Recent Efforts to use Small Unmanned Aircraft in Studying the Arctic Atmosphere: An Overview of COALA and ERASMUS

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Access to Airspace

R-2204
4 nm diameter circle centered on Oliktok Point. This airspace is split into two sections, low (up to 1500' MSL) and high (up to 7000' MSL).

W-220
20 nm on either side of 149.86° W, bounded to the south by 70.78° N, and to the north by 82° N. The warning area is divided into 16 sections of various lengths (A-H on map, including a low portion between 0' and 2000' MSL and a high portion between 2000' and 10000' MSL).
Recent Activities: COALA
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- Open Water
- Broken Ice
- Frozen Tundra
- Frozen Lakes
Recent Activities: COALA
ERASMUS I
ERASMUS II

Morrison et al., 2012

Radiative Cooling
- Drives buoyant production of turbulence
- Forces direct condensation within inversion layer
- Requires minimum amount of cloud liquid water

Microphysics
- Liquid forms in updrafts and sometimes within the inversion layer
- Ice nucleates in cloud
- Rapid ice growth promotes sedimentation from cloud

Dynamics
- Cloud-forced turbulent mixed layer with strong narrow downdrafts, weak broad updrafts, and $q_{tot}$ and $\theta_E$ nearly constant with height
- Small-scale, weak turbulence in cloudy inversion layer
- Large-scale advection of water vapour important

Surface Layer
- Turbulence and $q$ contributions can be weak or strong
- Sink of atmospheric moisture due to ice precipitation
- Surface type (ocean, ice, land) influences interaction with cloud
CU Pilatus

de Boer et al., 2016b
ERASMUS II
ERASMUS II
Acknowledgments and References

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References:


COALA: Lessons Learned
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Delta-T SPN-1 (Broadband Shortwave)
- 0.4-2.700 μm
- < 200 ms response time
- 140 mm x 100 mm, 940 g
- Pilatus will fly with three SPN-1s — up and down unshielded, and upward looking with shielding pattern to separate between direct and diffuse radiation for aircraft attitude correction (See Long et al., 2009 for details on the correction)

Kipp and Zonen CGR4 (Broadband Longwave)
- 4.5-42 μm
- 18 s response time (95%)
- 79 mm x 72.5 mm, 600 g
- 180 degree FOV
- Pilatus will fly with two CGR4s — up and down looking

Printed Optical Particle Spectrometer (POPS)
- Developed by Ru-Shan Gao and colleagues (NOAA ESRL Chemical Sciences Division, Gao et al., 2016)
- Provides aerosol size distributions for particles between 140-3000 nm
- Inlet and tubing to be heated in order to provide dry size distributions and prevent icing
- Approximately 1 kg total weight, including battery (~800 g total), requires ~3 W of power
- Approximate dimensions: 15x10x7.6 cm (spectrometer), 13x10x2.5 (electronics)
- Weather balloon deployable