Research and Creative Experience for Undergraduates Program (RCEU) Summer 2021

Monitoring Atlantic Hurricane Intensity Changes using 1-min GOES-16 Geostationary Lightning Mapper Data

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Overview/Introduction

- On 26 August 2020, Hurricane Laura experienced rapid intensification (RI), strengthening from a category 1 (65-83 knots) to a category 4 hurricane (114-134 knots) in around 12 hours.
- RI occurred for nearly 17 hours, between 0430 UTC and 2130 UTC, bringing Laura's maximum winds to 130 knots (150 mph).
- Using 1-minute data from the Geostationary Lightning Mapper (GLM), optical energy of the entire hurricane was tracked through the beginning and end of RI.

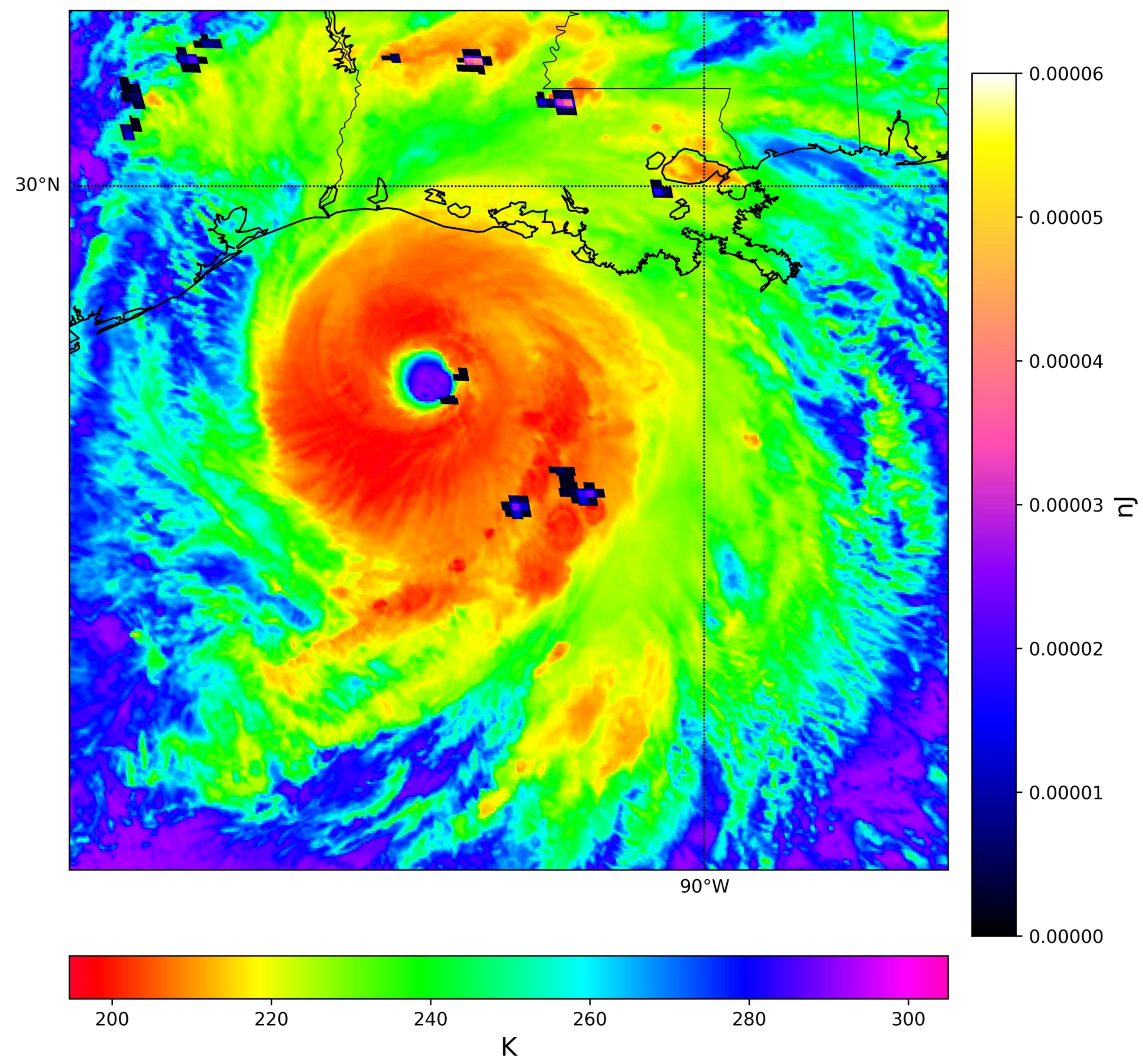

Fig. 1: Optical energy measurements (dark blue squares) overlaid on a GOES-16 10.35 µm channel satellite images of Hurricane Laura at the end of RI (2130 UTC)

Key Findings/Results

- Optical energy falls dramatically and quickly recovers at the beginning of RI possibly due to an increase in strong updrafts leading to smaller, more frequent flashes (Fig. 4).
- The end of RI brings a steady increase in optical energy, which continues after RI, likely due to an increase in convection in the outer rainbands and eyewall.
- The optical energy varies with not only the intensification of the hurricane but also localized changes in eyewall convection.
- Analyzing flash density and flash area can be very helpful tools in determining patterns in energy.

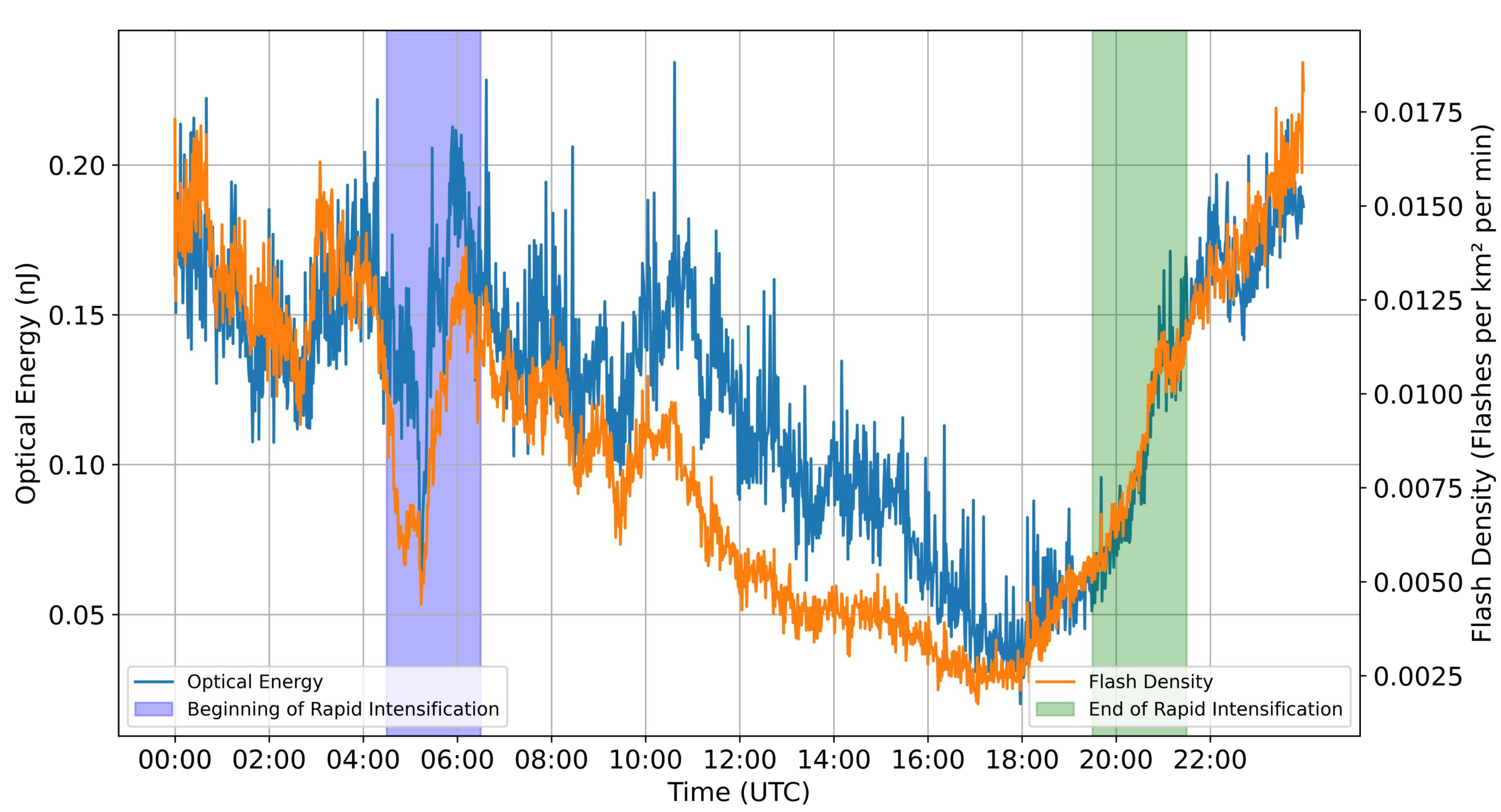

Fig. 3: Optical energy at the end of RI, from 1930-2130 UTC.

Background

- Hurricane Laura entered the Gulf of Mexico from the western Caribbean Sea on 25 August at 1500 UTC as a category 1 hurricane and made landfall in southeast Louisiana as a category 4 hurricane on 27August at 0600 UTC.
- Optical energy (nanoJoules–nJ) is a relatively new feature in lightning research and can be defined as the electromagnetic energy that is emitted by a lightning flash.

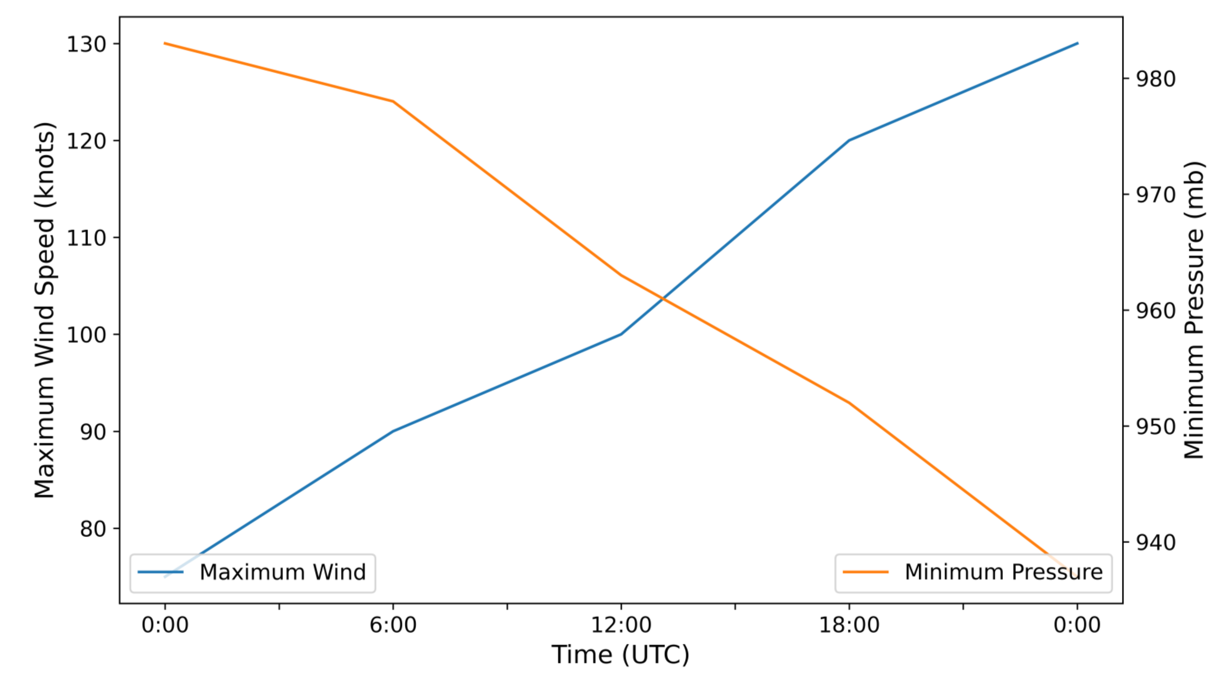

Fig. 2: Maximum winds and minimum central pressure of Hurricane Laura on 26 August 2020, in which RI occurred from 0430-2130 UTC.

Impacts

- Learning how optical energy behaves within RI cycles in tropical cyclones can give weather forecasters a greater understanding of how to track and forecast RI.
- More studies are needed on the behavior of optical energy throughout a hurricane's lifecycle, in particular during RI cycles, so that optical energy can be used as an effective real-time forecasting tool.

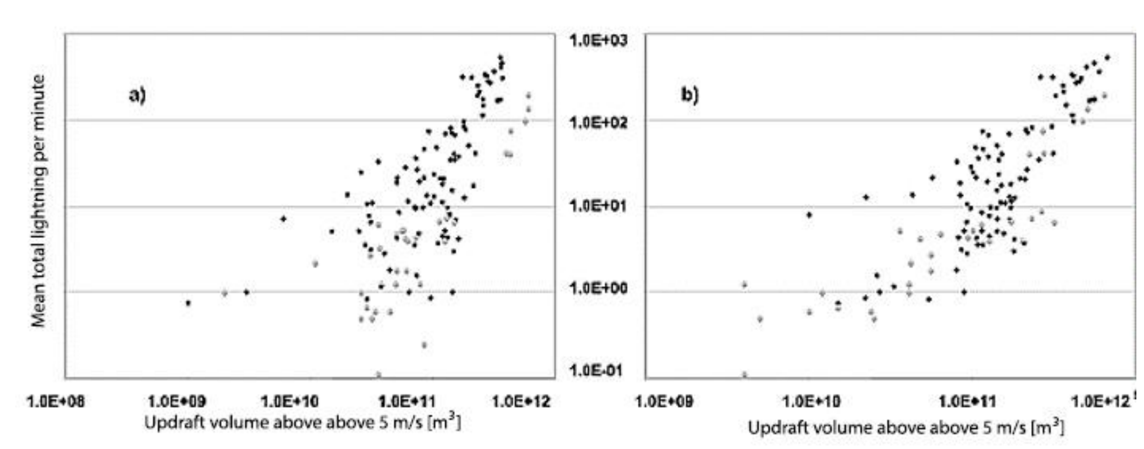

Fig. 4: Deierling and Peterson plot of total lightning activity as an indicator of updraft characteristics

Future Research

- Further investigation into patterns in optical energy throughout the entire lifecycle of hurricanes are needed to further understand their relationship.
- A look into increases in convection and flash rate could be useful in determining if there is any correlation between RI and optical energy in hurricanes.

Acknowledgements

Special thanks to David Haliczer and Chris Tracy for helping with this project, Dr. Patrick Duran and Dr. Chris Schultz with NASA SPoRT for providing support and data, and the UAH Office of the President, Office of the Provost, Office of the Vice President for Research and Economic Development, The Dean of the College of Science, the Dean of the College of Engineering, the Alabama Louis Stokes Alliances for Minority Participation, and the Alabama Space Grant Consortium for making this project possible.

References

1. **Deierling, W., and Petersen, W. A. (2008), Total lightning activity as an indicator of updraft characteristics, J. Geophys. Res., 113, D16210, doi:10.1029/2007JD009598.**
2. **Bruning, E. C., & MacGorman, D. R. (2013). Theory and Observations of Controls on Lightning Flash Size Spectra, Journal of the Atmospheric Sciences, 70(12), 4012-4029. Retrieved Aug 3, 2021, from https://journals.ametsoc.org/view/journals/atsc/70/12/jas-d-12-0289.1.xml**