Aerosol and Ice nucleating particles in the Southern Ocean Boundary layer: DOE campaign results and needs for the future study

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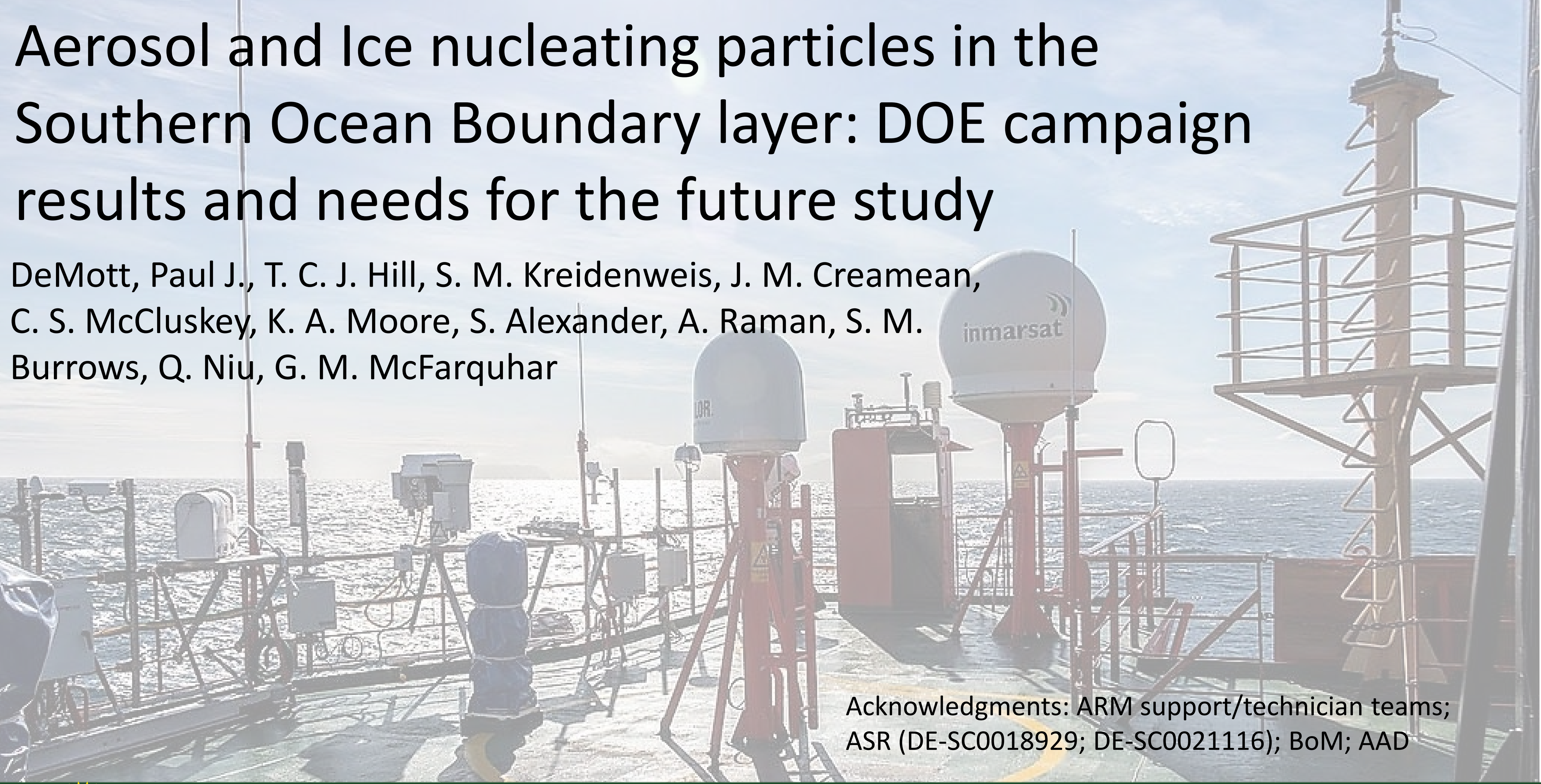
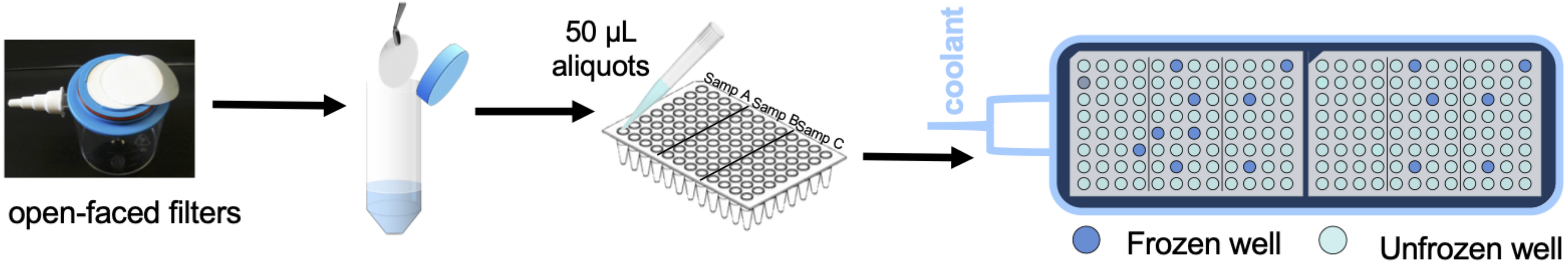
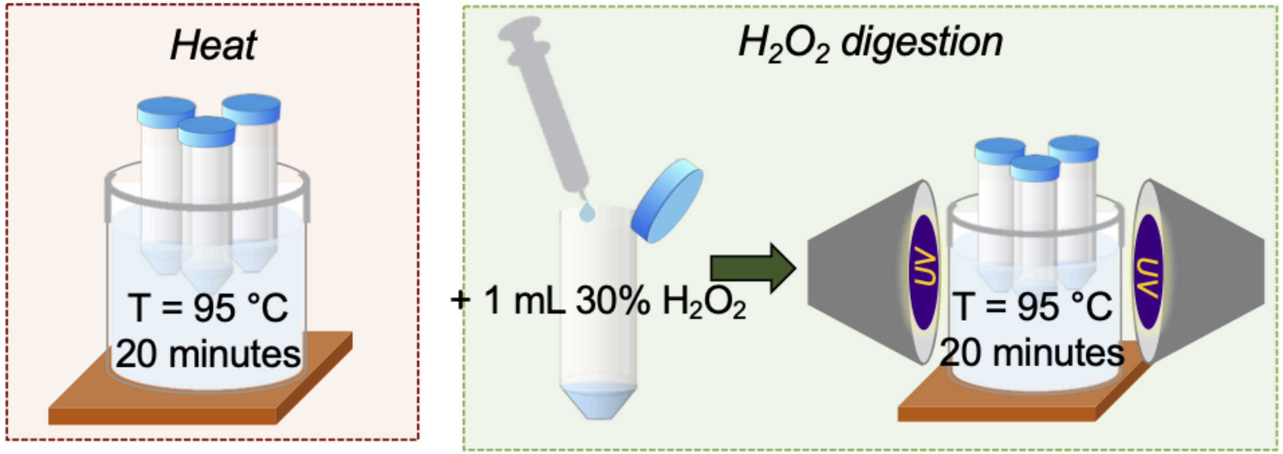


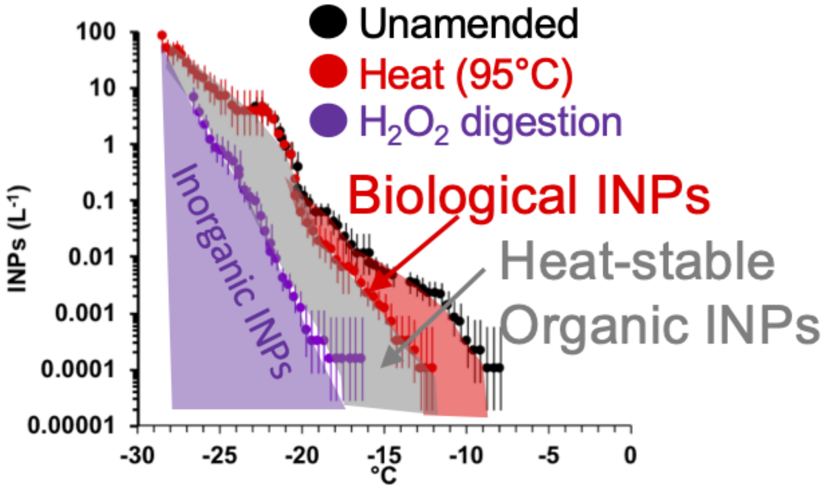
Acknowledgments: ARM support/technician teams; ASR (DE-SC0018929; DE-SC0021116); BoM; AAD

INP measurements refresher



Offline treatments:





INP results MICRE (T. C. J. Hill, P. J. DeMott and MICRE team)

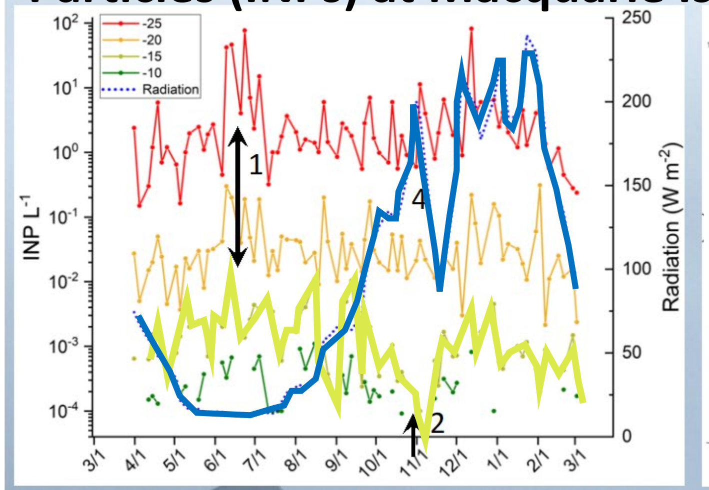
Objective

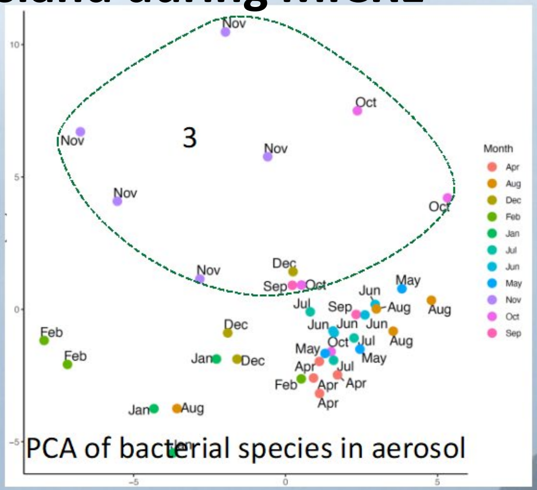
- Annual cycle during MICRE (Macquarie Island Cloud and Radiation Experiment) to characterize boundary layer INPs: concentrations, seasonal trends, likely sources.

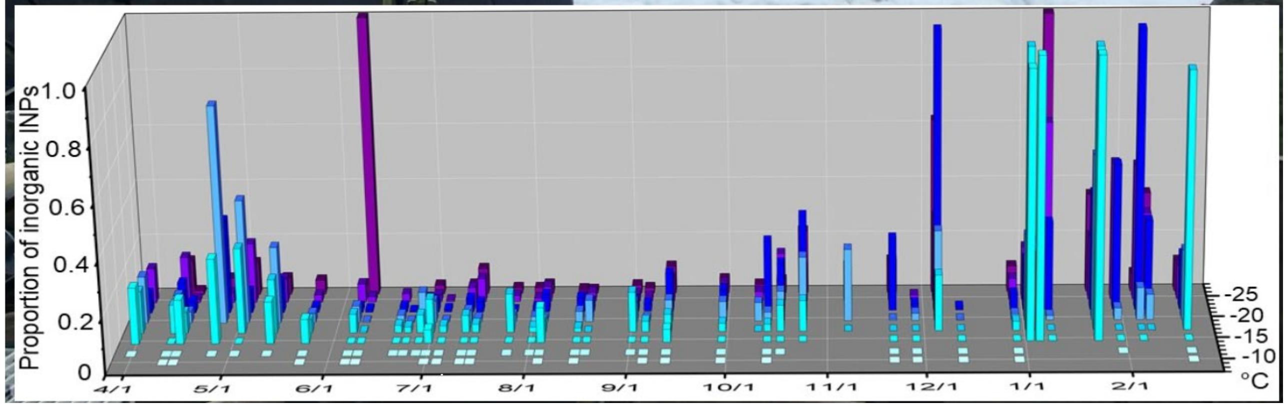
Findings

- INPs at upper end of MARCUS (island effects – see Raman et al., ACPD)
- Seasonal INP variation limited to a peak in mid winter (1) and a **decrease at >-15°C** in spring (2).
- Decrease of INPs at -15°C in spring coincided with a change in bacteria in the aerosol (3), and an **increase in solar radiation (4)**.
- Organic INPs predominant (winter). Inorganic INP abundance increased mid-summer and fall. No relation apparent with radon.

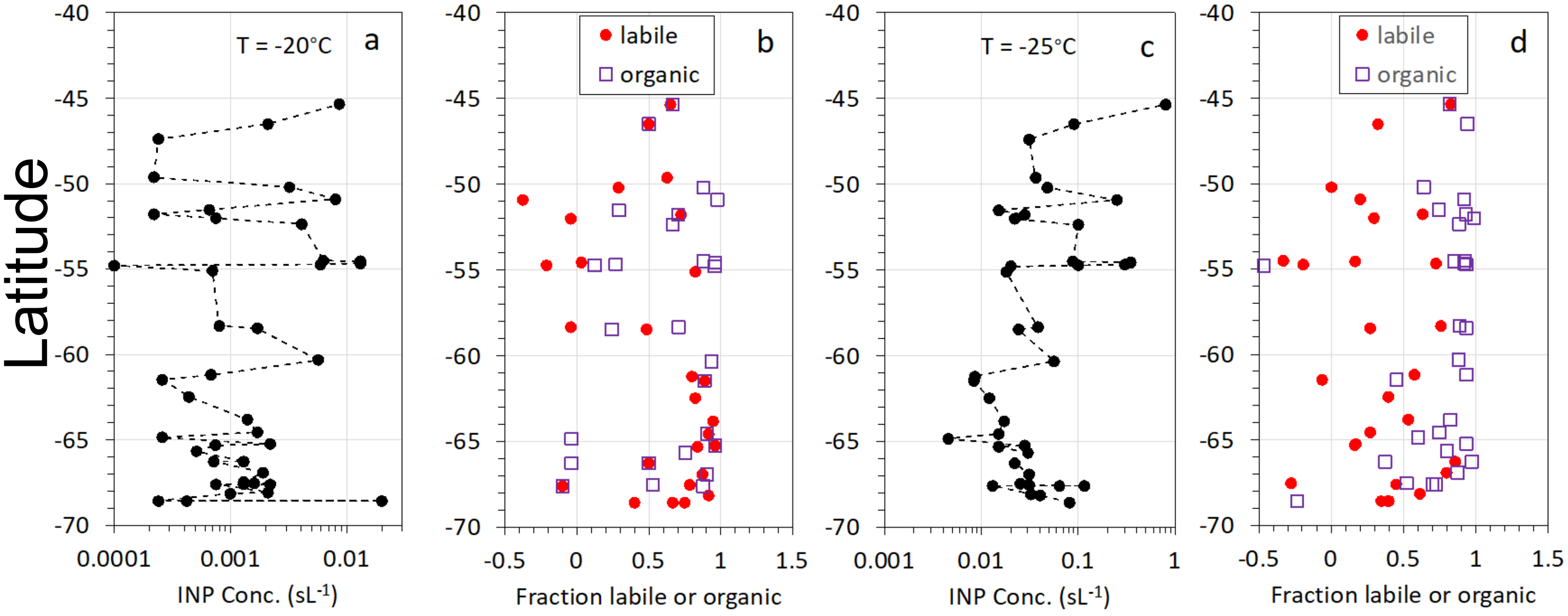
Concentrations and Characteristics of Ice Nucleating Particles (INPs) at Macquarie Island during MICRE



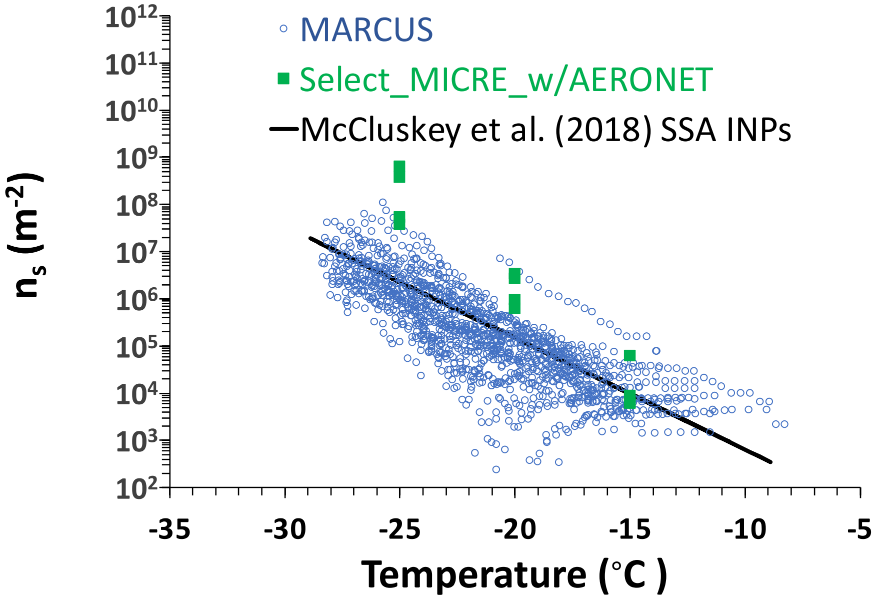




INP results MARCUS: Variable heat labile INP fraction, dominant organic INPs at most times (consistent with MICRE)



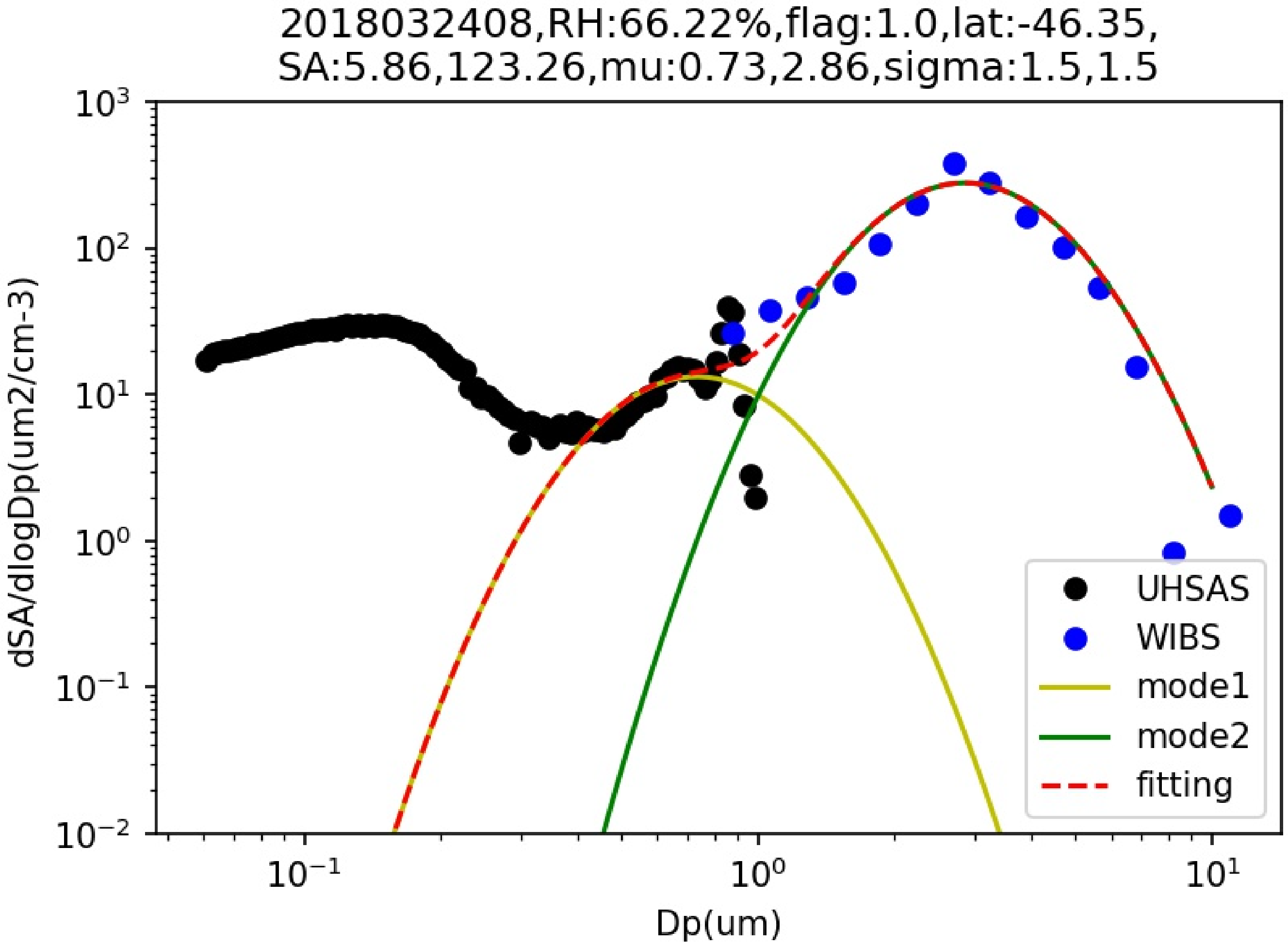
MICRE and MARCUS active site density (correspondence best at higher T)



Consistent with contributions from SSA and episodic dust INPs, including possible Antarctic influences: See talk by C. McCluskey

Aerosol property investigations: closing integrated and optical properties

Critical need for supermicron aerosol data in future studies: UHSAS data only in ARM archive. WIBS data (shared previously by Martin Schnaiter) completes size distribution, capturing dominant coarse surface and volume modes



Aerosol property investigations: direct aerosol measurements and use of optical property data

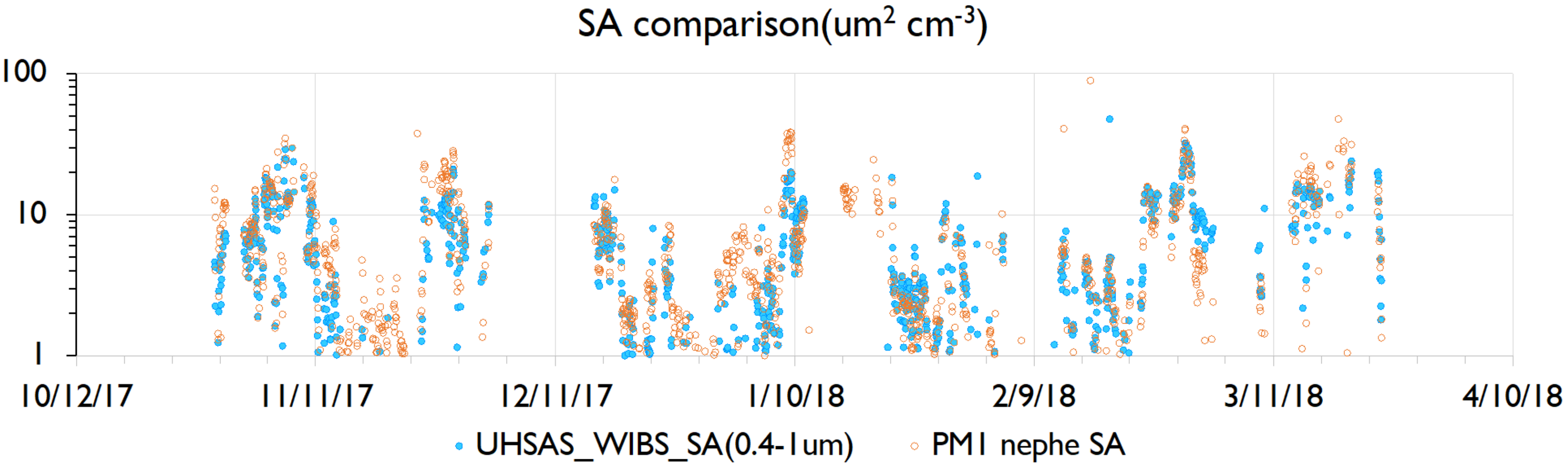
Surface area (SA) from spherical equivalent aerosol assumption versus

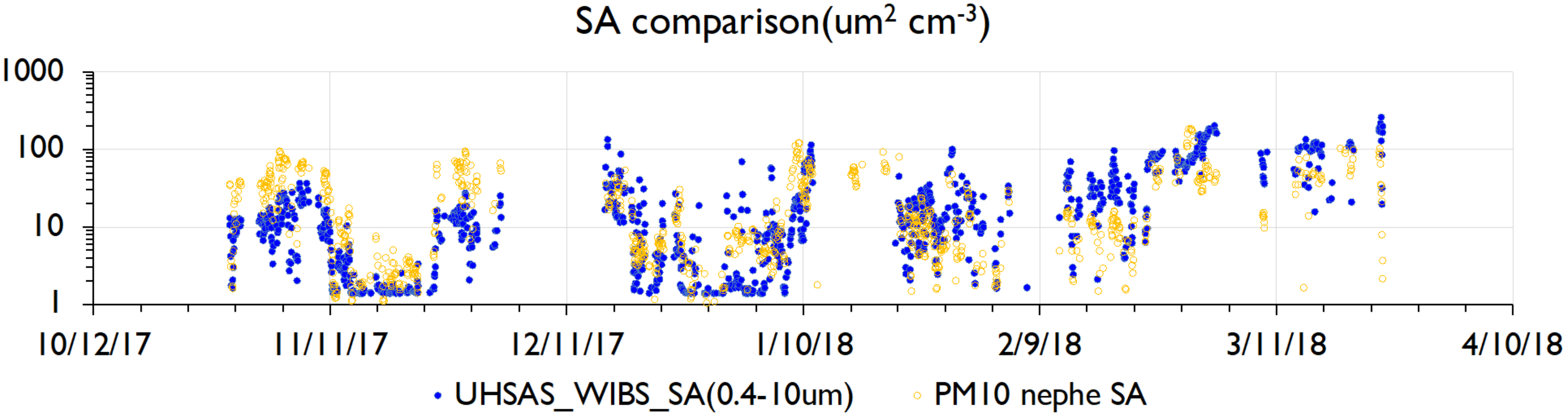
SA = (4* Bsc/Q)

for nephelometer, where:

Q = 2 for > 1 μm particles
Q = 3 for <1 μm particles

following DeMott et al. (2016). Lidar could be added to this comparison (Moore et al., in review)





Future needs

1) Measurements of INP size (relevant to transport and sources)
2) Can we better identify INP sources to clouds?
   -How far from coastal regions (Australia, Antarctica, Africa, S. America) does continental dust reach?
   -Does dust reach SO clouds primarily through the free troposphere or also in the boundary layer?
   -Relation of sea spray INPs to seawater biology in different regions and over time.
   -Relatedly, what are the emission factors of sea spray INPs?
3) Can we identify the role of oxidation processes and scavenging on INP concentrations in the real atmosphere.
4) Longer term and off-season (Winter) measurements of INPs
   -Coastal Antarctica in addition to fixed sites like MQI and Cape Grim (e.g., like INP mentor studies at other sites)
   -Floating platform or stationary ships to escape island/coastal effects completely
5) Better alignment aerosol measurements in all future studies (full size distribution to 30 μm)
6) TBS measurements, if possible, aligned with remote sensing of cloud property (top and base heights, phase, water contents) measurements