Partnerships in the use of GOES SST in the continental US (CONUS)

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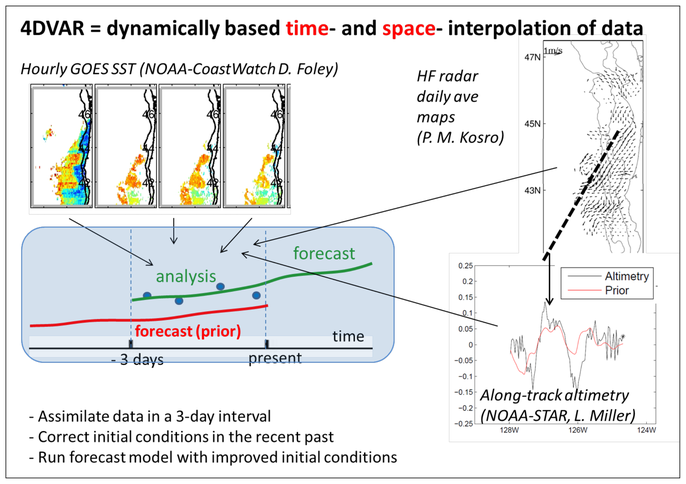
Hourly GOES SST has been assimilated in a real-time coastal ocean forecast model off Oregon (US West coast):

Products:

- noise-free SST maps
- synthesis of SST with other data (alongtrack altimetry, surface currents from high-frequency (HF) radars
- 3-day forecasts of SST, surface currents and other oceanic variables
- Forecast fields available via the web site of the Northwest Association of Networked Ocean Observing Systems (NANOOS, an IOOS Regional Association, www.nanoos.org)
- Fields provided to NOAA ORR via an OpenDAP server



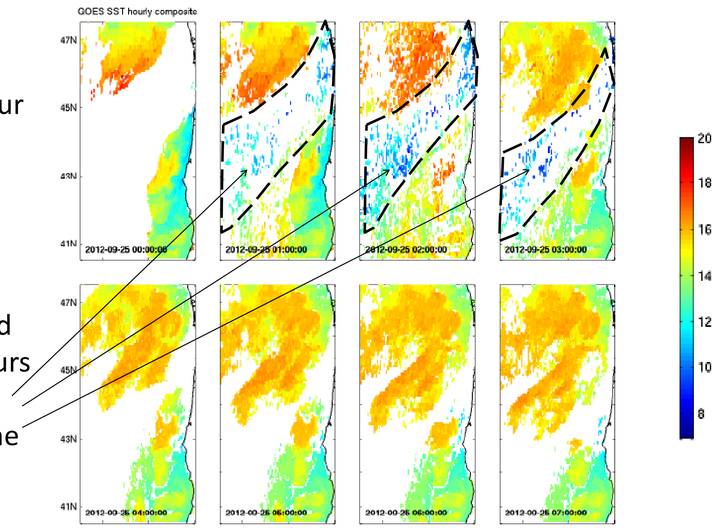
Model details:

- forecast model – 3D ROMS (www.myroms.org)
- atmospheric forcing – NOAA NAM
- data assimilation – 4DVAR, using AVRORA tangent linear and adjoint model components (developed at OSU)
- 72 hourly GOES SST images are assimilated in every 3-day window → *smooth estimates of SST constrained by GOES data*
- Everyday updates of 3-day forecasts

SST data quality control: before any data are assimilated into our system, their quality is assessed. Our concerns about data accuracy are reported back to data providers.

Example: In summer months, the hourly GOES SST product has consistently shown erroneously cold areas during sunrise and sunset hours (glint from clouds, as seen in highlighted areas in the figure on the right).

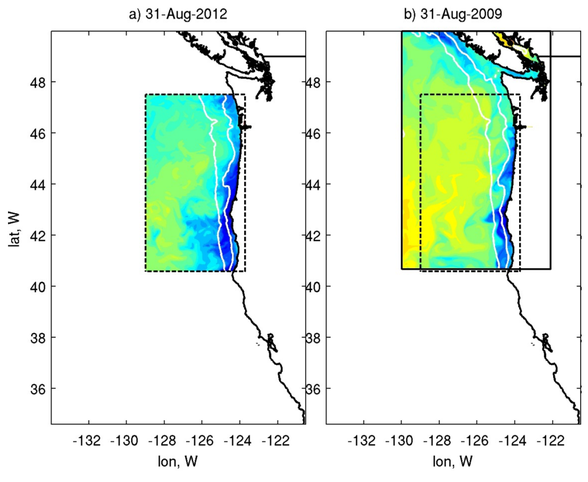
Remedy: use a cloud mask from neighboring hours.



Model domains (*shown is the model SST on 31 Aug 2012*):

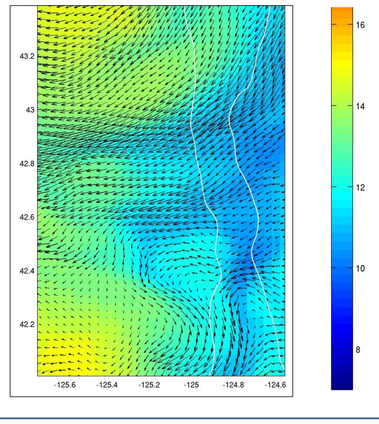
(Left): the present real-time forecast model (Oregon)

(Right): the model in the extended domain (Oregon-Washington), which includes the Columbia River discharge; data assimilation tests in this model are ongoing; transition to real time operation is planned later this year



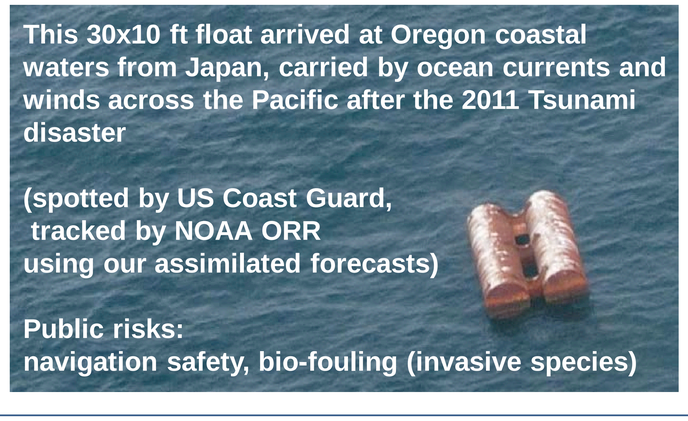
Surface velocities are dynamically coupled w/ SST (advection, geostrophy). **Assimilation of GOES SST provides correction to velocities**

A snapshot of model SST and surface currents, 23 Aug 2011



Surface ocean velocity estimates have been used to track marine debris objects:

Our surface current forecasts have been provided to the NOAA Office of Response and Restoration (ORR) Lab in Seattle. Our colleagues from NOAA ORR coupled our model currents with the GNOME oil spill and particle transport software and used it to track objects like the one shown below.



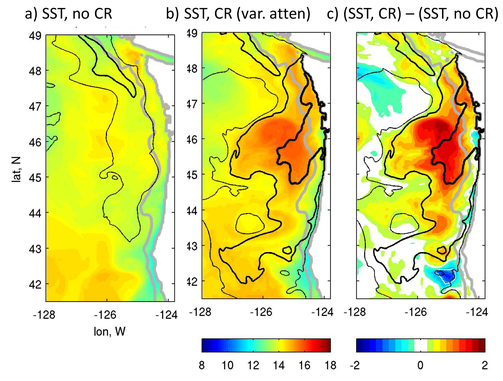
Model improvement: include the Columbia River (CR) discharge, study effects of CR on the SST

Three models are compared: (1) without CR, (2) with CR and spatially constant parameters for the shortwave radiation (SWRAD) attenuation, (3) with CR and spatially variable parameters for SWRAD attenuation (since the CR is turbid, SWRAD is attenuated in a shallower column in the plume area).

Winter: the CR plume is colder than the ambient ocean

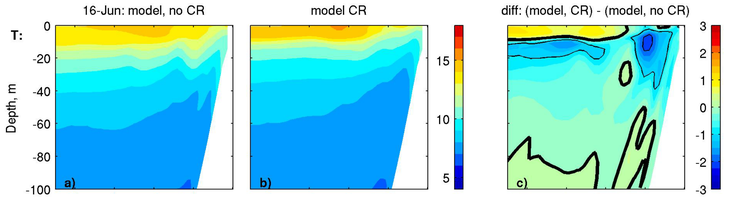
Summer: the CR plume water may be 1-2°C warmer (atm. heat is captured in a thinner boundary layer); variable SWRAD attenuation yields an additional warming effect. During strong upwelling events, water inshore of the CR plume edge may be colder than in the model case without CR. *The net effect of CR during upwelling: adding 2-4°C SST contrast*

Monthly ave. (June 2009) model SST, °C: (a) w/out CR, (b) w/ CR (var. attenuation), (c) difference [(b) – (a)]. Black contours are sea surface salinity (32.5, 30, 28 psu). Half-tone contour is 200 m isobath.

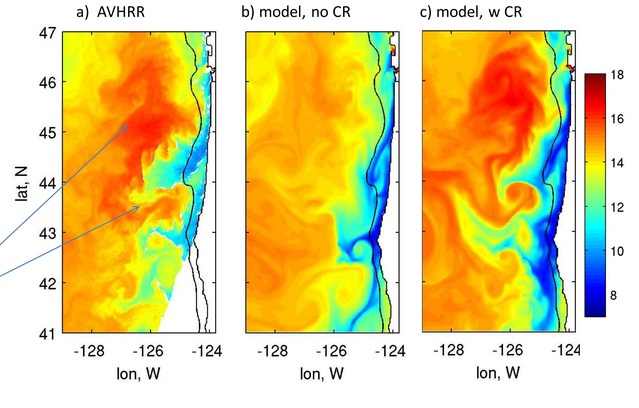


Cross-shore sections of temperature near coast, 16 Jun 2009, 45N: (left) no CR, (middle) w/ CR, (right) difference.

In the model with CR, water below the surface boundary layer in the area of the plume would be relatively colder than in the model without CR. During wind-driven upwelling events, this colder water is exposed to the surface, such that water inshore of the front may be relatively colder in the case without CR.



SST during a strong upwelling event: (left to right) AVHRR satellite, model w/out CR, w/ CR (variable SWRAD attenuation), 27 June 2009:

The model w/ CR reproduced better:

- warmer temperature within the plume
- separation of the coastal current between 44-45N