



Monitoring the Earth – Present and Future observational capabilities

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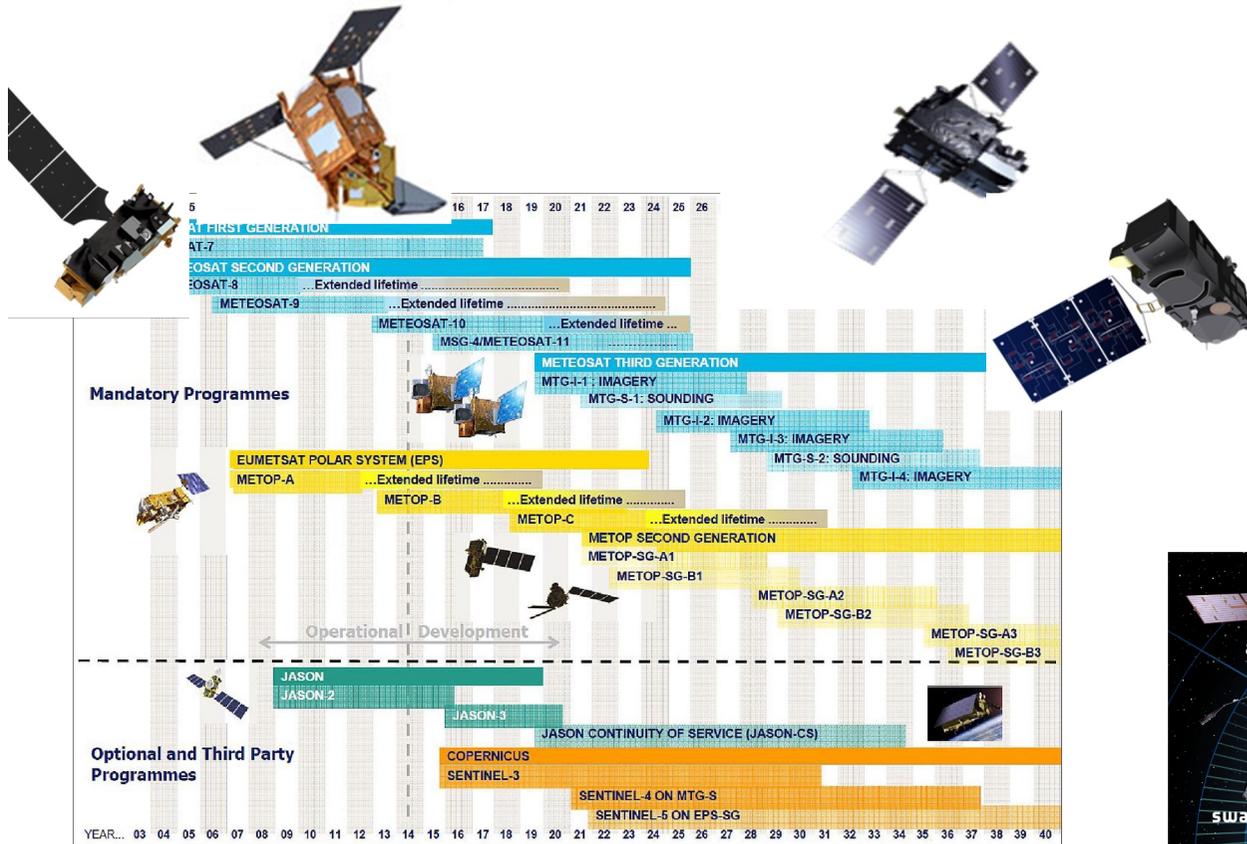
IR0000032 – ITINERIS, Italian Integrated Environmental Research Infrastructures System
(D.D. n. 130/2022 - CUP B53C22002150006) Funded by EU - Next Generation EU PNRR-
Mission 4 “Education and Research” - Component 2: “From research to business” - Investment
3.1: “Fund for the realisation of an integrated system of research and innovation infrastructures”





A huge step forward for monitoring environment and climate

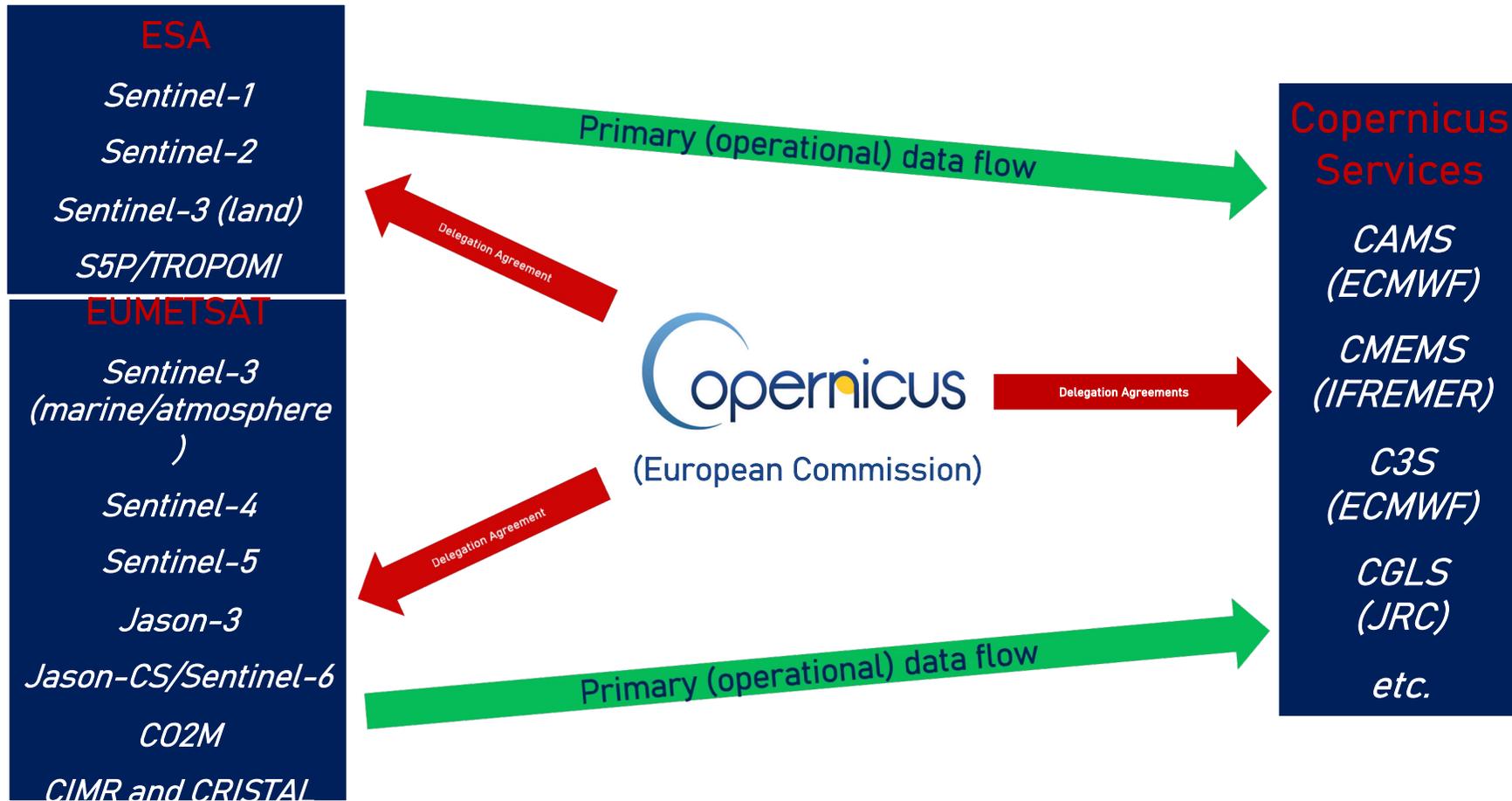
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	SENTINEL-1: 4-40m resolution, 3 day revisit at equator	S1A and 1B in orbit
	SENTINEL-2: 10-60m resolution, 5 days revisit time	S2A and 2B in orbit
	SENTINEL-3: 300-1200m resolution, <2 days revisit	S3A and S3B in orbit
	SENTINEL-4: 8km resolution, 60 min revisit time	1st Launch 2022
	SENTINEL-5p: 7-68km resolution, 1 day revisit	SSP in orbit
	SENTINEL-5: 7.5-50km resolution, 1 day revisit	1st Launch 2023
	SENTINEL-6: 10 day revisit time	1st Launch 2020

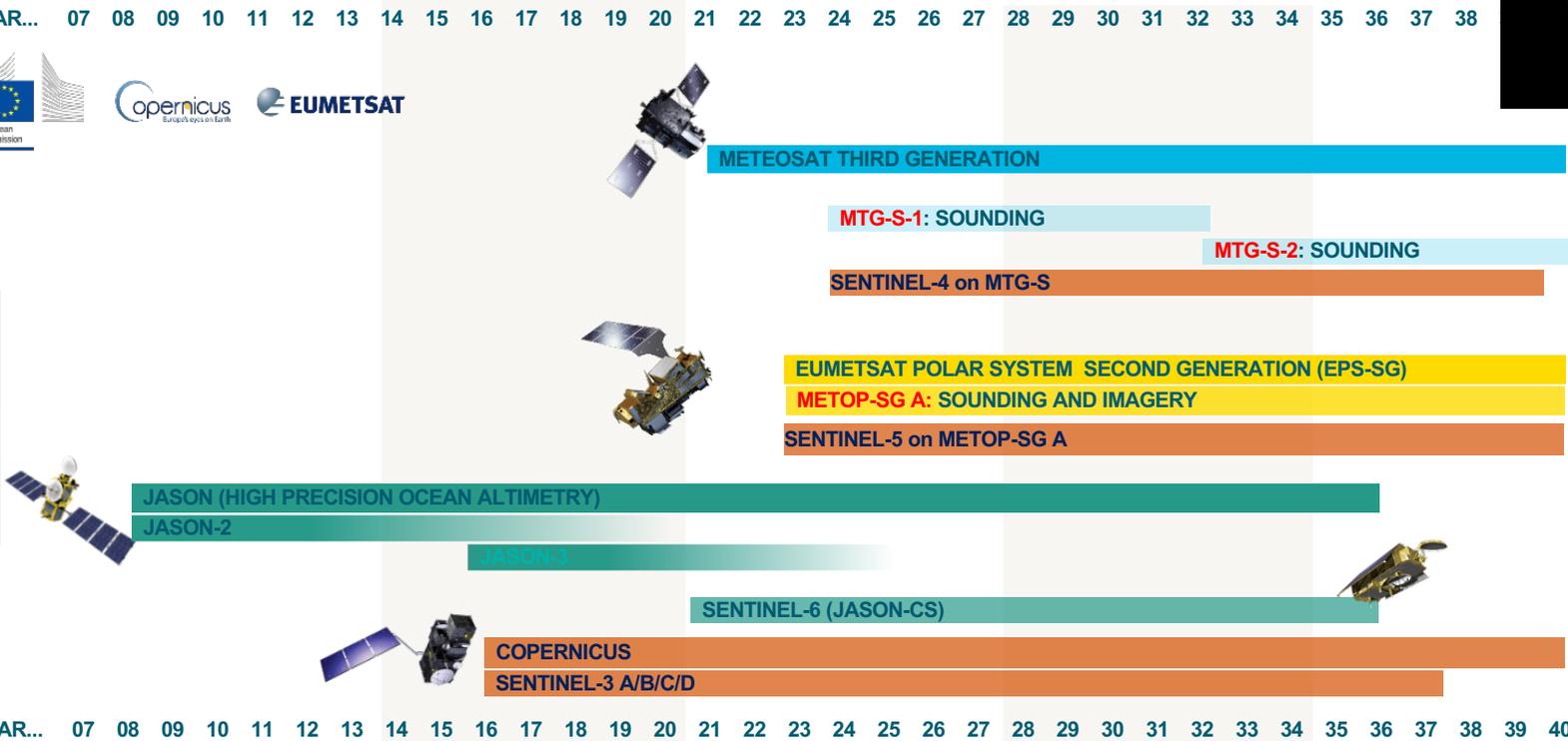
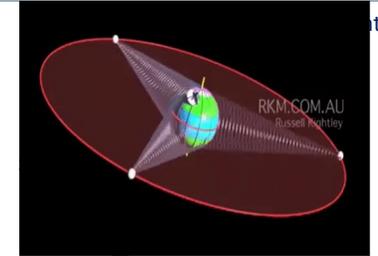


A simplified view of the Copernicus programme



Copernicus Sentinels operated by EUMETSAT

YEAR... 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38

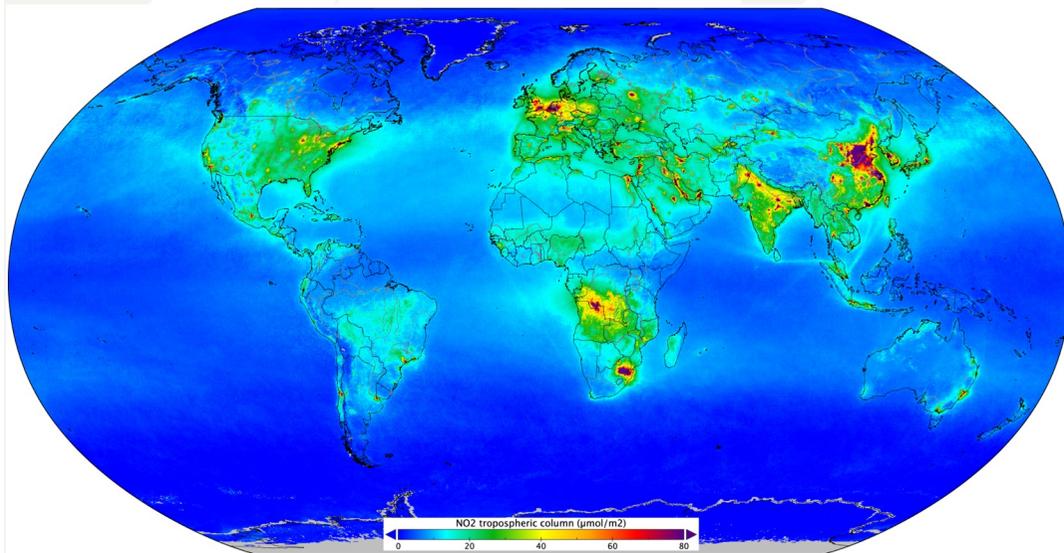


YEAR... 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40

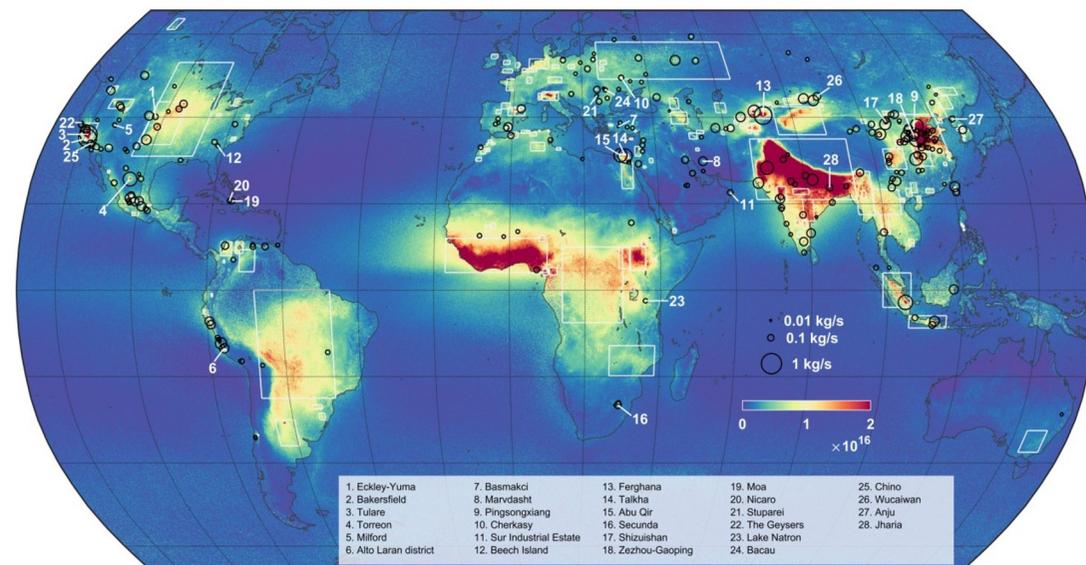


Satellite monitor pollutants and support observational effort

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Nitrogen Dioxide from 1 month TROPOMI data
© Copernicus program

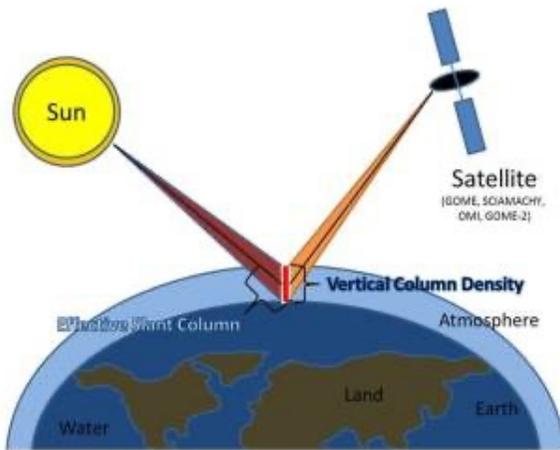


Ammonia fluxes based on 9 years of IASI data
© Martin Van Damme and Lieven Clarisse / ULB



Products for Trace Gas: EUMETSAT and Sentinels

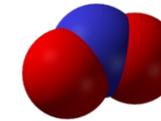
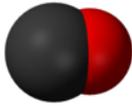
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PRESENT FUTURE

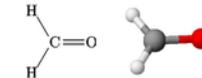
Product	Metop GOME-2	Sentinel 5 and 5p	Metop IASI	Metop-SG IASI-NG	MTG-S S4/UVN
O ₃ total column	✓	✓	✓	✓	✓
O ₃ profile (incl. troposphere)	✓	✓	✓	✓	✓
O ₃ tropospheric column	✓	✓	✓	✓	✓
NO ₂ total column	✓	✓	✓	✓	✓
NO ₂ tropospheric column	✓	✓	✓	✓	✓
SO ₂	✓	✓	✓	✓	✓
SO ₂ Layer Height	✓	✓	✓	✓	✓
HCHO	✓	✓	✓	✓	✓
CHOCHO	✓	✓	✓	✓	✓
BrO	✓	✓	✓	✓	✓
OCIO	✓	✓	✓	✓	✓
HNO ₃	✓	✓	✓	✓	✓
NH ₃	✓	✓	✓	✓	✓
CO	✓	✓	✓	✓	✓
CH ₄	✓	✓	✓	✓	✓
SIF	✓	✓	✓	✓	✓
CO ₂	✓	✓	✓	✓	✓
H ₂ O	✓	✓	✓	✓	✓
UV Products	✓	✓	✓	✓	✓

Carbon monoxide (CO) is present in small amounts (about 80 ppb) in the Earth's atmosphere. About half of the carbon monoxide in Earth's atmosphere is from the burning of fossil fuels and biomass (such as forest and bushfires) Most of the rest of carbon monoxide comes from chemical reactions with organic compounds emitted by human activities and plants.



Nitrogen dioxide (NO₂) is produced from oxidation of monoxide (NO) that is in turn produced by combustion – high temperatures to break nitrogen and oxygen molecules

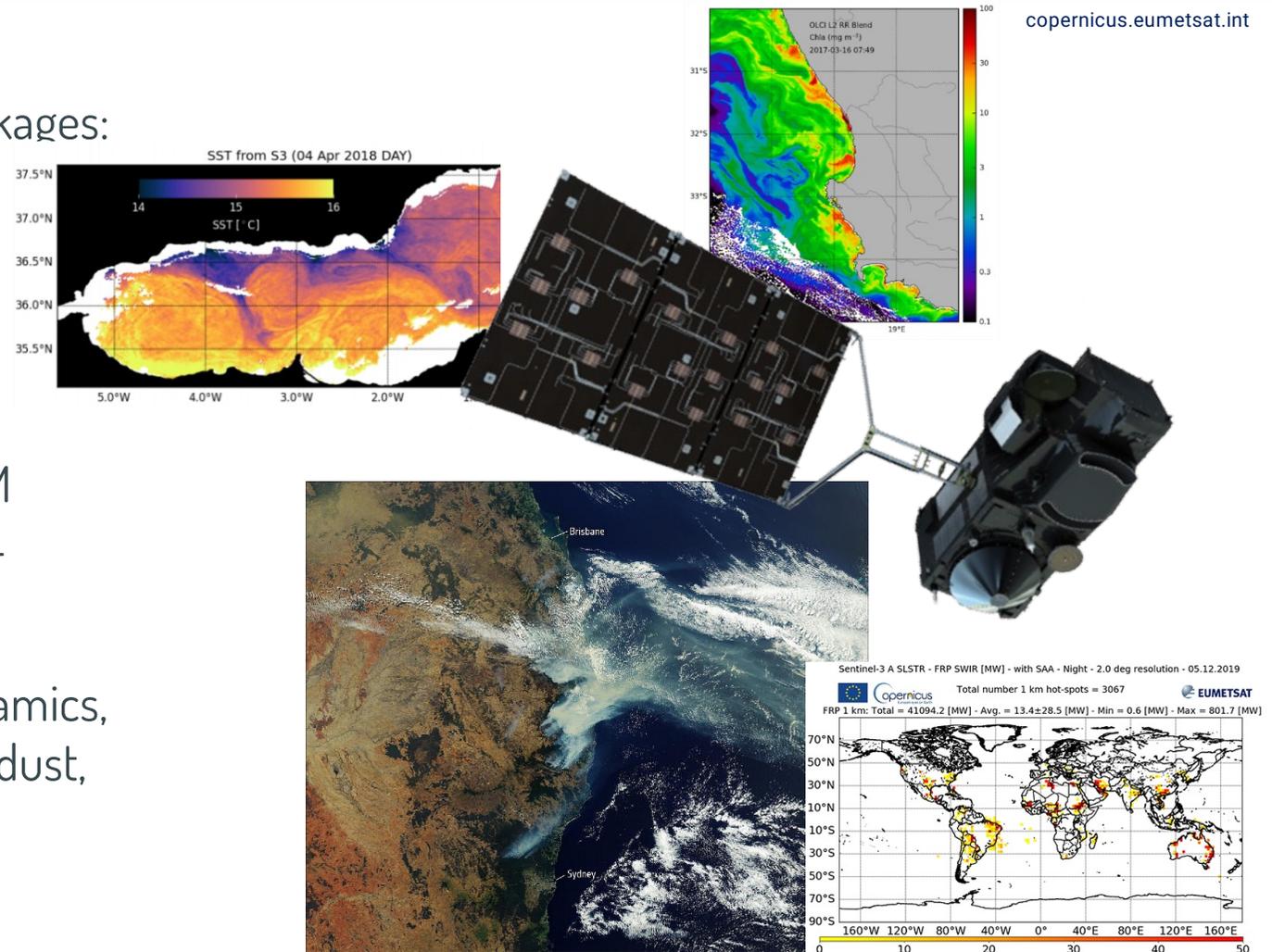
HCHO Formaldehide also produced in fires Synthesis product – potentially toxic



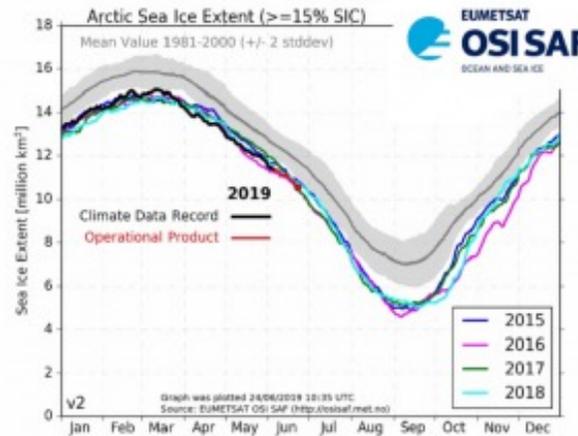
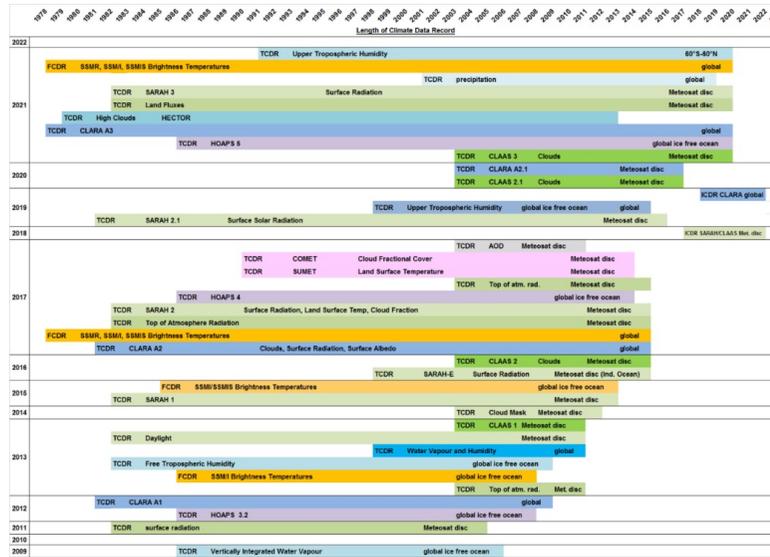
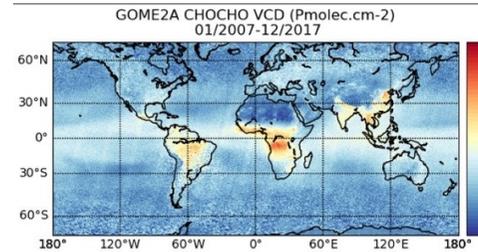
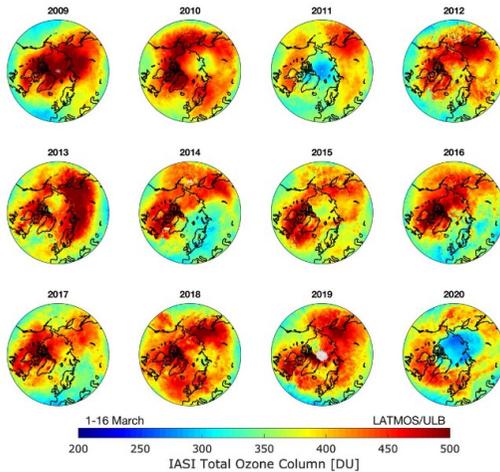
NH₃ – Ammonia produced in livestock- also Synthesis product – potentially toxic

Sentinel-3: Synchronous ocean and atmosphere data

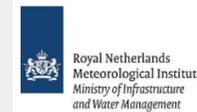
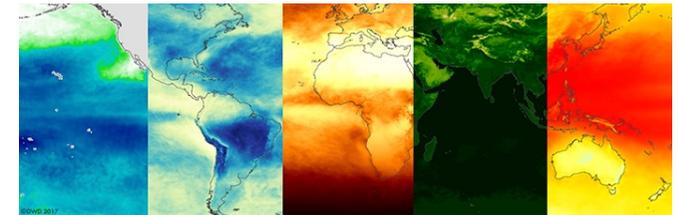
- ~ Daily data from 3 instrument packages:
 - OLCI
 - SLSTR
 - Altimetry (SRAL)
- Wide variety of relevant products:
 - Ocean colour, chlorophyll, TSM
 - Aerosols, Fire Radiative Power
- Many relevant applications:
 - Carbon cycling, sediment dynamics, waves/wind, air quality fires, dust, volcanic eruptions.



applications



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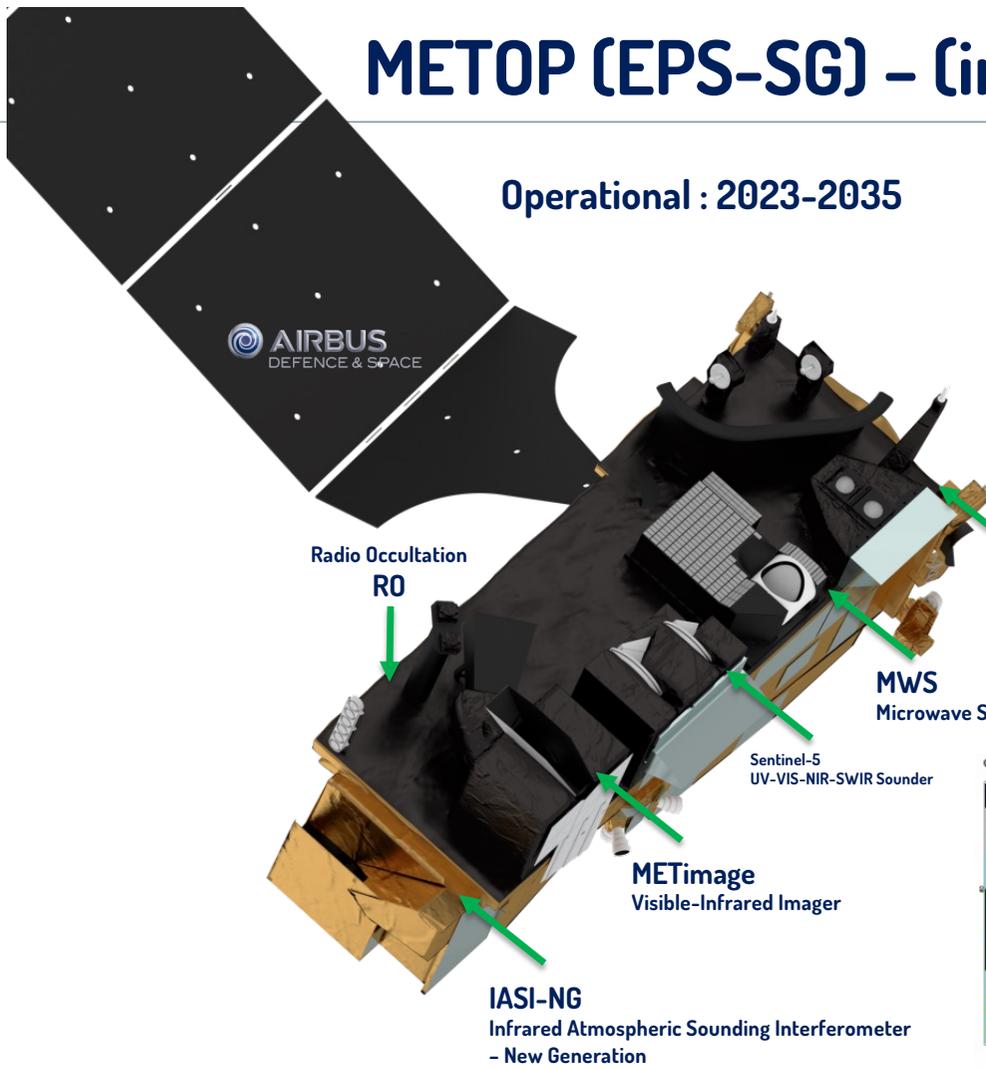


METOP (EPS-SG) – (incl. Sentinel 5)



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Operational : 2023-2035



Radio Occultation
RO

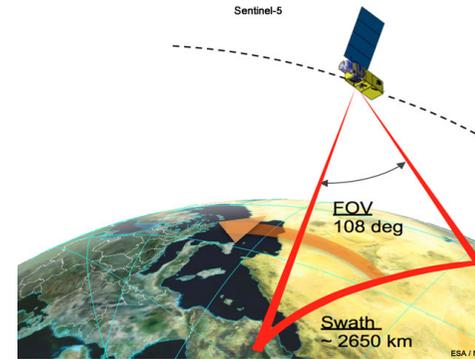
3MI
Multi-viewing,
-channel,
-polarisation Imager

MWS
Microwave Sounder

Sentinel-5
UV-VIS-NIR-SWIR Sounder

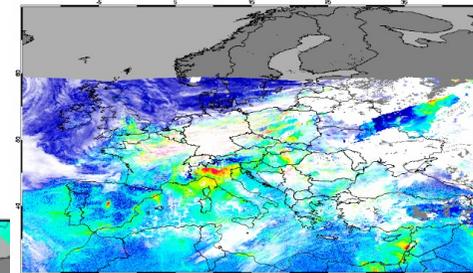
METimage
Visible-Infrared Imager

IASI-NG
Infrared Atmospheric Sounding Interferometer
– New Generation

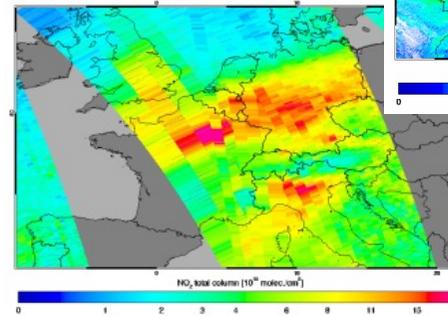


TROPOMI tropospheric NO₂, 11 Jan 2019

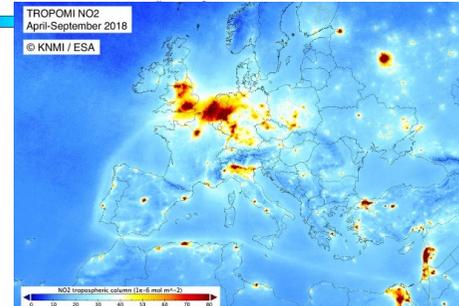
KNMI/ESA



OMI total NO₂, 11 Jan 2019



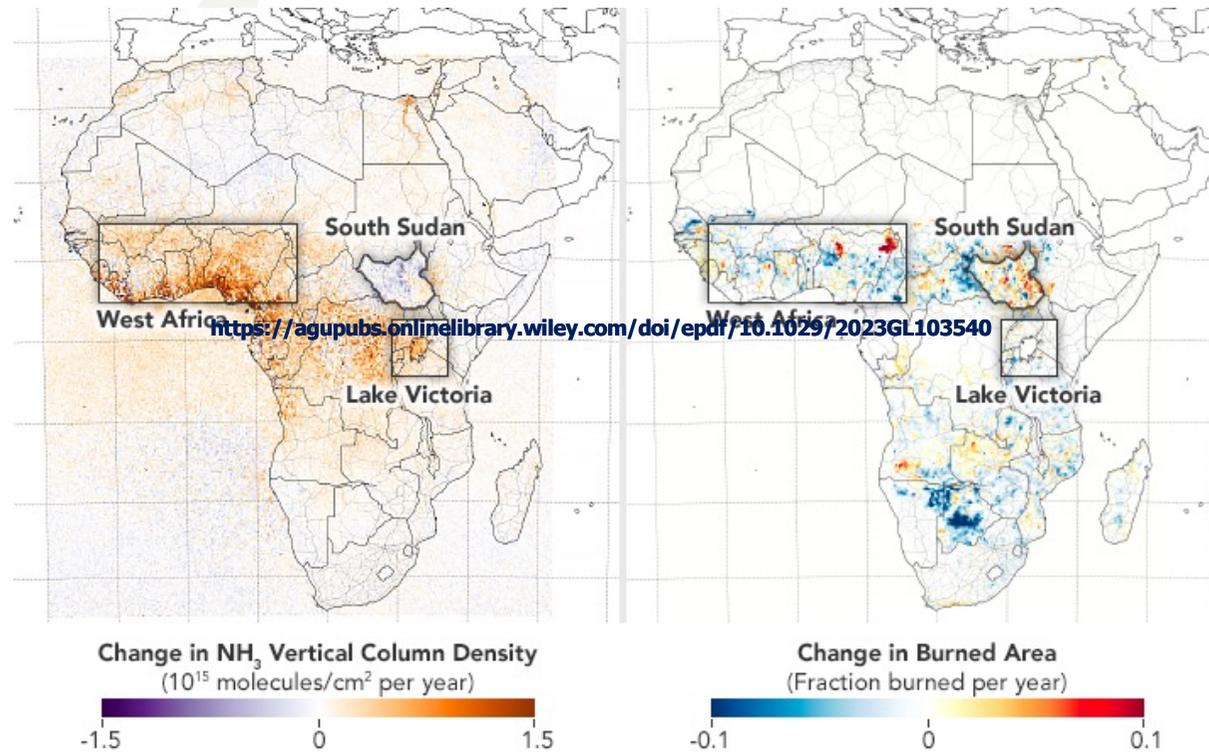
TROPOMI NO₂
April-September 2018
© KNMI / ESA



Example: Changes in ammonia concentrations

What does it mean – support air quality monitoring

Analysis of 7 years of IASI data from <https://acp.copernicus.org/articles/21/16277/2021/>



<https://agupubs.onlinelibrary.wiley.com/doi/epdf/10.1029/2023GL103540>

<https://agupubs.onlinelibrary.wiley.com/doi/epdf/10.1029/2023GL103540>

Meteosat Third Generation (MTG): Mission overview

▪ Imagery missions (MTG-I):

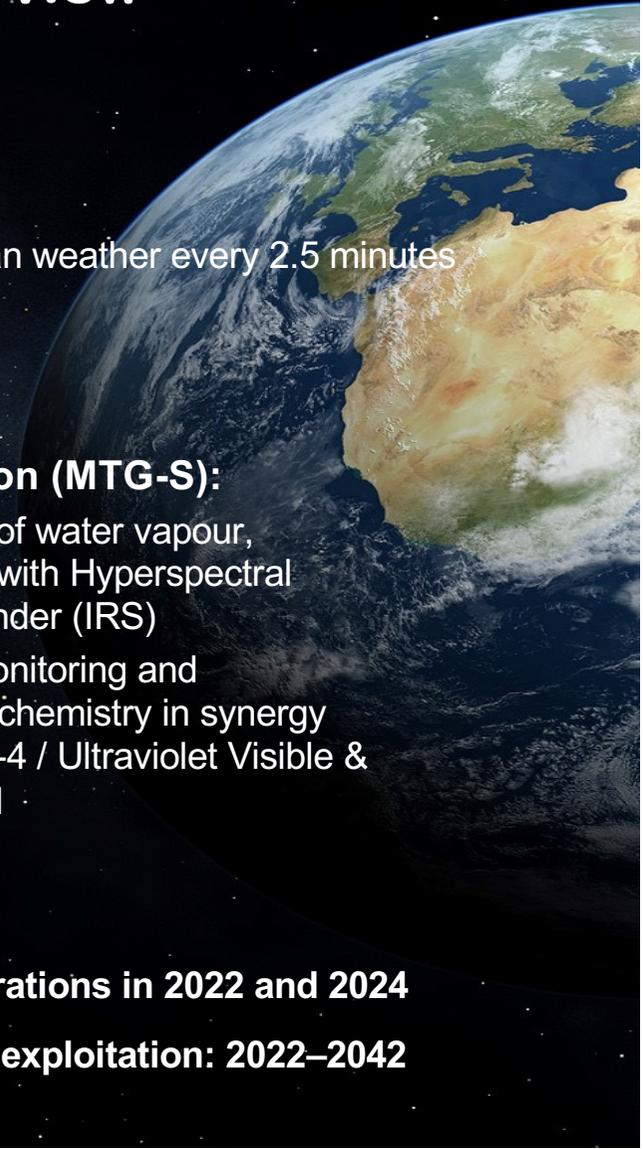
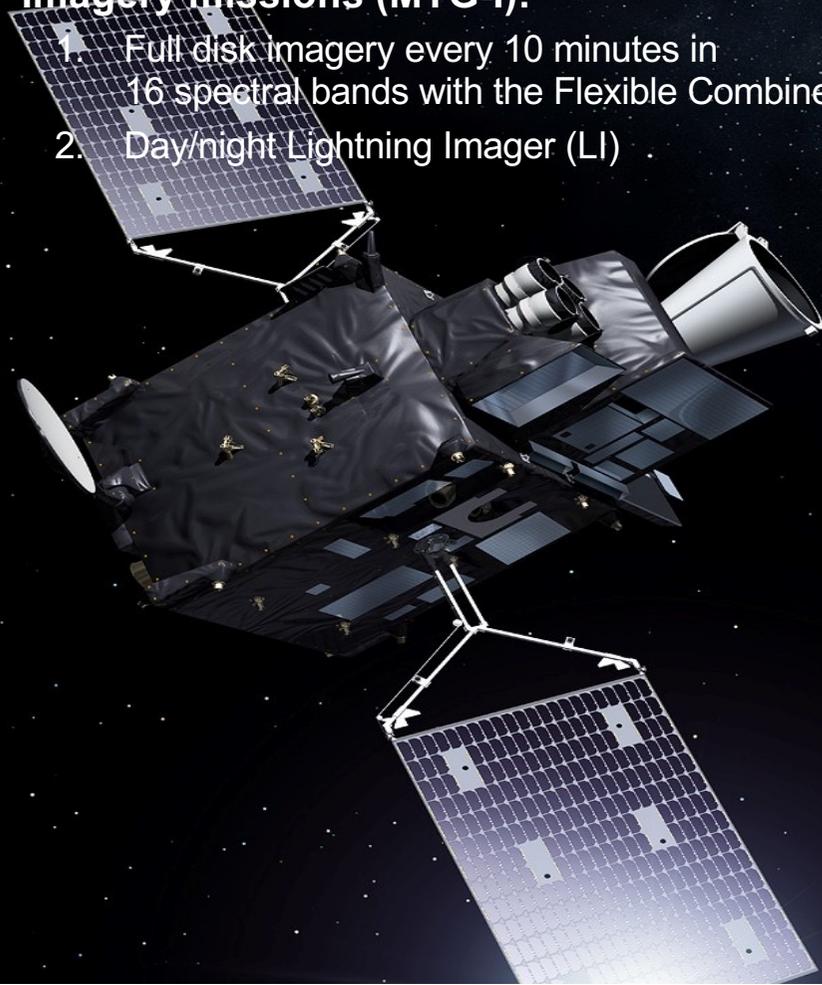
1. Full disk imagery every 10 minutes in 16 spectral bands with the Flexible Combined Imager (FCI). Fast imaging of European weather every 2.5 minutes
2. Day/night Lightning Imager (LI)

▪ Sounding mission (MTG-S):

1. 3D mapping of water vapour, temperature with Hyperspectral Infrared Sounder (IRS)
2. Air quality monitoring and atmospheric chemistry in synergy with Sentinel-4 / Ultraviolet Visible & Near-infrared

▪ **Start of operations in 2022 and 2024**

▪ **Operational exploitation: 2022–2042**



Example: MTG-S Sounding Mission – Sentinel 4

The spatial resolution ~ 8 x 8 km
with hourly temporal resolution

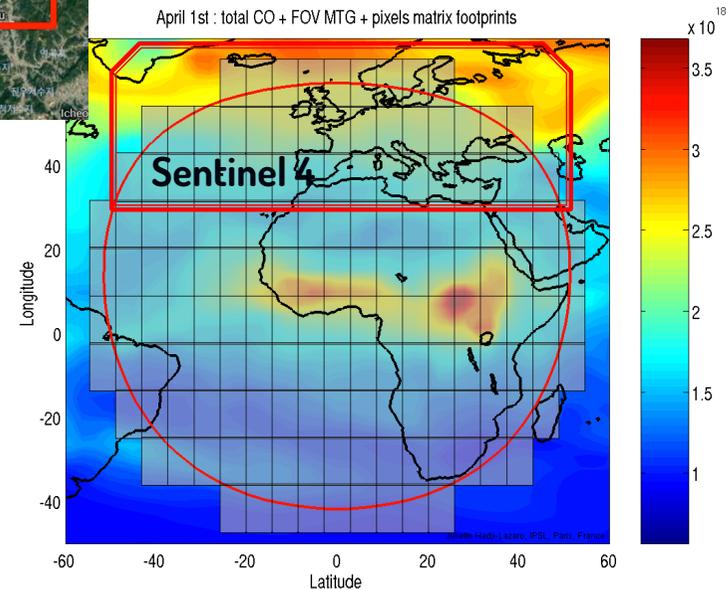
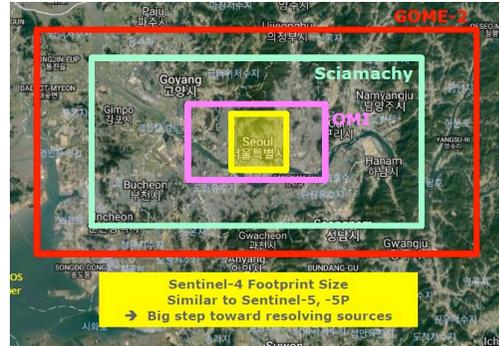
First Geostationary over EU

Focus on air quality with the main data products being O₃, NO₂, SO₂, HCHO, and aerosol optical depth.

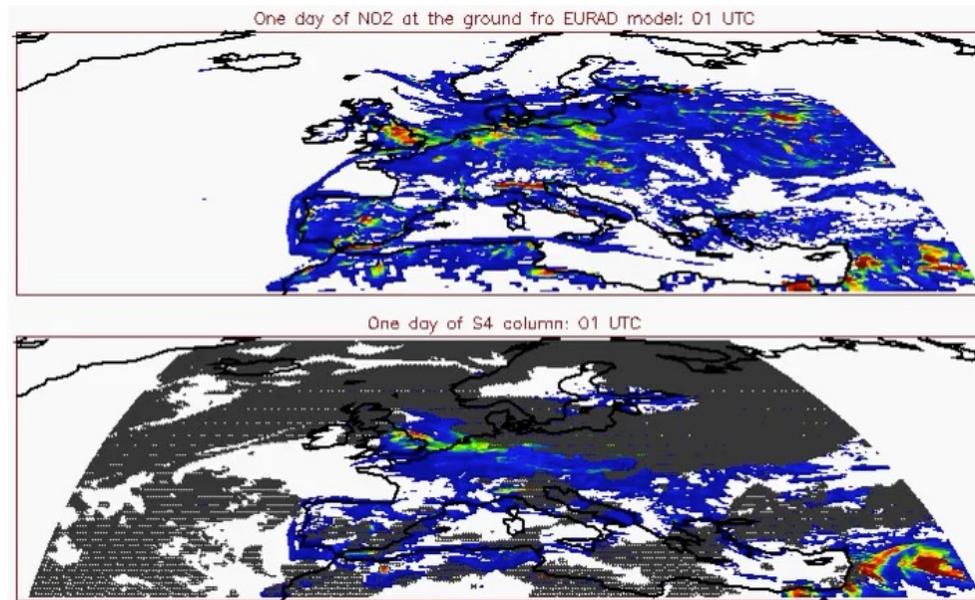
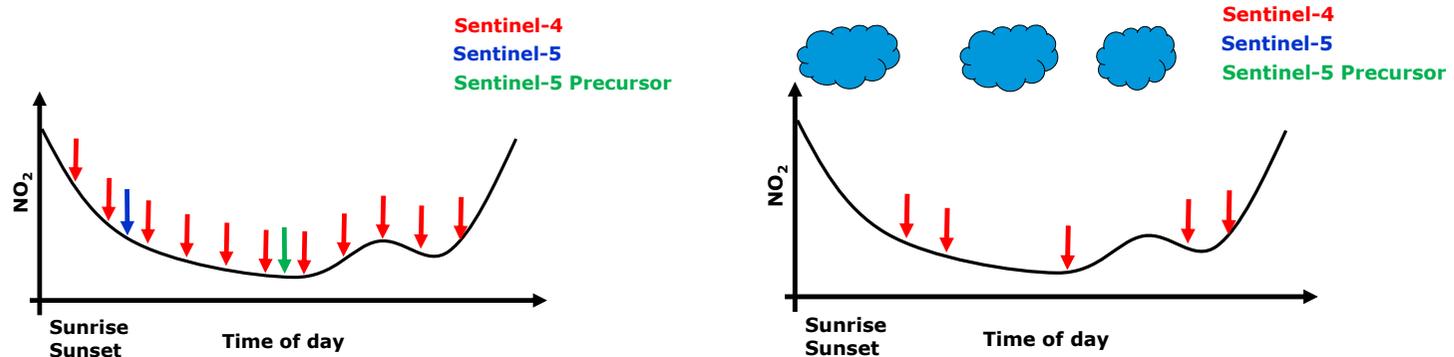
Start of operations: 2023

Operational : 2023-2042

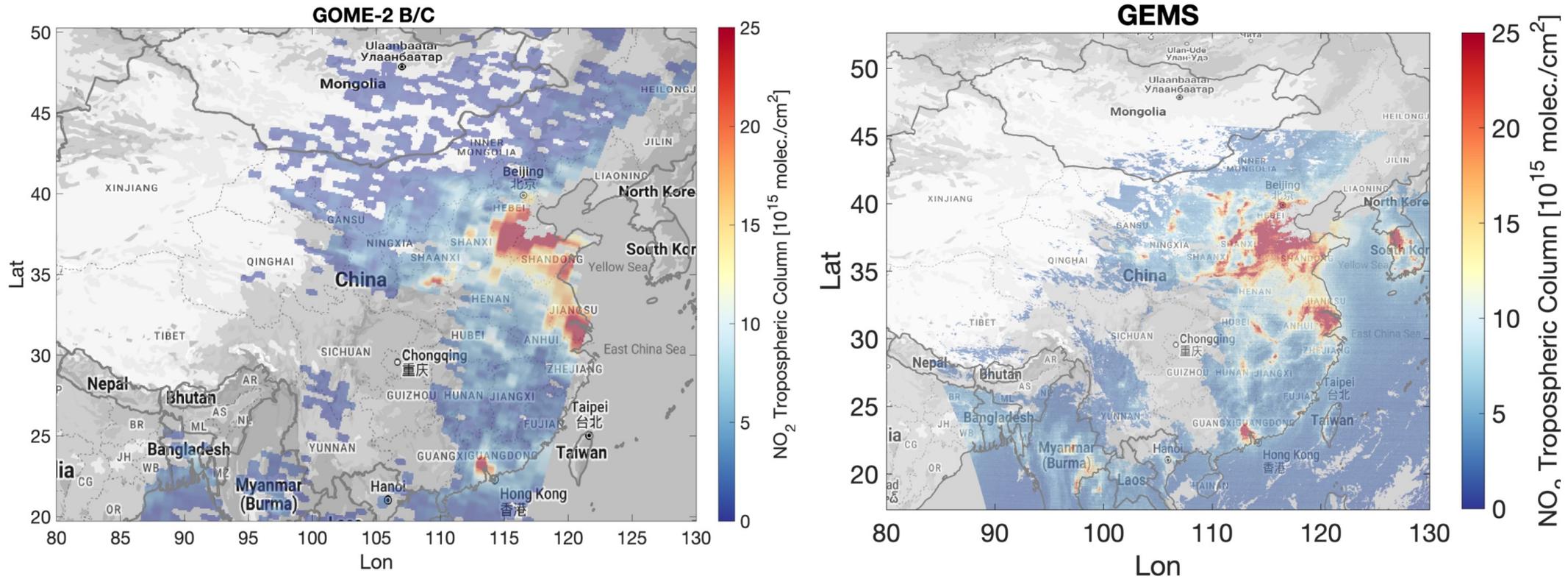
Synergy with the instruments on the EUMETSAT Meteosat Third generation



Example: Better coverage with multiple satellites

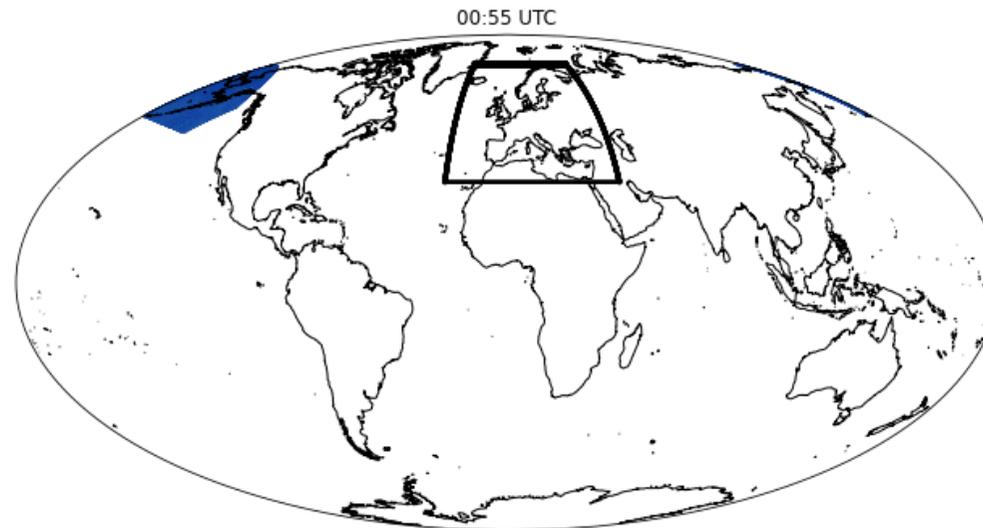


GEMS as Sentinel-4 precursor – LEO vs GEO



Combining the polar and geostationary worlds: S4 & S5

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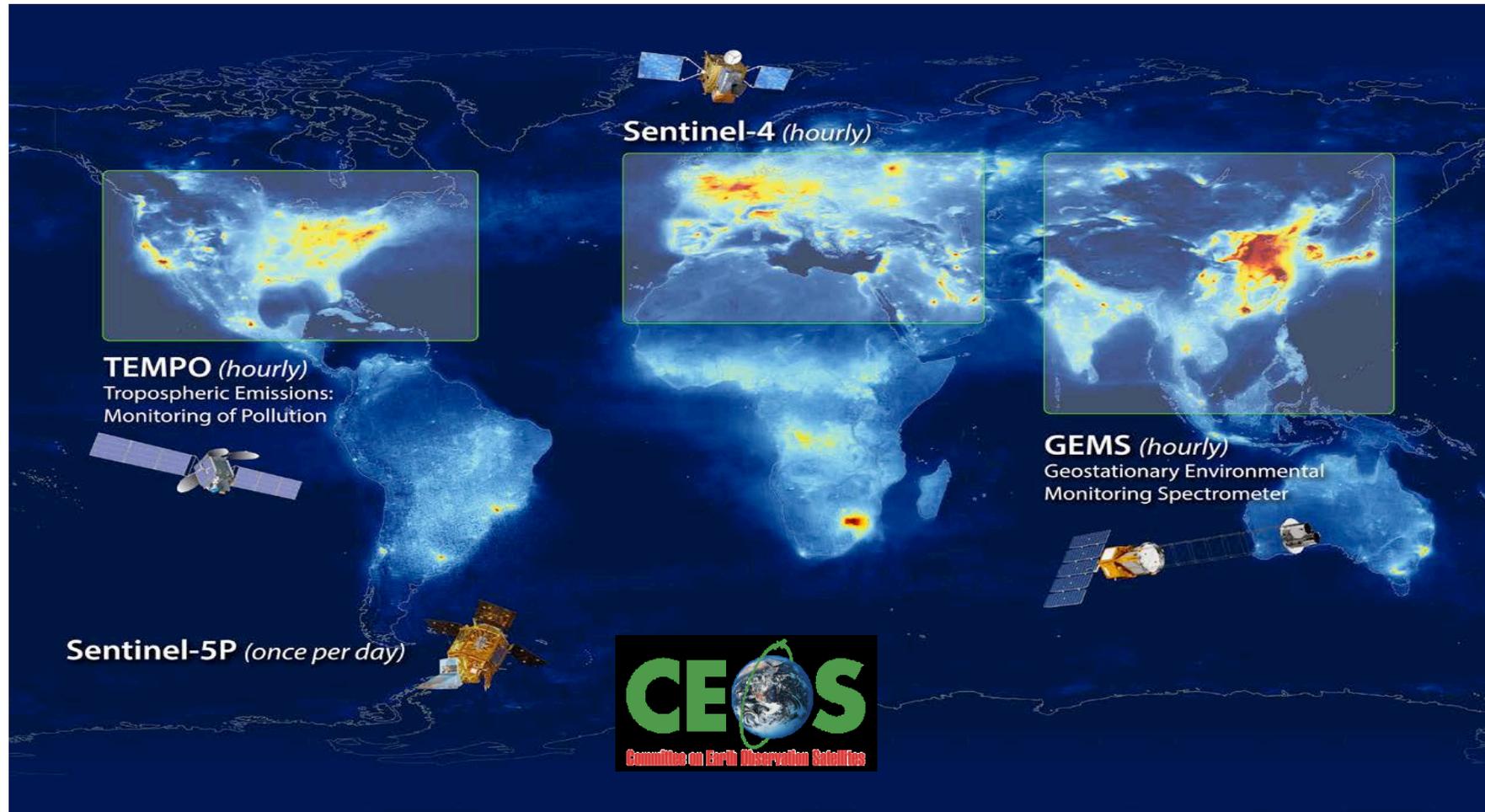


Scan to see a video on S4 instrument



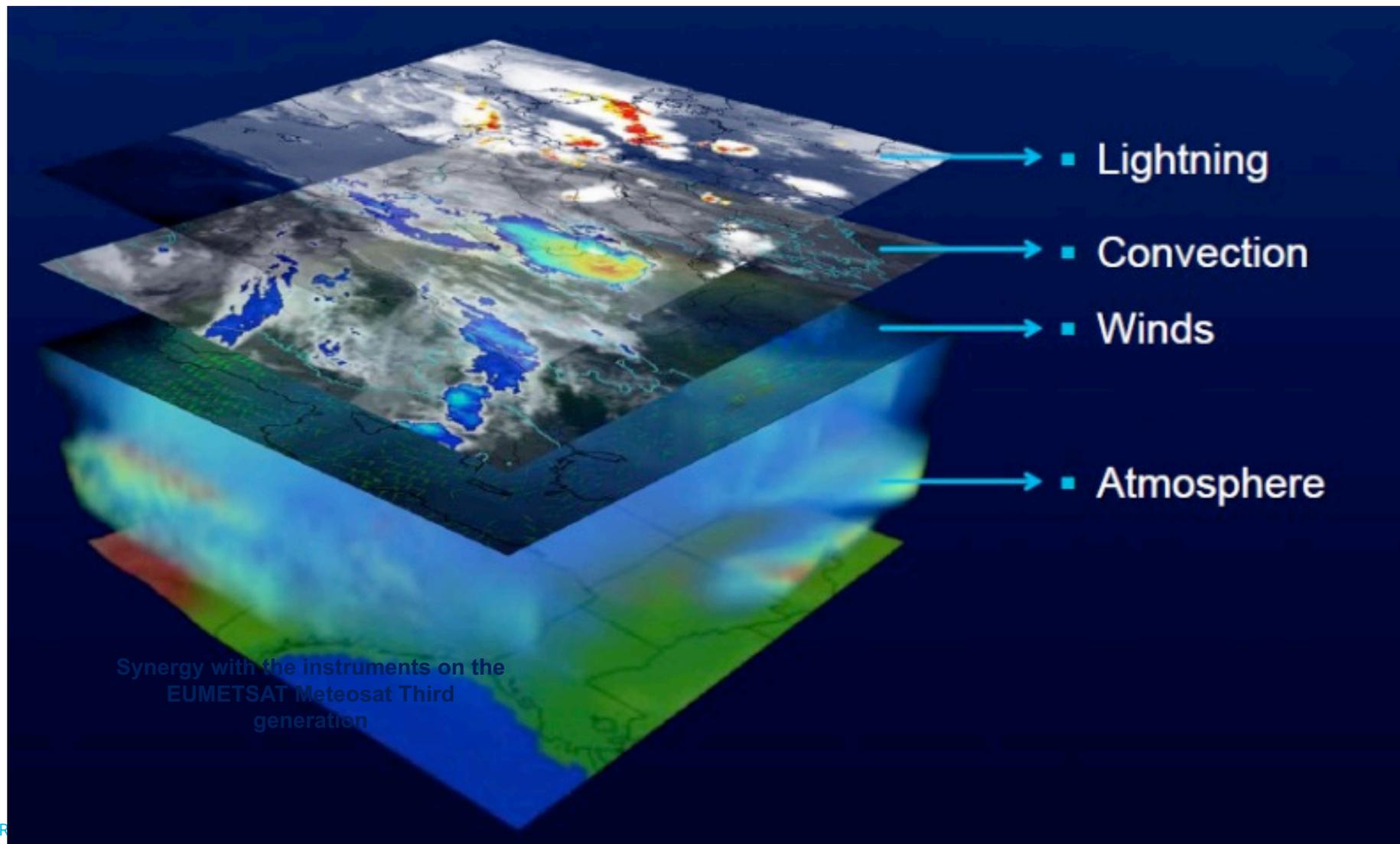
Sinergy – Constellation

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generation

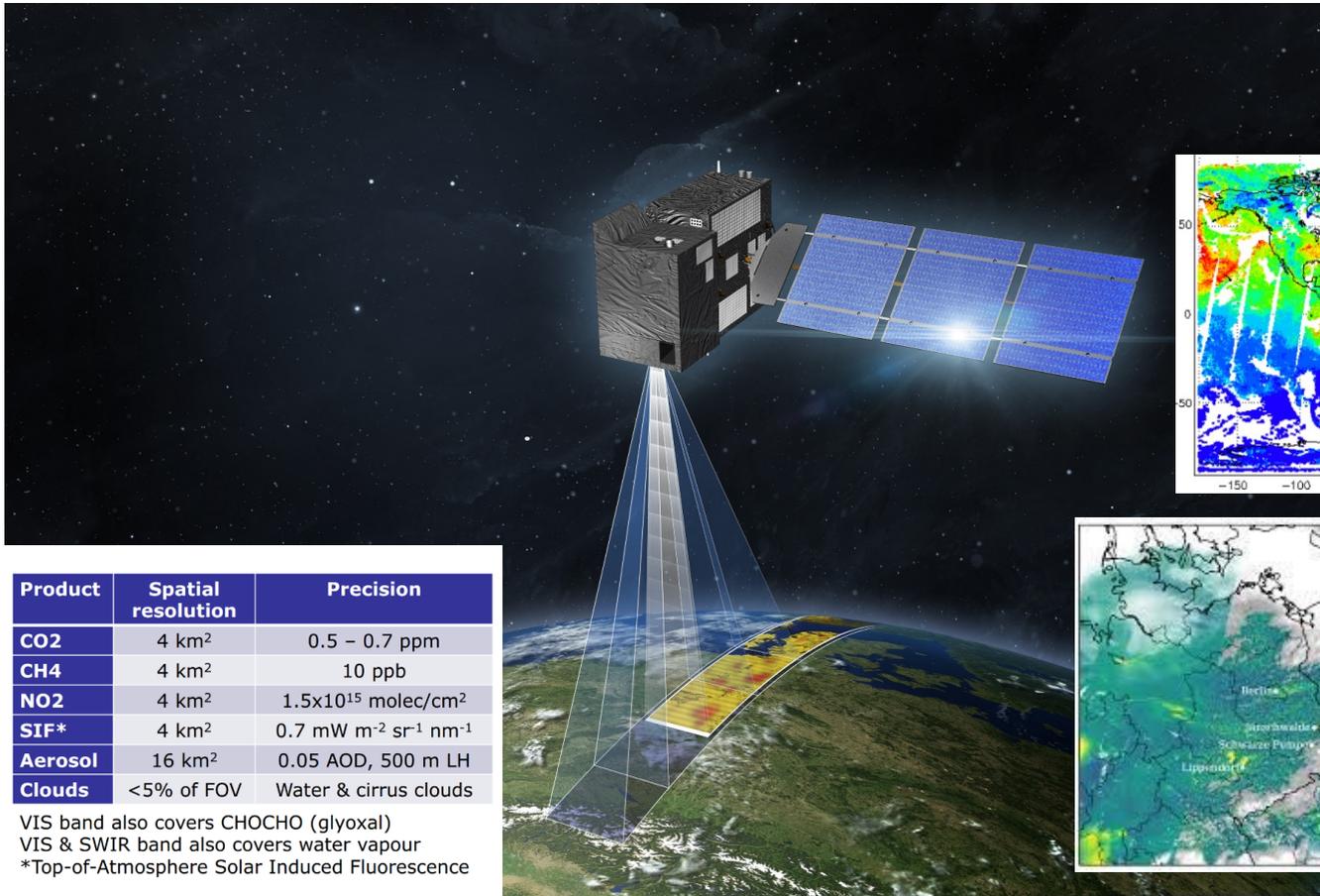
Sinergy – Weather Cube





Greenhouse gases – preparing for CO2M

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Product	Spatial resolution	Precision
CO ₂	4 km ²	0.5 – 0.7 ppm
CH ₄	4 km ²	10 ppb
NO ₂	4 km ²	1.5x10 ¹⁵ molec/cm ²
SIF*	4 km ²	0.7 mW m ⁻² sr ⁻¹ nm ⁻¹
Aerosol	16 km ²	0.05 AOD, 500 m LH
Clouds	<5% of FOV	Water & cirrus clouds

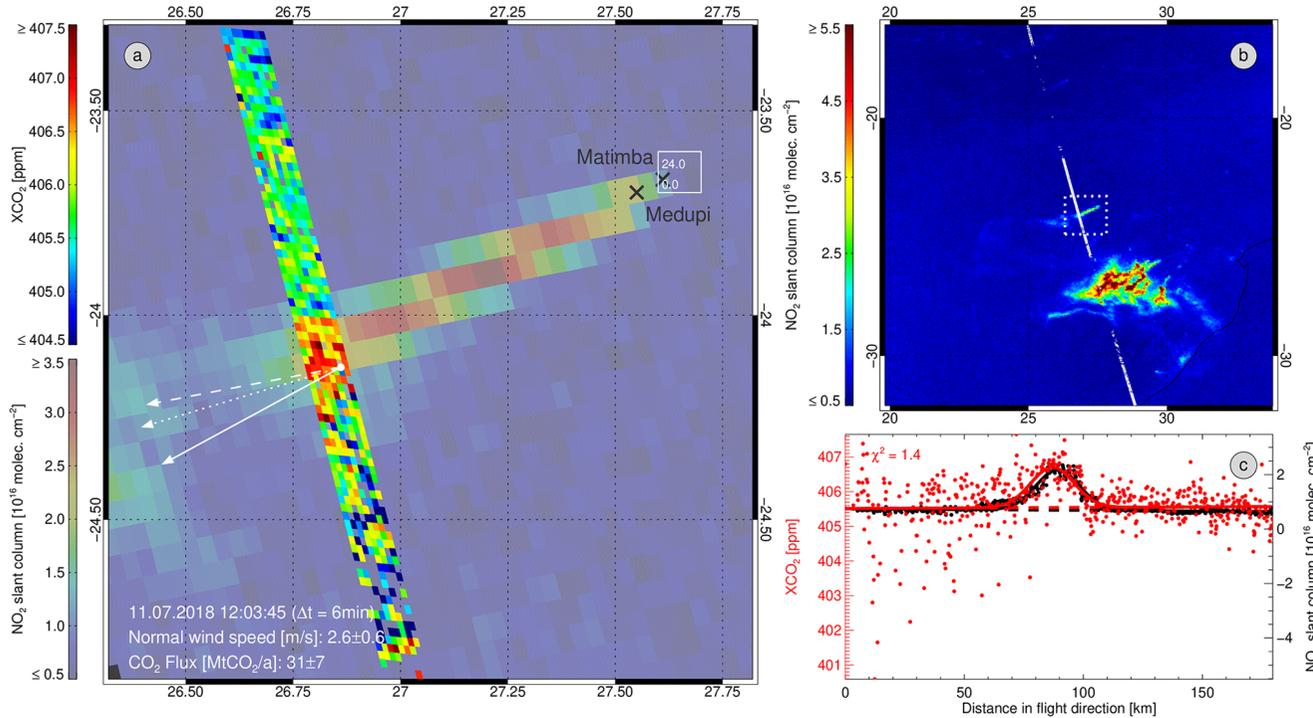
VIS band also covers CHOCHO (glyoxal)

VIS & SWIR band also covers water vapour

*Top-of-Atmosphere Solar Induced Fluorescence



Example: Monitoring Carbon Dioxide



Experimental study on Matimba Power Station



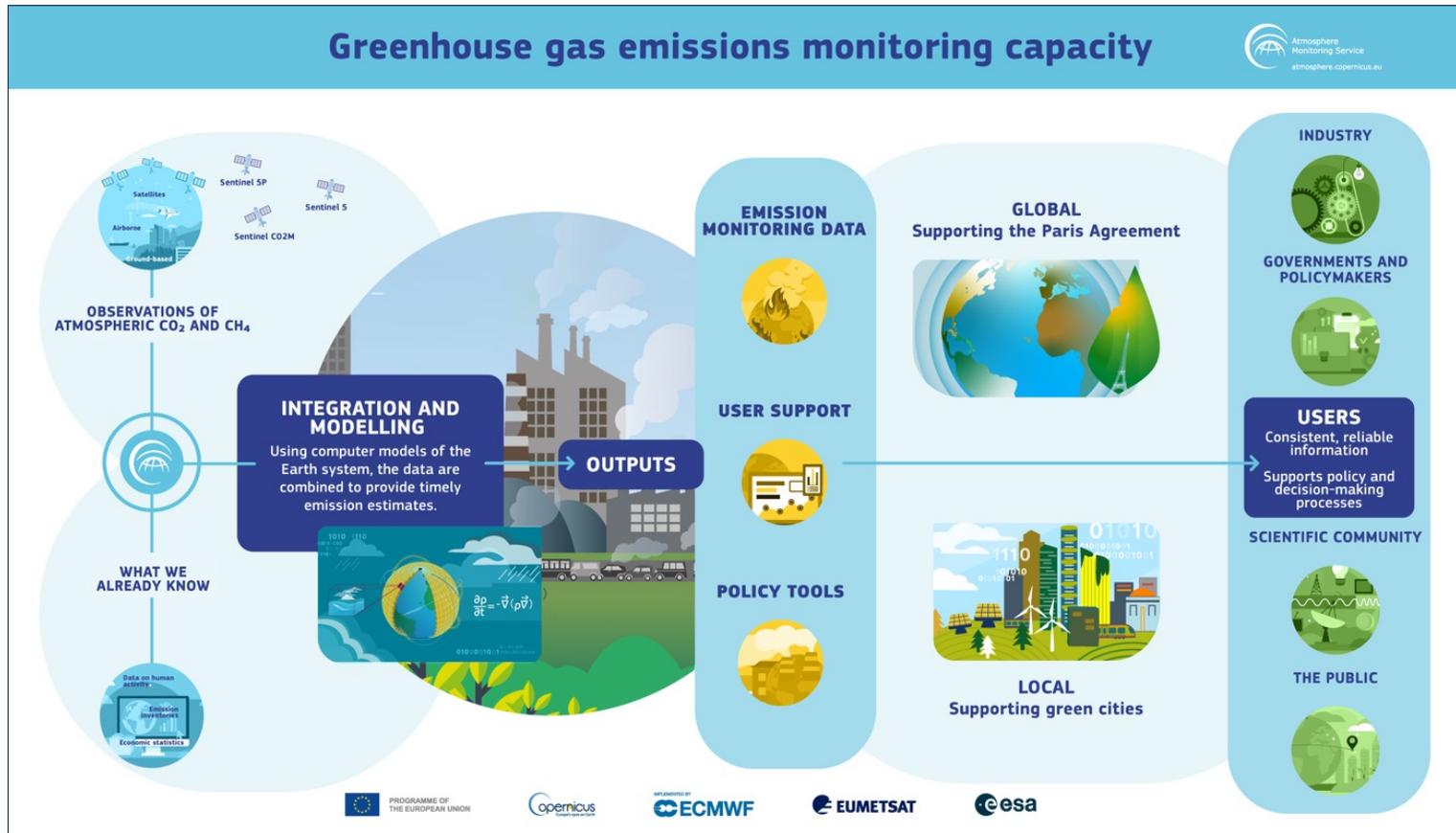
Nitrogen Dioxide from TROPOMI data
© Copernicus program & CO₂ from OCO2
Credit – Hakkarainen et al. 2020



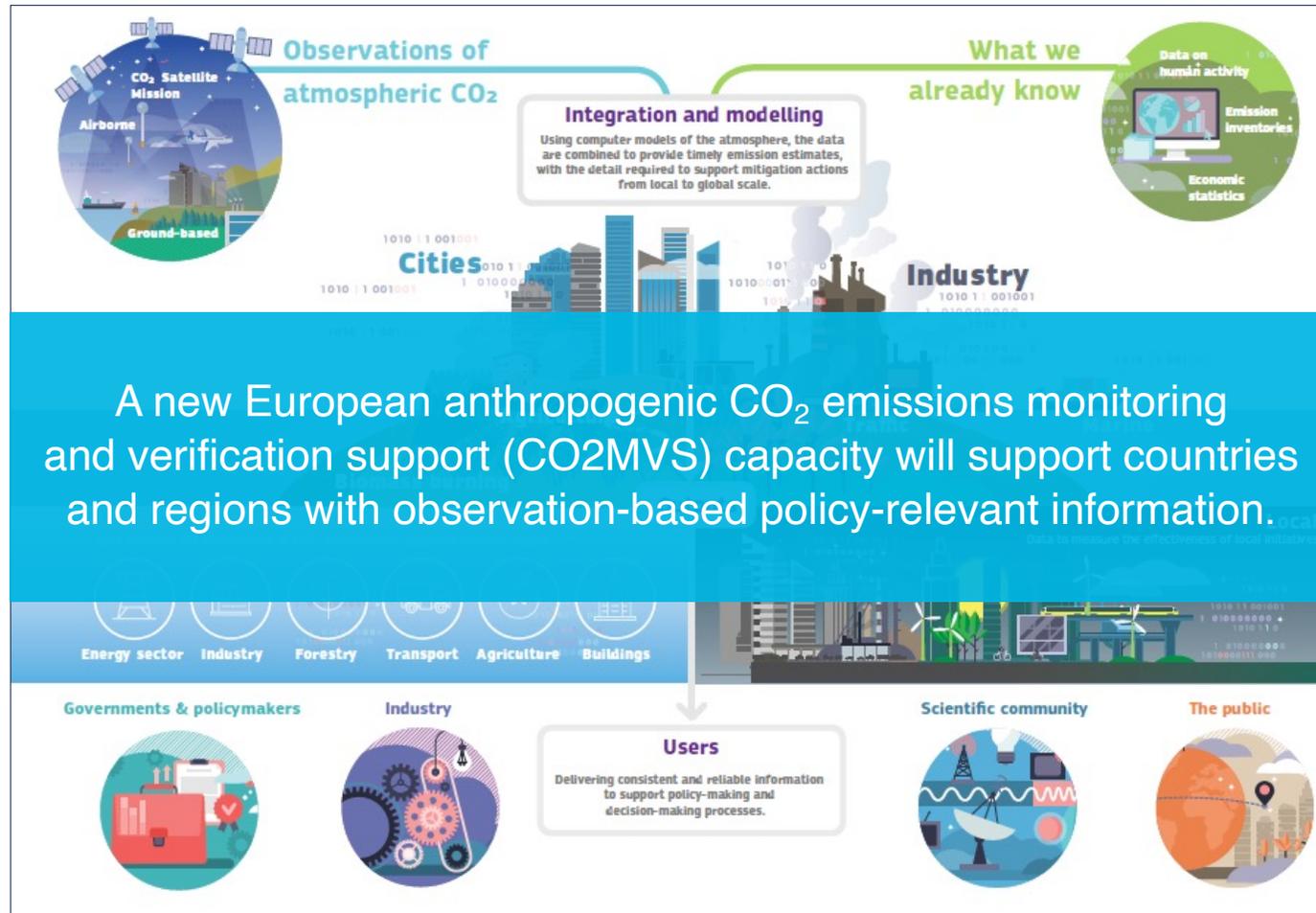
Atmosphere
Monitoring

CAMS: GHG MONITORING CAPACITY

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<https://atmosphere.copernicus.eu/ghg-services>





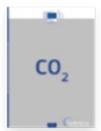
TIMELINE OF COPERNICUS CO2MVS

From expert groups through dedicated research funding, to operational services



Sentinel 5p

CO2 TASK FORCE GUIDANCE DOCUMENTS



2015



2017



2019



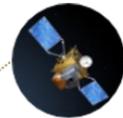
2017



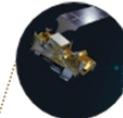
2018

RESEARCH AND PREPARATORY PROJECTS

SATELLITE MISSIONS



Sentinel 4



Sentinel 5



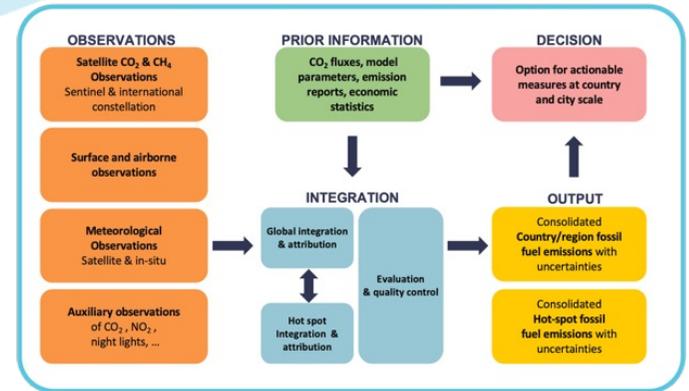
CO2 Mission

Operational ramp-up in CAMS

Air Quality emissions 2025

SERVICE COMPONENTS

CO₂ Monitoring & Verification Support (CO₂MVS)



2021 ICOS Cities



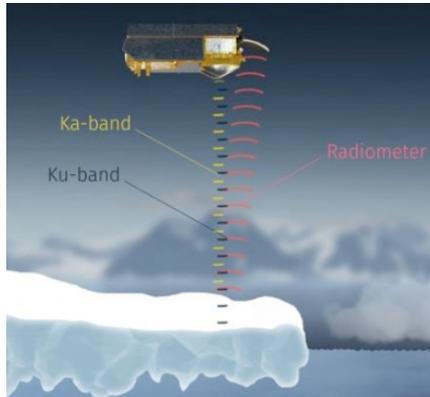
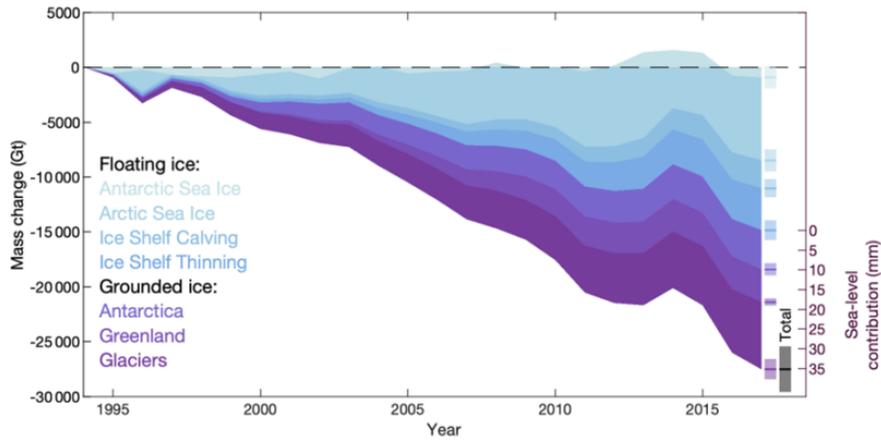
2022

CoCo2 Prototype system for a Copernicus CO₂ service

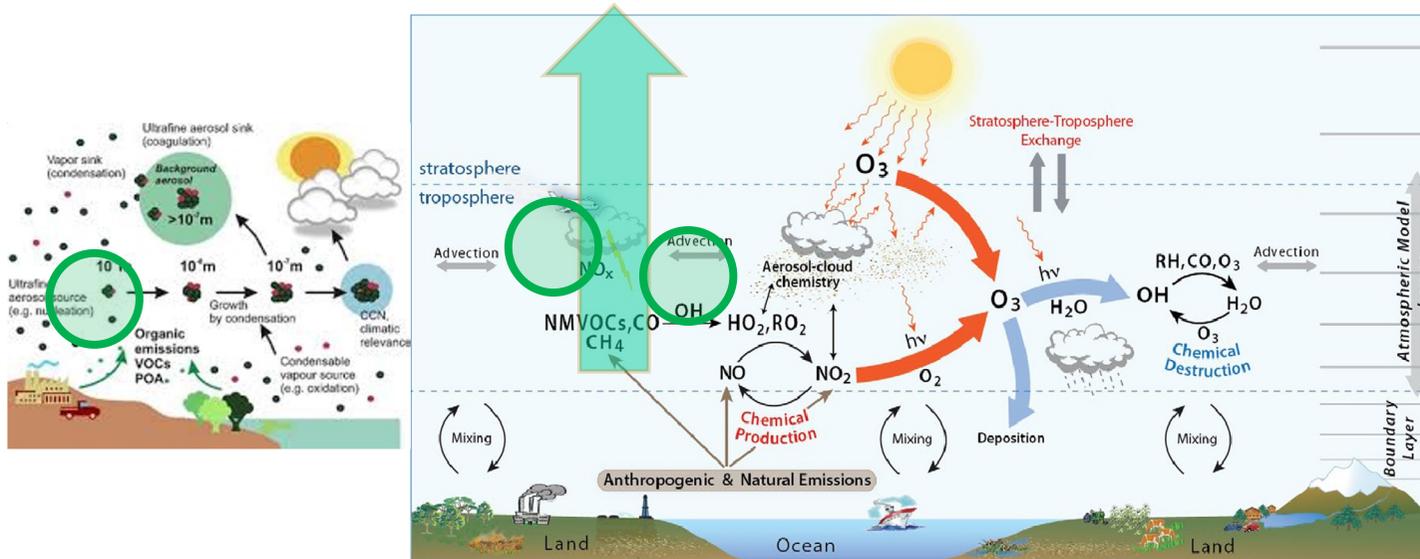
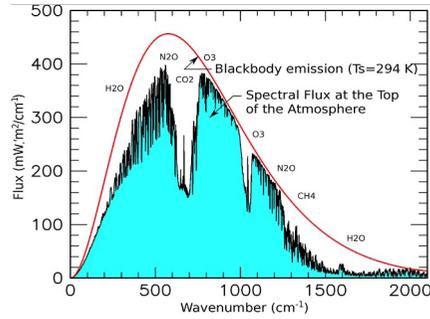


Copernicus expansion missions – focus on cryosphere

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What we see and what Satellites see



Programs are divided by orbit type ☺

Why monitoring from space?

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- Use data and algorithms instead of eyes
- Observe and measure from a distance without modifying the target
- Access to spatial and temporal scales impossible without the contribution of satellite
- Consistency of measurements worldwide

- *Low earth orbits (circling the earth)*

Advantages:

More near to Earth -> Higher spatial resolution
Used also for Active Obs.(Radar/Lidar) and PMW

Disadvantages:

Poorer time resolution -> needs of constellation



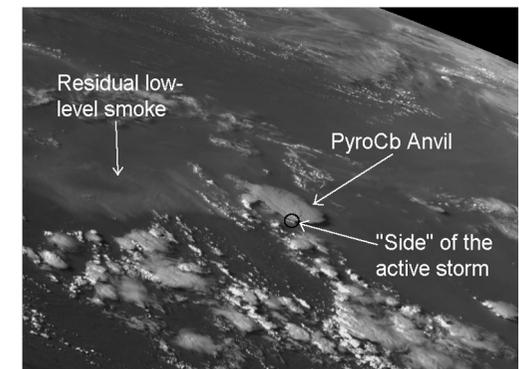
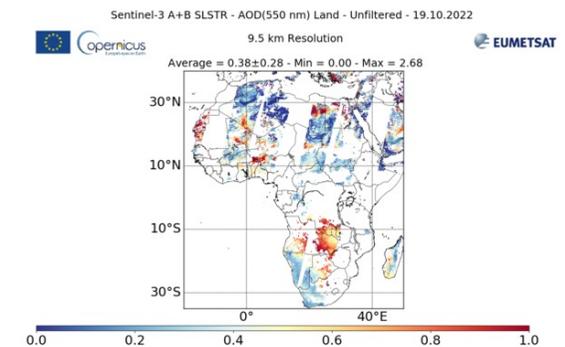
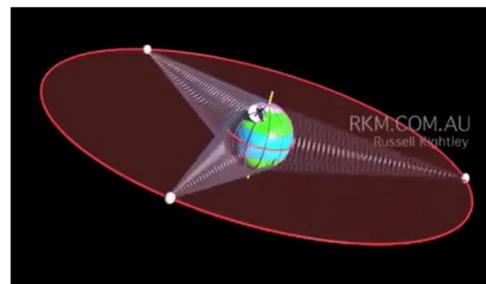
- *Geostationary (fixed position above earth)*

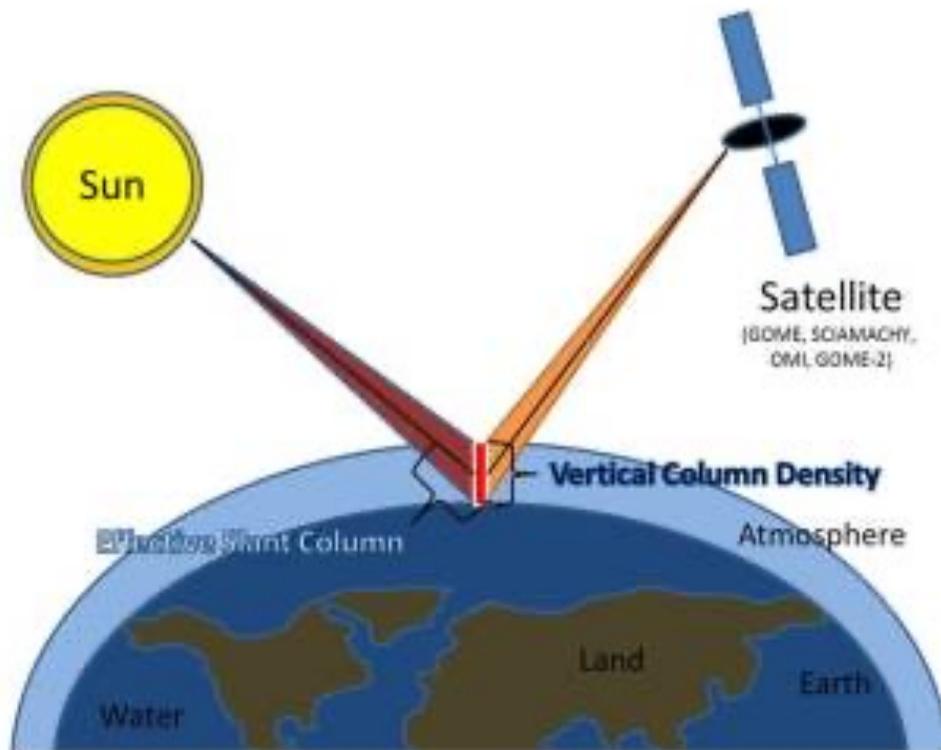
Advantages:

Better time resolution

Disadvantages:

One side of the Earth -> needs of constellations
large viewing angles at the borders -> geometrical distortions
Only VIS/IR and passive Obs.



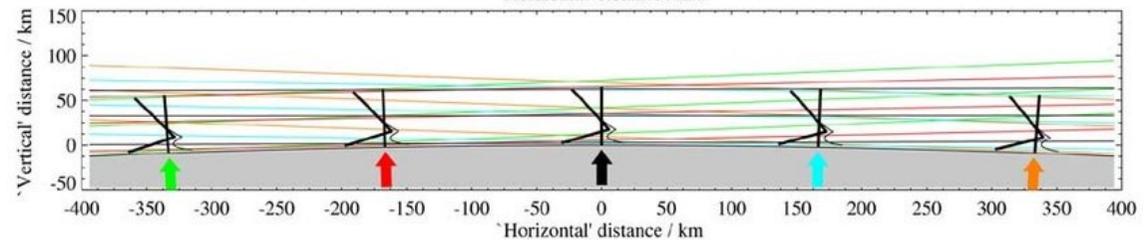
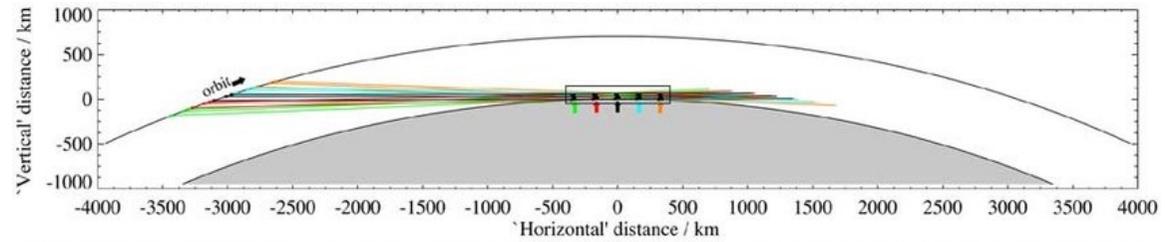
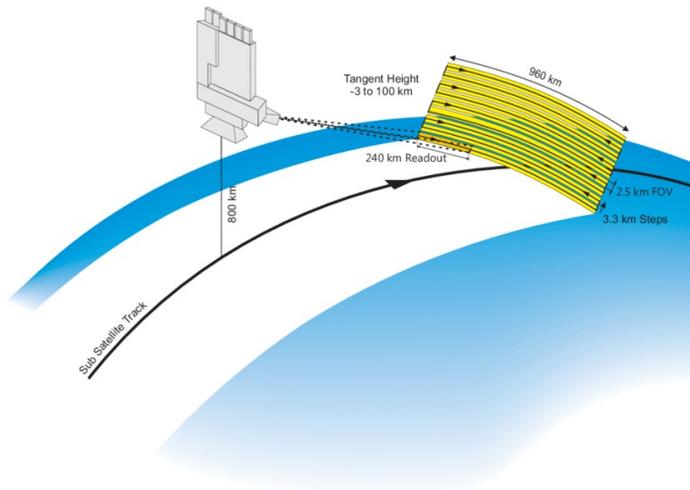


Satellite measurements
Radiation emerged from the
interaction with the
Atmosphere-Surface system

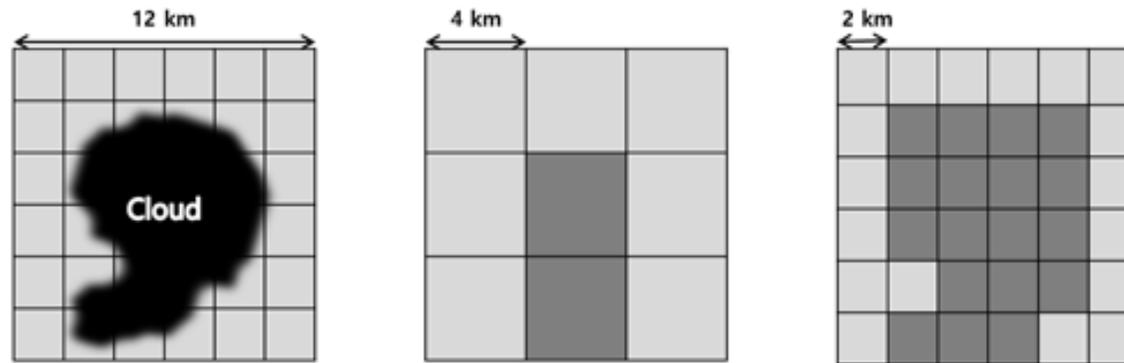
COMPARED TO

Modelled measurements
- A priori information on the
system (atmospheric
scenarios)
- Model of the system
(Forward model)

Limb scanning – vertical profiles



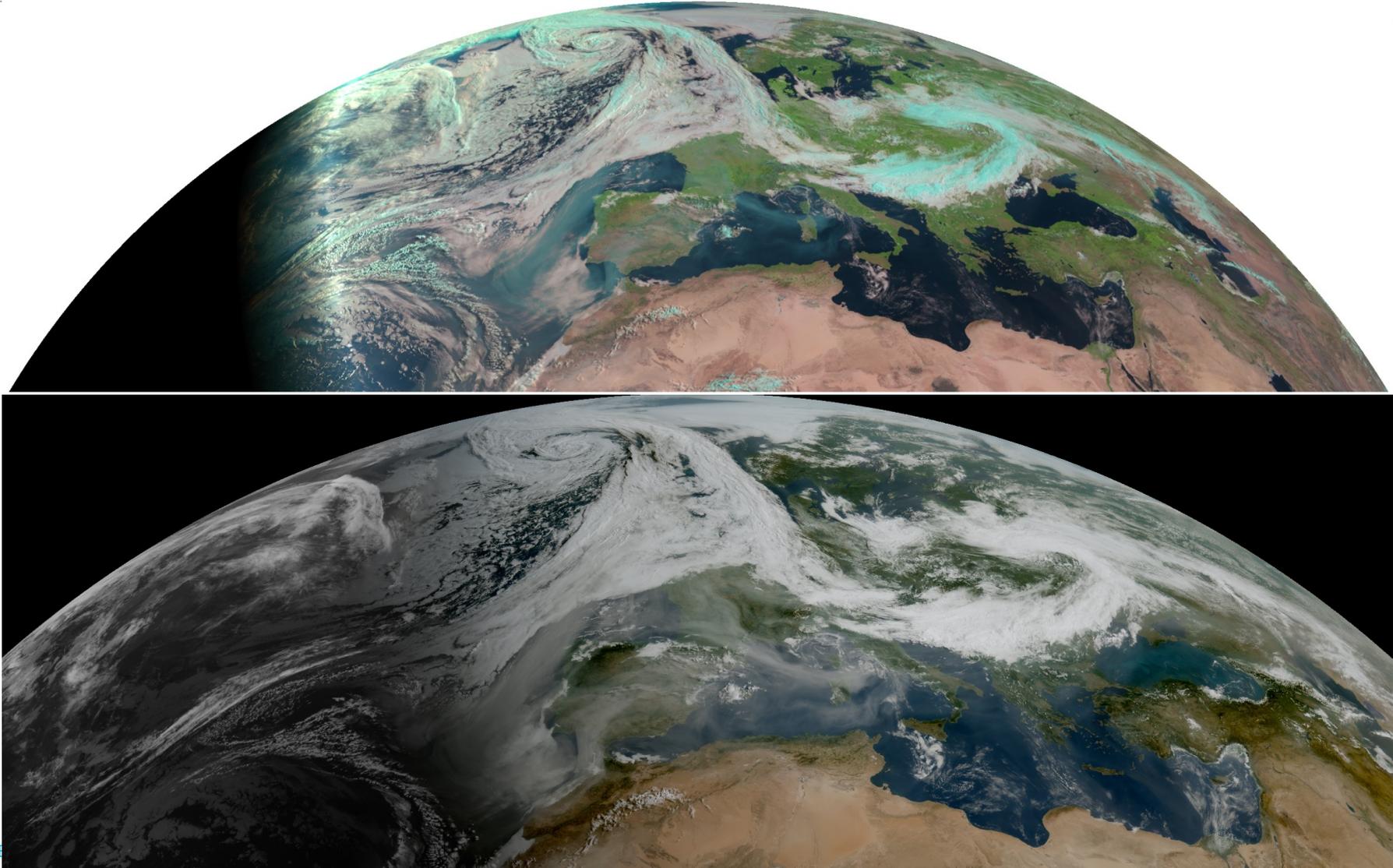
A question of resolution ...





Resolution – Third vs Second Gen ... MTG data are preliminary

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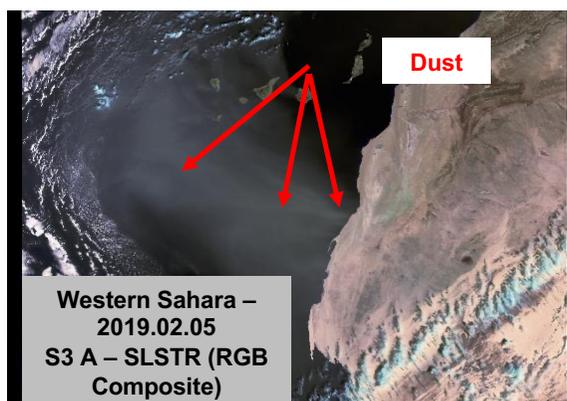


Observe smoke : In a nutshell

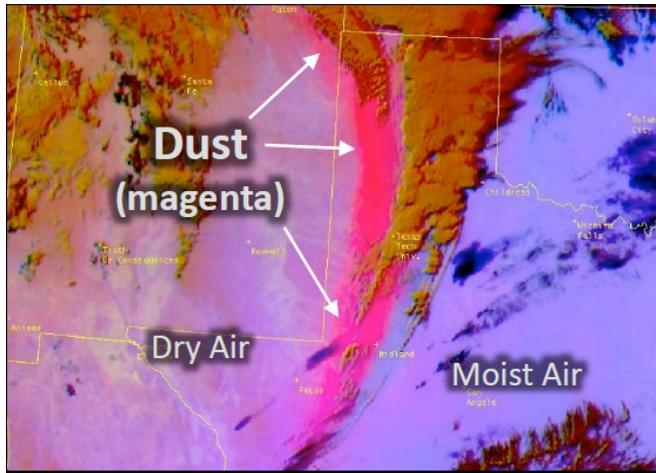
AOD (Aerosol Optical depth) = How much Solar light attenuated by aerosols?

- A proxy of the aerosol amount in air

Looking at the contrast between aerosol layer & the underlying surface



Dust measured on visible channels (RGB)



Limitations

High clouds obscure dust: High cloud cover can obscure dust plumes beneath them and make spatial analysis of the dust more difficult.



Dust thickness typically unknown: Magenta/pink variations in daytime are not indicators of thickness, but rather density. However, very thick dust plumes are purple in both day and night scenes.

Low clouds look like dust over oceans: Marine stratus over the ocean in the tropics appear light purple and can look similar in color to dust, particularly at night.

Dust RGB Recipe (GOES/ABI, H8/AHI)

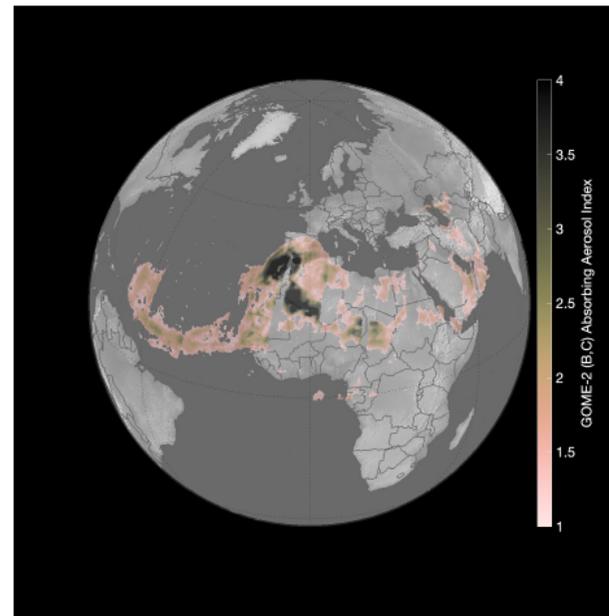
Color	Band / Band Diff. (μm)	Physically Relates to...	Small contribution to pixel indicates...	Large Contribution to pixel indicates...
Red	12.3-10.3	Optical depth / cloud thickness	Thin clouds	Thick clouds or dust
Green	11.2-8.4	Particle phase	Ice and particles of uniform shape (dust)	Water particles or thin cirrus over deserts
Blue	10.3	Surface temperature	Cold surface	Warm surface

Contributor: Kevin Fuell NASA SPoRT <https://weather.msfc.nasa.gov/sport/>

Aerosol measured on UV channels

Absorbing Aerosol Index (AAI)

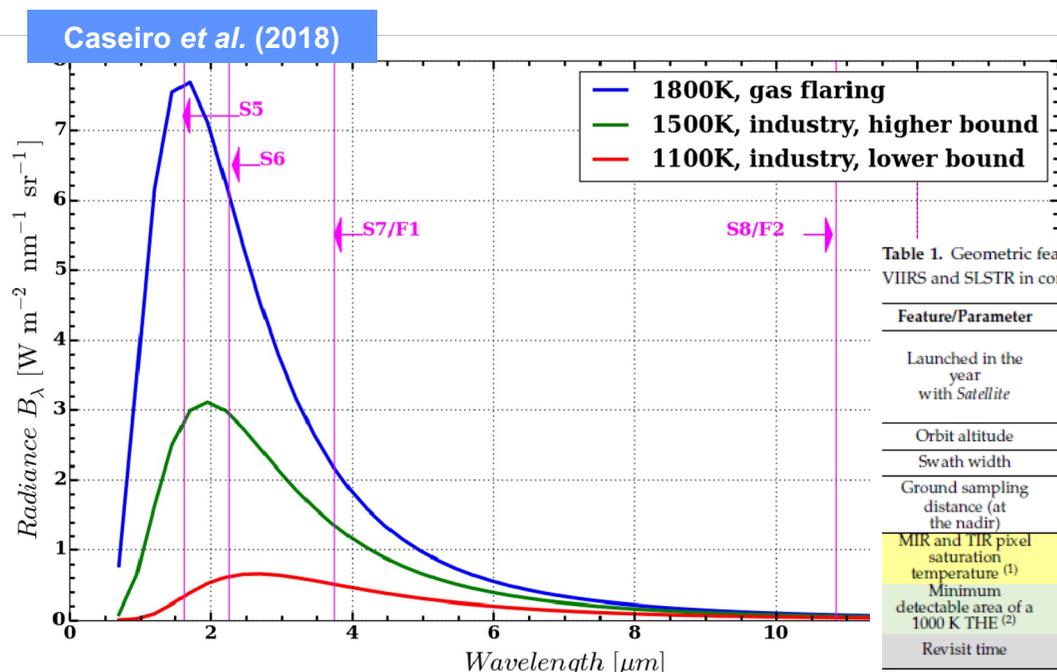
- Also known as UV Aerosol Index (UVAI)
- Defined using UV-wavelengths (typically 340 – 380 nm; **GOME-2**, **TROPOMI**, OMI, OMPS)
- Sensitive to **absorbing** aerosols: smoke, volcanic ash, desert dust
- AAI separates the spectral contrast at two **UV wavelengths** caused by aerosol extinction from that of other effects (e.g. molec. scattering)
- Can be obtained also for cloudy scenes, where aerosols are on top of clouds.



➔ **AAI is a good tracer for dust, smoke and ash plumes**

Fire Hot-Spot from space – In a nutshell

- A hot spot radiates a strong heating signal.
- Looking at the temperature contrast between the local hot-spot pixel and the surrounding background



- Hot-spot more emissive than the ambient background

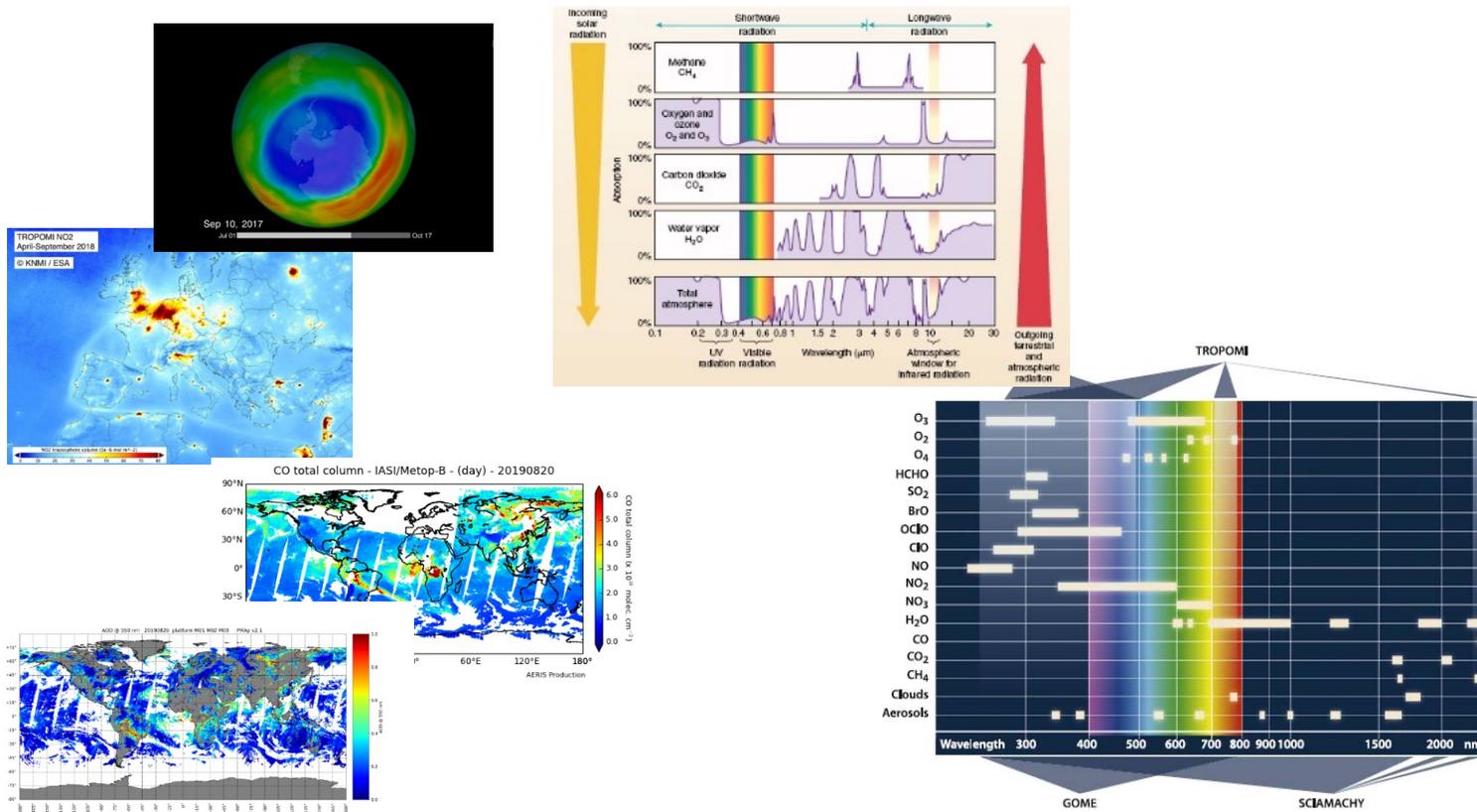
- **N = 100 => TIR (112 μm)**
- **N = 1000 => MWIR (3.7 μm)**
- **N >> 1000 => SWIR (1.5-2.25 μm)**

Table 1. Geometric features and further sensor parameters of the operational IR sensors MODIS, VIIRS and SLSTR in comparison with HRSR, flown on BIRD, TET-1 and BIROS.

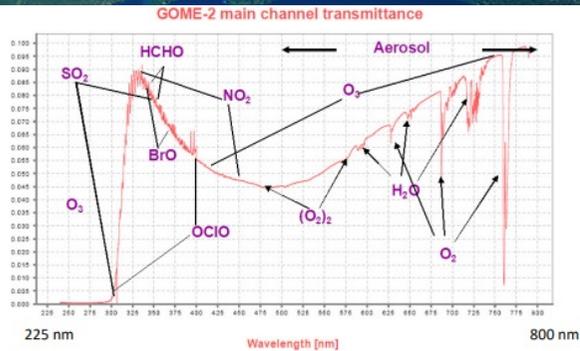
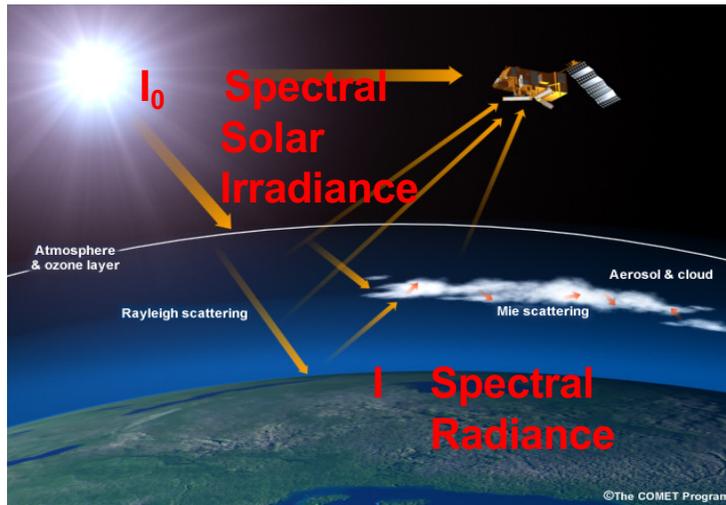
Feature/Parameter	MODIS	VIIRS	SLSTR	HRSR
Launched in the year with Satellite	1999 "Terra", 2002 "Aqua", i.e., two nearly identical instruments	2011 "Suomi NPP", 2017 "NOAA-20"	2015 "Sentinel-3A", 2018 "Sentinel-3B"	2001 "BIRD" 2012 "TET-1" 2016 "BIROS"
Orbit altitude	705 km	829 km	815 km	500–560 km
Swath width	2330 km	3060 km	1407 km	162–178 km
Ground sampling distance (at the nadir)	1000 m	375 m	1000 m	170–185 m
MIR and TIR pixel saturation temperature ⁽¹⁾	MIR: 450 K, TIR: 400 K	MIR: 367 K, TIR: 300 K	MIR: 500 K, TIR: 400 K	MIR: 630 K TIR: 600 K
Minimum detectable area of a 1000 K THE ⁽²⁾	~150 m ²	~20–30 m ²	~150 m ²	15–20 m ²
Revisit time	12 h (achieved with two instruments)	12 h	24 h	12 h–3 d ⁽³⁾

⁽¹⁾ In the IR bands used for observation of high-temperature events (HTEs), ⁽²⁾ at 300 K background temperature, see also Figure 15a in [3] for more details. ⁽³⁾ The revisit time of BIRD, TET-1 and BIROS is/was variable due to the possibility to move the line of sight (LoS) by +/- 30° from the nadir. This "roll-movement" of the LoS is a tool to enhance the field of regard (FoR) of the satellite sensor. This also allows observing an area of interest (AoI) three times within 3 days.

We walk the line ... chemistry – air quality climate

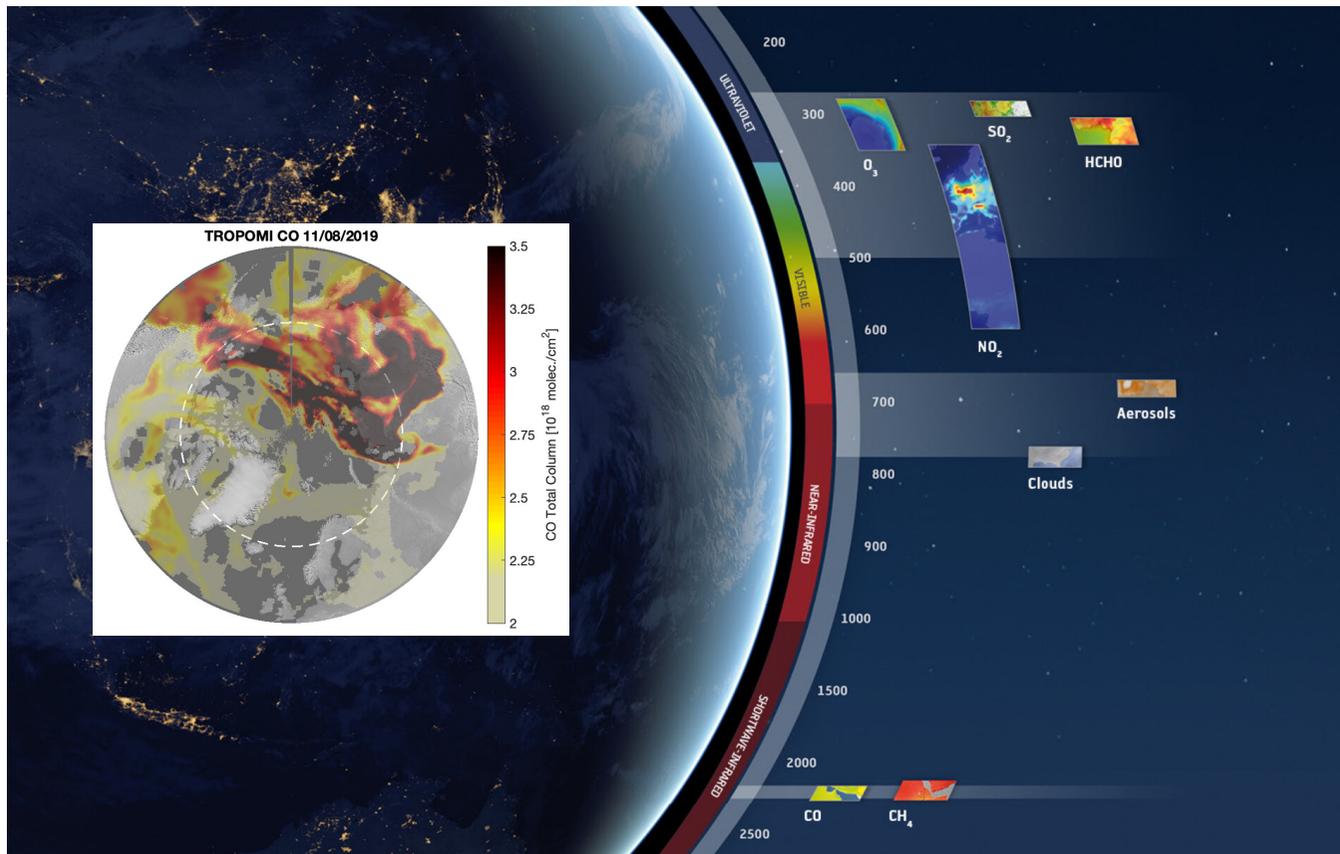


GOME-2 a good example for UV-VIS

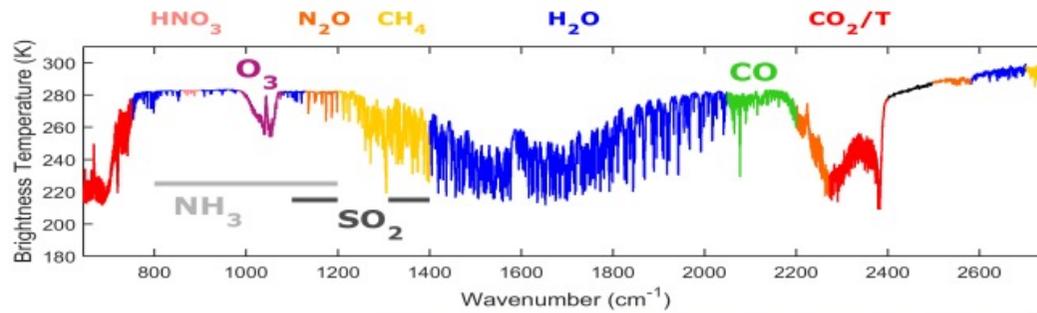


- Satellites provide amount of specific gas in total column / tropospheric column
- Satellite observation \neq surface concentration
- Even though satellites have limited sensitivity close to surface concentrations, to a high degree satellites tell “the same story” as surface measurements.
- Observations can be limited by cloudiness and or polar winter (UV-VIS)
- Wind information is often very useful when analysing the data

Observe gaseous species: example of TROPOMI

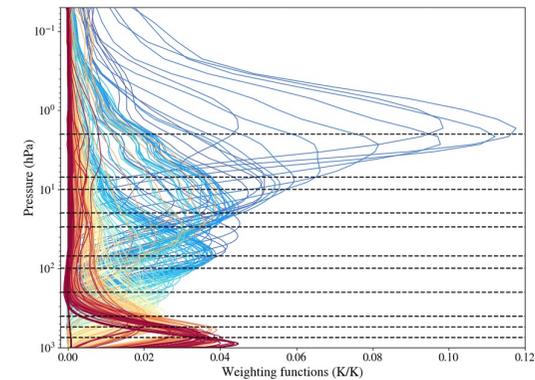
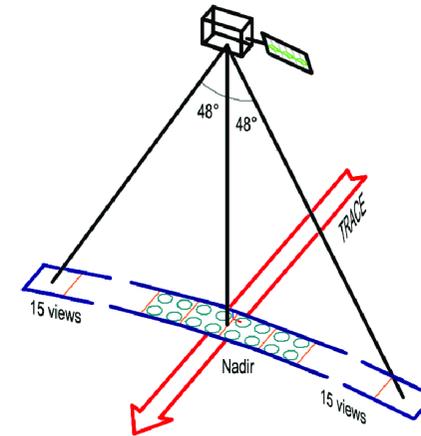


IASI on-board METOP-ABC

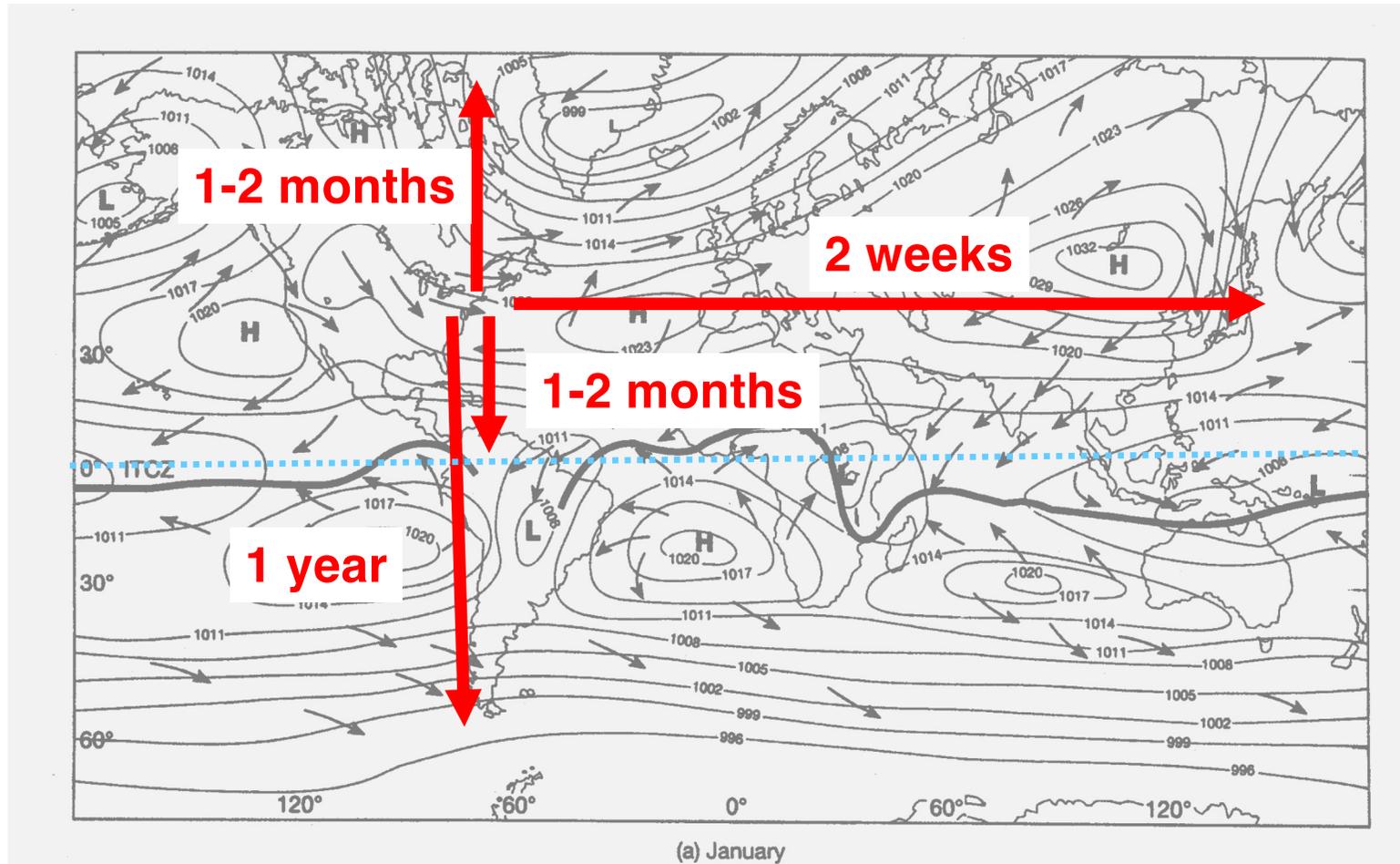


Now 33 species measured or *detected* by IASI

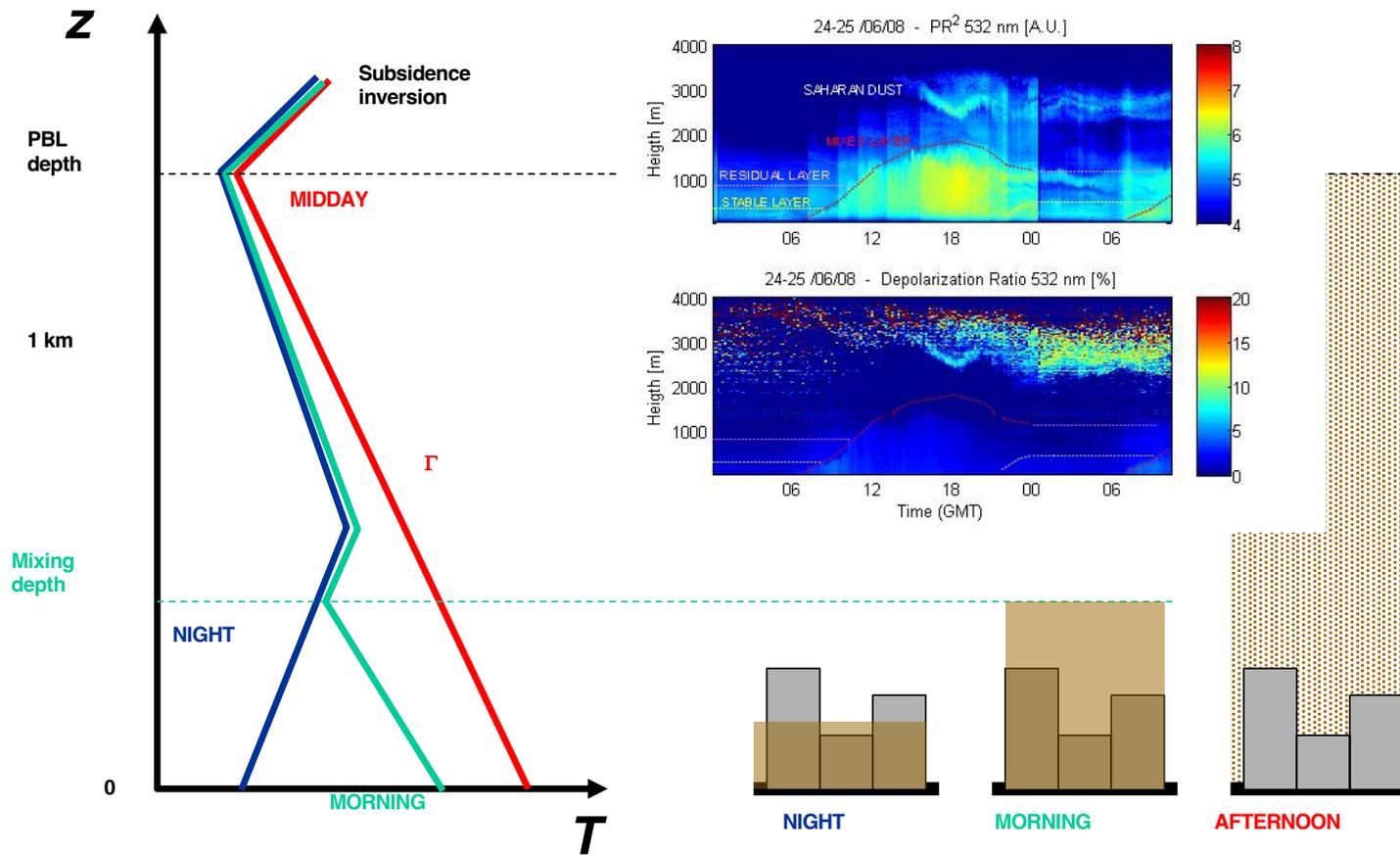
Greenhouse gases and ozone-related substances (13)	H ₂ O, CO ₂ , CH ₄ , N ₂ O, O ₃ , HNO ₃ , CFC-11, CFC-12, HCFC-22, CF ₄ , SF ₆ , CCl ₄ , HFC-134a
Air quality and VOCs (12)	CO, CH ₃ OH, HCOOH, CH ₃ COOH, CH ₃ COCH ₃ , C ₂ H ₂ , C ₂ H ₄ , NH ₃ , HCN, PAN, SO ₂ , OCS
Concentrated plumes (6)	HCl, H ₂ S, C ₃ H ₆ , C ₄ H ₄ O, HONO, HCHO

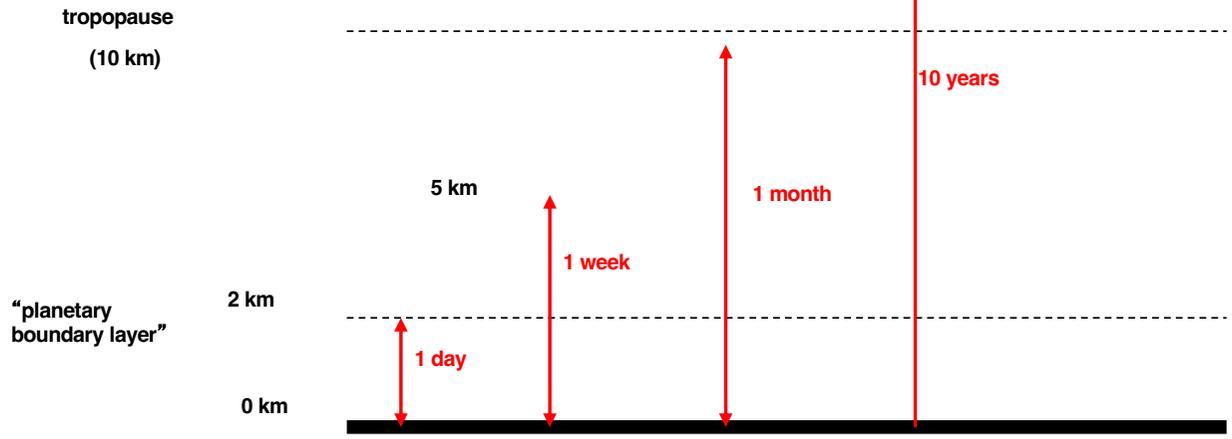
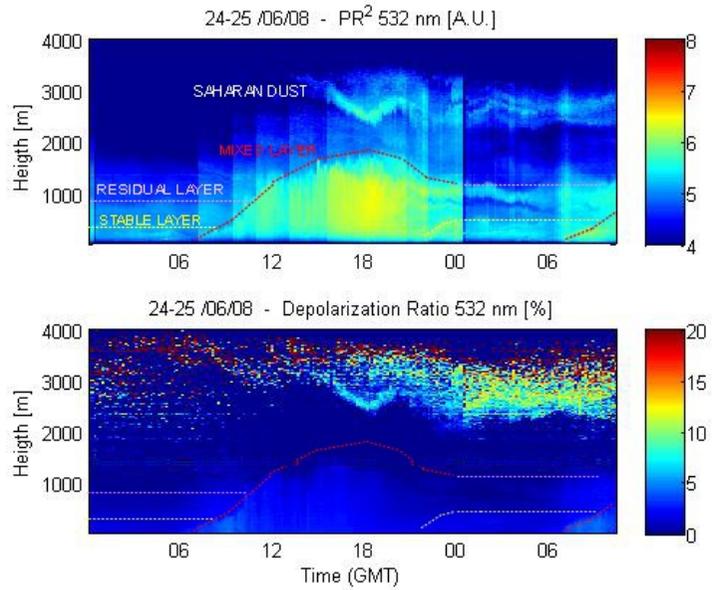


TIME SCALES FOR HORIZONTAL TRANSPORT (TROPOSPHERE)

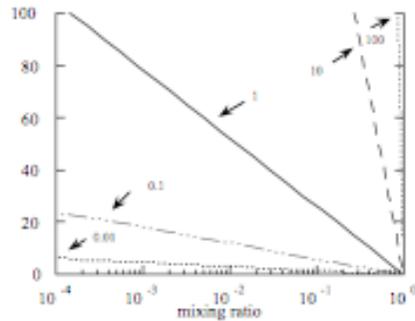


DIURNAL CYCLE OF SURFACE HEATING/COOLING: ventilation of urban pollution





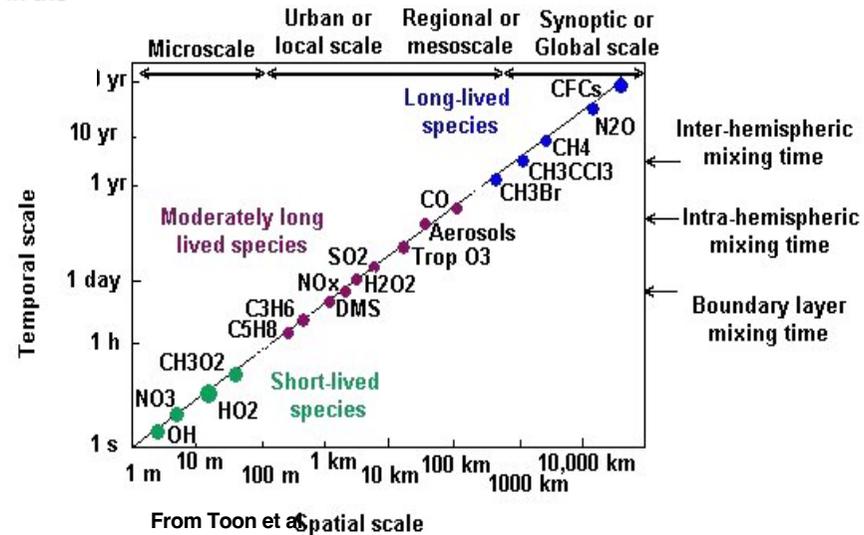
Chemical vs. transport lifetime

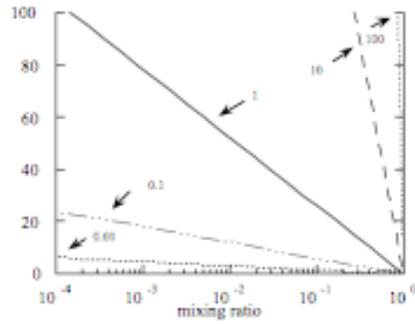


- When the chemical lifetime is 100 times larger than the dynamical lifetime, materials will have an almost constant mixing ratio to nearly 100 km altitude.
- However, when the chemical lifetime is 1% of the dynamical lifetime the mixing ratio falls very rapidly in the troposphere.

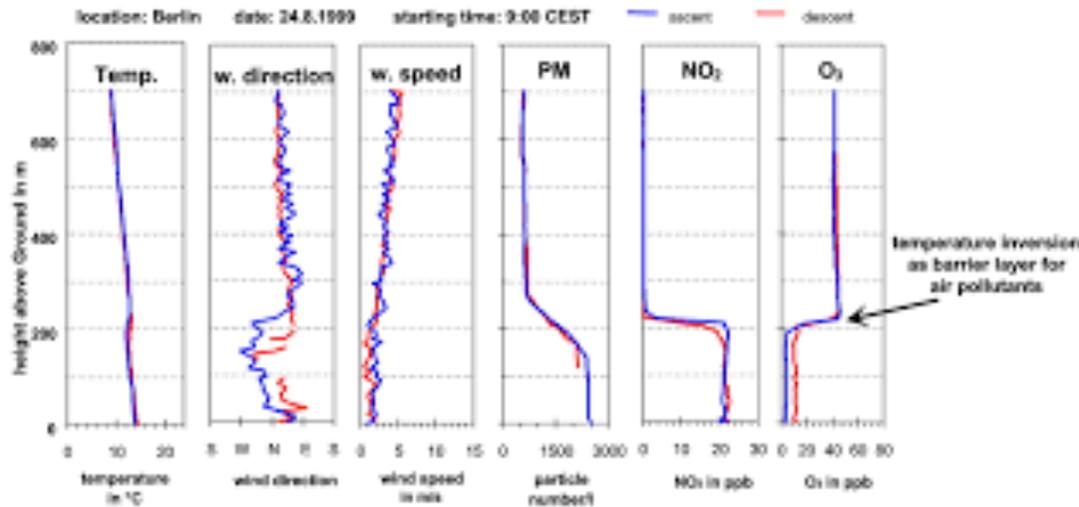
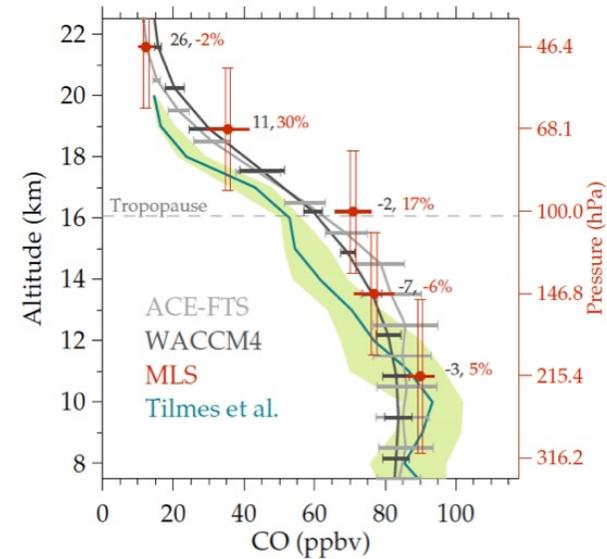
Lifetimes of some interesting materials

Material	M_w Abundance (Tg)	P_w Source (Tg/yr)	t_c Lifetime (yr)
H ₂ O	1.3×10^7	5×10^6	0.025
CH ₄	5×10^6	555	10
CO ₂	5.2	1.2	4.3
SO ₂	0.6-0.9	200	.003-.005
N ₂ O	2.5×10^3	12-21	120
CFC-11	8.2	0.25	50
CFC-12	10.3	0.37	102
CH ₂ Cl	5	3.5	1.5
NaCl	3.8	1300	0.003

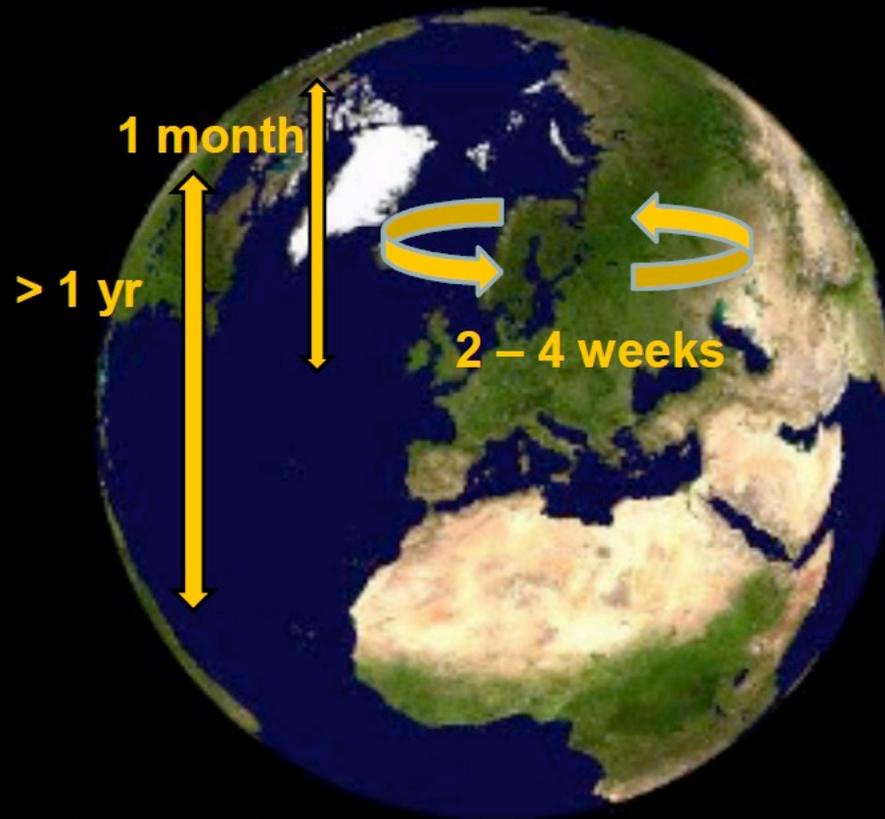




• When the chemical lifetime is 100 times larger than the dynamical lifetime, materials will have an almost constant mixing ratio to nearly 100 km altitude.
 • However, when the chemical lifetime is 1% of the dynamical lifetime the mixing ratio falls very rapidly in the troposphere.



Atmospheric lifetime



Climate gases

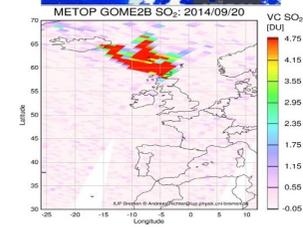
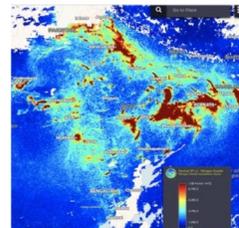
H₂O
CO₂, NO₂ [100 yr]
CH₄ [10 yr]
(O₃)

Pollutants

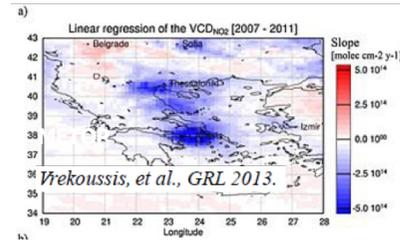
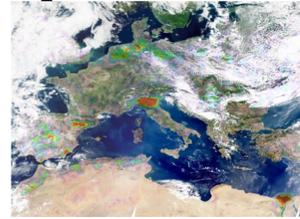
CO [4-8 weeks]
O₃ [weeks]
NO₂ [days]
Formaldehyde,
methanol, formic
acid [days]
NH₃ [hours – days]

C. Clerbaux 2015

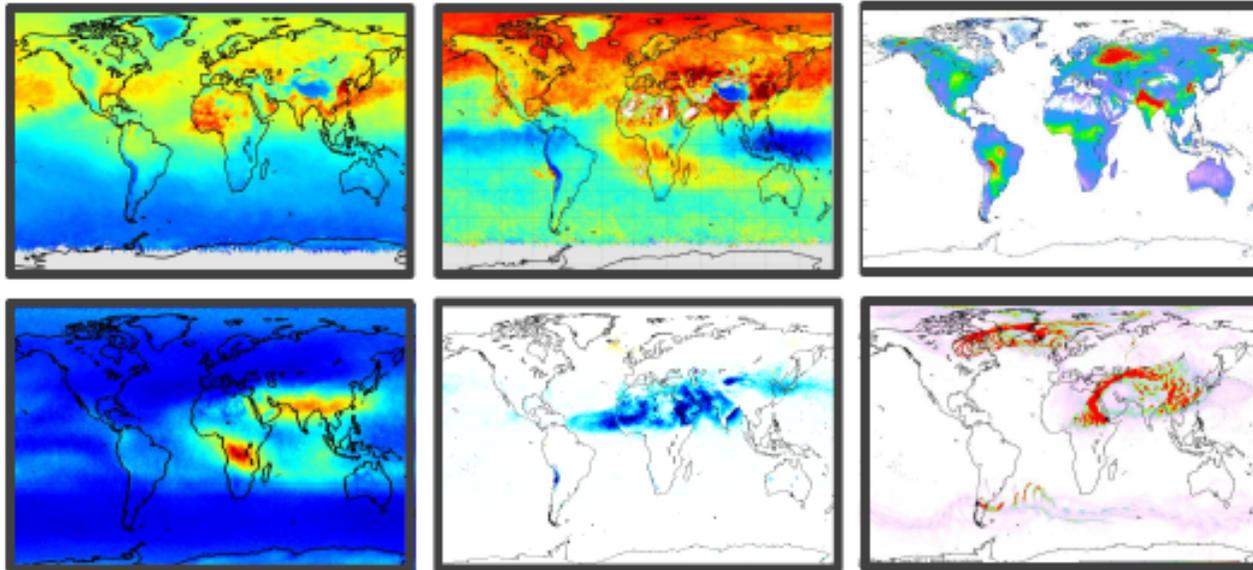
What can be observed from space ?



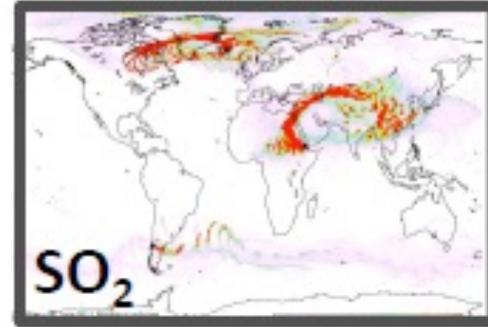
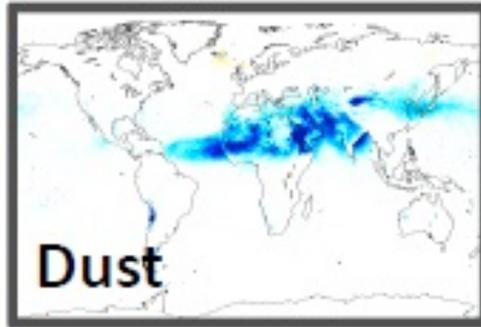
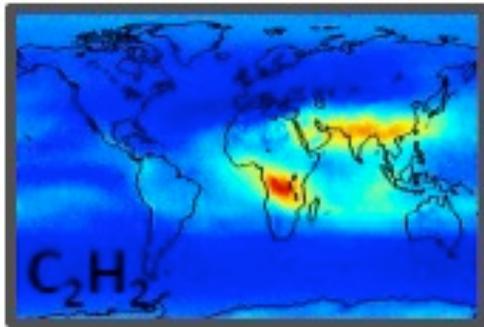
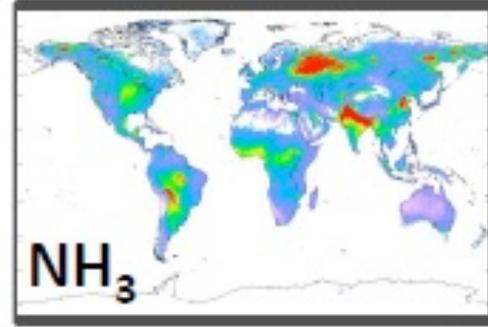
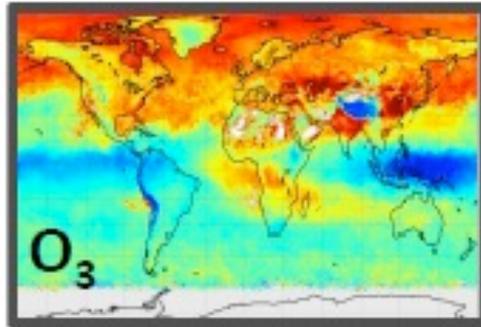
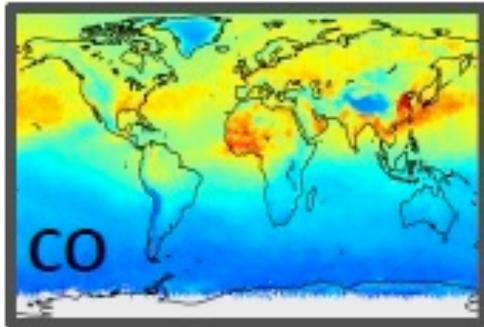
What can be observed from space ?



Whose map is it (retrieved from TIR IASI)?

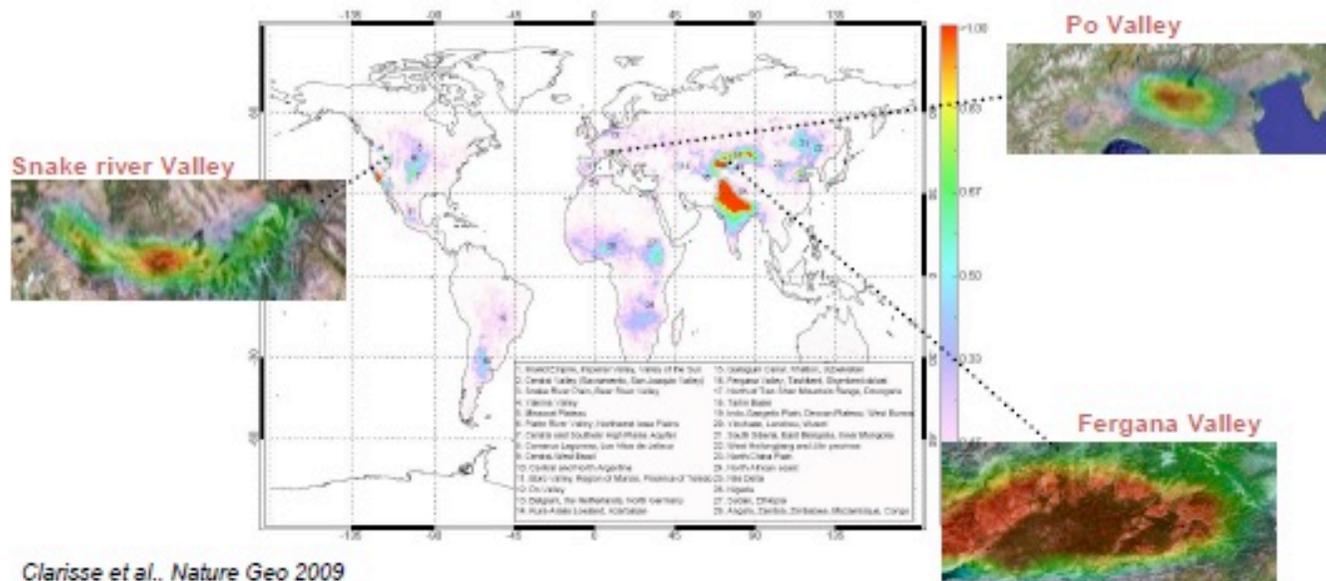


Tropo O₃, C₂H₂, column CO column, ammonia column ?
Ash-volcano, dust (sand) ?



Ammonia

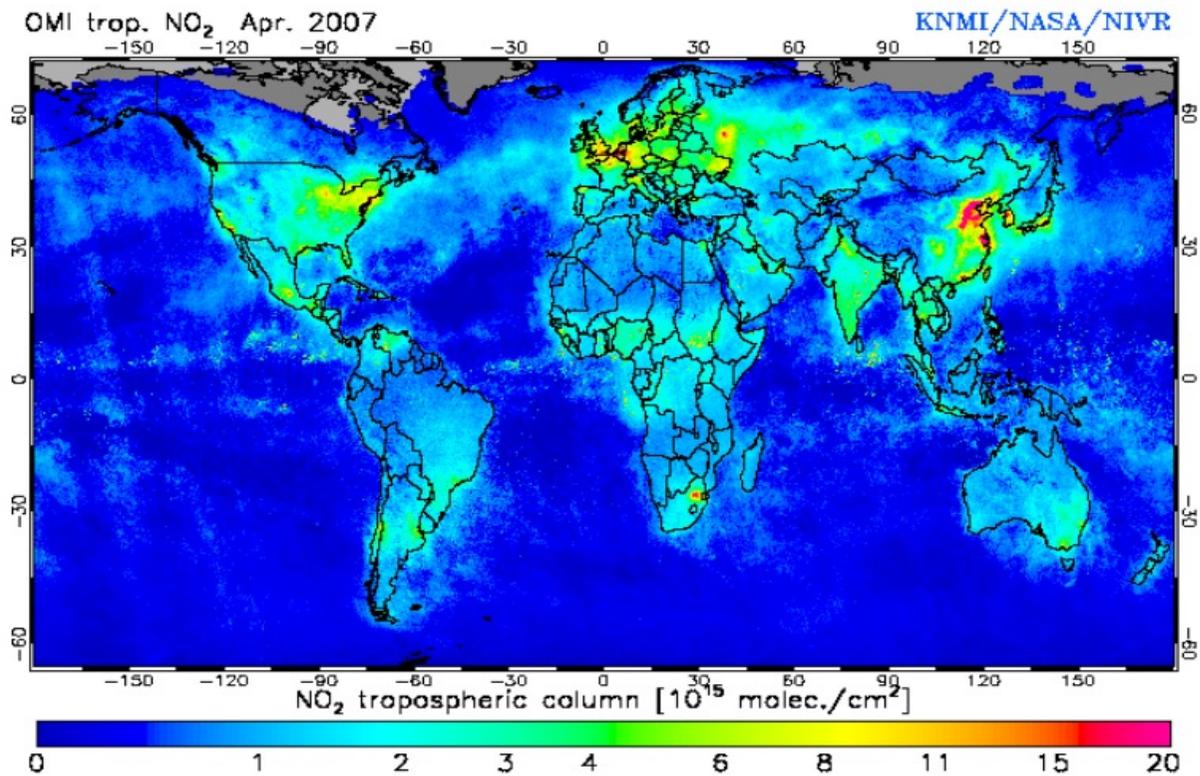
Mapping from local to global scale
 → 28 emission hotspots identified



Clarisse et al., Nature Geo 2009

NO₂ emitted by combustion, has atmospheric lifetime ~ 1 day:
strong gradients away from source regions

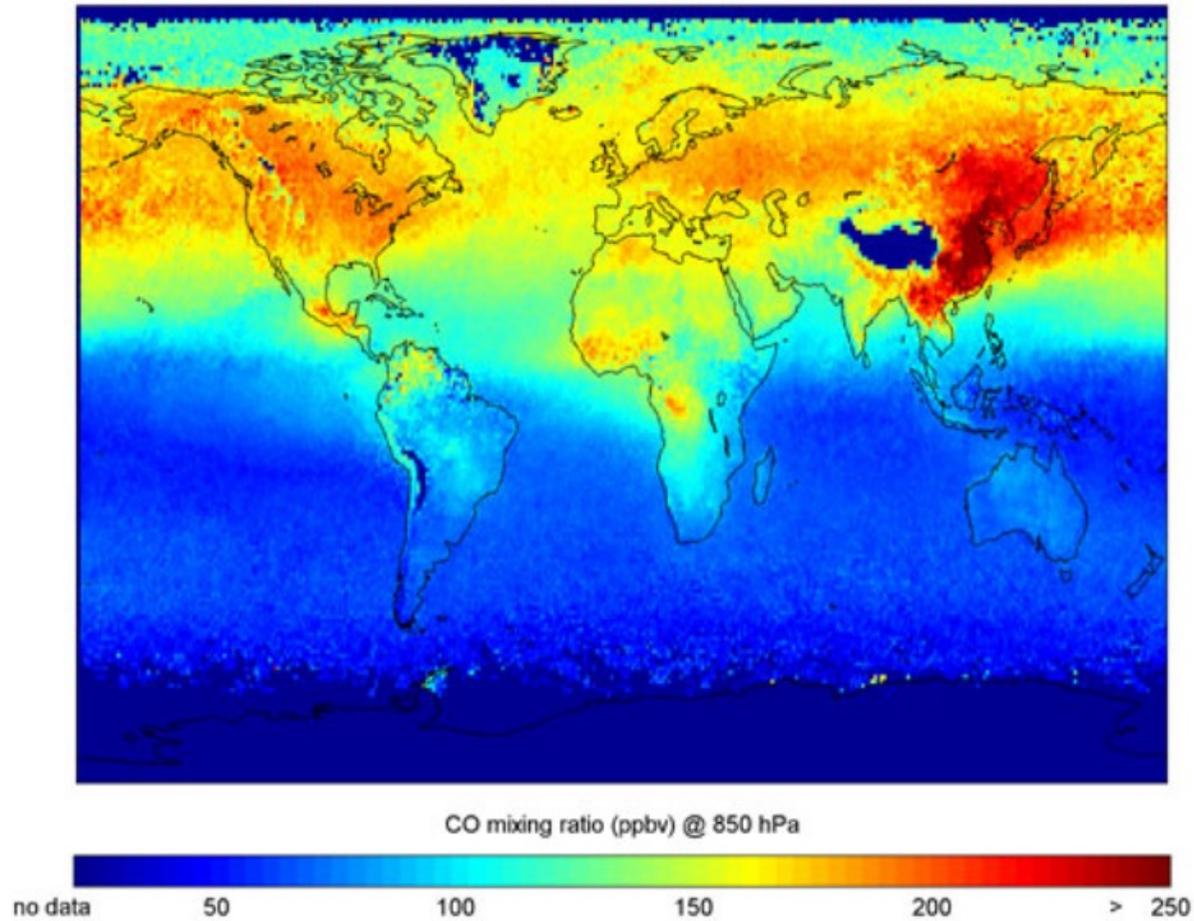
Satellite observations of NO₂ columns



CO emitted by combustion, has atmospheric lifetime ~ 2 months:
mixing around latitude bands

Satellite observations

Mopitt - spring

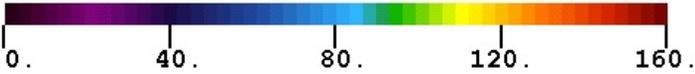
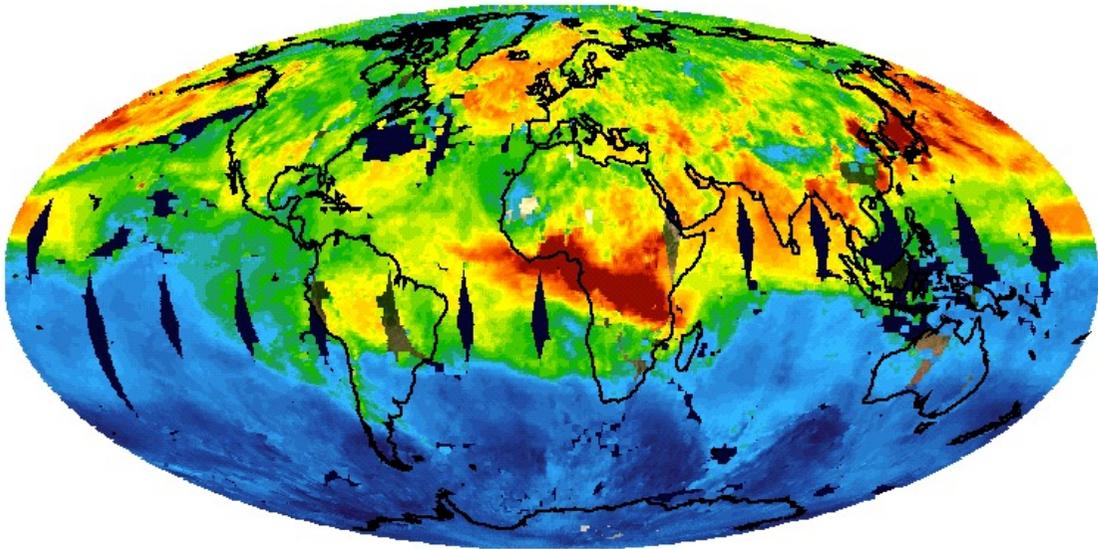
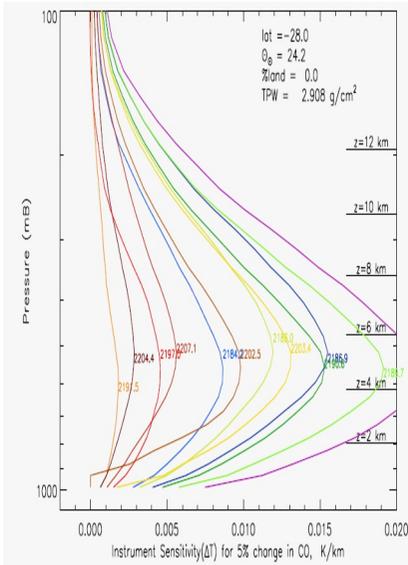


OBSERVATION OF CO FROM AIRS SATELLITE INSTRUMENT

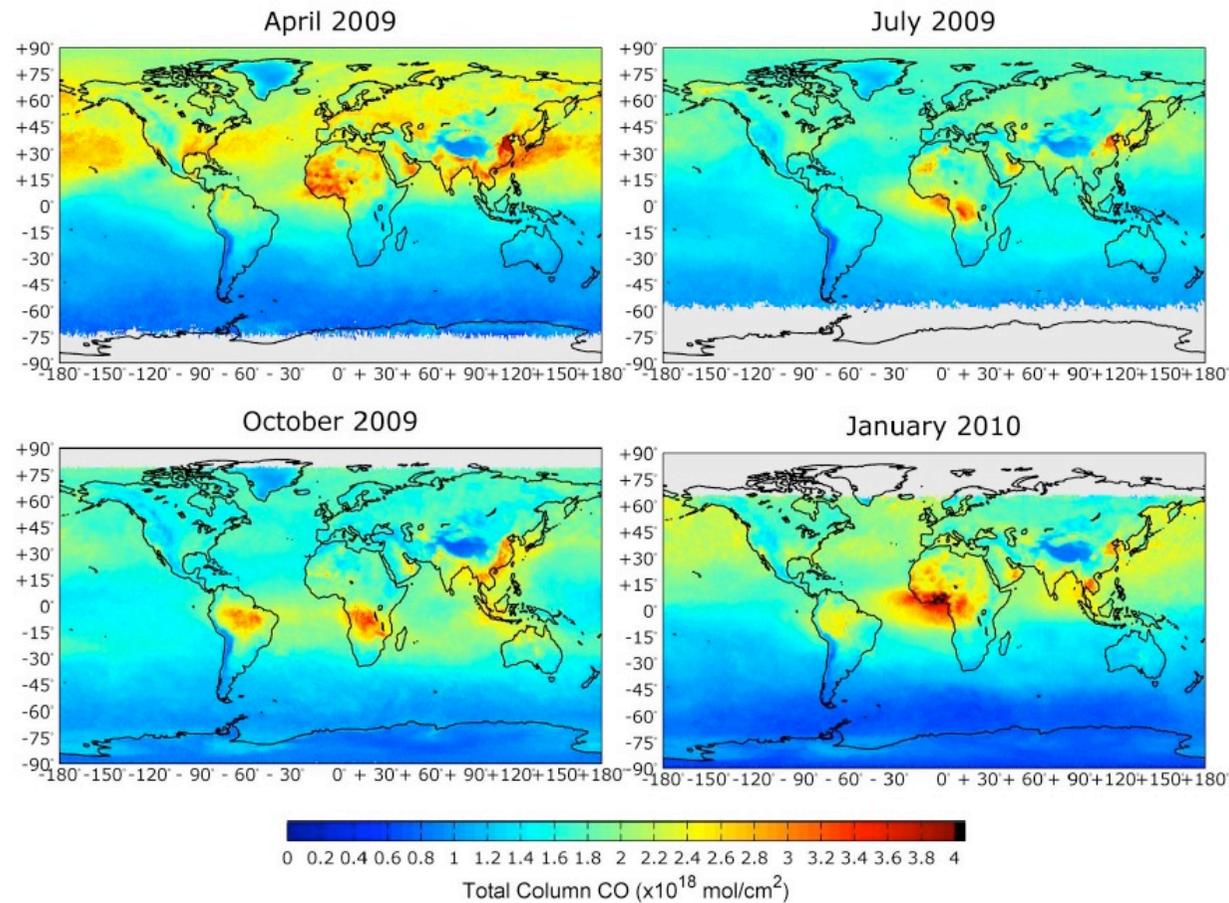
AIRS CO data at 500 hPa (W.W. McMillan)

AIRS DAILY CO AT 500 mb (ppbv) 20070101

Averaging kernels
for AIRS retrieval

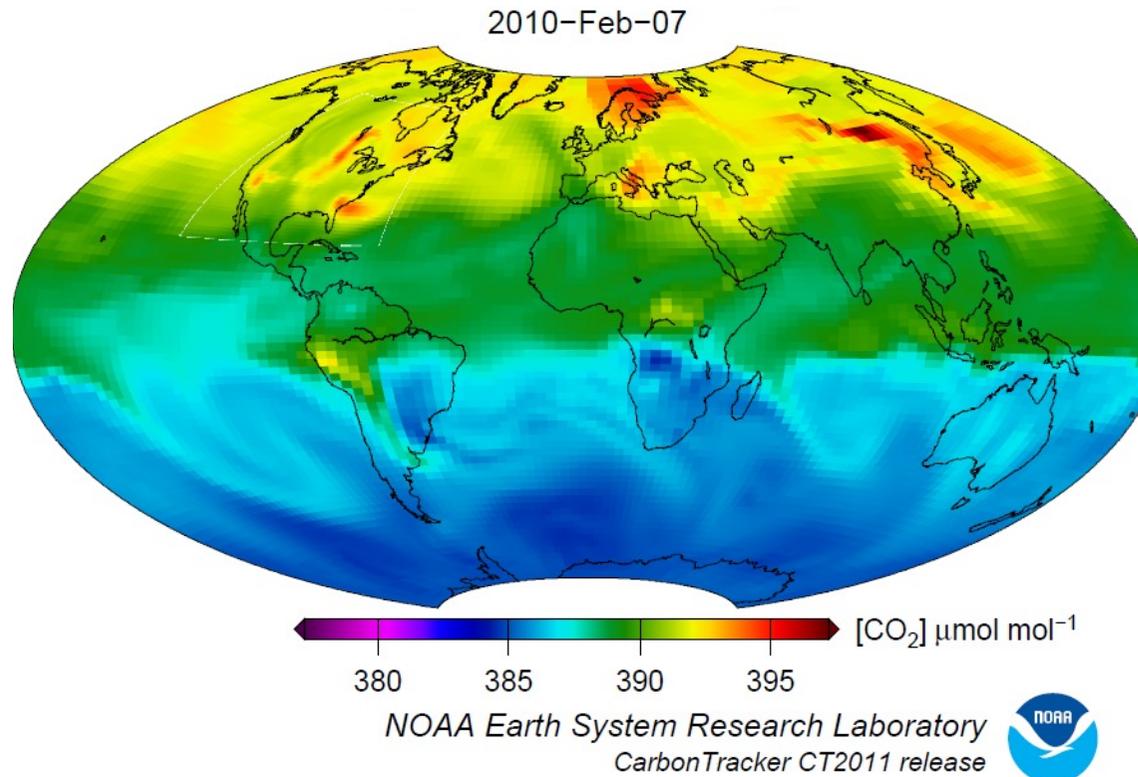


Carbon monoxide (CO) : seasonal distribution



CO₂ emitted by combustion, has atmospheric lifetime ~ 100 years:
global mixing

Assimilated observations



Useful links



EO Portal
eoportal.eumetsat.int

Create and manage your user account, subscribe to our services



User Portal
user.eumetsat.int

Explore our catalogue, what and where, supporting documentation



EUMETView
view.eumetsat.int

Visualise and explore, create layers in GIS applications



Copernicus Browser
browser.dataspace.copernicus.eu

Visualise and explore Copernicus products



WEkEO
wekeo.eu



Data Store
data.eumetsat.int

Download Metop,
Meteosat First and Second
Generation and Copernicus (Sentinel 3, Sentinel-6) data



Data Tailor
Transform both historical and near-real-time satellite data



AC SAF
acsaf.org
Explore even more atmospheric composition data

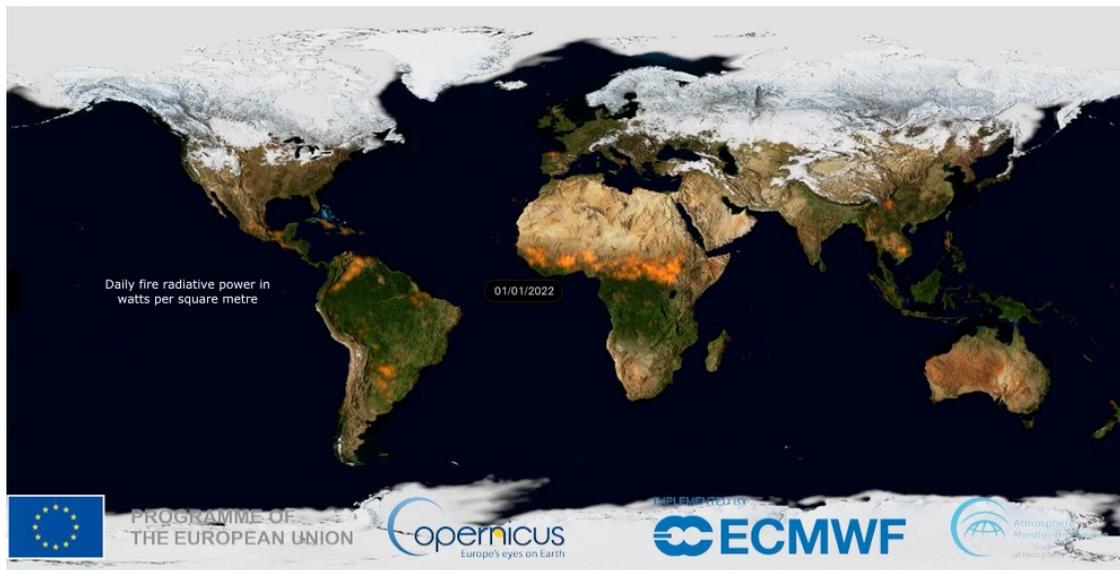


Atmosphere
Monitoring

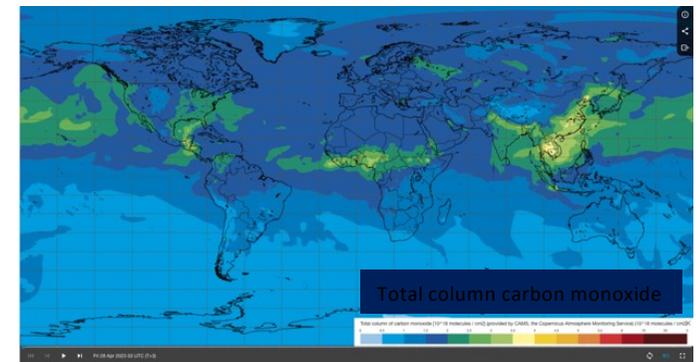
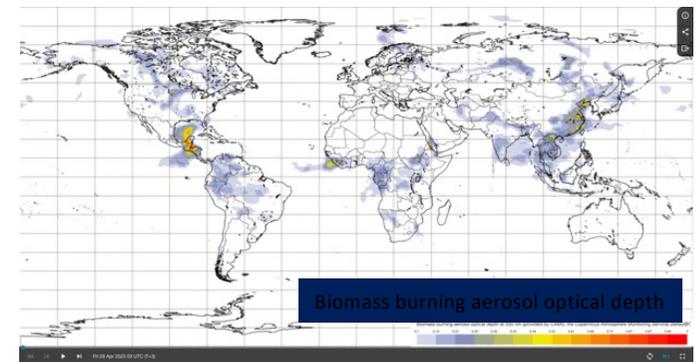
MONITORING WILDFIRE EMISSIONS

copernicus.eumetsat.int

Wildfires are a significant source of atmospheric pollution, including carbon gases, volatile organic compounds and particulate matter, influencing global atmospheric composition and chemistry.



Daily total Fire Radiative Power 1 Jan-31 Dec 2022



Example CAMS forecasts initialized 28 April 00 UTC valid for 03 UTC

<https://atmosphere.copernicus.eu/global-fire-monitoring>



Example: Synergy of observational datasets to monitor wildfires

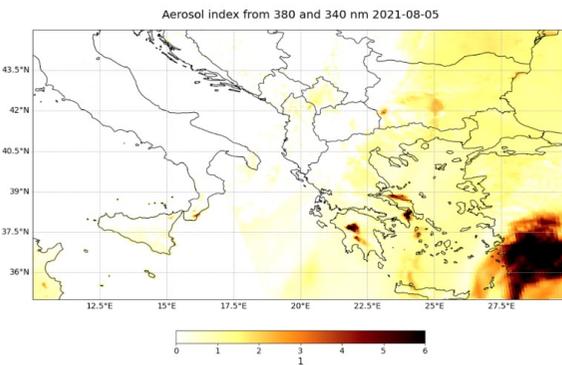
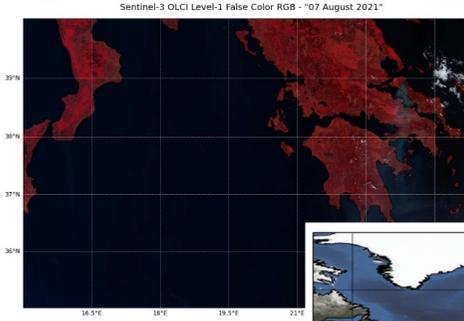
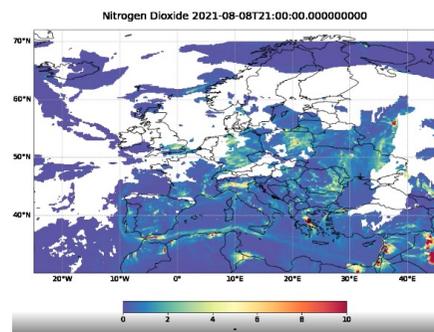
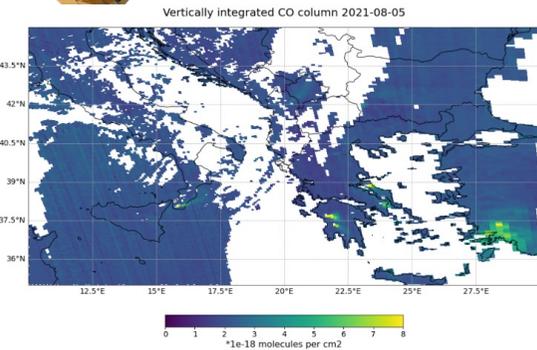
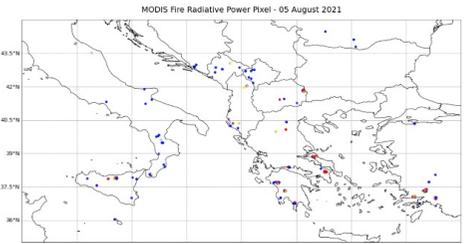
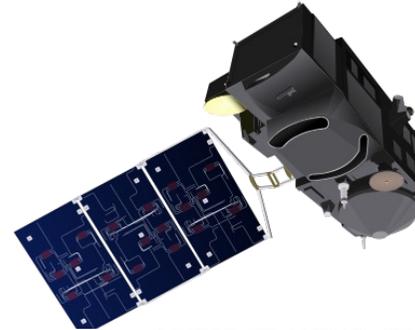
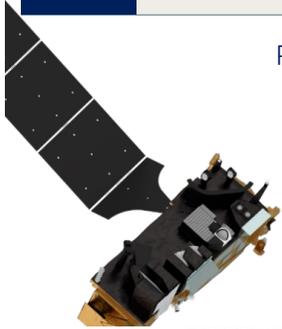
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Pollutants, hot spots & intensity from satellite observations

Measurement of fire intensity

Linked to emission of combustion gases & aerosols into

the atmosphere

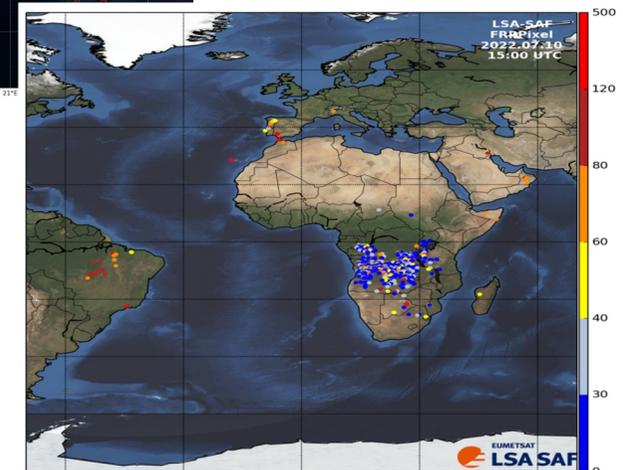


MSG/SEVIRI – every 15-minute allows:

Strong seasonality

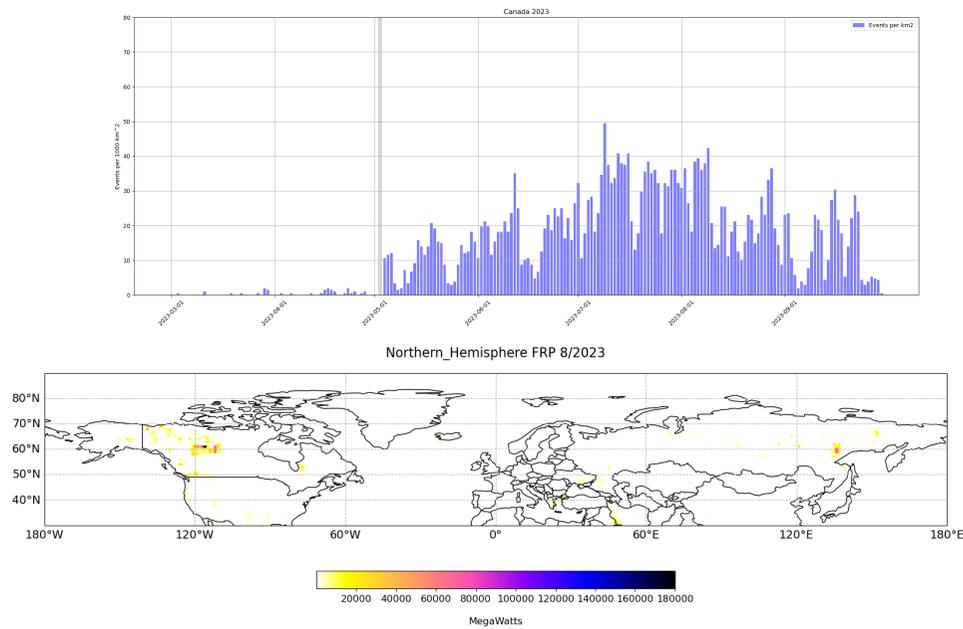
Strong diurnal cycle

Fire Radiative Power



Individual 1 km hot spot and day-time imagery

Fire radiative power Sentinel-3 NRT product



● 1-km Fire Radiative Power [MW]
RGB Composite from SLSTR Solar Channels (R=2.2 μ m, G=1.6 μ m, B=0.6 μ m)



Monitoring from space: Sentinel-3 observations of Canadian wildfires

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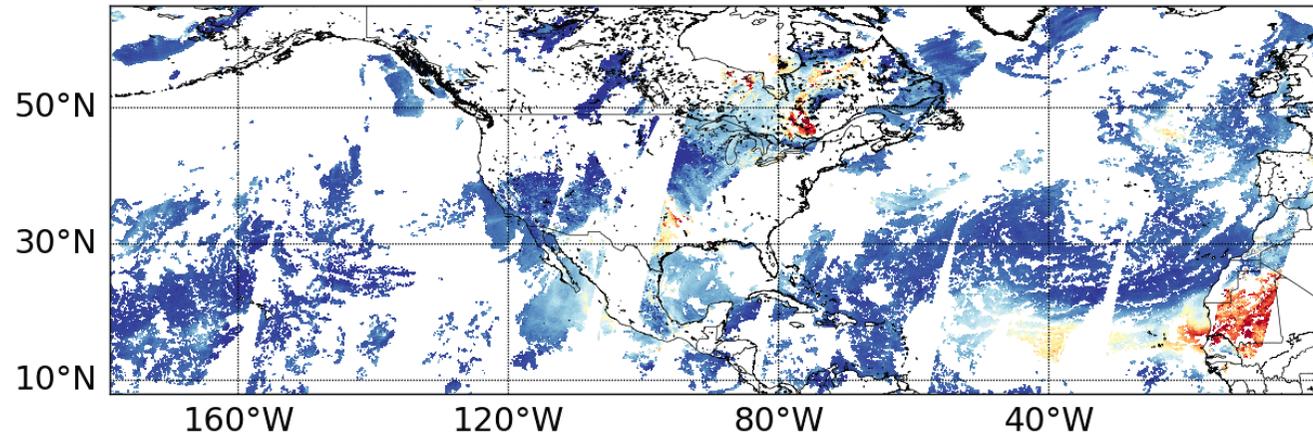


Sentinel-3 A+B SLSTR - AOD(550 nm) - Quality (Land + Ocean QI 2 & 3) - 20.06.2023



9.5 km Resolution

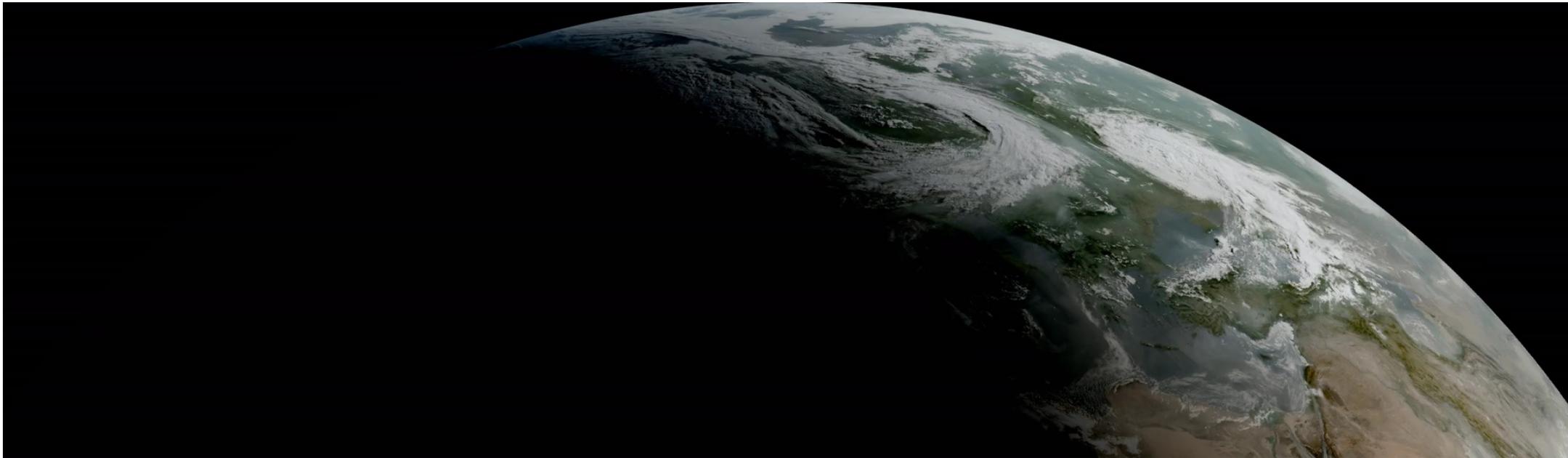
Average = 0.15 ± 0.16 - Min = 0.00 - Max = 1.85





Monitoring from space: MTG observations of Canadian wildfires

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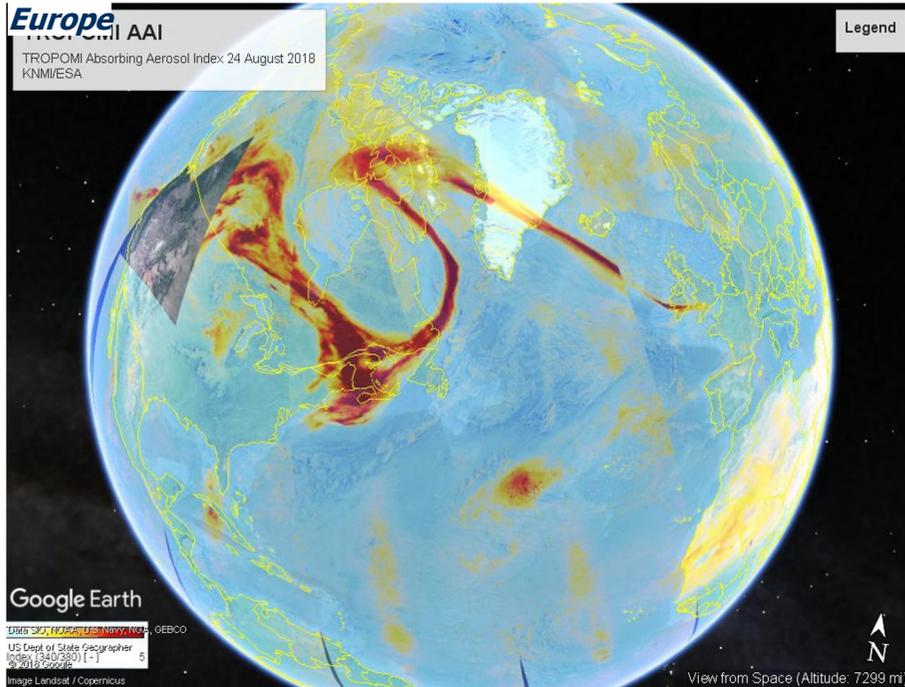




Monitoring from space

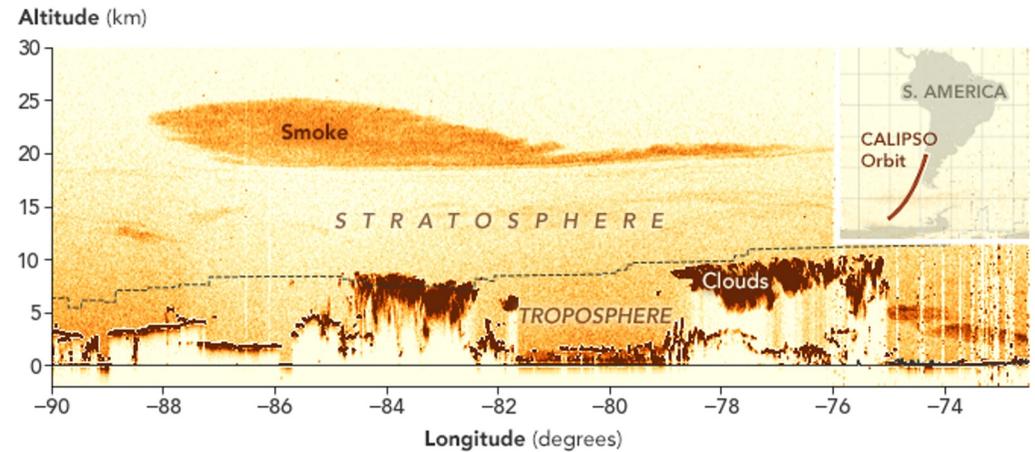
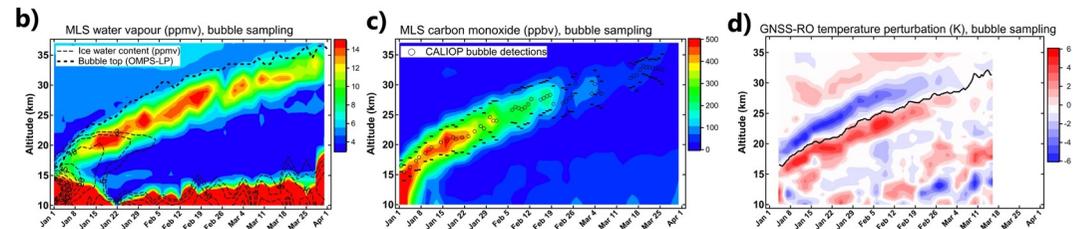
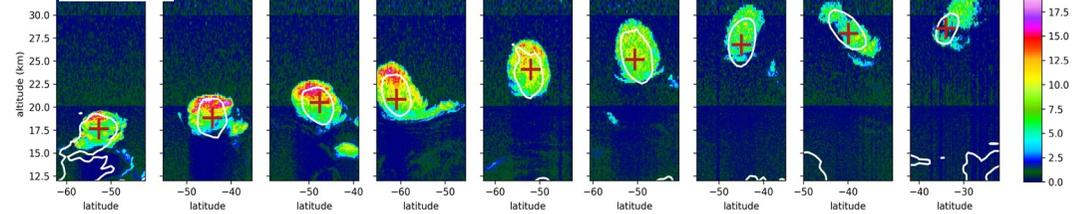
worldwide monitoring of wildfire smoke and air pollution

follow the smoke: smoke from Canada fires 2018 reached



copernicus.eumetsat.int

follow the smoke: Australia bushfire smoke 2020/2021 reached 35 km altitude





Monitoring from space: Sentinel-4

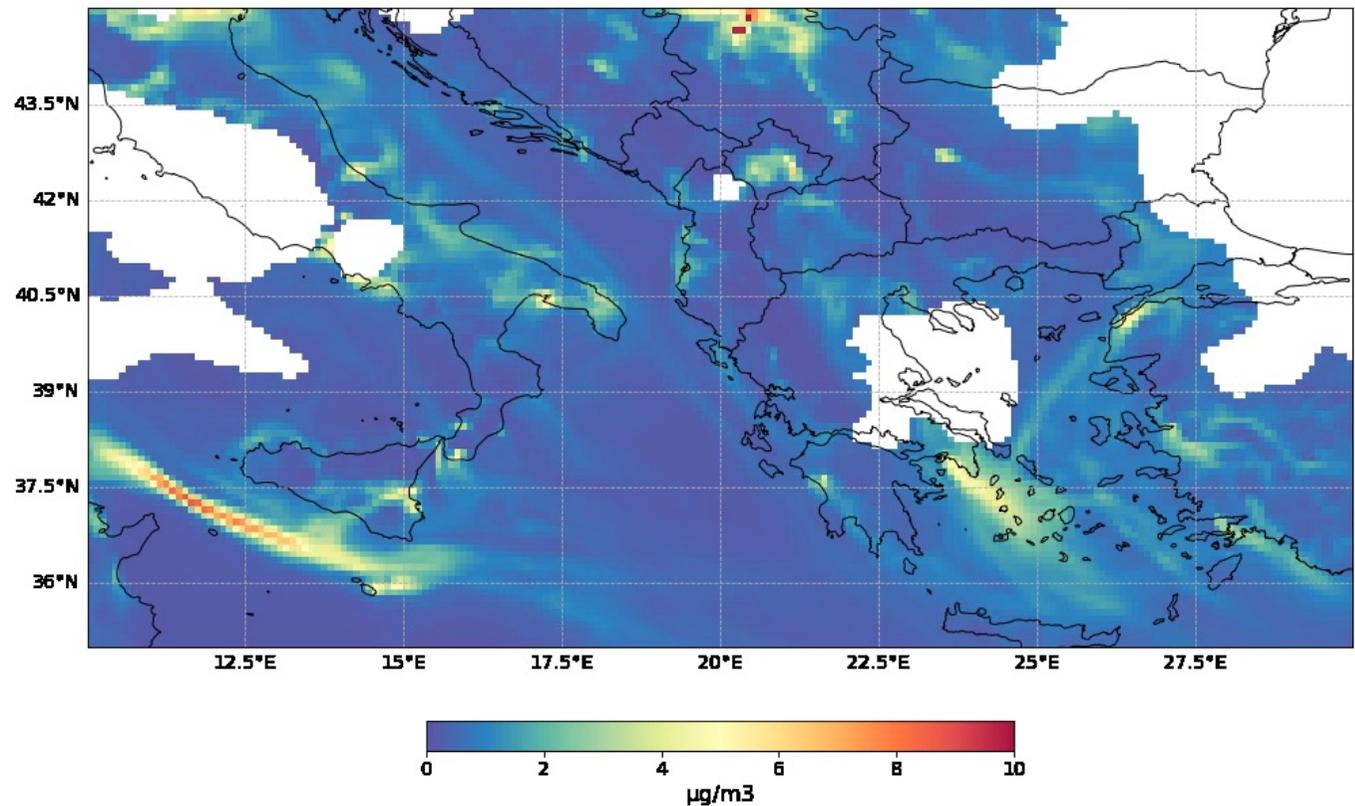
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a whole new dimension will be explored by Sentinel-4:

daytime hourly air quality data over Europe

Simulated Sentinel-4 Nitrogen Dioxide
2021-08-07 at 00:00 UTC





Part of an unique data value chain

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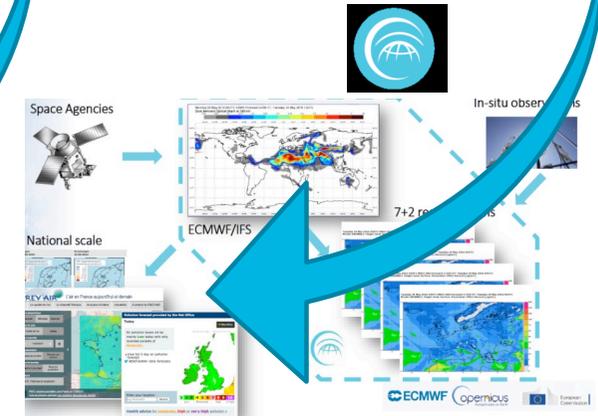
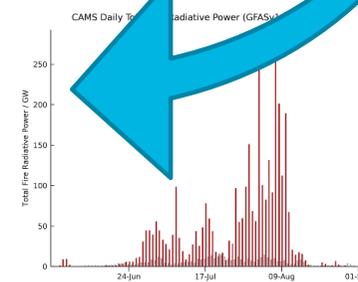
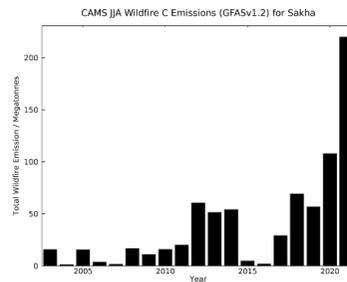
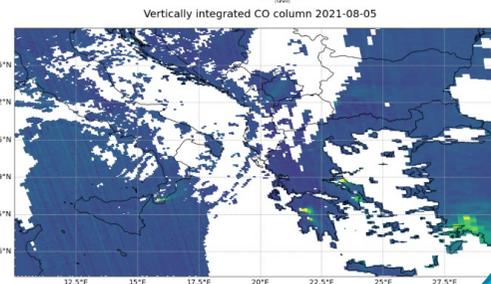
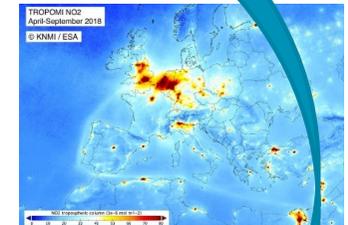
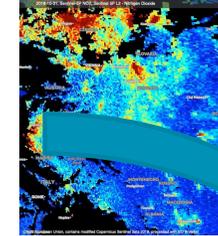
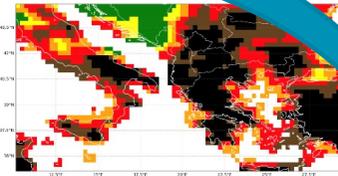
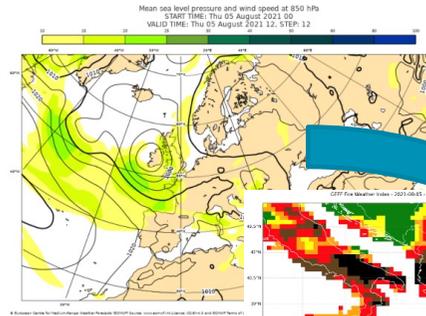
Bring to Users the concept of “Copernicus improves usability”

User journey encompassing:

- Forecast
- Monitoring and nowcasting
- Estimate of impacts

Integrated system:

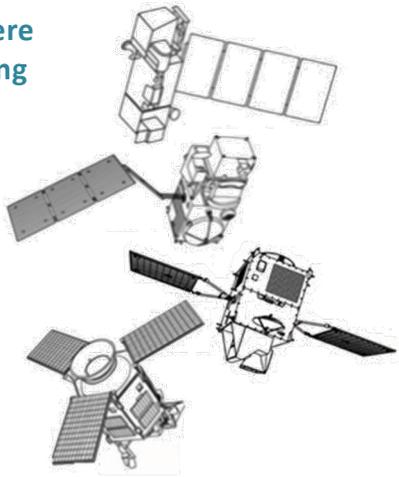
- Satellite and non satellite, models
- Support emission estimate
- Generate added value products
- Ensure Quality and usability



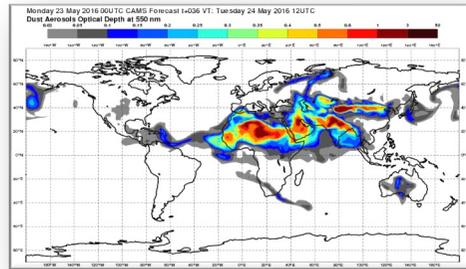
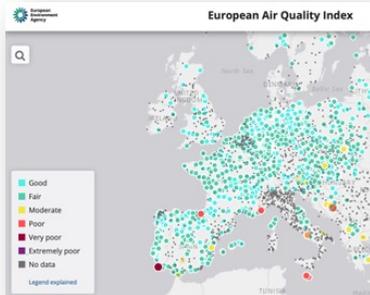


Atmosphere
Monitoring

CAMS INFORMATION FLOW

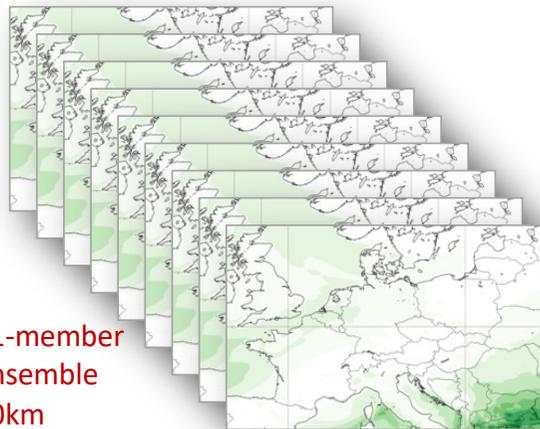


Earth Observation
from satellite (>75
instruments) and in-
situ (regulatory and
research)



IFS 40km (oper) / 80km (rean) Globe

CAMS main operational data
assimilation and modelling systems



11-member
ensemble
10km
Europe

PREVAIR L'air en France aujourd'hui et demain

La qualité de l'air Le dispositif français Analyses et bilans Actuaires A propos de PREVAIR

Pollution forecast provided by the Met Office

Today
Air pollution levels will be mainly Low today with only localized pockets of Moderate.

View full 5 day air pollution forecast
@DefraUKair daily forecasts

Enter your location:
[Search]
[Go] [Refresh]

Health advice for moderate, high or very high pollution: [Link]

CAMS users

- Applications
- Policy products

The Weather Channel

iOS

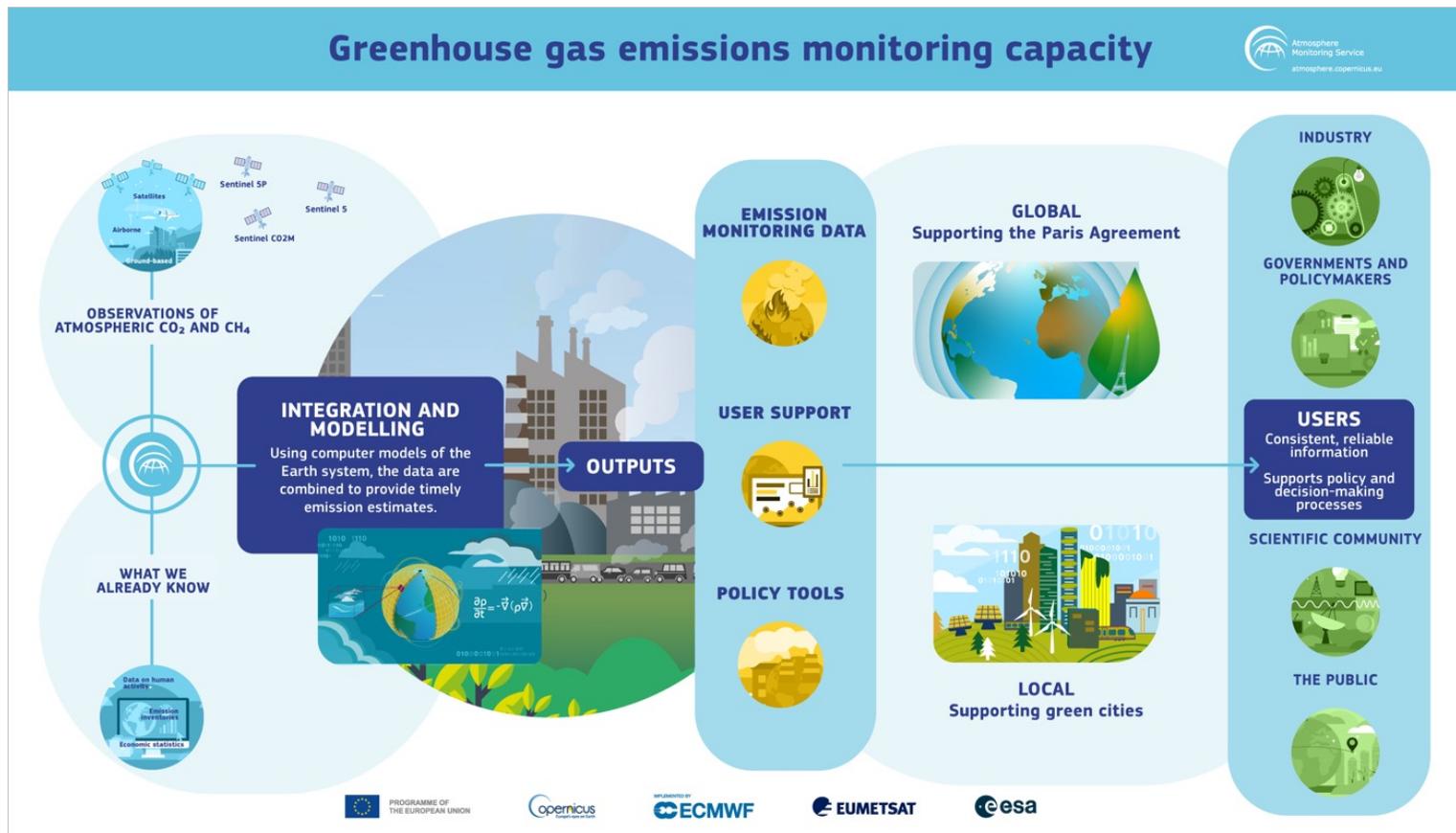
CNN

euro news.



Atmosphere
Monitoring

CAMS: GHG MONITORING CAPACITY



<https://atmosphere.copernicus.eu/ghg-services>



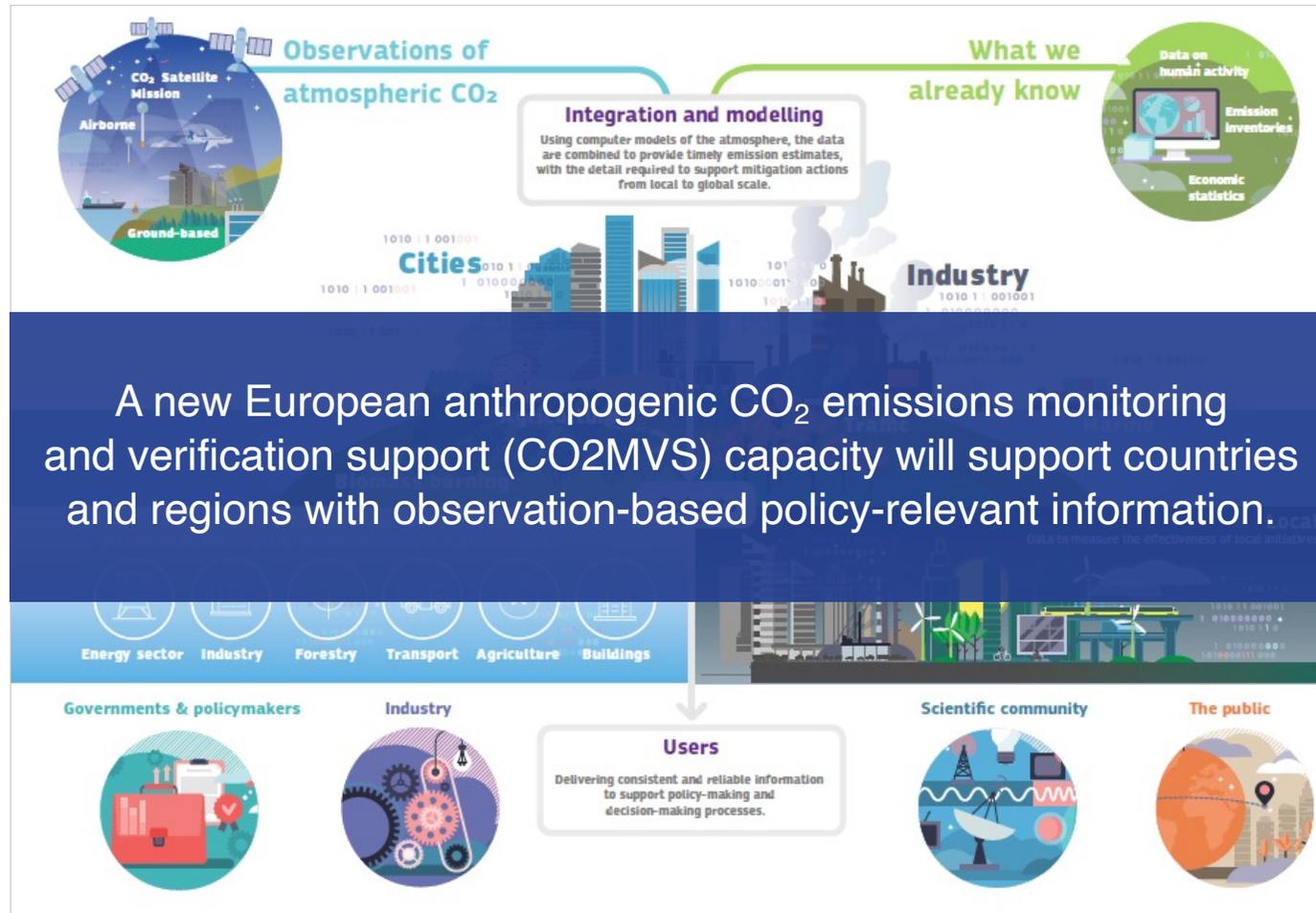
PROGRAMME OF
THE EUROPEAN UNION





Atmosphere
Monitoring

CAMS: CO2 MONITORING AND VERIFICATION SERVICE



PROGRAMME OF
THE EUROPEAN UNION

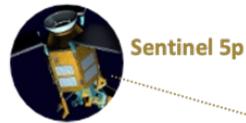




Atmosphere Monitoring

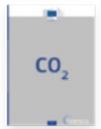
TIMELINE OF COPERNICUS CO2MVS

From expert groups through dedicated research funding, to operational services



Sentinel 5p

CO2 TASK FORCE GUIDANCE DOCUMENTS



2015

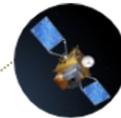


2017



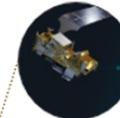
2019

SATELLITE MISSIONS



Sentinel 4

Operational ramp-up in CAMS



Sentinel 5



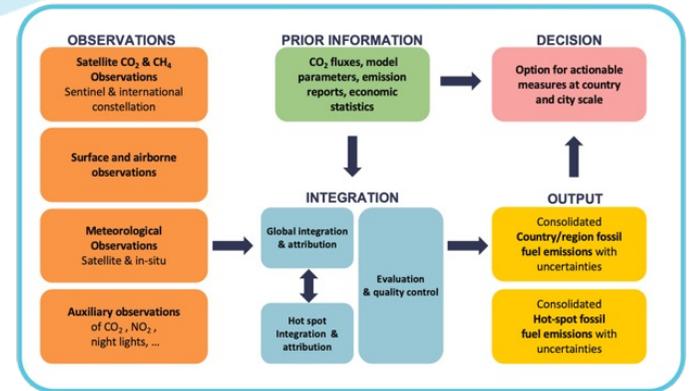
CO2 Mission

Air Quality emissions 2025

2026

CO2 Monitoring & Verification Support (CO2MVS)

SERVICE COMPONENTS



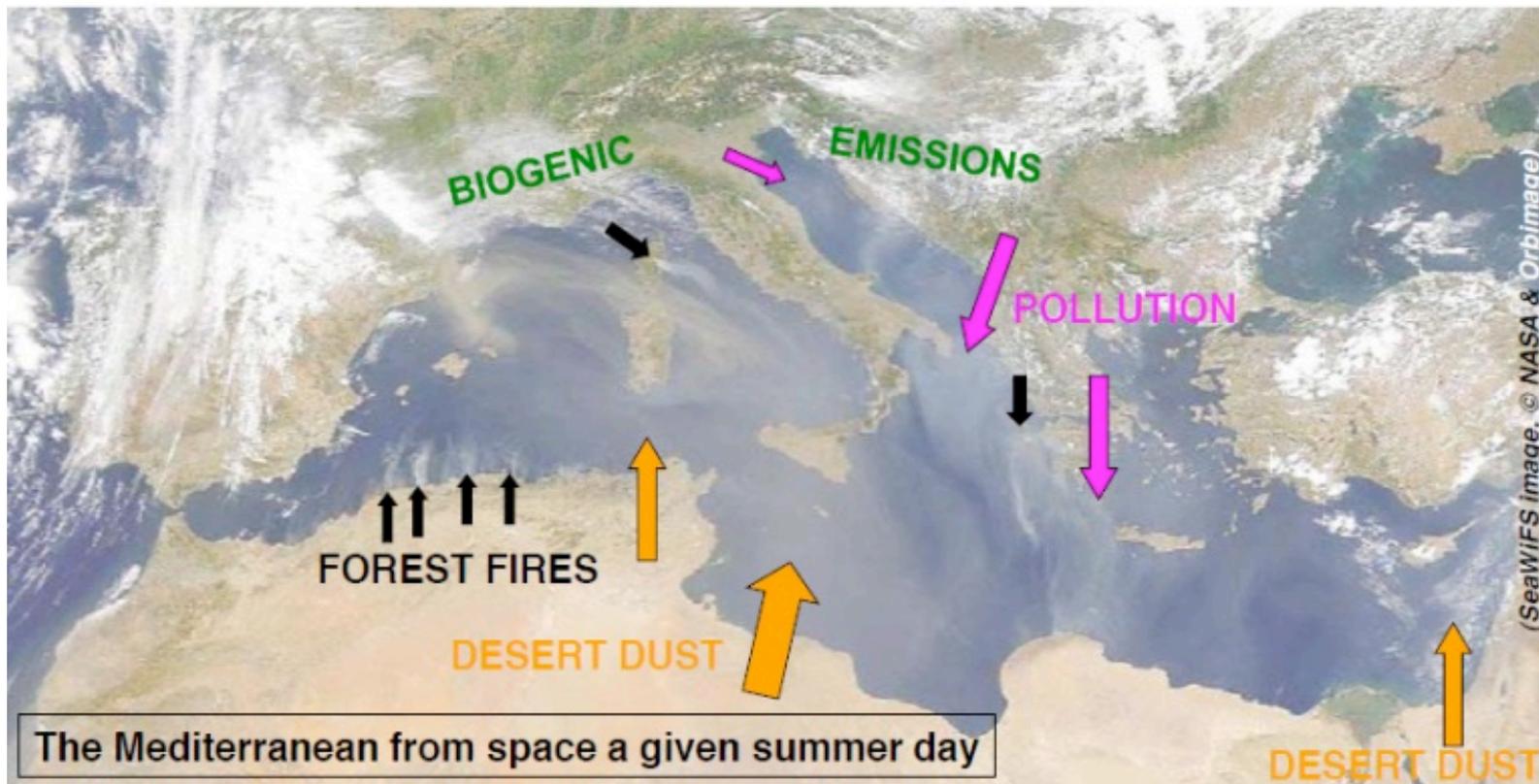
RESEARCH AND PREPARATORY PROJECTS





⇒ A natural laboratory to study

- (i) the contribution of long-range transport,
- (ii) the ageing of continental air masses over the basin,
- (iii) the impact of aerosol on the regional climate,
- (iv) the impact of atmos. deposition on low-Chl, low-nutrient surface waters



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Explore our catalogue, what and where, supporting documentation



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Visualise and explore, create layers in GIS applications



Copernicus Browser
browser.dataspace.copernicus.eu

Visualise and explore Copernicus products



WEkEO
wekeo.eu



Data Store
data.eumetsat.int

Download Metop, Meteosat First and Second Generation and Copernicus (Sentinel 3, Sentinel-6) data



Data Tailor
Transform both historical and near-real-time satellite data



AC SAF
acsaf.org
Explore even more atmospheric composition data