TNA User Report

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eurochamp2020@lisa.u-pec.fr

Project title	**Inter-comparison of new ice-nucleating particle counters (CAL01)**
Name of the accessed calibration center	AIDA cloud chamber
Number of users in the project	7
Project objectives (max 100 words)	To compare newly developed INP counting instruments against the well-established AIDA chamber, and to develop calibration techniques for future inter-comparisons. These techniques are important to ensure consistent methods and measuring and measurement reporting across the community.
Description of work (max 100 words):	Online INP counters were connected to the AIDA chamber in order to ensure consistent sampling conditions, and made measurements concurrently on the same aerosol samples. Parallel to this, filter samples were taken for offline techniques to use. 9 different test samples (single or mixed aerosols) were used, at varying concentrations and temperatures.

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New user	No

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[1] Physics; Chemistry, Earth Sciences & Environment; Engineering & Technology; Mathematics; Information & Communication Technologies; Material Sciences; Energy; Social sciences; Humanities.
[2] UNI= University and Other Higher Education Organisation;
RES= Public Research Organisation (including international research organisations and private research organisations controlled by public authority);
SME= Small and Medium Enterprise;
PRV= Other Industrial and/or Profit Private Organisation;
OTH= Other type of organization.
[3] UND= Undergraduate; PGR= Post graduate; PDOC= Post-doctoral researcher; RES= Researcher EXP= Engineer; ACA= Academic; TEC= Technician.
[4] Reproduce the table for each user who accessed the infrastructure

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Trans-National Access (TNA) Scientific Report

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Instructions

Please limit the report to max 5 pages, you can include tables and figures. Please make sure to address any comments made by the reviewers at the moment of the project evaluation (if applicable, in this case you were informed beforehand). Please do not alter the layout of the document and keep it in Word version. The report will be made available on the eurochamp.org website. Should any information be confidential or not be made public, please inform us accordingly (in this case it will only be accessible by the European Commission, the EUROCHAMP-2020 project partners, and the reviewers). Please include:

- Introduction and motivation
- Scientific objectives
- Reason for choosing the calibration facility
- Method and experimental set-up
- Data description
- Preliminary results and conclusions
- Outcome and future studies
- References

Name of the PI: Michael Adams
Calibration center's name and location: AIDA cloud chamber, Karlsruhe Institute of Technology
Campaign name and period: CAL-01 02/05/2019 – 17/05/2019
Text:

• Introduction and motivation

Ice-nucleating particles (INPs) a play a key role in dictating important cloud properties such as radiative forcing and lifetime, as well as influence precipitation. There is a growing body of evidence showing the first-order importance of INPs in mixed-phase clouds (Vergara-Temprado et al., 2018; Whale, 2018), highlighting the need to further our understanding of INPs and their effects. Our current understanding of INP concentrations in the atmosphere is poor both spatially and temporally, leading to a poor predictive capacity when considering the effects of INPs in our atmosphere (Hoose & Möhler, 2012; Kanji et al., 2017; Murray et al., 2012). As quantifying the INP concentrations on a global scale is beyond the scope of any one group in the INP community, it must be a community effort. As our understanding has progressed, the need for improved instrumentation has arisen, leading to different groups employ different measurement techniques in the field. However, the use of inconsistent protocols and instrumentation will lead to unnecessary discrepancies within the community and a reduction in the rate of progress made. A robust, well characterized inter-comparison allows for different groups not only to inter-compare their instruments, but also their data analysis techniques and general thinking processes.

• Scientific objectives

The scientific objectives of this inter-comparison are two-fold. The first objective is to develop and improve protocols for making field measurements of INPs, allowing experts with different ideas to refine and harmonise these ideas and to disseminate them to the wider community.

The second objective is to ensure that when under consistent conditions, different instrumentation reports consistent measurements. This is vital for ensuring that different groups within the community are able to build on each other's work.

• Reason for choosing the calibration facility

The AIDA chamber has produced several influential studies on INP and is recognized within the community as a standard in ice nucleation measurements. As it has hosted previous inter-comparisons (Demott et al., 2018; Hiranuma et al., 2015) it has demonstrated that is well suited and able to host such a campaign.

• Method and experimental set-up

A sample aerosol(s) was injected into the AIDA chamber, and its number concentration/size distribution were measured (approx. mins). Once the desired concentration had been achieved, each online INP counter sampled from the AIDA chamber in order to ensure homogeneous sampling conditions, operating continuously for 1-3 hours. Concurrently to this, filter samples were taken from the AIDA chamber in order for analysis by offline instruments for 1-3 hours. Once the online and offline sampling procedures were completed, and AIDA expansions took place, taking around 30 minutes. Once all measurements were complete, AIDA was cleaned for approx. 3.5 hours. Table 1 shows the experimental plan from the campaign.

Table 1: An experiment list for the CAL-01 campaign, detailing experimental parameters and dates of experiments.

Run id	Date	T_gas AIDA in °C	Aerosol	Concentration in cm^{-3}
1	06.05 (Morning)	-22	ATD	~ 100
2	06.05 (Afternoon)	-26	ATD	~ 100
3	07.05 (Morning)	-18	ATD	~ 250
4	07.05 (Afternoon)	-22	ATD	~ 150
5	08.05 (Morning)	-22	SDSA01	~ 150
6	08.05 (Afternoon)	-26	SDSA01	~ 250
7	09.05 (Morning)	-22	IlliteNX	~ 250
8	09.05 (Afternoon)	-26	IlliteNX	~ 300
9	10.05 (Morning)	-18	FS01	~ 250
10	10.05 (Afternoon)	-26	FS01	~ 100
11	13.05 (Morning)	-26	$(NH_4)_2SO_4$, 0.1% solution SDSA01 (after both injections measurements with PINE and CFDCs; after 2nd injection AIDA expansion without cleaning the chamber afterwards)	~ 500 ~ 10
12	13.05 (Afternoon)	-26	$(NH_4)_2SO_4$, 5% solution	~ 300

13	14.05	-26	$(NH_4)_2SO_4$, 2% solution SDSA01 (after both injections measurements with PINE and CFDCs)	~ 300 ~ 10
14	15.05 (Morning)	-22	SDSA01 $(NH_4)_2SO_4$, 1% solution (Measurements with PINE and CFDCs only after 2nd injection	~ 10 ~ 300
15	15.05 (Afternoon)	-26	SDSA01 $(NH_4)_2SO_4$, 1% solution (Measurements with PINE and CFDCs only after 2nd injection	~ 10 ~ 300
16	16.05	-30	H_2SO_4	~ 1000
17	17.05 (Morning)	-22	ATD $(NH_4)_2SO_4$, 1% solution (Measurements with PINE and CFDCs only after 2nd injection	~ 10 ~ 300

• Data description

The data produced by all instruments describes the number of ice nucleating particles standardized to some quantity. This quantity will predominately be surface area (although in some instance particle number may also be used).

• Preliminary results and conclusions

The preliminary data analysis shows both good agreement between instruments, but also that we have been able to develop a robust way of comparing and calibrating different online INP counters. Namely the experiments using ammonium sulphate and dust aerosol, which enabled us to measure INP using atmospherically relevant aerosol concentrations. Figure 1 shows some preliminary data analysis between the online instruments.

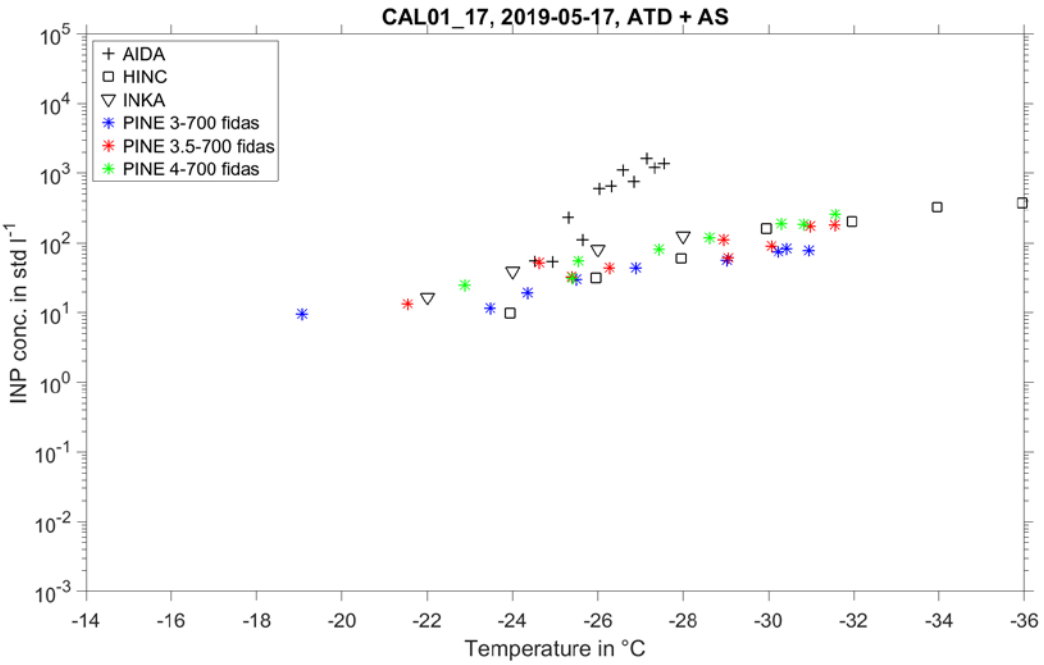

Figure 1:INP concentrations for online INP counters and AIDA as a function of temperature for a mixed dust and ammonium sulphate sample.

The agreement between each of the online instruments was very good, with the AIDA chamber producing data at slightly higher temperatures, potentially due to the onset of some deposition freezing prior to the immersion freezing that the other instruments would not have experienced. More data analysis will need to be undertaken to conclude if this is a consistent trend or an anomaly. Offline filter samples taken during the campaign are currently being analyzed by participants in order to compare offline vs online techniques. Firmer conclusions will be made upon completion of the data analysis.

• Outcome and future studies

The overall campaign was considered a success. Preliminary results show both good agreement between online INP counters, and that a new method for calibrating INP counters at atmospheric aerosol levels was developed. This data will be used to inform the community in an effort to ensure consistent measurements techniques and data reporting.

As more instruments with new techniques are developed, the need for finding consistent techniques will continue. It is hoped that the data taken and the methods developed in this campaign will serve as the basis for future studies striving to achieve similar goals.

• References

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