Artificial Intelligence and Earth Observation: from Innovation to Service

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Using AI to downscale CAMS reanalysis for high-resolution air quality mapping across Europe

The CHROMAP model (v1.0)

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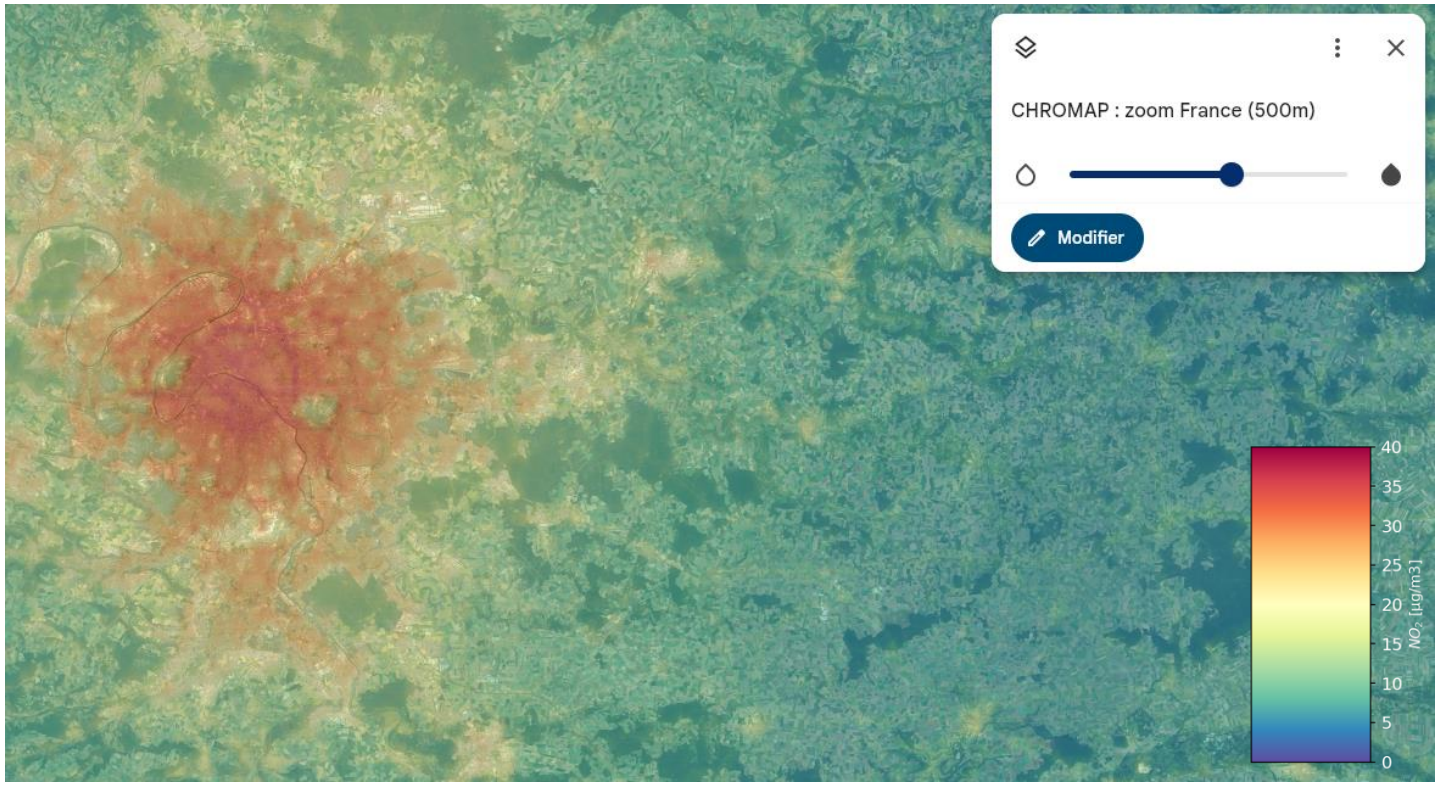
Highlights

The AI-based CHROMAP model

High-resolution air quality mapping :

- on the complete European region
- at 500 meters resolution (from regional to local scale)
- annual maps (over 2012-2023)
- for the main regulated pollutants (NO_2, PM2.5, PM10 and O_3) and the SOMO35 indicator
- interpretable AI diagnosis
- ensemble of predictions provided (~uncertainty quantification)
- fast to run (~20 minutes)



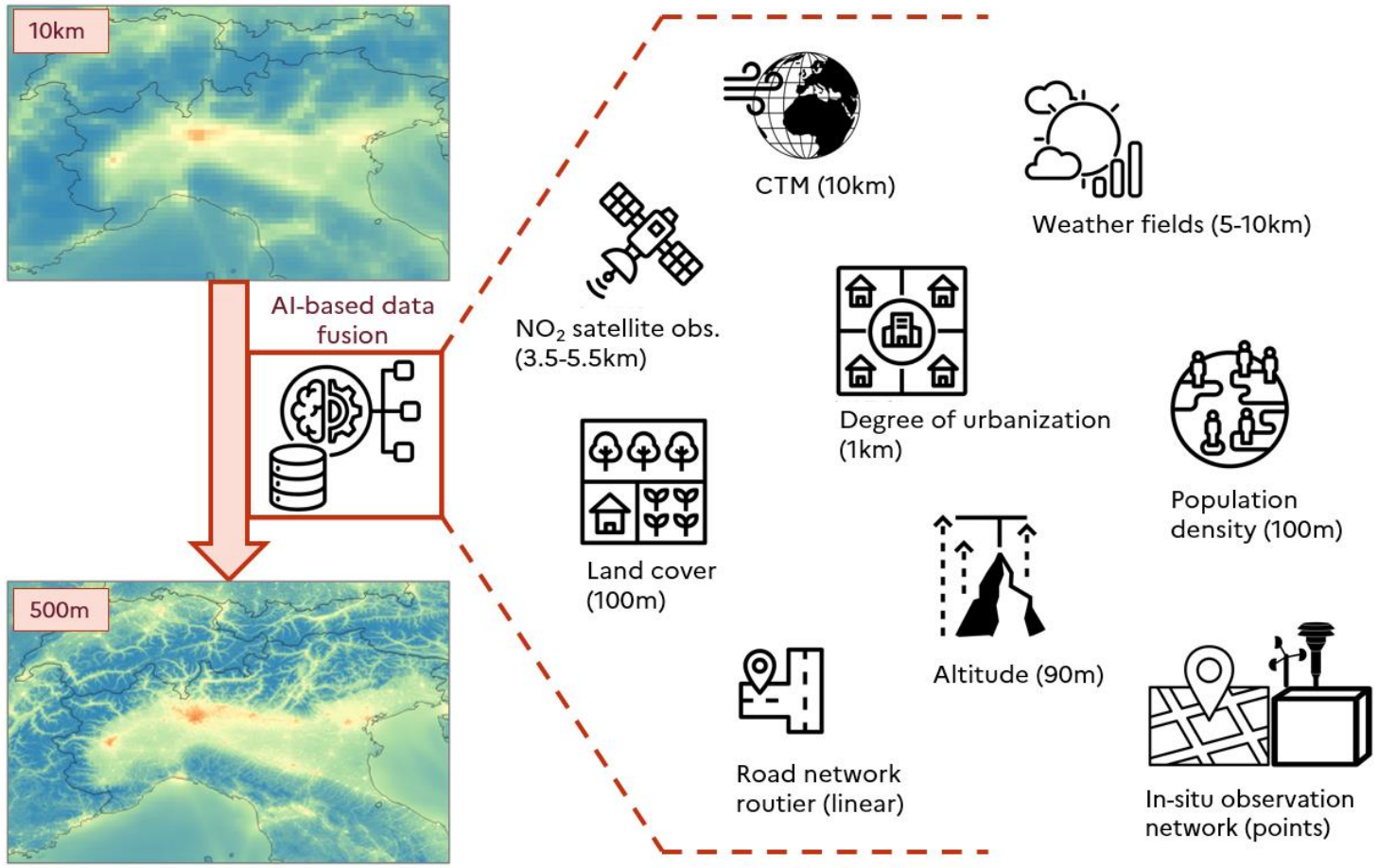
Example of CHROMAP output (NO_2, 2021) .

Model characteristics

- Data fusion of multi-scale predictors (26) : deterministic models, in-situ and satellite observations, and spatial proxies
- Using an ensemble of Machine and Deep Learning algorithms
- Allowing to downscale CAMS reanalysis and correct bias

➔ **Code available** in open-access

Guion, A. (2026). CHROMAPv1.0. Zenodo. https://doi.org/10.5281/zenodo.18846210



CHROMAP : **C**omputational model for **H**igh-**R**es**O**lution air quality **MAP**s based on data fusion using artificial intelligence

Model characteristics

➔ **Model description paper** in open-access, currently under review for the journal Geoscientific Model Development

Guion, A., Gressent, A., Descombes, G., Janati, Y., Real, E., Ung, A., Meleux, F., Schucht, S., and Colette, A.: High-resolution mapping of air quality across Europe: an ensemble machine and deep learning framework integrating multi-scale spatial predictors (CHROMAP v1.0), EGUsphere [preprint], https://doi.org/10.5194/egusphere-2026-1109, 2026.

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Abstract | Assets | Discussion | Metrics

06 Mar 2026

Status: this preprint is open for discussion and under review for Geoscientific Model Development (GMD).

High-resolution mapping of air quality across Europe: an ensemble machine and deep learning framework integrating multi-scale spatial predictors (CHROMAP v1.0)

Antoine Guion, Alicia Gressent, Gaël Descombes, Yassine Janati, Elsa Real, Anthony Ung, Frédérik Meleux, Simone Schucht, and Augustin Colette

Abstract. This article presents a model for mapping air quality at high-resolution (called CHROMAP) based on the fusion of data from deterministic models, in-situ and satellite observations, and spatial proxies using an ensemble of ML and DL algorithms. Annual estimates of the SOMO35 indicator and the average concentrations of NO_2, PM2.5, PM10, and O_3 are produced and evaluated for the 2013–2023 period at a spatial resolution of 500 meters over the European domain. The methodology maintains consistency across all pollutant indicators while ensuring flexibility and transferability.

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Short summary
This article presents CHROMAP, a high-resolution air quality mapping model based on the fusion...
Read more

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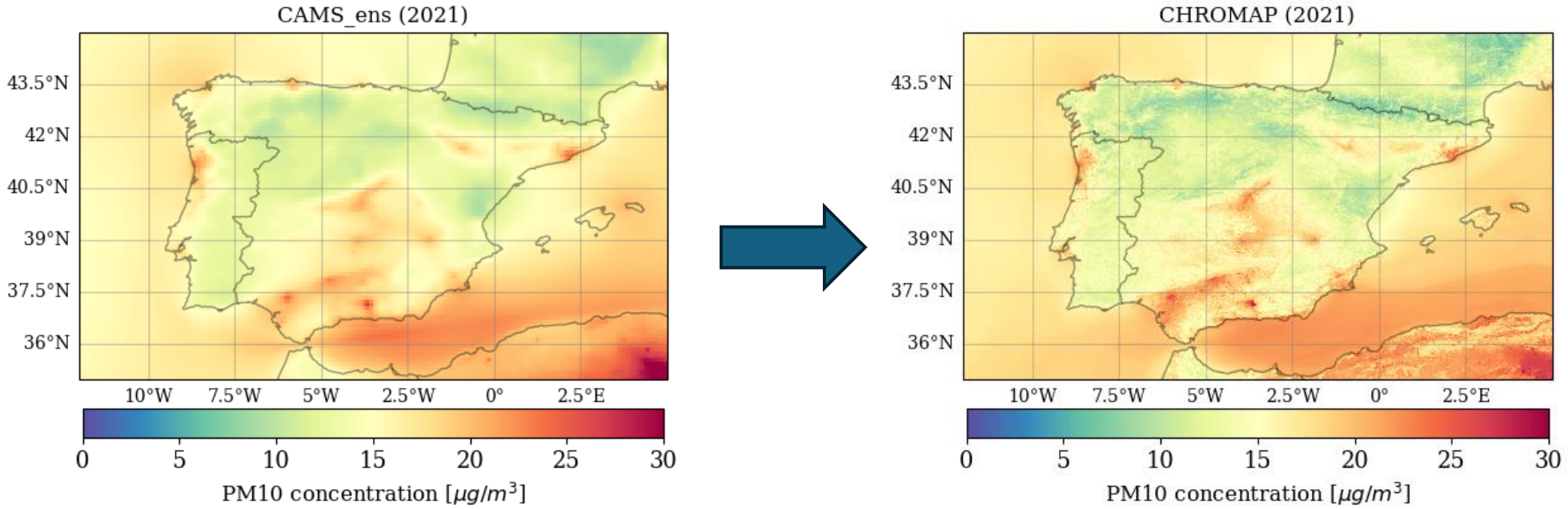
*Complete dataset **soon available** in open-access …*

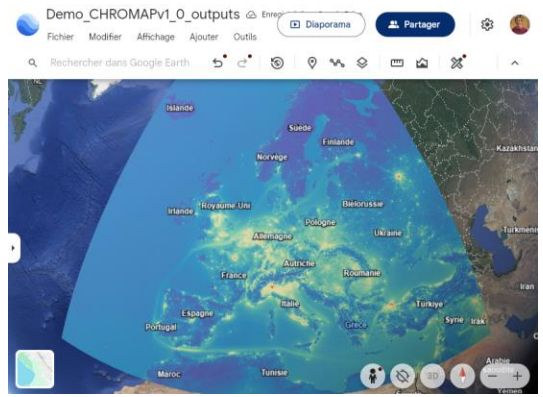
Data visualization



Interactive maps

➔ public link to visualize CHROMAP outputs (2021 as example) :

https://earth.google.com/earth/d/13UnCIuyaiDHigUUzJ1oidK8qCB2F9E6e?usp=sharing



Data visualization

Interactive maps

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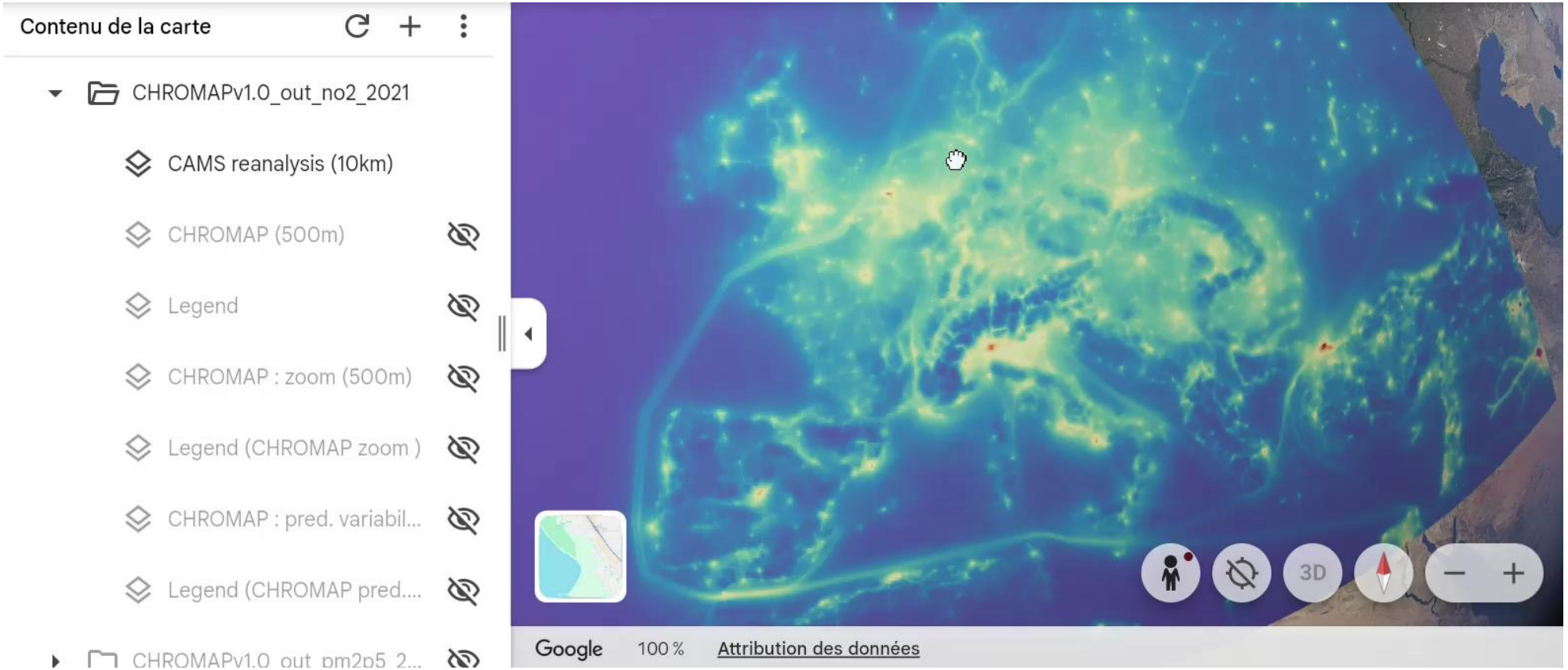


Example of application

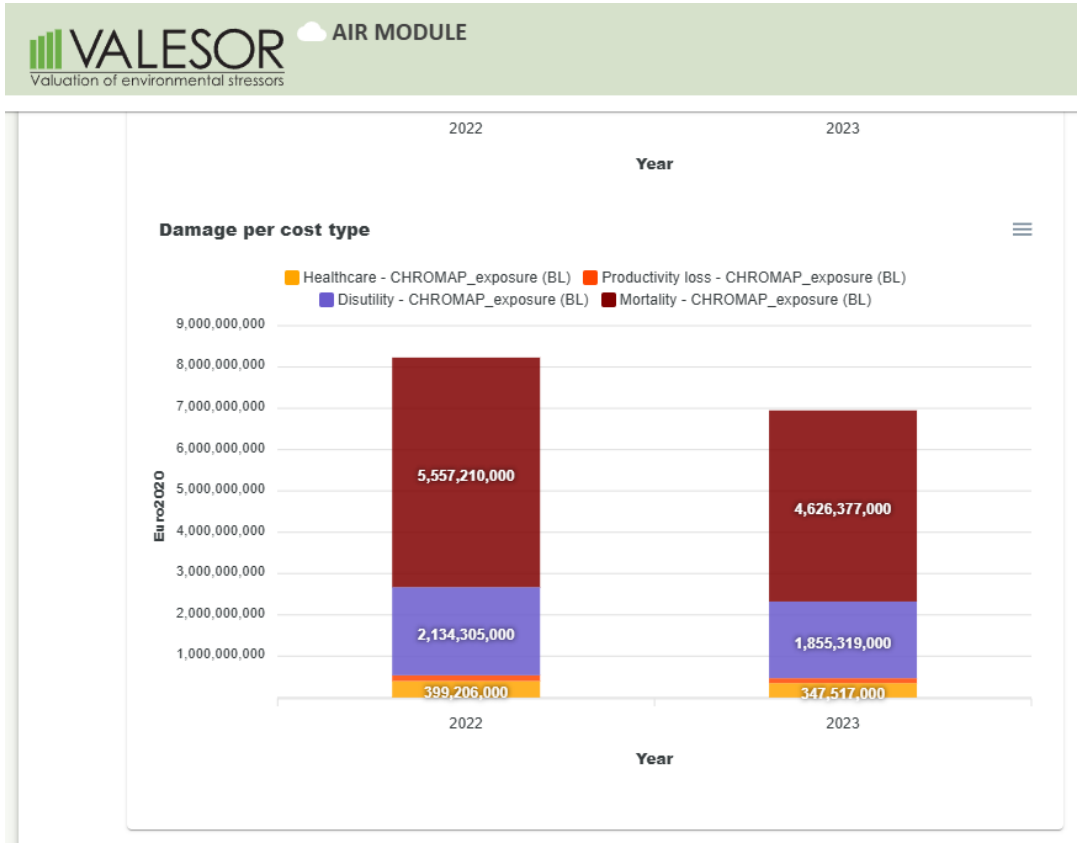
Supported by the **VALESOR project**

- funded by the European Union, executive agency HADEA (2023-2025)
- recognizing the costs of chemicals and air pollution in policy making
- **Development of the VALESOR tool** : available in open-access

  https://ivl-valesor-swce-web-test.azurewebsites.net/

➢ CHROMAP outputs (aggregated by country) as default values for exposure

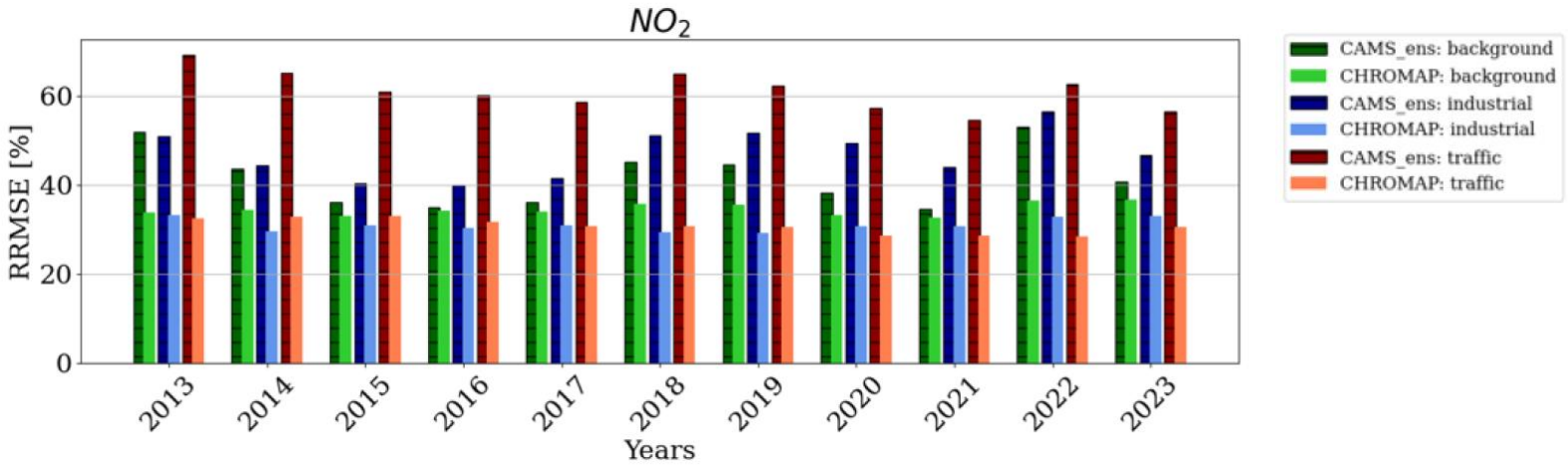
➢ Helping to assess health and economic impacts with more precission



Exemple of cost impact for PM2.5, Austria (using CHROMAP exposition).

Model validation

Improvement of CAMS scores at different types of stations, representative of local pollution



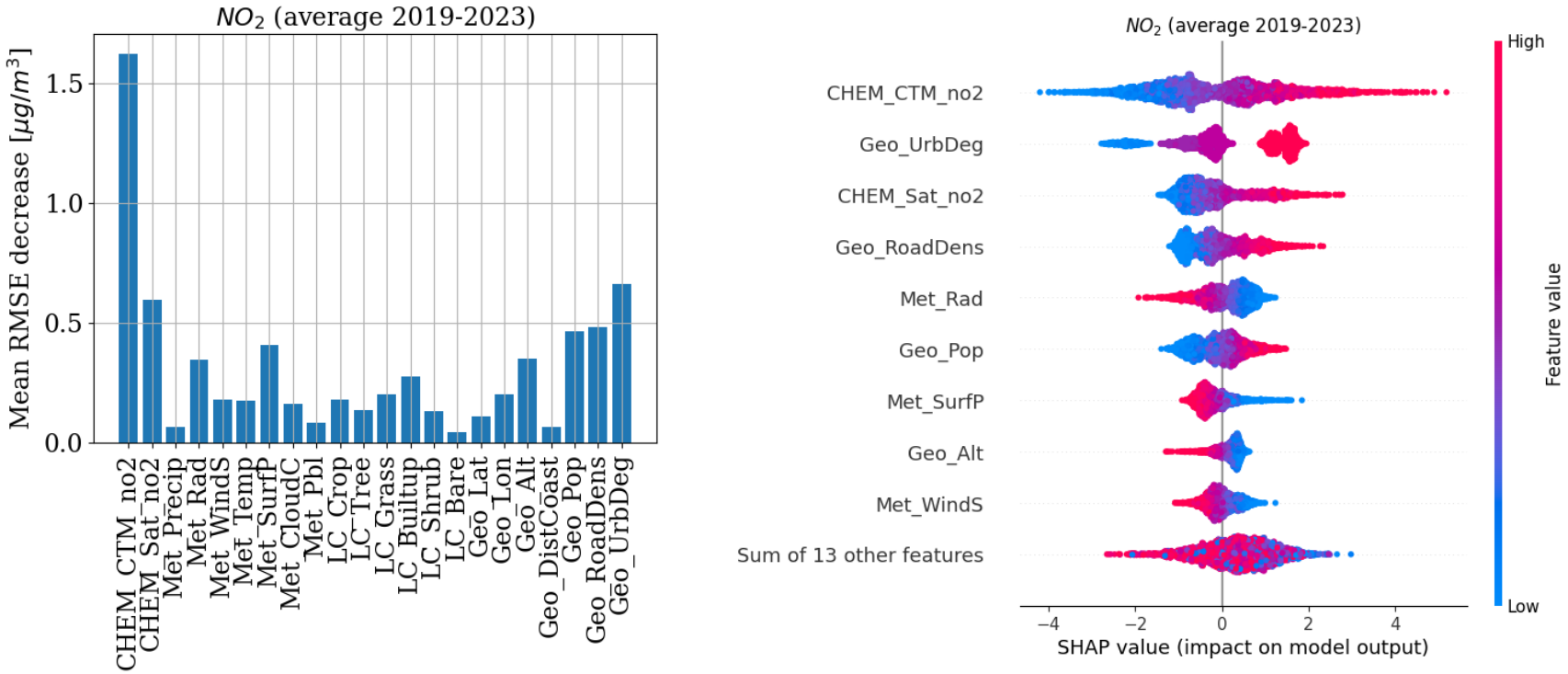
Comparison of performance scores (RRMSE) between CHROMAP at 500 m spatial resolution (light bars) and CAMS at 10 km spatial resolution (dark bars). The scores are presented by monitoring stations type: background in green, industrial in blue and traffic in red.

In summary (averaging any type of stations) :

Metric	Relative RRMSE difference between CHROMAP and CAMS_ens	Relative R^2 difference between CHROMAP and CAMS_ens
Average NO_2	-32.7 %	+28.1 %
Average O_3	-21.2 %	+33.7 %
SOMO35	-9.8 %	+18.0 %
Average PM2.5	-21.5 %	+14.4 %
Average PM10	-37.2 %	+36.0 %

Interpretable AI diagnosis

Necessary to understand the behaviour of the model



Permutation feature importance expressed as a decrease in RMSE (left panel) and distribution of SHAP values (right panel) for NO_2.

Many pesperctives

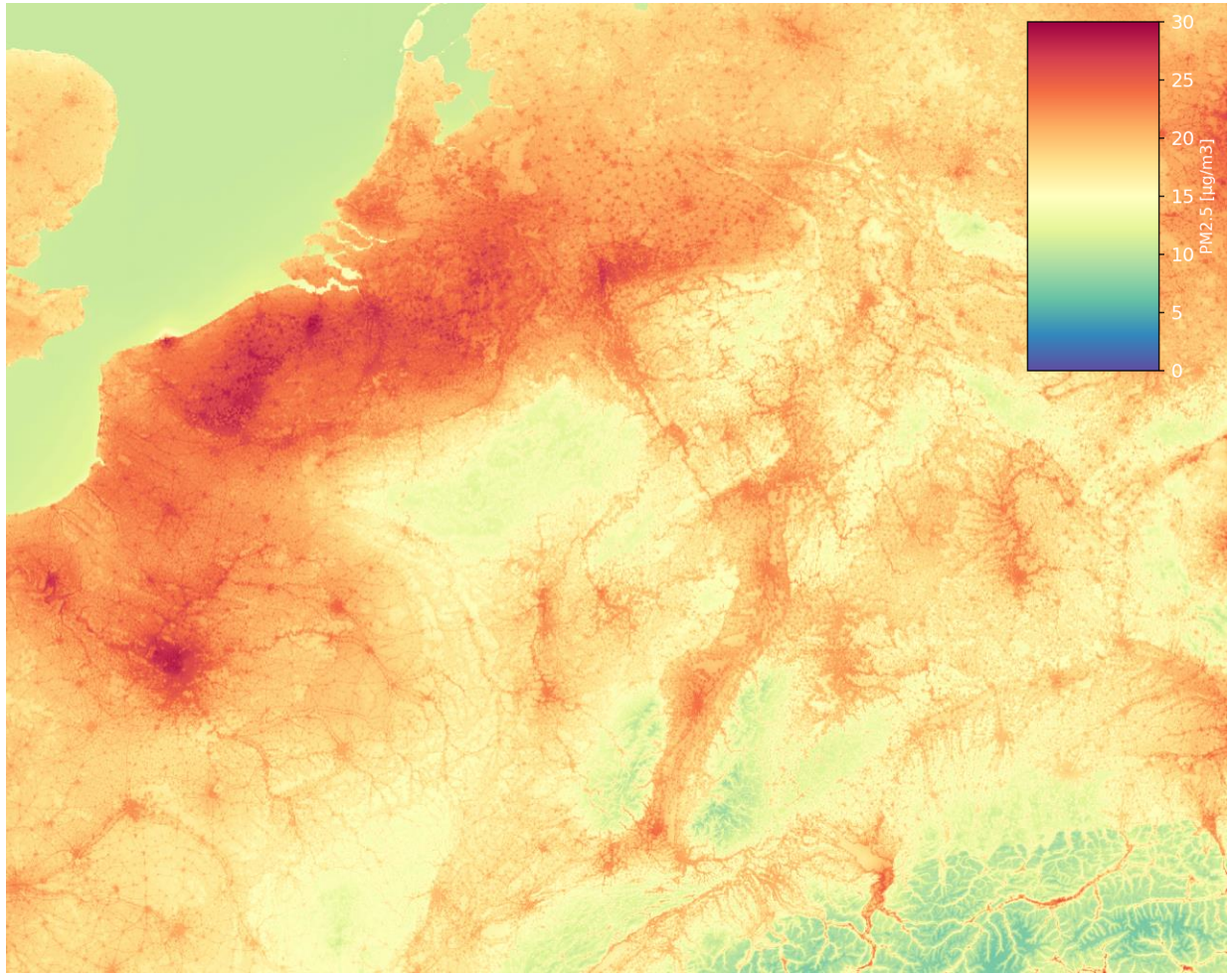
- First official release of the model
- Developments are planned as part of different projects :

  ➔ Maps of BaP and heavy metals

  ➔ Increase the temporal resolution

  ➔ Extend the temporal coverage

  ➔ Include additional satellite products



Example of CHROMAP output (PM2.5, 2021) .