

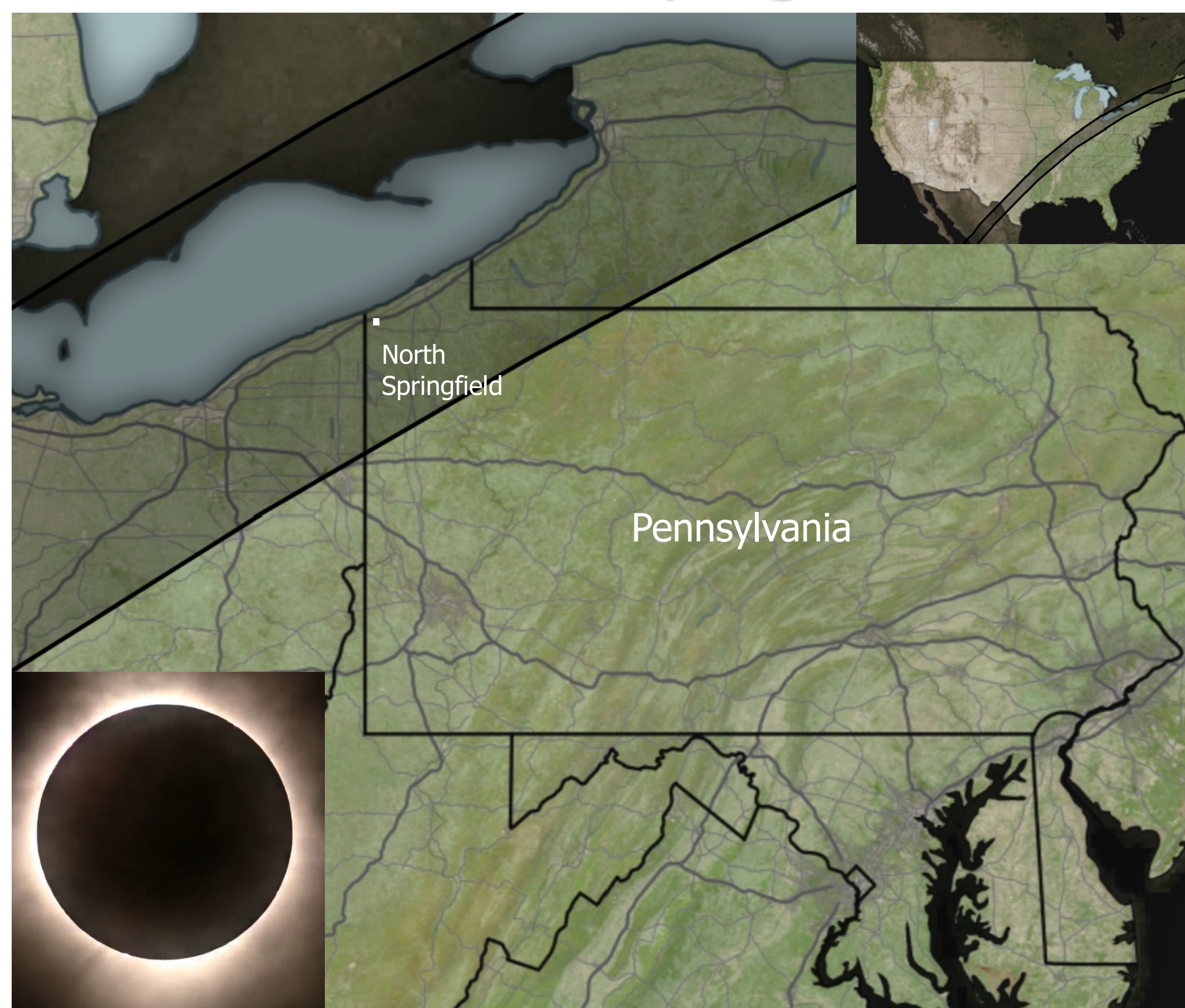
Planetary Boundary Layer Height Determination and Lapse Rate Analysis Based on Atmospheric Conditions Surrounding the 2024 Total Solar Eclipse

Konstantine Geranios,¹ Caeley Hodges,¹ Alexander D. Chambers,¹ Matthew T. Bernards,¹
¹University of Idaho, Moscow, ID

Introduction

The local planetary boundary layer (PBL) is a critical component of atmospheric research but the determined height is highly subjective depending on what method is used to determine it. A study was conducted analyzing 30 hours of radiosonde flights surrounding a total solar eclipse to compare atmospheric conditions via commonly used methods, and to determine if the total solar eclipse had a significant impact on PBL and lapse rate development.

Field Campaign



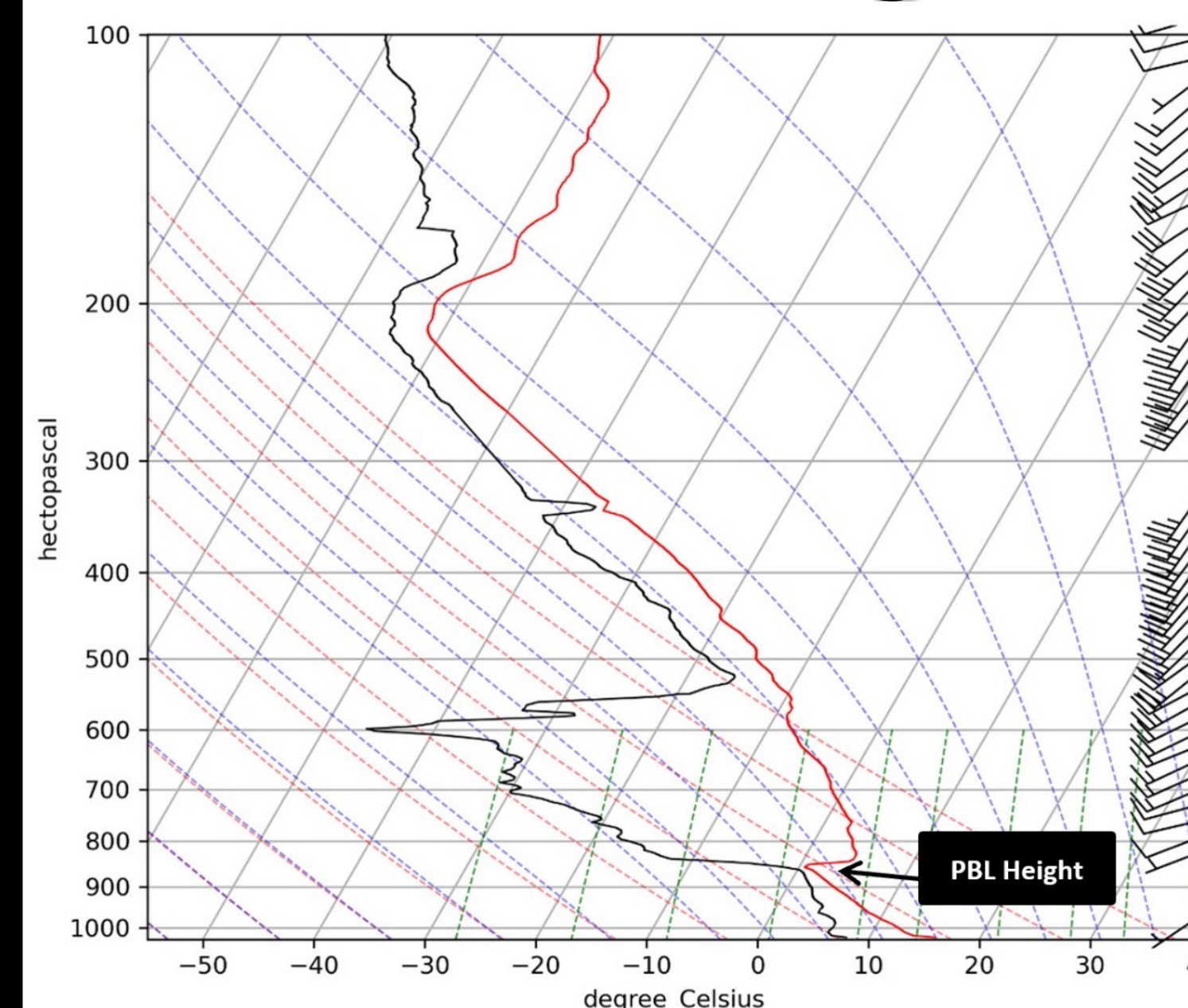
- A 30-hour field campaign was conducted in North Springfield, Pennsylvania.
- Graw radiosondes were launched using weather balloons every hour on the hour.
- The flight profiles were evaluated using three analytical methods for determining the PBL height.

Conclusions

- A distinct drop in the PBL during the eclipse was seen and it stayed low.
- An increase in the positivity of the lapse rate was observed.
- The eclipse had the expected impacts on the lapse rate and PBL.



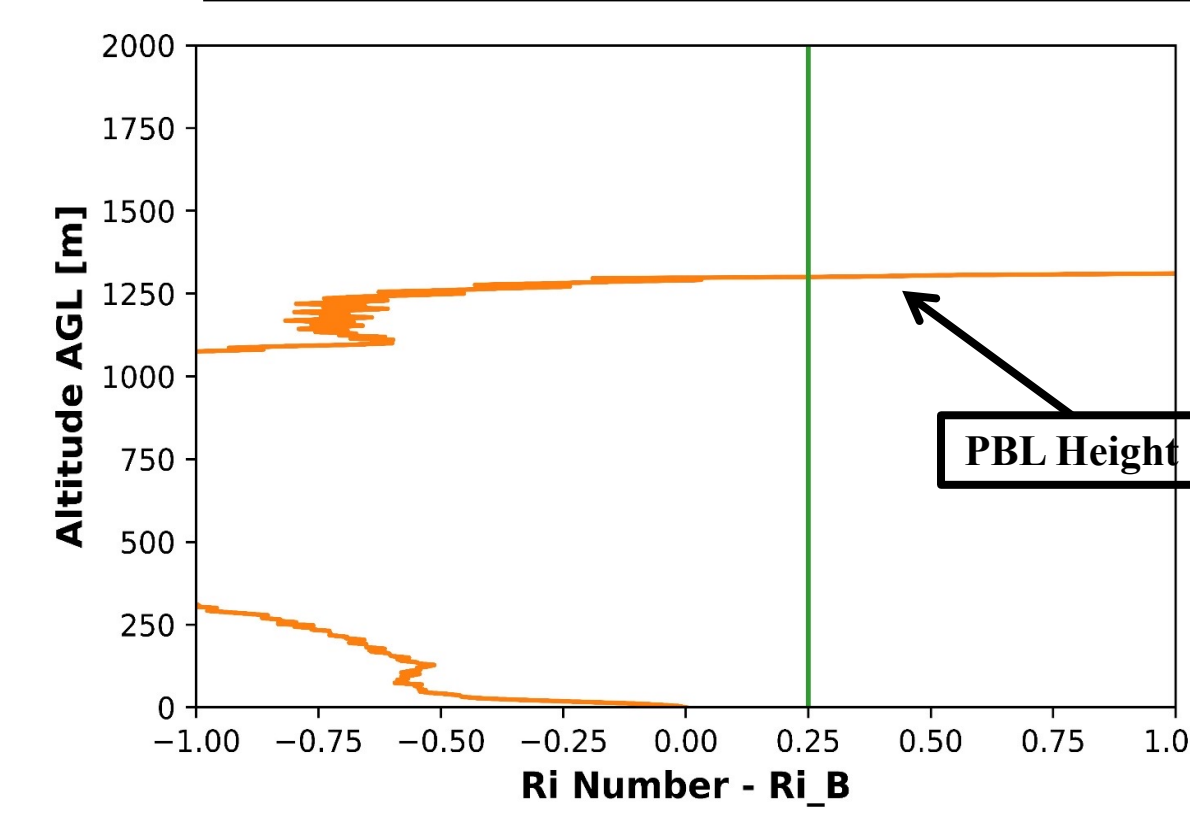
SkewT-LogP Diagrams for PBL



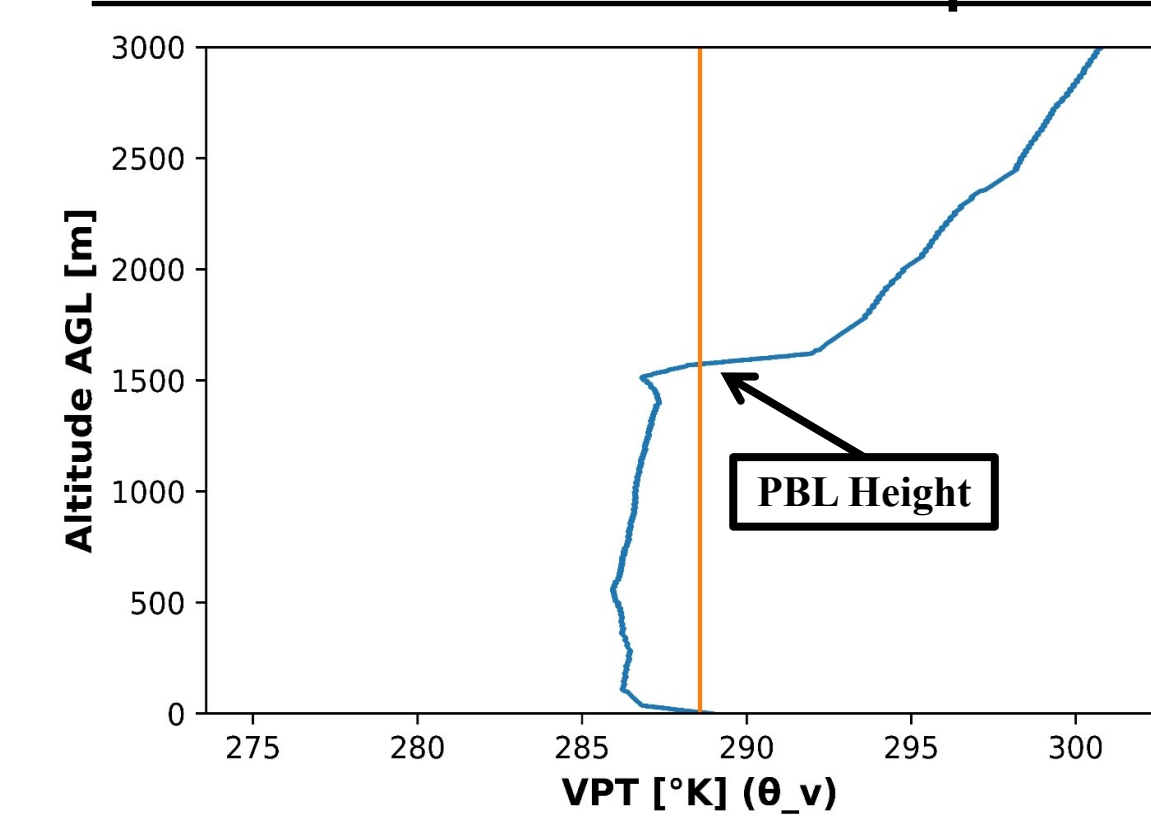
- Visual analysis of multiple SkewT-LogP diagrams is a lengthy process.
- Atmospheric conditions impact accuracy of analytical methods.
- Trends identified from 48 radiosonde profiles gathered in 2020.
- Algorithm generated to use specific PBL method based on atmospheric conditions.

PBL Analytical Methods

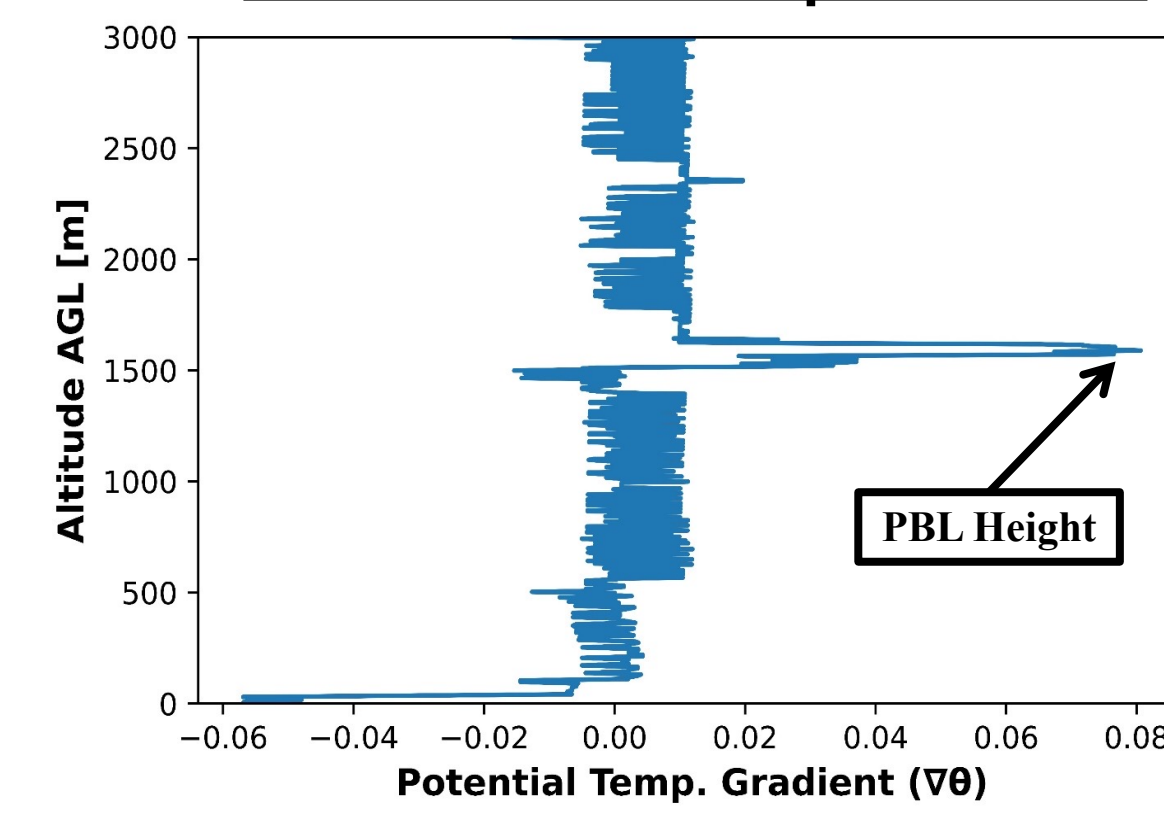
Bulk Richardson Number



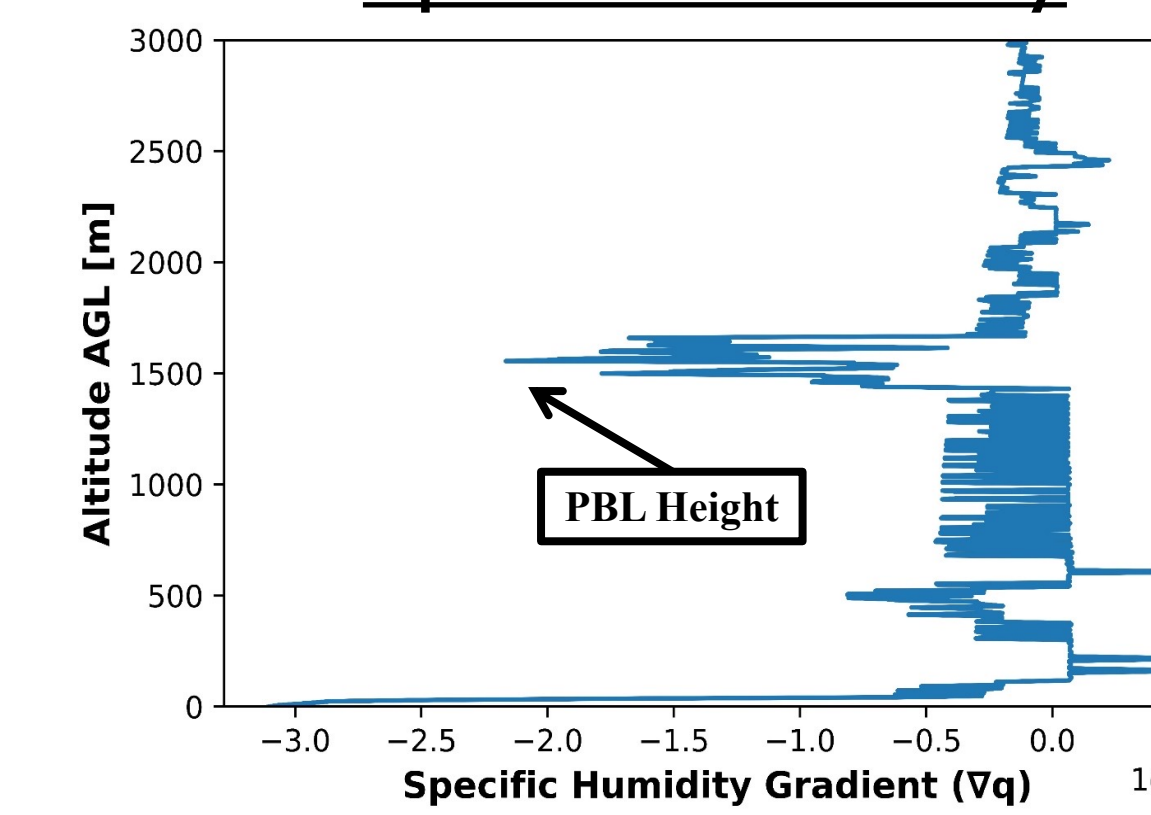
Virtual Potential Temperature



Potential Temperature



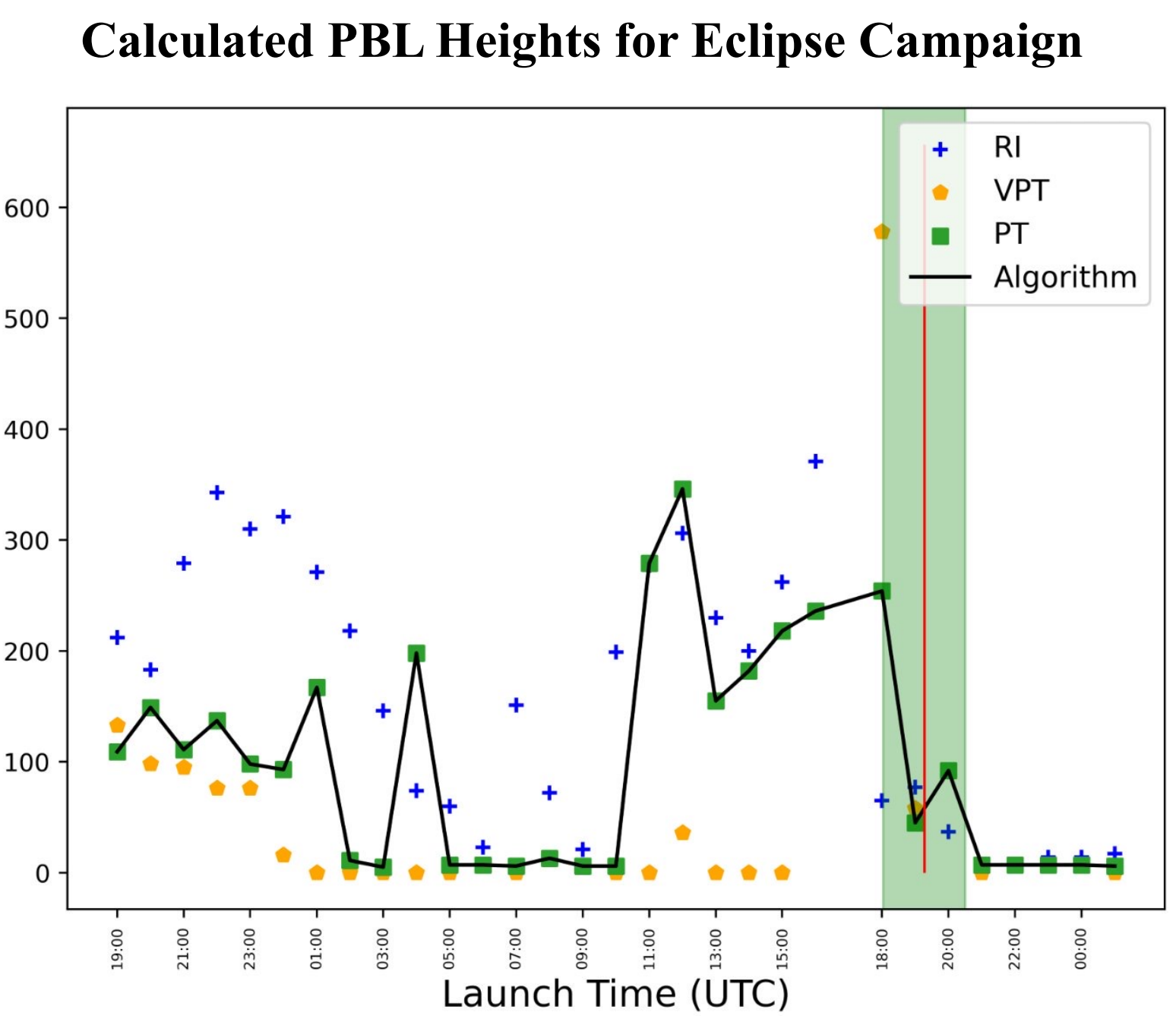
Specific Humidity



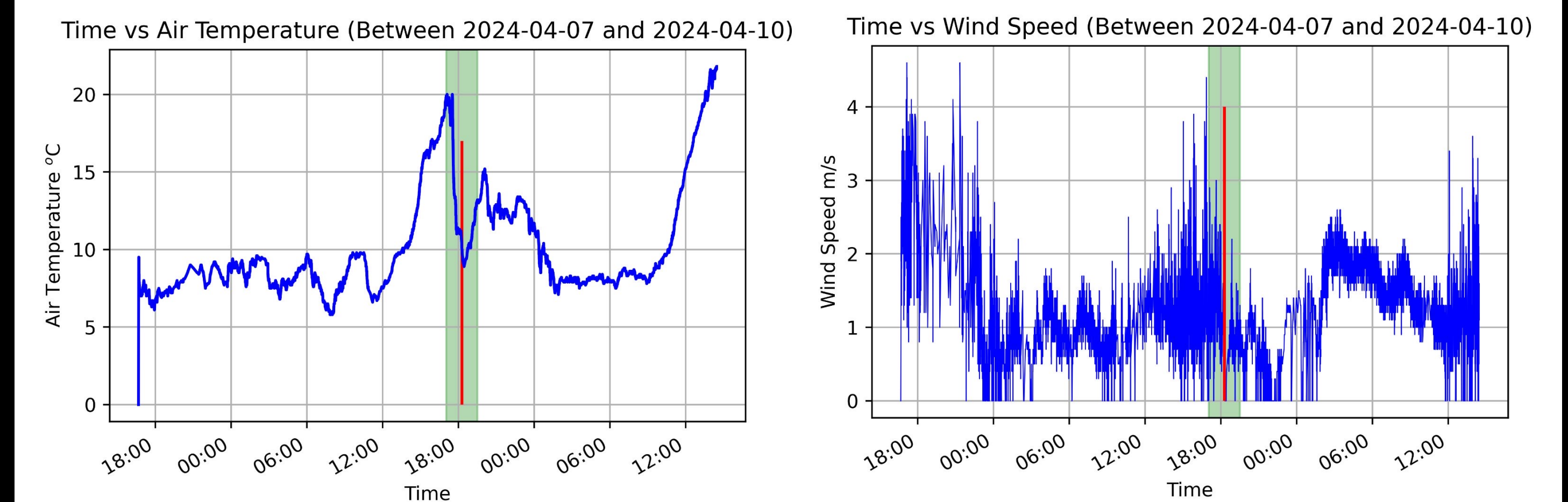
| Atmospheric Conditions | | | PBL Method |
|----------------------------------|-----------|--------------------------|---------------|
| Nocturnal Layer | Stability | Saturation | Chosen Method |
| Present | Stable | Unsaturated | PT |
| -- | Unstable | Unsaturated | RI |
| -- | Stable | High Saturation (RH>70%) | VPT |
| Other Combinations General Trend | | | RI |

PBL Results

- A total solar eclipse resembles the normal diurnal cycle on a shorter time-scale.
- The planetary boundary layer height is expected to drop during an eclipse and behave similarly to a nocturnal boundary layer.

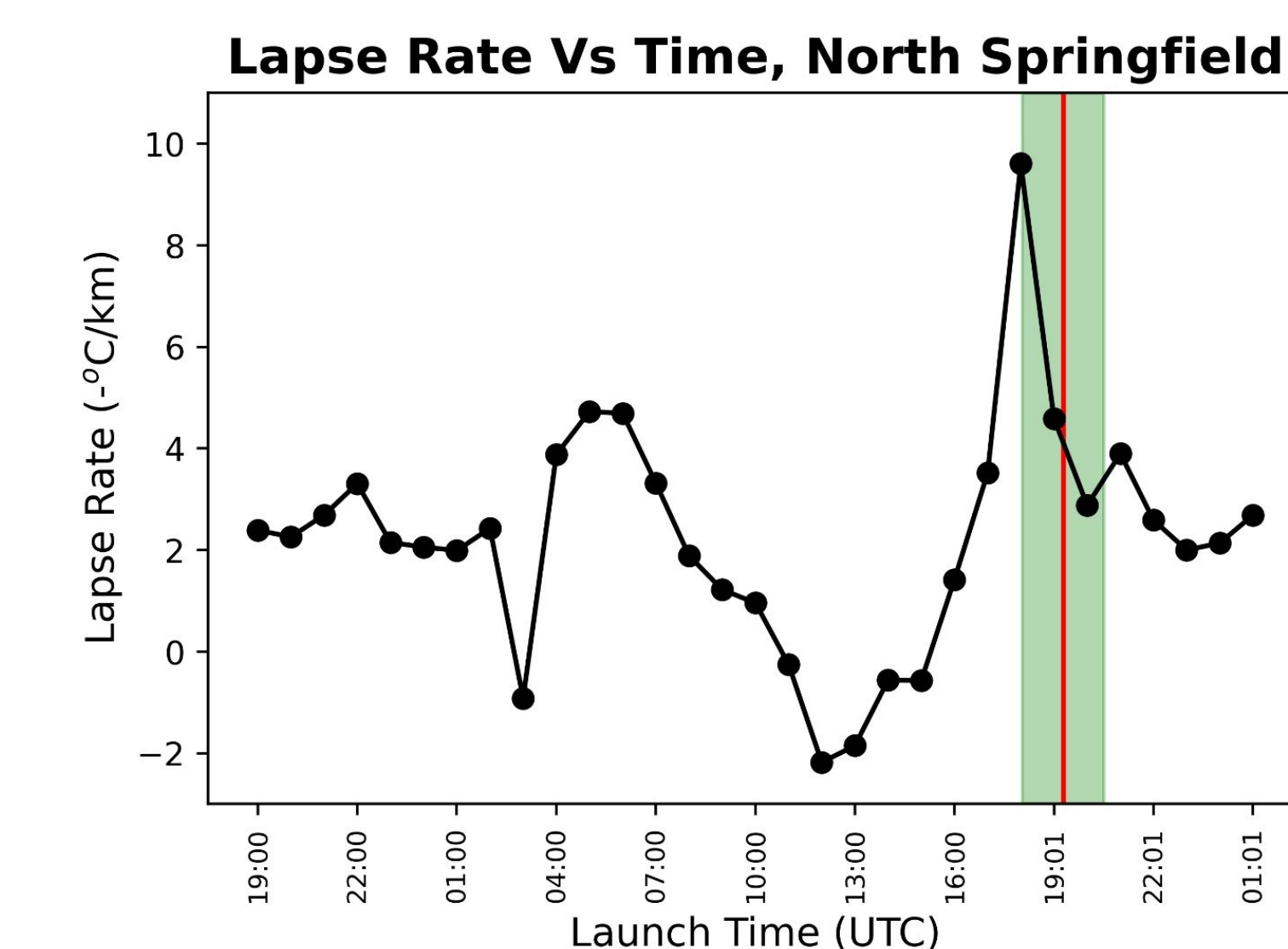


Atmospheric Conditions - LUFFT



- There was cloud cover prior to totality and following fourth contact.
- Atmospheric conditions during the length of the eclipse were as follows: lower temperatures, decreased relative humidity, minimal wind, no solar irradiance.

Lapse Rate Result



- Lapse rate is the slope of the temperature gradient.
- Expected to become less negative during an eclipse.



Acknowledgements

Student and travel support provided by the Idaho Space Grant Consortium: Grant #80NSSC20M0108.
 Travel and research support provided by NASA: Grant #80NSSC22M0003.

