Cloud Image Report

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MCEN 4151: Flow Visualization: Dr. Jean Hertzberg

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The clouds in this photo describes multiple aspects of fundamental fluid dynamics, emphasizing different forces that can create the wind motions seen on this cloud. One purpose of this photograph is to show how multiple aspects of the weather can affect the local air characteristics. The main force creating the shapes in this picture is mostly wind shearing forces. However, as will be revealed later, there is more going on in this picture than meets the eye. The picture was taken on February 11, 2011 at 4:03 PM off of Valmont Road and Center Green Drive in Boulder, Colorado, facing west toward the Flatiron mountain range. What sticks out the most about this cloud is the fact that there is wind shearing on the top and the bottom, but occur in opposite directions from one another, giving some insight to the weather conditions at the time. Along with this, a lot of information can be gathered about the physics of a cloud and how their shapes can change with time and local weather conditions.

The classification for this particular cloud is Altocumulus Lenticularus. While the cloud doesn't display the traditional lens-shape clouds, the altitude where they form (which will be discussed with the Skew-T plot) and location of the clouds near the mountains put this one in this particular category. Near the Flatirons there is a warm wind front called a Chinook wind which causes warm air to come over the mountains. This helps to explain why we see most clouds to have a "stop point" near the mountains because the Chinook wind moves over the mountains, creating a barrier for the cloud which breaks up as it reaches this front, or help to create the lens-shaped clouds.[1] What is also interesting is the fact that there are two visibly different wind fronts occurring along this cloud. From the direction of the wind (and noting that this is *facing* the flatirons) we can see that the wind is moving from west to east on the top region of the cloud and from east to west on the bottom region.

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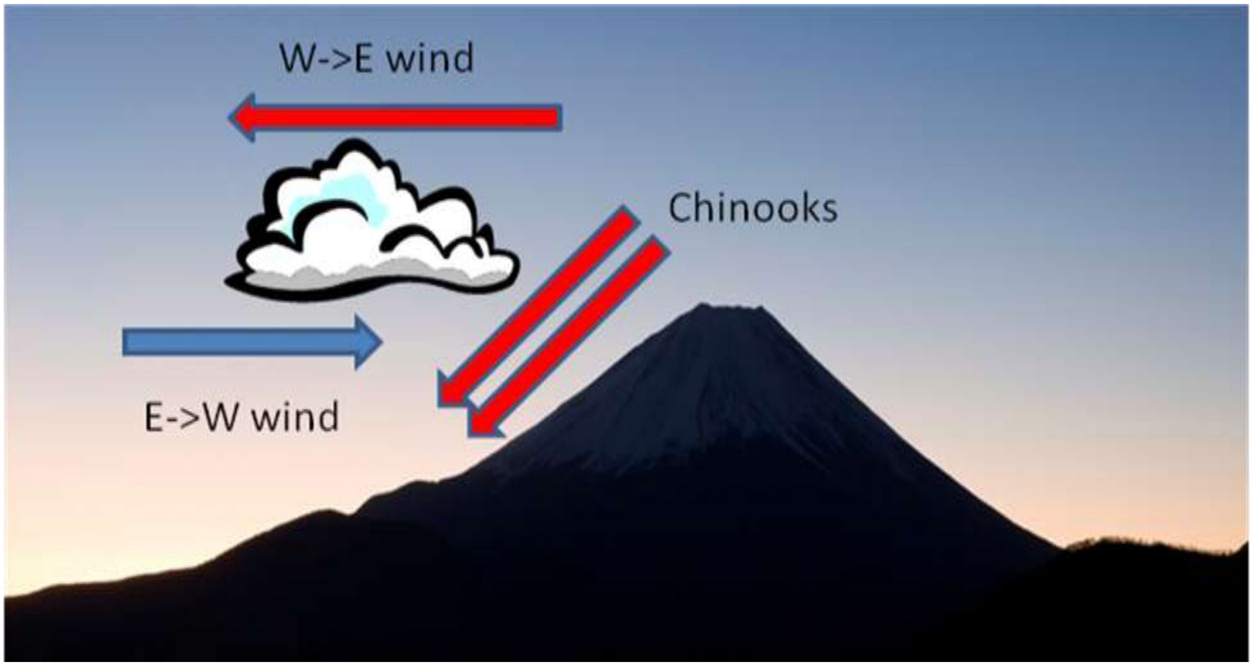
[1]Marshall, Jacque. "Boulder's downslope winds." *Boulder's Downslope Winds* 10 Apr. 2000. Web. 3 Mar. 2011. <http://www.ucar.edu/communications/factsheets/winds.html>



While the wind pattern appears somewhat complicated, the physics of the wind shearing helps to explain why the "tails" which can be seen on the top and bottom section of the cloud appear to drift in opposite directions. What is also interesting is the one stream cloud in the top right section of the photograph, which suggests the possibility of a contrail from an earlier jet or airplane flight. All of these things contribute to the reason the cloud is shaped the way it is, along with why the cloud stops near the mountain side.

For the reasons for why an altocumulus cloud was present, we must examine the Skew-T plot of the local atmosphere at this time of the day[2]. While the picture was taken at about 4 PM and the plot available closest to this time is at 6 PM, we can gather some information still about the local atmosphere.

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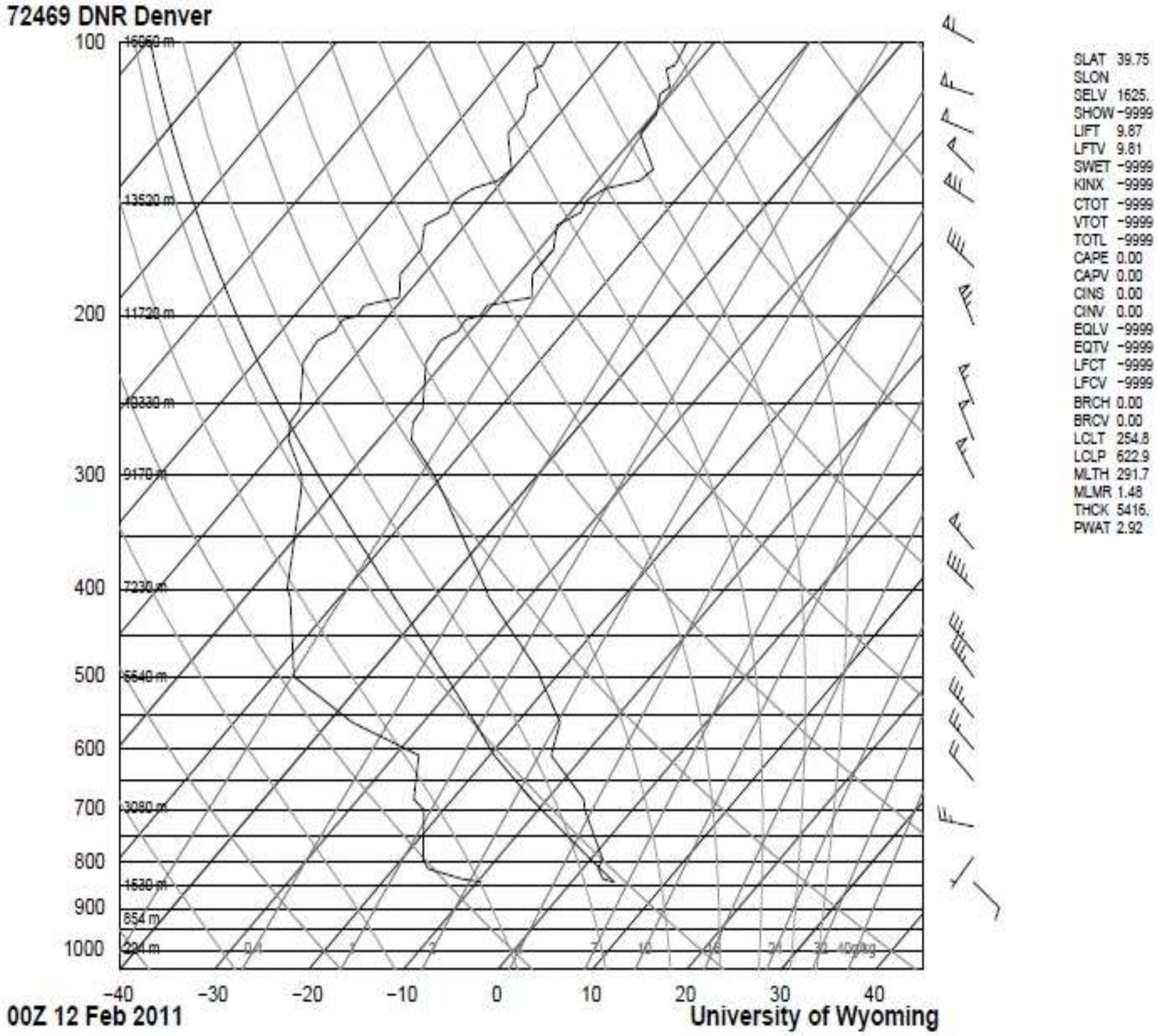
[2]Skew-T Plot DIA, 2/12/2011 00Z, Retrieved March 2, 2011, 8:30 PM. University of Wyoming Sounding Database.
<http://weather.uwyo.edu/cgibin/sounding?region=naconf&TYPE=PDF%3ASKEWT&YEAR=2011&MONTH=02&FROM=1200&TO=1200&STNM=72469>



What is first recognizable is that this plot is not of Boulder, but of Denver International Airport. When looking east from Boulder, there were hardly any clouds in the area so this cloud was one of a rare few that were visible at that moment in time. The plot also implies that the atmosphere was relatively stable considering how parallel the three plot lines are to one another. When looking at the plot, the lines shift from the parallel line going to the top left side of the plot to heading toward the top right, suggesting a change in temperature in the colder region[3]. This is when water is more likely to condensate since cold air holds less

[3] Hertzberg, Jean. PhD. Class Lecture: Cloud Physics: Skew-T, stable vs unstable. MCEN 4151: Flow Visualization: The Physics and Art of Fluid Flow. University of Colorado at Boulder, ITLL Room 1B50. February 7, 2011.

water vapor than warm air, allowing condensation at this area. The altitude of around 7000 m is where altocumulus tends to form so this explains why the cloud is classified as an altocumulus.

The camera that was used to take this picture is a Canon Exilim EX-H5 which has a pixel count of 12.1 Mega Pixels. The ISO was set to a value of 64 since the sun admitted a great deal of light despite being hidden by the cloud. The focus was also at a value of 10.1 and a shutter speed of 1/800 of a second, which gave a nice resolve of the cloud so that there wasn't too much sun exposure to make the picture unusable. The picture shows a great amount of detail inside the cloud by allowing the sun to be completely covered by the cloud. This timing really helps to not only control the light but also expose the density of the cloud and where the cloud nucleated from*

The cloud was an amazing timing of the sun setting in the west but allowing the cloud to be at just the right angle to show an amazing amount of detail in the physics of cloud formation and wind shear. Along with this, the Chinook effect over the mountain range is beautifully exposed to reveal why Boulder can have relatively mild winters. Overall the picture provided much more information than anticipated and brought into light a physics which is a staple of the Boulder area, a very unique climate area in the state of Colorado.

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*To nucleate means to originate in one particular region and to then grow outward from that location. Typically how clouds form and then grow, depending on the local weather conditions and the moisture content.