Strong Decline In Power Plant NO_x Emissions Sensed By S5P/TROPOMI

Ioanna Skoulidou[1], Maria-Elissavet Koukouli[1], Arjo Segers[2], Astrid Manders[2], Dimitris Balis[1], Trissevgeni Stavrakou[3], Jos van Geffen[4] and Henk Eskes[4]

[1] Laboratory of Atmospheric Physics, Aristotle University of Thessaloniki, Greece [2]TNO, Climate, Air and Sustainability, Utrecht, The NetherlandS [3]Royal Belgian Institute for Space Aeronomy (BIRA-IASB), Brussels, Belgium [4]Royal Netherlands Meteorological Institute (KNMI), De Bilt, The Netherlands

*corresponding author e-mail: *ioannans@auth.gr*

Introduction

Current anthropogenic emission inventories generally rely on "bottom-up" approaches which are often highly uncertain due to their low temporal and spatial resolution since geographical and statistical data of different sources are mainly used to compile them infrequently. In this study, S5P/TROPOMI NO_2 observations are employed in order to estimate updated NO_x emissions over four of the largest power plants in NW Greece. NO_x emissions in the region have been reported to significantly decrease in recent years due to the country's targets set by the Directive 2016/2284/EC concerning the reduction of certain national atmospheric pollutants. In particular, the country is committed in reductions of 31% in NO_x emissions for the period between 2020 and 2029.

Region of study

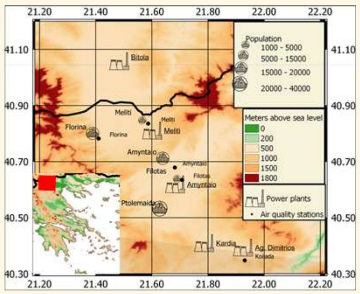

Figure 1. The topography of the region of study with the locations of power plants, cities and towns, and available air quality stations

According to E-PRTR (European Pollutant Release and Transfer Register), the highest NO_x emissions from lignite power plants (p.p.) in 2007 are reported in the NW Greece. By 2019, 4 lignite p.p. were operated in the region (**Figure 1 and Figure 2**). NO_x emissions are reported to decrease significantly between 2015 and 2019 which is followed by the energy production reports of the 4 p.p. according to Energy Exchange Group EnEx and OMI/Aura NO_2 observations

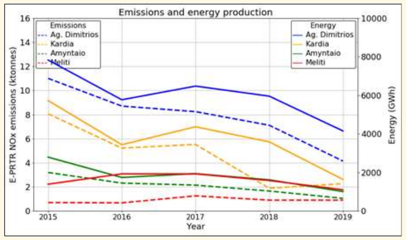

Figure 2. Annual NO_x emissions (dashed line) and energy production (solid line) for the four power plants for 2015-2019.

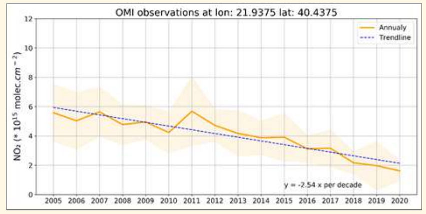

Figure 3. Time series of mean annual NO_2 columns from OMI/AURA at the pixel where Ag. Dimitrios is located with the standard deviation (shaded area) and the trend (blue line).

Data and methods

Level 2 offline **NO_2 S5P/TROPOMI** data (OFFL v1.03) are obtained via the Copernicus Open Data Access Hub for summer of 2019. The data are filtered for a quality assurance value higher than 0,75.

The LOTOS-EUROS CTM (Manders et al, 2017) is used to simulate NO2 tropospheric columns over the region. The apriori emissions used in the model are based in CAMS-REG 2015.

For the assimilation of the S5P/TROPOMI observations the model an Ensemble Kalman Filter implemented around LOTOS-EUROS is used

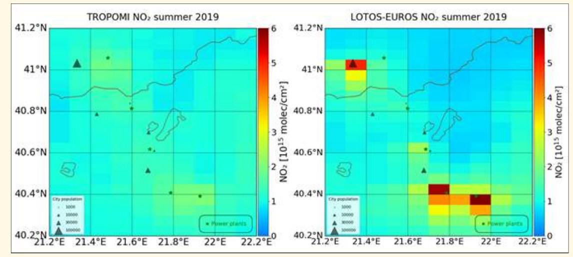

Figure 4. NO_2 summer 2019 TROPOMI observations (left) and simulated columns after the application of TROPOMI Averaging Kernels (AK) based on the apriori emissions of CAMS-REG 2015. The 4 p.p. are denoted with the green stars

Results and evaluation of the method

Aposteriori emissions

Table 1. Relative differences between aposteriori emissions in summer 2019 and apriori emissions in summer 2015

Power plants (P.P.)	Emissions changes 2019 -2015
Ag. Dimitrios	-63%
Kardia	-63%
Amyntaio	-37%
Meliti	-1%

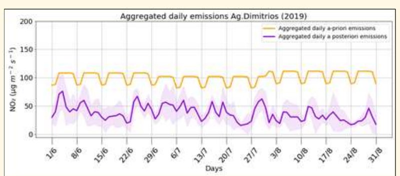

Figure 5. Aggregated daily NOx apriori (orange) and aposteriori (purple) emissions and the propagated uncertainty (shaded purple area) in the pixel where Ag. Dimitrios plant is located

Annually aposteriori vs E-PRTR emissions

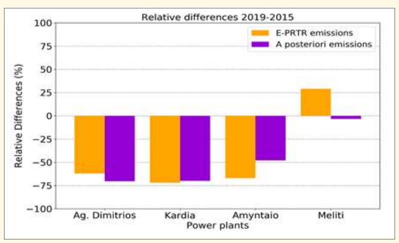

Figure 6. Relative differences **of E-PRTR annual** reported emissions and the **aposteriori emissions** in 2019 with respect to 2015 reported emissions

Summer aposteriori emissions vs energy

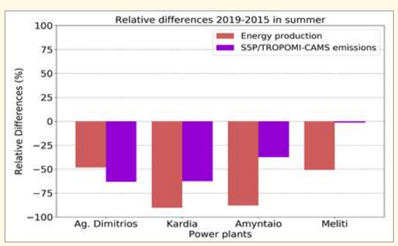

Figure 7. Relative differences between **summer aposteriori 2019 and apriori 2015 emissions and energy productions** in summer 2019 and 2015.

Assimilated NO_2 simulations vs in situ measurements

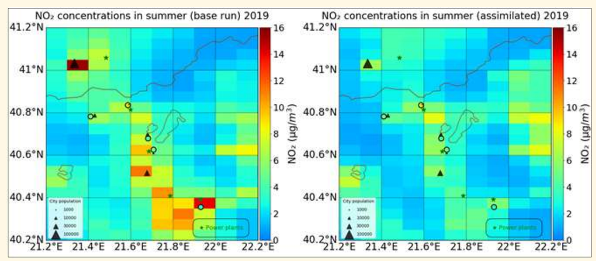

Figure 8. LOTOS-EUROS **NO2 surface simulations compared with in situ measurements for summer 2019** simulaltions form the base run (left) and after the assimilation of TROPOMI (right). The color of the circle denote the summer value of the measurements.

Table 2. Biases between LOTOS-EUROS surface simulations in the base and assimilated runs and surface measurements in the summer of 2019.

In situ stations	Emission Sources	Bias (μg/m3)	
		Base Run	Assimilated
Koilada	P.P. Ag. Dimitrios	10.52	2.00
Filotas	Town of Filotas/P.P. Amyntaio	−0.47	−2.26
Amyntaio	Town of Amyntaio/P.P. Amyntaio	3.49	1.73
Meliti	Town of Meliti/P.P. Meliti/P.P. Bitola	−1.63	−2.34
Florina	Town of Florina	1.17	−0.35

Conclusions

- S5P/TROPOMI NO_2 observations **manage to track the strong decline in NO_x emissions** over the p.p. in Northwest Greece suggesting that are **appropriate in detecting emission trends of local large emitters**
- **High emission decreases** are estimated in summer 2019 over the two larger stations, i.e. Ag. Dimitrios and Kardia (~ -60%)
- The **energy changes reported agree well with the emission changes** at the grid pixel where the large stations are located
- In situ measurements in the region show **lower biases** when compared with the assimilated NO_2 concentrations than when compared with the base run except of the stations near the smallest power plants
- The results in Meliti power plant were found not to be representative mostly due to presence of **other emission sources** affecting that grid cell (Skoulidou et. al, 2021).

References

Manders, A. M. M. et al.. (2017). Curriculum vitae of the LOTOS-EUROS (v2.0) chemistry transport model. Geoscientific Model Development, 10(11), 4145–4173. https://doi.org/10.5194/gmd-10-4145-2017

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