ARISTO 2016 Report for Colorado State University

Our group had several objectives for ARISTO-2016. Our primary goals were: 1) To complete re-certification of the HIAPER version of the CSU continuous flow diffusion chamber (CFD-1H) ice nucleation instrument for readiness for flight and online sampling on the NSF/NCAR G-V in the Southern Ocean Clouds, Radiation, Aerosol Transport Experimental Study (SOCRATES), tentatively planned for early 2018; 2) To add inline filter samplers (for aerosol collections for offline immersion freezing measurements) to the CFDC-1H rack, and to achieve sample flow rates for these on the order of 10 lpm during flight periods; and 3) To test in-flight re-icing procedures and selected new automated software-based controls for the CFDC-1H that could prove vital for SOCRATES. Requisite for sampling were level cumulative flight periods of 10-20 minutes. Sampling targets of interest, using an aerosol inlet, were lower altitudes over agricultural regions, sampling of forest fire smoke plumes and sampling of urban air.

We achieved changes required for re-certification and are continuing the process of updating the documentation that will be required for flight on the G-V. We then operated the CFDC-1H successfully on most ARISTO flights. We encountered great difficulty in attempting to practice chamber re-icing procedures, and this also led to loss of successful operational time, including during the long flight. Water overflows occurred during two attempts at re-icing during ARISTO-2016, something that may have happened only once previously in our history of operating the instrument on multiple aircraft. This was due to a decision not to allow us to vent a 2 lpm excess flow of nitrogen, which is part of the re-icing procedure that occurs after totally isolating the instrument from the inlet and raising the pressure to cabin pressure. Because we had to pass this excess flow to the inlet dump, the chamber was at lower than cabin pressure during the procedure, and this pressure differential caused uncontrolled release of the icing water (held at cabin pressure) that normally requires controlled pumping into the chamber. It is hoped that in the future, the release of small amounts of compressed air (nitrogen is not required) will be permitted. Not allowing it, or not figuring an engineering fix that keeps the entire system at cabin pressure could be a fatal blow to our participation in long SOCRATES flights (especially where the most important CFDC sampling in that project will not occur until after nearly 4 hours of flight). The PI accepts some responsibility for not being present to know that this change was made during ARISTO-2016, and therefore not advising his staff and NCAR technicians that the request to dump the excess flow would lead to this loss of ability to ice during flight (and undesirable water spills). Our entire team understands this issue now.

The filter collection system tests were a stellar success, and demonstrate full readiness for SOCRATES. Three different student/postdoc/scientist operators obtained invaluable experience operating our systems during flights. Scientifically, the data collected over the North Park fire are of strong interest, especially the filter samples that are being stored frozen, but will soon be processed. These will support Gregory Schill's studies of ice nucleating particles produced from biomass burning, as part of his NSF Postdoctoral Fellowship.

A primary objective not met regarded automation of CFDC operations. This task was not the highest priority due to the expectation that much of the effort needs to occur in a laboratory setting before being put into practice on the aircraft. Although there was not sufficient time to fully achieve operational readiness, we hope to be fully prepared with first automation of temperature control for ARISTO-2017, should our proposal be accepted.

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