



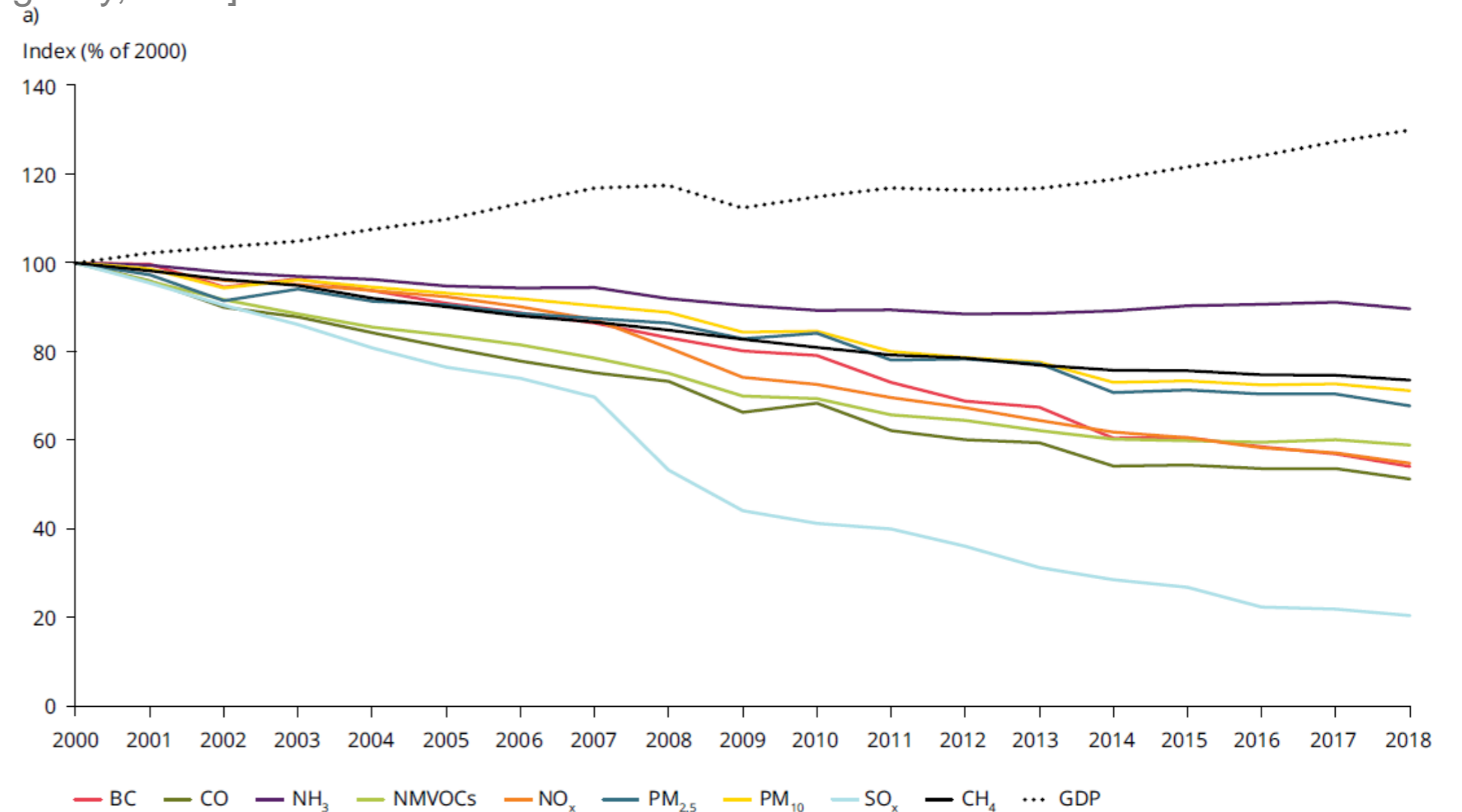
# Ammonia and PM<sub>2.5</sub> Air Pollution in Paris during the 2020 COVID Lockdown

Camille Viatte, Jean-Eudes Petit, Shoma Yamanouchi, Martin Van Damme, Carole Doucerain, Emeric Germain-Piaulenne, Valérie Gros, Olivier Favez, Lieven Clarisse, Pierre-Francois Coheur, Kimberly Strong and Cathy Clerbaux



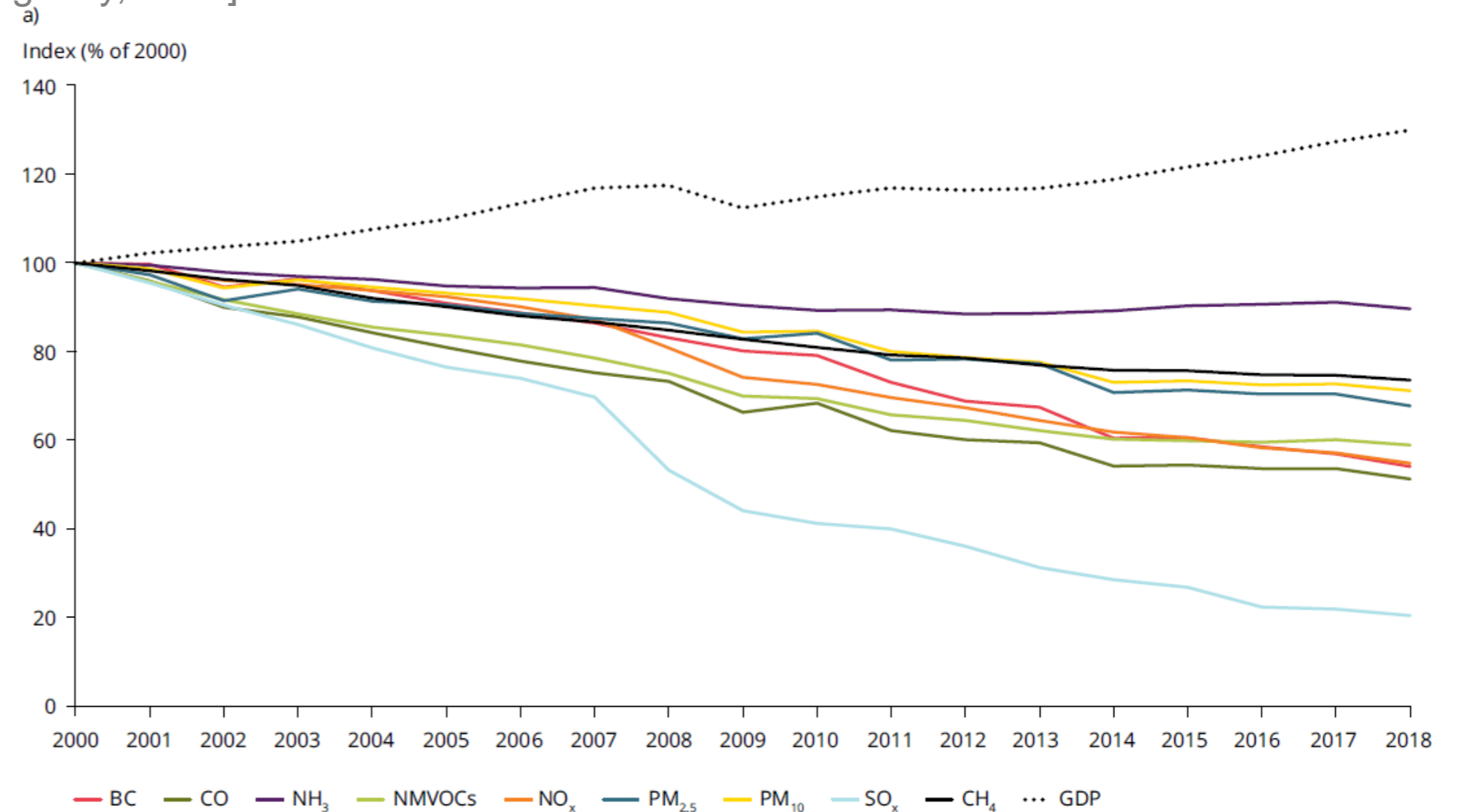
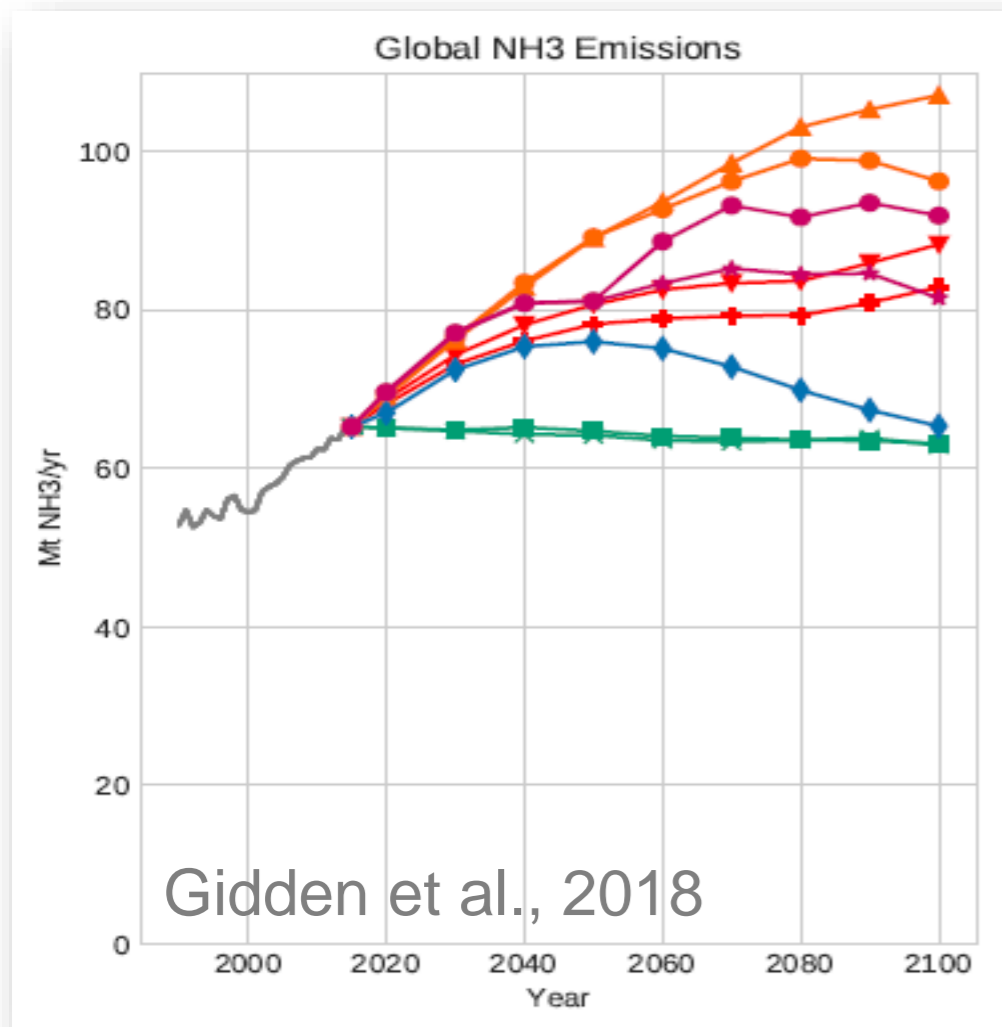
# Ammonia

- 94% of  $\text{NH}_3$  emission is coming from the agriculture sector [CITEPA, 2018]
- Over Europe, the Gothenburg Protocol set a reduction of 19% in 2030, but emissions have increased between 2013 and 2017 [European Environment Agency, 2020].

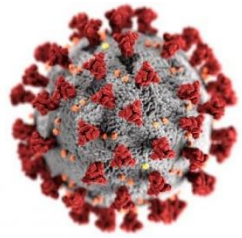


# Ammonia

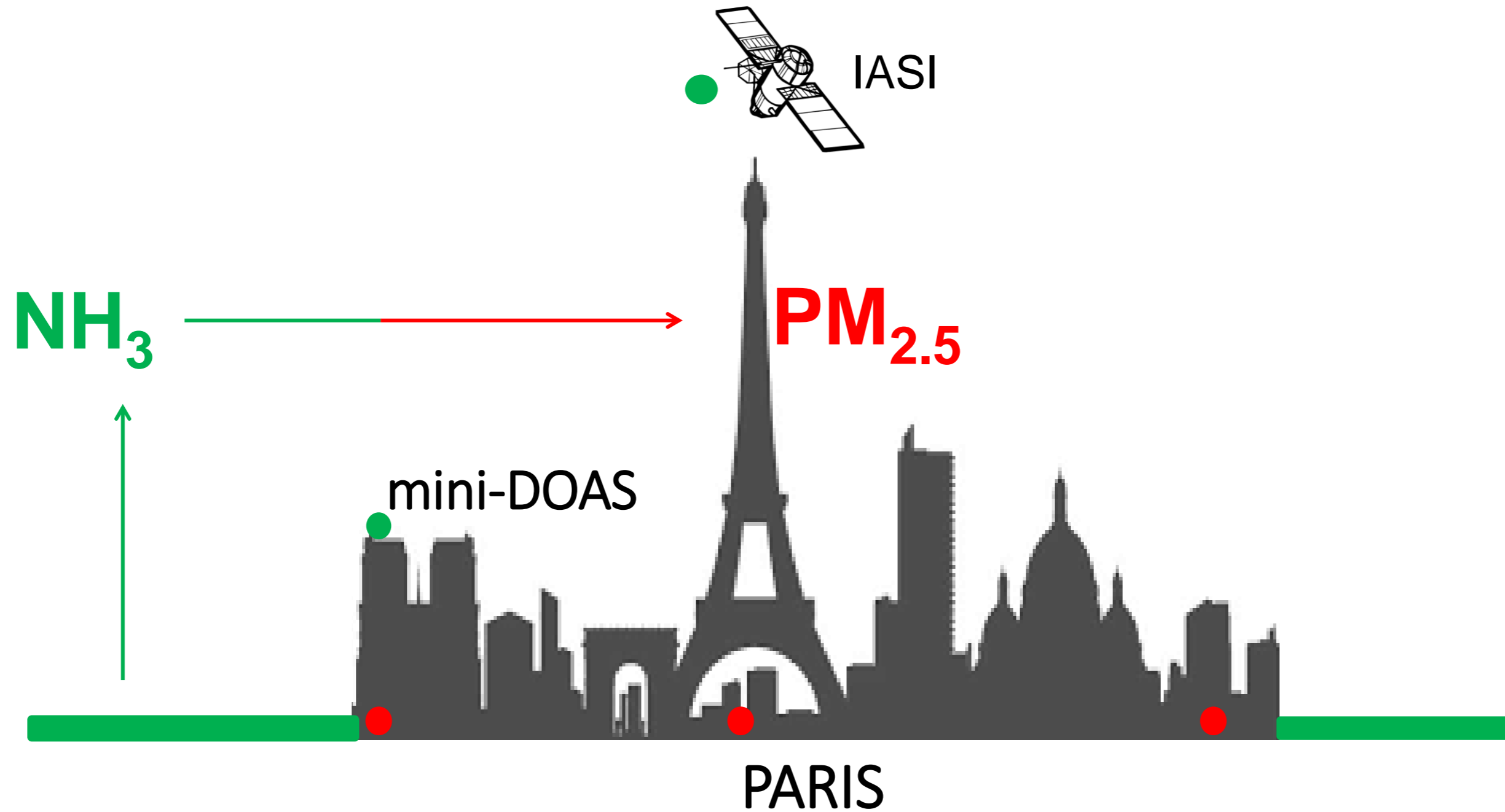
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$\text{NH}_3$  emissions are projected to increase in the future → Most unknown precursor of harmful particulate matter ( $\text{PM}_{2.5}$ )

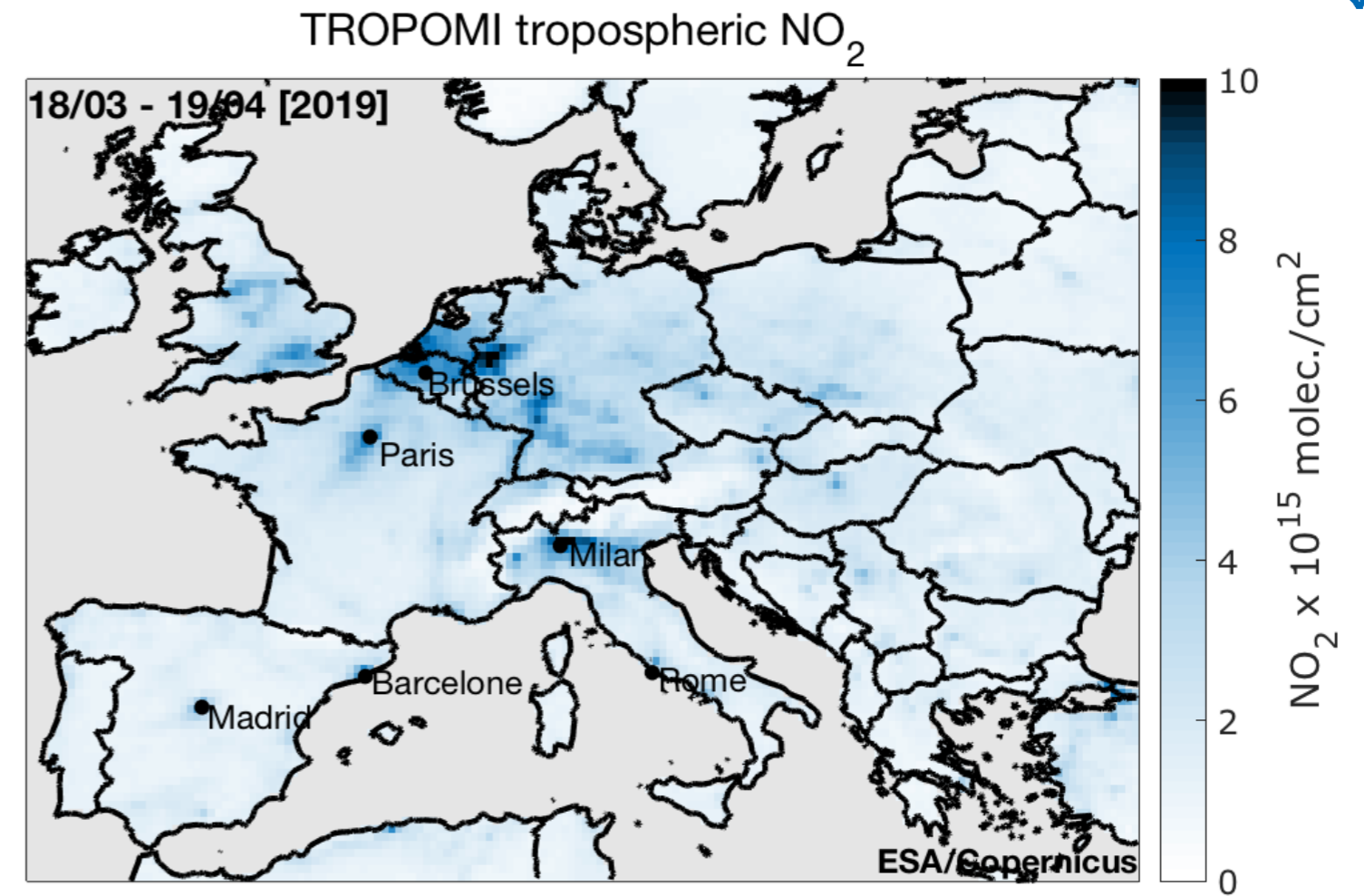
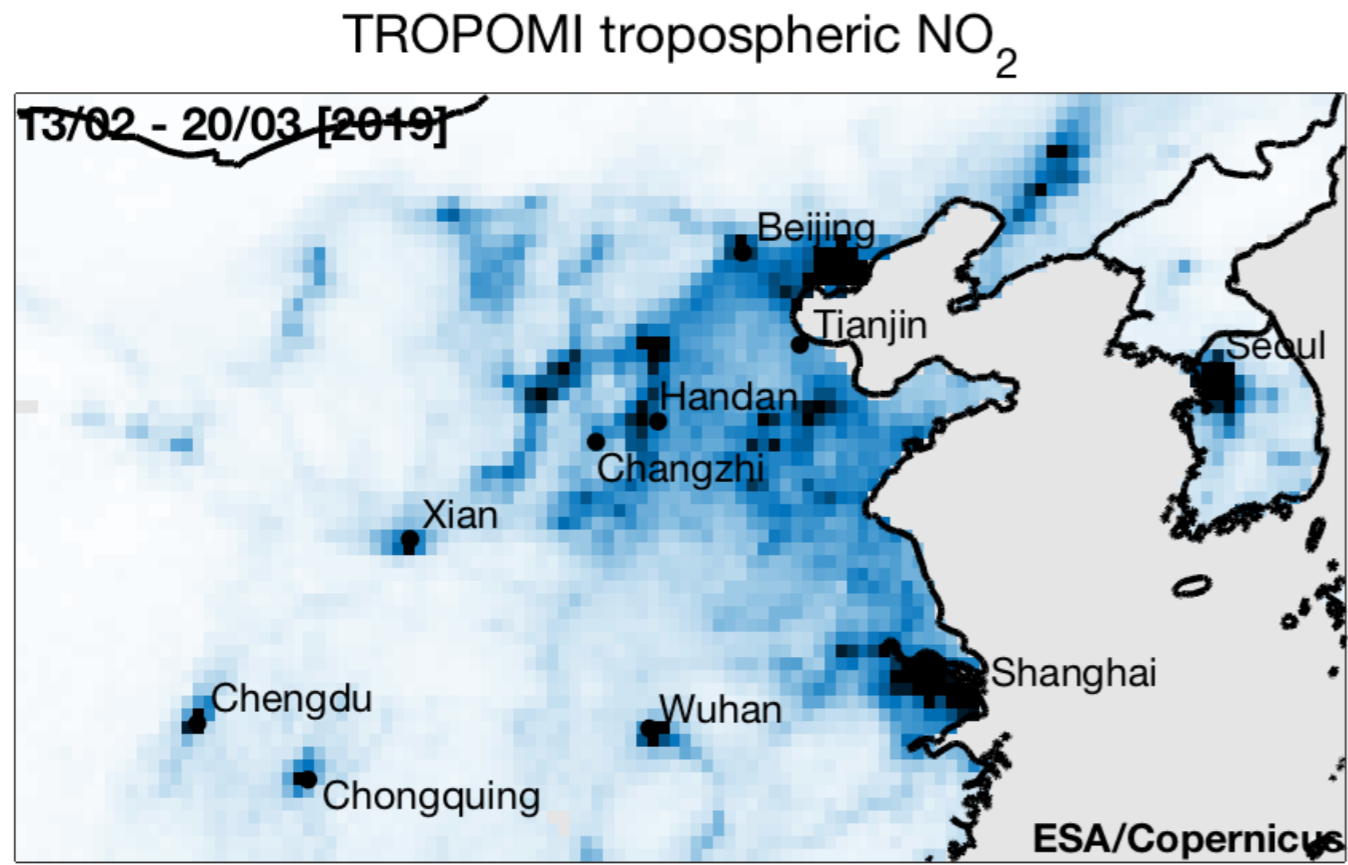


# Ammonia and PM<sub>2.5</sub>



# Lockdown in 2020

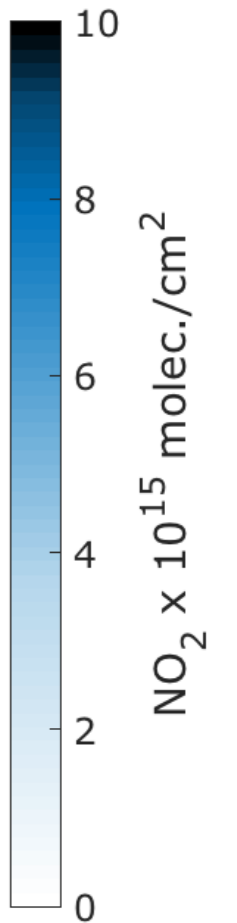
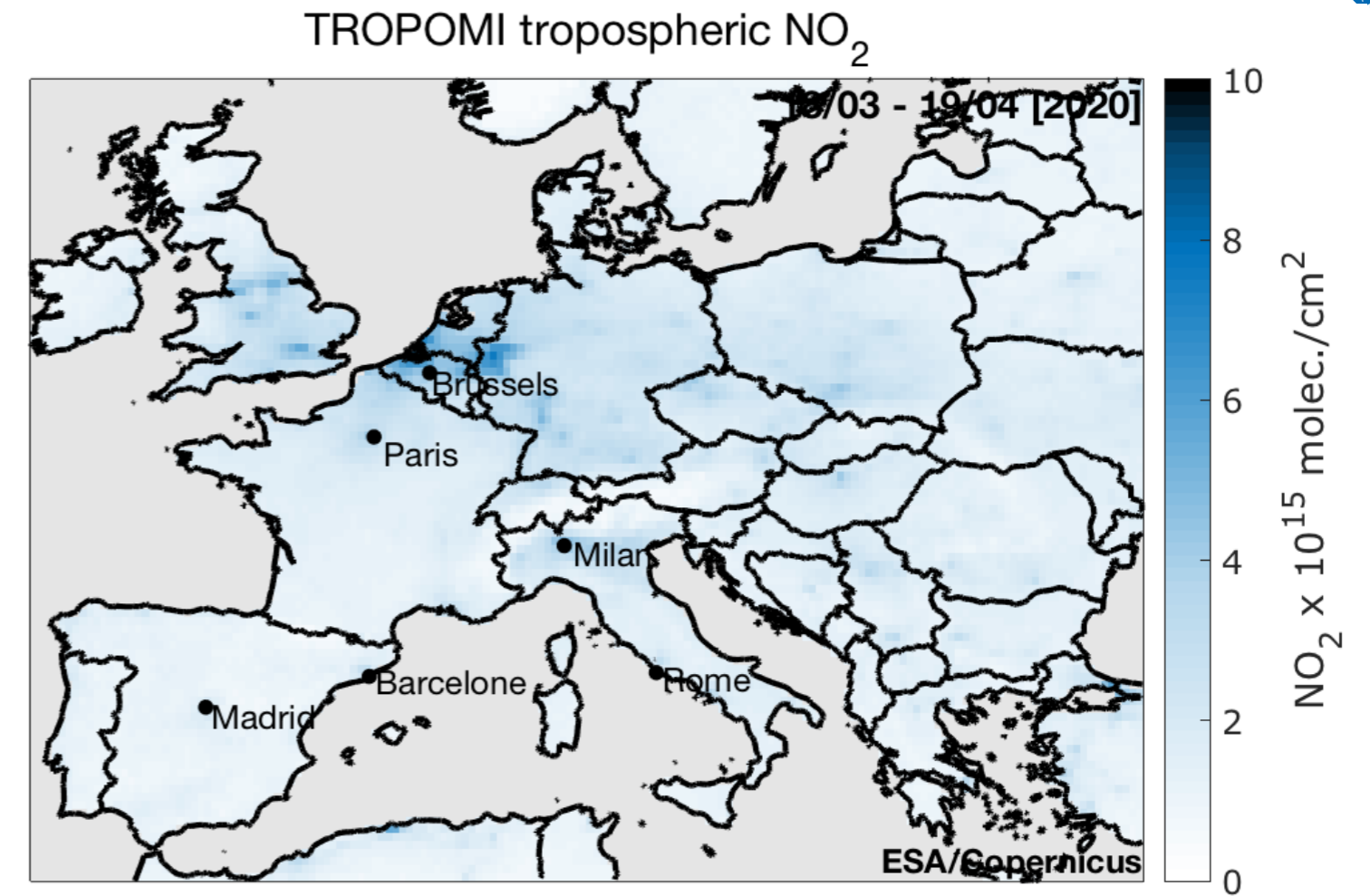
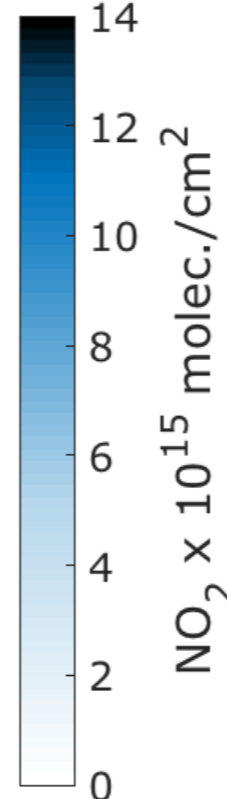
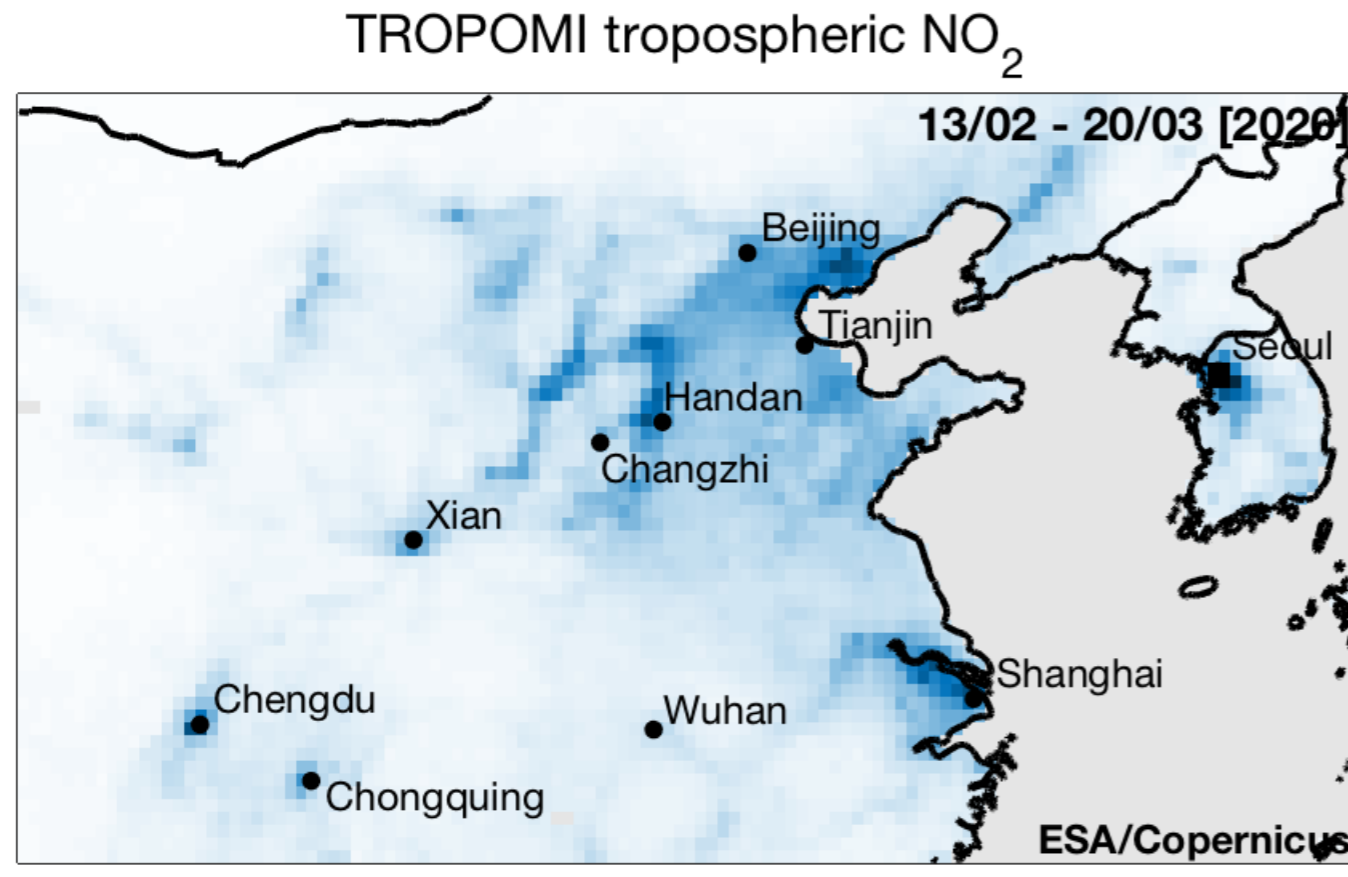
2019



Credit Anne Boynard

# Lockdown in 2020

2020



Credit Anne Boynard

The average NO<sub>2</sub> columns decreased by 40% across Chinese cities and ~20% in Western Europe compared to the same period in 2019 [Bauwens et al., 2020]

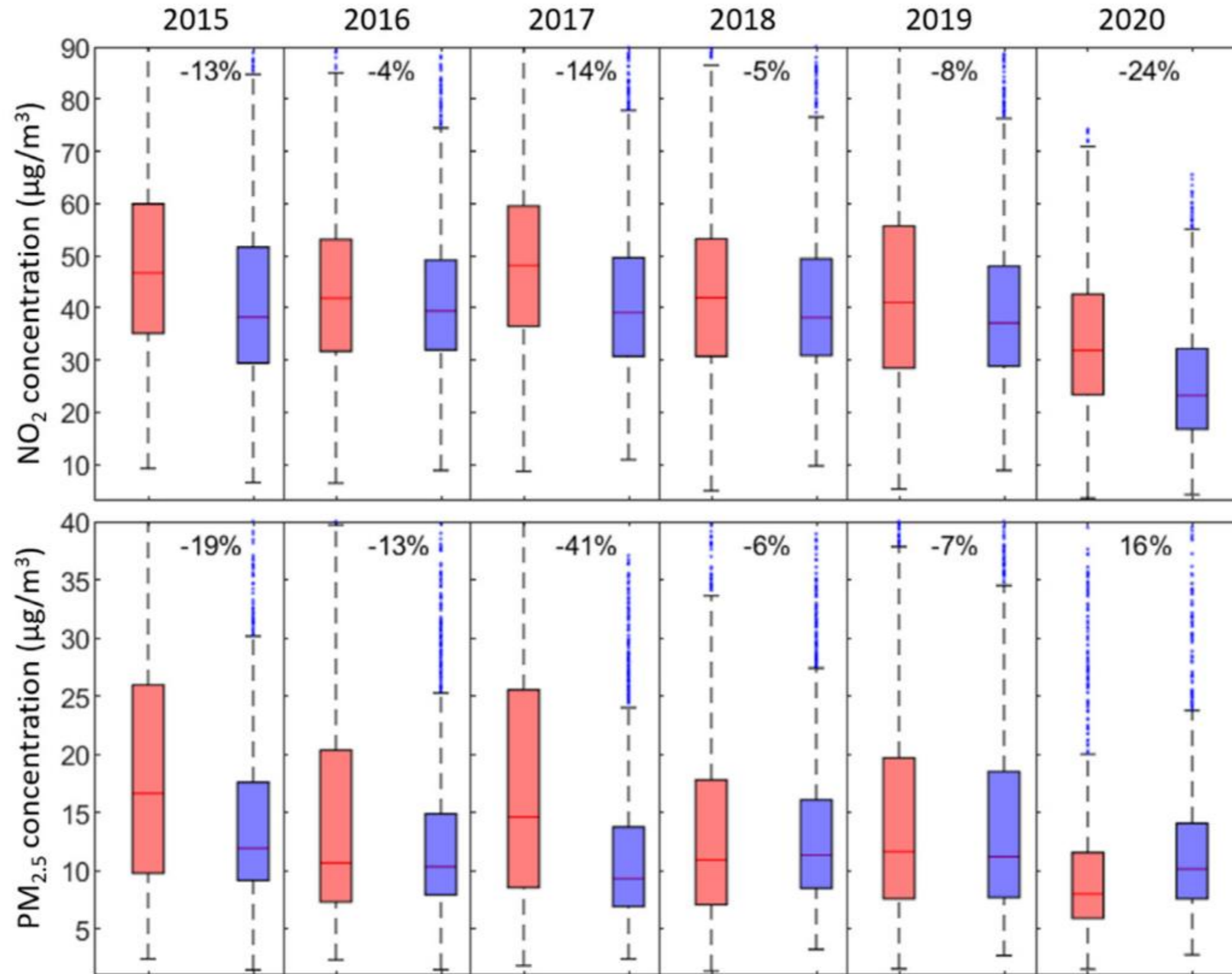
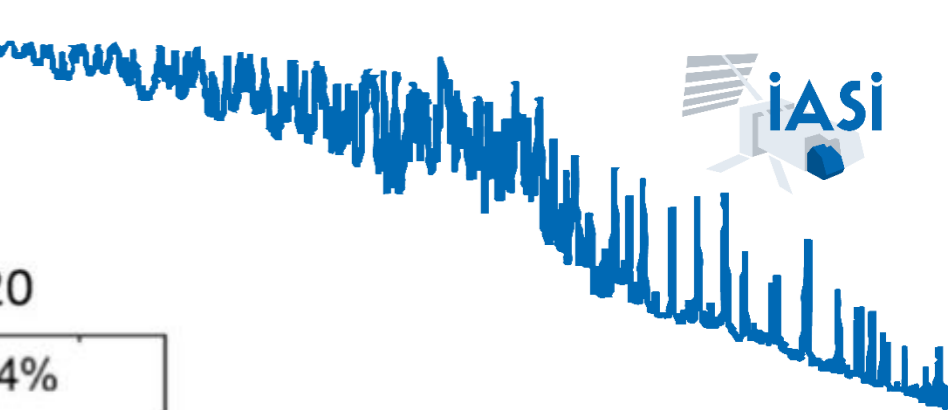
# Lockdown in 2020

March 17 2020 → lockdown in France



In Paris, the usual 15.5 million of motorized trips were severely restricted, leading to reduce by half the daily  $\text{NO}_2$  emissions for three weeks after lockdown [Airparif, 2020]

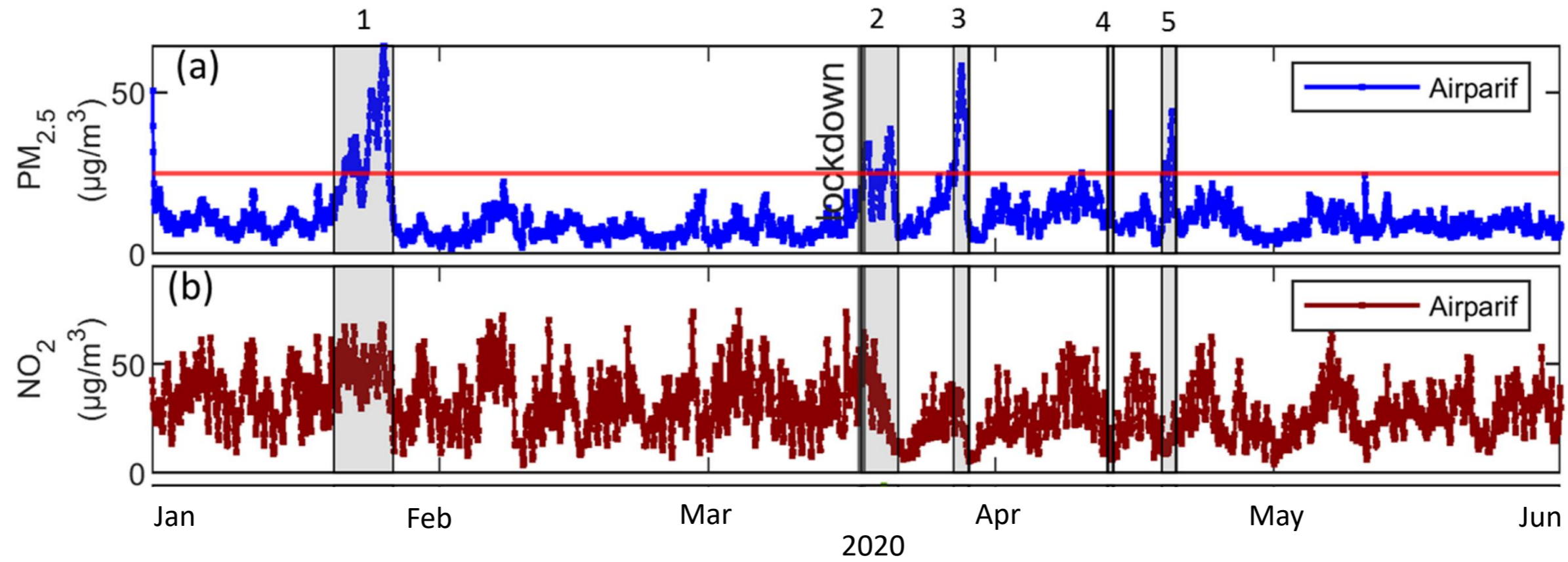
# Pollutants in Paris in 2020



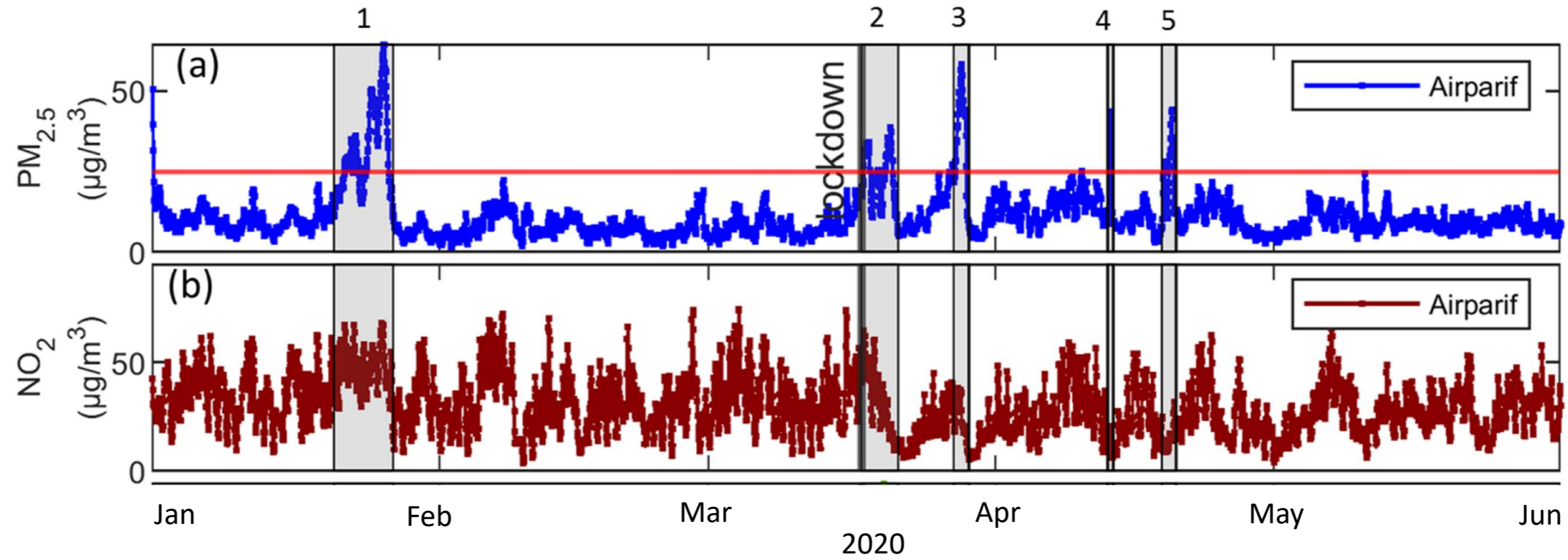
Jan 1 – Mar 17  
Mar 17– Jun 1



# Pollutants in Paris in 2020



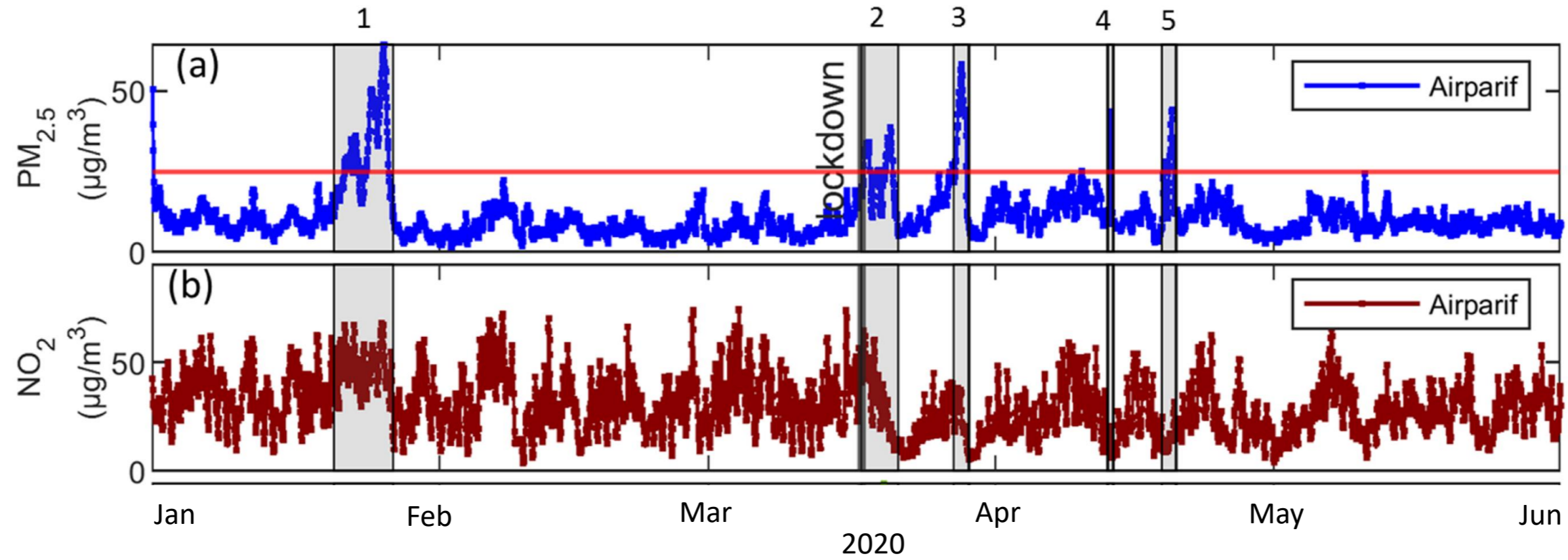
# Pollutants in Paris in 2020



## Mini-DOAS



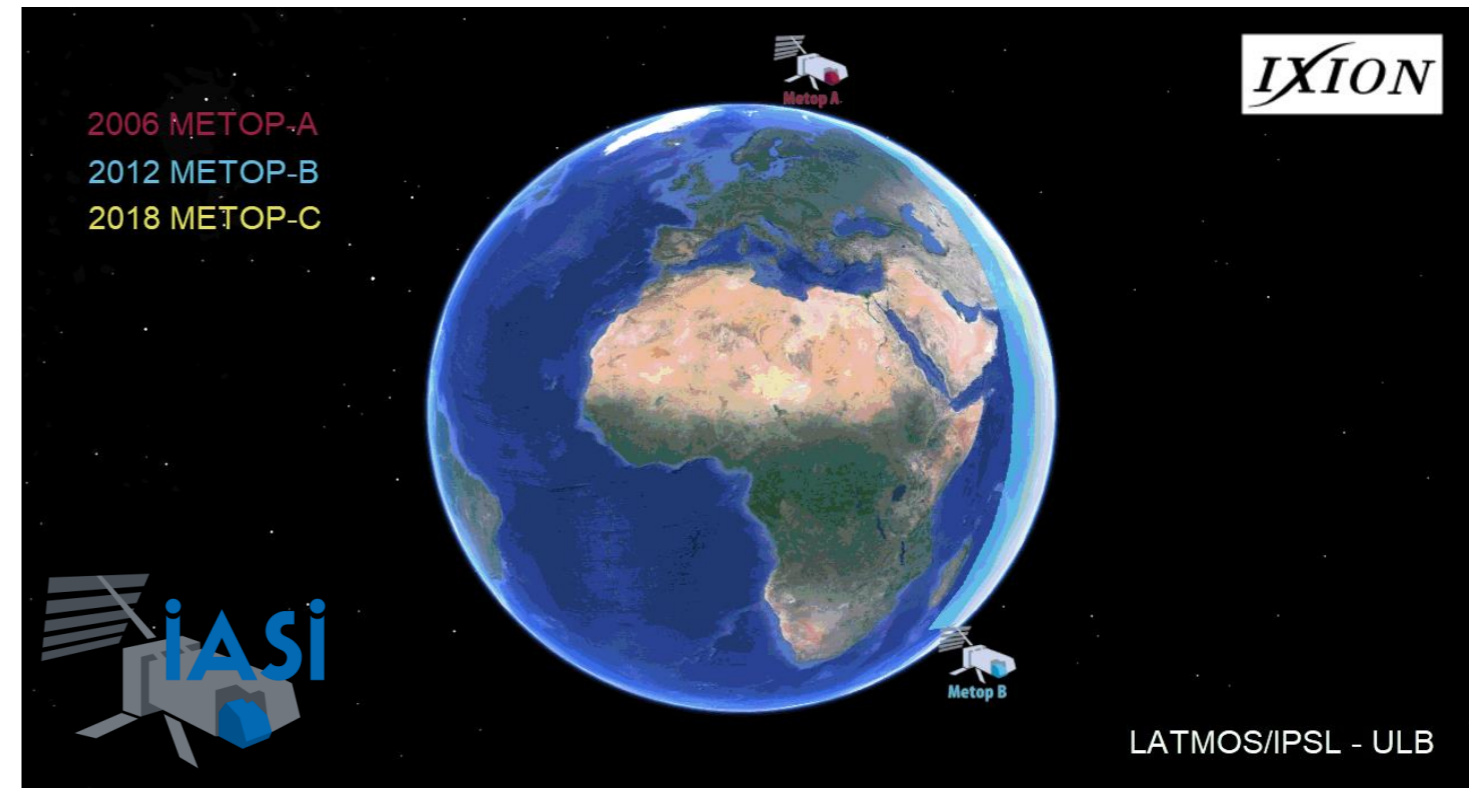
# Pollutants in Paris in 2020



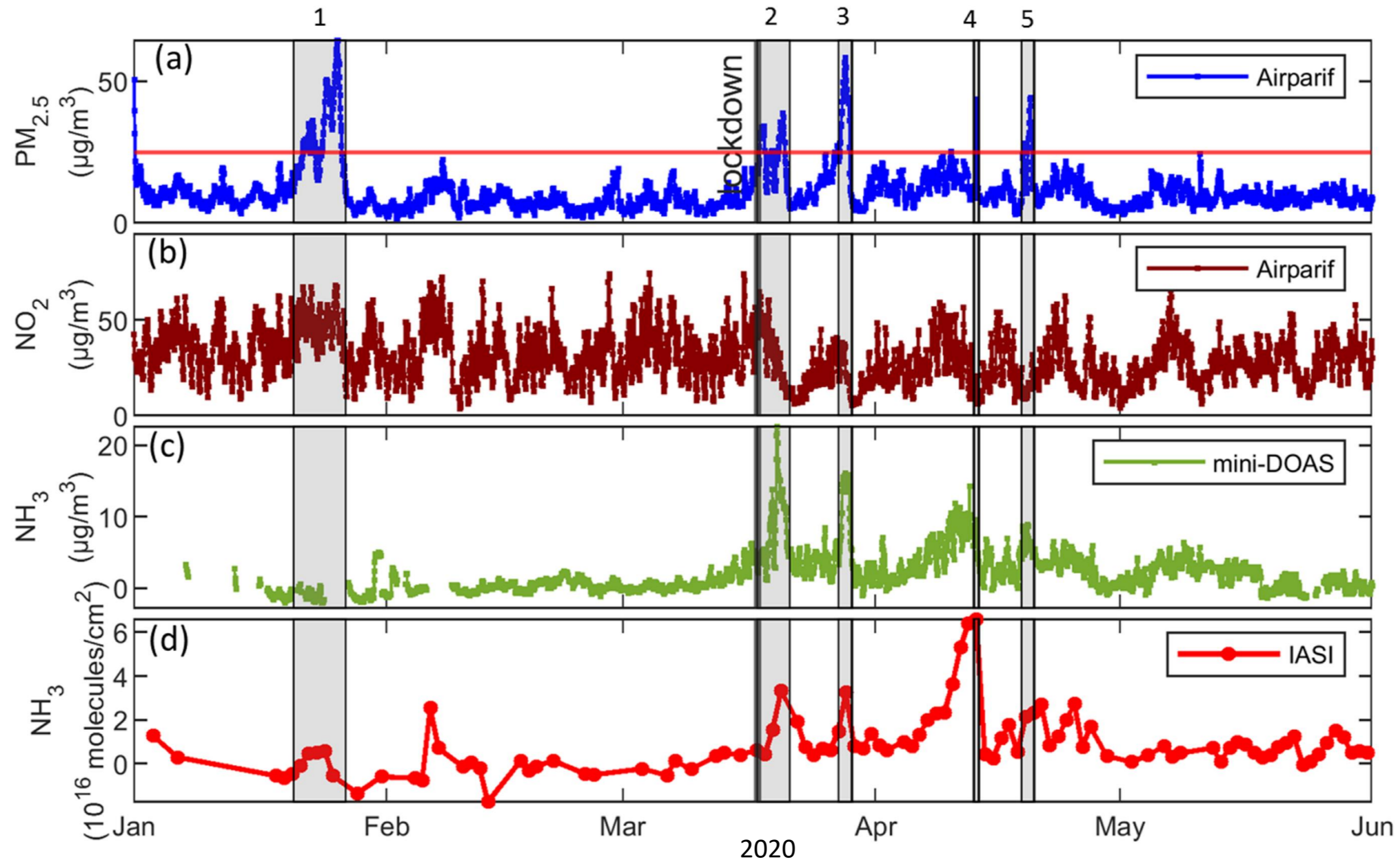
Mini-DOAS



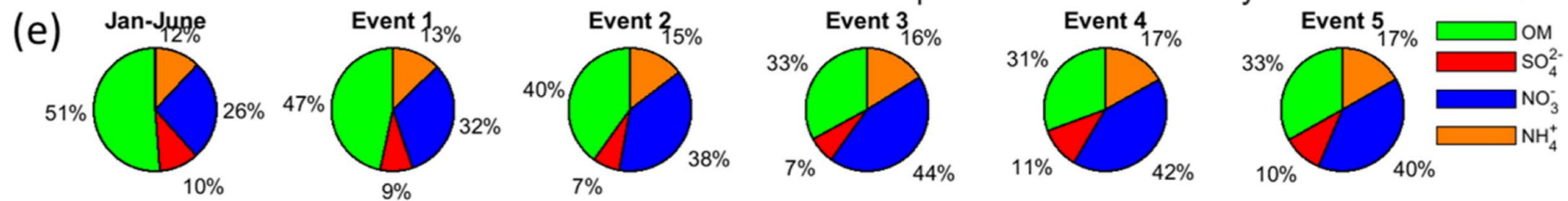
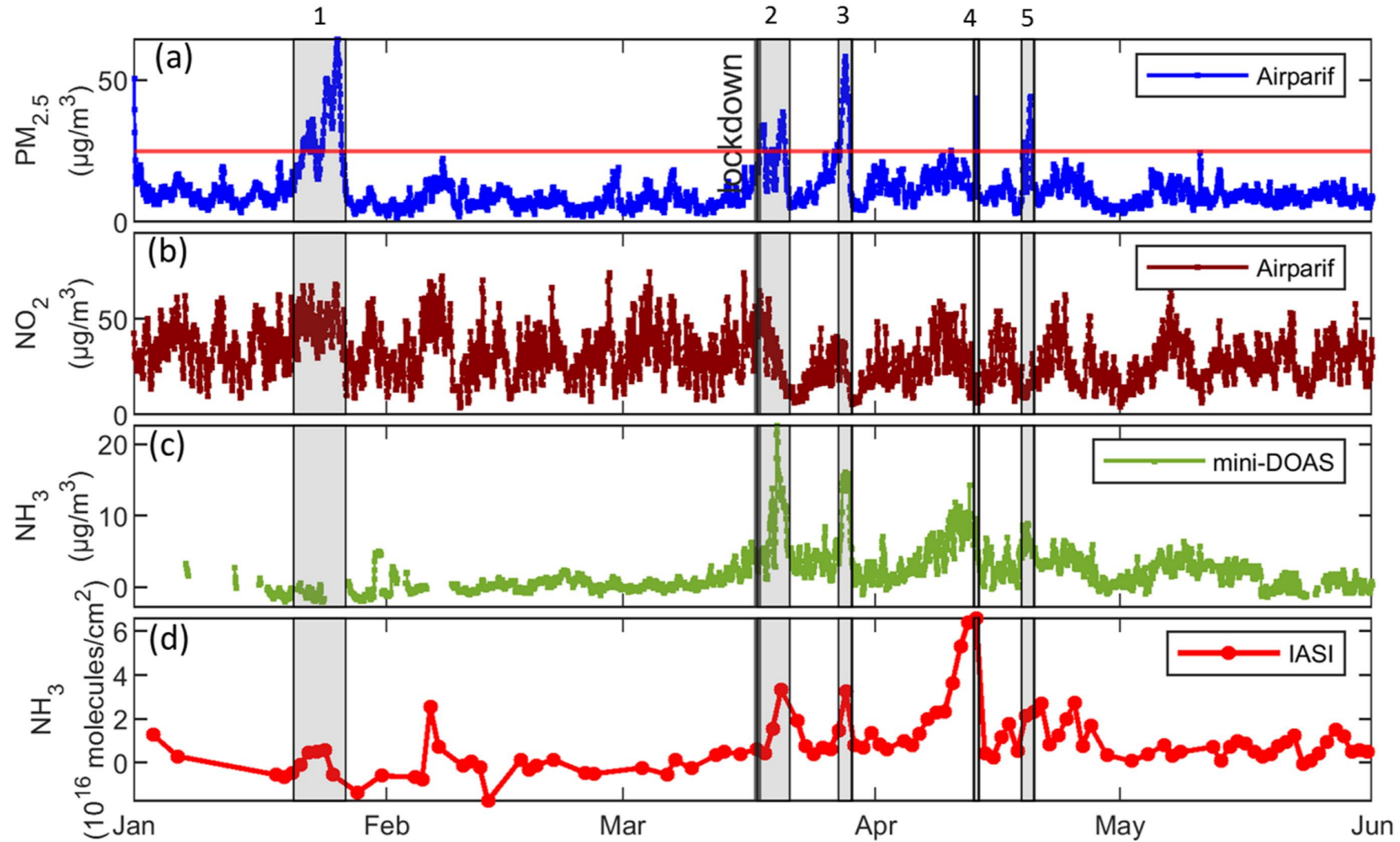
IASI

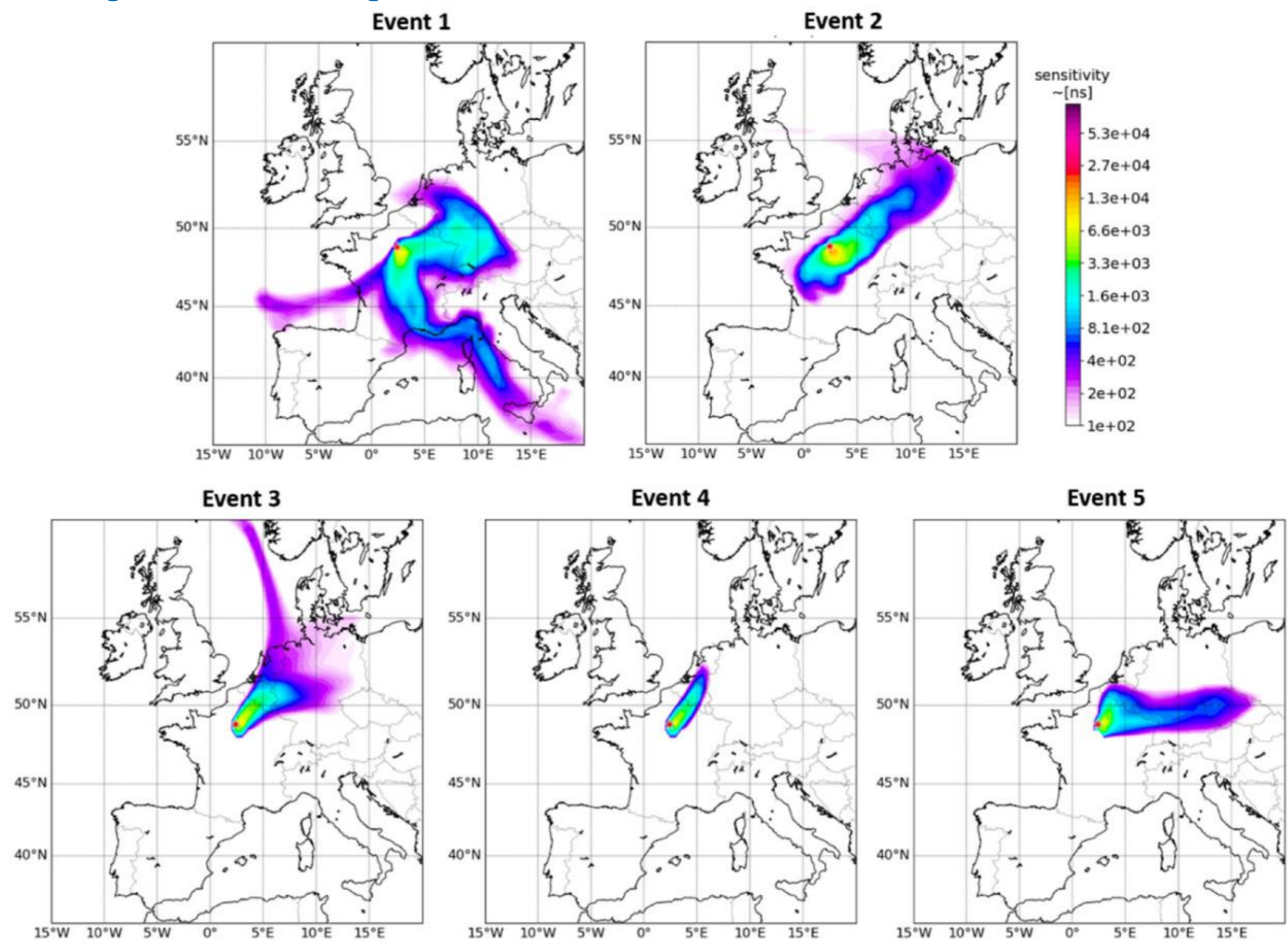


# Pollutants in Paris in 2020

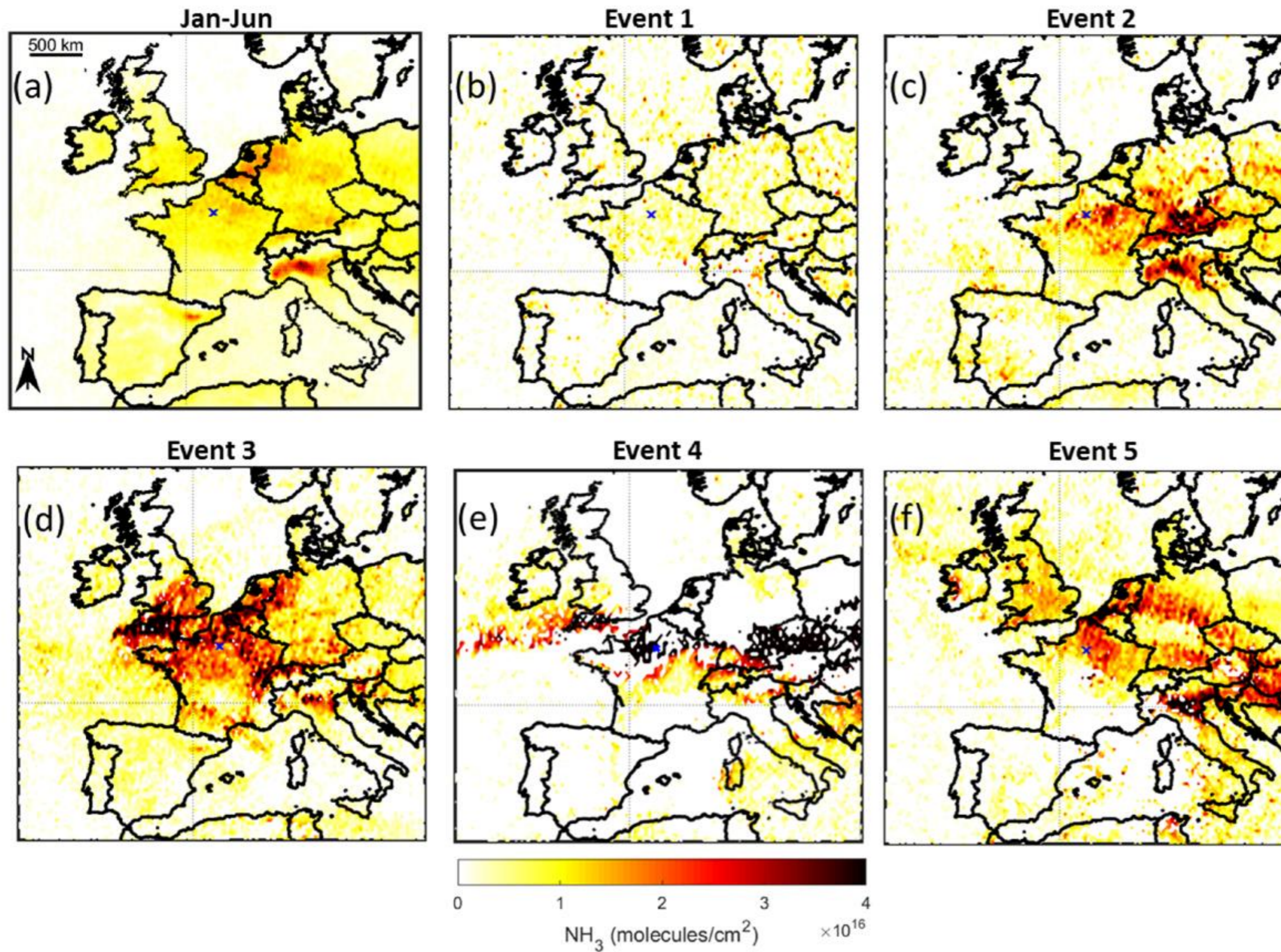


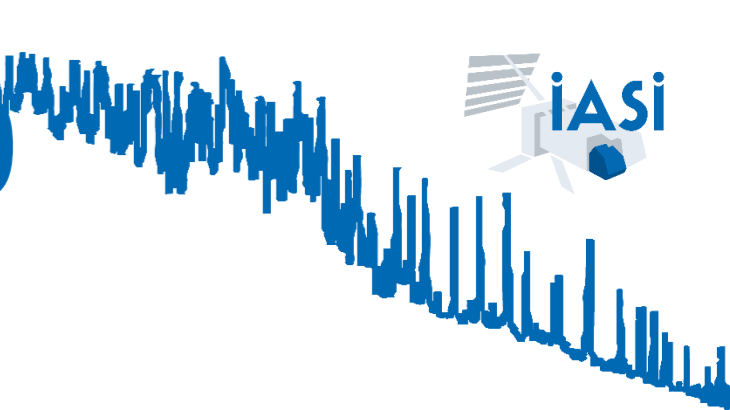
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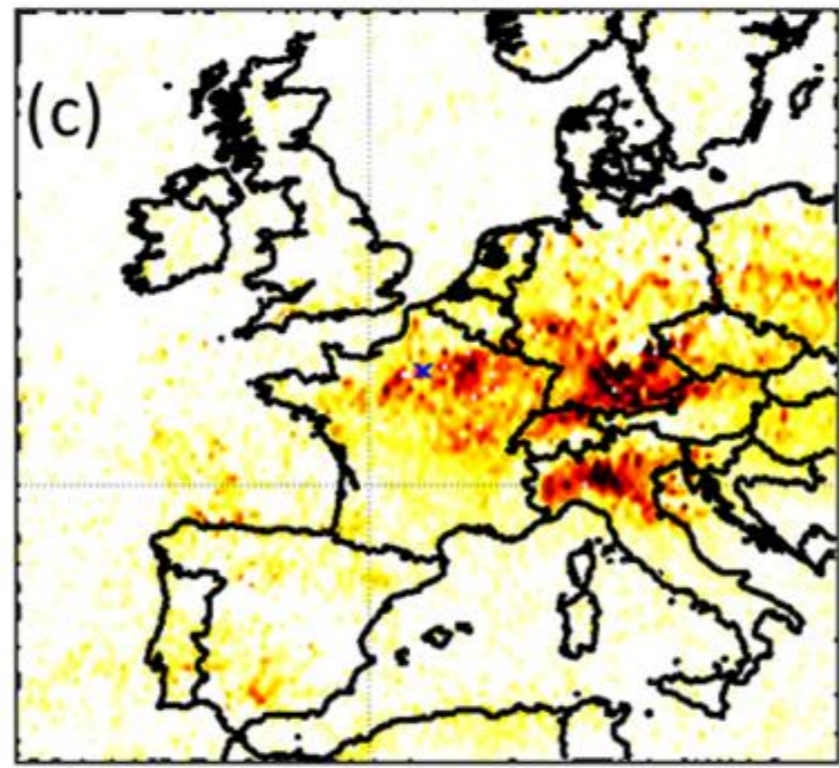


# Transport of pollutants in Paris in 2020

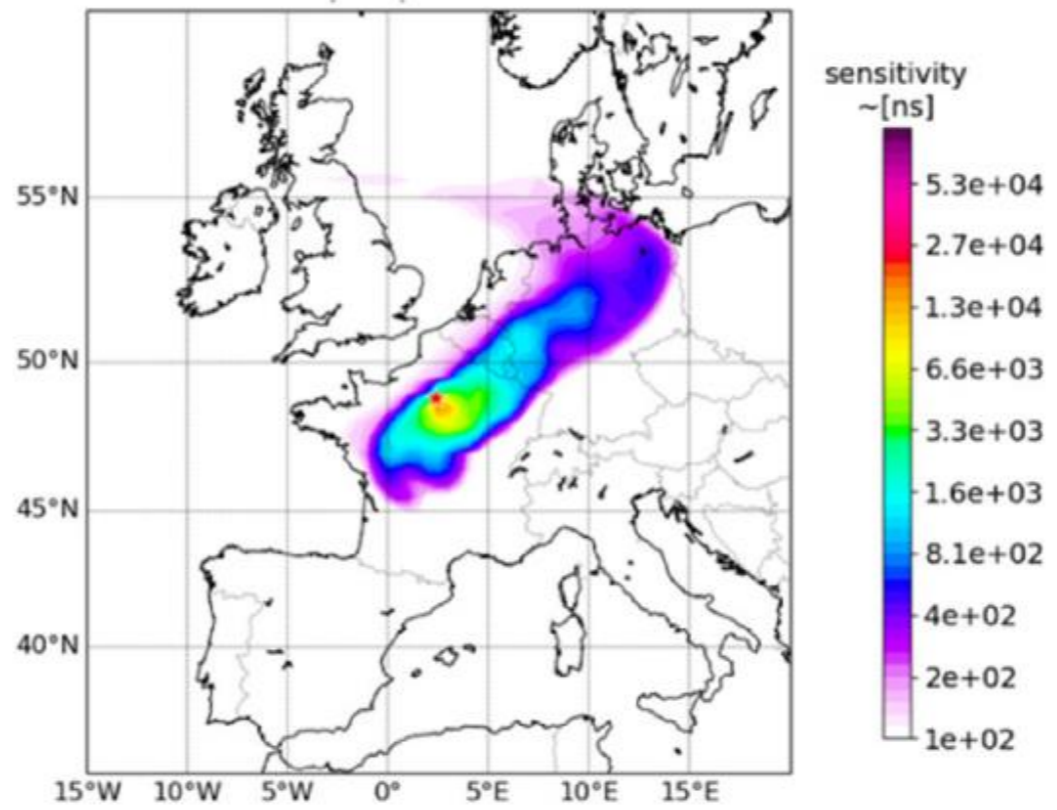




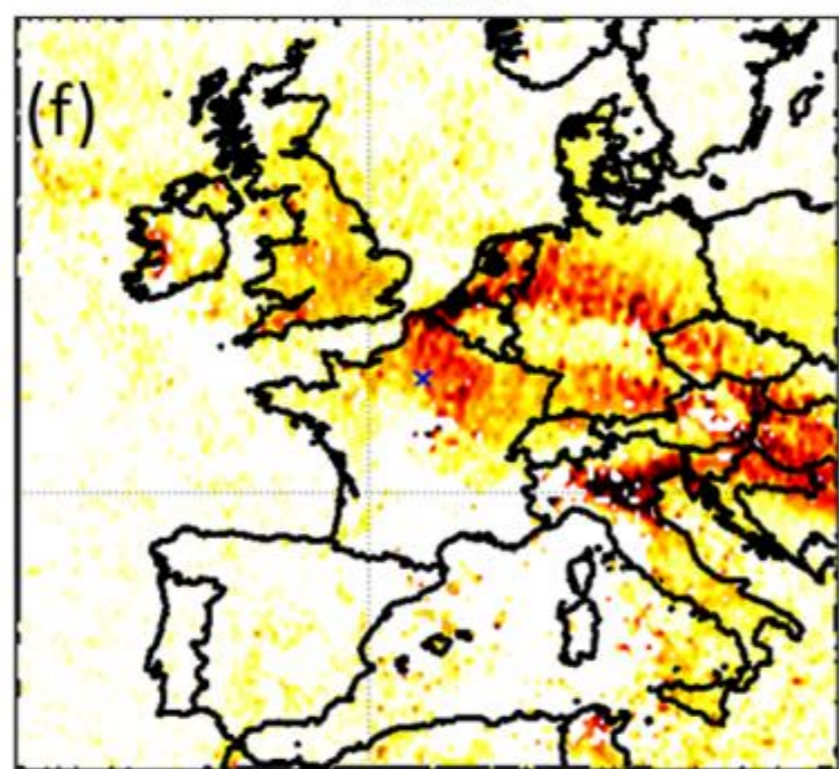
Event 2



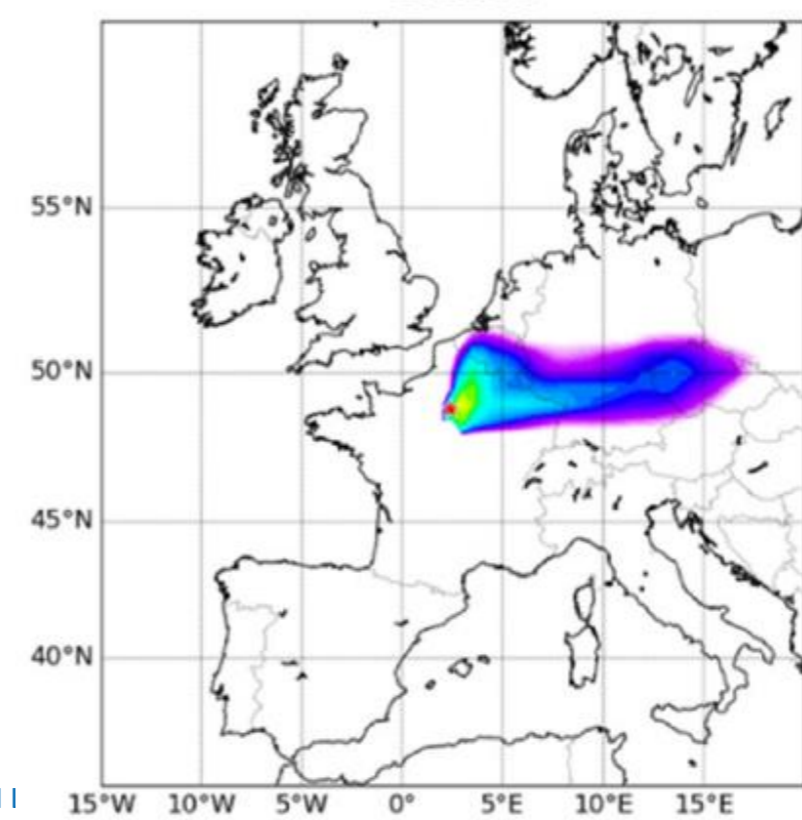
Event 2



Event 5



Event 5

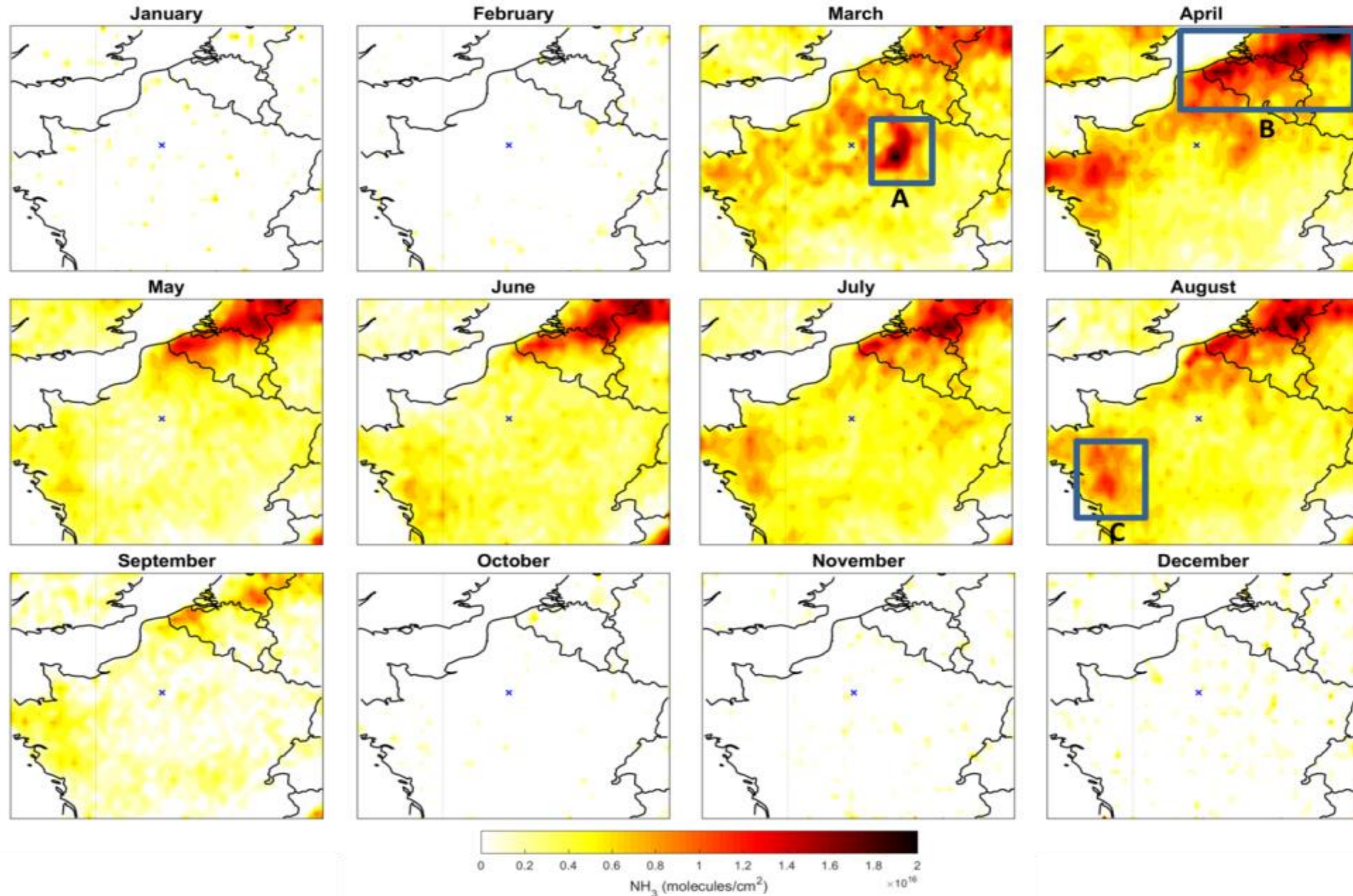




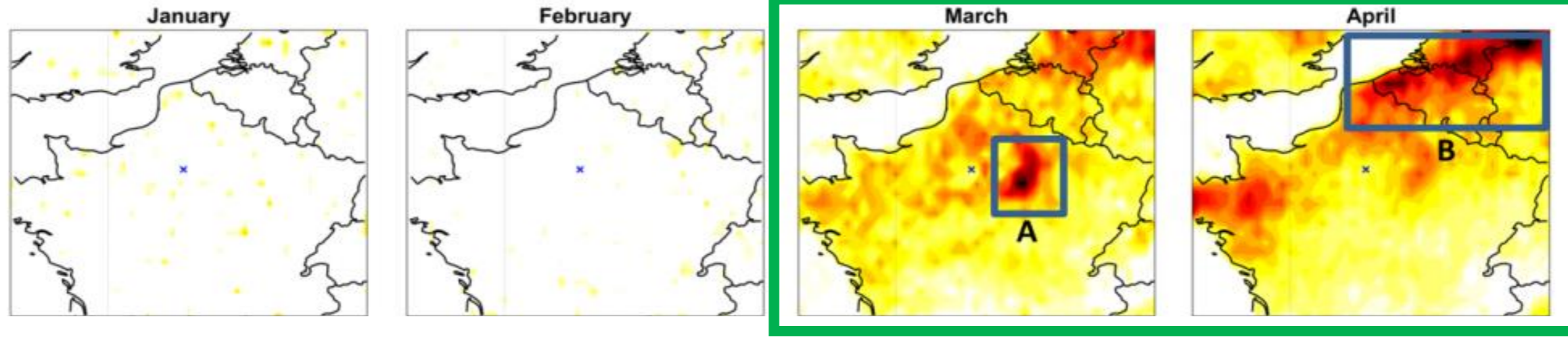
# Spatio-temporal variabilities of NH<sub>3</sub>



10-years (2008-2017)  
~9h30



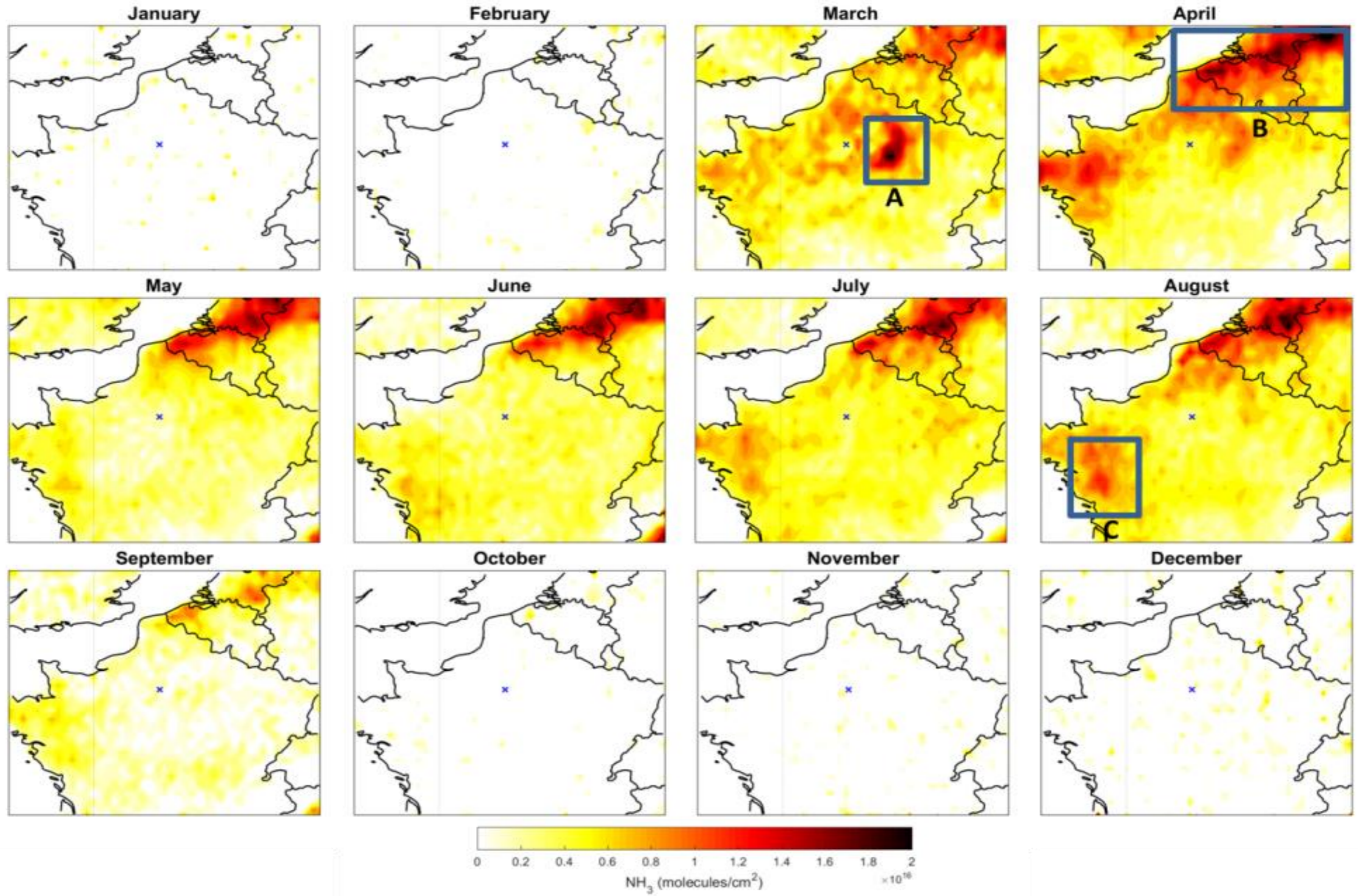
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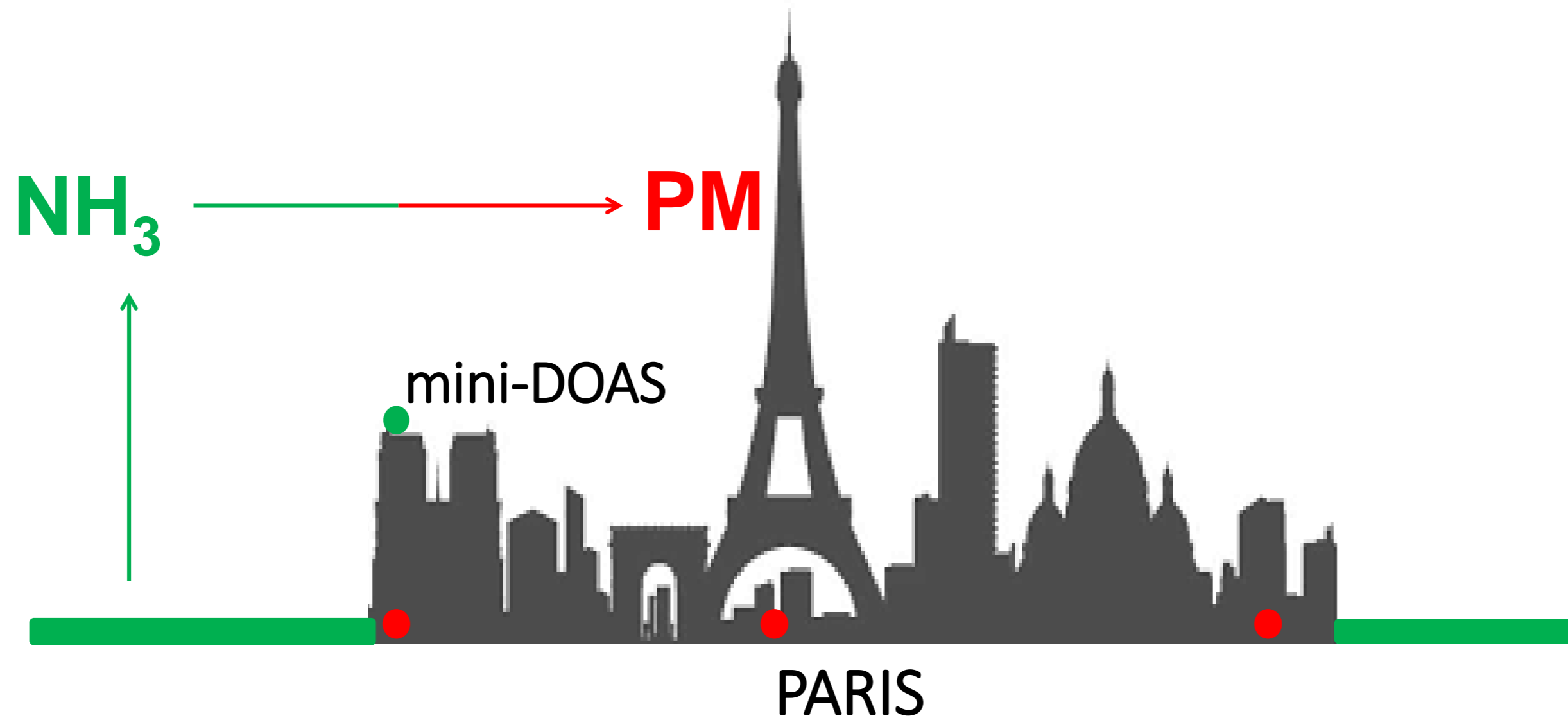
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# Spatio-temporal variabilities of NH<sub>3</sub>



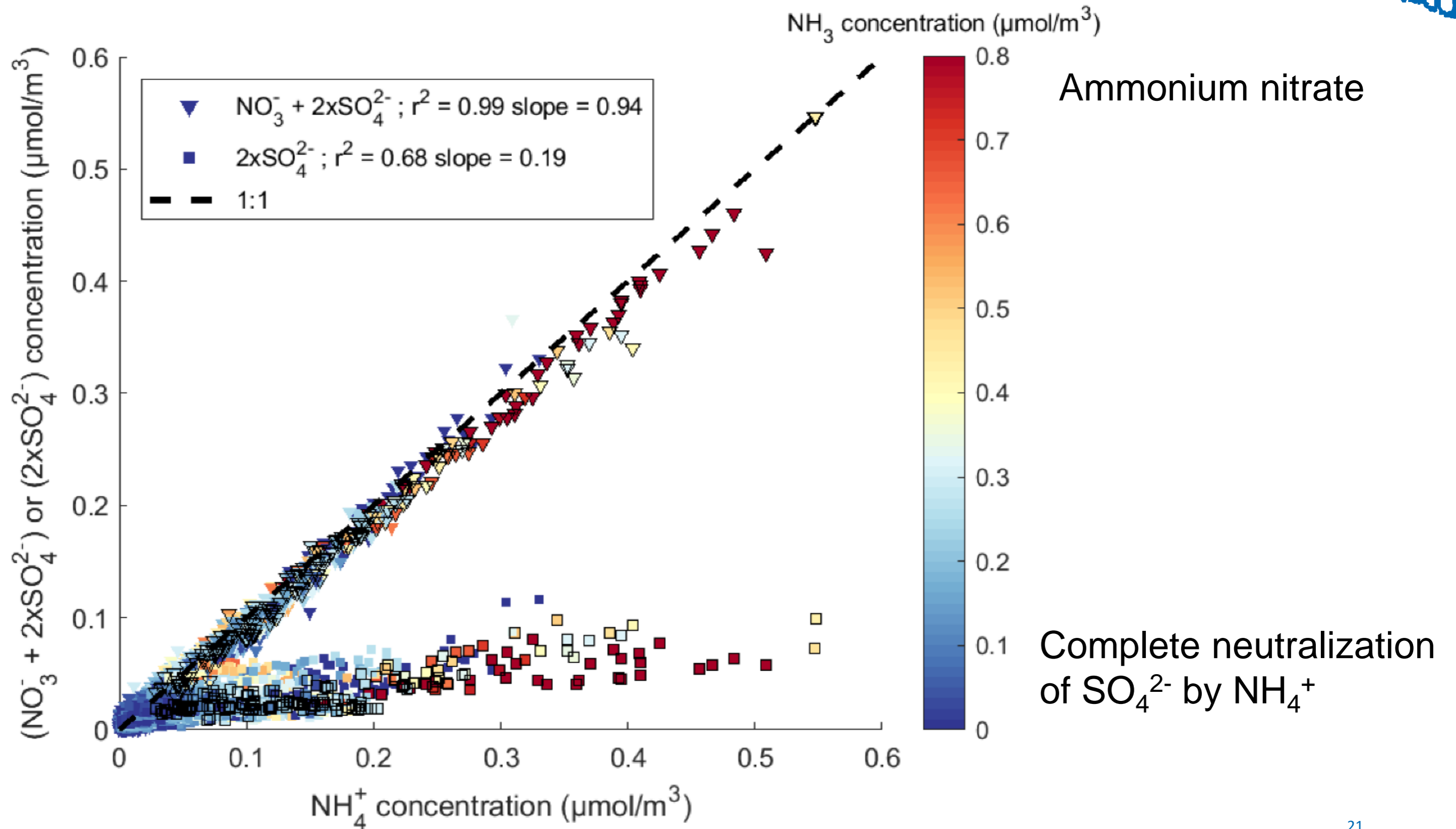
# Link between $\text{NH}_3$ and $\text{PM}_{2.5}$



In the troposphere,  $\text{NH}_3$  neutralizes sulfuric acid before reacting with nitric acid to condense on aerosols as ammonium nitrate

In Paris, local ammonium nitrate formation has been shown to be minor overall [Petetin et al., 2016], although it can be significant for specific episodes [Petit et al., 2017]

# Link between $\text{NH}_3$ and $\text{PM}_{2.5}$

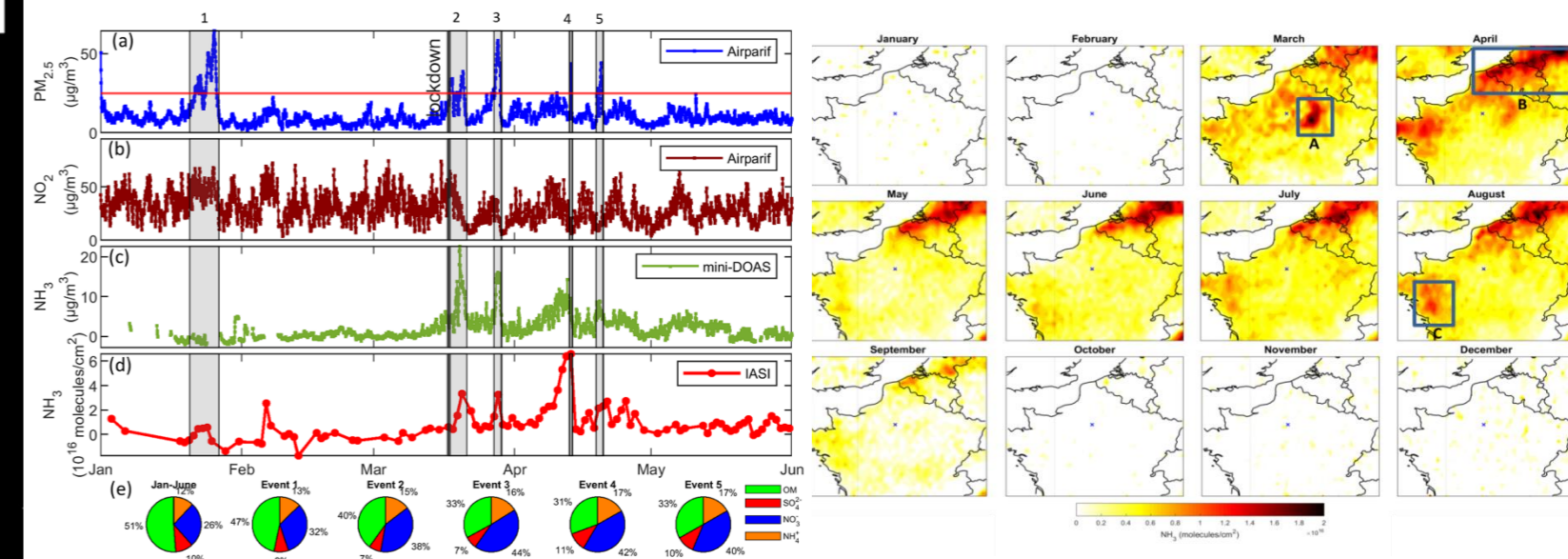
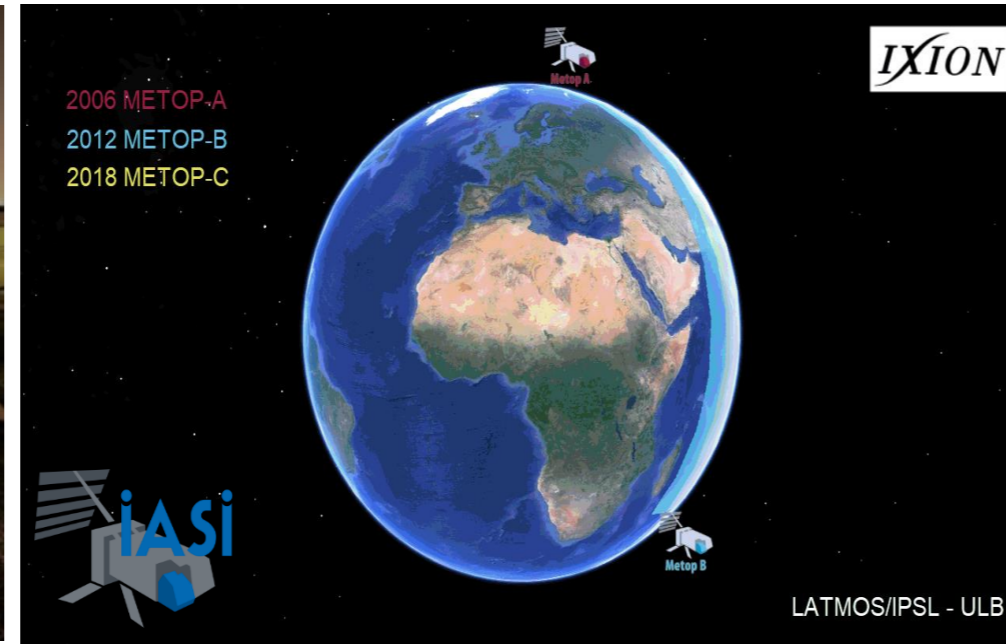


# Conclusions

During the March 2020 lockdown, Parisians did not necessarily breathe cleaner air with the fine particle pollution events

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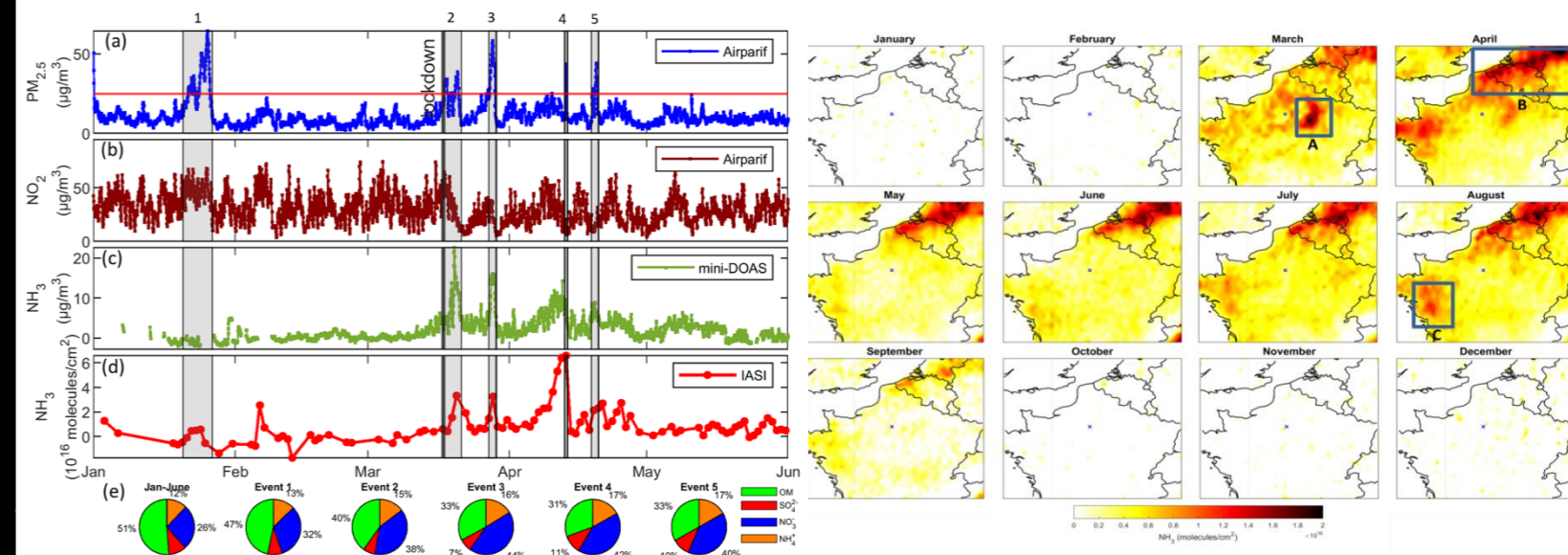
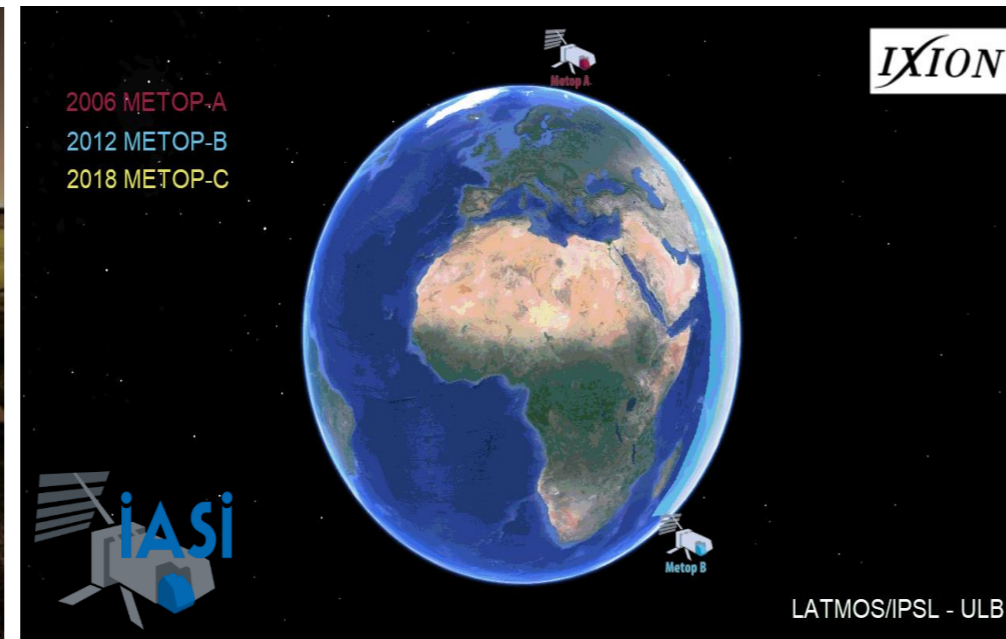
During the March 2020 lockdown, Parisians did not necessarily breathe cleaner air with the fine particle pollution events



By combining multi-platform and multi-species observations, we can access additional information and improve our knowledge of air pollution sources and transport

# Conclusions

During the March 2020 lockdown, Parisians did not necessarily breathe cleaner air with the fine particle pollution events



By combining multi-platform and multi-species observations, we can access additional information and improve our knowledge of air pollution sources and transport

In 2023, the launch of a geostationary IRS-MTG satellite will provide a better understanding of the spatial and temporal variability of  $\text{NH}_3$  (evaporation and the lifetime)

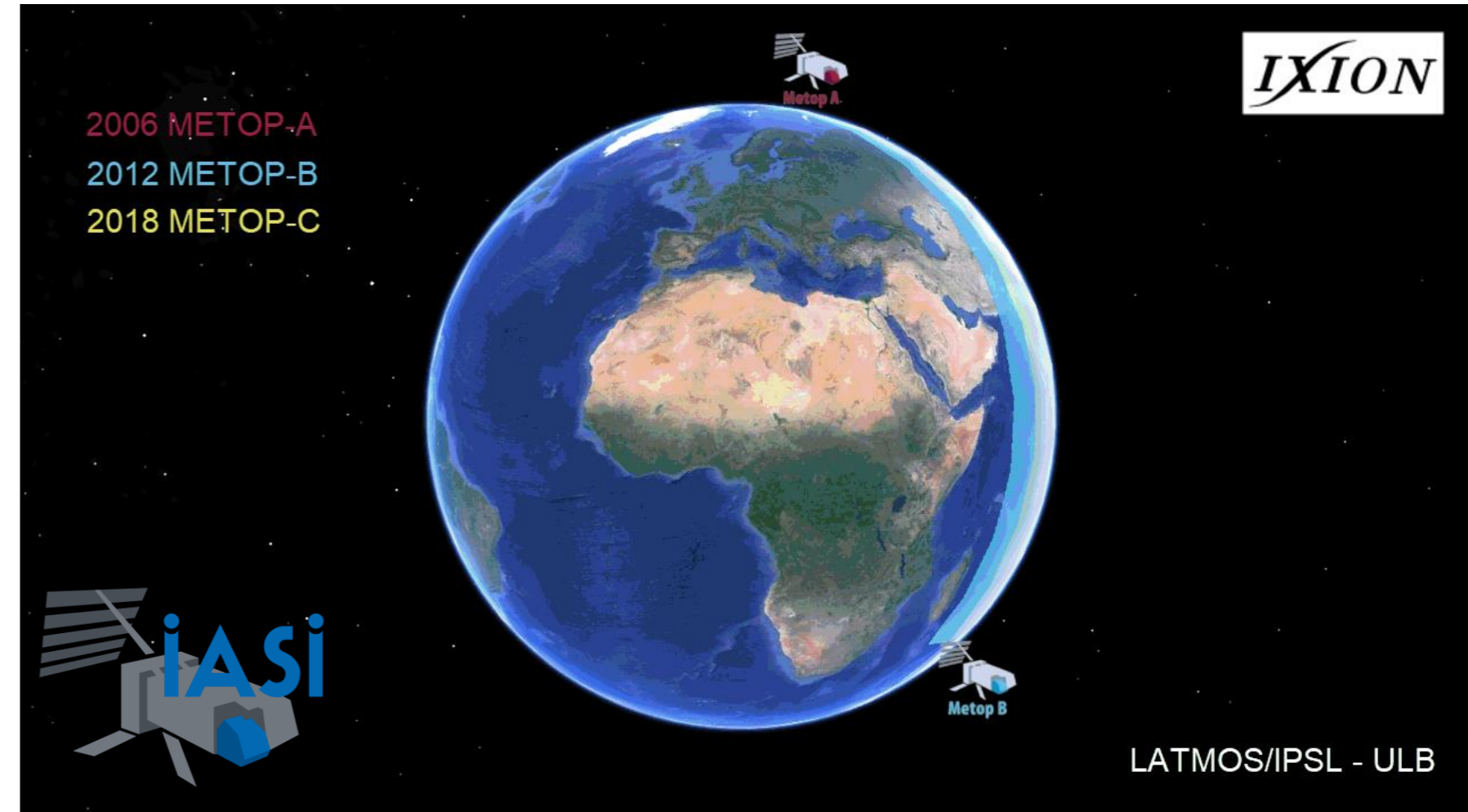


# Thank you for your attention

## Mini-DOAS

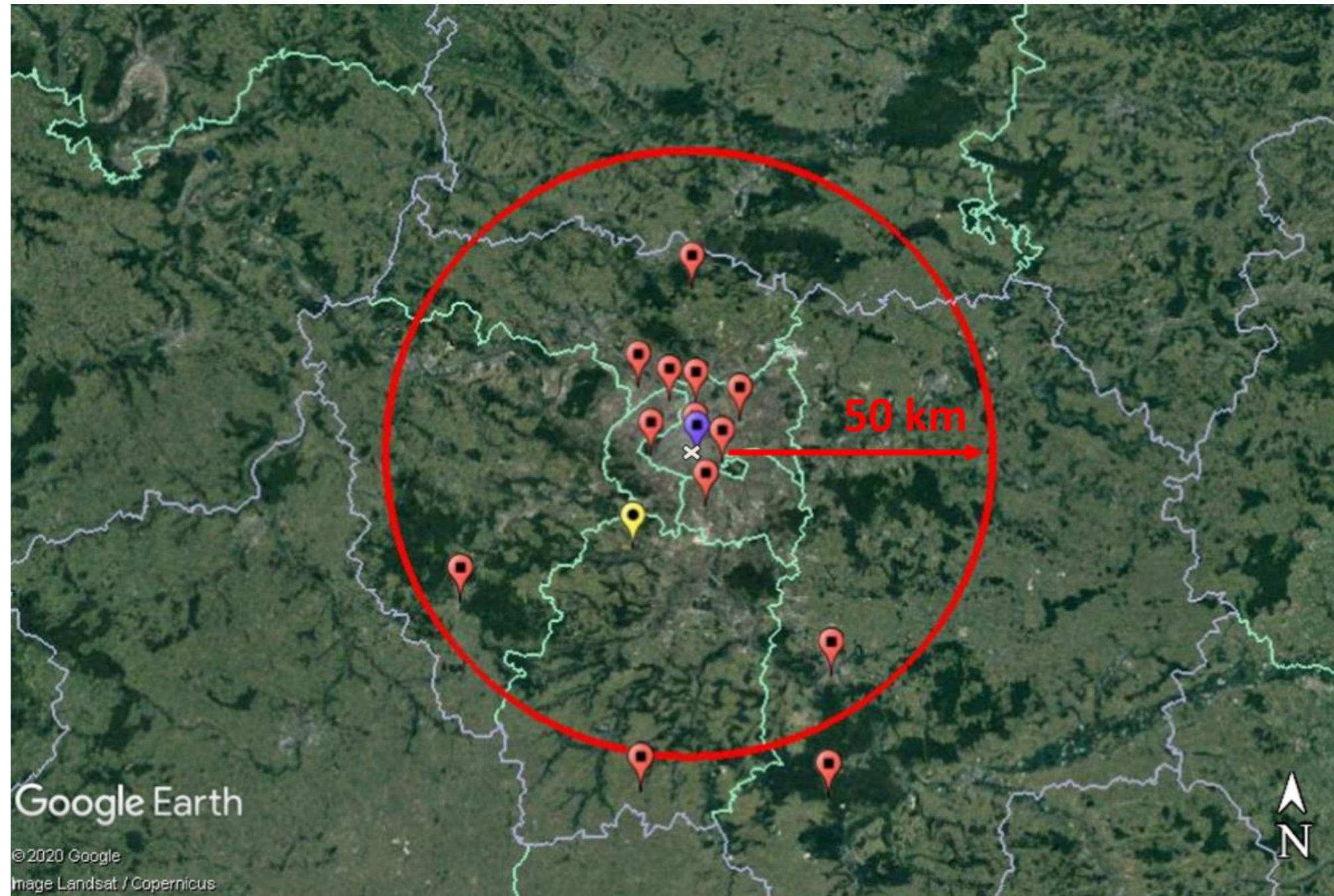


## IASI



*Ammonia and PM<sub>2.5</sub> Air Pollution in Paris during the 2020 COVID Lockdown*





The domain of study around Paris (white cross) showing locations of the  $PM_{2.5}$  and  $NO_2$  observations from the Airparif stations (red pins), PM composition observations at SIRTA (yellow pin), as well as  $NH_3$  observations derived from the mini-DOAS instrument (blue pin) and from the IASI satellite instrument (inside the red circle).

Map provided by Google Earth V7.3.2.5776, US Dept. of State Geographer, ©Google, 2020, Image Landsat/Copernicus, Data SIO, NOAA, US, Navy, NGA, and GEBCO.