Ocean circulation forecasts along the coasts of the US Pacific Northwest region

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D. Foley (NOAA-CoastWatch), L. Miller (NOAA)

Sponsors:
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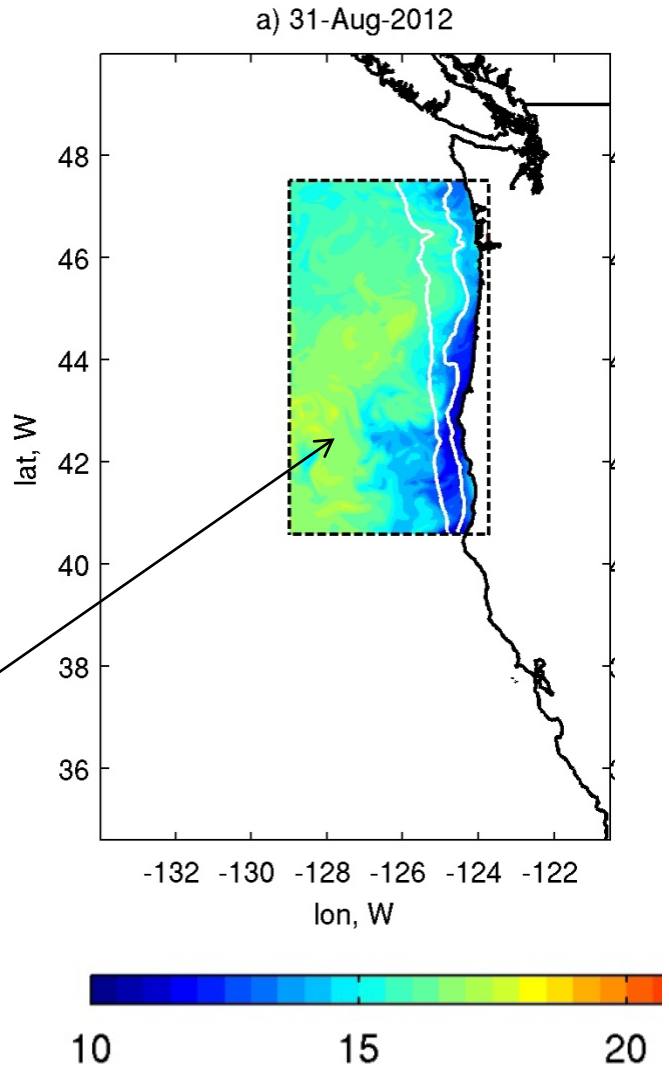
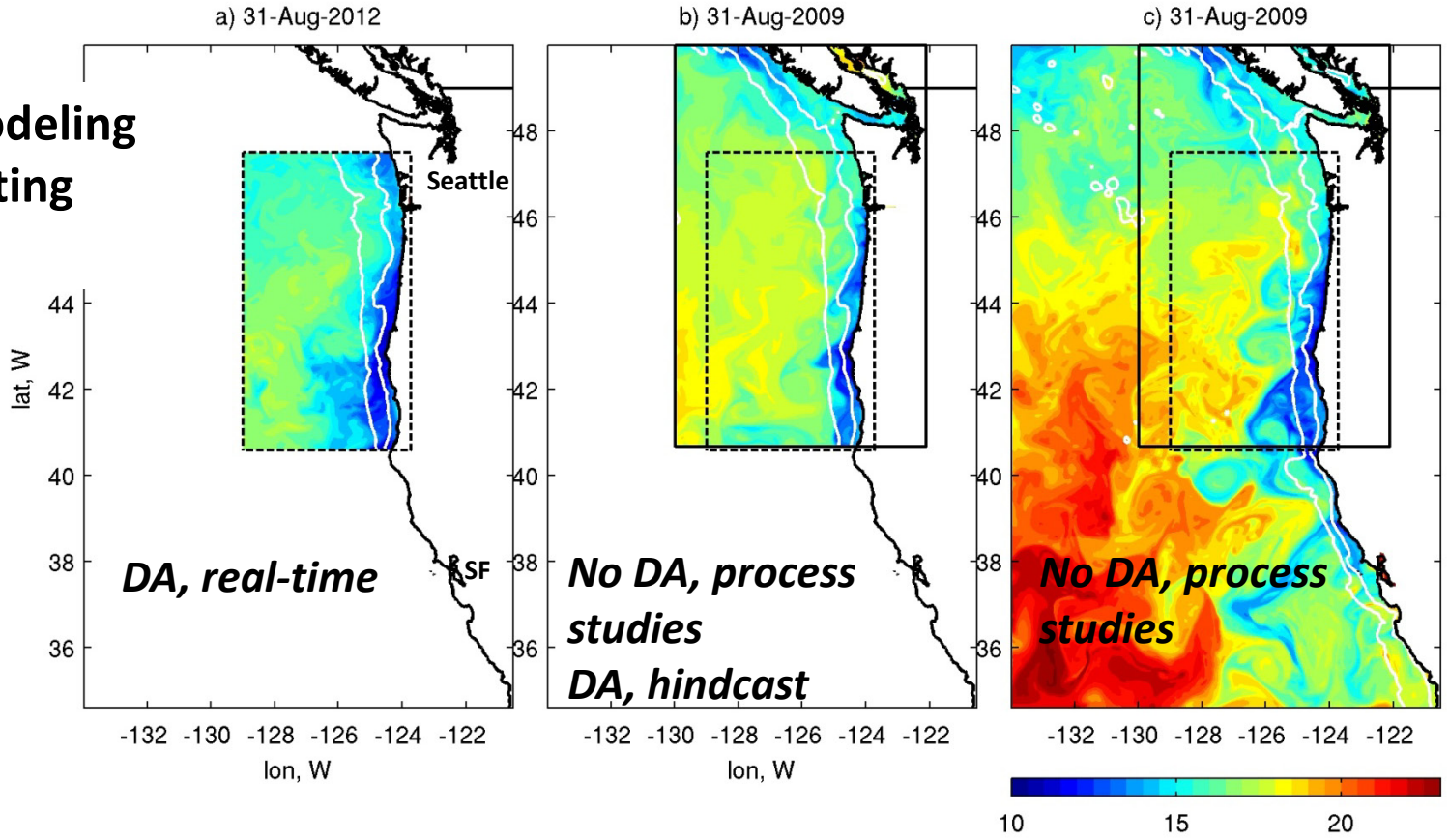


The domain of the present real-time forecast model
(daily updates of 3-day forecasts)
(shown: model SST 31 Aug 2012)

Ongoing modeling and forecasting activities:



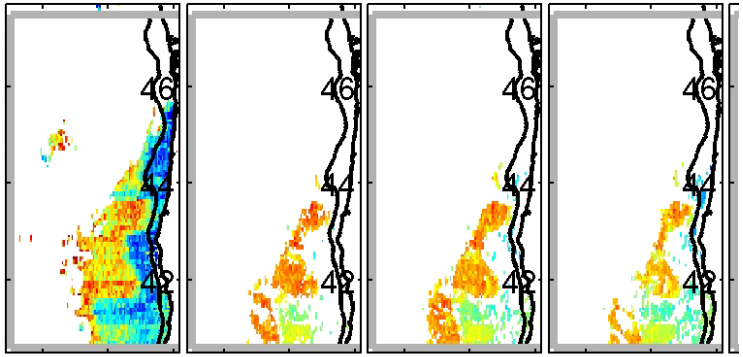
a) The real-time forecast model. 3-km resolution. 4DVAR (RADS alongtrack J-1, J-2, En, CryoSat; GOES SST; HF radar surface currents). 3-day forecasts (SST, currents)

b) The new forecast model (testing phase). 2-km. +Tides and the Columbia R. discharge.

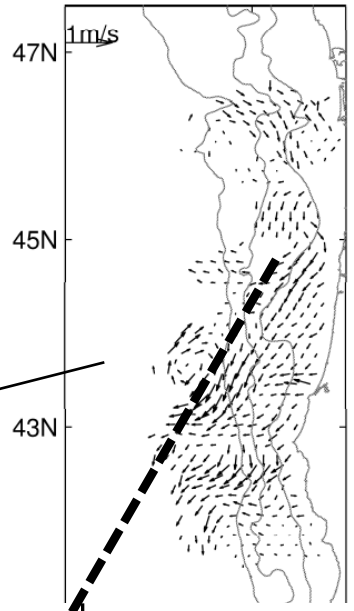
c) The 2-km resolution regional model. ROMS. Boundary conditions from 1/12 degr. HYCOM. No data assimilation. Simulations w/ realistic forcing (NOAA NAM), 2009-2010.

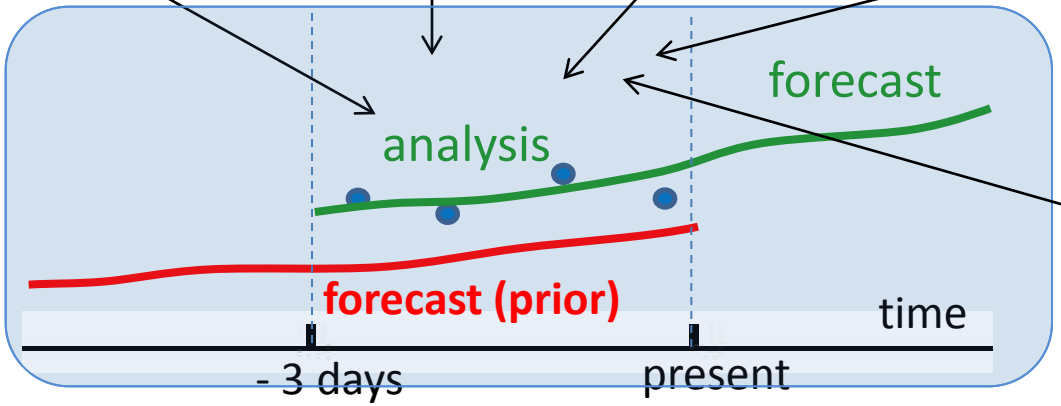
4DVAR = dynamically based time- and space- interpolation of data

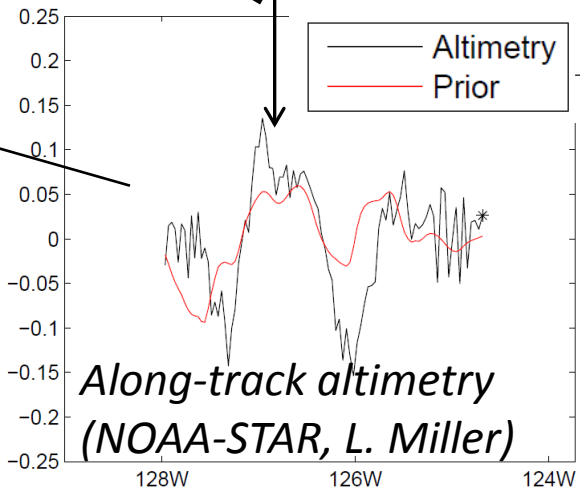
Hourly GOES SST (NOAA-CoastWatch D. Foley)



HF radar daily ave maps (P. M. Kosro)



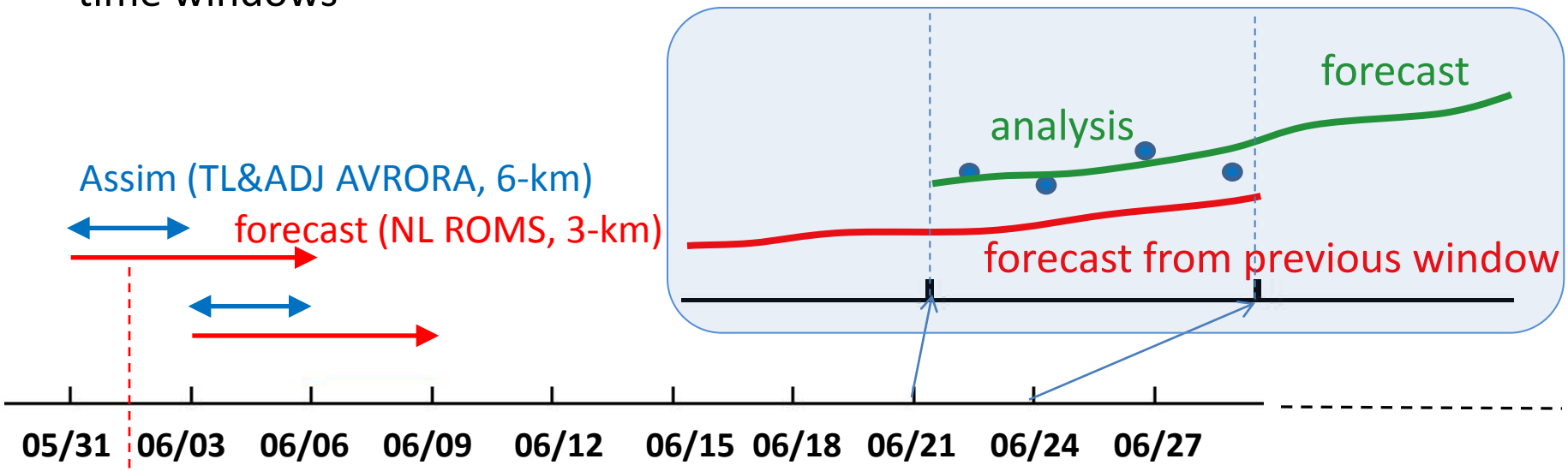




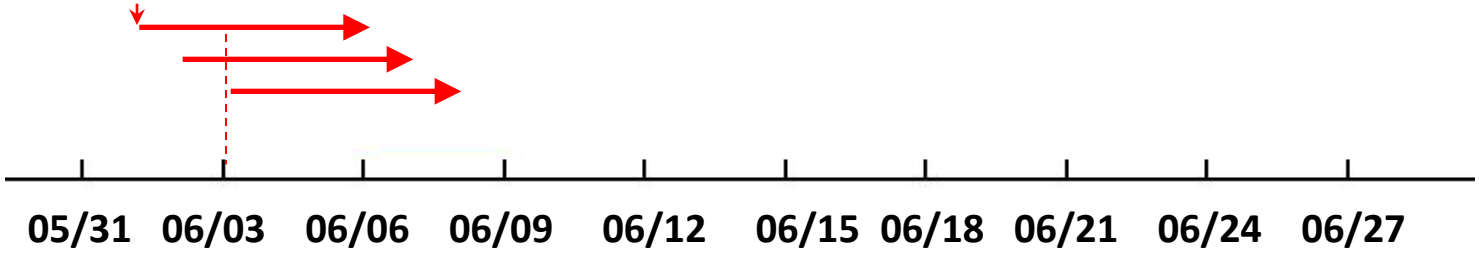
Along-track altimetry (NOAA-STAR, L. Miller)

- Assimilate data in a 3-day interval (TL&ADJ AVRORA)
- Correct initial conditions in the recent past
- Run forecast model (ROMS) with improved initial conditions

Real-time coastal ocean forecast model: variational DA in a series of sliding time windows



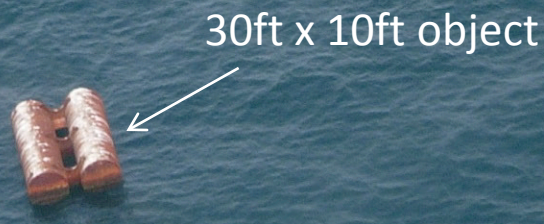
Forecast component



Our model forecasts are currently used by NOAA ORR to track marine debris objects like this, sighted recently by the Coast Guard. [Photo courtesy CG and G. Watabayashi]

Risks:

- **navigation safety**
- **bio-fouling (invasive species)**



"As long as the object is within the OSU ROMS grid, we will continue to make the model one of the key data sources we tap into…"

Glen Watabayashi (NOAA ORR, Seattle)

A dock from Japan settled on the Oregon coast (Agate Beach)

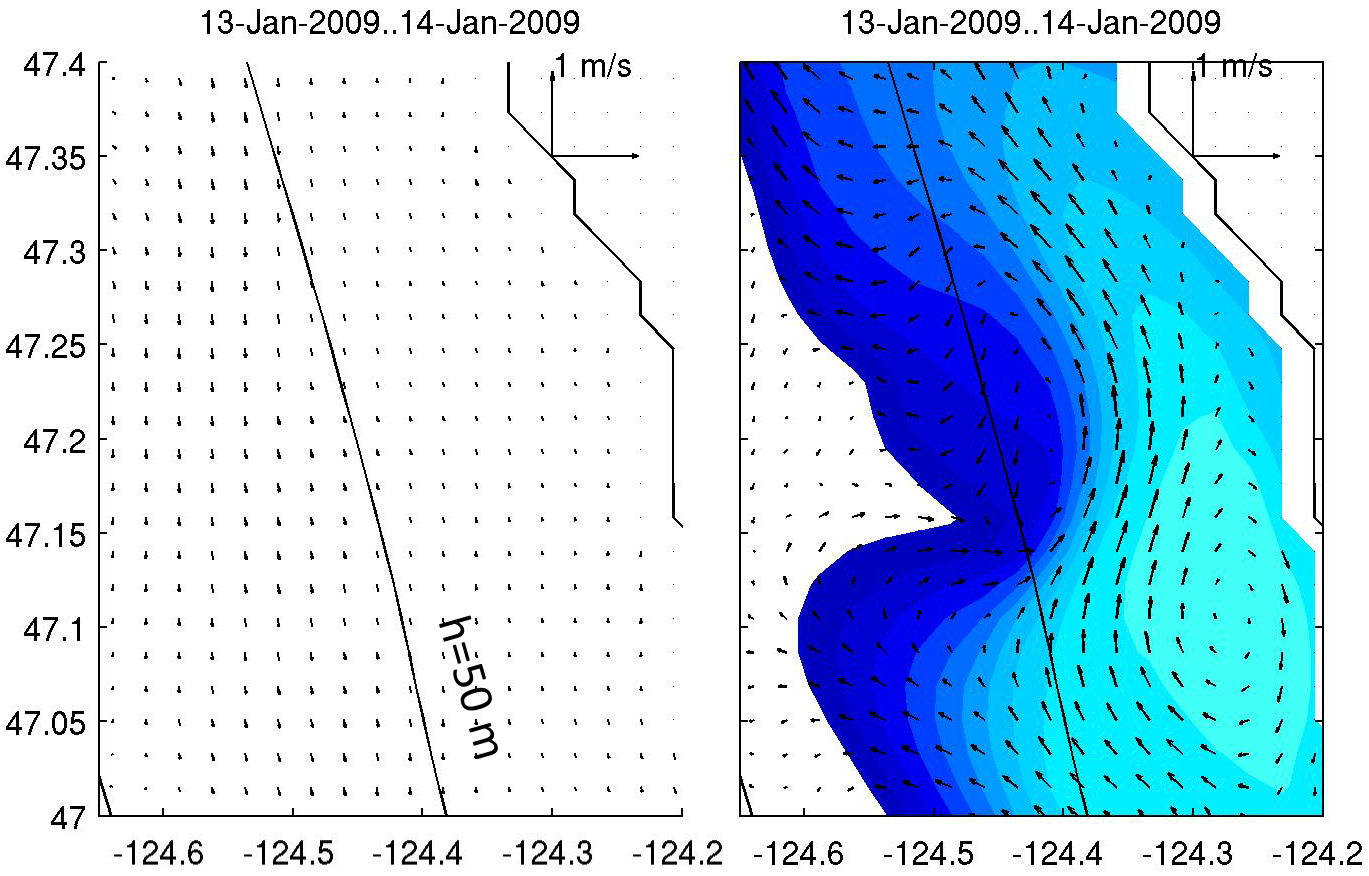
(photo courtesy J. Stork, KVAL.com)

Velocity differences in the river plume (winter):

ROMS w/out CR

ROMS w/ CR

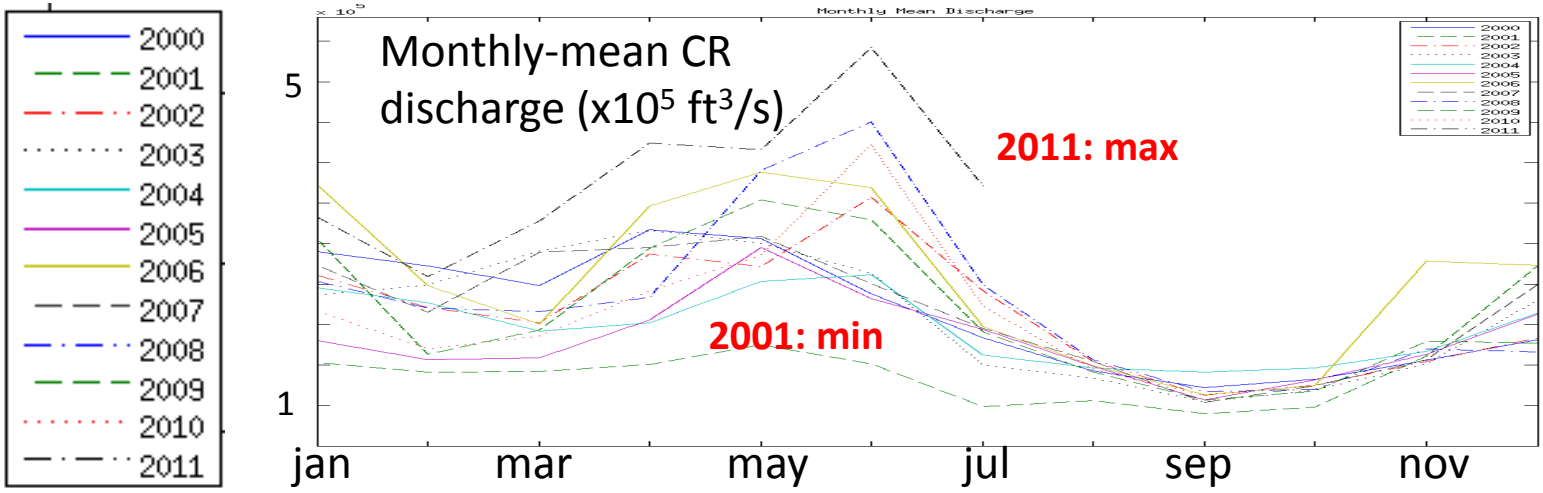
(color is SSS, < 32 psu)



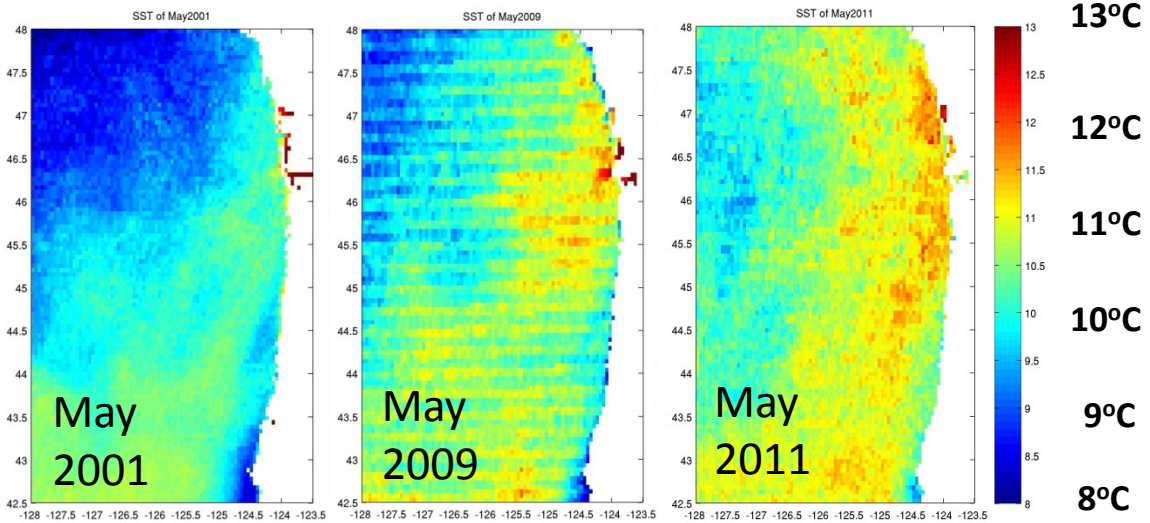
Low-pass filterted and daily ave currents on Jan 13 2009 (low winds)

In spring, the Columbia R. waters are warmer than the surrounding ocean

- Challenge for assimilation (a thin water layer with anomalous T-S properties)
- Contribution to inter-annual variability in the coastal ocean



Monthly GOES SST composites, May



Images courtesy E. Simmons III, the NSF-REU summer intern

Model: Regional Ocean Modeling System (ROMS, www.myroms.org)

ROMS Resolution: 2 km

Atm. Forcing: 12 km res. NOAA NAM

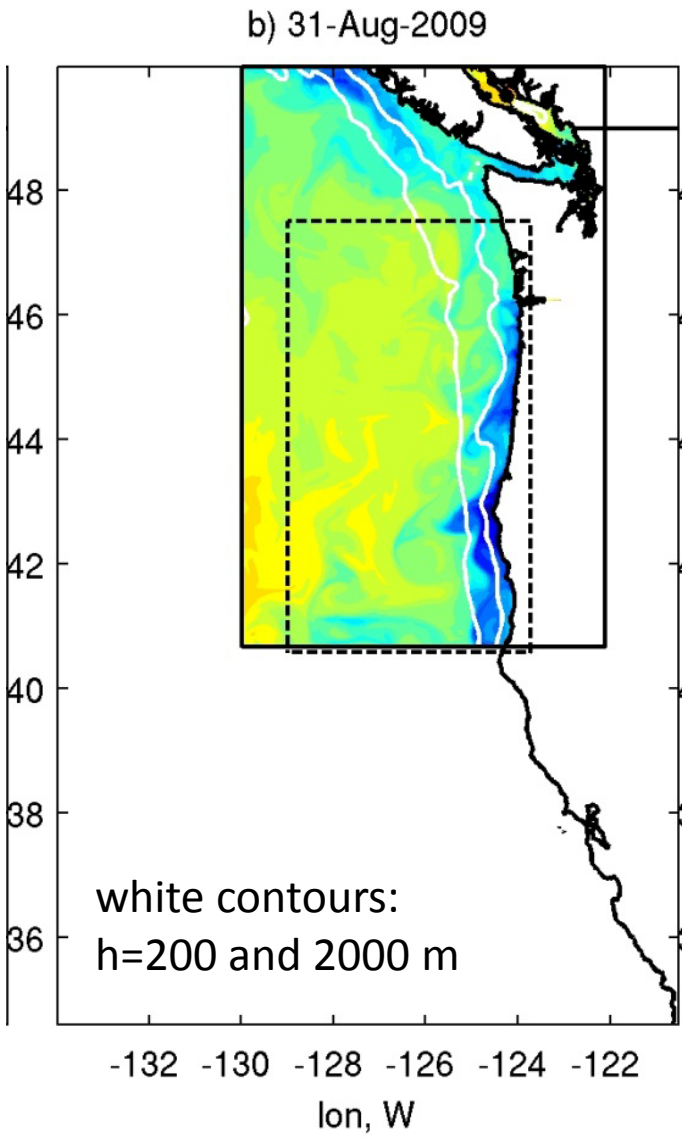
IC & BC: 1/12th degr Navy HYCOM

Columbia R. discharge: daily (USGS Beaver Army Station)

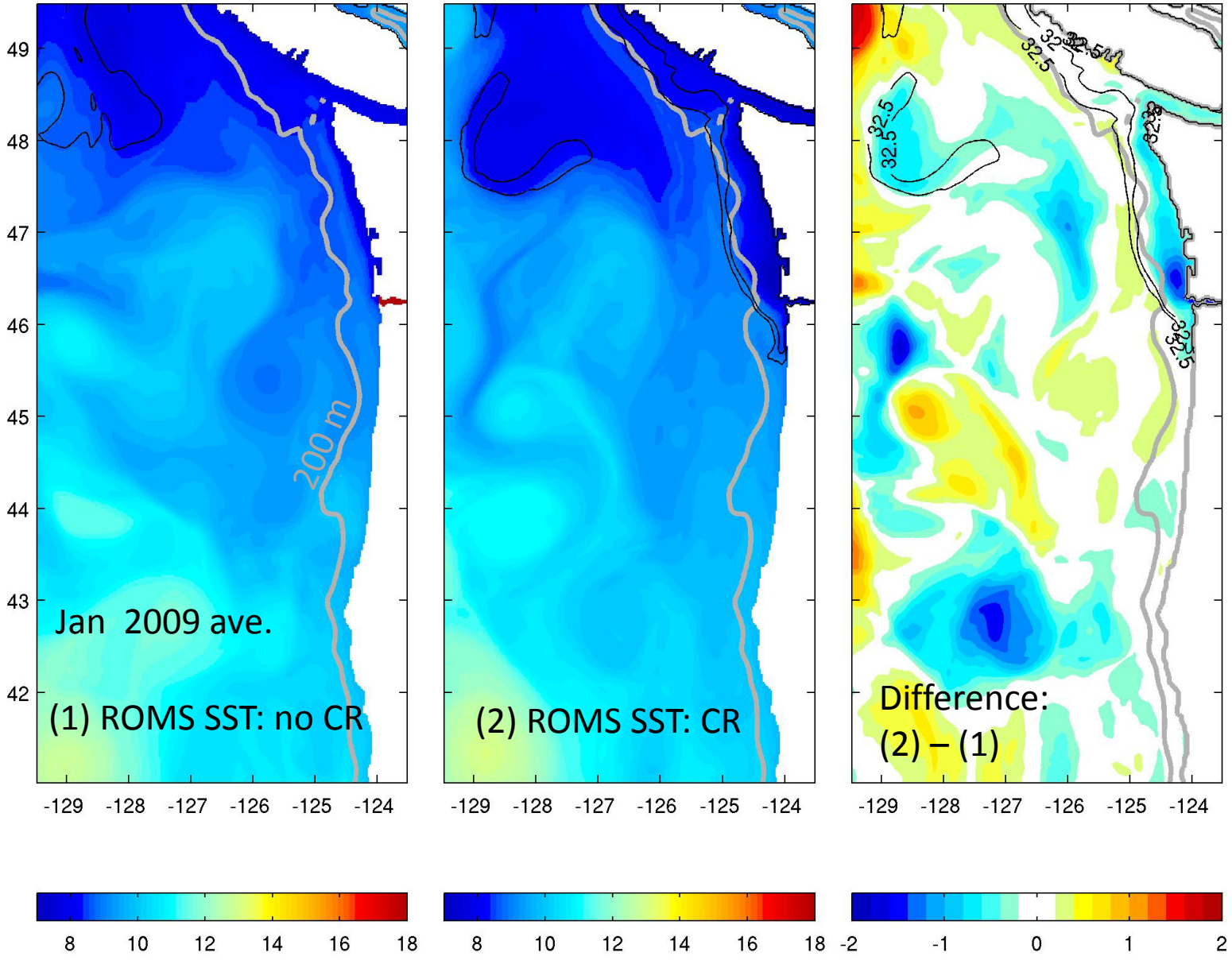
Barotropic tides at the boundaries: TPXO (Egbert and Erofeeva)

Run without assimilation: Sep. 2008- Dec. 2010

Adj. sensitivity tests: 4-km resolution
TL&ADJ: AVRORA

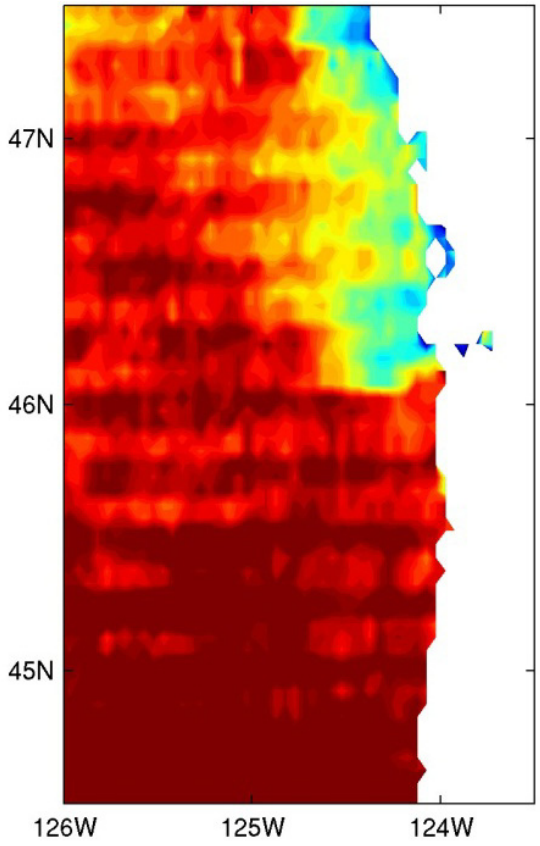


CR plume waters in winter: - turning to the right from the river mouth
- colder than ambient ocean

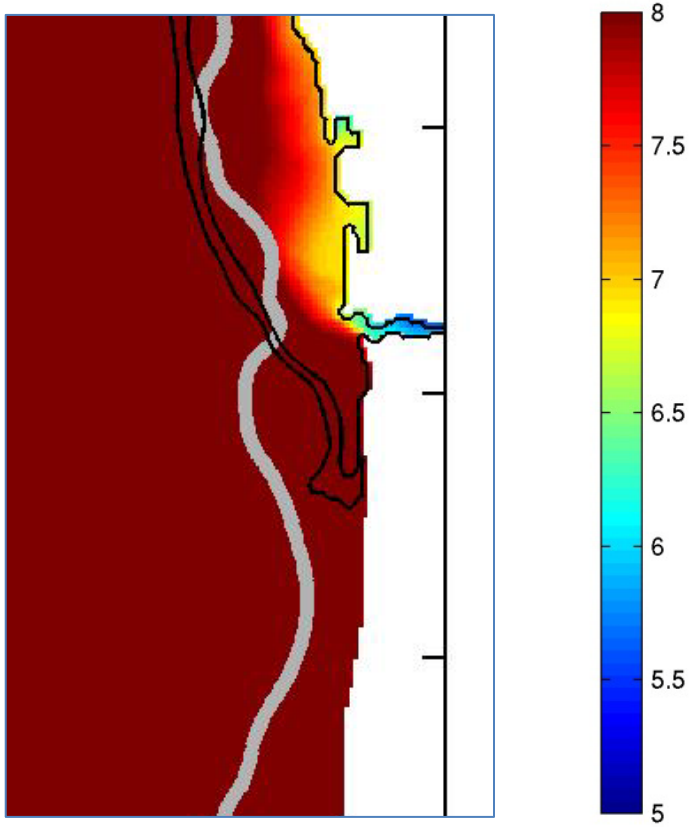


Colder SST associated with the CR plume in winter is observed in satellite SST

Jan 2009: GOES SST

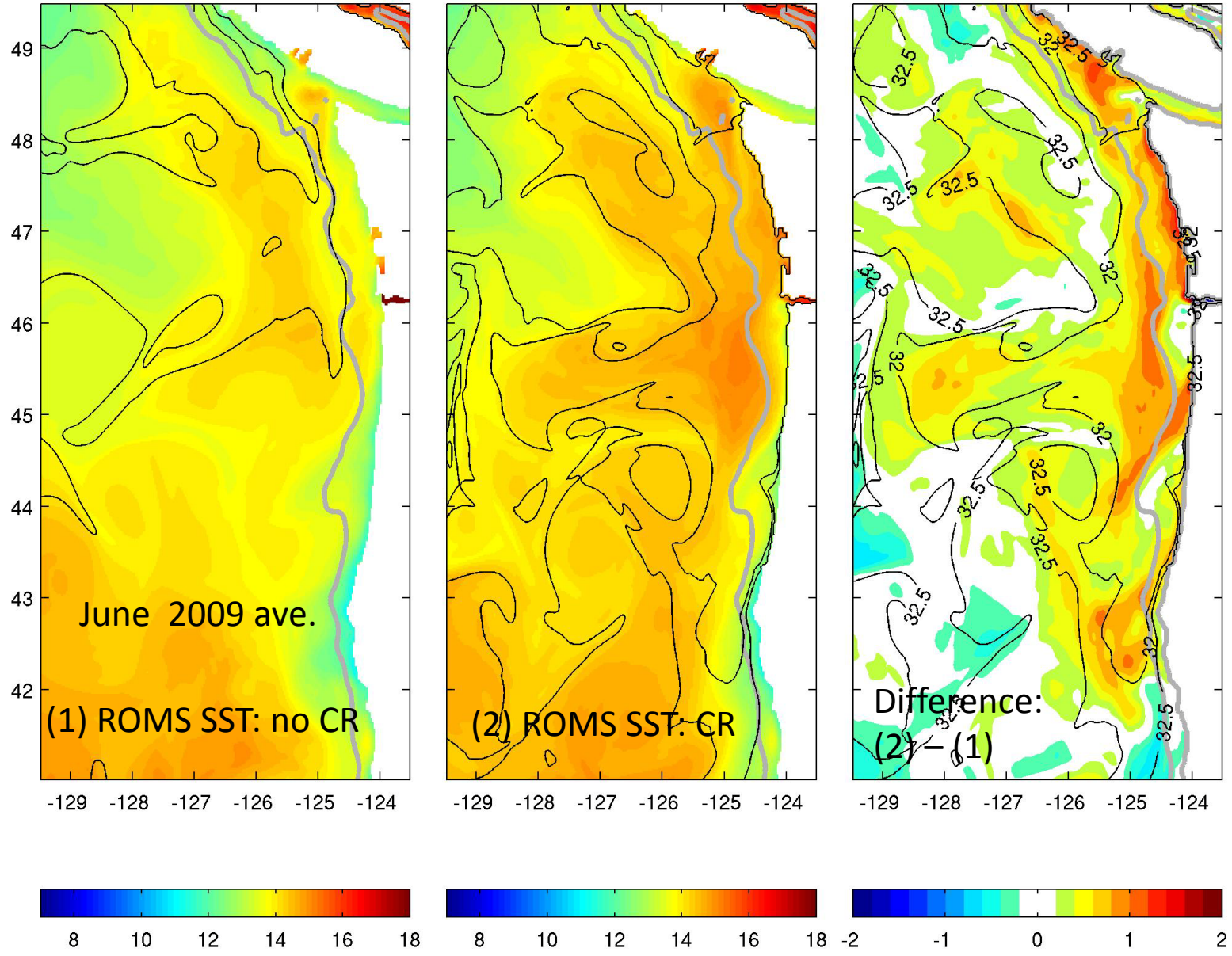


ROMS w/ CR

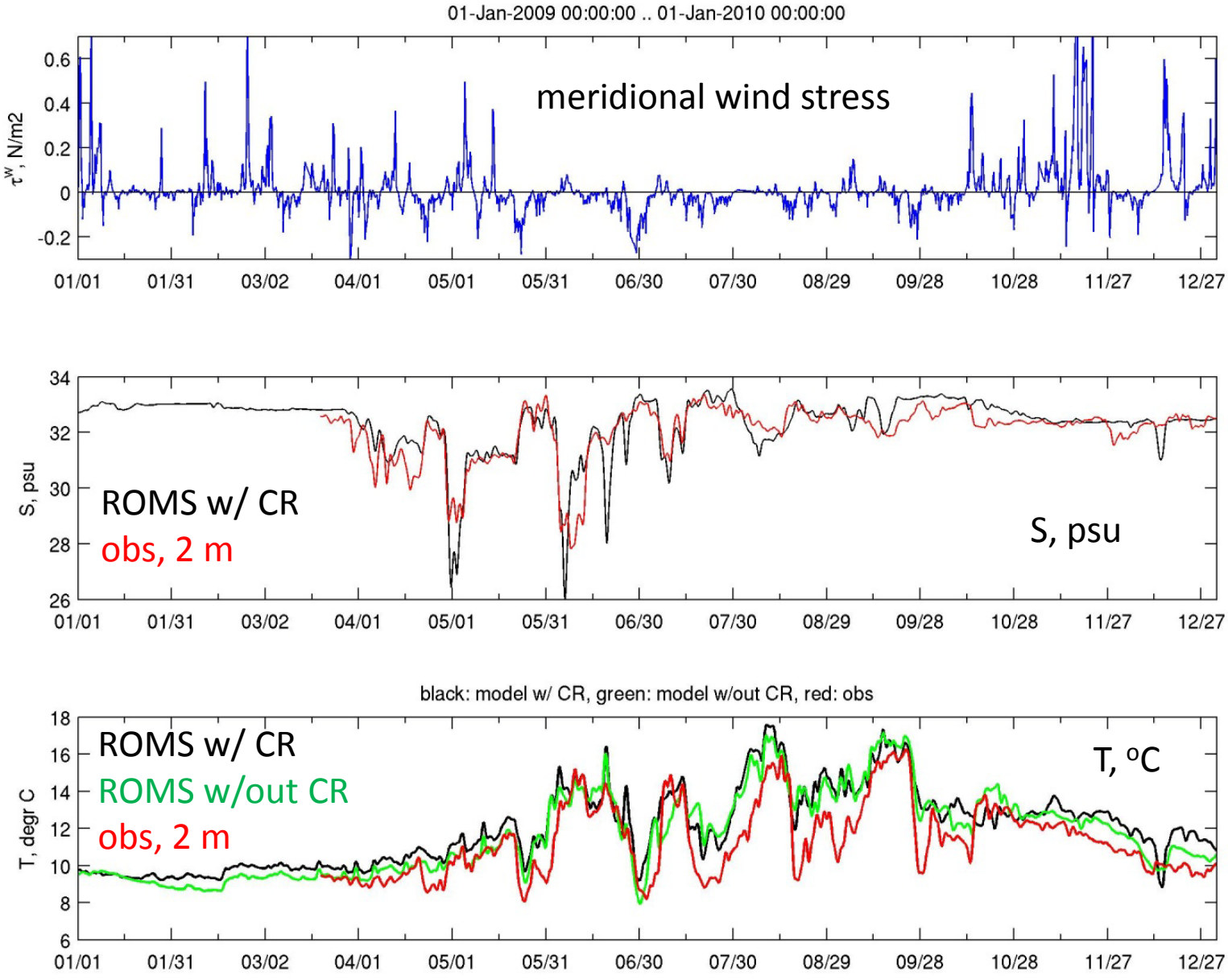


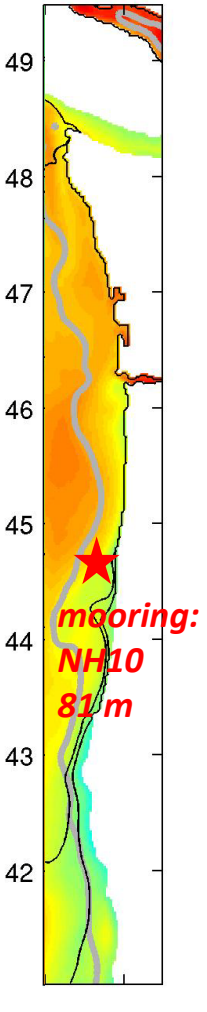
(black contours: SSS at 32, 32.5 psu)

CR plume waters in summer: - carried to south/southwest with upwelling
- relatively warmer

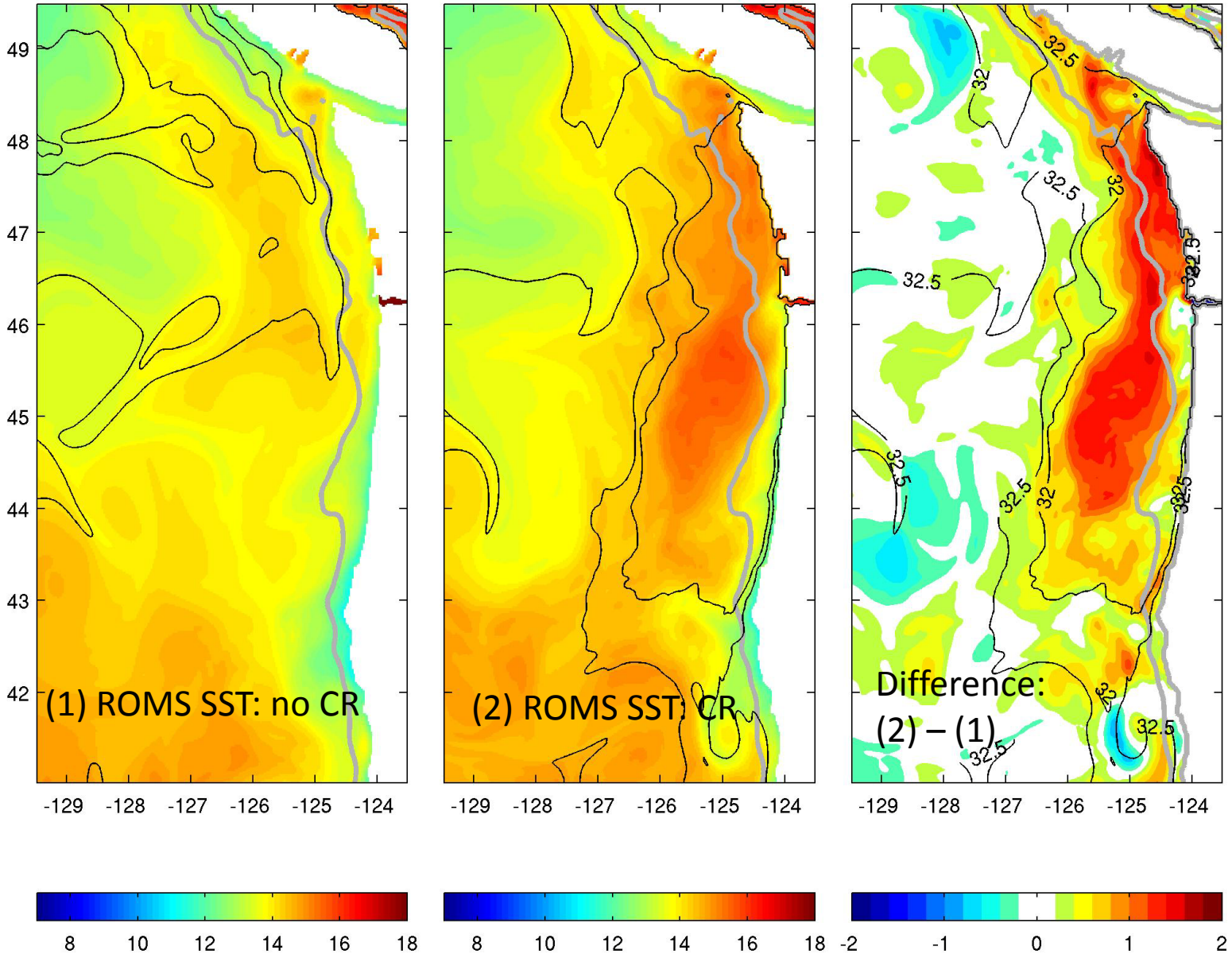


Model-mooring data comparisons: temporal variability in near-surface T and S is reproduced by the model





SST (Jun 2009): no CR, CR (variable attenuation), difference

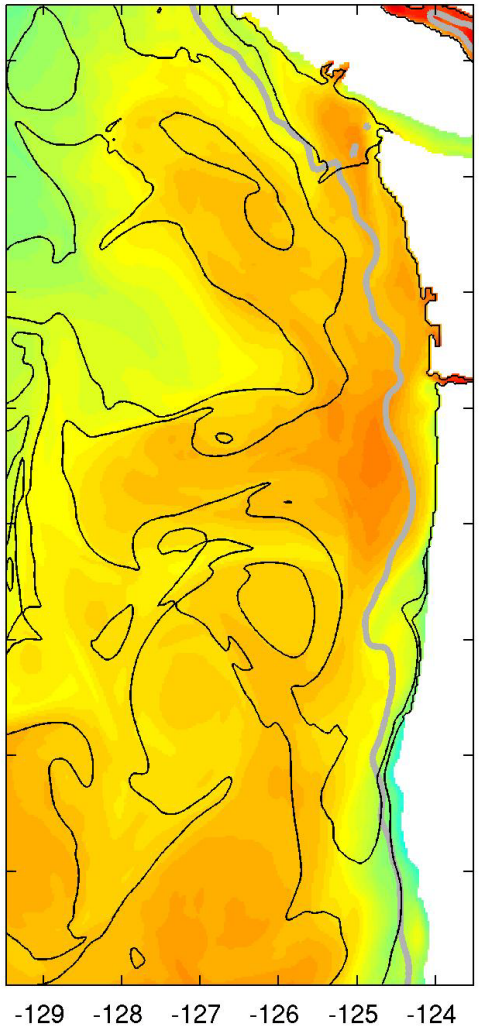


Jun 2009 SST (model):

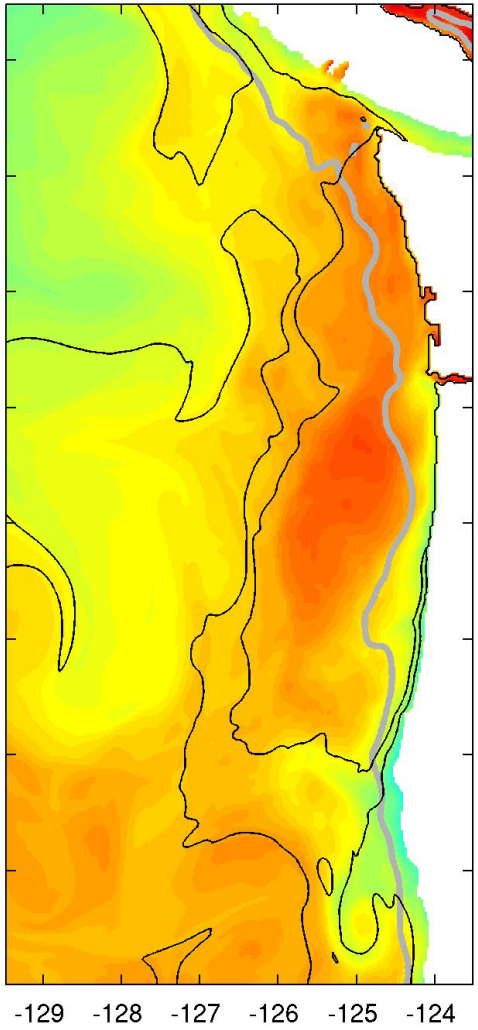
A more stable outer edge of the river plume in the case with SSS-dependent attenuation ?

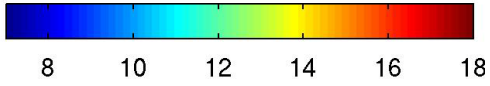
(possibly: stronger stratification in a more shallow layer inhibits boundary layer instabilities)

w/ const. attenuation

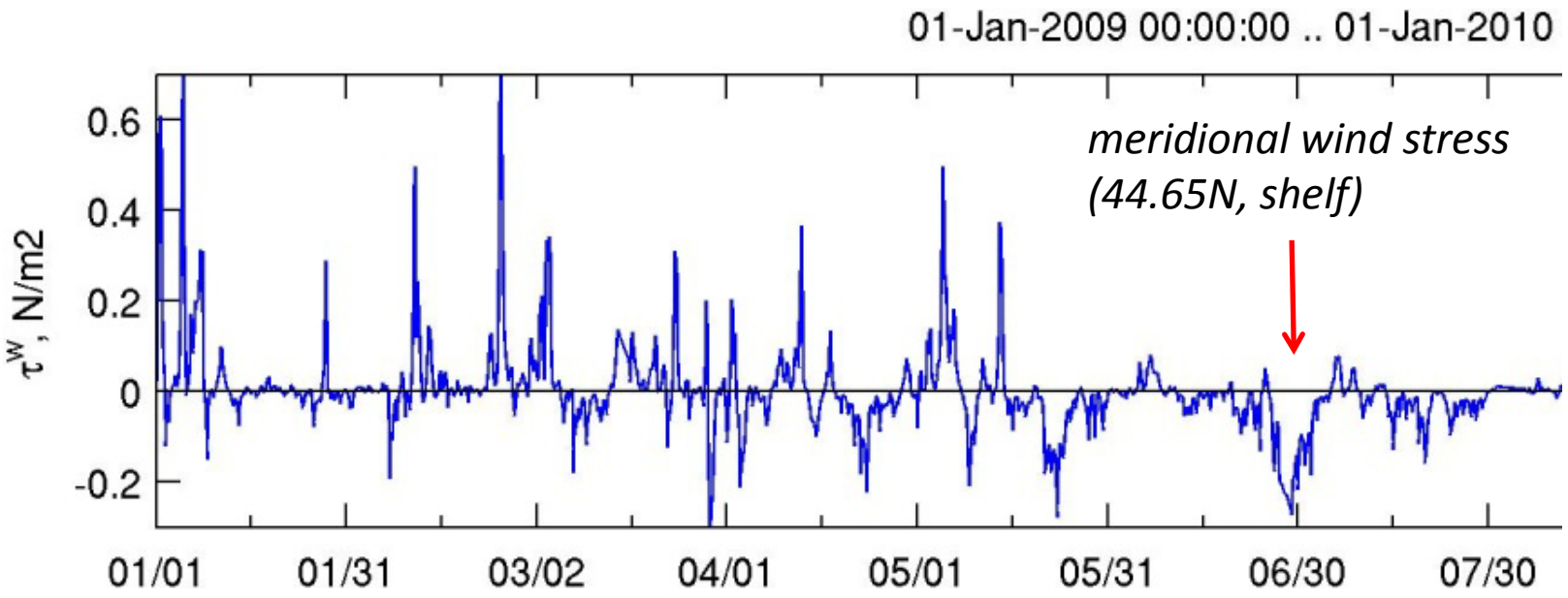


w/ variable attenuation

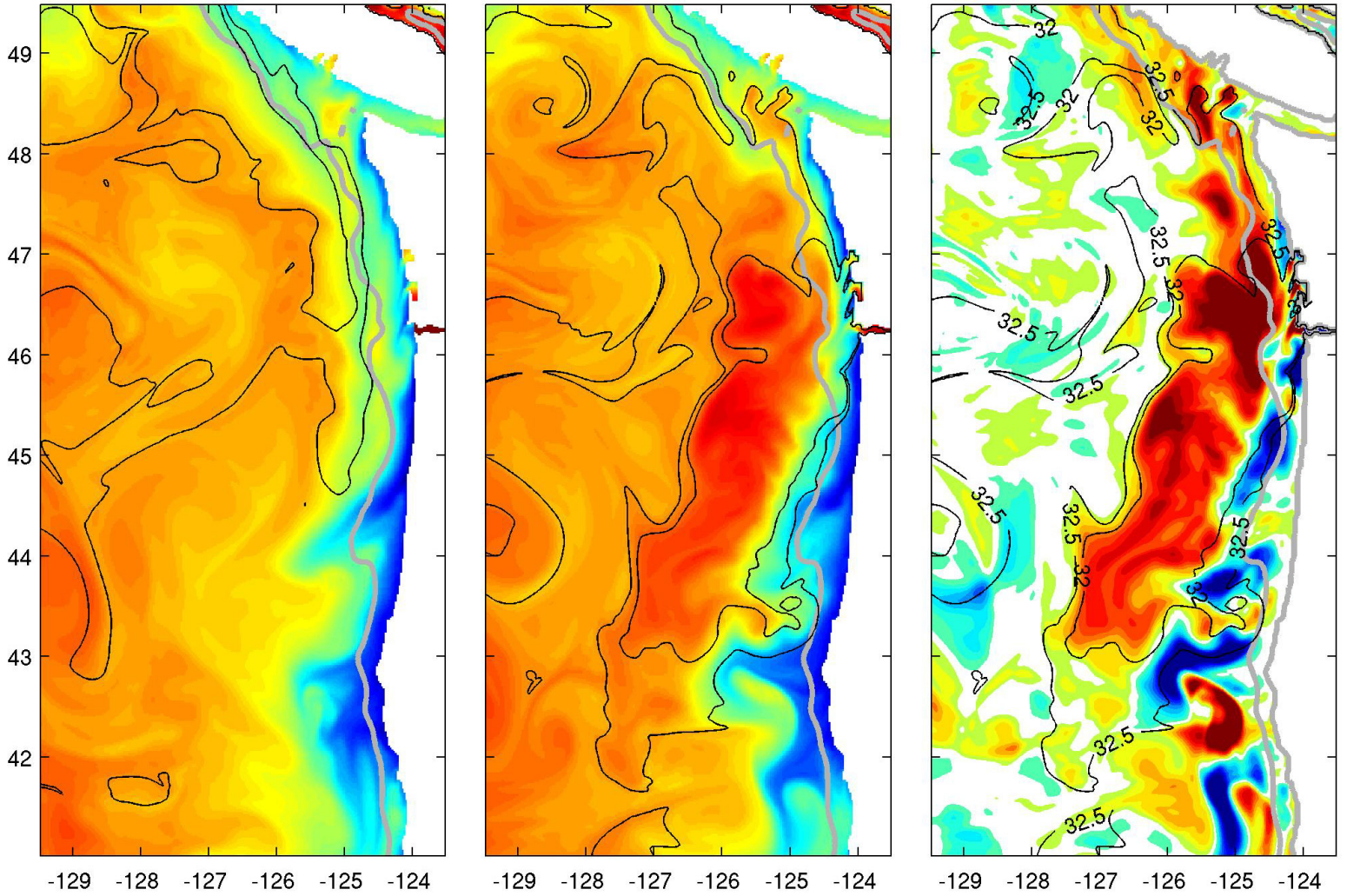




Next slides: compare solutions at a peak of a strong upwelling event (29 June 2009)



SST (06-29-09): (1) ROMS no CR (2) ROMS w/ CR **(var. atten.)** difference: (2) – (1)

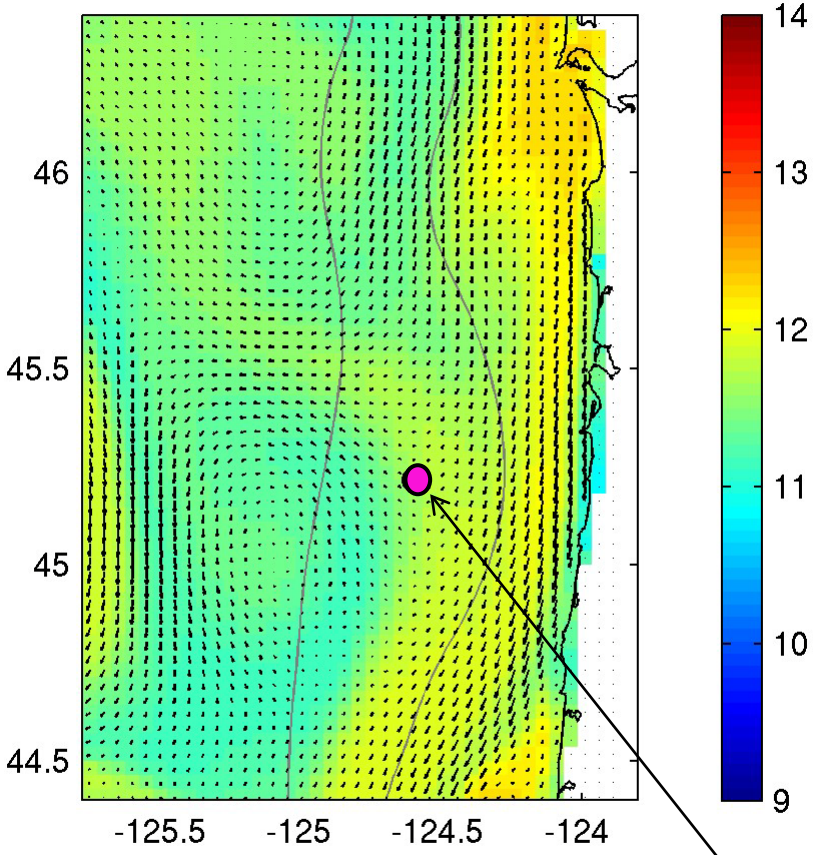


Case with CR (var. atten.):colder water inshore of the CR plume

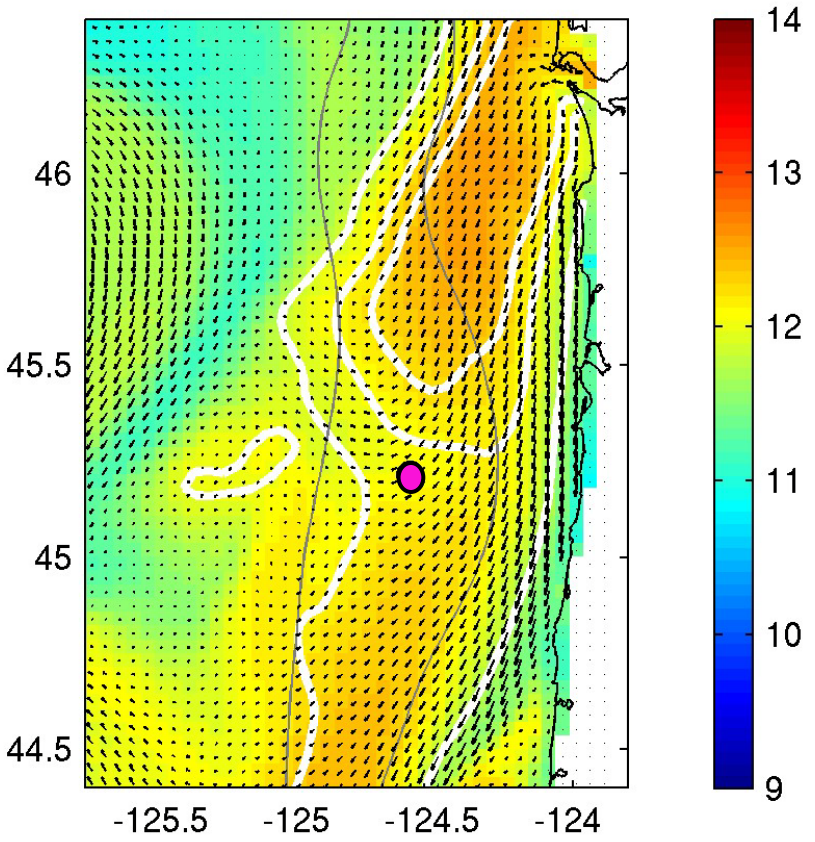
Adj sensitivity studies (case without CR vs. case w/ CR plume)

Background solutions (SST, surf. current):

w/out CR



w/ CR



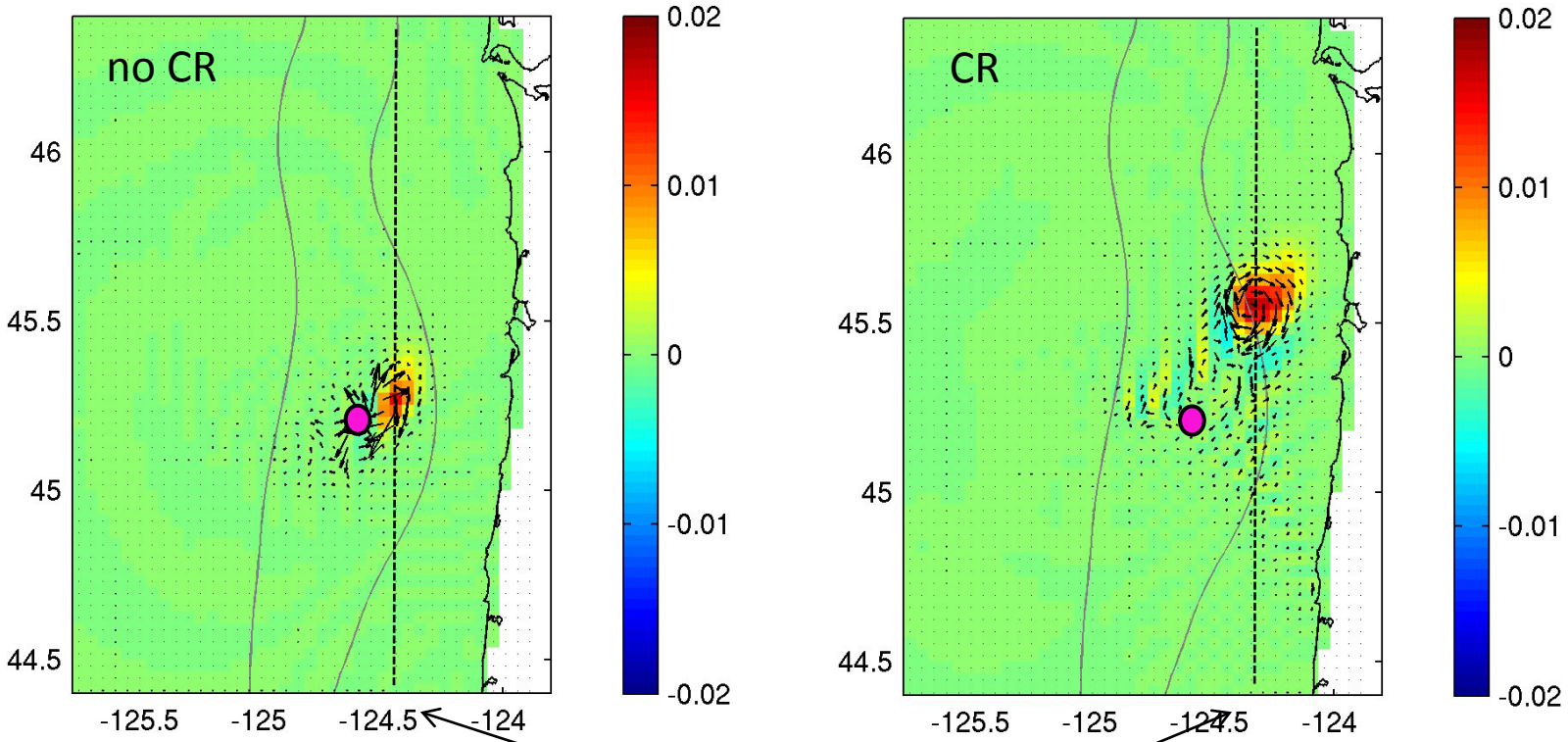
(*use adjoint AVRORA*)

obs. location

Observation: SST (t=3 d)

Shown: SST (t=0) adj sensitivity field

The area of max adj sensitivity is displaced farther offshore (stronger advection in the case w/ CR)

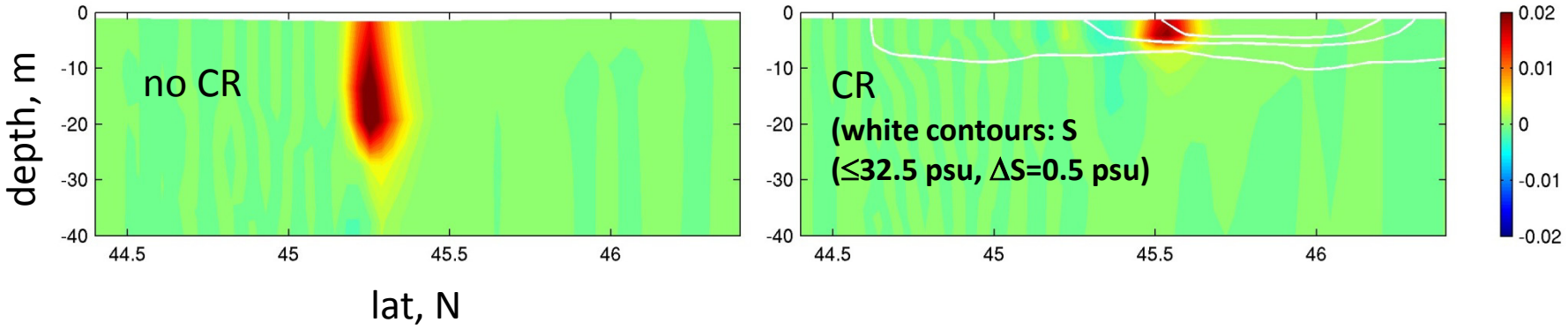


sections through areas of max influence are shown on the next slide

Observation: SST (t=3 d)

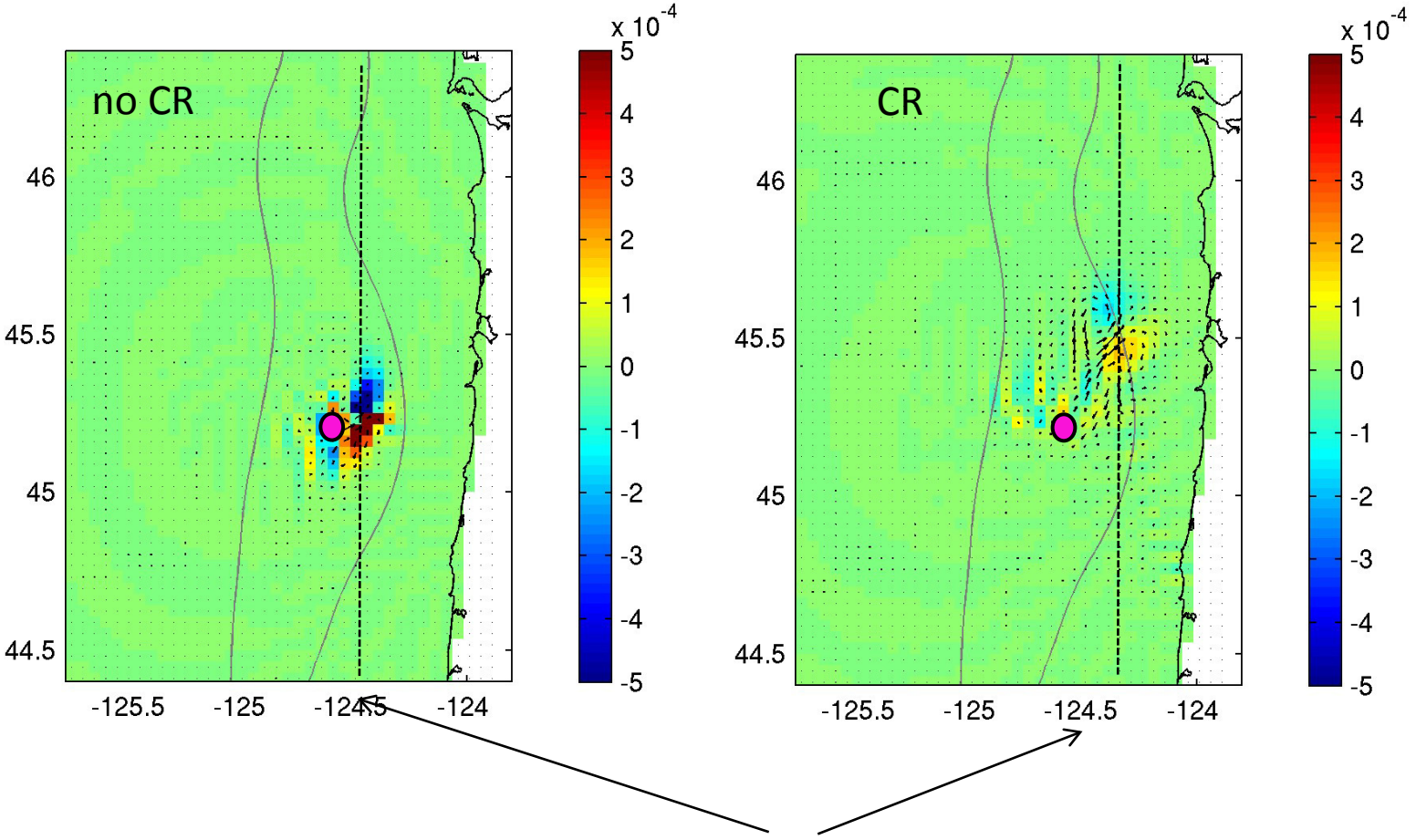
Shown: T (t=0) adj sensitivity field

Depth of influence is limited by the CR plume



Observation: surf. u (t=3 d) *-- zonal velocity component*

Shown: SST (t=0) adj sensitivity field

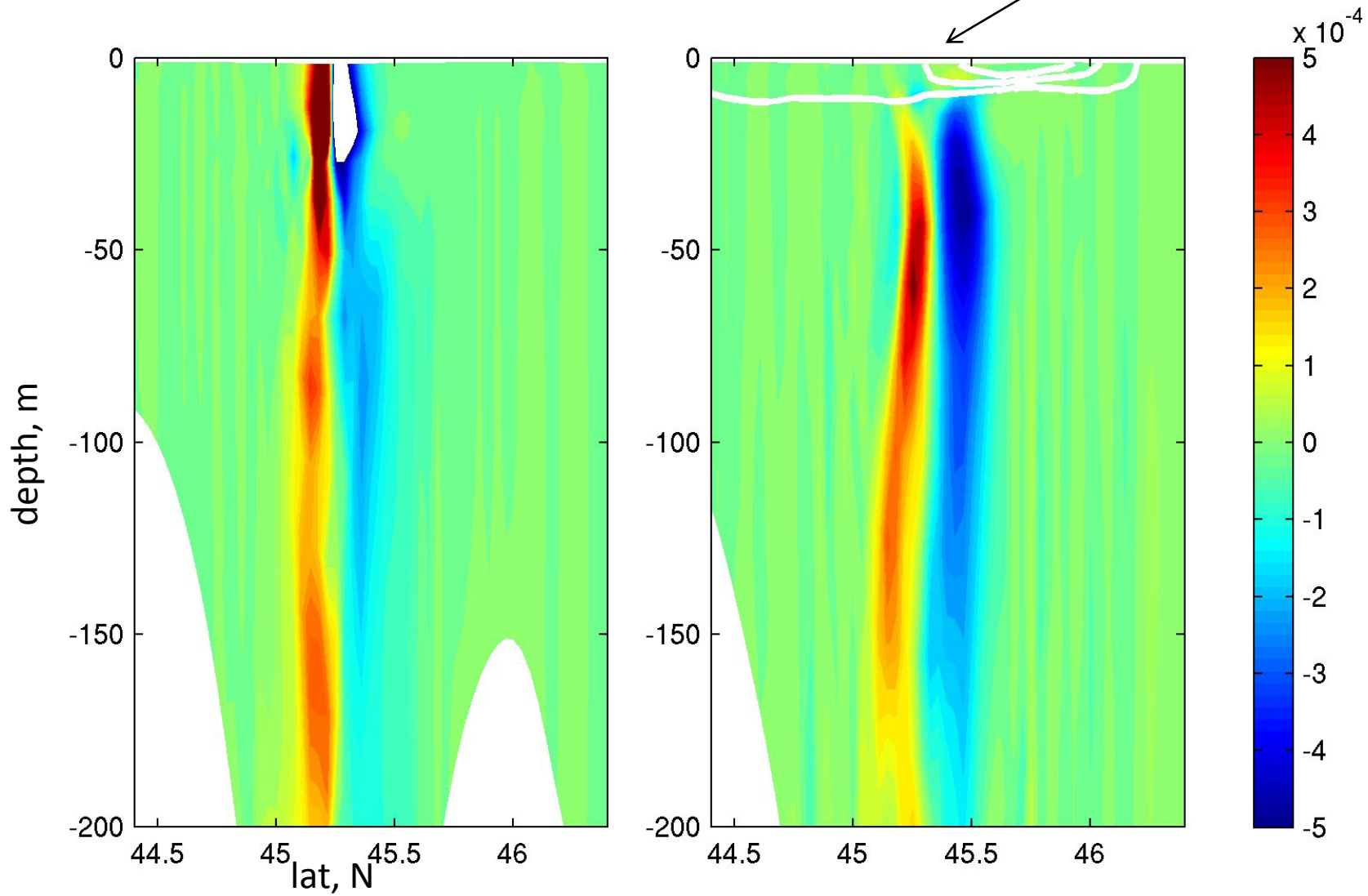


sections through areas of max influence are shown on the next slide

Observation: surf. u (t=3 d) *-- zonal velocity component*

Shown: T (t=0) adj sensitivity field

reduced sensitivity in the plume area



SUMMARY:

- The current pilot Oregon coastal ocean forecast model has been utilized for tracking marine debris objects

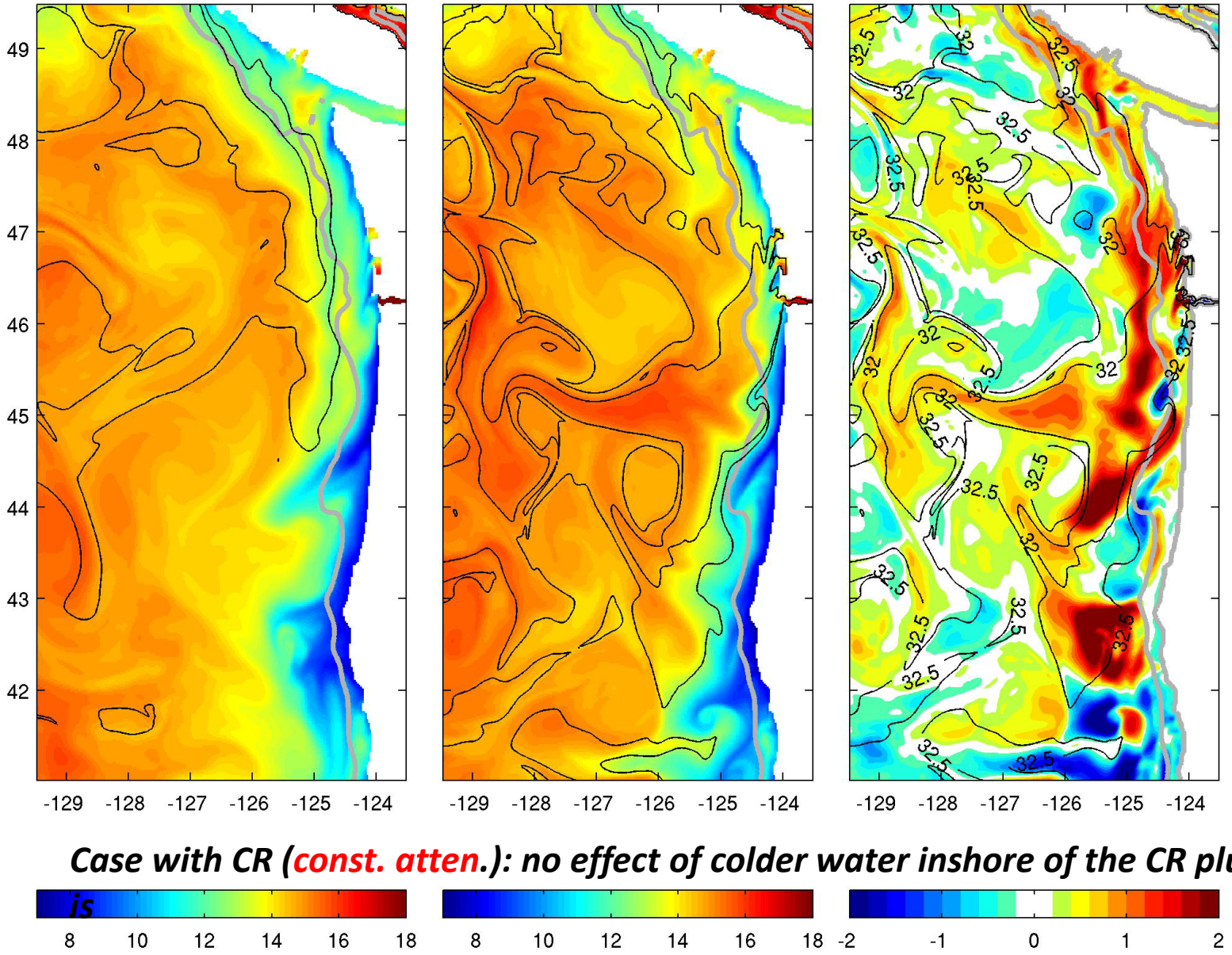
- The new model is being tested: extended domain (OR-WA), CR plume, tides

- Importance of variable short wave radiation attenuation in the area of the river plume to represent spring/ summer stratification over the shelf

- The presence of the river plume affects the zones of influence of assimilated observations (in 3D)

    - may suggest a need for a modified initial condition covariance (suitable for horizontally inhomogenenous near-surface conditions)

SST (06-29-09): ROMS no CR ROMS w/ CR **(const. atten.)** difference



Case with CR (const. atten.): no effect of colder water inshore of the CR plume is

How deep and space- and time-dependent is short-wave radiation attenuation?

For future consideration: info. about the front structure may come from satellite radiance observations

Shown:

Normalized water-leaving radiance at 555-nm, MODIS-SeaDAS (image - courtesy G. Saldias, OSU)