

The Eyjafjallajökull Eruption A Systemic Perspective

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Overview

- » Background
- » What happened?
- » Was there an Overreaction?
- » Paradoxical Situations
- » Institutional Issues
- » What is needed?

Background

- » Eruptions and the Ejection of Volcanic Ash have Occurred on a Regular Basis through Aviation History
- » The detrimental Effects of Volcanic Ash on Aircraft Jet Engines had been Known for two Decades
- » Considerable Effort had been Expended, primarily by ICAO, on Development of Methods and Procedures for Responding to Volcanic Ash
 - › Warnings by NATS/SPG of Potential Disruption of Air Traffic on the North Atlantic
- » Aviation Community thought that Appropriate Measures had been Developed



8. okt. 1999
Magnús Tumi Guðmundsson

Eyjafjallajökull Volcano with a Glacial Crown

1821-1822



What happened?

- » The Scientific Community was Caught by Surprise When Eyjafjallajökull Erupted on 14 April 2010
- » Air Navigation Service Providers Implemented the Contingency Plans and Procedures as Prescribed
- » Contingency Procedures lead to the *de facto* Closure of much of European Airspace and the Eastern North Atlantic for six days
- » Serious Airspace and Airport Closures on a more Limited Scale recurred for over a Month

Eyjafjallajökull 14 April 2010



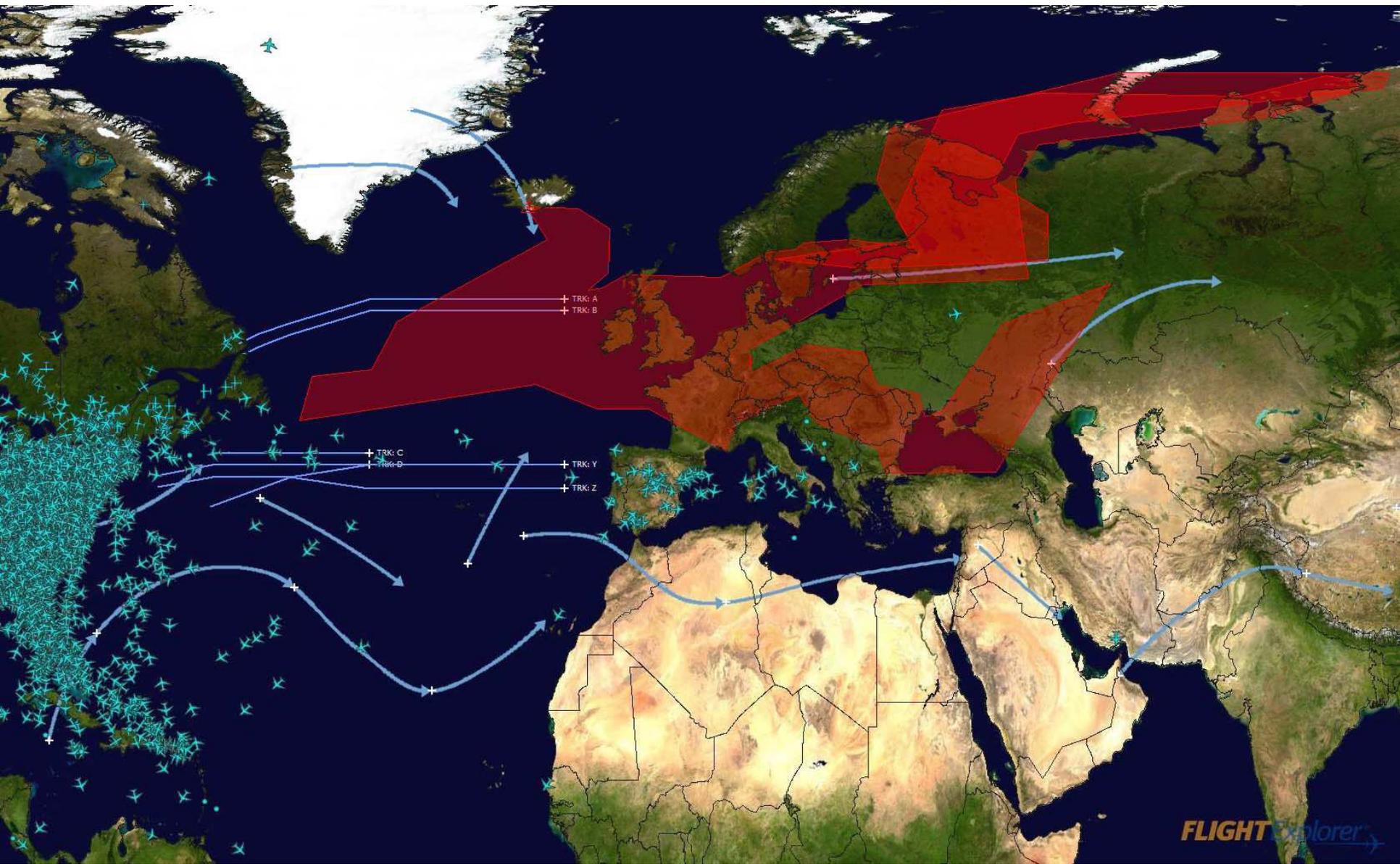






Was there an Overreaction?

- » Procedures were Implemented as Prescribed
- » In Retrospect the Measures Taken were Excessive
 - › Limits of Tolerable Ash were set far too low
 - › Estimates of Ejected Ash Volume were too High and Lacking in Geological Detail
 - › Network for In-situ and fixed Base Observations of Volcanic Ash was not in Place
 - › Reliance on Open-Loop Computations of VA Dispersion was too high in the Long Run
- » The Air Transport Industry was taken by Surprise and had to improvise



Paradoxical Situations

- » Airports were being closed under Apparently Best of Environmental Conditions (CAVU)
- » Inconsistencies between Airborne Measurements and Ash Forecasts
- » Application of Visual Flight Rules to enable Air Transport Operations within Red Area
- » Inconsistent Decisions by State Authorities
- » Operation in High Ash Density due to Resuspension

Measurement Flights in Iceland

9 May 2010



10 May 2010



Measurement Flight 11 May 2010



Institutional Aspects

- » State Aviation Authorities in Europe were unsure of how to deal with this Situation
- » Air Navigation Planning Groups and Eurocontrol had Established Procedures for dealing with Volcanic Ash
- » Defined in Accordance with ICAO Guidelines and Procedures developed for the NAT Region
- » National Aviation Authorities apparently had not been involved in any Major Way
- » EASA and other EU Institutions had not formally Addressed the Issue

Institutional Aspects...

- » Institutional Difficulties in Dealing with a Long-term Wide-Area Threat of the Kind Posed by the Eyjafjallajökull Eruption
- » Result was an Institutional Gridlock that Existed for a good Part of a Week
- » The first Knot was Cut on 19 April with the Ministerial Meeting Called by the EC

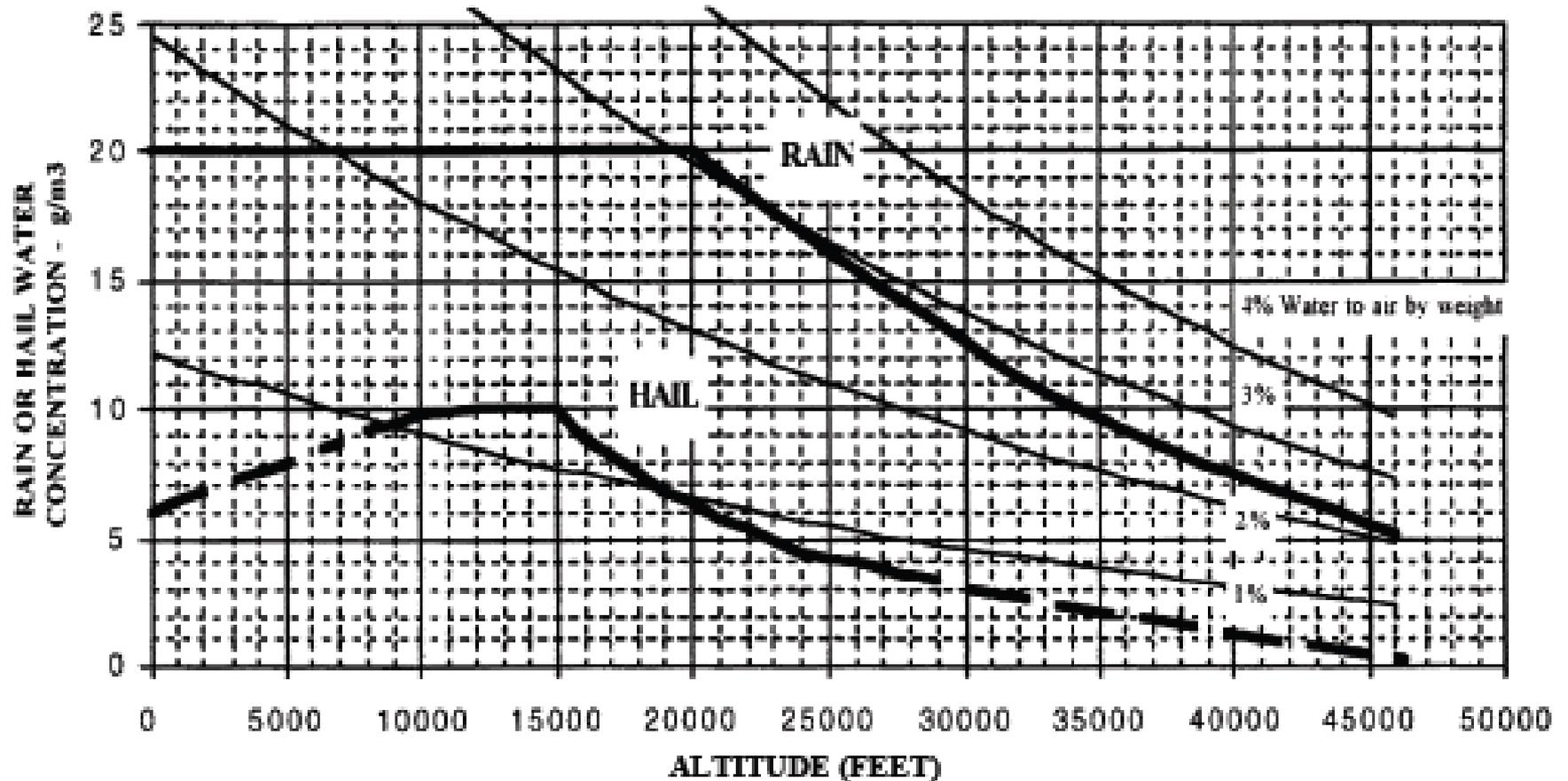
Gridlock Situation

- » No one Authority had the Responsibility for dealing with the whole of European Airspace
 - › National Authorities had Jurisdiction only in their National Airspace
 - › Many Authorities were apparently unprepared for Dealing with the Volcanic Ash Situation
- » Introduction of the Two- and eventually Three-Zone Methodology

What is needed?

- » Development of Airworthiness Standards
 - › Ash Penetration Capability
 - › Engine Tolerances
- » Volcanic Ash Sensors for Transport Aircraft that provide Crew with Awareness of Particle Density
- » New Ways of Monitoring Engine Performance and Degradation

Rain and Hail Threats



What is needed?....

- » Early Warning of an Impending Eruption
- » Improved Volcanic Ash Dispersion Models
 - › Lagrangian; Eulerian
 - › Assimilation Based on Measurements
- » Robust Measurements and Estimation of Source Output
 - › Volume and Content
 - › Downwind Plume Probing
- » Network of Volcanic Ash Measurements
 - › Fixed-Base
 - › Airborne and In-Situ
 - › Satellite Imagery
 - › Pathfinders

What is needed?....

- » Optimal Up-dating of the Estimated Volcanic Ash Density and Composition
 - › Probabilistic Models
 - › Sensitivity Analysis
- » Methods and means for “sanitizing” Airspace around Airports
- » Collaborative Management of Risk
 - › Airlines
 - › Service Providers
 - › Authorities
- » Comprehensive Testing, Validation of the VA Management System

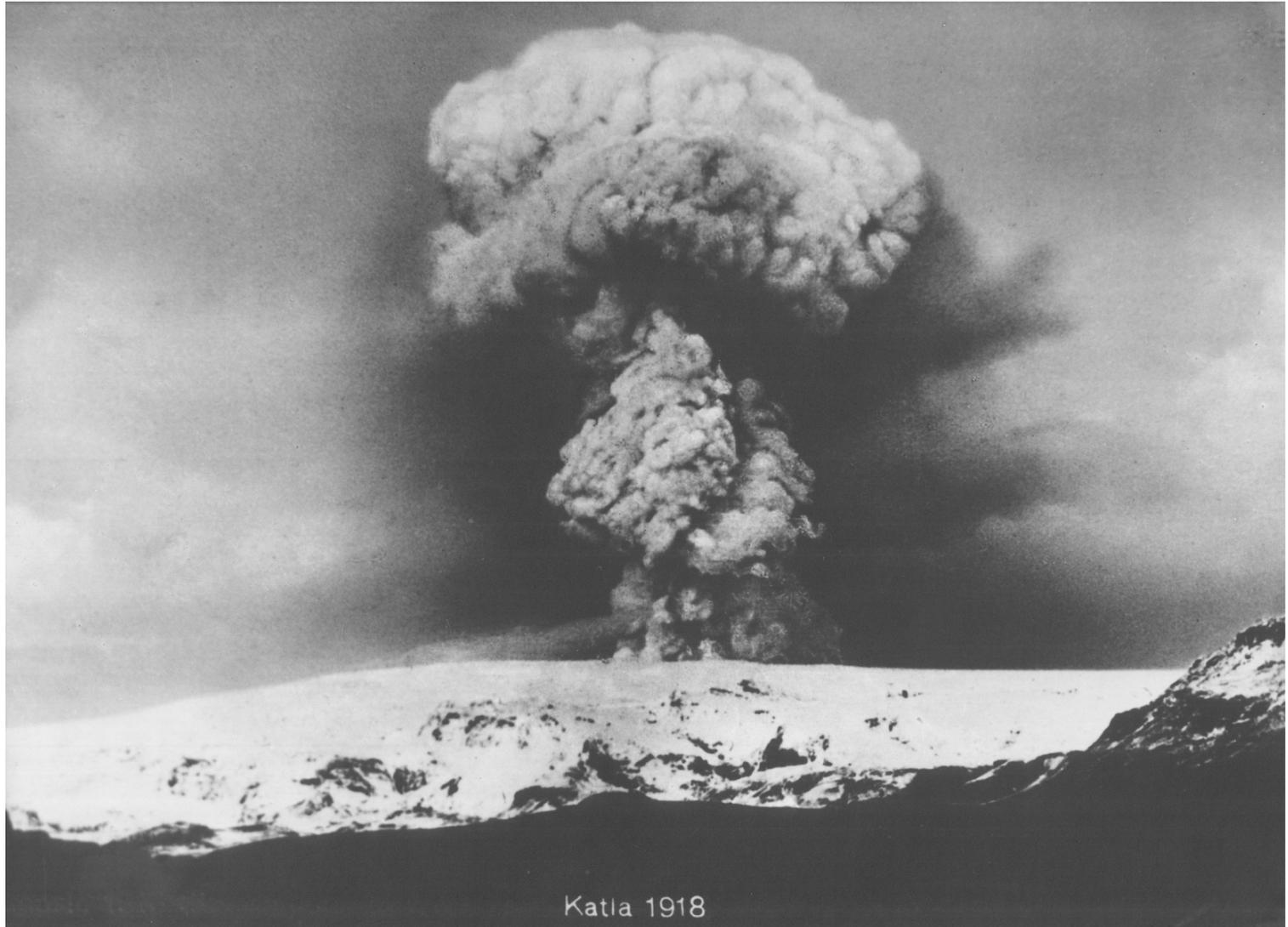
What is needed?....

- » Clear Assignment of Responsibility to all Stakeholders involved
 - › Aviation Authorities
 - › Service Providers
 - › Airlines
 - › Scientific Institutions (Volcanology)
- » Final Decision taken by Airlines and Pilots

Conclusions

- » A Robust Wholistic System must be Established
 - › Governance and Roles of Institutions
 - › Scientific Aspects
 - › Operational System
 - › Roles of Service Providers
 - › Responsibility of Airlines
 - › Information Sharing
 - › Decision Making
 - › Risk Management
- » System must be subjected to thorough Safety Validation and Verification
- » No Major Advancement of Science has been made without Performing Painstaking Measurements

Katla Eruption 1918



Katla 1918