SnT 2025
8 SEPTEMBER ONLINE DAY
9 TO 12 SEPTEMBER AT HOFBURG PALACE, VIENNA & ONLINE
CTBT: SCIENCE AND TECHNOLOGY CONFERENCE

P2.3-585

Regional-Scale Air Pollution Source Identification Using Backward Particle Dynamics

Prof. Evgeny Burnaev

Skoltech, AIRI

INTRODUCTION AND MAIN RESULTS

This presentation proposes a new algorithm for a single air pollution source localization. The algorithm was tested on several semi-synthetic and practical cases and compared with other solutions in this field. The algorithm demonstrates better or at least comparable results with existing algorithms.

SnT 2025 CTBT: SCIENCE AND TECHNOLOGY CONFERENCE
8 SEPTEMBER ONLINE DAY
9 TO 12 SEPTEMBER AT HOFBURG PALACE, VIENNA & ONLINE

Regional-Scale Air Pollution Source Identification Using Backward Particle Dynamics

Prof. Evgeny Burnaev

P2.3-585

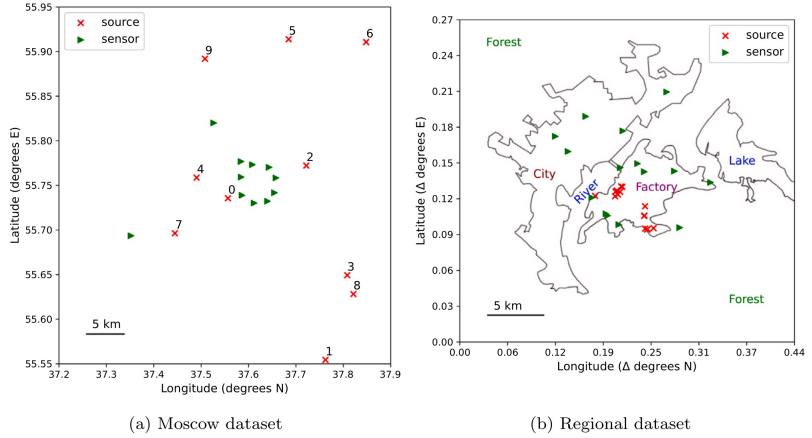
Introduction

Air pollution is one of the most harmful consequences of industrialization because of its strong influence on both human health quality and climate in general.

Often there appears a need to identify one single strong source of air pollution appearing as a result of an accident.

In this work, we propose a new algorithm for a single pollution source localization.

On new datasets the proposed algorithm outperforms the main methods presented in other papers. The algorithm gets comparable results with other papers on the ETEX dataset.



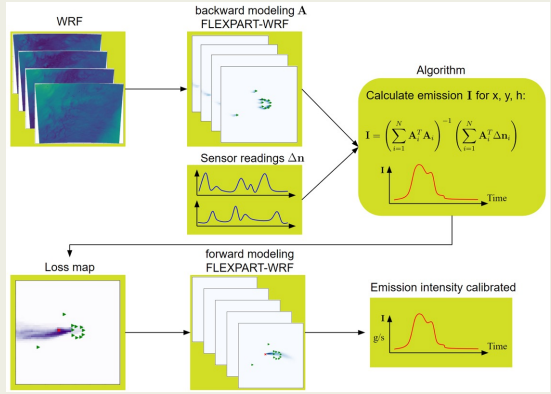
(a) Moscow dataset (b) Regional dataset

Location of sources and sensors for two datasets. Note that coordinates in Fig. (b) are shifted to (0,0) in the south-west corner for the sake of the data anonymization.

Methods/Data

What do you need to know about the alorithm?

- The proposed algorithm uses the source–receptor matrix concept and assumption about the linearity of pollution transport that allows us to use the pollution spread simulations backward in time.
- In particular realization, we make use of the weather regional forecast model WRF for airflow simulation and of Lagrangian particle dispersion simulation software FLEXPART-WRF for pollution advection simulation both forward and backward in time.
- As a result, our algorithm produces the semi-empirical heatmap of possible pollution source locations with marked point of the biggest probability and estimative emission intensity at this point as a function of time.



Mariia Filippova, Oleg Bakhteev, Fedor Meshchaninov, Evgeny Burnaev, Vladimir Vanovskiy. Regional-Scale Air Pollution Source Identification Using Backward particle dynamics. Atmospheric Environment, 2025.

Results

The algorithm is tested on several semi-synthetic and practical cases and compared with other solutions in this field. The mean distance between the predicted and the real sources is around 7 km for the Moscow dataset with 1096 experiments and 45 km region size and around 3 km for the Regional dataset with 803 experiments and 30 km region size. We also conduct an experiment on European Tracer Experiment-1 and get a strong performance on it: distance between the real and the predicted sources is around 6 km, which is comparable or superior to other approaches.

Algo	Distance, km	Time, IOU
Our*)	**6.4**	**0.57**
[1]	4.7	-
[2]	66.7	-
[3]	108	0.57
[4]	156	-

Comparison of the results on ETEX first emission. Our algorithm*) stands for results, when we do not account the nearest sensor to the source to reduce the calibration error of the emission intensity.

- https://remon.jrc.ec.europa.eu/Past-Activities/ETEX-subsite
- [1] Wang, Jilin, et al. "Inversion method for multi-point source pollution identification: Sensitivity analysis and application to European Tracer Experiment data." Atmospheric and Oceanic Science Letters (2022)
- [2] Zhao, Yungang, et al. "Source Reconstruction of Atmospheric Releases by Bayesian Inference and the Backward Atmospheric Dispersion Model: An Application to ETEX-I Data." Science and Technology of Nuclear Installations (2021)
- [3] Andronopoulos, Spyros, and Ivan V. Kovalets. "Method of source identification following an accidental release at an unknown location using a lagrangian atmospheric dispersion model." Atmosphere (2021)
- [4] Tomas, Jasper M., et al. "Detection of radioactivity of unknown origin: Protective actions based on inverse modelling." Journal of environmental radioactivity (2021)

Skoltech Applied AI

AIRI