

Imaging various lenticular clouds: A Clouds Second Report

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Imaged at 16:15 PM on November 10, 2019, Lakewood CO

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1. Introduction

The goal was to try and capture an image containing clouds at different altitudes. Lenticular clouds are common in the foothills of Colorado, so using this opportunity to image lenticular clouds at the regular, alto and cirrus heights was quintessential.

2. Image Circumstance

The image was taken in Lakewood, CO near the foothills of the mountains in Golden, CO on 11/10/19 at 16:15 PM. The camera was facing due north.

3. Cloud Characteristics

Various lenticular clouds can be seen in the image at different ranges in height. We can also see some gravity waves in the cirrus clouds up above. The most prominent feature, however, is the eyebrow cloud captured to the left of the building as seen in Figure 3. The eyebrow clouds are formed due to a layer of moist air sandwiched between two layers of dry air. These clouds move extremely quickly, and their motion is easily observable with the unaided eye. To support the fact that the clouds captured were at different heights, a Skew-T plot is provided below (figure 1). The areas of convergence confirm cloud formations in different altitudes.

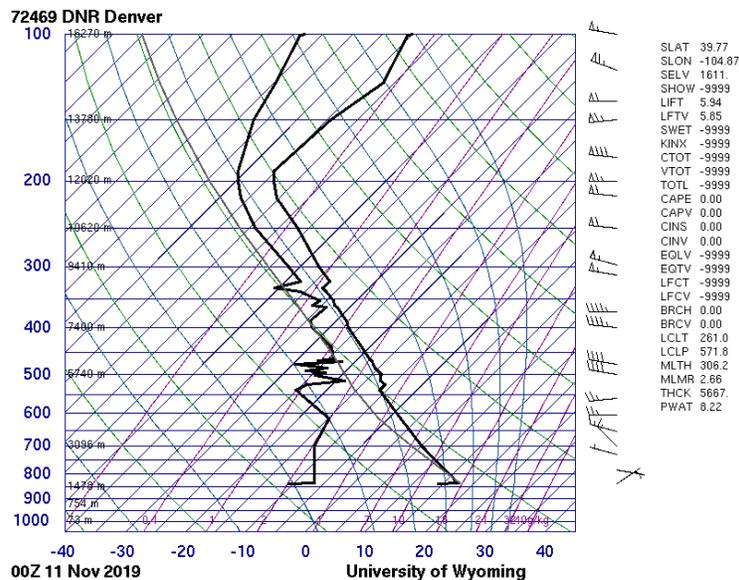


Figure 1: Skew-T plot

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4. Photography Technique

The Camera used was a Nikon D3200 with an 18–55 lens (DSLR digital camera). The parameters used are listed and calculated as follows:

1. *Lens Specs* – Focal length: 18 mm, F number (f/): 3.5
2. *Exposure specifications* – Shutter Speed: 1/1250 sec, ISO: 200, Aperture size = 5.15 mm⁽¹⁾, Deliberately underexposed by -1.0
3. *Camera and Image* – Nikon 3200 DSLR (digital), Original (w x h) = 6016 x 4000 pixels, Final (w x h) = 6016 x 4000 pixels
4. *Distance of object (to lens)*: 5700 – 9200 m
5. *Field of View*: 6.7 x 4.5 km²⁽²⁾.
6. *Final cut processing (Photoshop)*: The self-explanatory Figure 2 summarizes the adjustments made in Photoshop, and Figure 3 shows the image before and after processing. A retrowave style aesthetic was chosen for the image. The green and purple frames were selected and turned into a GIF via the animator tool in Photoshop.

Reasons for choosing the mentioned settings: In broad daylight, and the object being of high albedo, a lower ISO was used to minimize noise. Shutter speed was automatically set to 1/1250th of a second, to prevent oversaturation in the image. Deliberate underexposure was added before taking the picture, to reduce saturation due to albedo (and obtain more detail out of the image).

Calculations:

$$^1\text{Aperture size: } D = F / f \# = 18 \text{ mm} / 3.5 = \underline{5.15 \text{ mm}}$$

Angle of view for length (degrees):

$$= 2 \times \left(\arctan \left[\frac{\text{Sensor Width (mm)}}{2 \times F(\text{mm})} \right] \right) = 2 \times \left(\arctan \left[\frac{23.2}{(2 \times 18)} \right] \right) = 65.6^\circ$$

Angle of view for height (degrees):

$$= 2 \times \left(\arctan \left[\frac{\text{Sensor Height (mm)}}{2 \times F(\text{mm})} \right] \right) = 2 \times \left(\arctan \left[\frac{15.4}{(2 \times 18)} \right] \right) = 46.32^\circ$$

Angle of view for diagonal (degrees):

$$= 2 \times \left(\arctan \left[\frac{\text{Diagonal (mm)}}{2 \times F(\text{mm})} \right] \right) = 2 \times \left(\arctan \left[\frac{27.85}{(2 \times 18)} \right] \right) = 74.75^\circ$$

²Hence Field of View for length:

$$2 \times \left(\tan \left(\frac{\text{Angle of View}}{2} \right) \times \text{Object Distance} \right) = 2 \times \left(\tan \left(\frac{65.6}{2} \right) \times 5200 \times 1000 \right) = 6702342 \text{ mm} = 6.7 \text{ km}$$

Hence Field of View for height:

$$2 \times \left(\tan \left(\frac{\text{Angle of View}}{2} \right) \times \text{Object Distance} \right) = 2 \times \left(\tan \left(\frac{46.32}{2} \right) \times 5200 \times 1000 \right) = 4448853 \text{ mm} = 4.5 \text{ km}$$

So the area covered in the image was about **6.7x 4.5 km²**, which is the field of view.

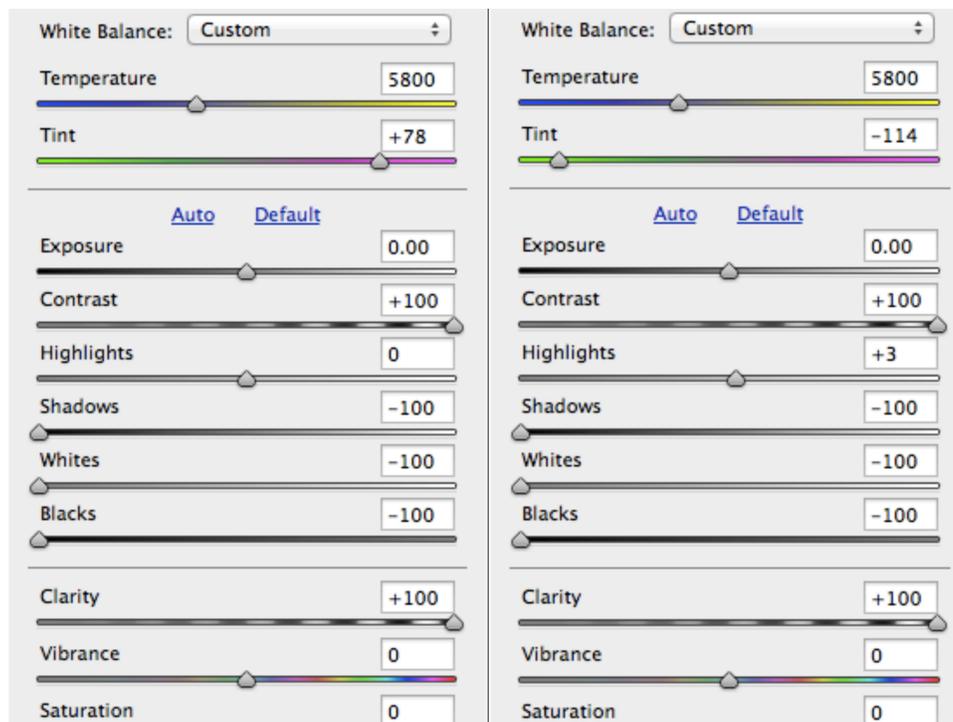


Figure 2: Editing on preliminary menus on Photoshop. Purple tint on the left and green on the right.



Figure 3: Unedited (top left and bottom left) and Edited (right) versions of Image



Figure 4: Eyebrow clouds observed

5. Image Characteristics

Post-processing brings out a lot of details not originally apparent in the raw image. Very pleased with the capture of multiple types of clouds in a single image. Some gravity waves can be seen in the Cirrus clouds. Thrilled to capture eyebrow clouds as they are a rare occurrence.