

JPL Ocean Data Assimilation

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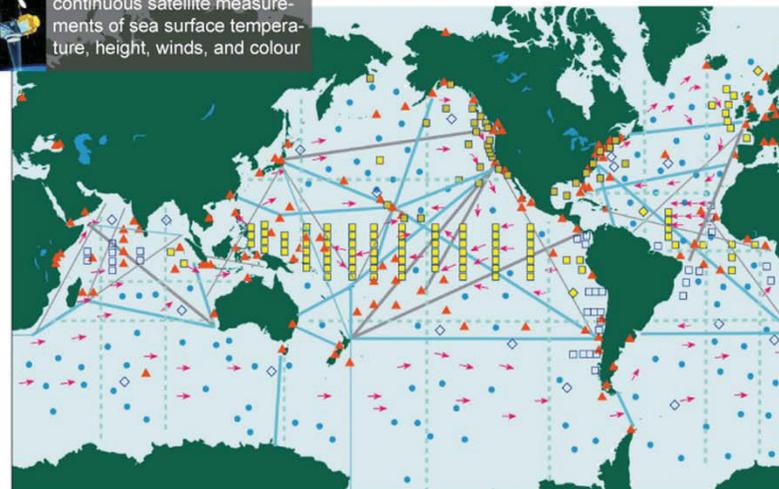
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- Global ocean state estimation (reanalysis)
- Coastal ocean analysis and forecast
- Relations to UKMO efforts

Ocean Data Assimilation provides an optimal way to synthesize observations with dynamics



continuous satellite measurements of sea surface temperature, height, winds, and colour



Reference time series



Global reference mooring network



Global tropical moored buoy network



Surface measurements from volunteer ships (VOSclim)

200 ships in pilot project



Global drifting surface buoy array

5° resolution array: 1250 floats



Tide gauge network (GCOS subset of GLOSS core network)

170 real-time reporting gauges



XBT sub-surface temperature section network

51 lines occupied



Profiling float network (Argo)

3° resolution array: 3000 floats



Repeat hydrography and carbon inventory

Full ocean survey in 10 years



ECCO

<http://ecco-group.org>

Main partners:

Massachusetts Institute of Technology (MIT)
Atmospheric and Environmental Research (AER)

Main goal: to advance & sustain global ocean state estimation for oceanographic & climate research



National Oceanographic Partnership Program



funded by



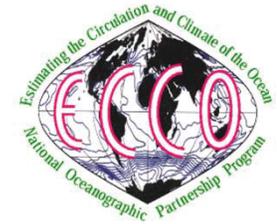
ECCO Global Ocean State Estimation Activities

Model: MITgcm

Resolution: 1° to 18 km, 23 to 50 levels.

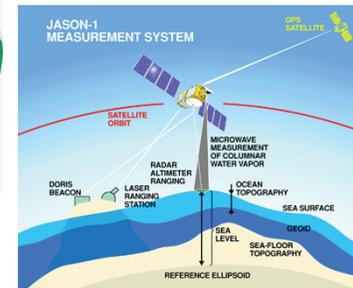
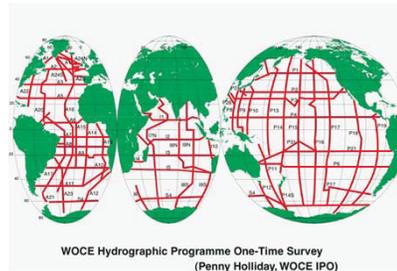
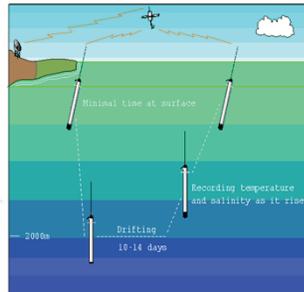
- ECCO-GODAE (adjoint)
- ECCO-JPL near realtime estimation (Kalman filter & smoother)
- ECCO2 eddy-permitting ocean sea-ice synthesis (Green's function, adjoint)

ECCO-GODAE

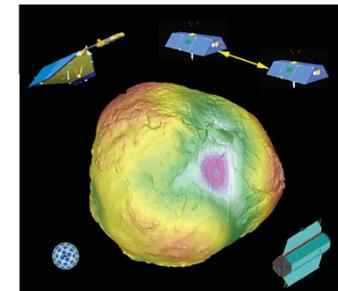


- Adjoint-based assimilation of a large suite of satellite & in-situ data
- Production & maintenance being transferred from MIT to JPL
- Continuing improvements of model & assimilation (e.g., sea ice, controls, error cov.)

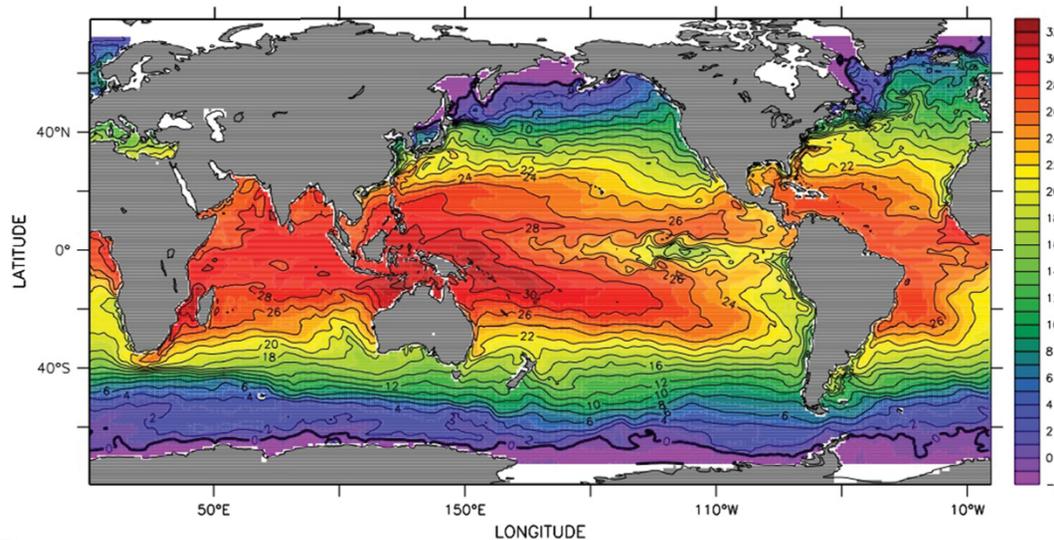
In-situ observations



Satellite data



Assimilation (Adjoint) by ODAP



ECCO-GODAE: synthesis of very diverse observations

Sum = [100(obs) + 800(forcing)] million individual elements

<i>observation</i>	<i>instrument</i>	<i>product</i>	<i>area</i>	<i>period</i>	<i>dT</i>	<i>#</i>
Mean dynamic topography (MDT)	<ul style="list-style-type: none"> GRACE GGM02 GRACE SM004-GRACE3 	U-Texas (B. Tapley) CLS/GFZ (A.M. Rio)	global global	time-mean	time-mean	3.2E4
Sea level anomaly (SLA)	<ul style="list-style-type: none"> T/P, Jason ERS, ENVISAT GFO 	PO.DAAC AVISO NOAA, USN	66°N/S 82°N/S 65°N/S	1992 - 2006 1992 - 2006 2001 - 2004	daily daily daily	1.7E7 1.2E7 6.6E6
SST	<ul style="list-style-type: none"> blended, AVHRR (O/I) TRMM/TMI AMSR-E (MODIS/Aqua) 	Reynolds & Smith (1999) NASA, NOAA NASA, NOAA	Global 40°N/S	1992 - 2006 1998 - 2003 2001 - 2006	monthly monthly monthly	6.5E6 2.9E6
SSS	In-situ, ships	ECOP (France)	Pacific	1992 - 1999	monthly	2.4E4
In-situ T, S	<ul style="list-style-type: none"> Argo, P-Alace XBT CTD SEaOS TOGA/TAO, Pirata 	lfremer, ... S. Behringer (NCEP) Various SMRU & BAS (UK) PMEL/NOAA	"global" "gobal" sections SO Trop. Pac.	2003 - 2006 1992 - 2006 1992 - 2006 1992 - 2006	daily daily daily daily daily	2.1E7 1.0E7 2.0E6 5.2E5 3.3E6
Mooring velocities	<ul style="list-style-type: none"> TOGA/TAO, Pirata RAPID 	PMEL/NOAA SOC (UK)	Trop. Pac. N. Atl.	1992 - 2006 3/2004 - 5/2005	daily daily	2 x 1.1E6
Climatological T,S	<ul style="list-style-type: none"> WOA01 (upper 300 m) WOCE 	Conkright et al., 2002 Gouretski & Koltermann, 2004	"global" "global"	1950 - 2000 1950 - 2002	time-mean time-mean	2 x 8.1E6
Wind stress	QuickScat	NOAA, NASA	global	1999 - 2004	2-day	2 x 4.7E6
Tide gauge SSH	Tide gauges	NBDC/NOAA	sparse	1992 - 2006	monthly	5.5E4
Flux constraints	NCEP/NCAR variances	Kalnay et al., 1997	global	1992 - 2006	2-day	4 x 2.0E8
Balance constraints			global	1992 - 2006	time-mean	2 x 3.6E5
bathymetry		Smith & Sandwell, ETOPO5	global	-	-	-

ECCO-JPL Kalman filter/smoothen near real-time ODA system



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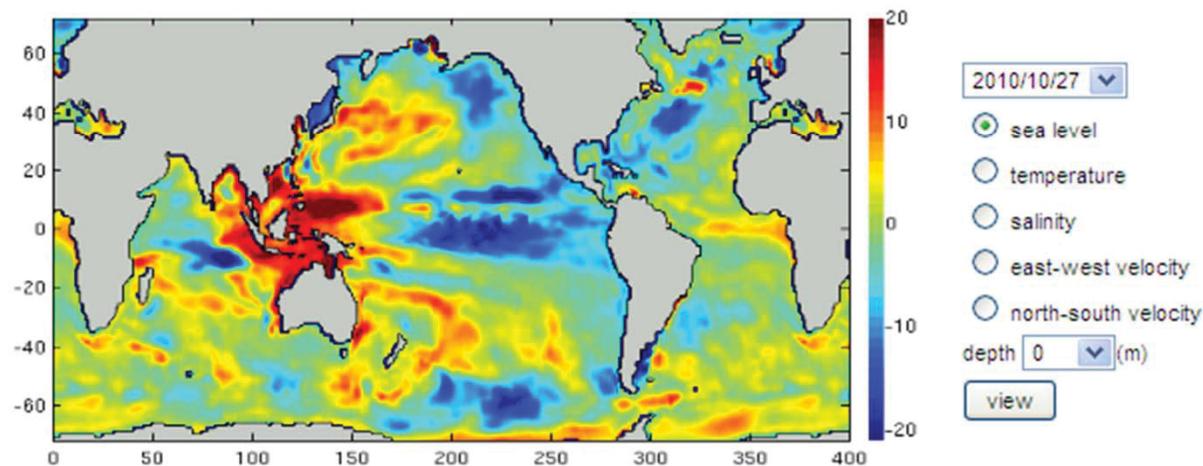
TECHNOLOGY

JPL ECCO Ocean Data Assimilation

A Member of ECCO Consortium (JPL | MIT | SIO)

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ECCO Near Real-Time Ocean Estimate for October 27, 2010



Sea level anomaly (cm) relative to average seasonal cycle

Project Description

[Publications](#) [Meeting Posters](#)

[Animations](#) [People](#)

Access to Products

[OPeNDAP Server](#) [Rsync](#) [HTTP](#)

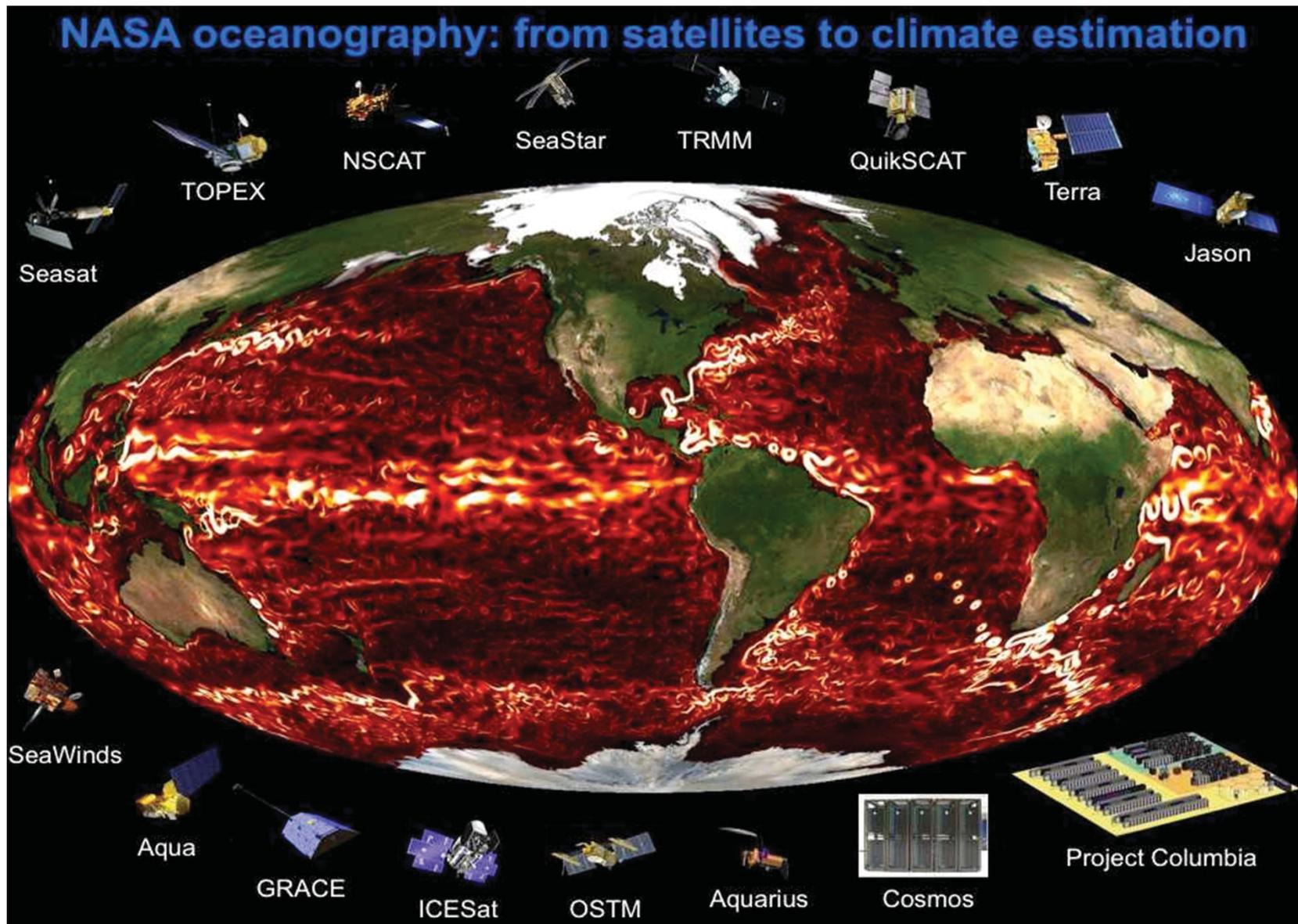
[Live Access Server](#) [Tracer Simulation](#)



Last updated: November 3, 2010
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ECCO2 high-resolution global ocean-sea ice synthesis: building capability to utilize SWOT data



ECCO products & tools are geared towards climate applications, including biogeochemistry

Examples:

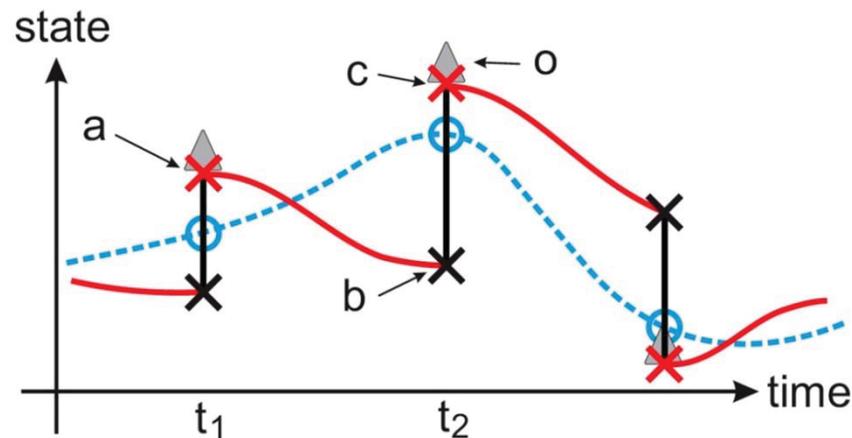
Heat & salt budgets, attribution of forcing mechanisms, driving biogeochemical models, (adjoint) sensitivity analysis.

- **Property conservation is an important requirement for climate research and biogeochem. applications**
- **ECCO products satisfy this requirement.**

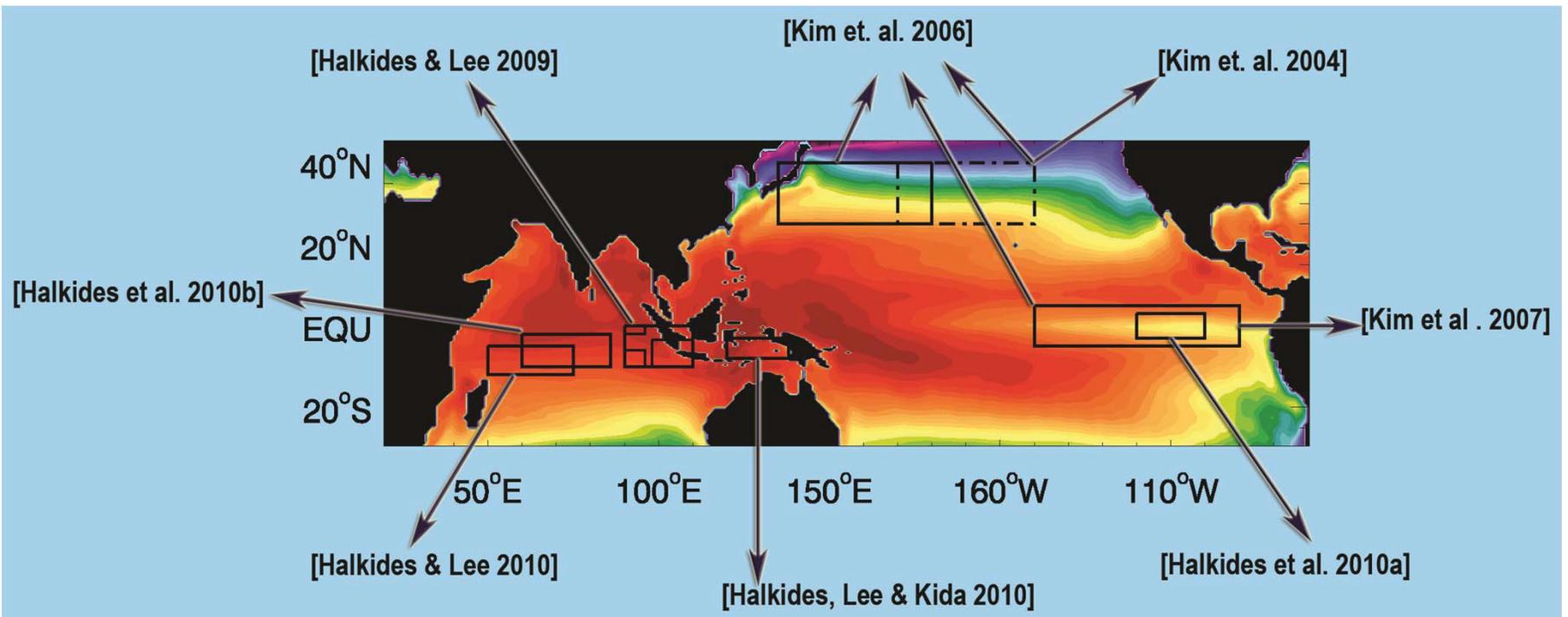
ECCO products satisfy property conservation

How?

Instead of applying statistical correction to model state variables, ECCO corrects sources of model errors (e.g., surface forcing, initial state, mixing parameters) through inverse estimation.

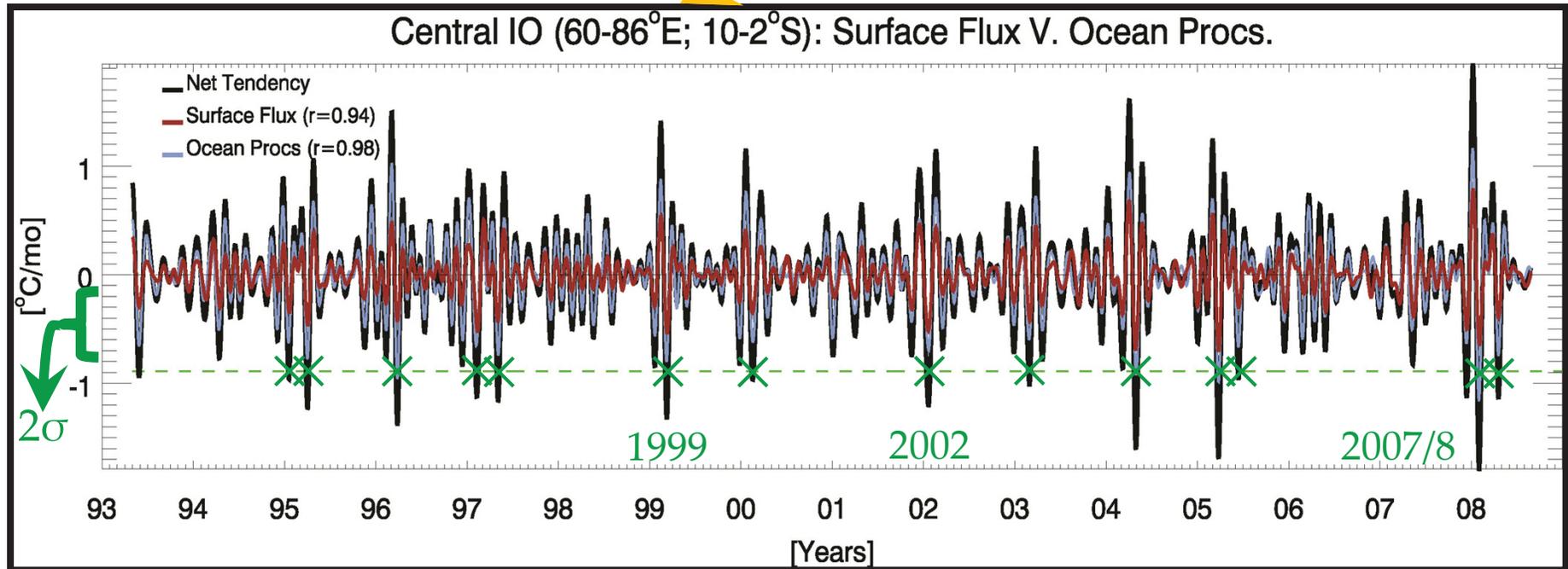
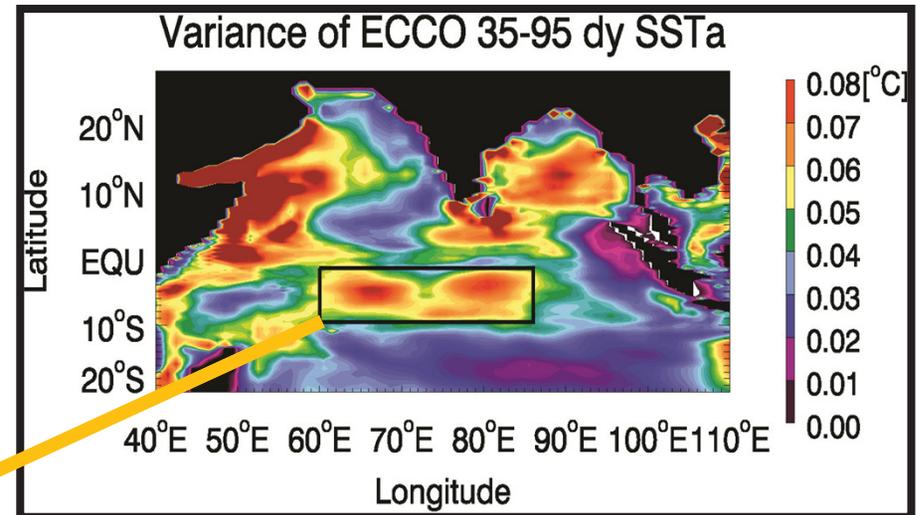


Examples of mixed-layer temperature (MLT) balance studies using ECCO-JPL product



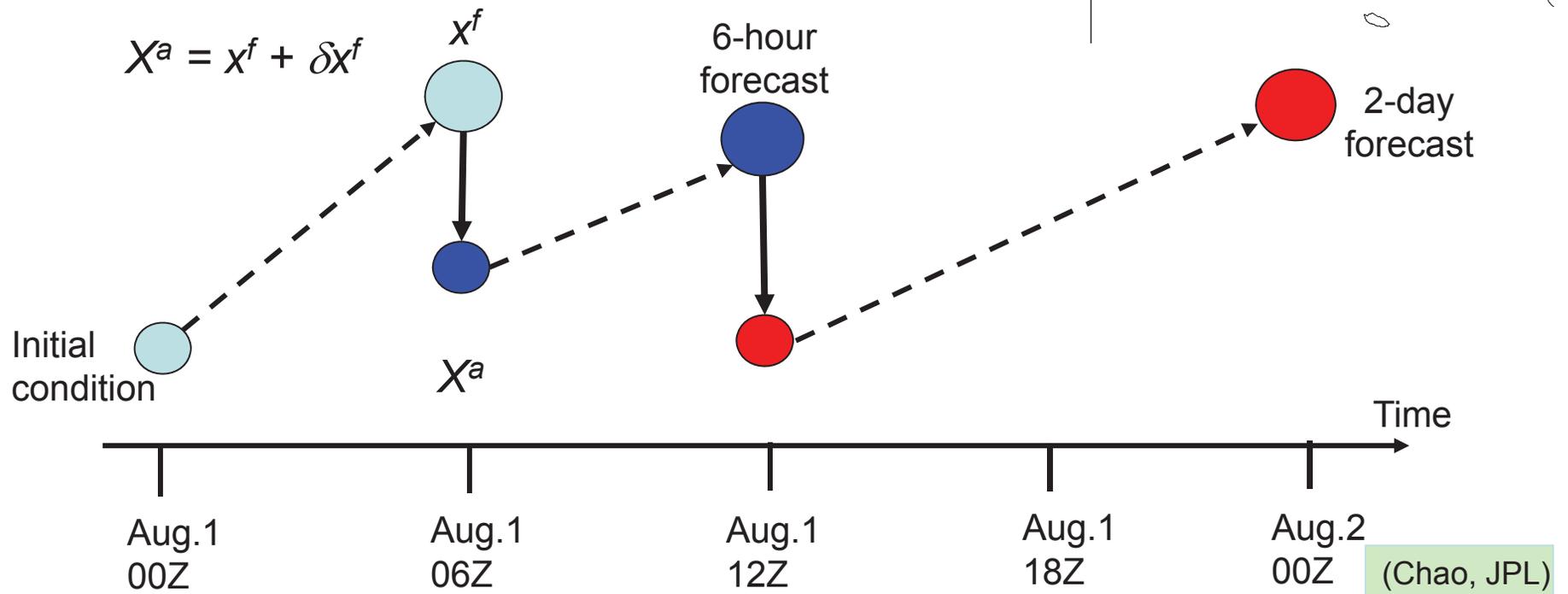
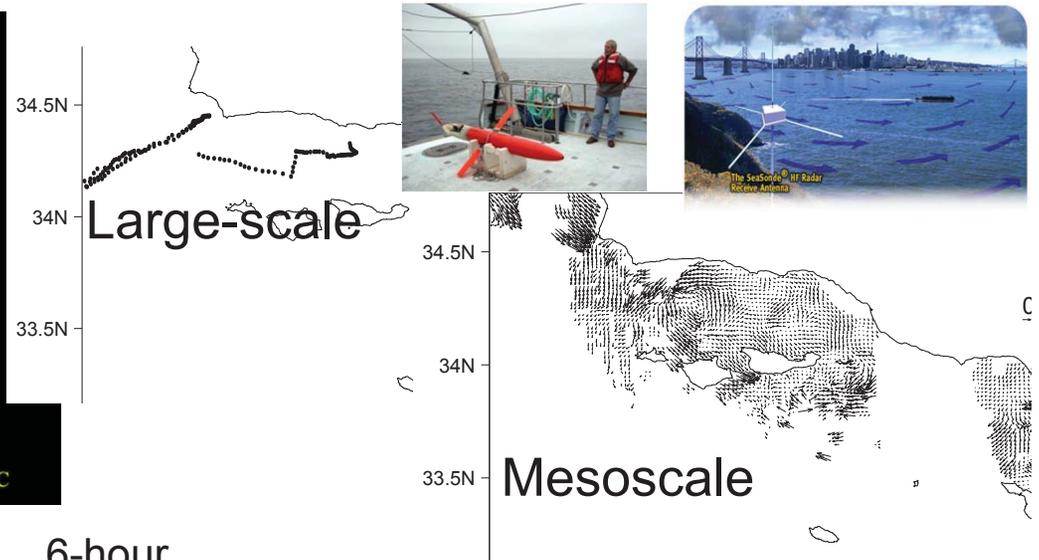
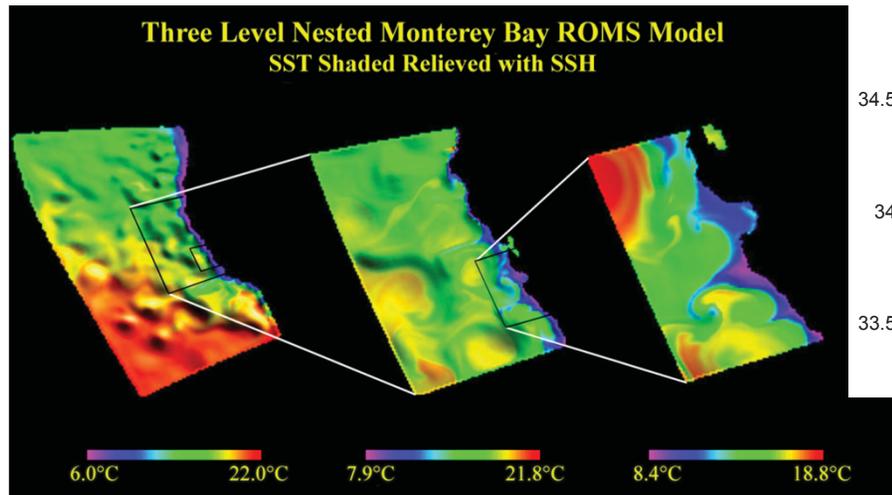
MLT Budget Example: CTIO (60-86°E, 2-10°S)

Halkides et al. (2010b)



JPL Coastal Ocean Data Assimilation Effort

One- or Two-Way Nested Modeling & Multi-Scale, 3-Dimensional Variational (MS-3DVAR) Data Assimilation



Real-Time Nowcast (six hourly) and 3-Day Forecast over the Southern California Coastal Ocean

View Nowcast and Forecast

November 2009

Su	M	T	W	Th	F	S
01	02	03	04	05	06	07
08	09	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30					

<< < > >>

ROMS Nowcast

- Temperature
- Salinity
- Current
- Sea Surface Height

ROMS Forecast

- 3D Output

WRF

- Wind

ROMS vs. Data

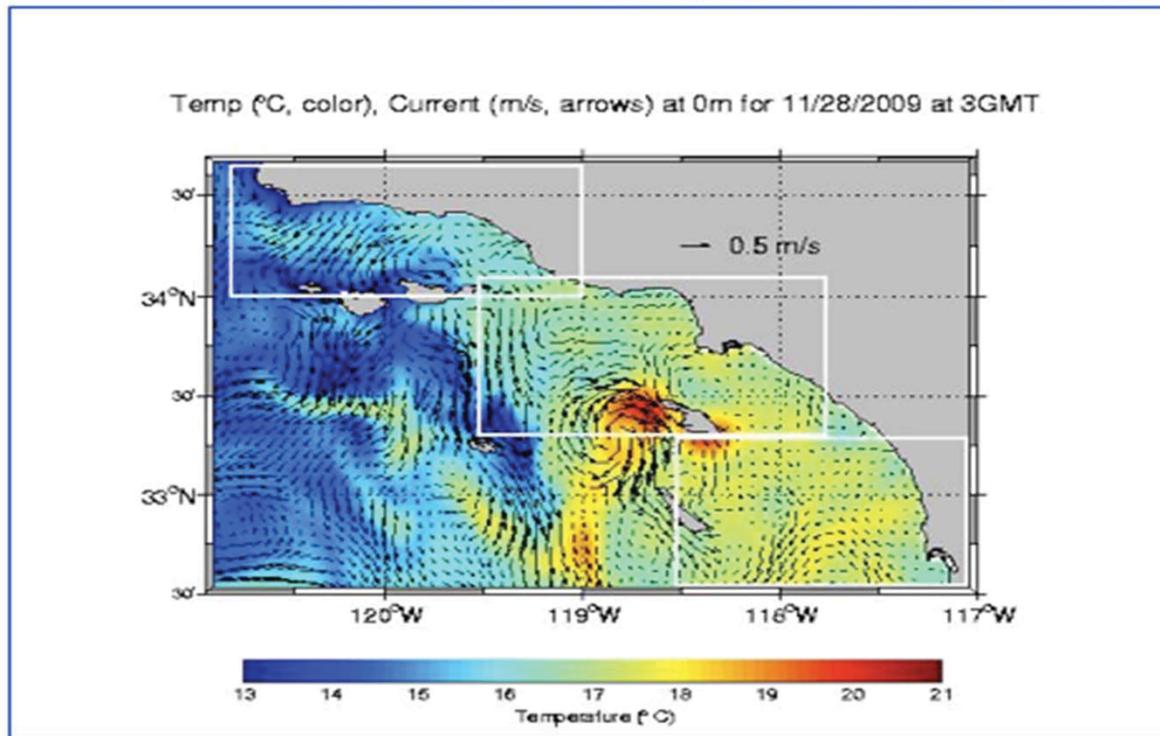
- Tide Gauge
- HF data and ROMS data
- SIO Glider Profile
- USC Glider Profile
- 1km SST

Temperature Nowcast

The Southern California Bight (SCB) ocean forecasting system is based on the Regional Ocean Modeling System (ROMS). The ROMS configuration ... [more](#)

File Name	File Size	Download	View
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scb_das_2009112809.nc	9090984	http	Header LAS Image
scb_das_2009112815.nc	9090984	http	Header LAS Image
scb_das_2009112821.nc	9090984	http	Header LAS Image

Click inside the white boxes in the images below to zoom in on sub-regions of the domain



<http://ouocean.jpl.nasa.gov/SCB>

Time (GMT). Pacific Daylight Time (PDT) is seven hours behind GMT-07:00.

(Chao, JPL)

Previous & ongoing interactions with UKMO scientists related to ODA

Within the Climate Variability and Predictability Program (CLIVAR):

- Effort coordinated by the Global Synthesis and Observation Panel (GSOP): intercomparison of ocean synthesis estimates (including DePreSys, Led by Doug Smith).

Within the Global Ocean Data Assimilation Experiment (GODAE):

- Interactions with UKMO Forecasting Ocean Assimilation Model (FOAM) effort (led by Mike Bell, Matt Martin)
- Utility of ODA products for ecosystem research (led by Rosa Barciela)