Aurora Borealis Over Boulder, Colorado

Introduction

On October 10, 2024, residents of Boulder, Colorado, were treated to an extraordinary natural spectacle: the aurora borealis, or northern lights, illuminated the night sky far beyond their typical polar regions. This rare event was the result of a significant solar storm that propelled charged particles from the Sun toward Earth, interacting with our planet's magnetic field and atmospheric gases to produce the mesmerizing light display. Such southern excursions of the aurora are uncommon, making this occurrence particularly noteworthy.

Image Description and Analysis

Captured at 8:37 PM on October 10, 2024, the photograph reveals the aurora borealis casting vibrant red and purple hues across the night sky, set against a backdrop of illuminated clouds. The presence of these colors indicates a high-altitude aurora, typically occurring above 150 km, where atomic oxygen emissions produce red light. The interplay between the natural light display and the city-lit clouds offers a striking contrast, highlighting the dynamic interaction between human activity and natural phenomena.

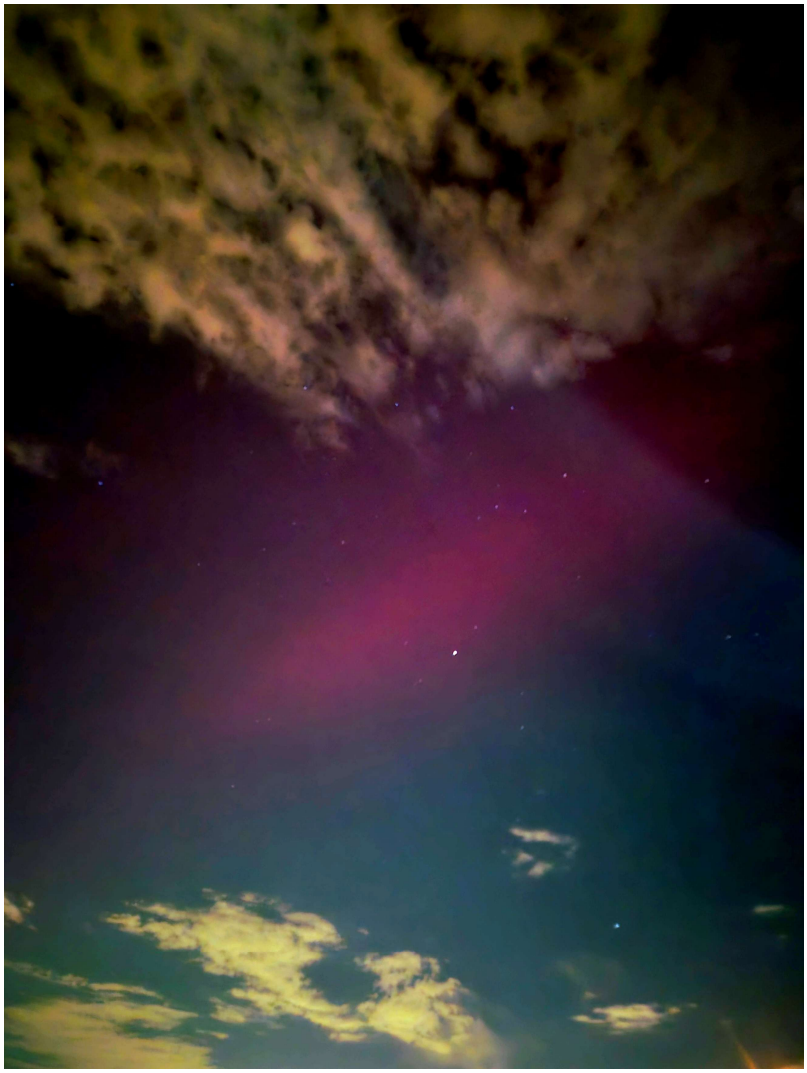

Figure 1 Aurora with Clouds

Skew-T Plot Analysis

To gain a deeper understanding of the atmospheric conditions that facilitated this rare auroral display, we examine the Skew-T plot for Grand Junction, Colorado, recorded at 00Z on October 11, 2024. Skew-T plots are essential tools in meteorology, providing a vertical profile of atmospheric temperature, moisture, and stability, which are crucial for understanding cloud formation and weather patterns.

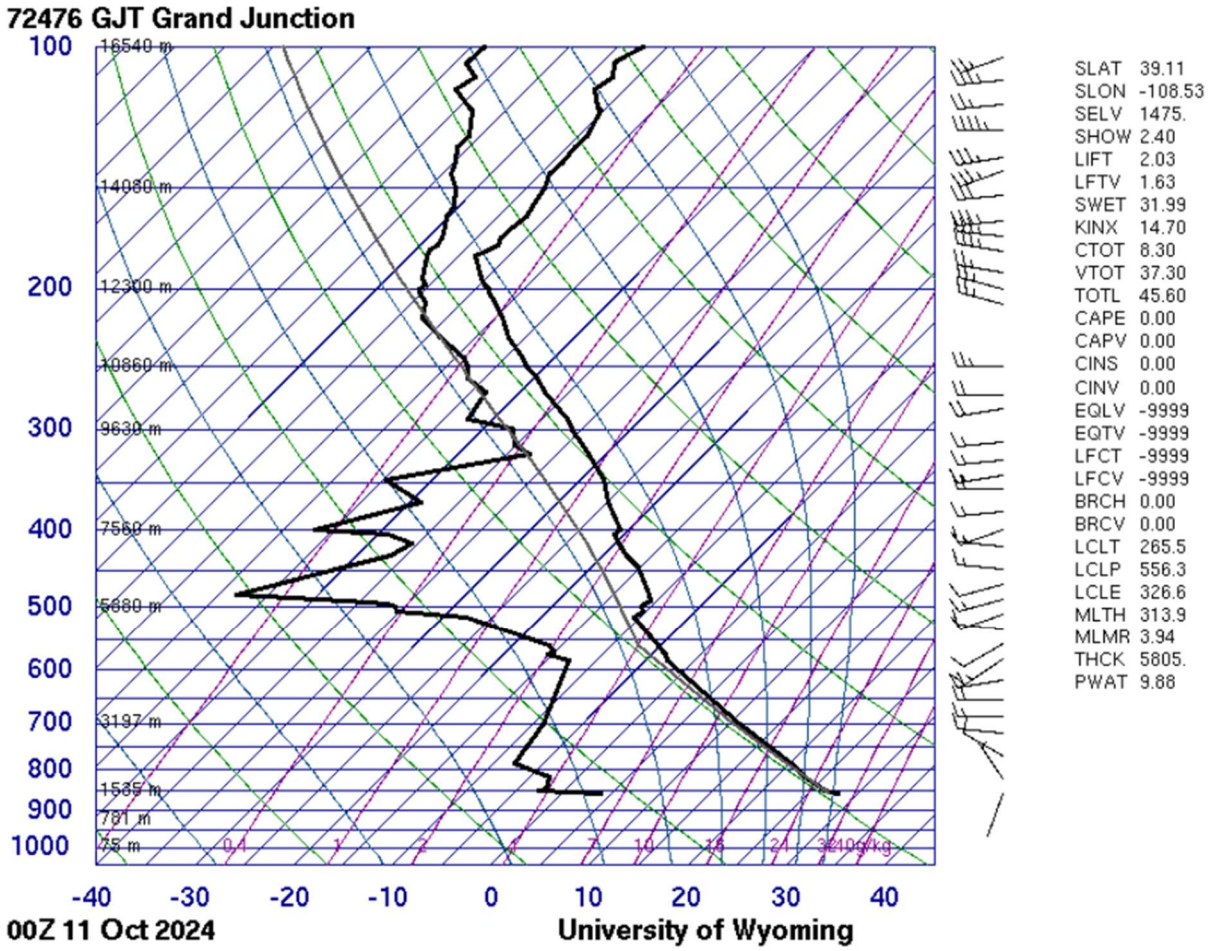

Figure 2 Skew T plot from that night

1. Stable Layer in the Lower Atmosphere:

The Skew-T plot indicates a stable layer in the lower troposphere, characterized by a positive lapse rate (temperature increasing with height) and a close proximity between the temperature and dew point curves. This stability suppresses vertical motion, leading to the formation of stratified clouds such as altocumulus or cirrostratus. These cloud types are consistent with the thin, layered clouds observed in the photograph, which were illuminated by city lights, adding depth to the auroral display.

2. Moisture Profile and Cloud Formation:

The moisture profile reveals high moisture content in the lower atmosphere, with the temperature and dew point lines closely aligned near the surface. This high relative humidity is conducive to cloud formation, as the atmosphere is saturated with water vapor. The presence of these clouds not only enhanced the visibility of the aurora by reflecting and scattering its light but also contributed to the unique visual effect observed in the photograph.

3. Temperature Inversion:

A temperature inversion is evident at mid-levels, where temperature increases with height instead of the typical decrease. This inversion can trap moisture and pollutants, leading to the formation of haze or fog. In this instance, the inversion likely reduced light scattering, allowing for a clearer and more vivid display of the aurora. The inversion also contributed to the stability of the atmosphere, preventing the vertical mixing of air masses and maintaining the clarity of the auroral colors.

4. Wind Patterns:

Wind barbs on the Skew-T plot indicate relatively calm winds at lower levels, with increasing wind speeds at higher altitudes. These calm lower-level winds allowed for the gentle movement of clouds without disrupting the visibility of the aurora. The stronger upper-level winds likely influenced the patterns and dynamics of the auroral display, contributing to the observed visual effects.

Conclusion

The exceptional aurora borealis observed over Boulder, Colorado, on October 10, 2024, was the result of a powerful solar storm interacting with Earth's atmosphere under favorable conditions. The Skew-T plot analysis reveals that a stable lower atmosphere, high moisture content, and a temperature inversion created an environment conducive to cloud formation and enhanced the visibility of the aurora. These atmospheric conditions, combined with the geomagnetic activity from the solar storm, culminated in a rare and spectacular light display that captivated observers in Boulder and beyond.

References

- Skew-T Plots | National Oceanic and Atmospheric Administration (NOAA)
- G4 (Severe) Storm Watch for 10-11 October | NOAA / NWS Space Weather Prediction Center
- Colorado Aurora Update: The Northern Lights could be visible again Friday evening in the Front Range, but it's no guarantee they will show! | BoulderCAST
- Could Colorado See the Northern Lights Again This Week? What to Know About the Aurora Borealis | Westword
- How to see the northern lights in Colorado on Friday night | The Colorado Sun
- Northern lights could be visible in Colorado's High Country tonight thanks to solar storm | Sky-Hi News
- Skew-T for the Common Pilot | New Lang Syne
- The Skew T, Log P Diagram | University of Arizona
- Skew-T Log-P Diagrams | NOAA JetStream
- Skew-T Parameters and Indices | NOAA
- Model Sounding | National Weather Service
- Skew-T Plots | NOAA
- Skew-T Log-P Diagrams | NOAA JetStream
- Skew-T Parameters and Indices | NOAA

- Skew-T for the Common Pilot | New Lang Syne
- The Skew T, Log P Diagram | University of Arizona
- Skew-T Log-P Diagrams | NOAA JetStream
- Skew-T Parameters and Indices | NOAA