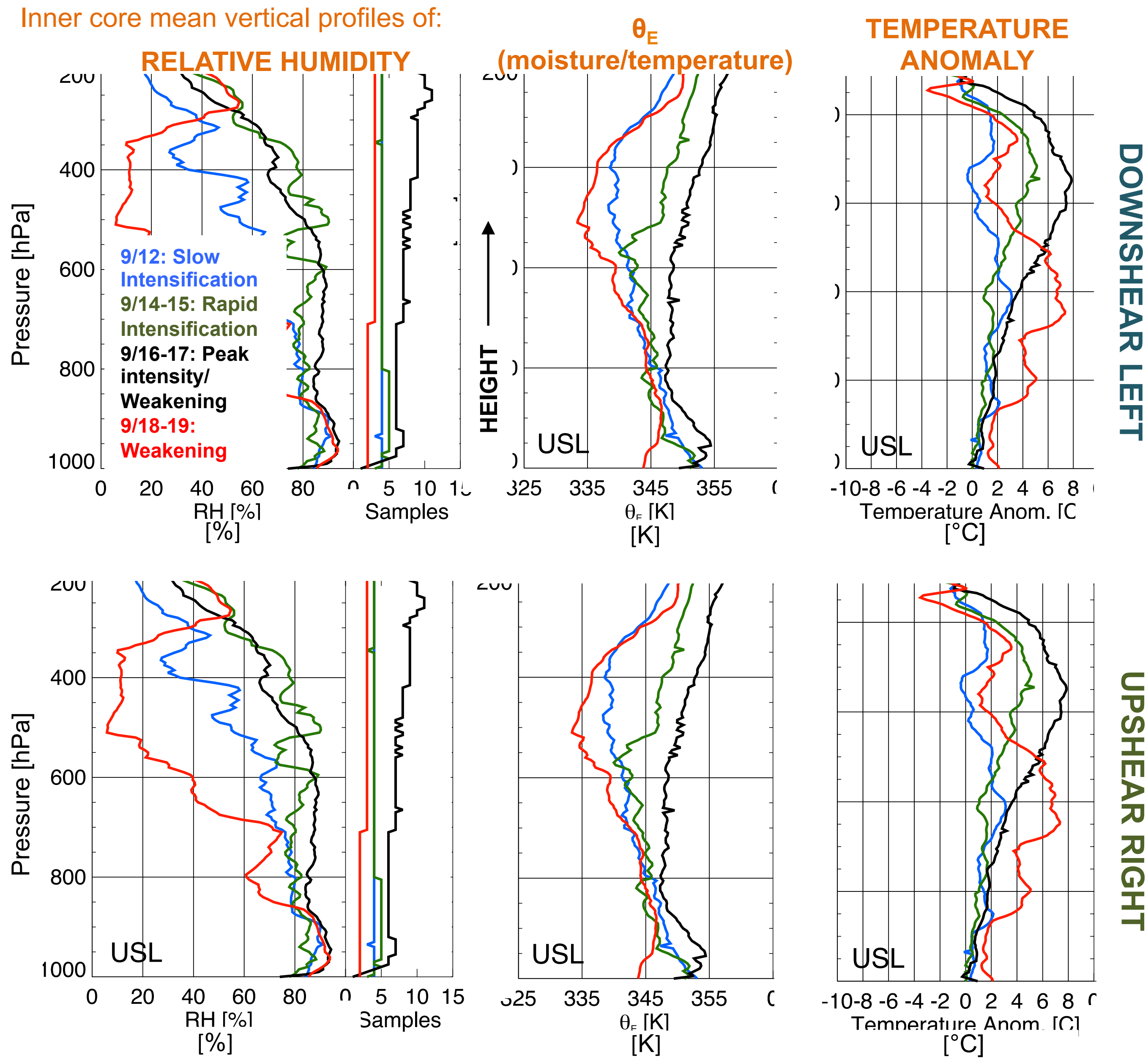
Thermodynamic Structure of Hurricane Edouard (2014) as seen by the NASA HS3 Global Hawk Dropsonde Data



Downshear left (**DSL**) shows the ***least change in RH, moisture, and temperature during intensification***

Most change occurs during the **"slow" intensification** period

➡ quadrant with the greatest precipitation coverage

Humidification, moistening, upper-level warming more delayed during intensification upshear right (**USR**)

Observations show symptoms of **subsidence drying/warming in mid- and upper-levels**

➡ quadrant with the least (more variable) precipitation coverage

- **Wind shear-induced asymmetry exists during intensification/weakening**
- **Symmetry only achieved when peak intensity (9/16-17) is reached**
- **upshear experiences the most change**

"Observations of the structure and evolution of Hurricane Edouard (2014) during intensity change. Part I: Relationship between the thermodynamic structure and precipitation"

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Highlights:

- Part 1 of this two-part paper focuses on the precipitation evolution and thermodynamic (humidity, moisture, temperature) changes observed within Hurricane Edouard (2014) during the four Global Hawk flights that occurred throughout its life cycle
- As a slowly intensifying tropical storm (12 September), while a more rapidly intensifying hurricane (14–15 September), during the initial stages of weakening after reaching peak intensity (16–17 September), and later while experiencing moderate weakening in the midlatitudes (18–19 September).
- Synthesis of satellite observations with 277 Global Hawk dropsonde observations available over the 4 missions
- An asymmetry is observed whereby, in a vertical wind shear-relative framework, the downshear quadrants consistently exhibit the greatest precipitation (deep convection) coverage and highest relative humidity, while the upshear quadrants (particularly upshear right) exhibit relatively less precipitation coverage and lower humidity, particularly in the midtroposphere.
- Whether dynamically- or precipitation-driven, the relatively dry layers upshear appear to be ubiquitously caused by subsidence.
- This precipitation and thermodynamic asymmetry is observed throughout the intensification and later weakening stages, while a consistently more symmetric distribution is only observed when Edouard reaches peak intensity.
- The precipitation distribution is intimately linked to the thermodynamic symmetry, which becomes greater as the frequency, areal coverage, and, in particular, rainfall rate increases upshear.
- Observations in Edouard also indicate that subsidence warming in the low to midtroposphere very near the center may have contributed favorably to organization early in the intensification stage.

Description of Figures: The mean profiles (defined as within 200 km of the center) of relative humidity (RH; left column), equivalent potential temperature (θ_E; middle column), and temperature anomaly (right column), in the downshear left (DSL; top row) and upshear right (USR; bottom row) quadrants. Color symbolizes each GH flight into Edouard; 12 September (blue), 14–15 September (green), 16–17 September (black), and 18–19 September (red). The number of samples contributing to each mean profile is shown on the right of the RH panels. Only DSL and USR are shown as they are the pair that exhibits the most contrast.

Scientific Significance and Relevance to Future Missions:

- The analyses presented in this study are unique in that they offer a rare opportunity to describe the *evolution of the inner core thermodynamic structure over the entire depth of a hurricane*
- *NOAA and Air Force hurricane missions*, which contribute most to the historical record, *do not typically fly at an altitude high enough to facilitate similar dropsonde-based analyses*.
- As such, this study has demonstrated one of the invaluable benefits of the Global Hawk — its capability to provide high altitude dropsonde sampling at a high spatial and temporal frequency unique among the rest of the aircraft currently used for hurricane observation.