SOCRATES GV Wideband Integrated Bioaerosol Spectrometer measurements

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1.0 Data Set Overview

These measurements were part of the Southern Ocean Clouds Radiation Transport Aerosol Transport Experimental Study (SOCRATES). The main objective of the SOCRATES 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 Colorado State University Wideband Integrated Bioaerosol Spectrometer (WIBS) instrument flown onboard the NSF/NCAR HIAPER G-V during SOCRATES. The WIBS was used to measure horizontal and vertical 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. Flights were based from Hobart, Tasmania. The time period covered is January 15 to February 24, 2018. A total of 15 research flights were flown with the WIBS instrument operational at latitudes between -42.5 and -62.5 degrees and longitudes 134 to 163 degrees, and altitudes within the lower 6 km of the Earth's atmosphere. 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:

Data were collected continuously in real-time with the WIBS, and then pooled during level legs of at least a few minutes to calculate concentrations of fluorescent and non-fluorescent particles in the categories described above. During SOCRATES, the WIBS sampled from the counterflow virtual impactor (CVI) inlet mounted on the underside of the G-V. The CVI was used in two modes during SOCRATES: in “standard” mode to capture cloud particle residuals or in “total” mode (without counterflow) to capture ambient aerosol particles. Only WIBS data collected with the CVI in “total” mode are reported here, and data were also screened to remove cloud and drizzle. The CVI enhances particle concentrations in both “standard” and “total” mode. These enhancements were modeled and used to adjust the data reported here to ambient concentrations. Line losses in the tubing between the CVI and WIBS were also estimated and used to correct the measured concentrations. The influence of RH on particle sizes measured is under review, but was not adjusted for in this dataset. 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 liter of air, at ambient temperature and pressure. The concentrations reported for each category are the average value over a level or almost-level leg lasting at least 2-3 minutes. Only particles larger than 0.8 μm 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). A data flag is included in the array (CVI_Heater_Flag) to indicate whether the CVI inlet heater was on (1) or off (0) during each measurement, in addition to aircraft position and altitude information for each measurement. 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
Time_Stop, seconds, Time_Stop, seconds_past_midnight_UTC
Time_Mid, seconds, Time_Mid, seconds_past_midnight_UTC
LAT, degree, Platform_Latitude_InSitu_None, Midpoint sample period latitude
LON, degree, Platform_Longitude_InSitu_None, Midpoint sample period longitude
ALT, meter, Platform_AltitudeMSL_InSitu_None, Midpoint aircraft altitude (meters ASL) during sample period
WIBS_A_Conc, number per liter, A_Conc, Number of fluorescent particles larger than 0.8um in the A category per liter of air (ambient temperature and pressure)
WIBS_B_Conc, number per liter, B_Conc, Number of fluorescent particles larger than 0.8um in the B category per liter of air (ambient temperature and pressure)
WIBS_C_Conc, number per liter, C_Conc, Number of fluorescent particles larger than 0.8um in the C category per liter of air (ambient temperature and pressure)
WIBS_AB_Conc, number per liter, AB_Conc, Number of fluorescent particles larger than 0.8um in the AB category per liter of air (ambient temperature and pressure)
WIBS_AC_Conc, number per liter, AC_Conc, Number of fluorescent particles larger than 0.8um in the AC category per liter of air (ambient temperature and pressure)
WIBS_BC_Conc, number per liter, BC_Conc, Number of fluorescent particles larger than 0.8um in the BC category per liter of air (ambient temperature and pressure)
WIBS_ABC_Conc, number per liter, ABC_Conc, Number of fluorescent particles larger than 0.8um in the ABC category per liter of air (ambient temperature and pressure)
WIBS_Non-Fluor_Conc, number per liter, Non-Fluor_Conc, Number of non-fluorescent particles larger than 0.8um per liter of air (ambient temperature and pressure)
WIBS_AC_ABC_Conc, number per liter, AC_ABC_Conc, Number of fluorescent particles larger than 0.8um in the AC or ABC categories per liter of air (ambient temperature and pressure)
WIBS_Non-B_Conc, number per liter, Non-B_Conc, Number of fluorescent particles larger than 0.8um in every category except B per liter of air (ambient temperature and pressure)
WIBS_Total_Conc, number per liter, Total_Conc, Number of all particles larger than 0.8um per liter of air (ambient temperature and pressure)
CVI_Heater_Flag, unitless, none, 0=CVI heater off, 1=CVI heater on

The file names archived as “preliminary” are:
SOCRATES-WIBS_20180116_R0_RF01.ict
SOCRATES-WIBS_20180119_R0_RF02.ict
SOCRATES-WIBS_20180124_R0_RF04.ict
SOCRATES-WIBS_20180126_R0_RF05.ict

SOCRATES-WIBS_20180131_R0_RF07.ict
SOCRATES-WIBS_20180204_R0_RF08.ict
SOCRATES-WIBS_20180208_R0_RF10.ict
SOCRATES-WIBS_20180217_R0_RF11.ict
SOCRATES-WIBS_20180218_R0_RF12.ict
SOCRATES-WIBS_20180220_R0_RF13.ict
SOCRATES-WIBS_20180222_R0_RF14.ict
SOCRATES-WIBS_20180224_R0_RF15.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. Start, end, and midpoint times of each sample period are provided, and the representative average conditions for each record is listed. As mentioned above, no assessment of confidence intervals has been attempted for this dataset as yet, but will be provided in a future version. Particle hygroscopic growth has been considered but particle sizes reported in this dataset have not been adjusted to account for varying RH. 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. Lastly, since the number concentration corrections are extensive, only below-cloud data has been reported in this preliminary data set (version R0). Future versions will also include above-cloud measurements.

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.