



NOAA/AOML/HRD Hurricane Field Program Advancing the Prediction of Hurricanes Experiment (APHEX)



TCORF / 75th IHC

2021 HFP Leadership

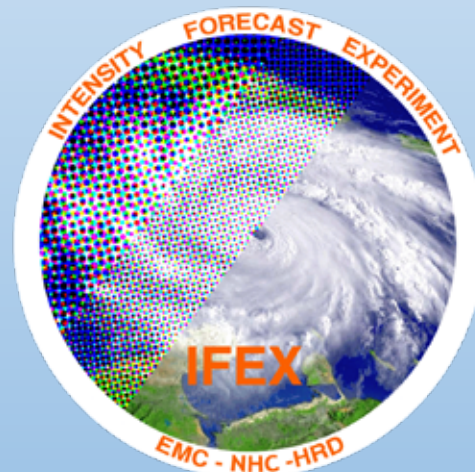
HFP Director, Jason Dunion¹

HFP Deputy Director, Jon Zawislak¹

2020 HFP Director, Lisa Bucci²

¹ NOAA/AOML/Hurricane Research Division

² University of Miami/CIMAS - NOAA/AOML/Hurricane Research Division





HFP-APHEX Overview

APHEX is motivated by the priorities of the “next generation” 5-year HFIP Strategic Plan (2019-2024):

- **Reduce forecast guidance errors:** track and intensity
- Produce **7-day forecast guidance** as good as the current 5-day
- Improve **RI prediction**
- Improve **guidance on pre-formation** disturbances, including genesis timing
- Improve **hazard** guidance (surge, rain, tornadoes) and risk communication

➤ **Our flight strategies and instruments will need to evolve to keep ourselves at the forefront of advancing our understanding and prediction of TCs**

- real-time analysis
- assimilation of observations
- observations to guide model improvements

➤ **Collaborations inside and outside of NOAA, across operational partners and research laboratories will be critical**

- Consider the new G550 and potential justification for P-3 replacements in the future
- Effective use of limited aircraft assets

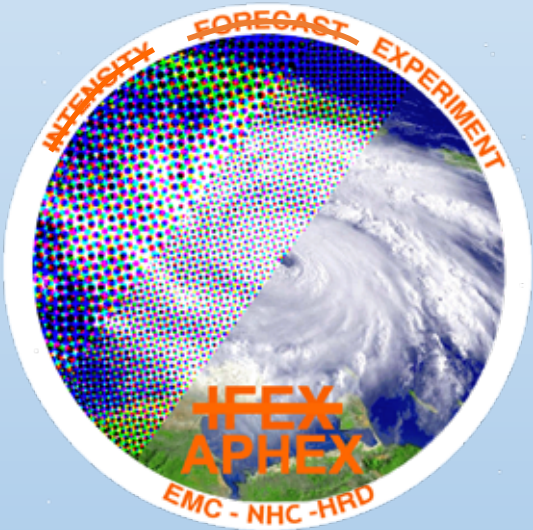
Advancing the Prediction of Hurricanes EXperiment (APHEX)

Advancing the Prediction of Hurricanes EXperiment (APHEX)*

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

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

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

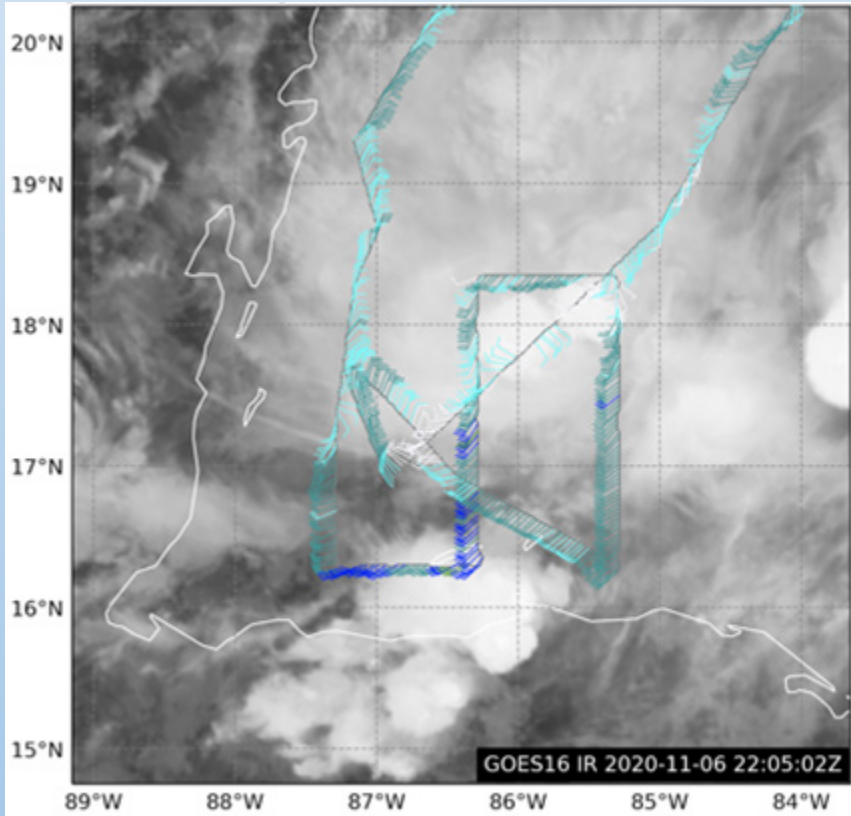


* Intensity forecasting at the inception of IFEX is now a narrow scope within a **broad expanse of forecast challenges and knowledge gaps** that must be addressed at **all stages of the TC life cycle**, though especially in the genesis and early stages

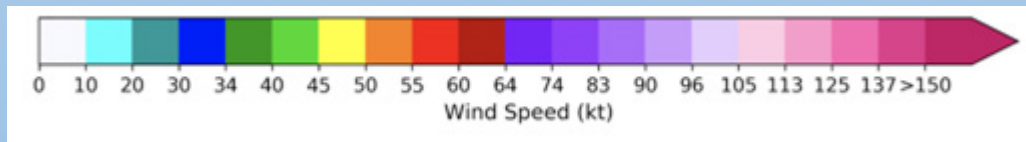
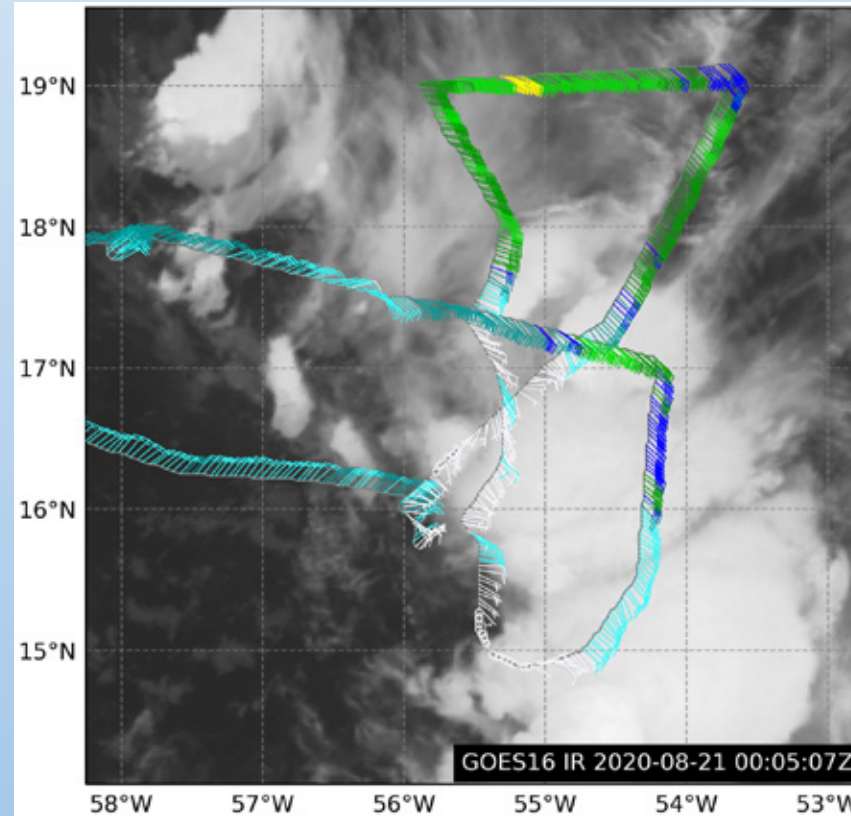
Advancing the Prediction of Hurricanes EXperiment (APHEX)

Genesis Stage

Reformation of Eta: 6 Nov 2020



TD13 (Laura): 21 Aug 2020

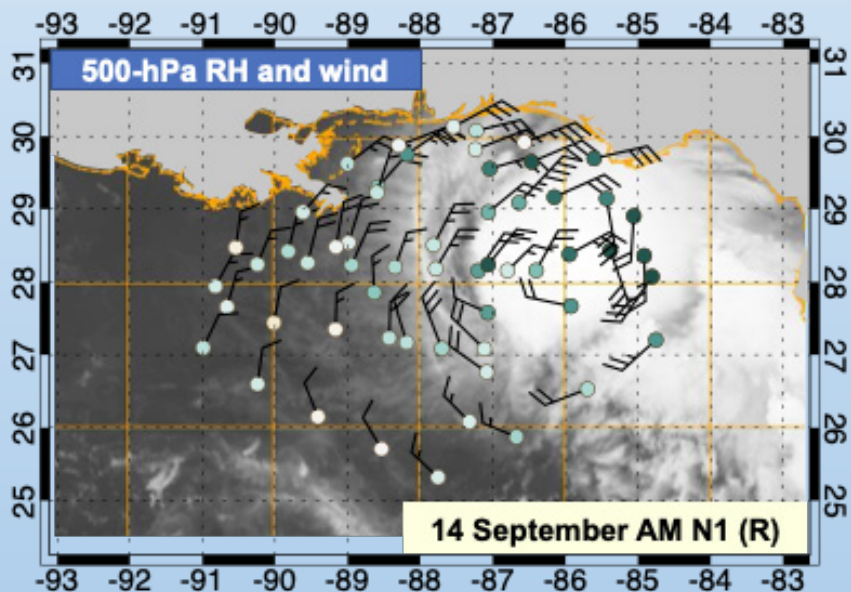


- No dedicated genesis research missions in 2020
- Piggybacking on operational invest missions
 - *EMC mission into Eta: reemerged off the coast of Honduras and redeveloped*
- Pattern in Eta proved useful >> combination of lawnmower (envir survey) with Fig. 4 (vortex and precipitation contributing to formation)
- Genesis remains a priority in 2021 (APHEX-PREFORM experiment)

Advancing the Prediction of Hurricanes EXperiment (APHEX)

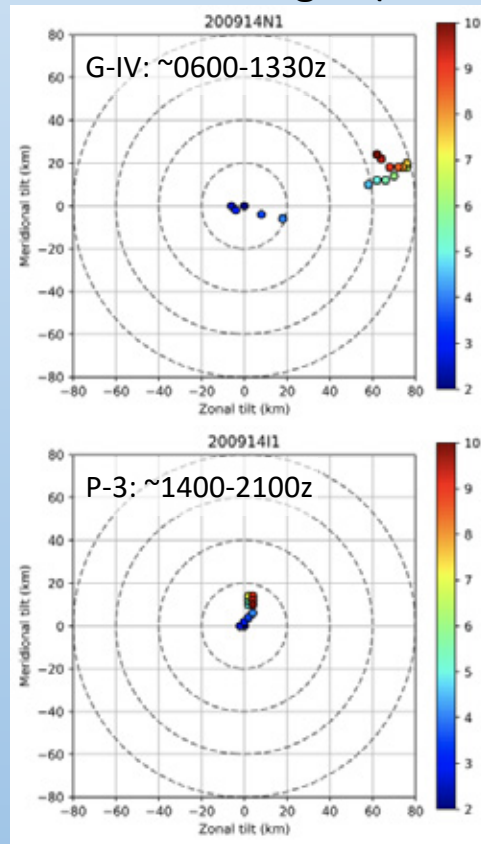
Early Stage

Hurricane Sally 14 Sep
 High-density G-IV *dropsondes*
 (NOAA-ONR collaboration)



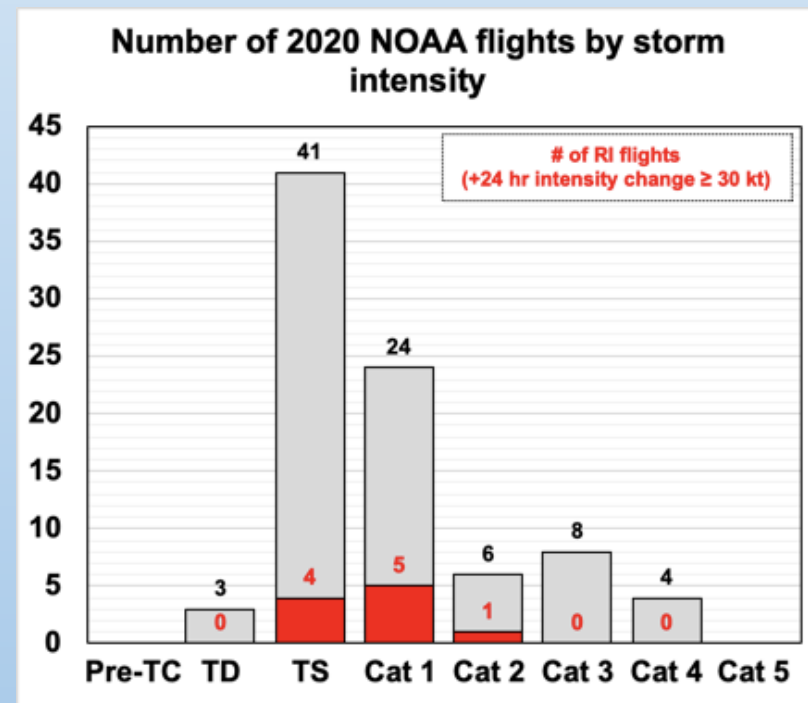
Courtesy: Jon Zawislak (UM/CIMAS – NOAA/AOML/HRD)

Hurricane Sally 14 Sep
 Radar-derived vortex center
 locations with height (shading)



Courtesy: Michael Fischer(UM/CIMAS – NOAA/AOML/HRD)

Accomplished excellent early-stage
 sampling in 2020 (75% of all missions)



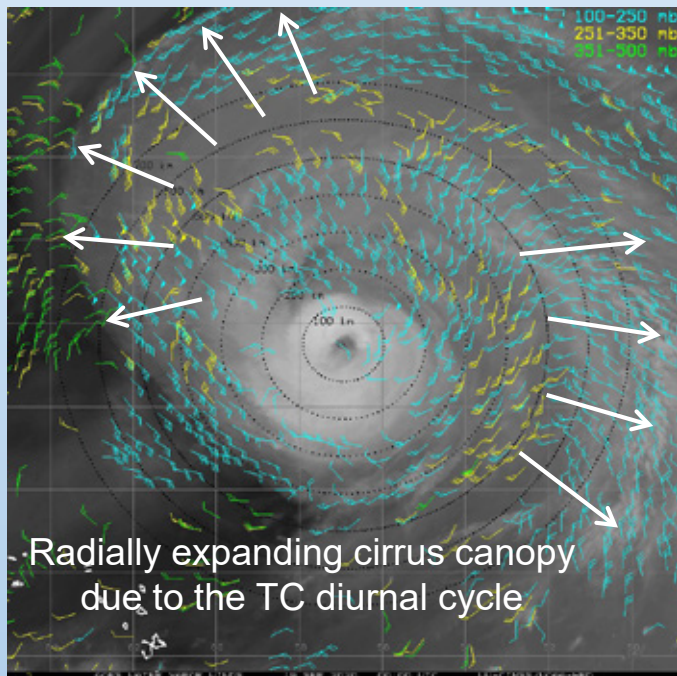
Courtesy: Jon Zawislak (UM/CIMAS – NOAA/AOML/HRD)

Advancing the Prediction of Hurricanes EXperiment (APHEX)

Mature Stage

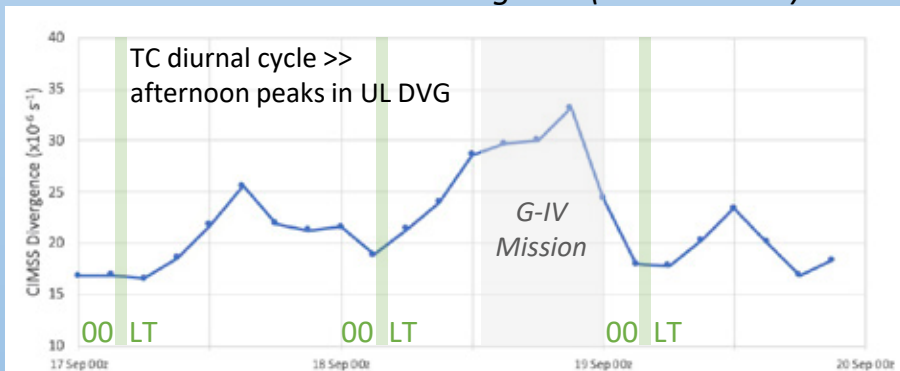
UW-CIMSS Water Vapor AMVs

Hurricane Teddy: 18 Sep 00z – 19 Sep 00z



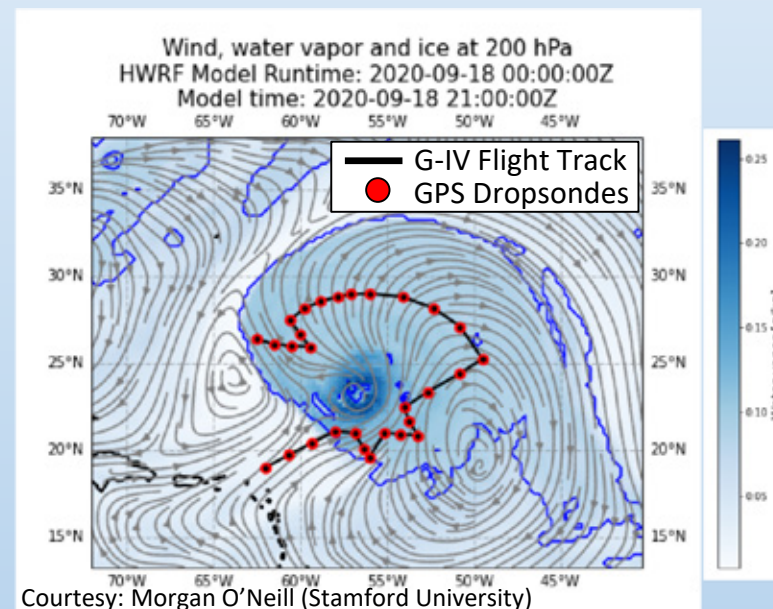
Radially expanding cirrus canopy due to the TC diurnal cycle

CIMSS 150-300 hPa Divergence (R= 0-500 km)

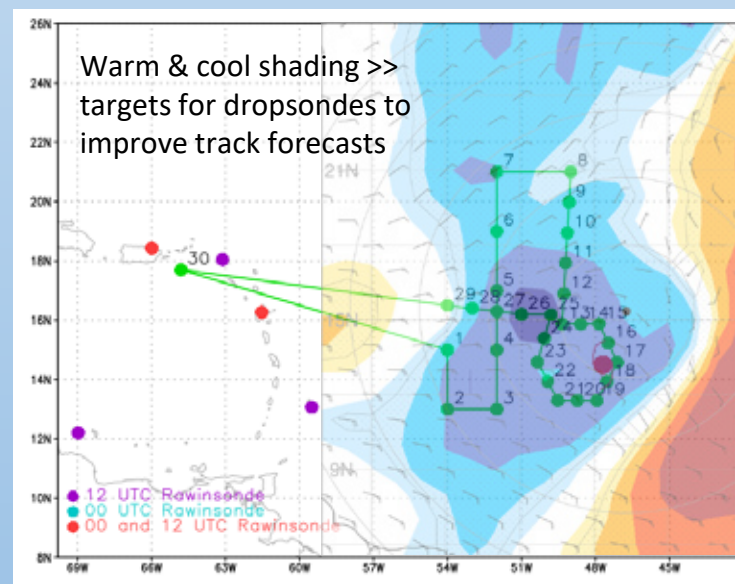


Courtesy: Jason Dunjon (UM/CIMAS – NOAA/AOML/HRD)

- G-IV TC Diurnal Cycle Experiment Mission
- HWRF 21-h forecast of Teddy's expanding cirrus canopy (valid 18 Sep 21 UTC)



Courtesy: Morgan O'Neill (Stamford University)



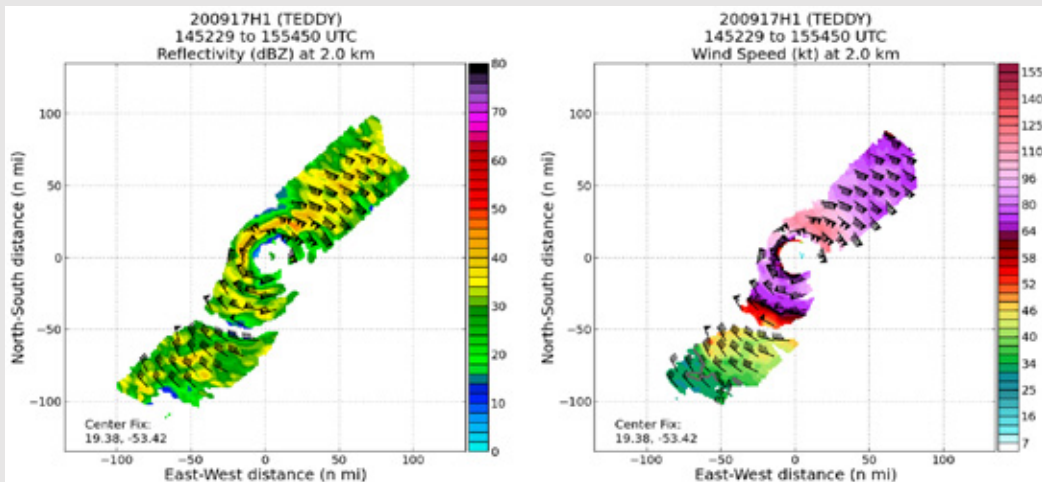
Courtesy: Ryan Torn (University at Albany/SUNY)

- G-IV Synoptic Flow Mission (15 Sep)
- Ensemble-based sensitivity targeting (ECMWF)

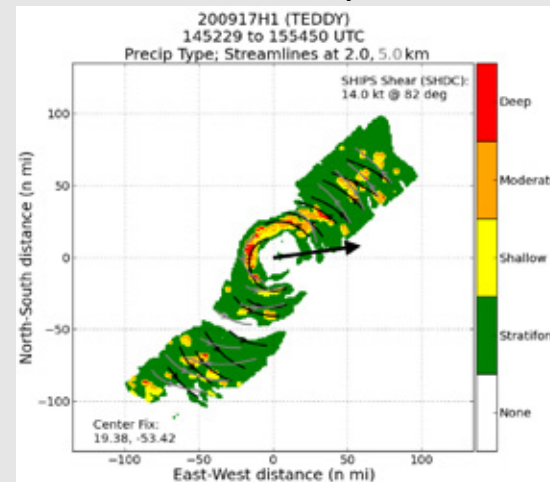
Advancing the Prediction of Hurricanes EXperiment (APHEX)

Mature Stage

TDR data >> NHC capturing RI (Teddy)



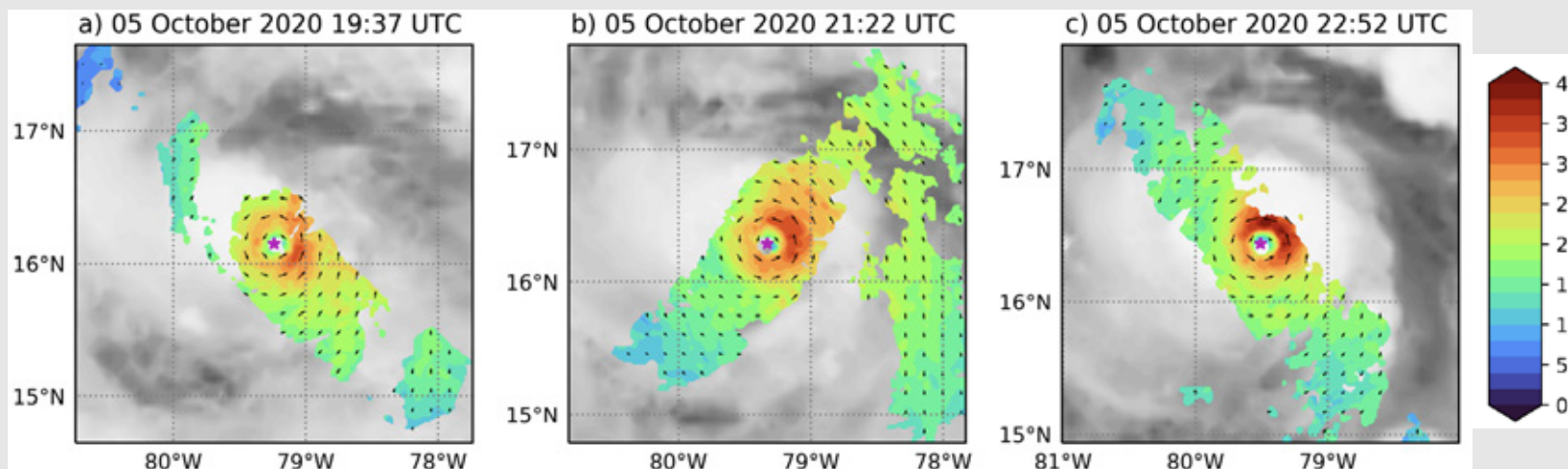
Real-time TDR analysis & transmission to EMC, vis. in AWIPS-II



Real-time Analyses

New in 2020:
Analyses for each swath,
and precipitation type
classification

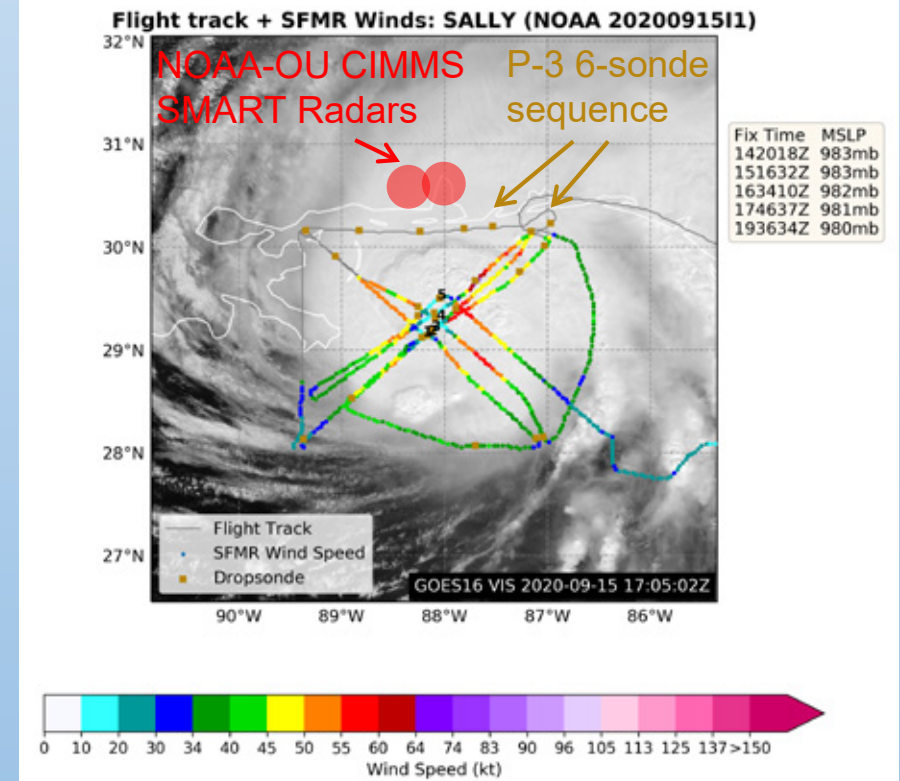
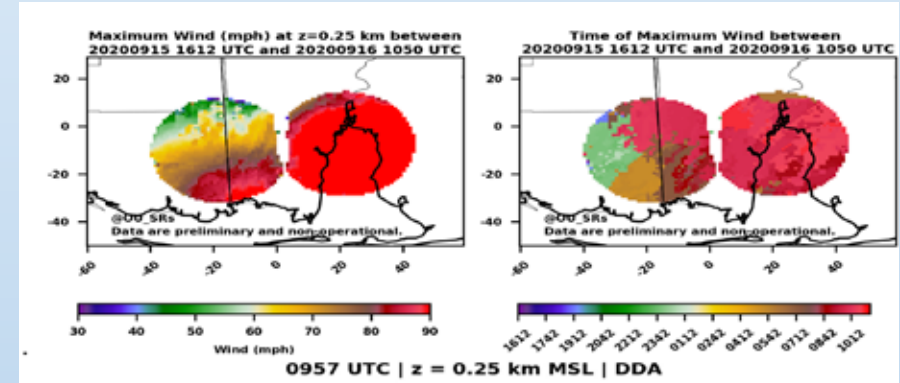
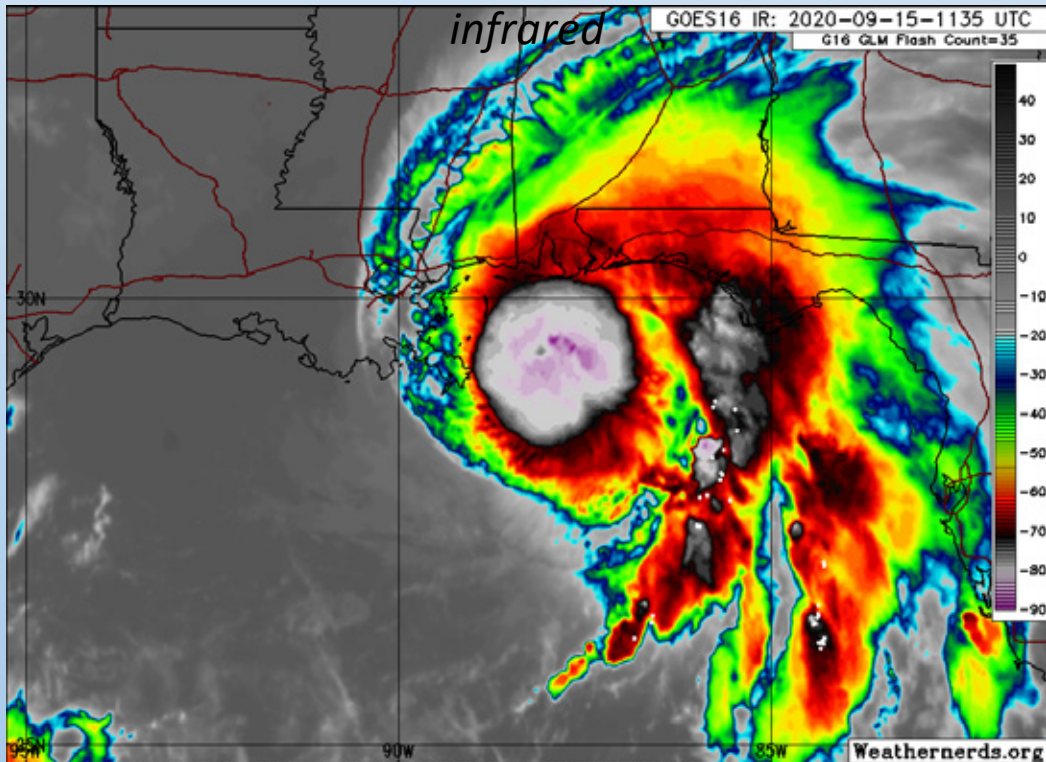
TDR data from sequence of P-3 passes (over ~3 hr) in rapidly intensifying Hurricane Delta



*NHC forecasters used AWIPS-II to monitor Delta's small inner core and significant RI from pass to pass

Advancing the Prediction of Hurricanes EXperiment (APHEX) End Stage

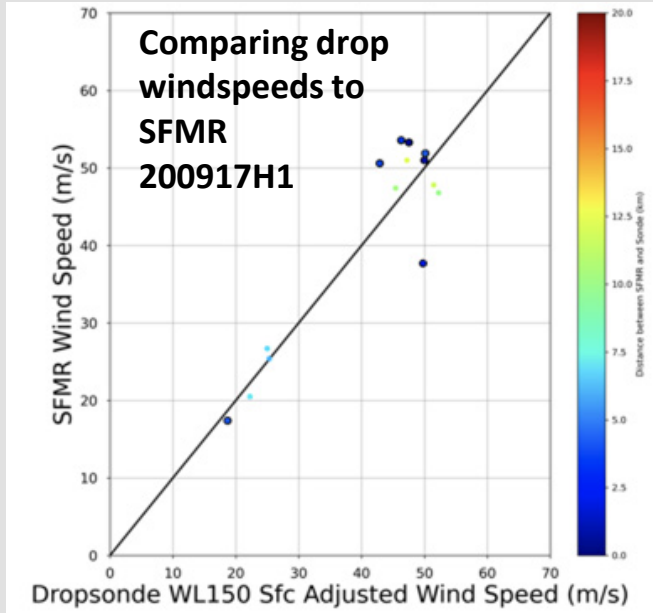
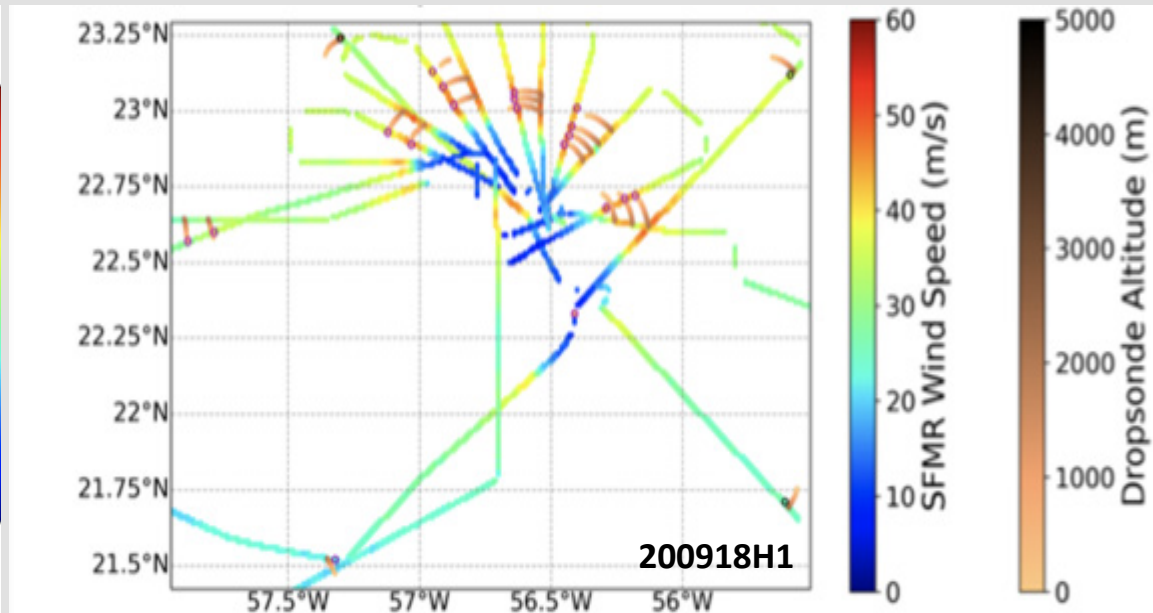
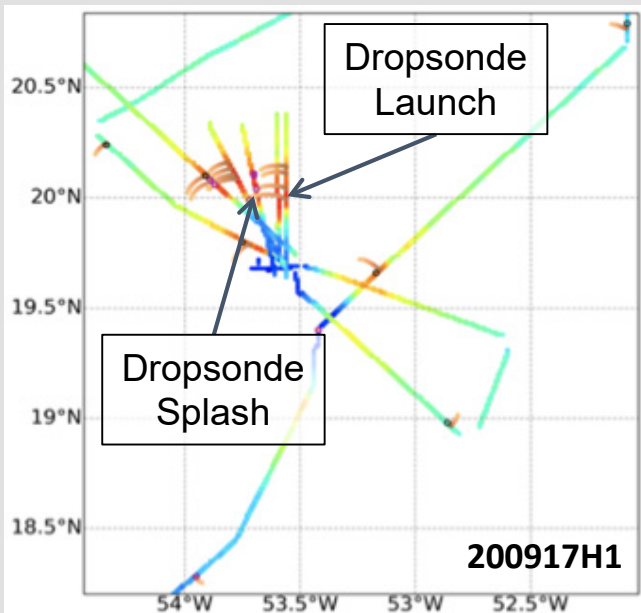
Hurricane Sally (15 Sep): GOES-16 11 micron



Advancing the Prediction of Hurricanes EXperiment (APHEX) *Stepped Frequency Microwave Radiometer (SFMR)*

Hurricane Teddy: Overflight of dropsonde splash position to validate SFMR

Science Goal: Validate SFMR surface wind measurements, particularly in high winds



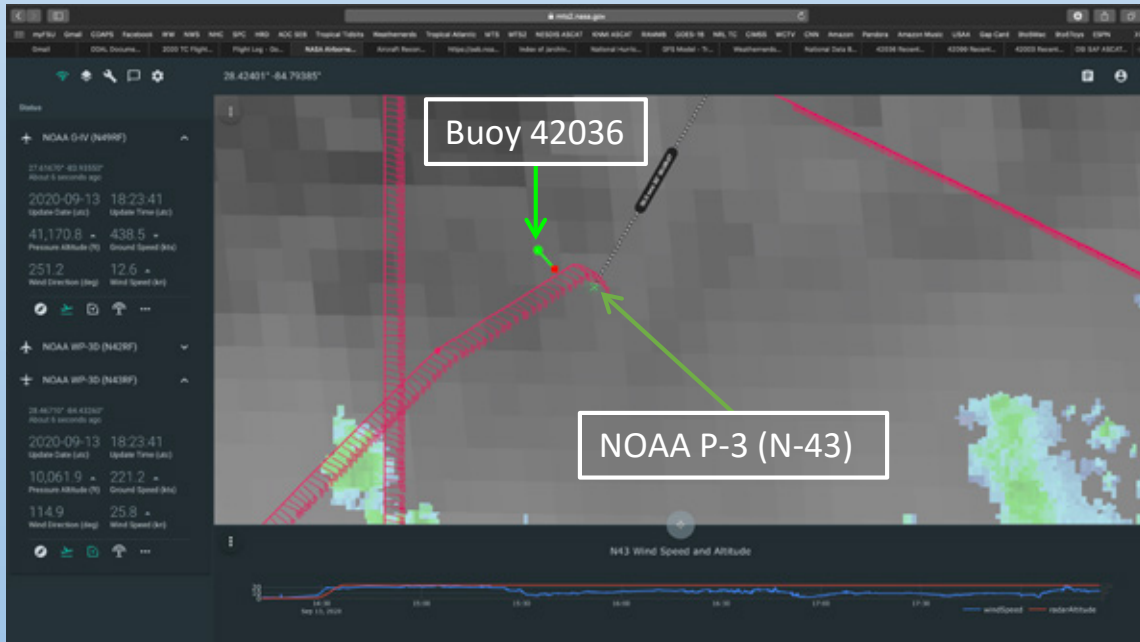
Courtesy: Heather Holbach (FSU/NGI – NOAA/AOML/HRD)

Advancing the Prediction of Hurricanes EXperiment (APHEX) Wide Swath Radar Altimeter (WSRA)

NOAA buoy 42036, 13 Sep 2020 (Hurricane Sally, NE Gulf of Mexico)



NASA Airborne Mission Tools Suite (MTS)
tracking NOAA P-3 mission 2020091311



Science Objectives

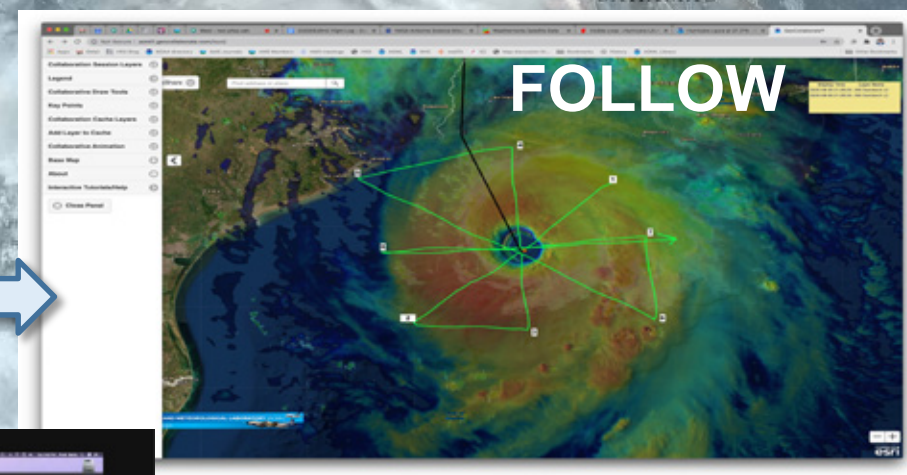
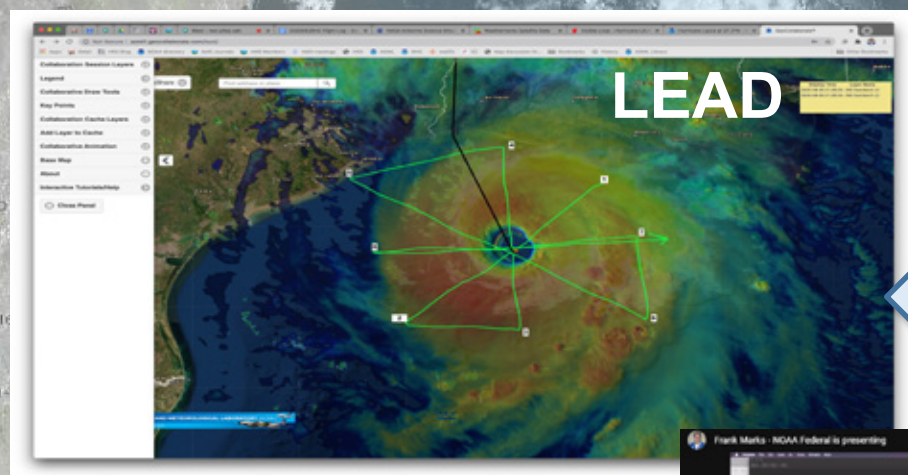
- Validate various WSRA products (e.g., significant wave height and directional wave spectra)
- Perform a 90-deg aircraft turn to ensure there is not a dependence on the angle between the aircraft heading and propagation direction of the dominant wave

P-3 Flight Pattern

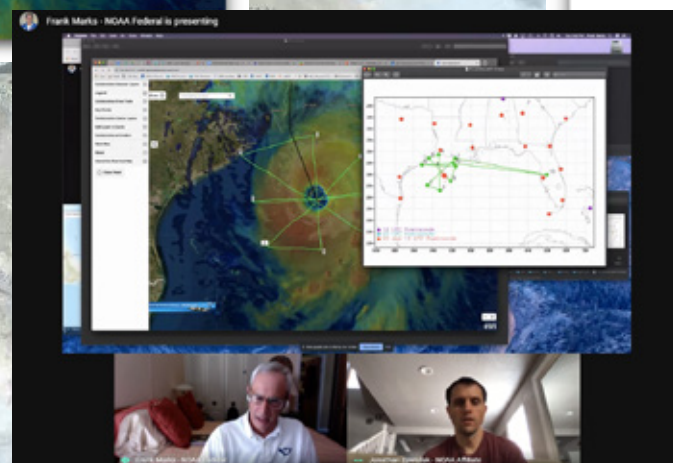
- Approach buoy 42036, ~5 min straight and level
- Deploy a dropsonde over 42036, turn 90 deg
- Fly straight and level ~2.5 min

Use Case: NOAA HURRICANE RESEARCH DIVISION Improving Science and Knowledge Sharing through GeoCollaborate

- Encourage information sharing that goes beyond text chats and includes actual data exchange, interactive drawing, key information points and a dashboard for aircraft position and plotting of data collected [Adapt & Communicate]



GeoCollaborate +
Google Meet
Combined



Final Flight Plan
based on
GeoCollaborate Live
Interaction





2021 NOAA/AOML/HRD Hurricane Field Program
Advancing the Prediction of Hurricanes Experiment (APHEX)



2021 APHEX Collaborations

- Main science & observing objectives >> similar to 2020; continue to prioritize collaborative programs:
 - ❑ **ONR TCRI**
 - ❑ **NASA CPEX-AW**
 - ❑ **sUAS (Altius-600)**
 - ❑ **Satellite Validation (NESDIS/JPSS, ADM-Aeolus, NASA TROPICS)**
- High priority >> sample genesis and early stages of storms, with a focus on those experiencing wind shear with the potential to intensify
- P-3 instrumentation: Compact rotational Raman Lidar (**CRL**, aerosol, water vapor, T), **WSRA** (SWH, ocean directional wave spectra), testing NOAA CSL's Doppler Wind Lidar (**DWL**, 3-D winds)
- Explore new deployment sites to maximize research and operational objectives (e.g., Aruba and Cabo Verde)
- Continue to adapt how HRD contributes to mission execution, especially in this pandemic environment



2021 NOAA/AOML/HRD Hurricane Field Program
Advancing the Prediction of Hurricanes Experiment (APHEX)



2021 APHEX Collaborations

Office of Naval Research: Rapid Intensification of Tropical Cyclones (TCRI)

Participating Aircraft: NOAA 42, 43, 49
Collaborating Agencies: NOAA APHEX, ONR
2021 Campaign Period: 1 July - 30 September

Objective: Understand environment and storm structural evolution as it relates to rapid intensification processes

NASA's Convective Processes Experiment - Aerosols and Winds (CPEX-AW)

Participating Aircraft: NOAA 42, 43, 49, NASA DC-8 (Cape Verde)
Collaborating Agencies: NOAA APHEX, NASA
2021 Campaign Period: 1 July - 15 August

Objective: Validate the NASA-European Space Agency ADM-Aeolus spaceborne wind lidar and sample meteorological phenomena that dominate in the East Atlantic / West Africa

Questions?