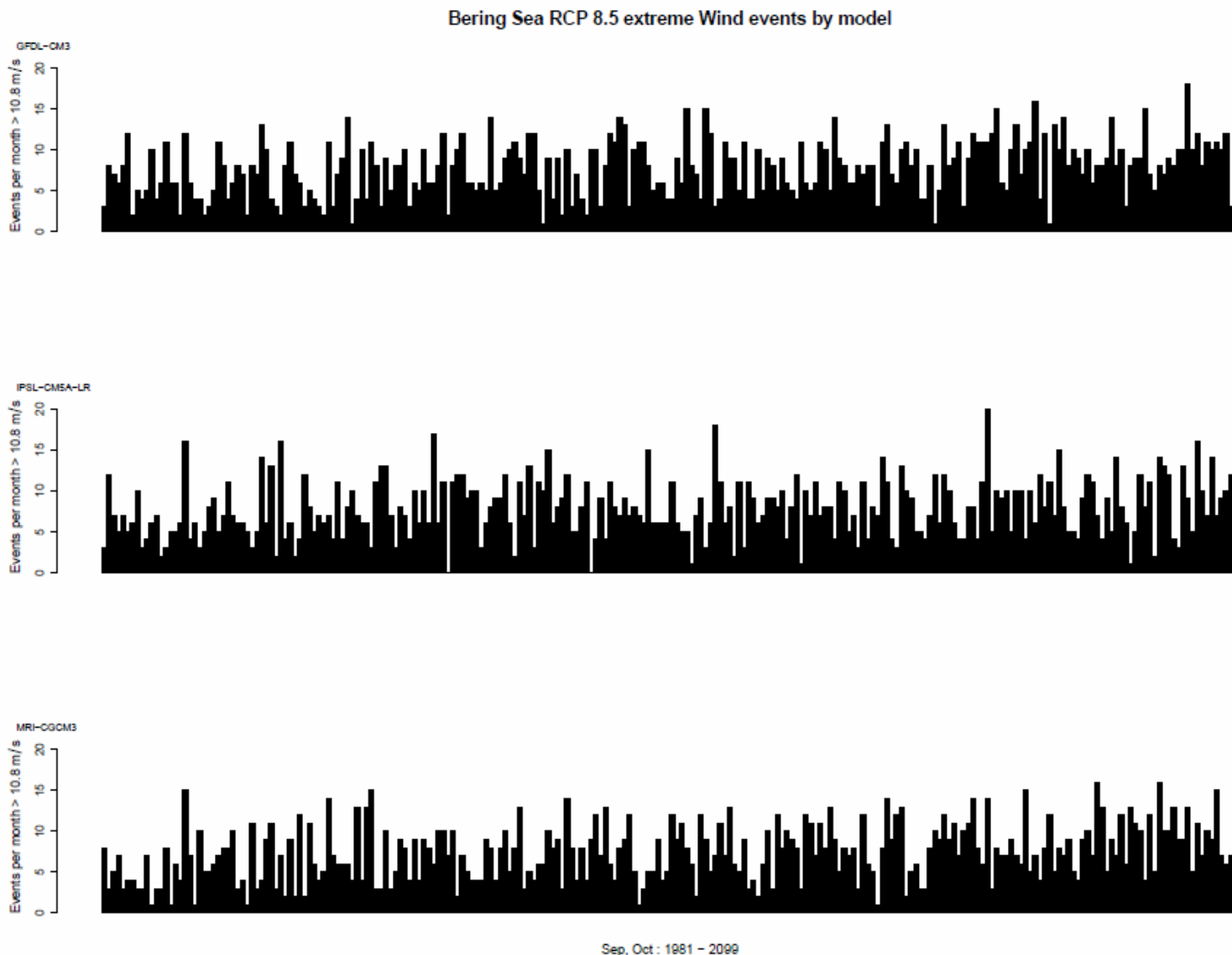
Episodic Events: # of days with average temperature $> 12^{\circ}\text{C}$ Bering Sea, Jun-Aug 1981-2099, 3 models (RCP 8.5) *-- large increase in summer days warmer than 54°F*



Episodic Events: # of days with average windspeed >10.8 m/sec

Bering Sea, Sep-Oct 1981-2099, 3 models (RCP 8.5)

-- increase in autumn storminess



Dynamical Modeling for the Bering Sea Project

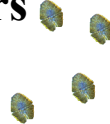
Higher trophic levels
(Pollock etc.)



Secondary Producers
(Zooplankton)

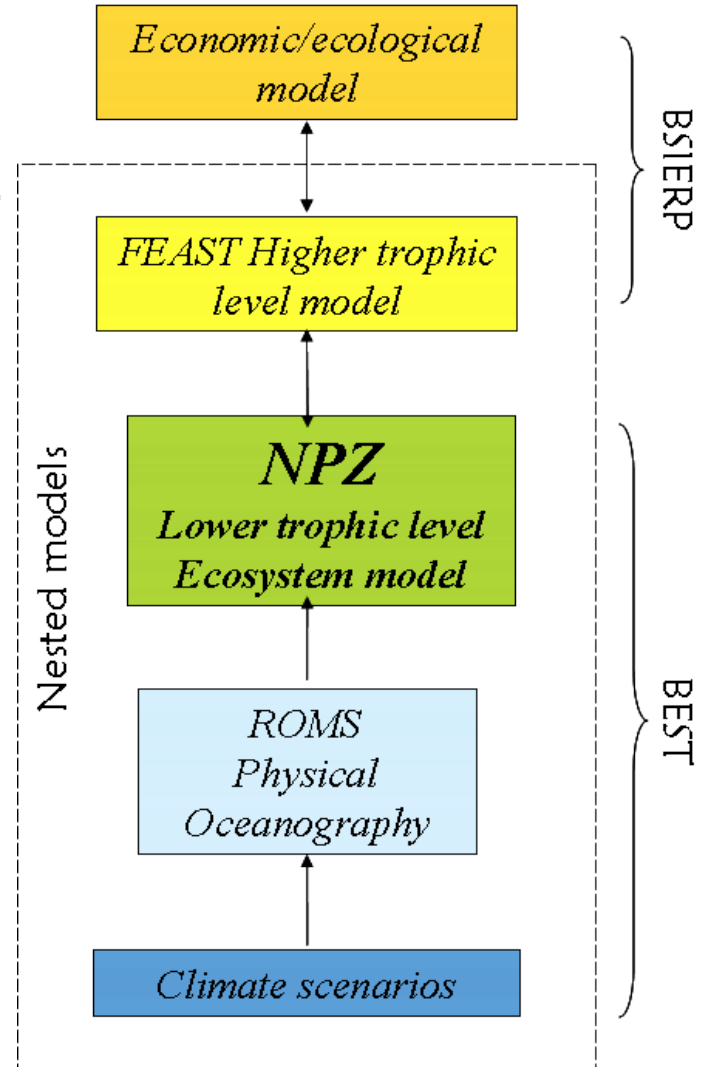


Primary Producers
(Phytoplankton)



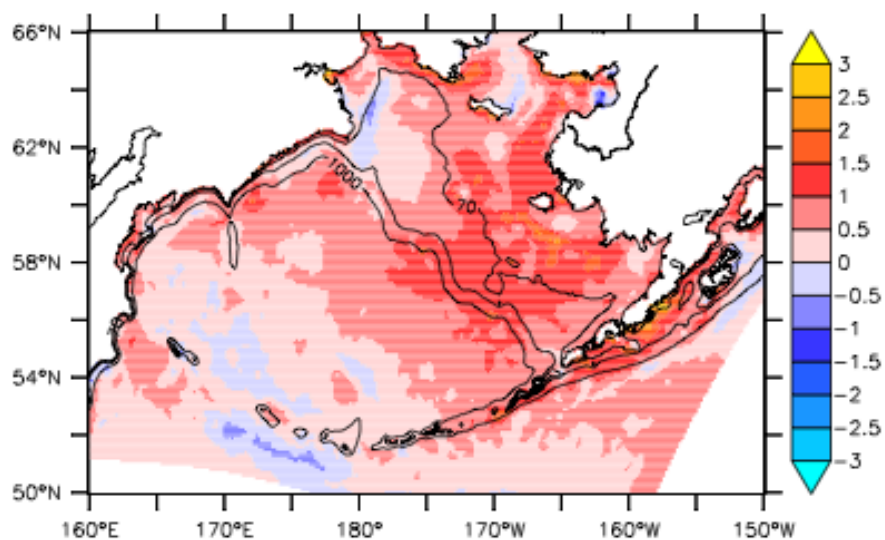
Nutrients
 NO_3 , NH_4 ...

Physical Forcing
(Wind, temp, sun)

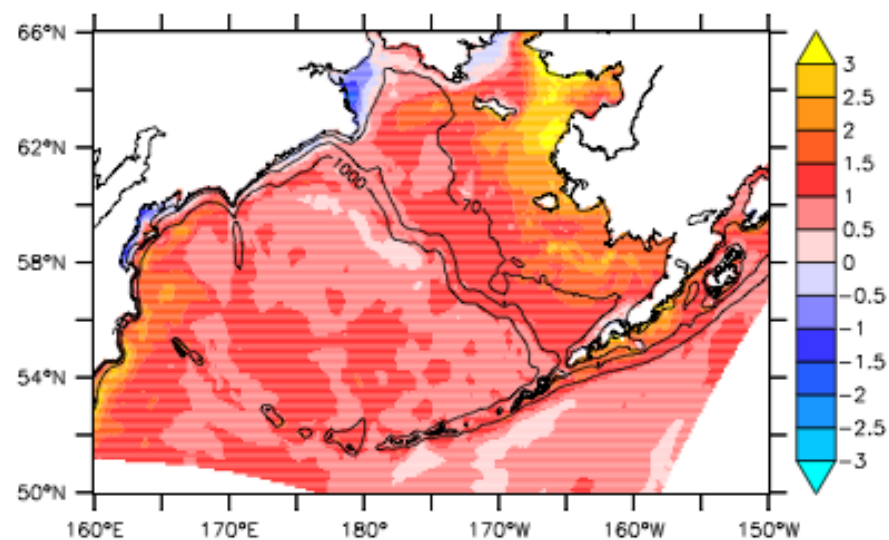


Surface Temperature Changes (August) from Present to 2030s

Al Hermann, UW



CCCMA



MIROC

◀ Back to Search Results

Layer Metadata ⓘ

Map ↻

Download ▾

Ice Phytoplankton Concentration

+ Add to queue

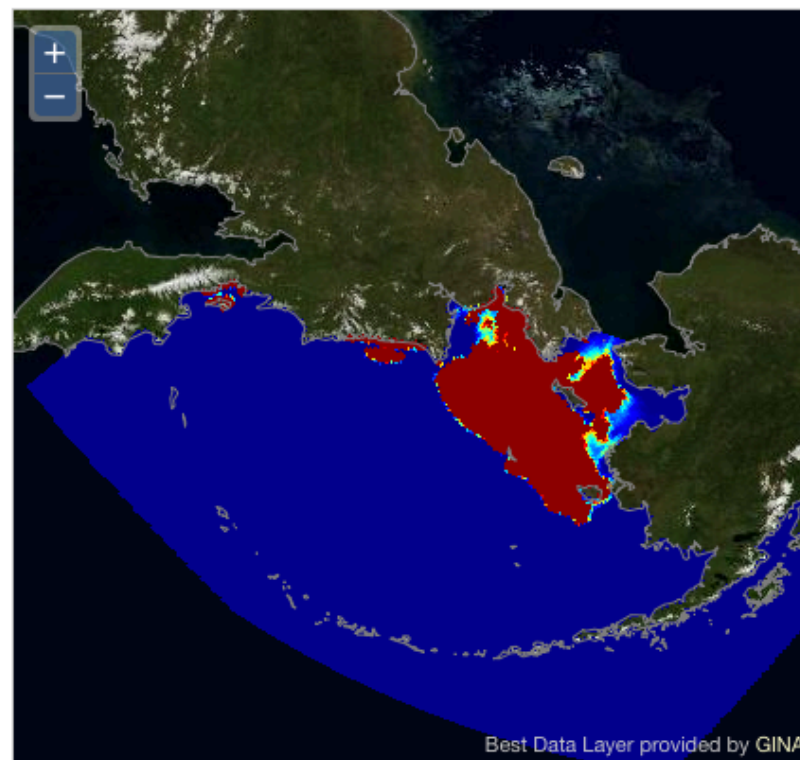
• **Date Range:** 12/29/2002 04:00 - 12/04/2039 04:00

The modeled concentration of Ice algae averaged over time.

Data set

PMEL MIROC Climate Model

NOAA's Pacific Marine Environmental Laboratory (PMEL) produced downscaled climate forecasts from three global climate models for the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report (AR4). This product contains one of the models: the Model for Interdisciplinary Research on Climate (MIROC)-M model developed by a consortium of agencies in Japan. Compared to other models tested by PMEL, MIROC-M was intermediate in degree of warming over the Bering Sea shelf for the first half of the 21st century.



05/07/2034 05:00



0 Meters ▴

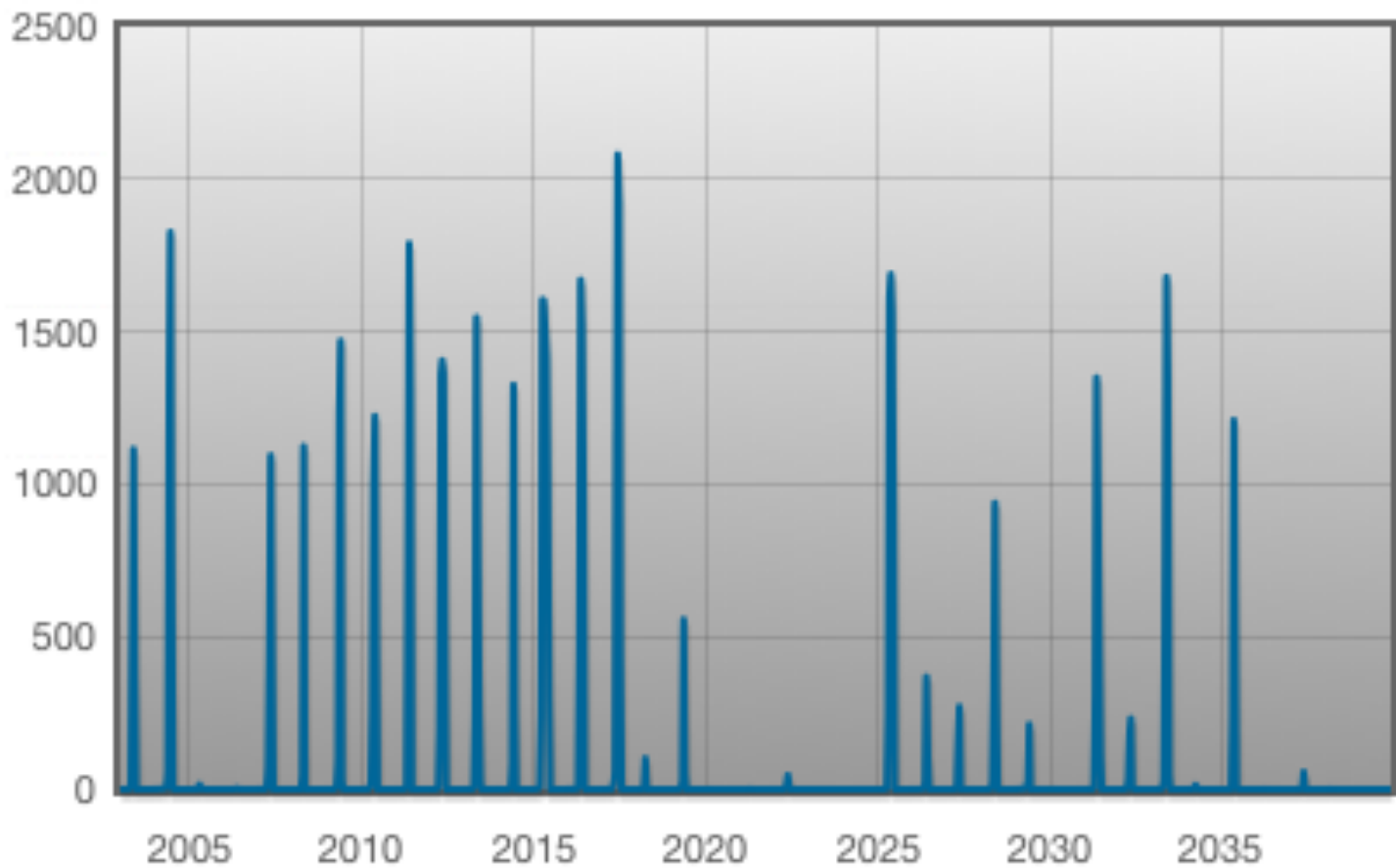
Virtual Sensor




ice_phytoplankton_concentration [mgC/m2]



Time Series for a Location West of Nunivak Island based on Climate Forcing from MIROC



 [Download time series data](#)

ice_phytoplankton_concentration [mgC/m2]

A Couple of Takeaways

- Dynamical downscaling and empirical approaches are being used with global climate models for various types of applications
- Extreme/episodic events can be a key aspect of the climate forcing of a system, complicating long-term projections
- Check out www.snap.uaf.edu &

<http://data.aos.org/maps/search/arctic.php?#search?q=pmel&tagId=null&page=1>

Google “AOOS Arctic Data Integration Portal” and Search “PMEL”

J-SCOPE

J-SCOPE



JISAO's Seasonal Coastal Ocean Prediction of the Ecosystem (J-SCOPE)

Nick Bond, Al Hermann, Jan Newton, Samantha Siedlecki (UW)
**Isaac Kaplan, Phil Levin, Bill Peterson, Greg Williams (NOAA/
NWFSC)**

1. Brief Description of System

2. Early Results

	Juvenile Migration Year				Adult Return Outlook	
	2010	2011	2012	2013	Coho 2014	Chinook 2014
Large- scale ocean and atmospheric indicators						
PDO (May – Sept)	■	■	■	■	●	●
ONI (Jan-Jun)	■	■	■	■	●	●
Local and regional physical indicators						
Sea surface temperature anomalies	■	■	■	■	●	●
Coastal upwelling	■	■	■	■	●	●
Deep water temperature and salinity	■	■	■	■	●	●
Local biological indicators						
Copepod biodiversity	■	■	■	■	●	●
Northern copepod anomalies	■	■	■	■	●	●
Biological spring transition	■	■	■	■	●	●
Winter Ichthyoplankton	■	■	■	■	●	●
Spring Chinook Salmon--June	■	■	■	■	--	●

Key ■ good conditions for salmon ● good returns expected
 ■ intermediate conditions for salmon — no data
 ■ poor conditions for salmon ● poor returns expected

Salmon returns are linked to conditions encountered by young salmon during their first summer at sea

B. Peterson NOAA/NWFSC

Elements of Forecast System

- Large-scale atmospheric and oceanic conditions provided by NCEP's Coupled Forecast System (CFSv2) model
- Dynamical downscaling (~1.5 km grid) with the Regional Ocean Modeling System (ROMS) with a lower-trophic level (NPZD2) module
- ROMS output used in an integrated ecosystem assessment
- Projections publically available on the NANOOS website

Regional Ocean Modeling System (ROMS)

1.5 km grid spacing

Tides

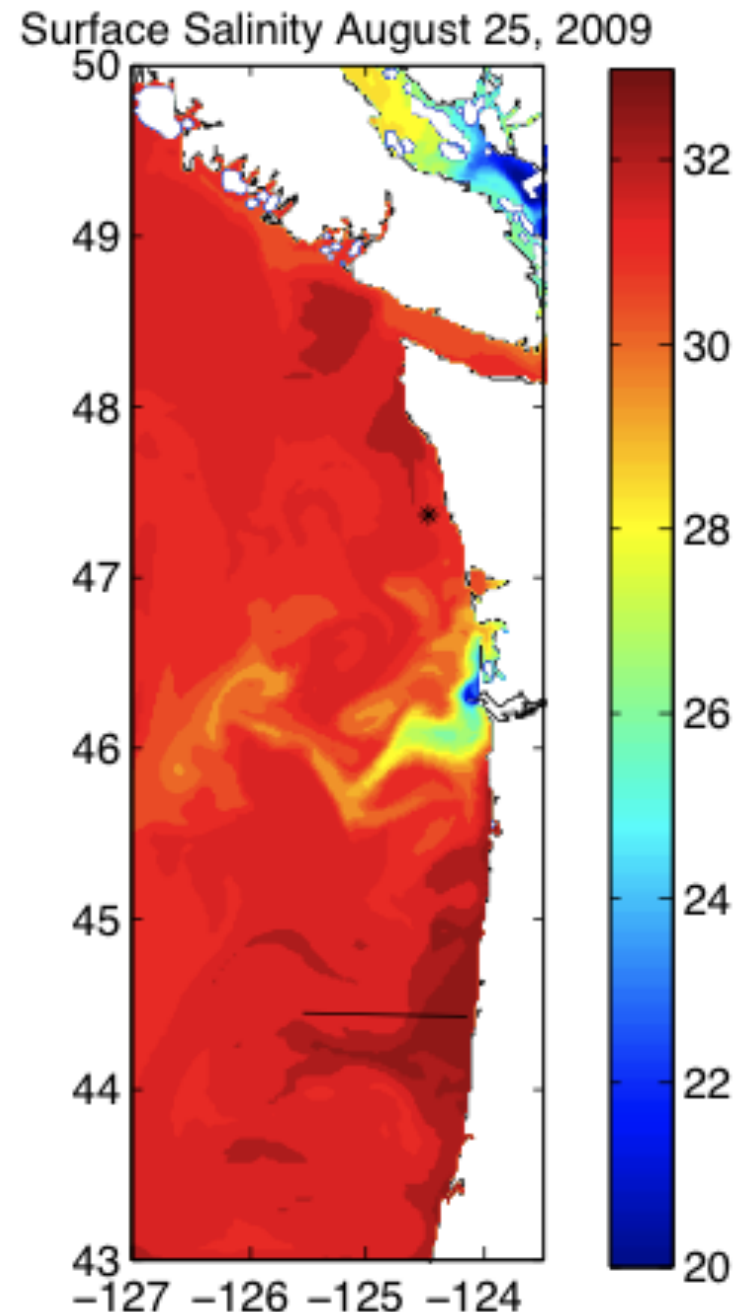
Climatological freshwater runoff

NPZD module from Banas et al. (2009) with
additional detrital and oxygen sub-model

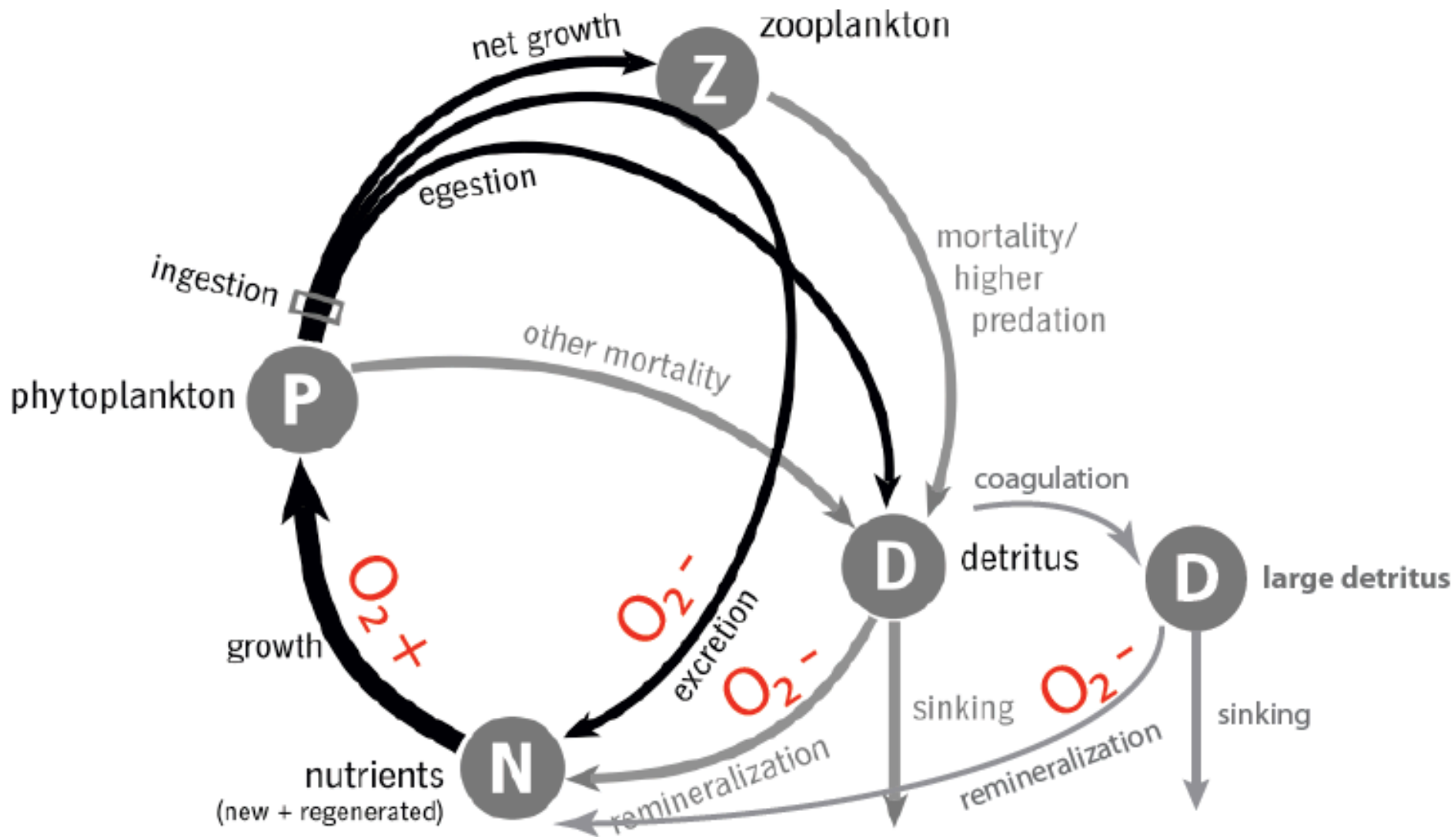
Algorithms using oxygen and temperature
to derive pH and aragonite undersaturation

Nitrate and oxygen values for initial and
boundary conditions based on CFSv2
salinity and observed relationships

Phytoplankton and zooplankton set as
seed stocks at ROMS boundary



Focus on the biogeochemistry (pH, $p\text{CO}_2$, $p\text{O}_2$); Banas et al. (2009)







NANOOS

Welcome to NANOOS, the Pacific Northwest regional ocean observing system of IOOS (Integrated Ocean Observing System). NANOOS is creating customized information and tools with these areas of emphasis:

[Maritime Operations](#)[Ecosystem Assessment](#)[Fisheries & Biodiversity](#)[Coastal Hazards](#)[Climate](#)

[Home](#)
[About NANOOS](#)
[Join NANOOS](#)
[Contact Us](#)
[Disclaimer](#)
[Site Map](#)

[NVS](#)
[Products](#)
[Mobile Apps](#)

[Education](#)
[Resources](#)

[Log In](#)
[New Account](#)



Data Exploration

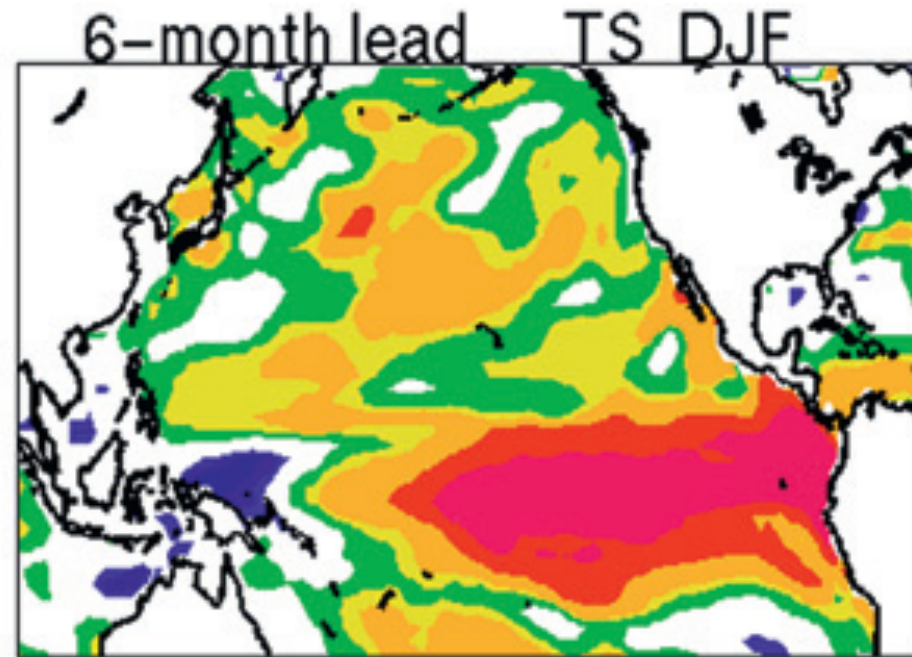
NVS (NANOOS Visualization System) is a web app that provides easy access to observations, forecasts, data, and visualizations.



Ocean Acidification in the Pacific Northwest

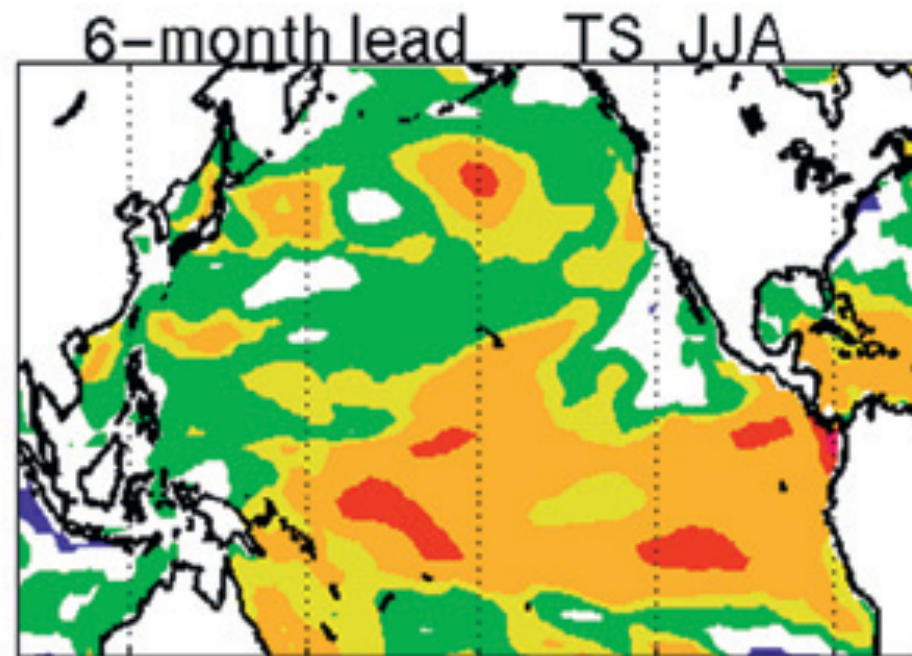
The marine waters of the Pacific Northwest are particularly vulnerable to ocean acidification. NANOOS, with its partners, is collecting and making available ocean acidification related water quality data from sensitive areas along the coast and within Puget Sound.

[Visit the OA Page](#)[NANOOS and the Shellfish Industry](#)

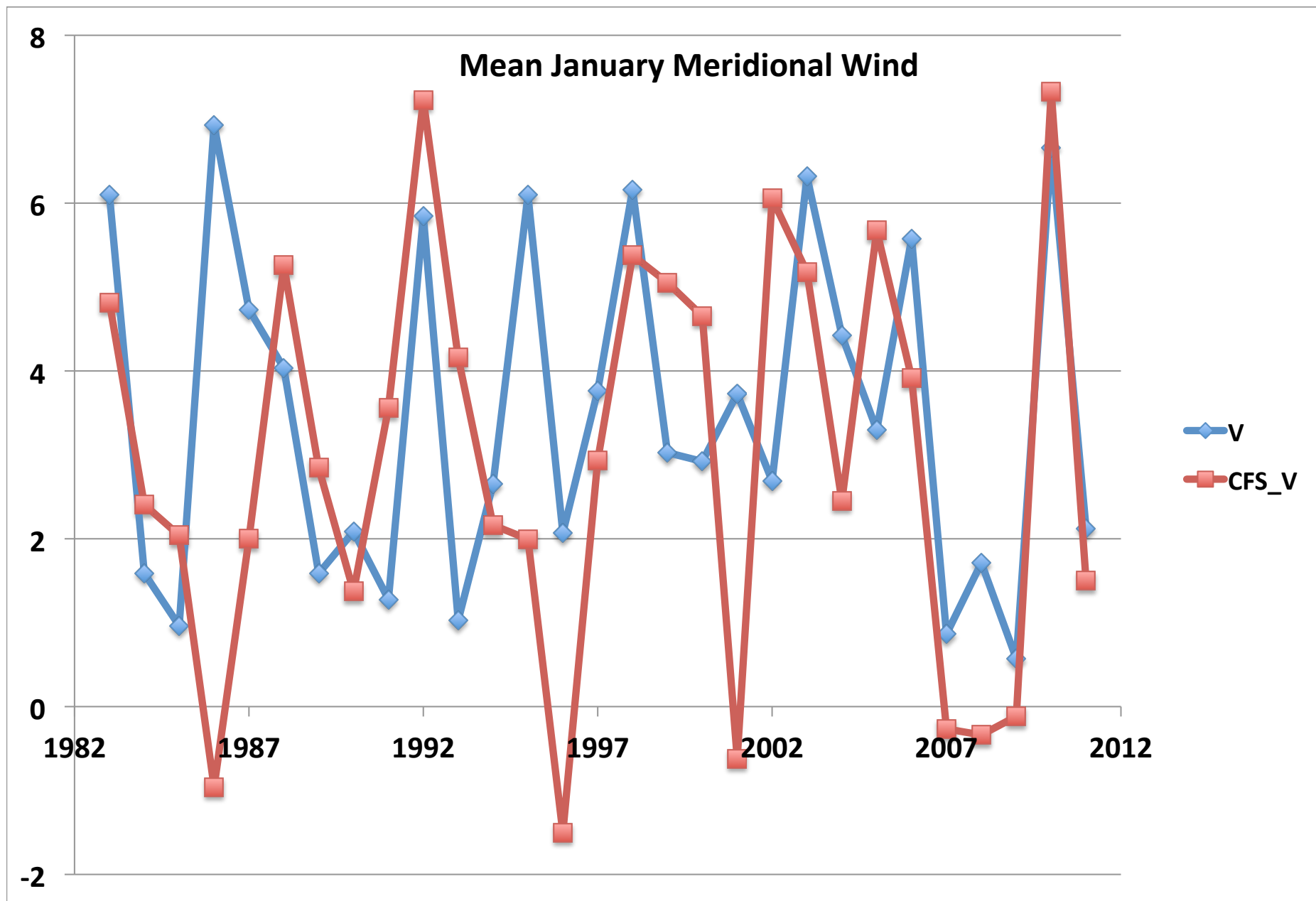


Wen et al. 2012

Seasonality of
Correlation
Skill in SST
Forecasts

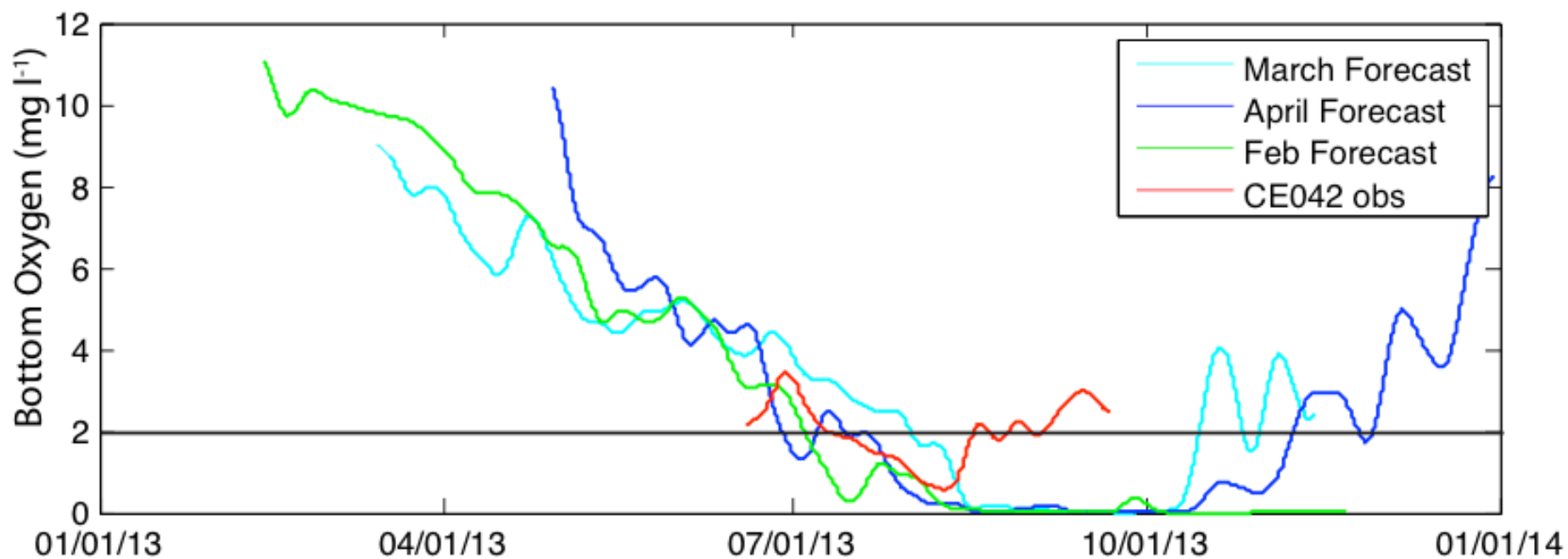


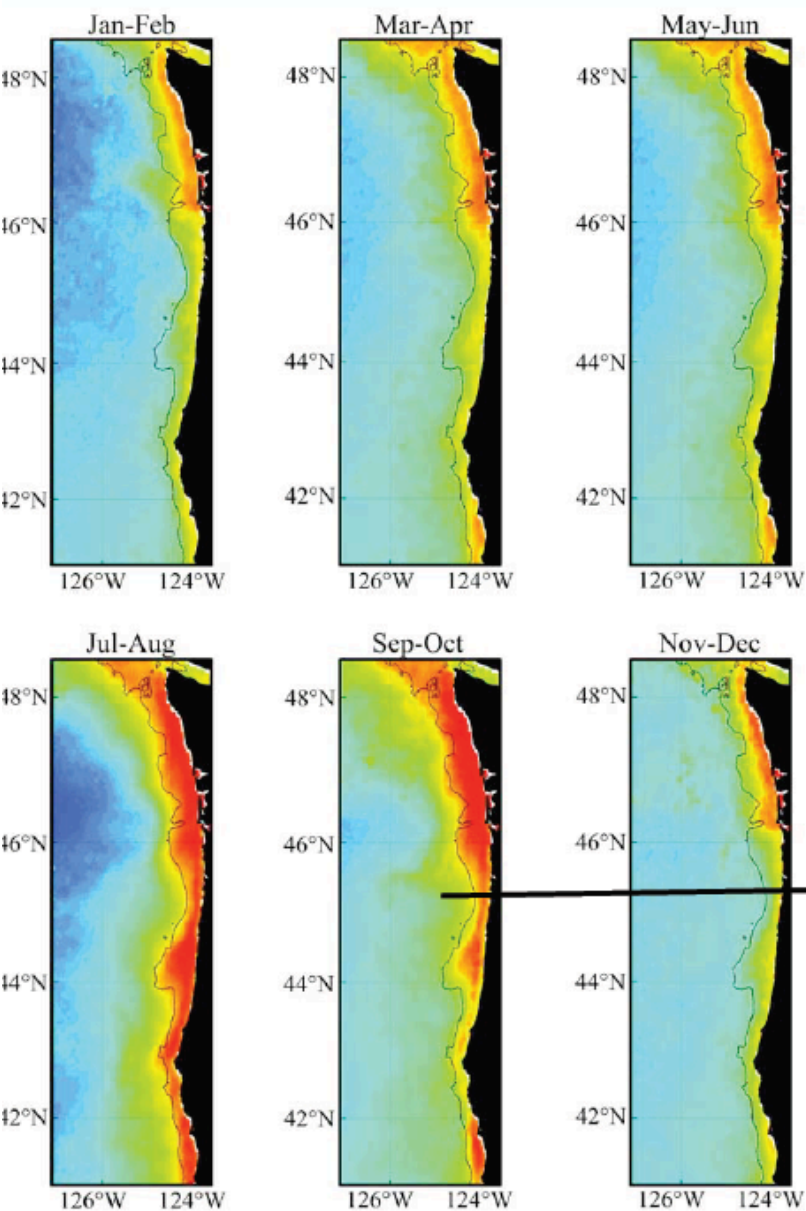
120E 160E 160W 120W 80W



6 month forecasts (initialized previous July) for 43-49 N, 128-124 W

Oxygen Concentrations off the Washington Coast



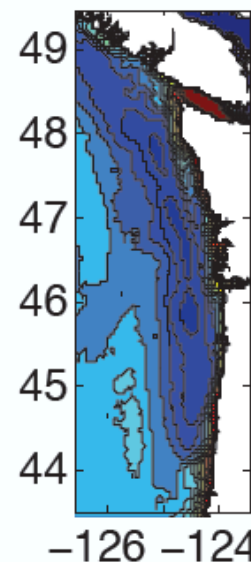


Venegas et al, 2008

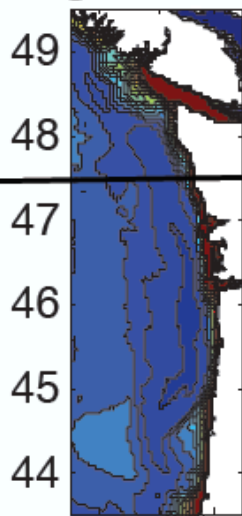
Surface Chl Climatology



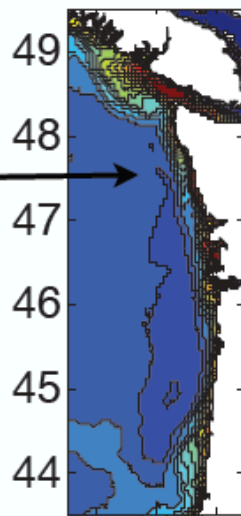
May–June 2014



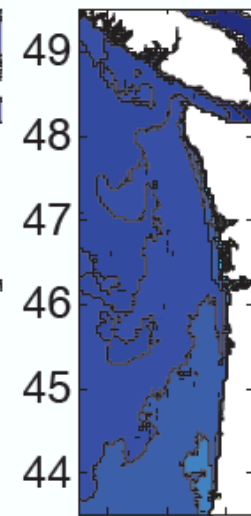
**July–
August 2014**



**Sept–
Oct 2014**



Nov–Dec 2014



Sept 2014 is higher than average
but closer to the coast

Too Warm

Too Much Primary Productivity

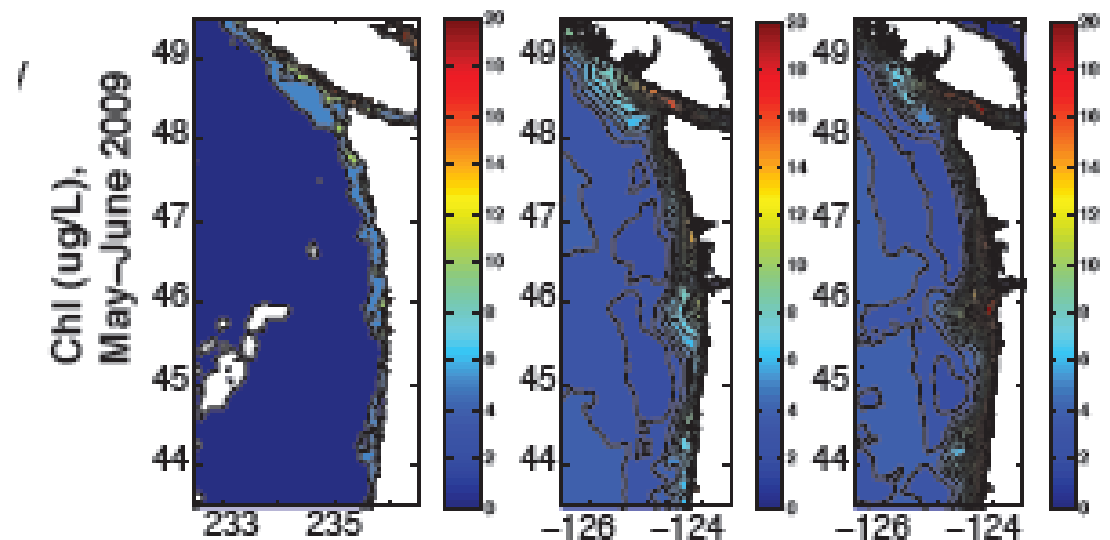
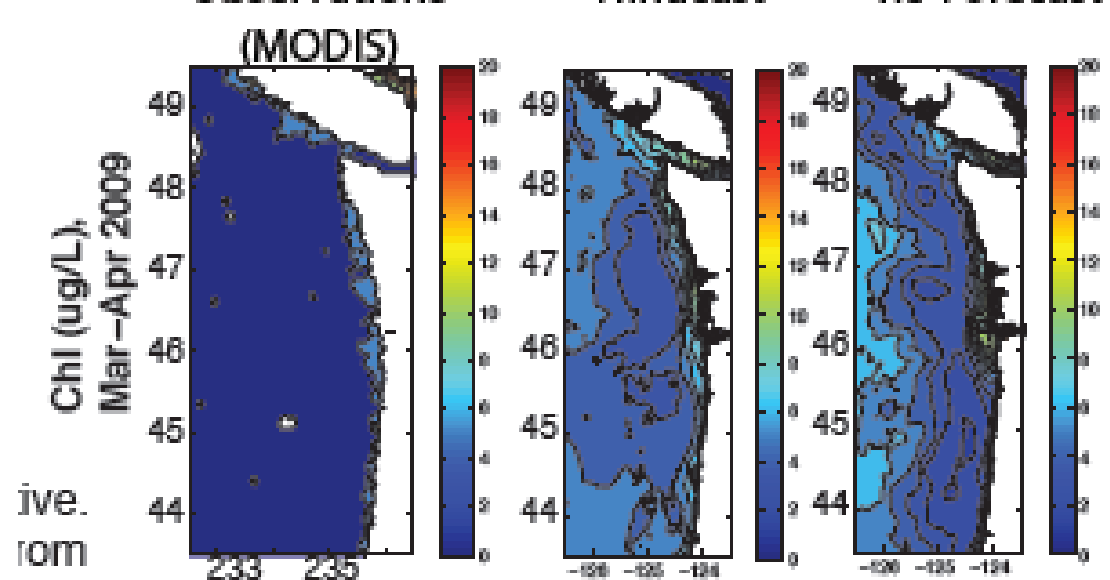
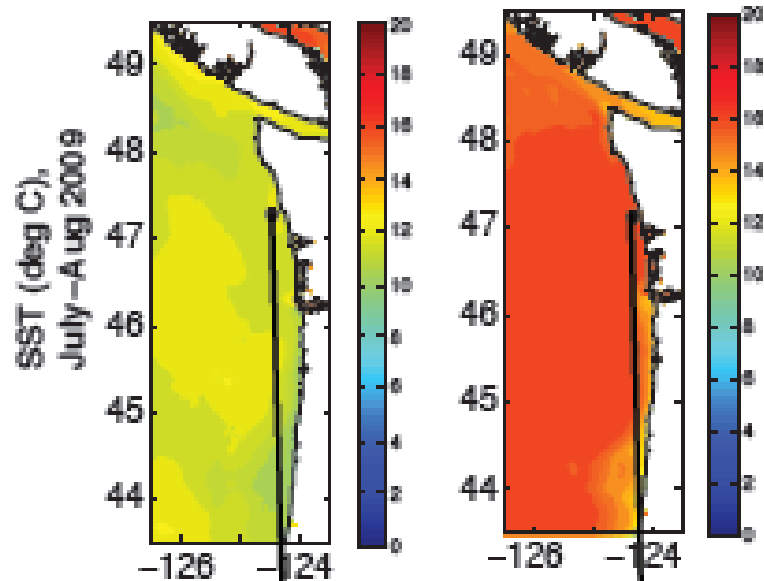
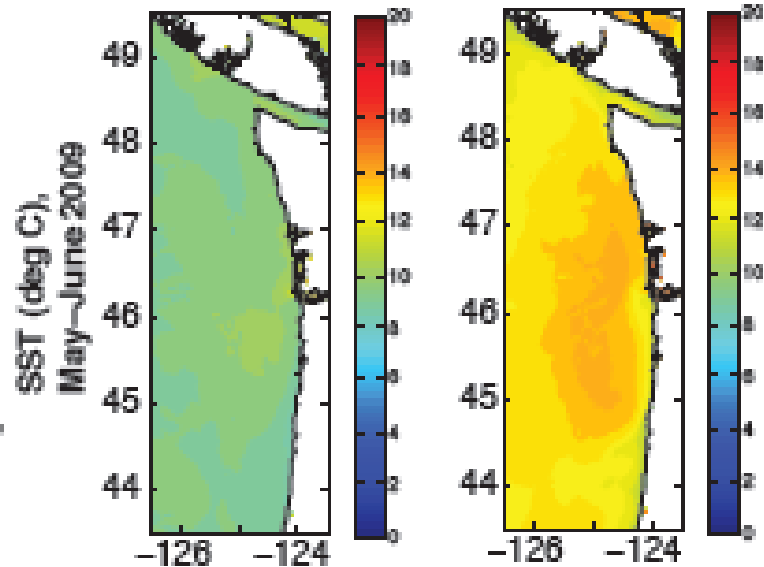
Hindcast

Re-Forecast

Observations

Hindcast

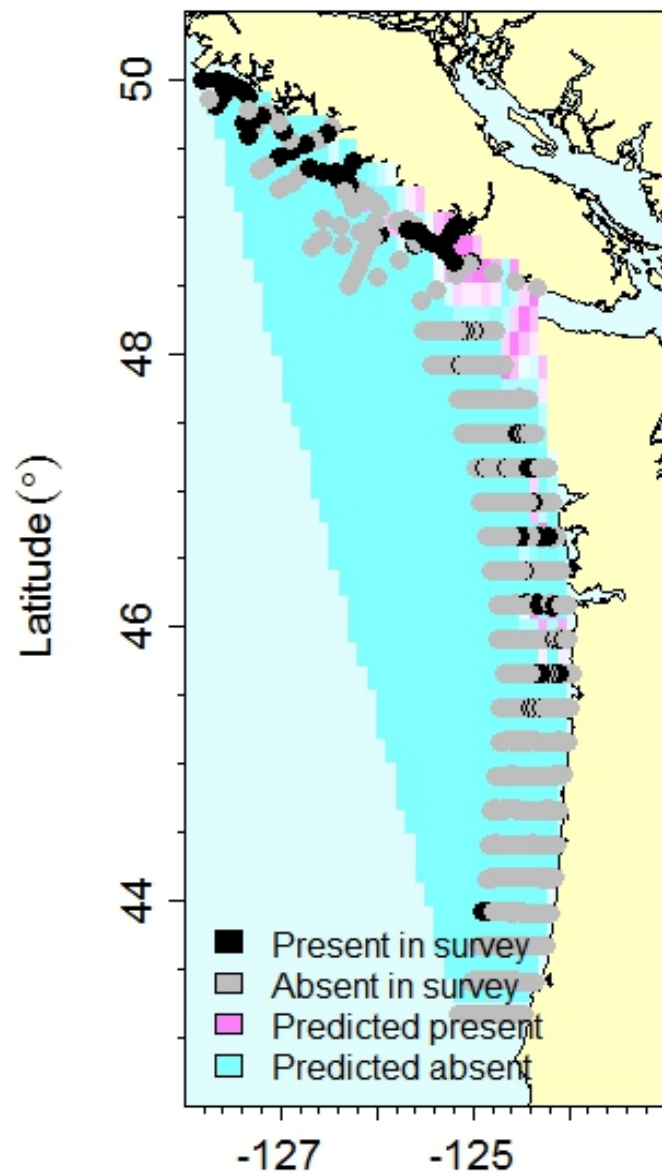
Re-Forecast



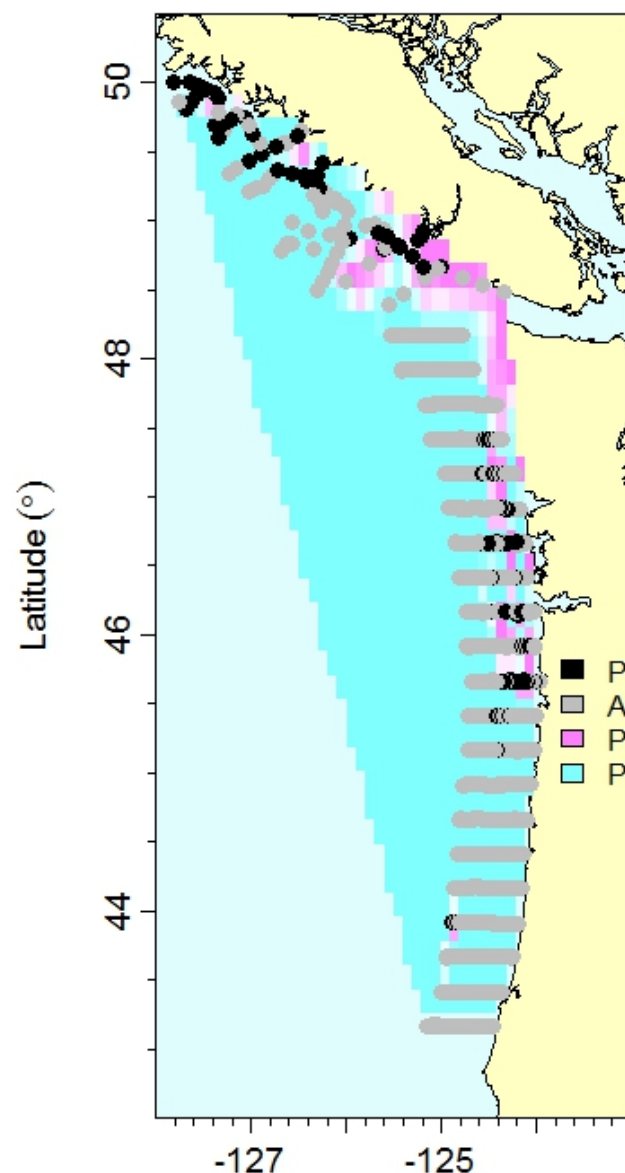
Systematic Errors from ROMS Simulations

Predicted vs. Observed Presence of Sardines in 2009 based on ROMS re-forecasts of T, Salinity, Chl, O2 (Kaplan et al.)

Simple Model



Complex Model





J-SCOPE

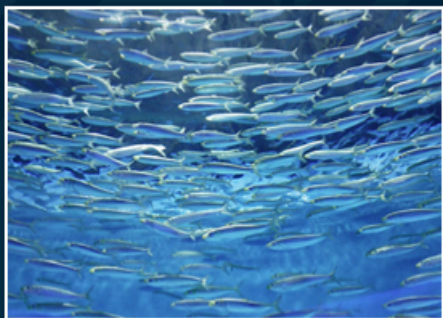
JISAO Seasonal Coastal Ocean Prediction of the Ecosystem

Home
Forecasts
About the Model
Hindcast
People
Partners
Notices
Disclaimer
Contact



An ecosystem is: "The functional unit of a biological organization interacting with the physical environment such that the flow of energy and mass leads to a characteristic trophic structure and material cycles." ~ Odum, 1969.

NOAA further defines the environment as "the biological, chemical, physical, and social conditions that surround organisms. When appropriate, the term environment should be qualified as biological, chemical, and/or social" (Murawski and Matlock 2006).



The J-SCOPE forecasts are developed to support the [California Current Integrated Ecosystem Assessment](#). Integrated Ecosystem Assessments (IEAs) are a framework for informing ecosystem-based management, which aims to take into account interactions among ecosystem components and managed sectors, as well as cumulative impacts of a wide spectrum of ocean-use sectors ([Rosenberg and McLeod 2005](#)). IEAs are a synthesis and quantitative analysis of information on relevant natural and socioeconomic factors, in relation to ecosystem management objectives ([Levin et al. 2009](#)).

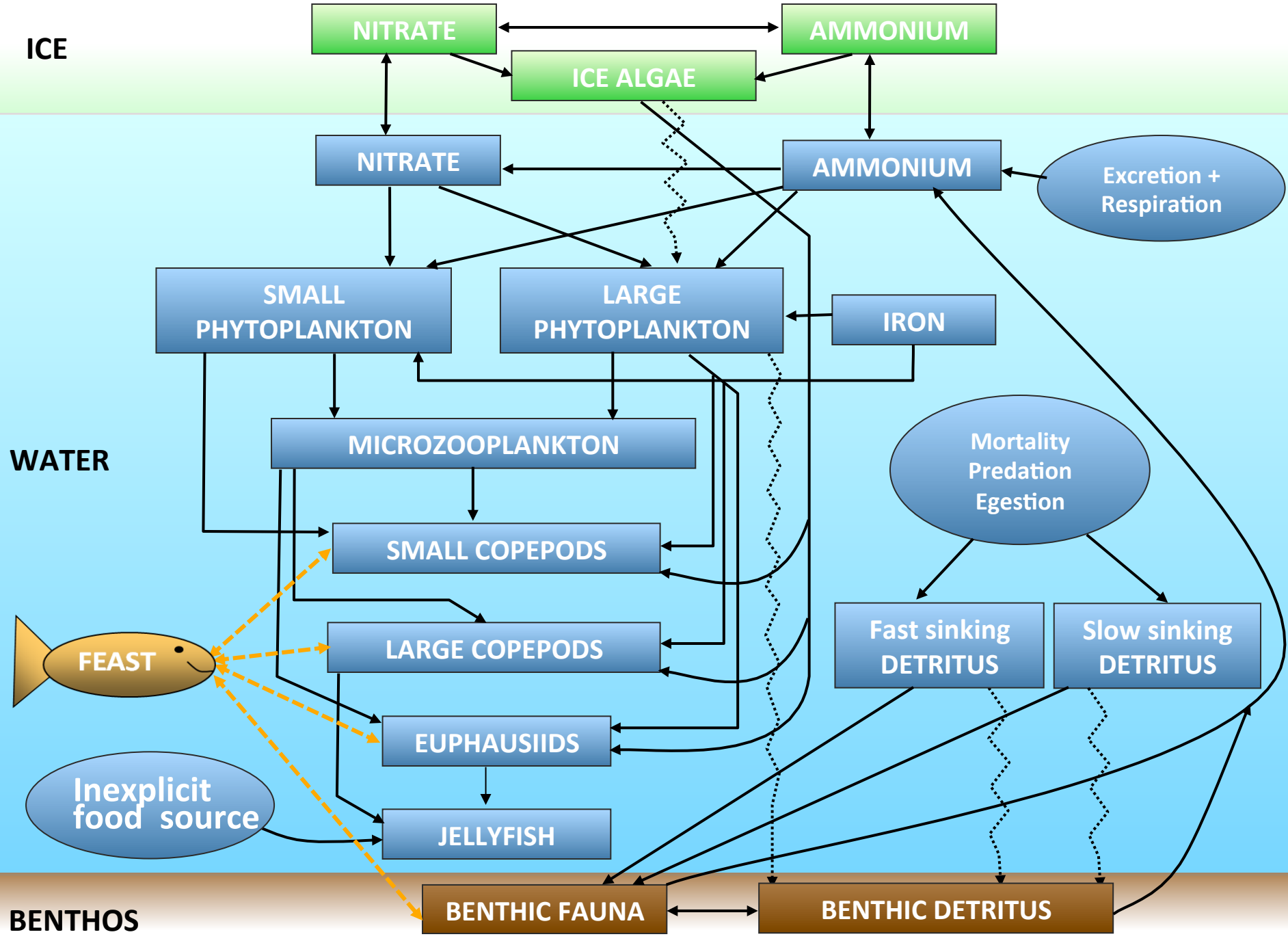


In the context of the California Current IEA, JSCOPE provides short term (six to nine month) forecasts of ocean condition that are testable and relevant to management decisions for fisheries, protected species and ecosystem health. Results will directly inform the IEA process, and will forecast indicators requested by the [Pacific Fishery Management Council](#).



Final Remarks

- Downscaling from global climate models has been undertaken under the auspices of the SNAP and Bering Sea projects
- A seasonal prediction system (J-SCOPE) has been developed for the coastal waters of the PNW
- A similar effort is beginning for the Bering Sea



FEAST

11 ages/ 15 lengths
high detail

15 lengths
medium detail

biomass pools
low detail

NPZ

