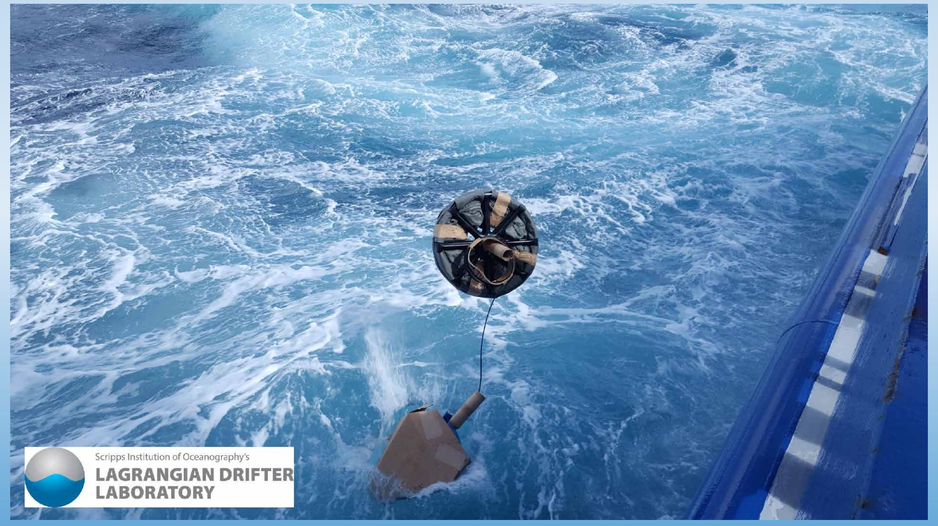
# Global Wave Observations from Expendable Drifters

Scripps Institution of Oceanography's
LAGRANGIAN DRIFTER LABORATORY

Credit: USAF 53rd WRS





Credit: USAF 53rd WRS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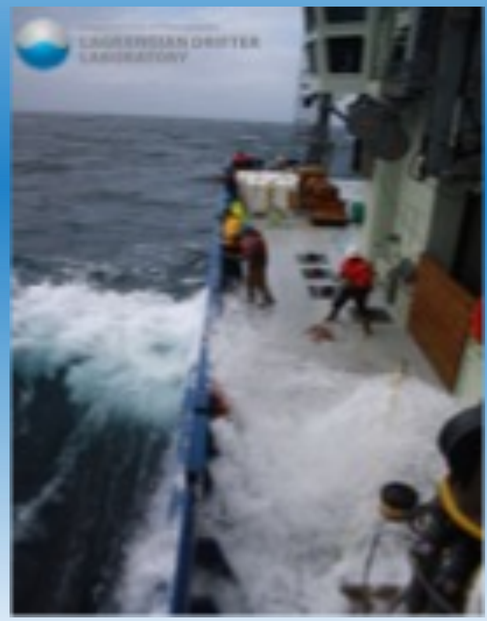
**http://gdp.ucsd.edu/**




**First DBCP Mediterranean Training Workshop on Ocean Observations and Data Applications , November 11, 2022**

# The Global Drifter Program in a Nutshell

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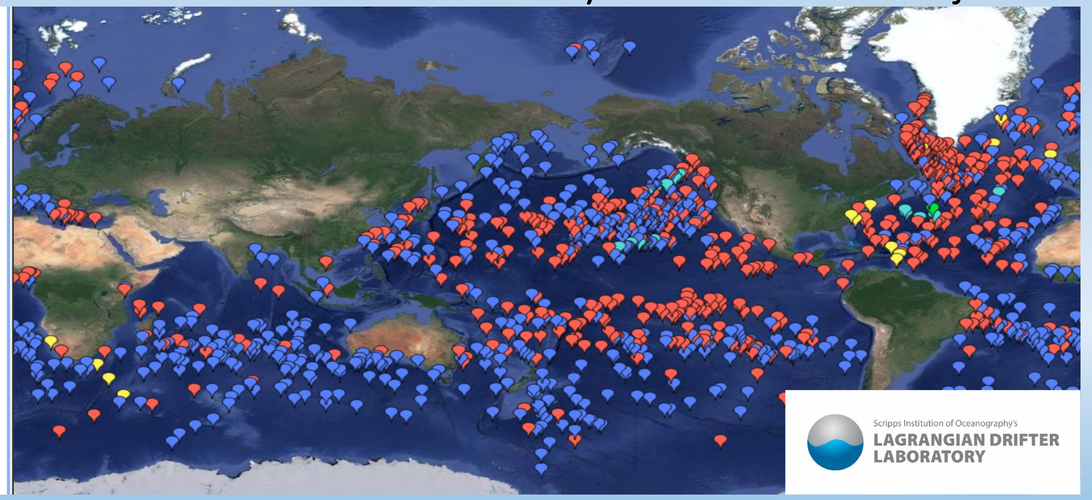
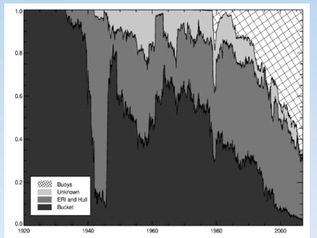
The Only Global Scientific Project for In-Situ Ocean Observing at the Air-Sea Interface



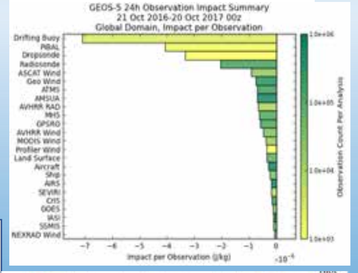


## Main Critical Impact Areas



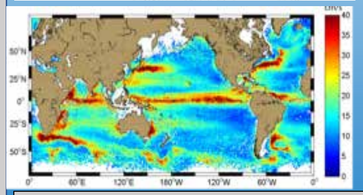

### SST From Space Cal/Val

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*:**

**-Further our scientific understanding** of the ocean, atmosphere and climate by observing surface physical processes in the global ocean.

**-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 drifter array.

Metrics:

- Full 5 X 5 array
- Real time data distribution on ERDDAP and GTS
- Global data accessibility
- Verified Lagrangian characteristics
- Quality-controlled data, archived

The GDP provides publicly available (FAIR-O) 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 fore research and operations are large and well documented**

See https://gdp.ucsd.edu/ldl/global-drifter-program/ for a complete description of the GDP

# Rationale for *in-situ, FAIR-O,* GDP Global Open Ocean Wave Observations

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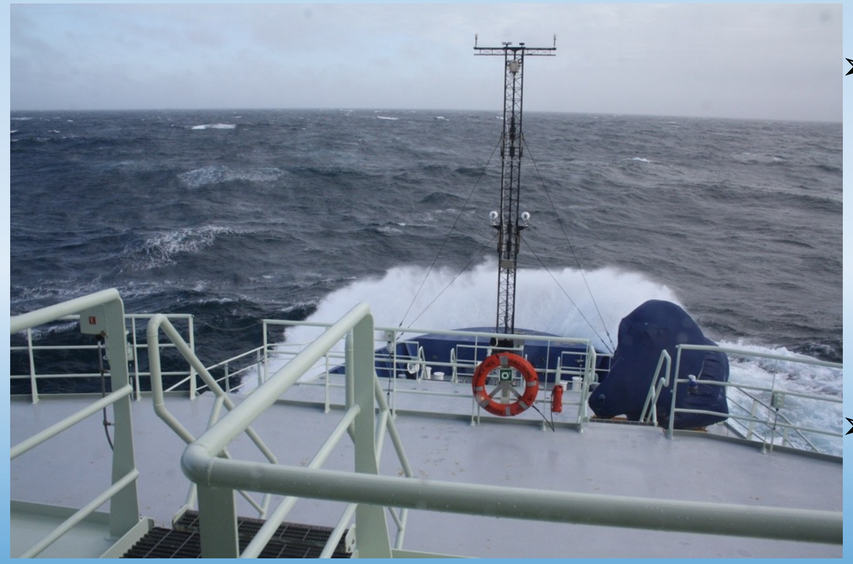


- **Basic Science**: Wave propagation (trans-basin/local), air-sea interaction (e.g. momentum and gas fluxes), wave/current interaction (e.g. wave modulation by strong currents), wave/wave interaction, wave/internal wave interaction (implications for diapycnal mixing), engineering of offshore structures, climate assessment, risk assessment and planning

- **Societal**: Navigation efficiency and safety (wave/Gulf Stream interactions), SOLAS, marine insurers, Lloyd's ship hull strength metric, wave inundation warnings (e.g. India, Sri Lanka, West Africa)

- **Satellite/Airborne missions**: Calibration and validation of remotely sensed significant wave height and spectral characteristics retrievals of the surface wave field

- **Validation and forecasting:** Validation and scientific assessment of wave forecasting products, assimilation of wave data into wave forecasting models, open ocean in-situ Boundary conditions to improve coastal wave forecasts where people live and work

*Photo credit: Icelandic Coast Guard*

**In-situ wave observations in the open ocean are very sparse.**

**The FAIR-O GDP data policy is CRUCIAL for rapid advancement of science, as demonstrated by nearly 40 years of GDP operations, in contrast with for-profit ocean observing activities**

**Wave/current interaction can cause serious ship accidents. In-situ data are needed to constrain, validate and assess models**

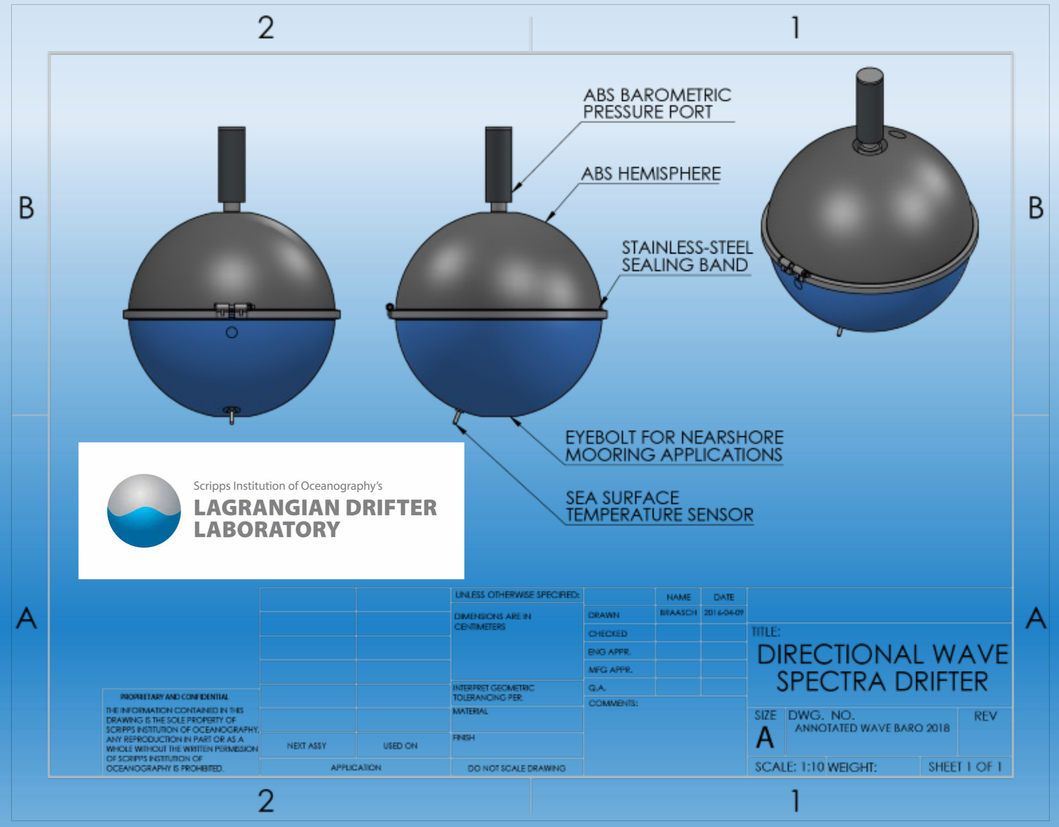
**A research based, open data, global array of wave sensors is needed**

Centurioni et al, 2019, Frontiers in Marine Science, **6**-419.

# The Directional Wave Spectra Barometer (Option) Drifter (DWSBD™)

## THE LDL DWSB™ Drifter

DESIGNED TO MEASURE DIRECTIONAL SURFACE GRAVITY WAVES




CAN BE MOORED OR FREELY DRIFTING

## Technical Specifications

**Construction:**

- Same components and hardware construction as the SVPB family instrument
- Extension of existing platform => **SVPB drifter with *less* hardware but *more* software**

**Sensors:**

- GPS localization (accuracy: 10 m rms)
- SST (thermistor ±0.05° C, @ ~17cm depth)
- SLP (Honeywell IPT, ±0.4hPa ) - *optional*
- Directional Wave Sensor (GPS based, 2sec-32sec wave periods; Frequency spectrum $a_0$ , $a_1$, $b_1$, $a_2$, $b_2$ and Integral parameters $H_{m0}$, $T_p$, $T_a$, $D_d$

**Telemetry:**

- 2-way Iridium telemetry for fast data relay (< 1 min) and over-the-air mission control

**DWS drifter deployments began in 2015. Since inception, over 450 DWS drifters have been deployed globally**

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# THE GDP COMMITEMENT FOR A CLEAN ENVIRONMENT
## The Biodegradable Wave Drifter

- In recent months the GDP has deployed several prototypes of wave buoys made of oil-free, non-toxic bioplastic; While all the LDL made drifters have used recycled materials for years, our goal is to improve our efforts to minimize the impact of our critical observations on the environment.
- Our interest in the recent deployments of biodegradable drifters is into determining if this new material is suitable for long term applications, in other words, we want to see how long they will survive in a real application.
- Approximately two years of data on the performance of the biodegradable drifters indicate that these products are a viable alternative to petroleum-based plastic


The biodegradable DWS™

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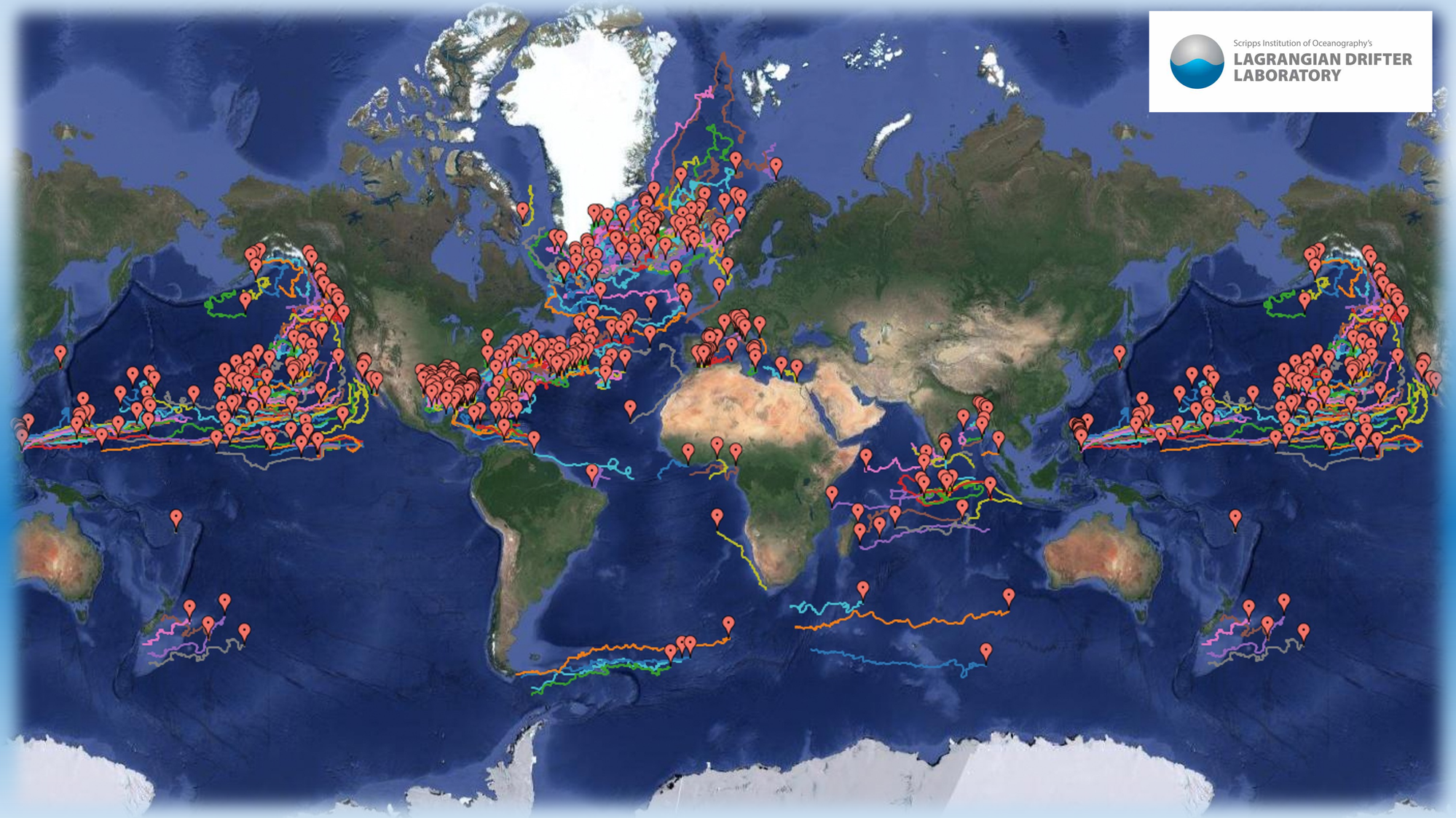
# Directional Wave Spectra Drifters Deployed

## Trajectories of 430 A/DWS/B Drifters Deployed to Date



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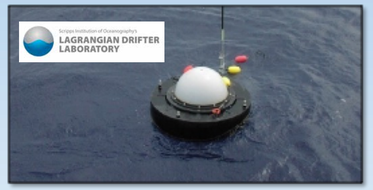
# Directional Wave Spectra Drifters Milestones and Key Features



Prototype/testing

LDL DWS MOORING

**A-size DWSD**

- Delivered first batch to 53rd/NRL for 2022 Hurricane Season
- Adds flexibility to targeted deployments

**Significant Milestones:**

- 2005: First prototype (GPS, bottom pinger and ADCP)
- 2015: Release of TRL 9 DWSD by the GDP/LDL at Scripps Institution of Oceanography to sustain a global array of wave sensors.
- 2015: Global pilot array implementation begins
- 2018: Targeted deployments (air-drop) in front of hurricanes
- 2019: Atmospheric rivers deployments (air-drop) off the US west coast
- 2021: A-size version release

**Key Features**

- Cost-effective, scalable to sustain global operations
- Expandable sensor suite
- Low power system, endurance consistent with other SVP drifters
- Shared hardware with the Surface Velocity Program instrument class
- Available in traditional, recycled of biodegradable or plastic
- Drifting or moored
- GTS ready, readily fits into operational forecasting and advisory enterprise

**Sensors in the Basic Configuration**

- GPS
- Sea Surface Temperature
- Barometer

**Telemetry**

- Two-way Iridium telemetry for fast data relay (< 1 min) and over-the-air mission control

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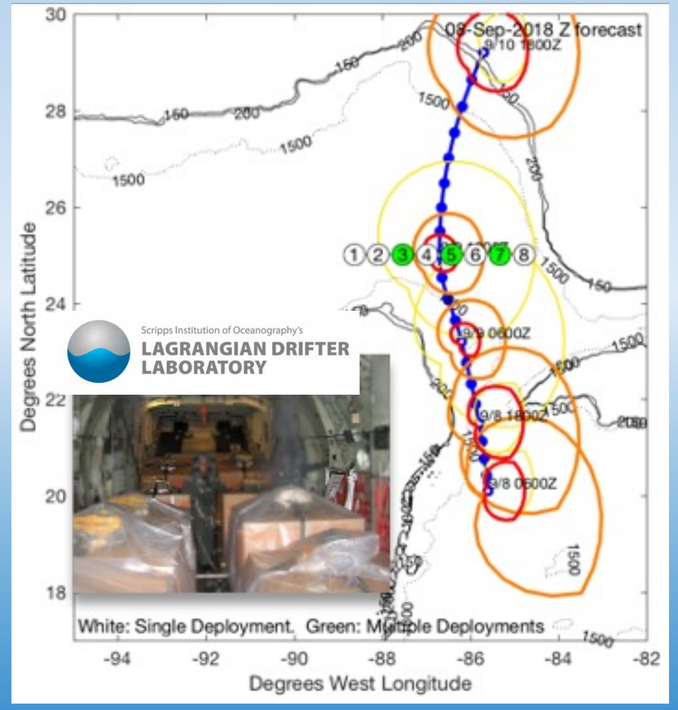
# Advantages of LDL drifting wave technology




- **Reliable, low cost, accessible data**
- **Essential, targeted wave observations**
- **Deep water wave observations**

**First hurricane air-deployment of GDP wave buoys ever. See NOAA research news: (2018)**
https://research.noaa.gov/article/ArtMID/587/ArticleID/2388/Drifting-buoys-track-Hurricane-Michael-in-the-Gulf-of-Mexico

**Test deployment: A-Size Drifters by AOC NOAA P-3**

Schönau et al., in prep

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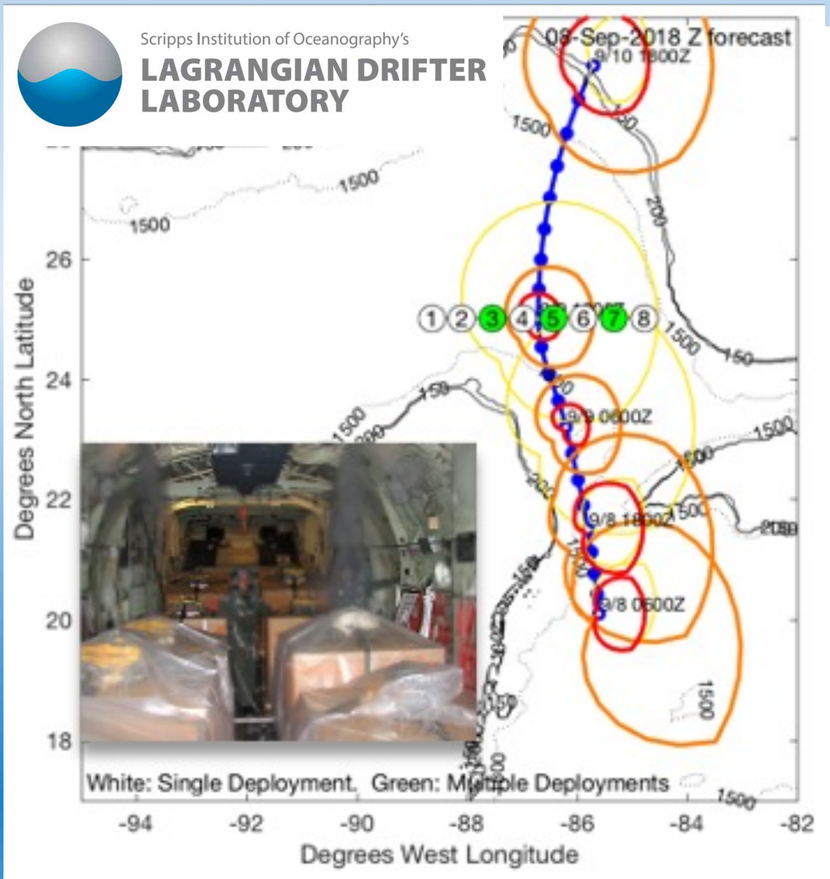
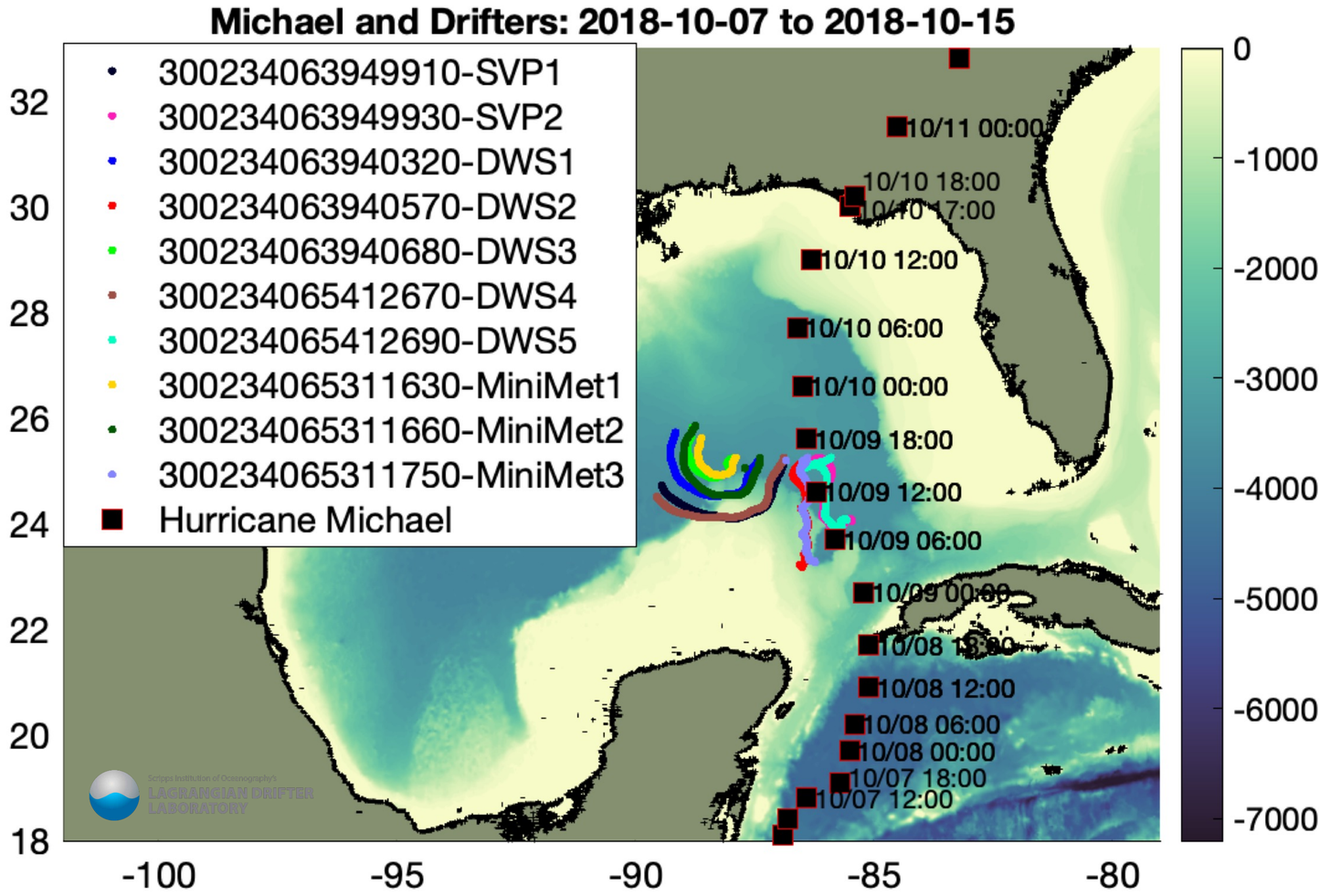
# Hurricane Wave Observations: Hurricane Michael (2018)




First hurricane air-deployment of GDP wave buoys ever. See NOAA research news: https://research.noaa.gov/article/ArtMID/587/ArticleID/2388/Drifting-buoys-track-Hurricane-Michael-in-the-Gulf-of-Mexico

**Deployment 24 hours ahead of the predicted track of Michael**




Schönau et al., in prep

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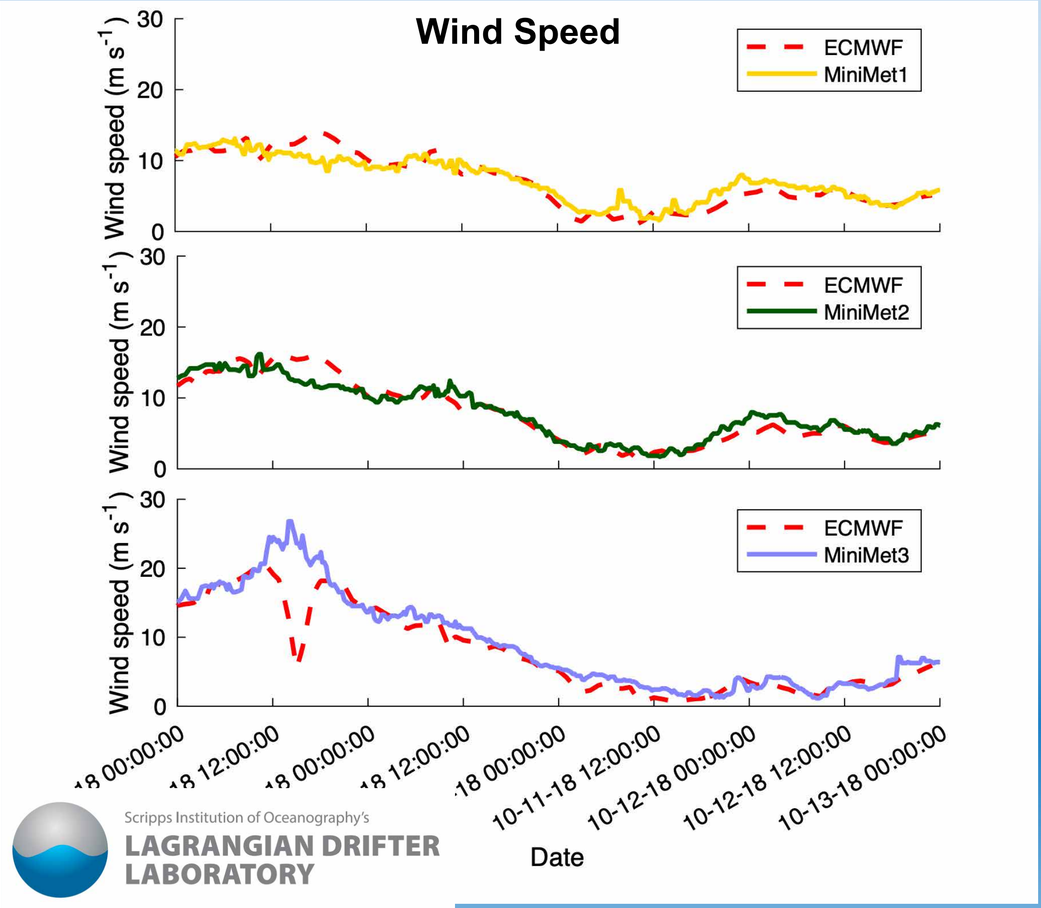
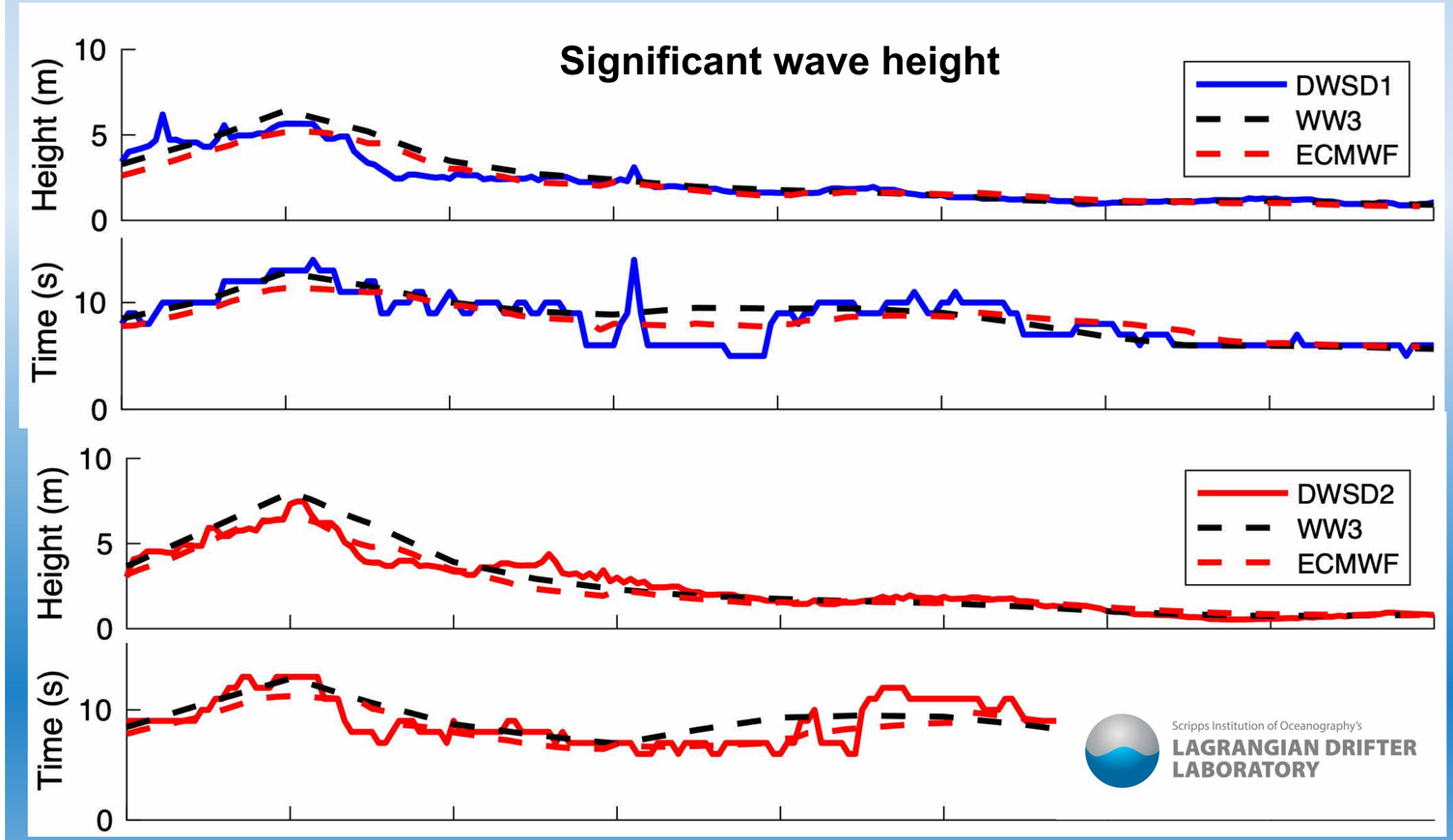
# Hurricane Wave Observations: Hurricane Michael (2018)

## Comparison to Models: ECMWF and WW3




Schönau et al., in prep

# Conclusions

- Global wave data are needed for ocean and atmosphere science, forecasting, warnings and for risk evaluations such as the exposure of coastal communities to inundations caused by extreme events and regional coastal changes in a changing climate scenario.

- The SVP/DWSD technology developed by the Lagrangian Drifter Laboratory at Scripps Institution of Oceanography has been demonstrated over several decades to be fit to support a sustainable, cost-effective global array of directional wave sensors and targeted observations within extreme environments, such as hurricanes and typhoons.

- The decades-long, LDL/GDP **FAIR-O** data policy supports basic science and forecasting around the globe and encourages participation of both private and public sectors. GDP scientists will continue to promote the use of drifter data and the new wave observations to train the next generation of ocean and climate scientists. Note that over 1,200 peer-reviewed publications using traditional drifter data exist.