Evaluation of Routine Atmospheric Sounding Measurements using Unmanned Systems (ERASMUS)

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ERASMUS Project Summary

Overview

A 2-week campaign (spring of 2015), aimed at *evaluating potential contributions* of UAS to the ARM/ASR programs. We will use inexpensive UAS to demonstrate potential for future routine measurements.

Goals

- *Goal 1:* Demonstration of frequent and regular profiling of basic meteorology from surface to cloud base over a 2-week period
- *Goal 2:* Demonstration of unique measurement capabilities relevant to ARM/ASR (cloud properties, radiation, aerosol concentrations, etc.)
- *Goal 3:* Evaluation of environmental limitations to flight operations (e.g. wind, visibility, precipitation, cloud cover, icing, etc.) at Oliktok
- *Goal 4:* Collection of scientifically relevant measurements of parameters central to ARM/ASR mission, including spatial variability. This specifically includes measurements that complement those from the AMF3.
- *Goal 5:* Demonstration of utility of UAS in ARM operations (e.g. AMF radar calibration)

Final Products

- Final report detailing the outcome of the proposed experiments, including information on current operational constraints at the Oliktok site
- Formatted and QC'd datasets for the two week experiment submitted to the ARM archive
- Publications highlighting the potential for future UAS activity at Oliktok Point along with potential scientific contributions to be made

Scientific Motivation

Lower atmospheric thermodynamic structure

- High temporal resolution measurements currently not available
- Infrequent profiling leaves numerous open questions about evolution of temperature and humidity in transition (cloudy to clear or clear to cloudy) periods, and the impacts of precipitation on lower tropospheric stability

Profiles of Aerosol Concentrations/Properties

- Currently only surface-based measurements are available, making evaluation of aerosol influence on clouds and radiation challenging

Relative roles of local processes and large-scale advection in cloud production and maintenance

- Poorly understood contributions from local (cloud-driven) processes and large scale transport of temperature and moisture

Environmental/Aerosol influence on thermodynamic phase of hydrometeors

- Under what thermodynamic conditions does ice form in the Arctic atmosphere?
- Under what aerosol characteristics does ice form in the Arctic atmosphere?

Vertically resolved measurement of radiation

- Surface based radiation estimates can not distinguish between contributions from the atmosphere, the cloud and precipitation

UAS to be Used

For Routine Profiling: *DataHawk*

Overview: Small, lightweight (~700 g), inexpensive (~$1000) UAS with basic meteorological instrumentation on board
Advantages: Lightweight, cheap, relatively easy to operate, maneuverable
Disadvantages: Small payload, limited endurance

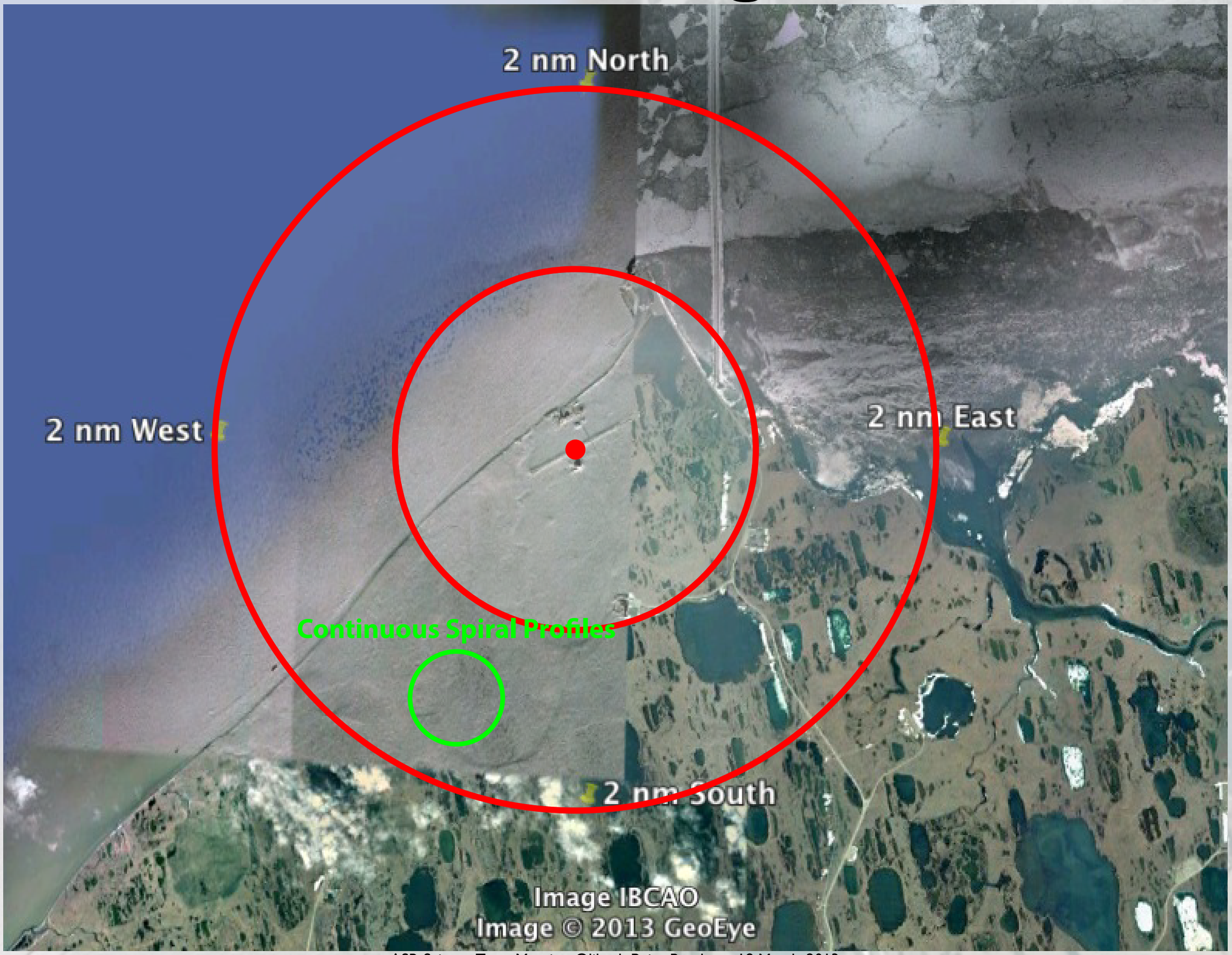
For Instrument Demonstration: *Tempest*

Overview: 10.5 ft. wingspan, 1 hour endurance, 75 kt. cruise speed, 15 lb. maximum takeoff weight
Advantages: Larger payload capabilities, longer endurance
Disadvantages: More expensive, front-mounted propeller
Payload Demonstrations: cloud particle imager, broadband radiometers, aerosol counters

For Radar Callibration: *Multicopter*

Overview: Small, lightweight quad- or hexa-copter with attached corner reflector and advanced navigation for precise height/position
Advantages: Hovering capabilities, inexpensive
Disadvantages: Operation in calm conditions

Potential Profiling Patterns



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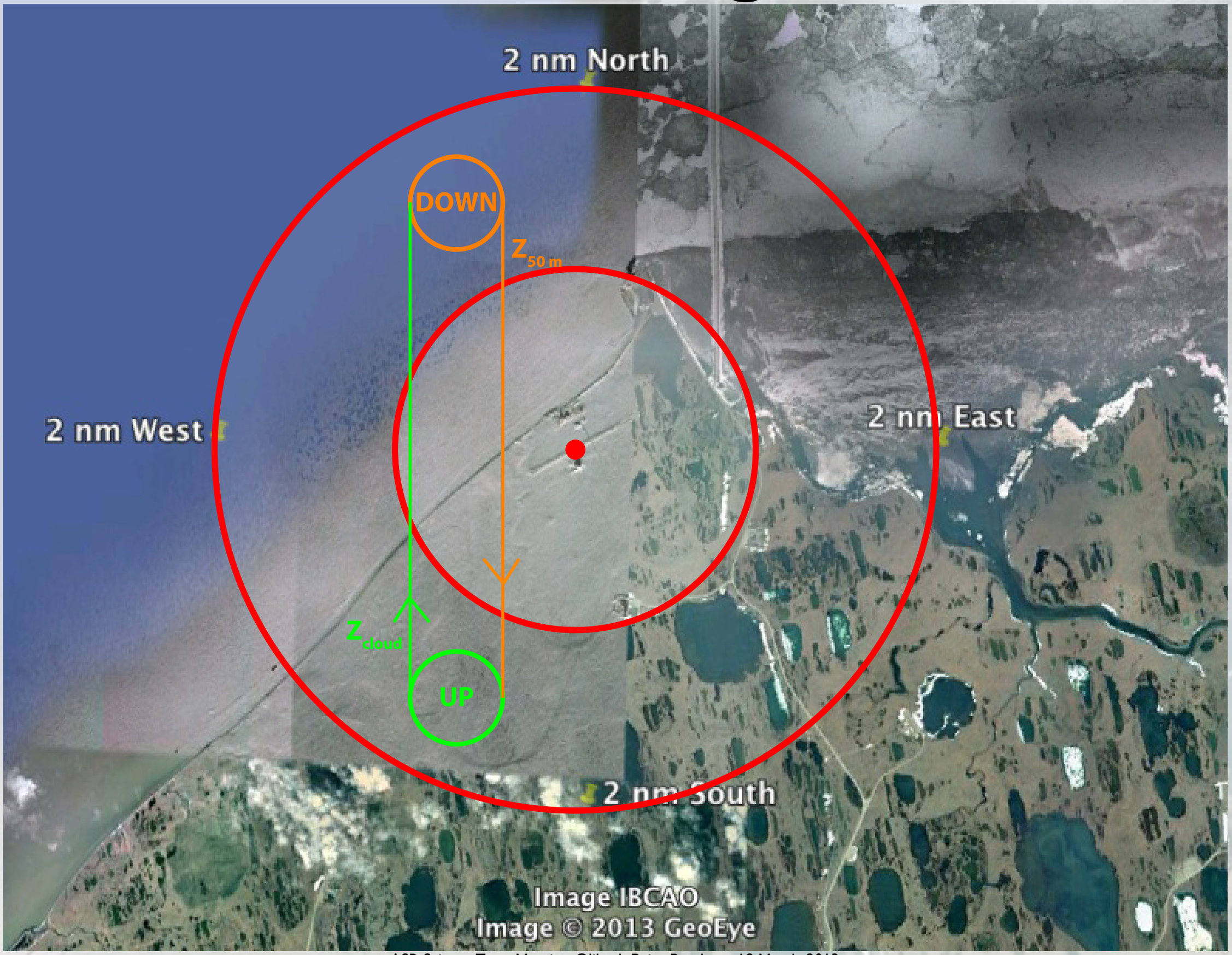

Considerations/Questions

For ASR Science Community:

- What role do YOU envision for UAS use for Arctic atmospheric science?
- What measurements would you like to see profiles of?
- What length of transect is necessary in order to evaluate large-scale advection? At what frequency?
- What frequency would you like to see basic meteorological variables profiled at?
- What is the size range of aerosol particles for which we would like to have profile information?
- Which wavelengths are of interest for broadband radiation profiles?

For ACRF/Sandia personnel:

- Is it possible to recover vehicles in the vicinity of the Oliktok Point site?
- What radio frequency are other instruments operating at?
- What is the general frequency and flight path of oil company helicopter traffic?
- What are the specific needs for radar calibration?
- Is it possible to travel between Deadhorse and Oliktok on a semi-regular basis?
- What is the status of heat/electricity of structures available for use?
- Will there be additional personnel on site for AMF3 operations that will require bunks?
- Is the restricted airspace centered on the point, or on the hangar?
- Are there other projects proposed during this time period?