

NOAA's APHEX Hurricane Field Program: 2022 Highlights & Plans for 2023



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Advancing the Prediction of Hurricanes EXperiment (APHEX)

NOAA APHEX Partnership: HRD, AOC, NHC, EMC, NESDIS 2022 Collaboration: Office of Naval Research TCRI Program



<u>Goal 1:</u> Collect **observations** that span the TC life cycle in a variety of environments for **model initialization and evaluation**

<u>Goal 2:</u> Develop and refine **measurement strategies and technologies** that provide improved real-time analysis of TC intensity, structure, environment, and hazard assessment

<u>Goal 3:</u> Improve the **understanding of physical processes** that affect TC formation, intensity change, structure, and associated hazards



2022 Season by the Numbers



NOAA P-3 and G-IV Missions

• Potential TC 2 (Pre-Bonnie), AL97 (Cabo Verde), Earl, Fiona, Ian, Julia, Lisa, Nicole







Hurricane Field Program Plan: https://www.aoml.noaa.gov/2022-hurricane-field-program/

...and Hurricane Field Program Data Page: https://www.aoml.noaa.gov/2022-hurricane-field-program-data/





2022 Hurricane Field Program-APHEX Operations & Logistics



Primary Atlantic Operating Bases and Ranges (2-h on-station time)





HFP Experiments and Modules



GENESIS STAGE (2)

Favorable Air Mass (FAM) Experiment

Precipitation during Formation and Observing its Response across Multiple Scales (PREFORM)

MATURE STAGE (10)

Eye-Eyewall Mixing Module

Gravity Wave Module

Hurricane Boundary Layer Module

NESDIS Ocean Winds

Rainband Complex Module (RCM)

Research In Coordination with Operations Small Unmanned Aircraft Vehicle Experiment (RICO SUAVE)

Surface Wind and Wave Validation Module

Tail Doppler Radar Analysis Evaluation Module

Tropical Cyclone Diurnal Cycle Experiment

Ventilation Module

EARLY STAGE (4)

Analysis of Intensification Processes Experiment (AIPEX)

Convective Burst Structure and Evolution Module (CBM)

Impact of Targeted Observations on Forecasts (ITOFS)

Stratiform Spiral Module (SSM)

END STAGE (2)

Extratropical Transition

Tropical Cyclones at Landfall Experiment

OCEAN OBSERVING (2)

Ocean Survey Experiment

Sustained and Targeted Ocean Observations

SATELLITE VALIDATION (2)

NESDIS JPSS Satellite Validation Experiment

NASA TROPICS Satellite Validation Module



HFP Experiments and Modules Flown: 11 Total



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2022 Hurricane Field Program-APHEX *Atlantic Missions Overview*







2022 Hurricane Field Program-APHEX Atlantic Missions Overview





1st ever Altius-600 sUAS deployment in a hurricane

24-28 Sep





2021 & 2022 Hurricane Field Program-APHEX

2021 & 2022 Seasons by the Numbers





~1/2 of flights flown at TS intensity or less
7 missions with previous periods of RI
3 missions with subsequent periods of RI



~2/3 of flights flown at TS intensity or less
7 missions with previous periods of RI
8 missions with subsequent periods of RI



2022 Hurricane Field Program-APHEX Successes



- First return to Barbados as a deployment site since 2019 (COVID logistics)
 - $\,\circ\,$ Barbados's eastern location can be a significant advantage for HRD research missions flying east
- ITOFS-East (G-IV missions: Sal, Cabo Verde)
 - First-ever NOAA deployment to Cabo Verde
 - Required a pre-season site visit & mitigation strategies so that no operational taskings were missed
 - Kudos to AOC >> this was a very successful series of research missions in an area that was unfamiliar









Successes

Hurricane Earl

- $\,\circ\,$ 12 consecutive days of sampling (P-3s & G-IV)
- One of the most comprehensive set of aircraft missions to sample Atlantic TC genesis & the TC life cycle

• Altius-600 sUAS

- $\,\circ\,$ First-ever P-3 deployment of the Altius sUAS in a hurricane (Ian)
- \circ Deployed in lan's eye (~102 min flight)
- $_{\odot}\,$ Winds measured as high as 187 kt at ~2,100 ft (west eyewall)











2022 Hurricane Field Program-APHEX Successes



P-3 Stratiform Spiral Module

- Continues to provide valuable (and rare) cloud microphysics data in the TC environment
- HRD appreciates the willingness of P-3 crews to successfully and safety fly this module
- Coordinated release of dropsondes near
 Saildrones

 e.g., Hurricane Fiona





Cloud Imaging Probe (CIP): improve our understanding of how rain droplets, ice, and snow particles are vertically distributed in TCs and how accurately they are represented in forecast models.

Hurricane and Ocean Testbed (HOT) live demo (Hurricane Lisa)
 SFMR, TDR, WSRA, IWRAP



Ongoing OSE Work at HRD: which dropsondes benefit HWRF the most?



Study dataset: 2017-2020 GPS dropsondes

AF C-130s, NOAA P-3s & G-IV, NASA Global Hawk



Improving TRACK forecasts:

- sample the environment in weak storms
 - sample the vortex in strong storms

Improving INTENSITY forecasts (VMAX):

- sample the environment in weak storms
- sample the vortex in all storms (especially weak)





2023 HRD APHEX Hurricane Field Program Highlights

- HFP Plan (Experiments & Modules)
 - o Genesis Stage Early Stage Mature Stage End Stage Ocean Observing Satellite Validation

• HFP High Priorities:

- 1) Early-lifecycle intensification processes (focus on genesis and RI onset)

 Facilitated by collaborations ONR Moisture & Aerosol Gradients/Physics of Inversion Evolution (MAGPIE)
 July Aug (Barbados)
- 2) Ocean structure and air-sea interaction
 - $\,\circ\,$ Facilitated by collaborations with AOML/PhOD & NOAA's GOMO Program
- 3) Testing emerging technologies (sUAS, new dropsonde technologies) • APHEX RICO SUAVE Experiment
- 4) Structure change, with an emphasis on surface wind field structure and evolution
- 5) Collaboration with NHC-EMC (expanded deployment locations) o e.g., Cabo Verde...Liberia, Costa Rica...La Paz, Mexico





2023 HRD APHEX Hurricane Field Program (Cont'd)

• HRD Instrumentation (P-3, G-IV) – installs/availability still TBD



- o Cloud microphysics: Cloud Droplet Probe, Cloud Imaging Probe, Precip Imaging Probe, Cloud & Aerosol Spectrmtr
- NOAA PSL W-Band Radar (3 mm): sea spray, very small water droplets of fog or mist
- Wide Swath Radar Altimeter (WSRA): significant wave height, ocean directional wave spectra
- Airborne Radio Occultation System (Scripps): temperature & moisture profiles
- Airborne Doppler Lidar (ADL): nadir pointing (vertical winds) >> install TBD
- o *microSWIFT-2L expendable wave buoy:* SWH, peak wave period, dominant wave dir, wave energy spectrum

2023 HRD APHEX HFP Plan

- Call for submissions is out; submissions due 7 April
- HFP Plan release: on or before 14 April 2023
 - NOAA/AOML/HRD website: <u>https://www.aoml.noaa.gov/hurricane-research-division/</u>







Questions?