Oliktok Point, AK
Tethered Balloon Capabilities
Update

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Sandia National Laboratories (SNL) has operated on behalf of ARM:

- Barrow installation since 1997
- Atqasuk facility from 1999-2010
- ARM Mobile Facility #3 (AMF3) at Oliktok Point since 2013
SNL operates R-2204 at AMF3, the only ARM site with restricted airspace.

The restricted airspace encompasses a two nautical mile radius centered on Oliktok Point and is segmented by altitude into R-2204 Low (0-1,500’ MSL) and R-2204 High (1,500-7,000’ MSL).

Pursuing TBS operations at NSA in Barrow in late July 2016
Objectives of TBS

• ARM is developing a tethered balloon system (TBS) capable of operating at AMF3 up to 6,000’ AGL within DOE’s R-2204 restricted area.

• The TBS operates within clouds and collects high vertical resolution atmospheric data that will improve process understanding.

• Primary science objectives are improved understanding of arctic cloud, aerosol, and precipitation properties.
Current Equipment & Capabilities

Enclosed winch and 35 m$^3$ helikites used for Sep & Oct 2015, April 2016 flights

30 lb and 1600’ AGL

Balloon launcher #28 Skydoc aerostat planned for May 2016 flights
Launcher expected to arrive in Oliktok on 5/13/16

80 lb and 6000’ AGL
Current Equipment & Capabilities

- Limiting factors to TBS operations:
  - Crew availability
  - Sensor battery life in cold
  - Launch/retrieval wind limit of sustained winds > 30 mph at surface
  - Ice loading
  - Helium diffusion
  - Have experienced some EMI with TBS sensors at Oliktok

- Need Restricted Airspace or FAA Waiver to operate TBS > 150’ AGL

- Must have emergency deflation device on balloon
12 tethersondes provide a vertical profile of temperature, pressure, relative humidity, wind speed, wind direction, and altitude. Suspect SACR at Oliktok is interfering with compass (bad wind direction). Further testing is planned in May.

6 Supercooled Liquid Water Content (SLWC) sensors collect supercooled liquid water droplets on a vibrating wire. The frequency change of the wire’s vibration is related to SLWC. Ice content (IWC) and liquid water content (LWC) sondes expected to be deployed in fall 2016.
**Distributed Temperature Sensing (DTS) system** composed of 1.5 km of fiber optic cable. The fiber optic cable serves as the thermometer, with a laser serving as the illumination source. Provides measurements of temperature every 2 meters every 30 seconds with temperature resolution of < 0.1°C. First flown on TBS at Oliktok on 4/18/16.
3 **LWSs** (Leaf Wetness Sensors) estimate wetness by measuring the dielectric constant of the sensor’s upper surface. The sensor detects the presence of miniscule amounts of water, ice, or frost.

**Turbulence Pod** provides turbulence measurements from 3D sonic anemometer that are motion-corrected in order to calculate turbulent momentum fluxes. Expected to be deployed on TBS in October 2016.
TBS Sensors: VIPS, POPS, miniSASP

VIPS (Video Ice Particle Sampler) collects high-resolution imagery of ice particles for the purpose of obtaining size distributions and habit (shape) information for particles that range in size up to 1 mm. Expected to fly on TBS in October 2016.

POPS (Printed Optical Particle Spectrometer) measures dry aerosol number density and size distribution; derives dry AOD profiles & humidification effect

(AALCO) Aerial Assessment of Liquid in Clouds at Oliktok

- Proposed IOP at AMF3; PI: Erika Roesler of Sandia National Laboratory
- If approved operations expected in July 2016

- Laboratory Directed Research & Development (LDRD) funds to reduce uncertainty in regional climate change from Sandia National Laboratory cover equipment, labor, and analysis

- Studies performed with high-resolution and global models have uncertainties in understanding many properties of Arctic clouds.
- Goal is to reduce the number of unknowns in high-resolution Arctic cloud modeling by testing liquid water sensors on tethered balloons.
Planned operations include a smaller balloon (compared to the TBS) on an auto-reeler system. The auto-reeler will carry super-cooled liquid water content (SLWC) sensors and i-Met radiosondes into arctic clouds.

SLWCs flown on TBS at AMF3 in October 2015 were compared against the LES System for Atmospheric Modeling (SAMv6.10.8), an LES, simulated 26-29 October 2015 with $\Delta x = 100$ m, $\Delta z = 40$ m initialized by ARM’s ECMWF reanalysis data product.

Temperature, humidity, winds nudged to ARM’s ECMWF reanalysis data product every 6 hours with prognostic ice concentration of 0.4 $\#$/L used to tune for better agreement with SLWC.