



# IASI : products and applications

*for IRS and IASI-NG see Dorothee's talk yesterday ;  
for IASI dust see Sophie's talk tomorrow*



EUMETSAT



IASI contributes the most to **weather forecast**

**15 330**

**Earth orbits**

per year for [Metop-A, Metop-B and Metop-C]

**>500**

**Publications**

using IASI data



Detection of volcanic plumes, large fires, pollution peaks, etc.

2012 Launch of Metop-B

2006 Launch of Metop-A

2013 Launch of Metop-C

**~17**  
**Terabytes**  
**of data**  
per year

**33**  
**Gases**  
measured:  
4 times  
more than  
anticipated

**8461**  
**Spectral**  
**channels**  
measured at  
high resolution

First space mission to study atmospheric composition for at least

**18**  
**years**



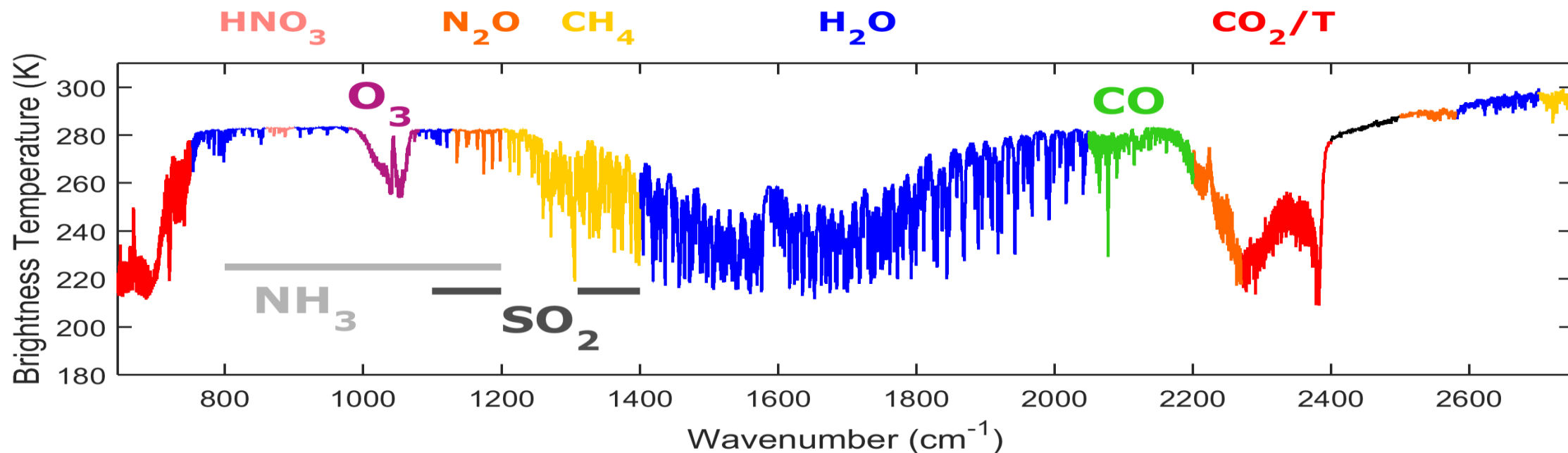
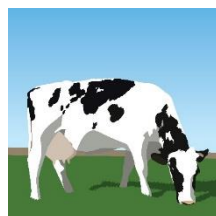
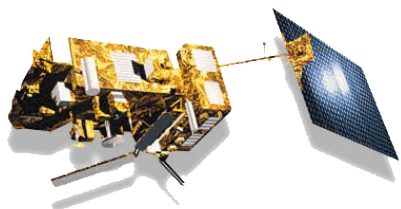
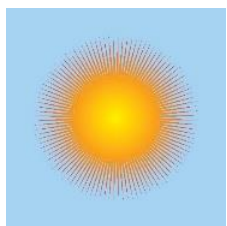
The IASI instrument studies the evolution of atmospheric composition

VIDEO



VIDEO





Now 31 species  
measured or *detected* by IASI

Greenhouse gases and ozone-  
related substances (13)

H<sub>2</sub>O, CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O, O<sub>3</sub>, HNO<sub>3</sub>, CFC-11,  
CFC-12, HCFC-22, CF<sub>4</sub>, SF<sub>6</sub>, CCl<sub>4</sub>, HFC-134a

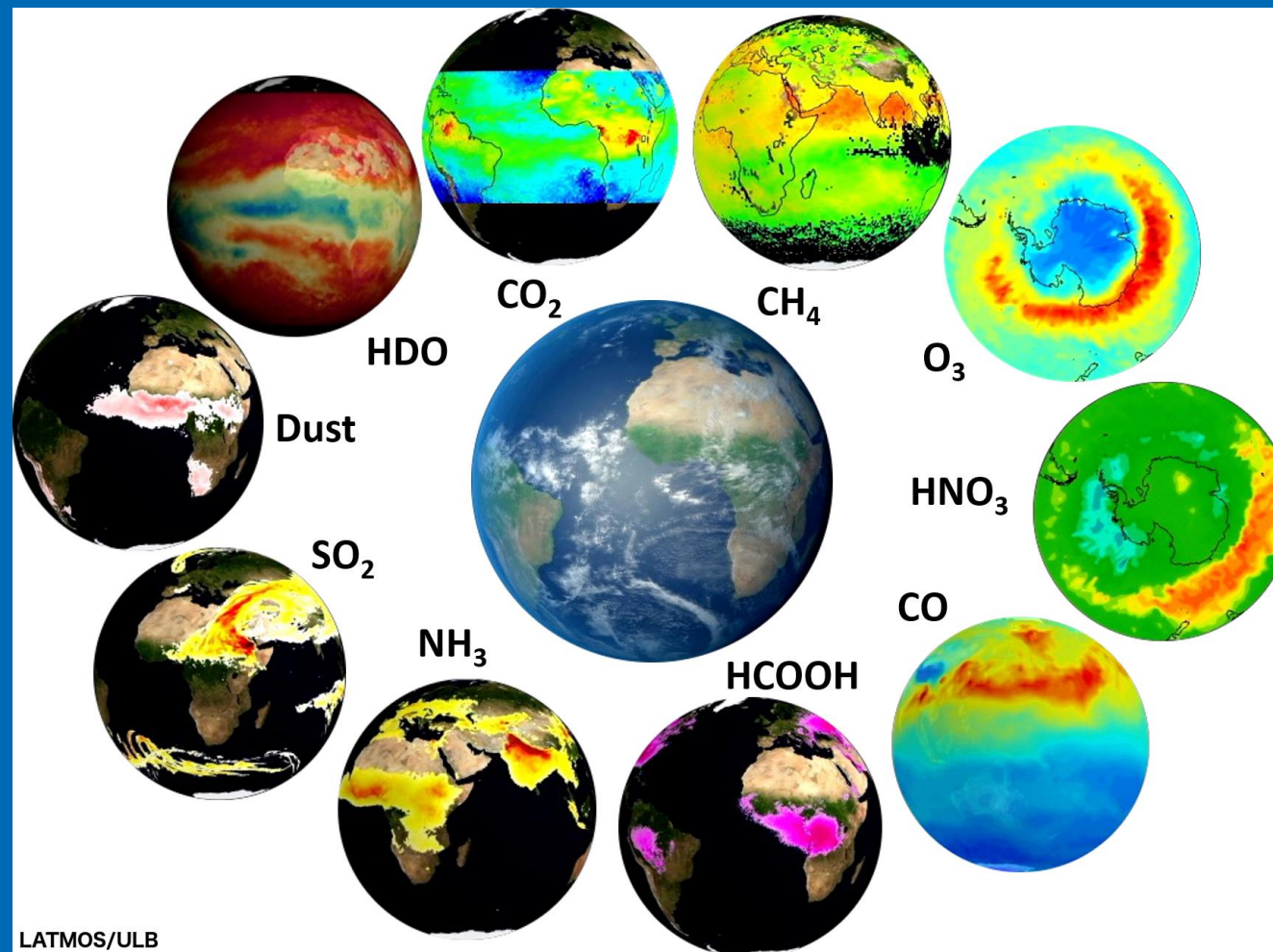
Air quality and VOCs (12)

CO, CH<sub>3</sub>OH, HCOOH, CH<sub>3</sub>COOH, CH<sub>3</sub>COCH<sub>3</sub>,  
C<sub>2</sub>H<sub>2</sub>, C<sub>2</sub>H<sub>4</sub>, NH<sub>3</sub>, HCN, PAN, SO<sub>2</sub>, OCS

Concentrated plumes (6)

HCl, H<sub>2</sub>S, C<sub>3</sub>H<sub>6</sub>, C<sub>4</sub>H<sub>4</sub>O, HONO, HCHO





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

XX= CH<sub>4</sub>, CO, O<sub>3</sub>, O<sub>3</sub>\_iasgo2, NH<sub>3</sub>, NH<sub>3</sub>RI, SO<sub>2</sub>, HCOOH, dust, cloud,  
+ HNO<sub>3</sub>



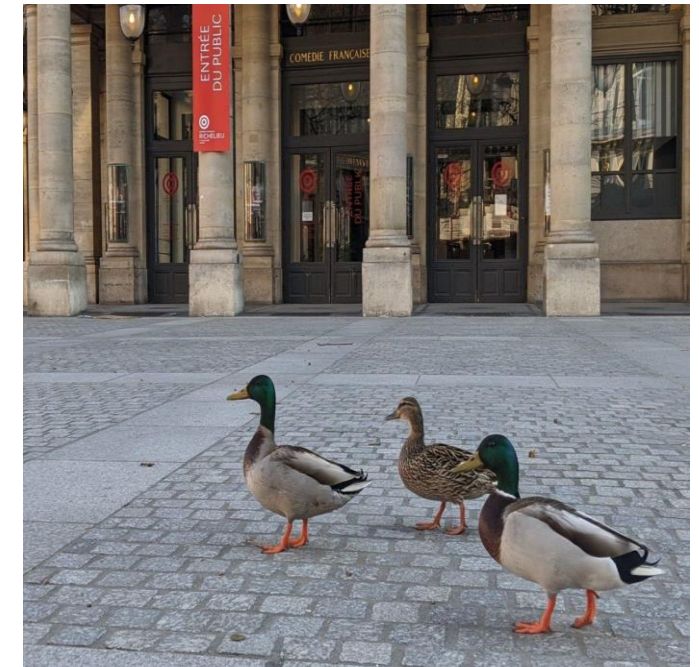
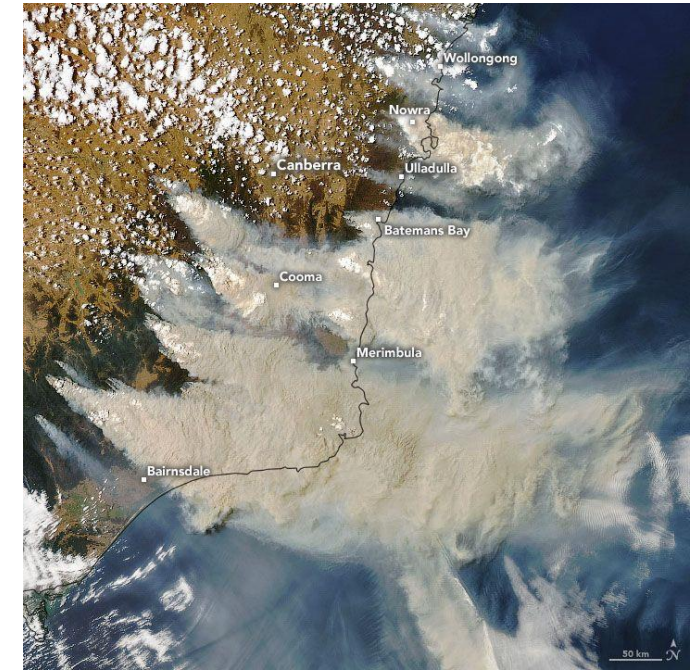


Ozone hole(s) 2019-2020

Australian fires : CO, COVs

Ammonia sources

Covid and pollution: CO, NH<sub>3</sub>  
and PM





Ozone hole(s) 2019-2020

Australian fires : CO, COVs

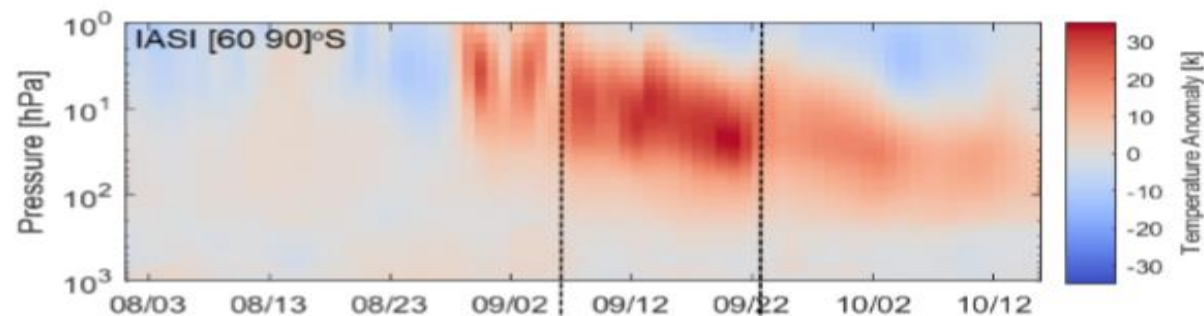
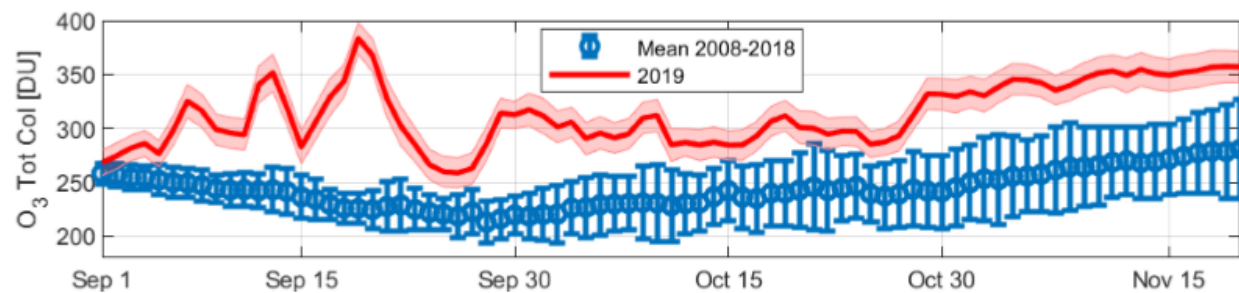
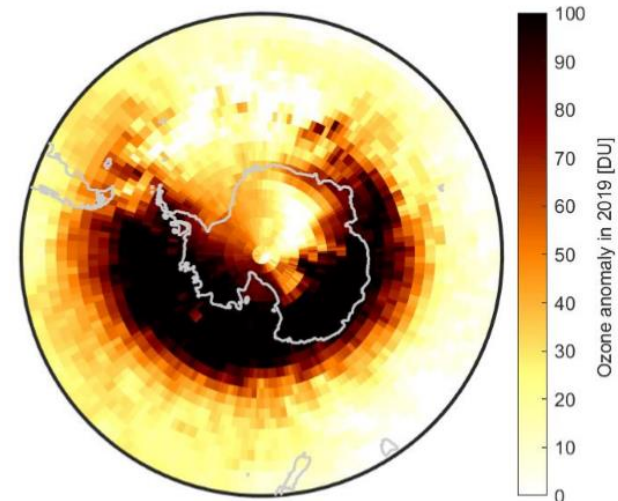
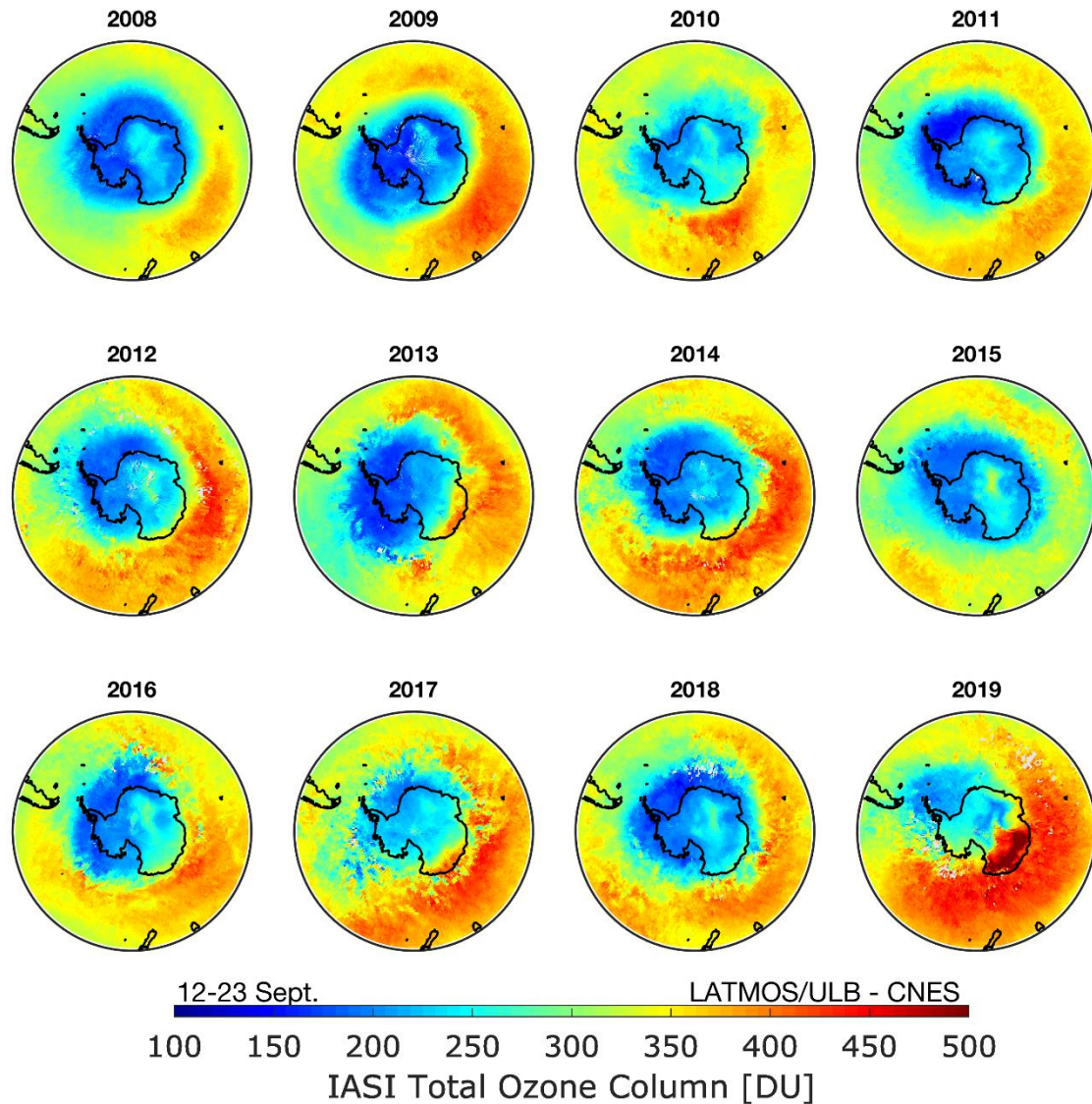
Ammonia sources

Covid and pollution: CO, NH<sub>3</sub>  
and PM





# Ozone @ South Pole

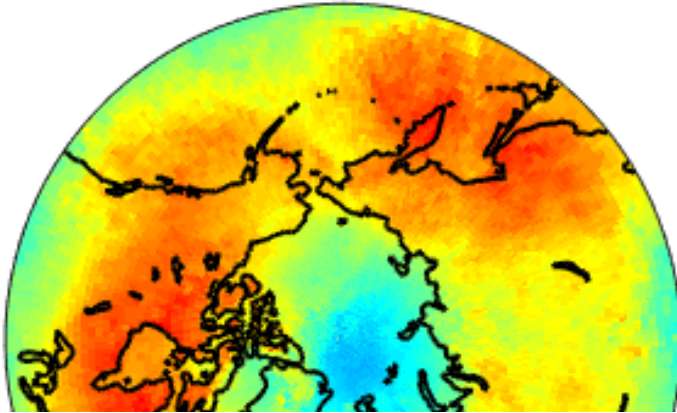


Safieddine et al (LATMOS), GRL 2020

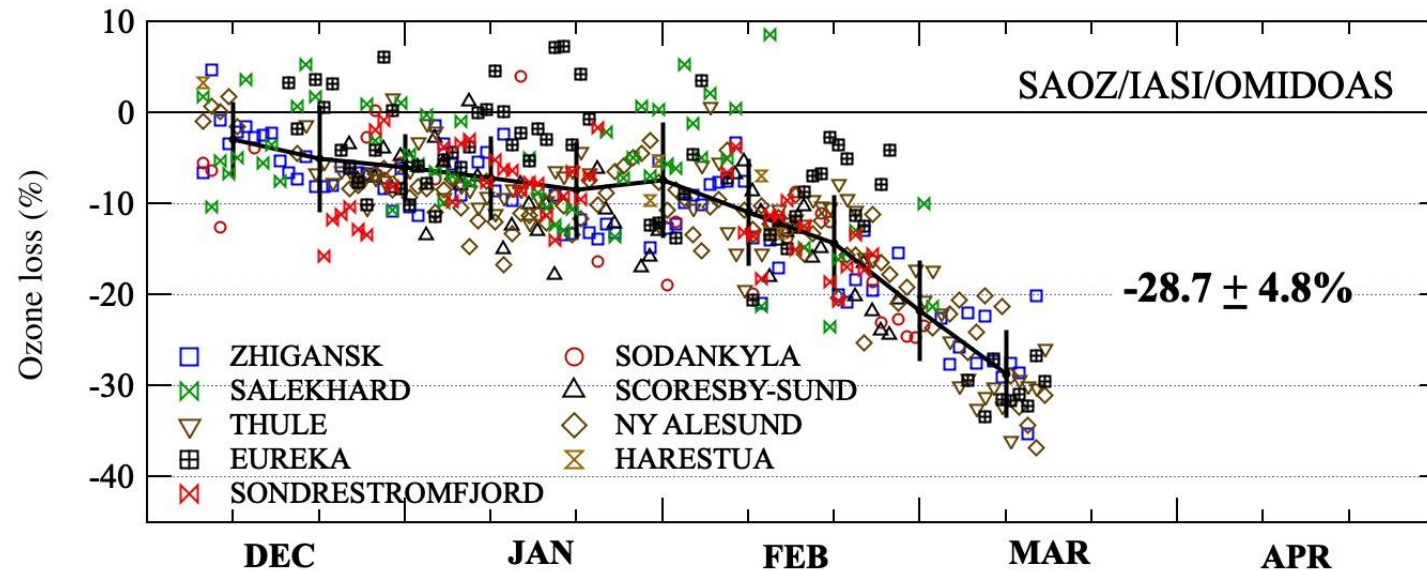
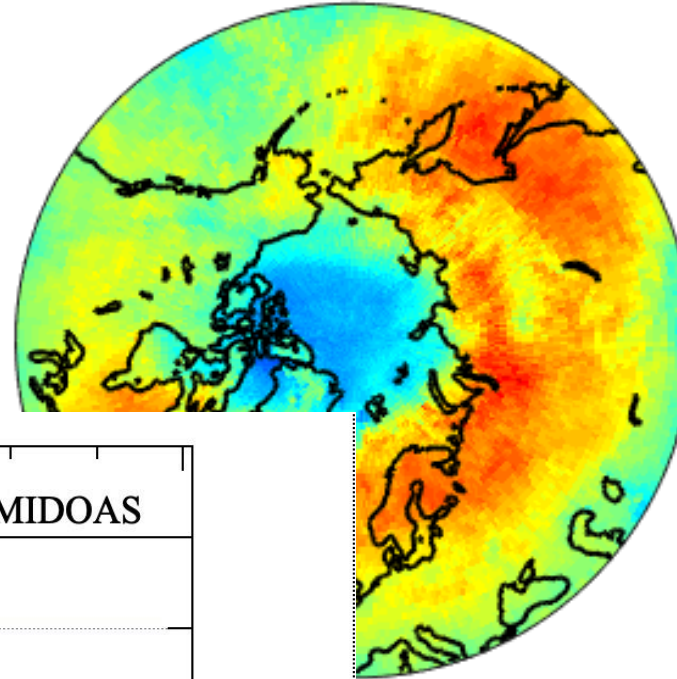


# Ozone @ North Pole

March 2011



March 2020



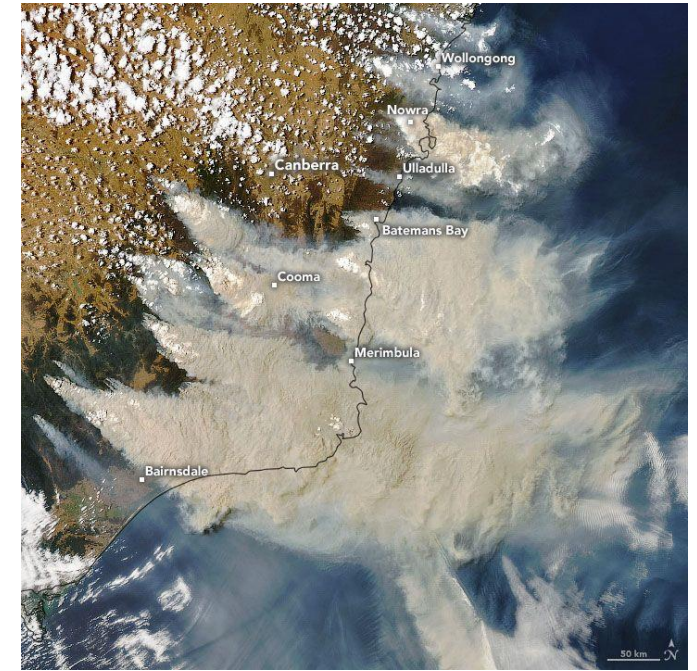


Ozone hole(s) 2019-2020

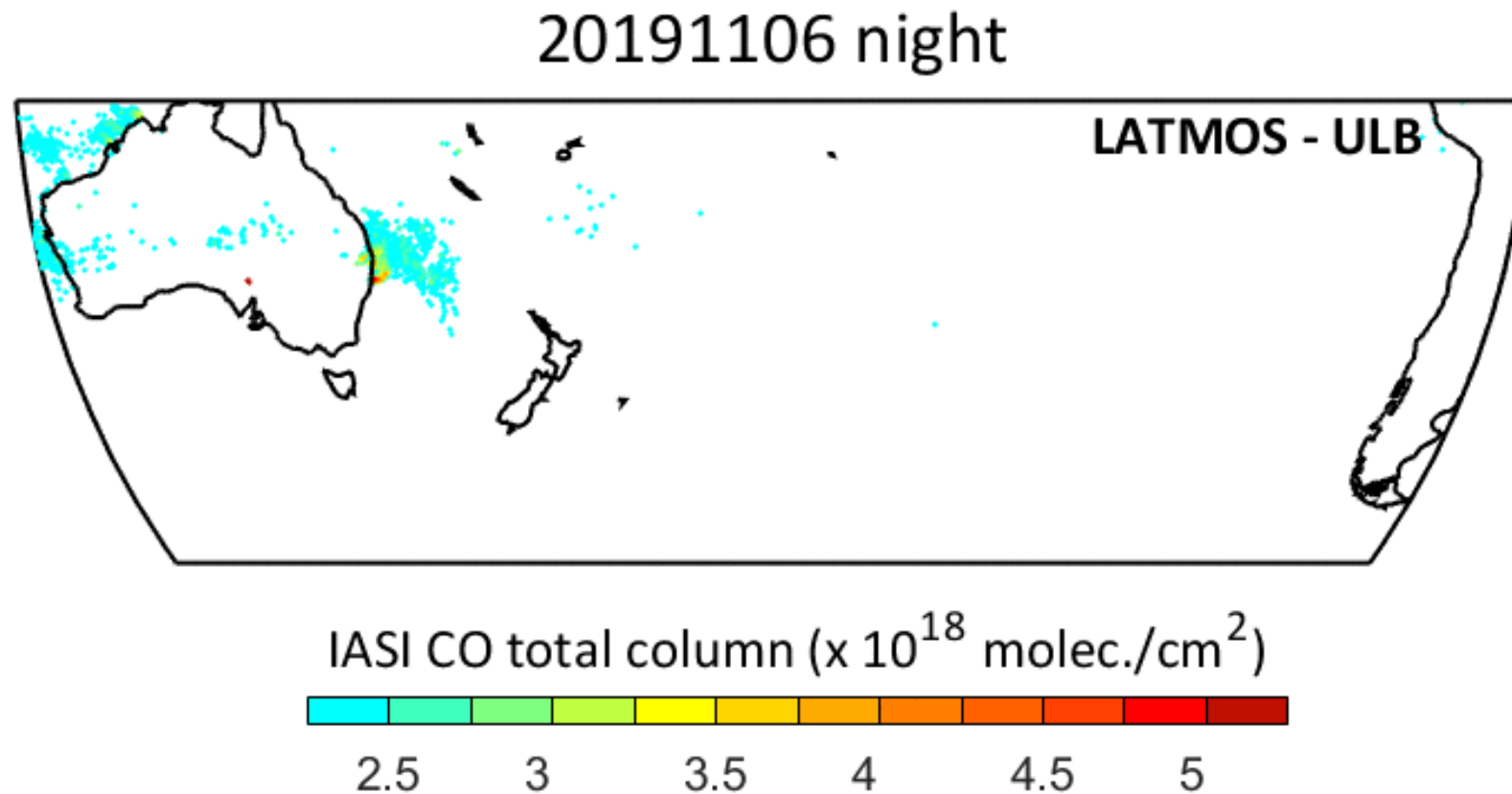
Australian fires : CO, COVs

Ammonia sources

Covid and pollution: CO, NH<sub>3</sub>  
and PM



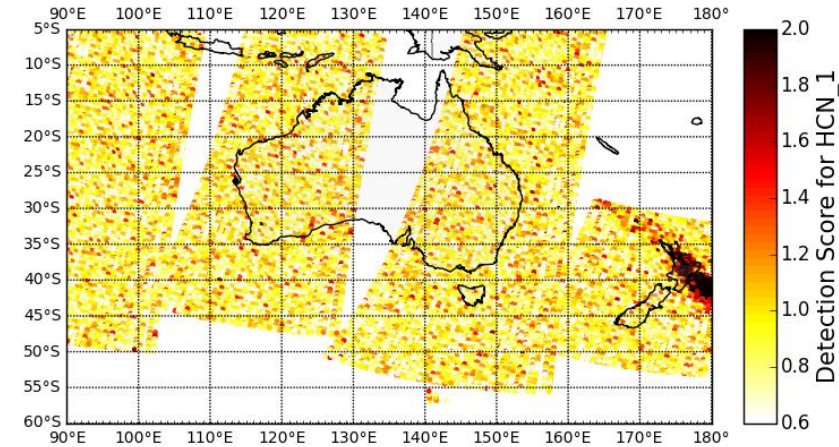
## Australian fires, november 2019 – january 2020



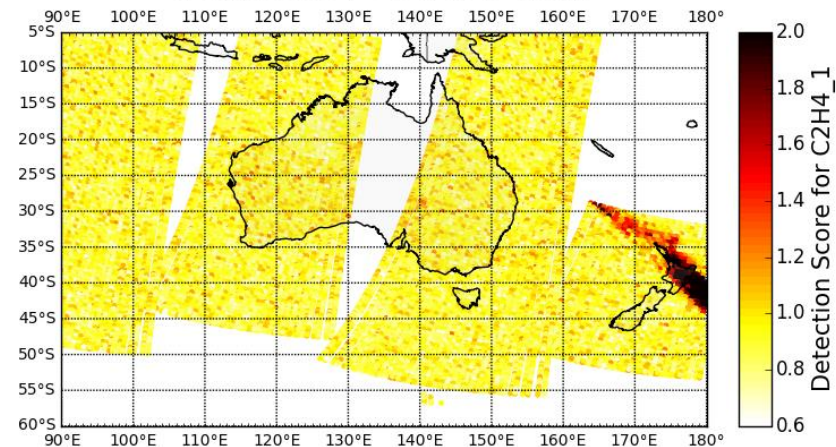


# Australian fires, PCA indicators

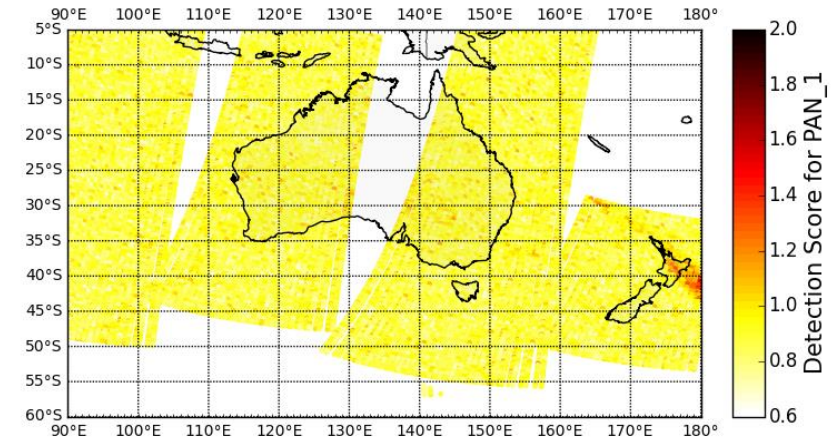
IASI/MetopA - 1/1/2020 (Day)



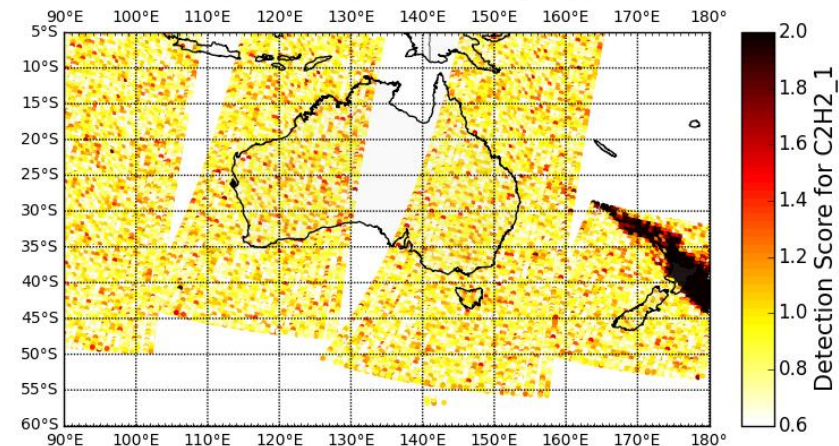
IASI/MetopA - 1/1/2020 (Day)



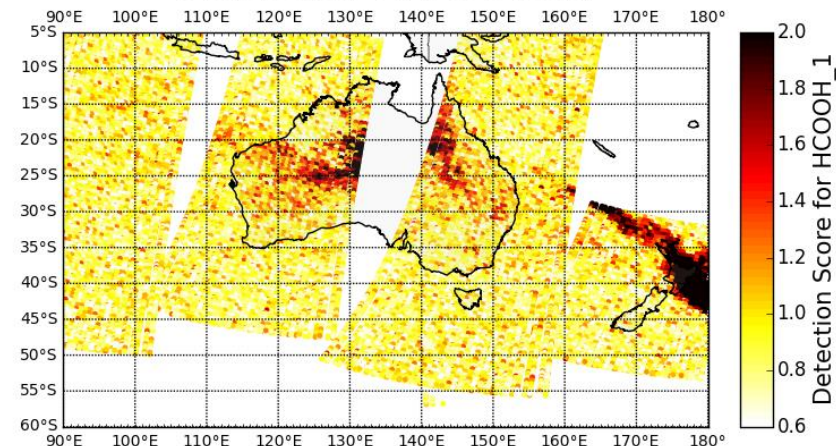
IASI/MetopA - 1/1/2020 (Day)



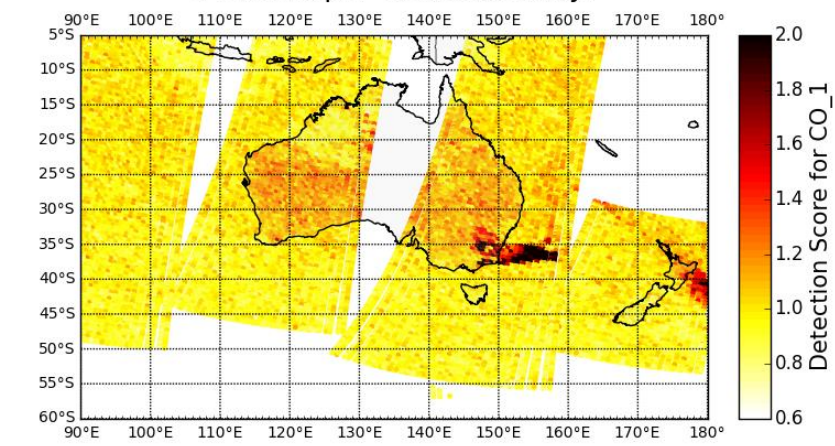
IASI/MetopA - 1/1/2020 (Day)



IASI/MetopA - 1/1/2020 (Day)



IASI/MetopA - 1/1/2020 (Day)



HCN, C<sub>2</sub>H<sub>4</sub>, PAN, C<sub>2</sub>H<sub>2</sub>, HCOOH, CO

Credit Adrien Vu Van, PhD @ LATMOS



# Australian fires, 23 december 2019 – 18 january 2020

IASI/Metop-A & -B

Dec-23-2019

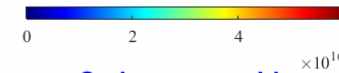
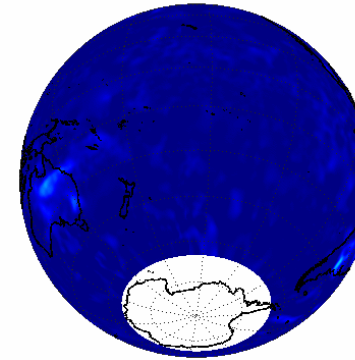
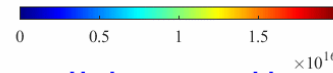
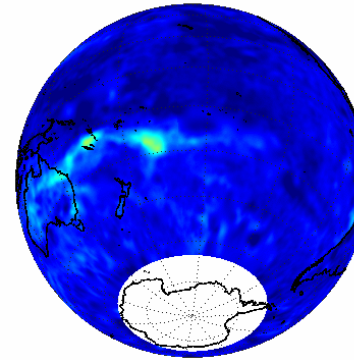
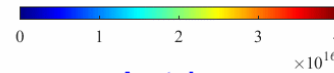
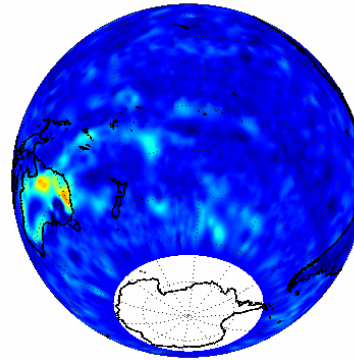
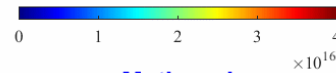
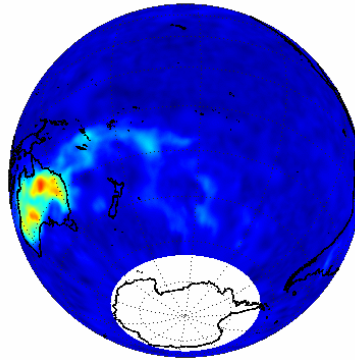
Gas total column (molecules  $\text{cm}^{-2}$ )

Formic acid

Acetic acid

PAN

Ammonia

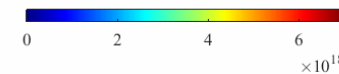
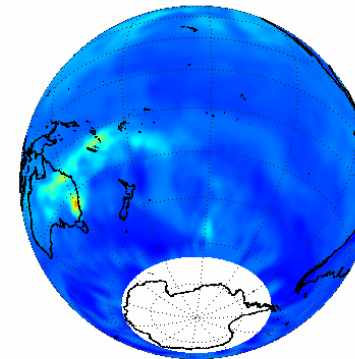
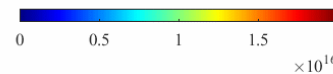
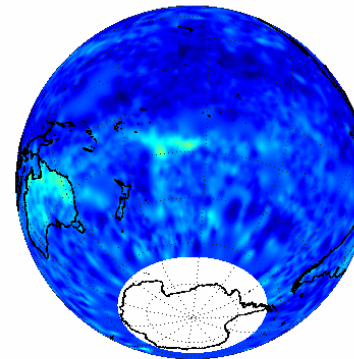
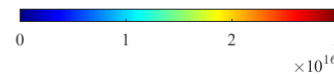
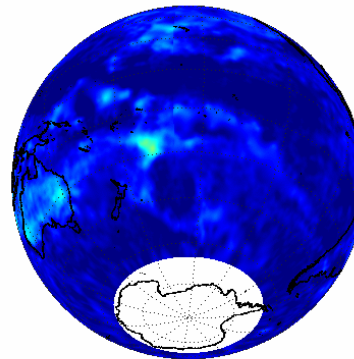
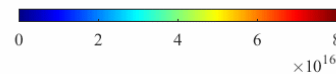
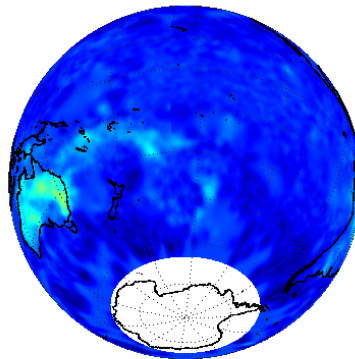


Methanol

Acetylene

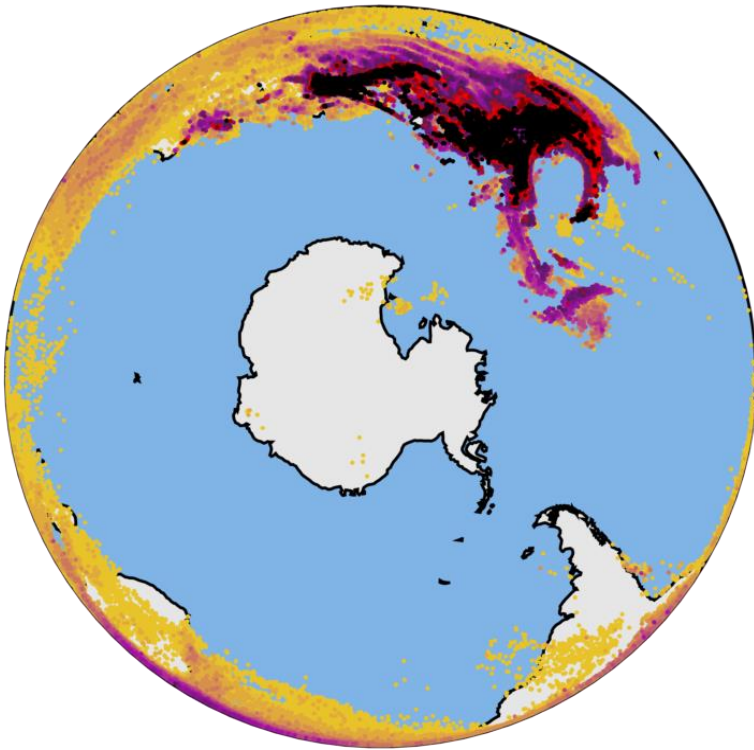
Hydrogen cyanide

Carbon monoxide

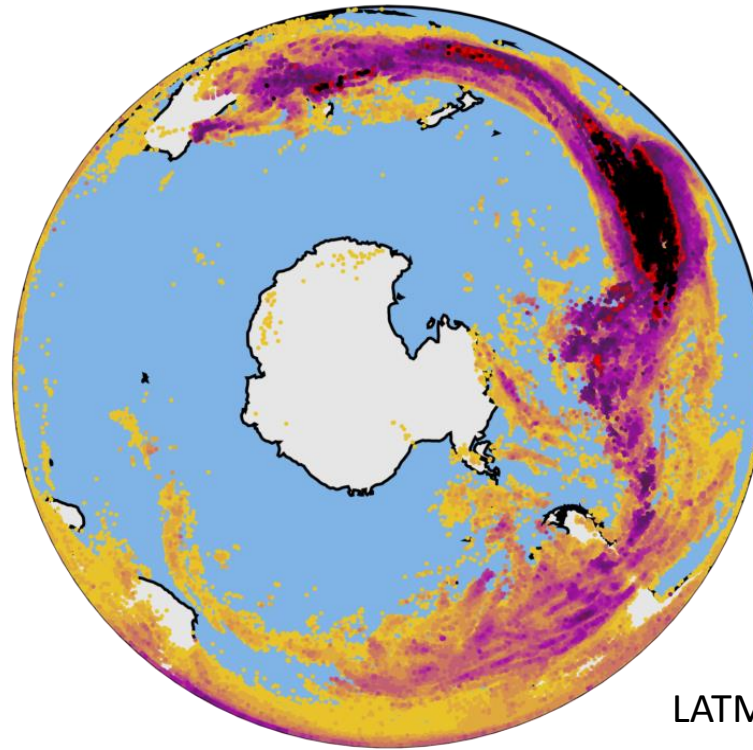


# Australian fires, november 2019 – january 2020

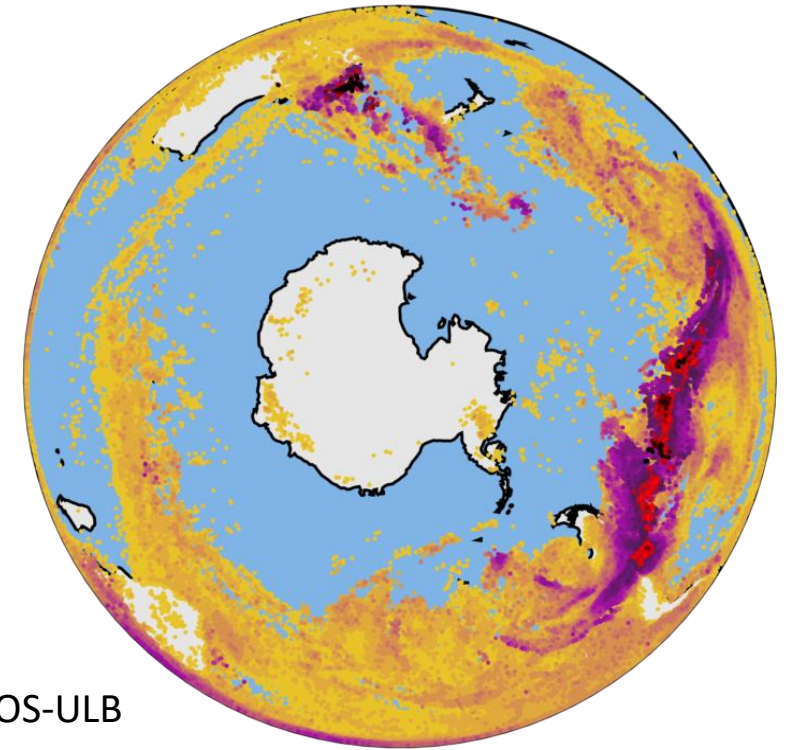
20191231-20200102



2020 01 07-09



2020 01 14-16



LATMOS-ULB

IASI CO total column ( $\times 10^{18}$  molec./cm<sup>2</sup>)



2 3 4 5 6 7 8 9 10

Credit Maya George (LATMOS)





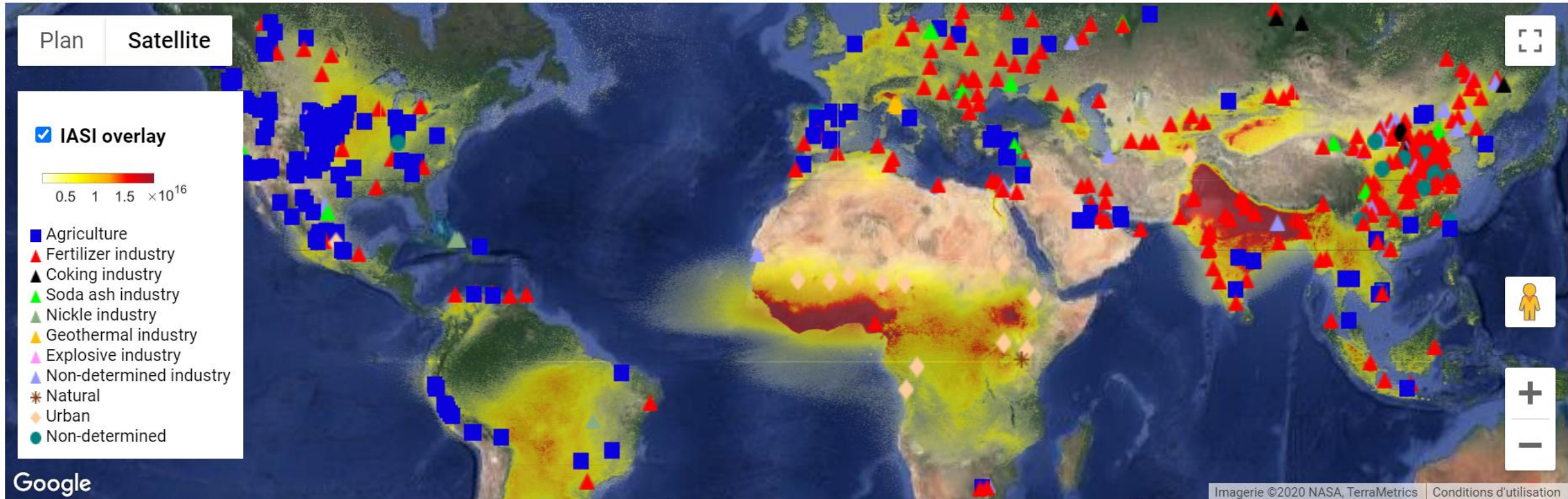
Ozone hole(s) 2019-2020

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and PM





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

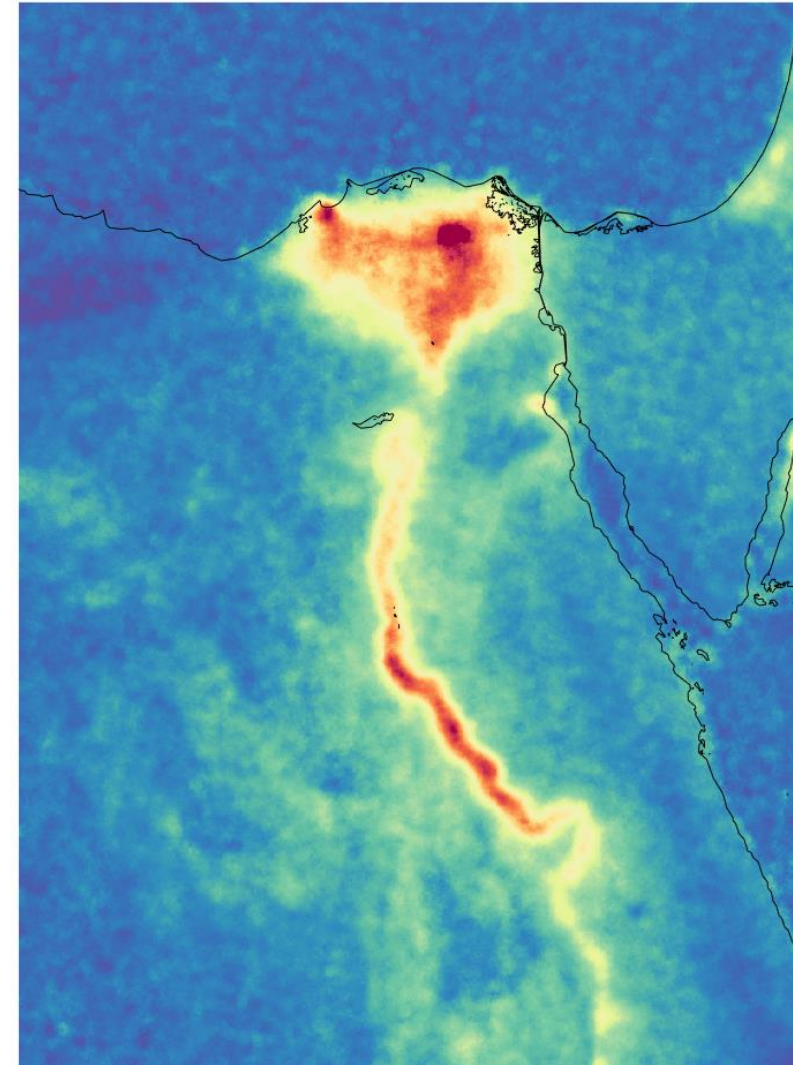
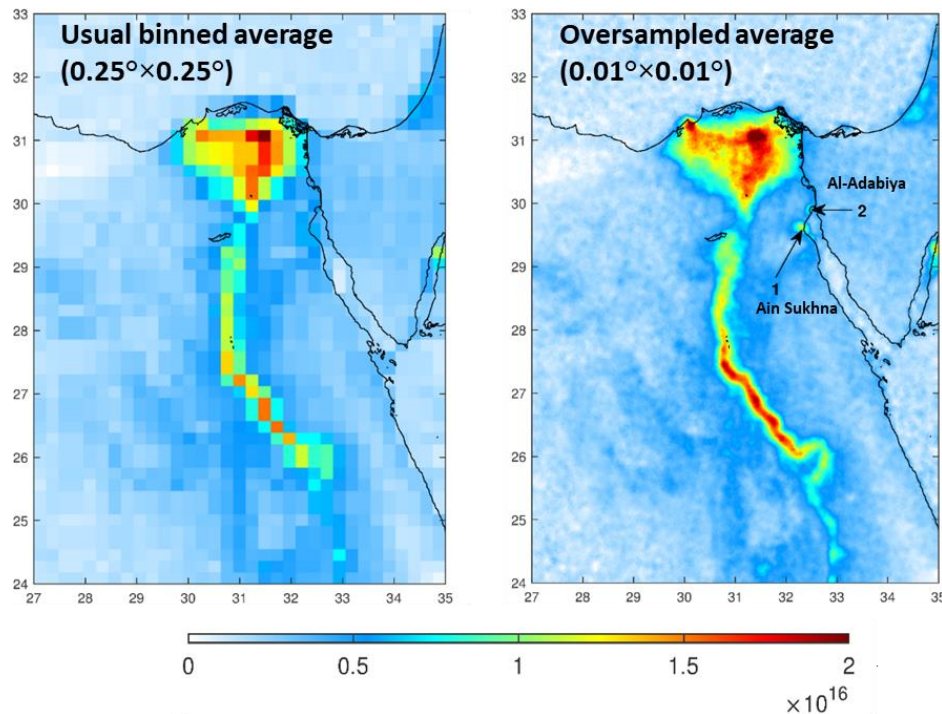




# NH<sub>3</sub> emission sources

## regular oversampled average

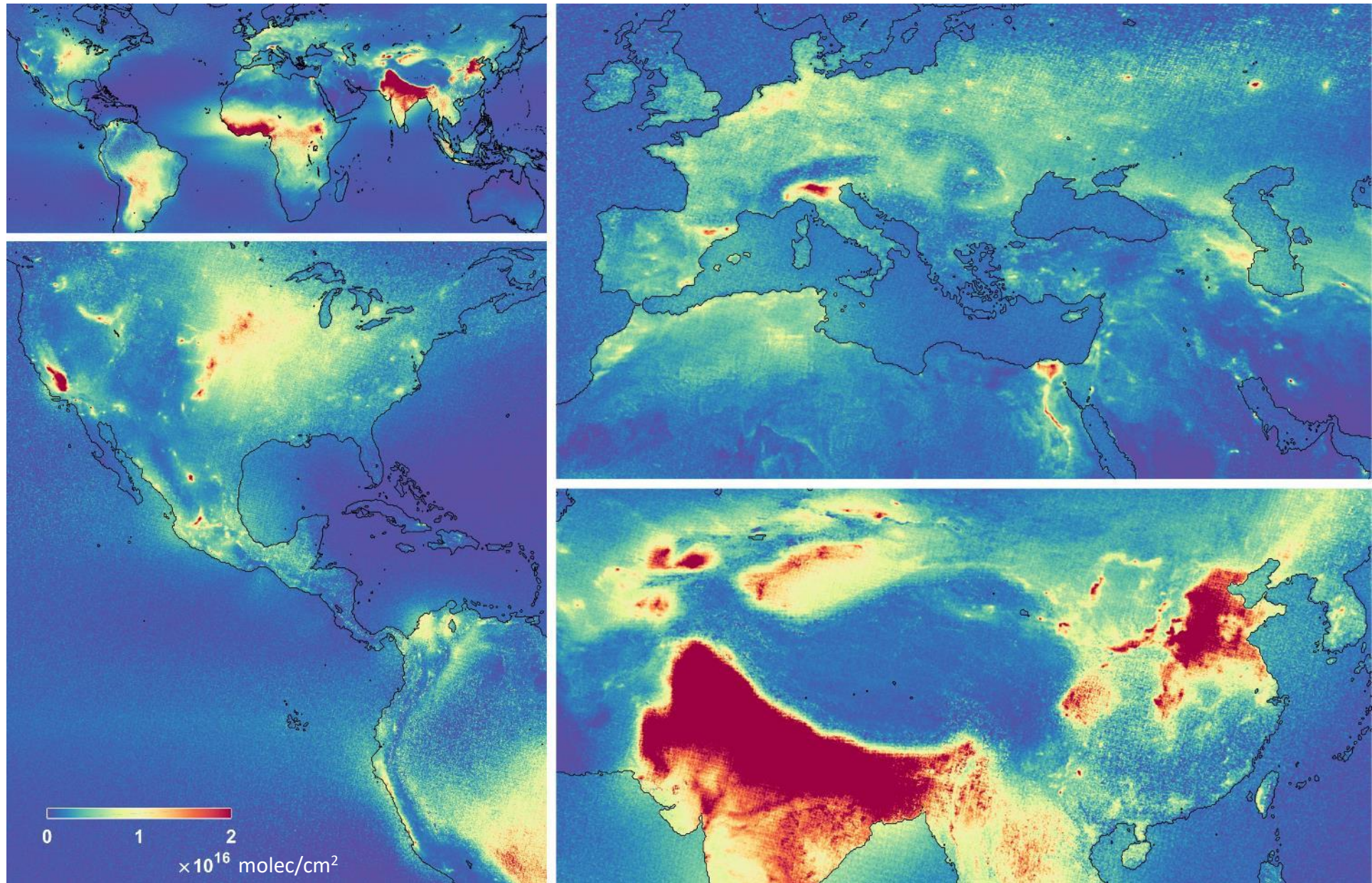
The elliptical footprints of IASI are averaged on a **0.01° × 0.01°** high-resolution grid and weighted by the inverse of their footprint area



10 years



## Spatial oversampling approach





## Agricultural



Picture: GoogleEarth

Credit Martin Van Damme, Lieven Clarisse (ULB)

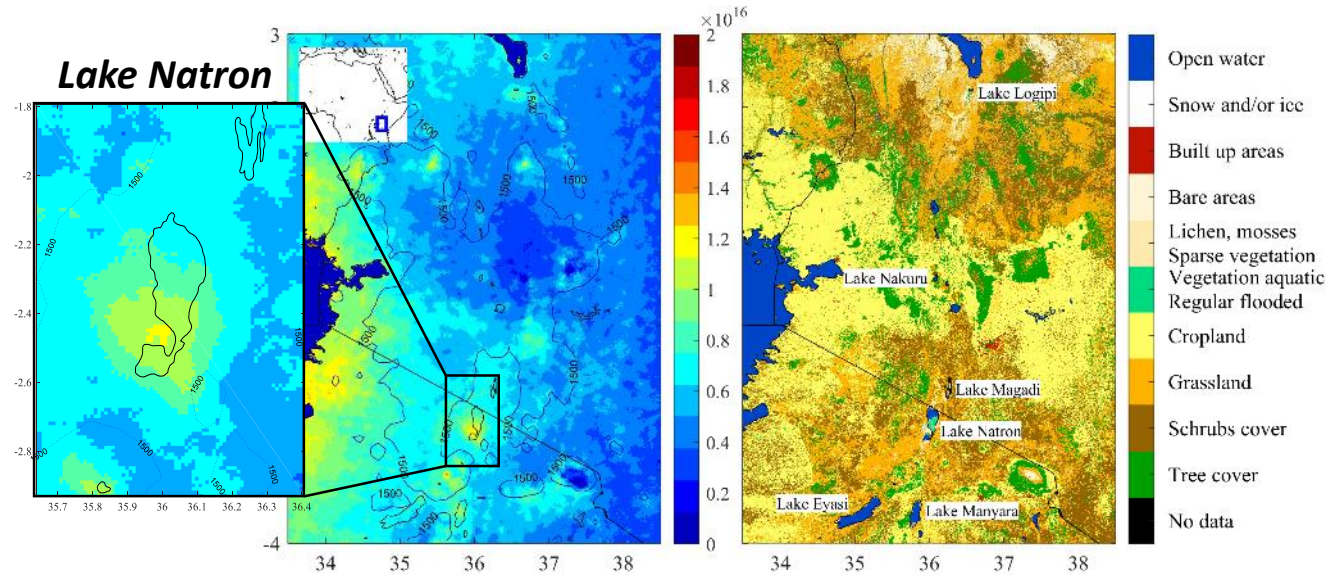
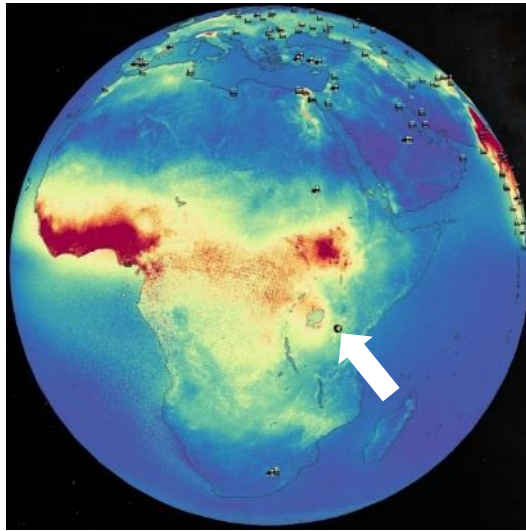
Industrial

Picture: GoogleEarth

Credit Martin Van Damme, Lieven Clarisse (ULB)



## Natural



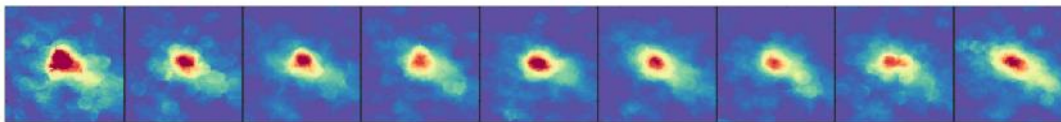
Picture: <http://animalia-life.club/other/lesser-flamingo-lake-natron.html>



pH of 10 / T° of 35°C / 92% of ammoniacal N in solution is present as NH<sub>3</sub>

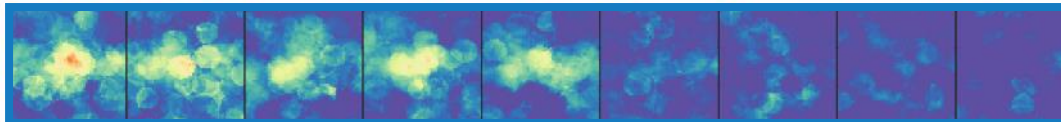
## Point sources monitoring

Marvdasht (Iran)

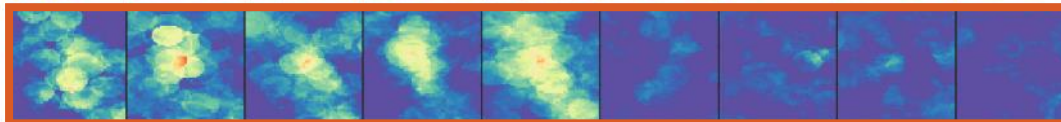


← *constant industrial emission*

Nicaró (Cuba)



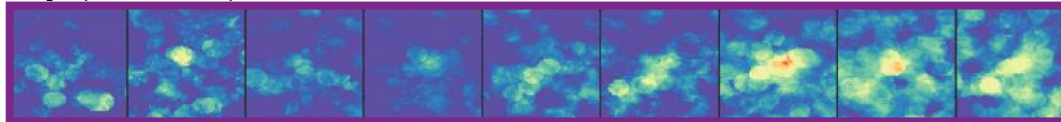
Bacau (Romania)



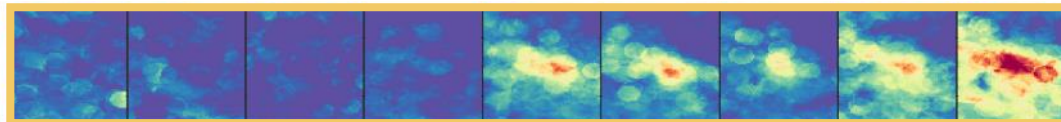
Alto Laran District (Peru)



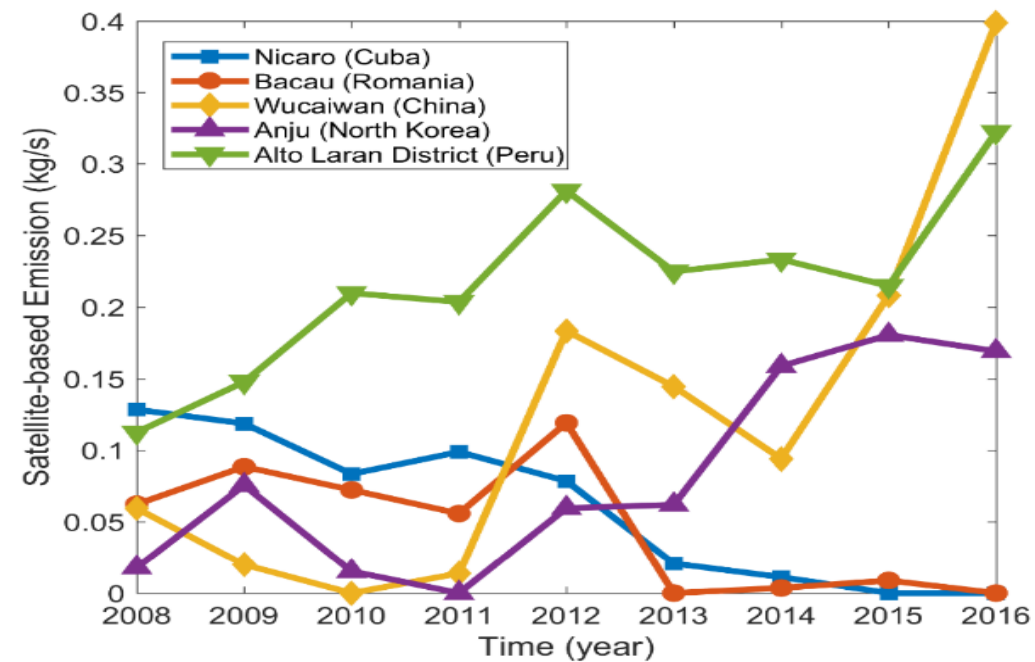
Anju (North Korea)



Wucaiwan (China)



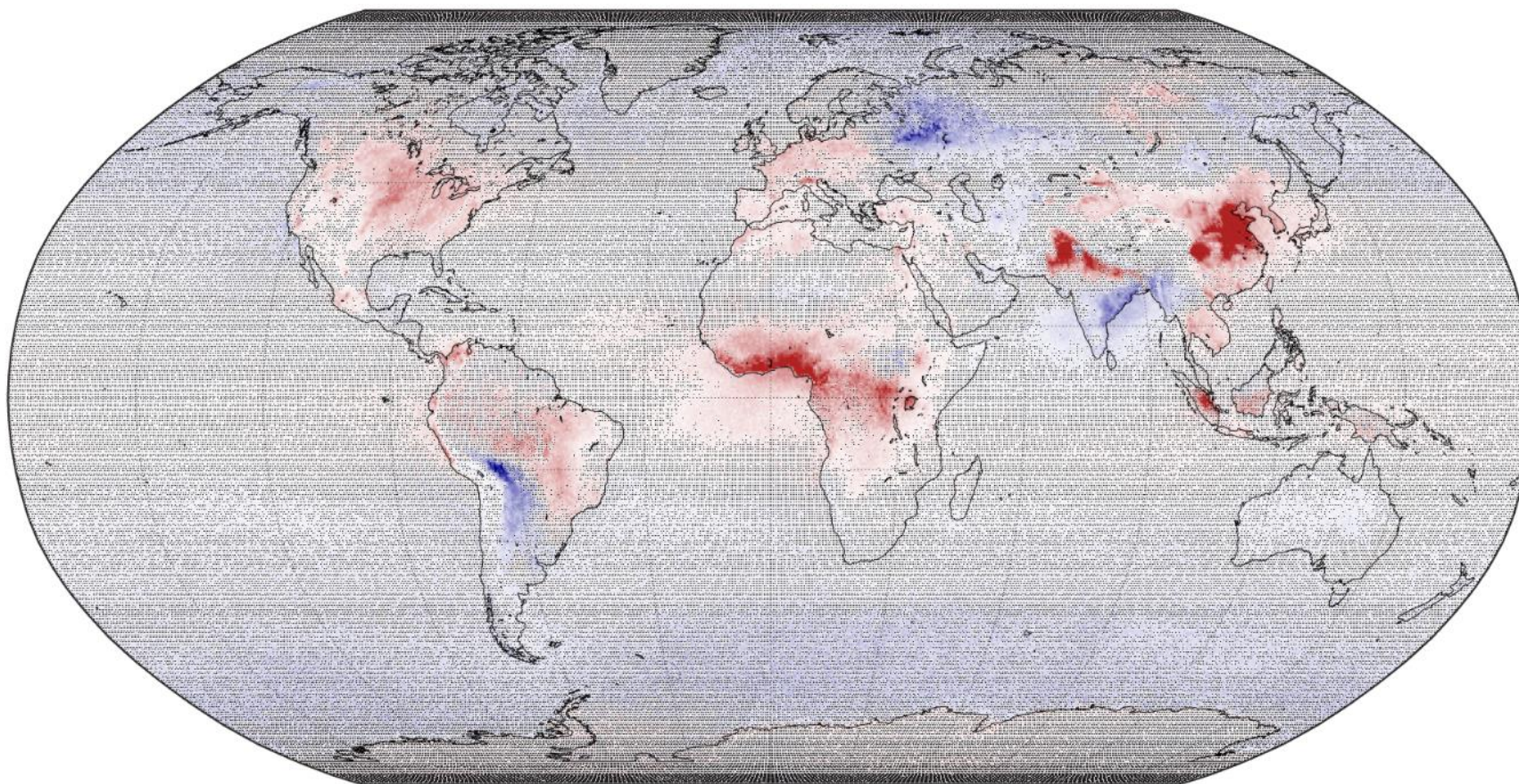
2008 2009 2010 2011 2012 2013 2014 2015 2016



➤ **Onset or discontinuation of anthropogenic activities**  
unambiguously detected and monitored



# NH<sub>3</sub> trends

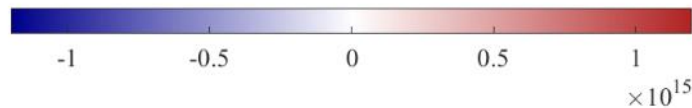


## Global trends

Bootstrap resampling method (Gardiner et al., 2008)

Daily time-series (0.5°×0.5°)

ANNI-NH<sub>3</sub>-v3R-ERA5 2008-2018 IASI/Metop-A



● = not significant at 2 $\sigma$

Credit Martin Van Damme, Lieven Clarisse (ULB)

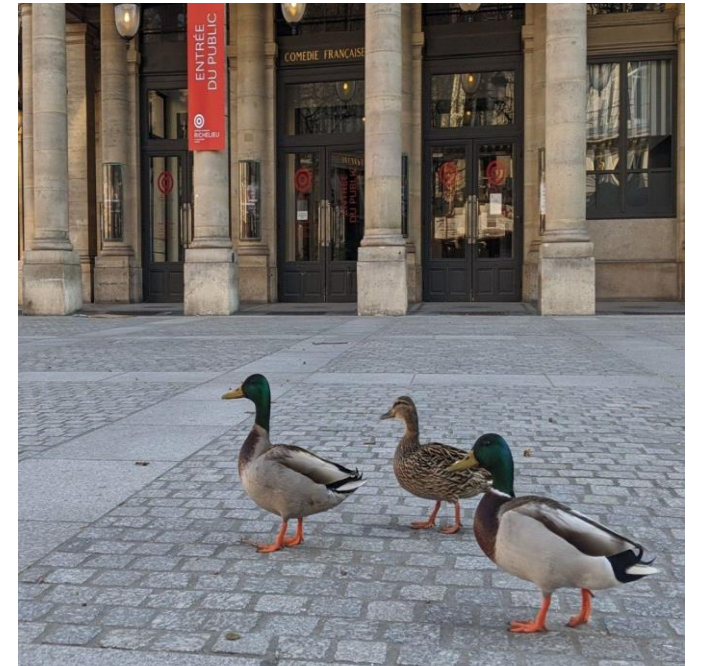


Ozone hole(s) 2019-2020

Australian fires : CO, COVs

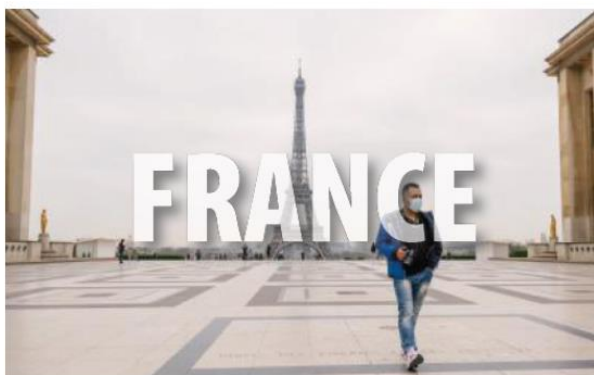
Ammonia sources

Covid and pollution: CO, NH<sub>3</sub>  
and PM



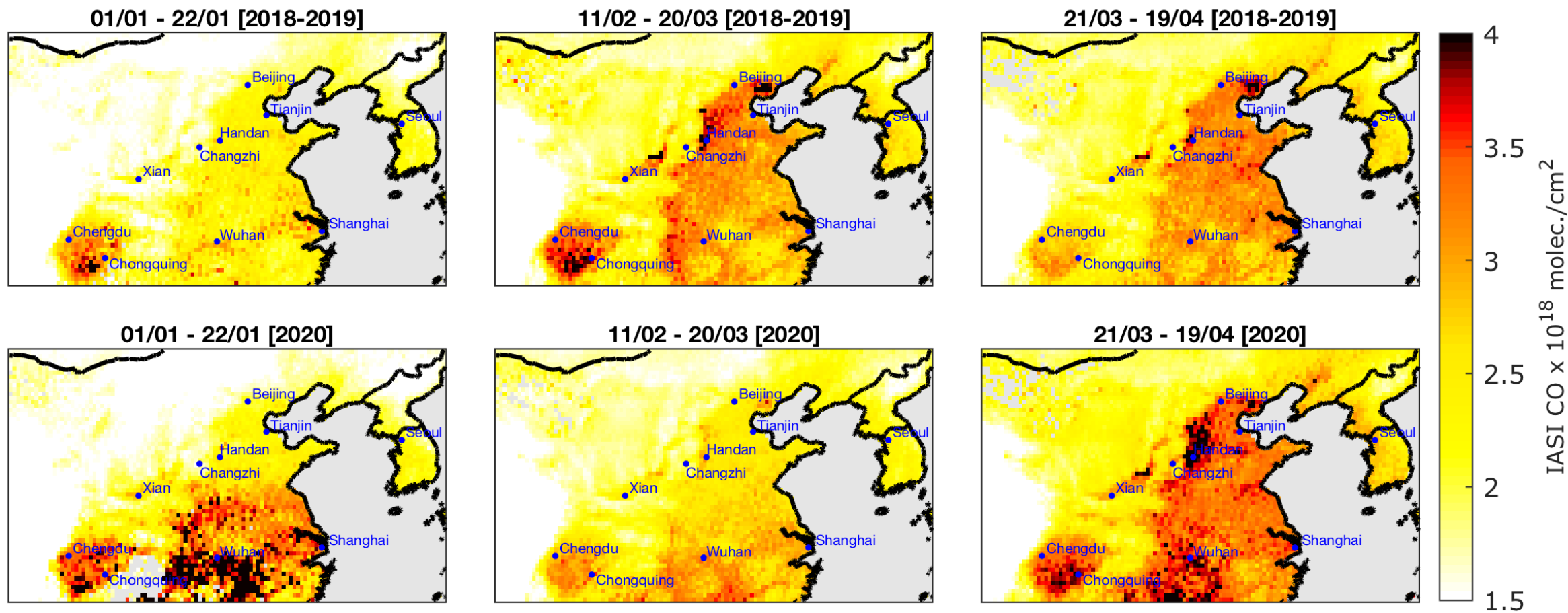


# IASI observations before, during, and after the lockdown



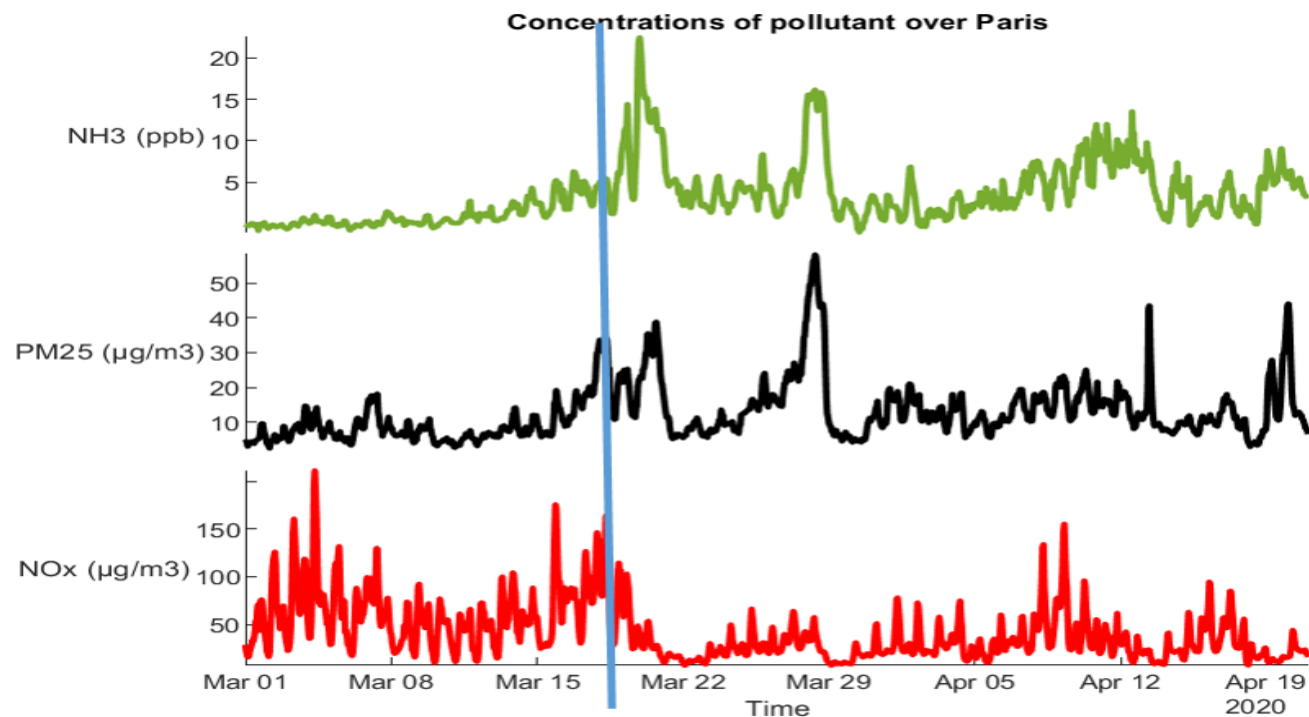
More plots : CO, NH<sub>3</sub>, ozone for EU, US, India, China, <https://iasi.aeris-data.fr/covid-19/>

# CO observation before, during and after the lockdown



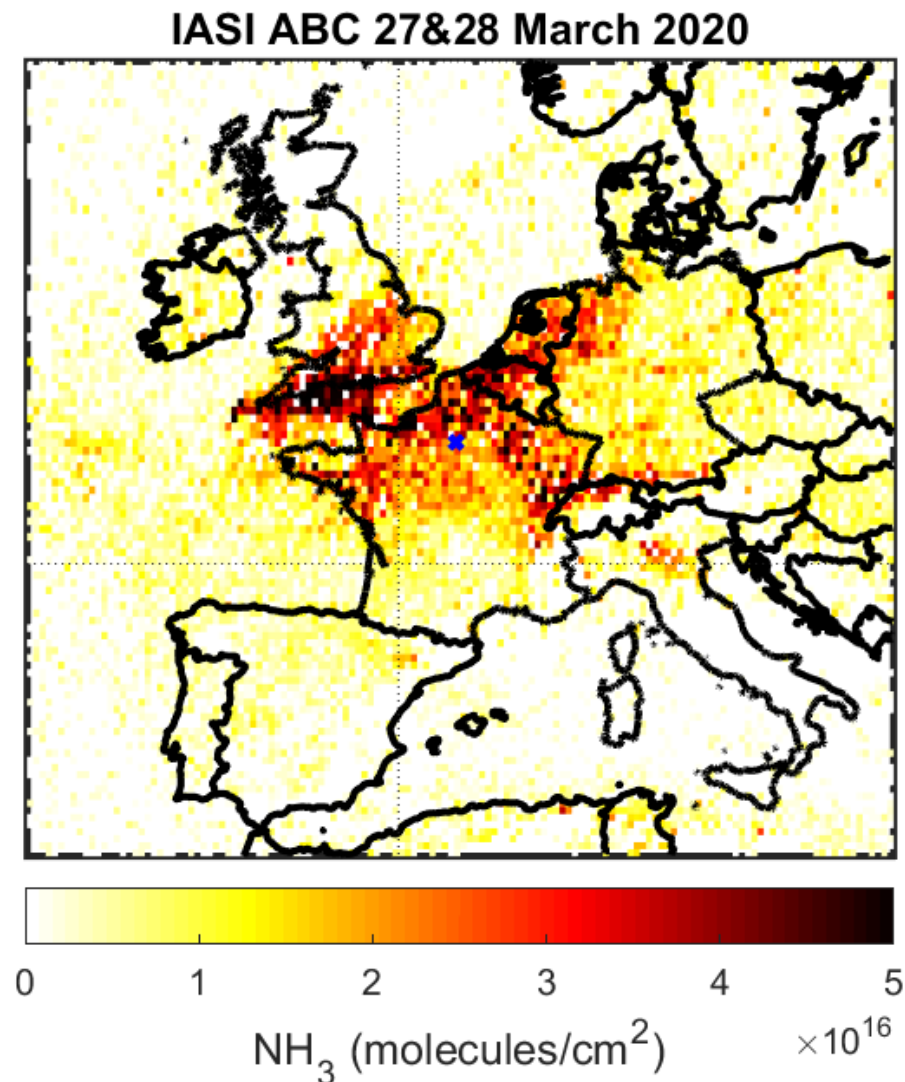


# NH<sub>3</sub> and PM observation before and during the lockdown




NH<sub>3</sub> observations over Paris (mini-DOAS), along with ground-based AQ data (NO<sub>2</sub> and PM – Airparif)

Credit Camille Viatte (LATMOS)



# Users

Implemented by ECMWF as part of The Copernicus Programme




Climate  
Change Service

News Events Press Tenders Help & Support


ABOUT USWHAT WE DO

DATA

QSEARCH




European  
Commission



Copernicus  
Europe's eyes on Earth

IMPLEMENTED BY

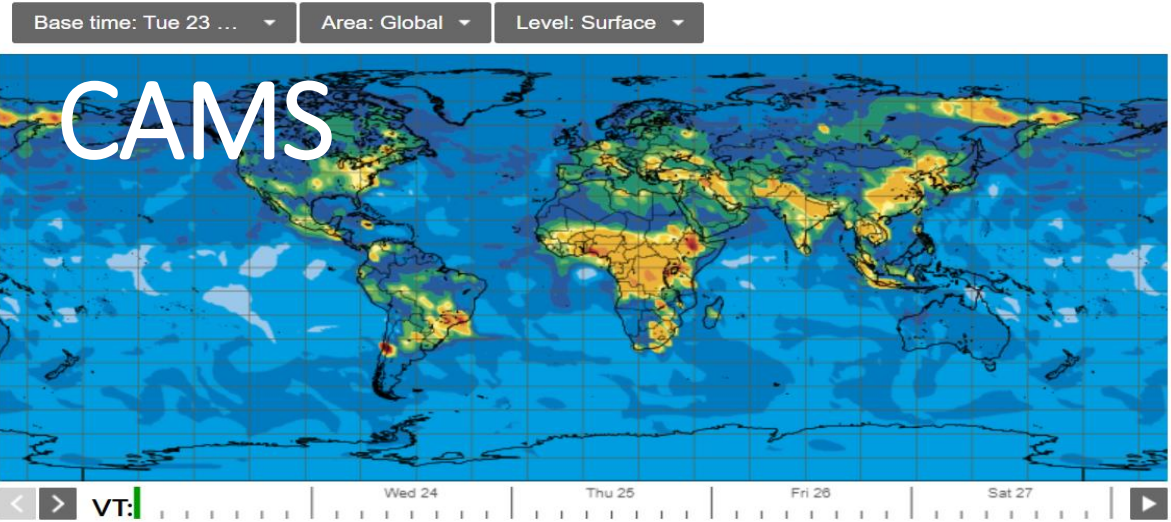



ECMWF

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C3S


We provide authoritative information about the past, present and future climate, as well as tools to enable climate change mitigation and adaptation strategies by policy makers and businesses.






SACS







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Engage




Support to Aviation Control Service




esa

SACS home >

NEAR REAL-TIMENOTIFICATIONSPRODUCTS



latest SO<sub>2</sub> notification

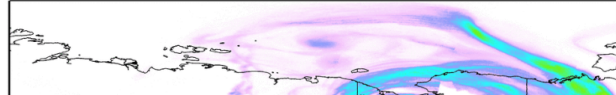


latest ASH notification

Copernicus Sentinels catch emissions of volcanic eruption

The Copernicus Sentinel-5P satellite detected the sulphur dioxide emissions from the **Raikoke eruption**, showing the largest amounts of SO<sub>2</sub> since the Nabro 2011 eruption emission.

log(SO<sub>2</sub> (DU)) 02.07.2019



## Scientific Users

PAYS	CO	NH3	NH3RI	SO2	O3	HDO	HCOOH	TOTAL
Allemagne	2	0	0	0	1	0	0	3
Canada	2	0	0	0	1	0	0	4
Chine	1	16	5	1	1	1	0	25
Colombie	0	0	0	0	1	0	0	1
Corée	1	6	1	0	0	0	0	8
Finlande	1	1	0	1	1	0	0	4
France	7	3	2	4	1	0	2	19
Ile Reunion	1	0	0	0	0	0	0	1
Inde	1	2	3	0	2	0	1	9
Indonésie	0	0	0	0	1	0	0	1
Irlande	1	0	0	0	0	0	0	1
Italie	2	1	0	1	1	0	0	5
Japon	0	0	1	0	0	0	0	1
Maroc	0	1	0	0	0	0	0	1
Oman (moyen-orient)	1	0	0	0	1	0	0	2
Pays-bas	0	3	1	0	1	0	0	5
Pologne	0	0	0	1	0	0	0	1
Portugal	1	1	2	0	0	0	0	4
Roumanie	1	0	0	1	0	0	0	2
Suisse	0	0	1	0	0	0	0	1
Taiwan	0	0	0	1	0	0	0	1
UK	2	2	1	2	1	0	0	8
USA	3	5	2	0	0	0	1	11
Total	27	41	19	14	11	1	5	118