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MCEN 5151

Clouds 2 Report

This report describes a photograph taken for the second clouds assignment of the *Flow Visualization* course offered at the University of Colorado at Boulder campus. The intent of the image was to capture a cloud or set of clouds that have a specific formation or look. Once the image was taken the physics of the cloud are described using whether sounding data and available knowledge about the atmospheric conditions at the time. The phenomenon captured in this photograph is a fast moving cumulus cloud that is breaking up slightly allowing for crepuscular rays to radiate outwards.

This photograph was taken from a beach in Cancun, Mexico on March 23rd. The clouds are traveling from east to west, coming from the ocean over the beach. Although the skew-T plot that I was able to find for the day did not portray the information in the same way the website was able to describe the altitude and wind speeds. The altitude was measured as a atmospheric pressure and the wind speed was estimated at each pressure gradient. The clouds were estimated at ~750 mb referring to an altitude of approximately 2000 meters. The wind speed at that altitude was estimated at 17 knots (20 mph).

I would classify the clouds in this photograph as Cumulus Humilis/ Cumulus Fractus. Visually speaking the clouds are certainly of the cumulus shape and form. According to the skew-t plots for the daily sounding (Figures 1) the most likely altitude for clouds to occur are near 2000 m (750 mb), again classifying them as the lower altitude cumulus clouds. As my photograph was taken at sea level, I would say that this estimate is relatively accurate. Based on the photograph the clouds look a bit lower than that, but not much. The cloud species of Humilis, meaning “humble” in Greek, refers to the smaller size of individual clusters of the clouds throughout the photograph. At the time the sky was riddled with many of these smaller sized clouds. The fractious cloud species refers to the fragmenting parts of the cloud dissipating along its edges. This is most common when there are high wind speeds which cause the edges of the clouds to break away from the main body and dissipate. In analyzing the skew-T plots, the suggested cloud altitudes approximately match my estimated altitudes based on the photograph. The atmospheric soundings suggests a slightly unstable atmosphere (cape 34) agreeing with a cumulus type of cloud.

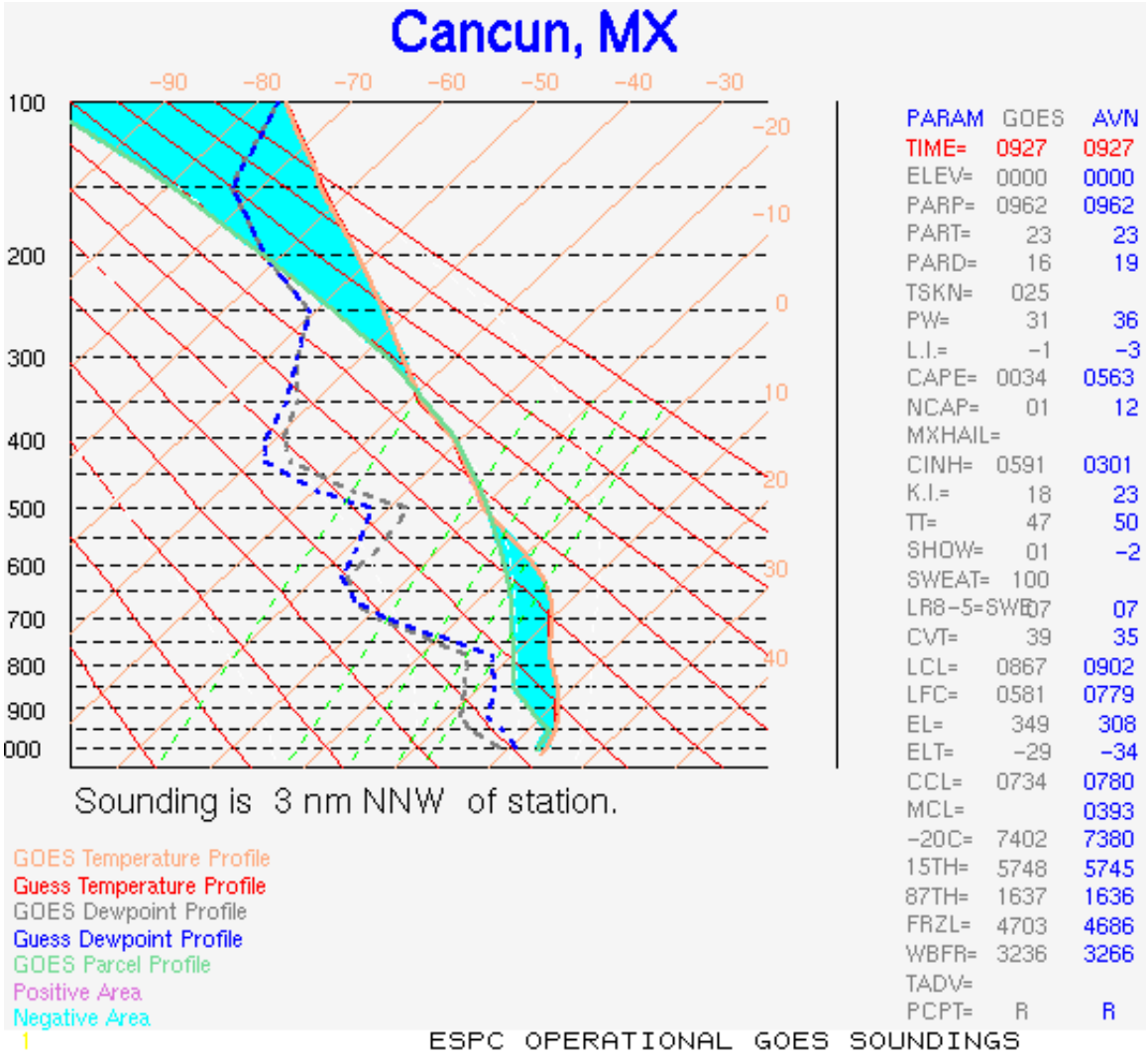

Figure 1 - Skew-T plot for the single GEOS sounding in Cancun, Mexico.

Very aesthetically pleasing portions of this photograph are the crepuscular rays appearing through the fragmenting portion of the clouds. Crepuscular rays are rays of sunlight that appear to radiate from a light source (in this case the sun). These rays of light are passing through gaps in the fragmenting cloud and appear as columns of light separated by the shadows caused by the clouds. The name Crepuscular is derived from the fact that this phenomenon occurs most often during sunrise and sunset, the crepuscular hours. Crepuscular rays are almost parallel beams of light emitted from its source but look to radiate in a circle to the perspective in which you view them. For example Figure 2 (from atoptics.co.uk) shows a set of clouds that are parallel to each other, however from your point of view the clouds appear to be in a radial array at various angles apart. This is the same type of perspective issue that causes the rays to appear to radiate outwards. These sunbeams become more visible with an increase in airborne particulates that cause a combination of diffraction, reflection or scattering. These particulates range anywhere from water vapor to pollutants to airborne dust.

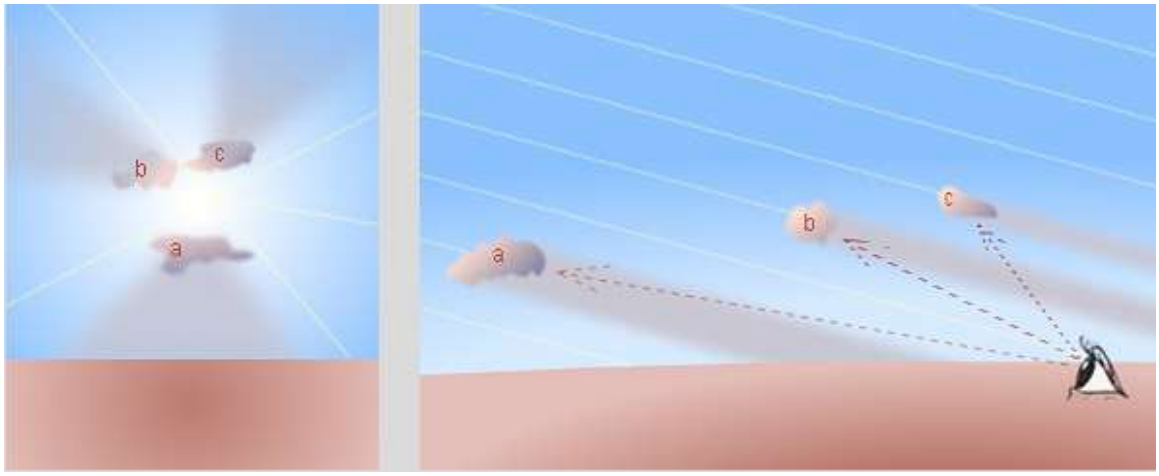

Figure 2 – The linear perspective and the optical illusion of parallel beams

I was sitting on the beach with my camera just taking pictures of the various clouds that passed by; I chose this one because the palapa adds a lot to the picture. I was laying down and the camera was angled at about 85 degrees from the horizontal. I took two pictures with my point and shoot Sony Cyber-Shot camera while this cloud quickly passed by and one of them turned out really nicely. I would estimate based on the width of the cloud and its height that the field of view is between .25-.5 miles wide. I was using the automatic capture mode which automatically choses the camera setting. The original photograph (Figure 4) was 1920 × 2560 pixels with a neutral exposure bias (+0.00). These settings are as follows:
Aperture – 8.9
Shutter Speed – 1/640
ISO – 100
Focal Length – 6.66 mm

Once in Photoshop I increased the contrast to a point which clearly showed the clouds crepuscular rays. I really like this photograph because of a few reasons including: I was able to take it in Mexico, I was able to capture come great crepuscular rays and because the lighting allowed for shadowing and perspective that added a lot to the picture. There is one main thing I wish I could change about the picture. I wish I had taken a panoramic view of these clouds; I would have been able to capture a great deal more of what the sky looked like along with more crepuscular rays. Although it is very difficult to actually "capture" the physics of this fluid flow, this photograph captured enough of the phenomenon and enough clues to able able to analyze the situation. Lastly, I have began to constantly look at the clouds and try to figure out what is happening; I love engineering because I get to learn how things work and what certain things happen, this just adds to my experience.

Figure 3 - Edited Cloud Photograph.

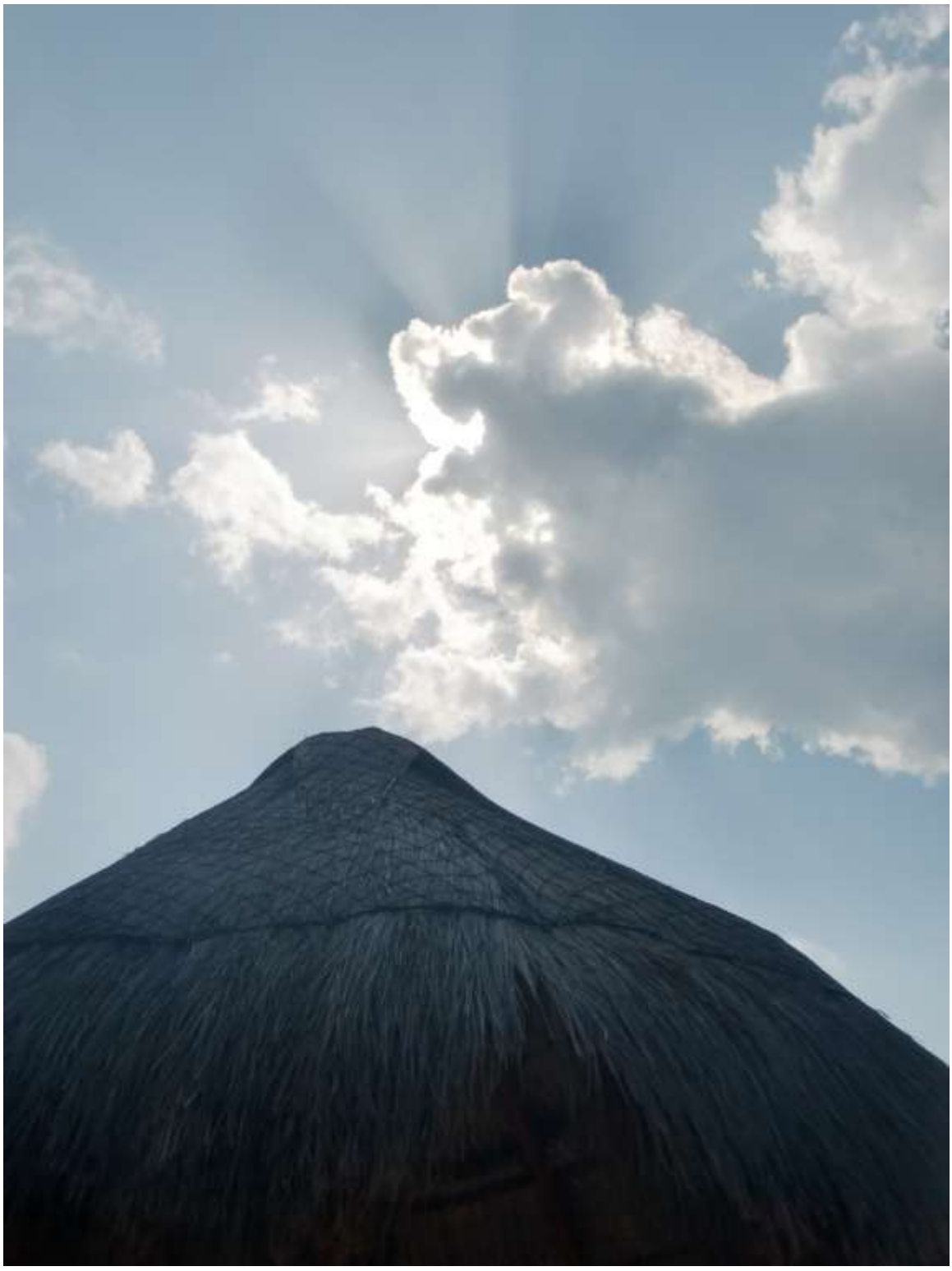

Figure 4 - Original Cloud Photograph.

References:

1.) M.S. VAN DEN BROEKE, W.H. BEASLEY, M.B. RICHMAN. *The Role of Atmospheric Conditions in Determining Intensity of Crepuscular and Anticrepuscular Rays*. University of Oklahoma (2010)
2.) David K. LYNCH. *Optics of Sunbeams.* Thule Scientific. Vol. 4 No. 3 March 1987. J. Opt. Soc. Am. A
3.) Les Cowley. *Atmospheric Optics.* <http://www.atoptics.co.uk/> (Accessed 4-16-2011)