EO 4 Ecosystem Accounting 2022

Remote Sensing To Monitor Air Quality At 1-Kilometer Resolution

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SUMMARY

1. Air quality : Why it is a problem ?
2. Space technology for air quality monitoring
3. Enhancing air quality data: Why ?
4. Super resolution model
5. Conclusion

Air quality : Why it is a problem ?

- ✓ **Air quality** is the degree to which **air is suitable or clean enough** for humans, animals, or plants to remain **healthy**
- ✓ Air quality is **affected by human activity** (vehicles, industrial activities…)
- ✓ Air quality is **influenced by meteorological conditions** : climate change has the potential to increase local air pollution in many regions

⟶ Air pollution is one of the greatest environmental health risk

⟶ In 2019, 99% of the world population lives in places with unsafe air quality

⟶ Air pollution was estimated to cause 4.2 million premature deaths worldwide in 2016

⟶ Well targeted policies and investments could significatively reduce air pollution

WHO key facts

Space technology for air quality monitoring

ESA Sentinel-5P mission - Global air monitoring for Copernicus

- “Tropomi” spectrometer to detect multitude of trace gases affecting the air we breathe
- Map the whole planet every 24 hours

Copernicus Atmospheric Monitoring Services (CAMS)

- Model for high-level aggregated data products
- European (~10km resolution) and Global (~45 km resolution) scales
- Hourly temporal resolution

CO	NO_2	O_3
$PM_{2.5}$	PM_{10}	SO_2

Air quality monitoring application

Index to benchmark air quality in 32 European cities

- Combines main pollutants according to WHO guidelines
- **Satellite measurements** are comparable from a place to another
- **Historical data** to track changes

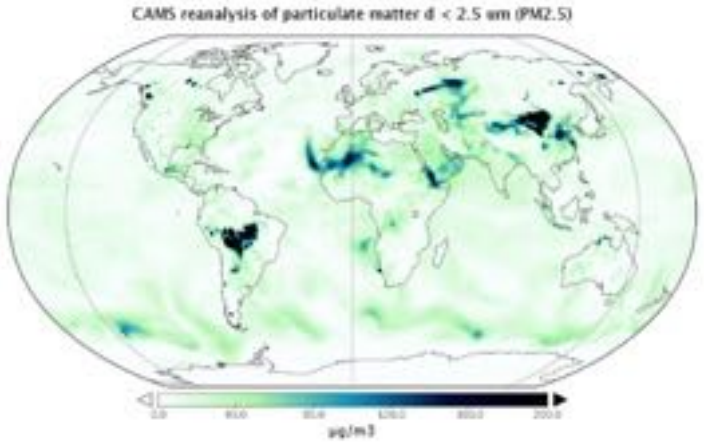
Some findings…

- **Madrid** and **Lisbon** have seen their air quality **improve by 50%** between 2019 and 2021
- **Warsaw** and **Sofia** have seen their air quality **deteriorate by 200%** between 2019 and 2021.

Enhancing air quality data: why ?

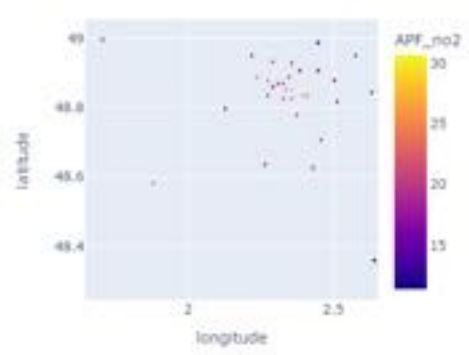
Satellite data :

- Coverage
- Resolution



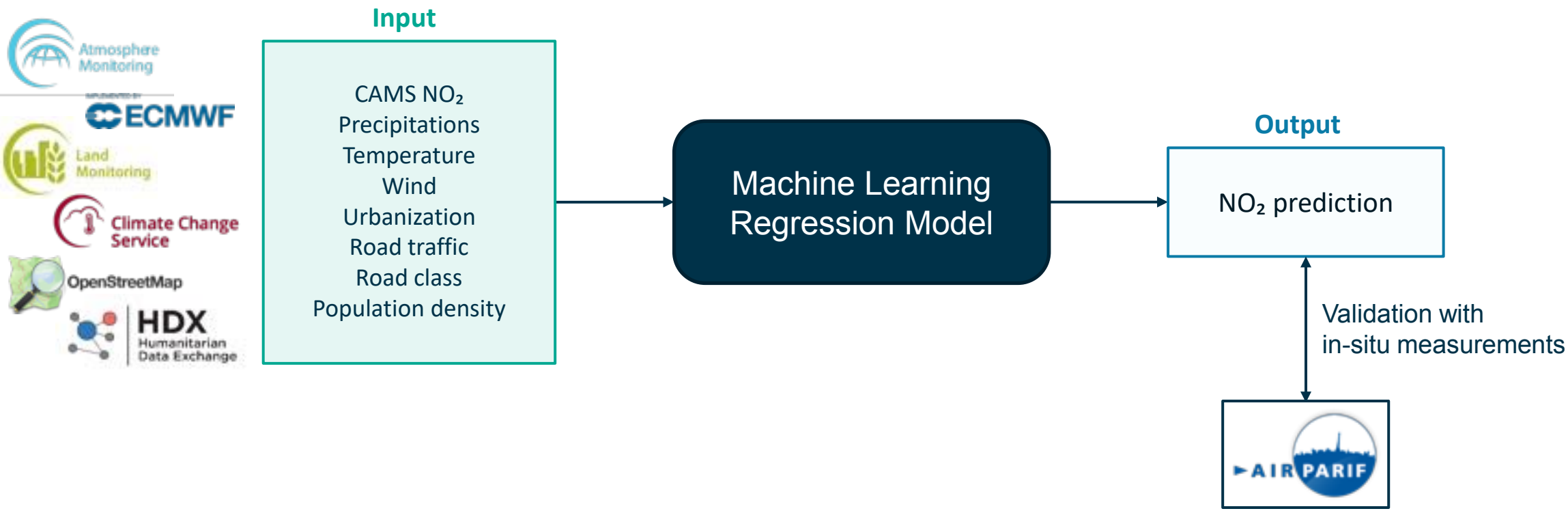
In-situ sensor data :

- Coverage
- Resolution



Need :
- Global coverage
- High resolution

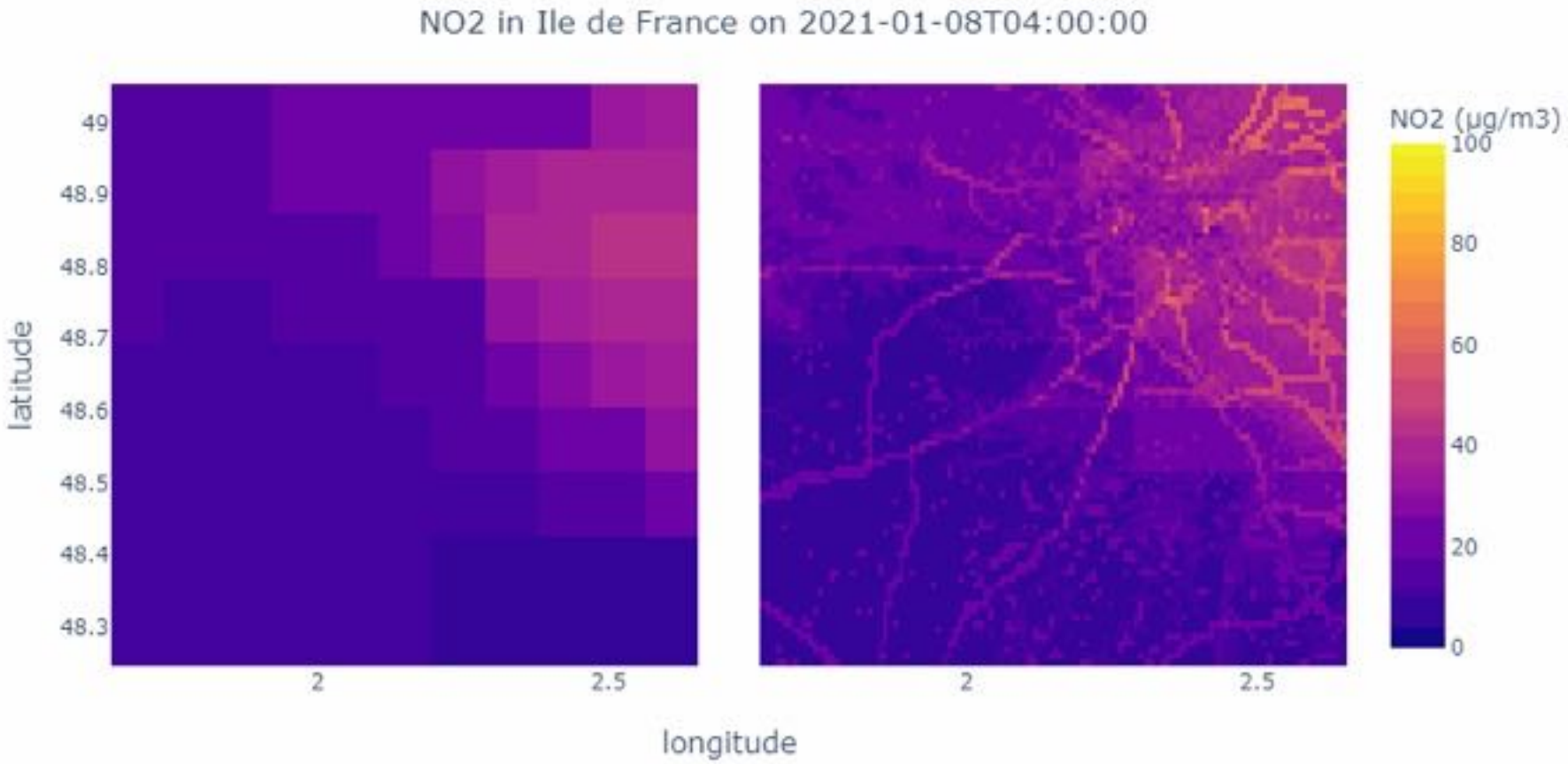
Super Resolution Model: methodology



Super Resolution Model: results

Model on trained stations
MAE = 5.644
R2 = 0.813

Model cross validation
MAE = 9.303
R2 = 0.504



Conclusion

- The 1-km super-resolution model is beginning to be used in **operational applications**
- Capacity to benchmark air quality at the **neighbourhood/street level**
- Allows the links between **human activities** and **air quality** to be studied in much greater detail
- Next steps, improvements and perspectives
  - ✓ Improve the capacity of generalisation by validating with in-situ sensors from various locations
  - ✓ Export the model beyond Europe (with the generalization of the underlying CAMS models)
  - ✓ Integrate road traffic data in addition/replacement to road network
  - ✓ Raise awareness regarding air quality in urban areas, and provide our operational tools to decision/policy makers

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Challenges & actions

1. What are the main challenges in the uptake of "Remote Sensing To Monitor Air Quality At 1-Kilometer Resolution" for urban/municipal planning and policy purposes?

- Lack of knowledge regarding the use of space technology for air quality monitoring
- The diffuse responsibility on the topic of air quality monitoring and subsequent actions
- The non-binding regulatory framework (progress is made on effective penalties in case of non-compliance)

2. What are the priority actions for the next 5 years in "Remote Sensing To Monitor Air Quality At 1-Kilometer Resolution" ?

- [Technical] Add various in-situ sensors to improve the super resolution model's cross-validation
- [Technical] Work with road traffic in addition/replacement to road network
- [Technical] Export the model beyond Europe (with the generalization of the underlying CAMS models)
- [Capacity building] Raise awareness regarding air quality in urban areas, and provide our operational tools to decision/policy makers