Hyperlapse of a Cloudy Day over Boulder

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Clouds Second

MCEN 5151: Flow Visualization

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Captured 4th December, 2023

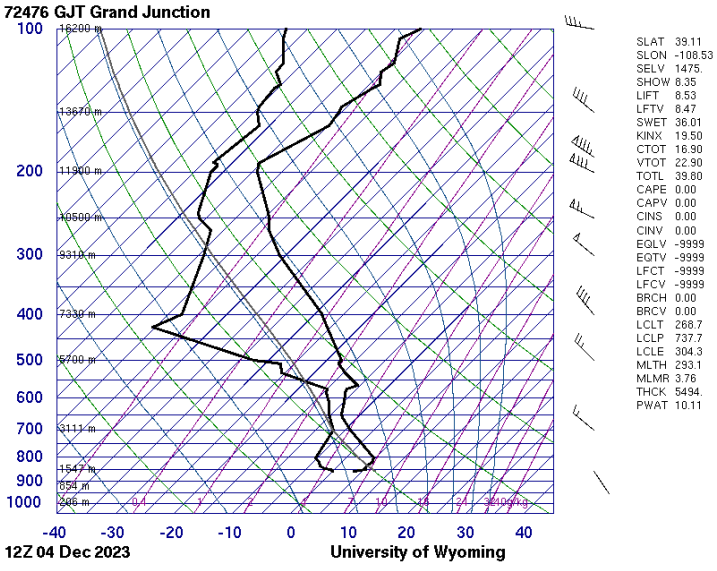
Newton Court, Boulder, Colorado

Context and Purpose

The primary objective of this assignment was to capture the evolving cloud formation over Boulder, Colorado, from dawn to dusk for the Clouds Second assignment of MCEN 5151: Flow Visualization course offered at University of Colorado Boulder in Fall 2023. The focus was to document the dynamic nature of the sky, capturing various cloud types and their movements influenced by local weather conditions. This report presents an analysis of the cloud formations observed on December 4, 2023, utilizing a time-lapse video technique. The intent of the hyperlapse was to explore how different atmospheric conditions interact over time to create diverse cloud patterns, particularly considering Boulder's unique geographical location adjacent to mountain ranges.

Location and Time

The time-lapse video was captured from a fixed location in Boulder, facing approximately 306 degrees North-West, with a camera pitch of around 40 degrees above the horizon. This positioning provided an expansive view of the sky, encompassing the mountainous terrain from the lower left corner to the center of the frame. The recording was attempted over 22 days, with the final selection being the footage from December 4, 2023, shot between 5:00 AM and 5:30 PM.



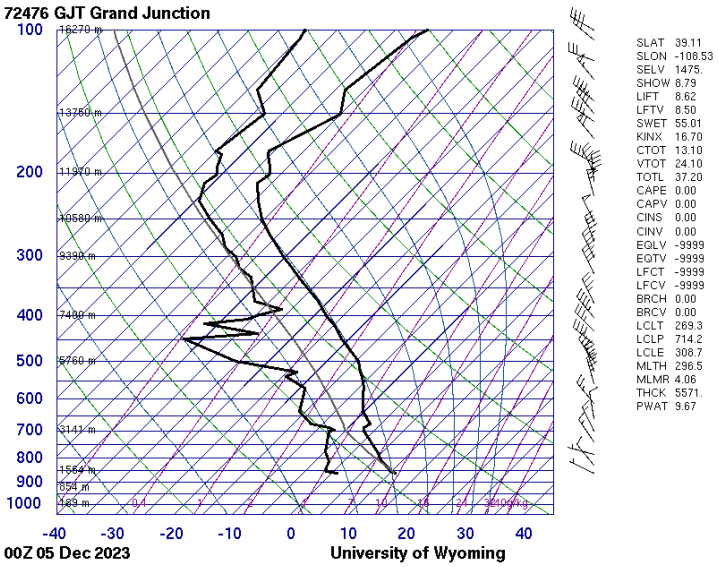


Figure 1 Skew-T Log-P diagram at 6am and 6pm, Dec 4th 2023, Grand Junction CO

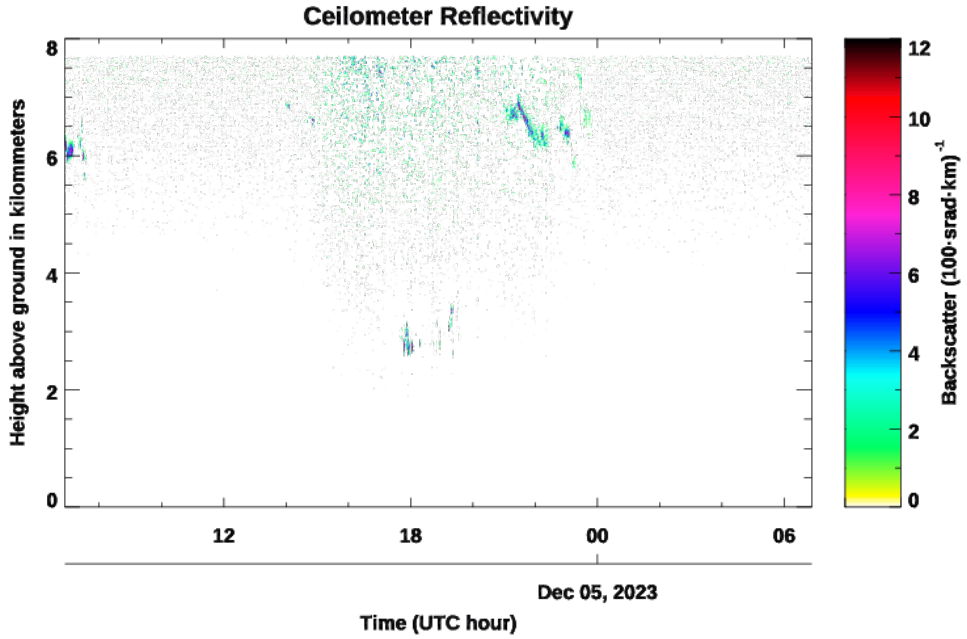


Figure 2 Ceilometer reflectivity plot, 4th Dec 6am to 5th Dec 6am (UTC), Boulder CO

Cloud identification and analysis

The observed cloud types included Cirrus, Cirrocumulus, Altocumulus, Cumulus, Stratocumulus, and Altocumulus clouds, alongside visible Contrails. The presence of these clouds indicated a mix of atmospheric conditions. Skew-T plots for the day, along with a Ceilometer plot from December 4 to 5, were analyzed to understand the atmospheric stability and cloud heights. Upon examination of the image and accompanying Skew-T Log-P diagram from the University of Wyoming for Grand Junction, taken at 6am and 6pm on Dec 4th, the dewpoint and temperature lines indicate that there was a high probability of clouds forming at altitudes of 3km to 5km and approximately 12km in the morning and at an altitude of 3.2km, 11.9km to 13km in the evening. The CAPE metric being 0 on both SKewT plots show stability in the atmosphere. The proximity to the mountains, as explained in the FlowVis guide on lift mechanisms due to orographics, likely influenced the cloud formation patterns observed. The LCLP which provides the pressure at which condensation can occur shows the reading of 737mB and 714mB corresponding to an altitude of approximately 3km altitude where most of the altocumulus clouds were seen. The readings on the Cielometer plot from the SkyWatch observatory seem to be inconclusive. The dynamic sky and varying cloud layers suggested changes in weather, corroborated by snowfall in the subsequent days.
Here is a link to the Hyperlapse video: https://youtu.be/F3U3gAjiXbE

Acknowledging the numerous cloud formations in the hyperlapse video capturing the whole day, the identification and brief explanation of the clouds is provided using some shapshots from the video. The time stamp of the video is mentioned for each.

23 sec – Cirrus and Cumulus
The day started with somewhat clear skies, but the presence of Cumulus clouds near the mountains could be due to localized convection, where the sun heats the mountainous terrain, causing the air to rise and cool, leading to the formation of these clouds. The Cirrus clouds at high altitudes are less affected by the orography and are more indicative of broader atmospheric conditions.

35 sec – Cirrocumulus and Cirrus
Cirrocumulus forming near the mountains may suggest moisture being lifted to higher altitudes, possibly due to orographic forces. These clouds, combined with the persistent Cirrus, could hint at an incoming weather system being influenced by the mountain range.

49 sec – Cirrus and Altocumulus
The formation of Altocumulus near the mountains (bottom left small grey clouds) can be a result of a stable layer of air being disrupted by the orographic lift, leading to the creation of these mid-level clouds. The layered appearance may indicate waves of air flowing over the mountains.

1min 7sec – Cirrus, Cumulus, and Contrails
Cumulus clouds are again observed, which could be growing in response to the uneven heating of the earth's surface by the sun, exacerbated by the complex topography of the mountains. This localized convective activity is common near mountainous regions during the day. By this time multiple contrails are also visible left from passing jets.

1min 15sec - Cumulus and Cirrus
The persistence of Altocumulus and cumulus may be due to moist air being continuously lifted over the mountains, while the Cirrus again indicate less direct influence from the orography and more from the conditions in the upper troposphere. The Cirrus clouds are seen morphing into Cirrus Undulatus clouds next.

1min 15sec - Cirrus undulatus, Cirrostratus, Altocumulus, and some Contrails
The Cirrus clouds are morphed to Cirrus Undulatus visible by their parallel streaks in the upper atmosphere with some Cirrostratus clouds seen at the lower side of the video. The Cumulus and Altocumulus clouds persist and are seen to be morphed into some Altostratus clouds next.

1min 22s – Cirrus Altostratus and Cumulus
The cumulus and altocumulus clouds are seen to morph into a sheet like formation of Altostratus and Stratus clouds heading south and south-east.

Figure 3to 9: Image snapshots from the hyperlapse video with identification and brief description

In the context of the location of this video being in Boulder, which sits at the foothills of the Rocky Mountains, orographic effects are a crucial aspect of weather. The mountains can lead to the development of clouds and precipitation on the windward side and can also create a rain shadow effect on the leeward side. These snapshots from the hyperlapse are a testament to how mountains interact with atmospheric processes to shape the local weather and cloudscapes.

Photographic Technique

The time-lapse video was captured using a Samsung M31 smartphone mounted on a tripod facing approximately 306 degrees North-West, with a camera pitch of around 40 degrees above the horizon. The camera was set to capture images at 15.6-second intervals, with a resolution of 3840 x 2160 pixels from 4am to 7pm. The video playback rate was set to 375x, providing an accelerated view of the cloud movements. The lens focus was set to infinity to capture the broad sky expanse with angle of view being approximately 65°. Image and video processing involved compiling these images into a the hyperlapse video, only the extra clip length was cut with the recording in the dark at the time of dawn and dusk with minimal adjustments and cropping to maintain the natural appearance of the sky.

Image and visual analysis

The final video reveals a fascinating array of cloud formations, movements, and interactions, accentuated by the varying wind speeds at different altitudes. The time-lapse technique effectively captured the fluid physics of cloud formation and dispersion. Particularly striking was the pinkish-reddish hue of the clouds before sunset, adding a dramatic effect to the visual narrative. While the video fulfilled the initial intent of capturing diverse cloud dynamics, further exploration could involve analyzing cloud formations during different weather phenomena or seasons to deepen the understanding of local atmospheric conditions.

References

[1] "Atmospheric Soundings." Accessed: Dec. 06, 2023. [Online]. Available: http://weather.uwyo.edu/upperair/sounding.html

[2] "Clouds Notes," Flow Visualization Guidebook. Accessed: Dec. 06, 2023. [Online]. Available: https://www.flowvis.org/links/

[3] "Skywatch Observatory." Accessed: Dec. 06, 2023. [Online]. Available: https://skywatch.colorado.edu/