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# Unmanned Aerial Systems and The Arctic

John F Burkhart

Associate Professor, Department of Geosciences, University of Oslo

Science Coordination Office, Greenland Environmental Observatory at Summit,  
University of California

GEOSummit Workshop, NASA Goddard

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30 January, 2014

# Why (not) UAS?

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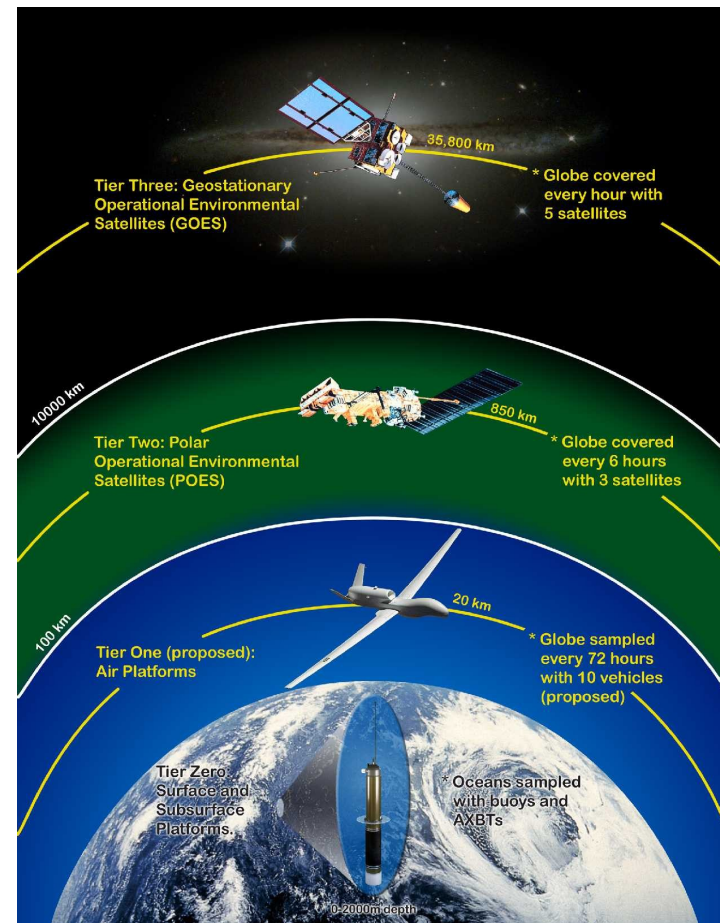
- Airspace access
- Flights in US airspace require a Certificate of Authorization (COA) from the FAA
- Primary limitation is “see and avoid”
- Many current demonstrations in military or foreign airspace
- *Affordability*



- Limitations DO exist!
  - Most importantly, keep realistic expectations
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# Why UAS?

- Fulfill a key gap in the existing observing system
- Hazardous conditions
- Remote areas
- Long endurance
- Stealthy performance
- Cost?



# Operational Elements and Requirements

	Canada	Finland	Greenland/ Denmark	Iceland	Norway	Russian Federation	Sweden	USA
UAS regulations	Yes	Yes	Yes	No	No <sup>a</sup>	Yes <sup>b</sup>	Yes	No
Regulations in process <sup>c</sup>	Yes	No	No	No	Yes	Yes	No	Yes
Ops history	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
Commercial allowed	Yes	No	?	?	Yes	Yes	Yes	No
BLOS allowed	Yes	No	Yes <sup>c</sup>	?	Yes <sup>d</sup>	?	Yes	No
RC allowed	Yes	Yes	Yes	Yes	Yes	Unknown	Yes	Yes
Ground observers required	Yes	Yes	Yes	?	Yes	?	Yes	Yes
Size limits	No	20 kg	25 kg	5 kg <sup>e</sup>	No	?	Yes	Yes
Altitude limits	As specified in SFOC	150 m	100 m <sup>f</sup>	?	No	?	Yes	Yes
Time limited	Yes	Yes	Yes	?	No	?	?	Yes
Pilot certification required	Yes	?	?	?	No	?	Yes	Yes
Insurance required	Yes	?	Yes	No	Yes	?	?	No

<sup>a</sup> Following and participating in EUROCAE and ICAO harmonization efforts, no specific regulations in Norway.

<sup>b</sup> Regulations, if they exist at all, are unclear in this translation. Some UAS activities appear to be allowed, but the unit(s) of Russian Federation Government that has/have authority over those activities is also unclear. Clarification is desired.

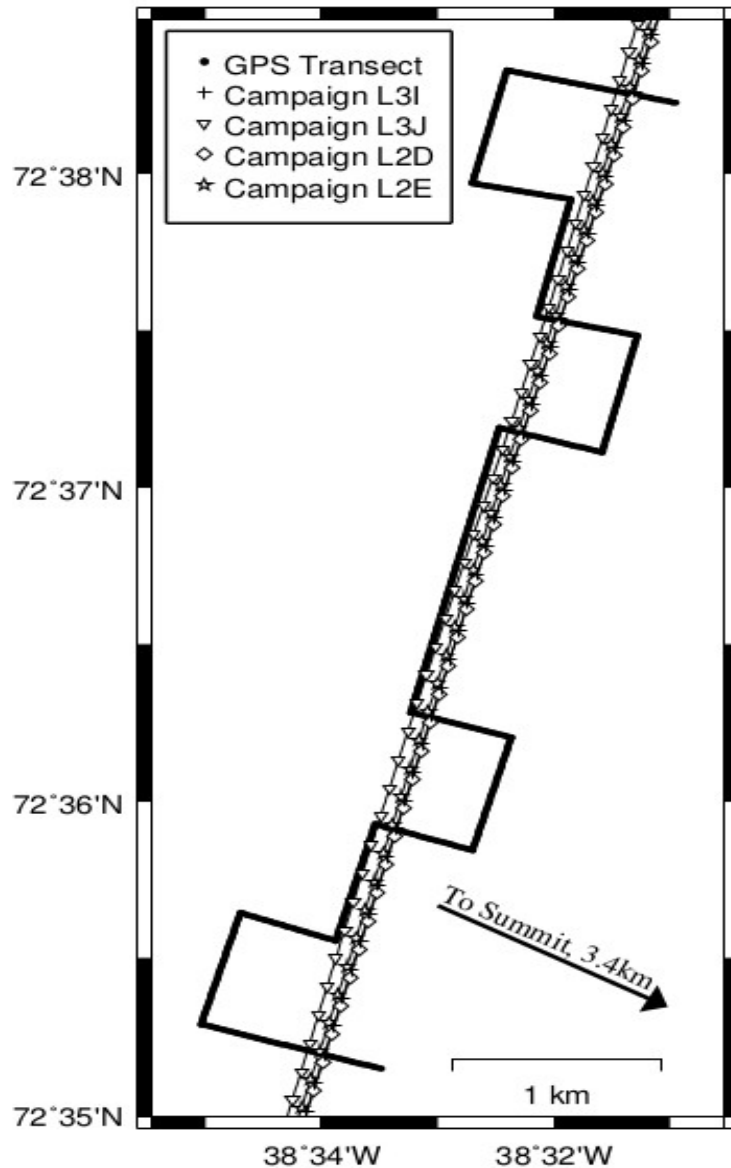
<sup>c</sup> BLOS not allowed on mainland Denmark and Greenland, may be allowed in Arctic and away from airfields/populated areas.

<sup>d</sup> If within segregated airspace or danger areas.

<sup>e</sup> For RC aircraft. No stated weight limit or other restrictions on non-RC UAVs.

<sup>f</sup> Flight above 100 m AGL may be allowed in Arctic and away from airfields/populated areas.

# ICESat-2 and UAS

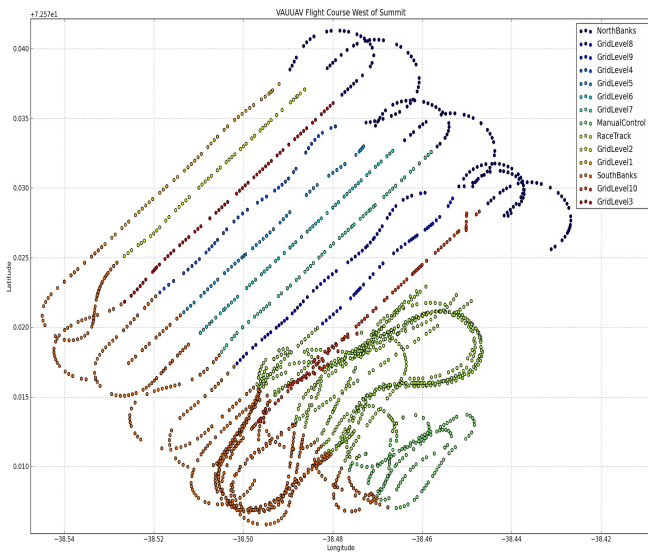


- Opportunities:
  - Lidar profilometry
  - Surface properties
  - albedo
- Long term observations
- Repeat transects
- Economic value w/persistent duration deployments



# Arctic Observations

## Unmanned Aerial Systems for Observing the Arctic



### Trios Spectrometers

- Ground: Up & Down looking cosine corrected, 7-deg FOV down
- AIR: Up Cos Corr., Downward looking 7-deg FOV

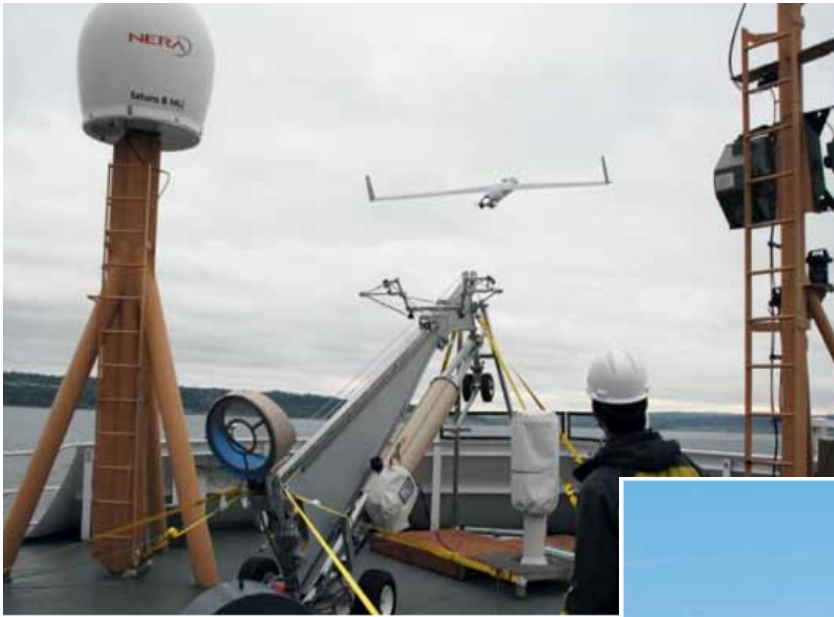
### Snow pack characterization

- Black Carbon sampling top 'layer'
- Snow pits for physical profiles
- IR Photography & grain size pictures

=== CryoWing ===

- Meteorologic Package
- Canon 450-D raw image collection

# Agile Systems



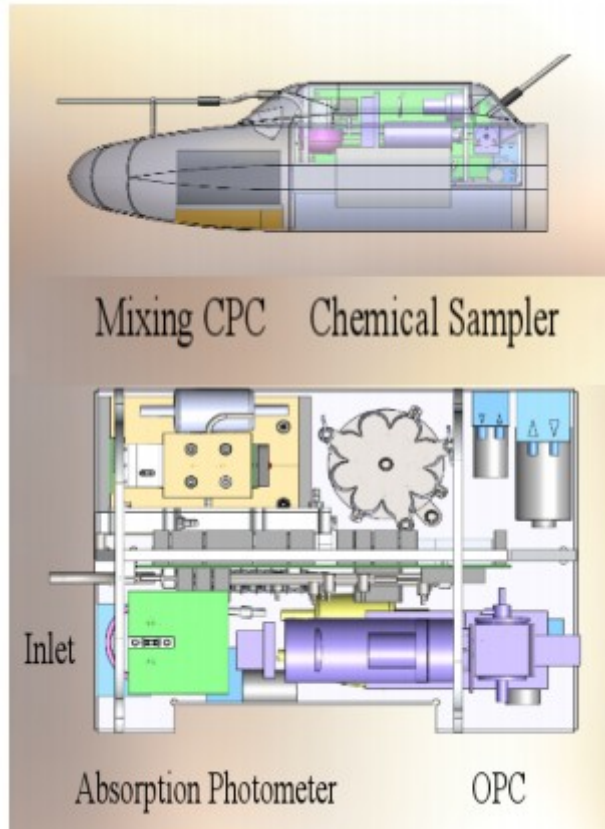
# CICCI 2011

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# UAS Measurements during CICCI/VAU UAV



Atmos. Meas. Tech. Discuss., 6, 2483–2499, 2013  
[www.atmos-meas-tech-discuss.net/6/2483/2013/](http://www.atmos-meas-tech-discuss.net/6/2483/2013/)  
doi:10.5194/amtd-6-2483-2013  
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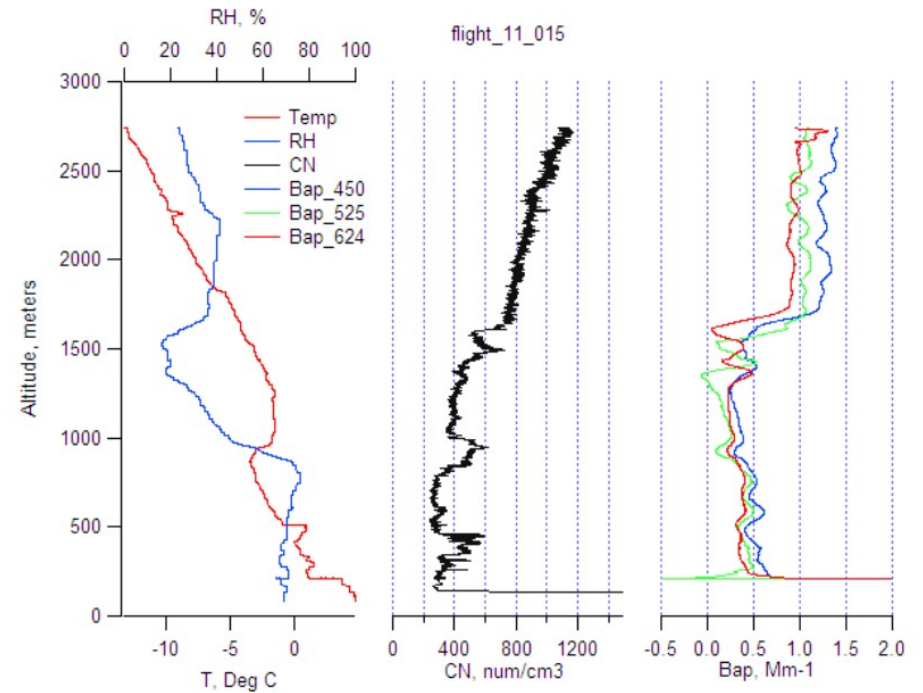
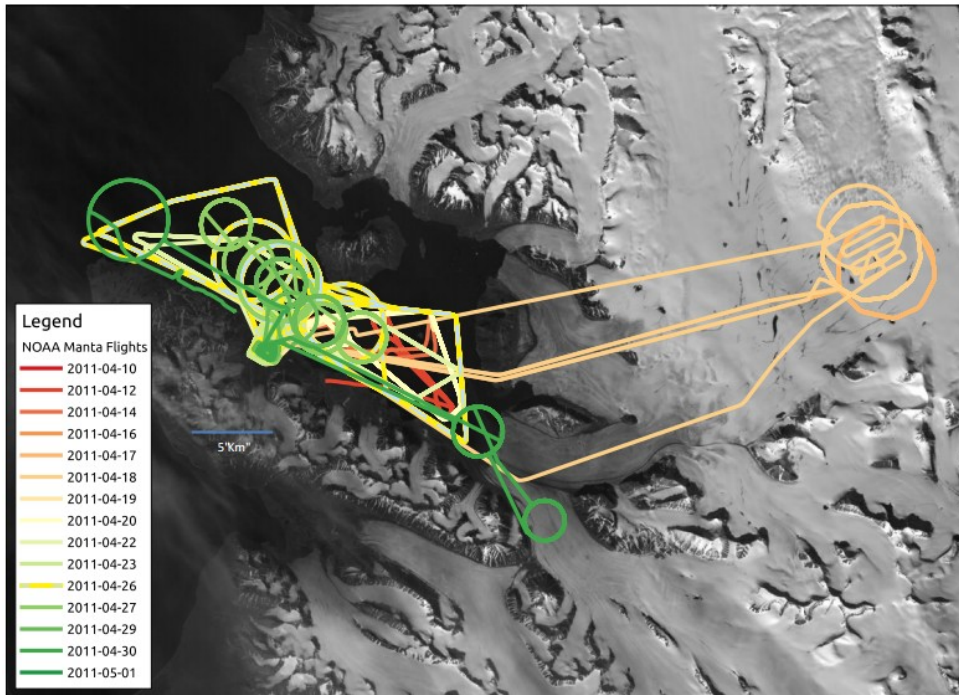
Atmospheric  
Measurement  
Techniques  
Discussions  
Open Access  
EGU

This discussion paper is/has been under review for the journal Atmospheric Measurement Techniques (AMT). Please refer to the corresponding final paper in AMT if available.

## Measurements of atmospheric aerosol vertical distributions above Svalbard, Norway using unmanned aerial systems (UAS)

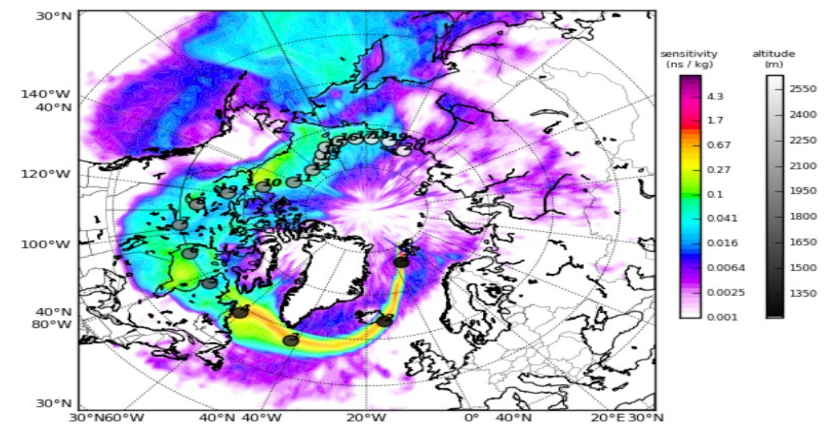
T. S. Bates<sup>1</sup>, P. K. Quinn<sup>1</sup>, J. E. Johnson<sup>2</sup>, A. Corless<sup>3</sup>, F. J. Brechtel<sup>3</sup>,  
S. E. Stalin<sup>1</sup>, C. Meinig<sup>1</sup>, and J. F. Burkhardt<sup>4,5</sup>

# Quick Looks from the Manta



Sensitivity at Footprint m.a.s.l.: AIRTRACER

Release Start: 2011-04-26 16:49:41, Release End: 2011-04-26 16:50:35



# UAS to address Open Questions

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- What changes can we expect as the Arctic:
    - Becomes a source?
    - Has local sources?
  - Required changes in observational capacities?
  - How can we better utilize UAS technologies for observations?
    - *Need to better understand known / unknown feedback mechanisms*
    - *UAS provides a valuable tool for vertical profiling*
    - *Coverage of large areas*
    - *Economical for long-term deployments / monitoring*
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