

Cirrus Vertebratus

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Flow Visualization

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Project #5 (Clouds 2)

Due 11/29/07

Purpose:

This is the fifth project of the semester, and like the first cloud project, our purpose is to photograph some clouds, and explain the physics behind our picture. The picture should be at least somewhat aesthetically pleasing or interesting to the observer, while the physics should be easily explainable. The photograph specific to this paper attempts to show some lower level cirrus clouds forming above the western mountains in Boulder, Colorado. The report will hopefully provide insight into the reason of these formations from a scientific standpoint.

Taking the Photograph:

The image was taken on 11/18/07 near NCAR (National Center for Atmospheric Research) in Boulder, Colorado facing the western mountains. It was afternoon, approximately around 2:00pm. The sun was moderately covered by clouds, and so sunlight wasn't causing any halo phenomena, but provided sufficient illumination. The photograph shows cirrus clouds forming in front of a thick cloud sheet in the background. The reason this works out really well is because of the contrast of the cirrus clouds to the background. The final photograph after Photoshop adjustments is shown below (Figure 1).

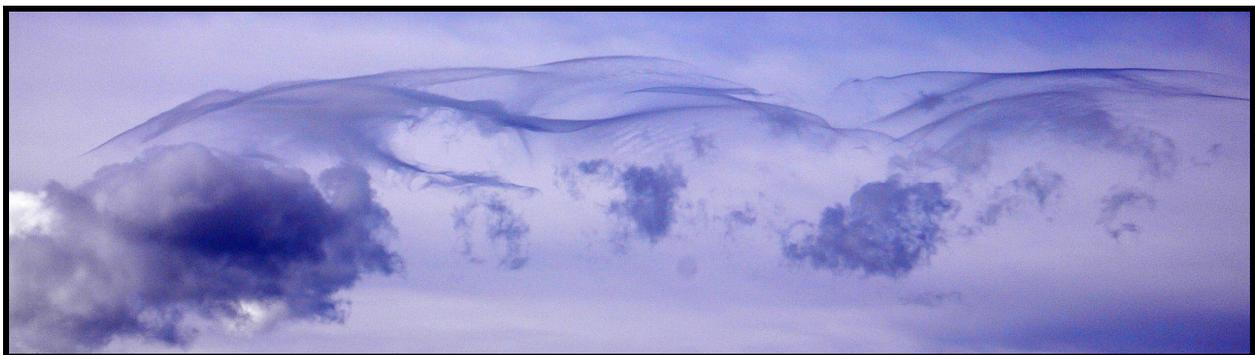


Figure 1: Cirrus Vertebratus

Physics:

As the observer can see, there are white clouds behind the grayish-bluish cirrus clouds. This allows for a very nice contrast, and provides detailed visual information for these cirrus clouds. There are really two different types of clouds visible in this photograph. The report will talk about the wispy upper clouds in particular, but this shows two fundamentally different types.

The lower patchy clouds are most likely Cumulus Fractus, right below a transitioning point into the formation of cirrus clouds. “Cumulus Fractus are fair weather clouds broken up by strong winds.” [1] The wispy upper clouds are known as Cirrus Vertebratus. Most Cirrus clouds appear in the form of bright white filament like strands really high up in the sky. They can form anywhere from 16,500 ft and up, hence the formation of them in the picture specific to this report. It is estimated that the picture shows clouds at about 14k-20k ft. Cirrus clouds are composed of ice crystals. In this photograph, these clouds appear as wispy strands that somewhat resemble a fish skeleton. This formation is specific to the term Vertebratus. Clouds can resemble this formation when the elements are arranged in a way such that they observably look like vertebrae, ribs, or a fish skeleton. [2] This mainly happens in Cirrus clouds.

Sounding Data:

Sounding data [3] was taken for this date and time to try and relate what was happening in the atmosphere to our cloud formations. Looking at the sounding data below (Figure 2), the theoretical air parcel (black dotted line) doesn't actually pass the dew point temperature line (black solid line) until around 10km (~30k ft). This would suggest the formation of clouds at that elevation, but below that point, we can look at the stability of the atmosphere to better understand our situation. If we look at the plot for most elevations below 10km, the atmosphere seems to be marginally stable, because the air parcel path is really close in slope to that of the local temperature profile. The existence of clouds in our regime (14k-20k ft) can be explained by how close the dew point line is to the local temperature line at the point. We can also see that at this elevation, it is cold enough for ice crystals to be present, suggesting the existence of Cirrus clouds.

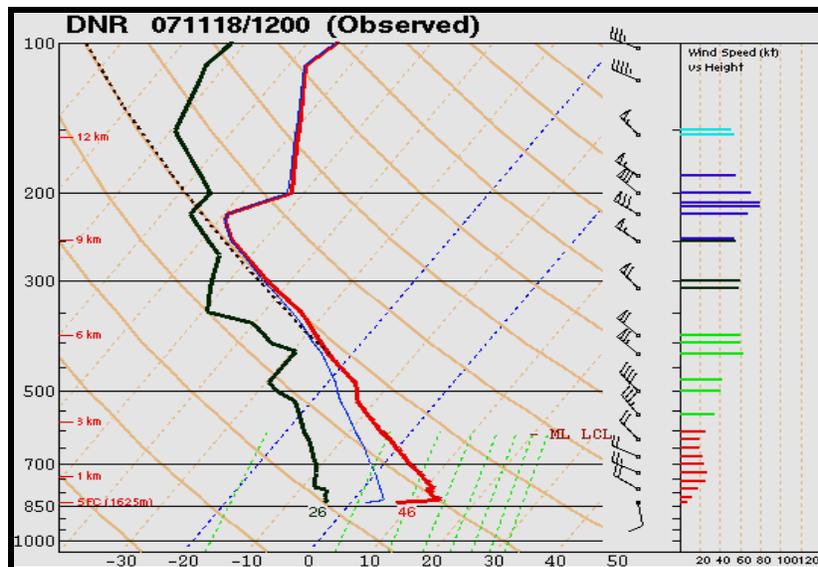


Figure 2: Sounding Data for 11/18/07

Photographic Technique:

The resolution wasn't a particular concern for this photograph, both spatially and temporally. The reason being the fact that the picture was taken anywhere from 16k-20k feet away, and fast movements of the clouds would result in relatively small movements to the observer. Also, the illumination was provided by the neighboring sun, and no other visualization techniques were used.

- Make/Model: Panasonic Lumix DMC-FX7 2560 X 1920 Pixels
- 35mm equivalent, 5.8mm – 17.4mm focal length range, 2.8 – 5.0 F-Stop range
- Actual specs for cloud photo: 17.4mm focal length, 10.0 F-Stop
- Field of View: ~10k-20k feet
- Exposure Specs: 1/125 sec exposure, max aperture value of 3.0, ISO speed rating of 80

The contrast was increased, and the brightness decreased to bring out the details of the front Cirrus clouds in Adobe Photoshop. This proved to give a smoother image, and provided more detail information for the observer. The image was also cropped, to remove distracting details. The original photograph is compared to the adjusted one below (Figure 3), to show this added information.

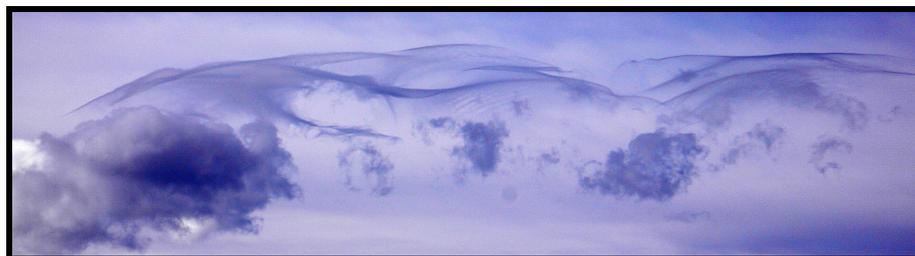


Figure 3: Comparison Between Original and Final Image

The Image:

There is a really high contrast between the closer clouds (darker ones) and the distant clouds (white ones). The fish skeleton resemblance of the clouds is well portrayed, showing the Vertebratus phenomenon. The most interesting aesthetic aspect of this photograph is the really thin wispy characteristic of the Cirrus clouds. It is almost as if someone placed dark strands up in the sky with a white cloud sheet background. It is aesthetically pleasing, and mysterious. There have been several surreal looking clouds in the Boulder sky as of late, and have provided numerous opportunities for great photographs.

References:

[1] Cloud Chart Incorporated. Purdue University. Department of Earth and Atmospheric Sciences. Provided in class. Available online: www.purdue.edu/eas

[2] Abridged Atlas. *International Cloud Atlas*. World Meteorological Organization. 1956. Reprinted in 1969. Provided in class by Prof. Jean Hertzberg.

[3] Sounding Data. Available online:

<http://www.spc.noaa.gov/exper/soundings/>