

Early Warning System for environmental and Meteorological Hazards

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ALARM Project - Consortium



<https://alarm-project.eu/>

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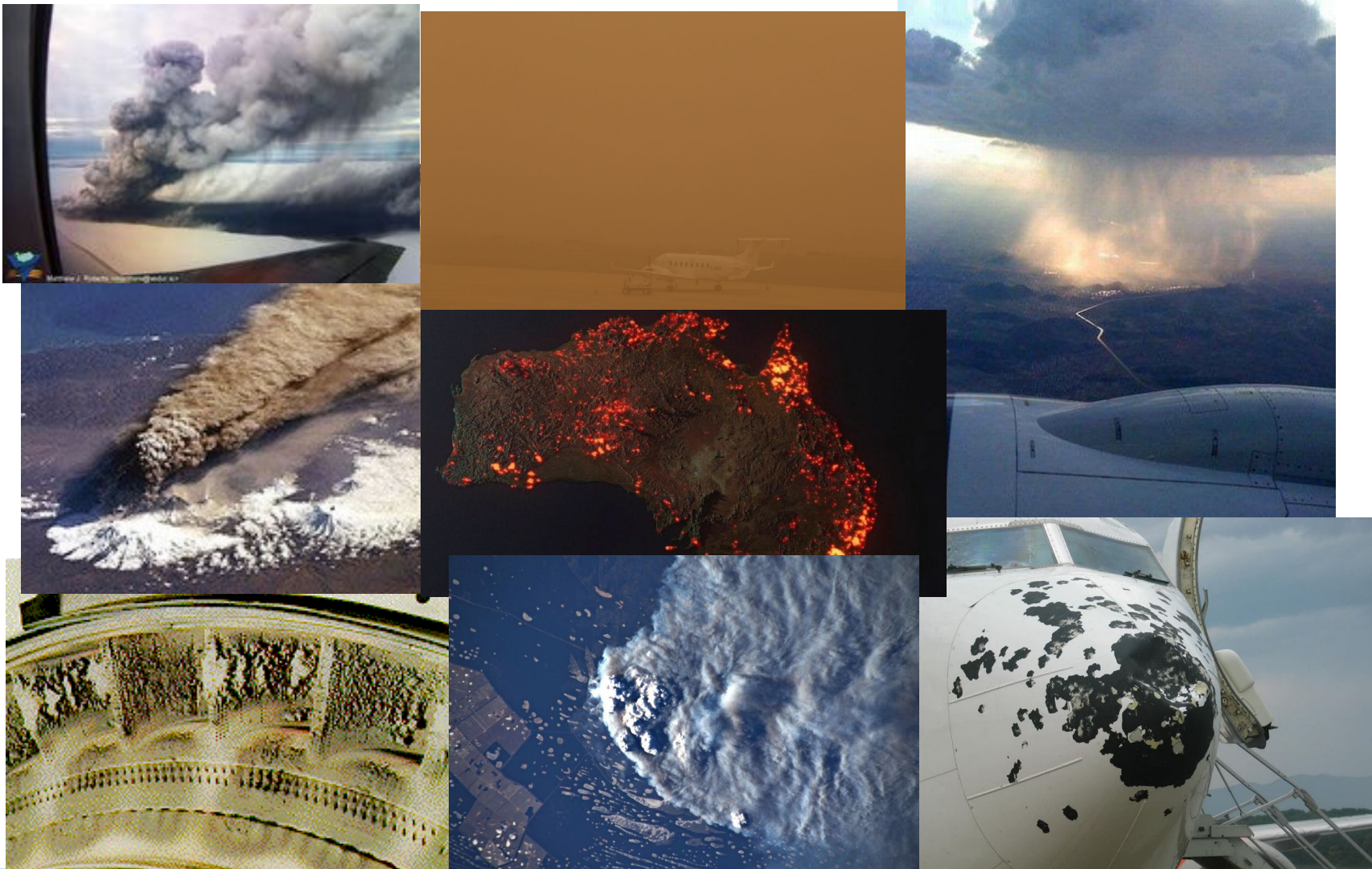
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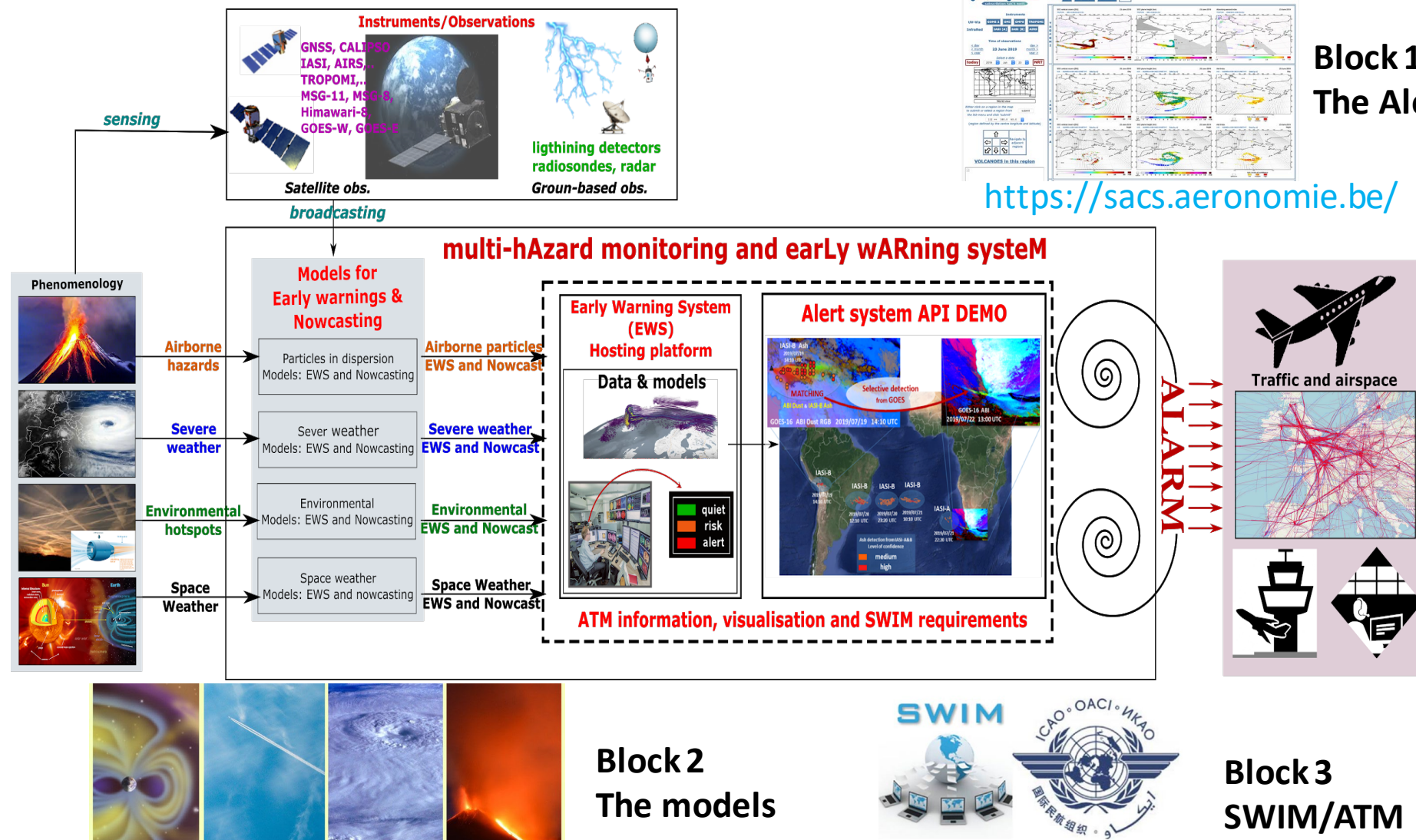
Aviation Met Hazards and resilience



Aviation Met Hazards and resilience



Alert System Platform: Overall Concept



State of the Art

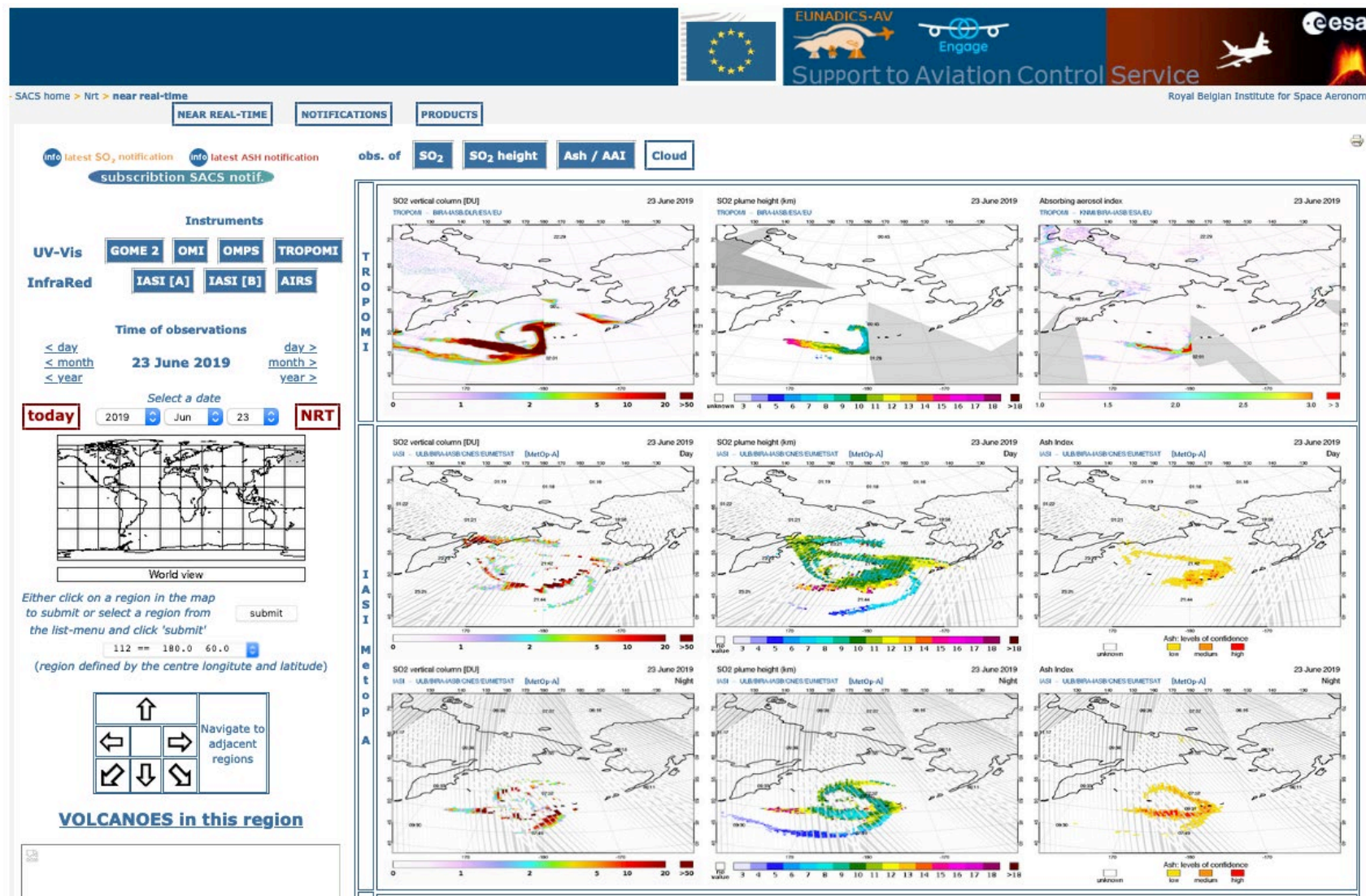
ALARM has four ambitions, namely:

ALARM's Ambition #1 lays on the **combined use of geostationary (global coverage)** and polar orbiting sensors to improve NRT quasi-continuous selective detection of natural airborne hazards (ash, dust, smoke) from geostationary sensors, incorporating new alert products on nowcasting/forecasting of SO₂ dispersion. **VOLCANO, DUST and SMOKE observations and short-term forecasts of SO₂**

ALARM's Ambition #2 is to develop standardised space weather messages with a three-colour coding (green for quiet, orange for a risk of impact on aviation, and red for an alert detected) providing information on increased radiation levels at flight altitudes and HF disturbances due to polar cap absorption, based on observations and forecasts as provided within PECASUS. **Observations of Space weather (Global)**

ALARM's Ambition #3 is to integrate climate change information within ALARM Early Warning System, representing a cornerstone towards an eco-efficient ATM. **Forecasts of Climatic Hotspots (Global)**

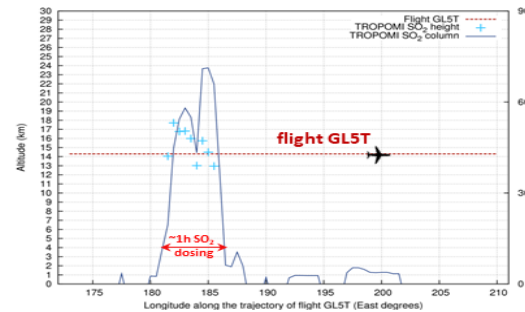
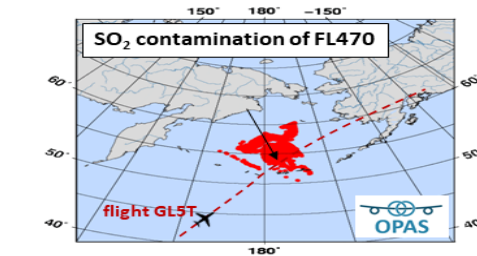
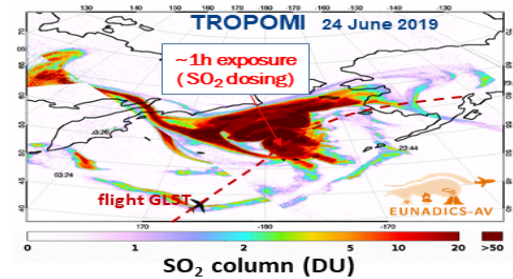
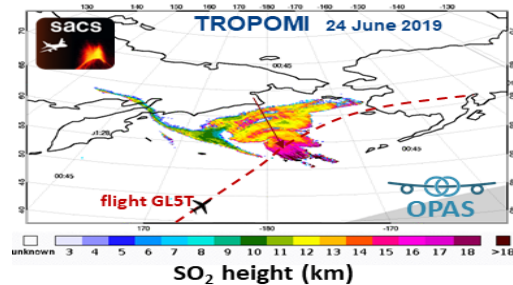
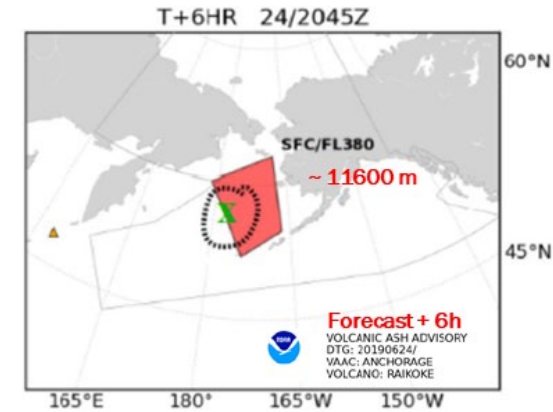
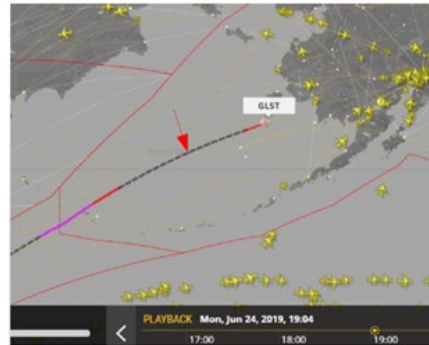
ALARM's Ambition #4 is to develop advanced nowcasting models (including overshooting) capable of providing accurate predictions of severe thunderstorms developed locally (with small characteristic sizes of ~1km) and in a very short time (< 30 min). **Local nowcasting and short-term forecasting of severe weather**



Alert System Platform -Enhancing Situational Awareness

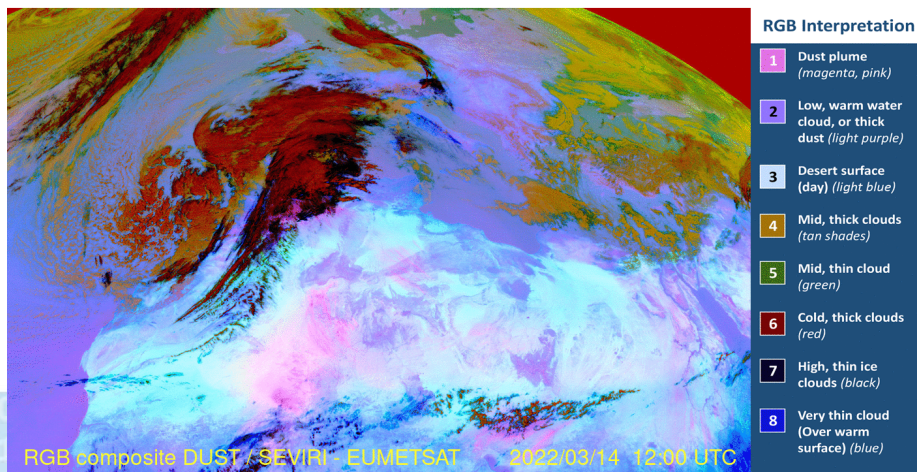
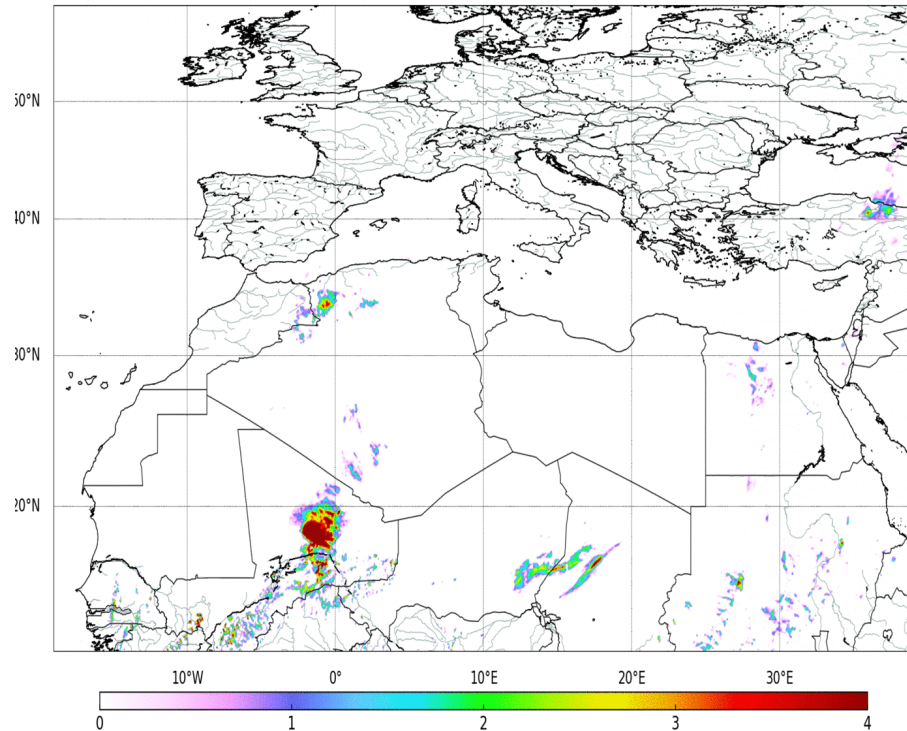
The flight GLT5 in direction of Anchorage airport was flying at FL470 (~ 14300 m) on 24 June 2019. Following, the VAA from Anchorage VAAC, this flight could fly over the ash plume from Raikoke

Flight GL5T 18:22 UTC (56N 176.5 W)
flight level: FL 470 ~ 14300 m



However, the route of flight GL5T crossed Raikoke SO₂ & ash cloud.



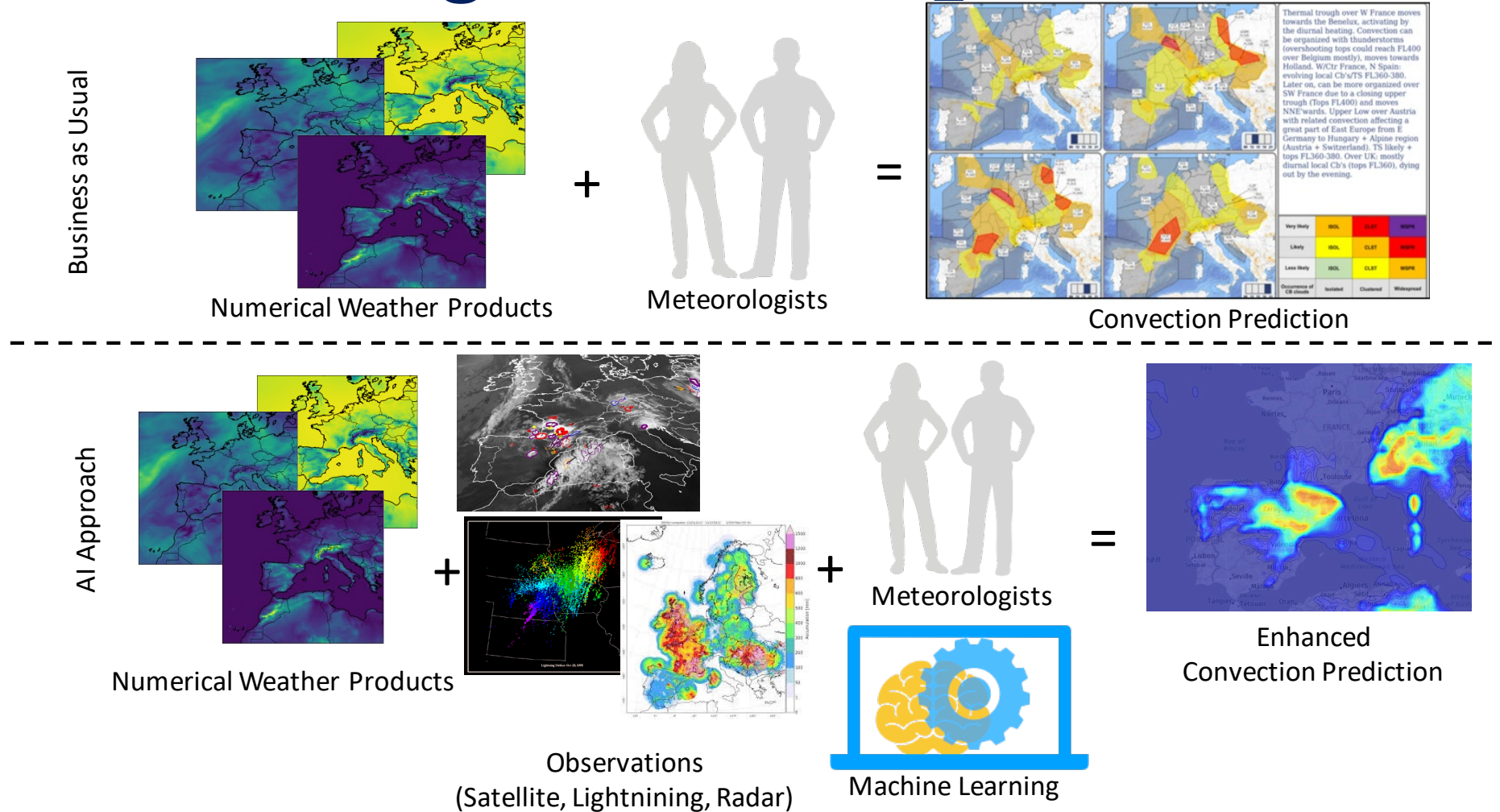


Dust Event

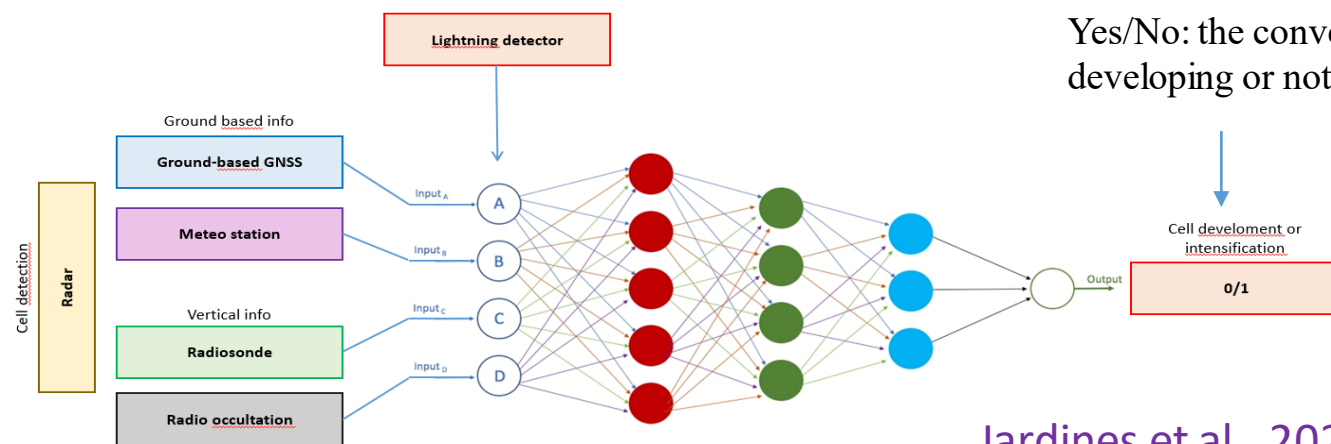
In the framework of the ALARM activity to warn of aviation risk, BIRA has developed a new algorithm to perform a selective detection of mineral aerosols (dust and ash) from the geostationary instrument SEVIRI on board MSG-4.

This animation shows the detection of dust using the SEVIRI RN index from 14 to 16 March 2022 (top image). The lower part of this animation shows the RGB composite (dust) provided by EUMETSAT. We can see the interest for the National Weather Service to combine ALARM dust detection with the EUMETSAT RGB composite to provide key information to aviation stakeholders.

Weather Forecasting Artificial Intelligence Paradigm Shift



Severe weather hazards

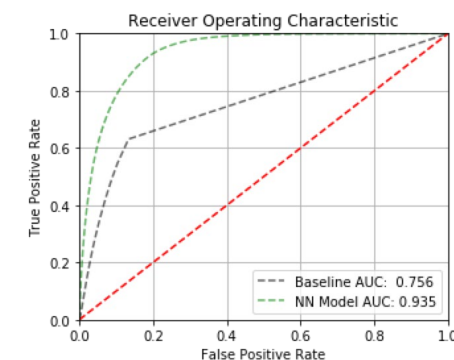
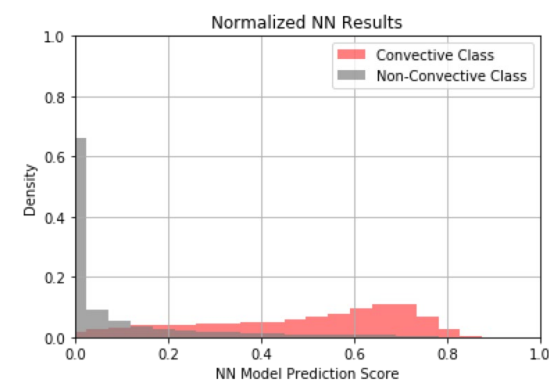
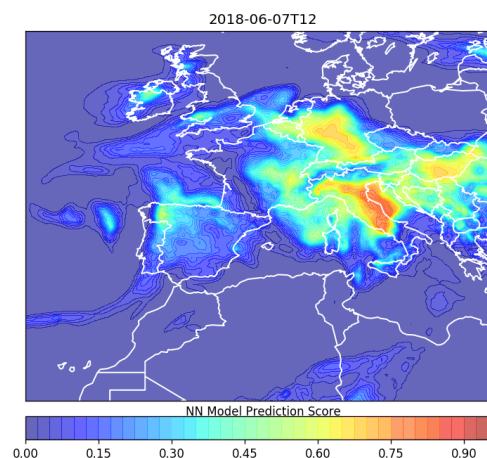
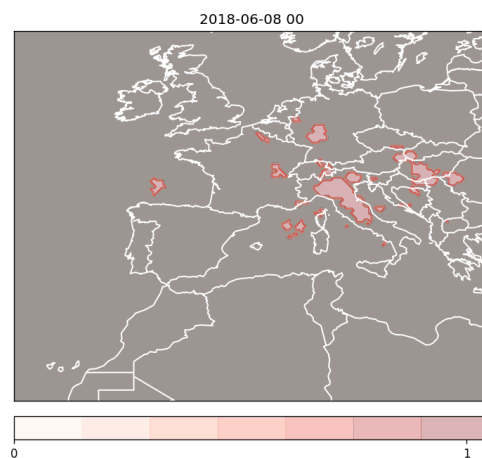


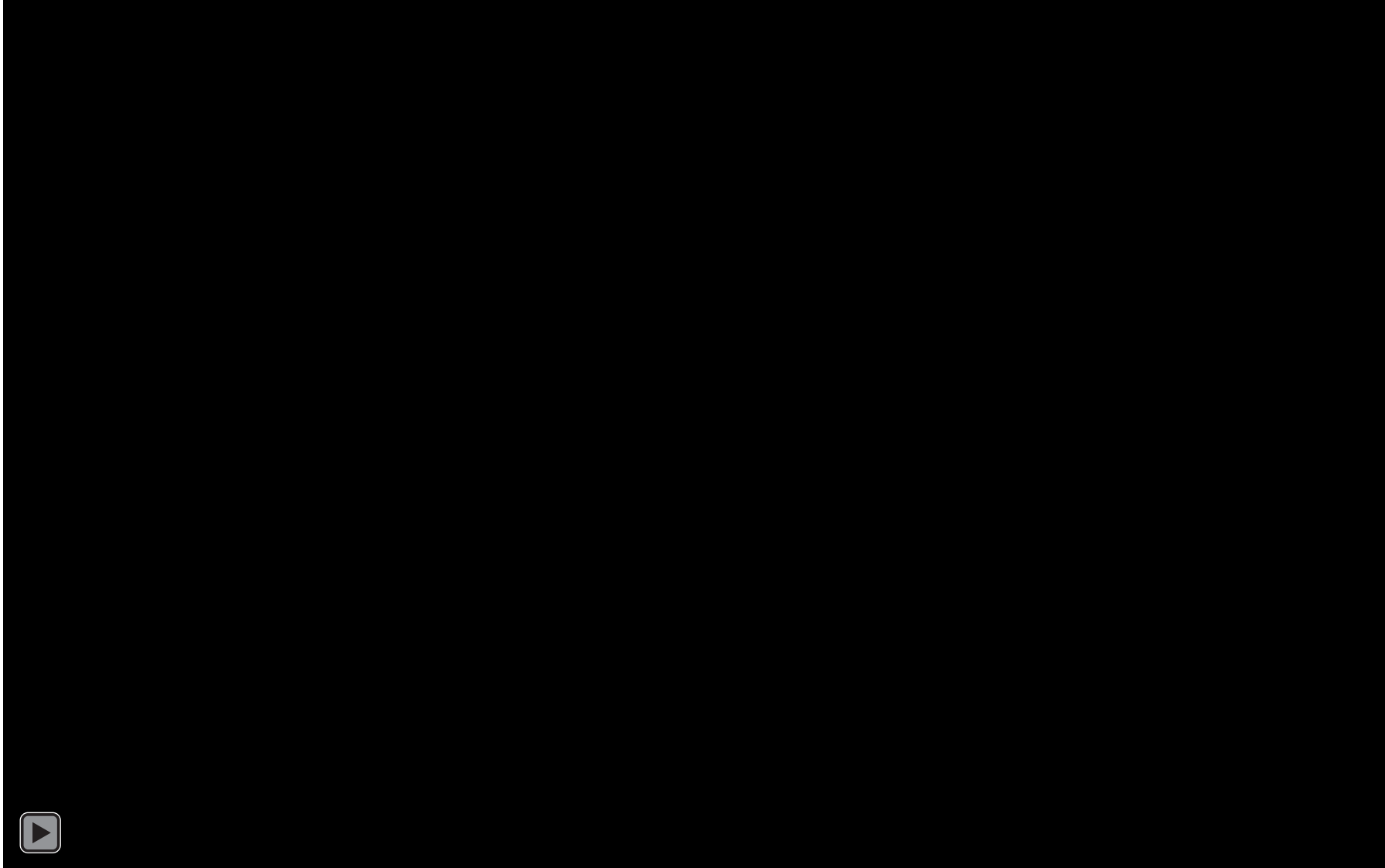
Jardines et al., 2020 and 2021

Actual Storms

D-1 12:00 Prediction

D 00:00 Prediction

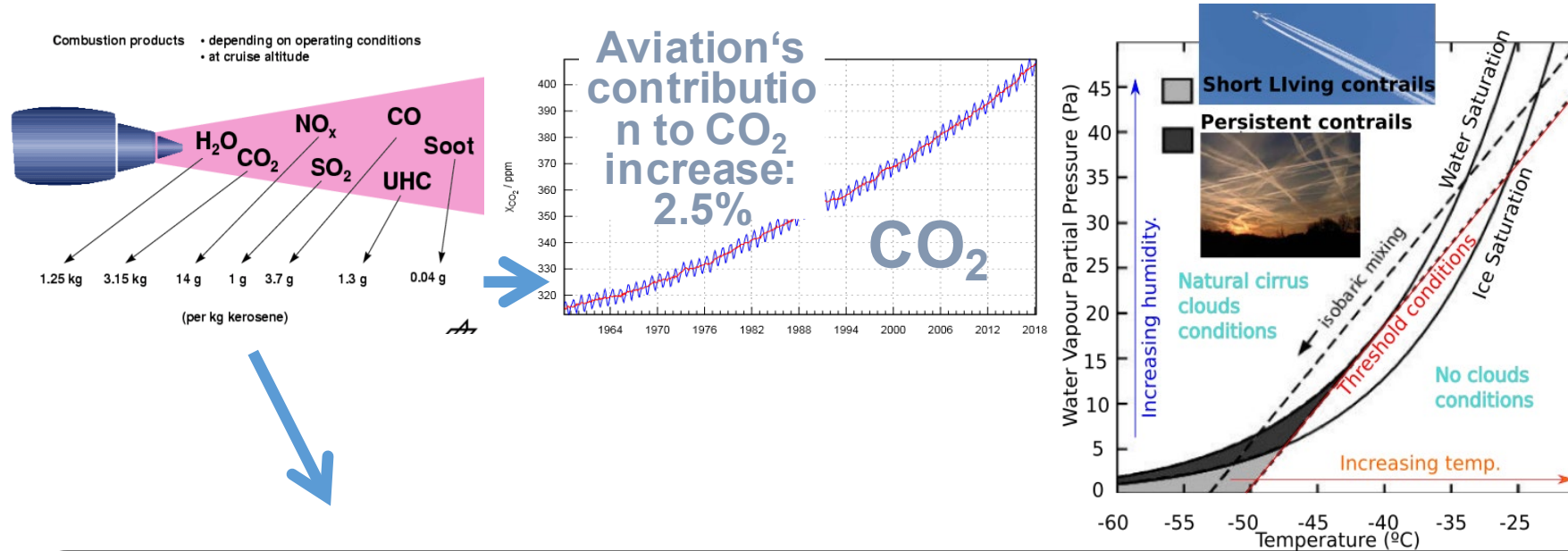




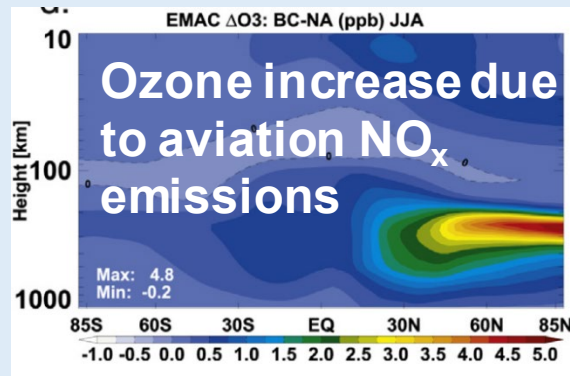
This project has received funding from the SESAR Joint Undertaking under the European Union's Horizon 2020 research and innovation programme under grant agreement No 891965



Climatic Hotspots - Motivation and background



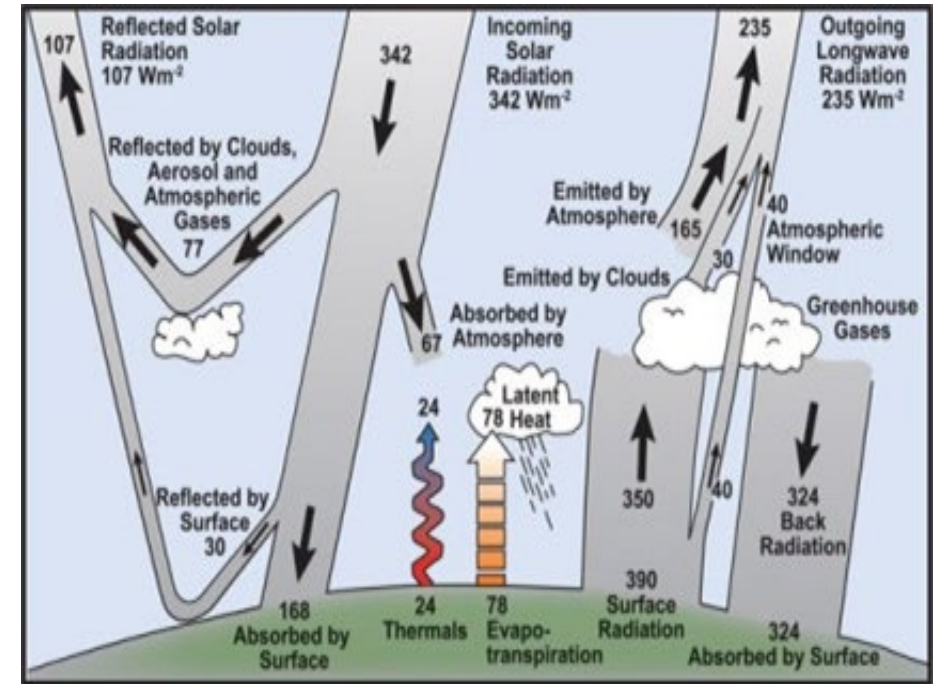
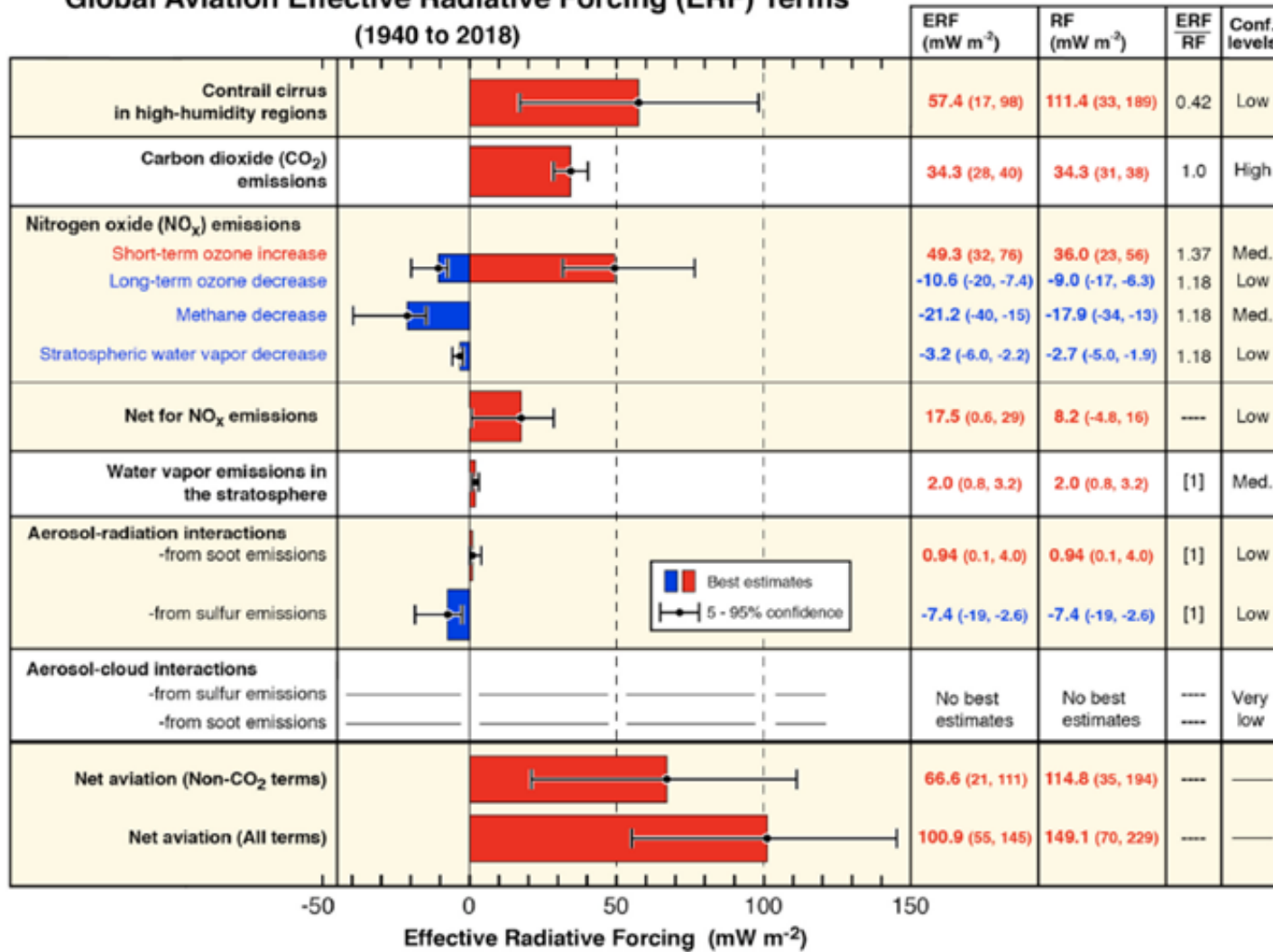
Søvde et al. (2014) **Climate impact of non-CO₂-Effects**



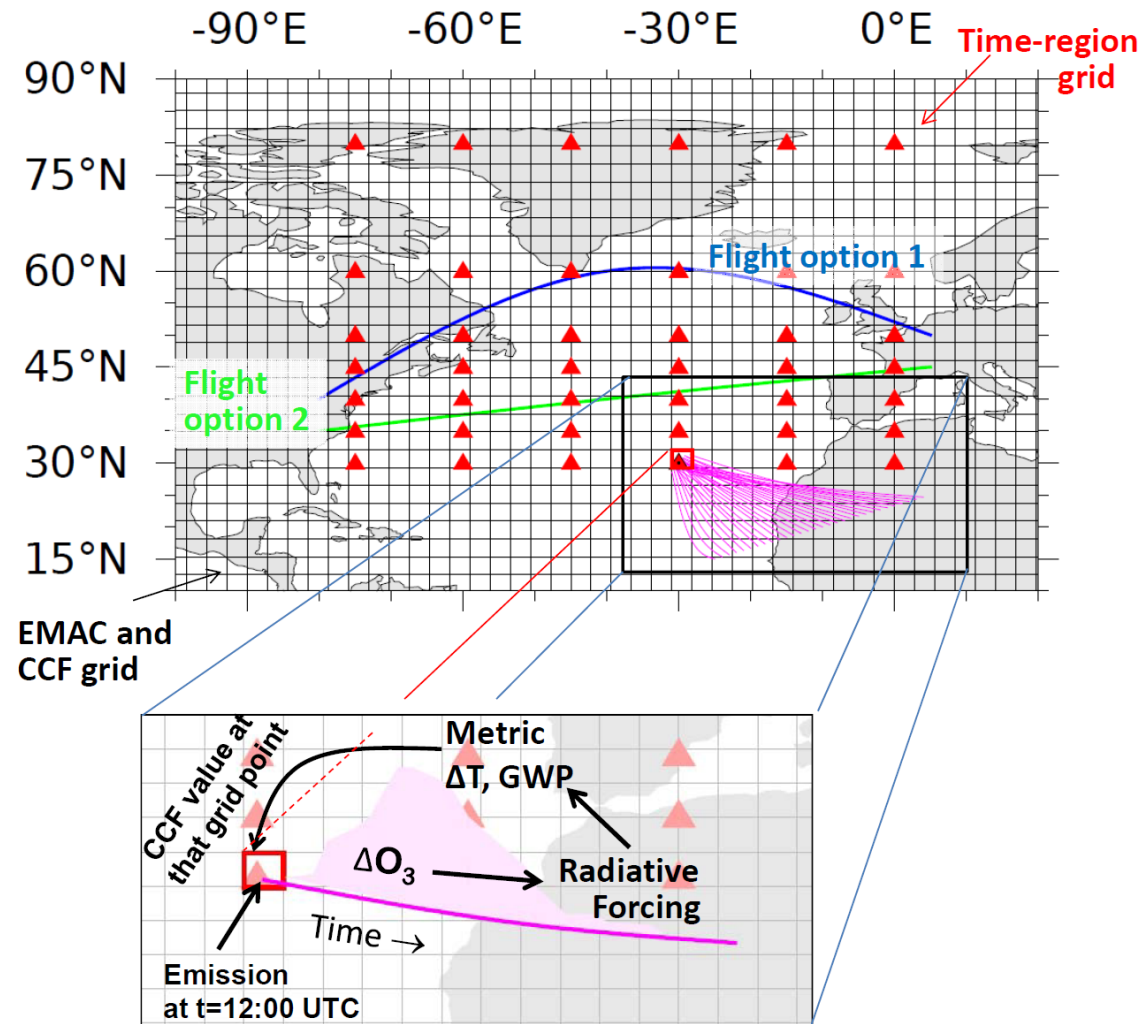
MET services for enhanced safety and sustainable aviation

Climate impact of aviation

Global Aviation Effective Radiative Forcing (ERF) Terms
(1940 to 2018)



What are Climate Change Functions?

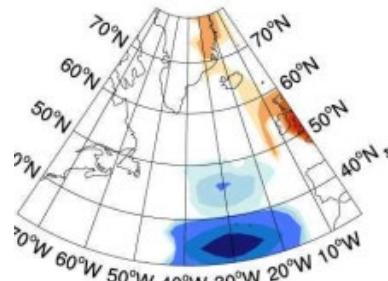


- Climate-Chemistry Model
- Locally confined emissions
- Transport calculation with trajectories
- NMHC chemistry
- Calculation of effects of NO_x emissions on
 - Ozone
 - Methane
 - Primary mode ozone
- Calculation of the change in climate metrics

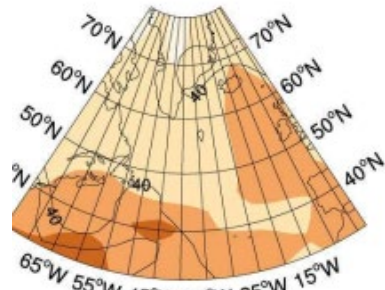
Grewe et al., GMD (2014)

Climate Hotspots

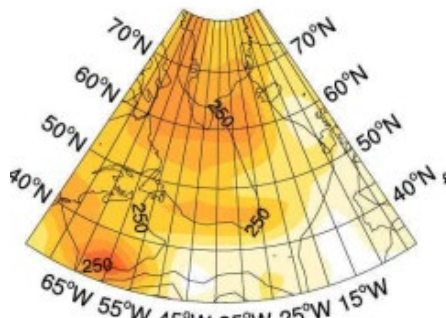
Contrail CCF



Ozone CCF

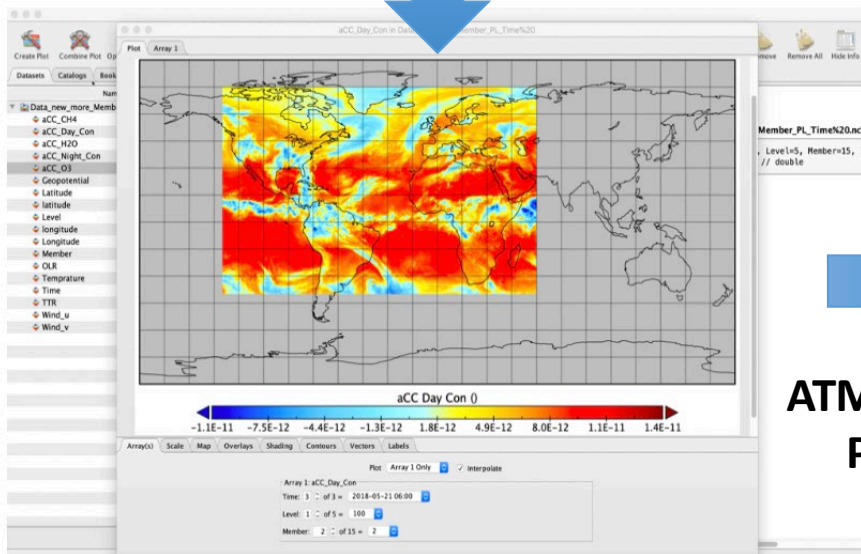


Water vapour CCF

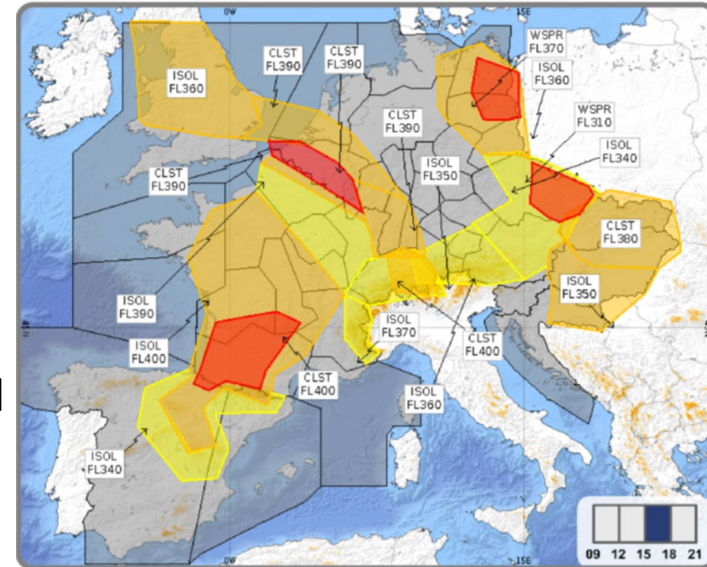


Use of a-CCFs
forecasting [from 2h to 48h]
at regional/global scale

From CCFs to a-CCFs

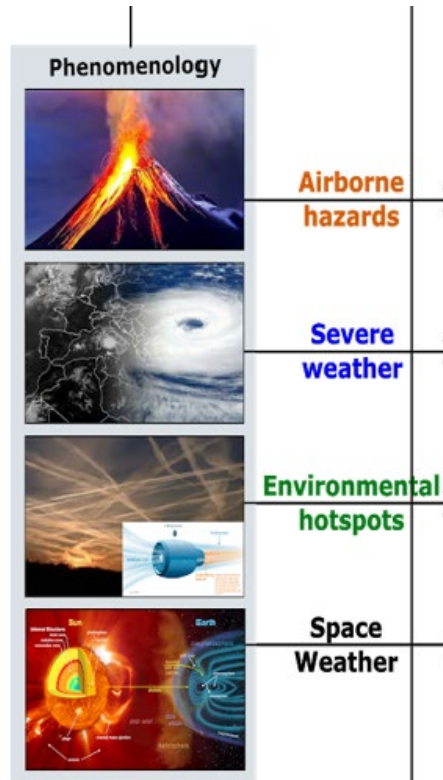


ATM oriented
Product



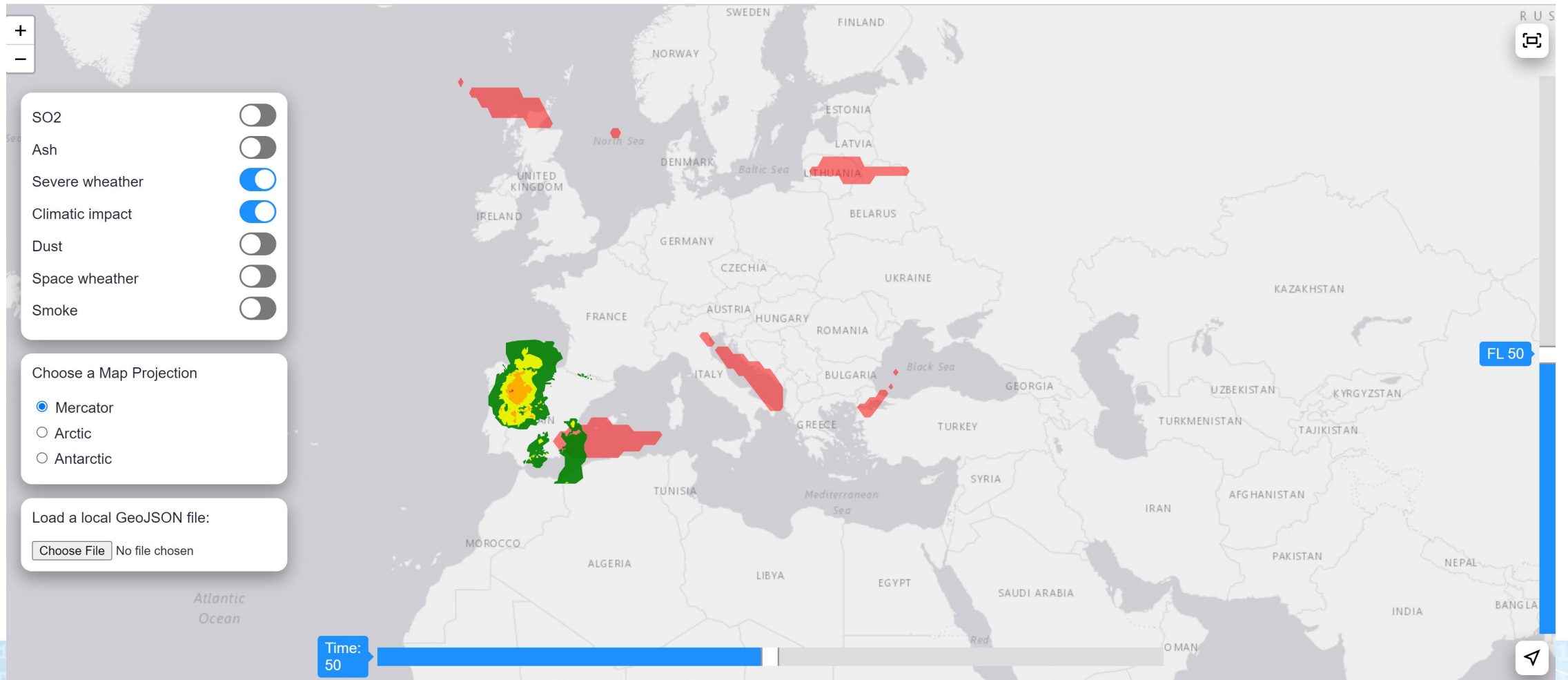
MET services for enhanced safety and
sustainable aviation

How to bring this information to stakeholders?



- **Develop the roadmap for future development and deployment**
 - Identify and define stakeholder requirements
 - Draft information requirements for the SWIM service for the alert products developed in WP2 to WP5
 - Develop **visualization API**

Visualisation demo

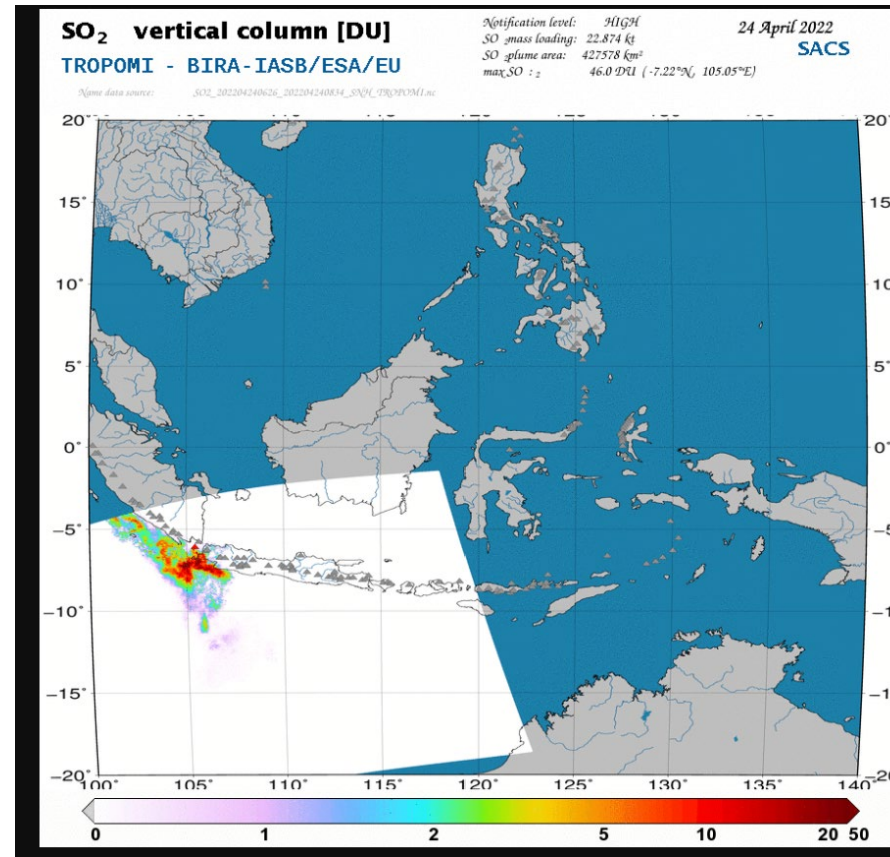
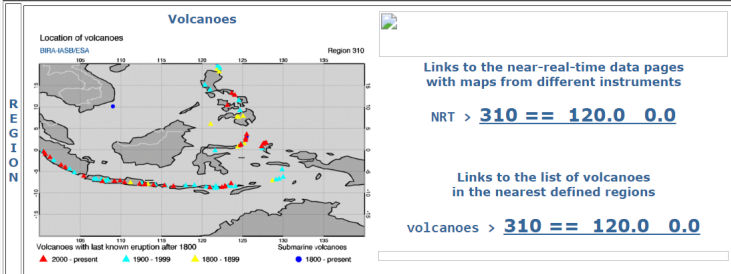
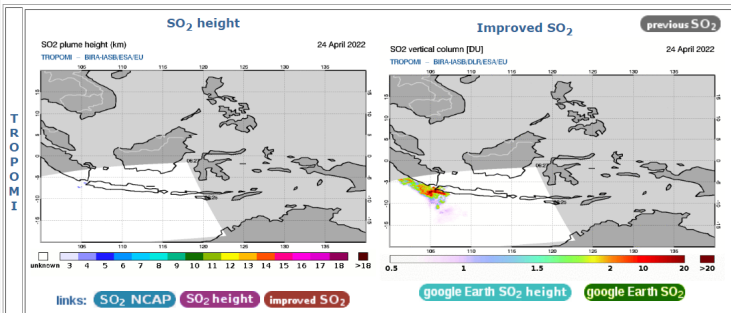


Requirements example - SO2

SO₂ height NOTIFICATION

TROPOMI region 310

Date : 2022/04/24
Time : 06:26 UTC
SO2 max : 46.0 DU (lat: -7.22 N; lon: 105.05 E; SO2 height: 3.2 km)
SO2 mean (centre of mass) : 1.9 DU (lat: -9.29 N; lon: 105.72 E)
SO2 height a.s.l. : 2.0 - 5.0 km (centre of mass: 3.2 km)
SO2 mass loading : 22.874 kt
SO2 plume area : 427578 km²
Notification level : HIGH
Volcano erupting : Krakatau (most likely)
Cloud data : used for VCD
SZA : 30.1 deg.
Name data source : SO2_202204240626_202204240834_SNH_TROPOMI.nc



• The meaning for the airlines:

- Maintenance?
- Quality of in-flight environment?

Future?

- **Meaning of the information for stakeholders, examples:**
 - E.g. climate functions still being validated and verified
 - Could this trigger new environmental rules/regulations?
 - Pollution around the airports - the end-user requirements
- **SWIM subscription**
 - The product needs to be operational
- **Should we aim at one-stop shop for weather/atmospheric information?**

THANK YOU



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