SSH Variability Along the US West Coast in Winter

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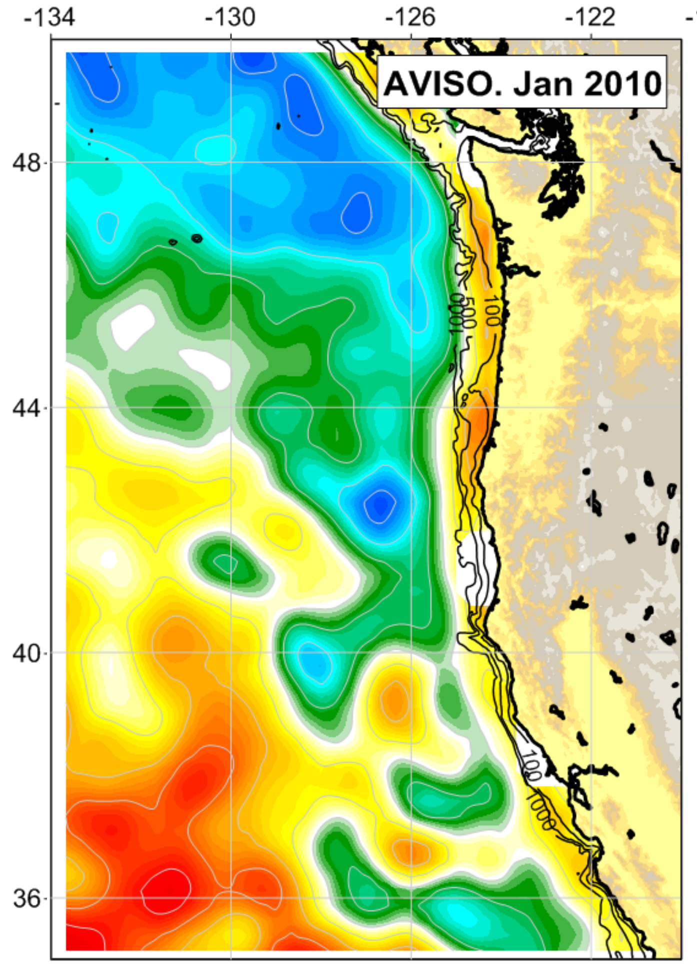
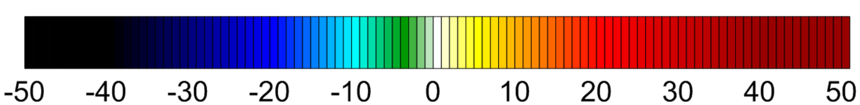
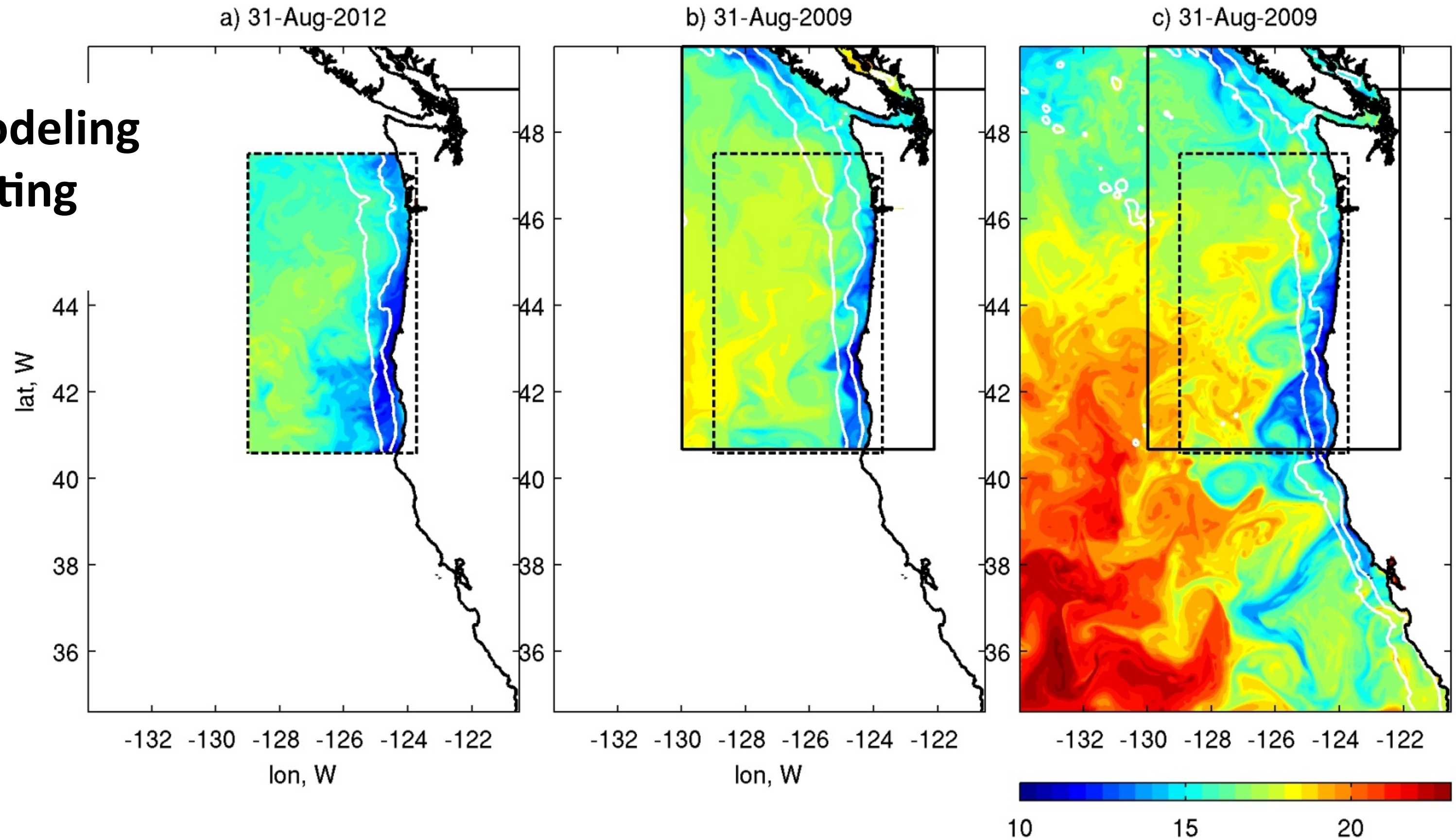


***Shown is** AVISO ADT (minus area mean),*
Jan 2010



Ongoing modeling and forecasting activities:



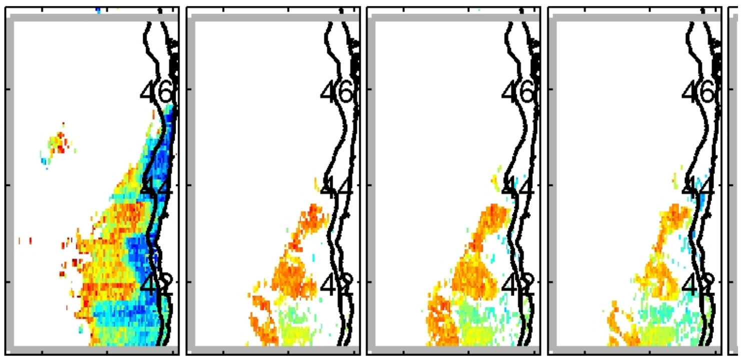
a) The real-time forecast model. 3-km resolution. 4DVAR (RADS alongtrack J-1, J-2, En, CryoSat; GOES SST; HF radar surface currents). 3-day forecasts (SST, currents)

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

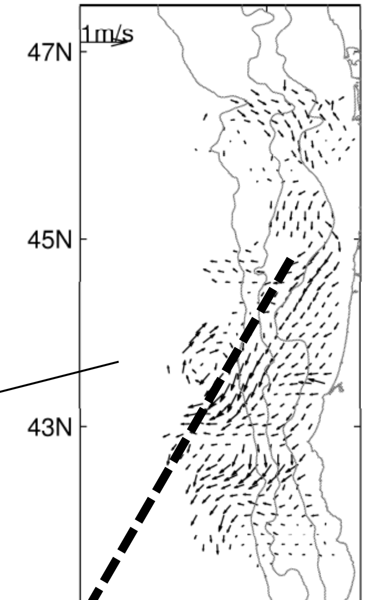
c) The 2-km resolution regional model. ROMS. Boundary conditions from 1/12 degr. HYCOM. No data assimilation. Simulations w/ realistic forcing (NOAA NAM), 2009-2010.

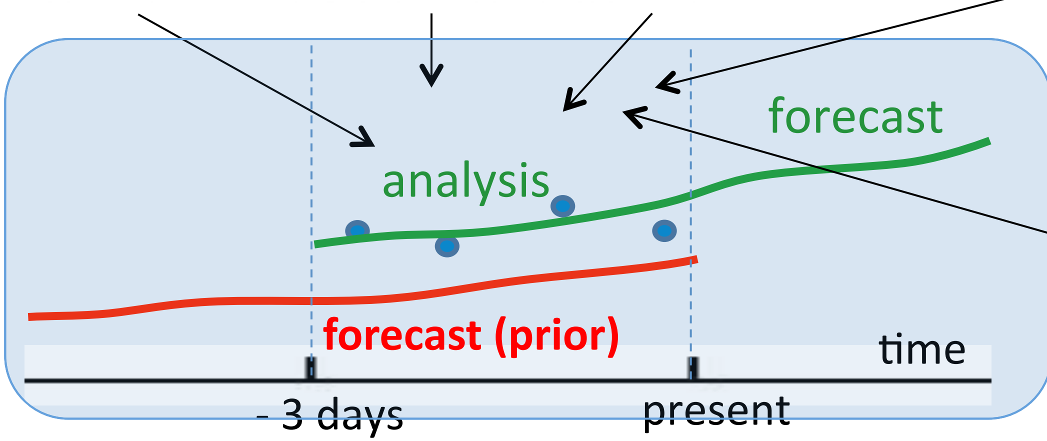
4DVAR = dynamically based time- and space- interpolation of data

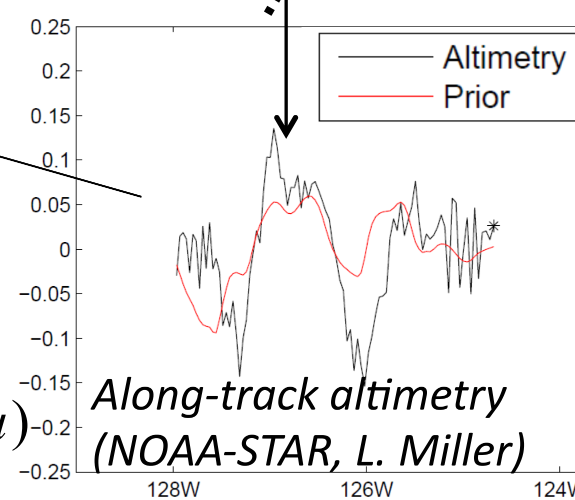
GOES hourly data (NOAA-CoastWatch D. Foley)



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







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

$$J(u) = (u(0) - u_0^B)^T C_0^{-1} (u(0) - u_0^B) + (d - Lu)^T C_d^{-1} (d - Lu)$$

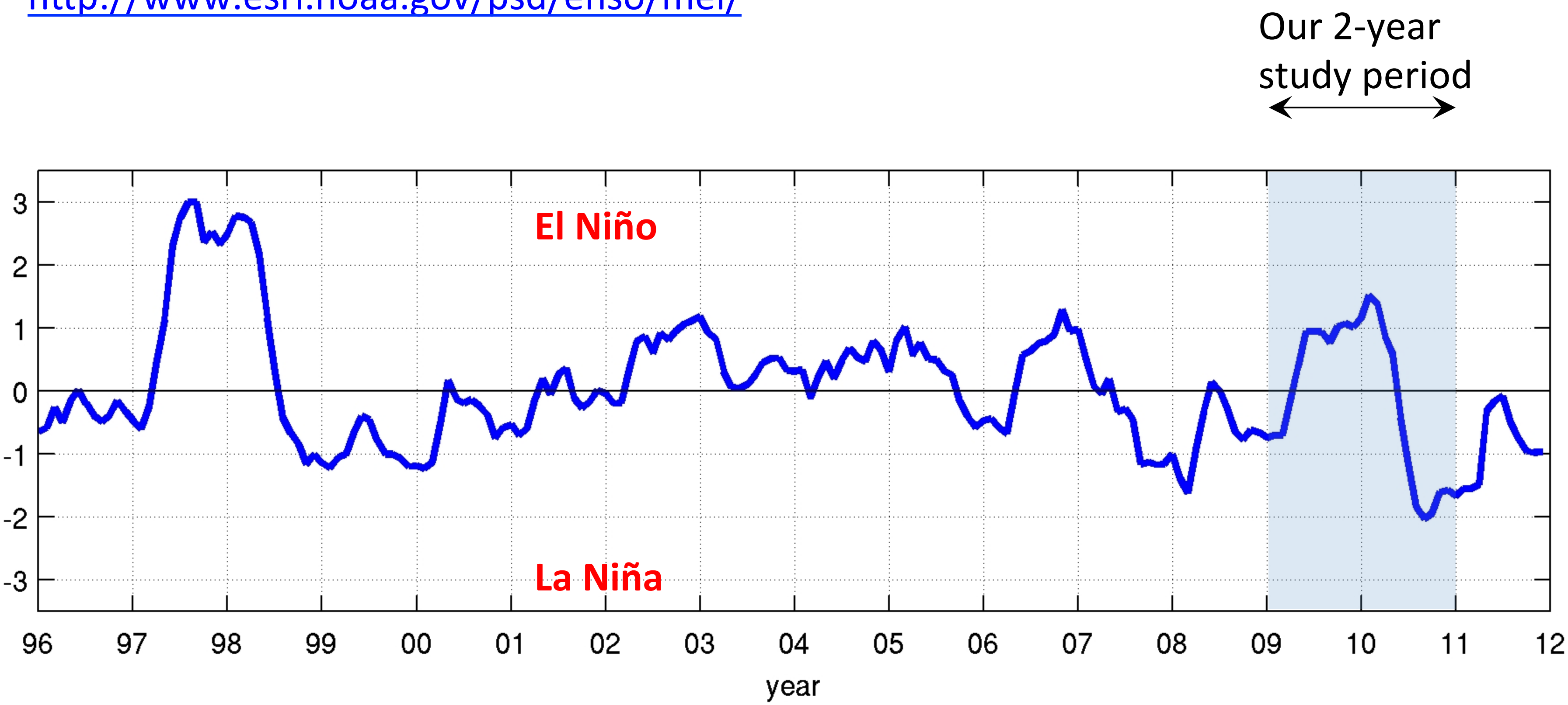
Forecasts: ROMS

Assimilation: our own tangent linear and adjoint codes AVRORA (Kurapov et al., 2009, 2011, Yu et al., 2012)

Multivariate ENSO Index (MEI)

Wolter, 1987; Wolter and Timlin, 1993

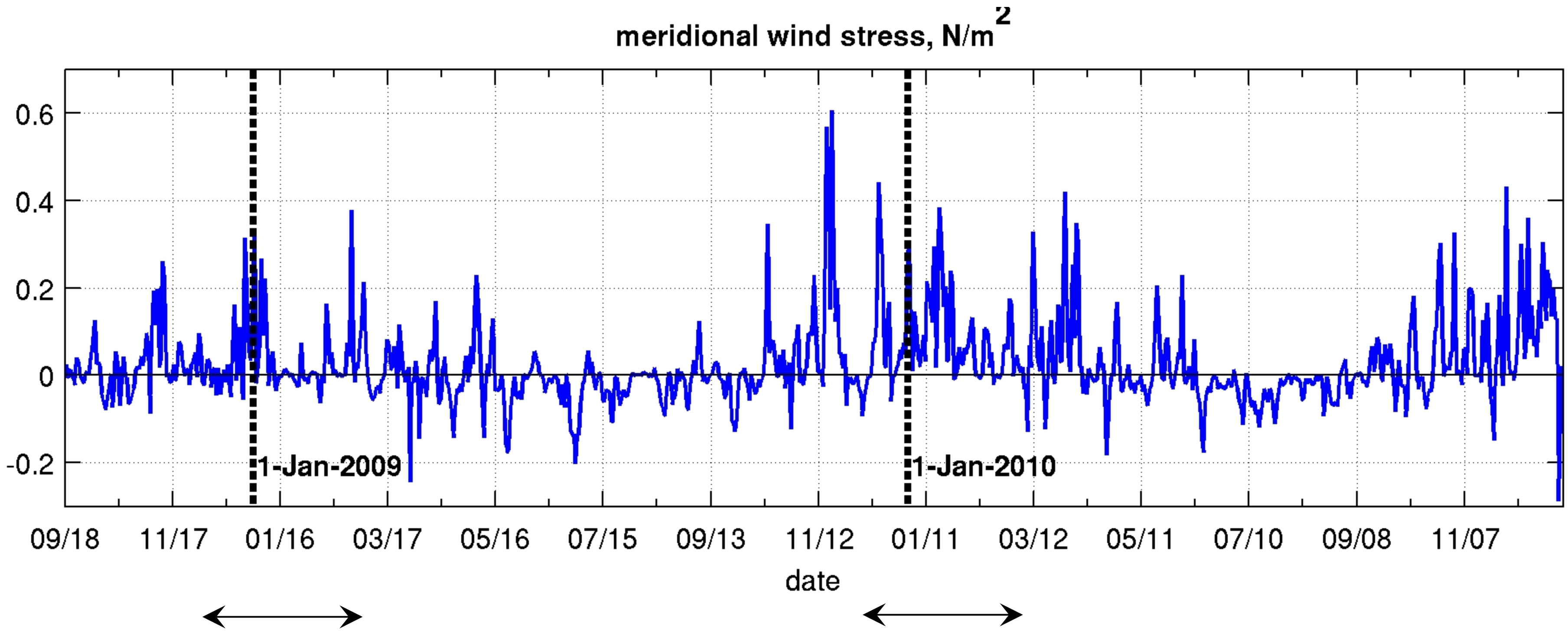
http://www.esrl.noaa.gov/psd/enso/mei/



El Nino manifistation along the US West Coast:

- Stronger northward (downelling favorable winds) – influence of atmospheric teleconnection (Schwing et al., 2002)

Meridional wind stress (over shelf, 46.65N, off Oregon):



winter '08-09

winter '09-10
Stronger, more persistent northward (downwelling favorable) winds

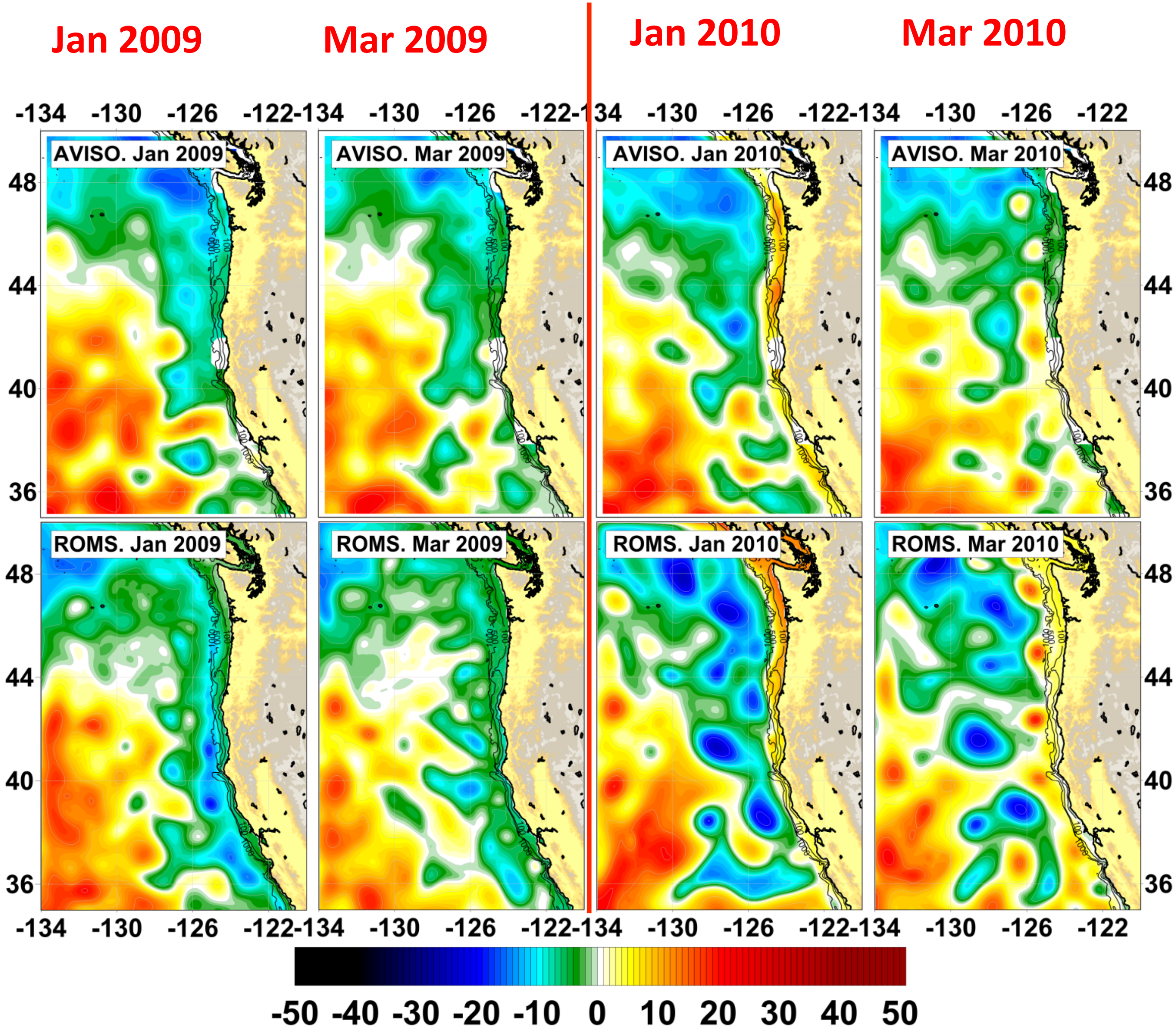
SSH maps (Jan, Mar / 2009, 2010):

a stronger SSH response along coast in 2010, large anti-cyclonic eddy generation

AVISO
(adt,
each map
demeaned
individually)

ROMS

About anti-cyclonic eddies in the Gulf of Alaska (lat>50N), see (Henson & Thomas, DSR, 2008)

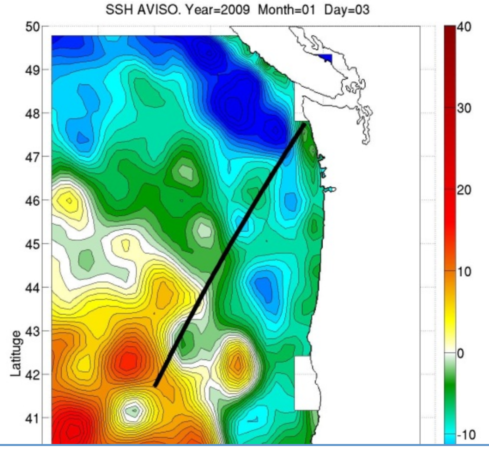


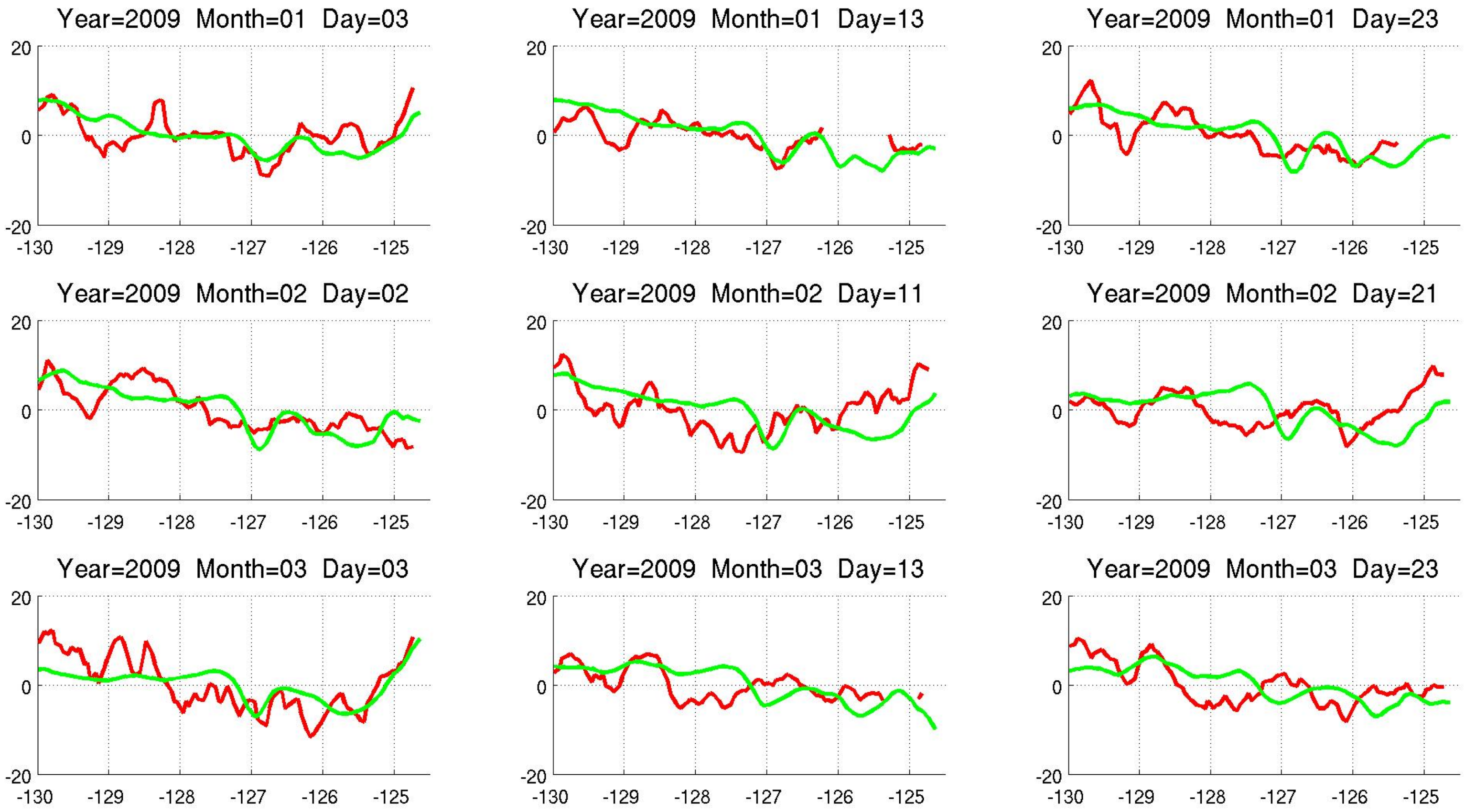
Jason-2 alongtrack altimetry vs. ROMS:

Track 171, Jan-Mar, 2009

(ADT, each pass demeaned individually)

- Downwelling events (northward winds): SSH higher near coast
- ROMS reproduces correctly the SSH slope (alongshore surface geostrophic currents)

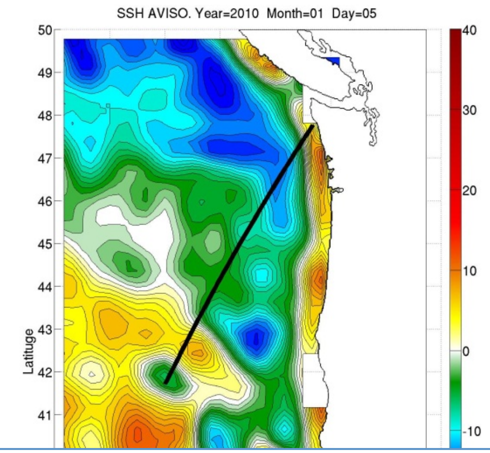


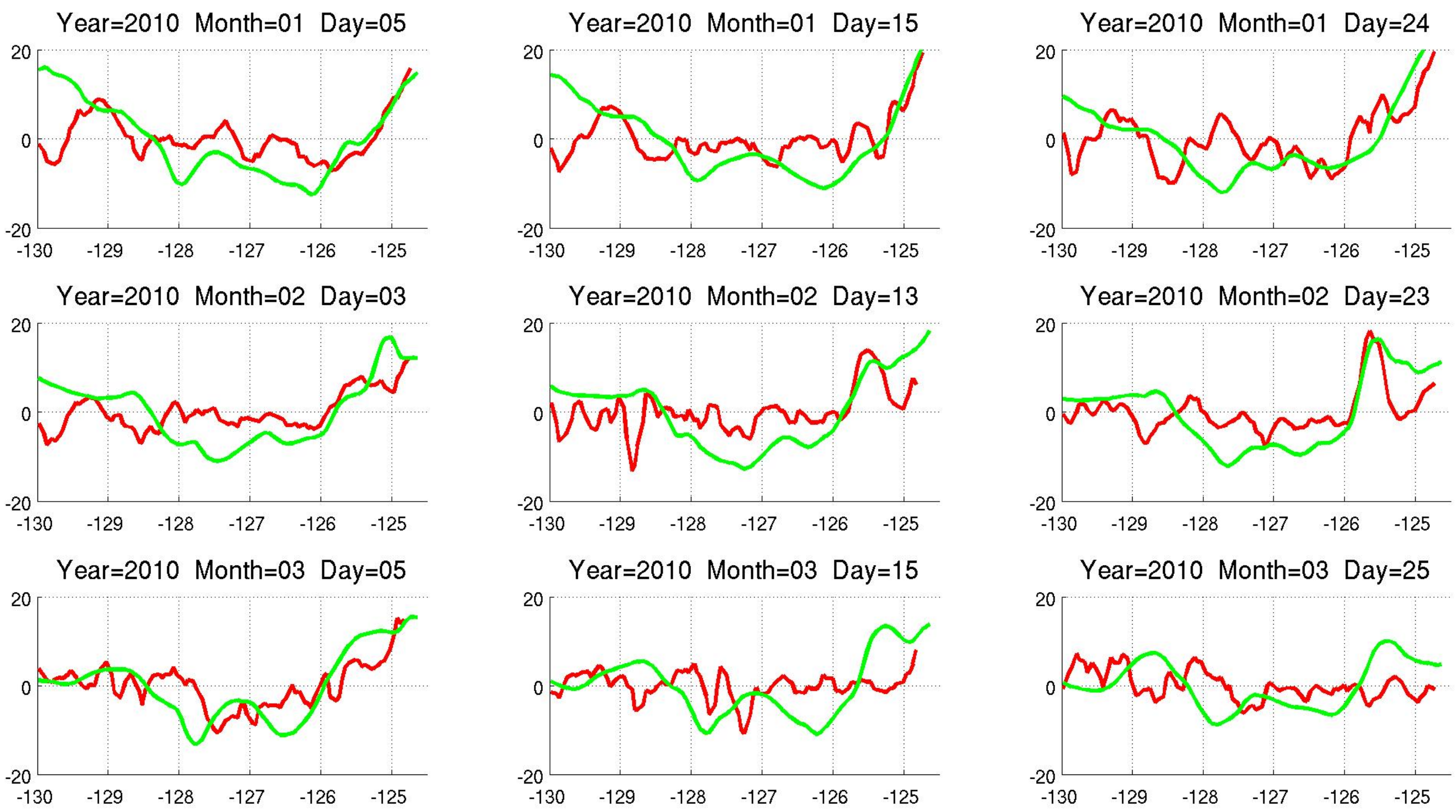


Jason-2 alongtrack altimetry vs. ROMS:

Track 171, Jan-Mar, 2010
(ADT, each pass demeaned individually)

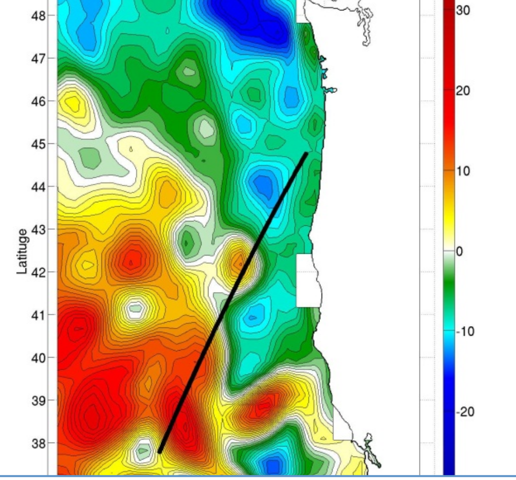
- Sronger SSH slope near coast than in 2009
- ROMS reproduces correctly the SSH slope
- Feb-Mar: evidence of anti-cyclonic eddies

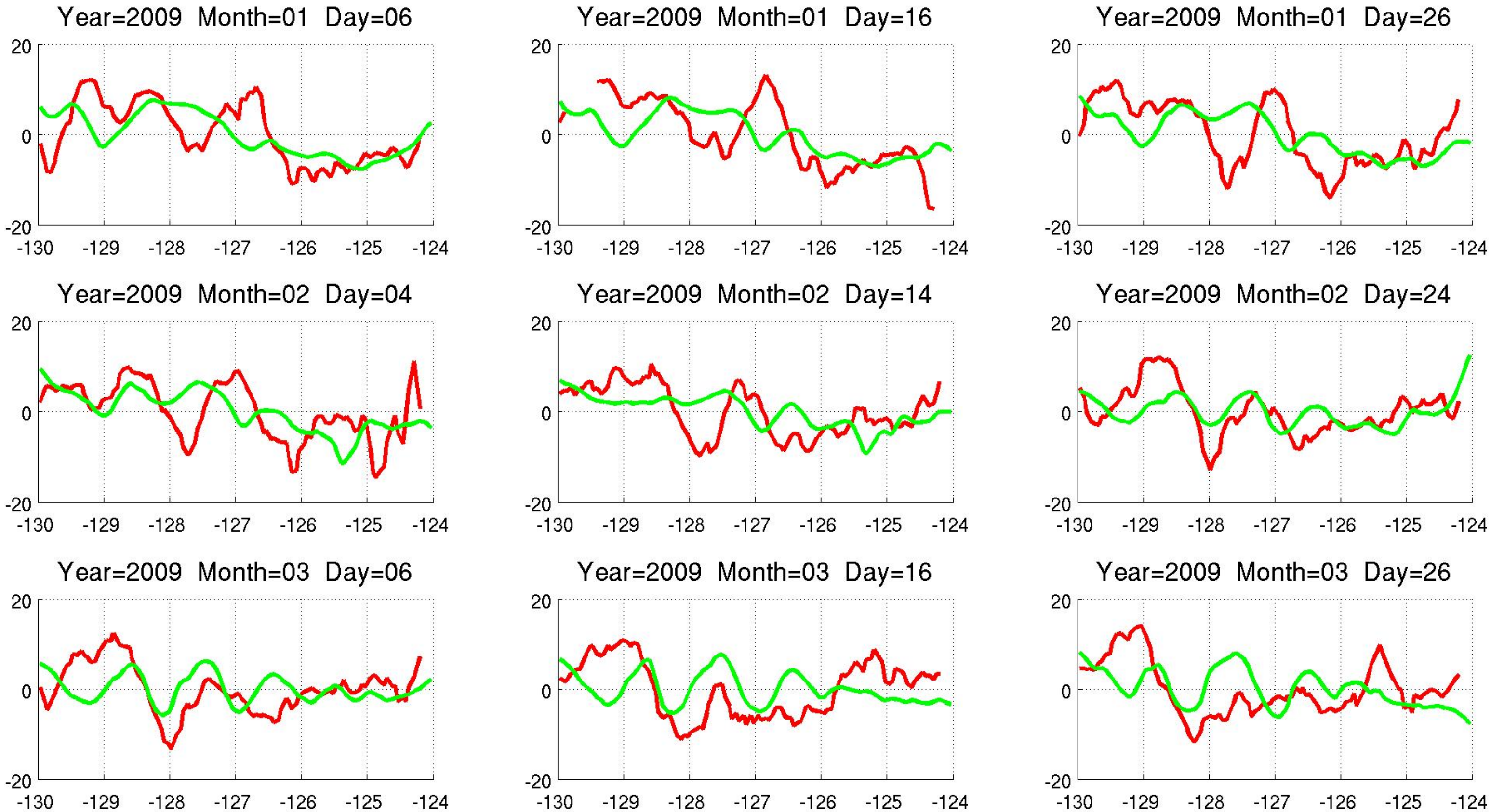




Jason-2 alongtrack altimetry vs. ROMS:
Track 274, Jan-Mar, 2009
(ADT, each pass demeaned individually)

- Downwelling events (northward winds): SSH higher near coast
- ROMS reproduces correctly the SSH slope (alongshore surface geostrophic currents)

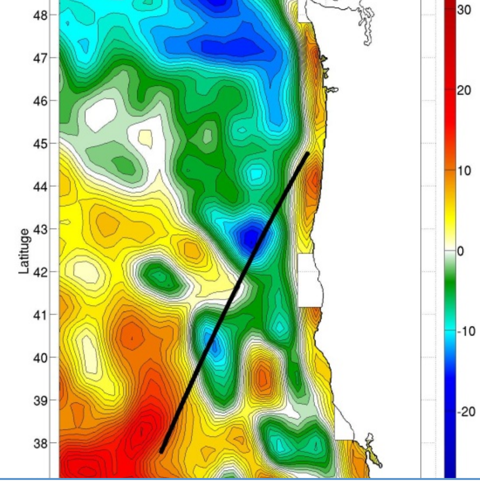




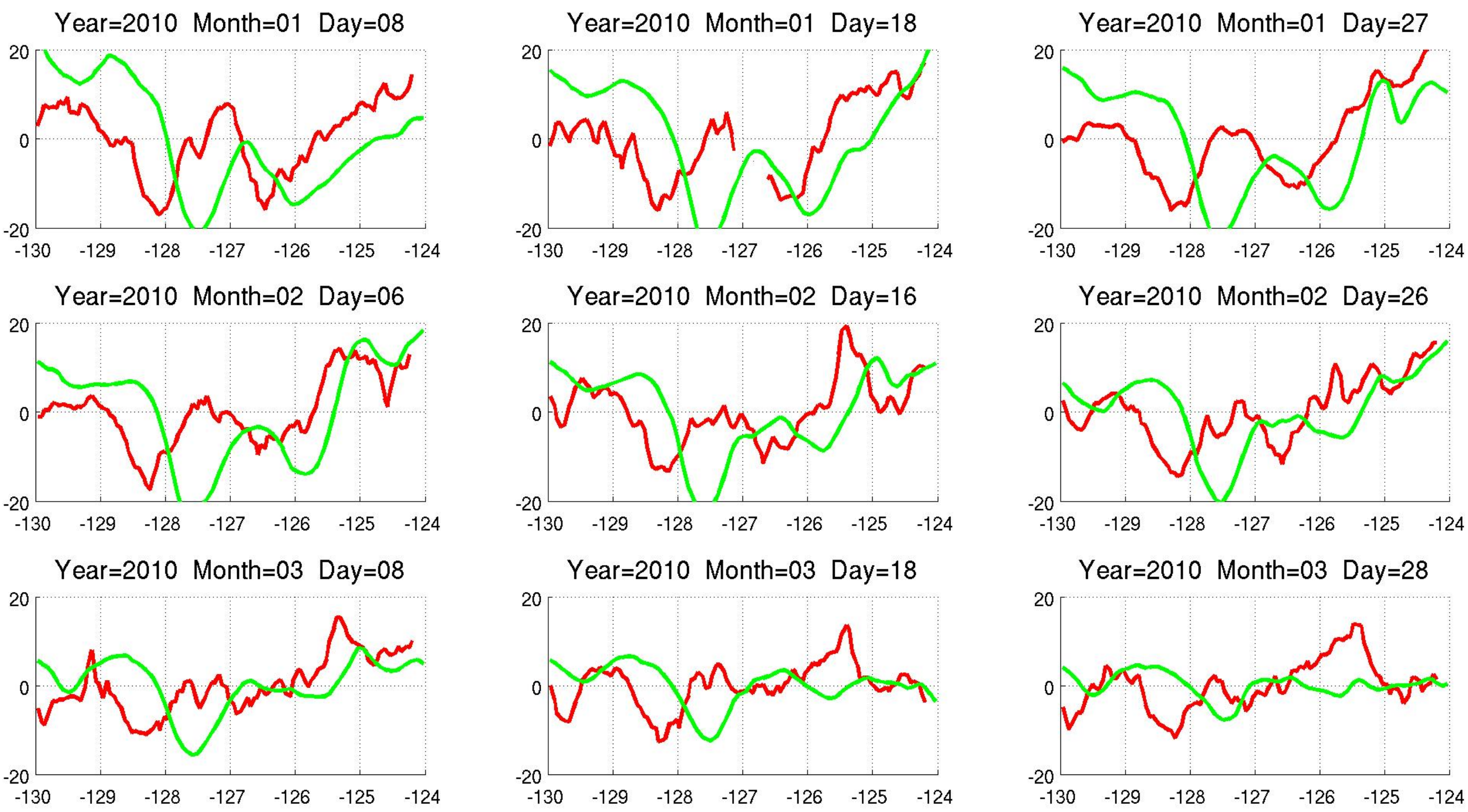
Jason-2 alongtrack altimetry vs. ROMS:

Track 274, Jan-Mar, 2010

(ADT, each pass demeaned individually)



- Sronger SSH slope near coast than in 2009, similar in ROMS/obs
- Cyclonic eddies between CCS and coastal currents
- Feb-Mar: evidence of anti-cyclonic eddies

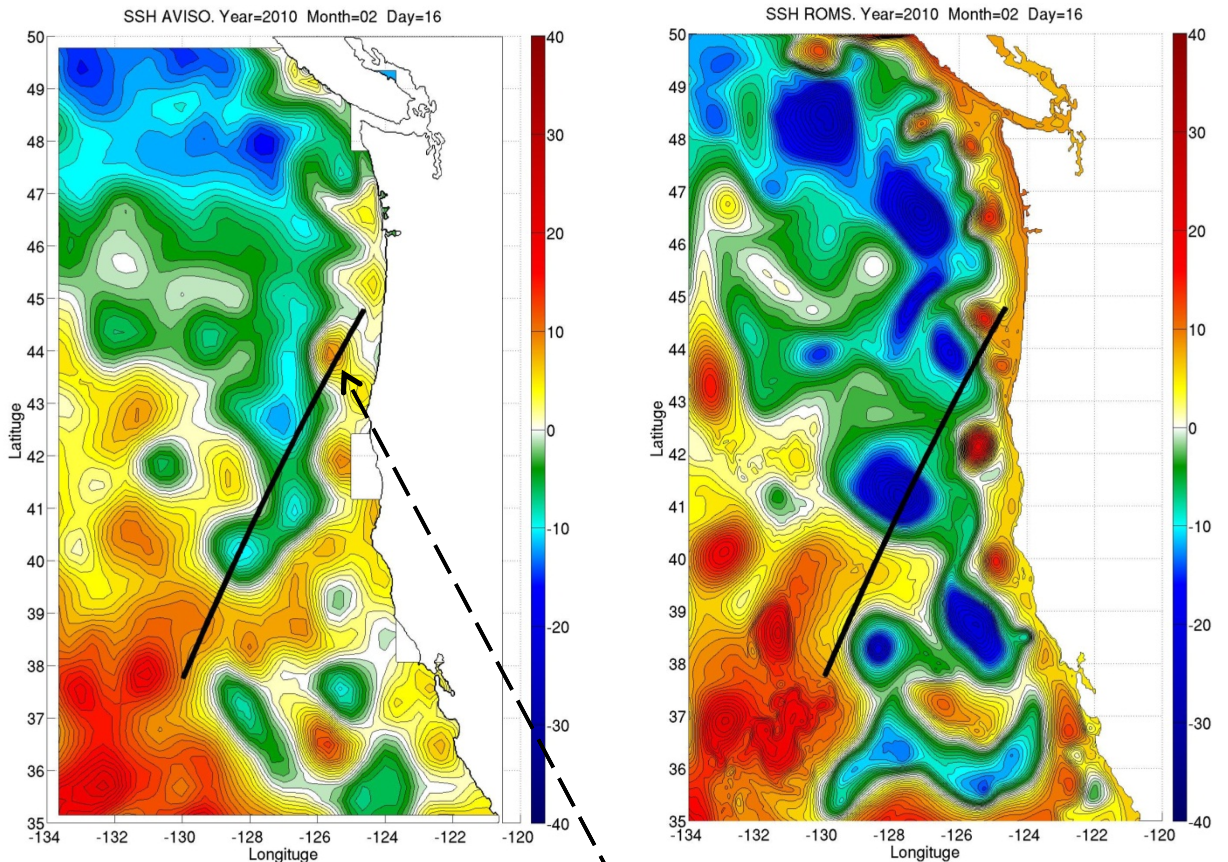


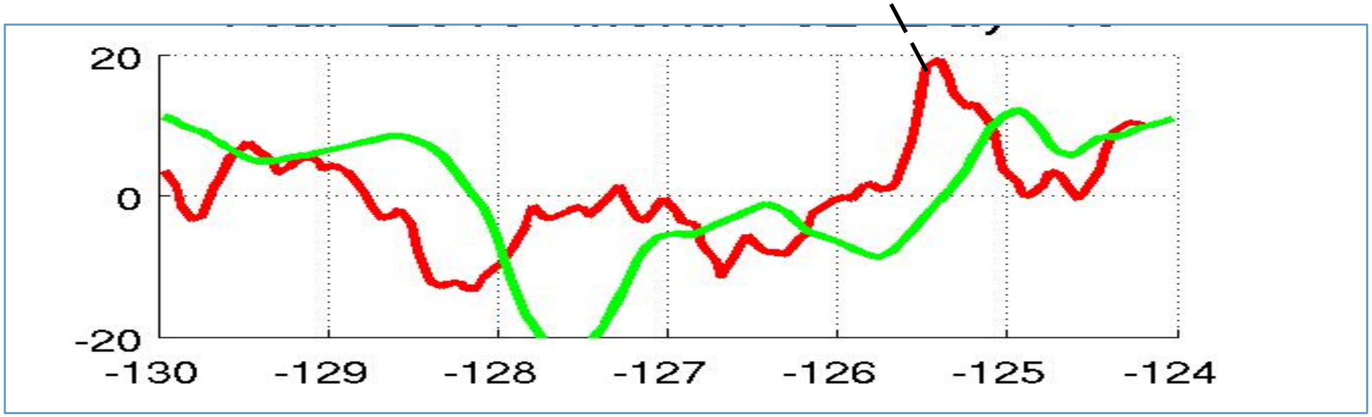
Eddies

- in SSH maps
(left) AVISO
(right) ROMS

- in alongtrack data
- (AVISO, ROMS)

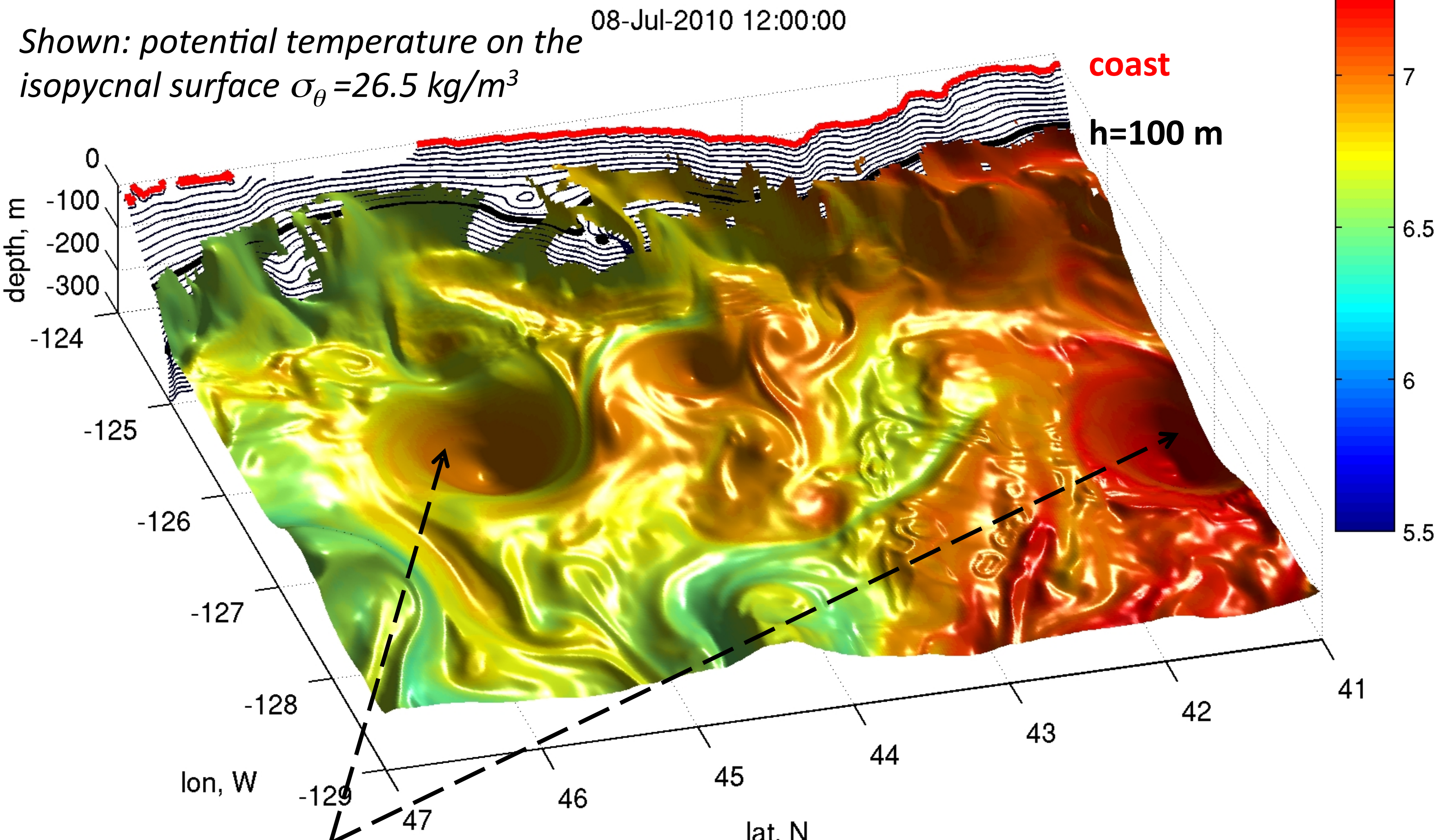
Feb 16, 2010





Surface-intensified eddies affect subsurface material and heat transports

Shown: potential temperature on the isopycnal surface σ_θ=26.5 kg/m^3



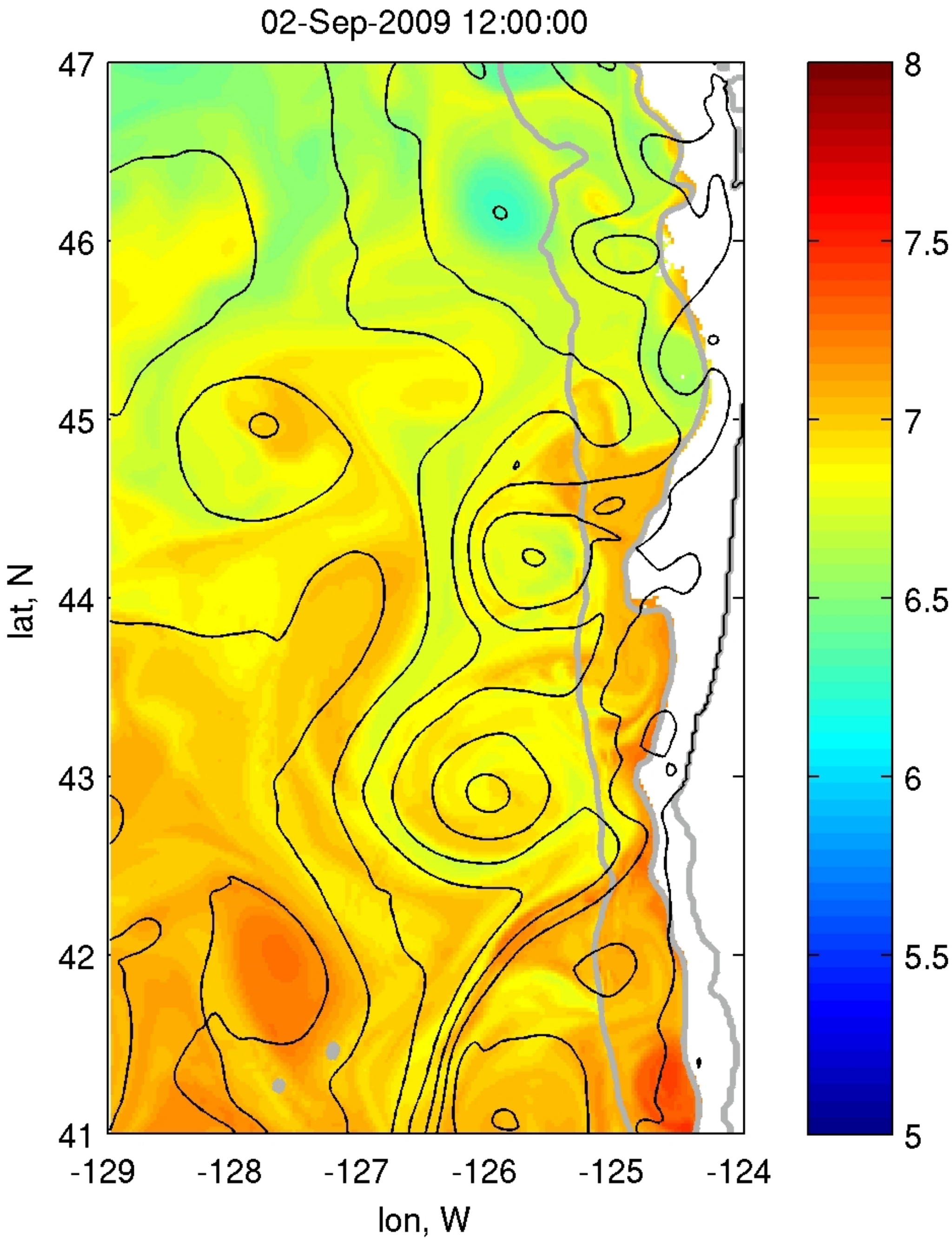
anti-cyclonic eddies generated in Feb (isopyc surf depressed)

Potential temperature on the isopycnal surface σ_θ =26.5 kg/m³

Color: temperature
Black contours: SSH (every 5 cm)
Half-tone contours: h=200m, 2000m

(the movie:
2 Sep 2009 – 30 Aug 2010**)**

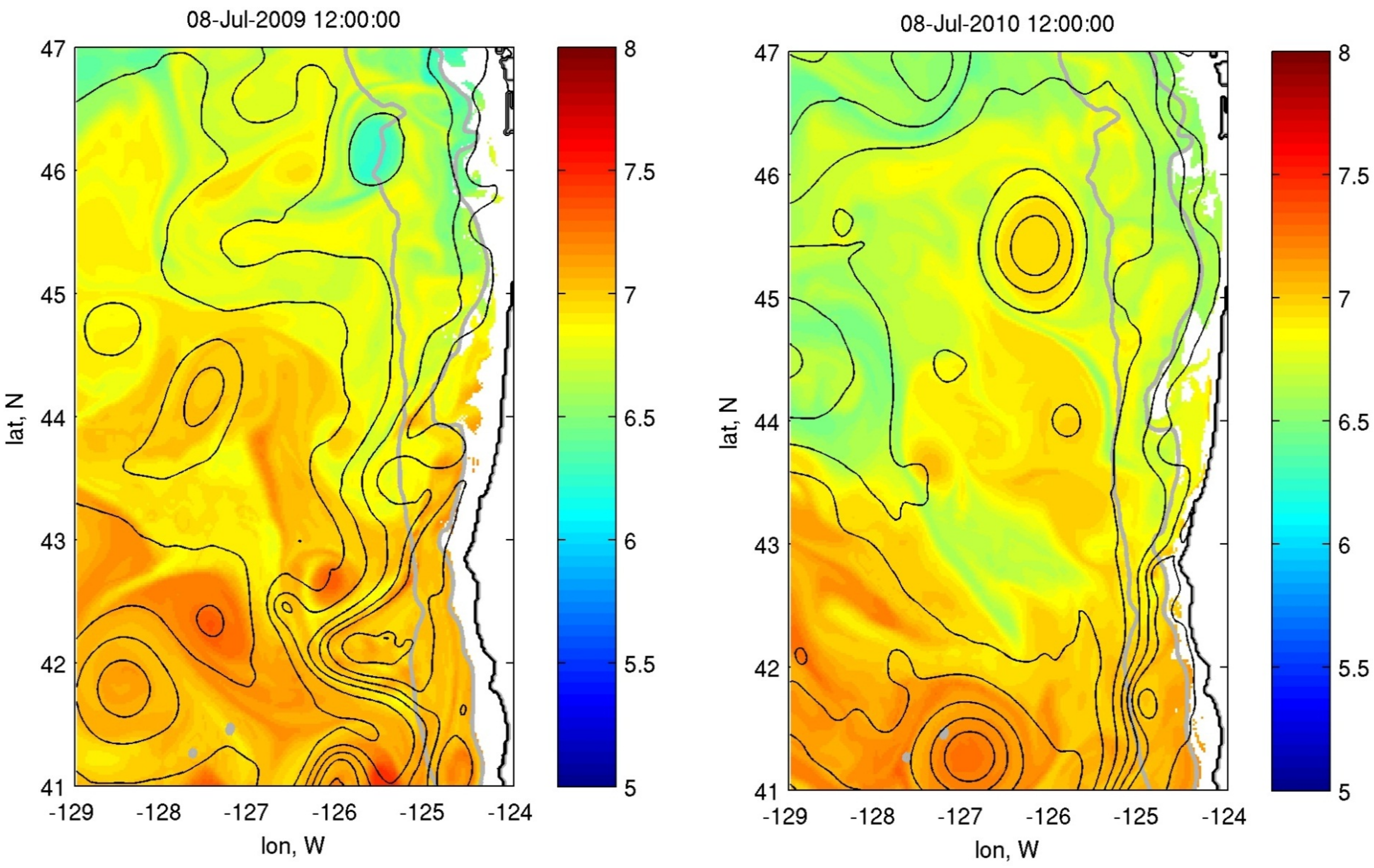
Eddies affect subsurface circulation, in particular variability in the poleward undercurrent



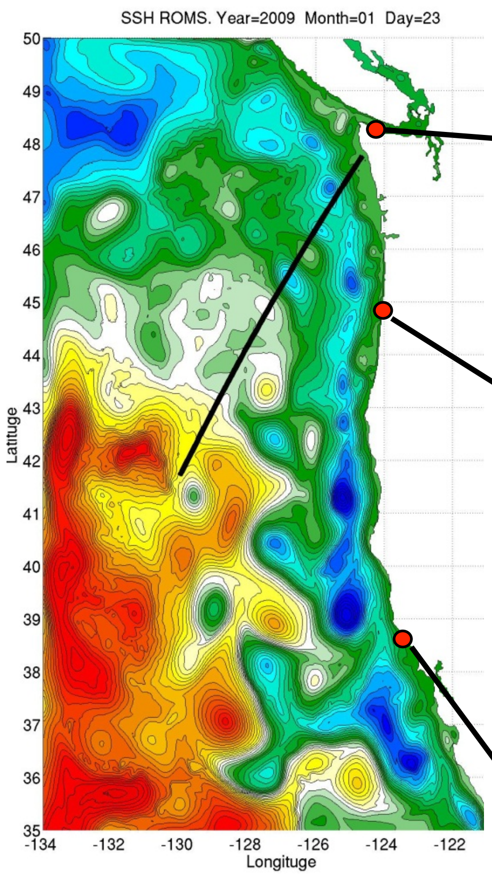
Potential temperature on the isopycnal surface σ_θ =26.5 kg/m^3

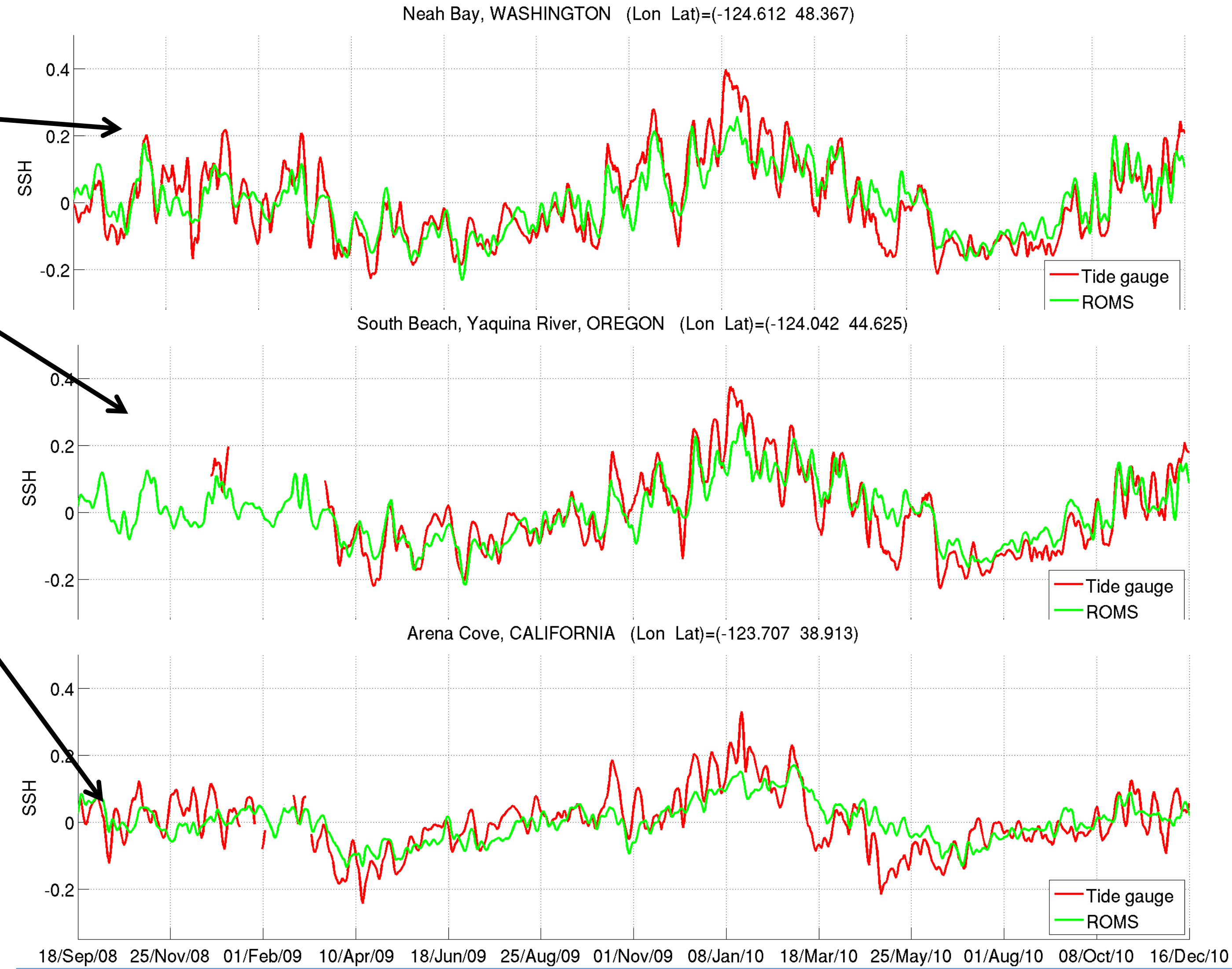
Summer: Water with different properties may be upwelled on the Oregon shelf

- <u>subarctic</u>: colder, fresher (given the same σ_θ), potentially more oxygen
- <u>subtropical</u>: warmer, saltier, potentially less oxygen



Comparisons: ROMS SSH near coast / tide gauge data





09/18/08 02/01/09 06/18/09 11/01/09 03/18/10 08/01/10 12/16

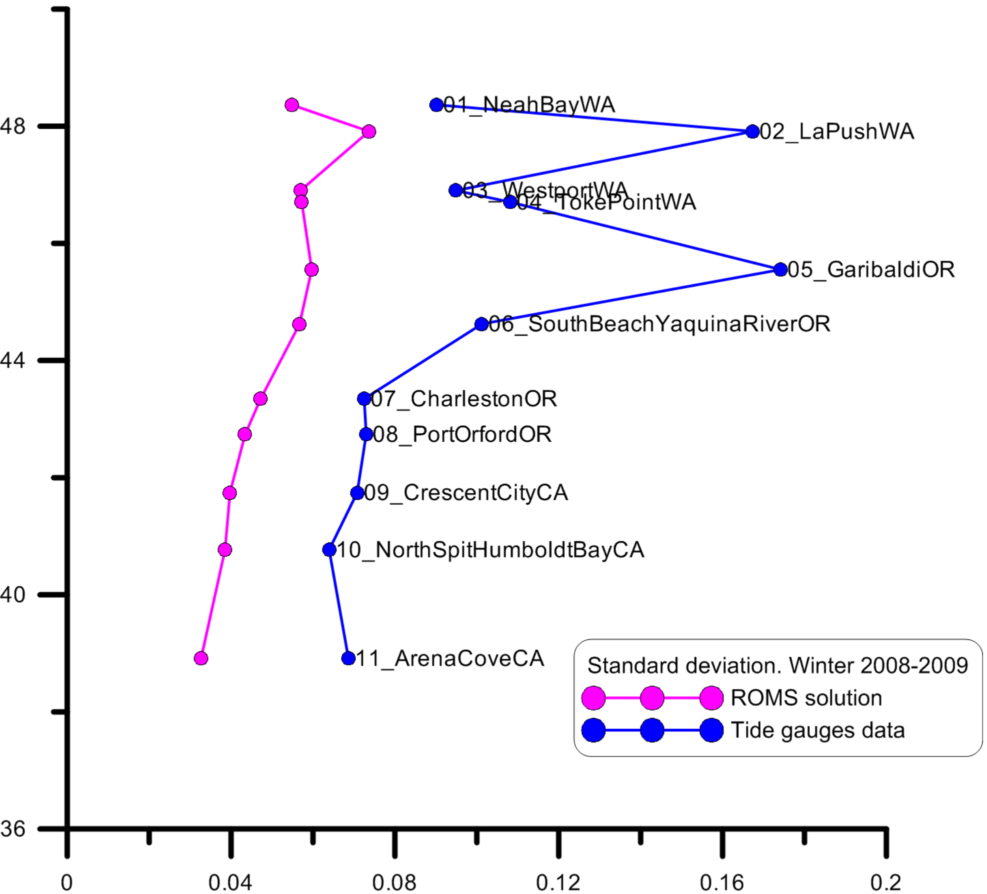
model:
daily → 3-day ave.

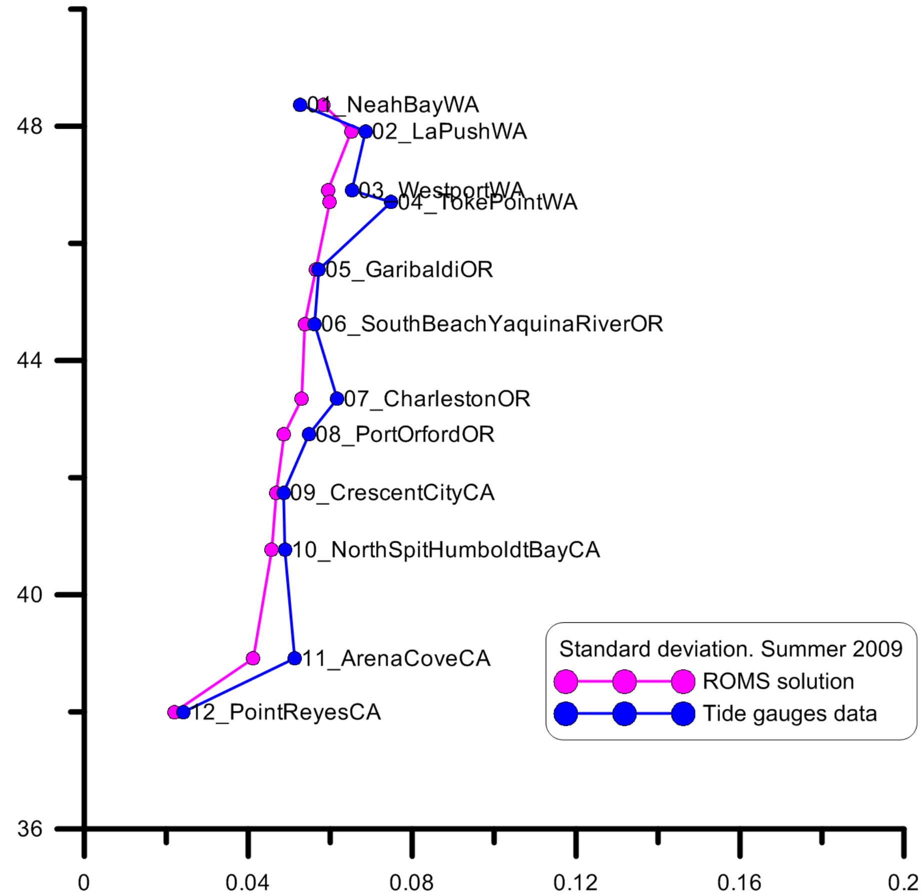
obs:
low-pass filtered (40h)
→ 3-day ave.

SSH ROMS/tide gauge standard deviations:

- winter: observed stdev is larger than modeled
- summer: more similar

2009





SSH standard deviations:

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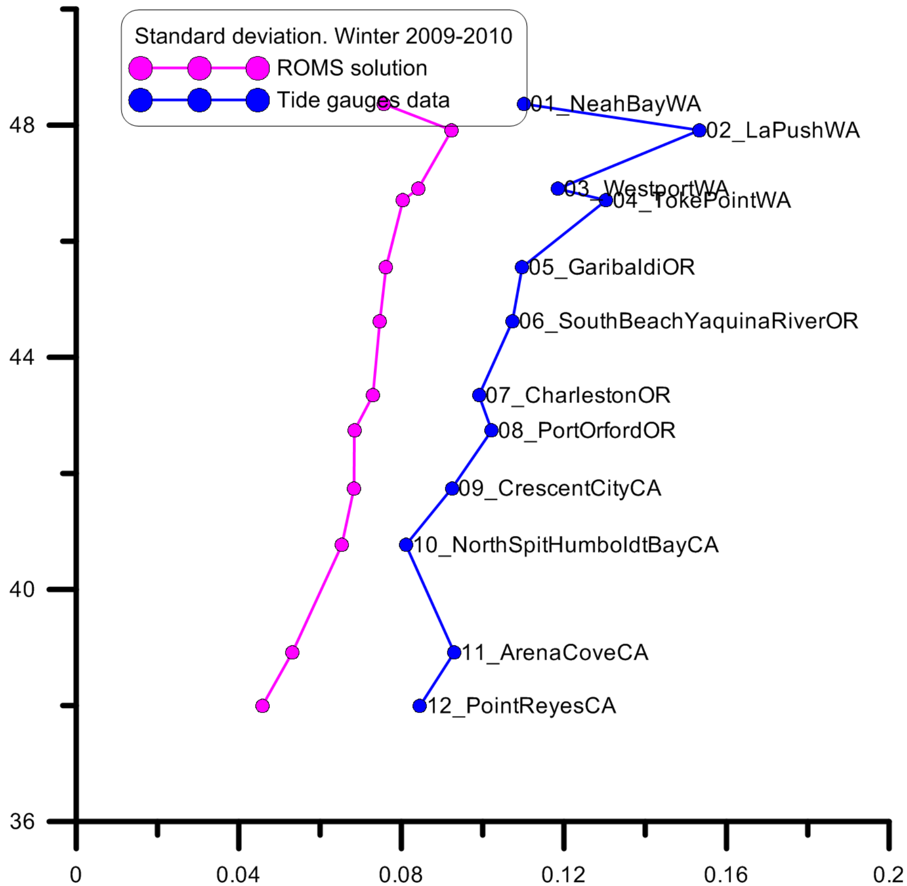
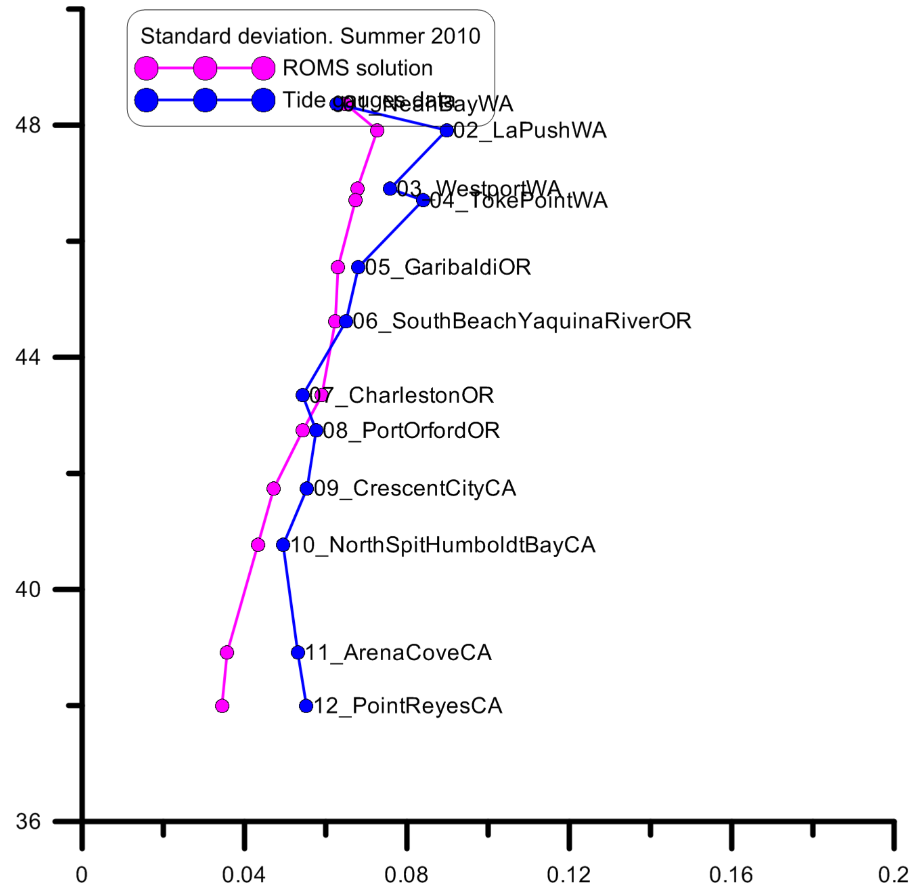
2010





Care should be taken when attempting to synthesize coastal altimetry and tide gauge data

SUMMARY:

Altimetry helps us verify behavior of ocean circulation models at regional and coastal spatial scales and understand dynamics at seasonal and inter-annual time scales

Altimetry assimilation in coastal ocean circulation models helps improve surface and subsurface transport estimates

A coastal-resolution, regional-size model of the California Current System has been developed to study influences of the interior ocean on coastal ocean circulation

Analysis of the model and observations (2009-2010) reveals strong inter-annual variability of coastal circulation along the US West coast, influenced by EL Niño/La Niña

- SSH cross-shore slope / alongshore current
- Poleward undercurrent along the continental slope
- Transport of upwelling source waters

Surface intensified anti-cyclonic eddies generated in the lee of the El Nino event (Feb 2010) affect subsurface heat and material transport near the coast later that year

Additional studies are needed to understand variability in coastal SSH at sub-tidal scales (modeled and observed at tide gauges)