Clouds Framed by Skyscrapers

Gabriel Bershenyi[1]
University of Colorado, Boulder

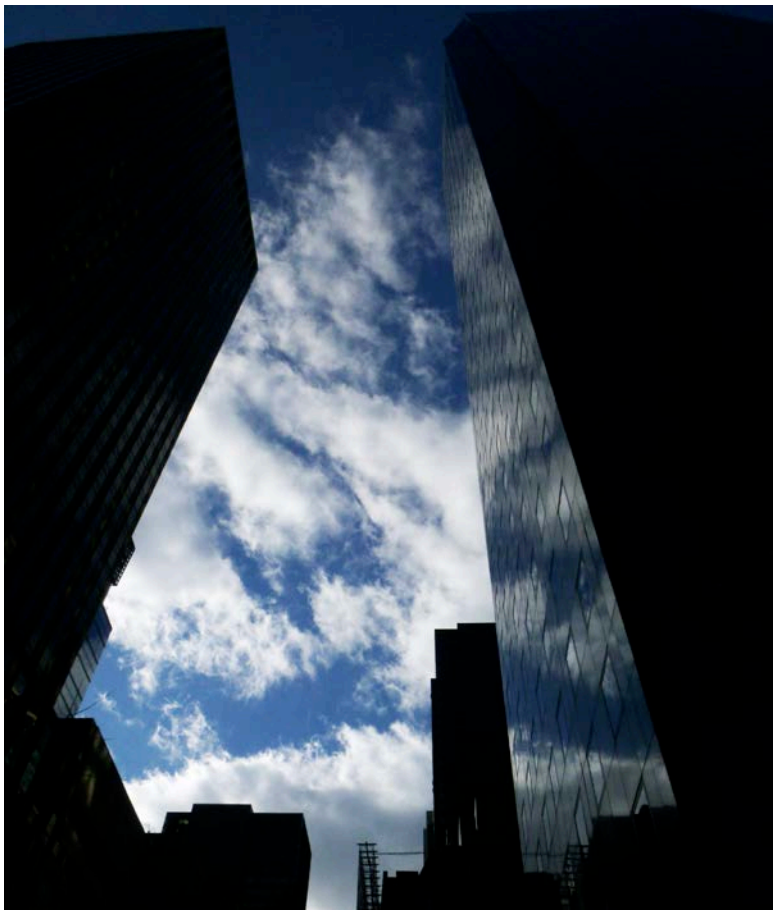

Figure 1: Altocumulus clouds over New York City

I. Introduction

THIS photographic experiment was intended to capture an image of clouds that demonstrated an interesting atmospheric phenomenon while also presenting artistic beauty. The experiment was part of an assignment called "The Photography of Clouds" for the Flow Visualization class at the University Of Colorado Department Of Mechanical Engineering. This specific image is an attempt to capture a set of clouds that are not typically observable in Colorado. The clouds imaged were stratocumulus fractus clouds that formed as part of the marine boundary layer.

[1] Student, MCEN 5151 - Flow Visualization: The Physics and Art of Fluid Flow

II. Image Conditions

The image presented in this experiment was captured from the corner of 44th Street and 6th Avenue looking west along 44th Street. The image was captured at 15:50 EST on March 23, 2013.

The height of the clouds can be estimated using WeatherSpark records of cloud ceiling, which lists a cloud ceiling of 6500ft. at 16:00 EST on March 23, 2013.[6] This height was confirmed by using the Skew-T diagram shown in Figure 3. In this figure, one can see that the two jagged lines approach near 5500ft. (1700m) in altitude. This means that the local measured temperature and the dew point temperature are close enough to allow for cloud formation at that altitude. For the analysis that will follow, we will take the mean of these estimates and assume a cloud height of 6000ft.

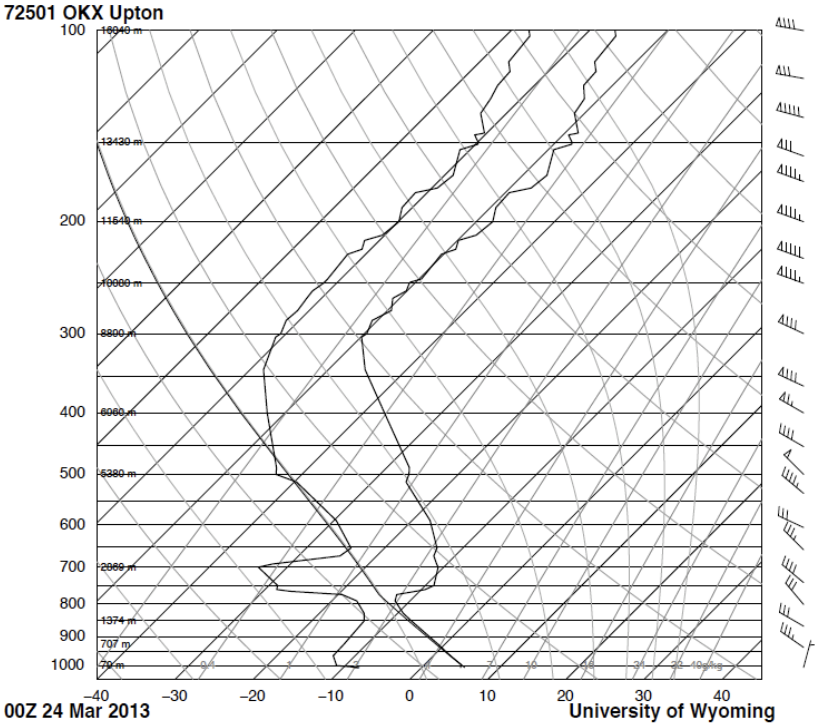

Figure 2: Skew-T Diagram[2]

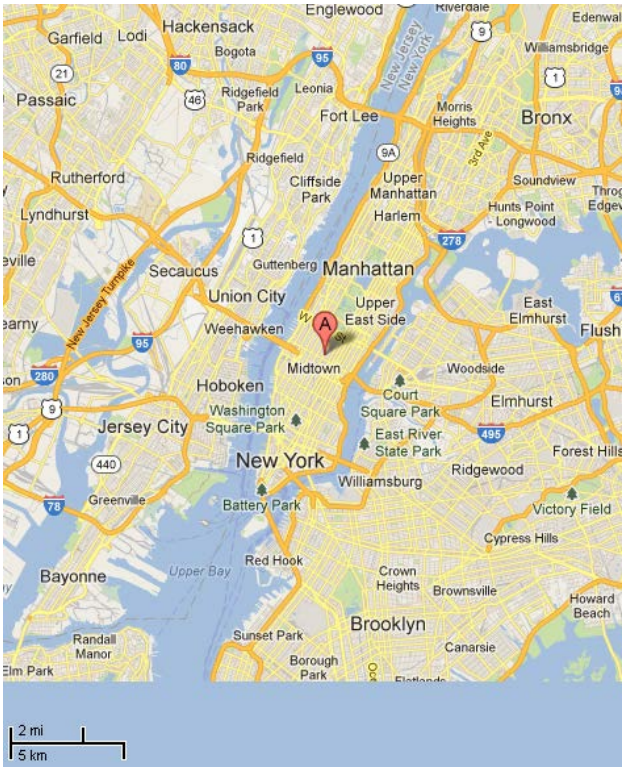

Figure 3: Photograph Location[1]

III. Cloud Analysis

This image presents clouds that are examples of stratocumulus fractus clouds. The clouds can be identified by their low altitude, the fact that they formed as part of a broad layer of similar clouds, and the way that the clouds demonstrate a fractured rather than smooth texture. All of these characteristics fit the description of stratocumulus fractus clouds.[4]

These clouds formed in an area close enough to the ocean and large water bodies that we will assume that the marine boundary layer influenced the formation of the clouds. In this boundary layer, it is documented that "sea-surface heating leads to the formation of stratus layers."[5] The clouds shown here are part of a stratus layer that formed as moist sea air was lifted by convection from the warm surface of the land and sea. In observations of shallow marine type clouds, it is found that these clouds form as part of a moist stable atmosphere.[3] This agrees with the CAPE value of 0 that was calculated with the atmospheric sounding data that is presented in Figure 2.

Figure 4: 11s time comparison

The velocity of the clouds can be estimated by comparing their location in two images separated by 11s. The two images in Figure 4 show the clouds moving 250 vertical pixels out of 2560 total vertical pixels. This can be translated into an angular measurement by calculating the field of view of the camera with its 35mm equivalent focal length of $f =$ 25mm and the equivalent sensor height of $d =$ 36mm.

$$\alpha = \text{atan}\left(\frac{d}{2f}\right)$$

This calculation yields an angular field of view of 71°, so at a range of 6000ft, the cloud moved at an estimated velocity of 66ft/s or 45mph. The sounding data indicates a wind speed of 32-37mph at the height of the clouds. If we assume a height of 5000ft instead, then this method estimates a speed that fits within that range.

IV. Photographic Technique

The image was captured using a Panasonic TS20 point-and-shoot digital camera. The image was recorded with a focal length of 4.5mm, an aperture of f/9, an exposure time of 1/640s, and an ISO sensitivity of 100. The exposure bias was set to -2 in order to image the full detail of the clouds and capture the buildings in silhouette so that they would not act as a distraction.

Figure 5: Original Image

The image was processed using Adobe Photoshop photo editing software from its original state as seen in Figure 4. The image was first cropped from an original size of 1920x2560 pixels to 1844x2170. A higher resolution image would have been helpful to resolve more of the detail of the turbulent edges of the clouds. The color was then adjusted using the transfer function curves to increase the brightness of the sky and the clouds. Some cloud detail was lost in this adjustment, so an exposure bias of -1 is suggested to reduce editing requirements.

V. Conclusion

The image successfully presented a set of marine layer clouds that are not typical of the photographer's home state of Colorado and also demonstrated aesthetic beauty through the framing of the clouds through the buildings. The easiest ways to improve the image would be to use a higher resolution camera setting so that more cloud detail could be captured and to use an exposure bias closer to zero so that less modification would be necessary to achieve the optimum cloud brightness.

References

[1] "6th Ave & W 44th St, New York, 10036." *Google Maps*. N.p., n.d. Web. 16 Apr. 2013.

[2] "Atmospheric Soundings." Atmospheric Soundings. University of Wyoming, 23 Mar. 2013. Web. 15 Apr. 2013.

[3] Holt, Teddy R., and Sethu Raman. "Three-Dimensional Mean and Turbulence Structure of a Coastal Front Influenced by the Gulf Stream." *Monthly Weather Review*120.1 (1992): 17-39. Print.

[4] "National Weather Service Weather Forecast Office Louisville, KY." *Cloud Classification*. NOAA, n.d. Web. 16 Apr. 2013.

[5] Paluch, I. R., and D. H. Lenschow. "Stratiform Cloud Formation in the Marine Boundary Layer." *Journal of the Atmospheric Sciences* 48.19 (1991): 2141-158. Print.

[6] "WeatherSpark Beta." *Beautiful Weather Graphs and Maps*. N.p., n.d. Web. 16 Apr. 2013.