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The Global Drifter Program: Methods and Impacts

- L.R> Centurioni

IR0000032 – ITINERIS, Italian Integrated Environmental Research Infrastructures System
(D.D. n. 130/2022 - CUP B53C22002150006) Funded by EU - Next Generation EU PNRR-Mission 4 “Education and Research” - Component 2: “From research to business” - Investment 3.1: “Fund for the realisation of an integrated system of research and innovation infrastructures”

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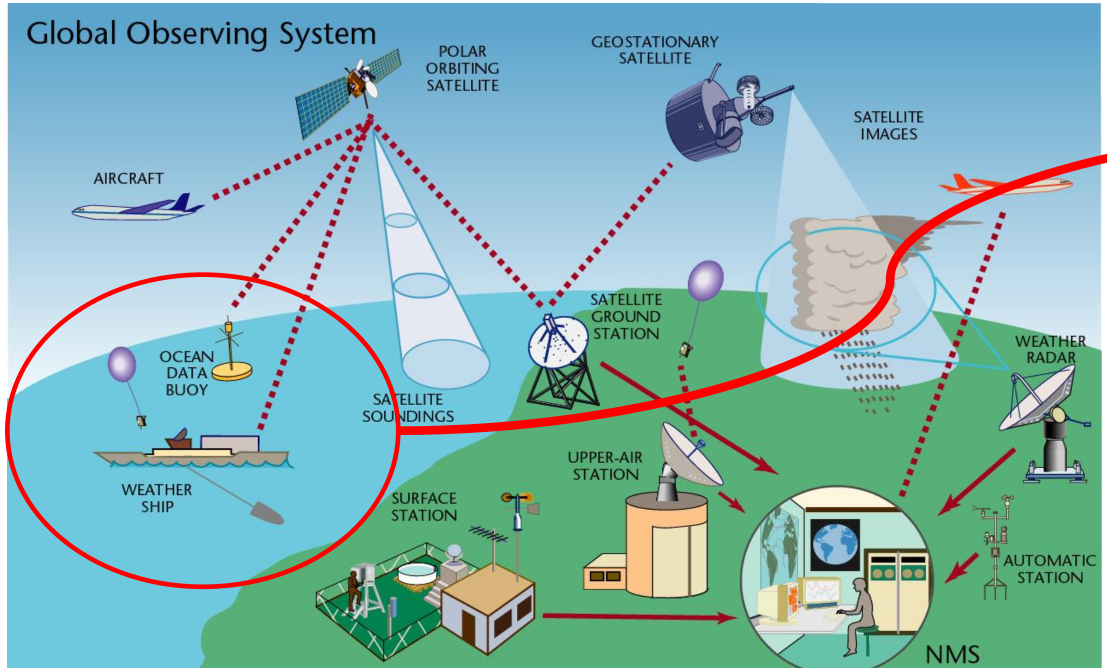
THE Global Drifter Program is a Major Component of the of the Global Observing System



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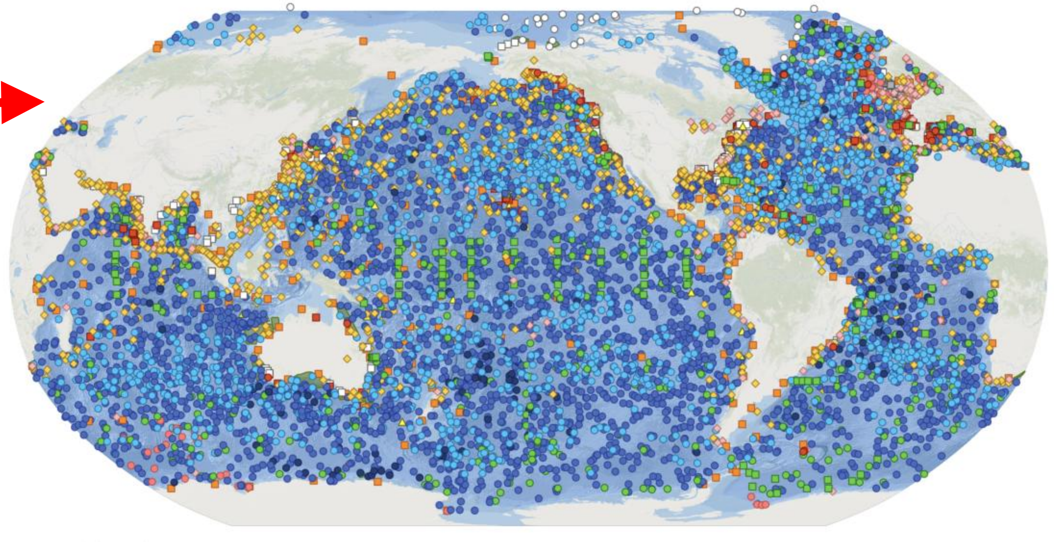
Global Ocean Observing System



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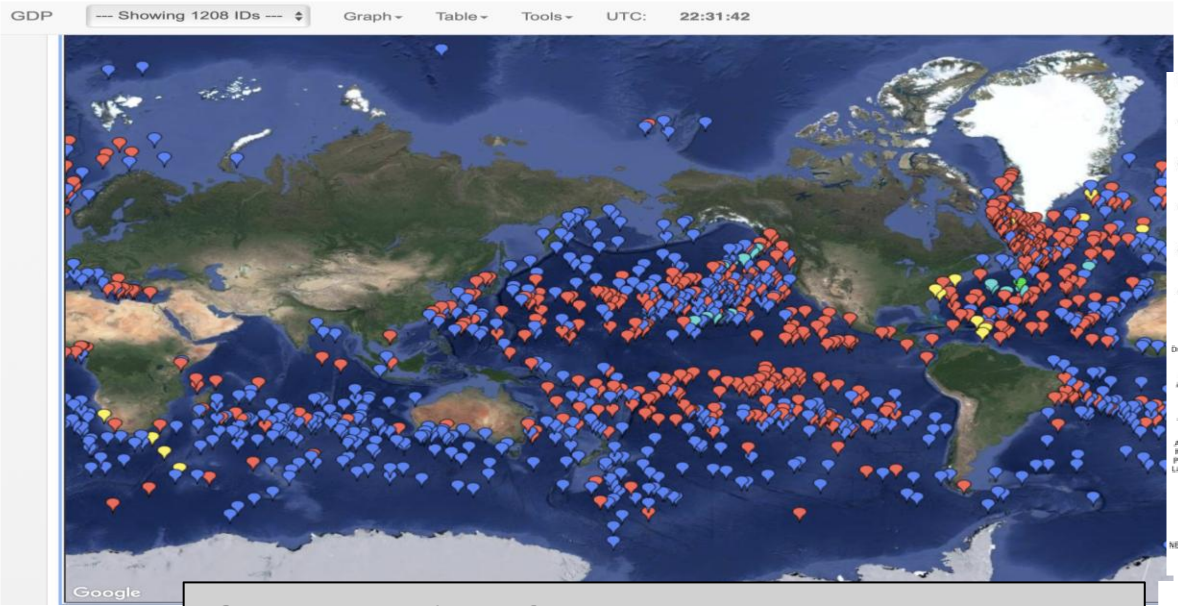
The Main Oceanographic Components of GOOS:

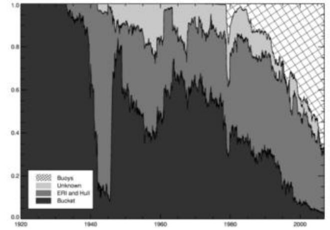
- Drifters (Surface)
- Ships (Surface and Subsurface)
- Moorings (Surface and Subsurface)
- Gliders (Subsurface)
- Floats (Subsurface)

The Global Drifter Program in a Nutshell

The Only Global Scientific Project for In-Situ Ocean Observing at the Air-Sea Interface

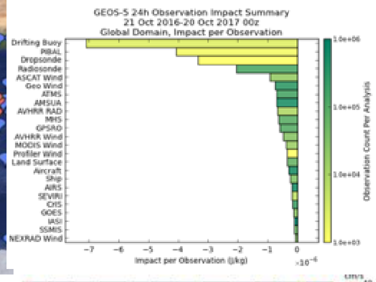


Main Critical Impact Areas



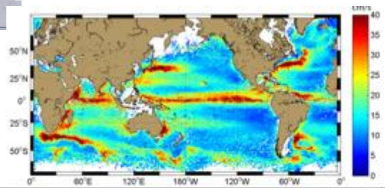
SST From Space Cal/Val

Left: Fractional contribution of SST data by platforms (buoys refers primarily to drifters, that provide more SST data than all the other sources combined). From Kennedy et al, 2011, JGR. Drifters provide X100 daily SST obs than Argo.



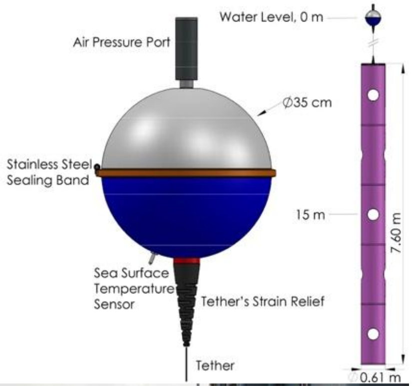
SLP for NWP and Climate Indices

Left: Drifters SLP data have the largest positive impact per observations (Centurioni et al. 2016, BAMS). Both forecasting and climate studies benefit from drifter data, especially in the southern ocean where the drifters are essentially the only source of in-situ SLP data.



Science

Over 1,100 paper published to date use drifter data directly



***Overarching Goals*:**

Maintain a global 5ºx5º array of surface drifting buoys to meet the needs for an accurate and globally dense set of in-situ observations: **mixed layer currents, SST, atmospheric pressure**, winds, and salinity.

Build a ***collaboration*** with the international community to maintain

The GDP provides publicly available observational baselines in the upper-ocean mixed-layer and fills a unique role in the Global Ocean and Climate Observing System. The positive impacts of the GDP data are large and well

Science Supported by the Drifters

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LAGRANGIAN DRIFTER LABORATORY

Supported Scientific Research

- Physical Oceanography: Descriptive, Dynamical, Satellite
- Climate
- Air-Sea Interaction (e.g. role of surface waves in hurricane intensity)
- Numerical Weather Prediction
- Marine Biology and Fisheries
- Over 1,200 papers published using drifter data

The Hurricane Component of the GDP

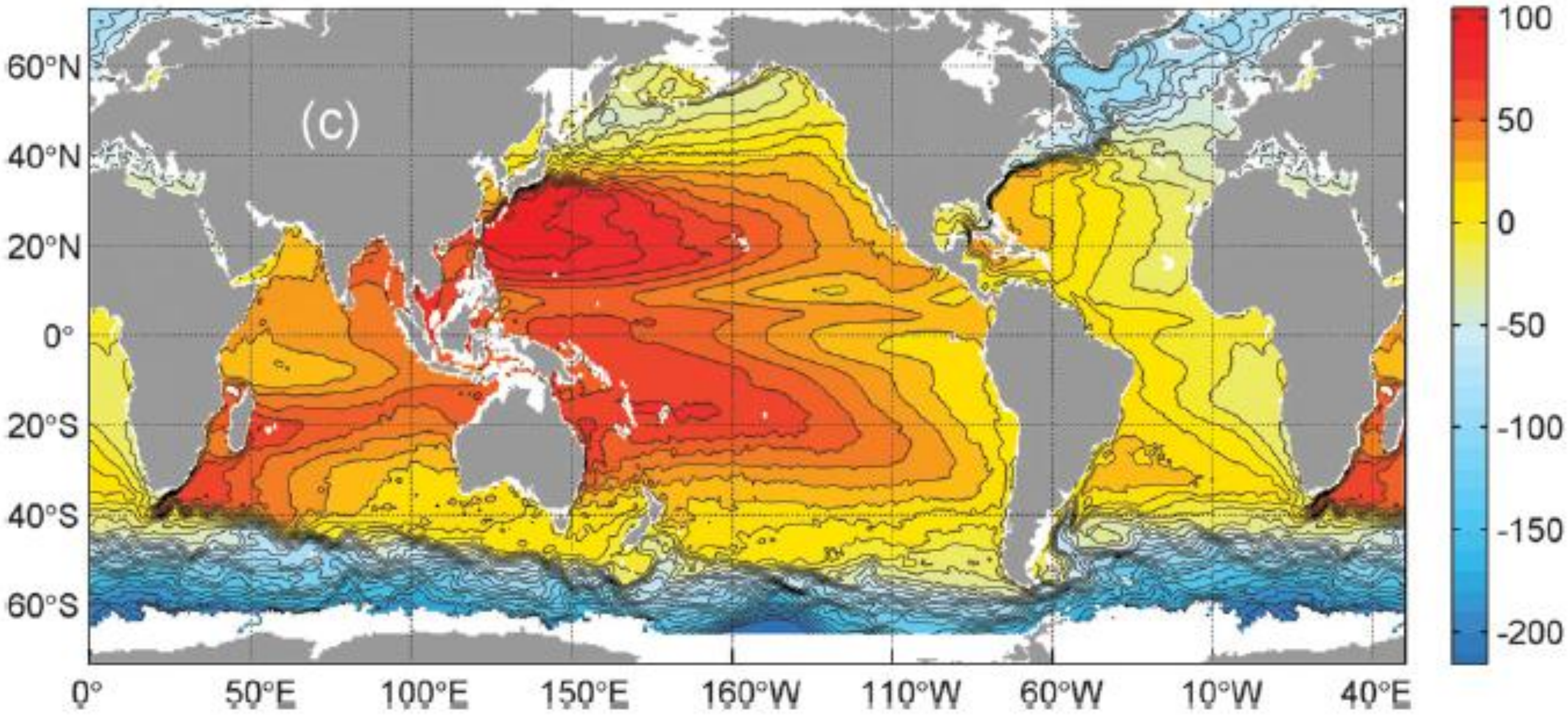
Quick Statistics on GDP Hurricane Drifter Efforts

- 24 Tropical cyclones targeted (19 hurricanes, 5 typhoons)
- 90 ADOS (wind, SLP, SST, subsurface temperature)
- 91 Minimets (wind, SLP, SST, 15 depth currents)
- 70+ SVPB deployed (SLP, SST, 15 depth currents)
- 100+ DWSD/DWSBD deployed (directional wave spectra, SST, SLP)
- 96% Deployment success rate
- LDL's papers published on this topic: 16

Two Examples of Global PO Studies

Example of Use of Currents from Drifters: the Mean Dynamic Topography

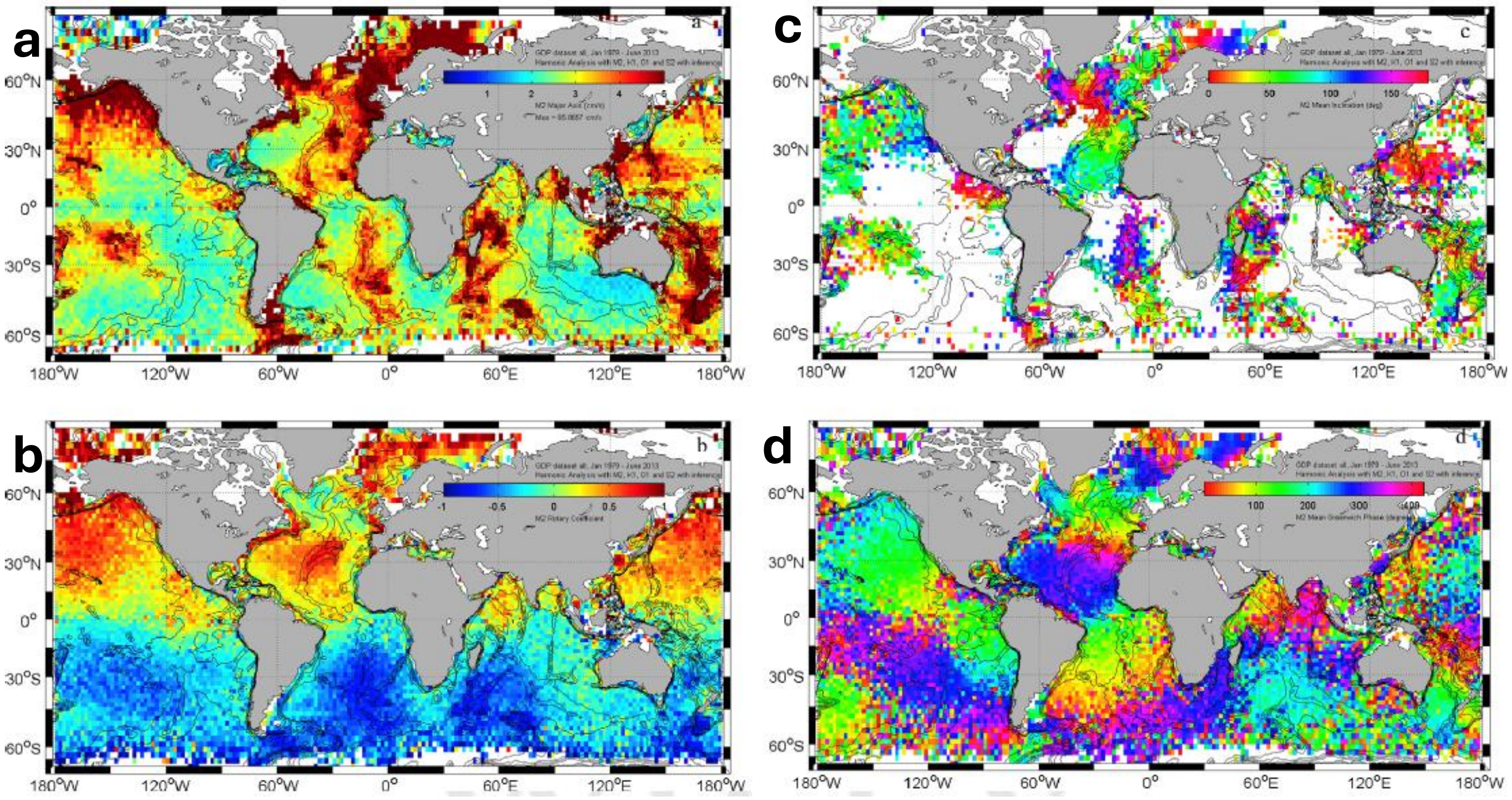
A mean dynamic topography is computed by minimizing a cost function that contains the large-scale sea level from GRACE (to constrain the planetary scales), wind, and the drifter data (to constrain the ocean meso-scale)



Maximenko, N., P. Niiler, L. Centurioni, M.-H. Rio, O. Melnichenko, D. Chambers, V. Zlotnicki and B. Galperin (2009). "Mean Dynamic Topography of the Ocean Derived from Satellite and Drifting Buoy Data Using Three Different Techniques*." Journal of Atmospheric and Oceanic Technology **26**(9): 1910-1919.

Use of Velocity from Drifters at High Frequency: Computation of Tides

Mean amplitude (a), rotary coefficient (b), inclination (c) and Greenwich phase (d) of M2 tidal currents averaged in 2º x2º bins. Amplitudes in excess of 5 cm/s are saturated. For the inclination, bins with small (semi-major axis < 3 cm/s) and near-circular (rotary coefficient larger than 0.9 in absolute value) tidal currents are excluded.



Poulain, P.-M. and L. Centurioni (2015). "Direct measurements of World Ocean tidal currents with surface drifters." Journal of Geophysical Research: Oceans **120**(10): 6986-7003.

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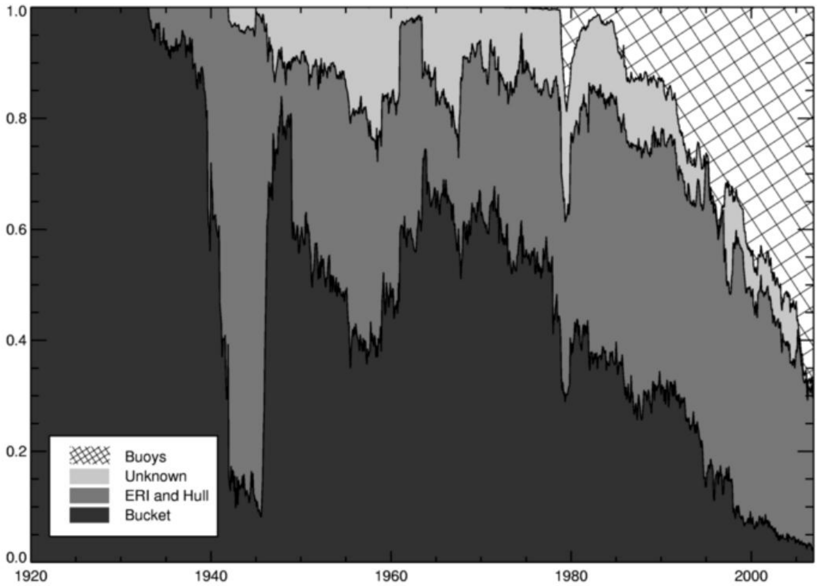
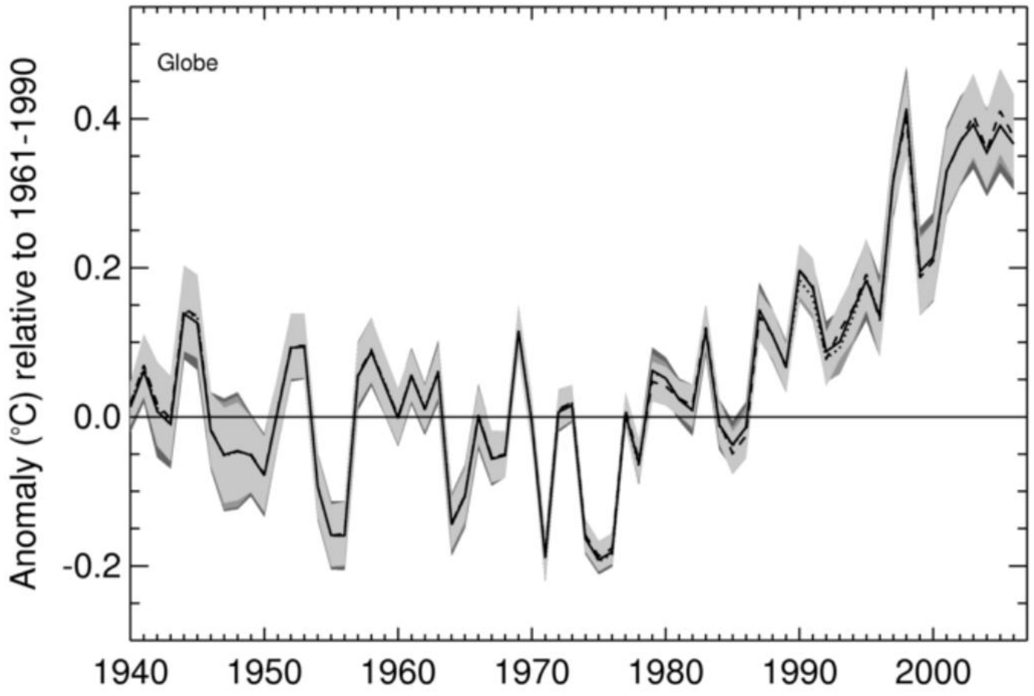
Drifters and SST Cal/Val

Impact of Drifter Data on Sea surface Temperature
Origin of SST Data by Platform Type and Global SST Anomaly



Left: Fractional contribution of SST data by platforms (buoys refers primarily to drifters, that provide more SST data than all the other sources combined). From Kennedy et al, 2011, JGR



Right: Global SST anomaly with uncertainty relative to the 1961-1990 period. The solid line is from the main dataset. The dotted line is from drifting buoys only. From Kennedy et al, 2011, JGR

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Drifters and Numerical Weather Prediction

Sea Level Pressure (SLP) Impacts: Weather, Altimetry, Climate Indices

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- Largest Source of global oceanic *in-situ* SLP
  - **Drifter SLP data have the largest positive impact per observation. Both forecasting and climate studies benefit from drifter data, especially in the Southern Ocean where the drifters are essentially the only source of in-situ SLP data.** See also Centurioni, et al (2016). Bulletin of the American Meteorological Society **98**(2): 231-238
  - **Inverse Barometer Effect, from SLP reanalysis, is important for altimetry correction**
  - Because of impacts, the GDP/DBCP Barometer Upgrade Program, adds ~100 units/year

The barometer drifter array has several large impacts, and it is implemented in collaboration with major international weather services

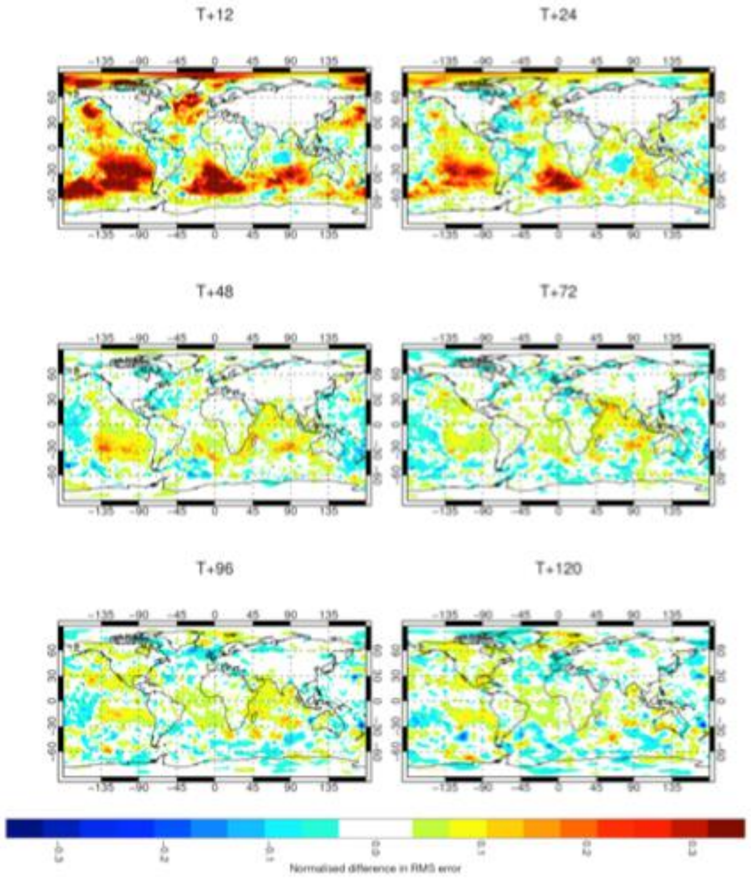

Figure: Normalised differences of mean sea level pressure root mean-squared errors between the control and denial experiment. Red (blue) colours indicate degradations (improvements) in the denial experiment. Forecast ranges: 12h, 24h, 48h, 72h, 96h and 120h.

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The GDP Vision for the Next Decade

Centurioni, L. R., J. Turton, R. Lumpkin, L. Braasch, G. Brassington, Y. Chao, E. Charpentier, Z. Chen, G. Corlett, K. Dohan, C. Donlon, C. Gallage, V. Hormann, A. Ignatov, B. Ingleby, R. Jensen, B. A. Kelly-Gerreyn, I. M. Koszalka, X. Lin, E. Lindstrom, N. Maximenko, C. J. Merchant, P. Minnett, A. O'Carroll, T. Paluszkiewicz, P. Poli, P.-M. Poulain, G. Reverdin, X. Sun, V. Swail, S. Thurston, L. Wu, L. Yu, B. Wang and D. Zhang (2019). "Global in situ Observations of Essential Climate and Ocean Variables at the Air–Sea Interface." Frontiers in Marine Science **6**(419).

Take-home message

- The GDP is the only global network that measures in-situ SST, air pressure and Lagrangian Currents. It has strong positive impacts for science (over 1,100 peer review papers), for operations (SST, waves, currents) and numerical weather prediction. The GDP network can be easily augmented with new sensors.

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THANKS!

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