Aerospace Engineering Seminar

Aircraft Behavior under Adverse Weather: Aerospace Icing Phenomenon

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Abstract

Aircraft and aero-engine icing is a significant weather-related hazard to flight safety in cold environments. Ice accretion on critical aircraft surfaces—including wings, propellers, aero-engine fan and compressor blades, and aerodynamic sensors—can result from the impingement of supercooled water droplets and/or ice crystals in clouds. The resulting ice accumulation can substantially alter aerodynamic characteristics and degrade aircraft and engine performance, posing a serious threat to flight safety.

In this seminar, the speaker will present a series of experimental investigations into dynamic ice accretion and unsteady heat-transfer processes associated with aircraft and aero-engine icing, with particular emphasis on inlet guide vane (IGV) icing induced by supercooled water droplets and ice-crystal icing within aero-engines. Leveraging the unique capabilities of the Icing Research Tunnel, comprehensive experimental studies have been conducted to characterize the critical microphysical and thermodynamic processes governing ice accretion under various icing conditions.

Various advanced experimental diagnostic techniques, including Particle Image Velocimetry (PIV), Digital Image Projection (DIP), and high-speed infrared (IR) thermography, have been developed and employed to quantify droplet and ice-crystal impingement dynamics, unsteady heat transfer during ice accretion, dynamic solidification processes over test surfaces, and the transient behavior of wind-driven water runback flows. In addition, the anti-/de-icing performance of various state-of-the-art hydro-/ice-phobic coatings and functional surfaces has been quantitatively evaluated across a broad range of icing conditions, from dry rime to wet glaze icing.

The findings from these studies provide new insights into the fundamental physics governing aircraft and aero-engine icing, contribute experimental data to validate and improve icing-accretion models, and support the development of more effective anti- and de-icing strategies for safer and more efficient aircraft and aero-engine operations in cold-weather environments.

Dr. Haiyang Hu is an assistant professor in the Aerospace Engineering Department at WPI. He earned his Ph.D. from the Department of Aerospace Engineering at Iowa State University in 2021. His current research interests focus on developing advanced experimental diagnostic techniques/platforms and exploring their applications in active/passive flow control, aircraft performance in adverse weather, non-thermal plasma, and UAV/UAM/UAS.