



Biomass Burning Fluxes (BB-FLUX)  
 University of Wyoming King Air Research

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Release	Date	Changes
qc1		Field release
qc2	17 Oct 2018	Allow two PCASP probes in post-project tests. Project data files are unchange.
qc3	16 July 2019	Merge CO and O3 into the dataset. Use post-project flow calibrations for the PCASP probes.
qc4	16 Nov 2019	Add radiometer measurements to data files.
qc5	19 Dec 2021	Further corrections to the PCASP calibrations. Added Heitronics KT1585 downward IR temperature to processing

Date	Flight # (*.kml)	Status	Times (UTC)	Hours	Crew/Notes
17 Sep 2018	RF38	Instrument test flight. Fly around the Cache Valley near Logan. Landed in Logan to refuel.	1805-2009	2.2	E Sigel N Kille L Oolman K Zarzana
16 Sep		Second flight of day.	2201-		E Sigel N Kille

## Links







-  [WE-CAN field catalog](#)
-  [InciWeb - Incident Information System](#)

## Order BB-FLUX Data

-  [Flight Notes](#)
-  [Lidar and PCASP quicklooks](#)
-  [King Air 1 Hz files](#)
-  [King Air high rate 25 Hz files](#)
-  [Zenith Cloud Lidar](#)
  -  [Level 1](#)
  -  [Level 0](#)
-  [University of Colorado SOF Data](#)

2018	RF37	More loops around the Cache Valley.	2353	1.9	L Oolman K Zarzana
16 Sep 2018	RF36	Flight to test instrumentation. Flew around magnesium plant on the Salt Lake, over salt and brine, and around the Cache Valley near Logan. Landed in Logan to refuel.	1715-2026	3.3	E Sigel N Kille L Oolman K Zarzana
15 Sep 2018	RF35	Second flight of the day. Fly down wind of Pole Creek/Bald Mountain Fires in northern Utah and southern Wyoming.	2032-2340	3.3	E Sigel N Kille L Oolman K Zarzana
15 Sep 2018	RF34	Ferry from Redmond, OR to Provo, UT. Explore the Pole Creek/Bald Mountain Fires.	1513-1839	3.5	E Sigel N Kille L Oolman K Zarzana
8 Sep 2018	RF33	Second flight by the Teepee Fire southeast of Bend, OR. When the winds switched from the north, the plume became disconnected from the fire and drifted to the east.	2228-0020	2.0	E Sigel N Kille L Oolman K Zarzana
8 Sep 2018	RF32	First flight by the Teepee Fire southeast of Bend, OR.	1844-2139	3.0	E Sigel N Kille L Oolman K Zarzana
7 Sep 2018	RF31	Ferry from Yakima to Redmond	2303-2353	0.9	E Sigel B Howard L Oolman

## User Information

-  Planning Chart
-  EOL Facilities
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-  Planning and tracking tools
-  Facility User's Guide

## Facility Instruments

-  In Situ
-  Wyoming Cloud Radar
-  Wyoming Cloud Lidar

## Contact

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					K Zarzana
7 Sep 2018	RF30	Second day for the Miriam Fire. Refuel in Yakima.	1825-2123	3.1	E Sigel K Zarzana L Oolman B Howard
6 Sep 2018	RF29	Second flight of the day for the Miriam Fire. Take off from Yakima.	2211-0046	2.6	E Sigel N Kille L Oolman K Zarzana
6 Sep 2018	RF28	First flight of the day for the Miriam Fire that is southeast of Mount Rainier. Refuel in Yakima, WA.	1839-2102	2.5	E Sigel N Kille L Oolman K Zarzana
5 Sep 2018	RF27	Ferry from Boise, ID to Redmond, OR. Fly the Terwilliger Fire.	1651-1951	3.1	E Sigel N Kille L Oolman K Zarzana
31 Aug 2018	RF26	Study the Steward Creek Fire. The Licor 7500 was set to 1 Hz for the duration of the project.	1953-2321	3.6	E Sigel K Zarzana L Oolman B Howard
28 Aug 2018	RF25	Satellite overpass and intercomparison with C-130 in Boise urban plume. No Li-7500 measurements.	1929-2248	3.4	T Drew K Zarzana D Plummer N Kille
26 Aug 2018	RF24	Second flight of day, Lagrangian sampling downstream of Watson Creek fire.	2136-0019	2.8	T Drew R Volkamer D Plummer N Kille
26 Aug	RF23	First flight of day, transit from Redding and sample Mendocino	1655-	3.8	T Drew R Volkamer

Facility Manager:  
**Jeff French**



2018		and Watson Creek fires before refueling at Klamath Falls.	2037		D Plummer N Kille
25 Aug 2018	RF22	Second flight of day, sample around Watson Creek fire with brief transit by Hirz fire, basing in Redding.	2158-0034	2.7	T Drew R Volkamer D Plummer N Kille
25 Aug 2018	RF21	First flight of day, transit from Redding and sample around Watson Creek fire before refueling at Klamath Falls.	1707-2059	4.0	T Drew R Volkamer D Plummer N Kille
24 Aug 2018	RF20	Second flight of day, sampled around Watson Creek fire and Stone fire; Based overnight in Redding, CA (RDD).	2052-2351	3.1	T Drew R Volkamer D Plummer N Kille
24 Aug 2018	RF19	First flight of day, sampled around Watson Creek fire before refueling at Klamath Falls.	1615-1945	3.5	T Drew R Volkamer D Plummer N Kille
23 Aug 2018	RF18	Sampled around South Sugarloaf fire; satellite underpasses north of Boise.	1756-2149	4.0	T Drew K Zarzana D Plummer N Kille
20 Aug 2018	RF17	Second flight of day, sampling around Sheep Creek fire in Nevada coinciding with C-130 measurements.	2016-2315	3.1	T Drew N Kille D Plummer K Zarzana
20 Aug		First flight of day, Sheep Creek fire in	1715-		T Drew N Kille

2018	RF16	Nevada. Refuel early at Elko to be onstation with C-130.	1908	2.0	D Plummer K Zarzana
19 Aug 2018	RF15	Second flight of day, focusing on Watson Creek fire in Oregon.	2035-0019	3.8	T Drew K Zarzana D Plummer B Howard
19 Aug 2018	RF14	First flight of day, focusing on Watson Creek fire in Oregon. Refuel at Klamath Falls. <b>Secondary PCASP operated beginning on this flight.</b>	1628-1928	3.1	T Drew K Zarzana D Plummer B Howard
15 Aug 2018	RF13	Transects and profiles around Rabbit Foot plume, with simultaneous measurements at different altitudes with C-130. No PCASP/Aero Laser CO/WCL measurements.	1941-2324	3.8	T Drew R Volkamer D Plummer C Lee
12 Aug 2018	RF12	Second flight of day, primarily focusing on Rabbit Foot fire. No PCASP measurements.	2228-0122	3.0	T Drew N Kille D Plummer K Zarzana
12 Aug 2018	RF11	First flight of day, focused on background profiling and plume from Rabbit Foot fire.	1709-2036	3.6	T Drew N Kille D Plummer K Zarzana
9 Aug 2018	RF10	Targeted smoke centered in vicinity of Rabbit Foot fire,	2000-	3.2	T Drew R Volkamer

		primarily for crew and procedure familiarization.	2306		D Plummer B Howard
8 Aug 2018	RF09	Targeted plumes from Sharps and Rabbit Foot fires.	2004-2330	3.6	B Wadsworth N Kille D Plummer K Zarzana
4 Aug 2018	RF08	Return to Sharps Fire. Less smoke than the previous day.	2211-0055	3.8	B Wadsworth N Kille L Oolman K Zarzana
3 Aug 2018	RF07	Second flight of the day. Study plume downwind of the Sharps Fire. The plume was distinctly lofted on the south end. A corrupt file caused loss of data 2326-0001.	2216-0115	3.1	B Wadsworth C Knote L Oolman N Kille
3 Aug 2018	RF06	Survey flight around the Sharps Fire.	1713-2108	4.0	B Wadsworth R Volkamer L Oolman C Lee
2 Aug 2018	RF05	Intercomparison with the C130. Flew past southern end of the broad plume from the west coast fires and then flew most of the way to the northern end.	1857-2243	3.8	B Wadsworth C Knote L Oolman N Kille
		Flew near the western border of Idaho to studied background smoke from the west coast fires. Extended to the north of the edge of	1843-		B Wadsworth C Knote

1 Aug 2018	RF04	the smoke. Did one pass downwind of the Mesa Fire. First flight after the repair of the coupler for the azimuthal motor on the SOF.	2117	2.7	L Oolman N Kille
26 Jul 2018	RF03	Flew downwind of the MM73 HWY55 Fire and then worked the Keithly Fire.	2011-2335	3.5	B Wadsworth R Volkamer L Oolman N Kille
24 Jul 2018	RF02	Flew the Rattlesnake Creek fire	1945-2319	3.6	B Wadsworth R Volkamer L Oolman N Kille
21 Jul 2018	RF01	Flew two circuits around the Reynolds Lake fire on the Idaho/Montana border.	2103-0035	3.6	B Wadsworth R Volkamer L Oolman N Kille

### Test Flights

4 Feb 2019	TF09	Dual PCASP intercomparison, WCR reinstalled. No 2D-S measurements.	2147-2314	1.5	B Wadsworth S Fuller D Plummer K Spradley
22 Oct 2018	TF08	Test of CIP/2D-S, 1 PCASP operational.	1926-2102	1.7	T Drew J Snider D Plummer A Morgan
28 Sep 2018	TF07	Test of dual PCASP probes.	1902-2022	1.5	B Wadsworth J Snider L Oolman S Fuller
					E Sigel

17 Sep 2018	FF02	Ferry from Logan, UT to Laramie.	2142-2257	1.2	N Kille L Oolman K Zarzana
31 Aug 2018	TF06	Pilot familiarization flight, no data recorded.	0000-0000	1.3	E Sigel T Drew L Oolman
9 Aug 2018	TF05	Pilot familiarization flight, no data recorded.	0000-0000	0.5	T Drew
18 Jul 2018	TF04	Test flight to the Reynolds Lake Fire. The Licor 7500 was in a mode that output labels. The processing would need to be re-written to handle it.	2105-2341	1.2	<b>B Wadsworth</b> N Kille L Oolman C Lee
17 Jul 2018	FF01	Ferry to Boise, ID	2105-2341	2.7	B Wadsworth N Kille L Oolman C Lee
15 Jul 2018	TF03	Flew a circle around and two legs downwind of the Jim Bridger power plant. Overcast with light rain at Laramie.	1821-2005	1.8	B Wadsworth L Oolman N Kille K Zarzana
10 Jul 2018	TF02	Test of SOF downwind of Wheatland powerplant, high altitude leg for the calibration of the Lidar.	2222-2350	1.6	B Wadsworth L Oolman C Lee N Kille
6 Jul 2018	TF01	Initial test flight of equipment	2041-2229	1.9	E Sigel D Plummer B Howard N Kille



Flight Hours

As of Feb 04, 2019, 119.6 out of 112 research hours were flown, -7.6 remain.

Test and Ferry: 16.9

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## **09/17/2018 BBFLUX Pilot notes (Research Flight 38 and 39)**

Crew. Sigel, Oolman, Zarzana, Kille.

Flight Time: 5.2

**Planned:** Takeoff from PVU at 11:00 file on an IFR flight plan to Logan (LGU) through the class B airspace. Fly to LGU and do air quality testing about 2000 AGL in the Cache valley. Land at LGU to refuel and reposition to LAR on Flight 39.

### **Research Flight 36**

**Actual:** Departed PVU at 11:00. Filed IFR to fly though the SLC class B airspace. Started at 14000 MSL.

We flew directly to the LGU airport. I canceled the IFR clearance 20 miles from LGU to get lower. We continued our same race track type pattern around the valley that we followed to the T. Once again no one brought a fork and I forgot. We made about 6 full turns around the valley at 2000 MSL. I was asked to make ascending turns to 17500 MSL and descend back 2000 AGL while in the same turn. At the same predetermined spot as we did the day before. Traffic was heavy at the airport and I was unable to perform this in the same place. We went about 10 miles to the North West and preformed the maneuver. We then landed at the Logan airport.

### **Research Flight 37**

**Actual:** Departed LGU at 15:30 IFR. Laramie Direct very uneventful.

## 09/16/2018 BBFLUX Pilot notes (Research Flight 36 and 37)

Crew. Sigel, Oolman, Zarzana, Kille.

Flight Time: 5.2

**Planned:** Takeoff from PVU at 11:00 and file a VFR flight plan to Logan (LGU) under the class B airspace. Midway through the flight, circle a magnesium manufacturing plant and make several passes 5 miles to the north east at 500 ft. AGL. Continue the flight to LGU and do air quality testing about 2000 AGL in the Cache valley. Land at LGU to refuel continue the air testing and then return to PVU VFR.

### **Research Flight 36**

**Actual:** Departed PVU at 11:00. Filed VFR to fly to around the SLC class B airspace. Started at 8500 MSL picked up our VFR flight following. Headed towards to magnesium plant which sat in a large open valley. The valley had two restricted airspace in it. I had Salt Lake center pointing out traffic coming off the fire. I avoided them by flying lower and they lost radar contact with me. They were getting terrain alerts. This seemed to make them angry so they canceled my VFR flight following. I just stayed low and out of there airspace. There was no traffic in the area. We circled the plant from the south at 500 feet AGL about 5 miles away. We could have gone lower but it was hard with the white salt flats making out the horizon. We then stayed low and traveled to the Cache valley. We flew directly to the LGU airport. We had set up a race track type pattern around the valley that we followed to the T. we made about 3 full turns around the valley at 2000 MSL. We then landed at the Logan airport 9000 ft runway.

### **Research Flight 37**

**Actual:** Departed LGU at 13:00 VFR. Continue the flight on the exact same flight pattern this time counter clockwise. No one had a fork so I was unable to put it in my eye. We flew the same pattern about 5 times. Made one accent to 17500 MSL in a turn and descended in the same turn. After this we returned to PVU at low level which changed the view and was fun. On landing they were calling for birds on the runway. Yep they were there and we took one on the left wing. I inspected the aircraft after landing and there was no damage. Very small birds.

## **09/15/2018 BBFLUX Pilot notes (Research Flight 34 & 35)**

Crew. Sigel, Oolman, Zarzana, Kille.

Flight Time: 6.8

**Planned:** Takeoff at 8:00 Reposition to Provo, Utah to Pole Creek Fire. File IFR for the flight over cancel IFR. Circle the TFR to looking at terrain. Fly over the TFR from the east to the west. Fly profiles till we topped the fire. Setup a route around downwind on the north east side of the TFR as low as terrain and visibly permit. Fly low level under the plume and ascend and descend on same track. Return to Provo for refueling if time permitted we would return to the TFR.

**Actual:** Departed RDM at 8:00 on **Research flight 34** IFR. We Flew to PVU and canceled. Flew VFR around the fire and TFR. We approached the TFR from the North West side at 17500 feet MSL. The TFR had no Aircraft on it. We were able to raise the Air Attack on the given frequency and they were expecting us. They informed us that there weren't many aircraft due to high winds and low visibility. After we circled the TFR we looked at flying down a valley that we had planned on in the morning. I did not like how tight it was to the TFR and how close it was to the peaks. I started down the valley and the visibility was very little and could see that it was going to get worse as we went. I pulled up and turned towards the TFR and mad a 180 and refused to fly lower or towards our planed rout. Larry backed this decision. At this point they were frustrated but did not argue with my decision. Seeing that this was not going to happen they decided that we should land early regroup and find something I might fly. We landed in PVU.

### **Research flight 35**

Departed PVU at 13:00 on an IFR flight plan. We flew over the highest terrain and then descended to about 1000 feet AGL over Heber (HCR). We circled HCR up to 17500MSL and descend back to a 1000 AGL. I then dropped the IFR clearance and picked up VFR flight following. I was asked to fly the valley to the south from Heber towards Strawberry reservoir. Once again I started down the valley and started to lose visibility and refused. Once again Larry backed me on this decision. We then flew northeast to the north side of the Elizabeth Mountains. On the north side we climbed up to 9500 MSL and over flew to the east. We started our east legs at approximately 2000 feet AGL, The plume here was more detached and there was fair visibility under it. I familiarized myself with the terrain and we got lower and were able to stay under the plume. We made 6 passes east and west. After the last pass to the east I picked an IFR clearance back up with the same squawk. We were about directly under the plume we climbed up to 18000 MSL and descended to 15000 4 times. The plume was right between us and PVU so I worked well. PVU was calling for 2 miles visibility so we did the ILS for RWY 1.

## **09/08/2018 BBFLUX Pilot notes (Research Flight 32 & 33)**

Crew. Sigel, Oolman, Zarzana, Kille.

Flight Time: 5.0

**Planned:** Takeoff at 11:30 to Teepee Fire. Fly as low as comfortable. Circle the TFR to look at terrain. Fly over the TFR to the east. Fly profiles till we topped the fire. Setup rout around downwind on the south east side of the TFR as low as terrain and visibly permit. Fly low level under the plum ascend and descend on same track. Return to Redmond for refueling if time permitted we would return to the TFR.

**Actual:** Departed RDM at 11:20 VFR. We Flew to Teepee fire. We approached the TFR from the north east side at 17500 feet MSL. The TFR Had Aircraft all over it and looked to be a mess waiting happen. It was not we encountered very little traffic the rest of the day. We flew over the highest terrain and then descended to about 1000 feet AGL. We circled the TFR again and once on the west side we climbed up to 9500 MSL and over flew the TFR to the east. We started our north south legs at approximately 2000 feet AGL, The plume was very detached and there was good visibility to under it. As I familiarized myself with the terrain we got lower and were able to stay well under the plume. We made 8 pass north to south. And 2 profiles to 10000 feet MSL. After the last profile we returned to Redmond.

Research Flight 31 took off at 14:20 and headed back to the Teepee fire TFR. We started by flying low level on the previous scouted north south legs. Approximately 4 legs in all. The smoke was starting to dissipate and was becoming less visible. We climbed up on the south side of the TFR then over flew it and descended on the east side to 1000 feet AGL. The plume had detached from the fire and was floating to the east. We climbed back up and followed the plume east at 15000 MSL. Climbing and descending from 1000 AGL to 15000MSL. The fire had basically been put out and was no longer viable. We returned to Redmond.

## 09/07/2018 BBFLUX Pilot notes (Research Flight 30 & 31)

Crew. Sigel, Oolman, Zarzana, Howard.

Flight Time: 4.0

**Planned:** Takeoff at 11:30 file IFR to Cascade Lock State cancel there and explore a prescribed burn at the base of mount Adams in the Lewis river valley. Fly to Miriam fire and repeat the legs from Research flight 28 and 29. Fly as low as comfortable. Fly profiles till we topped the fire. Setup rout around downwind on the north east end of the fire as terrain and visibly permit. Fly low level under the plum ascend and descend on same track. Return to Yakima for refueling and if cloud cover permitted we would return to the fire. Expected weather was calling for High clouds that would move in and make further research difficult. If weather did move in we would reposition to RDM.

**Actual:** Departed RDM at 11:25 IFR. We Flew to Cascade and descended towards mount Adams. Started out to the North at 7500 MSL. Visibility was very good. After reaching 7500 we hit our first point on our pre decided plan and continued our rout. The terrain was high to the north so I kept my Altitude. We circled the prescribed burn and I was mostly out and had very little smoke. After one circle we proceeded to the Miriam fire. The visible and familiar Terrain made easy to get low in the valleys again. The fire was not putting out a really good plum. We made 9 low passes around the north and east side of the fire on the preselected rout. As the clouds started to move in they were having trouble losing the sun. Do to this we proceeded to Yakima. Get fuel in Yakima they decided to head back to Redmond. I Filed IFR back to Redmond the flight was uneventful.

## 09/06/2018 BBFLUX Pilot notes (Research Flight 29)

Crew. Sigel, Oolman, Zarzana, Kille.

Flight Time: 2.6

**Planned:** Takeoff at 14:30 Fly low level to Miriam fire on pre-selected route. Fly as low as comfortable. Fly profiles till we topped the fire. Setup rout around downwind on the north east end of the fire as terrain and visibly permit. Fly low level under the plum ascend and descend on same track. Return to Redmond for the night.

**Actual:** Departed YKM at 14:30 VFR. Started out to the West at 7500 MSL. Visibility was still very good. After reaching 7500 we hit our first point on our pre decided plan and continued our rout. The terrain was very visible and familiar so it was very easy to get low in the valleys. The fire was putting out a really good plum now and there was good visibility around it. We made 6 low passes around the north and east side of the fire. As the day went on and the light and visibility started to decrease. This was exacerbated by the angle of the sun. Descending into the valleys was limited by visibilities. On the last low leg looking towards the sun the hills would turn black and I advised the crew that we would no longer be doing low legs in the valley. They agreed and asked for a vertical profile to the top of the smoke which we did to 15000 MSL. After that they ask for a decent back in to the valley over the fire. At this point I was less than enthusiastic about descending because we had lost visual contact with the ground and were basically VFR on top. This was due just to the angle of sun hitting the clouds and turning it white. At no time was the visibility less than 3 miles. My decision was reaffirmed when I noticed that the terrain feature on the iPad was now not working. I thought that the battery had gone dead and said that I would not continue with the research. On the leg back to Redmond I discovered that I had the vision had stuck to the right. I was able to correct this enroot to RDM. I tried to pick up an IFR back to RDM but was unable do to the load on the controllers. I settled for VRF flight following proceeded to RDM for landing.

## 09/06/2018 BBFLUX Pilot notes (Research Flight 28)

Crew. Sigel, Oolman, Zarzana, Kille.

Flight Time: 2.5

**Planned:** Takeoff at 11:30 Fly low level to Miriam fire on pre-selected route. Circle the fire and look at terrain. Lower as comfort level increased. Fly profiles till we topped the fire. . Setup route around downwind on the northeast end of the fire as terrain and visibly permit. Fly low level under the plume, ascend and descend on same track. Land in Yakima to refuel and continue the research as before for Research flight 29.

**Actual:** Departed RDM at 11:30 VFR. Started out to the east at 17500 MSL. Visibility was good and very little smoke. After reaching 17500 we had our first point on our pre decided plan changed while we were in rout. The navigation point was not far from the first and I had plenty of time to review so we changed our first point. Descended to about 2000 feet AGL and continued towards the Miriam fire. We circled the Fire and looked at the terrain around it. The fire was putting out a good plum and there was good visibility around it and in the valleys. We mad multiple low passes around the north and east side of the fire. Each time I was able to get lower as I understood the terrain. It helped that the tops of the terrain is very low as far as an MSL altitude. We flew most legs between 500 and 1000 AGL and only had to come up to 2000 AGL for the wilderness areas. After our legs to the north and east of the fire we over flew the fire directly at about 12000 MSL and descended to about 4000 MSL on the other side. We were asked to refuel before we were close to our limit on fuel. Hoping that the plum would increase later in the afternoon . We proceeded to Yakima, which was about a 15 minute flight.



## BB-FLUX RF28 (2018-09-06)

Ed Sigel, Natalie Kille, Larry Oolman, Kyle Zarzana

LOD: Brent Glover

**Mission:** Fly the Miriam fire southeast of Mount Rainier

1839 Take off  
1845 Gap in haze visible to right of aircraft and in the Lidar data.  
1850 FL150 PCASP conc 5000 cm<sup>-3</sup> with distinct peak around channel 16. Not many counts in low channels.  
1851 FL166, T=-7 C, DP=-28 C, winds 18 kt from 220 degT, O3=70 ppb, CO=1.3 ppm  
1858 FL188 out of smoke  
1901 FL200, T=-15, DP=-45, winds 16 from 235, O3=30, CO=60, PCASP=40  
1907 FL150, in clear gap with thick smoke layer 2-4 kft above us.  
1922 Unable to get out from high level smoke layer. Reversing course and heading to the Miriam Fire.  
1928 FL075, T=17, DP=1, winds 6 from 200, O3=27, CO=130  
1950 Appear to be west of high level smoke layer. In situ CO rising slowly, now at 225 ppb. Top of low level Lidar returns extend to about 13,000 ft msl.  
2003 Starting to see layer at around 13,500 ft msl. Thicker low level layer extends to about 8,000 ft msl  
2024 WCL seeing smoke from Miriam Fire extending about 4 kft above us (to 10,000 ft). Plume is tracking north of fire  
2030 East of fire, turning back to north  
2039 NW of fire, climbing to FL100  
2041 FL090, out of regional plume  
2045 Descending back into smoke  
2103 Land

## 09/05/2018 BBFLUX Pilot notes (Research Flight 27)

Crew. Sigel, Oolman, Zarzana, Kille.

Flight Time: 3.1

**Planned:** Takeoff at 11:30 climb to 20000 ft. MSL reposition to Redmond area and fly on the Terwilliger fire. Setup rout around downwind on the north east end of the fire to fly low level under the plum ascend and descend on same track. Return as low level to Redmond refuel and return to the Terwilliger fire and repeat.

**Actual:** Departed BOI at 11:30. Filed IFR to fly to Redmond. Started decent into Redmond and asked for VFR flight following. Headed to the Terwilliger fire. On the way to the fire was asked to circle mount Bachler which I did at 2000 AGL. We proceeded to the fire and circle the outside of the TFR on planed route. I canceled the flight following. Visibility was very low with smoke. We started flying legs on the north east side of the TFR and they were very tight to the TFR Airspace. The valleys were very narrow and there were wilderness areas that prevented low flight. Air attack did not respond and there was no traffic in the area. We made approximately 4 passed back and forth a crossed our planed route. There were multiple layers of smoke which would take the visibility form fair to marginal with little heads up. We were getting close to my fuel estimation so we started back to Redmond. On the way we proceeded back along the west side of the TFR and thought that we may be able to get lower on this side. As we descended visibility went from fair to very marginal VFR. We climbed out and got into better visibility and flew to Redmond.

## BB-FLUX RF27 (2018-09-05)

*Ed Sigel, Natalie Kille, Larry Oolman, Kyle Zarzana*

*LOD: Brent Glover*

**Mission:** Reposition aircraft to Bend, OR. Fly around the Terwilliger Fire

**Pre-mission:** cycle power on Aerolaser to get rid of intermittent data

1651 Take off  
1706 FL175, top of boundary layer  
1725 FL200 T=-17, DP=-39, winds 27 kt from 210 degT, O3=41 ppb, CO=62 ppb, pcasp=80 cm-3  
1731 Under cirrus  
1734 Starting slow descent  
1740 Slight 'S' turn to improve MMQ heading  
1748 FL100, T=11, DP=-13, winds 19 from 210, O3=35, CO=125  
1750 Descend to FL080  
1807 FL084 near Mt Bachelor, T=13 DT=-2 winds 6 from 200, O3=28, CO=200  
1810 Start climb to FL175  
1819 FL175, T=-9 DP=-26, winds 21 from 210 O3=21, CO=64  
1820 Start descent. From satellite, it appears the smoke is staying low and flowing to the west above the McKenzie River.  
1822 Rapid increase in CO from 80 ppb to 230 ppb  
1827 FL053, SW of TFR, T=20, DP=3, winds 9 from 220, O3=26, CO=280  
1831 FL043 Turn to E, north of TFR. Thick smoke below, above the river.  
1832 Climb for higher terrain and visibility. CO=550, PCASP up to 6000  
1855 Following McKenzie River to see survey area  
1924 On NW side above McKenzie River, visibility decreasing.  
1925 Climb out of smoke layer  
1926 FL036  
1941 FL115 to SE of TFR  
1952 Land

## **08/312018 BBFLUX Pilot notes (Research Flight 26)**

Crew. Sigel, Oolman, Zarzana, Howard.

Flight Time: 3.5

**Planned:** Takeoff at 1:30 climb to 11500 ft. MSL fly low level around the Stewart creek fire. Second set up rout at south east end of the fire to fly low level under the plum ascend and descend on same track at 9500 10500 and 15500. Return as low level to Boise.

**Actual:** Departed BOI at 13:30 asked for right hand turn to a heading of 090 at 11500. After departure we were asked to turn to the right for traffic. We were able to get across the centerline of both runways and fly strait. After reaching the fire we had trouble getting the Stewart creek fire air attack to respond. I was able to make contact with them after they switched air attack controllers. We proceeded to circle the fire on the proposed track visibility was good. We started on our south east legs 10 altogether back and forth at the planed altitudes. The low leg could not be perform to the north due to rising tron. The south bound legs had difficulties due to the helicopter base and houses. Multi diversions were required for both. The visibility gradually became worse but was never less than 5 miles. We returned to BOI at 8500 ft. on as straight as line as we could to reset the instrument.

## BB-FLUX RF26 (2018-08-31)

Ed Sigel, Kyle Zarzana, Larry Oolman, Ben Howard

LOD: Ben Heesen

**Mission:** Fly the Steward Creek Fire east of Boise

**Pre-mission:** AV did not see forward camera. Replugged Ethernet cable on the AV computer. Needed to cycle power on Aerolaser to get it to send data.

1954 Take off  
2003 FL115, T=2, DP=-18, winds 19 kt from 265 degT. CO=90 ppb, O3=36 ppb  
2008 Start descent into a box pattern around the fire.  
2026 WCL display not updating. Cycled record button.  
2028 South of fire. Plume only weakly getting over ridge.  
2032 Working N-S leg downwind of fire. FL076. CO up to 180 ppb. PCASP up to 3000 cm-3  
2036 Reverse towards south. Climb to FL096  
2040 FL096, T=10, DP=-2, winds 7 kt from 246, CO=165, O3=29  
2041 Descend and reverse towards north  
2050 Lidar computer rebooted  
2100 Climb until out of boundary layer and then spiral down on south end  
2107 Start climb  
2109 FL078  
2114 Southbound  
2121 South end at FL053  
2129 North end at FL103  
2137 South end  
2144 North end  
2152 Start profile  
2159 Descending from FL155 at north end  
2214 Heading north and climbing  
2226 Back to south end of track  
2302 On low track back to Boise  
2321 Land

## **8/28/18 BB-FLUX Pilot notes (Research Flight 25)**

**Crew:** Drew, Zarzana , Plummer, Kille

**Flight Time:** 3.4

**Planned:** Takeoff at 13:15, climb to 15,500 ft. MSL and orbit POTSY intersection. C130 will orbit at POTSY at 14,500 until getting into position. Fly five minutes each at 15,500, 9,500, 5,500 ft. MSL and then low approach at Boise. Fly low-level to circle point, and fly three nm circles around point at 500 ft. AGL. C130 will climb to altitude and spiral over the point to 1000 ft. AGL and back up. After C130 leaves King Air will spiral up and do circles at three altitudes and then return to 500 ft. for another circle and return to Boise low-level.

**Actual:** Science equipment delayed takeoff by 15 minutes. Departed Boise and climbed to 17,500. Descended down to 8000 ft. then back up to 15,500 ft. MSL and started the orbit. After C130 reported in position made a left 270 and headed towards Boise flying at 15,500, 9,500, and 5,500 for five minutes each and maintaining 170 kts. Slowed to 150 kts on final and the C130 fell back and to the left. After the low approach departed airport to the northwest low altitude, C130 continued ahead to high altitude. Just south of the waypoint, had a Mode A only traffic target in our immediate vicinity, diverting off to the north to clear once acquiring visual contact.

Entered the three nm circle at 3500 ft. MSL and reported to the C130. They made their spiral down to 4000 ft. and reported the King Air in sight, then spiraled back up and departed the area. After they left, climbed to 17,500 ft. MSL and did another orbit. However, Boise called and vectored us to clear a United flight climbing from Boise. Returned to circle and stepped down back to 3500 ft. MSL before returning to Boise.

**Project:** BB-FLUX18

28 Aug 2018

**Flight:** RF25

*Notes:* Flight planned around intercomparisons with C-130, focusing on Boise urban influence as there are no suitable fire plumes nearby. Three maneuvers planned - join up NW of Boise and do five minute straight and level legs at 15.5 kft, 9.5 kft, and 5.5 kft enroute back to Boise; a low approach over BOI; maintain circle at minimum altitude (~500 ft AGL/3.5 kft MSL) while C-130 completes descending and ascending vertical spiral. Also planned a few profiling maneuvers before and after C-130 coordination.

No Li-7500 measurements, instrument was outputting header information (as in TF04). Flight was already delayed due to issues & maintenance on power strip for CU instruments, so no time to correct ahead of takeoff.

Crew: Drew, Zarzana, Plummer, Kille

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*Flight Summary:*

UTC Comment

1929 Wheels up

1931 Cycled Aero Laser power, data had been spotty after last calibration cycle on the ground.

1943 At 17.5 kft, down to 16.5 kft; we have some time before C-130 joins up.

1946 Down to 8 kft prior to rendezvous - may be CO layer below to sample later.

1954 Ascend back up to 15.5 kft for joinup with C-130.

2006 Orbiting at 15.5 kft.

2010 C-130 in sight.

2017-2022 Straight and level at 15.5 kft, C-130 to right and offset back a bit.

Descend to 9.5 kft, still lined up.

2028-2034 At 9.5kft.

2034 Descend to 5.5 kft.

2039 C-130 maneuvering to our left for 5.5 kft leg and low approach.

2040-2045 5.5 kft measurements.

2045 Slow to 150 kt for low approach, start descent.

204830 At 60' AGL over runway.

2049 Out of low approach, head to spiral point NW of Boise.

2056 Dropping to 500 ft AGL, maneuver for traffic before getting circle set.

2059 At 3.5 kft, setting in 3 nmi right circle.

2102 C-130 in descent from 17.5 kft, will level at 4 kft outside our turn radius.

2117 C-130 outside our turn at low altitude.

2121 C-130 back in climb.

2136 C-130 heading home, we'll finish this circle then ascend to 17.5 kft for three more samples.

2140 Ascending spiral to 17.5 kft, will do Aero Laser calibration after finishing ascent.

2151-2157 Note, did two Aero Laser calibrations, then continue circle at 17.5 kft after maneuvering for traffic.

2205-2211 Descend to 8.5 kft for additional circle.

2211 On circle at 8.5 kft.

2218-2222 Descend to 3.5 kft for final circle.

2222 Circling at 3.5 kft.

2232 Heading south.

2237 Return to Boise.

2248 On the ground.



## **8/26/18 BB-FLUX Pilot notes (Research Flight 23-24)**

**Crew:** Drew, Volkamer, Plummer, Kille

**Flight Time:** 3.8 / 2.8

**Planned:** Takeoff at 10:00, fly planned route around Mendocino fire low level, and conduct a profile on the return route. Reaching north end of the track, fly to Redding and then towards the Watson Creek Fire. Overfly the TFR and fly established low-level leg. Climb over TFR before heading to Klamath Falls to refuel. Return to Watson Creek over the TFR and descend setting a new roughly north-south leg on the lee side and two more parallel about 20 nm apart. Then ferry to Boise.

**Actual:** Departed Redding climbing above haze layer and back down on way to north waypoint of the Mendocino track. Flew the pre-planned track around the mountains and TFR at low level. Reaching the southern end of the TFR did a climbing 180 turn north to 10,500 ft. MSL and back down and continued track to east. Reaching the eastern end-point reversed course climbed to 9,500 and back down to low level prior to turning northbound. Followed track to the north until reaching the north side of the TFR and the mountains, then got off the established track and followed the terrain to the north. Climbed to 5500 ft. MSL and flew south towards north end of TFR directly for the active Heli-base. Noticed a mode A only transponder target over the heli-base, so we turned to the east early to avoid. Then returned to the north at low-level again following terrain west of the track announcing our intention to those on the TFR frequency, I don't think they had an Air Attack airborne. About 10 nm north climbed to 10,500 ft. MSL reversing course over the foothills, before turning direct Redding and continued towards Watson Creek.

Decided to descend into the valley south-east (KLKV) of Watson Creek and then join the established NW-SE line at low level. Flew it at 5400 ft. MSL and returned at 7500 ft. MSL. Reversed course and flew over the TFR and then descended to low-level enroute to Klamath Falls.

After refueling, set up a north south line that could then be offset 20 nm. Departed Klamath, overflew TFR and then descended in a spiral on SE side of TFR and rejoined established low-level leg to the NW. Reversed course quite early back to the SW and continued SW beyond the waypoint, which required climbing for the higher terrain. Reversed course and descended into the earlier used valley allowing a slightly lower altitude. Flew partially up the low-level track and then offset 20 nm to the east doing a profile to the south end. However, it turned out that the new track was over a wilderness area, so we flew low level around the south side and just followed it north along the east side. At the north end started climb and just flew a heading of about 130 until reaching southern end of a new track north, however, because of clouds decided to return on a similar path at low-level and then back to the south east side of the wilderness area. Climbed on a heading of 100 to 16,500 ft. MSL and then returned to Boise.

**Project:** BB-FLUX18

26 Aug 2018

**Flight:** RF24

*Notes:* Second flight of day after basing in Redding and refueling in Klamath Falls. Focus was on Lagrangian measurements downwind of Watson Creek plume, mainly doing NE/SW transects offset downstream, with some profiling as well. Flight was cut a bit short when clouds moved in, and we returned to Boise.

Main issue was the continuing degradation of the optics from smoke contamination after several days of field deployment (Li-7500 in particular).

Crew: Drew, Volkamer, Plummer, Kille

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*Flight Summary:*

UTC Comment

2136 Wheels up

2149 Initial plan was to head direct for TFR at 14.1 kft.

2154 Turn more easterly, descend to 12.5 kft.

2157 Faster descent, spiraling down to end heading northbound. Into plume around 11.5 kft.

2200 At 6.5 kft and heading NNW.

2203 Getting into background, will return SSE at 7.5 kft - however, descend to 6.5 kft at 2206 UTC.

2209 Opting to extend southerly end of transect, still looks like we're in main plume.

2212 In background now - turn and descend for a northbound cross transect, eventually at 5.5 kft.

2220 At northern end, out of plume - next plan is to offset 20 mi downwind/east and do vertical profile across plume.

Getting into thin plume again near 9-9.5 kft.

2226 At 13 kft, in clear air now - begin descent. Back in top of plume near 11 kft.

2233 At southeast end, working further east to avoid wilderness area.

2237 Now starting northeasterly track, 6.8 kft.

2246 At northeast end. Climbing to 14 kft for next 20 mi offset transect. Out of plume close to 11.5 kft.

2251 leveling off above 13 kft, start descent headed SE across plume through 2254 at 6.8 kft.

Plan will be to reverse previous leg but at low altitude, as clouds are moving in downstream.

2258 Turn and descend to go back northwest on same transect as low as possible.

2311 Finished low level northwesterly leg, probably time for one leg + one profile before heading to Boise.

Start with additional leg to SSW, roughly along previous leg east of wilderness area.

2325 Ending full leg to SSW, will return to center of plume, do vertical profile, then head home.

2331 Turning east, in middle of plume. Ascend to 17 kft. Plume tops close to 12.5 kft.

2340 Head back to Boise.

0006 Just below cloud/precip, looks like mammatus/virga on lidar backscatter and especially depolarization.

0019 On the ground.

**Project:** BB-FLUX18

26 Aug 2018

**Flight:** RF23

*Notes:* First flight of day, basing in Redding. Primary focus for morning flight was on the Mendocino Complex, with plume and background measurements made before transiting to Watson Creek fire and refueling at Klamath Falls in preparation for second flight.

Main issue was the continuing degradation of the optics from smoke contamination after several days of field deployment (Li-7500 in particular). The Applanix did lose our position again (as in the preflight for RF21), it was good initially but displaced us south of Redding while sitting on the ground during the startup procedures - again, just rebooted as we were ready to taxi out.

Crew: Drew, Volkamer, Plummer, Kille

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*Flight Summary:*

UTC Comment

Note, rebooted Applanix as we were getting set to taxi out. Position came up OK.

1655 Wheels up.

1700 Up and running, enroute to Mendocino Complex first.

1707 Looking at Mendocino outflow - at 2.3 kft, looks like deeper remnant layer topped by thin new layer on lidar. Total extent is 1+ km above flight level.

1718 Have been at minimum altitude AGL transecting below plume, maneuvering for helicopter traffic.

1728 WCL display stuck after starting new file, toggled acquisition during climb.

1736 Do x-profile - starting ascent.

1736 Have good amount of background, descend and turn back onto line. Lidar echo tops starting ~6.8 kft.

1747 Eastbound, start another x-profile, at ~1 kft. Will turn and ascend westbound.

1750 Beginning climb. Exiting lower lidar haze layer near 4 kft, noting very thin layer 1+ km above - roughly at 7.5-8 kft.

1756 At 9.5 kft, above both layers - begin descent remaining westbound.

1800 At west end, at 2.7 kft - returning north at low altitude.

1809 Turning westbound towards Mendocino plume.

1812 Turning north, will hug ridge as close as possible. Plan to go north, then do vertical profile on return south, then head to Watson Creek.

1822 Generally in background now. Start with ascent, then to 5.3 kft and retrace path southward.

1831 In thick plume from lidar and in situ measurements.

1834 Divert east for visibility.

1837 Descend to 2.3 kft and rejoin westbound leg.

1844 Climb ~2 kft, prepare for spiral ascent closer to mountains & plume.

1851 At 10.5 kft, head off to Watson Creek before refueling at Klamath Falls.

1910 Initiated Aerolaser cal and set interval to zero; cycled power afterwards as had started to drop out after changing the calibration interval.

1935 Start slow descent, heading northeast towards Watson Creek.

Note, Li-7500 CO<sub>2</sub>F continues dropping relative to 7000.

1950 Entering thicker plume on lidar, near 5.5 kft. Heading NNW on east side of fire.

1953 Longer-lasting plume coming over ridge to our west, looks like the main plume on lidar.

1957 Out at northern end, return south and climb to 7.5 kft.

2001-2004 Lidar-indicated plume, increase in aerosols/CO.

2005 At south end, return into plume at 5.5 kft, then do ascending star profile.

2009 Start 120-deg turn and ascent, in plume. Tops on lidar ~10.8 kft.

2015 Leveling at 13.2 kft, pass over TFR heading west.

2021-2026 Still westbound, descend for upwind profile.

2026 Enroute to Klamath Falls for refuel.

2037 On the ground

## **8/25/18 BB-FLUX Pilot notes (Research Flight 21-22)**

**Crew:** Drew, Volkamer, Plummer, Kille

**Flight Time:** 4.0 / 2.7

**Planned:** Takeoff at 10:00, fly to Watson Creek fire. Do stacked legs on established SE-NW track. Overfly TFR and do established low-level leg. Climb over TFR and head to Klamath Falls to refuel. Return to Watson Creek over the TFR and descend getting back on the same track. Then ferry back to Redding.

**Actual:** Departed Redding, and climbed to 17,500 ft. MSL enroute and then descended to low-level at the southern end of the Stone fire track. Flew track to the north and then headed to a point just to the west of the Watson Creek TFR and then to a point well north and east. Flew this elongated N-S track to the south and reversed course to the north at low level. Made a profile with 120 degree turns to 14,500 ft. MSL and back to low level joining NW-SE line from previous flights. Flew this line at 5400, 7400, 9000 ft. MSL lengthening and shortening the legs as needed. Reversed course, climbed initially eastbound then overflew the TFR, and then descended to low-level enroute to Klamath Falls.

After refueling, departed Klamath heading straight for center of TFR, changed to visual target of plume over the fire. Overflew the TFR and then descended in a spiral on SE side of TFR and rejoined established low-level leg to the NW. Repeated this line at multiple levels, 5400 MSL, 9,500 MSL, 11,500 MSL, 13,500 MSL, 15,500 MSL and 17,500 MSL. Made an initial east turn to climb over the TFR heading for the center point but changed directions to overfly a plume. Descended to low-level on windward side and then turned towards Redding. Climbed to 12,500 enroute and then descended into the Redding valley on the lee side of the Hirz fire keeping as low as practical with the terrain before landing at Redding.

**Project:** BB-FLUX18

25 Aug 2018

**Flight:** RF22

*Notes:* Second flight of day, after basing in Redding and refueling at Klamath Falls. Flight continued to focus on Watson Creek fire.

Main issue was the continuing degradation of the optics from smoke contamination after several days of field deployment (Li-7500 in particular).

Crew: Drew, Volkamer, Plummer, Kille

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*Flight Summary:*

UTC Comment

2158 Wheels up

2215 Initial track was to transit over TFR at 17.5 kft - pyrocu tops beside track extending just to flight level.

2218 In descent.

2220 In major plume, 10 ppm CO on Aero Laser.

2225 To south end, return to northbound line through thicker plume at 7.5 kft.

2233 Turn and descend at NW end from 7.5 kft to minimum altitude.

Looks like plume is elevating, lower edge of thickest plume is near 9.5 kft and up to 17.5 kft.

2242 Northbound leg at 9.5 kft.

2250 In clear air, turning for southbound pass at 11.5 kft.

2258 Turn back northbound, ascend to 13.5 kft.

2304 Thickest plume, Aero Laser preliminary estimates 12+ ppm CO.

2308 Turning and ascending to 15.5 kft for southbond transect, losing solar tracking at north end due to clouds moving in.

Thickest part of plume still attenuates lidar signal within a few hundred meters.

2317 At southern end, turn back at 17.5 kft - never saw plume on lidar.

2325 turning, step down to 16.5 kft.

2329 At 17.5 kft, doing 120-degree triangle legs while descending.

2335 Finishing descent, ascending southbound to 9 kft. Will climb over TFR and do in situ upwind profile, then to Redding.

2345 Just over top of one pyroclu plume.

2348 Quick descent to minimum ( $< 6$  kft) for a few minutes, then head to RDD.

0010-0012 Ascend briefly for measurements in clear air.

0017 Descend for quick view of Hirz plume.

0034 On the ground at RDD.



**Project:** BB-FLUX18

25 Aug 2018

**Flight:** RF21

*Notes:* First flight of day, after basing in Redding. Made brief measurements around Stone fire enroute to primary goal of sampling Watson Creek area again.

Noting degradation of the optics from smoke contamination (Li-7500 in particular). Applanix came up OK during startup but eventually lost the location (while still on the ground) and displaced us south of Redding. Noted when we were bringing engines up and rebooted during taxi - came up without issue this time.

Crew: Drew, Volkamer, Plummer, Kille

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*Flight Summary:*

UTC Comment

1707 Wheels up

1710 Lidar operational, ascend to 17.5 kft on transit leg

Note, turned off Aero Laser calibrations after measurements on the ground. Cycled power because of data dropouts after changing cal interval. LWC started late, but still in clear air.

1728 Descend for Stone fire first.

1738 Past Stone fire plume, characterize regional background as low as possible.

1800 Nearing Watson Creek at 6.1 kft, starting with longer leg to characterize conditions upwind of TFR.

Noting continuing degradation of Li-7500 relative to Li-7000 further; CO<sub>2</sub> now 20 umol/mol apart. Have been in very smokey environments.

1803 Turning at SW corner, still heading N on west side of TFR.

1820 Extended northern end of transect, turning more northerly and profiling up to 14 kft, reversing south halfway through.

Quite shallow haze layer, below 8 kft.

1823 Reverse south and continue ascent from ~10 kft.

1826 Stay at 14 kft briefly, then do descending profile.

1830 Descending now, into smoke layer. Top of layer is around 9.5 kft. Looking ahead (south) to actual plume, growth is strong enough to deepen the mixed layer ahead.

1840-1844 In thicker plume, lidar structure appears like new plume may be sitting on top of background.

1847 Turning for northbound return leg at 7.5 kft.

1853 Getting into thicker plume.

1858 Just outside of main plume, return south at lowest possible altitude.

1911 In "triangle" (120-degree turns and straight legs) descent from 13.5 kft, trying to stay in plume. Plume tops ~10.5 kft on lidar.

1916 Out of descent at 5.3 kft, heading SE out of plume.

1918 In background on lidar, turning for return northwest.

1930 Into background at NW end and turning for return southeast at 7.5 kft.

1943 At southeast end, returning northwest. Will do full vertical profile on this leg.

1946-1952 Ascent to 14 kft at overall same heading, doing 120 turns to remain within main plume. Plume tops near 11.5 kft.

1953-1958 Gradual descent from 14 to 5.4 kft continuing northwest, then return along southeast track.

2011 Turning at SE end, up to 7.5 kft.

2019 Out of plume, descend to 5.4 kft and return southeast.

2026 Return northwest at 7.5 kft.

2032 Beginning transit to refuel, will do some maneuvers enroute.

2035-40 Great view of pyrocu tops over TFR.

Will descend to 6 kft upstream of fire enroute to Klamath Falls.

2059 On the ground at Klamath Falls.

## **8/24/18 BB-FLUX Pilot notes (Research Flight 19-20)**

**Crew:** Drew, Volkamer, Plummer, Kille

**Flight Time:** 3.5 / 3.1

**Planned:** Takeoff at 10:00, fly to Watson Creek fire. Do stacked legs on established SE-NW track. Climb over TFR and head to Klamath Falls to refuel. Return to Watson Creek over the TFR and descend getting back on the same track. Fly on the lee side of the Stone Fire and then ferry to Redding.

**Actual:** Departed Boise at 10:00. Climbed above haze layer and back down on way to north east waypoint of the Watson Creek track. Decided to start at a point about 10 nm offset east from established low level track. Flew headings north and east and then intercepted the established track on the west side. Made a 180 climbing turn directly upwind of the fire to 17,500 ft. MSL and back down. After re-intercepting the track southbound, I realized the TFR had expanded three nm, and our established track on the south side needed to be shifted to clear it. I decided that three nm south would be required to clear the TFR. Descended on the track on the east side to 5400 ft. MSL and repeated it twice. Then climbed over the TFR to 13,000 ft. and descended back to low level prior to heading to Klamath to fuel. F-15's were practicing tailwind landings, so we had to orbit to the NW a couple of times before being cleared in.

After fueling, departed towards the NW waypoint climbing to 17,500 ft. MSL and back down. Intercepted the west track southbound at low-level and followed it around to the NE side. Then offset the primary track 10 nm downwind, and repeated with a profile in the transit.

Headed to the NE waypoint for the Stone Fire and flew track north to south at low level. Reversed course climbed to 7,500 and repeated the track at low-level before climbing for ferry to Redding.

**Project:** BB-FLUX18

24 Aug 2018

**Flight:** RF20

*Notes:* Second flight of day, sampling Watson Creek and Stone fires. Based overnight in Redding, CA (RDD). Had to cycle Aerolaser power after takeoff, came back online. Note licor measurements' offset continues.

Crew: Drew, Volkamer, Plummer, Kille

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*Flight Summary:*

UTC Comment

2052 Wheels up

Will ascend to 17.5 kft first for vertical profile. Starting with box around TFR at 7.5 kft, too little wind below. Eventually will extend legs south.

2131 Turn north at southeast end of box.

2133~2137 Intersecting thicker plume to the east of the fire.

2139 In background, turning to return south at 10.5 kft to sample plume tops. Looks fairly consistent with boundary layer tops, ~13-14 kft?

2145 Climb out to see tops - close to 13.5 kft. Then descend down to 7.5 kft, including reverse course on same line.

2156 Approximate center of plume from lidar, signal attenuated much more than background.

2200 Turning to offset transect ~20 nmi downwind, plan ascending/descending profile to end at 7.5 kft on downwind leg.

2205 Descend along transit to next transect, haze tops again ~13-13.5 kft.

2213 On line headed north, will do transect at 7.5 kft, and descend for return leg.

2215 Lidar echoes, in situ measurements suggest in main plume. Less distinct boundary on north side.

2220 Out of plume on lidar, returning south at ~6 kft.

2231 Ascending, move to Stone fire (to SW) before ferrying to Redding. Will do profile up through background enroute, but need to be under 3 kft AGL before MOA.

2240 Tops near 13 kft, will descend back down.

2254 Heading south, heading into Stone plume @ 6 kft.

2257 Lidar backscatter shows stronger signal, offset south from where satellite suggests.

2258 Aerolaser calibration cycle.

2308 Heading north, just out of thicker plume on lidar, still looks offset south from satellite. Turning back south.

2314 At 6 kft, lidar in plume, just at south edge of plume on visible satellite.

2319 Climbing at south end of transect.

2320 Heading to Redding, doing vertical profiling enroute. Elevated O<sub>3</sub>, up to 80 between 16.5-17.5 kft.

2351 On the ground

**Project:** BB-FLUX18

24 Aug 2018

**Flight:** RF19

*Notes:* First flight of day, sampling Watson Creek fire initially. Refuel at Klamath Falls, then second flight ending in Redding, CA (RDD).

Crew: Drew, Volkamer, Plummer, Kille

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*Flight Summary:*

UTC Comment

1615 Wheels up

Will start with a high-altitude transite to the Watson Creek fire.

1636 Continuing at 16.5 kft, somewhat elevated CO/O<sub>3</sub> and weak layer on lidar (especially in depolarization channel). Will do some vertical profiles through this layer, down to 10 kft.

1646 Ascent leg of profile.

1655 Descending, want lidar sampling through top of main haze layer. Stronger layer around 13 kft.

1702 Very stratified plume on lidar, heading towards Watson Creek fire.

1703 Turn SW to transect across plume at 5.8 kft.

1711 Optically much thicker, entering under main plume.

1720 Transected ~SW across plume, still optically thick on lidar. Head NW.

~1724 onward, better view of layer top.

1734 Looks like northern plume boundary, turning WSW and tracking north of fire.

1740 Climbing to 7.5 kft for terrain, will skirt around west side of TFR next.

1744 Good enough visibility to drop a bit lower.

1750 Start ascending for x-profile west of fire.

1751 Out of smoke layer at ~8.5 kft, will reverse course to head north and keep ascending parallel to line.

1757 At 14 kft, will reverse south and descend. Good view of fires to east.

1759 CO calibration cycle.

1804 Turning at SW end, TFR has expanded so we will be working further south.

1818 Northbound to the east of the fire, in heavier plume.

1824 Exited north side of plume, in background layer now. Return south.

1836 At south end, will return north along same path and ascend for wind profile.

1840 Ascending for winds, haze layer up to 11.2 kft.

1845 At 13 kft, descend along same line.

1847 Reverse course and continue descent south.

1858 Turning back north for final leg before refuel. Will ascend to 7.5 kft.

1909 Out of main plume on lidar, will ascend over TFR enroute to refuel at Klamath Falls.

1917 At 13 kft, overflying TFR.

1922 Descend enroute to Klamath Falls.

1945 On the ground.

## **8/23/18 BB-FLUX Pilot notes (Research Flight 18)**

**Crew:** Drew, Zarzana , Plummer, Kille

**Flight Time:** 4.0

**Planned:** Takeoff at 10:00, climb to altitude and back down enroute to first waypoint around east side of the MOA. Fly low level around MOA and under southern MOA on an established track north to south on the lee side of the South Sugarloaf Fire. Repeat track to the north and transit to one of two coordinates to conduct three nm circles under satellite pass with the C130. Then return to Boise.

**Actual:** Departed Boise at 10:00. Climbed to 17,500 ft. MSL and back down on way to north waypoint around the MOA. Descended to low level until reaching the southern point. Flew the southbound lee side leg at about 7500 ft. MSL. Then offset 10 nm to the east and climbed to 9000 ft. MSL for northbound leg and intercepted the established track. Offset to the east about three miles and continued at low level. However, later had to adjust path back to the west some to avoid a wilderness area.

Overflew Boise at 1000 ft. AGL enroute to second point. Set up a three nm radius around the given point, but switched to a square with sides three nm from the point. Repeated square with some variations first at low-level and then at three other altitudes up to 15,500 ft. MSL. Returned to Boise first flying a heading of 180 and then 165, at low level until into the Boise valley and returned.



**Project:** BB-FLUX18

23 Aug 2018

**Flight:** RF18

*Notes:* Two primary goals for today's flight, start with measurements around South Sugarloaf fire, then head north of Boise for satellite overpass. Initial plan was to do coordinated measurements with C-130, but they were delayed enough on startup that we operated on our own for the satellite validation. A couple brief (~1 minute) dropouts on PCASP.

Crew: Drew, Zarzana, Plummer, Kille

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*Flight Summary:*

UTC Comment

1756 Wheels up

Initial plan will be to do a vertical profile enroute to South Sugarloaf fire.

1807 Nearing 17.5 kft, O3 down from 50s to near 20 ppb at altitude. CO near 65, PCASP is few/cc aside from noise in lowest bin.

Dewpoint from Li-7500 TDP near -12, TDP/TDP70 are -17 to -20 in drier air. Later, close to 2C offset at low alts. CO2 looks closer between the 7500 & 7000: 400-405 mmol/mol on both.

1813 Descending profile leg.

1820 At 4.6 kft, will do low level next. O3 up to 45-50 in haze layer, a bit lower as it clears out below. CO leveling off near 410, max was ~800 during descent.

Multiple stratified layers on lidar, some convective/rolling structure in lowest km as well.

1834 Turning west, still at low levels. Essentially downwind (east) of South Sugarloaf plume.

1846 Turning SSW, still at low altitude.

1949 Much stronger echoes and attenuation on lidar, some O3/CO response. Ascend to 9 kft on return leg to try to get lidar sampling through top of plume.

Note, short dropout on PCASP around 185030-185130. Caught again at 1854, came up after cycling power.

1857 Turning at south end, up to 9 kft.

1904 Losing lidar signal at top end of plume as we head north.

1909 Turning at northerly end, and heading east.

1917 Turning back north, will pass Boise for urban plume then work the satellite track. Start with an ascending/descending profile here.

1930 Turn NW for parallel leg back towards Boise.

1936 CO calibration cycle.

1954 Transiting Boise airspace at 1000' AGL.

2020 Will do multiple stacked hexagons due to C130 delay, our plan is to be 500 ft AGL when they arrive. Note, will switch to 6 nmi squares to have more straight leg time.

2041 C-130 has further delays on startup, canceling their spiral for satellite pass as it would be too delayed to be useful. We will do a vertical profile instead.

2058 Haze layer top is between ~9.5-10 kft, with a weaker layer above that. Clear air starting around 14 kft.

2101 Doing a box at 15.5 kft in clear air, then step down for the same in midlevel haze.

2108 Descend for box at 7.5 kft.

2111 Dewpoints again pretty far off in clear air - 20+ degree separation for Li-7500. Tough comparison in drier air, but will plan for calibration.

2119 Descend for final low measurements, then enroute to Boise at low altitude.

2149 On the ground.

## **8/20/18 BB-FLUX Pilot notes (Research Flight 16-17)**

**Crew:** Drew, Kille, Plummer, Zarzana

**Flight Time:** 2.0/3.1

**Planned:** Takeoff at 10:30, ferry to Sheeps Creek fire. Planned to fly track around the west, south and then east sides of TFR and then repeat east-side track. First flight will be short, refuel in Elko, and return for longer flight. Repeat tracks and make profiles.

**Actual:** Takeoff time pushed back to 11:30. Possibility of C130 flying over same fire enroute to California. Took off and ferried to Sheeps Creek fire at 16,500 ft. MSL. While descending on the west side of fire, checked in with the air-attack on station. He reported two helicopters and 8 SEATS stacked or ferrying between Battle Mountain and the fire. It was very busy airspace on the south side of the TFR just north of Battle Mountain. Flew eastern track four times at 5500 ft. MSL, raising a little for terrain on northern end. Flew about halfway up the track and then climbed to 15,500 ft. MSL enroute to Elko.

Refueling was very fast, but we elected to wait for about 30 minutes before starting up. While idling the C130 called to ask our position, and that they were descending into the valley on the east side of the TFR. When we approached the east track the C130 was still working at 1000 ft. AGL, so we circled the TFR clockwise at low altitude starting on the south side to allow for the descent. About the middle of the north track we came across an aircraft at our altitude, so we did a 360, after which it was still in the same position, perhaps a SEAT holding outside the TFR. Altered course around to the north to avoid it. Checked in with C130 they reported heading north out of the area, so we repeated the east track twice. We then repeated the circle around the TFR one more time, however this time we did not encounter any traffic, either by the airport or on the north side. In the morning, the Air Attack was calling for each SEAT to reload and return, however, in the afternoon he was not having them return.

We repeated the east track a couple of times and then climbed initially east and then west over the TFR to 16,500 ft. MSL. Descended on west side to low altitude and flew northwest for five minutes. Then ferried back to Boise at 12,500 ft. MSL.

**Project:** BB-FLUX18

20 Aug 2018

**Flight:** RF17

*Notes:* Second flight of day, focusing on Sheep Creek fire after refueling in Elko. Limited coordination with C-130.

Startup on engine power generally worked well, satcom was slow to connect and had to reboot AV computer to establish VNC but otherwise good. Brief PCASP counts dropout late in flight - note for later reference, problem is likely with chips on control board. These would need to be cleaned and resealed.

Crew: Drew, Kille, Plummer, Zarzana

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*Flight Summary:*

UTC Comment

2016 Wheels up

2021 Recording camera imagery.

2023 Startup checks done, enroute to fire. At 16.5 kft, C-130 is now sampling at 5.5 kft.

2028 Descend to work box around TFR from SW corner

2030 Stronger lidar echoes during descent, tops look more like convective structure.

2040 At 5.4 kft, C130 is at 9 kft.

2045 On north side, maneuvering for traffic - likely in air attack staging area.

2058 Repeating leg 2x, then do second box.

2059 C130 at low altitude west of TFR, they will finish measurements here and depart.

2105 At north end of transect east of TFR, return south.

2113 At south end, now do second box around TFR. Nothing distinct on lidar, O3 staying in low 40s.

2134 At southeast end of box, now do two more transects downwind of TFR before vertical profiles.

2141 Turning at northerly end of transect for one more pass.

2148 At south end, head back along transect to midpoint, then do E/W ascent to get over TFR.

2151 Turn east to start ascent.

2155 Turning back west to continue ascent from ~10 kft over TFR. Ascending out of lidar echoes around 13.5 kft. Lidar/CO clearly out of smoke layer, O3 increases to 50 - more than seen in smoke layer.

2205 Interesting wave-like tops to aerosol layer on lidar, 500 m above us at our 12.5 kft FL.

2210 Continue close to 5 kft for a few minutes then ascend and return to Boise. 2215 Turning and ascending for profile enroute to Boise.

2230 Note Li-7500 dewpoint now 20 degrees lower at altitude, -12C vs -38C on 7000.

2235 Maneuvering to avoid clouds

2240 PCASP counts dropped out for about a minute. Cycled power and instantly had spectra again. Showed spectra not long before that as well.

2315 Wheels down.

**Project:** BB-FLUX18

20 Aug 2018

**Flight:** RF16

*Notes:*

Focus was on Sheep Creek fire in Nevada, first of two flights today with refueling stop in Elko. No C-130 coordination on first flight, some on second.

Main note, system scientist tablet froze midway through the flight and had to force a reboot. Everything looked to come up ok again, recording was not interrupted.

Crew: Drew, Kille, Plummer, Zarzana

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*Flight Summary:*

UTC Comment

1715 Wheels up

Will transit out high to be onsite as fast as possible. Refuel either before or after C-130 coordination depending on their timing - tentative 1 PM takeoff, onsite 1345-1400 local.

1722 O3 at 45 ppb climbing through hazy background layer.

Note for reference, Li-7500 dewpoint 10 degrees higher during climbout, around -22C on 7000/Edge but -12 on 7500. CO2 comparison looks more typical. TDP75 near -17C vs -34C at 16 kft during ferry leg.

Later note, descending to 6 kft, came closer into line: 7500 was +2-3C, 7000 was near zero.

1734 DOAS heater reading consistently 75F during ferry, followed set procedure.

1740 Watchdog notes again on KADS monitor, still looks like writing correctly.

Will start at NW corner outside TFR, start with descending vertical profile, do low altitude measurements around TFR.

1809 Start initial descent from 16.5 kft.

1816 Adjusting for terrain, currently 6 kft. Multilayered structure in background large-scale plume from lidar.

1824 Passing from west to east at 5.4 kft north of Battle Mountain airport. TRF 25C, TDP offset still 3-4C. O3 has been 35-40 passing through larger background plume west of fire and while transiting east along south side.

1829 tablet froze, rebooted but nothing appeared to be interrupted, still recording data.

1837 Turning to resample plume

1838 Aero Laser calibration cycle.

1845 At south end, return north along same leg for another transect. Lidar showed more substantial echoes/attenuation but otherwise not a distinct plume boundary.

1850 Go to middle of transect then head out for early refuel.

1854 Ascend and turn, enroute to Elko.

1901 In clearer air ~15 kft, to Elko.

1908 Wheels down.

## **8/19/18 BB-FLUX Pilot notes (Research Flight 14-15)**

**Crew:** Drew, Zarzana, Plummer, Howard

**Flight Time:** 3.1/3.8

**Planned:** Takeoff at 10:30, ferry to Watson Creek fire. Planned to fly track around the north, west, south, and then east sides of TFR and then repeat east-side track several times. The first flight will be shorter, refueling in Klamath Falls, and then return for a longer flight. Repeat tracks and make profiles and fly zig-zag route towards Boise along smoke.

**Actual:** Took off at 10:30 and ferried to Watson Creek fire at 16,500 ft. MSL. making two profiles enroute. Descended on west side of fire and self-announced on fire frequency, just a helicopter working low level in the TFR. Was able to descend to 7300 ft. MSL on the west and south side, except near the ridge over the VOR where we climbed to 8000 ft. MSL. Once in the valley on east side was able to descend to 5200 ft. MSL except on north end, which was higher.

Repeated east leg to the south climbing to 17,500 ft. MSL. Reaching south end, descended in the turn to 9000 ft. MSL, but later descended to 7000 ft. MSL. On southbound leg, started climb to 17,500 ft. MSL overflew the TFR and then descend to low level on the windward side before heading to Klamath Falls. Visibility was very low in the Klamath Valley. The airport was reporting 3 miles and 3,100 ft. overcast, however, no overcast was actually present.

Takeoff was delayed slightly by a Navy helicopter that was fueled just after us, which caused a delay to pay for the fuel. Departed towards the northwest corner climbing to 17,500 ft. MSL. Decided not to go to the NW point, but rather join the track southbound midway at 10,000 ft. MSL, however that required a 360 turn in order to make the descent to 10,000 ft. MSL. Once on the track decided to descend to 7300 ft. MSL. On the south track climbed back up to 10,000 ft. MSL. Repeated the east track at 10,000 ft. MSL. After turning southbound climbed to 17,500 ft. MSL making a 180 degree turn about halfway back to the north. Descended to 10,000 ft. MSL for the next two legs. Arriving at the NE point turned to a heading of 090 and then climbed to 16,500 ft. MSL. Working generally eastbound (with headings) made a series of heading reversals and climbs and descents from low level to 16,500 ft. MSL and then from 13,000 to 10,000 ft. MSL. flying roughly NW/SE headings. Ending the headings at the north end then turned towards Boise doing a climbing 180 turn enroute and then descending to low altitude before returning to Boise.



**Project:** BB-FLUX18

19 Aug 2018

**Flight:** RF15

*Notes:*

Second flight of day, focusing on Watson Creek fire in Oregon after refueling at Klamath Falls. Startup on engine power went quickly, just over an hour turnaround total with some delay on refueling.

Crew: Drew, Zarzana, Plummer, Howard

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*Flight Summary:*

UTC Comment

2035 Wheels up

Note, had to cycle power for PCASP a couple times on ground to get full response.

2039 Everything up and running, ascending to 17.5 kft.

2048-2054 Good pyrocu buildup, descend to 10 kft.

2059 Hangup on satellite feed - connection was fine; later identified as location issue and corrected for subsequent flights.

2101 At 7.2 kft in haze layer.

2102 Turning.

2111 At 10 kft.

2118-19 Plume center based on lidar, echoes to flight level through transect. Mild increase in CO<sub>2</sub>, spike in CO/PCASP.

2125 Turning at northerly end of transect.

2133 Ascending, looks like we're heading into plume edge.

2135 Better defined lower boundary of plume vs background in lidar profiles, near ~11.5-12kft.

2143 Turning back south. AV computer unresponsive; power button woke computer at 2147, I disabled sleep settings.

2156 Lidar display acting sluggish, unresponsive, toggled data acquisition during turn outside plume.

2157 Returning north.

2159 Entering plume, thin descending layer above background on lidar.

2206 Turn east for profiling ascent when we hit plume.

2212 Ascending, ultimately to 17.5 kft.

2218 Aero Laser calibration cycle (at 120 minute interval).

2221 In major plume, 2.5 ppm CO, 20k/cc on PCASP, CO<sub>2</sub> incr from 400-450 umol/mol.

2222 Slow descent, settle at 15.5 kft.

2225 Turn to 330.

2230 Maneuvering for measurements, under "shelf" of plume - note that satellite feed is updating again.

2240 Looks like secondary plume starting just north of the main fire, tracking alongside the primary plume. Noted two thin upper layers on lidar, jumping down in altitude as we head north from main plume.

2245 Returning southeast, will do ascending/descending profile along this transect.

2248 Beginning ascent.

2253 At 17.5 kft, visually clearing but lidar has echoes through ~19 kft. Descending to 10.5 kft.

2317 Turning east, and return to base. Will remain at 10 kft to transect plume, then ascend for vertical profile enroute.

2332 Quick profile in plume, ascend to 17.5 kft.

2338 Reverse course at 17.5 kft for a couple minutes, then descend back on course.

2342 Turn, descend back down to 10 kft and finally return to Boise.

0019 On the ground.

**Project:** BB-FLUX18

19 Aug 2018

**Flight:** RF14

*Notes:* First of two flights today on Watson Creek fire in OR, with refuelling stop at Klamath Lake prior to second flight. **Secondary (UW) PCASP was operated starting on this flight - using previous calibrations so in-flight measurements are only qualitative, measurements to be reprocessed later on.** Additionally, a brief interruption in the KADS monitor (no issue noted) and briefly lost connection to WCL again.

Crew: Drew, Zarzana, Plummer, Howard

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*Flight Summary:*

UTC Comment

1628 Wheels up

Note, bumped 7000 power switch after takeoff.

1640 At altitude, 16.5 kft and -3 to -4C. No nitrogen used for this flight, second flight planned for higher IFR legs, will conserve for that.

1642 In clear air above widespread background haze, will descend into this layer.

PCASP concentrations increasing starting near ~16 kft, CO slowly dropping then steady near 150. Stronger lidar echoes starting ~14 kft.

1649 Levelling out at 6 kft. CO showed gradual increase > 200, but O3 only increase from 8-13+ (compared to 35-55, and up to 75 in previous flight's fresh plume).

1653 Begin ascent, in middle of aged plume.

1700 Main plume tops out around 14.5 kft, some wisps above visible on lidar through ~15.5 kft.

1704 KADS monitor closed somehow. Looks like it's continued recording without issue.

1717 Descend as low as possible, can't see ground from above smoke layer. Entering tops just under 13 kft here.

1724 Turning at 6.5 kft into plume.

1729 In center of plume not too far downstream from source, lidar attenuated within 1 km above.

1732 Clearing as we exit the north side of of the plume.

1739 Ascending to 7.5 kft, on NW side (upwind).

1744 Plume site is off left window - much worse visibility in background haze than satellite imagery suggests. Somewhat weaker lidar backscatter than main plume, but deeper and more striated with layers visible.

1747 CO in calibration cycle - was set to 120 minutes, right at two hours after power up.

1752 Turning on SW end, enroute to downwind

1802 Turning at SE end for downwind legs, starting at 5.5 kft.

1805 Very distinct banding in first km above in lidar, weaker echoes to 2+ km above.

1813 Plume is decoupled, we are 15 nmi downwind from source, no particular CO response. Lidar echoes above flight level.

1818 Turning on N side of plume for second downwind pass.

1822 Starting ascent for sawtooth profile across plume.

1825 Leveling for a bit at 11.5 kft, started ascent too early based on satellite - the main plume is still ahead of us.

1827 Ascending again, substantially stronger lidar echoes, show the actual primary plume to ~13.5 kft. Head of plume visible off to our right.

1833 At 17.5 kft, descending to 9.5 kft. Will turn shortly for northbound transect.

1838 Lidar connection dropped out while I was looking at it, software closed and had to re-login from VNC.

1841 Descend to 7.5 kft to have more certainty of being below plume.

1846 Thin upper layer is visible on lidar from actual plume, thickening and merging with background layer. Actual plume may be at FL, quick change to strong echoes at our level.

1857-1900 Ascending to overfly TFR, then head to center of plume at altitude. Then turn to fly over head of plume at 15.5 kft.

1907 Turning for final profile, then refuel. Ascend to 17.5 kft.

1911 Descend as low as possible enroute.

1928 Wheels down

## **8/15/18 BB-FLUX Pilot notes (Research Flight 13)**

**Crew:** Drew, Vokamer, Plummer, Lee

**Flight Time:** 3.8

**Planned:** Takeoff at 13:50, Ferry to Rabbits Foot fire. Planned to fly the track over the Lemhi river valley northwest of Leadore, and fly the track through the Salmon River canyon towards Challis. Also possibility to fly short SW-NE track just north of Challis if visibility is too low in the canyon. Also possibility to fly SW-NE track near Bannack in case the visibility plume direction was not good for Rabbits Foot fire.

Take off time was planned to coincide with the time the C130 would be working the Rabbits Foot fire. They would stay IFR at 14,000 MSL. We would stay below that. No other coordination plans. Decided to takeoff an hour early (12:30) to verify visibility in the valleys. Left the option open to refuel in Dillion.

**Actual:** Problems starting the science gear put aircraft startup time in flux. We would pull out and start whenever we were ready. Ended up starting around 13:30, just a little earlier than originally planned. Climbed to 12,500 ft. MSL and then dropped to 11,500 ft. MSL heading for Challis. After Challis dropped to 11,000 ft. MSL to make first assessment of the Salmon River canyon towards Salmon. At the north end decided to fly the second leg at 7000 ft. MSL. Repeated this track multiple times. Once the C130 left the area, climbed to 17,500 ft. MSL on southbound leg. Made a series of 60 degree heading changes to help calibrate science gear and then repeated northbound track. At the north end descended back to 7000 ft. MSL for several more tracks. Near the last northbound leg, encountered a transponder equipped southbound aircraft 300 ft. below our altitude, so we climbed to 8000 ft. MSL temporarily as he passed. Reaching the north end reversed course, climbed to 17,500 ft. MSL, and headed towards Boise. Made a few climbs and descents along the way.

I did talk to Rabbits Foot AA when we arrived. He checked on our status an hour or two later, and I checked out with him when we left. As we were leaving he said he was about to call us to tell us they were launching a UAV in our area.

**Project:** BB-FLUX18

15 Aug 2018

**Flight:** RF13

*Notes:*

Planned to coincide with C-130 sampling Rabbit Fire plume, no direct coordination as UWKA would operate at low levels with C-130 at or above 14 kft. Accepted limitation of no PCASP/Aero Laser to take advantage of simultaneous measurements.

PCASP down prior to flight. Aero Laser down immediately before flight, no CO data. No connection to WCL computer during flight, decision was made to proceed without full restart to arrive ahead of C-130 - reestablished connection with WCL computer on ground after flight.

Crew: Drew, Volkamer, Plummer, Lee

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*Flight Summary:*

UTC Comment

1935 Taxi.

1941 Wheels up.

2013 Have been troubleshooting lidar connection enroute - no luck after power cycling, network connection looks good. Probably stuck on startup. Good view of plume from 11 kft.

2017 Just into edge of plume on satellite.

2021 In plume, fairly low visibility at 11 kft ~halfway through. Hopefully 10 kft for next pass.

2026 Out of plume, descend to get visibility and work at 7 kft.

2040 C130 in region, will remain at 7 kft until they exit, then ascend for our own wind profile.

2052 In turn for return leg S.

2054 On fourth transect, remaining at 7 kft.

2106 Turning for fifth transect N.

2119-2121 Turning for sixth transect.

2127 In plume, C130 behind at 14 kft, will overtake before end of our leg. O3 near 40, maxima have mostly been 40-50, some to 55.

2133 Into seventh transect.

2138 C130 close to overhead, 8500 ft above.

2145-2148 Turn for eighth transect - C130 heading out, will now do sawtooth profiling.

2151 Starting ascent, 1000 ft/min through 17.5 kft.

2200-2207 At 17.5 kft, a few maneuvers for DOAS then reverse course for upper background leg

2206 Rapid pyrocu growth from Rabbit Foot fire.

2213 In plume at 17.5 kft, elevated CO<sub>2</sub>/O<sub>3</sub> (75 ppb, though suspect)

2215 Descent for low transect.

2218 Return towards fire during descent.

2226 Entering thicker plume southbound @ 7000 ft, quite red sun!

2228 Under quite thick plume, extremely orange hue.

2234 Returning to transect thick plume.

2236 Ascend to 8 kft briefly for traffic.

2237 Descend back to 7 kft.

2241-2243 Turning for ascending profile.

2243 Beginning ascent.

2247 Underneath "vault" of plume, ascend through plume to ~2250.

2252 RTB, will do some sawtooth profiling enroute. O<sub>3</sub> ~30 ppb at ~17 kft. No particularly strong gradient noticed through 12.5.

2324 Wheels down

## **8/12/18 BB-FLUX Pilot notes (Research Flight 11-12)**

**Crew:** Drew, Kille, Plummer, Zarzana

**Flight Time:** 3.6 /3.0

**Planned:** Take off to the NW and fly north in the Snake River canyon on the Oregon border, then overfly both the Kiawa fire and the Rabbits Foot fire at altitude. Descend into the NW-SE valley on the east side of the Rabbits Foot fire. Fly the valley at low level several times, then fly the canyon next to the TFR from Salmon to Challis. Plan to change altitudes some. Depart the area to Dillon, MT to refuel. Restart the data system on generator power and then return to same valleys. Planned to keep the total flight time below 7.0 hours. Called Dillion Air Service to verify airport status and confirm jet fuel availability.

**Actual:** Conducted a normal start and then departed to the NW at around 2000 ft. AGL. Dropped into the Snake River canyon and flew approximately 1000 AGL (or higher as needed for terrain) until northwest of the Mesa fire area. Then climbed to 17,500 MSL and did several profiles from 13,500 to 17,500 MSL enroute to the Rabbits Foot fire. Overflew the fire and descended into the SE-NW valley on the lee side of the Rabbits Foot fire on the SE side towards Leadore. Made the first pass to the NW along the western edge of the valley with several doglegs and overflew the Salmon airport near the middle of the leg. Climbed on the NW end to get above the low hills surrounding the salmon canyon to the NW. After completing the turn, returned to lower altitudes once into the valley. Removed the Salmon airport from the route to fly a fairly straight line with a single dog-leg, and shortening the line to the SE.

After repeating the line several times repeated the line at 9,500 MSL and then to 14,500 MSL. Then dropped back down low for two more passes. Decided to continue on the same line instead of trying to fly the canyon between Salmon and Challis. Upon returning to the lower altitudes, it was apparent that the visibility had decreased significantly since the last low pass. Did two more passes then a profile from NW until under the plume then climbed to the NE (90 degrees to the track) avoiding the neighboring TFR for the Goldstone fire. Climbed to 17,500 MSL enroute to Dillon.

Prior to landing, we received no response on the radio from Dillion Air Service. After shutdown requested a quick-turn, however the fueller informed me that the truck was out of diesel fuel and he was going into town to get some. However, after he returned the truck was not running correctly. After some convincing, he agreed to try to fuel us with the truck as is.

After fueling, we started and departed to the north to get out from under a cloud layer. Then flew over to the north side of the Big Hole valley and tried a low-level track in that valley to the south. Reaching the south end of the valley, decided to climb south over the mountains and go back to the same valley that we worked in the morning. After descending into the valley made several more passes, with significant slip at times to get a better sun angle. The visibility had deteriorated significantly since the morning. Made a pass at 9,500 MSL and 17,500 MSL and then dropped back down to low altitude. After completing a low pass to the NW, climbed to 9,500 MSL until near the center of the plume and then climbed along wind to 17,500 MSL. Picked up an IFR clearance, reversed course, and climbed to FL 220. Blocked 16,000 MSL – FL 200 and made several climbs and descents between the two. Returned to Boise at 16,000 ft. MSL.



**Project:** BB-FLUX18

12 Aug 2018

**Flight:** RF12

*Notes:* Second flight of day, refueled at Dillon, MT (KDLN) with a delay on the ground, then continued to work Rabbit Foot plume. Moderate temperatures and cloud cover mitigated the heating inside the aircraft during this delay.

Did fast startup on engine power, in the air within 15 minutes of engine start. Took only 4-5 minutes for Meridian to sync, things generally went quickly on the ground afterwards, main instrument issue was PCASP reporting correct flow rates but zero response in particle counts. Licor-7000 reference gas opened late. Briefly lost ground communications later in flight, but reconnected without having to cycle power.

Crew: Drew, Kille, Plummer, Zarzana

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*Flight Summary:*

UTC Comment

Engine power 2213, TFOM sync by 2218.

2228 Wheels up. Previous flight 3.6 hrs.

Our instruments generally working aside from PCASP, but spent early portion of flight coordinating and checking PCASP. Sample flow ~1-1.5 cc/sec (normal) but no response at all on counts.

2257 Opened 7000 ref gas, delayed notice from being focused on PCASP issue.

2300 Have been sampling first valley, orientation requires too much bank for solar tracking...moving to next target.

2312 Out of plume, turning to avoid clouds to south.

2321 Overview of track on vis satellite - substantial plume is spreading NE, our track has overall made multiple lengthy traverses.

2329 At N end of transect, turning for return leg - will do profiles on S legs due to poor sun angle.

2337 Ascending out of south edge of plume, will reverse course and continue ascent in plume.

2347 Turning, good view of plume.

Lost satcom for a bit, took a few minutes to reset.

2359-0003 Descent, low altitude N pass will require some left bank for sun angle.

0014 Climbing for final profile, focused on in situ.

0020 Great view of plume wrapping overhead, good view from lidar as well.

0027 On final set of profiles at 17.5 kft, request IFR for higher transit back to BOI 19-22 block.

0032 22 kft is just above top of plume, very stratified - will do vertical sawtooth profile enroute.

0044 Just over head of fire, nice bump through plume, cleared out shortly afterwards.

0122 Wheels down.

**Project:** BB-FLUX18

12 Aug 2018

**Flight:** RF11

*Notes:* Plan for the day it to transit NW of Boise and do low-level pass following Snake River, "porpoising" on main W-E transit leg before sampling focused on Rabbit Foot fire.

Note, KIT O3 values displaying without issue for this flight, likely problem was just an older software version for the data monitor. Note, starting near ~2004 UTC got watchdog errors on data system monitor. Still writing to disk correctly, disk space and other status looked OK so I left it running for the tail end of the flight. Did not see any issues subsequently after powering up for next flight.

Crew: Drew, Kille, Plummer, Zarzana

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*Flight Summary:*

UTC Comment

1709 Wheels up

1712 Instruments up and recording OK.

1714 At 4.6 kft, 17C, CO ~60 ppb for low transit leg. Plan to go as low as feasible over Snake River.

1725 At 4 kft, Distinct narrow plume on lidar, 1-1.5 km above.

1732 At Snake River, going as low as possible - 1200 ft RALT3F, 3.2 kft altitude. Light haze on lidar 1-1.5 km up, nothing really visible. Low CO near 30 ppb, O3 near 20.

1747 Climb up past haze layer (tops at 9 kft on lidar), head east. CO varying ~30-50 ppb without strong signal during ascent. O3 increased from near 20 to ~50s aloft.

1758 At 17.5 kft, starting descending profile down into haze layer - more generally hazy, light returns on lidar below ~14 kft.

1804 Much stronger CO gradient ~10.5 kft, up past 200 ppb. Ascend back up for multiple profiles. O3 ~45.

1814 16.5 kft, interesting aerosol layers to 2+ km above FL.

1819 Just getting under a few thin clouds, at 17.5 kft/-7C, clouds within 1000 ft. Some suggestions of waves in lidar, clouds off to right.

1826 On descent, intend to work western side of valley for Rabbit Foot plume.

1828 First track at 1000 AGL to see terrain. O3 40, CO variable 150-200.

1834 Approximately 16 nm from plume, may be decoupled - in situ may not pick it up. Moderate haze in valley, CO gradually increasing above 200 ppb heading north. O3 near 35 still.

1841 Preparing to return south.

1846 Finishing turn, will attempt south leg along similar track. Cal cycle on Aerolaser (should be only one during flight).

1854 Will repeat similar leg 3x at low altitude (typically do four total but want to end up on N end).

1906 At N end, turning back S.

1917 Returning N, lidar shows plume to ~1 km or so above with some variability and echoes above.

1927-1930 Ascending to 9.5 kft for return south.

~193530-193830 In plume, strong echoes/attenuation on lidar, PCASP/CO increase.

1939-1943 Ascend to 14.5 for final pass, outside of plume.

1943 in plume by end of ascent, PCASP to 15000/cc, CO ~1000 during pass.

1948 Outside plume, starting descent

2005 Turning for final transect.

2036 Wheels down.

## **8/9/18 BB-FLUX Pilot notes (Research Flight 10)**

**Crew:** Drew, Volkamer, Plummer, Howard

**Flight Time:** 3.2

**Planned:** At the 9 AM meeting, it was decided that although not a good day for a science flight because the winds were too low, we would still plan to fly the Rabbits Foot fire at 2:00 PM. This would allow me to get familiar with the area, allow Dave to practice starting the data system on the aircraft generators, and give Ben a chance to practice with the CU gear. We planned five waypoints in a zig-zag pattern south to north on the lee side (south side) of the fire. Also discussed squeezing between the TFR and the wilderness area on the west side. On the way toward the fire we planned to do some climbs and descents and roll maneuvers for calibration purposes.

**Actual:** Started aircraft and then brought up science gear on generators. After departure climbed to 15,500 MSL direct toward the center of the TFR. Delayed maneuvers until getting science gear to work. However, after flying about 25 minutes decided to return to Boise because gear was not working properly. After heading towards Boise for about ten minutes, got it working so resumed course back towards the fire. Then did a climb and decent up to 17,500 MSL and back down. Decided to terminate the maneuvers and descend southeast direct towards the first point of zig-zag.

Dropped to 2000 AGL over the first waypoint and headed to the second, deciding to skip the third waypoint and pick it up on the fourth leg for terrain, this put us over the Challis airport westbound. Started the turn to the Northeast prior to the waypoint due to high terrain located near waypoint. Heading northeast up the valley towards Salmon, just north of the Challis airport lost required forward visibility and spiraled over the airport.

Decided to pick up an IFR clearance and do the RNAV-D into Salmon. After receiving the ATC clearance for the approach, I noticed the TFR had expanded in the last 30 minutes from a five nm circle to a larger square and now included a portion of the approach path for the RNAV 35. Salt Lake Center kept me above the TFR until NE of it, but that kept us a little too high to get down to minimums before the MAP. Did the published MAP and elected to try the RNAV 17, which was not impacted by the TFR. On the published missed, canceled IFR and tried to go down a valley to the south-east, on the lee side of Goldstone fire. However, decided instead to return to Salmon and try to get down the valley (south) back to Challis, however, the flight visibility in the valley again prevented this option. So again, returned back down the valley to the southeast towards Leadore. Decided to turn southwest over the higher terrain to get to the lee side of the Rabbits Foot fire. However, had to fly further south to maintain the flight visibility finally dropping back into the Challis valley southeast of Challis. Started back up the valley to the northwest however, approaching Challis the visibility once again went below requirements, so turned to the south and climbed to 16,500 MSL for the return to Boise. Along the way, made several climbs to 17,500 MSL and descents down to 14,500 MSL.

**Project:** BB-FLUX18

9 Aug 2018

**Flight:** RF10

*Notes:* Crew switchover, first flight with Drew replacing Wadsworth as pilot. Targeted smoke around Rabbit Foot fire, primarily for pilot familiarization and testing out shortened startup procedure for later flights following refueling.

Took ~13 minutes from engine start to wheels up including ~10 minutes for Meridian to sync. Need to streamline my shortened startup to avoid missing instruments (CDP/7500,PCASP), KIT was also delayed due to confusion about startup responsibilities.

Crew: Drew, Volkamer, Plummer, Howard

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*Flight Summary:*

UTC Comment

~1947 Engine start

2000 Wheels up, most instruments up properly.

2057 Rebooting KIT, have not had data in monitor, so it may not be receiving time stamps.

2100 KIT rebooted, still can't see it but mode indicates it is receiving packets.

2101 Descend and return to plume.

2120 Lower altitude has too little visibility to work, ascend out of haze.

2128 Descend to 14 kft for approach at Lemhi Co. (SMN), over TFR (to 13 kft).

2140 Descent to Lemhi Co.

2145 Out of approach, will reshoot a second time.

2201 Out of short approach, into VFR to attempt lower transect.

2220 Through various maneuvers looking at environment for piloting and science perspective.

2236 Opting to RTB.

2242 Doing pitch maneuvers at 16.5-17.5 kft, just out of smoke/aerosols at 17.5 kft.

2246 Descend to 14.5 kft for several minutes, then 17.5 kft again.

2306 Wheels down.

## 8/8/18 BB-FLUW Pilot notes (Research Flight 9)

Crew: Wadsworth, Kille, Plummer, Zarzana

Flight Time: 3.6

Planned: At the 9 AM meeting, we planned to fly the Rabbits Foot fire. That was it. Takeoff planned for 2 PM. We met again at ~ 1230 PM. Rainer then was primarily talking about the Rabbit's Foot Fire, but was also bringing up the Sharps fire. At about 1:15 PM, now Rainer wanted to fly around the Sharps Fire prior to flying the Rabbits Foot. This was ½ hour prior to walking to the aircraft for takeoff. In this case, we accepted the task with the potential to land in Pocatello, ID for fuel prior to a second flight around one or both of the named fires. Also wanted to do a few pitch and roll maneuvers to calibrate the DOAZ.

Actual: Departed, climbed to 15.5K'. Did the DOAZ maneuvers. This took enough time that we were jammed for the descent. Started down, but had to reverse back to the west to ensure we would get to low altitude to sample appropriately near the Sharps Fire. Checked in with the Sharps Air Attack. Crossed from West to East on the South side. Then climbed to, I dunno, 16,500' on route up to vicinity of Challis. Descended to minimum altitude to the east of Challis airport, then started up the Lemhi Valley from Challis to Salmon.

Visibility was generally okay, with the exception of area about 1/3<sup>rd</sup> of the leg up. Appeared to be a blind corner or box canyon, but we climbed over the area the first pass up, got more familiar with the canyon so that later passes were unimpeded.

Made four passes, up & down at low altitude. Then did two transects at higher altitude. First was about 11,500' when northbound. Second was 16,500' southbound. These legs are the most difficult of the entire flight. Horizontal visibility is not definitive.

After completion, did a couple more cycles up & down the Lemhi valley. Then set up for a sounding, from low altitude up to 16,500 on the leg from Salmon to Challis, then to return directly to Boise. There were three Caravans departing Salmon and heading down the same valley, and got ahead of us. Did some talking with them, then we offset to the west a bit, and started an aggressive climb as soon as we could.

On the climb, at ~11,000', we got ,a traffic alert for an aircxraft at the same altitude, a bit to our West. We angled to the east, resolved the electronic TCAS alert, and continued on our way.

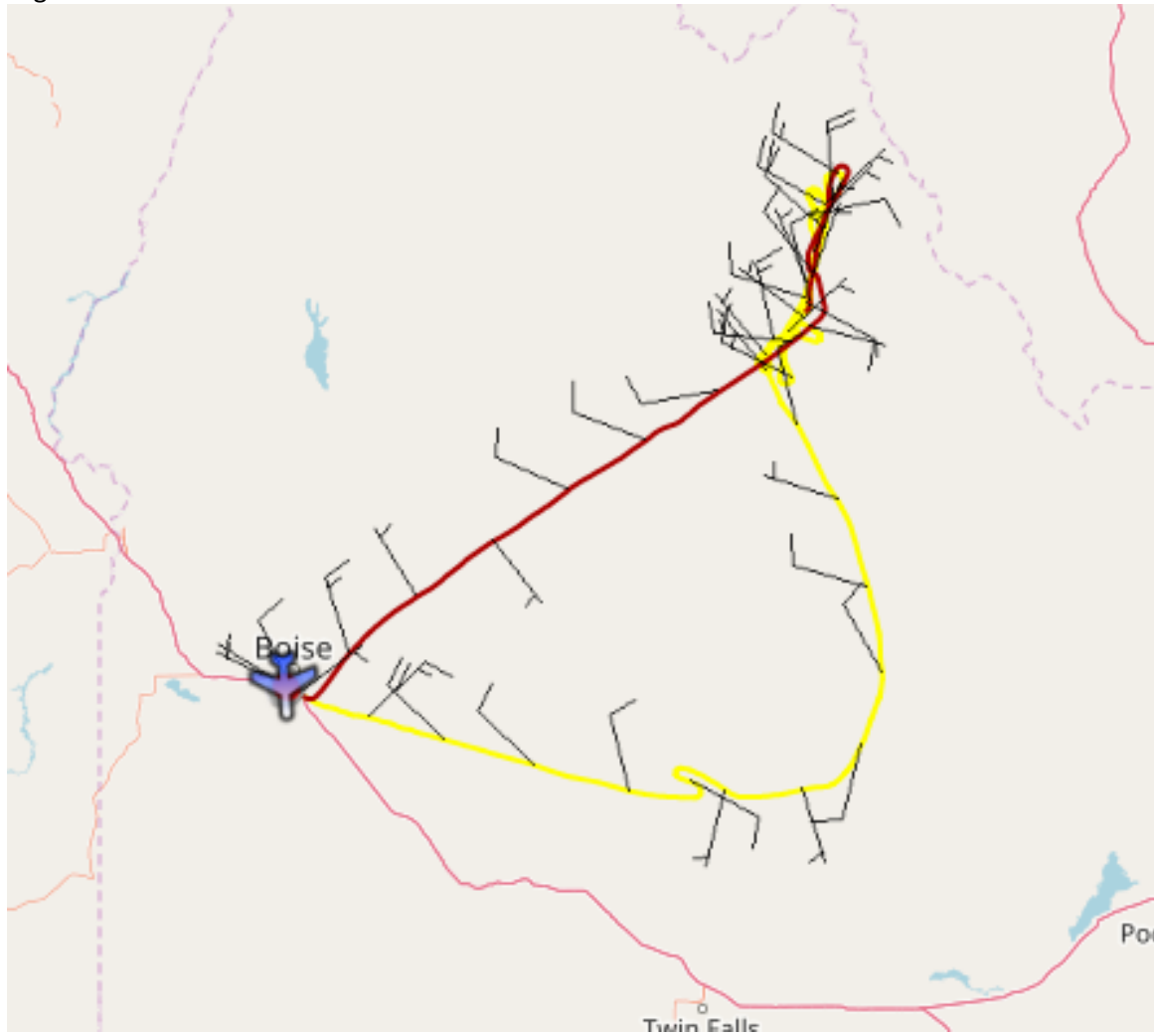
Check-in with Rabbits Foot Air Attack was not easy. Took multiple attempts.

Overall:

1. First trip down a new canyon in poor visibility is tough.
2. Foreflight plus the terrain display on the Garmin & KMD are huge!
3. Most turbulent area was in the boundary layer.

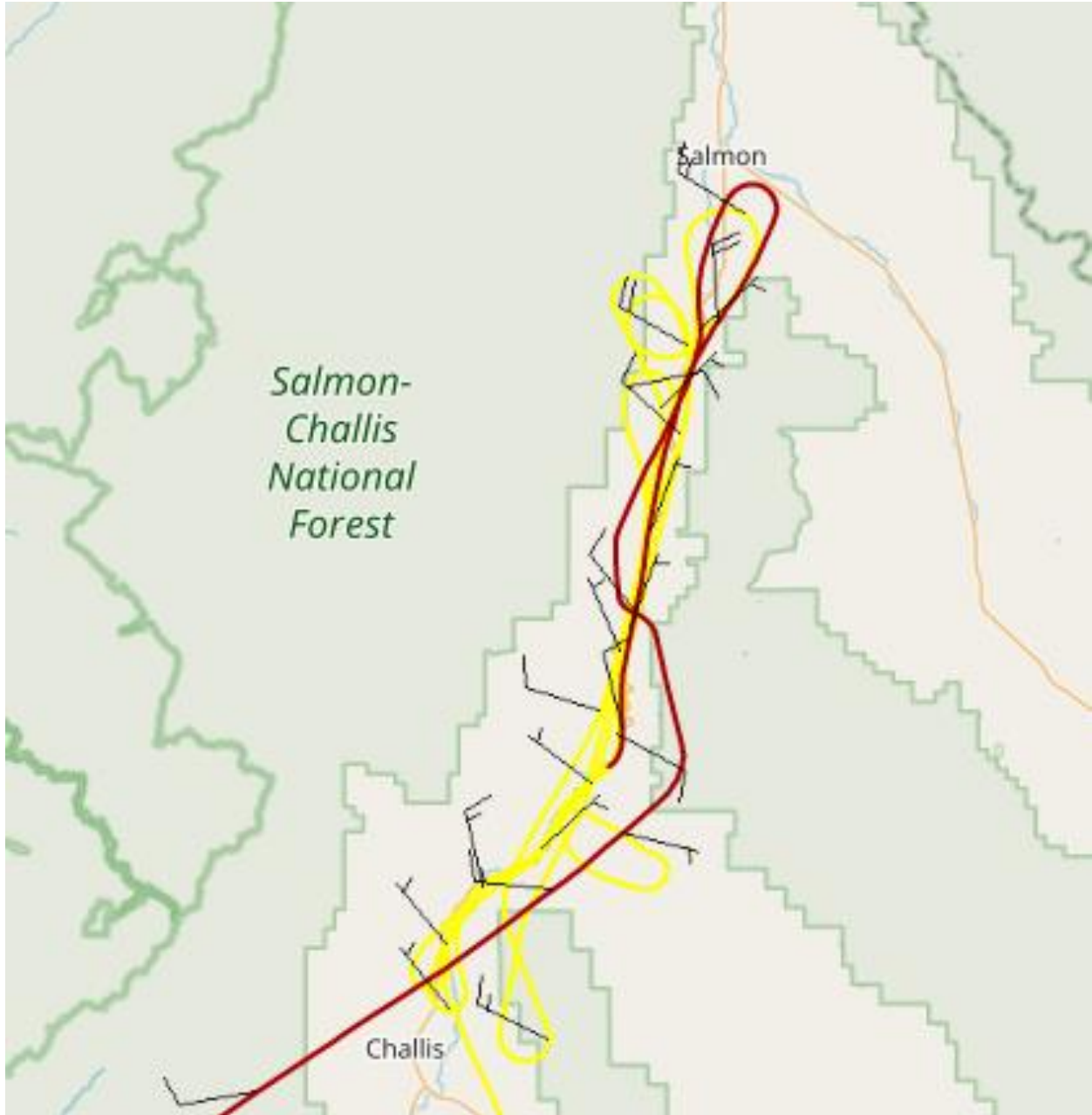


Flight track:



Badger Creek

Detail of maneuvers



**Project:** BB-FLUX18

8 Aug 2018

**Flight:** RF09

*Notes:* Targeted Sharps fire briefly, with primary focus on Rabbit Foot fire. Instruments generally functioned well: The WCL display froze several times, I toggled data acquisition once during a turn to generate a new file. Lost VNC connection to WCL at a later point, with acquisition and display software crashing - a few minutes were lost reconnecting and reconfiguring the acquisition settings. Sporadic issues with camera software early in flight, worked well subsequently.

Note, was unable to switch off Aerolaser calibrations until late in the flight due to environment, calibration timing coincidentally resulted in some missing CO measurements in plumes. We have also seen bad CO data in the main data display (alternating normal measurements and zeroes for a few seconds at a time) following configuration changes, had to reboot Aerolaser because of this.

Crew: Wadsworth, Kille, Plummer, Zarzana

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*Flight Summary:*

UTC Comment

2001 Engine runups

2004 Wheels up

2009 Instruments up and running, enroute to 15.5 kft - will be performing some small pitch/roll maneuvers for DOAS enroute. Background CO is ~60 ppb.

2016 Running well, doing pitch variations near 15.5 kft.

2021 Profile has deep mixing through ~14 kft, slight inversion and drop in dewpoint above.

2025 Descending to 6.5 kft for Sharps plume.

2028 Reversing briefly to increase descent ahead of plume.

2029 CO cal cycle.

2030 Returning to original course at ~750 ft agl.

2050 Note, rebooted AV computer, appears to be writing correctly again. Ascending to 17.5. Looks like mixing to ~16 kft here.

2054 Descending into valley.

2102 CO cal cycle.

2104 750 ft agl in valley, a bit turbulent. Hazy ahead, fairly clear looking above. CO is ~150 ppb.

2113 At 6.5 kft, CO increasing to 300+ ppb with most dense plume through 2118.

2118 Climbing for turn, in background environment.

2129 Returning N, delaying for CO cal at 2132. For future reference, science is better suited to continue transects despite loss of one CO measurement.

2148 WCL display frozen, quickly toggled WCL data acquisition during turn.

2150 Transect at 10.5 kft.

2153 Fast CO spike into plume, to 1.5 ppm.

2158 Ascend to 15.5 kft.

2202 Connections to WCL VNCs dropped out, acquisition/display software had stopped when reconnected. Requiring data by 2203 after reconfiguring as per startup.

2208 Switched CO cal off - halted descent to reboot Aero Laser at 2213 following data dropouts. Up by 2215.

2218 Center of plume - 500+ CO, O3 low 40s.

2224 Center of plume.

2226 Return transect, center at 2232.

2244 Final profiling ascent through canyon, CO up to 2 ppm at max.

2330 Wheels down.

## 8/4/18 BB-FLUW Pilot notes (Research Flight 8)

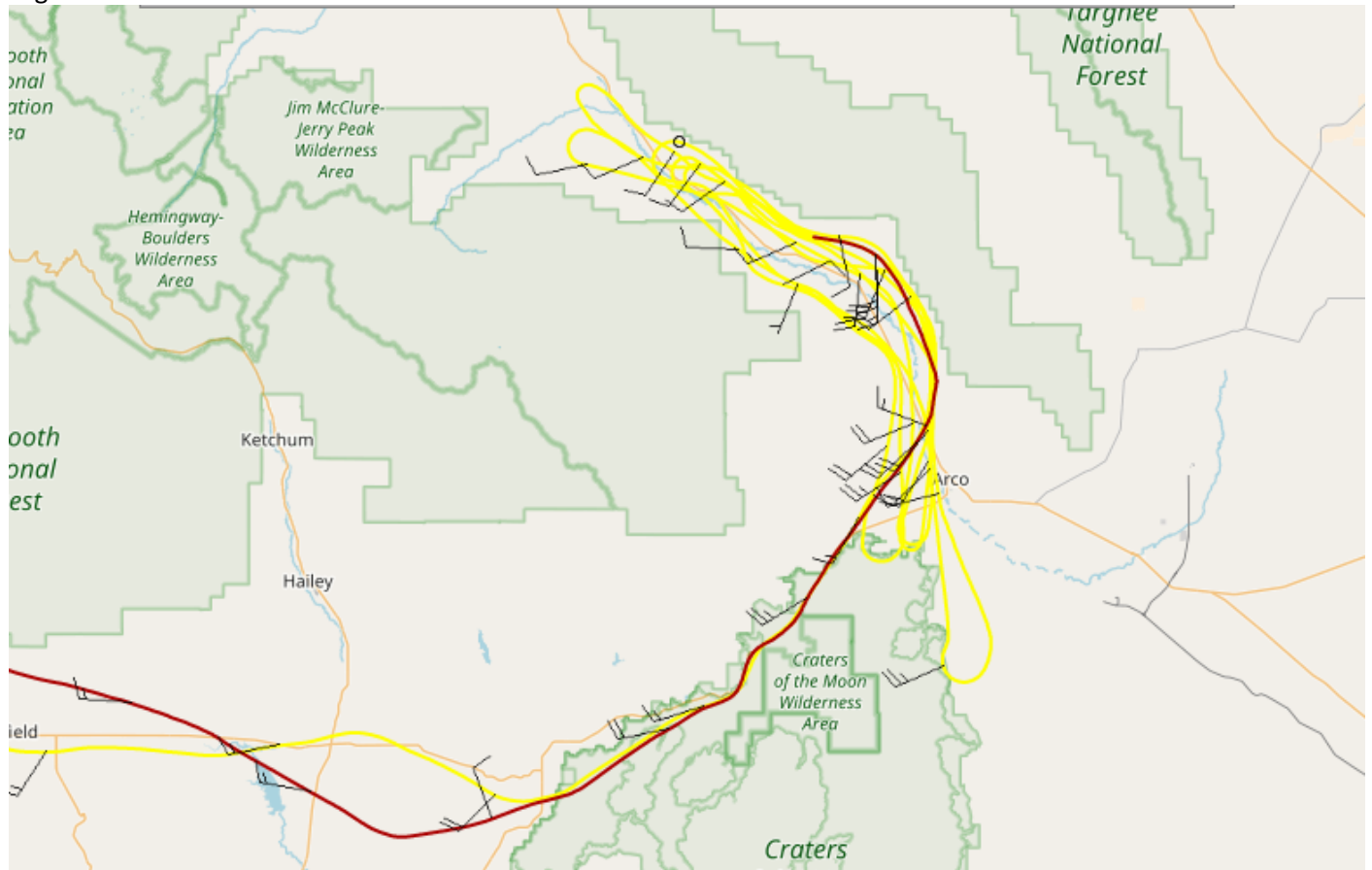
Crew: Wadsworth, Kille, Oolman, Zarzana

Flight Time: 3.8

Planned: Fly the Sharps Fire. Do a low-altitude flight past the south edge of the TFR, then work the same valley as the previous two flights, north of Arco.

Actual: Departed, climbed to 11.5K'. Descended to minimum altitude after 60 nm. Checked in with Air Attack and then went to the area near Arco. Flew about 4 times up & down the valley to Mackay at min altitude. Then climbed to 10.5k' for a northbound leg. Then climbed to 15.5k' for a southbound leg. Descended back to min altitude for two more laps up and down the valley, then returned to Boise at min altitude, along the south end of the TFR.

Flight track:



## BB-FLUX RF08 (2018-08-04)

Brett Wadsworth, Natalie Kille, Christoph Kotte, Larry Oolman, Kyle Zarzana

LOD: Zane Little

**Mission:** Fly the Sparks Fire to the east of Boise.

2111 Take off  
2114 CO cal  
2120 FL115, T=3, DP=-6, winds 12 kt from 240 degT, O3=34 ppbv, CO=145 ppbv, CONC=1000 /cm3, top of BL 4500 ft above  
2126 Start descent  
2131 FL060, T=21, DP=-3, winds 20 from 260, O3=33, CO=145, CONC=1000  
2147 CO cal  
2155 CONC up to 3000  
2158 Heading north up east side of valley to east of the Sparks TFR  
2200 A few clouds  
2201 FL069, T=21, DP=-5, winds 9 kt from 200, O3=40, CO=240, CONC=2600  
2206 Turning to south on west side of valley. CONC up to 3500 last pass, CO up to 280  
2219 CO cal while starting northbound leg  
2229 Turn back to south along east side of valley. CONC peaking around 3000, CO around 250. O3 has been 35-40. CONC=1000 at north end of valley, CO around 150.  
2240 Climb to FL105.  
2245 Restart WCL recording and IDL display  
2246 FL105, T=10, DP=-7, winds 15 from 245, O3=40 CO=270, CONC=3500  
2251 CO cal  
2252 Climb to FL155  
2256 Heading back south. T=-5, DP=-12, winds=12 kt from 240, O3=36, CO=150, CONC=800. Cloud base around 17,000 ft. Appear to be above smoke.  
2300 Intercepting top of plume. CONC up to 4000, CO up to 280  
2302 From Lidar, smoke probably reaching same level as cloud base – 17,500 ft  
2305 Hit higher values, CONC=5000, CO=350  
2307 In clean air  
2308 Back to surface  
2314 FL066 heading north along east side of valley, T=21, DP=-6, winds 18 kt from 240, O3=37, CO=170, CONC=800  
2325 Turning south, CONC up to 4000, CO up to 280. CO cal  
2326 North of plume CONC=1100, CO=180, O3=37  
2337 Turn to north  
2338 Elevated layer 4000-6000 ft above us (FL066)  
2348 Turn to south  
2356 CO cal  
0000 CONC to 4000, CO to 350  
0013 Coming around the southern edge of the TFR. FL060, T=23, DP=-6, winds 18 kt from 260, O3=38, CO=190, CONC=1200  
0029 CO cal  
0056 Land

## **8/3/18 BB-FLUW Pilot notes (Research Flight 7)**

Crew: Wadsworth, Knot, Oolman, Kille

Flight Time: 3.1

Planned: Fly around the Sharps Fire. Do what we can as the solar angle would be the limiting factor. Partially to see if we can do two flights in this heat. Today was significantly cooler than the previous two weeks.

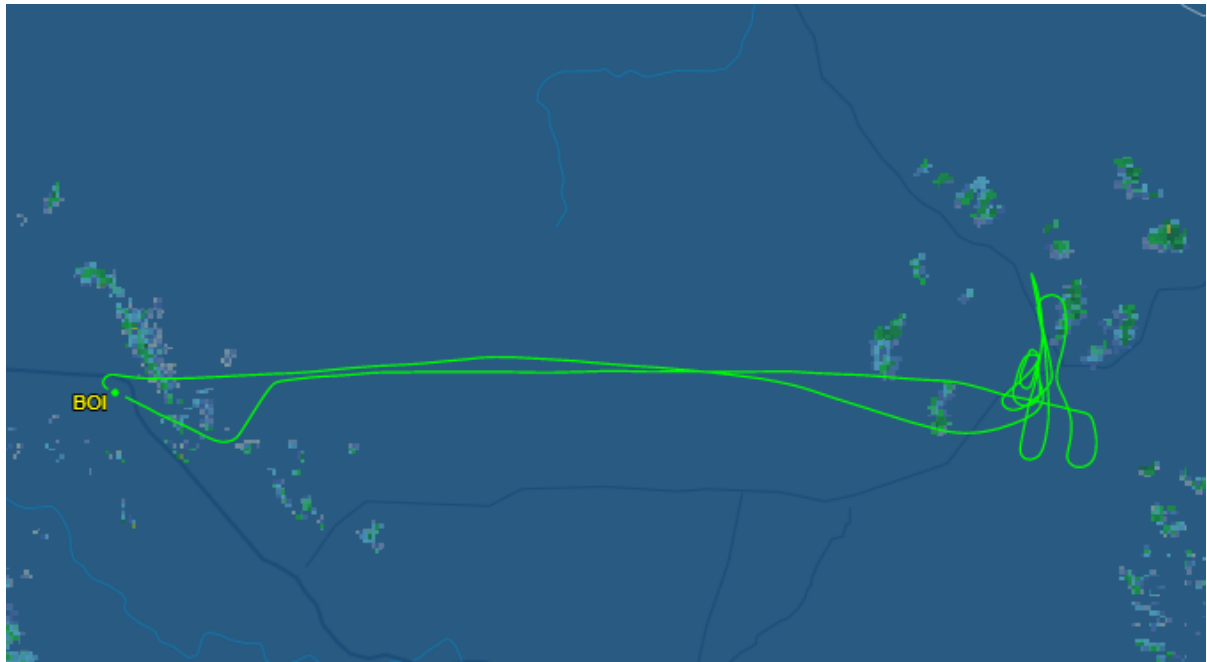
Actual: Departed, climbed to 16.5K'. Crossed the TFR. Descended on the SE side of the TFR and the significant decoupled plume (yes, they do exist). The fire had really taken off late in the day with the existing winds. We saw a pyro-cum sitting over the fire as we were heading east, but it dissipated, as we got closer. Descended to the SW of Arco, close to Craters of the Moon. Got below the plume and headed up the same valley we had worked during the earlier flight.

The valley was familiar, the visibility was marginal, but VFR for some of the transit from north of Arco to south of the Mackay airport.

We worked the valley under the plume for multiple transits between Arco and Mackay. As the sun got low, started working on the endgame. While heading south down the valley, request was to elevate to 9000' MSL, and then for another track north at 12000' MSL. 9000' was barely workable. Got to the south, outside the plume and climbed to 12,500'. Headed north. It became unworkable (visibility went below VMC), so we climbed out of it and turned south again. Flew south of the plume, descended back down to ~700' AGL south of Arco, then did a sounding to the south of the plume, remaining in VMC conditions to 16,500' MSL. Picked up flight-following with Salt Lake Center, asked them what their min IFR altitude was in that area. The answer was 14,000' MSL.

So this is challenging. Use the tools we have. The iPad on Foreflight froze on me once today in flight. I had to turn it off and back on to recover, but it did, and worked fine for the rest of the flight. While it was coming back up, it made me realize how much I depend on the synthetic vision as an essential tool, coupled with the Garmin and the KMD terrain display. If Foreflight had not recovered, I was considering terminating the flight.

Flight track: Not exact, but close.





## BB-FLUX RF07 (2018-08-03 B)

Brett Wadsworth, Christoph Knote, Larry Oolman, Natalie Kille

LOD: Zane Little

**Mission:** Fly the Sparks Fire to the east of Boise. Second mission of the day. Evidence of good plume on satellite.

2217 Take off  
2226 Turn on Licor 7000 switches  
2232 FL175, T=-9 C, DP=-50, winds 40 kt from 260 degT, O3=60 ppbv, CO=74, PCASP=10  
2231 Nice pyro-Cu ahead of us.  
2234 CO cal  
2245 Start descent on south side of plume.  
2250 Descend into BL at FL098  
2253 Under the plume  
2255 FL066, CO up to 600 ppbv, PCASP up to 8000 /cm3  
2259 Lidar up to 15000 MSL north of plume  
2300 Turning back to south, T=25, DP=-16, winds=22 kt from 210, O3=48, CO=150, PCASP=800  
2302 West side of valley, under plume  
2307 CO cal  
2308 Out south side of plume, CO up to 500, PCASP up to 7000  
2311 Under south edge of plume in same track  
2312 Smoke reaching our level  
2316 Out north side, up to CO=750, PCASP=9500, turn to east side of valley  
2318 Under plume  
2325 Out south side, maximum values similar, plume on south side distinctly lofted and works down as we proceed north. Satellite image also show sharper edge on the south side.  
2232 Out north side, extend about 6 miles  
2336 Turning back to south, O3=37, CO=150, PCASP=750, winds 20 kt from 240  
2339 Back in/under the plume, CO in cal  
2347 Out southern end  
2348 Turn to north  
2350 Under plume  
2352 Smoke mixing down to our level  
2357 Turning back toward south  
2358 Climbing  
0004 FL090, CO exceeded 2 ppm  
0005 Climb to FL120  
0011 Climb to FL125, on northerly heading, T=7, DP=-27, winds 30 kt from 280, O3=42, CO=in cal, PCASP to 20,000.  
0013 CO up to 3.3 ppm  
0014 Climb out of plume at FL148  
0017 FL175, overfly plume  
0018 Start descent  
0024 FL092, entering BL to south of plume  
0026 800 ft agl, FL060, starting sounding parallel to the plume but offset to the south

0034 FL165, T=-5, DP=-22, winds 45 kt from 260, O3=32, CO=70, PCASP=20, heading to Boise

0100 Starting down

0115 Land

### **8/3/18 BB-FLUW Pilot notes (Research Flight 6)**

Crew: Wadsworth, Volkamer, Oolman, Lee

Flight Time: 4.0

Planned: Fly around the Sharps Fire. Work downwind, arc around the south side for an upwind sounding on the West. Get back to the east side for most of the flight time. Do a sounding up across the TFR.

Actual: Basically did as planned. Terrain was significant on the North and NE side. One great valley on the east side that is wide, flat and long, extending from the Arco area up past Challis. Visibility marginal at times. The upwind leg past the Hailey airport was interesting. The airport was active with multiple aircraft arriving and departing while we did one pass up the valley and then back down to the south. I would not be surprised to receive a phone call from the FAA on this part of the flight. While passing the Hailey airport (and talking to tower) a yahoo on a Cessna that landed as we were going past asked tower for the altitude of the King Air as we went over Bellevue. Tower asked me. I reported 700-1000' AGL which is IAW our waiver. We'll see if there is any follow up from the FSDO. The local FSDO's have a copy of our paperwork and waivers.

Long flight. On the return to Boise, Big Sky wanted to turn us back to 090 to sequence us. Could not accept the delay and said we were minimum fuel, so they brought us in for 28R.

Winds were higher today than any day so far. Out of the west so be heads-up on fuel. 4 hours when the entire flight is at low altitude burns a lot of fuel. Also with the A-10s and F-15s coming back short on fuel, the controller may turn/delay us for sequencing.

Flight track: NA

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## BB-FLUX RF06 (2018-08-03)

Brett Wadsworth, Rainer Volkamer, Larry Oolman, Chris Lee

LOD: Zane Little

**Mission:** Fly the Sparks Fire to the east of Boise

1714 Take off  
1724 FL148, PCASP counts suddenly dropped above BL. CO dropped to 70 ppbv.  
1725 FL155, T=-4 C, DP=-44 C, winds 38 kt from 240 degT, O3=47 ppbv, CO=70 ppbv, PCASP=20 /cm<sup>3</sup>  
1730 FL155, starting to intercept top of BL. Depolarization ratio (uncalibrated) > 8%. Higher than what we had been seeing on previous flights.  
1739 FL155, over TFR, T=-2, DP=-26, winds 33 kt from 250, O3=40, CO up to 700, PCASP up to 4000  
1744 Start descent east of TFR  
1749 CO cal  
1752 FL082, south of TFR, T=16, DP=-4, winds 18 kt from 230, O3=39, CO=270, PCASP=1400  
1802 FL057, SE of fire, T=22, DP=4, winds 13 kt from 220, O3=37, CO=240, PCASP=1200  
1806 Start climb near Hailey Airport  
1812 FL105, north of TFR, T=10, DP=-6, winds 17 from 225, O3=42, CO=240, PCASP=1300, reversing course to head back south to the west of the TFR.  
1822 CO cal  
1826 Start a climb east of the TFR to avoid terrain=-8, DP=-40, winds 44 kt from 250, O3=47, CO=78, PCASP=20, a few Cu coming through our altitude.  
1858 Spike in PCASP and CO  
1901 Start descent  
1907 FL145, beneath Cu  
1917 In valley nearest TFR, climbing to get into the next valley east and proceed back north.  
1926 CO cal  
1934 FL075, NE of TFR, T=21, DP=-8, winds 24 from 270, O3=40, CO=212, PCASP=1000  
1950 Lidar had stopped for water level warning. Restarted. Turned around to the north of the fire. Heading back to south and to east of the fire.  
1959 CO cal  
2015 FL064. South end of line to the east of the TFR, turning back to north.  
2019 Climbing to get over TFR.  
2023 PCASP, CO, and O3 increasing  
2024 FL154, out of smoke, PCASP 10000, CO=850 just before exiting.  
2029 FL166, Intercepted plume, PCASP up to 20000, CO up to 2.3 ppm  
2031 CO cal  
2031 In free trop, T=-7, DP=-20, winds=30 kt from 245, O3=42, CO=140, PCASP=40  
2036 FL152, O3 at 55 ppm  
2108 Land

## 8/2/18 BB-FLUW Pilot notes (Research Flight 5)

Crew: Wadsworth, Knot, Oolman, Kille

Flight Time: 3.8

Planned: Do intercomparison with the C-130, then fly at low altitude into Nevada, then a sounding when out of the plume, then descend after back over the plume and return north. Continue up to the North side of the background plume, do an 'X-sounding', then return to Boise. During the crew brief, I told them that there would be no talking among the N2UW crew while the intercomparison was taking place or else I would unplug their headset. It worked and it helped. A lot. It also helped that Renier was not on the aircraft. ..

### Actual:

For the inter-comparison, we met yesterday (WECAN PIs & PM, BBFLUX PI & PM, plus pilots for both aircraft) and generally mapped out the plan. I met with Scotty & Ed at 11 AM to review what we talked about and solidify the plan.

The plan:

Common frequency: 119.95. Backup of 123.45.

N2UW would take off ~10 minutes prior to Science Quest 1 (SQ1). They would be in the C-130 prior to us, so we would check-in on the common freq. while starting to see how it was going. We would taxi before them. We departed VFR, they would take off on an IFR flight plan and cancel when away from the field. Both aircraft would fly a line from the BOI VOR to the RME VOR, with N2UW on the right side of the line, SQ1 on the left side. Planned for the first pass to occur at 10.5K' MSL. They would pass down our left side, then turn back east in a left hand turn while we would climb to 16.5k'. They would again turn back to the west and chase us down while climbing on their side of the line. I input an offset into the FMS to have N2UW .5nm right of the course line while they were flying about .75nm left of the line. I would keep N2UW at 140 KIAS in the climb and until they were approaching us for the pass to help their closure. After getting to 16.5k', they again passed us on the left side. We were about over the RME VOR so I asked them to stay at 16.5k' while I descended. Once N2UW was below 1000' AGL, I cleared them down to their min altitude. Updated them on the general terrain altitude and turbulence. They descended at ~1000 fpm then started to climb again. Their scientists told them to leave shortly after that, so they left the orbit and headed to California.

Goods: We didn't hit each other. We had a good idea of what the plan was.

Bads:

-As soon as I told them that I was starting to descend from 16.5k', they immediately came right of course and crossed the line we'd used for deconfliction. Yes, they were a bit ahead and pulling away from me, but it probably wasn't adequately discussed. We should have briefed that they would stay left of the line until I cleared them across with 500' of altitude separation since N2UW was behind them, I could see them, they could not see me..

-We did not establish the criteria for them to start their descent. My impression from Renier was that they would not descend until we were at our minimum altitude. The C-130 announced that they were starting to descend when N2UW was only about 1000' below them. I asked them to remain at 16.5k' until I was at the bottom, which they accepted.

-We did not analyze how much time was going to be required for this nor if we had enough airspace from the BOI VOR to the RME VOR. We almost screwed this up. When it looked like we were going to

get to the RME VOR before we had completed the close passes, we were talking about backup options (turning south from the RME to the SDO VOR with them remaining left while we stayed on the right. Then when it looked like we were going to be close, simply going into heading mode and extending the flight path SW of the RME VOR for the short amount that might have been required to complete the close work.

Others:

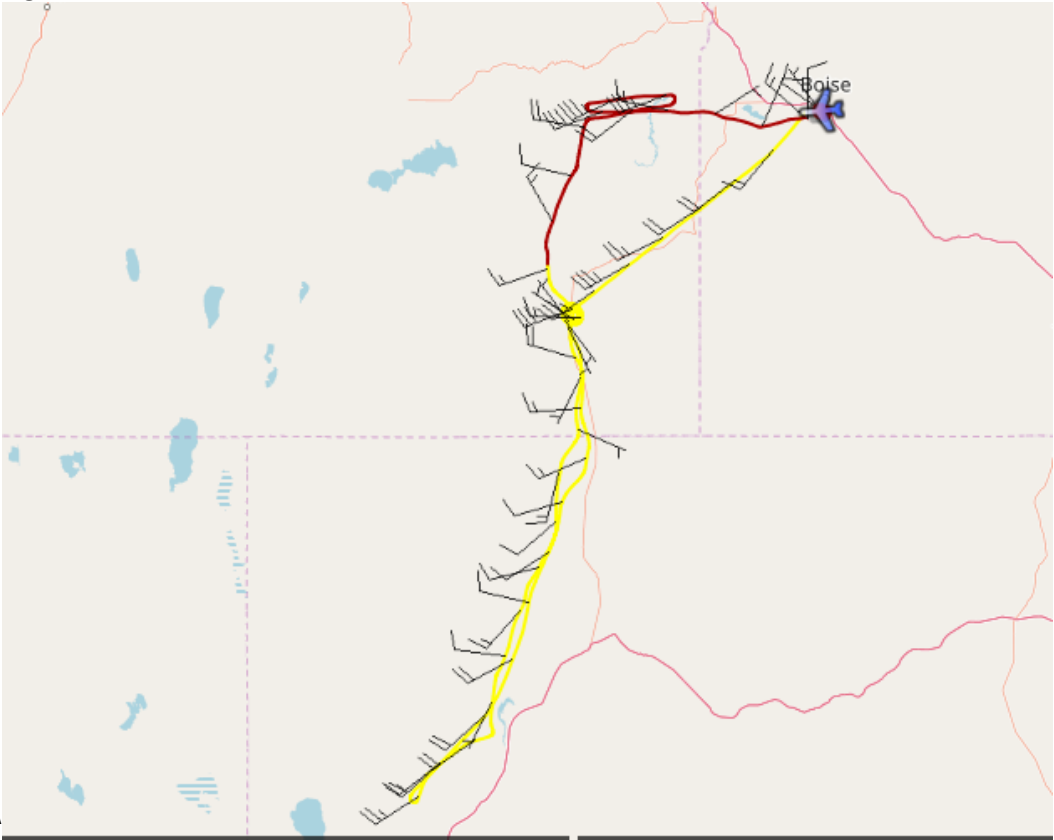
-Not much. Deliberately remaining in close proximity to another aircraft when TCAS is screaming is distracting at best. It's been a long time since I've done it, but it was good to knock the first level of rust off.

Remainder of the flight. Departed the RME VOR for the SDO VOR at an altitude of 400-1000' AGL. The terrain was fairly permissive as it is relatively flat in SW Oregon with some mountains here & there, but miles & miles of miles & miles. Not even many cows.

We got down to the vicinity of the LLC VOR before we were out from under the background plume, then did a sounding up to 16.5K'. We reversed course back to the NNE to get back over the plume, then descended back down through it to under 1000' AGL IAW our waiver. Again crossed over the SDO then RME VOR before planning to turn NW to avoid the SADDLE B MOA. Attempted to contact COWBOY on 134.1 to determine the status of the MOA, but no response. Fuel was starting to become a factor to complete everything desired by the PI. Became clear that we could not get to the north of the background plume AND do an "X sounding". Also found via Foreflight that the bottom of the SADDLE MOA was 8000' MSL, so after passing RME VOR, we headed basically north under the MOA. Continued discussion via chat with the PI (he was not onboard the aircraft), so we elected to exit to the north side of the MOA, then turn toward Boise and do an X sounding before returning to the airport.

Overall: Good flight. Pulling off an intercomparison isn't automatic.

Flight track:



Orbit over RME VOR for Intercomparison.





## BB-FLUX RF05 (2018-08-02)

Brett Wadsworth, Christoph Knote, Larry Oolman, Natalie Kille

LOD: Zane Little

**Mission:** Intercomparison with C130 then south to North Pass under broad California plume.

1857 Take off  
1859 WCL overtemp, cycle power, came up fine.  
1902 Thin cirrus around 30,000 ft  
1903 FL105, T=11 C, DP=-8 C, winds 17 kt from 225 degT, O3=53 ppbv, CO=275 ppbv  
1906 Turn on Licor 7000 reference gas.  
1913 Start CO cal  
1918 C130 to our left  
1919 Start climb to FL165, out of plume shortly after.  
1923 At FL165, T=-4, DP=-29, winds=34 kt from 240 degT, O3=36 ppbv, CO=65 ppbv  
1931 C130 to our left. Still cirrus above. Start descent.  
1933 Enter plume at FL120  
1937 FL055, C130 starting their spiral down.  
1940 FL047, T=28 C, DP=-2 C, winds=7 kt and variable, O3=46 ppbv, CO=230 ppbv  
1944 WCL computer rebooted  
1945 CO cal  
1948 C130 at FL053  
1954 Heading to south  
2001 FL054, T=28, TP=-6, winds 11 kt from 320 degT, O3=47, CO=236, PCASP=1200 cm-3  
2008 From satellite, it appears the smoke make go as far south as N40 45', about 90 nmi south of our position  
2011 FL048, smoke extends 6 kft above us, with 2 kft of clear, then 2 kt more weak lidar return.  
2017 CO cal  
2024 From sat, it appears we are below the thickest plume, FL043, T=31, DP=-7, winds 12 kt from 235, O3=44, CO=285, PCASP=1300  
2029 FL044, CO>550, O3=48, PCASP>3000  
2040 Low depolarization, FL055, R=28, DP=-13, winds 18 @230, O3=48, CO=130, climbing  
2050 Start CO cal, FL165, T=-4, DP=-14, winds 23 kt from 240, O3=41, CO=65, PCASP=50, wall of smoke the north  
2102 FL165, T=-4, DP=-17, winds 20 from 245, O3=52, CO=75, PCASP=70  
2103 Top of plume FL158, CO peaked at 1500 ppbv  
2108 FL105, CO=1000, O3=75  
2114 Bottom of profile, FL047, T=30, DP=-4, winds 10 kt from 200, O3=51, CO=340, PCASP=1700  
2122 CO cal  
2142 CO and PCASP slowly climbing, CO=315, PCASP=1600, O3=43  
2154 Restarted DDS and XFER. May have had internal array overflow from long time running on ground. CO cal  
2200 Start sounding toward east, FL055, T=25, DP=-3, winds 28 kt from 270, O3=40, CO=210, PCASP=1000  
2205 Top of BL around FL110  
2207 FL145, T=0, DP=-19, winds 32 kt from 250 O3=34, CO=65, PCASP=50, reversing course to west.  
2218 Turning back to east and starting descent. FL145, T=0, DP=-21, winds 31 kt from 240, O3=40, CO=70, PCASP=40  
2226 Bottom of sounding, FL035, T=29, DP=4, winds 9 kt from 90, O3=48, CO=280, PCASP=2000, start CO cal  
2243 Land



## 8/1/18 BB-FLUW Pilot notes (Research Flight 4)

Crew: Wadsworth, Knot, Oolman, Kille

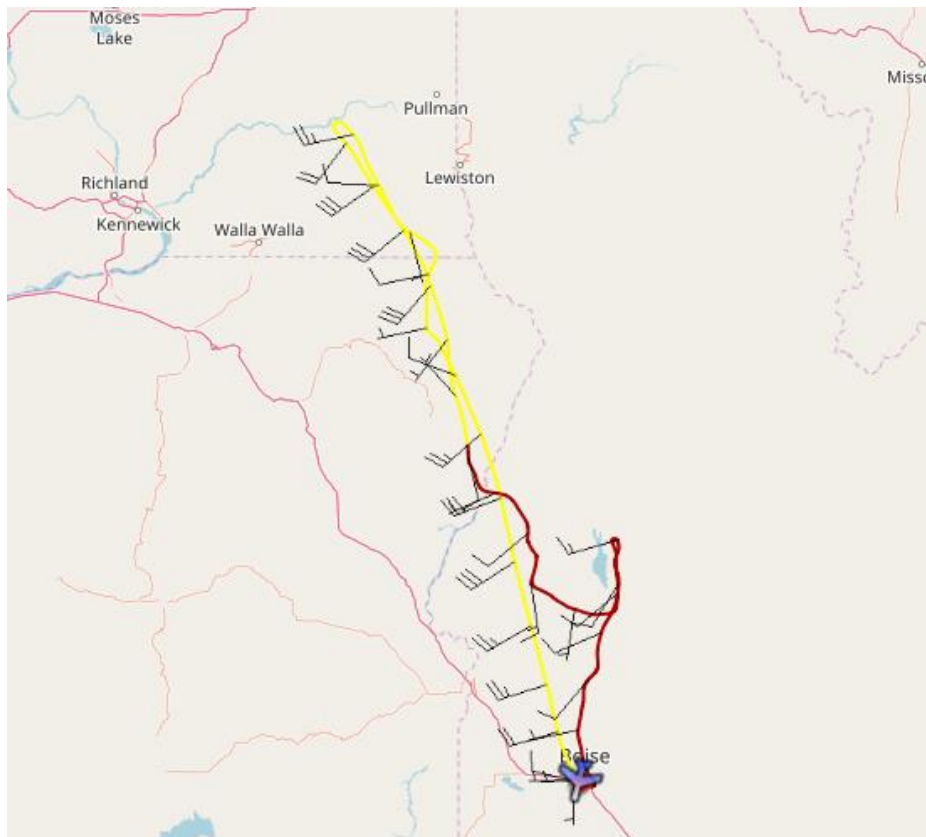
Flight Time: 2.7

Planned: Get background data on general smoke in atmosphere. Fly near the Mesa fire, then to the NW of Lewiston, ID. Do a couple soundings along the way. Possibly delay near the Mesa fire on return depending on fire activity..

### Actual:

Just prior to takeoff, we decided to immediately climb to 17,500' on departure to help cool the cabin & instruments since N2UW had been towed out early. We remained at altitude and started the decent so as to clear high ground on the east side of the Wallowa Mountains in NE Oregon. Remained at low altitude as we wandered north. Maintained flight following reasonably with SLC, then Seattle, but they had weak radar contact in various areas. Once north of the LaGrande River, Seattle had us pretty well. Upon getting out from under the general background plume of smoke, we turned around and did another sounding up to ~17000', then immediately started our decent back down again. Climbed to clear the high ground to east of the Wallowa's, then where the track below shows a brown track, we worked around the Mesa Fire, crossed the ridge to the east and flew north to McCall before reversing and heading back down to Boise.

Flight track:



## BB-FLUX RF04 (2018-08-01)

Brett Wadsworth, Christoph Knote, Larry Oolman, Natalie Kille

LOD: Zane Little

**Mission:** Look at background values from OR/CA fires. Study Mesa Fire if it looks good. Ran aircraft on ground for a couple hours prior to flying. WCL indicated too hot. Cycle power on laser power supply.

1845 Take off, climb to FL175. Climbed out of the boundary layer at FL170. CO up to 300 ppbv  
1858 Back in and out of boundary  
1904 FL175, clean at this altitude (PCASP around 200/cm, CO around 60 ppbv). WCL sees layers up to about 1 km above us.  
1907 Under clouds  
1911 Start descent  
1913 FL145, seeing higher values of PCASP, CO, and O3  
1915 CO above 400 bbbpv, slowly dropping as we get lower.  
1922 Bottom of descent. FL050, From WCL depol, bottom of plume 800 m above us.  
1935 SW of Warner Gulch Fire. Se blackened area but not smoke.  
1946 FL025, reverse course to south and start climb. PCASP~300, CO~80  
1950 FL070, entering plume from below  
1952 FL100, out of top of plume, PCASP=3000, CO=400  
1954 FL105, climb through thin layer  
2000 FL170, start back down  
2004 FL125, back in plume, O3~49 ppbv  
2005 FL110, O3=57, CO=500, PCASP=3000, winds 25 kt from 215 degree T  
2009 CO in cal  
2013 Low depolarization in low level air  
2030 Upwind of Mesa fire. May be some smoke coming from it.  
2041 CO cal  
2053 Measurements downwind of Mesa not above background. Head back to Boise.  
2117 Land

**7/26/18 BB-FLUW Pilot notes (Research Flight 3)**

Crew: Wadsworth, Volkamer, Oolman, Kille

Flight Time: 3.5

Planned: Fly around the MM 73 and Keithly fires.

Actual:

Flew around the MM 73 and Keithly fires. Talked with both Air Attacks. Terrain much more accommodating around the Keithly fire than the MM 73 and the Rattlesnake.

No legible flight tracks to show today. Poor tracking by the UCAR catalog./

Foreflight has added a new feature to the synthetic vision. You can swipe the screen to view 360 degrees around you. It will also show ADS-B traffic on the synthetic vision at their location on the horizon.

## BB-FLUX RF03 (2018-07-26)

Brett Wadsworth, Rainer Volkamer, Larry Oolman, Natalie Kille

LOD: Austin Morgan

**Mission:** Study the Keithly, MM73, and Tresle Fires to the north of Boise. Current limiter between aircraft and research power failed and had to be replaced.

2012 Take off  
2028 Down wind of Mile Marker 73 Highway 55 Fire, CO up to 200 ppb  
2045 In plume of Keithley Fire, T=30 C, DP=-1 C, winds from 260 at 8 knots, PCASP up to 4000 cm-3, CO up to 250 ppb, O3 up to 65 ppb  
2056 Heading back south over Snake River, FL034, T=32, DP=0, winds 50 at 3 kt. CO 90, PCASP 350 O3 43  
2100 Upwind of the Keithly Fire  
2101 Burned area to our right  
2110 Heading back north up downwind side of Keithly  
2113 O3 up to 70 ppm  
2118 Turning south for another downwind leg  
2123 Extra 360 turn to give tankers time to get in front of us  
2136 Northbound again  
2138 Start sounding near center of plume  
2143 FL105  
2149 FL135, near top of plume  
2152 At FL175, start descent at 1500 ft/min  
2156 SOF saturated, level out at FL150 while Natalie restarts it.  
2209 Starting descent again.  
2219 Bottom of sounding, heading south  
2223 Northbound under elevated plume, winds from 280 at 10 kt  
2237 Azimuth motor on SOF required restart  
2238 Smoke from Rattlesnake fire appears to be thick in valleys to our north  
2245 Late enough in afternoon that we are starting to lose the sun.  
2250 Flying towards sun helps SOF sun angles, lost azimuth motor again.  
2258 Heading north upwind of fire  
2335 Land

## 7/24/18 BB-FLUW Pilot notes (Research Flight 2)

Crew: Wadsworth, Volkamer, Oolman, Kille

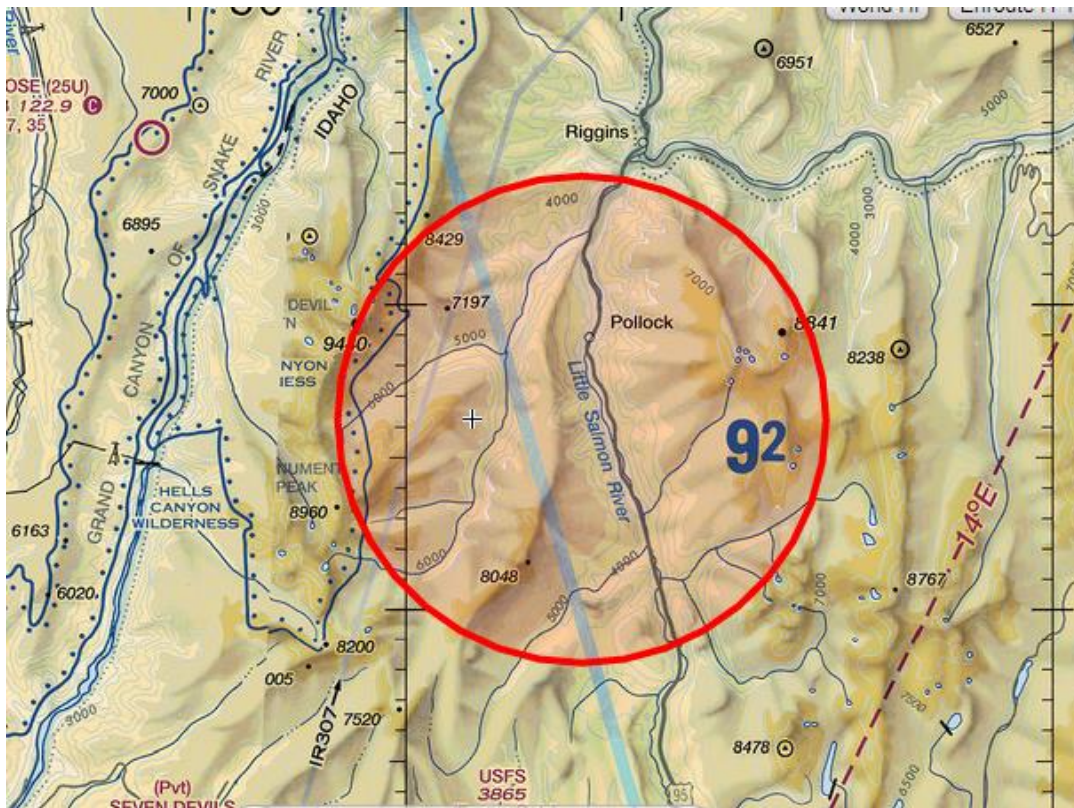
Flight Time: 3.6

Planned: Fly to the north of the Rattlesnake fire, skirting along the west side between the Wilderness area and the TFR, then SE to the east side of the TFR for multiple passes, N/S in a canyon; do a sounding, north again until outside the background smoke from the Oregon fires, then south again. Aside from the sounding, all to be done at low altitude.

### Actual:

Pre-flight with Stan Kubota (NSF liaison to the USFS) was very helpful. Based on conversations the previous night, we knew which fire we were interested in. He collected contact info for the Air Attack over the fire so we could start trying to contact them from about 25 nm out. Coordination with Scotty & Ed from NCAR was important. We will use 123.45 for coordination with them in-flight. We have decided to start using the central point from the NOTAM on the TFR as a reference point. When we talk when airborne on 123.45 around the fire, we use the reference point to relay our distance and direction from the fire. A common point to build a common picture.

During the brief with the PI, he wanted to fly up Hells Canyon for an upwind leg since it lies between two Wilderness Areas, and he thought we could get lower in there. I refused to consider it. I suggested that we try to fit in-between the TFR and the Wilderness area on the west side.

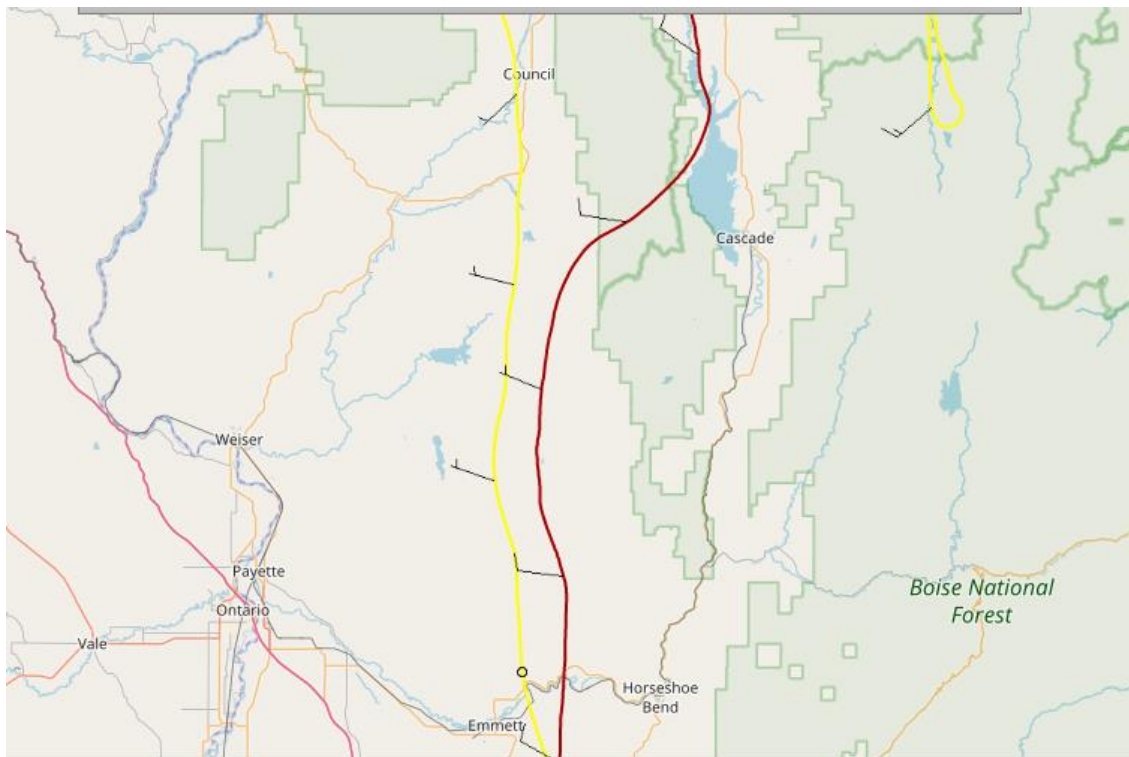


The TFR has been expanded since we flew so that it now overlies the Wilderness Area a bit.

So, we basically agreed to the gameplan as discussed above in the plan. When we flew and contacted the Air Attack, they asked us to climb above 12K as we approached the TFR. Not what we wanted, but we did so. We skirted along the West Side of the TFR and were given traffic info on a co-altitude aircraft within a mile to the west of us within a half mile. Never saw this aircraft. When past the TFR, we asked the Air Attack for a lower altitude. He let us down to ~9K'. Once past Riggins by 10 miles, which was the IP for the tanker stack, he let us continue to descend. The valley was the route for fire traffic flowing north to Grangeville, and there was traffic on TCAS.

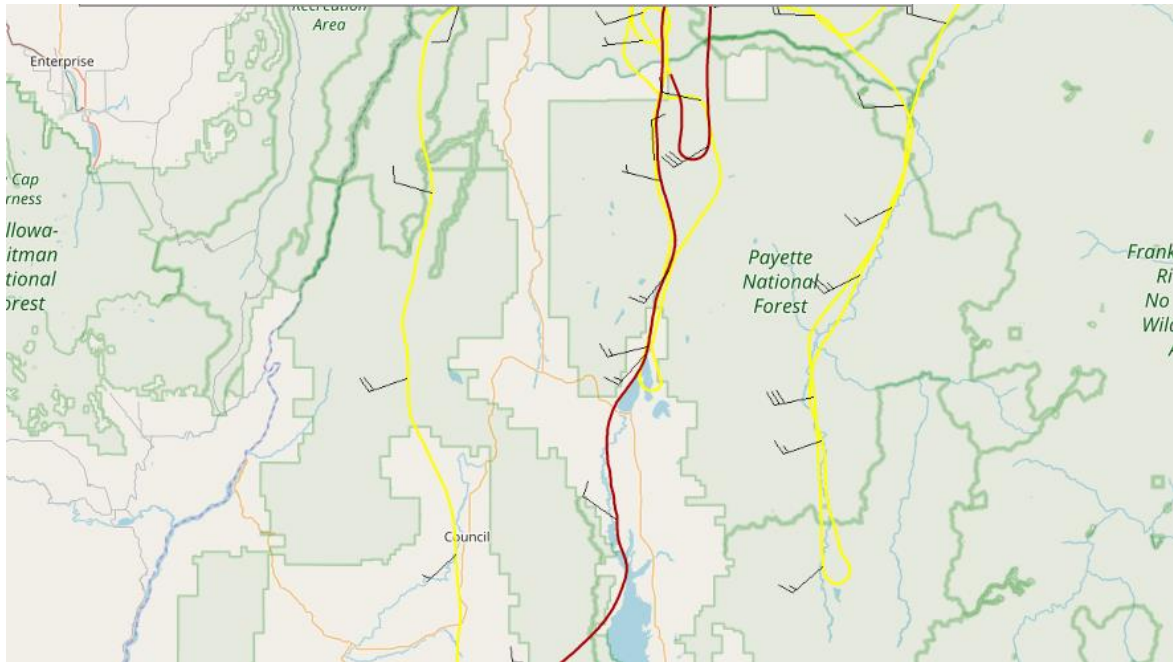
We continued to the north as far as a bit past Grangeville ID to get north of the smoke plume from Oregon before turning back to the south. We angled to the SE to try to get to the north end of a N/S valley about 15 – 18 miles east of the fire. We got there and started south, but the visibility went bad, really bad as we edged south. We were below the surrounding ridges so we started climbing before we got into the terrible visibility and turned to the north. We worked further to the east and used another N/S valley that we used to fly south, then reversed back to the north.

Below shows the start & end of the flight. Yellow is the flight north. Brown is the termination route back to Boise.





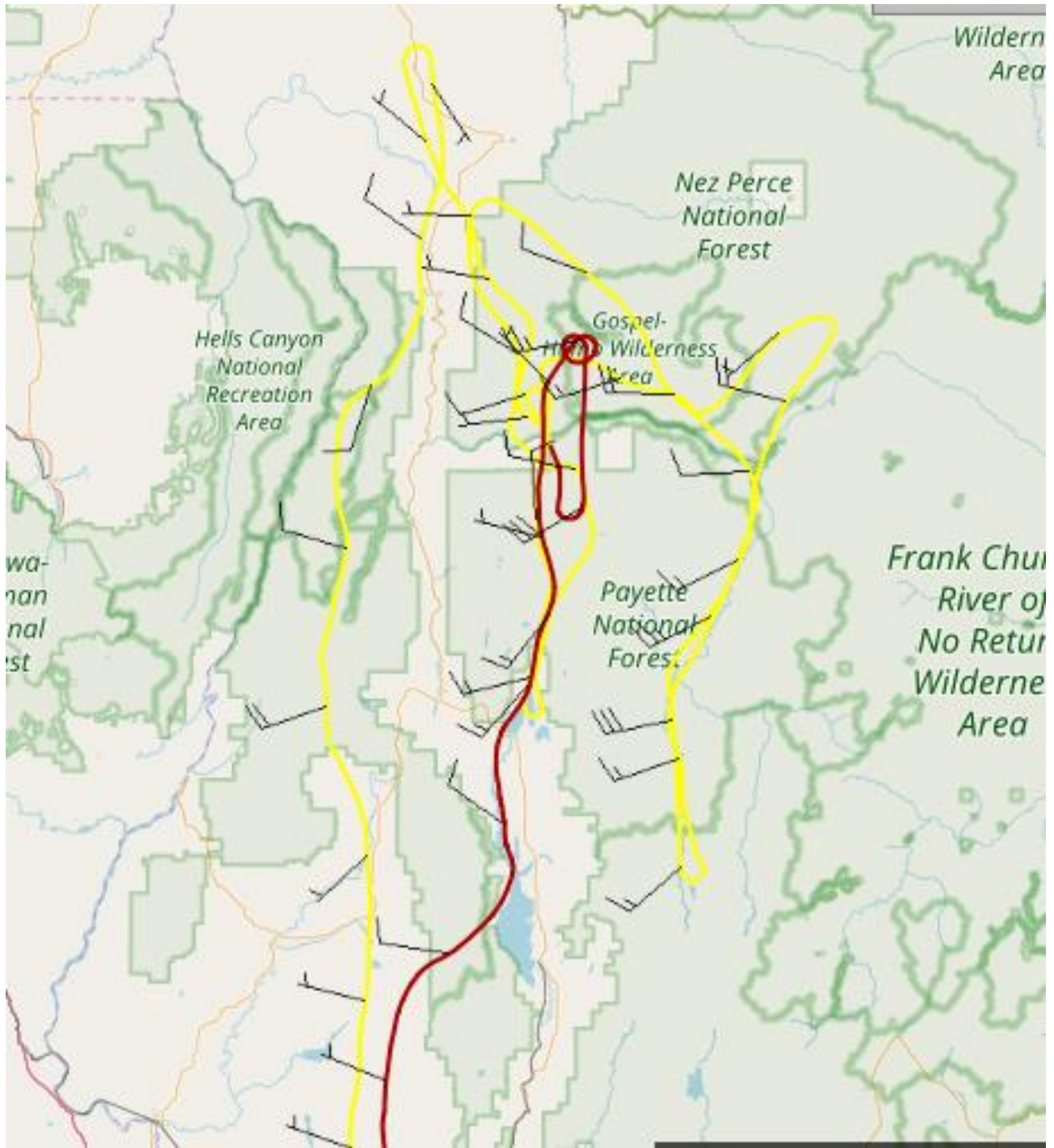
Further to north.



Northernmost end of the area.



Overall flight path below.



So, not to bludgeon a dead horse, but the major lessons-learned.

1-Synthetic Vision on Foreflight is a great tool. Not using it to fly in shitty conditions that don't meet minimum VMC, but using it to help evaluate and forecast clearance of high terrain that we will have to clear; to help give an idea of how canyons unfold ahead. Not betting the aircraft on what it provides, but it is a great tool in addition to the moving map and our own eyes.

2-This fire was busy. We spotted two separate aircraft at close to our altitude (one a helo). The first traffic to west of TFR we never did see it.

3.Some canyons are better flown starting from the south, rather than the north. Has to do with the amount of sunlight that may be received after hitting smoke particulate, as well as shadow on the iPad.

4. Monitoring 3 radios (Center, Air-Attack, and common with the C-130) can get busy, particularly when our PI has no awareness of what the pilot is consumed with.

Overall, we must default to a conservative approach in terms of terrain clearance and visibility. This aircraft just does not have a great climb rate when heavy and working in/around some seriously rugged terrain. Be looking for an option in case something goes wrong at the wrong time. Be alert & aware.

## BB-FLUX RF02 (2018-07-24)

Brett Wadsworth, Rainer Volkamer, Larry Oolman, Natalie Kille

LOD: Austin Morgan

**Mission:** Study the Rattlesnake Creek Fire about 90 nmi north of Boise.

1946 Take off  
2002 CO starting cal  
2007 Start profile to FL130  
2021 Start descent  
2034 CO cal  
2033 Complete upwind leg to sample background smoke from fires on the west coast, turn south to the east of the fire.  
2100 Set CO cal to zero, data now intermittent.  
2109 Start climb, WCL power decreases.  
2113 Cycled power on Aero Laser. Data returned.  
2115 Again in climb, WCL power drop again? Head back towards north  
2120 WCL power returns about time we stop climbing.  
2150 Turn back to the south  
2151 Climb/WCL power drop  
2215 Start profile towards the north.  
2220 Back towards the south  
2227 FL175, spiral descent  
2235 Back near surface  
2249 Head back towards Boise  
2314 DOAS window 96 F  
2320 Land

## 7/21/18 BB-FLUW Pilot notes (Research Flight 1)

Crew: Wadsworth, Volkamer, Oolman, Kille

Flight Time: 3.6

Planned: Fly to the north of the Reynolds Lake fire, then SW to it; orbit the TFR twice, then do a sounding and return back to Boise.

### Actual:

NCAR reps showed up in the lobby of the FBO as we were in final prep for the flight. Emily and two others. NCAR has a liaison with the USFS that they are going to use to coordinate with the USFS before flight. He provided frequencies to contact the USFS Air Attack plane when near the TFR.

Filed a VFR flightplan. Talked to Clearance and they didn't even bother looking for what I filed. Asked for type of aircraft, direction of flight, duration and they gave me a code..

Departed Rwy 28L. Tower turned us on-course shortly, switched us to Big Sky. They then handed us off to Salt Lake Center.

Verified with SLC what freqs would work for them over the course of the flight. They said they would keep us for about 30 minutes on the same one. They did pass us off to Seattle Center who was able to see us until we headed SE towards the fire when radar service was terminated.

We remained at relatively low altitude for the entire flight up to and around the TFR. Pretty bumpy at times. Flew over Wilderness area, so had to elevate over it. Use of synthetic vision on Foreflight was helpful as a predictor for distant terrain. Lowest altitude reached today was about 500' AGL over ridges. Did not attempt to get to the lowest possible altitude anywhere because of the need to preserve a safe escape if something goes wrong.

Upon approaching the TFR, contacted Reynolds Lake Attack. Told him who we were, what we were planning and that we were doing research. No objections. He asked us to let him know when we departed the area.

Did the two laps around the fire. Then headed back to the NW and climbed to FL250 for a sounding. Seattle Center was very helpful. They did not bother collecting all the standard info for the clearance when I told them it would only be for a short duration before dropping back down and proceeding VFR.

Returned to Boise at low altitude again. Remained bumpy. Sun angle was getting low, so using left rudder to get a right AOB so the SOF could see the sun helped data collection.

Flight path below – more or less.



## **BB-FLUX RF01 (2018-07-21)**

*Brett Wadsworth, Rainer Volkamer, Larry Oolman, Natalie Kille*

*LOD: Austin Morgan*

**Mission:** Study the Reynolds Lake Fire

2104 Take off  
2126 Friehe A & B both reading 3-4 C low  
2127 LICORT reading zero.  
2134 FL079, T=18 C, DP=-3 C, winds 14 kt from 235 degrees.  
2135 Lidar power increased  
2158 FL065, T=15, DP=-3, winds 8 knots from 300 degrees.  
2201 Turn to SE and head towards the Reynolds Lake Fire  
2218 To the north of the TFR  
2228 Decrease in WCL power  
2231 Discontinuity in WCL, sudden increase in power  
2244 Completed first circle outside of TFR  
2248 Decrease in WCL power  
2307 Done with circles, start climb from FL100  
2322 FL250, NW of Reynolds Lake, T=-25, DP=-45, winds 75 kt from 240 degrees.  
2326 Direct to Boise, descending  
2351 Started CO calcs  
0004 FRTMPB looks good, A is way off  
0024 CO cal  
0035 Land

**Project:** BB-FLUX18

4 Feb 2019

**Flight:** TF09

*Notes:*

Primarily for PCASP intercomparison doing H-pattern over Saratoga and Laramie Valleys, primarily in clear air but with some limited cloud penetrations. WCR also reinstalled. No 2D-S measurements due to computer hardware issue.

Crew: Wadsworth, Fuller, Plummer, Spradley

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*Flight Summary:*

2147 Wheels up

2150 WCR up, thin layers above to -10 dBZ

2153 GAST pump on

2154 At ~12 kft, cloud base is 3 kft above on WCR, winds ~225

2202 Clouds thinner and higher as we progress west, ~6 kft above same FL12 and < 1km thick

2205 Descending to 10.5 kft for legs over Saratoga Valley.

2214 At NW end, return back SE. CIP shows a few crystals falling through FL, just below cloud base at end of leg.

2217 Heading SE at 10.5 kft.

2223 At SE end, returning back N. Opting to look for a few clouds, then do spiral ascent and leg back.

2224 On track to the NW.

2229 Spiraling.

2230 At 15 kft, heading for some clouds.

2234 In a brief cloud, CDP response.

2236 CIP larger particles, CDP response between -15 and -20C in cloud.

2238 Dropping back down to 10.5 kft.



2240 Turning to the SSE to begin second set of legs, over Laramie Valley.

2243 At 10 kft, heading SSE.

2244 11 nm from Med Bow VOR at end of leg, turning back to return NNW.

2247 Diverting for traffic avoidance.

2253 Returning at 10 kft.

2302 Returning to Laramie.

2312 Gear down.

2314 On the ground.

## 7/18/18 BB-FLUW Pilot notes (Research Flight 4)

Crew: Wadsworth, Kille, Oolman, Lee

Flight Time: 1.2

Planned: Fly to the Lodgepole Fire. Possibly orbit; possibly do downwind legs.

### Actual:

Routing filed: Direct to a lat/long on the east side of the Lodgepole Fire.

Clearance: asked for VFR climb on-course. They didn't initially give it to me. Told me to possibly get it from Tower. Tower did give it to me.

Cleared for a right turn off Rwy 28 on course. Climb to 120. Flew out to the vicinity of the fire. Not much of a fire. Didn't match the model in any way. On approaching the filed point, asked for VFR flight following. Granted.

There was a valley on the east side of the fire, outside the TFR, west of the Wilderness area that we were able to work. Climbed above the boundary layer (~17,xxx') before descending back into the valley. Transited north/south a couple times before completing our work in the valley, climbed up to 17,500' and returned to Boise. Boise landing runway 28. Cleared for a right base to 28L.

Was pretty bumpy at low altitude (below the elevation of surrounding terrain). Lowest altitude reached was ~460' AGL over a lake.

Flight path below.

