**2019 NOAA/AOML/HRD Hurricane Field Program - IFEX**

**MATURE STAGE EXPERIMENT**
***Science Description***

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**Experiment/Module:** Eye-Eyewall Mixing Module

**Investigator(s):** Sim Aberson (PI)

**Requirements:** Categories 2–5

**Mature Stage Science Objective(s) Addressed:**

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

**Motivation:** Eyewall miso- and mesovortices have been hypothesized to mix high-entropy air from the eye into the eyewall, thus increasing the amount of energy available to the hurricane. They may also produce very high wind-speed signatures at the surface leading to small regions of extreme damage at landfall.

**Background:** Signatures of eyewall miso- and mesovortices have been seen in cloud formations within the eyes of strong TCs, in radar reflectivity signatures (Hurricane Fabian), from above during aircraft penetrations (Hurricanes Hugo and Felix), and in damage surveys (Hurricane Andrew). Doppler radar was able to sample such features in Hurricanes Hugo and Felix, though interpretation with sparse observations through the small features has been difficult. Dropwindsondes released in very intense tropical cyclones, in conjunction with large-eddy simulations, have provided some thermodynamic data, especially in instances with multiple soundings sampling the same feature. However, the kinematic and thermodynamic structures of these features have never been directly observed, nor do we know whether these features ultimately impact intensity changes. Observations within the eye near or below the inversion can allow for the study of the these mesovortices and improve knowledge of small-scale features and intensity changes in very strong TCs.

**Hypotheses:**

1. Eyewall mesovortices play an important role in TC intensity change.

**Aircraft Pattern/Module Descriptions (see Flight Pattern document for more detailed information):**
The proposed P-3 aircraft pattern has two parts and will target category 4 and 5 hurricanes:

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 P-3 will penetrate the eyewall at the standard-pattern altitude. Once inside the eye, the P-3 will descend to a safe altitude below the inversion, if below that flight-level) while performing a Figure- 4 pattern. The leg lengths will be determined by the eye diameter, with the ends of the legs at least 2 n mi from the edge of the eyewall. Upon completion of the descent, the P-3 will circumnavigate the eye about 2 n mi from the edge of the eyewall in the shape of a pentagon or hexagon. Time permitting; another Figure-4 will be performed during ascent to the

original flight level. Depending upon the size of the eye, this pattern should take between 0.5 and 1 h. The module need only be done once and will then be evaluated for the future.

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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