2019 Terrain Effect on Clouds and Precipitation – An Educational Campaign (TECPEC)
University of Wyoming King Air Research

Summary

TECPEC has the following primary goals:

1. To provide opportunities for graduate students to investigate orographic clouds and precipitation using advanced instrumentation with hands-on experience with experimental setup, instrument operation, and data handling, focussing principally on remote-sensors on the UWKA.
2. To enable undergraduate students in an Atmospheric Chemistry and Air Pollution class to examine profiles of wind, temperature, aerosol properties, and carbon dioxide in an inversion over the Uinta basin.

Links

- Planning and tracking tools
- Plot of flight hours
- Lidar, Radar, and PCASP quicklooks

Date	Flight # (*.kml)	Status	Times (UTC)	Hours	Crew/Notes
29 Mar 2019	RF09	Flight primarily in cloud collecting microphysical data in vertically stacked passes along radials from CYS	1916-2211	3.0	Ed Sigel Hunter Brown Dave Plummer

Order TECPEC Data

- King Air 1 Hz files
- King Air high rate 25 Hz files
- CIP 2D images
- Nadir Cloud Lidar
- Wyoming Cloud Radar Level 1
- Wyoming Cloud Radar Level 2

User Information

- Planning Chart
- EOL Facilities
- Software Repository
- Projects & Data Requests

		radar, a missed approach at Wheatland.			Alice Shen
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21 Mar		First flight of day. Ferried to SLC, making multiple passes through orographic clouds between the Uinta	1411-		Brett Wadsworth Jeff French

- Planning and tracking tools
- Facility User's Guide

Facility Instruments

- In Situ
- Wyoming Cloud Radar
- Wyoming Cloud Lidar

Contact

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Facility Manager:
Jeff French

UNIVERSITY OF WYOMING

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4 Mar 2019	TF02	Test KPR, sensitivity was at least 10 dB lower. 2D-S was not receiving the UDP broadcast. PCASP still not working correctly	2121-2214	1.0	Tom Drew Yazhe Hu Larry Oolman Shreta Ghimir
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Flight Hours		As of May 07, 2019, 20.8 out of 14 research hours were flown, -6.8 remain.		Test: 3.4	

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TECPEC RF 8

Weather: Synoptic scale precipitation east and north of the Laramie Range brought on by a short-wave trough traveling east across Wyoming. The eastern precipitation, located over Nebraska, was associated with a warm front as well as weak SE upslope flow. Northerly precipitation was associated with the passage of a cold front shortly after takeoff.

Date: 03/29/19, 1:16 – 4:11 PM, Duration: 2 h 55 min.

Crew: Ed, Hunter, Dave, Alice

Legs were flown parallel to Cheyenne Nexrad (KCYS) radials at varying heights to allow for WCR/NexRad comparisons. The first two legs were flown along a radial aligned with Scottsbluff, NE. Leg 1 was flown at 14,000 ft MSL and, following a small flurry of large droplets and graupel, positioned the aircraft in clear air ~3 kft above and below two cloud decks. Intermittent small ice particles were observed, associated with the upper cloud layer. Leg 2 attempted to sample the upper level clouds at 18,000 ft, but cloud was more intermittent than anticipated. Due to the variability of the clouds within flight range, passes to the east were abandoned in favor of the stronger reflectivity signals observed to the north and slightly east of KCYS. Legs 3-7 flew passes between 15-30˚ east of the north KCYS radial, with adjustments made to pass through the strongest KCYS reflectivity. The leg heights varied from18,000 ft (near cloud top) – 9,000 ft. Temperatures varied from -23˚C (18,000ft) to -4˚C (9,000 ft), and a variety ice habits and aggregates were observed in the lower passes with the largest ice measured at ~1.25 mm. Large droplets were observed at the 12,000 ft pass, but icing wasn't a big issue. Possible K-H waves were observed at cloud top in the KPR.

Project: TECPEC-19
29 Mar 2019

Flight: RF08

Notes:

Flight designed to sample cloud microphysics at multiple levels, via vertically stacked passes along radials from CYS radar. We made an inital pass out to Scottsbluff but found too little and too variable cloud coverage, so the majority of the measurements were made north of CYS, following deeper clouds and precip and sampling between 9 and 16 kft. We ended with a low approach at Wheatland, still in enough coverage to have very low visibility on the approach.

Crew: Sigel, Brown, Plummer, Shen; LOD: Morgan

Flight Summary:

UTC Comment

1916 Wheels up

1925 Convection near Cheyenne during our transit, cleared up quickly afterwards. Skirted the main cells but some WCR echoes to ~26 kft.

1930 The main area of precipitation is from Scottsbluff eastward, will try a radial from CYS heading NE to Scottsbluff to sample some cells enroute.

1935 Between thin cloud layers, had some ice falling through flight level.

1940 Cutting through cloud & precipitation while continuing NE.

1950 Between cloud layers; bases above us near 20 kft. Heading back along radial SW at 18 kft to get some samples in previous clouds, considering a radial ~northward from CYS next for better coverage.

2000 Just into cloud - fairly thin and too variable to get multiple good passes.

2005 Thinking is that a NNE radial from CYS will be the best bet locally based on NEXRAD map.

2013 In right turn at CYS VOR, will do first radial at 015 degrees and 18 kft to assess cloud depth.

2023 Had very deep clouds and precipitation along radial with good returns on WCR & KPR, primarily in ice. Turning for return leg SSW at 16 kft.

2028 Lining on CYS radial, down to 16 kft.

2037 Turning back NNE and stepping down to 14 kft.

2040 At 14 kft, temperatures approximately -14C.

2050 Turning at NE end, stepping down to 12 kft.

2052 Back into cloud droplets near -11C.

2053 Headed SW at 12 kft, -9C.

2105 Turning 90-270 to head back NE.

2109 Heading NE, descending to 9 kft when possible due to traffic.

2114 At 9 kft, -4C, some LWC evident.

2122 Finished leg, ascending up to 10 kft to head to Wheatland for missed approach.

~2124 a couple minutes of substantial liquid, multipixel droplets evident on 2D-S.

2140 Switched WCR and KPR to up transmission only for approach at Wheatland.

2145 Got down to ~0C in approach, stayed fairly high due to low visibility. Returning to base.

2D-S vertical channel blank with some stuck bits as we were exiting clouds - trying to build a mask wasn't working well, could not clear its response. Mostly out of cloud but enough ice to get some measurements in H channel.

2209 Wheels down.

2211 On the ground.

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3/23/19 TECPEC Pilot notes (Research Flight 7)

Crew: Wadsworth, Taylor, Plummer, Wessler

Flight Time: 1.3

Planned: AQ2. Low-level throughout the area west & south of Salt Lake. Changed the original AQ2 route to stay out of the Class B surface area.

Actual:
Routing filed: AQ 2, VFR. Put the lat/long of all the points into the routing.

Call the tower supervisor & emailed him the screenshot of the planned routing. Called TMU about an hour before takeoff to updated.

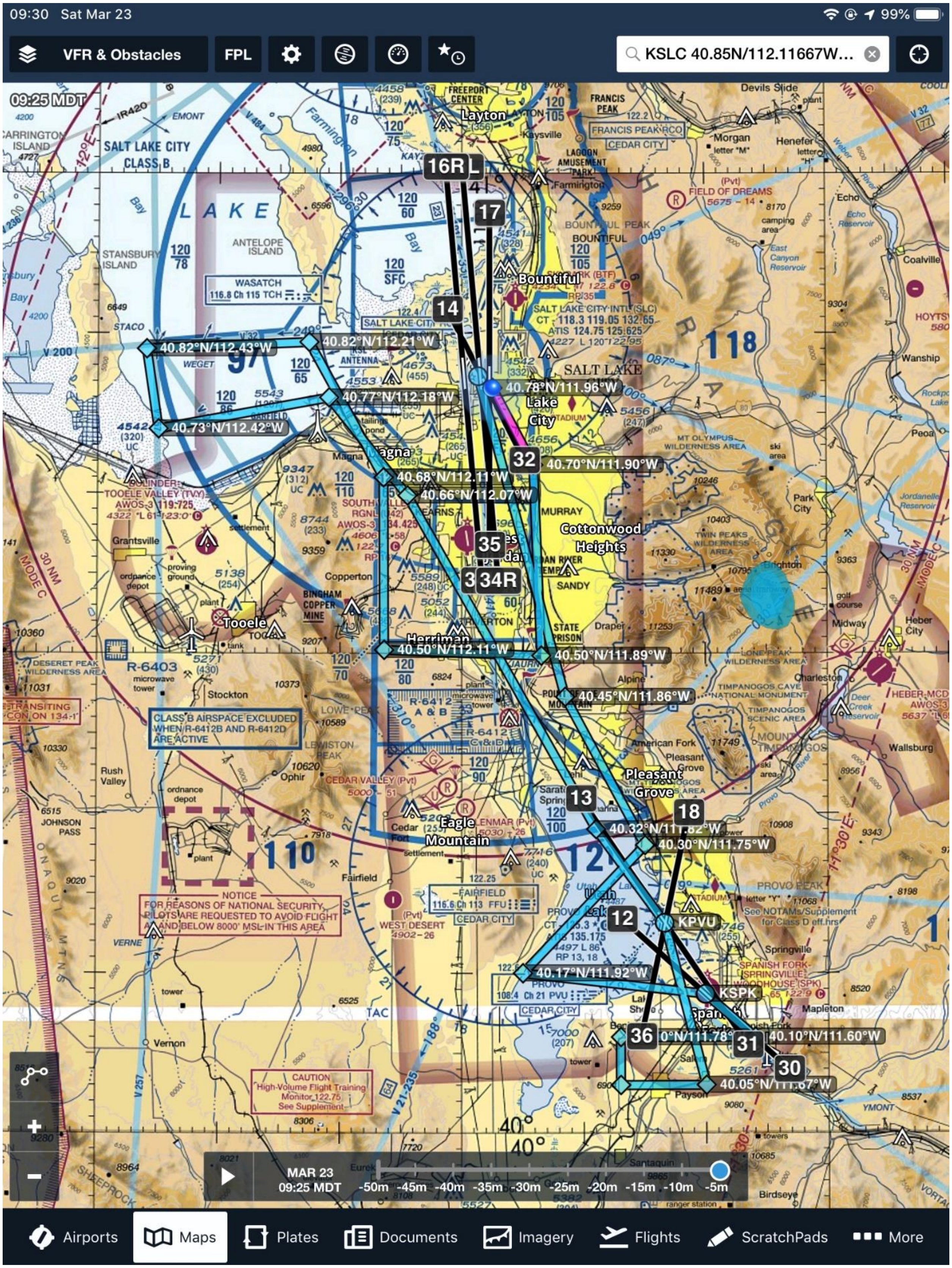
Area south of KSLC, around KU42 (Salt Lake Muni) was very busy. A ton of VFR traffic. Was sandwiched below the bottom of the class B airspace and 1000' AGL min altitude. Not a great location to work in. On leg to NW heading for the lake, there was VFR traffic coming the opposite direction at 5900'. Never saw him, but Departure cleared us up into the Class B to deconflict.

Did a low approach at Provo. Received a go-around as our interval traffic was still on the runway.

Set up for a low approach at Spanish Fork. There were two GA singles doing pattern work there. On the low approach we offset to the side of the runway as again, our interval was still on the runway.

A large number of big birds throughout the entire area.

Again a busy flight in the areas near the airfields.


09:30 Sat Mar 23
99%
VFR & Obstacles
FPL
KSLC 40.85N/112.11667W...
09:25 MDT
SALT LAKE CITY CLASS B
LAKE
Layton
16R
L
17
14
Bountiful
40.82°N/112.43°W
40.82°N/112.21°W
40.77°N/112.18°W
40.73°N/112.42°W
40.78°N/111.96°W
Salt Lake City
32
40.70°N/111.90°W
40.68°N/112.11°W
40.66°N/112.07°W
Cottonwood Heights
35
34R
Tooele
Herriman
40.50°N/112.11°W
40.50°N/111.89°W
40.45°N/111.86°W
CLASS B AIRSPACE EXCLUDED WHEN R-6412B AND R-6412D ARE ACTIVE
13
Pleasant Grove
18
40.32°N/111.82°W
40.30°N/111.75°W
Eagle Mountain
NOTICE
FOR REASONS OF NATIONAL SECURITY, PILOTS ARE REQUESTED TO AVOID FLIGHT IN AND BELOW 8000' MSL IN THIS AREA
12
KPVU
40.17°N/111.92°W
KSPK
36
31
30
40.10°N/111.60°W
40.05°N/111.67°W
CAUTION
High-Volume Flight Training
Monitor 122.75
See Supplement
MAR 23
09:25 MDT
-50m -45m -40m -35m -30m -25m -20m -15m -10m -5m
Airports
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Documents
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ScratchPads
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TECPEC RF 07

Objective: Air quality flight over the Salt Lake and Utah valleys

Date: 03/23/2019 (Takeoff 11:01 MDT, Touchdown 12:12 MDT, Duration 1 h 11 m)

Crew: Brett Wadsworth, David Plummer, Michael Wessler, Zac Thayn

Synoptic: Low amplitude shortwave ridge axis moving through this morning with broad negatively tilted trough now well off to the east. Widespread stratiform cloud over the region spreading in from the SW and all quiet on radar. Morning sounding at KSLC well-mixed to 3 km with a layer of drier air just above surface. Weak NW flow aloft, weak southerly within the boundary layer.

Notes: Flew AQ2 flight plan with focus on WCL and in-situ CO2 and aerosol sampling in daytime boundary layer. Exited KSLC to the S. Made the initial pass over I-15 to south end of the valley before flying along Bacchus highway north to the southern extent of the lake, did not extend to repeat flyover of Mag. corp. Noted uptick in CO2 and shift in aerosol size distribution passing Lake Point and Kennecott Power. Slight visible haze over Sandy and Draper at SE corner of Salt Lake valley. Increased cloudiness in the area, more convectively active than to the north. Occasional, but slight turbulence. Little else of note over Utah Lake and the Utah valley. Return flight followed I-15 from the Traverse Range to Rose Park before banking and descending to land. Altitude varied through the end of the leg for other traffic.

Majority of track was flown at 5500-6500 ft AMSL with the exception of the missed approaches at KPVU, U77, lots of VFR traffic out. Observed very light southerly flow 5-10 kts throughout the Salt Lake valley with variable winds throughout Utah valley. Missed approaches provide some vertical profiles of met data in addition to single balloon launch near I-15 in Sandy at 12:00 PM. Sounding launch was well coordinated with King Air flyover. No known issues with instrumentation.

3/22/19 TECPEC Pilot notes (Research Flight 6)

Crew: Wadsworth, Ed Zipser, Plummer,Eric Besill

Flight Time: 3.1

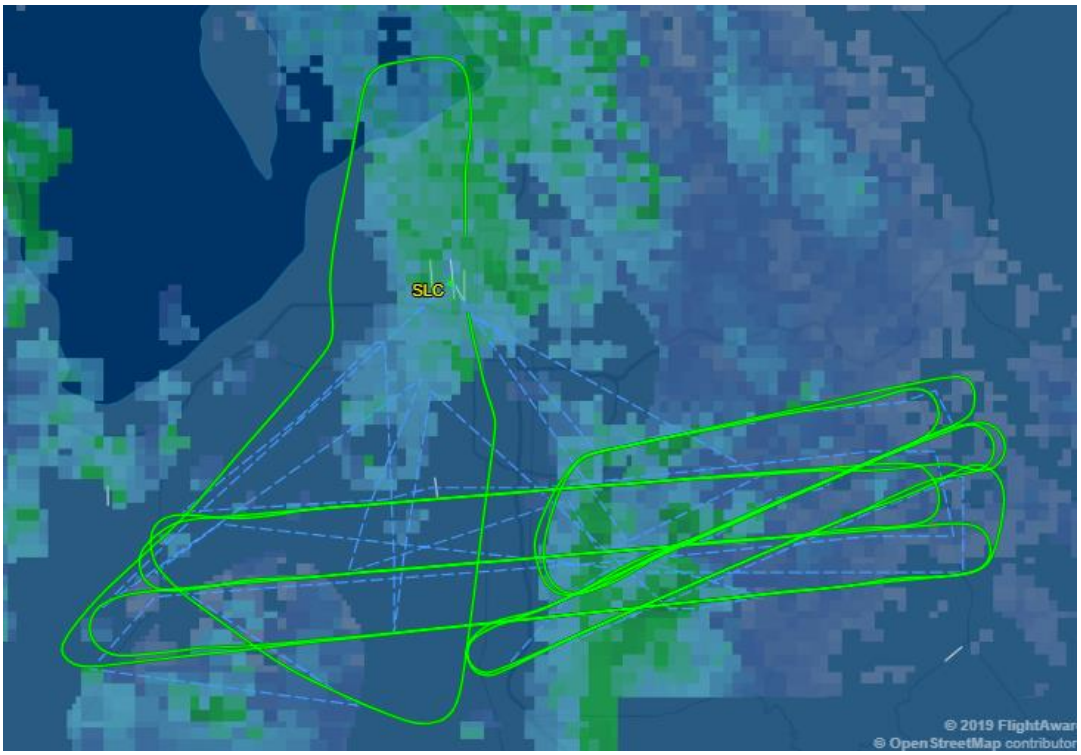
Planned: Pattern as shown below – basically. A significantly tweaked version of a couple of the OP patterns near Salt Lake.

Actual:
Routing filed: Put the lat/long of all the points into the routing. Sent graphic & points to tower supervisor. Called TMU to talk with the duty guy. Very helpful.

Sending a digital image of the route with labels on the points greatly helped. Used these labels (A1 – A6, B1-B6) to describe what we wanted to do. Went easy & well. Weather was not what was expected. Minimal icing.

On RTB, was vectored to intercept the ILS 17.

Overall a good, easy flight.



King Air RF06 22 March, SLC - SLC Rough notes by Ed Zipser (right seat) All times UTC

1956: Start taxi 2007: Liftoff 230850: Land

~2020 - 2033: Leg 1 A1 - A2
~ 203430 - 2047: Leg 2 A4 - A3
204845 - 210100 : Leg 3 A5 - A6
~2105 - 211140: Leg 4: B6 - B5
211310 - 211940: Leg 5: B3 - B4
212100 - Leg 6: B2 - B1
212930 - 213510: Leg 7: B5 - B6
213630 - 214435: Leg 8: B4 -B3
~2147 - 215320: Leg 9: B3 - B4 (?)
215500 - 220230: Leg 10: B2 -B1
220310 - 220920: Leg 11: B3 - B4
221125 - 2224 Leg 12: A2 - A1
222520 - 2237: Leg 13: A3 - A4
223815 - 2253: Leg 14: A6 - A5

Weather, etc. comments:

On initial climb, enter thin cloud 8-9000 ft.
2032: exited cloud, Td dropped from -18 to -19.5 but T -Td always > 4°C. Why when we were in cloud quite a lot?
203430: Can see ground in turn, hazy but with breaks
203610 -203615: Some light turbulence
2038: Smooth now, bright, hazy
2042: Approaching Oquirrhs - not so bright
2047: Leg 2 disappointing - little sign of echo or non-zero vertical velocity. Bright sun here.
2056-57 over Wasatch - within 1 km of terrain but no bumps until 205830 - 2059 - a few; bright
205940 - 205959: Some light turbulence
2100 - 2103: Can see ground, halo above
2105 - 2108 bright, still see halo
210940: Multiple layers of W on radar above and below us
212220: Sunny, bright halo
213510: bright sun

2155: blue sky patches above, some cirrus, still halo
2200 - 2203: T/Td about -12.5/-15.5; wind veering to 290 and at times 300/~15 knots
but returned to 280/13 a few minutes later
221635: 290/17kts, -12.5/-15.5
2220: only few clouds here, blue sky, downslope flow?
222120: 300/19 kt, -12.3/-15.5
2224: At A1 took photo of blue sky and bright sunshine here
~2226: enter some cloud, few light bumps, pilot notes trace of ice on wing
222835: 312/17 kt, -12.2/-15.7
Question: why is pilots radar (and WSR-88D) radar showing echoes here and ahead of us? Showing lots of ground clutter??? Picking up high peaks?
223330: 306/19 kt -12.5/-15.5
223815: Over A6, wind here closer to 275/12 kt
2241: Now 291/19.5 kt, -12.3/-15.8
2242-43: 294/21 kt
224350 - 224630: Getting brighter, lots of blue sky
224820: A few very slight bumps; some banded clouds oriented N-S just above us. Lee or K-H waves?
224925: More light bumps, maybe touching thin clouds
2250: No more thin clouds near our altitude
2251: Smooth. Surface visible.
2253: End of leg; photo of scattered clouds in turn.
2254: Heading 030 degrees; can see Oquirrhs through thin clouds below and east of us
2300 - 2304: in thick clouds on descent from FL 130 - FL 080. breaking below clouds and into light rain
230850: Land in light rain.

Project: TECPEC-19
22 Mar 2019

Flight: RF06

Notes:

Repeated passes at 14 kft along two sets of legs, over Wasatch Range centered near Sandy, UT. System weaker than expected; while we were in cloud much of the time, orographic wave development was weak.

Note: continued zero response on noseboom heat. Final system data file corrupted - right around end of final research leg. A sporadic KPR server error midway through the flight.

Crew: Wadsworth, Zipser, Plummer, Betsill; LOD: Little

Flight Summary:

UTC Comment

2007 Wheels up

2020 Starting first eastbound leg at 14 kft. Weak waves observed in velocity at FL, increasing in strength in eastern half of leg.

2034 On westbound leg, stepped south from first leg. Vertical velocity trace 1-2 m/s towards east end of leg.

2046 At west end of second leg, continue to see weaker structure on radar and vertical winds as we move west.

2048 On third eastbound leg.

2057 Note that 2DS filesize was not updating - looks like it was an issue refreshing, but reset 2DS software.

2100 At east end, will just focus on shorter eastern legs for now since not much activity on long legs.

2102 Start first short leg, heading southwest.

2111 At end, turning for second (northeast-bound) leg.

2113 On NE leg.

2120 Heading SW on northernmost short leg.

2129 On line, for repeat of short legs.

2136 On second leg.

2154 Start of last leg in pattern.

2209 Moving back to first set of legs.

2211 Heading westbound along first longer leg.

2225 Return eastbound on 2nd longer leg

2238 Start final leg, westbound. Note a KPR IO error on switching to 30-m configuration.

2252 End final leg and return to base.

2307 On the ground.

3/21/19 TECPEC Pilot notes (Research Flight 5)

Crew: Wadsworth, Lin, Plummer, Chris

Flight Time: 1.9

Planned: AQ1. Low-level throughout the Salt Lake area

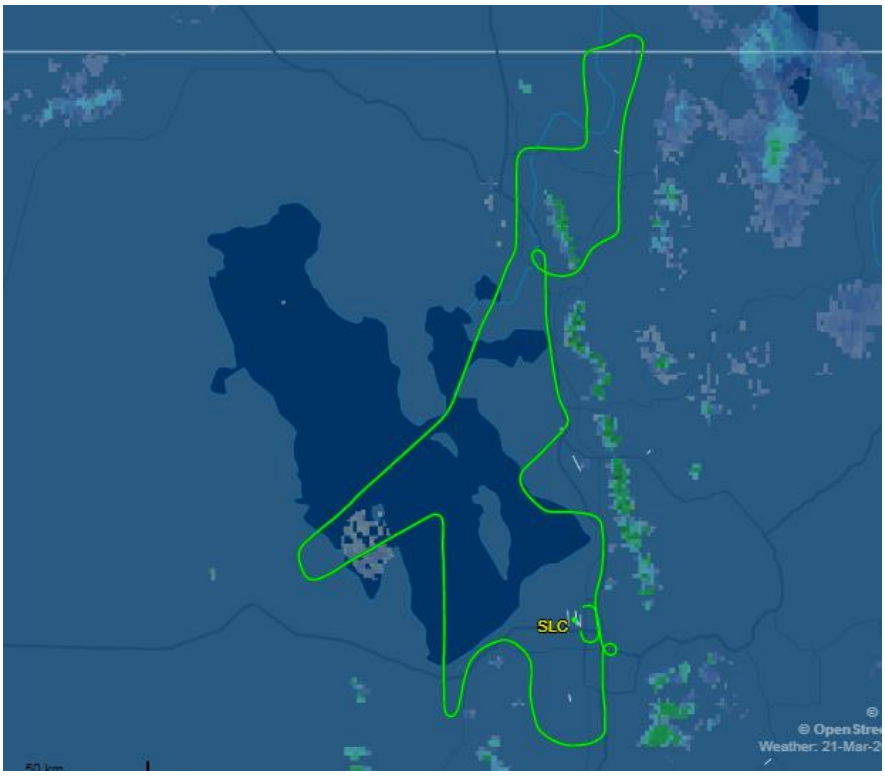
Actual:
Routing filed: AQ 1, VFR. Put the lat/long of all the points into the routing.

Clearance received was "Cleared to depart the Class B airspace VFR, maintain 5000'." On takeoff on 17, tower gave me a left turn to track north on I-15 out of the Class B. There was a bugsmasher in front of us which we were rapidly catching. Had to climb when just out of the B airspace to avoid. Was also trying to get clearance across the approach corridor to the west side of it to commence the desired routing. Departure handed us off to Approach who cleared us with a vector to the other side.

After that, the traffic issues decreased rapidly. The low approaches at the four airports were easy. Ogden had the only manned tower. Lot's of big birds throughout the area. On the southern end of the route it got a little more interesting as we adjusted to the north end of the Oquirrh Mountains, then turned back to the south when to the east side of them. We got a little squeezed in altitude as we remained west of the South Valley Regional airport, we squeezed up against the bottom of the class B airspace when trying to remain above 1000' AGL. Approach Control was very helpful.

Got to the east side of the departure corridor, then were complete. Approach passed us to Tower. Tower told us to maintain 6000' and follow I-15 northbound. They had to give us one 360 turn over the city for spacing on our interval to land.

Busy flight – particularly within 15 miles of KSLC. Otherwise it went well.


SLC

3/21/19 TECPEC Pilot notes (Research Flight 4)

Crew: Wadsworth, French, Plummer, Lambert

Flight Time: 3.6

Planned: Ferry to KSLC. Some orographic work along the way.

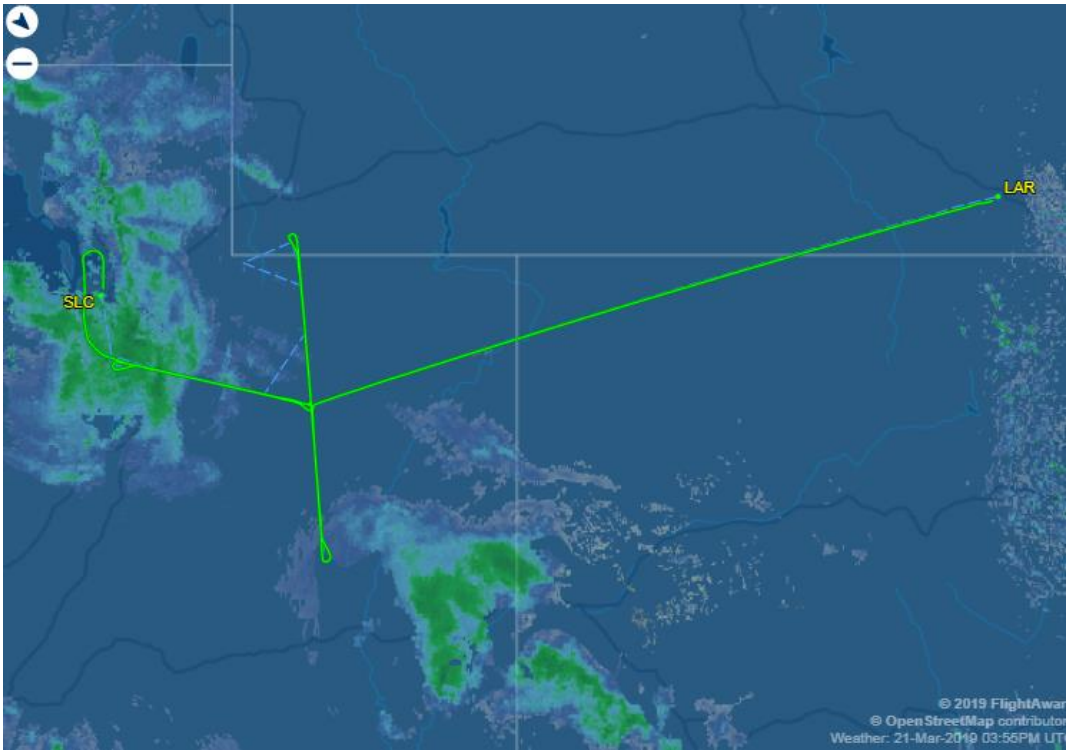
Actual:
Routing filed: As shown below. Filed with lat/long of the cross-pattern. Audibled with Center for repeated legs.

Clearance routing received was “as filed, FL 230”.

Transit to the start of the pattern was mostly in the clear. About an hour to get there. Descended to the low teens for the pattern.

Light icing in spots in the north/south leg. Minimal ice on the western leg.

Routing after complete on the west end was vectors to intercept the ILS to Rwy 17. Was lot’s of traffic on the arrival at that time but it went well.



Project: TECPEC-19
21 Mar 2019

Flight: RF04

Notes:

First flight of day, ferrying to SLC while making research measurements. Did cross pattern with N-S legs between Uinta Range and the Book Cliffs, then headed west over the Wasatch range before landing at SLC.

KPR showed server I/O errors on startup and after multiple power cycles. Was able to succesfully restart enroute; spent the flight changing through multiple configurations. Largely worked well with one additional error on changing configuration midflight.

Crew: Wadsworth, French, Plummer, Lambert; LOD: Little

Flight Summary:

UTC Comment

1411 Wheels up - plan for ferrying out at 23 kft.

1454 PCASP had noisy first bin early on, now large concs in multiple lower bins, 20000+ cm3

1456 Skirting top of cloud layer, near -30C.

1507 KPR showing echoes in cloud, particularly below.

1517 Turning for first southbound leg at 16 kft.

Deep clouds through 6 km above on WCR, -12 to -13C with only a blip of liquid on CDP.

1525 Skimming tops of lower layer, supercooled droplets evident. Temperatures still near -13C.

1535 At southern end, turning north.

1538 Northbound at 15 kft, will climb at halfway point for Uinta terrain.

1548 At original turn point and continuing north, will climb to 16 kft for remainder of northbound leg.

1559 Clearing up quickly as we move north of terrain, will stay at 16 kft when we return south as tops are near or below FL. Good lee wave evident in vertical wind structure.

1603 At northern end, return south to original point at 16 kft.

KPR errored out again just after changing config file to 75-m and starting recording.

1609 KPR up again, tried out a few configurations and seems to be working.

1624 turning westbound for final sets of passes.

Out at 16 kft, back east at 15 kft, then 14 kft if possible going westbound.

1642 At west end, reversing east at 15 kft.

1703 At east end, reversing west at 14 kft then to SLC.

Switched KPR & WCR to up only for descent, drizzle likely.

1739 Drizzle/raindrops evident on 2D-S.

1741 On the ground.

3/14/19 TECPEC **Pilot notes (Research Flight 3)**

Crew: Drew, Grasmick, Oolman, Zhang

Flight Time: 2.3

Planned: Takeoff at 14:00 when airport is scheduled to open, Fly to a point NW of Storm Peak and set an along wind track over Storm Peak. Make multiple stacks and a sounding over Storm Peak and then fly the IAP into KSBS

Actual: Took off at 14:00, picked up IFR on the ground, climbed to first waypoint and turned SE over Storm Peak. Over most of the clouds at 16,000 ft. MSL. Flew first leg and descended to 14,500 during the first turn. Made an additional leg north and south and then turned to the IAP for the RNAV approach into KSBS. After flying published missed, went back to Storm Peak and did a spiral up to FL 230. Made an additional track down and up along the line at FL 230. Reaching the north end descended to 16,000 ft. MSL heading 350. Then decided to turn towards MBP at 14,000 ft. MSL. After crossing over MBP turned north and then south east towards Sheep Mountain, but could not find dense enough clouds. Returned to KLAR VFR.

TECPEC RF 3

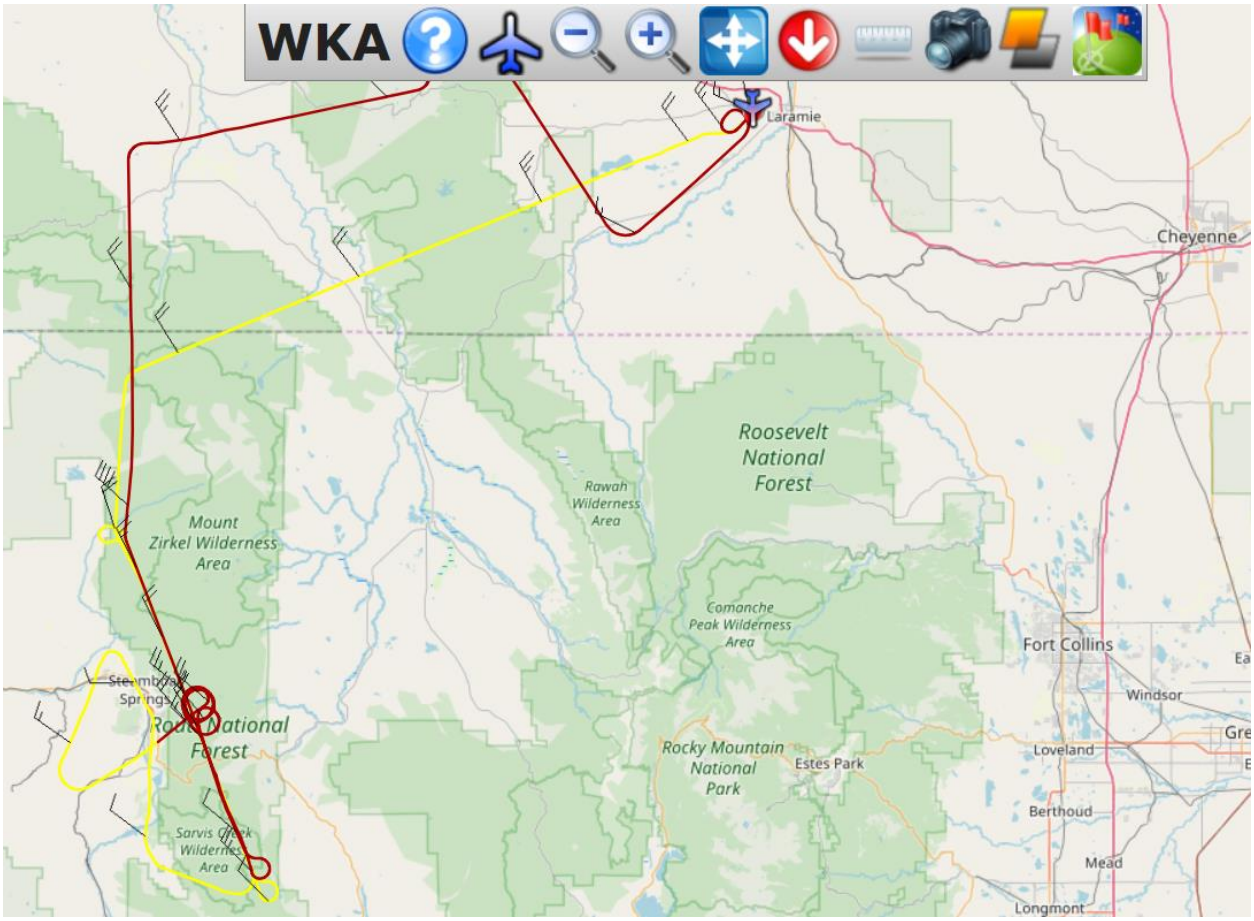
Lingering orographic clouds/precipitation after a deep midlatitude cyclone that brought extended blizzard conditions to NE Colorado and SE WY.

Date: 03/14/19, take off at 2 pm. Duration: 2 h 20 min.
Crew: Tom, Coltin, Larry, Meng

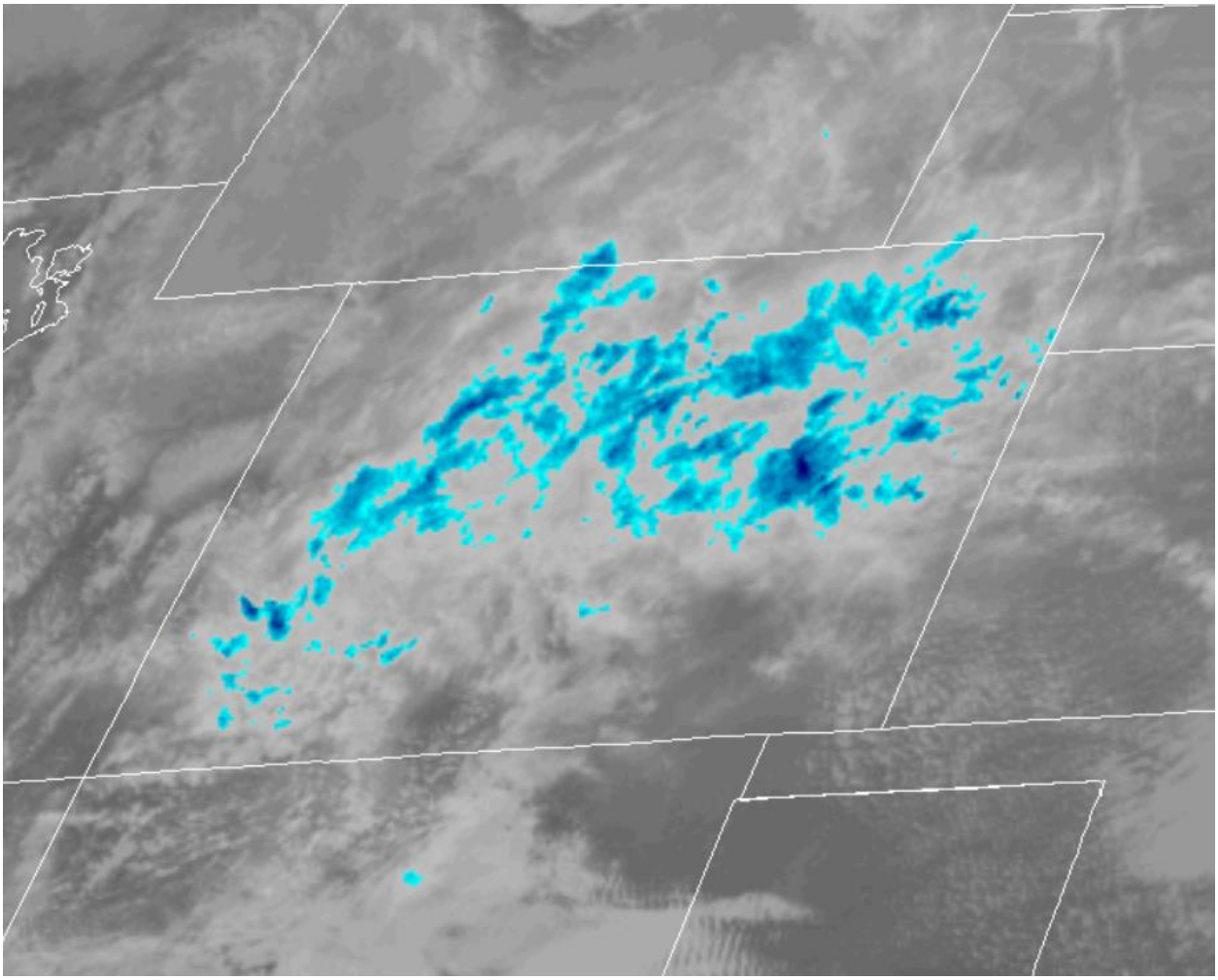
Multiple flight maneuvers beginning with 3 legs over Storm Peak Lab. Shallow clouds existed just below flight-level (14,500 ft, the lowest we could go) beneath a dry/stable layer. Flight track was aligned with a 320-330 deg wind. At about 3pm we did a missed approach at the Steamboat Springs airport where we flew through a few clouds but it was mostly clear over Steamboat. We then returned to SPL for a spiral from 14,500 up to ~23,000 ft where there was a thin upper cloud layer. After two legs through this cloud (on top of the previous flight legs) We moved north in search of deeper clouds over the higher terrain. Unfortunately, conditions seemed to be drying out so after a bit of cloud hopping from the Sierra Madre to the Snowy Range, and Sheep Mountain we returned to Laramie, landing just before 4:20.

Synoptic Conditions: Orographic clouds in NNW flow between the exiting trough/cyclone to the east and building shortwave ridge to the west.

No balloon sounding for this flight but sounding information is available from both the missed approach and spiral.



Flight Track



IR Satellite from 2207 UTC: Blue, higher cloud tops are visible above Park Range and the Sierra Madre.

3/8/19 TECPEC **Pilot notes (Research Flight 2)**

Crew: Drew, Majewski, Oolman, Lin

Flight Time: 2.6

Planned: Takeoff at 12:00, Fly OP 5 line NE of Snowies, over Sierra Madre's and Elk head and reverse. Start at 16,000 ft. MSL descend to 15,000. Shorten the legs to just the Medicine Bow Range and do a rising vertical stack with a spiral on the SW side.

Actual: Took off at 12:00 picked up IFR on the ground climbed to first waypoint and turned SW. Little ice over the Snowies. After established back northeast descended to 15,000 until NE point then stepped up to FL 180 in 1000 ft. increments each leg. Descended from FL 180 west of Medicine Bow and completed last leg at 14000. Then flew the RNAV 12 into Laramie.

Flight Scientist Summary

Author: Adam Majewski

Date/Time: 2019-03-08 19:00:00 UTC

Summary of Operations:

TECPEC RF02:

Weather: This research flight targeted prefrontal embedded convection ahead of a slow-moving cold front. Flight level flow was Southwesterly with little directional shear predicted in the vertical based on pre-flight model guidance.

Flight Summary: The flight took approximately 2.4 hrs and followed flight track OP5. The first two legs covered the entire flight track, and then several stacks were flown back and forth over Medicine Bow Peak (MBP). Very light ice was encountered, mostly in pockets of SLW during the first leg, and with little to no rollback even when CWC was greater than 0.4 g/m^3 at -12 °C. The cloud was mostly ice—the pockets of SLW encountered seemed to be located near the top of the lower cloud layer in the earlier legs and within convective updrafts during later legs. Ice encountered ranged from small ice to large aggregates. Flight level temperatures ranged from -10 to -17 °C.

Leg	Times (UTC)	Dir.	Alt. (kft)	Notes
1	19:10-19:39	SW	16	Whole length flight track, SLW/light icing around 19:17. Split layer for much of leg
2	19:44-20:03	NE	15	Up/down couplet near MBP
3	20:07-20:18	SW	14	Begin short legs over just MBP
4	20:21-20:28	NE	15	Clear over Saratoga Valley (Vis. to ground)
5	20:32-20:43	SW	16	Clear over Saratoga Valley
6	20:46-20:52	NE	17	
7	20:56-21:08	SW	18	Spiral down in place at SW end of leg
8	21:12-21:14	NE	14	

3/6/19 TECPEC **Pilot notes (Research Flight 1)**

Crew: Drew, Geerts, Oolman, Hatt

Flight Time: 1.4

Planned: Takeoff at 13:00, Fly OP 5 line NE of Snowies, over Sierra Madre's and Elk ridge then East to Park Range and reverse. Start at 16,000 descend to 15,000 then 14,000.

Actual: Took off at 13:00 picked up IFR on the ground climbed to first waypoint and turned SW. Little ice over the Snowies, descended to 15,000 over the Sierra Madre's but traffic was very busy in and out of Hayden with airliners and corporate jets. Over Sierra Madre's at 15,000 started to pick up significant ice droplet sizes getting larger and larger. As we approached the waypoint I asked for 16,000 due to the large drop sizes. At max power, I reported severe icing and asked for a block altitude MIA to FL180. He was unable due to the traffic at Hayden, but gave me 16,000-FL180. Continuing SW put us in clear air so I climbed very slowly to FL 210 after getting block FL190-FL210. Then reversed course and rejoined OP5 line back to LAR. Over MBP started descent into the LAR valley, on the RNAV 12. Landed LAR.

TECPEC RF 1

Orographic Precip flight in the remnants of a strong Atmospheric River.

Date: 3/6/19, take-off scheduled 1 pm , actual take-off 1:03 pm. Duration 1 hr 20 min.
Crew: Tom, Bart, Larry, Melinda

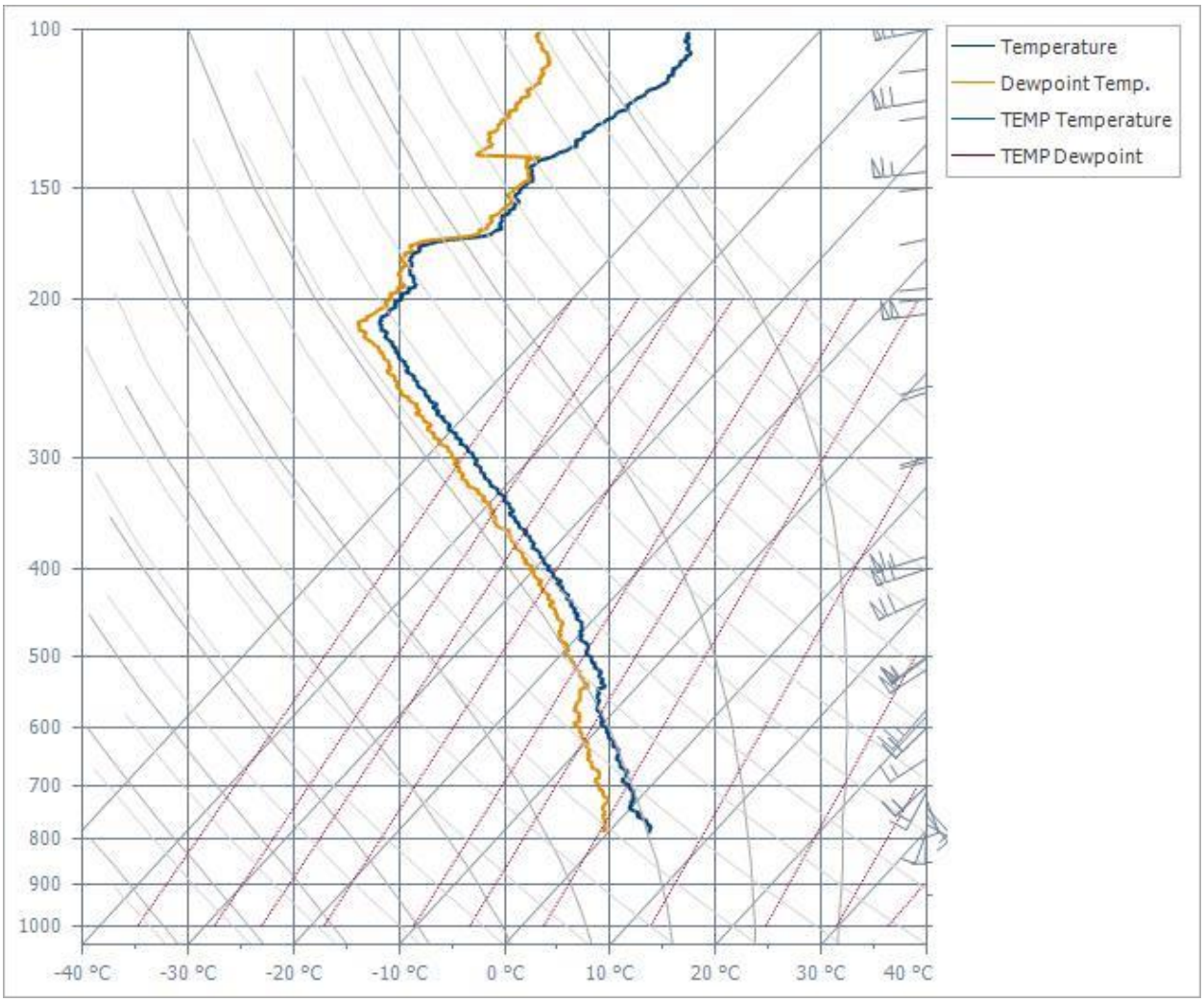
Two long legs over three mountain ranges (Med Bows, Sierra Madre, and Elkhead range). Flight leg to the SW at 16 kft over the Med Bows (~-10°C), then at 15 kft (~-8°C) the rest of the way. Strong headwinds at flight level. Strong WCR returns along most of the flight leg. Cloud was deep, deepest (~10 km MSL) over the Med Bows, more shallow to the SW. Some supercooled liquid water over the Sierra Madre, more SLW with large drops encountered near the SW end of the leg, upwind of the Elkhead range. The original plan was to add a back & forth leg over the Park Range at the location of the Storm Peak Lab since some data were being collected there (CIP, PIP, MRR), but because of excessive airframe icing it was decided to fly back the length of the leg at 21,000 ft. This level was above cloud at first, but in cloud over the SM and MB ranges. Descent into Laramie started over the Med Bows, mostly on the lee side of the mountains.

Altogether a successful shakedown mission. Excellent WCR data

Synoptic conditions:
Remnants of a strong Atmospheric River, overrunning the cold air that had been present the day before. Strong jet stream just south of the track. The wide precip band was associated with a vort max at upper levels.

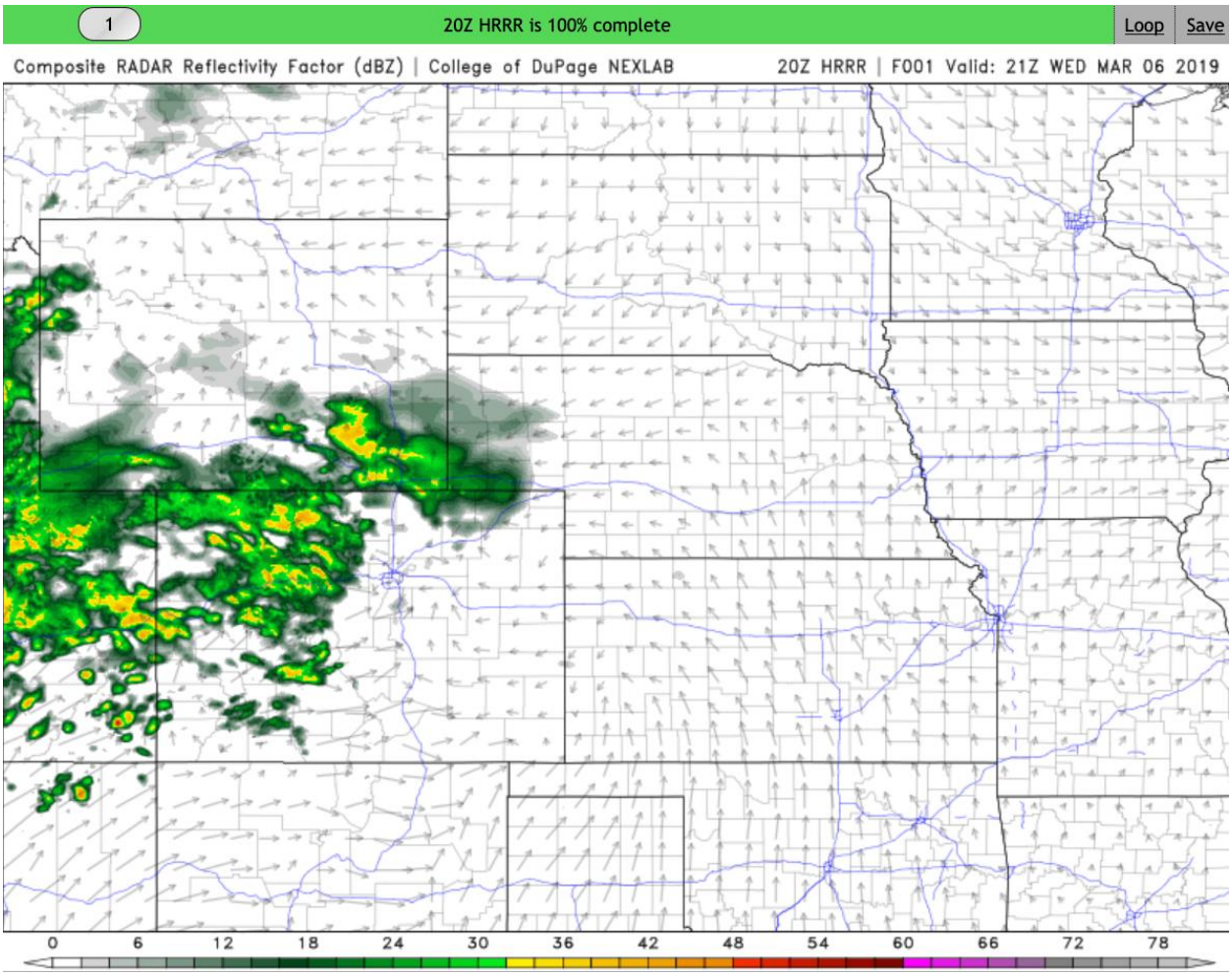
Skew T from Saratoga and some images off the web on the next few pages.

Also some photos from the flight



Radiosonde sounding from Saratoga during the flight (launch time: 20:41 UTC)


LAR
20 km
20 mi
Past Flight
Replay
Speed 10x
Loop Off


1
20Z HRRR is 100% complete
Loop
Save
Composite RADAR Reflectivity Factor (dBZ) | College of DuPage NEXLAB
20Z HRRR | F001 Valid: 21Z WED MAR 06 2019
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6
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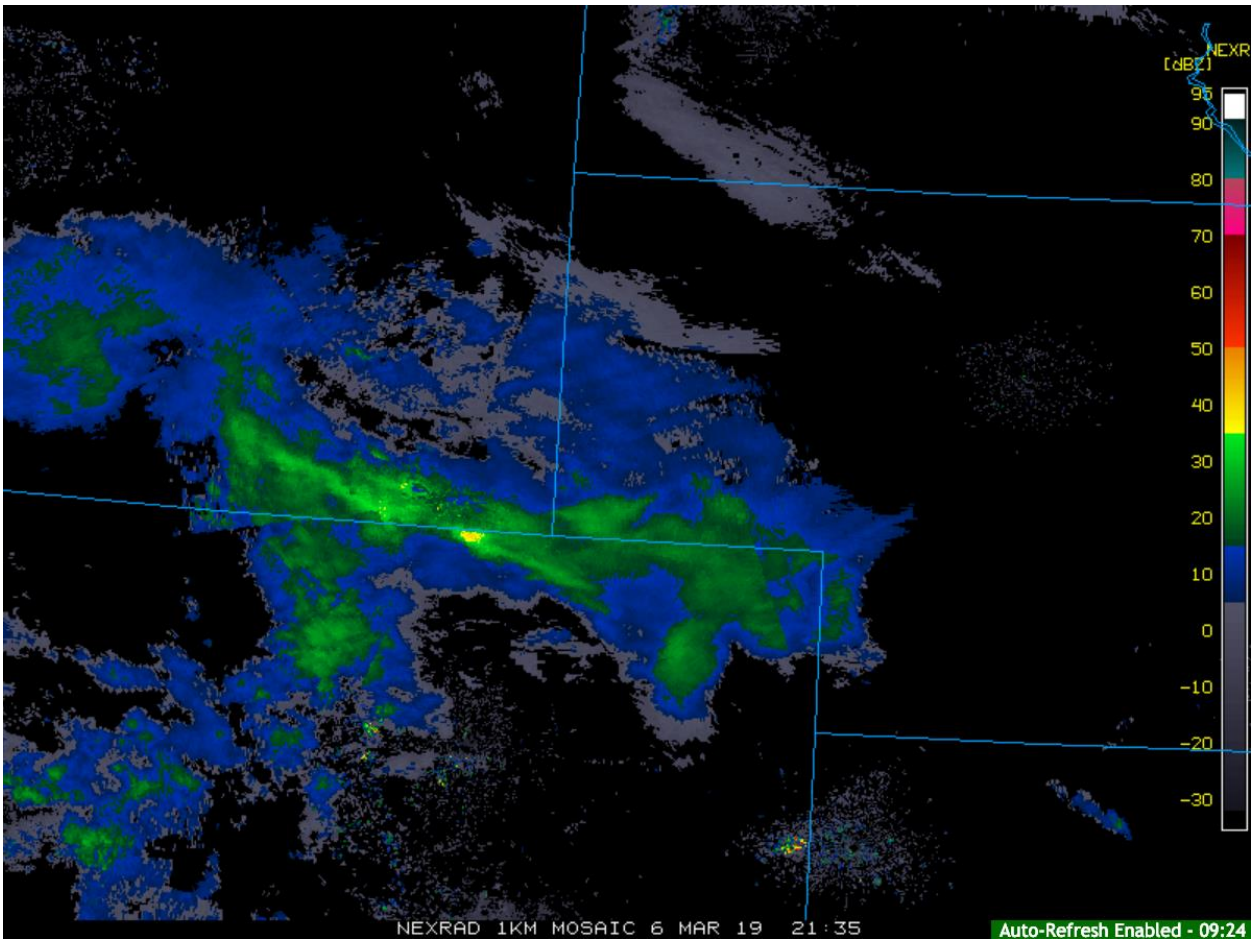
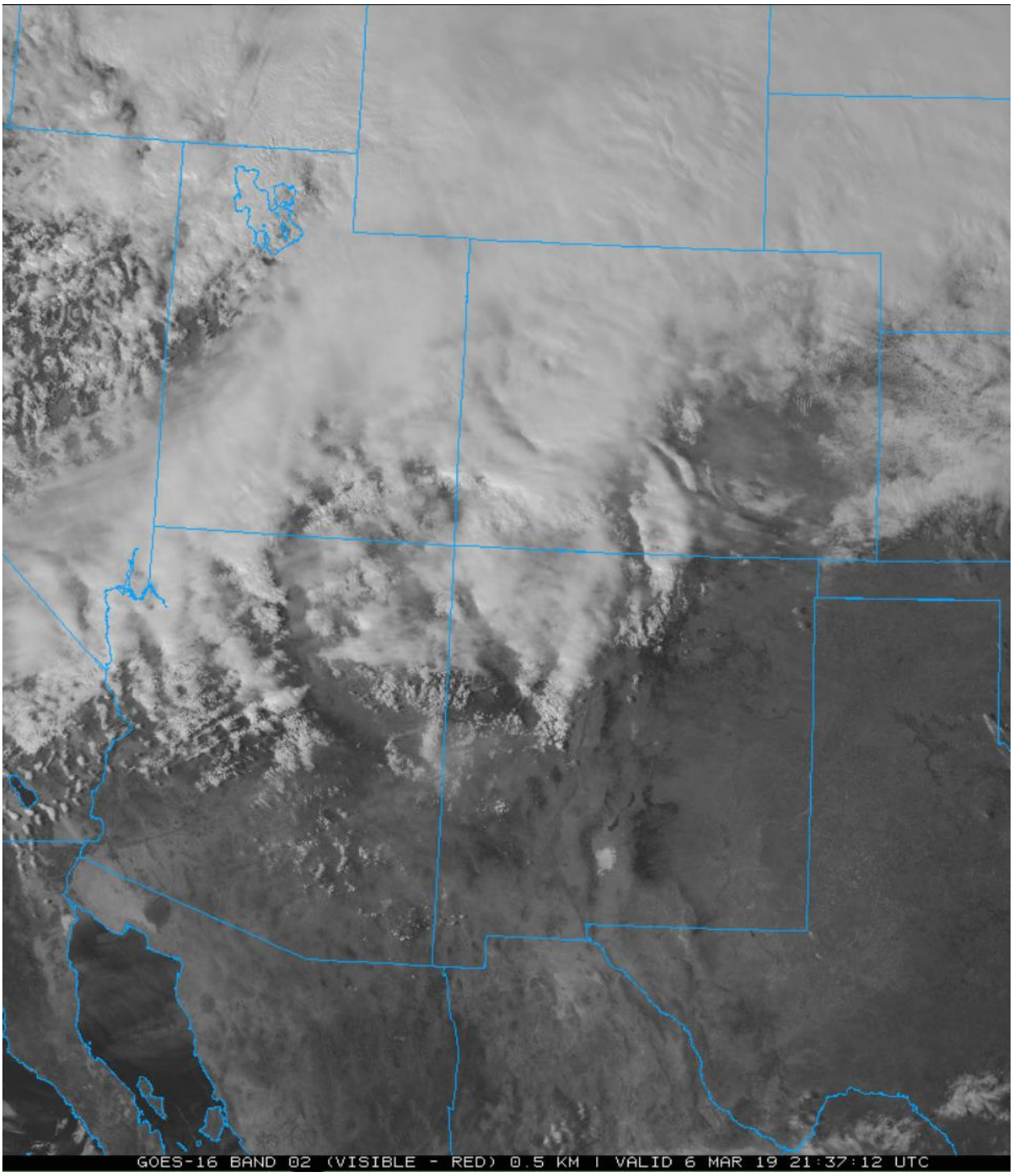
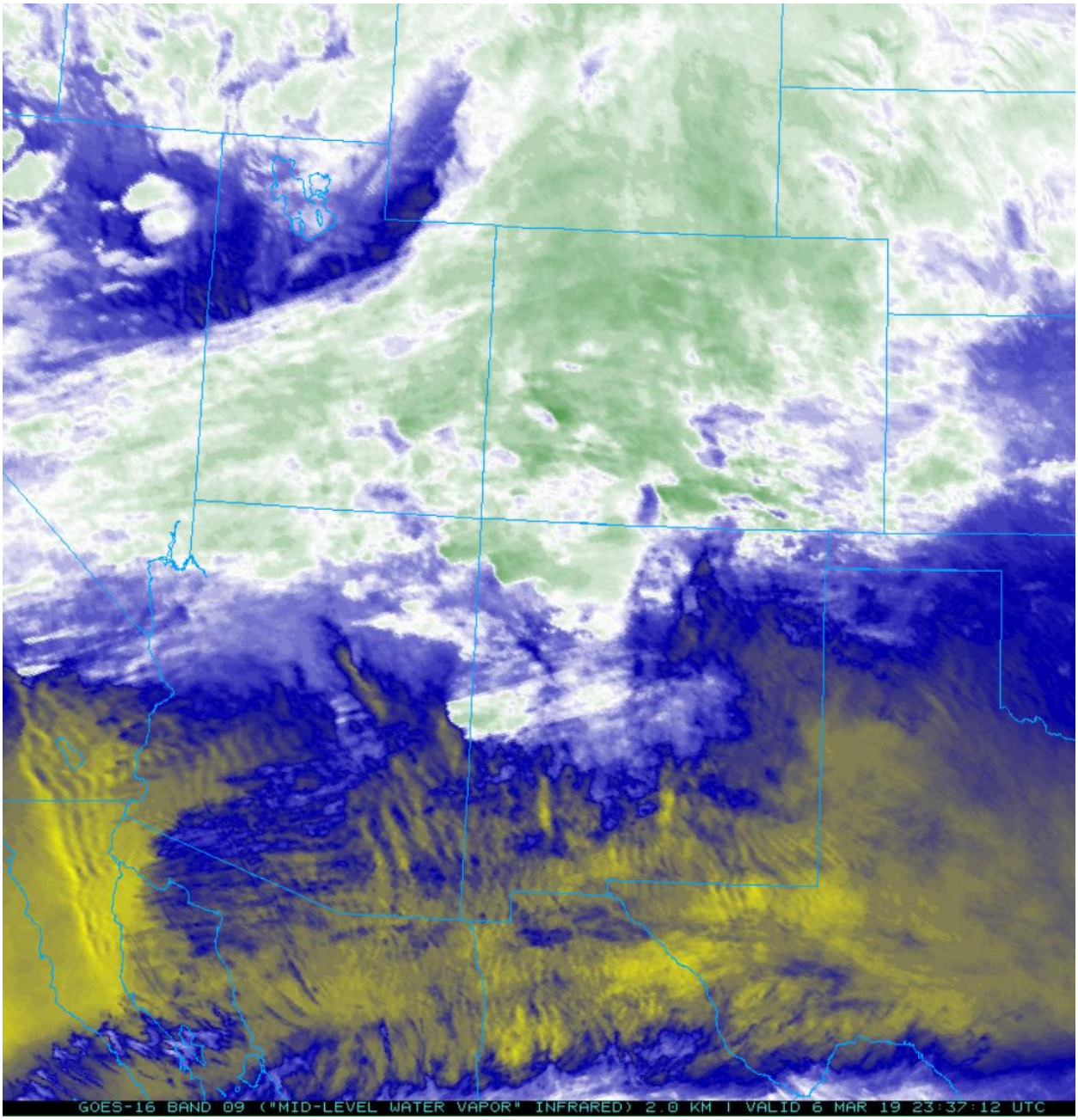
18
24
30
36
42
48
54
60
66
72
78


NEXR
[dBZ]
95
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
NEXRAD 1KM MOSAIC 6 MAR 19 21:35
Auto-Refresh Enabled - 09:24


GOES-16 BAND 02 (VISIBLE - RED) 0.5 KM | VALID 6 MAR 19 21:37:12 UTC


GOES-16 BAND 09 ("MID-LEVEL WATER VAPOR" INFRARED) 2.0 KM | VALID 6 MAR 19 23:37:12 UTC


DONALD L. VEAL

TECPEC RF01 – 6 March 2019

Tom Drew Bart Geert, Larry Oolman, Melinda Hatt, Brent Glover (LOD)

2003 Take off
2028 CDP drop size around 40 microns, LWC about 0.2. Over the Sierra Madre
2036 LWC100 power is intermittent
2041 200-300 micron drops on 2D-S, near cloud top north of Craig, CO. Aircraft is losing performance. Climb and head home.
2121 Land