Modeling and data assimilation in Monterey Bay Area.

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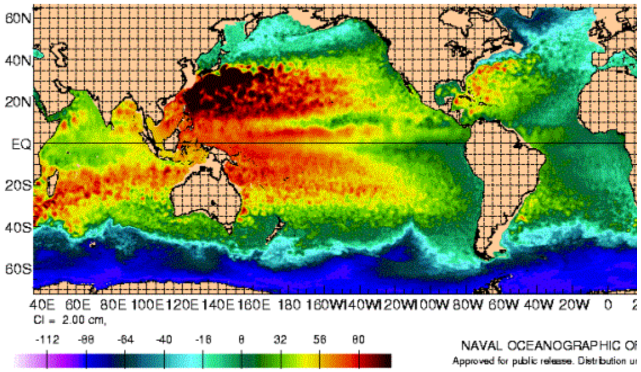
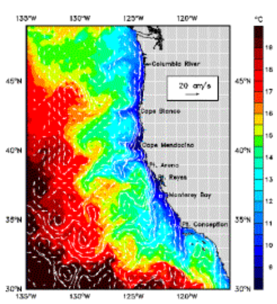
Hierarchy of the different resolution models in the Pacific Ocean.

Global (NLOM or NCOM)

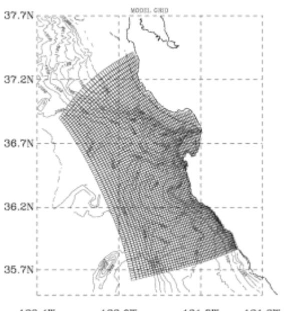


PWC (POM or NCOM)



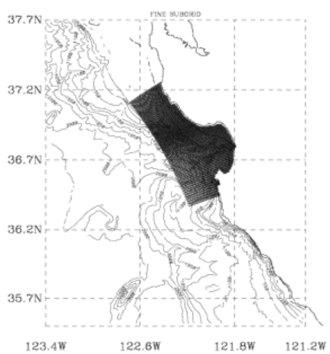
ICON MODEL

- Grid resolution ~ 1-4 km, 30 vertical
- Open boundary conditions are derived from Pacific West Coast (PWC) NRL model (resolution ~10km).
- Atmospheric forcing from NOGAPS and COAMPS predictions.
- Assimilation of CODAR data.



FINE RESOLUTION MODEL (frsICON)

- Grid resolution is 500-650m around MUSE experiment.
- Open boundary conditions are derived from the ICON model predictions.
- Atmospheric forcing from COAMPS predictions.
- Assimilation of CODAR data



ICON MODEL

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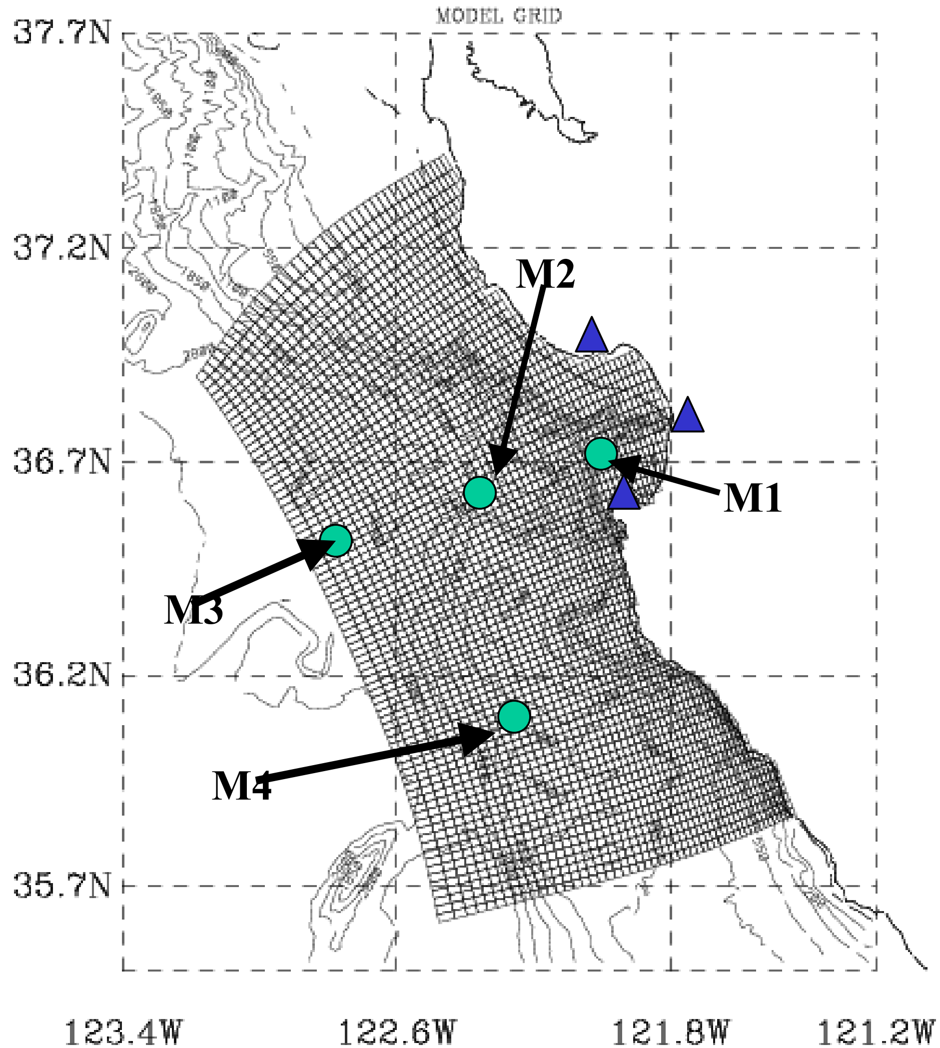


The **modeling objective** of the NOPP ICON project is to demonstrate the capability of a high resolution model to track the major features in an upwelling system when constrained by the proposed measurement suite and nested within a regional model.

Table 1.

ICON Model Runs in 1999				
Run #	Wind Forcing*	Surface Heat Forcing**	Open Boundary Forcing***	CODAR Assimilation
1	NOGAPS	None	PWC0.0	None
2	NOGAPS	MCSST	PWC0.0	None
3	COAMPS	None	PWC0.0	None
4	COAMPS	MCSST	PWC0.0	None
5	COAMPS	COAMPS	PWC0.0	None
6	COAMPS	None	PWC2.1	None
7	COAMPS	COAMPS	PWC2.1	None
8	NOGAPS	None	PWC0.0	Yes ****
9	COAMPS	None	PWC0.0	Yes ****
ICON Model Runs in 2000 (January 1 – October 1)				
10	COAMPS	COAMPS	PWC10.9	No
11	COAMPS	COAMPS	PWC10.9	Yes

V

Run 11 is on ONR ftp site

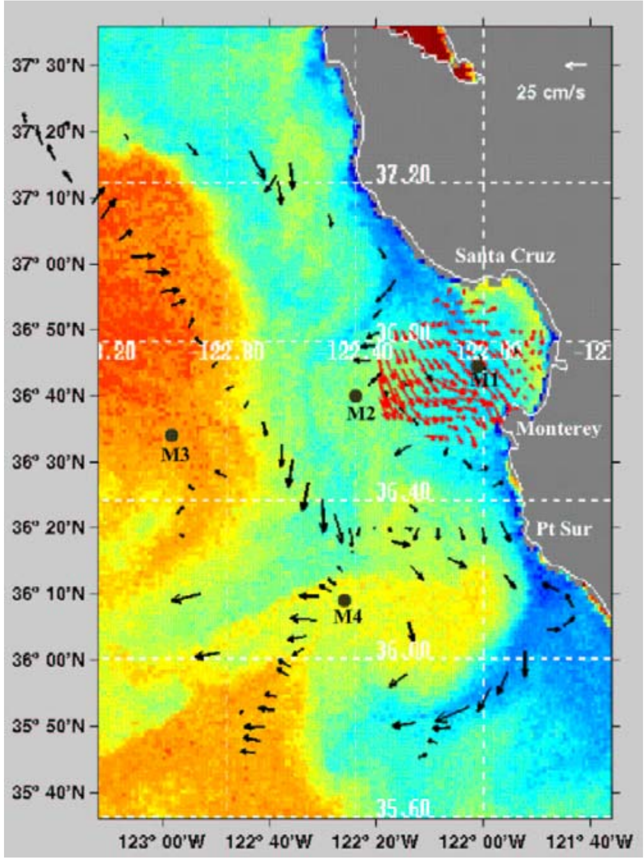
* 9km resolution COAMPS used

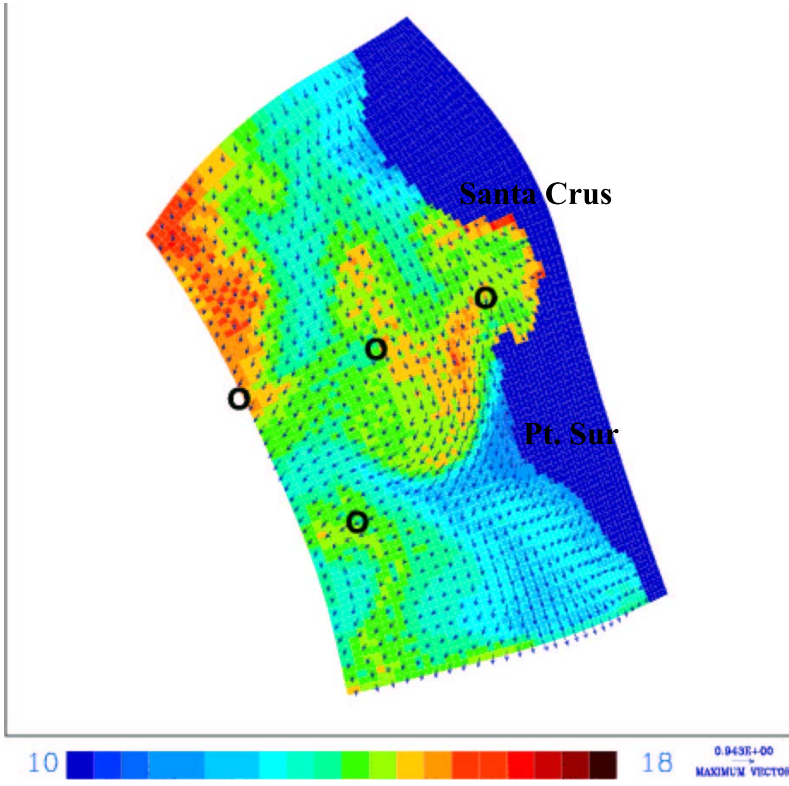
** MCSST surface temperatures always assimilated into PWC but only assimilated in ICON model where indicated.

*** PWC0.0 is forced with NOGAPS wind, PWC2.1 and PWC10.9 are forces with 27 km, operational COAMPS wind in 1999 and 2000 respectively.

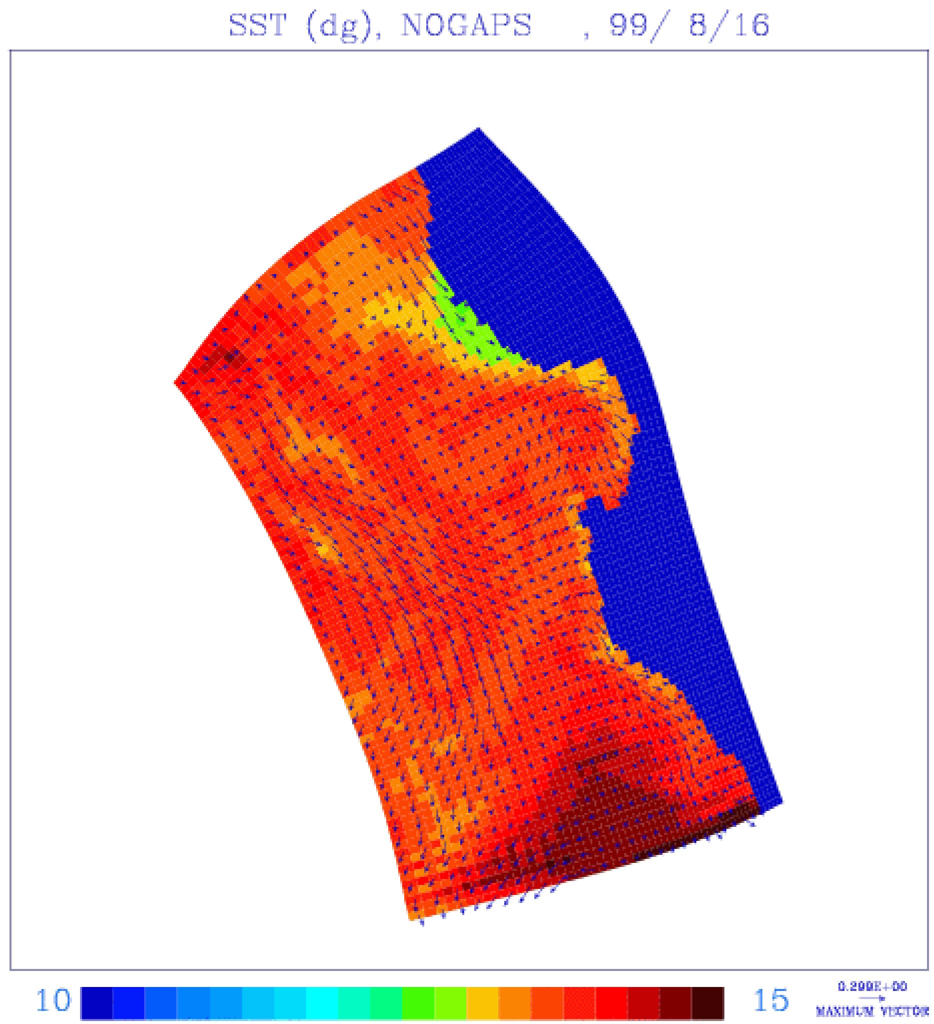
**** Runs 8, 9 and 11 were done with the use of several CODAR data assimilation schemes.

Observed and ICON model SSTs August 31, 1999

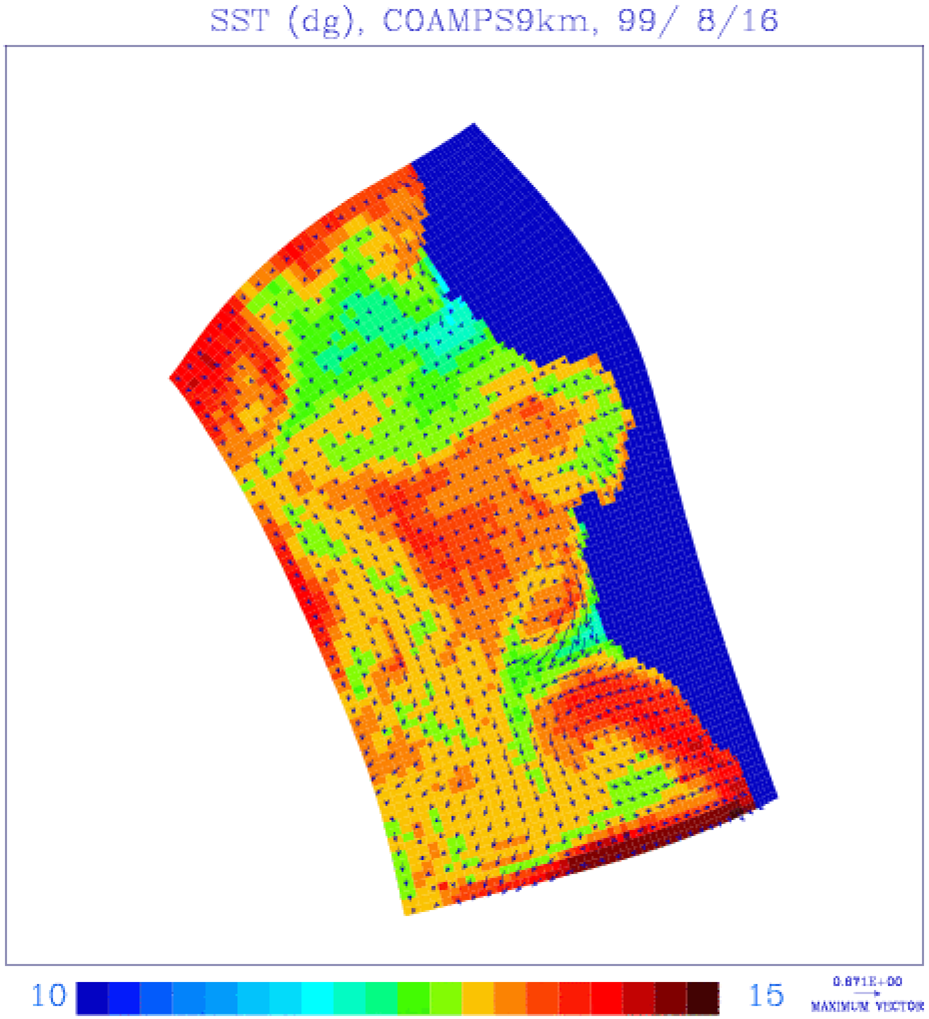




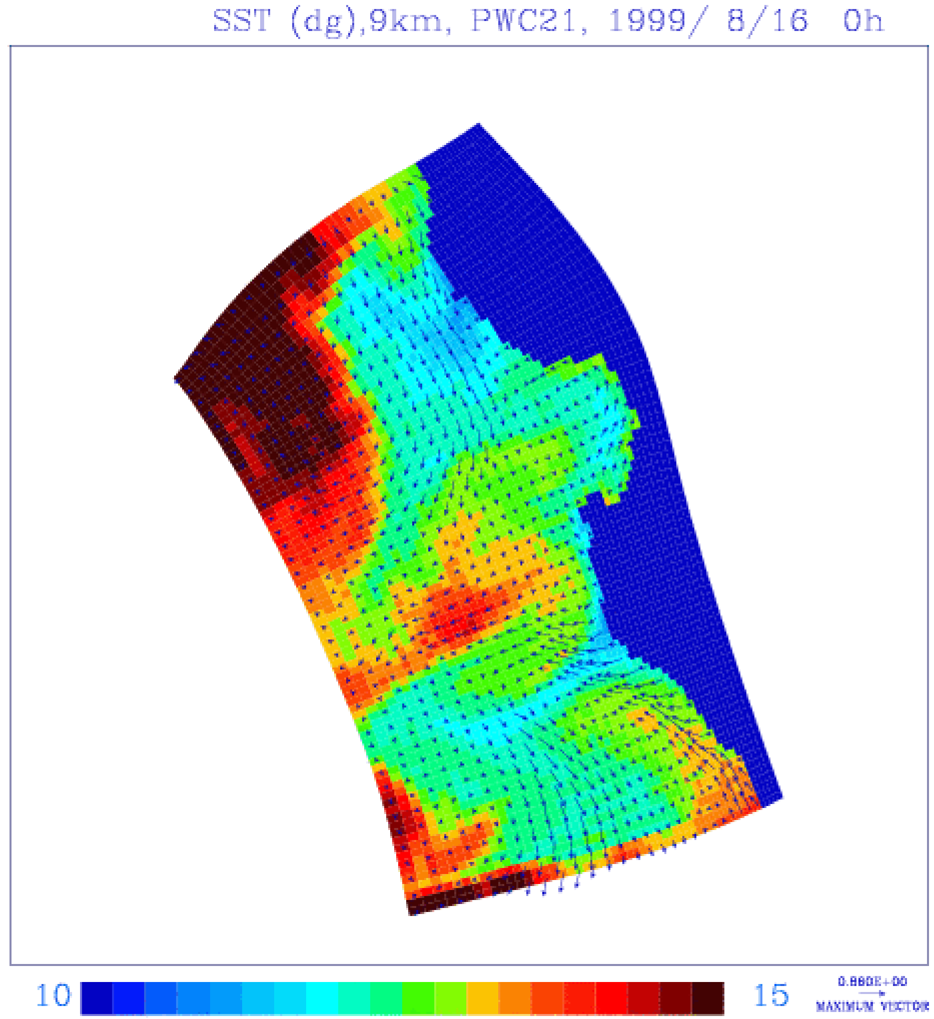
NOGAPS is forcing for ICON and PWC



ICON with COAMPS, PWC with NOGAPS

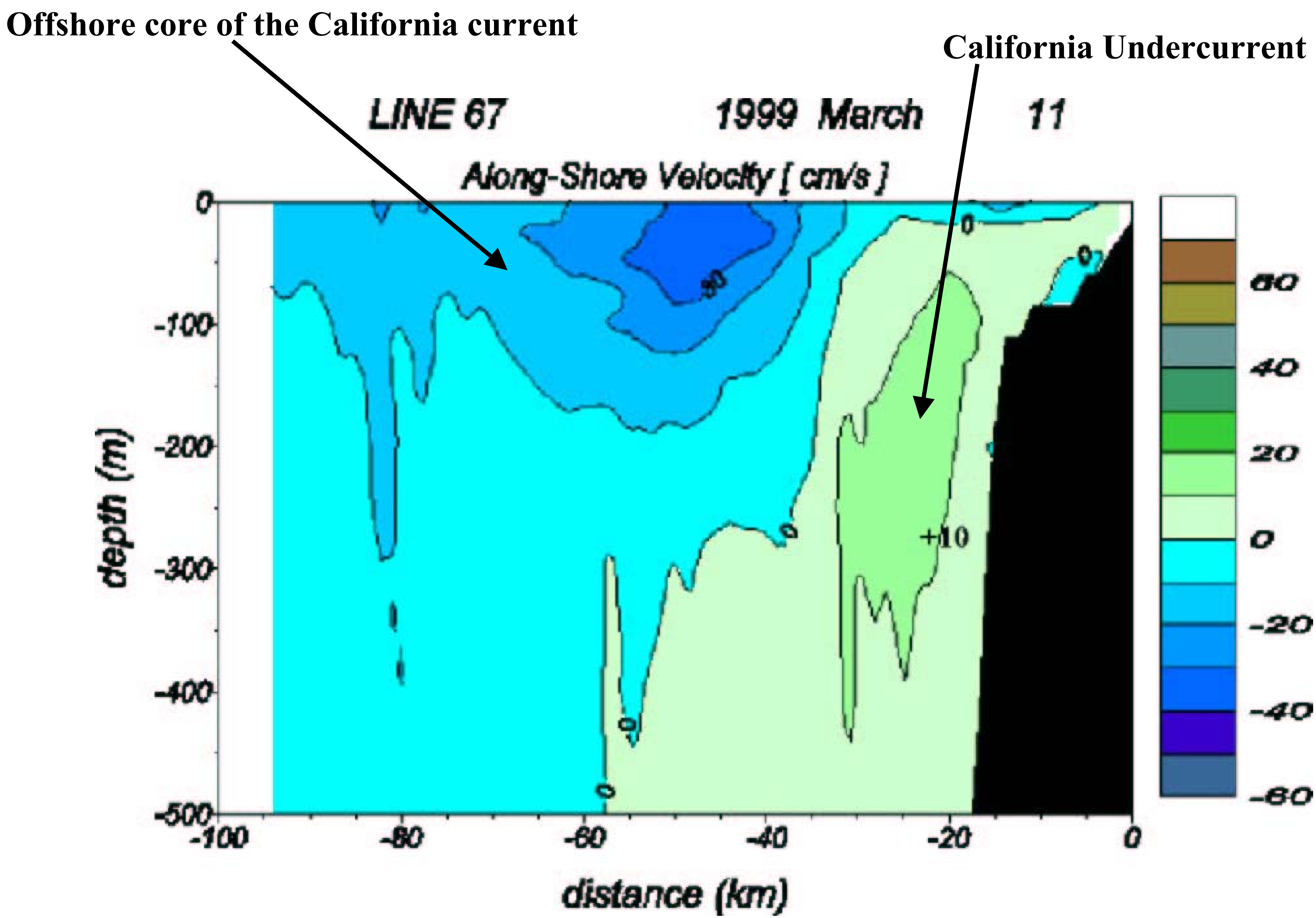


COAMPS is forcing for ICON and PWC



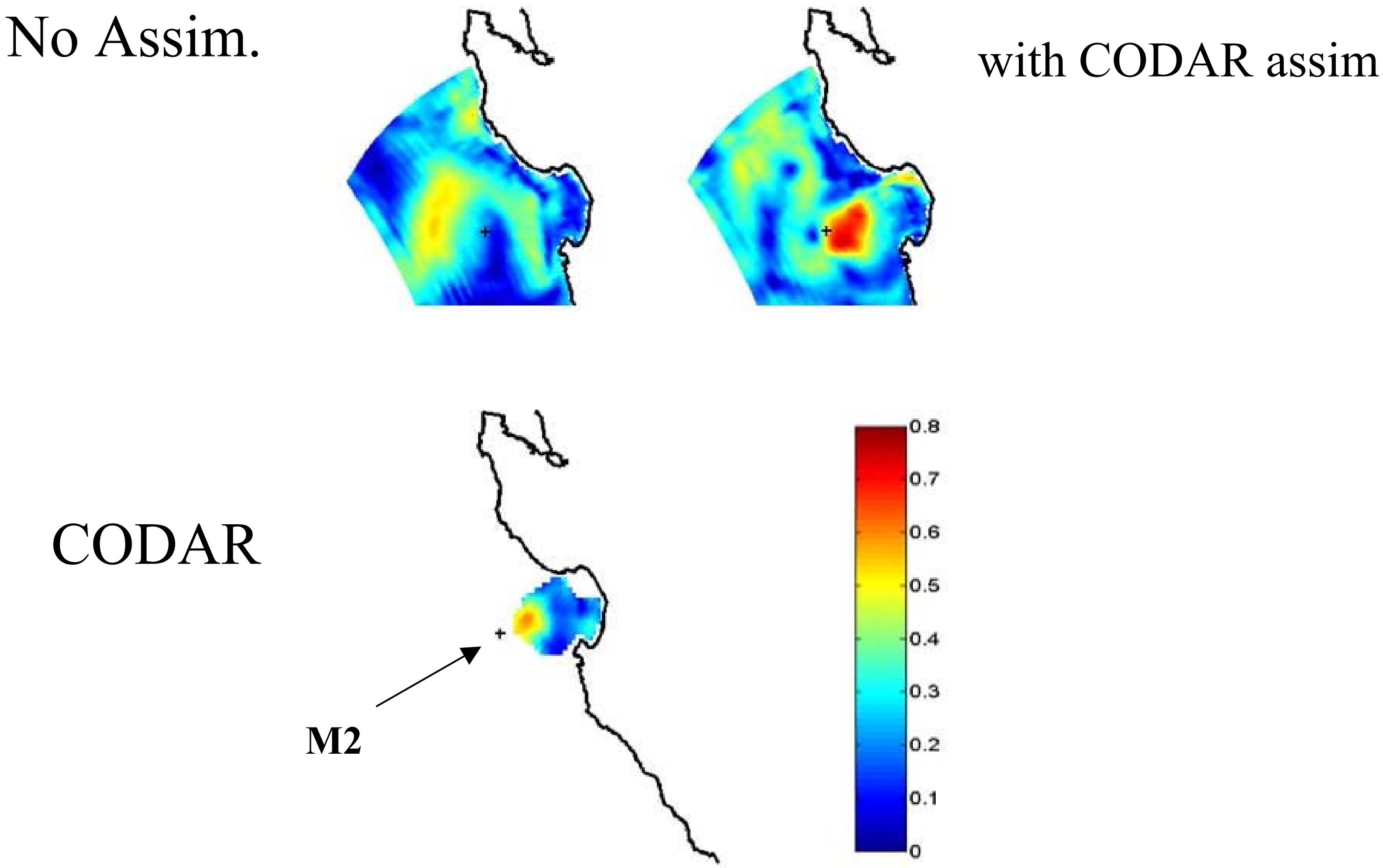
Observed and model predicted MLDs (m).

	M1 7-9/99		M4 9/99	
	0.1 °C	0.2 °C	0.1 °C	0.2 °C
Observed	10.8	11.6	12.6	13.2
ICON (1)	24.1	29.0	19.2	21.7
PWC	11.0	15.4	10.7	13.8
ICON with MCSST assimilation (2)	18.3	22.9	18.2	22.1
ICON with COAMPS τ (3)	24.4	28.6	25.1	29.1
ICON with COAMPS τ, heat fluxes (5)	12.8	14.0	14.7	17.1

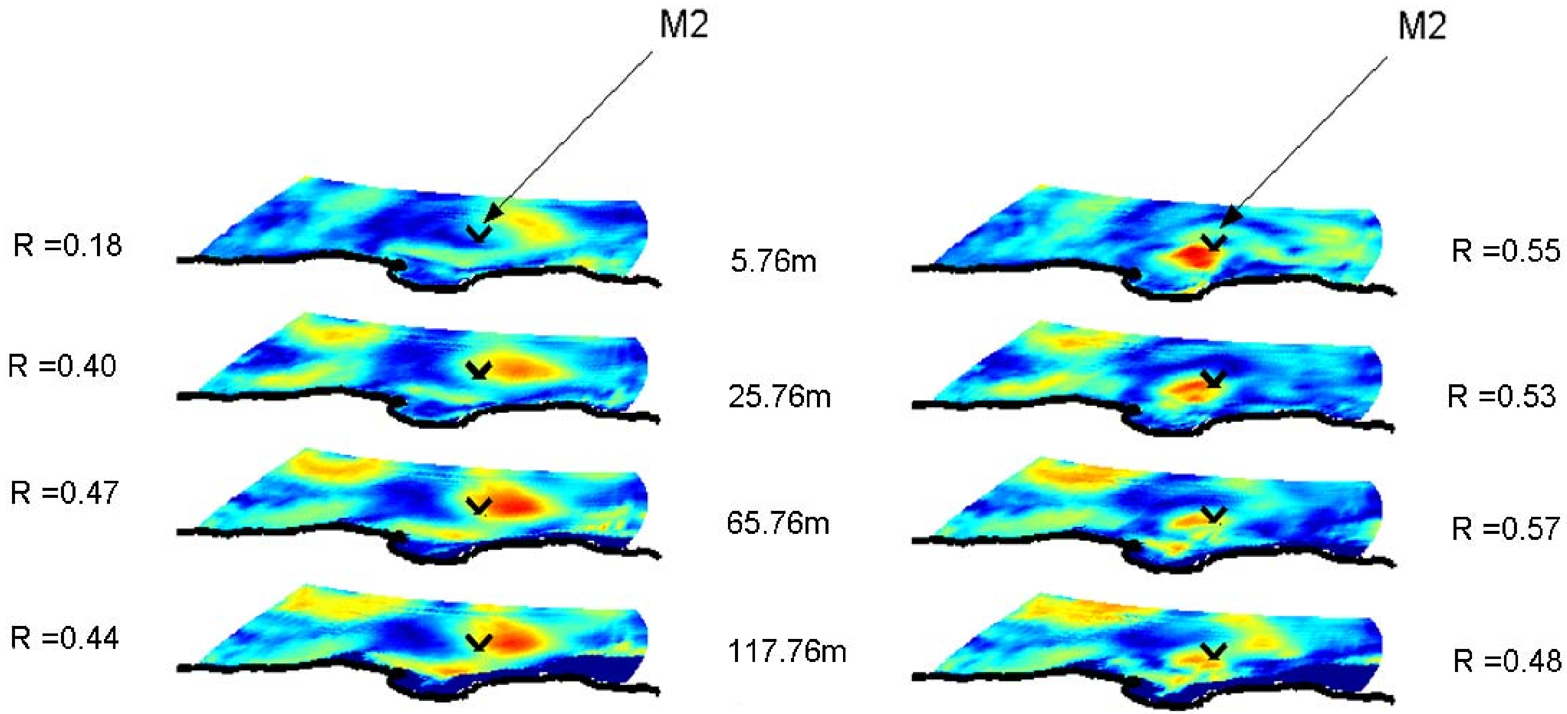


Offshore core of the California current
California Undercurrent
LINE 67
1999 March
11
Along-Shore Velocity [cm/s]
0
-100
-200
-300
-400
-500
-100
-80
-60
-40
-20
0
depth (m)
distance (km)
-30
+10
60
40
20
0
-20
-40
-60

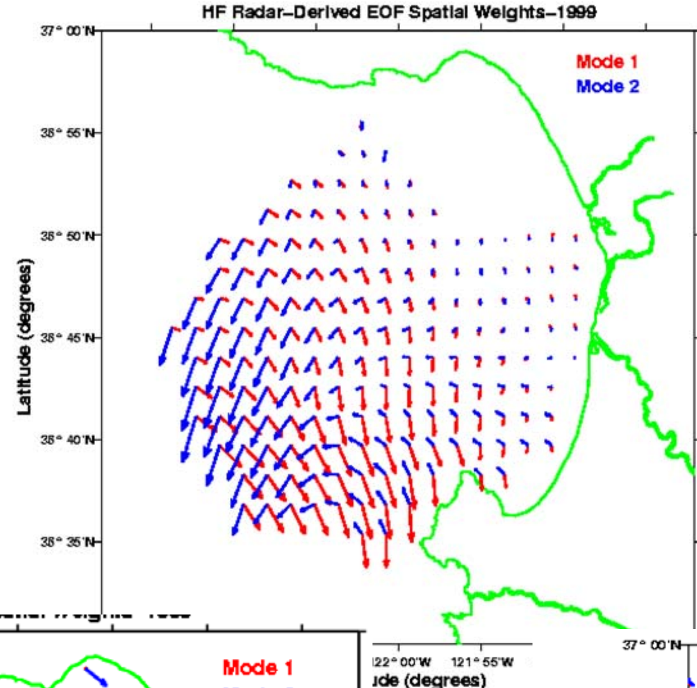
Magnitudes of complex correlation of model surface currents and CODAR currents with velocities of the M2 first bin.



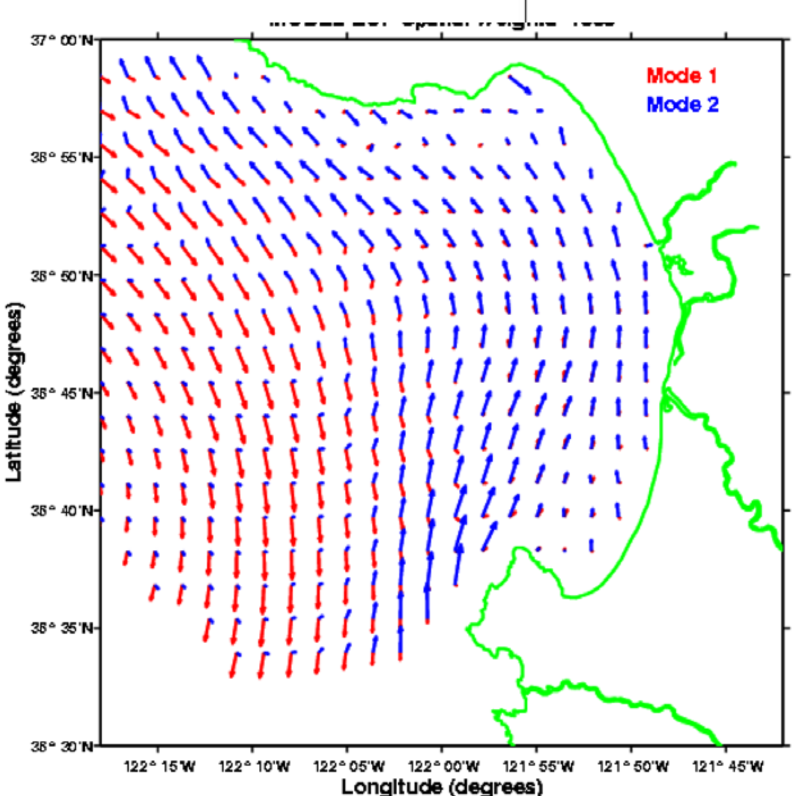
Magnitudes of complex-correlation coefficients between the ADCP and model-predicted currents at M2.



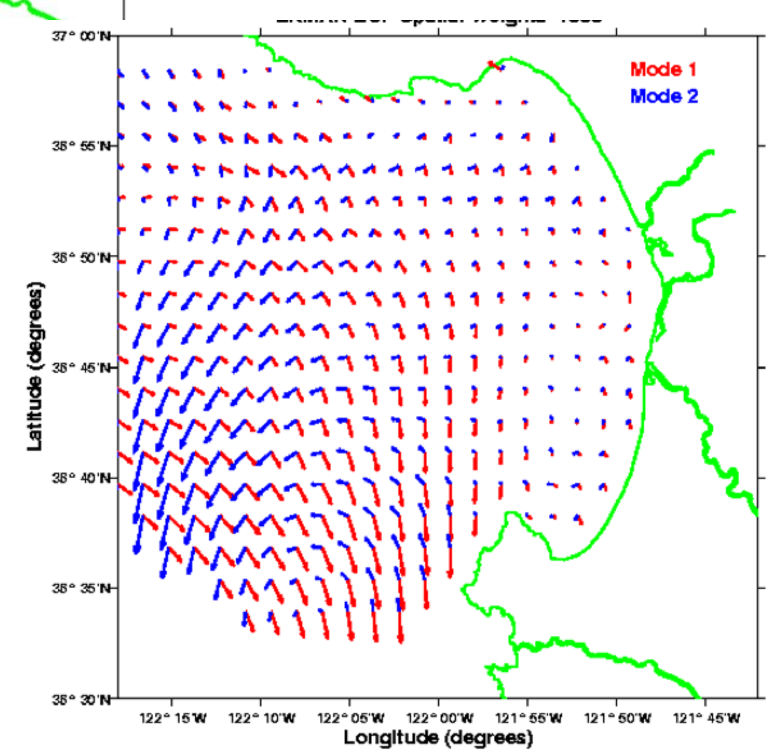
CODAR



No assim



Assim.



- **The model predictions demonstrated the significance and importance of coupling the ICON model with the larger-scale PWC model.**
- **The model run with COAMPS 9km wind forcing better captured the influence of the complex coastline, displayed more observed details and produced stronger headland effects.**
- **The inclusion of high-resolution surface heat fluxes from COAMPS predictions is important for accurate prediction of the mixed layer shallowing during the summer time.**

- **With high-resolution atmospheric forcing the ICON model captures "the essence" of observed hydrographic conditions. However, sometimes, the "details" of observed variability are missed.**

- **Assimilation of CODAR-derived surface currents improves significantly surface and subsurface model correlation with ADCP data.**

ICON model improvements

- Implementation and testing tides
- Data Assimilation

Use of the circulation model for optimal sampling of the bioluminescence intensity in the Monterey Bay.

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I. Shulman

Naval Postgraduate School
J. Paduan, L. Rosenfeld

WHOI
D. McGillicuddy

Naval Research Lab
J. Kindle, P. Rochford,
S. Derada, S. Cayola

Prediction of the Bioluminescence potential in the ocean represents a very challenging problem:

- there is a lack of spatial and temporal coverage of available BL observations for robust model initialization;
- little is known about life cycles of autotrophs, grazers, and predators producing the BL;
- little is known about the mathematical formulation and parameterization of biological processes governing BL variability in a complex ecosystem.

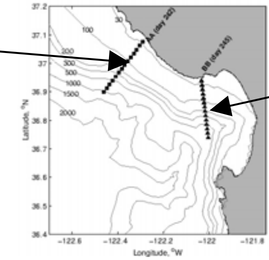
Pilot Study of BL predictability (MUSE)

How much of the short-term (2-3 days) of BL variability can be explained by advective-diffusive processess of the tracer model combined with the circulation model and available limited BL observations?

Research has been focused on inferring and predicting the location and intensity of BL maximum.

Bioluminescence potential predictability experiments demonstrated the strong utility of the circulation model in predicting the location and intensity of the BL maximum over a 72-h period, and over distances of 25-35 km.

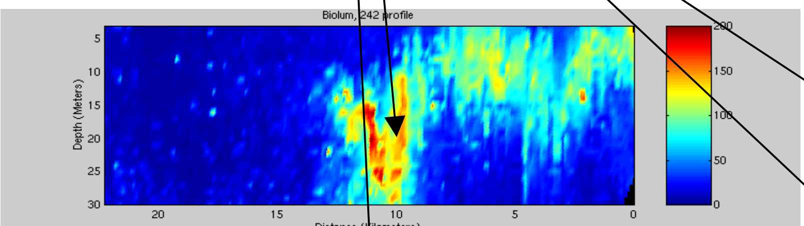
BL maximums at 242d and 245th days are located in the frontal areas representing a strong reversal of flow direction.

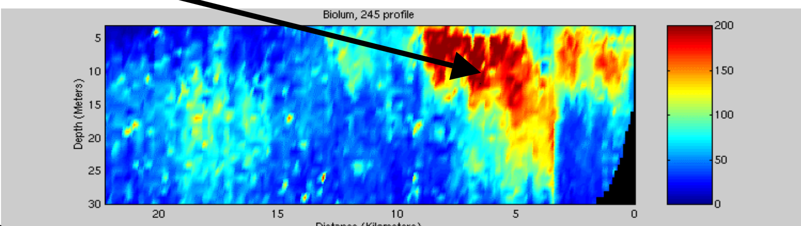


242d day

245th day

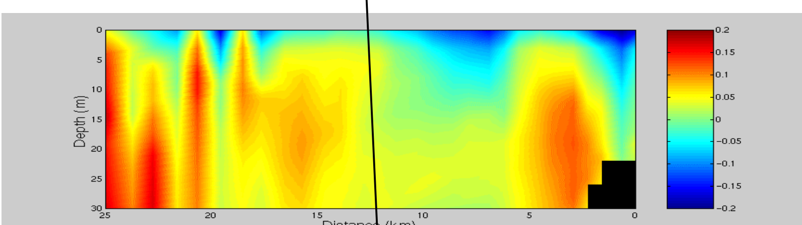
Bioluminescence

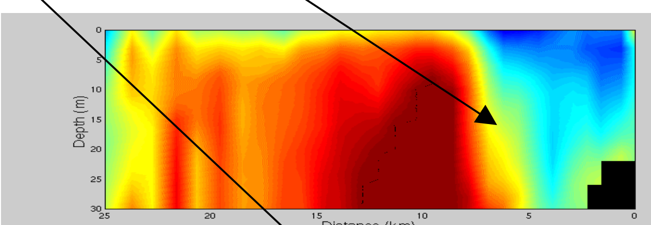


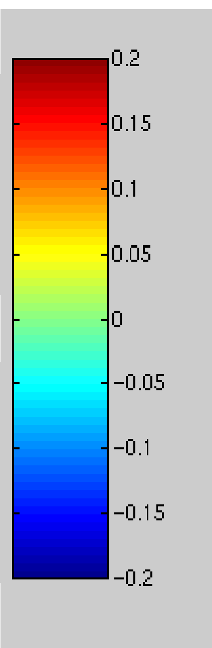


Cross-section model velocities

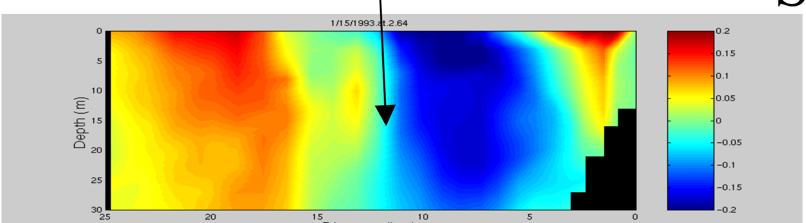
Section AA

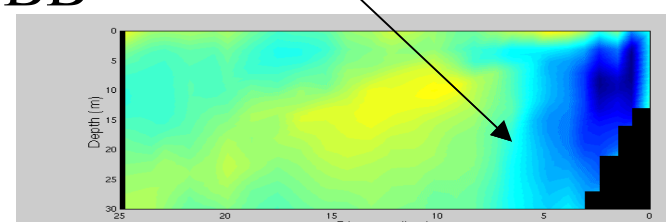






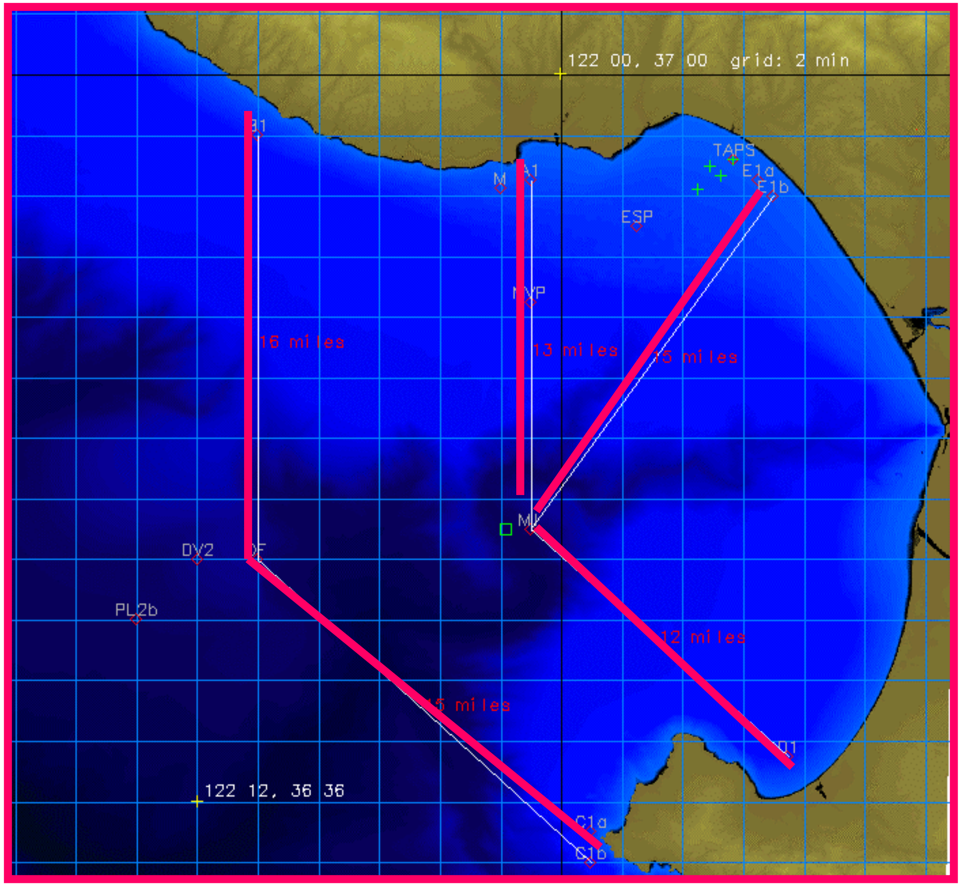
Section BB





PLAN

Observational Program (S. Haddock)



OBJECTIVE

Investigate utility of the circulation model in optimizing limited BL sampling for maximum impact on short-term (2-3 days) BL forecasts.

AOSN HYPOTHESIS

(AOSN_II_Performance_Summary_2002_oct24.doc)

water seed populations control the biological community structure, in particular the bioluminescence constituents, in the region of the upwelling plume.

APPROACH (proposal on ONR ftp site)

- **use ICON and frsICON models to study optimal positions for BL sections during various oceanographic seasons and various atmospheric conditions.**
- **study of the sensitivity of 3 day BL forecasts with the tracer model to the locations of the BL surveys.**
- **investigate the relationship among 5 proposed observational sections by tracking particles advected from their initial locations along these sections.**

APPROACH (proposal on ONR ftp site)

- **use of more objective approaches for optimal observational design and adaptive sampling: adjoint-based, ensemble-based.**
- **we will conduct this research in collaboration with adaptive sampling group involved into AOSN II experiment.**
- **the inclusion of tidal forcing is crucial for accurate BL predictions, which rely on short-term particle tracking.**

Other AOSN activities

- **ICON model outputs for June-August of 2000 were provided to adaptive and modeling groups.**
- **Collaborate with adaptive and modeling groups on testing their techniques with ICON model output data.**
- **Investigate outputs from ICON model to better estimate the space-time evolution of the upwelling plumes and their interaction with California Current System (AOSN Hypothesis).**
- **Collaborate with HOPS and ROMS group in AOSN II modeling activities.**
- **Conduct hindcast/nowcast runs of the ICON model for time frame of the AOSN II experiment and compare model outputs with forecasts produced during the experiment.**