Clouds 2 Assignment
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MCEN 4228: Flow Visualization
4/15/09

Introduction

The purpose of this assignment was to capture another interesting and artistic image of a cloud that demonstrates atmospheric phenomena. This was the second cloud assignment for the semester.

Image Circumstances

This image was taken in Boulder, CO in parking lot 436 at the University of Colorado on April 7th, 2009 at 12:54 PM. The angle from the horizon was approximately 90 degrees. The cloud was viewed directly above relative to the observer.

Cloud Classification

The cloud seen in the image was a sheet of cirrostratus undulatus, high-altitude cloud with wave formations, which contained a dark streak slicing it in half. The rest of the sky was covered with other sheets of cirrocumulus and cirrostratus with many aircraft contrails. Typically these types of clouds have a ceiling between 25,000 and 40,000 ft [1]. The dark streak passing through the cloud was probably an aircraft dissipation trail (distrail). Distrails can be formed under several conditions. The hot, moist exhaust from a jet engine can evaporate the cloud in its wake leaving a gap in the cloud formation [2]. The turbulent mixing of the air above an aircraft with the thin sheet of cloud below can also produce distrails [2]. And if the cloud happens to be in a supercooled state, such as a cirrocumulus or altocumulus, the passing aircraft can glaciate the droplets causing them to grow and fall below creating a distrail [2]. Since this cloud image was a cirrostratus undulatus, the creation of the distrail was probably caused by jet exhaust or the mixing of the air. In the skew-T diagram, fig. 1, the closest point between the Dew Point and

Temperature profiles is around 12,000 m (40,000 ft), which supports the classification of the cloud taken in the image (high-altitude cloud). The distance between these two lines at lower altitudes suggest a relatively dry atmosphere. The skew-T plot also shows strong winds present around this altitude, a possible cause for the undulations or waves that are seen in lower portion of the image.

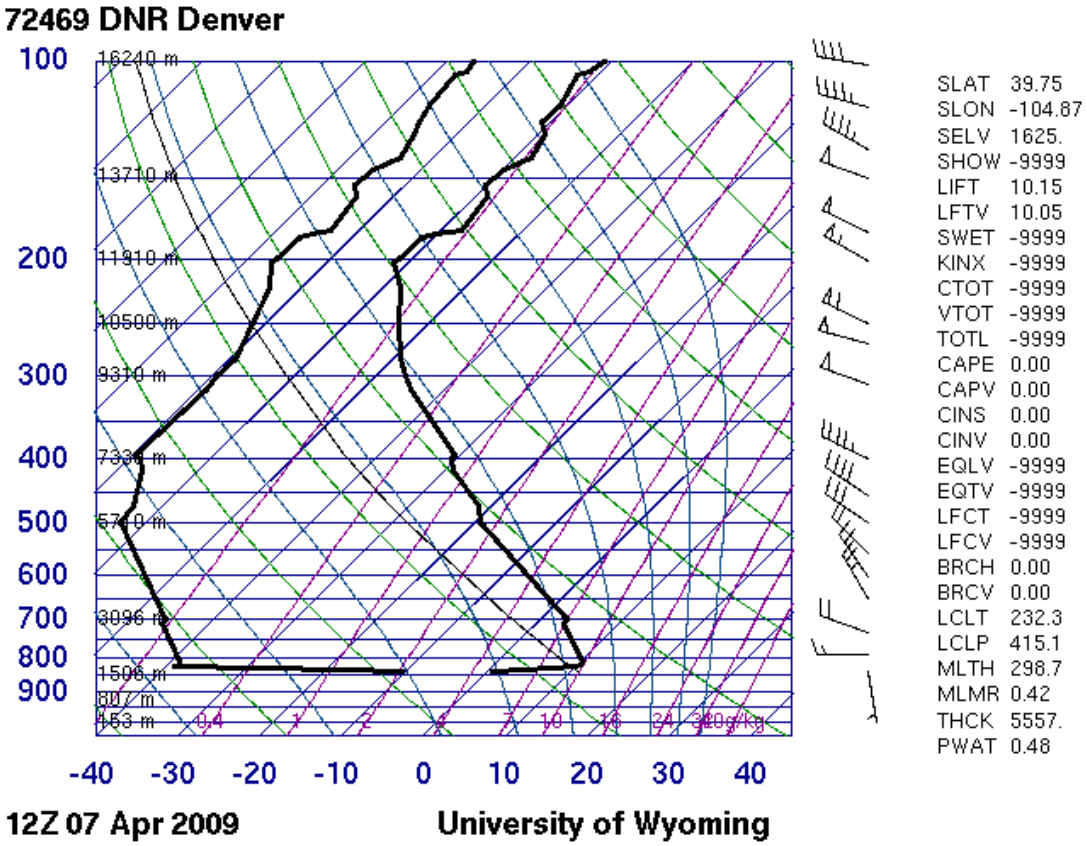

Figure 1: Skew-T Sounding Data for 4/7/09 @ 12 hrs [3]

Photographic Technique

Digital photography was used to capture the image. The camera used was a 6 MP Nikon Coolpix L1 with a Nikkor 5X Optical Zoom lens (6.3-31.4mm, 1:2.9-5.0). The original and final image width and height was 2816 x 2112. The field of view (FOV) was about 8068 m x 6048 m with an object distance of 8840 m (29,000 ft). The object distance was determined to be the altitude of

the cloud, since the image was taken directly over head. The FOV was calculated by multiplying the camera's sensor dimensions (5.75 x 4.31 mm) by the object distance and dividing that quantity by the focal length. The lens focal length was 6.3 mm. The exposure setting on the camera was set to 0, with the white balance setting on automatic. No flash was used, and natural light from the sky was used to create the image.

Table 1: Photographic Technique

Field of View (FOV)	8068 m x 6048 m (width x height)
Object Distance	8840 m (29,000 ft)
Focal Length	6.3 mm
Aperture	f/2.8
Shutter Speed	10/15343 sec
ISO setting	50
Exposure	NONE, set to 0
Original Image Size	2816 x 2112
Final Image Size	2816 x 2112

Photoshop

The only adjustments made in Photoshop were using the curve adjustments tool, as seen below in figure 2.

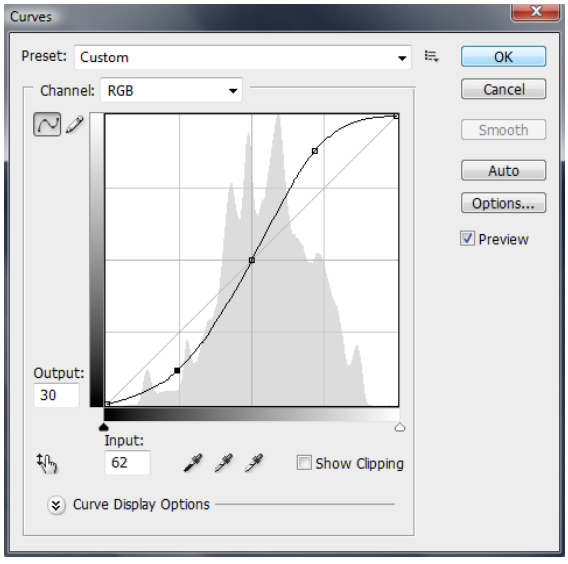

Figure 2: Curve Adjustment

Conclusions

This image reveals pretty standard atmospheric conditions that arise in Boulder, which are usually pretty mild and dry. I really like how the image is divided in half by the dissipation trail, and contains contrasting textures above and below. There really isn't anything I do not like about the image. It would have been nice to see the entire cloud; a wide angle lens might have helped. The atmospheric fluid physics are quite visible. To develop this image further, I think taking multiple shots or video to get a time lapse would allow better atmospheric flow visualization. A video showing the presence of an aircraft and then appearance of the distrail would be really cool, but would nearly be impossible to set up.

References

1. http://www.bp.com/managedlistingsection.do?categoryId=4503666&contentId=57754
2. Duda, David P., & Minnis, Patrick (2002). Observations of aircraft dissipation trails from GOES. Monthly Weather Review, 130(2), 398-406.
3. http://weather.uwyo.edu/upperair/sounding.html