UNIVERSITY OF COLORADO - BOULDER

Flow Visualization

Clouds 1

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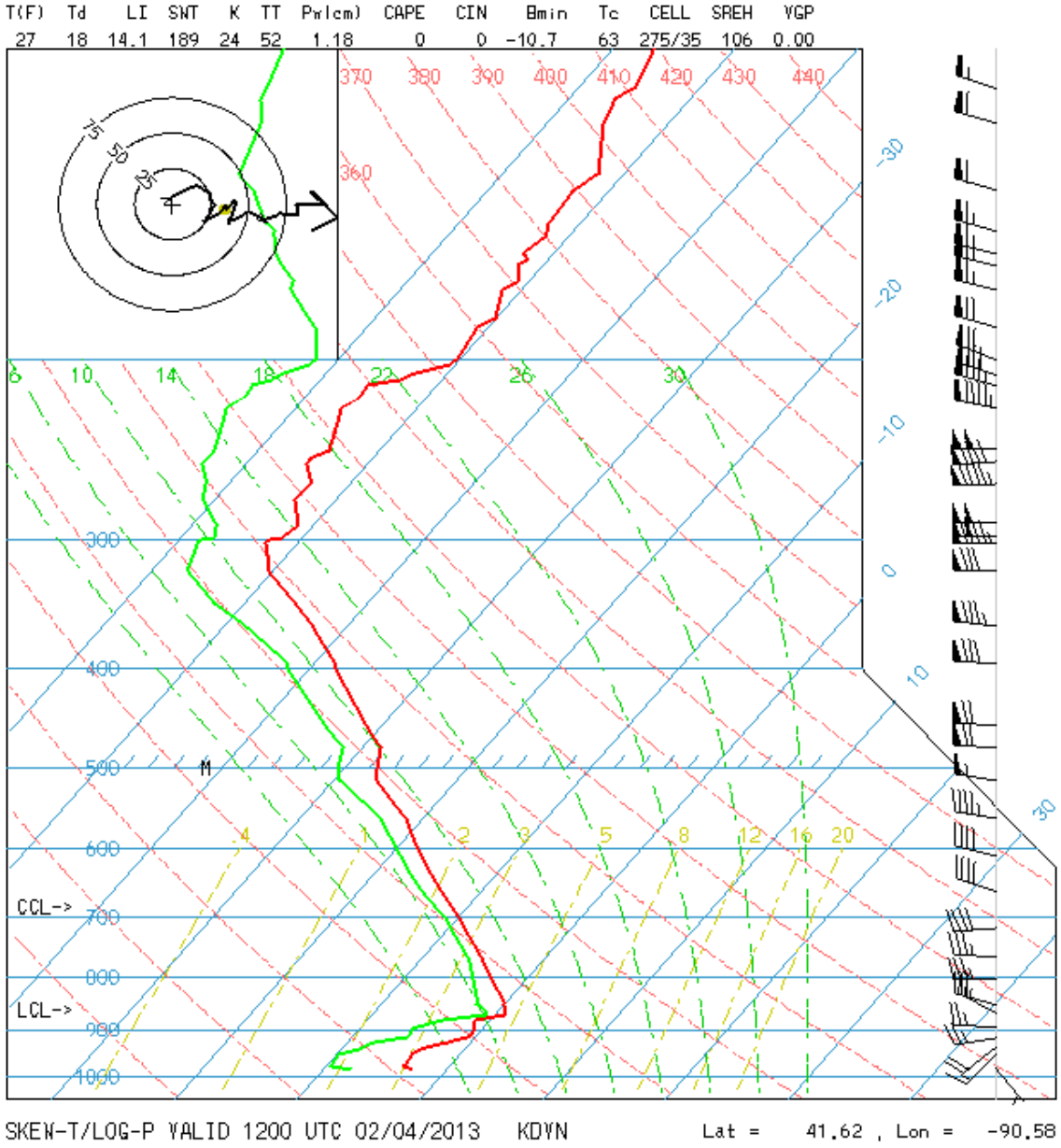
MCEN 4151 – Professor Jean Hertzberg

Living next to the Flatirons, Boulder is the perfect place to see dynamically driven wind events. In this case, I wanted to capture hydraulic jumps, rotor, and Lee waves. The artistic intent of this image was to capture the beauty of the University of Colorado at Boulder and the clouds that add to it. The position of the photo was key. I wanted to capture a campus skyline framed by buildings. This spot was chosen because it lends a behind the scenes feel through the parked maintenance vehicles, but with the back lighting of sunset the cloud remains the center of attention.

This photo was taken February 4th 2013 at 5:50 PM mountain time. The photo was taken from the ground facing West toward the setting sun. The center building is the University Memorial Center, to the right is the Art Museum and to the left is the Telecommunications building. There was steady wind from the west and the surface temperature was 38 degrees Fahrenheit.

I believe the large center cloud is a stratocumulus created by a hydraulic jump off the front range. Mountain waves are characterized by the Froude number which is the ratio of characteristic velocity to the wave propagation velocity[3]. When the ratio is balanced, about equal to one, standing waves form[1]. The Wave propagation velocity is determined by the atmospheric stability and mountain's change in height. The constant wind from the west likely matched the needed velocity given the front range is about 1,500 feet and was a very stable temperature gradient up to the lower condensation

limit. The cloud was stationary and possibly pinned by the inversion at 860 hPa. There were no other clouds at the same elevation.



Skew-T Diagram from UCAR's Archive[2].

A Nikon Coolpix L100 camera was used with F-stop f/3.5, 1/6 second exposure time, ISO-800, 5mm focal length, and3.6 aperture. Photoshop was used to darken the skyline and bring out details in the clouds by adjusting color contrast.

This image does not reveal much in the way of fluid physics. The focus is on the artistic looming feel of the cloud's stagnant volume. While I wanted to take a photo that was un cluttered by scientific insight, I would like to try to depict more of a process in the new cloud photo. Possibly through Photoshop the cloud could be taken out of its element and presented as abstract flow.

Wor Cited:

[1] "Advances in Meteorology, Climatology and Atmospheric Physics - Springer." *Advances in Meteorology, Climatology and Atmospheric Physics - Springer*. N.p., n.d. Web. 05 Mar. 2013.

[2] "Image Archive." *Image Archive*. N.p., n.d. Web. 05 Mar. 2013.

[3] "Froude Number." *Froude Number*. N.p., n.d. Web. 05 Mar. 2013.

Original Photo: