



# University of Wyoming LPVEX 2010

## Light Precipitation Validation Experiment

September 15 2010 - October 20 2010

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

### UWKA Update (30 Sept 2011):

Reprocessed data with LPVEX\_QC13--check global attributes in netCDF header. The data affected from previous release are calculations from the imaging probes (CIP and TwoDP); all other data should have remained the same. Currently all files contain Nevzorov LWC & TWC **except** Sep 19, Oct 08, & Oct 20. When Nevzorov data becomes available will add to those files. All flights with multiple files have been merged.

- [Contacts](#)
- [Plot of Flight Hours](#)

### [Science LPVEX Website](#)

[Project Ops summary brief](#) courtesy T. LeCuyer

### [UWKA Web Page](#)

Date	Flight # (* .kml)	Status	Times (UTC)	Hours	Crew/Notes
<i>Research Flights</i>					
20 Oct	RF16	Completed two spirals (Harmaja & Emasalo) and 2 sets of RHI legs, one along Porvoo track, the other along Emasalo track. All data collected were in regions with rain at the surface. Transitioned	0729 -	3.8	<a href="#">T Drew</a> T LeCuyer L

		back towards Turku along FIR leg; rain at surface on eastern half of leg. No known instrument problems; LWC100 is suspect for aircraft file 'a' due to lack of clear air for processing.	1115		<a href="#">Lepomemi</a> <a href="#">J French</a>
19 Oct	RF15	Worked precipitating clouds west and north of Turku out over the water. Focused primarily on collecting microphysics data around the melting level with radar up/dn in regions of precipitation of 0 to +10 dBZ at the surface. No known instrument problems.	0700 - 1120	4.5	<a href="#">T Drew</a> <a href="#">T LeCuyer</a> <a href="#">J French</a>
17 Oct	RF14	Modulator failed on startup--No WCR data for this flight. Continued with Microphysics flight; focused on snow showers over land; mostly north and east of Helsinki. No other known instrument problems. Took 18 Oct for radar maintenance; Brent found faulty switch in modulator control box; radar was fixed for next flight.	0719 - 0945	2.5	<a href="#">T Drew</a> <a href="#">T LeCuyer</a> <a href="#">J French</a>
16 Oct	RF13	Precipitating ice from thin stratus deck confined between roughly 5500 and 6500 ft. Ice precip not reaching ground; extending down to about 3000 ft. Mostly flown over water. Last 20 minutes of flight along FIR leg at FL180 to compare surface return of WCR with data from cloudsat overpass. No known instrument problems	0913 - 1151	2.5	<a href="#">T Drew</a> <a href="#">N Wood</a> <a href="#">J French</a>
14 Oct	RF12	Data drive filled at 075719; No aircraft data after ~45 minutes following takeoff. Radar and CIP data were not lost. Forward blower quit functioning during flight; 15 October was down due to aircraft maintenance (to replace fan)	0718 - 1115	4.1	<a href="#">T Drew</a> <a href="#">N Wood</a> <a href="#">L Oolman</a> <a href="#">P Ristola</a>
12 Oct	RF11	Flew multiple legs at Porvoo. Completed mission with a spiral from 9000 ft at Emasalo. PCASP wasn't working. After the flight we found that the de-ice breaker for the right wing was tripped. After the flight a bare wire on the CIP de-ice was repaired.	0659 - 1109	4.3	<a href="#">T Drew</a> <a href="#">N Wood</a> <a href="#">L Oolman</a> <a href="#">A Heymsfield</a>
10 Oct	RF10	Stacks along Mansala and Porvoo tracks	0730 - 1206	4.6	<a href="#">T Drew</a> <a href="#">N Wood</a> <a href="#">L Oolman</a> <a href="#">A Heymsfield</a>
08 Oct	RF09	Short flight north of Helsinki though thin stratus clouds. Pressure transducer for CABINP is now used for PUMPPRES.	0956 - 1140	1.9	<a href="#">T Drew</a> <a href="#">N Wood</a> <a href="#">L Oolman</a>
04 Oct	RF08	Clear air flight to look at the specular backscatter off the ocean by the radar. The surface winds were higher than on the previous flight. Did 4 flight legs at 18,000 ft: 2 strait and level, 1 with a roll of 5 degrees, and 1 with a roll of 10 degrees. Also did a number of legs through thin stratus around 5000 feet. The flight was delayed waiting for the Meridian time server to come up. Shut down the gast pump in flight when it started to make noises. This affects the CPC aerosol and Licor humidity and carbon dioxide.	0851 - 1132	2.8	<a href="#">B Wadsworth</a> <a href="#">M Lebsock</a> <a href="#">L Oolman</a> <a href="#">T Drew</a>
29 Sep	RF07	Clear air flight to look at the specular backscatter off the ocean by the radar. Did 6 flight legs at 18,000 ft: 2 strait and level, 2 with a roll of 5 degrees, and 2 with a roll of 10 degrees. Except for	0708 - 0952	2.8	<a href="#">B Wadsworth</a> <a href="#">M Lebsock</a>

		RALT3 and BIAS, there were no data system problems.			<a href="#">L Oolman</a>
25 Sep	RF06	Showers inland, on north end of Mansala track. Flew several legs on track, focusing primarily on north end and conducted one spiral over northern point. KNOWN instrument/data problems: BIAS bad entire flight, PCASP bad at high altitudes (does not act like leak, more like temperature issue, changed dessicant after flight; checked heaters); POSSIBLE (likely?) operator error on data system- last .tdms file of zero length, perhaps forgot to stop realtime at shutdown (?); lost about 20 minutes of data at end of flight (portion during clear air ferry back to Turku). Last file was recovered using windows CHKDSK; no loss of data.	0704 - 1009	3.2	<a href="#">B Wadsworth</a> <a href="#">T LeCuyer</a> <a href="#">J French</a>
23 Sep	RF05	Mission to fly the 3 inland legs and spiral at lowest altitude to verify terrain and obstacle clearance. Also take the opportunity to obtain measurements of radar cross section of ground over dry land, to determine if we are saturated at FL150. Finally, also to test CIP if opportunity arises following optical alignment. KNOWN Instruments Problems: BIAS looked very bad entire flight; FSSP/2DP dropped out and needed a data system reboot mid-way through flight. PCASP bad at high altitude, temperature related?	0853 - 1128	2.7	<a href="#">B Wadsworth</a> <a href="#">T LeCuyer</a> <a href="#">P Wechsler</a> <a href="#">J French</a>
21 Sep	RF04	"Perfect" LPVEX day. Widespread light to moderate precipitation over the Gulf of Finland. Took off a little later to attempt to capture some data near the end of the flight corresponding to a Cloud SAT overpass schedule for 1106 Z. We completed 3 full spirals, one full set of Emasalo legs and a portion of Kumupla legs. Rebooted/restarted data system 3 times in flight; did not have any period where the FSSP/2DP went down. No known instrument problems. Woolly-bugger (Data System) clock did not get set correctly at bootup, original filenames were named 20100920_ rather than 20100921_. All data and times in files are correct. Processed data filenames have been corrected. CIP computer appeared to reboot itself late in flight, may be some missing data from the CIP on the RTB portion of the flight.	0755 - 1155	4.0	<a href="#">B Wadsworth</a> <a href="#">T LeCuyer</a> <a href="#">P Wechsler</a> <a href="#">J French</a>
19 Sep	RF03	Focused on legs and spirals over the water. Precipitation was more "showery" in nature, making targeting a bit more difficult. N2UW completed a total of 3 spirals and one full set of stack legs and a second, somewhat aborted set of stack legs. Instruments operated well; BIAS was intermittent during flight, likely due to water infiltration. No RALT3, data system was rebooted twice for preventative care from losing FSSP and 2DP, each time losing 2-3 minutes of data. Lost fssp and 2DP near the end of the flight; decided not to reboot 3rd time as we were inbound to Turku.	0645 - 1035	3.9	<a href="#">B Wadsworth</a> <a href="#">T LeCuyer</a> <a href="#">P Wechsler</a> <a href="#">J French</a>
18 Sep	RF02	Mission aborted shortly following takeoff due to maintenance issues with UWKA.	0730 - 0745	0.3	<a href="#">B Wadsworth</a> <a href="#">T LeCuyer</a> <a href="#">P Wechsler</a> <a href="#">J French</a>
16 Sep	RF01	First research flight for LPVEX; flew legs over the water. Poor weather conditions for research, but felt it was necessary to conduct operations to test legs and coordination with ATC. In general, things went well. Flew some repeated legs between FL010 and FL150, encountering an ice layer on some of the highest legs. Also encountered rain, graupel and high CLWC's on return leg to Turku near the end of the flight. Instruments worked well: as with TF's in Finland, not getting any sensical data from the radar alt. Suspect this data system issue. Had to reboot/restart data system twice in flight after lost all reporting of radaralt, fssp, and 2DP; total data loss about 5 minutes per reboot.	0741 - 1050	3.2	<a href="#">B Wadsworth</a> <a href="#">T LeCuyer</a> <a href="#">P Wechsler</a> <a href="#">J French</a>

WCRSERV crashed once in flight lost about 5 minutes radar data. No other known problems.

*Test Flights in Finland*

13 Sep	TF02	Test Flight 2 in Finland; Repeated legs north of Turku field; primarily between cloud decks, with some precipitation falling out of upper deck. Legs were conducted at 3000 and 6000 feet. Higher legs had some cloud penetrations. Also cloud penetrations on climb out and return into Turku. RadarALT appeared bad from the beginning. About halfway through the flight, RADARALT, FSSP, and 2DP quit being updated in the data system. Upon landing, data system was rebooted and 3 probes came back.	0735 - 0835	1.1	B Wadsworth P Wechsler B Glover J French
11 Sep	TF01	Test Flight 1 in Finland; Flew in clouds almost the entire flight, repeated legs at roughly 3000 MSL north of the Turku field. Radaralt appears bad the entire flight; processing for the lwc100 failed due to lack of convergence for determination of dry-air term (although power looked OK). Data system crashed 3/4 of the way through the flight; did not try to reboot system in the air. Rebooted on ground and came up just fine.	1237 - 1330(?)	0.9	B Wadsworth P Wechsler B Glover J French

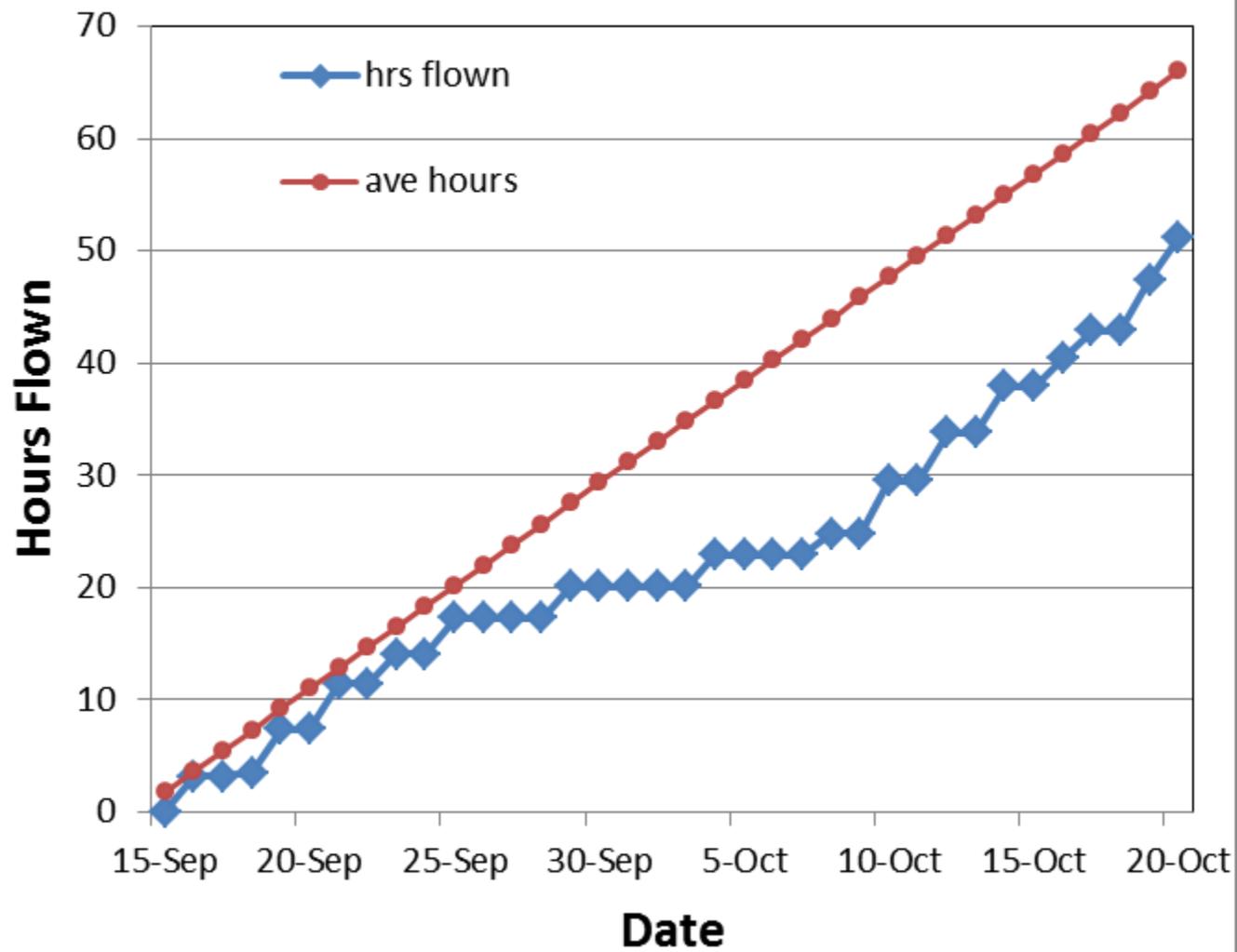
*Test Flights*

12 August	TF04	Test Flight 4; Several cloud penetrations mostly through cu and cu-congestus, some limited CIP and 2DP data. 2DP data have bits reversed	2037 - 2124	0.9	T Drew P Wechsler L Oolman J French
10 August	TF03	Test Flight 2; radar beam calibrations, some limited cloud penetrations 2DP data have bit reversed;	2003 - 2052	0.9	T Drew P Wechsler L Oolman J French
06 August	TF02	Test Flight 2; radar beam calibrations, Rodi maneuvers, 2DP data have bit reversed; ALL data shifted by 1 second; neverzerov channels ilwcref & ilwccol switched	1853 - 2054	2.1	T Drew P Wechsler L Oolman D Lukens
05 August	TF01	Test Flight 1; No INS data, No GPS data	1626 - 1747	1.4	T Drew P Wechsler L Oolman B Glover

Total Research Flight Hours

51.2 out of 50 (+16)

# LPVEX Flight Hours



Date: 10/20/2010

Crew: Drew, French, L'Ecuyer,

Flight time: 3.8

Objective: Do spiral over pt 7 then do pt 10-11 stack. Then transit to 8-9 stack. Then climb to do spiral over pt 17. Then transit to 5-6 stack

Planned: Spiral over pt 7 then do pt 10-11 stack. Then transit to 8-9 stack. Then climb to do spiral over pt 17. Then transit to 5-6 stack.

Actual: : Departed EFTU to 15000 to first point. Decided to spiral over pt 7 from 10000 to 1000 then do pt 10-11 stack, did several legs. Then climbed to 10000 for spiral over pt. 17. Then transited to pt 8 for 8-9 stack, ended at 15000. Then decided to fly 4-3-2-1 leg enroute to EFTU at 15000. Returned to EFTU.

## LPVEX-10 RF16

### Crew:

Drew  
LeCuyer  
French  
Lepomemi

### Mission:

Fly precipitation south and east of Helsinki. Focus on spirals at Harmaja and Emasalo. Focus on RHI legs along Porvoo and Emasalo tracks.

### Weather at takeoff:

0720Z: wind 170@07, vis 6.0 km; lite rain; BKN 006, BKN011, OVC013; T/TD 07/06

Restarted D/S just before engine start to maximize time before 3.5 hour restart for FPGA/FSSP/2DP issue

0729 Wheels up

0734 everything appears to be working, radar is operational and all instruments look OK. Passing through FL090 climbing for FL150 for ferry to start point

0751 at FL150, ferrying to pt 7, solid precipitation at surface, ~10 dBZ; at flight level in cloud with some precipitating ice, cloud tops to 25 kft

0759 at pt 7, begin Harmaja spiral; 2 separate cloud layer—upper layer has base around 5 kft; all liquid in lower cloud

0816 bottom of spiral, over pt 7 at FL010

0818 at FL020—transitioning to pt 10 for Porvoo tracks

0828 at pt 10, begin leg 1, raining heavily at our level, melting level ~1500 ft above us, we're in cloud with LWC's ~0.4 g/m<sup>3</sup>

0835 at pt 11, end leg, climb and reverse course

0837 begin leg 2 at FL035, right at top of melting level, CIP looks like partially melted ice, solid echo to surface

0845 end leg 2, reverse course and climb

0848 begin leg 3 at FL054→inch dow to FL050

0854 end leg 3, reverse course and descend

0848 begin leg 4 → porpoise between FL030 and FL040 to bracket melting level/layer  
0904 end leg 4, climb to FL100 and transition to Emasalo for spiral  
0908 at FL100  
0912 begin spiral over Emasalo  
0929 end spiral → transition to Emasalo track at FL010, below cloud and in the rain  
0936 begin leg 1, Emasalo track, at FL010, under cloud in rain  
0943 end leg 1, reverse course and climb  
REBOOT/RESTART D/S at convenient time in turn to preempt FPGA/FSSP/2DP issue at ~3 hours  
0946 begin leg 2 at FL035  
0953 end leg 2, reverse course and climb  
0955 beg leg 3 at FL060, T~-3C, no cloud water, plenty of ice and precip  
1002 end leg 3, reverse course and climb  
1006 begin leg 4 at FL100, T~-8.5  
1012 end leg 4, reverse course and climb  
1016 begin leg 5 at FL150, above main precipitating cloud, some (but very low concs) of 200-800 micron ice from upper levels  
1023 end leg 5, transition to FIR leg then fly FIR towards west at FL150  
1029 on FIR leg, FL150  
1050 end FIR leg at pt 1, RTB direct to Turku  
~1115 On ground

**DEBRIEF:**

Meridian did not come up in hangar, it came up on reboot when aircraft was outside

Tried to pull-out under power—plug fell out during pullout and needed to restart everything once aircraft was outside

Date: 10/19/2010

Crew: Drew, French, L'Ecuyer, Glover

Flight time: 4.5

Objective: Work a line NW/SE over water to the west of Turku.

Planned: Climb to 15000 to 1<sup>st</sup> pt then fly to 2<sup>nd</sup> point. Spiral over 2<sup>nd</sup> point to 1000 ft. Fly stack between points.

Actual: : Departed EFTU to 15000 to first point. Did 15000 ft. leg. Did Spiral over second point. Returned to pt 1 at 1000ft. Did a few more legs below 5000 ft. Shortened leg to just Northwestern half. Did a few legs of climbs and descents between 2500 and 4000 ft. Returned to EFTU.

## LPVEX-10 RF15

### Crew:

Drew  
LeCuyer  
French  
Glover

### Mission:

Fly clouds and precipitation over water west and north of Turku. No known instrument problems prior to flight. Following RF14 we had no fly day to repair the WCR modulator...fix worked

### Weather at takeoff:

0650Z: wind 220@09, vis 2.0 km; DRZ; BKN 019, OVC023; T/TD 07/04

Restarted D/S just before engine start to maximize time before 3.5 hour restart for FPGA/FSSP/2DP issue

0700 Wheels up

0708 all instruments appear to be working, 0C level about 3500 ft, from WCR bright band appears ~3000 ft; lots of crystals 100 micron to 1 mm with ice up high; small circular ice mixed with a few larger dendrites and aggregates; max CLWC on climb out was ~0.5 g/m<sup>3</sup> in lower part of cloud

0711 level at FL150, T~-18, no CLWC

0718 at pt s (south point), on leg 1 at FL150; z at sfc ~-5→0 dBZ, steady bright band, tops ~10 kft above us; optically thin cloud at our level and above

0728 breaking out of cloud as we get near pt n (north point); still 0→+5 dBz at surface, but tops slowpe down to the north

0735 end of line, begin spiral down around pt n

0740 passing through FL125, T~-14; seeing +5 dBZ at sfc; @ flight level CIP shows mode at 200 microns and smaller secondary mode at 800 microns; now liquid water, bright band ~3000 ft AGL

0749 passing through FL079, T~-6, starting to pick up lots of 1-2 mm particles on the P-probe

0751 FL060, just beginning to pick up trace amounts of cloud liquid; T~-2C

0757 passing through FL030, T~+1 C, just passing through bright band; @FL025 breaking out of cloud base, all particles are liquid

0800 end spiral, coming level at FL010

0802 begin leg 2 from N to S; FL010, below cloud, in rain with 1-2 mm diameter drops

0814 about halfway through line, less rain, smaller drops further south, also lower concentrations

0830 end line, climb and reverse course

0832 on line, leg 3 at FL030; at melting level/bright band, just below cloud base, CIP is mix of liquid and ice

0838 about 1/3 through line, starting to see cloud down to our level; CLWCs max ~0.4 g/m<sup>3</sup>

0845 2/3 through line, very little or no precip now at the surface

0846 starting to get into more precip at the northern 3<sup>rd</sup> of line, from CIP particles 200 micron look to be all water, larger particles are partially melted

0852 end leg 3, reverse course

0854 begin leg 4 at FL030, seeing light precip at surface

0859 ¼ way down line, transition from light precip to essentially no precip

0913 2/3 down the line, scattered clouds at our level to surface, no precip; only higher clouds on the radar

0924 end of line

REBOOT D/S to preempt FSSP/2DP/FPGA issue; stopped radar during reboot

0927 beg leg 5 at FL050; still no precip at surface, lower clouds seem to be building in more

0940 2/3 through the leg, back into some precip as we go further north on line

0946 end leg 5, reverse course and climb 500 ft

0946 begin leg 6 at FL035, T 0C; just above top of bright band

0948 looks like little or no liquid on CIP, particles difficult to classify

0958 lots of precip—all ice at our level—200 microns to 2 mm diameter particles; lots of cloud liquid (20 micron drops) up to 0.6 g/m<sup>3</sup>

1002 end leg early; precip looks real good so will focus on north half of original line; rev course and set up for porpoising leg from ~2500 ft to ~4000 ft

1005 on line, leg 7 at FL035, begin descent to 2000 then begin porpoise

1013 end leg, reverse course and repeat; at FL040, T~-0.5C; crystals look to be mostly needles and aggregates of needles, with a few dendrites and needles aggregated

1016 begin leg 8, start descent for porpoise

1029 end leg 8, reverse course at FL040

1031 begin leg 9, start descent for porpoise

1040 end leg 9 reverse course, one more leg then RTB

1042 begin leg 10—porpoising

1052 end leg 10—return direct towards Turku

1111 (or so) CIP computer rebooted

1120 on ground

**DEBRIEF:**

No issues with any instruments

Everything worked on startup

Date: 10/17/2010

Crew: Drew, French, L'Ecuyer

Flight time: 2.5

Objective: Fly out to Pt 16 and do spiral, then do 12-13 track stack, then transit to 8-9 track and do stack. Then do spiral at pt 17.

Planned: Fly out to Pt 16 at 15000 and do spiral, then do 12-13 track stack, then transit to 8-9 and do stack. Then do spiral at pt 17 from 15000 to 1000. Return to EFTU

Actual: : Departed EFTU to 15000 but decided to drop to 10000 for spiral. Did spiral at pt 16 to from 10000 -1000 ft. then decided to do stack at 10-11. Did several legs on 10-11 and returned to EFTU.

## **LPVEX-10 RF14**

### **Crew:**

Drew  
LeCuyer  
French

### **Mission:**

Modulator failed on startup...complete mission without radar. Aim for snow showers north and east of Helsinki

### **Weather at takeoff:**

N/A

0719: Wheels up

0730: level at FL150, completely clear above 9000 ft, plan for spiral at Jarvenpaa from FL100 to FL010

0736: begin descent to FL100, enroute to Jarvenpaa

0741: level at FL100

0746: begin spiral down over Jarvenpaa

0749: jest getting into tops at FL079

0802: end spiral (FL010), transition o Porvoo track at FL020

0808: over pt 10, proceeding to pt 11 at FL020, at beginning of leg in a shower, mostly small graupel

0814: over pt 11, rev course and climb to FL040

0824: at pt 10, rev course and climb to FL070

0826: begin leg 3 at FL070, in cloud and some precipitating ice

0833: at pt 11, rev course and descend to FL040 for next leg

0836: beg leg 4 at FL040

0844: end leg, pt 10, descend to FL020 and rev course

0845: begin leg 5 at FL020

0852: end leg, pt 11, climb to FL050 and rev course

0855: begin leg 6 at FL050

0903: end leg—RTB, climb to FL070

0945: wheels down (ended up holding about 15-20 at Turku prior to landing)

**DEBRIEF:**

Modulator failed on bootup; radar down during flight

Meridian did not come up, required 15 minutes of playing before it was finally happy...

Date: 10/16/2010

Crew: Drew, French, Wood

Flight time: 2.5

Objective: Fly out to the (1234) track and make a single pass. Do stack at 8-9. Fly back along 4321 track at 18000.

Planned: Planned to pt 2 (Active Danger areas enroute to 1) then 2-3-4 then transit to pt 9 full stack at 9-8 end at pt 8. Climb to 18000 to Pt. 4 and fly 4-3-2-1. Return to EFTU.

Actual: : Flew 7000-5000 to pt 2 then 2-3-4. Then made transit to pt 9 and did a full stack at 9-8 ending at pt 8. Climbed to 18000 enroute to Pt. 4 and flew 4-3-2-1. Returning to EFTU descended to 5000-6000 for a few miles prior to visual.

## **LPVEX-10 RF13**

### **Crew:**

Drew  
Wood  
French

### **Mission:**

Precipitating ice from thin cloud deck between 5500 and 6500 ft. Ice was not reaching the surface; high LWC's noted in clouds. Tracks mostly over water. Last FIR track completed at FL180 in order to compare return from WCR with cloudsat surface return during overpass period.

Don fixed right wing deice just day before. Breaker tripped on RF11 and RF12 resulting in bad PCASP data when outside  $T < 0C$

### **Weather at takeoff:**

N/A

Rebooted/restarted system just prior to engine start to give us maximum time with FSSP & ZDP

0913: Wheels up

0921: radar running, everything up; level at FL070, just skimming cloud tops; ferrying down to begin point...

0929: descended to FL060, that puts us in middle of echo, but just below cloud base (light precipitating ice...echo is confined to about FL040 to FL070)

0935: passing over pt2—turning to pt3 to get on FIR line

0937: still at FL060—in cloud, near bases

0944: cloud tops slant down as we progress eas, drop to FL055 to stay in clouds

0947: noticed CIP computer rebooting, also started new radar file

0948-0951: LWC100 went offline for about 3 mintues....

0956: pt 4, transition to Emasalo track at FL055; CIP computer back operational...

1001: on Emasalo track at FL055

1008: over point on west end of line, dropping to FL045 to get just under bases on west end—as we fly east along line, bases drop and we get back in cloud

1017: over pt on east side, descend to FL035 to get under cloud for entire leg

1027: over pt on west, ascend to FL060 to do final leg

1029: @ FL060 a little high, descend to F055

1035: on east end of leg, turn and return leg AT FL055

1037: CIP computer rebooting

1039: CIP back....lots of 25 micron particles...high LWCs

1045: over end of leg, completed RHI legs, transition to pt 4, climbing to FL180

1053: over pt 4 at FL180, on FIR leg

1059: over pt 3 to pt2

1109: over pt 2

1112: over pt 1, complete FIR leg, turn back to Turku

1120: at FL060, just below base, in middle of radar echo, seeing some dendrites on CIP

1126: descending toward Turku

1131:??On ground

**DEBRIEF:**

DMT LWC100 dropped out for about 3 minutes from 0948-0951

CIP computer rebooted twice—1<sup>st</sup> time lost data ~10 minutes, 2<sup>nd</sup> time lost data ~2 minutes

Right wing deice fix seemed to work

After look at data—high LWCs encountered and some evidence of water in AIAS; had Don blow out nose boom, he noted water in tubes

Date: 10/14/2010

Crew: Drew, Oolman, Wood

Flight time: 4.1

Objective: Do two spirals at either 16, 7, or 8. Do a few passes on the North track and transit to south side of EFHK. Do a full stack on 8-9 and transit to next spiral location. Transit to 6-5 and do full stack. Fly over satellite track between points on way back to EFTU.

Planned: Fly spiral at pt 16. Fly 14-15 track, transit to 8. Fly 8-9 track, transit to pt 7 fly spiral transit to 6 and fly 6-5 stack transit to 1<sup>st</sup> Satellite overpass point fly to second overpass point return to EFTU.

Actual: : Flew spiral at pt 16 and moved to the 14-15 track North/South then transited to Pt 8. Did 4 stacked legs on 8-9, transited to pt 7 at 15,000. Did spiral at pt 7 to 1000 ft. Transited to 6 and flew 3 stacked legs on 6-5 Flew around active area to 1<sup>st</sup> Satellite overpass point and on to second overpass point then returned to EFTU.

**Tom Drew**

University of Wyoming

## LPVEX – RF12, Larry Oolman Notes

14 October 2010, 0718 - 1115 UTC

Crew: Tom Drew, Norm Wood, Larry Oolman, Petra Ristola

**Plan:** Wide spread showers around the Helsinki area. Ferry at 15,000 ft, Javanpaa spiral and stack, Emasalo spiral and stack, Kumpula stack.

Take off delayed because the Meridian was unable to get a GPS lock. Note: need to use the 'Back' button to accept the new coordinates, not 'Enter'. Data drive filled at 075719.

0718 Take Off

0729 At 15,000 feet to ferry to Javanpaa.

0742 Start Javanpaa spiral (pt 16).

0802 Freezing level 2,800 ft.

0805 1,000 ft, about at cloud base. T = +3C. One big radar file until now.

0809 Pt14 Javanpaa leg, 2500 ft. T=+0.5C.

0821 Pt15. 3,200 ft. Clear to north. T=-1.4C

0833 Done. Head to Emasalo (pt8).

0850 Pt8, 1000 ft. +4.5C.

0857 Pt9, 2400 ft. +1C. Passing 0.8 g/m<sup>3</sup> monodisperse cloud spectrum at 20 micron

0908 Pt8, 3700 ft. -1C

0913 CIP computer rebooted.

0916 Pt 9, climb to 15000 ft. Becoming more difficult to find sweet spot on Gast pump.

0923 Right probe heat breaker tripped. PCASP data bad.

0931 Pt8, heading to Pt7 for spiral. 15,000 ft. -19.5C.

0936 Start spiral. Freezing level 2900 ft.

1002 Done. Headed to pt6.

1010 Pt6, 1000 ft. +4.5C. Cloud base around 5000 msl.

1019 Pt5, climb to 2200 ft. Snow on west end of line. +1.3C. 2 cloud layers with break around 10,000 ft MSL.

1029 Pt6, climb to 3400 ft.  
1040 Pt5, navigate around danger area to follow satellite pass track.  
1042 Reboot, new radar file, new CIP directory.  
1046 Start cloudsat pass. 3400 ft. Mostly clear, some Cu.  
1055 Done, headed to Turku.  
1100 Turn off radar to close door in clear area between convection.  
1115 Land

Date: 10/12/2010

Crew: Drew, Oolman, Wood, Heymsfield

Flight time: 4.3

Objective: Fly North and East tracks with possible spiral at pt 16.

Planned: Fly track 12-13, spiral over pt 16, fly track 10-11, fly track 8-9 and return.

Actual: Enroute to Pt 12 at FL90 changed to Pt 10-11 stack for better weather. Flew multiple legs between 2000-FL150. Requested spiral at 16, unable due to traffic. Instead did spiral over Pt 8 from 9000-1000, did one turn in hold awaiting clearance. Returned to EFTU at FL80.

**Tom Drew**

University of Wyoming

## **LPVEX – RF11, Larry Oolman Notes**

*12 October 2010, 0659 - 1109 UTC*

**Crew:** Tom Drew, Norm Wood, Larry Oolman, Andy Heymsfield

**Plan:** Fly post frontal snow bands.

Flew multiple legs at Porvoo. Completed mission with a spiral from 9000 ft at Emasalo. PCASP wasn't working. After the flight we found that the de-ice breaker for the right wing was tripped. The data system continues to quit collecting FSSP and 2D-P data after about 3 hours.

0659 Take Off

0705 At 9,000 feet to ferry to Mansala track. T = -16 C. Clear.

0707 PCASP looks messed up. Strong peak at channel 14. Concentrations over 50,000 /cm<sup>3</sup>.

0722 Start descent to 2,000 feet. Mansala clear, heading to Porvoo.

0733 Pt10, 2000 ft. -3 C.

0745 Pt 11, 4000 ft. T = -7 C.

0751 Pt10, 6000 ft. T = -9 C.

0802 Pt11, 11000 ft. High PCASP counts now centered on channel 5.

0810 PCASP centered at channel 16

0811 Pt10, climb to 15000 ft. Above clouds.

0821 Pt11, 10,000 ft. Near radar tops.

0831 Pt10, descend to 4000 ft. Kumpula reports ZDR signature. -7 C. From CIP, it looks as if particles could be thin plates. Laser sees through. 2-3 mm stellar images on the 2D-P probe.

0840 Pt11, descend to 2000 ft. There is a dusting of snow on the ground. T = -3C. There is a definite altitude dependence on the PCASP. The spurious peak is now at channel 3.

0851 Pt10, climb to 4000 ft.

0901 Pt11, 6000 ft.

0909 Pt10, 8000 ft.

0919 Pt11, 15000 ft. Above clouds.

0929 Pt10, 8000 ft.

0939 Pt11, 6000 ft.  
0947 Pt10, 4000 ft.  
0956 Reboot  
0957 Pt11, 2000 ft.  
1008 Pt10, climb to 9000 ft and transition to Emasalo (Pt8) for spiral.  
1016 Pt8, Holding for traffic, 9000 ft.  
1021 Start spiral at Emasalo.  
1043 Done. Climb to 8000 for return to Turku.  
1109 Land

Date: 10/10/2010

Crew: Drew, Oolman, Wood, Heymsfield

Flight time: 4.6

Objective: Fly North and East tracks with two spirals.

Planned: Planned to fly track 12-13, spiral over pt 16, fly track 10-11, spiral over pt 8 fly track 8-9 and return over the 4-3-2-1 track.

Actual: Flew to Pt. 12 at FL150, and completed 12-13 stack. Ferried to pt 16. Did spiral over Pt 16 from 7000-1000. Proceeded to Pt 10 for 10-11 stack. Instead of flying the pt 8 spiral and the 8-9 stack decided to repeat 10-11 stack. Returned to EFTU

Tom Drew

University of Wyoming

**LPVEX – RF10, Larry Oolman Notes**

*10 October 2010, 0730 - 1206 UTC*

**Crew:** Tom Drew, Norm Wood, Larry Oolman, Andy Heymsfield

**Plan:** Fly Mansala and Porvoo legs. Spiral descent at Javanpaa.

Andy noted that the FSSP appeared to be higher than the CDP in turns.

0730 Take Off, very dry above 7000 ft.

0755 Pt12, 15000 ft.

0808 Pt13, spiral down to 5000 ft.

0814 Pt13, 5000 ft, T = -1.5C

0828 Pt12, 4100 ft.

0847 Pt13, descend to 2000 ft

0908 Pt12, climb to 7000 ft

0916 Pt16, spiral to 1000 ft

0932 Pt10, climb to 2000 ft

0941 Pt11, climb to 4300 ft

0953 Pt10, climb to 5200 ft

1002 Pt11, climb to 15000 ft

1019 Pt10, descend to 5000 ft, T = -1.5C

101925 Beam switching error for about 30 seconds at end of file.

1030 Reboot

1034 Pt11, 4000 ft.

1043 Pt10, 2000 ft.

1051 Pt11, 3800 ft.

1054 Pull the LWC100 breakers to test if it is causing the noise in the WCR, it isn't.

1103 Pt 10, 4400 ft

1112 Pt11, 3500 ft

1122 Done, ferry back at 8000 ft.

1206 Land

Date: 10/8/2010

Crew: Drew, Oolman, Wood

Flight time: 1.9

Objective: Fly 12-13 track

Planned: Planned to fly the 12-13 track.

Actual: Flew to Pt. 12 at FL150, then turned toward Pt. 13. After getting to Pt. 13, descended to 3400 feet and return to Pt 12 along the same track.

After passing Pt. 12 returned to EFTU.

**LPVEX - RF09, Larry Oolman Notes**

8 October 2010, 0956 - 1140 UTC

Crew: Tom Drew, Norm Wood, Larry Oolman

**Plan:** Test fixes to aircraft. Familiarization flight. Fly clouds if they can be found. Do tests on radar to isolate noise problems.

0956 Take Off

1006 At 15,000 feet to ferry to point Mansala track.

1023 At Pt12

1036 Pt13, spiral down to 3400 feet.

1046 Cloud tops 3700 feet, +1.8 C

1106 Pt 12 at 3,100 ft.

1111 Short radar file with Transmit off

1114 Short radar file with Power off

1117 Short radar file with Power on

1120 Short radar file with Transmit on

1140 Land

The pressure transducer from CABINP is now used for PUMPPRES.

Date: 4 October, 2010

Crew: Wadsworth, Lebsack, Oolman, Drew

Flight time: 2.8

Objective: 1-Some radar return profiles over the FIR track.

Planned: Fly points 1,2,3,4 at FL 180 and repeat. Do this about 3 times, then decrease altitude to ~4000 feet MSL to get into clouds. Legs 2 & 3 at 5 degrees AOB then 10 degrees AOB. The in-cloud legs would be at 0 deg AOB.

Actual: Got airborne late so requested to just work between pt 2 & 3. Did 4 times as planned, then did a descent spiral at Pt. 1 down to 4000 feet. Asked for a block of 4000 – 5000 to elevate into the clouds. Later asked for FL 50 – 60. Managed to just get into some clouds (barely). Received a L Bleed Warning & secured the bleed air on that side.

## **LPVEX - RF08, Larry Oolman Notes**

*4 October 2010, 0851 – 1132 UTC*

Crew: Brett Wadsworth, Matt Lebsack, Larry Oolman, Tom Drew

Plan: Clear air legs at FIR at 18000 feet then a few passes in clouds around 5000 feet.

Meridian time server came up in hangar but would not go to TFOM 4 on ramp. We left on for about an hour and then cycled power, but still no luck. Turned off power and reseated the antenna connectors. This time it worked.

- 0851 Take Off
- 0854 DualDown-7.1, testing the switching spikes.
- 0858 DualDown-6.2, testing the switching spikes.
- 0901 DualDown-7.1, testing the switching spikes
- 0914 Pt1. DualDown-7.1, FL180, straight and level.
- 0918 Gast pump making strange noises. Turn off briefly to verify.
- 0923 Turned off Gast pump. Noises sound metallic.
- 0928 Up-DualDown-7.1, roll +5 degrees.
- 0911 DualDown-7.1, roll -10 degrees.
- 0954 DualDown-7.1, straight and level
- 1009 Up-DualDown-7.1, spiral down to 4000 feet.
- 1020 At 4000 feet, doing passes between pt 1 and pt 2. Below clouds.
- 1024 Turn Gast pump on.
- 1026 Turn off Gast pump.
- 1030 Climb to 5000 feet for some passes through thin stratus clouds.
- 1103 Up-DualDown-6.2, heading back to Turku.
- 1131 Land

Date: 29 September, 2010

Crew: Wadsworth, Lebsack, Oolman

Flight time: 2.8

Objective: 1-Finding precipitation.

Planned: Clear weather flight over the FIR leg, multiple times at FL 180. Some of the legs to be flown in 5 & 10 degree angle of bank.

Actual: Filed & flew to Pt. 1 at FL180, then to Pts. 2,3,4. Repeated this five more times. Remained at same altitude throughout. 3<sup>rd</sup> & 4<sup>th</sup> leg done at 5 degree AOB. 5<sup>th</sup> & 6<sup>th</sup> at 10 degree AOB. Interaction with Helsinki Radar was easy. No issues.

Overall: a very easy day.

## **LPVEX – RF07, Larry Oolman Notes**

*29 September 2010, 0708 – 0952 UTC*

Crew: Brett Wadsworth, Matt Lebsock, Larry Oolman

Plan: Clear air legs at FIR at 18000 feet to look at the specular backscatter from the ocean. At the end of the flight a few short files will be taken to try to identify noise spikes in the radar data that may be from the switching.

0708	Take off
0712	Start WCR recording, all files use the dual-down 7.1 km mode. The first file contains the climb out and first leg.
0729-0750	East bound along points 1,2,3 and 4, straight and level at FL180.
0753-0809	West bound, straight and level.
0811-0831	East bound, banked -5 degrees.
0834-0850	West bound, banked +5 degrees.
0852-0913	East bound, banked -10 degrees.
0915-0930	West bound, banked +10 degrees.

### **Start of WCR test files**

093215	Radiate off
093504	Modulator off
093856	Modulator on
094146	Radiate on

The tests were inconclusive since the radar was not exhibiting the anomalous behavior on this flight.

BIAS and RALT3 continue to be inoperative.

Date: 25 September, 2010

Crew: Wadsworth, L'Ecuyer, French

Flight time: 3.2

Objective: 1-Finding precipitation.

Planned: Possibility of finding precipitation along the northern routes. Planned to fly the Mansala track and then attempt a spiral at Pt. 13, then climb back up using the Mansala legs to FL 150. Kept option of doing another spiral over Pt. 16

Actual: Filed & flew to Pt. 12 at FL150, then turned toward Pt. 13. Helsinki ATC does not cover the northern ends of either the Mansala or Jarvanpaa tracks. The controller asked me what heading I would be taking along the track. I asked Helsinki about doing a spiral over Pt. 13 before they turned me over to Tampere Radar on 132.325. Helsinki did state that they would coordinate the spiral with Tampere. Checked in with Tampere and waited a few miles before asking for the spiral. He gave it to me immediately.

Bottom of spiral at 2000 feet MSL. Was just above a low overcast deck. Flew the leg to Pt. 12 at 2000'. Tampere passed me off to Helsinki before entering the TMA. I coordinated with Helsinki to climb to 5000 feet after Pt. 12 and return to Pt. 13. Passed again to Tampere. Asked them to climb to FL80 after passing Pt. 13 and to reverse my course back to Pt. 12. He offered me a block from 5000' to FL80. I also asked to work along the northern 20 miles of the track, from the PIR 110 at 56nm to PIR 086 at 53nm. He approved this.

After flying ½ the track southbound at FL80, we asked to reverse course and climb to FL110. Approved. After getting to Pt. 13, asked to descend to 5000 feet and return to Helsinki along the same track.

I don't know if Tampere has any idea about the numbering of each of the endpoints of the tracks or the names of the tracks, so I refer to the endpoints via radials & DME off the PIR VOR.

After switched to Helsinki, I told them that I would be ready to return to Turku via ARTUR after passing Pt. 12. Given routing as expected.

Enroute to ARTUR, was given ARTUR-RUS. When passed to Turku, they gave me a descent to 2000 feet "when ready" and to intercept the 079 radial for the ILS 26.

Overall: an easy day.

## September 25, 2010: Research Flight #6 - *Tristan L'Ecuyer*

### Summary:

Today provided an opportunity to sample more isolated precipitation associated with the transition from a stable boundary layer covered in a low stratus deck (overcast below 2000 ft) to a convective boundary layer with isolated convection at the northern end of the observation area.

### Details:

- Overcast with very light drizzle at takeoff, enough to wet the ground and collect on the aircraft but little more. Fairly uniform stratiform cloud deck extended from 600-2000 ft with LWC  $\sim 0.4$  g/m<sup>3</sup>. Weak inversions at 2000 ft and at the freezing level ( $\sim 6000$  ft). We initially climbed to 15000 ft and flew a long transit leg to point 12 on the Mansala track north of Jarvenpaa with uniform stratus cloud below and only isolated patches of very light drizzle.
- Flew the Mansala track at 15000 feet and observed light precipitation (0 dBZ at the surface) toward the northern end of that leg. Continued to observe precipitation on a spiral down to 2000 ft (see below) in multi-layered clouds with high liquid water contents aloft (0.8 g/m<sup>3</sup> at 13000 ft). Intercepted more isolated light precipitation down through the freezing level with reflectivities at the surface exceeding 5 dBZ in places and drizzle droplets impacting the window. By 8500 ft, all particles appeared to be melted and cloud thinned out with the exception of a continuing stratus layer at 1500 ft.
- We continued to encounter light but isolated precipitation (0-5 dBZ) along the northern part of several stacked flight legs along the Mansala track. Microphysics was sampled at approximately 1 km intervals at 2, 5, 8, 11, and 15 kft. Precipitation became more convective later in the flight as we flew at 11000 and 15000 ft with graupel and large amounts of super-cooled water in excess of 1.5 g/m<sup>3</sup> in cloud towers.
- Concluded with a final return leg toward Helsinki at 5000 ft. Boundary layer cloud deck had completely broken up and mostly clear conditions were encountered.
- Note: The PCASP experienced problems on portions of the flight that took place above the freezing level. Anomalously high particle concentrations were observed in the first 6 or 7 size bins and it is unclear whether data collected in the other size bins or at lower altitudes can be trusted at this time.

### Notes:

- Today's 3+ hour flight provides observations of the onset of precipitation,

drizzle, and isolated convective precipitation to explore rainfall detection capabilities, evaluate the effects of inhomogeneity, and examine variability in the land-surface backscatter cross-section at 94 GHz.

## **LPVEX-10 RF06**

### **Crew:**

Wadsworth  
LeCuyer  
French

### **Mission:**

Fly mission over Mansala track; expecting scattered precipitation on north end of legs

Shoot for 0700 takeoff.

### **Weather at takeoff:**

051Z; 15 C/14 C; 210/06; vis 6.0 km; OVC006

Rebooted/restarted system just prior to engine start to give us maximum time with FSSP & ZDP

BIAS looks bad sitting on ground

0704: Wheels up

0706: through thin cloud layer just above the surface; CDP lwc looks low on initial climb, need to look close at the data; possible fogging of lens on a climb?

0715: at FL150, thin cirrus well above us, thin BL clouds well below us, cannot see low clouds on radar

0723: Noticed that PCASP went out to lunch; looked good early in flight

0725: setting up for leg 1 (south to north) on Mansala track at FL150

0731: on track; leg 1; Pt 12 to Pt13; FL150, no rain on this end of leg

0732: turned off (and back on) DMT to see if high PCASP counts were related to electronic noise from DMT, no difference

0742: end leg 1, begin spiral over north end of leg, seeing some precipitation on this end

0745: thru a cloud at FL130 during descent; cloud liquid water 0.6 g/m<sup>3</sup>, precip to ground on radar, looks very light (FSSP lwc high?)

0752: continue passing into/out of pockets of showers, some with rain to ground, others not.

0800: PCASP looks better as we get lower altitude

0808: at FL020, end spiral, return to northern point then setup for leg 2 at FL020

0810: begin leg 2, headed south

0814: definitely much less precip/much less strong echo as soon as we get much south of northern point, a few showers, but weaker and more widespread

0828: end leg 2, climb to FL050 for return leg

0830: on track, begin leg 3, FL050. No precip on south end, may try to see if we can work just northern end only

0845: on track, leg 3 at FL080

0852: end leg, climb to FL110

0854: begin leg 4 at FL110, headed to the north

0859: end leg 4, climb to FL150 for next leg

0903: begin leg 5 at FL150, PCASP goes out to lunch again

0909: end leg 5, descend to FL110 for return leg

0912: begin leg 6 at FL110

0916: end leg 6, descend to FL050

0918: kinda on leg 7, still descending....

0920: level at FL050

0931: end leg 7, climb to FL080 and RTB

1008: (or so) wheels down

**DEBRIEF:**

Right engine firelight #1 not working...

Icing in Cu congestus—need to keep an eye on it, there are at times very high LWCS with reasonably large droplets at -8 C; currently OC level is pretty high, but will be dropping as project goes on

BIAS is hosed; I think the sensor is dead

PCASP looks bad at high altitudes

Upon copying files, the last tdms file was zero length...possible (likely) that I shutdown the data system incorrectly. Looks like last 30 minutes of flight may be lost. Luckily we were in clear air, but still....

Date: 23 September, 2010

Crew: Wadsworth, L'Ecuyer, French, Weschler

Flight time: 2.7

Objective: 1-Flying the inland tracks at low altitude to verify that there are no obstacles to flight in IMC conditions.

Planned: Porvoo (Pt 10-11-10) then Mansalo (Pt 12-13-12), then Jarvanpaa (Pt. 14-15-14), then on to Pt. 16 for one turn in "holding". All at ~2000 feet MSL.

Actual: Scattered to broken layer at 2000 feet MSL over Helsinki. The controller cleared us to 1500 feet MSL. Flew from Pt. 10 to within 5 nm of Pt. 11 when the controller told us that a glider area was active ahead. We reversed course back to Pt. 10 at 1500 feet. After Pt. 10, flew to Pt. 12. The terrain rises a bit enroute to Pt 12 so I asked for 2000 feet and was given it immediately. Flew Pt. 12 – 13 – 12. The tall tower (more than 5nm east of the track) was visible as it cleared the horizon. After reaching Pt. 12 again, we flew to Pt. 14. The Jarvanpaa leg may have the most possible conflicts. There is a small airfield just NW of Pt. 14. There is a Danger area just to the west of the northern end of the track which was active today. The Helsinki controller passed us off to Tampere Radar (on 127.1) who had us on radar as we were northbound. No problems with the handoff or with the controller at all. The Helsinki ATC supervisor had called to coordinate with Tampere which alleviated any potential issues. The track does avoid the Danger Area by about 3 nm, but I deviated a bit further to the east to ensure no questions. On the track back to Pt. 14, and when passed off to Helsinki, I coordinated to fly over Pt. 16 and do one turn in the hold. It took him a couple of minutes to work this out, but then cleared us for it. I also told him that we would be ready to return to EFTU after the turn over Pt. 16. The clearance was ARTUR-RUS up to FL150 on the return.

On return to Turku, Tampere gave me the MEDOT4A STAR. Tower gave me from MEDOT, cleared for the ILS 26.

Overall:

-I have no concerns about flying the Porvoo track down to 1500 feet MSL with the exception of the last five NM which we were not able to fly today. Once you depart Pt. 10, you should climb to 2000 feet MSL enroute to any other point north.

-I have no concerns about flying the Mansala or the Jarvanpaa track at 2000 feet MSL. Be cognizant of the Danger Area near the Mansala leg and the Tampere Military airspace depicted on the sectional.

N2UW: UNS-1Lw Nav database updated today.

## **September 23, 2010: Research Flight #5**

### **- *Tristan L'Ecuyer***

#### **Summary:**

Conditions were well-suited for performing a visual survey of all inland operations areas today. Broken clouds were present throughout most of the region with ceilings in excess of 2500 ft. We transited at 15000 ft from Turku to Jarvenpaa (point 16) before descending to 2000 ft and flying two passes along the Porvoo track from point 10 to point 11 and back again. That was followed by a short transit to point 12 and two passes along the Mansala leg to/from point 13. We then repeated the exercise along the Jarvenpaa leg from points 14 to 15 before doing a single loop around the Jarvenpaa site and heading back to Turku at 15000 ft.

#### **Details:**

- Two transit legs were conducted at FL150 to/from point 16 measuring the surface return over land surfaces in clear-sky conditions. Land surfaces sampled include forest, inland lakes, urban areas, and cropland. Ascent/descent at either end of the transit legs may be useful for confirming the altitude at which the radar beam begins to saturate.
- No major obstacles were evident on any of the inland legs or at the Jarvenpaa site itself.

#### **Notes:**

- This flight should be useful for examining variability in the surface return over land. Forested, agricultural, inland lake, and urban regimes were all sampled.
- Aerosol data may also prove useful but PCASP may not have been performing properly at higher altitudes.

## **LPVEX-10 RF05**

### **Crew:**

Wadsworth  
LeCuyer  
French  
Wechsler

### **Mission:**

Test fly the 3 inland legs and the Jarvenpaa spiral at between 1500 and 2000 ft in clear air to verify terrain and obstacle clearance. Also, would like to check performance of CIP following re-alignment during ground-maintenance day on 22 Sept.; and verify proper operation of data system in-flight following software upgrade to eliminate FSS/2DP dropout at 1 hr 25 min into file.

Shoot for 0700 takeoff.

Takeoff delayed until 0820 Z; upon power up/walkthrough of the aircraft, all fuel gauges were pegged; Spiker needed to repair gauges—turned out water in gauges and relays were causing problem, after drying them all gauges were fixed.

### **Weather at takeoff:**

0820Z; 13 C/10 C; 240/09; vis 4.0 km; BKN017, BKN023, OVC042

0853: Wheels up

Through a few clouds on climb, all lwc probes look good. BIAS looks terrible.

0910: after level at FL150 for sometime, checked diode plot for CIP and it appeared “perfect”; very few particles but the ones we see look like they are imaged fine

0915: descending to FL050 on our way (eventually) to FL020 for leg flights

0923: level at FL015

0927: noticed FSSP quit reporting; rebooted system—forgot to stop CIP and WCR

Quick back of envelope calculation suggests data system has been running 3.5 to 4.5 hours before fssp/2DP failure—much improved but not fixed.

1007: decided to quit transmitting on radar to keep temperature within operating limits

1051: radar back on, finished flying legs, climbing to FL150 for return legs

1102: into lite ice cloud, CIP and 2DP look great!

1125?: wheels down

**DEBRIEF:**

Databases need to be updated on the Garmin prior to next flight

Fuel gauges are working better, continued working through flight; need to keep eye on the gauges and water getting in vent window when the aircraft is sitting outside.

We ended up waiting for fuel before flight again; from now on we will fuel following flight

BIAS was way out to lunch; need to look at prior to next flight.

D/S FSSP/2DP problem happened again, it appeared after ~3.5-4.5 hours of running the system. Following the reboot it ran for another 2 hours prior to landing and didn't happen again. Need to verify running time prior to problem and get Matt some diagnostic information.

RTMM did not show up for this flight. Expect it is a problem on the NASA side. Will test tomorrow.

Date: 21 September, 2010

Crew: Wadsworth, L'Ecuyer, French, Weschler

Flight time: 4.0

Objective: 1-Finding precipitation.

Planned: We expected some pretty decent precipitation throughout the areas over water, south of Helsinki. We planned to fly:

Pt 7, spiral descent just to the southeast of it as the good ship Aranda was supposed to be there. Then to Pt 8-9 at 1000'. Fly the Emasalo track four times, climbing to FL150, then to Pt. 17 for a spiral descent to 1000. Fly to Pt. 6 and climb to FL150 enroute. Spiral descent at Pt. 6 to 3000' (as the danger area was active below it) and then work the Kumpala track, climbing each leg and finish at ~FL100.

Actual: Enroute to PT. 7, the controller told us we could only spiral down to 3000 feet due to the danger area. This danger area was to the east of the descent point, but apparently the controller was being a bit conservative. We then asked to go to Pt. 8 for a spiral descent to 1000 feet which he approved. We did the spiral so as to cheat to the SE a bit to try to get closer to where the Aranda was supposed to be. After down to 1000', we flew the Emasalo track five times at altitudes: 1000', 4000', FL60, FL80 and FL120. After finishing at Pt. 8, we did a spiral descent at PT. 17 down to 1000'. Then direct to Pt. 6, climbed to FL150. Did another spiral at Pt. 6, then flew the Kumpala track at 3000', 4500' and FL60.

On return to Turku, I expected to fly the STAR, but Tower gave me direct to Uteli for the ILS to 26. She also told me to keep my speed up. The weather had come up a bit from what it had been for most of the day. For the approach it was: winds 170/7, vis 10KM, -RA, OVC 7. No other traffic executing any of the STARS or approaches while I was monitoring tower.

N2UW: Running like a champ

## September 21, 2010: Research Flight #4 - *Tristan L'Ecuyer*

### Summary:

The setup was ideal for aircraft operations today with widespread, homogeneous, stratiform precipitation throughout the entire observing area. In addition, the RV Aranda was located between the Harmaja island ground site and Emasalo track, a NOAA-17 overpass occurred at 8:09 UTC and a CloudSat overpass occurred at 11:06 UTC. With the precipitation so widespread, today provided a perfect opportunity to perform multiple spirals and test coordination with C-band ground radars along the Emasalo and Kumpula tracks with little need for modifications in flight. Being in the warm sector, the freezing level was somewhat higher than usual for this time of year at 7800 ft throughout the duration of the flight.

### Details:

- Overcast conditions with moderate rainfall at take-off, temp. 13 C, RH 100%, light winds, and freezing level ~ 7800 ft on initial climb out of Turku. Ceilings were 500 ft and observed LWC ranged from 0.4 g/m<sup>3</sup> near cloud base to well above 1 g/m<sup>3</sup> above 1 km. Very little liquid water was observed above the freezing level at 7800 ft but precipitating ice was observed to above 4 km and cloud tops extended to 6 km.
- Continuous stratiform precipitation was observed while transiting from Turku to point 8 with a well-defined and very uniform bright band. A 500 fpm spiral descent was performed at point 8, the approximate location of the RV Aranda . The freezing level was crossed at 7700 ft and the top of the bright band observed at 7400 ft. Melting particles were observed down to 6200 ft below which all collapsed into raindrops. LWCs > 0.5 g/m<sup>3</sup> were observed between 4000 and 6000 ft but little liquid water outside this layer. Below 4000 ft only patchy clouds and precipitation remained.
- Five legs were then flown along the Emasalo track at 1, 4, 6, 8, and 12 kft. Temperatures of 2.45°C and -0.2°C were observed at the 6 and 8 kft levels, respectively, bracketing the freezing level and bright band. Continued moderate precipitation was observed at the surface throughout the stack with slightly less intense rain at point 9 than point 8. Patchy clouds with bases ~1000 ft were prevalent along the entire leg. Significant cloud LWC was only encountered on the 6000 ft leg. Cloud tops were at least 9-10 km throughout the region.
- A second 500 fpm spiral was performed at Emasalo (point 17) from 12 to 1 kft to establish rainfall homogeneity relative to point 8. Once again intercepted the FL at 7700 ft and all particles were melted below 5600 ft. Cloud LWC was generally low below the freezing level, visibility was good down to the surface, and moderate rainfall was encountered below 5600 ft. The exception was an area of cloud on one edge of the spiral that contained surprisingly high cloud droplet concentrations (several hundred

- per cc) and high LWC between 1500 and 6000 ft.
- The aircraft then ascended from 1000 to 15000 ft to transit to point 6 for a spiral descent around the time of a CloudSat overpass at that location. This segment transected some lighter precipitation and drizzle with reflectivities between -5 and 0 dBZ near the surface. No visible evidence of precipitating ice was observed on the spiral descent but light drizzle was encountered below 6600 ft with cloud LWC  $\sim 0.3$  g/m<sup>3</sup>. Began a leg at 1 km altitude along the Kumpula track to point 5 at the time of the CloudSat overpass. Precipitation intensified along the leg with cloud LWC increasing to more than 1 g/m<sup>3</sup> and reflectivities increasing to more than 10 dBZ near the surface. After the overpass, this leg was repeated at 4500 and 6000 ft, all below the melting level.
  - Concluded the almost 4 hour long flight by returning to Turku at FL100 in continued light to moderate (but more variable) rainfall providing additional ice microphysics sampling at -3.3°C.
  -

**Notes:**

- This flight provided extensive sampling of the microphysical properties of stratiform rainfall.
- This case will be an excellent target for future modeling studies.
- This flight coincided with overpasses of both AMSU-B (on NOAA-17) and CloudSat.
- Spirals were conducted over both the RV Aranda and Emasalo ground sites to add a vertical dimension to ground observations.

## LPVEX-10 RF04

### Crew:

Wadsworth  
LeCuyer  
French  
Wechsler

### Mission:

Aim for 0745 Z takeoff, got off late waiting for fuel; although in the end it worked out just fine...conduct several legs over the water in clouds and precip. Forecast is for widespread light to moderate, stratiform precipitation---perfect LPVEC day.

### Weather at takeoff:

0737Z; 13 C/12 C; 180/07; vis 9.0 km; Hvy Rain; BKN005, OVC008

0755: Wheels up

On climb freezing level at 7900/8000 ft, precipitation can be seen all the way to the surface with a well-defined bright-band/melting layer on the WCR; tops appear to extend to 20 kft or higher.

Above 0 C level; very little liquid, but below, CLWC's measured as high as 0.8 g/m<sup>3</sup>.

0813: level at FL150, turn direct to Pt7

0821: noticed that filename was incorrect (a day off and about 3 hours) in lower right corner of KA\_DAS monitor→DATA SV TIMESTAMP was wrong, all other times are correct—{turns out not a problem with any of the data; only a system setup problem, this was fixed prior to next flight; all processed filenames were changed to correct date/time}

0830: need to change spiral location to Pt8 to avoid active Danger Area

083304: Reboot/Restart D/S prior to beginning spiral—forgot to stop radar (oops)

0836: D/S up and running; begin spiral to FL010, started new radar file

0851: at FL080, 0 C level

0852: FL074, bright band on WCR

0904: spiral complete, below cloud base at FL010

0905: begin Emasalo track, expect 5 legs; leg 1 at FL010

0913: end leg 1, climb to FL040 for next leg

0916: begin leg 2, FL040 (acutally we are below the ovc deck out here!)

0923: end leg 2, climb to FL060

0925: begin leg 3, FL060, in cloud, small CLWC's 0.1-0.2 g/m<sup>3</sup>; droplet concs incredibly low 30 /cm<sup>3</sup>, T 2.5 C

0932: end leg 3, climb to FL080

0935: begin leg 4 at FL080, T -0.2 C, few or no cloud particles (just precip)

0941: end leg 4, climb to FL120

0944: begin leg 5, FL120, T -7 C, no cloud water, lots of CIP and 2DP

0951: end leg

0952: transition to Pt17; reboot/restart data system

0954: everything back up, start new radar file

0957: begin spiral down to FL010

1007: 0 C level at 7000 ft

1009: getting into melting layer at 6400 ft

101030: at 550 ft, particles on CIP become perfectly round (completely melted)

1019: end spiral transition to Pt6—note that in lower part of spiral there are lots of water droplet (500+ /cm<sup>3</sup>) and lots of large aerosol—polluted air??

1020: begin climb to FL150

1036: at Pt6, begin spiral from FL150 dow to FL030 (cannot go lower due to active Danger Area); precip at surface has lightened up somewhat since leaving Emasalo track, Zsfc ~ 0-5 dBZ

1058: end spiral, setup for Kumpula track leg at FL030

1100: on track, begin leg 1 at FL030; CLWCs on this track 0.4-0.6 g/m<sup>3</sup>, droplet spectra centered on 20 microns, precip at sfc ~10dBZ

1108: end leg, climb to FL045

1108: reboot/restart in turn; begin no radar file

1112: begin leg 2 at FL045; seeing some more variability in WCR echoes at sfc

1118: end leg 2, climb to FL060

- 1121: begin leg 3, FL060
- 1122: CIP computer rebooted itself
- 1128: end leg, RTB do to fuel, fly back at FL100
- 1133: level at FL100

**DEBRIEF:**

**BY FAR—best weather flight for LPVEX to date**

Working with ATC pretty good today, were limited just a bit due to Active Danger area

BIAS which was issue on last flight looked find now, cleaning out line must have fixed problem.

There was an issue with how the Data System time got originally set—this caused a bad name for the data files (off by roughly 22 hours)....processed files have had names corrected, no issue with the times in the data files. We have a d/s upgrade to hopefully fix this problem.

CIP computer rebooted itself on the last leg of the flight

Stuck bit in the CIP probe in the end of the flight—likely something on the mirror

DDS crashed at the end of flight—no affect on data file.

Date: 19 September, 2010

Crew: Wadsworth, L'Ecuyer, French, Weschler

Objective: 1-Finding precipitation.

Planned: We expected some pretty decent precipitation throughout the areas over water, south of Helsinki. We planned to fly:

Pt 1-2-3, spiral descent just to the east of Pt. 3 as the good ship Aranda was supposed to be there. Then to Pt 8-9 at 1000'. Fly the Emasalo track four times, climbing to FL100, then to Pt. 7 for a spiral descent to 1000. Finish by flying to Pt. 5 at 1000' and working the Kumpula track, climbing each leg and finish at FL100.

Actual: Flew to Pt 1-2-3 at FL150. Did the spiral descent just to the east of Pt. 3. Didn't see the ship anywhere. Flew to the Emasalo track, executed as planned. Then asked to do a spiral descent at Pt 17. It was approved. Then flew to Pt. 3-2-5. Did some amount of the Kumpula track, climbing to FL100, then did a spiral descent at Pt. 5, as there was a decent rainshower occurring there. Then flew through Pt. 1 and returned back to EFTU at FL90. We checked in with Turku tower just a bit before two other aircraft who were put into holding at UTELI for the ILS as a CB had moved over the field.

N2UW: It looks like we have gotten past some of the issues that were plaguing the aircraft. The tarps over the engines are keeping a lot of water out and preventing additional issues from developing.

## September 19, 2010: Research Flight #3 - *Tristan L'Ecuyer*

### Summary:

We conducted a full research flight today in areas of scattered precipitation. Rainfall was very isolated, somewhat convective, and systems were very fast moving but we managed to intercept several cells particularly on the extreme western and eastern edges of the operations area. Both areas of precipitation were within polarimetric C-band radar coverage.

### Details:

- Scattered clouds and drizzle at take-off, temp. 10°C, light winds, and freezing level ~ 5500 ft on initial climb out of Turku. Wide-spread low cloud layer capped by a 600 ft thick isothermal layer at ~7300 ft.
- Between points 1 and 3, this lower layer appeared to be seeded by precipitating ice (mostly aggregates) from an overlying high cloud (first image). A spiral was conducted at point 3 in hopes of coordinating with the Aranda but no precipitation was present at the time.
- We then proceeded to the Emasalo track and performed stacked legs at 1, 4, 6, and 10 kft intercepting precipitation at the southernmost edge of that track (second image). Legs 2 and 3 bracketed the freezing level that was ~5600 ft but only leg 2 intercepted significant precipitation (air temperatures on leg 3 were -1°C).
- A few km north we performed a spiral at Emasalo from 10 to 1 kft encountering a few isolated but very wet clouds (LWC > 1 g/m<sup>3</sup>) with bases ~0.8 km on the descent.
- We then transited along the FIR leg between points 4, 3, and 2 at 1000 ft and sampled along the Kumpula track focusing on an area of stratiform precipitation at point 5. Two radials were flown between points 5 and 6 along with a race-track spiral at point 5 sampling rainfall from cloud base (~1.5 km) down to 0.3 km. Continued to sample rainfall below cloud base en route to Turku (third image).

### Notes:

- This flight provided microphysics sampling in the more convective rainfall regimes and may be useful for exploring inhomogeneity within the satellite field of view.
- To minimize saturation of the radar by the surface, transit legs should generally be conducted at or above 4 km unless conditions are well-suited for sampling rainfall.

## **LPVEX-10 RF03**

### **Crew:**

Wadsworth  
LeCuyer  
French  
Wechsler

### **Mission:**

Aim for 0645 Z takeoff, conduct several legs over the water in clouds and precip. Forecast is for pockets of rain; showery with BL clouds and embedded convection.

### **Weather at takeoff:**

0631Z: 10 C/09 C; 310@05, vis-3.0 km; few004; drizzle

0645: Wheels up

On ascent out noted cloud tops at FL073 w/ isothermal layer and significant drying above that;  
O C level at FL055

0656: level at FL150

0702: thin cloud deck below us around FL070, as we proceed SE we are beginning to see ice cloud above us, and cloud is thickening

0704: getting into base of ice cloud, 200-400 micron particles on CIP and 2DP in cloud; cloud shows up strong on radar.

0705: turn east at Pt 1; FL150

0708: at Pt2, turn to Pt3

0716: mid/upper clouds have thinned

0718: begin spiral descent over Pt Aranda (ship)

0744: end spiral, transition to Kumpula track

0746: during transition reboot/restart D/S

0749: system back up and radar is once again recording

0750: on track at FL010

0752: thru a rainshaft

0755: end leg, climb to FL040

0758: on track, leg 2 level at FL040

0806: end leg 2, climb to FL060

0813: end leg 3, climb to FL100

0817: on leg 4, level at FL100

082(?): end leg 4, transition to Emasalo Spiral

0827: at Pt, begin spiral descent to FL010, begin new radar file

0835: at FL050 in spial descent, through a precip shaft

0845: complete spiral, proceed to Pt3 at FL010 then onto Pt1, transition to Kumpula track

0849(51): stop recording, stop radar, reboot/restart D/S

0851(39): everything is back up

0854: noticed had been running radar in Up/Dn entire flight; change to Up/DualDown

0857: Pretty clear as we transition to Kumpula track

0915: begin leg 1 at FL010, Kumpula track looks dry, but rain maybe moving in from SW

0923: end leg 1; climb to FL040, begin leg 2, clear on this north end of line

0932: end leg 2, climb to FL060

0935: on course, decide to audible and climb to FL100, then return to south end for spiral descent (only precip is on very south end of line).

0943: level at FL100

0949: over Pt 5, begin spiral descent, in cloud

0956: thru the brightband at 5500 ft

1004: spiral is complete, transition to Pt 1 at FL010, then RTB

1007: at Pt 1, climb and RTB

1015: lost FSSP and 2DP, 1 hour 25 minutes

1035: wheels down

**DEBRIEF:**

Working with ATC pretty good today

Radio traffic with ops ground at times was distracting, need to limit communications

Operator error: ran Up/Dn mode in radar for first 2/3-3/4 of flight, should be running up/Dual down

BIAS is intermittent, Perry and Brent looked at after flight; expect that water in line or on transducer may be issue. Pilot display of BIAS looks OK.

Reboot/Restart D/S twice during flight, if goes smooth, lose about 2.5 minutes of data for each reboot.

Date: 18 September, 2010

Crew: Wadsworth, L'Ecuyer, French, Weschler

Objective: 1-Finding precipitation.

Planned: We expected some pretty decent precipitation throughout the areas over water, south of Helsinki. We planned to fly the Kumpula & Emasalo tracks and spirals at Pt. 17, Pt 7 and possibly Pt. 1.

Actual: Shortly after getting airborne, we experienced compressor stalls in the right engine – three total. Due to some issues which we had experienced the previous flight, the decision was made to secure the right engine and return to Turku. The problem was found to be a sticking bleed air valve.

Date: 16 September, 1020

Pilot: Wadsworth

Objective: 1-Finding precipitation if foul weather. 2-If nice weather, to just get into the airspace, work with the controllers, see how flexible they are; fly some of the tracks at low altitude to ensure there are no obstacles/obstructions for flight.

Planned: The notification sent the previous night had outlined a flight plan that remained over the water. During the morning brief, we found that the weather was pretty nice conditions (few clouds or rain) near Helsinki, so we changed the plan to attempting to fly over as many of the tracks/legs as we could at low altitude to verify terrain & obstacle clearance.

Actual: When we were finally airborne to the area, we found that there was a scattered to broken layer over the landmass around Helsinki. We flew the FIR leg 3 times, then the Emasalo track. Both tracks at 1000 feet MSL. I have no concerns about flying these or the spiral at Pt. 7 or the Kumpula track at 1000 feet. There are a few towers on some of the islands, but all of these are no factor as they appear to only be around 300 feet in height.

We also did two spiral descents over Pt. 1.

## LPVEX-10 RF01

### Crew:

Wadsworth  
LeCuyer  
French  
Wechsler

### Mission:

Aim for 0730 Z takeoff, conduct several legs over the water, hopefully in clouds and precip (though radar and forecast not looking promising at morning briefing). If clear skies, conduct some lower level legs to verify absence of obstacles along leg.

### Weather at takeoff:

0720Z: 12 C/11 C; 160 @08, vis-2.0 km; few011, ovc???: lite rain

0741: wheels up, following takeoff, climb towards FL150 at point on SWrn end of FIR leg

0752: level at FL150, in a layer of small ice, visually it looks clear; reflect ~-10dBZ, tops at ~18 kft, base of ice layer ~10 kft

0807: at Pt2, turned towards pt 3, got out of cloud/ice, low BL clouds over the water, well below us and WCR cannot see them

0817: at pt3, turned to pt 4

0822: at pt4, reverse course, back to pt 1

0830: at pt 3, turned to pt2

0832(15): **lost fssp and 2DP (and radaralt)**

0835: stopped radar from easiness of processing radar data

0838: noticed lost, reboot/restart data system from KADAS monitor, reconnected D/S, Perry started DDS. FSSP and 2DP look good. Began getting data from radaralt, but still messed up.

0843: at pt2, turn to pt 1

0846: at pt1, begin spiral down to FL010....no clouds to speak of...

0852: at FL115, descend out of bottom of layer of ice crystals

0911: end descent/spiral. At FL010, begin FIR leg

0929: at pt3, turn to pt4  
0935: at pt4, turn toward Emasalo track  
0939: at pt8, turning to pt7, on Emasalo track, cut leg short, no obstacles on track  
0940: climb to FL150, back to pt4, plan to fly FIR leg back to pt1  
0946: at pt4, turn to pt3, climbing through FL085  
0953: at pt3, turn towards pt2 at FL115  
1003(20): **lost FSSP and 2P (and radar alt)**  
1005(30): reboot/restart system, stop radar first  
1007: everything back up, fssp and 2DP reporting, radaralt data coming in but still looks hosed  
1007: looks like wcrserv died....disconnected control and display....ssh'd into kestrel, manually killed wcrserv and restarted....all ok  
1011: radar back running  
1039: on return to Turku; passing through some high LWCs with some graupel and ice, T~-6C  
1050: on ground

#### **DEBRIEF:**

Difficult for tech to see the pilot prior to startup, careful using hand signals so everyone is aware of issue

Seemed easier than expected to work with ATC

Weather not very conducive for experiment, but useful to get first flight under our belt

Vertical wind realtime calculation is wrong, appears to have 1-2 m/s bias almost the entire flight, horizontal winds look OK.

Radar alt was bad entire flight, but data appeared to be coming from it. Twice in flight (about 75 minutes into file both times) we lost reporting from FSSP, 2DP, and radaralt. Both times, a reboot/restart of the data system fixes it. Total data lost for this process is about 5 minutes.

Wcrserv died once, ssh'd into ferret and had to kill using 'kill' command. Was able to restart without issue. Lost data about 5 minutes.

Down camera image looked bad. After flight checked and saw a lot of condensate on camera window.

A lot of water dripping/condensate on the inside ports in the fuselage. Will have towels available to dry these in next flight.