In Situ Verification of Aircraft Icing Conditions Involving Needle Crystals and Supercooled Water in Winter Storms

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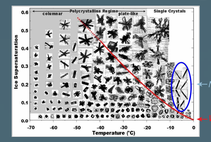
Crystal Habit Diagram

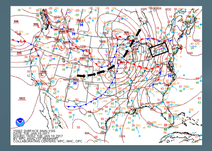
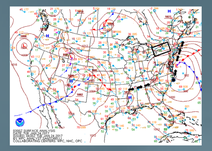
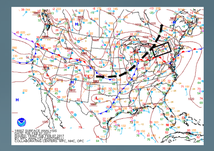
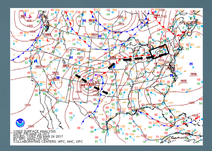
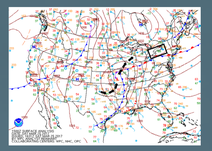
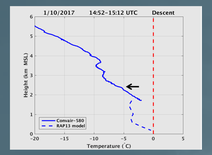
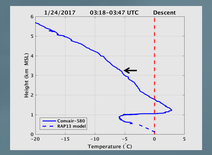
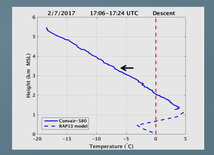
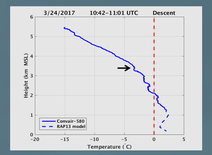
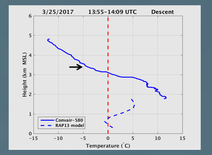
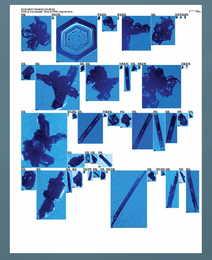
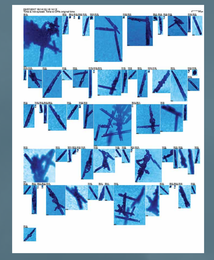
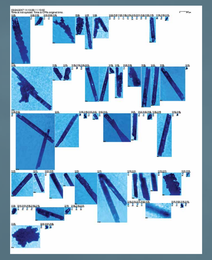
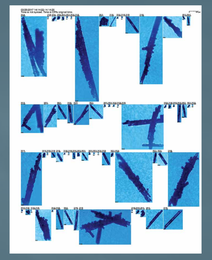
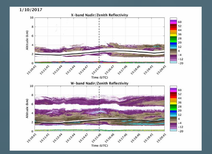
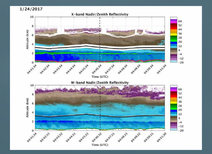
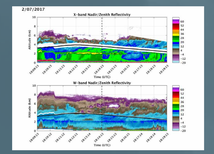
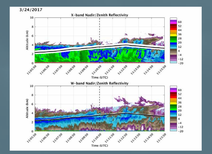
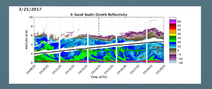


Introduction

A general strategy in an earlier Buffalo Area Icing and Radar Study (BAIRS I) aircraft campaign has been the identification of possible dual polarimetric radar signatures linked with supercooled liquid water (SLW) and aircraft icing conditions. In laboratory diffusion chamber results, needle crystals are associated exclusively with water-saturated conditions, and by inference with SLW. Needles are also anisotropic targets to dual polarimetric radar. This study is concerned with further use of Convair-580 aircraft measurements in the BAIRS II winter storms campaign to examine the synoptic and in situ microphysical conditions associated with needles in rimed and unrimed conditions. To distinguish continental from maritime air mass conditions, synoptic analysis has been used to identify the origin of air ingested by five winter storms.

Convair-580 Observational Suite for this Study

- Temperature probe
- Cloud Particle Imager (CPI)
- Polarimetric lidar
- X-band radar
- W-band radar

	10 January 2017 Continental	24 January 2017 Maritime	7 February 2017 Continental	24 March 2017 Continental	25 March 2017 Continental
Surface Analysis					
Temperature Sounding and Location of CPI Image					
CPI Imagery					
Vertical Profile X-band W-band Reflectivity					

Conclusions

- Storms for four of five flights ingested continental air
- Needle crystals were targeted because of their association with water-saturated conditions and expected SLW, the aircraft icing hazard
- Needle crystals were prevalent in all storms in a temperature range of -3° to -8° C, consistent with laboratory diffusion chamber results, and coincident with radar reflectivity values generally less than 20 dBZ based on X-band and W-band vertical profiles
- Needle crystals were frequently rimed with small droplets in continental cases
- Needle crystals were often unrimed in the maritime case characterized by larger drops but SLW was invariably in close proximity
- The lidar-measured cloud opacity of the maritime case was anomalously large, also consistent with inferred presence of SLW in the form of large cloud drops

Acknowledgements

This study would not be possible without the full cooperation of the NRC pilots Paul Kissmann, Anthony Brown, and Rob Erdos that led to the five successful missions.

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