Seasonal Forecasts of Biogeochemistry in the CCS: Focusing on the N-CCS

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Check out our website: http://www.nanoos.org/products/j-scope/home.php
Fish of commercial interest have changed in abundance over the past several decades - some linked to environmental data.
Many biological processes are sensitive to changes associated with ocean acidification and hypoxia. These include:

- **Increased mortality** for juvenile shellfish
- Potential **loss of water quality benefits** provided by shellfish
- **Increased risk** for early life stages of Dungeness Crabs
- Potential **increase in toxicity** of harmful algal blooms
- **Impacts on the nervous system** of some fish
- **Increased mortality** among pteropods (a type of plankton) - with potential food web impacts to higher trophic levels like salmon
A lot of spatial/temporal variability in corrosive water ($\Omega$) and hypoxia

Feely et al., 2008; Hickey and Banas, 2008
Seasonal decline on the shelf in bot. oxygen

Observations from Connolly et al, 2010; Hickey, unpublished
ENSO and hypoxia or OA

- Bottom oxygen in Oregon, inter annual variability correlated with NPGO
- In California, El Nino events correlated to higher oxygen and pH, while La Nina events are correlated with lower oxygen and pH.

(Nam et al. 2011)
What is needed to build a regional forecast system for ocean conditions?

- **Observational network** with real time data access capabilities.
- Working **hindcast simulations** - regional models that can predict oxygen and/or pH variability over timescale(s) of interest on the shelf, in the past
- **Predictable winds in the region** on the timescale(s) of interest in the global model used to drive the regional model
- **Predictable SST in the region** on timescale(s) of interest in the global model used to drive the regional model
- **Stakeholder group(s) needs identified**
- **Metric of uncertainty**
- **Continued testing** and comparisons with observations on varying time and space scales…. because these are works in progress!

*Siedlecki et al. 2016; Hobday et al. 2016; Tommasi et al. in prep*
JISAO’s Seasonal Coastal Ocean Prediction of the Ecosystem (J-SCOPE)

Check out our website:

Siedlecki et al, 2016
Building a Forecast System

Climate Forecast System (CFS) - ocean boundary conditions and atmospheric forcing (Ocean: ~50km, Atm: ~200km resolution)

CFS + UW CMG regional ROMS-based model with biogeochemistry (~1.5 km resolution)

Biogeochemical model including Oxygen (Siedlecki et al., 2015) and new DIC and TA
Mini-Ensemble Forecasts 2015-Onset of Oxygen decline at Cha’ba
J-SCOPE Climatology: Extending our records in time and space

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Bottom O₂ Anomaly
Forecasts show ocean conditions are predictable on Seasonal Timescales.
J-SCOPE
January 2016
OA Forecasts

Check out our website:
Bottom $\Omega$ Anomaly - 2016 forecast

2016 Bottom Oxygen (mg/l), Oregon Shelf

Bottom Oxygen (mg/l)

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan

Hypoxia
Bottom $\Omega$ Anomaly - 2016 forecast

May/June

Bottom Omega, Anomaly - DIC, TA

Jul/Aug

Bottom Omega, Anomaly - DIC, TA

Anomaly from mini-climatology (2009-2014)
J-SCOPE
Habitat/
Ecosystem Indices

Check out our website:
Implications for Marine Food Webs - Pteropods

Particles released along tracks where samples obtained

Particles vertically migrate

Particle tracks run forward and backward in time for 30 days to calculated undersaturation days experienced

Bednarsek et al., in review
Undersaturation Days - a Severity Index

Saturation-state sensitivity of marine bivalve larvae to ocean acidification

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\[
I = T - \Omega_{\text{mean}},
\]

\[
S = I \times D,
\]

\[D = \text{days}, \ T = \text{threshold}\]
30 day Severity Index, T=1.3, surf 50 m

Severity

July 2016

Aug 2016

Sept 2016

Seasat Location
Conclusions

J-SCOPE forecasts (2009, 2013-2014) of subsurface ocean conditions have measurable skill on seasonal timescales, for variables relevant to management decisions for fisheries, protected species and ecosystem health.

Forecasting efforts are aided by a relationship with local stakeholders and a real-time observational network.

Physical and biogeochemical conditions are not enough, we need to move toward indices designed with management in mind - requires these measurements and development is done together.

Long term monitoring is essential to establish these relationships between environmental variables and biological indices, but in the absence of data, a well validated model can be used as well.
Next Steps

Expand forecasts to Multi-Model Ensemble?

Providing output for Pacific Fishery Management Council via Integrated Ecosystem Assessment (IEA)

Applications to additional stakeholders:
- hake
- crab

Validate hake, crab, shellfish indices with data - may require commercial collaborations
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