

***A real-time nowcast-forecast system for the  
Southern California Bight (SCB) based on the  
Regional Ocean Modeling System (ROMS)***

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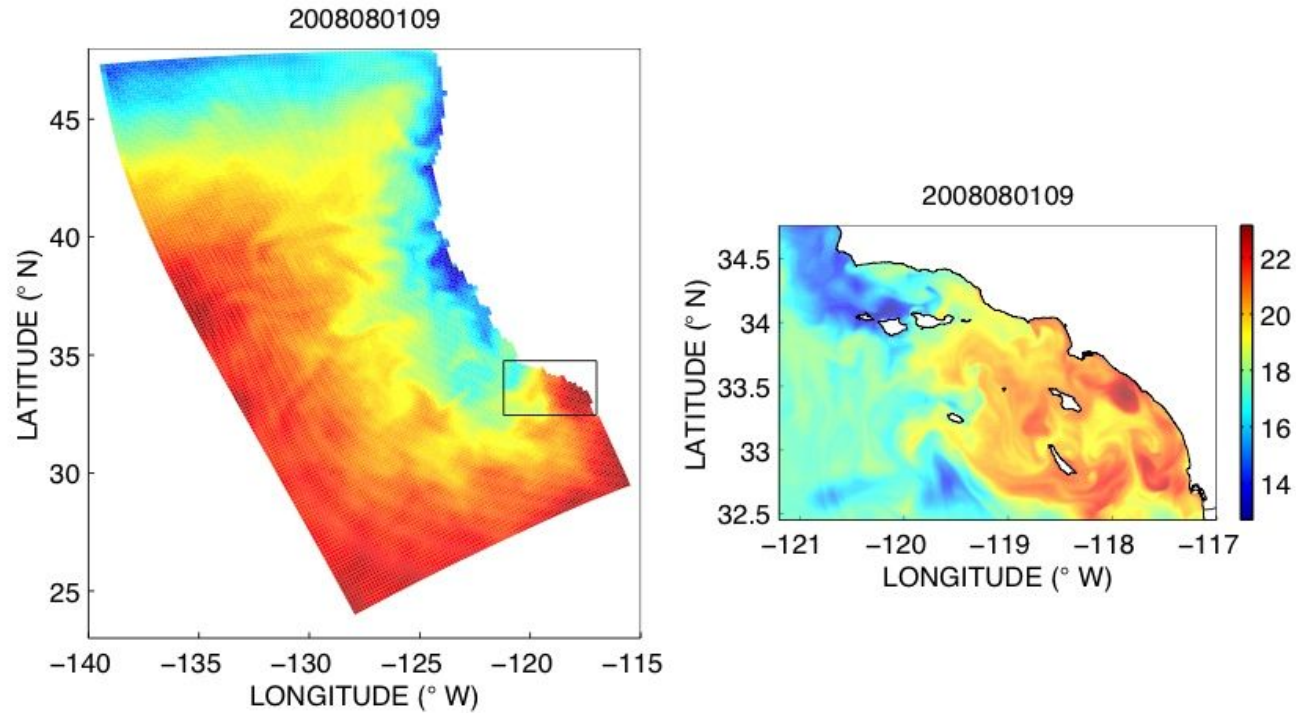
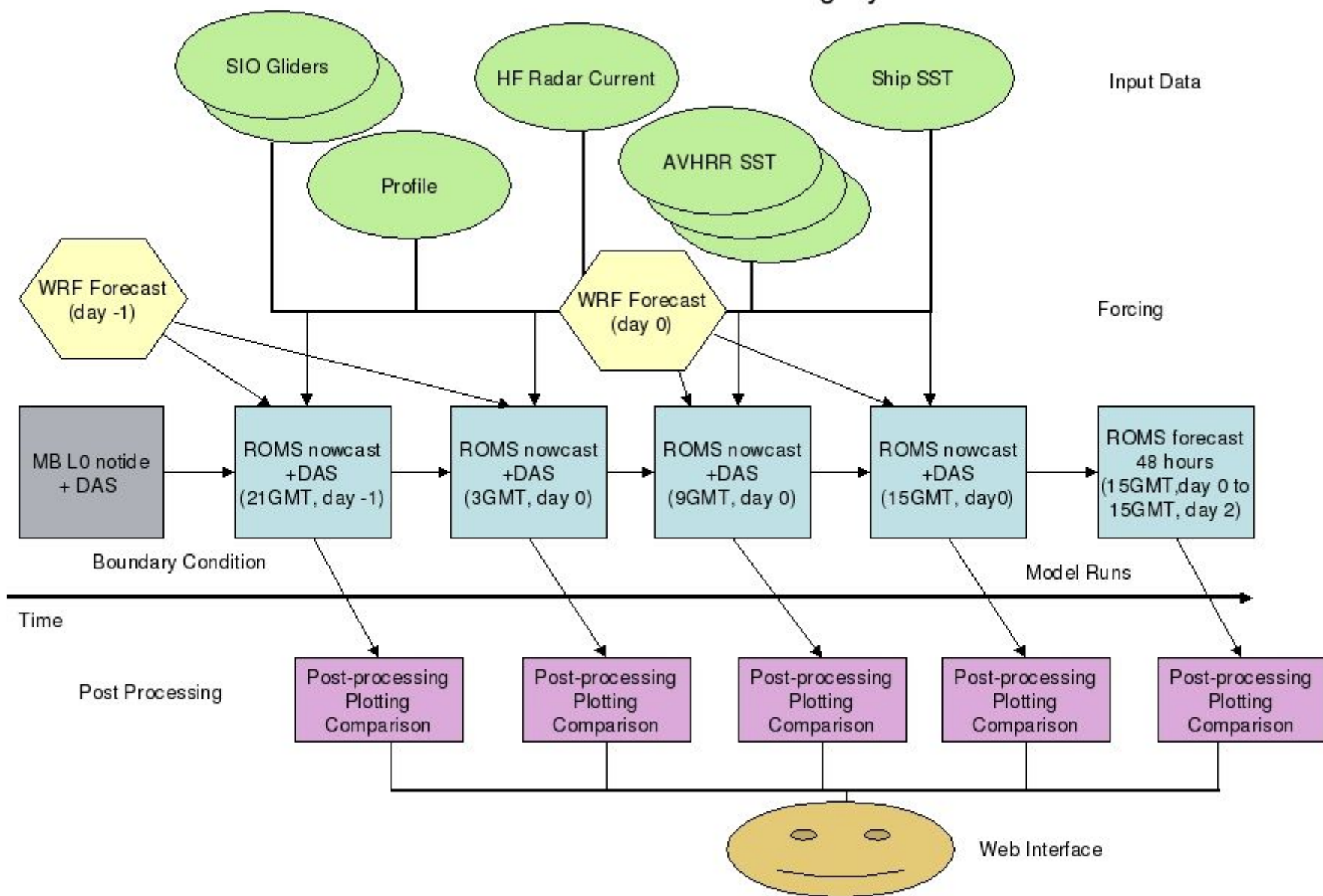
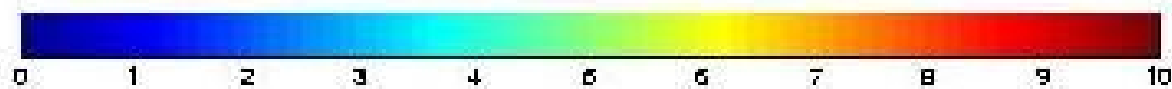
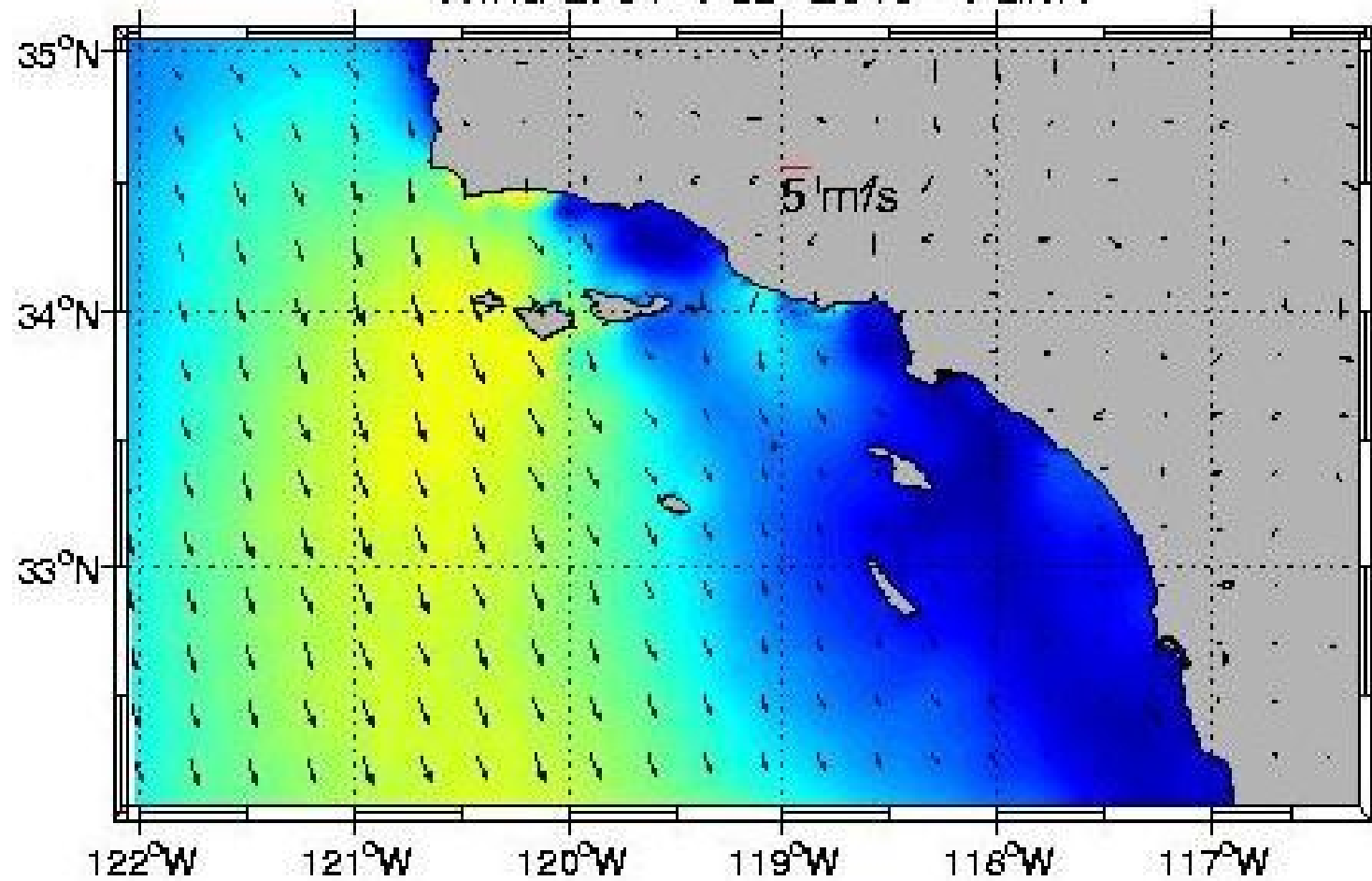


Fig. 1. ROMS model domains for a two level nested configuration. The USWC domain ROMS has a horizontal resolution of 15km, while the SCB domain ROMS has a horizontal resolution of 1km. The 3DVAR is implemented separately for each level. The colors show the SSTs at UTC 09, August 01, 2008, and the SSTs are from the data assimilation analyses for each domain.

# ROMS SCB Real Time Modeling System



Wind at 01-Feb-2010- 7GMT



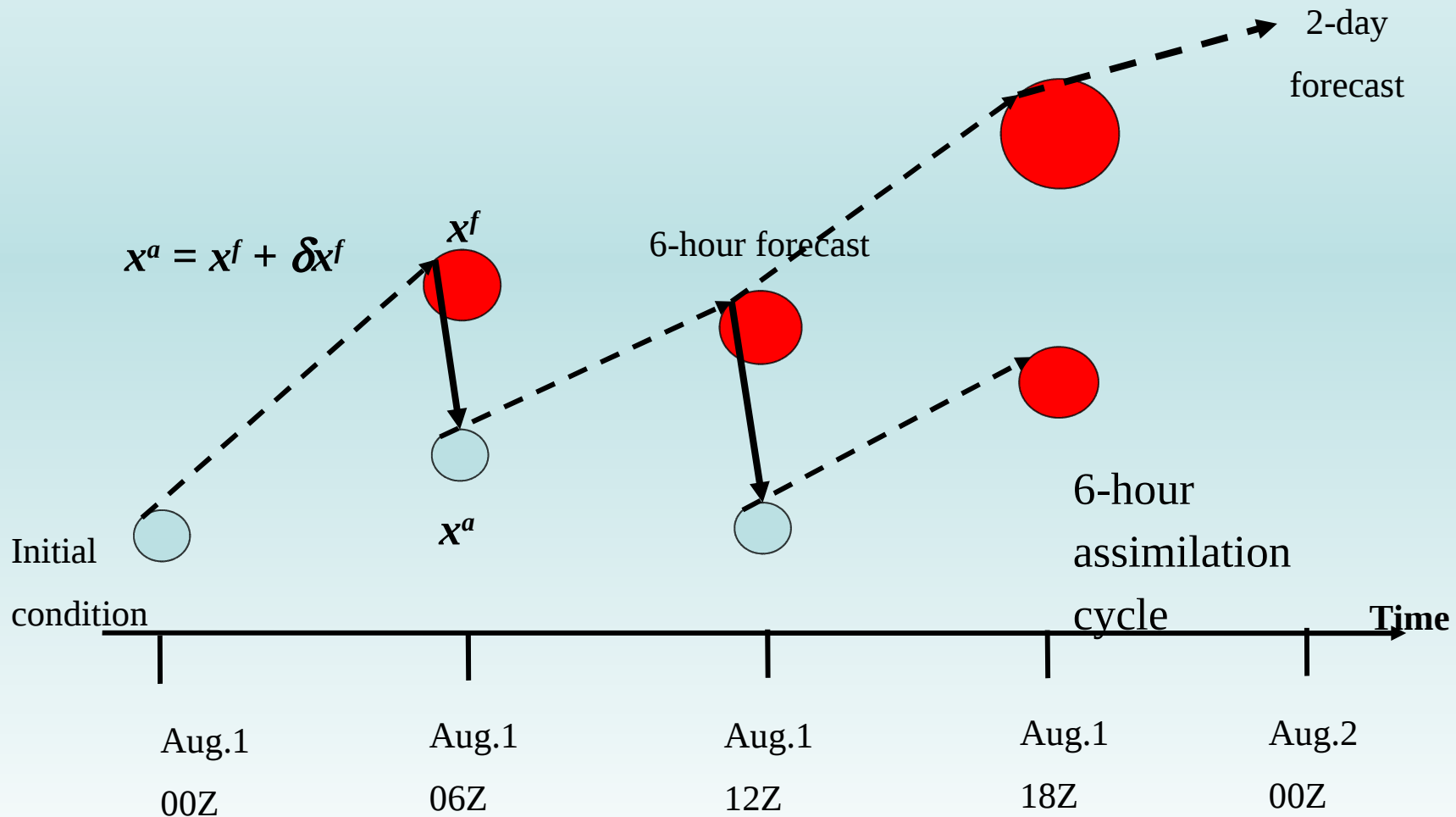
# Cycle of analysis and forecast for a real-time system

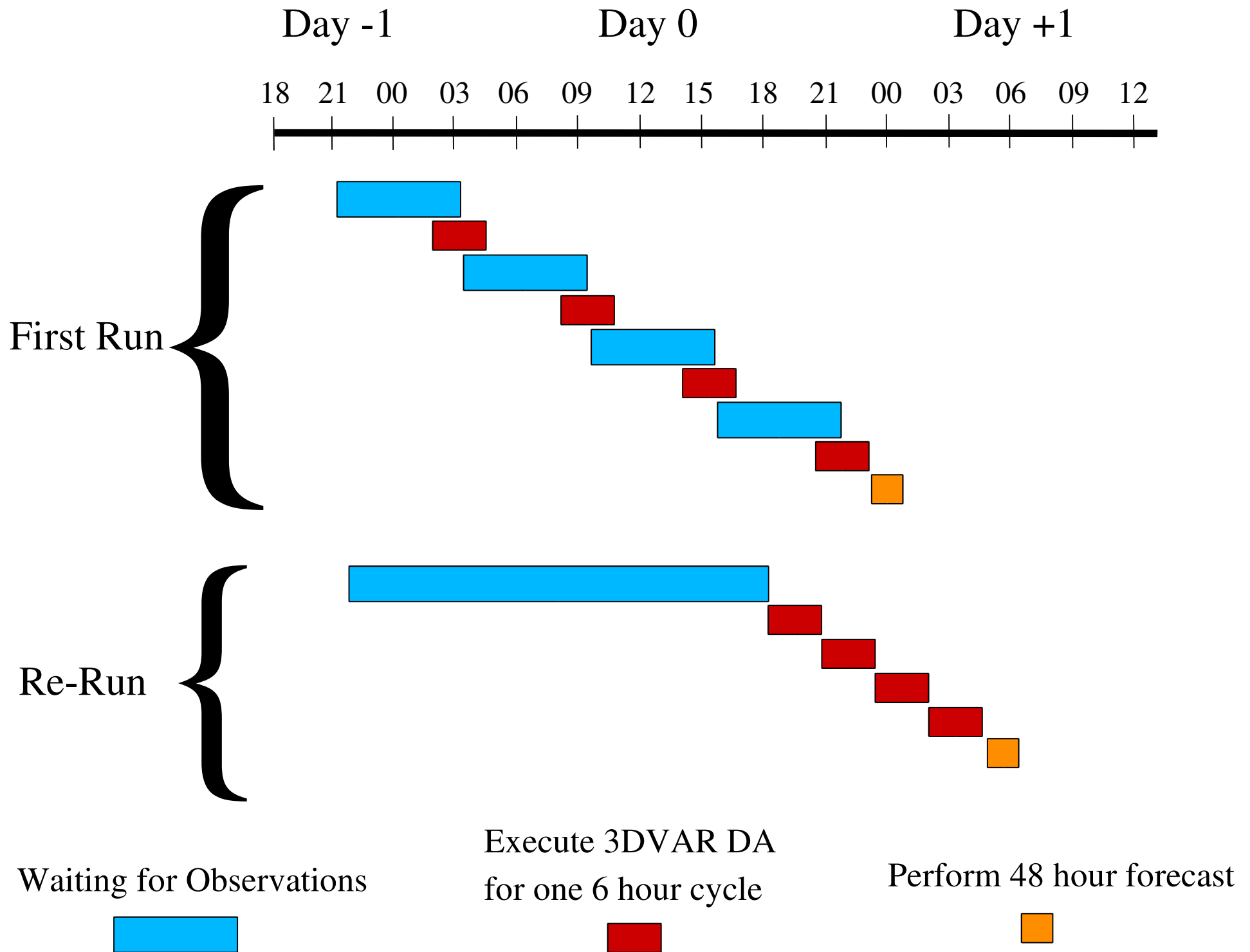
3-dimensional variational (3DVAR) method:

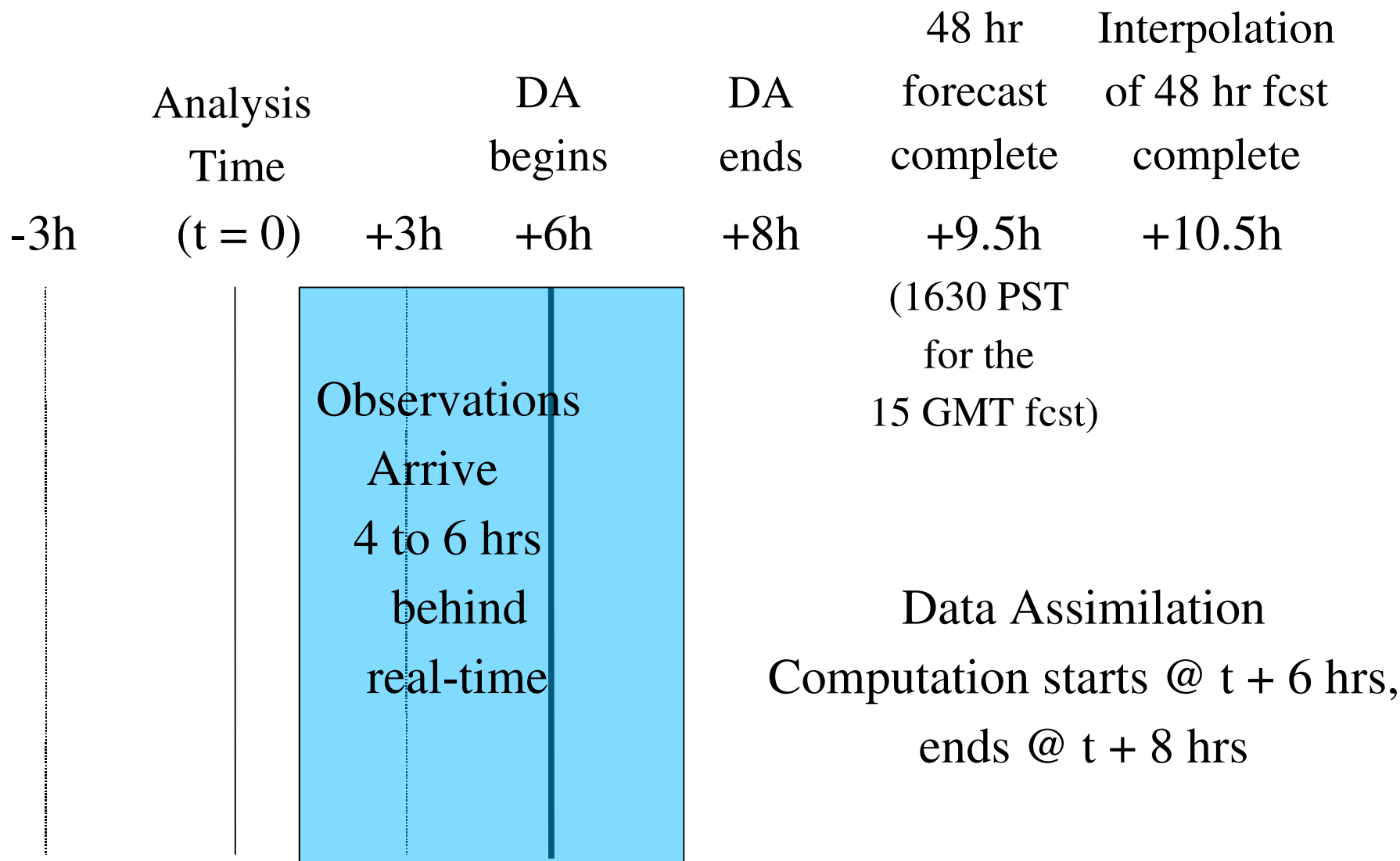
$$J = \frac{1}{2} (x - x^f)^T B^{-1} (x - x^f) + \frac{1}{2} (Hx - y)^T R^{-1} (Hx - y)$$

**y: observation**

**x: model**







Analysis Window  
uses data valid from  
t-3h through t+3h



**ROMS Nowcast**

- ☒ Temperature
- ☐ Salinity
- ☐ Current
- ☐ Sea Surface Height

**ROMS Forecast**

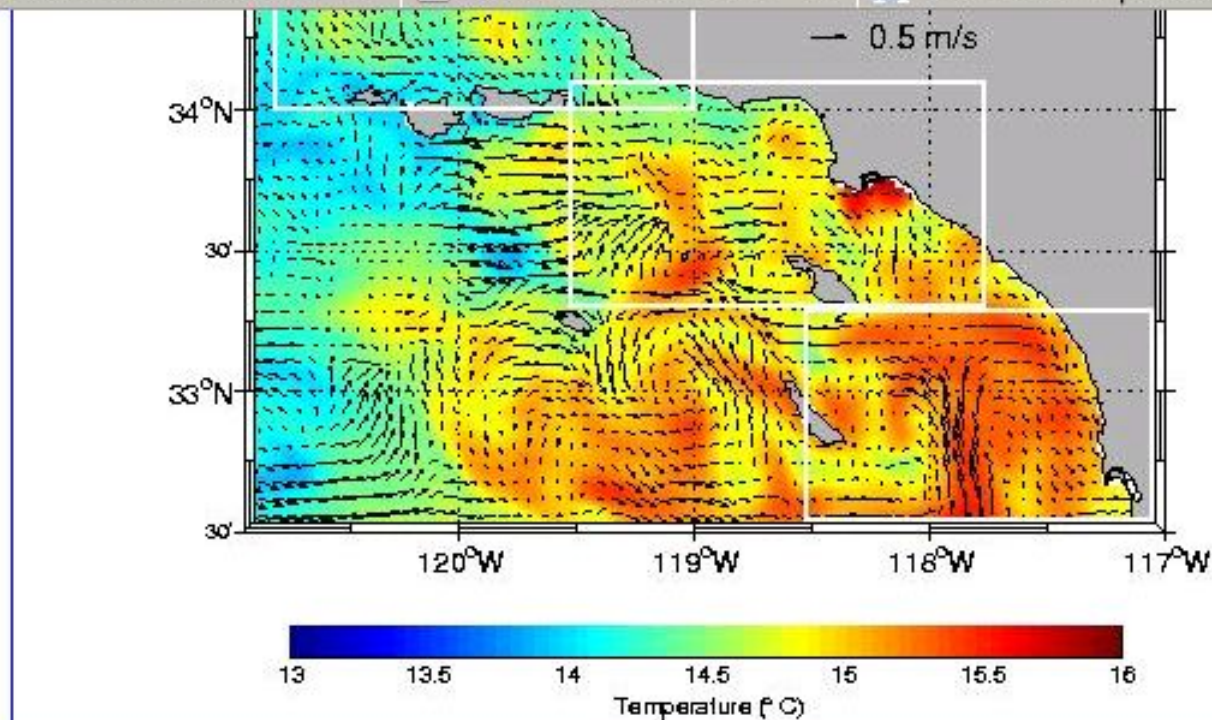
- ☐ 3D Output

**WRF**

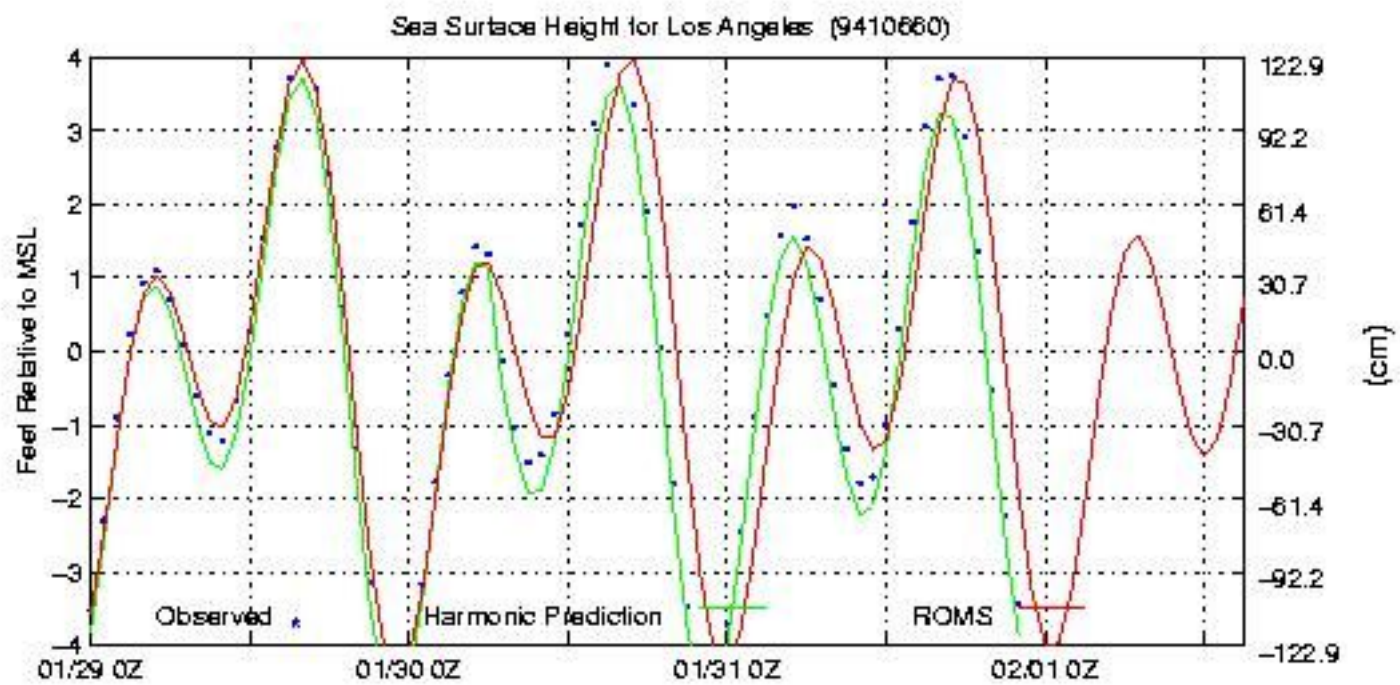
- ☐ Wind

**ROMS vs. Data**

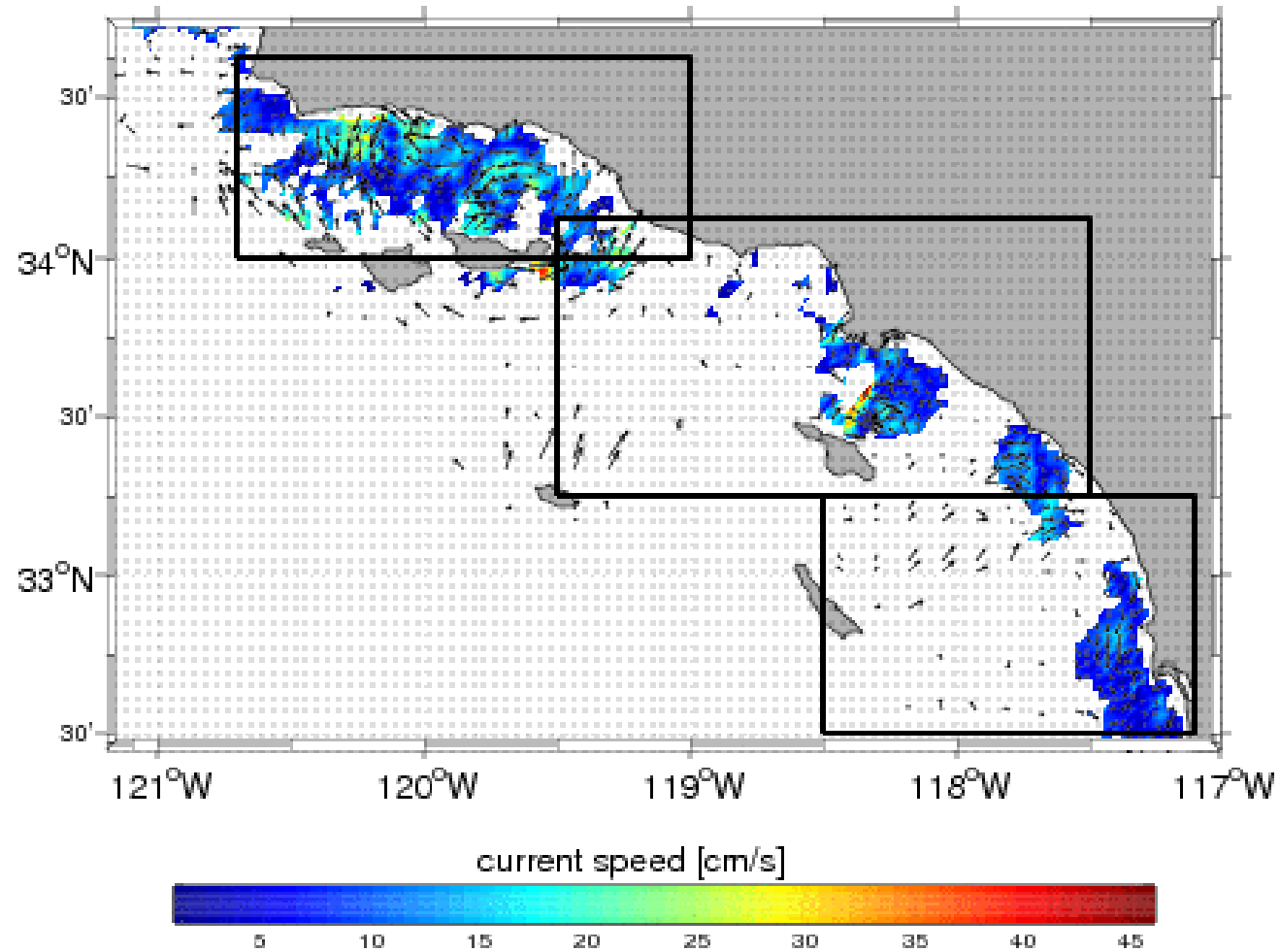
- ☐ Tide Gauge
- ☐ HF data and ROMS data
- ☐ SIO Glider Profile
- ☐ USC Glider Profile
- ☐ 1km SST



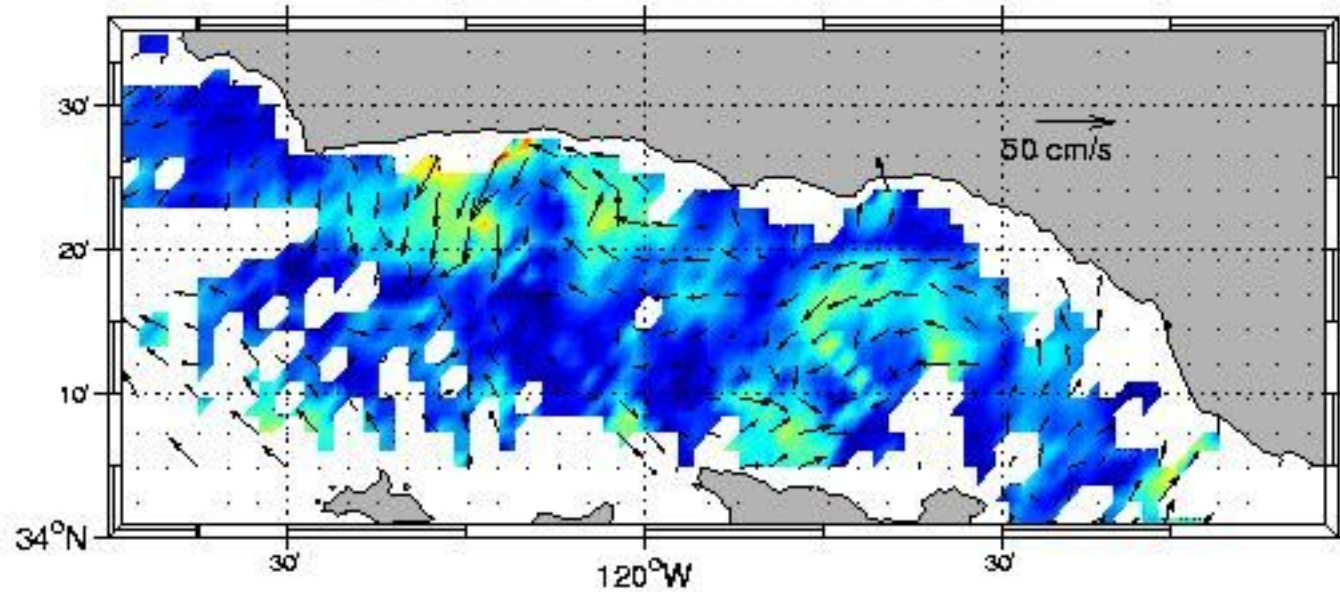
Throughout our web site, we are using Greenwich Mean or Meridian Time (GMT). Pacific Daylight Time (PDT) is 7 hours behind GMT, i.e.,  $PDT = GMT - 07:00$ .



HF Radar surface currents at 2010/02/01/15GMT



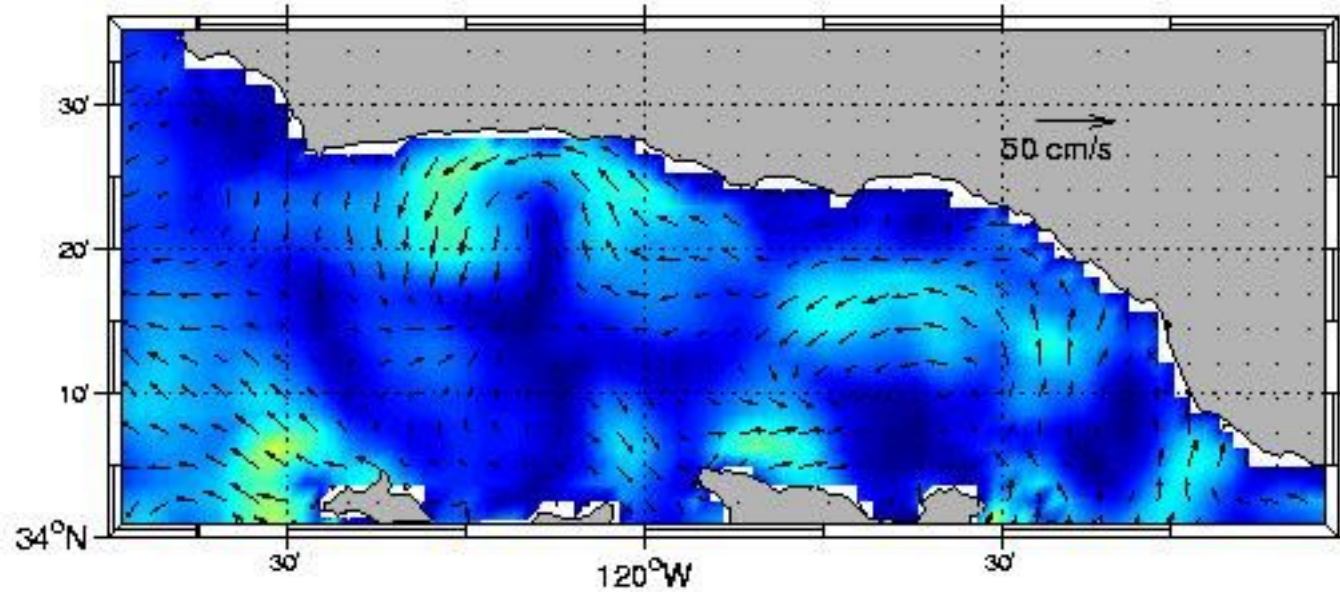
HF Radar surface currents at 2010/02/01/15GMT

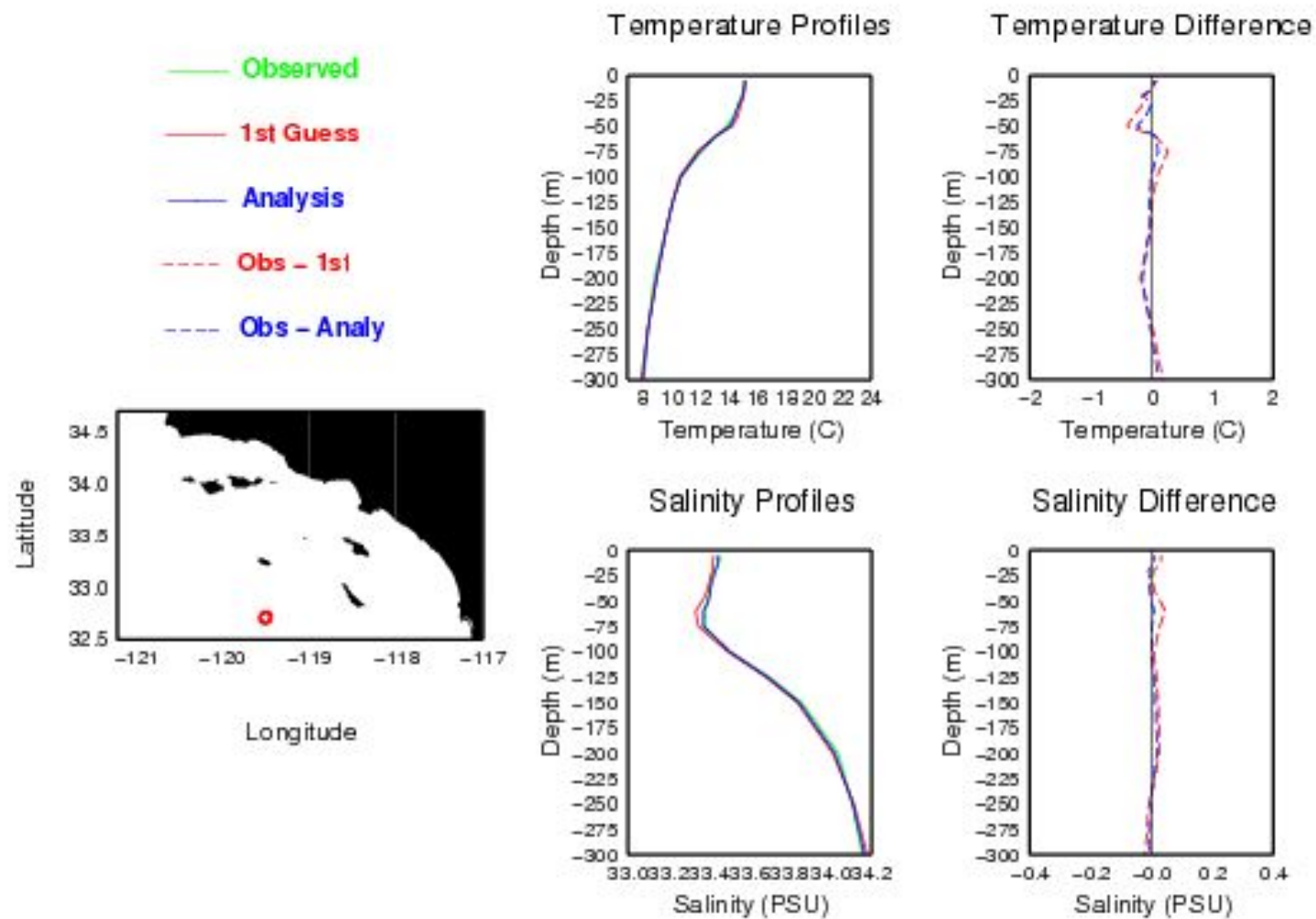


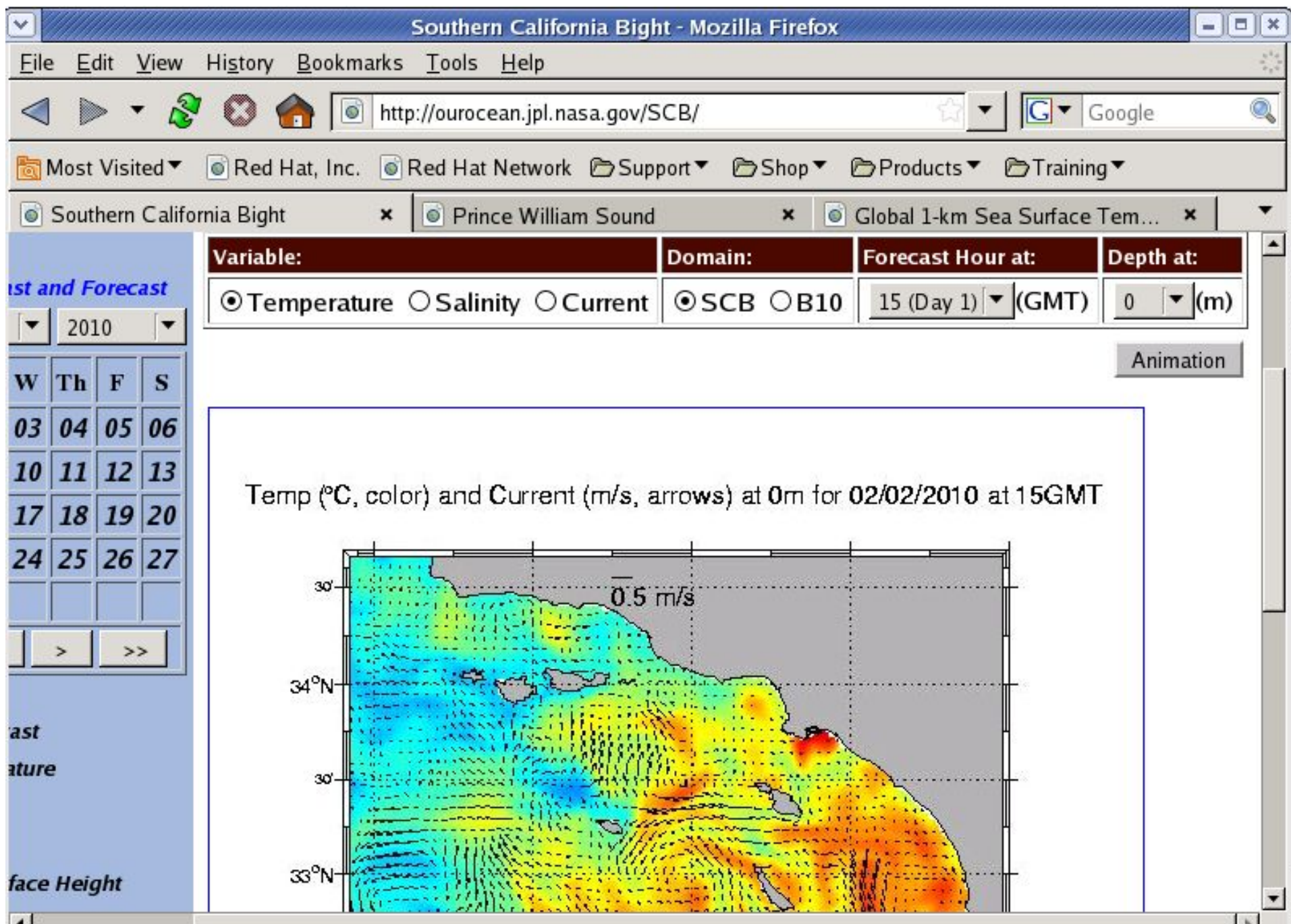
current speed [cm/s]



ROMS surface currents at 2010/02/01/15GMT







# Nowcast (or Analysis) Performance

AVHRR, G1, ROMS

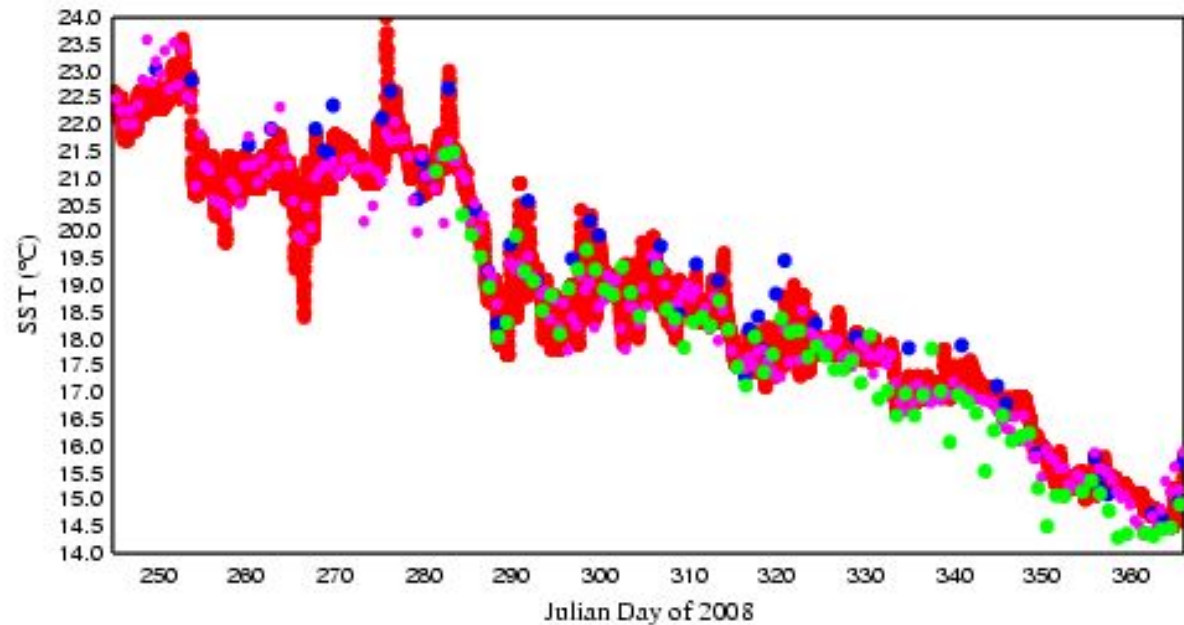
Bias, RMS, Corr

+0.25, 0.43, 0.99

-0.10, 0.58, 0.95

-0.12, 0.37, 0.99

NDBC Buoy 46225 Oceanside (Red) vs. AVHRR SST (Blue), G1 SST (Green), ROMS Reanalysis (Purple)



AVHRR, G1, ROMS

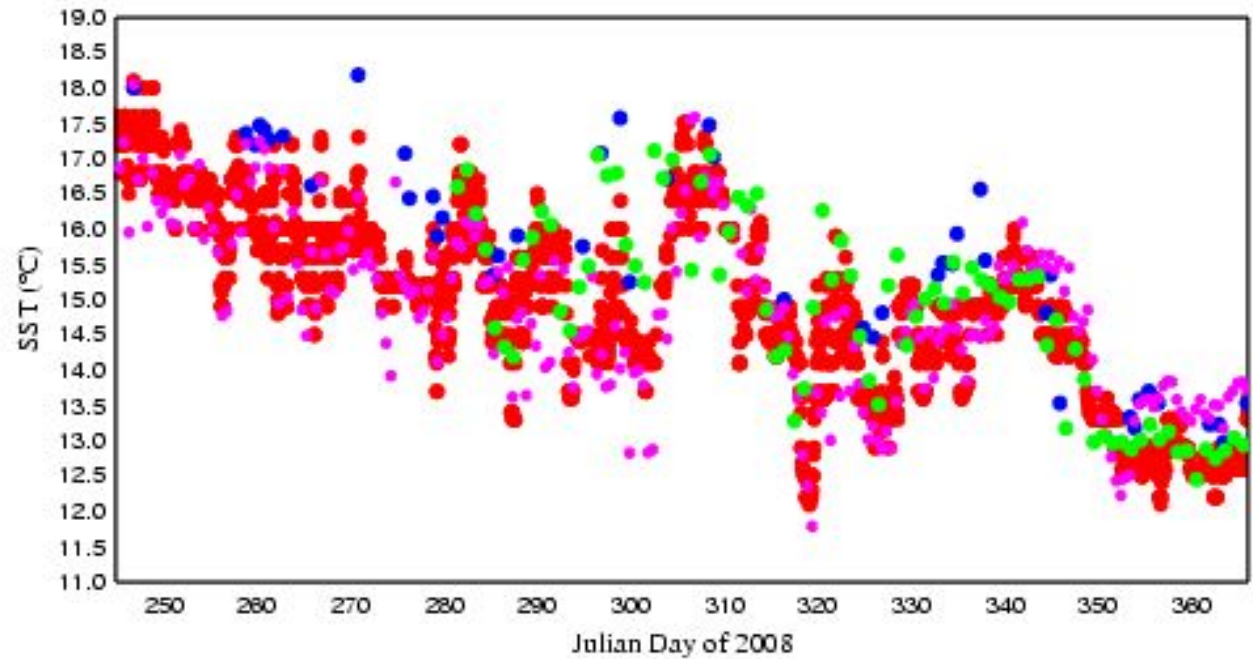
Bias, RMS, Corr

+0.76, 0.96, 0.91

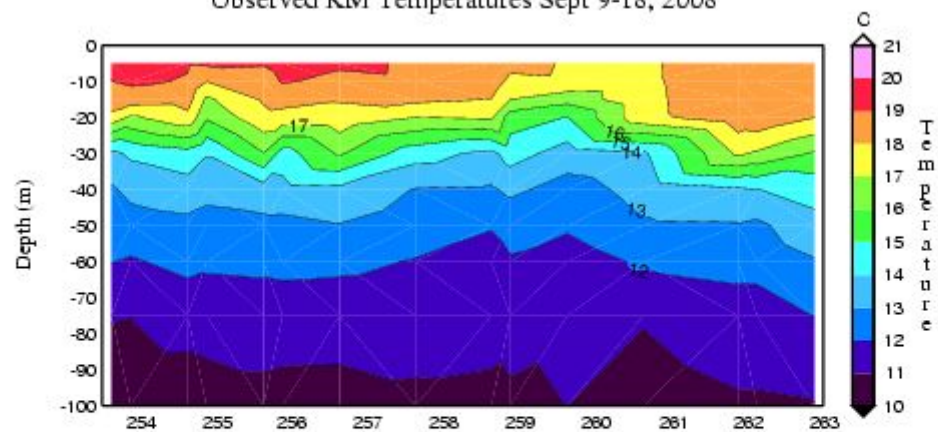
+0.50, 1.03, 0.73

-0.11, 0.68, 0.87

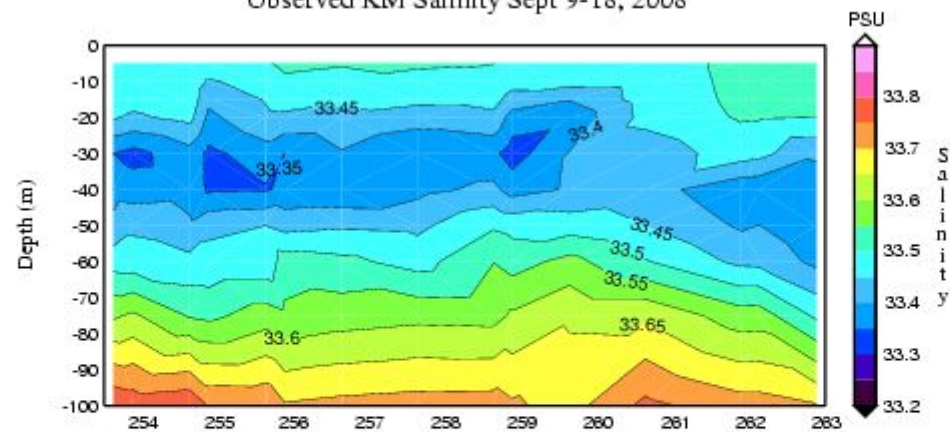
NDBC Buoy 46054 Pt. Conception (Red) vs. AVHRR SST (Blue), G1 SST (Green), ROMS Reanalysis (Purple)



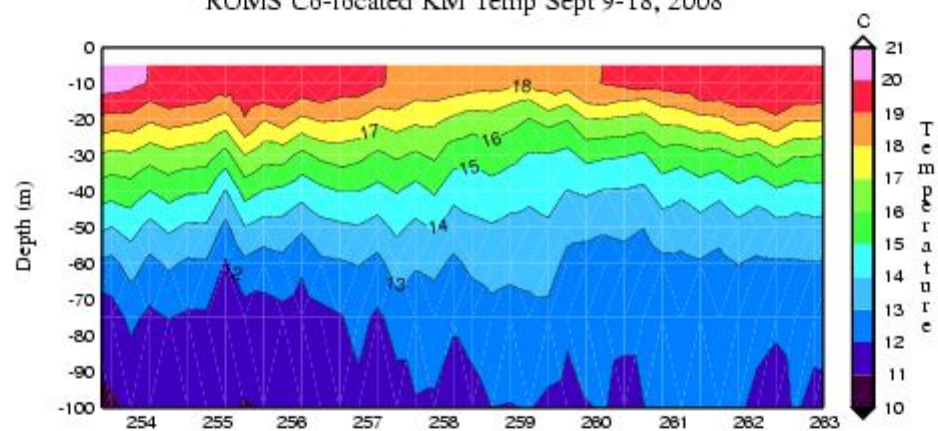
Observed KM Temperatures Sept 9-18, 2008



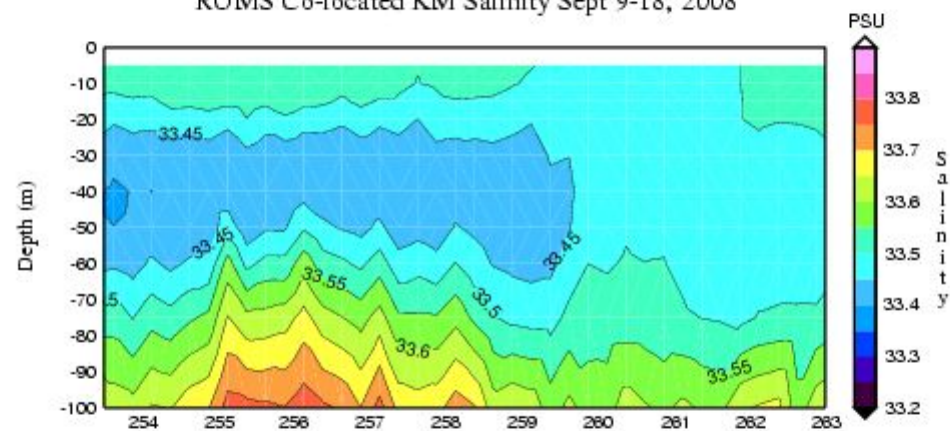
Observed KM Salinity Sept 9-18, 2008



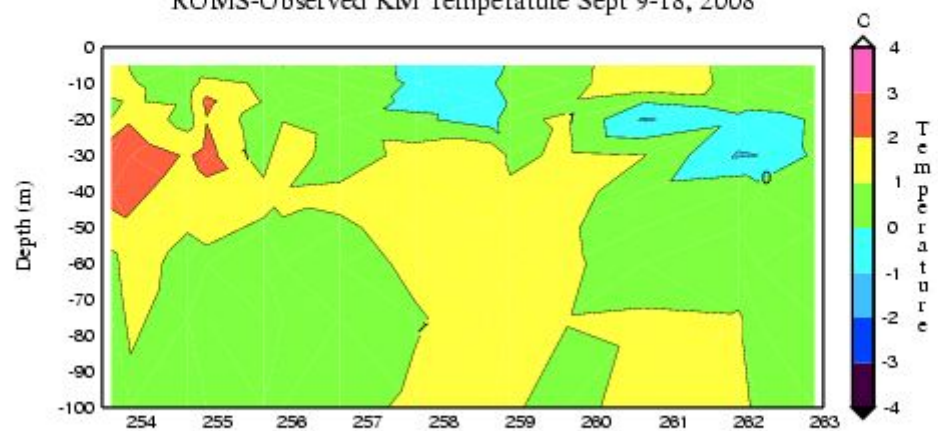
ROMS Co-located KM Temp Sept 9-18, 2008



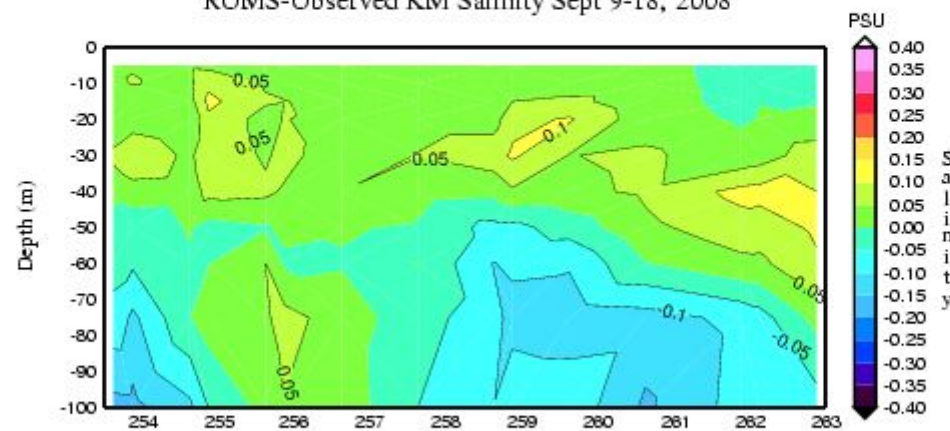
ROMS Co-located KM Salinity Sept 9-18, 2008



ROMS-Observed KM Temperature Sept 9-18, 2008



ROMS-Observed KM Salinity Sept 9-18, 2008

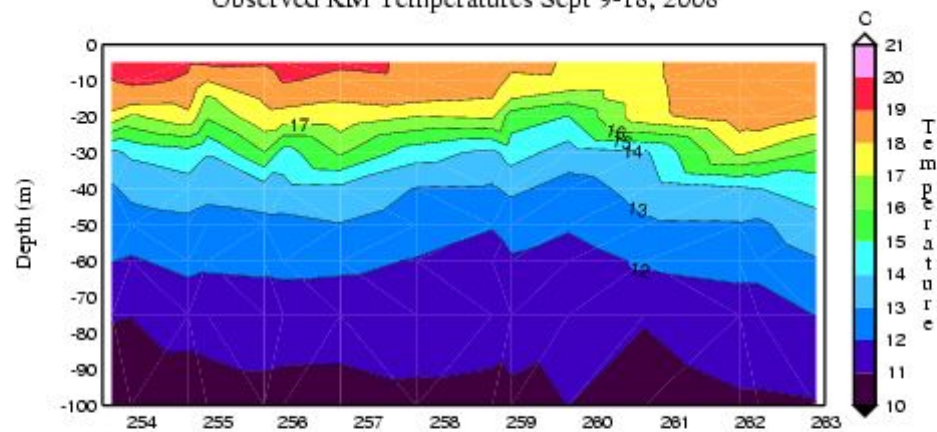


Julian Day 2008

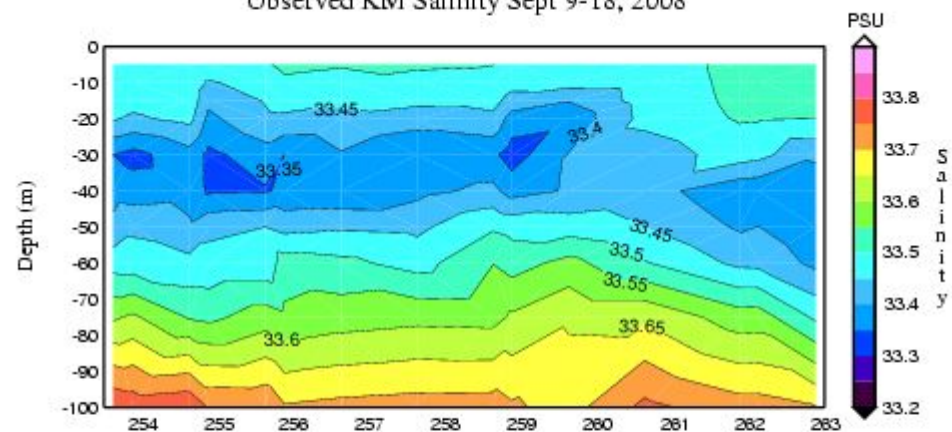
Julian Day 2008

# ROMS 48 hr Forecast

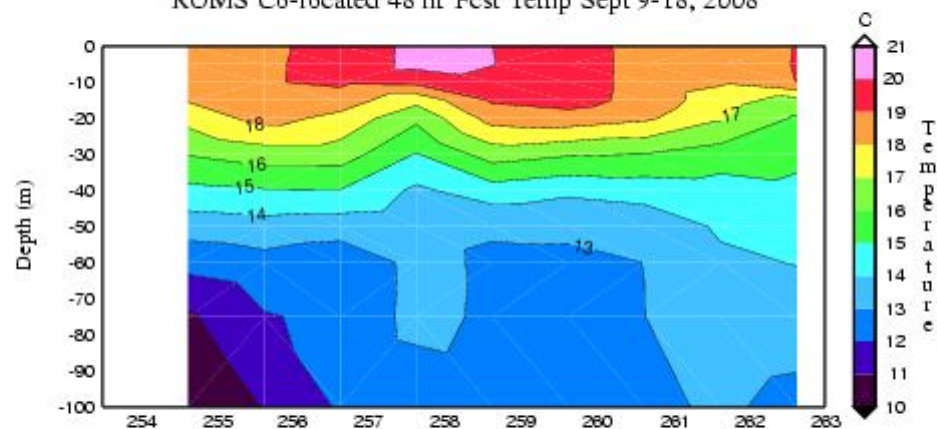
Observed KM Temperatures Sept 9-18, 2008



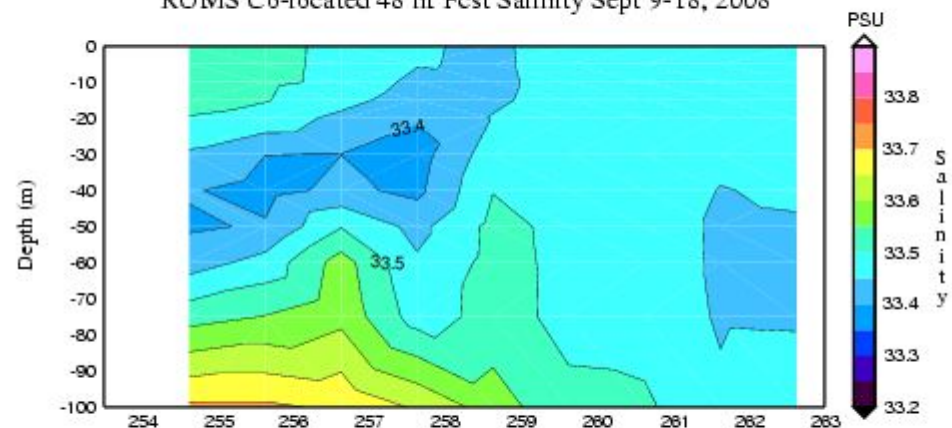
Observed KM Salinity Sept 9-18, 2008



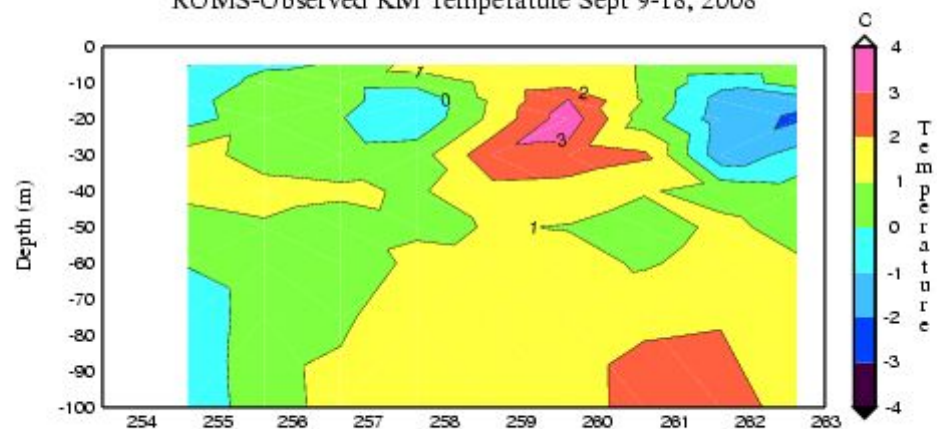
ROMS Co-located 48 hr Fcst Temp Sept 9-18, 2008



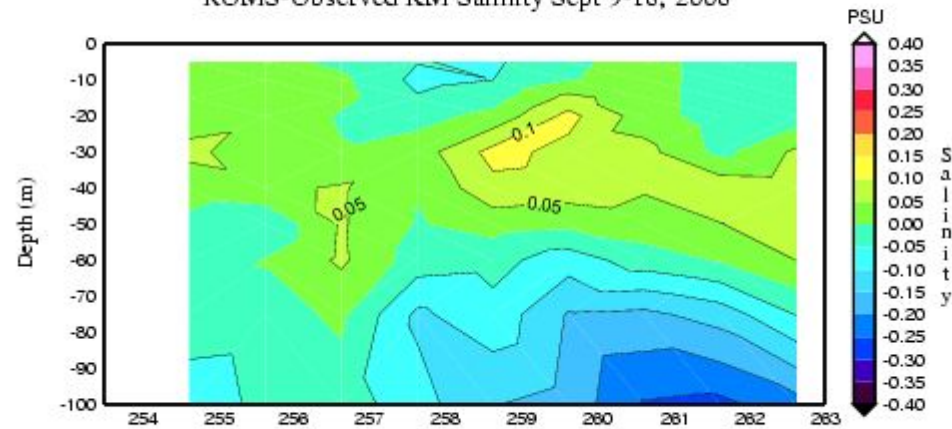
ROMS Co-located 48 hr Fcst Salinity Sept 9-18, 2008



ROMS-Observed KM Temperature Sept 9-18, 2008



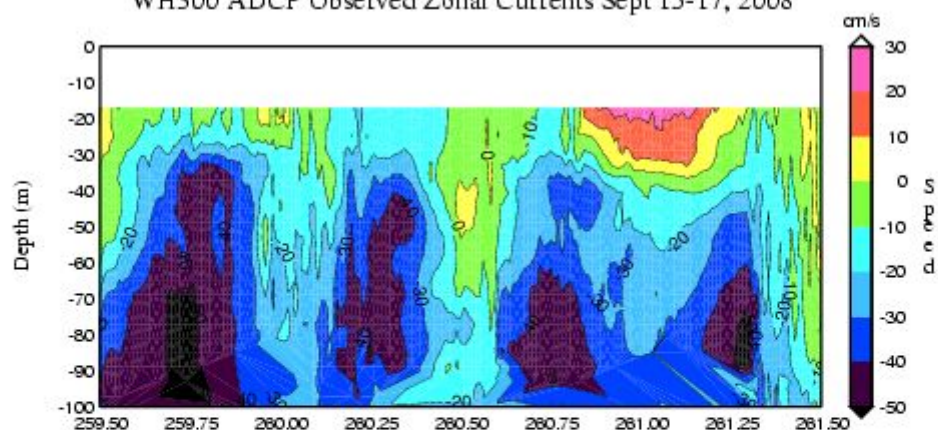
ROMS-Observed KM Salinity Sept 9-18, 2008



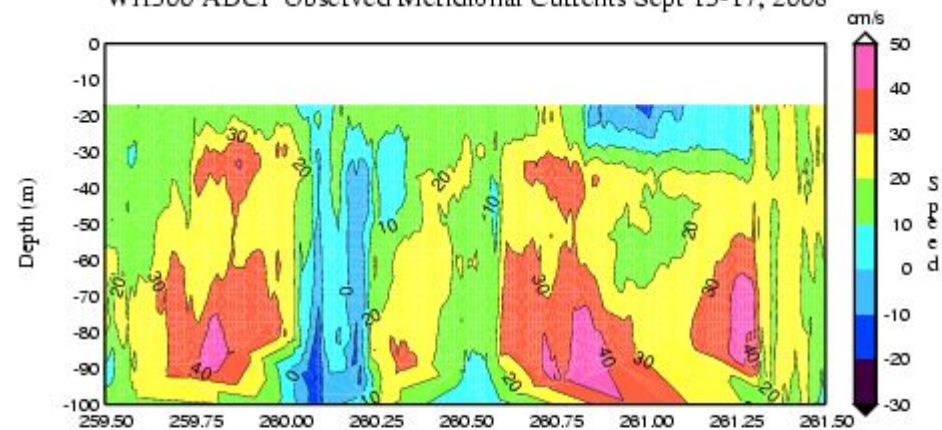
Julian Day 2008

Julian Day 2008

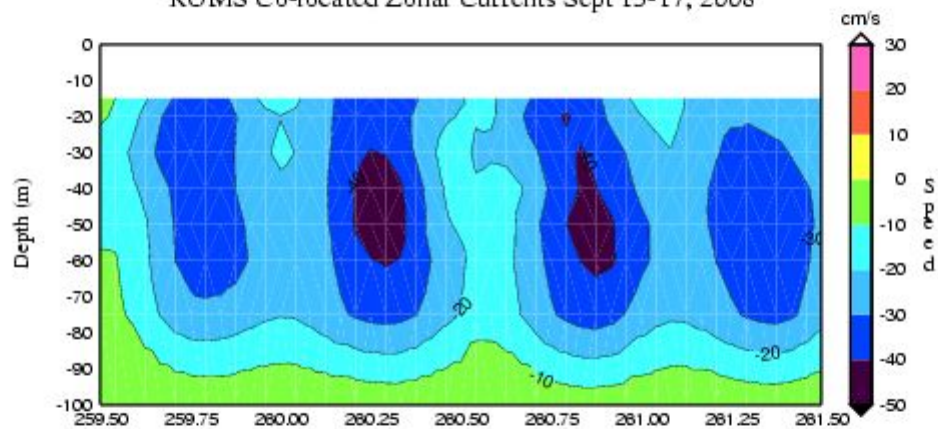
WH300 ADCP Observed Zonal Currents Sept 15-17, 2008



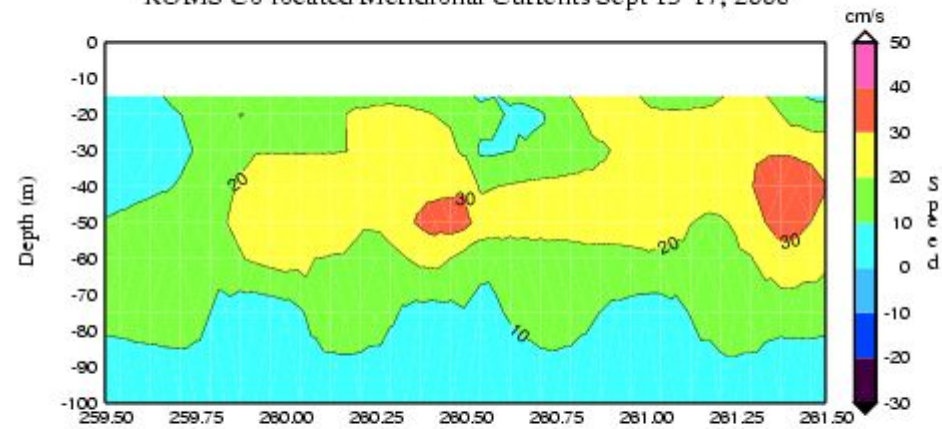
WH300 ADCP Observed Meridional Currents Sept 15-17, 2008



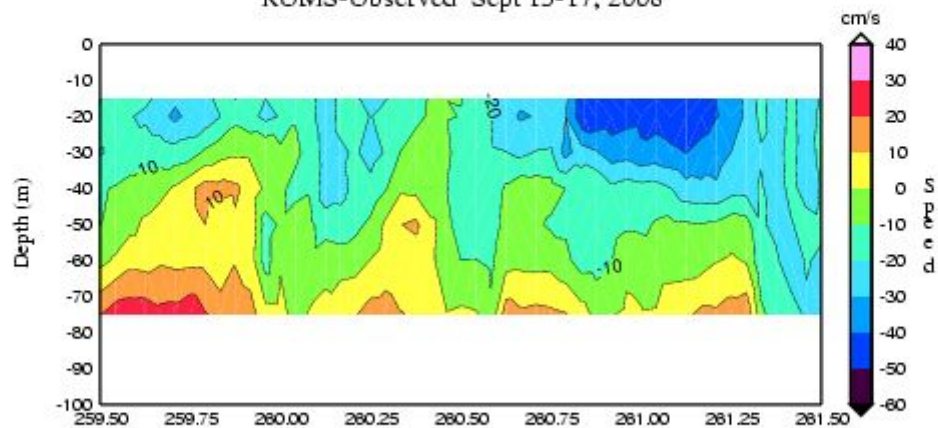
ROMS Co-located Zonal Currents Sept 15-17, 2008



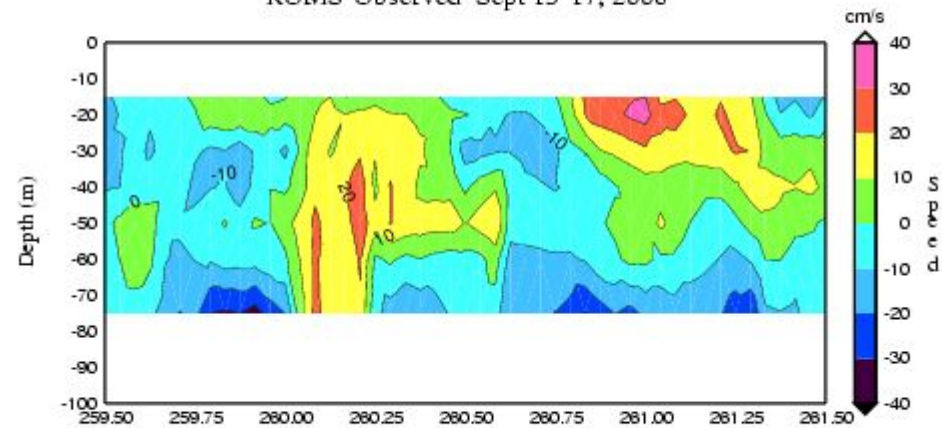
ROMS Co-located Meridional Currents Sept 15-17, 2008



ROMS-Observed Sept 15-17, 2008



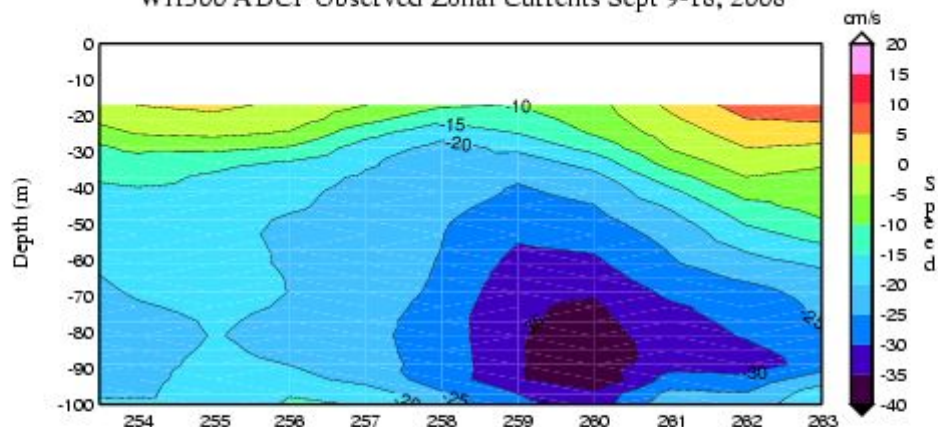
ROMS-Observed Sept 15-17, 2008



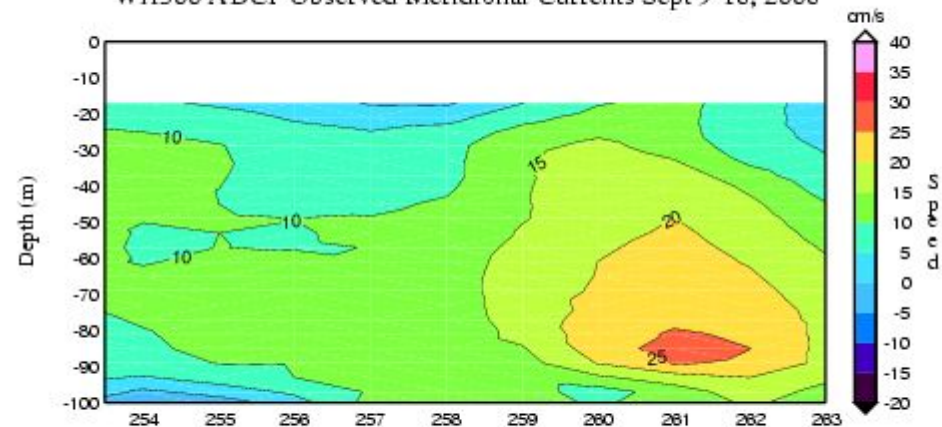
Julian Day 2008

Julian Day 2008

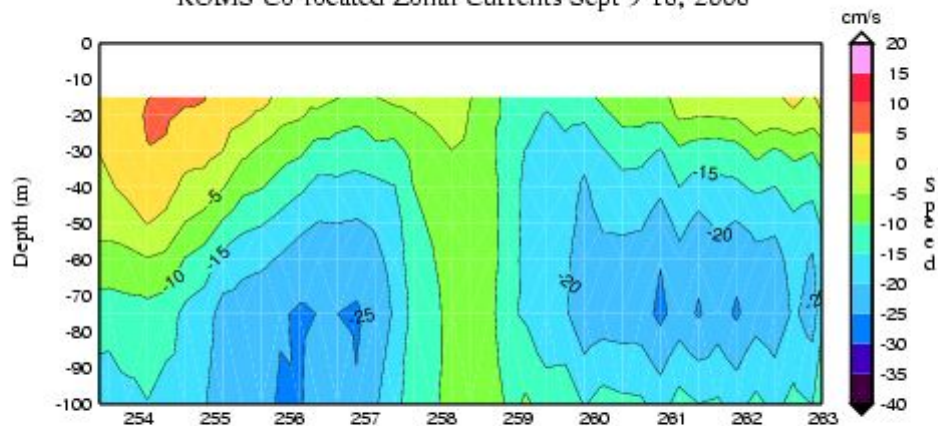
WH300 ADCP Observed Zonal Currents Sept 9-18, 2008



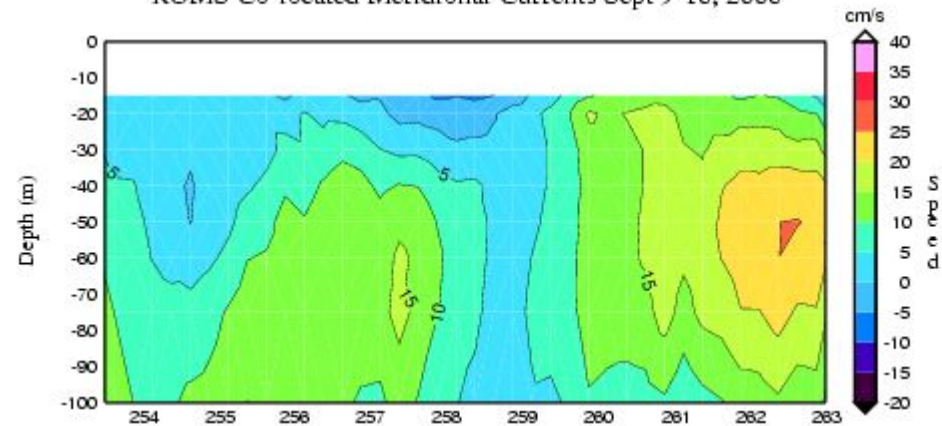
WH300 ADCP Observed Meridional Currents Sept 9-18, 2008



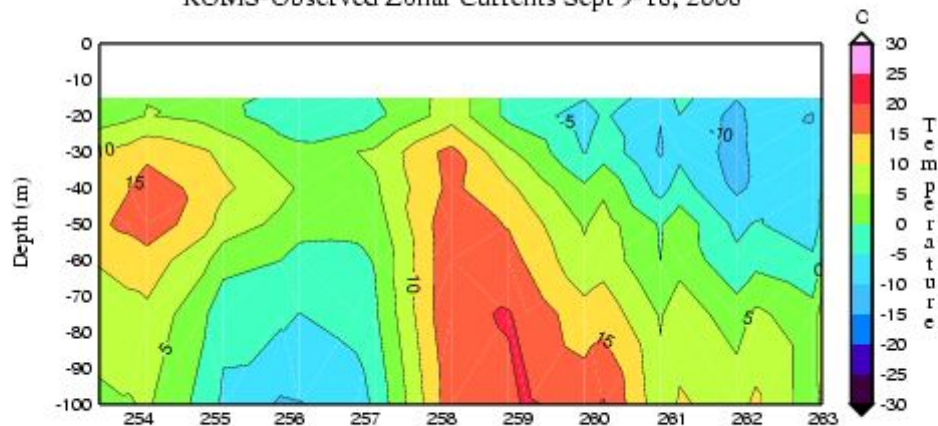
ROMS Co-located Zonal Currents Sept 9-18, 2008



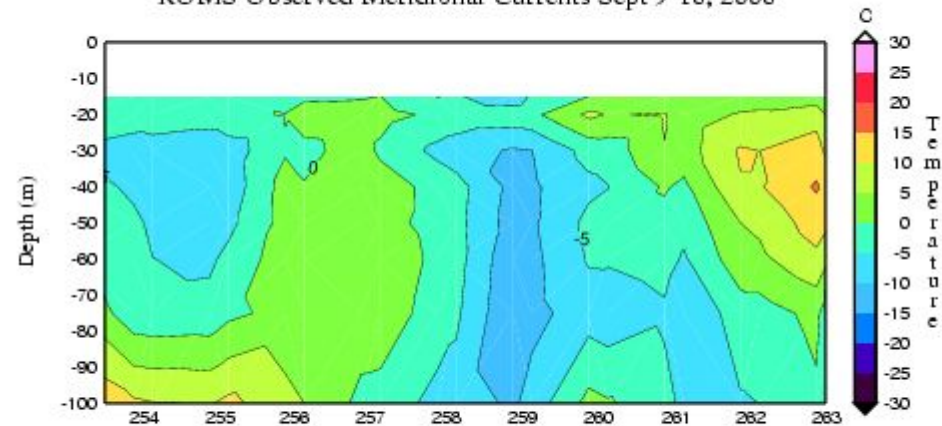
ROMS Co-located Meridional Currents Sept 9-18, 2008



ROMS-Observed Zonal Currents Sept 9-18, 2008



ROMS-Observed Meridional Currents Sept 9-18, 2008



Julian Day 2008

Julian Day 2008

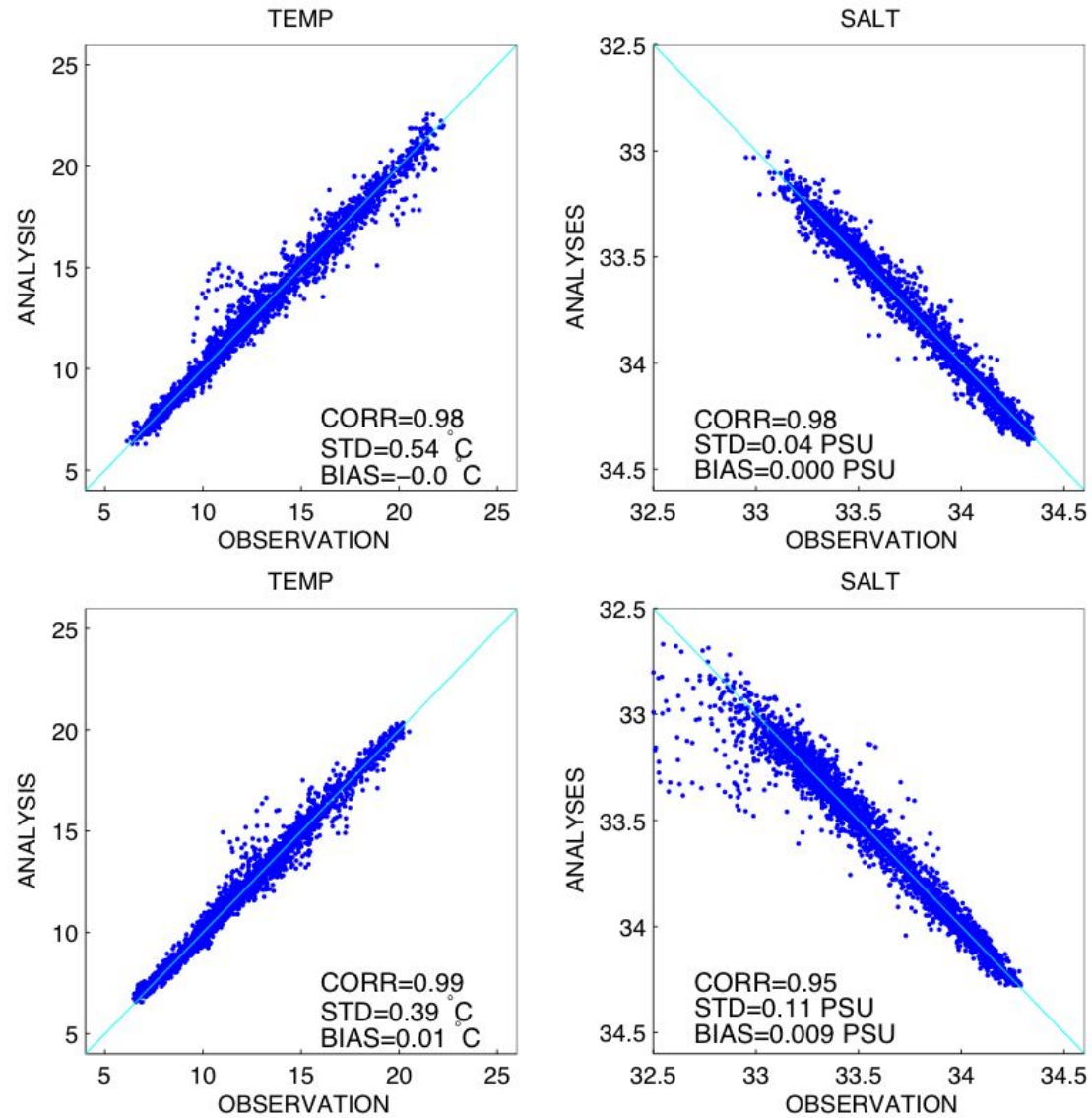


Fig. 4. Scatter plots between analyses and glider vertical profiles that are assimilated. The above row is for August and the lower row for October. The correlation, root-mean-square of the difference, and bias are listed.

Table 1

Correlations and the root-mean-square (RMS) of the difference between the HF radar and data assimilation analysis velocities, as well as between the HF radar and velocities from the free run. The standard deviation (STD) of the HF radar velocities is also given. All the values are the average over the period of three month from August 1 through October 31, 2008.

|          |   | CORRELATION | RMS      | STD      |
|----------|---|-------------|----------|----------|
| ANALYSIS | U | 0.68        | 0.13 M/S | 0.19 M/S |
|          | V | 0.72        | 0.12 M/S | 0.16 M/S |
| FREE RUN | U | 0.32        | 0.26 M/S |          |
|          | V | 0.39        | 0.17 M/S |          |

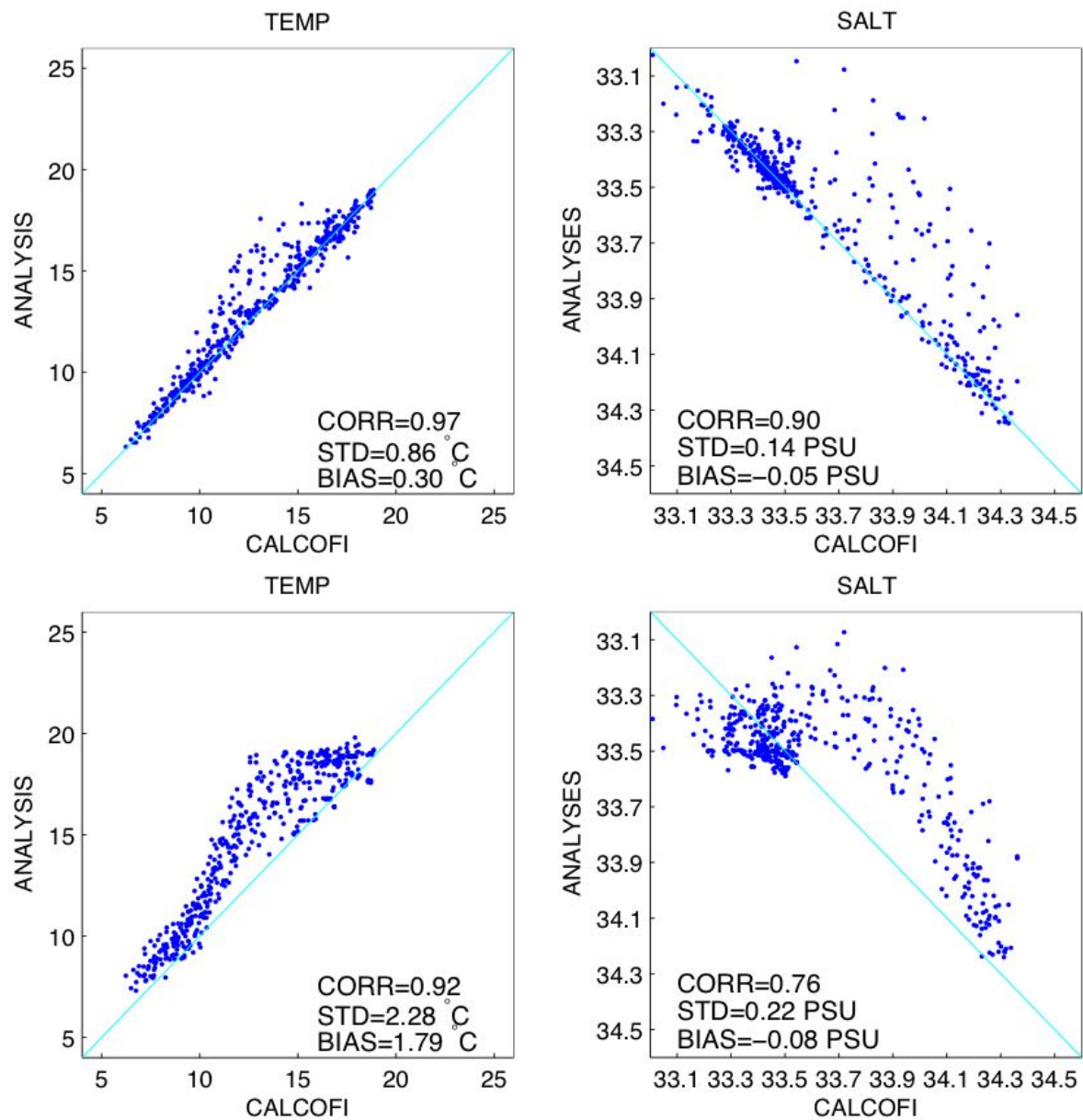


Fig. 10. Same as in Fig. 9, but for the CALCOFI survey during October, 2008.

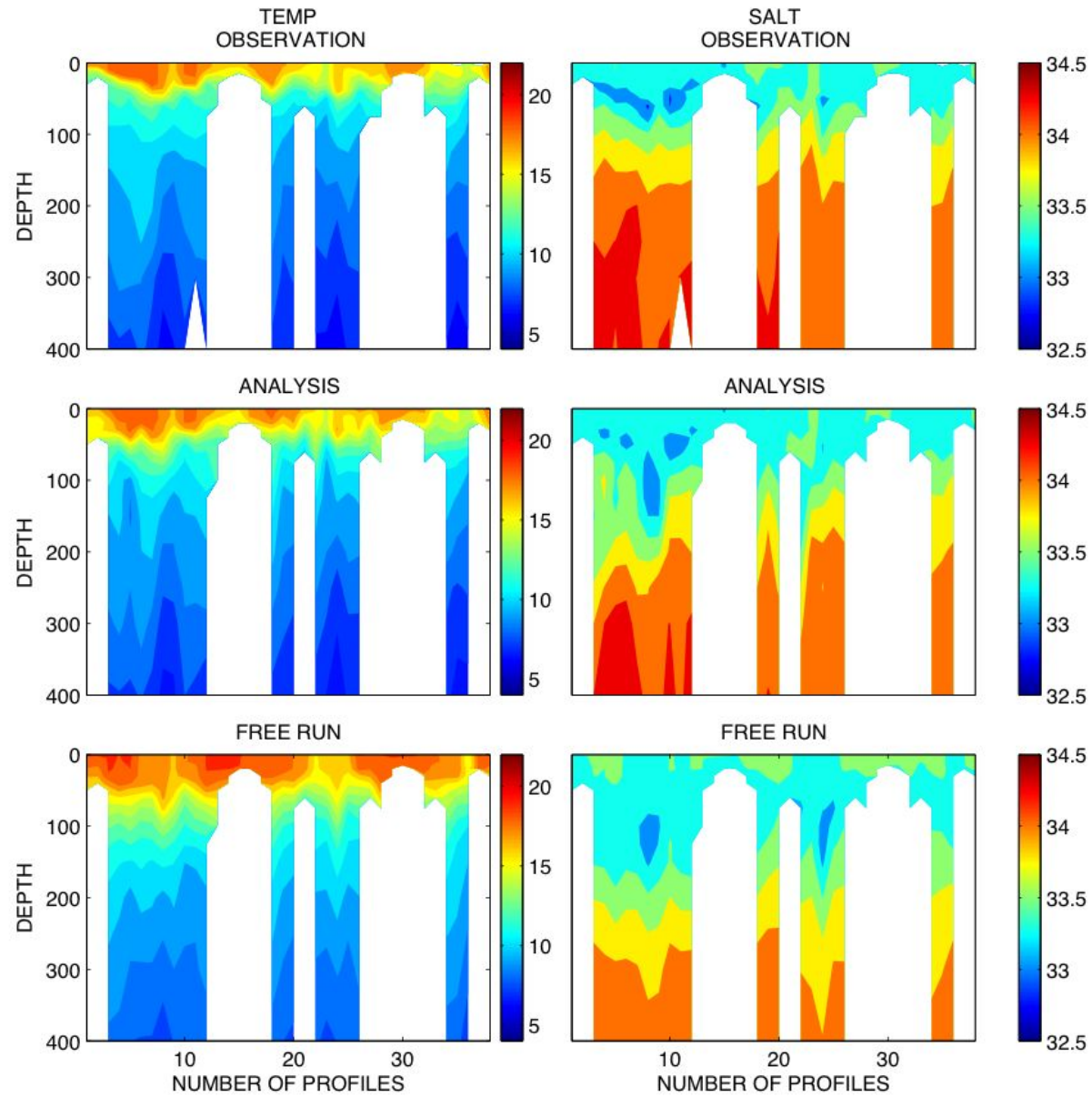


Fig. 11. Vertical profiles from the CALCOFI survey during the period of time from October 14 through 30, 2008, along with the collocated profiles from the ROMS3DVAR analyses and free run. The numbers show the sequence of profiles following the measuring time.

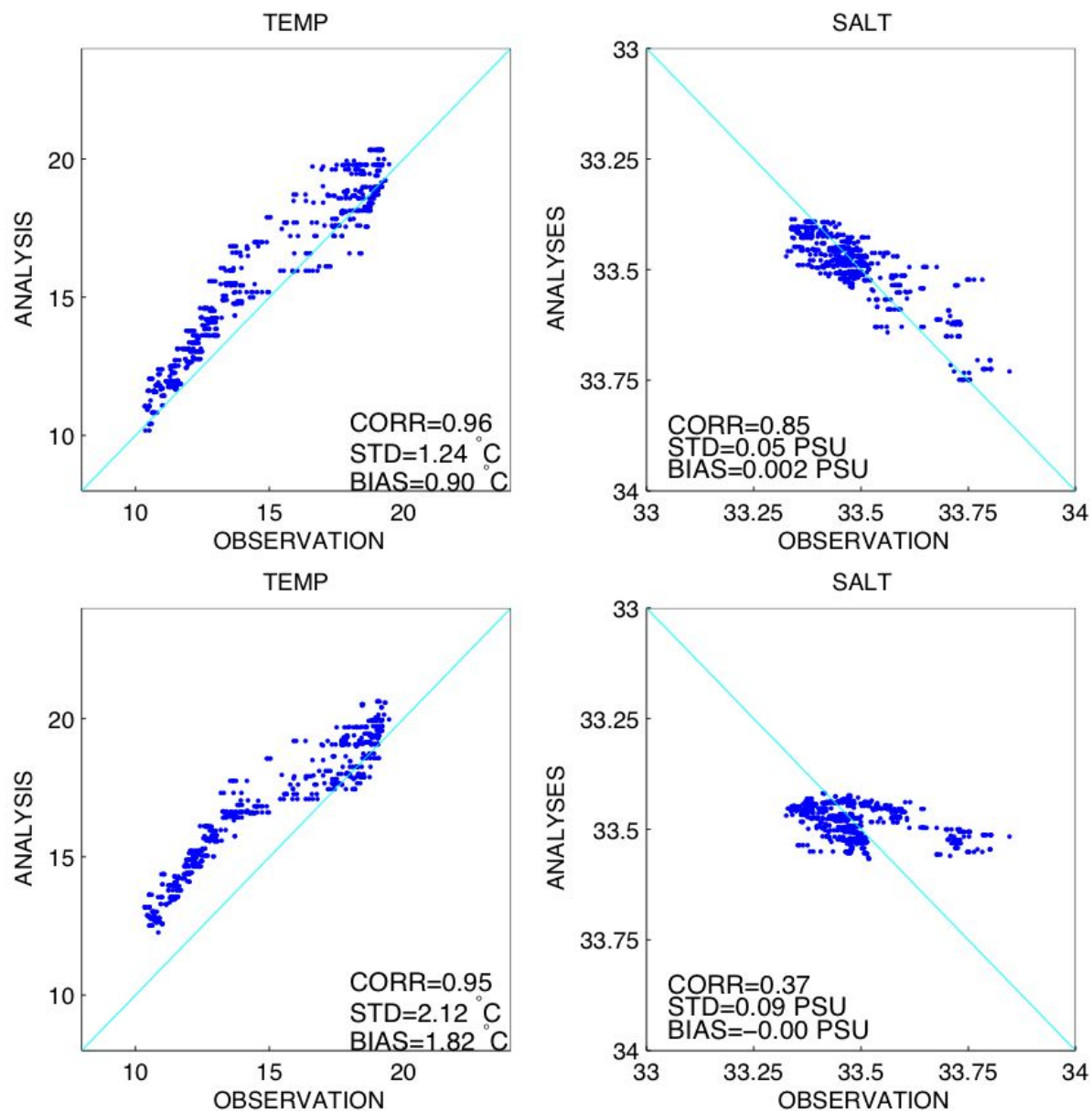


Fig. 12. Scatters between the ROMS3DVAR analyses and RaDyO observations (upper row) and between the free run (lower row) and RaDyO observations in both temperature (TEMP) and salinity (SALT). The values given in the plot are correlation (CORR), root-mean-squared values (RMS) of the difference between the analyses and observations, and bias (BIAS).

# Forecast Performance

Table 2

Root-mean-squared (RMS) of the difference between glider observations and model forecasts for 12h and 36h during the period of three months, along with those from the ROMS3DVAR analyses and free run.

|         | ANALYSIS | 12h  | 36h  | FREE RUN |
|---------|----------|------|------|----------|
| T (°C)  | 0.55     | 0.76 | 1.25 | 2.70     |
| S (PSU) | 0.07     | 0.08 | 0.11 | 0.15     |

Table 3

Root-mean-squared (RMS) of the difference between CALCOFI observations and model forecasts for 12h and 36h during the period of three months, along with those from the ROMS3DVAR analyses and free run.

|         | ANALYSIS | 12h  | 36h  | FREE RUN |
|---------|----------|------|------|----------|
| T (°C)  | 1.25     | 1.62 | 1.75 | 2.27     |
| S (PSU) | 0.11     | 0.15 | 0.16 | 0.19     |

Table 4

Correlations and root-mean-squared (RMS) values of the difference between HF radar surface velocity observations and model forecasts for 12h and 36h during the period of three months, along with those from the ROMS3DVAR analyses and free run.

|             | ANALYSIS | 12h  | 36h  | FREE RUN |
|-------------|----------|------|------|----------|
| U (CORR)    | 0.68     | 0.54 | 0.36 | 0.33     |
| V (CORR)    | 0.72     | 0.43 | 0.42 | 0.39     |
| U (RMS M/S) | 0.13     | 0.22 | 0.24 | 0.26     |
| V (RMS M/S) | 0.12     | 0.16 | 0.15 | 0.17     |

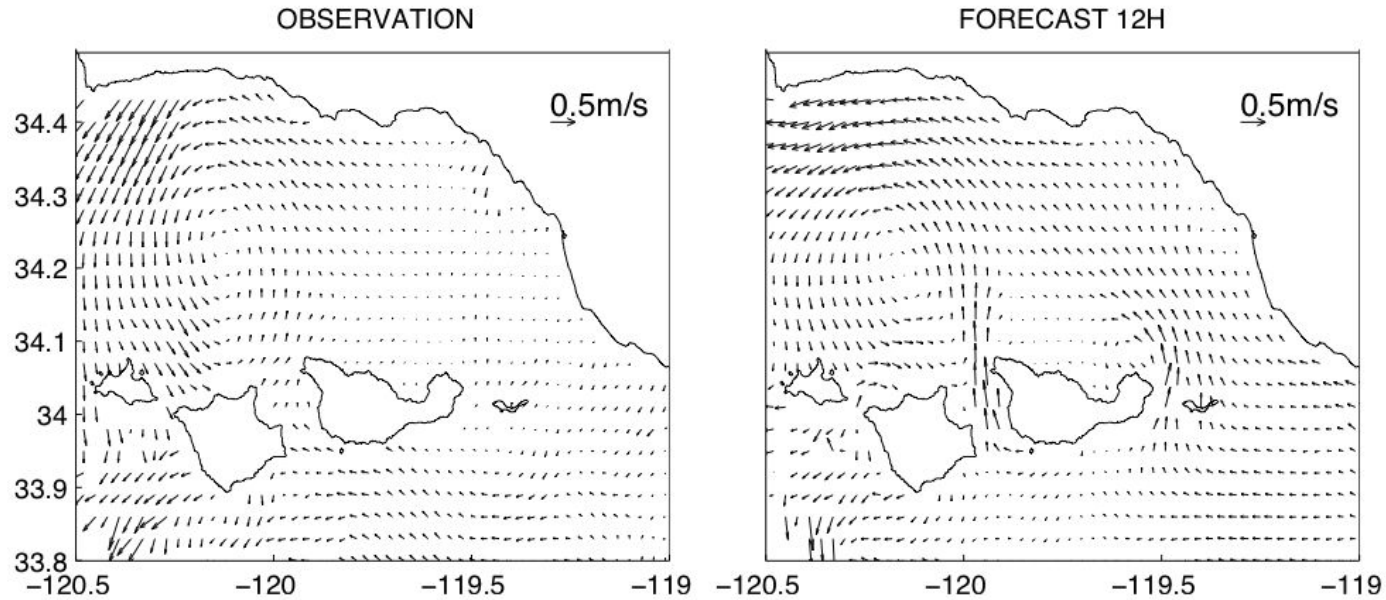


Fig. 15. Monthly mean HF radar and 12h forecast velocities of October.

Table 5

Correlations of the 24h and 48h model and persistence forecasts during period August 1 through October 31, 2008.

|          | FORECAST |      | PERSISTENCE |      |
|----------|----------|------|-------------|------|
|          | 24h      | 48h  | 24h         | 48h  |
| VELOCITY | 0.78     | 0.66 | 0.66        | 0.46 |
| SST      | 0.69     | 0.57 | 0.58        | 0.36 |

Table 6

The root-mean-error of the 24h and 48h model and persistence forecasts during the period August 1 through October 31, 2008.

|          | FORECAST |          | PERSISTENCE |          |
|----------|----------|----------|-------------|----------|
|          | 24h      | 48h      | 24h         | 48h      |
| VELOCITY | 0.12 m/s | 0.17 m/s | 0.18 m/s    | 0.23 m/s |
| SST      | 0.62°C   | 0.83°C   | 0.76°C      | 0.96°C   |

# Summary

A ROMS configuration consisting of a single domain covering the southern California coastal ocean from Santa Barbara to San Diego at a resolution of 1 km assimilating in-situ glider, satellite and coastal HF radar measurements is producing nowcasts every 6 hours and a daily 48 hour forecast for the region in near real-time. Nowcast and forecasts images and data can be found at <http://ouerocean.jpl.nasa.gov/SCB>.

Selected comparisons of **nowcast** fields with both assimilated and independent measurements show very good agreement of the observed temperature ( $\text{RMS} < 1^\circ\text{C}$ ) and salinity values ( $\text{RMS} < 0.15 \text{ PSU}$ ) with the co-located ROMS-analyzed values.

Anomaly correlations for the surface currents and temperatures were found to be larger than 0.6 for 48-hour **forecasts**, significantly larger than those of a persistence forecast. Consistent with this, the forecast RMS errors in the surface fields are smaller than those of a persistence forecast.

[ouerocean.jpl.nasa.gov/SCB](http://ouerocean.jpl.nasa.gov/SCB)