Photo courtesy of Dave Moore; King's College, London

University of Wyoming
CAMPS 2011

Colorado Airborne Multi-Phase Cloud Study

December 15, 2010 - February 28, 2011

- StormVEx site
- Contacts
- King Air Data
- Wyoming Cloud Radar Data
- Wyoming Cloud Lidar Quicklooks
- Plot of Flight Hours
- Waypoints in Google Earth

UWKA Web Page

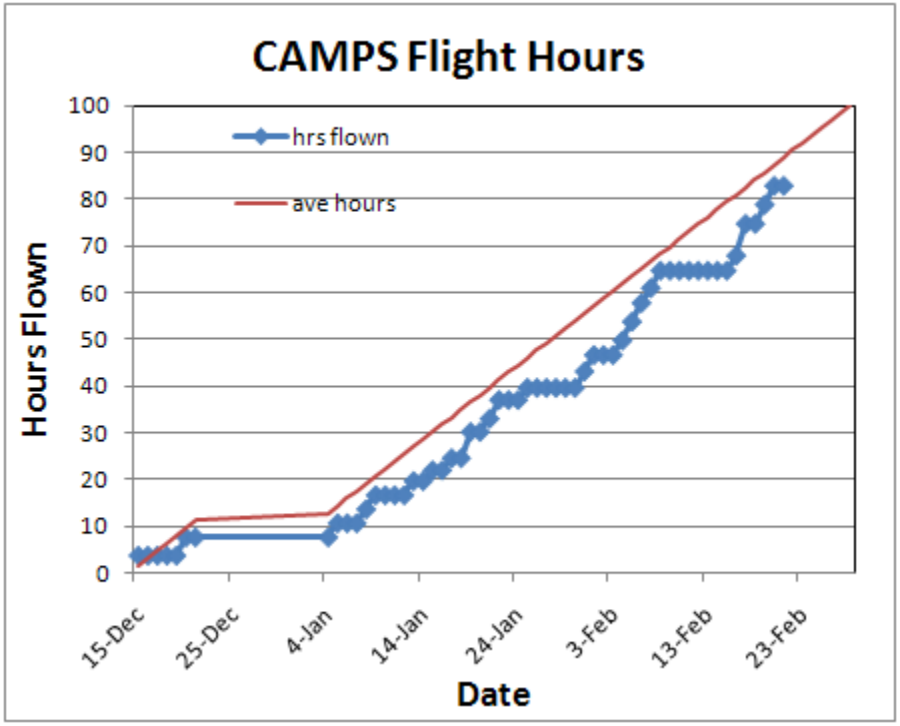
Date	Flight # (*.kml)	Status	Times (UTC)	Hours	Crew/Notes
Post-project notes					
7 Dec 2012		2d files now contain CIP images.			
30 Nov 2011		CLH data added to 1 Hz files.			
7 Nov 2011		Data reprocessed. Changes include increasing the sample area of the CDP starting with 15 Jan. A number of bug fixes were applied to the 2D processing.			
Research Flights					
27 Feb	RF29	Delayed takeoff 1 hour waiting for weather to develop. Began with east-west legs, switched to north-south later in the flight. Clouds were primarily wave-type, developing throughout the flight. Some significant trapped lee waves on downwind side of Park Range, and some turbulence. On return ferry home, performed flap and gear tests for Rodi. Four times there occurred port switching/scrambling with radar. They were all caught quickly only losing 1-2	1759 - 2203	4.2	A Bandani L Avallone J French B Emery

		minutes of data each time. CIP computer rebooted once. No other known problems.			
26 Feb	RF28	Takeoff delayed 3 times--snowsquall first time, bleed-air valve indicator light second time, problems booting up lidar computer third time. Worked middle three legs (east-west) first half of flight and middle three legs (north-south) second half of flight. WCR in up looking mode only because ground-based W-band radar was scanning. High CLWC's, up to 1 g/m3 with larger drops. Aside from startup issues, no known problems.	1750 - 2124	3.7	A Bandani L Avallone J French A Luebke
25 Feb	RF27	Cloud SAT overpass, west of Park Range. Worked clouds along line north of Hayden airport for about 1 hour; mostly above clouds during time of overpass (1325 local). Second half of flight, worked racetrack over Park Range on SPL (middle) leg, and then leg just to the west. Beautiful crystals (dendritic) and regions with liquid water composed of high concentration of very small droplets. No known problems.	1930 - 2215	3.8	A Bandani L Avallone J French A Luebke
24 Feb	RF26	Flight over Park Range--mostly had to stay north of SPL due to air traffic. Cumulus clouds from 140 to about 170. Ice clouds in a layer around 220. Flight tracks focused on lower cumulus deck. No known problems. CDP wiring fixed prior to this flight.	1754-2106	3.3	A Bandani L Avallone J French N Mahon
20 Feb	RF25	Presidents Weekend, flight over Muddy Mountain near Casper. The CDP was down 174854-193218.	1708-2104	4.0	A Bandani L Avallone L Oolman S Dorsi
19 Feb	RF24	Presidents Weekend, flight over Muddy Mountain near Casper. The CDP was down 173622-195315. The 2D-P end element voltages dropped. Spurious to continous zero area images and noise from 195943-204005.	1658-2056	4.1	A Bandani L Avallone L Oolman S Dorsi
17 Feb	RF23	Second flight in two-flight day. Bad power switch over at beginning of flight, ended up needing to restart equipment, delaying takeoff by ~45 minutes. WCR server crashed once in flight, lost ~5 minutes of data. Wyoming's CDP replaced with DMT's to try to diagnose the outages. The CDP was down from 22:59 until the end of the flight. I believe UW's probe was reinstalled after this flight.	2224-0142	3.4	A Bandani L Avallone J French P Campbell
17 Feb	RF22	First flight in two-flight day. Worked 24 pattern. Precip to the ground over the mountains, cloud tops to FL200 early; slightly lower by later in flight. CDP failed for first ~half of flight.	1606-1927	3.4	A Bandani L Avallone J French B Liu
16 Feb	RF21	First flight with the upward lidar, noise from radar showed up on ground, prior to takeoff. Not the greatest cloud day, but some wave clouds did build in over the mountains over the course of the flight. CDP died off and on during flight. Right side generator failure at startup.	1908-2200	3.2	A Bandani L Avallone J French B Liu
08 Feb	RF20	Clouds to 22 kft; observed very little or no liquid water through entire flight; clouds composed entirely of ice, very cold at high altitudes (-40 C). CDP wuit working for portion of flight, presumably due to the cold; CIP computer rebooted once (1813).	1546-1932	3.7	A Bandani L Avallone J French Y Luo

07 Feb	RF19	Upon arrival on station two distinct cloud decks, upper layer cloud around 20 kft composed entirely of ice and lower cloud deck that appeared more wavelike in structure. over the course of flight, upper deck dissipated and lower deck thickened; last 1/2 of flight focused on lower deck from 142 to 155; Lower deck mostly liquid with a few large ice particles; we encountered high CLWC's up to 1.0 g/m3--ended up having to vacate cloud several times becasue of ice accumulation on aircraft. WCR operated in up only mode due to scanning ground-based radar. DMT LWC100 iced up a couple of times during flight--no other known problems	1553-1900	3.2	A Bandani L Avallone J French B Liu
06 Feb	RF18	Beginning of flight; marginal ice clouds--optically thin--between 17 and 22 kft; Second half of flight through growing cu with moderate LWC and graupel; reasonably vigorous. CDP went down about 45 minutes into flight and was down remainder of flight; WCL nitrogen ran out and ice crystals developed on window; Data System crashed during ferry back--did not attempt to restart. WCR in up-only mode since ground-based radar was scanning.	1650-2043	4.0	A Bandani L Avallone J French B Liu
05 Feb	RF17	Flight through clouds from 140 upto 220. Clouds and precip appeared "showery" with much apparent temporal variation(?). Executed 3 full patterns at FL220, FL142, and FL180; and one spiral descent over SPL. Known Problems: AIAS/BIAS disagreed at times-- following flight AIAS blew out (water was present); CDP was down from 2058-2126 and 2159-endoflight. CDP came back on ground. Subsequent check did not reveal anything.	2033-0029	4.0	A Bandani L Avallone J French B Liu
04 Feb	RF16	Flight through clouds between 140 and 180; moderate liquid present, particularly later in flight. Last ~1 hour of flight focused on porpoising through liquid layer from 160 to 180. Known Problems: LWC100 completely iced over last 1/4 of flight. 'PXI Watchdog failure' message from KADASMonitor (although data integrity seems unaffected by this.	2005-2302	3.1	A Bandani Z Wang L Oolman J French
01 Feb	RF15	Flight through very thin clouds at 18,000 and -38 C. Possibly homogeneous nucleation. Finished mission with legs at 14,200 ft above low clouds or blowing snow.	1747-2108	3.5	A Bandani Z Wang L Oolman M Zhou
31 Jan	RF14	Flight through tail end of storm. Takeoff delayed for snow in Laramie. Short outage of CDP data 1905-1912.	1841-2209	3.5	A Bandani L Avallone L Oolman B Liu
25 Jan	RF13	Flight through tail end of fast moving system. The clouds were dissipating rapidly. The flight was delayed because of generator problems and snow in Laramie. The CIP computer would not boot. The nadir door failed on this flight.	2238-0110	2.6	A Bandani L Avallone L Oolman D Lukens
22 Jan	RF12		1637-2027	4.0	A Bandani L Avallone L Oolman D Edwards
21 Jan	RF11	Flight over shallow clouds. The radar had a new controller board. The element on the LWC100 was replaced.	1604-1845	2.8	A Bandani L Avallone L Oolman D Edwards

19 Jan B	RF10	Second flight. Clouds dissipating during the flight.	2142-0000	2.4	A Bandani L Avallone L Oolman D Edwards
19 Jan A	RF09		1627-1937	3.2	A Bandani L Avallone L Oolman D Edwards
17 Jan	RF08	CloudSat overpass above Casper Mountain	1919-2148	2.6	A Bandani L Avallone L Oolman D Edwards
15 Jan	RF07 pt1 pt2	Flight through the tops of low clouds over the Snowy Range. First flight with the rebuilt CDP. The data system hung so the data is split into two files. CDP data from this date forward are processed with a sample area of 0.377 mm^2	1911-2119	2.3	A Bandani L Avallone L Oolman B Liu
13 Jan	RF06	Flight over low level clouds on Storm Peak. Since there were few 2D images, the 2D processing was not done.	1539-1838	3.0	A Bandani G Hallar L Oolman E Strom
09 Jan	RF05	Multiple passes through low clouds over Storm Peak	2052-2350	3.0	A Bandani G Hallar L Oolman A Pina
08 Jan	RF04	CloudSat overpass flight in southern Wyoming. Radar started blowing the breaker on the DC power supply so the data ends at 2014Z. The turbulence probe is fixed.	1929-2217	3.0	A Bandani G Hallar L Oolman E Strom
05 Jan	RF03	Flew the CP18 horizontal pattern at 20,000 and 15,000 ft with a missed approach into Steamboat in between.	1613-1906	3.0	A Bandani L Avallone L Oolman G Hallar
20 Dec	RF02	Deep clouds to 36,000 ft. Fly 270 degree along wind pattern at 26,000 ft, spiral down to 15,000 ft, then do a vertical latter climbing 1000 ft between legs.	2235-0222	3.9	B Wadsworth L Avallone L Oolman B Liu
15 Dec	RF01	The controller for the tip heater on the CLH inlet errored and did not heat. Tip iced over.	1612-1952	3.8	B Wadsworth L Avallone L Oolman B Liu

Test Flights					
28 Jan	TF07	Flight to check the lidar alignment after the installation of the new window. AC on the radar Tx subsystem did not have power. The CIP computer was not connected to the probe. The noise on the radar appeared whenever the engines were run up. This occurred both on the normal run up prior to the flight and after the flight.	2309-2358	0.9	A Bandani L Oolman S Haimov B Liu
04 Jan	TF06	Test flight after Christmas to check that everything is still running.	1756-1929	1.6	A Bandani B Glover L Oolman B Liu
17 Dec	TF05	Test flight for wind calibration maneuvers and to try to diagnose a noise problem on the radar. The lidar was not operated.	1824-1859	0.6	B Wadsworth B Kuestner J French L Oolman
10 Dec	TF04	Test flight of radar and lidar. CDP heater still broken. Second radar file had beams scrambled.	1707-1806	1.1	B Wadsworth T Sturtevant L Oolman B Liu
09 Dec	TF03	Test flight of radar and lidar. The lidar was cabled wrong. The radar mirror was not switched to the side for the radar circles. CDP heater still broke.	2058-2148	1.0	A Bandani L Peng L Oolman B Liu
06 Dec	TF02	Test of the CLH. Climbed to 20,000 feet and flew through wave clouds. Still no 2D-C, 2D-P, or turbulence. Broken CDP heater may be compromising the data for this probe.	2111-2211	1.0	A Bandani B Glover L Oolman S Dorci
01 Dec	TF01	Test flight for pilot proficiency. Flew to Hayden, shot a missed approach and flew home. Software for the FSSP, 2DC, 2DP, and RS232 Radar Altimeter still in development. Turbulence (TURB) not working. Dew point hygrometer bad 2225-2244 until it was autocalibrated.	2221-2339	1.4	A Bandani B Wadsworth L Oolman P Wechsler
Flight Hours		At completion of project, Research: 97.7 out of 100		Test: 7.6	


CAMPS Flight Hours
Hours Flown
100
90
80
70
60
50
40
30
20
10
0
hrs flown
ave hours
15-Dec
25-Dec
4-Jan
14-Jan
24-Jan
3-Feb
13-Feb
23-Feb
Date

CAMPS 2011 Post Mission Report

February 27, 2011

1. Crew: Bandani, Avallone, French, Emery.
2. Pre-Flight Brief: 0845
3. Planned T/O time: 1000
4. Flight Time: 4.2 Hrs
5. Weather: IMC for T/O, IMC in the working area, and VMC for Landing.
6. Lowest cloud deck: Scattered/broken layers at 14200', 15000', 16000', and 17000'. Tops variable 16500'- FL 180.

A. Brief:

Briefed mission for the 180 profile starting at FL 220 followed by climbs and descends to intermediate altitudes. Decision was made to delay the take off for one hour for better conditions.

Execution:

EndX, Fin!

Discussion:

Pleasure working the project.

Clouds are still an amazing and fascinating weather phenomenon, learned quite a bit too!

CAMPS 2011 Post Mission Report

February 26, 2011

1. Crew: Bandani, Avallone, French, Luebke.
2. Pre-Flight Brief: 0645
3. Planned T/O time: 0800
4. Flight Time: 3.7 Hrs
5. Weather: IMC for T/O, IMC in the working area, and VMC for Landing.
6. Lowest cloud deck: Scattered/broken layers at 14200', 15000', 16000', and 17000'. Tops variable 16500'- FL 190.

A. Brief:

Briefed mission for the three legs (3-4, 5-6, and 7-8) of the 180 profile starting at FL 220, followed by climbs and descends to intermediate altitudes.

Execution:

Filed to Hayden VOR (CHE) 084/026 fix w/delay of 3 hours and requested to work w/in 25 NM of this fix all quadrants. Departed KLAR at 1045 (delayed take off due to sudden snow squall during the booting up process requiring cleaning of the a/c surfaces and then maintenance action to check the right bleed air valve sticking) and climbed to FL 190. Received clearance from ATC to work w/in the requested air space and began the 180 profile at Pt 3. Once complete descended to 17000', 16000', and 15000' and reran the legs. Vectored by ATC to the west for arrivals in the KHDN. PI requested to switch to the 270 profile at Pt 8. Following ~10 minutes on a westerly heading as instructed by ATC, received clearance from ATC and ran the legs 8-7, 6-5, and 4-3 of the 270 profile at 16000' and 17000'. Once complete coordinated our return back to KLAR.

B. Discussion:

All data instruments worked as advertised w/a minor momentarily glitch in the Radar.

Long day, but got off the ground and completed the mission!

CAMPS 2011 Post Mission Report

February 25, 2011

1. Crew: Bandani, Avallone, French, Luebke.
2. Pre-Flight Brief: 1100
3. Planned T/O time: 1230
4. Flight Time: 3.8 Hrs
5. Weather: IMC for T/O, IMC in the working area, and VMC for Landing.
6. Lowest cloud deck: Scattered/broken layers at 14200', 15000', 16000', and 17000', FL 180. Tops variable 16500'- FL 220.

A. Brief:

Briefed mission for the planned Cloud Satellite track and the two legs (5-6 and 7-8) of the 270 profile starting at FL 220.

Execution:

Filed to Hayden VOR (CHE) 335/086 and 084/026 fixes w/respective delays of thirty minutes and two hours and thirty minutes at each fix. Requested to work w/in 15 NM of the first fix and w/in 25 NM of the second fix all quadrants. Departed KLAR at 1230 climbed to FL 220. Received clearance from ATC to work w/in the requested air space and began the Cloud Satellite track at FL 220 at 1306. PI requested descend to 17000' for the track. Requested and received clearance and commenced the remainder of the track at 17000'. At 1322 Started the spiral descend to 13000' and ran the track for an additional 25 minutes at 13000'. Requested and received clearance to proceed to CHE 084/026 fixe at 14200'and work w/in 25 NM of this fix all quadrants. Ran the leg 5-6 and 7-8 of the 270 profile at 14200', 15000', 16000', 17000' and the 5-6 leg at FL 180. Once complete coordinated our return back to KLAR.

B. Discussion:

All data instruments worked as advertised (2nd day in a row!)

Good day to fly!

CAMPS 2011 Post Mission Report

February 24, 2011

1. Crew: Bandani, Avallone, French, Mahon.
2. Pre-Flight Brief: 0930
3. Planned T/O time: 1100
4. Flight Time: 3.3 Hrs
5. Weather: VMC for T/O, IMC in the working area, and VMC for Landing.
6. Lowest cloud deck: Scattered/broken layers at 15000', 16000', and 17000'. Tops 17000'.

A. Brief:

Briefed mission for the planned 180 profile starting at FL 200, followed by a descend over Storm Peak to 14200' and redoing the 180 profile.

Execution:

Filed to Hayden VOR (CHE) 084/026 fix w/delay of 3+00 and requested to work w/in 25 NM of the fix, all quadrants. Departed KLAR at 1055 climbed to FL 200. Received clearance from ATC to work w/in the requested air space, requested altitude 17000' block FL 190 (FL 180 not available) and with clearance began the 180 profile at of FL 180 at Pt 2. Turning on to Pt 4 descended to 17000' and continued with the profile. Prior to reaching Pt 5, PI asked for a change to start the 270 profile at Pt 2. Reaching Pt 5 on the 180 profile was rerouted to the north by ATC due to arrivals into KHDN and was told to expect 25 minutes delay before being able to work south of Storm Peak. PI chose to work the 180 profile instead and started the profile from Pt 2. Reaching Pt 5 was cleared by ATC to work all quadrants and started the 270 profile at Pt 7. Due to better conditions for the middle three legs of the 270 profile, ran those legs at 15000' and once complete reran the same legs at 16000'. KLAR weather forecast (Garmin) for the 2200Z was less than favorable, so once complete at 16000' coordinated our return back to KLAR.

B. Discussion:

Today, all data instruments worked as advertised.

Bumpy flight.

Summary of CAMPS Research Flight 26

24 February 2011

Flight crew: A. Bandani, L. Avallone, J. French, N. Mahon

The goal of this flight was to sample clouds that formed in the Steamboat Springs area following a trough passage. Light intermittent snowfall had been reported on the ground. We intended to fly the 180 (E/W) pattern at multiple altitudes, but the clouds were quite sparse both to the east and to the west of the Park Range, so we decided to switch over to the 270 (N/S) pattern following the spiral over Storm Peak. ATC had other ideas for us today, which resulted in us continuing the 180 pattern for a while at a lower altitude, then switching to the 270 pattern (middle 3 legs) and eliminating the spiral. Almost all cloud encounters showed mixed-phase, with hundreds of small liquid drops and large ice crystals. We ended the flight a bit early because of concerns about landing conditions back in Laramie.

Instrument status:

- Good data were reported from ALL instruments throughout the flight.
- The CDP appears to be fixed – it worked the entire flight.

Flight details (all times are UTC)
(flight track details given below)

17:54:15	Take off Very large ice crystals on climb out, including some nice dendrites on CIP; local cloud tops at 14,500 ft
18:04:20	At 20,000 ft about 45 nm from Storm Peak; very dry layer centered at 500 mb Cloud tops look well below us – descend to 18,000 ft
18:16:05	Start of 180 pattern at northeast corner; clouds still below us so descend to 17,000 ft
18:17:30	At 17,000 ft; T = -24 ^{o}C, Td = -48 ^{o}C; cloud tops still below us, but increasing in height as we go west
18:21:30	Lidar shows liquid water in clouds below us; cirrus layer about 5 – 10,000 ft above
18:30:40	Through small wave cloud with 150/cm3 of 6 µm particles, LW ~ 0.3 g/m^3
18:31	Post-wave cloud, Td increased from -50 ^{o}C to -33 ^{o}C very quickly
18:41:40	Over Storm Peak Dewpoint Ts are higher on west side of range than east by about 10-15 ^{o}C
18:52:45	Very brief liquid cloud encounter (LW ~ 0.15 g/m^3)

18:57:25	At end of 4th pattern leg, ATC asked us to turn N; won't let us work southern end of area because they have lots of backed-up traffic into Eagle Get permission to descend to 15,000 ft and start on 180 pattern again there
19:05:25	Start 180 pattern again at northeast corner
19:05:40	At 15,000 ft; T = -19 ^{o}C, vertical velocities here -2 to -3 m/s
19:09:00	2 mm ice crystals with some liquid present; T = -21 ^{o}C, Td = -25 ^{o}C
19:10:25	300/cm^3 liquids at 15 µm; LW ~ 0.5 g/m^3
19:13:00	Still mixed phase cloud with large ice (several hundred microns) and 150 – 300/cm^3 liquid at 10 µm; vertical velocities 3 – 4.5 m/s
19:14:50	Into clear air
19:20:20	About 400/cm^3 liquid particles at 12 µm, LW ~ 0.4 g/m^3; T = -21.5 ^{o}C, Td = -24 ^{o}C
19:22:30	Much smaller ice particles here
19:29:50	First encounter with large ice particles on this leg
19:30:45	Ice crystals are several hundred µm
19:31:20	Now 300-400/cm^3 liquid particles; vertical velocity 2 m/s
19:32:15	Over Storm Peak
19:33:35	FSSP shows 300/cm^3 at 10 µm; ice particles are around 500 µm; LW ~ 0.2 g/m^3; cloud tops about 1-2000 ft above us
19:36:10	Got clearance from ATC for access to the rest of our area; switch to 270 (N/S) pattern
19:40:35	Brief liquid cloud with LW ~ 0.3 g/m^3
19:45:10	Start of 270 pattern at SW corner
19:54:25	Cloud has ice particles 500 – 800 µm and highly variable liquids; as much as 300/cm^3
20:01:50	400/cm^3 at 10 µm; very deep cloud (lots above us), up to 0.6 g/m^3 LW
20:05:25	Clouds quite variable on this leg – some extremely large ice (mm-size) with liquids; some seem to be ice only.
20:14:00	Climb to 16,000 ft
20:16:40	At 16,000 ft in clear air
20:17:40-48	Through cloud tops; some small wisps with small ice; T = -22 ^{o}C, Td = -29 ^{o}C
20:19:30	Really large ice with about 200/cm^3 at 8 µm
20:20:00	Clear air, but still getting ice particles from somewhere
20:21:45	200-300/cm^3 at 13 µm, LW ~ 0.3 g/m^3
20:24	ATC asks us to maintain heading for traffic – we end up well past leg end point (10 nm or more)
20:28:35	Finally cleared to return to pattern; have passed through a lot of mixed-phase cumulus buildups with LW 0.3-0.5 g/m^3 and up to 8 m/s vertical velocity
20:32:00	200 – 300/cm^3 at 12 µm, LW ~ 0.3 g/m^3

20:34:10 Back on pattern and in clear air

20:35:55 Small cloud with only liquid

20:38:30 Over Storm Peak it is mostly clear, but then shortly after into cloud with 300 µm ice and little LW (< 5/cm^3 at 20 µm on FSSP)

20:42:05 End of pattern; climb to 17,000 ft for transit; cloud now all ice

21:05 Landing

East/west (18CP) pattern

Altitude/Leg		**Start Time**	**End Time**
17,000 ft	Leg 1 (E→ W)	18:16:05	18:25:55
	Leg 2 (W → E)	18:27:55	18:34:35
	Leg 3 (E→ W)	18:36:25	18:46:40
	Leg 4 (W → E)	18:48:50	18:55:10
15,000 ft	Leg 1 (E→ W)	19:05:25	19:15:55
	Leg 2 (W → E)	19:18:15	19:25:00
	Leg 3 (E→ W)	19:27:05	19:36:10

North/south (27CP) pattern

Altitude/Leg		**Start Time**	**End Time**
15,000 ft	Leg 4 (S→ N)	19:45:10	19:52:45
	Leg 3 (N → S)	19:54:25	20:03:40
	Leg 2 (S→ N)	20:05:25	20:14:00
16,000 ft	Leg 2 (N→ S)	20:16:05	20:24
	Leg 3 (S → N)	20:34:10	20:42:05

CAMPS 2011 Post Mission Report

February 20, 2011

1. Crew: Bandani, Avallone, Oolman, Dorsi.
2. Pre-Flight Brief: 0815
3. Planned T/O time: 1000
4. Flight Time: 4.0 Hrs
5. Weather: VMC for T/O, IMC in the working area, and VMC for Landing.
6. Lowest cloud deck: Scattered/broken layers at 14000', 16000', FL 180, FL 210, and FL 220. Tops FL 220.

A. Brief:

Briefed mission for a planned 3 leg profile over Muddy Mountain, and redoing the 3 legs at multiple altitudes.

Execution:

Filed to Muddy Mountain VOR (DDY) 165/045 fix w/delay of 3+00 and requested to work w/in 30 NM of the fix, all quadrants. Departed KLAR at 1007, received clearance from ATC to work w/in the requested air space and began the profile at FL 220. Once complete descended to FL 210, FL 190, FL 180(only the first leg), 17000', 15000', 13000', and 12000' redoing the profile at all the respective altitudes. Once complete, coordinated our return back to KLAR.

B. Discussion:

A Good day!

Summary of CAMPS Research Flight 25

20 February 2011

Flight crew: A. Bandani, L. Avallone, L. Oolman, S. Dorsi

The goal of this flight was to sample again a deep cloud system over mountains southeast of Casper associated with fairly substantial snowfall. We used the same track from the day before of 3 30 nm-long legs, 5 nm apart parallel to the mountain ridge axis (about 160/330 headings) and flew these at several different altitudes from 22,000 ft down to 12,000 ft. The clouds were quite thin at times and almost exclusively ice (large halo around the sun present most of the time), with nice examples of columns, plates and dendrites at the lowest altitudes.

Instrument status:

- Good data were reported from most instruments throughout the flight.
- The CDP died early in the flight and came back to life toward the end of the flight.

Flight details (all times are UTC)
(flight track details given below)

17:08:25	Take off
17:20	Very tiny particles on 2D-C at 21,000 ft, along with a few small particles on FSSP
17:21	At 22,000 ft
17:23:30	Just past MBW, clouds thin above us with light radar returns; clouds to ground
17:31:25	Start of pattern at 22,000 ft
17:35:35	Into cloud with 100-200 µm ice particles; T = -34 ^{o}C, Td = -35 - -41 ^{o}C
17:41:20	Radar shows clouds as much as 3000 ft above us, but weak
17:44:30	Into clear air
17:49:10	CDP dies
17:52:20	Into cloud; tops about 1000 ft above us; 200-300 µm ice particles; T = -33 ^{o}C, Td = -38 ^{o}C; lidar shows all ice above
17:57:15	In fall streaks, 300-500 µm ice particles
17:59:35	At 21,000 ft, T = -31 ^{o}C, Td = -38 ^{o}C
18:00:30	Start pattern at 21,000 ft, about 4000 ft of thin cloud above
18:05:00	Into clear air
18:11:40	Between layers
18:13:00	Brief period of large ice crystals, then back to 100-200 µm ice
18:14:50	No particles, briefly
18:15:20	Back into cloud with small ice, about 2500 ft of cloud above us

18:20:25 Few dendrites and columns on imaging probes
18:26:10 Small ice again (~ 200 µm); sun halo prominent
18:31:20 At 19,000 ft; T = -27 ^{o}C, Td = -33 ^{o}C
18:37:00 Finally some ice on this track (~ 400 µm particles)
18:38:15 Not much going on at this altitude, descend to 18,000 ft
18:40:50 At 18,000 ft; not great here either, so descend further
18:43:00 At 17,000 ft; T = -24 ^{o}C, Td = -29 ^{o}C
18:45:30 Little cumulus below us with liquid water on lidar
18:54:35 Very white around us now, ~ 500 µm ice; radar echoes up to 7000 ft above us
19:02:15 At 15,000 ft; fairly broad size distribution
19:03:15 Radar shows cloud 10,000 ft above us
19:06:20 T = -20 ^{o}C, Td = -23 ^{o}C
19:16-17 Lots of columns showing up on 2D-C, about 300-400 µm, cloud 4000-5000 ft thick above
19:26 Clear air, flying between layers; cloud tops remain 3000-4000 ft above us
19:28 Broad size distribution in imagine probes
19:32 CDP came back to life!
19:34:05 At 13,000 ft; T = -16 ^{o}C, Td = -20 ^{o}C; lots of short columns appearing; some tiny LWs 0.02-0.03 g/m^3
19:38:20 Tops at least 5000 ft above here
19:44:30 Lots of columns on imaging probes; about 600 µm longest dimension
19:50:00 Tiny LWs (0.02 – 0.05 g/m^3), with a few (< 5) 40 µm particles
20:06:30 At 12,000 ft; T = -14 ^{o}C, Td = -18 ^{o}C
20:08:00 Lots of capped columns
20:14:35 Small amounts of LW (0.03 – 0.2 g/m^3); particles about 30-40 µm
20:18:45 Some very large aggregates here (maybe 1 mm); clouds tops 9-10,000 ft above
20:20:25 A few plates
20:23:15 Capped columns again
20:25:00-40 Dendrites!
20:29:00 Mix of plates and columns
20:37:45 End of patterns, return to Laramie
21:04 Landing

North/south pattern

Altitude/Leg		**Start Time**	**End Time**
22,000 ft	Leg 1 (SE→ NW)	17:31:25	17:39:05
	Leg 2 (NW → SE)	17:40:40	17:47:30

	Leg 3 (SE→ NW)	17:49:00	17:57:15
21,000 ft	Leg 1 (SE→ NW)	18:00:30	18:07:40
	Leg 2 (NW → SE)	18:09:30	18:17:35
	Leg 3 (SE→ NW)	18:19:10	18:26:45
19,000 ft	Leg 3 (SE→ NW)	18:29:10	18:38:15
18,000 -> 17,000 ft	Leg 2 (NW → SE)	18:40:10	18:47:20
	Leg 1 (SE→ NW)	18:48:55	18:57:50
15,000 ft	Leg 1 (NW→ SE)	19:01:50	19:09:55
	Leg 2 (SE → NW)	19:11:55	19:21:00
	Leg 3 (NW→ SE)	19:23	19:30:50
13,000 ft	Leg 3 (SE→ NW)	19:33:25	19:43:50
	Leg 2 (NW → SE)	19:44:30	19:52:45
	Leg 1 (SE→ NW)	19:54:25	20:04:15
11,000 ft	Leg 3 (NW→ SE)	20:06:30	20:14:35
	Leg 2 (SE → NW)	20:17:05	20:26:45
	Leg 1 (NW→ SE)	20:29:00	20:37:45

CAMPS 2011 Post Mission Report

February 19, 2011

1. Crew: Bandani, Avallone, Oolman, Dorsi.
2. Pre-Flight Brief: 0815
3. Planned T/O time: 1000
4. Flight Time: 4.1 Hrs
5. Weather: VMC for T/O, IMC in the working area, and VMC for Landing.
6. Lowest cloud deck: Scattered/broken layers at 14000', 16000', FL 180, FL 200, and FL 220. Tops FL 240.

A. Brief:

Briefed mission for a planned 3 leg profile over Muddy Mountain, and redoing the 3 legs at multiple altitudes.

Execution:

Filed to Muddy Mountain VOR (DDY) 165/045 fix w/delay of 3+00 and requested to work w/in 25 NM of the fix, all quadrants. Departed KLAR at 1000, received clearance from ATC to work w/in the requested air space and began the profile at FL 220. Once complete climbed to FL 240 and redid the pattern followed by a descend to FL 200, FL 180, 16000', and 14000' redoing the pattern at all the respective altitudes. Once complete, coordinated our return back to KLAR.

B. Discussion:

Cloud Gods were smiling big time and that made for a happy PI.

Last flight on Thursday learned something new….dipping Bessie's wing in the cloud during a turn with the opposite wing in the clear makes for an unhappy data set!

Summary of CAMPS Research Flight 24

19 February 2011

Flight crew: A. Bandani, L. Avallone, L. Oolman, S. Dorsi

The goal of this flight was to sample a deep cloud system over mountains southeast of Casper (since we are barred from the Steamboat Springs area this weekend). We set up a track of 3 30 nm-long legs, 5 nm apart parallel to the mountain ridge axis (about 160/330 headings) and flew these at 6 different altitudes from 24,000 ft down to 14,000 ft. The clouds were primarily ice, but there were pockets with liquid water only and areas of mixed-phase.

Instrument status:

- Good data were reported from most instruments throughout the flight.
- The CDP died early in the flight and came back to life toward the end of the flight.
- The 2D-P had some problems midway through the flight, probably caused by icing or fogging.

Flight details (all times are UTC)
(flight track details given below)

16:58:10	Take off; dry layer between surface and 650 mb
17:07	First clouds at 18,500 ft
17:12	At MBW VOR at 22,000 ft; clouds 7000-8000 ft above us and below us
17:13:50	On our way to track at 22,000 ft, T = -28 ^{o}C, Td = -30-36 ^{o}C; big ice crystals – few hundred microns to 1 mm
17:19:15	Start of pattern at 22,000 ft
17:25	Looks like broad PSD of ice crystals
17:33:40	Tiny amounts of LW (0.05-0.1 g/m^3)
17:34:10	20-30/cm^3 on FSSP, 12-15 µm diameters
17:42:45	Start climb to 24,000 ft, particle sizes dropping obviously as we climb
17:47:10	At 24,000 ft
17:47:30	Some pristine bullet rosettes mixed in with small junky ice; Td = -41 ^{o}C, T = -34 ^{o}C
17:49:10	Clouds still 7000 ft above us, but very small returns (-30 dBz)
17:51:15	CDP has died
17:51:50	Clear air, but some echoes above; still seeing ice crystals about 400 µm
17:58:15	Into cloud – thin above, extending about 12,000 ft below us
18:00:00	Clear air
18:01:50	Back into cloud, as much as 5000 ft of radar echo above us

18:06:35	100 µm ice particles
18:13:20	Descend to 20,000 ft
18:17:20	At 20,000 ft
18:17:50	Start pattern; T = -23 ^{o}C, Td = -29 ^{o}C; ice particles a few hundred microns
18:20:10	About 2000 ft of cloud above then broken cloud above that; radar echoes to ground
18:21:35	Ice crystals at least 2 mm; cloud 9000 ft thick above us
18:24:15	Small LW ~ 0.1 g/m^3; few 20-30 µm particles on FSSP (maybe 5 -30/cm^3)
18:25:55	Clouds at least 10,000 feet thick above, strong echoes 1000 ft above; particles 2 mm, LW ~ 0.05-0.15 g/m^3, 10-15/cm^3 at 15-20 µm on FSSP
18:29:50	Into clear air with thin cloud 1000 ft above
18:36:20	T = -23 ^{o}C, Td = -28 ^{o}C; ice particles 300-400 µm
18:41:45	Back to 1 mm ice particles, with occasional spurts of LW up to 0.15 g/m^3
18:43:25	Start descent to 18,000 ft
18:46:45	At 18,000 ft, T = -18.5 ^{o}C, Td = -23 ^{o}C
18:49:55	about 6000 ft of cloud above us, cloud to the ground
18:52:00	Into clear air
18:57:00	Lidar suggest LW at tops of clouds below us
19:02:00	More beneath than in cloud here, but seeing some particles
19:13:00	Large ice again, ~ 2 mm; very occasional small particle on FSSP
19:18:15	Fairly steady LW at 0.2 g/m^3, 18-30 µm particles (a few to 20/cm^3)
19:50	In turn, 60/cm^3 at 12 µm, very large ice (up to 4 mm?)
19:21:30	Start descent to 16,000 ft
19:23:50	At 16,000 ft; T = -15 ^{o}C, Td = -18 ^{o}C
19:26:15	All liquid cloud – 18-20/cm^3 at 20-30 µm, LW ~ 0.2 g/m^3
19:28:05	Dendrites on the imaging probes!
19:31:10	Large aggregates – several hundred microns to 1 mm
19:34:25	0.1 g/m^3 LW, 20-30/cm^3 at 25 µm; 2-3 mm ice particles
19:36:10	50/cm^3 at 10-20 µm along with large ice; T = -14 ^{o}C, Td = -17 ^{o}C
19:38:40	Seem to be between layers
19:42:20	Highly variable LW here, from zero to 0.15 g/m^3
19:45:50	Into clearing, but still a few large ice particles (falling?)
19:50:03	Descend to 15,000 ft, then get permission to 14,000 ft
19:52:35	At 14,000 ft
19:53	CDP came back
19:55:20	20-30 µm liquid particles, few – 20/cm^3, T = -10 ^{o}C, Td = -12 ^{o}C
20:00:50	40-60/cm^3 particles at 20 µm, LW ~ 0.4 g/m^3
20:06:00	2D-P going bad – no images after this

20:07:00 ATC asks us to turn south for traffic

20:10:05 Able to turn back north, about 12 nm into track; can see particles streaming past plane

20:14:00 Cloud tops now about 18,000 feet above us!

20:15 Larry reports seeing 300 µm capped columns

20:22:55 Getting very bright, but still snowing

20:24:20 LW up to 0.3 g/m^3; 35/cm^3 at 20 µm; cloud about 5000 ft above us

20:25:20 Into clear air

20:28:00 Back into mixed phase cloud

20:29:15 Finish patterns, head back to Laramie at 14,000 ft; somewhat bumpy with LW up to 0.4 g/m^3

20:56 Landing

North/south pattern

Altitude/Leg		**Start Time**	**End Time**
22,000 ft	Leg 1 (SE→ NW)	17:19:15	17:25:45
	Leg 2 (NW → SE)	17:27:10	17:35:55
	Leg 3 (SE→ NW)	17:38:00	17:44:25
24,000 ft	Leg 3 (NW→ SE)	17:47:30	17:56:05
	Leg 2 (SE → NW)	17:58:15	18:04:10
	Leg 1 (NW→ SE)	18:06	18:14:55
20,000 ft	Leg 1 (SE→ NW)	18:17:50	18:24:15
	Leg 2 (NW → SE)	18:25:55	18:34:55
	Leg 3 (SE→ NW)	18:36:20	18:43:50
18,000 ft	Leg 3 (NW→ SE)	18:47:50	18:57:35
	Leg 2 (SE → NW)	18:59:55	19:06:40
	Leg 1 (NW→ SE)	19:08:50	19:18:15
16,000 ft	Leg 1 (SE→ NW)	19:21:10	19:28:10
	Leg 2 (NW → SE)	19:29	19:38:40
	Leg 3 (SE→ NW)	19:40:15	19:47:35
14,000 ft	Leg 3 (NW→ SE)	19:49:50	20:00:50
	Leg 2 (SE → NW)	20:03	20:15:50
	Leg 1 (NW→ SE)	20:18:20	20:29:15

CAMPS 2011 Post Mission Report

February 17, 2011(times two)

1. Crew: Bandani, Avallone, French, Liu/Campbell.
2. Pre-Flight Brief: 0715 and 1330
3. Planned T/O time: 0900 and 1430
4. Flight Time: 6.8 Hrs (3.4 hrs x2)
5. Weather: VMC for T/O, IMC in the working area, and VMC for Landing.
6. Lowest cloud deck: Multiple scattered/broken layers at 14200', 16000', and 17000'. Tops varied between 16000' to 17000' and FL 180.

A. Brief:

Briefed mission for two hops, first hop a 300 profile and the second a 270 profile starting at FL 220 and FL 180 respectively including a descend to 14200' over Strom Peak and redoing each profile at 14200'.

Execution:

Filed to Hayden VOR (CHE) 084/026 fix w/delay of 3+00 and requested to work w/in 25 NM of the fix, all quadrants. Departed KLAR at 0905 and 1530 respectively and climbed to FL 220 and FL 190 (FL 180 was unusable.) Received clearance from ATC to work w/in the requested air space and began the 300 profile at of FL 220 at Pt 1and the 270 profile at FL 190 at Pt1. Once complete during each hop descended to 14200' and redid the pattern at 14200'. During the second hop after the completion of the 270 profile reran legs 3-4 and 5-6 at 15500'. Once complete, coordinated our return back to KLAR.

B. Discussion:

A happy PI.

Double pumped!

Summary of CAMPS Research Flight 23

17 February 2011

Flight crew: A. Bandani, L. Avallone, J. French, P. Campbell

The goal of this flight was to continue sampling the cloud system observed in the morning flight. Several issues delayed our takeoff for an hour beyond what was originally planned. In an attempt to focus more on the orographic effects in these clouds, we selected the 270 (N/S) pattern that follows the ridgeline. Flow was still primarily out of the southwest although winds had abated somewhat. We first flew a higher altitude pattern above clouds to map them out, then performed a spiral descent over Storm Peak and repeated the 5-leg pattern in mixed-phase clouds at 14,200 ft. Finally we flew the second and third legs at 15,500 ft to sample the very tops of the clouds.

Instrument status:

- Good data were reported from most instruments throughout the flight.
- The LiCor had an issue early in the flight, but power cycling brought it back.
- The replacement CDP died early in the flight and never came back.
- The radar computer died during the flight and was rebooted.
- The downward radar was turned off for leg 3 of the 270 pattern and in the spiral.

Flight details (all times are UTC)
(flight track details given below)

22:24:50 Take off
22:34:15 Transit to study area in clear air at 19,000 ft; T = -29 ^{o}C, Td = -42 ^{o}C
22:48:55 Start of 270 pattern at NE corner
22:53:25 Cloud tops about 4000 ft below on radar; 1.2-1.3 km below on lidar
23:16:50 Over Storm Peak
23:27:10 Cloud tops about 4000 feet below us, echoes not reaching ground
23:43:50 End of pattern, turn in toward Storm Peak
23:48:40 Over Storm Peak at 19,000 ft, start spiral descent
Couple of wingtip passes through cloud at 17,000 ft
At 16,000 ft, see about 150/cm^3 water drops; T = -22 ^{o}C, Td = -28 ^{o}C
At 15,200 ft, mixed phase cloud – LW about 0.2 g/m^3, 10 µm particles on FSSP; 400-800 µm ice, increasing in size as we descend
At 14,200 ft: T = -19 ^{o}C, Td = -22 ^{o}C; 0.1 g/m^3 LW; 200-250/cm^3 particles about 7-8 µm; ice larger than 1 mm

00:00:10 Clouds getting thinner (brighter), particles are smaller

00:02:50 Into clear air, T = -18 ^{o}C, Td = -26 ^{o}C

00:08:00 Radar computer crashed; rebooted within a few minutes

00:10:00 Starting 270 pattern at 14,200 ft

00:12:00 – 15:00 In cloud with 0.2 g/m^3 LW, > 2 mm ice particles; lots of 10-20 µm liquid drops; T = -19 ^{o}C; Td = -22 ^{o}C; tops of clouds about 1000 ft above us

00:16:25 Under, then into cloud; ice > 2 mm

00:21:30 - 25:25 Into cloud with 0.2 g/m^3 LW, 1 mm ice particles; 170 – 200/cm^3 6-10 µm liquid drops; T = -19 ^{o}C; Td = -22 ^{o}C

00:25:25 Into clear air

00:34:50 Into cloud with 0.2 g/m^3 LW, 2 mm ice particles; 150 – 250/cm^3 7-10 µm liquid drops; cloud tops about 2000 ft above us; vertical velocities -1.5 to +3.5 m/s; imagers show a very few pristine crystals, rest "junky"

00:42:35 Cloud suddenly now all ice particles – no liquids; reflectivity increased about 10 dBz, clouds a bit thicker above

00:44:50 Some liquid back in cloud now

00:45:35 Into clear air, with a few tops

00:46:15 All cloud below us

00:57:35 Into cloud – all ice, Td = -23 ^{o}C

01:00:40 End of pattern, climb to 15,000 ft

01:02:55 On Leg 2 of pattern – climb to 15,500 ft to get into tops

01:05:55 Cloud composition – still mixed phase; large ice and lots of small liquid particles; 0.2 g/m^3 LW

01:07:40 – 01:08 Cloud might have been pure liquid, about 0.1 g/m^3 LW

01:15:45 On Leg 3 – note wave clouds have formed above these cumuliform ones

01:19:50 Mixed phase similar to earlier pass here – LW about 0.1 g/m^3; crystals up to a few mm; vertical velocities -0.5 to + 3 m/s; clouds extend about 500 ft above us

01:23:30 End of leg; climb to 17,000 ft for transit back to Laramie; passed through another mixed-phase cloud in climb

01:42 Landing

North/south pattern (27CP)

Altitude/Leg		**Start Time**	**End Time**
19,000 ft	Leg 1 (N→ S)	22:48:55	22:58:55
	Leg 2 (S → N)	23:01:40	23:09:05
	Leg 3 (N→ S)	23:11:55	23:21:50
	Leg 4 (S → N)	23:24:35	23:31:45
	Leg 5 (N→ S)	23:34:25	23:43:50

14,200 ft	Leg 5 (S → N)	00:10:00	00:17:50
	Leg 4 (N→ S)	00:19:40	00:29:40
	Leg 3 (S → N)	00:31:20	00:39:10
	Leg 2 (N → S)	00:40:45	00:51:15
	Leg 1 (S → N)	00:52:50	01:00:40
15,500 ft	Leg 2 (N → S)	01:02:55	01:13:05
	Leg 3 (S → N)	01:15:45	01:23:30

Summary of CAMPS Research Flight 22

17 February 2011

Flight crew: A. Bandani, L. Avallone, J. French, B. Liu

The objective of this flight was to sample precipitating clouds associated with the passage of a cold front. Flow was primarily out of the southwest, with very strong winds aloft (about 100 kts at 22,000 ft). We used the 300 pattern to try to achieve better alignment with the wind direction, but were still off about 30^{o}. We performed the pattern above cloud at 20,000 ft, did a spiral descent over Storm Peak and repeated the 5-leg pattern at 14,200 ft. The high winds and several interferences from ATC limited our time on station.

Instrument status:

- Good data were reported from most instruments throughout the flight.
- The CDP died early in the flight and never came back.
- The downward radar was turned off for leg 3 of the 300 pattern and in the spiral.

Flight details (all times are UTC)
(flight track details given below)

16:06:50	Take off; transit to study area in clear air at 22,000 ft; winds 100 kts
16:25:30	Well above clouds, so descend to 20,000 ft; winds about 80 kts; T = - 30 ^{o}C, Td = -45-50 ^{o}C
16:31:10	ATC diverts us to 260 heading for traffic
16:34	Allowed to resume pattern
16:36:40	Back on course on 300 pattern, leg 1 Clouds reach to ground; tops are 3000 - 5000 ft below us
16:49:50	On second leg, cloud tops are at 17,000 ft; radar shows strong echoes near the ground which are probably precip; lidar suggests some small pockets of liquid near cloud top
17:00:35	Diverted to 270 heading for traffic
17:03:20	Allowed to resume our pattern
17:06:10	Lidar suggests cloud tops are liquid layer, but can't determine how thick
17:07	Back on course
17:09:20	Over Storm Peak
17:16:35	Clouds reach to ground on leg 4, tops still about 3000-4000 ft below us
17:35:00	End of pattern, head in toward Storm Peak ATC denies our request to descend, so we keep spiraling at 20,000 ft

17:45:20 Finally get permission to descend

17:51:25 Over Storm Peak at 16,400 ft, in clear air

17:52:55 Into cloud at 15,900 ft; T = -22 ^{o}C, Td = -27 ^{o}C; 70-80/cm^{3} drops at about 12 µm, LW ~ 0.1 g/m^{3}; some 200 µm ice particles on 2D-C

17:55:50 At 14,200 ft, between cloud layers, but seem to be getting 600 – 1000 µm ice particles falling from above

17:58:40 Back over Storm Peak, head out to pick up pattern again at SW corner; clouds are about 1000 ft above us, with lots of big particles falling

18:07:15 Clouds thicker above us, falling particles are about 1 mm, T = -19 ^{o}C, Td = -24 ^{o}C

18:09:15 Start of 300 pattern

18:17:30 Small amounts of LW, with a very few particles on FSSP; lidar shows some LW above us

18:20:40 Between layers, clouds above us by about 2000 ft

18:22:00 Lidar suggests thin layer of liquid below us

18:30:40 ATC puts us on 090 heading for traffic

18:34:35 We got so far off course that we decided to resume pattern at furthest end and work inward

18:40:05 Flying through some patches of dissipating cloud

18:48 Between layers, upper layer about 1000 ft thick
Last about 15 nm of this leg seeing large ice particles on 2D-C, but can't tell if they are falling from above or we are in very thin layer of cloud

19:01 Over Storm Peak; ice particles greater than 1 mm here; cloud looks quite dense below; clouds above us are 1000-2000 ft thick

19:04:20 End of pattern, climb to 17,000 ft for transit back to Laramie

19:27 Landing

Northeast/southwest pattern (30CP)

Altitude/Leg		**Start Time**	**End Time**
20,000 ft	Leg 1 (NE→ SW)	16:36:40	16:47:10
	Leg 2 (SW→ NE)	16:49:50	16:55:20
	Leg 3 (NE→ SW)	16:57:20	17:14:35
	Leg 4 (SW → NE)	17:16:35	17:22:55
	Leg 5 (NE → SW)	17:25:00	17:35:00
14,200 ft	Leg 5 (SW→ NE)	18:09:15	18:16:20
	Leg 4 (NE→ SW)	18:18:20	18:29:20
	Leg 1 (SW→ NE)	18:34:35	18:40:05
	Leg 2 (NE → SW)	18:42	18:54:30
	Leg 3 (SW→ NE)	18:57	19:04:20

CAMPS 2011 Post Mission Report

February 16, 2011

1. Crew: Bandani, Avallone, French, Liu.
2. Pre-Flight Brief: 0915
3. Planned T/O time: 1100
4. Flight Time: 3.1 Hrs
5. Weather: VMC for T/O, in the working area, and for Landing.
6. Lowest cloud deck: Scattered/broken layers at 16000', 17000'. Tops FL 200.

A. Brief:

Briefed mission for the planned 330 profile starting at FL 220, followed by descends and/or climbs as appropriate to an intermediate altitude and redoing the 330 profile. Decision was made to delay the take off by one hour for better cloud coverage in the working area.

Execution:

Filed to Hayden VOR (CHE) 084/026 fix w/delay of 3+00 and requested to work w/in 25 NM of the fix, all quadrants. Departed KLAR at 1210 (right generator would not come on line) climbed to FL 220. Received clearance from ATC to work w/in the requested air space and began the 330 profile at of FL 220 at Pt 1. Once complete w/the first four legs of the profile requested and received clearance to work FL 180 block FL 200. Descended to FL 200 and redid the three legs in reverse. At the start of the leg 5-6 descended to FL 180 and finished the remainder of the profile at FL 180. Following that requested and received clearance to work 15000' block 17000' and reran the legs in reverse at 15000'. Upon reaching point 4 climbed to 17000'and finished legs 5-6 at 17000'. Requested and received clearance to work 17000' block FL 190 and ran the 6-5 leg at FL 180. Once complete, coordinated our return back to KLAR.

B. Discussion:

Cloud Gods did smile upon us today (after a 7 day hiatus) without requiring any sacrifices, and that made for a happy PI.

Great to be back in the air!

Summary of CAMPS Research Flight 21

16 February 2011

Flight crew: A. Bandani, L. Avallone, J. French, B. Liu

The original objective of this flight was to sample mid- and higher level clouds in advance of an approaching cold front, to compare to the ground-based HSRL and SWACR. In addition, we wanted to fly underneath higher clouds to test the newly installed upward-looking lidar on the aircraft. The clouds, however, had other ideas. When we arrived in the Steamboat Springs area, there was very little cloud and it was mostly low level on the eastern side of the ridge. We started the 330 (NE/SW) pattern at 22,000 ft, and after completing two legs in clear air, noticed the formation of wave clouds over the Park Range. We proceeded to fly through those on the 330 pattern at various altitudes, while they transformed into mixed-phase cumulus clouds, ending with two legs over Storm Peak Lab within and at the top of the clouds.

Instrument status:

- Good data were reported from most instruments throughout the flight.
- The CDP was up and down throughout the flight.
- The downward-looking lidar appears to have become slightly misaligned, leading to an about 20% decrease in sensitivity.
- The upward-looking lidar performed fine, although it needed some post-flight tuning to adjust the gain.
- The downward radar was turned off for leg 3 of the 330 pattern.

Flight details (all times are UTC)
(flight track details given below)

19:08:30	Take off Transit to study area in clear air
19:20:45	At 22,000 ft, T = -27 ^{o}C, Td = -54 ^{o}C
19:34	Start of 330 pattern at southeast corner; 75-80 kt headwinds, ground speed 140 kts
19:50	Start passing over wave cloud, which appears to be at about 19,000 ft
19:57:05	Over wave cloud; lidar shows it about 600-700 m below us
20:01:10	Over StormPeak fix, very thin cloud below us
20:12	Over wave cloud
20:13:30	Requested and received block altitude FL 180-200; start descending to 20,000 ft
20:14:30	Finish first pattern at end of leg 4 (no cloud further north)

20:18:30	Start pattern at 20,000 ft
20:34:40	Over Storm Peak at 19,500 ft, descending to get into cloud
20:35:20	At 18,500 ft; Td = -27 ^{o}C
	Into cloud at 18,300 ft; LW ~ 0.25 g/m^3, FSSP shows 50-80/cm^3; few tiny ice particles on 2D-C
20:37	Descent to 18,000 ft
20:41:20	Into cloud; T = -20 ^{o}C; Td = -28 ^{o}C, vertical velocities of -3 to -4 m/s; ice particles are a few hundred microns; LW ~ 0.25 g/m^3; FSSP shows 50-100/cm^3 at d = 17 µm
20:45:15	vertical velocities now around +3 m/s
20:46:30	Out of cloud
20:58:50	End of pattern, descend to 15,000 ft to get under clouds for lidar
21:01:30	Big ice particles falling from above
21:02:40	Start pattern at 15,000 ft
21:09:50	Clear air, T = -12.5 ^{o}C, Td = -18.5 ^{o}C; pretty bumpy; getting some large (~ 600 µm) ice particles beneath wisps above
21:22:40	2 passes beneath clouds enough to test lidar and air is really rocky (vertical velocities up to + 8 m/s); climb to 17,000 ft
21:24:35	Into cloud at 16,800 ft – mixed phase, with 0.25 g/m^3 LW and ~600 µm ice crystals; T = -18 ^{o}C, Td = -22 ^{o}C, vertical velocities up to + 3 m/s
21:27:20	Jeff reports change in cloud structure on radar
21:28:25	Now 0.5 g/m^3 LW; FSSP seeing 20 µm particles; cloud appears to be more liquid toward edge than in center
21:30	Over Storm Peak
21:31:10	Into clear air; then another cloud encounter with vertical velocities between +2 and +7 m/s
21:37:35	At 18,000 ft
21:40:40	Into cloud – 80-100/cm^3 20 µm drops on FSSP; LW ~ 0.2 g/m^3; a few small ice particles
21:42:30-50	Another brief cloud encounter similar to previous
21:43:55	End of pattern
22:01	Landing

Northeast/southwest pattern (33CP)

Altitude/Leg		**Start Time**	**End Time**
22,000 ft	Leg 1 (NE→ SW)	19:34	19:46:25
	Leg 2 (SW→ NE)	19:48:25	19:53:15

	Leg 3 (NE→ SW)	19:55:10	20:06:45
	Leg 4 (SW → NE)	20:08:55	20:14:30
19,500 ft	Leg 4 (NE→ SW)	20:18:30	20:30
➔ 18,300 ft	Leg 3 (SW→ NE)	20:31:45	20:37
➔ 18,000 ft	Leg 2 (NE → SW)	20:39:00	20:50:45
	Leg 1 (SW→ NE)	20:52:30	20:58:50
15,000 ft	Leg 1 (NE→ SW)	21:02:40	21:13:55
	Leg 2 (SW→ NE)	21:16:00	21:22:40
17,000 ft	Leg 3 (NE→ SW)	21:24:35	21:36:25
18,000 ft	Leg 3 (SW → NE)	21:38:30	21:43:55

CAMPS 2011 Post Mission Report

February 08, 2011

1. Crew: Bandani, Avallone, French, Lou.
2. Pre-Flight Brief: 0715
3. Planned T/O time: 0900
4. Flight Time: 3.7 Hrs
5. Weather: IMC for T/O, in the working area, and for Landing.
6. Lowest cloud deck: Multiple Scattered/broken layers at 14200', 17000'. Tops FL 220.

A. Brief:

Briefed mission for the planned 270 profile starting at FL 220, followed by a descend over Storm Peak to 14200' and redoing the profile followed by a climb to an intermediate altitude for a last run of the 270 profile.

Execution:

Filed to Hayden VOR (CHE) 084/026 fix w/delay of 3+00 and requested to work w/in 25 NM of the fix, all quadrants. Departed KLAR at 0850 climbed to FL 220. Received clearance from ATC to work w/in the requested air space and began the 270 profile at of FL 220 at Pt 1. Once complete proceeded to Storm Peak for a spiral descend to 14200'. Reaching 14200' ran the 240 profile. Requested and received clearance to 17000' and ran the 270 profile. Once complete, coordinated our return back to KLAR.

B. Discussion:

A happy PI!

Great day to fly.

Summary of CAMPS Research Flight 20

8 February 2011

Flight crew: A. Bandani, L. Avallone, J. French, M. Luo

We sampled clouds over the Steamboat Springs area following passage of a front. Clouds were quite variable in depth and seemed to consist of multiple optically thin layers. We completed the 270 (N/S) pattern at 22,000 ft, which was near cloud top, to map out the cloud layer(s) below. We then performed a spiral descent over Storm Peak Laboratory and completed the 270 pattern at 14,200 ft. Finally we flew the 270 pattern at 17,000 ft to sample the middle part of the cloud.

Instrument status:

- Good data were reported from most instruments throughout the flight.
- The CDP was down for about one hour of the flight.
- The CIP computer rebooted itself on the first leg of the 17,000 ft pattern
- The downward radar was turned off for legs 3 and 4 of the 270 pattern and during the spiral descent.

Flight details (all times are UTC)
(flight track details given below)

15:46	Take off - in cloud on most of ascent Temperature and dewpoint profiles tracked almost perfectly with offset of 5 ^{o}C between T and Td
15:56:15	Out of cloud at 19,700 ft; still some wispy clouds above
15:58:40	At 22,000 ft; T = -38 ^{o}C, Td = -45 ^{o}C
16:03:55	Start of 270 pattern at northeast corner; in wispy tops with 200-400 μm particles on 2D-C; radar shows continuous cloud to the ground
16:11	Big gap in upper clouds – can see deeply into cloud layer Winds from south, about 30 kts
16:14:40-55	Beneath fall streaks; particles on 2D-C are a few hundred microns; lidar shows only ice cloud below
16:22:35	CDP not working
16:26:25	Over Storm Peak Lab, in clear air. Clear to ground except for a hazy layer well below us; T = - 39 ^{o}C, Td = -47 ^{o}C

16:30:05	Into cloud; ice particles ranging from 25-400 µm
16:30:40	Cloud extending about 1000 ft above plane
16:33:45	Into clear air, with hazy layer below us. Lidar says it is 3000 ft below and optically thin
16:41:25	Into tops; about 500-1000 ft of cloud above; particles 25-500 µm
16:43:25	Into clear air, with occasional wisps above
16:47	Light chop here – about 7 nm from south end of track
16:48:30	Into cloud (about 500 ft from top)
16:49:30	Ice particles falling from above – 200-400 µm aggregates
16:50:05	End of pattern
16:52:30	Heading in toward Storm Peak
16:57:20	Pass over SPL and start descent; encounter very thin cloud with 10 µm water droplets at 18,400 ft
17:04	Bigger ice particles at 18,100 - 17, 800 ft; about 400 µm aggregates
	17,300 – 16,200 ft – thin cloud with similar particles; T = -26 ^{o}C, Td = -34 ^{o}C
17:10	Over Storm Peak Lab at 15,200 ft; particles are aggregates, several hundred microns in diameter
17:11:10	At 14,200 ft; T = -20 ^{o}C, Td = -26 ^{o}C
17:18:45	Start of 270 pattern at 14,200 ft
17:20	2D-C shows big particles here, but radar shows no returns from below; Td = -28 ^{o}C; low cloud layer below us is liquid, but looks like it is converting to ice the further south we go on first leg
17:25:20	Particles are now several hundred microns to 1 mm
17:36	CDP back on within last 10 minutes
17:39:30	In very thin cloud here
17:43	Over Storm Peak
17:44:50	Particles here are 600-700 µm
17:53:00	Very optically thin cloud above us
18:08:50	End of pattern, climb to 17,000 ft
18:12:50	At 17,000 ft; T = -26 ^{o}C, Td = -33 ^{o}C
18:25:20	Start seeing particles on 2D-C, somewhat larger than 100 µm
18:28:00	Particles now 200-300 µm
18:28:50	About 5000 ft of cloud above
18:30:50	CIP showing 500 µm particles
18:33:35	Air appears to be clear, but still seeing particles a few hundred microns in size
18:35:15	Over Storm Peak Lab; thin cloud here
18:41	ATC directed us to keep on heading, which took us somewhat beyond the end of leg 3

18:46:10 Particles about 50 µm, then growing larger as we continue south; T = -26.5 ^{o}C, Td = -33.5 ^{o}C; clouds about 5000 ft thick above us

18:53:20 Cloud goes all the way to the ground and about 5000 ft above us; particles 400-500 µm; size distribution seems very broad

19:02:35 End of pattern; clouds below have really grown in since our earlier passes

19:31 Landing

North/south pattern (27CP)

Altitude/Leg		**Start Time**	**End Time**
22,000 ft	Leg 1 (N→ S)	16:03:55	16:12:05
	Leg 2 (S→ N)	16:14	16:20:45
	Leg 3 (N→ S)	16:22:35	16:30:40
	Leg 4 (S → N)	16:32:35	16:39:30
	Leg 5 (N → S)	16:41:25	16:50:05
14,200 ft	Leg 5 (N→ S)	17:18:45	17:26:15
	Leg 4 (S → N)	17:28:10	17:37:30
	Leg 3 (N→ S)	17:39:30	17:47:20
	Leg 2 (S → N)	17:49:15	17:58:45
	Leg 1 (N→ S)	18:01:05	18:08:50
17,000 ft	Leg 1 (S→ N)	18:12:50	18:19:05
	Leg 2 (N→ S)	18:21:00	18:28:50
	Leg 3 (S→ N)	18:30:50	18:40
	Leg 4 (N → S)	18:43:45	18:51:25
	Leg 5 (S → N)	18:53:20	19:02:35

CAMPS-11 RF20

02/08/2011

Crew-
A Bandani
L Avallone
J French
Y Liu
LOD-
B Glover

PLAN:
27 pattern, expect clouds to 22 kft or higher

Planned takeoff time 1600 Z

PREFLIGHT:
Nothing unusual

FLIGHT:

1546 Wheels up

1600 level at FL220, T~-38

1604 Leg 1, north to south, FL220, just skimming cloud tops, all ice

1611 end leg 1

1614 begin leg 2, still skimming tops

1621 end leg 2

1622 begin leg 3, middle leg over SPL, WCR up only

1623 noticed that CDP quit working

1631 end leg 3

1632 begin leg 4, south to north; mostly flying just above tops but around Steamboat and SPL a bit of a hole in the clouds with much lower tops (3 kft below us)

1639 end leg 4

1640 begin leg 5 WCR up/Dualdown

1649 end leg, proceed to SPL for spiral descent

1652 proceeding to SPL, WCR is up only

1658 begin descent, SPL still in bit of cloud hole, WCL suggests possibly some liquid around 18 kft?

1704 at FL180, penetration in top of lower cloud a little (very little) liquid (0.05 g/m3?), 8 micron drops

1711 end descent—resume 27 pattern, this time at FL142

1718 begin leg 1(a) furthest west, north to south, below base of clouds

1721 cloud about 2-3 kft below us, from WCL it looks like liquid at the top?—as we proceed further south it looks like upper cloud maybe dropping ice into lower cloud

1723 liquid layer in lower cloud disappears

1725 end leg 1

1728 begin leg 2, south to north, WCR up only

1736 CDP is back

??? end leg 2

??? begin leg 3 (SPL leg)

1748 end leg

1749 begin leg 4, south to north, WCR up/Dualdown, echo from 5 kft above us to sfc, 0 dBZ, 1 mm particles on CIP and twodc

1758 end leg 4

1800 begin leg 5

1809 end leg 5, climb to FL170 and repeat pattern

1811 begin leg 1, furthest east, south to north, still climbing

1813 CIP computer rebooting

1813 level at FL170

1816 CIP computer back online

1819 end leg 1

1820 begin leg 2, north to south

1829 end leg

1831 begin leg 3, WCR up only, in ice cloud at the southern end of leg, 200-400 micron ice

1841 end leg 3

1844 begin leg 4

1851 end leg 4

1853 begin leg 5 (south to north) furthest west leg, likely will be last leg—in cloud—thick cloud at this southern end and thins significantly by northern end

1902 end leg; Return to Laramie

1932 Wheels down

DEBRIEF:

CDP went down again in flight---will do some testing in environmental chamber prior to next flight and discuss problem with DMT

CIP computer rebooted once—Matt could not find anything in logs—no record of event—thus acts like a catastrophic failure (loss of pwr???)

CAMPS 2011 Post Mission Report

February 07, 2011

1. Crew: Bandani, Avallone, French, Liu.
2. Pre-Flight Brief: 0715
3. Planned T/O time: 0900
4. Flight Time: 3.2 Hrs
5. Weather: VMC for T/O, IMC in the working area, and VMC for Landing.
6. Lowest cloud deck: Multiple broken layers at 14200', 15000', 16000'. Tops variable 17000'- above FL 240.

A. Brief:

Briefed mission for the planned 240 profile starting at FL 180, followed by a descend over Storm Peak to 14200' and redoing the profile followed by a climb to an intermediate altitude for a last run of the 240 profile.

Execution:

Filed to Hayden VOR (CHE) 084/026 fix w/delay of 3+00 and requested to work w/in 25 NM of the fix, all quadrants. Departed KLAR at 0850 climbed to FL 220 (FL 180 unusable due to altimeter setting.) Received clearance from ATC to work w/in the requested air space and began the 240 profile at of FL 240 at Pt 1. Once complete proceeded to Storm Peak for a spiral descend to 14200'. Reaching 14200' it quickly became apparent this altitude will not be workable due to both rate and amount of icing. Requested and received clearance to 15500' and continued with the 240 profile. At the start of leg 5-6, the altitude due to both rate and amount of icing, once again became unworkable. Requested and received clearance to 16000' and continued with the 240. At the start of the 3-4 leg requested and received clearance to 16500' and finished the last two legs of the 240 profile. Once complete, coordinated our return back to KLAR.

B. Discussion:

A happy PI!

Clouds are one amazing weather phenomenon.

Summary of CAMPS Research Flight 19

7 February 2011

Flight crew: A. Bandani, L. Avallone, J. French, B. Liu

We once again sampled clouds associated with northwest flow into the Steamboat Springs area. Clouds were present in two layers – one mostly stratiform layer that extended about 5000-7000 ft AGL, the other a cirrus layer at least 28,000 MSL. We completed the 240 (NW/SE) pattern at 24,000 feet to map out the cloud layer(s) below. We then performed a spiral descent over Storm Peak Laboratory, entering a dense liquid water cloud at 15,200 ft. We were unable to complete legs at 14,200 ft because the airframe icing was too extensive, so we climbed to 15,500 ft and continued the 240 pattern, climbing twice more to get out of moderate icing conditions.

Instrument status:

- Good data were reported from most instruments throughout the flight.
- The LWC100 iced up in the first supercooled cloud encounter, but recovered after some time in clear air.
- The CLH ingested an extremely large amount of water in the first cloud encounter, so data for that pass are suspect.
- The downward radar was turned off for the middle legs of the 240 pattern and during the spiral descent.

Flight details (all times are UTC)
(flight track details given below)

15:52:55	Take off Passed through very dry layer (Td ~ -55 ^{o}C) at 550 mb on climbout
16:09:30	At 24,000 ft; between cloud layers. Upper layer shows only weak reflectivity on radar.
16:16:20	Start of 240 pattern at northeast corner (ground speed 290 kts heading to SE)
16:23:10	Clouds below are rolls over ridgelines; Td between -40 and -50 ^{o}C; Tair = -34 ^{o}C; very strong headwind – ground speed here is only 150 kts
16:38:20	Over Storm Peak Lab; clear air at 24,000 ft; Td = -55 ^{o}C, Tair = -24 ^{o}C
16:47:30	Clouds thickening below us as we head toward northwest end of track

16:45:55 Clouds about 6000 ft thick below us; radar reflectivity shows relatively smooth tops

17:00:00 End of pattern, turn in toward Storm Peak

17:07:25 Start spiral descent

17:08:36 Over Storm Peak Lab; lidar suggests 2 layers of clouds about 300 m apart below us

17:21:40 Into cloud at 16,400 ft; Td = -25 ^{o}C, Tair = -18 ^{o}C; very small droplets with only a very few ice particles at the bottom of the layer; layer less than 1000 ft thick
Back into cloud again at 15,200 ft; size distribution appears bimodal; LW ~ 0.8 g/m^3

17:25:48 At 14,200 ft; LW about 0.6 g/m^3; extensive airframe icing; LWC100 quit working; pilot requested climb to 15,500 ft

17:32:40 At 15,500 ft in clear air; head back to northwestern corner of 240 pattern

17:38:45 Start 240 pattern at NW corner; winds less at 15,500 than at 24,000 (ground speed 230 kts)

17:46:50 Small cloud encounter; 0.2 g/m^3 LW

18:03:10 Another dense cloud – 1 g/m^3 LW; T = -18 ^{o}C, Td ~ -20 ^{o}C; very few ice particles showing on 2D-C

18:05:05 Need to climb out of this – go to 16,000 ft

18:08:50 At 16,000 ft, back into very dry layer; Td back down near -40 ^{o}C

18:17:00 Enter another dense layer, about 100 ft from top; LW ~ 1 g/m^3; climb out to 16,500 ft

18:27:50 End of pattern; turn back to return to Laramie

19:00:10 Landing

Northwest/southeast pattern (24CP)

Altitude/Leg		**Start Time**	**End Time**
24,000 ft	Leg 1 (NW→ SE)	16:16:20	16:21:25
	Leg 2 (SE→ NW)	16:23:10	16:33:50
	Leg 3 (NW→ SE)	16:35:55	16:40:50
	Leg 4 (SE → NW)	16:42:50	16:53:00
	Leg 5 (NW → SE)	16:54:55	17:00:00
15,500 ft	Leg 5 (NW→ SE)	17:38:45	17:45:50
	Leg 4 (SE → NW)	17:47:50	17:57:55
15.5–16kft	Leg 3 (NW→ SE)	18:00:05	18:07:15
16-16.5 kft	Leg 2 (SE → NW)	18:08:50	18:20:15
16,500 ft	Leg 1 (NW→ SE)	18:21:40	18:27:50

CAMPS-11 RF19

02/07/2011

Crew-
A Bandani
L Avallone
B Liu
J French
LOD-
B Glover

PLAN:
Predicted tops to 14 kft, but visually expect higher tops?, conduct 24 pattern, planned takeoff time 16 Z

PREFLIGHT:
Nothing unusual

FLIGHT:

1553 Wheels up

1604 everything up and running

1611 FL240—setup for pattern 24, begin on NE end, between 2 layers—base of upper layer ~2 kft above us, top of lower layer varies from 6 kft below us and lower

1616 begin leg 1 at FL250—from WCL no clouds between aircraft and lower deck, lower deck has wave-like structure with solid reflectivity to ground of about 0 dBZ

1619 CIP computer lost connection—rebooted on its own

1621 end leg 1, CIP seeing low concs of 200 micron particles, just below thin clouds, T~-35

1623 begin leg 2

1634 end leg

1635 begin leg 3 (center leg) radar up only, strong wind from NW

1641 end leg

1642 begin leg 4 at FL240, just below thin ice cloud

1653 end leg 4

1655 begin leg 5, remain 1000 ft below thin ice clod, low-altitude echo about 6000 ft thick and extends to the surface

1700 end leg 5; proceed to SPL setup for spiral descent

1708 begin spiral descent over SPL

1712 WCL indicates at least 2 distinct WCL layers separated by about 300-400 m

1721 into the cloud tops at FL164

1723 through cloud at 154

1724 into lower cloud deck at ~153—WOW-bimodal distribution of cloud droplets at top of cloud! Lots of liquid water!

1726 at FL142

1727 LWC100 goes to lunch-too much ice buildup

1730 proceeding to NW point of patter, climb to 155 to get in lesser LWCs (building up too much ice).

1738 begin leg 1 at FL155, on this leg we are about 100-300 m above tops

1746 end leg 1, just getting into top of cloud through the turn, LWCs 0.25 g/m3, LWC100 back online

1748 online for leg 2, looks like we will be in and out of cloud as we skim the tops

1758 end leg 2

1800 begin leg 3 (center leg) skimming through the tops, seeing some liquid of 0.1 to 0.2 g/m3

1805 WOW—LWCs to 1.0 g/m3, accumulating lots of ice, need to climb above this

1807 end leg

1810 begin leg 4, FL160 above cloud by 500-700 ft

1818 in cloud, LWC of ~1 g/m3, need to climb to get out of icing, upto 165

1820 end leg 4

1822 begin leg 5 at FL165

1828 end leg 5, return to Laramie

1830 returning to Laramie

1900 wheels down

DEBRIEF:

High LWCs, needed to vacate cloud several times because ice buildup was too much, LWC100 iced over a couple of times.

CAMPS 2011 Post Mission Report

February 06, 2011

1. Crew: Bandani, Avallone, French, Liu.
2. Pre-Flight Brief: 0715
3. Planned T/O time: 0900
4. Flight Time: 4.0 Hrs
5. Weather: IMC for T/O, in the working area, and for Landing.
6. Lowest cloud deck: Multiple broken layers at 14200', 16000'-FL 180. Tops FL 210.

A. Brief:

Briefed mission for the planned legs 3-4, 5-6, and 7-8 of the 180 profile starting at FL 220 and then a 1000' descends and redoing the legs at 1000' increments down to 14200'.

Execution:

Filed to Hayden VOR (CHE) 084/026 fix w/delay of 3+00 and requested to work w/in 25 NM of the fix, all quadrants. Departed KLAR at 0950 (due to required plowing of the runway and ramp) climbed to our planned altitude of FL 220. Received clearance from ATC to work w/in the requested air space and began the legs of 180 profile. Descended to FL 210, 200,190 and then down to 14200' and completed the legs. Then switched to the legs 3-4, 5-6, and 7-8 of the 270 profile and ran them at 14200' and 16000'. Following that switched to leg 1-2 of the 270 profile and ran this leg at 14200', 16000', FL 180 and 200. Once complete, coordinated our return back to KLAR.

B. Discussion:

PI was all smiles (something regarding particle sizes and water content in the climbs!)

Good day to fly!

Summary of CAMPS Research Flight 18

6 February 2011

Flight crew: A. Bandani, L. Avallone, J. French, B. Liu

We sampled clouds associated with northwest flow into the Steamboat Springs area. In particular, we intended to use the middle three legs of the 180 (E/W) pattern to densely sample the volume scanned by the SWACR on the ground at Mt. Werner. We completed three sets of this pattern – at 21,000, 19,000 and 14,200 feet. By this time, the original cloud deck was dissipating, but new clouds were growing in over the ridge line. We switched to the 270 (N/S) pattern to explore these clouds, which contained a mix of small liquid particles and very large (mm-sized) ice crystals. We were able to stay with one line of clouds as it evolved and to sample these clouds at various altitudes.

Instrument status:

- Good data were reported from most instruments throughout the flight.
- The CDP failed about 30 minutes into the flight and did not recover.
- The downward radar was turned off for the entire flight because the SWACR was left in scanning mode.

Flight details (all times are UTC)
(flight track details given below)

16:49:45	Take off (delayed from original plan of 16:00 to allow for snow removal)
16:56	Passed through very dry layer (Td ~ -45 ^{o}C) at 16,200 ft
16:57:45	200 µm ice particles at 17,700 ft; moister layer above at 500 mb
17:02	Reached 22,000 ft, in clear air; dewpoint -53 ^{o}C
17:10	Drop down to 21,000 ft to get into clouds
17:11:45	Start 180 pattern (middle three legs); lots of wispy clouds going past; clouds below are thin enough to see the ground below
17:14	Cloud tops seem to have dropped; Tair = -40 ^{o}C
17:25:05	Over Storm Peak Laboratory CDP quit on this leg
17:30:20	In clear air; lidar suggests clouds below are only ice
17:37:05	Clear to the ground here
17:38:20	Descend to 20,000 ft

17:39:25 End of first pattern; Dewpoint increased 5 ^{o}C in dropping 1000 ft!

17:43 Start of pattern at 19,000 ft; in and out of tops; CIP shows 100-200 µm particles

17:47:55 Beneath clouds here; particles still 50-100 µm

17:54:34 Over Storm Peak Lab; in clear air at 19,000 ft, but ground appears to be in cloud

17:57:55 Small cloud here

18:08:25 End of pattern; descent to 14,200 ft

18:12:30 Start of pattern at 14,200 ft

18:14 Finally into cloud; 3-4 mm ice particles and 0.4 g/m^3 LW; pass through several small cumulus buildups; Td = -36 ^{o}C; Tair = -24 ^{o}C

18:25:15 Back into cloud with 0.5 g/m^3 LW

18:26:35 Over Storm Peak Lab; this leg has had good mixed phase cloud with 3-4 mm ice and 0.3 g/m^3 LW

18:29:20 Into clear air

18:35:10 Graupel – several mm particles hitting windshield; 0.75 g/m^3 LW max in this encounter

18:38:15 This cloud might be all liquid – didn't see any obvious ice on imaging probes

18:41:15 End of pattern; set up for N/S (270 pattern)

18:48:45 Start of 270 pattern at 14,200 ft

18:52:25 Cloud with 0.4 g/m^3 LW; some 2 mm particles; 15-25 µm liquid drops on FSSP; Tair =24 ^{o}C

19:00:30 Back into cloud: 0.5 g/m^3 LW; solid particles are a few hundred microns; 15-20 µm liquid drops on FSSP; vertical velocities 2-4 m/s

19:02:40 Over Storm Peak Lab

19:04:20 Graupel again; vertical velocities 3 m/s; 5 mm solid particles; 20 µm on FSSP; 0.5 g/m^3 LW

19:11:49 Cell with vertical velocity of 5 m/s, up to 0.7 g/m^3 LW; cells seem to be getting more energetic as we move east

19:20 In cloud, smooth!

19:21:20 – 24:45 This cloud has 2-3 mm solid particles; very tiny LW (0.05 g/m3), but still 20-30 µm particles on FSSP; vertical velocities 1-2 m/s

19:26:15 Into clear air

19:29:00 Climb to 16,000 ft and turn south

19:32:15 Back into cloud, with significant liquid again

19:33:15 Only small ice particles here

19:38:50 Back to liquid water/large ice particle mix

19:40 Ask to climb, ATC says no, so stay at 16,000 ft for another leg

19:44:10 – 45:10 Large particles mixed with a few 20-30 µm on FSSP

19:47:10 Tiny ice particles (about 50 µm); hazy cloud below, but can see ground

19:50:25	Clear air
19:51:20	Start climb to 18,000 ft and turn to head back south
19:54:15	At 18,000 ft
19:55:10	100 µm ice particles; 30 µm particles on FSSP; 0.1 g/m^3 LW
19:59:25	Sudden change to very large ice particles – is this a different cell?
20:00:35	Climb to 20,000 ft
20:05:20	Tiny ice particles (25-50 µm) and 0.05 g/m^3 LW
	In wisps and/or tops throughout this leg
20:12:40	Finish pattern and head home
20:17:00	King Air data display died; appears whole computer system quit
20:44	Landing

East/west pattern (18CP)

Altitude/Leg		**Start Time**	**End Time**
21,000 ft	Leg 2 (E→ W)	17:11:45	17:19:55
	Leg 3 (W→ E)	17:21:30	17:28:35
	Leg 4 (E→ W)	17:30:20	17:39:25
19,000 ft	Leg 4 (W→ E)	17:43	17:48:30
	Leg 3 (E→ W)	17:49:50	17:59:10
	Leg 2 (W→ E)	18:01:20	18:07
14,200 ft	Leg 2 (E→ W)	18:12:30	18:20:20
	Leg 3 (W→ E)	18:23	18:30:50
	Leg 4 (E→ W)	18:32	18:41:15

North/south pattern (27CP)

Altitude/Leg		**Start Time**	**End Time**
14,200 ft	Leg 4 (N→ S)	18:48:45	18:55:50
	Leg 3 (S→ N)	18:57:50	19:07:15
	Leg 2 (N→ S)	19:09:20	19:17:30
	Leg 1 (S → N)	19:20	19:29:00
16,000	Leg 1 (N→ S)	19:31:00	19:39:50
	Leg 1 (S→ N)	19:42:50	19:51:20
18,000 ft	Leg 1 (N→ S)	19:54:15	20:01:20
20,000 ft	Leg 1 (S→ N)	20:03:55	20:12:40

CAMPS-11 RF18

02/06/2011

Crew-
A Bandani
L Avallone
B Liu
J French
LOD-
B Glover

PLAN:
Run mode in uplooking mode only today—groundbased radar will be scanning. Will try to focus on 3 legs that are nearest SPL

Shoot for 1600Z takeoff time; delayed getting off ground due to snow on runway and waiting for airport to be plowed (3-5 inches of snow fell overnight)

PREFLIGHT:
Nothing unusual

FLIGHT:

1650 Wheels up; following takeoff all data looks good

1655 "normal" noise signal shows up on radar

1657 passing through FL177, lots of 200 micron ice, thin wispy cloud visually; WCR tops ~20 kft

1703 level at FL220, maybe just a bit too high? Will see when we get close to ops area

--Plan to conduct 3 E/W legs centered on SPL and step down through cloud. Tops of clouds from WCL (dn) are about 500 m below us, decide to descend 1000 ft to attempt to fly just above cloud top

1712 on line at FL210, just skimming top, CIP shows bunch of 25-100 micron particles

1715 optically clouds are thin, can see surface looking straight down.

1720 end leg 1-optically—clouds are thicker on west side of range, interestingly tops are also lower by about 1000 ft

1721 begin leg 2 (center leg)

1726 CDP quit; T~-40C

1728 end leg 2; tops are at our altitude at the east end of the leg—a few particles on the CIP, all D<125 micron

1730 begin leg 3 (furthest south)

1738 end leg, descend to FL200 and repeat pattern

1742 online-leg 1 (furthest south)—we are going to descend to 190 to get more into cloud tops

1744 level at FL190 and into tops of clouds

1748 end leg

1750 begin leg 2, center leg

1759 end leg 2, very few clouds on this west end.

1801 begin leg 3—furthest north and devoid of clouds. There are some cu hanging low to the mountains, maybe will try go to 142 for next set of legs to get into the cu

1809 end leg, descend to FL142 to set up for next set of legs

1813 online, leg 1—still descending, coming through FL150

1814 level at FL142, passing through tops of small cu—pockets of liquid up to 0.4 g/m3, some large ice on the twod's

1822 begin leg 2

1828 in cu right over SPL-LWC 0.2, dbar 20-30 microns, some large ice

1830 end leg

1833 begin leg 3—furthest south

1835 some graupel to about 2 mm

1841 end leg 3

1842 transition to pattern 27 (N-S legs)—leg 1 will be furthest west, leg 2 center (over SPL), leg 3 furthest east

1849 begin leg 1, FL142, north to south, 10 km west of SPL; mostly west of the largest cu

1856 end leg

1858 begin leg 2; northern half in/out of cu, 0.4-0.6 g/m3, +/-3 m/s, upto 5 mm graupel

1906 end leg

1909 begin leg 3, juicy clouds in middle of leg; LWC 0.6 g/m3, will add one more leg even further east

1919 begin leg 4

1929 end leg 4—begin climb to FL160 and reverse leg directions on this pattern

1932 begin leg 1 (furthest east) at FL160

1939 end leg, reverse heading at same altitude

1942 on leg 1(a) at FL160, northbound

1950 clouds/echo look much less variable on this pass compared to earlier legs

1951 end leg, begin climb to FL180; repeat same line at higher altitude

1954 begin leg 1(c) at FL180

2000 end leg 1(c); climb to FL200 for return leg

2003 begin leg 1(d);at FL200—little or no liquid at these higher legs

2012 end leg—Return to Laramie

201659 message on KADAS Monitor—PXI: WATCHDOG Failure, System Unresponsive

System light is Red-all other lights green, it says data recording but not updates on data or times—**appears system has crashed**—decide not to reboot system since we are ~15 minutes out of Laramie

DEBRIEF:

When first arrived on station there was high level ice clouds with nothing below; as mission wore on, upper level cloud dissipated and lower level cu began forming over ridge and advecting somewhat to the east/southeast. Later portion of flight focused on the cu

CDP quit working early in flight and never came back

Data system crashed on return to Laramie—did not reboot system

CAMPS 2011 Post Mission Report

February 05, 2011

1. Crew: Bandani, Avallone, French, Liu.
2. Pre-Flight Brief: 1215
3. Planned T/O time: 1400
4. Flight Time: 4.0 Hrs
5. Weather: IMC for T/O, in the working area, and for Landing.
6. Lowest cloud deck: Multiple broken layers at 14200', 16000'-FL 180. Tops FL 220.

A. Brief:

Briefed mission for the planned 240 profile starting at FL 220, followed by descend over Storm Peak to 14200' and redoing the 240 profile at 14200' followed by a climb to an intermediate altitude and running the 240 profile at that intermediate altitude.

Execution:

Filed to Hayden VOR (CHE) 084/026 fix w/delay of 3+00 and requested to work w/in 25 NM of the fix, all quadrants. Departed KLAR at 1320 climbed to our planned altitude of FL 220. Received clearance from ATC to work w/in the requested air space and began the 240 profile. Once complete proceeded to Storm Peak for a spiral descend to 14200'. Completed the 240 profile at 14200' and then climbed to FL 180 and ran the 240 profile at FL 180. Once complete, coordinated our return back to KLAR.

B. Discussion:

Good day to fly!

Summary of CAMPS Research Flight 17

5 February 2011

Flight crew: A. Bandani, L. Avallone, J. French, B. Liu

We sampled clouds associated with northwest flow into the Steamboat Springs area. Occasional disturbances bring moisture into the area and couple with orographic lift to generate clouds and some snowfall. We used the 240 pattern for this flight which aligned within 10 degrees with the wind direction. We started sampling at 22,000 ft at the north east end of the study area. Following completion of the first pattern, we performed a spiral descent over Storm Peak Lab and then carried out the 240 pattern again at 14,500 ft, where we'd seen the most cloud in the spiral. Finally we flew the pattern again at 18,000 ft before returning to Laramie.

Instrument status:

- Good data were reported from most instruments throughout the flight.
- The CDP failed about 30 minutes into the flight, recovered and then failed again for the remainder of the flight.
- The downward radar was turned off and blocked in any transits over or within 3 nm of the ground radars (Leg 3 of pattern and spiral).

Flight details (all times are UTC)
(flight track details given below)

20:32:10	Take off (early!)
20:38	Cloud bases at about 15,500 ft
20:44:35	At 22,000 ft; still in cloud but it's thin above – can see sun
20:45:50	Clouds here are liquid, then mixed liquid and ice
20:51	Mixed phase here – large ice particles (about 2 mm) + 0.1 g/m^3 LW
	Cloud tops about 1.5 km above us
20:55:35	Start 240 pattern at 22,000 ft
	20 µm particles on FSSP; Tair = -37 C, Td ~ -45 C
21:00	CDP has failed; LWs 0.15 – 0.2 g/m^3 on the first leg
21:07	Ice particles are quite small here (~ 100 µm)
21:17:22	Over Storm Peak Lab; clear at 22, 000 ft
21:19	Into clear air

21:22:45	Still in clear air, clouds very patchy below
21:24:30	Into cloud, 100 µm particles on 2D-C
21:26:00	About 1000 ft of cloud above
21:26:30	CDP came back on
	Consistent 0.02 g/m^3 LW in last 5 nm of this leg
21:38:40	End of pattern; in wispy clouds on transit to SPL
21:43:05	Over SPL, starting descent spiral
21:44:45	Into cloud at 20,900 ft
21:52:10	At 16,600 ft – particles here are a few hundred microns
	At 14,500 ft – liquid water with very large particle (> 2 mm)
22:06:40	Start pattern at SE corner at 14,500 ft
	First leg is predominantly ice
22:20:50	Much bigger particles showing up here; radar shows a gap to the ground; no precipitation – particles must be evaporating
22:27:55	Ice particles greater than 2 mm here; only a thin cloud layer below us
22:31:35	Over Storm Peak Lab
22:41	Clear air
22:43:25	Back into clouds
22:51:05	Clear to the ground
22:58	Back into cloud 5 nm from end of leg
22:59:15	Have climbed to 18,000 ft and finished pattern, but ATC requires us to maintain heading
23:03:15	Start 240 pattern at 18,000 ft
23:07:20	Into cloud with large particles
23:12:30	Clouds seem thicker than earlier in this area, but there are large gaps in them; again particles are huge (several mm) but radar return shows no precipitation to the ground
23:31:30	Particles now very small – 100 microns or less
23:26:50	Over Storm Peak Lab; particle sizes fairly uniform on this leg at a few hundred µm
23:39:20	Giant particles again – we appear to be in a sublimation or evaporation zone – no liquid water below, air fairly bumpy
23:50:35	End of pattern; return to Laramie
00:28:00	Landing

Northwest/southeast pattern (24CP)

Altitude/Leg		**Start Time**	**End Time**
22,000 ft	Leg1 (NW→ SE)	20:55:35	21:02:15
	Leg 2 (SE→ NW)	21:04:10	21:12:00
	Leg 3 (NW→ SE)	21:14:50	21:20:50
	Leg 4 (SE→ NW)	21:22:45	21:31:15
	Leg 5 (NW→ SE)	21:33:20	21:38:40
14,200 ft	Leg 5 (SE→ NW)	22:06:40	22:16:25
	Leg 4 (NW→ SE)	22:18:30	22:26:00
	Leg 3 (SE→ NW)	22:27:55	22:37:40
	Leg 2 (NW→ SE)	22:39:50	22:46:55
	Leg 1 (SE→ NW)	22:49:00	22:59:15
18,000 ft	Leg1 (NW→ SE)	23:03:15	23:10:35
	Leg 2 (SE→ NW)	23:12:30	23:21:45
	Leg 3 (NW→ SE)	23:23:50	23:30:35
	Leg 4 (SE→ NW)	23:32:25	23:42:00
	Leg 5 (NW→ SE)	23:43:20	23:50:35

CAMPS-11 RF17

02/05/2011

Crew-
A Bandani
L Avallone
B Liu
J French
LOD-
B Glover

PLAN:
Higher level clouds today, plan on transit at FL220, execute first pattern at this level and then work down; 240 pattern

Shoot for 2100Z takeoff time; everything is ready early so decide to takeoff early

PREFLIGHT:
Nothing unusual

FLIGHT:

2033 Wheels up

2037 nadir door is open, radar file has been started, everything looks good

2040 level @ FL220

2050 turn towards point 1

2056 on leg 1 at FL220

2058 CDP quit reporting, no data coming through at all, outside T -37C; cycle power, no help

2103 end leg 1, start new radar file, flying just above cloud tops

2104 begin leg 2

2112 end leg 2

2114 begin leg 3, go to up only mode with WCR; T~-40, edgetech and licor disagree by 5 C

2121 end leg 3, over a big hole in the clouds

2123 on leg 4

212630 CDP came back, outside T about the same??

2131 end leg 4

2133 begin leg 5

2138 end leg 5, proceed to SPL to set up for descent

2143 begin descent over SPL

2157 end spiral, liquid layer at FL145 (but low LWC's)

2159 CDP quit reporting AGAIN

2203 change WCR back to Up/Dualdown; setup to conduct full pattern at FL145

2206 begin leg 5 (south end) flying SE to NW at FL145

2216 end leg 5

2218 begin leg 4; FL145

2226 end leg 4, go to up only mode

2228 begin leg, middle of leg, up only with WCR

2237 end leg

2240 begin leg 2- WCR in Up/Dualdown

2247 end leg 2

2249 begin leg 1

2256 notice that AIAS and BIAS has 3 knot difference—likely ingested water in noseboom

2258 end leg 1; climb to FL180 and repeat pattern opposite direction

2302 begin leg 1 at FL180; mostly below clouds ecept for south end of line

2311 end leg 1; TDP/Licor comparison look good, T~-25

2313 begin leg 2

2319 AIAS/BIAS perfect agreement—check for water in boom after flight

2321 end leg 2

2324 begin leg 3; WCR up-only mode

2324? End leg 3

2332 begin leg 4

2342 end leg; just at base of echo; a little bumpy, evap particles from above→light turb

2344 begin leg 5

2350 end leg 5

Return to Laramie; climb to FL190

0014 closed nadir door; turned of lidar

0029 wheels down

DEBRIEF:

Twice in flight CDP quit working, first time about 25 minutes, then came back for 30 minutes then went down remainder of flight

At time AIAS/BIAS differed signicficantly—data shows water in boom (likely from previous mission); Brent blew out boom prior to next flight

CAMPS 2011 Post Mission Report

February 04, 2011

1. Crew: Bandani, Wang, French, Oolman.
2. Pre-Flight Brief: 1015
3. Planned T/O time: 1300
4. Flight Time: 3.1 Hrs
5. Weather: IMC for T/O, in the working area, and for Landing.
6. Lowest cloud deck: Multiple broken layers at 14200', 16000'-FL 180. Tops FL 200.

A. Brief:

Briefed mission for the planned 180 profile starting at FL 180, followed by multiple passes over any of the legs w/ cloud presence.

Execution:

Filed to Hayden VOR (CHE) 084/026 fix w/delay of 3+00 and requested to work w/in 25 NM of the fix, all quadrants. Departed KLAR at 1300 climbed to our planned altitude of FL 180. Received clearance from ATC to work w/in the requested air space and began the 180 profile at initial altitude of FL 180 at Pt 1. Once complete proceeded to Storm Peak for a spiral descend to 14200'. Flew the 180 profile legs 5-6, followed by leg 3-4, 4-8, and 8-7 with multiple climbs and descends to 16000' and then up to FL 180 and again descends back to 16000'. Completed the hop at FL 180 by final pass over leg 7-8 and coordinated our return back to KLAR.

B. Discussion:

PI was very happy!

CAMPS-11 RF16

02/04/2011

Crew-
A Bandani
Z Wang
L Oolman
Jfrench
LOD-
B Glover

PLAN:
Focus on clouds up to about 180 (clear above); Look for CLWC and attempt vertical profiles through clouds

Shoot for 2000Z takeoff time

PREFLIGHT:
Nothing unusual

FLIGHT:

2005 Wheels up—initial look on data everything appears OK

2028 on leg 1 at FL180 (east to west) only completed ½ of leg; this altitude appears 500-1000 ft above cloud top

2032 end leg 1

2041 end leg 2→in turn switch WCR to up only (leg over SPL)

2043 begin leg 3, WCR up only

2051 end leg 3

2053 begin leg 4, WCR up/dualdown; still just above tops, 5 dBZ echo at sfc, clouds/precip stronger on west side of mountains, virtually non-existent precip on east side

2100 end leg 4, proceed to leg 5

2110 end leg 5, go to up only for WCR, proceed to SPL at FL180 to set up for racetrack/spiral descent

2116 begin descent

2124 end descent, fly direct to SPL to execute center leg

2127 on center line, headed west at FL142

2130 reverse heading, back on line

2135 begin spiral up to FL180

2147 at FL180 setup for porpoise between 160 and 180 on leg 2 (appears most of CLWC confined to between these levels)

2152 brief departure on line for traffic

2158 turn south to west end of leg 4, climb 142 to 180 along west side of pattern

2201 turn east on to leg 4; porpoise for profile through cloud

2205 WCR port switching issues—started new WCR file

2210 execute leg 2 east to west, porpoising 160 to 180

2222 turn south on west side of legs

2225 turn east on leg 4, picking up lots of icing, decide to discontinue porpoising maneuvers

2226 Return to base, climb to FL200 to get above cloud

LWC100 completely iced over on last couple of legs

2302 on ground

DEBRIEF:

WCL background changed in middle of flight—Zhien says nothing to worry about but should watch this on upcoming missions

WCR—3 port switching events on this flight, all caught within 1 minute of the event and new file restarted…no significant loss of data

Operationally—we were picking up lost of ice so climb rate in porpoise ascents needed to be slower than PI wished in order to maintain airspeed.

CAMPS 2011 Post Mission Report

January 31, 2011

1. Crew: Bandani, Wang, Oolman, Zhao.
2. Pre-Flight Brief: 0815
3. Planned T/O time: 1000
4. Flight Time: 3.5 Hrs
5. Weather: VMC for T/O, in the working area, VMC for Landing.
6. Lowest cloud deck: Scattered layer at 14200'. Tops FL 200.

A. Brief:

Briefed mission for the planned 180 profile starting at FL 180, followed by multiple passes over any of the legs w/ cloud presence.

Execution:

Filed to Hayden VOR (CHE) 084/026 fix w/delay of 3+00 and requested to work w/in 25 NM of the fix, all quadrants. Departed KLAR at 1030 (late getting in, extreme cold temps so the car had trouble starting and had to get help to get it going!) climbed to our planned altitude of FL 180. Received clearance from ATC to work w/in the requested air space and began the 180 profile at initial altitude of FL 180 at Pt 2. Due to lack of cloud during this segment of the profile PI requested to move onto the leg 8-9 of the 180 profile and make multiple passes over leg 8-9. After the first pass requested and received clearance to work block altitude FL 180-200 and continued at FL 18.5. After few passes PI asked for a climb to FL 200 to continue passes over the 8-9 leg. Once complete, PI asked for a pass over Storm Peak followed by multiple passes over leg 5-6 at FL 190. Following that PI requested for a spiral descend over Pt 5 to 14200'and multiple passes over 5-6 leg at 14200'. Once complete, PI asked to move onto leg 1-2 for multiple passes at 14200'. Completed the hop with a final pass over Storm Peak followed by a final pass over leg 5-6 at 14200'. PI satisfied, coordinated our return back to KLAR.

B. Discussion:

PI was one tough customer, but managed to keep him Happy!

CAMPS 2011 Post Mission Report

January 31, 2011

1. Crew: Bandani, Avallone, Oolman, Liu.
2. Pre-Flight Brief: 0715
3. Planned T/O time: 0900
4. Flight Time: 3.5 Hrs
5. Weather: IMC for T/O, in the working area, VMC for Landing.
6. Lowest cloud deck: Broken layer at 14200'. Tops FL 220.

A. Brief:

Briefed mission for the planned 180 profile starting at FL 220, followed by a spiral descend over Storm Peak to 14200' and redoing the 180 profile at 14200', followed by multiple passes over the center leg of the 180 profile w/climb of 1000' per each pass.

Execution:

Filed to Hayden VOR (CHE) 084/026 fix w/delay of 3+00 and requested to work w/in 25 NM of the fix, all quadrants. T/O was delayed due to weather here in Laramie (poor vis/low ceilings.) Departed KLAR at 1140 and climbed to our planned altitude of FL 220. Received clearance from ATC to work w/in the requested air space and began the 180 profile at initial altitude of FL 220. Once complete w/180 profile proceeded to Storm Peak and after a 10 minute delay by ATC (traffic into KHDN) received clearance for spiral descend to 14,200'. Completed a second 180 profile at 14,200'.Once complete started the center leg (5-6 leg) w/ 1000' climb after each pass. After the first pass PI requested to move one leg over to the west (7-8 leg) for cloud penetration. Two passes and 2000' of climb it became apparent that clouds were dissipating. With PI satisfied that any additional climbs on the 7-8 leg passes were not to yield any measurable data, coordinated our return back to KLAR.

B. Discussion:

Cloud Gods were trying to smile and did for a short while, especially here in KLAR and during our transit out/back…and that made for a somewhat happy PI!

Summary of CAMPS Research Flight 14

31 January 2011

Flight crew: A. Bandani, L. Avallone, L. Oolman, B. Liu

We sampled clouds associated with a very cold Arctic frontal system. Low-level transport (700 mb) was from the northeast. Ground conditions in Laramie delayed takeoff for about 2.5 hours. We started sampling at 22,000 ft at the northern end of the study area, where the clouds were thin; we were flying mostly in the tops and clear air. Following completion of the first pattern, we performed a spiral descent over Storm Peak Lab and then the E/W leg pattern at 14,200 ft. Finally we flew a few horizontal legs over the Storm Peak Lab at different altitudes, but had little luck staying in clouds.

Instrument status:

- Good data were reported from most instruments throughout the flight.
- The CDP failed for about 10 minutes early in the flight and then recovered.
- There may have been some problem with the LiCor early in the flight as the dewpoint and CO_2 numbers did not look right.
- The downward radar was turned off and blocked in any transits over or within 3 nm of the ground radars (Leg 3 of E/W pattern and spiral).

Flight details (all times are UTC)
(flight track details given below)

18:41:45	Take off; initial portion of climb through snow and clouds
18:54:35	At 22, 000 ft; in tops with very tiny particles and no LW
19:03:10	Start of 18CP pattern at 22, 000 ft
19:07	CDP failed
19:08:15-45	Into tops with light chop
19:11:45	Big particles on 2D-C – must be falling from wispy clouds above
19:14:20	CDP came back online
19:19	Some dendritic particles
19:25:45	Over Storm Peak Lab, just in wispy clouds
19:27:25	In clear air, but beneath a thin layer
19:32	About 0.1 g/m^3 of LW
19:40:25	Appear to be in cloud; particles are really small (maybe ~ 100 μm)

19:43:00 Particles so small they are barely registering on the 2D-C; little amounts of LW coincident with light turbulence

19:45:30 Clear air; radar has shown a lot of structure below on this leg

19:47:55 End of first pattern, turn in toward SPL

19:51:30 At 20,000 ft in hazy cloud

19:52:25 Over SPL; Td ~ -40 ^{o}C; T = -31 ^{o}C; a little LW and 100 µm particles; ATC says we'll have to stay here about 10 mins before we can descend, so we continue to spiral

20:01:10 Got permission to descent to 17,000 ft

20:02:50 Into cloud at 19,000 ft; particles on 2D-C are a few hundred µm

20:06:10 Clouds are very thin below; can see the ground (few miles E of SPL)

20:09 Big particles here; a very occasional dendrite-looking particles; at 14,200 ft

20:11 Head out to start 18CP pattern at 14,200 ft

20:17:15 Start of pattern; this leg has had chunky particles up to about 500 µm

20:30:45 Broad range of particle sizes here – maybe 50 µm up to 1 mm

20:31 Spike of LW about 0.15 g/m^3

20:33:35 Into clear air between layers; doesn't appear that there's been much snow on E side of ridge (roads are clear)

20:43:35 Over Storm Peak Lab; some light chop here with 0.02-0.15 g/m^3 LW

20:53-55 Some good-sized bumps with LW up to 0.3 g/m^3

21:04:40 Into short cloud

21:05 Climb to 15,000 ft

21:06:20 At 15,000 ft about 10 nm from end of track; mostly clear here

21:10:05 End of pattern

Switch to vertical ladder on P5/6 line

21:18:45 Climb to 16,000 ft; clouds look better to south, so switch to P7/8 line

21:23:05 Seem to be in cloud via 2D-c data, but not obvious looking out the window

21:31:30 Climb to 17,000 ft

21:41:00 End of pattern; nothing there to see; head back to Laramie

21:43:40 Into cloud

21:53 Start descent to 15,000 ft

22:09:05 Landing

East/west pattern (18CP)

Altitude/Leg		**Start Time**	**End Time**
22,000 ft	Leg1 (E→ W)	19:03:10	19:11:45
	Leg 2 (W→ E)	19:13:40	19:20:00
	Leg 3 (E→ W)	19:21:34	19:30:10
	Leg 4 (E→ W)	19:32:00	19:38:25
	Leg 5 (W→ E)	19:40:25	19:47:55

14,200 ft Leg 5 (E→ W)	20:17:15	20:26:50
Leg 4 (W→ E)	20:29:00	20:36:25
Leg 3 (E→ W)	20:38:50	20:48:20
Leg 2 (W→ E)	20:50:35	20:57:55
Leg 1 (E→ W)	20:59:55	21:10:05

Vertical ladder

P5/6, 15,000 ft, (W→ E)	21:13:45	21:20:40
P7/8 16,000 ft (E→ W)	21:23:05	21:32:50
17,000 ft (W→ E)	21:35:30	21:41:00

CAMPS 2011 Post Mission Report

January 25, 2011

1. Crew: Bandani, Avallone, Oolman, Lukens.
2. Pre-Flight Brief: 1215
3. Planned T/O time: 1400
4. Flight Time: 2.6 Hrs
5. Weather: IMC for T/O, in the working area, and Landing.
6. Lowest cloud deck: Scattered/Broken layer at 15000'. Tops FL 210.

A. Brief:

Briefed mission for the planned 180 profile starting at FL 220, followed by a spiral descend over Storm Peak to 14200' and redoing the 180 profile at 14200', followed by multiple passes over the center leg of the 180 profile w/climb of 1000' per each pass.

Execution:

Filed to Hayden VOR (CHE) 084/026 fix w/delay of 3+00 and requested to work w/in 25 NM of the fix, all quadrants. T/O was delayed due to maintenance gripe (right side generator was not coming on line.) After trouble shooting and once corrective maintenance action to fix the gripe was completed and after aircraft surfaces were cleaned inside the hangar departed KLAR at 1540 and climbed to our planned altitude of FL 220. Received clearance from ATC to work w/in the requested air space and began the 180 profile at initial altitude of FL 210 block 220. During this portion of the profile the flight path remained in and out of cloud tops. Once complete w/180 profile proceeded to Storm Peak and received clearance for spiral descend to 14,500' block 15,500'. Upon reaching 15,500' began a second 180 profile at 15,500' excluding the center leg due to malfunctioning of the radar door. Approaching the last leg of the profile it was apparent the clouds were becoming very few and far in between, with PI satisfied that center leg passes were not to yield any measurable data coordinated our return back to KLAR.

B. Discussion:

Cloud Gods were trying to smile (and did for a short while) and that made for a somewhat happy PI!

RF"13" is done!

Summary of CAMPS Research Flight 13

25 January 2011

Flight crew: A. Bandani, L. Avallone, L. Oolman, D. Lukens

We sampled the remnants of a fast-moving cloud system in the area over Storm Peak and Steamboat Springs. An aircraft electrical problem delayed takeoff and the accumulated precipitation from a snow squall passing through Laramie while the electrical problem was being worked further delayed takeoff to about 1.5 hours later than originally planned. Cloud tops were initially at 21,000 ft at the northern end of the study area, but were very patchy. The mechanism used to close the radar door broke just as we entered the first leg over Storm Peak Lab, causing us to divert to the 4^{th} leg of the pattern. Subsequently, we turned the radar off completely when working in the vicinity of the ground-based radars. The remaining cloud layer was quite thin – about 400 ft thick at around 15,500 ft. We flew 3 additional legs in this layer, which appeared to be liquid water with ~ 20 μm drops, before heading back to Laramie.

Instrument status:

- Good data were reported from most instruments throughout the flight.
- The CIP computer failed to boot on the ground, so there were no CIP data.
- As a result of a broken door mechanism, the radar was turned off in any transits over or within 3 nm of the ground radars (Leg 3 of E/W pattern and spiral).

Flight details (all times are UTC)
(flight track details given below)

22:39	Take off; initial portion of climb through snow and clouds
22:57:10	Start of first pattern (18CP) at 21,000 ft. In and out of tops, but picking up a little bit of LW and some icing. Particles are moderate sized, LWs about 0.06 g/m^3
23:02:10	Into clear sky
23:09	Into cloud; appears to be about 4000 ft thick below, with a gap to the ground beneath that; highly variable particle sizes in this pass
23:16	Radar door won't close; abort this leg and head to next one
23:24	Got course corrected; seeing very broad size distribution (maybe bimodal?)
23:29:15	Very small particles with no LW
23:30	Clear air

23:31:55	In and out of tops; getting large particles on 2D-C beneath wispy clouds
23:37:55	End of first pattern, heading in toward SPL; radar turned off
23:41:30	Starting spiral, in clear air; clouds are higher east and south of here. Into cloud at 15,500 ft in descent – liquid water present; clouds 400 ft thick
23:51:15	ATC requested that we maintain 270 heading – took us out of spiral and west of Steamboat Springs
23:55	Head back toward 18CP pattern, at 15,500 ft; 0.2-0.3 g/m^3 LW here with 20 µm particles on FSSP; Td ~ -20 ^oC, Tair -19 ^oC
00:04:35	Clear air
00:06:30	Start of pattern at 15,500 ft
00:15:55	Consistently seeing 0.15 g/m3 LW and 20 µm particles; Td ~ -21 ^oC, Tair -18 ^oC
00:21:00	A few huge particles (~ 1 mm) on 2D-C
00:21:50	Into clear air – can see to ground, with cloud above us
00:24:00	Radar turned off
00:28:00	At bottom of cloud, FSSP 12-15 µm
00:34:20	Radar back on
00:36:45	This leg has been in completely clear air; abort pattern and head back to Laramie
00:43:50	Climb to 17,000 ft
01:01:00	LW in cloud, at about 13,000 ft; then snow
01:10:00	Landing

East/west pattern (18CP)

Altitude/Leg		**Start Time**	**End Time**
21,000 ft	Leg1 (E→ W)	22:57:10	23:04:20
	Leg 2 (W→ E)	23:06:40	23:13:20
	Leg 3 (E→ W)	23:15:30	Leg aborted
	Leg 4 (E→ W)	23:23	23:30:00
	Leg 5 (W→ E)	23:31:55	23:37:55
15,500 ft	Leg 5 (E→ W)	00:06:30	00:13:40
	Leg 4 (W→ E)	00:15:55	00:24:00
	Leg 3 (E→ W)	00:26:25	00:34:20
	Leg 2 (W→ E)	00:36:45	00:43:00

CAMPS 2011 Post Mission Report

January 22, 2011

1. Crew: Bandani, Avallone, Oolman, Edwards.
2. Pre-Flight Brief: 0715
3. Planned T/O time: 0900
4. Flight Time: 4.0 Hrs
5. Weather: IMC for T/O, in the working area, and Landing.
6. Lowest cloud deck: Few/Scattered layer below 14,200'. Tops FL 190.

A. Brief:

Briefed mission for the planned 180 profile starting at FL 190, followed by a spiral descend over Storm Peak to 14200' and redoing the 180 profile at 14200, followed by a 270 profile at 14200'and a possibility of flying the 270 profile again at a higher altitude.

Execution:

Filed to Hayden VOR (CHE) 084/026 fix w/delay of 3+00 and requested to work w/in 25 NM of the fix, all quadrants. Departed KLAR at 0920 and climbed to our planned altitude of FL 190. Received clearance from ATC to work w/in the requested air space and began the 180 profile at initial altitude of FL 190. During this portion of the flight we remained above the cloud tops. Once complete w/180 profile proceeded to Storm Peak and received clearance for spiral descend to 14,200'. Upon reaching 14,200' completed a second 180 profile at 14200'. Following that completed the 270 profile at 14200' and coordinated our return back to KLAR.

B. Discussion:

Today, the cloud Gods were smiling upon us and that made for a very Happy PI!

Summary of CAMPS Research Flight 12

22 January 2011

Flight crew: A. Bandani, L. Avallone, L. Oolman, D. Edwards

We sampled an horizontally extensive mixed-phase cloud in the area over Storm Peak and Steamboat Springs. A snow squall passing through Laramie delayed aircraft preparations, so takeoff was about 30 minutes later than originally planned. Cloud tops were in the vicinity of our minimum altitude, with occasional tops up to 19,000-20,000 ft. We executed a series of E/W tracks at 19,000 ft, followed by a spiral descent to 14,200 over Storm Peak Lab. We then did a series of E/W and N/S tracks at 14,200 before heading back to Laramie.

Instrument status:

- Good data were reported from all instruments throughout the flight.
- The downward radar door was closed in any transits over or within 3 nm of the ground radars (Leg 3 of E/W pattern and Legs 2 and 3 of N/S pattern).

Flight details (all times are UTC)
(flight track details given below)

16:37:20	Take off; initial portion of climb through a snow squall
16:41	Clear air from 11,300 to 19,000 ft; Td ~ -46 ^{o}C
16:53:40	First entry into cloud at 19,000 ft
16:57:30	Start of first pattern (18CP) at 19,000 ft; downward looking radar shows two distinct cloud layers here, which merge together about 5 nm further west
17:03:50	Another brief cloud encounter; cloud tops dropping below us
17:22:55	Over Storm Peak Lab; very small amount of cloud at 19,000 ft here; Td -45^{o}C
17:34	Three short passes through clouds with LW ~ 0.5 g/m^{3}
17:39:35	Ten seconds in cloud tops; clouds are patchy enough that we are sometimes getting only one wing tip in
17:47:20	End of pattern at 19,000 ft. Turn in toward SPL for spiral descent; downward radar door closed
17:51:55	Over SPL at 19,000 ft; starting descent Clouds are patchy in descent, little LW most of the time, but see snow streaming by the windows.

17:56:30 Liquid water appears – 0.8 g/m^3; small droplets on imaging probes

17:57:55 Continuous LW from 14,800 – 14,600 ft; about 0.4 g/m^3; then very little at 14,200 ft

18:00:46 Head E from SPL to pick up waypoint on 18 CP pattern – getting particles around 400 µm

18:03:45 Heading S to beginning of track – big particles with no liquid water here; diameters about 800 µm

18:07 Start of E/W pattern at 14,200 ft

18:08:30 Snow streaming by, particles on 2D-P about 1 mm

18:11 Large particles and 0.2 g/m^3 LW

18:15:30 Only hazy cloud at our level now, can see ground below us off and on; radar shows we are in lowest part of the cloud at this end of leg

18:20:45 Back into cloud

18:23 ~ 1 mm particles with 0.3 g/m^3 LW

18:24:30 Clear air, but getting occasional big particles of a few hundred micron diameter

18:33:55 Over Storm Peak Lab in clear air at our level; cloud below; there are buildups on both sides of us

18:36 Small liquid water cloud

18:43:25 Into deep cloud with big bumps; vertical velocities up to + 5 m/s

18:44 – 45 Very large frozen particles (~ 4 mm?) along with about 0.5 g/m3 LW; frozen stuff hitting plane sounded like a hail storm

18:46:35 Back to clear air

18:54:15 Into cloud; small particles at the edges, bigger ones (up to 1 mm) in middle with LW around 0.5 g/m^3

18:55:40 Another cloud, but smooth air – large frozen particles with no liquid

18:56:55 Bumpy air, 2 mm particles; some rimed dendrites on 2D-C; LW ~ 0.1 g/m^3

18:58:35-48 In and out of clouds and wisps

19:00:40 End of pattern

19:03:05 Start of N/S pattern, at western edge

19:04:10-19:05 Into cloud, then clear for 9 minutes

19:14:50 Short cloud encounter

19:15:55 -16:12 Cloud with LW ~ 0.3 g/m^3; large frozen particles

19:17:40 Beneath cloud, seeing falling particles

19:19:02-19:20:57 Cloud with 1 mm particles; mostly chunky, but occasional rimed dendrites; LW as high as 0.7 g/m^3, dropping as we head north; then into clear air, with cloud ~ 200 ft above us

19:22 Penetration into cloud in turn to next leg

19:23:30 – 30:45 Great leg with huge variability in liquid water and lots of structure on radar

19:27ish Over Storm Peak Lab (lost SP label on screen, so I'm guessing)

19:30:45 Into clear air

19:34:30 Into thick cloud; ice particles about 2 mm, LW ~ 0.7 g/m3; ice collecting on windshield. Similar patterns in clouds from 19:36:05-40; 38:35-39:05; 40:11-41:45

19:43:45 Into clear air

19:44:30 Into tops and getting some particles falling from above

19:48:35 Clear air

19:50:40 Thin cloud, can see hazy sunshine

19:51:30 End of pattern, climb to 15,000 ft for return to Laramie

19:53:00 Climb to 17,000 ft

19:55:28 – 56:55 Into cloud; 400 µm to 1 mm particles, LW ~ 0.4 g/m3; continue in mixed-phase cloud until 20:02:47

20:06:50 – 07:20 In and out of cloud in descent; Amazing snowflake images on CIP during descent

20:27:15 Landing

East/west pattern (18CP)

Altitude/Leg		**Start Time**	**End Time**
19,000 ft	Leg1 (E→ W)	16:57:30	17:08:00
	Leg 2 (W→ E)	17:09:40	17:15:55
	Leg 3 (E→ W)	17:17:45	17:28:00
	Leg 4 (W→ E)	17:29:50	17:36:00
	Leg 5 (E→ W)	17:37:55	17:47:20
14,200 ft	Leg 5 (E→ W)	18:07:00	18:17:10
	Leg 4 (W→ E)	18:19:35	18:27:00
	Leg 3 (E→ W)	18:29:10	18:39:15
	Leg 2 (W→ E)	18:41:35	18:48:45
	Leg 1 (E→ W)	18:50:55	19:00:40

North/south pattern (27CP)

Altitude/Leg		**Start Time**	**End Time**
14,200 ft	Leg 1 (S→ N)	19:03:05	19:09:55
	Leg 2 (N→ S)	19:12:05	19:21:30
	Leg 3 (S→ N)	19:23:30	19:31:00
	Leg 4 (N→ S)	19:32:45	19:42:35
	Leg 5 (S→ N)	19:44:30	19:51:30

CAMPS 2011 Post Mission Report

January 21, 2011

1. Crew: Bandani, Avallone, Oolman, Edwards.
2. Pre-Flight Brief: 0615
3. Planned T/O time: 0800
4. Flight Time: 2.8 Hrs
5. Weather: VMC for T/O, in the working area, and Landing.
6. Lowest cloud deck: Few/Scattered layer below 14,200'.

A. Brief:

Briefed mission for the planned 180 profile starting at FL 180, followed by a spiral descend over Storm Peak to 14200' and redoing the 180 profile at 14200, plus a possibility of an approach into KSBS (for cloud penetration) to a low approach followed by a 270 profile at 14200'and a possibility of flying the 270 profile again at a higher altitude.

Execution:

Filed to Hayden VOR (CHE) 084/026 fix w/delay of 3+00 and requested to work w/in 25 NM of the fix, all quadrants. T/O was delayed due to maintenance gripe (right side generator was not coming on line.) After trouble shooting it was determined the relay was not functioning and once corrective maintenance action to fix the gripe was signed off departed KLAR at 0900 and climbed to initial altitude of 15000'. Enroute and during the next segment climb to our planned altitude of FL 180 approaching ~30 miles from the fix, received clearance from ATC to work w/in the requested air space and began the 180 profile at initial altitude of FL 180. During this portion of the flight cloud deck remained below the flight path. PI for better cloud conditions, asked for lower altitude following the completion of the 4th leg of the profile. Requested and received clearance to 14,200'. Upon reaching 14,200' completed the profile at 14200'. However, the cloud deck remained below the flight path. PI requested for an instrument approach into KSBS (Steam Boat Springs) for an opportunity for cloud penetration. Requested and received clearance for RNAV GPS E approach to a missed approach starting at IAF TILLI to KSBS. Approaching MABKY and descending through 12000' entered cloud deck and after receiving clearance form ATC leveled off at 11500' to remain inside the cloud deck and followed the approach to BUSTE. Crossing BUSTE, cloud deck went away and so we executed the missed approach procedure. Requested and received clearance to climb to 14200' and to work w/in the 25 NM of CHE 084/026 Fix. Completed the 270 profile at 14200' and coordinated our return back to KLAR.

B. Discussion:

Today, the clouds were not cooperating!

Summary of CAMPS Research Flight 11

21 January 2011

Flight crew: A. Bandani, L. Avallone, L. Oolman, D. Edwards

We attempted to sample a small orographic cloud over Storm Peak and Steamboat Springs. An aircraft electrical problem delayed takeoff for an hour to about 9 am, by which time cloud tops had dropped below our minimum altitude. Nonetheless, we executed two patterns – a series of E/W tracks and a series of N/S tracks – for remote sensors. We also performed a missed approach to the Steamboat Springs airport, holding at 11,500 ft in cloud upstream of Mt. Werner for about one minute to gather in situ data.

Instrument status:

- Good data were reported from all instruments throughout the flight.
- The downward radar door was closed in any transits over or within 3 nm of the ground radars (Leg 3 of E/W pattern and Legs 2 and 3 of N/S pattern).

Flight details (all times are UTC)
(flight track details given below)

16:04:40	Take off
16:10:30	Sudden drop in Td at about 575 mb; low dewpoint layer extends to ~ 510 mb; Td as low as -52 ^{o}C
16:20:55	Start of first pattern (18CP) at 18,000 ft; cloud tops 4-5 kft below, so request minimum altitude (14,200 ft)
16:37:25	At 14,200 ft, still above the clouds
16:47:10	Over Storm Peak Lab; lidar suggests that clouds are small liquid drops here
17:13:20	End of pattern; waves in dewpoint T on the last leg were +/- 10 ^{o}C
17:14:50	Heading down to 13,000 ft to pick up approach to Steamboat Springs airport; receive permission from controller to stay at an altitude above the approach altitude anywhere along the track.
17:18:25	Enter cloud at 11,500 ft
17:19:50	Out of cloud
17:20:45	Climb out of approach pattern to 14,200 and head to 27 pattern
17:24:25	At 14,200 ft

17:31:00 Start of second pattern
17:58:00 Over Storm Peak Lab
18:24:35 End of pattern, head back to Laramie
18:46 Landing

East/west pattern (18CP)

Altitude/Leg		**Start Time**	**End Time**
18,000 ft	Leg1 (E→ W)	16:20:55	16:31:50
14,200 ft	Leg 2 (W→ E)	16:33:00	16:40:25
	Leg 3 (E→ W)	16:42:10	16:52:10
	Leg 4 (W→ E)	16:54:05	17:01:30
	Leg 5 (E→ W)	17:03:25	17:13:20

North/south pattern (27CP)

Altitude/Leg		**Start Time**	**End Time**
14,200 ft	Leg 1 (S→ N)	17:31:00	17:41:50
	Leg 2 (N→ S)	17:43:25	17:50:20
	Leg 3 (S→ N)	17:52:10	18:02:55
	Leg 4 (N→ S)	18:04:50	18:11:40
	Leg 5 (S→ N)	18:13:00	18:24:35

CAMPS 2011 Post Mission Report

January 19, 2011

1. Crew: Bandani, Avallone, Oolman, Edwards.
2. Pre-Flight Brief: 0715
3. Planned T/O time: 0900 and 1430
4. Flight Time: 3.2 and 2.4 Hrs
5. Weather: IMC for T/O, Layered deck starting at FL 200/190 down to 14200' in the working area, IMC for Landing.
6. Lowest cloud deck in the working area: 14000'.

A. Brief:

Briefed the mission for a planned two flight day. Both flights would be within the 25 NM of CHE 084/026 fix working area. First hop would cover the three middle legs of 180 pattern at FL 200 followed by a Spiral to 14200' over Storm Peak, middle three legs of 180 pattern at 14200' followed by a climb to 17000' and redoing the same three legs and finishing with the middle three legs of 270 pattern. Second hop would be the 270 pattern excluding the CP 1/2 and 7/8 legs. Pattern would be flown at FL 190, spiral over storm Peak to 14200', fly the same pattern and again at 17000'.

B. Execution:

Filed to CHE 084/026 Fix w/delay of 3+00 for the first hop and delay of 2+30 for the second hop, requested to work w/in 25 NM of the fix, all quadrants. First T/O was pushed back by thirty minutes to allow for setting up of instruments in the a/c. Also, a change for the second hop was the elimination of last planned segment to be flown at 17000' due to clear skies above 15000'. Departed KLAR at 0940 and 1435 respectively, climbed to initial altitude of 14000'. Once clearance received climbed to FL 200(first hop)/FL 190(second hop) and flew the patterns. PI satisfied coordinated our return back to KLAR.

Discussion:

Double pump day!

Good flight(s), PI happy!

Summary of CAMPS Research Flight 10

19 January 2011

Flight crew: A. Bandani, L. Avallone, L. Oolman, D. Edwards

We returned to sample the same cloud in the Steamboat Springs area that had been studied in the morning, following a trough passage. We used the N/S pattern on this flight and started at 19,000 ft because cloud heights had been dropping throughout the morning flight. In order to avoid shutting down the radar for too many tracks (both the 3rd and 4th legs, counting from the east, are within a 3 nm radius of the ground radars), we flew legs 2, 3, and 5. The cloud tops had dropped significantly since the morning flight and the western side of the study region was in nearly clear air. We passed over SPL 3 times, in addition to doing a spiral in the vicinity.

Instrument status:

- Good data were reported from all instruments throughout the flight.
- The downward radar door was closed in any transits over or within 3 nm of the ground radars.

Flight details (all times are UTC)
(flight track details given below)

21:30	Take off and climb to 20,000 ft; in thickish cloud at 14,500 ft and back out at 15,300 ft; between cloud layers at 17,000 ft
21:52	At 19,000 ft (final altitude); thin cloud layer about 10,000 ft above in radar
21:54	Hazy layer at our altitude, seeing a few moderate-sized particles on 2D-C
21:58	Completely clear to the ground; Td = -36 ^{o}C
22:02	Passed through small cumulus buildup
22:03:10	And through another
22:05:25	Start of first track of first pattern at 19,000 ft; essentially clear air, with occasional wisps passing the plane
22:18	Lidar showing liquid water about 3000 ft below
22:19:30	In wispy, hazy region with a few very large particles
22:20:25	Over SPL
22:30:30	Clear air here, beneath a layer that is thickening to the south; tiny particles on 2D-C

22:34	Back to clear sky
22:36	End of first pattern
22:38	Into cloud about 5 nm from SPL
22:38:45	Start of spiral
22:42:35	Into cloud briefly at 17,000 ft
22:48:15	At 14,200 ft, end of spiral
22:52:40	Over SPL on way to start of next pattern
22:55:30	Start of pattern 2, at 14,200 ft
22:58:30	Lots of liquid water and bumpy; several cumulus buildups on this leg with similar features
23:11:40	Concludes passes through three small buildups with liquid water up to 0.8 g/m^3
23:12:30-43	Another buildup over SPL – liquid water about 1 g/m^3
23:17:30	In clear air
23:27:45	Climb up to 15,000 ft for return to Laramie; decided to skip any other altitudes since clouds were mostly below us.
00:00:20	Landing

North/south pattern (27CP)

Altitude/Leg		**Start Time**	**End Time**
19,000 ft	Leg1 (N→ S)	22:05:26	22:14
	Leg 2 (S→ N)	22:16:40	22:24:05
	Leg 3	22:28:05	22:36
14,200 ft	Leg 1 (N→ S)	22:58:30	23:06:20
	Leg 2 (S→ N)	23:08:30	23:17:30
	Leg 3	23:21:15	23:27:45

Summary of CAMPS Research Flight 9

19 January 2011

Flight crew: A. Bandani, L. Avallone, L. Oolman, D. Edwards

We sampled cloud associated with a relatively fast-moving shortwave over the Steamboat Springs area. Using the NWS forecast of cloud top height, we targeted an initial altitude of 20,000 ft, mapping out an area of about 30 nm (E/W) by 15 nm (N/S) centered over Storm Peak Lab (the middle 3 legs of the 18CP pattern). We then performed a spiral descent over SPL, followed by a repeat of the horizontal ladder pattern at 14,200 feet and 17,000 ft. We started the 27CP pattern (which has long legs along the N/S axis) at 17,000 ft, but had to break off early to return to Laramie because of deteriorating ground conditions.

Instrument status:

- Good data were reported from all instruments throughout the flight.
- The downward radar door was closed in any transits over or within 3 nm of the ground radars.

Flight details (all times are UTC)
(flight track details given below)

16:28	Take off; climb to 20,000 ft; Clear air to 14,600 ft; 20,000 ft is in and out of tops
16:49:40	Start of first leg of first pattern (18CP); only a few small particles here, T ~ -28 ^{o}C
16:52:30	Into cloud
16:55:40	Bumps with vertical velocities up to + 5 m/s; particles got smaller here and there was considerable structure in the radar signal below
17:00:35	Clear air with a few tiny particles
17:02:45	Flying beneath cloud layer, getting occasional big particles; Lidar showing liquid in the tops
17:05	Completely clear above and below
17:10:50	Back into cloud tops, then into denser cloud. FSSP diameters 20-40 μm
17:16:30	Skirting edge of cloud buildup
17:17:35	End of first pattern, turn toward SPL
17:19:10	In and out of cloud tops
17:21:20	Starting spiral descent, about 6 nm horizontal legs, descent rate 500 m/s

17:25	At 17,500 ft – finally getting good-sized particles; very tiny amounts of liquid water at 16,600 ft, vertical velocities 1-2 m/s
17:30	At 15,200 ft – particle size has dropped dramatically
17:32	At 14,200 ft – very large particles; interrupted by unidentified traffic on TCAS – whoever it was came and went, never saw them
17:35	Very thin clouds at 14.2 kft, can see surface through them
17:40	Heading back west to pick up track pattern
17:44:35	Start of pattern at 14,200 ft
17:48	Very large particles, ~ 200 µm; tiny LWs – 0.02 g/m^3; Td = -19 ^{o}C, Tair = -17 ^{o}C
17:51:40	Vertical velocities of + 3.5 m/s
18:00	Over SPL, with very large rimed particles
18:04:42	Only a very thin cloud layer below
18:15:10	End of pattern 2, start climb to 17 kft
18:18:40	At 17,000 ft, start pattern 3; clouds have thinned so we can see hazy sun
18:24:45	Into clear air
18:32:25	Over SPL
18:36:45	Patch of bigger particles and a little liquid water
18:43	Waves in temperature, each accompanied by a peak of liquid water
18:45:30	End of third pattern; head toward N/S pattern (27CP)
18:55	Into clear air
19:04:35	Over SPL; a bit of LW here (0.1 g/m^3)
19:09	Weather at Laramie deteriorating; end pattern here to go home
19:11-19:15	Waves in dewpoint temperature again
19:22	Start descent to 13,000 ft
19:28	At 10,800 ft – first time this flight there were particles big enough to show on 2D-P
19:39	Landing in strong headwinds

East/west pattern (18CP)

Altitude/Leg		**Start Time**	**End Time**
20,000 ft	Leg1 (E→ W)	16:49:40	16:58:45
	Leg 2 (W→ E)	17:00:35	17:06:20
	Leg 3	17:08:10	17:17:35
14,200 ft	Leg 1 (E→ W)	17:44:35	17:54:45
	Leg 2 (W→ E)	17:56:30	18:04:42
	Leg 3	18:05:45	18:15:10

17,000 ft	Leg 1 (W→ E)	18:18:40	18:25:35
	Leg 2 (E→ W)	18:27:30	18:37:55
	Leg 3	18:40:00	18:45:30

North/south pattern (27CP)

Altitude/Leg		**Start Time**	**End Time**
17,000 ft	Leg1 (N→ S)	18:50	18:57:45
	Leg 2 (S→ N)	19:00:10	19:09
	Leg 3	Not started	

CAMPS 2011 Post Mission Report

January 17, 2011

1. Crew: Bandani, Avallone, Oolman, Edwards.
2. Pre-Flight Brief: 1000
3. Planned T/O time: 1200
4. Flight Time: 2.6 Hrs
5. Weather: VMC for T/O, Layered deck starting at FL 210 down to 14000', VMC for Landing.
6. Lowest cloud deck: 14000'.

A. Brief:

Briefed the mission for a planned Cloud penetration and 1320 local Cloud Satellite track. Based on weather reports and satellite imagery, decision was made to work north of Casper Mountain, along the eastern edge and southern tip of Big Horn Mountain. DDY 298/024 was the Bulls eye with a 30 NM North-West/South-East track centered on the Bull's eye as the planned working track for the mission.

B. Execution:

Filed to DDY 298/024 Fix w/delay of 2+00 and requested to work w/in 25 NM of the fix, all quadrants. Departed KLAR at 1205, climbed to initial altitude of 14000'. 40 miles from the fix it became apparent the track was too far north and the clouds were south of the track. Received clearance to work 35 NM west and south of the DDY 298/024 to better accommodate PI's requirement. Worked the track FL 210 block 15000' and once PI was satisfied coordinated our return back to KLAR.

Discussion:

Good flight, PI happy!

Summary of CAMPS Research Flight 8

17 January 2011

Flight crew: A. Bandani, L. Avallone, L. Oolman, D. Edwards

The goal of this flight was to coordinate with a CloudSat overpass at 20:19 UT over central Wyoming (near Casper). We set up a flight line along the satellite ground track and found a reasonably thick, precipitating mixed-phase cloud along the central point of the track. The clouds were thinning toward the northern end of the track. Since we had 20 minutes before the overpass time, we were able to relocate the track to the south where clouds were more dense. After the overpass, we continued to explore the cloud, flying legs along the ground track from 16,000 to 21, 000 ft.

Instrument status:

- Good data were reported from all instruments throughout the flight. There was a brief loss of radar data (maybe 1 minute) after the mode switch following the CloudSat overpass

Flight details (all times are UTC)

19:20:30	Take off; climb to 14,000 ft in clear air
19:25:30	At 14,000 ft; ATC reports moderate icing near Casper at altitudes from 15-19 kft (yay!)
19:43	First particles appear – mostly falling from clouds above
19:47	Below base of substantial cloud; into cloud at 19:46; radar showed a ~1000-ft thick cloud above, then clear layer, then thick layer above that, extending at least 5000 ft.
19:54	Start climb to 19,000 ft; clear layer from radar appears at 14,500 ft, back into cloud at 16,000 ft
20:03	Back in cloud at 19,000 ft; reconfigure flight track to fly more southerly end of ground track; got block from ATC of 16-19,000 ft; southern extension of line didn't have quite the right heading, but close
20:15	In clear air
20:18	Back into cloud – just in time for overpass!
20:19:10 – 20:20:50	WCR put in down-looking mode only for overpass
20:21:45	Turning back toward north and spiraling down to 16,000 ft

20:25	At 16,000 ft
20:27	Out of cloud and into large patch of clear air
20:33	Back into cloud at northern end of track, but mostly the ragged bottoms of the clouds; LW ~ 0.1 g/m^3; Td = -21 ^oC
20:34:30	Start climb to 17 kft; snow streaming by aircraft during turn
20:36:30	at 17,000 ft
20:40:50	Enter patch of clear air
20:43:30	End of track south, climb to 18,000 ft and turn north
20:44:10	at 18,000 ft and in cloud again
20:47:15	Back into clear patch
20:51	Into thick cloud, LWC ~ 0.2 g/m^3; Td = -25 ^oC
20:53	End of leg north, climb to 19,000 ft and turn south
20:56	At 19,000 ft
21:01	End of track, turn and begin climb to 20,000 ft
21:03	At 20,000 ft, heading north
21:06	Picking up small particles on 2D-C, but little LW (~ 0.03 g/m^3); Td = -32 ^oC
21:11:30	Sudden patch of big particles with light turbulence; lidar shows ice cloud to surface
21:13:45	At 21,000 ft; some bigger particles here; Td = -36 ^oC
21:14:50	Turn completed, heading back south – only very tiny particles on imaging probe. All ice here, mostly above the clouds. Lidar showing ice all the way through cloud
21:19	Picking up ~30 µm falling from above
21:20	Start heading back to Laramie
21:22	19,700 ft – bigger particles showing up on imaging probes; at 18,000 ft LW is 0.3 g/m^3; at 16-17,000 ft getting LW 0.6 – 1 g/m^3; enormous glaciated particles on 2D-C images
21:26:30	Lidar/radar show precipitation to the ground
21:27:55	At 15,000 ft; in and out of clouds and fall streaks
21:34:45	At 13,000 ft
21:38:00	At 12,000 ft; lots of structure on radar in clouds above
21:49	Landing

CAMPS 2011 Post Mission Report

January 15, 2011

1. Crew: Bandani, Avallone, Oolman, Liu.
2. Pre-Flight Brief: 1015
3. Planned T/O time: 1200
4. Flight Time: 2.3 Hrs
5. Weather: VMC for T/O, in the working area (first hour), and Landing.
6. Lowest cloud deck: Broken/Overcast layer 14000' and below.

A. Brief:

Briefed the mission for a planned Cloud penetration flight to stay within Wyoming. Based on weather reports and satellite imagery decision was made to stay within the local area. Chose LAR 260/025 Fix as Bulls eye with two 30 NM North-South/East-West tracks centered on the Bulls eye.

B. Execution:

Filed to LAR 260/025 Fix w/delay of 3+00 and requested to work w/in 25 NM of the fix, all quadrants. Departed KLAR at 1205, climbed to initial altitude of 15000'. Enroute got cleared to MBW and then direct to the LAR 260/025 fix. Once received clearance from the ATC to work w/in the requested air space at altitude FL 180 block 15000' started on the North-South track. Without any success for cloud penetration after the first half hour, changed track to an East-West direction. However, the cloud deck remained below the flight path during the next hour. With PI's satisfaction that cloud Gods were once again seemingly not with us, proceeded to get clearance back to KLAR at which time the ATC cleared the a/c for lower altitude of 14000' and direct to KLAR. During the descend penetrated cloud and requested to discontinue arrival and to work the previous East-West track at 14000' while remaining w/in the 25 NM of LAR 260/025 Fix. Request granted by ATC and clearance received began the East-West track w/in the cloud and remained on the track for next hour. PI satisfied, requested and received clearance back to KLAR for a visual, left downwind to runway 21and completed the hop.

Discussion:

Great day to fly!

Summary of CAMPS Research Flight 7

15 January 2011

Flight crew: A. Bandani (pilot), L. Avallone, L. Oolman, B. Liu

The goal of this flight was to explore orographic clouds over mountain ridges near Laramie (since we were unable to fly over Colorado per FAA restrictions for this busy long weekend). We had initially planned to fly over the Big Horns in north central Wyoming, but on the flight morning, that area appeared to be clear on satellite imagery. Instead, we targeted an area over the Medicine Bow range to the west of Laramie, which appeared to be shrouded in clouds. We flew out with an initial altitude of 15,000 ft and found ourselves above nearly all of the clouds; there was a fairly persistent cloud deck below and a variable deck about 10,000 ft above. The latter was not accessible due to ATC restrictions in the area.

We did both north/south and east/west legs over the ridge, each about 30 nm long, mapping out the cloud structure below. Finding little cloud at our altitude, we decided to look for another area to sample. ATC asked us to descend to 14,000 ft; at 14,600 ft we entered cloud! The pilot asked whether we could stay at 14,000 and we were granted permission to fly the east/west track at that altitude. We did an additional two east/west legs (for a total of 4 at this altitude), encountering relatively dense mixed-phase clouds. LWC values were around 0.5 g/m^3 and there were many large (~ 1 mm) dendrites on the imaging probes. Enhanced total water signals from the CLH exceeded 10,000 ppm. The airframe picked up quite a bit of ice during these transits.

Instrument status:

- Good data were reported from all instruments, until icing overwhelmed the LWC-100 and 2D-P. The CLH was saturated after the fourth pass and did not recover until we were on the ground.

Flight details (all times are UTC)

19:11	Take off
19:25	Begin north/south leg at north end; 15,000 ft
19:34	Returning north to center point of leg; few small particles on 2D-C
19:38	Reached center point, turning east to pick up E/W leg
19:43:30	Heading west

19:51-2	Short pass through cloud at 15,000 ft
19:55	Head east on E/W track
19:56-7	Brief encounter with cloud, mostly wisps
20:09	Decide to head back to Laramie
20:11	Descend to 14,000 ft; get into cloud! Receive clearance from ATC to work E/W leg at 14,000 ft
20:19	> 10,000 ppm on CLH; riming on probes and wing edges
20:20	King Air display froze up; Larry worked to reboot it
20:21	In clear air and very tops of clouds; holding at W end of track to allow time to get King Air display back up and working
20:28:30	Start track heading E; LWC 0.5 g/m^3; lots of ice shedding off props and hitting plane
20:32	Out of cloud into clear air; turn to head back west
20:36	Back into cloud, heading west; vertical winds 1-2 m/s
20:40	Out of cloud
20:42	Turn to head back east
20:44	Skimming tops
20:44:10	Into more dense cloud; particles on CIP are ~ 600 µm diameter, some as big as 2 mm
20:47	Out of cloud; turn to head west
20:51:50	Into cloud; LWC again 0.5 g/m^3; this leg appears to be much more in the tops – can see sun
20:58	Turn back to east; still in tops
21:00	Lost signal on 2D-P; CLH signal is saturated and not changing
21:19	Landing

Research Flight on King Air
1/13/2011
All times in GMT

Overall good remote sensing day, with clouds below the airplane; There was NO insitu data collected.

15:29 – On Ground, clear with few high clouds, temperature ~2C
15:30 – CLH inlet heater was at 50C. This was a spike, before it settled…
15:40 – Take off, clear with extremely thin wispy layers, bumpy
15:48 – Climbing to 20,000 ft – slow climb; CLH is one, looks good,
file name = UE011311.873, power 9800, p(v0) 9407, pzero 350
15:55 – Passing 18,000 ft, cloud tops are at 15,000 ft
16:02 – Tops of clouds are liquid, cloud tops at ~12,000 feet, LIDAR shows structure lovely wave clouds out the window
16:06 – Cross point one of first leg, clear pilot estimates that cirrus are approximately 45 miles away at 25,000 feet, -35 dewpoints
16:15 – a few separated wave clouds, overall inhomogeneous
16:18 – Crossed point 2
16:19 – Roll clouds below
16:20 – Dropping to 17,000 feet
16:22 – at 18,000 feet, still clear
16:27 – 14,200 feet dropping to get in cloud
16:29 – Glory scatter off right side of plan
16:31 – RH at 49%, no cloud, Note: LWC has a off-set on board of ~0.14 g/m3
16:33 – Can see ground through cloud
16:37 – closed door on radar
16:41 – Winds at 290 degrees, can see power plant clearly in Hayden
16:43 – Contrail very clear today from other airplanes
16:45 – When close to the lab see only thin clouds, too thin from a missed approach, decide to fly over just with the Lidar downward about the only data we can get with these condition (since we had to close radar door)
16:53 – Now opening the radar downward looking door
16:57 – See rainbow
16:58 – See little cloud above with radar, this is the first time we saw clouds above
17:00- CIP may be seeing particles (or noise?)
17:04 – Question if radar is working properly, radar seems to be getting warm, may need to be powered down and restarted
17:10 – Starting to get clouds below us
17:20 - Clear below us
17:25 –Still clear heading north now, changed from East/West to Norht/South legs
17:32 – Shutting down radar – needs hard reboot
17:33 – Closing radar door for restart since we are in the vicinity of Storm Peak Lab
17:43 – Radar was hung – i.e. not reporting, now it has restarted
17:54 – Opening door fro downward radar
17:58 – Trying (asking air traffic control) for a missed approach

18:04 – Turning North, preparing for missed approach into Steamboat airport
18:08 – at 13,000 feet
18:09 – at 11, 800 feet – stopped approach, no clouds, heading back to Laramie
18:17 – Cloud see 4 points hut below Storm Peak Laboratory through the clouds, clouds were patchy below
18:27 – Turned off TCAS – Traffic control avoidance system, to ee if this has an effect on the radar (IT DOES NOT)
18:29- Note CLH says “serial input time out”
18:38 – Bumpy coming into Laramie

Research Flight on King Air
1/9/2011
All times in GMT

~20:52 - Take off
On ground there is a few inches of snow, a little water/ice on wings of plane
Overcast conditions
Note – Laramie at altitude of ~8,800 ft, can see the mountains
Clouds are coving tops of mountains only
On ground, Temperature 10°F, Dewpoint -13°F
20:54 - Climbing to 22, 000 feet
20:55 – CLH turned on, looks good
20:56 – We are in cloud, LWC 0.2 g/m3
20:57 – 14,500 feet, air traffic control need to change flight altitude to 21,000 ft
21:00 – Above cloud tops at 17,000 ft
21:03 – Air traffic gave us ONLY a window between 14,200 and 16,000 ft due to traffic
CO2 seems high at 402ppm (note it was very recently calibrated) normally around 390ppm, maybe still cal gas in the line?
21:08 – Came back to 16,000 ft, bumpy, we are in and out of cloud, getting 2D-C images
Note: 16,000 feet appear to be Right at Top of cloud, blue sky above and cloud slightly below, we are flying a direct line to Storm Peak Laboratory
21:17 – Out of cloud
21:20 – Passing to North of SPL, heading towards point on upward leg, Concern about passing over the JPL radar (it is one mile north of straight East-West line and could damage the radar on the plane), thus we needed to change heading
Looks pretty clear, clouds breaking, mountains visible
21:21 – Clouds below
21:25 – Can see ground now, thin clouds
21:28 – Crossed North point of leg, turning around and dropping to 15,000 feet. Moving South, still appear above cloud
21:32 – Getting thin cloud, 0.25 g/m3 LWC
21:34 – Passing over the lab ~0.35 g/m3 LWC
21:36 – Lost auto-pilot, don't know why….
21:41- Liquid layer below us on LIDAR
Layer of higher reflectivity appear to be rising off ground, blowing snow due to strong winds we think…
21:44 – Can see ground
21:46 – Little cloud, thin, ~150 microns on CIP, riding atop a cloud, left side of plane in cloud
21:49 – Very thin layer above us, we think this is dropping particles to our CIP
21:50 – inside cloud
21:52 – Liquid water below us
Again cloud pretty uniform above the lab with ~10 micron particles on FSSP
21:53- Cloud has been all the way to the ground- still atop a cloud

21:55 – At point 1, we are out of uniform cloud and into a layer of variability
21:56 – Turning back around to continue the same leg again at 14,200 feet
22:01 – Appears clouds are all ice, little water, 0.05 g/m3 LWC
CDP has mean particle size at 5 micron; Lidar also shows a lot of attenuation, small particles
22:06 – Out of cloud again
22:09 – Turning back to Southeast to follow track at 14,200 feet
Radar really showing cloud just around lab, no cloud to Northwest and Southwest
22:13 – Below us see wave clouds ~2,500 feet below
22:14 – As approaching Storm Peak Laboratory going in and out of thin clouds
22:18 – Not much liquid water, FSSP shows 3 micron mean particle size, CDP showing 2 micron mean particle size, Lots of CIP and PIP images, obvious ice cloud
22:23 – Clouds above us now, we are going to change altitude to 14,500 feet on this turn back towards Northwest
22:30 Crossing over Storm Peak Laboratory again, ice cloud, no liquid on Lidar
22:32 – We can see the ground, very thin liquid clouds
22:34 – Turning back to South East, same track
22:43 – Skimming tops of clouds
22:44 – Dropping to 14,200 feet to get more clouds
22:48 – Story is consistent – no water, ice clouds, not glaciated, shallow clouds, because it is cold -25C, -29C dewpoint temperature
22:55 – In cloud
22:56 – Past Storm Peak Laboratory again
22:57 – Very thin liquid layer above Storm Peak Laboratory
22:58 – High winds, 35-40 knots; direction at 240 degree
23:00 – 23:07 – Little cloud
23:10- Back in Cloud
23:11 – Past over Storm Peak Laboratory, Could see Thunderhead Lodge and Snow maker Control Building
23:17 – Turning for last leg, see a rainbow
23:19 – Back out of clouds, overall clouds thinning throughout the flight
Still at 14,200 feet on last leg, still appears to be clearing and we can see the ground, appears there are very thin clouds below, Relative Humidity approximately 50-60% frequently, CO2 has been at ~390 ppm for most of flight (looks like initial high values are gone).
23:22 – Back in cloud, really small particles, stuff evaporating off the mountain?
23:25 – Amazing view of Rabbit Ears Pass
23:26 – Rising to 15,000 feet, heading back to Laramie
23:27 – In thick cloud, all is white below and above very briefly
23:37 – Been clear heading back to Laramie, views of mountains
23:48 – On landing got into a little cloud
23:50 - Land

Research Flight on King Air
1/8/2010
All times in GMT

~19:20 – Take Off
Heading to the North Point (in Wyoming) of the CloudSat line
19:37 – In cloud, images on the CIP and 2D-C, very brief cloud layer
19: 44 – In cloud again, can see tips of wings, but overall thick cloud with CIP images, LWC ~0.2 g/m3, very low FSSP values, quickly back out of cloud
Out the window- all is white, cloud below and above.
19:52 – In cloud but now can occasionally see the ground
19:54 – now over a liquid water cloud, seen by LIDAR, clouds are getting much deeper, can see the ground barely
FSSP is consistently large again ~30 microns – ice shattering (?),
Larry thinks the CDP is also under sizing
20:02 – Now can see clouds only below, liquid water drops
20:06 – Now can see ground
20:10- Clouds clearing out
20:11 – NOTE – it is really dry out here with -50C depoints!
20:15 – Starting point on CloudSat line, profile should start in 6 minutes
Radar is broken, unclear of the problem, breaker continued to fail.
Power just took out LIDAR also
20:22 – Still not in cloud
20:23 – Starting profile
* LIDAR is back on*
20:25 – 19,000 ft, no cloud
20:26 – In liquid cloud, little on FSSP, now at approximately 18,000 ft
20:27 – quickly out of cloud
20:28 – getting back in cloud, liquid
FSSP concentration approximately 30/cc, size ~25 microns, LWC ~0.2 g/m3
Now at 15,500 ft
20:36 – Clear air again, we can see the ground
Descended to 13,000 ft
Now climbing back to 16,000 ft, since most of the clouds were found there
We plan to fly the rest of the CloudSat line (Southward) at this altitude
20:40 – While climbing from 13,000 to 16,000 ft see more clouds, appear to be light liquid
20:44 – Light thin wispy clouds, we are going in and out of a very thin system, occasionally CIP and PIP images
20:49 – Made decision to descend to 15,000 ft, appears more clouds below us on the LIDAR
* Overall clouds are extremely NOT uniform *
20:53 – In and out of wispy clouds with a few ice particle images and FSSP concentrations of ~20/cc
20:57 – Seeing a few big snowflakes, overall really clear!
21:06 – Back at the start point of CloudSat Line

21:06-21:16 – Ten full minutes of NO cloud data from insitu instruments
21:16 – Made decision to descend to 13,000 ft to get to cloud base below us
21:19 – Got into cloud, 0.2 g/m3 water for a brief moment
21:22 – flying at 13,000 ft at cloud deck, FSSP and CDP at ~ 15 microns for mean diameter, 100 /cc concentration on FSSP
Seeing clouds ahead at South end of the leg really thin layers
21:32 – As we turn back north, still in cloud, now at ~0.4 g/m3, smaller particles, 15 microns on FSSP. Now seeing ice on the wing – only leading edge of boot
21:36 – Some big particles on CIP, yet almost pure liquid with little ice
21:38 – clouds seems to be changing with more ice for just a few seconds.
Turning back South to pass through the clouds again, we did not run the full leg since it is clear to the North
We now do not have enough fuel to perform legs over Storm Peak Laboratory
21:45 - Back through thick cloud, LWC now at 0.3 g/m3, all liquid now, no ice
21:48 – Extremely uniform cloud – amazingly uniform concentration with all CDP particles in the ~10 micron bin.
21:49 – Getting mixed phase clouds, ice and liquid, lots of CIP and 2-DC images, the wings continue to ice, air traffic controller requested that we return to Laramie at 14,000 ft.
21:53 – Out of cloud
21:57 – Back in Liquid Cloud, LWC ~0.2 g/m3, flying East
Cloud quickly thicken visually, now at LWC~ 0.7 g/3, cloud has water, FSSP concentration at ~100/cm
22:20 – Big Change, suddenly flying through a snow storm, HUGE snowflakes visible also out the window, we are over the mountains.
22:05 – Came out of cloud – can see ground, past mountains
22:07 – Begin decent into Laramie, clear on decent

Summary of CAMPS Research Flight 3

5 January 2011

Flight crew: A. Bandani, L. Avallone, L. Oolman, G. Hallar

The goal of this flight was to explore orographic clouds near Steamboat Springs. We targeted an initial altitude of 20,000 ft and mapped out the cloud structure above and below with radar and lidar. We then performed a missed approach to Steamboat Springs Airport (to a minimum altitude of 8800 ft), hoping to scan more of the vertical structure of the cloud, but found that there was very little cloud in the valley. After the missed approach, we performed the horizontal ladder pattern at 15,000 ft. We passed directly over Storm Peak Lab 3 times during today's flight and nearby on the return transit to Laramie.

Much of the flight was in clear air with cloud below. However, we passed through a series of wave clouds at both 20,000 and 15,000 ft, and some water-rich clouds on the return transit to Laramie. We also saw large (7 ^{o}C) temperature variations as we passed over the Park Range and encountered some substantial vertical velocities in the wave clouds (up to + 10.5 m/s).

Instrument status:

- Good data were reported from all instruments, except the CDP, which appears to be having some problems.

Flight details (all times are local; add 7 for UTC)

Details of track legs are given in the table below

09:13	Take off
09:23	At 20,000 ft
09:32:50	Start of horizontal ladder track at 20,000 ft
09:57:45	Above Storm Peak Lab
10:19:40	Finished track
10:21:30	Began approach to Steamboat Springs Airport
10:22:40	First encounter with cloud particles at 17,200 ft
10:29:40	Reached minimum altitude of 8800 ft
10:38	at 15,000 ft
10:40	Above Storm Peak Lab

10:43:50 Beginning of horizontal ladder track at 15,000 ft
11:09:50 Above Storm Peak Lab
11:35:50 End of horizontal ladder 15,000 ft
11:45 Vertical winds 10.5 m/s
12:05:45 Landing

Flight Track Details

Horizontal ladder pattern with five 30 nm legs oriented E/W and separated by about 5 nm. Center of leg 3 is above SPL (within 0.5 nm). Note that the ends of these flight tracks will appear rounded – the pilot used a different navigation method than before which resulted in cutting the corners of the track by ~ 1 nm.

Altitude/Leg		**Start Time**	**End Time**
20,000 ft	Leg1 (E→ W)	09:32:50	09:42:50
	Leg 2 (W→ E)	09:45:00	09:51:00
	Leg 3	09:53:00	10:01:45
	Leg 4	10:03	10:09:10
	Leg 5	10:10:45	10:19:40
15,000 ft	Leg 1 (E→ W)	10:43:50	10:53:30
	Leg 2 (W → E)	10:55:05	11:01:46
	Leg 3	11:03:50	11:14:45
	Leg 4	11:16:40	11:23:00
	Leg 5	11:25:10	11:35:50

Summary of CAMPS Research Flight 2

20 December 2010

Flight crew: B. Wadsworth, L. Avallone, L. Oolman, B. Liu

The goal of this flight was to explore thick precipitating ice clouds. We targeted an initial altitude of 26,000 ft and mapped out the cloud structure above and below with radar and lidar. We then performed a spiral descent over SPL at a rate of 500 ft/min (from 26,000 ft to 15,000 ft). After the spiral, we performed 30-nm-long east-west legs centered on SPL, starting at 15,000 ft and climbing in 1,000 ft increments to 23,000 ft.

Pilot requested to spend some time at higher altitude to burn fuel before doing spiral and vertical ladder. There is concern about getting the plane safely to an airfield should there be an emergency, so weight and altitude are important considerations in planning the flight track.

Instrument status:

- Good data were reported from all instruments
- The CLH inlet tip heater was fixed and data appear to be good.

Flight details (all times are local; add 7 for UTC)

Details of track legs are given in the table below

15:30	Take off
15:54	At 26,000 ft
16:15	Start of horizontal ladder track at 26,000 ft; 95 kt winds @ 250^{o}
17:11	Finished track
17:20:35	Start of spiral descent; horizontal legs about 6 nm (tried 4 nm, but strong winds made that difficult to fly). First signs of liquid water around 19,000 ft.
17:42	End of spiral descent
17:45	Start of vertical ladder, at 15,000 ft
18:40	Very small particles and no LW at 21 kft; radar showed more structure at 23 kft, so opted to climb to 23 instead of doing a leg at 22 kft.
19:00	End of vertical ladder, at 23,000 ft
19:23	Landing

Notes: Takeoff was delayed from 13:00 because of a generator problem on the aircraft.

Flight Track Details

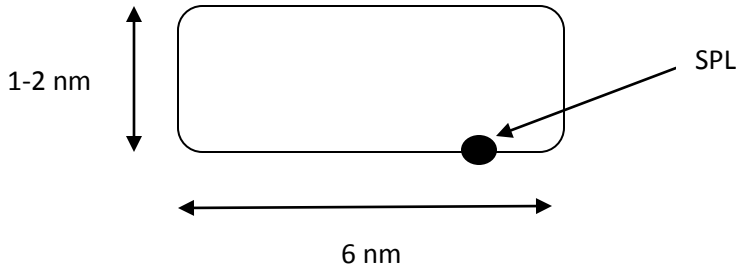
Horizontal ladder pattern with five 30 nm legs oriented E/W and separated by about 5 nm. Center of leg 3 is above SPL (within 0.5 nm).

Altitude/Leg		**Start Time**	**End Time**
26,000 ft	Leg1 (W→ E)	16:15	16:20
	Leg 2 (E→ W)	16:23	16:38
	Leg 3	16:41	16.46
	Leg 4	16:50	17:03
	Leg 5	17:06	17:11

Vertical ladder pattern: 30 nm legs oriented approximately E/W, separated by 1000 ft

Altitude (direction)		**Start Time**
15,000 ft	(E→ W)	17:45
16,000 ft	(W → E)	17:48:20
17,000 ft		17:56:08
18,000 ft		18:10:25
19,000 ft		18:19:24
20,000 ft		18:32:40
21,000 ft		18:40:50
23,000 ft		18:56:40

Spiral Pattern



Summary of CAMPS Research Flight 1

15 December 2010

Flight crew: B. Wadsworth, L. Avallone, L. Oolman, B. Liu

The goal of this flight was to explore the clouds over the Storm Peak Lab vicinity prior to a frontal passage. Based on information provided by M. Shupe from sounding and wind profiler observations, we targeted an initial altitude of 20,000 ft, as above the major portion of the cloud. With the downward-looking lidar and radar, we mapped out the cloud structure below, then chose an intermediate altitude (17,500 ft) to sample, followed by the lowest allowable altitude (15,000 ft).

Instrument status:

- Good data were reported from the *radar* and *lidar*.
- The 2D-C and FSSP worked well; the 2D-P worked sporadically – the laser was occasionally blocked by the extensive ice formation.
- The CLH inlet tip was not heated adequately, so ice formation ultimately blocked it. There are good data for 20 kft and for some of the 17.5 kft track; 15 kft is questionable.

Flight details (all times are local; add 7 for UTC)

Details of track legs are given in the table below

09:12	Take off
09:24	At 20,000 ft; mostly out of cloud, patchy cirrus above
09:34	Re-enter clouds (ATC reports icing conditions SW of our location)
09:44	Start of first sampling ladder track at 20,000 ft
09:59	Getting LWCs around 0.4 g/m3 and some ice shedding from props

Much of 20,000 ft track was in and out of cloud tops

10:37	Finished top level track – south-eastern end appeared to be out of the storm
10:40	At 17,500 ft
10:42:30	Start of second sampling track; ground visible through thin clouds
11:11:30	Right over SPL; LWC of 0.5 g/m3, particles up to about 400 um diameter
11:17	Almost completely clear above us

11:24	Into clear air, clear to the ground (on leg 4)
11:41	End of track 2; begin descent to 15,000 ft
11:45:45	Beginning of lowest track, leg 1; beginning to pick up bumps, low LWCs, but huge dendrites in 2D-P (about 1 mm)
11:53:30	In turn to leg 2 , could clearly see snow streaming past window, air T -15 oC
12:02	Picking up moderate chop, increased LWC and big dendrites again; lots of icing on the probe tips, etc.
12:12	LWC100 probe stopped reporting data
12:24	Decision made to return to Laramie, where conditions had dropped below VFR minimums
12:53	Landing

Flight Track Details

Horizontal ladder pattern with five 30 nm legs oriented E/W and separated by about 5 nm. Center of leg 3 is above SPL (within 0.5 nm).

Altitude/Leg		**Start Time**	**End Time**
20,000 ft	Leg1 (W→ E)	09:44	09:50
	Leg 2 (E→ W)	09:53	10:03:45
	Leg 3	10:06:50	10:13:50
	Leg 4	10:16:50	10:27
	Leg 5	10:30:11	10:37
17,500 ft	Leg 5 (E → W)	10:42:30	10:53:40
	Leg 4	10:56	11:03
	Leg 3	11:05:45	11:16:50
	Leg 2	11:19	11:26
	Leg 1	11:29:40	11:40:50
15,000	Leg 1 (W → E)	11:45:45	11:53:30
	Leg 2	11:56:30	12:07:25
	Leg 3	12:10	12:17:20