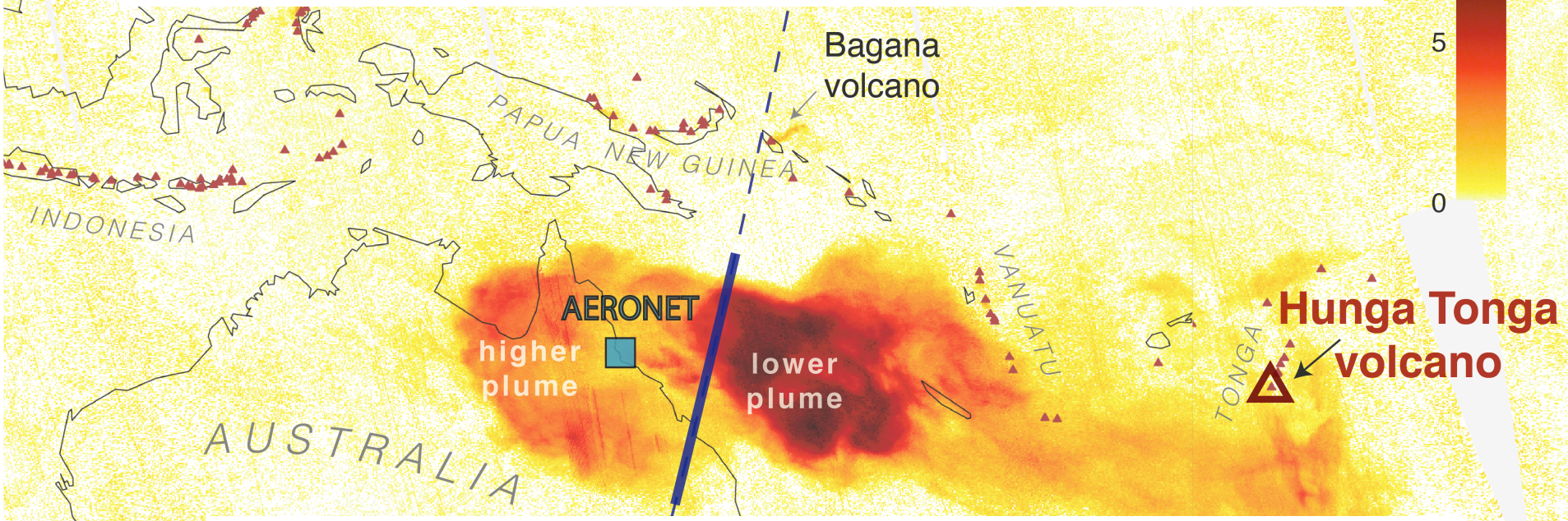
VolcPlume: une plateforme interactive pour l'analyse et le suivi multi-échelles des panaches volcaniques



<u>M. Boichu</u> (CNRS, Univ. Lille/Laboratoire d'Optique Atmosphérique LOA),
& T. Mathurin, M. Patou, R. Grandin, L. Blarel, N. Pascal, S. Neut, J. Riedi, C. Deroo, C. Brogniez, J. Descloitre

Projects: ANR VOLCPLUME, AERIS/ICARE, H2020 E-shape

PNTS scientific day, 1 April 2022

VolcPlume portal : scientific objectives, needs & challenges

Multi-scale 4D monitoring of volcanic plumes

- ✓ Gas (SO_2) & particles (ash, sulfate aerosols), clouds (impact on SO_2/particle retrieval)
- ✓ Multi-scale data/analysis: from local to global
- ✓ Understanding of various impacts:
  - ✓ Local volcanological hazards during eruption
  - ✓ Atmospheric impacts: air quality, air trafic, climate

A massive amount of atmospheric data is needed from multi-disciplinary communities:

- ✓ Satellite (passive/active, polar-orbiting low earth orbit LEO, geostationnary GEO, etc..)
- ✓ Ground-based remote sensing network (photometry, LIDAR) – ACTRIS-FR
- ✓ Ground-based in situ air quality networks (aerosol chemistry)

Retrospective & also near-real time analysis (NRT)

⇒ **Fast access to data, automated data analysis & interactive visualization are required**

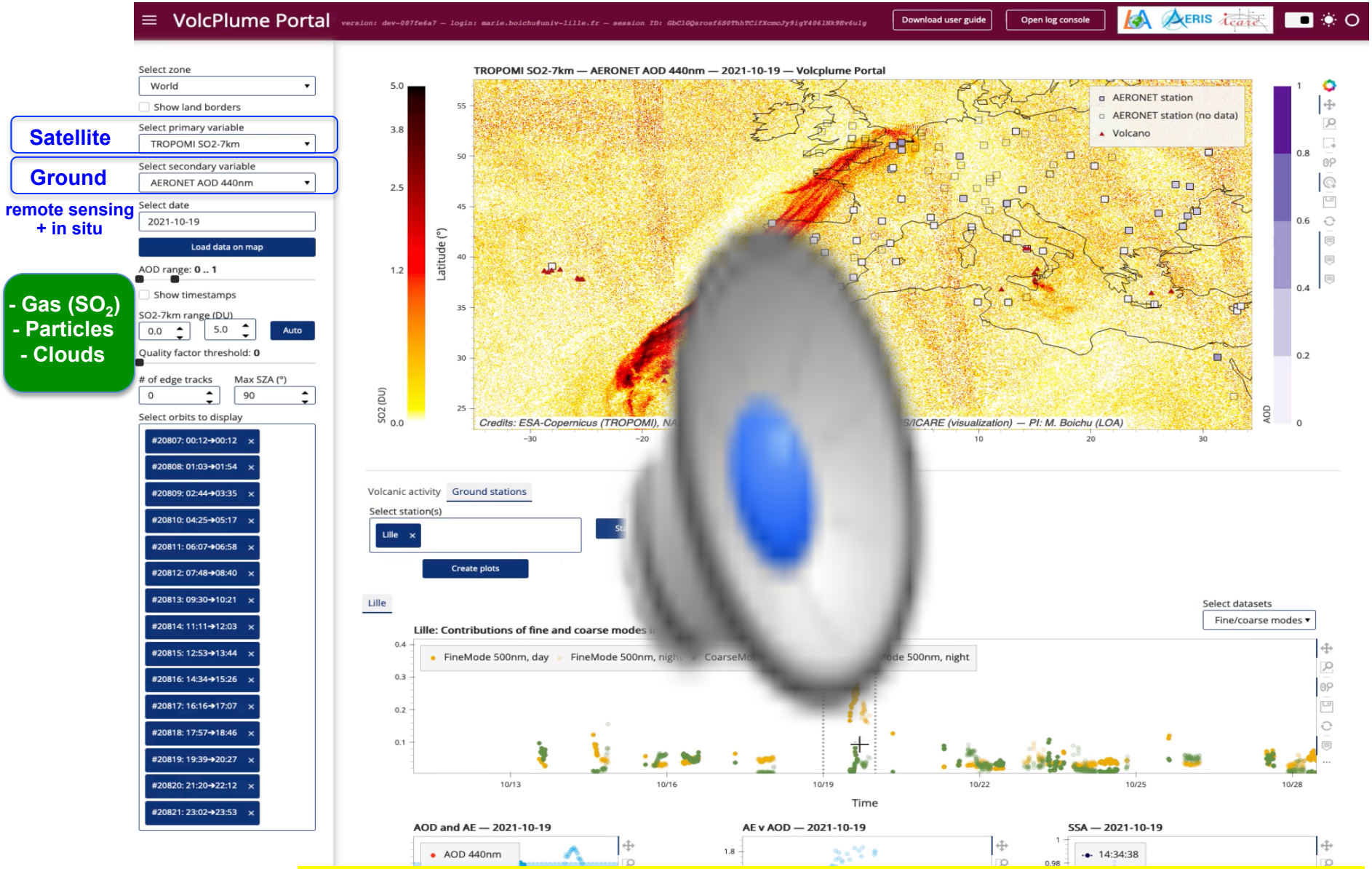
⇒ **Interdisciplinary collaborations:**

- ✓ **Atmosphere communities**: gas/particles; satellite/ground-based remote sensing/ground-based in situ, physics/chemistry
- ✓ **Atmosphere & Solid Earth-Volcanology**

=> Data Terra inter-pole

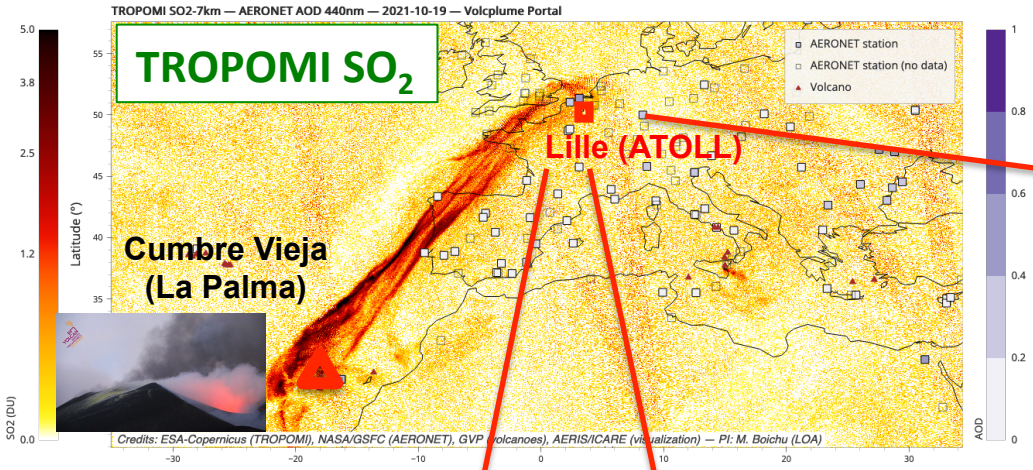
VolcPlume Portal: multi-scale NRT 4D monitoring & analysis of volcanic plumes

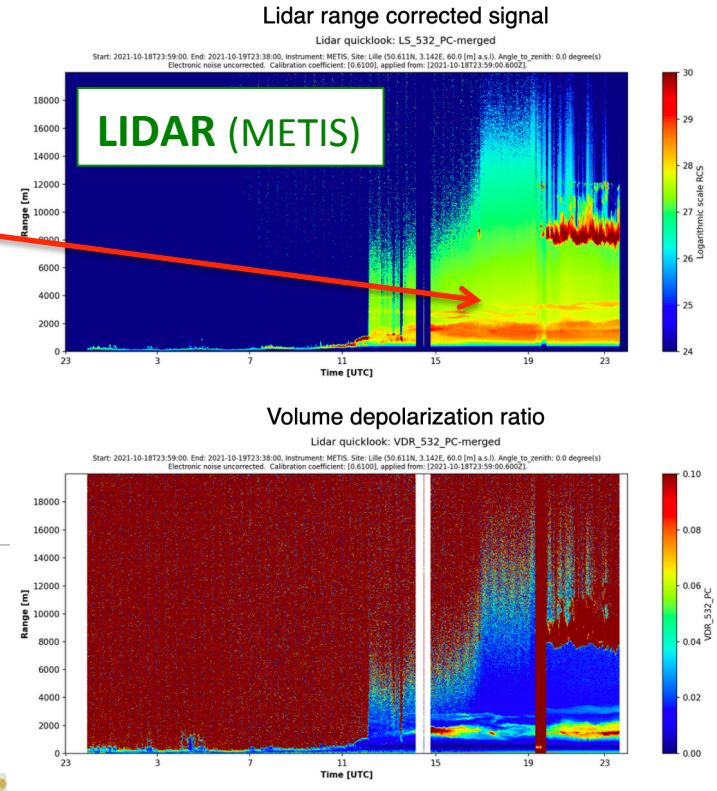
ANR & AERIS projects - PI: M. Boichu (LOA), data visualisation engineer: T. Mathurin (ICARE)



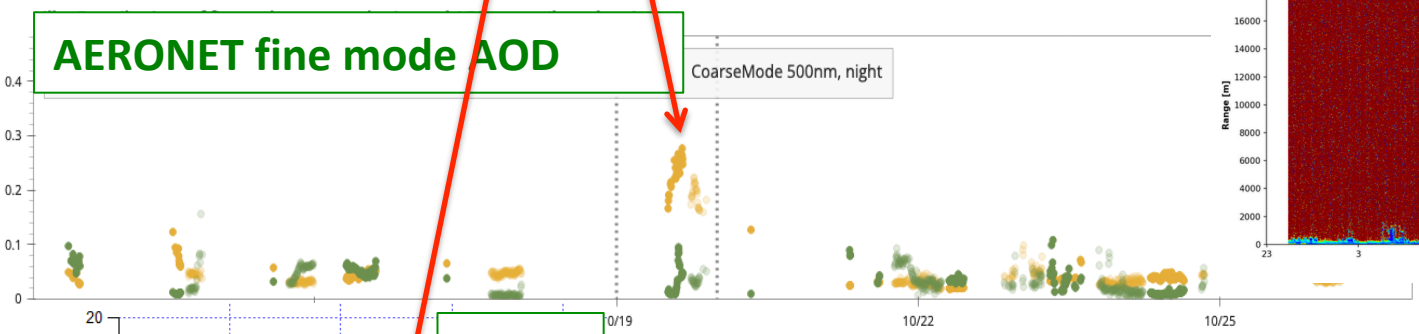
AERIS & Data Terra highlights: https://www.data-terra.org/en/volcplume-a-unique-platform-for-the-monitoring-and-4d-analysis-of-volcanic-plumes/

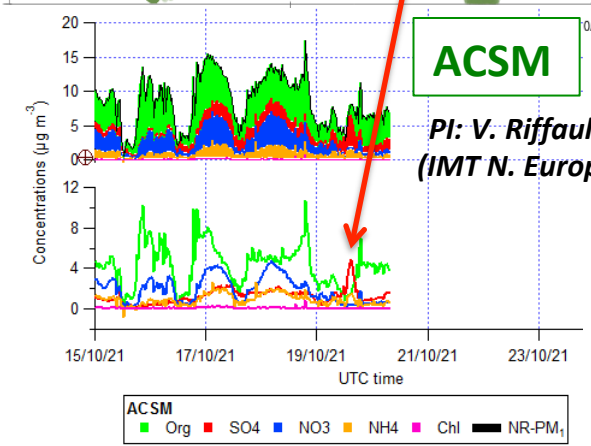
Impact on the French air quality of the Cumbre Vieja eruption (La Palma, Canary Islands, 2021)





PI: P. Goloub (LOA)





PI: V. Riffault (IMT N. Europe)

Characterization of volcanic sulfate aerosols

- ✓ TROPOMI: SO_2 rich-plume toward Lille
- ✓ Lille/ATOLL instrumental platform:
  - ✓ AERONET: excess fine mode particles
  - ✓ LIDAR: weakly depolarizing particles < 4 km
  - ✓ ACSM: excess SO_4 ground concentration

VolcPlume Portal: satellite (SO_2 gas/particles) & modeling products

Sentinel-5P/TROPOMI (SO_2, aerosols, clouds)

- TROPOMI SO2-{n}km: *sulfurdioxide_total_vertical_column_{n}km* dataset in S5P L2 SO2 product
- TROPOMI Cloud Fraction: *cloud_fraction* dataset in S5P L2 CLOUD product
- TROPOMI Aerosol Index: *aerosol_index_340_380* dataset in S5P L2 AER_AI product
- TROPOMI Aerosol Layer Height: *aerosol_mid_height* dataset in S5P L2 AER_LH product

METOP/IASI (SO_2)

- IASI SO2-{n}km: {n}km height data within *SO2_all_altitudes* dataset in METOPB LATMOS L2 SO2 product
- IASI SO2-interpolated: *SO2_interpolated* dataset in METOPB LATMOS L2 SO2 product
- IASI SO2-height: *SO2_vertical_level* dataset in METOPB LATMOS L2 SO2 product

Aura/OMI & SUOMI-NPP/OMPS (SO_2)

GEOSTATIONARY SATELLITES (GOES16, GOES17, HIMAWARI8, MSG2, MSG4)

- GEO ASH/Natural False Color: SEVIRI-Like RGB compositions (user guide, recipes) from L1B products
- GEO Brightness Temperature: IR channels (10.3, 10.4, 10.8, 11.2, 12.0 µm depending on instrument) from L1B products
- GEO SO2 (GOESNG and HIMAWARI only): NOAA SO2 RGB composition (reference)
- GEO Cloud Top Altitude: *ctth_alti* dataset in SAFNWC GEO CLOUD products
- GEO Cloud Top Pressure: *ctth_pres* dataset in SAFNWC GEO CLOUD products
- GEO Cloud Top Temperature: *ctth_tempe* dataset in SAFNWC GEO CLOUD products

(SO_2 & ash)

MODIS & POLDER (aerosols)

CALIPSO/CALIOP space-based LIDAR (aerosols)

ECMWF/ERA5

ERA5 Wind: *u*, *v* wind components datasets from ERA5 pressure-level reanalysis products

VolcPlume Portal: vertical distributions of volcanic plumes & atmospheric impacts down to the ground (3D)

- AERONET sun/lunar photometric network
- LIDAR network (ACTRIS-FR)
- In situ air quality GEOD'AIR network (SO_2, PM)
- In situ air quality ACSM (Aerosol Chemical Speciation) network (SO4, NH4, Org, NO3, Cl)- *ongoing*

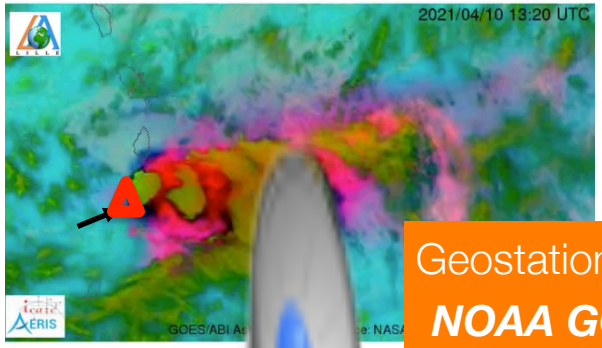
Toward a « Volcano Space Observatory » - *an interdisciplinary project: Atmosphere & Solid Earth/Volcanology*

H2020 FAIR EASE project with Data Terra
Collab: LOA, AERIS/ICARE, IPGP, ForM@TER

- InSAR (Radar interferometry) – Sentinel-1
- Visible imagery (Sentinel-2 & Pléiades)

Near-real time monitoring of explosive activity from space
(Soufrière Saint-Vincent eruption, April 2021)

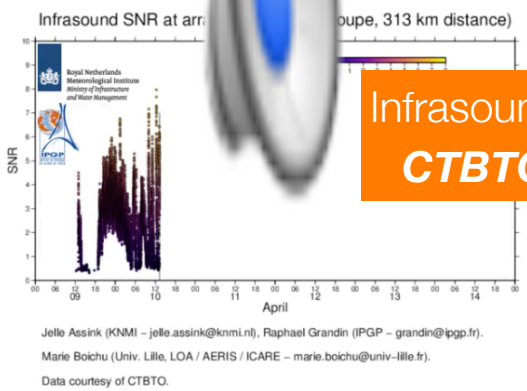
Boichu & Grandin (2021)



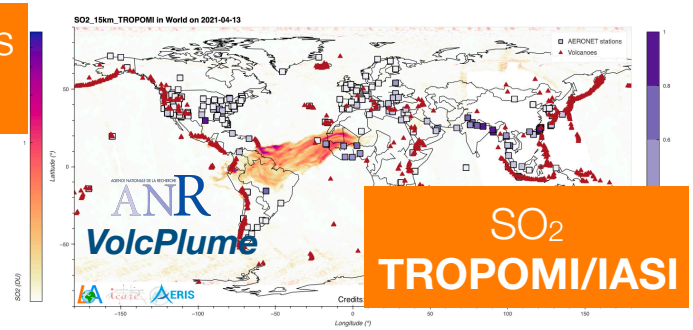
Geostationnary obs
NOAA GOES-16

Remote sensing

- **Multispectral**: ash/gas monitoring
→ eruptive dynamics 💥/ air traffic (VAAC) ✈️ & air quality 😷
- **Radar**: see through plumes → crater morphology 🌋
- **Visible**: deposit volumes → ash mud hazards 🏚️
- **Infrasound**: «hear » explosions → explosive dynamics 💥



Infrasounds
CTBTO



SO_2
TROPOMI/IASI

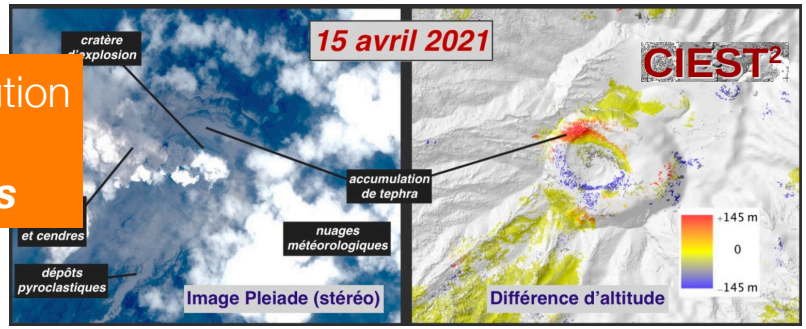
High resolution Radar
Capella

Data Terra/Inter-poles:

AERIS | ForMaTer | Theia

H2020 Fair-Ease project
« Volcano space observatory »
(LOA, Univ Lille & IPGP, Univ Paris)

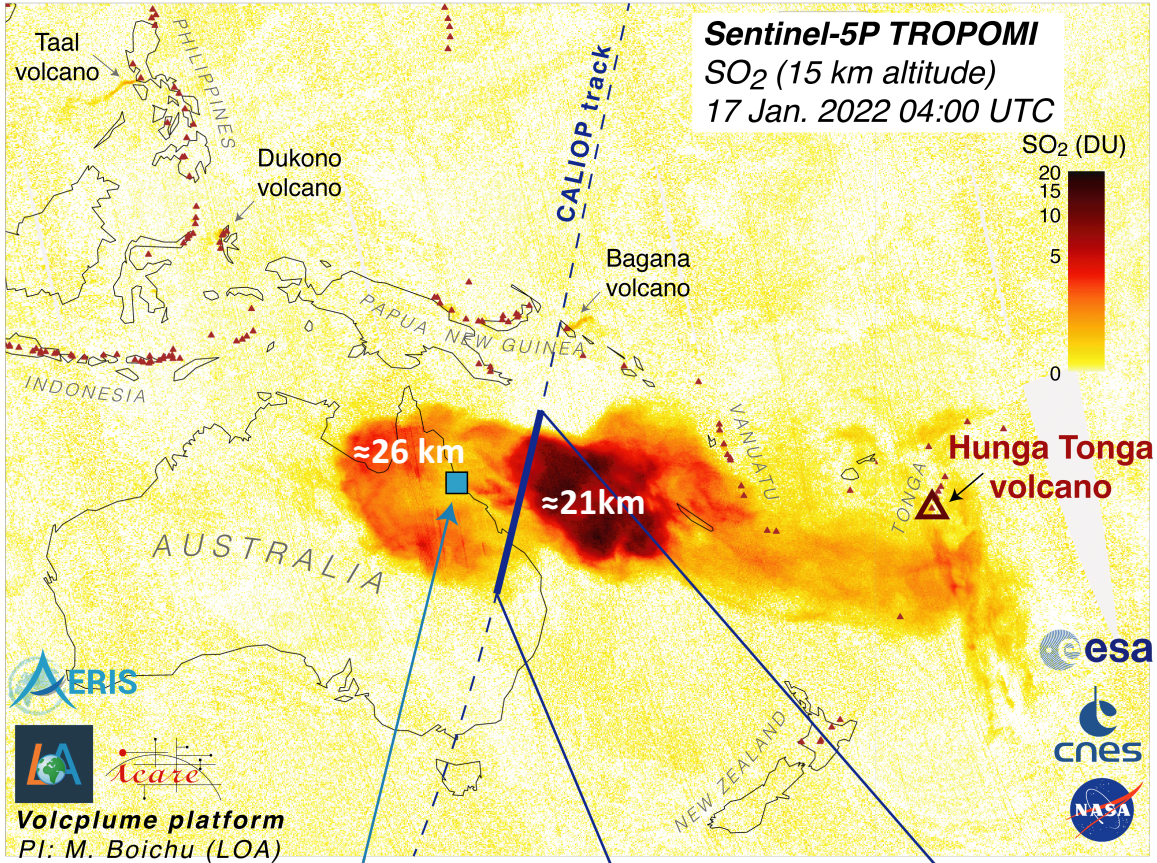
High resolution visible
Pléiades

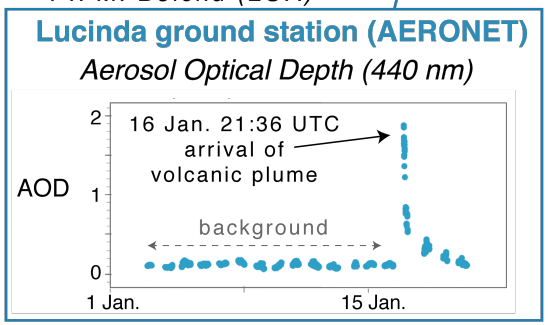


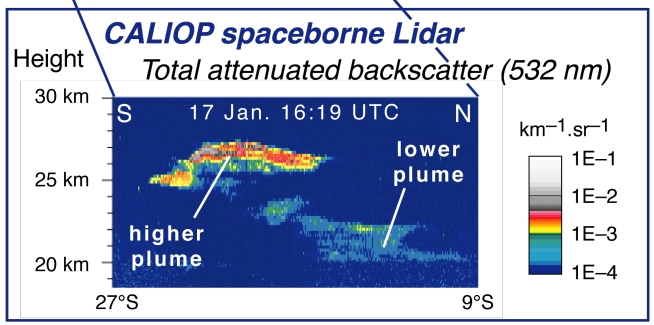
Hunga Tonga eruption & impact on climate: a young plume remarkably rich in sulfate fine aerosols & poor in coarse ash particles

Hunga Tonga volcano eruption – 15 Jan. 2022

Satellite and ground-based observations of volcanic plumes

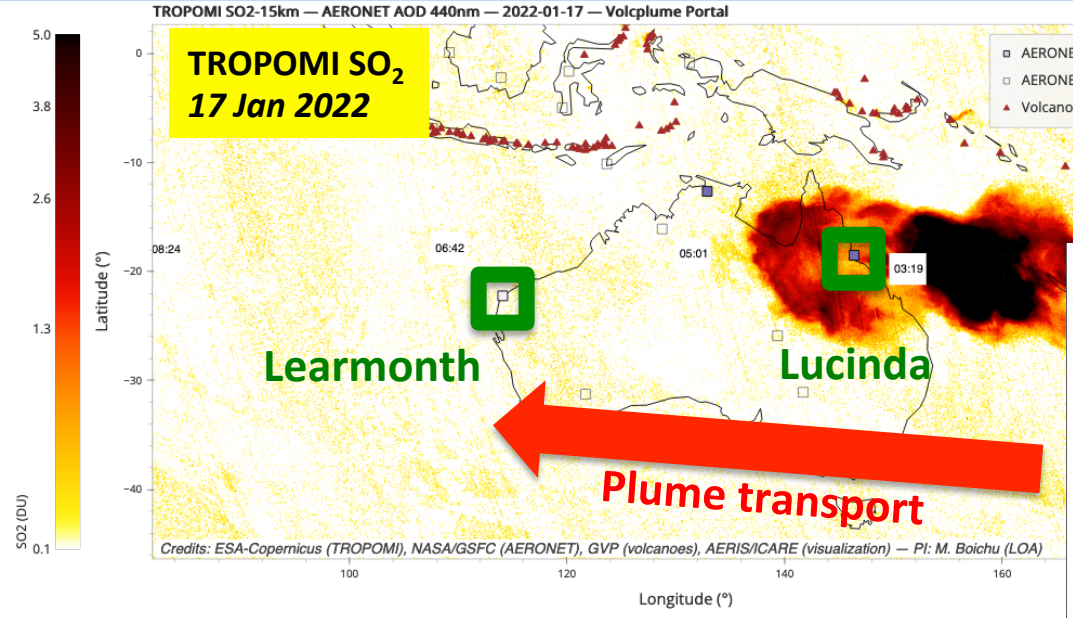


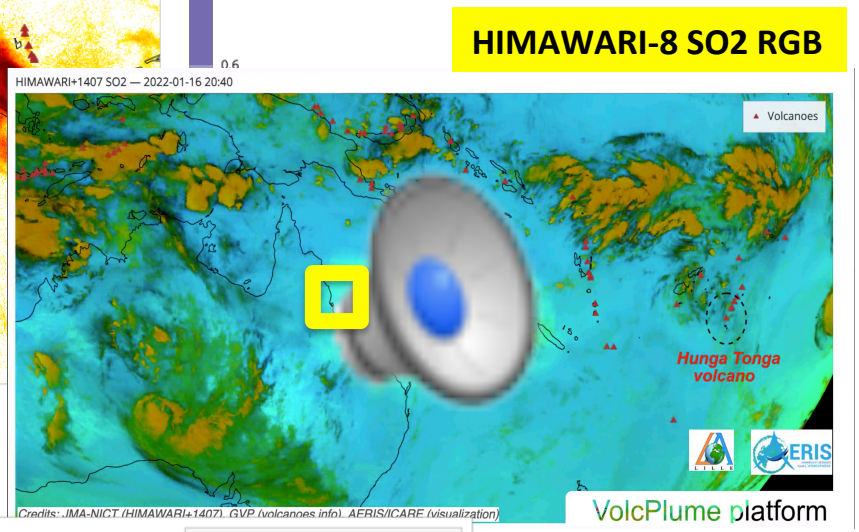




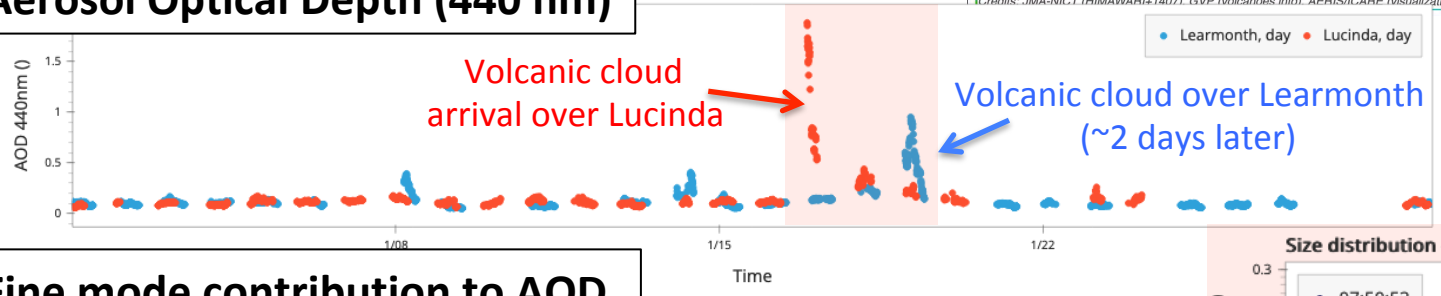
Hunga Tonga particle properties:

a multi-station analysis of AERONET ground-based data

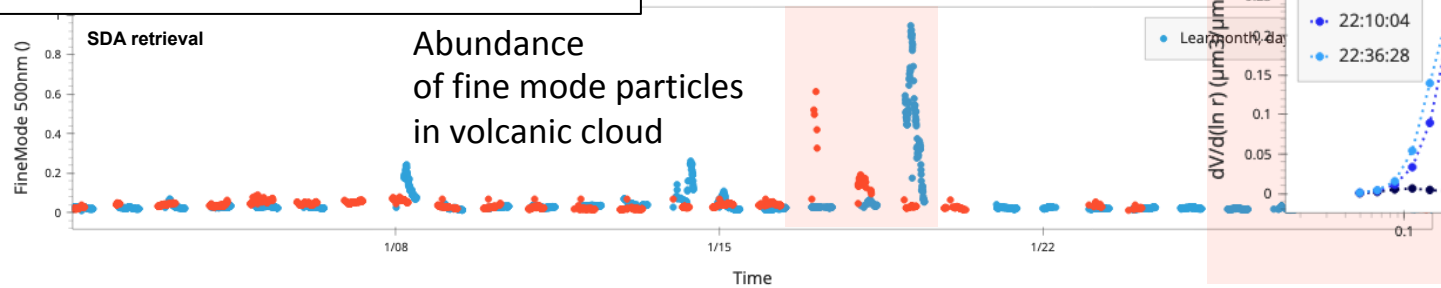




Aerosol Optical Depth (440 nm)



Fine mode contribution to AOD



Aerosol size distribution