Scripps Institution of Oceanography's
LAGRANGIAN DRIFTER LABORATORY

The Global Drifter Program

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GOMO review, July 2022

The Global Drifter Program in a Nutshell

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

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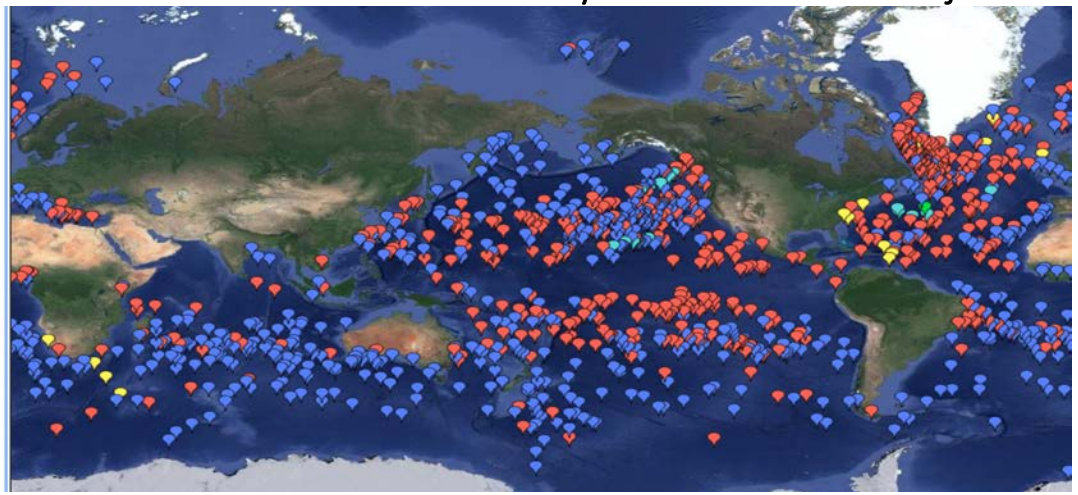
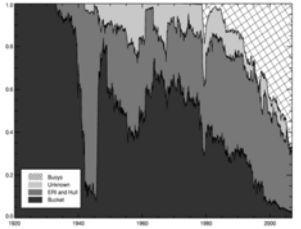
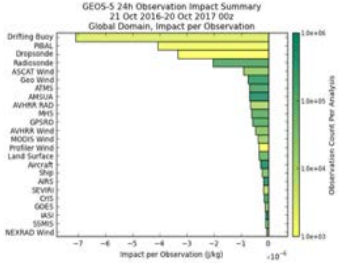


Main Critical Impact Areas



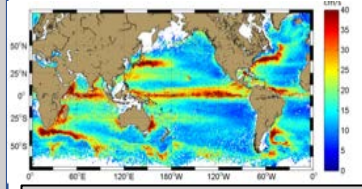
SST From Space Cal/Val

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 GTS
- Global data accessibility
- Verified Lagrangian characteristic
- Quality-controlled data, archived

Furthermore, the GDP provides publicly (FAIR-O) 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 documented

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

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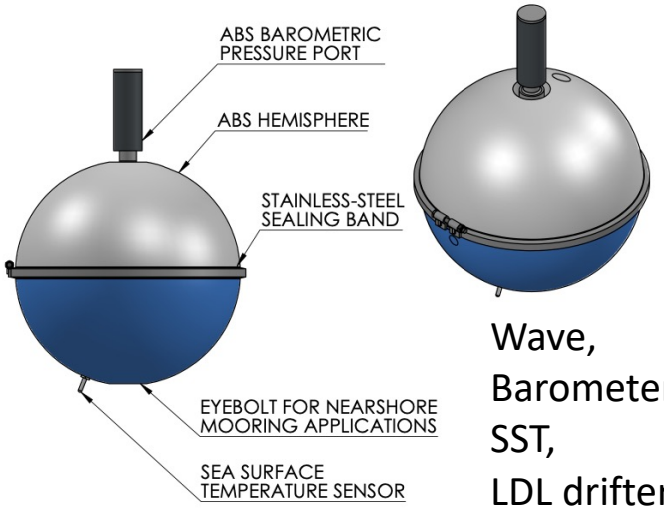
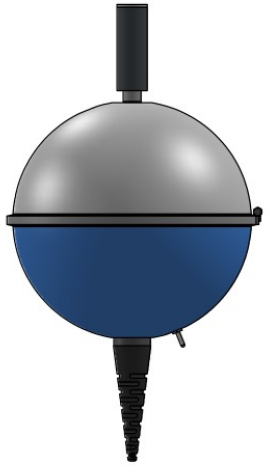
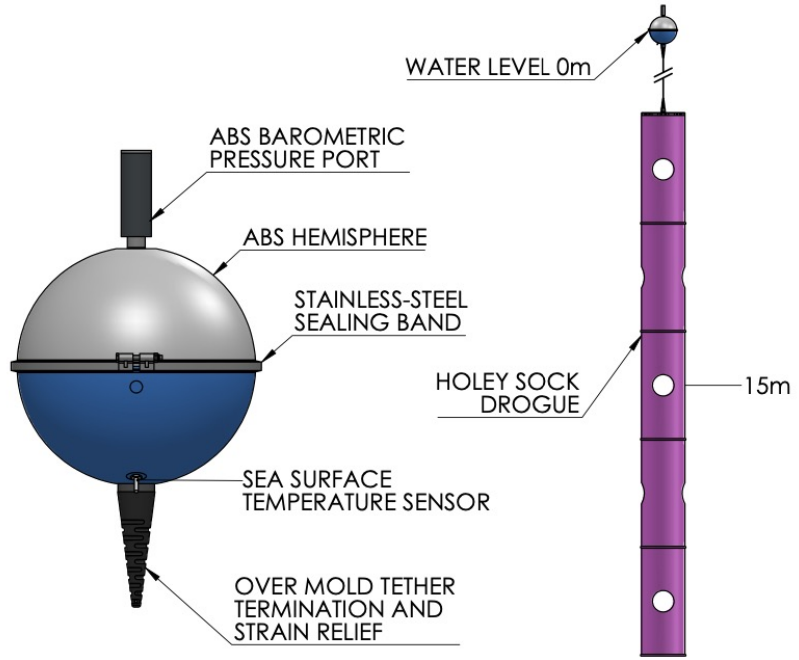
Global Drifter Program Technology



Wave, Barometer, SST, LDL drifter

Current LDL drifter: Barometer, SST
Options: LDL Directional Wave Spectra Barometer Drifter: Waves, Barometer, SST
Options: Bio-plastics construction (longevity tests underway)





Air deployment of drifters by the "Hurricane Hunters" squadron

Lt. Jeff Grabon, USN 3rd fleet, deploying GDP/LDL drifter during Oceania-Mission PP13

Students deploying a GDP/LDL drifter

See https://gdp.ucsd.edu/ldl/drifter-types/ for a full list of drifter technology

Data Management: Real-Time, QC'd, Served

- GDP data are available in near real-time through:

1. Public viewers (https://gdp.ucsd.edu/apps/projects/noaa/global-drifter-program.html , https://www.aoml.noaa.gov/phod/gdp/interactive/drifter_array.html)
2. The WMO's Global Telecommunication System, managed by the LDL at Scripps
3. Several ERDDAP servers and customized webservers/API

- GDP data are available in quality controlled delayed mode, curated by the AOML's drifter Data Assembly Center:

1. Six-hourly interpolated drifter data
2. Hourly Interpolated drifter data: Velocity
3. Hourly Interpolated drifter data: Temperature (under review)

Global Drifter Program

Strengths

- Very high visibility program
- Success in meeting metrics in spite of COVID – resiliency (i.e. GDP supported publications and global data coverage)
- The innovative drive and the “buying power” of academic system allowed for competitive Iridium pricing to meet the communication crisis
- Academic system’s FAIR-O data policy strengthens & allows peer-review of data quality and boosts the impact of GDP data compared to commercial data providers
- Critically important scientific results
- Data flow from research towards operations yield NWS impacts
- Constant innovations in the technology (i.e. introduction of bio-plastic) provide additional opportunities to meet community needs

Weaknesses

- Staffing shortages tax the ability to provide faster scientific results
- Different standards of accountability of the commercial sector, that operates outside of peer-review circuits, allows unfair competition; time is lost to countering the threat to funding/cooperation
- A growing number of unfunded mandates (i.e. from WMO) create stress on PI(s) time/billing
- Increasing blurred lines at program level between science and operations – science needs to lead us to success
- Budgetary policies keeps GDP capped, in spite of clear science driven needs and international requests to expand the GDP array, and thus opportunities are missed
- EEOOTT Task Force repeatedly emphasizes the need for wave measurements to support science and forecasting of hurricanes but little progress in expanding GDP to measure waves

Strengths: High Public Visibility of the GDP, Well Beyond the Science Community

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Hurricane Hunters brief mission, that includes GDP Hurricane drifter deployments, to President at interagency preseason hurricane event. May 18th, 2022

Photo Credit: 403rd Wing Public Affairs

Notable interest of the national and international press on the GDP in many instances, such as after after the MH370 disaster

The New York Times

Plane Debris Would Be Modest Clue Two Weeks After a Crash, Experts Say

Give this article

By Matthew L. Wald
March 19, 2014

WASHINGTON — Even if searchers are fortunate enough to spot floating debris in the ocean west of Australia from the missing Malaysia Airlines jet, it would be only a modest step in locating the rest of the Boeing 777, according to oceanographers and recovery experts. And only then could they dig into the question of why it crashed.

Almost two weeks after a crash, there is certain to be less of the debris on the surface, and what remains is more dispersed and farther from the clues that investigators really want, in the wreckage that has sunk beneath the waves, experts say.

See also https://gdp.ucsd.edu/ldl/media/

Strengths: GDP Data Are Widely Used by the International Science Community

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The use of GDP drifter data is widespread among scientists

- Over 1,200 papers that use drifter data directly have been published to date
- GDP data supports multidisciplinary studies
- See full list at https://gdp.ucsd.edu/ldl/drifter-bibliography/ and

https://www.aoml.noaa.gov/phod/gdp/bib/bibliography_chronological.php

Drifter technology in support of air-sea interaction studies: recent example

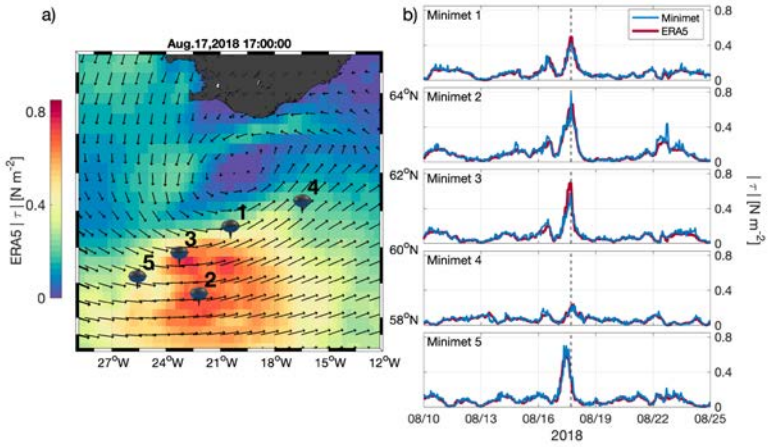

FIG. 4. a) Wind stress (colors) and wind vectors (arrows) from ERA5 at 17:00 UTC, 17 August 2018. The locations of five Minimets are shown. b) Time series of wind stress from Minimet winds (blue) and ERA5 winds (red) for each of the five Minimets shown in a). The vertical black dashed line corresponds to the time of the peak of the event shown in a).

Estimates of Near-Inertial Wind Power Input Using Novel in situ Wind Measurements from Minimet Surface Drifters in the Iceland Basin

Thilo Klenz[a], Harper L. Simmons[b], Luca Centurioni[c], Jonathan M. Lilly[d], Jeffrey J. Early[e], and Verena Hormann[c]

Journal of Physical Oceanography, June 2022, In Press

Measuring Directional Wave properties with DWSD™ (Wave Drifters)

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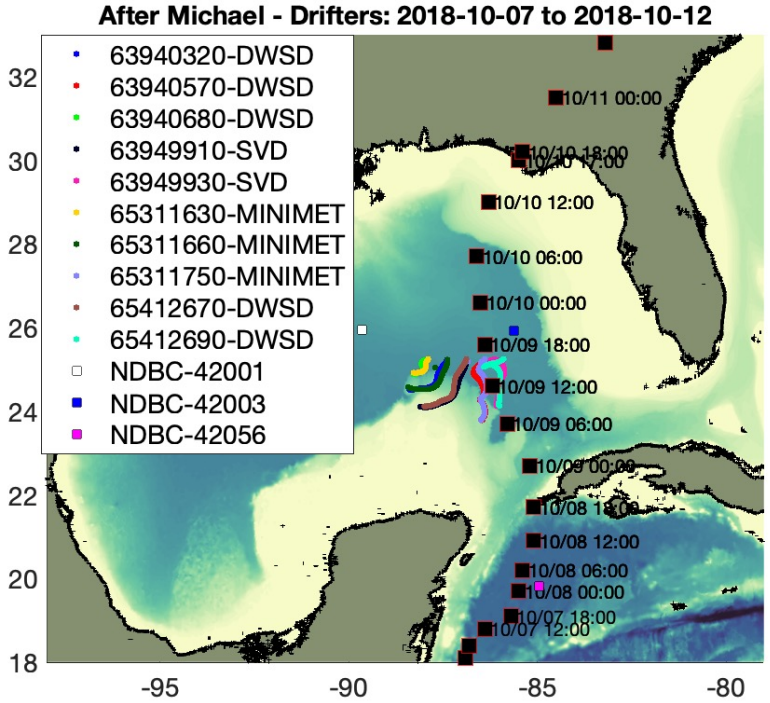
A-size Wave Drifter developed at LDL/SIO for deployment from NOAA/USAF/USN planes

- The A-size DWSD is a game changer because it allows more numerous and cost-effective targeted deployments within hurricanes and severe storms in general
- Also bear significance for research on storm surges (via a NOPP funded project)

A-DWSD™ deployed from NOAA's P3. Photo AOC/NOAA

Full-size DWSD/DWSBD first ever deployment, Hurricane Michael



Overarching Research Topic: role of surface waves in modulating air-sea coupling and implications for Hurricane Intensification. Dr. Martha Shonau, in preparation

Global Drifter Program

Opportunities

- We have demonstrated the scientific value of directional wave data from drifters. Lack of funds is the only impediment to systematically add wave drifters to the GDP to advance air-sea interaction studies
- Highly leveraged with international physical oceanography programs and collaborations
- Highly leveraged with other federal/non-federal funding for technical innovation
- Highly leveraged with PI(s) other federal funding for geographic diversity in field programs and deployment methods
- Growing interest from the marine biology sector to expand the sensor suite of the drifters and for their use in ecology studies

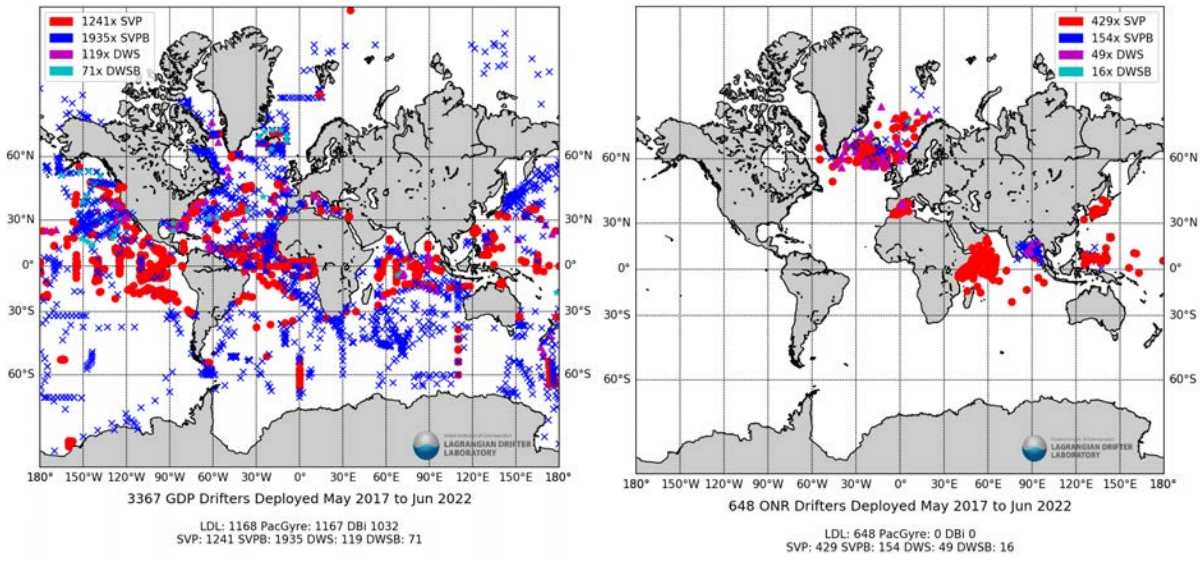
Threats

- Subsidized commercial sector
- Rising prices of shipping/materials
- Reduced budget for equipment – the significant cost savings realized by the GDP through the years were not reinvested/applied to the GDP budget
- Reduced budget for labor impacts direct GDP science output– more post-docs and staff scientists needed
- NOAA is not investing in drifter's technical innovation. Other agencies or lab funds are used for support, Since the GDP is a science program it needs technical innovation support from the main sponsor

Opportunities: Leveraging for a Better GDP

Leveraging resources from ongoing ONR DRIs 2017-2022

NOAA-GDP funded: 3367 (84%) ONR funded: 648 (16%)



Ongoing ONR experiments contributing

The GDP include, ARCTERX, NORSE, ASTRaL and NOPP NHCI

Bio-geochemical drifter development in collaboration with Rome's CNR-ISMAR (Dr. Bellacicco/Dr. Rosalia Santoleri)

- The LDL is experimenting the integration of biogeochemical sensors (e.g. backscatter, Oxygen, pH) on SVP drifters
- The approach allows direct physics/biology linkage with measurements of submesoscale kinematical properties (e.g. convergence), and thus of upwelling/downwelling, and of the concurrent biological response
- First prototype was built in 2021 and will be deployed in summer 2022
- It will provide validation data and will also allow to investigate the biological response to ocean processes in regions where satellites are not sampling (i.e. polar regions in winter)

Opportunities: Interdisciplinary Synergies, Two Examples

Atmospheric Rivers Research collaboration with C3WE

Atmospheric River RECON: Impact of Drifter Sea Level Atmospheric Pressure on Forecast Skill

Reference	Level	Metric	Variable	Level type	Region	0	24	48	72	96	120
ECMWF Analysis	200.0	RMS Error	Geopotential Height	pressure	North America	😐	😐	😐	😐	🙂	😐
ECMWF Analysis	200.0	RMS Error	Geopotential Height	pressure	Northern Hemisphere	☹	😐	😐	🙂	🙂	😐
ECMWF Analysis	200.0	Vector RMS Error	Wind	pressure	Northern Hemisphere	😐	😐	😐	😐	😐	😐
ECMWF Analysis	500.0	Anomaly Correlation	Geopotential Height	pressure	North America	😐	😐	😐	🙂	🙂	🙂
ECMWF Analysis	500.0	Anomaly Correlation	Geopotential Height	pressure	Northern Hemisphere	😐	😐	😐	🙂	🙂	😐
ECMWF Analysis	500.0	Vector RMS Error	Wind	pressure	Northern Hemisphere	😐	😐	🙂	🙂	🙂	😐
ECMWF Analysis	850.0	Vector RMS Error	Wind	pressure	Northern Hemisphere	😐	😐	😐	🙂	🙂	😐
ECMWF Analysis	1000.0	Anomaly Correlation	Geopotential Height	pressure	North America	😐	🙂	😐	🙂	🙂	🙂
ECMWF Analysis	1000.0	Anomaly Correlation	Geopotential Height	pressure	Northern Hemisphere	🙂	😐	😐	😐	🙂	😐

Standard scorecard metrics for North America and Northern Hemisphere NAVGEM forecasts as a function of forecast hour as verified against ECMWF analyses. Green colors indicate improvements in the metric with the assimilation of the AR-Recon drifter surface pressure observations that are statistically significant at the 95% level. Pink colors indicate degradations at the 95% level.

From: **Impacts of Northeastern Pacific Buoy Surface Pressure Observations (Submitted paper)**

Carolyn A. Reynolds[a], Rebecca E. Stone[b], James D. Doyle[a], Nancy L. Baker[a], Anna Wilson[c], F. Martin Ralph[c], David A. Lavers[d], Aneesh Subramanian[e], Luca Centurioni[f]

Marine Biology Scientific Colloboration

COMMENT

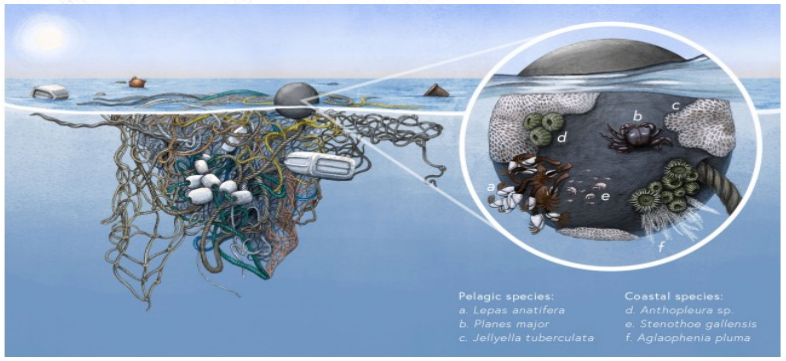
https://doi.org/10.1038/s41467-021-27188-6 OPEN

nature communications EARTH AND ENVIRONMENTAL SCIENCES TOP 25 READ ARTICLES OF 2021 OFFICIAL AUTHOR

Emergence of a neopelagic community through the establishment of coastal species on the high seas

Linsey E. Haram[1✉], James T. Carlton[2], Luca Centurioni[3], Mary Crowley[4], Jan Hafner[5], Nikolai Maximenko[5], Cathryn Clarke Murray[6], Andrey Y. Shcherbina[7], Verena Hormann[3], Cynthia Wright[6] & Gregory M. Ruiz[1]

Discoveries of persistent coastal species in the open ocean shift our understanding of biogeographic barriers. Floating plastic debris from pollution now supports a novel sea surface community composed of coastal and oceanic species at sea that might portend significant ecological shifts in the marine environment.



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Conclusions

- The NOAA- funded global drifter program has been highly successful in providing real-time and QC-served data to both the global research communities and global forecasting communities.

- The high-quality SST, SLP, wind and wave data have led to research advances in air-sea interaction physics and the use of this data has led to demonstrated skill gains in forecasting.

- The program has international renown and respect with a continual request to expand the barometer (SLP) upgrades and to add the wave component.

- Strong leveraging by the PI(s) benefit the program and NOAA with enhanced deployment opportunities and geographic distribution as well as advances in technology.

- The path for the future could/should include an expansion to extend wave measurements, continued support for sensing during extreme events, and a NOAA- sponsored innovation task to help move technology forward.