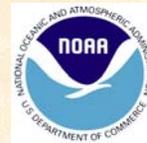
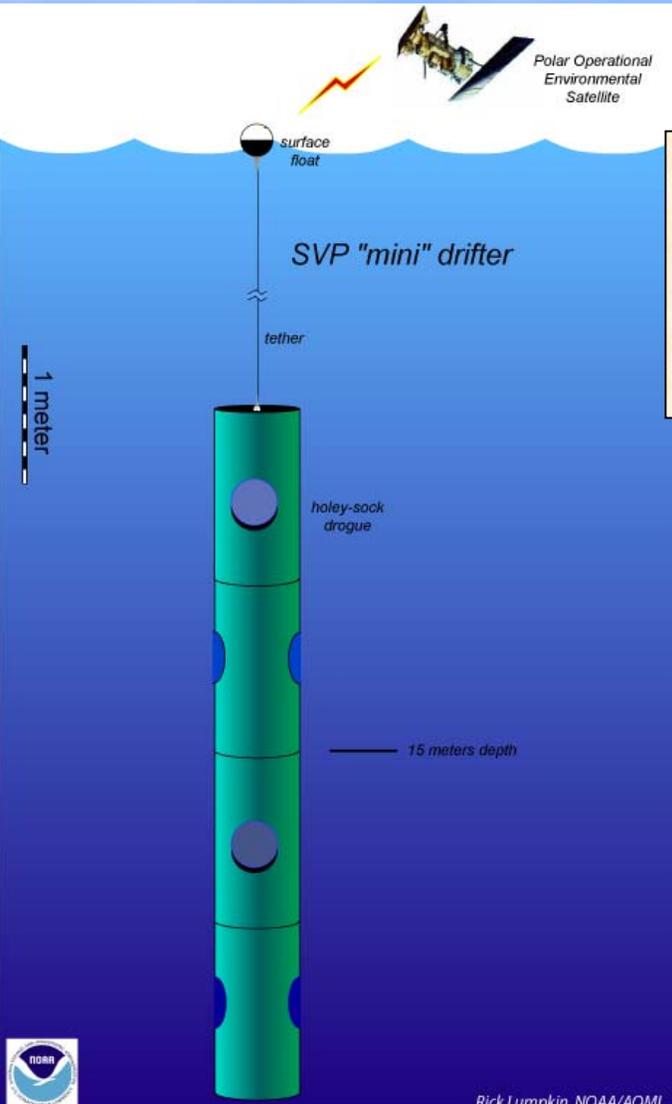


Global Drifter Program (GDP)

*Drifting buoy measurements of Sea Surface Temperature,
Mixed Layer Currents, Atmospheric Pressure and Winds*

<http://www.aoml.noaa.gov/phod/dac/gdp.html>



Rick Lumpkin

(Rick.Lumpkin@noaa.gov)

**Atlantic Oceanographic and Meteorological Laboratory (AOML)
Miami, Florida USA**



GDP: the principal component of the *Global Surface Drifting Buoy Array*, a branch of NOAA's *Global Ocean Observing System* (GOOS) and *Global Climate Observing System* (GCOS) and a scientific project of the DBCP.

Objectives:

Maintain a global 5°x5° array of 1250 ARGOS-tracked Lagrangian surface drifting buoys to meet the need for an accurate and globally dense set of in-situ observations: mixed layer currents, SST, atmospheric pressure, winds, and salinity.

Provide data processing system for scientific use of these data.

These data support short-term (seasonal-to-interannual) climate predictions as well as climate research and monitoring.

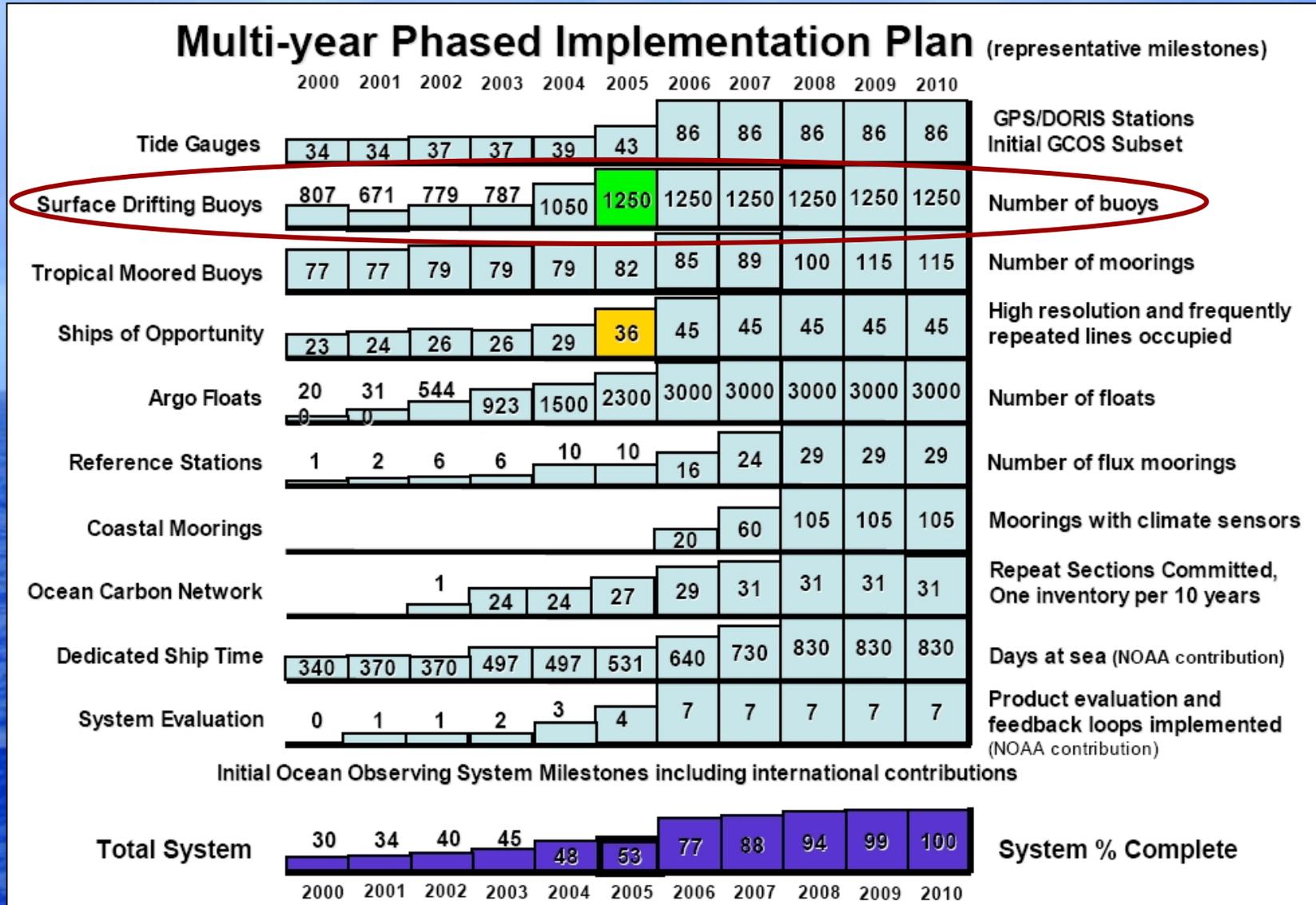
The GDP is managed with close cooperation between:

- ***Manufacturers*** in private industry: build the drifters according to closely monitored specifications
- NOAA's Atlantic Oceanographic and Meteorological Laboratory (***AOML***): coordinates deployments, processes the data, archives data at AOML and at MEDS (Canada), maintains META files describing each drifter deployed, develops and distributes data-based products, updates the GDP website
- NOAA's Joint Institute of Marine Observations (***JIMO***): supervises the industry, upgrades the technology, develops enhanced data sets

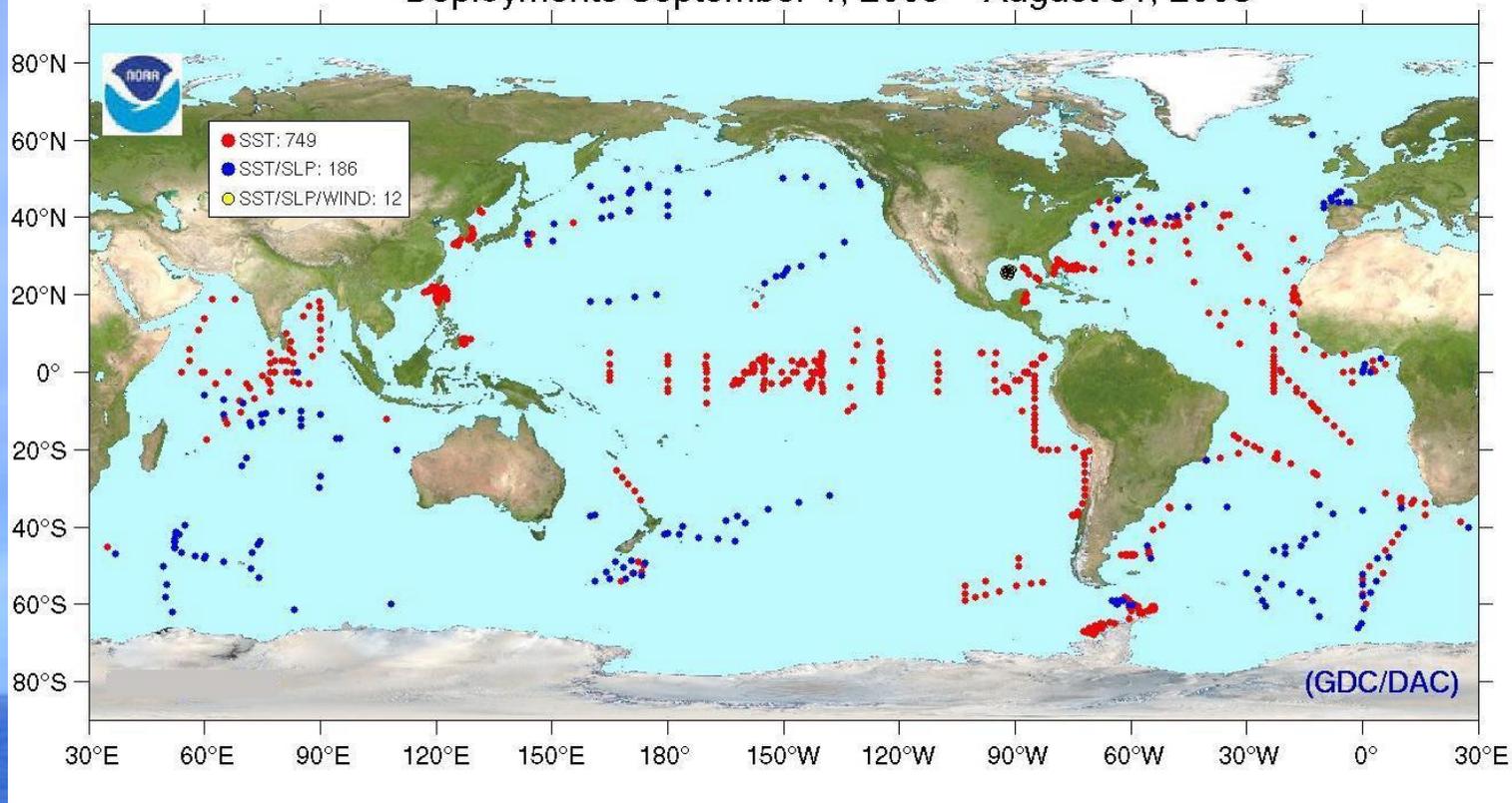
Drifter purchases and liaisons with individual researchers: both JIMO and AOML.

IOOS milestones

(from OceanOps2004, M.Johnson and E. Harrison)



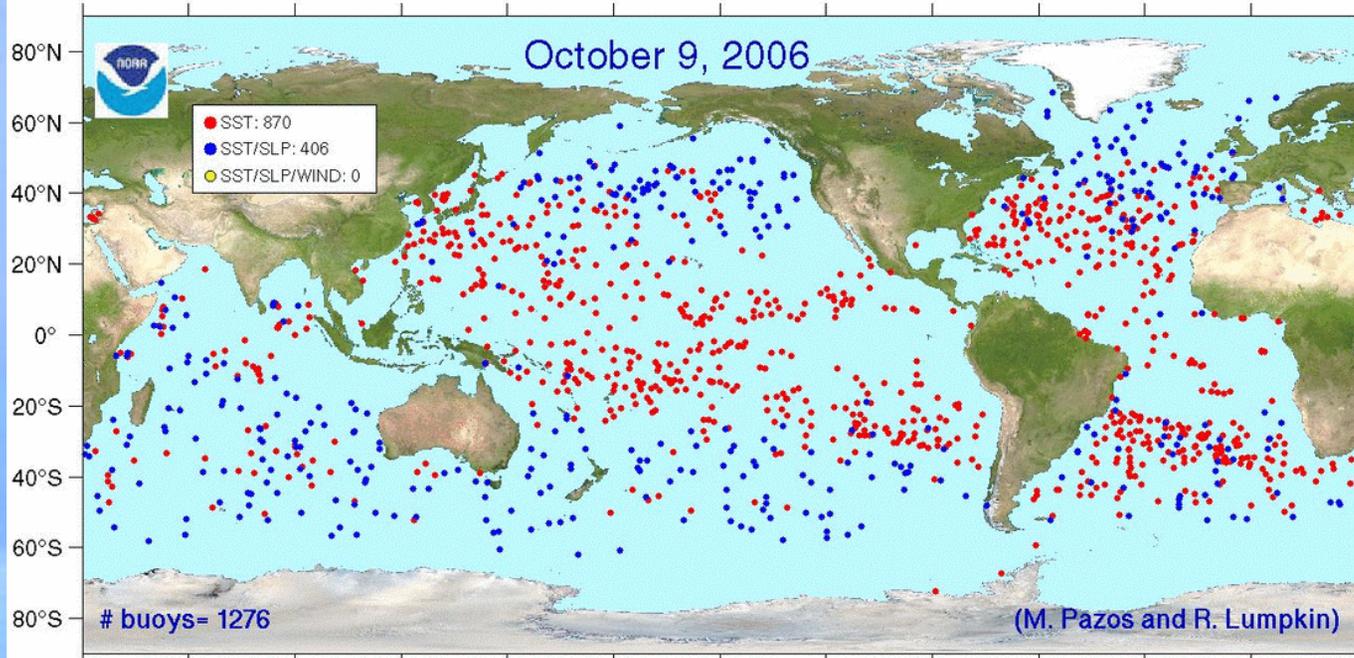
Deployments September 1, 2005 – August 31, 2006



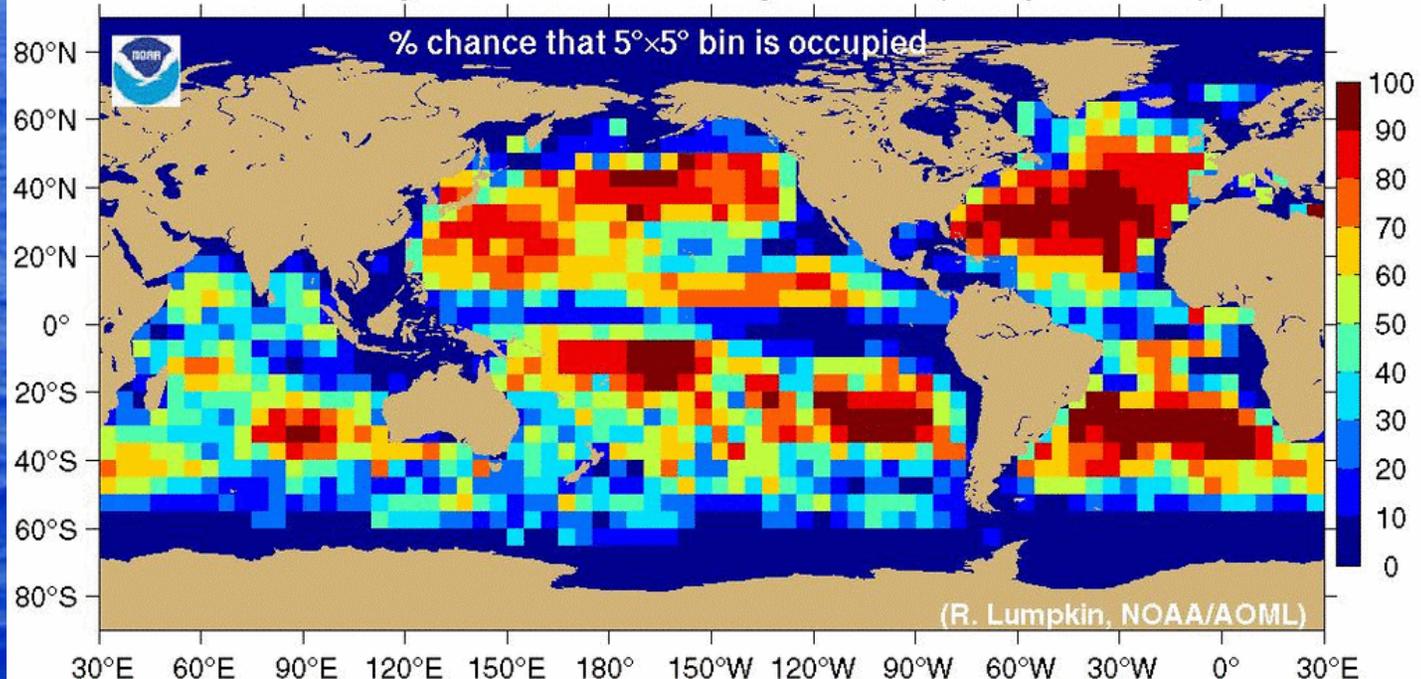
North Pacific	36
North Atlantic	31
Tropical Oceans	407
Southern Ocean	178
Consortium Research	239
<hr/>	
Total	891

Drifter Operations Center:
 Craig Engler (NOAA/AOML)
 Craig.Engler@noaa.gov

STATUS OF GLOBAL DRIFTER ARRAY

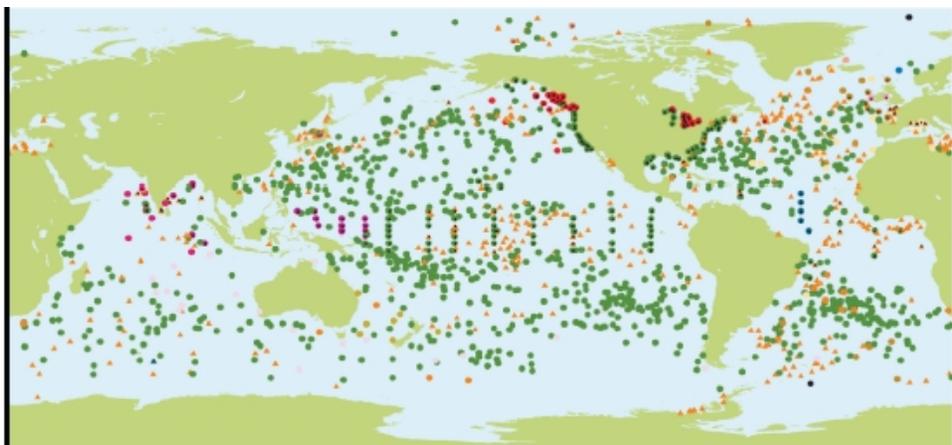
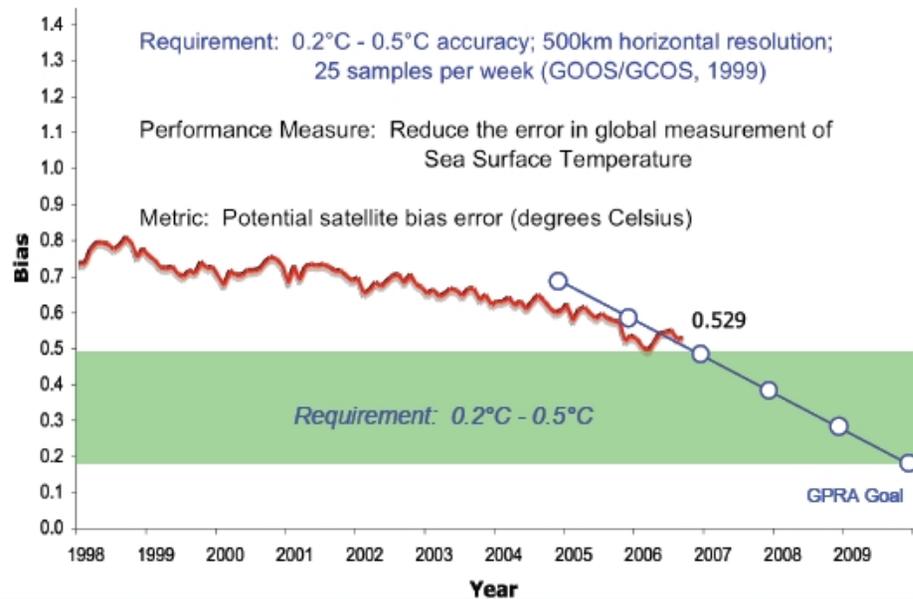


Drifter array forecast for January 8, 2007 (90d prediction)



Observing System Status: 2006, Q3.

Sea Surface Temperature



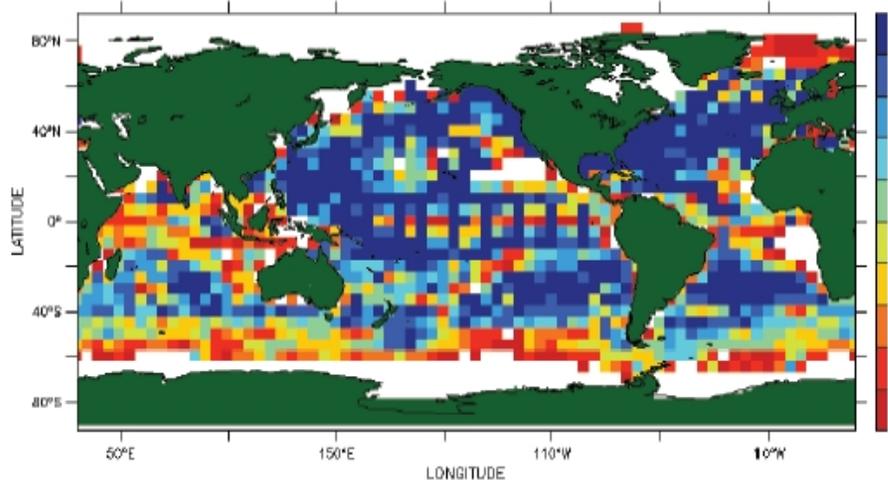
DBCPS status by country, June 2006 (data buoys reporting on GTS)



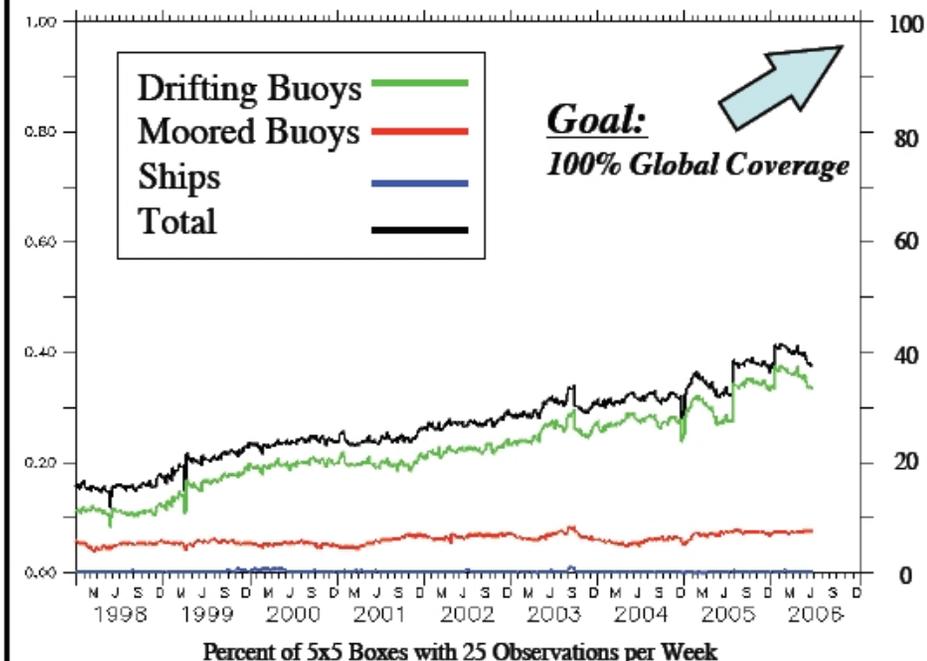
Note: Data received from GTS at JCOMMOPS via Météo-France; number of drifting and moored buoys in brackets respectively

Requirement: All boxes blue

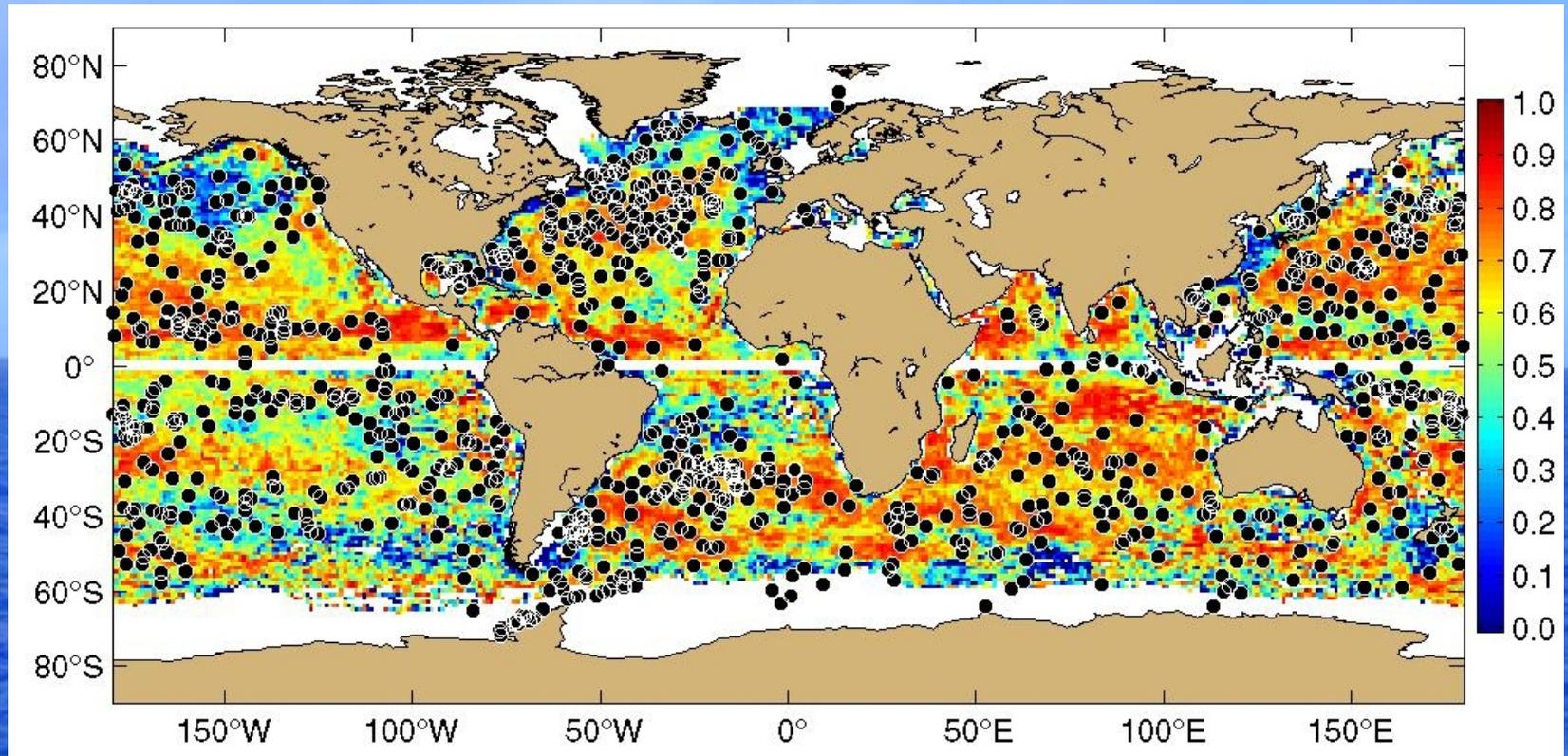
TIME : 01-JAN-2006 to 28-JUN-2006



Percent of Weeks with 25 Accuracy Weighted sst obs in 5x5 Box 2006
Drifting Buoys + Moored Buoys + Weighted Ship Observations



drifter measurements: Mixed layer currents



Bullets: location of all (974) drogued drifters on 17 April 2006.

Shading: correlation between drifter and satellite estimates of geostrophic current anomaly.

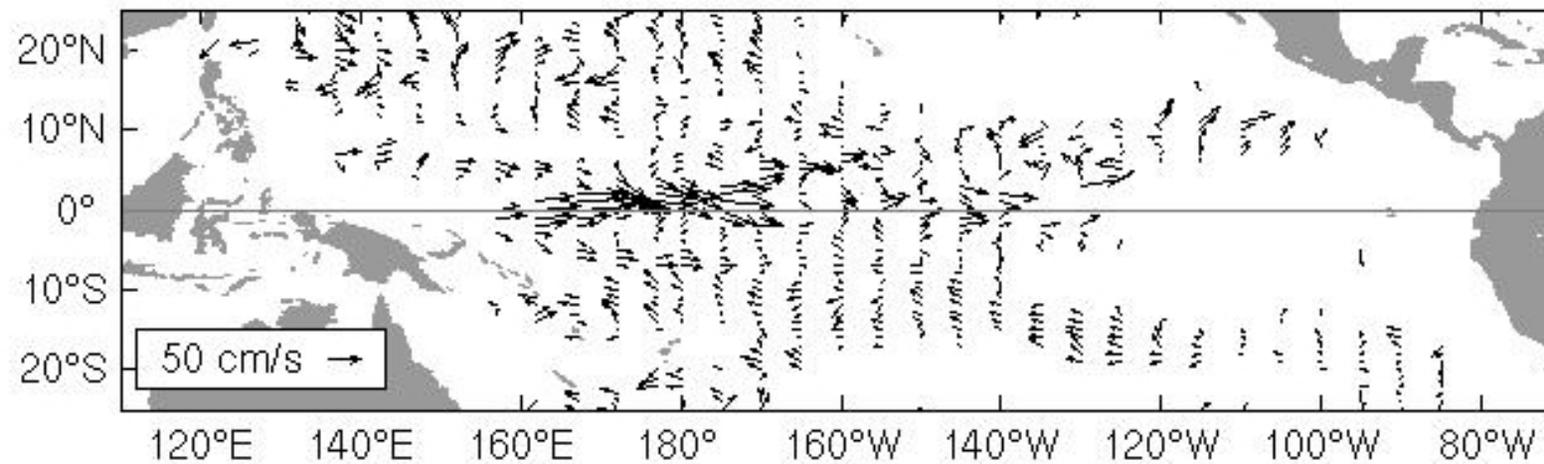
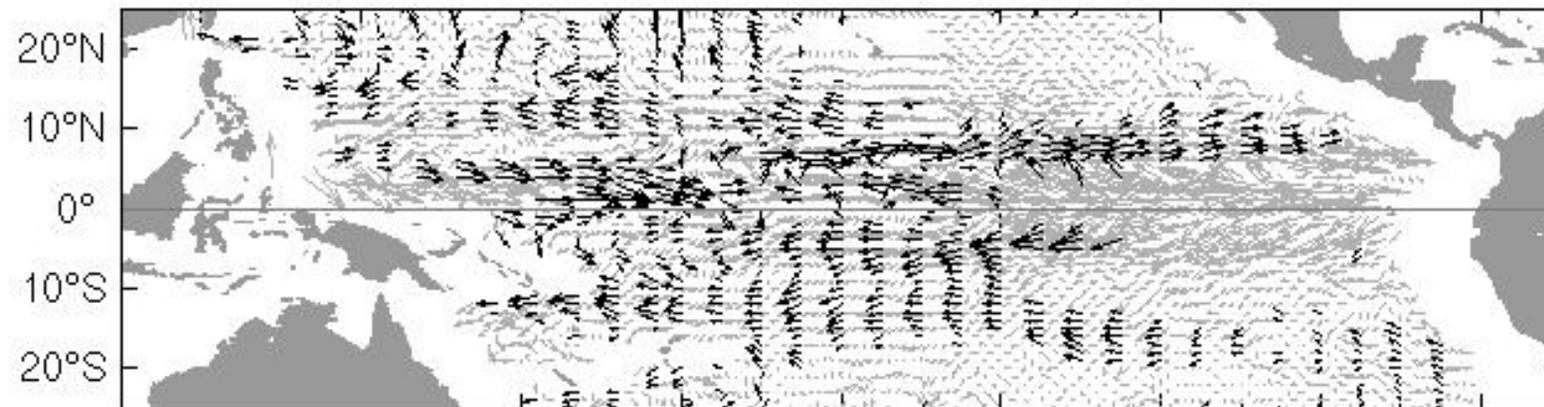
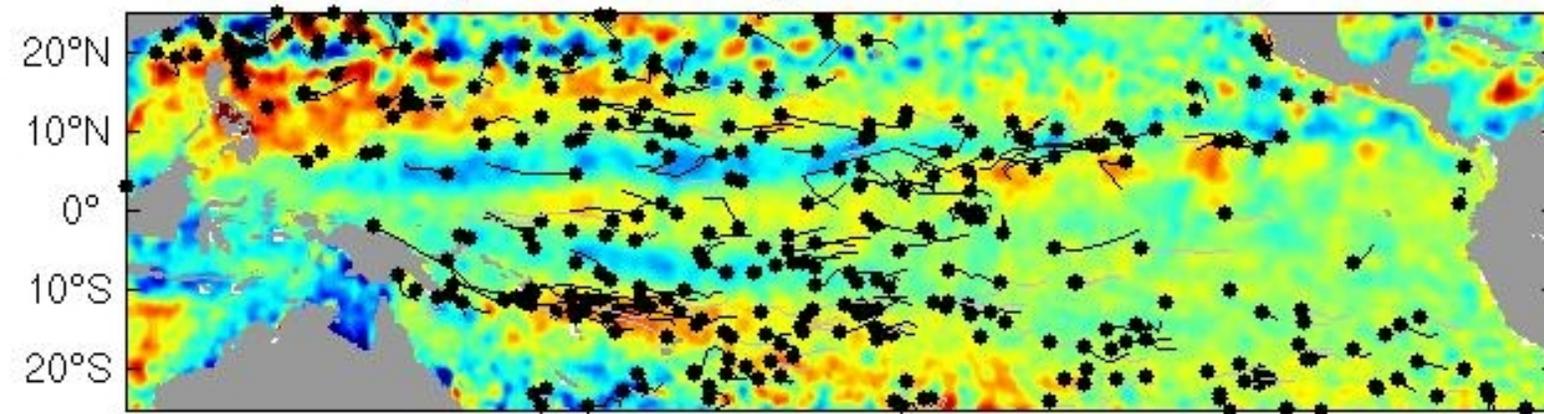
August 2006 – Tropical Pacific drifter array

August 2006: 439 drifters in Tropical Pacific, 63% with drogues attached.

Shading: AVISO gridded sea level anomaly (-30 to 30 cm), 18 August 2006.

Drogued drifter velocities during August 2006 (black) and for climatological August (grey).

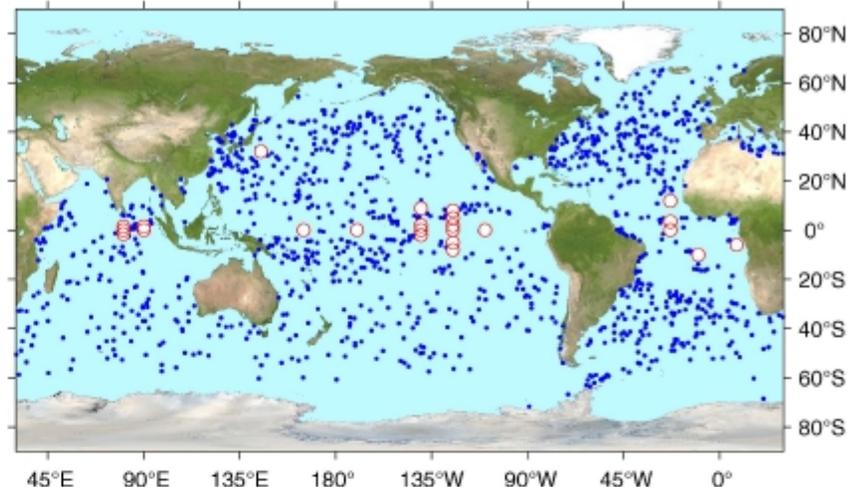
Velocity anomalies (August 2006 minus climatological August).



Observing System Status: 2006, Q3. Surface Currents (experimental)

Requirement: 2 cm/s accuracy (drogue on); 600 km resolution;
1 sample per month (GOOS/GCOS, 1999)

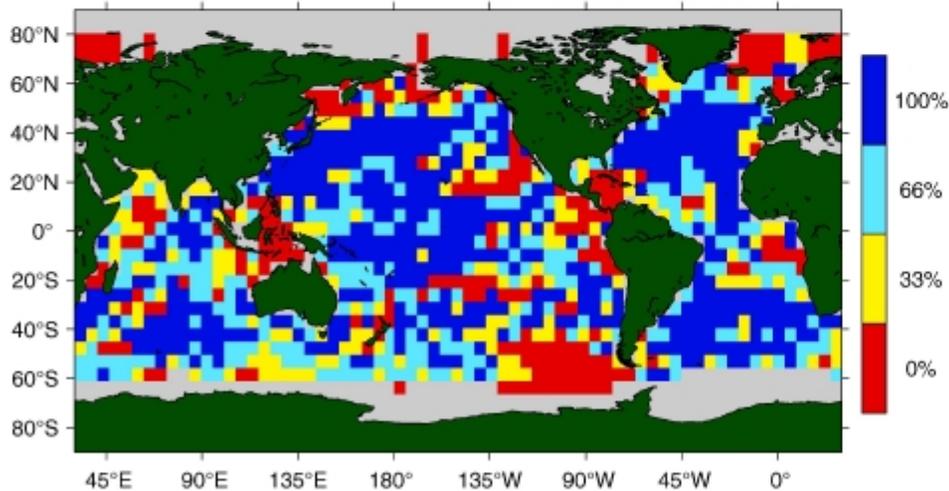
Performance measure: reduce the error in global
measurement of surface velocity



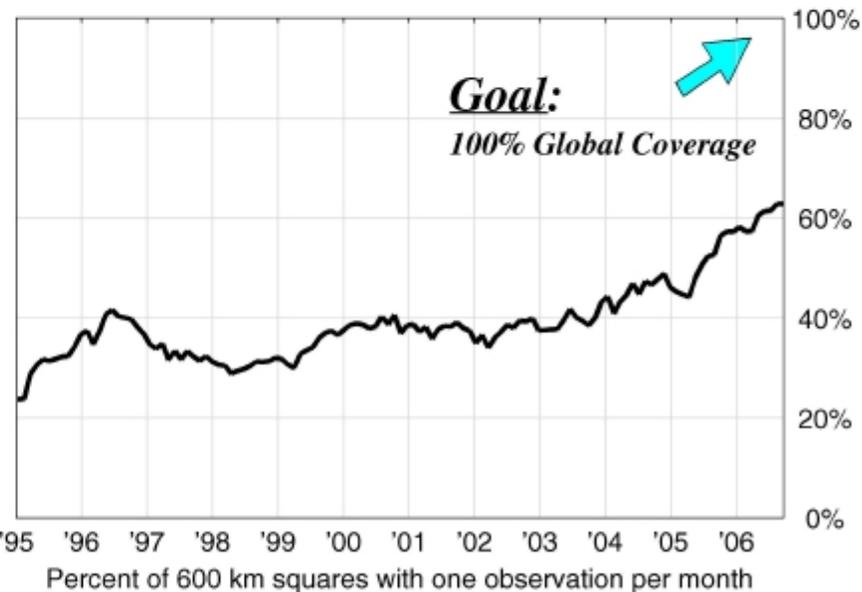
Observing system status, July–September 2006

• Drogued drifting buoys: 1232 ○ Moored buoys: 24

Requirement: all boxes blue

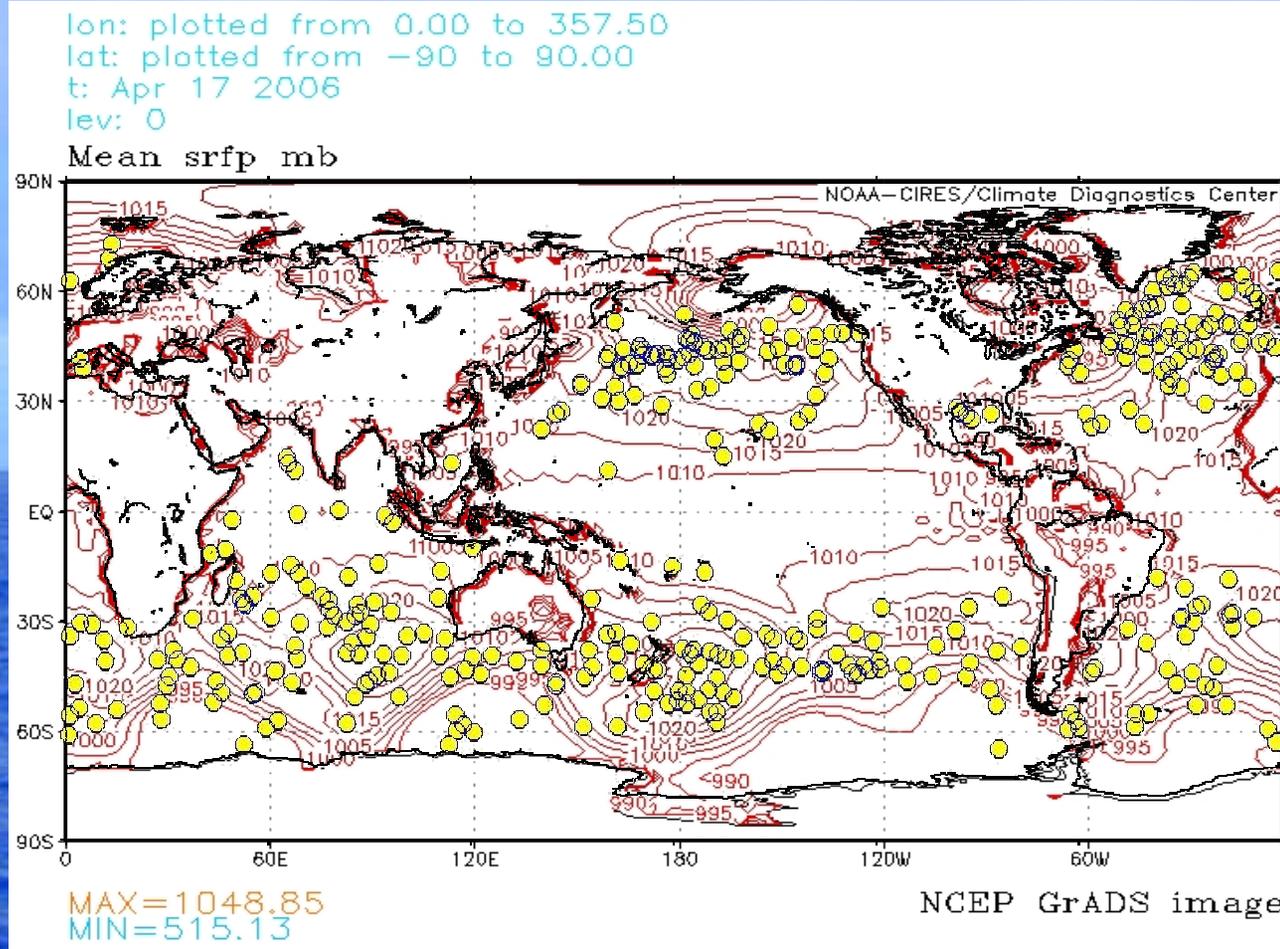
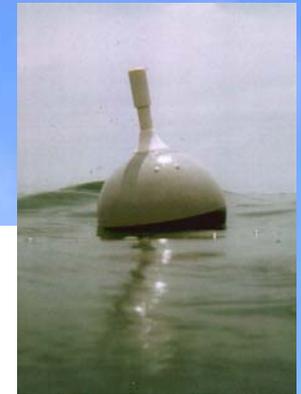


Percent of months in quarter with at least one observation



Percent of 600 km squares with one observation per month

sea level air pressure



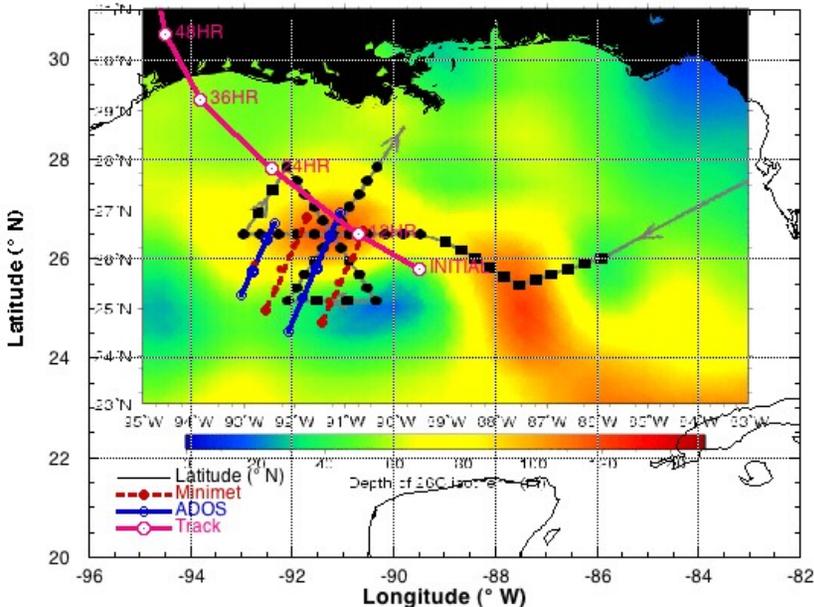
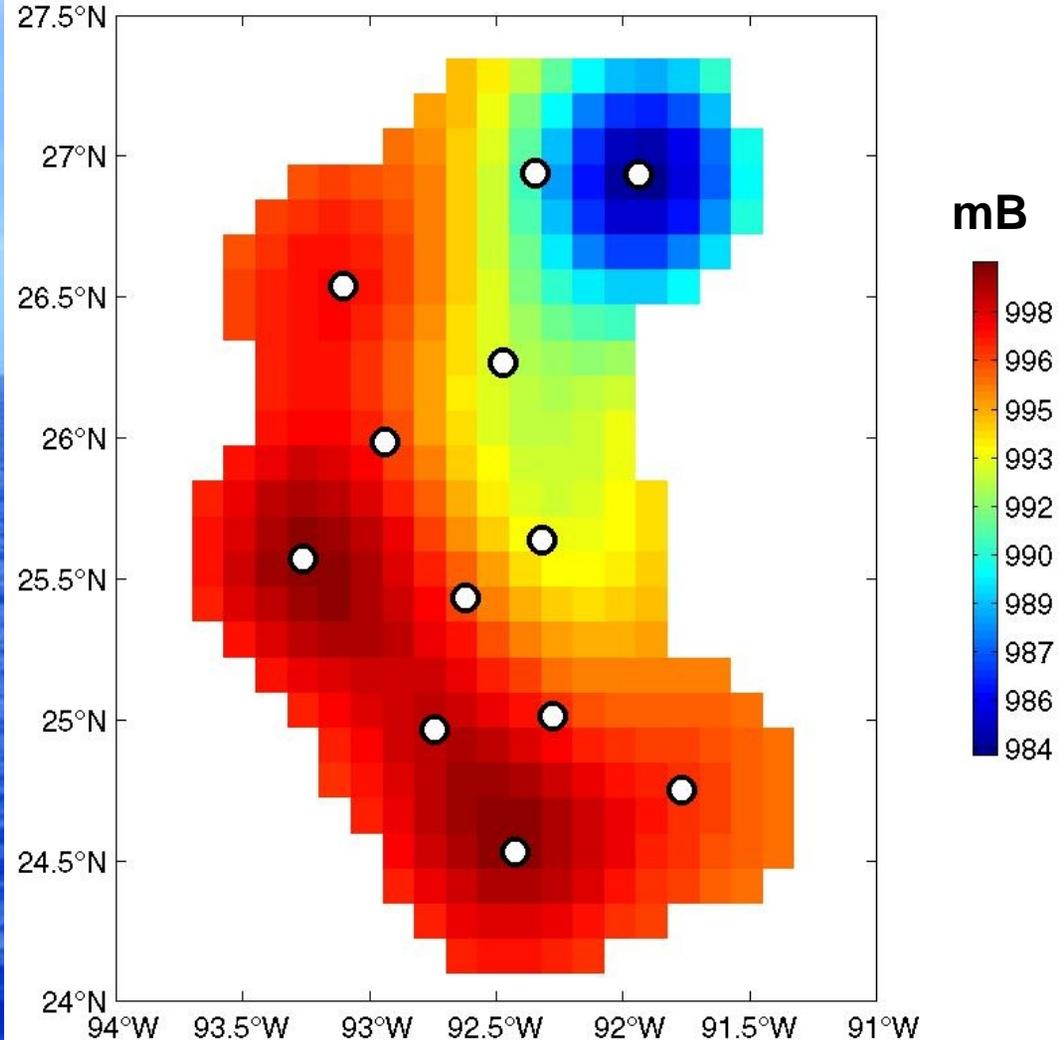
Bullets: location of all (393) drifters with barometers on 17 April 2006.
Contours: operational NCEP sea level air pressure for 17 April 2006.

Is sea level air pressure valuable at low latitudes?



2005 deployment of 12 wind/barometer drifters in the path of Cat5 "Rita"

23 September 2005 0730Z



sea surface salinity



2005 COSMOS deployments: 17 drifters in Bay of Biscaye



n°2, February 2006 - <http://www.ifremer.fr/coriolis/>

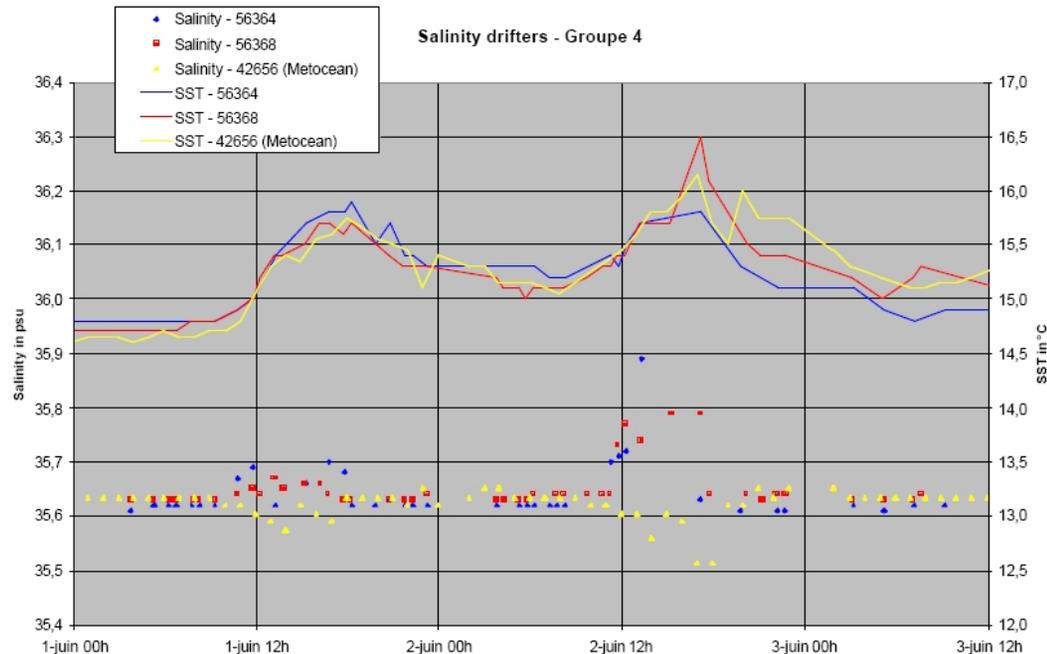
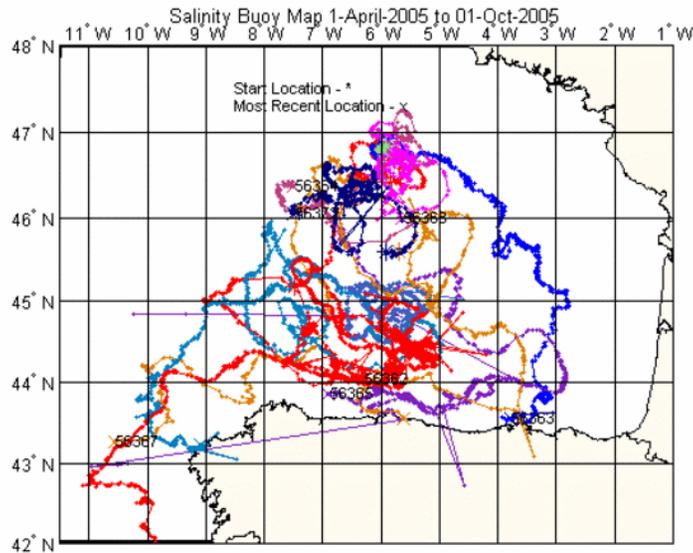


Figure 1: photograph of METOCEAN drifter 52197 in December 2005, roughly one week after its recovery during the CONGAS2 cruise. The subsurface sensor area is shown with noticeable algal fouling near the sensors.

Figure 2: Two daily cycles (June 1 and June 2 2005) during a period of weak wind and low cloudiness for three close-by drifters (SIO drifters: 56364, 56368; Metocean drifter: 42656).

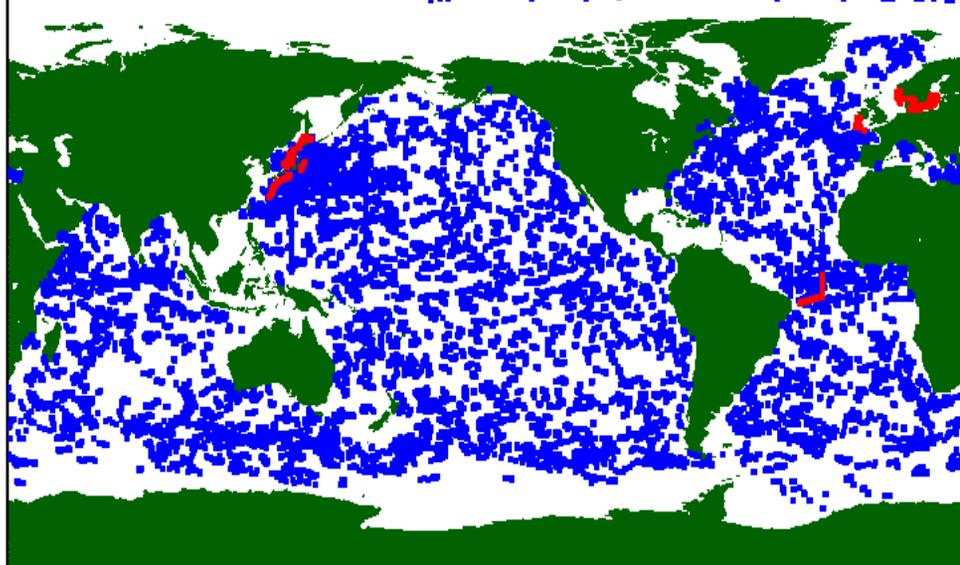
Observing System Status: 2006, Q2 Sea Surface Salinity

Sampling requirements:

1 observation

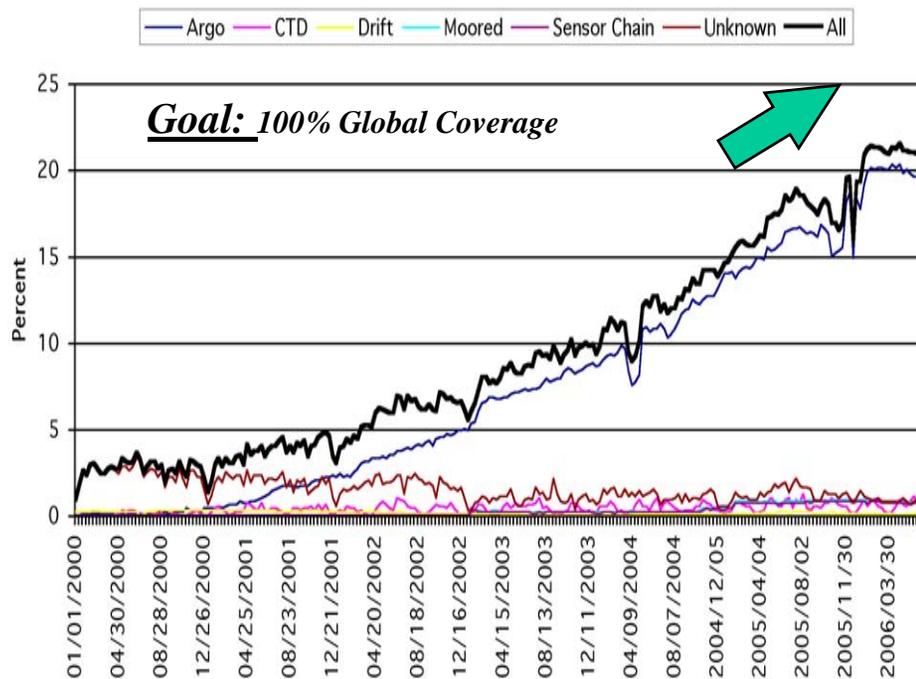
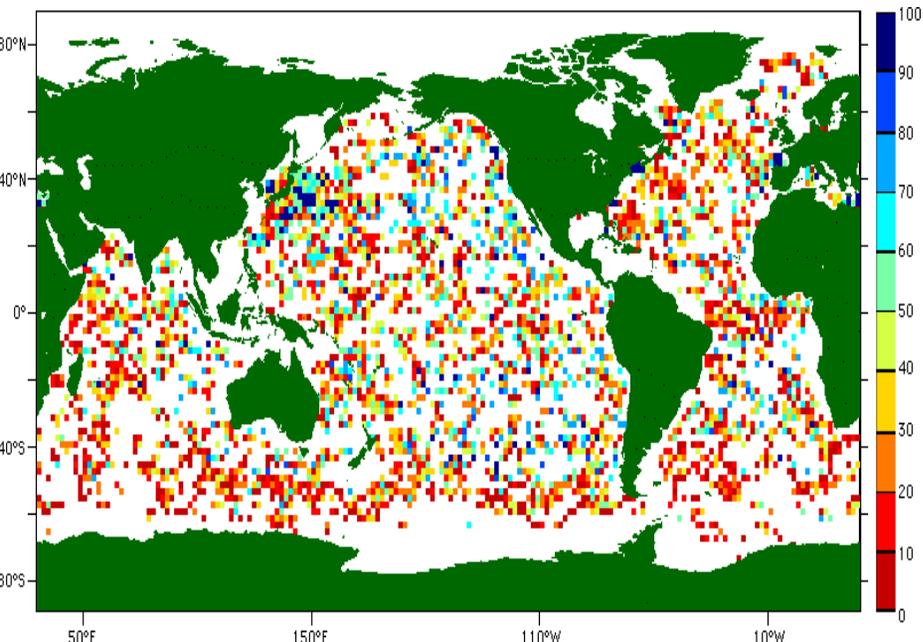
Every 10 days

In every $2 \times 2^\circ$



- BATHY (mostly XBTs)
- TRACKOB (surface underway data)
- TESAC (mostly Argo floats)
- BUOY (moored and drifting)

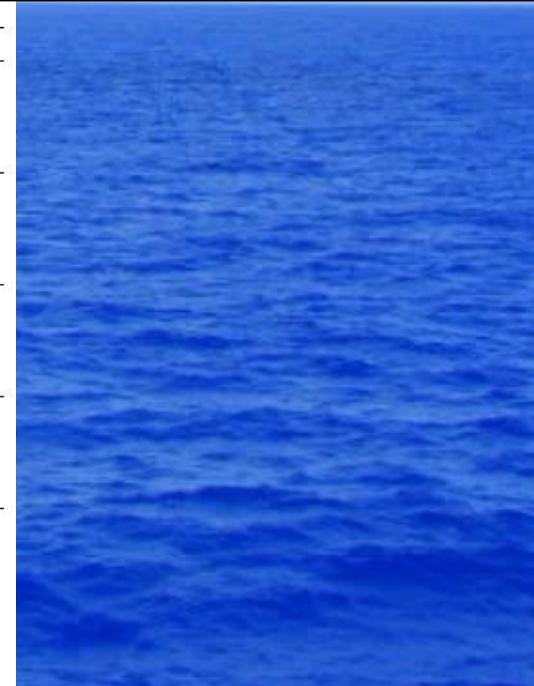
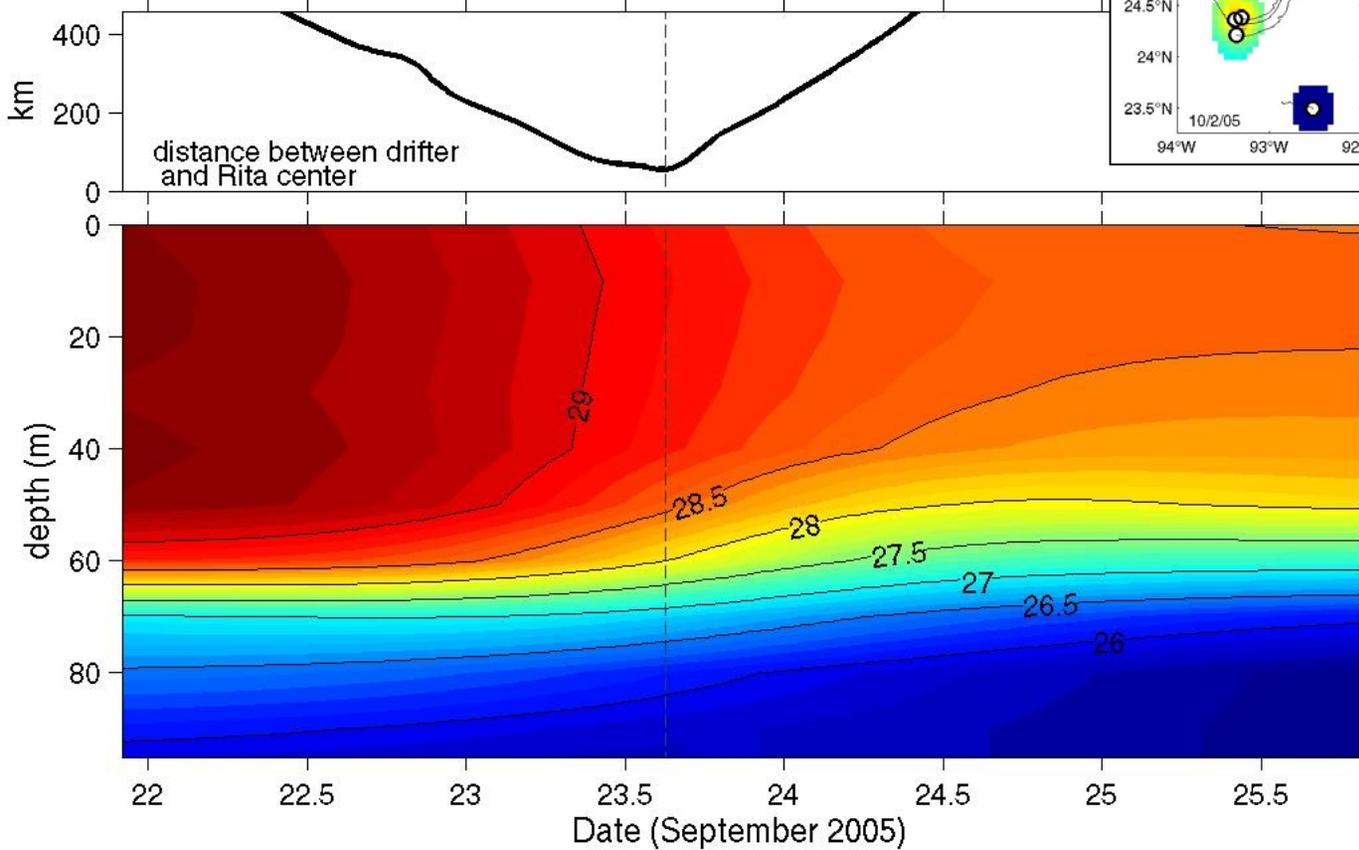
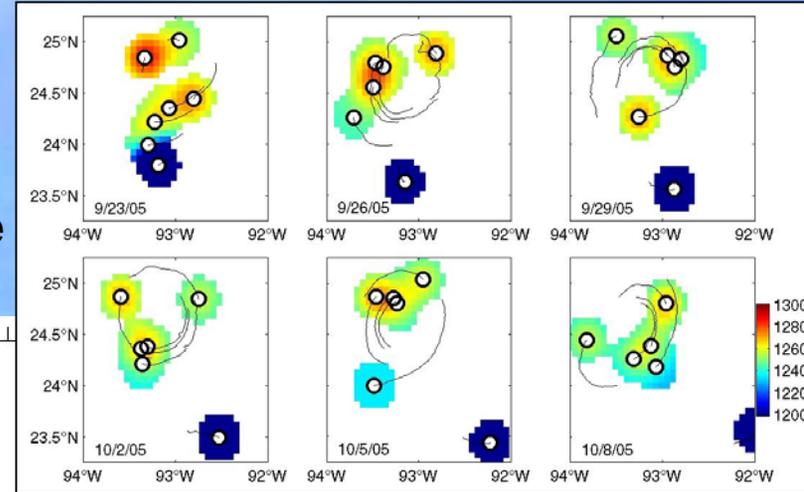
Requirement: All boxes blue



drifter measurements: upper ocean heat content



**2005 hurricane deployment:
8 thermistor chain drifters in the
path of Category 5 "Rita"**



Technological development,
Research, etc.



Drogue detection

NOAA/AOML's drifter Data Assembly Center (DAC) completed a drogue status reevaluation on 1 May. Many changes in time of "drogue off": some earlier, a few later.

Ongoing interpretation of drogue status is now based on what the DAC has learned during this process.

Differences in how submergence is counted, differences in sensitivity, and other factors all require manufacturer-dependent interpretation. This has prevented the DAC from implementing automatic drogue detection for the 1250-buoy array. Very sensitive submergence sensors appear to produce short-term spurious high or low values, preventing accurate real-time assessment (need to examine the long-term behavior).

Based on the DAC's experience, tether strain is the easiest record with which drogue presence can be determined. Automatic detection seems straightforward to implement here, based on a standard deviation criterion accompanied by a drop in strain.

March 2006 DBCP Data Users and Technology workshop recommendation: SST measured “on the hour, every hour.”

Motivation: calibration and validation of satellite observations.

Update from manufacturers:

Drifters currently measure SST every 60-90 seconds, and report average over 15-30 minutes.

Clock starts upon drifter activation.

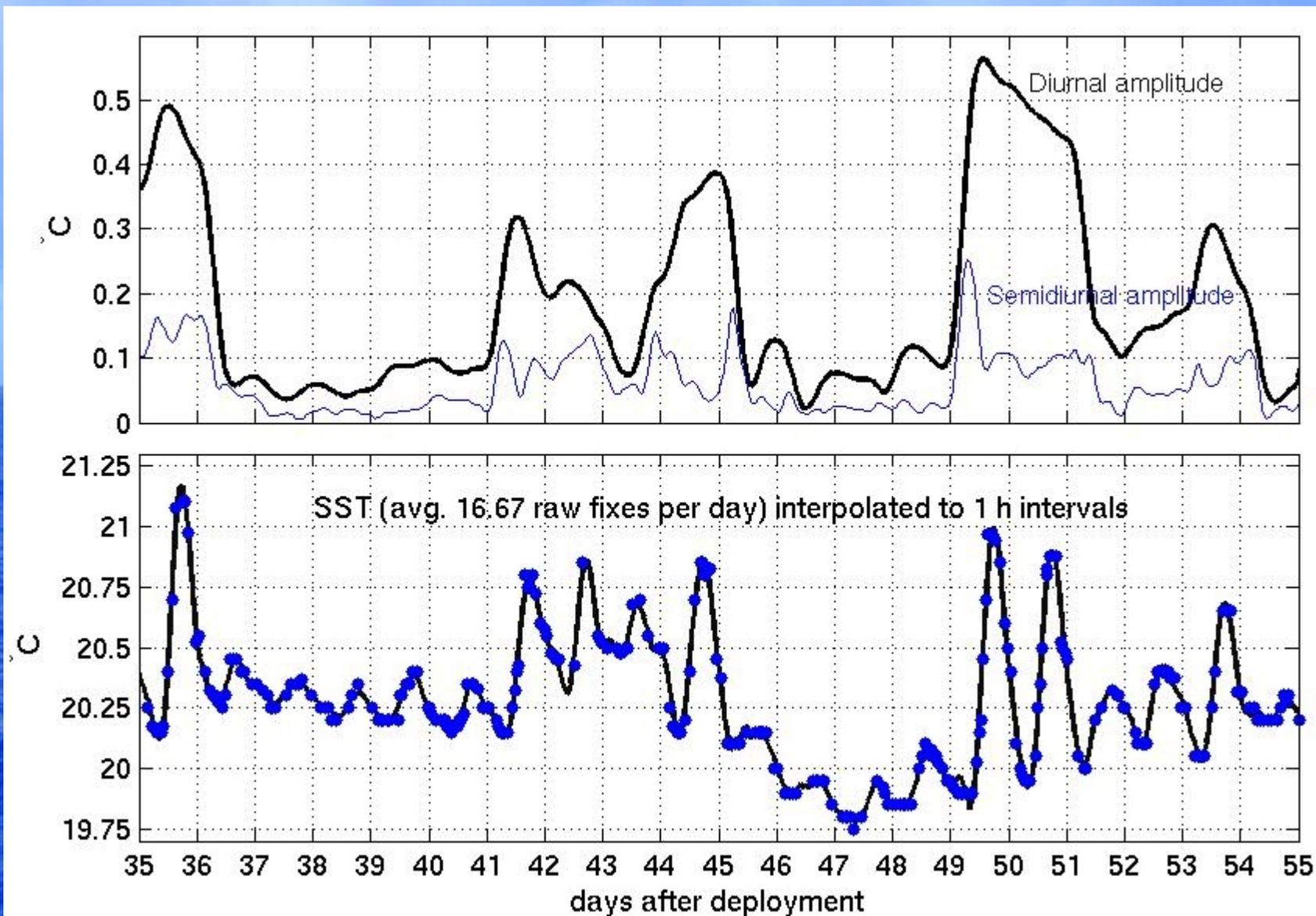
Extremely accurate time tag comes with Argos message.

Clock stability: current technology keeps time to 10 ppm, ~5 min in a year.

Issues:

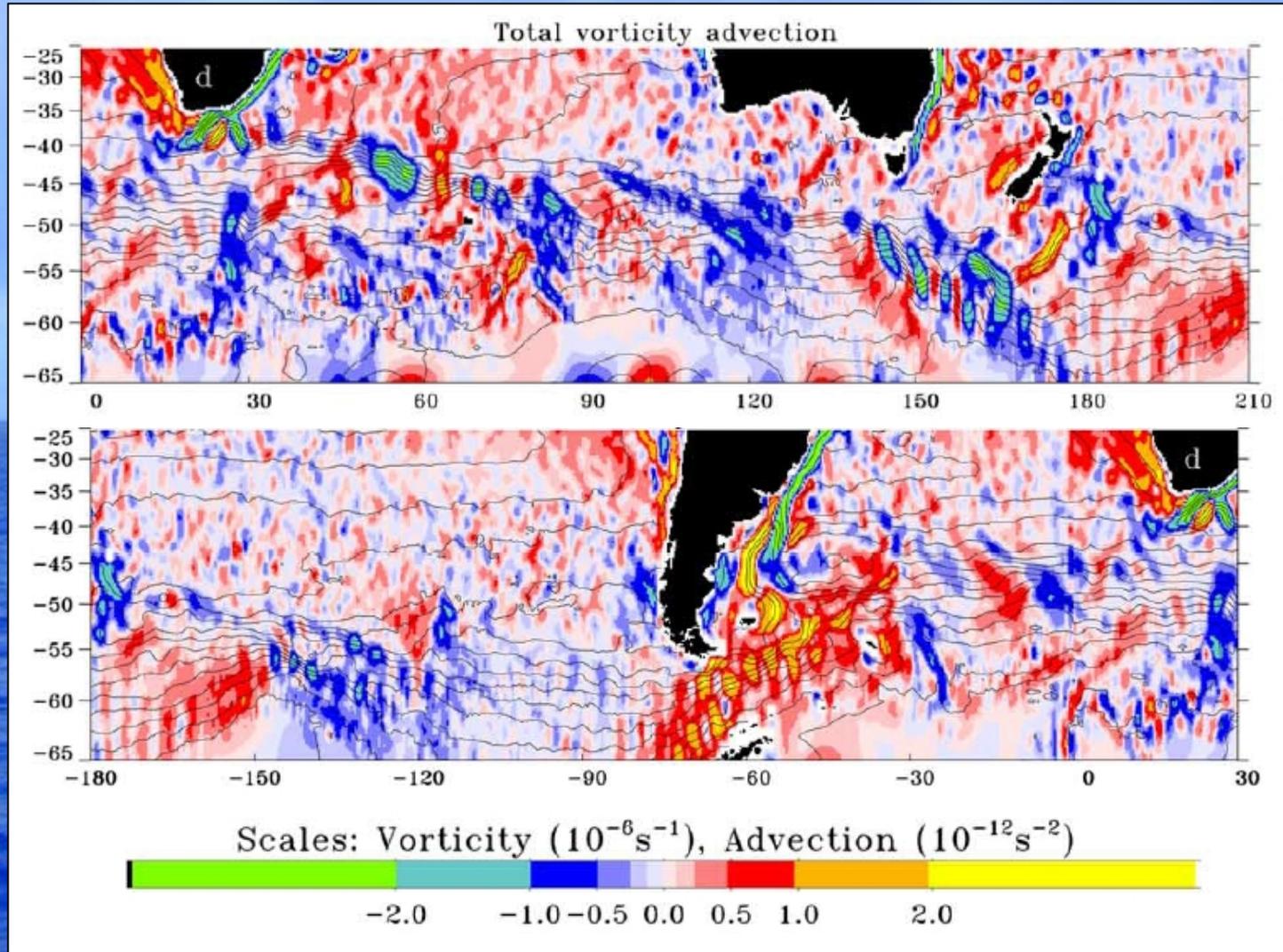
- Implementing a more stable clock adds to drifter cost – e.g., controller with Temperature Compensated Crystal Oscillator, ± 1 min/yr at 0—40°C.
- Alternative strategy: use GPS time and location – added cost, but also added location accuracy and frequency.
- Regardless of approach, these hourly reports will not be in real time with the current Argos satellite system.
- What is an “hourly” SST value? Instantaneous value at top of hour, average over surrounding 15 minutes, or 60 minutes?

March 2006 DBCP “Data Users and Technology” workshop recommendation: SST measured “on the hour, every hour.”



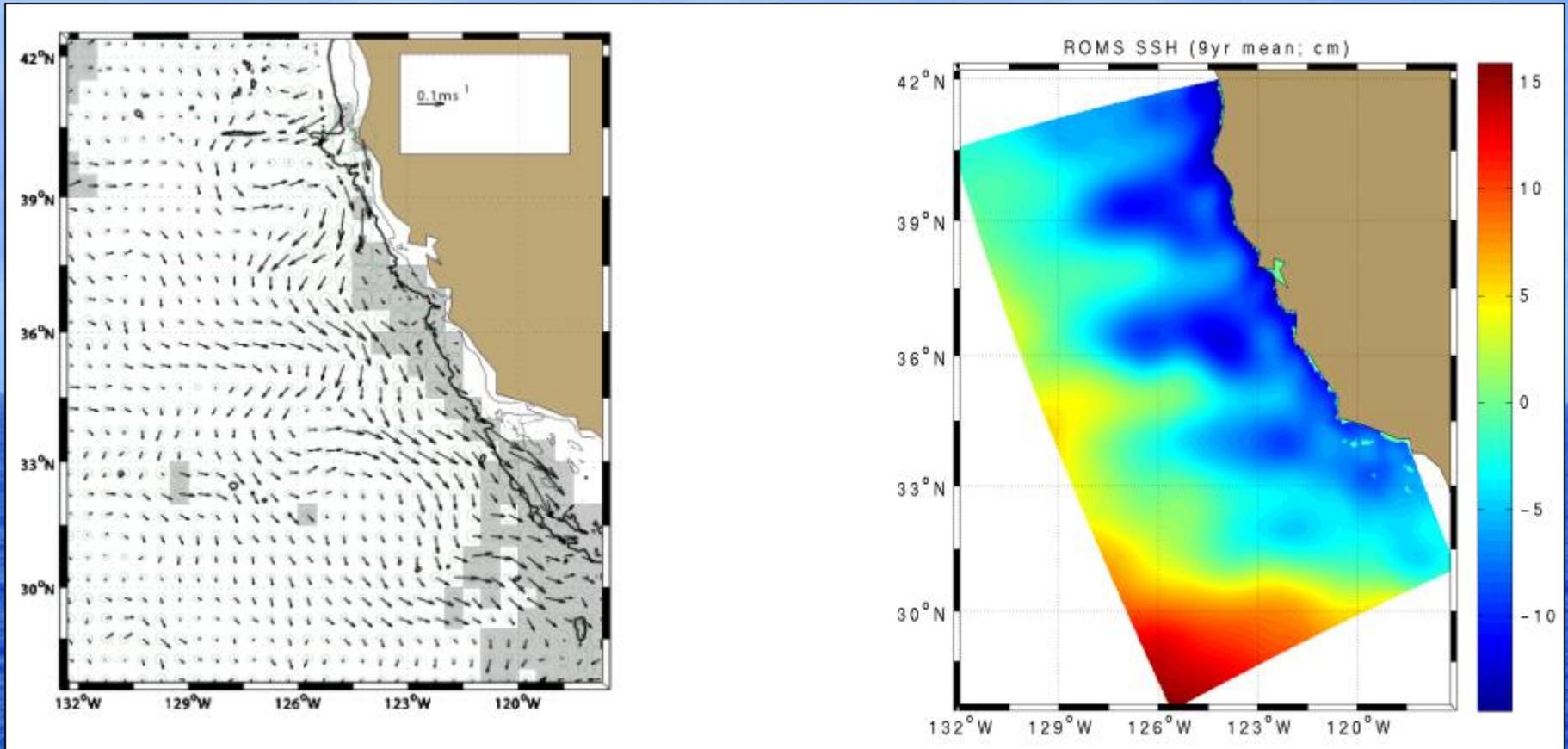
Oceanographic and climate research

(one recent example: Hughes, JGR110, 2005.)



Surface vorticity balance in the Southern Ocean

Climate Model Testing: Calibration and Validation



The drifter mean geostrophic velocity of the California Current (left panel) and mean sea level from ROMS model (right panel, courtesy of J. C. McWilliams). In both drifter and model data appear four heretofore-unknown, semi-permanent meanders.

2007: Goals and plans

*Deploy 960 Drifters in the period between October 2006 and September 2007.
Up to 330 SVP buoys upgraded with barometers .*

MAINTAIN 1250 drifters, continue to improve resolution (5° x 5° goal).

Hurricane drifters: For the 2006-2007 hurricane seasons, 22 thermistor chain drifters have been funded as a one-time addition to the Global Drifter Program. The drifters will be air-deployed in the paths of multiple hurricanes in operational mode. 2008 and beyond: 8 thermistor chain and 12 minimet (SST, barometric pressure, winds) drifters per year anticipated. Funding for a larger array is being pursued.

Our appreciation to the following Operational Partners for their contributions to GDP activities

Voluntary Observation Ships

Institut de Recherche pour le Développement;
Météo-France (France)

New Zealand Met. Service

Australian Bureau of Meteorology

Fundação Universidade Federal do Rio Grande;

Instituto Nacional de Metereologia; Centro de
Hydrografia de Marinha; INPE (Nacional
Space Institute); Brazilian Navy (Brazil)

Fisheries Research Institute; Servicio de
Hydrografía Naval (Argentina)

Instituto Canario de Ciencias Marinas (Canary
Islands)

National Institute of Oceanography; National
Institute of Ocean Technology (India)

Centro de Investigacion Cientifica y de
Educacion Superior de Ensenada
(Mexico)

International Ice Patrol

Scripps Institution of Oceanography

Woods Hole Oceanographic Institution

United States Air Force

Oregon State University

US Naval Oceanographic Office

United States Coast Guard

Raytheon Polar Services

United Kingdom Met Office

Environment Canada

University of Cape Town; South

African Weather Service (South
Africa)

... and any others I may have accidentally missed!



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Atlantic Oceanographic and Meteorological Laboratory (AOML)
Miami, Florida USA

