Sept 14th, 2020 View of Paulette, Rene, Sally, Teddy, & Vicky as seen from space.



NATIONAL OCEANIC & ATMOSPHERIC ADMINISTRATIC

### **2021 Hurricane Glider Operations** Kathleen Bailey, U.S. 100S Office





# **US Hurricanes Since 1990**



### \$916.2 Billion in Damages

57% of Billion Dollar Disasters

Track Improvement: Factor of 2-4

Intensity Improvement: Marginal





"On average, intensity error may represent one category difference above or below the actual hurricane intensity." - NHC

# **The Ocean Affects Hurricane Intensity**

# NORR

#### **Essential Ocean Features (EOFs)**

- Linked to rapid intensification and weakening
- Occur close to populated and vulnerable coastlines.

### Key Point

models

EOFs are challenging for models because:

1) Highly dynamic nature
2) Very limited sub-surface observations to initialize

### **Glider Operations**

Real-time ocean observations to **improve initialization** of numerical forecast models

• **Sustained and targeted obs:** Gliders have demonstrated to reduce error in hurricane intensity forecasts

#### Essential Ocean features in the Atlantic Basin



### **Improving Forecasts through Ocean Data Assimilation**

tributor (40%) of

Simulating realistic conditions with the assimilation of combined ocean observations reduces intensity forecast error by **54%** 



<u>Le Henaff et al. 2021</u> Hurricane Michael (2018) OSE Underwater gliders: Largest contributor (40%) of total error reduction that resulted by assimilating All Obs 24 hrs before landfall



Domingues et al. 2021 Hurricane Maria (2017)

# **2021 Operations Overview**









# **Partnerships Make it Possible**







- **79** missions in the Atlantic basin contributed data
- 82% success, determined by  $\geq$  15 days at sea
- **44** Hurricane Gliders deployed, collectively acquiring data for **2,359** combined days sea
- IOOS Glider Data Assembly Center (GDAC) allowed NOAA to leverage data from an additional **35** gliders (1,308 Days)
- **15+** Institutions provided data in support of the project
- **118,563** ocean profiles were submitted to the GTS by the IOOS GDAC in support of this project





2021 Profiles sent to GTS by Month



### **Glider data are assimilated into operational RTOFS**





# Storm Highlight: Ida - Ocean Features and Intensity



Storm was forecast to track across Gulf of Mexico Essential Ocean Features: - The Loop Current, a Loop Current Eddy, and Freshwater Barrier Layer

- Ida began to rapidly intensify over the warm and deep Loop Current, reaching peak intensity over coastal waters with a freshwater barrier layer

#### RTOFS Pre-storm temperature at 200 m 8/27

NOAA.



RTOFS Pre-storm sea surface salinity 8/27



# Storm Highlight: Ida - *Operational Impacts* 🛁 🖤



Vertical black lines = approximate eye-passage time

Initial (left of black line) ocean temperature and salinity compared well between the model and glider

### **Saildrone-Glider co-location**



First quasi-collocated / quasi-simultaneous observations of upper ocean and meteorological parameters from fully autonomous, uncrewed vehicles for hurricane studies and forecasts



### **Challenges**



- Ad-hoc & Sporadic Funding
  - Funding cycles out of phase with hurricane season operations
  - Recapitalization is a growing challenge
- Manufacture bottleneck creates delays
- Community access to operational models and the DA increments for storm simulation studies
  - More multi-platform OSEs and OSSEs needed to optimize pre-storm conditions.
- Getting ocean information to NHC forecasters during hurricane season







- Deployments similar locations to 2021
  - 2022 Disaster Supplemental funding
- Continue Navy-NOAA glider coordination (OMAO)
- Coordination with Saildrone project
- Contribute to Global Ocean Monitoring and Observing (GOMO) 2022 Integrated Field Campaign









