



Satellite observation of atmospheric composition

Cathy Clerbaux

LATMOS/IPSL (Paris) & SQUARES ULB (Brussels)

- How did I end in this field of research ?
- How to define a satellite mission
- 4 examples of what can we measure with IASI



Fires



Volcanoes

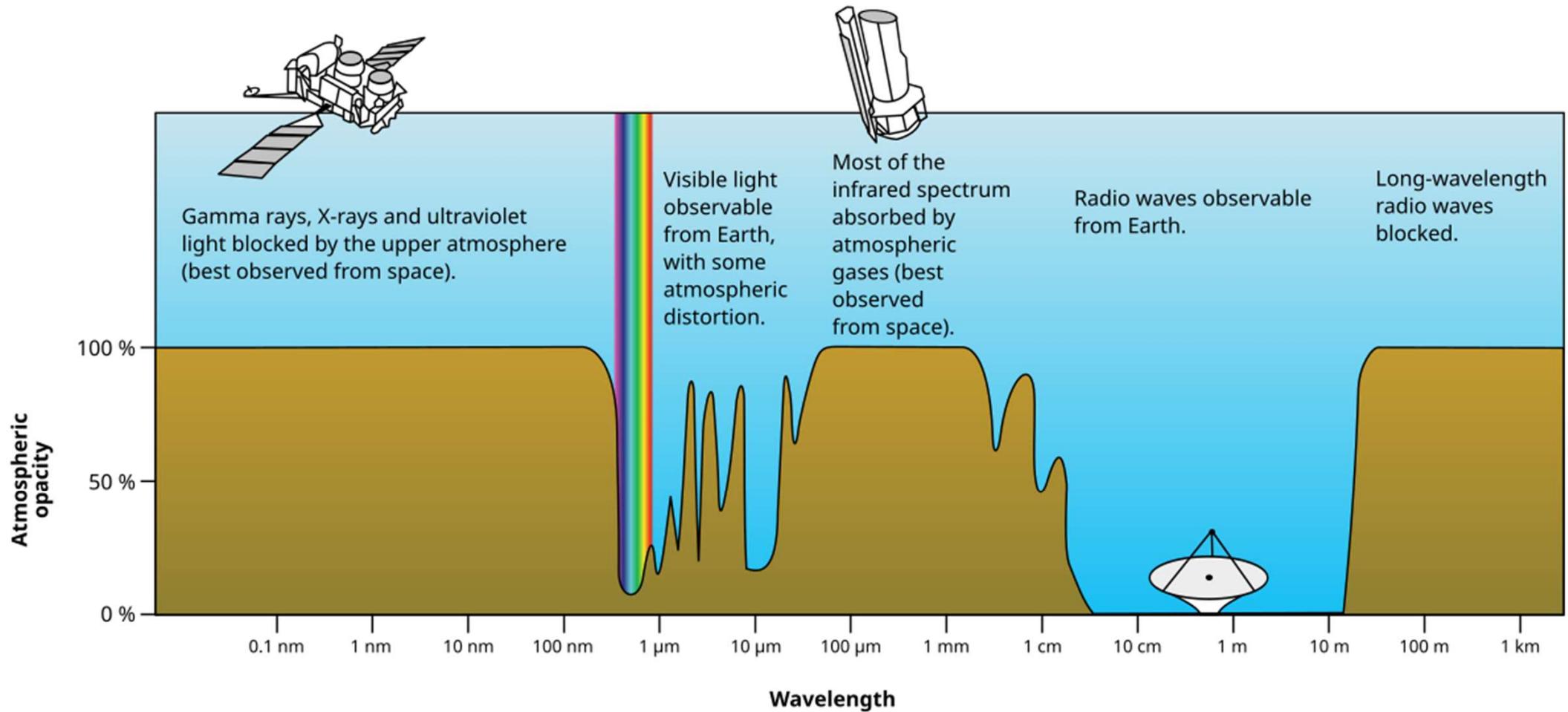


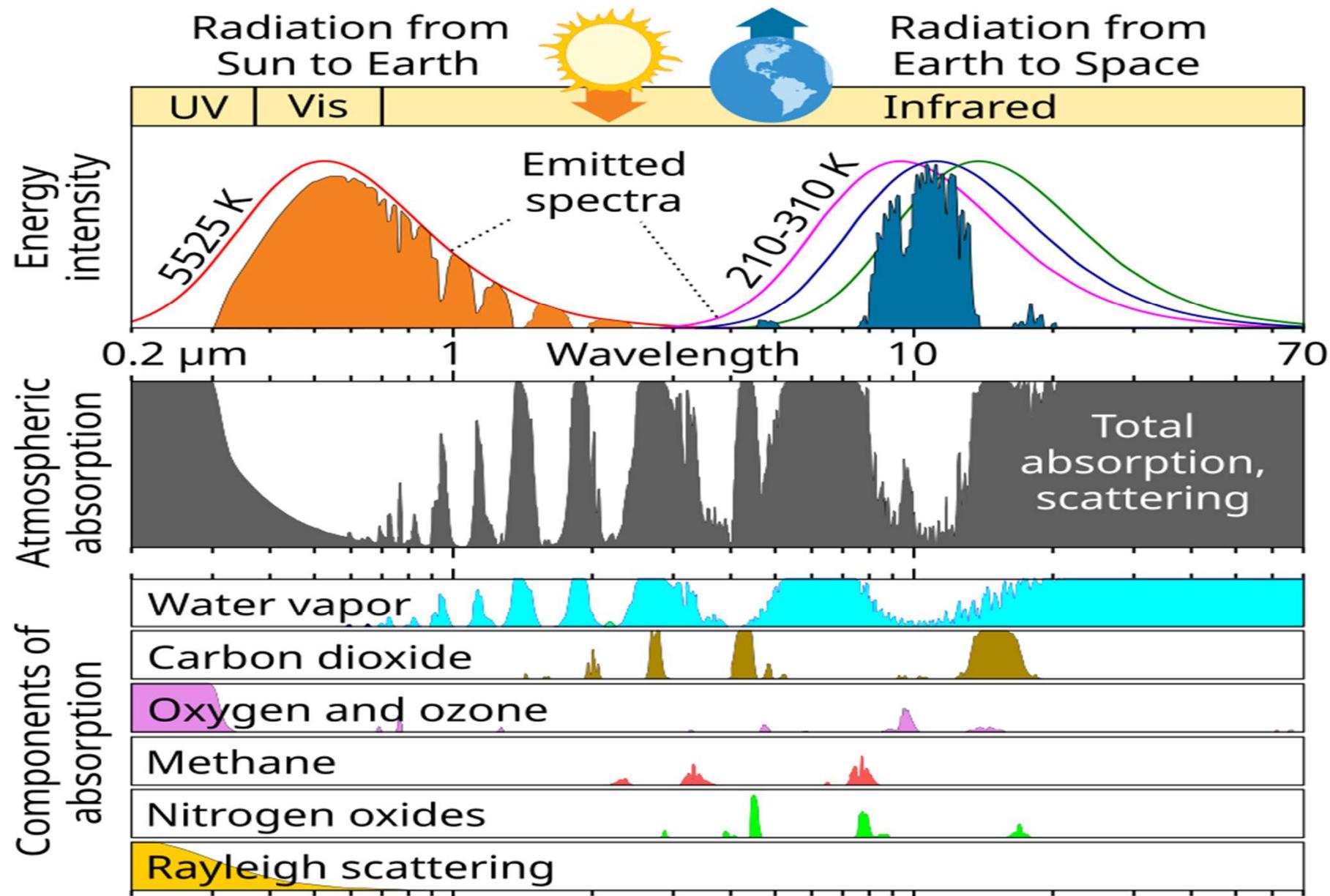
Agriculture



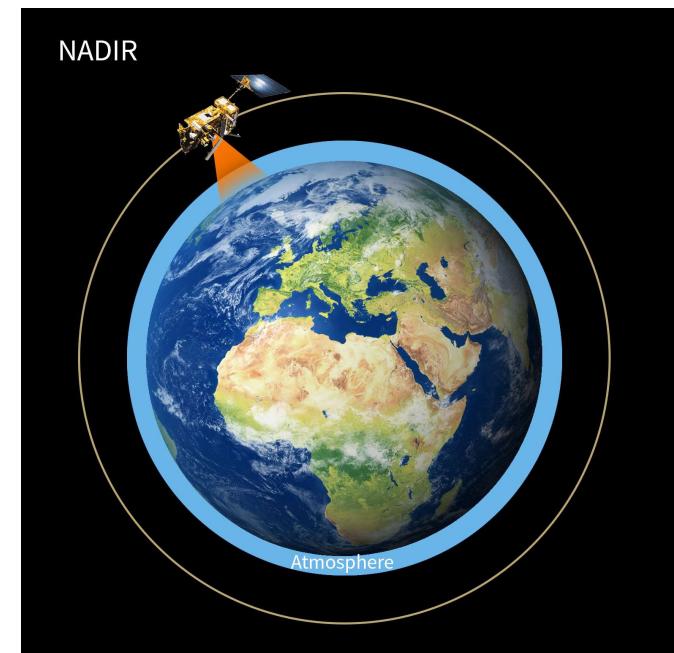
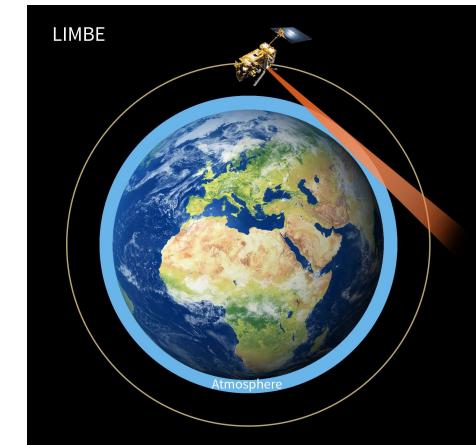
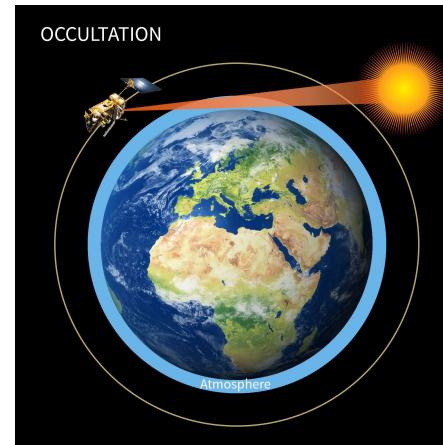
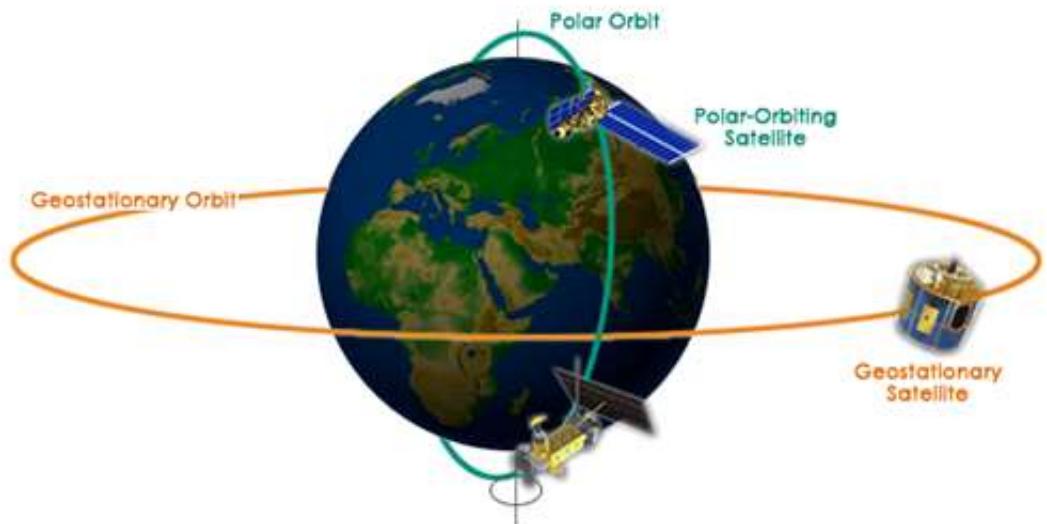
Gas leaks

- How can you exploit the IASI dataset?





Orbit & Viewing geometry to sound the troposphere

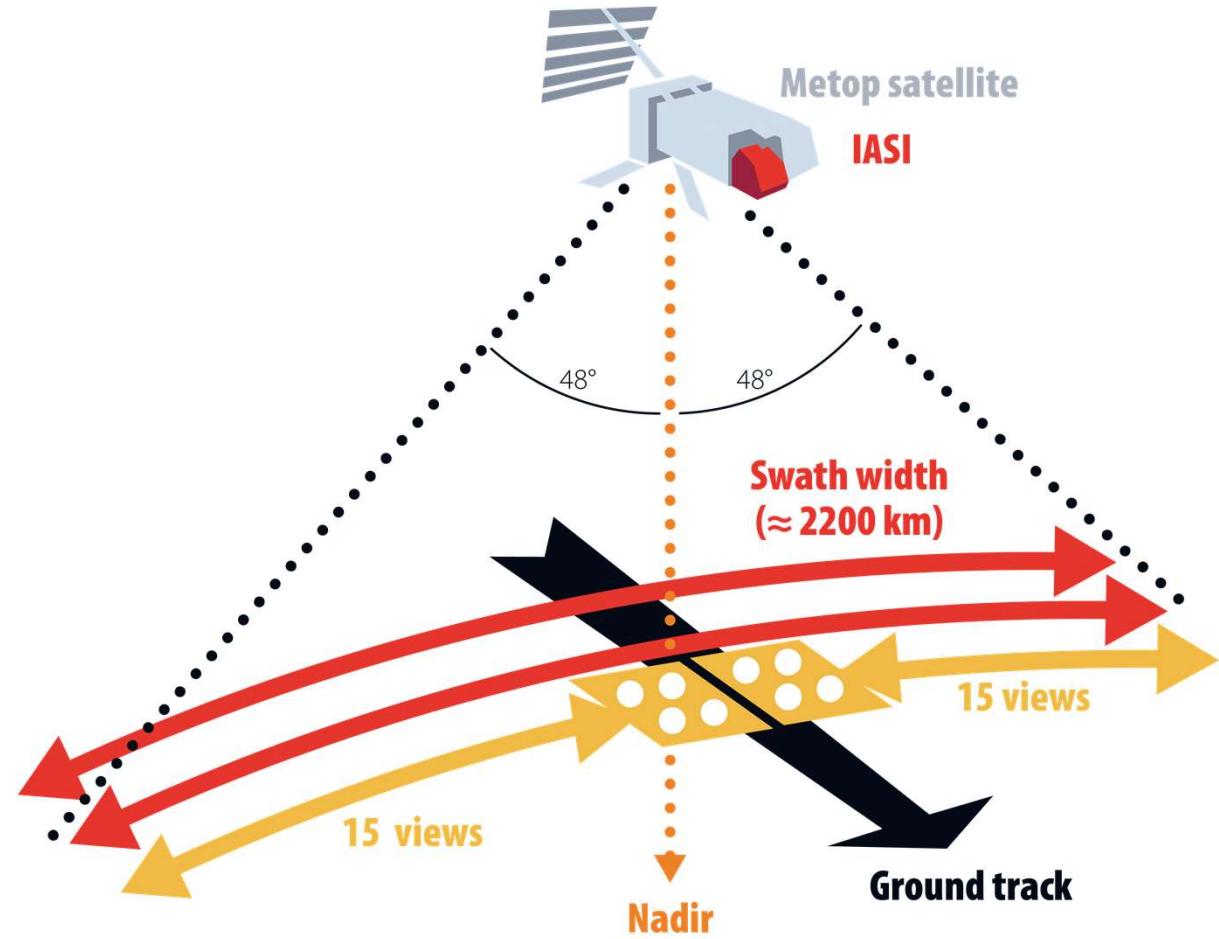
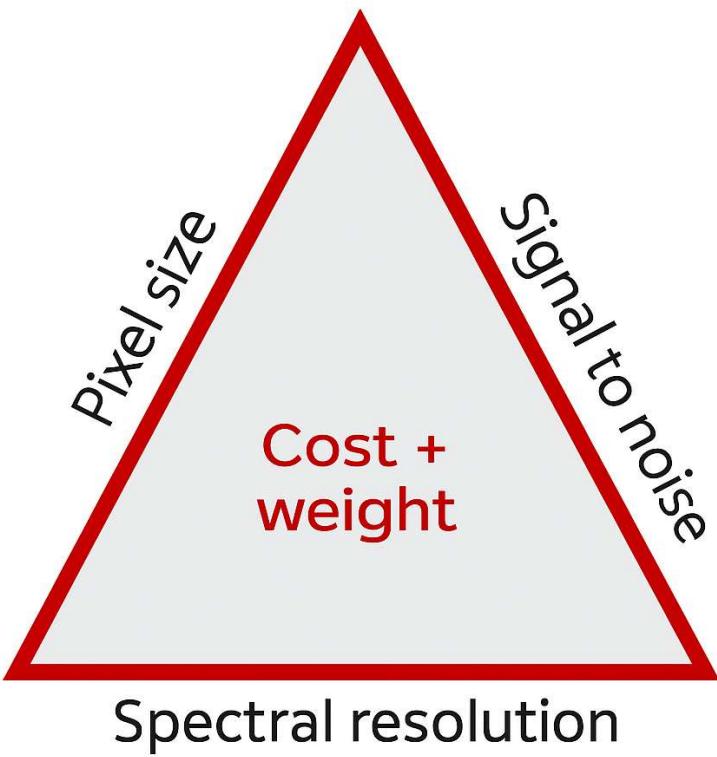


Design an atmospheric sounder - early steps



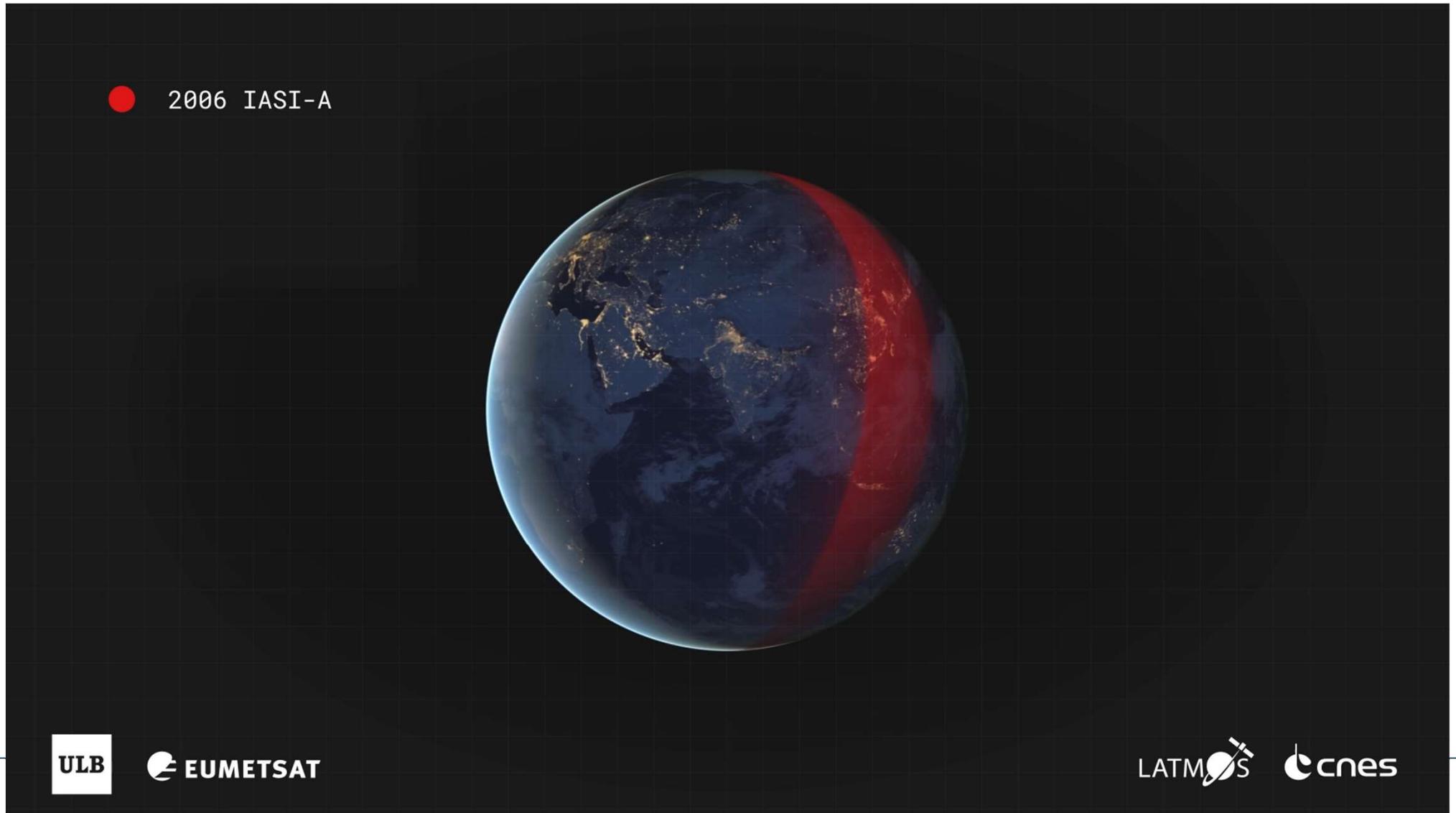
- What do we want to measure (spectral range) **Thermal infrared**
- Which gas/variables ? **CO, ozone, CH₄, SO₂, etc.**
- Regional or global ? **Global**
- How often ? **As much as possible**
- How well + vertical resolution ? **Vertical profile when possible**





Now I am a post-doc, with a well defined satellite mission...

The 3 IASI thermal infrared in polar orbit



What can we measure/detect in the TIR?

1/ H₂O, T

2/ Climate gases (long lifetime)

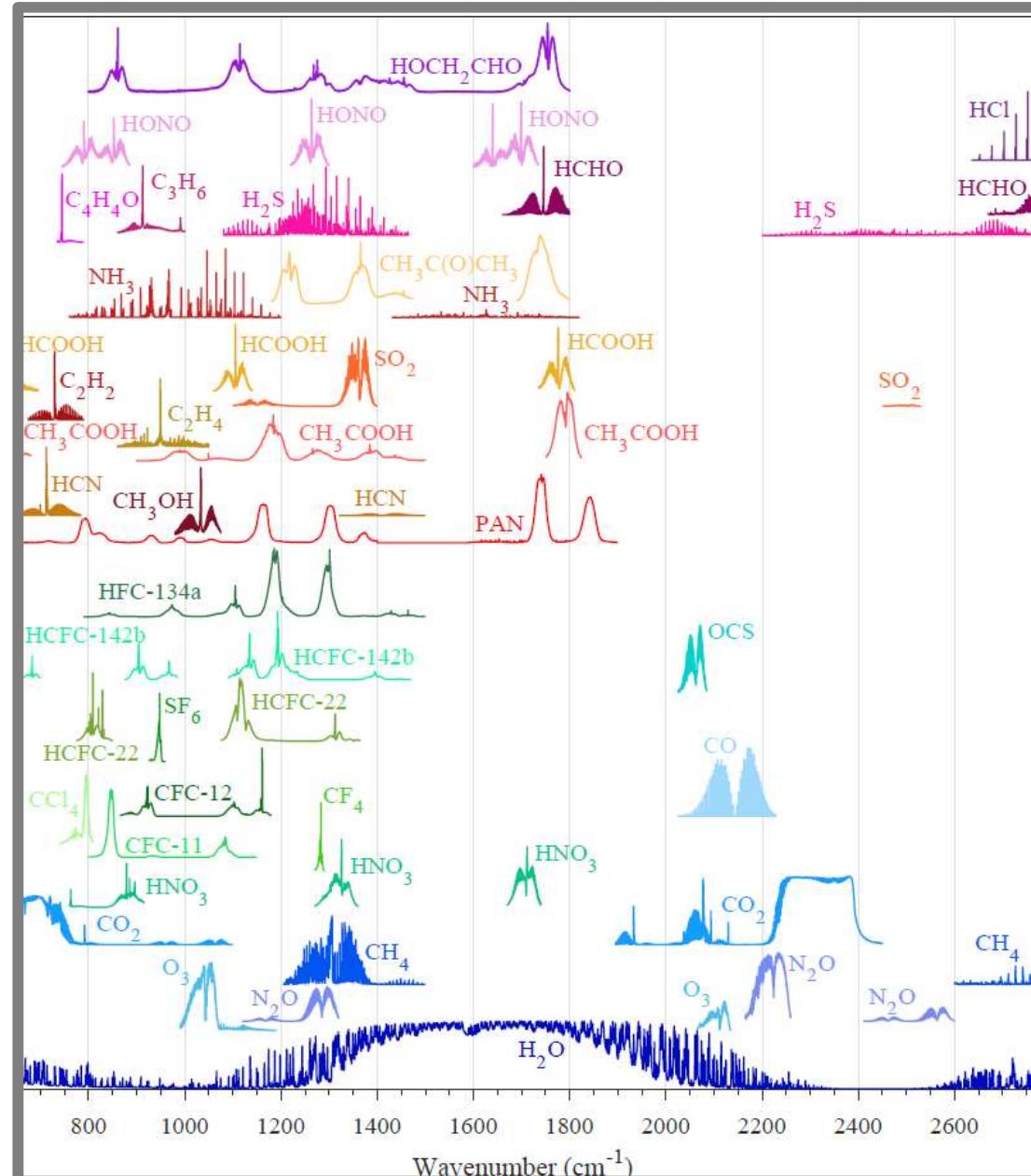
3/ Reactive gases : CO, O₃, HNO₃, SO₂

4/ Weak absorbers (short lifetime)

NH₃, HCOOH, CH₃OH, CH₃COOH, C₂H₂, C₂H₄, HCN, OCS, HCl, H₂S, C₃H₆, HONO, PAN, etc.

5/ Sand, ashes, etc.

- Clouds > no data
- Thermal contrast > no info near the ground



Infrared retrievals for reactive gases



Optimal estimation (CO, O₃, HNO₃)

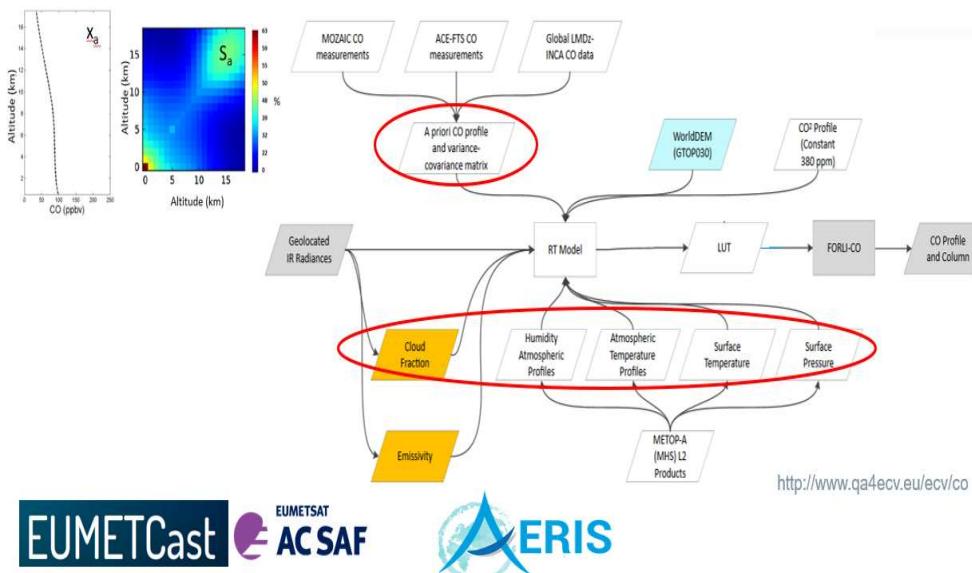
Metop temperatures

Cloud filtering (13-25%)

Avgk, error budget (thermal contrast)

NRT

Hurtmans et al., 2012.



HRI + NN



Metop temperature or ERA5

Cloud filtering or not

Fast & well suited for weak absorbers

PCA

For exceptional events

NRT

No cloud filtering

Well suited for weak absorbers

Weather – exceptional events



Biomass burning - Fires



Ozone monitoring



Volcanoes



Dust events



Agriculture/Livestock

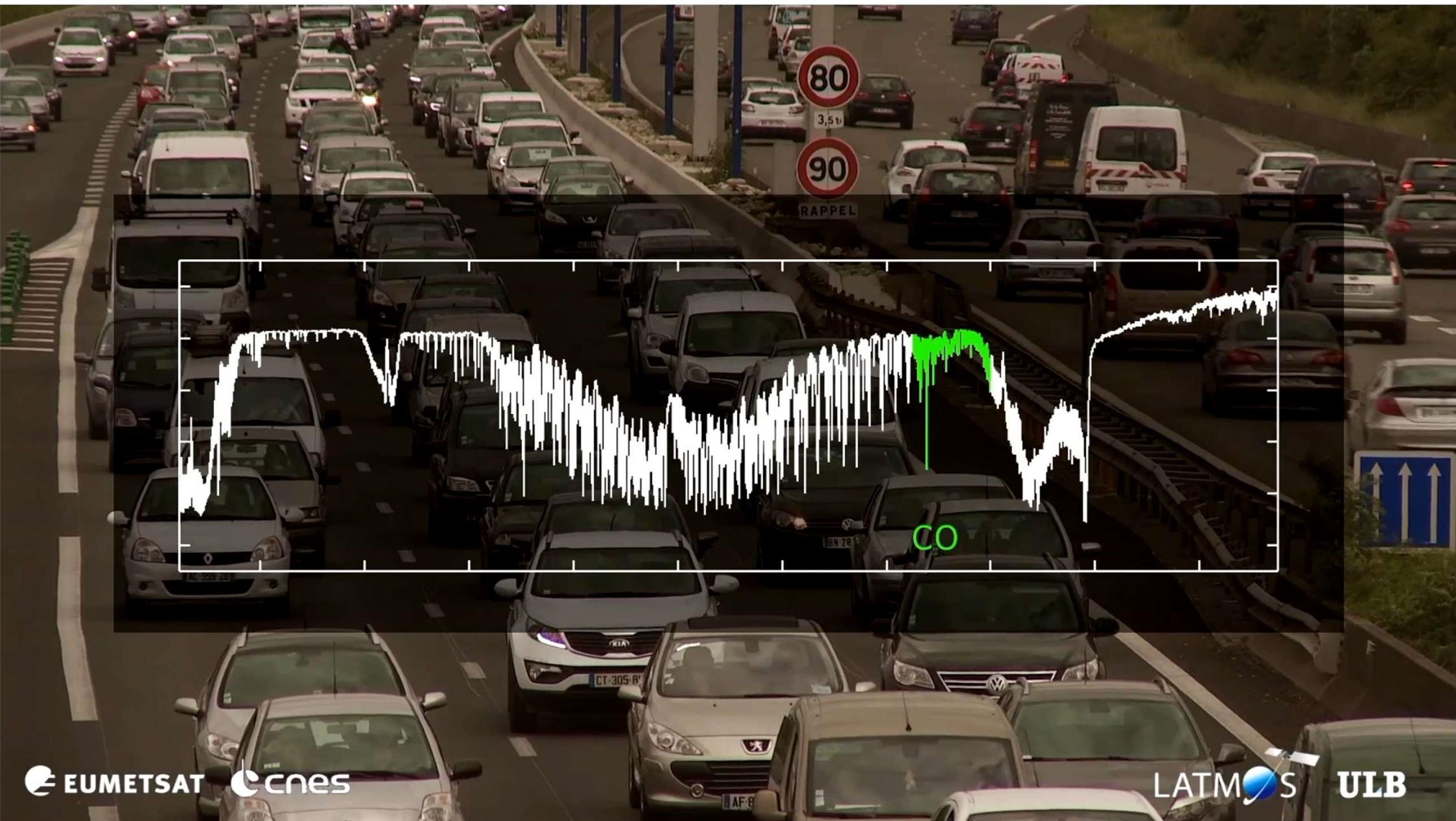


Industrial leaks

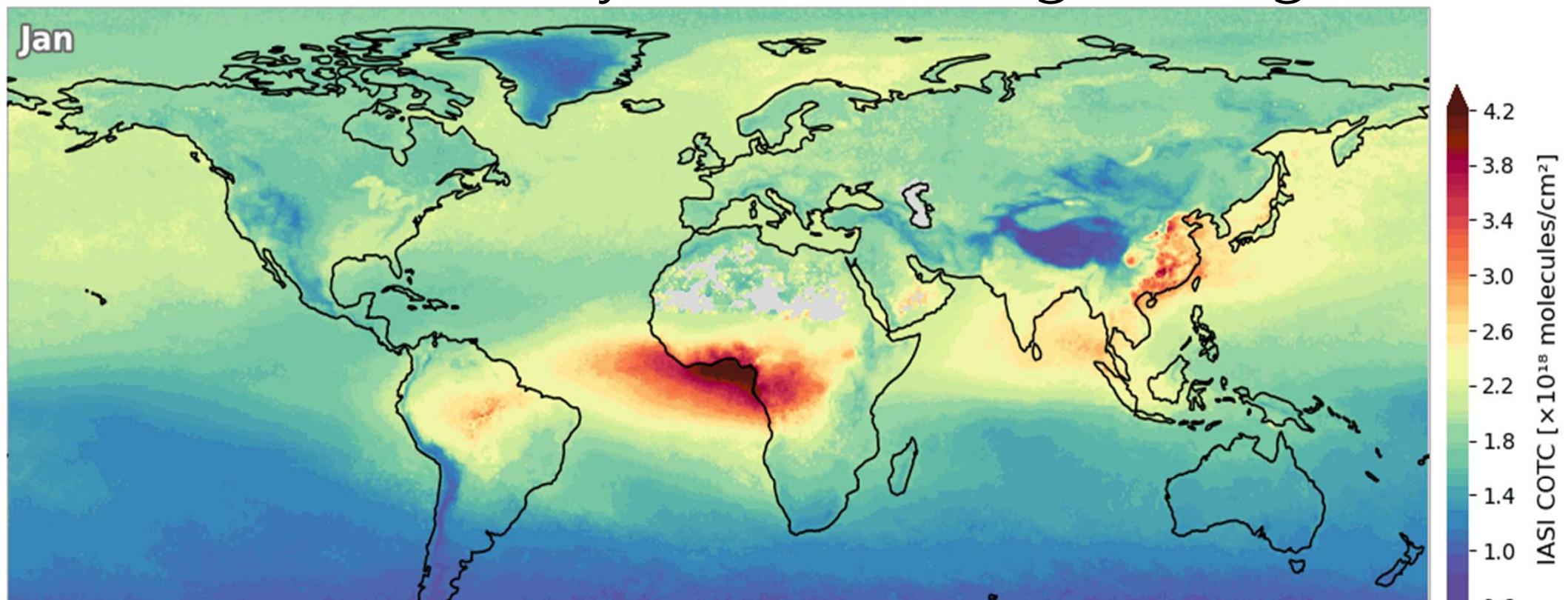


Fires (CO, carbon monoxide)





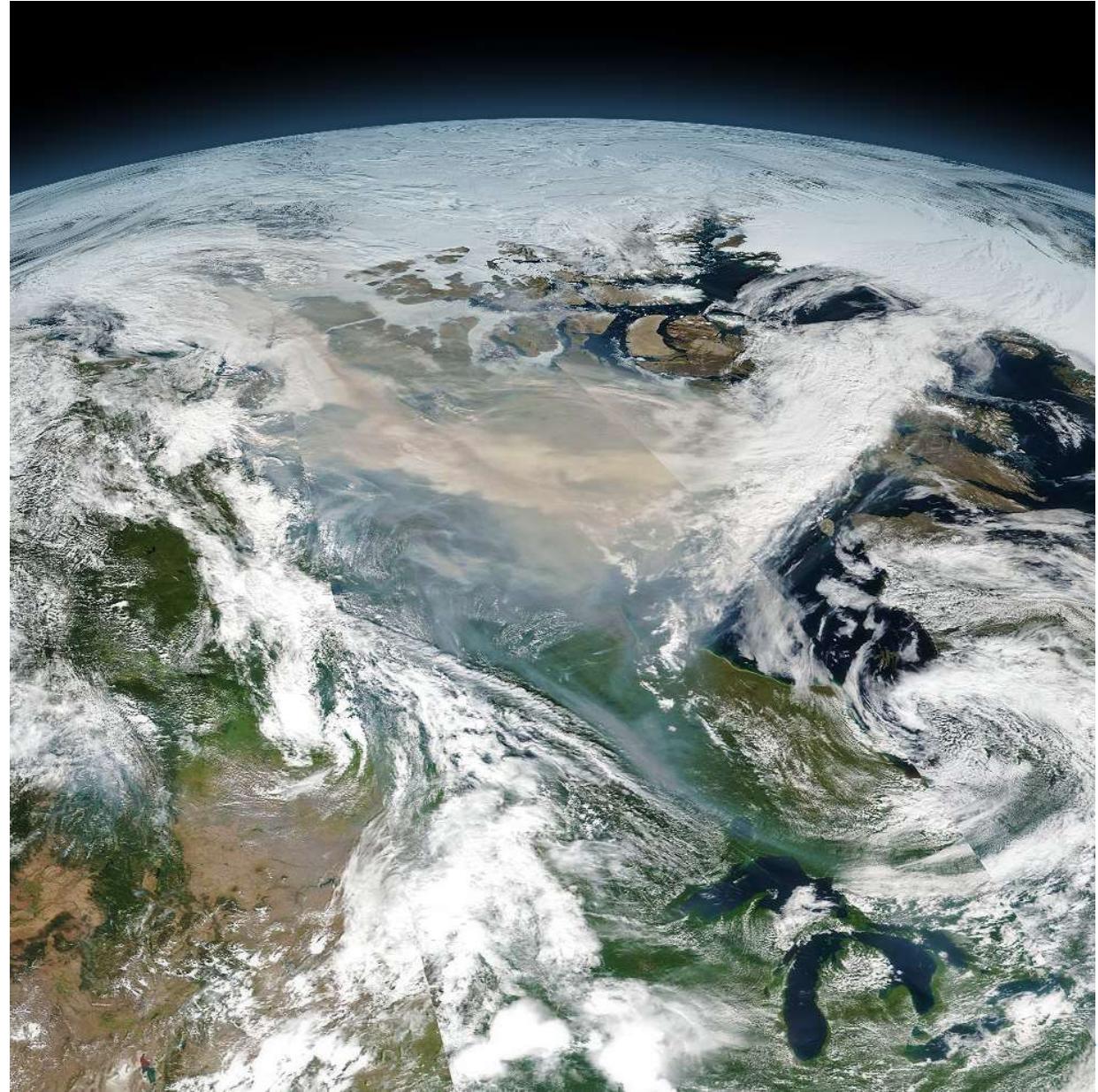
IASI CO – 1 year (smoothing average)

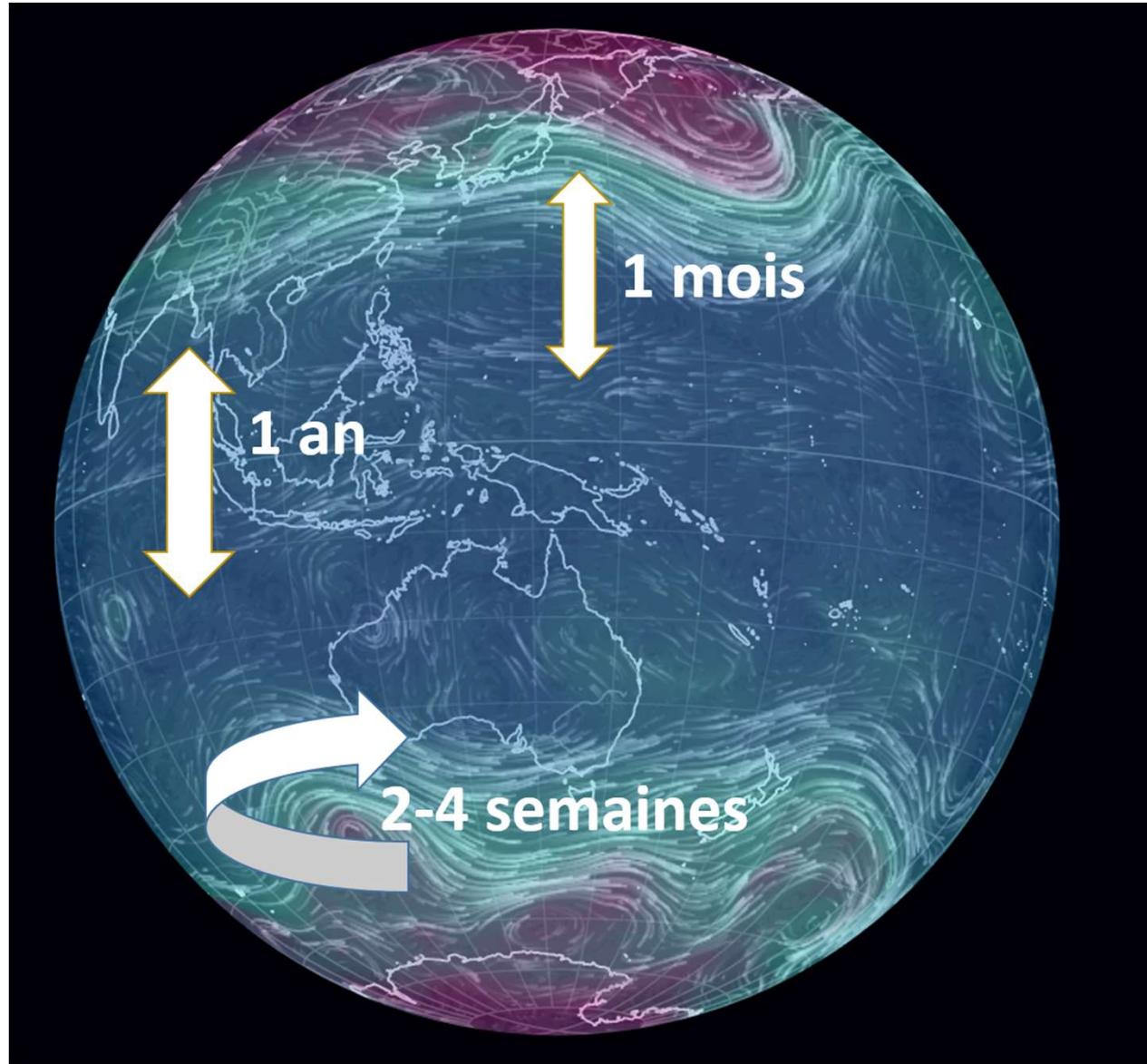


Credit S. Sinathamby (LATMOS)



How far
can CO
from smoke
travel?

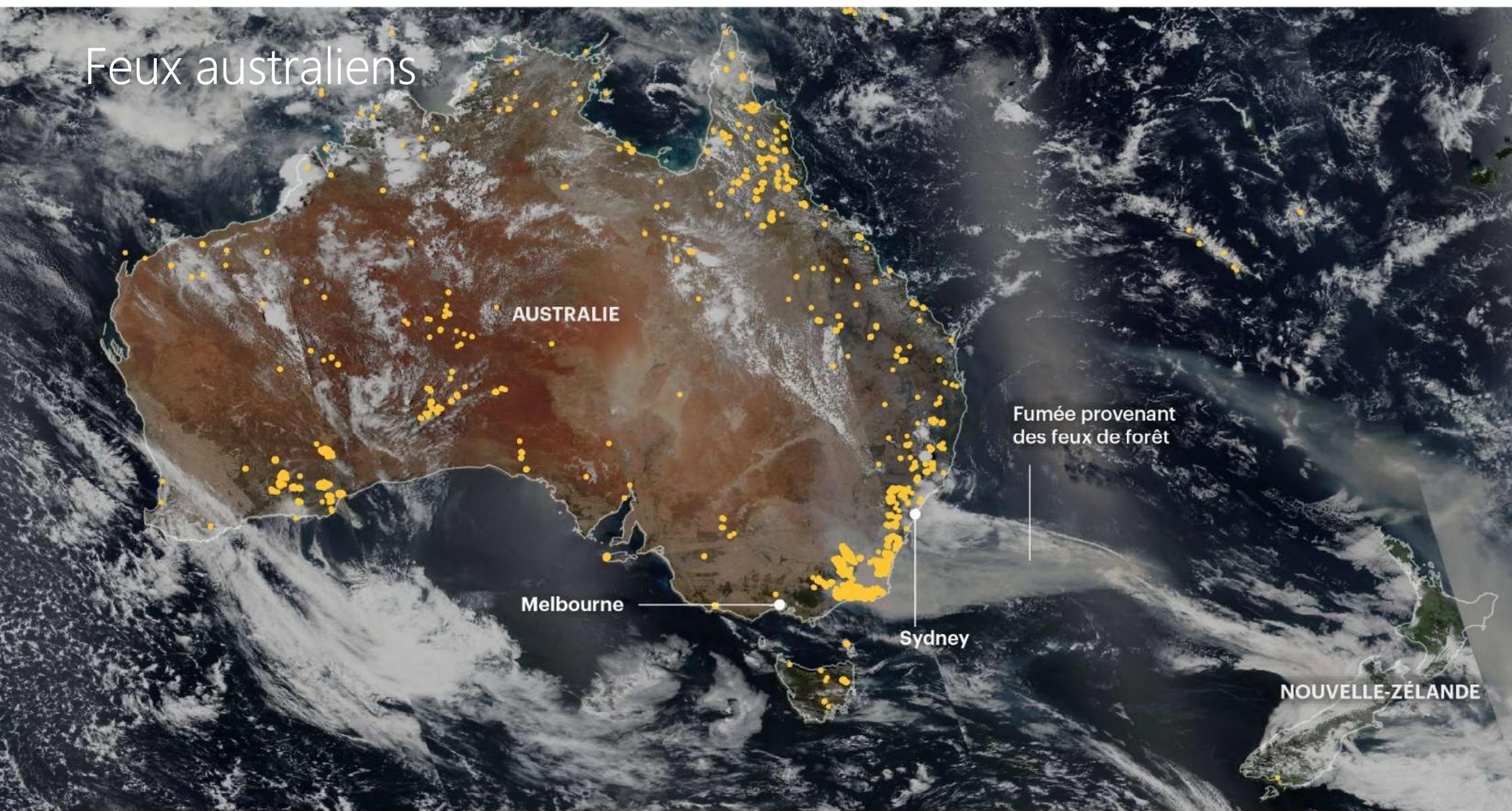






January 2020 : Australie

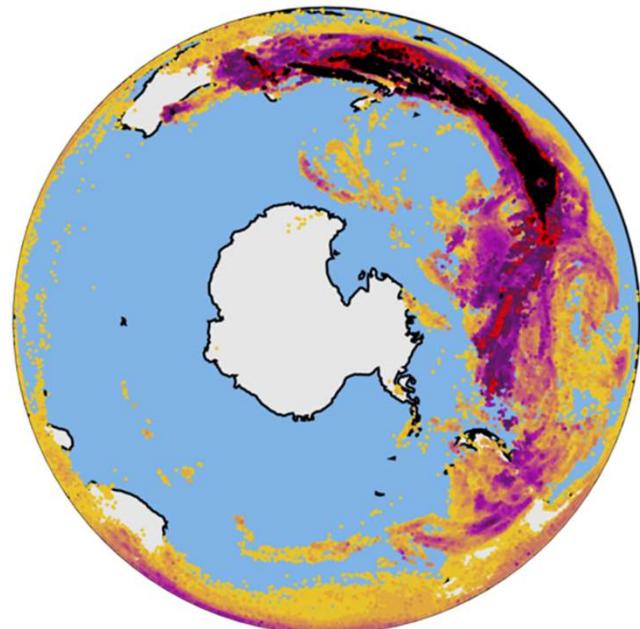
Feux australiens



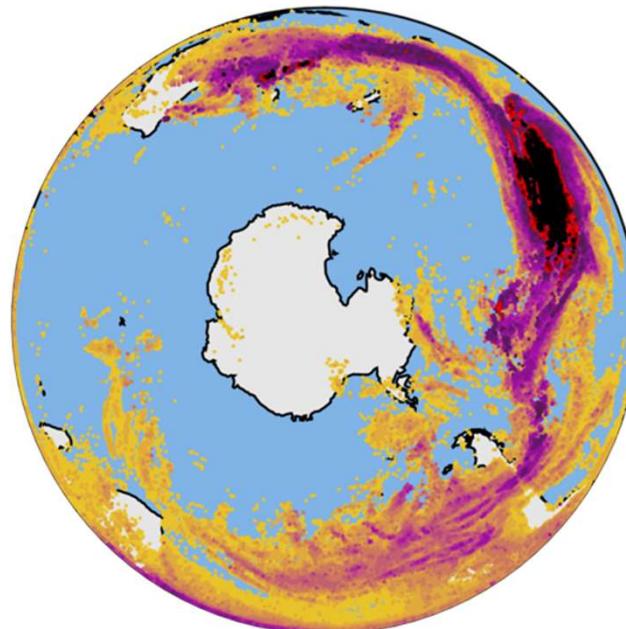
● Foyers d'incendie dans les 24 dernières heures



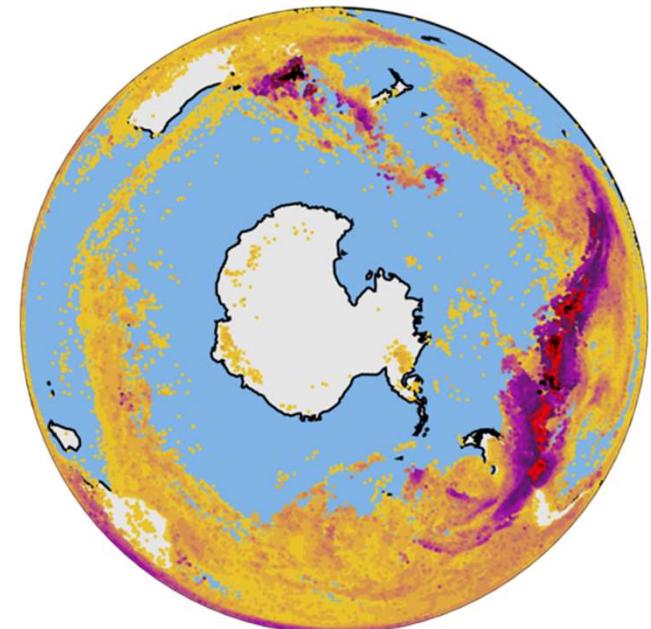
2020 01 05-07



2020 01 08-10



2020 01 14-16



Credit M. George/ C. Clerbaux (LATMOS)



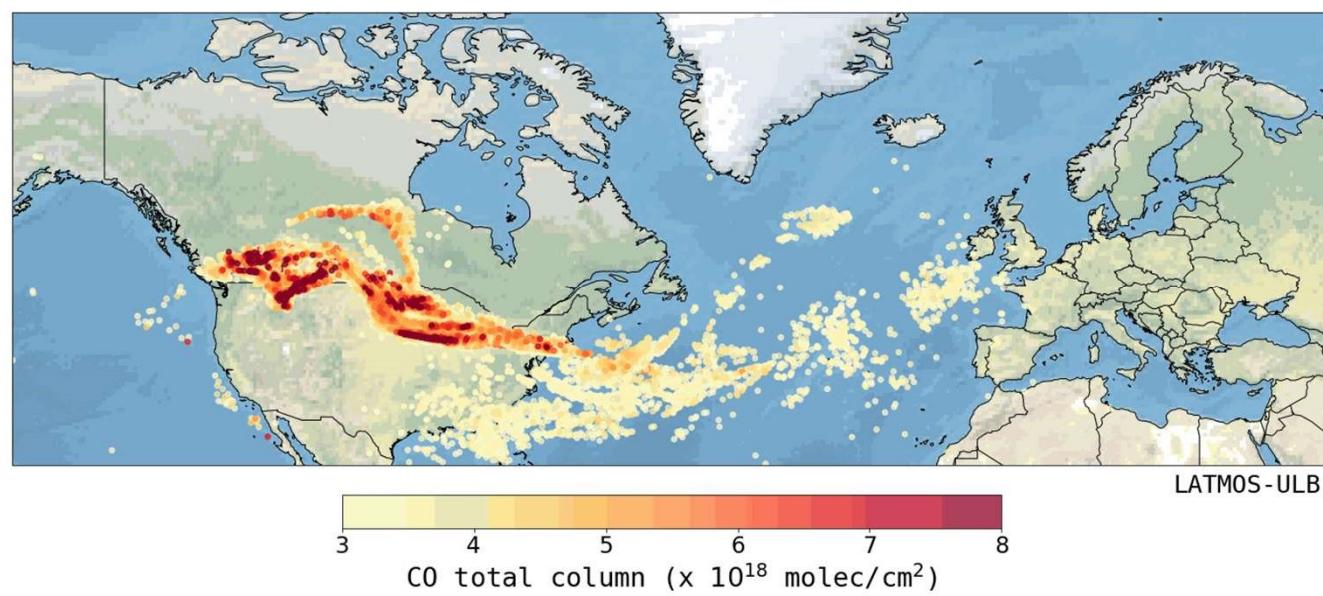
May – sept 2023 : Canada

(232 000 people moved)

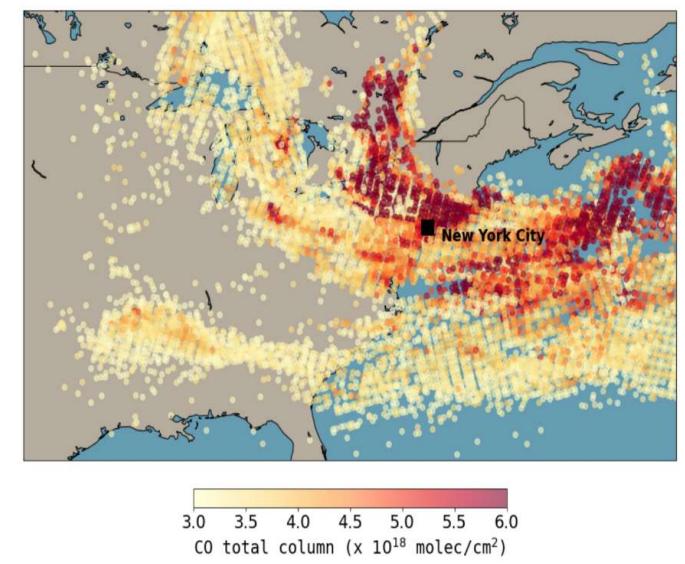




IASI/Metop B+C - 2023/05/16



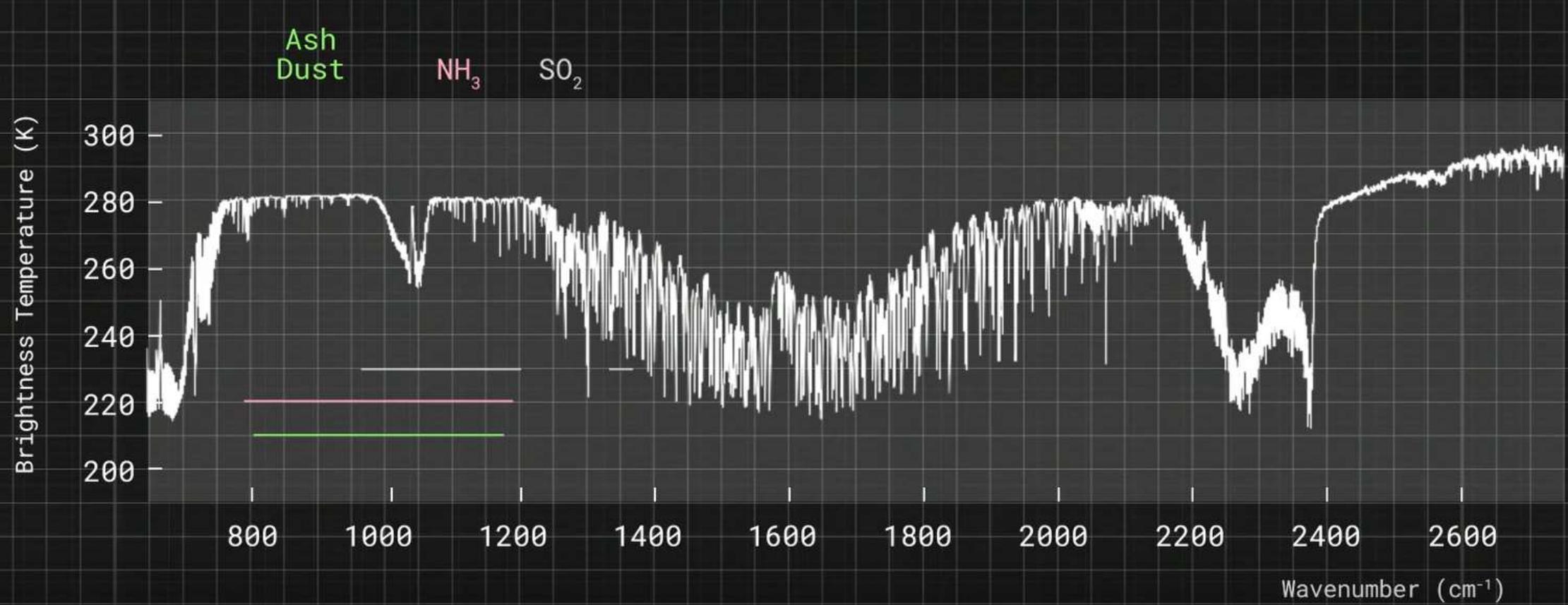
IASI/Metop B+C - 2023/06/07



Credit V. Jacquet/ C. Clerbaux (LATMOS)







Volcanic ash damages the aircraft engines

DEPARTURES

Time	Destination	Flight	Gate	Remark
16:55	FRANKFURT	LH4809		DUE TO VOLCANIC ASH
17:10	ZURICH	LX465		DUE TO VOLCANIC ASH
17:10	EDINBURGH	BA8712		CANCELLED
17:20	DUBLIN	AF5119		CANCELLED
17:35	AMSTERDAM	VG240		CANCELLED
17:35	EDINBURGH	AF5165		DUE TO VOLCANIC ASH
17:45	NANTES	AF5209		DUE TO VOLCANIC ASH
17:50	ROTTERDAM	VG290		CANCELLED
17:50	AMSTERDAM	VG240		DUE TO VOLCANIC ASH
17:50	MILAN/LINATE	AP4219		CANCELLED
18:00	EDINBURGH	BA8708		CANCELLED
18:05	ANTWERP	AF5237		DUE TO VOLCANIC ASH
18:10	GLASGOW	BA8728		CANCELLED
18:20	ROTTERDAM	VG292		DUE TO VOLCANIC ASH
18:20	ZURICH	LX467		DUE TO VOLCANIC ASH
18:20	PARIS - ORLY	AF5027		CANCELLED
18:30	COPENHAGEN	QI3626		CANCELLED

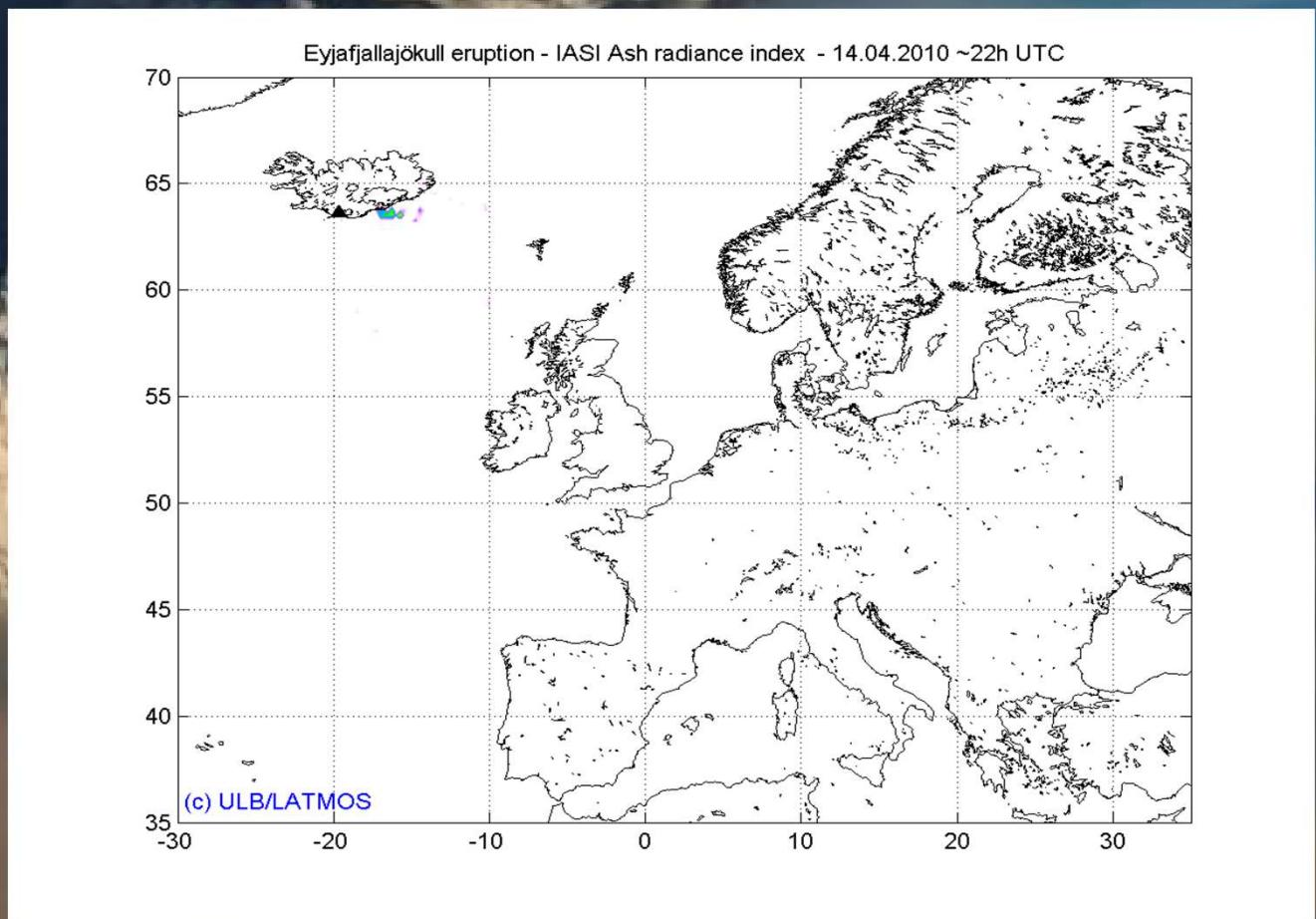
Som : Thursday 15 April 2010



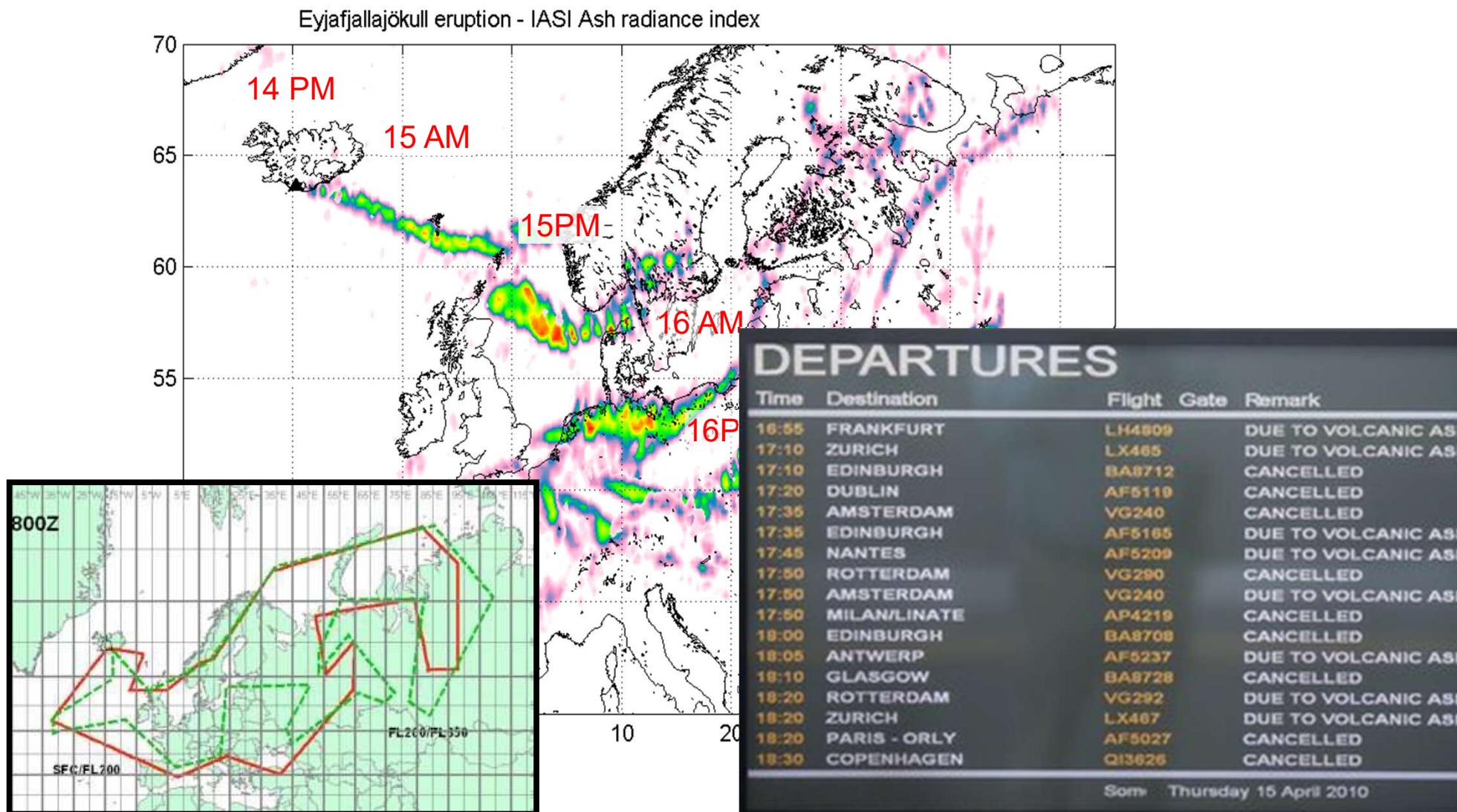
Eyjafjallajökull (2010)

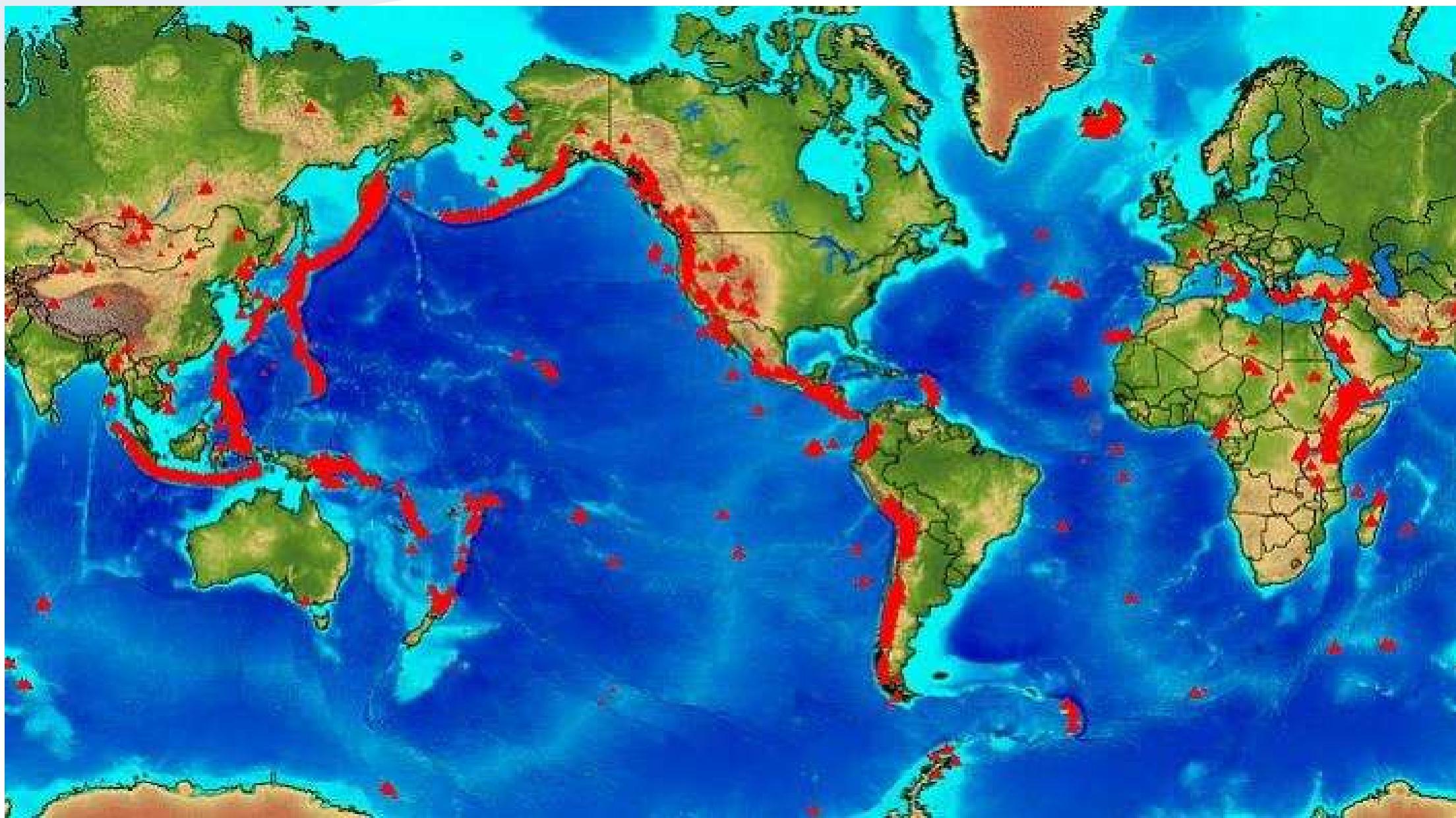
Crédit : RFI

Eyjafjallajökull (2010)



Eruptions volcaniques : Eyjafjöll avril-mai 2010





Vol BA 009 – 24 juin 1982



**ALL IN ALL, THE CREW EXPECTED AN
UNEVENTFUL 5-HOUR FLIGHT**

BRIGHT
SIDE





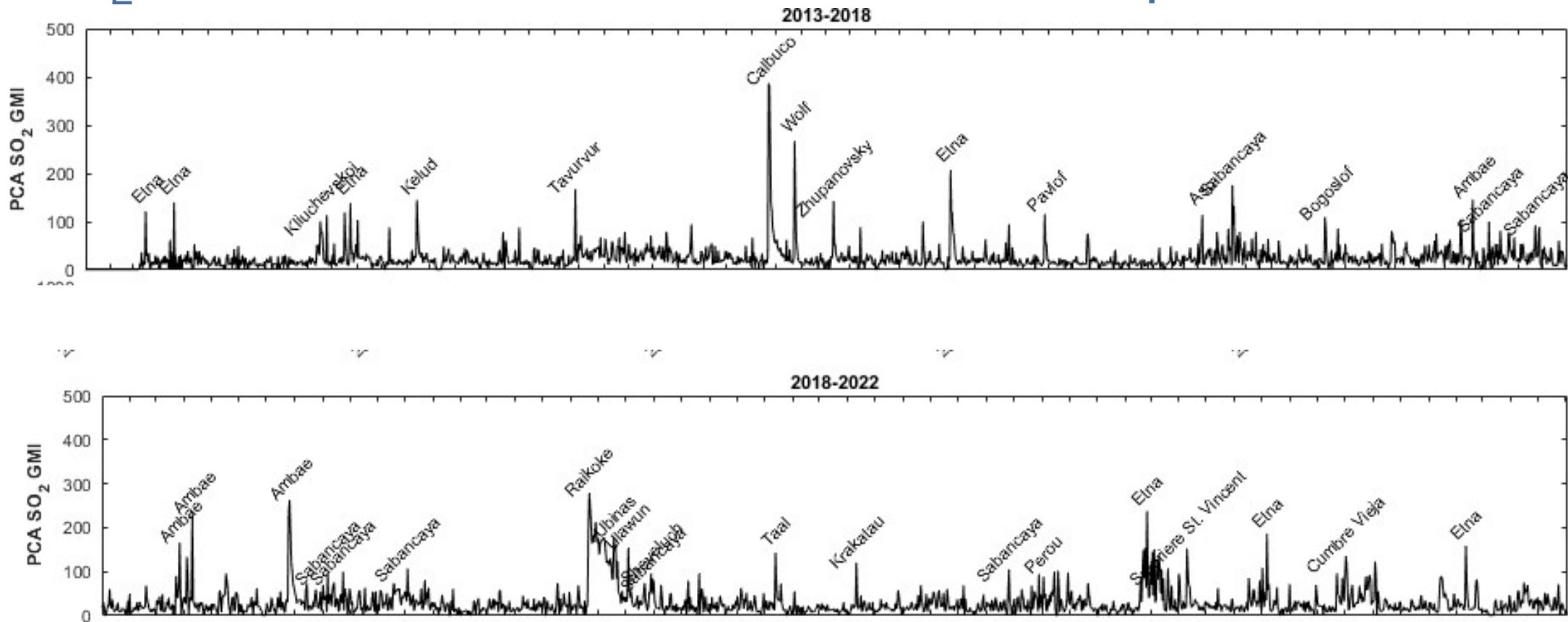
BRIGHT
SIDE



Volcanic Ash Advisory Centres



SO_2 IASI-B, excess due to volcanic eruptions



Crédit Adrien Vu Van (LATMOS)



Objet Automated SO2 Alert - Extended version 20250513.020232

De HURTMANS Daniel <Daniel.Hurtmans@ulb.be> 

Date 2025-05-13 06:03

Maximum Brightness Temperature difference:

=====

Location	> 122.929 8.61969
Value	> 32.1003 K
#Pixels above threshold	> 13

Maximum Partial Column:

=====

Location	> 123.467 10.6762
Value	> 17.3336 DU at 10 km
#Pixels in plume	> ~28

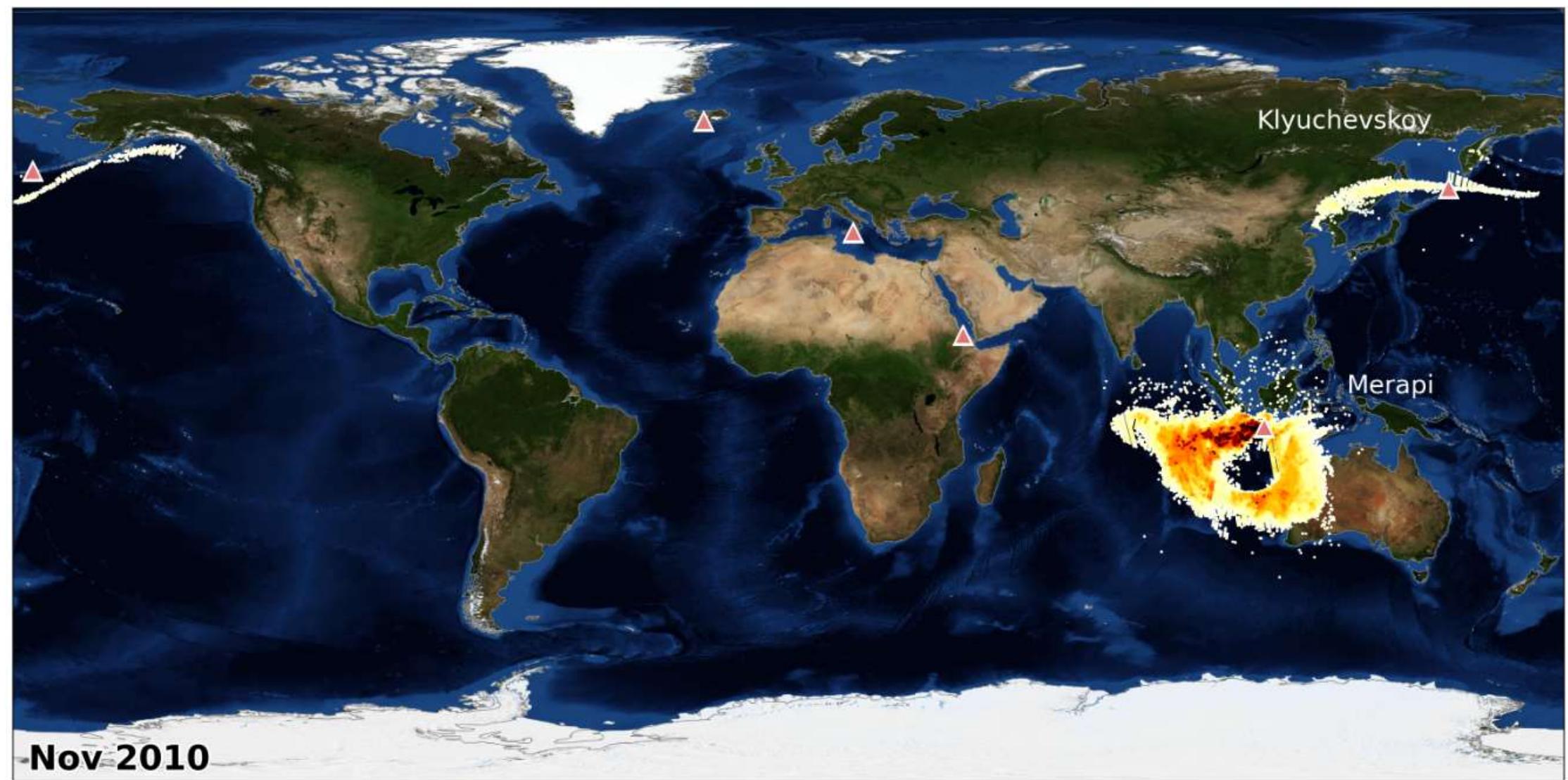
File > W_XX-EUMETSAT-

Darmstadt,SOUNDING+SATELLITE,METOPC+IASI_C_EUMR_20250513015959_33799_eps_o_l1.bin

Link: > https://cpm-ws4.ulb.ac.be/Alerts/index.php?NewYear=2025&NewMonth=05&sel_day=13&AlertList=SO2_iasi_20250513_015959_metopc_33799_eps_o.png



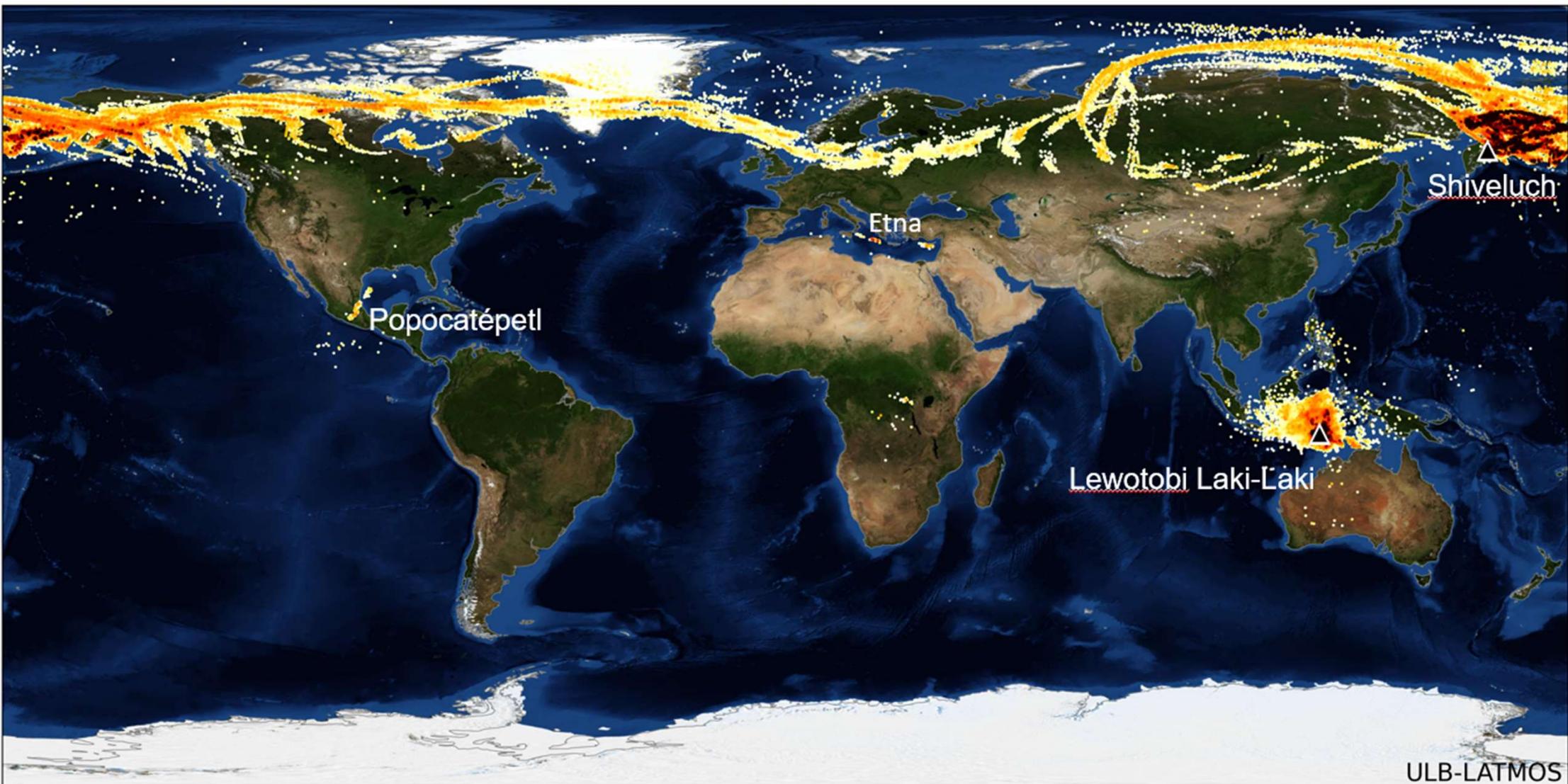
SO₂ volcanic plumes - IASI/Metop



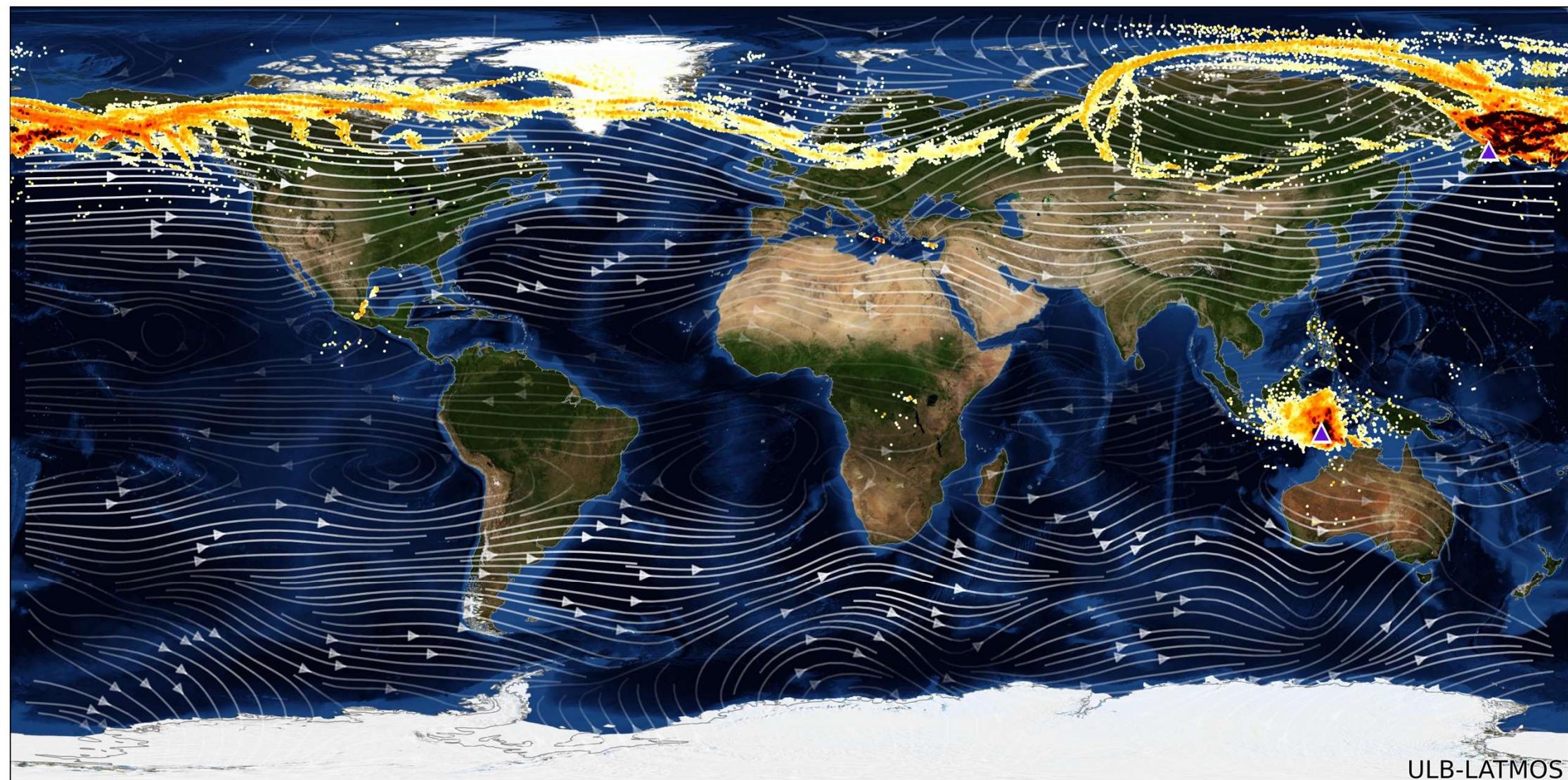
Nov 2010

ULB-LATMOS

SO₂ volcanic plumes - IASI/Metop



SO₂ volcanic plumes - IASI/Metop



ULB-LATMOS

A photograph of a volcanic eruption at Hunga-Tonga Island. A massive, dark plume of smoke and ash rises from the center of the island, which is partially submerged in the ocean. The sky is overcast and grey. In the distance, another small, dark rock formation is visible on the left.

Hunga – Tonga Island
(01/2022)

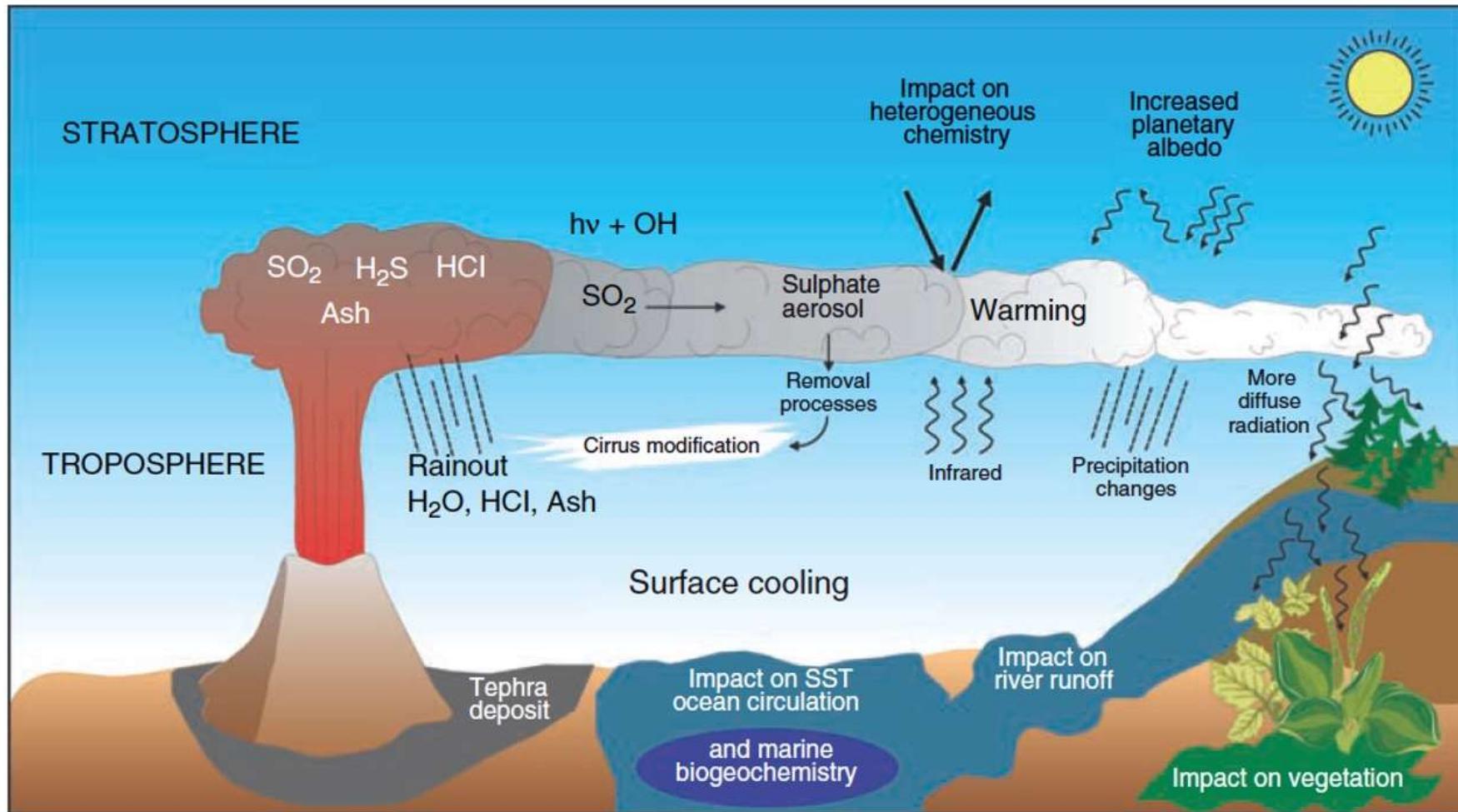
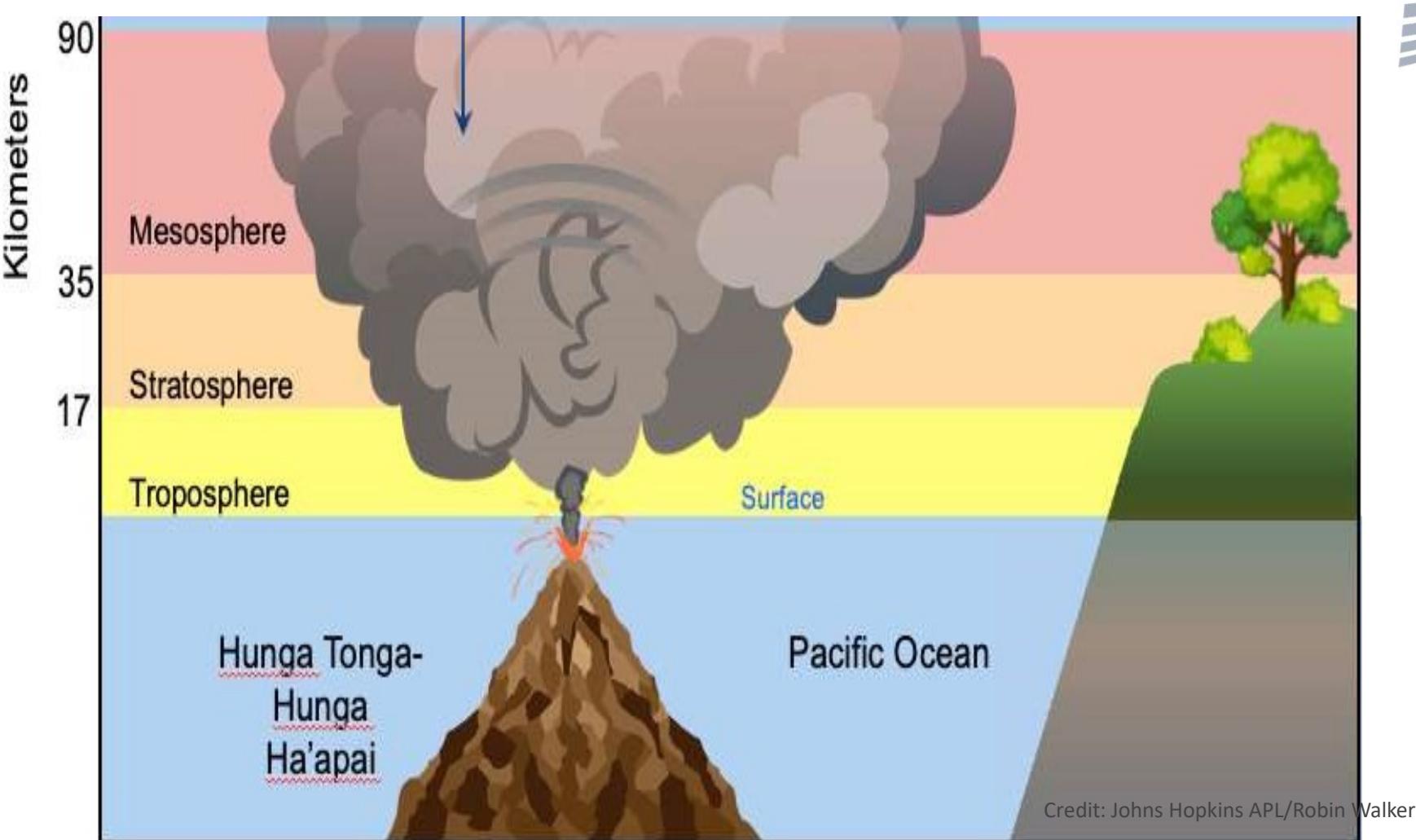


Figure 1: Schematic diagram illustrating influences from volcanic aerosol on stratospheric chemistry and climate
(from Timmreck, 2012 *WIREs Clim Change* 2012, 3:545–564. <https://doi.org/10.1002/wcc.192>)

Introduction



Temperatures

$\text{SO}_2/\text{H}_2\text{SO}_4$
 H_2O
Ozone

Day1
Day90
Day365>



January 15, 2022

DAY 1 Honga Tunga

Objet Automated SO2 Alert - Extended version 20220113.214536

De Automated SO2 Alert <daniel.hurtmans@ulb.be>

À Undisclosed recipients:

Date 2022-01-14 00:42

Maximum Brightness Temperature difference:

```
=====
Location      > -177.221 -20.2703
Value         > 9.30142 K
#Pixels above threshold > 22
```

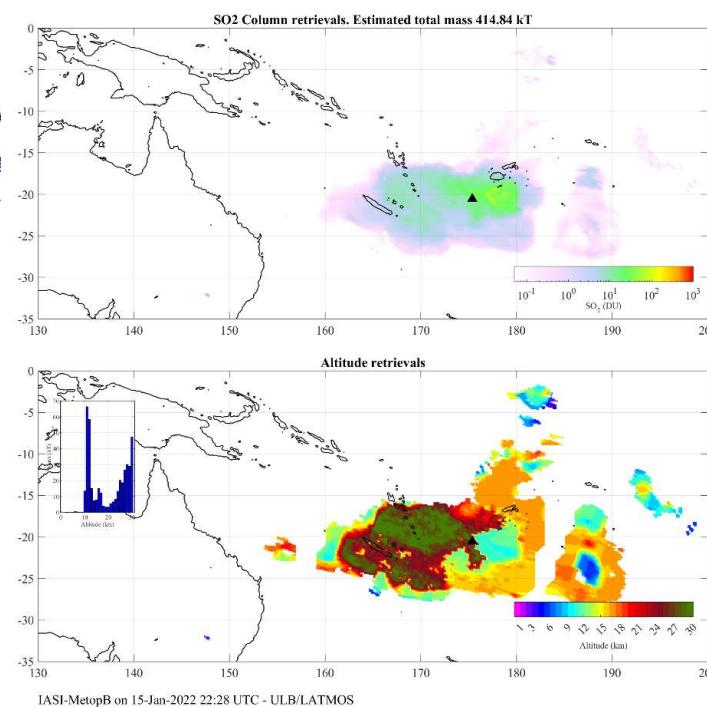
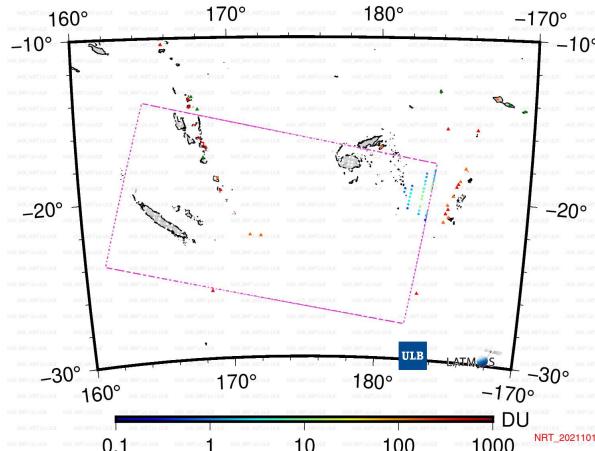
Maximum Partial Column:

```
=====
Location      > -176.498 -19.1573
Value         > 12.0275 DU at 15 km
#Pixels in plume > ~47
```

File > W_XX-EUMETSAT-Darmstadt,SOUNDING+SATELLITE,METOPC+IA

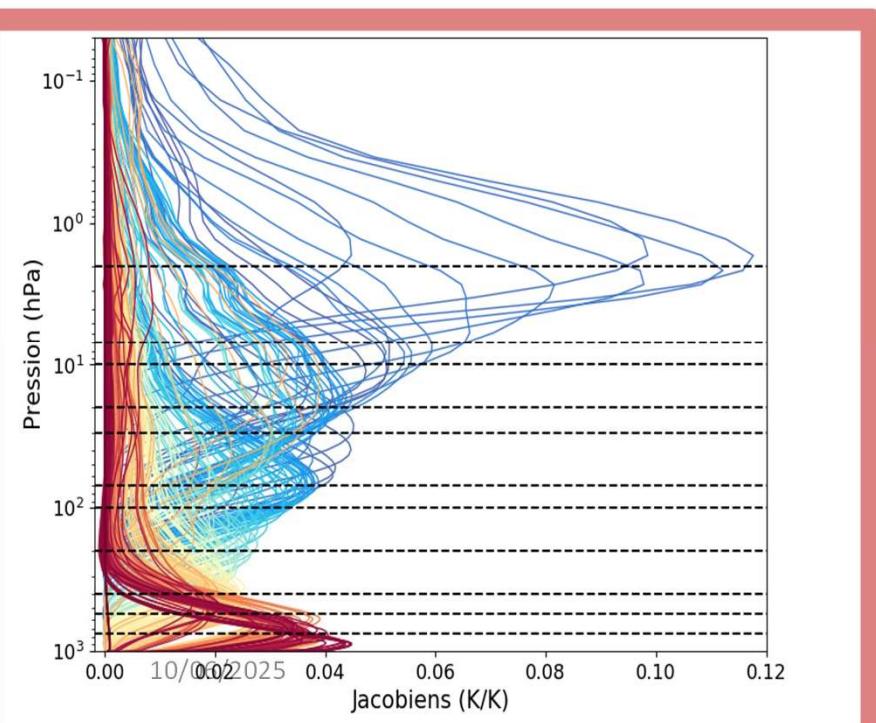
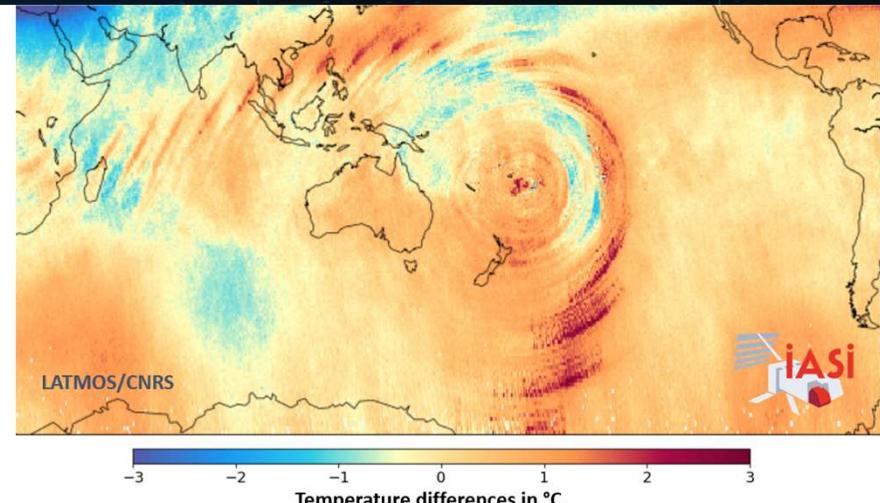
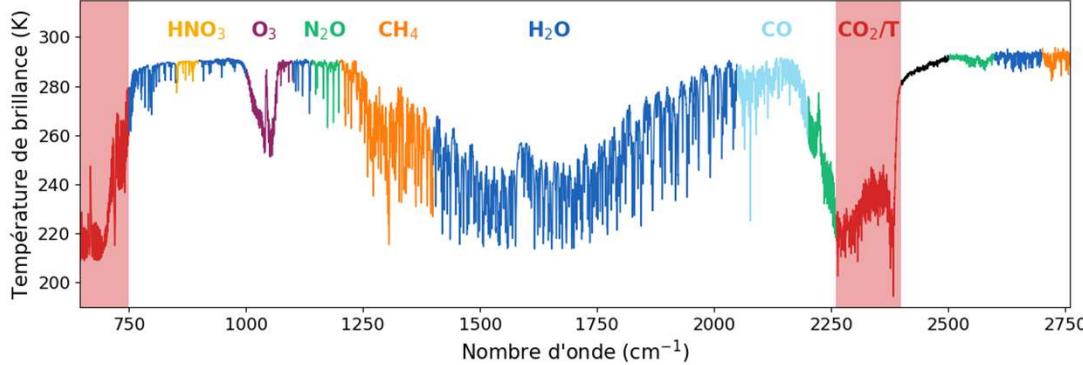
Link: > http://cpm-ws4.ulb.ac.be/Alerts/index.php?NewYear=2022&NewMonth=01&sel_day=13&AlertList=SO2_iasi_20220113

SO₂ Alert 20220113.214456 (c 16535) PC

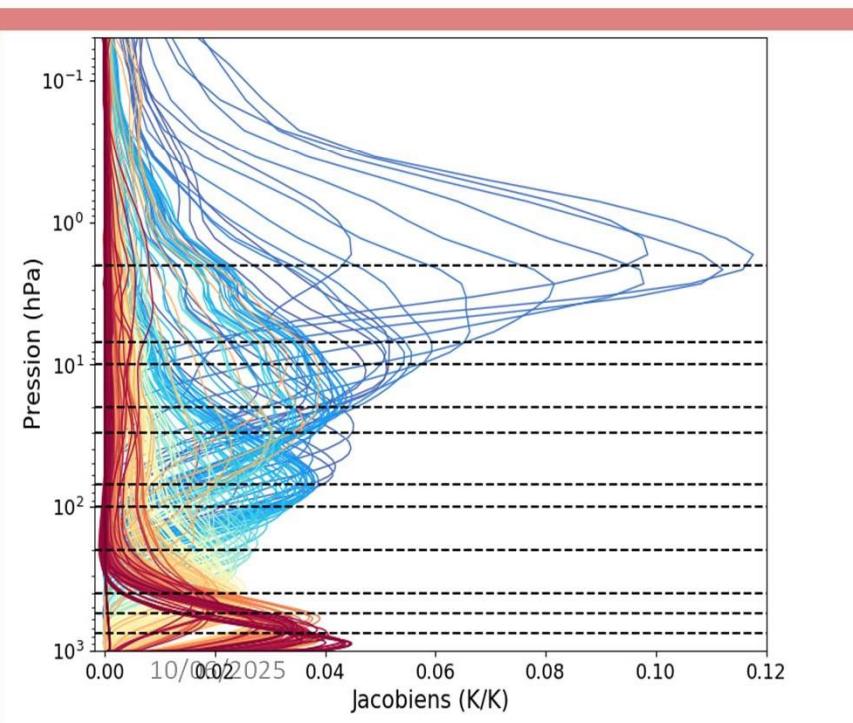
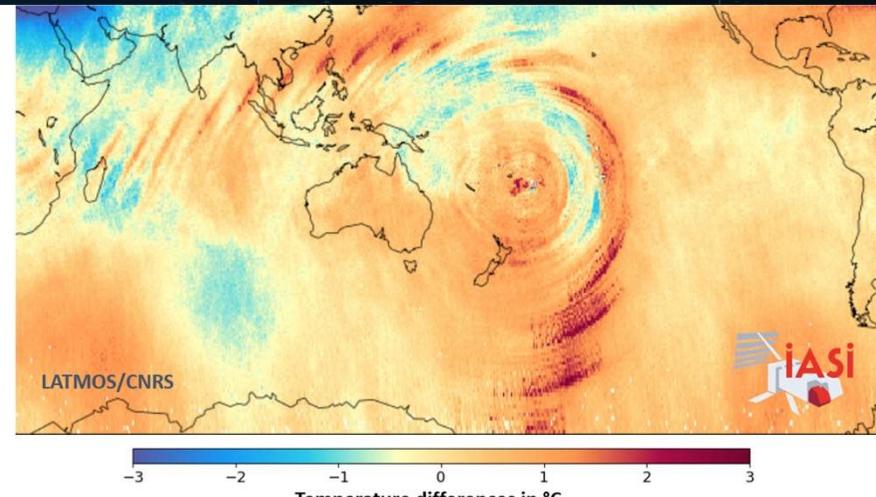
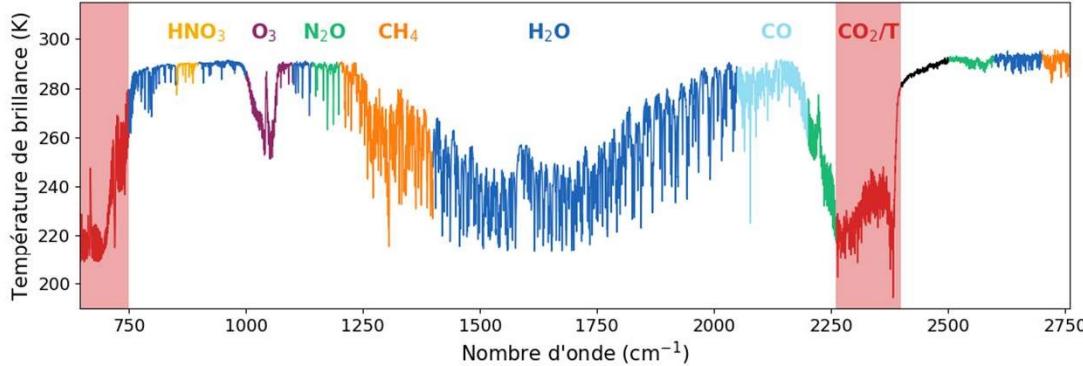


Courtesy Mathew Barlow (University of Massachusetts Lowell). Images taken by NOAA's GOES-West satellite (BT band 13, IR)

DAY 1 IASI spectra > Temperatures



DAY 1 IASI spectra > Temperatures



Stratospheric AIRS, CrIS and IASI observations show **wave activity across a range of spatial**, frequency and amplitude scales throughout the Pacific basin, all centred on Hunga Tonga

Credit : Ambr Agency

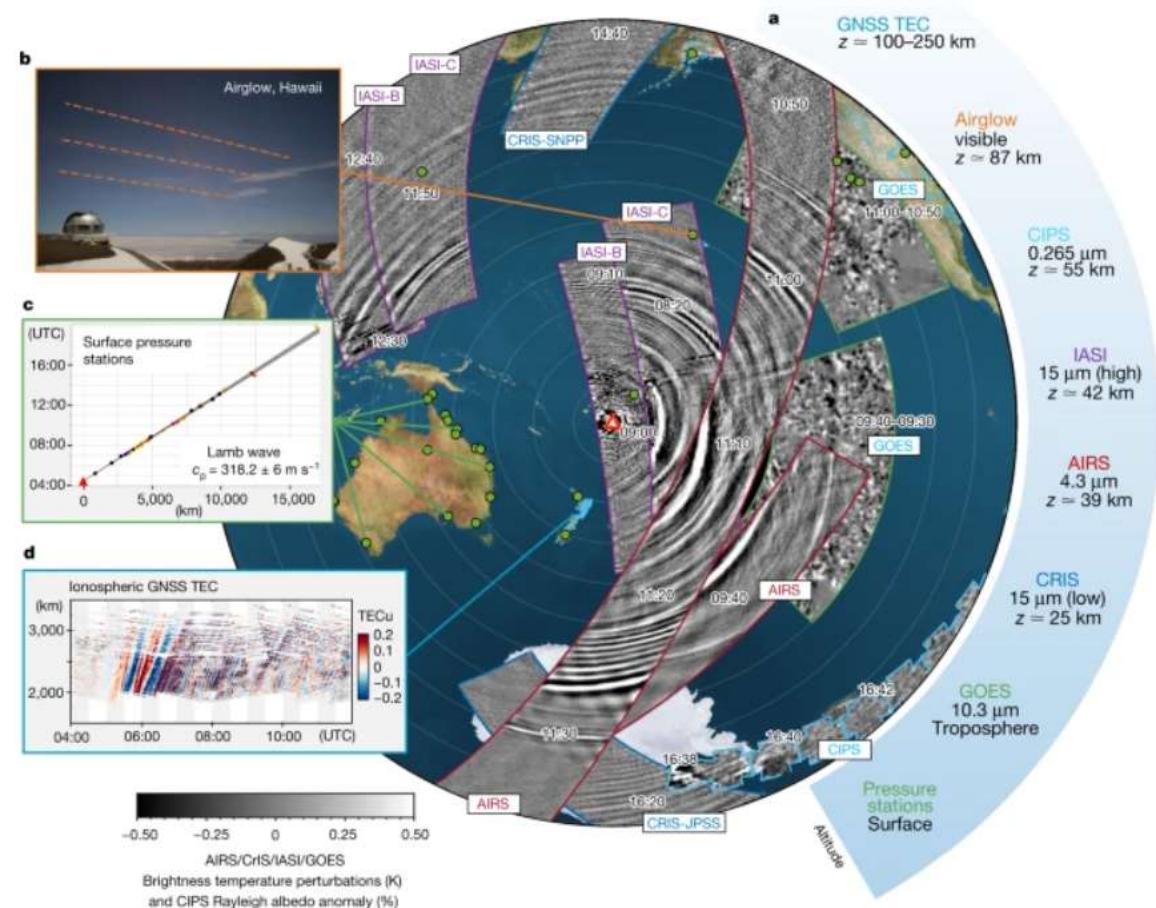


Article | Open Access | Published: 30 June 2022

Surface-to-space atmospheric waves from Hunga Tonga–Hunga Ha'apai eruption

Corwin J. Wright✉, Neil P. Hindley, M. Joan Alexander, Mathew Barlow, Lars Hoffmann, Cathryn N. Mitchell, Fred Prata, Marie Bouillon, Justin Carstens, Cathy Clerbaux, Scott M. Osprey, Nick Powell, Cora E. Randall & Jia Yue

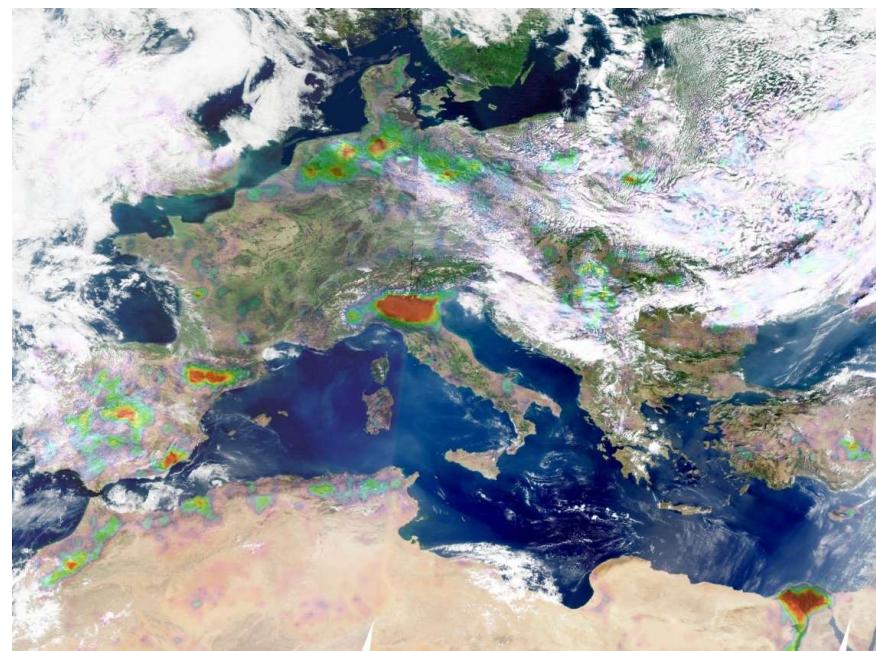
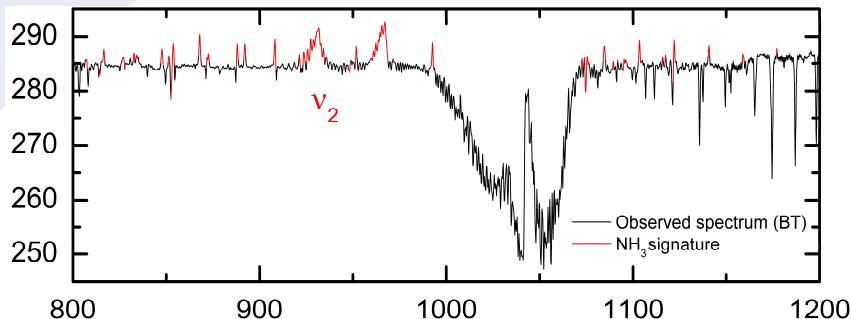
Fig. 2: Initial gravity wave and Lamb wave propagation at all heights.



Agriculture : fertilizers / animal farming
Ammonia (NH_3)



A small unexpected signature...

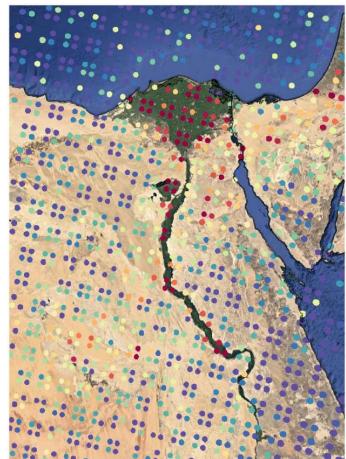


Clarisse et al., *Nature Geo* 2009

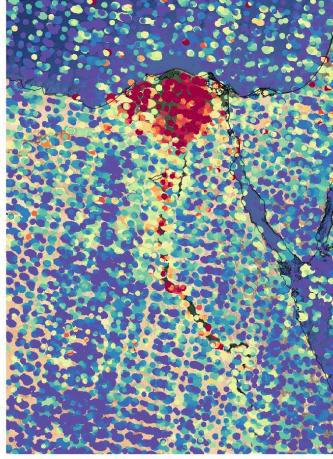




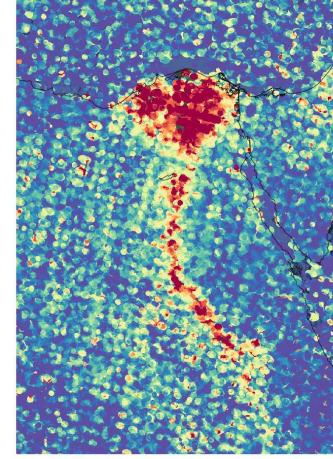
Infrared retrievals – Ammonia (NH_3)



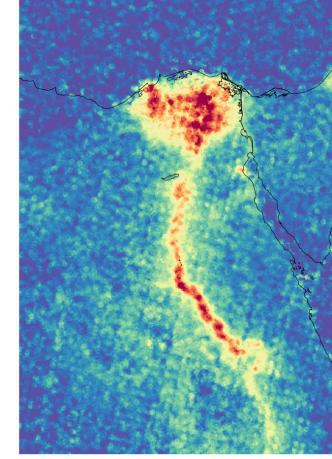
1 day



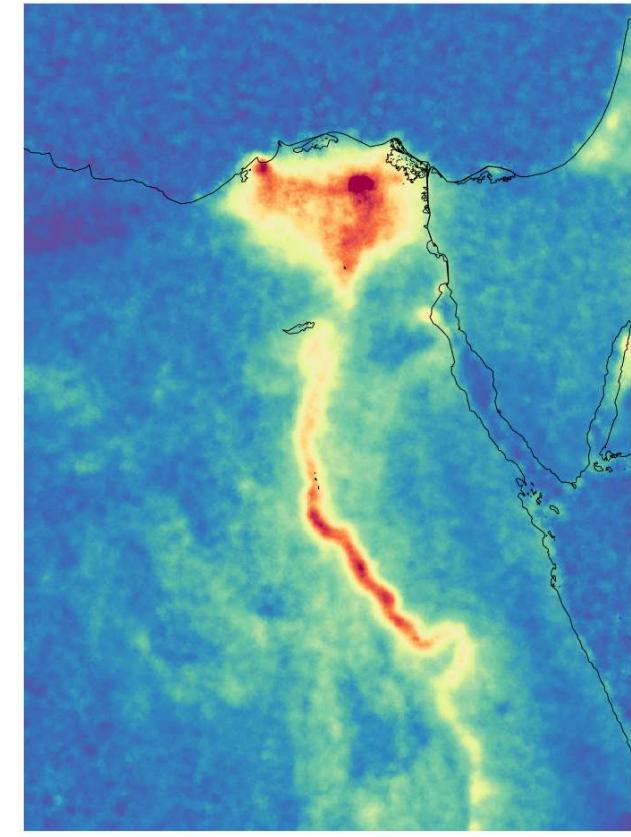
1 week



1 month



1 year

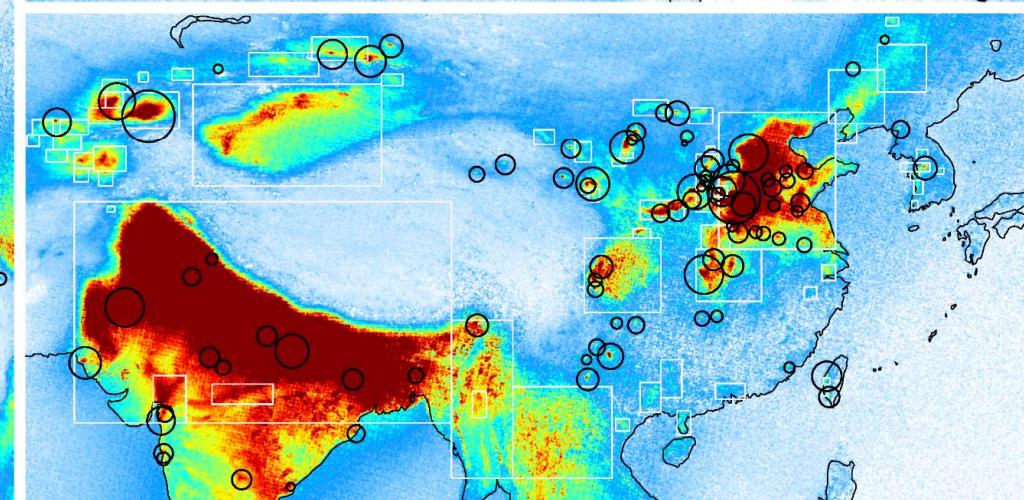
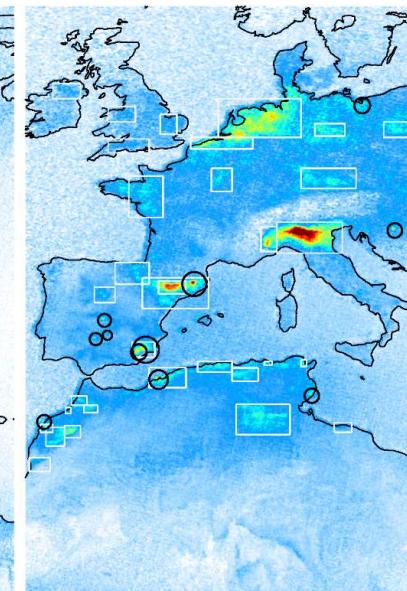
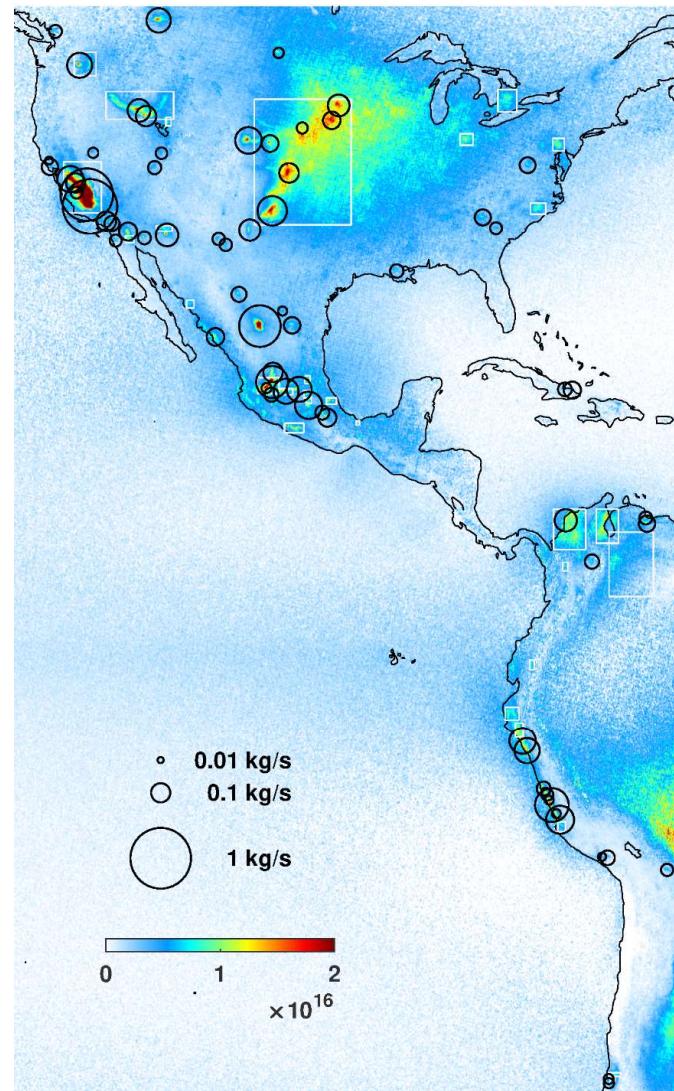


10 years

IASI-NH₃

(1 km²) distribution:

- >240 hotspots
- (+ >170 source regions)
- 3 classes:
 - Agriculture (83)
 - Industries (158)
 - Naturelle (1)

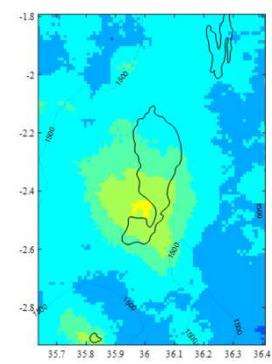
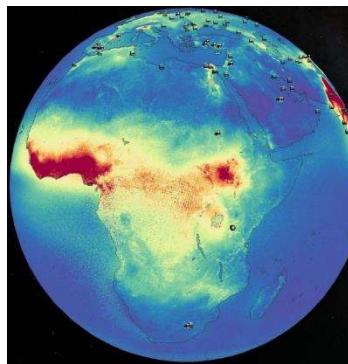
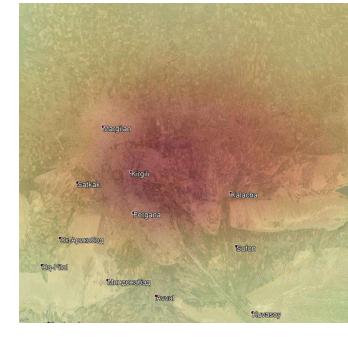
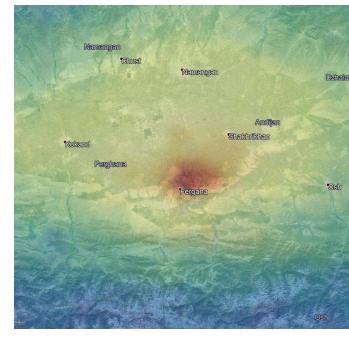
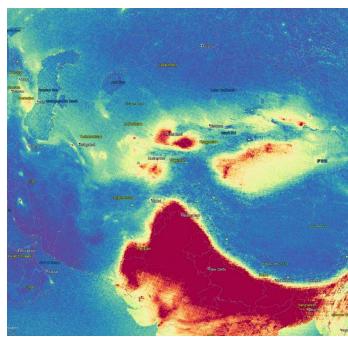
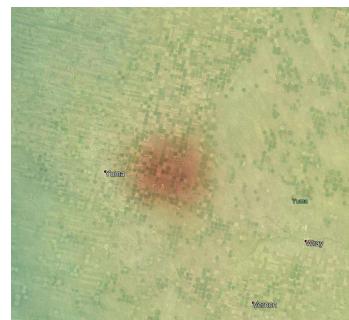
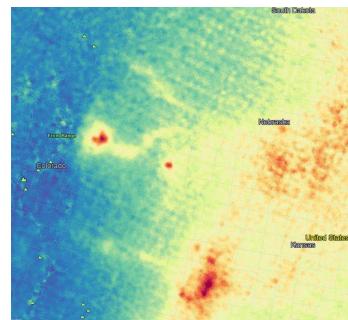
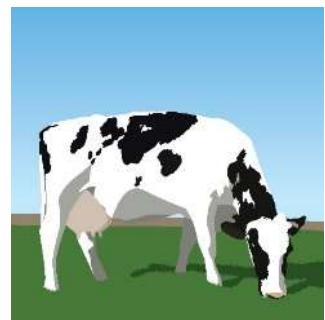


Letter | Published: 05 December 2018

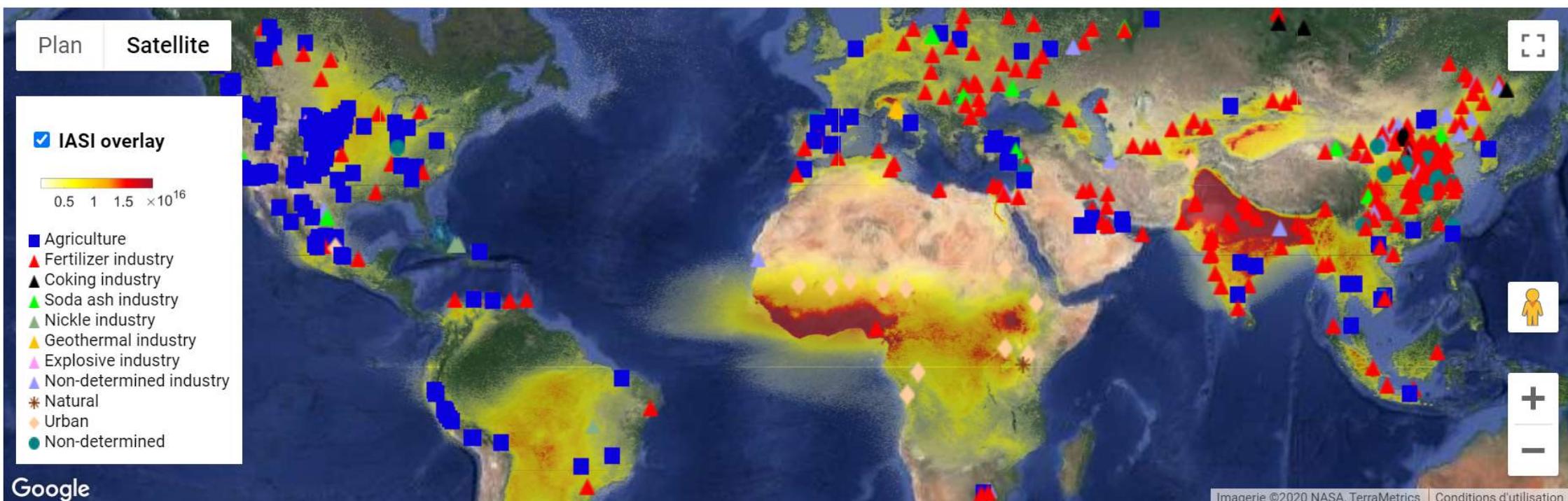
Industrial and agricultural ammonia point sources exposed

Martin Van Damme, Lieven Clarisse, Simon Whitburn, Juliette Hadji-Lazaro, Daniel Hurtmans, Cathy Clerbaux & Pierre-François Coheur

Ammoniac (NH_3) sources



Ammonia (NH_3)



Global ammonia point sources as seen by IASI satellite instruments

<https://www2.ulb.ac.be/cpm/NH3-IASI.html>

Van Damme, M., Clarisse, L., Whitburn, S., Hadji-Lazaro, J., Hurtmans, D., Clerbaux, C., Coheur, P.-F. **Industrial and agricultural ammonia point sources exposed.** *Nature* **564**, 99-103, doi: [10.1038/s41586-018-0747-1](https://doi.org/10.1038/s41586-018-0747-1), 2018



A photograph of a large, blue-painted industrial pipeline stretching across a dry, arid landscape. The pipe is shown from a low angle, curving from the bottom left towards the center. In the background, there are rolling hills and mountains under a bright blue sky with scattered white clouds.

Gas leaks, C_2H_4

Infrared retrievals – Ethylene (C_2H_4)



[nature](#) > [nature communications](#) > [articles](#) > [article](#)

Article | [Open Access](#) | Published: 28 October 2022

Ethylene industrial emitters seen from space

Bruno Franco Lieven Clarisse, Martin Van Damme, Juliette Hadji-Lazaro, Cathy Clerf, François Coheur

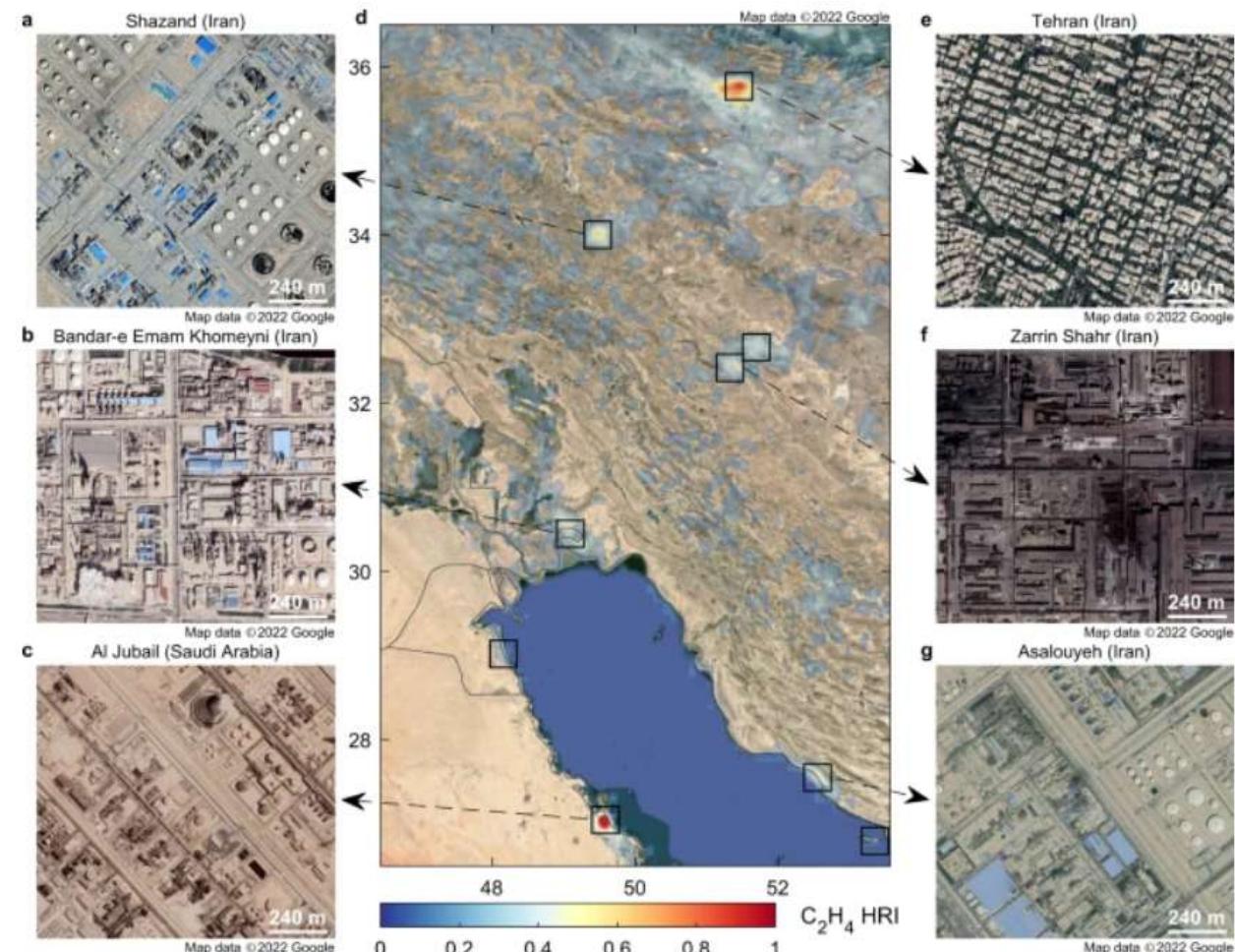
[Nature Communications](#) 13, Article number: 6452 (2022) | [Cite this article](#)

1573 Accesses | 1 Citations | 2 Altmetric | [Metrics](#)

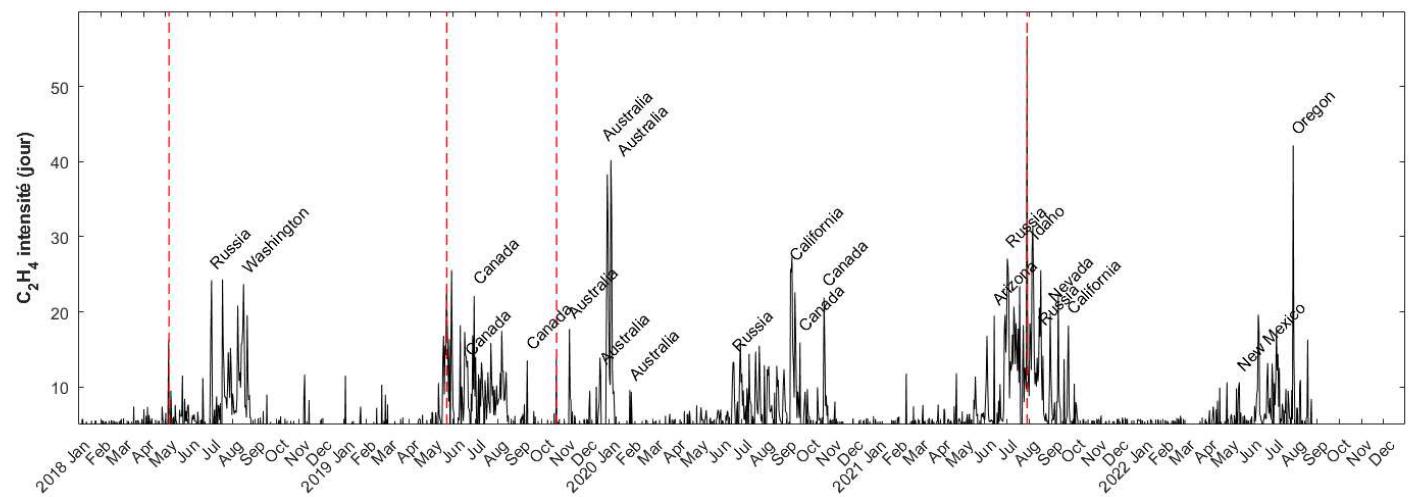
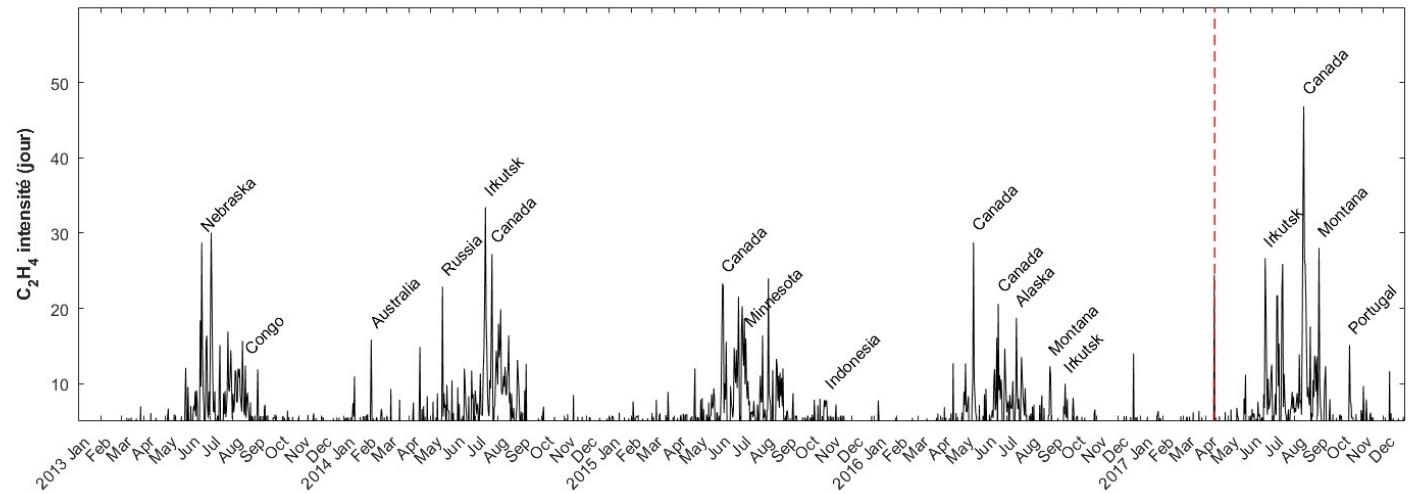
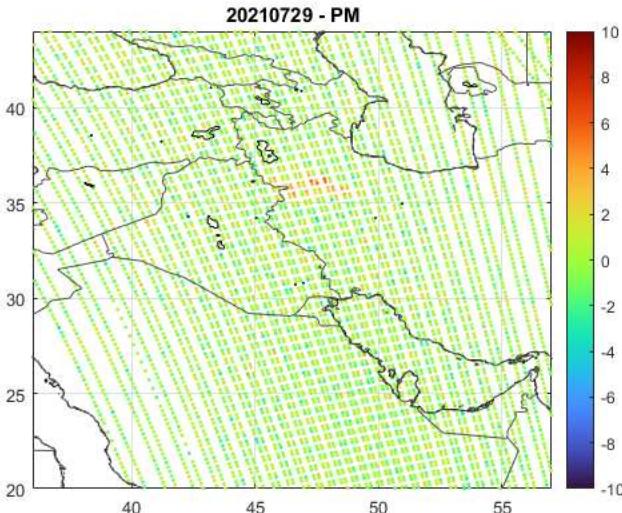
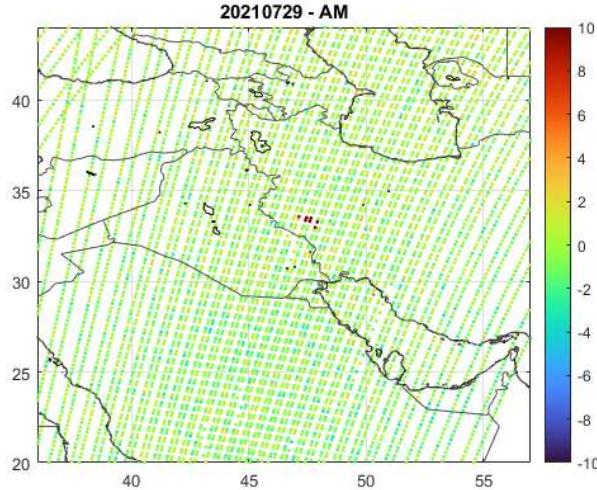
d Zoom-in of the C_2H_4 HRI from the 13-year IASI average superimposed on satellite visible imagery, over Iran and the Persian Gulf.

Hotspots of ethylene are indicated with black squares.

a–c, e–g Examples of close-up views on point-source emitters.

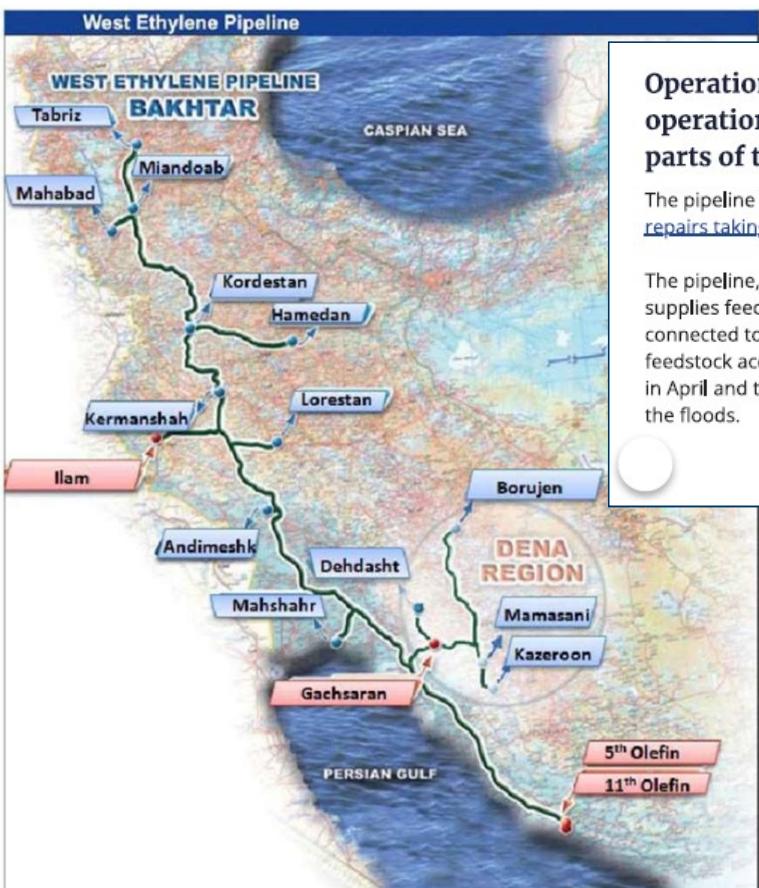


Infrared retrievals – Ethylene (C_2H_4)



A. VuVan/C. Clerbaux (LATMOS)

Industrially produced ethylene is transported from one petrochemical site to another, via the West Ethylene Pipeline (WEP), launched in 2012, which crosses western Iran from north to south, carrying ethylene from various petrochemical sites to the main ports on the Persian Gulf!



Operations at Iran's West Ethylene Pipeline are now operational two months after damaging floods hit parts of the country.

The pipeline was damaged at the end of March following the floods, with [repairs taking longer than expected](#) as flood waters took time to fully subside.

The pipeline, which runs from the Mideast Gulf port of Assaluyeh to Mahabad, supplies feedstock to several polymer plants in Iran. Polyethylene (PE) plants connected to the pipeline are now starting to produce polymers with their feedstock access restored. The PE plants ran at extremely low operating rates in April and temporarily stopped production in the immediate aftermath of the floods.



<https://en.shana.ir/news/265536/>
News ID 24 July 2016 - 06:59
265536
Petrochemical

شبکه اطلاع رسانی
نفت و انرژی

“External Factors Caused West Ethylene Pipeline Blaze”

TEHRAN, July 24 (Shana) — Deputy Managing Director of National Iranian Petrochemical Company Abdolhossein Bayat said on Saturday that external factors were responsible for leakage in West Ethylene Pipeline and the fire as a result.

Talking to Shana Bayat said the cause of fire will of course be revealed after collection of evidence and information and once reconstruction operations are complete.

Immediately after the incident, the HSE and other officials showed up in the area and tried to scale down damage and contain fire and it was over shortly in a matter of several hours, according to Bayat.

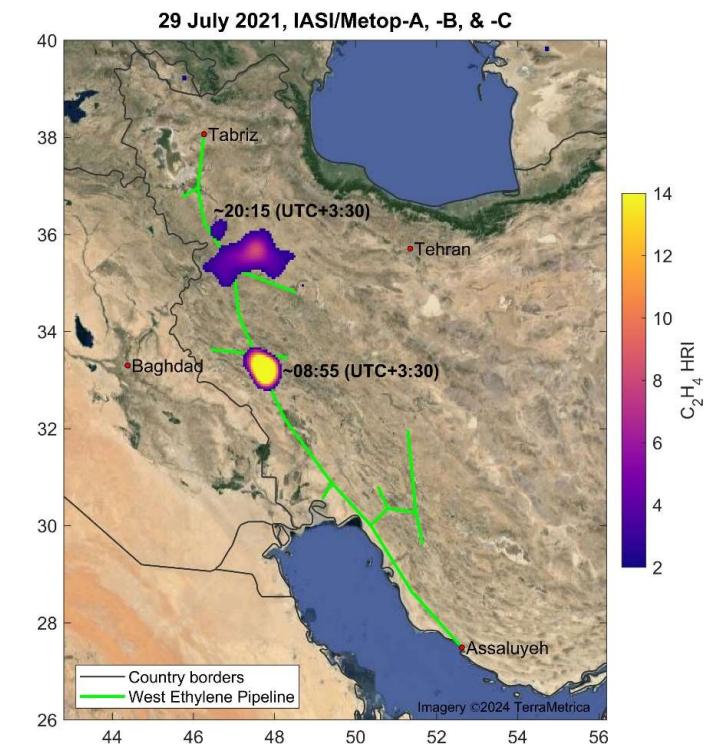
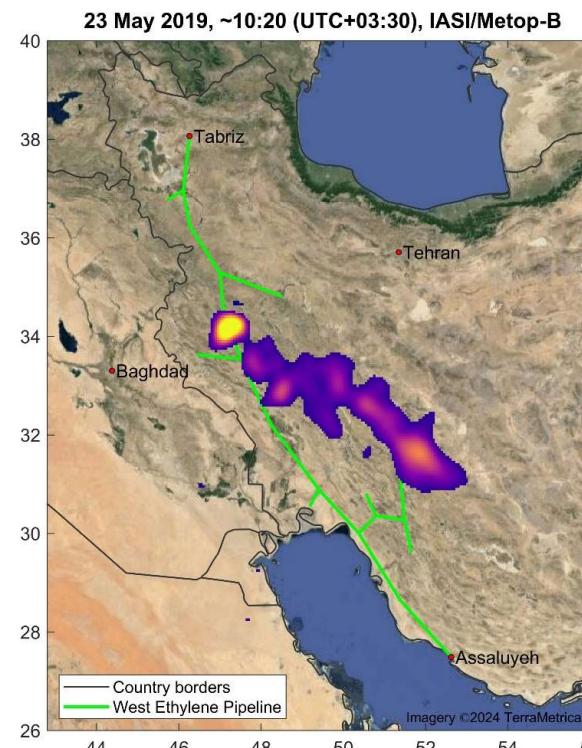
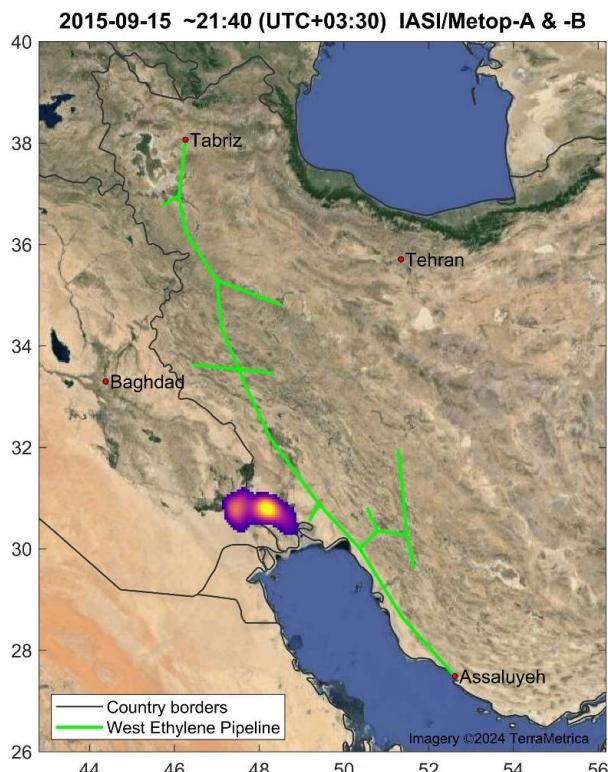
“The super ethylene could spread to other regions unwanted and cause unexpected events and fortunately through hard work and endeavors of colleagues the fire was checked,” he added.

He said repair and reconstruction operations on the pipeline are still going on and the pipelines are replaced. Bayat said the incident had left four injured, who are being treated.

On feedstock supply cut to petrochemical facilities in the periphery, he said there will be efforts to resume the flow as soon as possible.



Important leaks of C_2H_4 from the area where the WEP stands



B. Franco/L. Clarisse/C. Clerbaux (ULB-LATMOS)

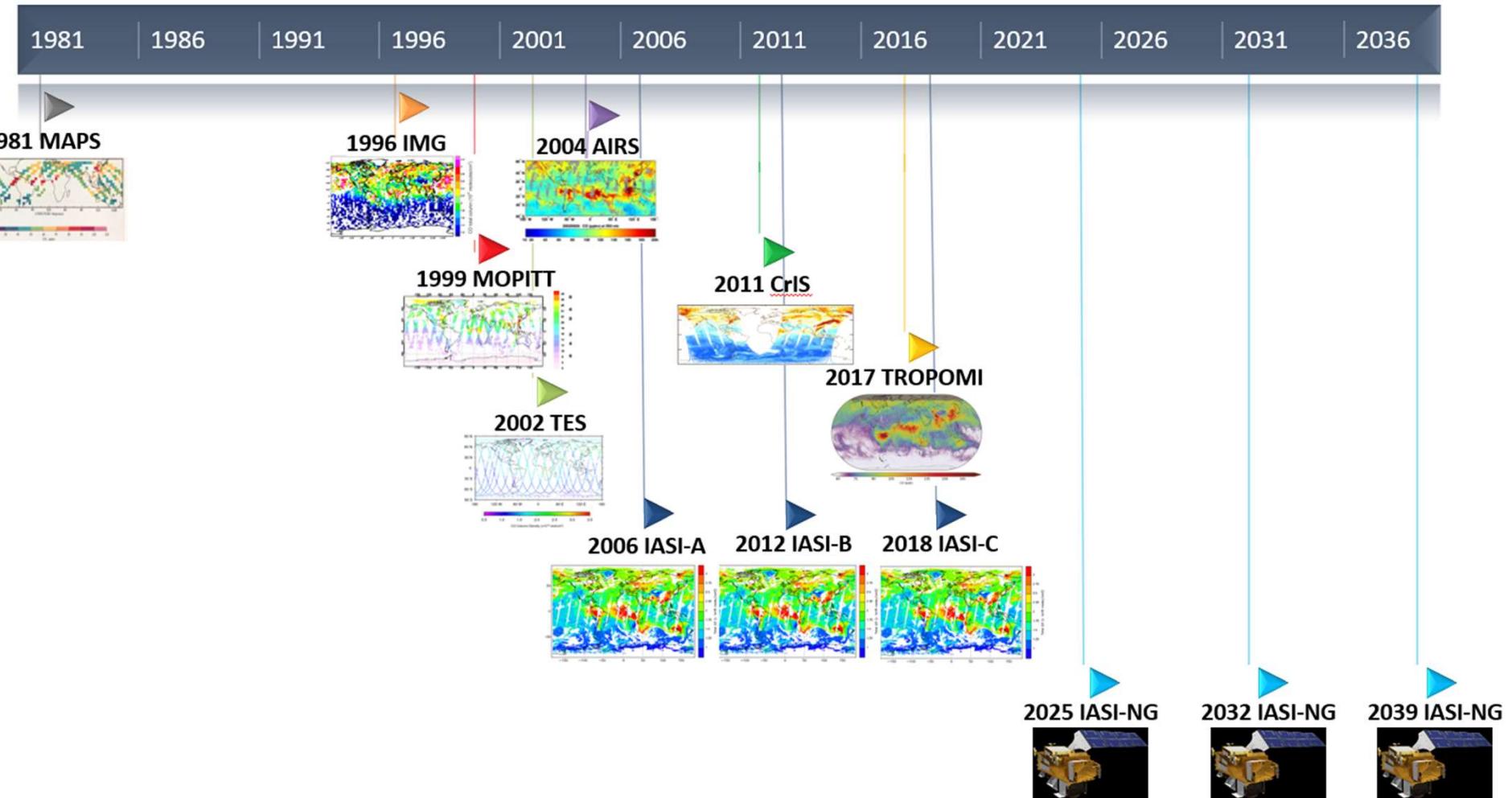
Summary



- IASIx3 has been sounding the atmosphere since early 2007
- 33 infrared absorbing gas have been detected
- CO, O₃/HNO₃, SO₂, HCOOH, NH₃ are retrieved in NRT and further distributed
- Fire and volcano alerts are delivered
- Trends can be generated (China : less CO and SO₂, more NH₃)



CO observations from space



IASI (Metop-A, -B & -C) >What's next ?

- EUMETSAT's MTG-S1 satellite, the first European geostationary satellite to carry an infrared sounder (**IRS**), will be launched by a SpaceX Falcon 9 rocket in July.



The Metop-SG satellite (second generation) will launch the **IASI-NG sounder** in August, with Ariane 6 from French Guiana. IASI-NG offers 2x better spectral and radiometric performance than IASI (> higher vertical resolution and greater accuracy).



How to download IASI data from AERIS ?

Availability of the IASI products



AERIS IASI

DATA ACCESS QUICKLOOKS TIMELINE GALLERIES PUBLICATIONS COVID-19 CONTACT Admin

IASI PORTAL
Atmospheric composition data products

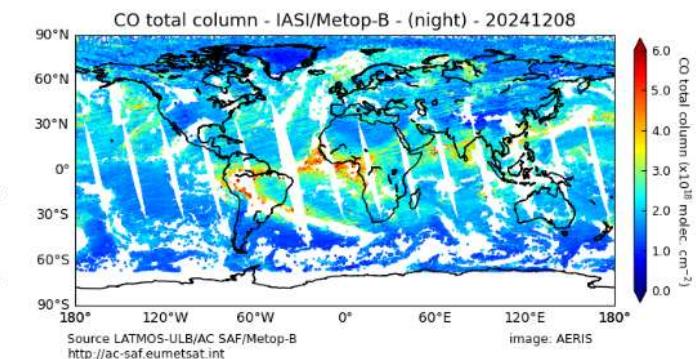
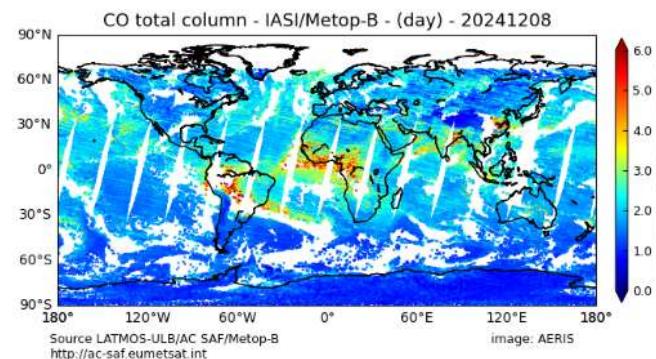
CO, O₃, SO₂, NH₃ + dust
NRT-same day

SST, Cloud,
CO₂, CH₄,
δD, HCOOH

CO total column from IASI (Level 2)

Satellite : Metop-B Domain : Global Level: L2

Date : < 2024-12-08 >



[IASI/Metop-B data access](#)



AERIS IASI portal (<https://iasi.aeris-data.fr/>)

The screenshot shows the homepage of the AERIS IASI portal. At the top, there are navigation links for DATA ACCESS, QUICKLOOKS, TIMELINE, GALLERIES, PUBLICATIONS, COVID-19, CONTACT, and PUBLICATIONS. On the right, there is an Admin link. The main banner features a satellite in space with Earth in the background, and several spherical maps of Earth showing atmospheric composition data. The text "IASI PORTAL" and "Atmospheric composition data products" is displayed. Below the banner, there is a section titled "Antarctic Ozone Hole" showing monthly average ozone hole images from 2008 to 2024. To the right, there is a "Welcome to the IASI Portal!" section with information about the data products and quicklook images. At the bottom, there is a "Highlights" section with three small image thumbnails.

IASI portal - Atmospheric comp... iasi.aeris-data.fr

AERIS IASI

DATA ACCESS QUICKLOOKS TIMELINE GALLERIES PUBLICATIONS COVID-19 CONTACT PUBLICATIONS Admin

IASI PORTAL

Atmospheric composition data products

Antarctic Ozone Hole
15 Sep. - 15 Oct. average

2008 2009 2010 2011 2012 2013

2014 2015 2016 2017 2018 2019

2020 2021 2022 2023 2024

ULB-LATMOS/AC SAF

IASI Ozone total column [DU]

Welcome to the IASI Portal!

The IASI Portal provides scientists with free and open access to atmospheric composition Level 2 data products retrieved from the IASI/Metop observations along with quicklook images for several species:

1. Level 2 data products
CO, O₃, HCOOH, NH₃, δD, SO₂, DUST-AOD, CH₄ & CLOUD
2. Quicklook images
Daily and monthly maps can be viewed on the global and continental scale

Highlights

HIGHLIGHT HIGHLIGHT HIGHLIGHT



Data access from Catalog page

To get information about all the IASI products available on AERIS

The screenshot shows the IASI Portal homepage. At the top, there is a navigation bar with links: CATALOG (highlighted with a red arrow), PRIVATE DATA (spirit users only), DATA ACCESS (highlighted with a red box), QUICKLOOKS, TIMELINE, GALLERIES, PUBLICATIONS, COVID-19, CONTACT, and PUBLICATIONS. Below the navigation bar is a large banner featuring a satellite in space and several Earth globes with atmospheric composition data. The text "IASI PORTAL" and "Atmospheric composition data products" is displayed. In the bottom left corner of the banner, there is a "SEARCH" icon. Below the banner, there is a section titled "Antarctic Ozone Hole" showing monthly average maps from 2008 to 2019. A color scale bar indicates ozone concentration in Dobson Units (DU) from 0 to 500.

Welcome to the IASI Portal!

The IASI Portal provides scientists with free and open access to atmospheric composition Level 2 data products retrieved from the IASI/Metop observations along with quicklook images for several species:

1. **Level 2 data products**
CO, O₃, HCOOH, NH₃, δD, SO₂, DUST-AOD, CH₄ & CLOUD
2. **Quicklook images**
Daily and monthly maps can be viewed on the [Quicklook page](#).



Data access from Catalog page

You can search for the data you need in the « Search » panel

The screenshot shows the IASI Data Access Catalog page. At the top, there are logos for AERIS and IASI. Below the header, there is a navigation bar with links: DATA ACCESS, QUICKLOOKS, TIMELINE, GALLERIES, PUBLICATIONS, COVID-19, CONTACT, and PUBLICATIONS. On the far right of the header, there is an Admin link and user icons.

The main area features a search panel on the left with a red border and an arrow pointing to it. The search panel includes a search bar with a magnifying glass icon, a 'RESET' button, and a large orange 'SEARCH' button. Below the search bar are dropdown menus for 'Temporal extent', 'Spatial extent', 'Parameters', and 'Levels'.

The central part of the page displays a list of 55 results under the heading 'METADATA'. Each result is a card with a title, a small thumbnail, and an 'IASI' badge. The titles include:

- Daily IASI+GOME2/Metop-B LISA ozone (O₃) L2 product (vertical profiles)
- Daily IASI/Metop-A LMD Dust-AOD and DUST-Mean Layer Altitude L2 product
- Daily IASI/Metop-A LMD carbon dioxide (CO₂) L2 product (mid tropospheric column) - Reanalysis
- Daily IASI/Metop-A LMD cloud properties (emissivity, pressure, type, temperature, height and...)
- Daily IASI/Metop-A LMD methane (CH₄) L2 product (mid tropospheric column) - Reanalysis
- Daily IASI/Metop-A ULB-LATMOS DUST L2 products (at 10 micron, 11 micron and 550 nm)
- Daily IASI/Metop-A ULB-LATMOS carbon monoxide (CO) L2 product (total column)

At the bottom of the list, there are navigation arrows: << < 1 - 25 / 55 > >>.

To the right of the search panel, there is a large text box with the heading 'Discover IASI data'.



Data access from Catalog (example with CO from IASI/MetopA)

Here's an example for IASI CO data for 2010. You can have more details by clicking on each result in the « Metadata » panel.

The screenshot shows the AERIS Data Access Catalog interface. At the top, there are logos for AERIS and IASI, followed by a navigation bar with links for DATA ACCESS, QUICKLOOKS, TIMELINE, GALLERIES, PUBLICATIONS, COVID-19, CONTACT, and two PUBLICATIONS links. An Admin link is also present. On the left, a search sidebar includes a search bar, a 'RESET' button, a 'SEARCH' button, and dropdown menus for 'Temporal extent' (From: 2010-01-01, To: 2011-01-01), 'Spatial extent', 'Parameters', and 'Levels'. The main area displays a search summary for '3 RESULTS' and a 'METADATA' panel for the first result. The metadata panel shows a timestamp of 2025-04-04 11:25:31 and a title: 'Daily IASI/Metop-A ULB-LATMOS carbon monoxide (CO) L2 product (vertical profile and total column – EUMETSAT processing)'. Below the title are tabs for INFORMATION, DOWNLOAD, STATISTICS, and INTEROPERABILITY. The INFORMATION tab is active, showing an 'Abstract' section with a detailed description of the dataset's processing, retrieval scheme, and quality. It also lists a Climate Data Record (CDR) available from July 2007 to October 2021. The DOWNLOAD tab shows a preview of the spatial extent with a world map and zoom controls.



Data access from Catalog (example with CO from IASI/MetopA)

Click on the download link in the « Data access » section.

The screenshot shows the AERIS IASI Data Catalog interface. On the left, there is a search bar with 'Full text search' and 'carbon monoxide' entered. Below it are four dropdown menus: 'Temporal extent' (From: 2010-01-01, To: 2011-01-01), 'Spatial extent', 'Parameters', and 'Levels'. In the center, a search result for 'Daily IASI/Metop-A ULB-LATMOS carbon monoxide (CO) L2 product (total column)' is displayed. A red arrow points from the 'Data access' section in the main content area down to the 'Data access' section in the detailed product view. The main content area includes tabs for INFORMATION, DOWNLOAD (which is selected), STATISTICS, and INTEROPERABILITY. The DOWNLOAD tab contains sections for 'How to cite', 'Data policy', 'Data Access Permissions', and 'Data access'. The 'Data access' section is highlighted with a red box and contains links for 'HTTP download links' and 'CO quicklooks and data'.

DATA ACCESS QUICKLOOKS TIMELINE GALLERIES PUBLICATIONS COVID-19 CONTACT PUBLICATIONS

Admin

Full text search
carbon monoxide

Temporal extent
From 2010-01-01 To 2011-01-01

Spatial extent

Parameters

Levels

Daily IASI/Metop-A ULB-LATMOS carbon monoxide (CO) L2 product (total column)

Daily IASI/Metop-A ULB-LATMOS carbon monoxide (CO) L2 product (vertical profile and...

Monthly IASI/Metop-A ULB-LATMOS carbon monoxide (CO) L3 product (total column)

How to cite

Cherbaux, C. & Coheur, P.-F. (2020). Daily IASI/Metop-A ULB-LATMOS carbon monoxide (CO) L2 product (vertical profile and total column – EUMETSAT processing). [dataset]. AERIS. <https://doi.org/10.25326/63>

Data policy

Description: <https://iasi.aeris-data.fr/data-use-policy/>

Data Access Permissions

Sign-in is required to download data.

Data access

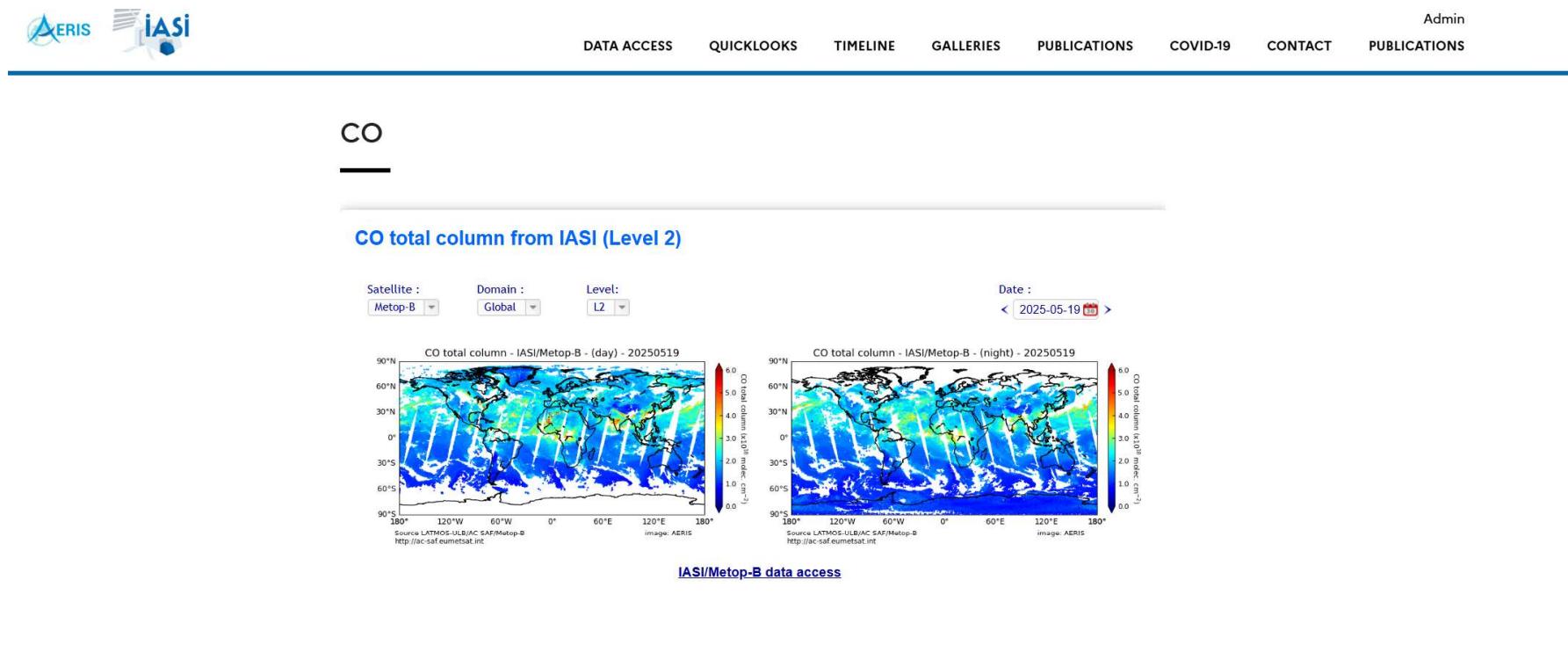
HTTP download links

<https://iasi.aeris-data.fr/CO/>

CO quicklooks and data

Data access from Quicklooks page

You are now on the Quicklooks page.



Data access from Quicklooks page

You are now on the Quicklooks page.

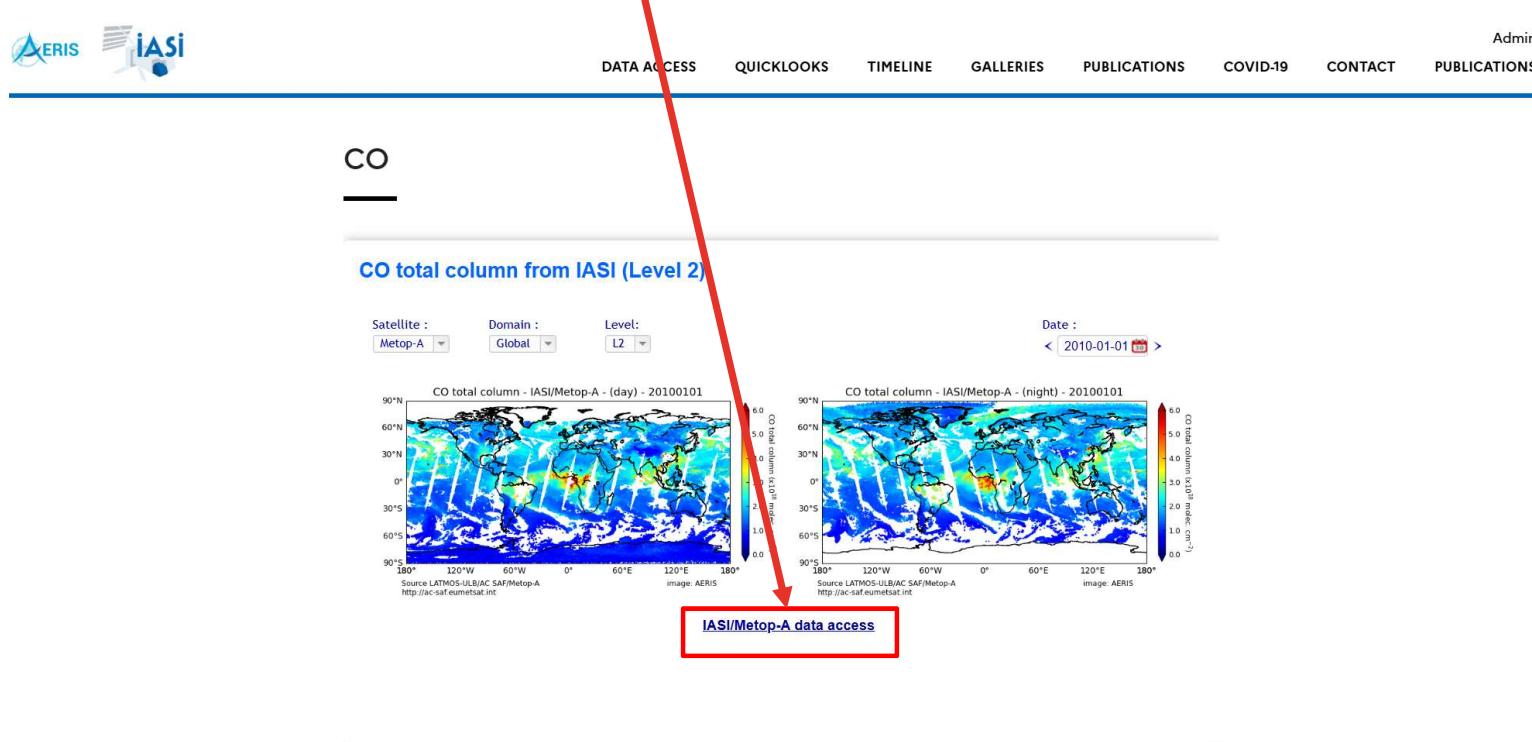
If you know in advance which data and periods you need, you can skip the previous steps and click directly on Quicklooks.

The screenshot shows the AERIS website interface. At the top, there are logos for AERIS and IASI. Below the logo is a navigation bar with links: DATA ACCESS, QUICKLOOKS (which is highlighted with a red box and a red arrow), TIMELINE, GALLERIES, PUBLICATIONS, COVID-19, CONTACT, and PUBLICATIONS. On the far right, there is an Admin link. The main content area is titled "CO". Below it, there is a section titled "CO total column from IASI (Level 2)". This section includes filters for Satellite (Metop-B), Domain (Global), Level (L2), and Date (2025-05-19). It also shows two maps: one for day (20250519) and one for night (20250519), both showing CO total column concentration in ppbv. The maps have a color scale from 0.0 to 6.0. At the bottom of this section is a link to "IASI/Metop-B data access".



Data access from Quicklooks page

Let's go back to our example and click on IASI/Metop-A data access.



Data access from Quicklooks page

If it's your first time accessing AERIS, you'll have to provide your details.



AERIS IASI

DATA ACCESS QUICKLOOKS TIMELINE GALLERIES PUBLICATIONS COVID-19 CONTACT PUBLICATIONS

Admin

IASI/METOP-A CO LEVEL 2 DATA

IASI/CO access

It's your first access to IASI CO data. Please, fill in the form below :

Last name :

First name :

Laboratory :

Country :

E_mail :

In a few words, explain below why you want to access to this data :



Downloading data for 1 day

You have 2 ways to download data for a single day :

- by clicking on any date in the calendar

AERIS  iASI 

DATA ACCESS QUICKLOOKS TIMELINE GALLERIES PUBLICATIONS COVID-19 CONTACT Admin PUBLICATIONS

IASI/METOP-A CO LEVEL 2 DATA

Data access : [2007](#) | [2008](#) | [2009](#) | [2010](#) | [2011](#) | [2012](#) | [2013](#) | [2014](#) | [2015](#) | [2016](#) |
[2017](#) | [2018](#) | [2019](#)

via calendar: click on a day to download the corresponding datafile [QUICKLOOKS](#)
[via curl command](#) [Metadata page](#)

Disclaimer: the data file of day D can still be updated until day D+30 because of some potential missing data.

January 2019 February 2019 March 2019 April 2019

Su	Mo	Tu	We	Th	Fr	Sa
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

Su	Mo	Tu	We	Th	Fr	Sa
		1	2			
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28		

Su	Mo	Tu	We	Th	Fr	Sa
		1	2			
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

Su	Mo	Tu	We	Th	Fr	Sa
		1	2			
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

May 2019 June 2019 July 2019 August 2019

Su	Mo	Tu	We	Th	Fr	Sa
		1	2	3	4	5
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

Su	Mo	Tu	We	Th	Fr	Sa
		2	3	4	5	6
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30						

Su	Mo	Tu	We	Th	Fr	Sa
		1	2	3	4	5
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

Su	Mo	Tu	We	Th	Fr	Sa
		1	2	3	4	5
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

September 2019 October 2019 November 2019 December 2019

Su	Mo	Tu	We	Th	Fr	Sa
		1	2	3	4	5
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30					

Su	Mo	Tu	We	Th	Fr	Sa
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

Su	Mo	Tu	We	Th	Fr	Sa
		1	2			
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
29	30	31				

70 

Downloading data for 1 day

You have 2 ways to download data for a single day :

- by clicking on any date in the calendar
- by using the curl command

AERIS iASI

DATA ACCESS QUICKLOOKS TIMELINE GALLERIES PUBLICATIONS COVID-19 CONTACT Admin PUBLICATIONS

IASI/METOP-A CO LEVEL 2 DATA

Data access : 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |

via calendar: click on a day to download the corresponding datafile

via curl command

Disclaimer: the data file of day D can still be updated until day D+30 because of some potential missing data.

via curl command

if you want to download the data file from 1st January 2019, type the command :
curl -insecure https://cds-espri.ipsl.fr/iasil2/iasi_co/V1.2.1/2019/01/IASI_METOPA_L2_CO_20190101_ULB-LATMOS_CDR_V1.2.1.nc -O

if you want to download more than one file, type :
curl -insecure https://cds-espri.ipsl.fr/iasil2/iasi_co/V1.2.1/2019/01/IASI_METOPA_L2_CO_201901[19-25]_ULB-LATMOS_CDR_V1.2.1.nc -O

January 2019 February 2019 March 2019 April 2019

May 2019 June 2019 July 2019 August 2019

September 2019 October 2019 November 2019 December 2019

QUICKL

71

Downloading data for 1 day

You have 2 ways to download data for a single day :

- by clicking on any date in the calendar
- by using the curl command

IASI/METOP-A CO LEVEL 2 DATA

Data access : 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |

via calendar: click on a day to download the corresponding datafile

via curl command

Disclaimer: the data file of day D can still be updated until day D+30 because of some potential missing data.

via curl command

Metadata page

Admin

QUICKLOOKS

CALENDAR

url curl command

calendar: click on a day to download the corresponding datafile

via curl command

if you want to download the data file from 1st January 2019, type the command :
curl -insecure https://cds-espri.ipsl.fr/iasi2/iasi_co/V1.2.1/2019/01/IASI_METOPA_L2_CO_20190101_ULB-LATMOS_CDR_V1.2.1.nc -O

if you want to download more than one file, type :
curl -insecure https://cds-espri.ipsl.fr/iasi2/iasi_co/V1.2.1/2019/01/IASI_METOPA_L2_CO_201901[19-25]_ULB-LATMOS_CDR_V1.2.1.nc -O

January 2019

February 2019

March 2019

April 2019

May 2019

June 2019

July 2019

August 2019

September 2019

October 2019

November 2019

December 2019

QUICKLOOKS

CALENDAR

url curl command

calendar: click on a day to download the corresponding datafile

via wget tools

if you want to download the data file from 1st January 2025, type the command :
curl -insecure https://cds-espri.ipsl.fr/iasi2/iasi_co/V6.7.1/2025/01/IASI_METOPB_L2_CO_20250101_ULB-LATMOS_ICDR_V6.7.1.nc -O

if you want to download more than one file, type :
curl -insecure https://cds-espri.ipsl.fr/iasi2/iasi_co/V6.7.1/2025/01/IASI_METOPB_L2_CO_20250101[19-25]_ULB-LATMOS_ICDR_V6.7.1.nc -O

72

Downloading data using bash scripts with curl command

Example of a bash script (“download_iasi_data_1day.sh”) to download 1 day of CO data from IASI-MetopC :

```
1 #!/bin/bash
2
3 YEAR=2025
4 MONTH=1
5 DAY=15
6 METOP=C
7
8 MMONTH=$(printf "%02d" "$MONTH")
9 DDAY=$(printf "%02d" "$DAY")
10
11 echo "${YEAR}${MMONTH}${DDAY}"
12 echo "IASI/METOP${METOP}"
13
14 curl --insecure https://cds-espri.ipsl.fr/iasi"${METOP}"_L2/iasi_co/V6.7.1/$YEAR/$MMONTH/IASI_METOP"${METOP}"_L2_CO_"${YEAR}${MMONTH}${DDAY}"_ULB-LATMOS_ICDR_V6.7.1.nc -O
15
```

Example of a bash script (“download_iasi_data.sh”) to download multiple days of CO data from IASI-MetopC :

```
1 #!/bin/bash
2
3 YEAR=2025
4 MONTHMIN=1
5 MONTHMAX=2
6 DAYMIN=10
7 DAYMAX=15
8 METOP=C
9
10 for ((MONTH=$MONTHMIN; MONTH <=$MONTHMAX ; MONTH++)); do
11     MMONTH=$(printf "%02d" "$MONTH")
12     NB_DAYS_IN_MONTH=$(cal $month $year | awk '{NF = $NF; END {print NF}}')
13
14     DAYMIN=$(printf "%02d" "$DAYMIN")
15     DAYMAX=$(printf "%02d" "$DAYMAX")
16
17     FILENAME="IASI_METOP${METOP}_L2_CO_${YEAR}${MMONTH}[${DAYMIN}-${NB_DAYS_IN_MONTH}]_ULB-LATMOS_ICDR_V6.7.1.nc"
18     echo "Downloading: $FILENAME"
19
20     curl --insecure "https://cds-espri.ipsl.fr/iasi${METOP}_L2/iasi_co/V6.7.1/$YEAR/$MMONTH/$FILENAME" -O
21
22 done
```



Downloading data using bash scripts with curl command

To run any of these scripts on Linux :

1. Open a terminal and go to where your script is with `cd`.
2. Write this in the terminal to run the bash script : `bash scriptname.sh`

```
(base) selviga@pc-selviga:~$ cd codes/ACAM/
(base) selviga@pc-selviga:~/codes/ACAM$ ls
download_iasi_data_1day.sh download_iasi_data.sh
(base) selviga@pc-selviga:~/codes/ACAM$ bash download_iasi_data_1day.sh
20250115
IASI/METOPC
% Total    % Received % Xferd  Average Speed   Time     Time      Time  Current
          Dload  Upload   Total Spent  Left Speed
55  859M  55  477M    0      0  109M       0  0:00:07  0:00:04  0:00:03  109M
```

3. Check with `ls` if the file is correctly downloaded.

```
(base) selviga@pc-selviga:~/codes/ACAM$ ls
download_iasi_data_1day.sh  download_iasi_data.sh  IASI_METOPC_L2_CO_20250115_ULB-LATMOS_ICDR_V6.7.1.nc
```



Downloading data using bash scripts with curl command

To run any of these scripts on Windows :

1. Open a PowerShell (Win + X and select Windows PowerShell)
2. Type `bash` and press Enter. This will drop you into a bash shell inside PowerShell, allowing you to run any bash commands. If Git Bash is not installed, see next slides.
3. Go to where the directory where the bash script is located with `cd`.
4. Run the script with `bash scriptname.sh`

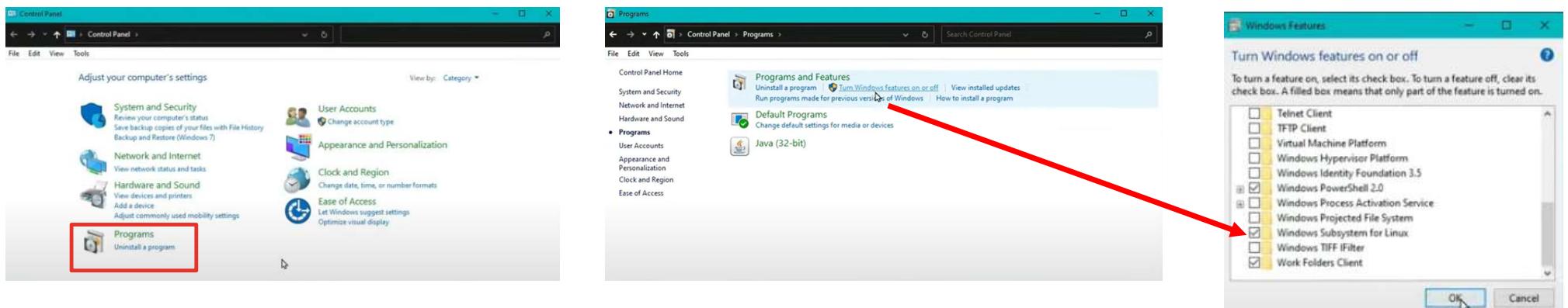
```
selviga@pc-selviga:/mnt/c/Users/selviga/Downloads$ bash download_iasi_data_1day.sh
20250115
IASI/METOPC
% Total    % Received % Xferd  Average Speed   Time     Time      Time  Current
          Dload  Upload   Total   Spent   Left  Speed
100  859M  100  859M    0      0  111M      0  0:00:07  0:00:07 --::--  112M
```

5. Check with `ls` if the file is correctly downloaded.



How to configure Windows PowerShell to run bash scripts

1. Go to Control Panel > Programs > Turn Windows features on or off. Turn on the Windows Subsystem for Linux and click on ok.



2. Open PowerShell as an Administrator (Win + X and select Windows PowerShell (Admin))
3. Download WSL with this command : `wsl --install` (more information here: <https://learn.microsoft.com/en-us/windows/wsl/install>)
4. Install Ubuntu 20.04 with this command : `wsl --install -d Ubuntu20.04` (To get the list of distributors, you can type this command : `wsl --list -online`)
5. Close the current panel and open PowerShell and type `bash` to check everything works. You can now run bash scripts.

