

Test flights for Radiation Monitoring Devices, Inc.'s  
Holographic Cloud Particle Imager (HCPI)  
University of Wyoming King Air Research

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## Summary

A set of flights based in Laramie to evaluate measurements for RMD's holographic cloud particle imager in a variety of cloud conditions.

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## Facility

● Convert Google Earth points to way points

Date	Flight # (*kml)	Status	Times (UTC)	Hours	Crew/Notes
20 Aug 2020	RF04	Data collected with many cloud passes between 16 and 23 kft. CIP now correctly ingesting airspeed.	1828- 2218	2.9	T Drew D Axisa D Plummer K Shaffer
19 Aug 2020	RF03	Data collected with many cloud passes from bases (near freezing), to tops (near -12C). CIP airspeed manually set to 110 m/s for research data collection.	2005- 2332	3.5	B Wadsworth D Axisa D Plummer K Shaffer
11 Aug 2020	RF02	Research flight collecting data in subfreezing convective clouds. No LWC-301 measurements. CIP airspeed now set to approximate TAS during cloud passes. No camera imagery.	1951- 2112	1.5	E Sigel D Axisa D Plummer J French
10 Aug 2020	RF01	Shakedown flight and collecting measurements in subfreezing clouds and virga at warmer temperatures. No LWC-301 measurements. CIP incorrectly set to low airspeed. HVPS not synced with time	2049- 2244	2.0	T Drew D Axisa J French D Plummer

## Instruments

- In Situ
- Wyoming Cloud Radar
- Wyoming Cloud Lidar

## Contact

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Facility Manager:

**Jeff French**



		server.			
Flight Hours	As of Aug 20, 2020, 9.9 out of 10 research hours were flown, 0.1 remain.		Test and Ferry: 0.0		

8/20/2020 Pilot notes HCPI RF 4

**Crew:** Drew, Axisa, Plummer, Shaffer

**Flight Time:** 2.9

**Planned:**

Planned to fly cumulus developments west of Laramie at multiple levels starting at FL200.

**Actual:**

Departed Laramie and made a westbound climb to FL200. Requested 30 nm radius around LAR VOR. Made multiple passes through cloud from 16,000 – FL 230. Flew some East/West legs through clouds along the state line at FL195. Returned to Laramie.



### 8/19/20 HCPI Pilot notes (Research Flight 3)

Crew: Wadsworth, Axisa, Plummer, Shaffer

Flight Time: 3.5

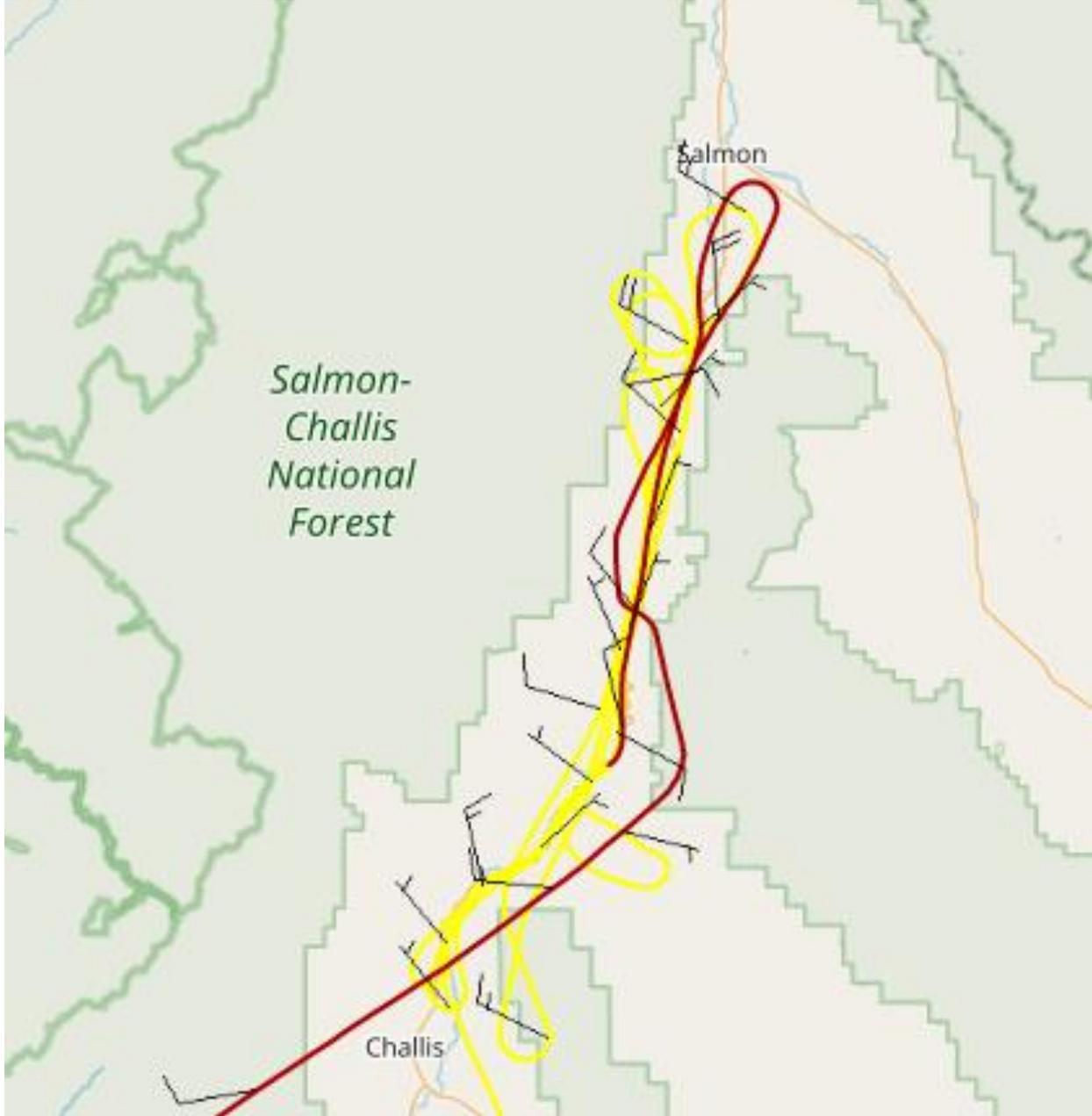
Planned: Climb to 15k. Direct to MBW to work the area.

Actual: Basically did as planned. Started at 15k in a 2k block. Gradually worked up. Spent most of the time at FL210. Flew through multiple “bubbles” of cloud tops. -12 degrees. Picked up enough ice that eventually descended to 14k to melt it off, then back to FL210. Overall went well.

Flight track:



Detail of maneuvers



**Project:** HCPI-20

11 August 2020

**Flight:** RF03

*Notes:*

Cloud passes in developing cumulus on fringes of main convective line. Cloud bases were colder than on prior flights, and much of the flight was spent making penetrations near -12C, near or slightly below the cloud tops. Instruments performed well, even with supercooled water consistently encountered. LWC-301 now responding to liquid water, although the internally-derived values are offset from the other LWC probe measurements. CIP again manually set to TAS of 110 m/s for research data collection.

Crew: Wadsworth, Axisa, Plummer, Shaffer; LOD: Little

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*Flight Summary:*

UTC Comment

HCPI first file: 00000000\_000000000023DF98 200148 UTC

2005 Wheels up.

Licor not turned on initially, switched on during takeoff

2008 Lidar recording.

2014 Missed radar altimeter, switched on now.

2014 At 15 kft, requesting a bit higher to get into cloud bases.

2022 Turning to intercept cloud - have not been in cloud but have seen some ice falling through our level on the OAPs.

2029 Turning again to get better sample through cloud base. Ice clouds, only tiny liquid blips. -1 to -2C, could be below main base?

2037 Up to 17 kft. Some small blips on PVM LWC, but nothing much on CDP/301.

2042 At 17 kft, scraping cloud bases at -3C.

2044 In cloud with liquid, 600/cc on CDP. 0.5-6 g/m<sup>3</sup> LWC. LWC-301 obviously responding in liquid, but offset.

2045 Again, 500-600/cc. Mostly small liquid on OAPs with 0.4-0.5 g/m<sup>3</sup>.

2050 Brief cloud again, 500/cc, 0.5 g/m<sup>3</sup> liquid.

2052-3 Large dendrites, estimating 6-7 mm on HVPS.

2055 Diverting east for some better looking convection, head to 18 kft.

2059 At 18 kft, -7C in cloud. Up to 0.4 g/m<sup>3</sup>, 400/cc droplet concentration.

2100 In more clouds, a bit less overall on each leg but lengthier penetration. Mix of droplets, ice. Diverted left to avoid electrical activity in stronger convection further ahead.

Overall view: more widespread cloud activity here, but tough to find individual convective elements to track up.

2106 Turning to reverse course. Requesting higher block of 19-21 kft.

2109-11 In a number of clouds, temperature near -12C. Liquid with droplet concentrations up to 300-400/cc, LWC .2-1 g/m<sup>3</sup> at various points, some ice present as well.

2115 In tops of smaller convection, lots of droplets and a few ice crystals evident. Temperatures near -12C, with LWC up to 0.8 g/m<sup>3</sup>, concentrations 200-300/cc. Pretty weak updrafts.

2124 Will maintain this track for a while. Good set of measurements in cloud along this leg.

2126 Reversing along this course.

2130 Now bearing right to intercept more clouds.

2133 Skirting tops at -11C, mixed phase with some larger droplets. 200/cc droplets, .2-.3 g/m<sup>3</sup>.

2137 At end of "line" heading SW, returning back NE.

2146 Returning back SW before reaching main convective line - modify track to get a view further north of previous legs.

2151 At 21kft, approaching cumuls with tops a bit above our level and near tops of surrounding cloud. Up to a gram/m<sup>3</sup> of liquid in the core, concentrations to 300/cc. Estimate +/- 5 m/s vertical winds.

Continued similar penetrations around 2154-55, 2157-58. Bimodal on CDP some of the time.

2159 Turn right, need to drop down to 14 kft to melt off some of the accumulated ice after noticing some drag.

2205 Cleared off ice, head back up to 21 kft.

2216 Back enroute heading ~WSW at 21 kft, -11C.

2220 A couple brief penetrations close to tops, CDP skewed towards mid-large droplets, up to 0.9 g/m<sup>3</sup>. -12 to -13C. Continued similar penetrations 2221, 2222, 2223.

2233 Continued passes skirting close to tops. Liquid common with occasional ice.

2248, 49 continuing passes through clouds, tops are growing more above our level (still at 21 kft, -13C). Plenty of liquid, some graupel.

2314 Returning eastbound, likely last set of passes.

2320 Turning for return, will descend to 12 kft heading back to LAR.

2332 On the ground.

**08/11/2020 HCPI Pilot notes (Research Flight 2)**

Crew. Sigel, Plummer, French, Axisa

Flight Time: 1.5

Planned: To go find clouds at 20,000. Penetrate the clouds at every 1000 feet. Request a block of 2000 so you don't need to bother the controller every time you change alt. Looking for solid green and yellow radar returns. File for MBW and ask for 30 nm range around it to maneuver.

Return to LAR

Actual: Departed LAR and started to fly to the clouds. LAR had a broken level at 12,000 feet. Out over the Shirley basin there was more build ups. We climbed to 20,000 feet and started penetrating green returns. After straight and level leg we broke out into clear air and made our first climb a thousand feet. We made small turns to hit the center of the clouds. Each leg ended with a 180 degree turn and a 1000 foot climb. Most legs were 15 miles long. We topped out at 25,000 feet and at this point were on top of all the clouds. Turbulence was minimal and we did have heavy perception at times. There was light ice. Other than that aircraft worked well I had no complaints. It was good to be back in the research aircraft.



**Project:** HCPI-20

11 August 2020

**Flight:** RF02

*Notes:*

Cloud passes focusing on subfreezing temperatures. A range of ice and mixed phase clouds were encountered, with very high droplet concentrations in some cases. Optical array probes performed well - HVPS is now synced with the time server. CIP did not ingest airspeed, but it was set to a more representative constant speed (generally 110 m/s).

Crew: Sigel, Axisa, Plummer, French; LOD: Little

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*Flight Summary:*

UTC Comment

194243 HCPI recording start time, first file is 00000000\_0000000019A41862.tiff

1951 Wheels up

In clouds a few minutes in, probes responding well. 2DS/HVPS working better after purge. CIP initially set to 95 m/s, set to 110 m/s once established on legs. Images look much better.

2004 On station near Medicine Bow VOR, will work a box around this area. At 21 kft, near -13C.

2005 Good cloud pass on all probes, slight liquid (up to 0.2 g/m<sup>3</sup>, increasing a bit later on).

2008 Clouds look promising here, will work in 20-22 kft block.

2009 Reversing course and climbing to 21 kft.

2011 In cloud on return leg, near -16C. Light turbulence, mostly small ice.

2016 At VOR, step up to 22 kft for return leg.

2017 Heading into cloud, -18C.

2022 Into more vigorous cloud, still -18C. Close to 0.8 g/m<sup>3</sup> on the LWC probes.

2024 At end of leg, returning back and will request 22-24 block.

2026 Stepping up to 23 kft.

2027 In cloud at -18C, over 1 g/m<sup>3</sup> liquid. Decided to hold altitude through pass, then continue climb.

2029 23 kft, near -20C.

2033 In cloud, still -20C and predominantly ice. Next, will step up to 24 kft.

2034 Starting a few turn maneuvers, heading north to target some more clouds at 2036.

2043 Turning back. Very high droplet concentrations encountered, up to 17-1800/cm<sup>3</sup>. Possibly associated with incoming smoke due to fire activity?

2046 In cloud at ~-24C. Some turbulence, moderate updrafts to 7.5 m/s. More liquid, concentrations up to ~1500/cm<sup>3</sup>.

2050 Turn back for return passes, temperatures near -25C.

2055 Liquid encountered up to 1 g/m<sup>3</sup>, along with 5 mm graupel and 10 m/s updraft, temperatures still near -25C.

2058 Heading back home, descend to 12 kft enroute.

2112 On the ground

8/10/2020 Pilot notes HCPI RF 1

**Crew:** Drew, Axisa, French, Plummer

**Flight Time:** 2.0

**Planned:**

Planned to fly cumulus developments over the Laramie Range between Laramie and Cheyenne at multiple levels.

**Actual:**

Departed Laramie and made a westbound climb to cloud base. Requested 30 nm radius around LAR VOR. Climbed 1500 ft. above cloud base (approximately FL 195 in block to FL 200. Planned to step up to FL 215 on the next pass, but decided FL 210 would make it easier to manage with ATC. Flew roughly E-W race track pattern climbing 1000 ft. at each turn up to FL 260.

Upon completion of final leg, descended westbound until under the cloud base, then maneuvered to penetrate a virga shaft in the Laramie valley at 12,000 ft. MSL, then one on the east side of the Laramie Range at 10,000 ft. MSL. Returned to Laramie.

