Improved thunderstorm information for pilots through satellite and ground based observing systems

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Today's weather information for pilots on thunderstorm conditions on their flight path is insufficient. Weather charts provided by the World Area Forecasting Centres and taken onboard by pilots before take-off are based on forecasts of large scale weather models which are initialized only twice a day. The information of the charts is therefore outdated, at least with respect to thunderstorm occurrence, at the time of use. They can only provide a rough estimation of thunderstorm hazards for relatively large areas. In contrast, thunderstorms develop quickly within tenths of minutes up to an hour and their exact time of occurrence and location is more or less impossible to predict deterministically hours in advance.

In this paper, the value of the satellite information on thunderstorm detection over the oceans is demonstrated by applying the DLR Cb-TRAM cloud tracker (Zinner et al., 2009) to last years occurrences of aircraft accident and incident over the Atlantic. In addition, two incidents over the European area with severe turbulence and hail encounter are investigated by satellite, radar and lighting data. The aim of the study is to demonstrate the improved information pilots would gain once the thunderstorm analyses and forecasts of the satellite and ground based systems would be brought, i.e. up-linked, to the cockpit during flight.

Today, pilots have information on thunderstorm activity through onboard radar equipment which provides quite good indication on thunderstorm activity within the close range part in flight direction, about 50 miles or so, provided there is precipitation within the convective up-droughts, strong enough to give radar returns. However, the radar returns are strongly attenuated when precipitation cells are large and intense, or several cells behind one another, due to the short wave length of the radars which operate at 3 cm. In that case the pilot's information of the situation is quite incomplete which makes it difficult for them to choose a proper path around thunderstorm cells or through a thunderstorm line. In addition there are cases where thunderstorm cells are just about to develop with weak or no returns on the radar, yet they can produce convective turbulence which can propagate to levels above the developing cells. In that case the aircraft might experience sudden turbulence without any pre-warning. Also, at high flight levels through tropical storms over the oceans, radar returns might be weak due to small droplet sizes, thereby giving a wrong indication of the severity of the storm.

In contrast to this onboard radar information, remote sensing by satellite, ground based radar and lightning can provide a more complete picture of the thunderstorm situation. Ground based systems have been developed which use this data to inspect cells from above, below and multiple viewing angles thereby providing a more complete picture of the thunderstorm situation (e.g.; Tafferner et al., 2009; Sénési et al., 2009). Thunderstorms can well be detected from satellite due to their cold cloud tops and characteristic cloud shape at already early development stage, the precipitation they produce can well be detected by radar and lightning discharges by lightning detectors.

References

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