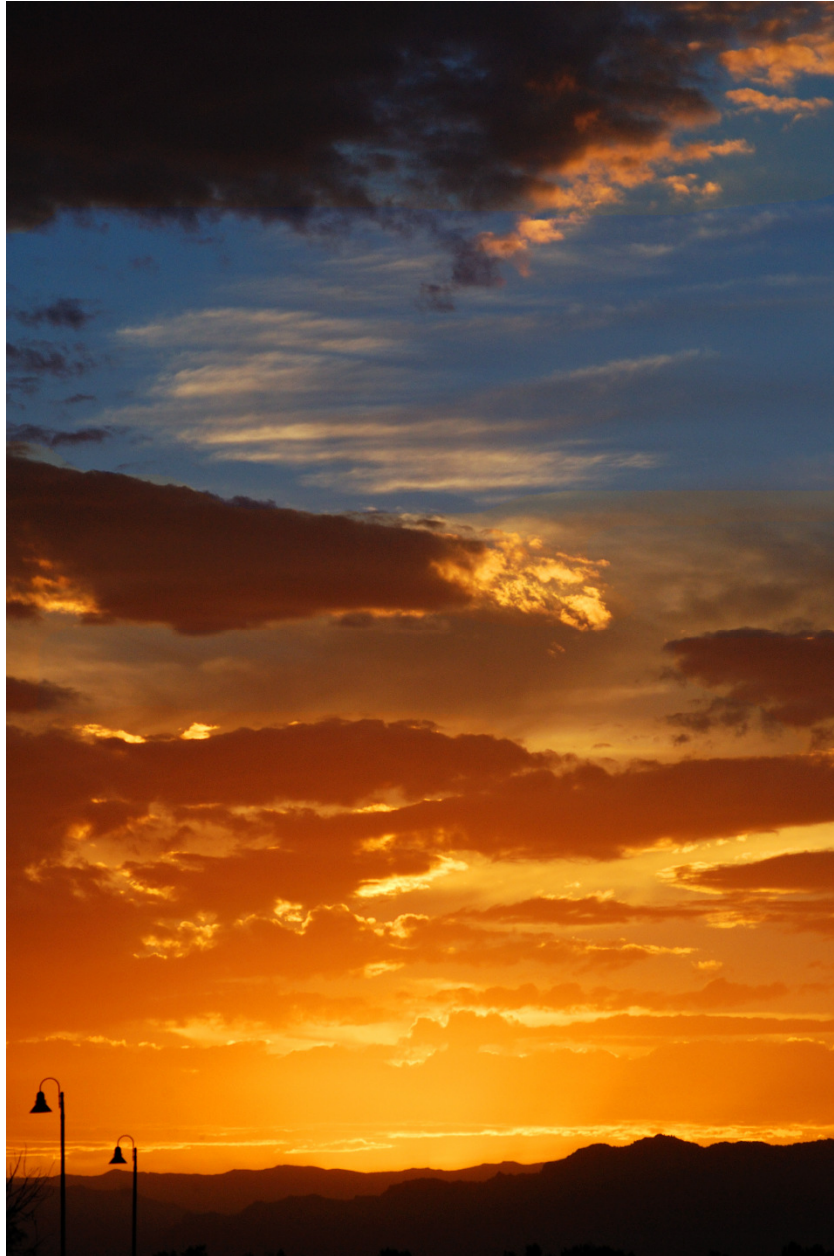


10/10/2007



MCEN 4228  
FLOW  
VISUALIZATION

## CLOUDS 1

Altostratus Undulatus over Cumulus | Joseph M. Graham

## **Introduction**

It seems slightly unfair that we, as members of the Front Range, have such unprecedented access to, what can only be considered, one of God's greatest palates on the planet. The barrier between the cold mountain air and the relatively warm plain air creates cloud formations, and inclement weather, that allowed for plenty of opportunities for capturing fantastic cloud images.

The purpose of the image is to capture some incredible flow visualization and understand the physics behind what makes these clouds tick. The varieties of cloud formations are widely accessible and multiple formation types can be covered in a single frame.

## **Image Background**

The image that I took was captured from east Broomfield at the Wal-Mart Supercenter on 136<sup>th</sup> and I-25. I was leaving the Wal-Mart to go home and quickly had to pull out my camera and take a few shots towards the mountains, as I was again astounded by the amazing color palate that was before me. It was approximately 7:30 to 8:00pm, the ground temperature reading from my car was 63 degrees Fahrenheit. Unfortunately, I forgot to retrieve the Skew-T plot when I arrived at home, but I was able to get the raw sounding data later from NOAA later. The data is shown in Appendix A, and once deciphered reveals relevant data for the cloud formations.

## **Cloud Analysis**

As can be seen from the photograph there are two distinct types of cloud formations. The first appears to occur at approximately 3000 ft AGL. This is a rough estimate based on a Pilot's expertise in guessing the cloud height above ground level (AGL). This is supported though by the sounding data, where between 2046 m and 2438 m (1420 AGL to 2700 AGL) there is a drastic change in the dew point

while the ambient temperature stays the same. This unstable configuration allowed the air to reach saturation and the clouds formed. After this point the temperature dropped drastically and no clouds were visible. These clouds that were formed were Cumulus as noticed by their density with cauliflower types of bulges. As can be seen from the sounding data also, is the direction of the warm air from the SE which allowed for the continuous warming of the base of the cold mountain air mass which was being blown in at a higher elevation from the SW. This interaction of the warm air mass below the cold air is a classic feature of Cumulus cloud formations [2]. The second formation that is visible is the altocumulus undulatus, clouds in patches, sheets or layers, which occurred at 3161 m to 4728 m (approximately 10,000 to 15,000 ft). These clouds are characterized by the elongated parallel rolls which are separated by clear lines. Based on the sounding data there is a small change in the dew point with a steep change in ambient temperature over this region. This region continues to have lower temperatures at higher elevations which contributed to the unstable condition and cloud formations.

## Photographic Technique

The camera that was used was a digital SLR Nikon D40. The camera was manually focused to infinity for best view of the scene. The appropriate settings that were used are listed below:

- Compressed RAW (12-bit)
- Image Size: Large (3008 x 2000)
- Lens: VR 55-200mm F/4-5.6 G
- Focal Length: 102mm
- Exposure Mode: Aperture Priority
- Metering Mode: Spot
- Exposure Specs:
  - Shutter Speed - 1/640 sec

- Aperture - F/11
- Exposure Comp.: +0.3 EV
- Sensitivity: ISO 400
- Optimize Image: Normal
- White Balance: Direct sunlight +3

The size of the field of view is too far to approximate, but it's on the order of tens of miles. The distance to the lens from the clouds also has a range on the order of tens of miles. Adobe Photoshop was used to post process the image. A Color Pop Action was utilized which adjusted brightness and contrast, boosted curves, adjusted hue and saturation, adjusted color balance, dodged and burned the image. The image was completed with sharpening and flattening.

## Conclusion

I especially enjoyed this image due to its inclusion of multiple types of cloud formations in a layered type of configuration. Of course, I am especially satisfied with the amazing sunset which brought out incredible colors in the cumulus clouds, showed the density of those lower formations, and maintained the clear blue sky behind the altocumulus undulatus. I don't dislike anything about the image, even the light-posts add balance. The purpose of the image was to classify a cloud type that was captured by the camera, and that purpose was fulfilled. Overall, I'm very satisfied with the final product and am glad I was at Wal-Mart to see God at work over the Front Range.

## References

- 1) NOAA Archived Soudnings; [http://raob.fsl.noaa.gov/temp/raob\\_soundings16582.tmp](http://raob.fsl.noaa.gov/temp/raob_soundings16582.tmp)
- 2) International Cloud Atlas

Appendix A: Raw Sounding Data (Denver/Stapleton Airport)

254	0	22	SEP	2007		
1	23062	72469	39.77N104.88W	1611	99999	
2	30	1640	1260	84	99999	3
3		DNR			52	kt
9	8380	1611	264	14	110	13
4	10000	52	99999	99999	99999	99999
4	9250	746	99999	99999	99999	99999
4	8500	1487	99999	99999	99999	99999
6	8173	1828	99999	99999	110	13
5	7970	2046	218	18	99999	99999
6	7890	2133	99999	99999	115	13
5	7800	2232	218	-12	99999	99999
6	7615	2438	99999	99999	130	9
6	7349	2743	99999	99999	165	6
4	7000	3161	144	-46	195	7
6	6588	3657	99999	99999	225	8
6	6115	4267	99999	99999	255	13
5	5780	4728	-3	-93	99999	99999
6	5672	4876	99999	99999	250	15
5	5110	5694	-89	-116	99999	99999
4	5000	5880	-81	-231	255	16
5	4910	6021	-81	-281	99999	99999
6	4862	6096	99999	99999	260	11
6	4137	7315	99999	99999	255	13
4	4000	7570	-187	-447	250	19
6	3973	7620	99999	99999	250	20
5	3830	7891	-213	-473	99999	99999

5	3730	8086	-205	-475	99999	99999
6	3658	8229	99999	99999	245	25
5	3530	8490	-237	-507	99999	99999
6	3364	8839	99999	99999	275	27
6	3226	9144	99999	99999	270	32
4	3000	9670	-327	-457	255	41