Determine of Nitrogen Dioxide Emissions over Khuoms City in Libya Using MODIS and TROPOMI Satellites

Dawi Muftah Ageel
Department of Geology and Environmental Science, Faculty of Sciences, Elmergib University, Khuoms, Libya.

E-mail: dmageel@elmergib.edu.ly

Abstract
Sentinel-5 Forerunner (S-5P), carrying the TROPO round recognition Instrument (TROPOMI) nadir-viewing crystal spectroscope, is that the beginning mission of the Copernicus Program committed to the recognition of air quality. Within the given data the TROPOMI tropospheric gas (NO$_2$) level-2 (L2) item has been substantial over capably sullied urban districts by comparison with coincident high resolution MODIS remote detecting observations (1 km x 1 km). Satellite products may be ideally surveyed backed 5 bands, as an out measured amount of lackey pixels may be completely mapped within the system of the S-5P approval campaign over Khuoms town in Libya. Each information’s was taken in 2020 over power station to Khuoms city in Libya, for mapping the level dissemination of tropospheric NO$_2$, each image pixels were fully covered by approximately 370 to 700 nm for visible spectrum (MODIS and TROPOMI pixels). The TROPOMI and MODIS NO$_2$ emissions were similar in concept, the regression analysis of both data with well correlated ($R^2= 0.87$) and there is negative relationship ($-0.03 \times 10^{15}$ molec/cm$^2$) recorded when clouds and dust were prevalent over the study area. From the results that obtained from MODIS and TROPOMI data, nitrogen dioxide emissions were high to medium (6.6 to $3.2 \times 10^{15}$ molec/cm$^2$) at their source and five kilometers from the source, while the rest of the study area ranged from (2.2 to $0.15 \times 10^{15}$ molec/cm$^2$) low to very low.

Keywords: TROPOMI, MODIS, Khuoms, Libya.
1. Introduction

1.1. Effects of NO₂

1.1.1. Health effects

High concentrations of NO₂ effecting on breathing air of the human respiratory system with ability on irritate airways. Thus, it leads to serious respiratory problems such as asthma when exposed to this pollutant for short periods. Also, coughing, wheezing, or difficulty breathing diseases. The elderly and children due to immunodeficiency are more exposed to this pollutant (NO₂) than other groups. In addition, nitrogen dioxide deposits affect the metabolic processes of hemoglobin and the exchange of oxygen at high concentrations of this pollutant, which leads to nitrogen poisoning. It also effects on the functioning of neurons, which contributes to mental illnesses such as insomnia, depression and anxiety (EPA, 2016).

1.1.2. Environmental effects

The physical properties of nitrate oxides are colorless and react with water vapor in the atmosphere or air to form nitrogen dioxide. Nitrogen dioxide has a distinctive odor and is impure, acidic and highly corrosive, affecting the surrounding environment. It produces yellowish-brown smog, which is toxic to the marine, plant and population environment. Household appliances such as heaters and heaters are a major source of nitrogen oxides, which makes the internal environment of the house polluted, toxic, and causes many diseases for the residents of those poorly ventilated dwellings. (EPA, 2018).

1.2. Data

1.2.1. MODIS imagery

NASA launched the Moderate Resolution Imaging Spectroradiometer (MODIS) sensor in 1999 by Terra (EOS AM) and then by Aqua (EOS PM) in 2002. Its data captures about 36 spectral bands, wavelengths between 0.4 and 14.4 µm and in degrees Varying spatial (2 bands at 250 metres, 5 bands at 500 metres, and 29 bands at 1 kilometer) (Morissette et al., 2012).

The MODIS satellite monitors the Earth daily, recording weather fluctuations and exposure of the atmosphere to solar and cosmic radiation, as well as ecological processes of ocean biomass and earth. MODIS uses four calibrators that include: a solar diffuser (SD), a solar diffuser stability monitor (SDSM), a Radiation Spectrum Calibration Kit (SRCA), and a black-body v-groove calibrator (Justice et al., 2015). A marine optical buoy was one use of the MODIS indirect calibration. MODIS has added VIIRS calibrators for the 2011 Suomi NPP and Joint Polar Satellites (JPSS). It is of high quality and supports advanced geophysical
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Faculty of Marine Resources, Alasmariya Islamic University, Libya

1.2.2. TROPOMI

TROPOMI data is based on DOMINO V2 and QA4ECV climate variability processing technologies, with a number of technologies important to the work of TROPOMI (Boersma et al., 2018), using a 3D parallel system on MP data to process data obtained from periodic data. Journal, Version 5 (TM5) of the Transfer Model (CTM) (Huijnen et al., 2016) it follows a three-step approach:

- Detection of NO\textsubscript{2} emissions along the light path used by DOAS method (Platt & Stutz, 2014) at the level of the spectral radiation of the single link and the multispectral radiation of TROPOMI. DOAS exploration is based on nonlinear recording of data (Van Noije et al., 2006), and uses SCDs to monitor the optical path through the atmosphere based on the geometry of vision, the prevailing atmospheric condition, and the solar radiation transmitted through it. Radiation reflected through the atmosphere and penetrating the troposphere is precisely recorded by SCDs (Williams et al., 2017).

- After the information is recorded by SCD technology, the data is stored on VCDs, which include the air masses associated with the recording period (AMFs). The AMFs illustrate the relationship between solar beam geometry and the vertical distribution of NO emissions, surface albedo, cloud height, aerosol scattering, and the nature of the terrain. All of these data are obtained by the integrated product of (1) daily vertical-measured AMFs of the TM5-MP model on a 1×1 grid covering 34 vertical layers (between surface and upper atmosphere; TOA). Square AMFs are calculated based on the KNMI-add multiplexing (DAK version 3.2) radiative transfer mode (RTM) (Griffin et al., 2019; and Ortega et al., 2015). The TROPOMI climatology data from 5 years ago is based on data aggregated in a 0.5×0.5 grid (Van Geffen et al., 2020). For nitrogen dioxide detection techniques, the Lambert reversal (LER) model is used. LER is defined as the surface corresponding to the required reflection according to that available TOA model under scattering conditions, i.e. clouds and aerosols. Indications for withdrawal are explored from the algorithm for calculating the availability of oxygen in the target range (Vasilkov et al., 2017).

Algorithms used to detect NO\textsubscript{2} emissions in TROPOMI technologies are defined using TM5-MP CTM technology, an improvement over the TM4 CTM, and run for OMI DOMINO v2.0. It contains a large spatial resolution (1×1), clearer information on nitrogen oxide processes (Friedel et al., 2017). MODIS satellite data covers the entire Earth every two days, covering the measurement of climatic fluctuations in the atmosphere, its exposure to solar and cosmic radiation, as well as the environmental processes of biomasses in the oceans and land. MODIS uses four calibration devices that include: a solar diffuser (SD), a solar disperser stability monitor (SDSM), a Radiation Spectral Calibration Kit (SRCA), and a black-body v-groove calibrator (Justice et al., 2015). The marine optical buoy was one of MODIS's indirect calibration uses. MODIS added the VIIRS calibrators for the 2011 Suomi NPP and Joint Polar Satellites (JPSS). It is of high quality and supports advanced geophysical processes (Friedl et al., 2017).
emissions, photolysis and detection of chemical interaction of emissions with atmospheric components (Van Geffen et al., 2020), where a gradient is observed in highly contaminated areas Nitrogen vertically and horizontally (Pinardi et al., 2020). These pollutant gradients cannot be measured over an area of 100x100 kilometer square (Dimitro et al., 2020).

Sentinel-5 Precursor (S-5P) is one of the products of the European Aerospace by Copernicus Company to monitor the atmosphere, and what it contains from natural phenomena such as weather, hurricanes and industrial such as climate change, the pollutant concentrations and their types. It was launched in October 2017 and it is still working well and accurately, and depends on it in the environmental studies. It carries the TROPO Isotope Display Spectrometer (TROPOMI) as its single payload. TROPOMI provides measurements of atmospheric composition with an unprecedented combination of resolution, spatial coverage and spatial resolution, providing new opportunities such as studying the diversity of pollutants on a city scale, as well as monitoring the global distribution of gases (Compernolle et al., 2020).

The new sensor technology and the method of exploration need to evaluate the effectiveness and importance of the data produced in terms of accuracy and that it meets the requirements of the required scientific research, in comparison with the existing data and available technical capabilities. TROPOMI's operational superiority lies in high quality, long-term routine monitoring of Level 1 (L1) and Level 2 (L2) (Ialongo et al., 2019). Troposphere NO$_2$ is one of the main monitored gas products by TROPOMI. It is a major pollutant of the environment and has a direct impact on human health, attaching to the ozone layer and particulate matter. NO$_2$ is formed from nitrogen monoxide (NO) and then rapidly oxidized to NO$_2$ by its reaction with oxygen in urban air, the primary source being combustion fuels due to traffic, home heating and industrial activities. Nitrogen dioxide is a short-lived species with a lifespan of approximately hours. Its distribution is characterized by a strong spatiotemporal variability when approaching emission sources (Kim et al., 2016).

TROPOMI is most suitable for monitoring emissions and sources of nitrogen dioxide in urban areas and at short wavelengths (Kleipool et al., 2018). Previous studies focus on evaluating the TROPOMI L2 tropospheric NO$_2$ product in continental polluted areas in general, but with this product it allowed accuracy in the results for less area polluted areas due to TROPOMI's limited lunar pixel size, which is usually much lower than heterogeneous pollution plume gradients. For example, a single isotope TROPOMI pixel of 3.5 km by 7 km has about 280 pixels (Constantin et al., 2016).

For the detection of NO$_2$ emissions by TROPOMI techniques in polluted areas and compare these data with MODIS sensor. By satellite pixel of each satellite image which were sampled from the target regions. This comparison as made by several previous studies such as Lamsal et al. (2017) and Heue et al. (2018). The validity and high quality of these comparisons were confirmed. Due to the large pixel footprint of the TROPOMI sensor in areas also covered by MODIS fingerprints. The TROPOMI instrument is a visible ophotometer by the Netherlands Space Office (NSO), the Royal Netherlands specter Meteorological institute (KNMI), the Netherlands institute for Space Research Organization (TNO) and ESA ogiestechnolworkare
similar to the SCIAMACHY sensor of Envisat’s by ESA agency and OMI on NASA’s Aura satellite (Levelt et al., 2006).

The main objective of the launch of the TROPOMI sensor is for tasks of making atmospheric measurements related to air quality, climate impact, zone, and ultraviolet radiation deceivers in ESA and TROPOMI bridges the gap in continuity of observations between its permissions (Broccardo et al., 2018; and 4-Sentinel & 5-upcoming Sentinel). The TROPOMI sensor consists of four spectrophotometers covering the UV-VIS-NIR-SWIR wavelength ranges with a spectral resolution ranging from 0.45 to 0.65 nm in the UV-VIS range. TROPOMI is located in a semi-polar sun-synchronous orbit at an altitude of 824 km with a tropical ascending node at 13:30 GMT. The portal telescope allows a wide field of view (FOV) of 108°, corresponding to a flat width of about 2,600 km, providing daily global coverage with a ground pixel size of about 3.5 km×7 km at perihelion (Zhao et al., 2020).

2. Method and Materials

2.1. Study area

The power plant in Khuoms is the main source of nitrogen oxides (NOx= NO+NO₂). When the wind blows, plumes can be observed near the shores of Khuoms, and on this basis, the Khuoms Power Plant (KPP) has been identified as a major problem in producing nitrogen dioxide (NO₂) pollutants. TROPOMI techniques were used in this study because of the observed urban damage from the nitrogen dioxide emissions of this station. The importance of the superior technologies of the TROPOMI sensor in the field of studying these pollutants, and a availability of MODIS hyper spectral images complementary to TROPOMI data at similar wavelength functions. Study area about (1,753 km²) as shown in Figure (1), this area cover the emission source.

The TROPOMI data pixels were used for statistical data to each single image. MODIS data were tabulated and the temporal variance reduction with the TROPOMI data for investigates from NO₂ emissions to both satellites. The data occurred in mostly cloud-free conditions and on days with good visibility (12% withdrawal percentage). During all study days there was recorded light emission between 0.3 and 0.7 mol/m² KPP, based on the average wind speed during the time of flight, the winds were usually blowing from the north and northwest, and there was a strong northwest wind. Wind data was collected from the Advanced High Resolution Radiometer (AVHRR) which is used to generate latitude wind field features in the visible spectrum window bands. All observations were made in the solar noon period. The favorable position of the sun during summer maximizes the light reflected off the sensor and reduces the signal smoothing that occurs at shallow sun elevation angles. On the other hand, the total NO₂ signal is generally lower during the summer due to the shorter lifetime of NO₂ (Lawrence et al., 2015).
2.2. Statistics

2.2.1. Regression method

Regression analysis is a statistical tool that investigates relationships between variables. Usually, the researchers seek to ascertain the causal effect of independent variables Y upon dependent variables \( x_i \) (Van Noije et al., 2006). When we use the model to forecast \( y \) for a particular set of values of \( x_i \), it need to measure how large the error of the forecast might be. All these elements, including dependent and independent variables and error, are part of a regression analysis, and the resulting forecast equation is often called a regression model (Van Geffen et al., 2021). Regression analysis is a basic technique in air pollution forecasting. Linear regression plays a strictly utilitarian role in the field of statistical methods. Its expression as given by Eqn. (1):

\[
Y = b_0 + b_1x + e
\]  

The TROPOMI emission data have compared with Moderate Resolution Imaging Spectroradiometer (MODIS) emission data and more specifically with regression line analysis. When comparing TROPOMI and MODIS emission the range value is much lower (-zero) for better comparison between both data emissions, and the similar values were found when comparing the data with same time. The emission is wavelength dependent and emission products at different wavelengths have been compared: MODIS at 550 nm, and TROPOMI emission at 480 nm. The observed overestimation of the NO\(_2\) seems to be consistent with comparison studies reported by Kleipool et al. (2018). According to Kleipool et al. (2018), this is partly related to viewing reflectance effects of the surface. The
TROPOMI and MODIS products are also not provided at the same wavelength, and time series analysis is used to determine the reflectance value.

2.2.2. Support vector regression
Support vector regression (SVR) is the implementation of support vectors in a regression function. SVR has the advantages of measuring the space of the measured and comparative dimensions and it depends on the optimization of the dimensions of the space of the input values (Hong et al., 2015). In the high-dimensional feature space, there is a linear function, which maps the input data to a two-dimensional space through a line graph. This linear function is known as the SVR equation [Eqn. (2)] (Shi, et al. 2008):

\[ f(x) = (w x) + b \]  

where:
\[ f(x) \] is denotes the pixel value as an area unit.
\[ w \] is the vertical values.
\[ x \] is the horizontal values.
\[ b \] is feature space.

2.2.3. Cloud fraction
A small cloud fraction indicates that there is more scattering in the atmosphere than computed based on the MODIS value. In the TROPOMI NO\textsubscript{2} emission, such small “cloud fractions” are used to implicitly compensate for aspects like too-small MODIS values (e.g. often the case over cities which have a higher reflectivity than the surroundings) or the presence of scattering aerosols, haze, or residual clouds. Ideally, the cloud pressure will indicate the altitude at which the scattering takes place (Mebust et al., 2016).

3. Results & Discussion

3.1. Spatial and Temporal distributions of NO\textsubscript{2} emission
MODIS and TROPOMI data to NO\textsubscript{2} emissions are provided in Figure (2). A minimum emission was 0.01 mg of NO\textsubscript{2} per month in order to discriminate and visualize the main emitters. NO\textsubscript{2} emissions are overlain as color-coded polygons, defined by the pixel corner coordinates provided in the Level2 product. However, elevated levels of NO\textsubscript{2} in the MODIS observations can be spatially resolved by TROPOMI and are averaged out within the TROPOMI pixel. The spatial resolution of the MODIS data allows revealing the scale NO\textsubscript{2} horizontal variability. The maps reveal that the NO\textsubscript{2} field is highly variable in both space and time. The NO\textsubscript{2} data by MODIS range were between 0.032 and 3.7\times10^{-15} molec./cm\textsuperscript{2} in study area. In KPP, NO\textsubscript{2} emissions are mainly related to industrial activities. Fine-scale plume from the KPP can be observed, the observed plume, narrow and confined close to the source; it is transported downwind for several tens of kilometers, as can also be observed in the TROPOMI data. The monthly average concentrations of NO\textsubscript{2} over the study area are shown in Figure (2).
Figure 2. Showing left column represents TROPOMI observations, while right column indicate to MODIS images to NO$_2$ emissions monthly over study area on 2020. Note that different color bands, blue and red colors were represent high NO$_2$ concentrations. While NO$_2$ emission plume indicate to the surface wind direction.
The average monthly concentrations of NO$_2$ showed periodic changes throughout the year. In the months of July and August (that is, summer); NO$_2$ reached a minimum value of $2.15 \times 10^{15}$ molec/cm$^2$, the values were in December and January (i.e., winter); NO$_2$ has a maximum value of $5.18$ molecules/cm$^2$, in February the tropospheric column NO$_2$ concentration was fairly stable and showed some low fluctuations in the last months of the year 2020.

TROPOMI observes a slightly lower NO$_2$ concentrations in June were $0.00 \pm 2.85 \times 10^{-15}$ molec./cm$^2$ and in January were $0.07 \pm 4.32 \times 10^{-15}$ molec./cm$^2$. The TROPOMI Level 2 tropospheric NO$_2$ product has been assessed based on independent high-resolution data, acquired over the target area. The accuracy of the tropospheric NO$_2$ emission recorded around $0.5 \times 10^{15}$ molec./cm$^{-2}$. The effect of clouds was not considered in this study, as data acquisition took place in mostly clear-sky conditions.

The study area is characterized by many differences in land use, urbanization, agriculture, and industrialization. This means a difference in the brightness of the satellite image according to the size of the captured pixel, and thus these regions receive strong spatial contrast from the satellite data recordings of NO$_2$ emissions, especially beaches and steep spatial gradients. Where satellites capture their data using several wavelengths that vary in frequency depending on the type of target if is agricultural, industrial or residential. Thus, the measurement of pollution rate varies with the nature of that target. Although it’s often has the same value when emitted into the atmosphere.

In this study, there was more pixel disturbance in the TROPOMI data due to the difference in the transverse path of the moon to capture the daily data, as a result of the intensity of the spectral reflection back on the satellite in the afternoon periods. This is illustrated in Figure (2) in violet from the source of nitrogen dioxide emissions. MODIS data show much more spatial detail when compared to TROPOMI data, as MODIS measures NO$_2$ peak values that are $3 \times 10^{15}$ particles/cm$^2$ higher than TROPOMI monitors.

Nitrogen dioxide concentrations were categorized in different seasons from highest to lowest as follows: In winter, downward airflow prevails over cold weather. Thus, pollutants are not easily dispersed, which is one of the important factors in reducing air pollutants during winter (Guo et al., 2016). Moreover, the steam station area is located on a site that receives a great deal of rainfall in winter, and light rains occur in autumn. The annual distribution of precipitation is uneven, that is, from June to October, 90~95% rain drops, which plays a large role in reducing the amount of pollution. According to the research results, precipitation has little ability to remove air pollutants when the daily precipitation is less than 5 mm. However, when the daily precipitation exceeds 5 mm; the pollutant removal efficiency increases with increasing precipitation. The higher daily precipitation, the higher filtering rate and the better air quality. In addition, the maximum removal rate of air pollutants can reach 48.55% (Xiao et al., 2011). Precipitation affects the concentration of pollutants in the spring, summer, and fall, although air pollution is also influenced by industrial and human factors (Cai, 2017).
3.2. Linear regression analyses

Regression line statistics are color coded blue for the comparison data. Note that vertical error bars indicate the overall errors in NO$_2$ (TROPOMI), while the horizontal whiskers represent the errors in NO$_2$ (MODIS). Data points are color coded based on the number of pixels, this is mean, TROPOMI pixels are more than 57% pixels in all data. While in MODIS pixels were reference to 43% pixels, and all pixels are analyzed. Overall, positive relationship can be observed for both data ($R^2=0.87$). For the NO$_2$ computation, the remaining disagreement between the both data sets can be potentially attributed to the following:

- There is disagreement due to different sensitivities to the NO$_2$ layer due to instrumental and algorithmic differences.
- There is disagreement due to differences in observation geometry and height.

In the event that there are temporal or spatial changes in the NO$_2$ field in the upper troposphere between the reference area and observed area, this should be implicitly measured. As the amount of NO$_2$ in the upper troposphere appears to be small compared to the total column over polluted sites, and as the MODIS retrievals still have some sensitivity to any impact on the comparisons to be minimal. There is disagreement due to temporal differences in the observation of a dynamic NO$_2$ field. MODIS data were acquired over the target areas, this is mean of the potential impact of temporal NO$_2$ variability due to the time offset between the MODIS and TROPOMI data. Relatively low and high biases occur at both small and large time offsets, which are pointing at a low impact of the temporal NO$_2$ variability under the current conditions. Due to the changes in the wind pattern, both data pixel footprints have different sizes. For example, on 13 February, 15 March, 09 April, 27 May, 26 September, 03 October, 02, 05, 09 and 22 November, additional to all December 2020, there was pollution not seen by MODIS satellite over the study area because of different pixels size recorded to both data. This is meant different values from NO$_2$ concentration depend on pixel size. Scatter plots and linear regression analyses of TROPOMI and MODIS NO$_2$ data showed in Figure (3).

![Figure 3](image3.png)

**Figure 3.** Scatter plots and linear regression analyses of average TROPOMI and MODIS data.
3.3. Support vector regression (SVR)

The spatial resolution (Figure 4) had a great role in detecting the pixel sizes associated with the emissions of nitrogen dioxide. Each of the pixels characterizes a certain concentration of nitrogen dioxide molecules. When recording MODIS observations, it was found that the pixels ranged from 0.0136 to 2.853 millimeters, while the pixel of the TROPOMI monitor recorded 0.08 to 3.062 millimeters. The accuracy of the degree of whiteness resulting from the intensity of spectral reflection or clouds recorded the pixel from -1.003 to 0.005. Accuracy evaluation of these resulting pixels shows the extent of compatibility between both data in the pixel accuracy of the images of those different satellites in the size of the pixels differing in their correlation, the degree of brightness and time of shooting the image.

![Figure 4. SVR to both data of pixel areas](image)

3.4. Impact of pixel size

Emission measurement depends on the pixel size of satellite images, as we said earlier. This is done based on high-resolution MODIS observations and under active measurement of emitted NO\textsubscript{2} according to a medium technology within 1 km×1 km grid cells. The NO\textsubscript{2} rates are shown as in Figure (3) for the data set obtained from the study area. Scattered rates that are high in pixel pitch can be distinguished due to turbulence in the direction of the wind, when in reality it is easy to determine the direction of that wind. Note that the highest concentration of NO\textsubscript{2} levels is due to the strong effect of these pixels. In Figure (4), the pixel grid of the MODIS sensor, which was then monitored over the study area, indicates that nitrogen dioxide emissions were high when the sky was free of clouds, the brightness of the pixels is very high. This explains the intensity of the temporal relationship between the satellites measurements at the same time of each month of the study year. The lines between the dots indicate twice the brightness and therefore twice the recorded data. The wavelengths of NO\textsubscript{2} emissions allow us to further detect the concentration level of pollution by evaluating the highest values of emissions generated by the pixel resolution of satellite images, as shown in Figure (2), where the red band of pixels indicate the highest values of NO\textsubscript{2} emissions, while the blue band of
pixels indicate the highest values of NO₂ emissions to low rates from nitrogen dioxide emissions. When increasing the pixel size, the NO₂ observations are low, while in case the pixel size decreasing NO₂ values are high. in this study showed that resolution of 1 km×1 km is a near-optimal resolution.

4. Conclusion

In order to prove that MODIS and TROPOMI data quality; this is one of the studies assessing NO₂ emissions over Khuoms city that resulting from gas power plant, impact pollution recorded in urban areas, based on the comparison between two satellites have high spatial accuracy. The NO₂ emissions that observed from MODIS, acquired on four seasons with clear-sky (2020), have been compared with TROPOMI observations. TROPOMI pixel has been covered by 230 to 1380 MODIS pixels. In this study the TROPOMI data were more accuracy from MODIS data, because of the difference in pixel size, and temporal resolution because of the amount of heterogeneity in the NO₂ field. Averaged over the four campaign seasons over study area, the average of the both data were estimated to be 3.6 ± 0.4 × 10¹⁵ molec./cm². The regression analysis was positive relationship (R² = 0.87). For quality studies at the city scale still require observations at higher spatial resolution by field studies or aircraft scanning, in order to assessment the typical heterogeneous NO₂ field. Results from the comparison with both data, have shown that the products meet the mission requirements in terms of accuracy. However, additional validation studies are required. Statistical models have a wide application and require less time to build models, but they require a large amount of historical data and have a high dependence on the long data time series approach. Statistic proved the satellite data and that forecast performance is better when considering the meteorological variables and the geographic factors. As the atmospheric environment is a complex system, there are many factors affecting the quality of the atmospheric environment, and the relationship between them is complicated. Therefore, air pollution forecasting based on the area and different pollutants should choose different forecasting methods. Moreover, there is no one best approach to make the most accurate forecast.

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