

TEST FLIGHTS FOR AMMONIA PHASE PARTITIONING AND TRANSPORT (APART-LITE)

University of Wyoming King Air Research

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Abstract

Ammonia (NH₃) is receiving significant increased attention nationally (and internationally) because it is an unregulated air pollutant that contributes to fine particle formation and nitrogen deposition. However, our observations of the atmospheric sources, sinks, and phase partitioning of NH₃ is limited compared to other major anthropogenic pollutants. In contrast to declining emissions of nitrogen oxides (NO_x) from combustion sources, the emissions of NH₃ from fertilizer applications and livestock production have grown in the U.S. As a result, the deposition of reduced nitrogen species (e.g., NH_x) in the U.S. has increased, and future progress in reducing the impact of nitrogen deposition will require decreasing emissions of NH₃ from agricultural and nonagricultural sources. Optimizing policies around reduced nitrogen has necessitated increased study of atmospheric NH₃ emissions, abundances and loss processes. Here we propose to identify and track gas-phase NH₃ in agriculturally impacted air masses in situ using the University of Wyoming King Air (UWKA) research aircraft. We propose to work in the Colorado Front Range since there are large emission sources of NH₃ from concentrated animal feeding operations and agriculture in northeastern Colorado and abundant meteorological events to transport nitrogen-rich air to the sensitive ecosystems in Rocky Mountain National Park (RMNP).

-  [UWKA flight planning and tracking tools](#)
- [Convert Google Earth points to way points](#)
- [Summary of flights](#)

Date	Flight # (*kml)	Status	Times (UTC)	Hours	Crew/Notes
15 Nov	RF02	Light wind day with strong low level	1857-	4.0	E Sigel D Caulton

Order APART-lite Data

- [Flight Notes](#)
- [King Air 1 Hz netCDF files](#)
- [King Air 1 Hz ICARTT files](#)
- [King Air high rate 10 Hz netCDF files](#)

User Information

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2019		inversion.	2254		L Oolman M McCabe
13 Nov 2019	RF01	Flight with moderate winds	1853- 2258	4.2	T Drew D Caulton L Oolman K Pozsonyi
09 Nov 2019	TF01	Test flight for instruments and to survey the sites.	1831- 2140	2.5	T Drew D Caulton L Oolman I Pollack
Flight Hours		10.7 hours flown			

 Facility User's
Guide

Facility Instruments

-  In Situ
-  Wyoming Cloud
Radar
-  Wyoming Cloud
Lidar

Contact

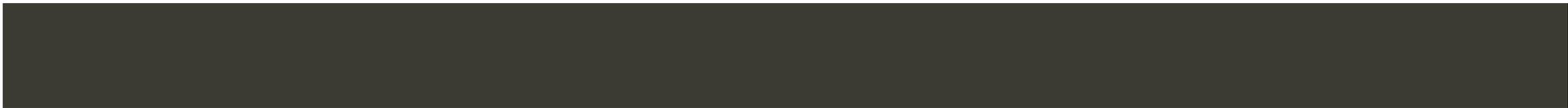
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Campaign Summary

APART-lite Campaign Summary

Flight Date	Hours Flown	Conditions	Sites surveyed	Mass Balance Experiments
11/09/2019	2.5	Clear, warm, weak winds	10	3 at Site #1
11/13/2019	4.2	Clear, warm, strong N – NE winds	6	1 at Site #3 2 at Site #8 2 at Site #9
11/15/2019	4.0	Overcast, warm, weak winds	6	1 at Site #1 1 at Site #6 1 at extra site
Total	10.7		12	11

11/15/19 Pilot notes (RF 2)

Crew: Drew, Caulton, Oolman, McCabe

Flight Time: 4.0

Planned: Depart LAR at 12:00 Climb to 13,500. Go direct to Horton feed lot Northwest. Circle down to 500 feet AGL. Then go to five rivers and do the repeat. After these we would move over to English, Magnum, ending with Cattle Co.

Actual: Departed Laramie at 12:00pm climbed to 13,500 MSL picked up flight following. Few Direct to Horton NW. Slightly over flew the feedlot and came back to it. After coming back to the feed lot and Spiraling down to 500 ft. AGL. We proceeded down wind and spiraled up to 11500. We then asked for the Five rivers feed lot and were denied. So we flew over to the English feed lot and did the same. Next we hit the Magnum feed lot and did not have any readings. We went over to the Cattle Co. feed lot and did low level circles around it and picked up a few reading but it was just to the west of a large coal plant. The readings we compromised. We spotted a feed lot to the west of the Feldpausch feed lot that looked promising and was as we circle. We went down wind of that 3 miles and circled more and then did two strait legs at 500 feet intervals climbing. After hitting the center of the plum we circled up to 11500 and then proceeded back to LAR. Denver was very helpful the whole time and had us on radar and in communications.

Name: Dana Caulton

Date: 11/15/2019

Flight: Test Flight #3

Preflight Brief ~9:00 MT.

Pilot: Ed Sigel. Crew: Dana Caulton, Larry Oolman, Megan McCabe.

Takeoff at 18:57Z.

Gast pump on at 18:56Z.

BL ~12.2 kft

Bkg seems really clean today.

Site #1 Horton Feedlots: Spiral down at 19:24Z. Small NH₃ and CH₄ enhancements. Plume seems to be staying very low. Attempt to do slower spirals with more level legs at ~3 mi downwind. Legs at 6.5, 7.5, 9.5 and 11.5 kft. Local BL ~12 kft.

Site #3 Five Rivers: ATC will not allow access to this site due to the approach direction of incoming air traffic. (S winds in the area).

Site #10 English Feedlot: At site ~20:00Z. Seem to see plumes from Magnum Feedyard (#11) mixed in. High Ethane.

Site #11 Magnum Feedyard: At site ~20:41 Z. You can smell this site. Not much wind.

Site #7 CattlCo: At site at 20:53Z There is a coal plant nearby. Winds put plume directly into power plant plume.

Site #6 Feldpausch Holsteins: At site at 21:04Z. Some CH₄ and NH₃. W winds. Do spiral ~3 mi downwind. Plume stays very low.

Extra site Pinneo: Nearby site (very big) found by Ilana. Spiral down. Do long transect E and seem to capture large enhancements from the area. Plume is staying below 1000 ft above the ground.

Head back at 22:15Z.

Gast pump off at 22:54Z.

Land at 22:55Z.

11/13/19 Pilot notes (RF 1)

Crew: Drew, Caulton, Oolman, Pozsonyi

Flight Time: 4.2

Planned: Ferry at 13,500 MSL to Feedlot #3 Five Rivers. Circle the feedlots, if interesting, move downwind 3nm and conduct spirals up at 3 nm and back down at 6 nm. Then move to #9 Q-Ranch.

Actual: Departed Laramie climbed to 13,500 MSL but had some clouds at that altitude so, descended back down to 11,500 MSL. Just before Greeley, climbed back up to 13,500 MSL. Called Denver Approach northwest of Fort Collins for VFR Flight Following. He wanted a report when we were starting the spiral down. The 3 nm and 6 nm spirals did go through the Denver Class B airspace, but approach cleared us into the Class B. Decided to set up a perpendicular (to the wind) leg at the 6 nm point and flew approximately 10 nm southeast and northwest. Did 1000 ft. steps up after each leg until 8,800 then 10,800 and 12,800 MSL. At the end of the last leg climbed to 15,500 MSL and ferried to #9 Q-ranch. Did a spiral over the lot then made a survey of lots 8, 7, 6 and new coordinates (from chat). That put us close to #7 - Cattle Co. so we moved downwind 3nm and spiraled up to 13,000 and moved to 6 nm and spiraled down. Changed the down spiral to an oval roughly 4 nm long by 2 nm wide (not precise).

Departed Cattle Co and flew to #12 Crow Creek. Canceled Flight Following along the way. Made a survey circle around the lot and then spiraled up to 15,500 MSL before dropping back down to 14,500 MSL for ferry back to Laramie.



Name: Dana Caulton Date: 11/13/2019 Flight: Test Flight #2

Pilot: Tom Drew. Crew: Dana Caulton, Larry Oolman, Kristin Pozsonyi.

Preflight Brief ~10:00 MT.

Takeoff at 11:50 MT. Gast pump on at 11:54 MT.

Site #3 Five Rivers: Observed winds ~210. BL around 1300 ft. Strong CH₄, NH₃ and C₂H₆ signal. Strong wind shear aloft. Winds moving to ~270 at top of BL. Two spirals (at 3 and 6 mi) initially attempted. Unclear if entire plume was captured. Long transect at ~1000 ft spacing until out of plume, 2000 ft spacing above plume.

Site #9 Q Ranch: Get to site at ~14:00 MT. High NH₃. Do spirals ~3 and 6 mi downwind.

Site #8 Teague Enterprises: Get to site at ~14:30 MT.

Site #7 CattlCo: Get to site 21:35 Z. Big site! Return at 21:50 Z. Do 3 + 6 mi spirals/racetracks downwind. Transects might encompass Teague (site #8).

Site #6 Feldpausch Holsteins: Small NH₃ peak

Site #1 Horton Feedlots: Did not visit

Site #12 Crow Creek Cattle: Very isolated and small site. No signal.

Head back to Laramie at 15:35 MT.

Land at 22:58 Z.

Gast pump off at 23:00 Z.

11/9/19 Pilot notes (TF 1)

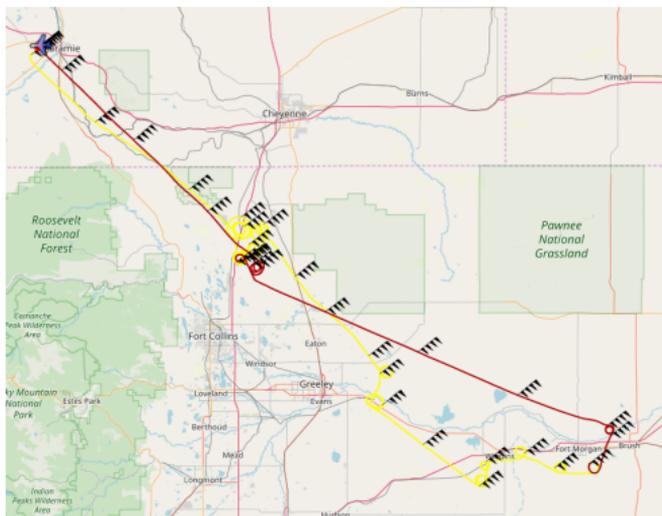
Crew: Drew, Caulton, Oolman, Pollack

Flight Time: 2.5

Planned: Ferry at 13,500. Do a few yaws and climbs and descents for calibration. Circle the feedlots, if interesting move downwind and conduct spirals or perpendicular tracks. Removed #5, #12, #13 off the agenda.

Actual: Departed Laramie climbed to 13,500 MSL and did a few yaws left and right and two climbs/descents to 14,500 MSL and back. Reaching the first site, called Denver approach for flight following. Spiraled down to 500 ft. AGL around feedlot. Moved to the second feedlot and circled it. Moved downwind 3 nm and did a spiral up to 11,000 MSL. Moved 6 nm downwind and did a spiral down to 500 ft. Flew to the next eight sites and just did the initial survey circles between 1000 AGL and 500 AGL.

After finishing circle around site #6 moved back up to site #1 and repeated circle, and moved downwind 3 nm and did spiral up to 11,000 ft. Returned to Laramie.



APART-lite Flight Notes

Name: Dana Caulton Date: 11/9/2019 Flight: Test Flight #1 (Survey Flight)

Pilot: Tom Drew. Crew: Dana Caulton, Larry Oolman, Ilana Pollack.

Briefing at 9:00 MT. Ground startup of instruments at 11:11 MT. Zero with zero air generator.

Takeoff at 11:54 MT. Gast manifold pump on at 11:53 MT.

Do flight maneuvers at 11:59 MT. Yaws first, then climb and descend.

Site #2 Heifer Authority: There is a nearby power plant. Small CH₄ and NH₃ peaks.

Site #1 Horton Feedlots: small but distinct CH₄ peak, ~100 ppb NH₃ peak. Went ~3 mi downwind and spiraled up to top of BL, went to ~6 mi and spiraled down. Revisited site at 20:42Z and spiraled up at ~3 mi.

Site #4 Wells Ranch: Bifurcated site, very complex. Lots of ONG in the area, visible drill rig nearby. Large CH₄, NH₃ and C₂H₆ peaks.

Site #3 Five Rivers: This was the biggest site and we could smell the site in the cabin. Large visible ONG operations in the area. Big CH₄, NH₃ and C₂H₆ peaks.

Site #5 Horton Feedlots: Did not visit

Site #11 Magnum Feedyard: Small but distinct CH₄ and NH₃ peaks.

Site #10 English Feedlot: Small but distinct CH₄ and NH₃ peaks.

Site #9 Q Ranch:

Site #8 Teague Enterprises:

Site #7 CattlCo: Small but distinct CH₄ and NH₃ peaks.

Site #6 Feldpausch Holsteins:

Site #12 Crow Creek Cattle: Did not visit

Site #13 Loyd Farms: Did not visit

Gast manifold pump off at 14:21 MT.

Back at hangar at 14:25 MT.