Cloud-II

Professor: Jean Hertzberg & Alex Sweetman
Student: Mu-Hong Lin

[Summary]

The photo is taken at Boulder Colorado while the cold mass is moving done from high lands in Rocky Mountains. On November 18th at 15:39, the lenticularis clouds (altostratus) on the sky formed an interesting image like layered fluids or even solids toward the Front Range line. The foreground sand dune strikes out brings a color contrast to the dark grey & blue sky. Right below the famous landmark Flatiron, the whole actually telling a geological story from river or ocean bringing done sands to sediments and becoming sandstone with time and pressure as those erected on Rockies or Flatiron. Take a close look at sky, a cumulus is sailing through in between and enjoy the beauty of Mother Nature.

Figure-1. Lenticularis clouds formed in Boulder at 15:39 on November 18 2007

[Geographic environment and macro meteorology]

The city of Boulder is located in Boulder Valley where the Rocky Mountain meets the Great Plains. The elevation of Boulder is 5430 feet (1655 m). East to Boulder belongs to Colorado piedmont which elevated from 750 m to ~ 1800 m. West to Boulder is mountain area which could be higher than 16000 feet (5000 m). Located at 40N, 105W in the westerly wind belt, most precipitation occurs during the winter and spring months brought by west wind from Pacific Ocean crossing mountains becoming a “high desert” climate.

During the winter starting from fall, polar maritime air masses formed in northern pacific brings cool and moistures all the way across rocky mountain arriving Colorado. While the cold air masses move through mountains, the humid air on the ground is lifted upslope forming clouds on the mountain area. When the air mass covers the east Colorado area, atmosphere is relative stable. Most clouds formed in mountain area brought here turned into altostratus or cirrostratus as shown in Figure-2. In table-I, observed weather data showing the cold air front arrived around 16th and then whole cold air mass is covering the area on 18th before the next front is arriving on 20th. Figure-3 shows the infrared satellites on surface of United States. It indicates the clouds are formed by the humid air brought from pacific through Seattle area and spreading around the high pressure center on the Colorado mountain area.

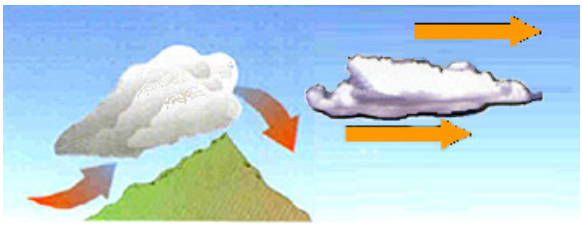

Figure-2. Cloud formation

15	16	17	18	19	20	21
OBSERVED	OBSERVED	OBSERVED	OBSERVED	OBSERVED	OBSERVED	OBSERVED
Hi 66°F Lo 24°F	Hi 67°F Lo 45°F	Hi 60°F Lo 45°F	Hi 69°F Lo 44°F	Hi 77°F Lo 42°F	Hi 57°F Lo 29°F	Hi 29°F Lo 12°F
Precip (in) 0in.	Precip (in) 0in.	Precip (in) 0in.	Precip (in) 0in.	Precip (in) 0in.	Precip (in) 0.02in.	Precip (in) 0.10in.

Table-1 Weather data close to Nov. 18 2007

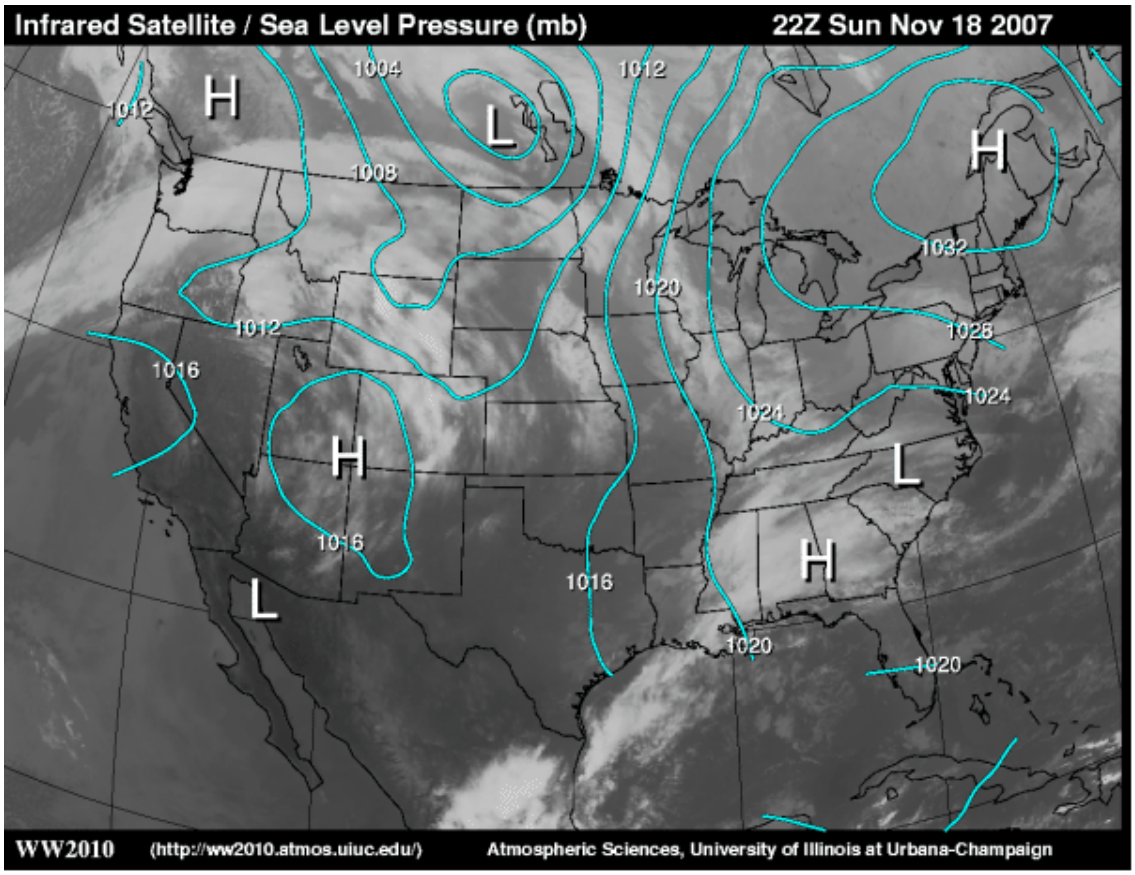

Figure-3. Sea level infrared satellite photo

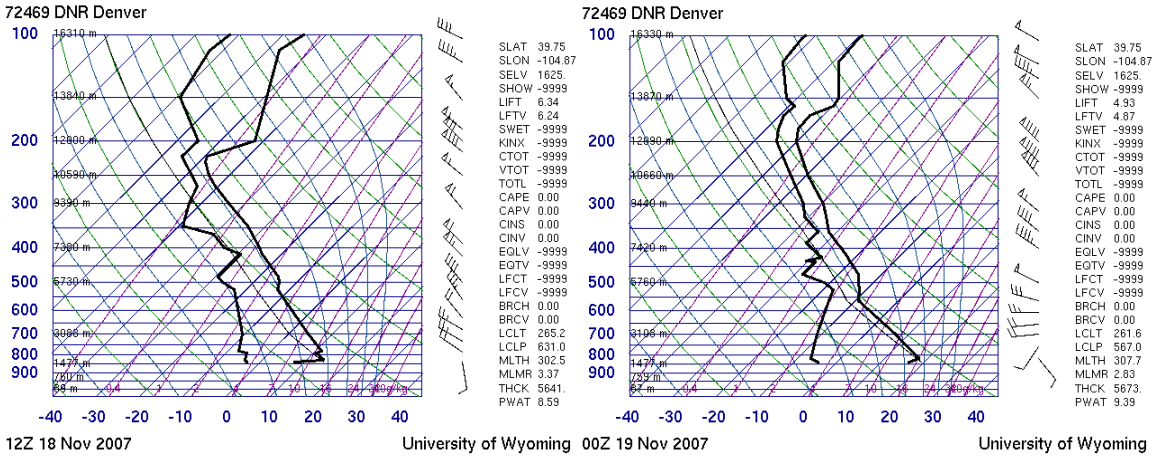

Figure-4. Skew-T plot in Denver at 12:00 (left) and 18:00 on Nov. 18th 2007.

[Micro meteorology]

Clouds form when rising air cools and the moisture in it condenses to form water droplets. If air becomes relatively warmer than surrounding air while lifting and will continue to rise without any outside forces (self buoyant), this atmosphere turns to be unstable and highly possible to form cumulus or cumulonimbus. Also, another indicator of clouds existing is the dew point particular altitude lever. If the dew point temperature is close to the air temperature, water is pretty easy to condense into clouds, too.

Figure-3 shows the skew-T in 12:00 and 18:00 mountain time on November 18, 2007. At 12:00, the air is stable or downwards from 1477 m (measurement ground level) ~ 5730 m. A lifting force is happening from 5730 m ~ 7000 m. Clouds might be generated around 7000 m since the dew point line has an abrupt bump closing to air temperature. However, above it are downward flows. At 18:00, dew point in general is close to air temperature more. Uplift force is found from 6500 m ~ 7800 m, and air above 7800 m is neutral and downward. However, the dew point is close to air temperature only at 7800 m.

Summarizing from skew-T information at sequential series, atmosphere are comparatively stable and clouds is difficult to form locally above Denver area. However, the air temperature on neutral atmosphere is pretty close to dew point. It suggests altostratus or cirrostratus clouds exist and could be formed and brought from mountain area.

[Photography environment]

The photo is shoot at NIST campus facing north with 15 degree angle. As the height estimated from skew-T is 6500 m above ground level (After deducted Boulder height ~1600 m above sea level), the distance of the lenticularis clouds could be calculated as 25 km (horizontal distance).

[Camera setup]

Nikon D80 2007/11/18 15:34:59.4

Image Size: Large (3872 x 2592)
Size of filed view: 32500 m x 2600 m (WxH)
Distance from the lenticularies clouds front to lens: 25 km (horizontal)
Focal Length: 31mm
1/125 sec - F/9 - ISO 200
Photoshop processing: level and saturation adjusted.

[Summary]

An amazing Zig-zag altostratus happening across the front range is captured on November 18th 2007 at 15:39. The lenticularies clouds (altostratus) on the sky formed an interesting image like layered fluids mapping to those layered sandstone in flatiron performing a beautiful harmony in Boulder.

[Reference]

[1] http://en.thinkexist.com/quotes/with/keyword/clouds
[2] http://imnh.isu.edu/digitalatlas/clima/imaging/clddev.htm
[3] http://www.wunderground.com/cgi-bin/findweather/
[4] http://www.csgnetwork.com/estcloudbasecalc.html
[5] http://weather.unisys.com/index.html
[6] http://www.atmos.uiuc.edu/weather/tree/viewer.pl?launch/irslp.
[7] http://www.vivoscuola.it/us/rsigpp3202/umidita/lezioni/form.htm