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

Luca Centurioni, SIO

28th Data Buoy Cooperation Panel session

2-6 October 2012

Fremantle, Australia

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. Additional instrument development at Scripps funded by ONR.

AOML (Miami, FL)
Rick Lumpkin

Drifter Operations Center (DOC)

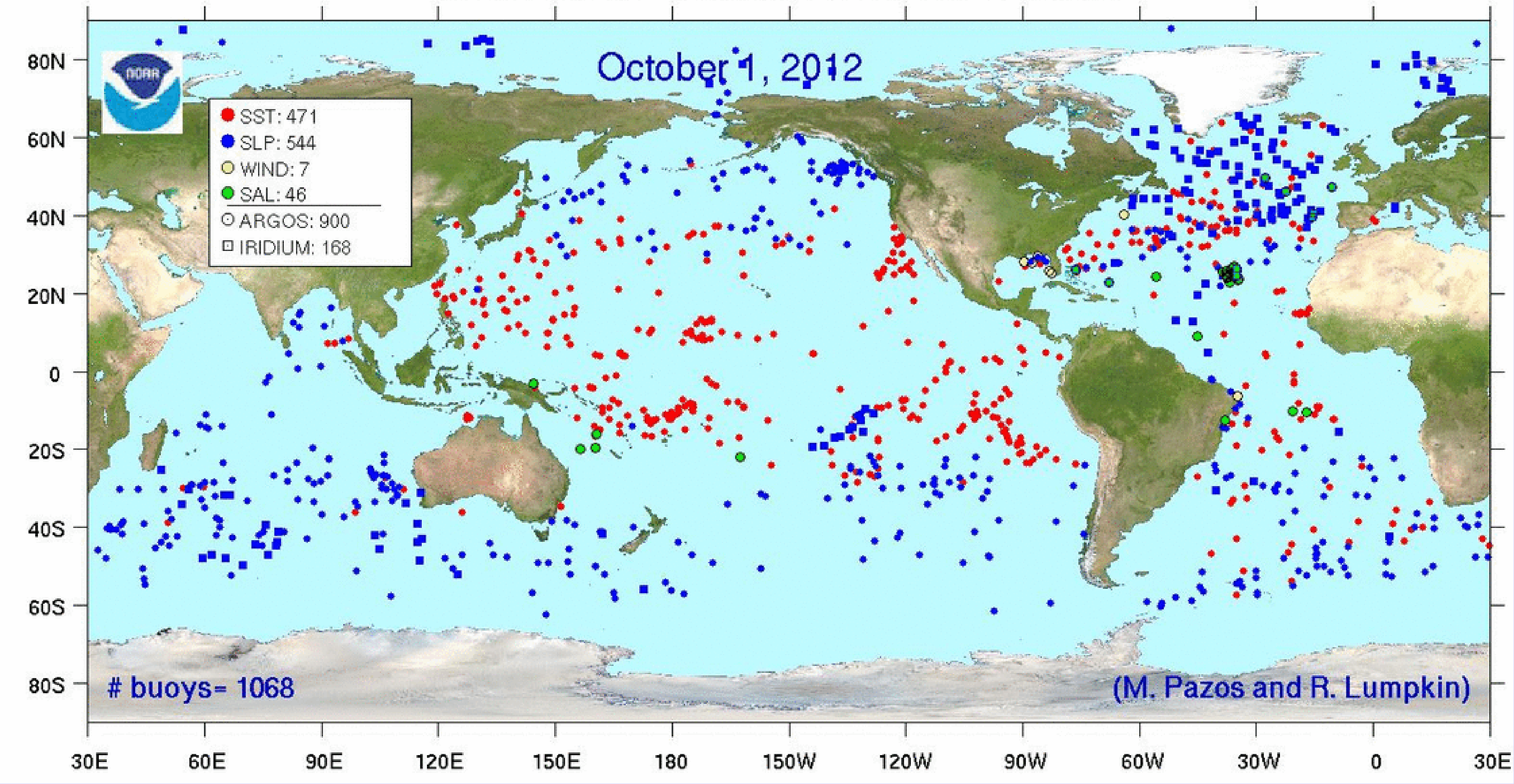
Drifter Data Assembly Center (DAC)

Scripps (La Jolla, CA)
Luca Centurioni
Supervises the industry, upgrades the technology, purchases most drifters, and develops enhanced data sets.

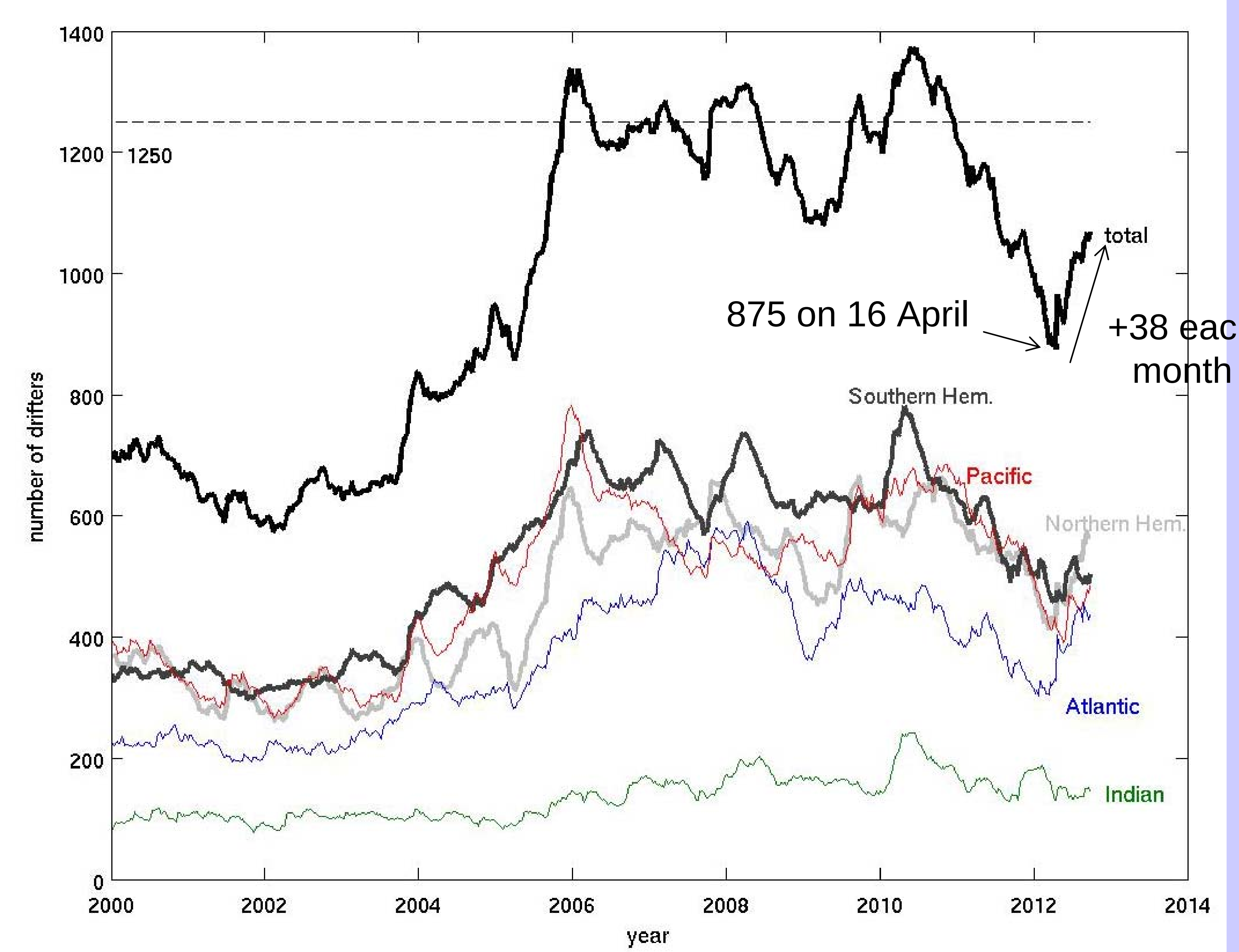
Manufacturers in private industry, who build the drifters according to closely monitored specifications

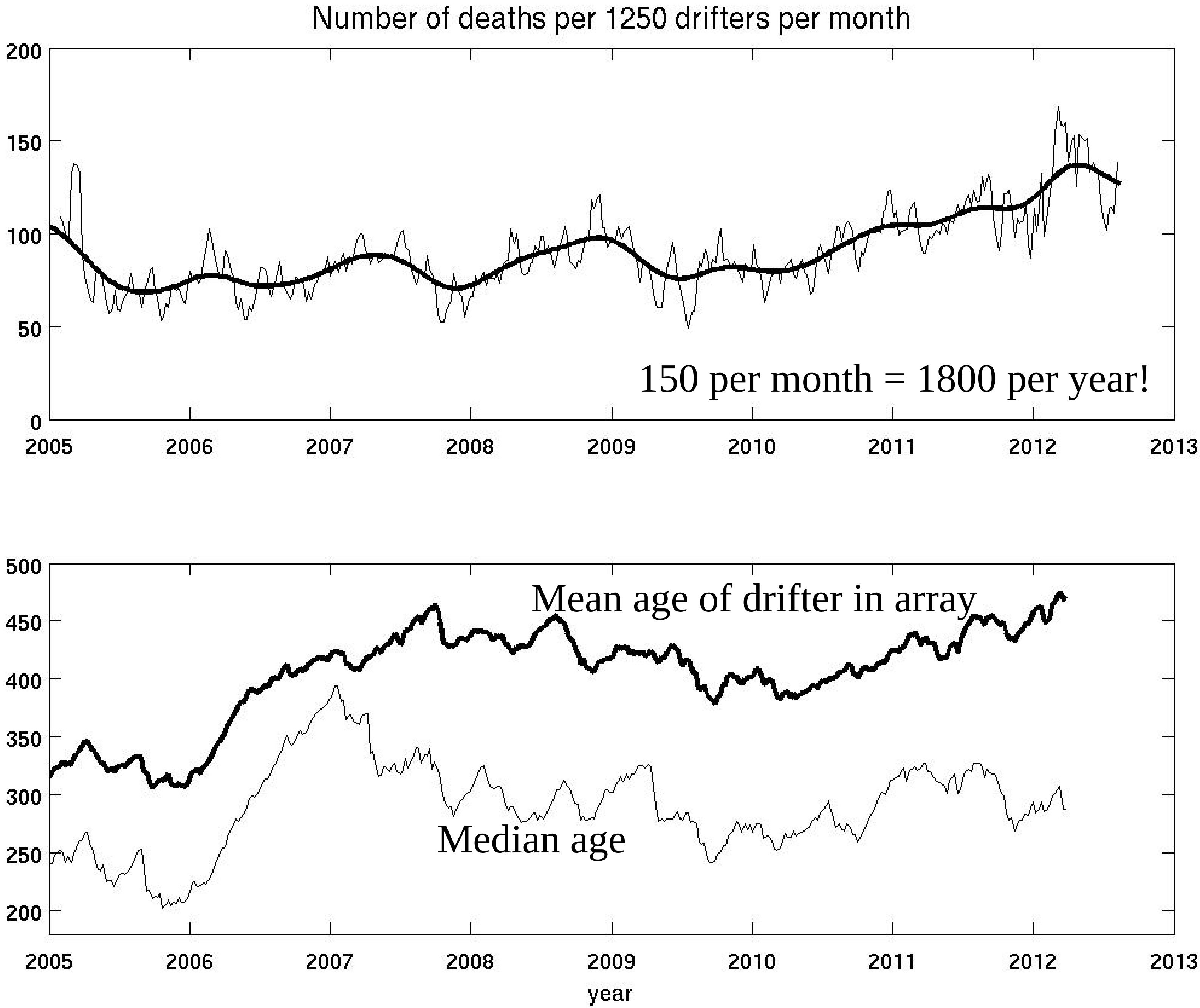
Current status of the global array

Last year: 1013 GDP drifters and dropping …

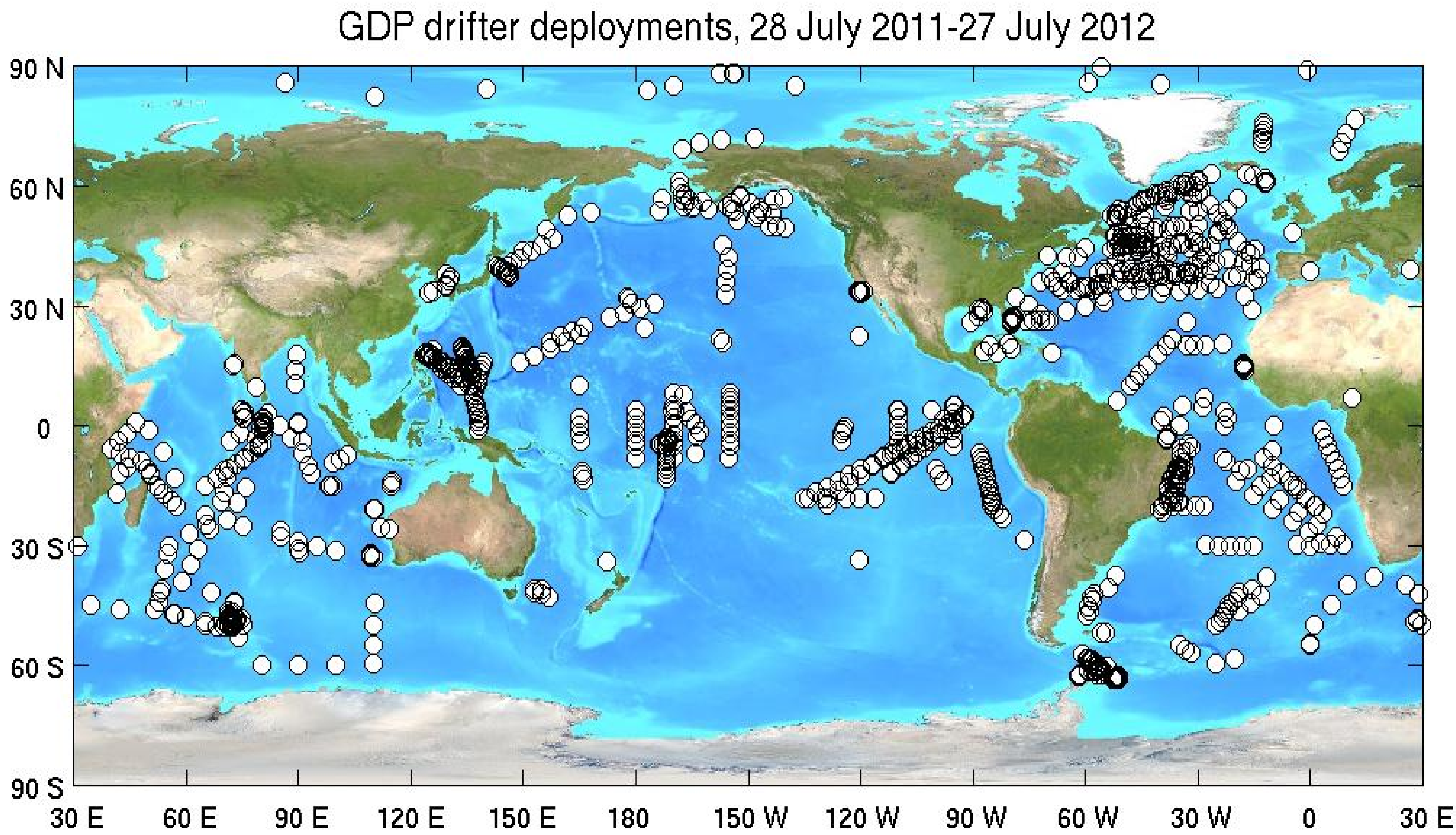


Evolution of the array





Number of deaths per 1250 drifters per month
150 per month = 1800 per year!
Mean age of drifter in array
Median age
year
200
150
100
50
0
500
450
400
350
300
250
200
2005
2006
2007
2008
2009
2010
2011
2012
2013



1203 drifters deployed in the period 27 July 2011 to 28 July 2012.

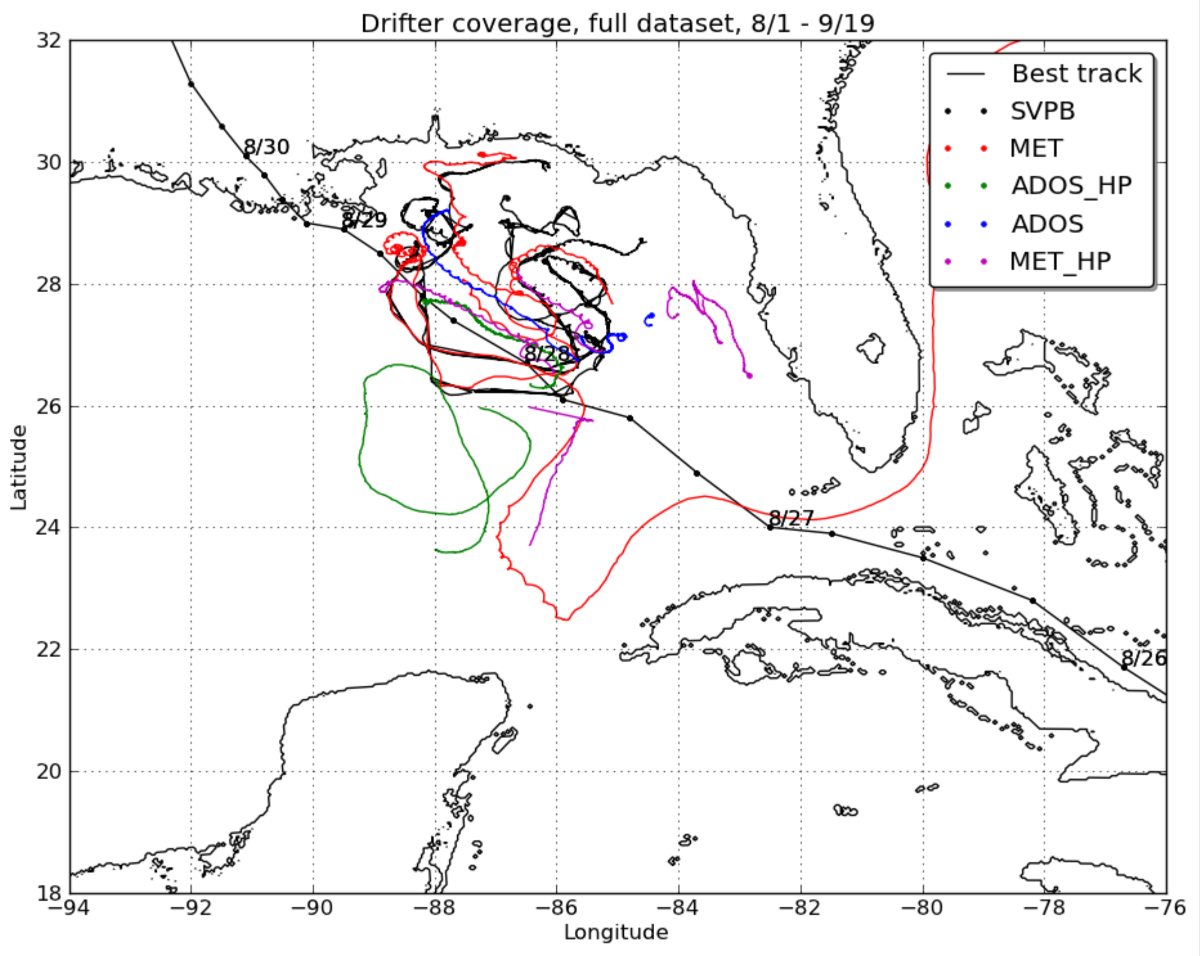
Drifter Operations Center:
Shaun Dolk (Miami, FL USA)
Shaun.Dolk@noaa.gov

2012 Deployment highlights

- 24 SVPBs in the Drake Passage (PI Christian Reiss)
- 20 SVPBs and 20 SVPGs near Falkland Islands (PI Andrew Thompson)
- 12 SVPBs in the east Indian Ocean (deployed by Indonesian collaborators)
- 20 SVPs in the Gulf Stream during the LatMix II experiment (PI Pascale Lelong)
- 35 SVPs during the Stratus servicing cruise in the southeast Pacific (PI Bob Weller)
- 20 SVPBs in the southern Indian Ocean (PI Isabell Ansorge)
- 20 new Scripps SVPs off the coast of California (PI Carter Olhmann)
- 16 SVPs in conjunction with Earth Day at 6 US Cities
- 10 SVPs in the Yucatan Strait (PI Estrella Malca)
- 12 SVPBs during the DART servicing cruise in the north Pacific (PI Karen Grissom)
- 35 SVPBs in the North Atlantic by the State University of New York Maritime College

Hurricane Isaac deployments

August 2012, Gulf of Mexico



Deployment of 5 ADOS, 5 Minimet drifters, and CARTHE drifters.
Graphics courtesy M. Curcic, Univ. Miami.

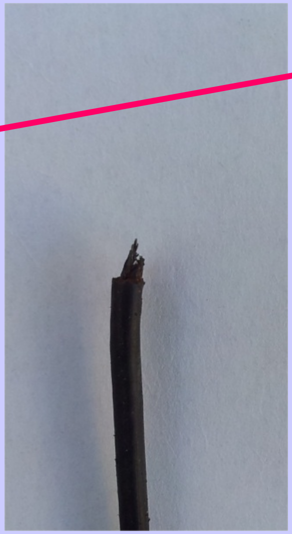
Technical developments

Overall goal: homogenize and ruggedize the SVP design

- Ruggedized tether attachment for strength and water infiltration implemented across the drifter fleet;
- Recommendation for high quality batteries issued to manufacturers;
- Recommendation for more accurate SST (0.05ºC) issued to manufacturers;
- Recommendation for ruggedized drogue design issued to manufacturers;
- SIO completed SVP and SVPB drifter design and started production;
- New tether material (synthetic rope) is currently under evaluation (20 SIO units).

Why do drifters lose their drogue (besides fish bite)?

SIO drifters recovered in Tuscany (Italy) ...



Note several kinks. Breaking points + rust

SIO is evaluating 20 drifters with new tether material (synthetic rope)

…and off Tigzirt (Algeria)

Damage due to ~1 week on cliff

SIO specified drogue (enhanced stitching, tacking, doubled folds)

IMPACT OF SLP DATA FROM DRIFTERS ON NWP

Workshop held on May 21, 2012 in Sedona, AZ:

Summary of conclusions:

- The impact of drifters (i.e. from fraction of beneficial observations, impact per observations and many others indicators) is very high for different assimilation systems (3D-Var, 4D-Var) and different global metrics;
- The impact is large especially for open ocean, high latitudes buoys (i.e. drifters) and for explosive cyclogenesis;
- There is little redundancy in the SLP observing system (high % of beneficial observations);
- Drifter SLP is very important to anchor the SLP pressure field and is more accurate than GPSRO;
- Need to run routine impact studies with drifters' SLP separated from other marine network components and for latitude bands;
- Introduce also alternate metrics, although not optimal in a global sense, such as surface winds, of more direct impact to society;
- Summarize Workshop discussion in a BAMS paper;
- Evaluate need to run more focused OSE (drifters only).

Research published in 2012: 16 peer-reviewed papers (so far …)

Castro, S. L., G. A. Wick, and W. J. Emery (2012), Evaluation of the relative performance of sea surface temperature measurements from different types of drifting and moored buoys using satellite-derived reference products, *Journal of Geophysical Research-Oceans*, *117*.

Guo, J. S., X. Y. Chen, J. Sprintall, B. H. Guo, F. L. Qiao, and Y. L. Yuan (2012), Surface inflow into the South China Sea through the Luzon Strait in winter, *Chinese Journal of Oceanology and Limnology*, *30*(1), 163-168.

Haza, A. C., T. M. Ozgokmen, A. Griffa, Z. D. Garraffo, and L. Piterbarg (2012), Parameterization of particle transport at submesoscales in the Gulf Stream region using Lagrangian subgridscale models, *Ocean Modelling*, *42*, 31-49.

Heinloo, J., A. Toompuu and M.-J. Lilover (2012), Gyration effect of the large-scale turbulence in the upper ocean, *Environmental Fluid Mechanics*, 6(4), doi:10.1007/s10652-012-9247-2.

Hobbs, W. R., and J. K. Willis (2012), Midlatitude North Atlantic heat transport: A time series based on satellite and drifter data, *Journal of Geophysical Research-Oceans*, *117*.

Hristova, H. G., and W. S. Kessler (2012), Surface Circulation in the Solomon Sea Derived from Lagrangian Drifter Observations, *Journal of Physical Oceanography*, *42*(3), 448-458.

Kartadikaria, A. R., Y. Miyazawa, K. Nadaoka, and A. Watanabe (2012), Existence of eddies at crossroad of the Indonesian seas, *Ocean Dynamics*, *62*(1), 31-44.

Lumpkin, R., N. Maximenko, and M. Pazos (2012), Evaluating Where and Why Drifters Die, *Journal of Atmospheric and Oceanic Technology*, *29*(2), 300-308.

Maximenko, N., J. Hafner, and P. Niiler (2012), Pathways of marine debris derived from trajectories of Lagrangian drifters, *Marine Pollution Bulletin*, *65*(1-3), 51-62.

Monzon-Arguello, C., F. DellAmico, P.Moriniere, A. Maro, L. F. Lopez-Jurado, Graeme C. Hays, Rebecca Scott, Robert Marsh and Patricia L. M. Lee (2012), Lost at sea: genetic, oceanographic and meteorological evidence for storm-forced dispersal, *J. R. Soc. Interface*, published on line 8 February 2012, doi:10.1098/rsif.2011.0788.

Piecuch, C. G. and T. A. Rynearson (2012), Quantifying dispersion and connectivity of surface waters using observational Lagrangian measurements. *Journal of Atmospheric and Oceanic Technology*., 29 (8), 1127Â–1138, doi:10.1175/JTECH-D-11-00172.1.

Renner, A. H. H., S. E. Thorpe, K. J. Heywood, E. J. Murphy, J. L. Watkins, and M. P. Meredith (2012), Advective pathways near the tip of t he Antarctic Peninsula: Trends, variability and ecosystem implications, *Deep-Sea Research Part I-Oceanographic Research Papers*, *63*, 91-101.

Reverdin, G., S. Morisset, J. Boutin, and N. Martin (2012), Rain-induced variability of near sea-surface T and S from drifter data, *Journal of Geophysical Research-Oceans*, *117*.

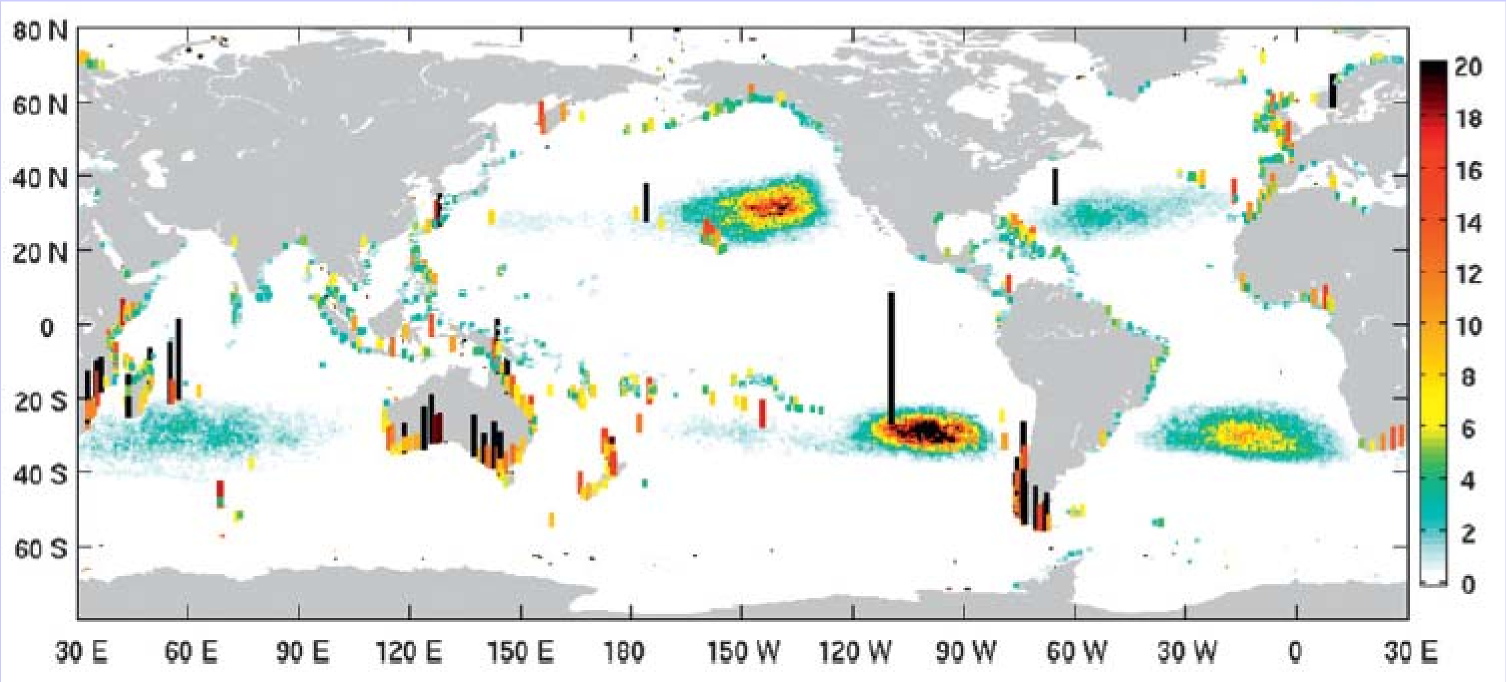
Volkov, D. L., and M. I. Pujol (2012), Quality assessment of a satellite altimetry data product in the Nordic, Barents, and Kara seas, *Journal of Geophysical Research-Oceans*, *117*.

Wang, G. H., D. X. Wang, and T. J. Zhou (2012), Upper layer circulation in the Luzon Strait, *Aquatic Ecosystem Health & Management*, *15*(1), 39-45.

Zedler, S. E., G. Kanschat, R. Korty, and I. Hoteit (2012), A new approach for the determination of the drag coefficient from the upper ocean response to a tropical cyclone: a feasibility study, *Journal of Oceanography*, *68*(2), 227-241.

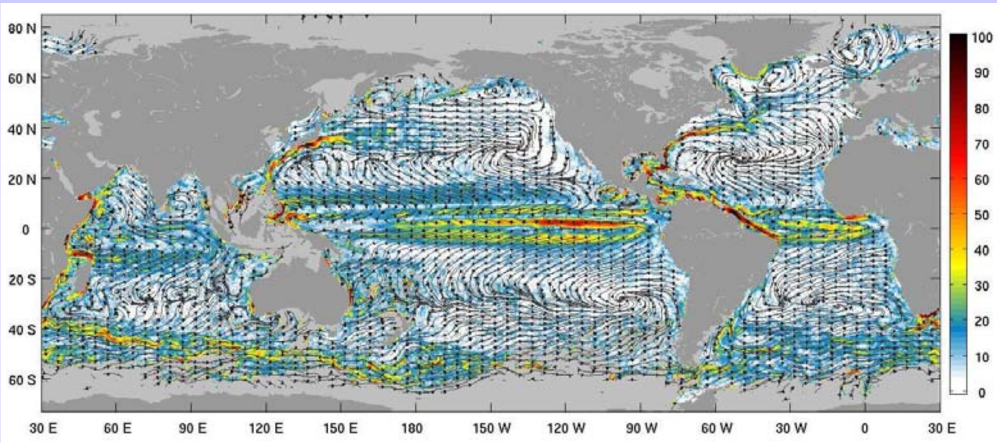
Exposure to marine debris

Lagrangian statistics and observed run-aground locations of drifters used to identify locations most exposed to marine debris deposit.

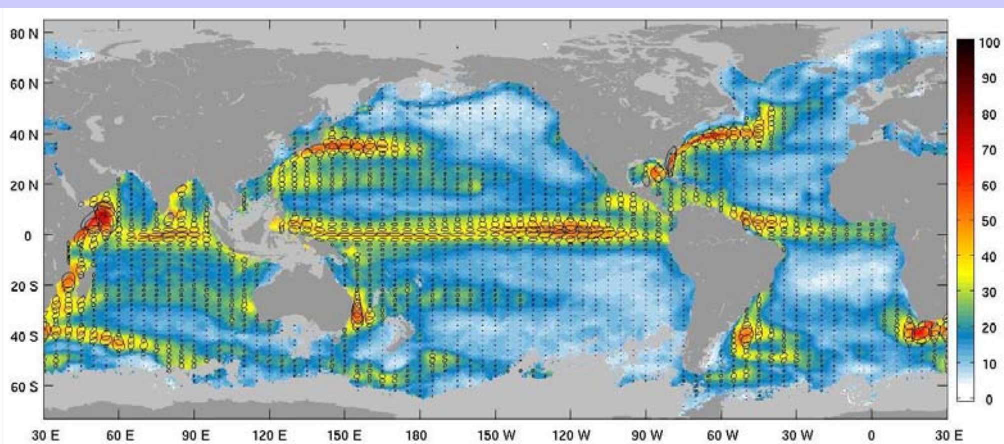


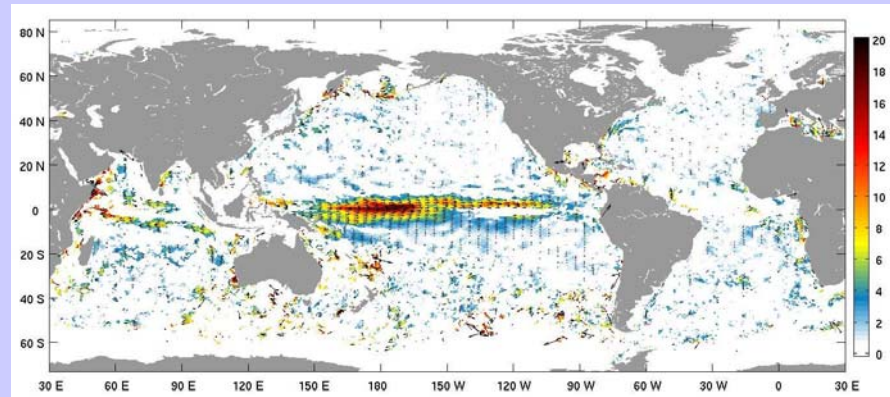
Concentration of floating marine debris in arbitrary units, after 10 years of integration from an initially homogeneous distribution of concentration unity. Vertical bars indicate the concentration of material that has washed ashore, with color corresponding to 10 times the value in the color bar. Lumpkin, Pazos and Maximenko (2012), *JAOT*.

New product: global near-surface currents, monthly, ½° resolution



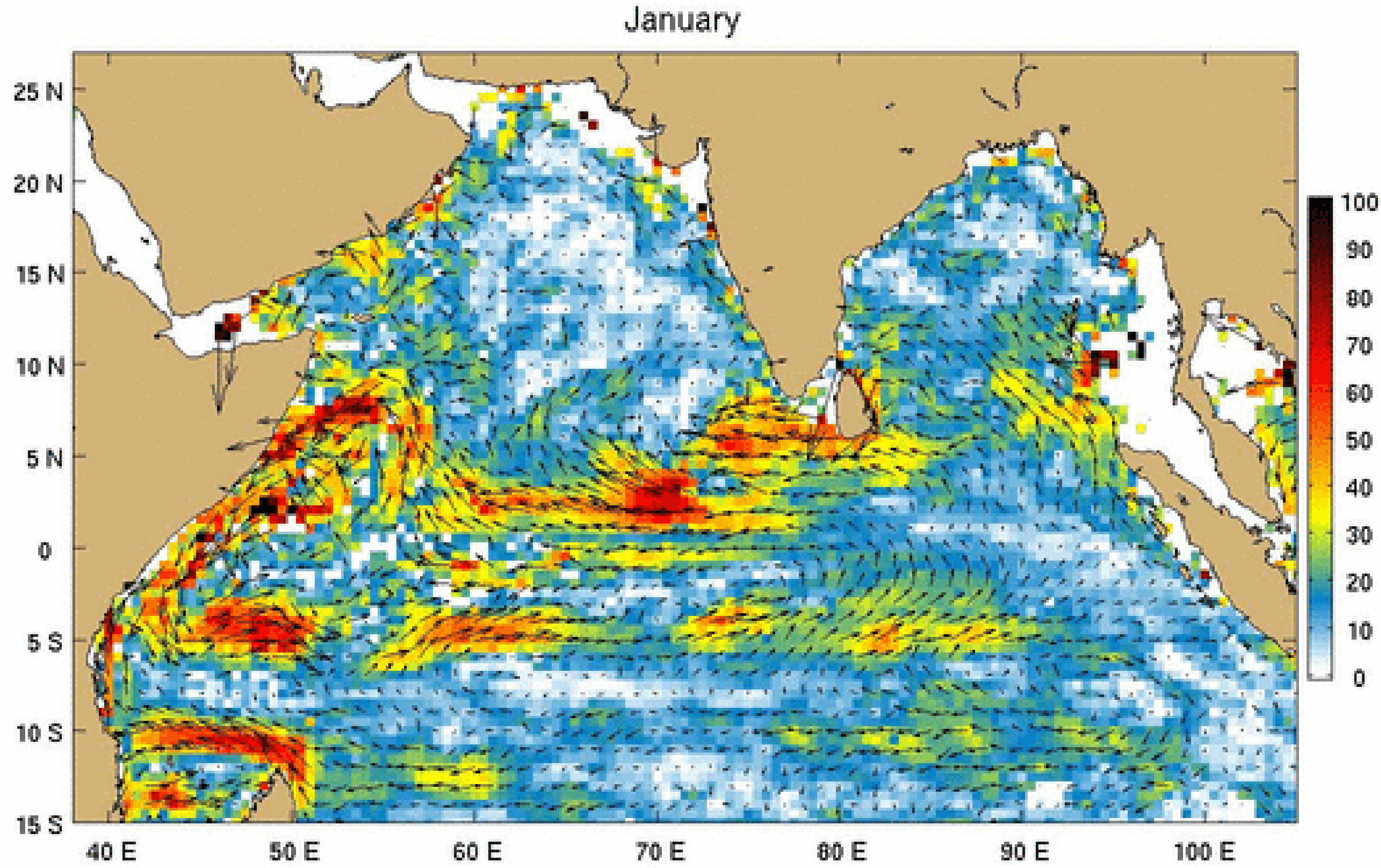
Above: time-mean currents. Below: eddy residuals.





Current related to Southern Oscillation Index.

Lumpkin and Johnson, *J. Geophys. Res.-Oceans* (submitted)


January
25 N
20 N
15 N
10 N
5 N
0
5 S
10 S
15 S
40 E
50 E
60 E
70 E
80 E
90 E
100 E
100
90
80
70
60
50
40
30
20
10
0

Deployment plans for 2013

Operational Buoy Deployments	800
Consortium Research Buoy Deployments	200
Total Deployments in 2012	1000

Regional deployment opportunities in 2013 include 60 SVPBs in the Southern Indian Ocean, 40 SVPBs in the South Pacific, and 80 SVPBs in the South Atlantic (all south of 40°S). As in previous years, cruises to service the global tropical moored array will be used opportunistically to seed drifters.

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; NOAA/Pacific Marine Environmental Laboratory, NOAA/National Data Buoy Center

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, (United States)

United States Air Force

US Naval Oceanographic Office

United States Coast Guard

Raytheon Polar Services