The Global Drifter Program
"Drifter Measurements of Surface Velocity, SST, SSS, Winds and Air Pressure"

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1. Project Summary

The NOAA funded Global Drifter Program (GDP hereafter, Niiler 2001) is the principal component of the Global Surface Drifting Buoy Array, a branch of NOAA's Global Ocean Observing System (GOOS and a scientific project of the Data Buoy Cooperation Panel (DBCP). The DBCP is an international program coordinating the use of autonomous data buoys to observe atmospheric and oceanographic conditions over ocean areas where few other measurements are taken. The DBCP was created in 1985 as a joint body of the World Meteorological Organization (WMO) and of the Intergovernmental Oceanographic Commission (IOC) of the United Nations Educational, Scientific and Cultural Organization (UNESCO). The DBCP constitutes the data buoy component of the Joint WMO-IOC Technical Commission for Oceanography and Marine Meteorology (JCOMM).

The ***long term objectives*** of the GDP are to:

1) maintain a global ocean observing network of 1250 Lagrangian drifters with a nominal resolution of 5°X5° that, through the Argos and Iridium satellite systems, return data of meteo-marine variables including near-surface ocean currents (15 m depth), sea surface temperature (SST), sea surface salinity (SSS), sea-level atmospheric pressure (SLP), sea-level winds (SLW) and subsurface temperature (Tz) and

2) provide a data processing system for the scientific and operational use of the drifter data.

<u>Societal Rationale</u>

Approximately 53% of the US population lives in coastal counties (estimated in 2003, source: NOAA http://oceanservice.noaa.gov/programs/mb/supp_cstl_population.html) and, globally, the density of the population is significantly higher in coastal areas than inland (Small; Nicholls 2003). The threats to coastal communities include a variety of short-term (i.e. severe weather, hurricanes, marine pollution) and long-term (i.e. climatic changes and coastal erosion) natural and anthropogenic conditions. The GDP array provides data which are readily available, either in real-time or near-real-time, for direct analysis or to be assimilated by a variety of models designed to understand, forecast and mitigate the impact of the Earth system and of pollution on people's lives, including commercial and recreational activities. On short time scales, examples include measurements of ocean currents to track pollutants such as oil and marine debris, to support fisheries management, to aid commercial and Navy's ship operations, as well as measurements of SLP, SLW, SST and SSS to improve Numerical Weather Prediction (NWP) and hurricane forecast. On longer time scales, examples include climate records of ocean currents, SST, SLP for use in climate models. Accurate measurements of the global distribution of the SLP, which is the weight of the atmosphere over the ocean –also called the inverse barometer effect- are important to accurately determine the global sea-level which is measured by the altimeters fitted to several satellites.

Scientific and Technical Rationales

Specific Science Objectives of the GDP

- Provide the Global Telecommunication System (GTS) of the World Weather Watch (WWW) with a stream of near-real time data of SST, SLP, SSS, SLW and Tz for use in climate, NWP and tropical cyclones forecast models. The data latency, i.e. the time between collection and availability on the GTS should be as small as possible. Currently it ranges from ~2 hours with the Argos satellite system to ~10 minutes with if the Iridium telemetry is used.
- Measure the mixed layer currents globally and provide GDP partners at the Atlantic Oceanographic and Meteorological Laboratory (AOML) of NOAA with data to produce maps of the World's ocean circulation that resolve seasonal and inter-annual variations. At present, the quality-controlled ocean current data are available in delayed mode.
- Provide the scientific oceanographic, climate and meteorological communities and the general public with enhanced, research-quality data sets of ocean currents that incorporate drifter data from individual research programs, including historical data from instruments that differ from the Surface Velocity Program (SVP) Lagrangian drifter design corrected for the wind-induced velocity bias, also known as "slip" (Niiler; Paduan 1995).
- Support programs of national and international interest, such as the recently launched Aquarius mission to measure SSS from space and NWP efforts worldwide.
- Analyze the GDP drifter data and provide a scientific interpretation of the results. Publish the findings in peer-reviewed, easily accessible journals.

Specific Technical Objectives of the GDP

- Maintain the nominal array resolution of 5°X5°, needed to keep the potential SST satellite bias error smaller than 0.5ºC (Zhang et al. 2009).
- Monitor and evaluate the performances of the GDP array in real time to identify early signs of, and troubleshoot, technical issues.
- Develop and introduce drifter' construction technological advances in sensors, electronics, power, methods of assembly and packaging for deployment. Special emphasis is given to the implementation of new sensors, air deployable instruments and methods for hurricane research, SSS measurements, and technical solutions to increase the endurance of the drifters.
- Share the technological advances with the drifter manufacturer community (commercial, university and federal agencies) with the goal to maintain a healthy GDP array.
-

Data and Products Accessibility/Archiving

- A subset of the GDP data, SST, SLP, SSS, SLW and Tz are publicly available through the GTS of the WWW.

  All GDP data and products are available from the GDP Data Assembly Center at AOML (http://www.aoml.noaa.gov/phod/dac/dacdata.php). The drifter data management plan is described in the OceanObs'09 Community White Paper "Data Management System for Drifting Buoys" by Keeley, Pazos and Bradshaw, available at http://www.oceanobs09.net/blog/?p=225.

- All GDP data and products are updated quarterly. The GDP data and are available from SIO upon request to Luca Centurioni (lcenturioni@ucsd.edu) or Lance Braasch (lbraasch@ucsd.edu). A SIO web page for data viewing is available at http://gdp.ucsd.edu/dashboard.html (password protected).
- All GDP raw and processed data and metadata are archived at AOML from the beginning of the program, and at SIO (starting from FY'11 for the raw data).

Users of the GDP data

The main users of the GDP data include:

- ***Weather Services: (including US, UK, France, Australia, New Zealand, Brazil, Canada, India, Republic of South Africa). Data used: Sea SST, SLP, Tz and SLW for weather and tropical cyclones forecast.***
- ***Climate research centers (US, UK, Brazil, Canada, France, New Zealand, Republic of South Africa). Data used: SST for climate models.***
- ***National Climate Data Center (NCDC, US). Data used: SST for satellite data for calibration/validation.***

- ***AOML (US). Near surface velocity (15 m depth) for annual and seasonal mean currents and anomalies.***
- ***Researchers (worldwide). Drifter velocity data for enhanced 15 m depth velocity dataset for oceanographic and climate research.***
- ***US Coast Guard. Near surface velocity data and sea surface temperature to aid commercial navigation in high latitude (icebergs drift).***
- ***Space Agencies (EU, US) Sea Surface Salinity to calibrate/validate satellite data.***
- ***Satellite altimetry scientific community. The atmospheric pressure data from drifters contribute to the calculation of the inverted barometer effect needed to estimate sea-level rise from altimeter data. The drifter velocity data are also used for sea level computations.***

Drifter velocity data are also used by operational agencies (e.g. UK MetOffice) for ocean current models and by schools worldwide for outreach programs (see for example NOAA's "Adopt a Drifter Program" http://www.adp.noaa.gov/).

2. Scientific and Observing System Accomplishments

A list of scientific and technical achievements is discussed below against the deliverables stated in our FY13-14 work plan. Collectively, the accomplishments summarize the success and to good state of health of the GDP, that underpins most of the in situ SST and SLP data used to calibrate and validate SST from space and improve the accuracy of NWP

D1: Procuring the Drifters Needed to Maintain the Global Drifter Array close to its Nominal Size of 1,250 Drifters

For this funding cycle the GDP has proposed to build and deploy a total 92 drifter systems (920 drifters) so divided: 43 SVP systems (430 SVP drifters) and 98 SVPB systems (490 SVPB drifters). The task was partially delayed for technical reasons. Most of the drifters were either deployed or delivered to AOML for deployment. A small number of drifters is still in production and is expected to be delivered shortly. Despite this delay, the goal to maintain the array at the 1,250 drifters nominal size was fully achieved and as of December 1, 2014, there were 1,389 GDP drifters actively reporting to the GTS (Figure 1). **This tasks addresses the program's priorities of delivering continuous instrumental records for global analyses of sea surface temperature and surface currents.**

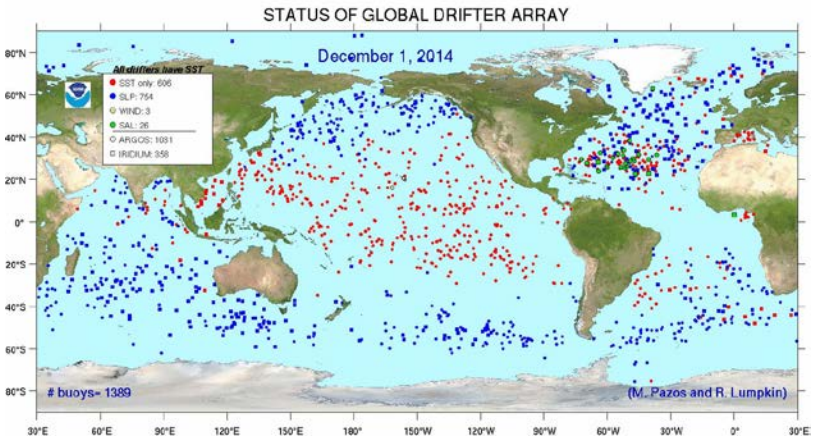

Figure 1: Distribution of drifters reporting to the GTS as of December 1, 2014.

<u>D2: coordinate GDP activities between the following entities: US manufacturers of drifters, AOML, SIO engineers, ONR and NASA for joint observational programs and D3 enhance the GDP array by encouraging principal investigators to purchase SVP drifters for their studies</u>

Accomplished. During the reporting period the GDP has assisted the industrial partners upon request with technical matters. We have also provided AOML with technical assistance on a variety of issues related to decoding and archiving drifter data from transmitted through the Iridium satellites.

Close coordination with scientific program funded by NASA (SPURS, 28 SVP drifters and 6 SVPS drifters) and ONR in the South China Sea (84 drifters) in collaboration with The National Sun Yat Sen University, in the Philippines Sea (16 SVP drifters July-August 2013), and in the Bay of Bengal (47 drifters) in collaboration with NARA, Sri Lanka.

Besides the synergy promoted by Dr. Centurioni between the GDP and other programs funded by NASA and ONR, Dr. Yu-Chia Chen of NSYSU has purchased 3 SVP drifters for his experiment and was given an extra 3 drifters from the GDP as part of our drifter matching program.

(D4) monitor and advise the drifter manufacturers to ensure that the specifications required for the GDP drifters are respected;

Accomplished. A thorough evaluation of the Argos 3 technology and of the method of assembly of the battery pack into the drifters was conducted was the main focus of this funding cycle. The GDP worked closely with CLS France, Pacific Gyre and DBi to rectify such technical issues. Drifter inspections are routinely performed by the GDP and if no-complying items are discovered, these are discussed with the manufacturers as needed.

(D5) update and maintain the enhanced GDP dataset, corrected for wind slip and drogue losses;

Accomplished. There were over 11 data requests, including Udajia Jinadasa (NARA, Sri Lanka), RC Lien (APL, U. of Washington), Fred Bingham (UNCW), Gilles Reverdin (LOCEAN, France), Eric Terrill (SIO, UCSD), Hemantha Wijesekera (NRL), Luc Rainville (APL, U. of Washington), Andrew Meijers (NOC, Southampton, UK), Pierre Poulain (OGS, Italy), Nikolai Maximenko (UH), Lou ST. Laurent (WHOI)

(D6) maintain real-time statistics of drifter performances.

Accomplished. Real time statistics are maintained at the gdp.ucsd.edu website and constitute the main tool for the PI to detect early signs of drifters' technical issues. An automated routine to detect run-aground drifters was implemented.

(D7) test the hurricane drifters stored at the Keesler AFB for sensors and hardware functionality and inspect the deployment packages and parachute riggings to ensure they are ready for deployment;

Accomplished. Mr. Lancelot Braasch and Mr. Lance Curtiss travelled to Keesler AFB for routine maintenance of the GDP hurricane array in May 2014. There were no hurricanes that could be targeted with our drifters in 2013.

(D8) report GDP's activities, scientific findings and technology advances in the DBCP "Technical Session";

Accomplished. Dr. Luca Centurioni, Dr. Dong-Kyu Lee, Dr. Verena Hormann and Mr. Lance Braach traveled to Paris and attended the DBCP 29 scientific and technical workshop, where they delivered a talk, and the plenary session of the DBCP 29 meeting. A list of presentations can be found at (http://www.jcomm.info/index.php?option=com_oe&task=viewEventAgenda&eventID=1299).

(D9) continue the scientific analysis of the GDP velocity, salinity and hurricane/typhoon datasets.

Accomplished.

Lee et al (2013). This paper studies the relationship between eddy modes and the intrusion of the Kuroshio currents into the East China Sea using GDP drifter data, among others. The relationship between the Kuroshio volume transport east of Taiwan (~24°N) and the impinging mesoscale eddies is investigated using 8-year reanalysis of a primitive equation ocean model that assimilates satellite altimetry and SST data. The mean and fluctuations of the model Kuroshio transport agree well with the available observations. Analysis of model dynamic heights and velocity fields reveals three dominant eddy modes. The decreased Kuroshio volume transports typically are associated with the impinging cyclonic eddies and the increased transports with the anticyclonic eddies. Selected drifter trajectories are presented to illustrate the three eddy modes and their correspondence with the varying Kuroshio transports.

A review article describing the advances in the study of the global ocean's surface circulation in the past 10 years has been published in Maximenko et al. (2013).

Hormann et al. (2014) investigates, the ocean's response to typhoon Fanapi using an extensive air-deployed drifter array. Separation of the observations into near-inertial and sub-inertial motions quantified the importance of strong advection by the sub-inertial circulation for the evolution of the cold wake formed by Typhoon Fanapi. The near-inertial currents generated during the storm showed the expected rightward bias, with peak magnitudes of up to 0.6 m/s and an *e*-folding time of about 4 days for the strong currents within the cold wake. The shear of the near-inertial currents is crucial for the storm-induced cooling and deepening of the mixed layer and such instabilities were here directly observed across the base of the mixed layer in Typhoon Fanapi's cold wake. During the recovery, the diurnal cycle—a dominant process for the wake warming—was found to be noticeably reduced when the near-inertial motions were strongest.

(D10) R&D activities.

The investigation to assess the causes of shortened drifter lifetimes was launched. The conclusions were determined to be incorrectly assembled battery packs and incorrect management of the drifter's electronics. The suppliers of GDP drifters were notified and corrective measured were adopted. The result of such actions are revealed by the current size of the array that, as of 12/1/2014 continues to be larger than the target size.

3. Outreach and Education

Note: some of the links below can become inactive with time. Please contact the Scripps Communication Office to obtain copies of the interviews.

i. Radio interview, Pacific Beat, ABC radio, Melbourne, Australia, June 2, 2013 on the Pacific Partnership 2013 and the Global Drifter Program, http://www.radioaustralia.net.au/international/radio/program/pacific-beat/more-buoys-keeping-watch-on-pacific-weather-currents/1140394
ii. Photo of the Week, Vessel of Opportunity, Scripps news, Feb 18,2014
iii. Newspaper article, New York Times, "Plane Debris Would Be Modest Clue Two Weeks After a Crash, Experts Say", http://www.nytimes.com/2014/03/20/world/asia/plane-debris-would-be-modest-clue-two-weeks-after-a-crash-experts-say.html?_r=0
iv. Newspaper article, The Malaysia Insider, 'For experts, locating flight MH370 still challenging even if plane debris is found", http://www.themalaysianinsider.com/malaysia/article/locating-flight-mh370-still-challenging-even-if-plane-debris-is-found-say-e
v. Newspaper article, The New York Times, 'The Search for Malaysia Airlines Flight 370', http://www.nytimes.com/interactive/2014/03/17/world/asia/search-for-flight-370.html?_r=0
vi. Newspaper article, The Los Angeles Times, 'Advanced U.S. aircraft combs Indian Ocean for Malaysia Airlines jet', http://articles.latimes.com/2014/mar/20/world/la-fg-malaysia-plane-20140321
vii. Newspaper Article, Video Interview, The Wall Street Journal, 'Malaysia Airlines Flight MH370: No Confirmed Debris Found', http://online.wsj.com/news/articles/SB10001424052702304026304579450222214063330'
viii. Interview with China's Xinhua News Agency L.A. Bureau, March 20, 2014

ix. Magazine Article, Discovery News, 'Malaysian Plane Debris? Why It's a Race to Find Out', http://news.discovery.com/earth/oceans/malaysian-plane-debris-why-its-a-race-to-find-out-140320.htm
x. TV interview, The Hannity Show, March 21, 2014
xi. TV Interview, MSNBC, March 20, 2014, 'Now, with Alex Wagner: Lessons from Air France flight 447 search', http://www.msnbc.com/now-with-alex-wagner/watch/lessons-from-air-france-flight-447-search-201403971766
xii. TV Interview, CTV news Channel, March 22, 2014 CTV News Channel: "Technology used in search. Luca Centurioni with Scripps Institute of Oceanography discusses the technology being used in the search for the missing Malaysian airliner." http://www.ctvnews.ca/search-results/search-ctv-news-7.137?q=centurioni
xiii. TV interview, CNN, Piers Morgan Live, March 21, 2014 "How satellite buoys may be the key to discovering debris from missing Flight 370', http://piersmorgan.blogs.cnn.com/2014/03/21/how-satellite-buoys-may-be-the-key-to-discovering-debris-from-missing-flight-370/?hpt=pm_mid and http://transcripts.cnn.com/TRANSCRIPTS/1403/21/pmt.01.html
xiv. Device Could Expand Oceanographic Studies with Unmanned Sensors, Scripps news, Apr, 4, 2014, https://scripps.ucsd.edu/news/device-could-expand-oceanographic-studies-unmanned-sensors
xv. TV Interview, CNN, State of the Union with Candy Crowley, http://edition.cnn.com/TRANSCRIPTS/1403/23/sotu.02.html
xvi. TV Interview, Rai News 24, April 10, 2014 http://www.youtube.com/watch?v=WPweaPmUKPo
xvii. TV interview, TVSI, May 7, 2014, 'Berna-Roma-L.A. #2 Luca Centurioni, Storie di italiani e svizzeri negli USA', http://www.tvsvizzera.it/attualita/tvsvizzera/Berna-Roma-L.A.-2-Luca-Centurioni-613729.html

4. Publications and Reports

4.1. Publications by Principal Investigators

Published

1. Boutin, J., N. Martin, G. Reverdin, S. Morisset, X. Yin, L. Centurioni, and N. Reul, 2014: Sea surface salinity under rain cells: SMOS satellite and in situ drifters observations. *Journal of Geophysical Research: Oceans***,** n/a-n/a.
2. Chang, Y.-C., P. C. Chu, L. R. Centurioni, and R.-S. Tseng, 2014: Observed near-surface currents under four super typhoons. *Journal of Marine Systems*, **139,** 311-319.
3. Chang, Y.-C., G.-Y. Chen, R.-S. Tseng, L. R. Centurioni, and P. C. Chu, 2013: Observed near-surface flows under all tropical cyclone intensity levels using drifters in the northwestern Pacific. *Journal of Geophysical Research: Oceans***,** n/a-n/a.
4. D'Asaro, E. A., and Coauthors, 2013: Impact of Typhoons on the Ocean in the Pacific. *Bulletin of the American Meteorological Society*, **95,** 1405-1418.
5. Gordon, A. L., P. Flament, C. Villanoy, and L. Centurioni, 2014: The nascent Kuroshio of Lamon Bay. *Journal of Geophysical Research: Oceans*, **119,** 4251-4263.
6. Hormann, V., L. R. Centurioni, and G. Reverdin, 2014: Evaluation of drifter salinities in the subtropical North Atlantic. *J Atmos Ocean Tech*.
7. Hormann, V., L. R. Centurioni, L. Rainville, C. M. Lee, and L. J. Braasch, 2014: Response of upper ocean currents to Typhoon Fanapi. *Geophysical Research Letters*, **41,** 2014GL060317.
8. Jan, S., and Coauthors, 2013: Observations of a freshwater pulse induced by Typhoon Morakot off the northern coast of Taiwan in August 2009. *J Mar Res*, **71,** 19-46.

9. Lee, D., and L. Centurioni, 2013: The Wintertime Subtropical Current in the northwestern Pacific. *Oceanography*, **26,** 28-37.
10. Lee, I. H., D. Ko, Y.-H. Wang, L. Centurioni, and D.-P. Wang, 2013: The mesoscale eddies and Kuroshio transport in the western North Pacific east of Taiwan from 8-year (2003–2010) model reanalysis. *Ocean Dynamics***,** 1-14.
11. Lucas, A. J., and Coauthors, 2014: Mixing to Monsoons: Air-Sea Interactions in the Bay of Bengal. *Eos, Transactions American Geophysical Union*, **95,** 269-270.
12. Maximenko, N., R. Lumpkin, and L. Centurioni, 2013: Chapter 12 - Ocean Surface Circulation. *International Geophysics*, S. M. G. J. G. Gerold Siedler, and A. C. John, Eds., Academic Press, 283-304.
13. Mrvaljevic, R. K., and Coauthors, 2013: Observations of the cold wake of Typhoon Fanapi (2010). *Geophysical Research Letters*, **40,** 316-321.
14. Vélez-Belchí, P., L. R. Centurioni, D.-K. Lee, S. Jan, and P. P. Niiler, 2013: Eddy induced Kuroshio intrusions onto the continental shelf of the East China Sea. *J Mar Res*, **71,** 83-107.

4.2. Other Relevant Publications

1. G. Reverdin, S. Morisset, J. Boutin, N. Martin, M. Sena-Martins, F. Gaillard, P. Blouch, J. Rolland, J. Font, J. Salvador, P. Fernández, and D. Stammer, 2014: Validation of Salinity Data from Surface Drifters. J. Atmos. Oceanic Technol., **31**, 967–983. http://dx.doi.org/10.1175/JTECH-D-13-00158.
2. Jenny A. U. Nilsson, Kristofer Döös, Paolo M. Ruti, Vincenzo Artale, Andrew Coward, and Laurent Brodeau, 2013: Observed and Modeled Global Ocean Turbulence Regimes as Deduced from Surface Trajectory Data. J. Phys. Oceanogr., **43**, 2249–2269. doi: http://dx.doi.org/10.1175/JPO-D-12-0193.1
3. Stephen M. Chiswell, 2013: Lagrangian Time Scales and Eddy Diffusivity at 1000 m Compared to the Surface in the South Pacific and Indian Oceans. J. Phys. Oceanogr., **43**, 2718–2732. doi: http://dx.doi.org/10.1175/JPO-D-13-044.1
4. Milena Veneziani, Annalisa Griffa, Zulema Garraffo, and Jean A. Mensa, 2014: Barrier Layers in the Tropical South Atlantic: Mean Dynamics and Submesoscale Effects. J. Phys. Oceanogr., **44**, 265–288. doi: http://dx.doi.org/10.1175/JPO-D-13-064.1
5. Thompson, A. F., and M. K. Youngs (2013), Surface exchange between the Weddell and Scotia Seas, Geophys. Res. Lett., 40, 5920–5925, doi:10.1002/2013GL058114.
6. Lavín, M. F., R. Castro, E. Beier, C. Cabrera, V. M. Godínez, and A. Amador-Buenrostro (2014), Surface circulation in the Gulf of California in summer from surface drifters and satellite images (2004–2006), J. Geophys. Res. Oceans, 119, 4278–4290, doi:10.1002/2013JC009345.
7. Nencioli, F., F. d'Ovidio, A. M. Doglioli, and A. A. Petrenko (2013), In situ estimates of submesoscale horizontal eddy diffusivity across an ocean front, J. Geophys. Res. Oceans, 118, 7066–7080, doi:10.1002/2013JC009252.
8. Coles, V. J., M. T. Brooks, J. Hopkins, M. R. Stukel, P. L. Yager, and R. R. Hood (2013), The pathways and properties of the Amazon River Plume in the tropical North Atlantic Ocean, J. Geophys. Res. Oceans, 118, 6894–6913, doi:10.1002/2013JC008981.
9. Sanial, V., P. Beek, B. Lansard, F. d'Ovidio, E. Kestenare, M. Souhaut, M. Zhou, and S. Blain (2014), Study of the phytoplankton plume dynamics off the Crozet Islands (Southern

Ocean): A geochemical-physical coupled approach, J. Geophys. Res. Oceans, 119, 2227–2237, doi:10.1002/2013JC009305.
10. Halo, I., P. Penven, B. Backeberg, I. Ansorge, F. Shillington, and R. Roman (2014), Mesoscale eddy variability in the southern extension of the East Madagascar Current: Seasonal cycle, energy conversion terms, and eddy mean properties, J. Geophys. Res. Oceans, 119, doi:10.1002/2014JC009820.
11. Zheng, Z.-W., Q. Zheng, C.-Y. Lee, and G. Gopalakrishnan (2014), Transient modulation of Kuroshio upper layer flow by directly impinging typhoon Morakot in east of Taiwan in 2009, J. Geophys. Res. Oceans, 119, 4462–4473, doi:10.1002/2014JC010090.
12. Park, Y.-H., I. Durand, E. Kestenare, G. Rougier, M. Zhou, F. d'Ovidio, C. Cotté, and J.-H. Lee (2014), Polar Front around the Kerguelen Islands: An up-to-date determination and associated circulation of surface/subsurface waters, J. Geophys. Res. Oceans, 119, doi:10.1002/2014JC010061.
13. Kennedy, J. J. (2014), A review of uncertainty in in situ measurements and data sets of sea surface temperature, Rev. Geophys., 52, 1–32, doi:10.1002/2013RG000434.
14. Djakouré, S., P. Penven, B. Bourlès, J. Veitch, and V. Koné (2014), Coastally trapped eddies in the north of the Gulf of Guinea, J. Geophys. Res. Oceans, 119, doi:10.1002/2014JC010243.
15. Liu, X., C. Dong, D. Chen, and J. Su (2014), The pattern and variability of winter Kuroshio intrusion northeast of Taiwan, J. Geophys. Res. Oceans, 119, 5380–5394, doi:10.1002/2014JC009879.

5. Slides