

Flying around ash clouds as with storms – DLR is developing flight guidance systems

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Since the Icelandic volcano system of Bardarbunga began erupting, concerns about a volcanic ash cloud spreading across Europe and bringing air traffic to a standstill, as occurred in April 2010, have arisen once again. To enable the aviation industry to respond to volcanic ash more flexibly in the future, the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt; DLR) has been developing an improved satellite-supported volcanic ash detection system as part of Project VolcATS (Volcanic Ash Impact on the Air Transport System). DLR researchers are using improved views of the situation to investigate how air traffic management can adapt flexibly to large-scale airspace restrictions caused by volcanic ash.

“The key issue for us is to develop an integrated monitoring and response system for future volcanic crises that can be used to respond quickly in the event of the formation of an ash cloud from Iceland,” says project leader Hans Schlager from the DLR Institute of Atmospheric Physics. “In doing so, we are drawing on the wide range of skills at DLR.” Fundamental to more flexible management of air traffic in Europe in the event of a new ash cloud is accurate and timely detection, which the DLR atmospheric researchers have been able to refine using data from the Meteosat satellite. Future flight guidance measures, as well as improved airline and airport management processes, will be based on this.

Airspace restrictions

The DLR Institute of Flight Guidance is developing algorithms and procedures under Project VolcATS, with the aim of minimising the impact on air traffic in Germany if another ash cloud should occur. “We need a robust air traffic management system that is able to cope with large-scale disruptions caused by volcanic ash,” says Institute head Dirk Kügler. To do this, the Braunschweig-based DLR researchers are focusing on redeveloping proven flight guidance systems that are already being used to find routes to avoid areas of bad weather, for example.

Ash clouds reduce the available airspace and create bottlenecks in air traffic, similar to those in road traffic when lanes are closed for roadworks, for example. “No aircraft should be forced to stay on the ground because airspace that has been constricted as a result of an ash cloud is not being used to the best effect,” says Kügler. This is where the new flight guidance systems come in. Tests are being carried out in the GECCO (Generic Experimental Cockpit) cockpit simulator, in conjunction with the TrafficSim air traffic simulator, to investigate various scenarios involving large-scale volcanic ash airspace restrictions.

Fewer flight cancellations due to volcanic ash

DLR researchers have already been using the effects on air traffic during the Eyjafjallajökull eruption in 2010 to investigate what mitigating effect will result from flight guidance measures combined with a more precise understanding of the distribution of volcanic ash. They took the flight traffic on 17 April 2010 as an example, when only approximately 5000 flights were completed in Europe due to the airspace restrictions caused by volcanic ash. On a normal day, there are more than 30,000 commercial flights in Europe. The wide-scale restriction of the airspace at that time was based on very rough volcanic ash predictions that could only be updated every six hours. At the same time, a strategy was being pursued to prevent aircraft from flying in areas containing volcanic ash, which led to large-scale airspace restrictions.

"In our comparison computation for 17 April 2010, we assume that the improved predictions of the future on ash concentration levels and distribution profiles – using all the technical capabilities available today – would be available," explains Bernd Korn from the DLR Institute of Flight Guidance. "By doing this, it became clear that, if such an improved ash prediction had been used on 17 April 2010, around 3700 more flights could have taken place, as the prediction at the time covered a significantly larger ash restriction area," adds Korn. "If more redirection algorithms are used, the number of possible flights rises by 2000." In addition, the researchers were able to demonstrate that aircraft left on the ground can now be put back into operation more quickly if a more frequently updated picture of the situation with ash distribution is provided (for example with hourly updates instead of the usual six-hour update cycle).

Test run in the control room simulator

Speed is also essential when distributing information in a crisis situation. Even more critical in future will be how effectively the Volcanic Ash Advisory Center (VAAC), the weather service, air traffic control, airports and airlines can exchange information on the current situation. This issue is being looked into in the DLR Institute of Flight Guidance ACCES (Airport and Control Center Simulator) control room simulator. "The important thing here is how information is processed for decision-makers in an operations centre" says Korn. In addition, interaction between all the parties involved is indispensable for a fully functioning system. "For example, it can help to divert some flights even further to guide more flights around an ash cloud. Such decisions are not always easy to make for commercial reasons, but they are worth considering, from the theoretical concept to their practical application."

Decision-making aid for airlines

Following the eruption of Eyjafjallajökull in 2010, approximately 100,000 flights had to be cancelled, and 10 million passengers were left on ground. The economic loss was immense. How an airline responds to such large-scale disruption – for example, which routes are shut down, which are kept going, which aircraft are used for them – gives rise to varying consequential costs when looked at closely. For this reason, DLR air transportation systems are developing more varied response models under VolcATS. This will illustrate the overall costs of the various decisions made in the event of large-scale air space restrictions and indicate the operational alternatives. "With this tool, we are creating a unique evaluation environment for high-level decision-makers to at least be able to roughly estimate the commercial impact," says Volker Gollnick, Director of the DLR Institute of Air Transportation Systems.

DLR research on volcanic ash and air transport

DLR conducts research into the effects of volcanic ash in the Volcanic ash impact on the Air Transport System (VolcATS) project. This project includes a satellite-based technique to determine the distribution of ash in the air at short notice and predict its movement. This contributes to a flexible air traffic management system in which information about those areas that are ash free and therefore safe for air traffic can be shared. The still inadequately understood effects of volcanic ash on aircraft engines are being studied and an ash warning system is being developed for commercial aircraft. Participants include the DLR Institutes of Atmospheric Physics, Flight Guidance, Materials Research, Propulsion Technology, and Air Transportation Systems together with DLR Flight Experiments.

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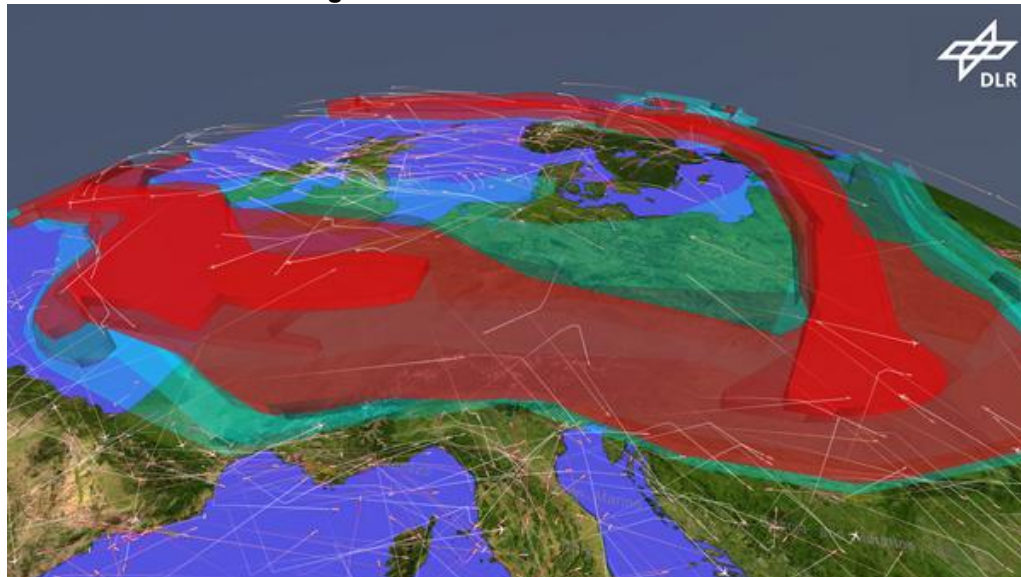
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Simulated air traffic during an ash cloud



Possible air traffic across Europe on 17 April 2010 with improved ash concentration forecast and using the re-direction method to allow high altitude flights to fly over the ash cloud. The colours in the chart give the predicted ash concentration levels in the three recommended concentration levels of the London Volcanic Ash Advisory Centre (VAAC) in London : low (cyan), medium (grey), and high (red).

Credit: DLR (CC-BY 3.0).

The Generic Experimental Cockpit (GECO)



The Generic Experimental Cockpit (GECO) is a modular fixed-base cockpit simulator with interchangeable flight-mechanical models. These are changed, depending on the application required.

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ACCES control centre



The Airport and Control Center Simulator (ACCES) emulates a management center with working positions for the various operators at an airport. The operators can avail of different support systems at their working positions depending on the application. ACCES can be operated in connection with the other simulators of the DLR Institute of Flight Guidance and with external partners via standardised interfaces (Software suite in photo: TAMS Consortium).

Credit: DLR.

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