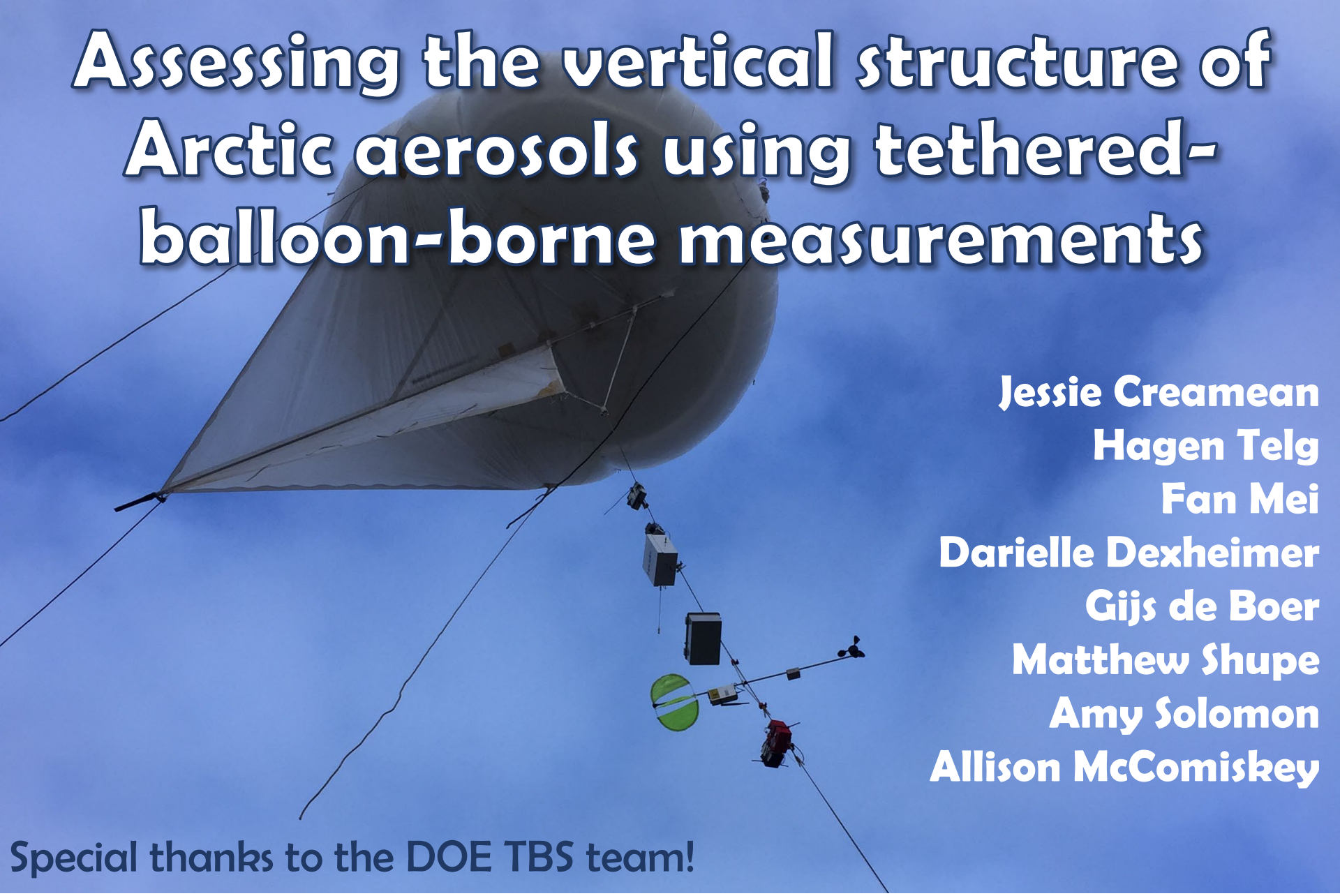
Assessing the vertical structure of Arctic aerosols using tethered-balloon-borne measurements



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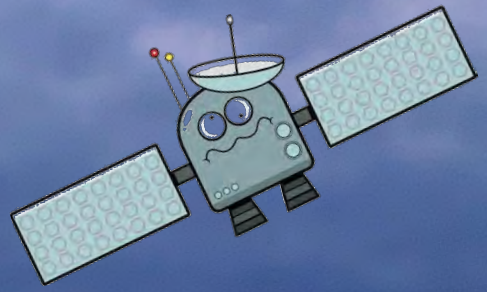
Special thanks to the DOE TBS team!

ASR Atmospheric System Research | ARM Climate Research Facility | Colorado State University | University of Colorado Boulder | NOAA | Pacific Northwest National Laboratory | Sandia National Laboratories | Brookhaven National Laboratory

Motivating science

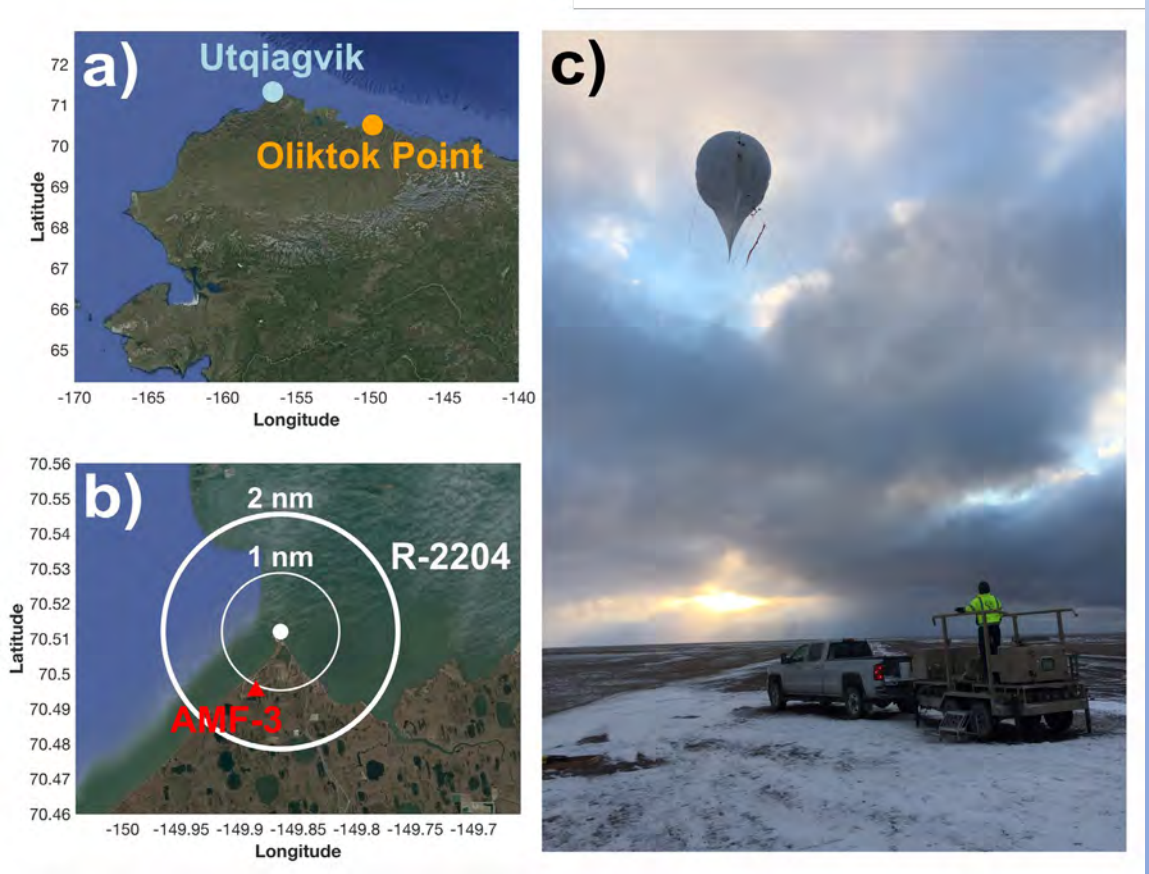


- The Arctic atmosphere often highly-stratified
  - Effects on aerosol-cloud interactions
- Very few routine vertical measurements of aerosols
  - Remote sensing limited by coverage, cloud interference, surface brightness and returns, quantification
  - Traditional aircraft are logistically/financially demanding, offer "snapshot", cannot reach ground
- TBS can fill observational gap between surface and traditional vertical measurements

Are ground-based aerosol measurements representative of those aloft?

ARM TBS campaigns on the North Slope

Campaign	Dates	# of flights
Inaugural Campaigns for ARM Research using Unmanned Systems (ICARUS)	May, Aug, Oct 2017	14
Aerosol Vertical Profiling at Oliktok Point (AVPOP)	May 2018	4
Profiling at Oliktok Point to Enhance YOPP Experiments (POPEYE)	Jul, Aug, Sep 2018	28



Main TBS instruments:

- POPS
- iMet

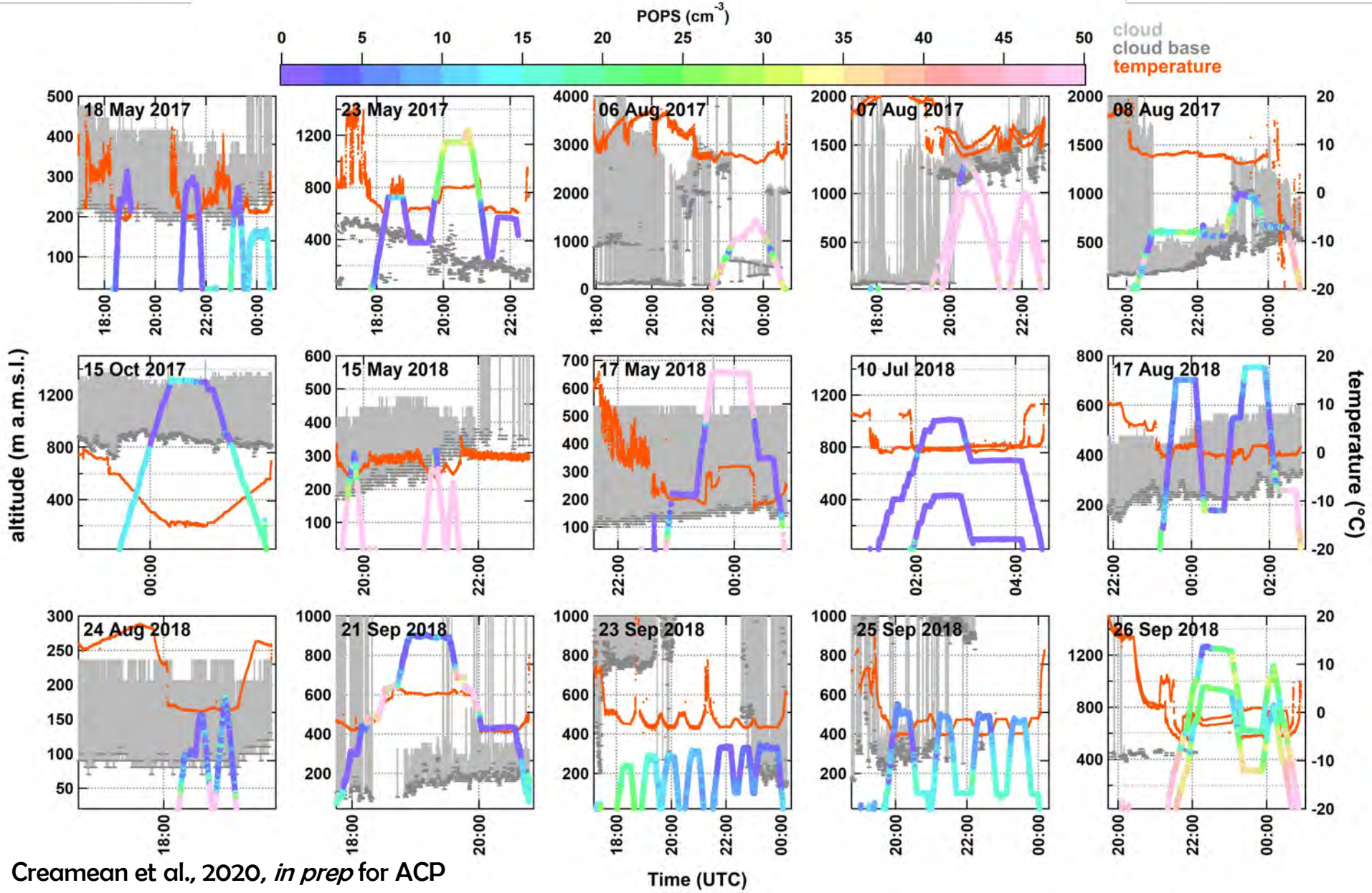
Also used…

- Ceilometer
- KAZR
- UHSAS

Creamean et al., 2020, *in prep* for ACP

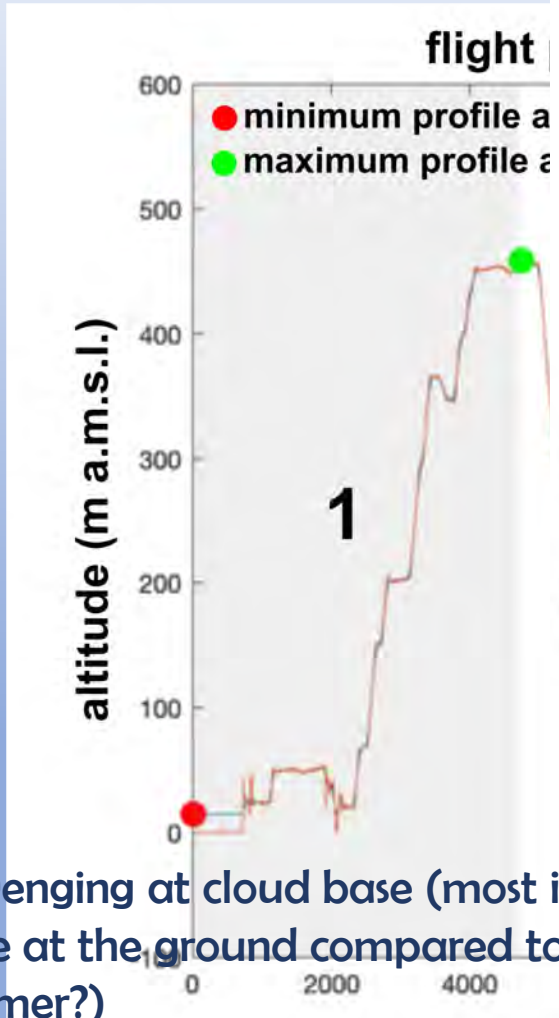
Overview of "typical" flights

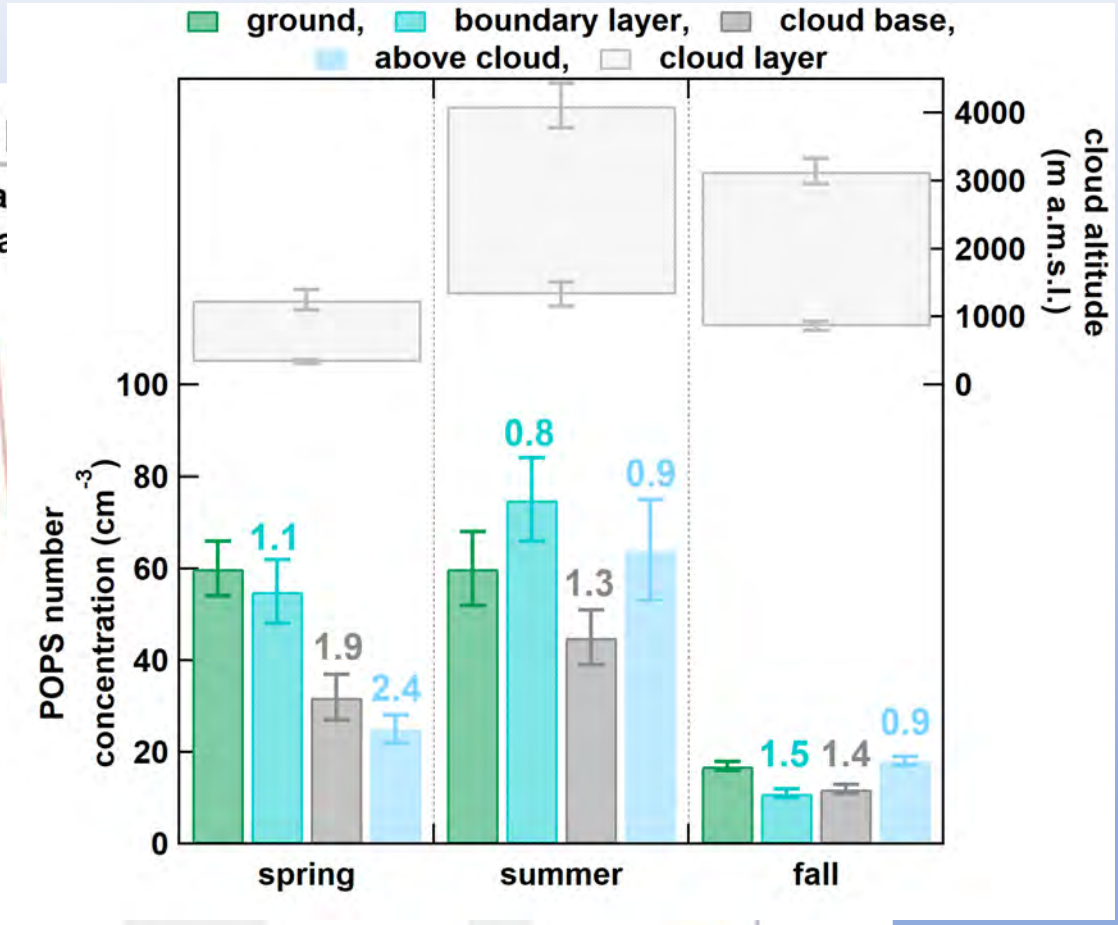
Flights cover a wide range of conditions and time periods



Creamean et al., 2020, *in prep* for ACP

Flight statistics: Breaking down the profiles

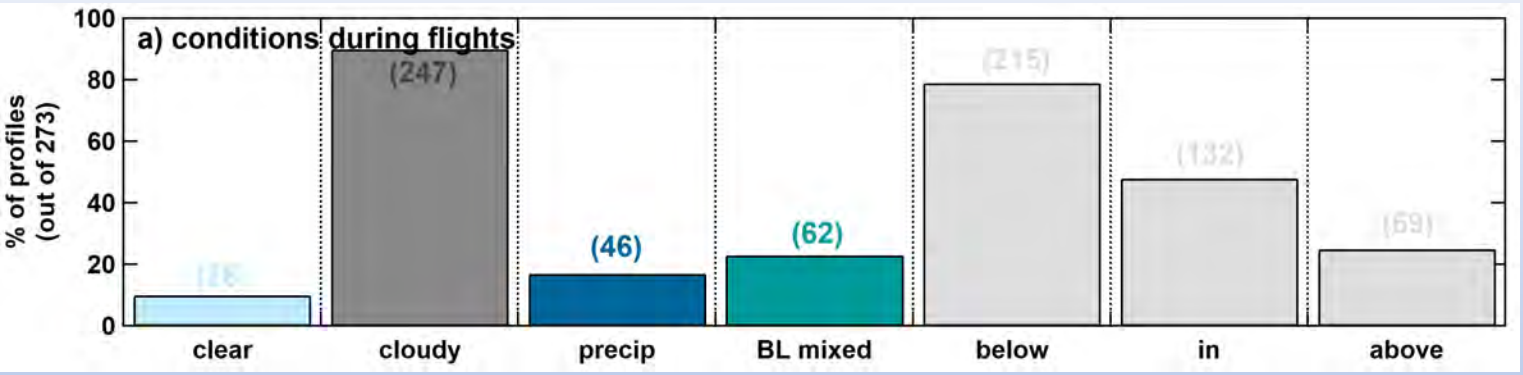




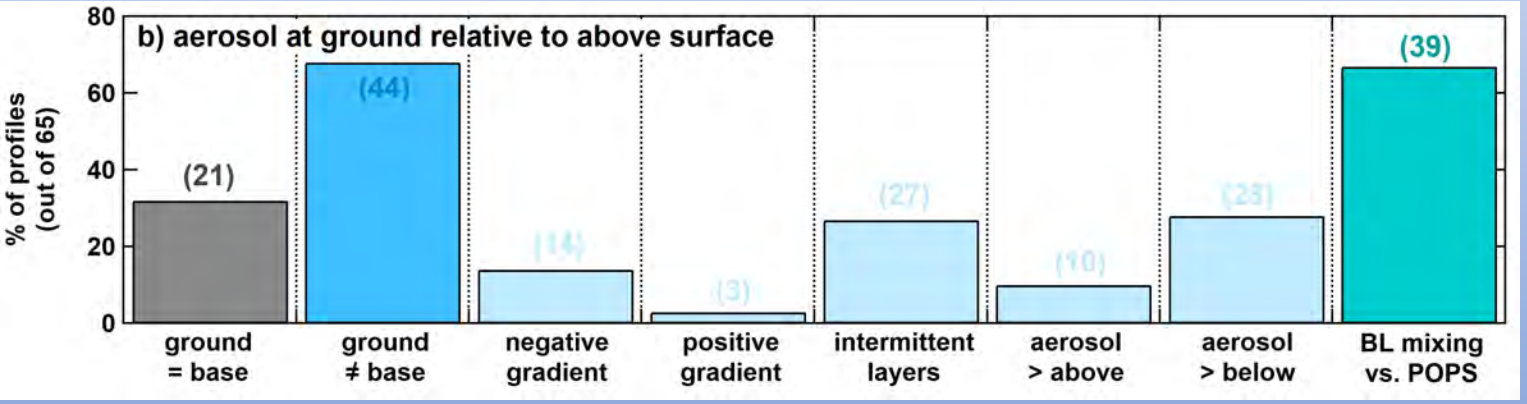
- Scavenging at cloud base (most in spring)
- More at the ground compared to BL, except for summer (regional fires? May = summer?)
- Highest concentrations in summer (ground same as spring, less in fall; local NPF?)
- Highest concentrations aloft, in summer

Creamean et al., 2020, *in prep* for ACP

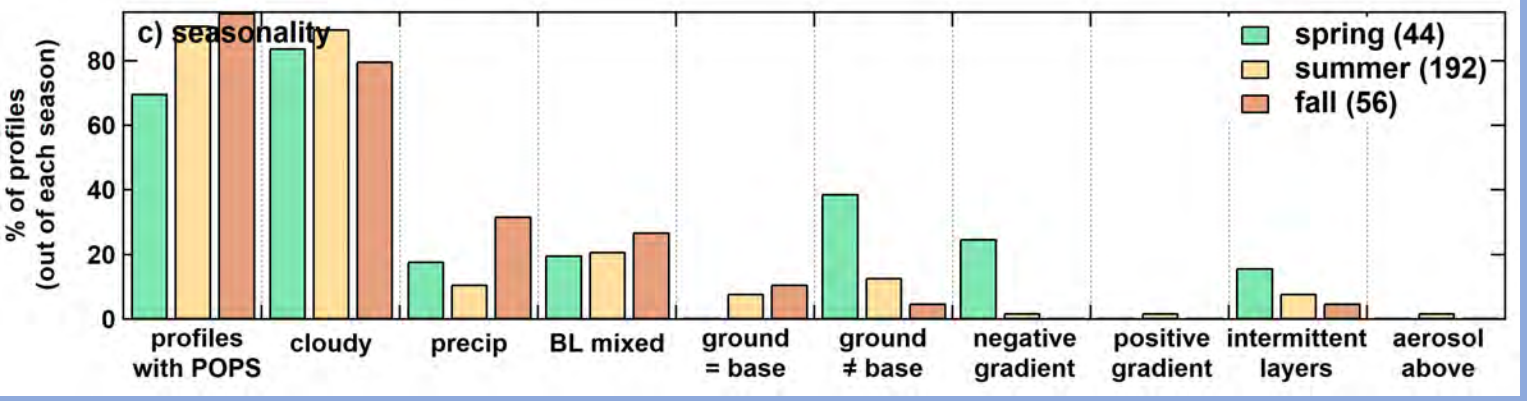
The big picture, based on statistics



- Lots of clouds
- Not well-mixed



- Most aerosol below cloud, in layers
- BL mixing reflects aerosol structure

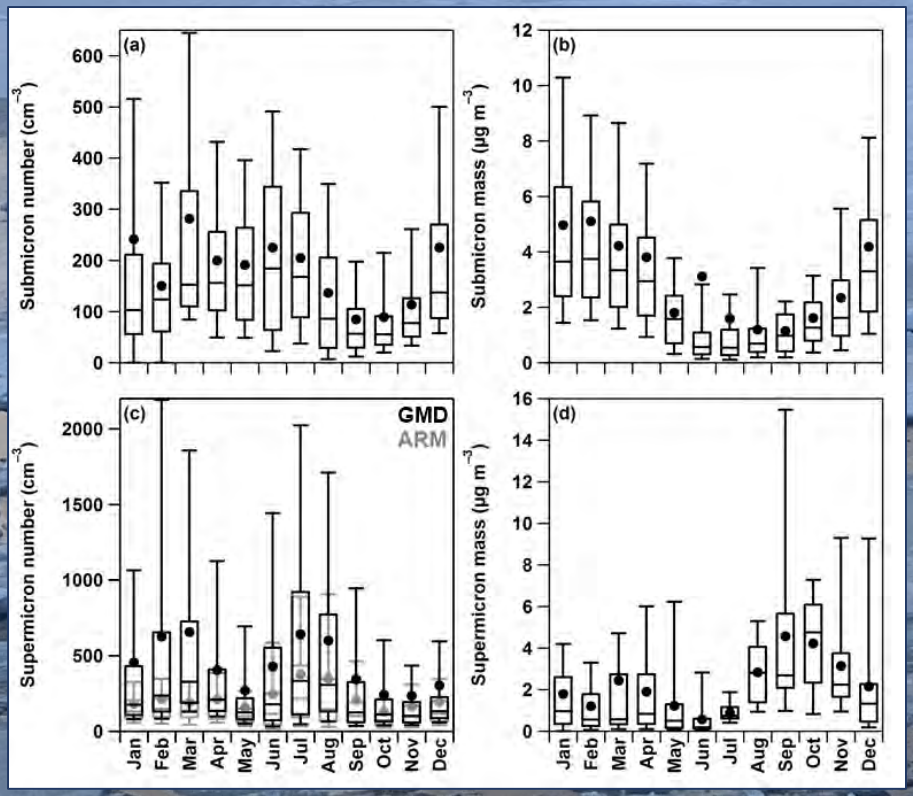


- Cloudiest in summer, most aerosol
- Precipitation anti-correlated Most layering in spring

Creamean et al., 2020, *in prep* for ACP

What we have learned thus far…

- TBS provides key information on aerosol vertical structure
- Ground aerosol = cloud base 32% of the time, BL mixed 23% of the time. Layers most of the time.
- Contrary to previous work suggesting haze = more aerosol, we saw more in the summer BY NUMBER (similar to Utqiaġvik)



- Wet scavenging can help explain numbers
- Thermodynamic conditions can explain aerosol vertical structure 67% of the time

Hey! Use our data!

Soon to be a PI product

Thanks for listening