

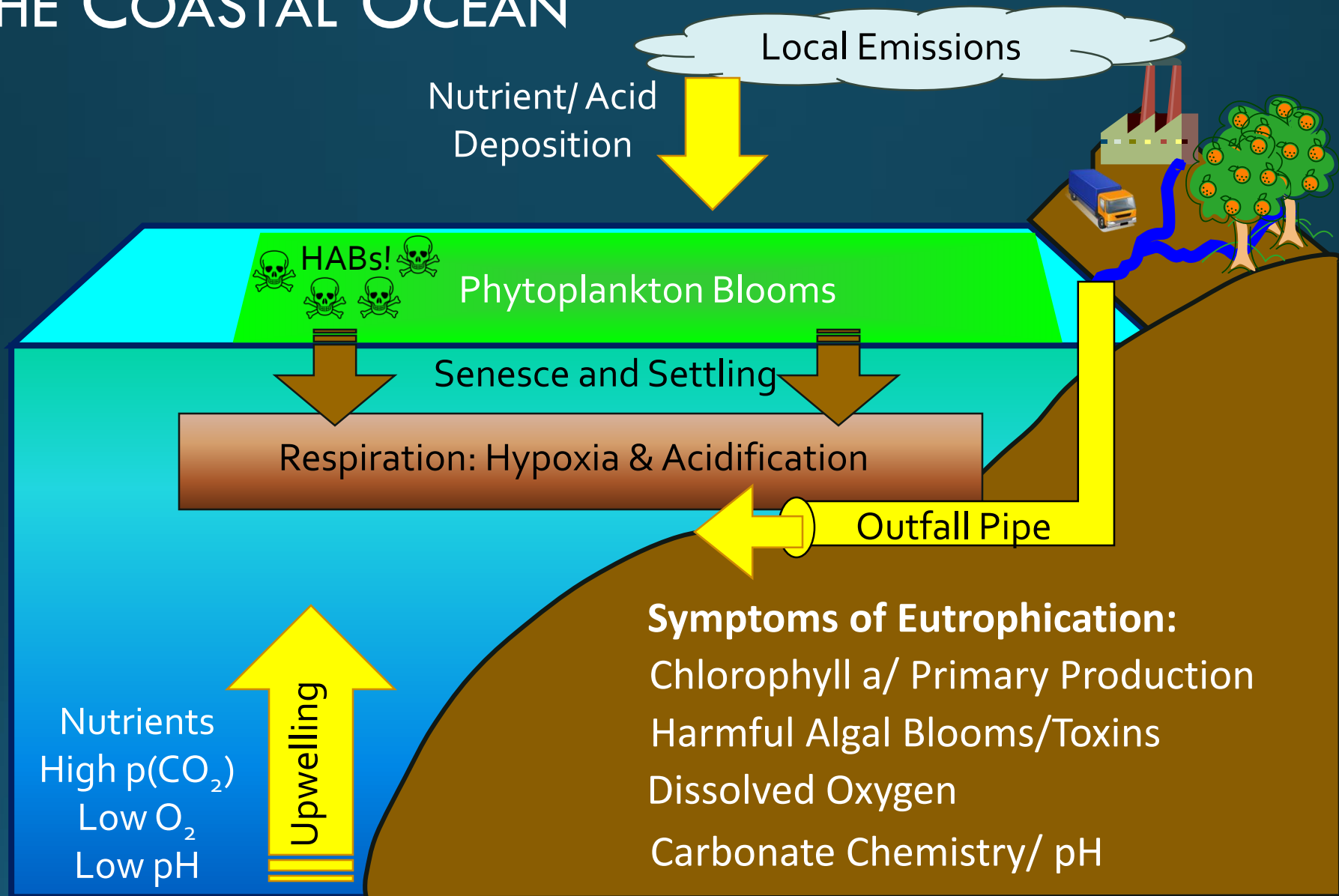
COUPLED PHYSICAL – BIOGEOCHEMICAL MODELS

Karen McLaughlin

March 4, 2016



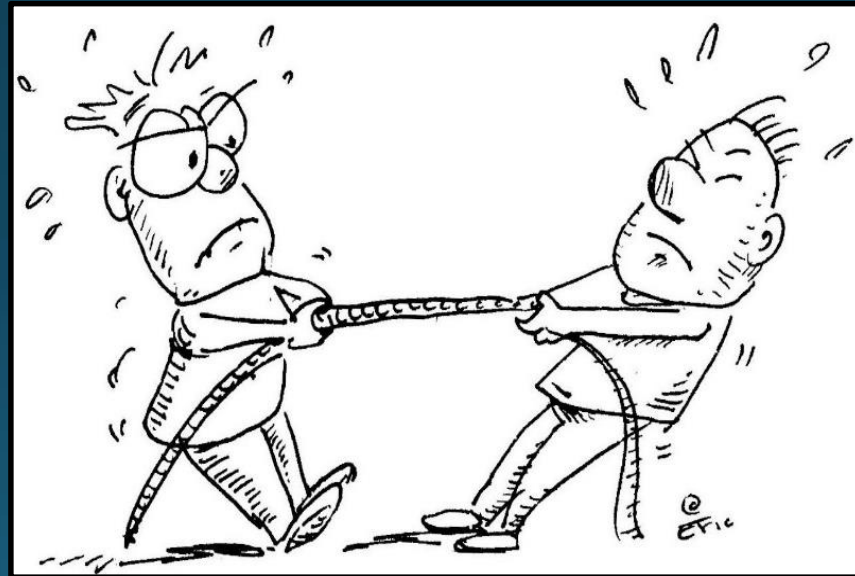
CONCEPTUAL MODEL OF EUTROPHICATION IN THE COASTAL OCEAN



ARE ANTHROPOGENIC NUTRIENTS IMPORTANT IN AN UPWELLING DOMINATED REGION?

Two Opposing Views:

California coastal waters are dominated by upwelling, therefore anthropogenic nutrients are not a primary driver



Local anthropogenic inputs can exacerbate global drivers, potentially pushing DO and pH to ecological tipping-points

OCEAN NUTRIENTS PROGRAM: KEY RESEARCH QUESTION

What are the relative contributions of three major drivers of symptoms of eutrophication and acidification/hypoxia in the SCB and beyond:

1. Anthropogenic inputs
2. Natural climate variability
3. Anthropogenically induced climate change

First step, Bight '08 Nutrient Source Comparison

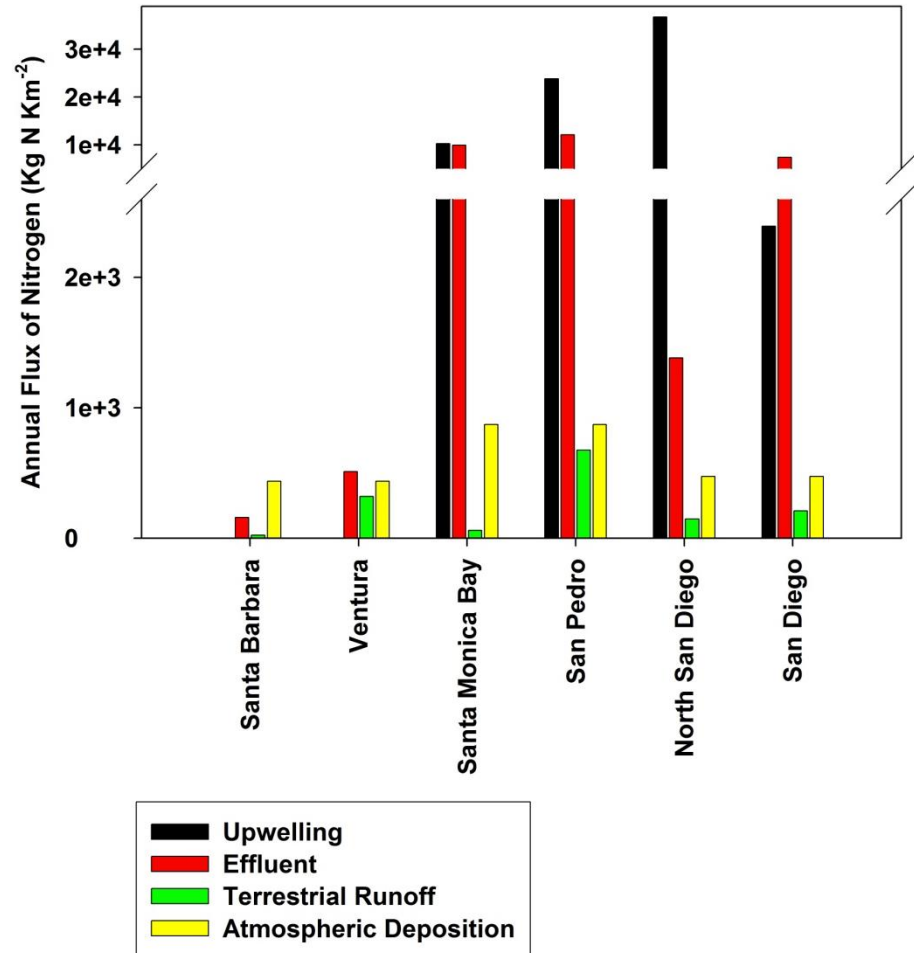
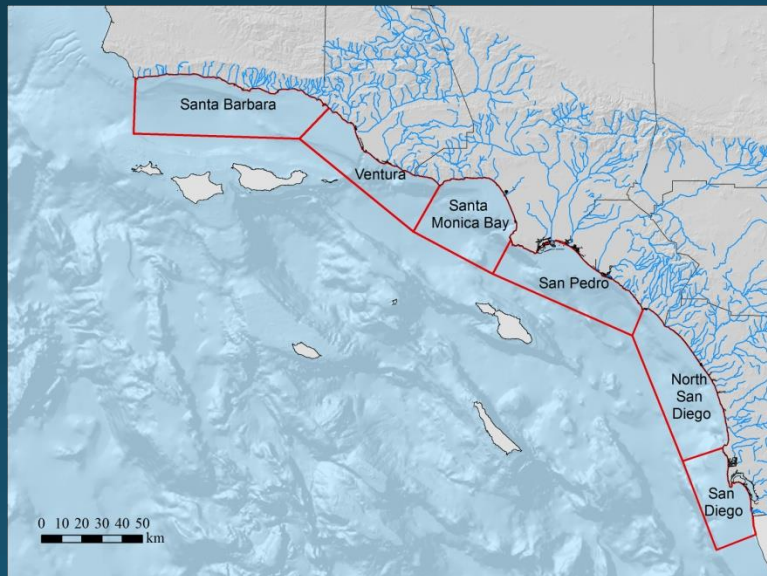
RELATIVE CONTRIBUTION OF ANTHROPOGENIC NUTRIENTS VARIES BY SCALE!

BIGHT-WIDE SCALE

Upwelling is the largest source

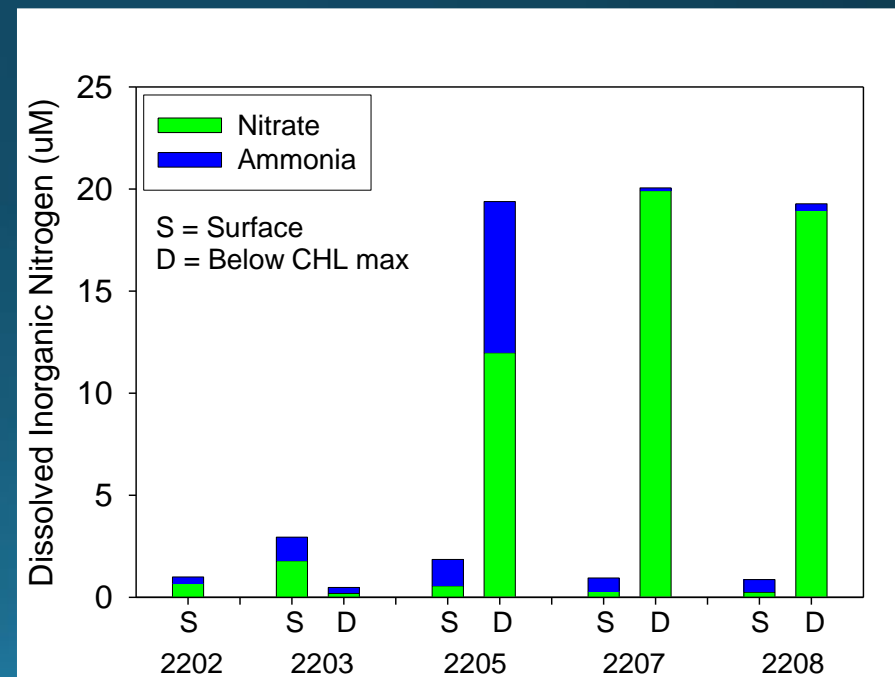
LOCAL SCALE

Nitrogen loads are equivalent

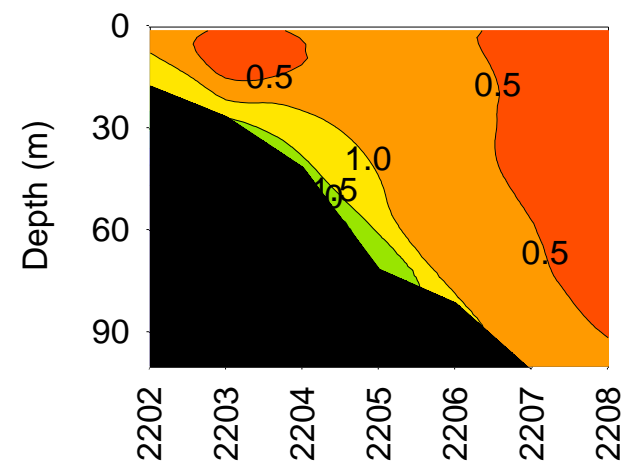
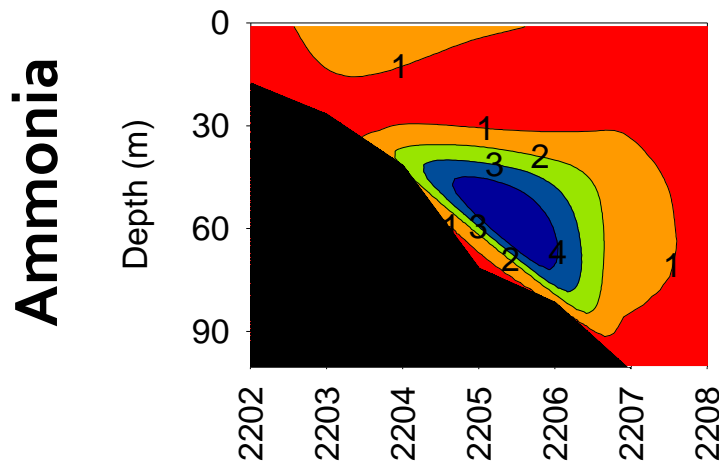
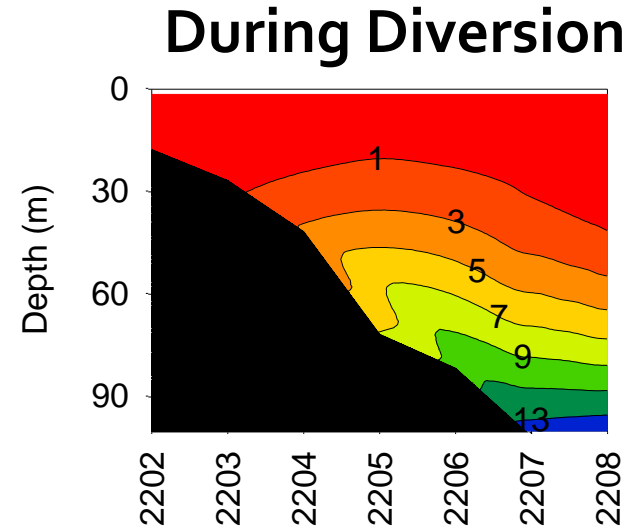
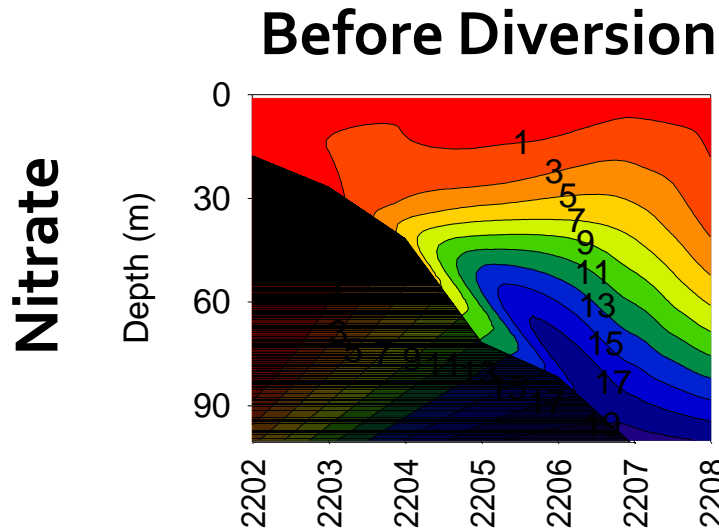


WHAT IS THE FATE OF ANTHROPOGENIC NUTRIENTS? NITROGEN FORM MATTERS

- Sources have equal magnitudes but the form of nitrogen is different:
 - Upwelled nitrogen is 90% nitrate
 - Effluent nitrogen is 80-90% ammonia
- Nitrate is primary form of inorganic N in the watercolumn
 - Where did the ammonium go?



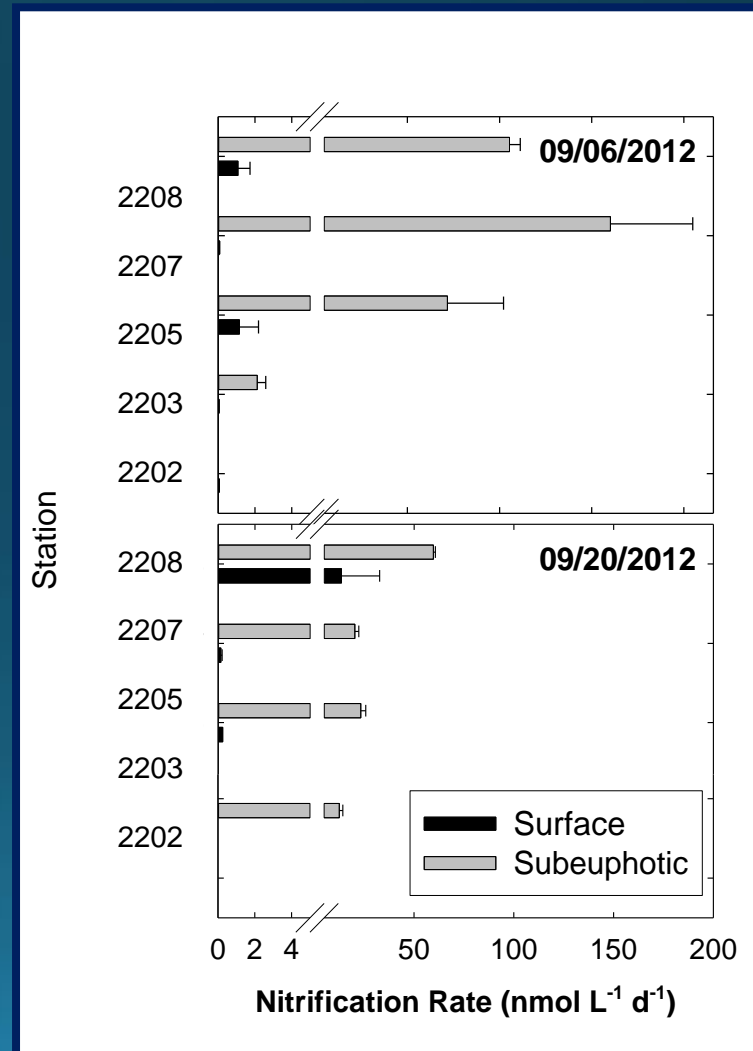
OCSD DIVERSION: NITROGEN FORMS ARE ELEVATED AROUND OCEAN OUTFALLS



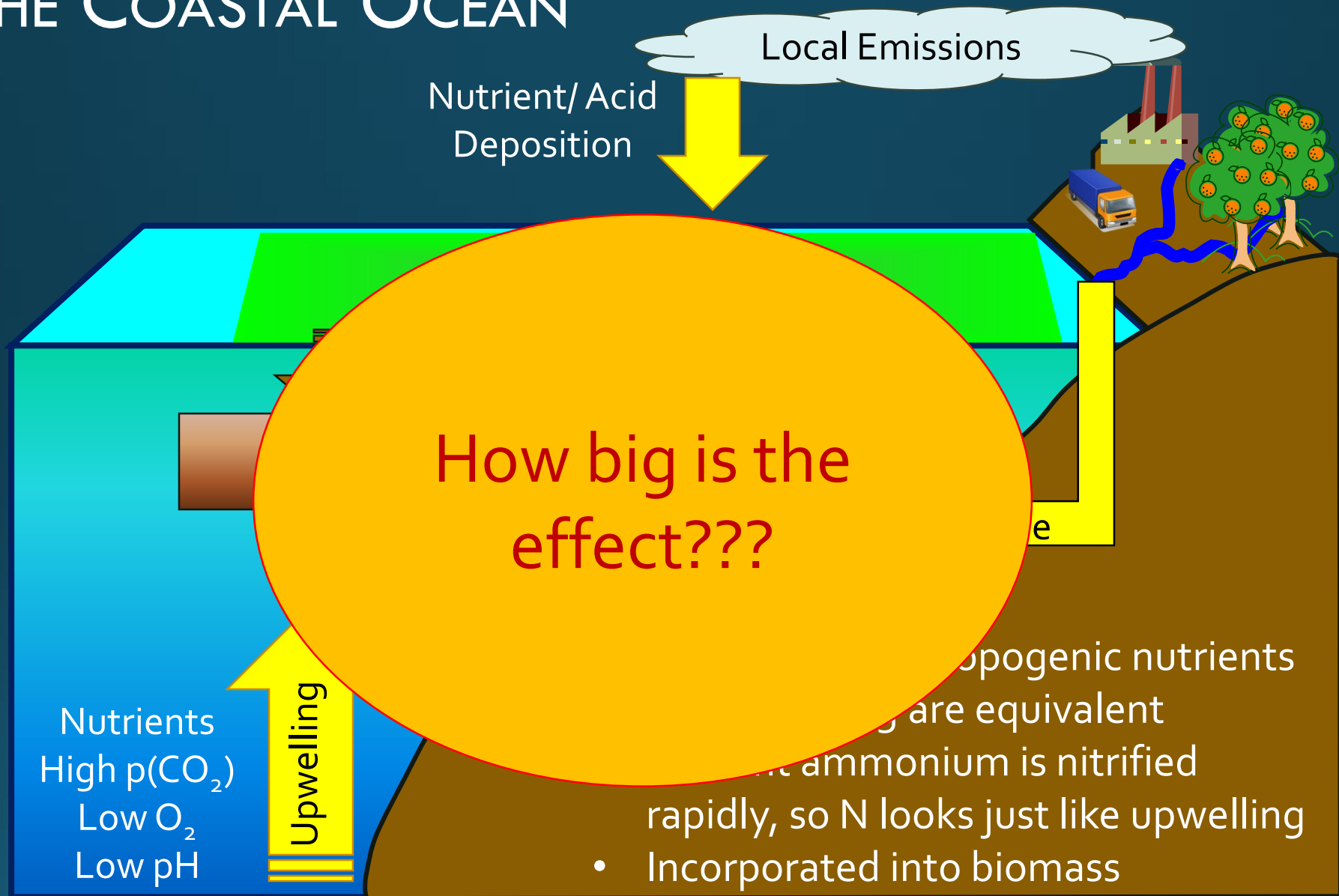
Concentrations in μM

WASTEWATER AMMONIUM IS RAPIDLY NITRIFIED

- While forms of nitrogen are initially different, rapid nitrification means the dominant form of inorganic N will be nitrate
- Isotopic evidence that effluent nitrate is incorporated into algal biomass

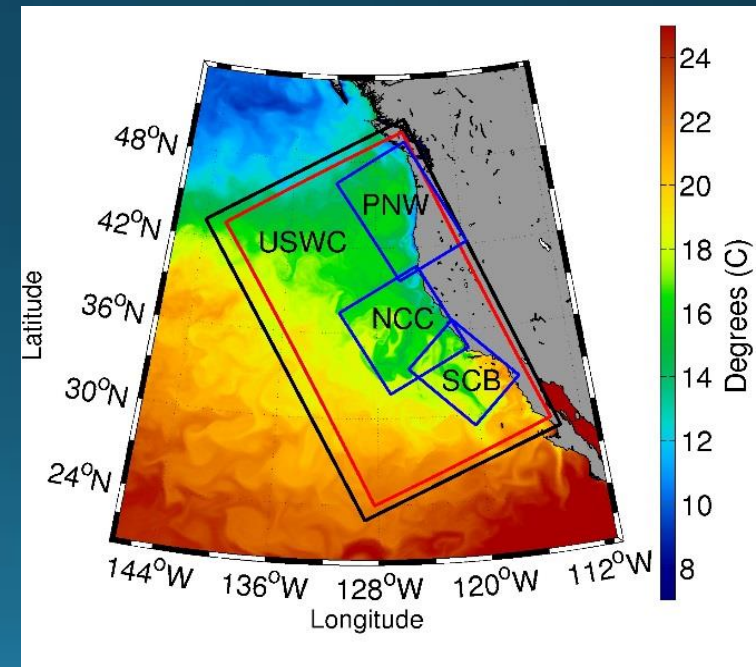


CONCEPTUAL MODEL OF EUTROPHICATION IN THE COASTAL OCEAN



MODELING PROGRAM GOALS ADDRESS OUR KEY RESEARCH QUESTION

- Develop OAH model of California Current System (CCS), with regional downscaling
 - So. California Bight, Central Coast, and the Oregon Coast
- Use the model to understand the relative contributions of :
 - Natural climate variability
 - Anthropogenically-induced climate change
 - Anthropogenic inputs
- Transmit these findings to coastal zone water quality and marine resource managers



MODELING APPROACH

- Enhance existing models
- Validate the models and quantify uncertainty
- Run climate change and management scenarios
- Outreach to inform management actions

ENHANCE EXISTING MODELS

- Physical model: Downscale to smaller spatial scales and move the model closer to shore
- Biogeochemistry: Improve the carbonate chemistry and develop important feedback loops with zooplankton (pteropods)
- Inputs: Customize the model to conditions in each of the intensification zones

VALIDATE THE MODELS AND QUANTIFY UNCERTAINTY

- Availability of local data for validation is key to reducing model uncertainty

Biogeochemical Model

**Good Data is
Rare and Patchy:**

Biogeochemical Processes
Data on pH and saturation



Physical Model

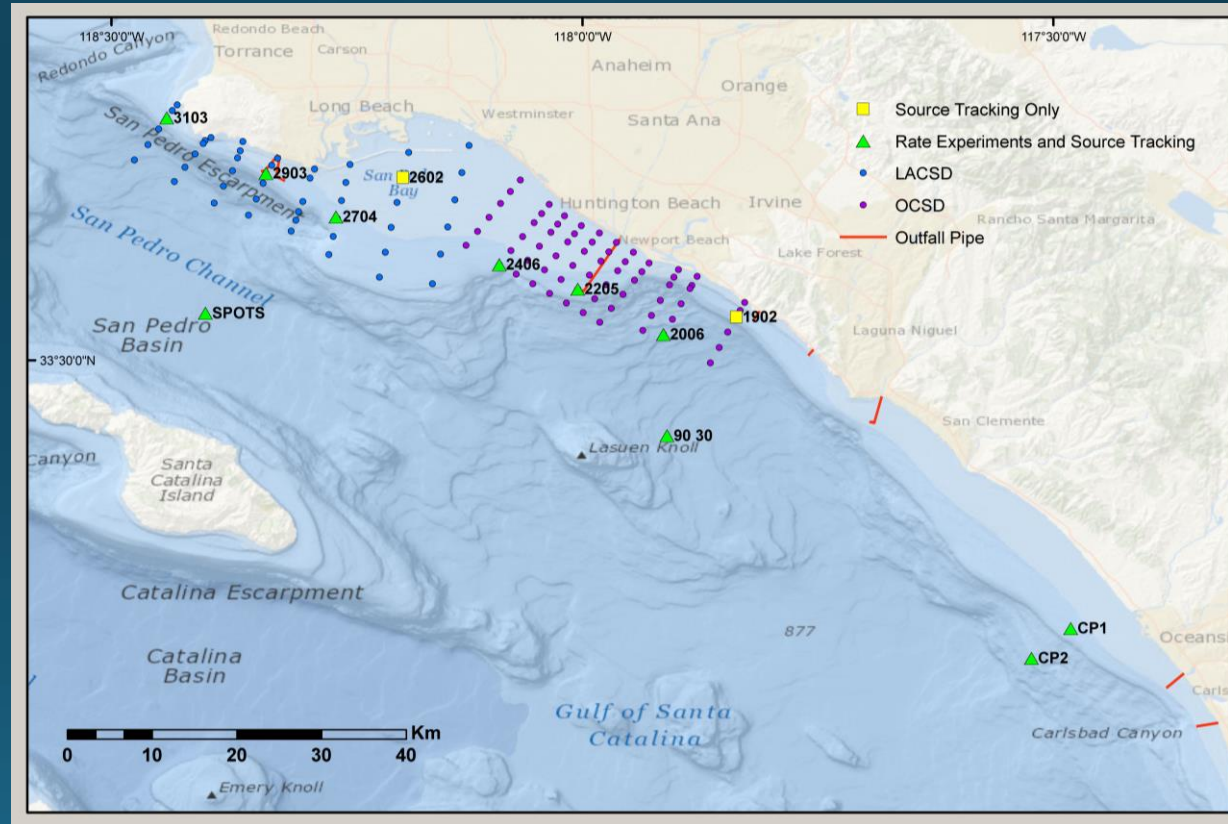
**Good Data is Relatively
Abundant:**

CTD Data
Mooring Data
Glider Data

VALIDATE MODEL USING BOTH STATE DATA AND RATE/PROCESS DATA

Bight '13 Process Studies

Compare sources and fate of nitrogen in effluent impacted regions to minimally-impacted regions



RUN CLIMATE CHANGE AND MANAGEMENT SCENARIOS

- Current day with and without anthropogenic nutrient reductions
- Future climate change (IPCC 2050-2070), with and without anthropogenic nutrient reductions

Additional modeling scenarios will be informed through discussion with managers

The details are important and we need your input!

LEVEL OF INTERACTION WITH MANAGEMENT AUDIENCES WILL VARY BY SCALE

West Coast Wide:

- Will coordinate through the West Coast Governor's Alliance
- Will use OAH expert panel for high level technical review

SCB Downscaled Region:

- Will develop stakeholder advisory committee
- This committee will provide both technical and management feedback throughout the project
- Will probably meet once or twice a year for three years

CONSENSUS NEEDED ON ENDPOINTS OF CONCERN TO INTERPRET MODEL OUTPUT

- What are the appropriate indicators and endpoints?
 - Are Ocean Plan standards relevant?
- How much is too much?
 - What is the duration and extent that is significant enough to warrant regulation?
- Don't want the modelers to make that call for you...
you want to define this for them to interpret model output.
 - First stakeholder meeting targeted for May 2016.