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SPACE DISTRIBUTION OF NO_2 POLLUTION OVER BULGARIA

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Abstract

In this work, we aim to track the behaviour of nitrogen dioxide over Bulgaria for the period 30th April 2018 to the end of July 2022 based on data from the Sentinel 5P data. We conclude that the biggest pollutant still remains the industrial regione near Stara Zagora. The second and third sources are respectively big cities and highways.

Introduction

Atmospheric pollution is one of the most important environmental issues of the industrialized developed and developing countries around the world. Both the energy production based on fossil fuels [1] and road traffic [2] are key factors creating serious public health problems, from local to regional and national levels [3, 4]. Nitrogen dioxide (NO_2) is one of the main air quality pollutants of concern in many urban and industrial areas worldwide, and particularly in the European region, where in 2017 almost 20 countries exceeded the NO2 annual limit values imposed by the European Commission Directive 2008/50/EC [5, 6]. NO_2 pollution monitoring and regulation is a necessary task to help decision makers to search for a sustainable solution for environmental quality and population health status improvement.

The recording of atmospheric pollutants is carried out in two main ways, by direct and by remote measurements.

Direct measurements are carried out at a single point (local), while remote methods provide data on volumetric content. Measurements from satellites contain the content for a given pollutant in the whole column of the atmosphere over a given area corresponding to the spatial resolution of the instrument. To obtain a complete picture of the phenomenon, it is best to use both sources of information in conjunction.

In this work, we aim to track the behaviour of nitrogen dioxide over Bulgaria for the period 30th April 2018 to the end of July 2022 based on the data from the Sentinel 5P data [7, 8]

Satellite data

TROPOMI [9, 10], launched in October 2017 aboard of the European Space Agency's (ESA's) S5P spacecraft, provides measurements in four channels (UV, visible, NIR and SWIR) of various trace gas columns, as well as cloud and aerosol properties, from an ascending Sun-synchronous polar orbit, with an Equator crossing at about 13:30 local time (LT). NO_2 retrieval is performed from the visible band (400–496 nm), which has spectral resolution and sampling of 0.54 and 0.20 nm, with a signal-to-noise ratio of around 1500.

Individual ground pixels are 7.2 km (5.6 km as of 6 August 2019) in the along-track and 3.6 km in the across-track directions in the middle of the swath. The full swath width is about 2600 km, with which TROPOMI achieves global coverage each day, except for narrow strips between orbits of about 0.5∘ wide at the Equator. The swath is across-track divided into 450 ground pixels (rows) and their size remains more or less constant towards the edges of the swath (the largest pixels are ∼14 km wide).

In this work we use dayli NO_2 data from Sentinel-5P Pre-Operations Data Hub [8] as well as visualization from EO browser [7]. For each one of the days for the period of April 30, 2018, till July 31, 2022, we download and process data for NO_2 and point the places with NO_2 increase over Bulgarian regione. For the NO_2 increase we've considered to use all values above 7.5 E-5 mol/m^2.

We must mention that in many cases we see values above 1 E-4 mol/m^2.

Results and Discussions

As a result of this research, we observe several regions over Bulgaria with repetitive NO_2 increases. Most often, more than once at every 3 days, we have observed increase over the regione of open mining near Stara Zagora. Below we named this region only "Stara Zagora", but it is not the region over the city.

The second place is Sofia as the biggest Bulgarian city, then Plovdiv. Unexpectabily after Plovdiv comes Kyustendil region. Then comes Varna, Ruse, Burgas, Pazardjic, Pernic and others.

On the Fig. 1 we show comparison between days with NO_2 increase over the first 5 of the above-mentioned places.

On the Fig. 2 we show one typical case of NO_2 pollution distribution over Bulgaria with increases over several places.

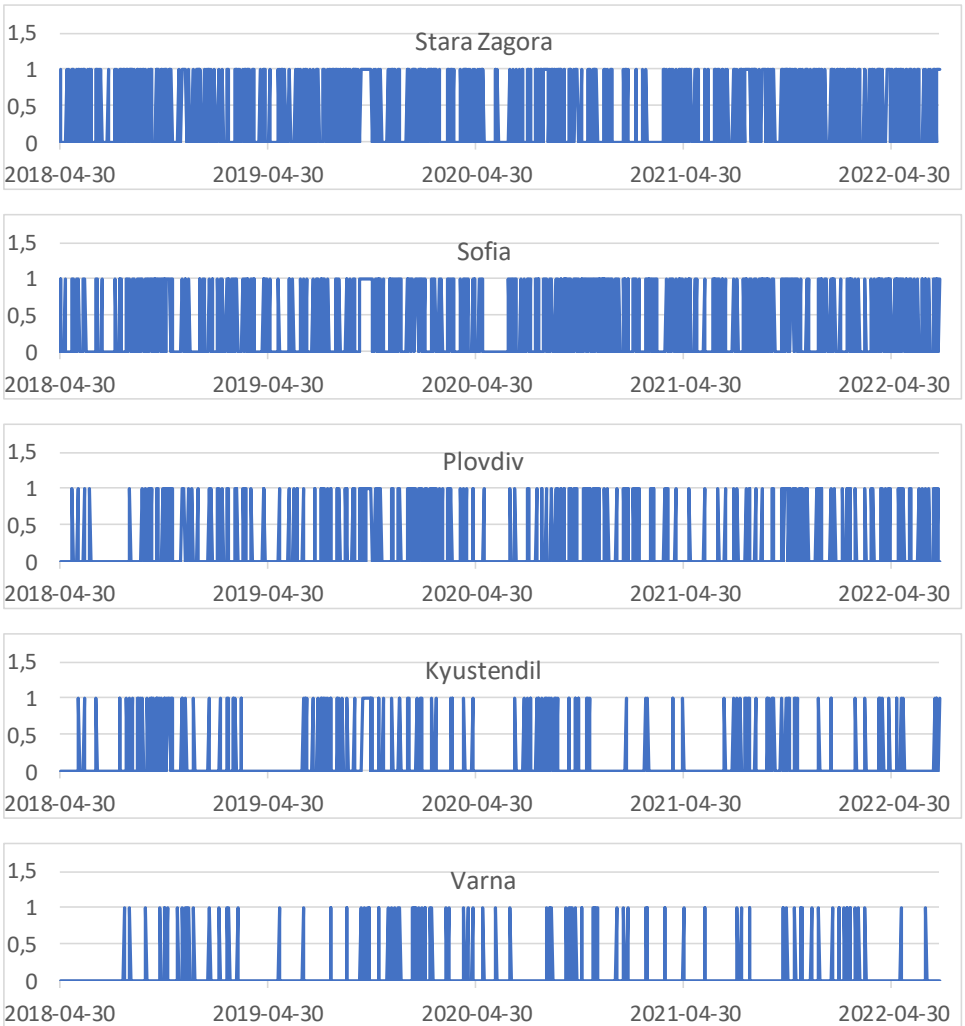

Fig. 1. Days with NO_2 increase over different places over Bulgaria

The increase of NO_2 over the regione of open mining near Stara Zagora covers a very big area (as we see on Fig. 2), while big cities pollute mainly the nearest of their area region.

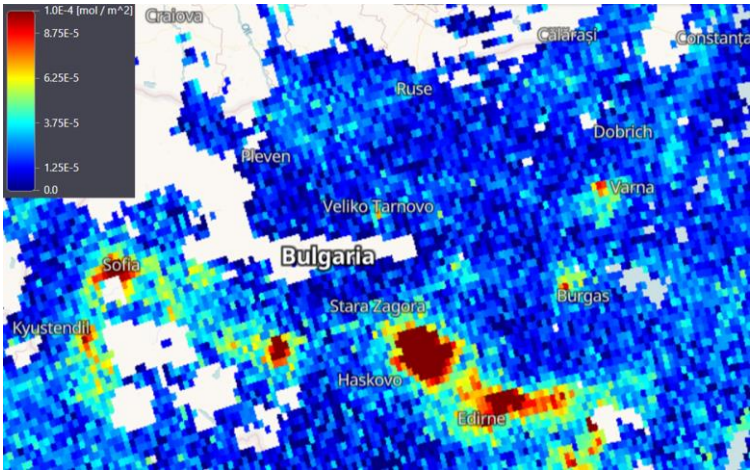

Fig. 2. An example of NO2 pollution distribution over Bulgaria

On Figures 3 and 4 we show respectively seasonal and temporal distribution of days with NO_2 increase over the above-mentioned places.

As we see on Fig. 3, NO_2 increases are more often during the autumn months.

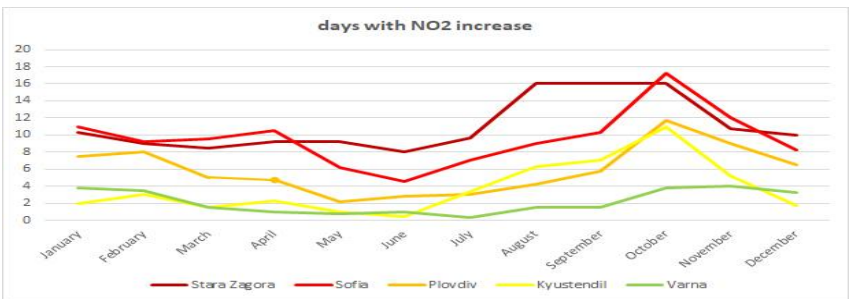

Fig. 3. Seasonal distribution of days with NO_2 increase over different Bulgarian regions

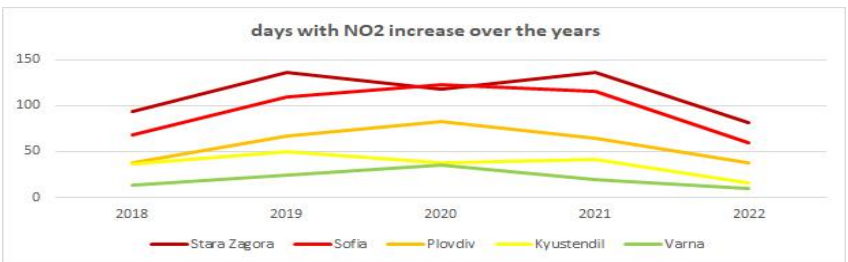

Fig. 4. Distribution of days with NO2 increase over different Bulgarian regions over the years

On the Fig. 4 we see that there was some decrease in NO_2 pollution during 2020 over open mining region and Kyustendil. Decrease in 2020 is caused by a smaller period (only 7 months).

Other repetitive picture is the increase of NO_2 over big regions above the two highways – Struma and Trakia. An example for this we show on Fig. 5.

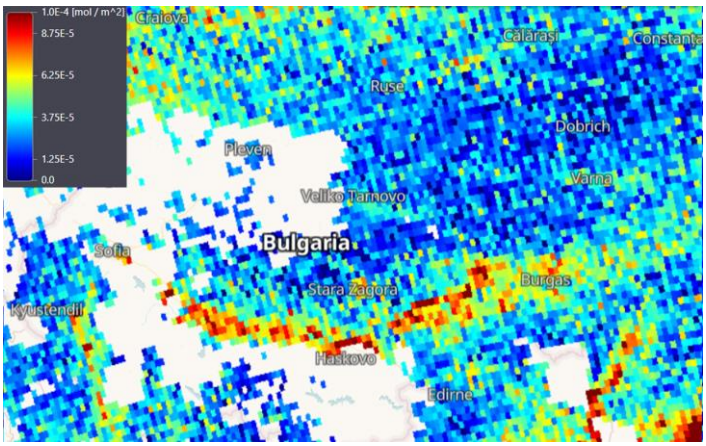

Fig. 5. An example of NO_2 pollution above highways in Bulgaria

Conclusion

With the help of the Sentinel 5P data, we can register and investigate the space distribution of air pollution over Bulgaria. We can also study NO_2 ground sources.

The biggest air pollution source is still the industrial region, east-south of Stara Zagora. For the NO_2 pollution in Bulgaria big cities are the usual sources, as well the highways.

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ПРОСТРАНСТВЕНО РАЗПРЕДЕЛЕНИЕ НА ЗАМЪРСЯВАНЕТО С NO2 НАД БЪЛГАРИЯ

М. Димитрова, Пл. Тренчев

Резюме

В тази работа се стремим да проследим поведението на азотния диоксид над България за периода 30 април 2018 г. до края на юли 2022 г. въз основа на данни от Sentinel 5P. Заключаваме, че най-големият замърсител все още остава индустриалният район край Стара Загора. Вторият и третият източник са съответно големите градове и магистралите.