Towards a service to assist mitigation of ash cloud impact on aviation?

Gerald Braun & Thomas Bouvet
IASCC, Cologne
09/09/1010
1. Presentation approach
2. Review of user needs
3. Data collection options
4. Service example
5. The IAP programme
6. FlySafe: Avian alert system
Presentation approach

- User needs
- User requirements
- System requirements
- System & service architecture

Inputs from the aviation community

System design / Logical sequence

Review of possible options

Example of a service

Still to be done!
Review of major needs & requirements
**NEEDS**

- **Pre-eruption warning**
  - When: How long before?
  - What: Geographical location / Intensity prevision?
  - Performance: Level of reliability required?

- **Early detection of ash cloud**
  - When? Within 3h of eruption outset, including during night time?
  - What? Geographical location / depth / height
  - Performance: Accuracy required (m)?

- **Monitoring & quantitative characterization of ash cloud**
  - Critical need to characterize the source
  - When? Update every 3-6h?
  - Maximum delay between measurement and reception of readily usable information by end user?
  - What: Position / height / horizontal and vertical extent
  - Source strength (ash outflow rate)
  - Particle concentration
  - Particle size distribution & optical properties
  - Performance: Vertical / horizontal resolution?
  - Accuracy of measurement?
Source characterization: Why?

Parameterisation of key processes in the dispersion model (sedimentation / aggregation / etc…)

Particle size distribution
Physical particle density
Particle concentration
Optical properties (scattering / absorption coefficient / etc…)

OBSERVATIONS

In-situ / Remote sensing

Source strength and injection height

Retrieval of remotely sensed data for ash dispersion model

Significance of source quantitative characterization

User NEEDS & requirements
Data collection: Possible options
Reference matrix

<table>
<thead>
<tr>
<th>OBJECTIVE</th>
<th>Early warning</th>
<th>Early detection &amp; characterization</th>
<th>Monitoring</th>
</tr>
</thead>
<tbody>
<tr>
<td>OBSERVATION ANGLE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Space</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Air</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ground</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Data collection: Possible options

Early warning

Possible anomalies

Surface deformation (bulging)

Seismicity

Outgassing (CO₂ / SO₂)

InfraSound

Continuous monitoring

Space

Ground (Air)

InSAR

Differential GPS

Tiltmeter

Distance meter

Infrasound sensors

Animal motion patterns

Seismographs

Electro-chemical sensors
Data collection: Possible options
Early detection / characterization

**Space**
- Multispectral, hyperspectral and thermal imaging towards ash
- Hyperspectral imaging in UV / Visible / IR bands, towards e.g. SO2

**Air**
- Remote sensing instrument on commercial aircrafts
- In-situ / remote sensing instruments
  - UAS
  - Balloons
- LIDAR on research aircraft with

**Ground**
- Ground LIDAR
Data collection: Possible options

**Monitoring**

- **Space**
  - Retrieval of vertical integrated ash column (TIR)
  - Retrieval of e.g. SO2 integrated column (Visible / UV / TIR)

- **Air**
  - In-situ / remote sensing instruments
    - UAS
    - balloons
  - LIDAR on research aircraft

- **Ground**
  - Ground LIDAR
Data collection
Available instrumentation in practice

OBJECTIVE

Early warning
Early detection & characterization
Monitoring

OBSERVATION ANGLE

Space

Not yet embedded operationally in services?

Air

Only few manned available, expensive & dangerous!

Ground

10% of active volcanoes monitored!
Integrated approach is needed to provide the right data at the right time!

**Problem:** Aircrafts and ground based assets are very expensive to procure and operate

A relevant solution?
Example of a potential service

Functional elements

**Volcano** routine monitoring

**Volcano** pre-eruption surveillance

**Ash cloud** early characterization & monitoring

- **Ground based instrumentation**
  - Deployment / installation
  - Operation
  - Info retrieval & analysis

- **Air borne instrumentation**
  - Deployment / installation
  - Operation
  - Info retrieval & analysis

- **Space data retrieval & analysis**
  - Anomaly alert

- **Coordination / data integration**
  - Standardization of data input – product output / quality assurance

- **Eruption alert**
Exploit systematically the extended **use of space capacity** and **capability** through the development, in close **partnership with end-users**, of integrated applications which can **demonstrate** a potential for user-side sustainable services.

“Connecting expert Communities & Combining Technologies”
Integrated Application Promotion Programme Structure

Space for Safety
Space for Develop.
Space for Energy
Space for ...

User Awareness
Feasibility Studies
Demonstration Activities & Pre-ops
Progressive Users engagement

Users Requirements
Sustainable Service Operation

Awareness Activities: Understand, foster and organise stakeholder demands.
Feasibility Studies: Assess technical and economic viability of services.
Demonstration Projects: Implement pre-operational services in partnership with users.
Scope of IAP activities

- **Financing** & management of feasibility studies and demonstration projects

- Activities are aimed at setting up OPERATIONAL end-to-end services

- The system architecture is composed of mature elements. Only minor pre-operational developments needed (in particular at interfaces)

- The service should leverage on more than one space asset (among SatEO, SatNAV, SatCom). Space assets are typically integrated with terrestrial assets within the system architecture
Yearly economical Impact of Bird Strikes


3. Royal Air Force 110 documented serious accidents until 2004

4. Estimated conservative cost due to damage and delays of commercial aircraft worldwide 1.2 billion USD
FlySafe objectives:

Improve flight safety & increase flight operation time in northwest Europe by:

- Improving existing bird route detection
- Reducing human dependency
- Developing bird forecast models
- Developing tools for bird flight activity detection at and near airports
- BIRDTAM Cross border harmonization

FlySafe activities:

Started 2007

Partners: RNLAF BAF FAF GAF
Studying behaviour using tracking data
“It’s just to let you know that FlySafe is really able to do spectacular things”

1. Belgian BIRDTAM forecast developed in the framework of the ESA FlySafe Project

2. BIRDTAM forecast: « For AF’s, a way to save money and life »


Photo: RNLAF
To know more on ARTES 20 opportunities visit:

http://iap.esa.int/

IAP contact: iap@esa.int