MARTIAN (Measurement of ARctic Troposphere Ice from Aerosol Nucleation)

Dan Lubin & Lynn Russell (Scripps)
Ismail Gultepe (Environment Canada)

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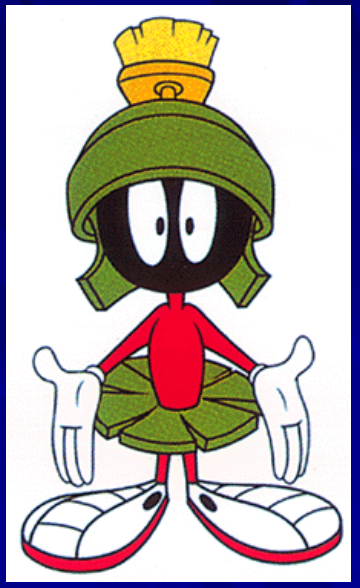
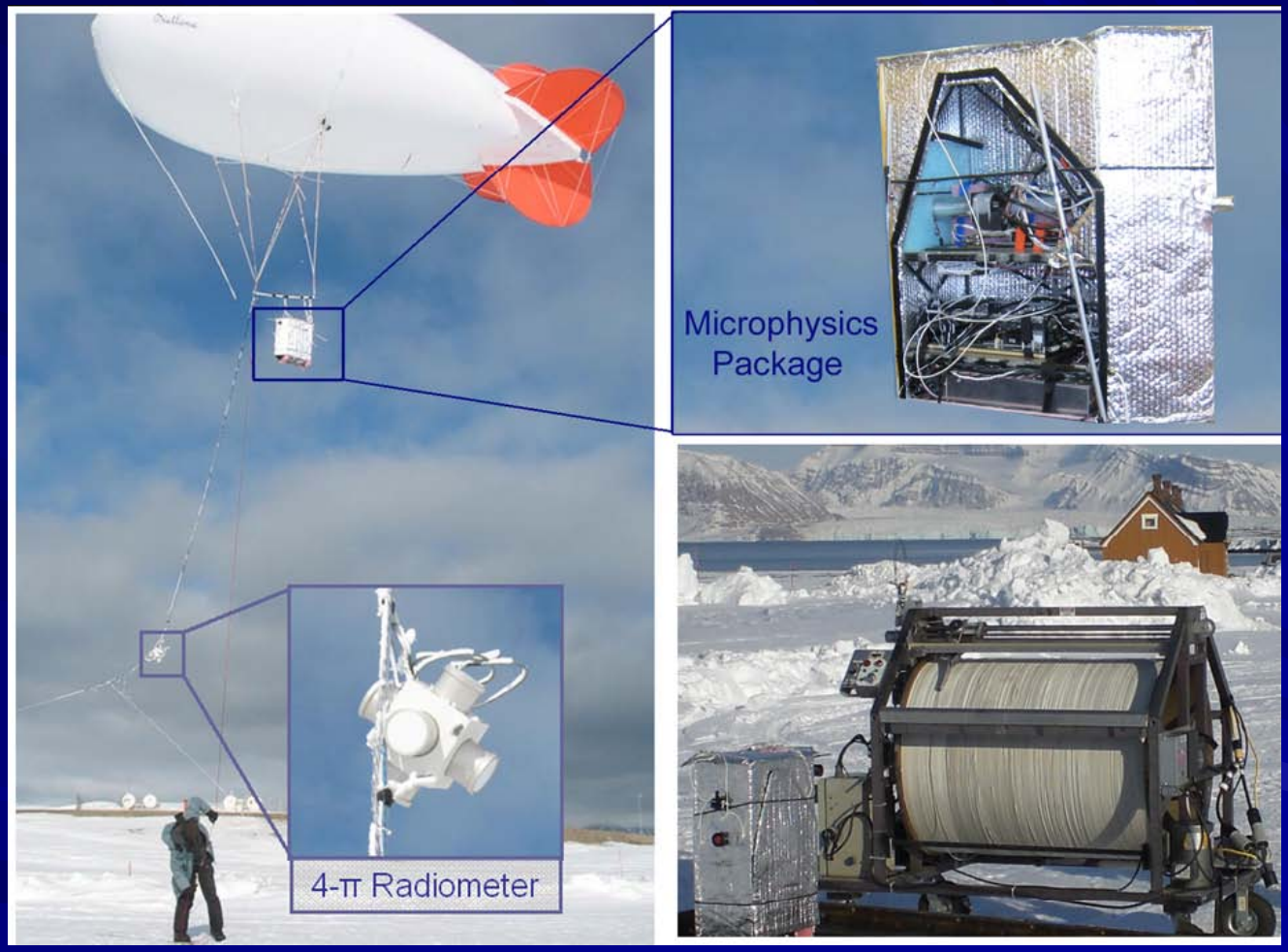
- Look specifically for single-phase ice clouds in the Arctic winter
- Aerostat (Tethered Balloon System) as primary sampling platform

Science Objectives



- For Climate Modeling Parameterizations
  - "Walk before we Run"
  - Ascertain behavior of the ice phase alone to wide variety of aerosol composition actually found in the Arctic
  - e.g., efficient IN (metals, mineral dust; Leaitch et al., 1984) vs. inefficient IN (sulfates, Borys, 1989)
  - Might we then have more confidence sorting out the various heterogeneous ice formation processes in mixed phase clouds?
- Unique Ice Phase Aerosol Indirect Effects in Arctic Winter
  - Girard et al. (2005) "Dehydration - greenhouse feedback"
  - Sulfates → Aerosol acidification → sulfuric acid coating inhibits ice formation by water vapor deposition → decrease ice crystal number density → increase ice crystal mean size → increased precipitation and dehydration of troposphere → LW radiative forcing of -9 W m^{-2}

Aerostat (Tethered Balloon System)

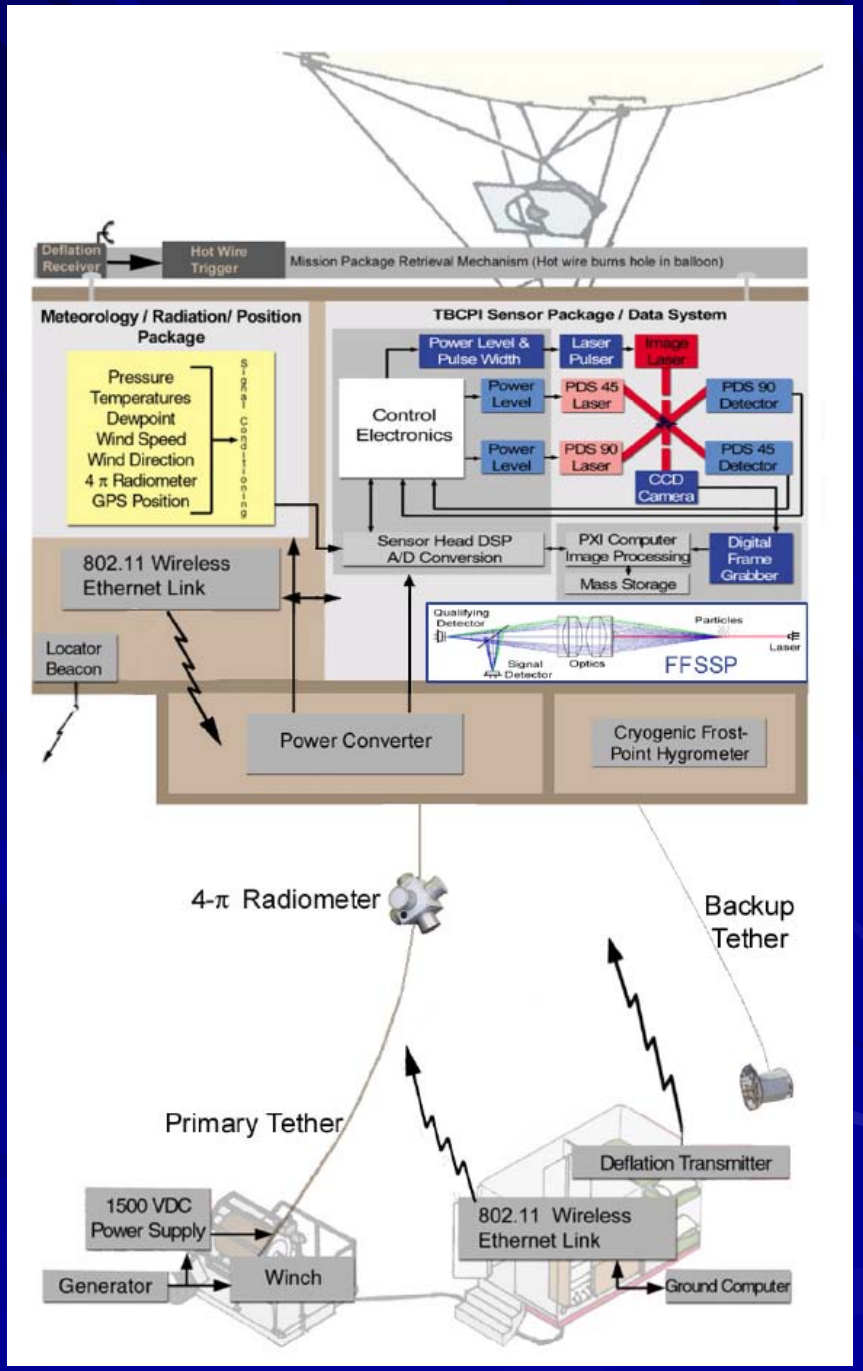


Sikand et al., 2010, JQSRT; Lawson et al., 2010, JTECHA in press

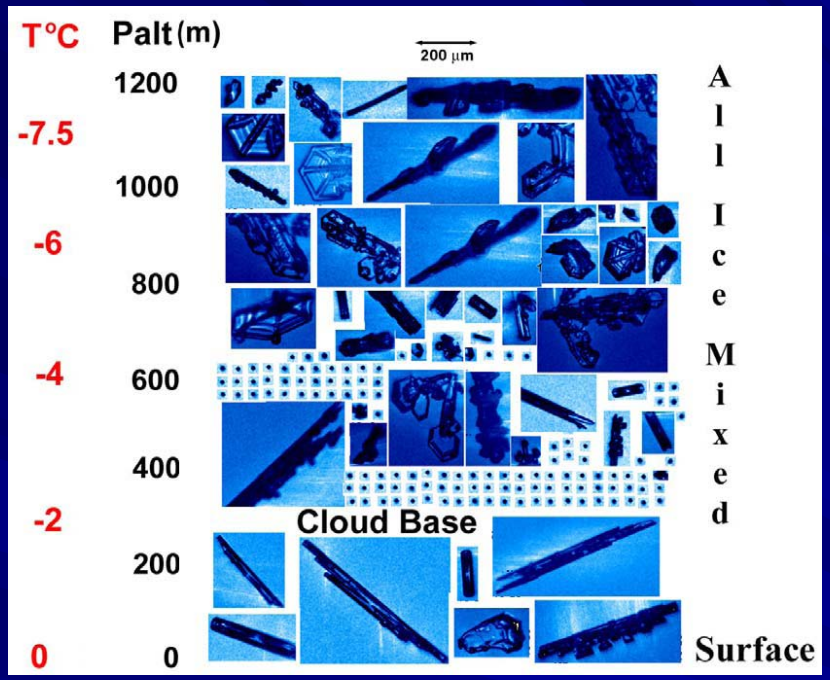
Aerostat Specifications

- Payload: ~ 15 kg
- Altitude Range: SFC – 2 km AGL
- Max Wind Speed: 15 m s^{-1}
- Duration: > 24 h
- Power Supply: 3 A via tether

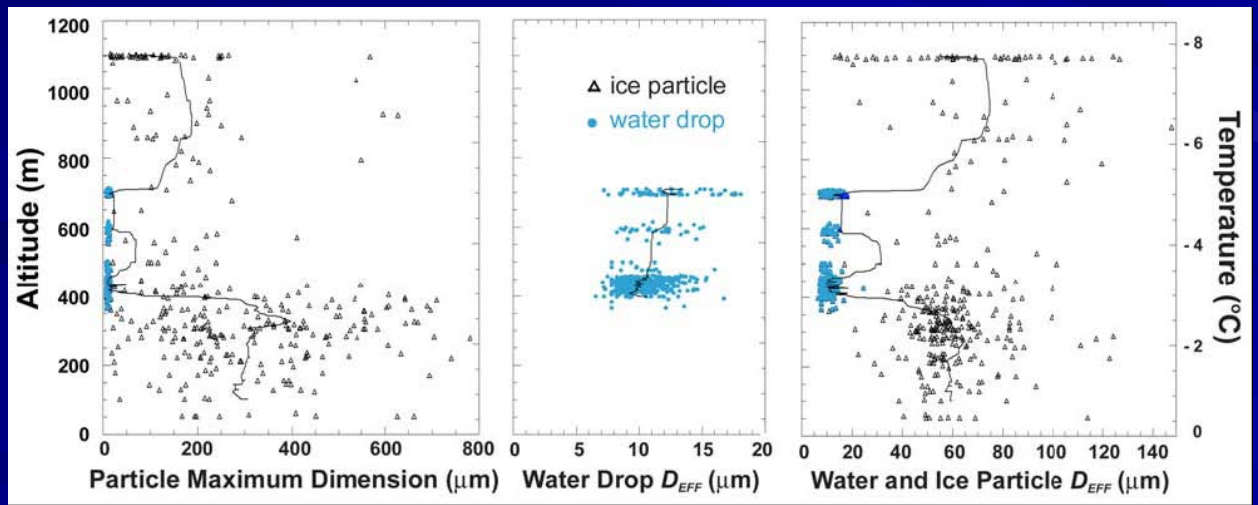
Lawson et al., 2010, JTECHA in press



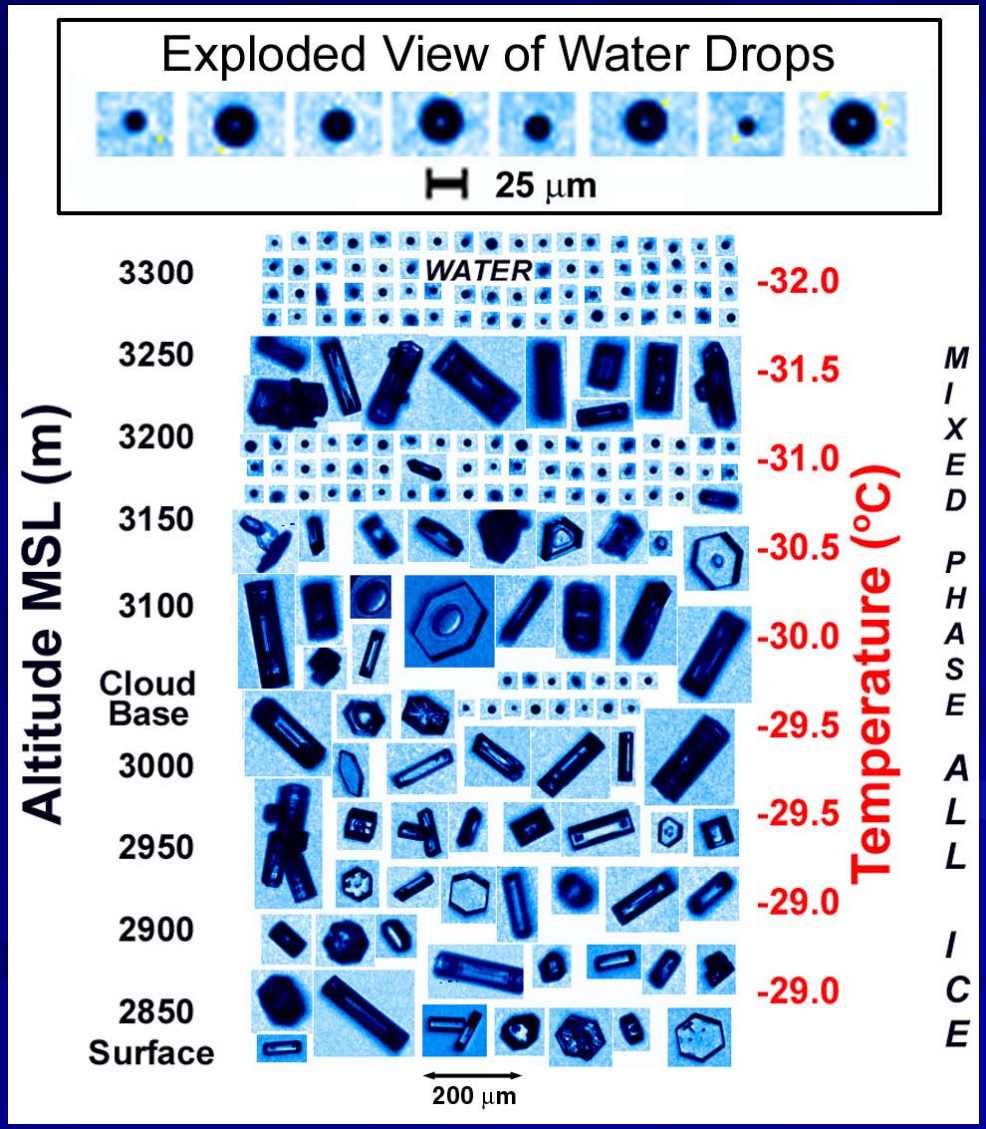
Examples of Cloud Particle Imager Data from Aerostat: Svalbard 7 May 2008



Lawson et al., 2010, JTECHA in press



Examples of Cloud Particle Imager Data from Aerostat: South Pole, 26 January 2009



Lawson et al., 2010, JTECHA in press

Ice Cloud Occurrence in Arctic Winter from CloudSat/CALIPSO

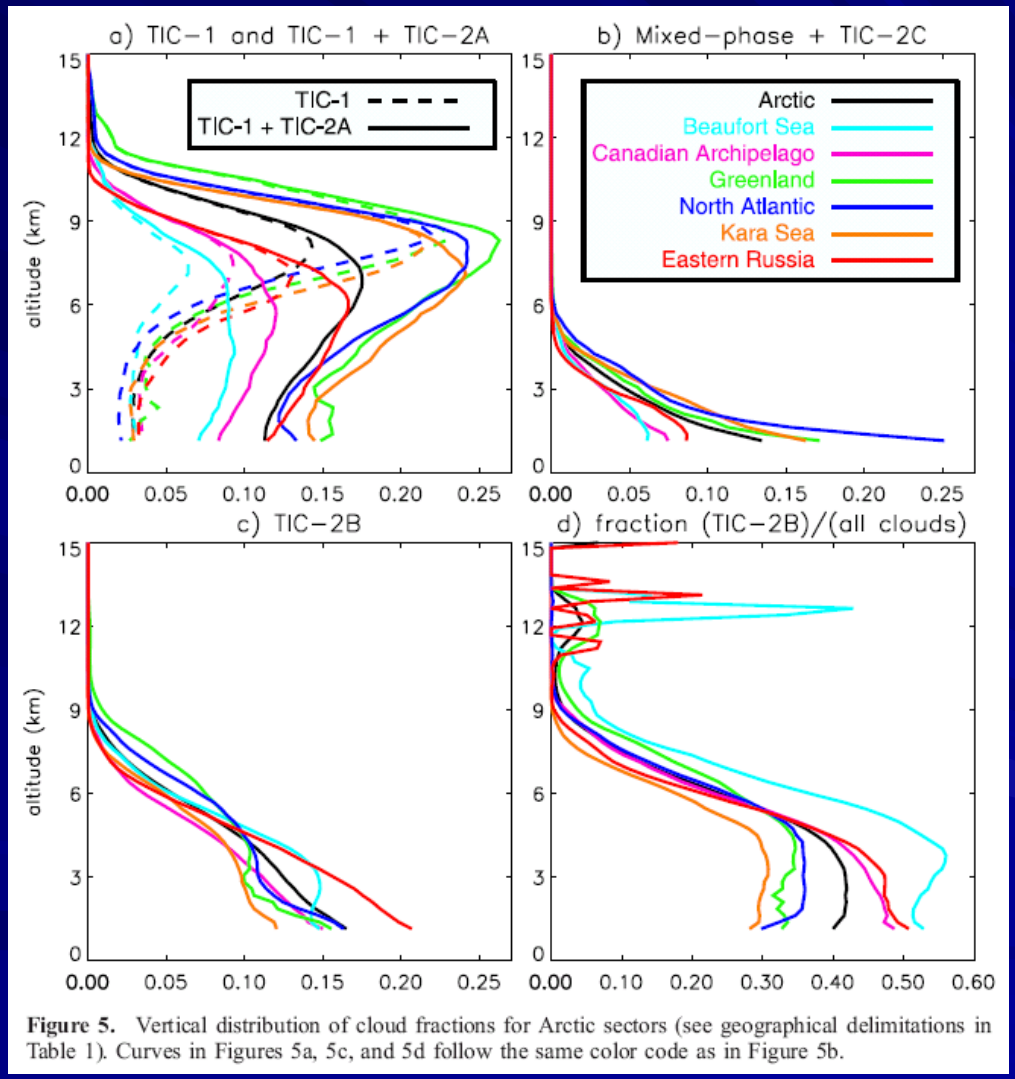
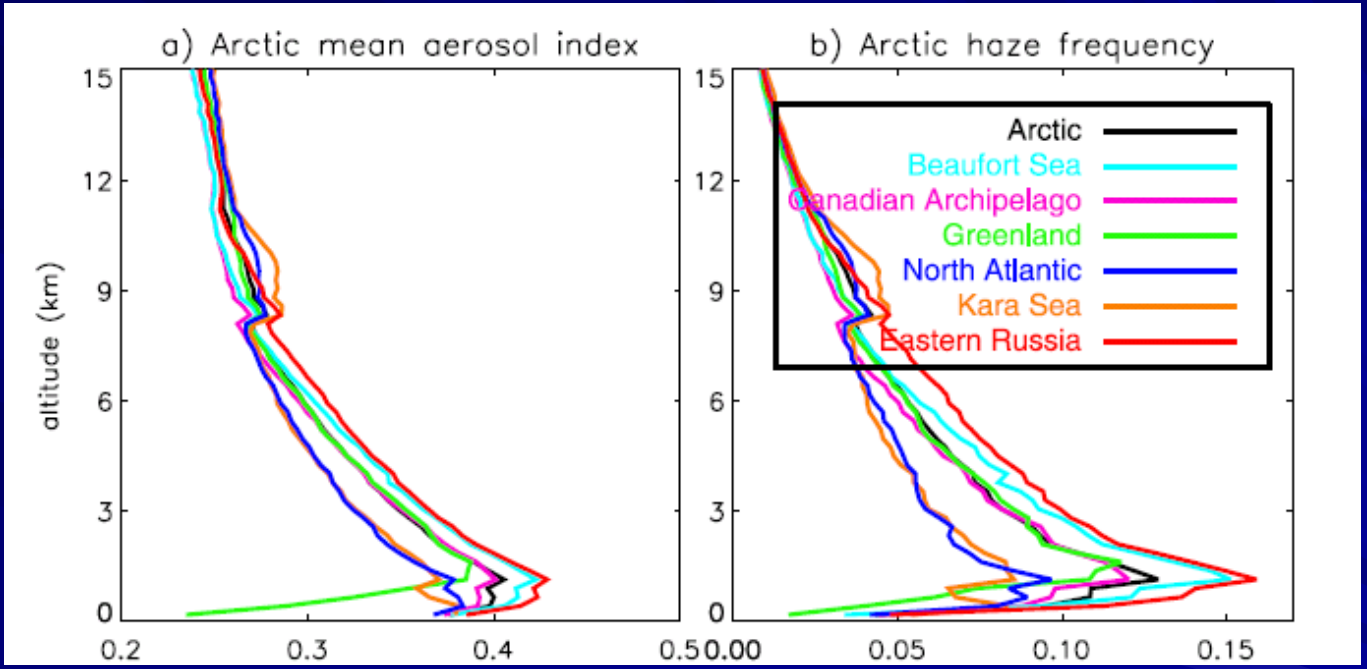


Figure 5. Vertical distribution of cloud fractions for Arctic sectors (see geographical delimitations in Table 1). Curves in Figures 5a, 5c, and 5d follow the same color code as in Figure 5b.

Grenier et al., 2009

Aerosol Occurrence in Arctic Winter from CloudSat/CALIPSO



Grenier et al., 2009

Duration of Proposed Arctic Winter Field Program

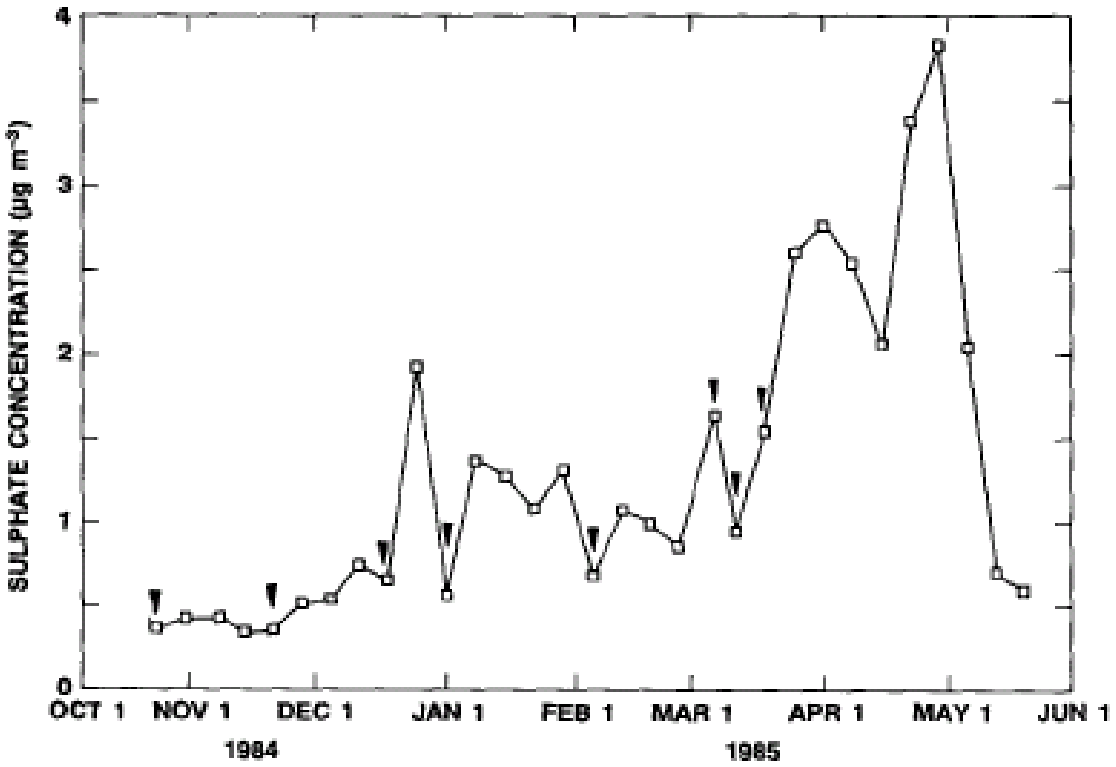


FIG. 2. Weekly average sulphate concentration measured at the Alert Station high-volume sampler. The lidar sampling weeks are marked by arrows.

Hoff, 1988

Need to sample through transition from clean air to Arctic haze events.

Frequency of Ice-Supersaturated Layers in the Arctic Troposphere

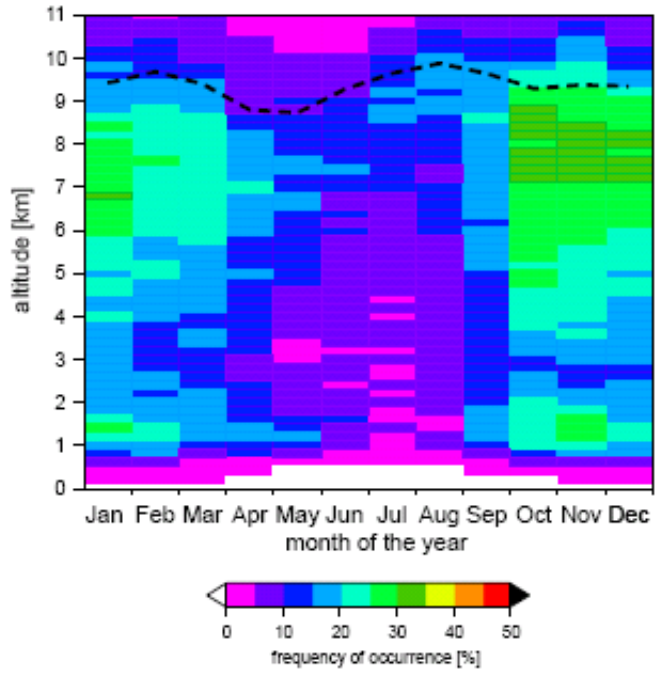


Fig. 6. Monthly mean frequency of occurrence of ice-supersaturation layers. The frequency of occurrence is defined here as the number of observations in a 200 m altitude range where RH with respect to ice is greater than 100% divided by the total number of observations for this altitude range. Dashed line represents the mean tropopause height determined using the WMO's definition of the tropopause (WMO, 1996).

Treffeisen et al., 2007

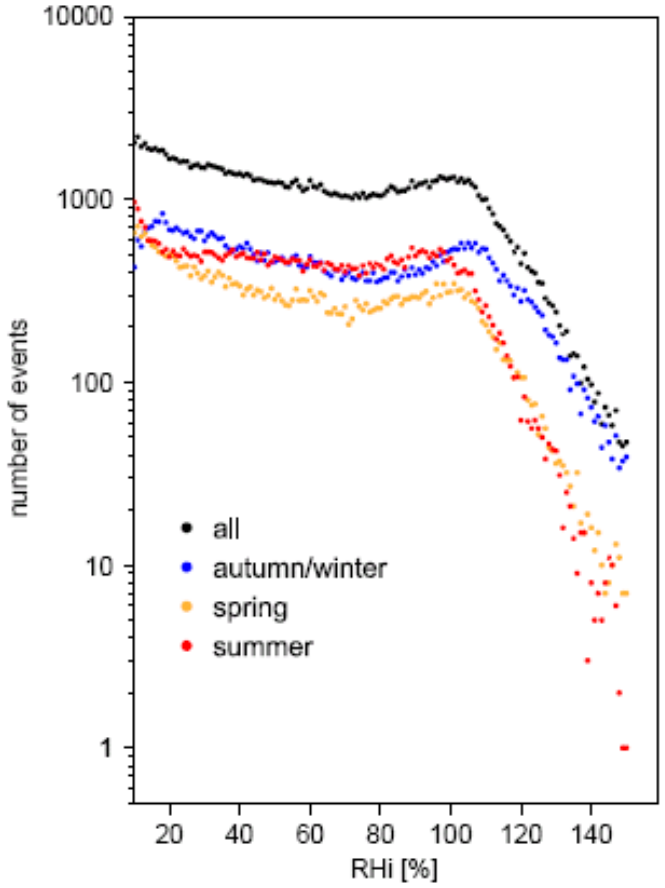


Fig. 7. Frequency distribution (per 1% RHi bins) of relative humidity with respect to ice (RHi), for data above 4 km height for the following time periods: all (black); autumn/winter (October–February; blue), spring (March–May; orange) and summer (June–September; red).

For Discussion…

- Warm Cloud – Single Phase Liquid
  - Numerous experiments to date, including from DOE ASR (VOCALS, RACORO, et al.)
- Arctic Summer
  - ASCOS (Swedish Arctic Summer Cloud Ocean Study)
- Arctic Mixed-Phase
  - Great data from DOE MPACE, ISDAC, ALTOS
- Arctic Winter – Single Phase Ice
  - Nothing recent, presently an experimental knowledge gap; should we go for it?
  - Aerostat may be cost effective way to sample given ice cloud climatology.

Oliktok Point in Winter

- But I'll go…
- Lubin and Gultepe would be willing to coordinate field program proposal.