

# Monitoring of ground-level pollutant concentrations from space

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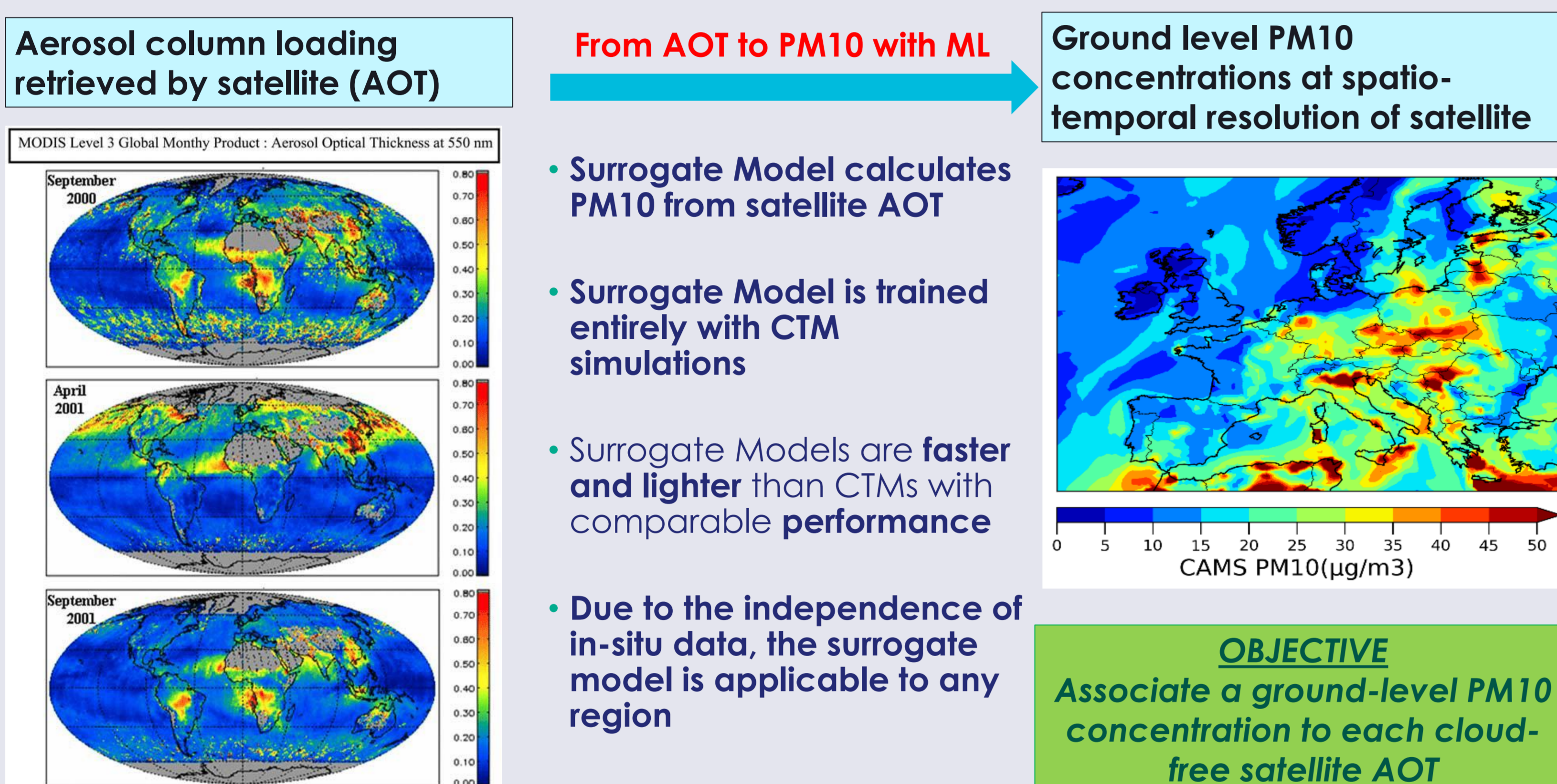
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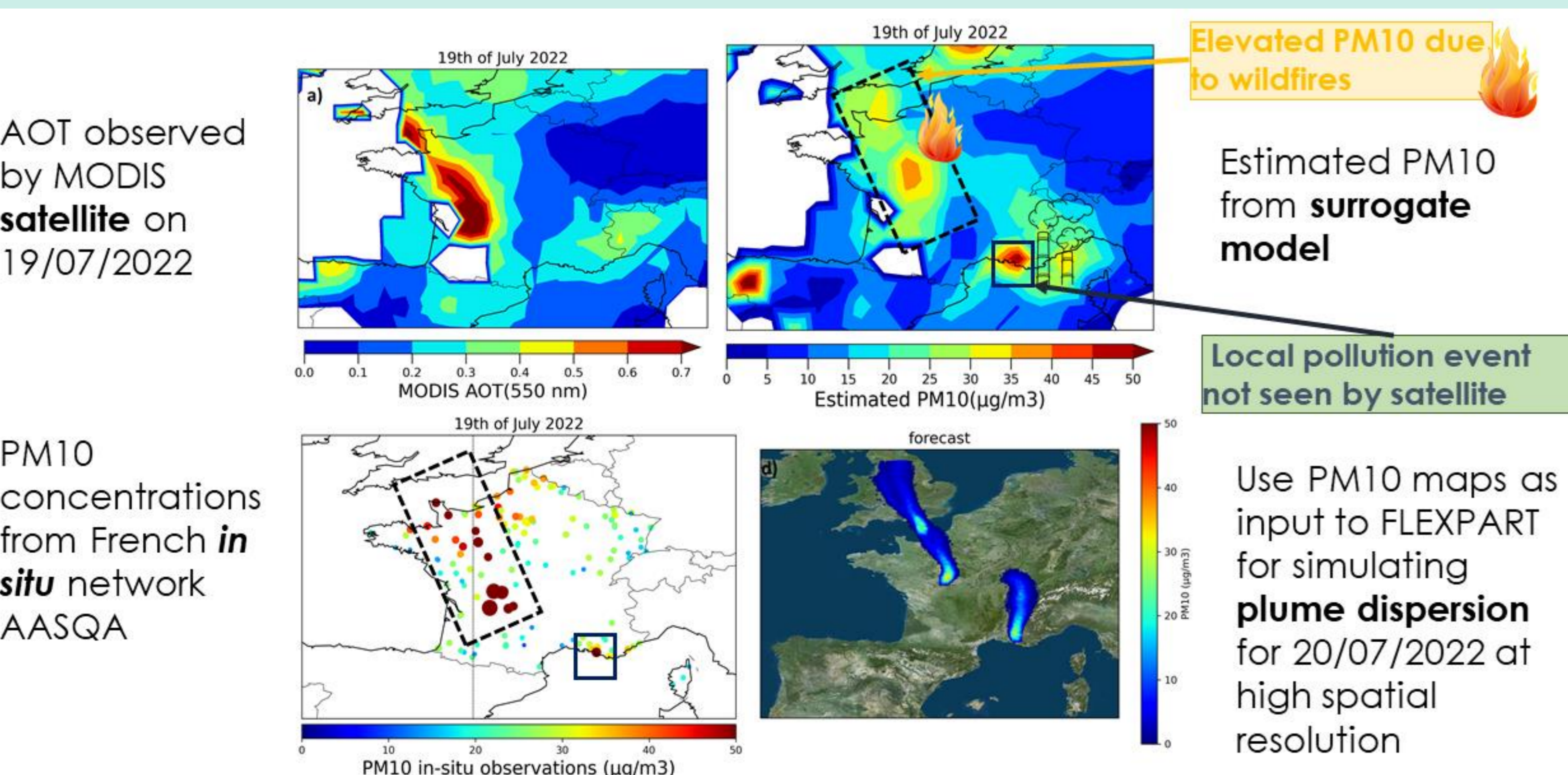
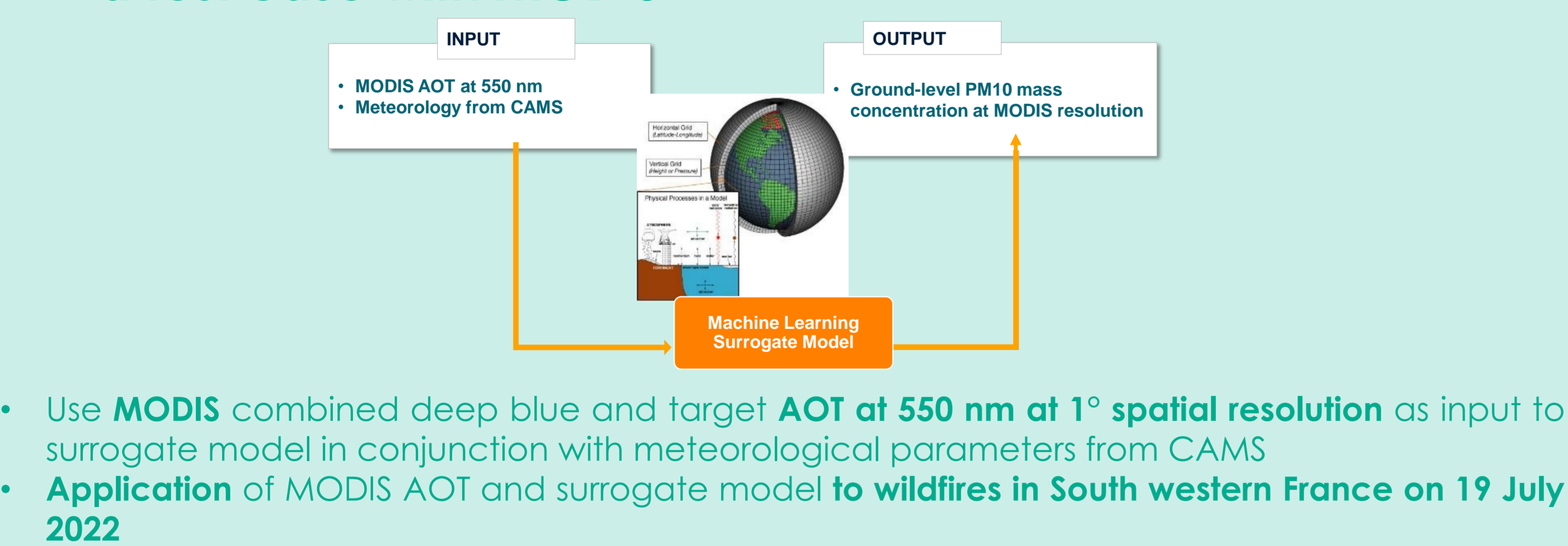
## 1 Air pollution monitoring from space

- **Comprehensive monitoring** and mapping of ground-level air pollutants is **essential for evaluating population's exposure** and **assessing the resulting health effects**
- Information provided by heterogeneously distributed monitoring sites is not sufficient for area-wide monitoring of the pollutant's spatio-temporal distribution
- **Satellites** provide a cost-effective for **area-wide pollution monitoring**. However, despite steady progress in remote sensing techniques, advanced techniques such as **machine-learning** are required to **infer the ground-level concentration from the column-integrated quantity**.
- A proof-of-concept for ground-level **PM10 using CAMS** simulations is presented

## 2 From AOT to ground-level PM10

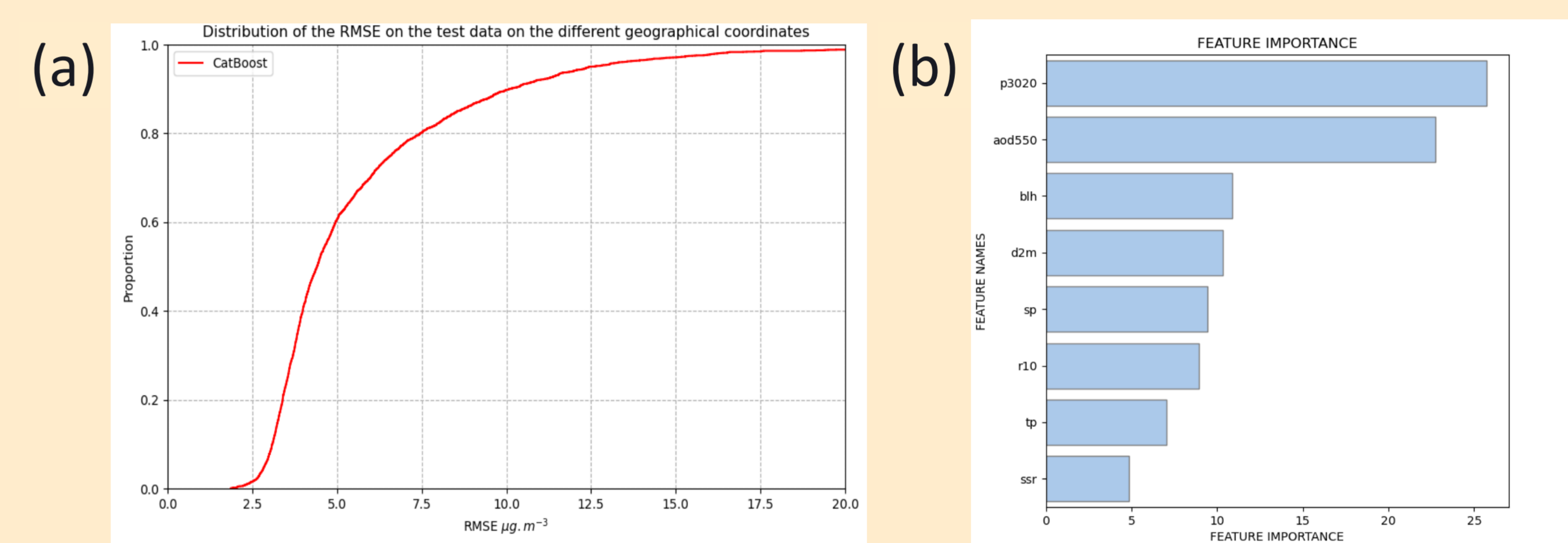


## 4 Detection & forecast of pollution at local & regional scale – a test case with MODIS



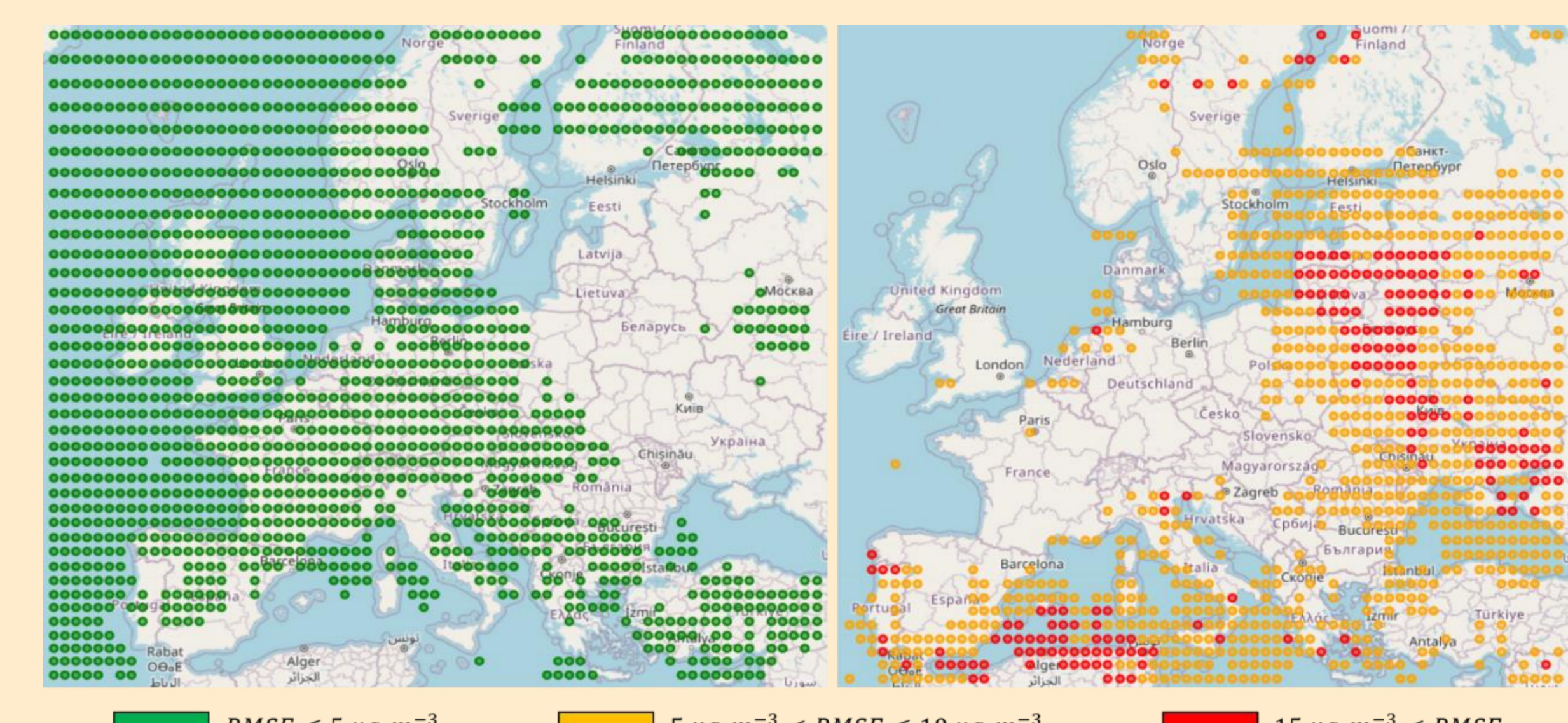
## 3 Building a surrogate model and Proof-of-Concept

Train and validate surrogate model with 3-months (JJA 2018) of CAMS Global Composition Forecast data over Europe.



(a) Cumulative distribution of Root-Mean Square Error in PM10 between CatBoost Algorithm and unused CAMS data averaged over all grid points in JJA 2018. **CatBoost yields similar performance to CTMs, which have accuracy of around 10 µg/m<sup>3</sup>** over Europe (Bessagnet et al., 2016, ACP). (b) **Feature importance** values averaged over each grid point. It indicates which variables are considered the most important by the CatBoost algorithm in the prediction of ground-level PM10.

## Spatial distribution of RMSE scores evaluated on test dataset (unused CAMS) during JJA 2018



## 5 Development of a sustainable, scalable platform

	Orbit	Revisit	Spatial resolution	Mission status	Products
<b>POLDER-3 on PARASOL</b>	Polar	Daily	6 km x 6 km	Terminated	AOT
<b>SEVIRI on MSG</b>	Geostationary	15 minutes	15 km x 15 km	ongoing	AOT
<b>OLCI-SLSTR on SENTINEL-3</b>	Polar	2 days	5 km x 5 km	ongoing	AOT
<b>TROPOMI on SENTINEL-5P</b>	Polar	Daily	7 km x 3 km	ongoing	O <sub>3</sub> , NO <sub>2</sub> , SO <sub>2</sub> , CH <sub>4</sub>
<b>GAPMAP GRASP</b>	Polar	5 x day	500 – 3 km	ongoing	Aerosols
<b>UVN/SENTINEL-4 on MTG-S</b>	Geostationary	Hourly	8 km x 8 km	To come	AOT, O <sub>3</sub> , NO <sub>2</sub> , SO <sub>2</sub>
<b>UVNS/SENTINEL-5 on METOP-SG</b>	Polar	Daily	7 km x 7 km	To come	AOT, O <sub>3</sub> , NO <sub>2</sub> , SO <sub>2</sub> , CH <sub>4</sub>
<b>3MI on METOP-SG</b>	Polar	Daily	4 km x 4 km	To come	AOT
<b>MAP-CO2i on SENTINEL-7</b>	Polar	Daily	4 km x 4 km	To come	AOT, CO <sub>2</sub> , NO <sub>2</sub> , CH <sub>4</sub>
<b>ABSOLUT Sensing</b>	Polar	GEN 1/2: daily GEN 3: > daily	50 m x 50 m	To come	GEN1 : CH <sub>4</sub> ; GEN2: CO <sub>2</sub> , CO, NO <sub>2</sub> , NH <sub>3</sub> , H <sub>2</sub> O, NO <sub>2</sub> ; GEN3: +SO <sub>2</sub>

- Applications to current & future satellite missions with different spatial resolution and revisit time.
- Leverage new advanced air quality products from up-coming missions: **ESA Sentinel-4 & 5, New Space technologies**

## 6 Current and future activities

- The monitoring tool has recently been **awarded the SCO label** (Space Climate Observatory project [SCO France: 2024 Edition | Space Climate Observatory]) by CNES
- Development of much larger training data base 4 years of **high resolution simulations with CTM CHIMERE** to cover seasonality and annual variability and as many different meteorological and pollution events
- Validation of **PM10 concentrations** derived from **Sentinel-3** during **Olympic Games 2024** in partnership with **INERIS**
- Computation of **ground-level SO<sub>2</sub> concentrations** from **Sentinel-5** has been conducted for the French electricity transmission system operator RTE
- Investigation of the potential impacts of **long-term time-series of PM2.5** for **health-related studies** in coordination with the **University Hospital CHU Toulouse**.



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