Assignment 2 – “Clouds 1”

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1 Objective

The objective of the image was to visualize atmospheric fluid dynamics by observing clouds. This was accomplished by photographing clouds at night from the peak of Green Mountain in Boulder, CO. A full moon provided light for the night photography allowing for an aesthetically pleasing photograph while accomplishing the objective of flow visualization.

2 Photographic Setup

Photographs were taken from the peak of Green Mountain in Boulder, CO to eliminate light pollution and line-of-sight obstructions. A pre-existing pedestal on the summit of Green Mountain was used as a tripod surface, providing the necessary stabilization for long exposure photos. Clouds were observed and photographed in all directions on September 27th, 2007 from 9:00 pm until 10:30 pm. All lighting was provided by a full moon and all photos were taken with a Canon Digital Rebel XT with an 18-55 mm lens.

The submitted photo was first acquired as the RAW image shown in Figure 1. The photograph was taken with a focal lenth of 18mm, an f-stop of 5.6, an ISO setting of 400, and a 15 second exposure. The RAW image was processed to a blue filtered black and white image, similar to the red filter with black and white film method used by Ansel Adams (Figure 2). The contrast of the blue filtered black and white image was enhanced, resulting in the finished image shown in Figure 3.

3 Discussion

The cloud photographed in figure 3 was north/northwest of Green Mountain. From the sounding data in the Skew-T plot (Figure 4), the height of the cloud is approximately 10000 ft, based on the Lifting Condensation Level. While the atmosphere is slightly unstable at the altitude of the cloud, as shown by the different slopes of the temperature and the parcel lapse rate, this is not likely the cause of the instability observed in the eastern edge of the cloud. This instability is likely caused by the eastward winds flowing over the topographical features of the Boulder Flatirons.

Figure 1 - Original RAW image of the submitted photo

Figure 2 – Filtered Black and White image from Figure 1

Figure 3 – Enhanced contrast image from Figure 2

The vertical profile of Boulder when viewed from the north combined with eastward winds yields a flow over a wedge scenario. In such a scenario, even small wedges cause boundary layer separation and onset of turbulence. While an unstable atmosphere would likely not cause the instability observed in the eastward edge of the cloud in Figure 3, it is conceivable that turbulent conditions induced by the Flatirons could create the observed instability, given the relatively close proximity of the wedge tip (approx. 8000 ft) to the photographed clouds. These turbulent conditions were observed during a 1989 Boulder windstorm[1].

4 References

1. Clark, T. L.; Hall, W. D.; Banta, R. M., 2-Dimensional and 3-Dimensional Simulations of the 9 January 1989 Severe Boulder Windstorm - Comparison with Observations. Journal of the Atmospheric Sciences 1994, 51, (16), 2317-2343.

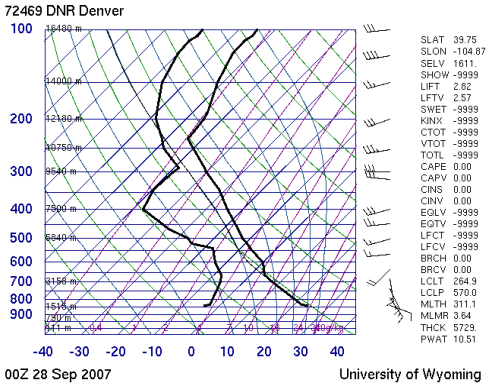

Figure 4 – Enhanced contrast image from

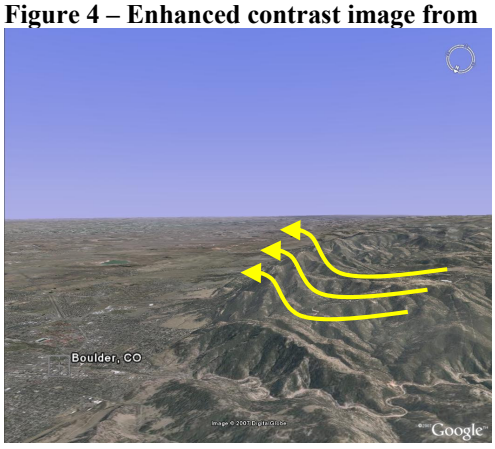

Figure 5 - Southward view of the Boulder Flatirions from Google Earth with flow contours of the hypothesized turbulence