Surface Current Trajectory Observations in the Southern California Bight

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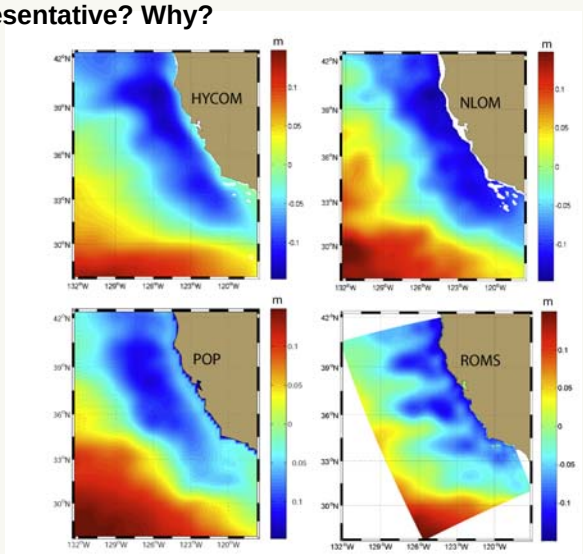
Goals

- demonstrate need to validate model results with data
- show existing drifter data from Southern California Bight
- motivate use of these data with models in SCB MPA studies

Outline

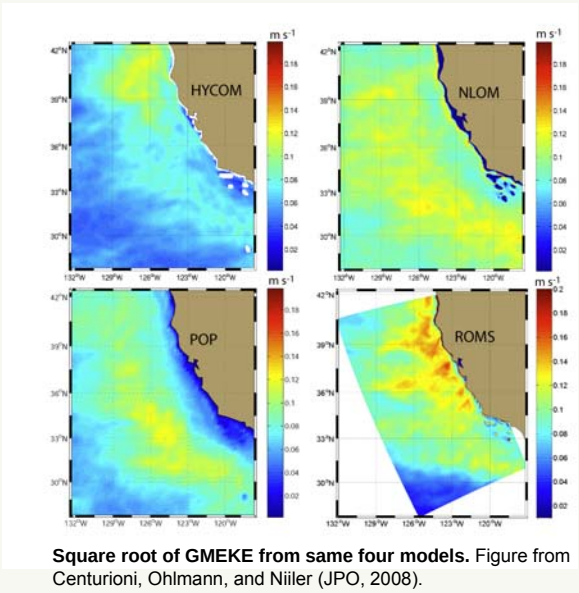
- models - necessary, each typically gives a unique solution
- drifter observations - relevance to connectivity studies
- existing drifter data in SCB - range of time/space scales
- using data with models to enhance understanding of connectivity

Which model of the mean Sea Surface Height (SSH) is most representative? Why?



Mean SSH for California Current from four models. Offsets were applied to make plots with the same color scale. Solutions are averages from 1990 to 2001. Figure from Centurioni, Ohlmann, and Niiler (JPO, 2008).

Which model of the EKE is most representative? Why?



Square root of GMEKE from same four models. Figure from Centurioni, Ohlmann, and Niiler (JPO, 2008).

- data are necessary for interpreting model results
- thorough model assessment is non-trivial, requiring a quantitative comparison of a number of parameters specific to model configuration, its planned use, the available data, and the circulation

optimal connectivity patterns require models, data, and thorough model assessment

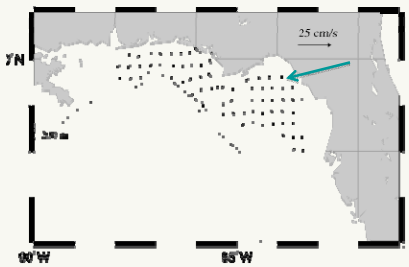
ocean current observations are available from many instruments

Eulerian observations give point measurements or time/space means

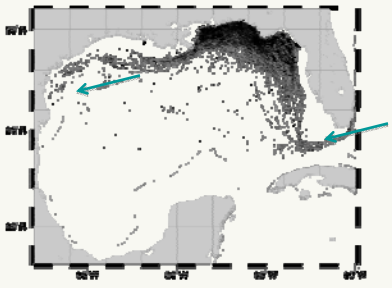
- satellite altimetry
- moorings (ADCP)
- ship/glider/AUV surveys
- high frequency radar

Lagrangian observations follow the path of a water parcel

- drifters (surface currents)
- floats (subsurface currents)



Eulerian means show velocities near zero



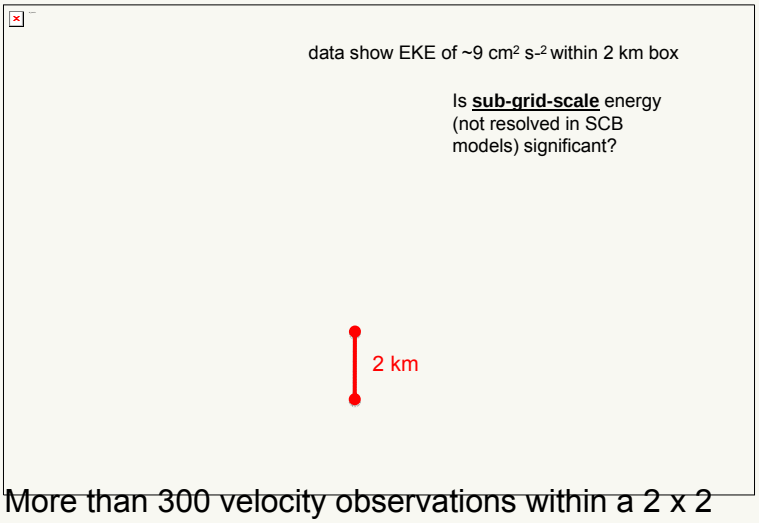
corresponding **Lagrangian** trajectories show significant displacements

Figures from Ohlmann and Niiler, 2005

Lagrangian drifter data are particularly relevant to connectivity

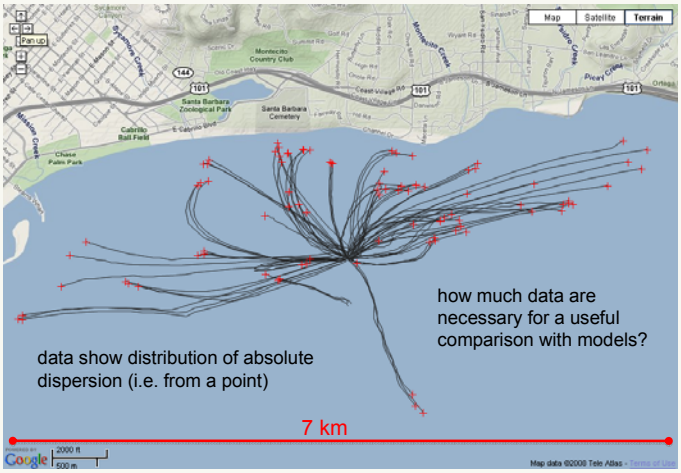
1) connectivity is a Lagrangian process
2) measure flow evolution in both time and space
3) provide independent means of model validation (not easily assimilated)
4) directly measure Lagrangian Stochastic Model parameters (σ^2, T_l, $D_{x,y}$)
5) can resolve a large range of scales (minutes -> years; meters -> 100's of km)
6) ~13,500 drifter days of data exist in the SCB region; more coming

Southern CA Bight drifter data on scales not resolved in regional models



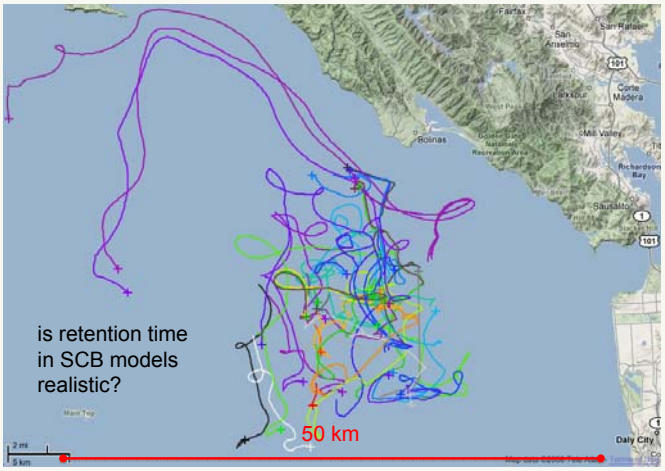
More than 300 velocity observations within a 2 x 2 km grid cell during 5 days to measure sub-grid-scale energy. Data in Ohlmann et al. (2007; JAOT).

SCB drifter data on scales connecting shelf to intertidal



Drifter triplets deployed weekly at a specific location. Drifters sample for ~6 hours as part of state funded interdisciplinary project. Data collection planned for 52 weeks.

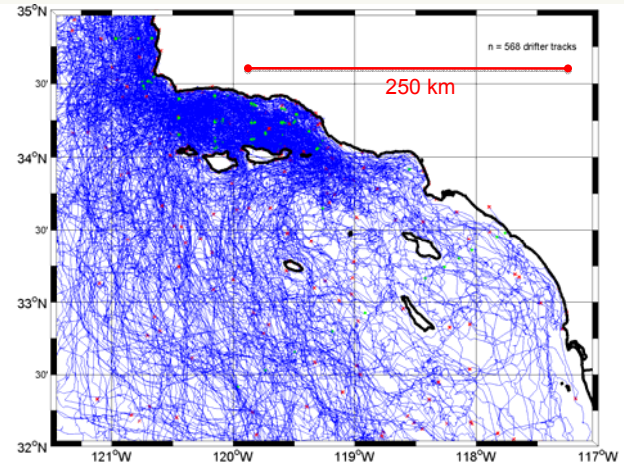
drifter data on the sub-meso-scale



Drifter sets deployed for 3-4 days just north of San Francisco as part of a validation experiment for oil spill response.

data from Garfield, Largier, Ohlmann, and Paduan

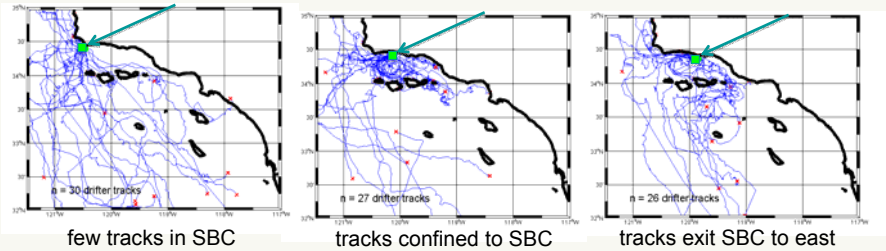
SCB drifter data on the regional scale



Drifters deployed ~quarterly from 1993 – 1999.
568 drifters sampling for an average of ~24 days give ~13,500 drifter days of data.

Dever et al., 1998

data show sensitivity to start location

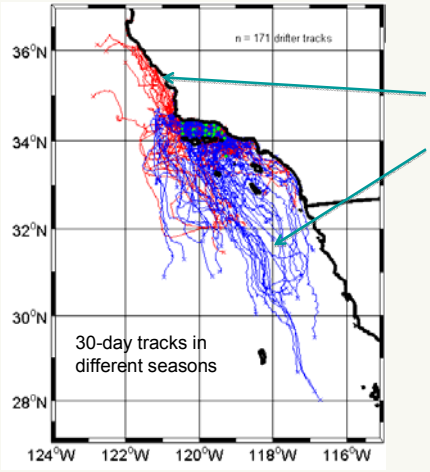


few tracks in SBC | tracks confined to SBC | tracks exit SBC to east

30-day drifter tracks deployed at 3 start locations ( )
separated by ~40 km

- descriptive patterns “look similar” to ROMS results shown by Satoshi
- must go beyond “look similar” with quantitative assessments

data show seasonal variations

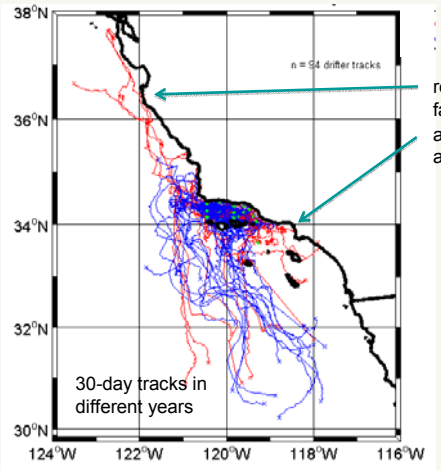


northward (relaxation) motion in winter

southward (wind-driven) flow in spring

RED: winter data (Dec, Jan, Feb)
BLUE: spring data (Mar, Apr, May)

data show inter-annual (ENSO) variations



red ENSO tracks go farther north, and move south-east along coast

RED: data from Jan '97 -> June '98
BLUE: data from July '98 -> Dec '99

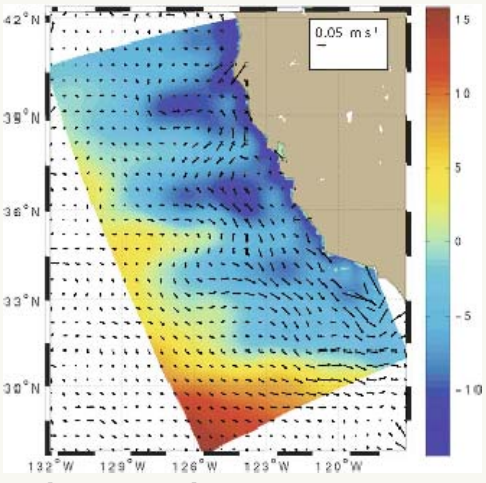
Summary

- connectivity requires models; models require data to assess skill
- drifter data are key (Lagrangian, time-space, scales, not assimilated)
- data exist; more forthcoming; how much are necessary?
- Southern California Bight data suggest sub-grid-scale, seasonal, and inter-annual signals

Correct connectivity solutions to a non-trivial problem require:

- collaborative (models-data) paradigm with thorough assessment
- specific metrics for assessing model skill quantitatively
- “applications-assessment” (?) funding (not “research” or “observations”)
- need patience and persistence; “the devil is in the details”

Data (overlaid vectors) are necessary to determine model skill.



Mean SSH from ROMS with the observed unbiased geostrophic velocity field superimposed. Figure from Centurioni, Ohlmann, and Niiler (JPO, 2008).