Inaugural Campaigns for ARM Research using Unmanned Systems (ICARUS): An update on ongoing flight activities in Alaska

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Introduction to ICARUS

Table 1. An overview of flight campaigns for COALA, ERASMUS, and ICARUS. Colors match those used in the map in Fig. 1.

<table>
<thead>
<tr>
<th>Campaign</th>
<th>Dates</th>
<th>Operator</th>
<th>Platforms</th>
<th>No. of flights (UAS/TBS)</th>
<th>No. of flight hours (UAS/TBS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>COALA</td>
<td>6–20 Oct 2014</td>
<td>CU, DOE ARM</td>
<td>DH1, TBS</td>
<td>29/3</td>
<td>6.5/3</td>
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<tr>
<td>ERASMUS</td>
<td>2–16 Aug 2015</td>
<td>CU</td>
<td>DH2</td>
<td>206/0</td>
<td>41/0</td>
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<td></td>
<td>2–16 Apr 2016</td>
<td>CU</td>
<td>DH2, Pilatus</td>
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<tr>
<td></td>
<td>9–22 Oct 2016</td>
<td>CU</td>
<td>DH2</td>
<td></td>
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<tr>
<td>ICARUS</td>
<td>22–28 Oct 2015</td>
<td>DOE ARM</td>
<td>TBS</td>
<td>130/55</td>
<td>77.8/198</td>
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<td></td>
<td>3–20 Apr 2016</td>
<td>DOE ARM</td>
<td>TBS</td>
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<td></td>
<td>5–11 Jun 2016</td>
<td>DOE ARM</td>
<td>DH2, TBS</td>
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<tr>
<td></td>
<td>26 Jun–27 Jul 2016</td>
<td>DOE ARM</td>
<td>DH2, TBS</td>
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<tr>
<td></td>
<td>25–26 Sep 2016</td>
<td>DOE ARM</td>
<td>TBS</td>
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<td>TBS</td>
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<td></td>
<td>15–17 Nov 2016</td>
<td>DOE ARM</td>
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<td></td>
<td>2–9 Apr 2017</td>
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<td></td>
<td>14–28 May 2017</td>
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<td>DH2, TBS</td>
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<td></td>
<td>1–15 Aug 2017</td>
<td>DOE ARM</td>
<td>DH2, TBS</td>
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<tr>
<td></td>
<td>12–24 Oct 2017</td>
<td>DOE ARM</td>
<td>TBS</td>
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Platforms and Instruments
Scientific Targets

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
Science Topics: Thermodynamic State
Science Topics: Stable Boundary Layers

(Sullivan et al., 2016)
Science Topics: Turbulence Intensity

\[ TI = \frac{\sigma_U}{U} \]

Theoretical (LES)

ISARRA 2018, 9-12 July, 2018, Boulder, CO USA
Science Topics: Surface Fluxes
Science Topics: Aerosol-Cloud Interactions

Condensation Particle Counter (CPC; 0.01 – 1.0 µm)
Printed Optical Particle Spectrometer (POPS; 0.15 – 3 µm)

ISARRA 2018, 9-12 July, 2018, Boulder, CO USA
Community Resource
Profiling at Oliktok Point to Enhance YOPP Experiments (POPEYE):

Stratified Ocean Dynamics of the Arctic (SODA):

Looking Ahead
Summary and Acknowledgments

Summary:
- UAS have been deployed to northern Alaska (Oliktok Point) to provide new perspectives to help us answer fundamental questions about the physics of the Arctic atmosphere.
- The ARM Climate Research Facility has developed an operational UAS observing capability through a variety of campaigns, including the combined engineering and research campaign ICARUS.
- Over a series of deployments, measurements were obtained of lower atmospheric thermodynamic state, turbulence, turbulent fluxes, aerosols and precipitation.
- These measurements are now beginning to be used to evaluate model physics across several numerical models.
- The ARM UAS capability can now be requested for scientific deployment by the community through a proposal process.

Acknowledgments:

References: