CAPRICORN-2 RV *Investigator* Wideband Integrated Bioaerosol Spectrometer measurements

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1.0 Data Set Overview

These measurements were part of the second Clouds, Aerosols, Precipitation, Radiation and atmospherIc Composition Over the southeRN ocean (CAPRICORN-2) campaign. The main objective of the CAPRICORN-2 experiment is to improve our understanding of aerosol-cloud interactions with respect to the major synoptic meteorological conditions in the Southern Ocean (SO) to reduce the uncertainties related to aerosols, clouds, and their feedbacks in our climate models. Specifically, PI DeMott's group deployed instrumentation for measuring ice nucleating particles (INPs) and bio-aerosols on multiple platforms. This archive relates to the NOAA Wideband Integrated Bioaerosol Spectrometer (WIBS) instrument installed on the CSIRO MNF RV *Investigator* during CAPRICORN-2. The WIBS was used to measure horizontal spatial variability of bioaerosol number concentrations, to determine their relation to ocean sources and long-range transport of aerosol and cloud microphysical properties in the Southern Ocean region. The campaign was based out of Hobart, Tasmania. The time period covered is January 11 to February 22, 2018. The voyage covered latitudes from -66 to -42 degrees South and longitudes between 132 and 150 degrees East. Peculiarities and issues with use of these data are discussed briefly below.

2.0 Instrument Description:

The WIBS pulls ambient air containing particles through an optical chamber, where particles are first sized using scattered light from a 635nm diode laser. Two filtered Xenon flashlamps (280 nm and 370nm) are triggered in sequence by the scattering signal, and fluorescence is monitored using two PMTs (310-400 nm and 420-650 nm). Particles can then be categorized into seven fluorescence categories, as well as non-fluorescent particles (Perring et al. 2015). The flashlamps have a maximum firing rate of

125 Hz due to needed recharging time, so reported particle concentrations have been corrected for particles missed during recharge periods using the ratio of total particles with scattering signal to particles for which the flashlamps fired (see Perring et al. 2015). Background fluorescence values in each channel in the absence of particles were measured daily. Only particles with fluorescence values greater than 2.5 standard deviations above the daily mean background value are reported here (Twohy et al. 2016). Particles below 0.8 μm were removed from the dataset, as particles smaller than this are at or below the limit of detection for the WIBS PMTs with their current gain setting (Perring et al. 2015). Following Twohy et al. 2016, two estimates for the concentration of FBAPs are reported: particles that fluoresce in both channels A and C (AC_ABC), and particles that fluoresce in either channel A or channel C, but not both (non-B).

3.0 Data Collection and Processing:

Air was sampled from a custom-designed aerosol sampling inlet, with the intake located approximately 18.4 m above sea level at the bow of the ship. The whole inlet is stainless steel, with an inner diameter of 16 cm, which tapers to a 4 cm conical intake. Ambient air is sampled into the conical intake section at ~440 L min^{-1}, which is oriented horizontally to limit the amount of precipitation entering the inlet, and automatically adjusts to orient into the wind (forward 180° only). The inlet then travels vertically down the foremast into the aerosol lab, which is located directly underneath the inlet at the bow of the ship, to minimize particle losses. Inside the aerosol lab, approximately 9 m from the intake, is a sample manifold with instrument pickoffs for aerosol sampling, from which the WIBS sampled. The WIBS aerosol stream was dried to below the efflorescence relative humidity (ERH) of sea salt, ~45-48%, prior to measurement. Data were collected continuously in real-time with the WIBS, and then pooled in 5-minute intervals to calculate concentrations of fluorescent and non-fluorescent particles in the categories described above. Following the technique presented in Humphries et al. (2019), a timeseries of predicted exhaust influence on measurements during the CAPRICORN-2 voyage was created and used to exclude periods of likely exhaust influence from all data presented here. Theoretical calculations of particle transmission efficiency were made using the von der Weiden et al. (2009) Particle Loss Calculator and applied to the data to correct measurements to reflect ambient concentrations. Particle sizes measured by the WIBS were adjusted to account for sea salt dry density and shape factor. No assessment of confidence intervals has been attempted for this dataset as yet, but they should not exceed ±50%.

4.0 Data Format:

The data is presented as an array (using ICARTT format) of particle concentrations per cubic centimeter of air, at ambient temperature and pressure. The concentrations reported for each category are the average value over 5-minute intervals. Only particles larger than 0.8 μm (as sized by the WIBS prior to adjustment for sea salt density and shape factor) are included in this dataset, as the efficiency of fluorescence detection decreases rapidly below this size (see Perring et al. 2015). Concentrations of eleven particle categories are reported, 9 of which are fluorescent (A, B, C, AB, AC, BC, ABC, AC_ABC, and Non-B). The total number of all particles >0.8 μm are also reported

(Total), in addition to the number of non-fluorescent particles (Non_Fluor). The ship position during each measurement is included in the data files. A metadata header is included in each file, which has information about the variable names and units, as well as any notes specific to a single day or measurement. The list of variables and units are repeated here:

Time_Start, seconds, Time_Start, seconds_past_midnight_UTC
LAT, degree, Platform_Latitude_InSitu_None, Midpoint sample period latitude
LON, degree, Platform_Longitude_InSitu_None, Midpoint sample period longitude
WIBS_A_Conc, number per cm3, A_Conc, Number of fluorescent particles larger than 0.8um in the A category per cm3 of air (ambient temperature and pressure)
WIBS_B_Conc, number per cm3, B_Conc, Number of fluorescent particles larger than 0.8um in the B category per cm3 of air (ambient temperature and pressure)
WIBS_C_Conc, number per cm3, C_Conc, Number of fluorescent particles larger than 0.8um in the C category per cm3 of air (ambient temperature and pressure)
WIBS_AB_Conc, number per cm3, AB_Conc, Number of fluorescent particles larger than 0.8um in the AB category per cm3 of air (ambient temperature and pressure)
WIBS_AC_Conc, number per cm3, AC_Conc, Number of fluorescent particles larger than 0.8um in the AC category per cm3 of air (ambient temperature and pressure)
WIBS_BC_Conc, number per cm3, BC_Conc, Number of fluorescent particles larger than 0.8um in the BC category per cm3 of air (ambient temperature and pressure)
WIBS_ABC_Conc, number per cm3, ABC_Conc, Number of fluorescent particles larger than 0.8um in the ABC category per cm3 of air (ambient temperature and pressure)
WIBS_Non-Fluor_Conc, number per cm3, Non-Fluor_Conc, Number of non-fluorescent particles larger than 0.8um per cm3 of air (ambient temperature and pressure)
WIBS_AC_ABC_Conc, number per cm3, AC_ABC_Conc, Number of fluorescent particles larger than 0.8um in the AC or ABC categories per cm3 of air (ambient temperature and pressure)
WIBS_Non-B_Conc, number per cm3, Non-B_Conc, Number of fluorescent particles larger than 0.8um in every category except B per cm3 of air (ambient temperature and pressure)
WIBS_Total_Conc, number per cm3, Total_Conc, Number of all particles larger than 0.8um per cm3 of air (ambient temperature and pressure)

The file names archived as “preliminary” are:
CAPRICORN-2-WIBS_20180112_R0.ict
CAPRICORN-2-WIBS_20180113_R0.ict
CAPRICORN-2-WIBS_20180114_R0.ict
CAPRICORN-2-WIBS_20180115_R0.ict
CAPRICORN-2-WIBS_20180116_R0.ict
CAPRICORN-2-WIBS_20180117_R0.ict
CAPRICORN-2-WIBS_20180118_R0.ict
CAPRICORN-2-WIBS_20180119_R0.ict
CAPRICORN-2-WIBS_20180120_R0.ict
CAPRICORN-2-WIBS_20180121_R0.ict

CAPRICORN-2-WIBS_20180122_R0.ict
CAPRICORN-2-WIBS_20180123_R0.ict
CAPRICORN-2-WIBS_20180124_R0.ict
CAPRICORN-2-WIBS_20180125_R0.ict
CAPRICORN-2-WIBS_20180126_R0.ict
CAPRICORN-2-WIBS_20180127_R0.ict
CAPRICORN-2-WIBS_20180128_R0.ict
CAPRICORN-2-WIBS_20180129_R0.ict
CAPRICORN-2-WIBS_20180130_R0.ict
CAPRICORN-2-WIBS_20180131_R0.ict
CAPRICORN-2-WIBS_20180201_R0.ict
CAPRICORN-2-WIBS_20180202_R0.ict
CAPRICORN-2-WIBS_20180203_R0.ict
CAPRICORN-2-WIBS_20180204_R0.ict
CAPRICORN-2-WIBS_20180205_R0.ict
CAPRICORN-2-WIBS_20180206_R0.ict
CAPRICORN-2-WIBS_20180207_R0.ict
CAPRICORN-2-WIBS_20180208_R0.ict
CAPRICORN-2-WIBS_20180209_R0.ict
CAPRICORN-2-WIBS_20180210_R0.ict
CAPRICORN-2-WIBS_20180211_R0.ict
CAPRICORN-2-WIBS_20180212_R0.ict
CAPRICORN-2-WIBS_20180213_R0.ict
CAPRICORN-2-WIBS_20180214_R0.ict
CAPRICORN-2-WIBS_20180215_R0.ict
CAPRICORN-2-WIBS_20180216_R0.ict
CAPRICORN-2-WIBS_20180217_R0.ict
CAPRICORN-2-WIBS_20180218_R0.ict
CAPRICORN-2-WIBS_20180219_R0.ict
CAPRICORN-2-WIBS_20180220_R0.ict
CAPRICORN-2-WIBS_20180221_R0.ict

Final file versions will have a different version number (Rx). Missing or erroneous values are reported as -9999.

5.0 Data Remarks

Data are not continuous, but the records are listed in chronological order and in even 5-minute intervals, with the beginning of each interval listed in the data files. As mentioned above, no assessment of confidence intervals has been attempted for this dataset as yet, but will be provided in a future version. Number size distributions for each particle type for all times reported in this dataset are available upon request from the PI, but are not reported here.

6.0 References

Perring, A. E., et al., 2015: Airborne observations of regional variation in fluorescent aerosol across the United States. Journal of Geophysical Research: Atmospheres, 120 (3), 1153–1170, doi:10.1002/2014JD022495.

Twohy, C. H., et al., 2016: Abundance of fluorescent biological aerosol particles at temperatures conducive to the formation of mixed-phase and cirrus clouds. Atmospheric Chemistry and Physics, 16 (13), 8205–8225, doi:10.5194/acp-16-8205-2016.

Humphries, R. S., McRobert, I. M., Ponsonby, W. A., Ward, J. P., Keywood, M. D., Loh, Z. M., et al. (2019). Identification of platform exhaust on the RV *Investigator*. *Atmospheric Measurement Techniques*, *12*(6), 3019–3038. https://doi.org/10.5194/amt-12-3019-2019

von der Weiden, S.-L., Drewnick, F., & Borrmann, S. (2009). Particle Loss Calculator – a new software tool for the assessment of the performance of aerosol inlet systems. *Atmospheric Measurement Techniques*, *2*(2), 479–494. https://doi.org/10.5194/amt-2-479-2009