Improved Safety for Air Traffic through Ground and Satellite Based Observing Systems

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Today's weather information for pilots on thunderstorm conditions on their flight 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 four times a day. These models have high predictive skill in forecasting the large scale weather situation, i.e., the distribution of high and low pressure areas together with synoptic scale fronts for the next days and precipitation for about one day in advance. Thunderstorms however, whose time and space scales typically range from tens of minutes up to an hour and from hundreds of meters to some kilometres in diameter, cannot be deterministically forecast by these models.

For the instantaneous picture in flight, pilots have information on thunderstorm activity through onboard radar equipment. The radar provides a good indication on thunderstorm activity within the close range ahead of the aircraft, about 50 miles or so, provided there is precipitation within the convective up-droughts, strong enough to give radar returns. However, when precipitation cells are large and intense, or several cells lie behind one another, the radar pulses are strongly attenuated. In such cases information about the situation is incomplete which makes it difficult for pilots 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 forewarning.

In contrast to onboard radar, remote sensing by ground based radar, satellite and lightning detectors 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 being able to provide a more complete picture of the thunderstorm situation. Thunderstorms can be detected from satellite observations due to their cold cloud tops and characteristic cloud properties; the precipitation they produce can be detected by radar and lightning discharges by lightning detectors. For the middle European area data retrieved by the Meteosat Second Generation satellites operated by EUMETSAT, radar data from the European radar network organized by the national weather services and lightning data from networks operated by EUCLID and LINET can be used in expert systems to deduce and nowcast hazards brought about by thunderstorms. Utilising these sources of data a thunderstorm weather information and management system - Cb WIMS - was set up within the course of the FLYSAFE project, which was part funded by the European Commission. CB-WIMS has successfully been employed and demonstrated during flight trials carried out in summer 2008 over Central Europe.

The aim of the paper is to demonstrate that the information provided by such a system could help pilots in gaining a better overview of the weather situation as compared to what can be provided by nowadays onboard systems. This in turn could help pilots in decision making, e.g. which route to take when passing through a thunderstorm line. For the study a number of aircraft accidents and incidents related to thunderstorm activity has been selected for demonstrating the usefulness of such a ground based weather information system. In each case, thunderstorm positions as detected by the ground based system are compared with actual aircraft positions and tracks where known. Finally, the possible up-link of the ground-based weather information to the cockpit is addressed by referring to ongoing and future activities in this direction.