

2024 Cloud First Report | Dron Das Purkayastha

Introduction

This report delves into the analysis of a striking cloud formation observed in the Target parking lot in Boulder, Colorado, on September 3, 2024, at 6:06 PM MDT. The image captured by a Samsung S24 phone camera, without any post-processing, showcases a unique atmospheric phenomenon: orographic strato-cumulus clouds generating crepuscular rays.

Orographic Cloud Formation

Orographic lifting, a fundamental meteorological process, is the primary driver behind the cloud formation observed in the image. As moist air masses encounter the topographic barrier of the Front Range of the Rockies, particularly the Flatiron Mountains, they are forced to ascend. As the air rises, it expands and cools adiabatically. This cooling process reduces the air's capacity to hold moisture, leading to condensation and the formation of clouds.

The specific type of cloud observed in the image, strato-cumulus, is characterized by its layered appearance. These clouds often form in stable atmospheric conditions, where the air is lifted in a shallow layer. The stability of the atmosphere, influenced by factors like temperature inversions and large-scale atmospheric patterns, plays a crucial role in shaping the cloud's morphology.



Figure 1 Orographic Strato-Cumulus Clouds with Crepuscular Rays

Crepuscular Rays

A captivating feature of the image is the presence of crepuscular rays, often referred to as "God rays." These rays are formed when sunlight passes through gaps in clouds or mountains, creating a series of parallel beams that converge at a distant point. The clarity of the atmosphere and the absence of significant haze or dust on September 3rd contributed to the visibility of these rays.

Atmospheric Conditions

To gain a deeper understanding of the atmospheric conditions on September 3rd, a Skew-T diagram for 00Z on September 4, 2024, was analyzed. This diagram provides valuable insights into temperature, humidity, and stability profiles.

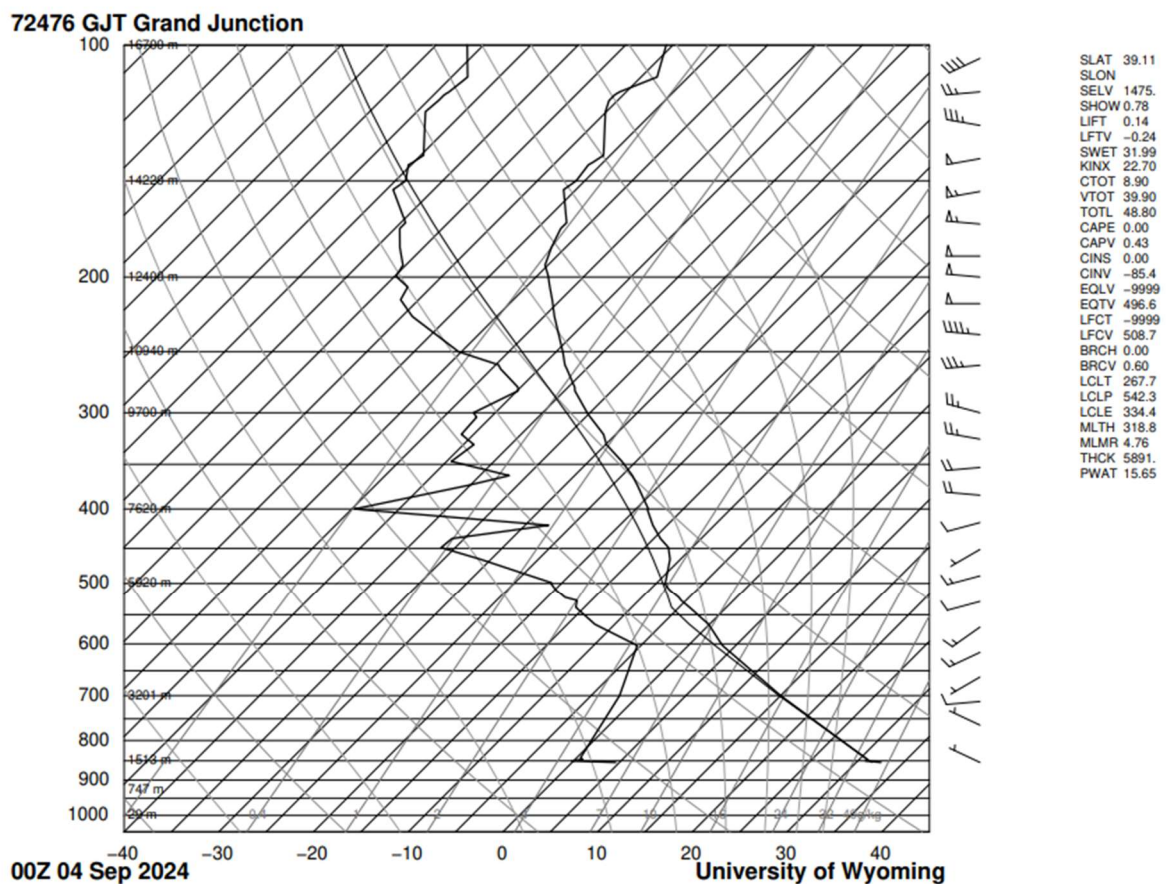


Figure 2 Skew-T Diagram for September 3, 2024: Analysis of Atmospheric Conditions

Temperature and Humidity: The diagram reveals a relatively moist atmosphere with dew points approaching freezing levels at higher altitudes. This high moisture content, coupled with orographic lifting, provided the necessary conditions for cloud formation.

Stability: The lapse rate of temperature, which indicates the rate of temperature change with altitude, was close to the moist adiabatic lapse rate in the lower levels. This suggests a conditionally unstable atmosphere, where lifting is required to initiate cloud development. The orographic lifting provided the necessary trigger. However, the overall weather pattern on September 3rd seemed

relatively stable, as evidenced by the absence of significant thunderstorm activity or rapidly changing conditions.

Impact of Flatiron Mountains

The Flatiron Mountains played a crucial role in shaping the cloud formation. The orographic lifting induced by these mountains forced the moist air to rise, leading to condensation and cloud development. The specific orientation and elevation of the Flatiron Mountains likely influenced the shape and extent of the cloud formation.

Conclusion

The observed cloud formation, characterized by orographic strato-cumulus clouds and crepuscular rays, is a striking example of the intricate interplay between atmospheric processes and topography. The combination of orographic lifting, high moisture content, and a conditionally stable atmosphere, influenced by the presence of the Flatiron Mountains, created the ideal conditions for this captivating display. The lack of post-processing on the image further emphasizes the raw beauty of this natural phenomenon.

Future Research

Future research could delve deeper into the precise timing and duration of the crepuscular rays, as well as the impact of local wind patterns on cloud formation and orientation. Additionally, analyzing a sequence of images could provide valuable insights into the evolution of the cloud formation and the movement of the crepuscular rays.

Acknowledgements

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References

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