Analysis of aircraft incidents caused by weather conditions

Science, Geography

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Knowledge of how the atmosphere works and the forces acting within it to create weather, is an essential part when it comes to understanding how specific weather phenomena affect flight. By understanding different weather effects, a pilot can make quick decisions in all phases of flight to avoid specific weather systems. Today, weather continues to be one of the most important aspects of aviation safety and efficiency. Weather is the uncontrollable variable that pilots death with every time they set foot aboard an aircraft. Weather can significantly affect aircraft operations. Fog, Low Cloud as well as rain can impede visibility at and around the selected airport, while thunderstorms can knowingly tamper with flight schedules. In commercial aviation, flying through certain types of weather often will not affect the aircraft because of they way the aircraft is built. In contrast to general aviation, where questionable weather conditions can sometimes prove fatal if it is to be encountered.

Such as the incident involving a Cessna 182Q aircraft, that was registered as VH-KKM. Thick cloud and turbulence were forecasted the day of the flight, which are not suitable for VFR flight. The weather mixed with the poor judgement of the pilot resulted in a fatal crash. Another incident involving a general aviation pilot was the crash of the Cirrus S22 on the 6th of February 2005, in Reno, Nevada. That suffered from a structural icing incident. Even with the progressions in weather reading technology, smaller aircraft will always be prone to weather related incidents.

Cessna 182Q VH-KKM

On the 23rd of October 2013, a visual flight rules-qualified pilot embarked on a private flight from Moruya Airport in New South Wales and was scheduled to land the same day at Mangalore Airport, Victoria. The flight route that the pilot planned indicated that he was to fly through the Alpine National Park. On this particular day, the forecast predicted that there would be extensive thick cloud and turbulence. Ignoring the weather warnings, the pilot proceeded to conduct his flight. Shortly after passing the airport of Mount Hotham, Victoria. The pilot unfortunately collided with rough terrain on the eastern side of Mount Blue Rag, at approximately 5000 ft above mean sea level. Unfortunately, the pilot had suffered fatal injuries and his aircraft was effectively destroyed (ATSB, 2015). The ATSB stated that, the pilot downloaded the appropriate weather forecasts for the flight between the hours of 0511 and 0637. He also submitted the flight plan to Air Services Australia, with a nominated SARTIME for his arrival at Mangalore 1130, but never made it.

This fatal incident highlights the risks associated with conducting a flight under VFR condition in challenging weather, even more so when operating in mountainous areas. According the Australian Transport Safety Bureau (ATSB), the pilot operating this flight had minimal total and recent flying experience. The pilot mistakenly departed Moruya Airport in less than ideal condition, especially not Visual Meteorological conditions. It was probable that the aircraft encountered this bad weather shortly after passing Mount Hotham Airport, while passing over the Alpine National Park. From the Evidence available it was more than likely that the pilot encountered reduced visibility to the extent that the terrain was unavoidable, resulting in a collision with terrain leading to a fatal crash. With closer analysis to the wreckage, the ATSB determined that the engine and the propeller was providing significant thrust which was consistent with normal engine operation, this ruled out a mechanical failure of the engine which means that the weather had a significant impact. With low cloud and turbulence predicted on the day of operation, this would have contributed to the fatal accident.

Low Cloud and Turbulence

As stated, low level cloud and turbulence played its part in the accident. Low level cloud can be quite dangerous as it can be quite thick and unpredictable. Low level clouds can be identified as Stratus, Cumulonimbus, Cumulus and Stratocumulus Clouds. All of which are recognisable under 6500 ft which classifies them as low-level clouds. Stratus clouds are identified as very low-level layers or patches of cloud. The Stratus clouds are the lowest clouds and are sometimes in the form of fog or mist. Usually Stratus clouds are quite grey in appearance, accompanied by drizzle, snow or snow grains as well. These clouds are usually accompanied by little to no rain, however they are capable of producing a slight drizzle. C cumulonimbus clouds are quite dense low-level clouds. They are capable of extending high in the sky resembling towers or mountain shaped peaks. These clouds are more commonly known as thunderclouds, where the base is usually flat and very dark and form only a few hundred feet above the earths surface. Cumulonimbus clouds are usually associated with heavy downpours and torrential weather. Distinctively, cumulonimbus clouds will produce thunder, lightening or hail. These clouds present the worst the greatest threat to general aviation aircraft. Cumulus clouds represent detached cauliflower shaped clouds that are usually visible on a fair day. The bigger these clouds get, the greater the threat of a downpour. Usually these clouds are white, but the base of these clouds can be quite dark. Stratocumulus clouds are low-level clumps or patches of cloud that will vary from bright white to very dark. As these clouds vary in colour along the skyline, they can have well defined bases with patches that are much darker than others. What makes these clouds so dangerous, is that they can be joined together, presenting a layer of dark cloud situated just above the earths surface. The Stratocumulus clouds form from a Stratus cloud that breaks up. These clouds are often indicators in a change in weather, usually indicates that it is a near a warm, cold or occluded front. According to the ATSB, satellite imaging presented that Stratocumulus cloud was present the day of the flight. The cloud presents a severe risk to the pilot as it would have impaired his judgement and his vision, he would then have been forced to use instruments to conduct the flight. The cloud was situated in the lee of the mountain where the accident occurred, they also indicated that rotor clouds and rotor waves were also there that day.

On the day of operation turbulence was also predicted in the weather updates that day. For an aircraft that operates with an MTOW of 5700kg turbulence can be quite unnerving. With large airliners, turbulence is nothing to worry about as the airframe can withstand the sudden drops of pressure on the exterior of the aircraft, but with smaller and lighter aircraft It can have a different effect. Although turbulence may not have been the deciding factor in this accident, it could have played a role. Turbulence can happen at any altitude and at any time, this is why it is so sudden. At high altitudes, turbulence is presented when air rises vertically. As the sun heats the surface of the Earth the hot air will start to rise as it expands. Otherwise known as convective turbulence. This form of turbulence is usually caused by Cumulus clouds or thunderstorms. As the air continues to rise it gradually reaches a dew point, if the air keeps rising to a higher altitude it begins to form particles of moisture inevitably creating clouds. The greater the vertical extent of the cloud the greater the updrafts created, therefore the greater the vertical extent the worse the turbulence will be. The fluctuation in air temperature and air pressure sometimes causes the aircraft to drop significantly and can be quite stressful on an aircraft’s airframe.

Another category of turbulence is Mountainous turbulence, strong winds may steer upward and over mountains. When the strong wind flows over the mountains it can create turbulence in the form of waves when it reaches the far side of the mountain. Although the turbulence cannot be seen, lens shaped lenticular clouds can be in the area. As this pilot crashed on the side of Mount Blue, mountainous turbulence may have affected his plan in the process of the accident. Along with poor visibility from the Stratocumulus clouds and the effects of turbulence the aircraft and pilot unfortunately collided with the face of Mount Blue.

Cirrus SR-22 N286CD

On the 6th of February 2005, Super bowl Sunday, the weather had taken a turned to a chilly and cloudy afternoon in Reno, Nevada. A 54 year old pilot of a Cirrus SR22 was gambling whether to delay his departure until the following day. The Cirrus SR22 was a state of the art aircraft equipped with ice protection in the form of a “ weeping wing”, although this protection was equipped it was still not authorised to operate in known icing conditions. The Pilot had 500 hours experience behind the controls of an aircraft and was also an instrument-rated pilot. The flight plan intended was to fly from Reno, Nevada to Oakland, California. With the decision to return home, he was to leave within the hour. The pilot contacted Reno Flight Services to obtain a standard weather briefing and also intended to file an IFR plan. As this was an hour long IFR flight, prior to departure the pilot worked closely with the ATC to plan the route back to Oakland. The weather briefing requested by the pilot displayed an upper-level low pressure system with a cold front approaching from the Northwest. Weather at the departure airport described as calm winds, few clouds at 5000ft, scattered 9000ft, 12000ft broken cloud and temperature 6. Along his intended flight path clouds ranged from 2000ft to 12000ft. Which meant that the pilot would have to conduct a majority of his flight in the midst of cloud. Reno Flight Services informed the pilot that there would be broken cloud over northern Nevada and the California mountains with the base of these clouds ranging from 12000ft extending to 15000ft MSL and peaks to be 18000ft to 20000ft MSL. Reno Flight Services then informs the pilot of the low freezing level at approximately 6000ft, Sacramento was to be 6500ft and San Francisco to be 7000ft due to some precipitation. As the Pilot taxis onto the runway the sun has already set, he is approximately 30 minutes behind schedule. After departure N268CD conducted a 180 degree turn onto his intended departure route. Approximately 17 minutes into the flight the pilot requests a higher altitude from the ATC, this is the first suspicion that icing may be apparent. Now approximately 27 minutes after departure the pilot reaches 16700ft where it is realised that icing on the airframe is becoming worse, coupled with it nearing its service ceiling the aircraft is close to stalling. Only a few seconds later the aircraft has entered a steep dive of around 5000ft per minute. The pilot deployed his ballistic parachute well above the systems maximum airspeed off 133 knots. The chute separated the airframe under the sheer load of the reaction. The aircraft the crashed into mountainous terrain unfortunately killing the pilot.

Following the incident the National Transportation Safety Board concluded that the probable cause was in flight loss of control following unforecast icing conditions. In addition the National weather Services inaccurate icing report was responsible for the fatal accident. Although the weather services report was inaccurate the crisis could have been averted. Airframe Icing Airframe Icing is referred to as a pilots worse enemy, as it is often undetectable. Not only can airframe icing cause loss of altitude or aircraft speed, but it can also be fatal such as the incident of N286CD. Airframe icing can occur in unexpected weather conditions and can take effect very quickly. In-flight airframe icing can occur when supercooled water freezes on impact with any part of the external surface of the aircraft.

A common misconception is that airframe icing can only happen on the leading edges of the aircraft such as the wings and tailplane. But ice can also form on propellers, windscreens, aerials and even air intakes. However, it becomes increasingly dangerous when it forms on the leading edge of the wings. Icing is dangerous not only to the increased weight, but more significantly disrupts the air flow that provides the lift necessary for the aircraft to fly. Airframe icing also has tendency to partially or completely block the air intake to any of the Pitot static system, tampering with these pitot instruments leads to inaccurate display of Altimeters, Airspeed indicators along with Vertical speed indicators. Ice accretion on an aircraft's airframe can be classified as either Rime Icing, Clear Ice or even a mix of the two that is referred to as Cloud or Mixed Icing. Rime ice consists of supercooled water droplets freezing on contact with a surface that is subject to sub-zero temperatures. The rapid transition to a frozen state allows the creation of a mixture of trapped air and tiny are particles. As the rime ice forms, it becomes opaque and its crystalline structure becomes brittle. Water droplets which exist in liquid form at temperatures below $0^{0}C$ are referred to as Supercooled water droplets. The larger supercooled droplets are referred to as Supercooled large droplets, these droplets are identified as having a diameter that is 50 micrometres. Droplets of this diameter are often found in areas of freezing rain as well as freezing drizzle.

Now with the advanced weather systems on-board aircraft, detection of large droplets is easier. This equipment is essential as droplets are a clear indication of in-flight icing. Wind tunnels and flight tests have shown that frost, snow and ice accumulation on the leading edges and the upper surface of the aircrafts wings, no thicker than a single piece of course sandpaper can in fact decrease lift by an astonishing 30% and increase the drag component by up to 40%.