Atelier cendres volcaniques

Yaoundé – Cameroun

16-20 Juin 2025

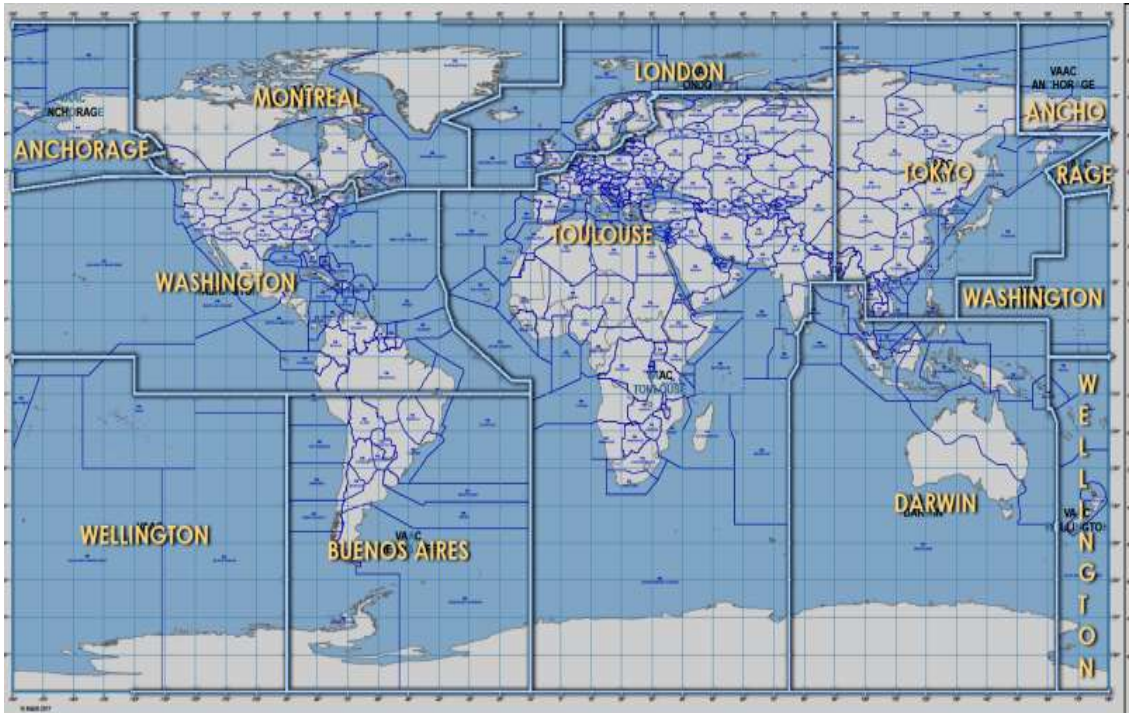
Images satellites et modèles de dispersion

S.Puginier – VAAC Toulouse

Plan

- Présentation du VAAC
- Les images satellites
- Les modèles de dispersion
- Les cartes de concentrations
- Les QVA

9 VAAC



The nine VAACs (Volcanic Ash Advisory Centres), have been designated by the International Civil Aviation Organization to provide their expertise to civil aviation in case of significant volcanic eruptions.

They are a basic part of the IAVW. (International Airways Volcano Watch)

VAAC Toulouse:

- 180 FIR over Europe, Africa and Asia, 2 hemisphere.
- Bordering 6 other VAAC : Buenos Aires, Darwin, London, Montréal, Tokyo et Washington
- VAAC Toulouse and London are back-up each other

Most active volcanos in VAAC Toulouse Area

Italy

Etna	Stromboli
25 VAGs en 2023 31 VAGs en 2022 **282** VAGs en 2021 48 VAGs en 2020 85 VAGs en 2019 10 à 50 VAGs/an 2014-2018	1 VAG en 2023 2 VAGs/an 2021-2022 6 VAGs en 2019

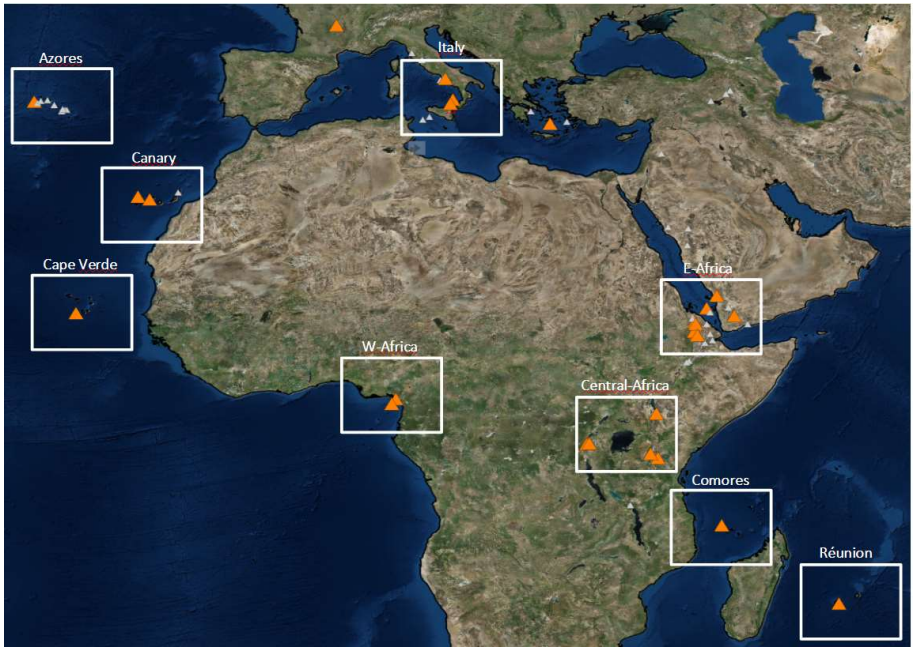
INDIAN OCEAN (WESTERN)
Piton de la Fournaise : 1 à 9 VAGS/an 2015-2023
Karthala : 2005-2007

CANARY ISLANDS :
La Palma : **372** VAGs en 2021

CENTRAL-AFRICA
Nyamuragira : 2011, 2023
Nyiragongo : 2021 54 VAGs
2012

CAPE VERDE
Fogo : 50 VAGs en 2014

E-AFRICA
Nabro : 38 VAGs en 2011
Dubbi : juin 2011
Ol Doinyo Lengai : 24 VAGs en 2008
23 VAGs en 2007
(anomalies thermiques en 2019)
!!! Meru : (PIREP) sept 2015



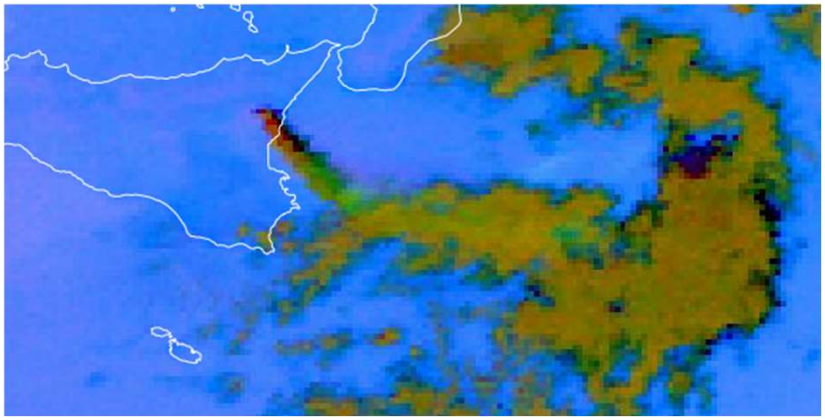
HORS ZONE VAAC TLSE :
CHILE-C
Cordon Caulle : 71 VAGs en 2011

WEST INDIES
Soufrière St Vincent : 14 VAGs en avril 2021

TONGA ISLANDS
Hunga Tonga : 14 VAGs en janvier 2022

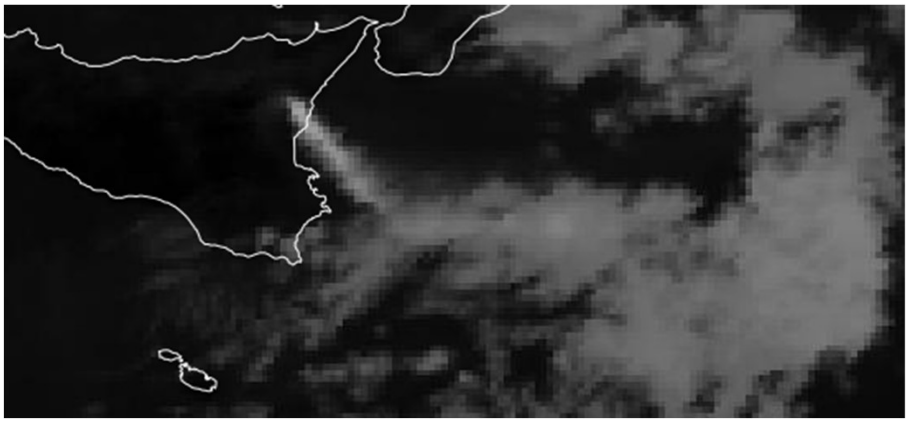
Satellite products

Exemple ETNA le 04/08/2024 , 05 à 06utc



Dust RGB - MTG

The Dust product is an RGB (Red, Green, Blue) composite based upon infrared channel data from the Meteosat satellite. It is designed to monitor the evolution of dust storms during both day and night. But it is also useful for discrimination of cloud types and ash cloud. The Dust RGB is composed from data from a combination of the SEVIRI IR8.7, IR10.8 and IR12.0 channels.

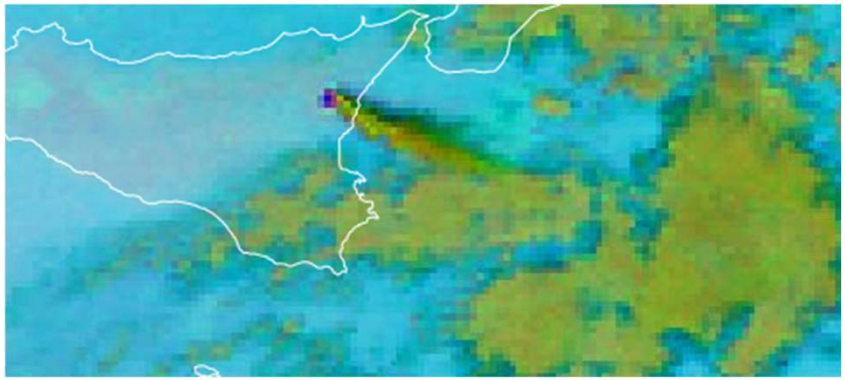


GeoColor RGB - MTG

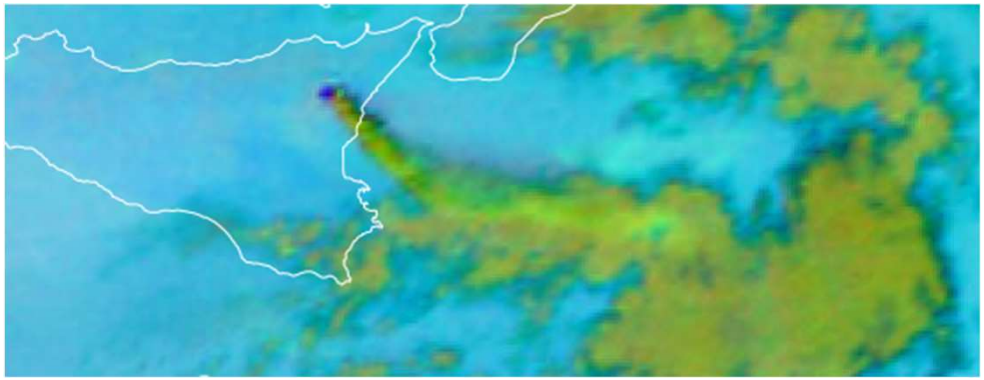
More usefull during daytime but can help also at night.

Satellite products

Exemple ETNA le 04/08/2024 , 05 à 06utc



Volcanish Ash RGB - MTG

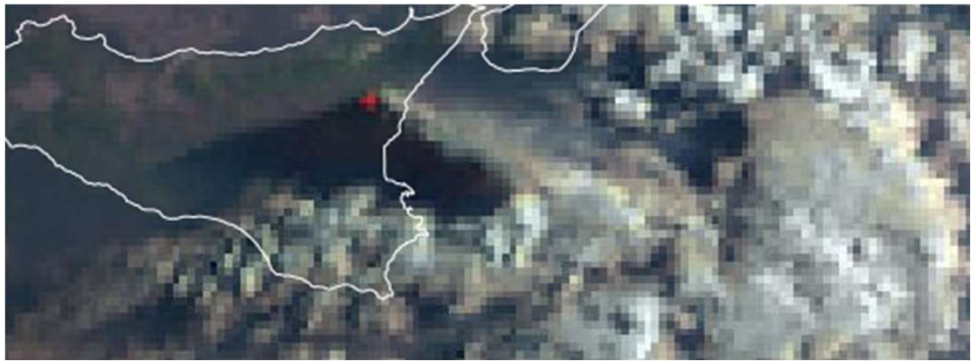


Volcanish Ash RGB - MSG

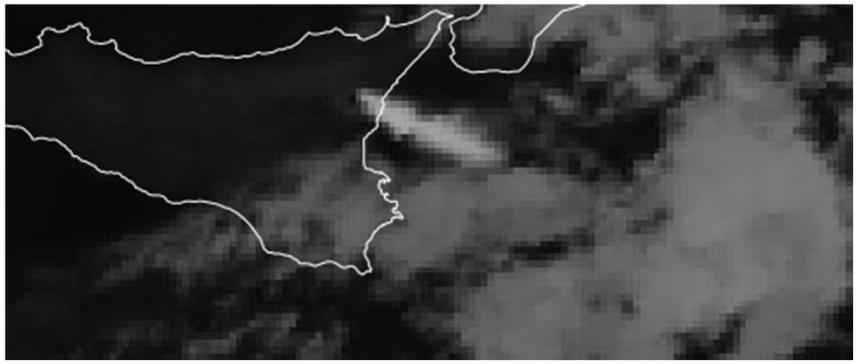
The Ash product is an RGB (Red, Green, Blue) composite based upon infrared channel data from the Meteosat satellite. It is designed to detect ash and sulphur dioxide (SO2) from volcanic eruptions which can be used for the provision of warnings to aviation authorities. The Ash RGB is composed from data from a combination of the SEVIRI IR8.7, IR10.8 and IR12.0 channels.

Satellite products

Exemple ETNA le 04/08/2024 , 05 à 06utc



Natural Color- MTG

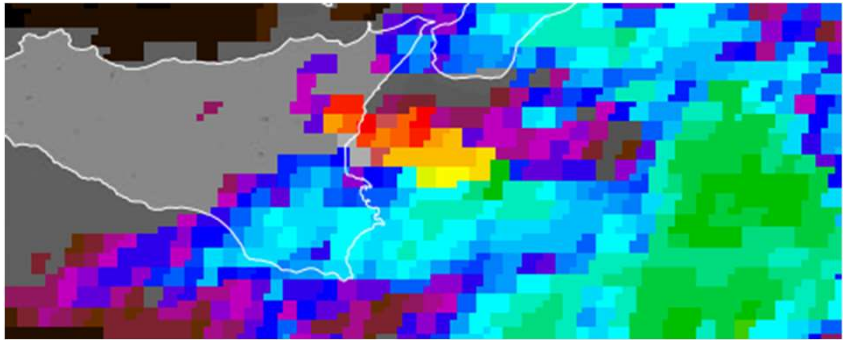


IR 10.8 - MSG

The Natural Colour Enhanced product is an RGB which utilises three SEVIRI solar channels: NIR1.6, VIS0.8 and VIS0.6. It’s natural for human perception.

Satellite products

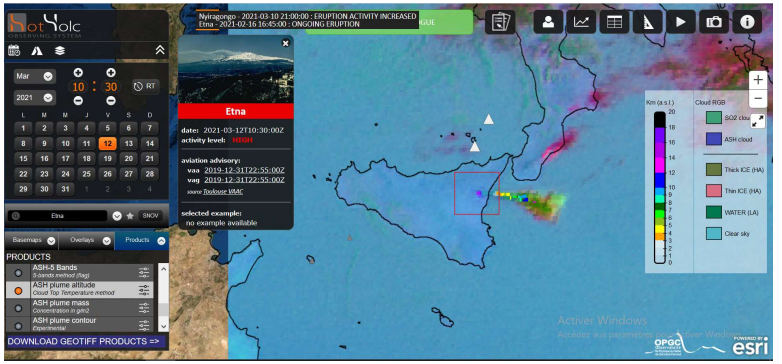
Exemple ETNA le 04/08/2024 , 05 à 06utc



Cloud Top Height RGB – MSG

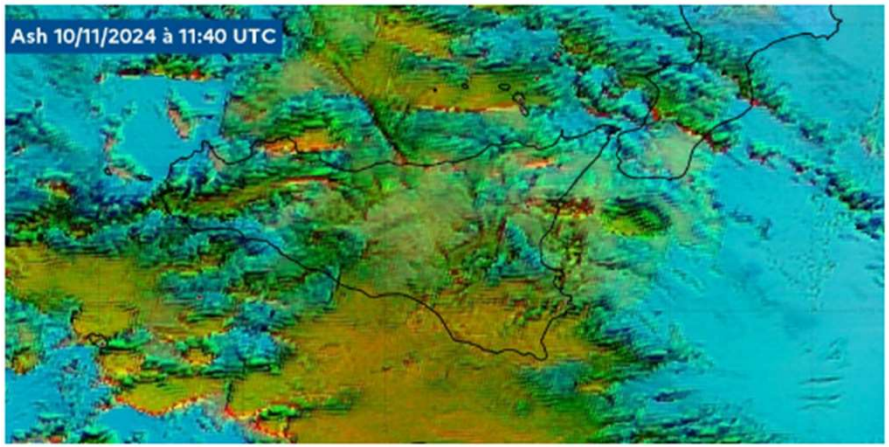
The product indicates the height of highest cloud. Based on a subset of the information derived during Scenes and Cloud Analysis, but also makes use of other external meteorological data. Applications and Users: Aviation meteorology.

12/03/2021

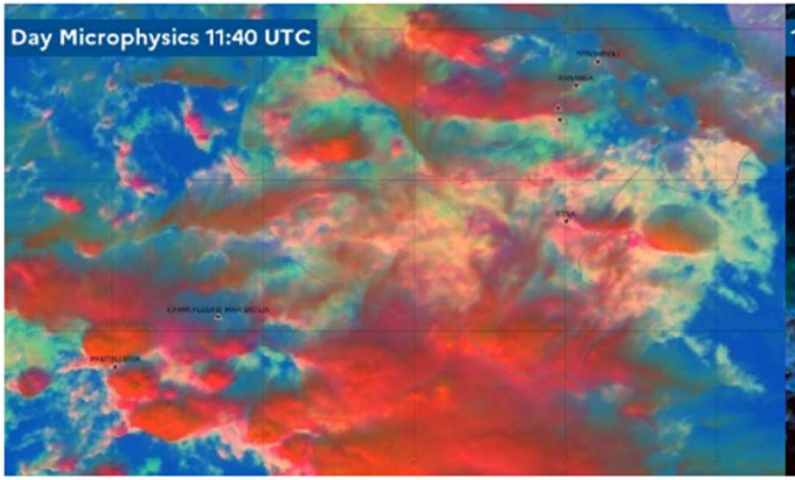


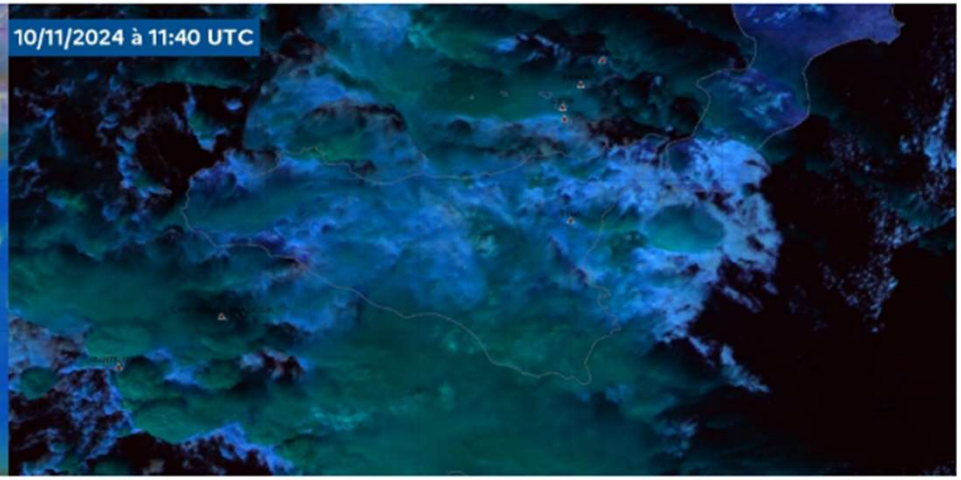
Ash plume altitude, 12/03/2021, HOTVOLC (Observatoire de Physique du globe de Clermont-Ferrand)

Satellite products , MTG benefits



A better resolution.
RGB compositions are usefull in order to detect volcanish ash.

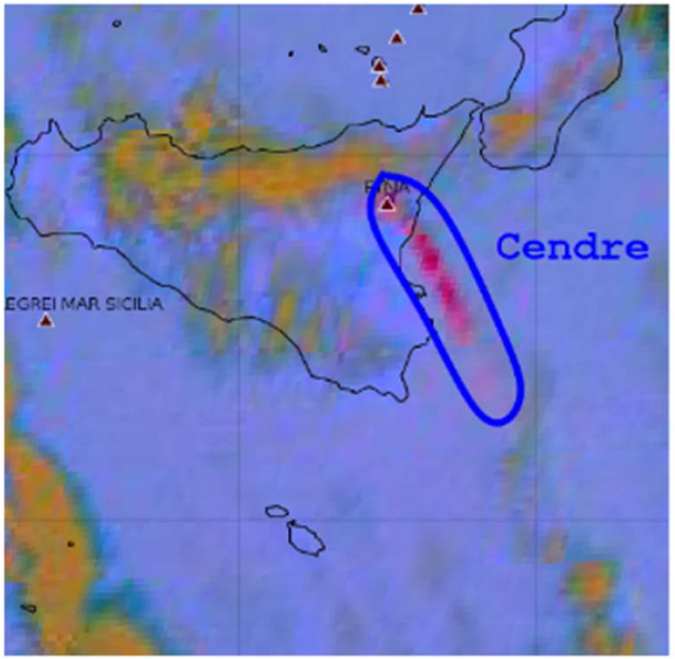




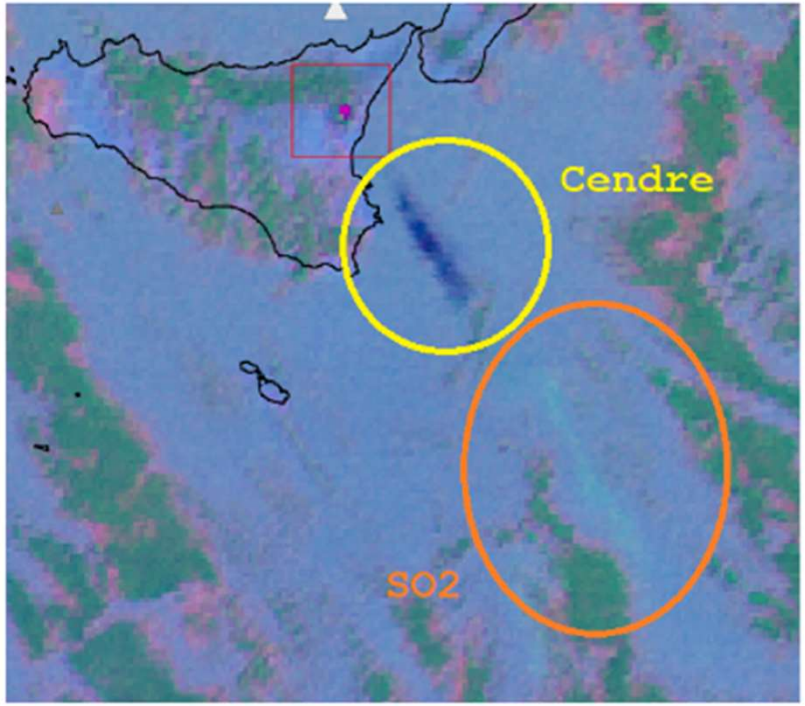
Satellites products

Distinction cendres/SO2

Colonne totale >0,2g/m3



MSG4_Aérosols_24-03-21_11Z



HOTVOLC_RGB_24-03-21_12Z

Les modèles de dispersion

Pour prévoir le transport des panaches de cendres, le VAAC Toulouse utilise deux modèles en fonction de l'intensité du rejet :

- Rejets forts, **MOCAGE-Accident HR** (Modèle de Chimie Atmosphérique à Grande Echelle, sans chimie). Modèle eulérien, résolution 0,1°.
- Rejets faibles à modérés, Flexpart. Modèle lagrangien travaillant sur un domaine à aire limitée (de 25° x 25°) centré sur la source, résolution plus fine.

Forçage météorologique avec les modèles ARP0,1 ou CEP0,125
Processus physiques mis en jeu :

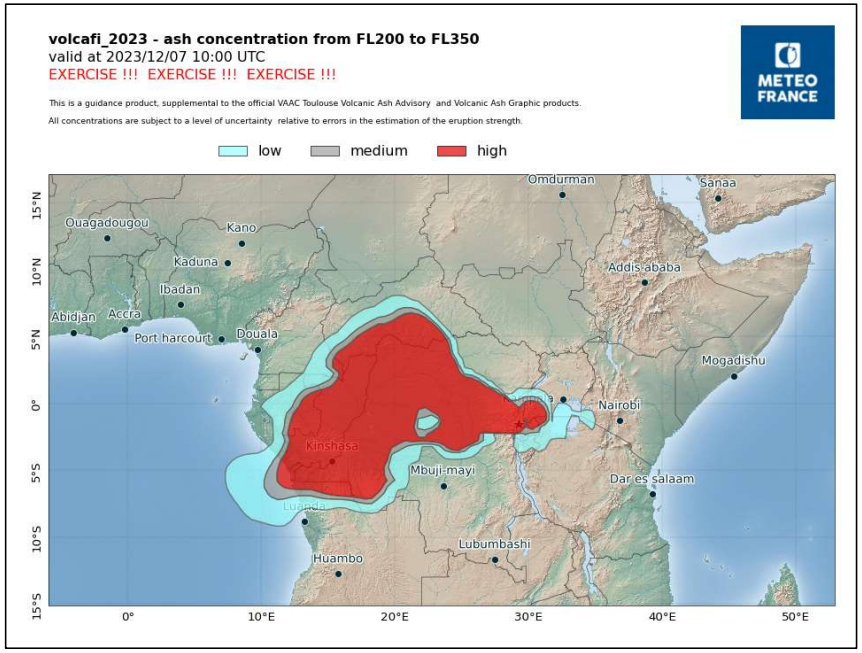
- **Advection** par un schéma de transport semi-lagrangien [Williamson and Rasch, 1989];
- **Convection** [Bechtold et al., 2000];
- **Mélange turbulent** [Louis, 1979];
- **Déposition sèche et déposition humide**, schéma détaillé 3D [Mari et al., 2000; Liu et al., 2001];
- **Sédimentation** pour les particules.

Les modèles de dispersion

La source d'émission peut être choisie n'importe où sur le globe: les paramètres d'initialisation:

- géo-localisation du volcan
- début et durée du relâchement de cendres
- Base et sommet de la colonne éruptive
- Taux d'émission
- Profil d'émission, distribution verticale
- Tailles des particules

Exemple de carte de concentration de cendres volcaniques FL200-FL350;
Exercice AFI VOLCEX 23/01, le 07/12/2023
Avec une éruption fictive du NYIRAGONGO



Current Concentration Charts

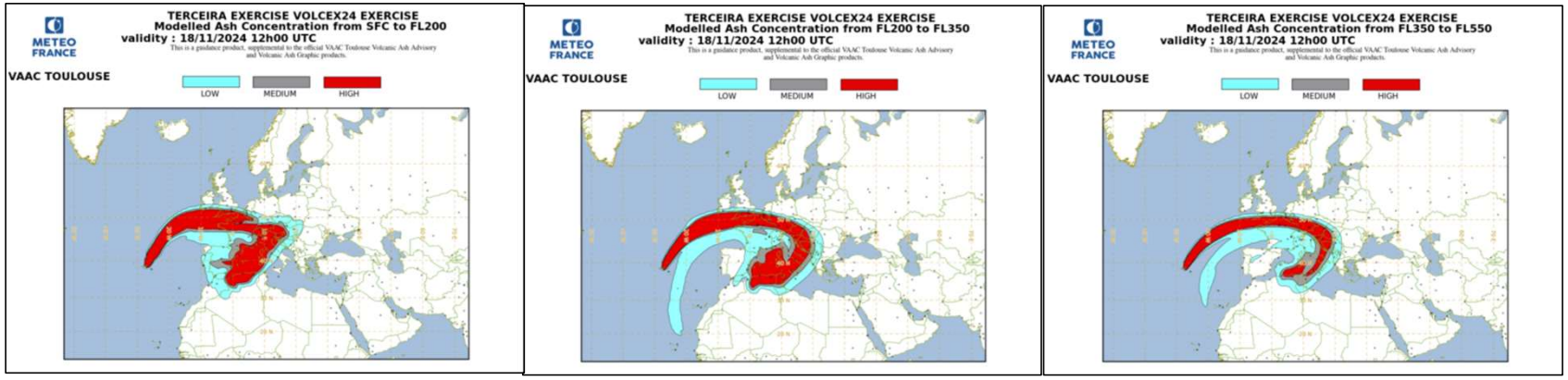
VAAC Toulouse

Concentrations charts (Ash cloud)

- Special feature of the EUR/NAT navigation : provision of concentration charts (Toulouse and London VAACs only)
- Real time, location and forecast of ash cloud T+06,T+12, T+18
- Possibility of updated charts every 6 hours
- Layer of 150 to 200 FL thickness
- 3 concentration thresholds : 0,2 / 2 / 4 mg/m3

Blue/green	LOW	0.2 mg/m³
Grey	MEDIUM	2 mg/m³
Red	HIGH	4 mg/m³

SFC-FL200 FL200-FL350 FL350-FL550



18/11/24 12utc

Future Products : QVA Quantitative Volcanic Ash

VAAC Toulouse

- Deterministic data :
  - Objects, polygones, IWXXM format
  - gridded data format, NetDCF4
- Probabilistic data : gridded data format, NetCDF4

Concentration thresholds:
exceeding 0.2mg/M3
exceeding 2mg/M3
exceeding 5mg/M3
exceeding 10mg/M3

In three-hourly valid time increments: 0, 3, 6, 9, 12, 15, 18, 21 and 24 hours.

Gridded QVA information will be produced with a horizontal resolution of 0.25 degrees latitude and longitude.

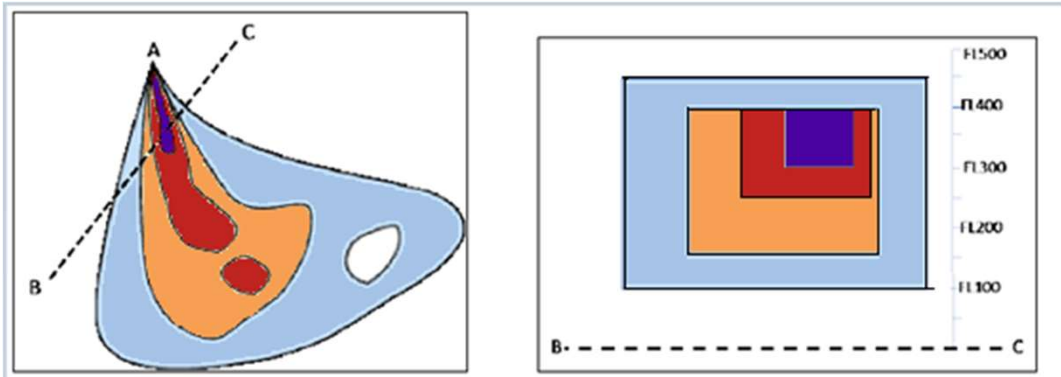
The vertical resolution of the gridded data will be in 5,000-foot flight levels (FL) from mean sea level to FL 600 (Table 2).

Table 2: Vertical resolution

Mean sea level to FL 50	FL 150 to FL 200	FL 300 to FL 350	FL 450 to FL 500
FL 50 to FL 100	FL 200 to FL 250	FL 350 to FL 400	FL 500 to FL 550
FL 100 to FL 150	FL 250 to FL 300	FL 400 to FL 450	FL 550 to FL 600

Deterministic QVA, Polygon, IWXXM format

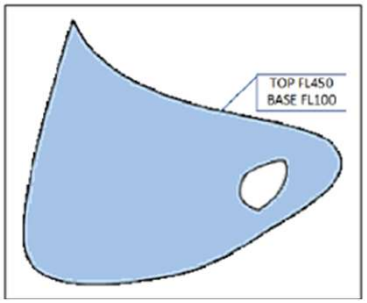
VAAC Toulouse



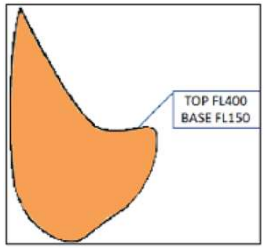
IWXXM objects showing all QVA thresholds depicted in the horizontal from a fictitious volcano.

The vertical depiction along line B-C

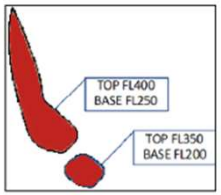
Colour Legend:



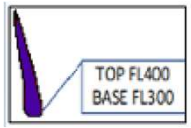
IWXXM object ≥ 0.2mg/m³



object ≥ 2mg/m³



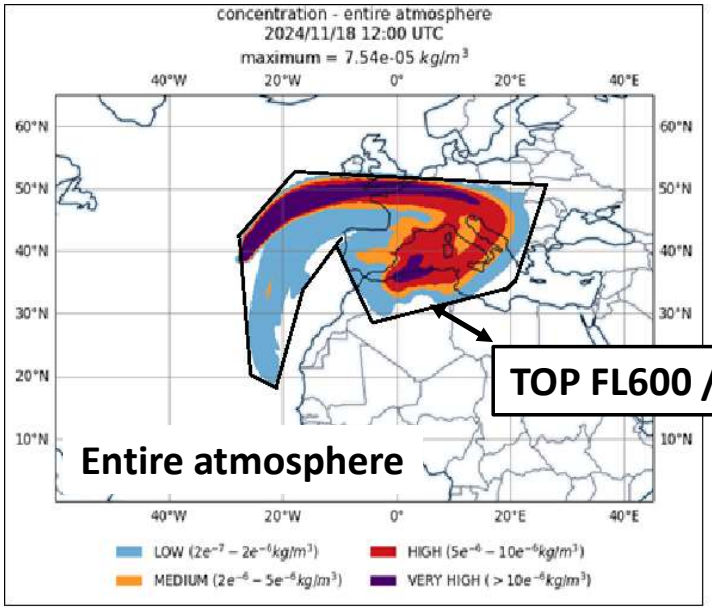
object ≥ 5mg/m³



object ≥ 10mg/m³

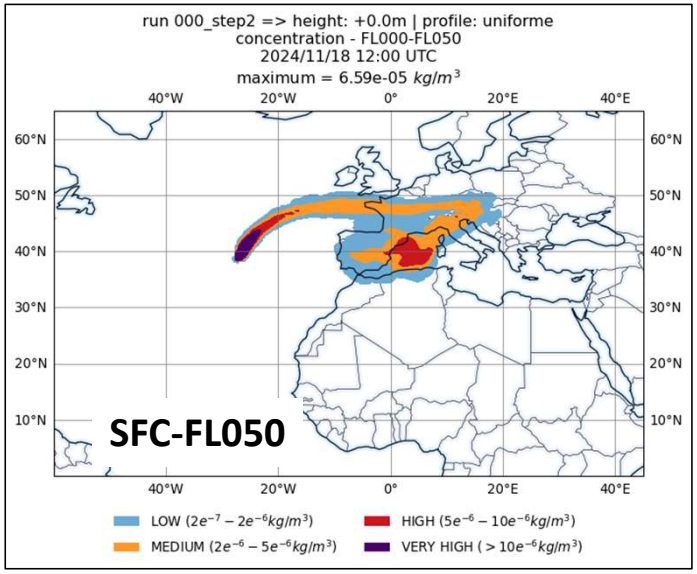
Deterministic QVA gridded data , NetCDF

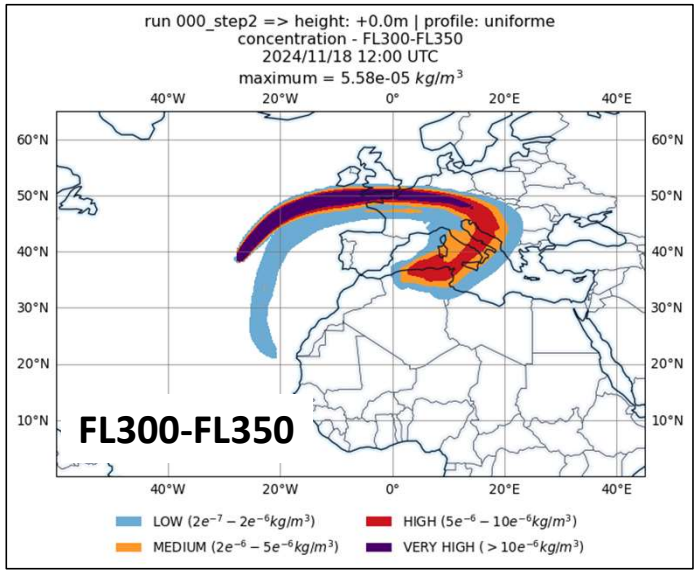
VAAC Toulouse

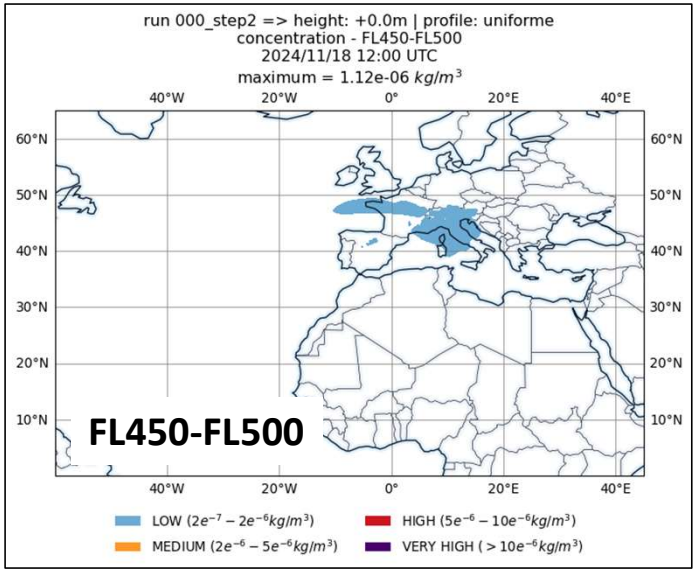


Colour Legend:

layer of 50 FL thickness, NetCDF format







Probabilistic QVA , Quantitative Volcanic Ash

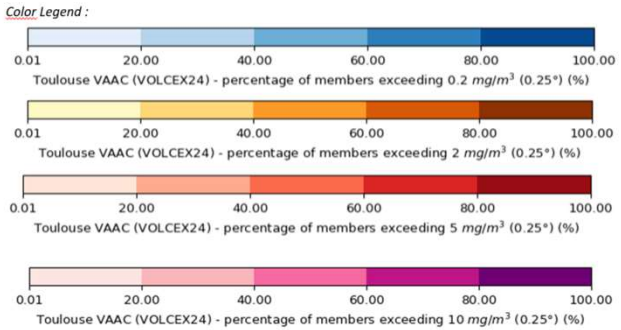
VAAC Toulouse

Probabilistic data

The VAAC Toulouse QVA ensemble set consists of 100 forecast predictions (+ the deterministic run).
In addition to the deterministic model run, the ensemble model runs are launched with the following source term parameters modified:

- ash ejection height: h*0.8, h *0.9, h, h*1.1, h*1.2
- emission profile : umbrella and uniform
- quantity of ash particles : q/3, q/2, q, q*2, q*3 (q=deterministic run quantity)
- size of ash particles

- Probability, Relative frequency of concentration exceeding



Low

Medium

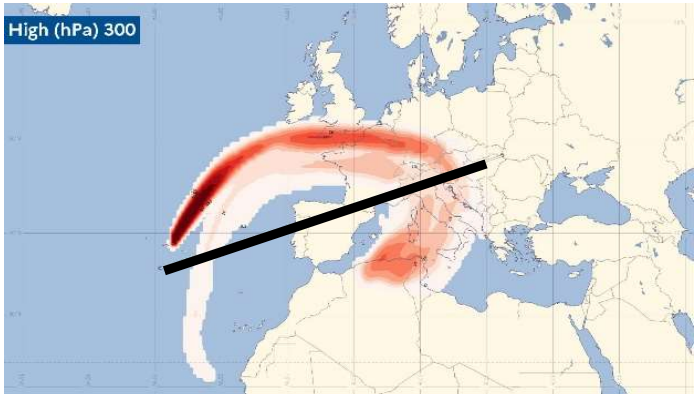
High

Very high

Probabilistic QVA : example

VAAC Toulouse

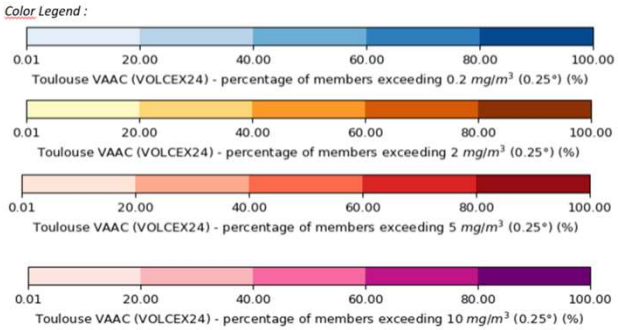
TERCEIRA EXERCISE VOLCEX24 : percentage of members exceeding xxmg/m3 with Vertical cross section, 2024/11/18 12utc



Axe designed over probabilistic QVA
High , 300hPa

1 : Probability to encounter ash in upper atmosphere

2: High probability to encounter ash but low risk in high concentration

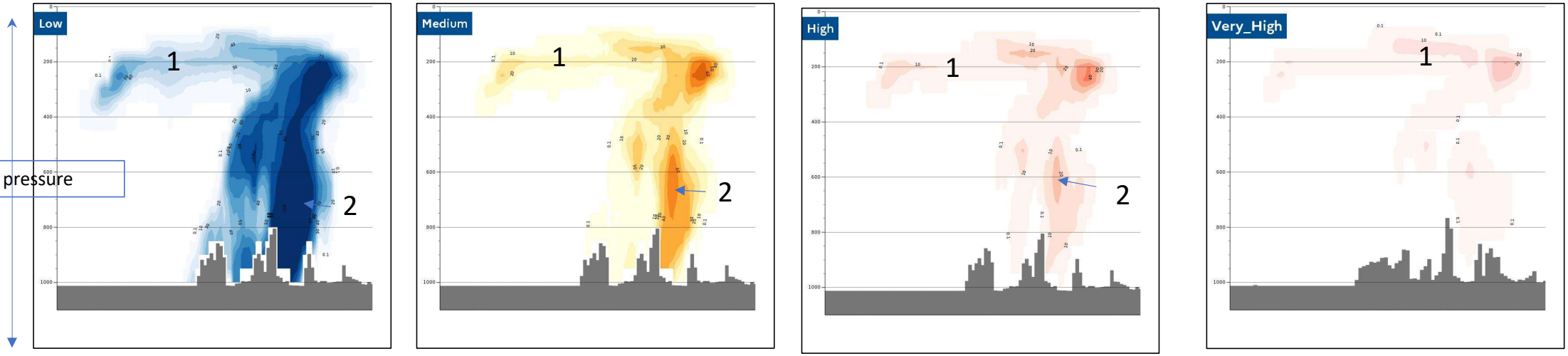


Low

Medium

High

Very high



How to Access to QVA : METGATE API

VAAC Toulouse

METGATE is the aeronautical API portal for Météo France,
Released as part of the SWIM programme end 2025, published on the SWIM Registry, abiding by CP1 requirements,
Currently exposes Web Services (WCS, WFS) and will support OGC API, end 2025 .

Machine-to-machine communication,

- Request/Reply, using HTTPS,
- Publish/Subscribe using AMQP 1.0

GetCapabilities:

- Lists all product instances and request functionalities,

DescribeFeatureType (WFS) or DescribeCoverage (WCS):

- Describes a specific product instance,

GetFeature (WFS) or GetCoverage (WCS):

- Retrieves the data, with filtering, sorting, counting, etc

THANK YOU FOR YOUR ATTENTION