International Journal of Geography, Geology and Environment

**P-ISSN:** 2706-7483
**E-ISSN:** 2706-7491
www.geojournal.net
IJGGE 2021; 3(1): 14-18
Received: 07-11-2020
Accepted: 09-12-2020

**Sandeep**
Mahatma Gandhi Chitrakoot Gramodaya Vishwavidyalaya, Satna, Madhya Pradesh, India

**Pooja Chaurasiya**
RK Group of Institutions nursing Department Prayagraj, Uttar Pradesh, India

**Rahul Pal**
All India Institute of Medical Sciences, Raipur, Chhattisgarh, India

**Mahima Singh**
Awadhesh Pratap Singh University Rewa, Madhya Pradesh, India

**Varsha Singh**
Awadhesh Pratap Singh University Rewa, Madhya Pradesh, India

**Ram Moorat Singh**
Chhattisgarh Council of Science and Technology, Raipur, Chhattisgarh, India

**Corresponding Author:**
**Ram Moorat Singh**
Chhattisgarh Council of Science and Technology, Raipur, Chhattisgarh, India

# Atmospheric measurements with the high Spatio-temporal resolution, to be used for air quality at Chhattisgarh state, based on remote sensing and GIS

**Sandeep, Pooja Chaurasiya, Rahul Pal, Mahima Singh, Varsha Singh and Ram Moorat Singh**

**DOI:** https://doi.org/10.22271/27067483.2021.v3.i1a.46

**Abstract**
Remote sensing data for air quality monitoring is important for health research. The advantage of remotely sensed air pollution data includes, but is not limited to, large coverage at a useful spatial and temporal resolution at Chhattisgarh state. Sentinel-5P is a rather new remote sensing data source but requires downloading and computationally intensive processing that is often a barrier to public use. For illustrative purposes, we focus on air pollutants including nitrogen dioxide (NO2), carbon monoxide (CO), ozone (O3), and sulfur dioxide (SO2), Spatio-temporal measurements across mainland Chhattisgarh. The spatial resolution of the measurements allows observations and mapping of air pollution at a scale.

**Keywords:** air pollution, remote sensing, monitoring, VISAN, Q-GIS, Arc-GIS

## Introduction
The Copernicus Sentinel-5 Precursor mission is the first Copernicus mission dedicated to monitoring our atmosphere at Chhattisgarh state. Copernicus Sentinel-5P is the result of close collaboration between ESA, the European Commission, the Netherlands Space Office, industry, data users, and scientists. The mission consists of one satellite carrying the TROPOspheric Monitoring Instrument (TROPOMI) instrument. The TROPOMI instrument was co-funded by ESA and The Netherlands. (Atmo, n.d.; Eskes *et al.*, 2019a) The satellite was successfully launched on 13 October 2017 from the Plesetsk cosmodrome in Russia. The satellite's local time of ascending node crossing of 13.30 h has been chosen to facilitate the so-called loose formation operation with NASA's Suomi-NPP spacecraft. (Eskes *et al.*, 2019b; Gonzalez Abad *et al.*, 2019; Ialongo *et al.*, 2020) [3, 5, 6] This concept will allow the utilization of co-located, high-resolution cloud mask data provided by the VIIRS (Visible Infrared Imaging Radiometer Suite) instrument onboard Suomi-NPP during routine processing of the TROPOMI methane product. (Atmo, n.d.; Eskes *et al.*, 2019a) [2].
The Copernicus Sentinel-5 Precursor mission reduces gaps in the availability of global atmospheric data products between SCIAMACHY/Envisat (which ended in April 2012), the OMI/AURA mission, and the future Copernicus Sentinel-4 and Sentinel-5 missions (https://sentinels.copernicus.eu/web/sentinel/missions/sentinel-5p). (Fehr, 2016; Eskes *et al.*, 2019b) [4]. The TROPOMI instrument combines the strengths of SCIAMACHY, OMI, and state-of-the-art technology to provide observations with performances that cannot be met by the current instruments in space. Performance of current in-orbit instruments is surpassed in terms of sensitivity, spectral resolution, spatial resolution, and temporal resolution. (Eskes *et al.*, 2019b; Ialongo *et al.*, 2020) [6].
The northern and southern parts of the state are hilly, while the central part is a fertile plain. Moist, deciduous forests of the Eastern Highlands Forests cover roughly 44 percent of the state. The Mahanadi is the chief river of the state. Godavari, Rihand, Hatkul, Chinar, Doodh, Sendoor, Nakti, Shivnath, Hasdo, Mand, Eb, Pary, Jonk, Kelo, Udanti, Sukha and Doori are the other rivers of the area. The Godavari is the second largest river. Rihand is Main River in the northern side of Chhattisgarh.

**Study site**

The present study in the total covered area is 135,194 km2 of Chhattisgarh state, in India. An approximate coordinate of this area Latitudes 21° 15' 0.0000" N and Longitudes 81° 37' 47.9892" E (Figure 1). Chhattisgarh state, in India for a study site. According to remote sensing and Geographical Information System calculation, the state of Chhattisgarh is a total cover area about approx. 135,192 km2. (Figure) The study area of about approx. 28 districts are covered. The main objective of the Copernicus Sentinel-5P mission is to perform atmospheric measurements with the high Spatio-temporal resolution at Chhattisgarh state, in India, to be used for air quality, ozone & UV radiation, and climate monitoring & forecasting.

The latitude of Raipur, Chhattisgarh, India is 21.250000, and the longitude is 81.629997. Raipur, Chhattisgarh, India is located at India country in the Cities place category with the GPS coordinates of 21° 15' 0.0000" N and 81° 37' 47.9892" E.

Chhattisgarh is a state in Central India. The state covers an area of 135,194 km2 with 25,540,196 inhabitants. The state is bordered by the states of Madhya Pradesh on the northwest, Maharashtra on the west, Andhra Pradesh on the south, Orissa on the east, Jharkhand on the northeast, and Uttar Pradesh on the north. The capital and largest city of Chhattisgarh in Raipur. The official language of the state is Hindi, Chhattisgarhi. Other languages spoken in the state are Urdu and Marathi. The state has the quality of life in the county with excellent physical infrastructure and it has 64.7% literacy level.

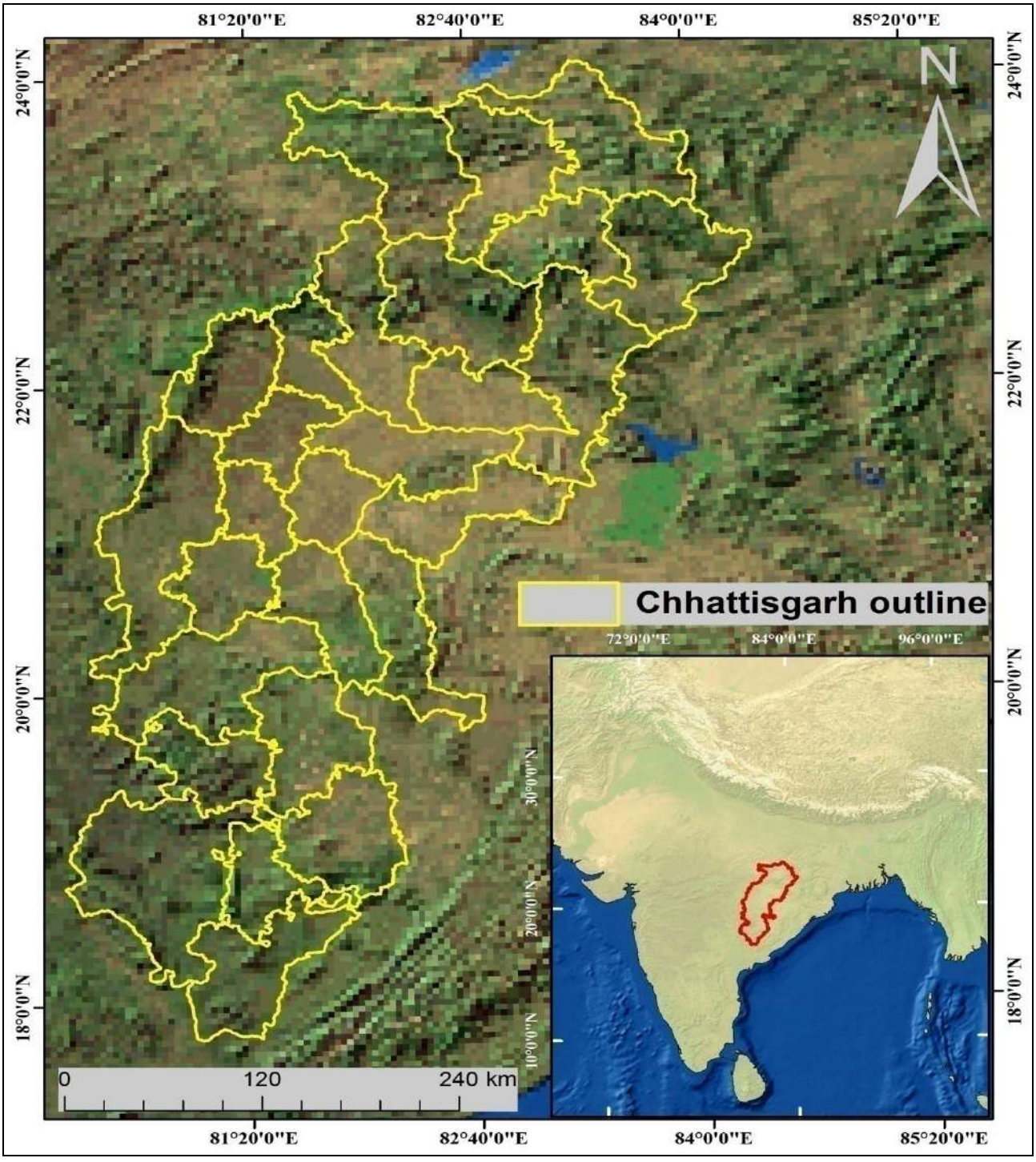


**Fig 1:** Location map of the study site in the state of Chhattisgarh.

**Experimental design, materials, and methods**

Sentinel-5P measurements (Daily and Month wise Analysis) between, with multiple attributes (e.g., latitude/longitude, WGS84 projection, and date of measurement), allowing both spatial and temporal observations of air pollutants. The data were also grouped by date allowing temporal assessment of pollutant density and quantitative observations such as monthly pollutant distribution. Satellite data with supporting ancillary information use in UTM (Universal transverse Mercator) Projection, spheroid datum WGS-84 (World Geodetic System) Zone-44 North.The monitoring of air pollution is an important task in public health. The availability of data is often hindered by the paucity of the ground monitoring station network. We present here a new Spatiotemporal dataset collected and processed from the Sentinel-5P remote sensing platform. (Zheng *et al.*, 2019; Verhoelst *et al.*, 2020; Vîrghileanu *et al.*, 2020) [11, 12, 13] As an example application, we applied the full workflow to process measurements of nitrogen dioxide (NO2) collected over the territory of mainland Chhattisgarh state.

The supplementary Python code package used to collect and process the data is made publicly available. The dataset provided in

**Table 1:** Specifications

| Subject | Environmental science |
|---|---|
| Specific subject area | Pollution |
| Type of data | Table, Image, Dataset, Python code |
| How data were acquired | The data was collected via the Sentinel Hub API. |
| Data format | Processed raw data, Analyzed, Filtered. |
| Parameters for data collection | The daily air pollution data was collected from 2018, 2019 and 2020. |
| Description of data collection | All the data was obtained from the Sentinel-5P satellite using the application programming interface. The collected data are processed by a Python code. |
| Data source location | Chhattisgarh |
| Data accessibility | Data is supplied on Mendeley. |

**Copernicus Sentinel-5 Precursor Data Provision Plan and actual product release to the public during the ramp-up phase**

**Launch +8 months:** Level-1B; Total Columns of Ozone (Near-Real-Time production), Nitrogen Dioxide, Carbon Monoxide; Cloud & Aerosol information data released on 10 July 2018

**Launch +10 months:** Total Columns of Ozone (Offline production), Formaldehyde, Sulphur Dioxide data released on 17 October 2018

**Launch +12 months:** Total Columns of Tropospheric Ozone, Total Columns of Methane data released on 1 March 2019.

The Copernicus Sentinel-5 Precursor ramp-up phase ended on 5 March 2019 and since this time the mission is in the routine operations phase. The public release of the Aerosol Layer Height product took place on September 30 2019 and the release of the Ozone Profile product is planned for early 2020.Level 1B and Level 2 products are available via the Copernicus Open Access Hub.Level 1B and Level 2 user documentation are available in the Products and Algorithms Technical Guide.Key users of the Copernicus Sentinel-5 Precursor products are Copernicus services such as the 'Copernicus Atmosphere Monitoring Service' (CAMS) or the 'Copernicus Climate Change Service' (C3S). Decision-makers will use the information provided by these services to take the right actions on environmental policies from which depends on the well-being and security of EC citizens and future generations. (Omrani *et al.*, 2020; Shikwambana *et al.*, 2020) [8, 10]

**Result and Discussion**

The quality of the individual observations depends on many factors, including cloud cover, surface albedo, presence of snow-ice, saturation, geometry, etc. In Sentinel-5P, a layer summarizing the different factors affecting the quality of the measurements is provided. (Quesada-Ruiz *et al.*, 2019; Zheng *et al.*, 2019; Omrani *et al.*, 2020) [8, 9, 13].

Sentinel-5P measurements (Daily and Month wise Analysis) between, with multiple attributes (e.g., latitude/longitude, WGS84 projection, and date of measurement), allowing both spatial and temporal observations of air pollutants. The data were also grouped by date allowing temporal assessment of pollutant density and quantitative observations such as monthly pollutant distribution. (Lorente *et al.*, 2019; Zheng *et al.*, 2019; Vîrghileanu *et al.*, 2020) [7, 12, 13]

1. CO June 2018 CO column number density (mol/m^2)
2. NO2 June 2018 Tropospheric NO2 column number density (mol/m^2)
3. O3 June 2018 Total ozone column (mol m-2)
4. SO2 October 2018 SO2 column number density (mol/m^2)

The present study of the observations of air pollution in the year of 2018 at Chhattisgarh state, parameters (CO, NO2, O3, and SO2). However, Observed the (Carbon Monoxide) CO June, 2018 value of air pollution reached to 0 - 0.190584 (Column number density (mol/m^2)), Observed the (Nitrogen dioxide) NO2 June 2018 value of air pollution reached to (-0.000277517) - 0.00049939 (NO2 column number density (mol/m^2)), Observed the (Ozone) 03 June 2018 value of air pollution reached to 0.1-0.1 (Ozone column (mol m-2)), and Observed the (Sulfur Dioxide) SO2 October 2018 value of air pollution reached to (-0.0131273) - 0.00799586 (SO2 column number density (mol/m^2)). (Show Figure 2)

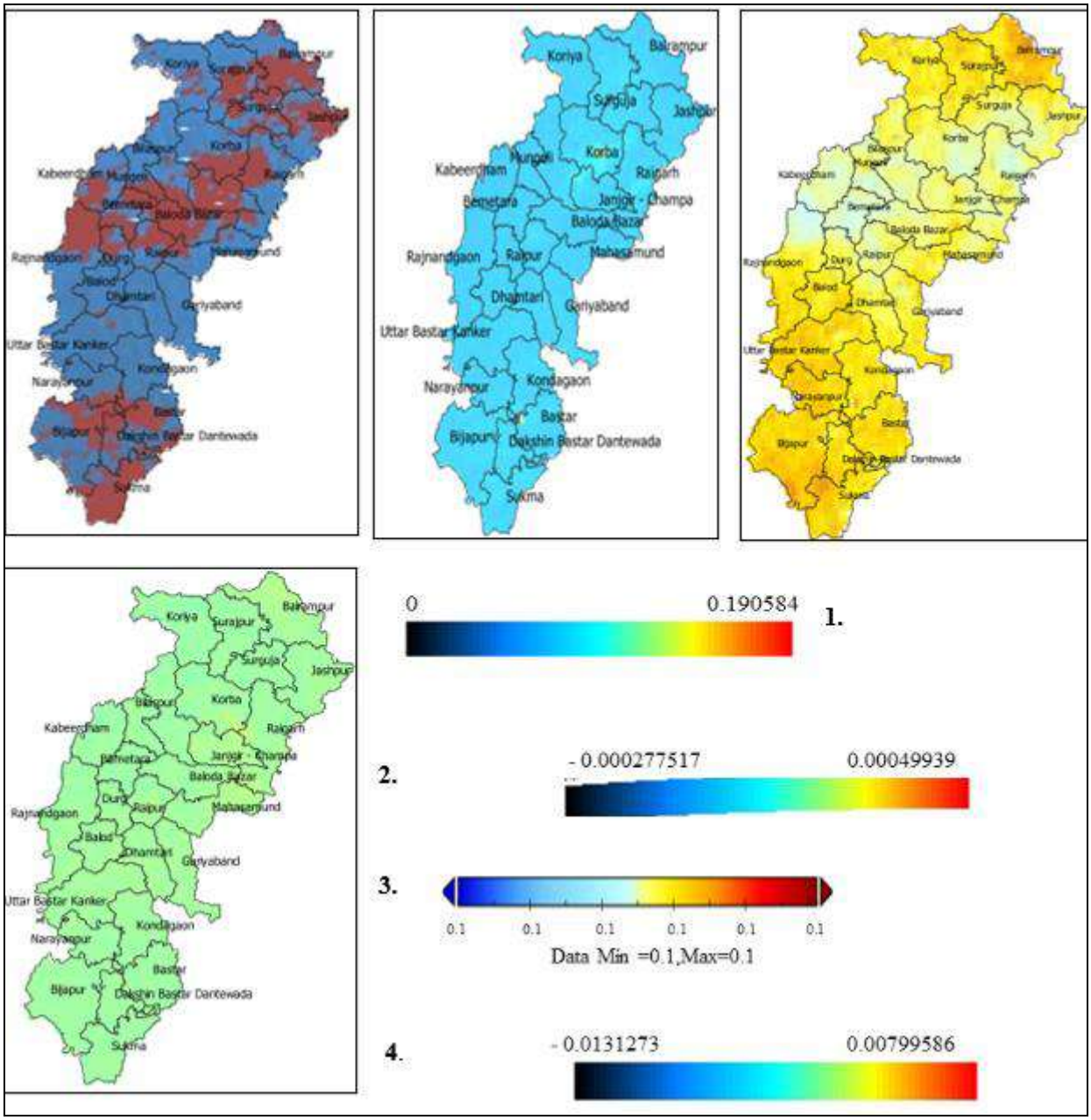


**Fig 2:** Show the Topospheric Density of Chhattisgarh state (CO, $NO_2$, $O_3$, and $SO_2$ mol/m^2), and the mission is to perform atmospheric measurements with high Spatio-temporal resolution.

The climate of Chhattisgarh is mainly tropical. It is hot and humid because of its proximity to the Tropic of Cancer. It is dependent completely on the monsoons for rains.

- Summer in Chhattisgarh is from April to June and can be uncomfortably hot, with the mercury hitting the high 40's.
- Monsoon season is from middle and late June to October and is a wonderful time to visit Chhattisgarh. The rains provide a welcome relief from the scorching summer heat and the whole state is covered with greens and waterfalls are at their best.
- The best season to visit the state is winter season which is from November to January. Winters are pleasant with low temperatures and less humidity.

## Conclusion

Chhattisgarh has plenty of such tourist locations. Each location speaks in volume almost its uniqueness. The pride of India lies in every tourist spot.

- The collected air pollution data offer a (cost) effective and scalable source for advancing the monitoring of CO, NO2, O3, and SO2 at a large scale.
- Policymakers can generate yearly, monthly, or even near-real-time datasets on air pollution map to support government efforts in reducing air pollution.
- The automated workflow to process Sentinel-5P data is transferable to any other study area on the globe.
- Satellite data can be merged with ground-based measurement or survey data. Use of Remote Sensing and GIS technology is very useful for the preparation of atmospheric measurements areas mapping & management plan on a scientific basis.

## Acknowledgements

Sandeep is highly thankful to the Mahatma Gandhi Chitrakoot Gramodaya Vishwavidyalaya, Satna Madhya Pradesh, Support Particular by Associate Profesor Dr. Ravi Chaurey for data collection and processing with Python and

providing all necessary facilities to carry out this research proposal. We wish to express our gratitude to Mr. Ram Moorat Singh (JRF, Chhattisgarh Council of Science & Technology (CCOST), Department of Science and Technology, Chhattisgarh) for important comments and suggestions which improved the Project proposal. The authors would also like to acknowledge the European Spatial Agency for providing the API for the Sentinel 5P Hub.

**Declaration of competing interest**

We declare that we have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

**References**

1. Atmo TKIT, N.D. Dfsdfgagriagragri Air Quality Monitoring With Sentinel 5p 1-28.
2. Eskes H, Geffen J Van, Boersma F, Eichmann KU, Apituley A, Pedergnana M, *et al.* Sentinel-5 precursor/TROPOMI Level 2 Product User Manual Nitrogendioxide 2019a, 147.
3. Eskes RHJ, Product MPC, MPC L, Coordinator V, Lead MPCE, MPC L, *et al.* S5P Mission Performance Centre Henk Eskes Angelik a Dehn Claus 2019b, 14.
4. Fehr T. Sentinel-5 Precursor: Scientific Validation Implementation Plan 2016;1:280.
5. Gonzalez Abad G, Souri AH, Bak J, Chance K, Flynn LE, Krotkov NA, *et al.* Five decades observing Earth's atmospheric trace gases using ultraviolet and visible backscatter solar radiation from space. Journal of Quantitative Spectroscopy and Radiative Transfer 2019;238:106478. doi:10.1016/j.jqsrt.2019.04.030
6. Ialongo I, Virta H, Eskes H, Hovila J, Douros J. Comparison of TROPOMI/Sentinel-5 Precursor NO2 observations with ground-based measurements in Helsinki. Atmospheric Measurement Techniques 2020;13:205-218. doi:10.5194/amt-13-205-2020
7. Lorente A, Boersma KF, Eskes HJ, Veefkind JP, Geffen JHGM van, Zeeuw MB, *et al.* Quantification of nitrogen oxides emissions from build-up of pollution over Paris with TROPOMI. Scientific Reports 2019**;**9:1-10. doi:10.1038/s41598-019-56428-5
8. Omrani H, Omrani B, Parmentier B, Helbich M. Spatio-temporal data on the air pollutant nitrogen dioxide derived from Sentinel satellite for France. Data in Brief 2020;28:105089. doi:10.1016/j.dib.2019.105089
9. Quesada-Ruiz S, Attié JL, Lahoz W, Abida R, Ricaud P, Amraoui L, *et al.* Benefit of ozone observations from Sentinel-5P and future Sentinel-4 missions on tropospheric composition. Atmospheric Measurement Techniques Discussions 2019, 1-34. doi:10.5194/amt-2018-456
10. Shikwambana L, Mhangara P, Mbatha N. Trend analysis and first time observations of sulphur dioxide and nitrogen dioxide in South Africa using TROPOMI/Sentinel-5 P data. International Journal of Applied Earth Observation and Geoinformation 2020;91:102130. doi:10.1016/j.jag.2020.102130
11. Verhoelst T, Compernolle S, Pinardi G, Lambert JC, Eskes H, Eichmann KU, *et al.* Ground-based validation of the Copernicus Sentinel-5p TROPOMI NO<sub>2</sub> measurements with the NDACC ZSL-DOAS, MAX-DOAS and Pandonia global networks. Atmospheric Measurement Techniques Discussions 2020, 1-40. doi:10.5194/amt-2020-119
12. Vîrghileanu M, Săvulescu I, Mihai BA, Nistor C, Dobre R. Nitrogen Dioxide (NO2) Pollution Monitoring with Sentinel-5P Satellite Imagery over Europe during the Coronavirus Pandemic Outbreak. Remote Sensing 2020;12:3575. doi:10.3390/rs12213575
13. Zheng Z, Yang Z, Wu Z, Marinello F. Spatial variation of NO2 and its impact factors in China: An application of sentinel-5P products. Remote Sensing 2019, 11. doi:10.3390/rs11161939