TESTING TOXIN PREDICTION MODELS IN A CALIFORNIA HAB HOTSPOT

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ABSTRACT

The documented link between upwelling-related physical signatures, macronutrients, and toxigenic *Pseudo-nitzschia* blooms in the various "hotspots" throughout California has motivated attempts to forecast these harmful algal blooms (HABs) as a function of select environmental variables. The Santa Barbara Channel (SBC), CA is one such localized region for toxic diatom blooms in the California Current System with nearly annual toxic events occurring in spring and summer months since 2002. Existing statistical models that use physical, chemical, and bio-optical observations for predicting *Pseudo-nitzschia* abundance and domoic acid (DA) concentration in the SBC are currently being tested in a nowcast mode using spatially-explicit predictions of environmental variables from MODIS ocean color geophysical data and a Regional Ocean Modeling System (ROMS) model for the SBC. Relevant thresholds for each model generate "event" forecasts, and results are validated relative to on-going monthly observations along a channel-wide transect to assess the potential use of model predictions by resource managers. Mesoscale physical processes such as seasonally-occurring eddies that may retain blooms within the SBC are often emergent features in model runs, and these features are compared to high-frequency radar (CODAR) images of daily surface currents. Additional comparisons of model output with domoic acid levels in commercial mussels collected by the CA Department of Public Health demonstrate the disconnect in the relationship between in situ bloom dynamics and the toxin loads measured in nearshore shellfish beds.

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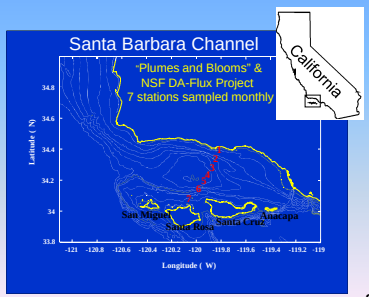
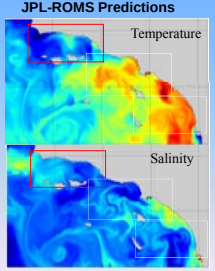
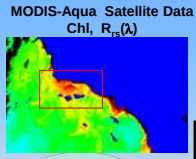
STUDY SITE



HYDRODYNAMIC MODEL + MODIS





BIOGEOCHEMICAL MODEL Embedded in ROMS COMING SOON!

RS HAB Models

STEP 1: Collate relevant environmental variables in near-real time

STATISTICAL MODELS

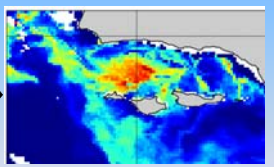
Anderson *et al* (2009) *Harmful Algae*	Significant Predictors FULL MODELS	Significant Predictors *REMOTE-SENSING* (RS) MODELS
***Pseudo-nitzschica* Abundance**	-R_{rs}(412/555) -Silicate:Nitrate ratio -R_{rs}(555) -a_g(490) -R_{rs}(510/555)	-R_{rs}(412/555) -R_{rs}(555) +R_{rs}(510) -Chlorophyll (level 2) -R_{rs}(510/555)
Particulate Domoic Acid	-R_{rs}(510/555) -Silicate:Phosphate -Temperature +Salinity	-R_{rs}(510/555) -Temperature +R_{rs}(490/555) -Day of Year +Salinity
Cellular Domoic Acid	-Temperature +a_g(412) +Salinity -R_{rs}(510/555) -a_g(510)	-Temperature +R_{rs}(412) +Salinity -R_{rs}(510/555) -R_{rs}(510)

HAB Maps

STEP 2: Run RS statistical models on values obtained in STEP 1

HAB NOWCASTS

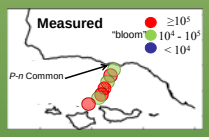
Predicted *Pseudo-nitzschia* & Domoic Acid Distribution



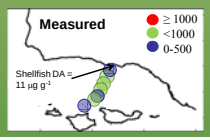
STEP 3: Map-project output from RS HAB models onto the ROMS grid for the SBC

MARCH 20, 2009

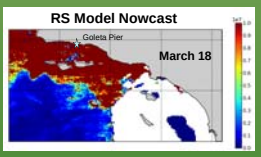
Pseudo-nitzschia Abundance (cells L^{-1})



Particulate Domoic Acid (ng L^{-1})



RS Model Nowcast



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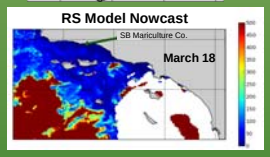
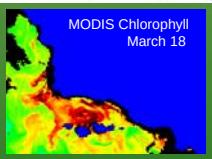
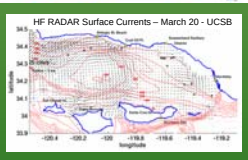


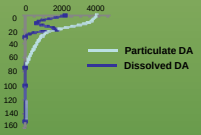




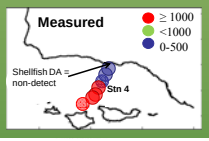
- Model output for March 18 is shown due to unavailability of MODIS data for March 20.
- RS models capture the high *Pseudo-nitzschia* cell abundance & low to moderate pDA measured across the SBC; low nearshore pDA is reflected in the low shellfish DA levels collected from the SBMC site (regulatory limit = 20 µg g^{-1}).
- Elevated DA at mid-channel stations is not reflected in the DA model, but may be a result of the mesoscale eddy seen in CODAR surface current structure and possibly in the MODIS Chl image for March 18 when an eddy feature was already spinning up.
- Cyclonic, convergent eddies in the SBC are often associated with high productivity over the basin (Brzezinski & Washburn, *in review*) and development of a local hotspot of DA during HAB events (Anderson et al., 2006, *MEPS*).

OCTOBER 30, 2009

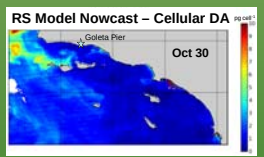
DA Vertical Profile (ng L^{-1}) Station 4



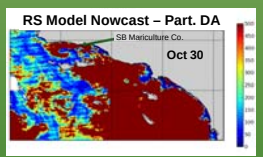
Particulate Domoic Acid (ng L^{-1})

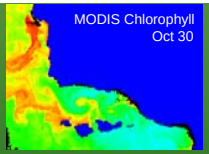


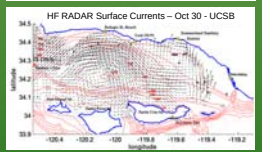
RS Model Nowcast – Cellular DA



RS Model Nowcast – Part. DA



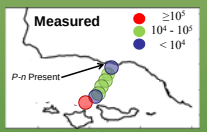




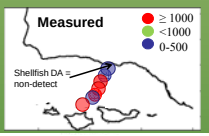
- DA events have generally occurred in Spring and Summer in the SBC, but the region experienced two large DA events in late Fall 2009 (ENSO?), similar to the Monterey Bay (*J. Lane; Oral*, W 2pm*; IT59: Oceans and Human Health, Predicting Harmful Algal Blooms*)
- RS model predictions for pDA are consistent with the more central-channel location of high observed DA concentrations, indicating that the model captures broad patterns in DA.
- Elevated **cellular DA** levels mid-channel are roughly inverse of pDA maxima and may be due to the presence of a cyclonic eddy (CODAR) that appeared to be concentrating biomass (MODIS) over the *central to western basin* where **the vertical profile of very high subsurface pDA & dissolved DA indicates sinking of a late phase surface bloom *or* the presence of a subsurface bloom maximum**.
- DA in shellfish was below detection with Jellett kits from Aug-Dec 2009, but DA-related sea lion strandings were reported from SF to the SBC from Sep-Dec 2009.

NOVEMBER 20, 2009

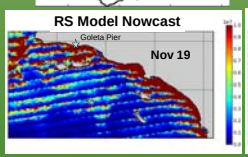
Pseudo-nitzschia Abundance (cells L^{-1})



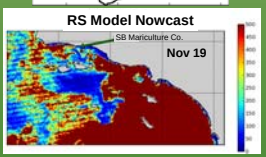
Particulate Domoic Acid (ng L^{-1})

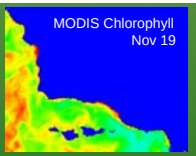


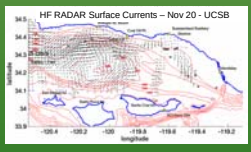
RS Model Nowcast



RS Model Nowcast







- Model output for Nov 19 is shown due to unavailability of MODIS data on Nov 20.
- *Pseudo-nitzschia* cell abundance and DA are generally elevated or high throughout the SBC during the November bloom, although highly patchy within the channel.
- Measured and modeled DA are both high mid-channel, corresponding with another potentially retentive, cyclonic eddy (CODAR) and **high pDA/dDA down to 30 m** (not shown).
- This spatial heterogeneity appears in the RS Model predictions of cell abundance and DA, however satellite noise artifacts potentially increase patchiness.
- Future model output will focus on near-real time moving averages of satellite data filled with the DINEOF interpolation program to improve temporal resolution and overall lead times of HAB predictions.