2016 IDS call

Utilizing remote sensing, models and *in situ* data to elucidate ecosystem hotspots in a moving ocean

Monique Messié
Monterey Bay Aquarium Research Institute (MBARI)

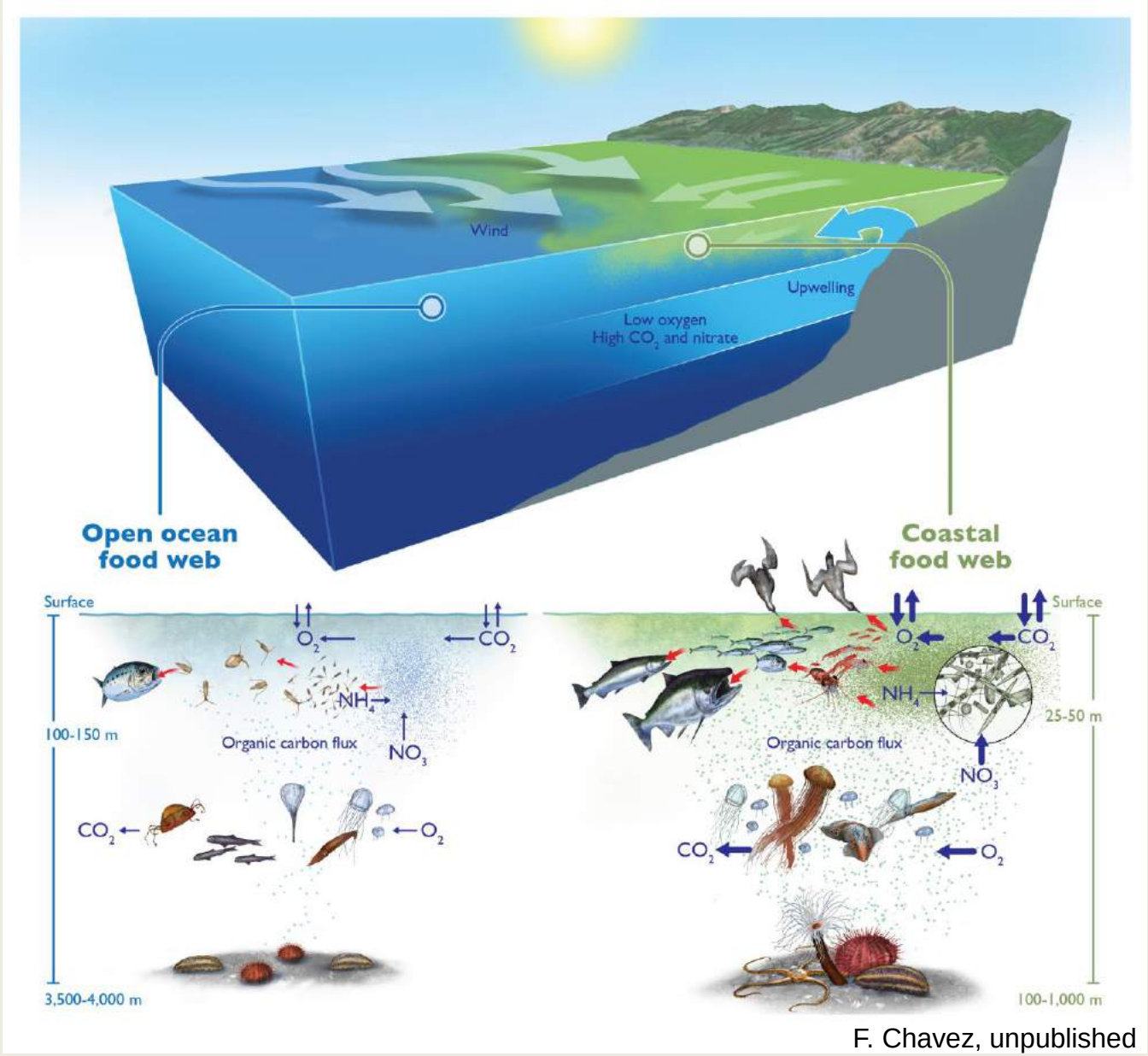
co-Is: Jerome Fiechter & Jarrod Santora (UCSC),
Francisco Chavez (MBARI)

"REACH": Relationships between Euphausiids, Advection and California Hotspots

Context: California upwelling ecosystem

WHERE?
California Current upwelling system

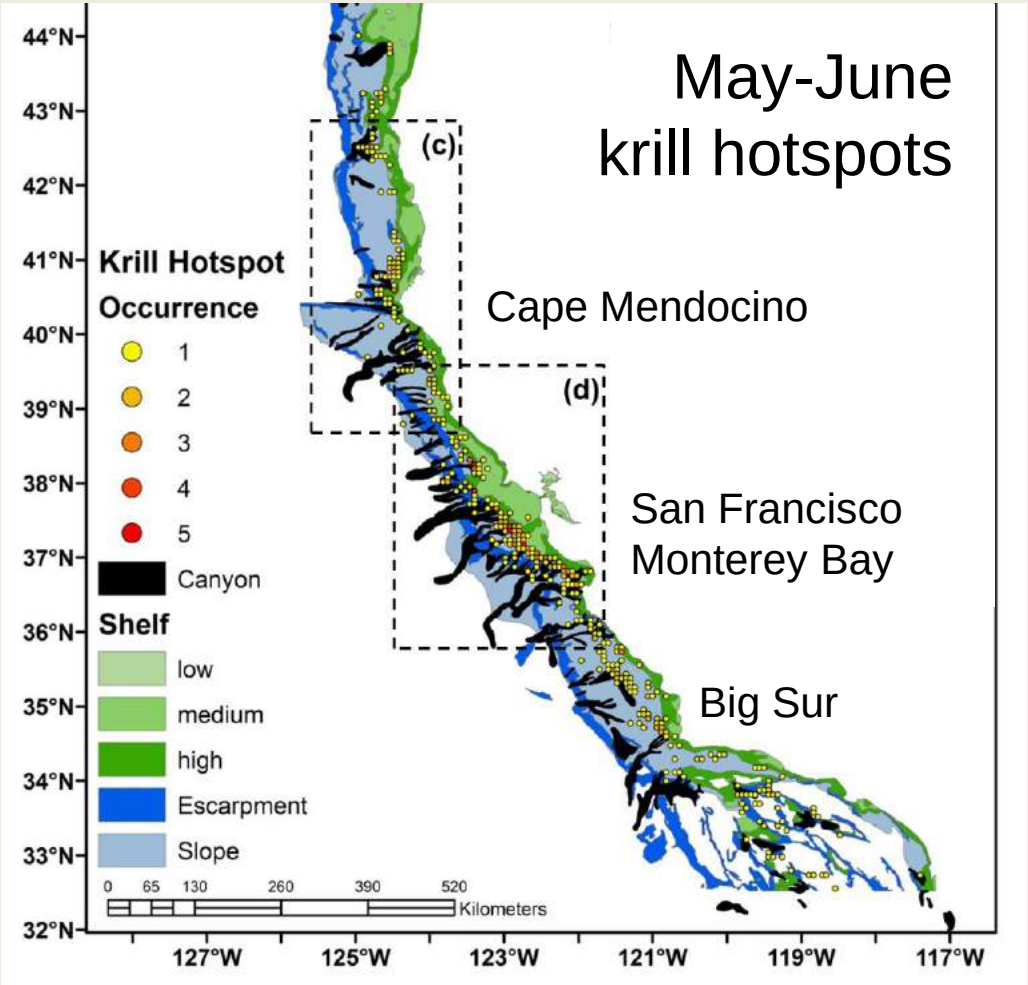
WHAT?
zooplankton (krill) and predators

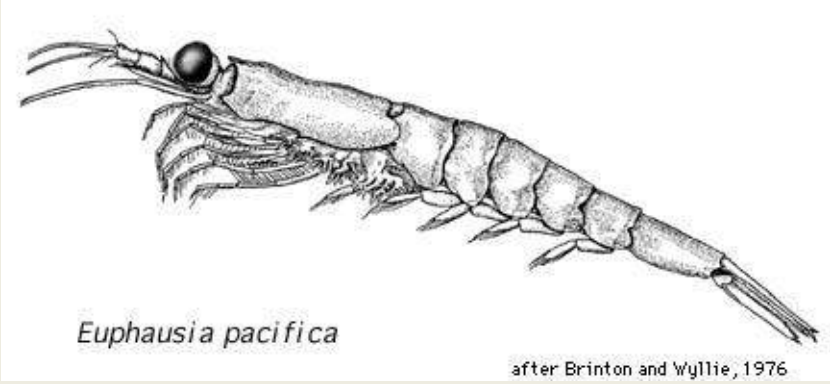


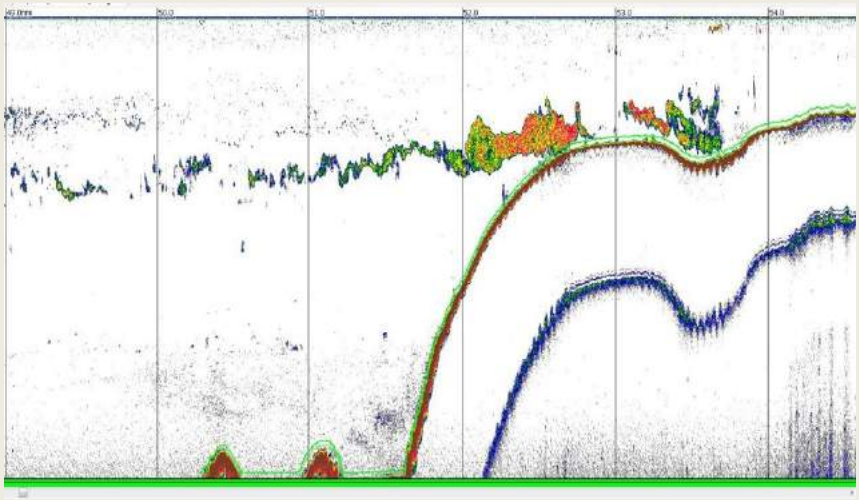
F. Chavez, unpublished

Context: krill hotspots

What drives krill hotspots? Can we predict them?
Are they more than just krill, ie. ecosystem hotspots?



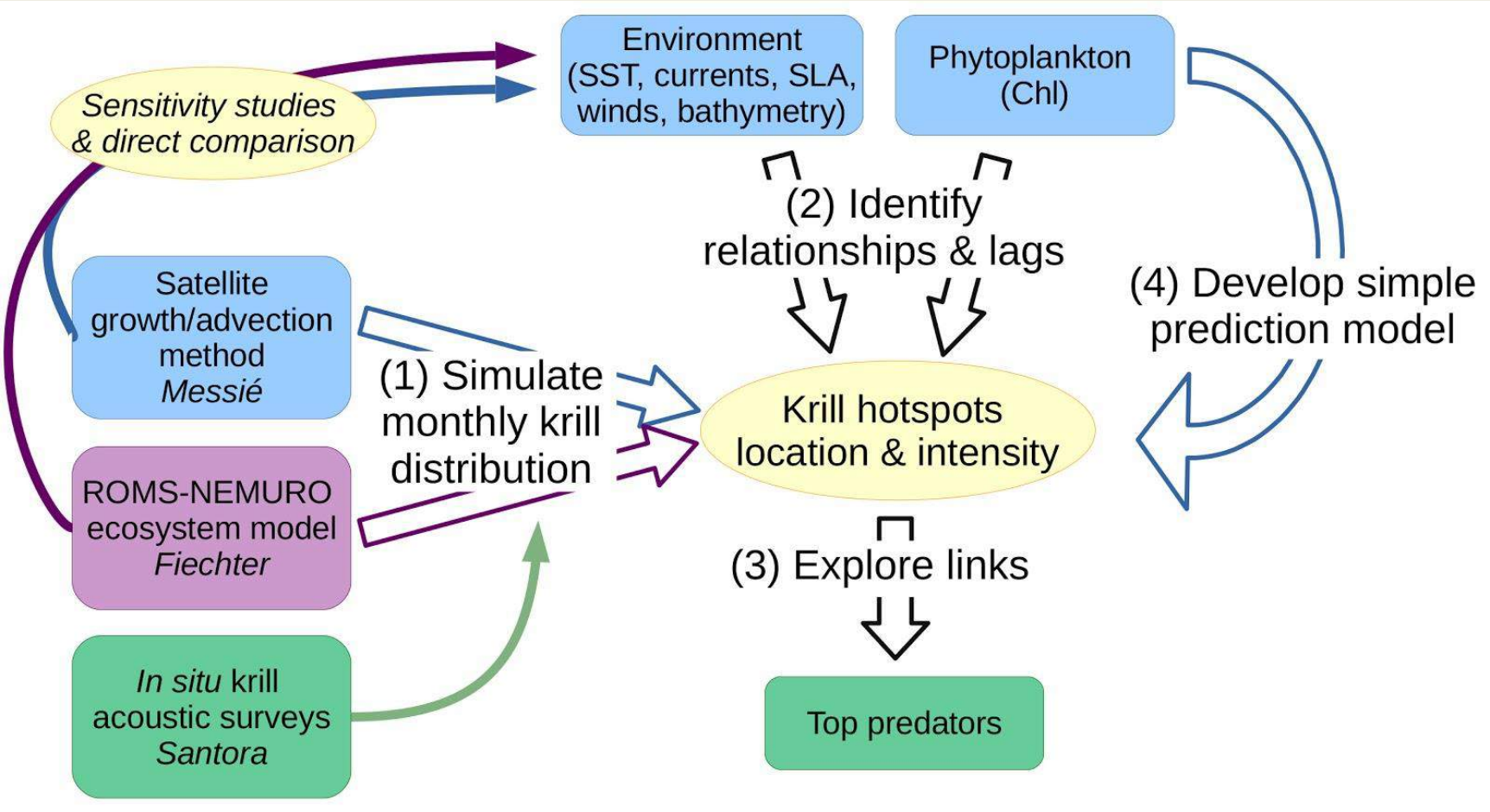




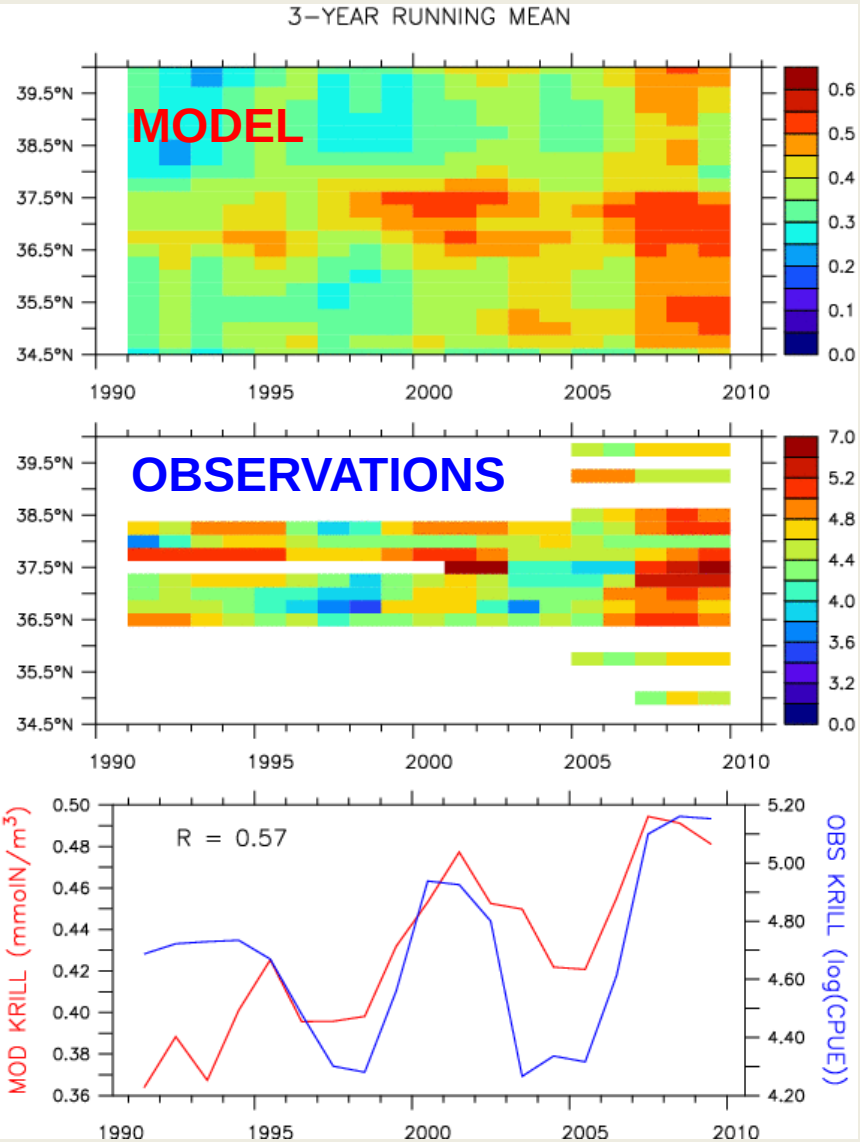
Santora et al. 2018, Scientific Reports

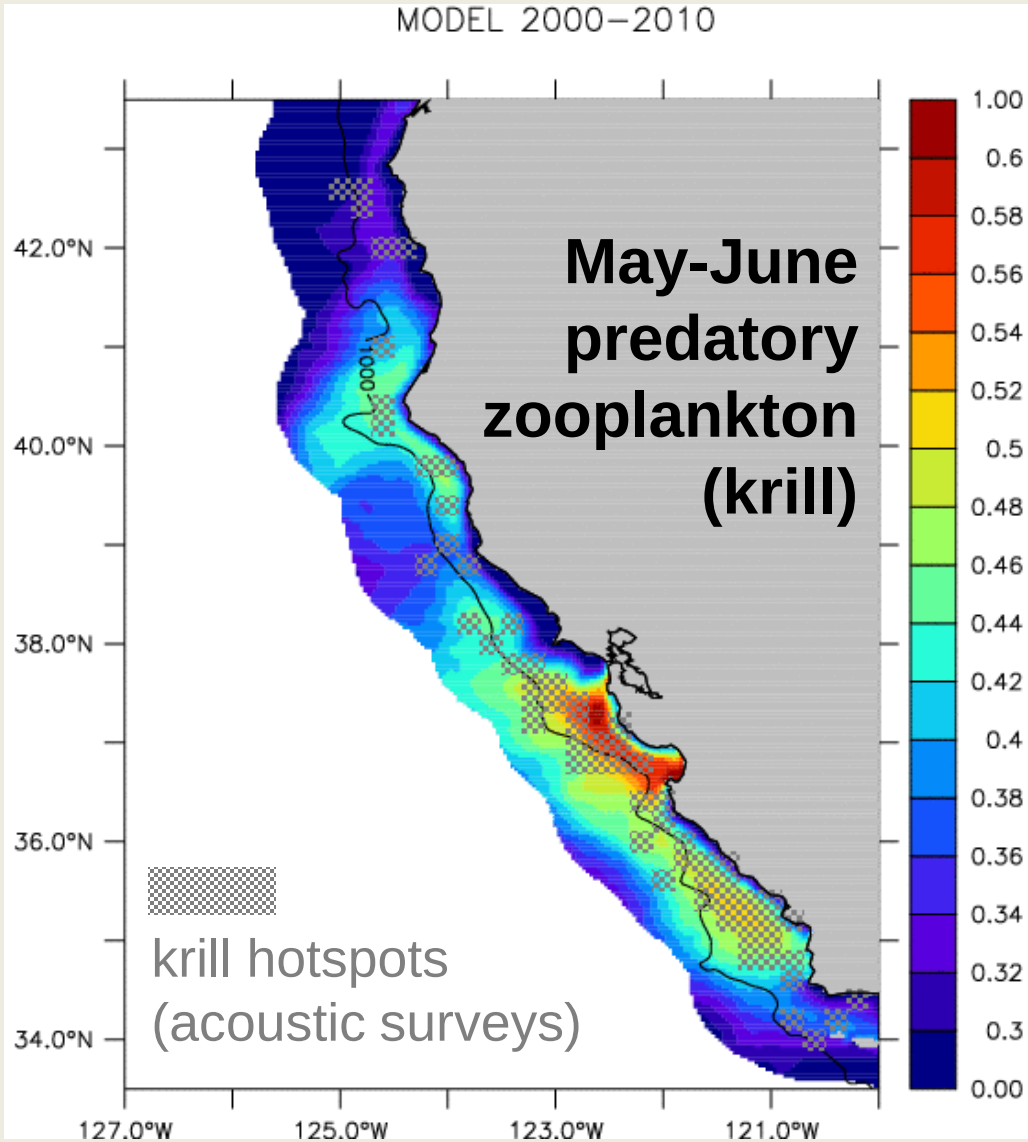
Project overview

Overarching goal: improve our ecological understanding of zooplankton and its relationship with (1) the physical environment and (2) lower/higher trophic levels.



ROMS-NEMURO model: validation





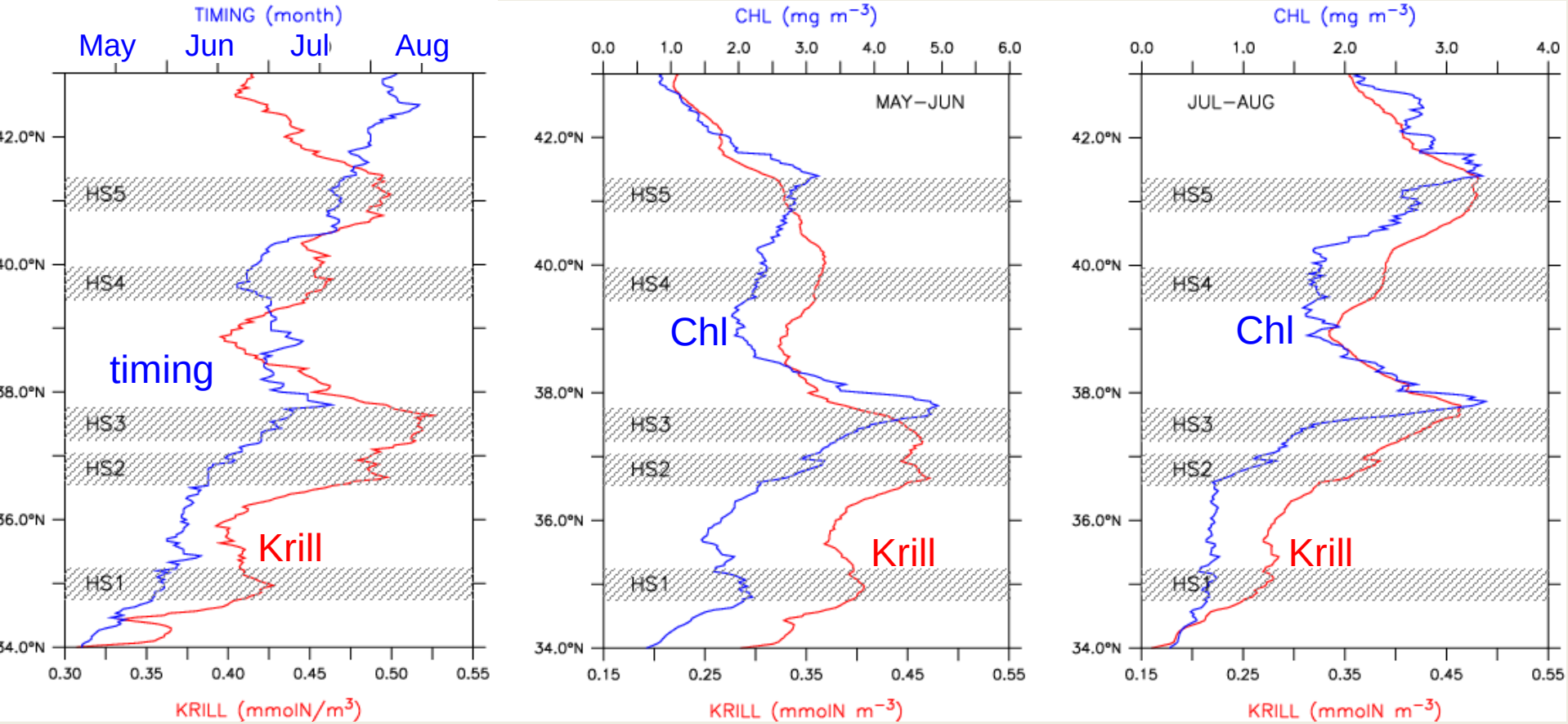
Fiechter et al., in prep

ROMS-NEMURO model: hotspot drivers

Northward propagation of hotspots

Spring: krill & Chl offset, strong current nearshore

Summer: krill & Chl collocated, upwelling jet moved offshore



Fiechter et al., in prep

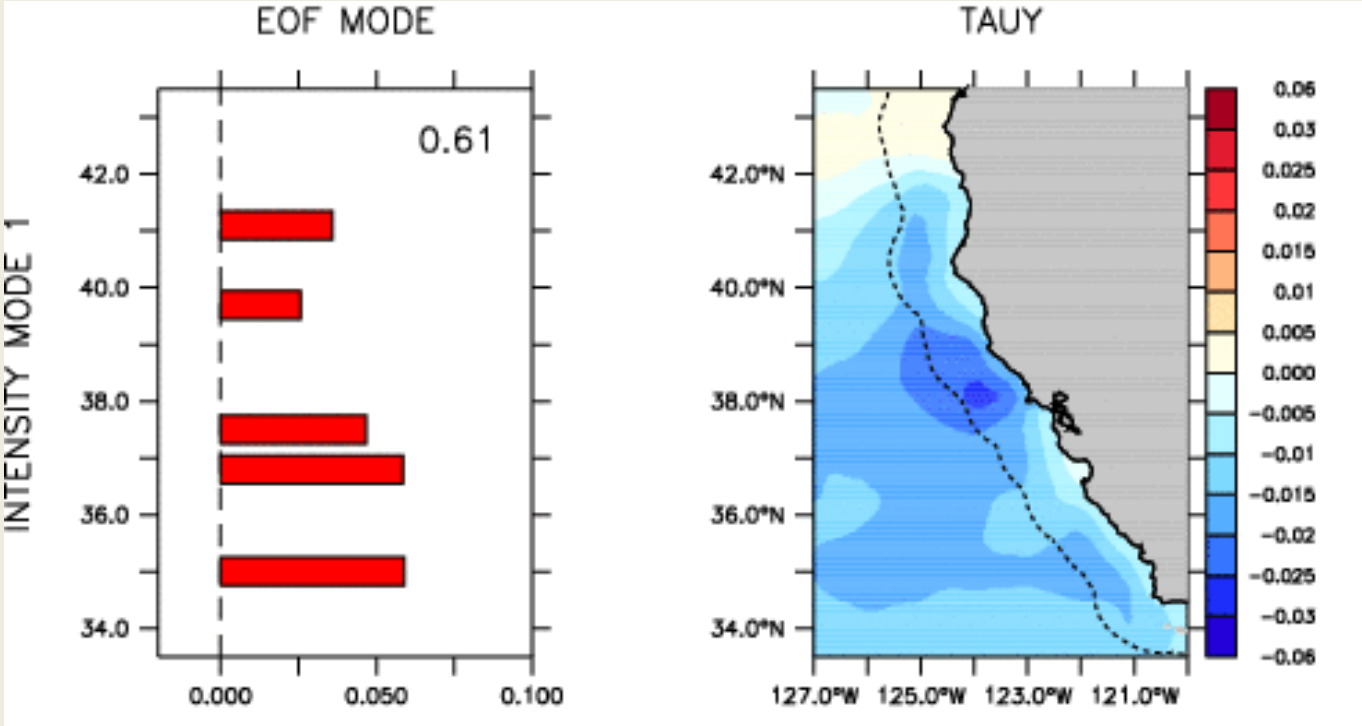
ROMS-NEMURO model: hotspot drivers

Hotspot interannual variability primarily driven by changes in upwelling winds

–

in turns impacts advection, nutrients, stratification, etc.

1st mode hotspot intensity

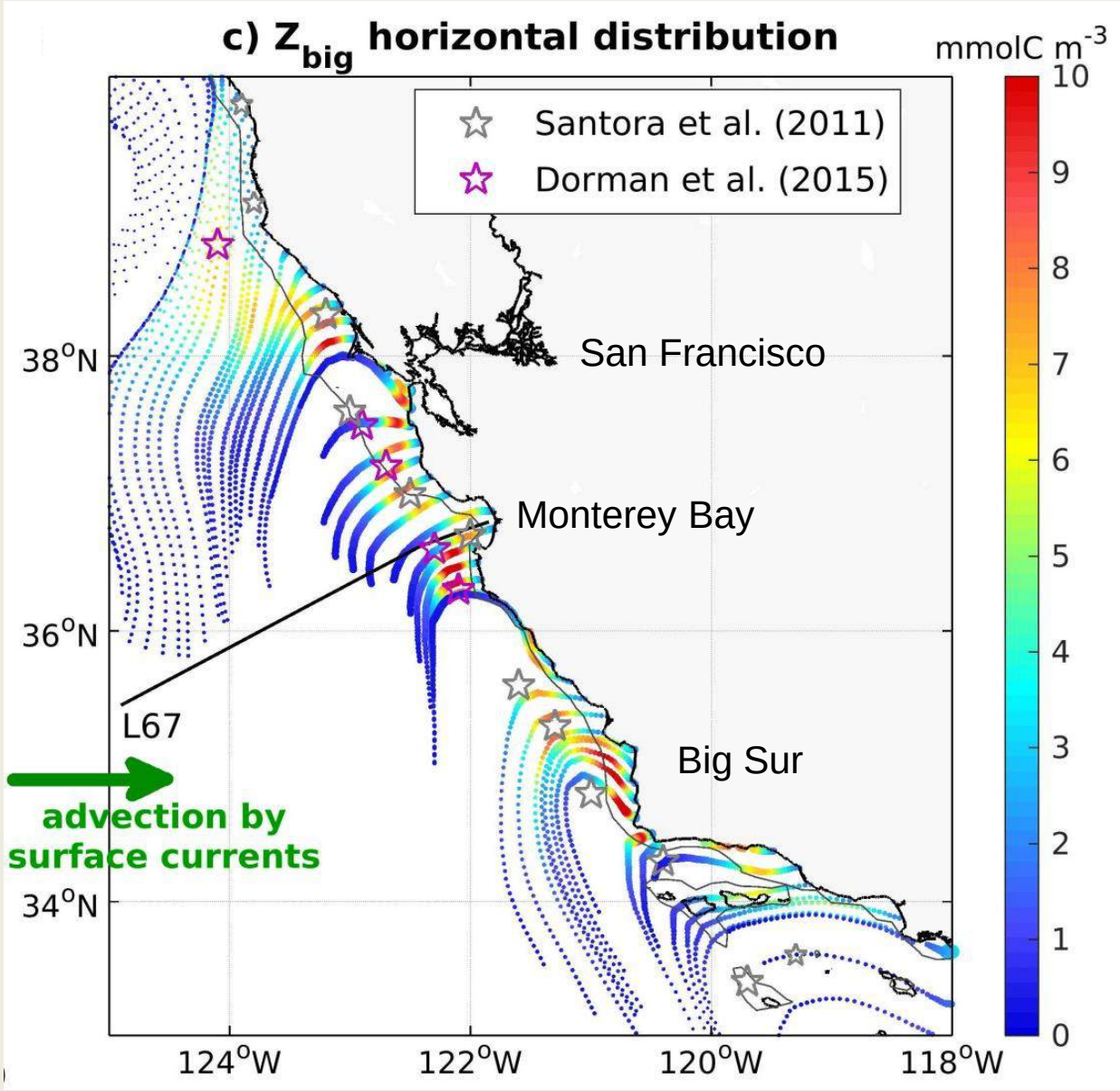


Fiechter et al., in prep

Satellite growth-advection method

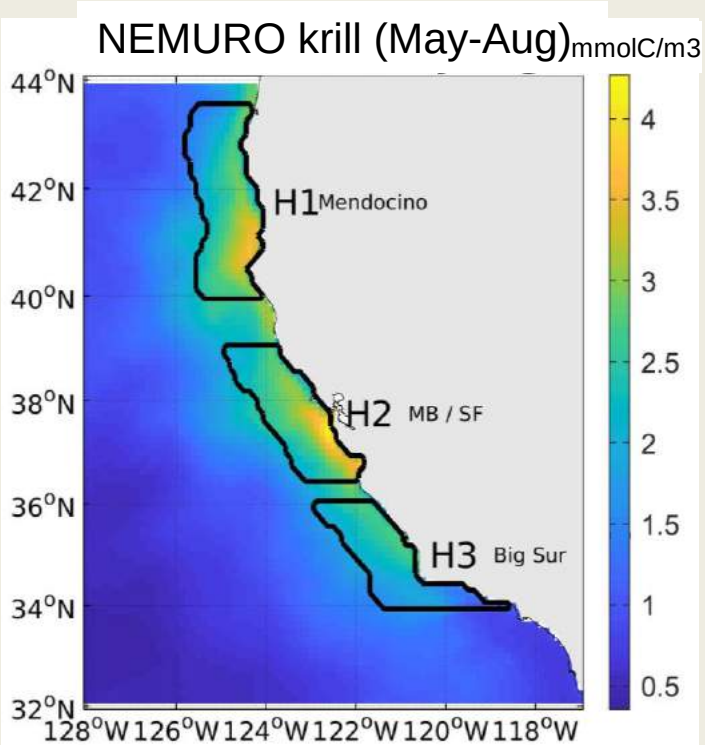
Biological evolution of a water mass during its advection ("conveyor belt").

Inputs = wind-driven nutrient supply + currents

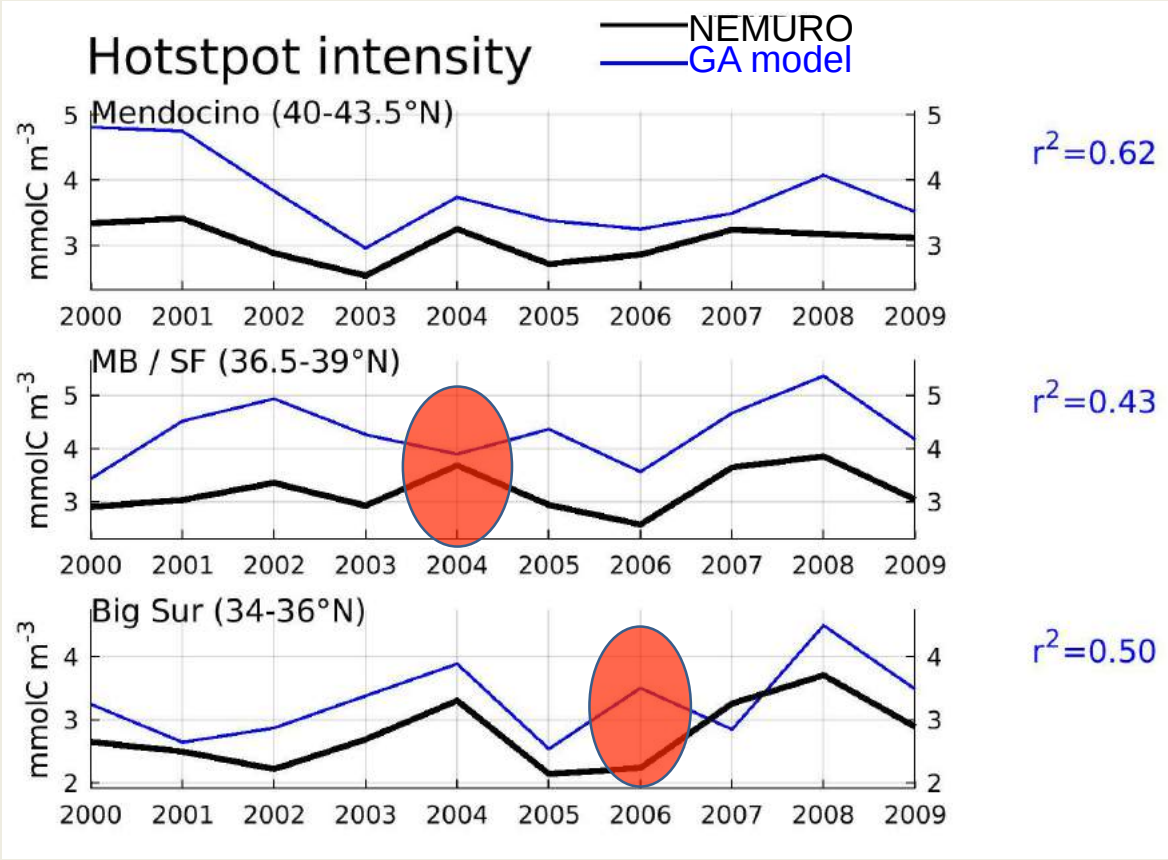


Messié and Chavez, GRL 2017

Towards predicting hotspots from satellite



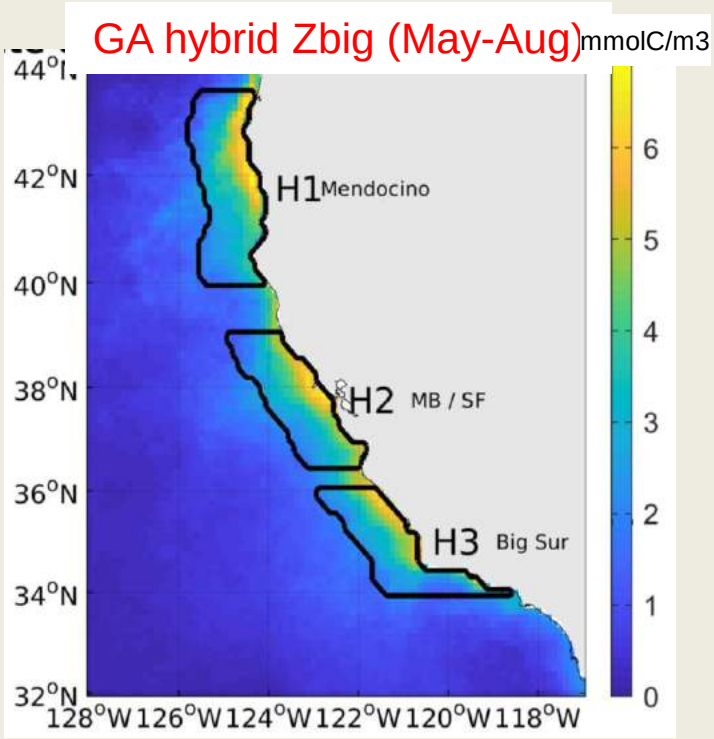
Krill annual maximum



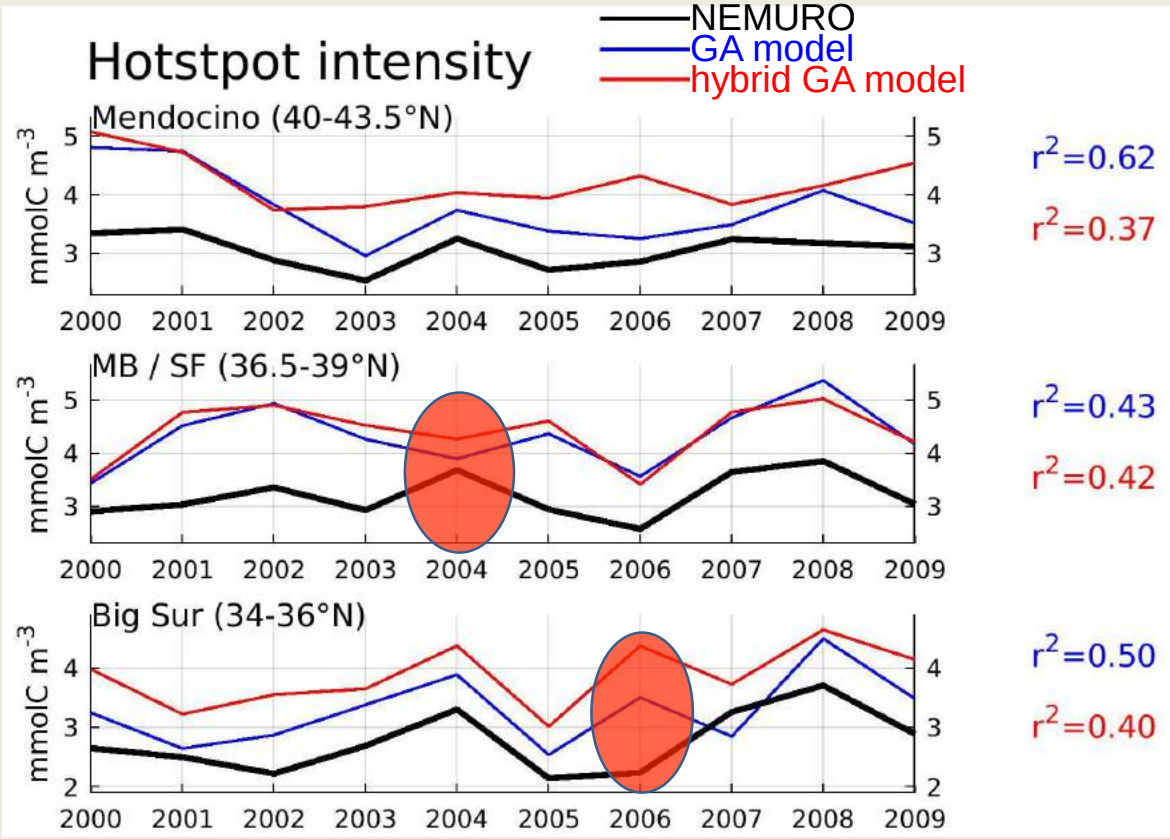
NEMURO = 3D biogeochemical model coupled with ROMS

GA model = growth/advection using the same wind/nutrient/currents fields

Towards predicting hotspots from satellite



Krill annual maximum

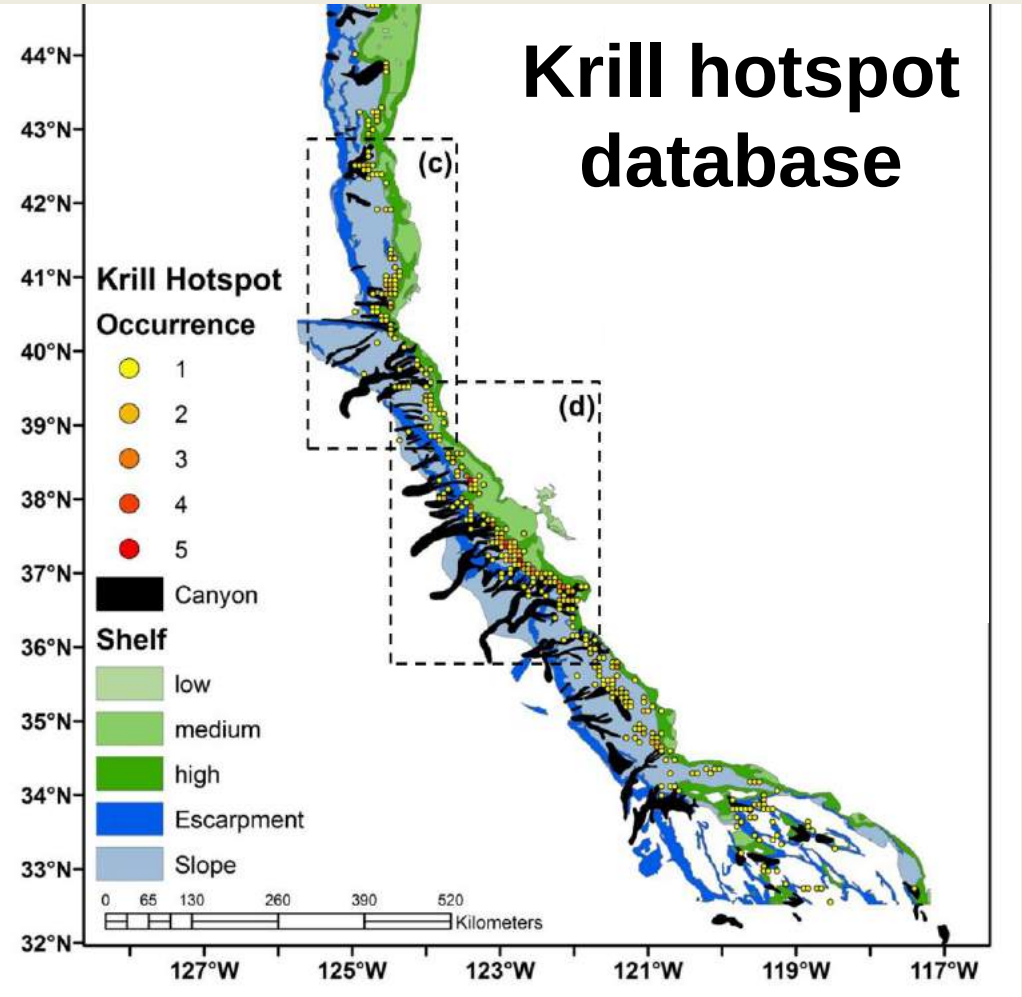


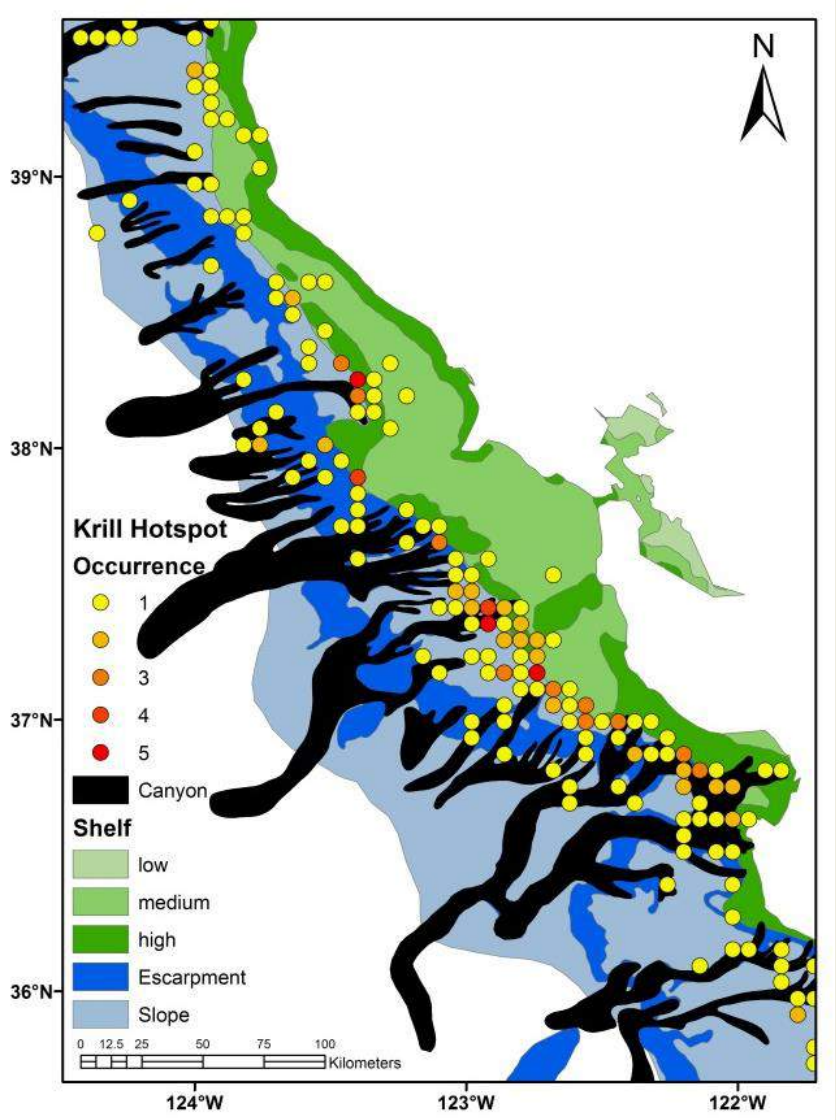
NEMURO = 3D biogeochemical model coupled with ROMS

GA model = growth/advection using the same wind/nutrient/currents fields

GA hybrid = growth/advection using satellite Nsupply and ROMS currents

In situ data: Assessment of observed hotspots





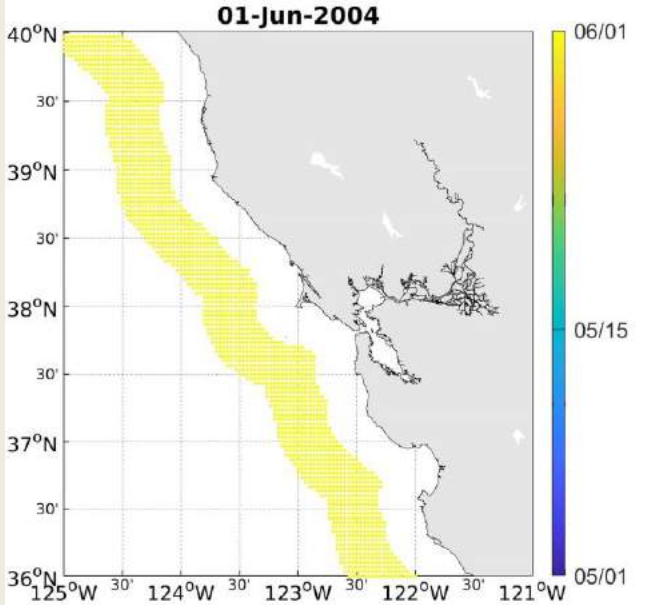
Summarized in Santora et al. 2018 Scientific Reports

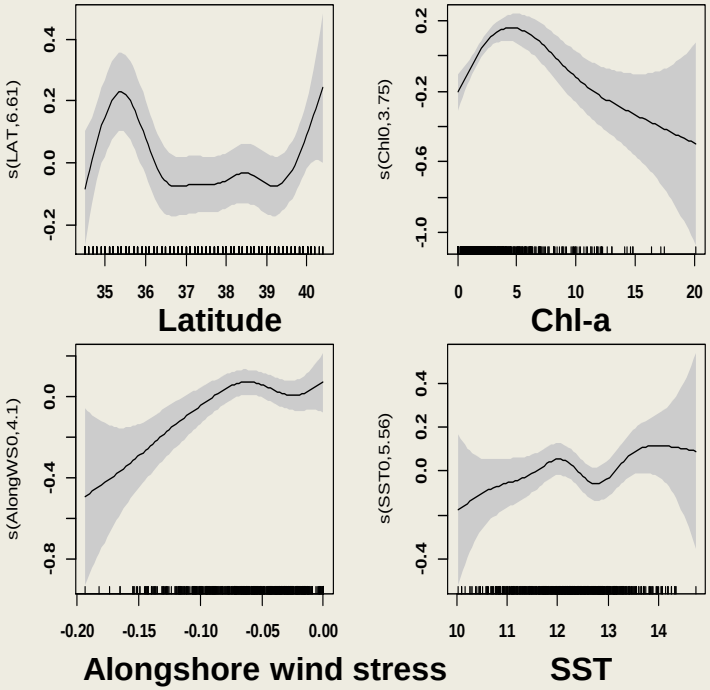
In situ data: Assessment of observed hotspots

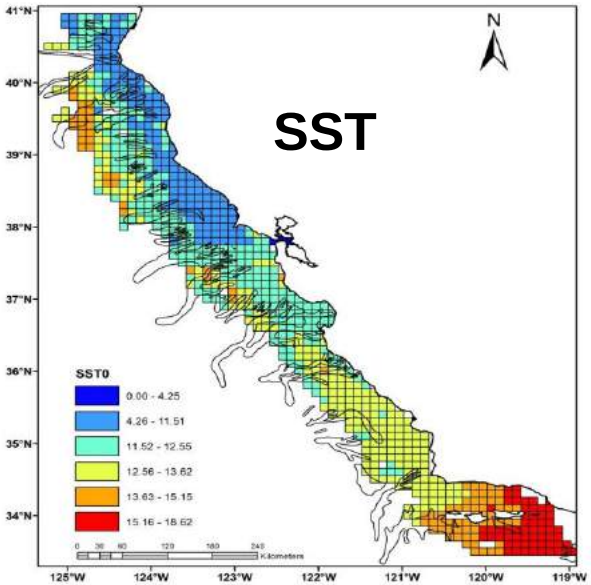
Observed krill hotspots and relationships with ocean conditions

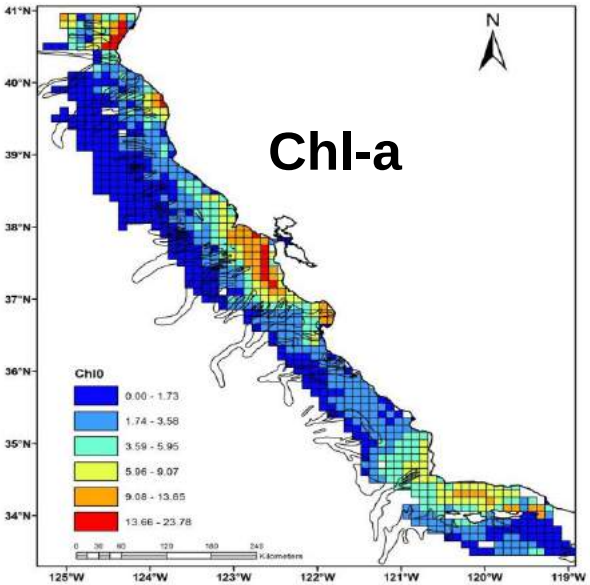
on a grid

following backward current trajectories





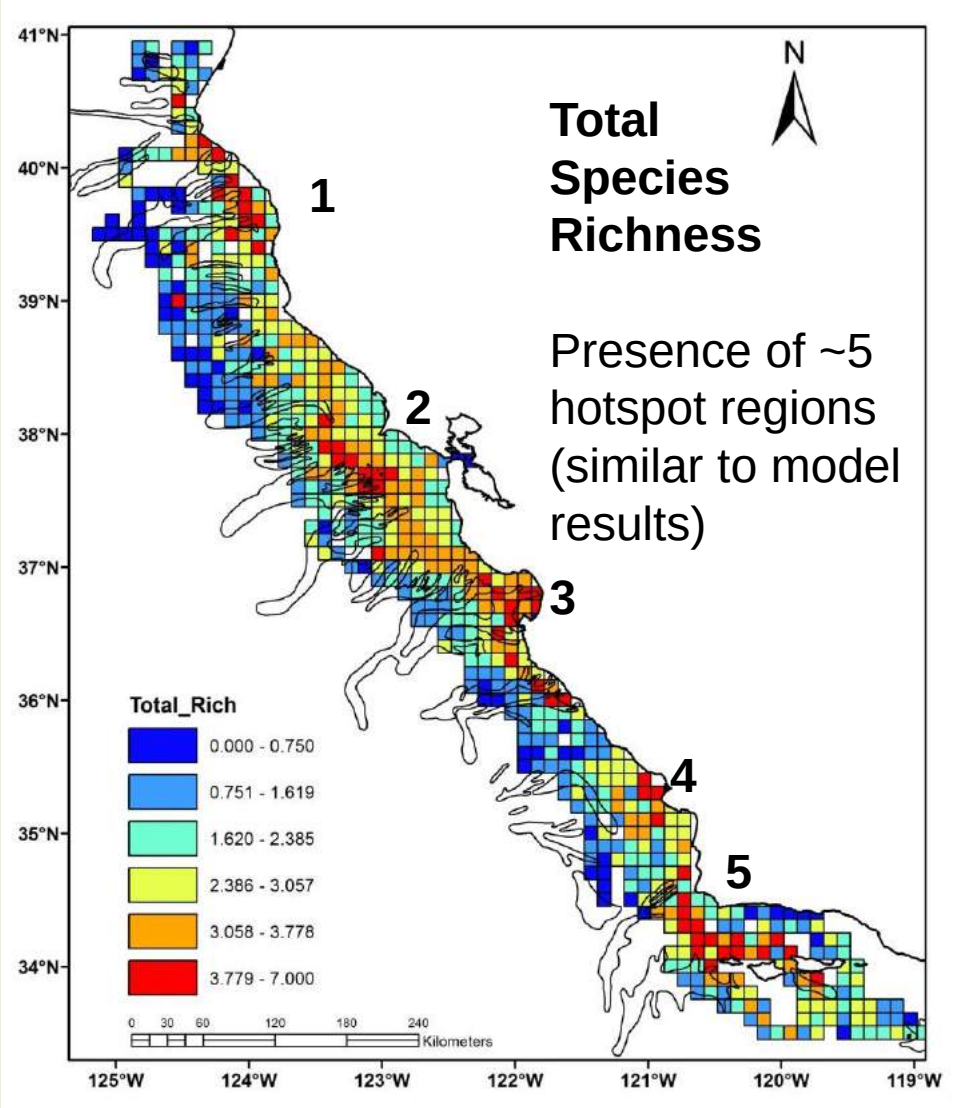




In situ data: Linking top predator patterns with observed and modeled hotspots

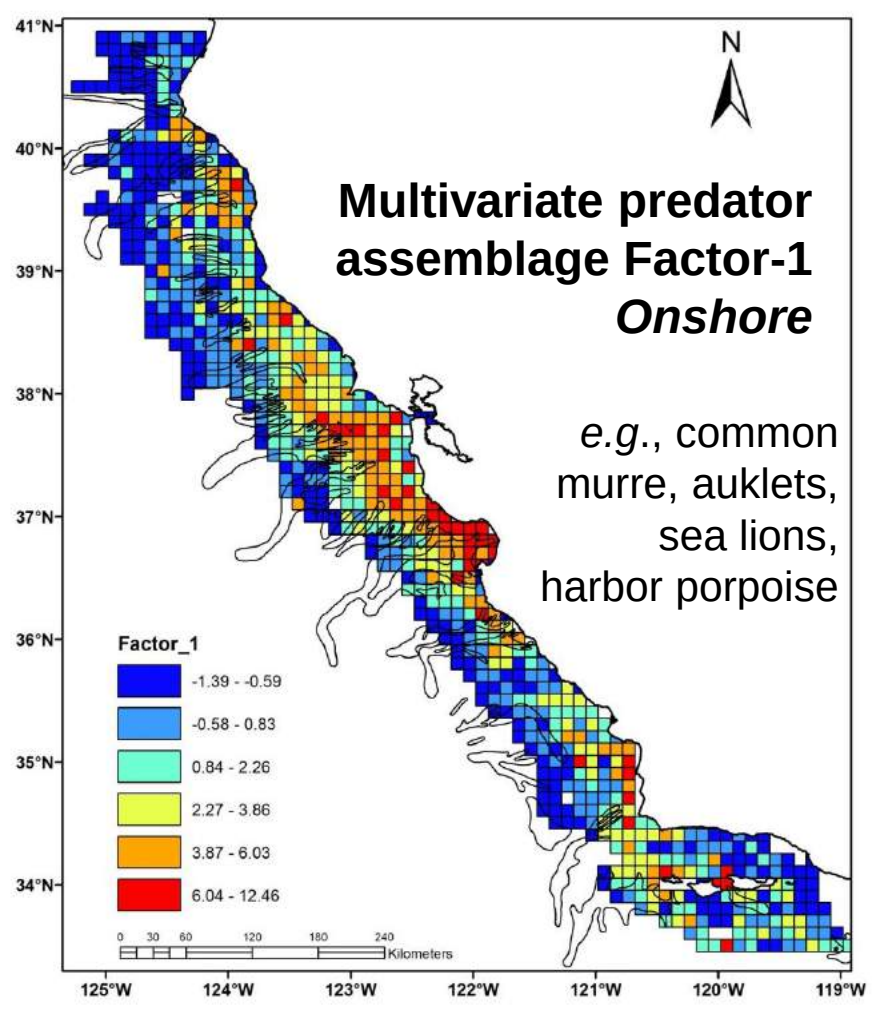
Spatial climatology (96-16)
93 species
(66 seabirds, 27 mammals)

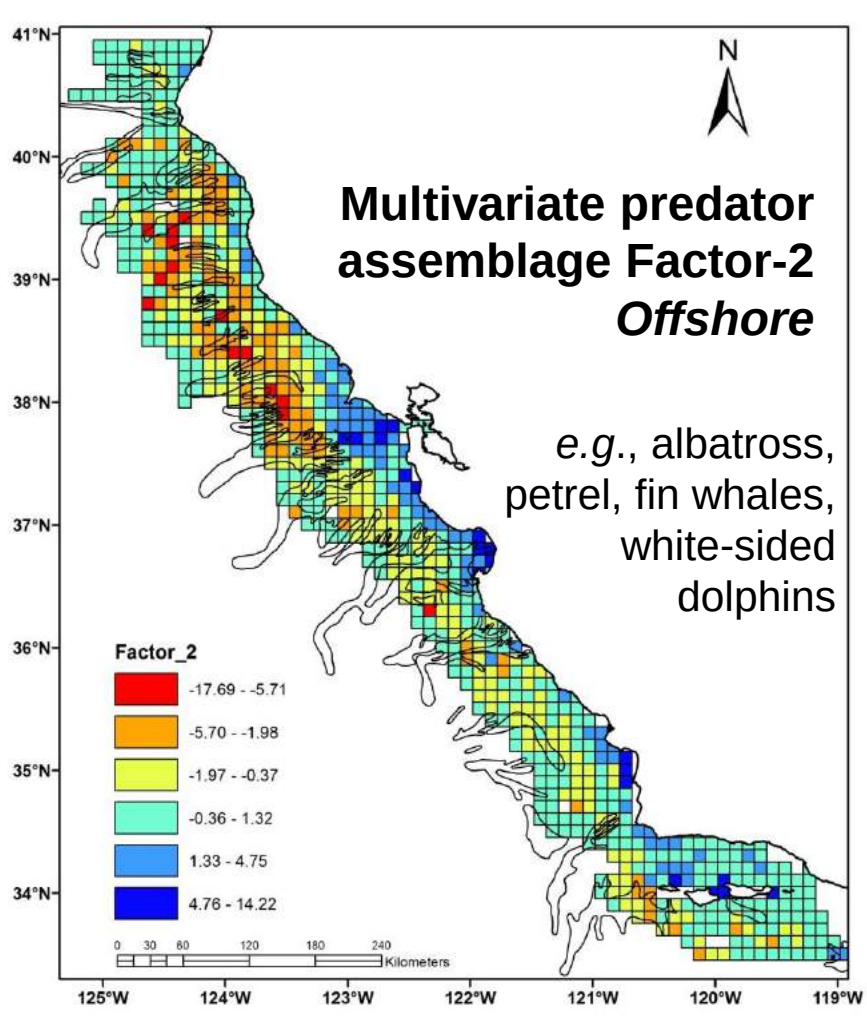
How are predator diversity and distribution patterns related to observed and modeled zooplankton hotspots?



In situ data: Linking top predator patterns with observed and modeled hotspots

Species assemblages verify onshore and offshore habitat affinities, onshore similar to krill hotspots





Key results

- Zooplankton get concentrated in “hotspots” primarily driven by winds (upwelling) and surface currents
- Models successfully capture the interannual variability of hotspots
- Krill hotspots coincide with predator hotspots, characterized by higher biomass and biodiversity

Submitted session at Ocean Sciences 2020:
Life in a moving ocean: observing and modeling ecosystem hotspots