18. What is "aircraft icing" and how does it affect an airplane?

Aircraft icing is an often misunderstood phenomenon that can have different effects in different situations, sometimes leading to fatal results.

Aircraft icing is most common on smaller prop driven airplanes, such as commuters and general aviation aircraft. When the air temperature approaches freezing, the metal skin of an aircraft also approaches freezing temperatures. When this cold airplane flies through a cloud of liquid water (or rainfall), the water impacts the aircraft and freezes. It is also possible for the liquid water to already be BELOW freezing temperature, which is referred to as "supercooled." In this state, any disturbance, such as an impact, causes an immediate freezing of the water droplet.

There are a lot of variables that go into how exactly the ice freezes on the aircraft. There are many different shapes of ice accretion, but in general, any ice that freezes on the lifting surfaces (the wing or tail) has a negative effect on the aircraft performance. Ice that collects on a lifting surface causes a reduction in the maximum lift and maximum angle of attack and an increase in drag. It is the reduction of the angle of attack that is usually the most significant problem. In the case of the wing, this reduction usually becomes a factor during an approach to land, when the angle of attack is increased, and the speed reduced. Due to the ice, what was previously a safe angle of attack is now a dangerous one, causing the wing to stall (lose lift) and nose down. During an approach, an airplane is usually close to the ground, which means a sudden loss of lift can have disastrous results.

In the case of tail icing (called tailplane icing), the same effect occurs on the tail. The only difference is that the tail produces a NEGATIVE lift (lift in the downward direction) to balance the pitching moment of the aircraft. Tail icing still causes the plane to nose down, but it is usually more violent, and often misunderstood and misdiagnosed by pilots.

While icing on lifting and control surfaces is usually the most critical, icing can also affect other key components of the aircraft. Ice accretion on propeller blades or other engine components reduces thrust and increases drag. Chunks of ice may also break off (called ice shedding) and be ingested by an engine causing significant damage. Even the sheer weight of the ice can be so great that it results in severe performance degredation.

There are many different devices used to prevent or remove icing from aircraft. You may have seen aircraft being sprayed with fluids before flight during potential icing conditions. These fluids may be de-icing fluids that melt and remove existing ice or anti-icing fluids that help prevent ice from forming. There are also electrothermal devices, which heat up a surface like a heating pad, either removing the ice or preventing the ice from forming. These devices are often used on propeller and rotor blades. A device often used on commuter aircraft is the de-icing boot, a rubber balloon-like device that inflates and deflates slightly (around 1/4 to 1/2 inch) at a high rate causing ice to break and fall off the wing. These devices can only be used to remove ice that has already accumulated. In the case of jet aircraft, hot bleed air from the jet engines is often routed through the wings, preventing ice from accreting.

There is signigicant research being conducted on aircraft icing. NASA Glenn Research Center (formerly NASA Lewis) in Cleveland, OH, is the government center for icing research, and is the home of the Icing Research Tunnel (IRT). The University of Illinois is another center of icing research focused on the development of a Smart Icing System. This system is intended to measure environmental and performance parameters to determine if ice accretion is occurring before warning the pilot or independently taking action to prevent the aircraft from entering a potentially critical situation.