CLOUDS II

Jeremy Tyler Parsons

University of Colorado: MCEN 5151-Flow Visualization 11/21/2016

Introduction

The image shown was created for MCEN 5151-Flow Visualization as the for the Clouds 1 assignment. The intent of the assignment was to observe clouds formations and document the unique beauty and flow visuals that they can illustrate. The cloud formations shown are alto-cumulus and are mechanically driven by atmospheric conditions and interactions with the local topography. The following report will detail the experimental setup and photographic techniques used to capture the image shown, as well as the fluid mechanics driving the cloud formations illustrated in the image.

Fluid Physics

The image shown above illustrates a diverse array of cloud types, all of which are likely the byproduct of orographic effects due to the local, mountainous topography. The primary clouds showcased in the image are altocumulus that transition toward cirrus as the formations are uplifted. One can also observer subtle stratocumulus formations on the far left and far right edges of the frame. These formations are likely due to decaying cumulus clouds. As the cumulus are lifting, the air masses will condense and create a local instability at cloud level[1].

The jagged mountain ranges and dramatic transition between the front range and the foothills creates a unique mechanism that facilitates these orographic cloud formations. Orographic uplifting is a process in which air masses are forced to rise because of the physical presence of elevated land, in this case the peaks of the front range[2]. As the parcel of air rises, it cools due to adiabatic expansion until the air is cooled to the local dew point and the air becomes saturated. The continued uplifting causes the altocumulus clouds formed over foothills to keep rising in altitude and transition into cirrocumulus formations and the local temperature becomes colder and the wind speeds increase at the higher altitudes.

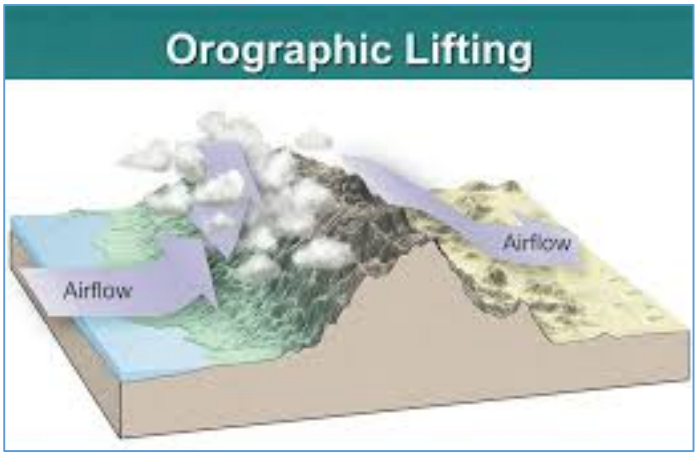

Figure 1: Orographic Uplifting

Shown below is the Skew-T plot for Saturday, November 5th at 00Z, which corresponds to approximately November 4th 6:00 PM MST. The sounding data was gathered by a via a weather balloon launched from Denver, CO. While these clouds show clear indications of orographic effects, due to the local, mountainous topography, the atmospheric sounding data can offer a macro-scale perspective of the local atmosphere at the time the image was captured. Based on the information present in the Skew-T diagram and a CAPE value of 0.00 the local atmosphere would be classified as stable.

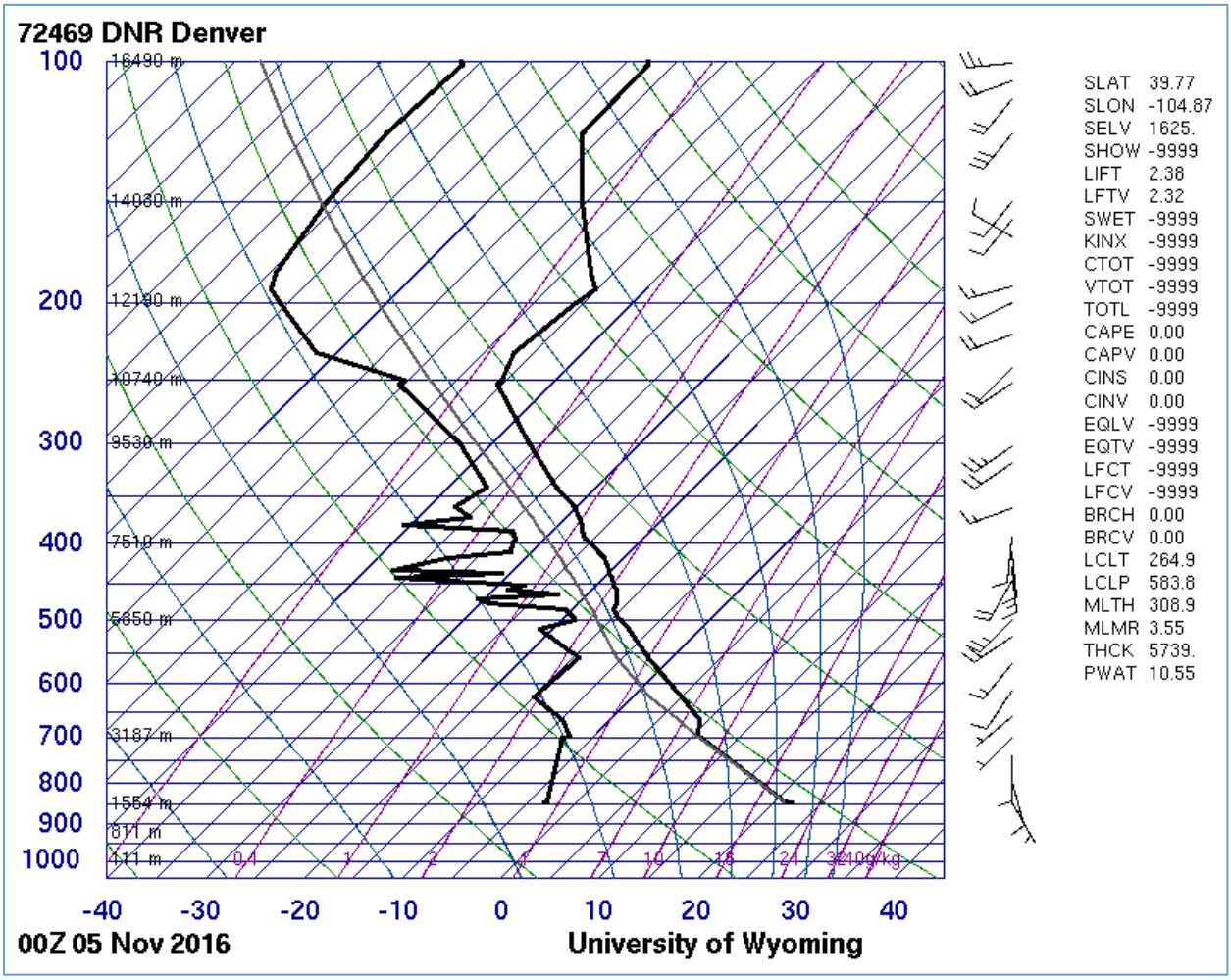

Figure 2: Skew-T Diagram for November 5th 2016

Experimental Setup

This image was created while monitoring the orographic clouds as they formed over the front range topography and matured as the sun began to set beyond the horizon. When I arrived on the scene, at about 4:00PM, the sky was initially clear. The clouds began to form as the sun was setting at about 5:45PM and the image was captured at 5:57PM as the temperature was dropping quickly and the wind speeds at ground-level progressively increased.

The image was shot during the final rays of direct sunlight were illuminating the high altitude clouds but not the landscape. This is what allowed for the deep contrast between the landscape in the foreground and the clouds above the front range on the horizon. This may have been what drove the cirrus transition as the clouds moved away from the mountains.

Photographic Technique

The image was shot on November 4th, 2016 at a lake located east of Boulder, Colorado. The image was shot using a Canon Rebel XTI digital DSLR camera. The following equipment and parameters were used to capture the image:

- Lens: 18-55mm Macroscopic Lens
- Shutter Speed: 1/625 Second
- Exposure Settings: ISO 200, F/9.0
- Image Resolution: Original- 4032 × 3024 pixels, Edited- 4032 × 2436 pixels
- Editing: Photoshop CS6 was utilized for post processing the image

A medium shutter speed was utilized to capture the clouds shown in the image. While the clouds were stationary relative to the landscape, the shutter helped to eliminate the presence of any motion blur in the image. An aperture of f/9.0 was used to capture the increased depth of field based on the perspective of the camera and length of the clouds in the image. A higher than normal aperture was required to capture the clouds from the foreground all the way to the back of the image. The field of view in the original image is likely 3-5 miles of clouds and skyline, ending at the rise of the mountain formations on the horizon.

Photoshop CS6 was used to post process the image. The resolution of the initial image was 4032 × 3024 pixels and was cropped down to 4032 × 2436 pixels to remove the foreground landscape from the photo and focus on the cloud formation above the horizon. The brightness was decreased and the contrast was increased substantially to create a distinct differentiation between the depth of the clouds and the sky. The color balance was also adjusted discretely to increase the contrast and really allow the clouds to emerge off the page, toward the viewer. The original and post-processed images are shown below.

Original Image

Figure 3: Original Image, Unedited

Edited Image

Figure 4: Final Image, After Post Processing

Commentary

While these clouds do not carry the same dramatic appeal as many of the stunning images documented thus far in the course, they were captured on a very pleasant Friday afternoon as a means to document the day spent enjoying the scenery outside of Boulder, CO. I especially enjoyed the deep perspective that was captured in the original image and utilized post processing to exemplify this perspective. The deep blues of the sky in the background create an appealing contrast with the warm reds of the clouds as they are illuminated by the fleeting rays on sunshine behind the mountains. For future work, this image would be interest to shoot as a time lapse, showing the formation of the orographic clouds and eventual transition to cirrocumulus as the uplift continues to push the parcels upward. Overall I am pleased with this image, as it illustrates the physics driving the cloud's mechanics, but also captures a fond memory of time well spent observing clouds and enjoying the final day of daylight savings time.

Citations

1. "Clouds Source: Excerpt from The Book " Weather "" The Airline Pilot's Forum and Resource. Accessed November 21, 2016. http://www.theairlinepilots.com/forumarchive/met/clouds.php#Stratocumulus.
2. Pidwirny, M. (2006). "Cloud Formation Processes". *Fundamentals of Physical Geography, 2nd Edition*. Date Viewed. http://www.physicalgeography.net/fundamentals/8e.html