CLOUDS

March 12, 2014
MCEN 5151

Kelvin–Helmholtz Instability By: Eric Fauble

Introduction:

The purpose behind this photo was to encourage students to start looking at clouds as being a part of the dynamic fluid that is our atmosphere, and how the shape and movements of clouds provide clues about what's really going on up there. This photo is the first of two cloud pictures I will be taking for MCEN 5151, and it illustrates the shearing phenomenon known as the Kelvin—Helmholtz instability[1].

Location:

This photograph was taken at the Winter Park Ski Resort in Winter Park, Colorado looking southwest off of the Eskimo Lift. The photo was taken around 1pm that afternoon as clouds started to move in from the horizon. It should be noted that the clouds that spotted the sky, for the most part, were not direct overhead, but rather of some distance away.

Figure 1: Map of Winter Park Ski Resort shows the location of the photo[2]

About the Cloud:

The weather report for January 6th was sunny skies in the morning with clouds developing in the early to late afternoon due to a storm that would be moving in in the next day. During the morning hours there was no presence of ground winds, however, as the clouds became visible and moved across the sky the wind came with it. Figures 2 and 3 from Weatherspark.com confirm these observations and show the snow from the storm that moved in as well as the wind that developed in the early afternoon. Weatherspark also was able to provide information regarding the cloud ceiling. It indicates the ceiling to be about 8000 ft.[3] From this information as well as the physical description of these clouds from The Cloudspatter's Guide it was determined that this is a photograph of a stratocumulus cloud.[4]

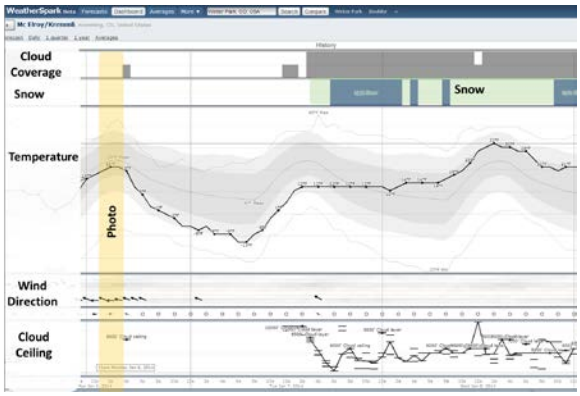

Figure 2: Weatherspark plot shows that a storm moved in the next day resulting in snow

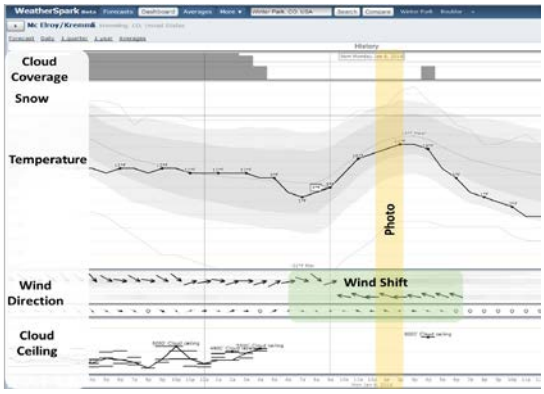

Figure 3: Weatherspark plot illustrates the wind change that occur during the day

The changing wind direction shown in Figure 3 may have been responsible for creating the Kelvin—Helmhotz instability in the clouds. This instability is the result of a shear force created when different fluid bodies flow past each other at different velocities. The fluid body moving at a relatively faster speed generates a low pressure zone at the boundary layer. This pulls the slower body into its path which then results in the "ocean wave" curl.[5]

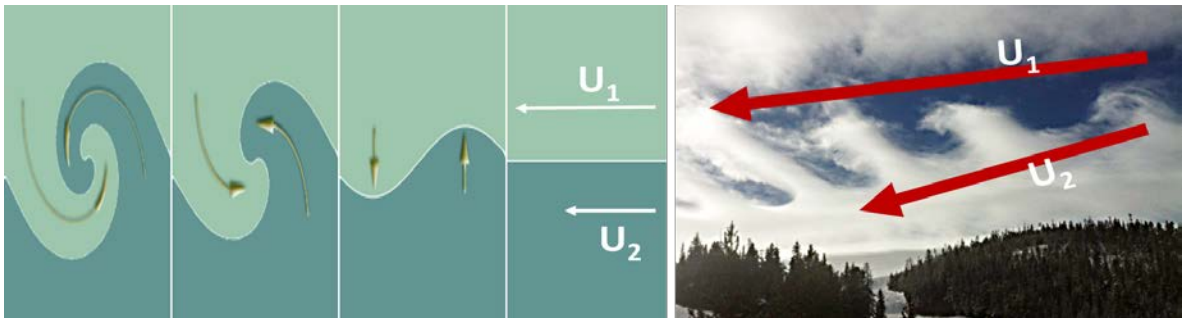

Figure 5: Physics behind the Kelvin-Helmholtz

The atmosphere that was associated with this cloud formation turned out to be fairly stable. The Skew-T plots shown below show the atmospheric condition in

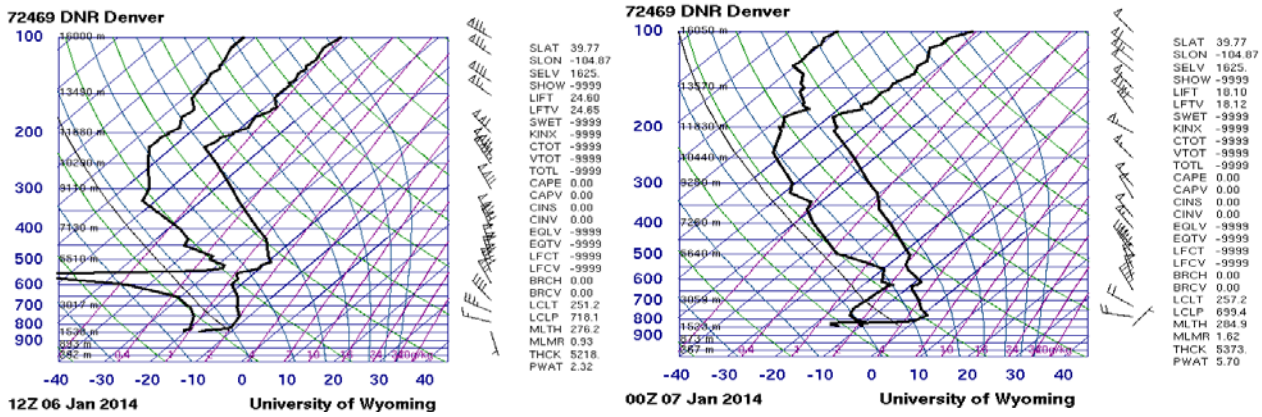

Figure 6: Skew-T plots Denver Jan 6th at 6am (left) and Jan 6th at 6pm (right)

Denver during that day. As you can see the CAPE is 0.00 indicating stability. The Skew-T plots also confirm a significant wind change in the lower atmosphere.[6]

Photographic Info:

This photo was shot using an iPhone while riding the Eskimo chair lift in Winter Park. Upon uploading the photo I was able to determine various photographic information. The photo graph was taken with a 3.9mm focal length, f/2.8, ISO 80, and a 1/6033 shutter speed. From here the original photograph underwent some post processing where it was cropped, brightened and sharpen.

Figure7: Original on the left, edited image on the right

Reflection:

I like how this image captures a Kelvin-Helmholtz instability because the wave-like shapes that it creates are not often associated with clouds. Thus, it helps us remember that the atmosphere is still a fluid and can flow like the ocean. One aspect of the photo that I like is how one is able to see the large scale of these clouds compare to the evergreen trees in the foreground. If I was too take this photo again, I would wish to take it with a better camera. Hopefully a better camera would improve the sharpness and clarity of the photo.

Bibliography:

[1] Dyke, Milton Van. *An Album of Fluid Motion*. Stanford, CA: Parabolic, 1982. Print.

[2] "Winter Park Resort." *Skimap.org*. N.p., n.d. Web. 17 Mar. 2014.

[3] "WeatherSpark Beta." *Beautiful Weather Graphs and Maps*. N.p., n.d. Web. 17 Mar. 2014.

[4] Pretor-Pinney, Gavin, and Bill Sanderson. *The Cloudspotter's Guide: The Science, History, and Culture of Clouds*. New York: Berkley Pub. Group, 2006. Print.

[5] "Cloud Structures - 'Kelvin-Helmholtz Instability' Cloud Structure - Description." *Cloud Structures - 'Kelvin-Helmholtz Instability' Cloud Structure - Description*. N.p., n.d. Web. 17 Mar. 2014.

[6] “Weather”. University of Wyoming—College of Engineering—Department of Atmospheric Science. Website Accessed February 18th, 2014. http://weather.uwyo.edu/upperair/sounding.html