CLOUDS PROJECT 1

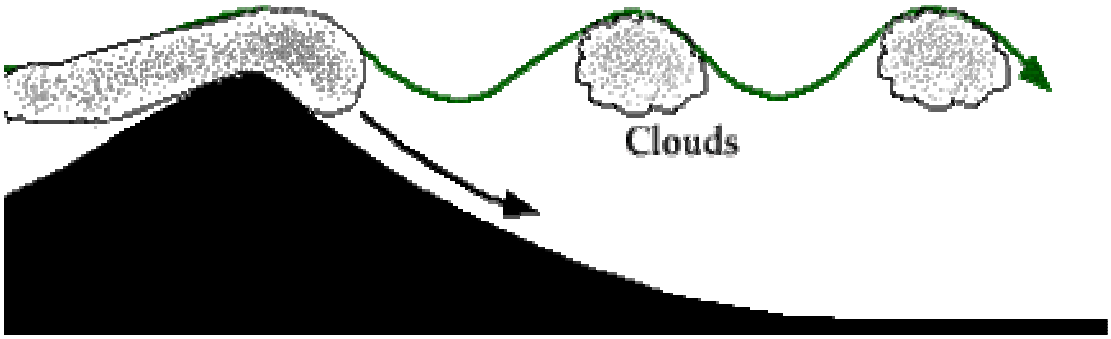
Context & Purpose:
My intentions were to capture a unique, interesting and beautiful cloud formation. I concentrated most of my images on clouds rolling over the foothills. I found the most interesting cloud flows and formations at the foothills edge.

Description of Flow:
The Images were taken after 5pm about a mile from the foot hills. Taken about the same time as a wind shift, which may have something to do with the stability of the clouds. The field of view is several miles wide and depth of field several miles deep. A large aperture was used to increase depth of field with a short shutter speed to avoid over exposure. The wind was traveling east (toward the camera in the left photo, away from the camera in the right photo).

Photos of Discussion taken by Chris O'Loughlin in Boulder Colorado, 10/04/07 at 17:00. Left is an unstable Orographic formation. As the clouds travel East past the mountains they become stable in the formation seen to the right.

The pictured flow was caused by winds carrying the air mass up over the mountains from a high pressure atmosphere to a low pressure caused unstable formations at the mountains peaks (above Left), and stable formations as the clouds descend east of the foothills(above right). Many types of cloud formations can be seen at the mountains peak, including:
Lenticular- the long horizontal wavy clouds seen to the right
foehn wall- the clouds formed parallel to the mountain range, seemingly stationary.
Cumulus- the clouds seen to the left with some vertical growth

This secession of cloud formations from one image to the next is due to Orographic lift. Orographic lift occurs when air is forced from a low elevation to a higher elevation as it moves over rising terrain, such as mountains. The air expands and cools as it gains altitude. At high altitude the air can not hold moisture as effectively, thus causing clouds to form. As the air moves past the elevated terrain it descends and warms. Now the flowing air mass is lighter than the surround air, it then rises until stabilization. This process is illustrated bellow.



Orographic clouds as a result of Earth's surface topography. [2] **Link**

Visualization Technique and Lighting:
Standard digital photography technique was used to capture scenery back lit by the sun.

Photographic technique:

Field of view:	Several miles
Distance from object to lens:	Several miles
Lens focal length:	55mm
Camera:	Digital 8.1 Mega Pixels Canon EOS
Shutter Speed:	1/1000 sec.
Aperture Value:	F7.1
ISO Speed:	100
White balance:	Cloudy
Image Processing:	None

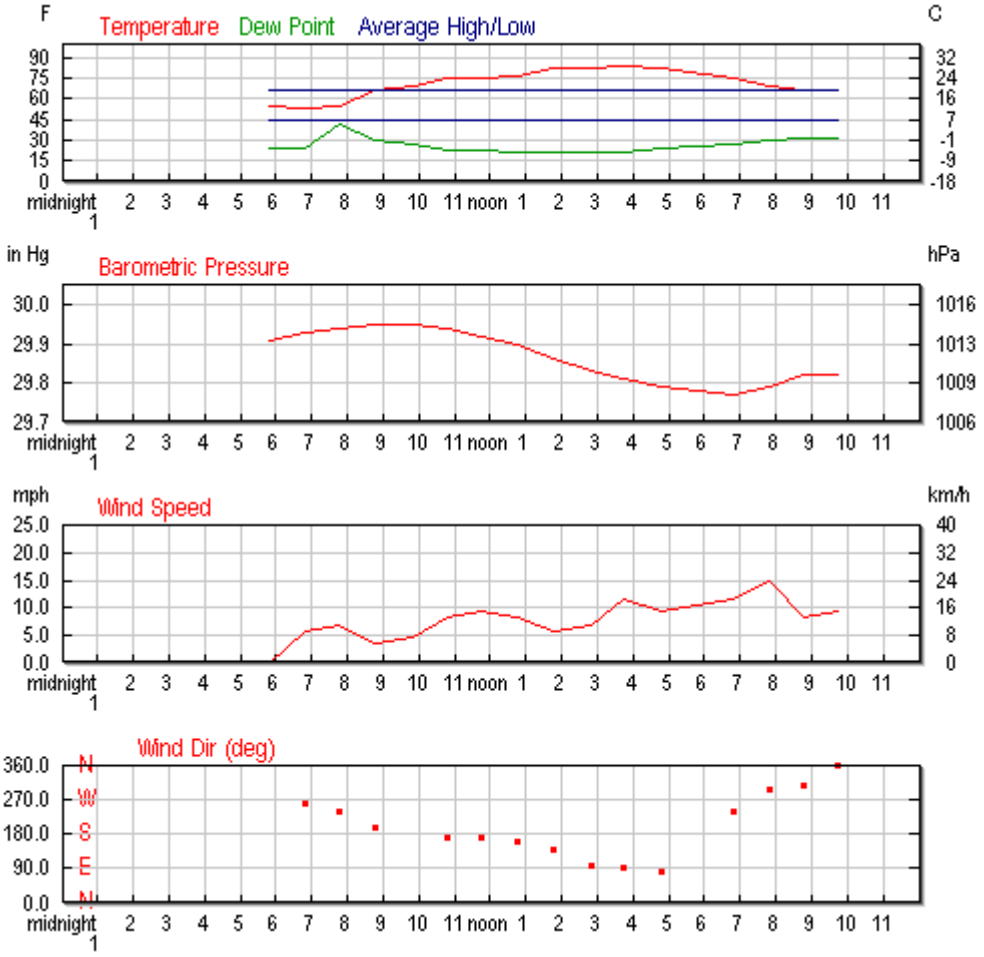
Conclusion:

The discussed images picture the Orographic effect caused by the mountains. The image to the left shows the un-stable cloud formations at the mountains peak, and the image to the right shows the stabilized flow of the clouds as they travel away from the mountain. Looking back I wish I had captured the flow from a perpendicular location looking down the mountain range as the clouds rolled over; similar to the illustration above. A timed average image with defined streamline would also be very helpful in displaying this fascinating and complicated flow.

Appendix:

A.1) Atmospheric Conditions as provided by Weather Underground

Averages and records for this station are not official NWS values.
T = Trace of Precipitation, **MM** = Missing Value **Source:** NWS Daily Summary



A.2)

72469 DNR Denver Observations at 12Z 04 Oct 2007

PRES hPa	HGHT m	TEMP C	DWPT C	RELH %	MIXR g/kg	DRCT deg	SKNT knot	THTA K	THTE K	THTV K
1000.0	20									
925.0	706									
850.0	1438									
833.0	1611	8.0	-2.0	49	3.98	140	3	296.2	308.3	296.9
829.0	1651	16.8	-2.2	27	3.94	143	3	305.9	318.4	306.6
821.0	1734	18.4	-4.6	21	3.32	148	3	308.4	319.1	309.1
700.0	3079	10.2	-11.8	20	2.22	236	6	313.8	321.2	314.2
677.0	3356	8.2	-14.8	18	1.80	255	6	314.5	320.7	314.9
656.0	3616	8.0	-18.0	14	1.42	272	7	317.1	322.1	317.4

652.6	3658	7.7	-18.1	14	1.42	275	7	317.2	322.2	317.5
605.3	4267	2.9	-19.2	18	1.39	240	3	318.6	323.5	318.9
561.3	4877	-1.9	-20.4	23	1.36	245	15	319.9	324.7	320.2
556.0	4954	-2.5	-20.5	24	1.35	243	15	320.1	324.9	320.3
532.0	5304	-3.5	-33.5	8	0.43	236	17	322.9	324.6	323.0
500.0	5790	-7.7	-37.7	7	0.30	225	20	323.6	324.8	323.6
480.3	6096	-10.6	-37.8	9	0.31	220	20	323.8	325.0	323.9
461.4	6401	-13.4	-37.9	11	0.32	220	21	324.0	325.2	324.0
432.0	6901	-18.1	-38.1	16	0.33	229	24	324.2	325.5	324.2
400.0	7470	-22.1	-35.1	30	0.49	240	28	326.2	328.0	326.3
391.8	7620	-23.4	-35.8	31	0.46	240	30	326.4	328.1	326.5
361.0	8216	-28.7	-38.7	38	0.37	243	33	327.1	328.5	327.1
352.0	8396	-30.3	-44.3	24	0.21	244	34	327.3	328.1	327.3
345.2	8534	-31.0	-46.1	21	0.18	245	35	328.2	328.9	328.2
323.0	9005	-33.3	-52.3	13	0.09	260	36	331.3	331.7	331.3
316.6	9144	-34.4	-52.9	14	0.09	265	36	331.6	332.0	331.6
300.0	9520	-37.5	-54.5	15	0.08	260	37	332.4	332.7	332.4
264.8	10363	-44.9	-56.4	26	0.07	250	37	333.7	334.0	333.7
253.1	10668	-47.6	-57.1	33	0.07	250	38	334.0	334.3	334.1
250.0	10750	-48.3	-57.3	34	0.07	250	39	334.1	334.4	334.1
220.1	11582	-51.6	-65.4	18	0.03	255	63	341.5	341.6	341.5
219.0	11616	-51.7	-65.7	17	0.03	255	63	341.8	341.9	341.8
200.0	12200	-55.1	-69.1	16	0.02	255	64	345.4	345.4	345.4
173.1	13106	-61.0	-73.2	18	0.01	250	78	350.2	350.3	350.2
170.0	13221	-61.7	-73.7	19	0.01	250	78	350.8	350.9	350.8
169.0	13257	-61.8	-73.8	19	0.01	250	78	351.2	351.3	351.2
150.0	13990	-64.3	-75.3	21	0.01	245	63	359.1	359.2	359.1
121.9	15240	-68.5	-79.5	19	0.01	245	50	373.4	373.5	373.4
108.0	15969	-70.9	-81.9	18	0.00	245	47	382.0	382.0	382.0
100.0	16430	-66.3	-78.3	17	0.01	255	47	399.4	399.4	399.4
99.5	16459	-66.3	-78.3	17	0.01	255	47	399.9	400.0	399.9
96.2	16665	-66.3	-78.3	17	0.01	254	43	403.8	403.9	403.8
85.5	17374	-69.3	-81.3	16	0.01	250	29	411.6	411.6	411.6
78.6	17875	-71.5	-83.5	15	0.00	244	34	417.1	417.1	417.1
70.0	18570	-66.1	-79.1	15	0.01	235	40	442.6	442.7	442.6
69.7	18593	-65.7	-78.9	14	0.01	235	41	444.0	444.1	444.0
68.5	18702	-63.7	-77.7	13	0.01	237	39	450.6	450.6	450.6
61.1	19395	-67.1	-81.1	12	0.01	246	29	457.9	458.0	457.9
57.8	19736	-57.5	-74.5	10	0.03	251	25	486.9	487.1	487.0
54.5	20107	-55.9	-74.9	8	0.03	256	19	498.9	499.1	498.9
51.8	20422	-57.6	-76.6	7	0.02	260	15	502.0	502.1	502.0
50.0	20650	-58.9	-77.9	7	0.02	250	11	504.2	504.4	504.2
47.7	20945	-60.1	-79.1	7	0.02	222	11	508.2	508.3	508.2
44.8	21336	-56.2	-76.1	6	0.03	185	12	526.7	526.9	526.7
44.6	21368	-55.9	-75.9	6	0.03	185	12	528.3	528.5	528.3
39.2	22186	-57.7	-77.7	6	0.02	196	12	543.6	543.8	543.6
36.8	22587	-55.1	-77.1	5	0.03	201	12	560.2	560.4	560.2
35.3	22860	-56.4	-77.7	5	0.03	205	12	563.8	564.0	563.8
34.4	23016	-57.1	-78.1	5	0.03	204	11	565.8	566.0	565.8
32.4	23398	-54.5	-76.5	5	0.04	202	8	582.5	582.8	582.5
30.0	23890	-54.9	-76.9	5	0.04	200	4	594.4	594.7	594.4
24.4	25209	-56.9	-77.9	5	0.04	185	5	624.7	625.1	624.8
20.0	26480	-54.1	-76.1	5	0.06	170	6	669.8	670.4	669.9
17.4	27371	-55.1	-77.1	5	0.06	268	6	693.8	694.5	693.9
17.2	27432	-54.7	-76.8	5	0.06	275	6	696.9	697.6	696.9
15.7	28033	-51.1	-74.1	5	0.11	257	8	727.6	728.7	727.7
14.2	28681	-53.7	-75.7	5	0.09	237	10	740.0	741.0	740.1
12.4	29566	-51.7	-74.1	5	0.14	210	12	776.5	778.0	776.5
11.8	29870	-51.0	-73.5	5	0.15	210	11	789.4	791.1	789.5
10.8	30480	-49.6	-72.4	5	0.20	225	8	815.9	818.2	816.0
10.0	30960	-48.5	-71.5	5	0.25	255	8	837.4	840.3	837.5
9.4	31394	-48.0	-71.4	5	0.27	285	13	855.0	858.3	855.2
8.5	32004	-47.4	-71.2	5	0.30	285	17	880.5	884.2	880.6
8.2	32269	-47.1	-71.1	5	0.32			891.8	895.8	892.0

Station information and sounding indices

Station identifier: DNR
Station number: 72469

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                          Observation time: 071004/1200
                          Station latitude: 39.75
                         Station longitude: -104.87
                         Station elevation: 1611.0
                              Lifted index: 9.48
    LIFT computed using virtual temperature: 9.21
      Convective Available Potential Energy: 0.00
             CAPE using virtual temperature: 0.00
                       Convective Inhibition: 0.00
             CINS using virtual temperature: 0.00
                      Bulk Richardson Number: 0.00
          Bulk Richardson Number using CAPV: 0.00
  Temp [K] of the Lifted Condensation Level: 263.88
Pres [hPa] of the Lifted Condensation Level: 581.11
     Mean mixed layer potential temperature: 308.18
              Mean mixed layer mixing ratio: 3.30
              1000 hPa to 500 hPa thickness: 5770.00
Precipitable water [mm] for entire sounding: 7.16
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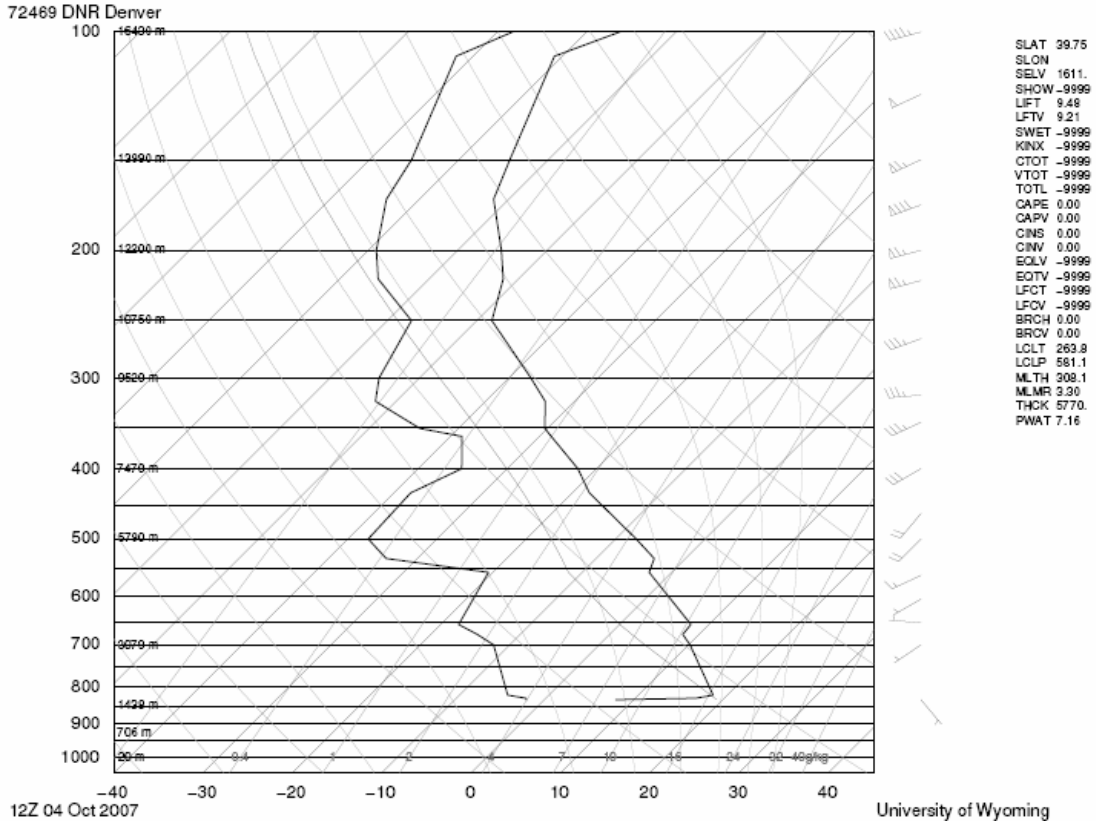
A.3)



References:

[1] World Meteorological Organization. "INTERNATIONAL CLOUD ATLAS." Abridge Atlas, 1969.

[2] The Kings School Worchester, "Orographic." Unknown. 10/10/07. http://atschool.eduweb.co.uk/kingworc/departments/geography/nottingham/atmosphere/pages/orographic.html

[3] Weather Underground, "History." Unknown. 10/10/07. http://www.wunderground.com/history/airport/KBJC/2007/10/4/DailyHistory.html?req_city=NA&req_state=NA&req_statename=NA