Artificial Intelligence models in solving Ill-posed Inverse problems of Remote Sensing GHG emission

MMDA

ІКД

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Objectives and data

Inverse problem-solving methods

- ☐ Algebraization of an ill-posed problems
- ☐ Regression approach to solving inverse problems
- ☐ NLLSM in solving inverse problems
- ☐ BIAS and Covariance Matrix of Solution Estimated Errors by LSM
- ☐ Analysis of the estimation of the solution by the LSM in the orthogonal basis of eigenvectors
- ☐ Methods for introducing apriori information
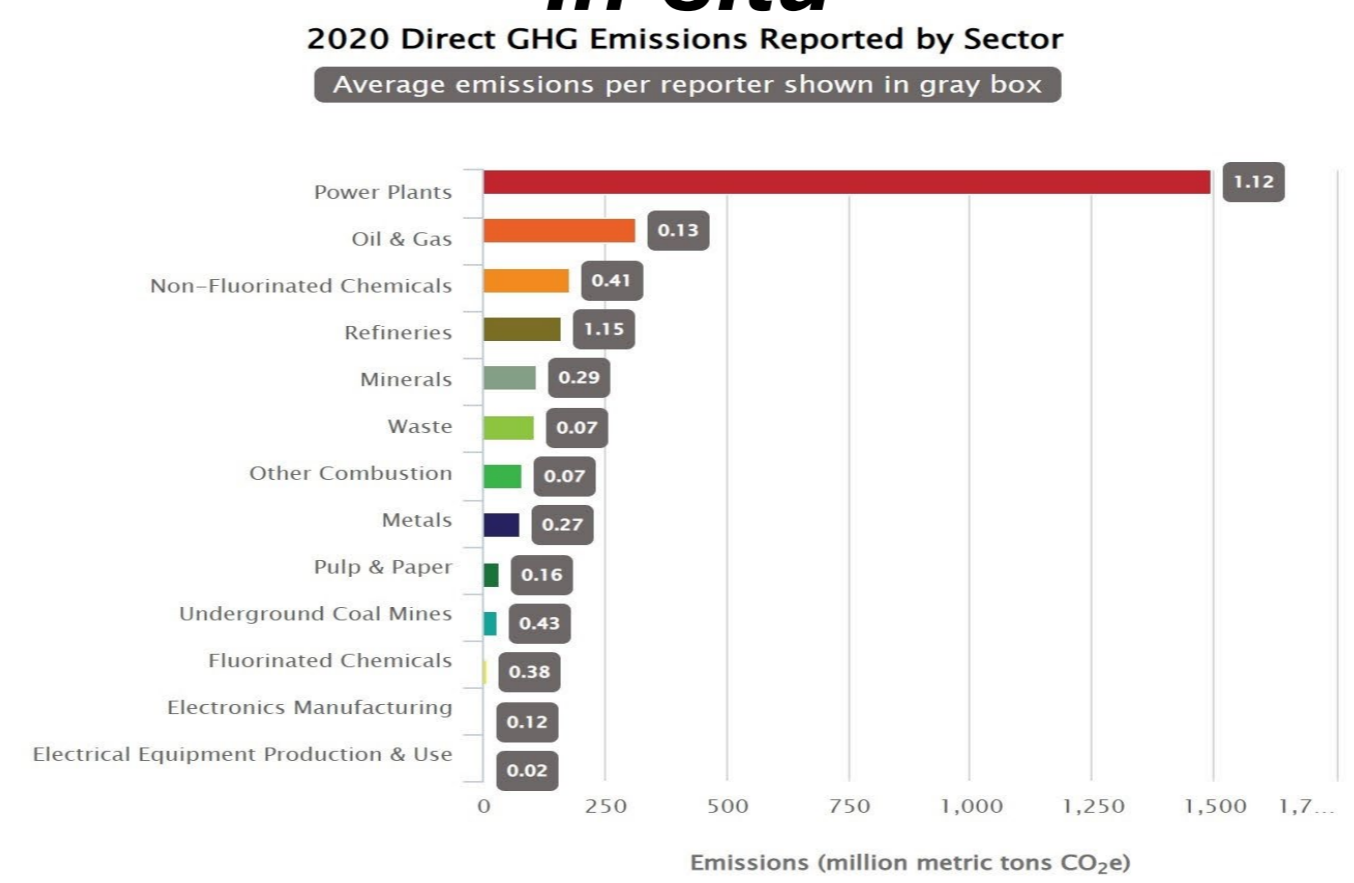- ☐ Projection methods for solving inverse problems

Challenges

1. Climate **change**, which involves conservation, sustainable management and restoration of ecosystems
2. Carbon dioxide and methane **measurement** in the layers of the atmosphere
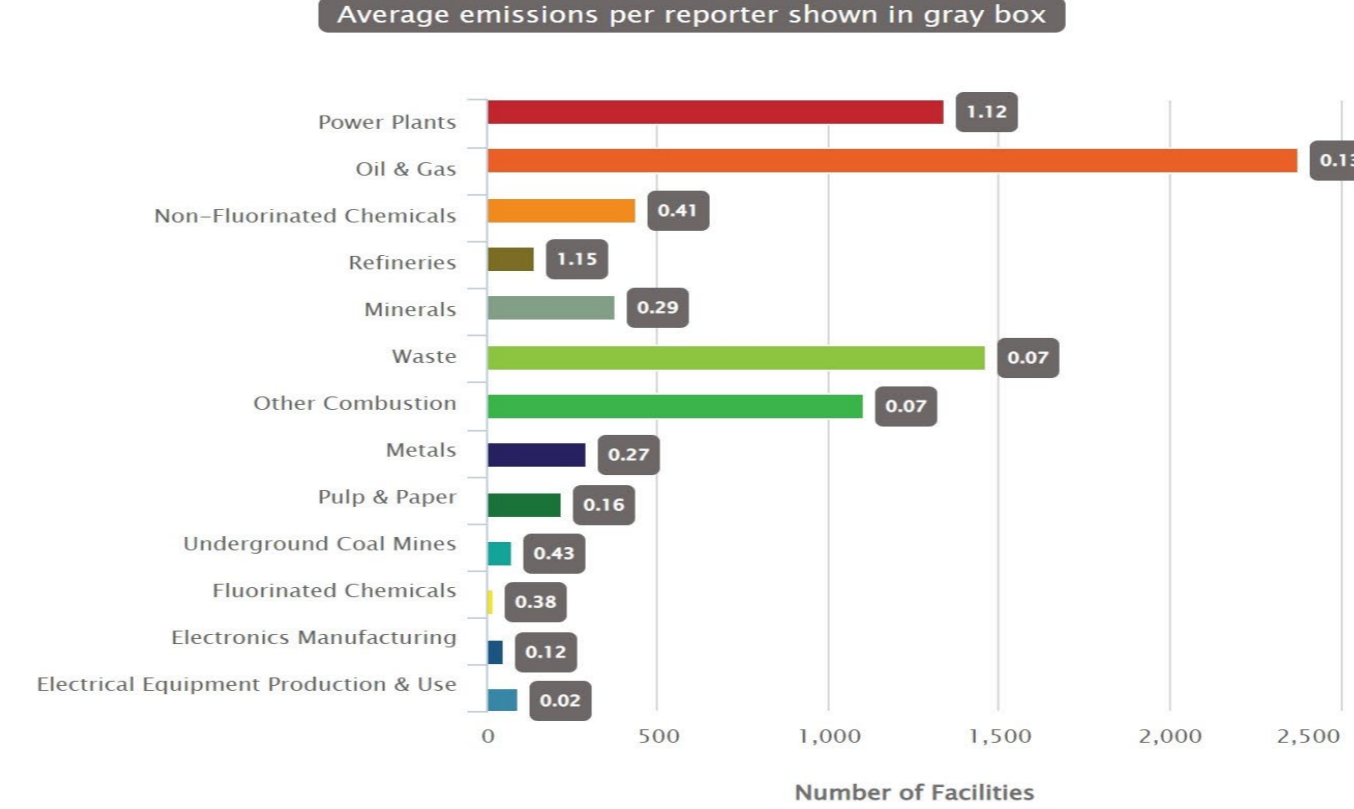3. **International collaboration**

Used data

- **Satellite data**
  - ➢ Sentinel NASA, OCO-3
  - ➢ Sentinel GOSAT mission
- **Train data**
  - ➢ In-situ CAMS, TROPOMI
  - ➢ Interpretation

In-situ

2020 Direct GHG Emissions Reported by Sector
Average emissions per reporter shown in gray box

2020 GHGRP Facilities by Sector
Average emissions per reporter shown in gray box

Key users

- ☐ **Governmental institutions**
  - ➢ Ministry of Ecology and Natural Resources of Ukraine
  - ➢ Ukrainian Hydrometeorological Center of the State Emergency Service of Ukraine
- ☐ **Academic**
  - ➢ Igor Sikorsky Kyiv Polytechnic Institute
  - ➢ Kyiv Academic University
- ☐ **Research**
  - ➢ UNFCCC bodies
  - ➢ VU University Amsterdam
  - ➢ Technical university of Denmark (DTU)
- ☐ **National inventory developers**
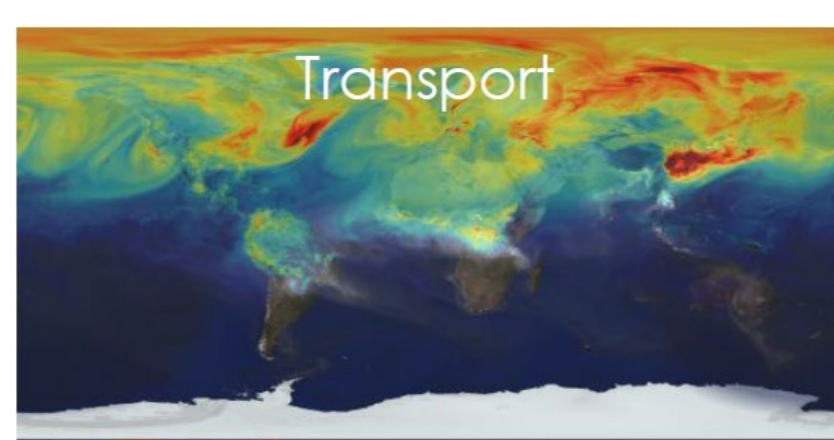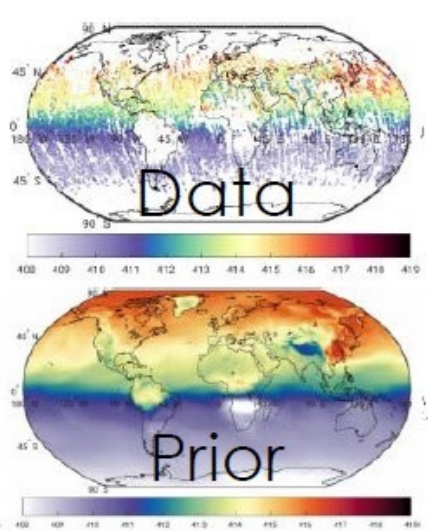
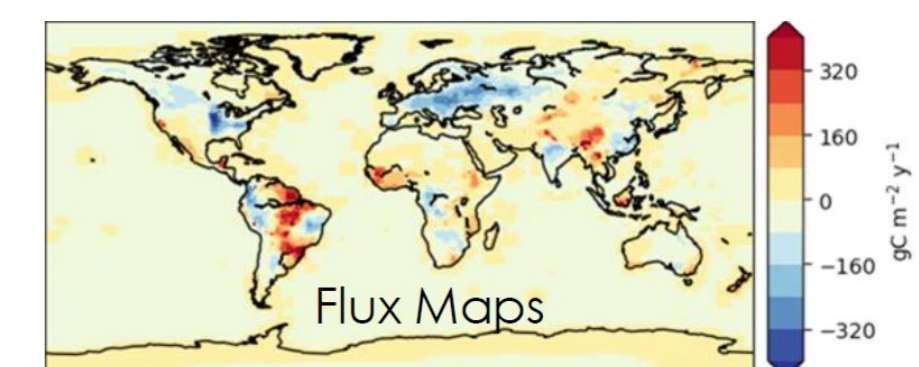# Methodology in solving ill-posed Inverse problem

CREODIAS

Sentinel Data

Data

Prior

Transport

Using atmospheric inverse moels to estimate CO2 and CH4 fluxes from atmospheric measurement
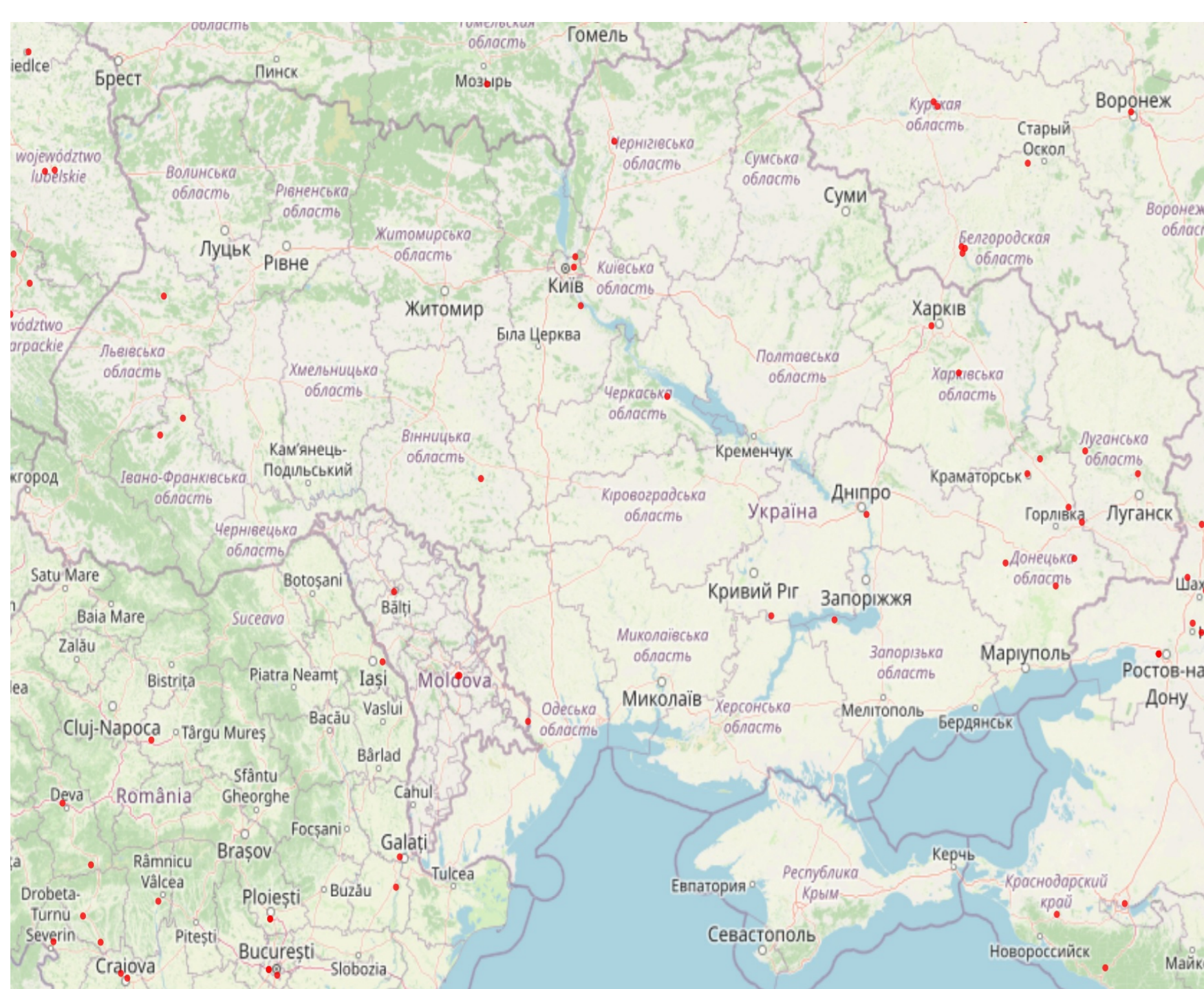
Inverse Model

$$\mathcal{J}(\mathbf{x}) = \frac{1}{2}||\mathbf{y} - \mathcal{H}(\mathbf{x})||^2_{\mathbf{R}^{-1}} + \frac{1}{2}||\mathbf{x} - \mathbf{x}_b||^2_{\mathbf{B}^{-1}}$$
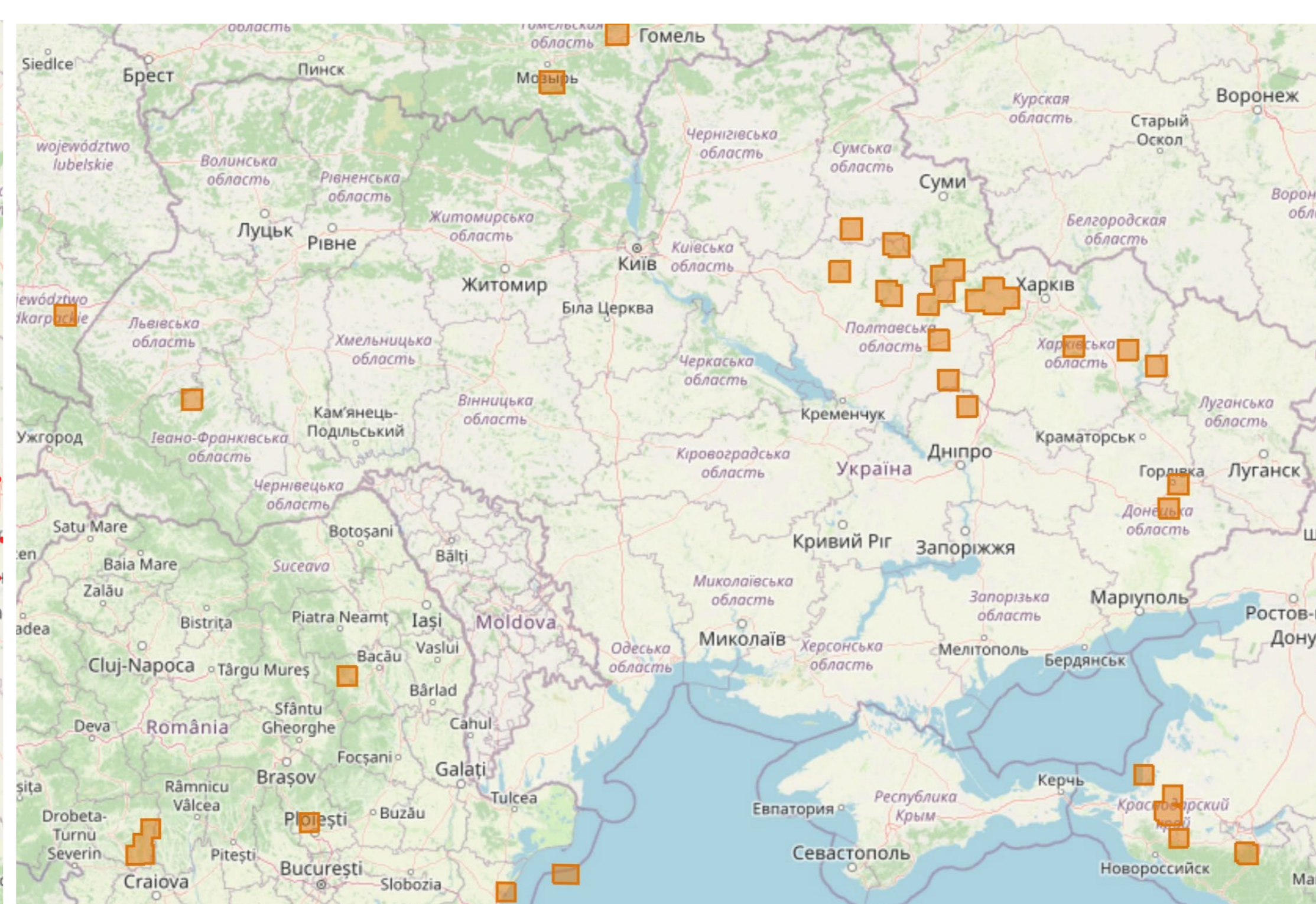
Flux Map

Flux Maps
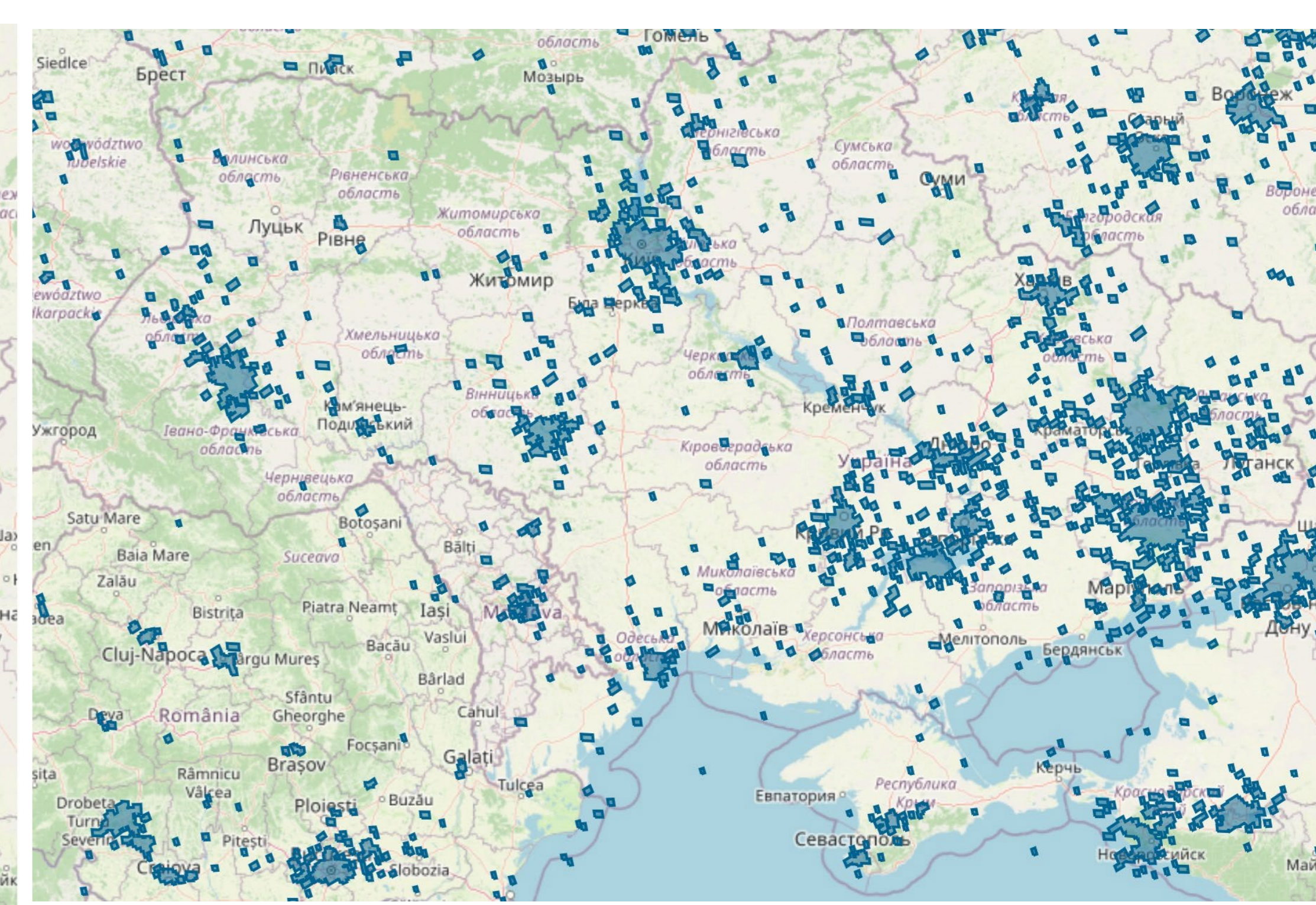
First results – 2022, Ukraine

Power Station

Nighttime Flaring

Plumes of NO2

References

1. A. Shelestov, H. Yailymova, B. Yailymov, N. Kussul, "Air Quality Estimation in Ukraine Using SDG 11.6.2 Indicator Assessment", **Remote Sens. 2021, 13, 4769.** DOI: 10.3390/rs13234769.
2. Shelestov, A.; Yailymova, H.; Yailymov, B.; Samoilenko, O.; Volynskii, M.; Shumilo, L. Ground based validation of Copernicus atmosphere monitoring service data for Kyiv. In Proceedings of the IEEE EUROCON 2021—19th International Conference on Smart Technologies, Lviv, Ukraine, 6–8 July 2021; pp. 88–91.
3. https://e-shape.eu/index.php/showcases/pilot7-1-global-carbon-and-greenhouse-gas-emissions

e-shape

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