Development of the routine small unmanned aerial system (sUAS) and tethered balloon system (TBS) observation

Fan Mei1, Darielle Dexheimer4, John Hubbe1, Gijs de Boer2, Casey Longbottom4, Peter Carroll1, Mark Ivey4, Beat Schmid1

1. Pacific Northwest National Laboratory, Richland, WA, United States.
2. Cooperative Institute for Research in the Environmental Science, University of Colorado-Boulder/NOAA Earth System Research Laboratory, Boulder, CO, United States.
3. Aerospace Engineering Sciences, University of Colorado, Boulder, CO
4. Sandia National Laboratory, Albuquerque, NM, United States.

Introduction & Motivation

- Unmanned aerial systems (UAS) are significantly expanding observational perspectives in atmospheric science.
- Large number of recent community workshops held by various agencies supporting atmospheric science (NOAA, NASA, DOE, NSF/NCAR)
- The Inaugural Campaigns for ARM Research using Unmanned Systems, or ICARUS (2016-2017) is an internal effort of ARM’s first foray into routine UAS and TBS (tethered balloon systems) operations with ARM instruments and measurement platforms to study the Arctic’s atmosphere.
- The main objectives of ICARUS are:
  - Demonstrate how low-cost small UAV (sUAV) can be used to continuously study the atmosphere in the Arctic.
  - Collect spatial information about the rapidly changing Arctic environment in conjunction with ground-based instruments, which are part of the ARM Mobile Facility (AMF3).
  - Study the feasibility of routine TBS operation with aerosol payload, which include Printed Optical Particle Spectrometer (POPS, Handix Inc.) and Condensation Particle Counter (CPC, TSI 3007).
  - Characterization of North Slope aerosol properties and seasonal variability using TBS aerosol payload.
  - Understand the different processes that affect the cloud life cycle.

Atmospheric profiling at Oliktok Point, AK

- Meteorological profiling from sUAV flights
  - Typical sUAV and TBS flight pattern: Profiling near AMF3 or ECOR point below cloud base.
  - Several sampling Periods Between 06/01/2016 to 10/31/2017

Preliminary results from TBS aerosol payload

- Dominant Aiken mode particles during non-cloud day.
  - 200 m AGL aerosol profiling – no cloud
    - No significant change in accumulation mode
    - Small particles (Dp<150 nm) dominated the area
- Significant daily variation was observed at Oliktok Point.
  - Cloud base ~240 m, in-cloud sampling at 400m, 600 m and 800 m.
  - No significant change in total aerosol concentration from CPC concentration.
  - Significant accumulation mode aerosol concentration decreases at 800 m

Summary

- ARM small UAS – DataHawk made good quality measurements during ICARUS.
- A turbulence parameter can be developed as a value-added product from DataHawk observation.
- Routine TBS operation with aerosol payload provides useful vertical information about Arctic environment.