



University of Wyoming
ASCII 2013

AgI Seeding of Clouds Impact Investigation

January 3, 2013 - March 3, 2013

Project Status

Updated: Mon Feb 25 10:49

Status:

With 9 hours, expect likely 2 cases left. Presently, Tuesday (Feb26) looks to be likely target an Thursday (Feb28).

- [Data and Forms](#)
- [Plot of flight hours](#)
- **Flight Planning**
 - [Forecast Links](#)
 - [Flight Patterns in Google Earth](#)
 - [PowerPoint describing flight timing and patterns](#)
 - [Excel file with endpoints for lines](#)
 - [FAA Letter of No Objection \(LONO\) for LIDAR Ops](#)
- **Blank Engineering Forms**
 - [Calibrations](#)
 - [Daily Ops](#)
 - [Install/Removal](#)
 - [Maintenance/Troubleshooting](#)

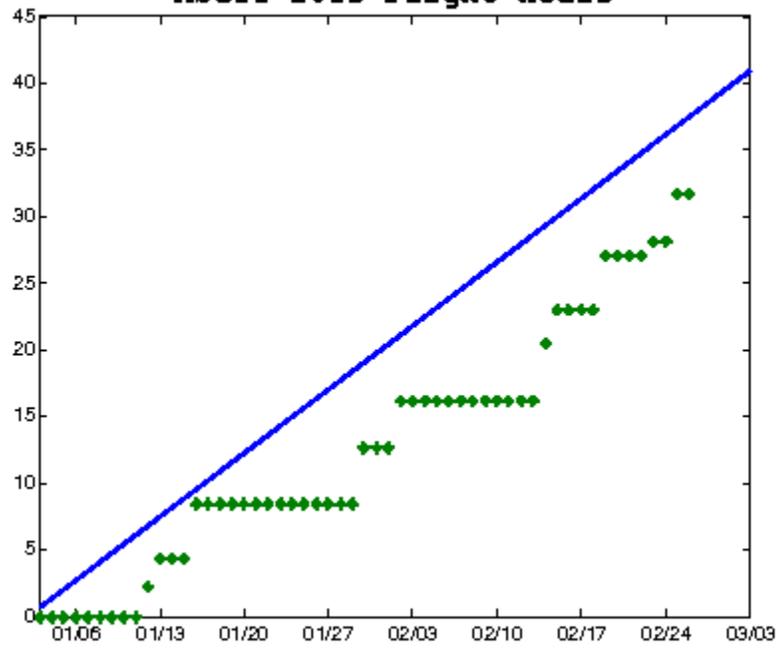
Date/Gnd Notes	Flight # (*.kml)	Status	Times (UTC)	Hours	Crew/Notes
<i>Flights</i>					
24 Feb	RF10	Targeting upslope clouds with a NNE wind. Utilized 2 generators and conducted a 3 leg ladder pattern specifically set for this flight. 3 Ladders prior to seeding, 3 Ladders after seeding began. Clouds thinned quite a bit during the flight. Radar echoes were considerably weaker by the end of flight. Almost entire flight was above cloud top. LWC100 was not working during this flight (bad element??)	1940 - 2307	3.5	T Drew B Pokharel J French D Snare
22 Feb	RF09	Targeting (marginal) thin clouds over the Snowies; turned out fairly cumuliform and tops only to about 13 kft. CIP realigned after last flight, appeared to work fine. Based on power measurements from LIDAR after last flight decide to operate WCL at 6.5 amps. WCL computer gave errors regarding Gage card, reboot sometimes allowed card to work for 10's of seconds then would quit working. Decided with marginal clouds and radar only for remote sensing to abort flight. LWC100 not working at all during flight.	2029 - 2131	1.1	T Drew B Pokharel J French G Sever
18 Feb	RF08	Targeting post frontal orographic/slightly convective with ASCII-only pattern. Shallow clouds early, becoming deeper with more LWC as flight went on. By late in flight (last ladder) the LWC-100 and 2DP no longer were operational due to ice buildup. The CIP is questionable for entire flight due to low illumination voltage (dirty optics or alignment?). No other known problems	1540 - 1940	4.1	T Drew B Pokharel J French D Suita
14 Feb	RF07	Early flight--planning ASCII-only pattern with reasonably shallow clouds. Completed two full ladders, mostly above clouds. Generators did not turn on properly--decided to scrap flight following the the along wind legs. No other known problems	1448 - 1708	2.4	T Drew B Pokharel J French P Bergmaier
13 Feb	RF06	Flight was late in the day on 12Feb (local) but began after 00Z on 13Feb. ASCII only case targeting shallow liquid cloud confined primarily to upwind side of the medbows. Most of cloud was below level of Kingair, only very sparse in situ cloud measurements. Torque did not work most of flight (it did not get turned on until late in flight). No other known problems	0130 - 0538	4.3	T Drew B Pokharel J French
01 Feb	RF05	Racetrack/control leg pattern. Lots of liquid water at -20C, Ice buildup on probes led to many in situ probes going down. Known problems include: LWC100, FSSP-100, CDP, CIP, PCASP. See J French flight notes for specifics and approximate times. Applanix failed on take off. Flight cut short by about 0.5 hours due to ice buildup on aircraft.	1839- 2206	3.6	B Wadsworth B Pokarel J French A Ward
29 Jan	RF04	ASCII only flight.	2144- 0151	4.2	B Wadsworth B Pokarel L Oolman C Kruse
15 Jan	RF03	Stand alone ASCII case with a five rung ladder pattern. The 2D-P probe iced over at 0237.	2355- 0349	4.0	A Bandani B Pokarel L Oolman

					X Chu
12 Jan	RF02	Second flight for an RSE case. The CIP computer clock was wrong. No PCASP counts. The Applanix failed on take off. Flew through a rotor near Sheep Mountain. No radar data on the outbound leg.	0143-0348	2.2	A Bandani B Geerts L Oolman Y Yang B Pokarel report
11 Jan	RF01	First flight for an RSE case. This was the first flight with the new CIP computer. The clock was wrong. No PCASP counts. The Applanix failed on take off.	2224-0031	2.2	A Bandani B Geerts J French X Jing B Pokarel report

Test Flights

06 Feb	TF05	Pilot familiarization flight. Did calibration maneuvers. First flight with the UWYO PCASP. LWC-100 looks broke.	1914-2006	0.9	T Drew L Peng L Oolman B Heesen
22 Jan	TF04	Pilot familiarization flight. Did calibration maneuvers.	2132-2257	1.5	B Wadsworth L Oolman B Glover
Jan 02	TF03	Post-Christmas test flight. Flew radar circles and wind calibration maneuvers. Flew a survey of the proposed legs below the 14,000 ft minimum. Radar beams were scrambled around 1942 UTC. No other instrument issues noted.	1838-1956	1.6	A Bandani P Wechsler L Oolman J French
Dec 14	TF02	Flew through all ice clouds; completed radar circles; Aligned the WCL-DN. Following TF01, WCL down was removed to conduct bench alignment in the lab. Alignment is better but not "perfect". Assessment of current alignment is about the same as PREAMBLE. GAST pump was installed prior to flight, LICOR and CPC ran (LICOR was not calibrated); PCASP was not working at beginning of flight, needed to cycle power in flight; Mirror switch for radar flaked out during flight; Applanix failed on takeoff. Torque intermittent during flight; WCR had one beam scramble.	1941-2114	1.4	A Bandani L Oolman B Liu J French
Dec 10	TF02	Flew through all ice clouds and mixed phase clouds, completed radar circles; Aligned the WCL-DN. Following flight, determined that WCL-DN had a serious misalignment between the parallel and perpendicular channel--removed lidar to complete a bench alignment in lab. GAST pump was not installed (no licor or CPC). Radar mirror switch not working.	1832-1929	1.0	A Bandani P Wechsler B Liu Jfrench
Flight Hours		As of Feb 25, 31.7 out of 41 research hours were flown, 9.3 remain.			Test: 6.4

ASCII 2013 Flight Hours



ASCII Forecast Links

- [NCAR RAP RT-FDDA model run](#)
- Time Height Forecasts
 - [NAM GFS](#): Saratoga
 - [NAM GFS](#): Medicine Bow Peak
 - [NAM GFS](#): Laramie
 - [NAM GFS](#): Wind River Mountains
- [Bart's forecast page](#)

2/24/2012 ASCII Pilot notes (Flight 10)

Crew: Drew, Pokharol, French, Snare

Flight Time: 3.5

Objective: ASCII Case

Planned: 6 - 3 leg E-W Ladder patterns and along-wind between 3 -4

Actual: Departed LAR 14,000 direct to LAR 262@27. Requested 25 nm radius of pt. at 14,000. Flew three rung ladder at 14,000 from Southeast to Northwest. Flew along wind 190 centered on MBP. Flew 3 more ladders. Returned to LAR.

ASCCII-13 Flight (RF10) 24 Feb

1940 – 2307 (3.5 hrs)

Drew, Pokharel, J French, D Snare

General:

ASCCII only seeding case—Winds out of the NNE, Bart and Binod designed a special 3-leg ladder to focus on two generators based on the wind direction. We conducted 3 ladders pre-seed; 1 along wind; and 3 ladders after generators were turned on. Clouds were marginal during second half of flight as they became significantly thinner with little precipitation. Entire flight was out-of-cloud (at least during the pattern).

Startup was unusual due to snowfall at LAR and poor visibility. Everything started in hangar with repeater, pullout under power and took off shortly after pullout.

- Applanix died on takeoff and again 2-3 more times early in flight. Following those incidents it worked fine rest of the flight
- WCL worked fine, operated at 6.5 amps
- LWC100 not working during entire flight—looks like bad element
- Two WCR beam scrambles (2222, 2245)

Flight:

1940 Wheels up

Applanix died on takeoff

1956 Begin Ladder 1 @ FL140

2013 End Ladder 1

 Above cloud through this ladder

 APPLANIX died 2-3 times during ladder

2016 Begin Ladder 2

2040 End Ladder 2

2043 Begin Ladder 3

2106 End Ladder 3

2115 Begin Along wind, SSE, tailwind

2124 End along wind

2134 Begin Ladder 4
2158 End Ladder 4
Clouds appear to be thinning, echoes weakening.

2200 Begin Ladder 5
2223 End Ladder 5

2225 Begin Ladder 6
2248 End Ladder 6

2307 Wheels down

2/22/2012 ASCII Pilot notes (Flight 9)

Crew: Drew, Pokharol, French, Sever

Flight Time: 1.1

Objective: ASCII Case

Planned: 4 Ladder patterns and along-wind between 2-3

Actual: Departed LAR 14,000 direct to LAR 262@27. Requested 25 nm radius of pt. at 14,000. Flew five rung ladder at 14,000 from Southeast to Northwest. Midway through rung 1 on the first ladder the flight was canceled. Returned to LAR.

ASCCII-13 Flight (RF09) 22 Feb

2029 – 2131 (1.1 hrs)

Drew, Pokharel, J French, G Sever

General:

ASCCII only seeding case targeting shallow clouds. Once we got out there, clouds looked quite cumuliform.

- CIP was re-aligned prior to flight—appeared to work fine during flight (based on diode output and the few particles we saw).
- LWC100 did not work—looks like bad element
- WCL data system failed—spent about 30 minutes in flight trying to trouble shoot, discussed with Matt via xchat, decided to abort flight. Following flight Matt determined there was a problem with the Gage card in the data system and changed the card.

Flight:

2029 Wheels up

2030 Applanix failed on takeoff

2039 Begin Ladder 1

UNABLE to get WCL working. Data system appears to be having problems with the GAGE card.

2120 Decide to abort flight

2131 Wheels down

2/18/2013 ASCII Pilot notes (Flight 8)

Crew: Drew, Pokharel, French, Suita

Flight Time: 4.1

Objective: ASCII Case

Planned: 4 Ladder patterns and along-wind between 2-3

Actual: Departed LAR 14,000 direct to LAR 262@27. Requested 25 nm radius of pt. at 14,000. Flew five rung ladder at 14,000 from Southeast to Northwest alternating starting points four times. Between ladders 2 and 3 flew along-wind leg 270. After ladder 4 returned to LAR.

ASCCII-13 Flight (RF08) 18 Feb

1540 – 1940 (4.1 hrs)

Drew, Pokharel, J French, D Suita

General:

ASCCII only seeding case targeting post-frontal orographic/slightly convective cloud, planned pattern consisted of 4 ladders with 2 along wind legs in between ladders 3 & 4.

Early in flight above cloud, as flight progressed, clouds deepened and we were penetrating regions of significant LWC (upto 0.4 g/m³), and picking up reasonable amounts of ice on airframe and instruments. Some In situ instruments failed late in flight due to ice buildup

- Entire Flight—CIP is questionable, probe was out of alignment (fixed after flight)—
- ~1830 LWC100 is questionable or fails due to ice buildup
- During last ladder-2DP failed due to ice buildup
- Five WCR beam scrambles (1611, 1636, 1556, 1720, 1910)

Flight:

1540 Wheels up

1556 Begin Ladder 1 @ FL140

1637 End Ladder 1

Mostly above cloud and skimming cloud tops through this leg, very small amounts of liquid (0.05 g/m³)

1641 Begin Ladder 2

1723 End Ladder 2

Seeing slightly deeper clouds

1729 Begin Along wind, leg 1 eastbound

1743 Begin along wind, leg 2 westbound

1755 End along wind

1800 Begin Ladder 3

1840 End Ladder 3

Clouds definitely deepening, picking up ice on airframe, LWC to ~0.5 g/m³; some imbedded convection

1843 Begin Ladder 2

1924 End Ladder 2

1940 Wheels down

2/14/2012 ASCII Pilot notes (Flight 7)

Crew: Drew, Chu, French, Bergmaier

Flight Time: 2.5

Objective: ASCII Case

Planned: 4 Ladder patterns and along-wind between 2-3

Actual: Departed LAR 14,000 direct to LAR 262@27. Requested 25 nm radius of pt. at 14,000. Flew five rung ladder at 14,000 from Southeast to Northwest alternating starting points two times. After ladder 2 flew 300 along-wind leg. After along wind leg returned to LAR.

ASCCII-13 Flight (RF07) 14 Feb

1448 - 1708 (2.4 hrs)

Drew, Pokharel, J French, P Bergmaier

General:

ASCCII only seeding case, planned pattern consisted of 4 ladders with 2 along wind legs in between ladders 3 & 4.

Seeding generators failed to fire, flight was aborted during the along wind legs

- One WCR beam scrambles (160115)

Flight:

1449 Wheels up

1458 Begin Ladder 1 @ FL140

1540 End Ladder 1

Mostly above cloud, some ice at our level and just above, from WCL appears liquid below, mostly on the upwind side

1544 Begin Ladder 2

1625 End Ladder 2

1633 Begin Along wind, leg 1 eastbound

1646 Begin along wind, leg 2 westbound

1648 received word via Xchat that generators malfunctioned and failed to fire, decision from ground was to abort mission. RTB

1709 Wheels down

2/12/2012 ASCII Pilot notes (Flight 6)

Crew: Drew, Pokharol, French,

Flight Time: 4.3

Objective: ASCII Case

Planned: 4 Ladder patterns and along-wind between 2-3

Actual: Departed LAR 14,000 direct to LAR 262@27. Requested 25 nm radius of pt. at 14,000. Flew five rung ladder at 14,000 from Southeast to Northwest alternating starting points four times. Between ladders 2 and 3 flew 270 along-wind leg. After ladder 4 returned to LAR.

ASCCII-13 Flight (RF06) 13 Feb

0130 – 0538 (4.3 hrs)

Drew, Pokharel, J French

General:

Flight was on 12 Feb (local time) but began after 00Z on 13 Feb.

ASCCII only seeding case, pattern consisted of 4 ladders with 2 along wind legs in between ladders 3 & 4; seeding generators were turned on near end of ladder 2. Cloud was quite shallow, mostly below level of King Air and thus few in situ microphysics measurements.

- Torque was OFF most of flight, turned on later in flight
- Two WCR beam scrambles (0417, 0523)

Flight:

0130 Wheels up

0150 Begin Ladder 1

0233 End Ladder 1

 Mostly thin cloud with liquid water below us (evident from lidar)

0239 Begin Ladder 2

0320 End Ladder 2

 Seeding generators turned on late in ladder

032550 Begin Along wind, leg 1 eastbound

033800 Begin along wind, leg 2 westbound

0349 End along wind

0355 Begin Ladder 3

0437 End Ladder 3

0441 Begin Ladder 4

0523 End Ladder 4

0539 Wheels down

2/1/2013 ASCII Pilot notes (RF 5)

Crew: Wadsworth, Oolman, Bohharel, Ward

Flight Time: 3.6

Objective: RSE X 3

Planned: Along wind, control leg, two laps of the 280 track, control leg & repeat until empty. Planned to fly at 16'000' MSL until burn down to 13,000 lb, then drop down to 14,000' MSL.

Actual: Departed LAR, climbed to 16,000. Requested 25 nm radius of LAR 274/23 fix at 16,000. Flew entire pattern as planned. Ice buildup was gradual & continuous. Remained at or near 1800 ft-lbs of torque until gross weight approached ~ 12,500. Gradually the power was able to come back a bit. Last two laps of the racetrack, we encountered some pretty heavy liquid water on the south east leg. Required full props & power to maintain 140 kts. Terminated the flight, got a climb from Denver to 180 (out of clouds) & came home.

ASCI13 Flight Scientist Report

Binod Pokharel

Tuesday, 1 February 2013

Crew: Brett Wadsworth, Jeff French, Binod Pokharel, Aaron Ward

Objective: Single flight IOP (Type 1, Joint with RSE) with race track and control leg (2 race track before (no) seed and 2 race track after seed)

Flight Details: Takeoff and landing times are 1840 and 2210 UTC. Four race track and 3 control leg patterns are conducted over the Medicine Bow Mountains. King Air made one alongwind leg (2331-2343 and 2345-1258 UTC) with 280° wind angle, three control leg and four race tracks. All 8 AgI generators (MB/SM) are turned on at about 2022 UTC and turned off at about 24:22 UTC. Flight is conducted at 16 kft level all time due to higher LWC and icing condition. Clouds are deep and stratified during the earlier flight and became convective with higher LWC later in the flight so that last track and fourth control leg is not completed.

Weather: cold (flight level temperature is about -21 °C), temperature is -8 °C, wind is from W/WNW with 40 knots speed at 700 mb.

At take-off the Snowy Range and Centennial Ridge are covered in cloud/snow, as seen from Laramie.

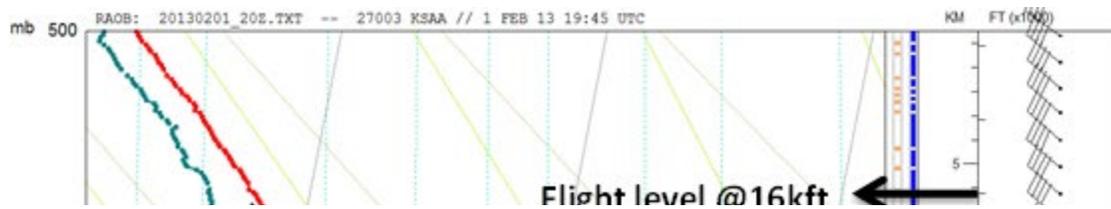
Clouds are stratified with clearly defined cloud top, high liquid water ($\sim 0.3\text{-}0.5\text{ g/m}^3$ at flight level). Due to high LW, icing occurs in most of the instruments mounted on the aircraft wings (Fig 1) and did not get data from these instruments after about 1925 UTC. First instrument affected by the icing is DMT 100 at about 1925 UTC. 2DP and FSSP are died around 1956 UTC, then CDP also died after couple of minutes around 2010 UTC. CIP was working until the middle of the flight, but icing on the tips as well as between the tips forced CIP to stop working. PVM was working during the whole flight.

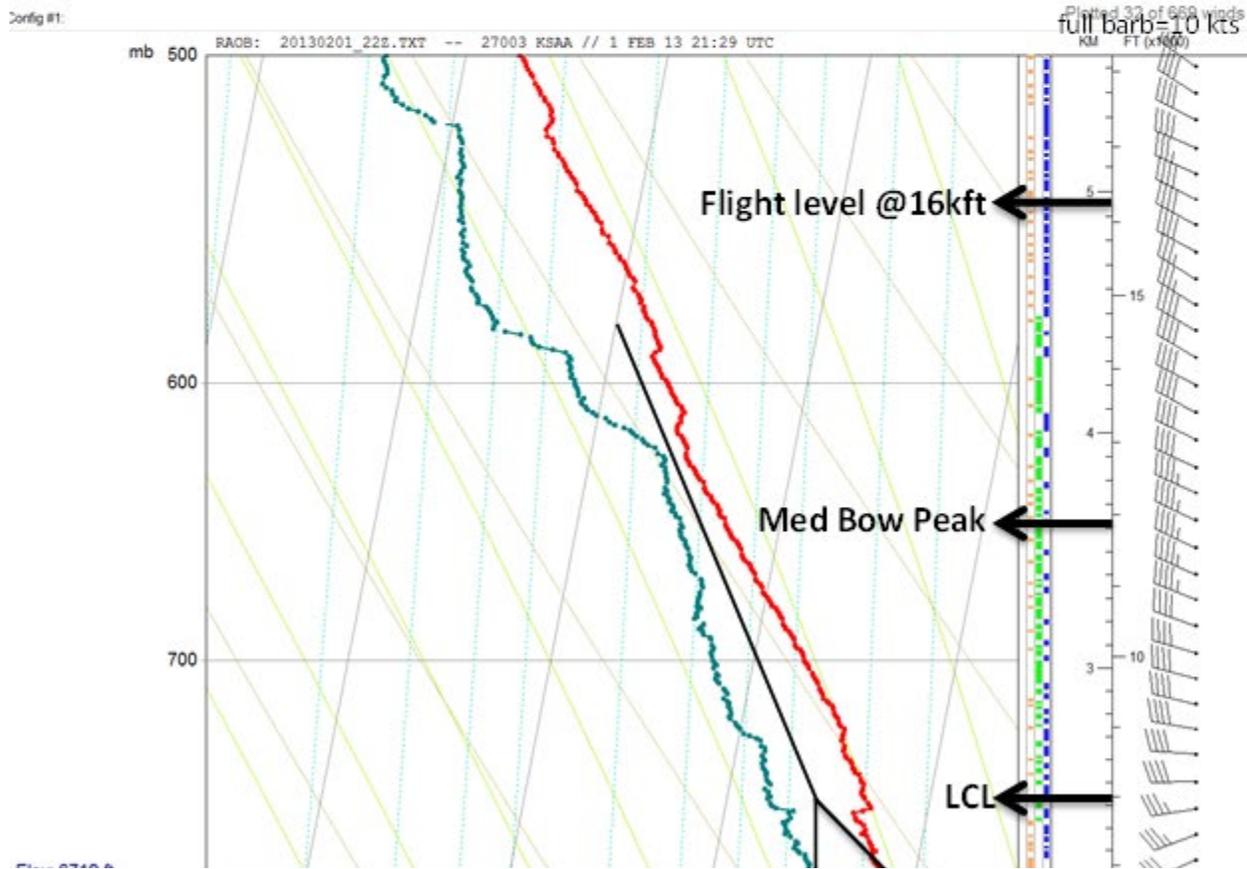
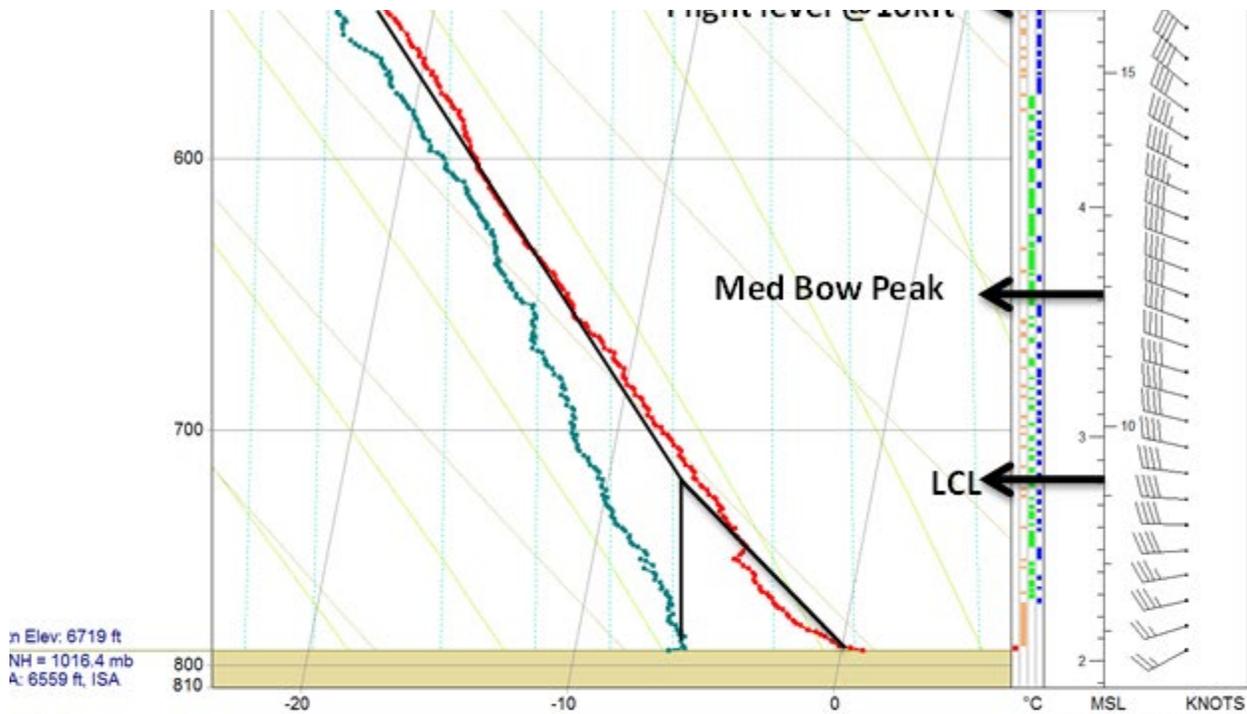
Sounding from Saratoga suggest a low LCL (2.8 km from 20Z sounding and 2.5 km from 22Z sounding) (Fig. 2). Atmosphere is unstable from surface to 600 mb and a thin layer of inversion is near 755 mb that can be seen in Fig 2. Strong wind and unstable atmosphere is expected to advect AgI plume up to mountain top. The Cedar Creek radiometer LW was quite high ($\sim 0.5\text{ mm}$) consistent with observation at flight level and RT model. The sounding suggests stronger wind ($\sim 25\text{ kts}$ at surface) with small veering and constant wind speed (40 kts) from 700 to 500 mb and stronger wind ($\sim 60\text{ kts}$) above 500 mb.

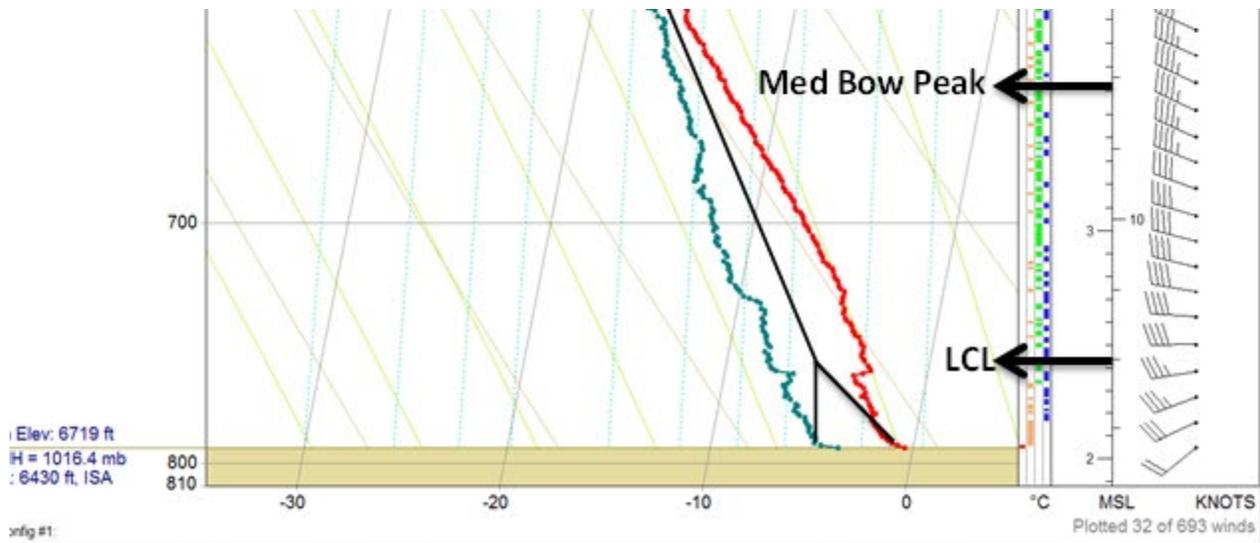
Cloud is stratified and deep earlier in the flight, but becomes more convective and shallower later in the flight. Due to convection with cumuliform cloud, LW is higher later in the flight so that last race track is not completed.



Fig 2: Icing on the instruments and CIP laser is blocked by ice (red spot) during middle of the flight around 2130 UTC.







full barb=10 kts

Fig 2: Saratoga soundings during the flight. Upper panel shows the sounding launched at 20Z and lower panel shows the sounding launched at 22Z.



Fig 3: Cloud top during later in the flight around 2150 UTC.

Alongwind leg, control leg and race track (times are in UTC):

Alongwind leg (280 degrees, 16 kft level)

(SE-NW) 1845-1859

During alongwind leg, higher radar reflectivity is observed below flight level (~10 dBZ) and LWC is about 0.3 g/m³.

Control leg #1 @16 kft level

(SW-NE): 1903-1910

During this flight, thin cloud below flight level and Saratoga valley is seen at the beginning, but cloud becomes thicker in middle of the flight and no cloud at flight level later in the flight.

Radar beam scrambled at about 1908 UTC.

Race track #1 @16 kft level

Leg B (NE-SW): 1915-1921

Leg A (SW-NE): 1923-1930

Leg B (NE-SW): 1931-1938

Leg A (SW-NE): 1939-1947

During race track #1, cloud is deep and radar reflectivity is about 15 dBZ and can't see ground.

Radar beam scrambled at about 1933 UTC.

Control leg #2 @16 kft level

(NE -SW): 1952-1958

Cloud mostly below flight level in the beginning of the flight, becomes thicker from middle of the flight and cannot see ground.

Race track #2 @16 kft level

Leg A (SW-NE): 2002-2010

Leg B (NE-SW): 2012-2018

Leg A (SW-NE): 2020-2027

Cloud is deep and stratified (cloud top is about 51 kft level), continuous snowfall and reflectivity is larger than 10 dBZ

Seeding generators (all 8 generators MB/SM) turned on

2022-2422

Race track #2 @16 kft level

Leg B (NE-SW): 2030-2036

Race track #3 @16 kft level

Leg A (SW-NE): 2038-2045

Leg B (NE-SW): 2048-2054

Leg A (SW-NE): 2056-2103

Leg B (NE-SW): 2106-2112

Similar cloud condition is observed with higher reflectivity and deep stratified cloud.

Radar stops working around 1941 due to radar program crashed. After restarting the program, which takes about 3-4 minutes, it started working again around 2045 UTC. No radar data is available during that time period from 1941-2045.

Control leg #3 @16 kft level

(SW -NE): 2119-2126

Cloud is only below flight level most of the time.

Race track #4 @16 kft level

Leg B (NE-SW): 2130-2137

Leg A (SW-NE): 2139-2146

Leg B (NE-SW): 2148-2155

More cumuliform cloud is observed during this flight with higher LWC ($\sim 0.5 \text{ g/m}^3$). More icing problem and could not complete the remaining legs.

ASCII-13 Flight (RF05) 01 Feb

1839 – 2206 (3.6 hrs)

Wadsworth, Pokharel, J French, A Ward (SDSMT student)

General:

Flight was cut short due to ice buildup on airframe. Spent almost entire flight in supercooled liquid water at -20 C and FL160, most of the in situ cloud physics instruments failed at some point due to excessive ice buildup.

- Applanix failed on takeoff, was restarted within ~30 seconds
- ~1900 LWC100 failed due to ice buildup
- ~1930 FSSP failed due to ice buildup
- ~1945 2DP failed due to ice buildup, CIP data suspect due to ice distorting flow around sample volume
- ~2000 CIP failed due to ice buildup
- 2005 CDP failed due to ice buildup
- 2 WCR beamscreens (1908, 1933)
- 2040 WCRserv crash, WCR down for about 4 minutes

Flight plan to conduct control leg followed by 2 racetracks and repeat 4 times

Flight:

1940 Wheels up

Applanix failed on takeoff, restart

Climb to FL160 for first pass (*ended up spending entire flight at 160 because of large amounts of supercooled liquid*)

1859 finished first along wind leg on west side of MedBows, P/C in Saratoga valley, saw 0.3 g/m³ of LWC on leg, decide to stay high for now

1903 Begin Pattern A (control leg followed by 2 racetracks)

1915 Begin Racetrack 1

1931 Begin Racetrack 2

During Pattern A saw LWCs upto ~.4 g/m³, drop size to about 25 micron

1952 Begin Pattern B

2002 Begin Racetrack 1

2020 Begin Racetrack 2

2038 Begin Pattern C (seeding is now “turned on”)—no control leg on this pattern (to save time)

2038 Begin racetrack 1
2056 Begin race track 2

2119 Begin Pattern D
2131 Begin racetrack 1 (tops seem to be collapsing somewhat—maybe seeing more cumuliform?)
2148 Begin racetrack 2

2155 decide to cutout, power creeping up, too much ice buildup on airframe

2207 Wheels down

ASCI13 Flight Scientist Report

Binod Pokharel

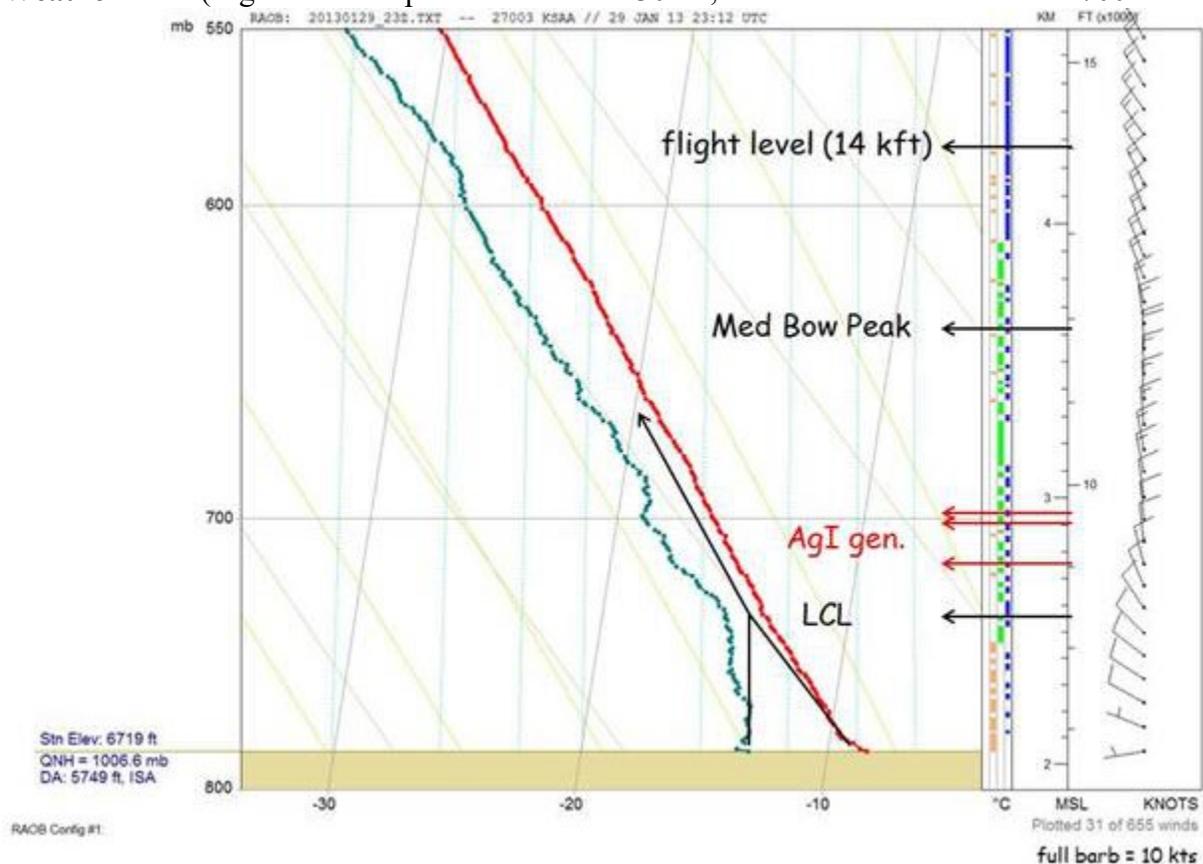
Tuesday, 29 January 2013

Crew: Brett Wadsworth, Larry Oolman, Binod Pokharel, Christopher Kruse

Objective: Single flight IOP (ASCI only case) with four ladder patterns (2 ladder patterns before (no) seed and 2 ladder patterns after seed)

Flight Details: Takeoff and landing times were 2145 and 2552 UTC. Four “Ladder” patterns were conducted over the Medicine Bow Mountains. King Air made two ladder legs before seeding (2159-2323 UTC), two alongwind legs (2331-2343 and 2345-1258 UTC) with 310° wind angle, and two ladder legs after seeding (2405-2535). Three AgI generators (MB03 (Turpin), 04 (Mullison), and 05 (Barrett)) were turned on at about 2315 UTC and turned off at 25:16 UTC. First ladder leg was conducted at 16 kft level, and rest of the flight was conducted at 14 kft level. Clouds were deep during the first two ladder patterns and became thinner/less intense during last two ladder patterns.

Weather: cold (flight level temperature is about -30 °C, wind is from NW/WNW at 700 mb).



At take-off the Snowy Range is covered in cloud/snow, as seen from Laramie, and Centennial Ridge is visible.

Clouds were cumuliform at first, becoming more stratified during the first two ladders, and drying out rapidly during 4th ladder. During At 2342 UTC, we penetrated a lee Cu cloud at 16 kft at the end of first alongwind leg(Fig. 2).

The sounding from Saratoga suggest a low LCL, below the level of the generators (Fig. 1). The Cedar Creek radiometer LWC was quite low (<0.05 mm), due to the low temperature and the northwesterly flow (Cedar Creek is on the west side). The sounding suggests little resistance to lift over the mountain, even though the wind speed was low. The surface wind certainly was too low for blowing snow.

Given the veering wind profile, AgI plumes are expected on the south side of the flight legs. According to the RT model, the 100 m trajectories from the 3 generators missed leg 5, as the plumes were deflected to the south.

During the flight the low-level wind veered a little, according to the RT-FDDA soundings. At flight level, no noticeable wind direction change is observed.

Clouds are more intense

Ladders and alongwind legs (times are in UTC):

Ladder #1 @16 kft level

During ladder#1, clouds are below only in L5 and L1, but deep cloud in L4, L3, and L2.

Up looking radar beam scrambled around 2222 UTC.

L5 (SW-NE): 2159-2206

L4 (NE-SW): 2208-2215

L3 (SW-NE): 2216-2223

L2 (NE-SW): 2224-2231

L1 (SW-NE): 2232-2236

Ladder #2 @14 kft level

During Ladder#2, clouds look similar to ladder#1.

L5 (NE-SW): 2243-2250

L4 (SW-NE): 2252-2259

L3 (NE-SW): 2300-2307

L2 (SW-NE): 2309-2316

L1 (NE-SW): 2317-2323

Seeding generators (3 generators only) turned on

2315-2516

First Alongwind leg (310 degrees, 14 kft level)

(NW-SE) 2331-2343

During both alongwind legs, clouds are thicker on upwind side (west), but thin and no cloud on downwind side (east)

Second Alongwind leg (310 degrees, 14 kft level)

(SE-NW) 2345-2358

Ladder #3 @14 kft level

During Ladder#3, clouds become thinner and less intense than during Ladders#1&2.

L5 (SW-NE): 2405-2413

L4 (NE-SW): 2414-2421

L3 (SW-NE): 2422-2430

L2 (NE-SW): 2432-2439

L1 (SW-NE): 2441-2448

Ladder #4 18 kft level

During ladder#4, clouds are drying out rapidly during L5 and L4, but are more intense during/after L3.

L5 (NE-SW): 2452-2459

L4 (SW-NE): 2501-2508

L3 (NE-SW): 2510-2517

L2 (SW-NE): 2519-2526

L1 (NE-SW): 2528-2535



Fig 2: Penetrating a lee cumulus cloud over Sheep mountain around 2342 UTC.

ASCII13 Flight (RF04) 2013-01-29

Crew: Brett Wadsworth, Binod Pokharel, Larry Oolman, Chris Kruse

Summary: ASCII only case. PCASP took three tries. First time – zero counts, second time – nothing.

2145 Take off. Applanix good.

2158 Add a little yaw to test PCASP. Still has higher counts when beta is negative.

2159 5SW at 16000 ft. In clear air with some convection around us. Temperature -31C.

2202 Had Brett trim aircraft so that beta is closer to -0.5 degrees instead of -1.0 degrees. PCASP looks better, but not perfect.

2206 Done

2208 4NE

2214 Done

2216 3SW

2222 Radar beams scrambled

2223 End leg 3

2224 2NE. Flew through pocket of 10 micron drops, temperature still -31.

2231 Done

2233 1SW

2239 Finished with first ladder

2245 5NE, 14000 ft, temperature -26

2251 Done

2252 4SW, clouds appear to be getting deeper

2259 Done

2300 3NE

2307 Done

2309 2SW

2316 Done

2317 1NE, Radar beams scrambled

2323 Done with second ladder. Almost no liquid water seen on this ladder.

2331 Downwind leg

2343 Done with downwind, up beam scrambled.

2358 Done with upwind leg.

0005 5SE, 14000 ft, temperature -26, seems to be less cloud on this leg this time.

0012 Done.

0014 4NE

0021 Done

0022 3SW

0030 Done

0032 2NE, above the clouds on the NE end of the line

0037 Snowing in Saratoga

0039 Done

0041 1SW, clouds are less deep and thinner on this ladder than the first two.

0043 Upward beam scrambled

0048 End of third ladder.

0052 Start fourth ladder, 5NE

0059 Done

0101 4SW

0108 Done

0110 3NE, clouds thicker than ladder 3.

0117 Done

0119 2SW

0126 Done

0128 1NE

0131 Some lwc with 8-10 micron drops

0135 Done with mission. No along wind leg.

0152 Land

ASCII 13 RF03 Post Mission Report

January 15, 2013

1. Crew: Bandani, Bokharel, Oolman, Chu
2. Pre-Flight Brief: 1530
3. Planned T/O time: 1700
4. Flight Time: 4.0 Hrs
5. Weather: VMC for T/O and Landing.
6. Lowest cloud deck: Scattered/ Broken layer 10,500' to FL 180.

A. Brief:

Show time was 1100 for a possible 1300 flight. The pre-flight brief was postponed due to WMI seeding hold. At 1530 briefed the ASCII only case research flight for a 300 along wind profile. Updated Denver ARTCC and filed for IFR flight plan to LAR 274R/023 DME fix at 16,000' with a delay of 4+00 hours.

Execution:

Performed an external power start and started the left engine first. No issues with the right generator. Departed KLAR at 1655 and climbed to initial altitude of 16,000'. Enroute approaching ~20 miles from the fix received clearance from ATC to work w/in the requested air space and began the ASCII profile at point 5NE. Flew two patterns; the first at 16,000' and the second at 16,500'. Once complete, flew a 300 deg along wind leg at 17,000' followed by two more ASCII profile at FL 180. Once complete coordinated our return back to KLAR.

B. Discussion:

Did the outmost to keep the profile, however there were number of issues regarding aircraft capabilities and performance. 1) yaw damp and autopilot engage and disengage in flight (suspect last two flight could have caused the control box connection issues), 2) unable to descend below 16,000' into moderate icing due to pilot windshield heat's inability of keeping pilot side windshield clear of ice and 3) the pressurization/depressurization has to be done manually as the controller unit is not cooperating.

Second night flight is done!

ASCI13 Flight Scientist Report

Binod Pokharel

Tuesday, 15 January 2013

Crew: Ahmad Bandani, Larry Oolman, Binod Pokharel, Xia Chu

Objective: Single flight IOP (ASCII only case) with five ladder legs as in WWDC 08-09

Flight Details: Takeoff and landing times were 23:55 and 03:50 UTC. Four “Ladder” patterns were conducted over the Medicine Bow Mountains. King Air made two ladder legs before seeding (00:09-01:42 UTC), one alongwind leg (01:49-01:55 UTC) with 300° wind angle, and two ladder legs after seeding (02:02 – 03:38). Three AgI generators (MB03 (Turpin), 04 (Mullison), and 05 (Barrett)) were turned on at about 0128 UTC. First ladder legs were conducted at 16 kft level, second ladder leg was conducted at 16.5 kft level, along wind leg was at 17 kft level and ladder legs 3 and 4 were conducted at 18 kft level due to icing problem on Pilot wind shield and on instruments (Fig 1) as well. Clouds were shallow with inconsistent depth.

Weather: cold, but warming slowly during the flight. Some broad E-W oriented waves in the upper-level clouds apparent in the VIS and IR satellite imagery, moving south. Some stratification is apparent in the clouds also. The lower atmosphere is quite stable, almost isothermal ~-10C to 650 mb. At take-off the Snowy Range is covered in cloud/snow, as seen from Laramie, and Centennial Ridge is visible.

Ladders and alongwind legs (times are in UTC):

Ladder #1 16 kft level

During ladder#1, cloud is mostly below flight level, thinner cloud in L5 than in L4, L3, and L2. No cloud during L1 at the beginning, but cloud is seen below flight level from middle of the flight.

L5 (NE-SW): 0009-0015

L4 (SW-NE): 0017-0025

L3 (NE-SW): 0028-0034

L2 (SW-NE): 0036-0044

L1 (NE-SW): 0046-0052

Ladder #2 16.5 kft level

During ladder#2, cloud looks similar to ladder#1.

Radar up beam scrambled around 0121 UTC.

L5 (SW-NE): 0057-0151

L4 (NE-SW): 0107-0113

L3 (SW-NE): 0115-0124

L2 (NE-SW): 0126-0132

L1 (SW-NE): 0034-0142

Seeding generators (3 generators only) turned on

01:28 – 03:29

Alongwind leg (300 degrees, 17 kft level)

No cloud on the way point so that we make short alongwind leg.

0149-0155

Ladder #3 18 kft level

During ladder#3, fly at higher level due to icing on the aircraft. Cloud condition looks similar to Ladders#1&2.

L5 (NE-SW): 0202-0208

L4 (SW-NE): 0210-0219

L3 (NE-SW): 0221-0227

L2 (SW-NE): 0229-0237

L1 (NE-SW): 0239-0245

Ladder #4 18 kft level

During ladder#4, similar cloud condition is observed to previous ladders looking the radar measurements. Two layers of shallow cloud are observed; one layer near to ground and one layer above, but both clouds are below flight level.

L5 (SW-NE): 0250-0258

L4 (NE-SW): 0301-0306

L3 (SW-NE): 0309-0317

L2 (NE-SW): 0320-0326

L1 (SW-NE): 0329-0338



Fig 1: 2DP and FSSP pictures taken before (upper panel) and after (lower panel) the flight. Instruments are covered by ice during the flight.

ASCII13 Flight (RF03) 2013-01-15

Crew: Ahmad Bandani, Binod Pokharel, Larry Oolman, Xia Chu

Summary: ASCII only case. The deice on the PVM was not turned on. The values looked reasonable. The lwc100 was encased in ice at the end of the flight. The values look poor the entire flight. The first research flight with the UWYO PCASP.

2356 Take off, Applanix good

0009 Point 5NE, 16,000 ft. In clear air, from radar – snow near the ground. PCASP counts in lowest channels excessively high.

0015 Point 5SW. More clouds and snow at lower levels on this end of the track.

0016 Nice KH waves in turn on video.

0018 Point 4SW

0025 4NE, in clear air the whole leg.

0028 3NE

0034 3SW, pilot windshield deice not working well. Staying high for the duration of mission.

0037 2SW

0044 2NE

0047 1NE

0052 1SW

0058 5SW at 16,500 ft.

0106 5NE, from WCR, clouds thicker above us than below.

0108 4NE, at this level the winds are almost directly out of the north.

0113 4SW

0116 3SW

0120 Upward WCR beam scrambled.

0124 3NE

0126 2NE

0128 Generators turned on.

0132 2SW

0134 1SW
0142 1NE, picked up ice on wind shield on this leg.
0149 Along wind leg. Heading 110 degrees true. Climbed to 17000 ft.
0155 Done
0202 5NE, 18000 ft
0208 5SW, mostly clear below after leaving NE corner.
0210 4SW
0219 4NE
0221 3NE, some clouds on the NE end of this line
0227 3SW
0228 2SW
0237 2D-P beam blocked
0238 2NE
0240 1NE
0245 1SW
0250 5SW
0259 5NE, some liquid water near this point in a layer that we intersected.
0301 4NE
0306 4SW
0309 3SW
0317 3NE
0320 2NE
0326 2SW
0329 1SW
0338 1NE, Done
0349 Land

ASCII 13 RF02 Post Mission Report

January 11, 2013

1. Crew: Bandani, Geerts, Oolman, Xiaoqin Jing.
2. Pre-Flight Brief: 1750
3. Planned T/O time: 1900
4. Flight Time: 2.2 Hrs
5. Weather: VMC for T/O, in the working area, and Landing.
6. Lowest cloud deck: Scattered/ Broken layer below 14,000'.

A. Brief:

Briefed the second flight following the first flight's debrief. Updated Denver ARTCC and filed for IFR flight plan to LAR 274R/023 DME fix at 14,000' with a delay of 2+30 hours.

Execution:

Performed a battery start to determine if the external power could be a culprit in right generator not coming on line during the start. Started the left engine first this time and the rest of the startup sequence worked as advertised. Departed KJAR at 1825 and climbed to initial altitude of 14,000'. Enroute approaching ~20 miles from the fix received clearance from ATC to work w/in the requested air space and began the 270 along wing profile. Once complete coordinated our return back to KJAR.

B. Discussion:

First night flight one out the door!

2013/01/11: Type 1 (double flight)

RF1 (2220-0030 Z) was part of an RSE case (seeding: SM or MB): 2020-0020 Z

Crew: Bandani, Geerts, French, Jing

RF2 (145-350 Z) involved ASCII type 1 seeding (MB or nothing): 0200-0400 Z

Crew: Bandani, Geerts, Oolman, Yang

Both flights did the Type 1 270° pattern, each with 3 racetrack loops, and with a control leg at the start and the end. The along-wind leg KLAR → N Platte valley was flown over the full length of the WCR echo.

Soundings from Saratoga at 20Z and 03Z

Little LW at Cedar Creek MR (0.05 - 0.1 mm, rather steady)

Weather:

Cold, T_{700} -17°C. Winds 31 kts from 270 at 700 mb. Conditions were fairly steady between the two flights. The low-level temperature dropped slightly, the winds veered 5-10 degrees, and the shallow orographic cloud deepened between the two flights. Nice acceleration and subsidence on the lee side, leading to a persistent, deep rotor circulation. This rotor was intercepted 4 times (each along-wind leg), but captured on WCR only twice, during the return along-wind leg in both RF1 and RF2. The rotor was beautiful in the setting sun, reaching up to maybe 15 kft in its center. It was not very long, and mostly north of where we crossed it on RF1. (It was dark on RF2, so its extent could not be seen).

During the first flight (RF1) the precipitating cloud layer over the mountain was quite shallow and mostly stayed below flight level (14 kft on the racetrack and 13.5 kft on the control leg), except over MBP and along the northern part of the control leg (Elk mtn). The echoes were stronger on the northern side of the control leg and esp the racetrack. The shallowness of the clouds was probably due to a stable layer (~670-630 mb in the SAA sounding). The cloud tops were more heap-like (not quite Cu-form) at first, with fuzzy edges and clear openings down to the ground, later they became more layered with some bandedness along the wind (ESE-WNW), and the echoes became more stratified. The lidar suggests pockets of liquid water, but not much, no strong cloud edges and generally high depol ratios. Light snow fell, just enough to partly obscure Centennial Ridge when seen from the airport (at T/O and return). A high cloud deck was present overhead. Its western edge (oriented SSE-NNW) was right above the racetrack, and it retreated slowly to the north. Early on snow from this high cloud fell down into the lower orographic cloud, at least at the northern end of the racetrack and on the control leg. Towards the end heavier snowfall (with basically no LW at flt level or below, according to lidar) fell near Elk mtn (around 2355), which was decorated by a 3-tier cake (stack of thick pancakes), connecting the upper cloud to the lower one. RF1 ended just after sunset.

During RF2 (in the dark) the high cloud deck was gone, but the shallow orographic cloud was deeper, and most of the flight was in cloud, with cloud tops near flight level at the S end of racetrack, and deeper to the north. Limited cloud liquid water, in some pockets. CIP concentrations were rather high, but most particles were rather small, esp. 0.15-0.20 mm. Echoes were more stratified and more intense than on RF1, and they were again more intense on the N part of the racetrack.

There were a number of instrument issues (see reports from French/Oolman)

Suggestions for future flights:

- (for pilot): rapid turns on the ASCII-only flights (5-leg ladder) are needed to complete 4 ladders in one flight
- (for scientist): if rotor cloud is visibly present from Laramie, ask pilot to first gain altitude closer to KLAR, and then start the along-wind leg across the rotor and MBP. This gives time to sitch on radar/lidar and capture the rotor.

ASCII 13 RF01 Post Mission Report

January 11, 2013

1. Crew: Bandani, Geerts, French, XJing.
2. Pre-Flight Brief: 1315
3. Planned T/O time: 1500
4. Flight Time: 2.2 Hrs
5. Weather: VMC for T/O, in the working area, and Landing.
6. Lowest cloud deck: Scattered/ Broken layer below 13,500'.

A. Brief:

The 0830 pre-flight brief was postponed due to WMI seeding hold. At 1315 briefed the first RSE case research flight for a 270 along wind profile. Updated Denver ARTCC and filed for IFR flight plan to LAR 274R/023 DME fix at 14,000' with a delay of 2+30 hours.

Execution:

Performed a battery start to determine if the external power could be a culprit in right generator not coming on line during the start. Right generator came on line for the start of the right engine but would not come on line for starting the left engine. Once the problem was remedied departed KLAR at 1510 and climbed to initial altitude of 14,000'. Enroute approaching ~20 miles from the fix received clearance from ATC to work w/in the requested air space and began the 270 along wing profile. Once complete coordinated our return back to KLAR.

B. Discussion:

First one out the door!

ASCII-13 Flight (RF01) 11 Jan

2223 – 0031 (2.2 hrs)

A Bandani, B Geerts, J French, X Jing

General:

Flight #1 of a planned 2-flight RSE case. Plan to fly 270-pattern

- Applanix died on takeoff
- PCASP was not working—sometimes would report housekeeping fine, but zero counts
- Audio and Video did not work during flight
- Torque did not work during flight
- LWC100 not turned on until halfway through flight
- One WCR beam scrambles
- First flight with new CIP computer—time was wrong on computer---I think Larry fixed the times in the processing—but may only be lined up within a few seconds

Flight:

2226 Wheels up

Applanix died on takeoff

0031 Wheels down