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Observational Simulation of Icing in Extreme Weather Conditions

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Abstract
Observations and prediction of icing in extreme weather conditions are important for aviation, transportation, and shipping applications, and icing adversely affects the economy. Icing environments can be studied either in the outdoor atmosphere or in the laboratory. There have been several aircraft based in-situ studies related to weather conditions affecting aviation operations, transportation, and marine shipping that includes icing, wind, and turbulence. However, studying severe weather conditions from aircraft observations are limited due to safety and sampling issues, instrumental uncertainties, and even the possibility of aircraft producing its own physical and dynamical effects. Remote sensing based techniques (e.g. retrieval techniques) for studying severe weather conditions represent usually a volume that cannot characterize the important scales and also represents indirect observations. Therefore, laboratory simulations of atmospheric processes can help us better understand the interactions among microphysical and dynamical processes. The Climatic Wind Tunnel (CWT) in ACE at the University of Ontario Institute of Technology (UOIT) has a large semi-open jet test chamber with flow area 7-13 m2 that can precisely control temperatures down to -40ºC, and up to 250 km hr-1 wind speeds, for heavy or dry snow conditions with low visibility, similar to ones observed in the Arctic and cold climate regions, or at high altitude aeronautical conditions. In this study, the ACE CWT employed a spray nozzle array suspended in its settling chamber and fed by pressurized water, creating various particle sizes from a few microns up to mm size range. This array, together with cold temperature and high wind speed, enabled simulation of severe weather conditions, including icing, visibility, strong wind and turbulence, ice fog and frost, freezing fog, heavy snow and blizzard conditions. In this study, the test results will be summarized, and their application to aircraft icing will be provided in detail. Overall, based on these results, scientific challenges related to icing environments will be emphasized for Arctic and cold environments in future projects in the ACE CWT.