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Clouds 2 Report  
Flow Visualization  
Prof. Hertzberg  
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Isolated Mountain Wave and Altostratus Clouds  
Capture 2:56pm, 11/23/20, Sedalia CO

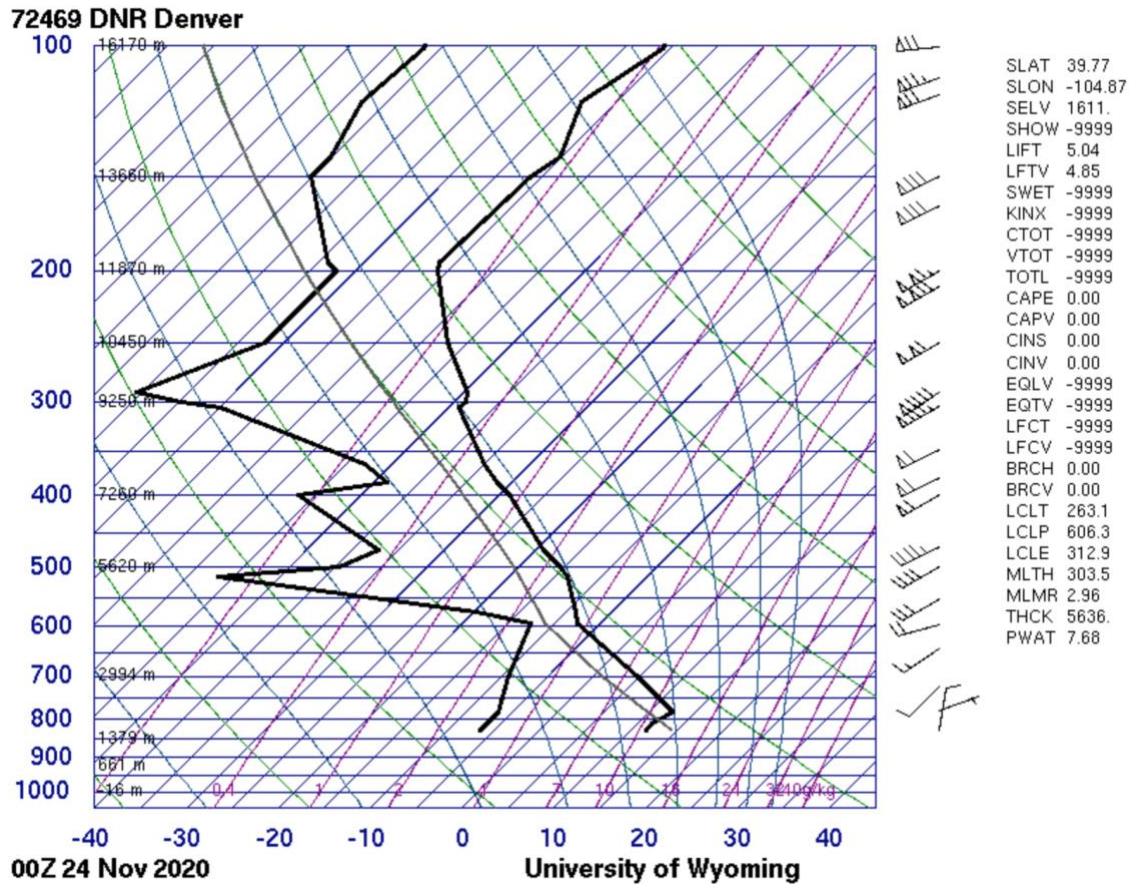


**Figure 1:** Mountain Wave Cloud captured while facing East. Taken from a vantage point in the foothills of Pike National Forest 5.5mi West of Sedalia, CO.

This image was captured, edited, and posted in fulfillment of the IV4/Clouds2 assignment in Prof. Hertzberg's Flow Visualization course at the University of Colorado Boulder. Most cloud imaging is about taking advantage of sudden opportunity, and this image was no different. These isolated mountain wave clouds were being produced in a mostly stationary location, appearing to curl over themselves like massive rolling pins. This image was taken to centrally frame these somewhat isolated mountain waves while capturing the depth of color in the atmosphere.

The image was taken at 2:56pm on Monday November 23rd 2020. The camera was facing about 52 degrees Northeast and 15 degrees upward, from a vantage point at about 7,000ft above sea level in the foothills of Sedalia, CO.

The somewhat Isolated horizontally arranged clouds central in the image are believed to be mountain wave clouds due to their apparent altitude, stationary nature, appearance and proximity to the mountains. The atmosphere was stable for Denver at 6pm that day, and weather history for that week shows no signs of impinging storm fronts. This combined with the 5-10 knot southwesterly wind at lower altitudes suggests a normal environment for orographic clouds. The upper layer of clouds are thought to be alto-stratus, likely between 13,000 and 15,000 ft based on the Skew-T Diagram (Figure 2).



**Figure 2:** Skew-T Diagram for Denver CO, at 0Z Nov 24th or 6pm on Nov 23rd, 2020. CAPE value of 0.00 means the atmosphere was stable.

This image was taken using a Canon Rebel T5i DSLR camera, equipped with a standard 18-55mm wide angle zoom lens with focal length 18mm and no image stabilization. The ISO light sensitivity was put at its lowest setting of 100, which helped to eliminate noise and motion blur, as well as lower the exposure and reduce washout in the bright whites of the clouds. A shutter speed of 1/4000 was used, in addition to a manual exposure shift of -0.67 EV because of how much light was available. The central clouds being photographed are thought to have been about 1-2mi from the camera, requiring a nearly infinite focus, and giving subject distance FOV of about 4 mi at the chosen zoom setting. The overlapping hills in the center horizon of the image is a feature locals refer to as “the notch” and was included in the image for both beauty and scale. Some optical zoom was used to get the proportion of sky to ground and properly illustrate the clouds present on the day. The original image was 5198 X 2462 pixels and was only minimally cropped to remove a brown tree on the left, since the optical focus was used to hone the subject framing and maximize use of the camera’s sensor. Somewhat of a procedure was used to edit the image for the effect of increased atmospheric depth. After minimally cropping as stated, the left and darker side of the RGB curve was lowered only slightly in DarkTable to darken the light greens in the forested areas, increase the contrast between the dark and light sides of the clouds, and bring out the vertical color gradient in the sky which ranges from the light blue on the horizon the deeper blue at the top of the frame. The exposure was then slightly increased by about +0.04 EV. This compensates for the heavy use of DarkTable’s haze removal tool, which was essentially used to give more definition to the cloud boundaries. Finally the Denoise and lens correction function were allowed to make minor adjustments automatically.



**Figure 3:** Left: Original image. Right: Image edited to bring out deep blues in atmosphere and make the central clouds more defined and with a broader light spectrum.

This image captures the gradient of blues from the horizon to the upper atmosphere very nicely. The added definition and contrast of the clouds was also achievable through editing. However, the editing choices trade overall light for contrast and coloration, giving a dark feeling in light. Another editing side effect is the discolored air above Denver, presumably from pollution, but possibly from smoke blowing across the planes.

## Website for Local Weather History

<https://www.accuweather.com/en/us/sedalia-co/80135/november-weather/2207663>