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PACMICE - Precipitation and Cloud
Measurements for Instrument Characterization
and Evaluation

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| <i>Research Flights</i> | | | | | |
|-------------------------|-------------------|--|----------------|-------|----------------|
| Date | Flight# (*kml) | Status | Times (UTC) | Hours | Crew/Notes |
| May 24 | | Flight in clear air for lidar work (note, 1.6 hrs from | 1615- | | B Wadsworth |

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| | | | | | |
|----------------|------|---|-----------|-----|---|
| 2017 | TF05 | base funding rather than PACMICE). KPR server testing. | 1745 | 0.0 | Z Little D Plummer M Deng |
| May 9 2017 | RF14 | Missed approaches in liquid clouds with small droplet sizes. 2D-S had bad TAS prior to ~1318 UTC, down camera & KT temps failed starting on 8 May flight, KPR server froze several times. 2D-C replaced CIP. WCL not onboard. | 1252-1545 | 2.9 | E Sigel S Faber D Plummer D Jacobson |
| May 03 2017 | TF04 | Flight in clear air for lidar work (note, 1.6 hrs from base funding rather than PACMICE). | 2014-2141 | 0.0 | B Wadsworth N Zelasko D Plummer M Deng |
| Apr 27 2017 | RF13 | Short flight primarily attempting to sample small, drizzle-size liquid drops below melting level. 2D-S V channel out after ~2140 UTC, window was fogged after landing. Repurged after flight. 2D-C replaced CIP. WCL not onboard. | 2027-2253 | 2.5 | T Drew S Faber D Plummer D Jacobson |
| Apr 19 2017 | RF12 | Flight scheduled around GPM satellite overpass at 0246 UTC. Primarily sampled mixed-phase cloud at subfreezing temperature, some measurements of liquid below melting level. No known instrument issues - 2D-C replaced CIP. WCL not onboard. | 0054-0427 | 3.7 | B Wadsworth A Tripp D Plummer S Faber |
| | | Clear air - Nevzorov & wind maneuvers, radar calibration | | | |

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Search

The Web UWKA

| | | | | | |
|----------------|------|--|-----------|-----|---|
| Apr 6 2017 | TF03 | circles. 2D-C replaced CIP prior to flight. WCR, 2D-C, and Nevzorov reference LWC not usable. WCL not onboard. | 2015-2143 | 1.6 | E Sigel E Collins D Plummer S Faber |
| Nov 21 2016 | RF11 | Radar calibration circles and multiple cloud passes at various radar settings. Lidar/Nevzorov/CDP not onboard. Multiple issues, including loss of flight data after 1800 UTC. | 1702-1837 | 1.7 | T Drew J French D Plummer S Faber |
| Nov 1 2016 | RF10 | Several cloud passes NW of Laramie for KPR testing. The Applanix was remounted on 9/27 prior to this flight. One of the mounting bolts was not seated into the rail prior to this. Radar calibration circles. Late start on 2DS. Lidar/Nevzorov/CDP not onboard. | 1540-1707 | 1.5 | T Drew H Brown D Plummer L Oolman |
| Sep 23 2016 | RF09 | Sampled clouds west of Laramie at temperatures from ~-20C to near freezing, with some embedded convection and moderate icing encountered. KPR transmitter was switched off until 1605 UTC. Gerber PVM was switched off through flight. | 1536-1917 | 3.8 | B Wadsworth A Tripp D Plummer N Guy |
| Sep 16 2016 | RF08 | Flight in clear air for KPR testing and general radar | 1521-1741 | 2.4 | B Wadsworth A Tripp |

| | | | | | |
|----------------|------|---|---------------|-----|--|
| | | calibration. | | | D Plummer N Guy |
| Sep 13 2016 | RF07 | Cloud passes between Douglas and Casper and spiral descent from 22 to 9 kft in cloud. Measurements coordinated with GPM satellite overpass at ~0315 UTC. KPR operational but data compromised with decreased sensitivity due to LNA damage on prior flight. CIP raking observed late in flight. | 0119- 0505 | 3.9 | E Sigel B Geerts D Plummer L Oolman |
| Sep 10 2016 | TF02 | Calibration flight, total time 1.9 hrs. Performed radar circles and wind maneuvers. Collected 20 minutes of flat leg lidar data for overlap correction. KPR operational but data compromised with decreased sensitivity due to LNA damage on prior flight. | 1524- 1715 | 0.0 | E Sigel S Faber D Plummer N Guy |
| Sep 9 2016 | RF06 | Sampled stratiform event near Douglas, WY. Minimum altitude limited by terrain and lidar operations box. Performed two missed approaches at Converse County airport. KPR AC/DC switches off, data unusable. 2D-S unusable during/after heavy icing. | 1614- 1933 | 3.4 | B Wadsworth J French D Plummer N Guy |
| Sep 4 | RF05 | Multiple passes through remnants of convection west of Laramie. Measurements | 1412- | 3.7 | B Wadsworth A Tripp |

| | | | | | |
|-------------|------|---|-----------|-----|--|
| 2016 | | focused on ice clouds at ~3-6 kft above freezing level. No known instrument issues. | 1749 | | D Plummer L Oolman |
| Sep 2 2016 | RF04 | Flight aborted, no research data collected. | xxxx-xxxx | 0.3 | B Wadsworth B Geerts D Plummer L Oolman |
| Aug 26 2016 | RF03 | Multiple passes through convective clouds to west and northwest of Laramie. Licor 7000 restarted late. | 1949-2206 | 2.3 | T Drew J French D Jacobson N Guy |
| Aug 25 2016 | RF02 | Sampled a stratiform cloud layer with convective elements in northeast Wyoming. Many types of ice habits and liquid precip. No known instrument issues. | 1301-1659 | 4.1 | B Wadsworth J French D Jacobson N Guy |
| Aug 24 2016 | TF01 | Downward lidar alignment. | 1707-1821 | 0.0 | B Wadsworth D Jacobson Z Wang N Guy |
| Aug 18 2016 | RF01 | Test of instrumentation. Performed Nevzerov calibration maneuvers. Sampled cloud at end of mission. Nadir port door mechanical failure upon closure. | 1452-1629 | 1.8 | B Wadsworth J French S Haimov N Guy |

| | |
|--------------|--|
| Flight Hours | As of Jun 28, 2019, 39.6 out of 37 research hours were flown, -1.9 remain. |
|--------------|--|

WCL Quicklooks

NOTE: WCR data acquired during PACMICE may be found on the [PACMICE16 radar project page](#). The flight numbers are different, be sure to look at the date to determine the correct file.

NOTE: Total project hours are 40, however 2.3 hours were used in Jan 2016 for initial KPR testing.

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05/09/2017 PACMICE Pilot notes (Research Flight 14)

Crew: Sigel, Faber, Jacobson and Plummer.

Flight Time 2.9

Planned: Fly LAR to CYS to EAN to TOR. Fly an approach to each looking for the optimum weather conditions. After finding desired weather conditions fly legs though multiple times.

Actual: LAR to CYS we flew the ILS to 27 to a missed. We got Direct to EAN and Flew the GPS A to a missed then we proceeded to TOR and Few the GPS Rwy 10 approach 5 times to a missed and then came back to LAR.

Project: PACMICE16

Date: 9 May 2017

Flight: RF14

Notes:

Plan is to focus on obtaining measurements with only small liquid drops, for KPR/WCR intercomparison. Forecasts suggest a persistent low-level stratus cloud on eastern slopes, between ~Wheatland and Cheyenne. Initial plan was to do a missed approach at Cheyenne, Wheatland, and Torrington, then pick the most useful legs and altitudes in cloud based on these profiles. Clouds were shallower than expected, and (early in the flight) looked to be primarily small liquid droplets given the weak WCR echoes and lack of strong KPR echoes. Ultimately the best conditions were found at low levels around Torrington, so the majority of the flight was comprised of five missed approaches (and up-antenna radar configurations) there.

Startup was delayed due to power interruption on switchover, but everything seemed to recover fine. No KT data and no downward camera images (both noted in previous flight), 2D-S software incorrectly configured to use static TAS on startup, corrected this at ~1318 UTC. KPR display (and apparently server) froze several times during the flight, more than seen previously. Data stream looks to be interrupted during these times.

Flight Summary:

UTC Comment

1247 Taxi

1252 Wheels up

1301 Finally up and running, at 11.1 kft w/clouds ~1.5 kft below on WCR.

1317 Heading down for missed approach at Cheyenne, TRF to +9C.

~1318 2D-S airspeed finally updating. On to Wheatland next.

1322 No substantial echo structure on KPR, -20 dBZ on WCR below us. Liquid clouds with tiny droplets at +3C, tops near 9 kft.

1329 Enroute to Wheatland, two thin layers below on WCR, tops close to 500 m AGL and ~9 kft still. Echoes still near -20 dBZ.

1335 In small drops, finally seeing some KPR echoes below. Right at cloud tops at 8 kft here, +5C.

1344 Switching to up antennas again, clouds unfortunately cleared up right about this time. Thin layers, ~7 and 9 kft? Base at 5400 ft, but no substantial echoes at that level.

~134630 In missed approach over Wheatland, TRF to ~+9C again.

*Look at climb out near 1348 UTC. Some larger streaks on 2DP, but mainly small though. Clouds still relatively sporadic near airport.

1349 Radars back in up/down configuration.

1354 Setting up for Torrington at 8 kft, tops just to flight level but often in clear air. Echoes -10 to -15 dBZ below on WCR, looking like small drops again. Swapping through KPR modes, often just no distinct echoes.

*1414 In missed approach at Torrington, check this on descent - looks like good drops, echoes are weak, though. Looks better over time. Still in 60-m, do another approach with 30-m configuration.

1418 Up to 8 kft again between approaches. Between cloud layers now, tops below at 6-7 kft

*1432 Going into second Torrington approach - potentially decent drop distribution ~1433, but weak echoes on KPR. WCR near -10 dBZ? Some streakers on 2dp, no full larger drops though.

Try next approach 30-m/400 ms averaging.

1443 Skirting cloud tops. Small droplets, but KPR echoes show structure now with 30-m/400 ms averaging, at and below flight level

*1448 Early descent ahead of missed approach, echo structure below looks potentially reasonable.

1449 Up-antenna configurations again.

*1453 - check around this time, heading into next approach at Torrington. Looks like going in and out of decent drop sizes, with sporadic ~-5 dBZ on KPR.

1455 Potentially good KPR structure & droplet sizes right around lowest point in descent.

*1506 Potentially reasonable droplet sizes heading into descent for final approach. Just at tops of KPR echoes, pretty rapid increase below to +10-15 dBZ.

1508 Still looks pretty good, unfortunately just before switching to up-antennas only.

1512 Still looks potentially reasonable heading into final missed approach at Torrington. KPR in standard 30-m configuration.

1516 Heading back - burning fuel faster today due to low altitude and ascents following approaches.

1545 Wheels down

PACMICE16 – RF14

May 9th, 2017

Jacobson flight notes

Crew: Sigel, Faber, Jacobson, Plummer

Plan

Target drizzle likely in low clouds between Cheyenne and Wheatland/Torrington, WY. Conduct missed approaches if necessary, long N-S flight legs below freezing level if possible. Take off: 6:30AM.

Flight summary

1252 Wheels up

1310 TAS not updating properly on 2DS, resolved by switching TAS source (under tools) to 'UDP input' and restarting GUI

1320 Missed approach at Cheyenne, cloud drops too small for sufficient KPR echo

Head north to Wheatland in search of more favorable drizzle conditions

1340 - 1342 ~100 um drops

1344 Some ~200 um drops

1348 Missed approach at Wheatland

Head east to Torrington

1407 ~100 um drops and smaller

1415 Missed approach at Torrington

Coming back around for another missed approach

1430 – 1433 More ~100 um drops

1434 2nd Missed approach at Torrington

1448 Some 200 – 300 um drops

1455 3rd Missed approach at Torrington

1507 – 1510 Decent sized drizzle drops

1514 4th Missed approach at Torrington

1545 Wheels down

3/27/16 PACMICE Pilot notes (Research Flight 13)

Crew: Drew, Faber, Plummer, Jacobson

Flight Time: 2.5

Planned: Fly to Scottsbluff and fly multiple approaches. Return to Laramie.

Actual: Filed to KBFF at 11,000 ft. MSL. After the Laramie Range, requested 10,000-12,000 block and flew at about 10,600 for -5 degrees. Flew the RNAV approach into KBFF in mostly clear weather. Flew the published missed then asked for a 090 heading at 6000 ft. ATC approved 090 at 7000 ft. After heading east about 10 nm canceled IFR and proceeded to make roughly E-W (slightly NE/SW) legs VFR at around 5000 ft. MSL. Reoriented to more SW-NE along a radar echo. Turned NW to clear air in order to reset the 2DS, and then returned to SW-NE leg. Conditions deteriorated on that leg so moved more to the North Northeast. Returned to Laramie at 11,000.

Project: PACMICE16

Date: 27 Apr 2017

Flight: RF13

Notes:

Plan is to focus on obtaining measurements with only small liquid drops, for KPR/WCR intercomparison. Ferry out to Scottsbluff, NE, at close to -5C in cloud if possible, but then focus on making measurements as low as possible to get below melting level. We did one missed approach on arrival at Scottsbluff, but cloud coverage was too scattered. The remainder of the flight was primarily spent flying VFR at low altitudes beneath cloud base, at +4 to +5C and ~500 m below top of bright band, looking for liquid drizzle size drops. Only up antennas were used for WCR & KPR due to the low altitude.

Applanix solution was lost at ~2054 UTC and recovered at 2108 UTC. Vertical channel on 2D-S was unusable from ~2140 UTC onward, some occasional issues on H channel. The optics windows were fogged after landing, the probe was purged to remove moisture following the flight.

Flight Summary:

UTC Comment

2027 Wheels up

2033 KPR/WCR on. At -6C, well below clouds.

2042 Cloud bases lowering, KPR & WCR returns in up beam.

2046 In west end of stratiform/convective area, tops to 5 km above flight level. At ~10.6 kft, -5C.

2051 Descending to 7 kft. Mixed phase towards convective end of line.

2059 Missed approach at Scottsbluff - cloud coverage too scattered here. General temperature profile approximately 0C at 7.7 kft, +2C at 7 kft, +4C at 5.4 kft, +6C at 4.6 kft. Will head east to look for better cloud and precipitation coverage.

Applanix solution off, fixed by 2108 UTC.

Note - potential drizzle measurements start here. Flying VFR below cloud bases, primarily saw top of bright band about 500 m above flight level in KPR measurements, with sporadic lowered reflectivity often corresponding to locally smaller droplets on 2D-S. Noted multiple times for closer inspection, will need to examine in detail for better quantitative droplet sizes and for contamination from larger particles, etc.

211010 weaker echoes but possibly small droplets on 2D-S. Otherwise, in larger rain but KPR and WCR 20+ dBZ. Up beams only at this point, getting close to 1600 ft radar altimeter.

2114 Maybe reasonable drop sizes. KPR low, WCR near 10 dBZ.

2117 Working edge of cells on NEXRAD display. 5.8 kft, ~+4C.

~2119 Descending to 5 kft, about as low as we can get. Drop sizes close to reasonable, with stretches of KPR fairly close to 0 dBZ and WCR a bit higher values.

212120 A brief segment of weaker KPR echoes with small droplets on 2D-S.

2123 Reversing course to try to hit the same weak patch.

212440 Weaker echoes on KPR again. Drop size may be just on the larger end on 2DS.

2127 KPR looks OK, 2DS drops probably too large.

~2130 Brief and sporadic weaker segments on KPR, 2DS looks close to usable size.

213140 KPR and 2DS look reasonable, again 10-20 second segments embedded in heavier precipitation.

213430 on, a few brief patches with weaker KPR echoes, and reasonable 2DS. Quickly get larger drops again afterwards, though.

213615 Looks like a good segment, but brief.

213840 Maybe a reasonable segment, but there may be some larger drops mixed in on 2DS. Several short segments spaced out with weaker KPR echoes and potentially small 2DS drops.

2140-on Apparent stuck bits, mostly masked diodes on 2D-S V channel. Reinitialized at 2145, both channels masked sometimes at this point.

2151 Cycle power and display on 2DS.

220640 KPR near zero dBZ, 2DS looks pretty good. WCR < 10 dBZ.

220830 Again, looks like potentially reasonable sizes on 2DS.

221130 Fairly small droplets on 2DS, with low returns on KPR. In and out of similar conditions over the next minute.

Note, 2DS H buffer filling up fast in clear air (checked response after purging following flight).

2253 Wheels down.

PACMICE16 – RF13

April 27, 2017

Jacobson flight notes

Crew: Drew, Faber, Jacobson, Plummer

Plan

Ferry to Scottsbluff, NE to target widespread precipitation event in search of drizzle measurements for WCR/KPR inter-comparison. Do several missed approaches at Scottsbluff airport (elev. 3,967 ft) to sample below the freezing level. Fly ~20 mi east with up and down antennae. Fly at -5 C level on ferry there/back in search of ice multiplication.

Flight summary

2027 Wheels up

2044 At 10,900 ft large ice, aggregates

2051 Ice crystals, needles and columns

2052 Start descent towards Scottsbluff

2053 Large concentration of clouds drops with LWC ~1 g/m³

2100 Missed approach at Scottsbluff

2107 Large ice

2110 Liquid drops

2114 Smaller drops

2115 New 2DS file started

2119 Drizzle sized drops

2128 Liquid drops ~1mm

2139 Decent sized drops, maybe drizzle

2143 Stuck bit in V channel of 2DS, tried building a mask to resolve the issue but no success

2146 Started new 2DS file, didn't fix stuck bit

Head for clear air to restart probe

2153 New 2DS file started

2155 Liquid drops

2207 Maybe drizzle

2219 Pristine ice crystals, needles

2223 Larger ice

2230 Restarted 2DS and GUI again, still having issues

2254 Wheels down

PACMICE Research Flight 20170419 (RF12_Apr19)
UWKA Targets GPM Overpass
Flight Scientist Summary

Author: Adam Tripp

Summary of Operations:

The UWKA flew one flight (RF12) on 20170419, approximately 3.5 hours. This was a dusk/nighttime flight in/out of KLAR that extended through parts of the Nebraska panhandle (west) and into southwestern South Dakota. Take-off (landing) occurred at 0100 UTC (0426 UTC). Altitudes ranged from 15 kft dropping down to 9 kft toward the end. The primary objective of this flight was to measure weather targets coincidentally with the GPM satellite overpass (Fig. 1 & 2). The UWKA encountered a narrow E-W oriented cloud band of enhanced reflectivity located along the South Dakota – Nebraska border. For this band, WCR and KPR reported reflectivity values of ~15+ dBZ, and the 2DS displayed capped columns/ice with D~100+ microns. This became the target for the GPM overpass, and a straight leg lasting ~20 minutes with a NE heading was achieved as the satellite whizzed overhead. On the way back to KLAR, the UWKA serendipitously encountered drizzle (D~200 microns) along the periphery of a convective cell for approximately 4 – 5 minutes.

GPM Waypoint Predictions:

2017/04/19 02:46:00 UTC

Lat: 41.529

Lon: 256.038

2017/04/19 02:47:00 UTC

Lat: 44.705

Lon: 258.857

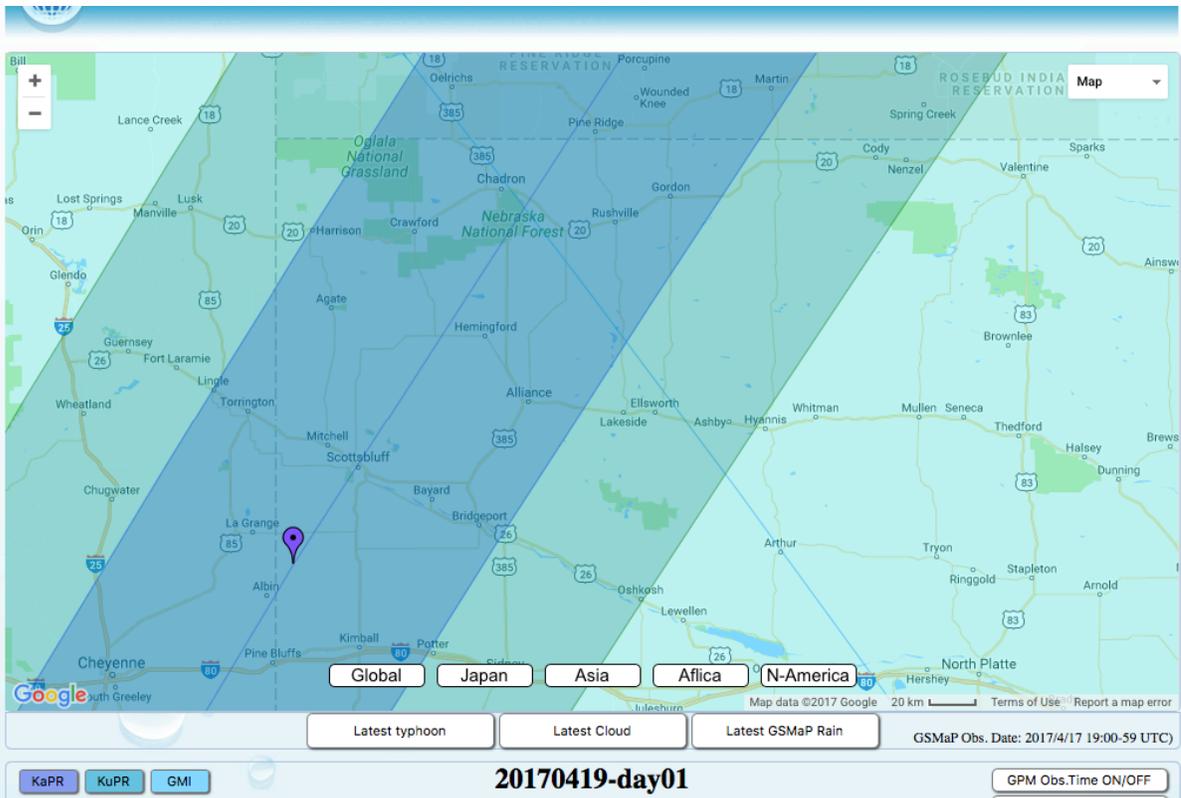


Figure 1: Southwestern extent of GPM overpass.

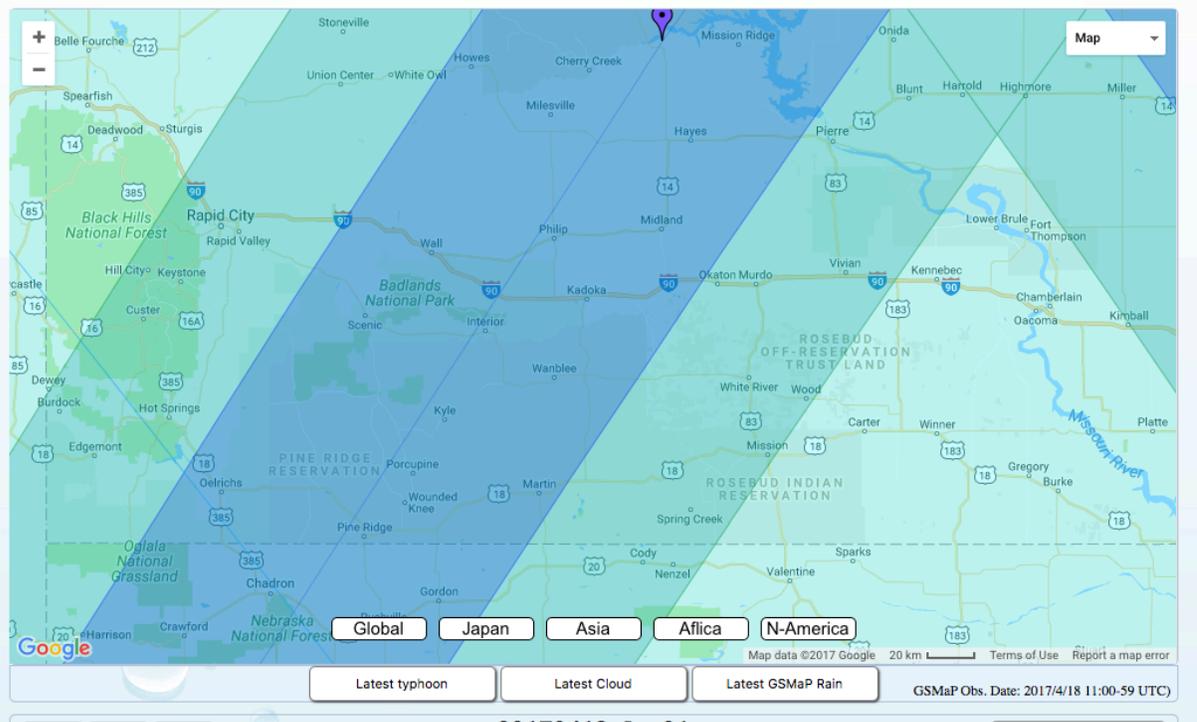


Figure 2: Northeastern extent of GPM overpass.

Forecast Discussion:

NAM and HRRR runs prior to the flight suggested a targetable enhancement of simulated reflectivity occurring around 3z on the eastern Wyoming/western Nebraska/southwestern South Dakota borders (Fig. 3). This will be an area of surface wind confluence/convergence with upslope easterly flow (Figure 4). Convective products suggest that there will be limited lightning, dry/warm low levels, and cloud bases located approximately at the freezing level (~10 kft MSL) (Fig. 5 – 7).

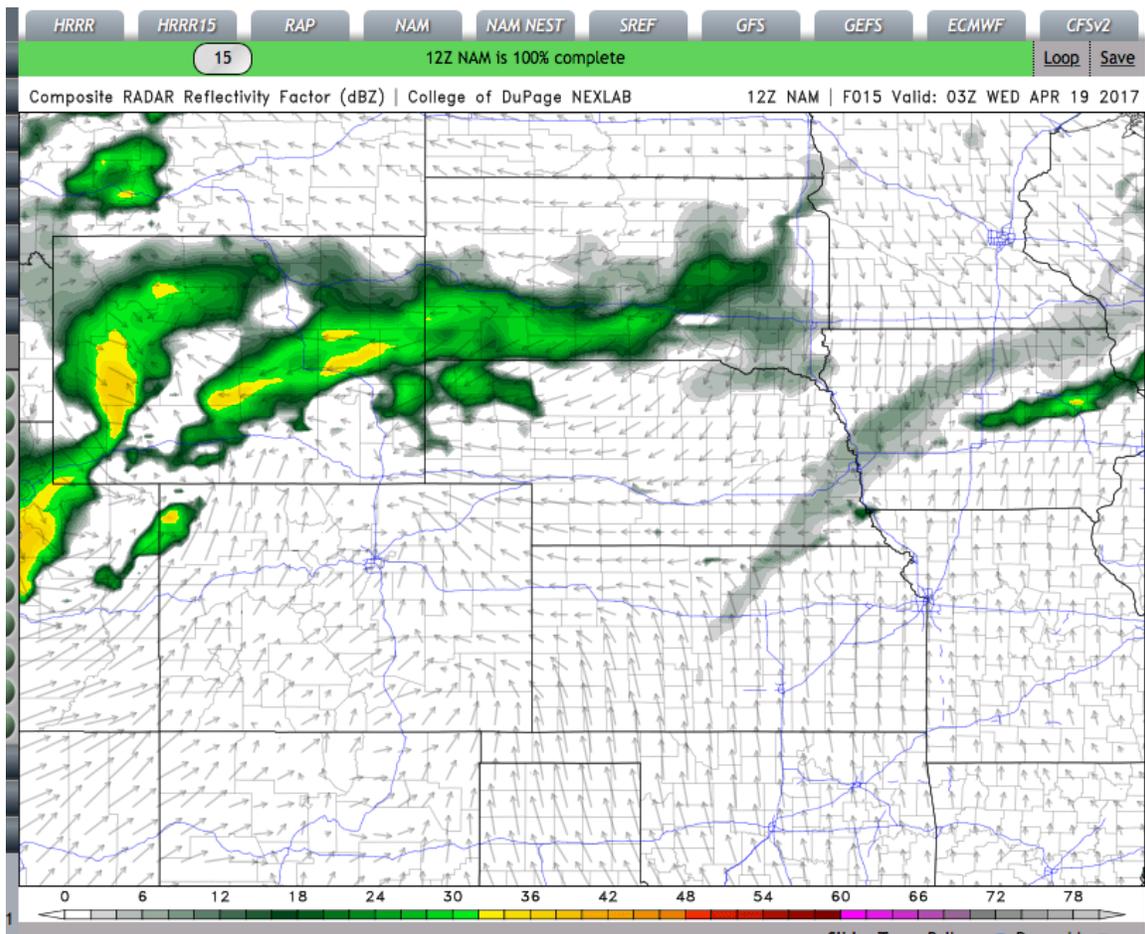


Figure 3: 12Z NAM run (valid @ 3Z 20170419) depicting simulated reflectivity

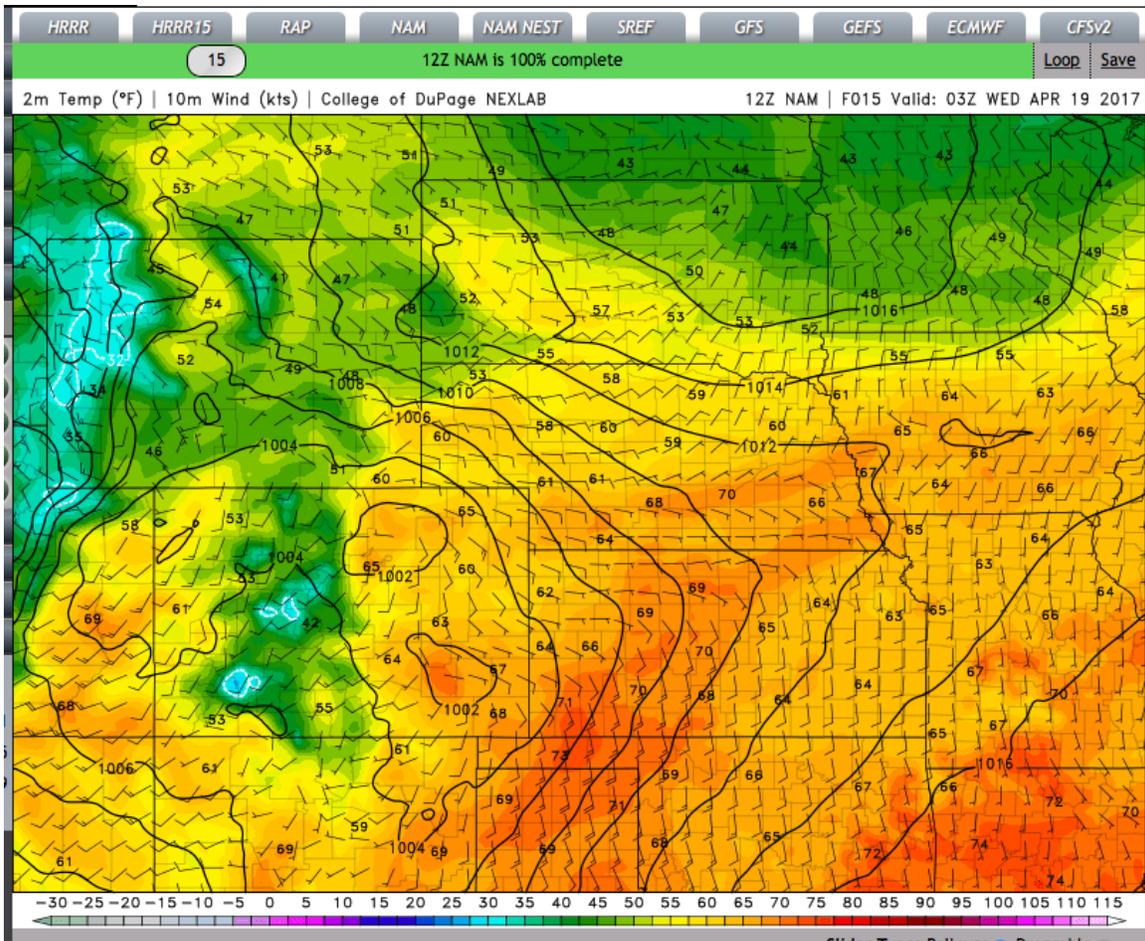


Figure 4: 12Z NAM run (valid @ 3Z 20170419) depicting 2m temp & 10m winds

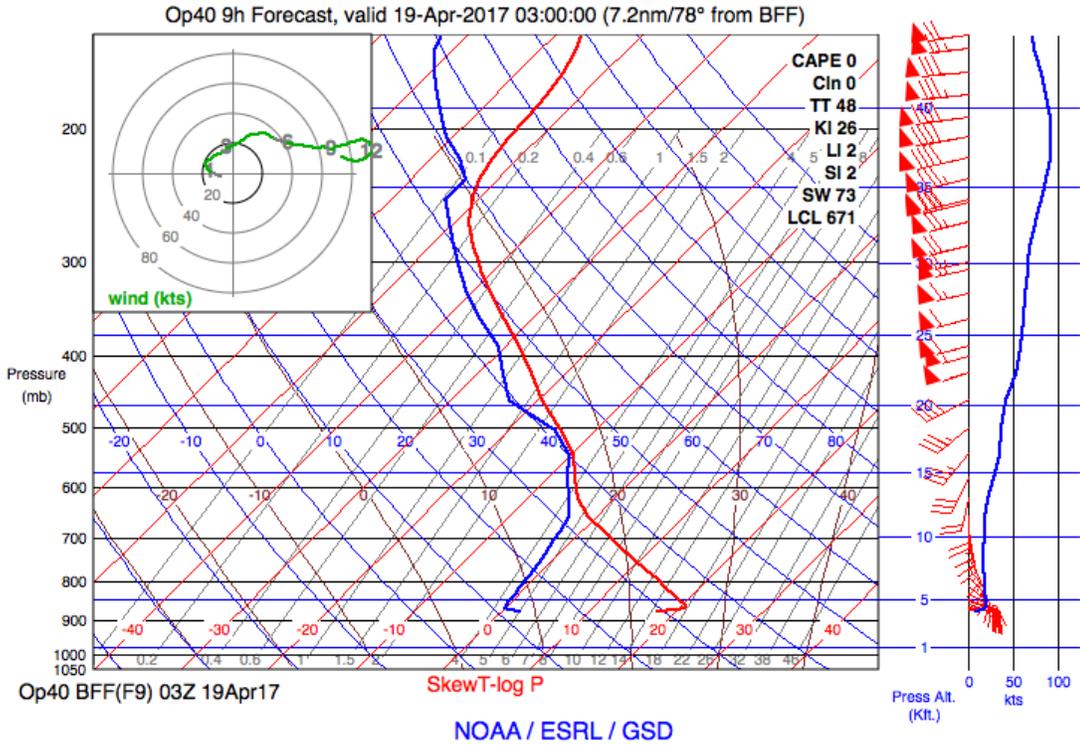


Figure 5: Scottsbluff, NE model sounding

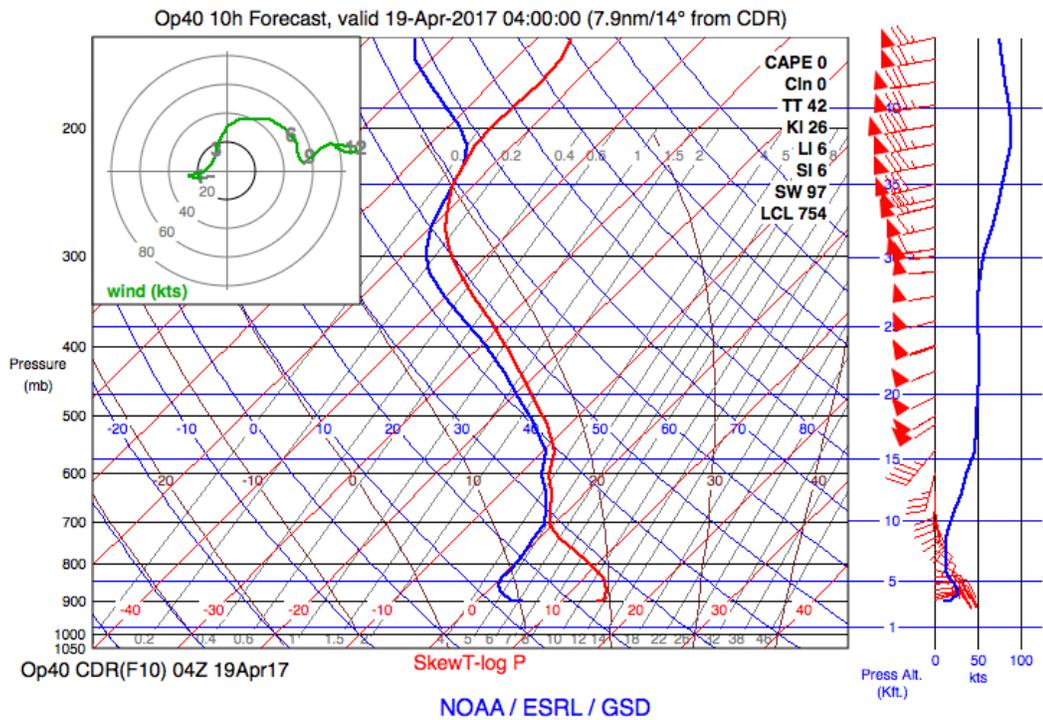


Figure 6: Chadron, NE model sounding

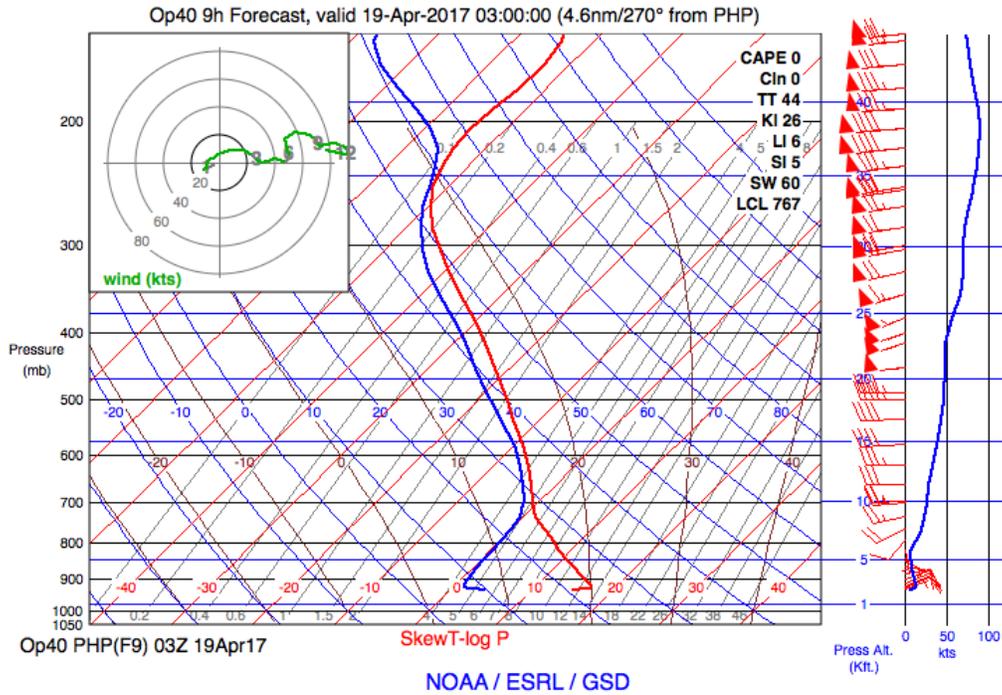


Figure 7: Philip, South Dakota model sounding

Actual Flight Details:

The UWKA flew approximately four long legs oriented SW to NE. Starting elevation was 15 kft dropping to 13 kft for the GPM overpass leg. FL winds were approximately 15 to 20 m s⁻¹ from the WSW. There were no known instrumentation issues, and the KPR transmitted up beam was turned off for approximately 2 minutes while the GPM satellite passed overhead.



The table below provides a brief summary of the observations from each leg.

| Leg # | Times (UTC) | Dir. | Alt. of UWKA | T [°C] | Notable Observations |
|-------|-------------|------|--------------|--------|--|
| 1 | 0121-0159 | NE | 15 kft | -7 | Observed two E-W oriented cloud bands of enhanced Z on NEXRAD to target for the GPM overpass. The southern band appeared to be 1-2 km deep with small ice (D~20-50 um) on 2DS and 0-10 dBZ returns on WCR/KPR. The northern band had ice particles D~50 um evident on the 2DS, with WCR/KPR returns 10+ dBZ . |
| 2 | 0200-0227 | SW | 14 kft | -7 | Isothermal layer between 14 – 15 kft FL. Cloud bands appear to be advecting to the east and intensifying which will be favorable for GPM overpass. At 0220, the KPR had interesting features extending out of cloud base. These features may be mammatus, but further analysis of Quicklook images and other tools are merited. |
| - | 0227-0239 | All | 13 kft | -5 | Holding pattern to set up for GPM overpass. UWKA limited by narrow nature of the cloud band. |
| 3 | 0239-0302 | NE | 13 kft | -5 | KPR up beam switched off at 0245Z. WCR & KPR (down) report 15+ dBZ returns at 0246Z (time of GPM overpass) with the 2DS showing D~100+ um ice (capped columns, etc.). KPR up beam switched back on at 0247Z. |
| 4 | 0303-0341 | SW | 9 kft | +2 | Dropped to 12 kft (T~-3C) before dropping down to 9 kft (below bright/melting band) to capture drizzle. At 0320Z, UWKA detoured slightly off the straight leg to avoid areas of extreme Z. In the periphery of the storm cell, the 2DS started to pick up spherical-shaped drops with D~200 um. These suspected drizzle drops were recorded from 0321 – 0326 Z before larger ice particles became evident. |

Preliminary Flight Plan (*changed once airborne*):

Take-off: 7:00 PM LDT (0100 UTC)

Ferry-time: KLAR to KBFF → 172 km → ~28 min

Flight Leg Anchors: KBFF (Scottsbluff, NE - 41°52'2"N 103°39'39"W) @ ~ 0220Z
to Howes, SD - 44°37'10"N 102°3'5"W (@ ~ 0315Z)
→ 207 mi (333 km)

Flight Details:

- Southwesterly Winds at FL ~ 35-40 kts (15-20 m/s) → tailwind out
- UWKA speed: 80-85 m/s (air-relative)
- TAS: ~100 m/s
- Total leg time (out): ~ 50 – 55 min
(back): ~ 65 – 70 min

Flight Level:

- Start at 13 kft MSL and drop 1000' every 5 minutes.
- Goal is to start 2 – 3 kft above freezing level and then end 1 – 2 kft below freezing level.
- Cloud base seems to be around 10,500 ft MSL which is also about the freezing level (Figures 1 – 3).
- We will need to update the FL closer to the time but currently plan to try and intercept drizzle around 8 kft on the return trip.

Targets:

- GPM has sensitivity of ~12 dBZ, so aim for KPR (WCR) stronger than this.
- For drizzle, WCR and KPR need to be ~5 dBZ.
 - Want Drizzle Diameter < 400 um.
- Precip growth will be in mixed-phase cloud w/ cloud base close to freezing level.

Project: PACMICE16

Date: 19 Apr 2017

Flight: RF12

Notes:

Plan is to focus on measurements corresponding to GPM satellite overpass at 0246-0247 UTC from near Scottsbluff, NE to western South Dakota. Waypoints initially chosen are 41 51.8N, 103 46.4W (SW end) and 44 37.2N, 102 3.1W (NE end). Plan is to start a few thousand feet above freezing (estimating ~10500 ft) and step downward in cloud along this track. After the overpass, focus on measurements below the melting level to try to sample small drops without ice contamination.

No major instrument issues; 2D-C seemed to work well with replacement power supply. WCR seemed fine with replaced cable connector, no sensitivity drop during flight.

Flight Summary:

UTC Comment

0054 Wheels up

Note that 0C level is higher altitude than expected, just under 13 kft. Will likely ascend to 15 kft instead of original 13 kft.

0111 Checking 60 m KPR. Some returns, basically nothing at 30 m.

0118 -6C at 13 kft, scattered ice from occasional clouds above.

0122 At SW end of planned track near Scottsbluff, will head along track to see where we find deeper clouds. Light and scattered here, -10 dBZ but deepening a bit as we head north.

0126 Several clouds, weak echoes and primarily single pixel cloud droplets on 2DS with some occasional ice. Had KPR in 75 m for a while, switched to 30 m with some echoes.

0131 Weak echoes below on KPR in 30 m configuration.

0137 Note this point as just south of what looks like better structure on NEXRAD display. Consider starting satellite leg here instead, could start around 0230 UTC to straddle overpass.

KPR echoes >10 dBZ above flight level.

0150 Entering second "band" on NEXRAD. Deep echoes above/below on WCR, some echoes on KPR but weaker in general.

0158 No echoes ahead on NEXRAD display, will turn and descend to 14 kft to prepare for satellite leg.

0204 On track south, may not have much time to step through altitude levels on satellite pass, as NEXRAD echoes are relatively narrow. -7C at 14 kft here.

0215 Just entering main band on NEXRAD. KPR echoes stronger on this pass, ~15 dBZ?

Also, looks like mammatus/pouches on underside of cloud near freezing level, 0215 on. Quicklook should show better.

0228 Holding pattern S of echoes on NEXRAD to prepare for underpass @ 13 kft.

023830 Turning N for satellite leg at 13 kft. NEXRAD echoes building to about this point.

GPM overhead near center of band. Deepest echoes, with static noted towards center of band on both of last passes. 25+ dBZ on KPR, large ice present.

0300 A few echoes left on NEXRAD, eventually saw melting level 1 km below on KPR, probably ~10 kft. -5C at 13 kft.

0303 Descend to 12 kft and return SW through showers and main band.

0309 Decided to go to 9 kft instead based on less remaining flight time than anticipated.

0C is close to 10 kft as guessed from KPR. +1.5C at 9 kft.

Convective cells outside main band, small scale fall streaks on KPR. Still ice on OAPs at this altitude. Plenty of turbulence through here.

0319 Deviate right around strengthened core in band.

0321 Small drops, guessing ~150-200 um from 2DS. Looks like liquid at this point. KPR shows 5-15 dBZ close to flight level, skirting periphery of NEXRAD echoes.

0326 Back into melting ice on 2DS.

0330-31 Brief times with ~100 um droplets, possibly still some ice though.

0342 Outside any cells on NEXRAD, will head home directly from here rather than proceeding to end of track.

0406 Skirting intensifying cell, larger drops (up to mm?). Maybe some decent smaller drops on periphery.

0427 Wheels down

Project: PACMICE16

Date: 6 Apr 2017

Flight: TF03

Notes:

Clear air flight with Nevzorov calibration, wind maneuvers, radar calibration circles.

Nevzorov airspeeds/altitudes abbreviated to correspond to operational behavior:

One minute at 145, 160, 175 kt at each altitude: 12, 16, 20 kft.

Bad current/voltage on Nevzorov LWC reference. WCR bad after first file (repaired after flight). 2D-C unusable.

Flight Summary:

UTC Comment

2015 Wheels up.

Nevzorov maneuvers (starting time for minute+ of clear air)

20 kft, 175 kt (202815 UTC)

160 kt (203015 UTC)

145 kt (203205 UTC)

16 kft, 175 kt (203740 UTC)

160 kt (204005 UTC)

145 kt (204205 UTC)

12 kft, 175 kt (204800 UTC)

160 kt (204935 UTC)

145 kt (205115 UTC)

Wind maneuvers at 14 kft, winds < 10 m/s

Right turn, yaw: 205800-210000 UTC

Left turn, yaw: 210000-210210 UTC

Left turn, acceleration: 210350-210520 UTC

Right turn, acceleration: 210610-210750 UTC **Radar circles** - winds < 10 m/s

Right turns, 211628-212042 UTC

Left turns, 212228-212550 UTC

2143 Wheels down.

11/21/16 PACMICE Pilot notes (Research Flight 11)

Crew: Drew, French, Plummer, Faber

Flight Time: 1.7

Objective: Complete radar circles, wind calibration maneuvers, and then fly a few legs through the middle of liquid clouds.

Planned: Complete radar circles in area north of Cheyenne. Climb to 16,500 and complete wind calibration maneuvers (depending on upper winds). Then try to find thicker clouds, probably over the mountains.

Actual: Departed Laramie to the northeast at 13,500. Dropped down to 8,500 (best guess for 3000 AGL) and did 2.5 circles left and 2.5 circles right. Decided not to attempt wind calibrations, instead, climbed out towards Laramie Peak and picked up the IFR clearance. Flew one SW-NE leg (along the wind) then switched to a NW-SE leg (perpendicular to the wind). Completed two complete legs and then returned to Laramie.

Project: PACMICE16

Date: 21 Nov 2016

Flight: RF11

Notes:

Plan is to do radar calibration circles, test KPR mounting, and obtain measurements in cloud at all three KPR configurations, plus test WCR & KPR in FFT configs.

This flight was problematic. Radar altimeter and 2DP were unresponsive in flight. Likely related, the data system incorrectly wrote tdms files to disk every ~4 minutes (normally ~40 min. intervals), completely filling the disk and losing data collected after 1800 UTC. Data collected spanned the radar calibration circles and most of the cloud passes in the three typical KPR configurations, but ended shortly before the radars were switched to FFT config. Additionally, the camera software was unresponsive before takeoff. The AV computer was rebooted but could not be connected to until later in the flight. The software appeared to be saving camera images, but nothing was written to disk despite apparently having the correct directory structure set up. The data distribution computer was also rebooted midway through the flight while attempting to troubleshoot the 2DP, causing an outage in data displays but no loss in the data written to disk during this period.

Flight Summary:

UTC Comment

1702 Wheels up

1721-1724 left calibration circle, start at 180

1726-1729 right calibration circle, start at 270

1732 Tops to 2 km above on WCR, 0.5-1 km above on KPR in 30-m config

1740 Diagnosing instrument issues. Restarted data dist computer

1749 Data distribution finally restarted

1750 KPR in 30-m config, clouds to 1 km or less below. Pretty shallow.

1752 Cycling through KPR configs. In 60-m config, concentrating and deeper clouds below.

1754 Reorient for longer passes in cloud, KPR still in 60-m config. Echoes to 500 m above, 1-2 km below. WCR shows 1 km above, 1.5 below.

1758 KPR in 75-m configuration, similar cloud characteristics.

1759 Clouds a bit deeper, some graupel.

1800 Data system drive full, no flight data saved for remainder of flight

1801 Switched KPR back to 30-m config for one more longer set of samples.

1809 KPR and WCR switched to FFT configuration, just out of echoes and turning back N to resample these clouds.

1811 Weak echo on KPR, just below flight level. 10 dBZ 750 m below, 250 m above. Strengthening as KA continues north, deepening with some echoes above, to 1-2 km below.

1815 Switched back to standard WCR and 30-m KPR configuration, returning to KLAR.

1837 wheels down

11/1/16 PACMICE Pilot notes (Research Flight 10)

Crew: Drew, Brown, Plummer, Oolman

Flight Time: 1.5

Objective: Fly a couple of legs under, through, and above cloud. Complete left/right radar circles.

Planned: Head up the valley towards visible clouds and try to get some passes under, through and above. Then complete radar circles in eastern area.

Actual: Started at about 9,500 MSL near MBW and flew below cloud base VFR through rainshafts and virga. Climbed to 13,300 IFR and flew a couple of NW/SE legs. Flew east to the radar circle area and completed left and right circles. Returned home.

Project: PACMICE16

Date: 1 Nov 2016

Flight: RF10

Notes:

KPR test flight, to make some cloud passes west of Laramie, followed by radar calibration circles. 2DS took some time to start - both arrays were initially masked out on startup and had to be cleared before the probe recorded incoming particles.

Note, camera software appeared to be writing to disk correctly, but no images were saved. Correct directory structure needs to be in place before images can be written.

Flight Summary:

UTC Comment

1540 Wheels up

(Missing some times while troubleshooting)

1553 second pass for KPR in 60-m configuration

1559 Turning back north to stay in rain

Passes are typically at +1 to +2 C, mostly liquid on OAPs

WCR echoes commonly to surface, tops 1.5-2 km above

1609 Turn back, climb up to focus on down-beam radar measurements

1613 At 13.3 kft/-6C for high passes, KPR in 30-m config

1619 Turn back for 2nd high altitude pass, KPR in 60-m config

1624 Return for last high altitude pass, KPR in 75-m config

1630 Enroute to calibration site

1643 Left circles

1647 Right circles

1650 Head home

1707 Wheels down

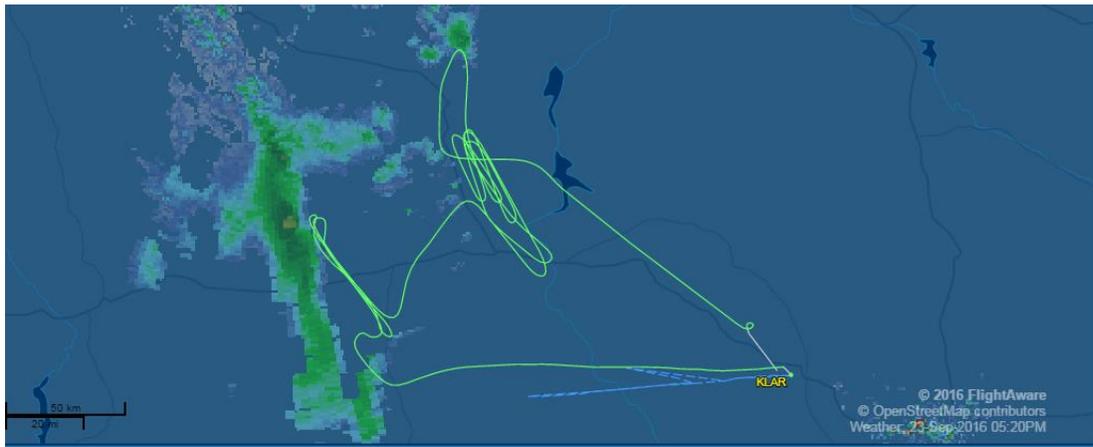
9/23/2016 PACMICE Pilot notes (Research Flight 8)

Crew: Wadsworth, Tripp, Guy, Plummer.

Flight Time: 3.8

Planned: Punch clouds looking for precip SW of Saratoga. Come home.

Actual: Started SW of Saratoga, worked further west than originally planned, then to SW of the CKW VOR. Initial altitude of FL230, then started descending in 1 – 2k' intervals. Encountered some moderate icing. Worked over N of Rawlins as the convective activity picked up. Came home.

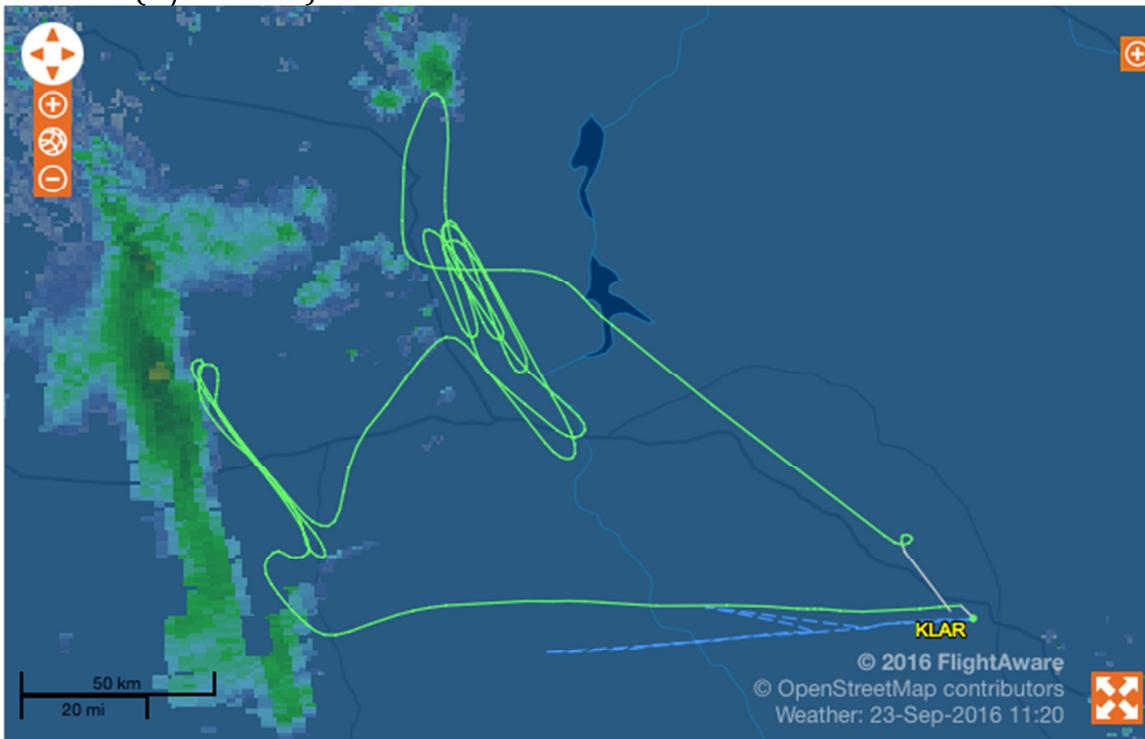


Project: PACMICE16
Date: 23 Sep 2016
Flight: RF09
Flight Scientist: Adam Tripp

Summary:

RF09 was a successful flight with respect to crew safety and data acquisition. An upper level low pressure system is pushing into the vicinity of Laramie bringing colder air at lower levels into the area (from the west). This culminated in several areas of deep clouds ranging from a CB around 0C to a CT around -20C. Several racetrack maneuvers were performed within these deep clouds at various altitudes. The crew was planning on doing a couple of missed approaches around Saratoga in order to sample drizzle in the area. However, convection began earlier than expected, so we had to spend most of the flight avoiding these areas of convection and skirting the perimeters of the cloud structure. Despite this, however, we were able to get a lot of robust RADAR returns on the WCR and KPR. The in-situ probes also picked up a variety of specimens.

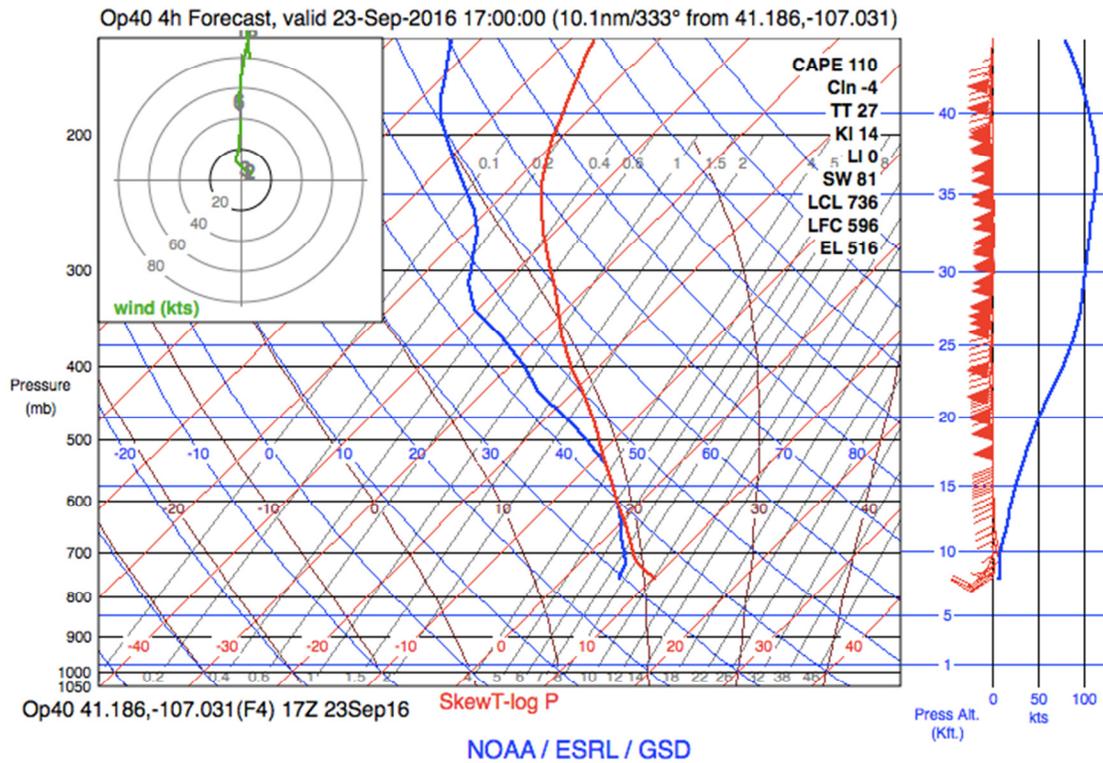
AC Track (w/NEXRAD):



AC Elevation/Speed Profile:



Vicinity Sounding:



UTC Comment:

1535 - takeoff

1546 - head SW toward Encampment, LL widespread shallow cloud deck to west (east of med bow)

1552 - at 23,000 ft msl, temps at -20C, deep clouds to SW that will target

1558 - thin cloud layers 2km above/below

1600 - great WCR return from clouds above sfc (clouds 3.5km thick)

1604 - no power to KPR??? turn on, now kpr return

1607 - reach cloud deck of interest, h NW at 23k msl for first leg

1610 - at edge of airspace, must turn around to h SE

1617 - aggregates visible to probes, nick reports elev convect on kpr

1621 - end leg h NW

1624 - repeat same leg but h SE

1627 - distinct layers evident in WCR return

1630 - out f cloud, end leg, turn around and drop to 22,000 ft msl

1635 - leg to NW skirting eastern bndry of cloud structure

1640 - end leg

1643 - start leg h SE

1647 - picking up static on radio - moving to area less charged

1651 - out of cloud, selecting rawlins as new ref pt, getting away from convection

1700 - hunting for targets while avoiding convection, descend to 20,000 ft msl, -13C ambient, h SE

1709 - end leg, turn back to h NW and descend to 18,000 ft msl

1714 - reach 18000 ft msl , lots of small drops, -11C with some icing outboard

1719 - end leg to NW, drop to 17,000 ft msl, turn to h SE

1722 - start leg, instr. collecting ice, -8C

1728 - turn left (east) to avoid convection

1733 - end leg, turn to h NW, descend to 15,000 ft msl

1737 - start leg

1740 - 2ds frozen over, need to drop to melt

1742 - large aggregates at flight level with large WCR returns

1744 - h SE

1745 - descend to 14,000 ft msl

1751 - turn to h NW

1752 - start leg h NW

1756 - cloud deck above below, -3C

1757 - turn to h SE and ascend to 15,000 ft msl to target strong upper deck

1804 - small drizzle on 2ds and cip

1805 - end leg, ascend to 16,000ft msl and h NW

1808 - still waiting for ascent clearance, h NW, adj block to target structure to NW

1816 - h SE, setting up to target cloud structure t west

1819 - begin leg to NW

1824 - end leg, turn to head SW

1828 - begin leg h SSW at 15,000 ft msl, -4C

1836 - end leg due to convection, strong echoes and drizzle above

1837 - head home

1913 - land at KLAR

Project: PACMICE16

Date: 23 Sep 2016

Flight: RF09

Notes:

Main issues were with pre-flight instrument setup. KPR transmitter power was switched off, which I didn't catch until we had just entered cloud near 1605. Gerber switches were reversed (or confused with Nevzorov) and the probe was unpowered during the flight.

Flight Summary:

UTC Comment

1536 Wheels up.

1605 ***KPR transmitter switched on.***

1605 At 23.5 kft, -21C. Just into cloud tops. WCR tops to 1 km above, echoes to surface.

1610 Getting flight pattern set, preparing for main legs NW/SE. At 23 kft, -22 C in cloud. WCR tops increasing to 2+ km above, multiple layers below to 1 km AGL.

1620 Right turn for SE leg. Return along same track.

1625 Well in cloud on SE leg. Embedded convection sporadically on KPR down beam, occasionally just to flight level.

1628 Developing weak mid level echoes around flight level towards S half of leg.

1632 Descend to 22 kft for return NW.

1638 Deeper echoes, stronger convection reaching through flight level.

1641 Turn at N end, picking up static on COM3, will keep an eye on NEXRAD structure to S.

1644 Continuing back SE at 22 kft, -19C in cloud. Clouds becoming convective to N, and main line of precip on NEXRAD is west of 108W at this point.

1647 Divert E to get out of charging in cloud.

1652 In light clouds, not showing up on NEXRAD.

1654 Heading N of Rawlins to check cloud outside of convective activity.

1658 Over cloud deck, main tops 1 km below with embedded convective cells extending higher.

1700 Heading SE to watch cloud development.

1702 Descend to 20kft to pass just above main cloud tops. Visually estimate taller active turrets extending to ~21 kft.

1708 Continuing to SE end. Some turrets through 20+ kft, but will need to hit ~18 kft on return leg to be in cloud consistently.

1710 Return NW, will descend to 18 kft.

1712-13 Liquid at tops, about -11C

1719 Turn back SE, descend to 17 kft, -9C in cloud. Mostly droplets, a few small ice.

1733 Descend to 15 kft for NW leg. Should go through bases, especially towards N half of path.

1742 Turn right for S leg, requesting block 13-15 kft.

1745 Descend to 14 kft, heading S.

1751 Right turn to bias further west on N leg. Not much going on for S half of leg. Maintain 14 kft. -1.5C in cloud.

1757 Turn for S leg, ascend to 15 kft. Should be in base of upper cloud deck for first 5-10 minutes of S leg.

1805 Turn back N, echoes weaken rapidly heading S. Request 15-17 kft block.

1811 Turning S while waiting for requested N extension of current location to sample deeper clouds at periphery of NEXRAD-indicated convection.

1817 Turning N at 15 kft.

1823 On N-S leg heading N at 15 kft, -3.5C. Trying to stay on periphery of NEXRAD cells.

1828 Nearing fuel limit for potential instrument approach at KLAR. Turning for final S pass at 15 kft, -3.5C in cloud. Still skirting NEXRAD echoes.

1837 Finishing up, return to KLAR @ 15 kft. Some convection to sample on the path home.

1839 Good cells above/below on KPR, great shear below.

1917 Wheels down.

9/16/2016 PACMICE Pilot notes (Research Flight 7)

Crew: Wadsworth, Tripp, Guy, Plummer.

Flight Time: 2.4

Planned: Transit Glendo reservoir. Do two pairs of three different elevation legs over the reservoir. Do radar circles. Come home.

Actual: We went over Greyrock reservoir to check the water level before going up to Glendo. Legs went as planned. Radar circles went as planned, but did three circles each direction just to quiet the spammer. Came home. Uneventful & a nice day to fly.

PACMICE-16, 16 Sept. 2016

Glendo reservoir looks good with minimal white caps on sfc and reflection from sun visible

Crash of front display - unable to catch details of pass 1 - see radar returns and back seat notes

KPR filter alternates 30m to 60m, respectively, every 2 passes

155700 start pass 1 h SE

155800 end pass 1

160200 pass 2 over glendo (@ 11,100ft - 2000m AGL NW heading each pass roughly 3 miles each)

160300 end pass 2

160700 pass 3 SE heading

160900 end pass 3

161240 pass 4 h NW

161358 end pass 4

adjust alt to 9,500 ft- 1500m AGL

161827 pass 5 h SE

161927 end pass 5

162347 start pass 6 h NW

162450 end pass 6

162855 start pass 7 h SE

163000 end pass 7

163406 start pass 8 h NW

163523 end pass 8

adjust alt to 8,100 ft - 1100m AGL

1638 boat observed moving in reservoir under legs

163900 start pass 9 h SE

164005 end pass 9

164347 start pass 10 h NW

1644 triple ground return (aliasing) observed with WCR

164430 end pass 10

164804 start pass 11 h SE

164909 end pass 11

165240 start pass 12 h NW

165344 end pass 12

1655 head to wheatland for radar calibration circles, some turbulence

1701 adj alt to 8,500 ft AGL h SE

171054 begin circles to right

1714 end third circle to right, begin circles to left

171730 end third circle to left

1718 head back to KLAR @11,500 ft AGL

1737 gear down

Project: PACMICE16

Date: 16 Sep. 2016

Flight: RF08

Flight Summary:

Clear air flight for KPR testing and general radar calibration. Repeated passes over Glendo Reservoir, 2 passes each in 30- and 60-m configuration at 11.1 kft, 9.5 kft, 8.1 kft AGL. Radar circles performed afterwards.

UTC Comment

1521 Wheels up. Lidar set to 2 km retrieval for relatively low altitude flight.

1531 WCR/KPR OK, restarting lidar software. Lidar looks weak, still no real time display. Doublechecked power. Restarting computer. Still looks the same.

1547 Lidar issues resolved?

11.1 kft AGL KPR passes:

1557 Rolled KPR file, in 30-m config. Winds at this level 8-9 m/s, ~330 degrees?

1558 Pass 1 done

1601 Roll file, returning for pass 2

1602-1603 Pass 2

1604 Turning for pass 3, set KPR to 60-m config.

1607 Rolled KPR file, lining up.

1608 Pass 3.

1609 Turning for pass 4

1612 lined up, rolled KPR file.

1614 Done with first four legs, descending to 9.5 kft and switch KPR to 30m.

9.5 kft AGL passes:

1615 Winds 9-12 m/s, 325-335 deg.

1617 KPR in 30-m config, rolled file.

1619 Turning for pass 2.

1622 Roll KPR file for pass 2.

1625 Turning for pass 3, KPR set to 60-m config.

1628 Roll KPR file for pass 3.

1630 Turn for pass 4.

1632 Roll file for final pass.

1634-1636 Pass 4, descend for final passes.

8.1 kft AGL passes:

Winds here 8-10 m/s at 315-325 deg. Occasional minor turbulence, but mainly outside passes over water.

1636 KPR set to 30-m config, descending to 8.1 kft.

1638 Rolled KPR file, first pass.

1640 Turn for 2nd pass.

1642 Roll file for 2nd pass - 164350-164450 triple ground echo

1645 KPR set to 60-m config, turning for pass 3

1647 Rolled file for pass 3 - 164800-164910

1649 Turn for final pass

1651 Roll KPR file for final pass, 165240-165350

1654 Enroute to calibration site Stopped lidar, out of disk space and stopped recording.

1659 Switched KPR/WCR to calibration config.

1710 Rolled KPR/WCR files. Calibration circles at 8500', 4-6 m/s winds.

1710-1714 Right hand circles, rolled both files.

1714-1717 Left-hand circles, a bit more turbulent.

1717 Enroute home.

1741 Wheels down.

Notes:

Couldn't seat WCR disk, got blue indicator light once, but disk did not mount and files had to be copied manually after flight.

Hit power switch on AV computer, system appeared OK on reboot.

Flight scientist PC rebooted itself ~1551

Lidar appeared to have low power early on, eventually worked after system reboot. Lidar disk full ~1613(?)

PACMICE – flt 2016/09/13 : 01:19 - 05:06 UTC

Crew: Sigel, Geerts, Plummer and Oolman

Synopsis:

Good flight in deep stratiform precip east of the Bighorn range. Almost the entire flight in the dark, take-off around sunset. Entire flight above freezing level, clear WCR bright band signature below. Stable lower atmosphere. Broad precip band, with some upslope flow east of the Bighorn range, and WSW flow above mountain level. Mostly laminar flow, occasionally some turbulence.

We conducted about 6 straight and level legs across the main precip band. The two most important ones straddle the GPM overpass. These two legs (first N-S, then S-N) were followed by a spiral sounding, from 22 kft down to 9 kft MSL, near the freezing level.

KPR data are compromised: high noise level, likely because of prior damage to receiver (LNA).

This is a GPM overpass flight.

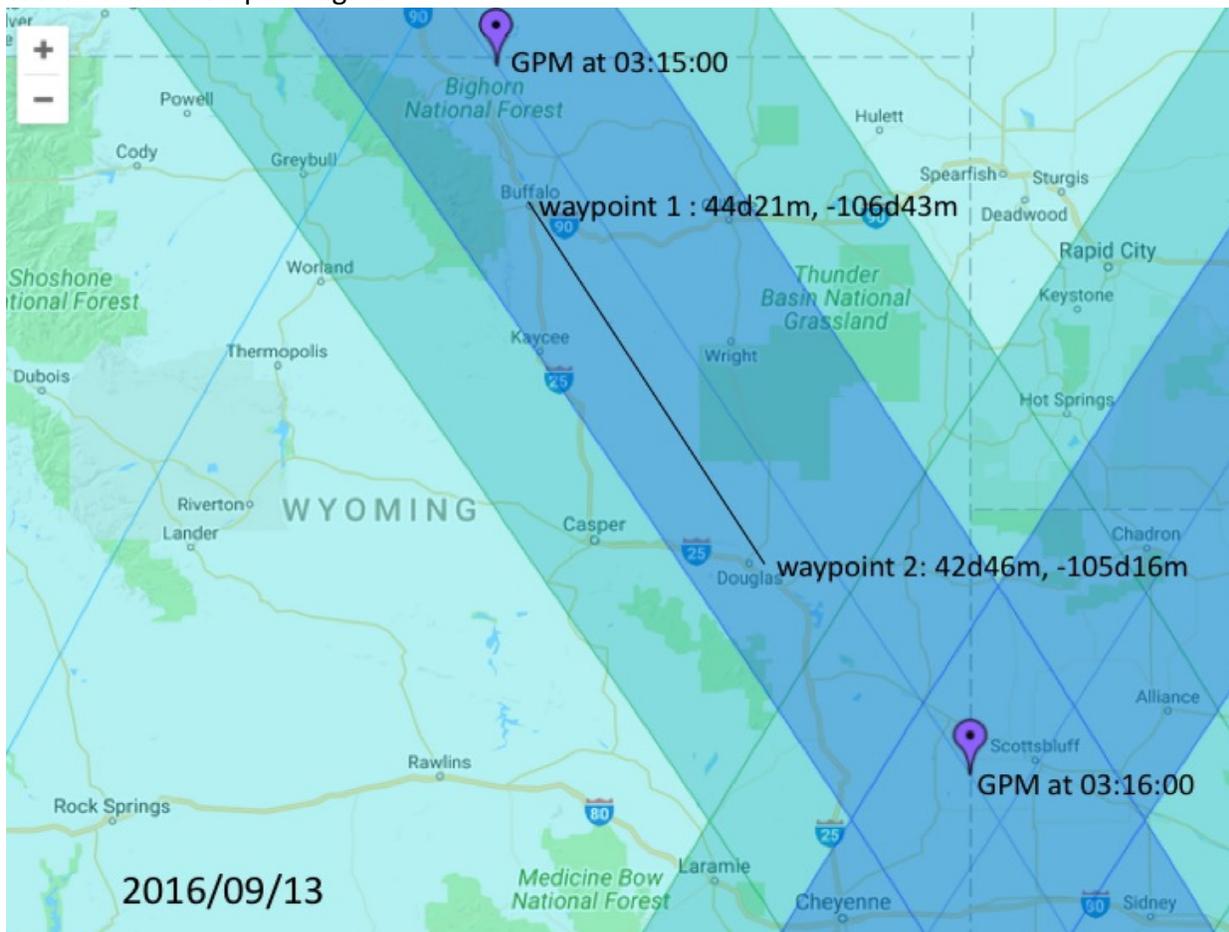


Fig. 1: GPM track from NW to SE. Dark blue is both radars, dark green Ku band radar only, the rest GMI only. (Ignore the other track)

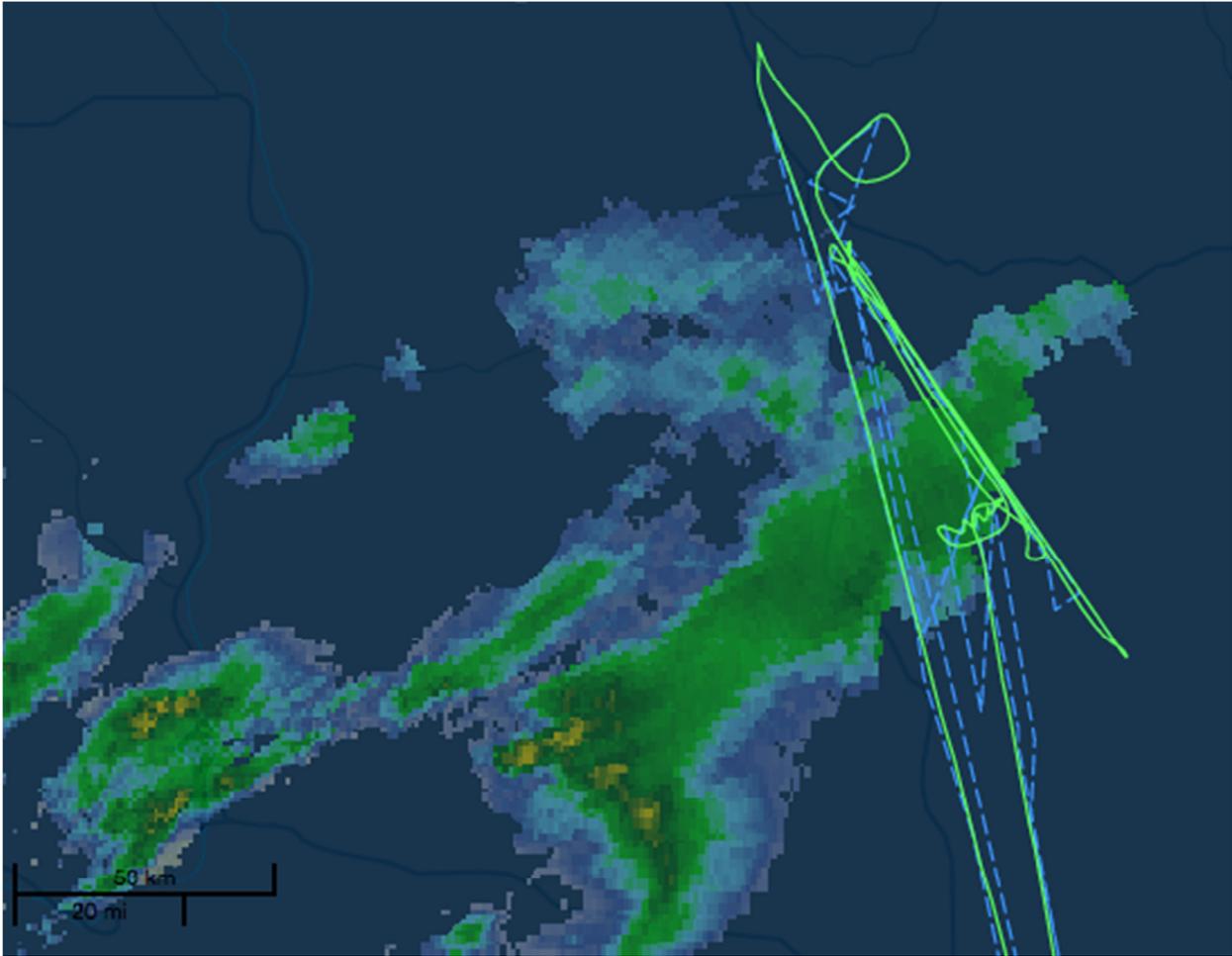


Fig. 2: Approx flight track and nexrad composite, from Flightaware

Flight sequence:

- Leg 1: long leg at 15 kft from LAR to north of the precip band. Slight banking & track adjustment near north end of band, we continued further NNW for another ~25 km
- Some unintended aircraft turning, then we line up along GPM track, starting at waypoint 1 (Fig. 1)
- Leg 2: short leg to S across precip band, 14 kft
- Leg 3: short leg to N across precip band, 12 kft
- Leg 4: long leg to S across precip band, 14 kft, 03:02 -03:17 UTC (GPM overpass)
- Leg 5: long leg to N across precip band, 17 kft, 03:19 -03:35 UTC (post-GPM)
- Leg 6: short leg to S across precip band, 22 kft, 03:37 -03:47 UTC
- spiral down in center of precip region, clockwise, 03:51-04:05 UTC
- Leg 7: short leg to S across southern precip region, 14 kft, 04:07 -04:17 UTC. Light precip continued further south, esp. around Casper mountain (upslope shallow precip).

Project: PACMICE16

Date: 13 Sept. 2016

Flight: RF06

Flight Summary:

The flight sampled deep clouds between Casper and Buffalo, and timed measurements to coincide with a GPM satellite overpass at 0315-0316 UTC. The primary precipitation area formed in a relatively narrow band, so flight legs were relatively short. Towards the end of the flight, a spiral descent was performed in cloud between 22 and 9 kft.

UTC Comment

0119 Wheels up. Will transit north to Buffalo at 18 kft, mainly above cloud.

0147 Lidar off as we pass 43N.

0151 Descend to 15 kft enroute, sample precipitation band. -6C in cloud, 2DS/CIP good. Multiple layers on WCR.

0159 Some icing, -3 to -4C plus ice on CIP. 2DS behaving OK.

0203 WCR cloud echoes to 2.5 km above, second layer between ~2.5-4.5 km above.

0211 Heading north at 14 kft/-4C. WCR tops to 5 km above, echoes down to surface w/weaker echoes ~1 km AGL

0216 Ascend to 15 kft, turn south. At upper cloud base, to 4 km above on WCR. Echoes from surface to 2.5 km AGL

0223 Multiple layers below on WCR, have been at upper base for a while. Rerouting east per ATC.

0227 Reroute back west to original path at 16 kft/-8C.

0232 Heading south along main path, descending to 14 kft/-4C.

0244 Return north at 12 kft.

0246 In some liquid at -3C. 2DS still looks good.

0250 On main leg through band at 12 kft/-2C. <0.1 LWC. WCR echo tops to 6 km above, nearly constant to surface. KPR to ~3 km above in 30-m config.

0259 Return south through band at 14 kft/-5C . Passing through shallow area between 2 cloud layers on WCR.

0315 GPM overpass for one minute - KPR switched to down beam only.

0316 Return north, ascending to 17 kft/ -9C. Approaching tops on WCR, more liquid. >0.5 g at times.

0328-0329 Brief ice likely on 2DP, resolved within a minute.

0335 Return south and ascend to 22 kft for spiral down within band.

0341 At 20kft, -20C. Atop main cloud layer, some weak echoes above on WCR but moon is clearly visible. Stronger echoes on composite are a bit further south.

0347 Heading southwest for main spiral descent through strongest remaining area on composite imagery. Initial descent planned to 11 kft.

0349 Beginning spiral, starting 22 kft/-21C in cloud.

0357 Passed 17 kft, -12 C.

0403 11 kft right at 0C. Clearance to descend further to 9 kft.

0405 End spiral at 9 kft/1.5C, ascending to 14 kft and heading home.

0416 Out of main cloud, between two layers on WCR. At 14 kft/-3C.

0505 Wheels down.

Notes:

Lidar software and display not updating after starting data sampling; looked good after restarting both.

Tx power on WCR often < 40, saw 25. Displays look good.

Noted afterwards that WCR data disk was not seated properly and did not mount. Data are recoverable from the system, but disk seating and data acquisition should be checked each flight.

Project: PACMICE16

Date: 10 Sept. 2016

Flight: TF03

Flight Summary:

Dry and clear day, doing lidar calibration legs, wind maneuvers, radar calibration circles.

UTC Comment

1524 Wheels up, ascending to 20 kft for lidar calibration. Note, winds relatively constant at ~20 kt from 14-15 kft. KPR in 30-m config for flight, not using 2DS.

1539 At 20 kft, beginning lidar leg

1550 End lidar leg

1556 Heading to 14 kft, looking for lowest winds for maneuvers. Planning 14.5 kft, winds 22-26 kt, +1C.

1607 Begin right-hand wind maneuvers, rolled KPR file just for reference.

1609-1612 Left-hand turns

1612-1617 Yaw maneuvers

1626-1636 Second lidar leg at 20 kft.

1636 Enroute to radar calibration site, descending to 8 kft.

1644 KPR in calibration config.

1650 At 8 kft, right circles.

1652 Left circles.

1655 Done w/calibration maneuvers, returning home at 10.5 kft.

1715 Wheels down.

Notes:

No particular instrumentation issues noted, everything looked good.

Project: PACMICE16

Date: 10 Sep 2016

Flight: TF03

System Scientist: Nick Guy

UTC Comment

1515 Wheels up

1536 The 15 kft MSL looks to be the best altitude.

1539 Level out at 20 kft for lidar overlap correction run.

1546 Torque = 2218 ft-lb.

1549 Winds at 34 kt at 20 kft.

1550 Descend to 15 kft

1553 18 kft, Torque = 2218 ft-lb., T = -7C

1556 Descend to 14 kft to check winds.

1607 Performing Rodi maneuvers at 14,500 ft MSL, no noticeable wave pattern in winds. Winds pretty steady around 22.5 kt. Right turn first.

1609 Make left turn for Rodi maneuvers.

1611 Back on south heading.

1612 Performing Rodi maneuvers with Yaw corrections.

1619 Ascending to 20 kft MSL.

1620 16,500 ft MSL, T = -3.5C, Torque = 2210 ft-lb.

1627 Level at 20 kft for lidar overlap correction run.

1630 T = 13.5C, Torque = 2211 ft-lb.

1636 Turning off this leg, descending down to 8000 ft for radar circles.

1642 13 kft, T = 2.7C, Torque = 2213 ft-lb.

1650 Begin radar calibration circles.

1655 Heading back to LAR.

1715 Wheels down.

Notes:

Flight Summary:

Calibration flight. Performed radar circles and Rodi maneuvers. Additionally, collected 20 minutes of flat leg lidar data for overlap correction. No known instrument issues.

9/9/2016 PACMICE Pilot notes (Research Flight 4)

Crew: Wadsworth, French, Guy, Plummer.

Flight Time: 3.4

Planned: Transit over to Lusk. Work the clouds. Radar circles south of Wheatland. Come home

Actual: Filed to the Hipsher VOR. Adjusted the point further to the west, between Douglas and Casper. We were pinched between the higher terrain and IFR altitudes over the Laramie Range and the north end of the PACMICE LONO area. Picked up icing as we were between zero and about minus 3 degrees. Boots continued to shed the ice as necessary. Did two instrument approaches into Douglas. Ferried to the radar circle area south of Wheatland but the cloud ceilings were too low to perform. Came home.

PAC-MICE16
RF05; 9 Sept 2016 – French flight notes

Wadsworth, French, Guy, Plummer

Preflight

Plan to target shallow frontal clouds in Douglas area. Front is dipping south and east and expect clouds to be moving in from Casper and the northwest throughout the flight.

Severe clear in Laramie

Aim for 16 Z takeoff, delayed about 10 – 15 minutes due to traffic around the airport.

Engine Start/Taxi

Uneventful, everything seems to be working fine.

Flight (times UTC)

1615 Wheels Up

Departed to the NW out of Laramie; sounding indicated a small inversion at the surface which a residual layer above that to 12500 ft that was dry adiabatic

1622 Level at 15 kft

1640 nearing initial point, cloud tops appear to be ~12000 ft

1641 begin short leg to the west at 15 kft, max echo is about -10 dBZ on WCR on western (strongest) end

1645 end leg, turn back to the east

1647 – 1651 Leg 2, above cloud at 15 kft entire time, weak echo on WCR

1653 – 1701 Leg 3 at 13 kft, right at cloud top. In cloud on the western half, almost entirely liquid, T=-6 C, echo below us is +10 dBZ reaching ground

1703 – 1706 Leg 4 tracking to the east, decide to cut it short and shift anchor point further west as clouds are deeper in that direction.

Descend to 12 kft

1707 -- ~1720 Leg 5 @ 12 kft, rather long because we shift further to the west and started leg on east end. T is -5 C, mix of liquid water and lots of columns, strong echo on WCR; 2DS gets hosed as we are on western end – water in tips???

1722? -- ~1730 ascend to 15 kft; Leg 6 – messing with 2DS, adjusted heater in arms from 5 C to 10 C, didn't help?

1732 – 1738 Leg 7, track west (altitude 15 kft); in and out of cloud during leg

1739? – 1744? Leg 8, descending to 10 kft during leg, LWC100 dies during leg due to icing over (it comes back later in flight), T ~-1 C

1745 – 1758 a couple of legs at this time at 10 kft, with T from -1 to -2 C, near the end of this period 2DS begins working again

Cannot get any lower due to altitude restrictions, decide to try for a couple of missed approaches at Douglas to get under clouds and into rain. Although this is a bit further east than we would like, its our only option in the region.

1803 start approach fix and begin descending, T is 0C at 8500 ft

1810 8 miles out at 6900 ft and some light drizzle is appearing

Descend to 500 AGL (not sure MSL altitude)

1818 finish missed approach on west side, turn back to the east to return to initial fix point at 8000 ft

1830 back over initial fix at 8000 ft, procedure turn to setup for 2nd approach.

1837 initial point, start descent

1846 end approach

1848 proceed to south to try to accomplish radar circles in Wheatland area

Decide clouds are too low to accomplish radar circles in VMC so decide to return to base

1915 begin shutdown early so Nick can step Dave P through the process

1933 wheels down

Post Flight

Clouds were well-behaved and reasonably easy to work. Because we were 'squished' between the Laramie Range/Casper Mountain region to the south and the northern most extent of our lidar box to the north, we were not able to get as low as we wanted. Thus we ended up working mostly in ice except for a couple of missed approaches at Douglas at the end of the flight.

TwoDS has problems when operating around 0 C in the presence of liquid water...lots of streakers and stuck bits.

Found out following the flight that KPR pre-amp was off, so the weak signal we saw on the KPR was due to that. Also learned (later) that because we transmitted full power from the

KPR down at low altitudes (during the missed approach) that the LNA's were likely damaged.

Project: PACMICE16

Date: 9 Sept. 2016

Flight: RF05

Flight Summary:

Clouds & precipitation entering northern end of lidar box near Casper, and expected to swing eastward as they progress south. Plan is to initially head near Douglas and do W-E legs traversing the clouds towards the north end of the usable area.

UTC Comment

1614 Wheels up

1633 Hints of cloud below on WCR, nothing on KPR.

1637 Echoes from surface to ~2 km AGL on WCR, nothing on KPR.

1640 Beginning W leg at 15 kft. Similar radar structure - WCR echoes ~800 m below aircraft and increasing in height.

1644 Clipping cloud tops - droplets on 2DS, no precip below on KPR.

1645 Eastbound leg at 15 kft, ~-10C in cloud. 2DS has some ice to a few 100s of microns. Weak WCR, no KPR echoes.

1651 Descending to 13 kft - switched KPR to 60-m, then 75-m configuration with only ground echo still evident. Retained 75-m configuration for majority of flight.

1653 Cloud tops again, ~-7C at 13 kft in cloud.

1657 2DS & CIP show 200-500 micron particles.

1659 10 dBZ below on WCR, very subtle echoes beginning on KPR.

1701 Turn east.

1707 Turning W, descend to 12 kft/-5C, some icing. Brief TAS dropout on 2DS?

1711 2DS begins showing major issues with stuck bits, then useless measurements. Near -5C with liquid/icing.

1720 Increase altitude to 15 kft/-8C and turn back east. 2DS still having issues.

1725 Out of cloud - note that we had to manually reenable 2DS heat from the control program. This should have been enabled already and may help

mitigate the performance issues.

1728 2DS looking better after redoing masks - one stuck bit at the moment.

1731 Turn W, still at 15 kft. 2DS back to stuck bits and shows some stretched particles (particularly exiting cloud tops).

1737 Turn E, descending to 12 kft. Then plan to descend to 10 kft to try to lose ice. 2DS still sporadic.

1744 Turn W at 10 kft/-2C, can see surface with some precip visually evident. Sporadic KPR returns ~1 km below aircraft.

1751 Turn E, good ice measurements on 2DS.

~1800 Planning to do missed approaches at Douglas airfield. Sporadic KPR layer ~750 m AGL through this time.

1805 At ~8.5 kft/0C, no KPR returns.

1806 At 8 kft for first missed approach.

1810 Liquid on 2DS, to 6.9 kft during approach.

1813 At 5.3 kft, some ice on 2DS.

~1815 Ascending out of first approach.

1839 At 6.9 kft for 2nd approach, liquid evident at -3C.

1842 In missed approach.

1844 At 8 kft after approach, heading to radar calibration site.

1847 Ascending to travel at 11 kft.

1907 Switched KPR to calibration configuration. At calibration site, but cloud bases too low to do circles. Returning home.

1933 Wheels down.

Notes:

Discovered following flight that AC/DC switches turned off on KPR. Echoes were visible on display, but much weaker than they should have been. KPR unusable, but related comments are retained.

The 2D-S had major (expected) issues in and following icing conditions encountered in cloud at -5C. Probe heat should be checked in the control software, as this was disabled by default on startup. It seemed to mitigate the issue but not eliminate it. Additionally, occasional particle stretching was evident even when the TAS feed looked correct, typically occurring in the final particles while exiting cloud and in the few scattered particles encountered between clouds. Behavior with more substantial concentrations in cloud generally looked good.

Project: PACMICE16

Date: 09 Sep 2016

Flight: RF05

System Scientist: Nick Guy

UTC Comment

1614 Wheels up

1628 Instruments up and running.

1640 Turn W on E-W leg at 15 kft MSL.

1643 Clouds are sloping up toward aircraft as we head west.

1646 Eastward on leg.

1650 Descend to 13 kft MSL, turn west.

1653 Puts us in cloud.

1701 Turn east.

1705 Will move fix point westward.

1706 Turn west, descend to 12 kft MSL.

1709 Starting to pick up some ice on wings and instruments.

1720 Turn east, ascend to 15 kft MSL.

1731 Turn west.

1738 Turn east, descend to 10 kft MSL.

1744 Turn west, some ice coming off at $T = -2$ or -3 C. Below cloud, precip falling.

1754 2D-S tips are now clear.

1800 Will execute missed approach at Converse County airport.

1805 T = 0C at 8500 MSL.

1809 Begin missed approach.

1815 Ascending out to northwest to 8 kft MSL and hold. Plan to turn around Culis and make a second missed approach.

1821 Turned back southeast for next missed approach

1830 Begin second missed approach.

1842 Ascend to 8 kft MSL out of missed approach.

1847 Head to Cheyenne area at 11 kft MSL for radar cal circles.

1911 Clouds are too low for radar circles. Will proceed back to LAR at 11 kft MSL.

1933 Wheels down.

Notes:

Create a CIP VNC for front screen.

Flight Summary:

9/4/2016 PACMICE Pilot notes (Research Flight 4)

Crew: Wadsworth, Tripp, Oolman, Plummer.

Flight Time: 3.7

Planned: Transit over to area west of Rawlins. Work the clouds. Radar circles south of Wheatland. Come home

Actual: Filed to the vicinity of the CKW VOR. Transited at 16K. Starting working precip and climbed to FL 210, then gradually came back down to 16k. Ferried to the radar circle area south of Wheatland and did crop circles. Came home.

Ground track below:



Nothing particularly significant from the flight.

Project: PACMICE16
Date: 4 Sep 2016
Flight: RF04
Flight Scientist: Adam Tripp

Summary:

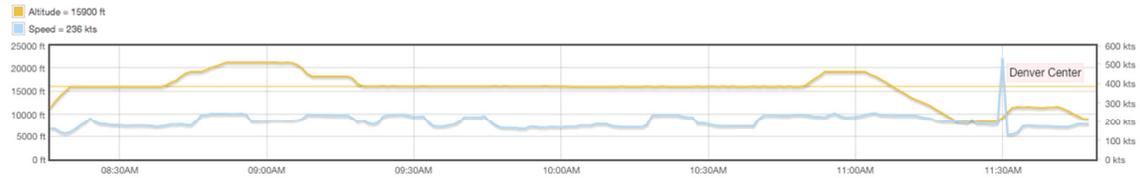
RF04 was a successful flight with respect to crew safety and data acquisition. A jet streak aloft, along with lower-level moisture, produced deep clouds west/southwest of Laramie. N2UW set out to perform racetrack maneuvers through these deep clouds. Despite model predictions, convective updrafts existed throughout the morning hours prompting the N2UW crew to be mindful of its flight track through the widespread cloud structures. Flight legs were performed at temperatures averaging -5°C or below, as well as at higher altitudes (16-, 18-, 19-, 21-; thousands of ft MSL). Visual inspection and the 2-DS revealed various ice specimens in vicinity of aircraft through the various flight legs. In an effort to calibrate the radars, circle maneuvers at $\sim 8,200$ ft MSL were performed at the end of the flight near the vicinity of Wheatland.

Post-flight evaluation of data reveals some scrambling in the KPR data. However, all instruments appeared to be functioning correctly during the flight (i.e., great cloud structure when clouds were present and consistent ground echoes when in clear air).

AC Track (w/NEXRAD):



AC Elevation/Speed Profile:



UTC Comment

1415 Wheels Up

1416 WCR, KPR, 2DS running by now. Starting Lidar

1420 Ascend to 15,900 ft MSL; heading W/NW to start legs through deep clouds W/SW of Laramie

1425-1437 Leg at 15,900 ft MSL; heading W

1438 Begin ascent to 21,100 ft MSL to get a visual of overall cloud structure and survey colder parts of cloud

1444 Turn to head E while ascending

1451-1454 Leg 21,100 ft MSL; Heading E

1455 Turn to head W

1456-1505 Leg at 21,100 ft MSL; heading W

1506 Drop down to 18,100 ft MSL and turn to head E

1509-1516 Leg at 18,100 ft MSL; heading E

1517 Begin descent to 16,000 ft MSL while turning to head W

1519-1648 Perform racetrack patterns in large cloud structure at 15,900 – 16,100 ft MSL; heading E/W and NE/SW around (intensifying) convective updrafts; lots of ice particles being picked up on 2-DS; WCR/KPR showing great returns with cloud base/tops at least 2 km below/above

1649 Ascend to 19,100 ft MSL; heading E to Wheatland for radar circles

1703 Descend to 8,300 ft MSL

1720-1728 Performing 2.5 circles clockwise and counterclockwise

1729 Ascend to 11,600 ft MSL to head W/SW back to Laramie

1749 Wheels Down

1753 Arrival at KLAR

Looking ahead:

Models call for drying over SE Wyoming for the next few days. It would be nice if 2nd seat flight scientists had mirror display access to the WCR and KPR to make more informed decisions on next flight legs.

Project: PACMICE16

Date: 4 Sept. 2016

Flight: RF04

Flight Summary:

This flight focused on sampling convection and remnant clouds over south central Wyoming. The clouds were deep enough that passes were made far enough above the freezing level (~13 kft) for up- & down-beam radar measurements to be made through deep ice cloud. There was a very well-defined melting level in the clouds sampled later in the flight, typically 1.2-1.5 km below the aircraft on the KPR downward beam. The 30-m configuration was primarily used for KPR, with two passes each in cloud using 60-m and 75-m configuration.

Radar calibration circles were done at the end of the flight.

UTC Comment

1412 Wheels up

1413 KPR recording, set in 30-m config, looking OK 2DS recording, TAS looks fine, just a few scattered small returns

1420 16 kft, approaching showers

1422 First cloud penetration, echo tops ~750 m above on KPR Ice particles look good on 2DS @ -5C

1424 Out of cloud - both KPR and 2DS appeared to be running fine

1428 Just in light echo, cloud droplets on 2DS? Still @ -5C

1437 KPR cloud tops ~3.5 km above, in 30-m config - ~5 km above on WCR. Switched to 60-m config to see sensitivity, still only ~4 km above.

1439 KPR back in 30-m config to prepare for start of stacked passes in cloud.

1444 Climb to 19 kft, turn back at west edge. At cloud tops on KPR/WCR, with higher cloud layer evident on WCR. Higher cloud tops 4-5 km above on WCR, ~3 km on KPR with a lag before they were evident relative to WCR.

1452 KPR boundaries at ~2 km above, 3 km below, compared to 3.5 km above and 3 km below on WCR.

1454 Switched KPR to 60-m config at turn back to the west. Tops decreasing from 3 to 2 km above, at 3+ km above on WCR.

~1501 Noted possible mammatus along well-defined cloud base, ~3 km below on KPR.

1506 Switched KPR to 75-m config for eastbound leg @ 18 kft.

1509 In cloud, tops only ~2 km above on KPR, 3 km above with an additional cloud layer evident on WCR. Similar bases at 1.5 km below on KPR & WCR.

1515 Well-defined melting level ~2 km below.

1516 Switched KPR to 30-m mode for return leg west @ 16 kft.

1522 Turning north to track along with more widespread clouds to northeast, only smaller, weakening cells along current path.

1524 Turned east through main area of clouds advecting northeast.

1531 Turn back west, good measurements ~1.5 km up and down within ice cloud.

1540 Turning east, at edge of cloud.

1543 NEXRAD composite indicates this area of cloud is breaking up quickly. Turning SW to next weak cell, will be repositioning soon.

1550 Switched KPR to 75-m config just to check for scattered clouds visible outside, no strong returns.

1553 Switched KPR back to 30-m config back in cloud.

1600 Transiting to more active region to southwest - CG lightning strike in main cell. Will stay in broad area of clouds on NW side of the active convection.

1608 Melting level in KPR ~1.2 km below, with precip to surface Deep clouds, 4 km above on KPR, 5.5 km above on WCR with a strong reflectivity gradient near KPR tops

1616 Out of cloud, returning northeast.

1626 Returning southwest, switched KPR to 60-m config.

1631 KPR tops near 5 km above, close to WCR.

1639 Last leg to northeast, switched KPR to 75-m config.

1649 In cloud, but now enroute to radar circles, switched KPR to 30-m config.

1659 Exiting main clouds.

~1700 Last few 2DS particles distorted near cloud edge. TAS looked fine. Saved main files and restarted some test files - particles looked fine again when we passed through more sporadic clouds.

1721 Radar calibration - set KPR to calibration config, rolled to new file ~172250 for start of maneuvers.

1729 Calibration done, returning home.

1749 Wheels down.

Notes:

2D-S performed well, with a few stretched particles evident in very low concentrations upon exiting cloud. TAS looked reasonable, and issue disappeared when in more substantial clouds. KPR performed well, several files were scrambled but this turned out to be a file header issue rather than an operational problem, and the data was recoverable.

8/26/16 PACMICE Pilot notes (Research Flight 3)

Crew: Drew, French, Guy, Jacobson

Flight Time: 2.3

Planned: Find growing Cu around MBW and make repeated passes.

Actual: Filed to MBW. Took off stair-stepped up on cloud passes from 14,000 to FL 210 working around MBW (mostly N-NE).

PAC-MICE16
RF03; 26 Aug 2016 – French flight notes

Drew, French, Guy, Jacobson

Preflight

Plan to target growing convection in fairly early stages NW of Laramie. Forecast suggests drier air moving in from west, so expect to drift east as flight continues. Larger convection expected/forecast for east of Laramie range and we want to avoid that. Cloud bases will be around 0 C, so don't expect any liquid precipitation in these clouds.

Aim for 1 PM (1900Z) takeoff. Ran into issues during startup; LOD needed to bring everything all the way down and then back up again; ended up delaying the takeoff by about 1 hour.

At time of takeoff there was already quite a bit of convection north of Laramie—so plan to work to that direction, maybe staying on the back (west) side?.

Engine Start/Taxi

Rained a bit before flight...2DS showed some odd behavior at the very beginning of flight—missed/stuck bits, maybe water in the optics? Following takeoff we built then cleared masks and that seemed to take care of the problem.

Flight (times UTC)

No real detailed notes...throughout the flight we targeted convection...individual cells to the extent possible. It was difficult to target anything around cloud base (about 14000 kft) because it was too messy. We had our best luck penetrating cells from ~18500 upto and just above 20 kft.

Several penetrations had CLWC in excess of 1 g m⁻³; some clouds had precip, other were devoid....it appeared (as no surprise) to depend on strength of updraft, height of cloud top, and how long the cloud appeared to have been around. Data set will be difficult to use for studying anything meteorological, but should be useful for radar and in situ instrument evals.

Post Flight

In general, everything worked well, except for the hiccup prior to flight in bringing up the data system.

Project: PACMICE16

Date: 26 Aug 2016

Flight: RF03

System Scientist: Nick Guy

UTC Comment

1950 Wheels up

1957 Radars running. Approaching base of cloud, 14.5 kft MSL. 2D-S not working properly, due to rain before takeoff?

2000 Licor display not working. Front panel

2010 Series of cell to the west of Laramie, passing through at 15 kft MSL.

2005 Climbing to 15.5 kft MSL for return trip through clouds.

2012 Had to reconnect to Licor. Now operating.

2016 CO concentrations from CDP of >2000 per cm^3 .

2021 Ascend to 17 kft MSL, continue work through clouds NW of LAR.

2026 They sent a new mask to 2D-S and the issues (heavy raking?) cleared up.

2028 Targeting large piles.

2034 Ascend to 18.5 kft MSL.

2037 Ascend to 19.5 kft MSL. Lots of liquid water, >1.5 g/m^3

2041 Ascend to 21 kft MSL.

2048 Hunting clouds. Switched to 60m res on KPR.

2106 Lidar power looks very low. Possibly window is iced up.

2108 Descend to 19 kft MSL for cloud penetration.

2119 Operating through a ragged line with 12 m/s updraft and 10 m/s downdrafts.

2120 Ascend t 20kft MSL for pass through again.

2127 LWC100 iced over but looks like it cleared after pass through 6 mm graupel.

2128 At 20 kft MSL.

2135 Big poofy cloud with no radar return.

2140 Sampling this same cloud, in decay stage.

2149 Heading home.

2207 Wheels down.

Notes:

Flight Summary:

Multiple passes through convective clouds to west and northwest of Laramie.
No known instrument issues.

8/25/16 PACMICE Pilot notes (Research Flight 2)

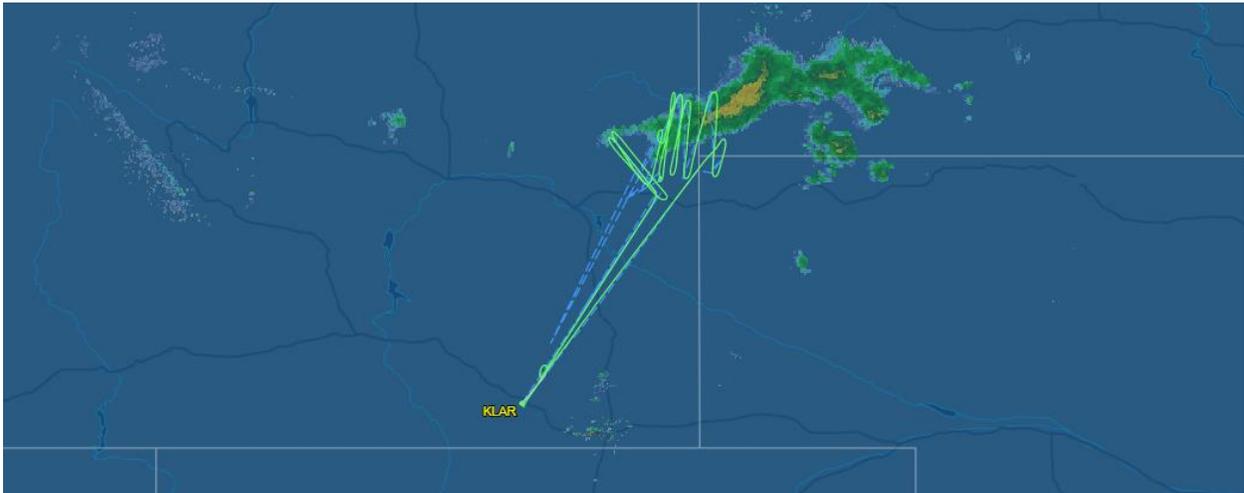
Crew: Wadsworth, French, Guy, Jacobson

Flight Time: 4.1

Planned: Transit over to area near Lusk. Work the clouds. Come home

Actual: Filed to the vicinity of Lusk. Flew over at 17k'. Worked off the Hipsher VOR for radial cuts & DME. Worked down from 17k' to 13k'. Then descended to 8k' & worked back up till finished at 13k'.

Ground track below:



Picked up some icing in the clouds. Last run at 13k', the ice on the wings was rough, and formed on the aft edge of the boots. We descended to 11k' which melted the ice off. Returned to Laramie at 11k'..

PAC-MICE16
RF02; 25 Aug 2016 – French flight notes

Wadsworth, French, Guy, Jacobson

Preflight

Plan to target stratiform-type precipitation NE of Laramie range. Satellite and surface obs show low clouds east of range, north of about Guernsey area. Radar is indicating wide-spread showers north of line from Douglas to Lusk, moving to NE. Models suggest clouds in this region should be deeper, with tops to -12 C; likely some remnants of convection on the previous day??

Aim for 7 AM (1300 Z) takeoff

Wx – overcast in Laramie valley prior to sunrise and just after. Low clouds, appeared thin, no precip. By takeoff, low stratus deck was becoming broken.

Plan – start with initial point somewhere near Lusk—use NEXRAD from ground to target region of showers that we expect will be located somewhere between Lusk and Douglas. Try to work in ~30 nmi legs beginning at ~top (maybe around 16 kft) and stepping down in 1000 – 2000 ft increments to as low as possible.

Engine Start/Taxi

Upon entering aircraft, noticed that KADisplay was not updating. After Nick verified that data system was indeed running, decided to reboot Data distribution computer. That appeared to take care of problem

Flight (times UTC)

1302 Wheels Up

1310 Level at 17 kft, pointed to the NE. Above clouds at this point.

1332 – 1341 Leg 1 at FL170, T~-11C, generally above clouds (at beginning of leg), clouds deeper near end of leg (west end), clipping tops. When in clouds, note all particles are ice.

1343 – 1351 Leg 2 at FL160, T~-9C

1353 – 1403 Leg 3 at FL150, T~-6 to -7 C, mostly in cloud

1406 – 1411 Leg 4 at FL140, T~-4 to -5C, columns and needles; echo dissipating on eastern half

Re-adjust leg locations to orient more north south and work a bit further east and north.

1414 – 1429 Leg 5, tracking NNE, FL 130 at T~-2C, added a circle in middle of leg for ATC while we awaited clearances

1431 – 1441 Leg 6, FL120, T~-1 C, 2DS began looking suspect during some of this leg--- suspect there is water infiltration? Played with mask settings, didn't help much, but finally got it working out of cloud.

Decided to drop to lowest possible altitude to ensure we got all water

1446 – 1456 Leg 7 at 8000 ft, T~+5 C, below cloud base in rain. Some spots have drops to 2mm

1459 – 1509 Leg 8 again at 8000 ft

151030 – 1521 Leg 9 at 9000 ft, T~+2.5 C, right at cloud base, into/out of cloud, almost all liquid, some (very few) partially melted hydrometeors

1523 – 1532 Leg 10 at 10000 ft, T ~+1.4 C, in cloud, mix of liquid and ice

1533 – 1544 Leg 11 at 11000 ft, T~0C, mix of liquid and ice

1546 – 1557 Leg 12 at 12000 ft, T~-2 C, clouds becoming broken; hydrometeors look like mostly aggregates, ~1552 2DS began showing some liquid

1558 – 1602 Leg 13 at 13000 ft, T~-3 C ... 2DS appears to have problems in regions with liquid just below freezing....we began seeing a lot of stuck bits and missing pixels....did not clear until we got out of this regime.

1603 Out of time, need to head home; expect ~1 hr ferry home.

Post Flight

Overall a very good flight with excellent data. Need to investigate how much data is lost with 2DS during time periods at T~0C (or a bit colder) and liquid; Also noted that PVM died at some point during flight, but came back at end.

Project: PACMICE16

Date: 25 Aug 2016

Flight: RF02

System Scientist: Nick Guy

UTC Comment

1300 Wheels up

1322 Lidar software not updating real time display. Data collected. Trying reboot.

1330 Lidar up and running again. Note forgot to commit hardware averaging right away.

1331 Passing over deeper cloud layer, reflectivity up to approx 15 dBZ. Down to 4 km below(sfc).

1332 First leg started at 17 kft MSL.

1335 In and out of cloud.

1341 Turning 180 and dropping to 16 kft MSL. Deeper clouds to northwestern extent.

1343 Back SE line. T= -8C, collecting some ice on probes.

1348 WCR return all the way to ground, decreasing dBZ generally to SE.

1352 Turn NW, descend to 15 kft MSL.

1353 T = -6C

1359 T = -5C, see slanted layer below in WCR, KPR is seeing really nice signal below.

1403 Turn to SE, descend to 14 kft MSL.

1405 Entering deep cloud, T = -4C.

1407 Saw mixed ice crystal, columns, needles, aggregates, etc.

1411 Turning due north, descend to 13 kft MSL.

1412 T = -2C

1416 Passing over southern edge of echo region.

1419 Had to abort the north track momentarily for ATC communication.

1421 Turn back northward.

1424 T = -3C, KPR showing nice structure below, various ice crystal types.

1429 Turn S, descend to 12 kft MSL.

1430 T = -1C, scattered cloud heading back into cloud.

1433 WCR PLO lock fault, earlier had a modulator fault momentarily.

1438 In drizzle. 2D-S seems to not be working.

1441 Begin descent to 8 kft MSL, 360 to continue descent.

1445 On N track, below cloud base at the southern end. T = +5C.

1449 In rain shaft, drops on all probes, KPR and WCR have nice returns.

1459 Turned S, rolled both radar files. Staying at 8 kft MSL. Out of precip on north side of leg.

1504 Into heavier precip.

1509 Turn N, ascend to 9 kft MSL. T = 2.5 C. In cloud.

1510 At cloud base on the southern portion of track.

1514 Just went below decaying cell via Nexrad (KCYS) and beautiful image from KPR.

1521 Turn south, ascend to 10 kft MSL. T = 1.5C.

1523 In ice.

1531 Turn north, ascend to 11 kft MSL. T = 0 C.

1544 Turn south, ascend to 12 kft MSL. T = -1.5 C. Stratiform area is breaking up.

1557 Turn north, ascend to 13 kft MSL. Picked up some ice from liquid hitting wing rolling back and freezing at around -2C.

1558 T = -3C. May be in forming convective cloud.

1602 Turning to head back to LAR.

1607 Noticed that the PVM is no longer working. Descending to 11 kft MSL as we have collected ice.

1626 KPR display disappeared when minimized. Had to restart display.

1634 KPR collection stopped.

1659 Wheels down.

Notes:

Had to restart Lidar computer. WCL display software not responding.

PVM was not working in a latter portion of flight, maybe too much liquid water?

Flight Summary:

Sampled a stratiform cloud layer with convective elements in northeast Wyoming. Many types of ice habits and liquid precip.
No known instrument issues.

8/18/16 PACMICE Pilot notes (Research Flight 1)

Crew: Wadsworth, French, Guy, Haimov

Flight Time: 1.8

Objective: Test and exercise all instruments. Calibrate Nezerov.

Planned: Nezerov calibration up & down the Laramie valley, followed by some short time in-clouds.

Actual: Filed to the LAR 320/20 DME. Picked up the clearance on climb to 10K to start the calibration legs. Denver as cooperative as always. Gave clearances as requested each time. Had to adjust the higher legs further to the south (directly over the LAR VOR, within 20nm) as higher-level clouds were starting to build. Finished with short period in clouds.

I had sent the normal fax notification via email to the address provided on the PACMICE LOD for the LIDAR system. When I called down just prior to flight, the ops desk had the notification in-hand and had no questions or problems.

PAC-MICE16
TF01; 18 Aug 2016 – French flight notes

Wadsworth, French, Guy, Haimov

Preflight

Flight to test initial installation of equipment; particularly operation of KPR and WCR3; 2DS; and conduct Nevzorov maneuvers

Aim for 9 AM (1500 Z) takeoff

Wx – clear in am, some clouds over the Snowies. Expecting increasing clouds through flight; not sure if we will be able to get full maneuvers in prior to clouds

Plan – conduct nevzorov maneuvers at 4 different levels:

10 kft, 14 kft, 18 kft, 23 kft; shoot for 5 airspeeds (IAS) for 60-90 s at each level:
130, 145, 160, 175, 190 kts

Engine Start/Taxi

Upon entering aircraft, noticed that KADisplay was not updating. After Nick verified that data system was indeed running, decided to reboot Data distribution computer. That appeared to take care of problem

Prior to taxi roll, noted that both temperatures (trf & trose) were railed. Went through a couple of minutes of trouble shooting before Nick noted that breakers for the probes were pulled. Reset breakers and problem went away

On taxi roll; connected/recording 2DS data. Upon checking file, noted that was not writing to new file. Quit 2DS program; recycled power to probe; started everything back up and appeared to be recording fine.

Flight (times UTC)

1452 Wheels Up

Following takeoff, Nadir port door opened & Nevzorov turned on

Nick & Sam were having issues with WCR; server was crashing....

1455 setting up for 1st set of Nevzorov runs

10 kft

| | |
|---------|-----------------|
| 130 kts | 145600 – 145730 |
| 145 kts | 145900 – 150030 |
| 160 kts | 150200 – 150330 |
| 175 kts | 150440 – 150630 |
| 190 kts | 150750 – 150930 |

14 kft

| | |
|---------|-----------------|
| 130 kts | 151345 – 151500 |
| 145 kts | 151625 – 151800 |
| 160 kts | 151905 – 152135 |
| 175 kts | 152240 – 152410 |
| 190 kts | 152605 – 152740 |

18 kft

| | |
|---------|-----------------|
| 130 kts | 153300 – 153430 |
| 145 kts | 153700 – 153830 |
| 160 kts | 154030 – 154200 |
| 175 kts | 154245 – 154415 |
| 190 kts | 154715 – 154900 |

23 kft

| | |
|---------|-----------------|
| 130 kts | 155545 – 155715 |
| 145 kts | 155810 – 155940 |
| 160 kts | 160125 – 160255 |
| 169 kts | 160430 – 160600 |

End Nevzorov Maneuvers

Noted somewhere near the middle/end of the Nevzorov maneuvers that the displayed TAS on the 2DS was not changing. Tried several different things; turning manual/automatic on/off; etc. Finally disconnected, restarted program; after that it appeared to update correctly. Hence there are two 2DS files. First one **may have a constant airspeed – need to check – maybe look in the header information of file. However, first file should have very few particles; mostly clear air. Second file **appeared** to work properly. We did get into cloud, so particles should look OK.

161045 – 161900 *times approximate* Made several passes through cu cluster with some graupel and rimed crystals. Cloud probes looked reasonable.

Post Flight

Following flight it was discovered that nadir port door did not close all the way and mechanism broke. Aircraft is down until that is fixed.

Project: PACMICE16

Date: 18 Aug 2016

Flight: RF01

System Scientist: Nick Guy

UTC Comment

1452 Wheels up

1456 Starting 10kft, 130 kt.

1456 WCR not operating

1510 Had to use the <http://192.168.127.249> connection to WCR server

1512 Started to record file

1519 See extensive cloud overhead.

1522 Changed from Serial to UDP and back to Serial on 2D-S.

1526 190 kts, 14k ft

1528 Tried to roll file on WCR. Lost server connection. Defunct, had to restart.

1540 Restared WCR for a second time.

1555 Started leg at 23k ft.

1605 Rolled WCR file, around 30-60 time delay.

1606 Begin descent and will sample clouds.

1610 Entering cloud.

1618 Finishing up cloud passes.

16 Wheels down.

Notes:

Very little air coming out cooling hose into WCR. Front A/C is stronger.

For notes on the Nevzerov calibration, see J French notes for the flight.

Flight Summary:

Test of instrumentation. Performed Nevzerov calibration maneuvers. Sampled cloud at end of mission. Nadir port door mechanical failure upon closure.