Use of Tethered Balloons and UAV’s to Measure Microphysics and Radiation in Polar Mixed-Phase Clouds

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Tethered Balloon with Instrument Package and 4π Radiometer

Instrument Package on Penquin UAV

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An Example of 2D-S Images in (Mixed-phase?) Cloud

Simultaneous CPI Images Show Several Supercooled Drops
The “Best” (and perhaps the only) way to Distinguish Ice and Water in Mixed-Phase is with High-Resolution Imagery

From Lawson et al. (2015) JAS

Other Techniques, i.e., SID, CAS-POL, AIITS all Produce “False Irregulars” in Warm All-Water Clouds
**Tethered Balloon Deployments**

- **2008**: Deployment of 43 m$^3$ Tethered Balloon System (TBS) with CPI and 4-$\pi$ SWL radiometer at Ny-Ålesund During Thorpex. First successful measurements of microphysics and radiative parameters in mixed-phase clouds.

- **2009**: Deployment of TBS with CPI, frost point hygrometer and IN filters at South Pole in mixed-phase clouds.

- **2012**: Deployment of 74 m$^3$ balloon at Oliktok Point (ALTOS) and loss of balloon.

- **2013 - 2014**: DOE/SBIR-Funded Development of new deployment system and instrument package based on lessons learned from ALTOS with Successful Deployments at Ft. Carson Army Base.
First Deployment in May 2008 at Ny-Ålesund in the Svalbard Archipelago
May 29 Descent and then Ascent in Mixed-Phase Cloud at Ny-Alesund

Sikand et al. (2010)
CPI Images of Mixed-Phase Cloud at -30 to -32°C at South Pole

Lidar Return from Mixed-Phase Cloud at -30 to -32°C (Lawson et al. 2011)
TBS Comparisons with Ground-Base Lidar Extrapolated to Show Occurrence of Mixed-Phase from Jan – Dec 2009 at the South Pole (Lawson and Gettelman 2014 – PNAS)
TBS Publications Resulting from Deployments at Ny-Ålesund and South Pole


A New Miniature Combined Optical Particle Probe (micro-COPP) Incorporates an FCDP, 2D-S and CPI into a 3-Kg Instrument
New High-Resolution (0.7 µm pixel) CPI will Improve Ice/Water Identification in Mixed-Phase Clouds
The Plan:

Deploy the Tethered Balloon System and Penguin UAV, both Equipped with Miniature Instrument Packages, to either Oliktok Point or Ny-Ålesund in the Spring of 2008 for a Demonstration Project in Mixed-Phase Clouds.

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