Mechanical Engineering
UNIVERSITY OF COLORADO **BOULDER**

Cloud Images II

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I. Background

This project was the second cloud assignment for my Flow Visualization class at the University of Colorado at Boulder. The goal of the project was to photograph a cloud in an interesting, and clear manner. I chose to capture a time-lapse image sequence of clouds during a moonrise over a desert ridge in order to visualize the fluid movement of the clouds in a bath of pale moonlight.

II. Image Circumstances

This image sequence was taken in Comb Wash, Utah (37˚22'54.27" N 109˚39'23.43" W, elevation 1414 m) between approximately 11:00 pm MST on March 26 and 12:30 am MST on March 27. The shot was captured looking approximately ESE at an elevation of approximately 25˚ above horizontal. The images were captured under the light of a near-full moon, which helps to highlight the clouds wonderfully and has the appearance of a nocturnal sun, which adds another degrees of complexity to the time-lapse.

III. Cloud Type and Atmospheric Conditions

The clouds captured in this time-lapse are both low-level and mid-level clouds. The cumulus fractus clouds seen in the foreground of the image sequence typically form in fair-weather conditions at low altitudes below 2000 m ("Cloud Classification and Characteristics" 2011). They are characterized by their jagged edges and dynamic nature, often dissipating after about 15 minutes (Pretor-Pinney 2009). Figure 1 shows a temperature inversion at approximately 1500-2000m, which is the altitude range for the formation of cumulus fractus clouds. The skew-T plot also shows a CAPE value of 0.00, indicating a stable atmosphere and the little vertical growth that is characteristic of these clouds. Based on the movement of the clouds within the image, the estimated fluid velocity of the cumulus clouds is approximately 40 km/hr.

Also present in the image sequence are mid-level altocumulus clouds traveling on westerly winds, which most likely formed in the inversion layer where the environmental temperature and the dew point temperature soundings approach each other at approximately 4000 m, seen in Figure 1 ("Mid level clouds" 2011). These clouds appear to be moving more slowly than the cumulus clouds, but Figure 1 indicates that the winds were stronger at this altitude, probably closer to 55 km/hr. While this sounding is from Grand Junction, CO, it is the closest center to the location of the captured footage and provides an estimate for the conditions in Comb Wash.

The weather preceding these clouds was very similar to the conditions captured in the time-lapse imagery. Thin cloud cover the day before provided minimal diffusion of the sunlight, which resulted in a very bright, sunny day. However, the temperature increased dramatically the following day, which may indicate that the clouds were arriving on a warm front. Warm front typically bring in mid-level stratiform clouds, which are similar to the altocumulus clouds seen in the time-lapse but with a more continuous coverage area (Roth 2006).

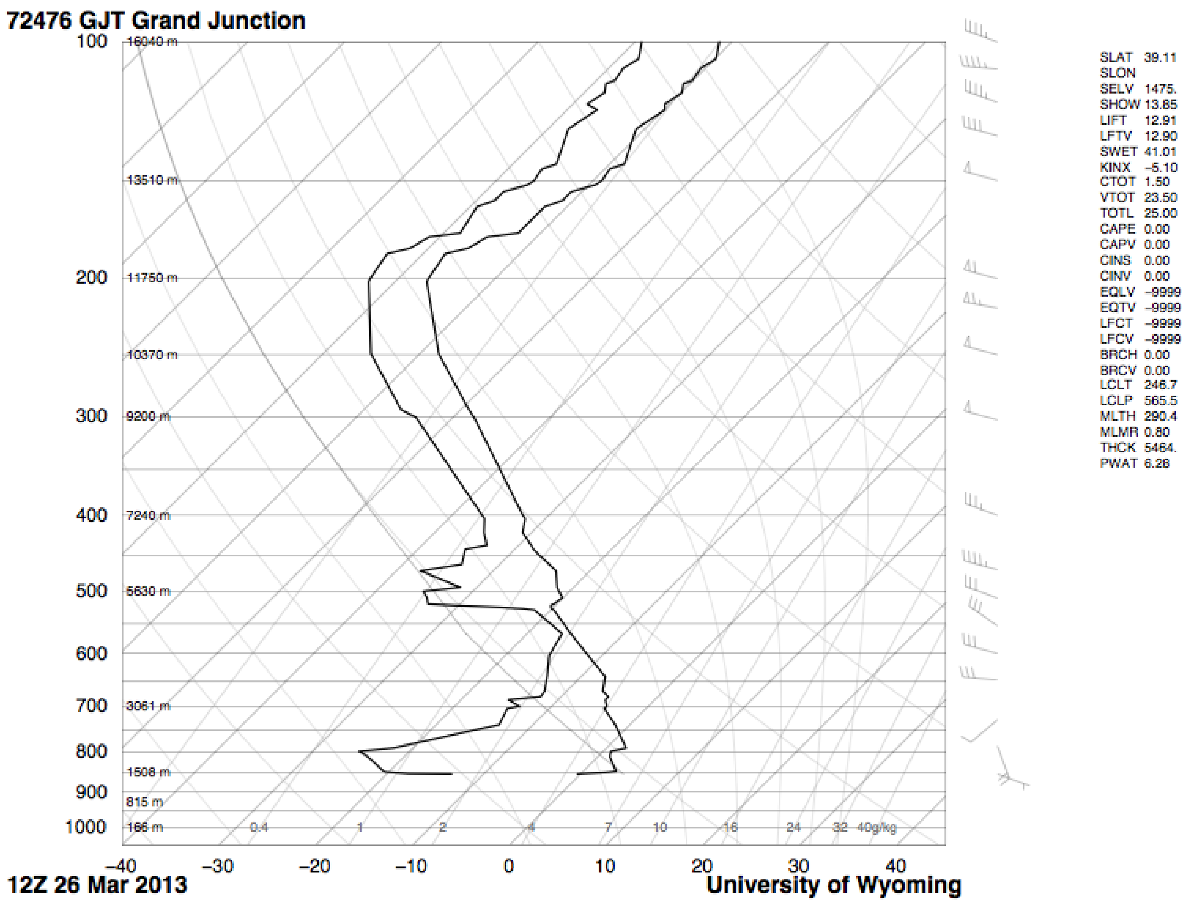

Figure 1: Skew-T diagram showing atmospheric sounding data for 12Z 26 Mar 2013, approximately 6 am MST (Oolman 2013).

IV. Photographic Technique and Settings

The field of view used to capture the image sequence was approximately 160 x 90 m across, with the low-level clouds at a distance of approximately 1,500 m from the lens of the camera. The images were captured on an EF-S 18-135 mm zoom lens at a focal length of 25 mm. A Canon EOS 60D DSLR camera was used to shoot original JPEG images that were 5184 x 3456 pixels in resolution. Each image was captured in one-second exposures at f/4.0 and 1000 ISO, with three-second intervals between shots. The relatively long exposures creates smoother-looking playback in the time-lapse, as the human eye sees the movement of the slightly blurred images in the sequence as more natural than with clear, individual frames. Post processing was done in Adobe Aftereffects by providing fade in/out effects, adding music and titles, and increasing the contrast. The final time-lapse video is in 1080 x 720 resolution played back at 25 fps.

V. Conclusions

This time-lapse imagery achieved my goal of capturing clouds at night. The full moon helped light the clouds very well, which allowed for greater contrast and more interesting cloud formations. The moonlight also added a sense of calm that is expressed differently than during daylight image sequences. I would suggest researching further into moon photography to see how one could capture both the full moon and clouds in focus. An additional interesting concept would be to capture the moon rising from a very far distance away by using a telephoto lens. This would make the moon appear very large within the frame of the photo and would create an appealing shot. I still believe time-lapse image sequences to be the best way to capture clouds as you can visualize fluid flow very well and the resulting video is aesthetically pleasing.

"Cloud Classification and Characteristics". National Oceanic and Atmospheric Administration. Retrieved 25 February 2013.

Oolman, L. (2013). *Atmospheric soundings*. Retrieved from http://weather.uwyo.edu/upperair/sounding.html

Pretor-Pinney, G. (2009). Cumulus fractus. Retrieved from http://cloudappreciationsociety.org/collecting/janice-smith/

Roth, D. (2006). "Unified Surface Analysis Manual". Hydrometeorological Prediction Center. Retrieved 15 April 2013.

UK Department for Innovation and Skills, Met Office. (2011). *Mid level clouds*. Retrieved from website: http://www.metoffice.gov.uk/learning/clouds/mid-level-clouds