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ARM CLIMATE RESEARCH FACILITY

Tethered Balloon Systems

Atmospheric Radiation Measurement (ARM) Climate Research Operations on the North Slope of Alaska

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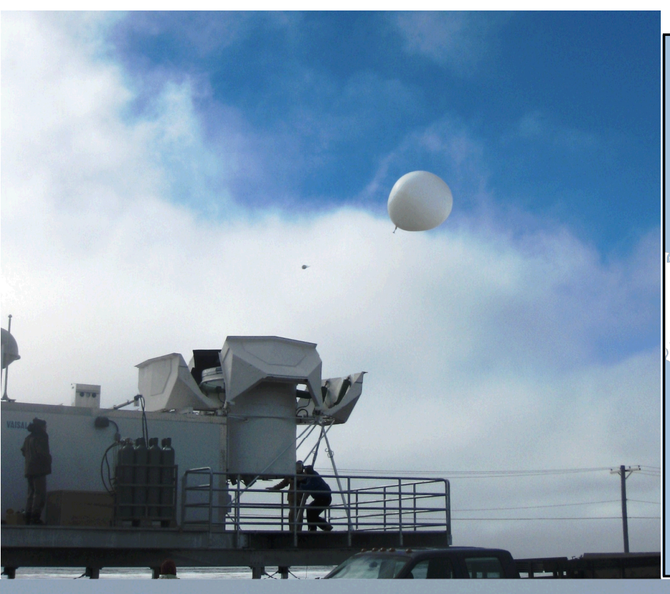
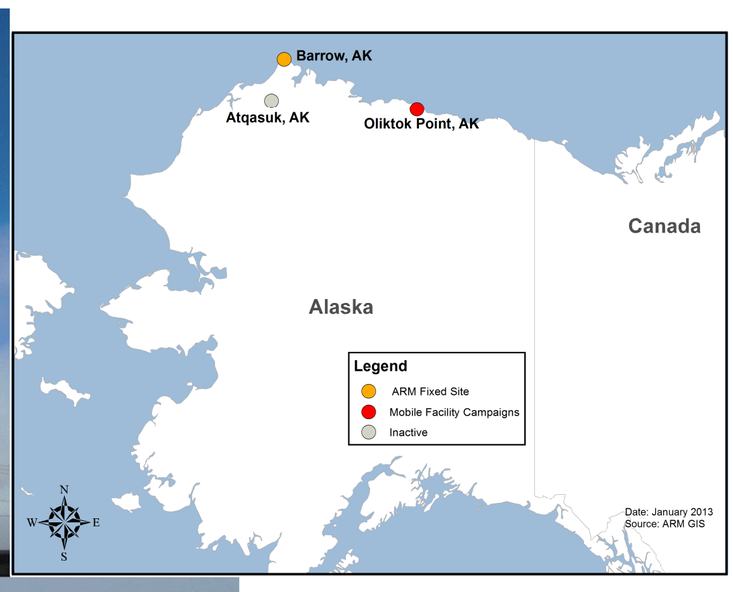
Introduction to ARM Tethered Balloon Operations

- ARM was created in 1989 by the U.S. Department of Energy (DOE) to develop several highly instrumented ground stations to study cloud formation processes and their influence on radiative transfer.
- ARM focuses on obtaining continuous measurements, supplemented by field campaigns, and providing data products that promote the advancement of climate models.
- ARM North Slope of Alaska (NSA) Science Mission is to collect high latitude data to refine climate models as they relate to the Arctic.
- ARM currently maintains two ground stations on the Alaskan North Slope in Barrow and Oliktok. Between the two facilities, over 32 instruments are supported.





Top Left: Automatic launching balloon system in Barrow, AK [1]
Right: Locations of ARM NSA ground stations [2]
Bottom Left: ARM Mobile Facility – 3 (AMF-3) in Oliktok, AK [3]

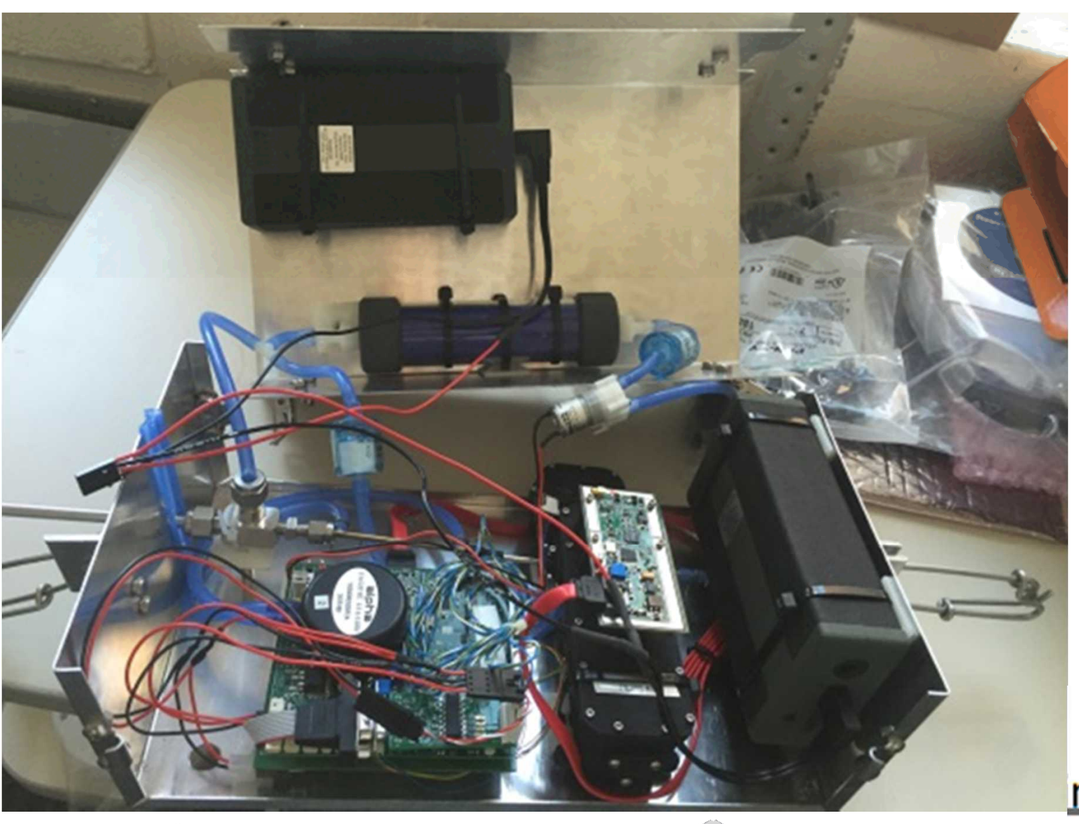
- SNL seeks to improve understanding of cloud properties using Large Eddy Simulation (LES) models.
- Static instruments found on ARM NSA facilities provide continual data streams, and auto launching, single instrument balloons provide simple, daily, vertical profile data.
- Tethered Balloon System (TBS) operations aim to provide supplemental data for use in tuning of high resolution LES models.
- Other areas include an SNL Laboratory Directed Research and Development effort to reduce uncertainty in regional climate models as well as overall improvement in the understanding and representation of clouds and aerosols in regional climate change models.

Tethered Balloon Systems Sensors

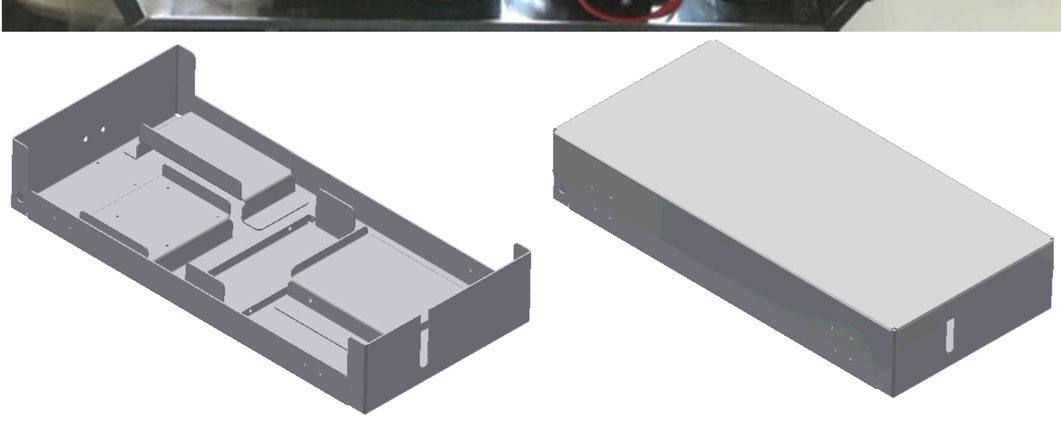
- SNL operates in a 2 nautical mile radius of restricted airspace at AMF-3. This allows for TBS operations of up to 6000’ Above Ground Level (AGL).
- Current TBS sensors include:
  - 12 Tethersondes that provide a vertical profile of temperature, pressure, relative humidity, wind speed, wind direction, and altitude
  - Supercooled Liquid Water Content Sensors (SLWC) that collect liquid water droplets on a vibrating wire
  - Distributed Temperature Sensing System (DTS) composed of a fiber optic cable acting as a high resolution thermometer
  - 3 Leaf Wetness Sensors (LWS) used to detect miniscule amounts of water, ice, or frost

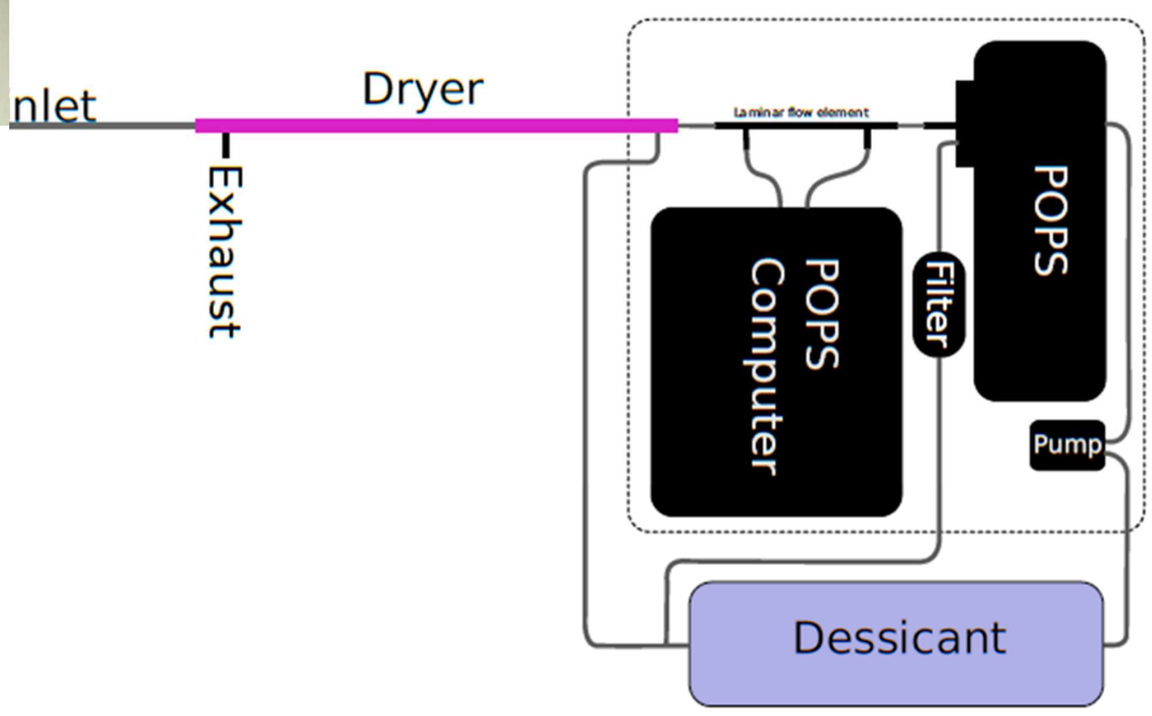
Left: Inflated TBS pre-launch [4]
Top Middle: Restricted Airspace at AMF-3 [5]
Bottom Middle: Tethersonde sensor [6]
Top Right: TBS in flight with active tethersonde [7]
Bottom Right: Leaf Wetness Sensor [8]

Printed Optical Particle Spectrometer Deployment



- The Printed Optical Particle Spectrometer (POPS) is an aerosol analysis system that was first deployed on the TBS during July operations.
- Operations and design were conducted as a joint project between SNL, Pacific Northwest National Laboratory, Handix Scientific and the National Oceanic and Atmospheric Administration.
- SNL provided custom housing design, TBS integration, and implementation of safe deployment.
- The POPS derives measurements of dry aerosol number density and size distribution as well as dry aerosol optical depth (AOD) profiles and humidification effect.





Top Left: Alternate POPS housing [9]
Bottom Left: Custom housing design from SNL [10]
Right: POPS flow schematic [11]

References
1-3: Pictures courtesy of U.S. Department of Energy Office of Science, https://www.arm.gov/sites/nsa/science
4-9: Pictures courtesy of Darielle Dexheimer, Sandia National Laboratories
10: Screenshot of custom POPS housing design, courtesy of Aaron Tucker, Sandia National Laboratories
11: Diagram courtesy of Gavin McMeeking, Handix Scientific
Mark Ivey – NSA Facility Manager. U.S. Department of Energy North Slope of Alaska Fact Sheet
Gavin McMeeking – Handix Scientific; POPS Design
Darielle Dexheimer – Sandia National Laboratories; TBS Operations Manager

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