



An Overview of Tropopause Heights Observed During the Nationwide Eclipse Ballooning Project



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Introduction

- The tropopause is defined as the transition layer between the troposphere and stratosphere
- There are many more complex ways to define the troposphere, including potential vorticity and static stability
- Occasionally, the formation of a double tropopause (DT) can be seen in radiosonde observations
- This research provides an overview of the characteristics of the single and double tropopauses from the most recent eclipses, including temperature, altitude, and the lapse rate definition
- A comparison of tropopause characteristics is performed using data provided by the University of Wyoming's Department of Atmospheric Science

Methodology

- Atmospheric sounding data collected during the Nationwide Eclipse Ballooning Project (NEBP) is utilized
- Data was collected by the NEBP SUNY Oswego team during the October 14, 2023 annular eclipse in Moriarty, NM and the April 8, 2024 total eclipse in Oswego, NY.
- For each eclipse, a total of 30 radiosondes were launched with the goal of capturing 24 hours before the onset of the eclipse and 6 hours after
- Each sounding is accompanied by Grawmet software determined tropopause information, which are included in the analysis
- Lapse rate plots are calculated by using the World Meteorological Organization (WMO) definition of the first and second tropopause
 - The first tropopause is the lowest level at which the lapse rate decreases to 2°C/km or less, cannot exceed this threshold for the first 2 km above this level
 - If above the first tropopause the average lapse rate between any level and all higher levels within 1 km exceeds 3°C/km, then a second tropopause is defined by the same criterion as before.

Results

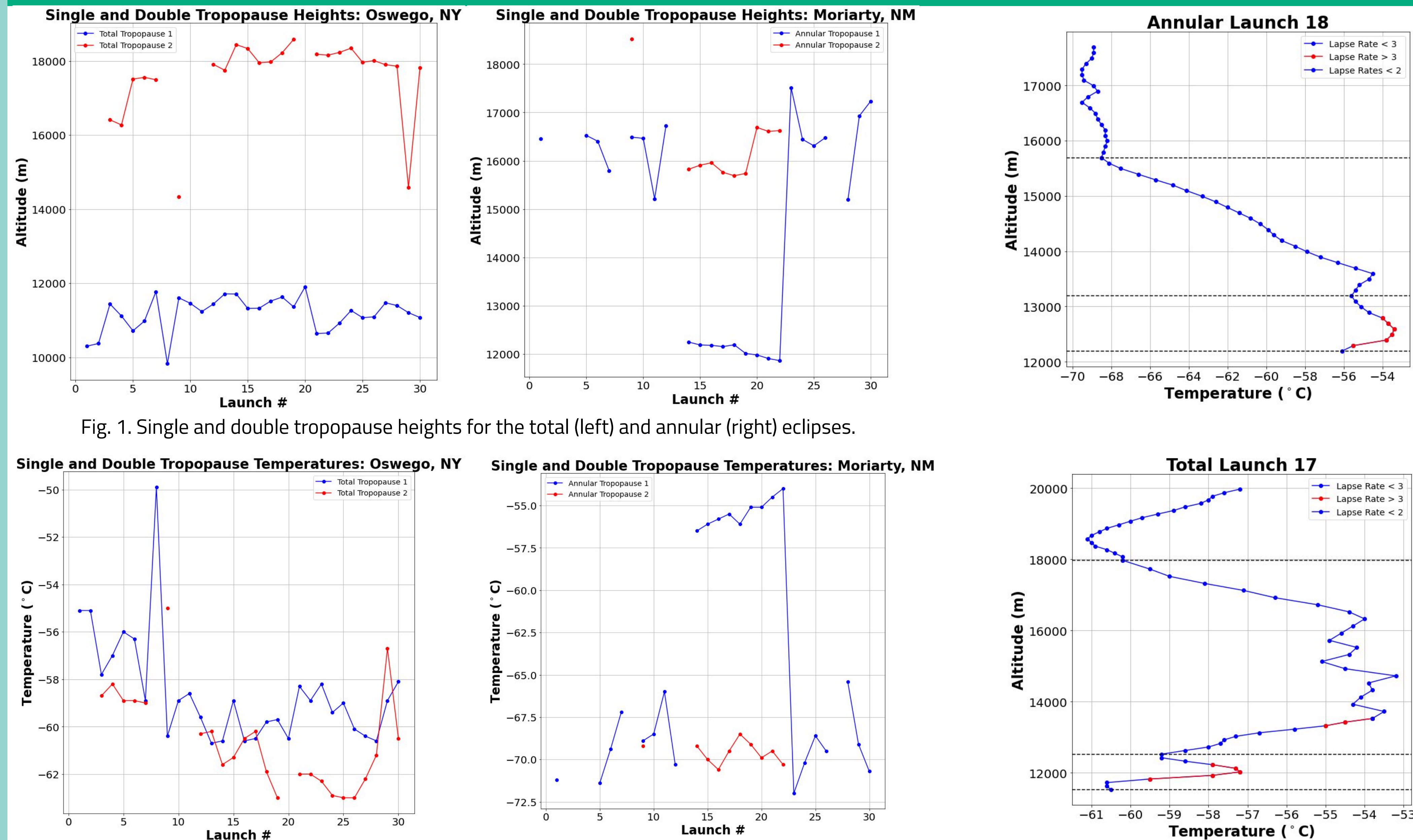


Fig. 1. Single and double tropopause heights for the total (left) and annular (right) eclipses.

Fig. 2. Single and double tropopause temperatures for the total (left) and annular (right) eclipses.

Fig. 3. Temperature profile from the tropopause height through the second tropopause height for the annular (top) and total (bottom). The red coloring indicates areas where the lapse rate exceeds the WMO definition, indicating that a DT should be present.

Table 1. Calculated averages for the NEBP tropopause data.

	Pressure (hPa)	Temperature (°C)
Annular (Only First Tropopause Present)	104.1	-69.3
Annular (First Tropopause data when DT is Present)	196.8	-56.8
Annular (Second Tropopause)	106.0	-69.6
Total (All 30 First Tropopauses)	222.4	-58.6
Total (All 24 Second Tropopauses)	82.9	-60.6

Table 2. Single tropopause pressures and temperatures from sounding data in Albuquerque, NM and Buffalo, NY for times before, during, and after the NEBP observation periods, provided by the University of Wyoming archives.

Annular Albuquerque, NM	Pressure (hPa)	Temperature (°C)	Total Buffalo, NY	Pressure (hPa)	Temperature (°C)
10/13 1200 UTC	106	-69.3	4/7 1200 UTC	226	-55.9
10/14 0000 UTC	-	-	4/8 0000 UTC	209	-60.1
10/14 1200 UTC	210	-55.3	4/8 1200 UTC	206	-58.9
10/15 0000 UTC	114	-67.3	4/9 0000 UTC	223	-58.3

- Only 3 of the 10 annular DTs met the criteria given by the WMO definition (Fig. 3)
 - Only 7 of the 24 total DTs met the criteria
- For both cases, the most common location where the WMO definition was not met was just above the second tropopause height
- Total eclipse showed near 50% of first tropopause lapse rates below the WMO threshold

- Average tropopause pressure and temperature for the annular eclipse are significantly different (Table 1)
- Evidence of a DT present in the Albuquerque data around the same time the NEBP soundings present a DT
- Average pressures and temperatures for Buffalo vs Oswego and Albuquerque vs Moriarty are mostly in agreement with no obvious outliers

Results Continued

- All 30 total eclipse soundings record a first tropopause height, 24 of these soundings recorded a secondary tropopause (Fig. 1.), consistent with past literature
- Annular eclipse saw only a 33% of the soundings record a DT, which is consistent with past literature
- Soundings with a DT had a significantly lower first tropopause height
- DT's are no longer present just before the onset of the eclipse
- DT temperatures are similar to those of the first tropopause during the total eclipse, but vary towards the latter half of the period
- Difference in first tropopause temperature between single tropopause-only cases and DT cases is much more noticeable during this eclipse

Conclusions and Future Work

- Observed single tropopause heights were significantly lower for the total eclipse than the annular eclipse
 - When a DT was observed for the annular eclipse, the altitude was still higher than those of the total
- Single tropopause heights varied less during the total eclipse
- Both eclipses observed changes in the tropopause temperatures
 - Tropopause temperature decreases are observed, but the magnitude of influence due to the eclipse is unclear
 - Future research is needed to determine the contributing factors to the cooling
- There is consistency in the presence of a double tropopause in Moriarty and Albuquerque, New Mexico during the annular eclipse
- Future work utilizing additional tropopause identification metrics is needed

Acknowledgements

Thank you to Dr. Barber, the Nationwide Eclipse Ballooning Project, SUNY Oswego, CLAS, and the Shineman Endowed Fund at SUNY Oswego #99305