ERASMUS: Update on Recent UAS Deployments

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Introduction

This poster presents information on unmanned-aircraft deployments to Oliktok Point, Alaska as part of the Evaluation of Routine Atmospheric Sounding Measurements using Unmanned Systems (ERASMUS) campaign. The first ERASMUS deployment took place in August 2015 and included CU DataHawk2 flights aimed at profiling thermodynamic properties of the lower troposphere. Here we provide information on flights completed, obstacles faced, and a preliminary look at results.

The second ERASMUS deployment took place in April 2016. This deployment featured the CU Pilatus, which carried more complex instrumentation aimed at measuring aerosol properties, broadband radiation and atmospheric thermodynamics. We again provide information on flights completed, along with an initial look at the measurements obtained. In addition to Pilatus flights, the April campaign involved testing of updated DataHawk2 software designed to harden the system against electro-magnetic interference from the US Air Force Radar at Oliktok point. We provide initial results from this testing.

PNNL has purchased four DataHawk2s and plan test deployments of these platforms this summer. Investigators interested in these activities should attend the UAS session scheduled during the Thursday afternoon breakout period.

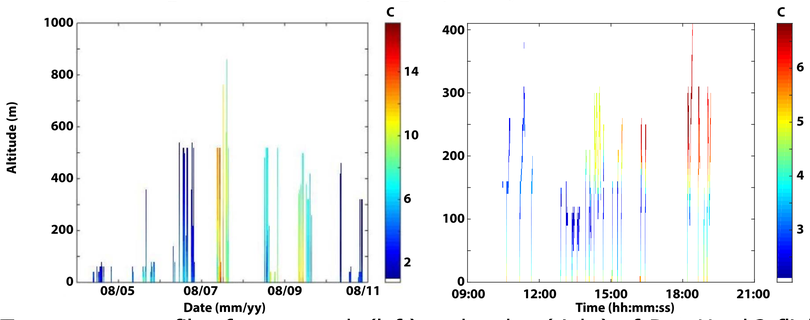
Platforms and Measurement Objectives

Aircraft	Wingspan	Weight	Endurance	Measurement Capabilities
CU DataHawk2	1 m	<1 kg	75 min	Temperature (fast from coldwire sensor + slow), humidity, wind estimate from local wind and aircraft state, pressure, IR sur face and sky temperature, aircraft state

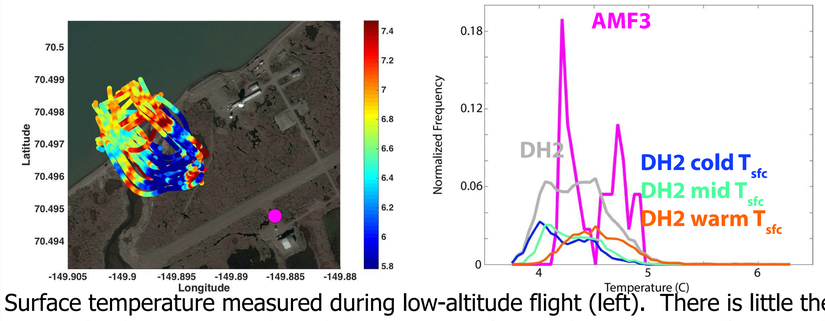
Aircraft	Wingspan	Weight	Endurance	Measurement Capabilities
CU Pilatus	3.2 m	16 kg	25 min	Temperature (slow), humidity, pressure, aerosol size distribution (Gao et al., 2015), up/downwelling broadband shortwave irradiance (albedo), up/downwelling broadband longwave irradiance, aircraft state, auto-pilot-derived wind estimates

ERASMUS Part I (August 2015)

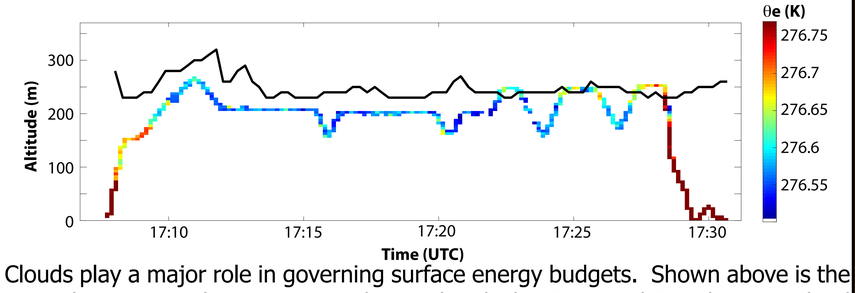
The summertime tundra-atmosphere interface, as seen from the rooftop deck of the AMF-3 during ERASMUS Part 1 (August, 2015).



Temperature profiles from a week (left) and a day (right) of DataHawk2 flights. Note: individual lights were cut short due to interference from the DEW line radar.



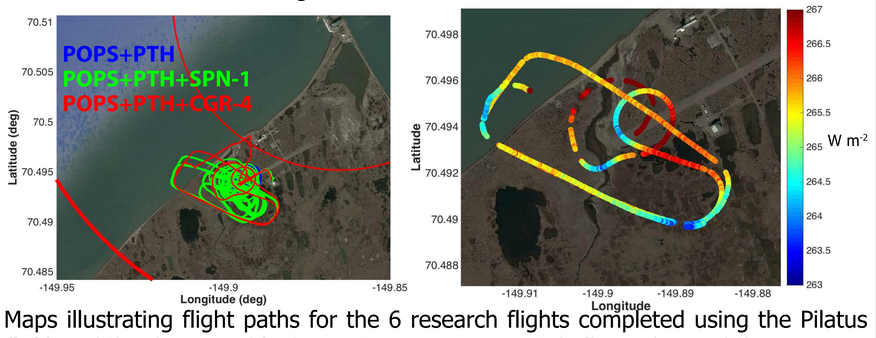
Surface temperature measured during low-altitude flight (left). There is little thermal contrast observed, with water and land surfaces within a degree of one another. The tundra is slightly colder than the water around it (ponds, river, ocean). Near-surface air temperature distributions are shown at right.



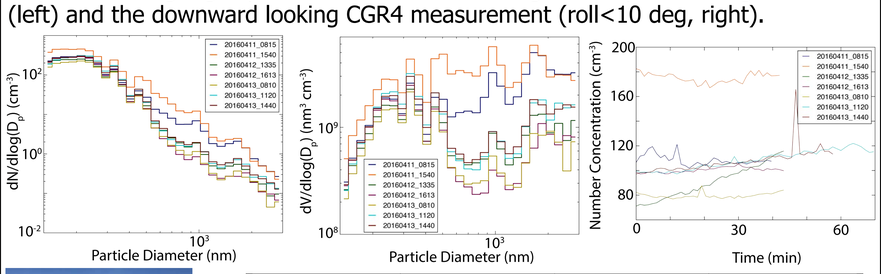
Clouds play a major role in governing surface energy budgets. Shown above is the equivalent potential temperature observed with the DataHawk2 in the near-cloud environment. Cloud base obtained from the AMF-3 ceilometer is indicated by the black line.

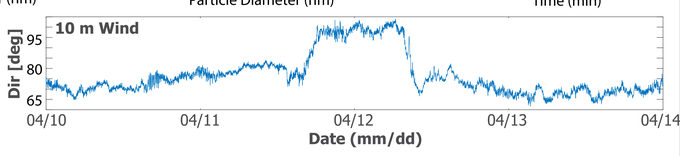
ERASMUS Part II (April 2016)

Scenes from the April 2016 ERASMUS deployment. Conditions were challenging, with winds consistently blowing at 20-40 mph over the two week campaign, resulting in wind chill values between -45 and 0 F. While the conditions limited flights, we were able to conduct six research flights using the Pilatus, several short flights using the DataHawks and make regular aerosol size distribution measurements with POPS.



Maps illustrating flight paths for the 6 research flights completed using the Pilatus (left) and the downward looking CGR4 measurement (roll<10 deg, right).





During high-wind conditions, we sampled aerosol size distributions at Oliktok Point using our POPS payload, strapped to the roof of the AMF-3 in an insulated box.

Due to conditions, the DataHawk was only flown a handful of times. However, during these flights and during all ground testing there were no signs of any radar-induced autopilot issues. Together with testing completed in Boulder to evaluate the autopilot's ability to handle in-flight resets, these results make us cautiously optimistic that the aircraft is now prepared to handle potential EMI from the US Air Force Distant Early Warning (DEW)-Line radar systems and that upcoming flight campaigns to be conducted by ARM should not be affected by this issue.

Summary

- Unmanned aircraft operations were completed at Oliktok Point in August 2015 and April 2016 as part of the ERASMUS campaign.

- The August campaign featured the CU DataHawk 2 UAS, and targeted routine thermodynamic profiling of the lower Arctic atmosphere.

- The US Air Force Distant Early Warning (DEW) Line radar caused substantial difficulty in the form of electromagnetic interference with the main microprocessor handling all computing on board the DataHawk. This resulted in a substantially reduced flight capability for the aircraft. Nevertheless, we completed regular profiles over the site from the surface to cloud base or 500 m altitude.

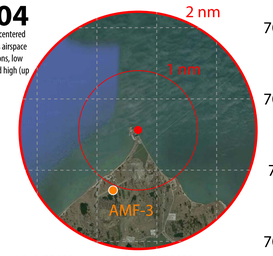
- The April campaign was recently completed and featured both Pilatus and DataHawk flights. Weather was a significant factor, with high winds (30+ mph) present during much of the two-week campaign. The campaign was extended by two days and we completed six Pilatus flights during the extension.

- Data processing is currently underway. Results from the August campaign are already available through the ARM archive. Results from the April campaign are expected to be ready later this summer.

Information on Oliktok Point Airspace

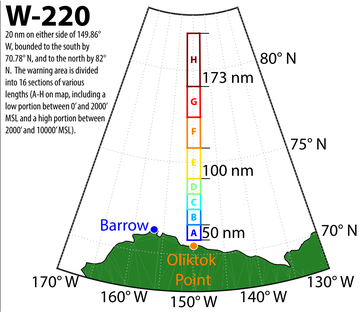
R-2204

4 nm diameter circle centered on Oliktok Point. This airspace is split into two sections, low (up to 1500' MSL) and high (up to 7000' MSL).



W-220

20 nm on either side of 149.86° W, bounded to the south by 70.78° N, and to the north by 82° N. The warning area is divided into 16 sections of various lengths (A-H on map, including a low portion between 0' and 2000' MSL and a high portion between 2000' and 10000' MSL).



Two areas of controlled airspace exist at Oliktok Point, including restricted area R-2204 and warning area W-220. ERASMUS was conducted entirely within R-2204.

References

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Acknowledgments

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