MATURE STAGE EXPERIMENT
Science Description

Experiment/Module: Eye-Eyewall Mixing Module

Investigator(s): Sim Aberson (PI)

Requirements: Categories 2–5

Plain Language Description: Features that look like small circulations are sometimes seen in satellite images of the eyes of major hurricanes. However, we do not know what these features are, nor whether they have any importance to intensity change. The goal of this module is to investigate these features, especially the temperature and humidity structures, to learn what they are and how they may impact intensity.

Mature Stage Science Objective(s) Addressed:

1) Collect observations targeted at better understanding internal processes contributing to mature hurricane structure and intensity change [*IFEX Goals 1, 3*]

Motivation: The motivation for this module is to confirm theoretical and modeling studies of the importance of miso- and meso-vortices in the eye and eyewall on intensity.

Background: It has been hypothesized that small-scale circulations in the eye and eyewall of hurricanes can mix war, moist air from the low-level eye into the eyewall, adding fuel for intensification, and this hypothesis has been supported by numerical model simulations. Features that look like these small circulations are sometimes seen in satellite images of the eyes of major hurricanes. However, true closed circulations have not been observed in the eye or eyewall of major hurricanes. Though small-scale regions of low pressure have been observed in certain cases, the thermodynamics of these features and their ultimate impact on intensity are unknown.

Goal(s): To measure the kinematic and thermodynamic structures of these features in the eyewall with dropwindsondes, and in the eye with flight-level data. The long-term goal is to test whether these features are important for intensity change.

Hypotheses:

1. Eyewall meso- and miso-vortices play an important role in TC intensity change.

Objectives:

1. Use dropwindsonde data to analyze the kinematic and thermodynamic structure of eyewall miso-vortices.
2. Use flight-level data to find whether eye/eyewall meso-vortices hypothesized from satellite images exist, and to analyze their kinematic and thermodynamic structures.
3. Assimilate quality-controlled high-resolution data from these measurements into a numerical model to test the hypothesis that these features impact intensity changes in the tropical cyclone.

Aircraft Pattern/Module Descriptions (see *Flight Pattern* document for more detailed information):
The proposed aircraft pattern has two parts. The two parts do not need to be completed during the same pass or even during the same flight.

1. The first is a break-away pattern that is compatible with any standard pattern with an eye passage (all P-3 patterns except the Square spiral or Lawnmower). The eye must be ≥ 25 n mi in diameter, and for asymmetric or non-circular eyes, the narrowest cross section from eyewall to eyewall must be 25 n mi. Additionally, a 2-n mi standoff distance should be maintained from the radar displayed inner eyewall. The P-3 will penetrate the eyewall at the standard-pattern altitude. Once inside the eye, the P-3 will maintain the flight level of the main mission and perform a single orbit of the eye with a separation distance of 2 n mi from the edge of the eyewall. The flight level of the orbit and 2 n mi minimum distance from the edge of the eyewall can be adjusted for safety considerations at the pilot's discretion. For non-circular eyes, maintaining a circular orbit is preferred (i.e., portions of the orbit could be >2 n mi from the eyewall).
2. The second part of the module occurs during the eyewall penetration of what is believed to be the strongest part of the eyewall. During the penetration, eight dropwindsondes will be released as fast as possible to try to obtain kinematic and thermodynamic observations in a single small-scale vortex. This was successfully accomplished during Hurricanes Mitch and Isabel, but with fewer instruments at lower resolution.

Links to Other Mature Stage Experiments/Modules: This can be coordinated with any other mature-stage experiment or module.

Analysis Strategy: The data will be examined to look for meso- or miso-scale vortices at the eye-eyewall interface. Analyses with an advanced data assimilation system will also be conducted.

References:

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