UAS-Based Observational Efforts Along the North Slope of Alaska

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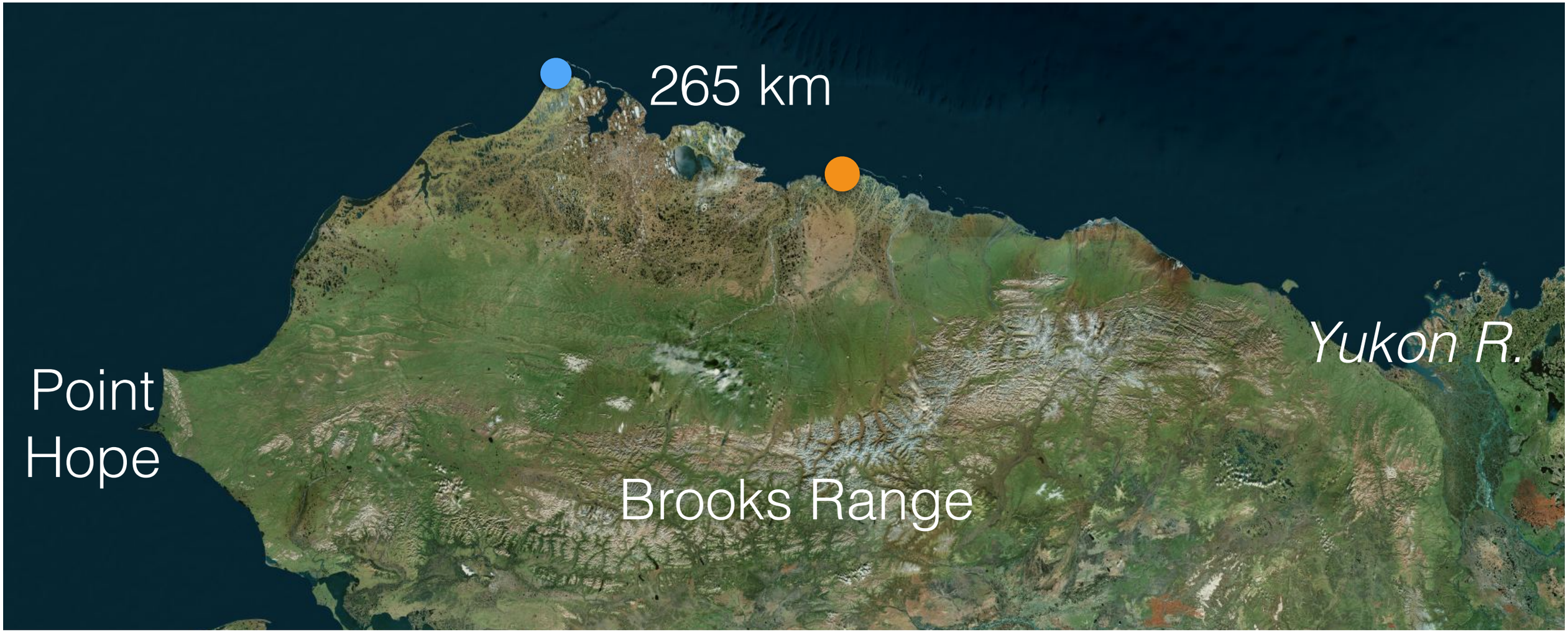
(1) University of Colorado Boulder (2) NOAA (3) BlackSwift Technologies (4) Sandia National Laboratories (5) Pacific Northwest National Laboratory (6) NASA

3rd ISARRA Conference, Norman, USA, 21 May, 2015

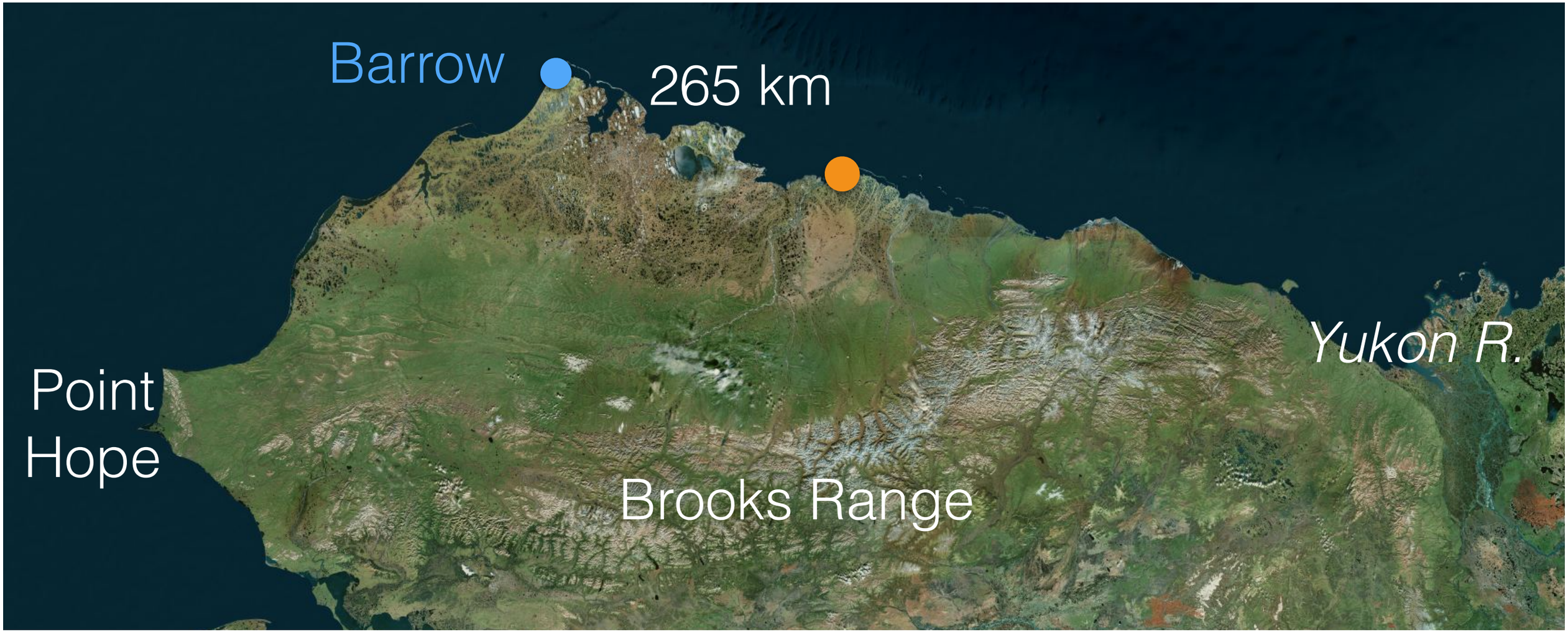
Introduction



Overarching Scientific Targets:

- Aerosols, Clouds and interactions between them
- Spatial variability of near-surface atmospheric thermodynamics
- Surface turbulent fluxes over a variety of environments

Introduction



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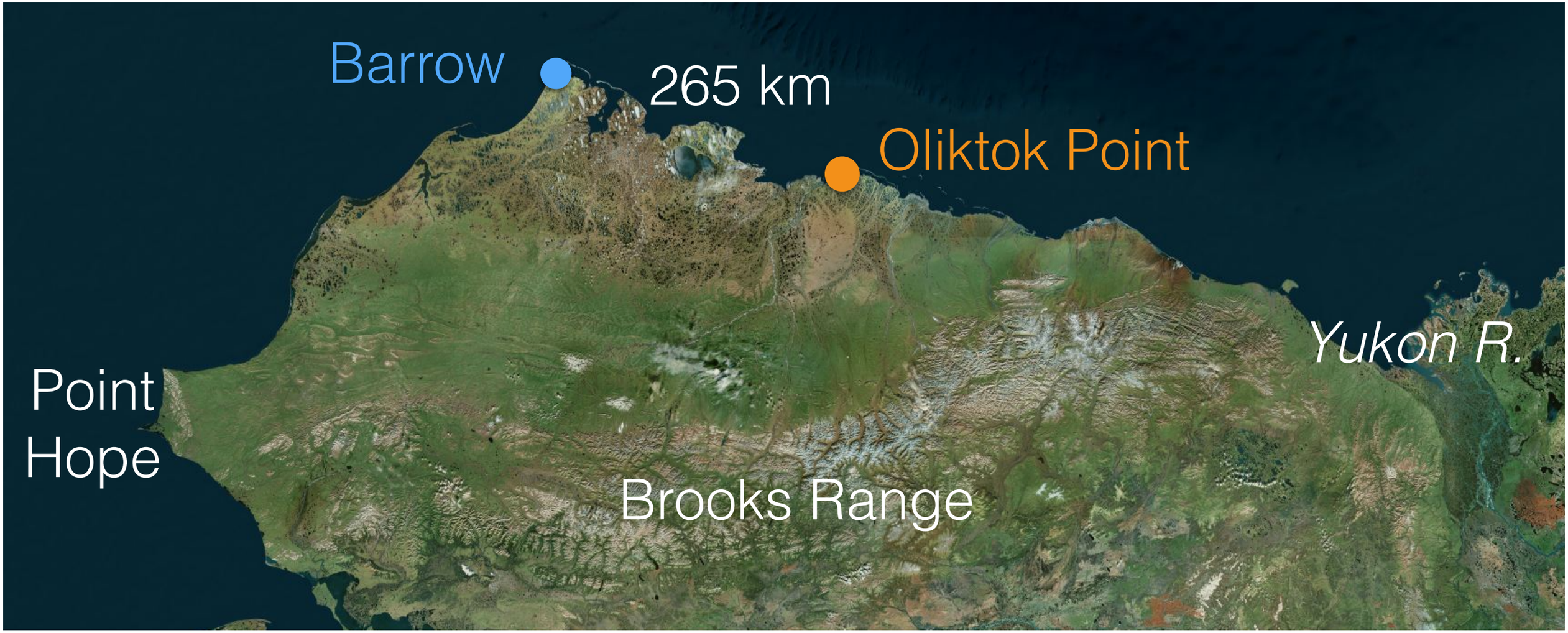

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- Aerosols, Clouds and interactions between them
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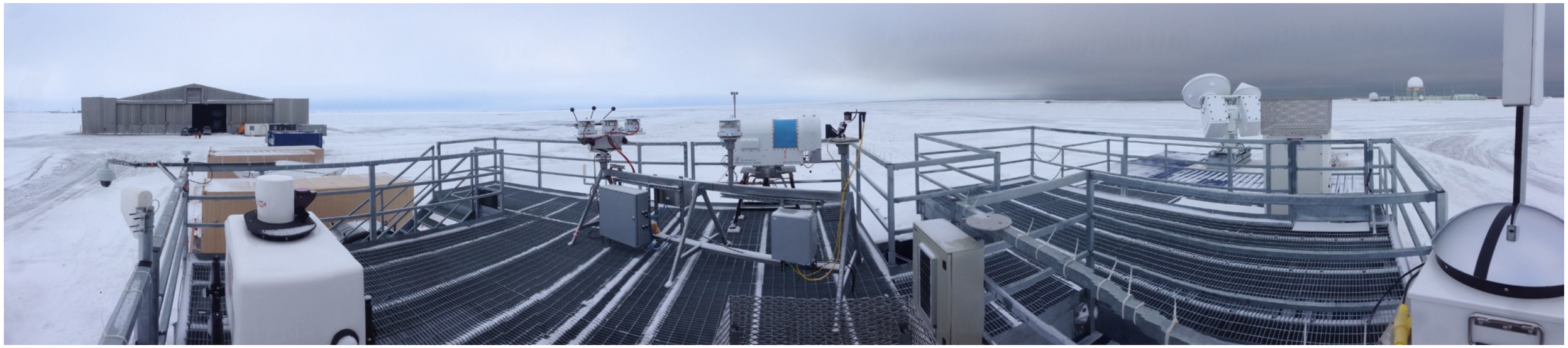
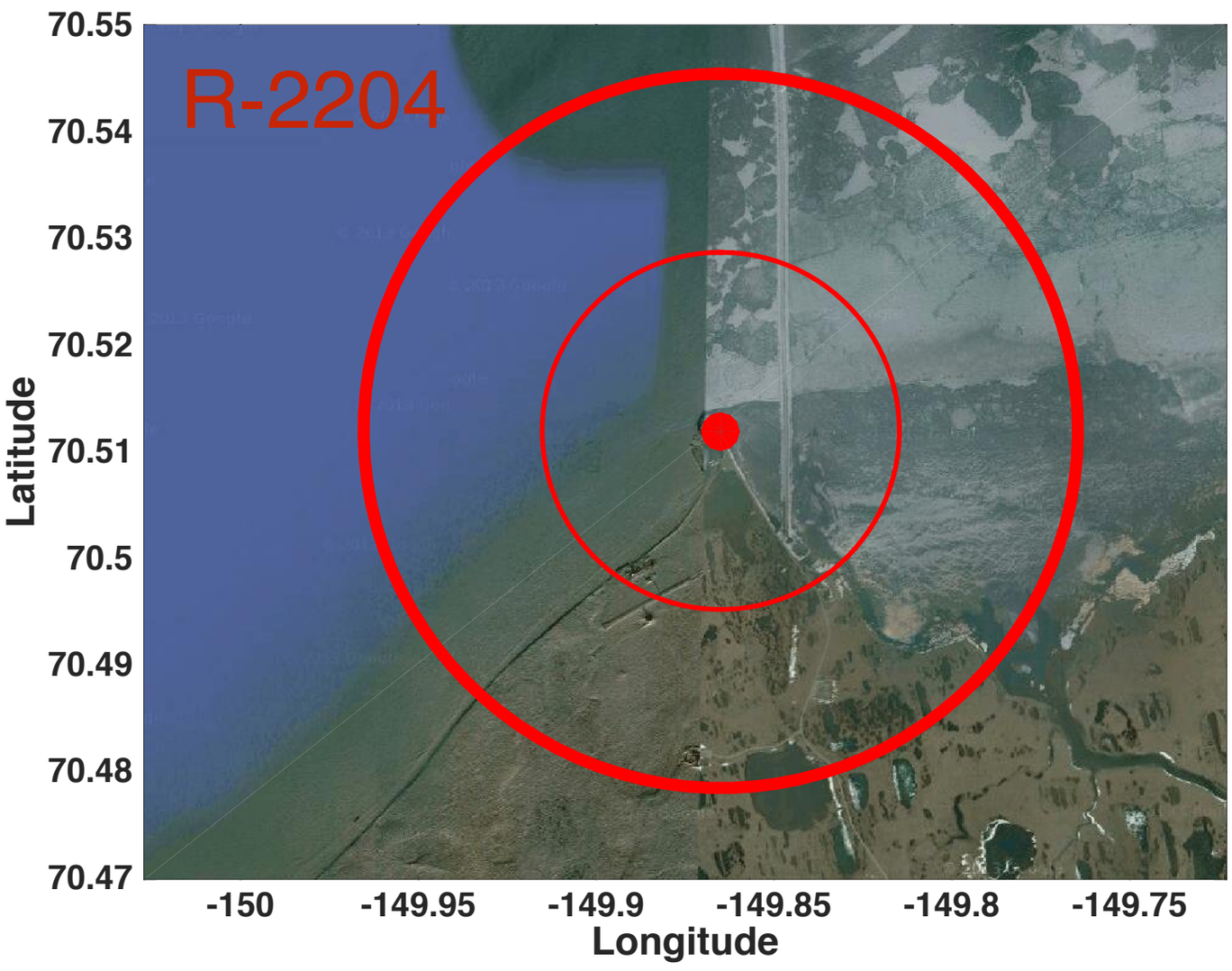
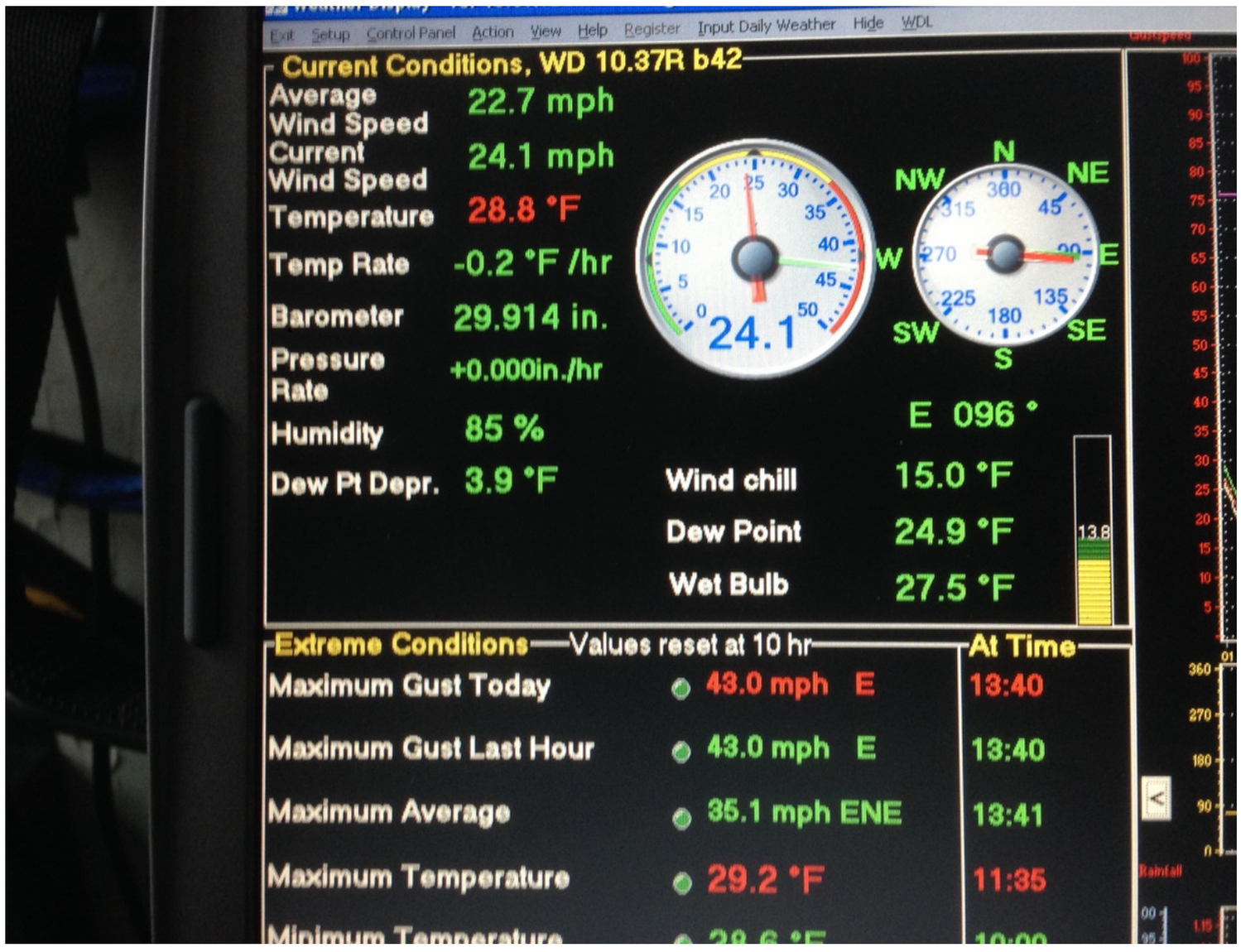
Oliktok Point





COALA


Exit Setup Control Panel Action View Help Register Input Daily Weather Hide WDL
Current Conditions, WD 10.37R b42
Average Wind Speed 22.7 mph
Current Wind Speed 24.1 mph
Temperature 28.8 °F
Temp Rate -0.2 °F /hr
Barometer 29.914 in.
Pressure Rate +0.000in./hr
Humidity 85 %
Dew Pt Depr. 3.9 °F
24.1
N
NW
NE
W
E
SW
SE
S
E 096 °
Wind chill 15.0 °F
Dew Point 24.9 °F
Wet Bulb 27.5 °F
13.8
Extreme Conditions — Values reset at 10 hr
At Time
Maximum Gust Today 43.0 mph E 13:40
Maximum Gust Last Hour 43.0 mph E 13:40
Maximum Average 35.1 mph ENE 13:41
Maximum Temperature 29.2 °F 11:35
Rainfall

DataHawk UAS

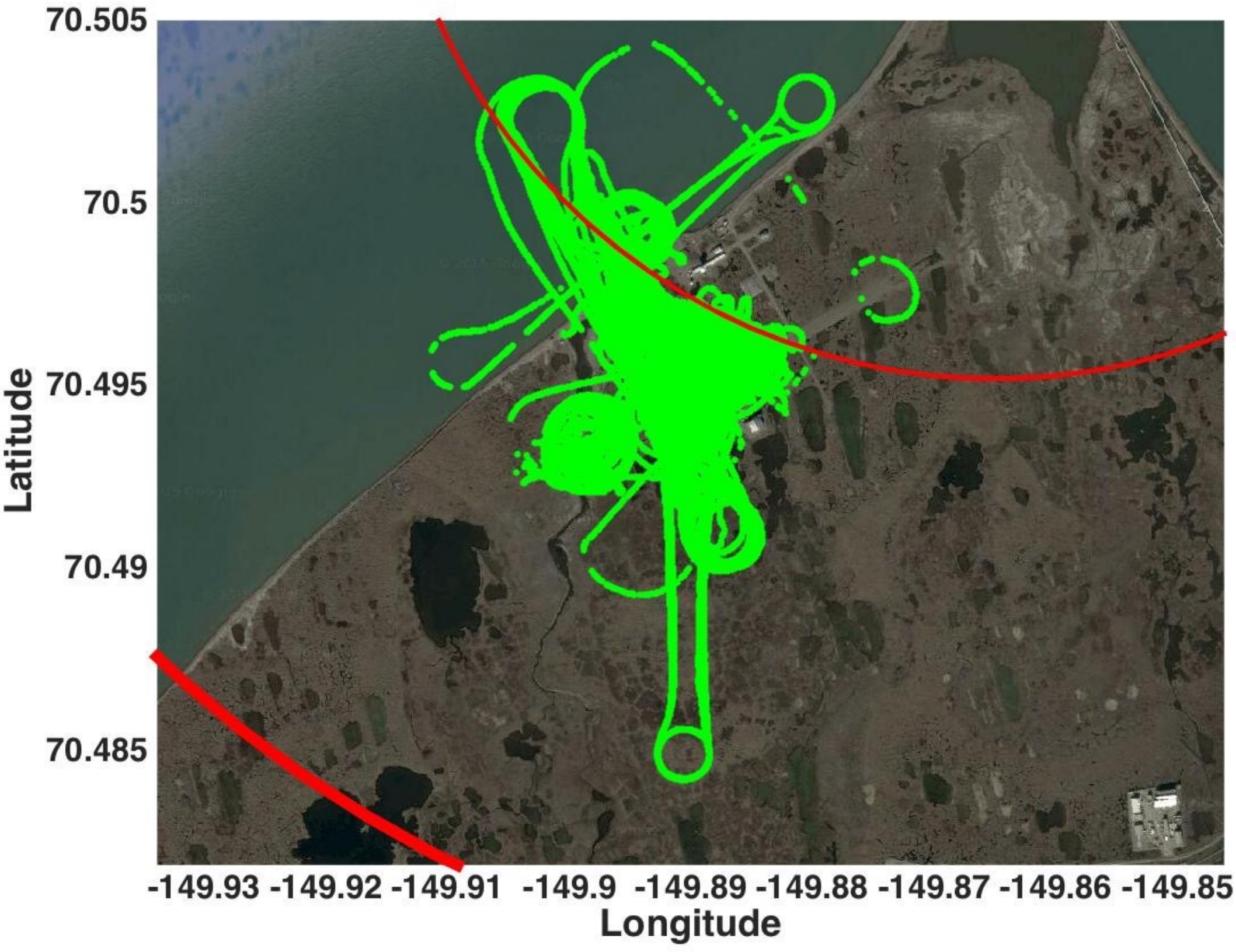
Description:

1 m wingspan
700 g total weight
~$1000 vehicle cost
12-16 m s^{-1} typical airspeed
50 min flight duration (level)
~35 km range (level)
2 km max altitude (powered)
50 m turn radius
5 m s^{-1} maximum climb rate

Measurement Capabilities

- Temperature
- Relative Humidity
- Pressure
- 2D/3D wind vector estimate
- IR Surface Temperature Proxy
- Location

COALA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70.5
70.495
70.49
70.485
Latitude
-149.93 -149.92 -149.91 -149.9 -149.89 -149.88 -149.87 -149.86 -149.85
Longitude

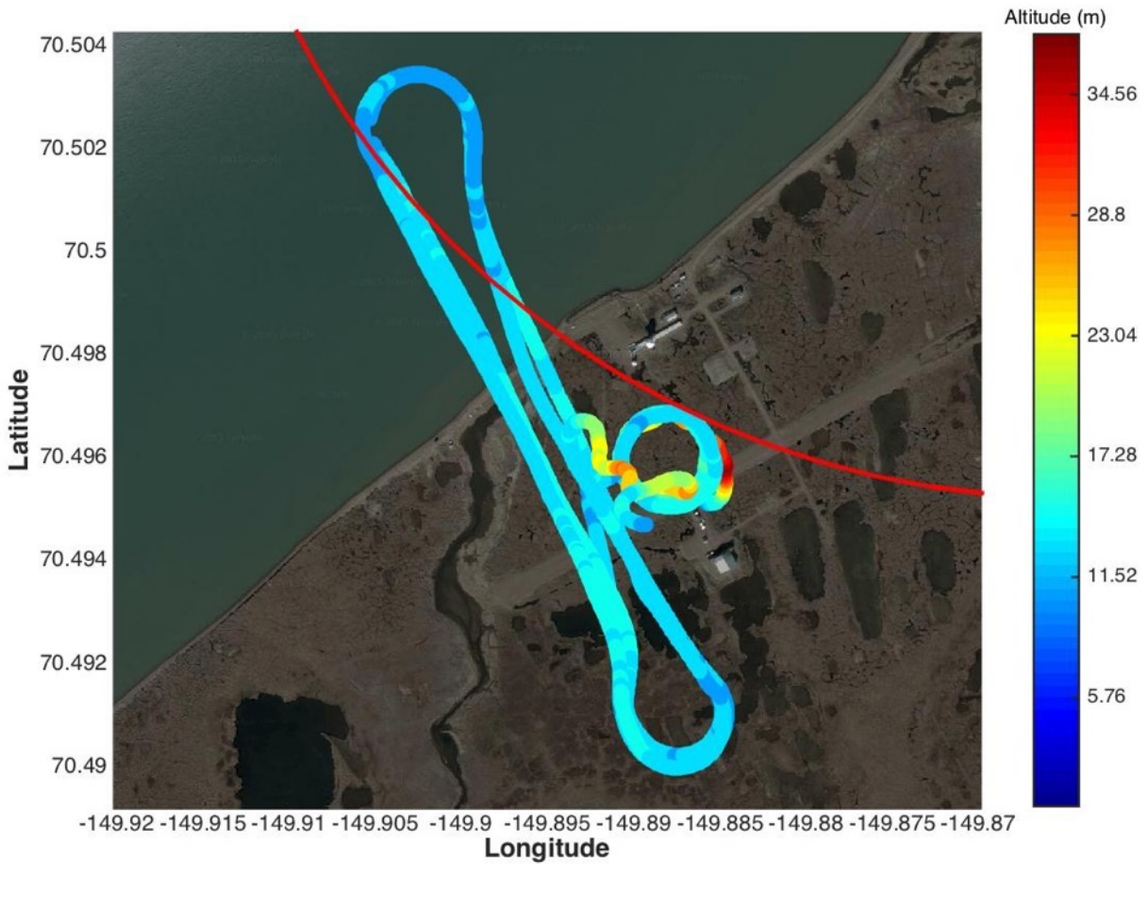
COALA

3rd ISARRA Conference, Norman, USA, 21 May, 2015

COALA

Altitude (m)
34.56
28.8
23.04
17.28
11.52
5.76
Latitude
70.504
70.502
70.5
70.498
70.496
70.494
70.492
70.49
-149.92 -149.915 -149.91 -149.905 -149.9 -149.895 -149.89 -149.885 -149.88 -149.875 -149.87
Longitude

COALA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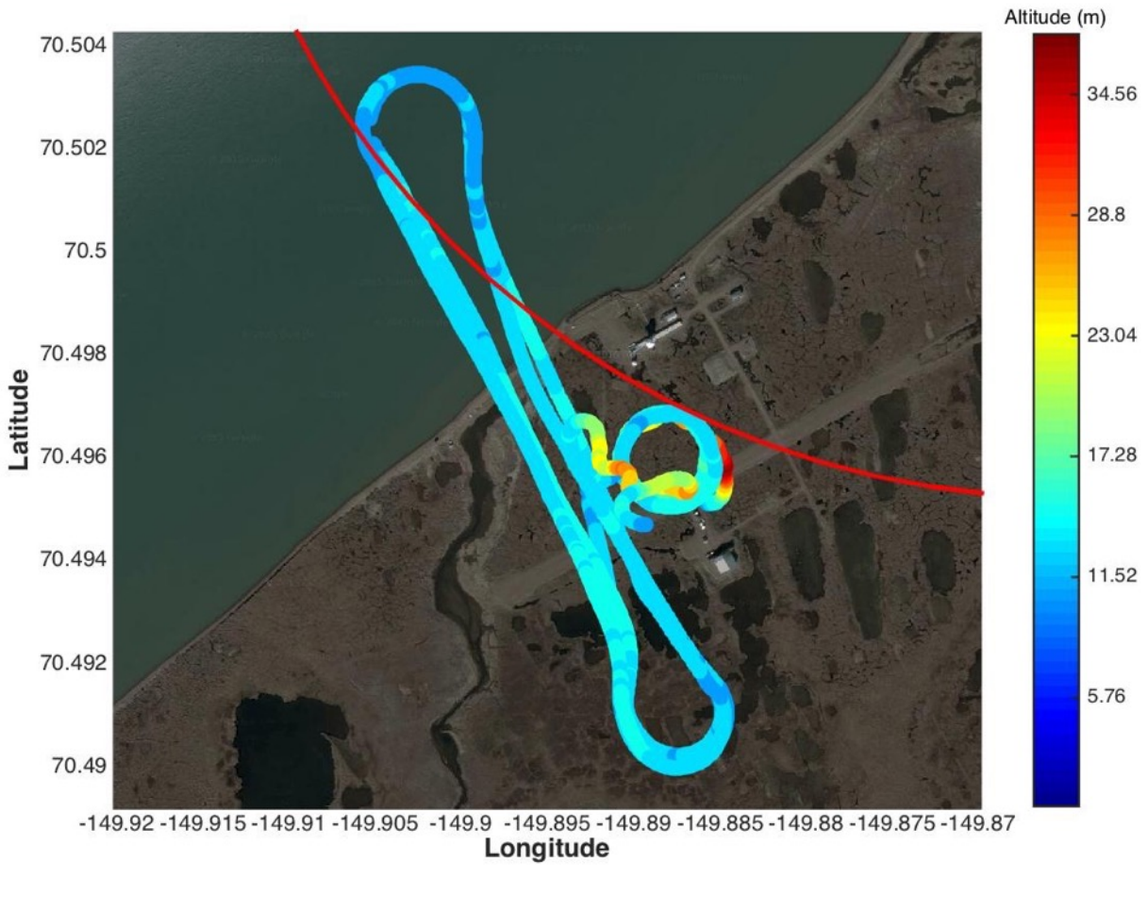
70.492
70.49
-149.92 -149.915 -149.91 -149.905 -149.9 -149.895 -149.89 -149.885 -149.88 -149.875 -149.87
Longitude

V5
1377.06
1365.22
1353.38
1341.53
1329.69
1317.84
Latitude
70.504
70.502
70.5
70.498
70.496
70.494
70.492
70.49
-149.92 -149.915 -149.91 -149.905 -149.9 -149.895 -149.89 -149.885 -149.88 -149.875 -149.87
Longitude

COALA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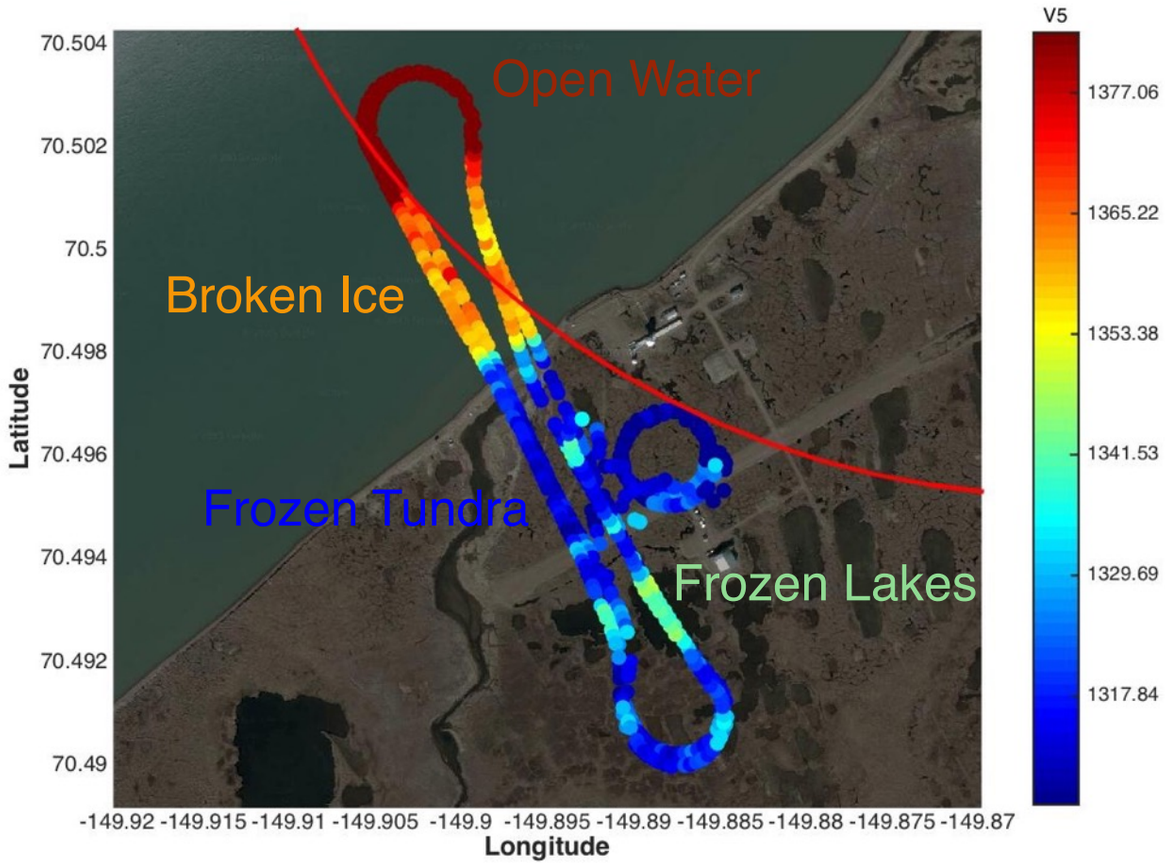
V5
1377.06
1365.22
1353.38
1341.53
1329.69
1317.84
Open Water
Broken Ice
Frozen Tundra
Frozen Lakes
70.504
70.502
70.5
70.498
70.496
70.494
70.492
70.49
Latitude
-149.92 -149.915 -149.91 -149.905 -149.9 -149.895 -149.89 -149.885 -149.88 -149.875 -149.87
Longitude

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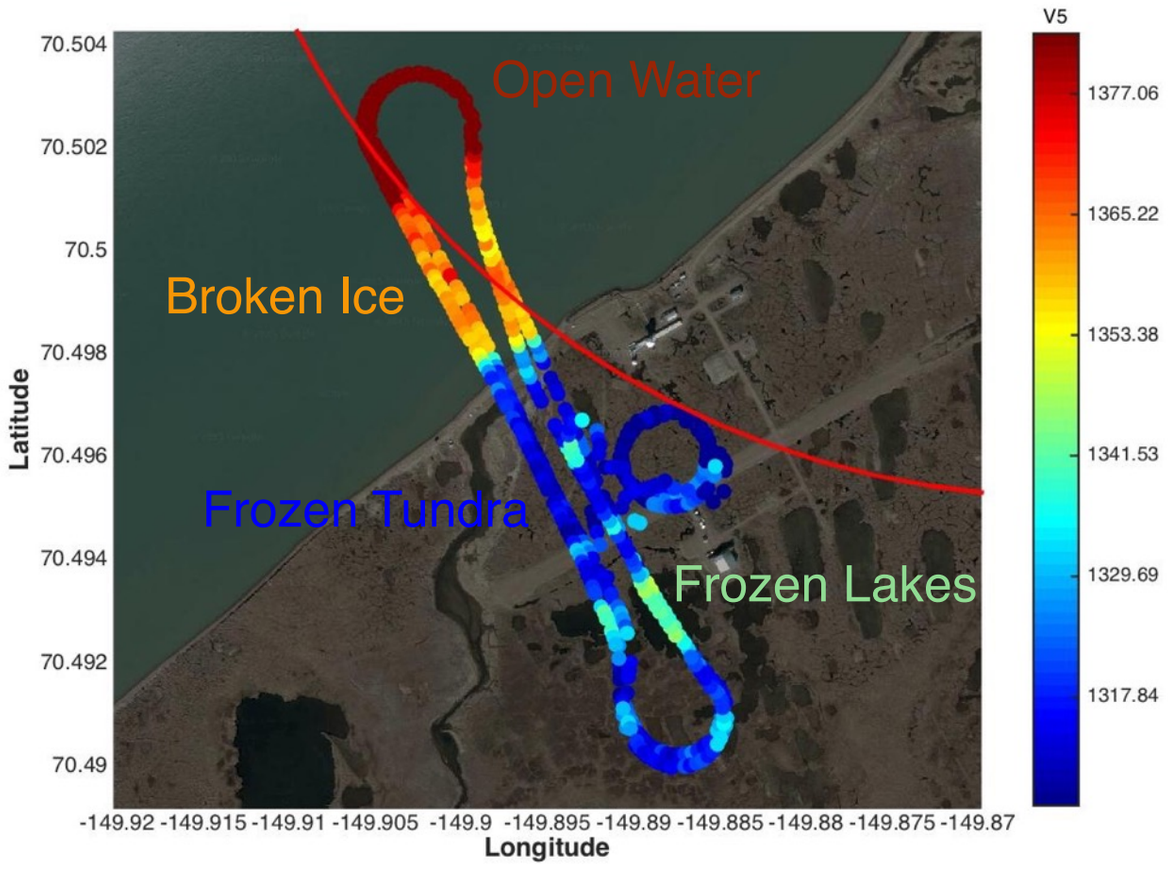
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Broken Ice
Frozen Tundra
Frozen Lakes
V5
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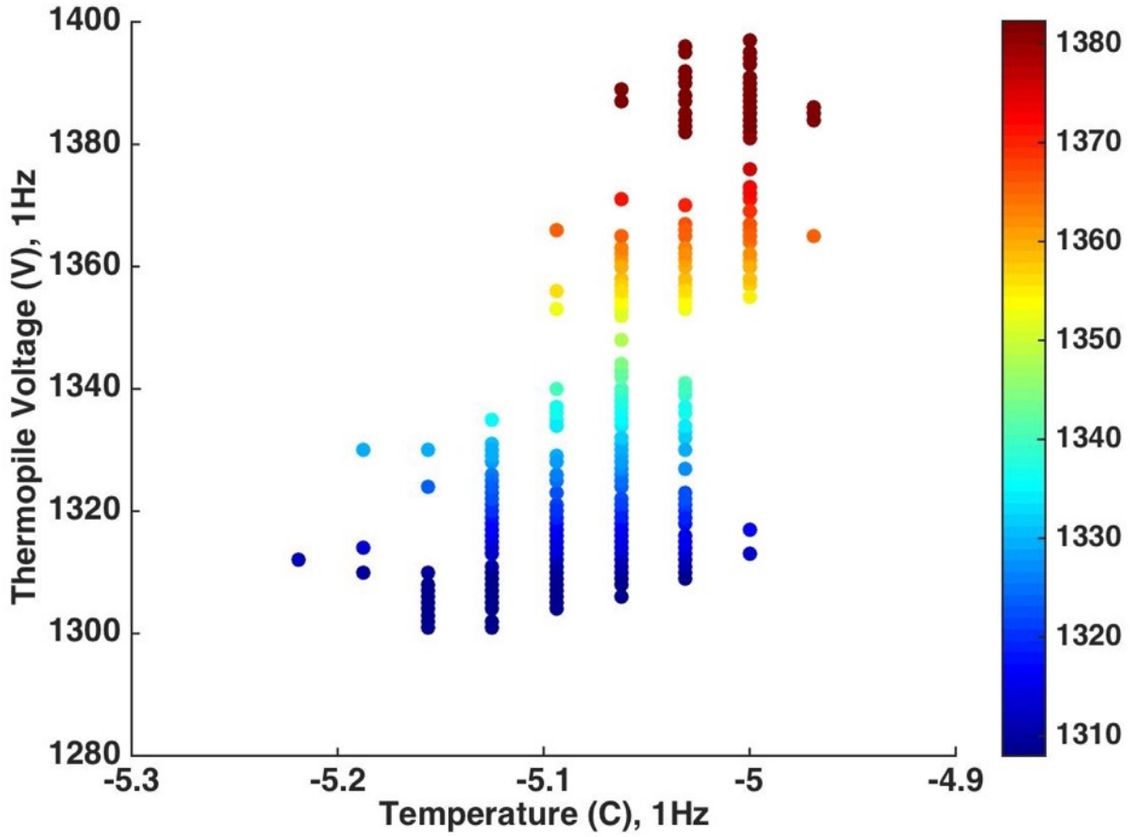
Thermopile Voltage (V), 1Hz
1400
1380
1360
1340
1320
1300
1280
-5.3
-5.2
-5.1
-5
-4.9
Temperature (C), 1Hz
1380
1370
1360
1350
1340
1330
1320
1310

COALA

Altitude (m)
34.56
28.8
23.04
17.28
11.52
5.76
70.504
70.502
70.5
70.498
70.496
70.494
70.492
70.49
Latitude
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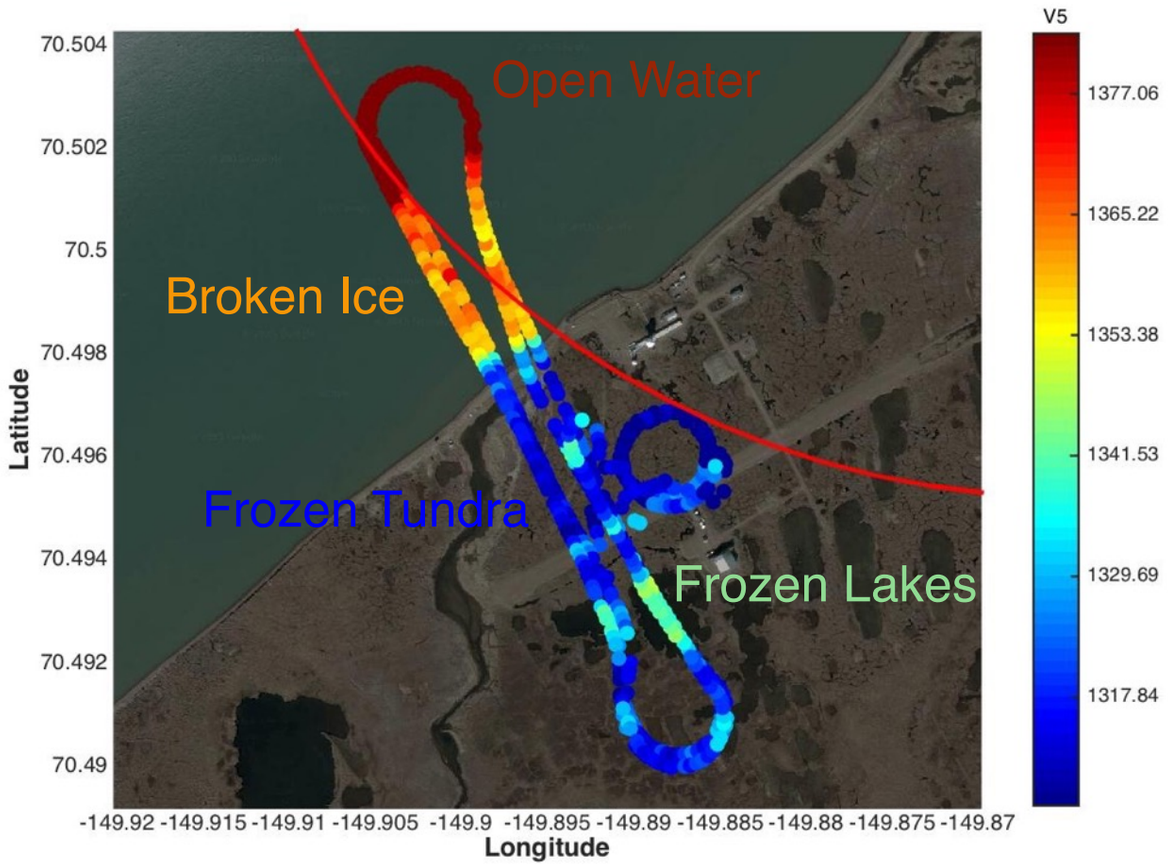
Longitude


V5
1377.06
1365.22
1353.38
1341.53
1329.69
1317.84
Open Water
Broken Ice
Frozen Tundra
Frozen Lakes
70.504
70.502
70.5
70.498
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70.494
70.492
70.49
Latitude
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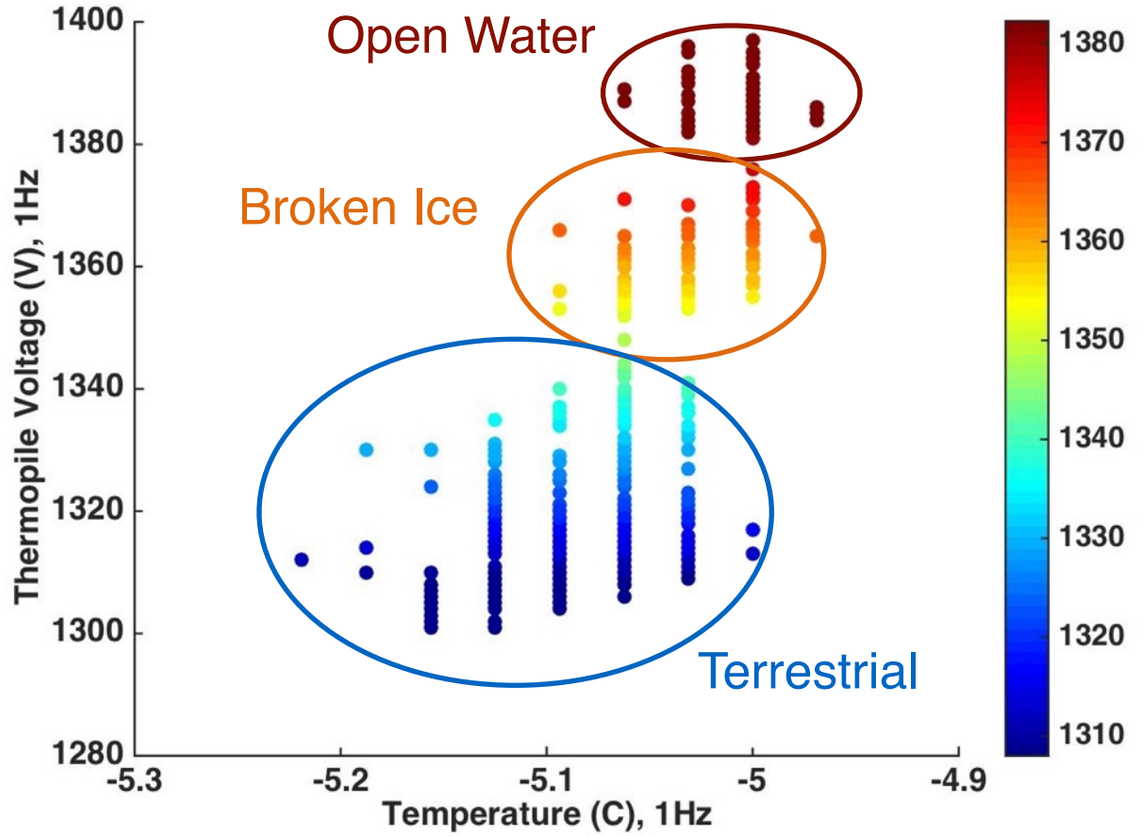
Longitude

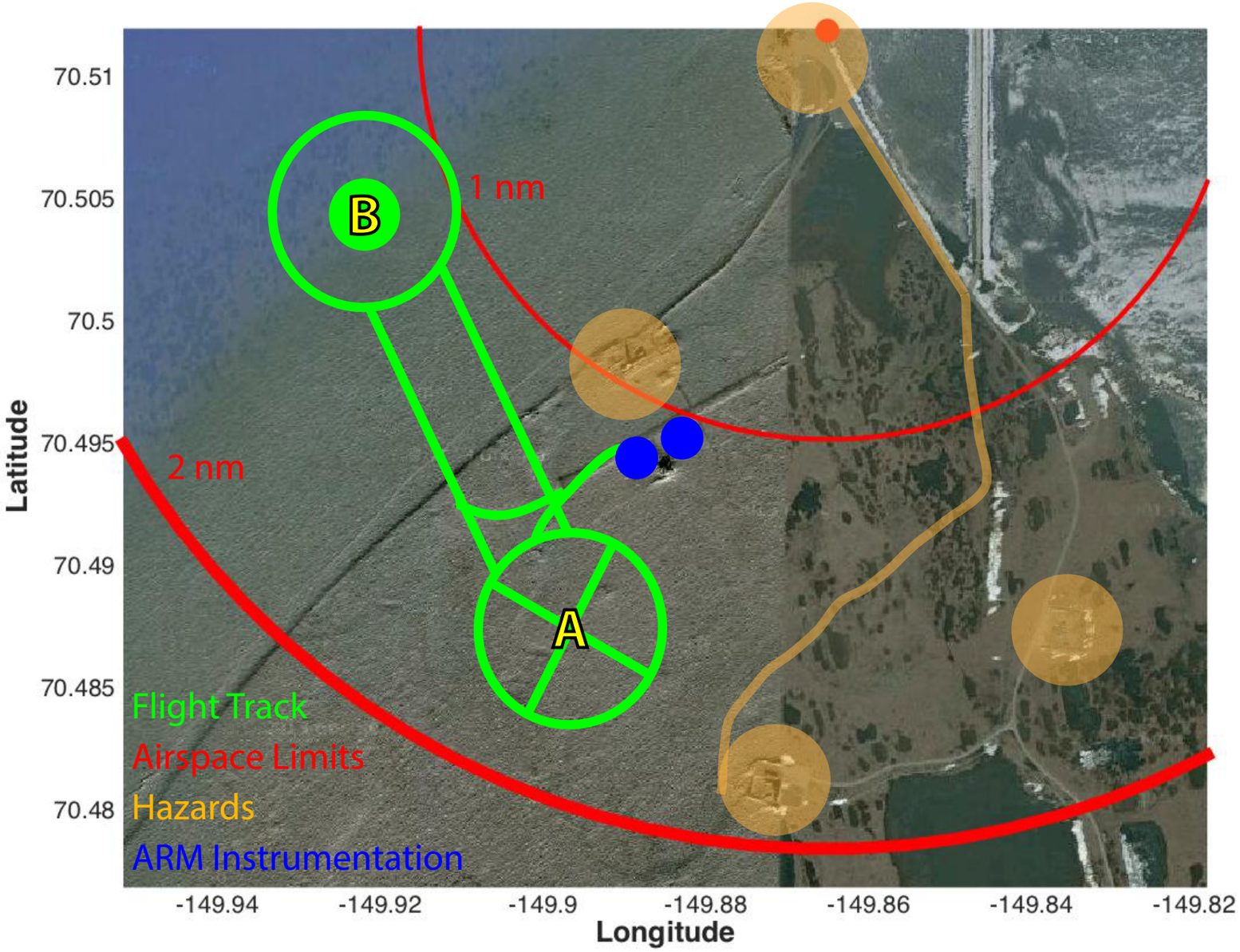

Open Water
Broken Ice
Terrestrial
1400
1380
1360
1340
1320
1300
1280
Thermopile Voltage (V), 1Hz
-5.3
-5.2
-5.1
-5
-4.9
Temperature (C), 1Hz
1380
1370
1360
1350
1340
1330
1320
1310

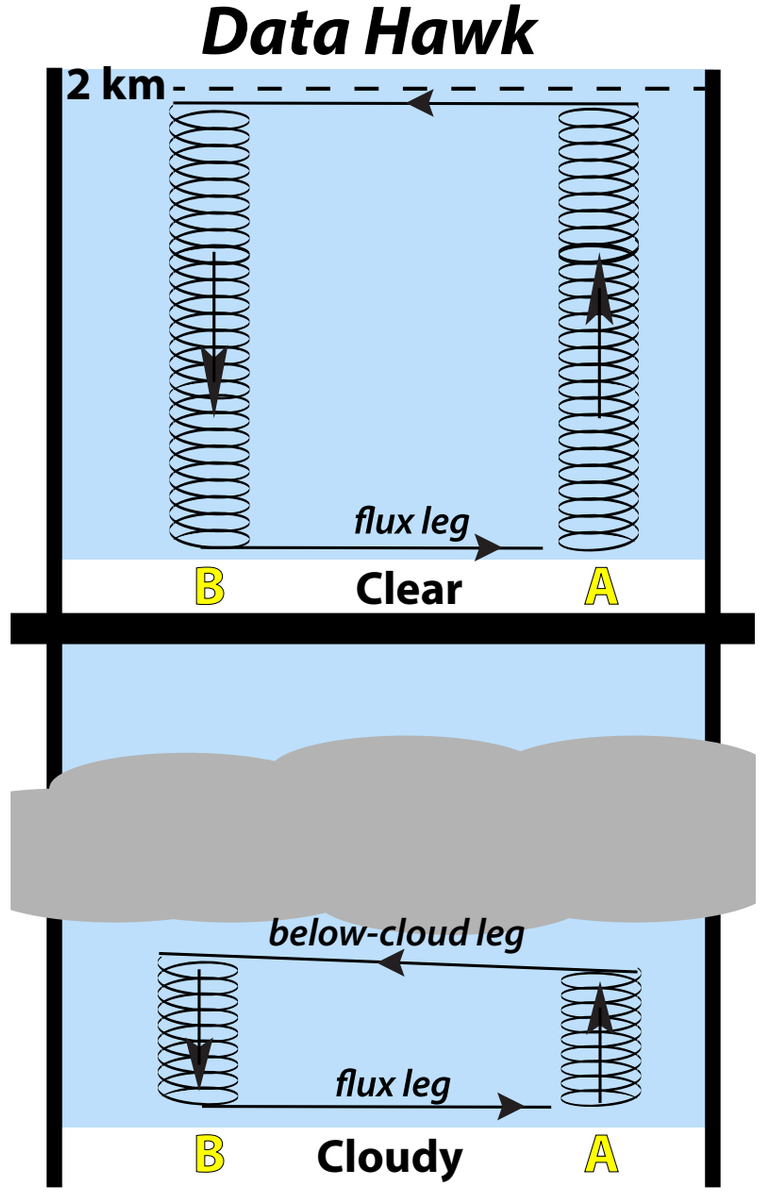
DataHawk UAS v2

Advances:

- Detachable wings for easy transport
- Increased endurance/payload
- No more thermopiles for attitude!
- Shielded sensor housing

ERASMUS





Evaluation of **R**outine **A**tmospheric **S**ounding **M**easurements using **U**nmanned **S**ystems (DataHawks)

- August, 2015
- Hourly flights, 12 hours per day, for two weeks

Pilatus UAS

Description:

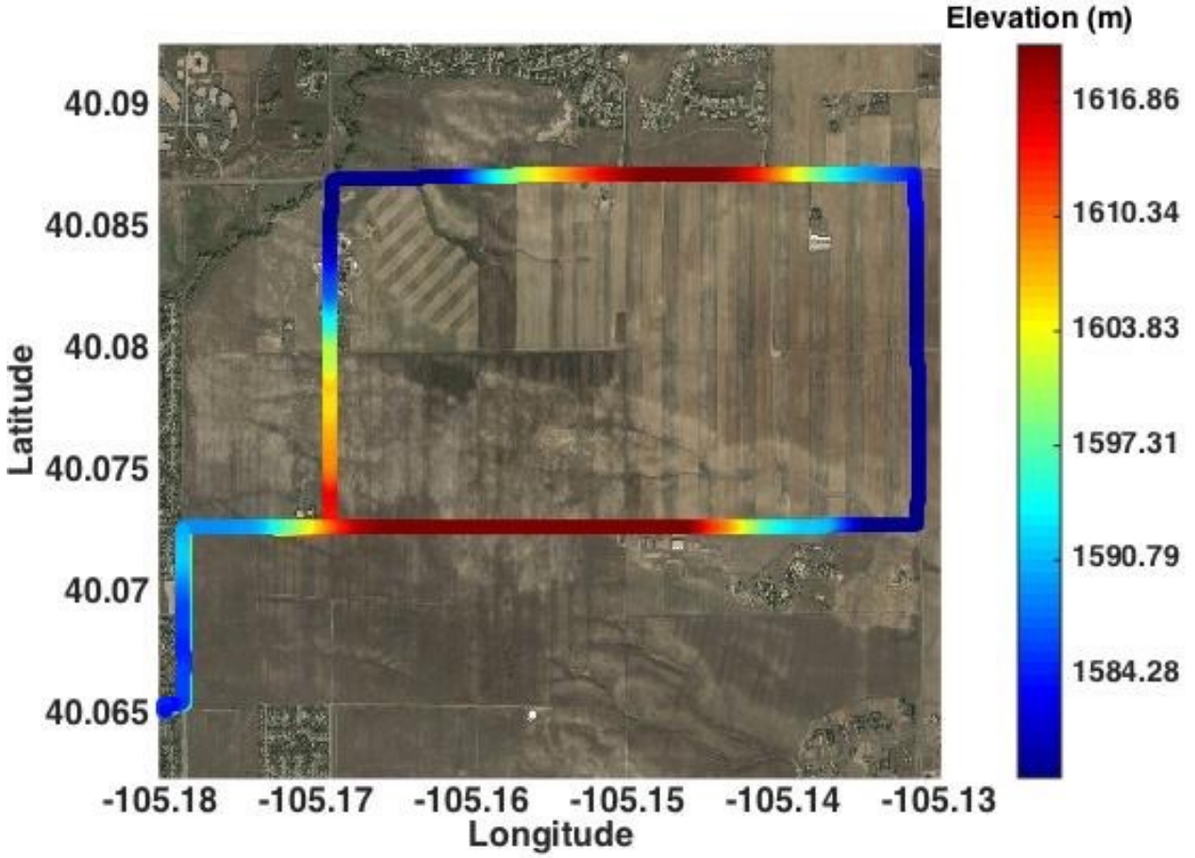
Electric propulsion
3.2 m wingspan
55 lbs total weight
60 knots airspeed (loaded)
80 knots dash speed
25 min flight duration (level)
100 m turn radius
2.5 m s^{-1} typical climb rate

Measurement Capabilities:

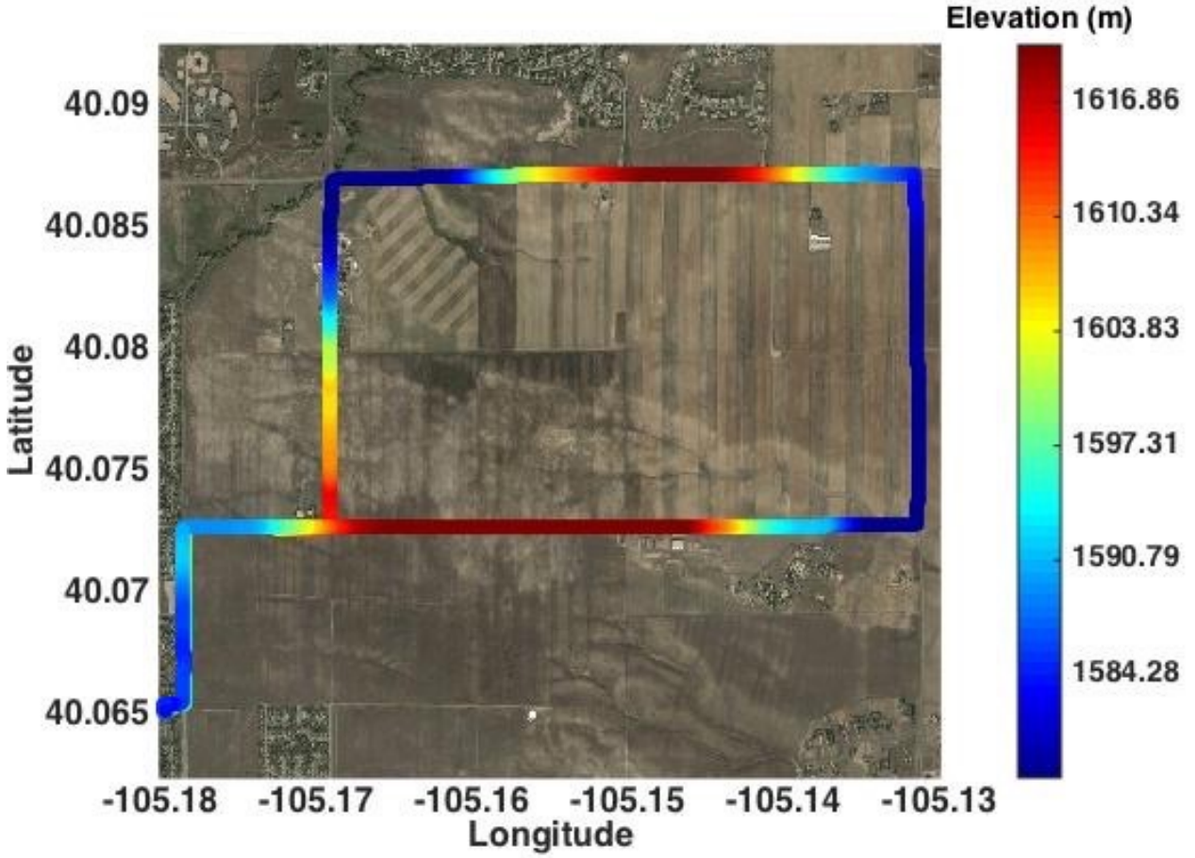
Temperature/RH
Pressure
3D wind estimate
Aerosol size distribution
Broadband Shortwave (400-2400 nm) and Longwave (4.5-42 microns)
Radiation (up/down)

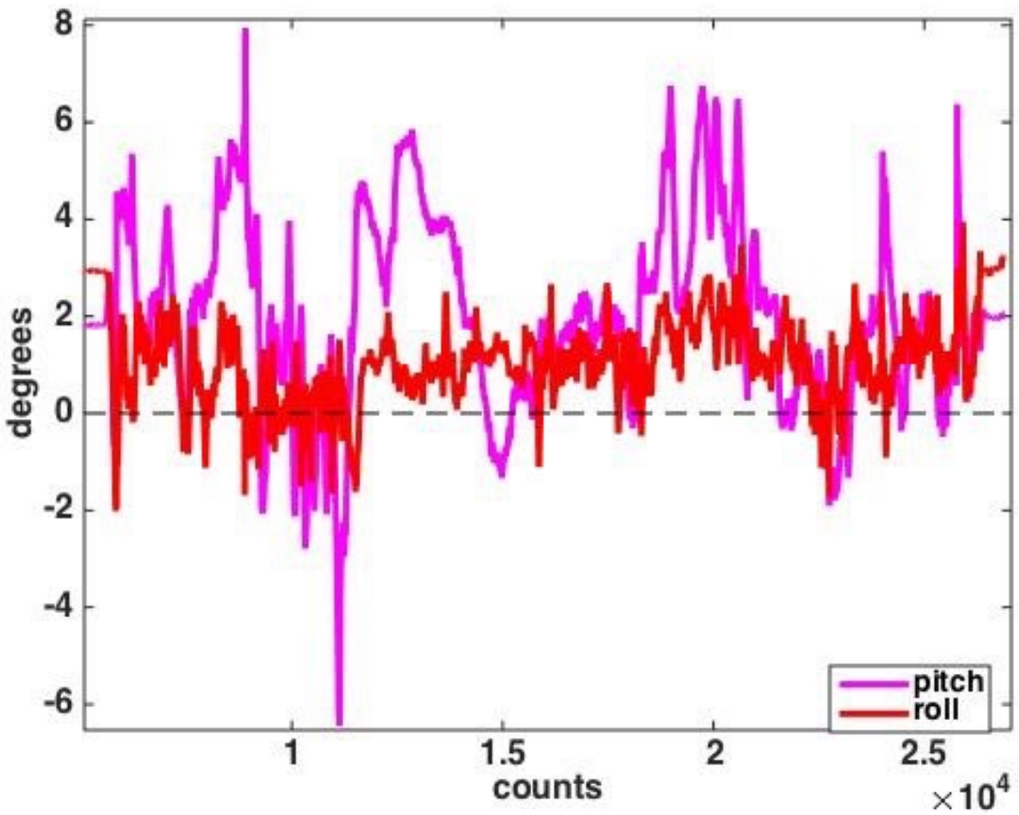
Radiation Correction

Radiation Correction

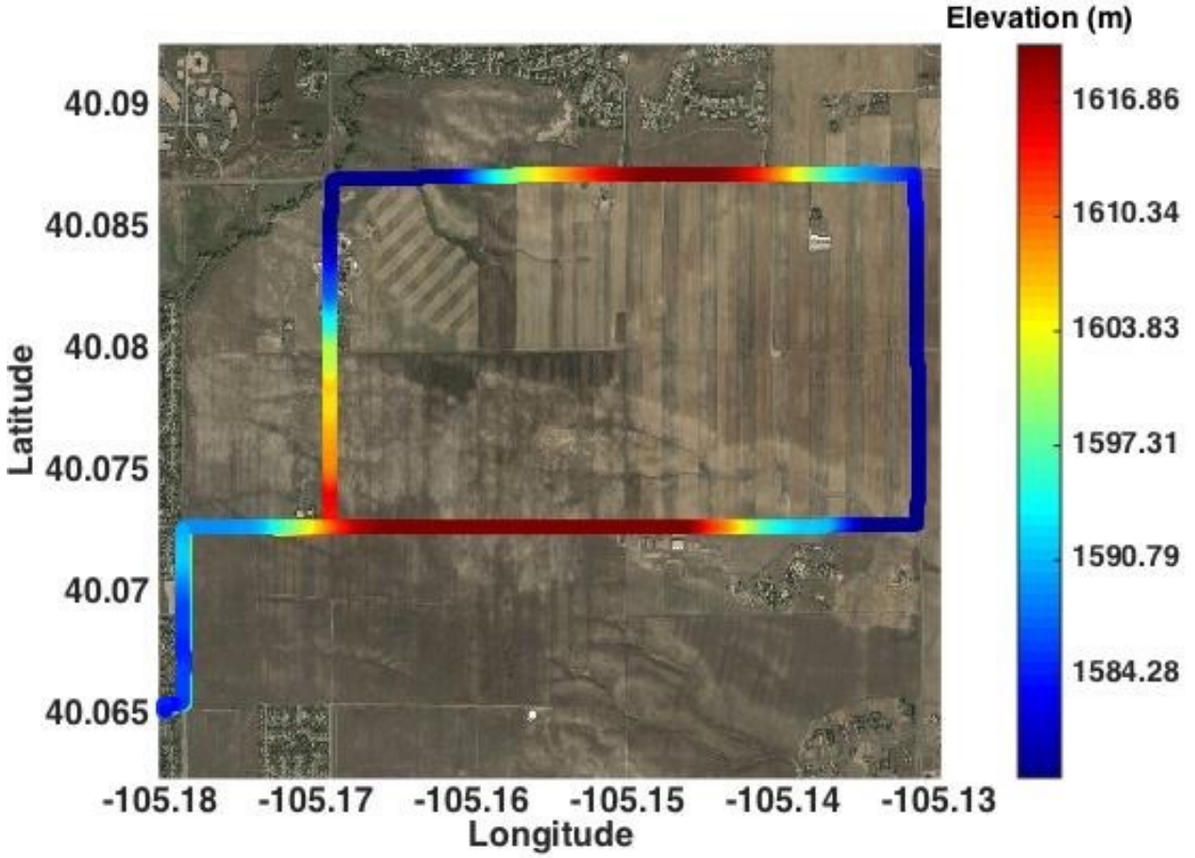


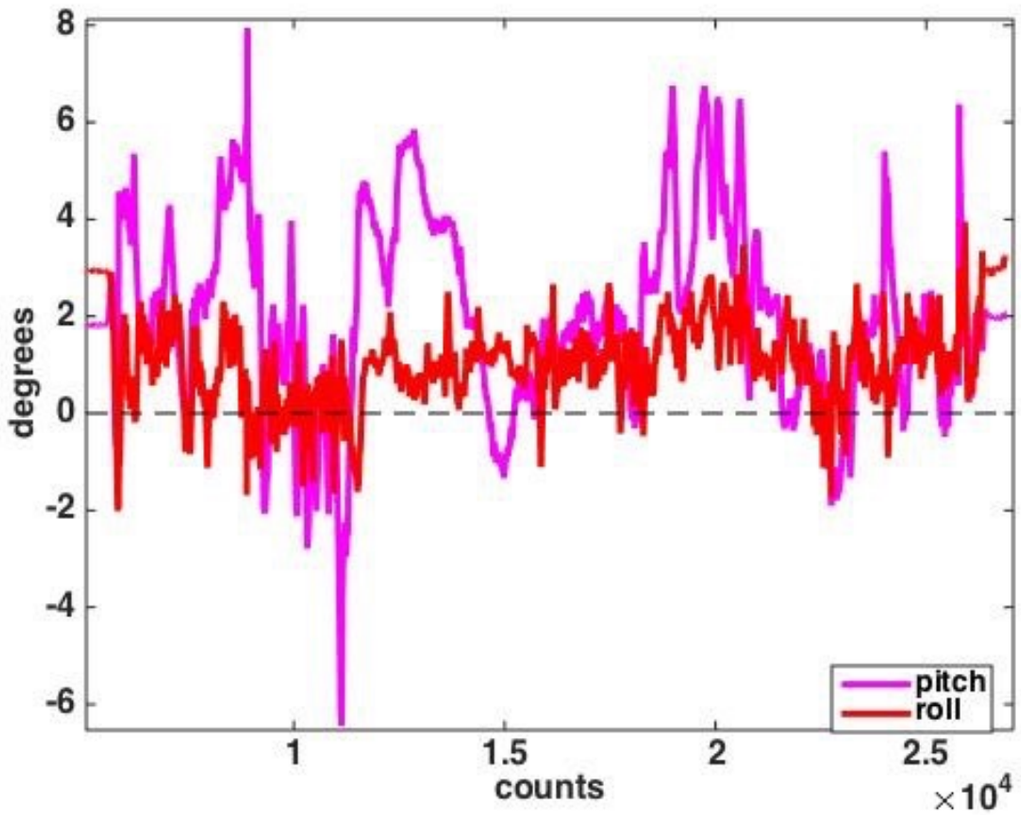
Radiation Correction

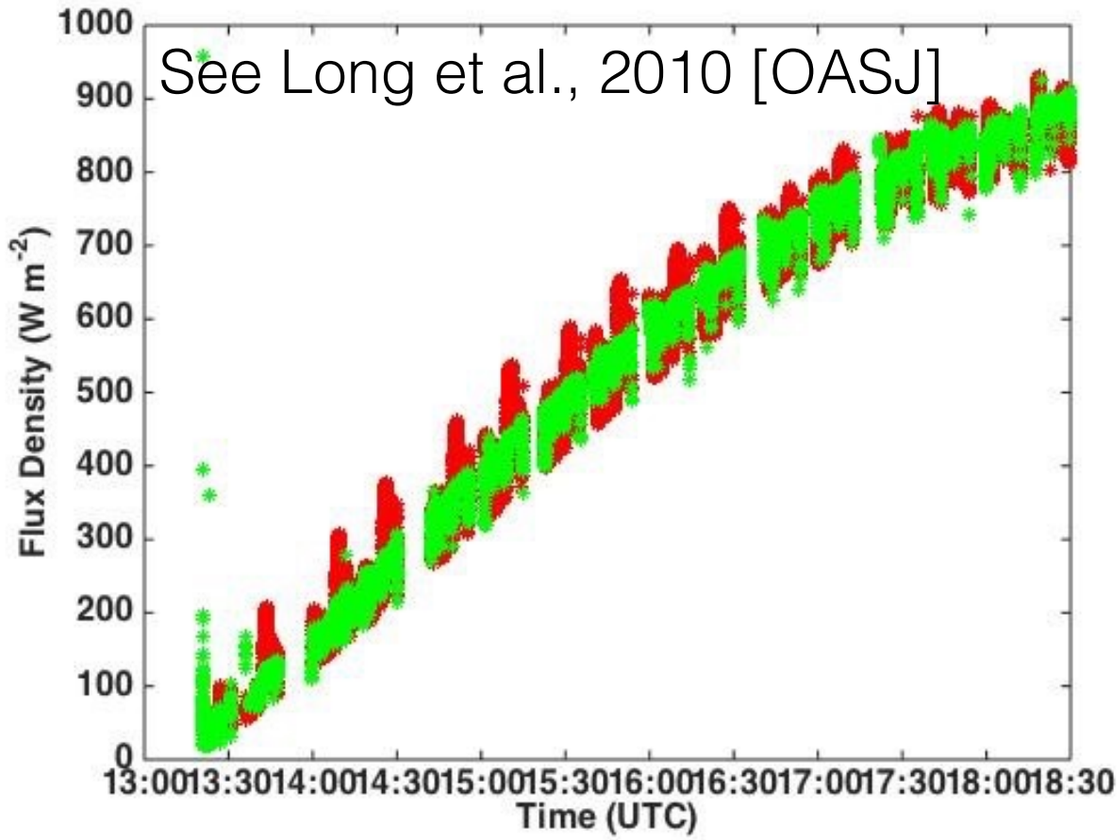




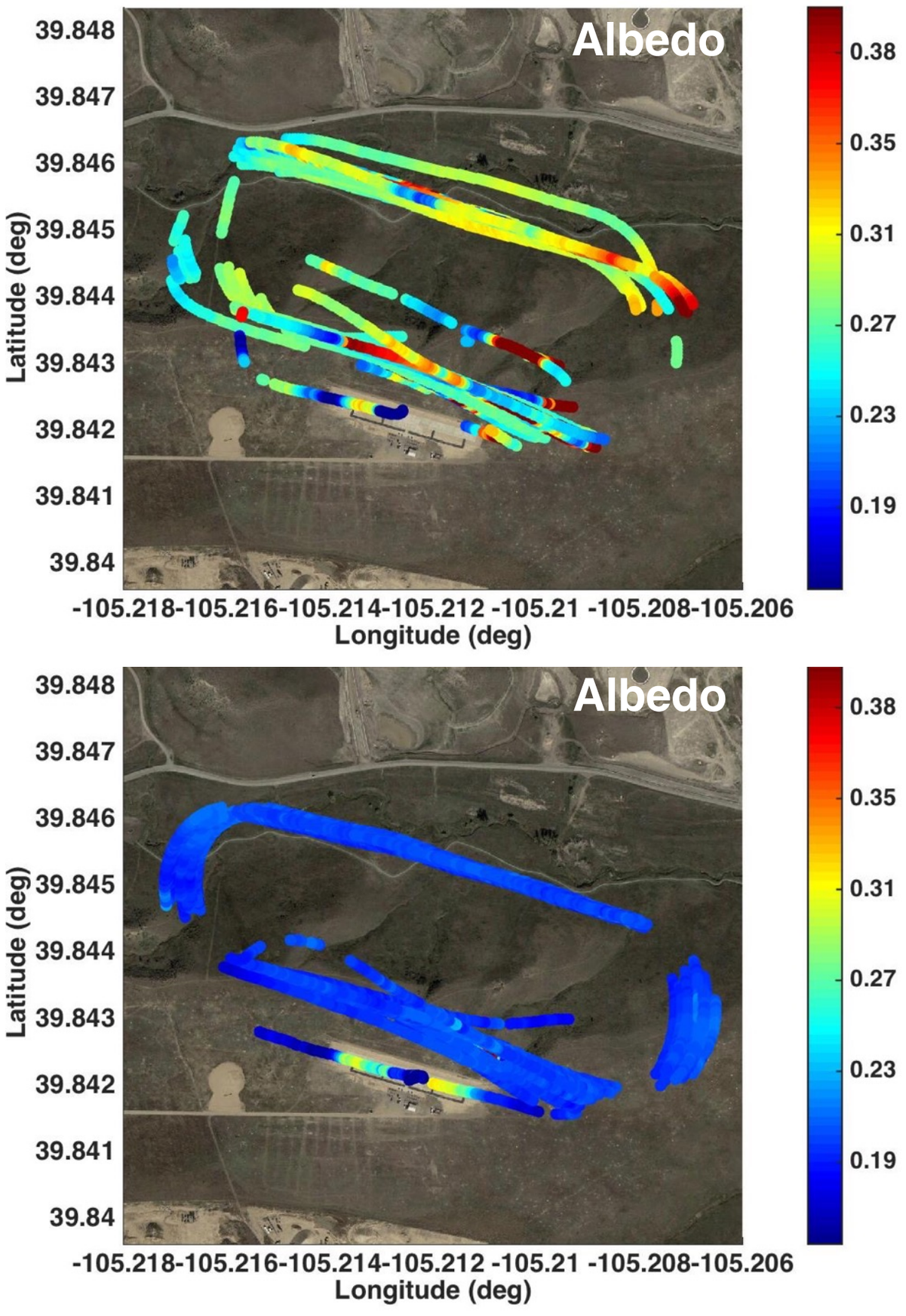
Radiation Correction







Pilatus Testing



Albedo
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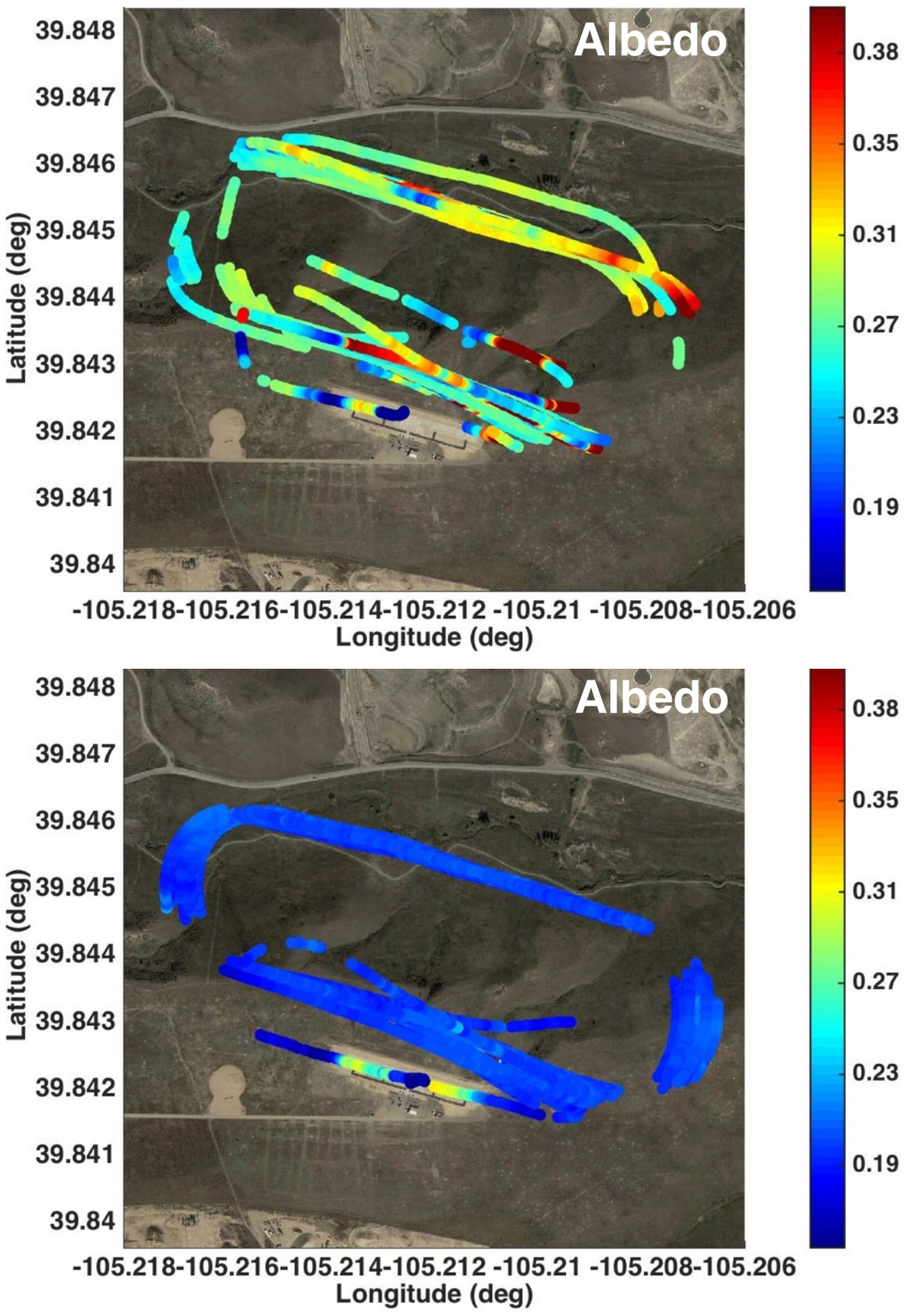
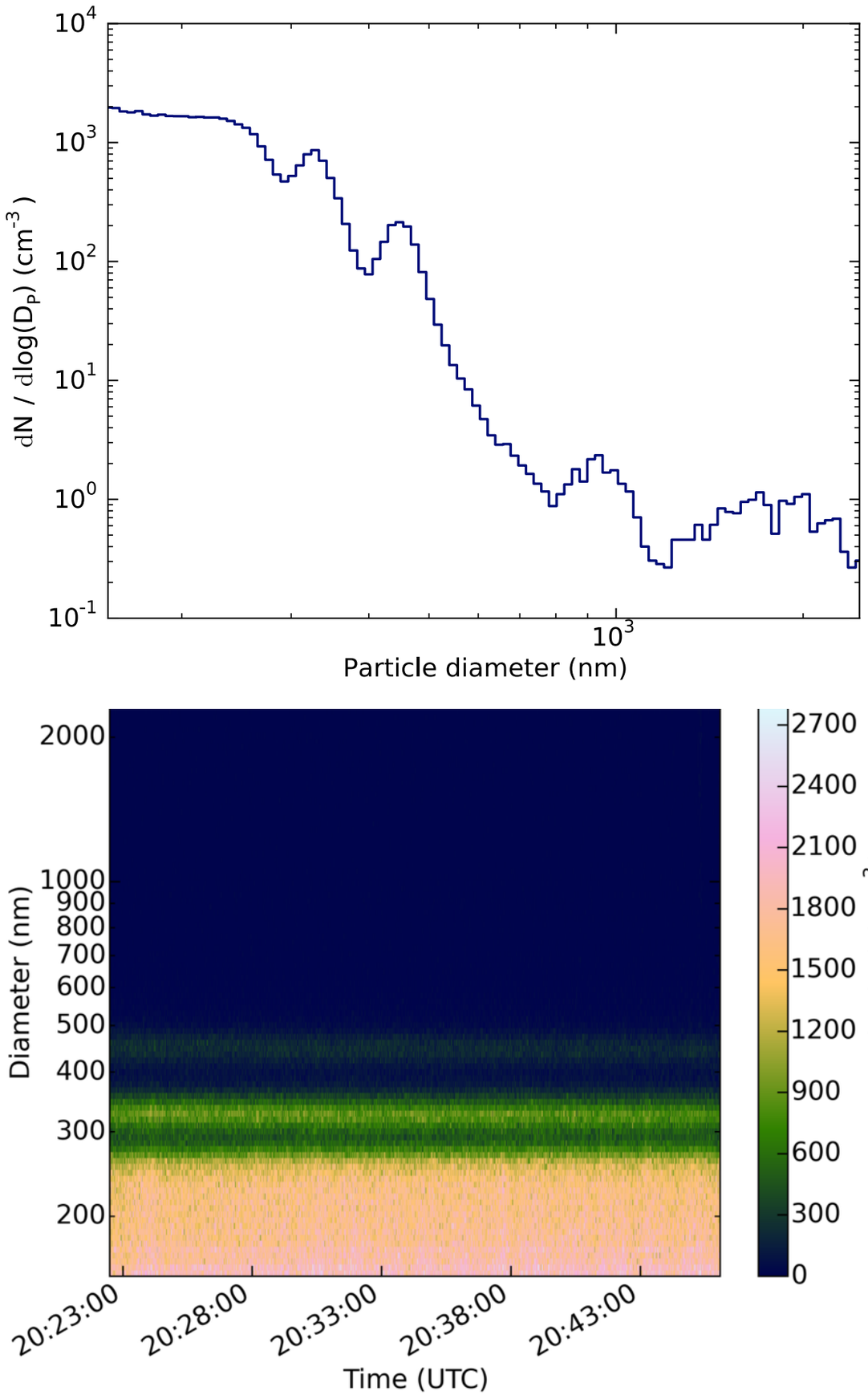
39.846
39.845
39.844
39.843
39.842
39.841
39.84
Latitude (deg)
-105.218-105.216-105.214-105.212 -105.21 -105.208-105.206
Longitude (deg)
0.38
0.35
0.31
0.27
0.23
0.19

Pilatus Testing





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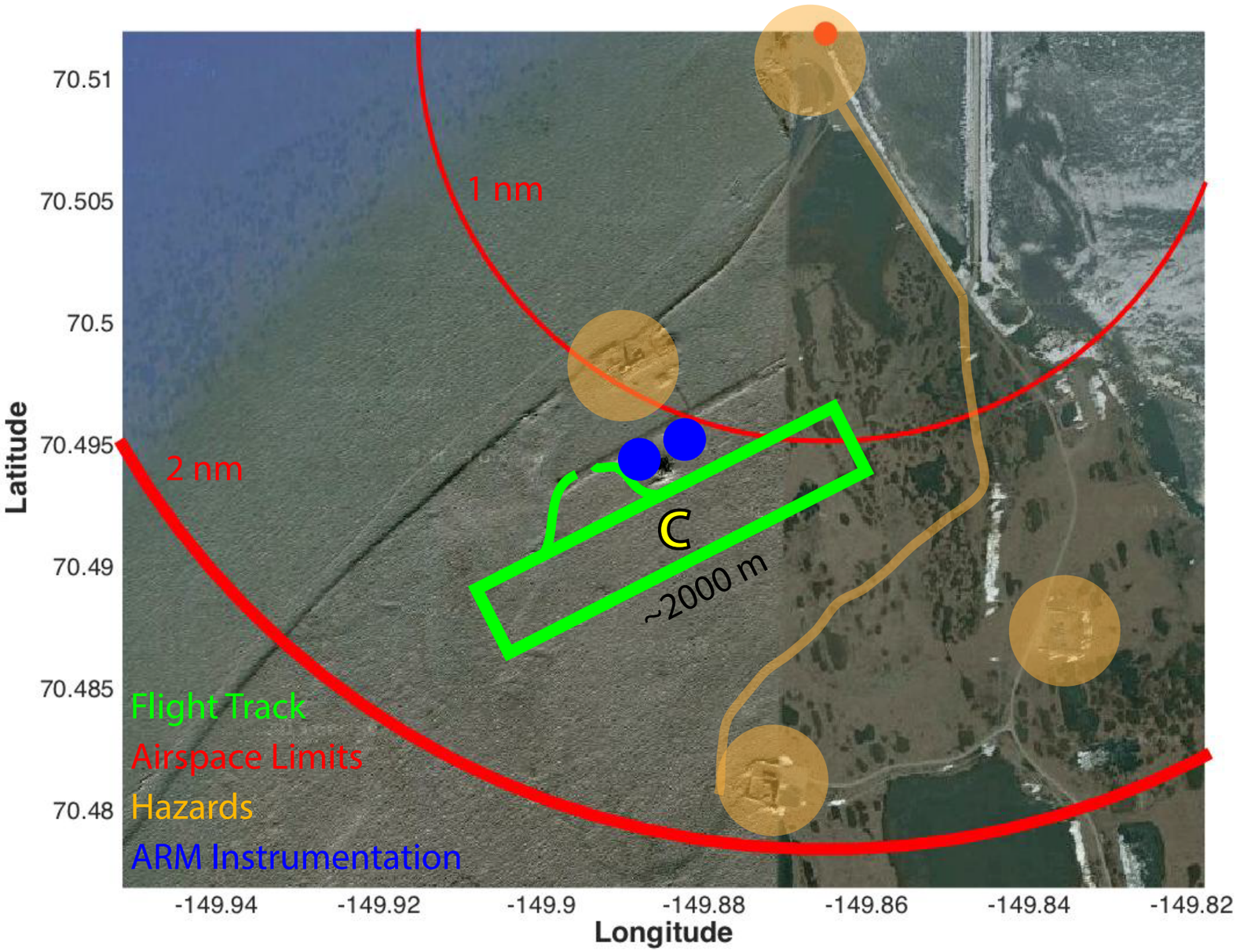

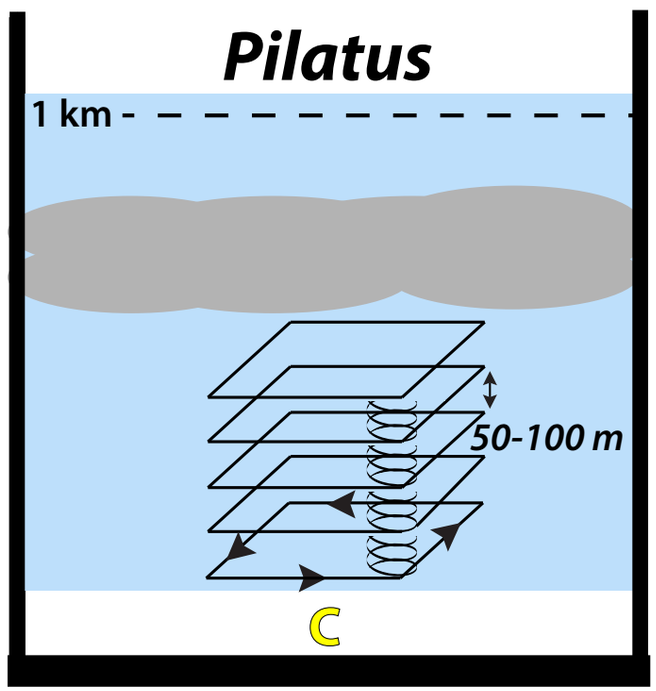

Evaluation of **R**outine **A**tmospheric **S**ounding **M**easurements using **U**nmanned **S**ystems (Pilatus)

- April, 2016
- Frequent profiles of aerosols and radiation in Arctic Haze

Summary

- We are developing and deploying a variety of tools for UAS-based research on the North Slope of Alaska
- In October of 2014, we deployed the DataHawk UAS to Oliktok Point to obtain measurements of the lower Arctic atmosphere and surface
- Development work has focused on improvement of the DataHawk UAS for Arctic applications, and the instrumentation and preparation of the Pilatus UAS for deriving measurements of aerosols and radiation
- The next generation DataHawk will be deployed to Oliktok Point for two weeks this summer
- The Pilatus will be deployed to Oliktok Point for two weeks in April, 2016

Funding

ASR Atmospheric System Research

ARM CLIMATE RESEARCH FACILITY

NOAA NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION U.S. DEPARTMENT OF COMMERCE