Geophysical Research Abstracts
Vol. 18, EGU2016-2924, 2016
EGU General Assembly 2016

Detection and Analysis of High Ice Concentration Events and Supercooled Drizzle from IAGOS Commercial Aircraft

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Hazardous encounters with high ice concentrations that lead to temperature and airspeed sensor measurement errors, as well as engine rollback and flameout, continue to pose serious problems for flight operations of commercial air carriers. Supercooled liquid droplets (SLD) are an additional hazard, especially for smaller commuter aircraft that do not have sufficient power to fly out of heavy icing conditions or heat to remove the ice. New regulations issued by the United States and European regulatory agencies are being implemented that will require aircraft below a certain weight class to carry sensors that will detect and warn of these types of icing conditions.
Commercial aircraft do not currently carry standard sensors to detect the presence of ice crystals in high concentrations because they are typical found in sizes that are below the detection range of aircraft weather radar. Likewise, the sensors that are currently used to detect supercooled water do not respond well to drizzle-sized drops. Hence, there is a need for a sensor that can fill this measurement void. In addition, the forecast models that are used to predict regions of icing rely on pilot observations as the only means to validate the model products and currently there are no forecasts for the prevalence of high altitude ice crystals.
Backscatter Cloud Probes (BCP) have been flying since 2011 under the IAGOS project on six Airbus commercial airliners operated by Lufthansa, Air France, China Air, Iberia and Cathay Pacific, and measure cloud droplets, ice crystals and aerosol particles larger than 5 μm. The BCP can detect these particles and measures an optical equivalent diameter (OED) but is not able to distinguish the type of particle, i.e. whether they are droplets, ice crystals, dust or ash. However, some qualification can be done based on measured temperature to discriminate between liquid water and ice. The next generation BCP (BCPD, Backscatter Cloud Probe with polarization detection) is now undergoing performance testing and can differentiate atmospheric particle types. Given that the BCP and BCPD are both single particle detectors, this permits high sensitivity to the smallest quantities and rapid detection (within seconds) to alert flight crews.
The BCPD is being implemented as part of a near real-time, flight forecasting system that uses satellite and models, coupled with in situ measurements from the BCPD and meteorological sensors. DAEDALUS is a weather threat situational awareness system for commercial aircraft currently funded by the European Space Agency and supported by major aircraft and engine manufacturers, airlines and air navigation service providers.
This presentation will describe the essential components of DAEDALUS and how it will be implemented to optimize aircraft flight paths while minimizing potential hazards. Examples of measurements from the BCPD will be given that demonstrate its capability for detection and differentiation of atmospheric particulates, especially supercooled liquid droplets and ice crystals, in near real-time.