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# Revealing Environmental COVID-19 Impacts for the Upper Adriatic TEN-T Trieste-Koper Corridor at 2020

Salvatore Polverino

*Department Training and Internationalization, Ordine degli Architetti, Pianificatori, Paesaggisti e Conservatori della Provincia di Napoli, Napoli 80142, Italy*

**Abstract:** To a greater or lesser extent, all the nations have worldwide faced off the Covid-19 outbreak' impacts. The National American Space Agency, in conjuction with its European counterpart (ESA), have offered a new set of options, starting from the First Atmospheric Mission Sentinel-5P and upcoming Sentinel-4 and Sentinel-5 satellites , which are capable to offer a near-real-time economic indicator, depending on the decrease in traffic and industrial activity. This case-study delivers a basic nitrogen dioxide ($NO_2$) based observation, in order to quantify and detect the unexampled man-made decreases of the Upper Adriatic corridor. The study also extends the evidence base for the uncertainty surrounding variables which are currently under fronteer-research (Mark Parrington, OBSERVER: Measuring Nox levels as an indicator of economic activty).

**Key words:** Sustainable development; Port-city, GIS, TEN-T, Trieste, Koper, Covid-19, Resielence, NASA, Copernicus.

## 1. Introduction

The Sentinel-5P is a multi-purpose spaceborne program operating in conjunction with ESA's Copernicus project. TROPOspheric Monitoring Instrument (TROPOMI) [1] is the payload of the S5P mission, by which scientists are discovering new strategies of implementation of its tropospheric results in the matter of quantitative labelled values of: pollutants, greenhouse gases, aerosol and diverse disturbances.

The products are separately offered by data and discerning specific metadata as NetCDF (network Common Data Form) files in the numeric form of several variables.

Each of these multidimensional scientific data is daily questioned in meteorology and related fields [2, 3, 4] in order to forecasting weather and assess advanced applications in the Geographic Information Systems (GIS) domain. Among these, the nitrogen dioxide related variables are the most versatile and herewith processed for the following analysis.

The results are interpreted as a result of GIS integrated infrastructural data which are compared to the measured levels with regard to documented remote sensing drawback, following trial and errors executions within Python Virtual Environments and its Packages.

## 2. Method and Materials

### *2.1 Spectral Domain*

A possibility of assessing fine particulate concentration, has been for years the Moderate Resolution Imaging Spectroradiometer [5, 6]

(MODIS). However, due to its limited definition approach, several low to high resolution have emerged.

Among these, the TROPOMI on-board spectrometry detects within 500-700 nanometers, by sampling a light energy sample emitted from the sun to a sample of light reflected through Earth atmosphere. The obtained light difference operating at wavelengths of 500 – 700 nanometers, displays the concentration of ozone in the atmosphere.

The resulted datasets are compiled in the informatic field of multispectral imaging as its previous OMI

**Corresponding author:** Salvatore Polverino, M.Eng., research fields: GIS Science and UAV Systems.

version. The TROPOMI version, in particular, unlike other spaceborne solutions [7,…,12], operates in multiple different spectrums: ultraviolet and visible (260-500 nm), near-infrared (675-775 nm), and short-wave infrared spectrums (2305-2385 nm).

This enhanced radiometric sensitivity has benefitted from its Ozone Monitoring Instrument (OMI) predecessor, as witnessed by a more defined pixel size, data from before on 6 August 2019, 7 km x 3 km rather than 24 km x 13 km without excluding any coverage (Veefkind, 2012).

In a timely short amount of years, the current bibliography still lacks of environmental error sources in the "retrieval" of trace gas, cloud and aerosol information [4] in the mid- and upper- tropospheric space. The resulting surface reflectance and anisotropic effects undermine the effectiveness of "boundary" layer trace gases and aerosols.

The retrieval procedure is furthermore addressed to three operations: slant column density (SCD) retrieval, separation of the SCD in two classes, stratospheric and tropospheric components, and conversion of these two into vertical column densities [1].

## *2.2 TROPOMI Wavelength Calibration*

The wavelength calibration, priorly to reflectance, is addressed to the sum of : nominal wavelength ($\lambda_{nom}$), wavelength shift ($w_s$) and wavelength stretch ($w_q<0$) or squeeze ($w_q>0$). These two non-linear parameters, are very important considering the necessity of assembling the initial wavelength grid (2) where λ(j) stands for the wavelength point center of detector pixel j.

$$\lambda_{cal} = \lambda_{cal} + w_s + w_q\ (\lambda_{nom} - \lambda_0), \quad (1)$$

$$\lambda(j) = a_1 + a_{2j} + a_{3j}^2 + a_{4j}^3 + a_{5j}^4, \quad (2)$$

The high-resolution reference spectrum by which this wavelength calibration performs is the solar spectrum (405-465 nm)

Figure 2 visualizes the wavelength mutations $w_s$ for the first considered pre-covid sars dataset resulted from an orbit on 12 December 2019 (red) and the last NetCDF from 17 May 2020 (blue). The gap of this temporal change observes a minimal oscillation of approximately 0.0015 and 0.0020 nanometers which also repeat itself with the Figure 3.

Beyond this stage, The calibration method has proved to be insufficiently accurate for the retrieval of ozone profiles, which still lacks of an accuracy in the wavelength calibration. Nonetheless, due to several unpredictable factors, e.g. clouds coverage and pressure, specific test-case applications have demonstrated that the quality of level-2 products is eligible of improvement.

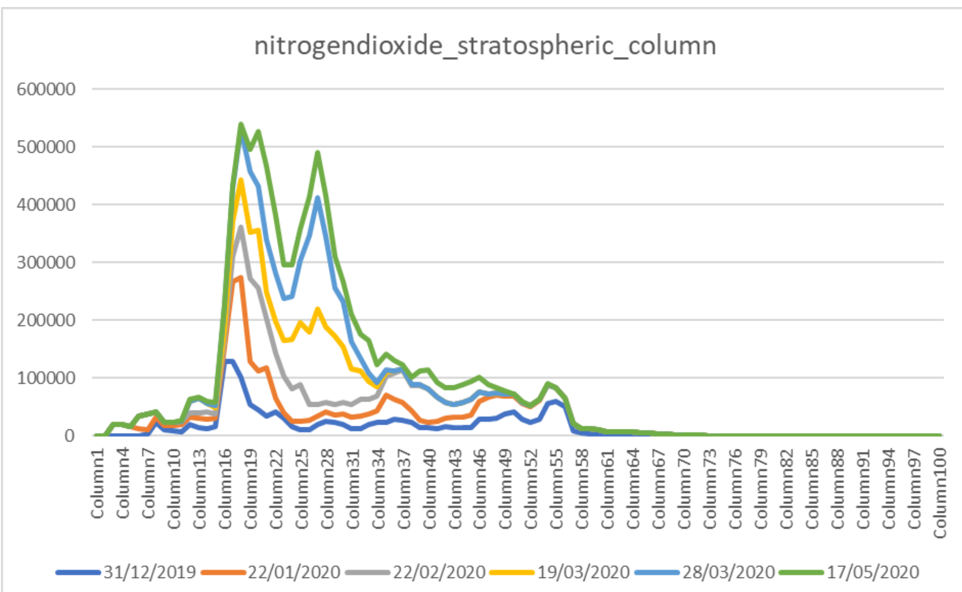


**Fig. 1 NO2 comparison from the considered stack.**

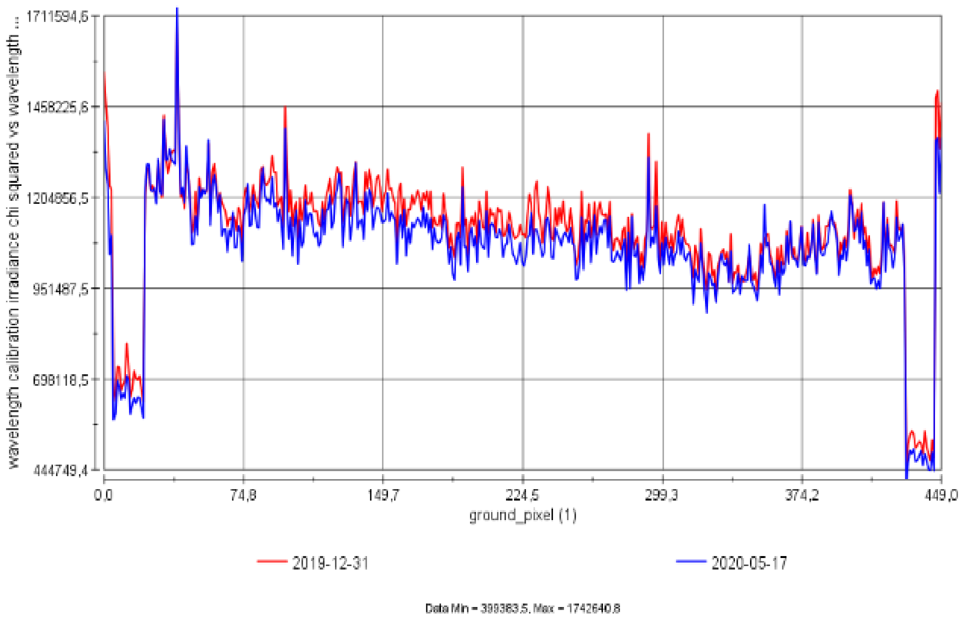


**Fig. 2 Wavelength calibration irradiance chi squared.**

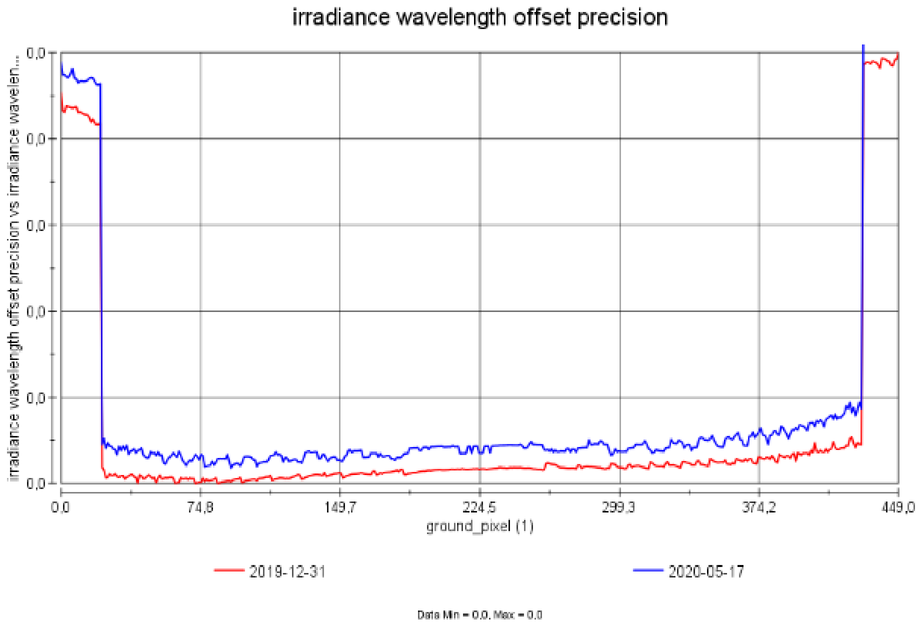


**Fig. 3 Irradiance wavelength offset precision.**

Identifying the clouds free regions is a mandatory step of this check-list, so that in order to ensure a clear sky condition, it's possible to compare the different layers.

*2.3 Impact of NO2 Above the Upper Adriatic Region*

The operative stage occurs during the $NO_2$ slant column retrieval and its processor $R_{mod}(\lambda)$ (1):

$$R_{mod}(\lambda) = P(\lambda) \cdot exp\left[-\sum_{k=1}^{n_k} \sigma_k(\lambda) \cdot N_{s,k}\right] \cdot \left(1 + C_{ring}\frac{I_{ring}(\lambda)}{E_0(\lambda)}\right)$$

The formula also includes ozone, water vapour, liquid water and the $O_2$- $O_2$ collision. The considered level-2 $NO_2$ multidimensional data retrieve on the version 0.04.00 which benefits of minor improvements such as handling for cloud pressure data and saturation effects on 2 December 2020.

Due to the limited spatial ampleness, the workflow has seen the implementation of opensource shapefiles, indicating the railways systems and administrative boundaries in order to strengthen its small-scale resolution.

For the spatiotemporal distribution, I selected the central orbit over Europe, which permits to have at disposal a conspicuous evaluation of this geographic area. Starting from the first three interrogations, an important air pollutant mass has constantly interested the Po Valley, across a wider range in the $NO_2$ columns.

Figure at 31 December 2019 suggests this urban footprint as result of traffic routes from the Tarvisio and Karavanke tunnels [13] and industrial clusters of Monteli and Saletti labelled in the sampling boxes.

The observations continued in the first trimester with a spread lowering of emissions because of the cessation of human activities [14] which are weakly persistent inside the urban core.

Negative factors are shown in the last two interrogations and are caused by important clouds coverage. The red blocks are easily distinguishable from the very moderate $NO_2$ concentrations.

Whereas allocated the two ports of Trieste (d) and Koper (e), high detectable $NO_2$ enhancements are correlated with their industrial proximity (a), (b), (c) [15].

Evolution of air quality over the upper Adriatic region during 2019-12-31 and 2020-05-17. Intercomparison and validation of different measurements which resent of confidently clear-sky conditions.

## 3. Discussions and Limits of the Investigation

The case-study has shown the disruption of imbalance in global trade on behalf of a scientific modern sensing solution. In this shipping crisis, the TROPOMI/S5 has demonstrated to be an important but questionable instrument within the remote sensing field [16].

According to a well documented bibliography, from the Algorithm Theoretical Basis Document, there are discerning chapters of physics that are also usable to other similar platforms. The limited of 7 years design lifetime, imposes another problem, regarding the redaction of precise machine learning forecasting within a limited temporal arc.

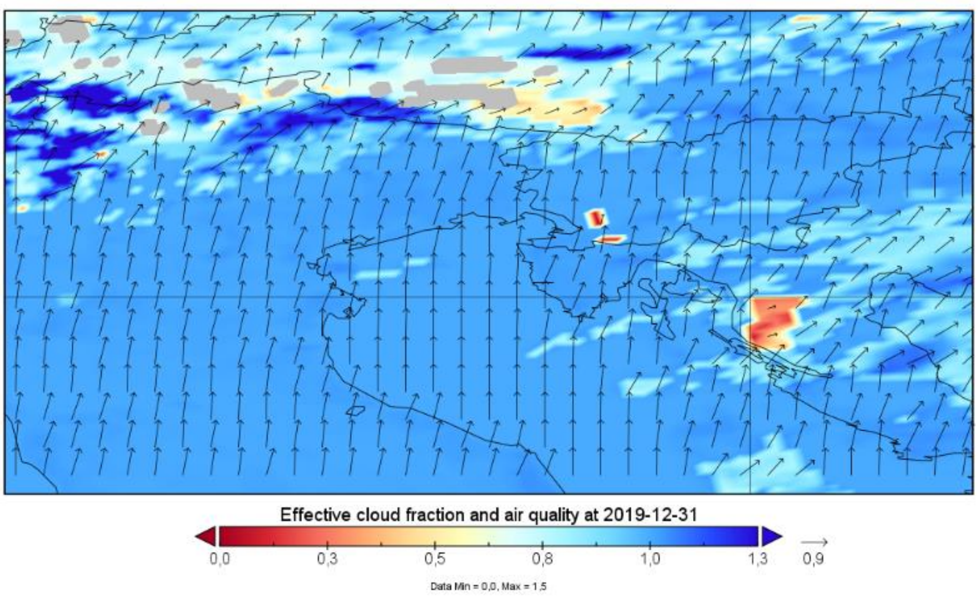


**Fig. 4 Comparison between the Effective cloud fraction from the cloud product and air quality. Except the Alps and parts of the Adriatic context, few were the cloud formations.**

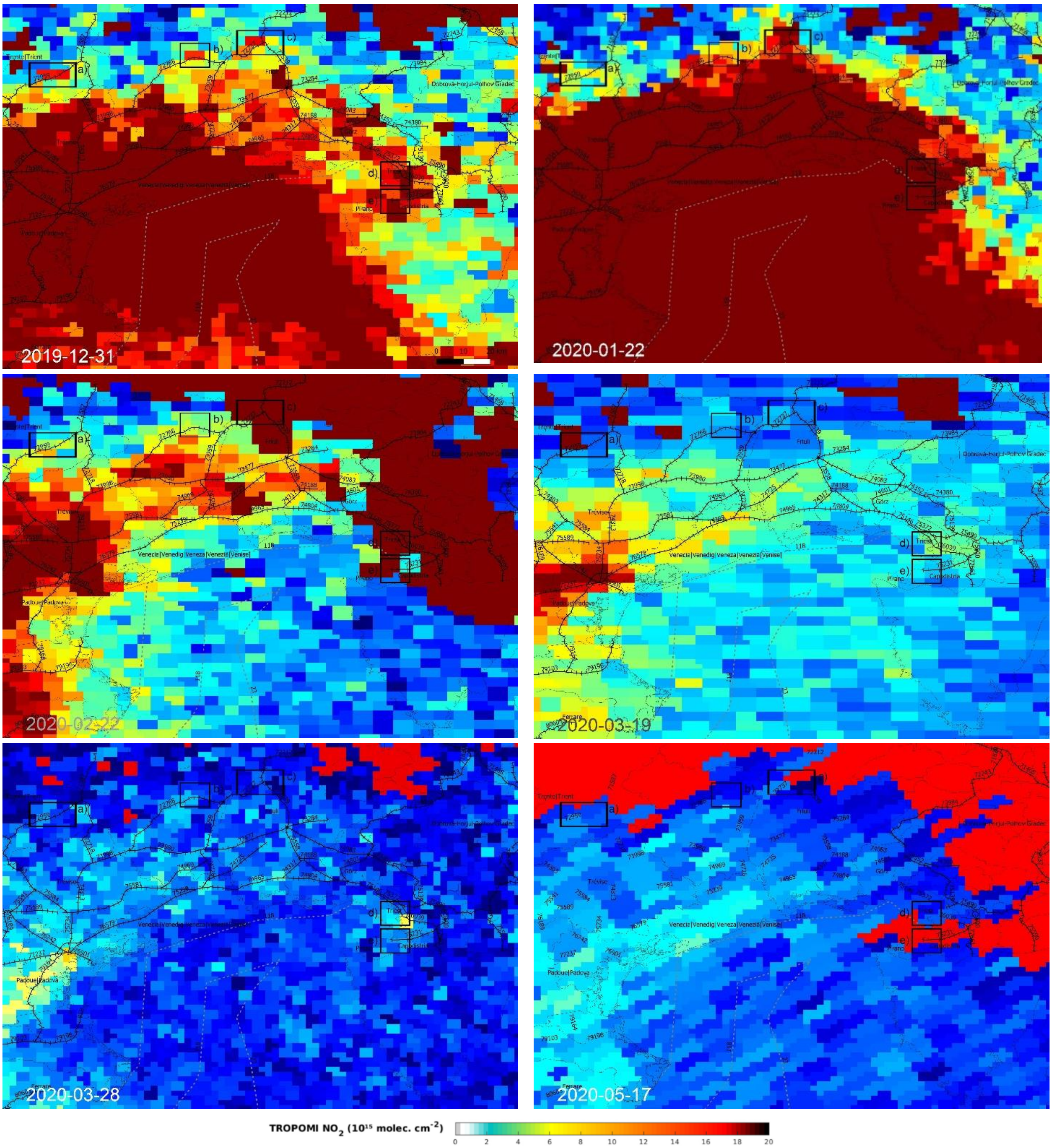


**Fig. 2** ***TROPOMI observations over the study domain.*** **TROPOMI NO2 columns over the upper Adriatic region, before (2019-12-31), during the outbreak (2020-01-22 and 02-22) and the lockdown period (03-19, 03-28, 05-17). Evident shutdowns are eported as follows : a) Belluno' gateway – b) Industrial complex Monteli– c) Industriale complex Saletti – d) Port Authority of Trieste – e) Port Authority of Koper.**

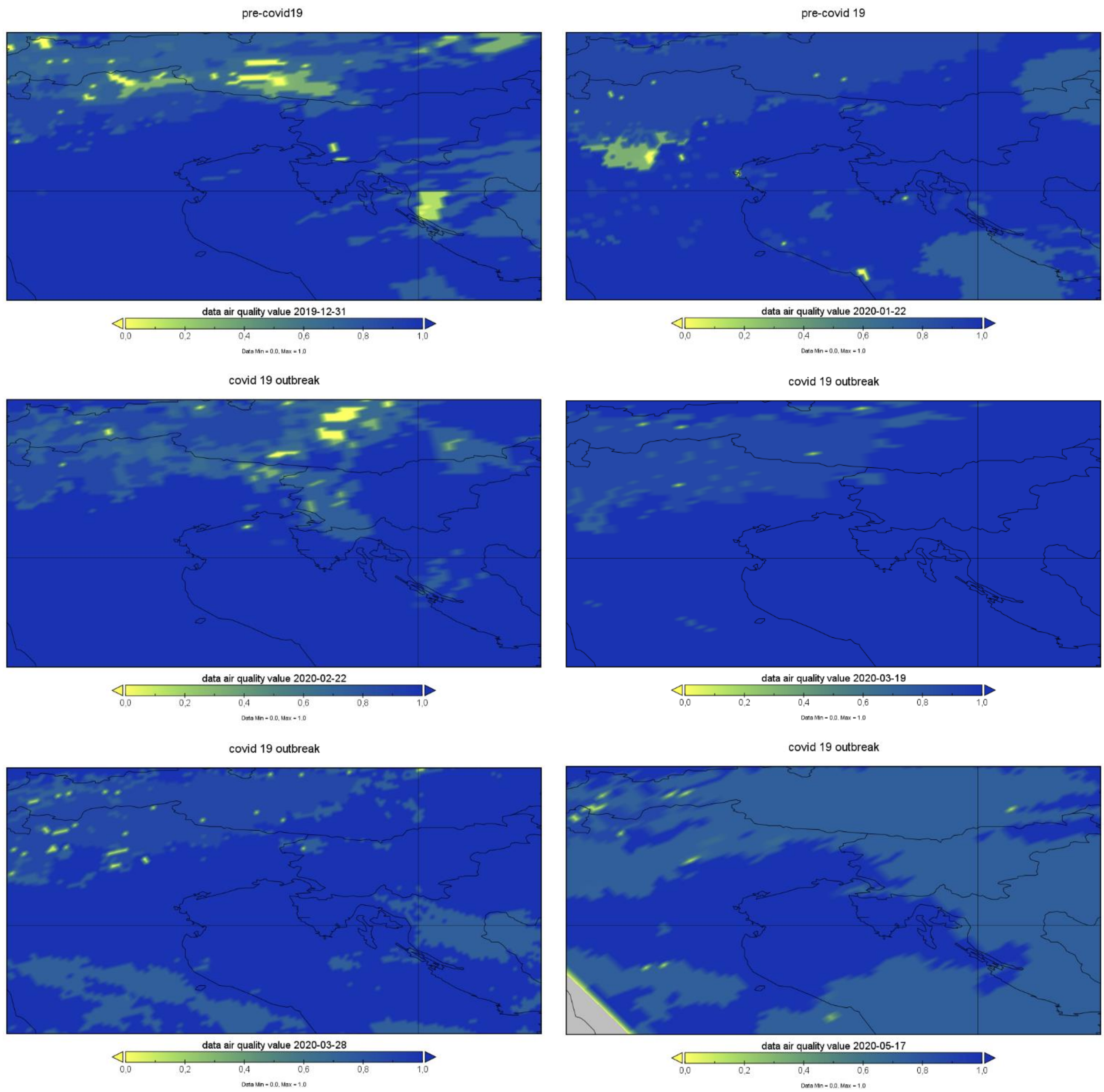


**Fig. 3 TROPOMI observations over the study domain.**

## 4. Conclusions

The Baltic-Adriatic Core Network Corridor has played a dominant position across the upper Adriatic region and continental eastern countries since the 2015. Consequently, in strengthening an East-West axis, a modern North Sea-Baltic Core Network Corridor was validated between 2018-2022.

Nonetheless the Belt and Road Initiative has been interested by recent global events, such as the Ever given case, which also fail to guarantee tangible financial advantages for economies like Poland, as core hub, whose potential role of the Silk Road Economic Belt is moreover aligned with the New Eurasian Land Bridge [17].

Its opportunity was well demonstrable across all the 2020 and it is capable of supporting bottom-up (RBU) emissions from the national inventory report demographical analysis, in situ values, i.e. cause-specific mortality, and open-source methods. Among these the estimation of economic impacts (Sannigrahi et al., 2021) have demonstrated to be calculated through different valuation methodologies, as reported by this recent article : carbon tax, the social cost of carbon, shadow price method, marginal cost method.

These extents aims to disentangles the hypothetical issues to ensure civil security

The joint-venture between the National Aerospace Space Agency (NASA) and the Suomi-National Polar-Orbiting Operational Environmental Satellite System Preparatory Project (Suomi-NPP) has finally demonstrated a new Mission Constellation Concept (ESA, 2019) by operating sun-synchronous orbits at 824 km altitude,16 day repeat cycle, in order to back-up mutual VIIRS/TROPOMI in critical mission safety.

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