

# U.S. DOE Atmospheric Radiation Monitoring (ARM) Facilities, Unmanned Aerial Systems, and Campaigns in the Alaska Arctic



2017 = 20 years at Barrow/Utqiagvik!

Poster #11197

Photographs Allowed

The ARM mission is to provide atmospheric observations that improve climate models



## Controlled Airspaces:

- R-2204: at Oliktok Point, AK
- domestic airspace, to 7000 ft (2134 m)
- W-220 40x700 n.miles (70x1296 km) toward North Pole
- international airspace, to 10000ft (3048 m)



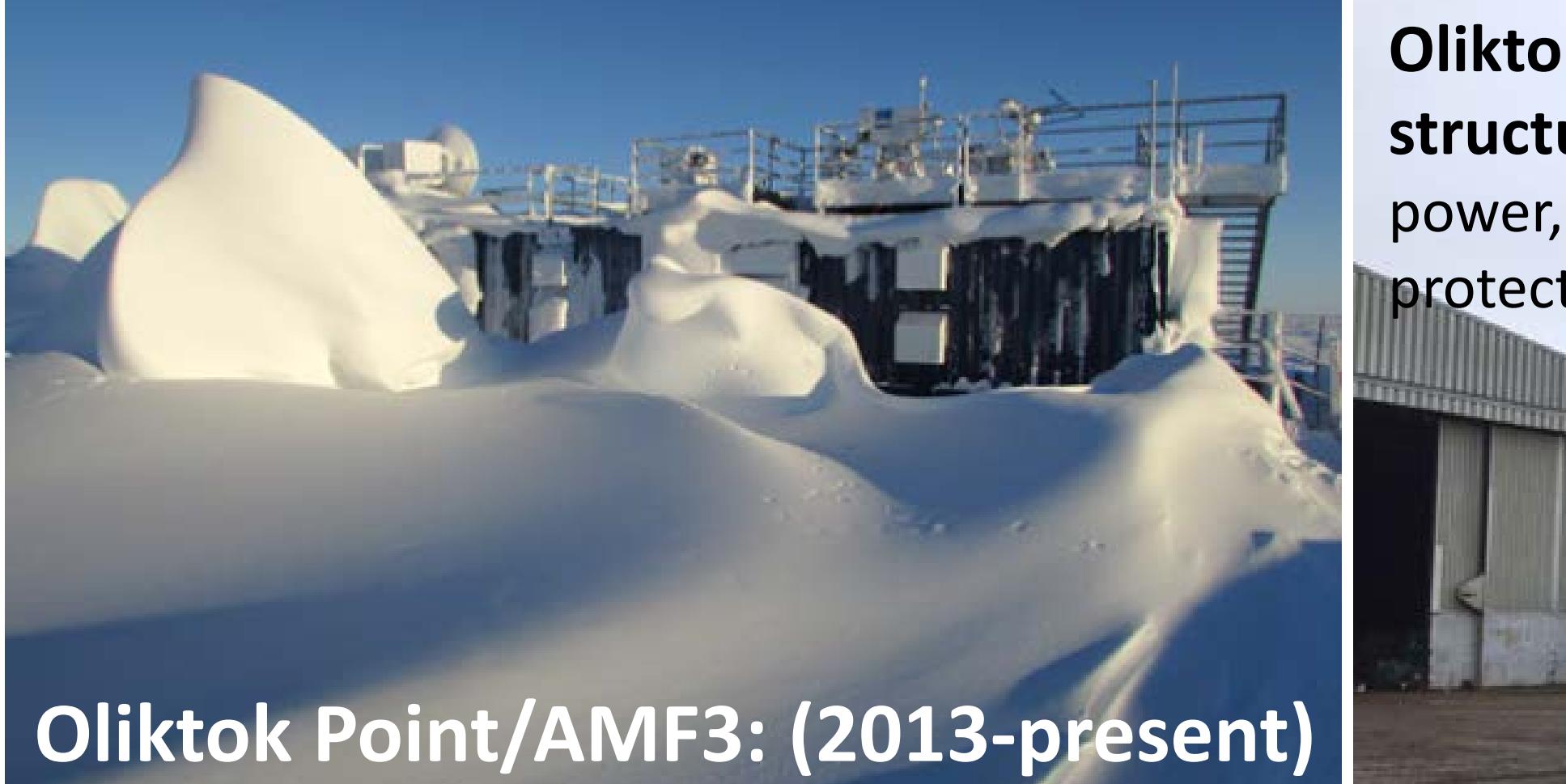
## Barrow/Utqiagvik NSA main site (1997-present)

Great White: User Shelter:  
ARM instruments Guest use/instruments



## Atqasuk: Pumpkin Shelter

(Credit: Will Shaw, Jim Barnard)



Oliktok Point Sprung structure and Hangar:  
power, lighting, weather protection



## Tethered Balloon systems (TBS)

- Can operate in clouds
- 35m<sup>3</sup> helikites: 30 lb payload; up to 2,000' (610 m) AGL
- Aerostat: 80 lb payload; up to 6,000' (1,830 m) AGL

## Distributed Temperature Sensing:

- Fiber-optic hi-res measurement of permafrost, active layer, atmosphere, sea ice, and ocean interfaces or profiles

## TBS ARM Instruments: \*Also fly guest instruments

### Aerosols:

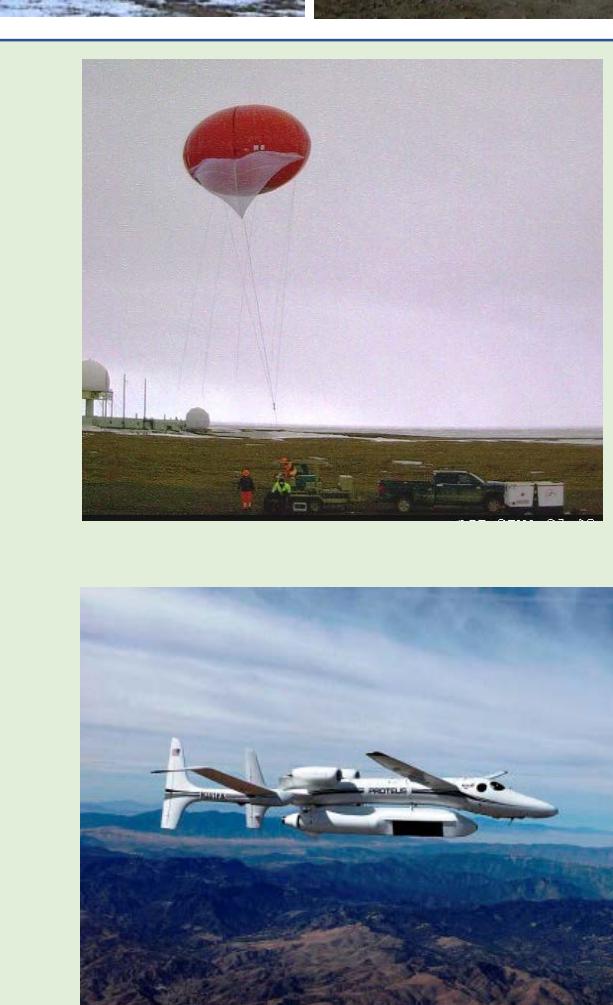
- POPS/Printed Optical Particle Spectrometer: aerosol concentrations/size distributions
- Mini-SASP/Miniature Scanning Aerosol Solar Photometer: aerosol optical depth/AOD profiles
- CPC/Condensat. Particle Counter: aerosol size distribution

### Meteorology & Thermodynamics:

- Tethersondes: for pressure, RH, temp., wind speed/direction, altitude, lat/long
- DTS/Distributed Temperature System: temperature profiles

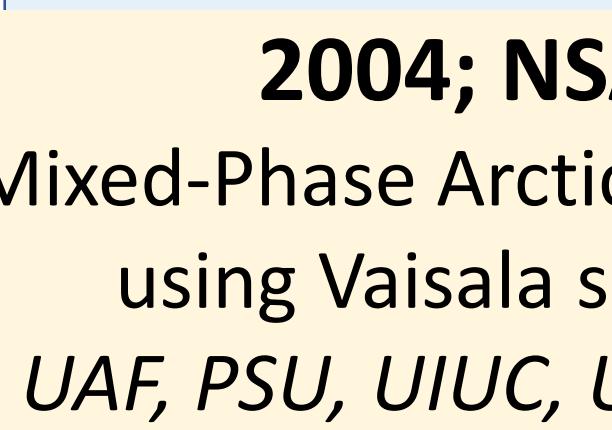
### Ice and Liquid in clouds:

- SLWCs/Supercooled Liquid Water Content sensors: cloud liquid water content
- VIPS/Video Ice Particle Sampler: ice microphysics

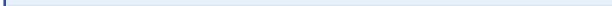


## UAS at ARM Arctic Sites

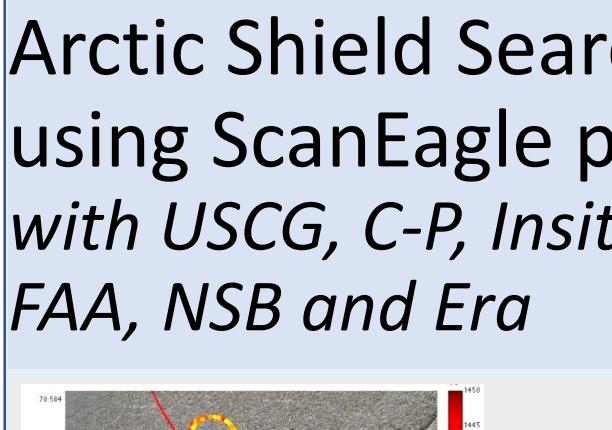
2001; NSA/Barrow:  
First UAV flights at  
North Slope AK  
Aerosonde with NSF



2004; NSA, ATQK, OLI, Toolik Lake:  
Mixed-Phase Arctic Cloud Experiment (M-PACE)  
using Vaisala sondes and ARM-Proteus UAV  
UAF, PSU, UIUC, UND, UWisc, PNNL and NOAA



2015; Oliktok:  
Arctic Shield Search & Rescue exercise  
using ScanEagle platform  
with USCG, C-P, Insitu, NOAA,  
FAA, NSB and Era



2015-16; Oliktok:  
ERASMUS-I, II  
DataHawk & Pilatus platforms  
with CIRES/CU-Boulder

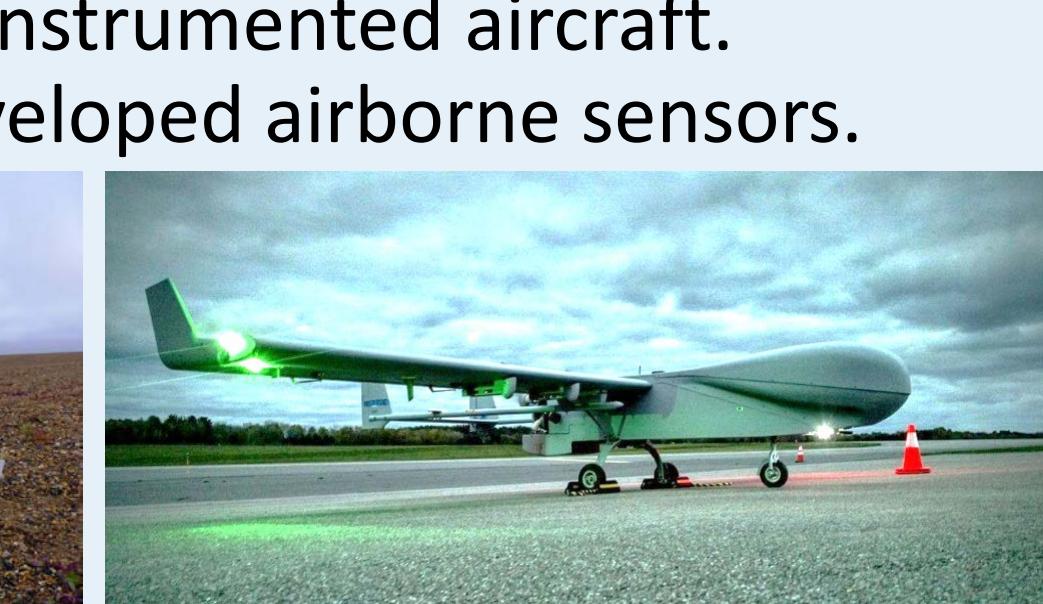


2017; Oliktok Point/OLI:  
Joint UAV-Balloon Activities (JUBA)  
using ARM-TBS and Sandia Cinestar 8 Octocopter  
Sandia National Labs



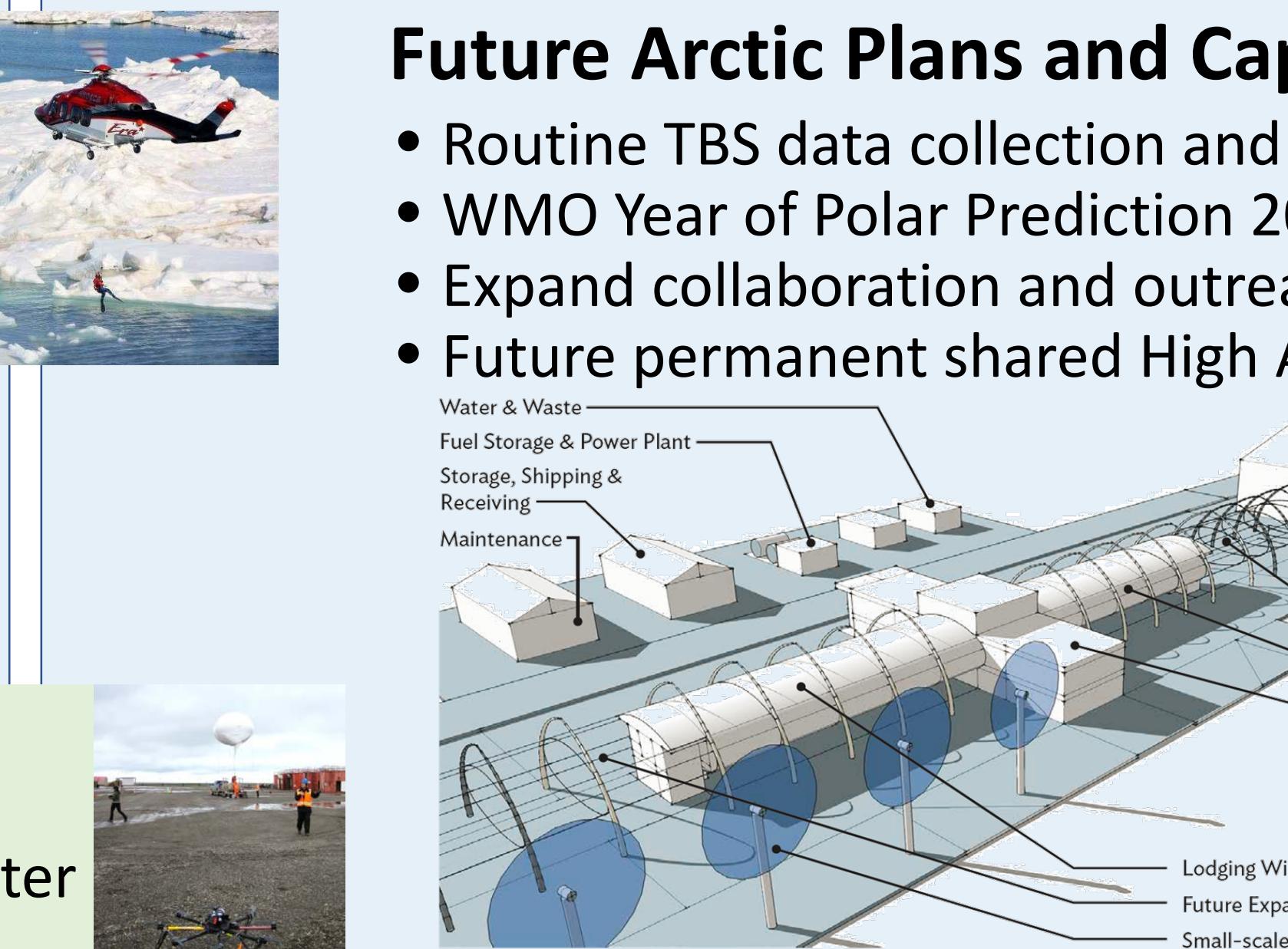
## ARM Aerial Facility (AAF, at PNNL)

- DataHawks: 1 m wingspan, light (700 g) UAS, static 80 g payload.
- Arctic Shark: 6.7 m wingspan UAV, payload ~45 kg, flight to 5500 m.
- G-1: Manned instrumented aircraft.
- Test newly developed airborne sensors.

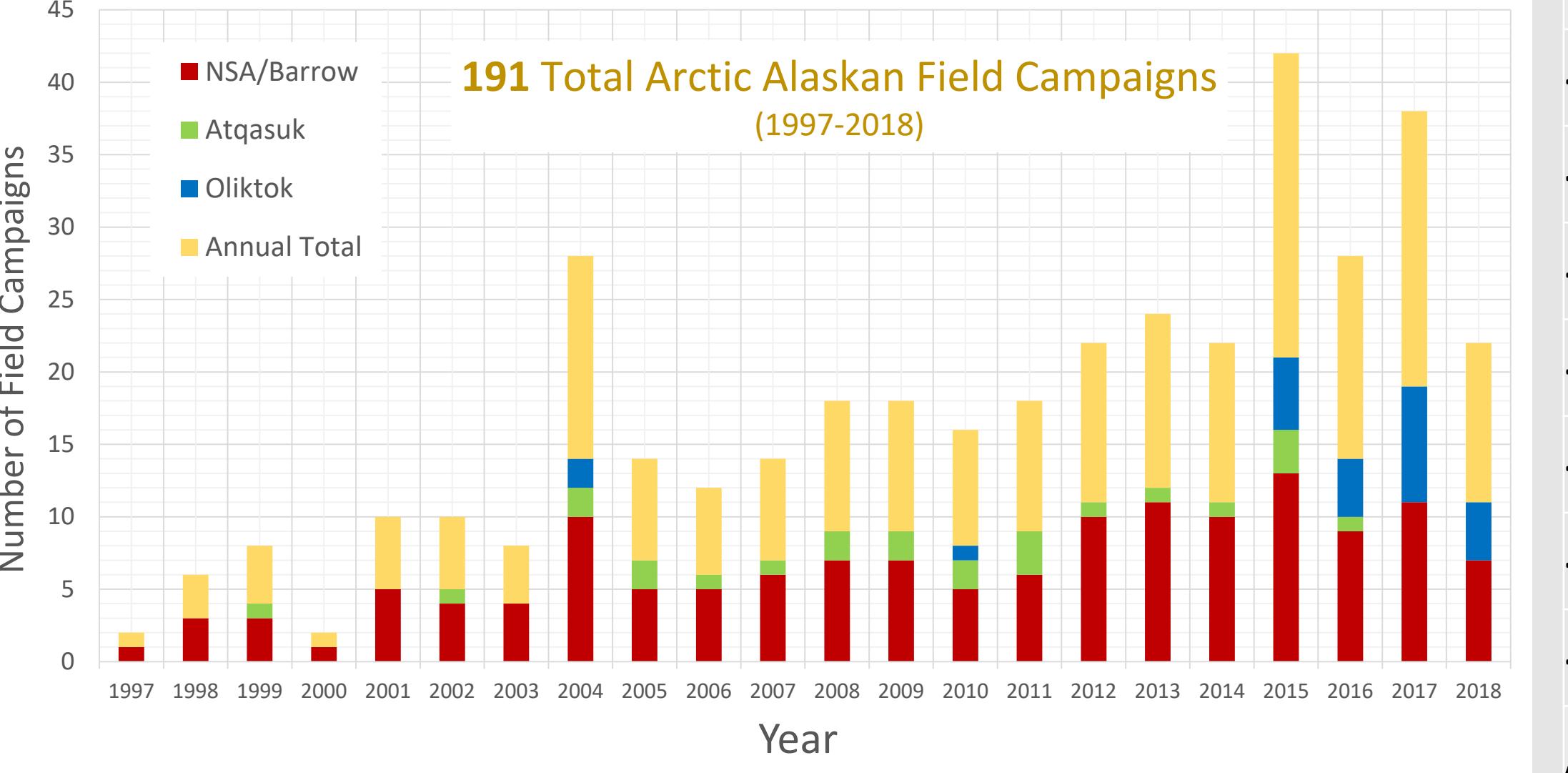


## Future Arctic Plans and Capabilities:

- Routine TBS data collection and joint TBS-UAV flights
- WMO Year of Polar Prediction 2017-19 campaigns
- Expand collaboration and outreach (STEM, NSF-LTER)
- Future permanent shared High Arctic R&D Center



## Field Campaigns at ARM Arctic Observatory Sites



## ARM Field Campaigns

The ARM Climate Research Facility provides the scientific community with the operational and logistical resources.

Any scientist can submit a proposal to do field campaigns at ARM's atmospheric observatories.

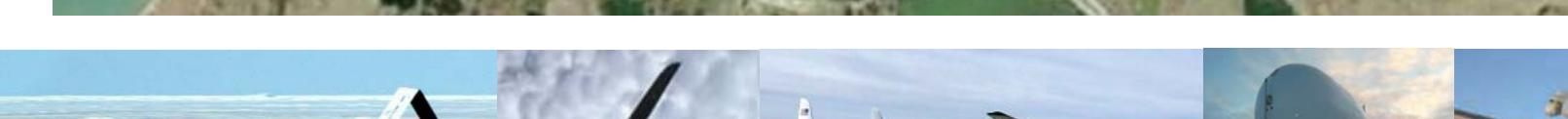
Proposals that coordinate with other DOE Bio-Environmental Research capabilities are encouraged, such as:

- Atmospheric System Research (ASR) program
- Energy Exascale Earth System Model (E3SM)
- Climate and Earth System Modeling programs

Two types of ARM field campaigns:

- Small Campaigns – cost ARM less than \$300k, may include guest instruments, use of ARM instruments for offsite deployments, or special operations.
- Annual Facility Call Campaigns – exceed \$300k cost to ARM and can involve a fixed-location observatory, mobile facility and/or aerial facilities.

To propose a campaign, principal investigators first submit a pre-proposal: <https://www.arm.gov/research/campaign-proposal>.



## Instrument Systems

### Instrument NSA ● AMF3 ●

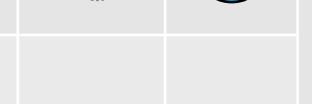
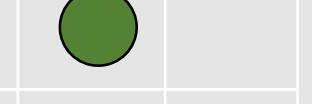
#### Surface Meteorology

- Meteorology tower (MET)
- Eddy Corr. Flux (ECOR)
- Ameriflux (AMC)
- Multi-angle Snow Camera (MASC)



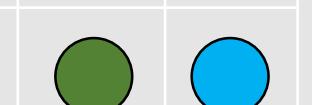
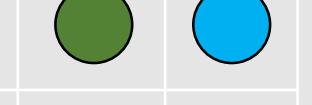
#### Atmospheric Profiling

- Balloon Sounding (SONDE)
- Automated SONDE
- Tethered Balloons (TBS)
- Unmanned Aerials (UAVs)



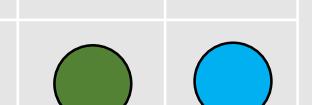
#### Cloud Properties

- Micropulse Lidar (MPL)
- Microwave Radiometer HF/Prof.
- Microwave Radiometer 3Chan
- Total Sky Imager (TSI)
- Vaisala Ceilometer (VCEIL)
- Ka-band Scanning Cloud Radar
- W-band Scanning Cloud Radar
- Ka-band Zenith Radar
- X-band Scanning Precip. Radar
- mm λ Radar Profiler (MMRP)
- Doppler Lidar (DL)
- Hi-Spec/Raman Lidar (HSRL/RL)



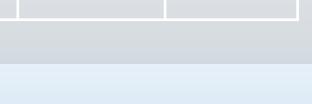
#### Radiant Flux Measurements

- Atmos. Emit. Rad. Interf. (AERI)
- Infrared Thermometer (IRT)
- Multifilter Shadowband Rad.
- Upwelling Radiation (GRNDRAD)
- Downwelling Radiation (SKYRAD)
- Multifilter Radiometer (MFR)
- Cimel Sunphotometer (CSPHOT)



#### Aerosols

- AOS shelter/instruments



Sandia National Laboratories

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