Clouds 1

Radiation Fog Above Boulder, CO

Carl Marvin – March 4th, 2014

Introduction

This time lapse was taken as an assignment for a course called “Flow visualization” at CU Boulder. The intent of the course is to visualize flows through photographic and videographic mediums in an artistically beautifully and scientifically significant way. Time lapses are a great way to expose motion that is too slow for the human eye to perceive. While fog is beautiful to look at, it also gives great insight into the physics of ground level atmospheric dynamics.

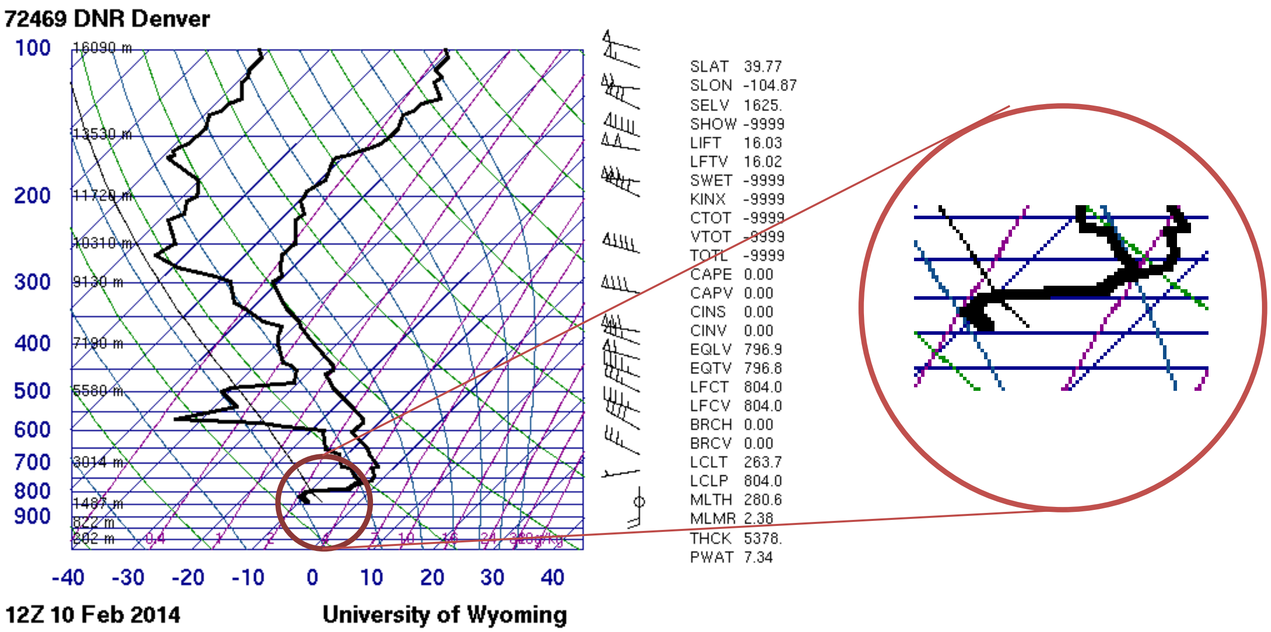
Image Circumstances

The two time-lapses were taken on the night of February 9th, 2014 from on top of the second flatiron rock formation above Boulder, CO. The first time lapse was taken from 8pm-9:30 pm, and the second time lapse was taken from 9:30pm – 11pm. Both series of images were taken from an elevation of 6780 feet above sea level. The first image was taken at a heading of 150 degrees, with a camera elevation of 5 degrees above horizontal. The second image was taken at a heading of 50 degrees with a camera elevation of 15 degrees below horizontal. [Calculated using Google Earth]

The images above were taken from Google Earth where the heading and elevation calculations were taken.

Atmospheric Conditions

The atmosphere was stable when the time-lapse was being taken. This is known by looking at the SkewT diagram from the night of February 9th. The following skewT diagram is from Denver, CO, and the atmospheric sounding was taken at 6pm.[Image from University of Wyoming atmospheric sounding archive]



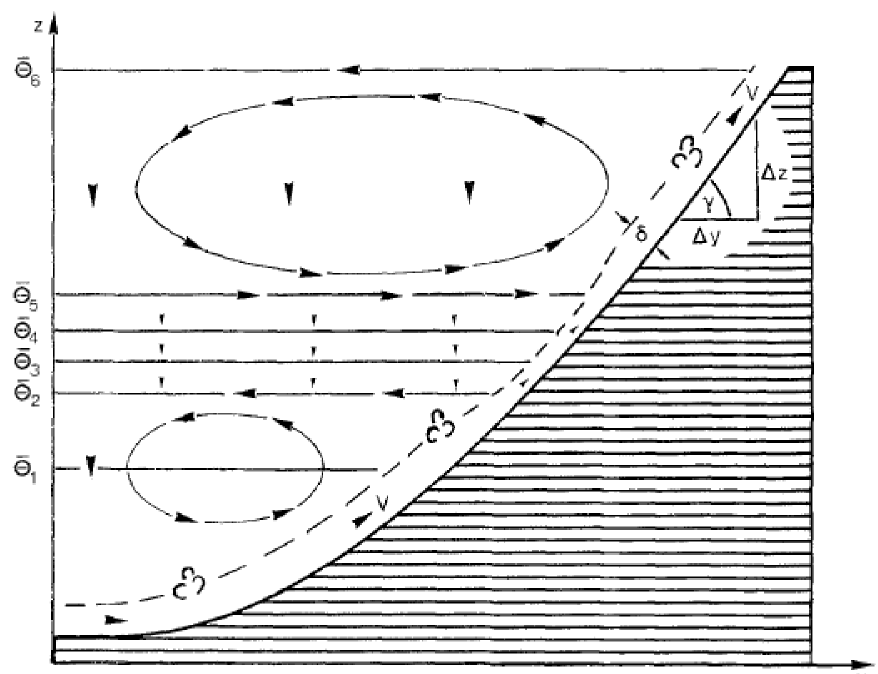
SkewT diagram with detail from 1480m – 3000m

As mentioned before, the atmosphere was stable at the time the image was taken. This is known from the “CAPE” value on the right hand side, which in this instance is 0. The CAPE value is the integral of the area between the dew point and the temperature profile of the sounding. In this case, the dew point profile is left of the temperature profile throughout the atmosphere, indicating a stable atmosphere. Interestingly, though, the temperature profile almost exactly matches the dew point profile from 1480m to 3000m. This is indicative of the fog that was imaged in the time-lapses, since clouds will condense at elevations with similar dew points and temperatures. The two profiles appear to diverge at about 2000m meters, and the image was taken from about 100m above that, so that shows that I was just above the fog layer for my image.

Ground-Level Atmospheric Dynamics

Radiation fog forms during the night when ground that was heated by the sun during the day radiates its heat back to the atmosphere. As the ground cools during a clear night, it cools air around it below its dew point, and clouds are formed at ground level. [1] This low level fog is not only beautiful; it shows the wind and displays the atmospheric dynamics quite well. Boulder is situated directly adjacent to the mountains, with Boulder canyon emptying into downtown Boulder.

In the first time-lapse, slope winds can be seen. Slope winds are driven by heat exchange up and down the mountain face, and are very intermittent and localized.[2] In the first time lapse, this is visualized as the fog reaches up in short bursts above its average elevation when it is next to the mountain slope.



Cross Section Of Slope Winds from (2) [Vergeiner, I., and E. Dreiseitl]

As mentioned before, Boulder Canyon empties directly into downtown Boulder. Winds up and down valleys can occur due to temperature differences at the top and bottom of valleys.[3] In the second time lapse, wind from boulder canyon can be seen creating circulation and blowing consistently from left to right in the upper left hand side of the video.

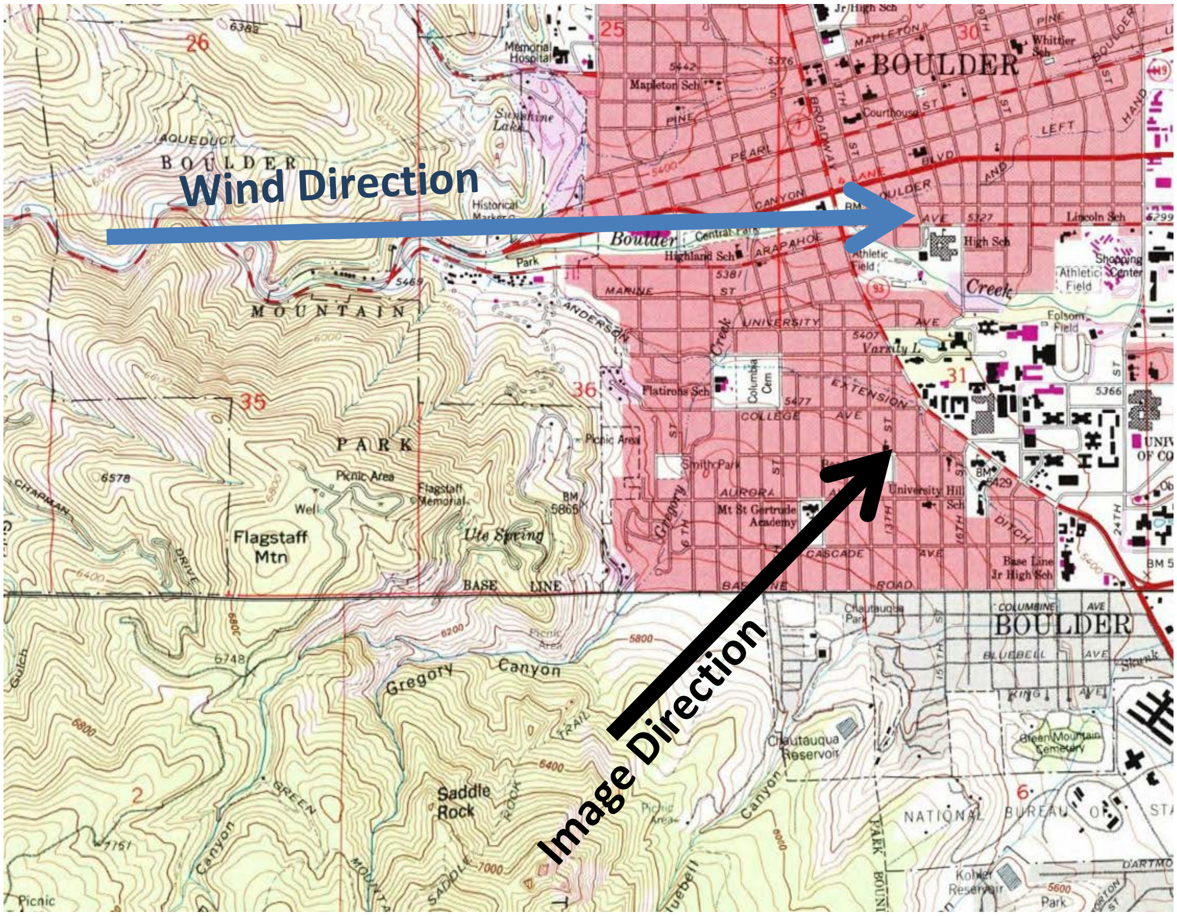


Image From USGS topgraphical maps

Imaging Details

Both Timelapses were taken with a Canon Rebel T2i Camera and a Sigma 10-20mm lens. The first time lapse was created from a series of 93 images, and the second time lapse was created from a series of 256 images. For each timelapse series, image data is as follows:

TIME LAPSE SERIES 1	
Exposure Time	15 Seconds
Aperture	4.0
ISO	400
Focal Length	10mm
Image Delay	20 Seconds

TIME LAPSE SERIES 2	
Exposure Time	6 Seconds
Aperture	6.0
ISO	800
Focal Length	10mm
Image Delay	8 Seconds

Raw, unedited stills from each series was edited using batch processing in Photoshop CS5 to increase contrast, correct white balance, and bring out detail in the shadows. Next, the images were spliced into an uncompressed AVI file using VirtualDub at a framerate of 24fps. The uncompressed AVI was then processed through adobe premiere elements 9 to add titles and music. Raw unedited photos can be found in the appendix, figures 1 and 2.

Works Cited

1 Guedalia, Daniel, and Thierry Bergot. "Numerical forecasting of radiation fog. Part II: A comparison of model simulation with several observed fog events."*Monthly weather review* 122.6 (1994): 1231-1246.

2 Vergeiner, I., and E. Dreiseitl. "Valley winds and slope winds—Observations and elementary thoughts." *Meteorology and Atmospheric Physics* 36.1-4 (1987): 264-286.

3 Whiteman, C. David, and J. Christopher Doran. "The relationship between overlying synoptic-scale flows and winds within a valley." *Journal of Applied Meteorology* 32.11 (1993): 1669-1682.

Appendix

Figure 1

Figure 2