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

26th Data Buoy Cooperation Panel session

27—30 September 2010

Oban, Scotland

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 5ºx5º 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.

Organization of the Global Drifter Program

FUNDING: from NOAA's Climate Program Office.

AOML (Miami, FL)
Rick Lumpkin

JIMO (La Jolla, CA)
Peter Niiler
Supervises the industry, upgrades the technology, purchases most drifters, and develops enhanced data sets.

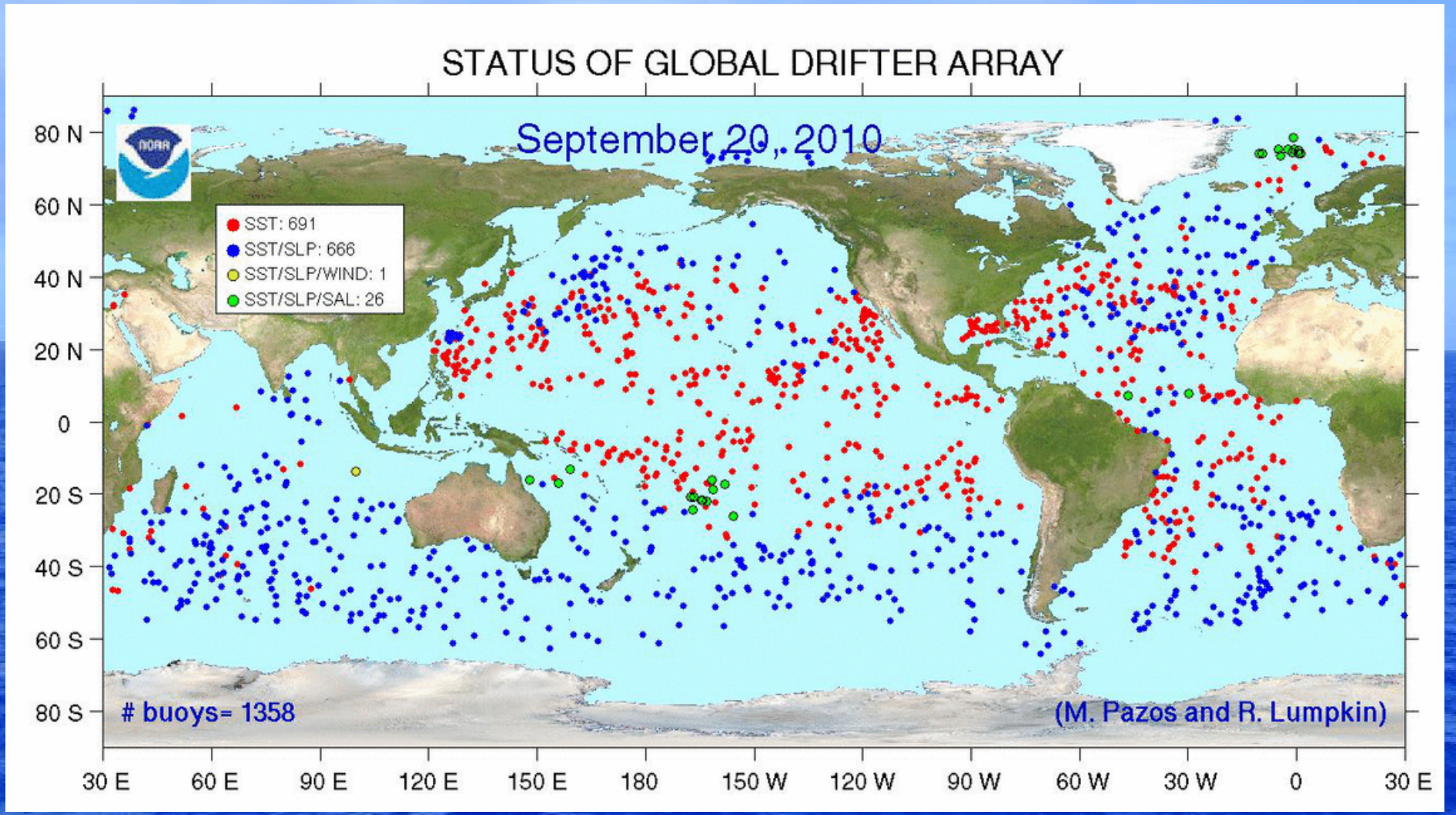
Manufacturers in private industry, who build the drifters according to closely monitored specifications

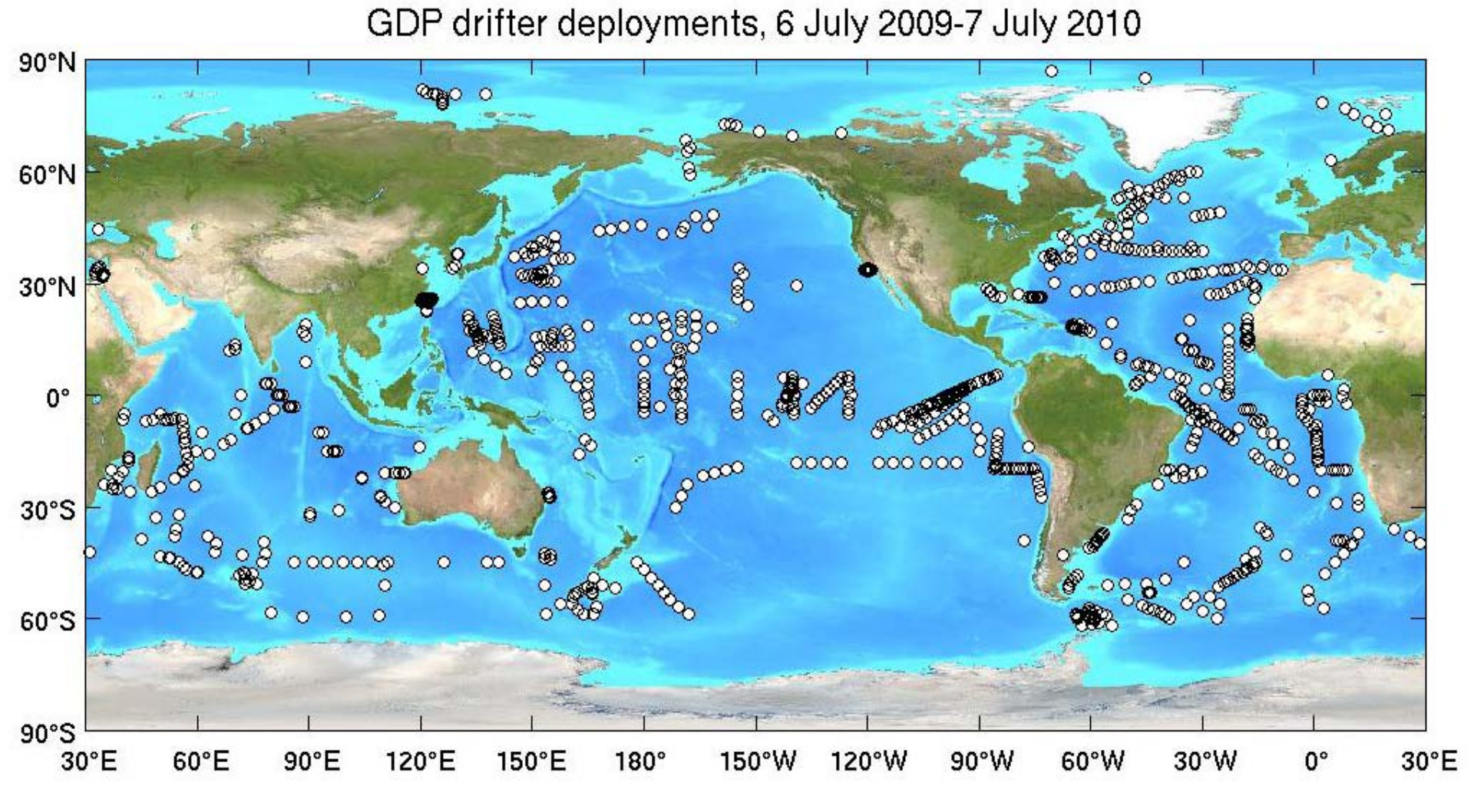
Drifter Operations Center (DOC)

Drifter Data Assembly Center (DAC)

Current status of the global array

~1350 GDP drifters (goal: 1250 annual average)





1245 drifters deployed
(245 above average)

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

2010 Deployment highlights

- 35 across the Pacific Ocean during DART servicing cruise.
- 17 in the central Gulf of Guinea from the R/V *Ronald H. Brown*, CLIVAR line A13.
- ~40 drifters in the western Indian Ocean and 15 in the Gulf of Guinea from various US Navy vessels, as part of the “African Partnership Station II” program.
- 10 from the Argo-chartered *Kaharoa* along 45°S, from 86—141°E.
- 36 from the R/Vs *Walton Smith* and *Nancy Foster* to monitor ocean currents in the Gulf of Mexico, in support of NOAA’s response to the Deepwater Horizon oil spill.

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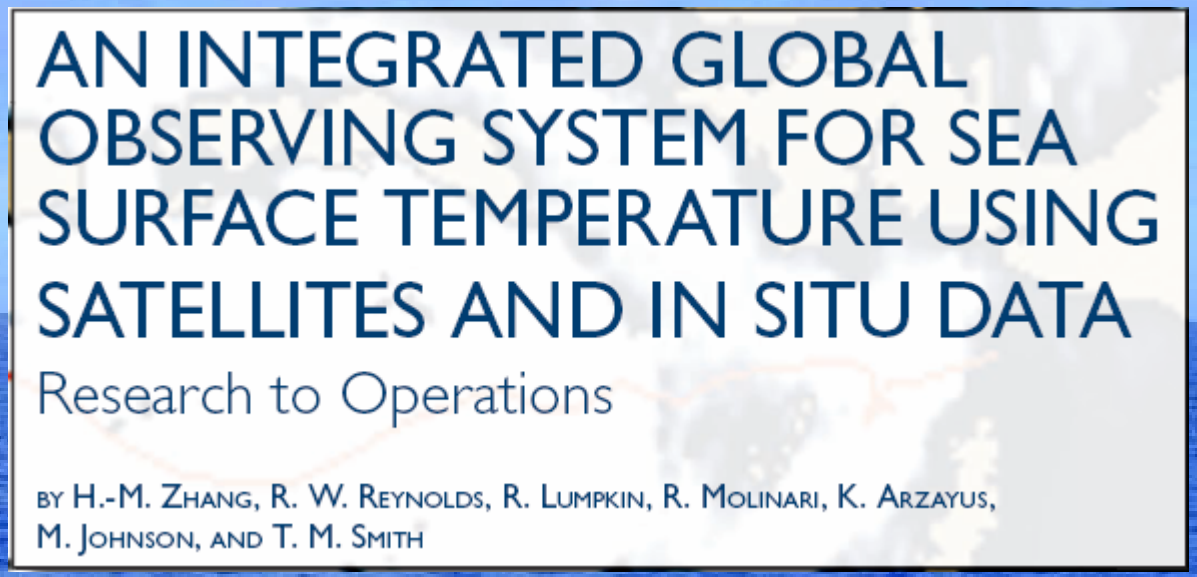
Deployment plans for 2011

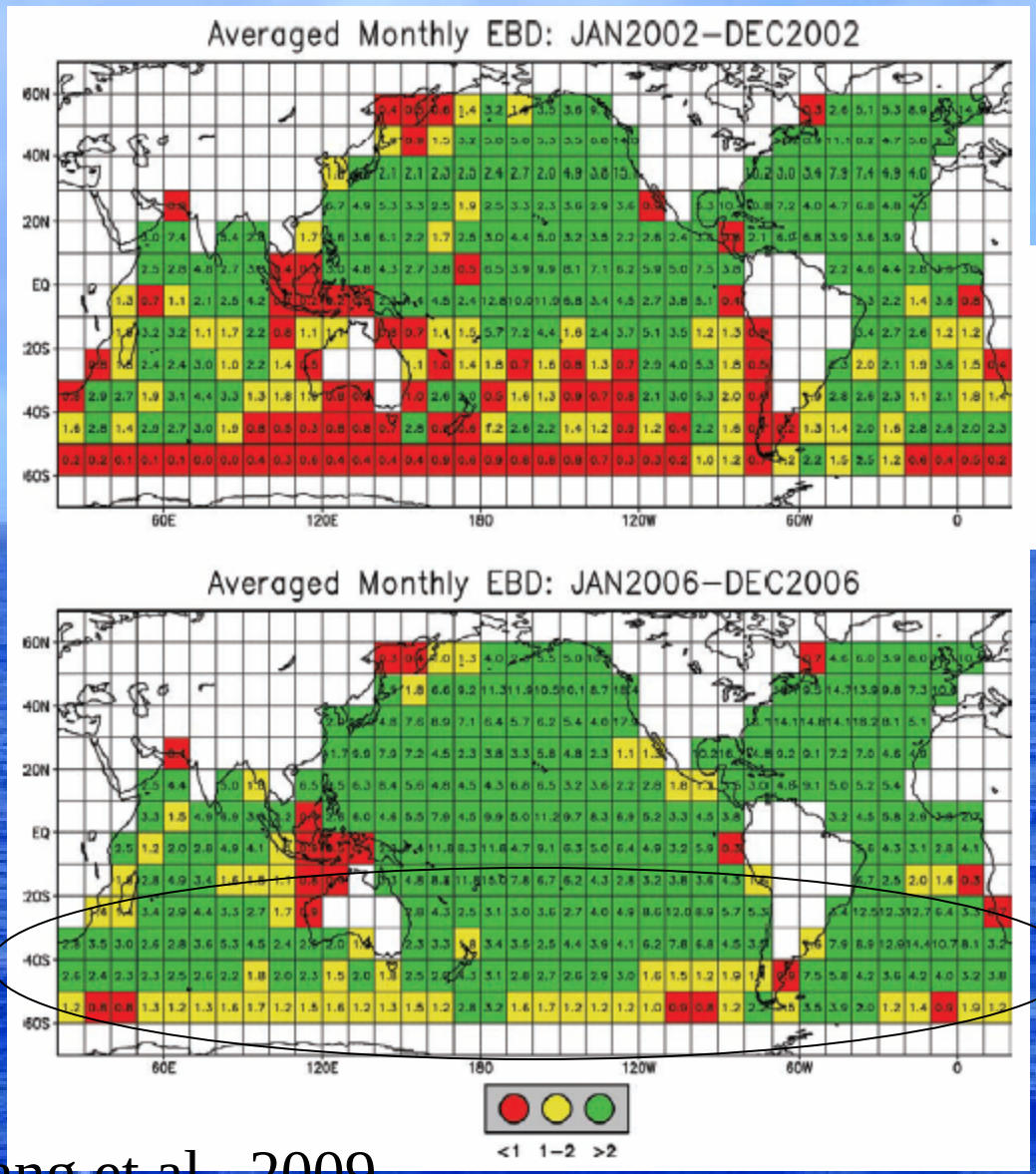
Operational Buoy Deployments	800
Consortium Research Buoy Deployments	200
Total Deployments in 2011	1000

Regional deployment opportunities in 2011 include the US Navy-led "African Partnership Station" program in the western Indian and eastern Atlantic, the possible NSF-funded "Dynamo" project in the tropical Indian Ocean, and the 2011 Argo charter of the Kaharoa in the South Pacific. As in previous years, cruises to service the global tropical moored array will be used opportunistically to seed drifters.

SST observations



Equivalent buoy density (EBD)



A combined ship–buoy density, Equivalent Buoy Density, is thus defined as

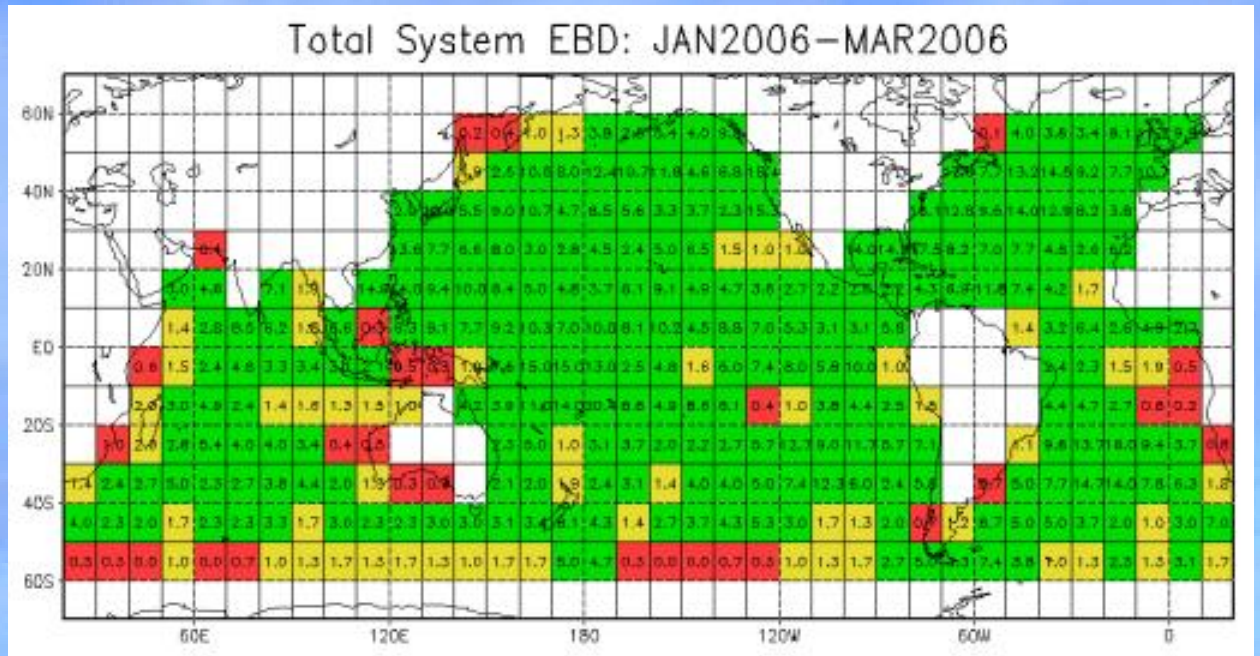
$$\mathrm{EBD} = n_b + \frac{n_s}{7},$$

where n_b and n_s are the independent number of observations from buoys and ships, respectively.

EBD>2 in a 10º box means potential satellite bias error <0.5ºC compared to a maximum of 2ºC.

Large improvement in SO primarily due to drifters

Zhang et al., 2009



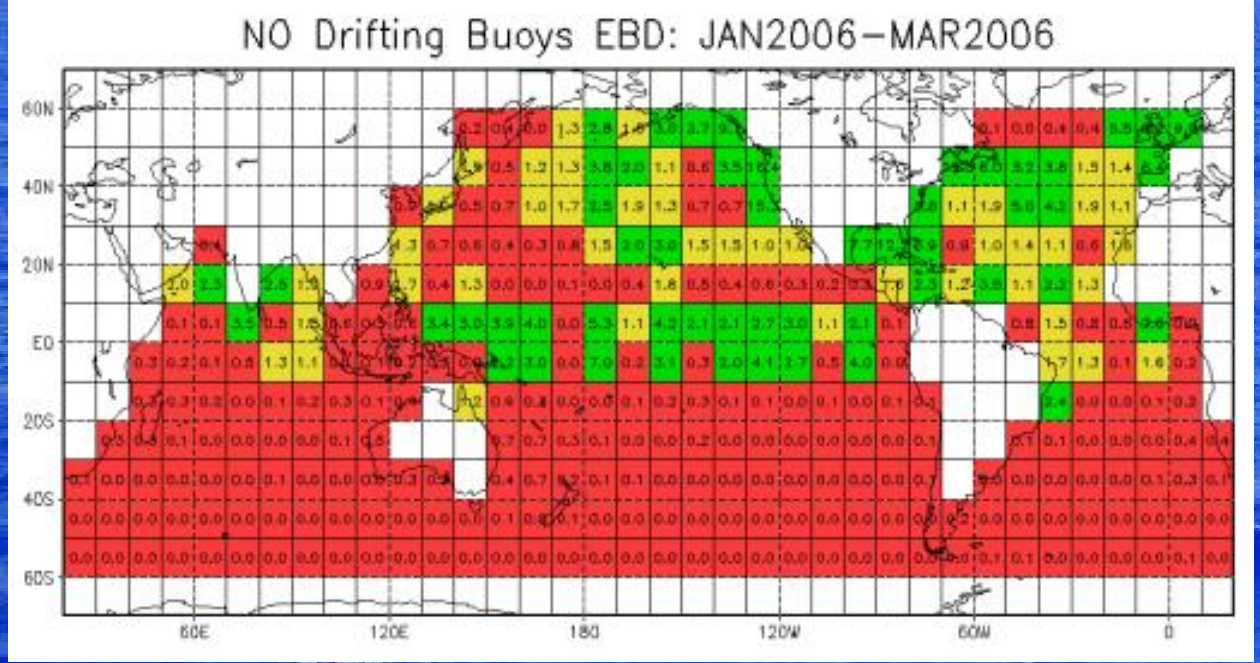
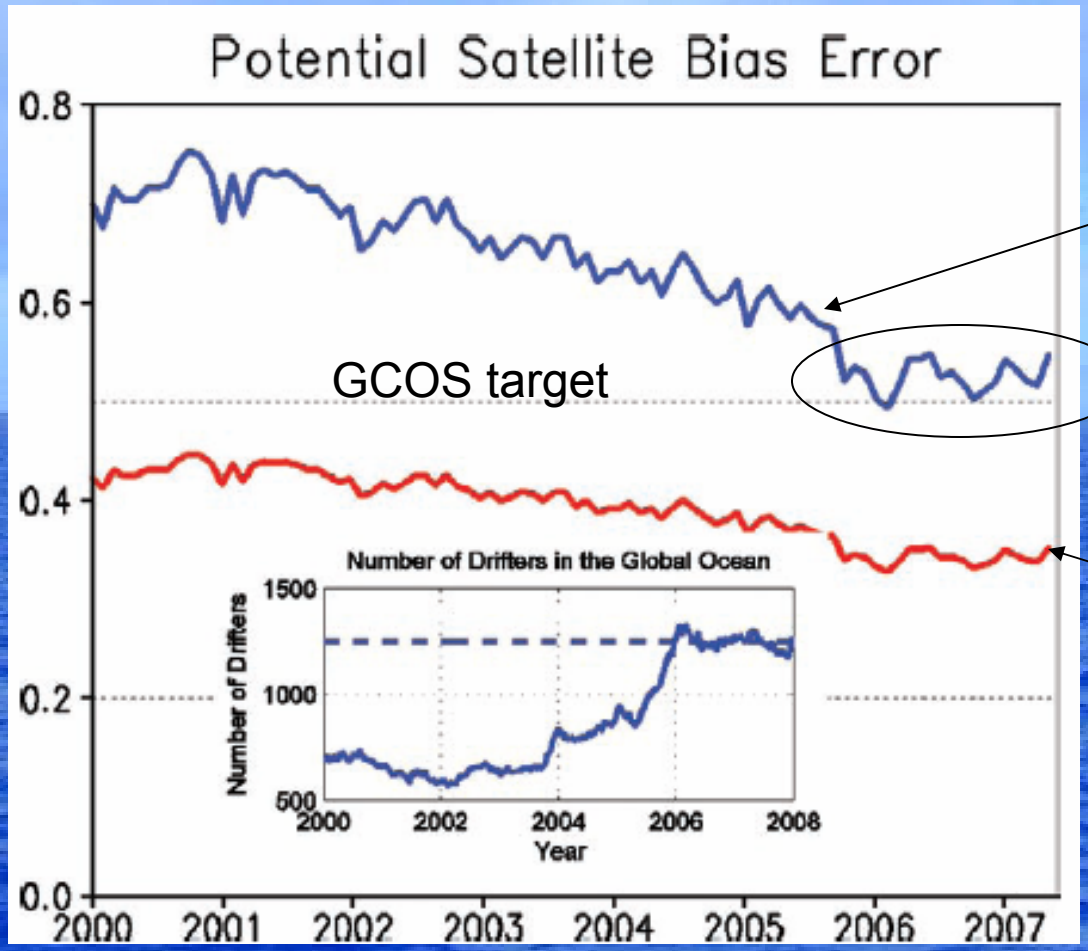


Figure courtesy
Huai-min Zhang,
NOAA/NCDC

Reduction in potential satellite bias error



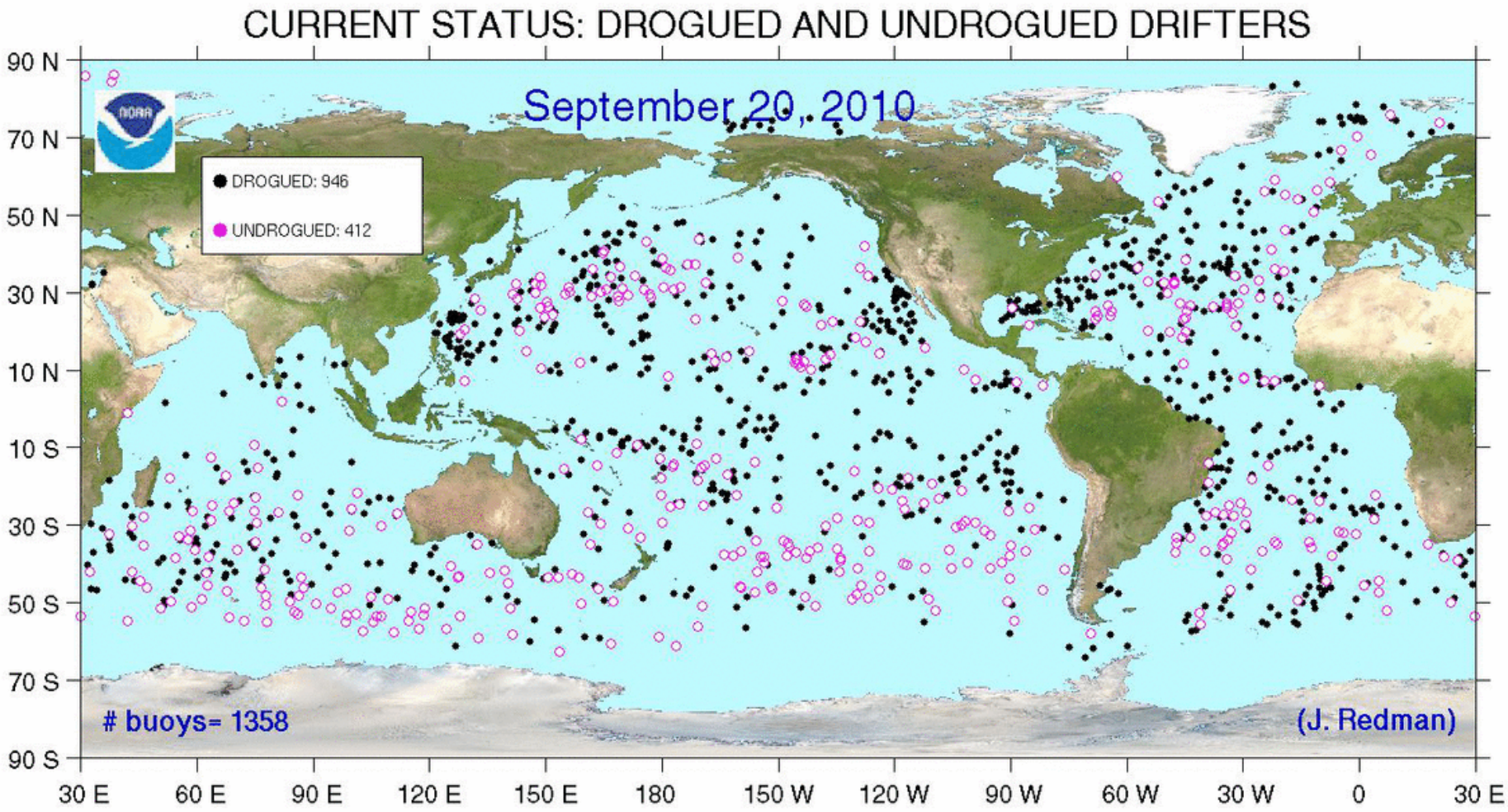
Worst case scenario

Plateau at target

Normal

Zhang et al., 2009

Mixed layer current measurements

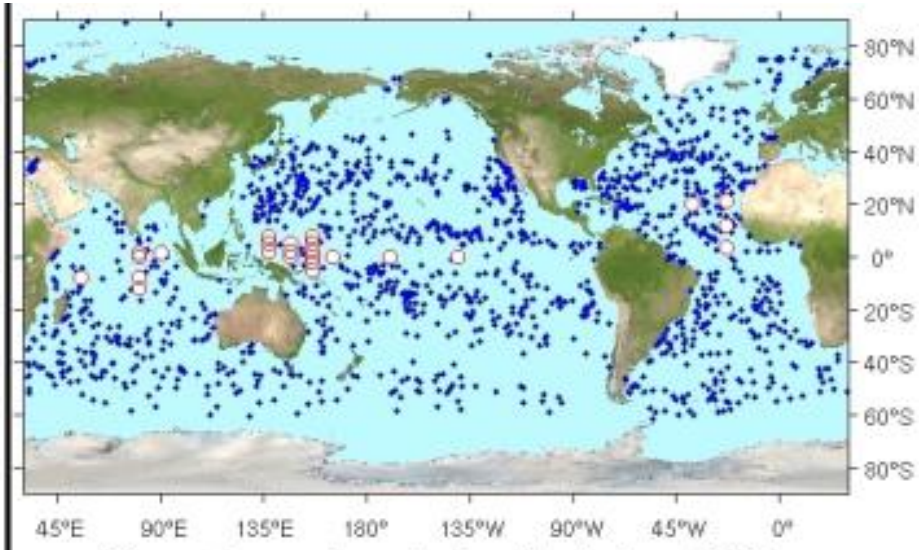


***Black Bullets*:** location of all (~100) drogued drifters .
***Open pink*:** drifters without drogues, still measuring SST.
~75% of the array has drogues attached (real-time estimate; delayed mode drops to ~50%)

Observing System Status: 2010, Q2.
Surface Currents

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

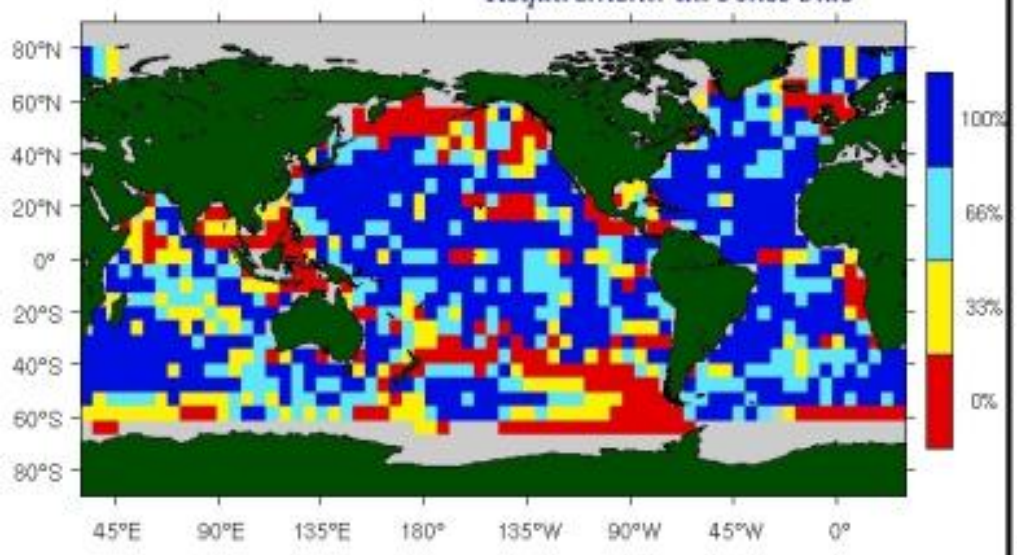
Performance measure: reduce the error in global measurement of surface velocity



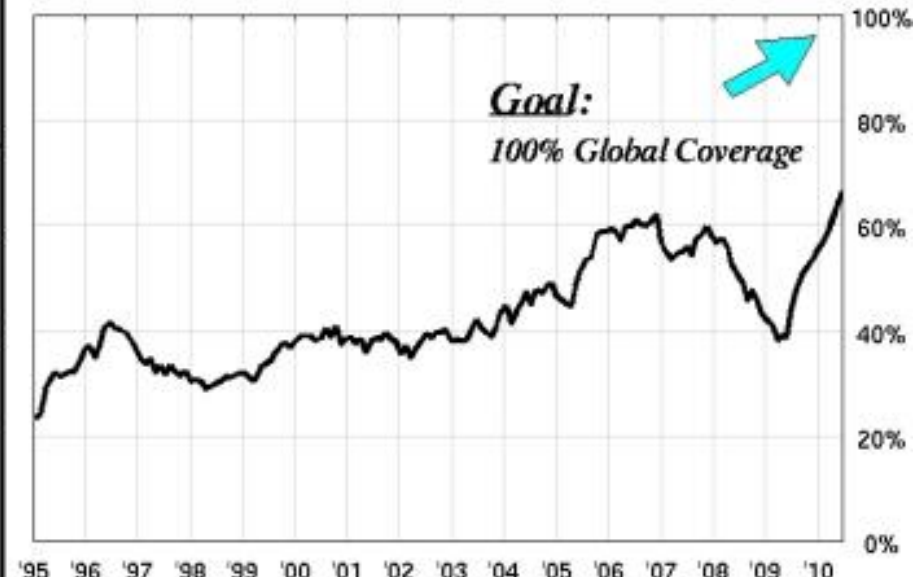
Observing system status, April-June 2010

• Drogued drifting buoys: 1388 ○ Moored buoys: 25

Requirement: all boxes blue

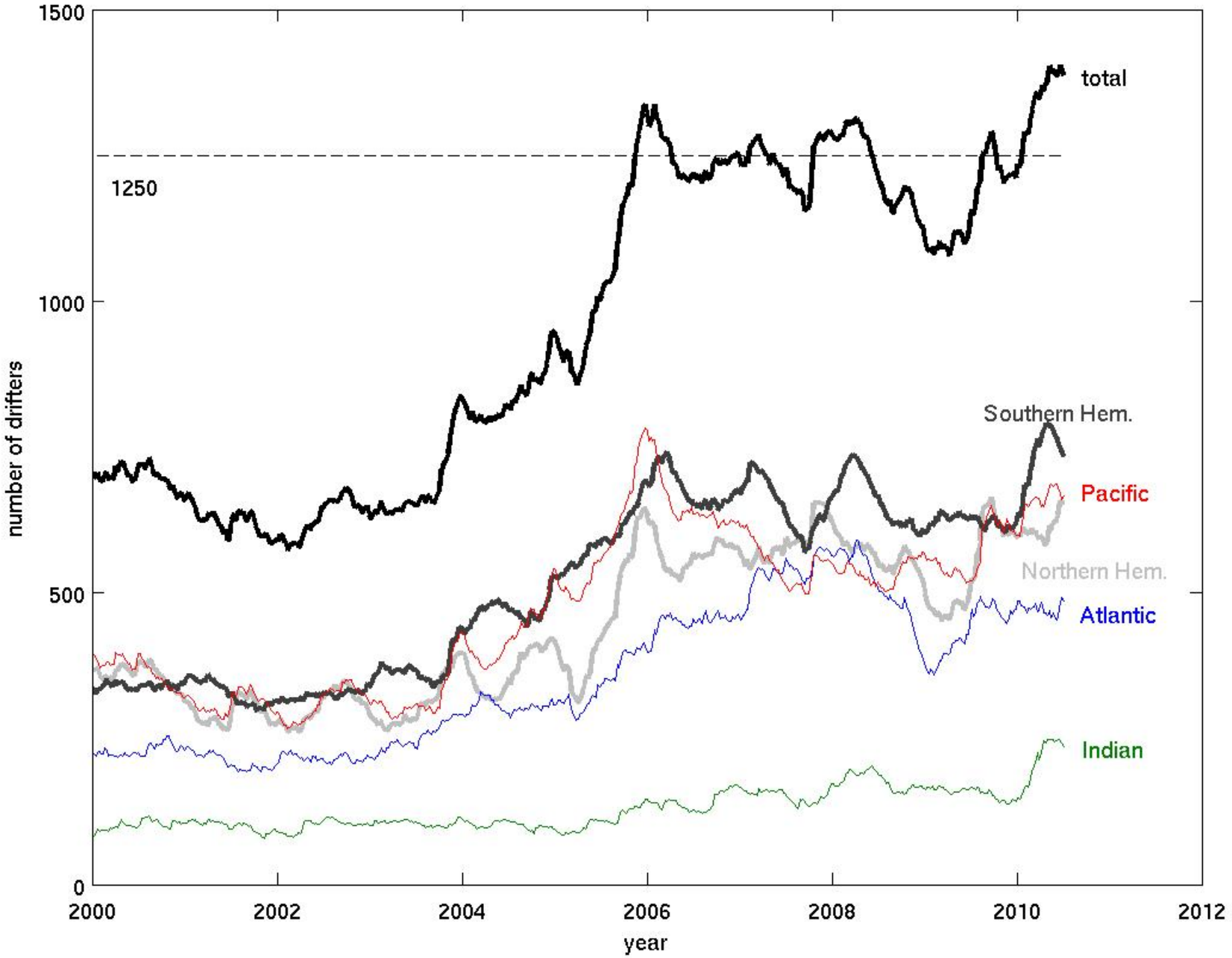


Percent of months in quarter with at least one observation



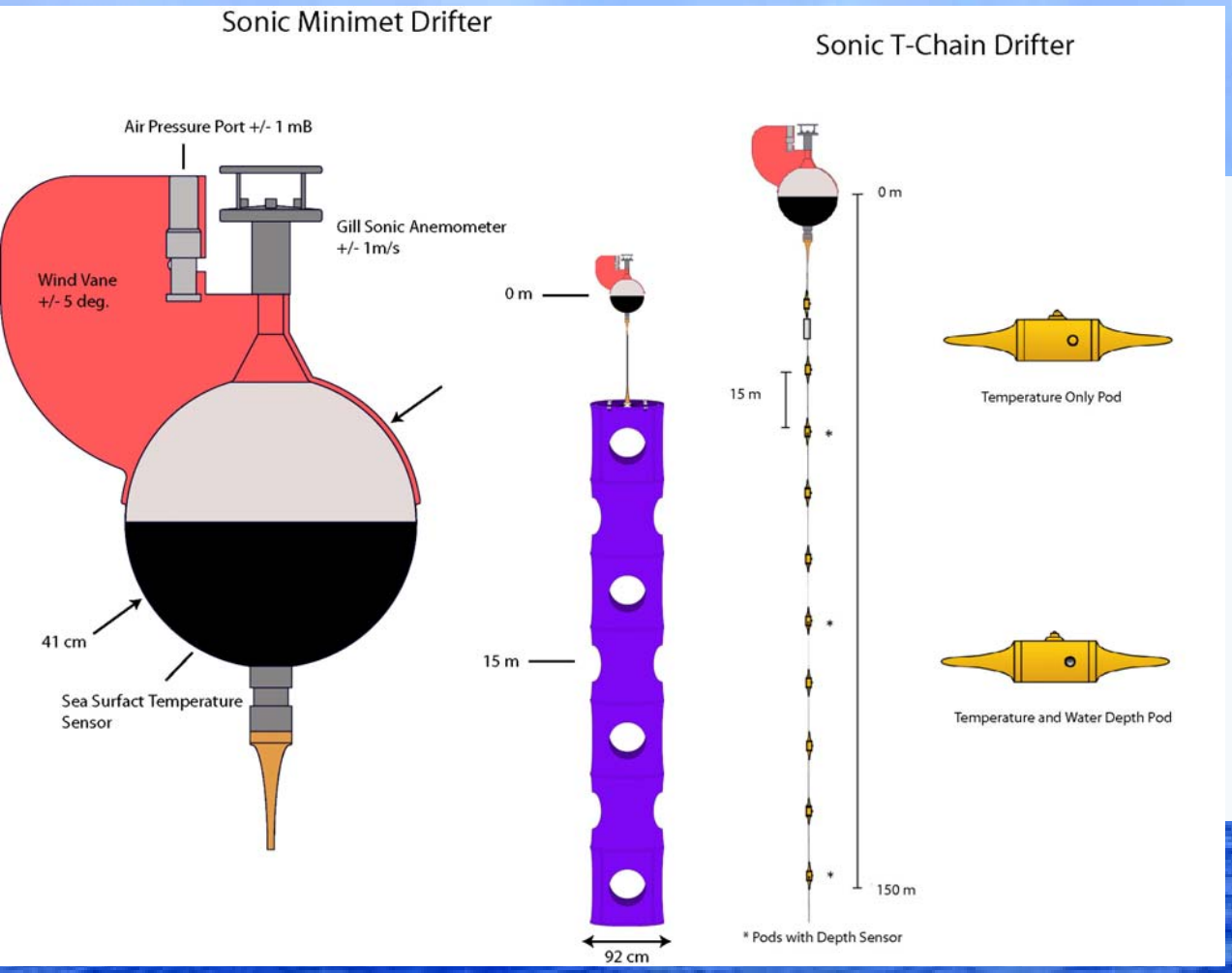
Percent of 600 km squares with one observation per month

Evaluation of the global drifter array

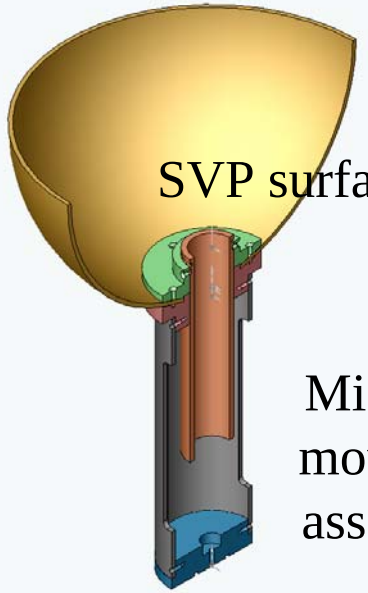

1500
1000
500
0
number of drifters
1250
total
Southern Hem.
Pacific
Northern Hem.
Atlantic
Indian
2000
2002
2004
2006
2008
2010
2012
year

Research and challenges

experimental drifters



Salinity drifter



SVP surface float

Microcat
mounting
assembly

SST accuracy

O'Carroll *et al*. 2008: three-way comparison.

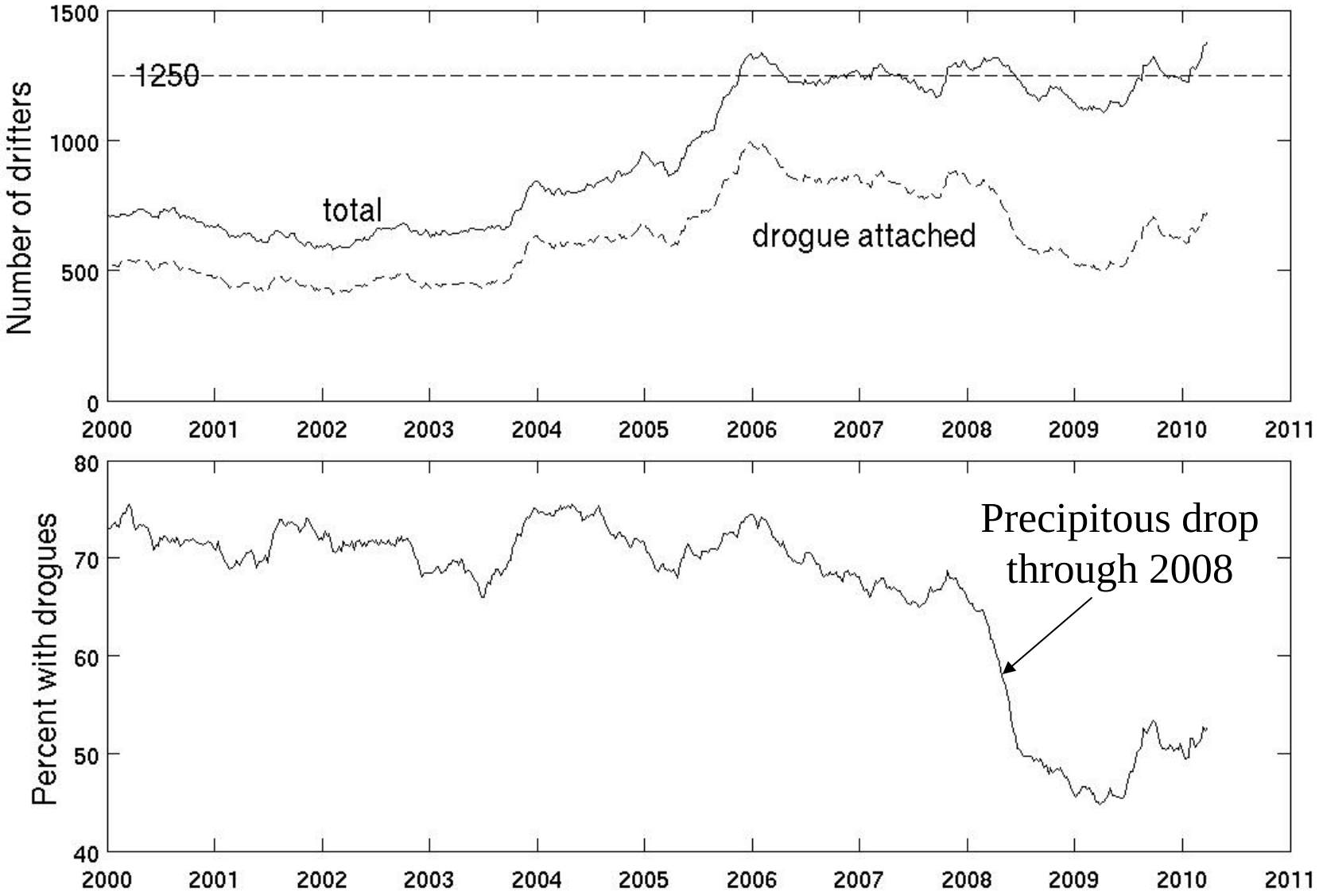
- Advanced Along-Track Scanning Radiometer (IR): σ = 0.13 K
- Drifters: σ = 0.21 K
- AMSRE (MW): σ = 0.43 K

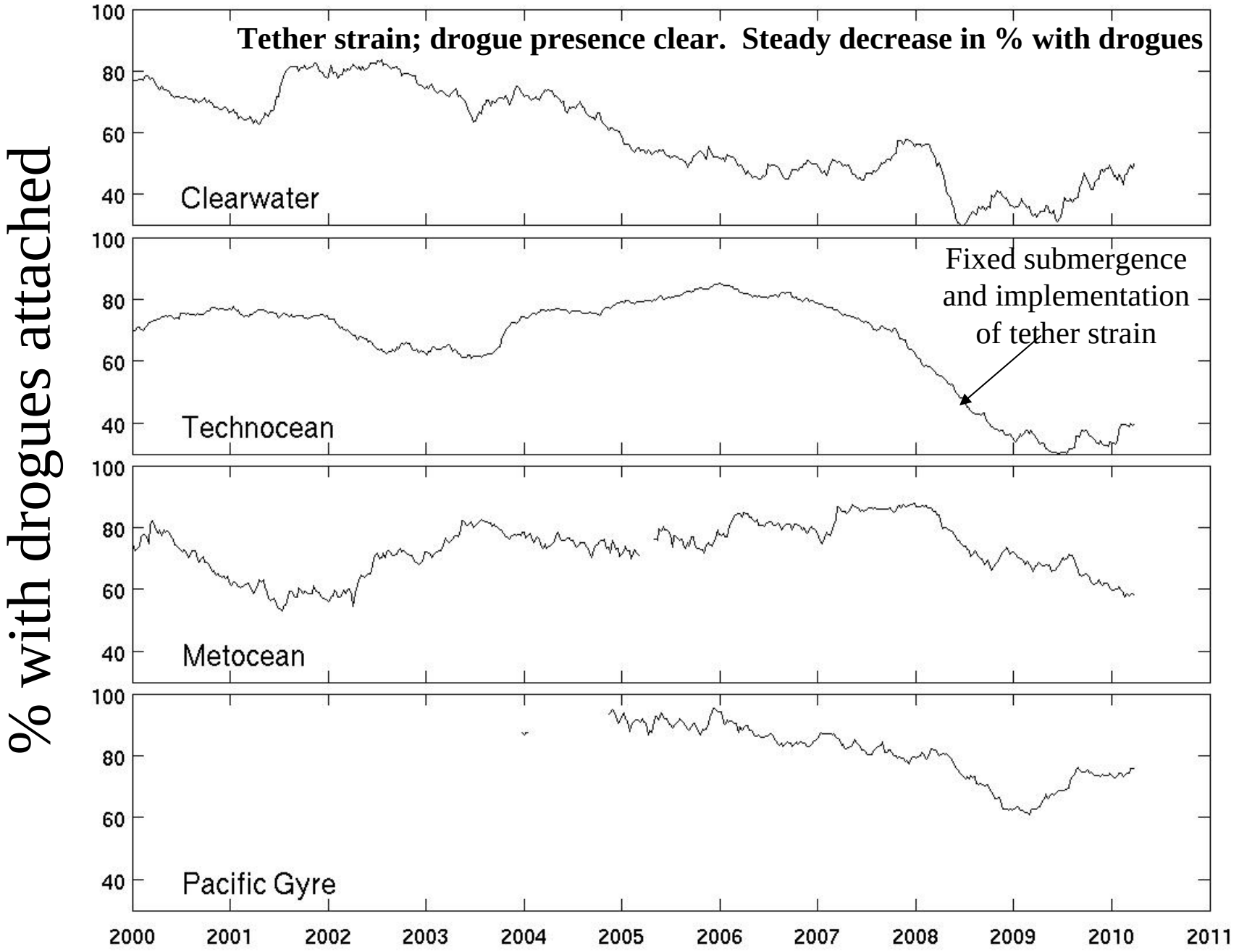
T(z) in upper few cm? Pixel vs. point?

Chris Merchant, pers. comm.: similar results. AATSR vs. Argo 4m nighttime temps: ±0.15K.

A 0.2K random error in drifter SST is twice the design accuracy. Is there undiagnosed drift/errors?

Ongoing work. These studies used real-time buoy data. What results would be obtained from QC data? Would results be different for first three months of drifter's data? Etc.


Number of drifters
1500
1000
500
0
1250
total
drogue attached
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
Percent with drogues
80
70
60
50
40
Precipitous drop
through 2008


% with drogues attached
Tether strain; drogue presence clear. Steady decrease in % with drogues
Clearwater
Technocean
Fixed submergence and implementation of tether strain
Metocean
Pacific Gyre
100
80
60
40
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011

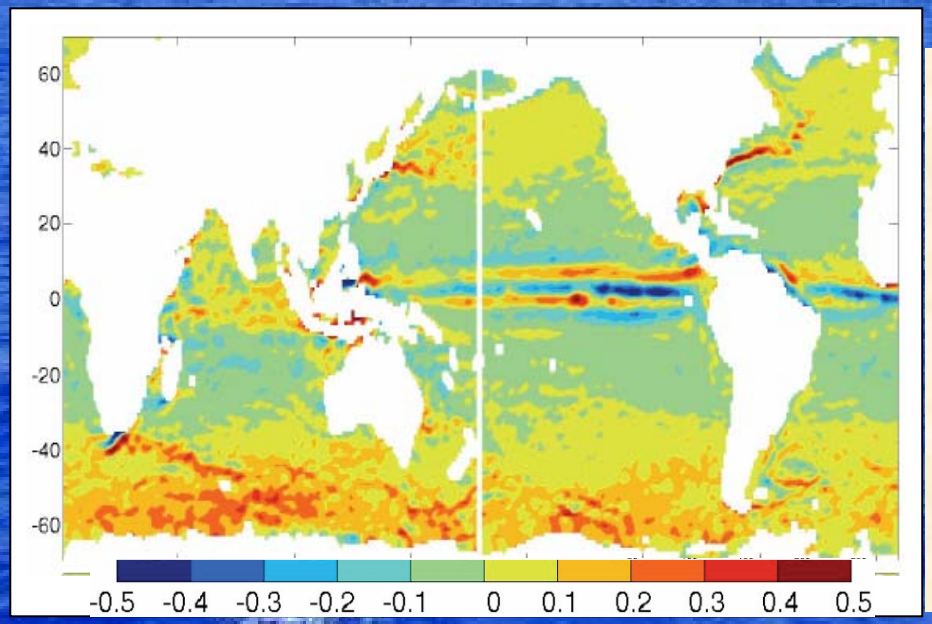
Slip in high wind/wave state

Niiler et al. (1995) measurements of slip were in $W \leq 8$ m/s.

Slip may exceeds linear relationship at high wind/wave state.

Niiler, Maximenko and McWilliams (2003): absolute sea height change, 40—60°S: 2.34m, all drifters; 1.98m, only drifters in $W \leq 8$ m/s; 1.55 m, hydrography referenced to floats (Gille, 2003).

Discrepancies with models: speeds too high to reproduce reasonable transports in Southern Ocean passages.



Left: mean zonal drifter speed (AOML climatology) minus mean zonal speed of ECCO-GODAE 1° state estimation, 15yr mean (figure courtesy M. Mazloff, WHOI).

Consistent offset in Southern Ocean.

2011: goals and plans

Deploy 1000 Drifters in the period between October 2010 and September 2011.

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

Continue to update quality-controlled interpolated database.

Evaluate 2010 AOML Data Buoy comparison study drifters.

Continue to participate in Argos-3 Pilot Project.

Fully incorporate Iridium drifters in GDP data stream.

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

Develop QC procedures for drifter salinity data.

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