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, NOAA/AOML

25th Data Buoy Cooperation Panel session

28 September – 1 October 2009

Paris, France

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 satellite-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

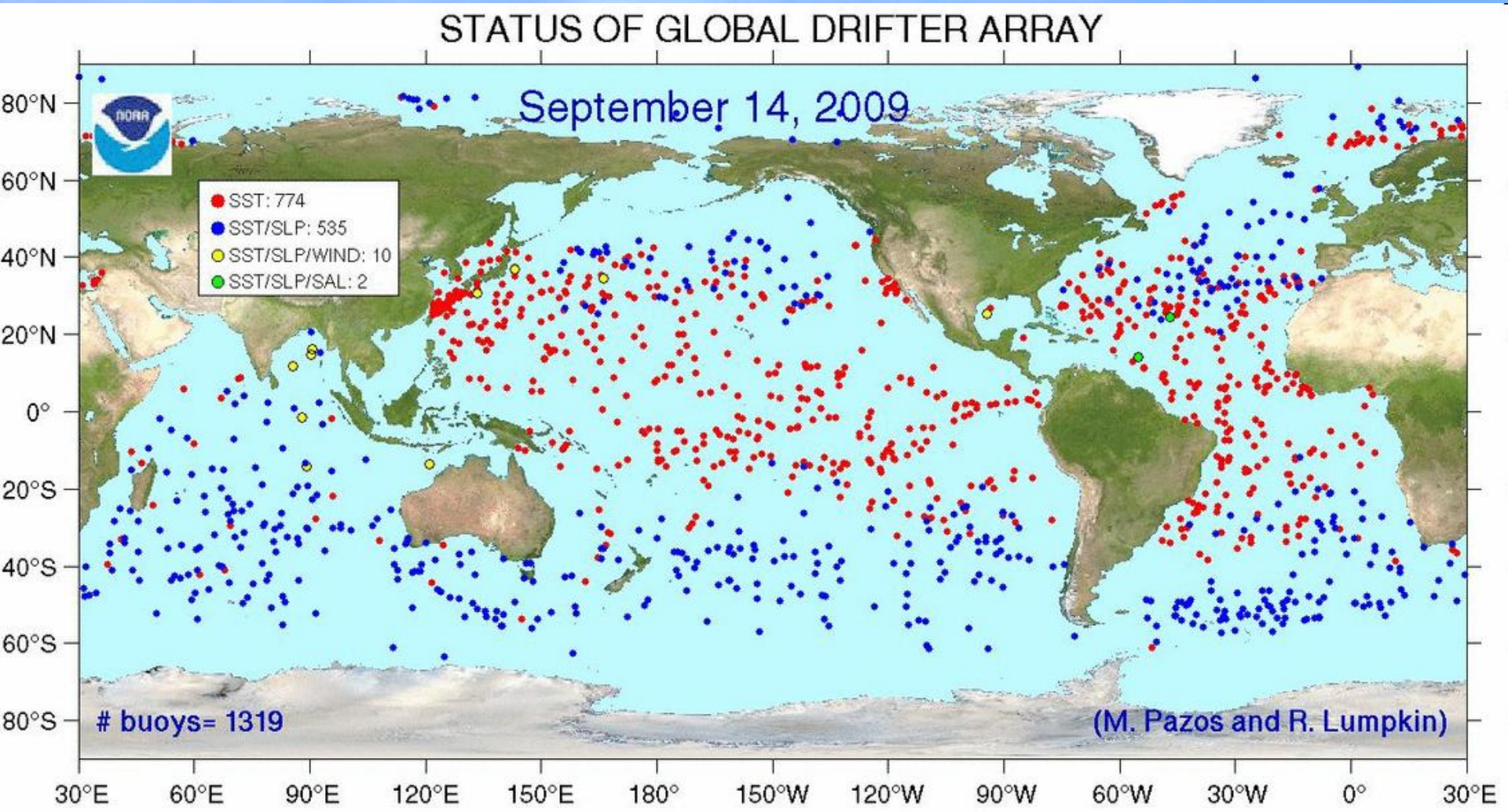
- NOAA's Atlantic Oceanographic and Meteorological Laboratory ***(AOML)***: coordinates deployments, processes the data, archives data at AOML and at MEDS (Canada), maintains META files describing each drifter deployed, develops and distributes data-based products, updates the GDP website

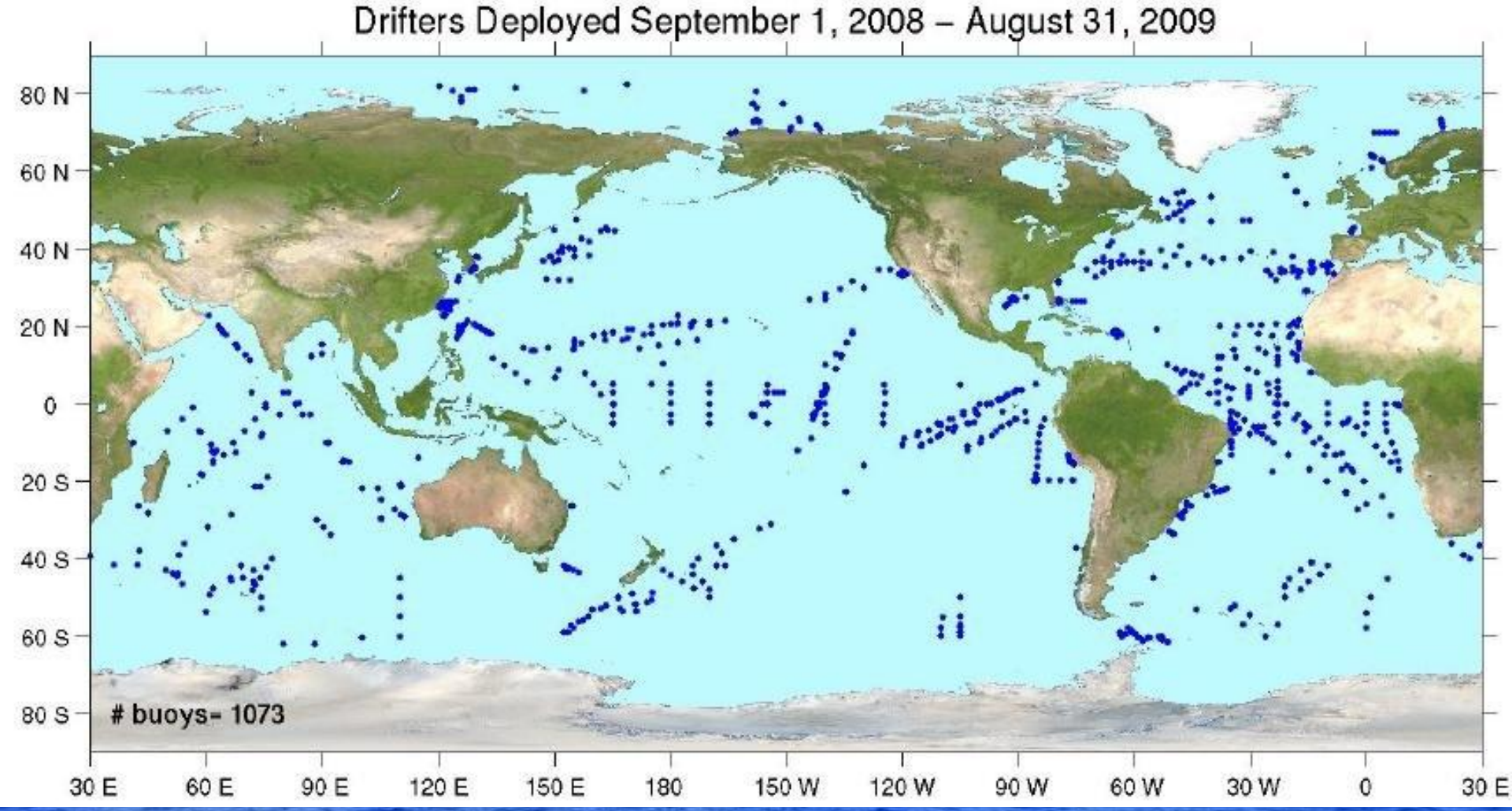
- NOAA's Joint Institute of Marine Observations ***(JIMO)***: supervises the industry, upgrades the technology, develops enhanced data sets

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

Current status of the global array

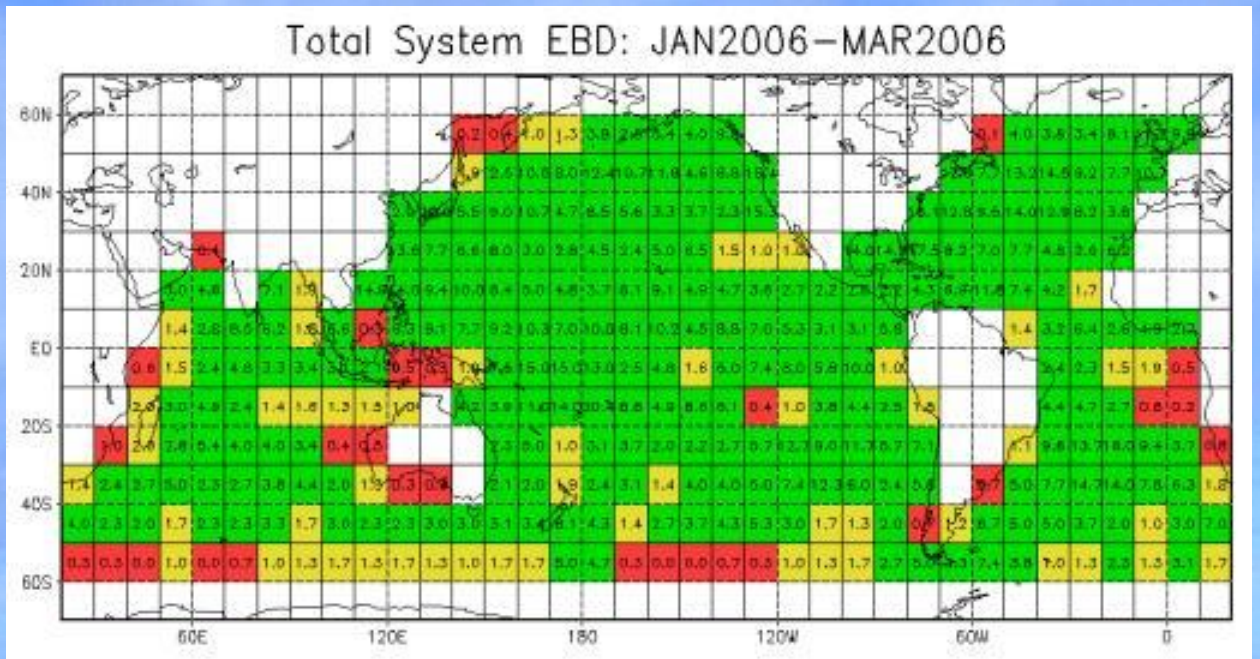
1319 GDP drifters (goal: 1250 annual average)

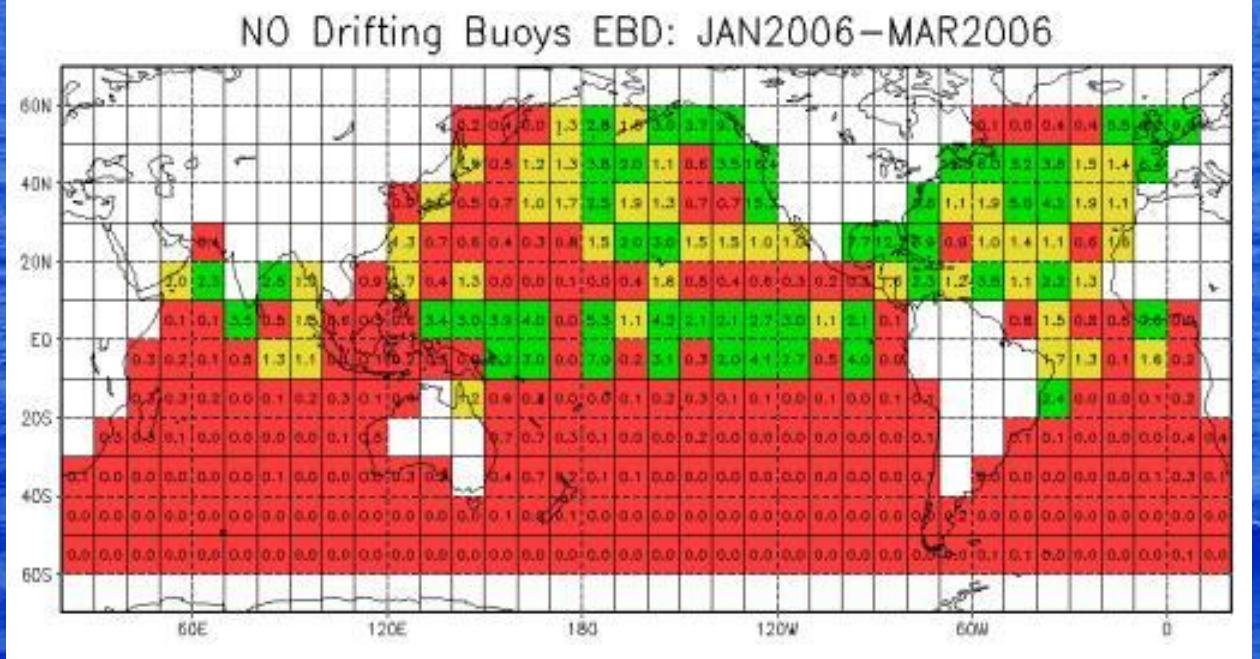




1073 drifters deployed (slightly exceeded goal of 1000 drifters)

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





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

Equivalent Buoy Density for most recently completed quarter

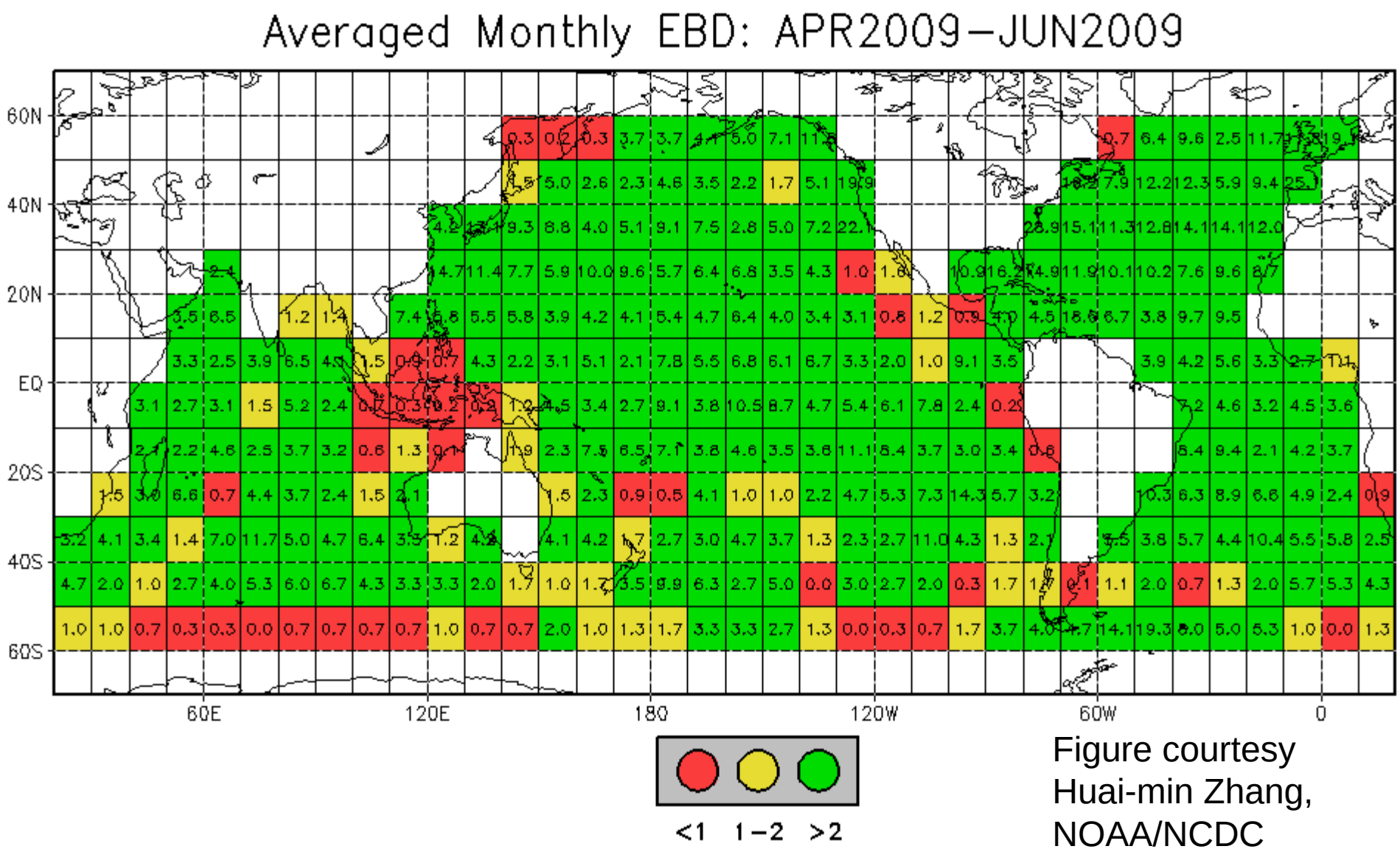
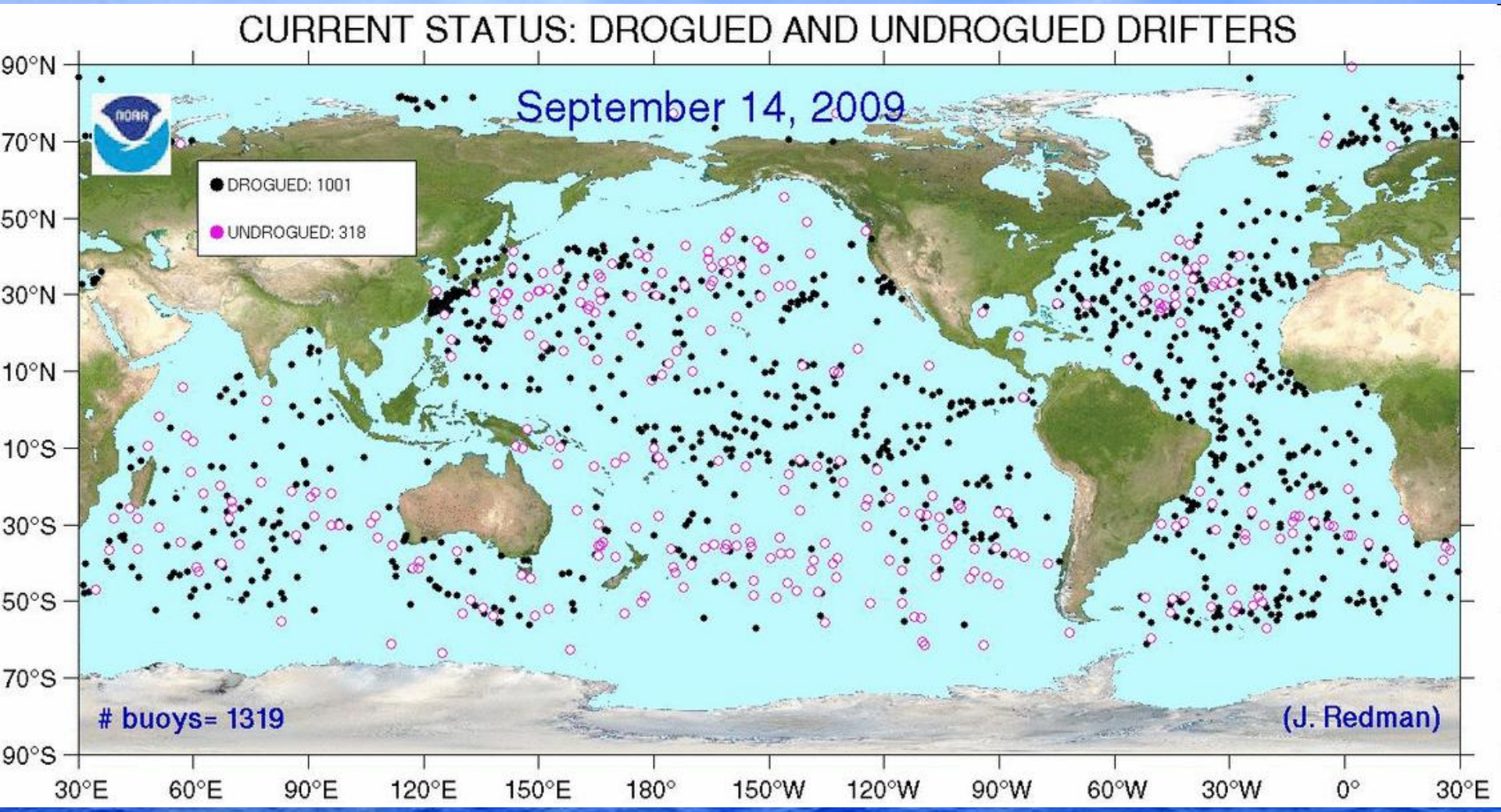


Figure courtesy Huai-min Zhang, NOAA/NCDC

Mixed layer current measurements

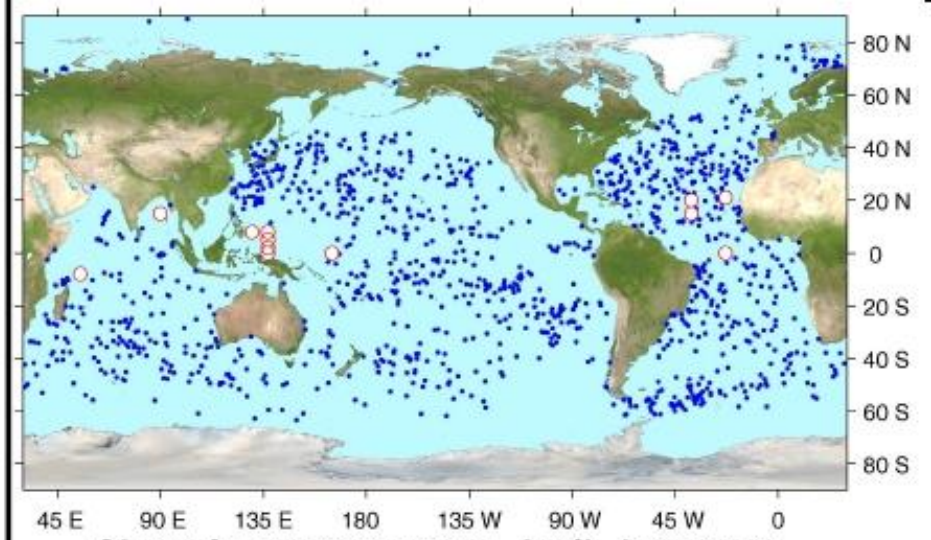


***Black Bullets*:** location of all (~100) drogued drifters .
***Open pink*:** drifters without drogues, still measuring SST.
~75% of the array has drogues attached.

Observing System Status: 2009, Q2.
Surface Currents (experimental)

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

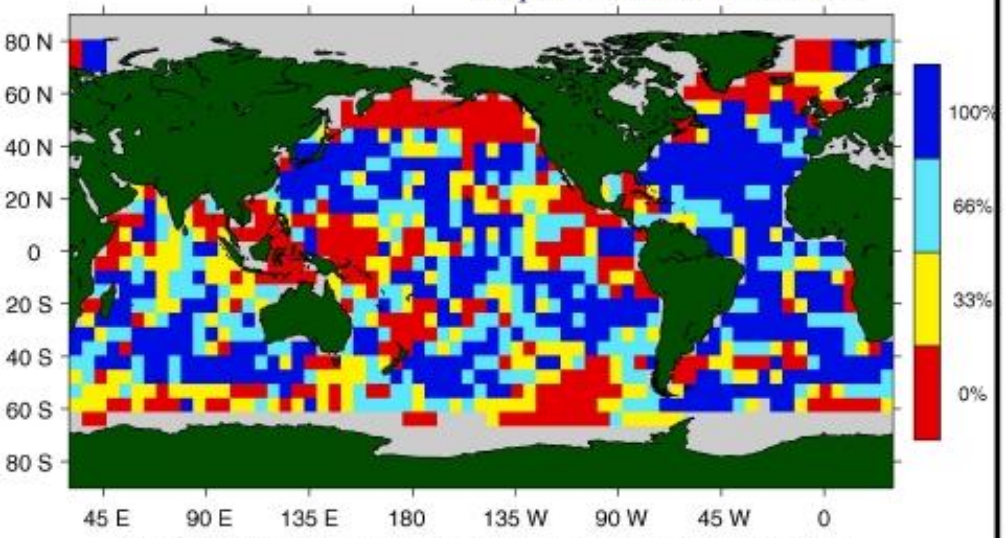
Performance measure: reduce the error in global measurement of surface velocity



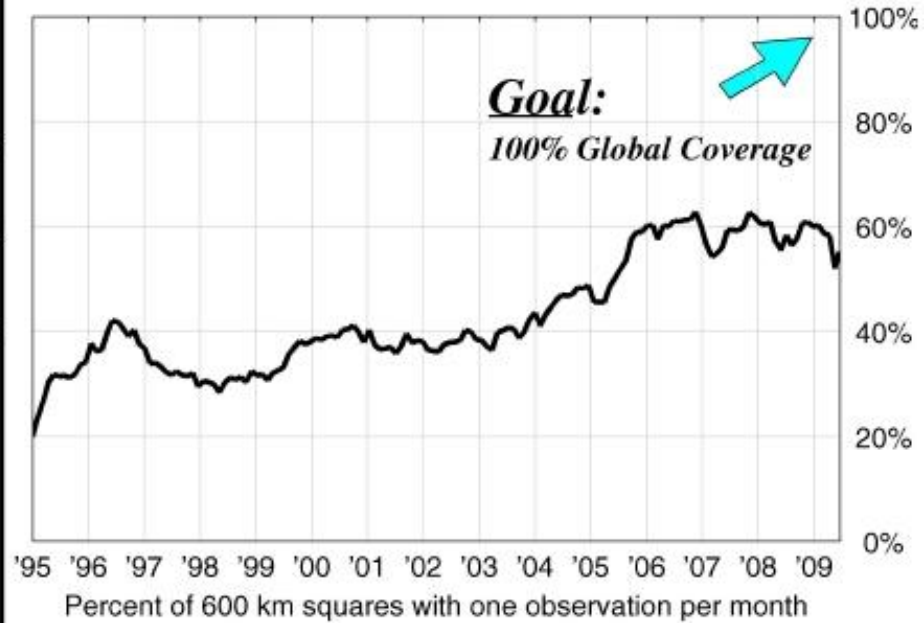
Observing system status, April–June 2009

• Drogued drifting buoys: 1238 ○ Moored buoys: 12

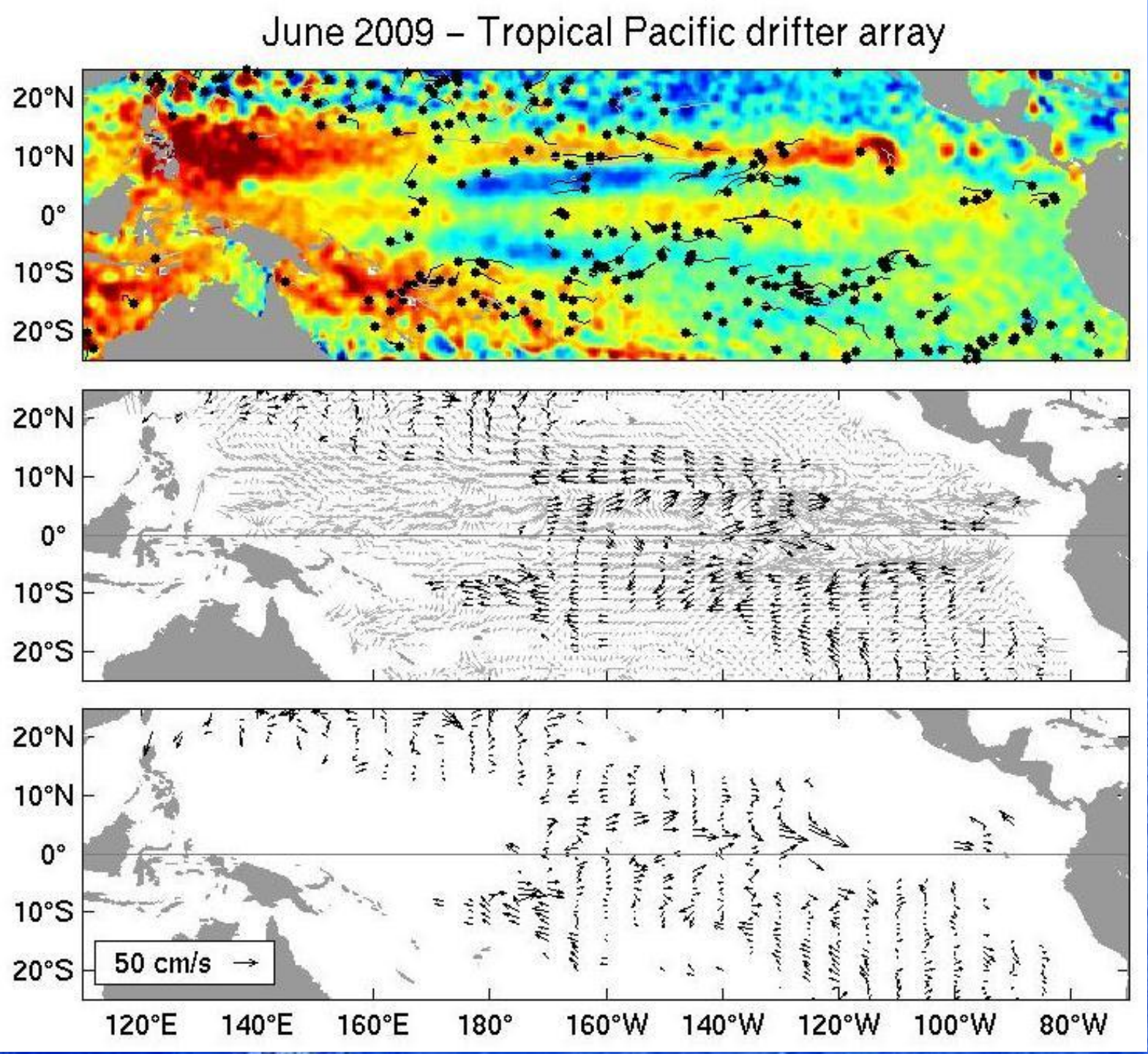
Requirement: all boxes blue



Percent of months in quarter with at least one observation



Percent of 600 km squares with one observation per month



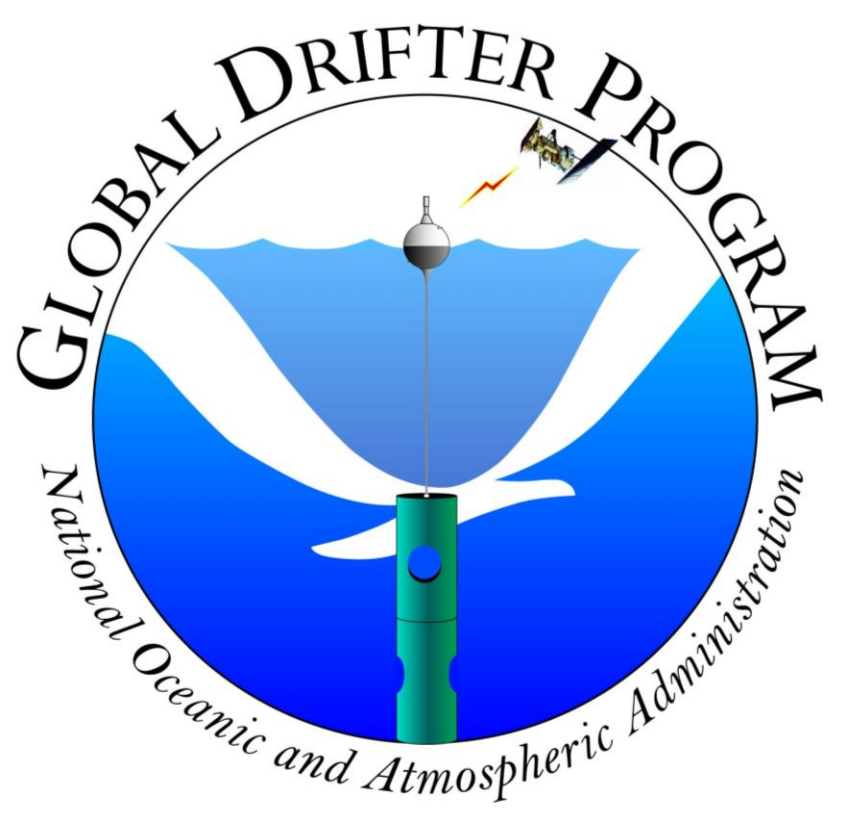
June 2009: 298 drifters in Tropical Pacific, 84% with drogues attached.

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

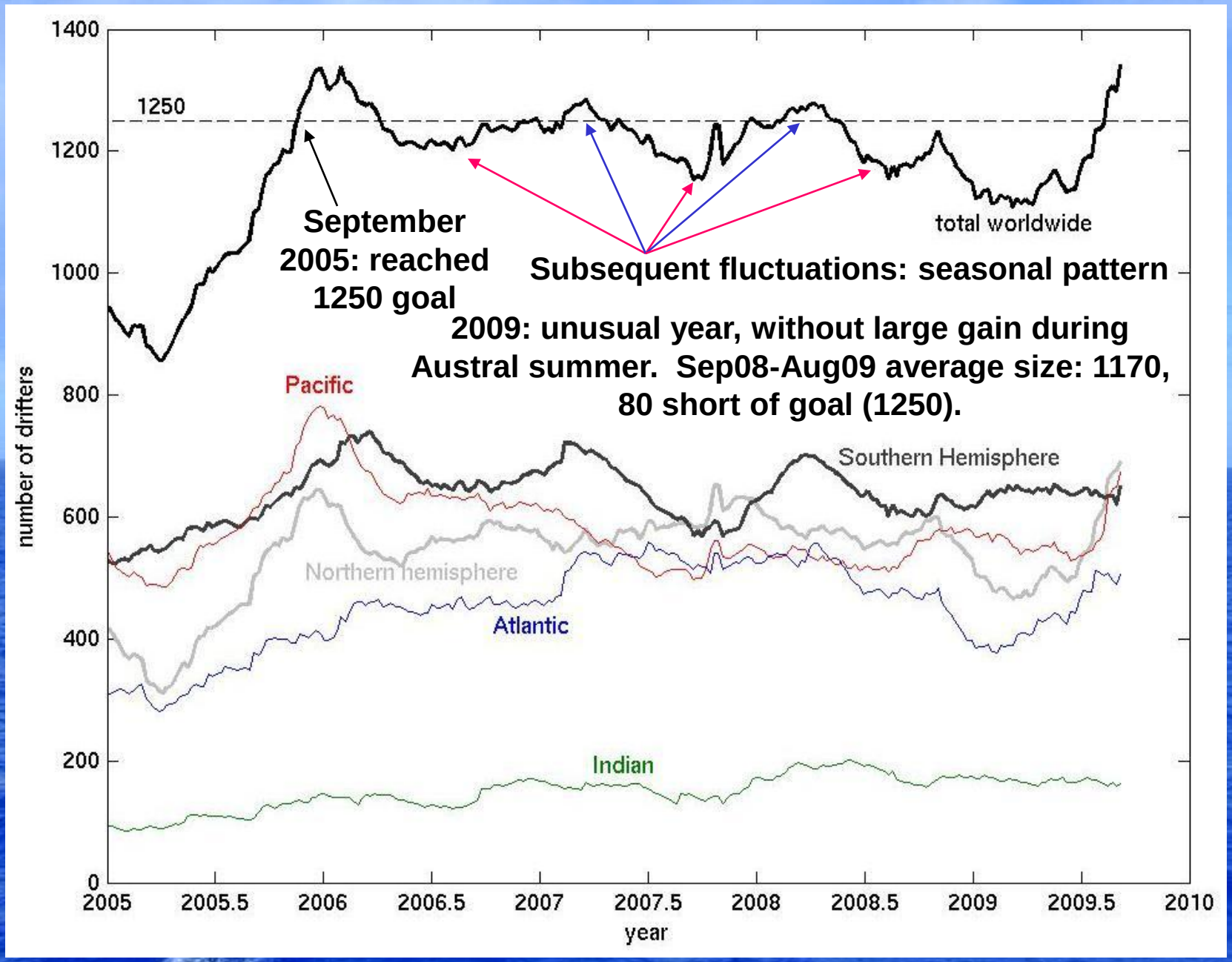
Drogued drifter velocities during June 2009 (black) and for climatological June (grey).

Velocity anomalies (June 2009 minus climatological June).

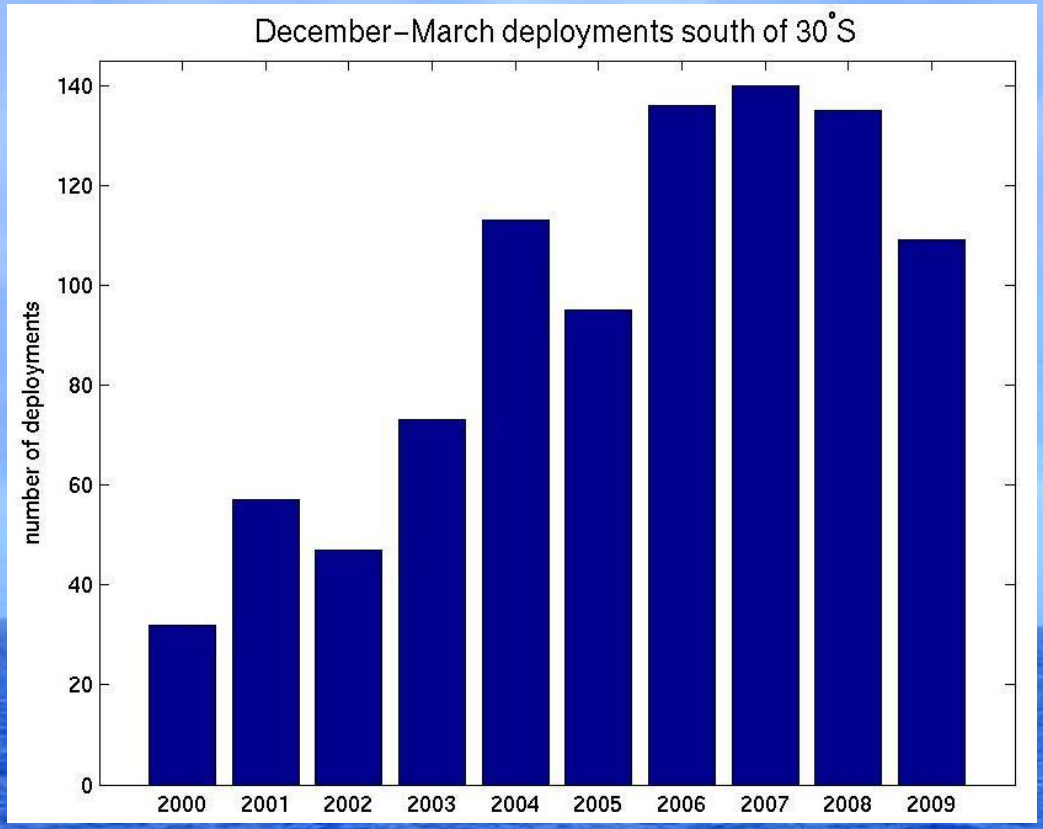
Evaluation of the global drifter array



Number of drifters



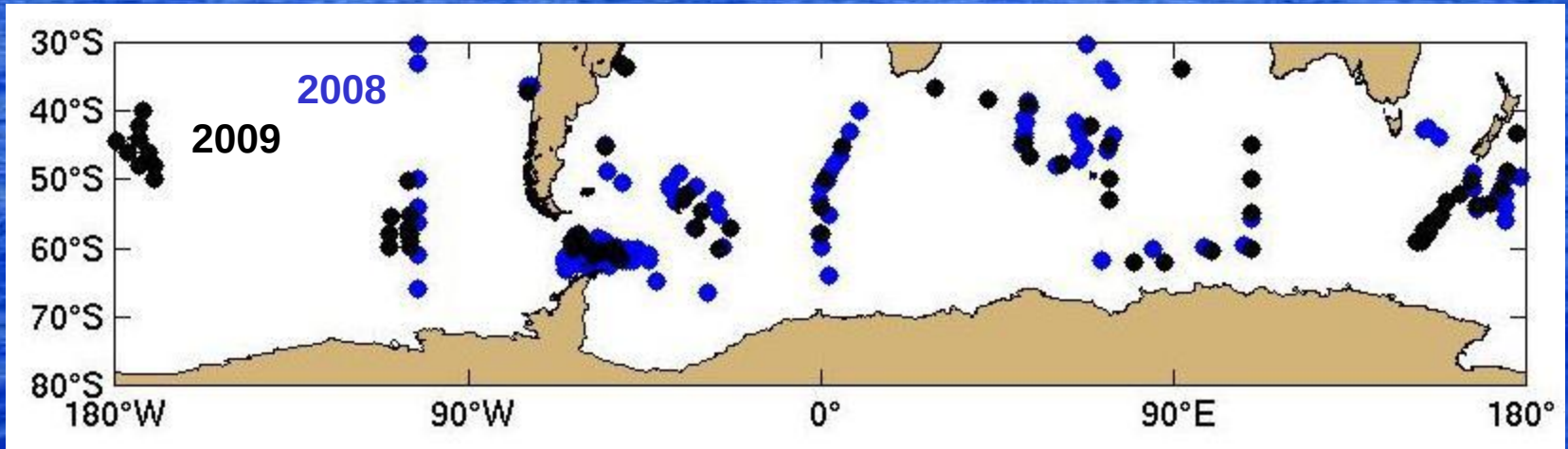
Southern Ocean deployments



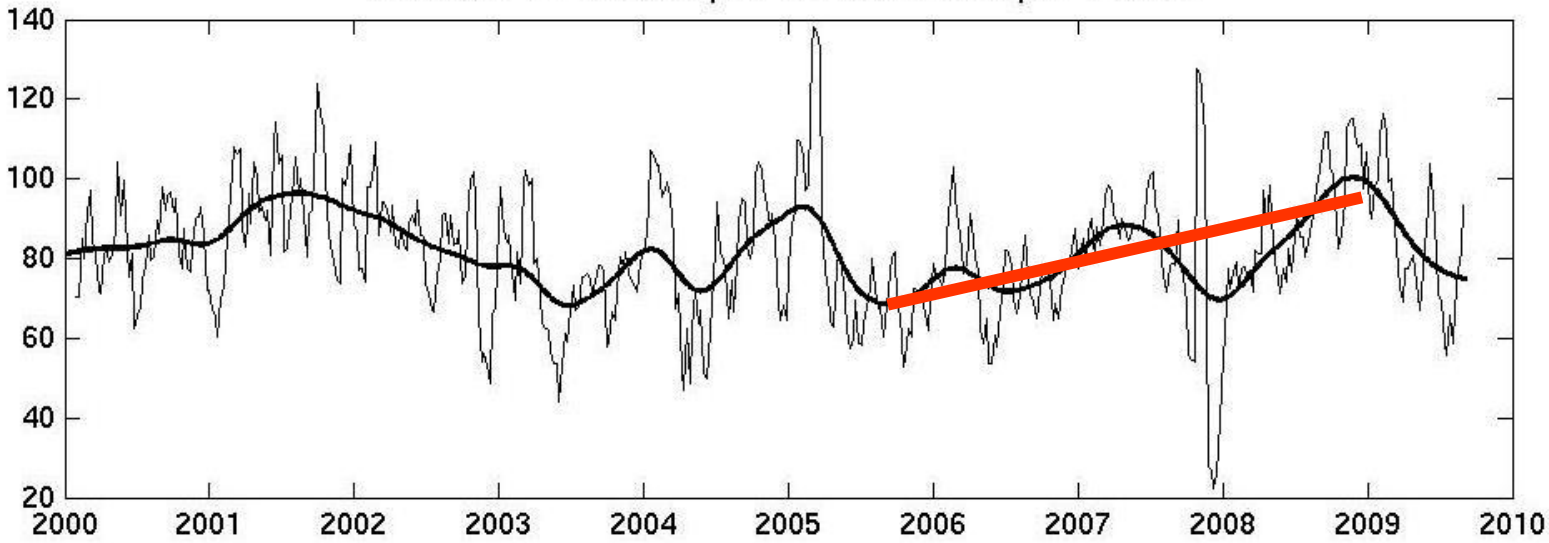
In 2006—2008, an average of 137 drifters were deployed each year south of 30S in December-March.

2009: 109 drifters deployed (28 fewer).

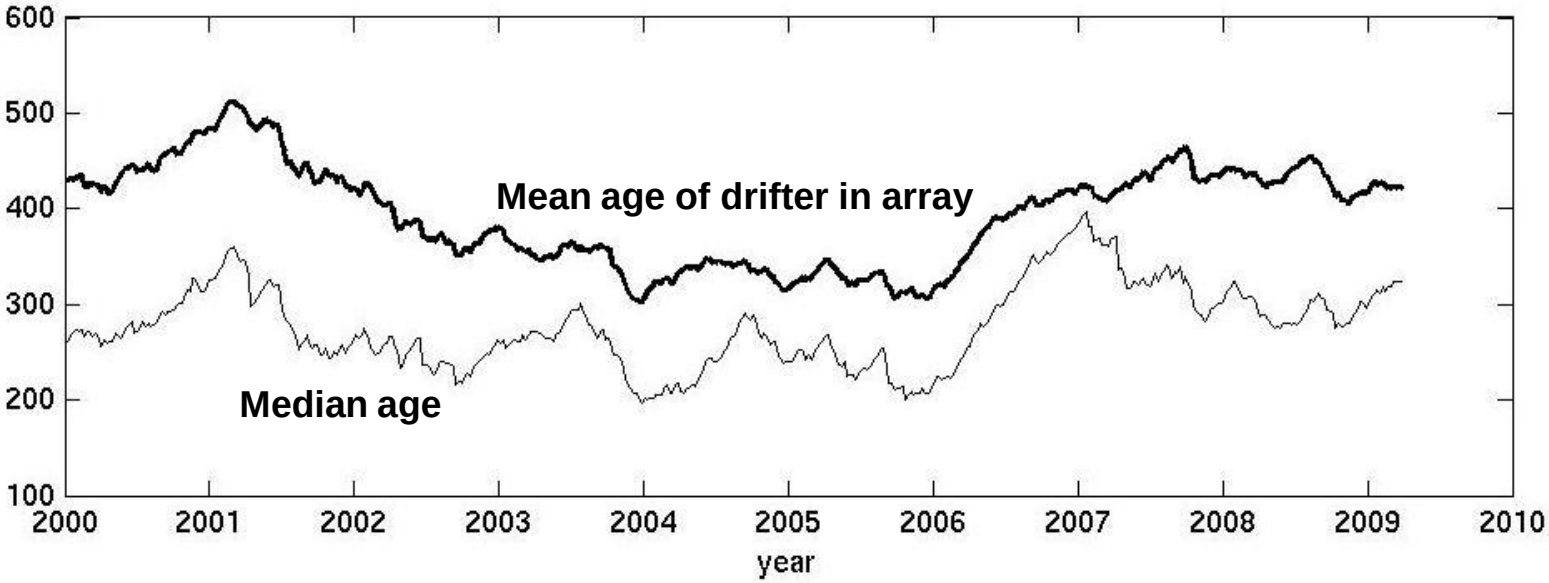
This only partly explains why the array did not grow in Austral summer 2009.



Drifter deaths



Average death rate, Sep08-Aug09: 90 per month (same as previous year)



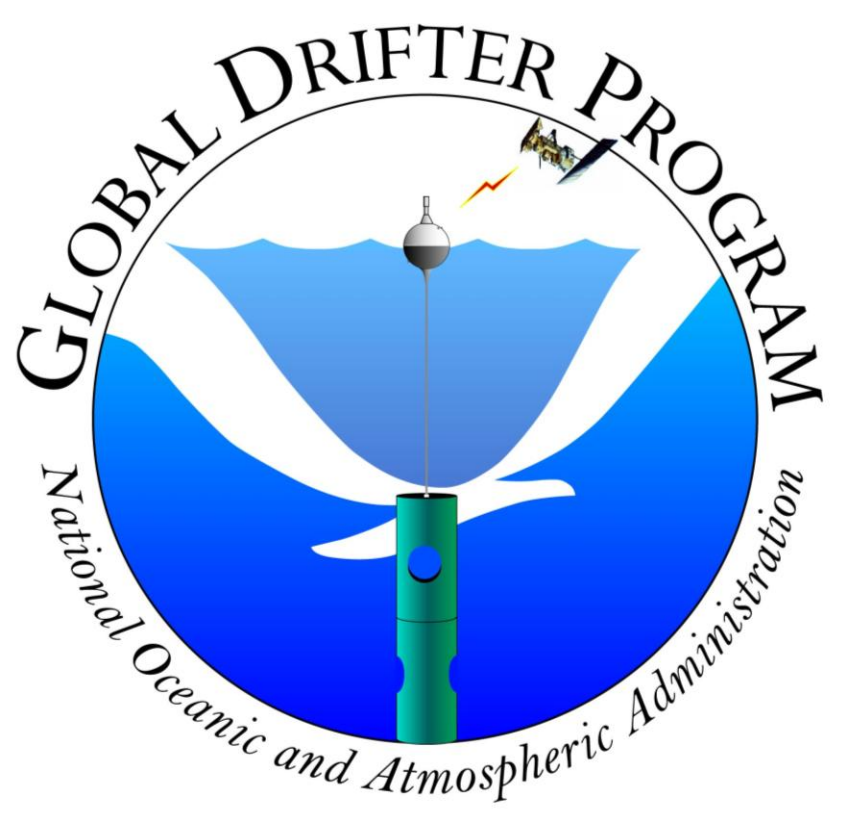
Death rate had been increasing from mid-2005 to end 2008. ~65 drifters per month in mid-2005, ~100 drifters per month end 2008.

Death rate peaked end 2008. Also slightly fewer deployments than normal in Austral winter . Result: array shrinking to minimum size of 1108 drifters on 9 March 2009.

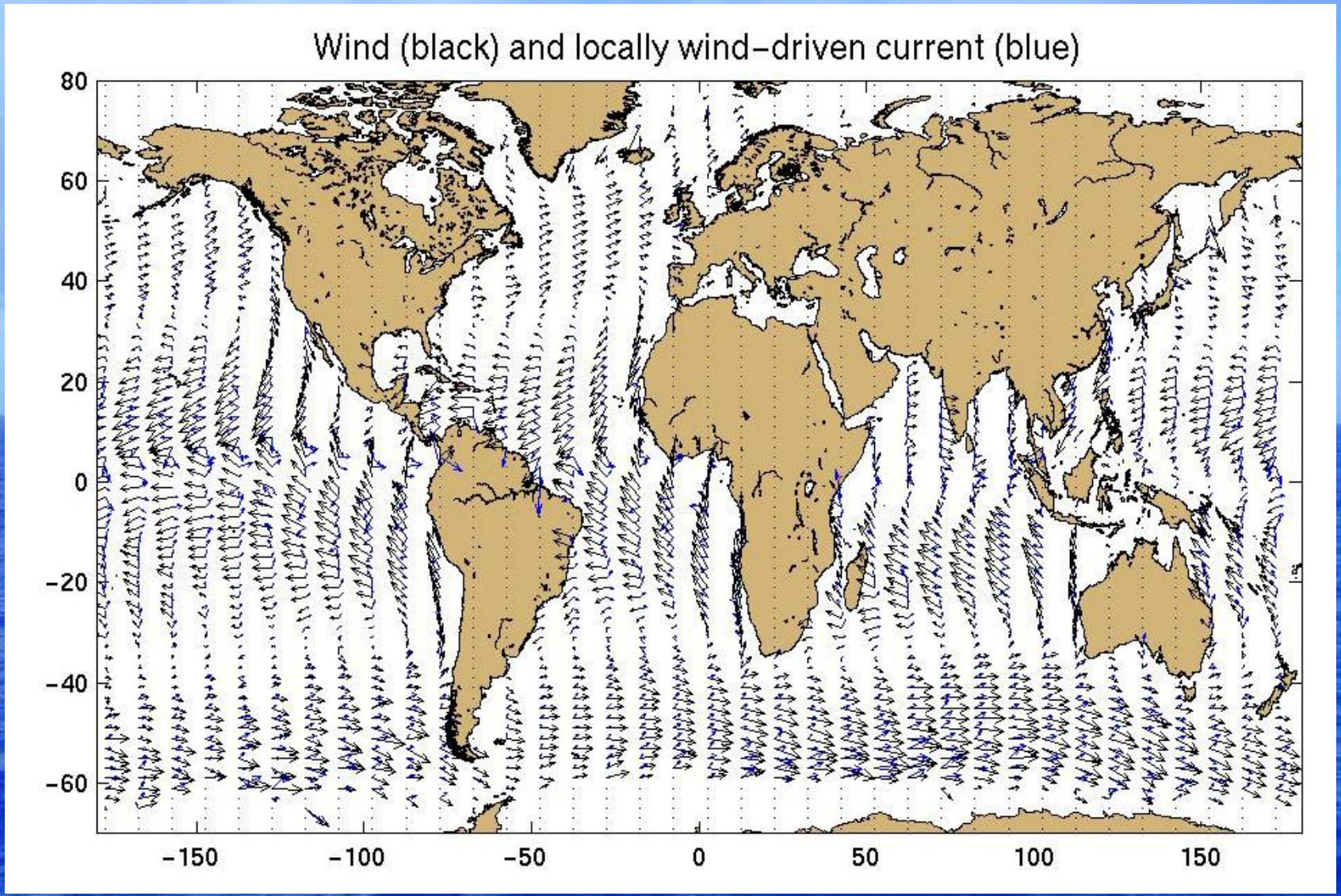
One of the reasons that the death rate had increased was the increasing age of the average drifter in the array. This age has now stabilized. Death rate peaked in early 2009, and has been decreasing since then. This, plus increased deployments, has led to the array now at 1319 drifters.

We will probably see the death rate fluctuate in the range 80—100 drifters per month in the foreseeable future. This suggests that we will need to deploy 960—1200 drifters per year to maintain array.

Research and new developments

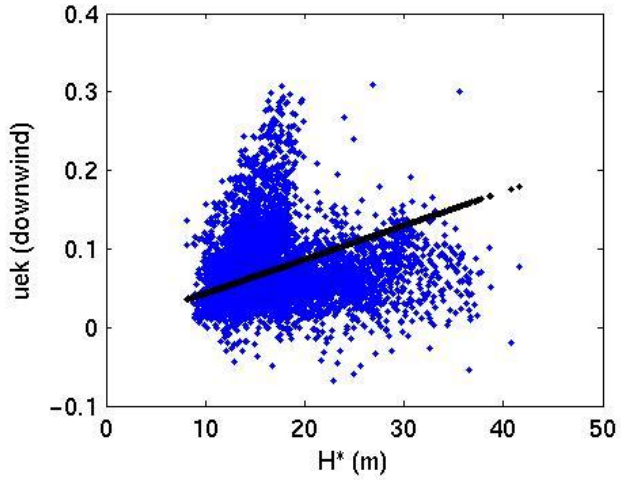


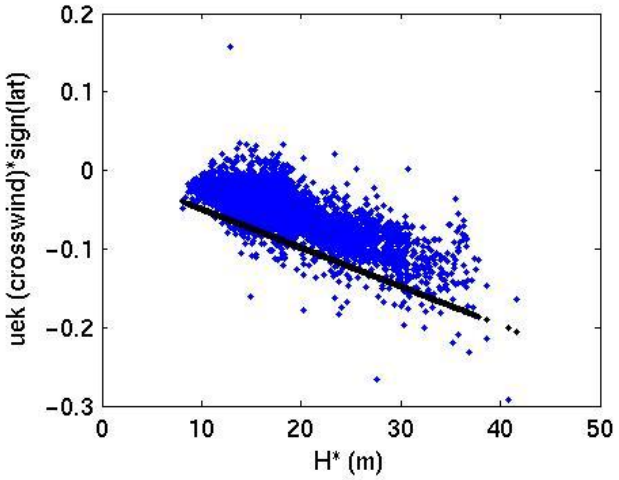
Wind-driven motion

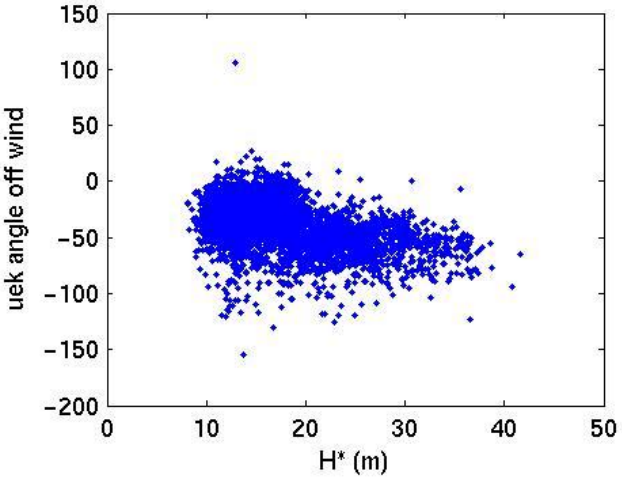


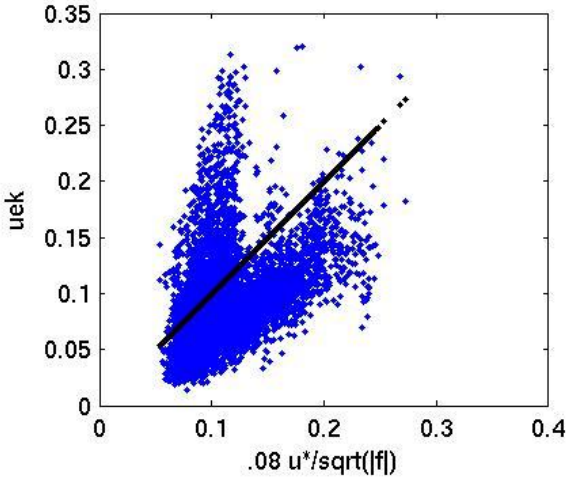
Comparison with Ralph & Niiler (1999)

$$u_{Ek} = A\sqrt{\tau / \rho |f|}. \qquad H_* = \sqrt{\tau / \rho |f|} / A.$$

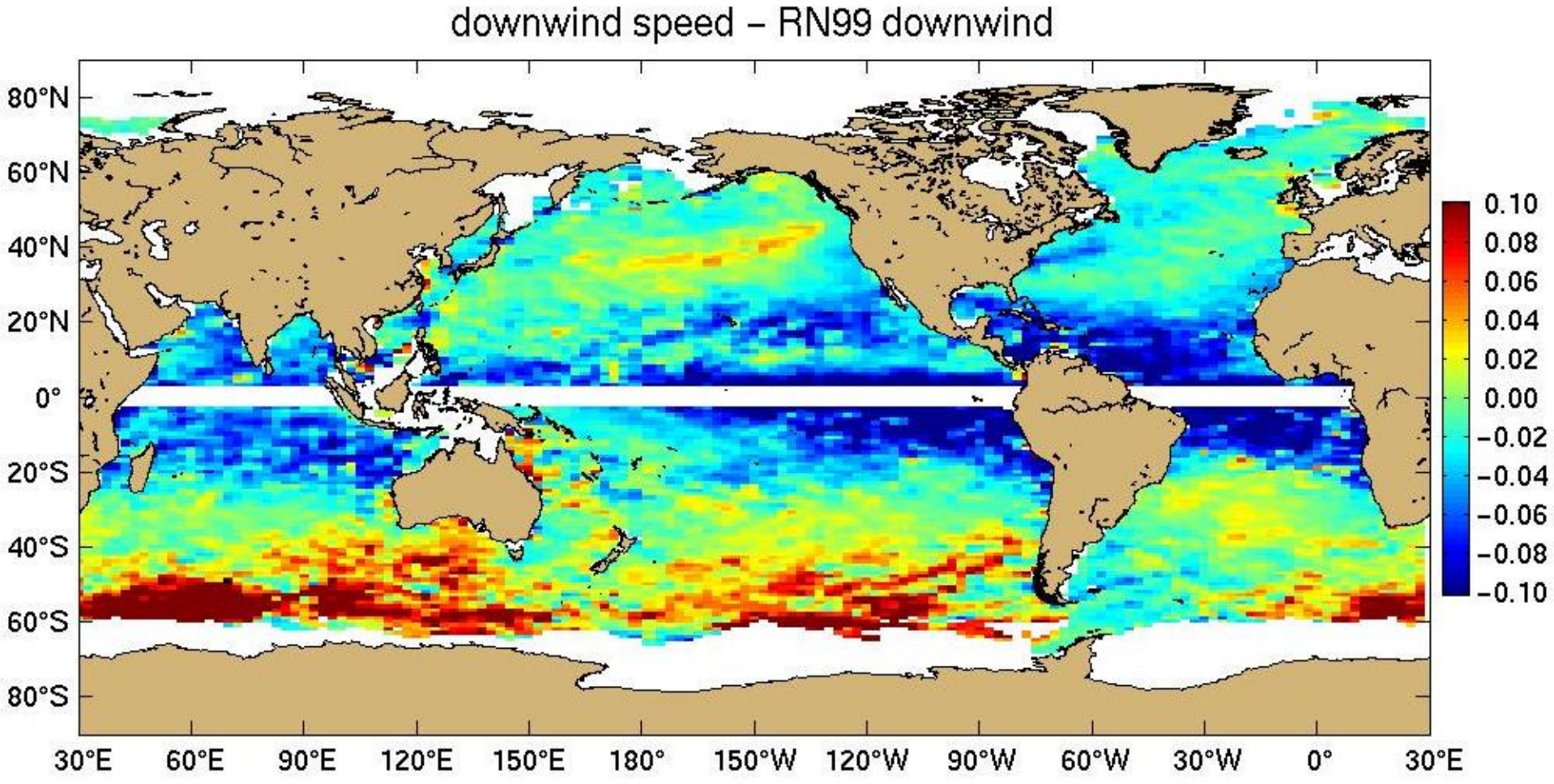




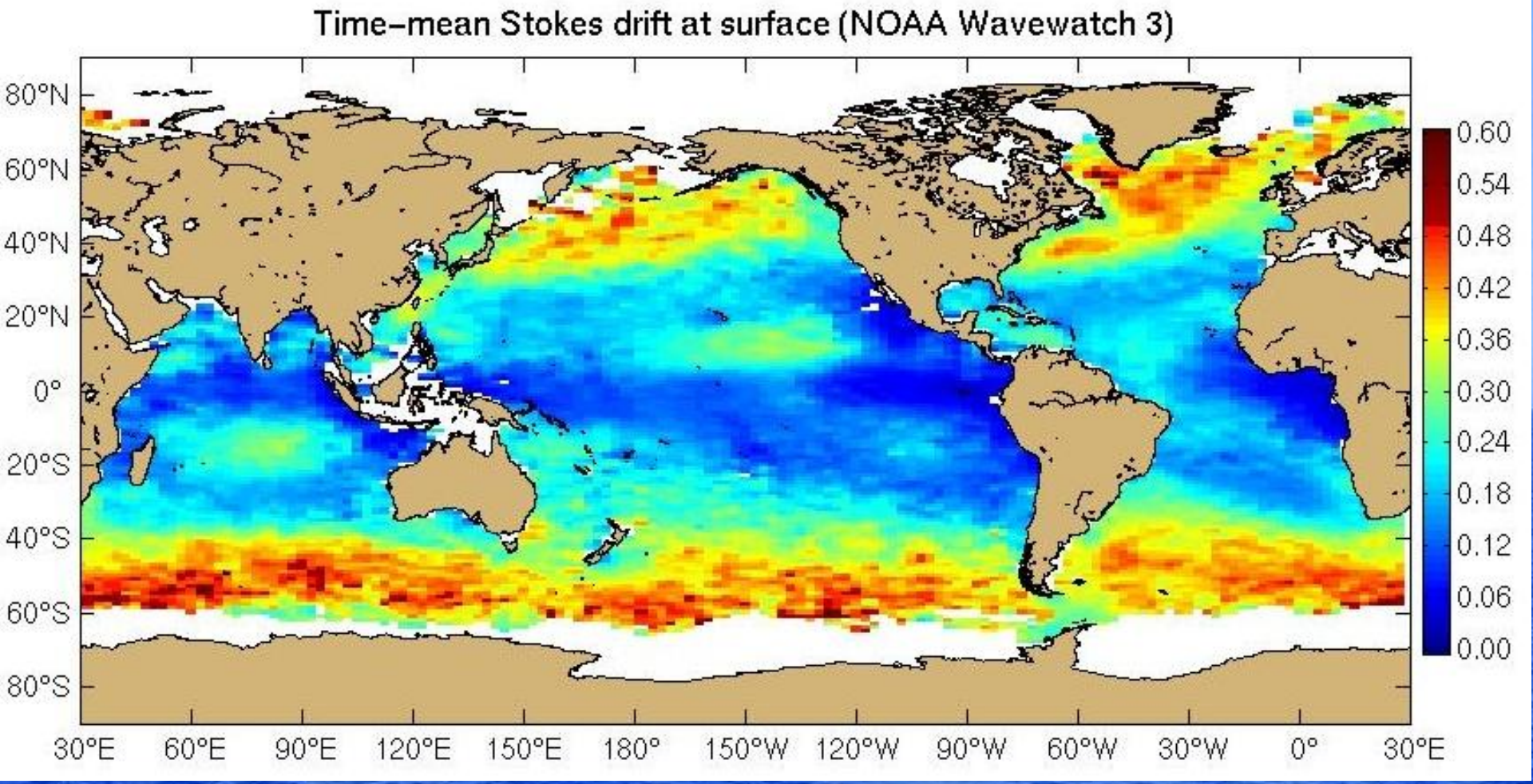




Where do these results differ from RN99?



Where do these results differ from RN99?

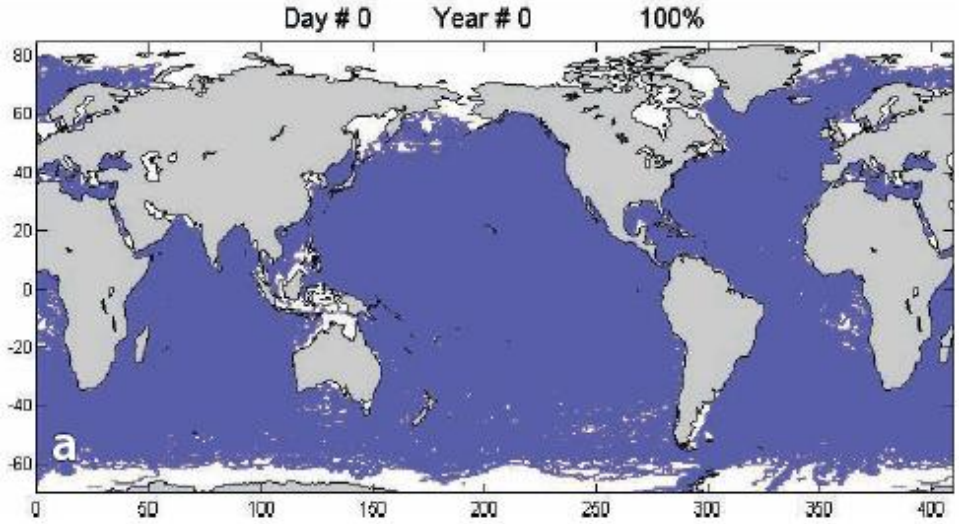


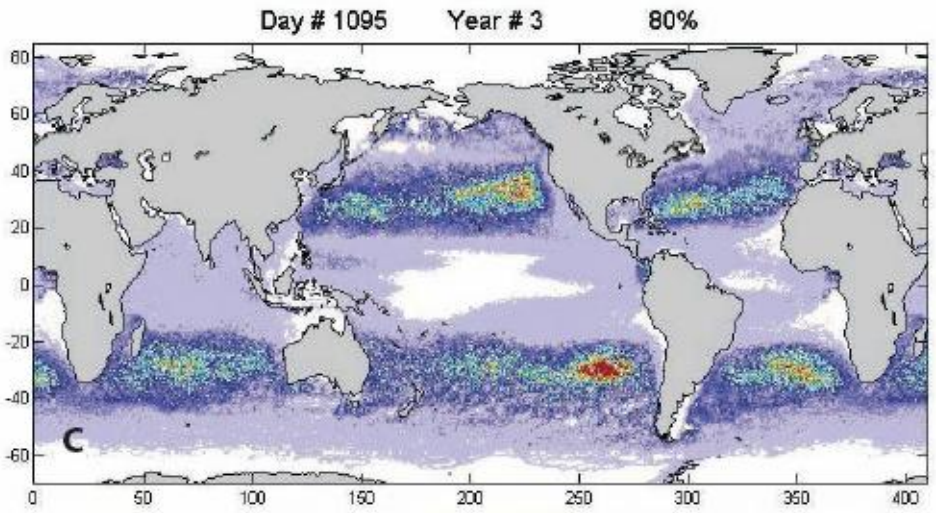
$$U_s = \frac{1}{g} a^2 \omega^3.$$

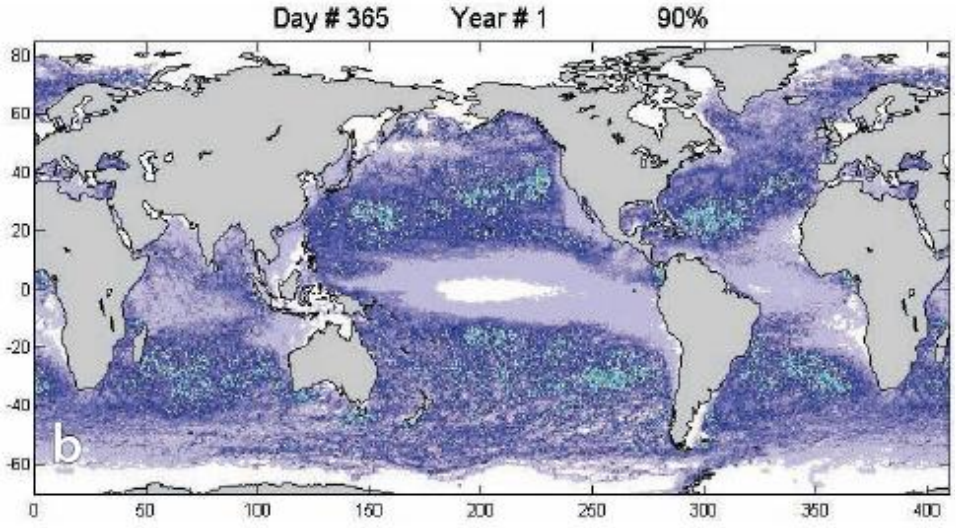
a: using significant wave height.

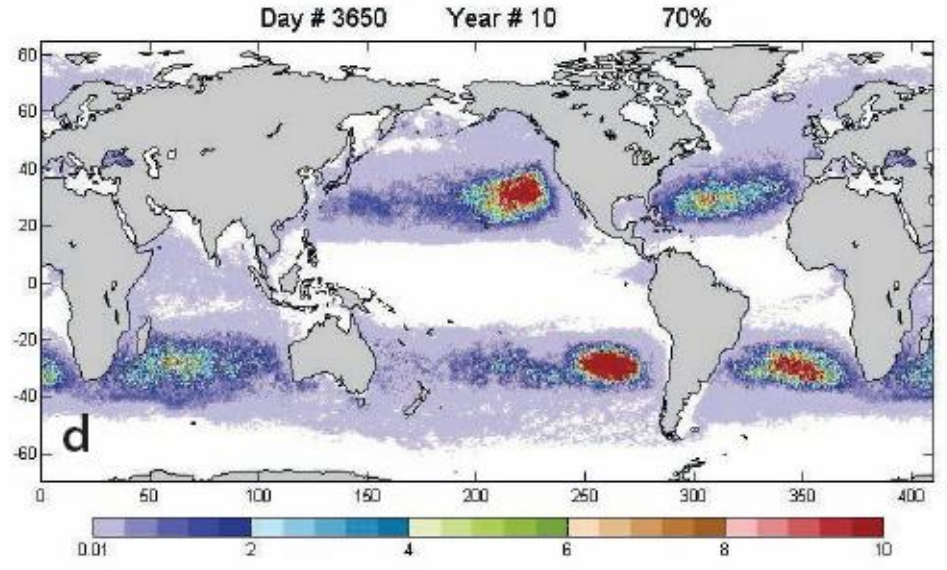
ω: using peak wave period.

Tracking ocean debris





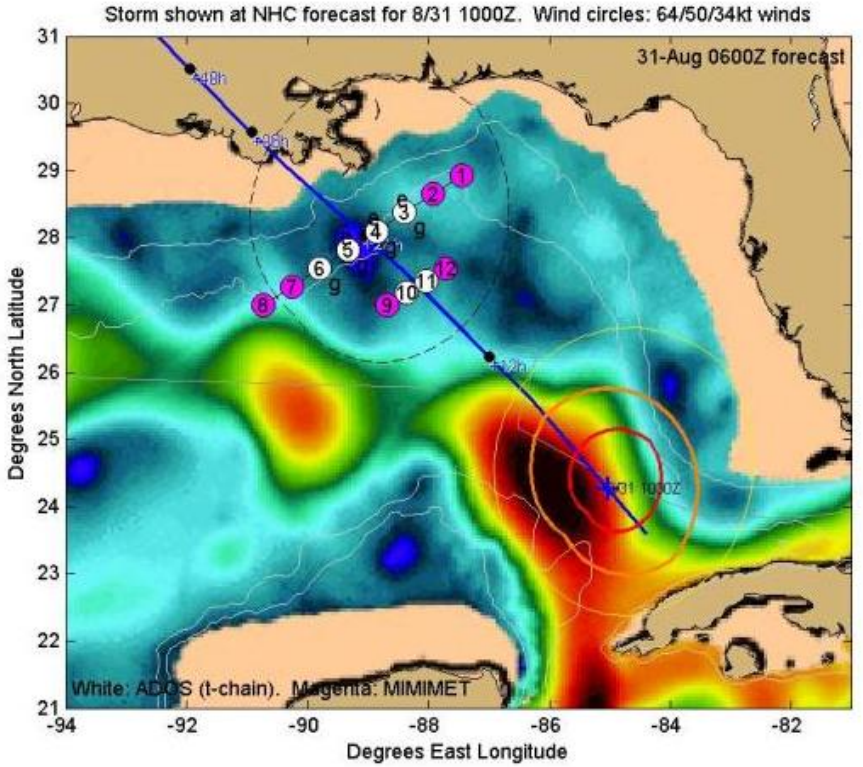


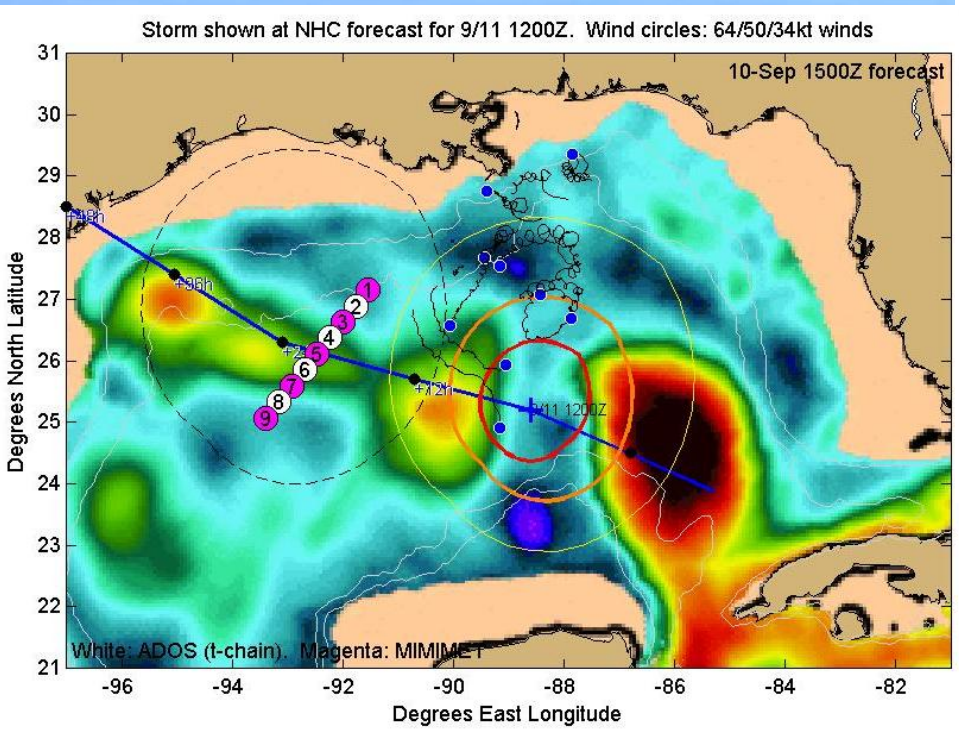


Work by Nikolai Maximenko

2008 Hurricane array drifter deployments

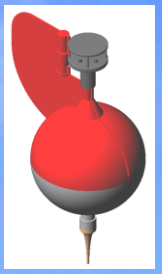
Array of 12 Minimet and ADOS (thermistor chain) drifters deployed in front of major hurricane Gustav, 31 Aug 2008.

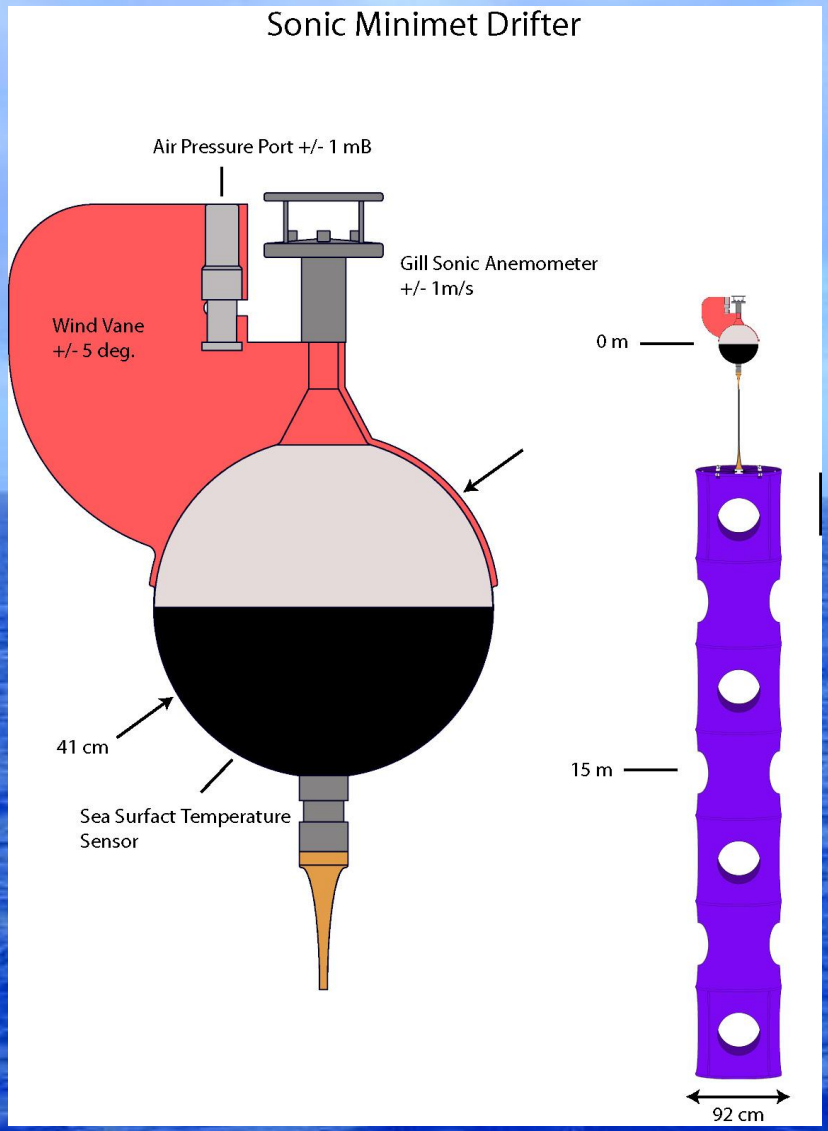


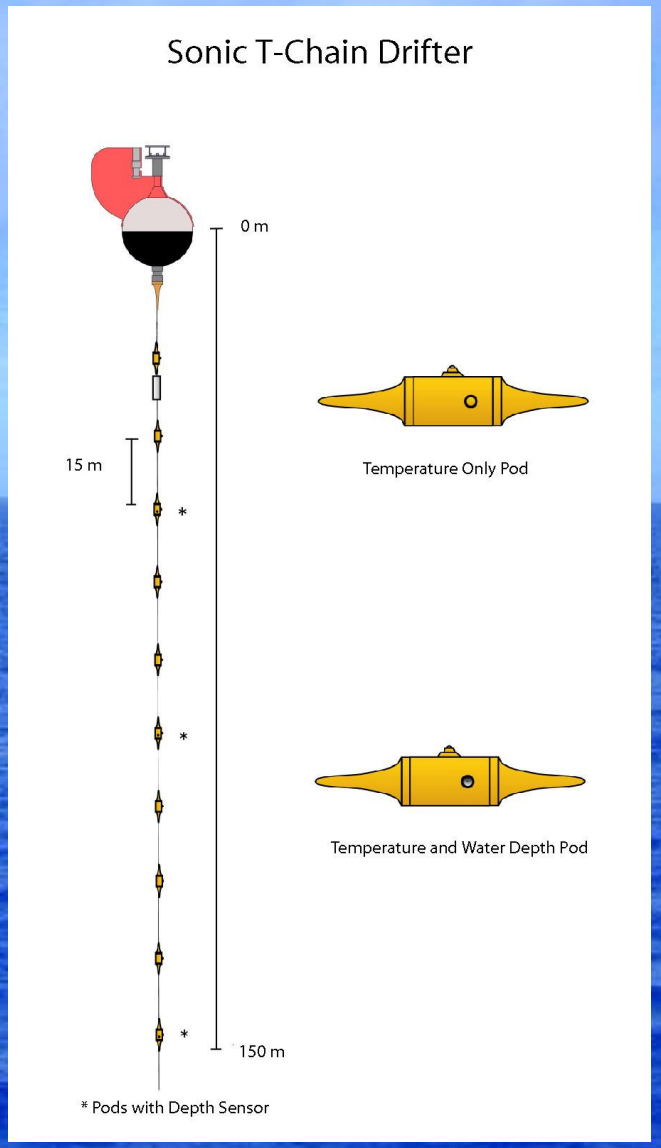


Array of 9 Minimet and ADOS (thermistor chain) drifters deployed in front of major hurricane Ike, 11 Sep 2008.

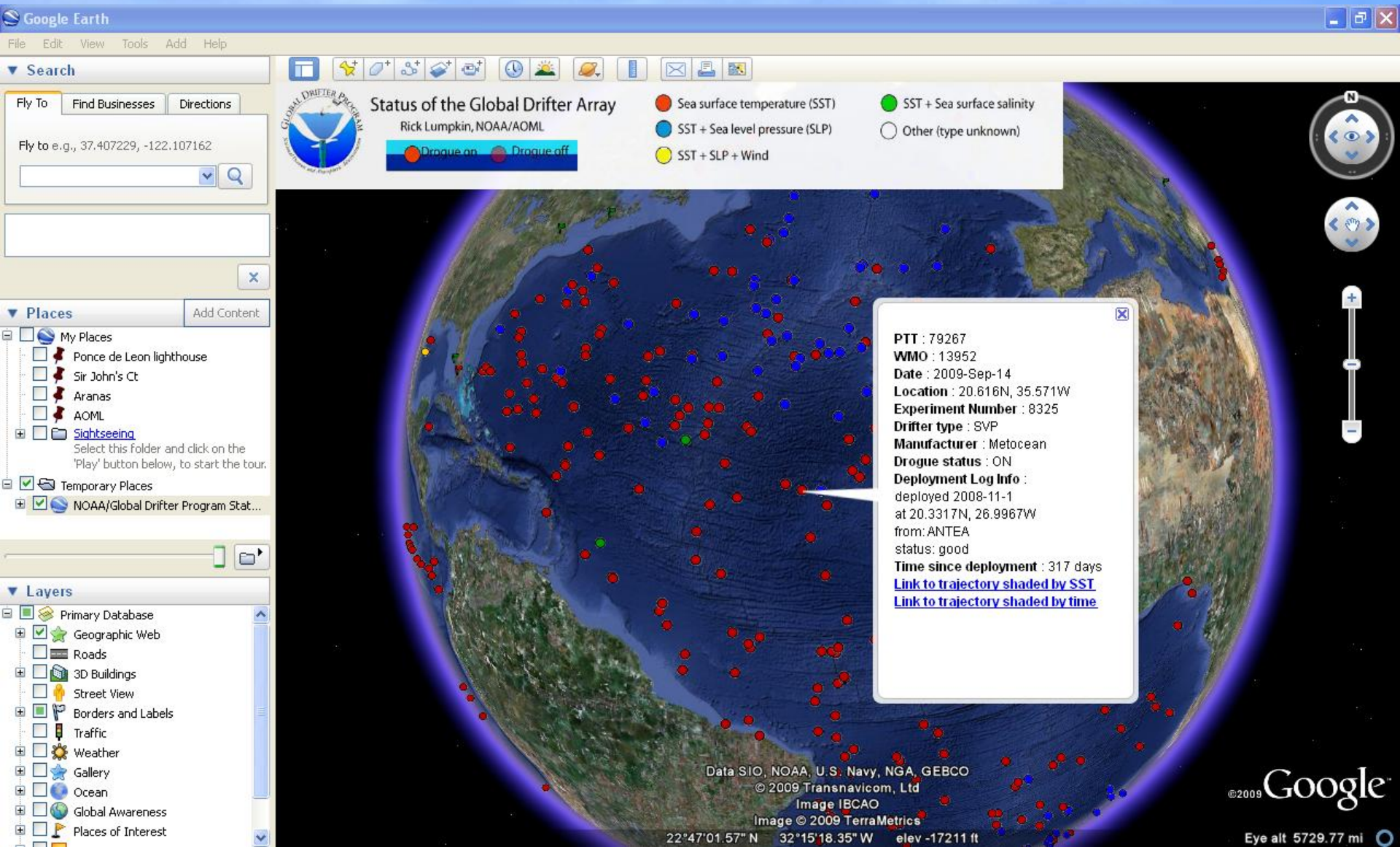
2009/2010: Sonic Minimet and T-chain drifters



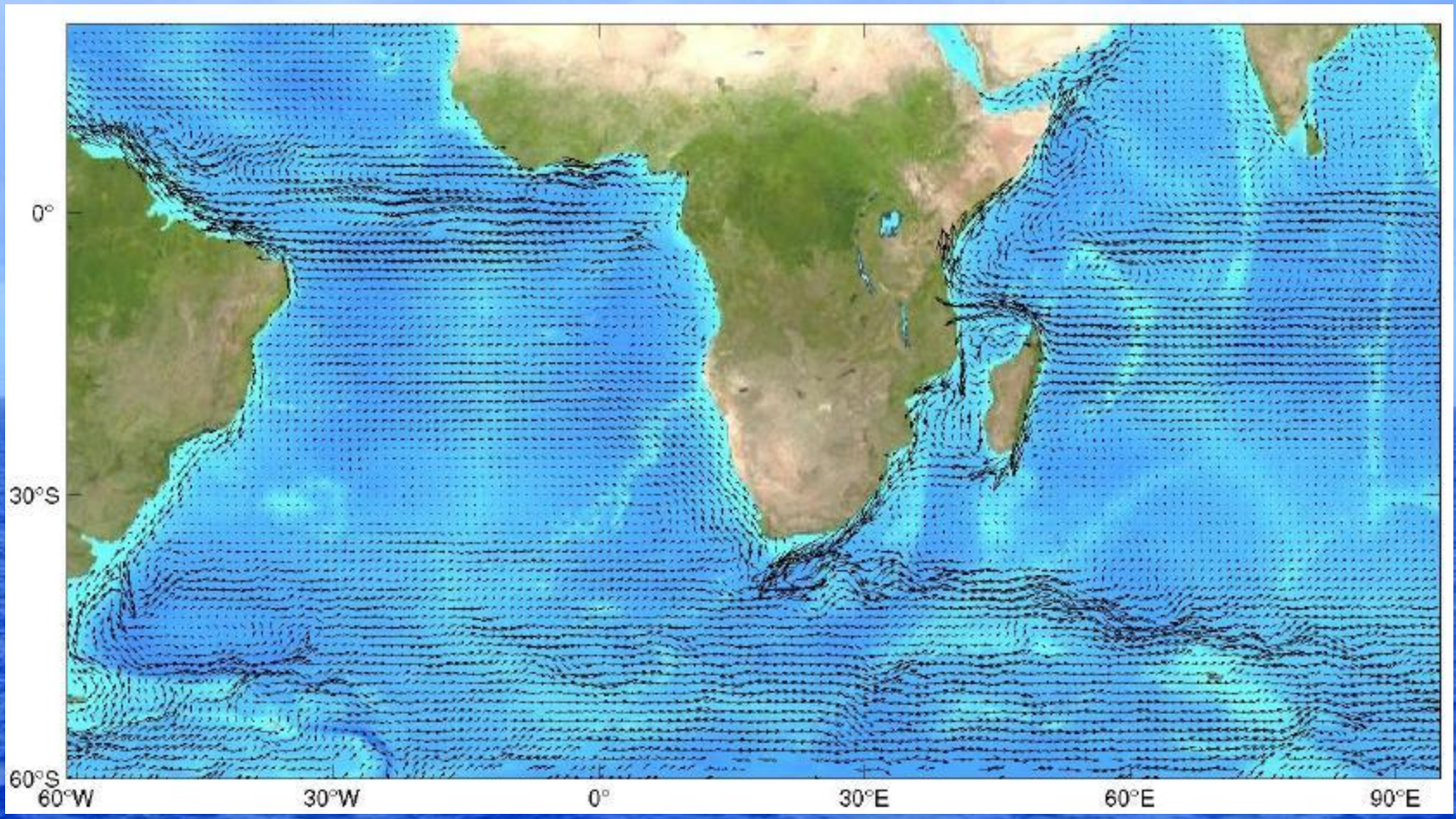




New products



New products



Updated high-resolution climatology of monthly currents: now resolves currents in previous data gaps such as Gulf of Guinea

2010: goals and plans

Deploy 1000 Drifters in the period between October 2009 and September 2010.

<u>MAINTAIN</u> 1250 drifters at a nominal resolution of 5˚x 5˚.

Continue to update quality-controlled interpolated database.

Conduct 2010 AOML Data Buoy comparison study.

Continue to evaluate array evolution, drogue detection and drogue lifetime.

Develop new products.

Our appreciation to the following partners for their contributions to GDP activities

NOAA's Voluntary Observation Ships, Ships of Opportunity, and National Marine Fisheries Service programs

Argo 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 Metereologia; Centro de Hydrografia de Marinha; INPE (Nacional Space Institute); Brazilian Navy; Brazilian Naval Directorate of Hydrography and Navigation (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)

Institute of Hydrological and Oceanic Services (Taiwan)

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

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

Instituto del Mar del Peru

Tristan da Cunha Administration, Tristan Island

United Kingdom Met Office

Fisheries Department of Falkland Islands

Environment Canada

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

Scripps Institution of Oceanography, Woods Hole Oceanographic Institution, Oregon State University, Marine Resources Research Institute, NOAA/Pacific Marine Environmental Laboratory, NOAA/National Data Buoy Center (United States of America)

United States Air Force

US Naval Oceanographic Office

United States Coast Guard

Raytheon Polar Services