



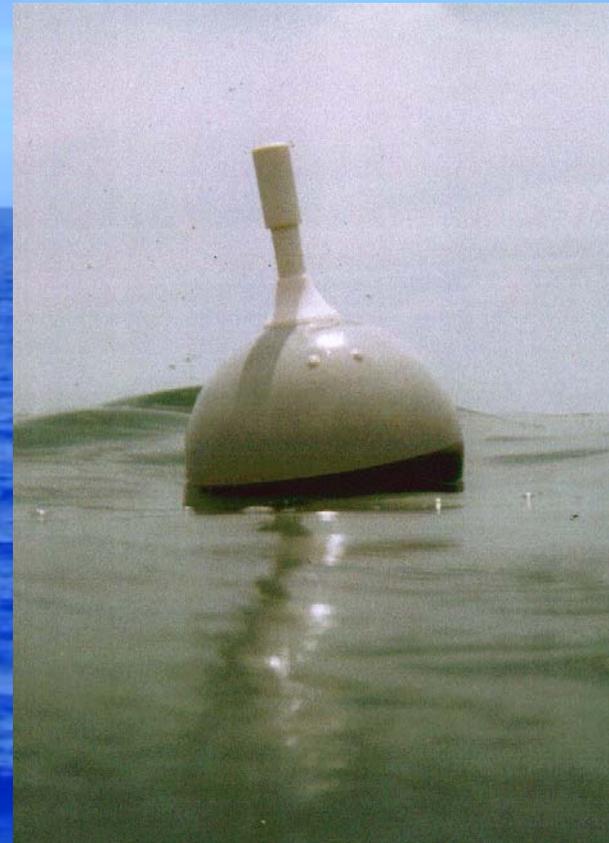
Global Drifter Program (GDP)



*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.

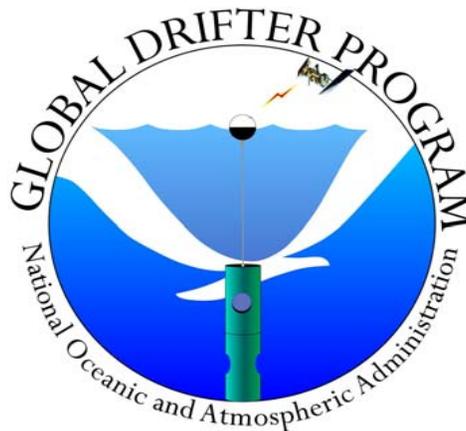
Objectives:

Maintain a global 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.

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.

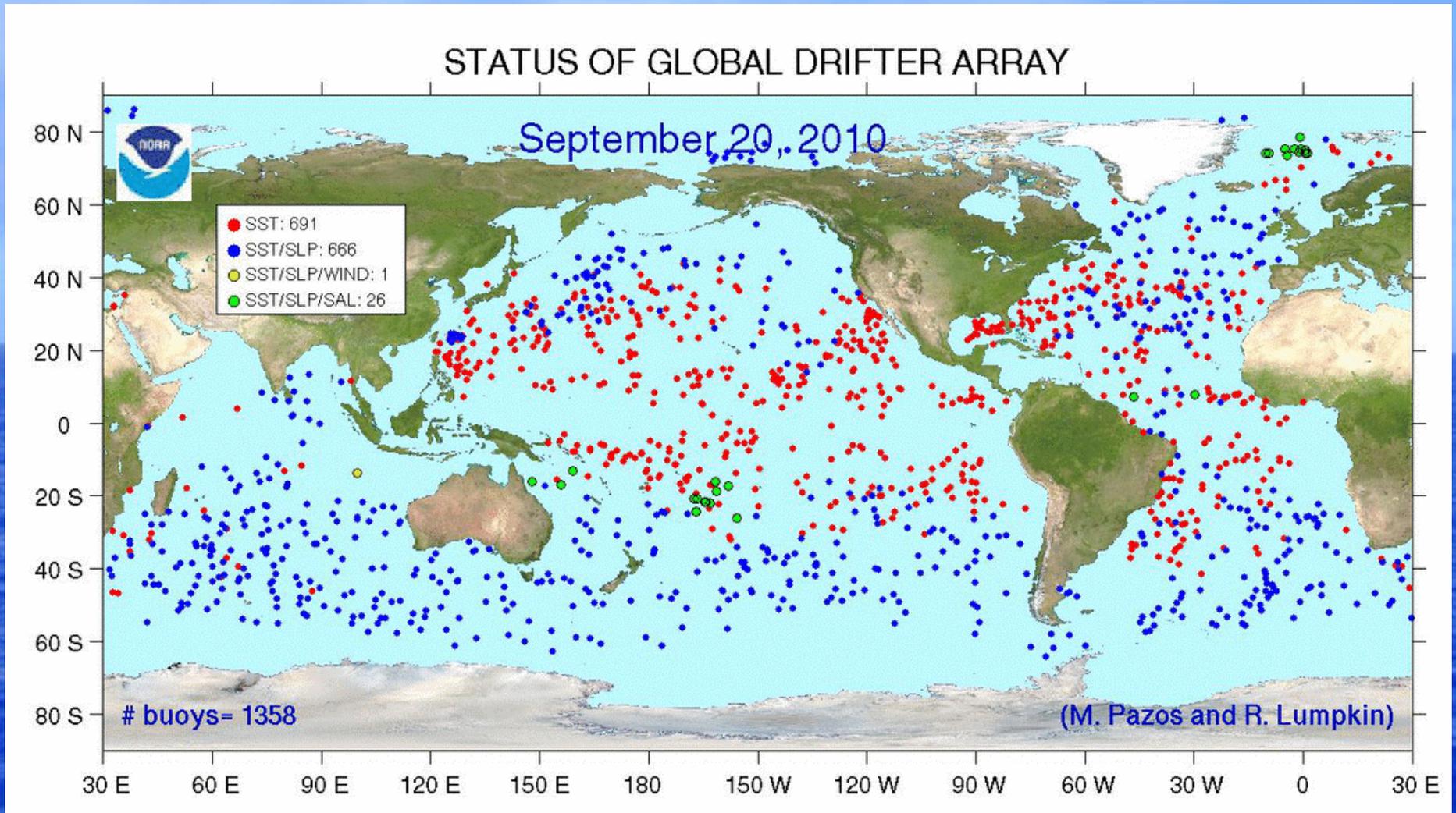
Manufacturers in private industry, who build the drifters according to closely monitored specifications

Drifter Operations Center (DOC)

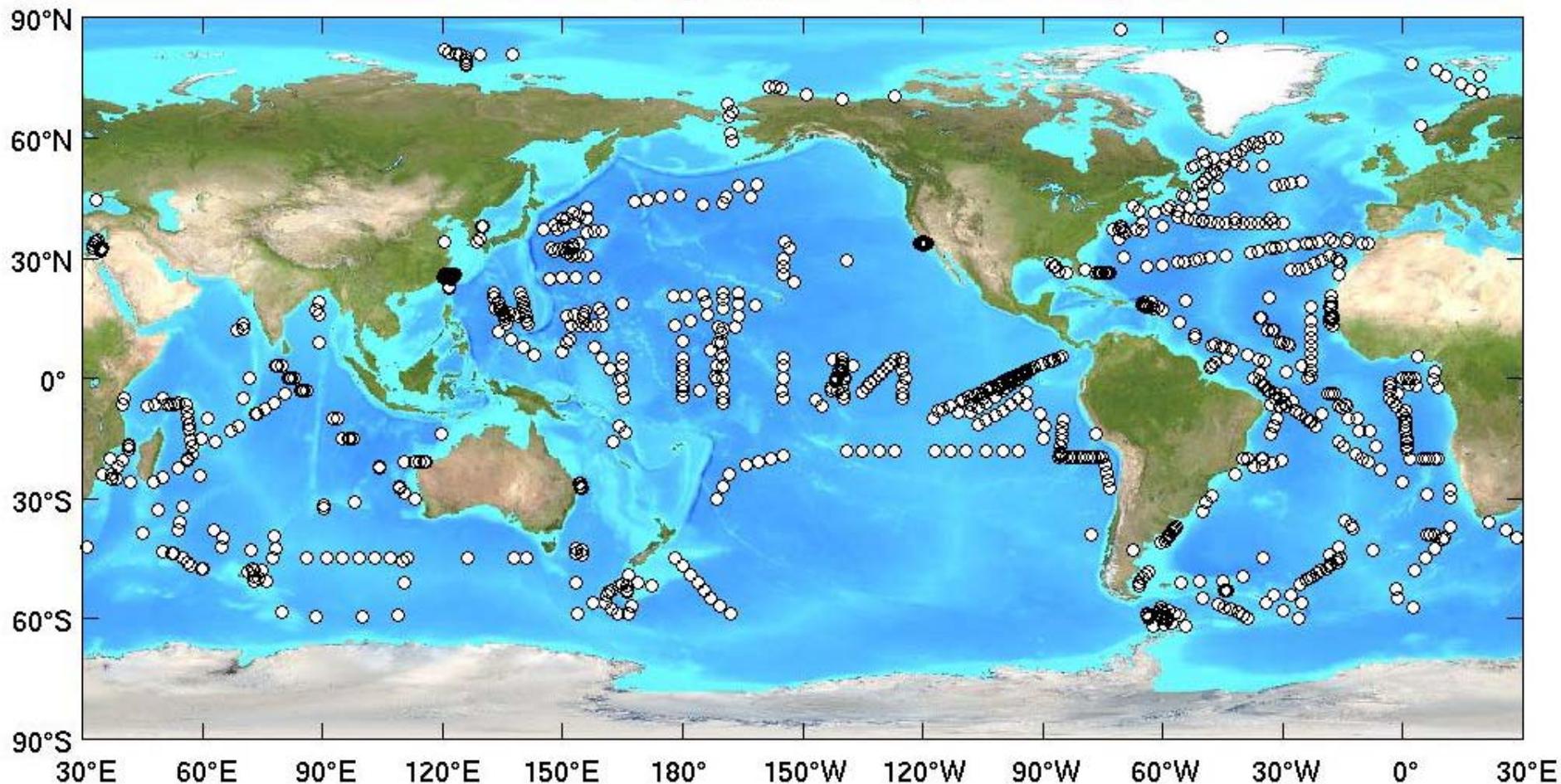
Drifter Data Assembly Center (DAC)

Current status of the global array

~1350 GDP drifters (goal: 1250 annual average)



GDP drifter deployments, 6 July 2009-7 July 2010



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.

Deployment plans for 2011

Operational Buoy Deployments	800
Consortium Research Buoy Deployments	<u>200</u>
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

AN INTEGRATED GLOBAL OBSERVING SYSTEM FOR SEA SURFACE TEMPERATURE USING SATELLITES AND IN SITU DATA

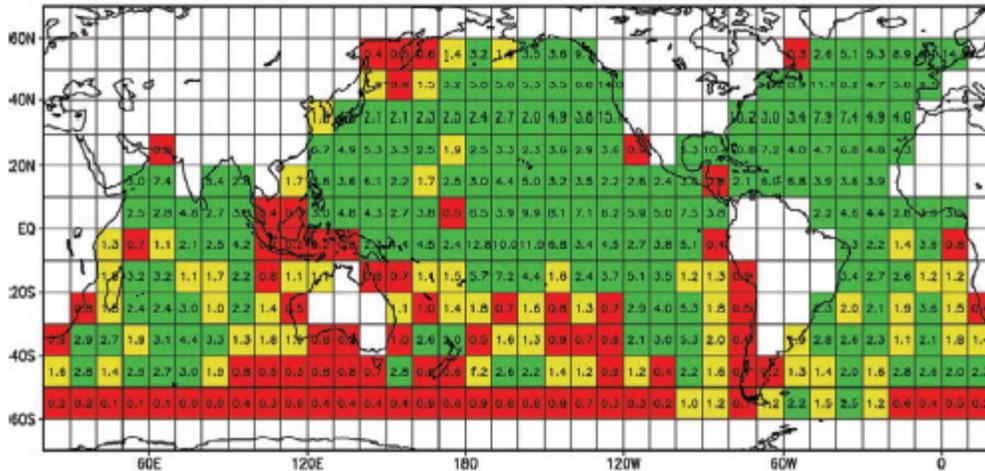
Research to Operations

BY H.-M. ZHANG, R. W. REYNOLDS, R. LUMPKIN, R. MOLINARI, K. ARZAYUS,
M. JOHNSON, AND T. M. SMITH

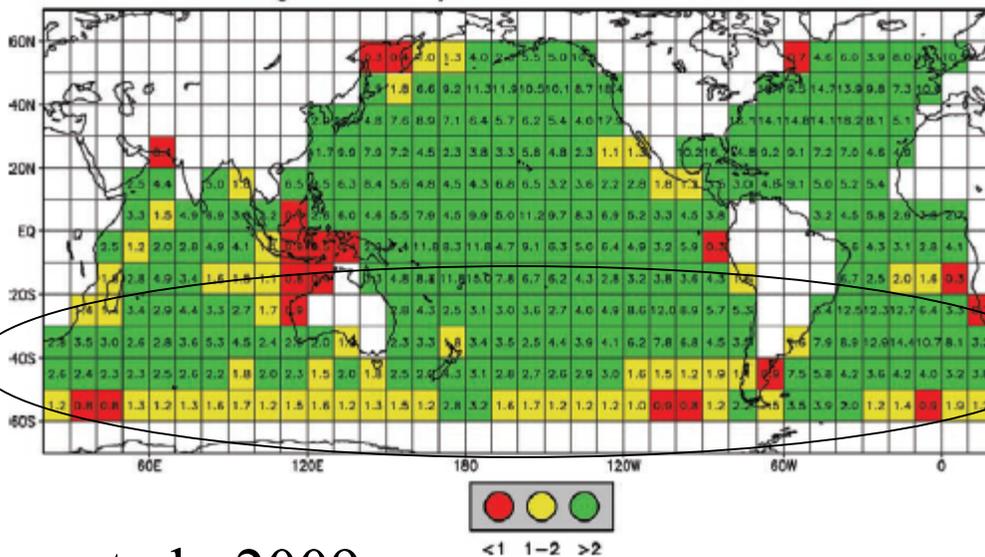
BAMS JANUARY 2009

Equivalent buoy density (EBD)

Averaged Monthly EBD: JAN2002–DEC2002



Averaged Monthly EBD: JAN2006–DEC2006



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

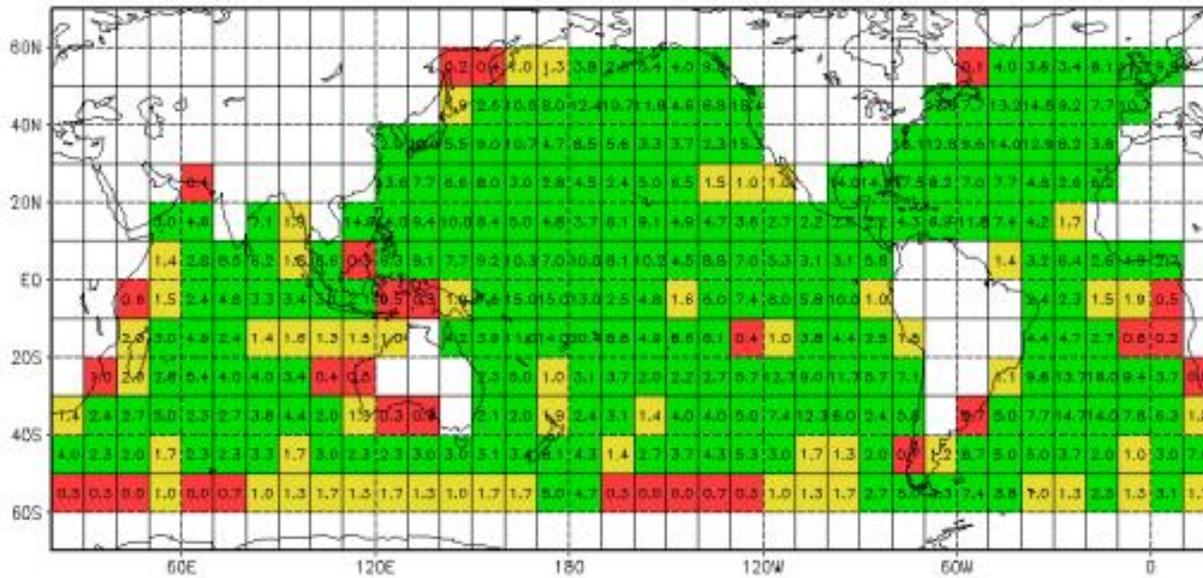
$$EBD = n_b + \frac{n_s}{7},$$

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

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

Large improvement in SO primarily due to drifters

Total System EBD: JAN2006–MAR2006



NO Drifting Buoys EBD: JAN2006–MAR2006

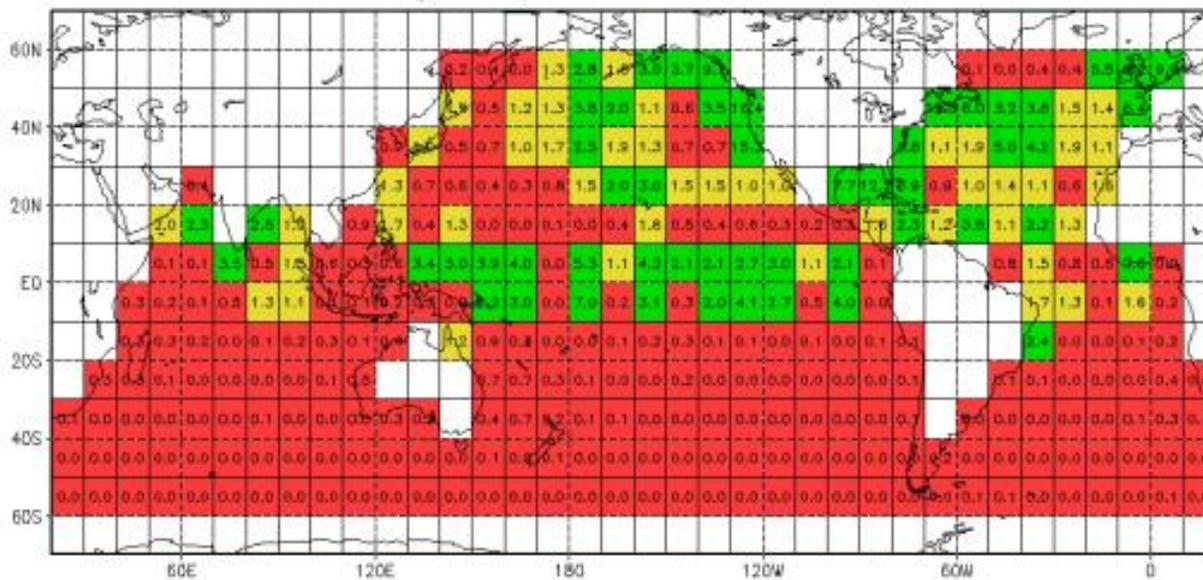
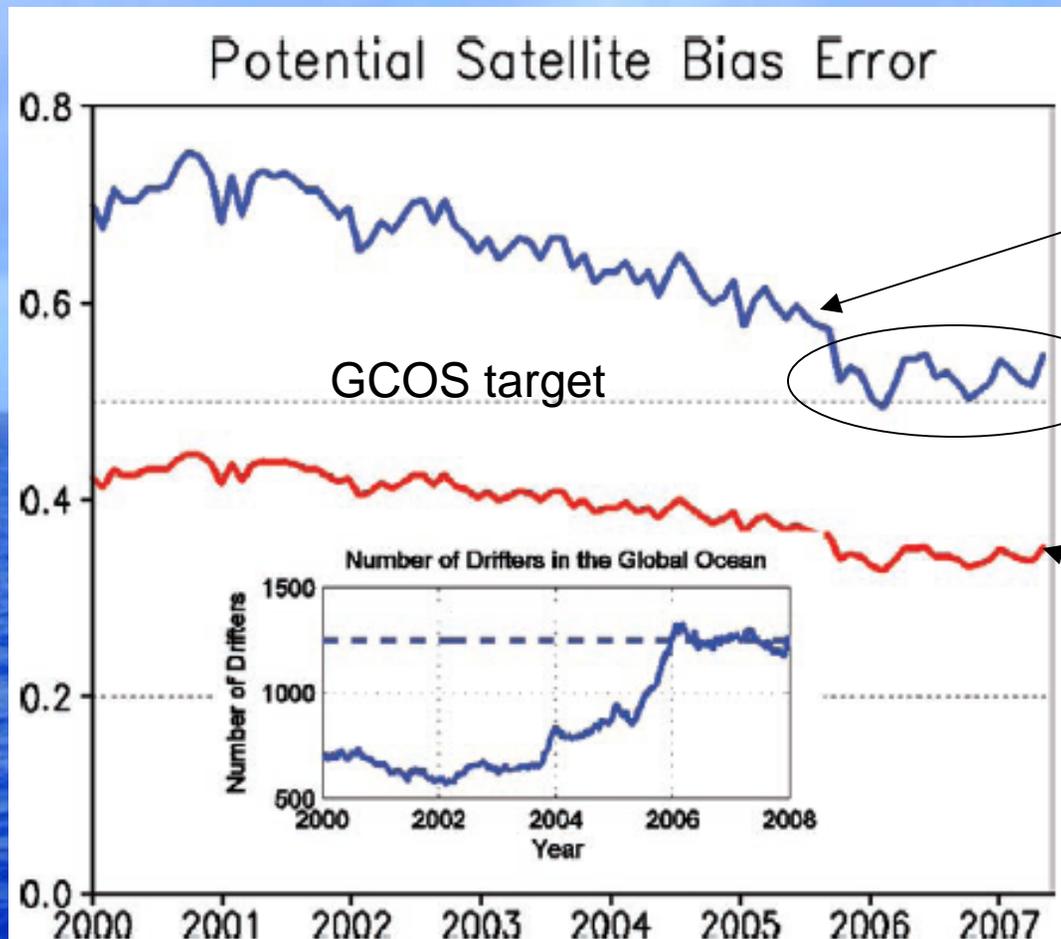


Figure courtesy
Huai-min Zhang,
NOAA/NCDC

Reduction in potential satellite bias error



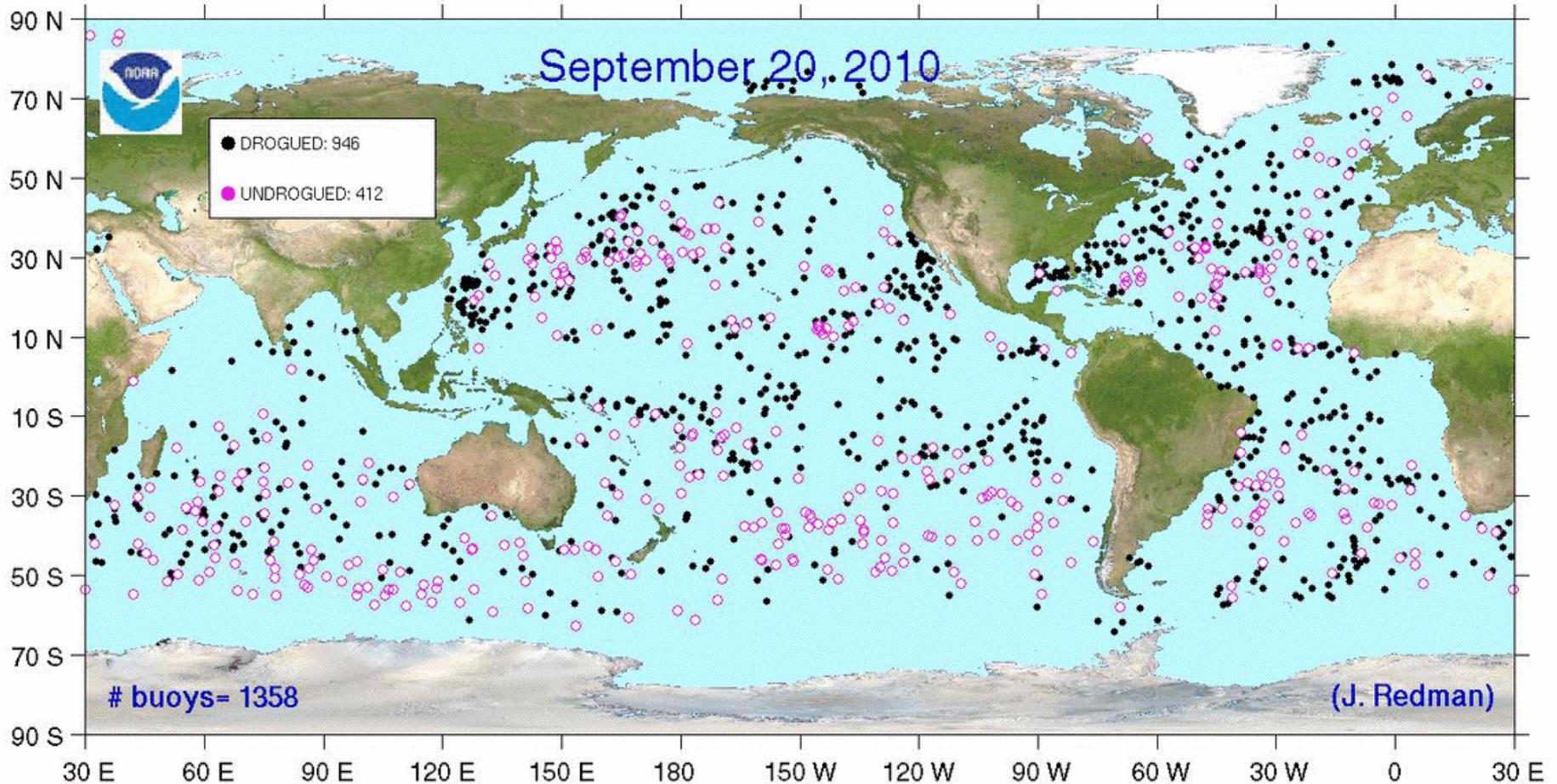
Worst case scenario

Plateau at target

Normal

Mixed layer current measurements

CURRENT STATUS: DROGUED AND UNDROGUED DRIFTERS



Black Bullets: location of all (~100) drogued drifters .

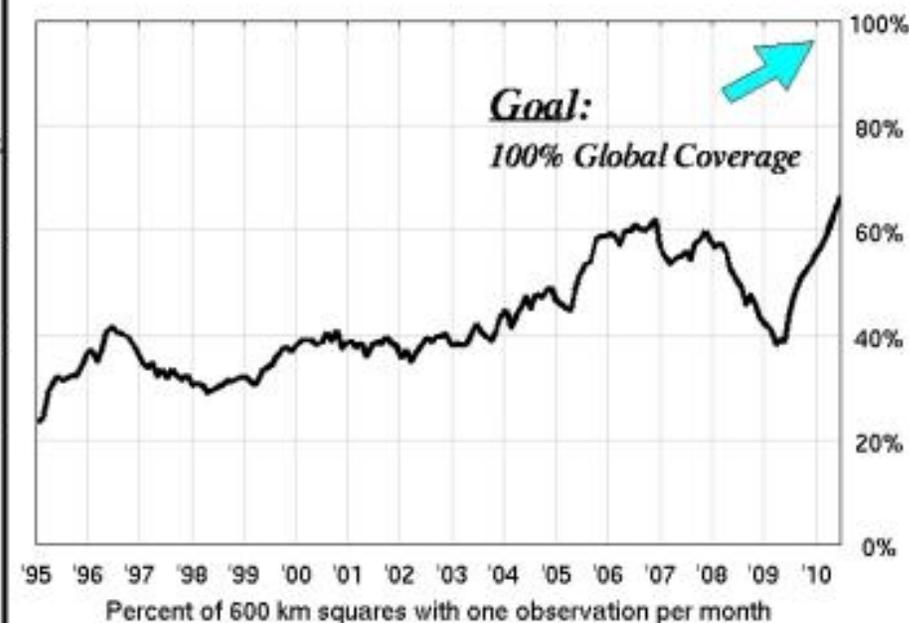
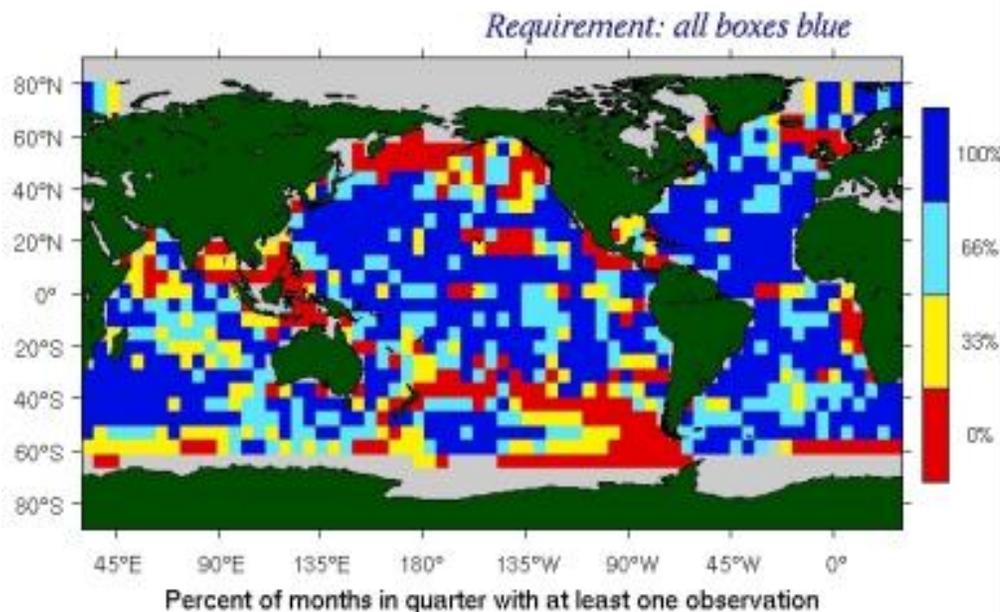
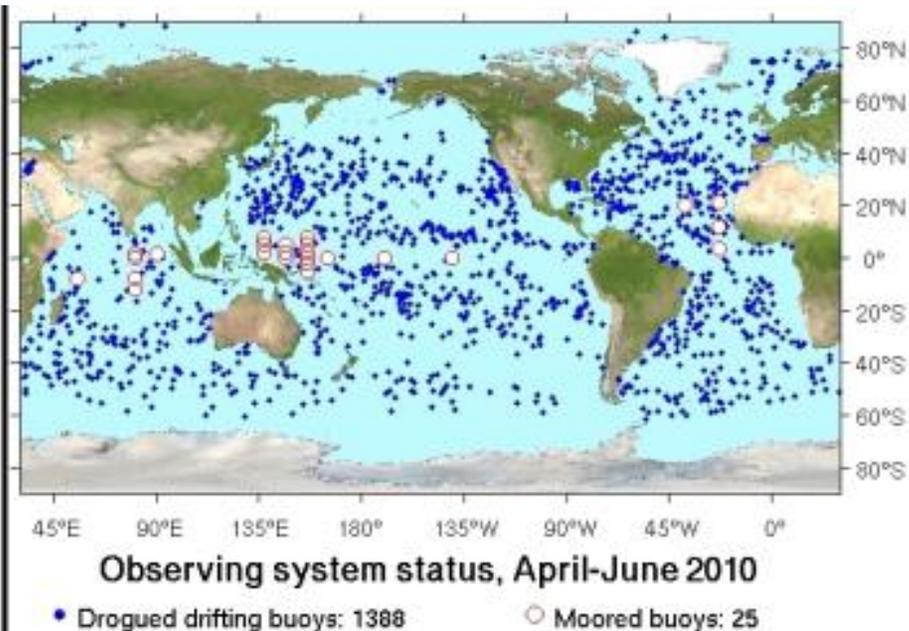
Open pink: drifters without drogues, still measuring SST.

~75% of the array has drogues attached (real-time estimate; delayed mode drops to ~50%)

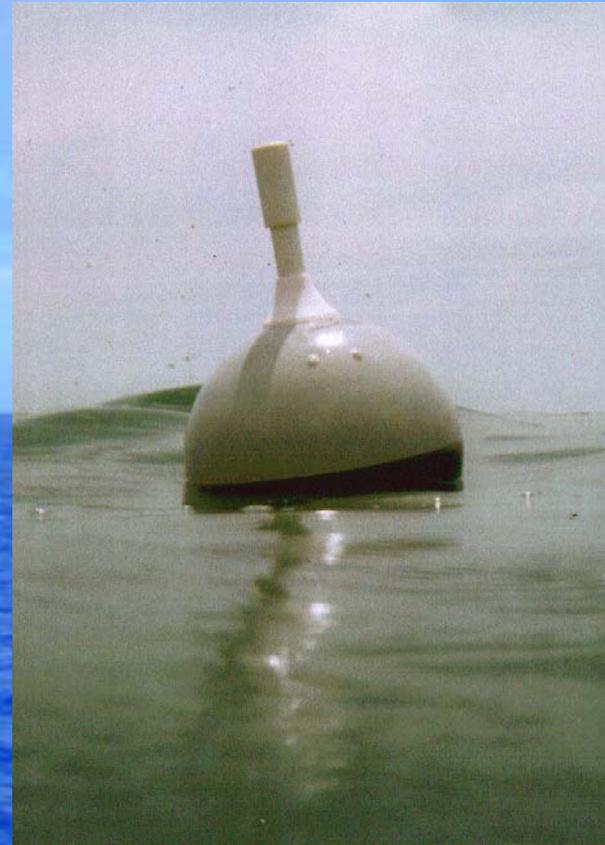
Observing System Status: 2010, Q2. Surface Currents

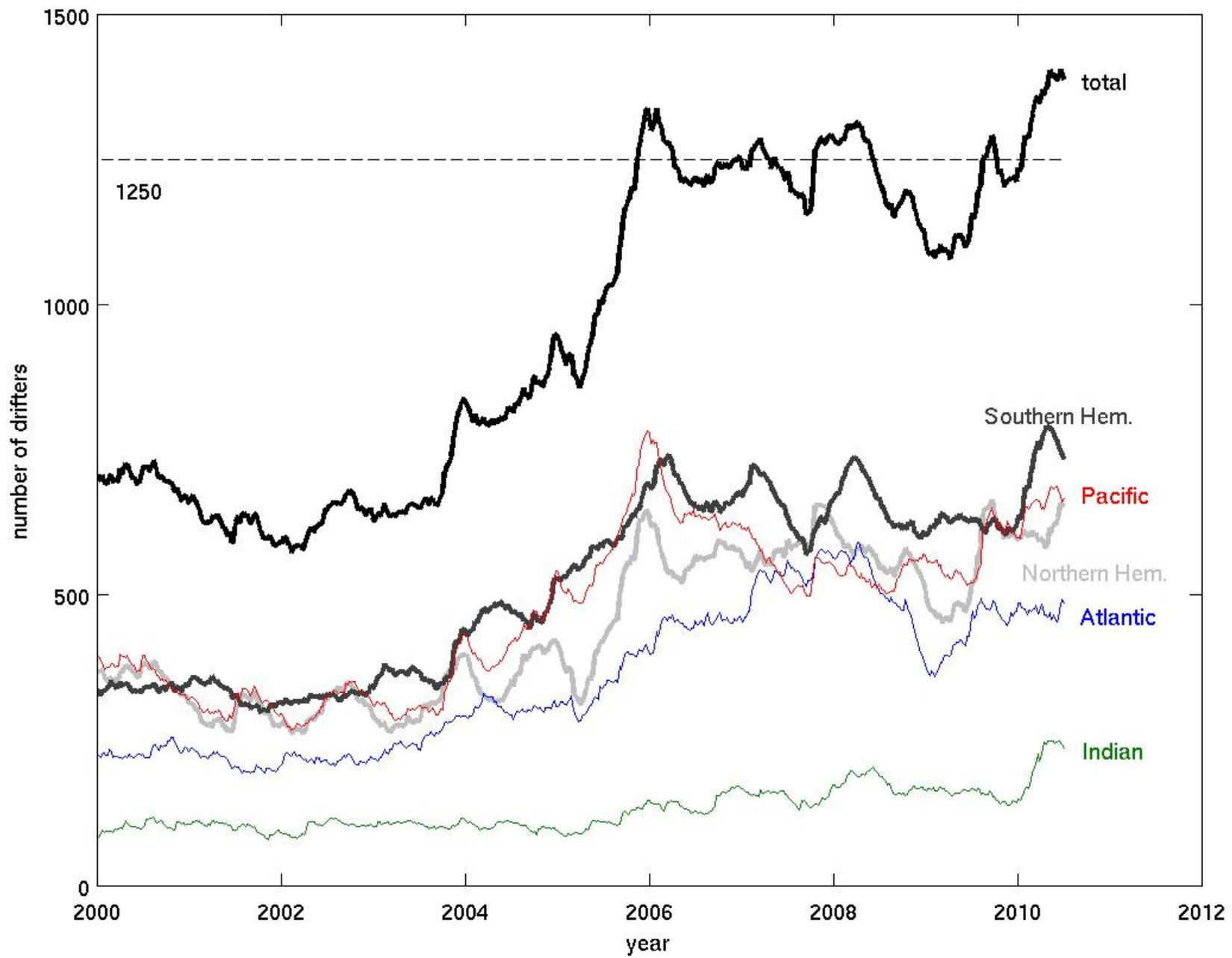
Requirement: 2 cm/s accuracy (drogue on); 600 km resolution;
1 sample per month (GOOS/GCOS, 1999)

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

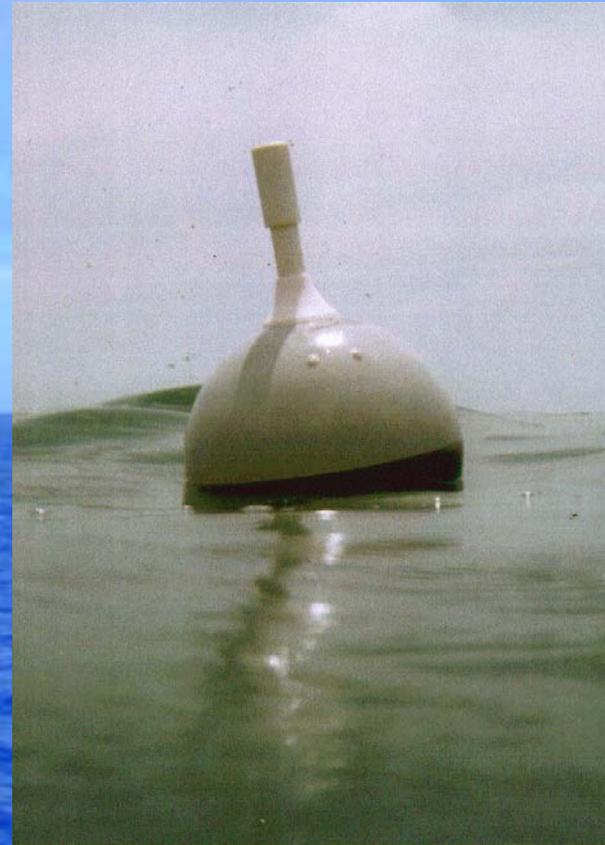


Evaluation of the global drifter array



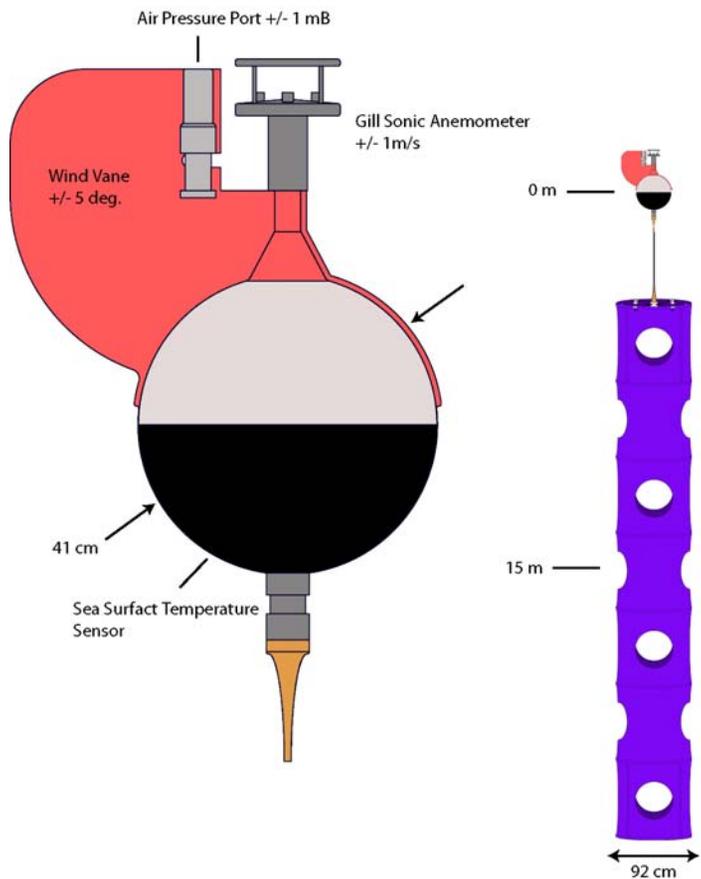


Research and challenges

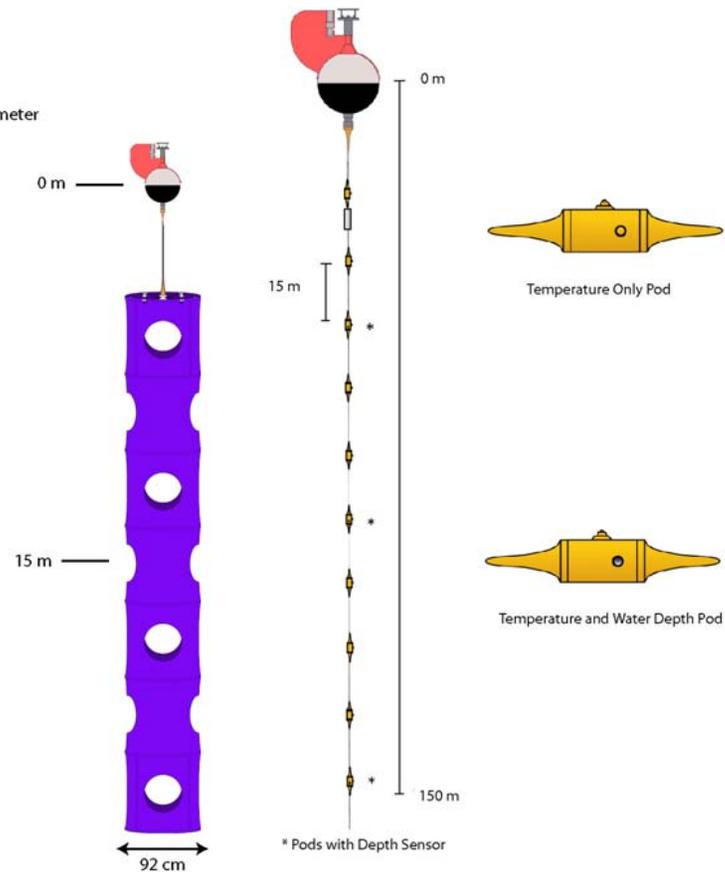


experimental drifters

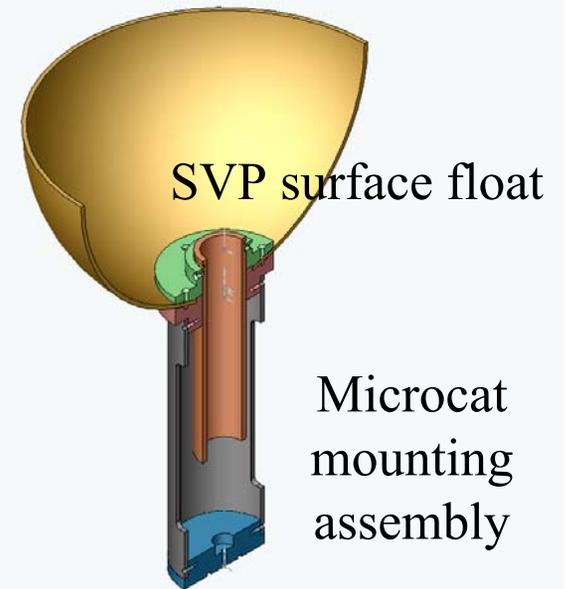
Sonic Minimet Drifter



Sonic T-Chain Drifter



Salinity drifter



SST accuracy

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

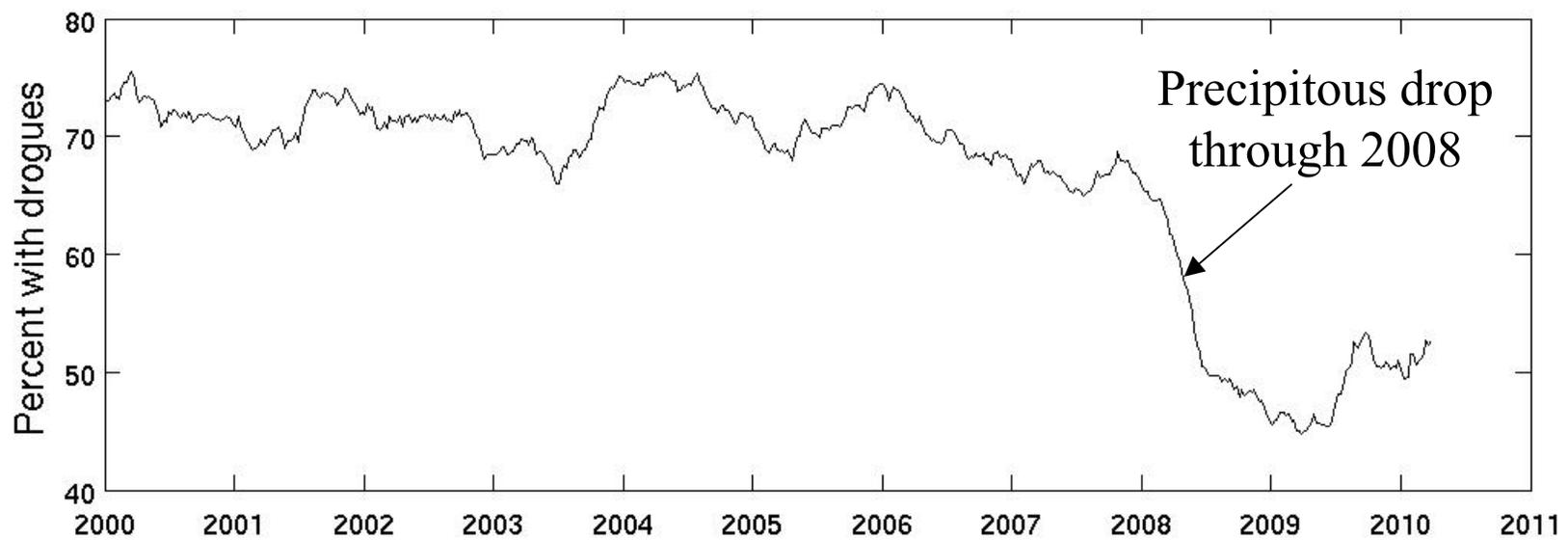
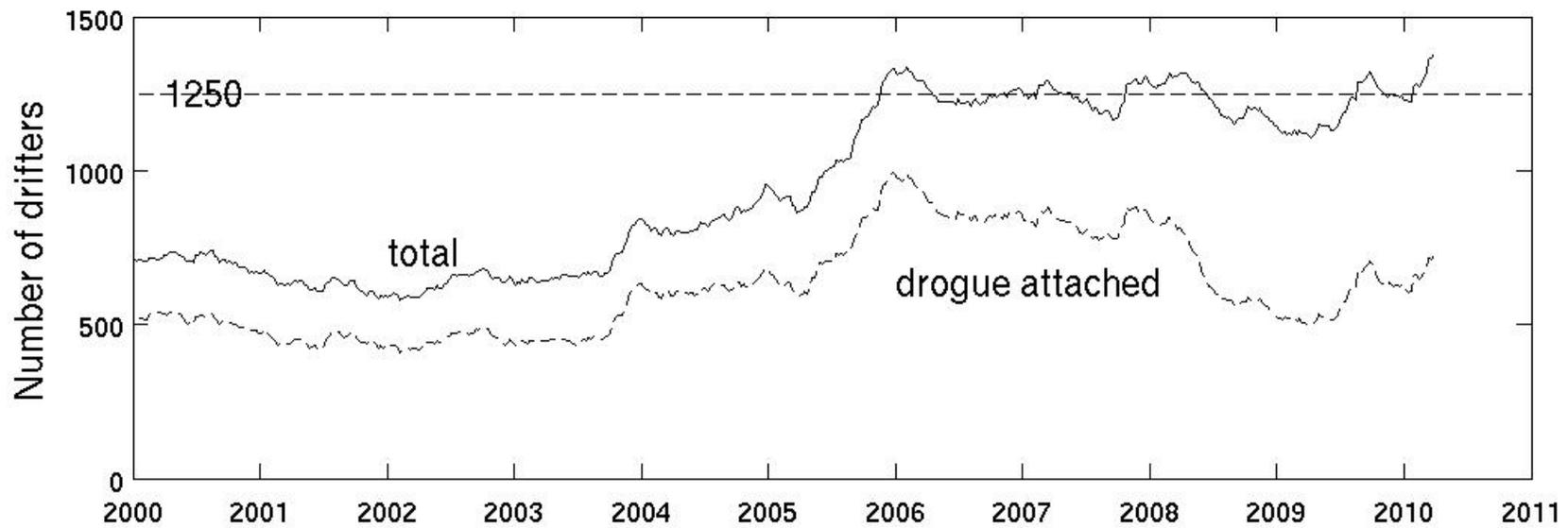
- Advanced Along-Track Scanning Radiometer (IR): $\sigma = 0.13$ K
- Drifters: $\sigma = 0.21$ K
- AMSRE (MW): $\sigma = 0.43$ K

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

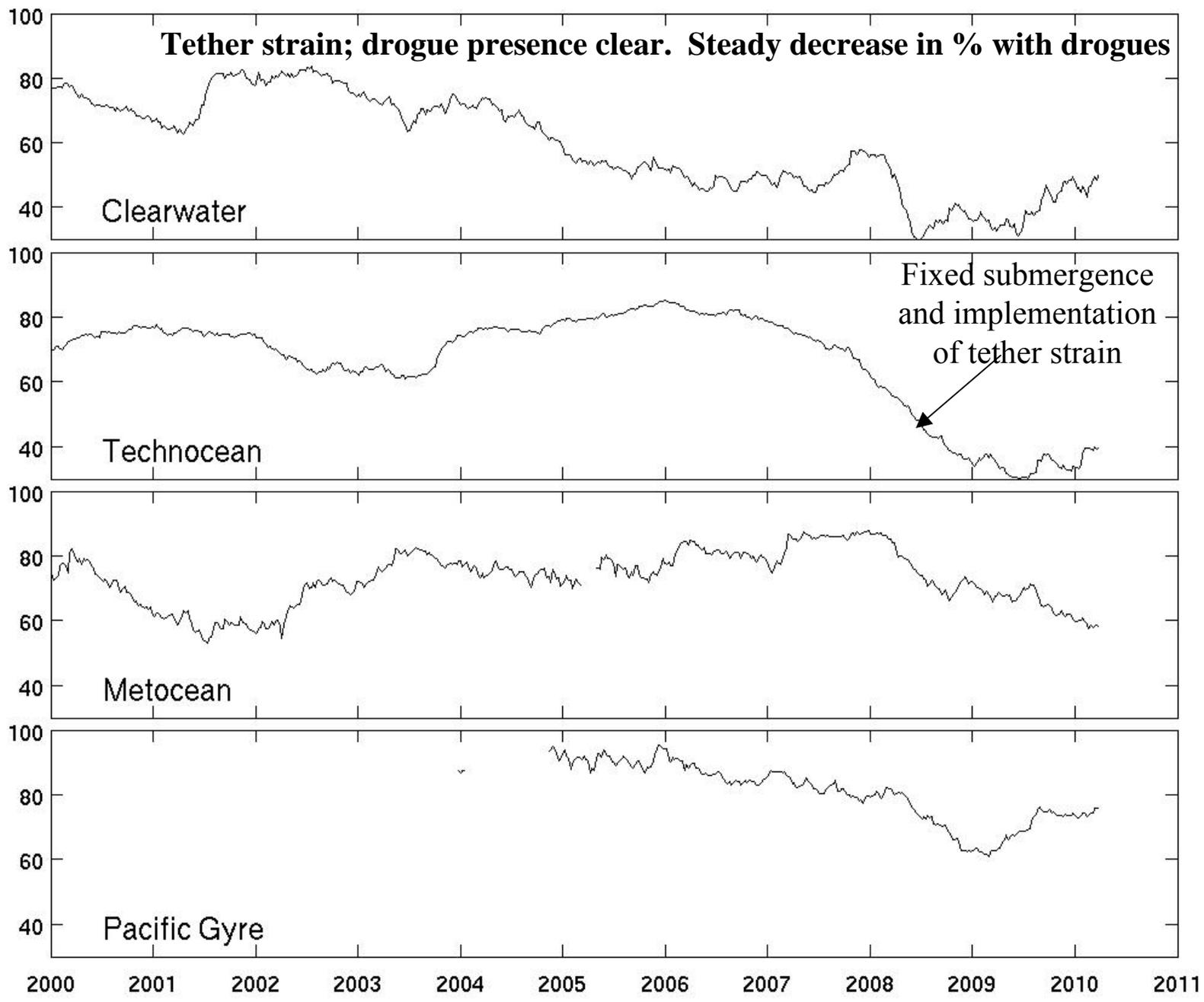
Chris Merchant, pers. comm.: similar results. AATSR vs. Argo 4m nighttime temps: ± 0.15 K.

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.



% with drogues attached



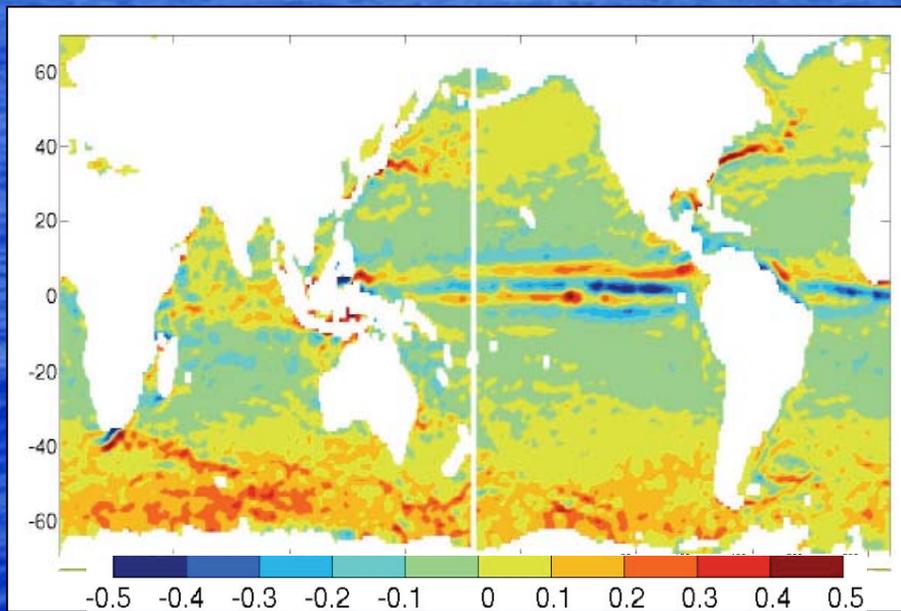
Slip in high wind/wave state

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

Slip may exceed 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.

MAINTAIN 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 Meteorologia; Centro de Hydrografia de Marinha; INPE (National 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 Development 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

