Cloud Image Report

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Flow Visualization

February 25, 2009

Context & Purpose

The intent of this assignment was for each student to individually photograph clouds in the atmosphere that displayed something of interest. Time was spent hiking through the outskirts of Boulder on very sunny to fairly sunny days for observing clouds and taking pictures. The aim of this particular image chosen was to show the audience two different types of clouds and to demonstrate the effect the flatiron mountains have on incoming clouds from the west.

Setting of Photograph

The image chosen for the report was taken from Chautauqua Park in Boulder. The trailhead at the base has an elevation of 5,710 ft, however the photo was captured after walking up the hill, so at roughly 5,900 -6,000 ft above sea level [1]. The image was taken at 2:40pm, which was at the same time of a drastic change in the wind direction. The wind preceding the image was heading primarily west and northwest, whereas after the image the wind shifted to the south and then east [2, 3]. There was also a sudden drop in the measured barometric pressure at that time, which may have contributed to the abrupt change in wind velocity [2]. These factors illustrate that the cloud formation that day was possibly unstable. The camera was pointed towards the east, and was at a very slight angle upwards, possibly around 5 degrees from the horizon. At the time the image was taken the wind was headed northwest at about 30 mph at a temperature of 55 degrees Fahrenheit (data in appendix).

Cloud & Weather Interpretation

The intent of the image was successful in attempting to capture at least two types of clouds. The long horizontal flat clouds higher in altitude are Cirrus clouds. It is difficult to tell exactly which type of Cirrus, but it is likely that they are either Cirrostratus or Cirrus Radiatus. The closer, lower elevation, clouds are Cumulus, probably Cumulus fractus because of the strong winds associated with them correlate to the weather that that time of day. The rest of the sky was mostly sunny. There were other Cirrus and Cumulus clouds scattered from my point of view. However it was interesting to notice that looking to the west were primarily Cirrus clouds. Similarly, the east was more dominated by Cumulus clouds. This suggests that cold air from the Rocky Mountains was headed towards Boulder that day, bringing the ice clouds with it. The Cirrus clouds became less popular looking to the east. It was interesting to have the two different types of clouds in the same image.

Measuring the stability of the atmosphere in a location on a given day is not a perfect science by any means. There are many factors that affect the stability. The closest skew-T plot available for reference (of weather from February 16 at 2:40pm) is from Denver and is inserted below [4].

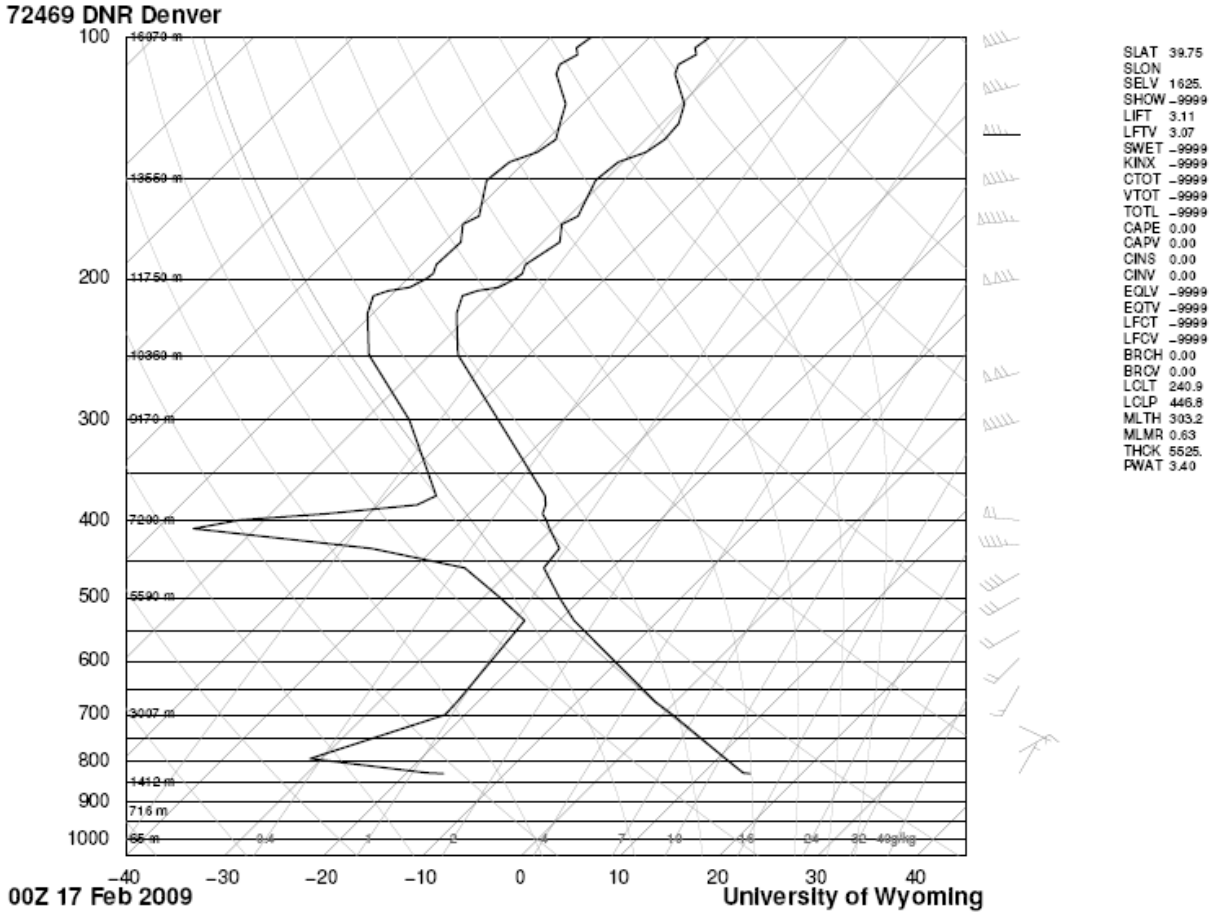


Figure 1: Skew-T Plot of Denver Area [4]

Based off the plot, the atmosphere seems to be stable because the LIFT coefficient is greater than zero, being 3.11. Cloud information can also be gathered from the plot. It is common for clouds to form when the distance between the two representative lines at any given altitude is less than 10 degrees Celsius apart [5]. This case is true at heights of about 5,000 meters (16,400 ft) and 11,000 meters (36,000 ft). Therefore the Cirrus clouds are located at the upper height and the Cumulus clouds are situated at the lower elevation. The direction of the wind changes dramatically in the lower elevations of the plot but settles in the east direction in middle and upper atmosphere. The magnitude of the wind also varies with height, but with little pattern. Generally speaking, the magnitude increases with altitude. The surface

level winds are only moving at about 10-20 knots, the middle and upper atmospheres experience winds up to 100 knots [6]. The sharp changes in temperature, located at 2,000 meters (6,600 ft) and 7,000 meters (23,000 ft) are likely to be boundary layers in the atmosphere.

It is likely that orographic lift is contributing to the stability in the atmosphere in the area. This effect takes place when air is forced into a higher elevation because of rising terrain, such as the flatirons [7]. Because the air is forced into upper altitudes it cools and often forms clouds. It is possible that some of the Cumulus clouds in the image were formed in this method because the wind prior to the photograph was headed west, therefore up the flatirons and raised into the atmosphere. As the clouds form they stabilize in elevation based off the temperature of the surrounding air. These clouds may oscillate in altitude until they become stabilized, like an under damped mechanical system. The nearest weather data collection center to Chautauqua Park is NCAR, in the foothills off of Table Mesa. Prior to the photo there are primarily winds headed west and northwest. The next closest location is in south Boulder, which suggests the wind at the time was going northwest. This supports the orographic lift effect in the area and may have significantly contributed to the formation of the Cumulus clouds.

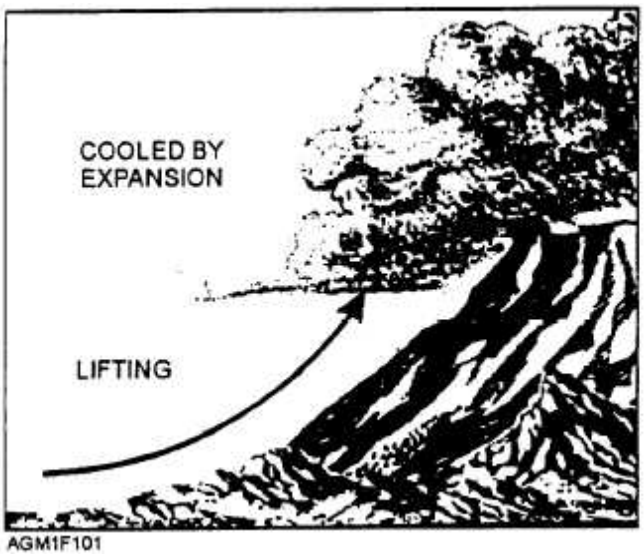


Figure 2: Illustration of Orographic Lift [7]

Photographic Technique

It is estimated that the field of view is 10 miles based of the lake in the far distance. The distant objects (Cirrus clouds) are approximately 7 miles away in the y axis and 10 miles in the x axis, so therefore approximately 13 miles from the lens of the camera. The dimensions of the image are 3456 x 2304 pixels with 2000 dpi. The color representation is sRGB. The type of camera used was a Canon EOS Digital Rebel XT. The focal length was 18 mm. The exposure time was reduced to 1/500 sec to prevent over exposure. ISO speed was set 100 because there was plenty of light. The aperture value was 9.

Photo processing was used on the original image to decrease the brightness and enhance the contrast between the clouds and the sky as well as between different types of clouds. At first several steps were taken to make the imaged how I envisioned it. The blue and green wavelength colors were reduced in amplitude because these colors, especially the blues were abundant in the original RAW image. The white balance was shifted into shade mode and the contrast was increased. The exposure was also decreased by 0.3. At the end the brightness was dramatically decreased to create the dark effect on the edges of the image.

Conclusion

In my opinion this photo is a good image of the unique atmospheric conditions we have here in Boulder. I wanted to capture two different types of clouds in one photo, which I did, but was unable to effectively show the orographic lift affect. The cloud physics are clearly shown, in that the high altitude Cirrus clouds enter the area from the west, but it is not visually obvious how the Cumulus clouds are formed. This is one aspect that I would have liked to improve on. If there was a day, or just a time when clouds were formed in the flatirons themselves and gained altitude, an ideal picture could have been made, but it is rare to observe that scenario. Another way to improve the image would to have a panoramic lens so that I could capture a wider field of view. I chose to dull down the edges of the image to really focus the audience on the clouds themselves. I think that this affect makes it easier to judge the distances and elevations of the clouds. The contrast is enhanced and is it easier to distinguish between cloud types. The processing of the image also widens the range of colors (spectrum). The original image had no black pigmentation and very little grey and dark brown, while the final photo has these colors and emphasizes the attention of the audience to the clouds.

Appendix

Atmospheric Conditions from Weather Underground:

NCAR Weather Data

History for MNCARM

NCAR Table Mesa NCAR, Boulder, CO — Current Conditions

The data provider for this station: INTERNET

Daily Summary for February 16, 2009

« Previous Day | MNCARM | name=graphspar | Next Day »

February | 16 | 2009 | View

Daily | Weekly | Monthly | Yearly | Custom

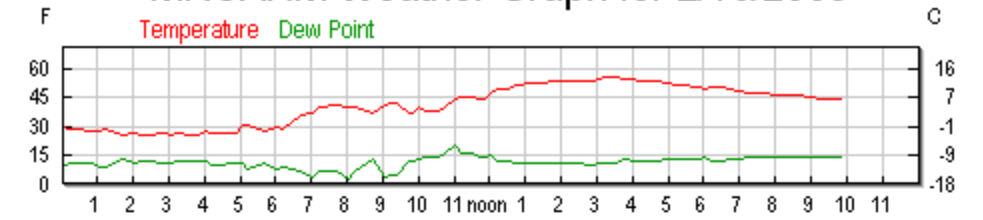
	Current:	High:	Low:	Average:
Temperature:	**50.0** °F	**56.0** °F	**26.0** °F	**42.0** °F
Dew Point:	**21.0** °F	**20.0** °F	**3.0** °F	**11.6** °F
Humidity:	32%	57%	17%	31%
Wind Speed:	**7.0**mph	**17.0**mph	-	**8.4**mph
Wind Gust:	**21.0**mph	**33.0**mph	-	-
Wind:	SSE	-	-	NNE
Pressure:	**30.02**in	**29.98**in	**29.79**in	-
Precipitation:	**0.00**in			

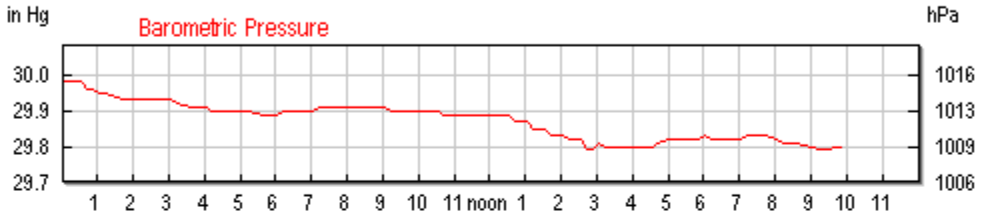
Statistics for the rest of the month:

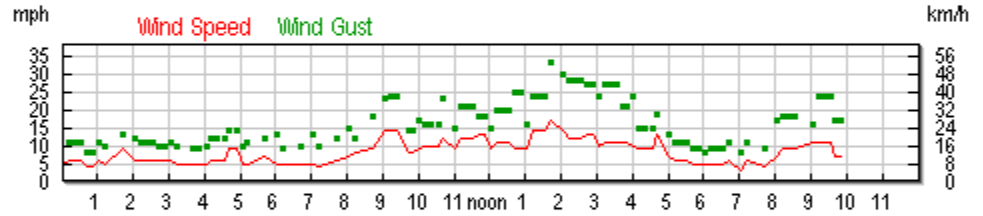
	High:	Low:	Average:
Temperature:	**64.0** °F	**17.0** °F	**38.7** °F
Dew Point:	**31.0** °F	**-10.0** °F	**12.5** °F

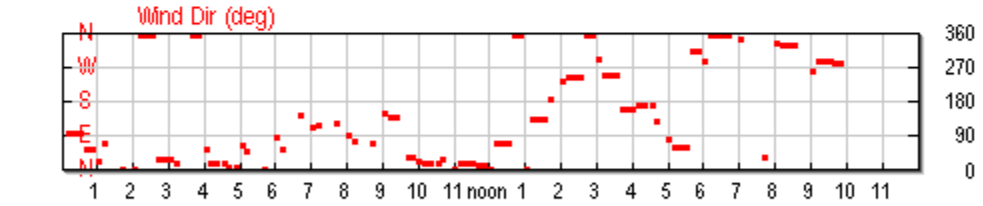
Humidity:	94.0%	8.0%	39.2%
Wind Speed:	**36.0**mph from the West	-	**10.3**mph
Wind Gust:	**72.0**mph from the West	-	-
Wind:	-	-	SSW
Pressure:	**30.35**in	**29.25**in	-
Precipitation:	**0.00**in		

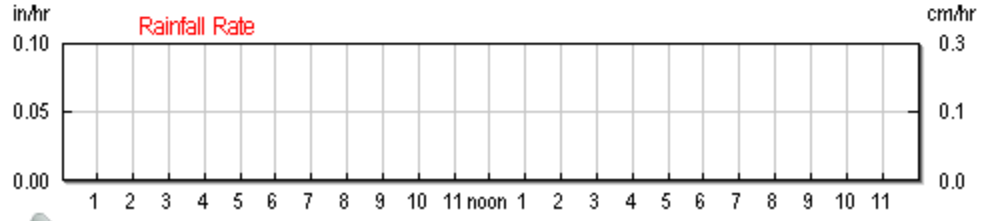
MNCARM Weather Graph for 2/16/2009











South Boulder Weather Data

History for KCOBOULD10

South Boulder, Boulder, CO — Current Conditions

Daily Summary for February 16, 2009

« Previous Day | KCOBOULD10 | name=graphspar | Next Day »

February | 16 | 2009 | View

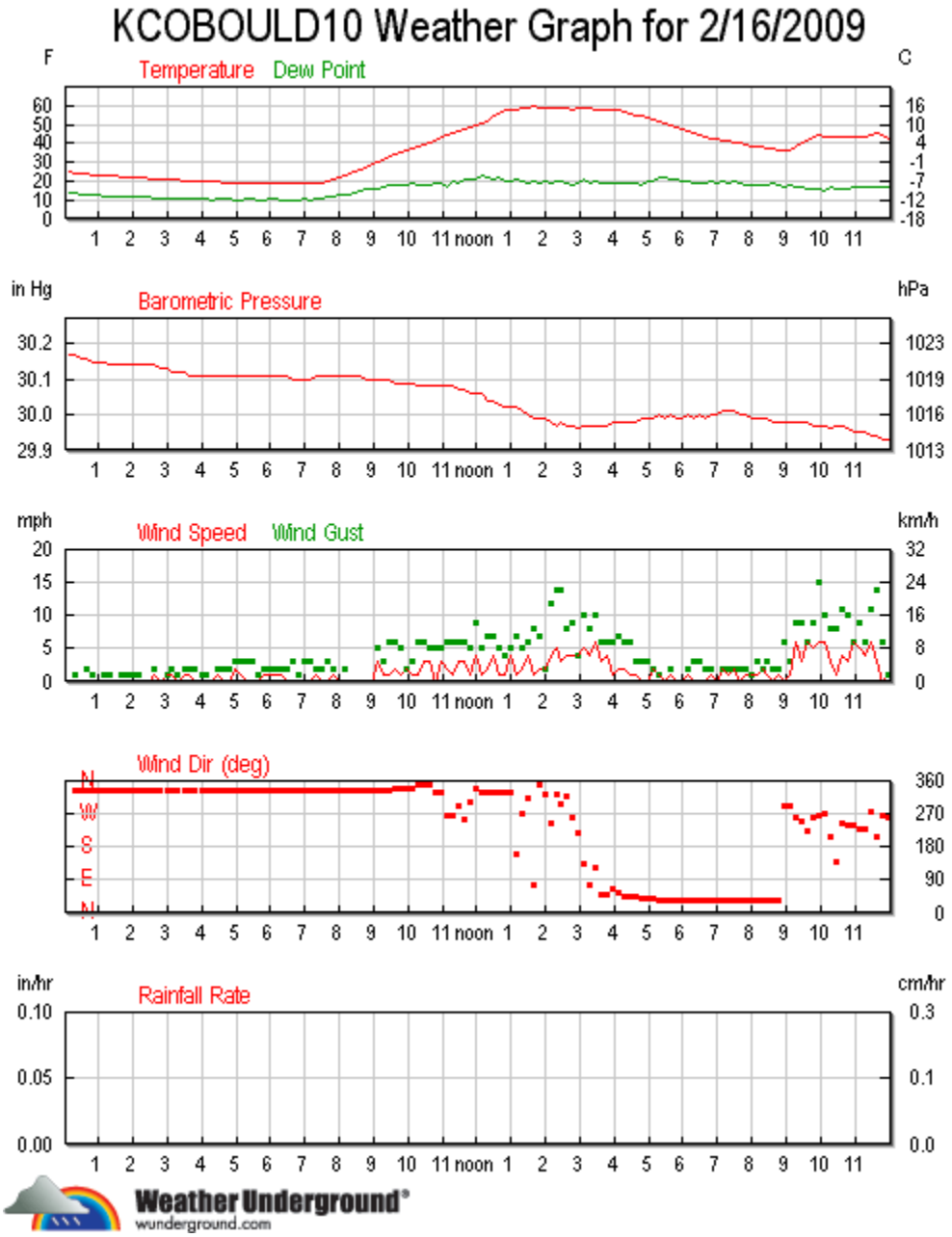
Daily | Weekly | Monthly | Yearly | Custom

	Current:	High:	Low:	Average:
Temperature:	**46.6** °F	**59.4** °F	**18.3** °F	**37.2** °F
Dew Point:	**21.7** °F	**22.8** °F	**9.8** °F	**15.8** °F
Humidity:	37%	70%	21%	46%
Wind Speed:	**2.0**mph	**6.0**mph	-	**1.5**mph
Wind Gust:	**5.0**mph	**15.0**mph	-	-
Wind:	SSE	-	-	NW
Pressure:	**30.17**in	**30.17**in	**29.93**in	-
Precipitation:	**0.00**in			

Statistics for the rest of the month:

	High:	**Low:**	**Average:**
Temperature:	**66.2** °F	**15.2** °F	**38.0** °F
Dew Point:	**32.0** °F	**-4.8** °F	**15.1** °F
Humidity:	86.0%	11.0%	42.7%
Wind Speed:	**39.0**mph from the West	-	**2.6**mph
Wind Gust:	**47.0**mph from the West	-	-

Wind:	-	-	WSW
Pressure:	**30.46**in	**29.51**in	-
Precipitation:	**0.24**in		



References

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