PROCESSING OF THE DATA MEASURED WITH CLOUD CONDENSATION NUCLEI COUNTER IN YEAR 2020 FOR SUBMISSION TO EBAS DATABASE

Moravec, Pavel
2023

PROCESSING OF THE DATA MEASURED WITH CLOUD CONDENSATION NUCLEI COUNTER IN YEAR 2020 FOR SUBMISSION TO EBAS DATABASE

Pavel MORAVEC, Tomáš JINDRA, Zdeněk WAGNER, Vladimír ŽDÍMAL

Institute of Chemical Process Fundamentals, AS CR, Prague, Czech Republic, moravec@icpf.cas.cz

Keywords: Atmospheric aerosols, CCNC, Cloud condensation nuclei concentrations

INTRODUCTION

Aerosol particles in the atmosphere that allow water vapor to condense and form cloud droplets are called Cloud Condensation Nuclei (CCN). Elevated concentrations of CCN tend to increase the concentration and decrease the size of cloud droplets. This can lead to suppression of precipitation in shallow and short-lived clouds and to greater convective overturning and more precipitation in deep convective clouds, Rose et al. (2010). The response of cloud properties and precipitation processes to increasing anthropogenic aerosol concentrations represents one of the largest uncertainties in the current understanding of climate change. One of the fundamental challenges is to determine the ability of aerosol particles to act as CCN under relevant atmospheric conditions. Knowledge of the spatial and temporal distribution in the atmosphere is essential to incorporate the effects of CCN into meteorological models of all scales, Huang et al. (2007). Long-term CCN measurements are performed at aerosol monitoring sites such as those forming ACTRIS (Aerosols, Clouds, and Trace Gases Research Infrastructure) network. Measured data are then submitted to the EBAS database, where they are available for the other ACTRIS researchers. In this paper, we present our experience with the processing of the data measured with CCNC for submission to the EBAS database. The data prepared for submission to EBAS from year 2020 are also presented.

EXPERIMENTAL SETUP

The instrument we are using for the CCN concentration measurements is a Dual Column Cloud Condensation Nuclei Counter (CCN-200) purchased from Droplet Measurements Technologies, USA. The DMT CCNC operates on the principle that heat conduction in the air is slower than molecular diffusion of water vapor (Roberts and Nenes, 2005). The CCNC operates by maintaining a positive temperature difference between the bottom and top of the column. Inside the column, the supersaturated water vapor condition is caused by diffusion of water vapor from the warm, moist column wall toward the centerline, at faster rate than heat. The CCN-200 counter allows making two simultaneous measurements of CCN concentrations, which offers interesting possibilities:

- measurement at different combinations of supersaturations (SSs) in each column, so that data for more SSs can be collected during one measurement cycle,
- polydisperse measurement of CCN in one column and monodisperse measurement in the other,
- measurements of CCN concentrations from different locations in each column.

Until now, we mostly used the same SSs in both columns during the measurement cycle. CCNC data are to be submitted to EBAS at three levels. In this work we processed the data for submission as level zero (EBAS Data Submission Manual). However, the data collected by CCNC contain a lot of ballast that is unusable for scientific purposes. Therefore, it is necessary to cure the data before submission. CCN-200 collects approximately a hundred items of data each second. They consist of time, CCN concentration, particle size distribution, and a number of parameters describing the state of the instrument: temperatures, flow rates, voltages etc. One measuring cycle consists of 5 or 6 SSs. Measurement at each SS consists of a transition period when parameters of the instrument, mainly temperatures, stabilize, which should be followed by a sufficiently long period of measurement with stable parameters of the CCNC. The data from those steady state periods have to be averaged. An example of processing of CCN concentration is shown in Fig. 1 for three hours of measurement, 60 minutes long measuring cycle and 5 SSs per cycle.

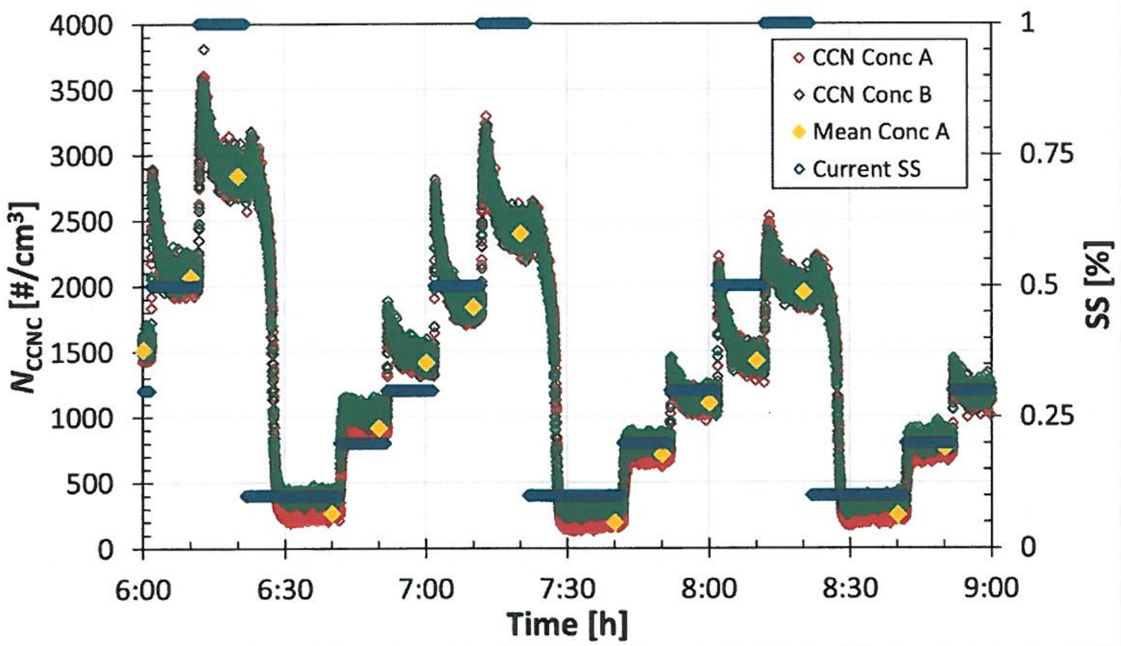

Fig. 1: Time dependencies of CCN concentrations and SSs during three measuring cycles, 10.9.2020.

Tab. 1: SS settings of measurement cycles in 2020. No 1 - period from 1.1. to 26. 2. 2020, No. 2 - period from 24. 6. to 21. 9. 2020, No. 3 - period from 21. 9. to 14. 10. 2020.

No. 1	**SS [%]**	0.1	0.15	0.2	0.3	0.5	1
	Time [min]	10	6	6	7	8	8
No. 2	**SS [%]**	0.1	0.2	0.3	0.5	1	
	Time [min]	20	10	10	10	10	
No. 3	**SS_A [%]**	0.15	0.2	0.25	0.5	0.7	
	SS_B [%]	0.1	0.2	0.3	0.5	1	
	Time [min]	20	10	10	10	10	

For averaging we selected last three minutes of measurement for each SS. Resulting average values of CCN Conc A show yellow points and we can see that this procedure reduced 10800 values of Conc A on 15. Consequently, 10800 rows with 100 items of data each was reduced to 15.

RESULTS AND CONCLUSIONS

In 2020, measurements were carried out using three variants of measuring cycle with parameters specified in Tab. 1. In the first period from 1.1. to 25.2.2020, we used 45 min measuring cycle with 6 SSs. The processed data from this period are shown in Fig. 2. Three months long gap between time periods 1 and 2 was caused by taking part on Calibration and comparison workshop at TROPOS, Leipzig and, predominantly by COVID-19 restrictions.

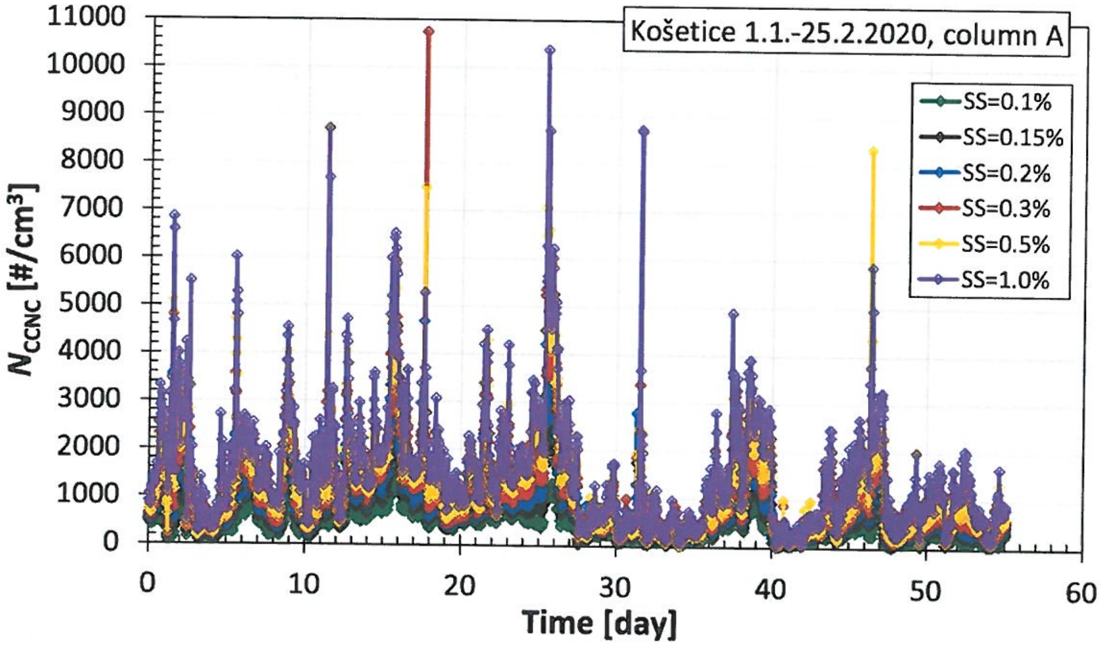

Fig. 2: Averaged values of CCN concentrations for 6 SSs and time period 1 in Tab. 1.

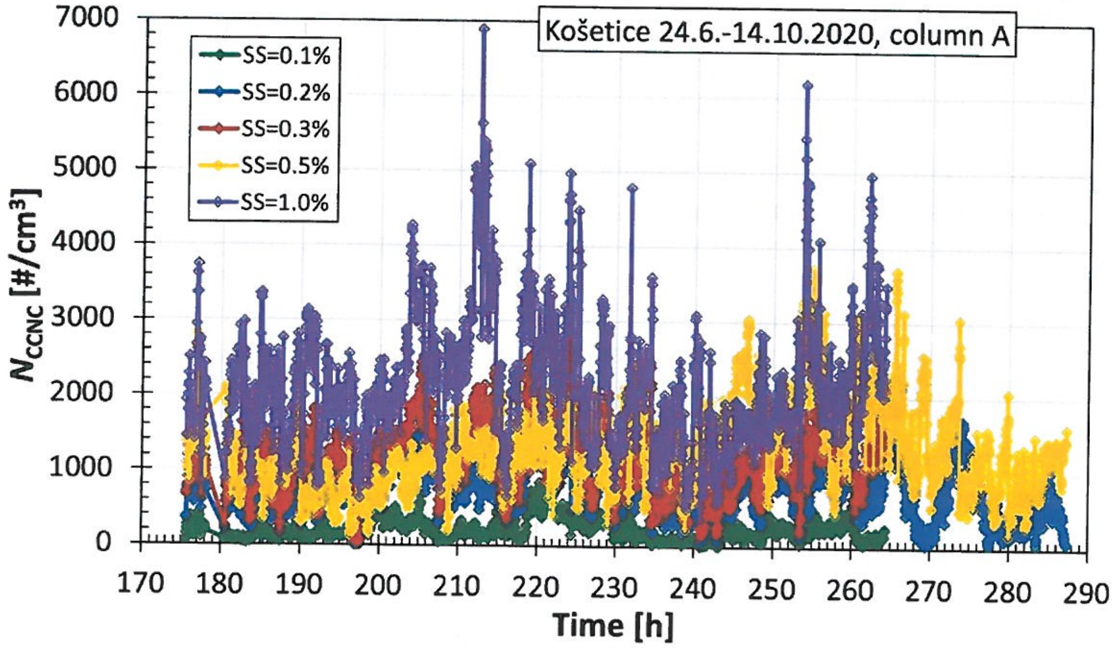

Fig. 3: Averaged values of CCN concentrations for 5 SSs and time periods 2 and 3 in Tab. 1.

Missing data from the end of the year were caused by sending CCN-200 to DMT for Win10 System Upgrade. During the workshop at TROPOS, we found that longer time periods are more suitable for measurements at individual SSs, especially for SS = 0.1%. Therefore, in the following measurements we applied 60 min measuring cycle with only 5 SSs, see Tab. 1 for details. CCN concentrations from time periods 2 and 3 are shown in Fig. 3. Nevertheless, the data collected during the 1st period (Tab. 1) are still valid because differences in temperatures were within allowed limits (Operator Manual, 2018). To date we already submitted to EBAS the data from year 2020 and the data from year 2019 are almost ready for submission. The data from year 2019 were already presented by Mishra *et al.* (2022). However, for data collected after CCN-200 - WIN10 System Upgrade, the procedure for submission to the EBAS database needs to be worked out and approved by NILU, because SS settings are somehow different in the new software.

ACKNOWLEDGEMENT

This work was supported by the infrastructure projects of the MEYS of the Czech Republic ACTRIS-CZ (LM2018122 and LM2023030), from European Regional Development Fund-Project "ACTRIS-CZ RI" (No. CZ.02.1.01/0.0/0.0/16_013/0001315) and from ACTRIS IMP - H2020-INFRADEV-2019-2, Grant Agreement no.: 871115.

REFERENCES

EBAS Data Submission Manual: https://ebas-submit.nilu.no/templates/Cloud-Condensation-Nucleus-Counter/ccnc-ss_lev0

Huang Y., Chameides W.L., Dickinson R.E., Direct and indirect effects of anthropogenic aerosols on regional precipitation over east Asia, *J. Geophys. Res.*, 112, D03212, (2007).

Mishra G., Moravec P., Ždímal V., First surface measurements of variation in Cloud Condensation Nuclei concentrations over a rural background site of the Czech Republic, IAC 2022, Athens, Greece, 4-9 September 2022.

Operator Manual for Dual-Column CCN, DOC-0128 Revision F, Chapter 12.2.2.1, p. 67, (2018).

Roberts G.C., Nenes A., A continuous-flow streamwise thermal-gradient CCN chamber for atmospheric measurements, *Aerosol Sci. Technol.*, 39, 206-221, (2005).

Rose D., Nowak A., Achtert P., Wiedensohler A., Hu M., Shao M., Zhang Y., Andreae M.O., Pöschl U., Cloud condensation nuclei in polluted air and biomass burning smoke near the mega-city Guangzhou, China – Part 1: Size-resolved measurements and implications for the modeling of aerosol particle hygroscopicity and CCN activity, *Atmos. Chem. Phys.*, 10, 3365-3383, (2010).