Expanding the Use of Numerical Modeling Beyond Ocean Acidification and Hypoxia

Commission Meeting

Martha Sutula
Biogeochemistry Department

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BACKGROUND

- **We have spent the last decade developing and validating a coastal numerical model**
  - With early applications focused on ocean acidification and hypoxia

- **But this model is a powerful tool that could be used for other water quality applications**

- **You asked for a briefing on other applications to understand the larger vision for coastal numerical modeling**

GOAL OF THIS TALK

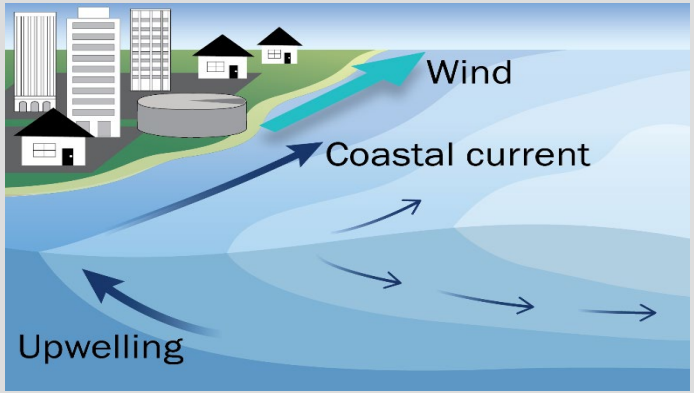
- **Describe a vision for multiple classes of ROMS-BEC applications**
  - Highlight some different ways in which models can support water quality management
- **Illustrate that vision with example projects on topics in which we are beginning to engage**

ROMS-BEC IS TWO MODELS

ROMS

Regional Ocean Modeling System

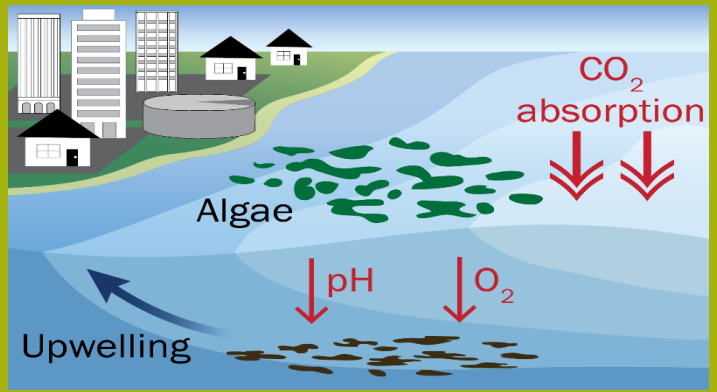
A physical circulation model that predicts how ocean water circulates



BEC

Biogeochemical Elemental Cycling Model

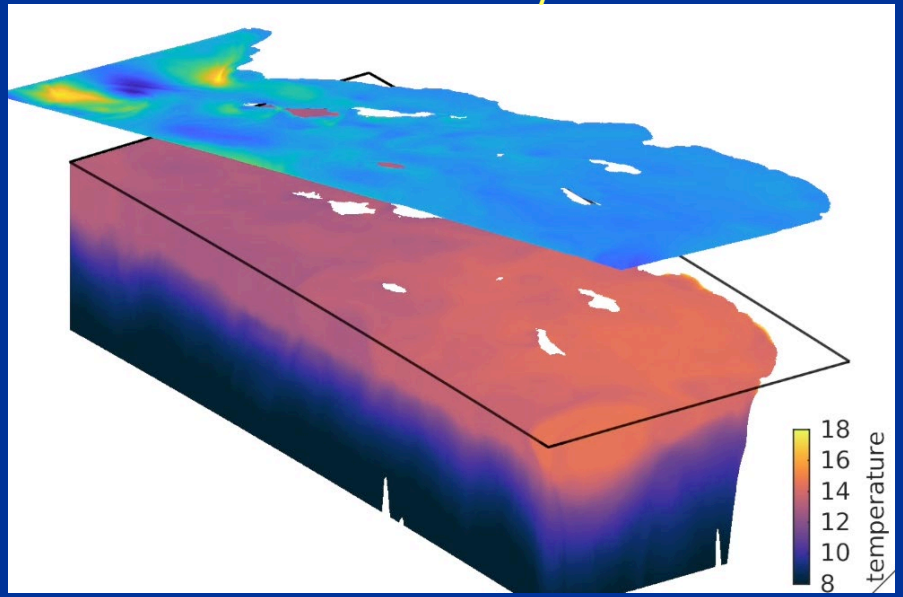
Predicts how human & ocean nutrient fuel plankton blooms that consume oxygen and lower pH



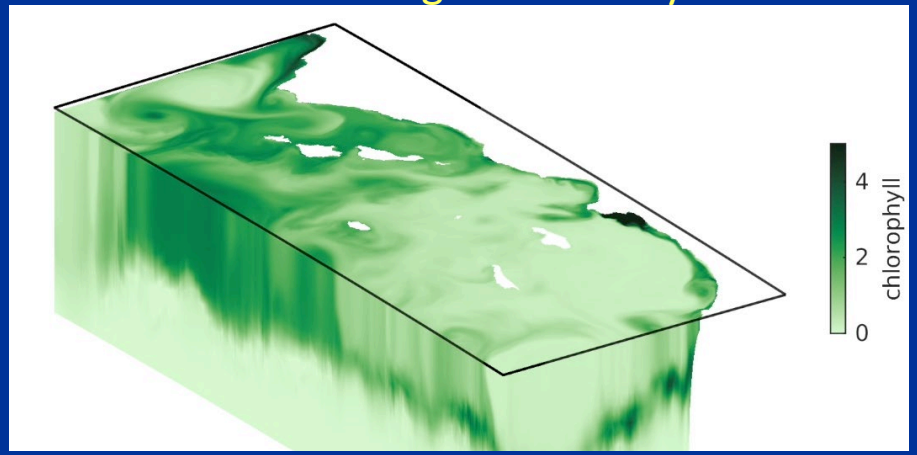
ROMS-BEC DOZENS OF VARIABLES ON OCEAN STATE, BUT WE'VE ONLY FOCUSED ON OAH

Which means that we haven't tapped the potential of this model for coastal water quality management

ROMS -- Physics



BEC -- Biogeochemistry



THREE MAJOR CLASSES OF APPLICATIONS

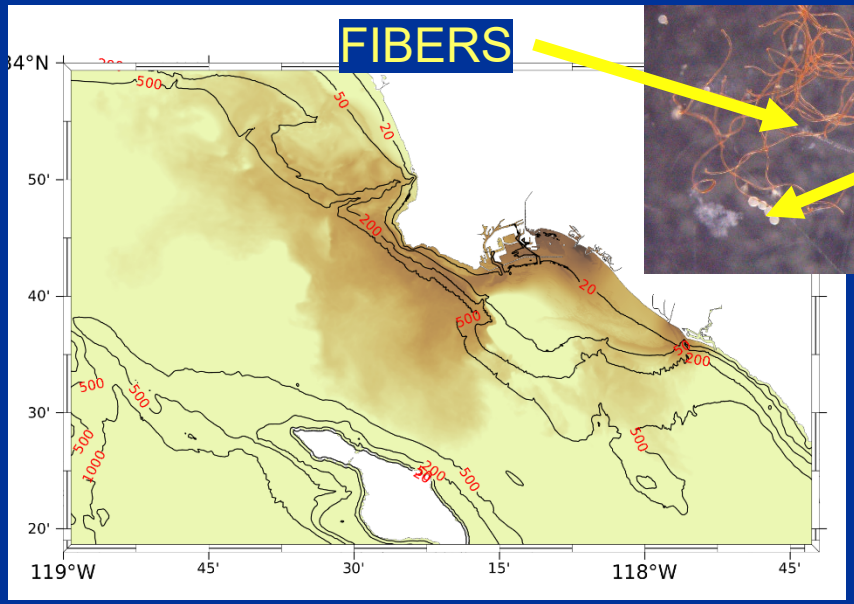
- Fate and transport
- Forecasting
- Siting and scaling of coastal “solutions” to climate change

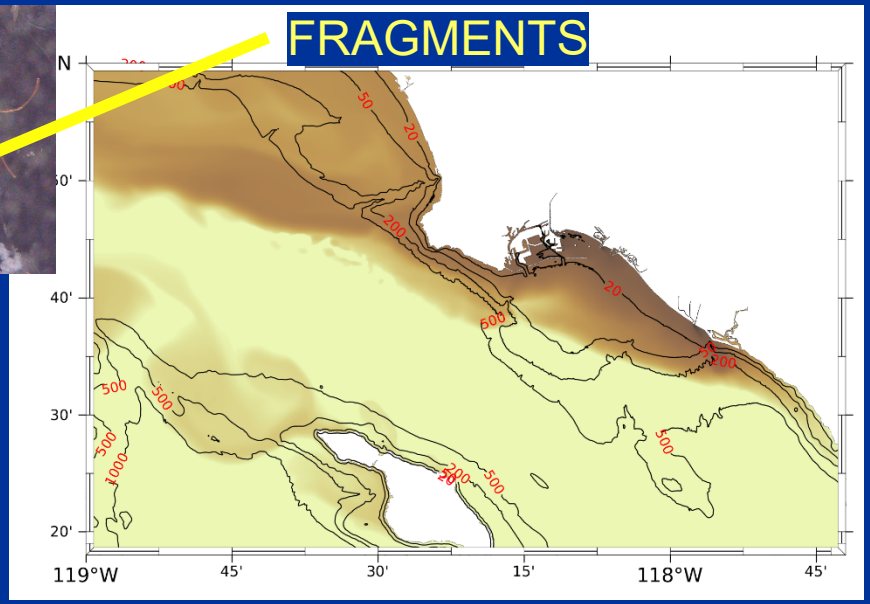
FATE AND TRANSPORT

- **ROMS tracks the movement of water masses in three dimensions, with submeter vertical resolution**
  - This makes it an ideal tool to track where something goes when it is released in the ocean
- **With limited monitoring resources, model can optimize monitoring strategy**
  - Or pinpoint habitats most at risk for more comprehensive assessment
- **Multiple applications**
  - Microplastic dispersion
  - Spread of invasive seaweed Caulerpa
  - Outfall plume predictions

FATE OF MICROPLASTIC PARTICLES WHEN RELEASED FROM LA AND SAN GABRIEL RIVERS?

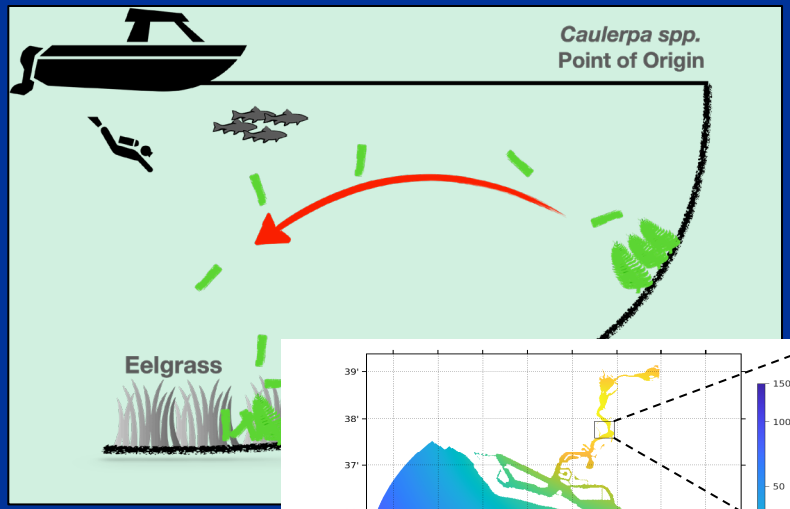
Deposition of FIBERS versus FRAGMENTS a month after release from the LA and San Gabriel Rivers

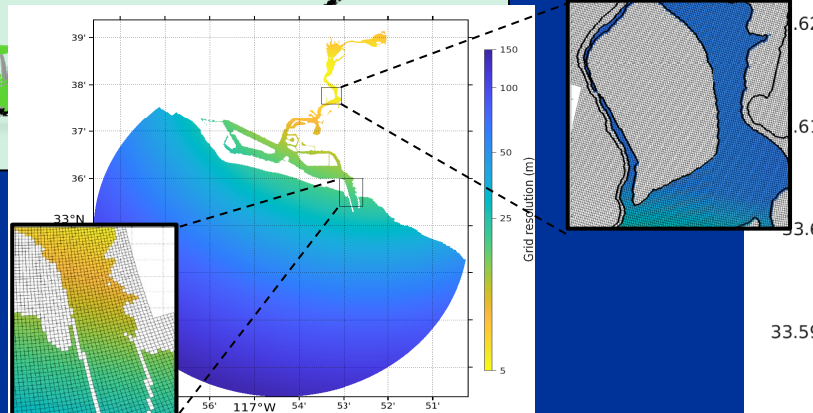




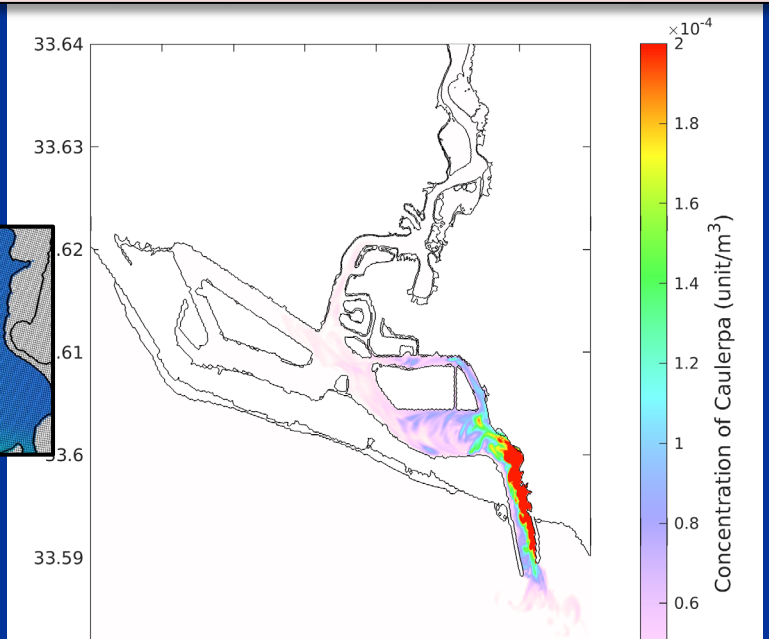
SCUBA RECONNAISSANCE FOR CAULERPA ERADICATION IS EXPENSIVE:

CAN MODELING HELP US PREDICT WHERE CAULERPA WOULD BE FOUND?



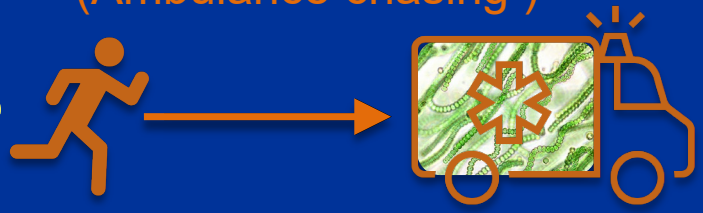


Model can predict the capture probability spatially from the point of origin



FORECASTING

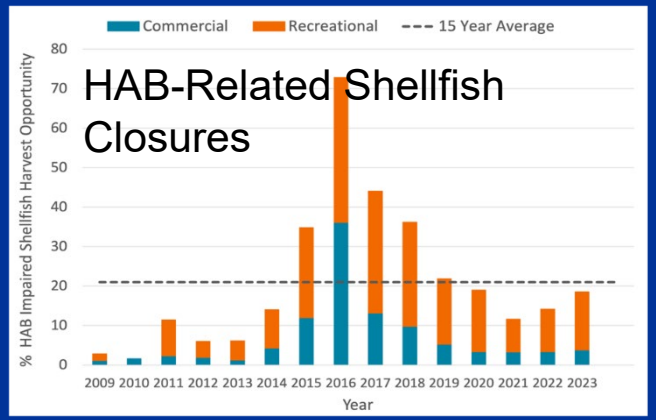
(Ambulance chasing)



Why Forecast? ***To Move From Reactive to Proactive and Adaptive***

- **Prepare for events that require mobilization of resources or rapid response**
- **Understand future trajectories in coastal water quality**
- **Understand what mitigation options are possible**

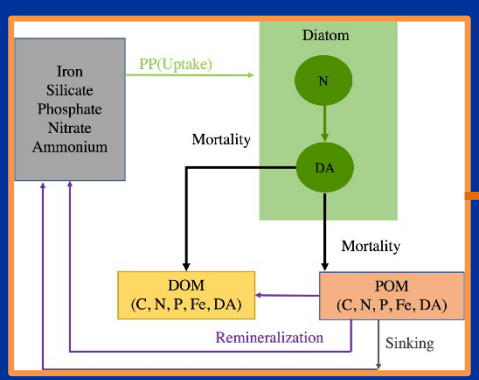
CAN WE PREDICT WHEN TOXIC HARMFUL ALGAL BLOOMS WILL OCCUR?



Domoic Acid (DA) Producing Pseudo-nitzschia Blooms

To forecast blooms, can we identify what factors appear to be important in promoting *Pseudo-nitzschia* spp.?

And what is controlling severity of DA events?

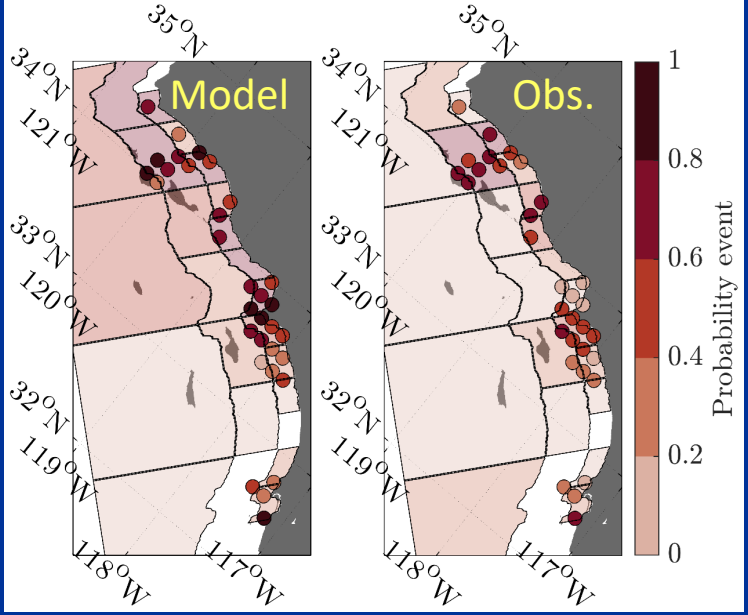


BEC

ROMS

WE ARE MAKING PROGRESS IN IDENTIFYING WHAT FACTORS ARE IMPORTANT IN CAUSING DOMOIC ACID EVENT

ROMS-BEC PN Skill In Predicting DA
> 0.5 ug/L Versus Observations



Sandoval-Belmar in prep, UCLA

Now studying what oceanographic conditions are contributing to major "events"

….With an eye towards to forecasting marine mammal strandings

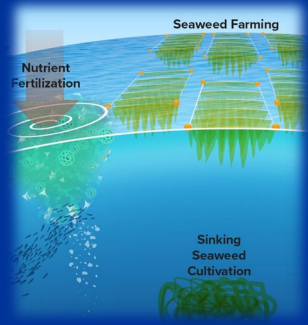
…..And shellfish bed closures

SITING AND SCALING OF COASTAL "SOLUTIONS"

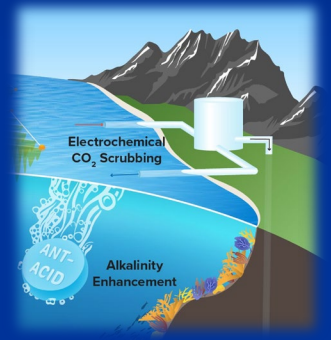
- **Marine carbon dioxide removal solutions promise to reduce impacts of climate change effects**
  - Enormous global public and private investment in these strategies and technologies

- **Numerous problems arise when implementing**
  - Not all locations are ideal for that solution
  - Potential for conflicts against competing uses
  - The solution itself might have adverse ecosystem effects

Enhancing surface ocean production



Altering ocean chemistry

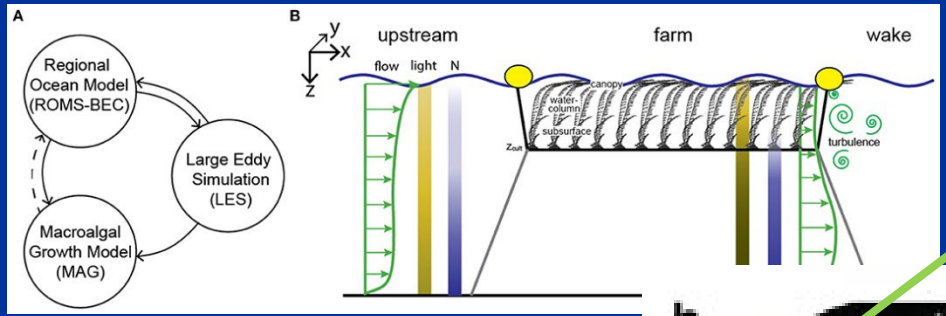


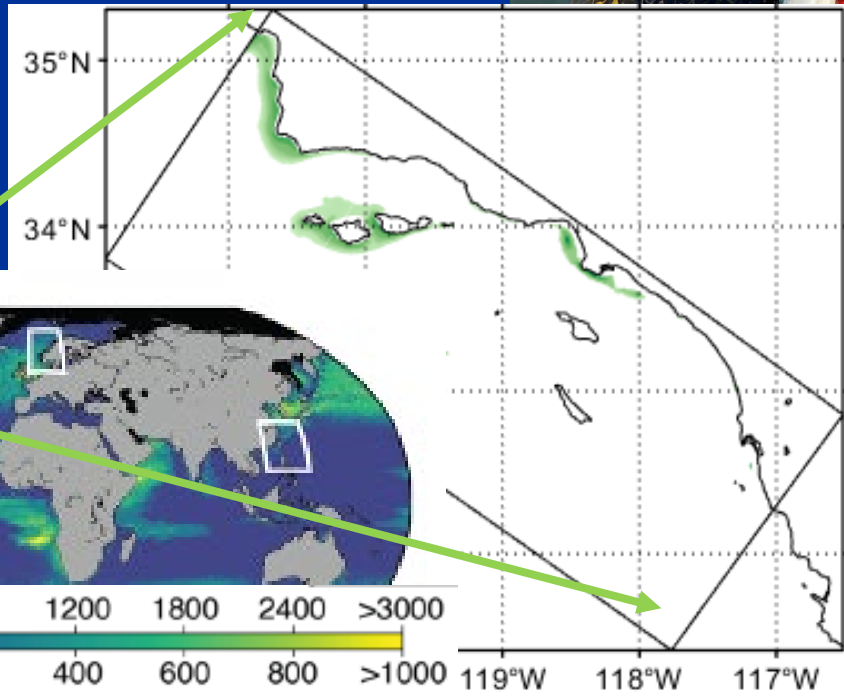
NUMERICAL MODELING CAN HELP ADDRESS THESE CHALLENGES AND AVOID EXPENSIVE MISTAKES

- Customization of technology to fit site-specific conditions
- Guide the siting to those places where the solution would yield a benefit
- Scaling the technology and modifying discharge to optimize benefits while minimizing adverse ecosystem effects

SITING: IDENTIFY AREAS WITH GREATEST POTENTIAL YIELD FOR KELP FARMING

We adapted ROMS-BEC to include a kelp farming submodel





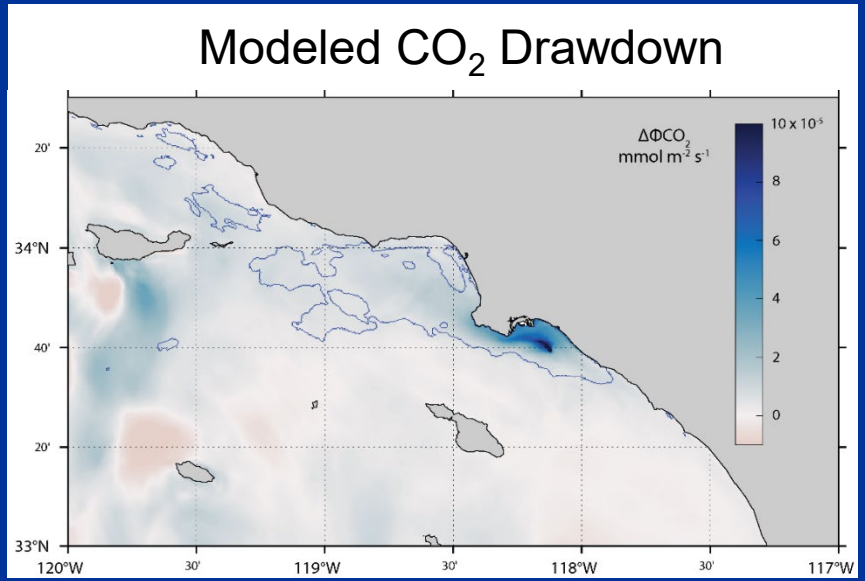
Estimate where the kelp farm yield would be best based on multiple factors

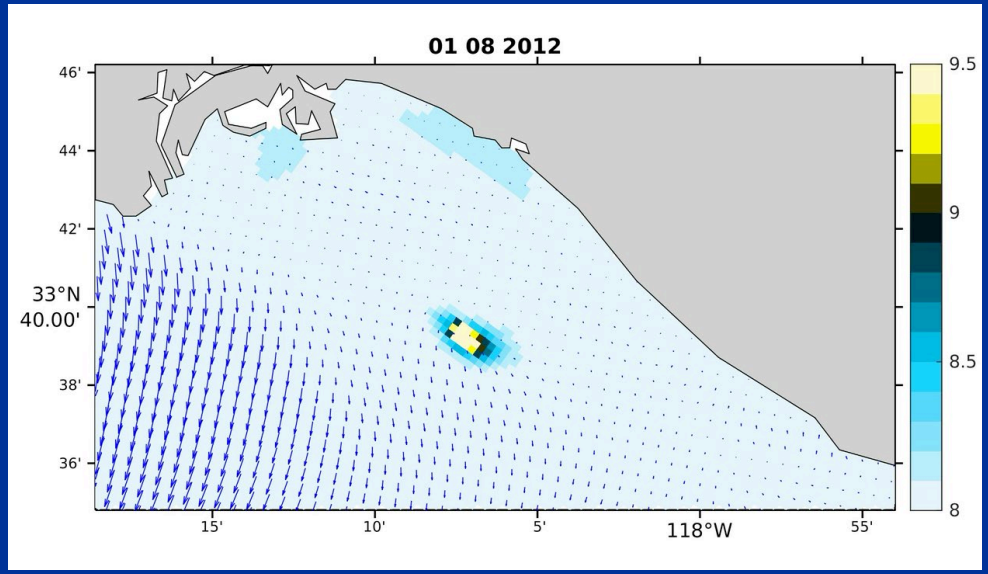
Compared to other regions

SCALING AND OPTIMIZING BENEFITS AND REDUCING IMPACTS OF DIRECT OCEAN CAPTURE

Estimated CO_2 drawdown efficiency of commercial-scale plant

Minimize high pH impacts vs maximize benefits of countering ocean acidification





QUESTIONS?