Seeded and Natural Orographic Wintertime clouds—the Idaho Experiment (SNOWIE - 2017)
University of Wyoming King Air Research

Summary

Seeded and Natural Orographic Wintertime Clouds—the Idaho Experiment (SNOWIE) will study wintertime orographic precipitation and the effectiveness of both ground and airborne seeding over Idaho's Payette Basin region.

Links

- Field Catalog
- Planning and tracking tools
- Plot of flight hours
- Radar and Lidar quicklooks

Date	Flight # (*.kml)	Status	Times (UTC)	Hours	Crew/Notes
16 Mar 2017	RF24	Track 3. Non-seeding case. 2D-C inop until ~014830 UTC. No KPR data. No CIP data.	0052-0431	3.8	T Drew J French D Plummer S Faber
9 Mar 2017	RF23	Track 4. Non-seeding case coordinated with N267CB. Deep ice clouds with limited liquid at lower levels. 2D-C inop until ~2239 UTC. No KPR data. No CIP	1956-2346	3.9	T Drew J French D Plummer S Faber

Order SNOWIE Data

- King Air 1 Hz files
- King Air high rate 25 Hz files
- Optical array probes 2D images
- Wyoming Cloud Radar Level 1
- Wyoming Cloud Radar Level 2
- Wyoming Cloud Lidar

User Information

- Planning Chart
- EOL Facilities
- Software Repository

		data.			
9 Mar 2017	RF22	Track 4. Non-seeding case with coordinated microphysics measurements from N267CB. Predominantly liquid clouds with ice increasing over flight time. 2D-C inop until ~1521 UTC. No KPR data. No CIP data.	1358-1658	3.1	T Drew J French D Plummer S Faber
7 Mar 2017	RF21	Track 4. Last seeding flight, relatively deep ice clouds with small amounts of liquid. 2D-S operational, 2D-C replacing CIP, inop until ~1521 UTC. KPR LNA damaged prior to start of flight, KPR removed after flight.	1400-1750	3.9	T Drew J French D Plummer S Faber
5 Mar 2017	RF20	Track 3. Flight in prefrontal clouds with fairly widespread precipitation. No 2D-S data. No CIP data.	1200-1500	3.2	T Drew J French D Plummer S Faber
4 Mar 2017	RF19	**Note: no RF18, to keep same numbering as general IOPs** Track 3. Flight in pre-cold frontal clouds with mixed-phase conditions, potential seeding signatures evident. No 2D-S data. No CIP data.	1315-1655	3.7	T Drew J French D Plummer S Faber
		Flight with significant icing. Applanix lost its real-time solution and			

- Projects & Data Requests
- Planning and tracking tools
- Facility User's Guide

Facility Instruments

- In Situ
- Wyoming Cloud Radar
- Wyoming Cloud Lidar

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21 Feb 2017	RF17	the calculations had to be restarted. AIAS ingested too much water, use BIAS for calculations. No CIP data.	1426-1817	3.9	T Drew F McDonough L Oolman S Faber
20 Feb 2017	RF16	Flight through deep stratiform clouds. Separated into two layers near end of flight. No CIP data.	1431-1742	3.2	T Drew F McDonough L Oolman S Faber
19 Feb 2017	RF15	Flight during passage of a line of thunderstorms. No CIP data.	1726-2058	3.7	T Drew F McDonough L Oolman S Faber
18 Feb 2017	RF14	Mostly glaciated with liquid water found primarily in low level StCu at the west end of the line. No CIP data.	2130-0048	3.4	T Drew R Bruintjes L Oolman S Faber
16 Feb 2017	RF13	Post-frontal case that was mostly glaciated on NE end of line and clear on the SW end. CIP computer frequently rebooted.	2330-0053	1.5	T Drew J French L Oolman S Faber
7 Feb 2017	RF12	Track 4. High-shear environment with relatively convective clouds, mixed-phase conditions. First flight with reinstalled KPR. CIP inoperative.	1949-2324	3.7	B Wadsworth J French D Plummer S Faber
4 Feb 2017	RF11	Track 4. Deep clouds with embedded liquid water. CIP inoperative.	2142-0127	3.8	B Wadsworth R Bruintjes D Plummer S Faber

3 Feb 2017	RF10	Track 3. Short flight with deep ice clouds, limited liquid water. CIP inoperative.	1944-2148	2.2	B Wadsworth R Bruintjes D Plummer S Faber
31 Jan 2017	RF09	Track 4. Short flight with primarily liquid cloud, limited direct microphysics measurements.	2050-2230	2.7	B Wadsworth J French D Plummer S Faber
22 Jan 2017	RF08	Rapidly moving upper level trough. Real-time solution invalid for the Applanix between 2243 and 2249.	2056-0032	3.6	B Wadsworth R Bruintjes L Oolman A Majewski
21 Jan 2017	RF07	Shallow system using ground based seeding generators. Much of the flight was cross wind rather than along the wind. KPR was removed prior to this flight.	2204-0141	3.8	B Wadsworth J French L Oolman A Majewski
19 Jan 2017	RF06	Second flight of the day. The vertical channel of the 2D-S experienced fogging for most of the flight.	2229-0204	3.7	B Wadsworth J French L Oolman A Majewski
19 Jan 2017	RF05	Shallow postfrontal system with distinct seeding signature on the DOWs. The LNA on the KPR was damaged prior to this flight.	1527-1831	3.1	B Wadsworth J French L Oolman A Majewski
18 Jan 2017	RF04	Trasnition from shallow to deep frontal system	1959-2313	3.4	B Wadsworth B Geerts L Oolman A Majewski

11 Jan 2017	RF03	Take off in rain. 2D-S and CIP optics contaminated.	0213-0546	3.7	B Wadsworth J French L Oolman A Majewski
9 Jan 2017	RF02	Atmospheric river event. Two layers early in flight that later merged. Particles from the upper layer may have fallen into the lower layer and depleted the LWC.	0416-0738	3.4	B Wadsworth J French L Oolman A Majewski
8 Jan 2017	RF01	Flight mostly above clouds containing large drops.	0222-0557	3.7	B Wadsworth J French L Oolman A Majewski
Test Flights					
16 Mar 2017	FF02	Ferry from Boise to Laramie	1803-1949	1.8	T Drew D Plummer
5 Jan 2017	FF01	Ferry from Laramie to Boise	2236-0107	2.6	B Wadsworth B Geerts L Oolman
3 Jan 2017	TF04	Short shakedown flight sampling ice & mixed-phase clouds.	2015-2100	0.8	B Wadsworth S Faber D Plummer A Majewski
20 Dec 2016	TF03	Clear air measurements for lidar alignment/depolarization check.	1712-1909	2.1	T Drew D Wu D Plummer M Deng
		Focused on measurements in cloud with passes over	2241-		E Sigel S Faber

14 Dec 2016	TF02	Medicine Bow hotplate. Primarily ice clouds with some embedded liquid over mountains.	0020	1.7	D Plummer D Wu
08 Dec 2016	TF01	Did radar circles, wind calibration maneuvers, and clear air legs to calibrate the Nevzorov. Were unable to start the AV software.	2223-0038	2.4	B Wadsworth A Majewski D Plummer D Wu
Flight Hours		As of Mar 30, 2017, 78.1 out of 80 research hours were flown, 1.9 remain.		Test and Ferry: 11.4	

References to the data [Digital Object Identifiers (DOI)]

University of Wyoming - Reseach Flight Center, 2017: Flight Level Data from the University of Wyoming King Air during the Seeded and Natural Orographic Wintertime clouds-the Idaho Experiment (SNOWIE) project, Version 1.0. University of Wyoming, College of Engineering, Department of Atmospheric Science, doi:10.15786/M2MW9F.
Format Citation (ReFindit). Download metadata: XML JSON Order 1 Hz data Order 25 Hz data Order 2D images

University of Wyoming - Reseach Flight Center, 2017: Wyoming Cloud Radar data from the University of Wyoming King Air during the University of Wyoming King Air during the Seeded and Natural Orographic Wintertime clouds-the Idaho Experiment (SNOWIE) project, Version 1.0. University of Wyoming, College of Engineering, Department of Atmospheric Science, doi:10.15786/M2CD4J.
Format Citation (ReFindit). Download metadata: XML JSON Order level 1 data Order level 2 data

University of Wyoming - Reseach Flight Center, 2017: Nadir pointing Wyoming Cloud Lidar (WCL) data from the University of Wyoming King Air during the Seeded and Natural Orographic Wintertime Clouds-the Idaho Experiment (SNOWIE) project, Version 1.0. University of Wyoming, College of Engineering, Department of Atmospheric Science, doi:10.15786/M2H66G.
Format Citation (ReFindit). Download metadata: XML JSON Order WCL data

3/15/17 SNOWIE17 Pilot notes (Research Flight 24)

Crew: French, Plummer, Faber

Flight Time: 3.8

Objective: Track 3

Planned: Climb to 15,000 ft. MSL on vectors, then to W end of track 3. Start high for the first two legs and then descend below seeder aircraft.

Actual: Departed Boise (East) and climbed out on a vectored left turn direct to the west endpoint of track 3. Requested ATC block 15,000-16,000 and climbed to 15,000 ft. MSL.

Started porpoise between 15,000 and 16,000 ft. MSL, above and into the cloud tops. Encountered little aircraft icing during the climb, however did start accumulating ice in the tops. Continued porpoise from tops down to 14,000 ft. MSL. Requested block 16,000 to 17,000 ft. MSL to allow WMI aircraft below us.

Aircraft icing was minimal for the remainder of the flight. Stepped down on each reversal from 16,000, 15,000, 14,000 13,000 stepping down on the reversals with the WMI aircraft. Once the WMI aircraft returned to Boise, then stepped down to 12,000, and 11,000. Reaching the SW point back up to 12,000 Northeast bound until just west of Packer John and then reversed course and climbed to 13,000 ft. MSL. Reaching the west end, returned to Boise.

Project: SNOWIE17

Date: 16 Mar 2017

Flight: RF24

Notes:

Track 3. Final research flight, non-seeding case with coordinated microphysics measurements from N267CB. . KPR and CIP not onboard. 2D-C again had bad/unusable image records through ~014830 UTC (~56 min), then started operating normally. TROSE offset ~-8C from TRF through much of flight, often very low during maneuvers. KACAMS timed out many times.

Flight Summary:

UTC Comment

0052 Wheels up.

Licor reference gas not on at start, turned on with lidar/radar

0106 Plenty of liquid at 15 kft, -9 to -10C, high concentrations of droplets. Going up a bit to get just past tops, 16 kft

0110 At 16 kft, -10C, out of cloud tops. Will dip down into cloud along this segment.

0118 Turning at northeast end.

0120 TROSE down at -45 to -70C during maneuvers.

0121 At start of southwest leg, 14 kft, -8C. Will porpoise to tops now.

~0132 Weaker radar echoes below, power and noise look ok.

0137 Up to 17 kft, -13.5C. In deep cloud moving in on southwest end of track.

0141 Turning on southwest end, will descend back to 16 kft.

0146 Timeout on KACAMS software.

~0149 2DC operational.

0154 Turning at northweast end of leg, 0159 on track. Still at 17 kft, -12C.

Descend 16 kft.

0208 KACAMS timeout again (happens frequently through remainder of flight).

0215 Starting turn at southwest end, will descend from 16 kft to 15 kft. 0218 On track, -9C.

0230 Start turn at northeast end, descending from 15 kft to 14 kft. 0234 on track, -8C.

0252 Turning at southwest end, descending to 13 kft, -6C.

0306 Turning at northeast end, staying at 13 kft. 0309 on track.

0327 Turning at southwest end, descend to 12 kft, -4C. 0330 on track.

0341 Turning at northeast end, will descend to 11 kft. 0345 on track, -4C at 11 kft.

Plan for short course reversal: east at 12 kft, then west at 13 kft, on west side of Packer John site.

0402 Turning at southwest end, ascend to 12 kft. 0405 on track, -5C.

0409 Turning back northeast, ascending to 13 kft, then RTB. 0411 on track at 13 kft, -7C.

0420 return to base at 11 kft.

0431 Wheels down.

3/9/17 SNOWIE17 Pilot notes (Research Flight 23)

Crew: French, Plummer, Faber

Flight Time: 3.9

Objective: Track 4(a).

Planned: Climb to 15,000 ft. MSL on vectors, then to W end of track 4. Start high for the first two legs and then descend below seeder aircraft.

Actual: Departed Boise (East) and climbed out on a vectored right turn to the west until direct to the west endpoint of track 4. Requested ATC block 15,000-16,000 and climbed to 15,000 ft. MSL.

Encountered no significant aircraft icing during the entire flight. After completing the first leg heading westbound, spiraled up to FL250 approximately 15 nm west of the east endpoint. Then continued the leg to the west at FL250. Stepped down on each reversal to FL230, FL210, FL180, 15,000 ft. MSL, 13,000 ft. MSL, 12,000 ft. MSL and 11,000 ft. MSL. The only ice accumulation (trace-light) occurred at 11,000 ft. MSL. Following the last leg returned to Boise.

Project: SNOWIE17

Date: 09 Mar 2017

Flight: RF23

Notes:

Track 4. Second flight of day, non-seeding case with coordinated microphysics measurements from N267CB. Much deeper ice clouds than in RF22, with limited amounts of liquid present at lower flight levels. KPR and CIP not onboard. 2D-C again had bad/unusable image records through ~2239 UTC (2 hr 42 min), then started operating normally. KACAMS timed out several times.

Flight Summary:

UTC Comment

Operated WCR during startup again, no issues noted this time. 2D-C shows similar bad response again at startup.

1957 Wheels up.

2014 Long ferry leg to 4, measurements generally looks good. Much deeper ice cloud than this morning's flight.

2020 On west end of line. Bright band on WCR at ~9 kft AGL.

2030 Turning at east end of line at 16 kft. Planning for spiral ascent roughly halfway between Packer John and eastern end of track, to 22+ kft

Note, ~4C offset for TROSE at 15 kft (-10C TRF vs -14C TROSE).

2040 Begin ascent (rolled WCR file), TROSE 4-5C lower during ascent.

Will be continuing ascent to 25 kft.

2056 Top of ascent, switched to 7.8 km WCR after range issues showing up in regular config. Continue westbound leg @ 25 kft.

TROSE ~3C lower than TRF at top of ascent, constant altitude (-32C/-35C).

Noticed KACAMS timeout again, on down camera. Killed KACAMS and restarted OK. "Error - 1074360293 occured at IMAQdx Get Image2.vi" NI-IMAQdx: (Hex 0xBFF6901B) Timeout. (also, a "camera removed" message sometimes)

2109 Beginning turn at west end and descending to 23 kft. Standard WCR configuration should be OK again.

2112 Switched WCR back to standard 6.3km range configuration at west end of line. -32C earlier, -28C now. Too much depolarization on lidar, iced over?

2118 TRF/TROSE back into ~0.8C agreement (-27.8/-28.7).

2123 Turn at eastern end, down to 21 kft, -23C.

2133 TROSE not in line with TRF yet, -23.3/-26.

2144 Turn at western end, descend to 18 kft for eastbound leg. TRF/TROSE back in line, -16.7/-16.9

2159 Turn at eastern end, descend to 15 kft, -10.5C.

2221 Turn at western end, descend to 12 kft. -5C, hints of liquid droplets

2235 Turn at eastern end, at 12 kft, still -5 or -6C.

~2239 2DC operational.

2257 Turn at western end, 12 kft.

2313 Already in turn at eastern end, at 12 kft, descending to 11 kft following 267CB.

2345 Wheels down.

3/9/17 SNOWIE17 Pilot notes (Research Flight 22)

Crew: French, Plummer, Faber

Flight Time: 3.1

Objective: Track 4(a).

Planned: Climb to 15,000 ft. MSL on vectors, then to W end of track 4. Start high for the first two legs and then descend below seeder aircraft.

Actual: Departed Boise (East) and climbed out on a vectored right turn to the west until direct to the west endpoint of track 4. Requested ATC block 15,000-16,000 and climbed to 16,000 ft. MSL.

Encountered significant aircraft icing during the climb-out from 11,000 ft. MSL to the tops at ~15,500 ft. MSL, with the most significant aircraft ice occurring near the cloud tops. Decided to porpoise between 15,000-16,000 ft. MSL (into and out) of the cloud tops in order to collect some cloud data.

Once the WMI aircraft was airborne we climbed to 17,000 ft. MSL to allow the WMI aircraft below us at 15,000 ft. MSL. As the WMI aircraft stepped down we regained the block 15,000-16,000 ft. MSL and eventually to 13,000-16,000 and continued to sawtooth from 13,000 ft. MSL to above cloud top. Continued to find significant aircraft icing throughout the flight. Following the last leg returned to Boise.

Project: SNOWIE17

Date: 09 Mar 2017

Flight: RF22

Notes:

Track 4. First of two flights on 9 Mar. First non-seeding case with coordinated microphysics measurements from N267CB. Predominantly liquid clouds with ice increasing over the course of the flight. KPR and CIP not onboard. 2D-C again had bad/unusable image records early, then started responding at ~1521 UTC (1 hr 24 min into flight)

Flight Summary:

UTC Comment

~1349 WCR recording on ground, noted drop in noise floor again but also resolved itself again after several minutes. 2D-C bad on startup and through first portion of flight again.

1357 Wheels up.

1404 Radar/lidar up and running.

1405 Encountering icing on the way to flight level, drizzle drops on 2DS between -4C and -10C.

1409 15-16 kft cloud tops upwind of mountains, no upper cloud layer. May have N267CB near tops, with us looking down.

1417 Tops have been nearer 15 kft with weak layer above. No issues seen on WCR since on the ground.

1420 Cloud radar & lidar suggest only liquid below.

1422 Begin leg at 16 kft, porpoising in tops at ~15.5 kft. CDP/2DS show cloud droplets in tops with a few <100 um on 2D-S. Handful of dendrites on additional passes down in cloud.

1428 Stronger second echoes from 2 km below, off and on. -13C above cloud, -15 within.

Note TROSE again showing bad response in maneuvers: Near -22C, TRF -15/16 in porpoising maneuvers.

1432 At east end, returning west. Try to continue porpoising, then up to 17 kft when 267CB starts at 15-16 kft.

1435 Back on track heading west. WCR echo structure a bit stronger below, to 5-10 dBZ maximum.

1437 At 15 kft, -14C. Will need to go up 17 kft, 267CB airborne.

~1448-1455 Note, data system started updating every second with no change in filesizes (as it writes every 40 seconds). Ftp'd in to verify disk was OK, cleaned out some older files from Feb 21 just in case, status window looked OK by 1455.

1457 Turning at west end of leg. 267CB just ahead of us at 15.5 kft

1502 Overhead of 267CB, passing slowly.

1509 Turning at east end of track.

1516 267CB requesting 13-14 kft, we'll get 15-16 kft block.

1518 Descending.

~1521 2D-C responding again.

1532 Turning at west end. Have had quite a bit of icing on this end. LWC100 dropped out in turn. Broad CDP distribution, with 100+ um drops on 2D-S.

Noting that CDP seems to drop out more in small droplets, where does ice accumulate?

1538 Plan to do porpoising again, down as low as 13 kft.

1546 Turning at east end of leg, at 15-16 kft in clear air, some tops extending to flight level. Deiced some at 13 kft, too cold to do so further aloft. May stay low for a bit.

1609 Turning at west end of leg, still at 13kft, -9C. More ice (lots of rimed & dendrites) but still plenty of liquid.

1612 Ascend to 15 kft.

1624 Turn west for last leg.

~1624 Lidar blank, no power profile. Other instruments have ice, LWC100 out. Shows response again at 1628 when we topped out of cloud.

Porpoising on last leg back, 16kft-13 kft. 400 um drops at -9C near cloud base, along with small droplets, ice.

1646 RTB

1658 Wheels down.

3/7/17 SNOWIE17 Pilot notes (Research Flight 21)

Crew: French, Plummer, Faber

Flight Time: 3.9

Objective: Track 4(a).

Planned: Climb to 15,000 ft. MSL on vectors, then to W end of track 4. Start high for the first two legs and then descend below seeder aircraft.

Actual: Departed Boise (East) and climbed out on a vectored right turn to the west until direct to the west endpoint of track 4. Requested ATC block 13,000-15,000 and climbed to 14,000 ft. MSL. We encountered almost no aircraft ice and the lidar showed very little liquid water below the aircraft on the first pass, so we descended to 11,000 ft. MSL during the turn. Little to no ice accumulated on the aircraft at 11,000 ft. MSL. We remained at 11,000 ft. MSL for the remainder of the flight. Shortened the western end of the track by a few miles on several legs, and made 270-90 turns at the east endpoint to prevent drift into the area with higher MVA's immediately to the east of the endpoint. On the last set of legs, repeated a short section of the east leg prior to turning back west. After passing Packer John (midpoint) on the last leg returned to Boise.

Project: SNOWIE17

Date: 07 Mar 2017

Flight: RF21

Notes:

Flight on Track 4. Last seeding flight, relatively deep ice clouds with embedded small amounts of liquid.

2D-S operational again. 2D-C installed to replace CIP, bad/unusable image records through ~1521 UTC, then started working normally.

KPR LNA damaged again, problem existed through entire flight. Noise flag on display, typically 12-15 dB with hot & warm noise values generally around -57 to -62 dB. KPR removed after flight for remainder of project. WCR problematic again for first few minutes after startup, similar to RF19. Looked better just before switching to up/down beams in flight.

Flight Summary:

UTC Comment

~1352 started up beams. WCR much weaker echoes again for first few minutes, through XXXX UTC.

1401 Wheels up.

1408 Started lidar, radar up/down configurations. WCR looking normal again.

1413 Rebooted KPR computer, display shows high noise without much echo structure. Only change has been CIP replacement with 2D-C; Cycled 2DC breaker to check for interference, but no effect.

1420 KPR back up again, same noise flag present.

1423 On W end of leg, at 14 kft/-21C.

1433 Return W, descend to 11 kft for westbound leg. Switched KPR to 30-m config just to watch echo structure & strength.

1452 Turning back E at 11 kft. -15C at west end of leg, nearly all ice.

1504 Overall weak cloud on WCR, but up to 15 dBZ in lowest km AGL.

1507 Return W at 11 kft, -16C at this end.

1521 2DC started responding normally, seemingly at random.

1524 Return E at 11 kft, plenty of ground visible visually.

1538 Return W at 11 kft, ground visible at this end as well.

1555 Return E, some cloud droplets at this end. -15C, with LWC from .2-.4 g/m3. Some embedded streamers below on KPR, but continued weak echo structure on display.

1558 KPR Pacsi error: "IO error updating test timed out" and "getting data product info timed out". Similar to prior flight, couldn't manually kill radar_rf_serv process, so rebooted system.

1602 KPR working again, using 30-m config for now.

1611 Turning W, some thickening evident in clouds below.

1627 Turning E, more consistently in cloud for this leg.

1643 Turning W.

1658 Turn back E.

1711 Turn W early. Will do 90/270 then same for quick return through band.

1716 Reversing back E.

1735 Returning to base.

1750 Wheels down.

3/5/17 SNOWIE17 Pilot notes (Research Flight 20)

Crew: French, Plummer, Faber

Flight Time: 3.2

Objective: Track 3.

Planned: Climb to 15,000 ft. MSL on vectors, then to SW end of track 3. Start high for the first two legs and then descend below seeder aircraft.

Actual: Departed Boise (East) and climbed out making a right turn to the SW point of track 3 at 15,000 ft. MSL. Requested ATC block 13,000-15,000. Descended to 14,000 ft. MSL for return leg. We encountered very short pockets of light icing at 14,000 ft. MSL, so we decided to descend to 12,000 ft. MSL for the next legs allowing the seeding aircraft to fly at 13,000 ft. MSL. Very little aircraft icing at 12,000 ft. MSL.

Started to shorten the legs on the west by 10 nm to concentrate on the NE end of the track. Returned to original SW endpoint on final leg and then returned to Boise.

Project: SNOWIE17

Date: 05 Mar 2017

Flight: RF20

Notes:

Track 3. Flight in prefrontal clouds with relatively widespread precipitation coverage. No 2D-S data. No CIP data.

Flight Summary:

UTC Comment

1159 Wheels up.

1204 onward, lidar display not working.

1215 Display working, only solution seemed to be completely stopping both programs and restarting recording, then reopening display. Proceeding along NE leg at 14 kft, -19C.

1223 Returning back SW, continuing at 14 kft.

1231 At 14 kft, -18 to -20C, noting that TRF/TROSE difference is a bit larger here.

1244 Returning NE and descending to 12 kft. Near -15C but with downward spikes -25 to -30C on TROSE during maneuvers. Similar previously.

1259 Return SW at 12 kft.

1317 Return NE a bit early, continuing at 12 kft/-15C.

1329 Note, KPR maxing out at 35+dBZ. Large aggregates on 2D-P. Still at 12 kft/-14C.

1330 Turning back SW. TRF -14C, TROSE sometimes down to -23,-24 in turn.

1346 Turning NE early again. Plenty of strong returns on radar and lidar (large aggregates on 2D-P) but not a lot of substantial liquid.

1359 Return SW at 12 kft, still -14C.

1417 Return NE at 12 kft.

1430 Return SW for final full leg.

1452 Return to base.

1502 Wheels down

IOP 20 Flight Notes
Faber

1158 Airborne

1221 Pockets of .5 g m-3, 1 – 2 mm graupel

123220 Regions of all ice

1245 Brief spikes of .3 g m-3 LWC

1254 In updraft with fairly consistent LWC = .4 g m-3

1312 Between cloud layers over Packer John

131650 Very brief periods of .2 g m-3 LWC, wide CDP distributions

1319 Spikes of LWC up to .5, wide CDP distributions

1328 In an updraft with heavier snow. Very brief mixed phase period with droplets of mean diameter ~10 um, 100 cm-3

1411 ~1.5 minutes of .1 g m-3, wide CDP distributions

1428 ~1.5 minutes of LWC = .3 g m-3, MVD = 22 um

3/4/17 SNOWIE17 Pilot notes (Research Flight 19)

Crew: French, Plummer, Faber

Flight Time: 3.7

Objective: Track 3.

Planned: Climb to 15,000 ft. MSL on vectors, then to SW end of track 3. Start high for first two legs and then descend below seeder aircraft.

Actual: Departed Boise (East) and climbed out making a right turn to the SW point of track 3 at 15,000 ft. MSL. Requested ATC block 13,000-15,000. At NE end descended to 13,000 ft. MSL for return leg. We encountered short pockets of icing at 13,000 ft. MSL, so we decided to descend to 12,000 ft. MSL for the next legs allowing the seeding aircraft to drop to 13,000 ft. MSL. At the NE point, we dropped to 11,000 ft. MSL where we continued to encounter only pockets of significant icing. I made 270-90 turns on the NE waypoint to ensure we stayed inside the 11,000 ft. MSL MVA, but it did result in completing the course reversal a mile or two west of the turn point.

Later we started to shorten the legs on the west end to just west of Packer John to concentrate on the NE end of the track. On our last leg we climbed up to 13,000 ft. MSL and extended the track NE by 15 nm, once reaching the normal endpoint westbound, descended back to 11,000 ft. MSL for the remainder of the track. Reaching the SW endpoint returned to Boise.

Project: SNOWIE17

Date: 04 Mar 2017

Flight: RF19

Notes:

No RF18, to keep flight number in line with general IOPs.

Flight on track 3, mixed-phase conditions in pre-cold frontal cloud layers. Potential seeding signatures evident on DOW-7.

2D-S bad from start of flight - buffers fill fast with no particles evident. No CIP data.

Flight Summary:

UTC Comment

1315 Wheels up

Used 60-m config for first KPR leg, weak echoes in general.

1339 At NE end of leg, turning back SW @ 13 kft. Switch KPR to 30-m config.

1345 Better echoes at and below on KPR (30+ dBZ), weaker above. 2D-P has moderate sized (few mm) ice, -12C at 13kft. Some turbulence w/LWC to 0.5 g/m3. Looks like convective cells & streamers on KPR.

1400 Turn back NE a bit early, descend to 12 kft.

1416 Returning SW at 11 kft, -10C.

Pretty consistent icing @ 11 kft, primarily in eastern 2/3 of leg.

1434 Return NE, able to maintain 11 kft.

1449 Return SW at 11 kft, tops have been lower overall than last leg.

1450 Sampling through possible seeding signatures on DOW-7.

~1500 TRF, TROSE separated by .8C, about "normal" for these flights.

1501 Return NE early as clouds are weakening to W. Will resample potential seeding signatures to E.

~1510-11 Big rimed/rounded on 2DP, LWC at .5 g/m3, still ~-10C.

1512 Returning SW, still at 11 kft.

~151430 on - will check heat/optics on CDP, seems to be icing over more than expected.

1524 Return NE, near Packer John site.

1534 Return SW, maintaining 11 kft.

1547 Return NE at 11 kft.

1558 Return SW.

1604 Continuing SW, will request 13 kft then turn back NE.

1608 Returning NE, switch KPR to 60-m configuration to look at sensitivity. 13 kft, -14C.

1619 Returning SW from extended leg. KPR back to 30-m configuration, no overall best config for mix of weak and strong echoes.

1625 Continuing SW, descend to 11 kft.

1627 CDP out for a while again, LWC evident on other probes. ~-9C at 11 kft.

1642 End leg, return to base.

1655 Wheels down.

IOP 19 Flight Notes
Faber

1347 Encountering first liquid region. ~.05 g m-3

1407 Pockets of water up to .5 g m-3

1426 Made a pass at 11 kft. Consistent LWC. Spikes to .4 - .5 g m-3, consistently around .25 g m-3

1444 LWC ~.3 g m-3. Brief period of 100 cm-3 droplets at 15 um

151430 CDP may have iced over

152800 CDP is back

1550 CDP shows near uni-modal droplet spectra at small diameter

1602 Penetrating cloud tops. Have pockets of liq up to .7 g m-3

2/21/17 SNOWIE17 Pilot notes (Research Flight 17)

Crew: McDonough, Oolman, Faber

Flight Time: 3.9

Objective: Track 3.

Planned: Climb to 15,000 ft. MSL on vectors, then to SW end of track 3. Start high for first two legs and then descend below seeder aircraft.

Actual: Departed Boise (East) and climbed out making a right turn to first point. Started line at SW point of track 3 at 15,000 ft. MSL. Requested block 14,000-16,000. At NE end dropped to 14,000 ft. MSL for return leg. Encountered quite a bit of ice on that leg, so decided to climb up to 16,000 ft. MSL for the next leg. We continued to encounter significant icing at 16,000 ft. MSL. Just past Packer John decided to climb to 17,000 ft. MSL for the rest of the leg and the return leg as we were getting a little low on reserve power. We continued to encounter short durations of significant aircraft icing. Just before reaching the SW point the CDP iced over and Larry suggested we should either drop down and shed the ice, or end the flight. Just after completing the turn at the southwest point, I reversed course again and flew to the southwest dropping to around 5500 ft. MSL. We flew circles at around +4 degrees until all the visible ice shed from the aircraft. We then climbed back to 17,000 ft. MSL enroute to the SW point and did two more legs. Decided to fly a leg at 13,000 ft. MSL, and found significantly less ice than at 17,000 ft. MSL. Decided to climb to FL 190 for next leg. Had a block of 17,000 to FL 200 and started at FL190 but later descended to FL180. The return leg was at 17,000 MSL where we encountered much less ice than the earlier legs at 17,000 ft. MSL. Reaching the end-point returned to Boise.

IOP 17 Flight Notes
Faber

1426 Airborne

1442 Penetrating scattered clouds with .06 g m-3, 12 um droplets with moderately-sized crystals

1446 Hitting pockets of .15 g m-3, around 80 um mean diameter

1448 Hitting more numerous pockets of .4 g m-3, 100 um drops, wide CDP distributions

1452 Regions of aggregates

1458 Mixed phase with .2 g m-3 liq, 100 – 200 um droplets

1528 Liq less than .1 g m-3

1537 Heavier snow

1540 2DP windows are iced over

1620 Region of snow, small droplets (18 um mean diameter, .05 - .1 g m-3), and some drizzle

1647 Mixed regions of mostly liquid

1706 2DS shows more pristine dendrites and a few columns

1736 Searching for generating cells. Skimming tops w/ 20 um drops, LWC .1 - .2 g m-3, a few larger drops around 80 um

1759 ~5 minutes of .2 - .4 LWC alternating between smaller droplets and small drizzle

1806 RTB

2/20/17 SNOWIE17 Pilot notes (Research Flight 16)

Crew: McDonough, Oolman, Faber

Flight Time: 3.3

Objective: Track 3.

Planned: Climb to 15,000 ft. MSL on vectors, then to SW end of track 3. Start high for first two legs and then descend below seeder aircraft.

Actual: Departed Boise (East) and climbed out making a right turn to first point. Started line at SW point of track 3 at 15,000 ft. MSL. Requested block 14,000-16,000. At NE end dropped to 14,000 ft. MSL for return leg. At southwest point, extended the track and dropped to 12,000 ft. MSL to get below the seeder aircraft at 13,000 ft. MSL. Flew several legs at 12,000 ft. MSL. Chat relayed two new points to conduct an up and down sounding to FL 250. Requested hold at the first point and climbed to FL250. Reaching FL250, headed towards descent point. However, chat requested a decent into the lower cloud deck, so we stepped down through the lower cloud to remain below the tops. Extended the track 10 nm and did the sounding down to 8000 ft. MSL there (more in the valley). Returned to Boise on a visual.

IOP 16 Flight Notes
Faber

1430 Airborne

1436 Entering thin clouds on ascent, aggregates with some dendritic structure

143930 Some small drops at cloud top

1442 Dendrites and a few rimed columns, minor turbulence

144700 Some dendrites

1451 Some small drops, narrow CDP distributions with MVD < 10 um

150200 Intermittent pockets of liquid with CDP MVD < 10 um, rimed dendrites, a few columns

151340 Some drops ~100 um

1520 Some snow

152720 Some small graupel

154520 LWC ~.3 g m-3 for a minute, minor turbulence

154700 Back into some LWC, drops ~20um

154820 Drops getting smaller

160650 ~2 minutes .2-.3 g m-3

161600 Large aggregates

162020 Brief increase of LWC to .5 g m-3

164440 Seeing a few more pristine dendrites

191720 LWC steadily ~.25 g m-3, spikes to .5 g m-3. Drops started around 100 um decreased to 25 MVD w/ wide distributions on CDP

192200 Well-defined gradients in droplet size. Started at MVD < 10 um with sharp peaks on CDP, jumping to bi-modal distributions with MVD moving to 18 um

2/19/17 SNOWIE17 Pilot notes (Research Flight 15)

Crew: McDonough, Oolman, Faber

Flight Time: 3.7

Objective: Track 3.

Planned: Climb to 15,000 ft. MSL on vectors, then to SW end of track 3. Start high for first two legs and then descend below seeder aircraft.

Actual: Departed Boise (East) and climbed out on Westerly heading. Chat requested to start track 20 nm SW of first point. Turned to that heading but realized a line of storms would prevent us from getting to that point. Started line at SW point of track 3 at 15,000 ft. MSL. Requested block 13,000-15,000, At NE end dropped to 13,000 ft. MSL for return leg. Half way to the southwest requested 12,000 ft. MSL (relay from seeder) to allow the seeder to fly at 13,000 ft. MSL. Flew several legs at 12,000 ft. MSL but had to cut the southwest end short by about 10 nm each time due to line of convection moving east. After the convection died returned to SW point. For the last two legs extended NE point by 10 nm and turned over Packer John. Returned to Boise on a visual.

IOP 14 Flight Notes
Faber

1726 Airborne, winds lighter on climb out: 10 knts to 9000 ft increasing to 35 knts at 13000 feet

175820 Regions of mostly liquid, .3 - .4 g m-3, 90 um drops on 2DS

180120 .1 LWC on CDP with slightly bimodal distributions

1823 Many smaller drops (MVD = 12 um), a few rimed plates

182740 Medium-sized aggregates intermixed with brief periods of liquid (CDP LWC ~.04 g m-3). Well-defined depol patterns on Lidar.

185020 1 minute period of .4 LWC

185200 Skimming cloud tops with LWC spikes to .5 g m-3, wide CDP distributions

1908 Hitting edge of line, LWC = .3 g m-3 mixed in with large aggregates

192010 brief periods of .4 g m-3 LWC, VMD around 25 um, large rimed dendrites on either side of liquid region

1950 Brief period of snow with some columns

200850 very brief pockets of liquid with dendrites of various size, some capped columns

201100 Region of high LWC: spikes to .9, steadily around .7 g m-3

201530 Spikes of LWC to .8 g m-3, narrow CDP distributions at 22 um MVD

201919 LWC near .5 g m-3, wide CDP distributions with MVD 20 um, some bi-modal distributions on front side

203220 More capped columns

203600 2 minute period of water, wide CDP dists, LWC spikes to .5, steadily at .2 g m-3

204030 Another liquid region, LWC around .35 g m-3, bimodal CDP dists

2046 RTB

2/18/17 SNOWIE17 Pilot notes (Research Flight 14)

Crew: Drew, Bruintjes, Oolman, Faber

Flight Time: 3.4

Objective: Track 2.

Planned: Climb to 15,000 ft. MSL on vectors, then to SW end of track 2. Start high for first two legs and then descend below seeder aircraft.

Actual: Departed Boise (East) and climbed out on Southwesterly heading until 14,000 then turned direct to SW point of track 2 at 15,000 ft. MSL. Requested block 14,000-15,000, then changed to 12,000-15,000. At NE end dropped to 12,000 ft. MSL for return leg. Requested a hard 12,000 to allow the seeder to fly at 13,000 ft. MSL. After a few legs requested block 11,000-12,000 and dropped to 11,000 ft. MSL. Very little ice collected on the boots during the flight and the SW end of the line was VMC on most legs. Returned for visual into Boise.

IOP 14 Flight Notes
Faber

2130 Wheels up

2134 Passing through some drizzle on climb, thin cloud layer at 6500 ft

2135 Small pockets of LWC ~.05 g m-3, graupel, a few columns

2137 Large dendrites, isolated pockets of LWC <.05 g m-3

220040 Encountering small pockets of liquid <.05 g m-3, CDP shows a variety of distribution shapes with MVD 10 um

2212 A few more pristine dendrites

221900 Region of nearly all liquid, steady LWC .1 g m-3 for ~1 minute, CDP shows narrow distribution with MVD 18 um

222420 Back in liquid region, LWC spiking to .16 g m-3, CDP shows 15 um MVD, 2DS shows a greater number of large rimed crystals

2239 Very brief pockets of water with more columns, capped columns. Lidar shows associated regions of variable depolarization.

2252 Passing through line with very minor turbulence, slightly larger ice. Scattered pockets of low LWC

225540 Back in liquid region encountered at 221900/222420. LWC is still around .15 g m-3. Fewer ice particles than encountered last time

230120 Another pass through same liquid region. Liquid pockets are more scattered with lower LWC

231100 Region of larger drops. CDP LWC ~.05 g m-3 with MVD 20 um. Larger drops (probably ~75 um diameter) on 2DS

231740 Noticed a few pristine plates

2343 Very sudden change in Ice characteristics. Particles are all needles and columns. Very small pockets of low LWC

235620 Back into needle/column region (2343). Columns are larger, perhaps more rimed. Still have small pockets of low LWC.

242220 A few more pristine dendrites

242520 Region of liquid with larger drops, minor turbulence

243400 Passing through shallow stratocumulus. LWC spikes to .3 g m-3

2441 RTB

2/16/17 SNOWIE17 Pilot notes (Research Flight 13)

Crew: Drew, French, Oolman, Faber

Flight Time: 1.5

Objective: Track 3.

Planned: Climb to 15,000 ft. towards RENOL then on to SW end of track after first two legs start down to get below the seeder aircraft.

Actual: Departed Boise and climbed out on runway heading to 10,000 ft. MSL before turning towards SW point of track 3 at 15,000 ft. MSL. Requested block 15,000-16,000. At NE end dropped to 14,000 ft. MSL for return leg. Dropped to 12,000 while conducting an early turn prior to SW end. After completing the turn at the NE end dropped to 11,000 MSL. Very little ice collected on the boots and the SW end of the line was VMC. The flight was canceled and we returned to Boise.

2/07/2017 SNOWIE Pilot notes (Research Flight 12)

Crew: Wadsworth, French, Plummer, Faber

Flight Time: 3.7

Planned: Track 4a of the SNOWIE options. Start pattern at 16,000 MSL.

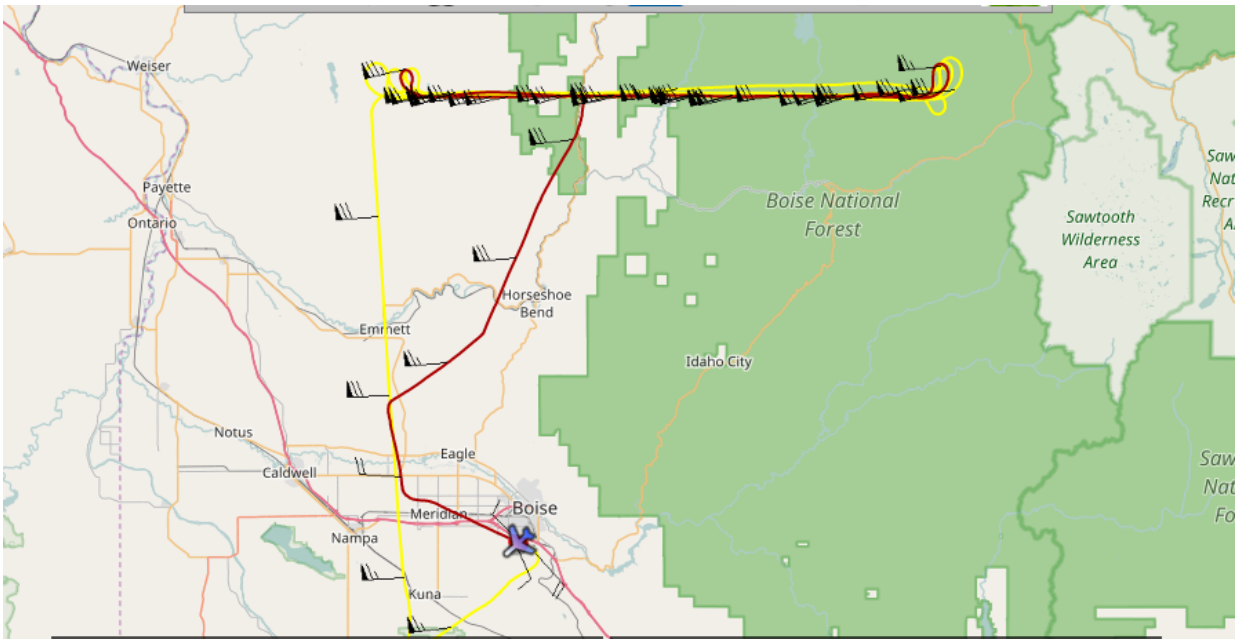
Actual:
Routing filed: RENOL BOI/323/042 BOI/023/051

Clearance routing received was "Cleared to Boise via the Boise 3 then as-filed. Climb via the SID." So, two flights in a row where the clearance received was what I filed.
When I checked in with tower, they gave me a right turn to 210, direct to RENOL when able.

As we went direct to RENOL, we entered clouds around 8.5K'. We were on-top by about 11.2K'. Asked for direct to BOI/323/042 which they gave to us.
Clouds were relatively low in the west to start. A pretty large buildup sitting over the east end that was convective in nature although without any electrical activity. Bumpy with fairly continuous low to moderate turbulence once we entered the buildup. Liquid water was isolated in pockets. Relatively low level of icing experienced overall throughout the flight as the ice boots were only cycled twice during the flight. Biggest concern was the turbulence and some pretty strong downdrafts experienced in the eastern end of the track. At one point, late in the flight with about 1100 lbs of fuel remaining, we were at 2100 ft-lbs of torque (props at 1650) to counter the downdraft when at 11,000 ' MSL.
We worked down from 16k' MSL initially to 14K', then we went down to the block of 11-12K when the seeding aircraft got on-station at 13k'. 11K' was relatively warm (~-4C on aircraft OAT). The tops throughout the area built up somewhat throughout the flight so that even on the west end of the track we were in clouds after the first lap on the track.
On RTB, they cleared us direct to JIMMI in prep for the ILS to 10R. When we were about 16 – 18 miles from BOI, we went through some virga and areas of shear that gave us a significant bump. Good thing that Dave was still in his seat and not in the back of the plane shutting things down. The winds were high at altitude (~65 knots) and remained high down to 8k' or so.

Power: After reaching 16k', had little ice on the aircraft. Power was running higher than I expected though, at ~ 1800 ft-lbs/side. After we intercepted the track and turned eastbound in VMC, the power gradually worked back to ~1650 ft-lbs. After entering the buildup in the east and reaching the east point, the power was back up to ~1700 ft-lbs.
Generally, the power ranged between 1600-1800 ft-lbs for most of the flight with the exception of the last westbound leg when the downdraft got us up to 2100 ft-lbs.

Crew coordination was good throughout the flight.


Weiser
Payette
Ontario
Boise National Forest
Sawtooth Wilderness Area
Horseshoe Bend
Emmett
Idaho City
Notus
Caldwell
Eagle
Meridian
Boise
Nampa
Kuna

Project: SNOWIE17

Date: 7 Feb 2017

Flight: RF12

Notes:

Track 4. Relatively convective case in higher-shear environment (clearly evident on radar profiles). Mixed-phase conditions.

First flight with reinstalled KPR. CIP inoperative.

Flight Summary:

UTC Comment

1938 Running WCR & KPR in up mode on ground, some light drizzle making it to surface

1949 Wheels up.

1958 Switched to up/down configuration.

2011 Looking at alternate KPR configurations to see sensitivity.

15 kft, -14.5C with clear air, convective clouds further east.

2013 At west end of track. KPR to 30-m configuration, no overall good choice for entire track.

2023 Turn west.

Convection below, breaking thru flight level (15 kft) to < 1 km above. Good structure now on KPR.

2046 Returning east at 14 kft.

2100 In turn for westbound leg, 12 kft, -8C

2124 Return east at 11 kft, to 12 kft towards east end.

2136 Returning west, descending back to 11 kft when able.

2156 Turning east.

2209 Turning W, again at 12 kft but descending back to 11 kft.

2231 KPR to 60-m config, no strong echoes on WCR.

2233 Turning east.

2247 Turning W, KPR back to 30-m config.

2250+ Turbulent with 200/cc droplets. Likely wave structure on vertical wind trace.

~2256 LWC-100 iced over.

2304 RTB.

2324 Wheels down.

2/04/2017 SNOWIE Pilot notes (Research Flight 11)

Crew: Wadsworth, Bruntjes, Plummer, Faber

Flight Time: 3.8

Planned: Track 4a of the SNOWIE options. Start pattern at 16,000 MSL.

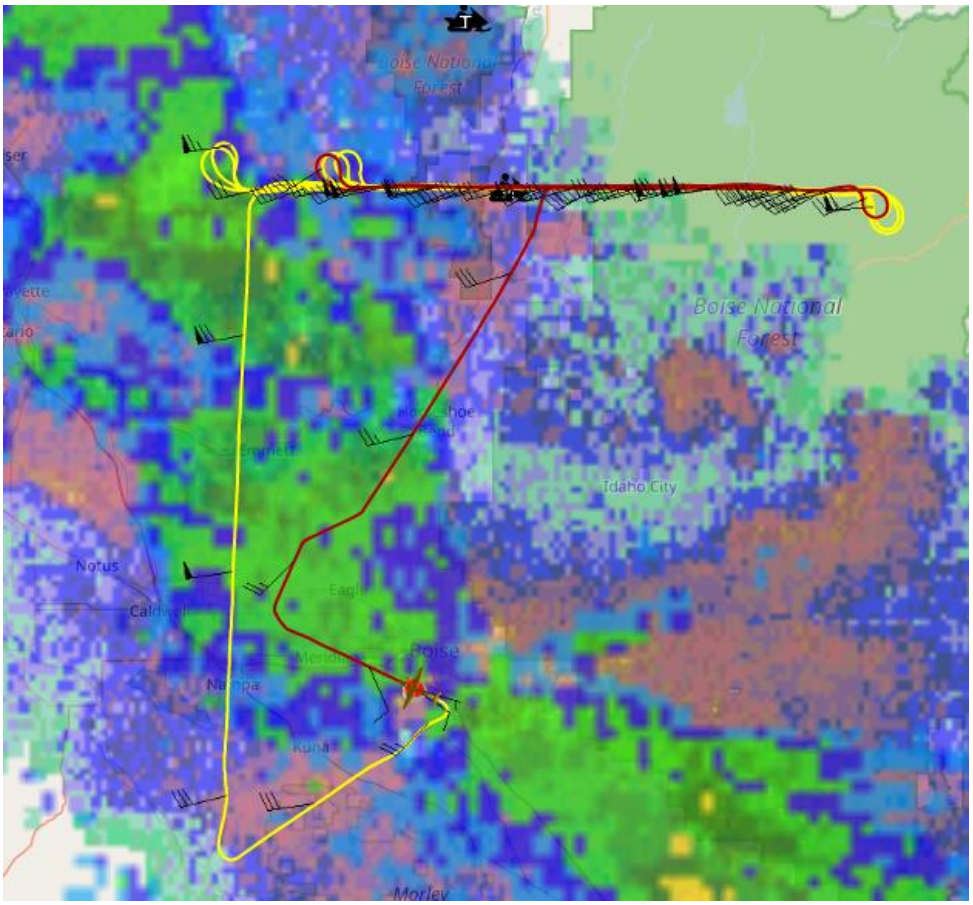
Actual:
Routing filed: RENOL BOI/323/042 BOI/023/051

Clearance routing received was "Cleared to Boise via the Boise 3 then as-filed. Climb via the SID." It is different every day. I didn't believe it, but they gave me what I filed.The past couple of flights did not remotely resemble what I file which was: RONOL BOI/320/030 BOI/009/060

As we went direct to RENOL, we entered clouds around 9K'. Reached 16K about the same time we got to RENOL. Roelof wanted to continue the climb as we were still in clouds and in liquid water. So we continued up to FL 210 where we were about 500 – 1000- above the cloud tops. We had only picked up a little ice on the acft even though we had encountered SLW all the way up in varying amounts. After that we gradually worked our way lower throughout the flight. The seeding acft arrived at 13K' as we had gotten down to the block of 14K-16K, so shortly we dropped down to 12K and stayed there the rest of the flight. We encountered pockets of moisture periodically, along with some amount of turbulence near the eastern end of the track.

Power: After reaching FL210, had a light amount of ice on the acft and the power was running at 180 ft-lbs/side. That was the highest power required for the entire flight, and it gradually came back from there. Towards the end of the flight, as we approached 12000 lbs gross weight, cruise power was about 1400 ft-lbs/side.

Crew coordination was good throughout the flight.


Boise National Forest
Boise National Forest
Idaho City
Notus
Caldwell
Nampa
Boise
Eagle
Kuna
Morley

Project: SNOWIE17

Date: 4 Feb 2017

Flight: RF11

Notes:

Track 4. Deep clouds with embedded liquid water. CIP inoperative.

Flight Summary:

UTC Comment

2142 Wheels up.

Note, Licor not turned on during startup, started w/WCR. Cabin pressure sensor inop.

2154 Large rimed on 2D-P, 2D-S. LWC ~0.2+ g/m3.

2200 At 18 kft, nearing tops. Rimed w/LWC still.

2205 At tops, 21 kft, -25C. Just out of LWC at this altitude. Upper layer evident on WCR, 1.5-2 km above.

2208 At west end of leg, between cloud layers.

2218 At east end of leg, descending to 20 kft. -28C, still some liquid and smaller rimed.

2233 Descend 19 kft.

2238 At west end, turning east at 19 kft.

2249 Descend to 17 kft for next leg.

2253 Returning west. 17 kft, -22C.

2302 Descending to 16 kft.

2311 Returning east, descending to 14 kft.

2318 Passing N267CB (at 13 kft), will descend to 12 kft.

2324 Possible signature on WCR, small particles evident.

2327 Returning west. -11, broad CDP distribution, large aggregates.

~2332 Streamer evident on WCR?

2343 Ending leg just upwind of N267CB, returning E.

2346 Reflectivity increase and streamers, but still just upwind of seeding track.

2353 Melting layer evident in lower terrain, ~2 km below. At 12 kft, -11C.

Liquid decreasing towards eastern end of track compared to earlier legs - mainly aggregates evident.

2356 Turning west.

0002, 0009 Streamers evident in WCR, probably too late for signature?

0012 Turning east.

0025 Turning west.

0035 Long streamer evident on WCR.

0042 Turning east.

0056 Returning west for final pass.

0106 RTB

0127 Wheels down.

IOP 11 Flight Notes
Faber

2150: 2DS shows high ice concentrations for 12 – 1000 um particles. Temperatures around -11 C

2158: CDP shows LWC ~ .15 g m-3, wide distribution

2203: Increase in CDP LWC

2205: CDP LWC decrease to ~.05 g m-3. Temperature = -27 C. altitude = 21k

2218: descending to 20k. Entering LWC ~.15 - .2 g m-3

2225: 2DS shows spike in 200 – 300 um particles. Nevzorov and CDP show LWC ~.1 g m-3. CDP has wide distribution with MVD = 12 um.

2230: CDP shows high concentration of drops with MVD 8 um. Nevzorov LWC = .02 g m-3

2234: Descending to 19k. CDP distributions shifting to 14 um MVD & showing wide distributions

2237: CDP shows sudden shift to many small drops (MVD = 8 um). 2DS sees ice at 200 – 600 um.

2241: Out of liquid

2242: Back into liquid. CDP MVD = 14 um with wide distribution. CDP LWC = .1 g m-3.

2246: CDP shows sudden shift to small drops.

2254: Starting descent to 17k. 2DS shows particles at 500 – 1000 um. CDP has MVD 20 um.

2303: Descending to 16k

2314: Just descended to 14k. 2DS shows ice particles of increased diameter; ~10 sec-1 of 1000 um particles. Very little liquid.

2321: 2DS has a few needles and columns/capped columns.

2325: Back into a little liquid. Nevzorov LWC = .05 g m-3. 2DS has high concentrations of small particles.

2327: Brief period of decent liquid. CDP and Nevzorov LWC = .2 g m-3. Drops are larger (CDP MVD = 30 um).

2332: Sudden decrease in liquid/ice

2339: Small amounts of liquid. 2DS shows broad distribution; 100 – 1800 um. Large rimed particles, a few columns.

2348: 2DS shows a few more dendrites

2350: A few plate crystals on 2DS

2351: 2DS has very brief spike of well-defined distribution ~10 sec-1 at 500 um. Could be associated with seeding track.

2153: Elevated LWC, CDP LWC = .1 g m-3, for ~40 seconds. CDP shows wide distributions.

2155: 2DS shows another spike of 500 um particles at 80 sec-1.

2159: 2DS shows 20 seconds of well-defined distribution at 100 – 1200 um. A few columns. A Little liquid: Nevzorov LWC and CDP LWC = .03 g m-3

2202: Streak on WCR. 2DS concentrations at 100 – 1200 um around 80 sec-1.

2209: Sudden drop in 2DS concentrations

2210: 2DS spike in small particles (1000 sec-1) and 100 – 1200 um particles. Some larger droplets: Nevzorov LWC = .03 g m-3. CDP MVD 22 um.

2215: 2DS small particle concentrations at 1000 sec-1.

2217: Very brief spikes in liquid. Nevzorov shows pulses of .4 g m-3. CDP MVD = 20 um.

2223: Ground visible through cloud.

2224: 2DS counts up to 1000 sec-1. Associated with liquid: Nevzorov LWC = .2 g m-3. CDP MVD = 25 – 30 um distribution of up to 50 cc.

2229: 2DS counts back up to 1000 sec-1 at 100 um. More liquid: Nevzorov LWC = .25 g m-3. CDP LWC = .3 g m-3 with MVD = 20 um.

2235: 2DS small particles at 1000 sec-1 up to 100 um with a secondary distribution at 200 - 300 um at 80 sec-1. Some liquid: Nevzorov LWC = .05. CDP shows 30 um MVD at 20 CC.

2250: 20 sec spike of small particles on 2DS

2252: 2DS concentrations increase to 1000 sec-1 for particles less than 100 um. CDP shows wide distribution. Nevzorov LWC = .2 g m-3.

2254: 2DS shows increase in very small particles (less than 50 um)

2257: 2DS small particles increase counts: 1000 sec-1 for particles less than 100 um. Almost no counts for particles greater than 400 um.

2259: Small particle concentrations increase to 1500 sec-1 on 2DS. Still very few larger particles.

2300: Increase in larger particles on 2DS (90 sec-1 for 500 – 1400 um particles).

2301: 2DS shows 100 sec-1 at 300 um and 1000 sec-1 at 100 um.

2309: RTB

2310: 2DS shows concentrations of very small drops 1000 sec-1 for 30 um and smaller.

2/03/2017 SNOWIE Pilot notes (Research Flight 10)

Crew: Wadsworth, Bruintjes, Plummer, Faber

Flight Time: 2.2

Planned: Track 3 of the SNOWIE options. Start pattern at 16,000 MSL.

Actual:
Routing filed: RENOL BOI/320/030 BOI/009/060

Clearance received was "Cleared to Boise via the Boise 3 departure, radar vectors to the BOI 350/050 Donnelly BOI 009/060 then as-filed, climb via the SID, cntc departure on 126.9 " It is different every day. The past couple of flights did not remotely resemble what I file which was: RONOL BOI/320/030 BOI/009/060
Departure was off 10R. Asked Big Sky for direct to RENOL. Clarified the routing to the two points as filed & desired
Conditions were known to be changing. Expected a possible deep storm as the IR Satellite was showing cloud tops at about -50C. By the time we got out there, the deep system was collapsing and moving to the east.
Altitudes change a bit through the flight. Start at 16K, work down a bit, then when pick up some icing and the power comes up, we elevated. Eventually the power comes back. The amount of liquid water has decreased so the amount of icing on the aircraft remains low for the rest of the flight.
For this flight, during the brief, I tasked Roelof with summarizing what was above us and below us after each leg. When we get out there for the first leg, nobody knows for certain what we will encounter. Operating at an altitude which is very cold (-15C-18C) helps to ensure that there is little liquid water. After flying that first leg, having the person in the right seat basically summarize what is above and below us helps to frame the surrounding environment for me.
Today was pretty easy. The amount of icing was light as the amount of moisture was light. The entire system was moving to the ENE as we operated, thus it was drying-out pretty rapidly.
Overall: For future flights, during the brief I will task myself report the power changes, I will also task the Primary Investigator to summarize what he/ she believes to be above/below our altitude after each leg.

Good flight. But short due to drying conditions.

Project: SNOWIE17

Date: 3 Feb 2017

Flight: RF10

Notes:

Track 3. Another short flight, generally deep ice clouds with limited amounts of liquid water. Brief power loss during switchover on startup, recovered everything except for instrument computer so CIP was inoperative for the flight.

Flight Summary:

UTC Comment

1944 Wheels up.

~1949 Instruments generally good except for CIP.

1954 Deep clouds evident on WCR, to +4 km. At 16 kft, echoes to 2 km below. ~-17C with only brief liquid evident.

2017 Deep echoes on WCR, surface to +3-4 km above flight level. Turning and descending to 14 kft.

2028 At 15 kft, -16C, just above icing level.

2038 Returning northeast at 15 kft.

2050 Returning southwest at 13 kft.

2103 Returning northeast early, descending to 12 kft.

2113 Turning southwest and descending to 11 kft.

2124 Returning to Boise

2148 Wheels down.

1/31/17 SNOWIE Pilot notes (Research Flight 9)

Crew: Wadsworth, French, Plummer, Faber

Flight Time: 2.7

Planned: Track 4a of the SNOWIE options. Start pattern at 16,000 MSL.

Actual:
Routing filed: RENOL BOI/323/042 BOI/023/051

Clearance received was "Cleared to Boise via the Boise 3 departure, radar vectors to the BOI 350/050 Donnelly BOI 323/042 then as-filed, climb via the SID. " It is different every day.
Departure was off 10R. Asked Big Sky for direct to RENOL. Clarified the routing to the two points as filed & desired
Conditions were different today than previous flights. Temperature was fairly constant over a range of altitude from ~ 10K or 11K up to about 14K before it continued to cool again. Winds were higher than previous flights. Over 60 knots and increased to over 70 knots by 16K'. The seeding aircraft made one pass on their track then returned to Boise because the winds were too high. We continued to work the pattern for a bit after they left and tried to follow the seeded plumes downwind. This meant we would shorten the legs on the western end and "drift" our pattern towards the eastern end.
Winds were high enough that we had to start using a 90/270 turn on the west end. 270/90 swag turn on the east end remains adequate.
Icing was heavier this flight. On departure out of Boise, we picked up a very light dusting of ice. It caused the required power setting when we leveled at 16,000' to be 200 ft-lbs higher than normal clean cruise settings (thus 1800 ft-lbs per side). We were initially relatively clear of clouds and then climbed to 17,000' and the light ice we had on the aircraft polished-up and the power gradually came back to 1600 ft-lbs/side.
We changed altitude a bit. Block altitudes of 15B16, 15B17, eventually 16B18. While 267MB was seeding we remained at 17K. Power levels were higher this flight for awhile than most of the previous flights. Eventually when at 16K we got up to 2100 ft-lbs per side with props at 1600, so we climbed back to 17K and later 18K. There we were above the clouds and the power started slowly coming down again.
We left the track from about the midpoint of the leg, from over Packer John. Big Sky gave us a PD descent to 9K. As we were high, I started down immediately. In hindsight, it would probably been a better idea to remain above the stuff as we passed through some large amounts of liquid water while on the descent.
Lessons-learned every flight..

Project: SNOWIE17

Date: 31 Jan 2017

Flight: RF09

Notes:

Track 4. Short flight with primarily liquid cloud, limited direct microphysics measurements due to ice accumulations in cloud. Possible seeding signatures evident in airborne and DOW observations.

Flight Summary:

UTC Comment

1950 Wheels up.

2005 In light liquid, at 16kft, -11C.

2014 Sporadic clouds at flight level, mostly a light layer below. Torque back to 1600, shed some ice.

2017 Stronger echoes below, tops at flight level extending to ~3 km below. Attenuating at ~1km on lidar, matches stronger WCR echoes.

Beginning first leg on track 4.

2021 In cloud tops, near flight level to +300 m. At 1800 torque.

~2024 Climbed to 17 kft due to icing. -13C, ~0.3 g/m3 but fairly continuous LWC.

2028 Torque at 1900, at 17 kft with cloud to ~16 kft and thin layers above.

2031 At east end of leg, heading west 2033.

2037 Torque at 1850, at -12C. Currently ~0.05 g/m3 but lots of low-level ice accumulation.

2046 Torque at 1950, LWC over 0.2 g/m3 for a while. T ~-13.5C. Smooth ice, with boots not clearing completely.

2052 Much weaker echoes on WCR towards west end of track.

2054 In turn at west end, still -13.5C in clear air. Torque down to 1830.

2058 Turning back along leg.

2101 Enhanced echoes on WCR at ~1 km below. Streamers noted, 2102, 210325. Torque ~1775 towards west end.

2106 Turn east again.

2109 Elevated reflectivity at cloud top, potential seeding signatures ~1 kft below at ~211040. Descending to 16 kft.

2112 Turning west. Just hitting enhanced reflectivity/ice.

2118 Another potential seeding signature further below flight level.

2119 Turning east. Still some icing, torque at 2000.

2122 Climbing out to 17kft. Will stay out of cloud for now, had steady accumulation.

2123 LWC100 bad response after ice accumulation. Ascending to 18 kft for westbound leg.

2131 At -15C, generally above tops. Only shallow, weak echoes ~750 m above.

2137 Passing seeding signature on DOW scans?

2138 No more signs evident on WCR, turning back east. Back on leg 2141.

2144 Turn west, will continue to Packer John then return to Boise.

2201 RTB

2230 Wheels down.

1/22/17 SNOWIE Pilot notes (Research Flight 8)

Crew: Wadsworth, Bruintjes, Oolman, Majewski

Flight Time: 3.7

Planned: Track 3 of the SNOWIE options. Start pattern at 15,000 MSL.

Actual:
Routing filed: RENOL BOI/320/030 BOI/009/060

Clearance received was "Cleared to Boise as filed, climb via SID. "
They had parked us right in front of the FBO again today.
Departure was off 10R. Tower gave instructions of "right turn direct to RENOL". Asked Big Sky for direct to the BOI/320/030. They cleared us to DONNELY then to some fix off the Boise VOR which was not anywhere in the flight plan that was filed. Asked them to take a second look, passed them the fixes that we needed. They cleared us to the first fix (BOI 320/30), passed us off the SLC who cleared us to operate between the two desired fixes as desired. It is a mystery each time to them about what we are planning to do.
Icing varied significantly through the flight, and was not predictable. Initially it was light at 15K. Dropped down earlier than desired to 12K because the seeding aircraft (267CB) arrived at 13K, so we dropped to 12K. Shortly after there was significant SLD at the western end. On following laps down there, we elevated because of what was showing on radar and the expected moisture we would encounter.
After about 2 hours, the event started to dissipate across the entire regime. Bottoms of clouds were around 12,500 ish. 267CB departed the track and we took one more lap. We got the block from 12-14K and tracked NE at 12K which proved to be below clouds. For the SW-bound leg we climbed to 13K. Little icing as the event had pretty much dissipated.
On RTB, took vectors initially, but we picked up the field from ~15 miles out and took the visual.

Overall, good flight. Roloff was enjoyable to fly with.

SNOWIE17 RF08 – 22 Jan 2017

Brett Wadsworth, Roelof Bruintjes, Larry Oolman, Adam Majewski, Zane Little (LOD)

Brief, deep system. WCL only at 140 mJ

2056 Take off

2111 On track 3. FL150, T=-19, winds=30 kt from 220 true. Almost all ice.

2123 NE end of track, descend to FL140

2125 On track. Clouds extend to 2 km above

2139 Clouds above thinning. Descend to FL120

2140 In clear air between layers. StCu below.

2141 At SW end of line

2144 On track at FL120. T=-13, winds=36 kt from 230 true

2150 Turning back to SW, very little LW this time

2155 Some pristine plates and columns

2201 Pocket of 0.25 gm/m3 SLW

2205 At SW, more consistent SLW, 25-30 micron, 0.25 gm/m3

2211 Mostly out of SLW

2218 At NE end of track, some LW at this end (around 0.1 gm/m3)

2224 Out of SLW

2233 In and out of tops with SLW

2238 SW end of track

2243 Clouds above us nearly gone. Shallow clouds below, probably all liquid.

2250 Applanix lost solution, reset.

2252 At NE end of line. Smoother and less LW at this end of track this time.

2302 In drizzle briefly, then out of cloud

2303 Back in drizzle up to 300 micron.

2308 Climb to FL140 to get out of SLW

2310 Out of SLW

2312 At SW end of leg

2326 At NE end of leg, only briefly in cloud

2329 On track, T=-17, winds=37 kt from 230 true

2343 From WCR, cloud base is about 2000 feet below us

2346 SW end of line, descend to FL120

2349 FL120, T=-14, winds=42 kt from 240 true. At cloud base

2357 In orographic cloud near NE end of track

0000 End of line, climb to FL130

0005 In drizzle up to 100 micron

0007 Back out of orographic cloud. T=-15, wind=32 kt from 240 true

0020 Done with mission

0032 Land

1/21/17 SNOWIE Pilot notes (Research Flight 7)

Crew: Wadsworth, French, Oolman, Majewski

Flight Time: 3.8

Planned: Track 3 of the SNOWIE options. Start pattern at 13,000 MSL. At some point would take new track, 90 degrees off of the track 3. New points required and included in the table below. Programed into the FMS as SN3NW and SN3SE.

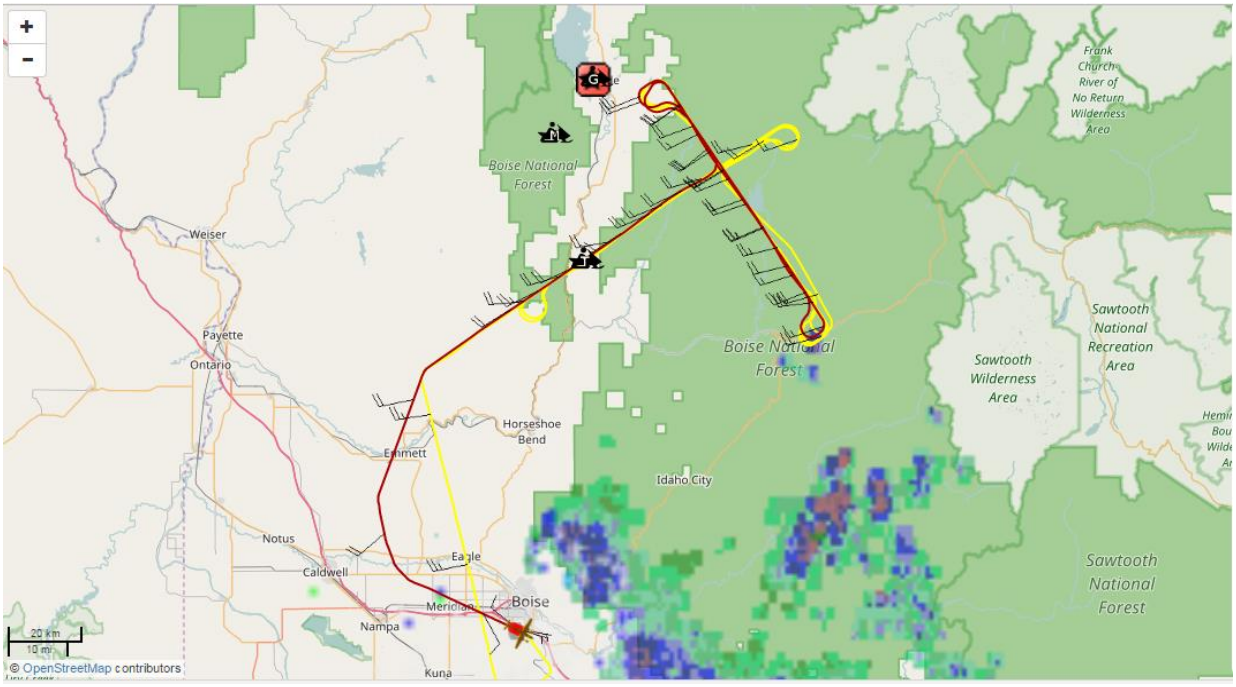
Track	W lat	W lon	BOI Rad/DME	FMS Name	E lat	E lon	BOI Rad/DME	FMS Name
2	43 53.82	116 24.9	322/23	SN2W	44 35.34	115 37.98	004/67	SN2E
3	44 00.6	116 28.08	320/30	SN3W	44 27.18	115 34.32	009/60	SN3E
	44 30.14	115 52.52	356/59	SN3NW	44 06.3	115 30.02	025/45	SN3SE
4a	44 12.42	116 31.8	323/42	SN4AW	44 12.42	115 25.8	023/51	SN4AE
4b	44 22.2	116 32.25	326/51	SN4BW	44 0.18	115 28.98	031/41	SN4BE
5	44 35.38	116 23.7	335/63	SN5W	44 0.42	115 29.388	031/41	SN5E
				Garmin Name				
Packer John Site	44 12	116 04	351/39	PJSN				
Snow Bank	44 25	116 09	345/52	SNBSN				

Actual:
Routing filed: RENOL BOI/320/030 BOI/009/060 BOI/025/045 BOI/356/059

Clearance received was as filed with the BOI 3..
They had parked us right in front of the FBO again today.
Departure was off 10R. Tower gave instructions of heading 130 on departure. Big Sky cleared us via own-navigation to RENOL. Turned early toward the next point after asking for it. We remained with Salt Lake Center for almost the entire flight. Coordination for the change in points was pretty easy with SLC. The first controller was again a bit nervous about our requested block of 11-14K, on the SW-NE leg, but after telling him we would turn early, he let us have the block.
Icing was relatively light on the SW-NE leg. When we got on the SE-NW leg, (positioned over an orographic feature that yielded significant moisture on previous flights, and known as “The Wet Spot”) we again found relatively high amounts of liquid moisture in the same area. We retained the block of 11K – 14K so we had options and used it to get above the relatively low-lying and moist clouds.

Eventually the clouds started to dry out through whatever medium and we were able to remain at the MIA of 11K' on the remainder of the flight.
As we approached the end of the flight, we coordinated with SLC to re-intercept the original Leg 3 to return to the SN3W point. Took vectors to final for the ILS. Picked-up the field by 10 miles out.

Overall, another good flight.



SNOWIE17 RF07 – 21 Jan 2017

Brett Wadsworth, Jeff French, Larry Oolman, Adam Majewski, Zane Little (LOD)

Weak case with ground generators. KPR removed for repair. WCL power low before flight. It read 160 mJ. Previously it measured 280 mJ. The laser spot appeared larger and more diffuse.

2205 Take off

2214 At cloud top, FL130

2215 T=-18, winds 27 kt from 255 true

2217 Mostly clear below us.

2222 On line 3 at FL130.

2233 We are mostly above the clouds with brief only brief time in clouds. Drops were about 20 microns. LWC=0.1 gm/m3.

2234 East end of line, descend to FL120

2238 In cloud, cdp showing mean size of 35 micron. 2DS had drops up to 200 micron. LWC=0.55

2247 At west end. Missed starting WCR recording until now.

2257 At east end

2300 Starting leg, FL120 T=-16 winds 25 kt from 250 true

2309 LWC100 offline

2310 Done with leg. More cloud at our altitude this time on line. Drizzle drops up to 300 microns. Climb to FL130

2321 East end of track, entirely above cloud.

2324 Heading to SE point of cross wind track

2330 At SE point, descend to FL120

2335 LWC to 0.6, drops up to 80 micron. Needing to increase power, climb to FL130. Went from 1600 ft-lbs to 2100 ft-lbs in 3 minutes

2341 NW end of line

2352 SE end of line, saw reflectivity on WCR to 15 dBZ.

2359 Higher reflectivity on WCR, dip to FL120. Missed band of high reflectivity seen on previous leg, it may have collapsed. Climb back to FL125.

0008 Descend to FL120, try to get to cloud tops.

0010 Descend to FL115 to try to get into plume

0013 Mixed phase clouds

0014 Can see ground below us, end of leg

0018 Descend from FL115 to FL110

0019 Cloud mostly glaciated

0025 NW end of line.

0033 +15 reflectivity near ground. Most liquid at our altitude (FL110)

0036 At SE end of line

0048 NW end of line

0050 Almost constant 25 micron, narrow spectrum, on CDP, 30-40 /cm3, 0.2 gm/m3

0059 SE end of line

0108 West part of line mixed phase, less LW than last time.

0110 At end of line

0115 Turn SW onto track 3.

0118 Cloud becoming deep (4 km above us)

0128 Done with research.

0142 Land

1/19/17 SNOWIE Pilot notes (Research Flight 6)

Crew: Wadsworth, French, Oolman, Majewski

Flight Time: 3.7

Planned: Track 2 of the SNOWIE options. Start pattern at 15,000 MSL. PI wanted to start the pattern 20 nm SW of the SW point and then just repeat between the standard 2 points of pattern 2.

Track	W lat	W lon	BOI Rad/DME	FMS Name	E lat	E lon	BOI Rad/DME	FMS Name
2	43 53.82	116 24.9	322/23	SN2W	44 35.34	115 37.98	004/67	SN2E
3	44 00.6	116 28.08	320/30	SN3W	44 27.18	115 34.32	009/60	SN3E
4a	44 12.42	116 31.8	323/42	SN4AW	44 12.42	115 25.8	023/51	SN4AE
4b	44 22.2	116 32.25	326/51	SN4BW	44 0.18	115 28.98	031/41	SN4BE
5	44 35.38	116 23.7	335/63	SN5W	44 0.42	115 29.388	031/41	SN5E
				Garmin Name				
Packer John Site	44 12	116 04	351/39	PJSN				
Snow Bank	44 25	116 09	345/52	SNBSN				

Actual:
Filed: RENOL BOI/268/024 BOI/322/023 BOI/004/067
Clearance received was as filed with the BOI 3 departure.
They had parked us right in front of the FBO again today.
Departure was off 10R. Big Sky cleared us via own-navigation to RENOL. Turned early toward the next point.. We remained with Salt Lake Center for most of the flight. Except for the fourth lap. We had worked down to 11,000' MSL for the eastbound leg. The seeding aircraft was on-track at 13,000', and we were picking up some ice so when we reached the NE point, we climbed to 14,000'. When we reached the SW point and asked to descend down to 11,000, SLC handed us off to Big Sky Approach. They were clueless about what we were doing. Good thing we were only working between two different points. Similar criticism to some degree about SLC. They are not fully briefing the next controller at shift change about what we are doing. Becomes most significant at the east or northeast point of our tracks. These points are close to somewhat higher MIA's. Some of the controllers get nervous about it, and have us turn a little early. Others are pretty relaxed.
Relatively light icing throughout the flight. I had re-applied ICEX prior to flight but the icing conditions were fairly localized and did not spread across the entire track. 11,000 was quite sustainable overall.

Overall, good flight.


BOI
50 km
20 mi
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Weather: 18-Jan-2017 09:35PM UTC

SNOWIE17 RF06 – 19 Jan 2017 B

Brett Wadsworth, Jeff French, Larry Oolman, Adam Majewski, Zane Little (LOD)

Second mission of day. Clouds should be building back in. Fly flight track 2.

2229 Take off, running up modes on KPR and WCR

2244 Start first line from extended point. FL140. T=-18, DP=-21, winds 21 kt from 265 true. Clear to ground.

2305 At end point. Descending to FL120

2308 Heading to SW at FL120. T=-14, winds 17 kt from 240 true. Some StCu extending above our level, most below.

2325 At SW end of line, from WCL cloud tops around 8000 ft msl. Descend to FL110

2328 On track, T=12, wind=20 kt from 260 true

2332 Starting to hit LW 20-30 microns about 0.2 gm/m3

2343 NE end of line, climb to FL120

0002 At SW end of line. Was in and out of cloud tops on this line. Descend to FL110.

0014 In drizzle

0019 At NE end of leg, climb to FL140

0023 On track, above cloud. T=-18, winds=15 kt from 260 true

0025 Through some cloud tops

0031 AV appears to have rebooted. May have bumped reset button when checking N2.

0039 Turning back to NE, descend to FL110.

0050 Back in large drop region. Seeing 200 micron drizzle on 2D-S

0056 Starting climb to FL140

0057 At end of leg, above cloud

0116 Descending to FL110

0117 In turn, saw some LW at the usual upslope area. Less than previously.

0136 Turning to SW.

0146 2D-S crashed

0150 Done with mission, heading back to Boise.

0204 Land

1/19/17 SNOWIE Pilot notes (Research Flight 5)

Crew: Wadsworth, French, Oolman, Majewski

Flight Time: 3.1

Planned: Track 2 of the SNOWIE options. Start pattern at 15,000 MSL. PI wanted to start the pattern 20 nm SW of the SW point and then just repeat between the standard 2 points of pattern 2.

Track	W lat	W lon	BOI Rad/DME	FMS Name	E lat	E lon	BOI Rad/DME	FMS Name
2	43 53.82	116 24.9	322/23	SN2W	44 35.34	115 37.98	004/67	SN2E
3	44 00.6	116 28.08	320/30	SN3W	44 27.18	115 34.32	009/60	SN3E
4a	44 12.42	116 31.8	323/42	SN4AW	44 12.42	115 25.8	023/51	SN4AE
4b	44 22.2	116 32.25	326/51	SN4BW	44 0.18	115 28.98	031/41	SN4BE
5	44 35.38	116 23.7	335/63	SN5W	44 0.42	115 29.388	031/41	SN5E
				Garmin Name				
Packer John Site	44 12	116 04	351/39	PJSN				
Snow Bank	44 25	116 09	345/52	SNBSN				

Actual:
Filed: RENOL BOI/268/024 BOI/322/023 BOI/004/067
Clearance received was as filed with the BOI 3 departure.
They had parked us right in front of the FBO again today.
Departure was off 10R. Big Sky cleared us via own-navigation to RENOL. Turned early toward the next point.. We remained with Salt Lake Center for most of the flight.
We started at 15K. Then asked for the block of 14-15K. Worked lower through the flight. Little icing today. Weather remained consistent with the TAF at KBOI and was VMC at the field throughout the day.
Recovery was via the visual to 10R.
During flight, we received chat from Bart that conditions were now looking likely for a flight later in the day.
Nothing else of great significance.


BOI
50 km
20 mi
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Weather: 18-Jan-2017 09:35PM UTC

SNOWIE17 RF05 – 19 Jan 2017

Brett Wadsworth, Jeff French, Larry Oolman, Adam Majewski, Zane Little (LOD)

Postfrontal system with two layers. Early in the flight, the upper layer may have seeded the lower.

1528 Take off

1536 4 degree difference between TRF and TROSE. In climb through FL130.

1538 At FL150, descend to FL140. Start line 2

1542 Cloud top 1 to 1.5 km below with a few tops at our altitude.

1544 Crossed normal SW point.

1547 TRF and TROSE now agree. TROSE wet?

1548 Enter cloud

1553 From WCL, looks like liquid 2000 ft below us.

1600 At NE end of line.

1602 Heading to SW, T=-15, winds 23 kt from 200 deg true

1612 Briefly in 30 micron drops

1620 At SW end of line. Switch KPR to 75 m.

1625 In 20 micron drops, 0.1 g/m3, LWC 100 lower

1636 LWC base line back to -0.25 g/m3 after spike

1637 At NE end of line, descend to FL120

1641 T=-11, winds=21 kt from 220 deg true

1643 35 micron drops to 0.2 gm/m3, Conc=10/cm3

1652 In clear air

1653 At end of line

1656 On line at FL120, cloud tops 2000 ft below us.

1703 CDP MVD=35 micron, LWC=0.25, CONC=8

1705 Out of liquid, into ice

1707 NE end of track, climb to FL130

1709 On track, T=-13, winds 27 kt from 210 true

1716 Out of cloud, swapped out N2 tanks

1723 Turning at SW end of track. Drop to FL120

1731 Starting to enter cloud.

1750 At SW end of line

1801 NE end of leg. Very few pockets of LW. Aircraft was mostly above the lower layer.

1821 Done with mission.

1831 Land

1/18/17 SNOWIE Pilot notes (Research Flight 4)

Crew: Wadsworth, Geertz, Oolman, Majewski

Flight Time: 3.4

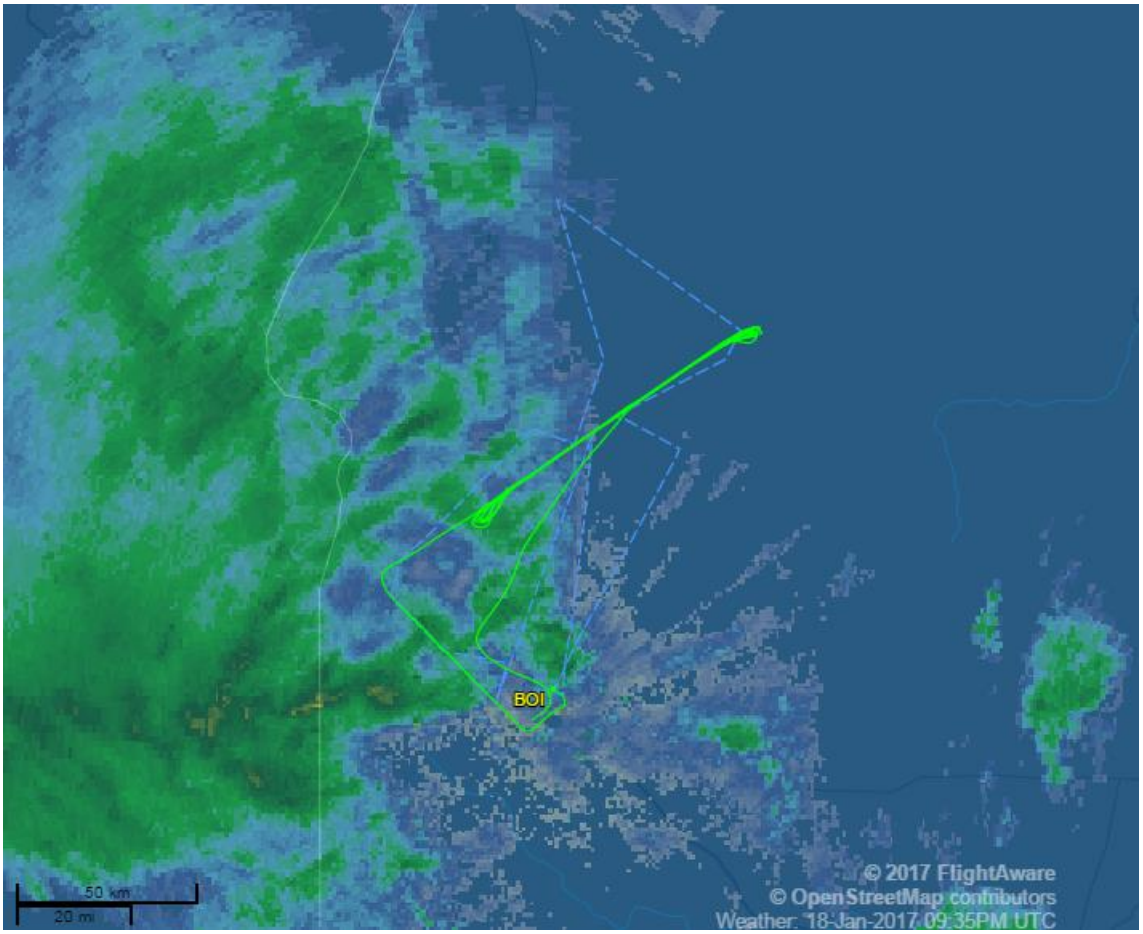
Planned: Track 3 of the SNOWIE options. Start pattern at 16,000 MSL. PI wanted to start the pattern 20 nm SW of the SW point and then just repeat between the standard 2 points of pattern 3.

Track	W lat	W lon	BOI Rad/DME	FMS Name	E lat	E lon	BOI Rad/DME	FMS Name
2	43 53.82	116 24.9	322/23	SN2W	44 35.34	115 37.98	004/67	SN2E
3	44 00.6	116 28.08	320/30	SN3W	44 27.18	115 34.32	009/60	SN3E
4a	44 12.42	116 31.8	323/42	SN4AW	44 12.42	115 25.8	023/51	SN4AE
4b	44 22.2	116 32.25	326/51	SN4BW	44 0.18	115 28.98	031/41	SN4BE
5	44 35.38	116 23.7	335/63	SN5W	44 0.42	115 29.388	031/41	SN5E
				Garmin Name				
Packer John Site	44 12	116 04	351/39	PJSN				
Snow Bank	44 25	116 09	345/52	SNBSN				

Actual:
Filed: RENOL BOI/285/033 BOI/320/030 BOI/009/060
Clearance received was as filed with the BOI 3 departure.
Startup went better, although I'd asked for the main gear to get some nitrogen servicing. It took 1.5 hours after the request to finally get them out on the ramp to service the tires. Zane had the data-system up & running on the battery cart by this point.
They had parked us right in front of the FBO today. Much appreciated. Some light snow while we were prepping for the flight, but it was melting on the wings and not re-freezing..
Departure was off 10R. Big Sky cleared us via own-navigation to RENOL. Turned early toward the next point and were essentially cleared to operate as desired after pimping Big Sky for it.. We remained with Big Sky for the entire flight. This is good & bad. You cannot talk to Big Sky for the eastern half of most of our legs that we have flown thus far. If 267 CB is up there, you can relay all requests through them, but if they aren't airborne, having a block of airspace gives some options.. When they depart the track, ask for a larger altitude block so that you can elevate as necessary to get out of the super-cooled moisture pocket that you may be in or to descend to satisfy the science objectives.
We started at 16K. Gradually worked down a bit to the block 14k-15K. We knew that WMI would be coming out at 14K. Our altitudes changed a lot during this flight. Initially working down, then working up to an altitude of 17,000' towards the end of the flight. After 267 MB departed the track towards the end, we got the block of 14,000'-17,000'. We used this for the eastbound leg, then westbound. While heading west (actually southwest) ATIS indicated that the weather had dropped below anything that had been previously forecast. D-ATIS was reporting ½ visibility. We asked to return to Boise through Big Sky as 267 MB was already off their track. Big Sky gave us a heading of about 215. Vectors to intercept the ILS to 10R. Reported weather went down to ¼ mile visibility while we were on the RTB. Actual conditions when we broke out were that we acquired the landing lights at about 500' AGL, around ¾ of a mile.
The weather at Boise had been forecast to not go below a mile of visibility throughout our time of flight. So much for the TAF out here.
In hindsight, we could have flown the track all the way to the SW end, and not impacted the fuel remaining much since we were on a SW-NE track. But with the significant change in the weather at

Boise, I wanted to head there immediately once it went to ½ mile of visibility AND it was significantly worse than the forecast.

Image of the flight track follows:



SNOWIE17 RF04 – 18 Jan 2017

Brett Wadsworth, Bart Geerts, Larry Oolman, Adam Majewski, Zane Little (LOD)

Transition from shallow to deep system.

2000 Take off

2009 Cloud top FL156

2010 In and out of cloud to south of track at FL160. T=-11.

2015 Switched KPR to 75 m.

2020 On track 3, just above cloud top. At FL160, T=-12 C. WCL suggests there are large drops or low concentration at cloud top

2024 Higher cloud gone. Cloud top now 2000 ft below. Looks higher ahead of us.

2030 In ice cloud.

2031 At NE end of track, reversing course.

2033 Completed turn, drop to FL150, T=-9

2042 In cloud. It may have moved 10 miles further east since our last leg. Small drops, MVD mostly less than 15 microns.

2050 At SW end of line, T=-10, winds 35 kt at 215 deg T. Descend to FL140 in turn.

2052 At the beginning of track. LWC up to 0.5 g/m3, D=25 micron

2100 LWC up to 0.4 g/m3, D=26 microns

2103 At 2100 lbs torque. Climbing to FL150

2104 At end of line

2107 On 2DS, drops up to 100 micron

2109 FL150, heading SW. Torque: 2100. Seeing aircraft at FL140

2111 Mostly out of cloud

2121 Approaching east end of line, in clear air.

2125 In turn, switch KPR to 30 m.

2132 Ice particles on OAP probes, WCR and KPR seeing clouds up to 2 km above.

2138 NE end of line, drop to FL140

2155 Lost LWC100, PVM may be gone, wild oscillations

2156 At SW end of line, climb to FL150. Out of liquid water. WCR seeing echoes up to 5 km above. KPR up to 2 km.

2208 CDP sizes 25-30 micron. LWC = 0.25. 60-70 micron drops on 2D-S. LWC-100 back

2211 Climb to FL170, seeding aircraft at FL160

2213 Out of LW cloud.

2215 At FL170, T=-14, Winds=41 kt at 215 deg true. On WCL, liquid about 1000 ft below us. WCR echoes 4 km above.

2231 SW end of line. Still at FL170. Hydrometeors appear to be all ice. T=-13.

2239 Descend to FL160, Seeding aircraft is done.

2242 Some turbulence. Descending to FL150.

2243 At NE end, descend to FL140

2251 Boise visibility down to ½ mile. Ending mission.

2313 Land

1/10/17 SNOWIE Pilot notes (Research Flight 3)

Crew: Wadsworth, French, Oolman, Majewski

Flight Time: 3.7

Planned: Track 4a of the SNOWIE options. Start pattern at 14,000 MSL. PI wanted to start the pattern 25 nm west of the west point and then just repeat between the standard 2 points of pattern 4a.

Track	W lat	W lon	BOI Rad/DME	FMS Name	E lat	E lon	BOI Rad/DME	FMS Name
2	43 53.82	116 24.9	322/23	SN2W	44 35.34	115 37.98	004/67	SN2E
3	44 00.6	116 28.08	320/30	SN3W	44 27.18	115 34.32	009/60	SN3E
4a	44 12.42	116 31.8	323/42	SN4AW	44 12.42	115 25.8	023/51	SN4AE
4b	44 22.2	116 32.25	326/51	SN4BW	44 0.18	115 28.98	031/41	SN4BE
5	44 35.38	116 23.7	335/63	SN5W	44 0.42	115 29.388	031/41	SN5E
				Garmin Name				
Packer John Site	44 12	116 04	351/39	PJSN				
Snow Bank	44 25	116 09	345/52	SNBSN				

Actual:
Filed: RENOL BOI/300/056 BOI/323/042 BOI/023/051
Clearance received was as filed with the BOI 3 departure.
They had parked us in a big mess of slush. GPU did not run. Started engines and Larry brought the system up. Only wasted about 60 lbs of fuel..
Departure was off 10R. Big Sky cleared us via own navigation to RENOL. Turned early toward the BOI/300/056 and were essentially cleared to operate as desired. We remained with SLC for the entire track.
Started at 14K. WMI aircraft flew at 13K. After the first lap around the track, we got the block of 11-12K. Icing tonight was generally heavier than previous flights. Typical power setting without ice was ~ 1600 ft-lbs/side. Eventually with icing we approached 1900 ft-lbs/side.
At 11-12K', we had to shorten the eastbound leg by about 10 nm to satisfy SLC.
WMI departed the pattern about 45 minutes before we were done, so we asked for the block 12-14K. We remained at 12K for the remainder of the flight.
Weather at Boise remained VFR throughout the flight. Took vectors to final for the ILS 10R, but we had the field early. Little traffic this late at night.

SNOWIE17 RF03 – 11 Jan 2017

Brett Wadsworth, Jeff French, Larry Oolman, Adam Majewski, Zane Little (LOD)

Deep system. The GPU that we checked the voltage on would not stay running. Started the data system on engine power.

0213 Take off

0236 2D-S optics contaminated. At FL140

0247 Start eastbound line further west of initial point on track 4 at FL140. T=-15C DP=-21 C, Winds= 54 kts @ 270 true.

0252 At western end of normal track.

0253 Between two layers. Surface layer extends to about 1.5 km AGL. Upper layer is 1.5 to 3.5 km above us.

0255 In cloud

0259 In a little LW. 0.2 gm/m3, 20 micron

0303 At east end of leg

0321 From lidar, could be some interesting cells approaching our altitude

0324 Turning early on west end of line. Not much going on at our altitude.

0332 Descend to block FL110 to FL120, need to turn our line 5 miles further west (BOI 022 deg 045 nmi)

0334 Turning to the west, moon dimly visible

0337 Westbound at FL120. T=-11, DP=-12, wind 43 kt at 275 deg

0340 LWC=0.25 g/m3, DBar=27 micron, conc=30 /cm3

0346 Out of cloud

0352 Turning to east

0355 Descend to FL115

0433 Lidar display not updating. Restart recording, then restarted acquisition.

0455 Swapped nitrogen tanks.

0458 On west end of line.

0506 In cloud

0513 On east end of line

0528 Head back to base

0547 Land

1/8/17 SNOWIE Pilot notes (Research Flight 2)

Crew: Wadsworth, French, Oolman, Majewski

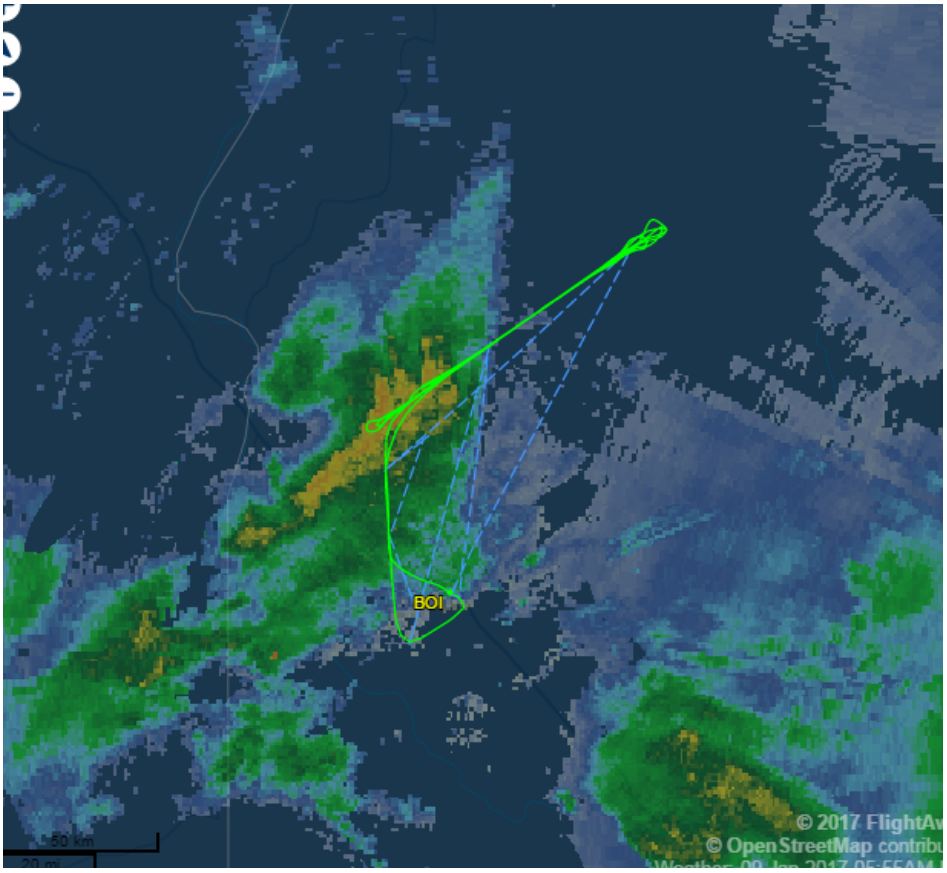
Flight Time: 3.4

Planned: Track 3 of the SNOWIE options. Start pattern at 16,000 MSL. Patterns are:

Track	W lat	W lon	BOI Rad/DME	FMS Name	E lat	E lon	BOI Rad/DME	FMS Name
2	43 53.82	116 24.9	322/23	SN2W	44 35.34	115 37.98	004/67	SN2E
3	44 00.6	116 28.08	320/30	SN3W	44 27.18	115 34.32	009/60	SN3E
4a	44 12.42	116 31.8	323/42	SN4AW	44 12.42	115 25.8	023/51	SN4AE
4b	44 22.2	116 32.25	326/51	SN4BW	44 0.18	115 28.98	031/41	SN4BE
5	44 35.38	116 23.7	335/63	SN5W	44 0.42	115 29.388	031/41	SN5E
				Garmin Name				
Packer John Site	44 12	116 04	351/39	PJSN				
Snow Bank	44 25	116 09	345/52	SNBSN				

Actual:
Filed: RENOL BOI/320/030 BOI/009/060
Clearance received was: KBOI BOI3 BOI/350/050. Queried CD about it as it was not what was filed. They "checked" and came back with the route that had been filed.
Taxi was via Juliet to runway 10R.Ramps were extremely slippery with rain falling on packed snow & ice. Brakes of little help.
Departure was off 10R. Big Sky cleared us via own navigation to RENOL. Turned to the SW point of track 3 just prior to reaching RENOL. Big Sky handed us off to Salt Lake. We were essentially cleared to operate as we needed. After reaching the NE end of the track and returning back toward the SW point, SLC handed us back to Big Sky, who kept us for the rest of the night. All requests for altitude changes took a little bit of time as Big Sky would have to coordinate with SLC, but it worked pretty well. Could not talk to Big Sky on the eastern half of the track below 16,000' MSL. The WMI aircraft relayed requests from us when necessary. After they departed the track we asked for a block to allow us to climb up if required.
We gradually worked down over the course of the evening, utilizing blocks of 1000-2000'. The first leg had significantly more turbulence then later legs but all night long the icing was light. The cloud tops fell during the course of the flight with little liquid water. Did not even cycled the boots during the flight until just prior to landing.
Weather at Boise remained VFR throughout the flight as well as the alternate. Took vectors for the ILS 10R, but had the field way early.
Overall: After indications and brief indicated that tonight was going to be much "juicier" than the first flight, it was exactly the opposite. So much for weather forecasters.

Graphic:


BOI
50 km
© 2017 FlightAv
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SNOWIE17 RF02 – 9 Jan 2017

Brett Wadsworth, Jeff French, Larry Oolman, Adam Majewski, Zane Little (LOD)

Deep atmospheric river. KT over water covered ice measures +0.5 C.

0416 Take off

0428 FL160

0430 Licor flow meter/controls turned on.

0442 LWC100 baseline around -0.20

0443 Mixed phase clouds, bumpier than last night.

0446 Reversing to SW at FL160. Lidar show sharp attenuation 300 meters below us. T=-14, DP=-19, Winds 60 kts @ 240 true. Turbulence suddenly much smoother at NE end of line.

0450 Done with turn, almost immediately bumpier.

0506 At SW end of track.

0512 Starting to hit light turbulence

0514 Descending to FL150

0517 NE end of line. LWC < 0.3, Dbar < 20 microns

0538 SW end of line. Descending to FL140.

0550 NE end of line, descend to FL130. Little LW on previous line.

0554 On track. T=-9, DP=-10, Winds are 53 kt @ 240 true.

0558 2D-P gone

0605 WCR still seeing echos up to 6 km but a dry layer between 3 and 4 km. KPR seeing melting level 2 km below.

0614 At SW end, almost no water

0618 Dry layer now 1.5 to 4.5 km above us.

0628 Turning.

0634 Dropping to FL120

0637 T=-8, DP=-11, wind=45 kt at 250 true

0647 Clouds thinning , 2D-P back

0650 At SE end of line

0654 No echos above 3 km on wcr

0705 NE end of line, light chop

0726 Done with research

0739 Land

1/7/17 SNOWIE Pilot notes (Research Flight 1)

Crew: Wadsworth, French, Oolman, Majewski

Flight Time: 3.7

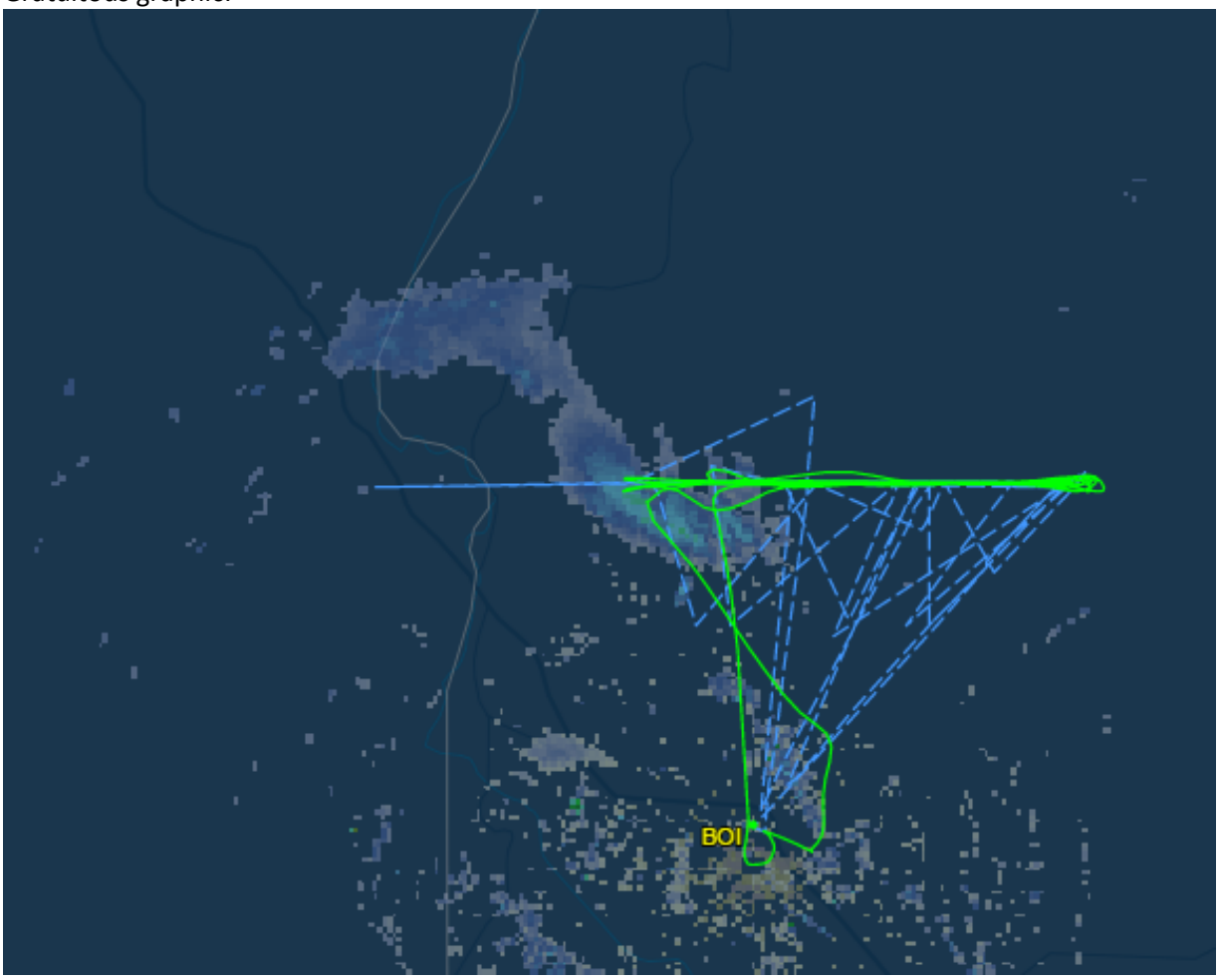
Planned: Track 4a of the SNOWIE options. Start pattern at 16,000 MSL.. SNOWIE patterns as follows:

Track	W lat	W lon	BOI Rad/DME	FMS Name	E lat	E lon	BOI Rad/DME	FMS Name
2	43 53.82	116 24.9	322/23	SN2W	44 35.34	115 37.98	004/67	SN2E
3	44 00.6	116 28.08	320/30	SN3W	44 27.18	115 34.32	009/60	SN3E
4a	44 12.42	116 31.8	323/42	SN4AW	44 12.42	115 25.8	023/51	SN4AE
4b	44 22.2	116 32.25	326/51	SN4BW	44 0.18	115 28.98	031/41	SN4BE
5	44 35.38	116 23.7	335/63	SN5W	44 0.42	115 29.388	031/41	SN5E
				Garmin Name				
Packer John Site	44 12	116 04	351/39	PJSN				
Snow Bank	44 25	116 09	345/52	SNBSN				

Actual:
Filed: BOI 323/042 BOI/023/051 for the track 4a waypoints then back to KBOI. KTWF as an alternate.
Pulling the plane out of the hangar brought back memories of OWLES – Lots of people pushing on the hangar door to get it open, later using the tug to push it.
Clearance received was: KBOI BOI3 Radar Vectors DEETZ ODYSY.
Taxi was via Kilo, Foxtrot, Juliet to runway 10R. Quick & easy except for the humongous snow piles and unplowed taxiways.
Departure was off 10R. Big Sky cleared us to DEETZ after reaching 7,000. Handed off to Salt Lake on the way to DEETZ. SLC was aware of what we were doing, and asked us which of the filed points that we wanted to start at. Told them the west point (BOI 323/42) and we were cleared to it.
Verified that we were cleared to work between the two filed points as desired, which was verified. Too easy.
Climbed to 16,000'. Reached the western point and started the track. Asked for a block altitude of 14-16K'. We were above the clouds, so of course, the PI wanted to get down into them. Silly idea, but we did. Turns out that the tops of the clouds elevate as you approach the east end of the track. So, we descended down to 15,000', got into some large particles of moisture along with higher moisture densities. Picked up some icing pretty quickly, so we bailed-out and climbed back to 16,000.
The WMI aircraft arrived out on their track somewhere around here. They started at 14,000'. We adjusted our block to 15-16K.
A complete lap around the track took about 30 minutes. We changed altitudes a number of times from 16K, to 15K, to 16K to 15K to 13K then 15K then a last attempt down to 14K. We spent about 25% of our time on-track in-cloud. The rest was above cloud with the exception of the eastern-most end of the track which put us into cloud every time and put some ice on the aircraft.
RTB: The WMI aircraft (N267MB) has less time-on-station than N2UW, so they departed the track about 20 or 30 minutes before us. We left the track after about 3:16 of flight time.
Weather at KBOI had become much better than the forecast had projected earlier in the day. METAR was VFR with winds 290/7, 9nm, 4.3 SCT, 6.0 OVC.
SLC turned us direct to KBOI when we told them we were done. Handed off to Big Sky to cleared us from 15,000' pilot discretion to 9,000'. Brought us over the field and vectored us in parallel to an Airbus that was landing on 28R for our landing on 28L.

Taxi back was the reverse of our taxi out. J to F to K. Plows were working unlike when we taxied out. Unfortunately, the FBO did not plow right in front of the hangar. Huge PITA to get N2UW back into the hangar. Western needs to do better.

Overall: we only spent about 25% of our flight time in icing conditions, but it still put a fair amount of ice on the aircraft. There were areas of large droplets and high moisture density. Overall, it produced less ice on N2UW than we picked-up in projects out of Laramie over the SNOWIES.
Gratuitous graphic:



SNOWIE17 RF01 – 8 Jan 2017

Brett Wadsworth, Jeff French, Larry Oolman, Adam Majewski, Zane Little (LOD)

First research flight. Cold system with considerable snow in Boise.

0223 Take off

0233 At FL160

0241 Descend to FL150

0245 On line, FL150

0257 0.4 gram/m3 of 35 micron drops on the CDP at the east end of line. Concentration mostly below 25/cm3, climb to FL160

0316 West of line

0328 East of line, descend to FL150

0350 Descend to FL130 on west end of track prior to turning east. There was not much LWC on the previous leg

0353 In cloud 0.2-05 gm/m3 20-25 micron.

0356 Out of cloud

0401 30 micron drops, 0.4 gm/m3, climb to FL150

0405 At east end of line

0429 At the west end of line at FL150.

0441 Into 30 micron drops 0.2 gm/m3

0443 West end of line

0450 Out of cloud

0507 East end of line

0514 Descend to FL140

0521 East end of line, climb back to FL150

0529 Drop from FL140 to FL130, 45 micron drops to 0.5 gm/m3.

0531 Back to FL140

0540 Done with mission, head to Boise.

0557 Land

Project: SNOWIE17

Date: 03 Jan 2017

Flight: TF04

Notes:

Short test flight just to make sure all systems are working. Instruments appeared to perform well, sampling thin ice and mixed-phase cloud, with the following exceptions: No camera images were saved to disk. Data forwarding to ground stopped midway through flight, restarting transfer program did not solve issue but led to issues with instruments ingesting data feed (e.g. 2DS TAS static at 95 m/s late in the flight).

Flight Summary:

UTC Comment

2015 Wheels up

2025 In clear air at -20C/14 kft, instruments appear to be working well.

2026 Starting penetration of thin clouds.

2027 Passing over hotplate site. Mixed phase regions at cloud top, still ~-20C.

Maneuvering to stay in cloud as much as possible, 14 kft near top of lower layer with thin layer well above. No deeper clouds visually evident.

2032 Liquid at cloud tops, -21C.

2036 More liquid, ~-22C.

2041 Shutting radar/lidar/Nevzorov down, proceeding to KLAR for instrument approach.

2100 Wheels down.

12/20/16 SNOWIE17 Pilot notes (Test Flight 3)

Crew: Drew, Wu, Plummer, Deng

Flight Time: 2.1

Objective: Complete Lidar alignment and then check signal at different altitudes.

Planned: Climb to 20,000 ft. to complete the alignment. Then complete several 10 min. legs at 20,000 and 17,000 ft. MSL. Finally if possible, find clouds to penetrate.

Actual: Departed Laramie to the northwest and climbed to 20,000 ft. MSL. Worked NW-SE (in valley). Made a couple of passes for alignment, then another to check the signal. Descended slowly to 17,000 ft. and made another pass. Decided to climb to 24,000 and complete another leg. Then completed a slow descent from 24,000 ft. MSL to 10,000 ft. MSL. Then returned to Laramie.

Project: SNOWIE17

Date: 20 Dec 2016

Flight: TF03

Notes:

Plan is to look for deep enough clear air to do lidar alignment and depolarization check, and just collect some KPR & WCR data to test out the new disk drives.

Instruments generally functioned well (though the flight was entirely in more or less clear air), with the exception of the AV computer being problematic on startup again, and the PADS software (CIP) disconnecting shortly before landing.

Flight Summary:

UTC Comment

1712 Wheels up

1725 Note, noisy CIP returns - not in cloud yet to get good probe response.

1726 Very weak cloud above on WCR, barely any signature at 75-m config on KPR.

At 20 kft for lidar work, ~-20C.

1737 Turn for 10 minute leg @ 20 kft.

1738 AV computer back up, reseated data disk. Camera now recording.

WCR echoes still ~2-3.5 km above, not much on KPR.

1743 1st alignment section done @ 20 kft.

1754 Starting slow descent to 17 kft.

1804 At 17 kft, ~-12C. WCR echoes ~4 km above now.

1812 Turn for climb to 24 kft. A couple thin layers above on WCR, still very weak.

1824 Nearing -30C @ 24 kft.

1831 Starting slow descent - better WCR above but still nothing notable on KPR.

1835 Turn, continue descent.

1840 Turn, continue descent.

1856 KPR to up beam, WCR idle - plan was to keep descending, but we obtained enough lidar measurements at this point.

~1906 VNC to PADS disappeared while prepping for landing. Had stopped recording when I reconnected, just left it idle for the last couple minutes of the flight.

1909 Wheels down.

12/14/16 SNOWIE TF02

Crew: Sigel, Faber, Plummer and Wu

Flight Time: 1.7

Objectives: Larry Oolman

We will be looking for both clear air and clouds.

Clear air

Check lidar alignment

Check background depolarization. The window appears to cause some polarization of the laser that is temperature dependent. We would like to fly 10 minutes at 10,000 ft, climb to 23,000 (of below cloud or particles falling from clouds) and fly 10 minutes, then descend to 15,000 feet for another 10 minute leg.

Cloud passes. Ideally we would like water clouds, ice clouds, and mixed. Fly east/west legs over the Medicine Bows. If possible, continue west until clear of any up wind clouds, as the cloud edge probably has the most liquid water. If there are wave clouds at a reasonable altitude, fly a couple passes through.

Actual: We departed Laramie to the northeast at 15,000 to HOCXU intersection which is 47 miles north of CYS. Before reaching HOCXU we asked for a 30 mile extension on the same heading to see if we could find clear air. About 10 miles past HOCXU we ask for an altitude change to 21,000. As we climbed up I was asked to turn around and head back through the same airspace we had just come through and proceed back to HOCXU. Crossing HOCXU we asked for 14,000 and to head from PP to OPPEE intersection which is about 5 miles north of the Hot Plate. We asked for a 30nm radius around OPPEE and within 30nm of OPPEE we proceed to the hot plate. We crossed HP at 14,000 Flew out 15 miles and climbed to 15,000 on the return leg and then proceeded to WALRU for the RNAV 3 in to Laramie.

Project: SNOWIE17

Date: 14 Dec 2016

Flight: TF02

Notes:

Plan is to find enough clear air for lidar alignment, then make measurements in cloud, likely doing multiple passes over the Medicine Bow hotplate site at N41 21.1' W106 13.4'.

Enough clouds moved in after several delays that lidar work was not feasible, so the measurements concentrated on cloud instead. Primarily ice clouds were sampled, with echoes from surface up to 2 km above at times, occasionally deeper. Embedded liquid was encountered in a few areas west of the mountains and while returning to base.

Instruments seemed reasonable in flight, except that the AV computer was again unresponsive before takeoff - this was rebooted and camera imagery was obtained a short way into the flight. 2DP had a hung bit in ~alternating buffers, noted with disk tests after previous flight.

Flight Summary:

UTC Comment

2241 Wheels up

Heading north for best chance at clear air.

WCR to 1 km+ above; KPR to 60-m mode, ≤ 1 km above with some echoes to ground.

~2250 AV computer rebooted, recording camera images.

2255 KPR in 75-m configuration with relatively weak echoes, 2 km below to ~500 m above.

2300 WCR thinning above, ≤ 1 km down to ~250 m (echo tops ~15-16 kft)

2302 ~Clear on 75-m KPR config, at 18kft. Ascending to 21 kft to attempt lidar alignment.

2305 RH turn to head back in clearest area, ascending to 21 kft.

2306 1-2 km echoes below on WCR, very weak on KPR in 75-m config.

2310 Concluded too many clouds for lidar work. Will proceed to hotplate site @ 14 kft.

2315 WCR shows weak/scattered echoes, KPR still in 75-m config w/echoes to 3 km below. 17 kft for now, will descend to 15 kft when possible.

Should get cloud samples enroute to hotplate.

KPR echoes from surface to ~500 m above, but still weak in 75-m config. WCR similar depths.

2323 Check 30-m conf for KPR - mainly to 1 km below, ~500 m above but still weak. Will switch to 60-m shortly. WCR echoes from surface to +1.5 km.

2327 CIP/2DS continuing well, no LWC so far @ -15C. 2DP responding well aside from hung bit.

2330 At 15 kft, WCR echoes from surface to +2.5 km, KPR in 60-m configuration, echoes from -2.5 km to +1 km above.

2332-2338 **WCR & KPR in FFT config** - in reasonably deep clouds, in case we don't get substantial clouds later. (Note brief turn at ~233445).

2338 KPR back to 30-m config, WCR back to standard config. WCR echoes 1.5 km below to 1-2 km above, KPR 1.5 km below to ~1 km above, but gradually thinning.

2344 KPR in 60-m config, echoes surface to 1-1.5 km above, WCR echoes surface to 1.5-2 km above. Descending to 14 kft for first hotplate pass.

~234740 Over hotplate site.

2349 Some liquid, CDP showing counts but with LWC to 0.2 g/m3 @ -12C.

2351 KPR to 75-m configuration, echoes from surface to 1.5-2 km above, 3 km above on WCR.

CDP to 0.6 g/m3, diameters near 30 um - turning for return leg @ 15 kft.

2355 **Second leg with FFT configuration for KPR & WCR** - in deeper clouds, KPR echoes from surface to 1.5 km above, WCR to 2 km above.

~000040 second pass over hotplate site

0001 KPR back to 30-m configuration for final pass. 15 kft altitude, KPR echoes surface to 1 km above.

Occasional similar LWCs/icing on return leg to KLAR.

0020 Wheels down.

Project: SNOWIE17

Date: 8 Dec 2016

Flight: TF01

Notes:

Plan is to do clear air legs at a range of speeds/altitudes for Nevzorov calibration, clear-air lidar calibration, wind maneuvers, and radar calibration circles.

Software unresponsive on AV computer, no camera images.

Flight Summary:

UTC Comment

2223 Wheels up

2231 Original plan was to do Nevzorov maneuvers first, but 2DS shows particles.

Will transit to radar calibration site, checking ice crystals and wind profile enroute.

Radar calibration:

2254-2257 Left-turn circles

2257-2300 Right-turn circles, added a bit extra at end.

Nevzorov maneuvers, time indicates start of segment - difficult to find areas completely free of ice. Extended some segments attempting to account for this.

10 kft: 230330 (160 kt); 230505 (170 kt); 230632 (180 kt); 230910 (140 kt); 231025 (150 kt)

14 kft: 231630 (140 kt); 231830 (150 kt); 232200 (160 kt); 232335 (170 kt); 232525 (180 kt)

18 kft: 233740 (140 kt); 234425 (150 kt); 234455 (160 kt); 234730 (170 kt); 234925 (180 kt)

23 kft: 235540 (140 kt); 235708 (150 kt); 235840 (160 kt); 000040 (170 kt - fastest leg at this altitude)

Wind maneuvers: Winds nearly constantly increasing from 10-17 kft. Deepest ~constant layer centered near 13 kft, winds here were 35-40 kt with little turbulence noted.

0008 Initial right circle

0010 Initial left circle

0013 Left circle w/speed adjustment

0016 Right circle w/speed adjustment

0019 Return home

0038 wheels down