Progress Report
The Global Drifter Program

"Surface Drifter Measurements of Currents, Temperature, Salinity, Wind, Air Pressure and Waves"

Period of Activity: 01 October 2021 – 30 September 2022

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Budget Summary
FY 2022: $2,732,748

The Global Drifter Program

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1. Project Summary

The Global Drifter Program (GDP) is a project that sustains an array with a nominal size of 1,250 drifters distributed across the World's oceans in support of cutting-edge scientific research. A surface drifter is an highly instrumented surface buoy, capable of relying physical observations in real-time from the ocean to shore, and connected with a tether to a sea anchor (drogue). The drogue ensures that the drifters move with ocean currents, thus providing a mean to calculate the currents' velocity. All buoys are equipped with an thermometer, a Global Positioning System (GPS) chipset for geolocation, a satellite transmitter and a microcomputer. Many drifters are also equipped with a barometer to measure the atmospheric pressure at sea-level. Occasionally, drifters are equipped with other sensors to measure salinity, solar radiation, wind as well as temperature below the ocean surface. A new family of drifters capable of measuring surface waves was developed. The GDP drifter array is extremely cost-effective and the cost per observation, when comparable in terms of resolution and accuracy, is much lower than commercial alternatives. GDP data are used in many scientific research disciplines, including physical and biological oceanography, climate and weather studies. In summary, the GDP is a unique infrastructure, optimally located at the air-sea interface, from which a wide range of multidisciplinary observations can be made. Furthermore, for many years the GDP has been the benchmark against which sea surface temperature products from satellites are calibrated and validated. Atmospheric pressure data from drifters are known to have a large positive impact for weather forecasting. Drifters are the only global source of ocean currents observations near the surface. Therefore, the GDP underpins a very large number of critical activities that range from weather forecasting to climate monitoring, fisheries and iceberg patrols. The GDP is part of NOAA's Global Ocean Observing System (GOOS) and the principal contributor to the Global Surface Drifting Buoy Array (GDA). The GDP is also a scientific project of the Data Buoy

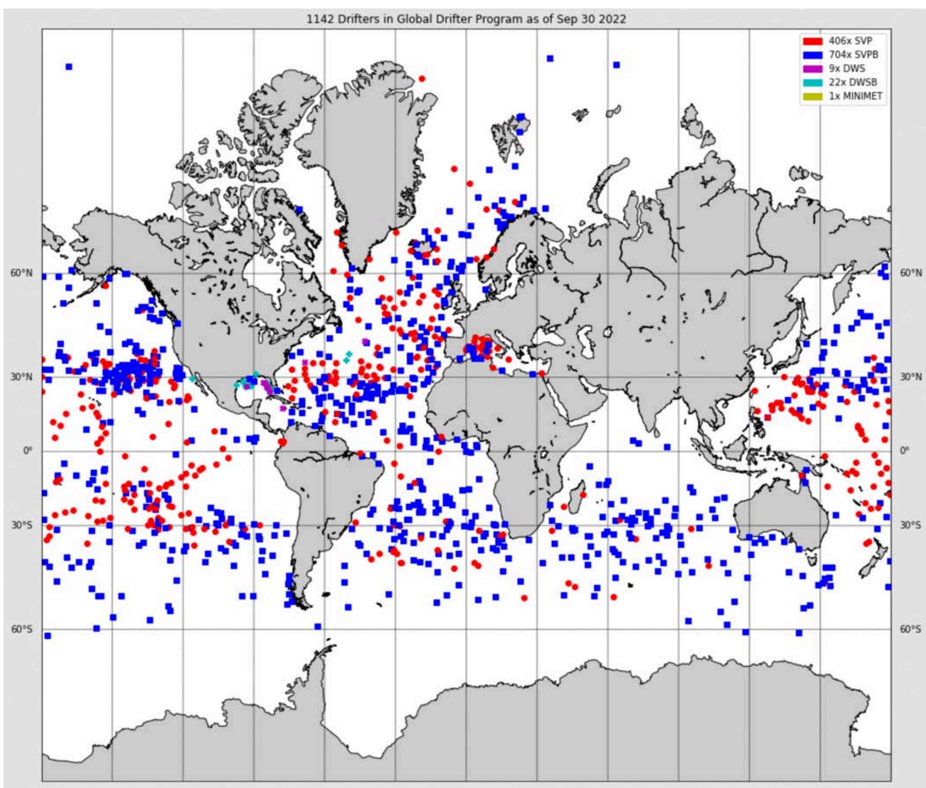
Cooperation Panel (DBCP). The DBCP is an international program coordinating the use of autonomous data buoys to observe atmospheric and oceanographic conditions over ocean areas where few other measurements are taken. The DBCP was created in 1985 as a joint body of the World Meteorological Organization (WMO) and of the Intergovernmental Oceanographic Commission (IOC) of the United Nations Educational, Scientific and Cultural Organization (UNESCO). The DBCP constitutes a major data buoy component, jointly between WMO and IOC. During the reporting period, the GDP remained operational despite the COVID-19 Pandemic. Our approach is described here: https://gdp.ucsd.edu/ldl/news-covid-19/

1. Scientific and Observing System Accomplishments

1. Progress on the milestones and performance measures.

○ Size of the GDP array

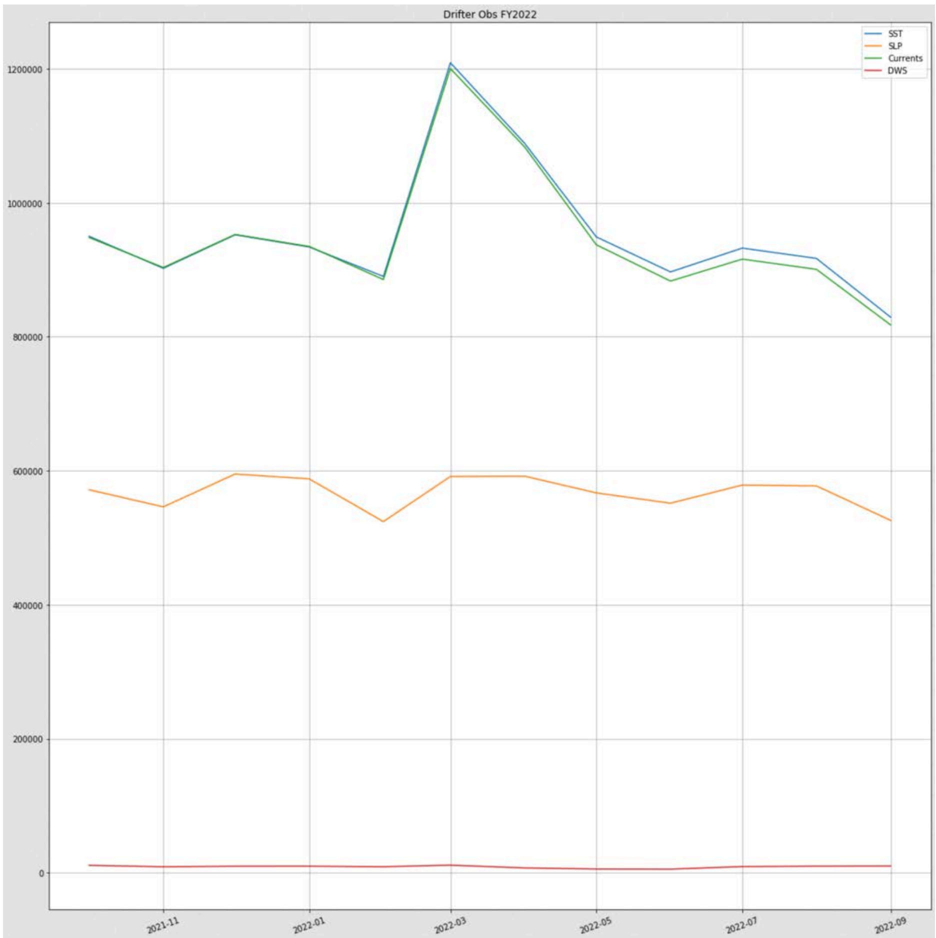
The nominal target size of the GDP array is 1,250 drifters. During the reporting period the array started to decline due to missed deployment opportunities and ended with 1,142 drifter on September 30th, 2022 (see picture below)



Size and distribution of the GDP array as of September 30th, 2022. Drifter are color coded according to their sensor suite

○ Number of GDP observation on the GTS

The GDP manages the real time data stream through the LDL's DAC. Such data management system is an integral part of the database that the GDP has built since 2014. The Figure below shows the number of GTS bulletins that the GDP DAC at LDL sent for GTS uploads



Number of GTS bulletins sent in real-time to the GTS, for sea surface temperature (SST), atmospheric sea-level pressure (SLP), currents and directional wave spectra (DWS)

The decoded GDP data are also sent to AOML's DAC monthly. AOML's role is to curate several delayed mode quality controlled datasets.

○ Data availability at DAC

100% of GDP data appear on the GTS within 15 minutes of reporting (not considering the rare outages due either to scheduled server maintenance or campus-wide networking disruption. Such technical outages are generally resolved within 48 hours).

○

Metrics regarding number of publications

- 12 peer reviewed publications authored/co-authored by PI
- 35 peer reviewed publications using data from the GDP network

2. Notable observing achievements during FY 2022

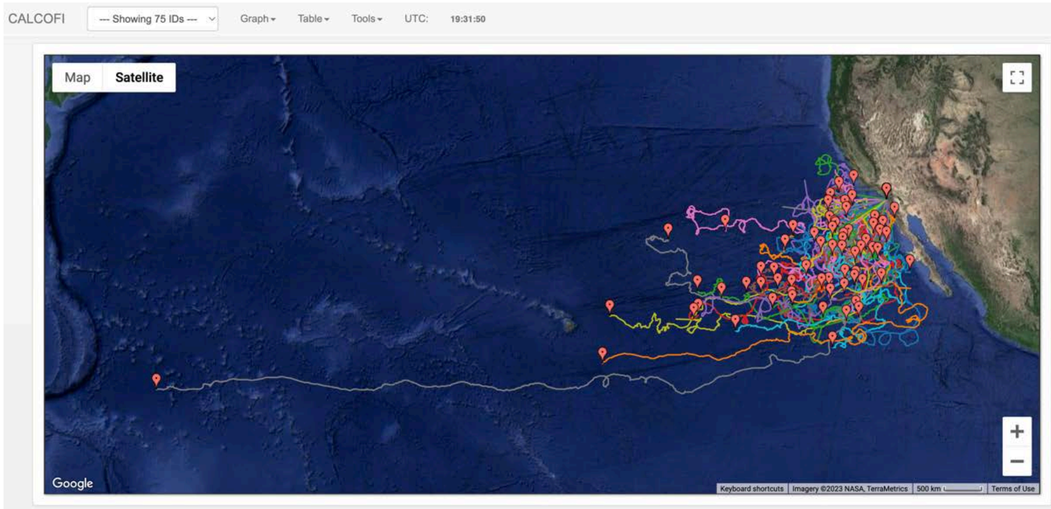
Atmospheric Rivers (AR Recon project)

10 SVPB (barometer) drifters and 10 and DWSB (wave+barometer) drifters were air deployed ion December 2021 by the 53rd WRS "Hurricane Hunters" to improve the predictability of atmospheric rivers off the west coast of the United States from a C-130J aircraft.

A box containing 2 SVPB drifters and one DWSB drifter is deployed by the 53rd WRS "Hurricane Hunters" from their C-130 aircraft. Credit: Mark Whitee, 53rd WRS "hurricane Hunter"

Drifter deployments in psrtnership with the CALCOFI program located at the Scripps institution of Oceanography (https://calcofi.org/about/)

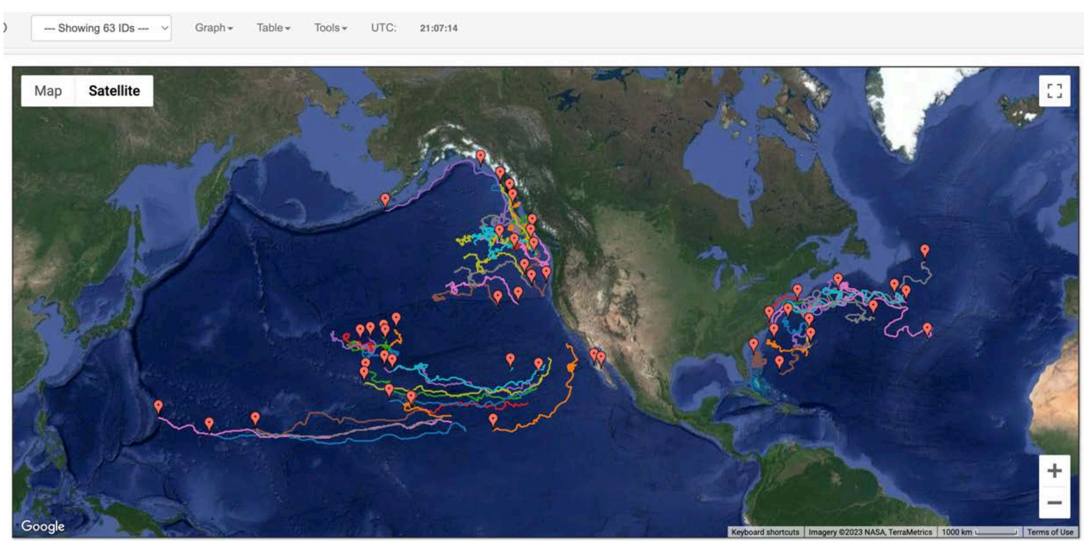
- Number of drifters deployed to date: 75
- Fall 2021 CALCOFI cruise: 10 SVP deployed
- Spring 2022 CALCOFI cruise: 10 SVP deployed
- Summer 2022 CALCOFI cruise: 10 SVP deployed



Tracks of drifters deployed during the CALCOFI cruise. Updated through April 12, 2023

<u>Deployment of drifter with NOAA's WPO funded barometers, in collaboration with Dr. Joseph Sienkiewicz, NOAA, OPC</u>

- Number of drifters with WPO funded barometers deployed to date: 63
- November-December 2021: the SSV Robert C Seamans of the Sea Education Association deployed 12 DWSBD drifters
- March 2022: the R/V John P Tully (Canada) deployed 10 SVPB drifter
- July 2022: the R/V Ronald Brown deployed 5 SVPB drifters
- August 2022: 4 DWSBD were shipped to NRL (Pax River) for hurricane deployment



Tracks of WPO co-funded drifters deployed to date. Updated on March 6, 2023

Deployment approval of the A size drifter from NOAA's AOC, 53rd WRS "Hurricane Hunter" and NRL

The newly developed A-size Directional Wave Spectra Drifter (A-DWSD™) developed by the LDL was successfully tested for deployment by three aircraft operators. NOAA's AOC and NRL successfully deployed the A-DWSD™ from their P3 plane. The 53rd WRS "Hurricane Hunter" successfully deployed the instrument from their C-130. The A-DWSD™ is now cleared for routine deployment by these groups.

Picture showing the deployment of ADWSD™ from NOAA's AOC P3

Hurricane Ian deployment

GDP drifters observed the surface wind, wave, temperature and atmospheric pressure conditions under Hurricane Ian. Three hurricane packages, each with one MiniMet and one DWSB drifter were deployed by the 53rd WRS C130-J in the path of Hurricane Ian on Tuesday, September 27th (Figure below). The drifters began reporting on 27 September 21 at 21:00:00. They were located to the front left of the hurricane, with observations primarily on the left-hand side. The targeted deployment strategy was limited by the turn of the hurricane trajectory across the west Florida shelf and the location of the Loop current.

Hurricane Packages being deployed from C130 for targeted observations of Hurricane Ian. Photo Credits: Steve Jayne

Scientific advances

1) Impact of SLP observations from drifters in forecasting atmospheric rivers

Abstract

Under the Atmospheric River Reconnaissance (AR Recon) Program, ocean drifting buoys (drifters) that provide surface pressure observations were deployed in the northeastern Pacific Ocean to improve forecasts of U.S. West Coast high-impact weather. We examine the impacts of both AR Recon and non-AR Recon drifter observations in the U.S. Navy's global atmospheric data assimilation (DA) and forecast system using data-denial experiments and forecast sensitivity observation impact (FSOI) analysis, which estimates the impact of each observation on the 24-h global forecast error total energy. Considering all drifters in the eastern North Pacific for the 2020 AR Recon season, FSOI indicates that most of the beneficial impacts come from observations in the lowest quartile of observed surface pressure values, particularly those taken late in the DA window. Observations in the upper quartile have near-neutral impacts on average and are slightly nonbeneficial when taken late in the DA window. This may occur because the DA configuration used here does not account for model biases, and innovation statistics show that the forecast model has a low pressure bias at high pressures. Case studies and other analyses indicate large beneficial impacts coming from observations in regions with large surface pressure gradients and integrated vapor transport, such as fronts and ARs. Data-denial experiments indicate that the assimilation of AR Recon drifter observations results in a better-constrained analysis at nearby non-AR Recon drifter locations and counteracts the NAVGEM pressure bias. Assimilating the AR Recon drifter observations improves 72- and 96-h Northern Hemisphere forecasts of winds in the lower and middle troposphere, and geopotential height in the lower, middle, and upper troposphere.

Reynolds, C. A., Stone, R. E., Doyle, J. D., Baker, N. L., Wilson, A. M., Ralph, F. M., Lavers, D. A., Subramanian, A. C., & **Centurioni**, L. (2023). Impacts of Northeastern Pacific Buoy Surface Pressure Observations. *Monthly Weather Review*, *151*(1), 211–226. https://doi.org/10.1175/MWR-D-22-0124.1

2) In-situ wind observations from Minimet drifters (SVPW™)

Abstract

The Minimet is a Lagrangian surface drifter measuring near-surface winds in situ. Ten Minimets were deployed in the Iceland Basin over the course of two field seasons in 2018 and 2019. We compared Minimet wind measurements to coincident ship winds from the R/V *Armstrong* meteorology package and to hourly ERA5 reanalysis winds and found that the Minimets accurately captured wind variability across a variety of time scales. Comparisons between the ship, Minimets, and ERA5 winds point to significant discrepancies between the in situ wind measurements and ERA5, with the most reasonable explanation being related to spatial offsets of small-scale storm structures in the reanalysis model. After a general assessment of the Minimet performance, we compare estimates of wind power input in the near-inertial band using the Minimet winds and their measured drift to those using ERA5 winds and the Minimet drift. Minimet-derived near-inertial wind power estimates exceed those from Minimet drift combined with ERA5 winds by about 42%. The results highlight the importance of accurately capturing small-scale, high-frequency wind events and suggest that in situ Minimet measurements are beneficial for accurately quantifying near-inertial wind work on the ocean.

Klenz, T., Simmons, H. L., **Centurioni**, L., Lilly, J. M., Early, J. J., & Hormann, V. (2022). Estimates of Near-Inertial Wind Power Input Using Novel In Situ Wind Measurements from Minimet Surface Drifters in the Iceland Basin. *Journal of Physical Oceanography*, *52*(10), 2417–2430. https://doi.org/10.1175/JPO-D-21-0283.1

3. **Instrumental records of Essential Ocean Variables , Essential Climate Variables, and related ocean attributes**

The Global Drifter Program is supported by two DACs that have distinct functions. The first DAC is located at, and operated by, the Lagrangian Drifter Laboratory (infrastructures: Scripps Institution of Oceanography, San Diego Super Computer Center and Amazon Web Services) and manages the real-time data stream of the GDP drifters, including receiving and decoding the Iridium messages, GTS real-time dataset (posting and metadata), real-time viewers and serving data on demand. The second DAC is located at AOML and it curates the delayed mode quality controlled datasets. The real-time DAC located at Scripps provides the AMOL's DAC with the drifter data with monthly frequency. The bulk of the ECV and EOV provided to the operational oceanic and atmospheric communities and to the general public include sea surface temperature, atmospheric pressure at sea level, 15 m depth near-surface currents and directional wave spectra.

4. **Issues related to funding that affect progress**

- Decline in the number of drifter available for deployment

Inflationary pressure and decline of funds available for equipment, is resulting in fewer drifters available for deployment. It is anticipated that moving forward the GDP will not be able to sustain the target size of 1,250 operating drifters in the world's ocean

5. Website for the Global Drifter Program
https://gdp.ucsd.edu/ldl/

2. Outreach and Education

- The GDP maintains a website with notable news: see https://gdp.ucsd.edu/ldl/media/

Noteworthy for this reporting cycle is the showcase of the GDP hurricane drifters to the president of the United States Joe Biden (https://www.403wg.afrc.af.mil/News/Article-Display/Article/3039874/hurricane-hunters-brief-mission-to-president-at-interagency-preseason-hurricane/)

- During the reporting cycle, the GDP has engaged with DBCP/WMO to install a mooring based on the DWSBD™ technology in the Solomon Island as part of a capacity building effort. This task also includes instructional activities to teach the local weather service how to operate the mooring and how to use the wave spectral data and it should be completed in FY 2023

3. Publications and Reports

3.1. Publications by Principal Investigators

The GDP is in the process of ***submitting a digital copy of final pre-publication manuscripts to the NOAA Institutional Repository once accepted for publication and the final pre-publication copy is available.***

- Published

1) Shroyer, E., Tandon, A., Sengupta, D., Fernando, H. J. S., Lucas, A. J., Farrar, J. T., Chattopadhyay, R., de Szoeke, S., Flatau, M., Rydbeck, A., Wijesekera, H., McPhaden, M., Seo, H., Subramanian, A., Venkatesan, R., Joseph, J., Ramsundaram, S., Gordon, A. L., Bohman, S. M., … Subrahmanyam, B. (2021). Bay of Bengal intraseasonal oscillations and the 2018 monsoon onset. *Bulletin of the American Meteorological Society*, *102*(10), E1936–E1951. https://doi.org/10.1175/bams-d-20-0113.1

2) Phillips, H. E., Tandon, A., Furue, R., Hood, R., Ummenhofer, C. C., Benthuysen, J. A., Menezes, V., Hu, S. J., Webber, B., Sanchez-Franks, A., Cherian, D., Shroyer, E., Feng, M., Wijesekera, H., Chatterjee, A., Yu, L. S., Hermes, J., Murtugudde, R., Tozuka, T., … Wiggert, J. (2021). Progress in understanding of Indian Ocean circulation, variability, air-sea exchange, and impacts on biogeochemistry. *Ocean Science*, *17*(6), 1677–1751. https://doi.org/10.5194/os-17-1677-2021

3) Haram, L. E., Carlton, J. T., **Centurioni**, L., Crowley, M., Hafner, J., Maximenko, N., Murray, C. C., Shcherbina, A. Y., Hormann, V., Wright, C., & Ruiz, G. M. (2021). Emergence of a neopelagic community through the establishment of coastal species on the high seas. *Nature Communications*, *12*(1), 5. https://doi.org/10.1038/s41467-021-27188-6

4) Maximenko, N., Palacz, A. P., Biermann, L., Carlton, J., **Centurioni**, L., Crowley, M., Hafner, J., Haram, L., Helm, R. R., Hormann, V., Murray, C., Ruiz, G., Shcherbina, A., Stopa, J., Streett, D., Tanhua, T., Wright, C., & Zabin, C. (2021). An integrated observing

system for monitoring marine debris and biodiversity. *Oceanography*, *34*(4), 52–60. https://doi.org/10.5670/oceanog.2021.supplement.02-22

5) Poulain, P. M., **Centurioni**, L., & Ozgokmen, T. (2022). Comparing the currents measured by CARTHE, CODE and SVP drifters as a function of wind and wave conditions in the southwestern Mediterranean Sea. *Sensors*, *22*(1), 18. https://doi.org/10.3390/s22010353

6) Essink, S., Hormann, V., **Centurioni**, L. R., & Mahadevan, A. (2022). On Characterizing Ocean Kinematics from Surface Drifters. *Journal of Atmospheric and Oceanic Technology*, *39*(8), 1183–1198. https://doi.org/10.1175/jtech-d-21-0068.1

7) Elipot, S., Sykulski, A., Lumpkin, R., **Centurioni**, L., & Pazos, M. (2022). A dataset of hourly sea surface temperature from drifting buoys. *Scientific Data*, *9*(1), 567. https://doi.org/10.1038/s41597-022-01670-2

8) Tarry, D. R., Ruiz, S., Johnston, T. M. S., Poulain, P., Özgökmen, T., **Centurioni**, L. R., Berta, M., Esposito, G., Farrar, J. T., Mahadevan, A., & Pascual, A. (2022). Drifter Observations Reveal Intense Vertical Velocity in a Surface Ocean Front. *Geophysical Research Letters*, *49*(18). https://doi.org/10.1029/2022GL098969

9) Cutolo, E., Pascual, A., Ruiz, S., Shaun Johnston, T. M., Freilich, M., Mahadevan, A., Shcherbina, A., Poulain, P., Ozgokmen, T., **Centurioni**, L. R., Rudnick, D. L., & D'Asaro, E. (2022). Diagnosing Frontal Dynamics From Observations Using a Variational Approach. *Journal of Geophysical Research: Oceans*, *127*(11). https://doi.org/10.1029/2021JC018336

10) Huntley, H. S., Berta, M., Esposito, G., Griffa, A., Mourre, B., & **Centurioni**, L. (2022). Conditions for Reliable Divergence Estimates from Drifter Triplets. *Journal of Atmospheric and Oceanic Technology*, *39*(10), 1499–1523. https://doi.org/10.1175/JTECH-D-21-0161.1

11) Klenz, T., Simmons, H. L., **Centurioni**, L., Lilly, J. M., Early, J. J., & Hormann, V. (2022). Estimates of Near-Inertial Wind Power Input Using Novel In Situ Wind Measurements from Minimet Surface Drifters in the Iceland Basin. *Journal of Physical Oceanography*, *52*(10), 2417–2430. https://doi.org/10.1175/JPO-D-21-0283.1

12) Zeiden, K. L., Rudnick, D. L., MacKinnon, J. A., Hormann, V., & **Centurioni**, L. (2022). Vorticity in the Wake of Palau from Lagrangian Surface Drifters. *Journal of Physical Oceanography*, *52*(9), 2237–2255. https://doi.org/10.1175/JPO-D-21-0252.1

3.2. Other Relevant Publications

1) Arbic, B. K. (2022). Incorporating Tides and Internal Gravity Waves within Global Ocean General Circulation Models: A review. *Progress in Oceanography*, 102824. https://doi.org/10.1016/j.pocean.2022.102824
2) Arbic, B. K., Elipot, S., Brasch, J. M., Menemenlis, D., Ponte, A. L., Shriver, J. F., et al. (2022). Near-surface oceanic kinetic energy distributions from drifter observations and numerical models. *Journal of Geophysical Research: Oceans*, *n/a*(n/a), e2022JC018551. https://doi.org/10.1029/2022JC018551
3) Beron-Vera, F. J., Olascoaga, M. J., Putman, N. F., Triñanes, J., Goni, G. J., & Lumpkin, R. (2022). Dynamical geography and transition paths of Sargassum in the tropical Atlantic. *AIP Advances*, *12*(10), 105107. https://doi.org/10.1063/5.0117623
4) Blanken, H., Valeo, C., Hannah, C., Khan, U. T., & Juhasz, T. (2021). A Fuzzy-Based Framework for Assessing Uncertainty in Drift Prediction Using Observed Currents and Winds. *Frontiers in Marine Science*, *8*. https://doi.org/10.3389/fmars.2021.618094
5) Chaitanya, A. V. S., Vialard, J., Lengaigne, M., d'Ovidio, F., Riotte, J., Papa, F., & James, R. A. (2021). Redistribution of riverine and rainfall freshwater by the Bay of Bengal circulation. *Ocean Dynamics*, *71*(11–12), 1113–1139. https://doi.org/10.1007/s10236-021-01486-5
6) Cobb, A., Ralph, F. M., Tallapragada, V., Wilson, A. M., Davis, C. A., Monache, L. D., et al. (2022). Atmospheric River Reconnaissance 2021: A Review. *Weather and Forecasting*. https://doi.org/10.1175/WAF-D-21-0164.1
7) Cotroneo, Y., Celentano, P., Aulicino, G., Perilli, A., Olita, A., Falco, P., et al. (2021). Connectivity Analysis Applied to Mesoscale Eddies in the Western Mediterranean Basin. *Remote Sensing*, *13*(21). https://doi.org/10.3390/rs13214228
8) Devana, M. S., Johns, W. E., Houk, A., & Zou, S. (2021). Rapid Freshening of Iceland Scotland Overflow Water Driven By Entrainment of a Major Upper Ocean Salinity Anomaly. *Geophysical Research Letters*. https://doi.org/10.1029/2021GL094396
9) Drouin, K. L., Susan Lozier, M., Beron‐Vera, F. J., Miron, P., & Olascoaga, M. J. (2021). Surface pathways connecting the South and North Atlantic Oceans. *Geophysical Research Letters*. https://doi.org/10.1029/2021GL096646
10) Eddebbar, Y. A., Subramanian, A. C., Whitt, D. B., Long, M. C., Verdy, A., Mazloff, M. R., & Merrifield, M. A. (2021). Seasonal Modulation of Dissolved Oxygen in the Equatorial Pacific by Tropical Instability Vortices. *Journal of Geophysical Research: Oceans*. https://doi.org/10.1029/2021JC017567
11) Ernst, P. A., Subrahmanyam, B., & Trott, C. B. (2022). Lakshadweep High Propagation and Impacts on the Somali Current and Eddies During the Southwest Monsoon. *Journal of Geophysical Research: Oceans*. https://doi.org/10.1029/2021JC018089
12) Fan, S., Zhang, B., Perrie, W., Mouche, A., Liu, G., Li, H., et al. (2022). Observed Ocean Surface Winds and Mixed Layer Currents under Tropical Cyclones: Asymmetric Characteristics. *Journal of Geophysical Research: Oceans*. https://doi.org/10.1029/2021JC017991
13) He, Z. W., Yang, D. Z., Wang, Y. G., & Yin, B. S. (2022). Impact of 4D-Var data assimilation on modelling of the East China Sea dynamics. *Ocean Modelling*, *176*. https://doi.org/10.1016/j.ocemod.2022.102044

14) Hiron, L., Miron, P., Shay, L. K., Johns, W. E., Chassignet, E. P., & Bozec, A. (2022). Lagrangian coherence and source of water of Loop Current Frontal Eddies in the Gulf of Mexico. *Progress in Oceanography*, 102876. https://doi.org/10.1016/j.pocean.2022.102876
15) Lee, C., DeGrandpre, M., Guthrie, J., Hill, V., Kwok, R., Morison, J., et al. (2022). Emerging Technologies and Approaches for In Situ, Autonomous Observing in the Arctic. *Oceanography*. https://doi.org/10.5670/oceanog.2022.127
16) Li, D., Chang, P., Yeager, S. G., Danabasoglu, G., Castruccio, F. S., Small, J., et al. (2022). The Impact of Horizontal Resolution on Projected Sea-Level Rise Along US East Continental Shelf With the Community Earth System Model. *Journal of Advances in Modeling Earth Systems*, *14*(5), e2021MS002868. https://doi.org/10.1029/2021MS002868
17) Liu, C., Freeman, E., Kent, E. C., Berry, D. I., Worley, S. J., Smith, S. R., et al. (2022). Blending TAC and BUFR Marine in Situ Data for ICOADS Near-Real-Time Release 3.0.2. *Journal of Atmospheric and Oceanic Technology*. https://doi.org/10.1175/JTECH-D-21-0182.1
18) Maillard, L., Boucharel, J., & Renault, L. (2022). Direct and Rectified Effects of Tropical Instability Waves on the Eastern Tropical Pacific Mean State in a Regional Ocean Model. *Journal of Physical Oceanography*, *52*(8), 1817–1834. https://doi.org/10.1175/JPO-D-21-0300.1
19) Morison, J., Kwok, R., & Rigor, I. (2022). Changes in Arctic Ocean Circulation from In Situ and Remotely Sensed Observations: Synergies and Sampling Challenges. *Oceanography*. https://doi.org/10.5670/oceanog.2022.111
20) Nishikawa, H., Mitsudera, H., Okunishi, T., Ito, S., Wagawa, T., Hasegawa, D., et al. (2021). Surface water pathways in the subtropical–subarctic frontal zone of the western North Pacific. *Progress in Oceanography*, 102691. https://doi.org/10.1016/j.pocean.2021.102691
21) Qiu, B., Nakano, T., Chen, S., & Klein, P. (2022). Bi-Directional Energy Cascades in the Pacific Ocean From Equator to Subarctic Gyre. *Geophysical Research Letters*, *49*(8), e2022GL097713. https://doi.org/10.1029/2022GL097713
22) Qiu, C. H., Yang, Z. H., Wang, D. X., Feng, M., & Su, J. Z. (2022). The Enhancement of Submesoscale Ageostrophic Motion on the Mesoscale Eddies in the South China Sea. *Journal of Geophysical Research-Oceans*, *127*(9). https://doi.org/10.1029/2022jc018736
23) Ramanantsoa, J. D., Penven, P., Raj, R. P., Renault, L., Ponsoni, L., Ostrowski, M., et al. (2021). Where and how the East Madagascar Current retroflection originates? *Journal of Geophysical Research: Oceans*. https://doi.org/10.1029/2020JC016203
24) Semper, S., Våge, K., Pickart, R. S., Jónsson, S., & Valdimarsson, H. (2022). Evolution and Transformation of the North Icelandic Irminger Current Along the North Iceland Shelf. *Journal of Geophysical Research: Oceans*, *127*(3). https://doi.org/10.1029/2021JC017700
25) Srinivasan, A., Chin, T. M., Chassignet, E. P., Iskandarani, M., & Groves, N. (2022). A Statistical Interpolation Code for Ocean Analysis and Forecasting. *Journal of Atmospheric and Oceanic Technology*, *39*(3), 367–386. https://doi.org/10.1175/JTECH-D-21-0033.1

26) Sun, L. Y., Penny, S. G., & Harrison, M. (2022). Impacts of the Lagrangian Data Assimilation of Surface Drifters on Estimating Ocean Circulation during the Gulf of Mexico Grand Lagrangian Deployment. *Monthly Weather Review*, *150*(4), 949–965. https://doi.org/10.1175/mwr-d-21-0123.1
27) Sun, Z. Y., Hu, J. Y., Lin, H. Y., Chen, Z. Z., Zhu, J., Yang, L. Q., et al. (2022). Lagrangian Observation of the Kuroshio Current by Surface Drifters in 2019. *Journal of Marine Science and Engineering*, *10*(8). https://doi.org/10.3390/jmse10081027
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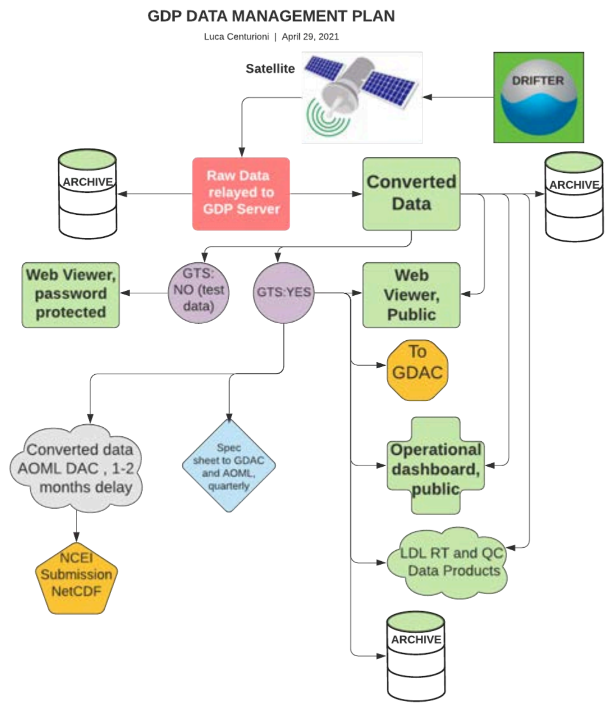
4. Data and Publication Sharing

The GDP data management plan is illustrated in the Figure below. The drifter relays the data to the LDL servers through a satellite communication system. The current satellite system of choice is Iridium. The raw data are then archived. The converted data are archived and then either relayed to an internal section (test data, available through a password protected website), or transmitted to the GTS. The GTS data are: 1) displayed through the public GDP web viewer, 2) monitored through a publicly accessible GDP operational dashboard, 3)automatically sent to the drifter GDAC, 4) used to create RT and QC's data products and 5) archived. The GTS converted data are also sent to the drifter DAC located at AOML with monthly to bi-monthly frequency, together with the drifter specification sheets, that are sent quarterly. The drifter specification sheets are also sent to the drifter GDAC, quarterly. The converted data are also available through the public web viewer, the operational dashboard and are used to generate RT and QC data products. It should be noted that the LDL manages the real-time data stream for GTS posting in compliance with WMO and JCOMM directives.



Flow chart of the GDP data management plan

6. Project Highlight Slides

1. See attachment