Flying Around Volcanic Clouds: A Pilots' Account

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ABSTRACT

Eyjafjallajökull - Bardarbunga - Puyehue: words that stand for more than nature plays. Each of these volcanic eruptions had its peculiarities, and influenced air traffic. What was common to all was that there was a degree of uncertainty about dealing with the concrete impact: pilots were surprised by a flood of information or were not given important information. Furthermore, instruments that detect volcanic ash or gas are presently not installed in operational aircraft. This paper presents a pilots´ view of volcanic clouds, and presents suggestions for more efficient as well as safer flights when volcanic clouds are present.

1 INTRODUCTION

Are volcanic eruptions special or was it a peculiarity that aviation in Europe had been spared decades of major problems with volcanic clouds until 2010? From the perspective of long-distance pilots, the latter is the case; Pilots are regularly confronted with volcanic eruptions.

A glimpse into a pilots´ log-book may remind you of eruptions, events, like these: Mt. Pinatubo, Philippines, 1991, Mt. Shishaldin, Alaska, 1999, Eyafjallaökull, Iceland, 2010, Grimsvötn, Iceland, 2011, Nabro, East Africa, 2011, Puyehue, Chile, 2011, Merapi, Indonesia, 2013, occasional eruptions of Colima and Popocatepetl in Mexico.

Clouds were predicted - or not, they were seen on satellite images or with the eye, perceived by the nose and flown around, under-flown, overflown.

Conclusion:

- Volcanic clouds are normal, are a natural phenomenon.
- Volcanic clouds occur globally.
- You have to deal with them - safely.

Figure 1: Jars containing volcanic ash from Puyehue, collected near Buenos Aires after it had been in the air at least 1000 km. Left jar: volcanic ash settled on the bottom, right jar: volcanic ash dispersed in the air

2.0 FLIGHT PLANNING

In general, the responsibility for the safety of flights lies with the operators (airlines) [1], they 'own' the risk, in the legal limits imposed by the states. The companies prepare risk assessments, so-called Safety Risk Assessments, which are audited and approved by the authorities. Their content varies, and is unknown to air traffic control, generally kept under wraps. Nevertheless, these Safety Risk Assessments are the legally valid basis for the planning and execution of all the companies´ flights when volcanic ash is present.

It has always been the most prominent task for pilots to ensure the safety of their respective flights - even when the planned flight path might place them near thunderstorms or volcano clouds. It is thus clear that the safe handling of volcanic clouds begins during flight planning. Information on observed and predicted volcanic ash clouds is published by the nine global Volcanic Ash Advisory Centers (VAAC), according to ICAO procedures. This information is based solely on the presence of volcanic ash, and the VAACs do not give an indication of the amount of volcanic ash. From a safety point of view, the corresponding air spaces are therefore to be regarded as highly loaded with volcanic ash, and consequently to be avoided.

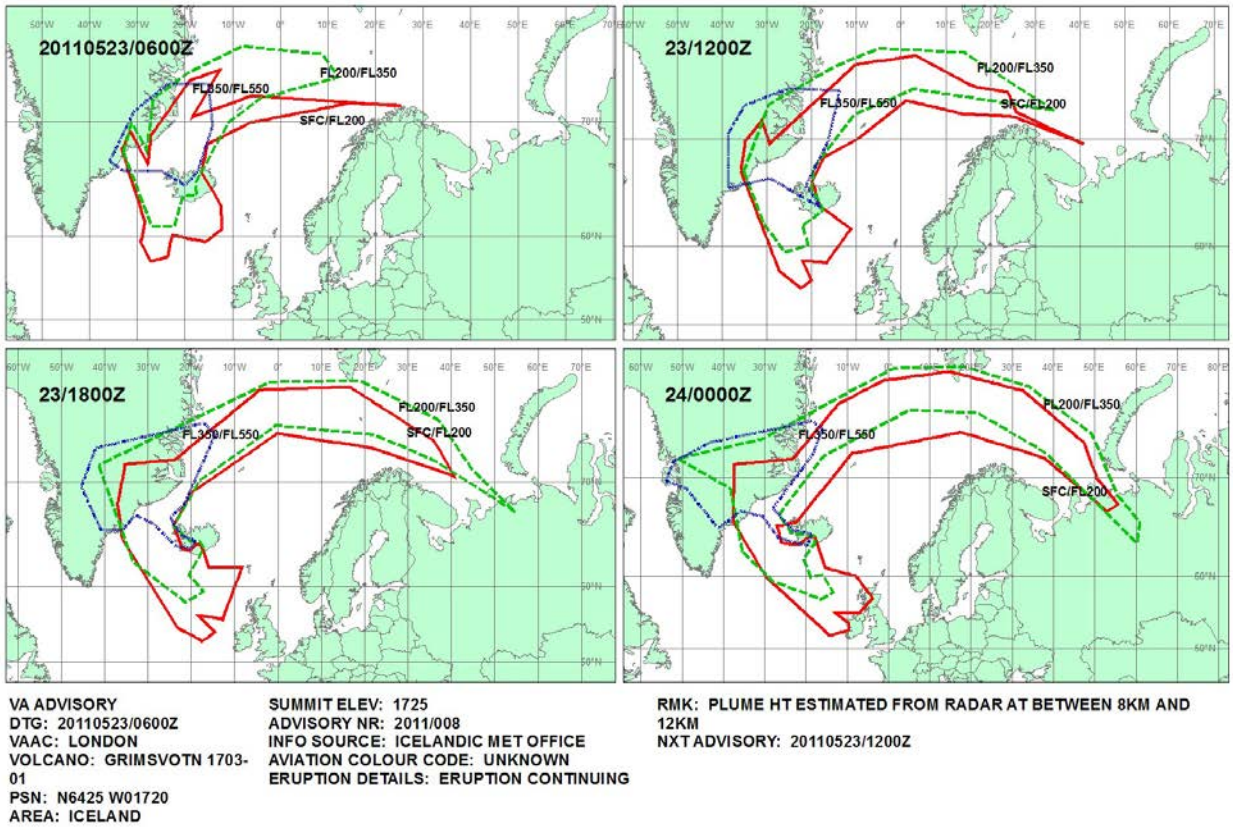

Figure 2: Example of an ash information chart of the VAAC London (2011)

2.1 Volcanic Ash Advisory Centers of Europe

For their areas of responsibility, the two VAACs of London and Toulouse also produce Volcanic Ash Concentration Charts, in addition to the ICAO standard maps. These special charts represent the ash loading in three stages: Low (0.2 - 2 mg ash / cbm), medium (2-4 mg ash / cbm) and high (more than 4 mg ash / cbm). Independent of the VAACs, national weather services such as Deutscher Wetterdienst (DWD) [6] for Germany or its counterpart in Norway [7], determine and predict the amount of volcanic ash in the airspace of their respective country. They do this on the basis of their own measurements, as well as the inclusion of satellite data, for example. Finally, it may happen that national authorities temporarily block -or release- airspaces for flights.

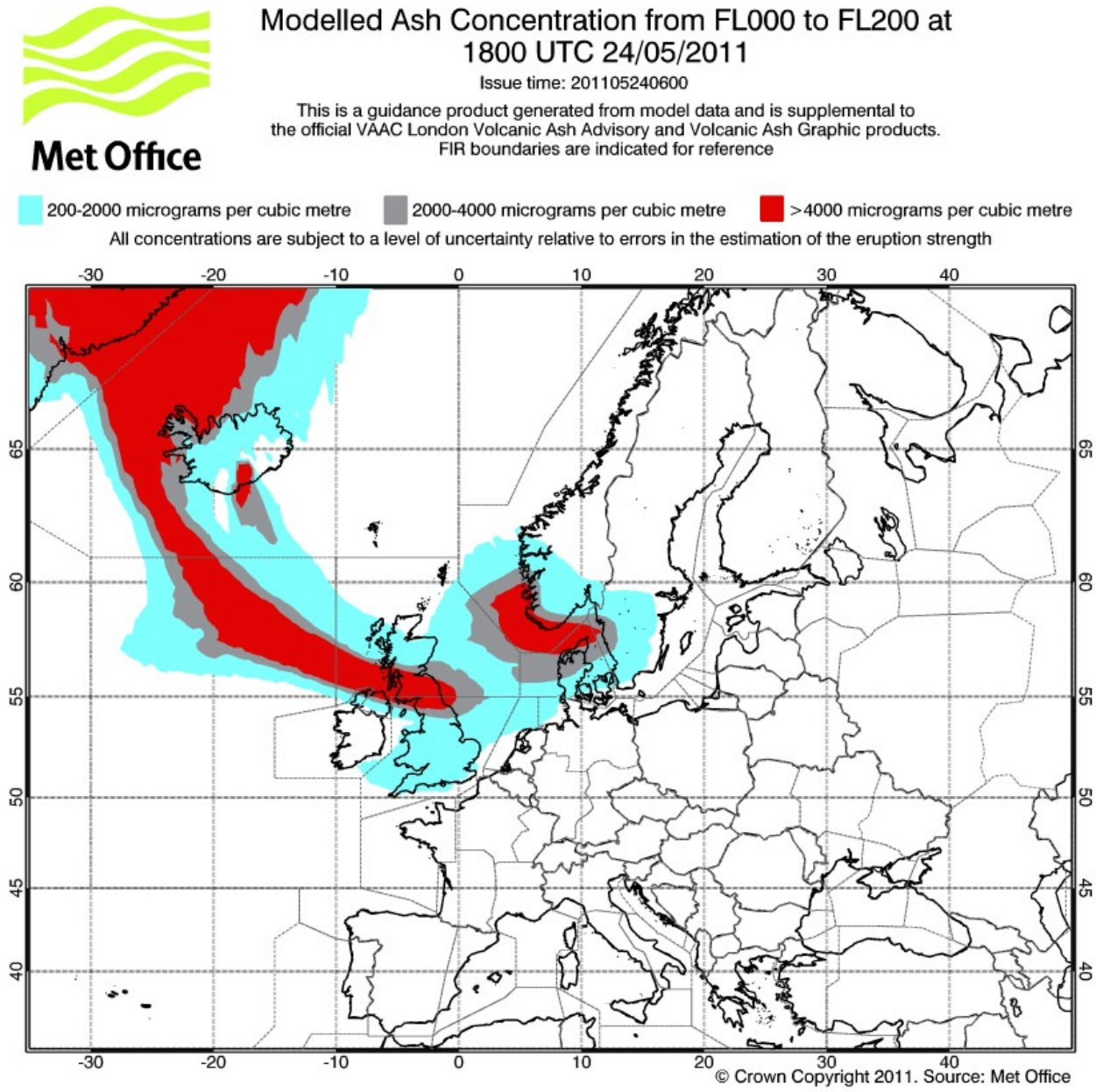

Figure 3: Example of a volcanic ash concentration map of the UK Met Office

2.2 Status

The procedures described here give the impression that there is a lot of room for clarification and harmonization - and so far it was only about the planning of flights! A further complication is that there are currently no ICAO-approved limitations and approval criteria for the resilience of aircraft systems with regards to volcanic ash. EASA has been quite pro-active in this field, prescribing a manufacturer's declaration of the sensitivity to volcanic ash for new large aircraft and engines (EASA CS-25 [4] and CS-E 1050, [5]). Transferring this requirement to older types would be obvious, but it would be difficult and hasn´t been implemented.

3.0 FLIGHT PERFORMANCE

Let's take a look at a flight. VAACs, meteorologists and states inform about volcanic ash clouds, air traffic controllers (dispatchers) plan the flights accordingly, pilots get the above mentioned information and then, the following rule applies, as described, for example, in the Safety Information Bulletin of EASA (2015) [3]:

Avoid operation in visible volcanic ash or, where visibility of the ash is impaired (IMC, night), avoid operation in discernible volcanic ash.

Definitions (ICAO Doc 9691, [2]):

Visible ash: volcanic ash observed by the human eye (not be defined quantitatively by the observer);

Discernible ash: volcanic ash detected by defined impacts on/in aircraft or by agreed in situ and/or remote-sensing techniques.

There are no near real-time volcanic ash satellite images in the briefing for the flight crew, there is no information as to where satellites or other instruments are detecting volcanic ash. Nevertheless this information is available, as shown in the examples of Fig. 3 and 4, and from other sources, too.

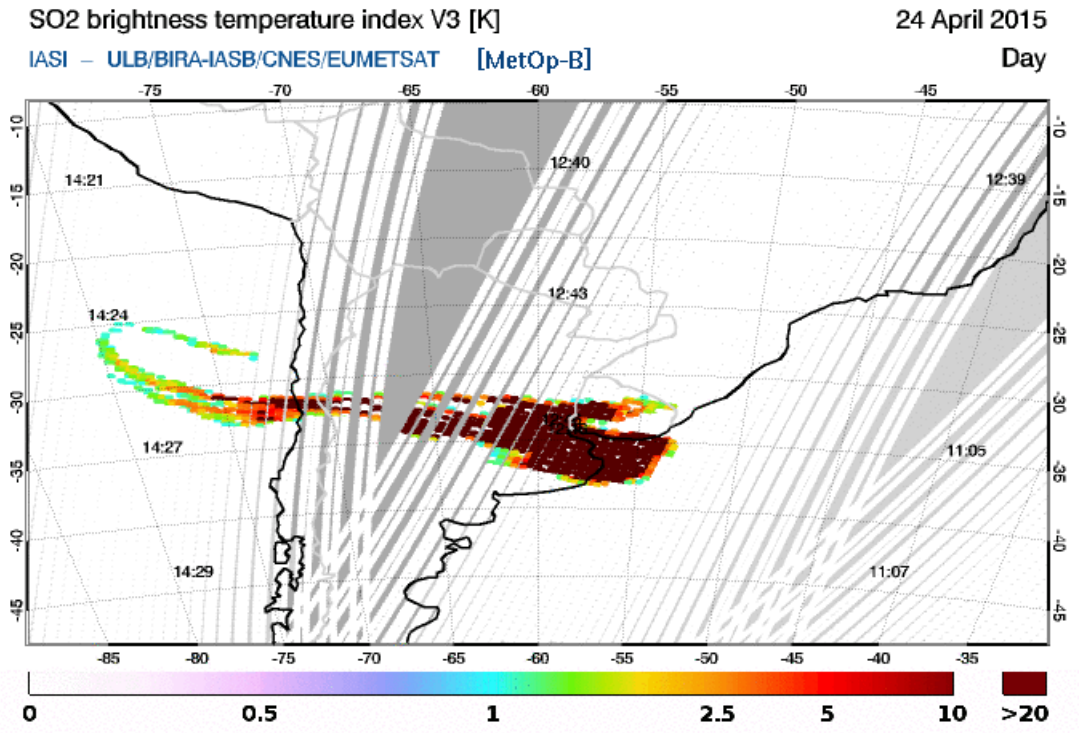

Figure 4: Volcanic gas (SO_2) , SACS, April 24, 2015

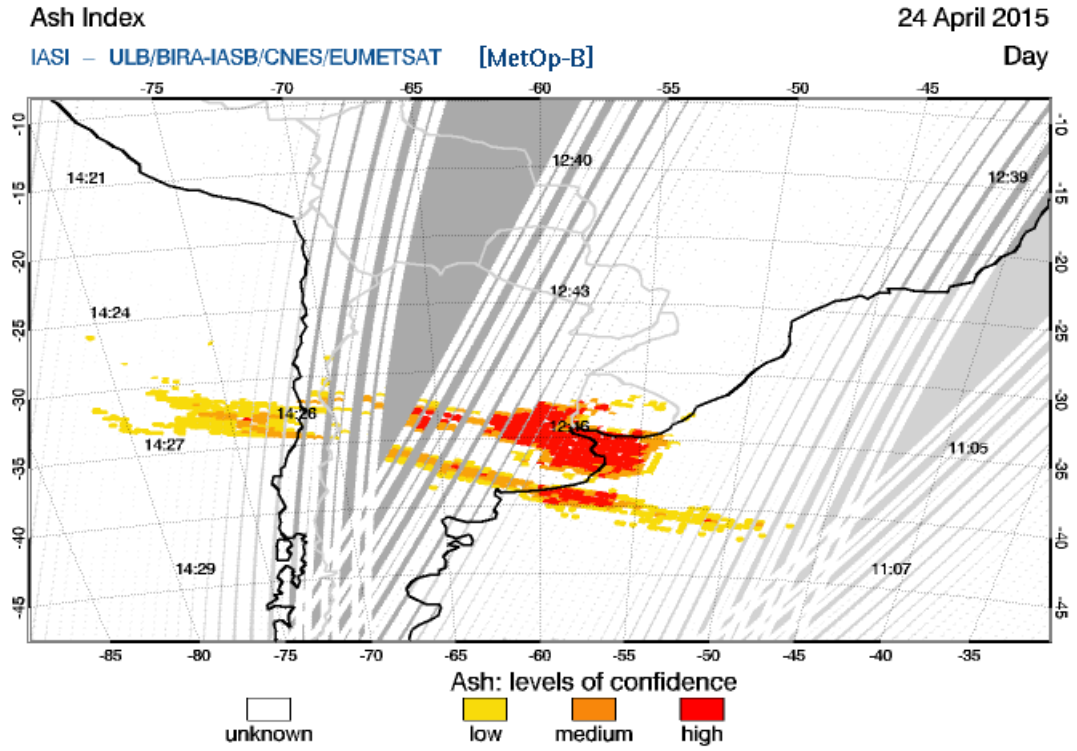

Figure 5: Qualitative display of volcanic ash, SACS, 24 April 2015)

3.1 Visible Volcanic Ash

Considering the above, the view from the cockpit is therefore still the decisive instrument which is to guarantee the safety of a flight, indeed of all the flights. Hard to understand: experience shows that volcanic gas or ash clouds cannot be reliably seen from the cockpit, except close to the volcano. They may be indistinguishable from meteorological clouds. Despite these shortcomings: ***'Avoid visible ash'*** is still the basis for aviation in areas threatened with volcanic clouds, strange as it may sound.

3.2 Instruments

Improvements are urgently needed! Instruments are needed to detect volcanic ash and to warn about impending entry into volcanic clouds and they should have range/display similar to radar. Thus, volcanic clouds could be avoided, flown around, with much increased safety levels.

There are considerations that several technologies would be needed to cover this task spectrum: a combination of infrared ash camera, lidar, particle- and gas sensor would be ideal. These instruments could also provide crucial information on dust clouds, ice crystals and other particulates. Measured values and warnings derived from the instruments should be displayed directly to pilots; also forwarding to central places via datalink is useful so as to help others and to improve airspace management. Investment in these technologies might be a wise choice for those that depend on mobility, for the public, and for airlines that still bemoan the loss of billions of revenue due to Eyjafjallajökull.

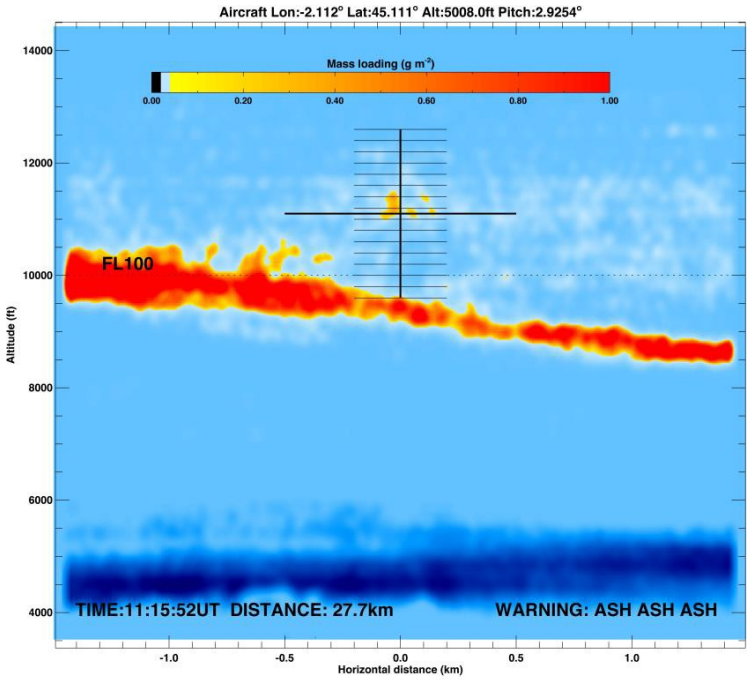

Figure 6: Volcanic ash cloud and volcanic ash warning

4.0 AIR TRANSPORT SYSTEM

VAACs publish the position of detected volcanic ash, as well as predictions about volcanic ash clouds, and they have started to work on similar products for volcanic gas like SO_2. Volcanic ash SIGMET are provided by the weather services, and in addition, States may close ash - affected airspace. All in all, a volcanic eruption generates a flood of information that pilots can best deal with on electronic media. The same is true for air traffic control, which directs the traffic flows or redirects them according to the volcanic cloud development: Air traffic management also needs tools to cope with the flood of information. The overview of the volcanic ash as well as the traffic situation that these tools provide is interesting for airlines, dispatchers and pilots and should therefore be made accessible to them.

5.0 CONCLUSION

In summary, this article is a plea for structured handling of volcanic ash and gas clouds according to the best available science. As with other environmental influences, it is also necessary to determine the resilience of airplanes and their systems in order to issue specific and accurate operations approval. Pilots then need instruments that will not only detect ash and gas, but can also be helpful to avoid, to deal with phenomena like desert dust, ice crystals or turbulence. Planning systems are required, which represent the volcanic cloud development in real time as well as forecast. All these things must be done in order to be able to deal safely with the volcanic clouds, for a safe flight around the clouds.

6.0 SOURCES AND REFERENCES

6.1 Images

Figure 1 : own work.
Figure 2 and 3 published by the UK Met Office, 2011,
Figures 4 and 5 : Illustration from the SACS system, Belgian Institute for Space Aeronomy, 2015
Figure 6 : Demonstration of ash detection system over Bay of Biscay, 2013.
Personal communication from Fred Prata

Permissions to use the pictures were given.

6.2 References

[1] International Civil Aviation Organization (ICAO), Doc 9974, Flight Safety and Volcanic Ash - Risk management of flight operations with known or forecast volcanic ash contamination, Montreal, 2012

[2] International Civil Aviation Organization (ICAO), Doc 9691, , Manual on Volcanic Ash, Radioactive Material and Toxic Chemical Clouds, Montreal, 2015

[3] **European Aviation Safety Agency (EASA),** Safety Information Bulletin 2010-17R7, Flight in Airspace with Contamination of Volcanic Ash, Cologne, 2015

[4] **European Aviation Safety Agency (EASA),** EASA CS-25

[5] European Aviation Safety Agency (EASA), EASA CS-E, Certification Specifications and Acceptable Means of Compliance for Engines, Cologne, 12 March 2015

[6] **Federal Republic of Germany, DFS Deutsche Flugsicherung GmbH (German Air Navigation Services**), AIC IFR 08 / 2014

[7] **Civil Aviation Authority, Norway,** AIC – IFR 07 / 2014