

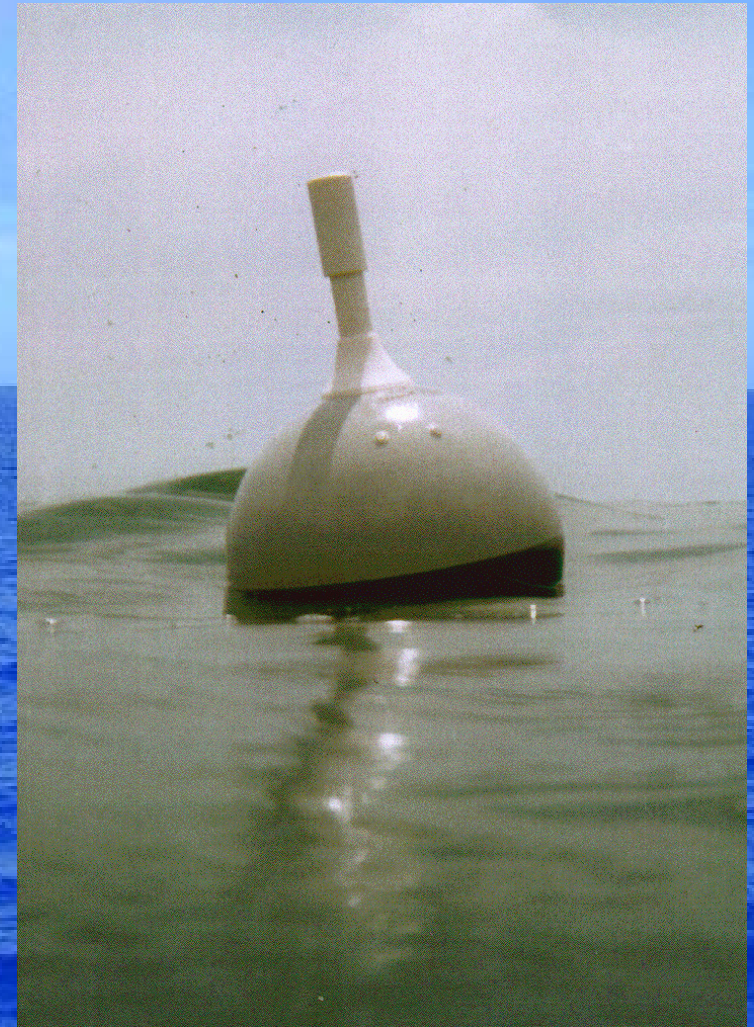


Global Drifter Program (GDP)



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

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



23rd Data Buoy Cooperation Panel session

October 15-19, 2007

Jeju, Republic of Korea

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.

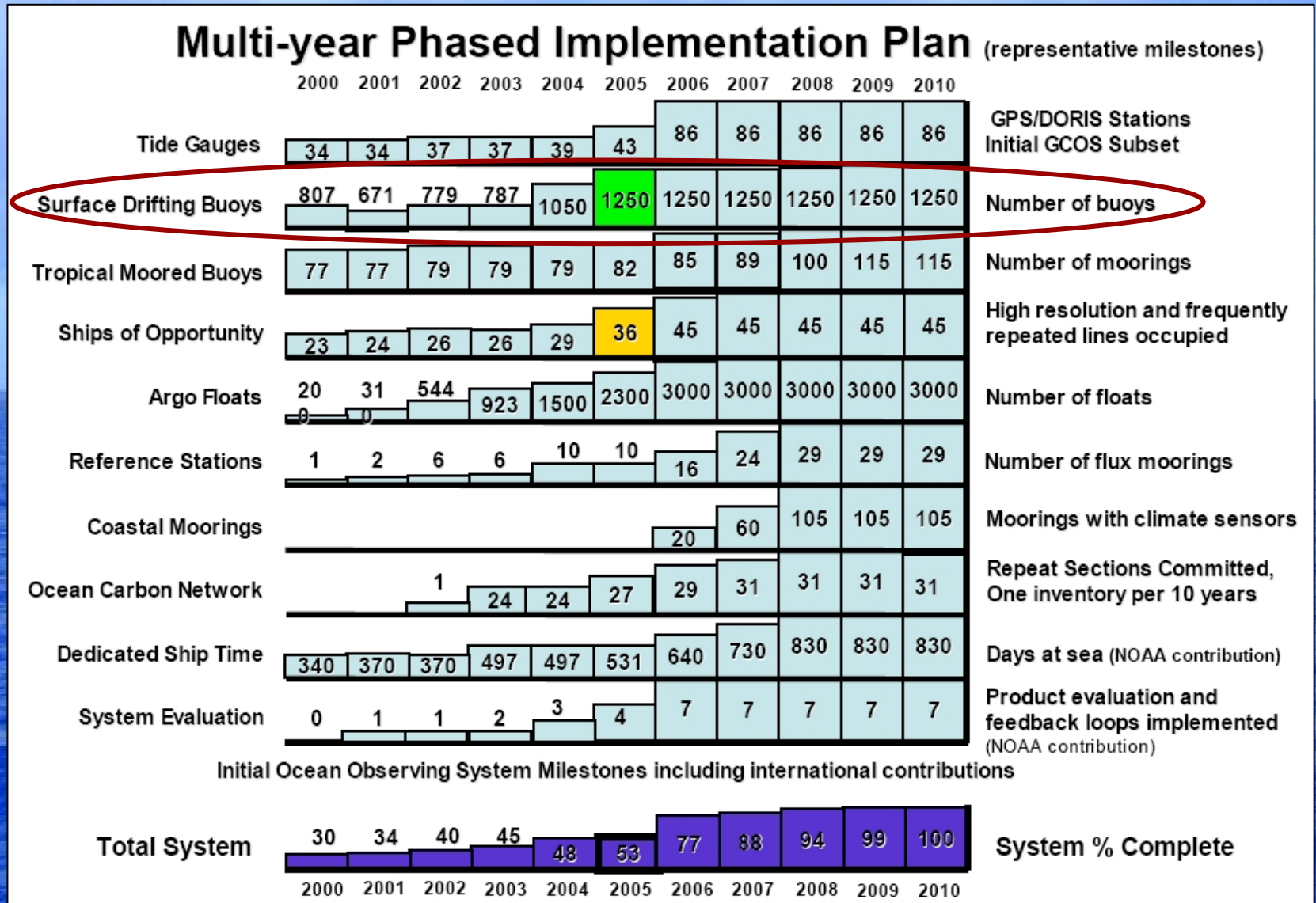
The GDP is managed with close cooperation between:

- ***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

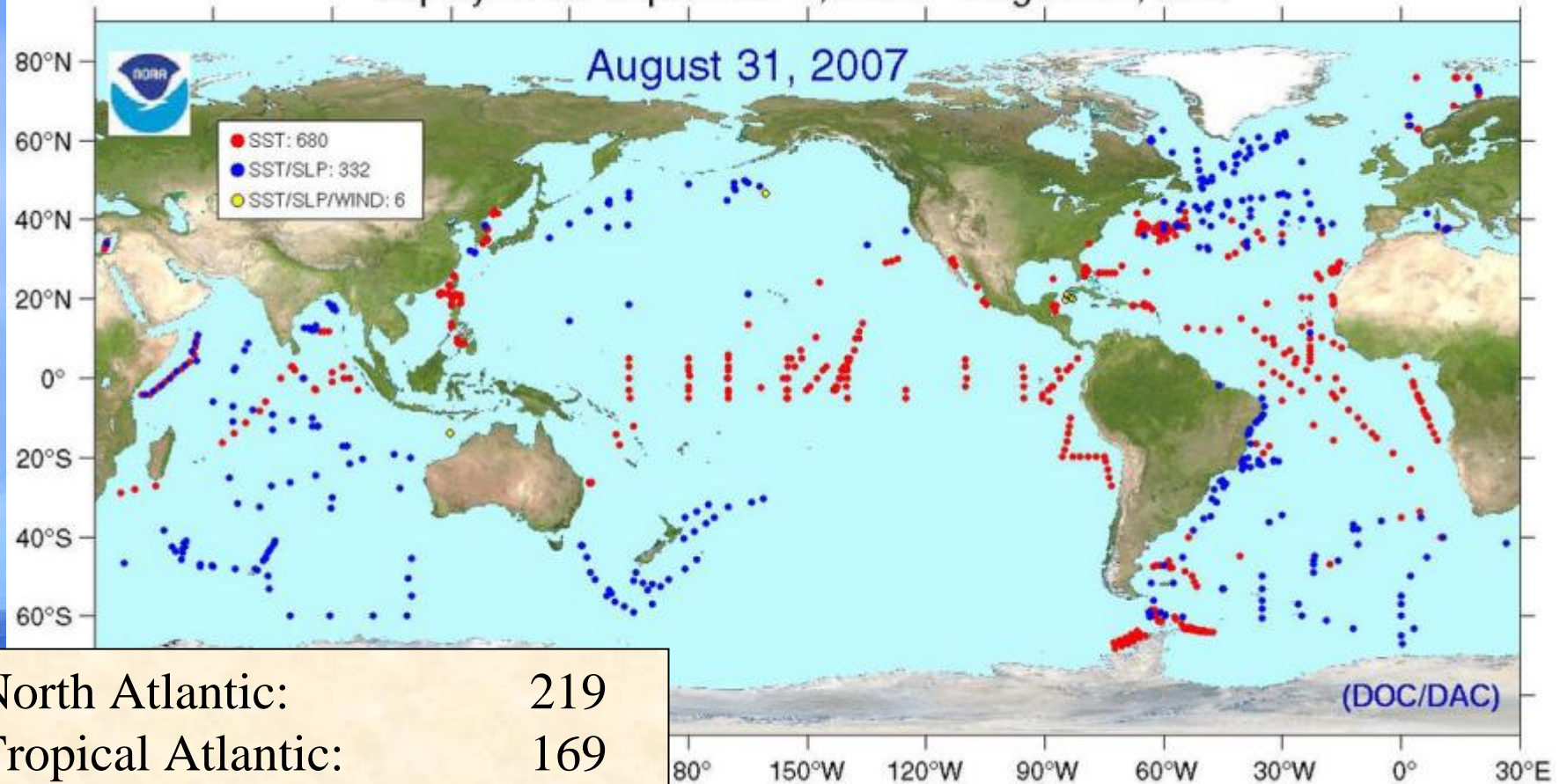
Drifter purchases and liaisons with individual researchers: both JIMO and AOML.

IOOS milestones

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



Deployments September 1, 2006 – August 31, 2007

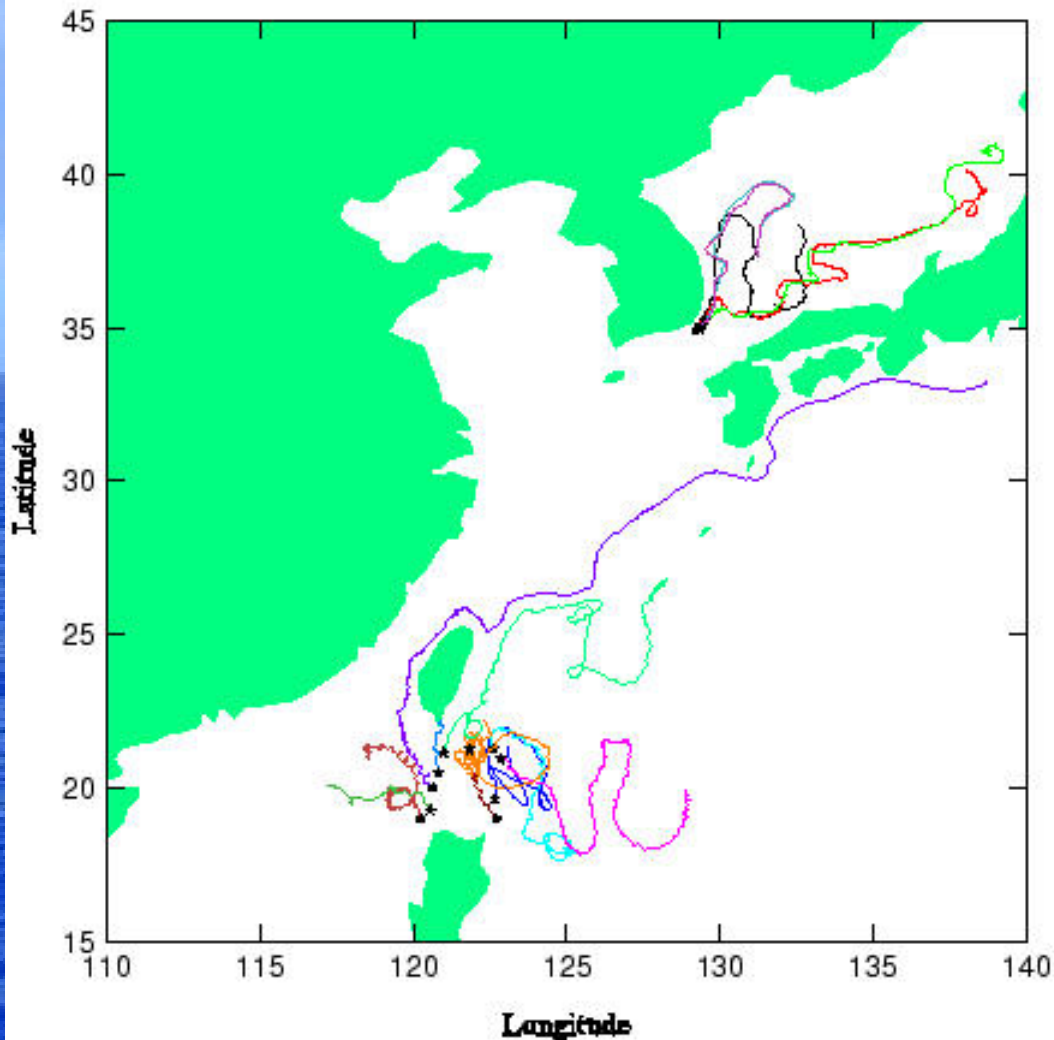


North Atlantic:	219
Tropical Atlantic:	169
South Atlantic:	152
North Pacific:	63
Equatorial Pacific:	206
South Pacific:	41
Indian Ocean:	147
Mediterranean Sea:	6
TOTAL	1003

Drifter Operations Center:
Shaun Dolk (Miami, FL USA)
Shaun.Dolk@noaa.gov

Deployment highlight: work with Korean colleagues

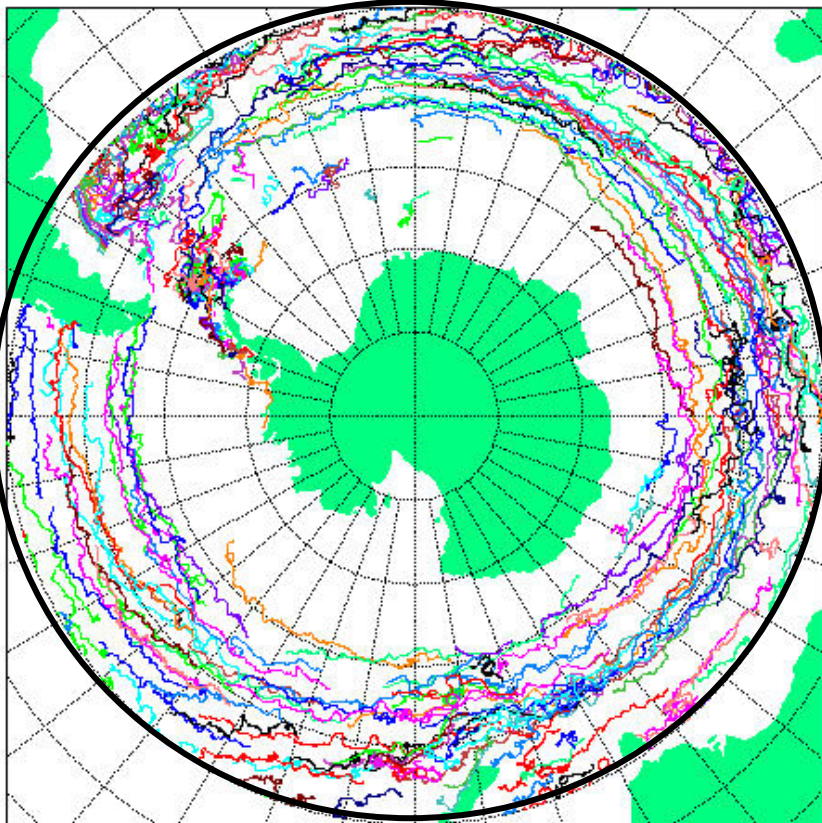
Deployments by Korea - May/June 2007



15 deployments so far,
expecting 35-40 more
within the next 12 months

Deployment highlight: high latitude deployments (IPY)

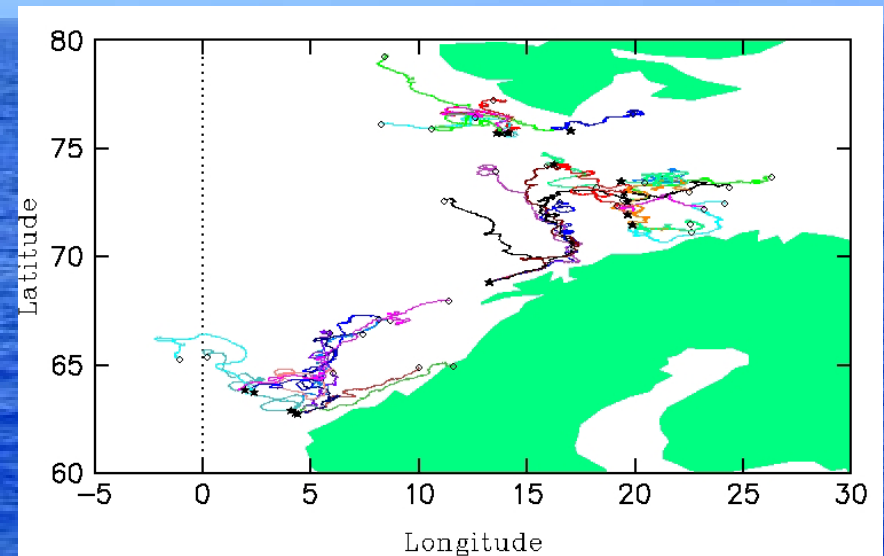
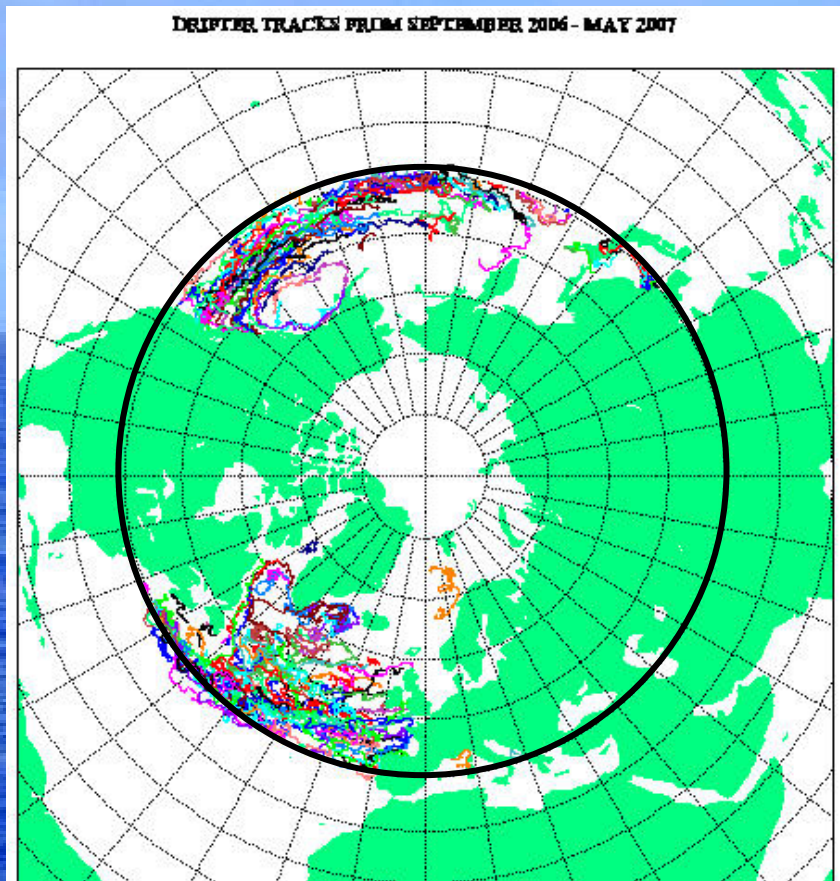
DRIFTER TRACKS FROM SEPTEMBER 2006 - MAY 2007



45 deployments planned for the Drake Passage, January—March 2008, in collaboration with NOAA/NMFS.

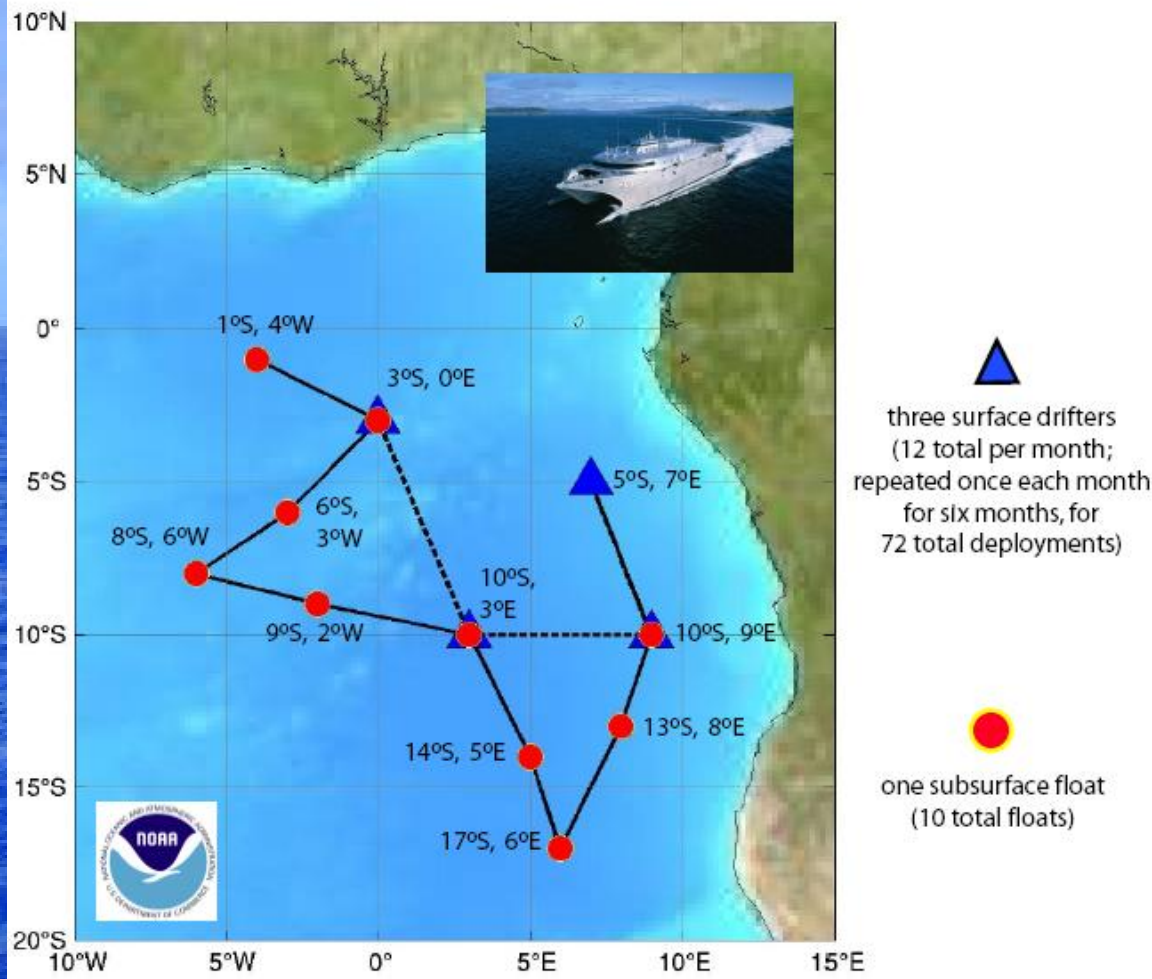
Deployment highlight: high latitude deployments (IPY)

150 deployments planned
in 2008—2009 in the
Nordic Seas (PI: Kjell
Orvik, Bergen, Norway).



Deployment highlights: Gulf of Guinea

Deployment locations for HSV-2 *Swift*



Collaboration between NOAA, US Navy and African nations bordering region (including training of African personnel).

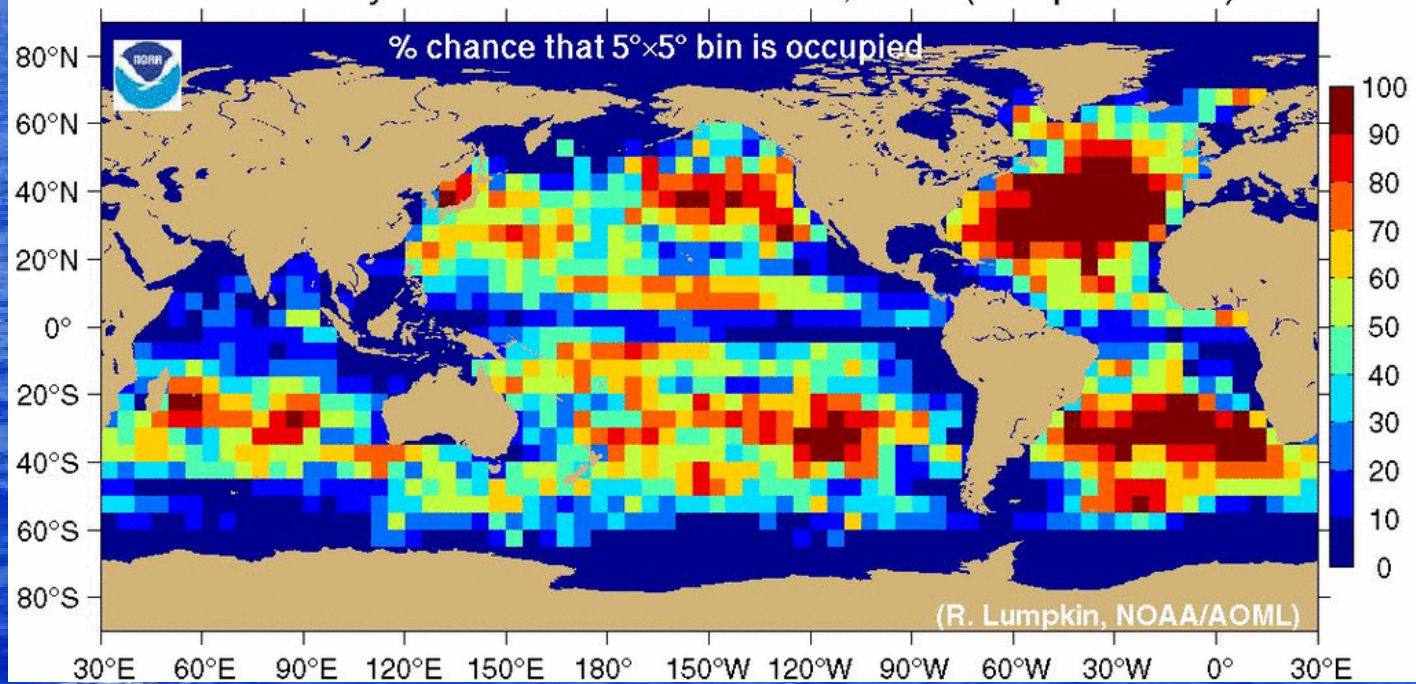
Deployments in a historically poorly sampled region.

72 total drifter deployments (+10 Argo floats).

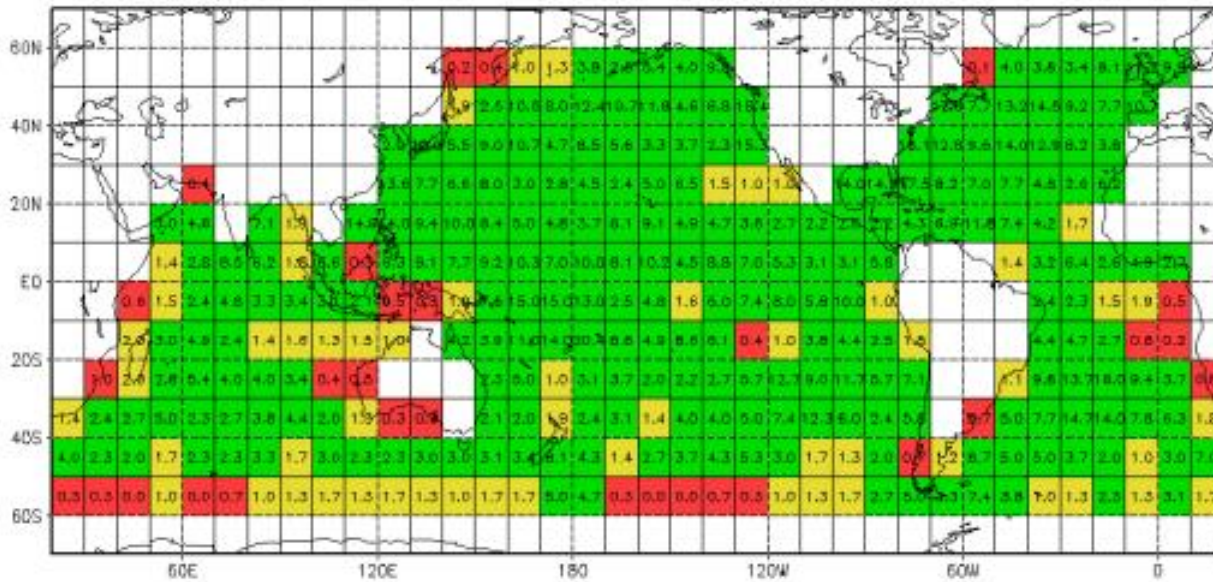
Planned for December 2007-mid 2008.

Plans to continue (if a success)

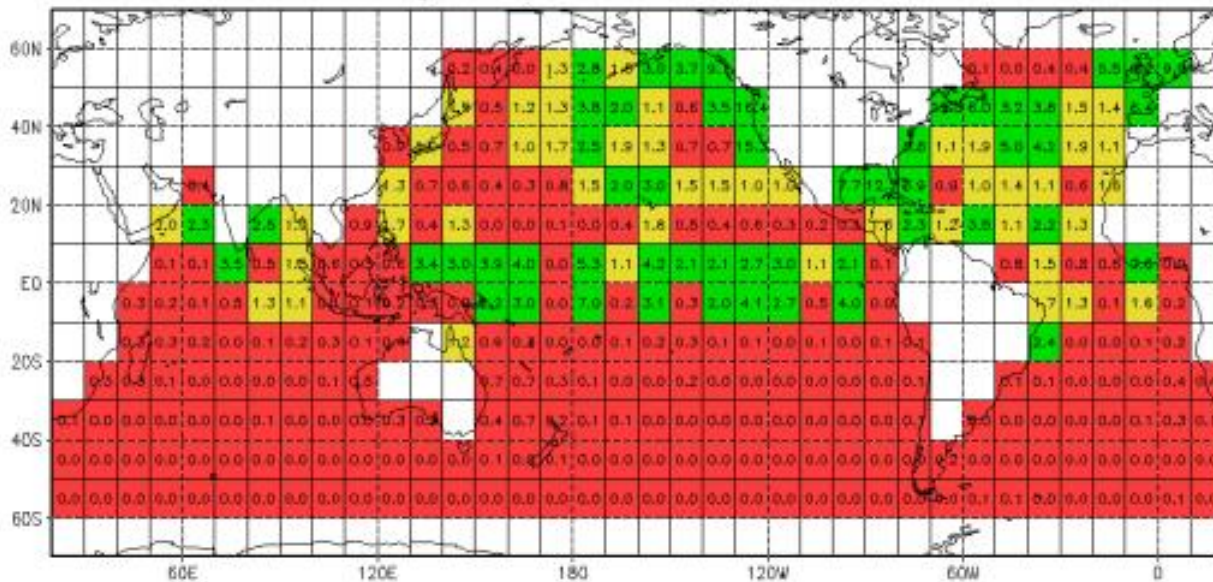
QuickTime?and a
TIFF (Uncompressed) decompressor
are needed to see this picture.



Total System EBD: JAN2006–MAR2006



NO Drifting Buoys EBD: JAN2006–MAR2006



SST measurements quantified by “Equivalent Buoy Density”.

Top: EBD from ships, moored buoys and drifters.

Green: square well sampled for SST.

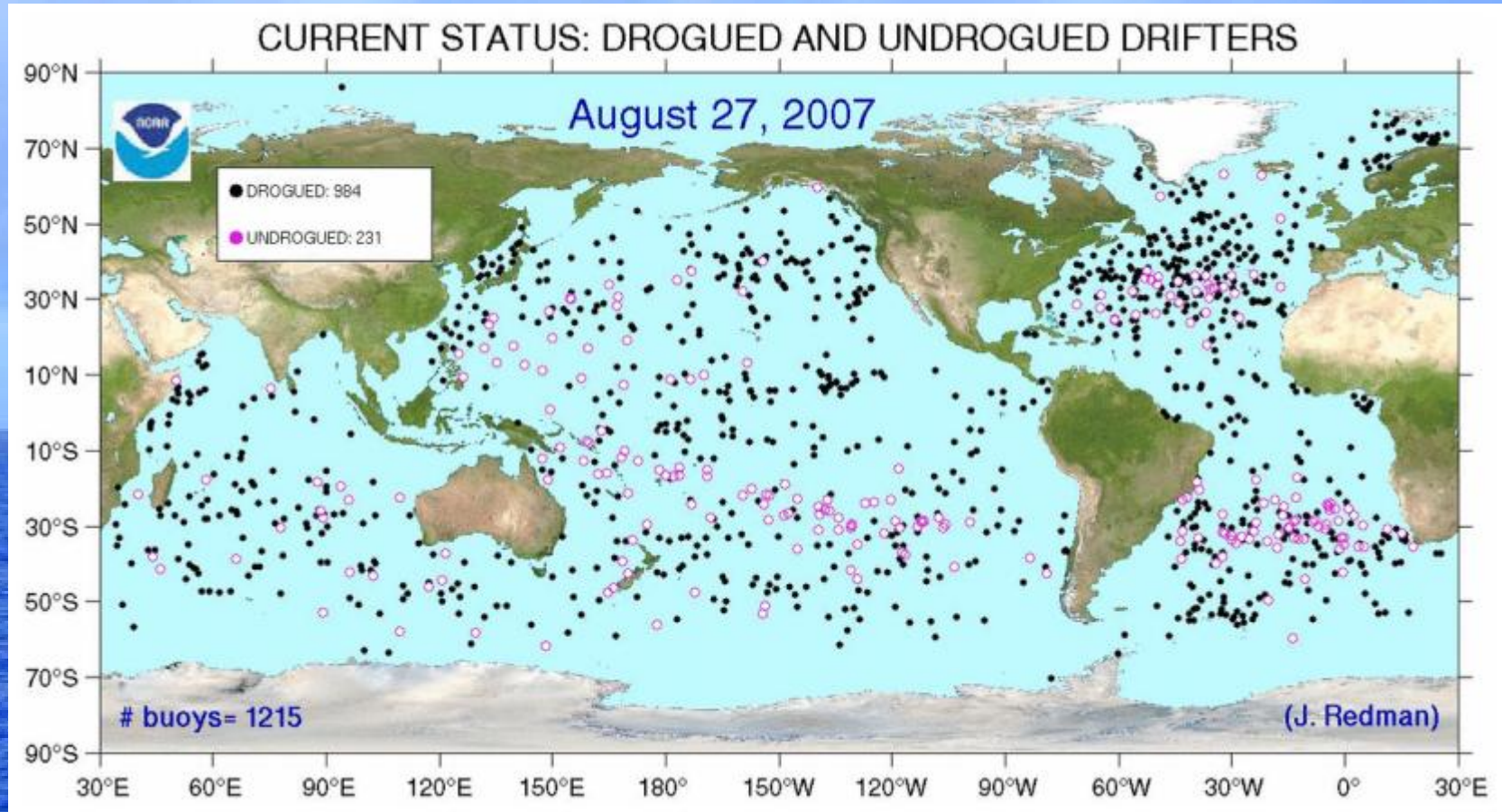
Yellow: marginal.

Red: poorly sampled.

Bottom: no drifters (ships and moorings only).

Figure courtesy
Huai-min Zhang,
NOAA/NCDC

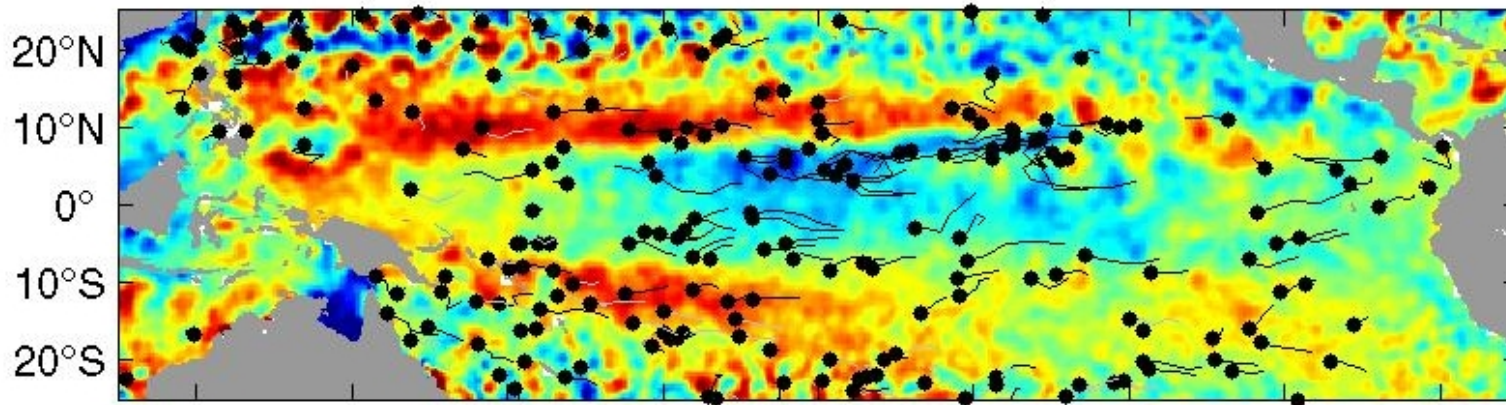
drifter measurements: Mixed layer currents



Black Bullets: location of all (984) drogued drifters .

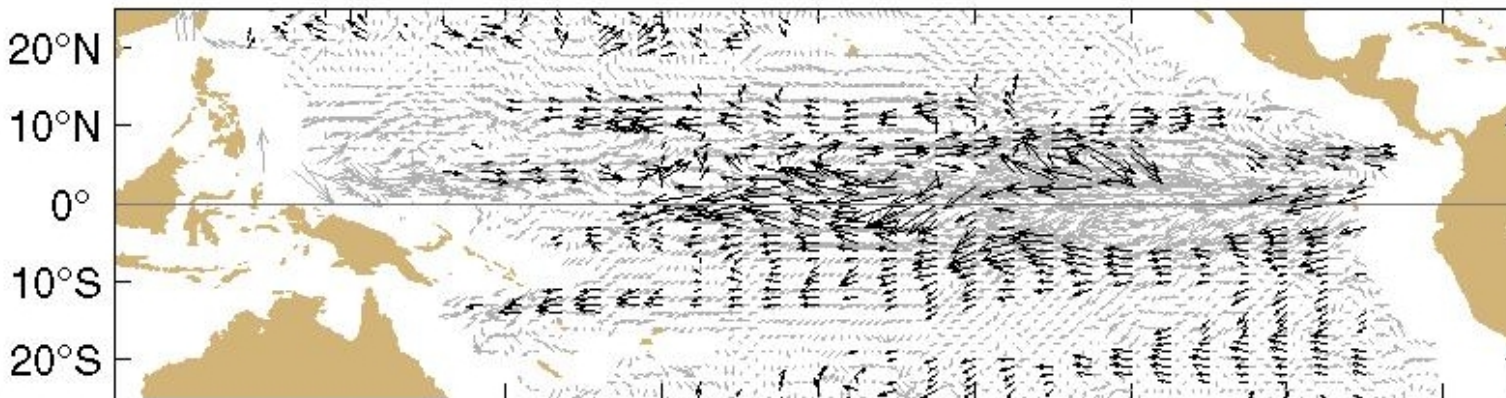
Open pink: drifters without drogues, still measuring SST.

August 2007 – Tropical Pacific drifter array

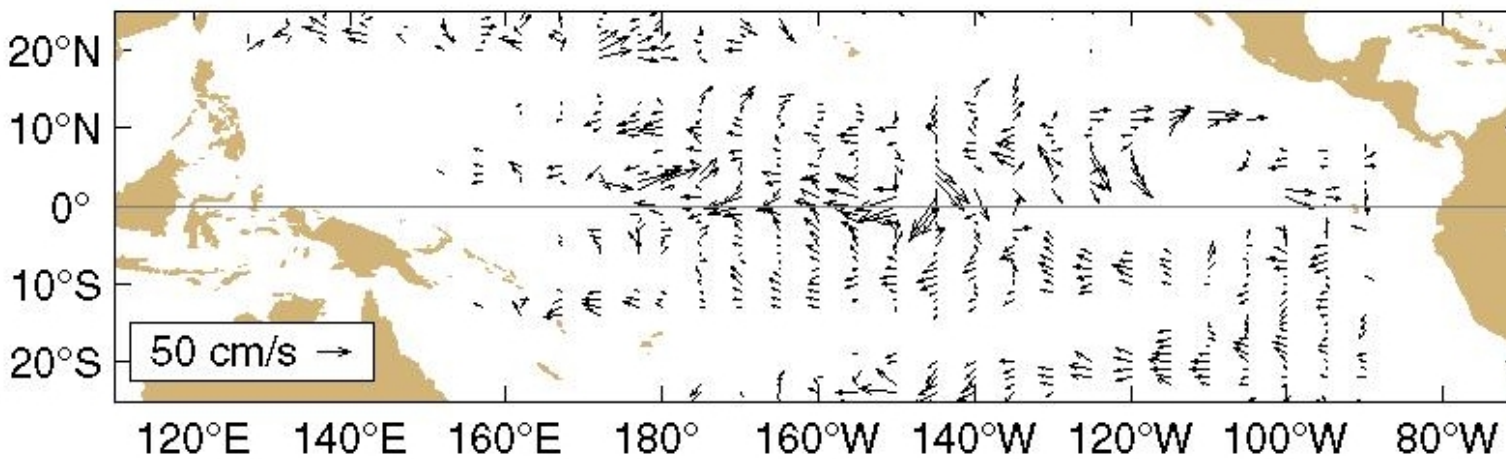


August 2007: 298 drifters in Tropical Pacific, 84% with drogues attached.

Shading: AVISO gridded sea level anomaly (-30 to 30 cm).



Drogued drifter velocities during August 2007 (black) and for climatological August (grey).

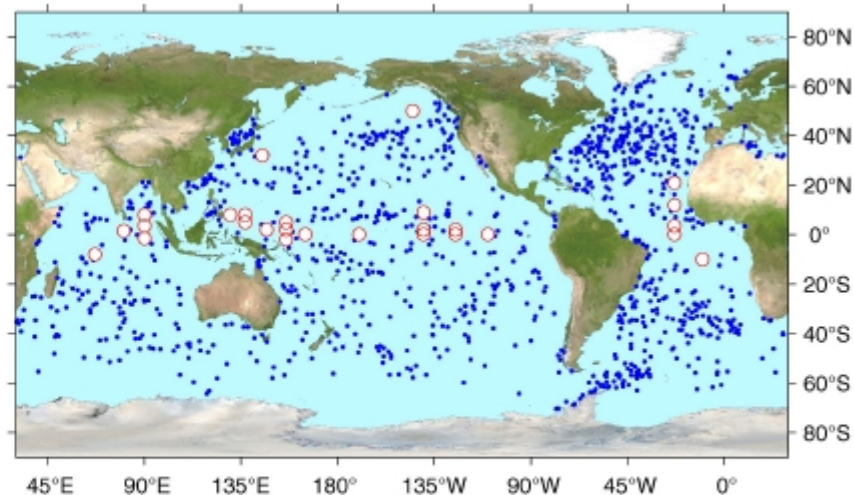


Velocity anomalies (August 2007 minus climatological August).

Observing System Status: 2007, Q2. Surface Currents (experimental)

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

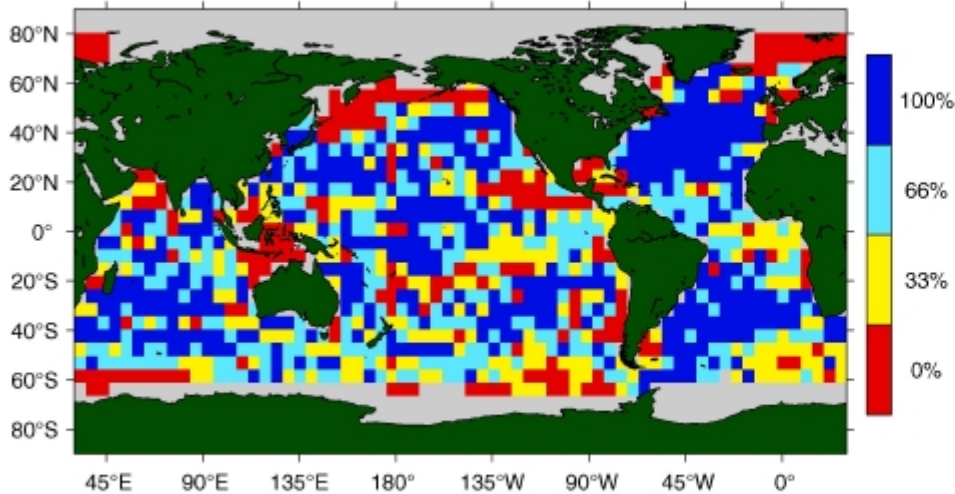
Performance measure: reduce the error in global
measurement of surface velocity



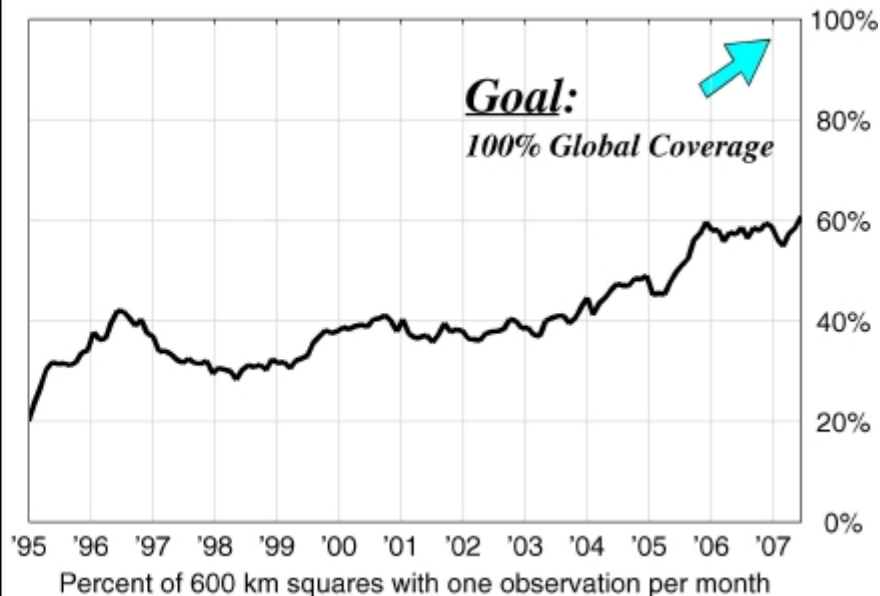
Observing system status, April-June 2007

• Drogued drifting buoys: 1183 ○ Moored buoys: 27

Requirement: all boxes blue

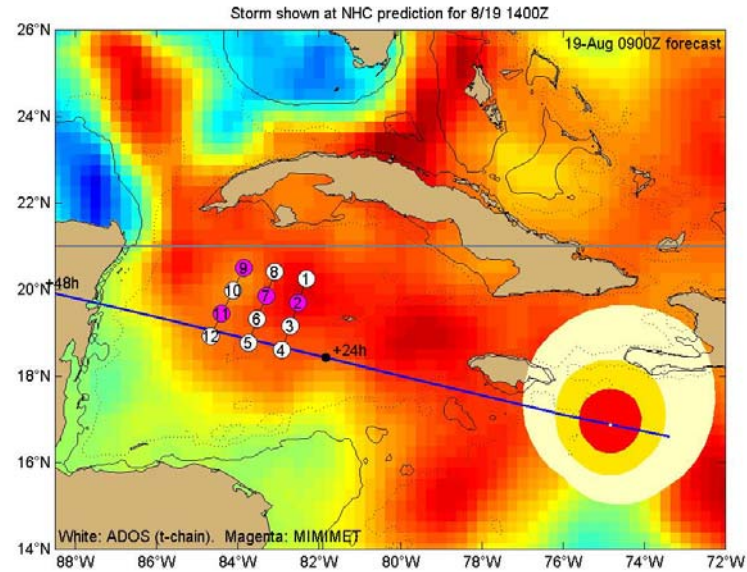


Percent of months in quarter with at least one observation



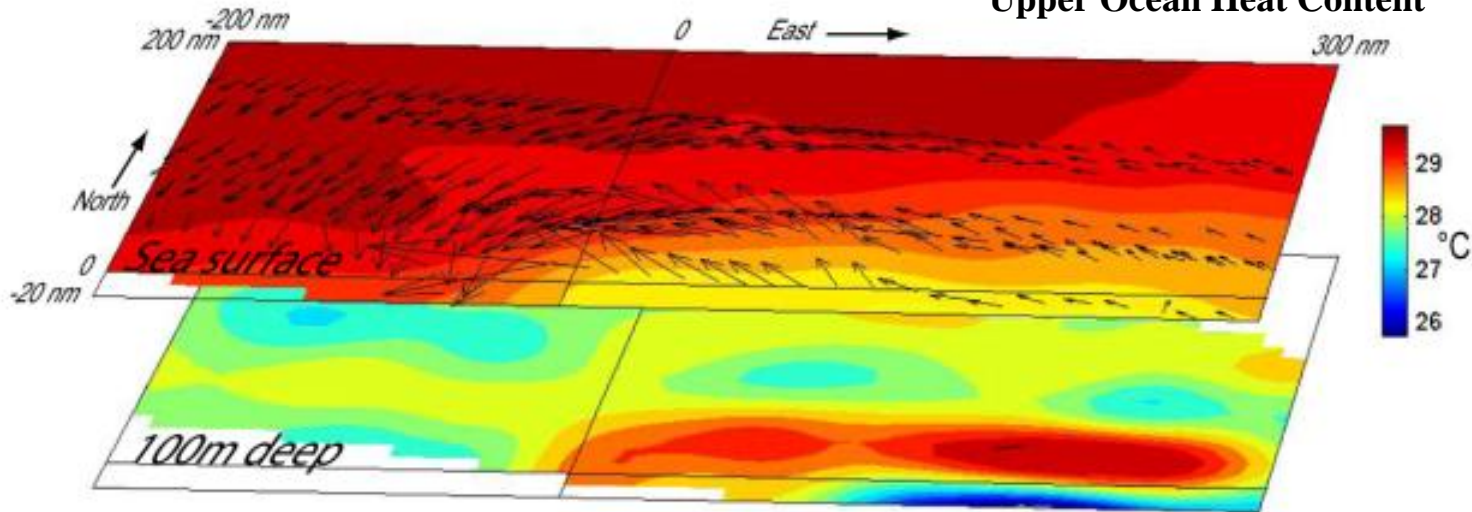
Percent of 600 km squares with one observation per month

2007 Hurricane array drifter deployments



Array of 12 Minimet and ADOS (thermistor chain) drifters deployed in front of major hurricane "Dean", August 2007.

Upper Ocean Heat Content



Top: Sea surface temperature (shading, °C) and winds (arrows) measured by the hurricane drifter array at top. Bottom: subsurface temperatures at a depth of 100m.

sea surface salinity



2005 COSMOS deployments: 17 drifters in Bay of Biscaye



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

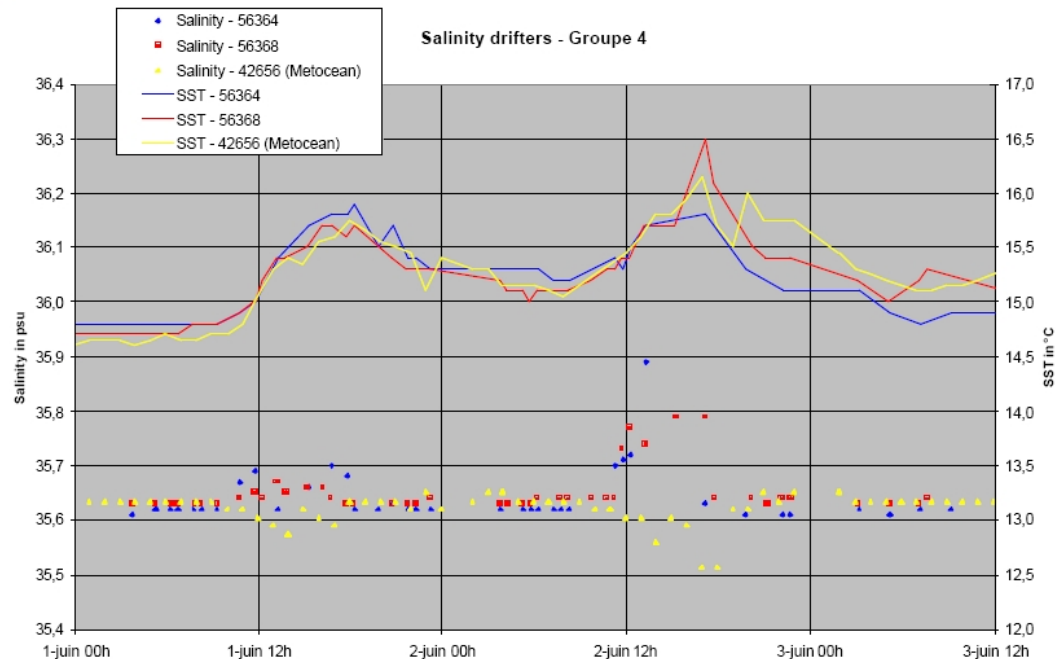
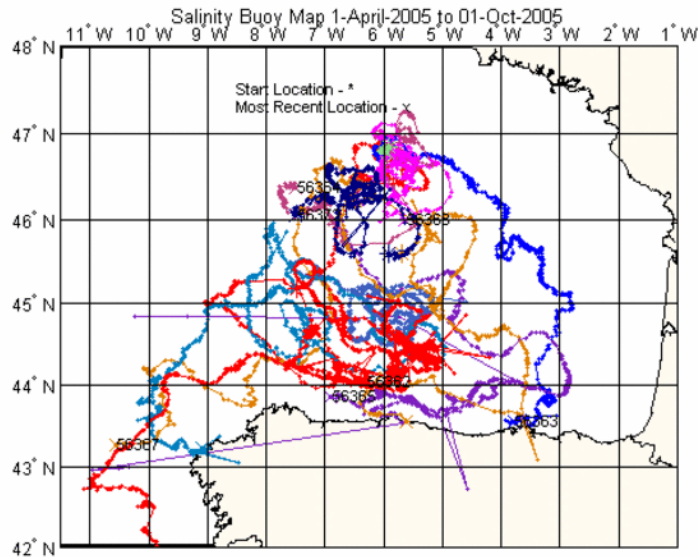


Figure 1: photograph of METOCEAN drifter 52197 in December 2005, roughly one week after its recovery during the CONGAS2 cruise. The subsurface sensor area is shown with noticeable algal fouling near the sensors.

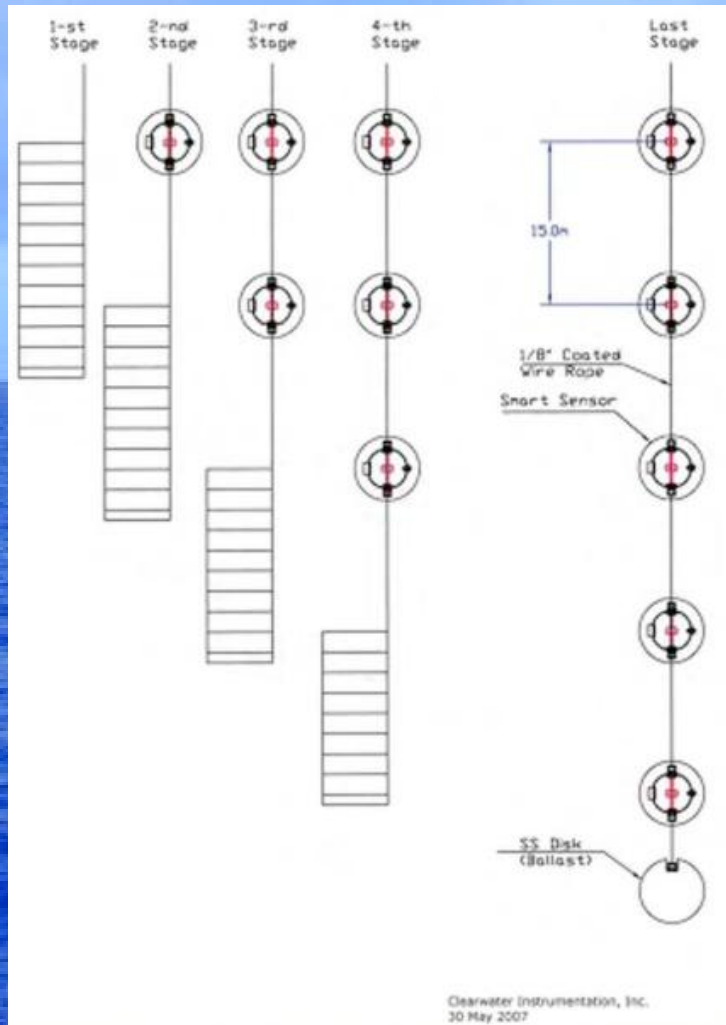
Figure 2: Two daily cycles (June 1 and June 2 2005) during a period of weak wind and low cloudiness for three close-by drifters (SIO drifters: 56364, 56368; Metocean drifter: 42656).

Technological development,
Research, etc.



Spooled thermistor chain drifters

(work with G. Williams)



P-3 deployable

150m long thermistor-chain

Built for P. Niiler by Clearwater Instruments, Inc. with NOAA support. The subsurface temperature data is sent up via digital induction through a 1/8" dia cable that is presently used to attach all drogues to the 1000 SVP drifters built each year for the "Global Drifter Program".

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.

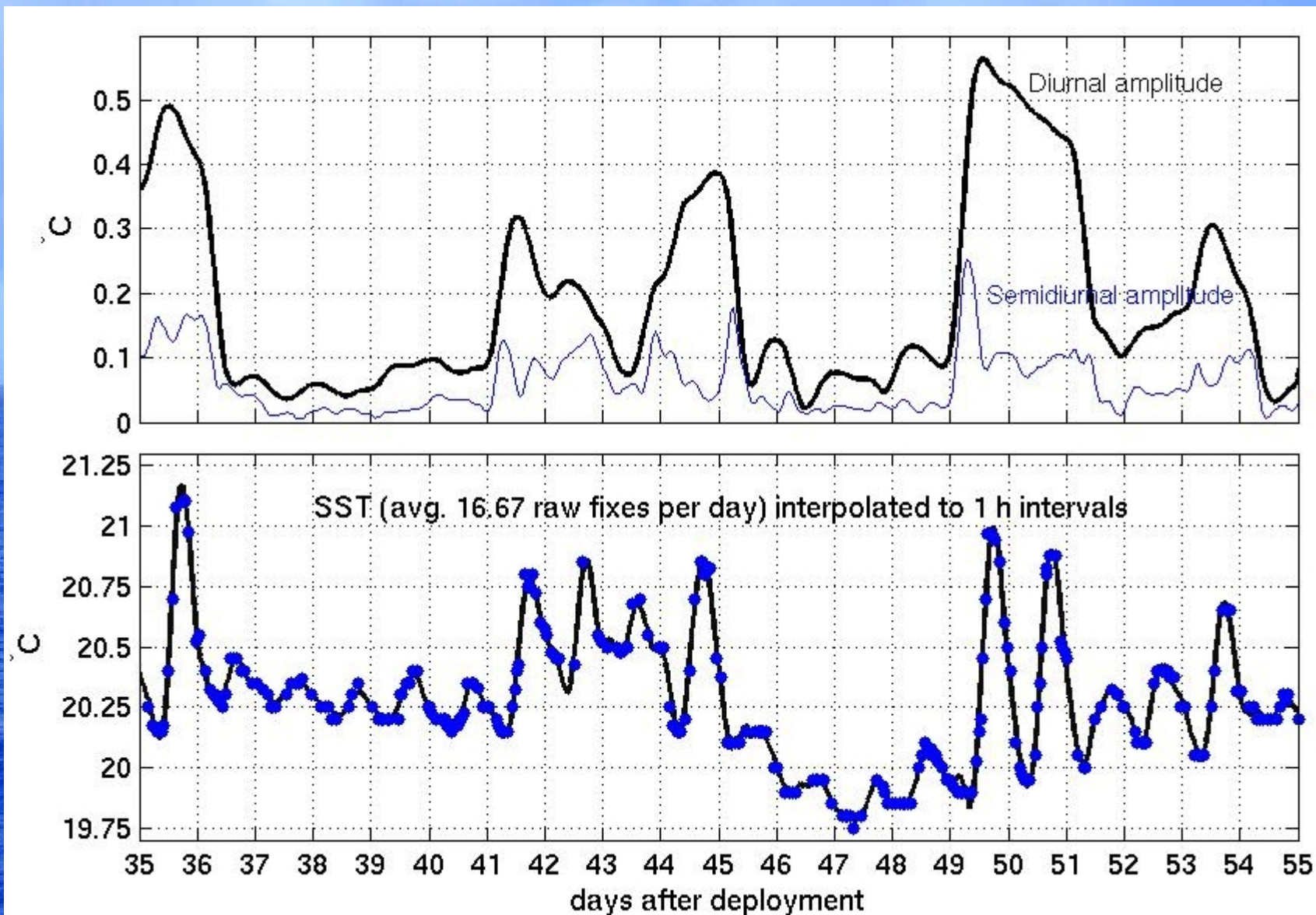
Extremely accurate time tag comes with Argos message.

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

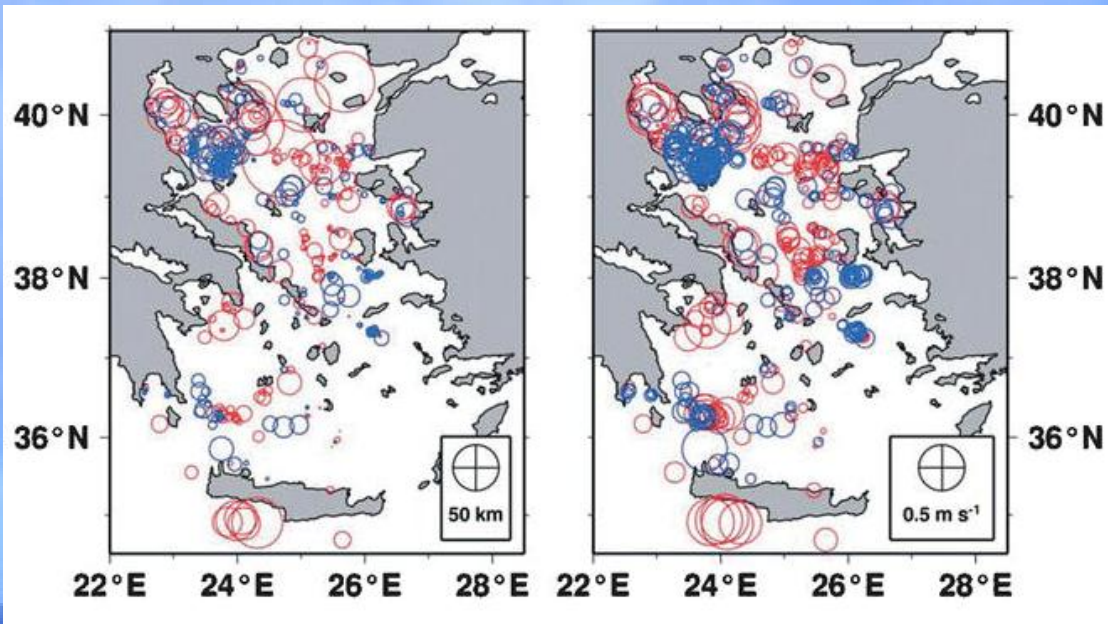
Issues:

- 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.”

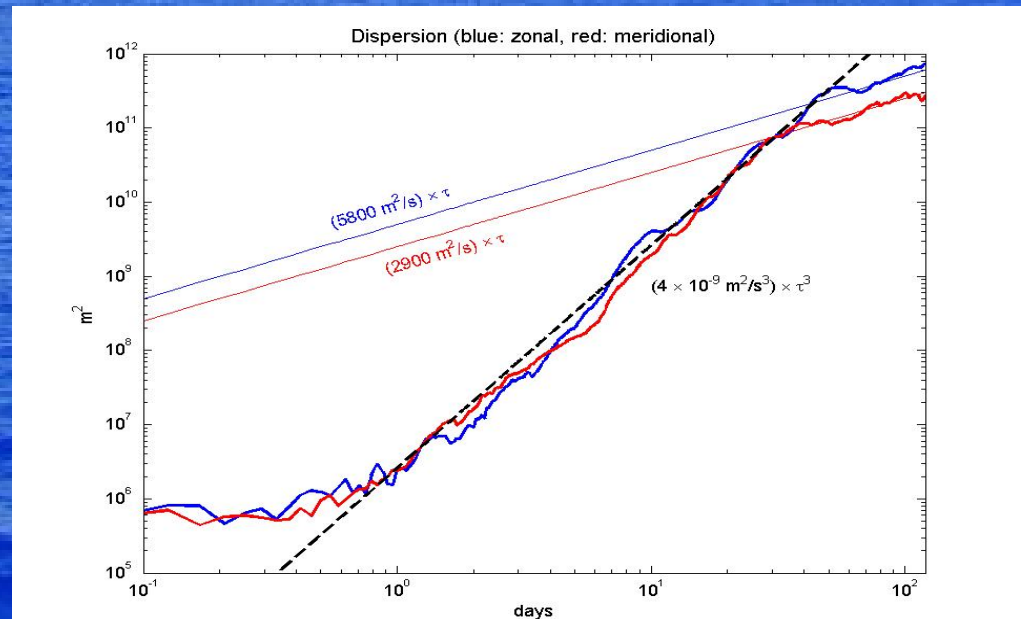


Oceanographic and climate research

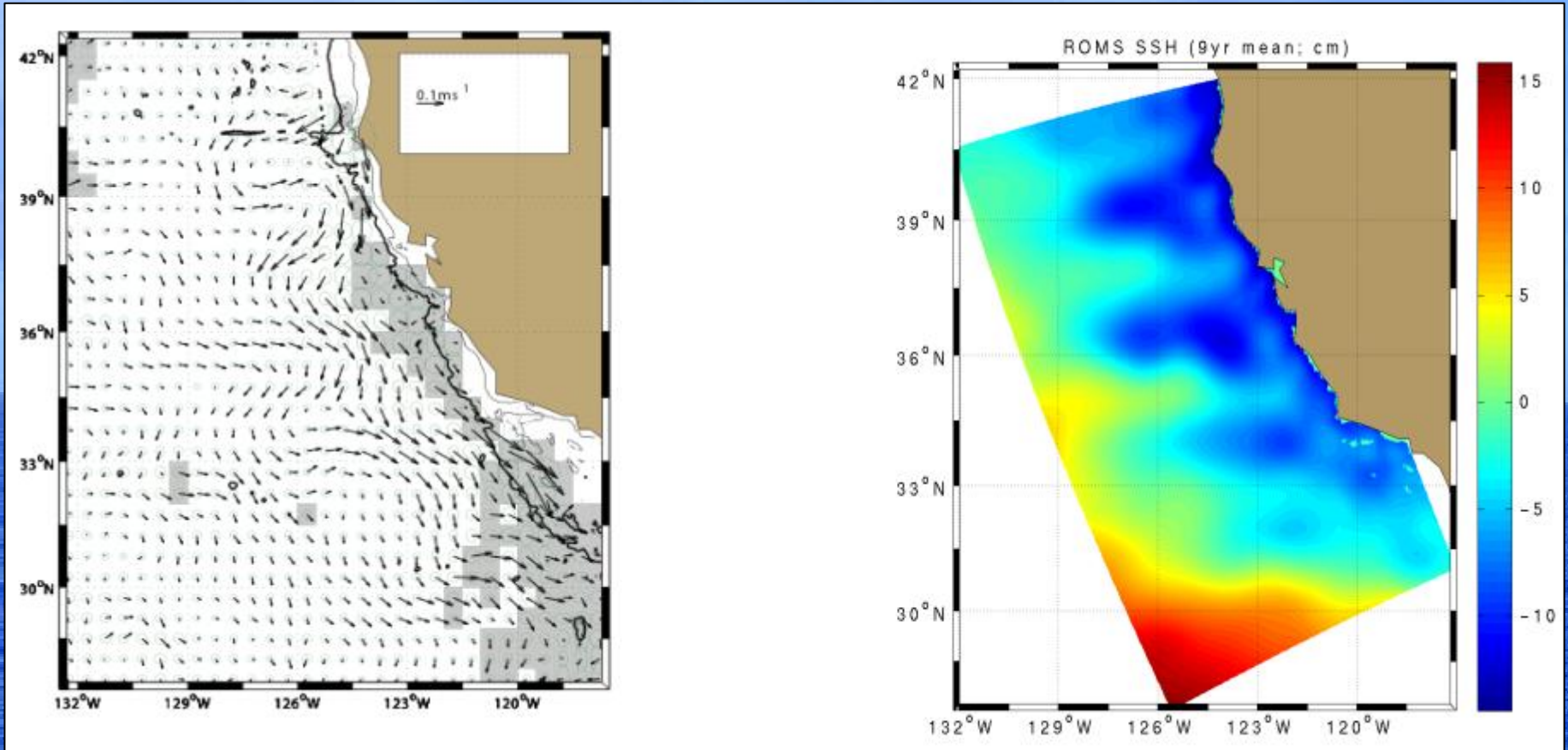


Distribution of size (left) and strength (right) of anticyclonic (red) and cyclonic (blue) eddies in the Aegean Sea, derived from drifter observations (Olson et al, 2007).

Relative dispersion of 60 drifter pairs in the Gulf Stream region, deployed in February—March 2007 as part of the CLIVAR Mode Water Dynamics Experiment (R. Lumpkin).



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.

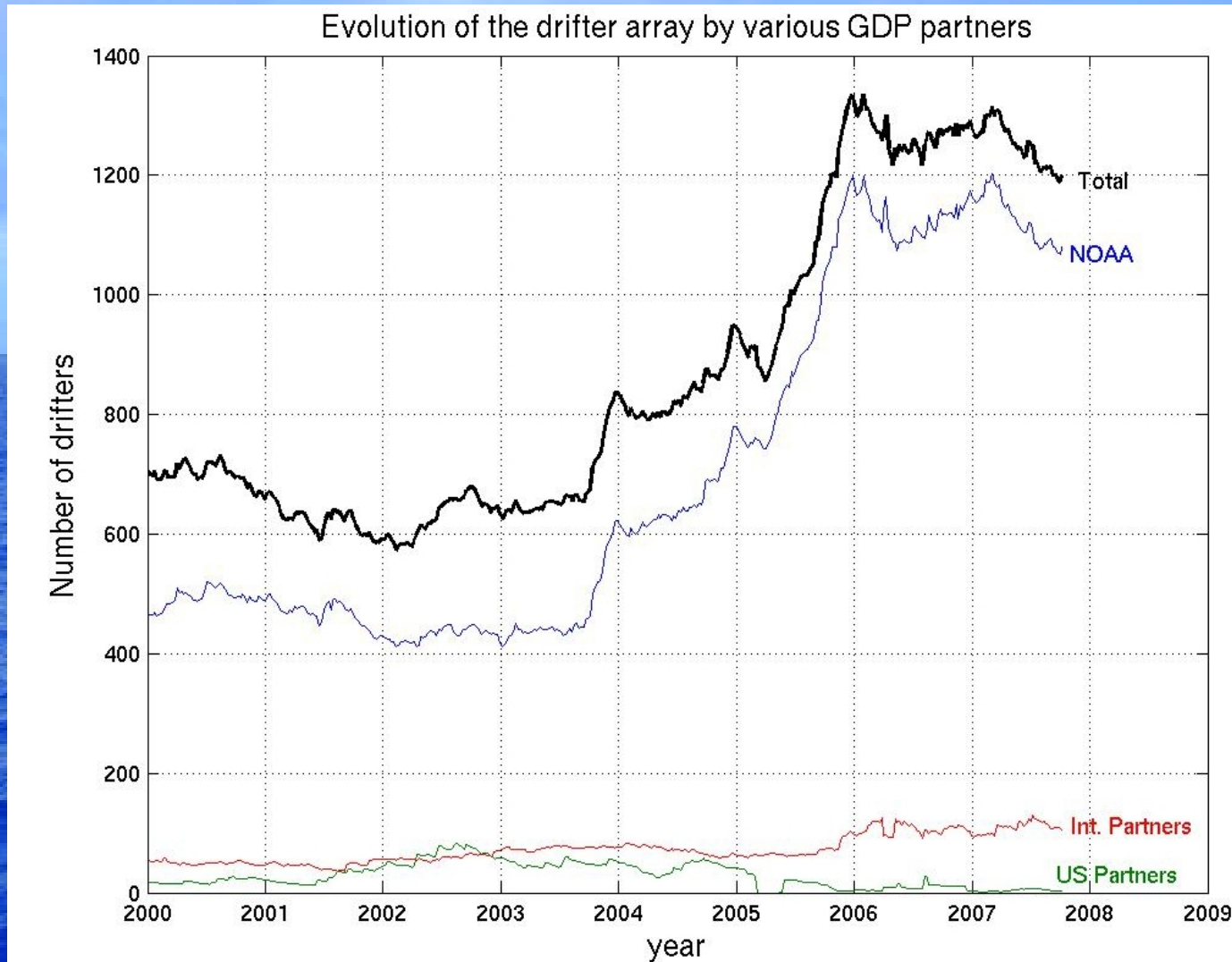
2008: Goals and plans

Deploy 1000 Drifters in the period between October 2007 and September 2008.

International Polar Year: focus on high latitudes.

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

In 2007, international partners maintained about 10% or 120, “others” were 50 in 2006 and 5 in 2007. NOAA has maintained about 1150 since Sept 2005. Increased commitment is sought from international partners.



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

Voluntary Observation Ships (VOS) program

International Ice Patrol

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

Leibniz-Institut für Meereswissenschaften an der Universität
Kiel (Germany)

New Zealand Met. Service

Australian Bureau of Meteorology

Fundação Universidade Federal do Rio Grande; Instituto
Nacional de Meteorologia; Centro de Hydrografia de
Marinha; INPE (Nacional Space Institute); Brazilian
Navy (Brazil)

Fisheries Research Institute; Servicio de Hidrografía Naval
(Argentina)

Instituto Canario de Ciencias Marinas; Universidad de Las
Palmas de Gran Canaria (Spain)

Instituto Nazionale di Oceanografia e di Geofisica
Sperimentale (Italy)

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

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

National Oceanographic Research Institute; Ministry of
Maritime Affairs and Fisheries (Korea)

Tristan da Cunha Administration, Tristan Island

United Kingdom Met Office

Environment Canada

University of Cape Town; South African Weather
Service (South Africa)

Scripps Institution of Oceanography, Woods Hole
Oceanographic Institution, Oregon State
University, NOAA/Pacific Marine
Environmental Laboratory

United States Air Force

Marine Resources Research Institute

US Naval Oceanographic Office

United States Coast Guard

Raytheon Polar Services