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Waveband Integrated Bioaerosol Sensor (WIBS4) for MARCUS Field Campaign Report

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Acronyms and Abbreviations

AMF	ARM Mobile Facility
ARM	Atmospheric Radiation Measurement
FBAP	fluorescent biological aerosol particles
INP	ice nucleating particles
KIT	Karlsruhe Institute of Technology
MARCUS	Measurements of Aerosols, Radiation, and Clouds over the Southern Ocean
PI	principal investigator
WIBS4	Waveband Integrated Bioaerosol Sensor Mk. 4

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1.0 Summary

The Waveband Integrated Bioaerosol Sensor Mk. 4 (WIBS4) of Karlsruhe Institute of Technology (KIT) was operated as part of the Measurements of Aerosols, Radiation, and Clouds over the Southern Ocean (MARCUS) field campaign from November 2017 to March 2018. WIBS4 was integrated in the U.S. Department of Energy Atmospheric Radiation Measurement (ARM) user facility second ARM Mobile Facility (AMF2), which was installed on the RSV *Aurora Australis* Australian Antarctic supply vessel during MARCUS. The aim of this campaign was to characterize the Southern Ocean boundary layer coarse-mode aerosol in terms of the fraction of biological or biogenic compounds. This work was done in close collaboration with Greg McFarquhar from the University of Oklahoma, the principal investigator (PI) for MARCUS, as well as Paul DeMott from Colorado State University, who concurrently sampled particle filters for off-line analysis of the ice nucleating particle concentrations.

During four voyages of the vessel between Hobart, Tasmania and the Australian Antarctic stations Davies, Casey, and Mawson, as well as Macquarie Island, fluorescent biological aerosol particles (FBAP) were monitored by the WIBS4 in the size range from 0.5 to 10 µm. A FBAP is defined by its fluorescent behavior that gives simultaneous signals in the F1 (λexcitation=280nm, λemission=310- 400nm) and F3 (λexcitation=370nm, λemission=420-650nm) channels of the WIBS4 (Toprak and Schnaiter, 2013).

2.0 Results

The single-particle data of WIBS4 was statistically analyzed to deduce fluorescent and total aerosol number concentrations and size distributions of the SO boundary layer in the latitude range from -47° to - 68°. It was found that the number concentration of the FBAP aerosol in the Southern Ocean boundary layer is rather low with a median value of 1.3 L^{-1} and 25 and 75 percentiles of 0.4 and 3.3 L^{-1}, respectively. This results in a mean FBAP fraction of 1.6 ± 5.2% in the 0.5 µm < $D_{optical}$ < 10 µm size range. However, this fraction can reach 20% in the below 2 µm size range and for latitudes higher than about 60° S (Figure 1). A first analysis of the latitude dependence of the total particle and FBAP number concentrations in the 0.5 µm < $D_{optical}$ < 10 µm size range reveals a strong decrease of the total number concentration with latitude while the FBAP concentration is rather stable with a tendency to increase towards the Antarctic coast (Figure 2).

In collaboration with Paul DeMott the WIBS4 FBAP number concentrations and size distributions will be compared with ice nucleation particles (INP) measurements that are specifically analyzed for biological INPs. The role of biological particles in the Southern Ocean boundary layer for the macrophysical and microphysical properties of Southern Ocean clouds will be investigated with Greg McFarquhar.

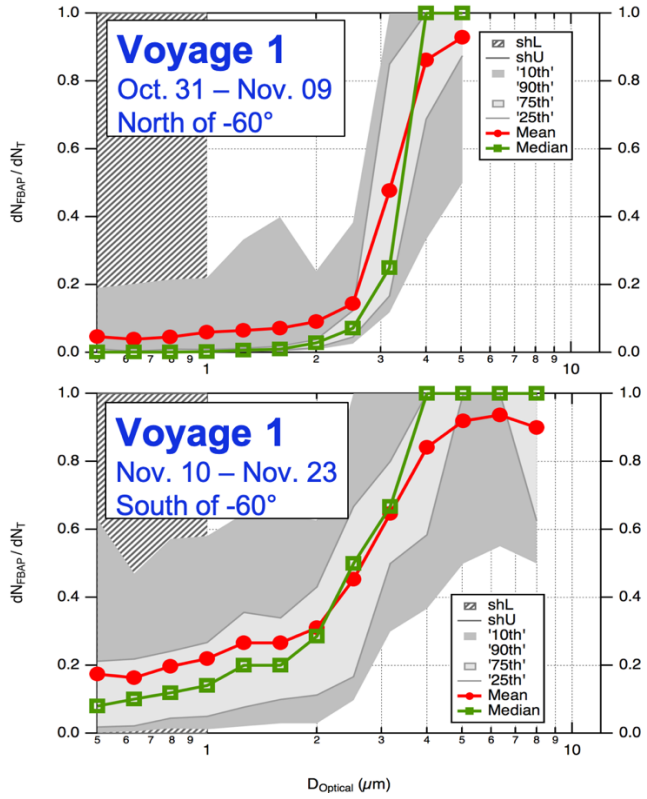

Figure 1. Size segregated fraction of FBAP particles detected during MARCUS Voyage 1 north of -60° (upper panel) and south of -60° latitude (lower panel). The FBAP fraction reaches 100% for particles larger than 4 µm. There is a higher fraction of FBAP particles in the size range < 2 µm south of -60°.

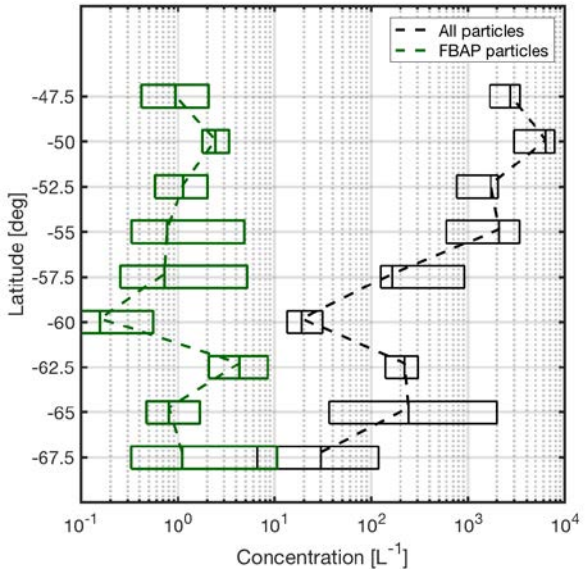

Figure 2. Statistical analysis of the number concentration of all (black) and FBAP (green) particles in the 0.5 µm < $D_{optical}$ < 10 µm size range as a function of the latitude.

3.0 Publications and References

Toprak, E, and M Schnaiter. 2013. “Fluorescent biological aerosol particles measured with the Waveband Integrated Bioaerosol Sensor WIBS-4: laboratory tests combined with a one year field study.” *Atmospheric Chemistry and Physics* 13(1): 225–243, https://doi.org/10.5194/acp-13-225-2013

Schnaiter, M, PJ DeMott, TCJ Hill, and G McFarquhar. 2019. “Fluorescent biological aerosol particles of the Southern Ocean boundary layer and their potential role for ice nucleation in clouds.” Presented at the 99th American Meteorological Society Annual Meeting, Phoenix, Arizona.

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