Global Drifter Program (GDP)

Drifting buoy measurements of Sea Surface Temperature, Mixed Layer Currents, Atmospheric Pressure, Salinity and Wind

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

Rick Lumpkin, NOAA/AOML

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32nd Data Buoy Cooperation Panel session

17-21 October 2016

La Jolla, CA USA

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 ~1300 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 Observations Division of the Climate Program Office. Additional development and instruments at Scripps funded by ONR.

AOML (Miami, FL)
Rick Lumpkin

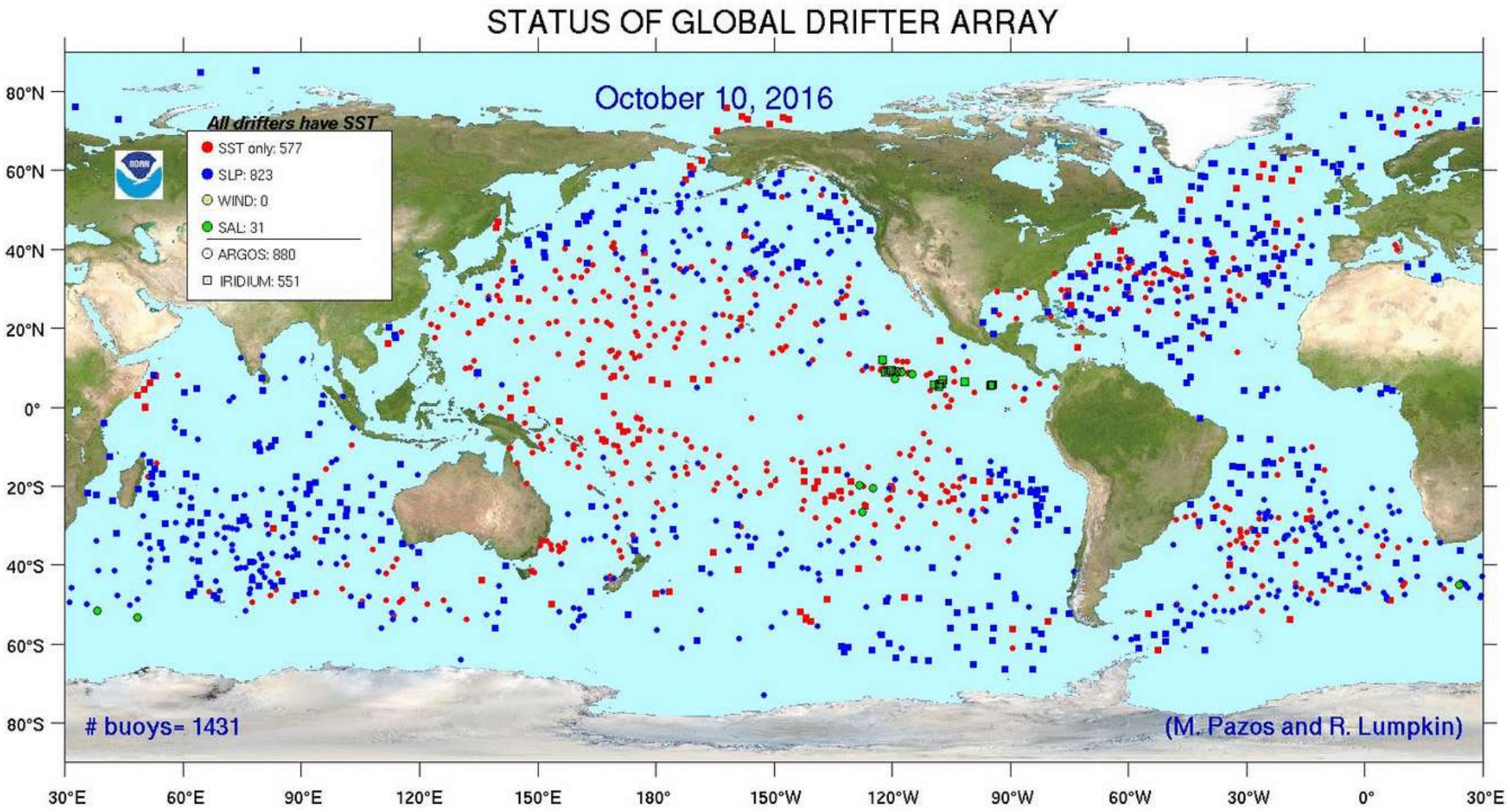
Scripps (La Jolla, CA)
Luca Centurioni
Supervises the industry, upgrades the technology, purchases most drifters, and manages several aspects of Iridium data stream

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

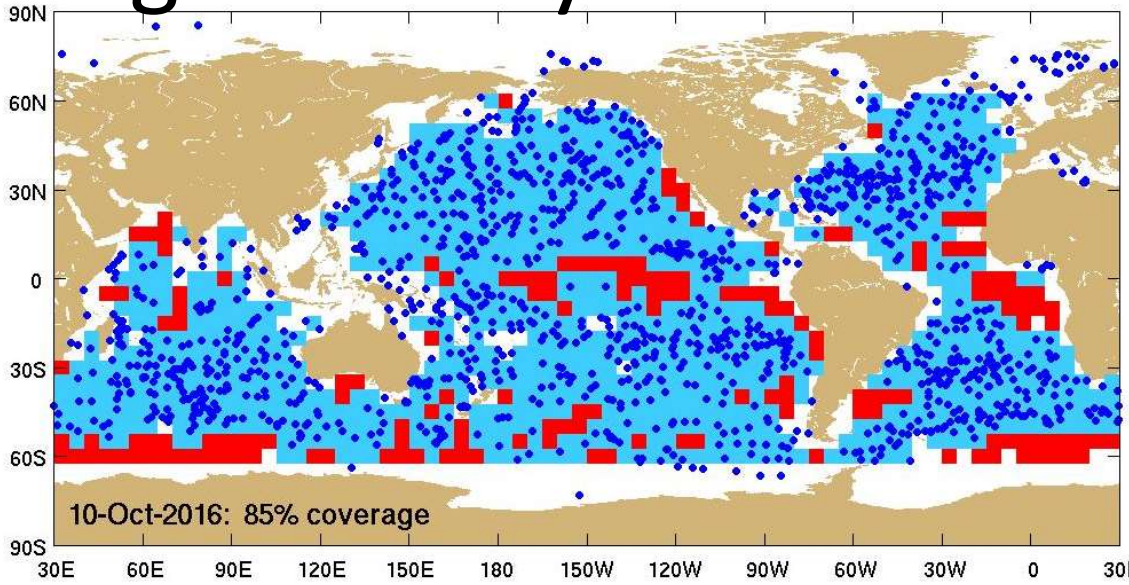
Drifter Operations Center (DOC)

Drifter Data Assembly Center (DAC)

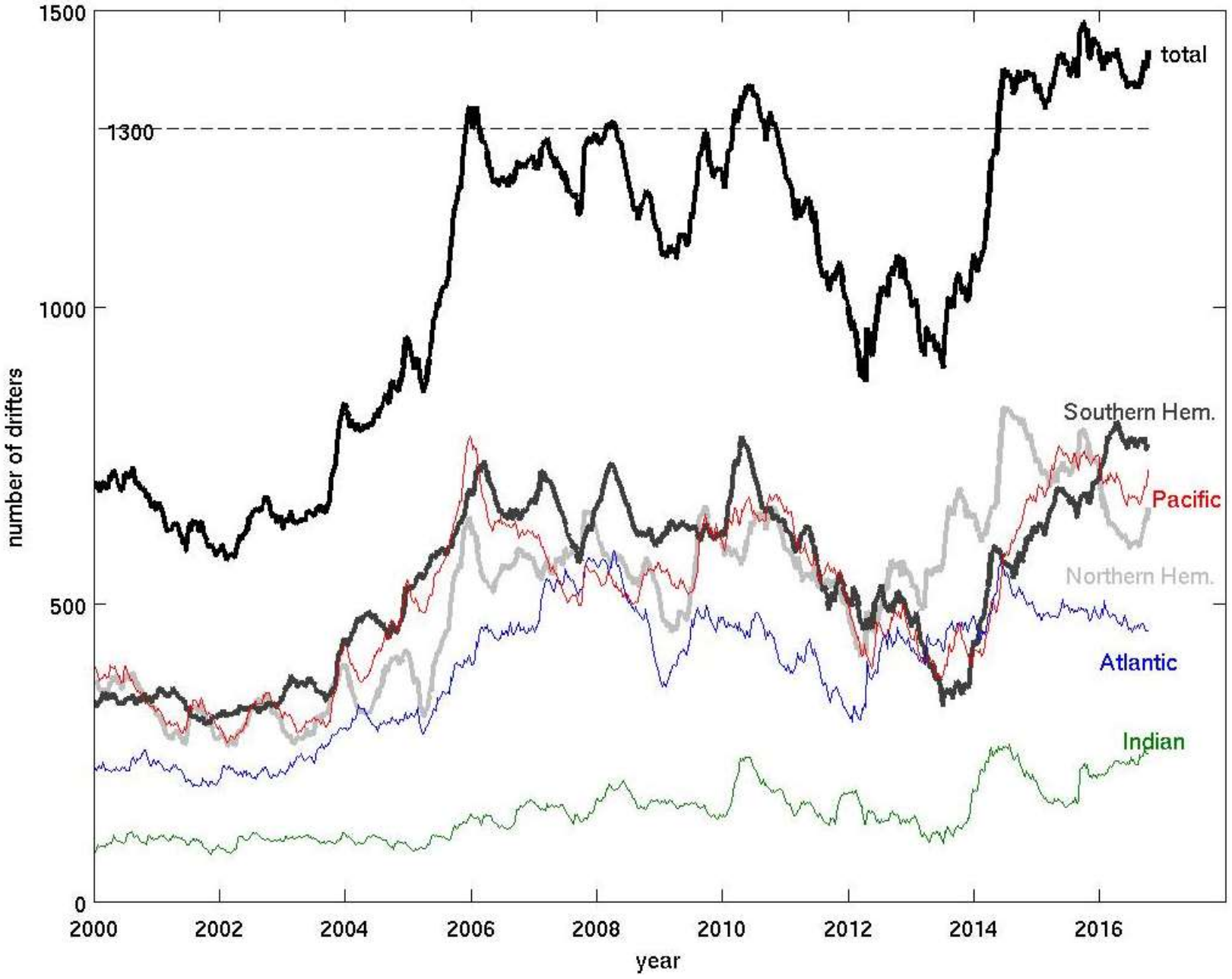
Current status of the global array



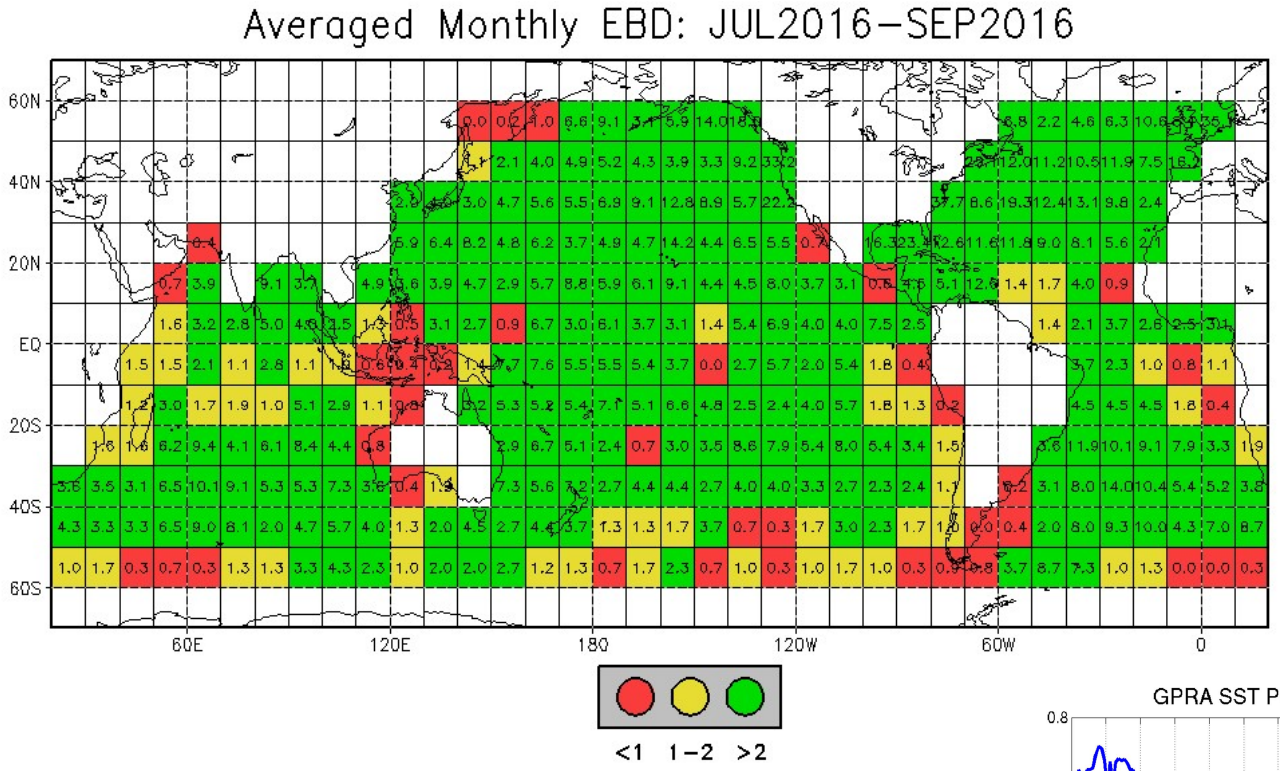
Evaluating the array for 5°x5° coverage



Evolution of the array by basin

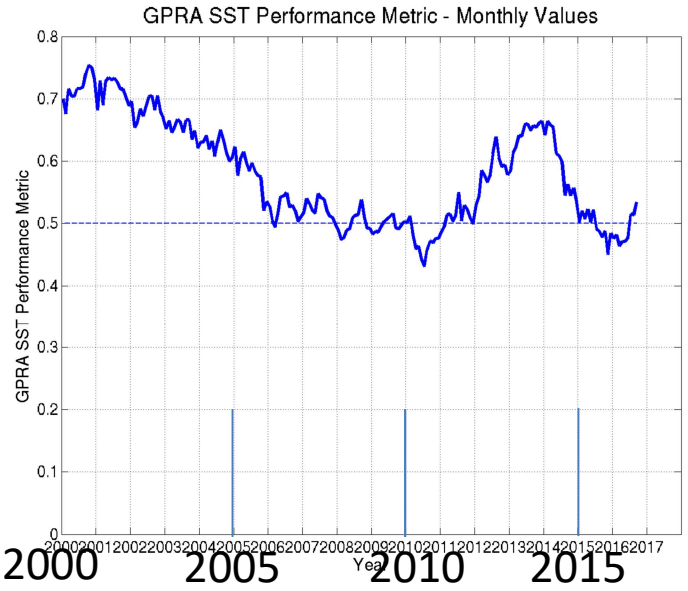


Evaluating the GOOS for SST



Figures courtesy H.-M. Zhang

Note that this includes drifting and moored buoy and ship observations, but drifters dominate spatial coverage (note correlation between performance metric at right and # of drifters in array)

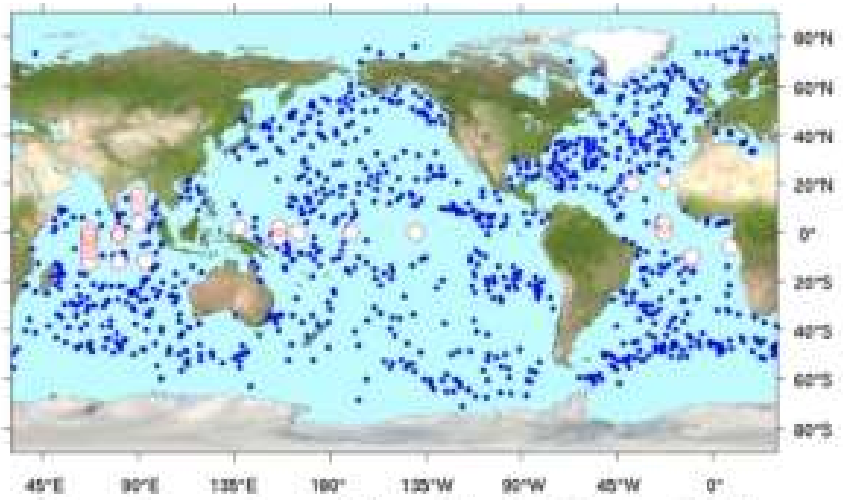


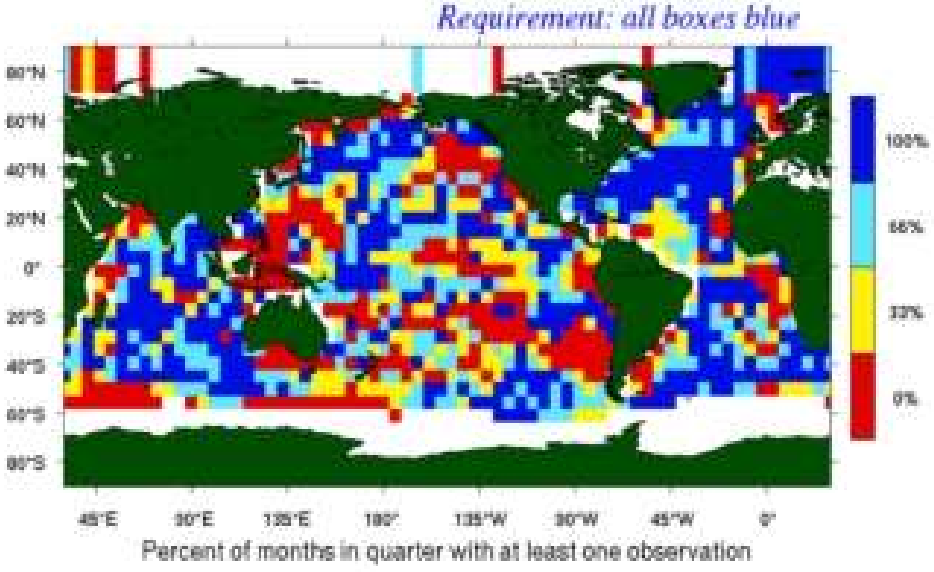
Evaluating the GOOS for SSV

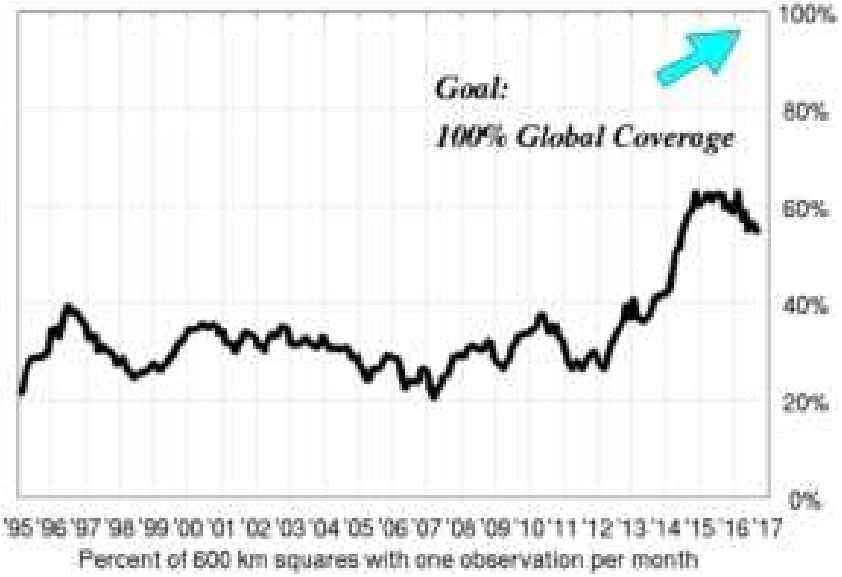
Observing System Status: 2016, Q3.
Surface Currents

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

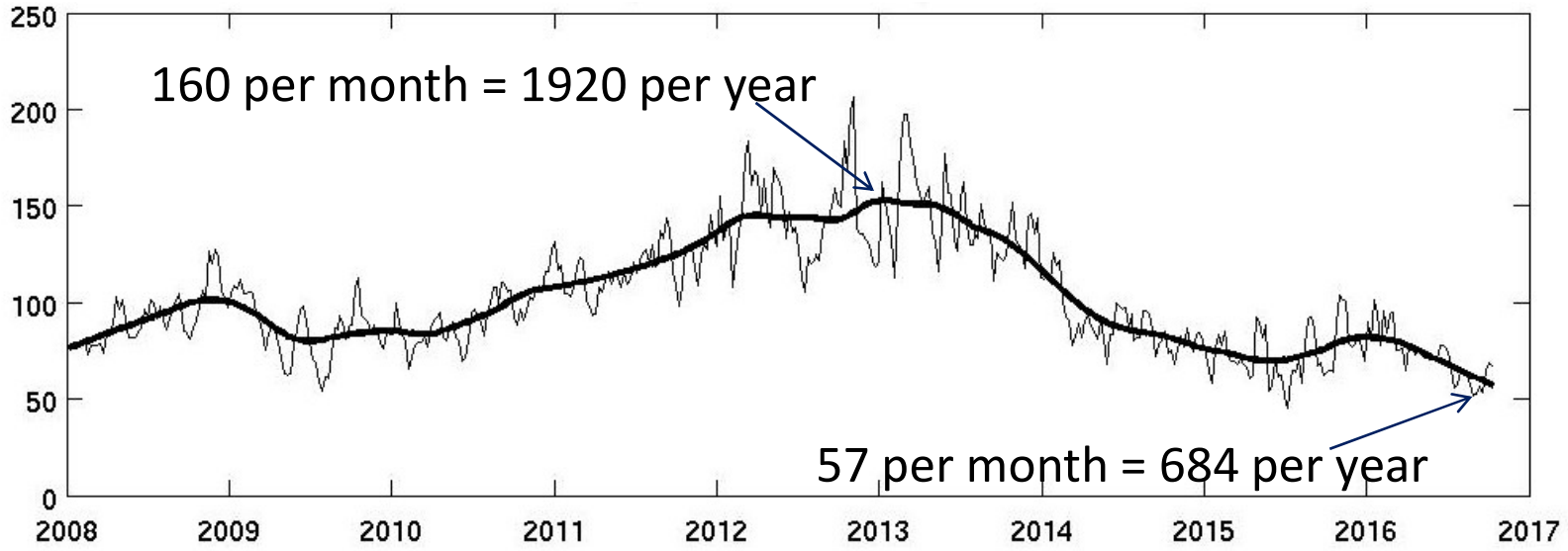
Performance measure: reduce the error in global measurement of surface velocity



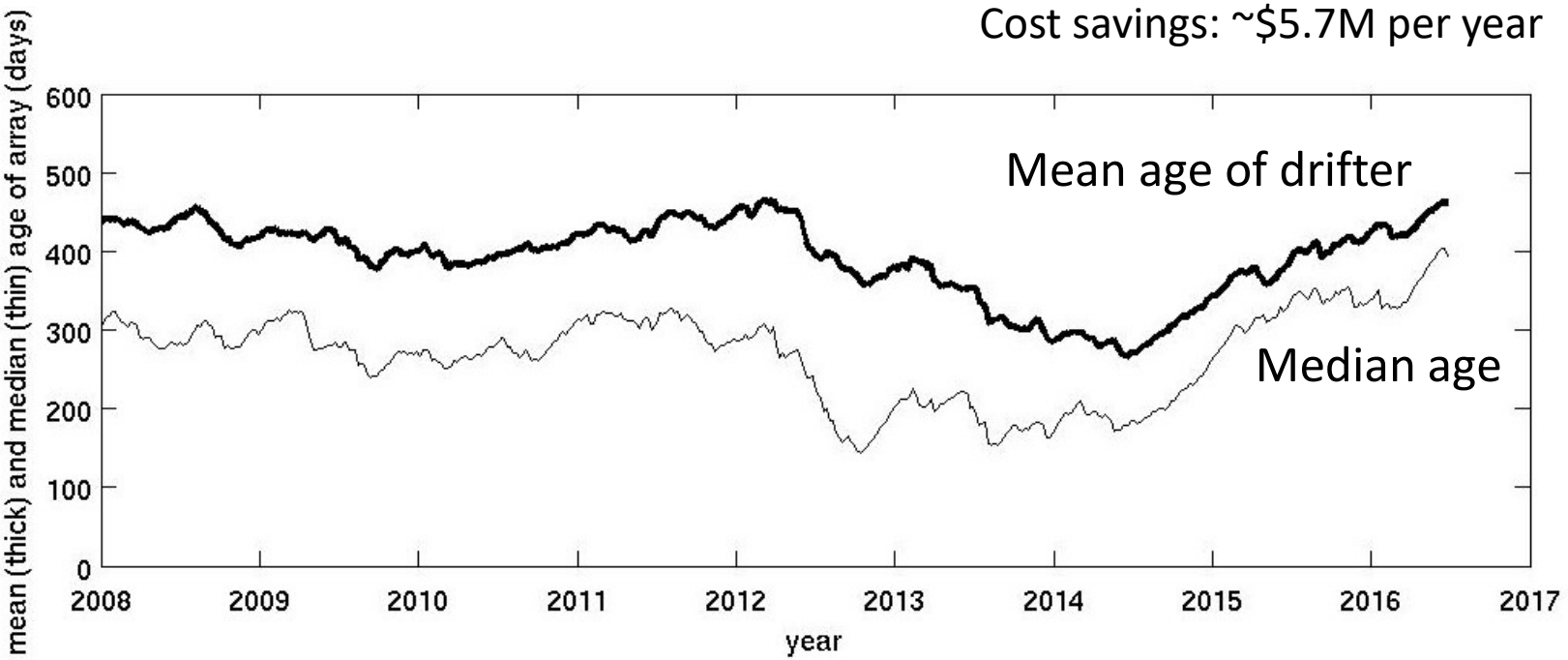




Number of deaths per 1250 drifters per month



Cost savings: ~$5.7M per year



Half-life of drifters (days)

Number of days after which half are dead, as function of deployment year. Excludes drifters “ran aground” and “picked up”

Bold: less than 200 days

"Quit" drifters:

Manufacturer	***2008***	***2009***	***2010***	***2011***	***2012***	***2013***	***2014***	***2015***
Clearwater	217	213	**162**	**155**	**199**	388	459	421
DBi	*	*	*	364	298	715	>760	>422
Marlin-Yug	856	634	963	*	962	*	>389	*
Metocean	456	448	274	221	**180**	316	262	>238
Pacific Gyre	598	346	345	235	227	498	>754	>539
SIO	*	*	*	*	201	482	579	>422
Technocean	959	642	280	**190**	**54**	**0**	**32**	**4**

Percent which lived <90 days

quit at <90d divided by # deployed that year. Includes Failed on Deployment

Bold: more than **10%**.

Manufacturer	***2008***	***2009***	***2010***	***2011***	***2012***	***2013***	***2014***	***2015***
Clearwater	**11%**	**11%**	**25%**	**27%**	**12%**	**12%**	**14%**	**12%**
DBi	*	*	*	**25%**	9%	6%	4%	5%
Marlin-Yug	6%	0%	10%	*	**14%**	*	**29%**	*
Metocean	5%	6%	5%	**11%**	**17%**	**11%**	**14%**	**24%**
Pacific Gyre	**12%**	**16%**	4%	5%	7%	3%	5%	2%
SIO	*	*	*	*	4%	7%	8%	**14%**
Technocean	8%	4%	**11%**	**31%**	**52%**	**90%**	**32%**	**26%**

Drogue Half-Life (days)

Number of days after which half of drifters lose their drogue , as function of deployment year.

Bold: less than **100 days.**

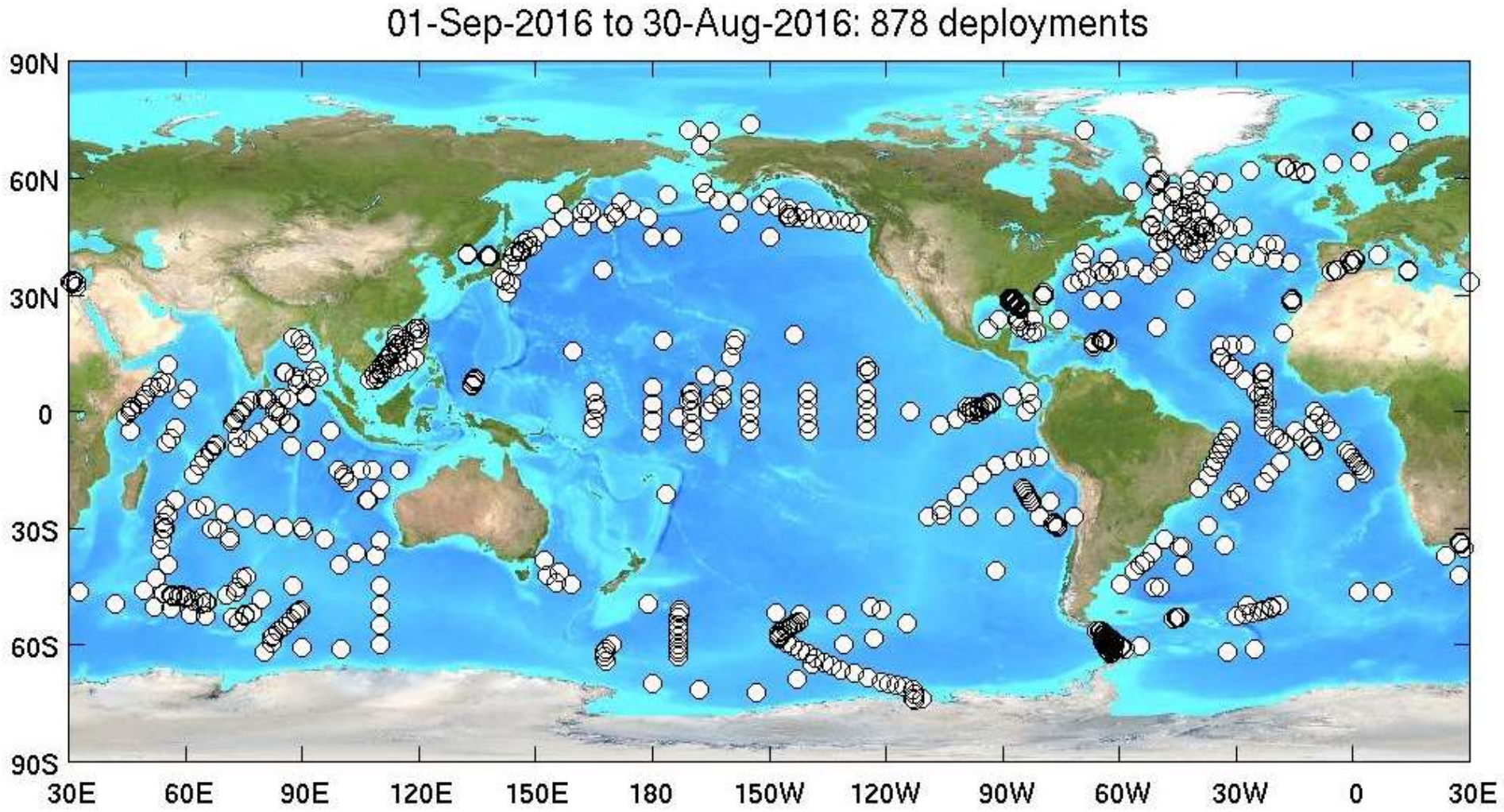
Manufacturer	***2008***	***2009***	***2010***	***2011***	***2012***	***2013***	***2014***	***2015***
Clearwater	101	104	**95**	**84**	>293	>438	434	>431
DBi	*	*	*	279	227	243	228	>263
Marlin-Yug	**72**	**57**	167	*	**0**	*	**20**	*
Metocean	269	224	**77**	**89**	115	207	217	>232
Pacific Gyre	206	241	248	207	>228	241	229	206
SIO	*	*	*	*	**66**	>140	130	>149
Technocean	**33**	**63**	**74**	154	>62	**0**	>14	**0**

% with drogue off after <90 days

drifters lose their drogue at <90d divided by # deployed that year.

2015: values through June. **Bold**: more than **25%.**

Manufacturer	***2008***	***2009***	***2010***	***2011***	***2012***	***2013***	***2014***	***2015***
Clearwater	**36%**	**30%**	**36%**	**39%**	14%	5%	16%	0%
DBi	*	*	*	25%	11%	12%	7%	6%
Marlin-Yug	**41%**	**46%**	**40%**	*	**43%**	*	**71%**	*
Metocean	17%	**26%**	**40%**	**45%**	**33%**	14%	21%	6%
Pacific Gyre	22%	17%	10%	16%	21%	9%	16%	15%
SIO	*	*	*	*	**40%**	23%	14%	20%
Technocean	**78%**	**53%**	**46%**	**27%**	**33%**	**30%**	**44%**	**57%**



A total of 878 drifters were deployed this year, compared to 1086 last year and 1664 the year before (when the array had fallen below 1250 and needed to be replenished).

Deployment plans for 2016-2017

In the coming year, the GDP Deployment Plan is:

Operational Buoy Deployments	800
Consortium Research Buoy Deployments	200
Total Deployments in 2016-2017	1000

More deployments may be needed to fill gaps in the global array as they develop, and will be conducted if more drifters are available for deployment.

In addition to the regular deployment opportunities provided by vessels of opportunity and regularly occurring research cruises, notable deployments planned for August 2016-July 2017 include:

- ~ 80 SVP drifter deployments in the equatorial Pacific, during TAO mooring cruises (~ 10 deployments per line)
- 30 SVP drifter deployments in the equatorial Pacific Ocean from KIOST
- ~40 SVPB drifter deployments in the Indian Ocean, during RAMA mooring cruises
- 10-15 SVP drifter deployments in the Atlantic Ocean, during the PIRATA mooring cruise
- 10 SVPB drifter deployments in the Indian and Pacific Oceans from the R/V *Kaharoa*
- 10 SVPB drifter deployments in the southern Indian Ocean from NZ Navy
- ~15 SVP drifter deployments in the equatorial Pacific Ocean, during P18
- ~15 SVPB drifter deployments in the south Pacific Ocean, during P18
- ~50 SVP drifter deployments in the Pacific Ocean by the US Coast Guard
- 40 SVPB drifter deployments in the Drake Passage
- 20 SVPB drifter deployments in the SE Pacific Ocean by the University of Valparaiso
- 20 SVPB drifter deployments in the south Pacific Ocean, during STRATUS

Iridium transition plan

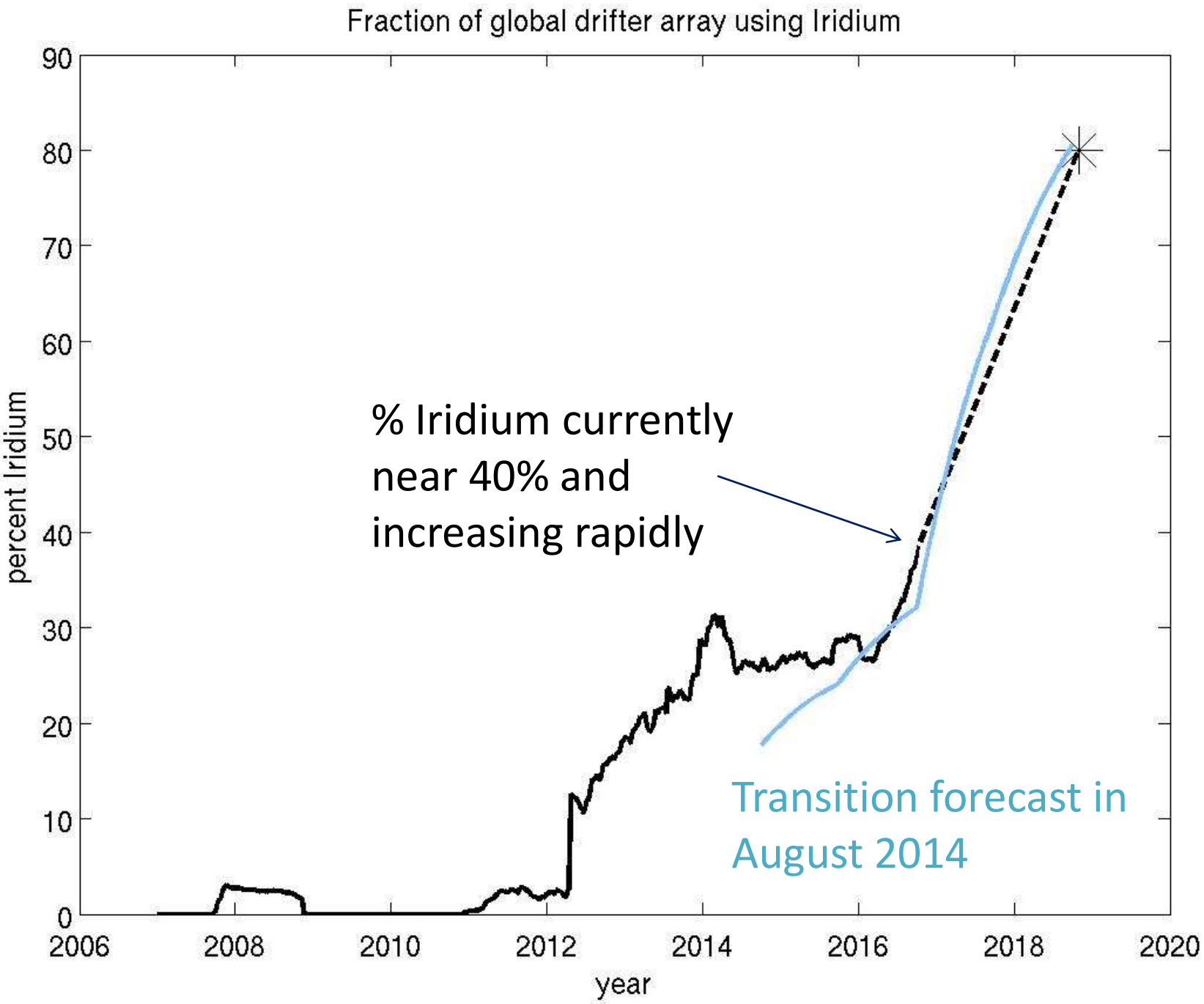
Purpose of transition:

- Provide timely data worldwide for ocean state estimation and numerical weather prediction.
- Include GPS, which provides hourly, highly accurate positions and allows real-time drogue detection.
- Cost savings.

Overview of process:

- Iridium SBD modems are purchased by the manufacturer
- Registration/activation of the modems: OAR @ PMEL (primary), SIO and AOML (secondary)
- Receipt of the data: SIO and AOML both email recipients. Two raw data archives will be maintained
- SIO provides decoded data to AOML, and assistance during implementation of decoding at AOML.
- SIO handles GTS insertion. AOML handles data screening for GTS removal.

GOAL: transition to 80% Iridium+GPS by mid-2019


Fraction of global drifter array using Iridium
percent Iridium
year
0
10
20
30
40
50
60
70
80
90
2006
2008
2010
2012
2014
2016
2018
2020
% Iridium currently
near 40% and
increasing rapidly
Transition forecast in
August 2014

Other significant advances

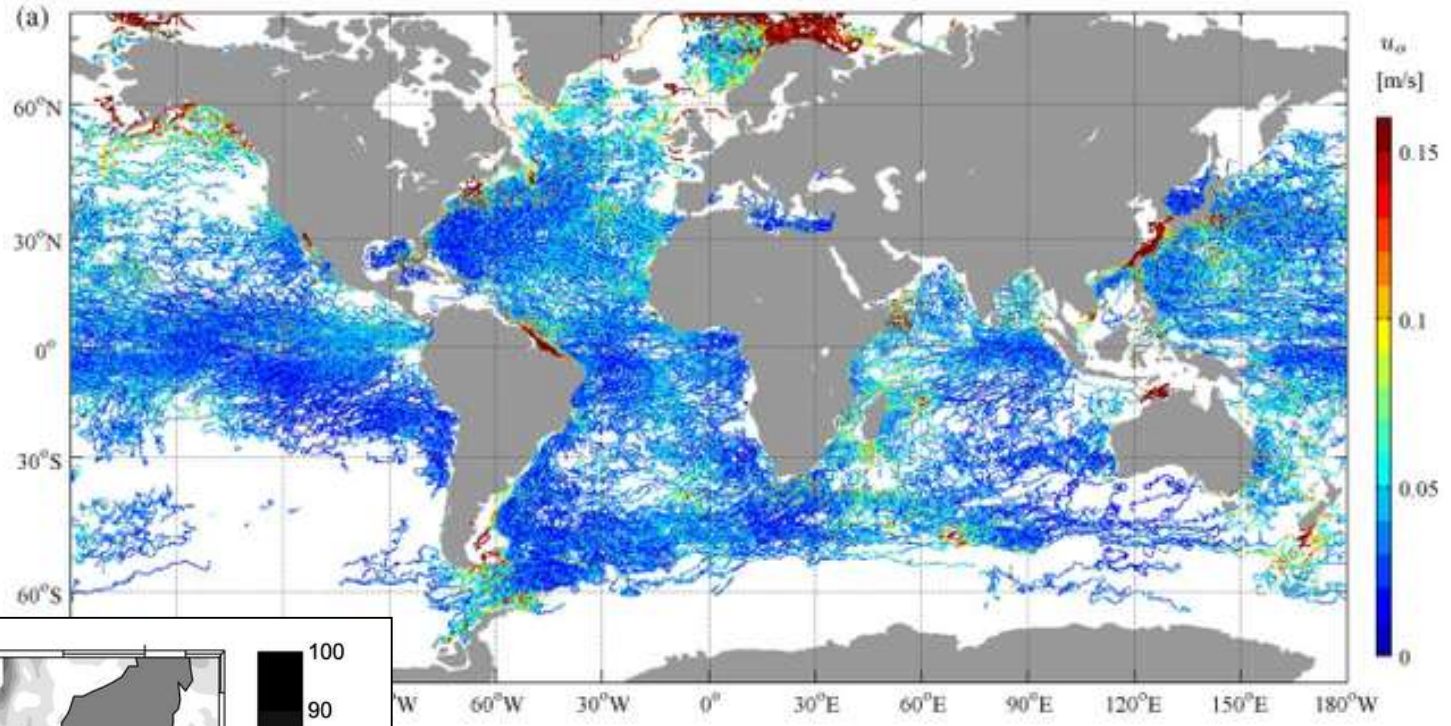
- Drogue presence using TTFF (from GPS) has been validated as more robust than tether strain.

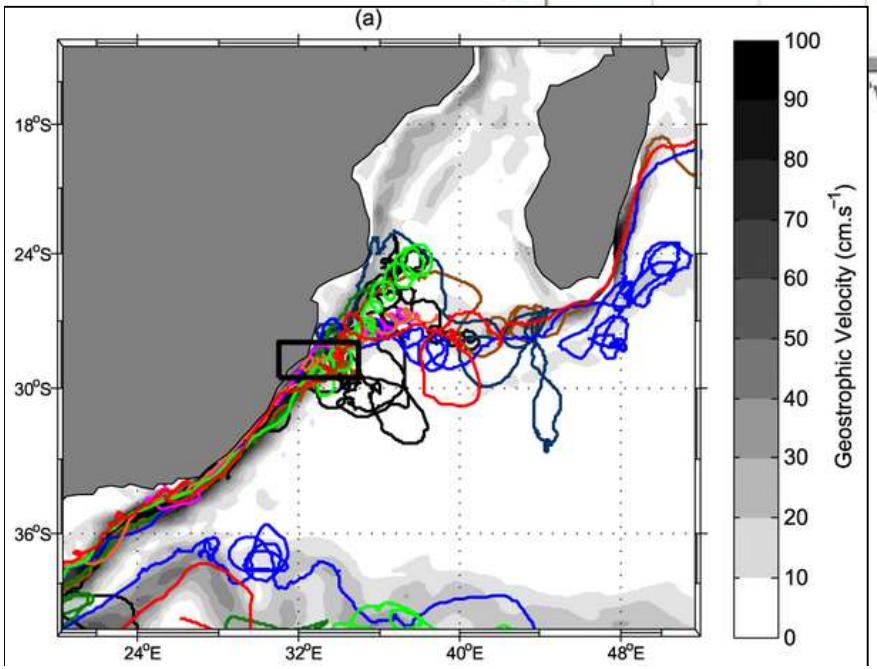
- Real-time drogue detection is being developed as more drifters transition to Iridium with GPS, thus allowing operational near-surface currents to be released to the GTS.

- The positive effect of drifter's SLP assimilation in NWP models was quantified through a data denial experiment run by ECMWF. Results of this DBCP Pilot Project have been published in BAMS (Centurioni et al., 2016). The impact of the drifter data is also monitored operationally by NASA. Drifters data have a very large impact on a per observation basis.

Research

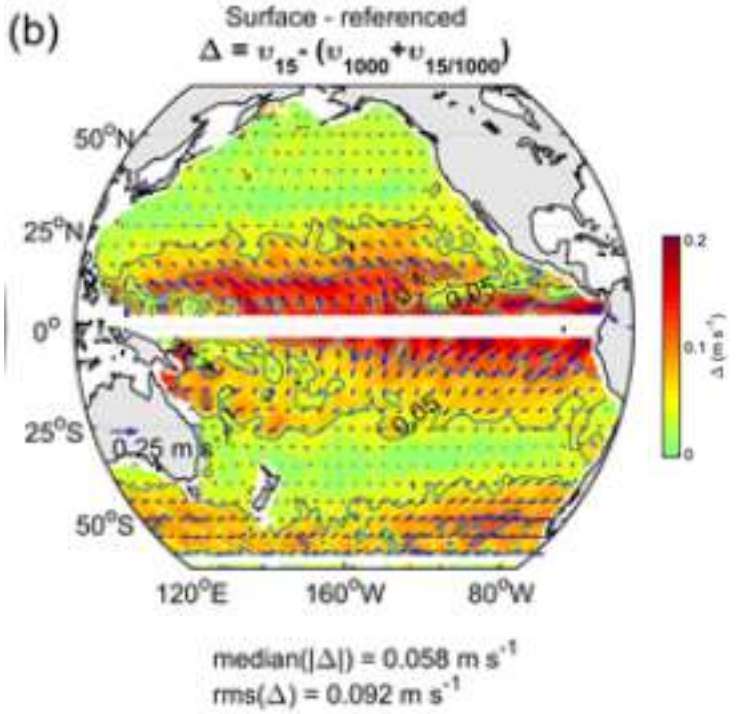
High-resolution distribution of M2 tidal amplitude derived from high frequency drifter positions
Kodaira et al. (2016)





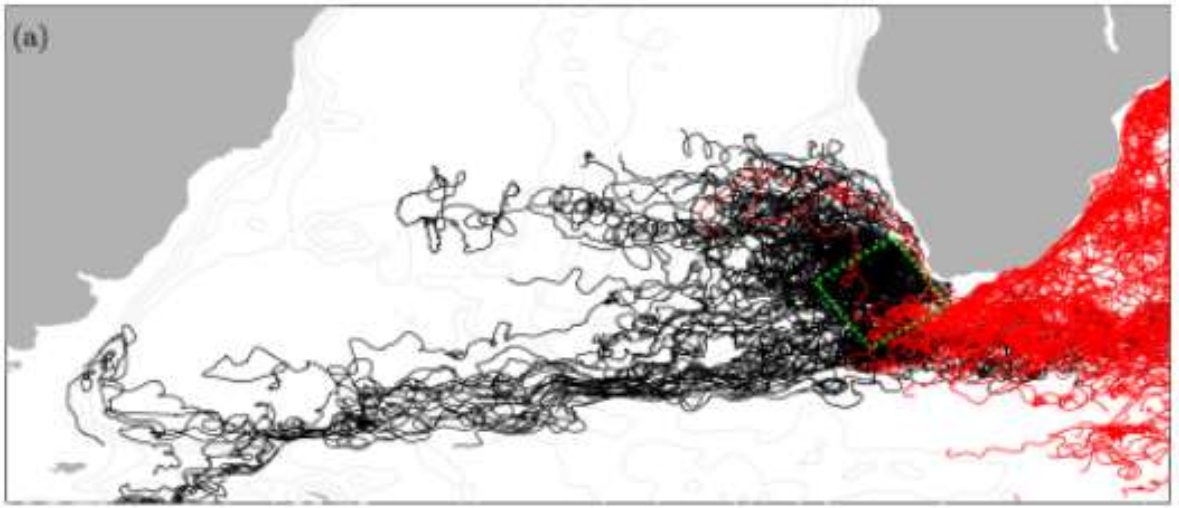
Drifter trajectories used to diagnose eddy dissipation in the Agulhas Current system. Braby et al. (2016)

Research



Estimate of wind-driven ageostrophic time-mean flow in the Pacific from drifter and Argo float observations, revealing larger values than found in earlier studies

Chiswell (2016)



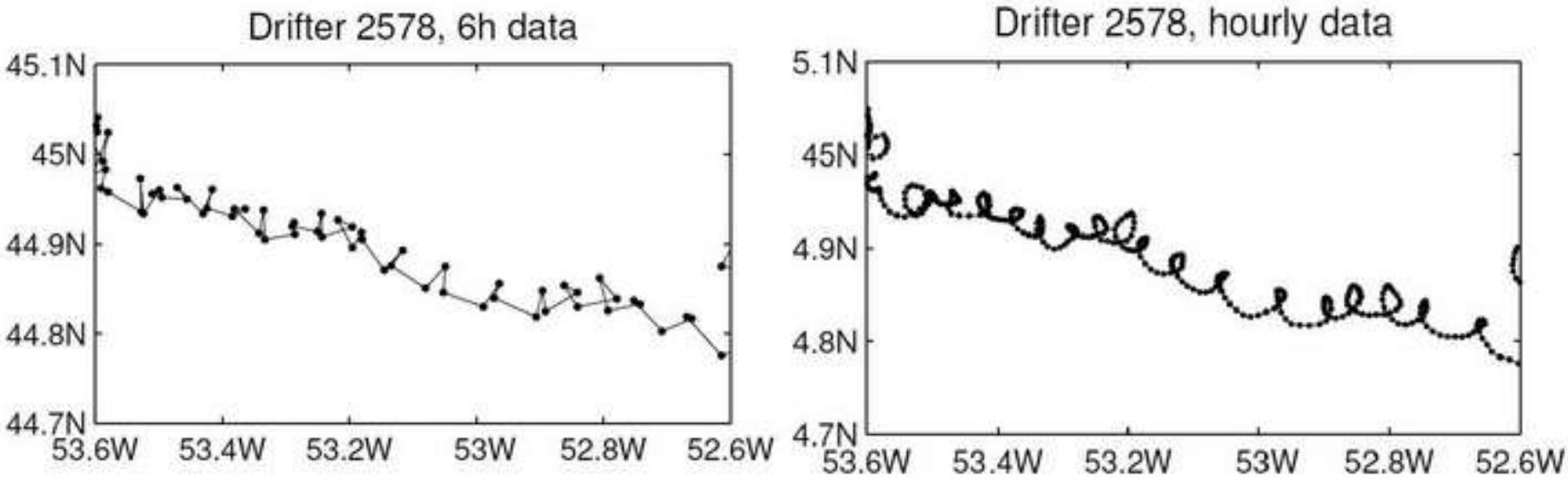
Drifter trajectories used to evaluate the life cycle of Agulhas rings

Wang et al. (2016)

New Product:

hourly drifter data (since Jan 2005)

includes error estimates for position, velocity



New version in development will include all data from beginning of program with sufficient temporal density, and will include hourly SST as well as hourly positions and velocities.

Elipot et al., 2016

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

E-SURFMAR

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)

Korea Institute of Ocean Science & Technology (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

Universidad de Valparaiso (Chile)

Chilean Navy

Hong Kong Observatory

Half-life calculations

The half-life tells us how long it takes for 50% to die. Unlike mean lifetime, which can't be calculated until ALL are dead, we can calculate this once half are dead.

Simple example: 100 drifters are deployed, the half life is the number of days it takes 50 drifters to die

If more than half are still alive, we can calculate an "at least" half life:

1) For still alive drifters: use age (so far) instead of death age.
2) Calculate half-life using all ages.
3) Remove "still-alive" ages that are < half life.
4) Repeat 2, 3 until all "still-alive" ages are > half life.