CLIMATE AND ATMOSPHERE RESEARCH & INNOVATION IN THE EASTERN MEDITERRANEAN & MIDDLE EAST

October 11-12, 2021

[1]

Quantifying nitrogen oxides emissions in Egypt using satellite observations

Anthony Rey-Pommier

F. Chevallier[1], P. Ciais[1], T. Christoudias[2], J. Kushta[2], J. Sciare[2] and G. Broquet[1]

[2]

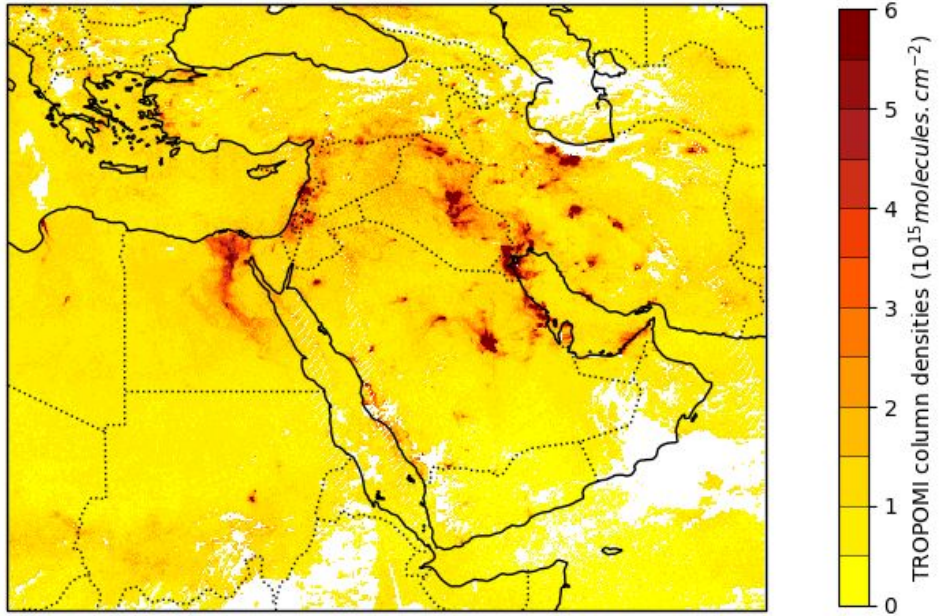
THE CYPRUS INSTITUTE

EMME-CARE
EASTERN MEDITERRANEAN MIDDLE EAST – CLIMATE & ATMOSPHERE RESEARCH CENTRE

2021 CLIMATE CHANGE in the Mediterranean and Middle East 2nd INTERNATIONAL CONFERENCE

Nitrogen oxides (NO_x=NO+NO_2) in the EMME region

02/07/2020



Rationales for the quantification of nitrogen oxides emissions:

- Interacts with different chemicals in the atmosphere
- Participate to air and soil pollution
- Produced by the burning of fossil fuels

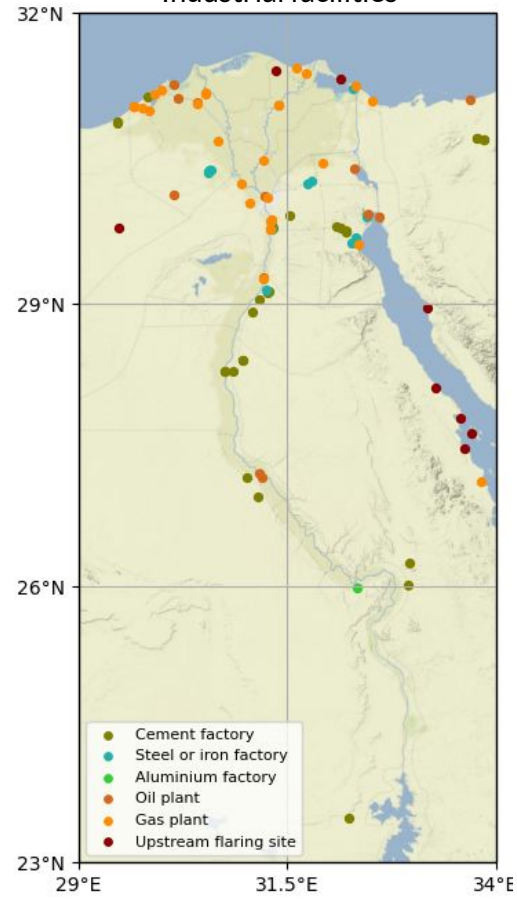
Sentinel 5P / TROPOMI

TROPOMI (TROPOspheric Atmosphere Monitoring Instrument)

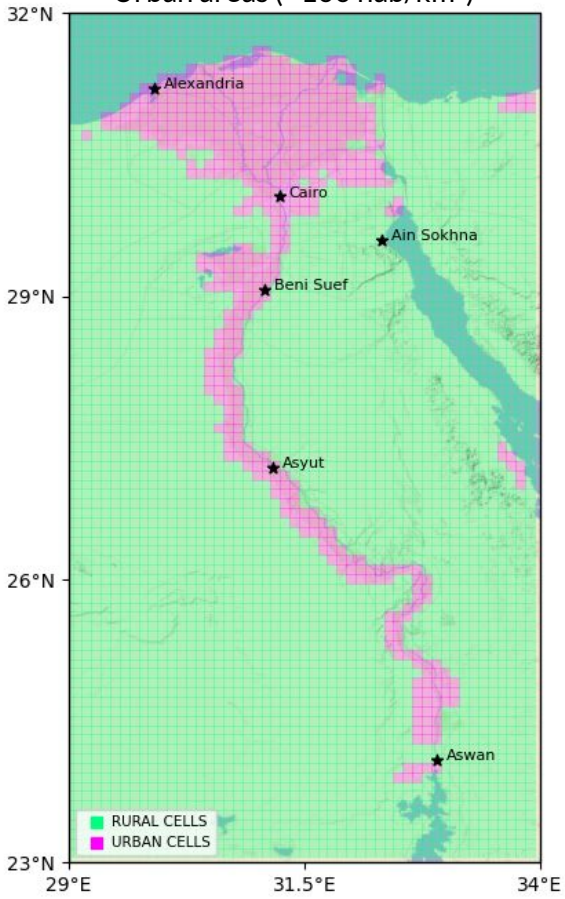
- Launched in 2017 onboard Sentinel 5-Precursor
- Measurement of NO_2, CH_4, CH_2O, SO_2, CO, O_3, etc.
- Spatial resolution: 3.5×5.5 km^2 (nadir) over a 2600 km swath
- Temporal resolution: 1 day, 13:30 local time

Main sources of nitrogen oxides in Egypt

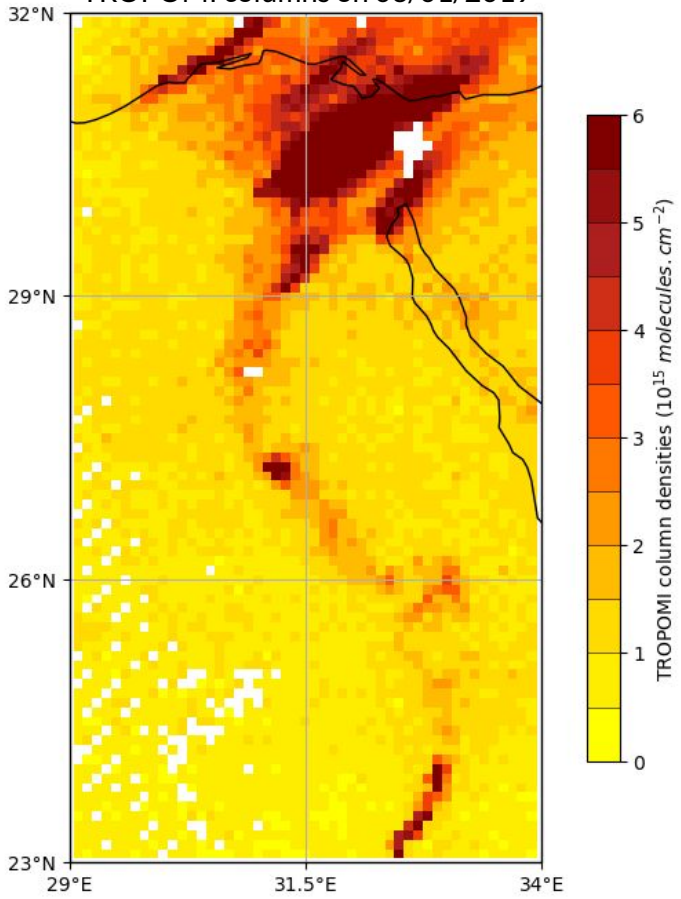
Industrial facilities



Urban areas (>100 hab/km^2)



TROPOMI columns on 03/01/2019



Additional data for inferring NO_x emissions from NO_2 concentrations

$$e_{\mathrm{NO}_x} = L(\mathrm{div}(X_{\mathrm{NO}_2}\mathbf{w}) + K(T)\cdot[\mathrm{OH}]\cdot X_{\mathrm{NO}_2})$$

Process	Quantity	Data	Resolution
Transport of pollutants with the wind	Horizontal wind	ERA5	3 hr, 0.25°×0.25°
Reaction between NO_2 and OH	Temperature	CAMS near-real-time	3 hr, 0.4°×0.4°
	OH concentration	CAMS near-real-time	3 hr, 0.4°×0.4°
Transformations between NO_2 and NO	NO_x/NO_2 factor	CAMS near-real-time	3 hr, 0.4°×0.4°

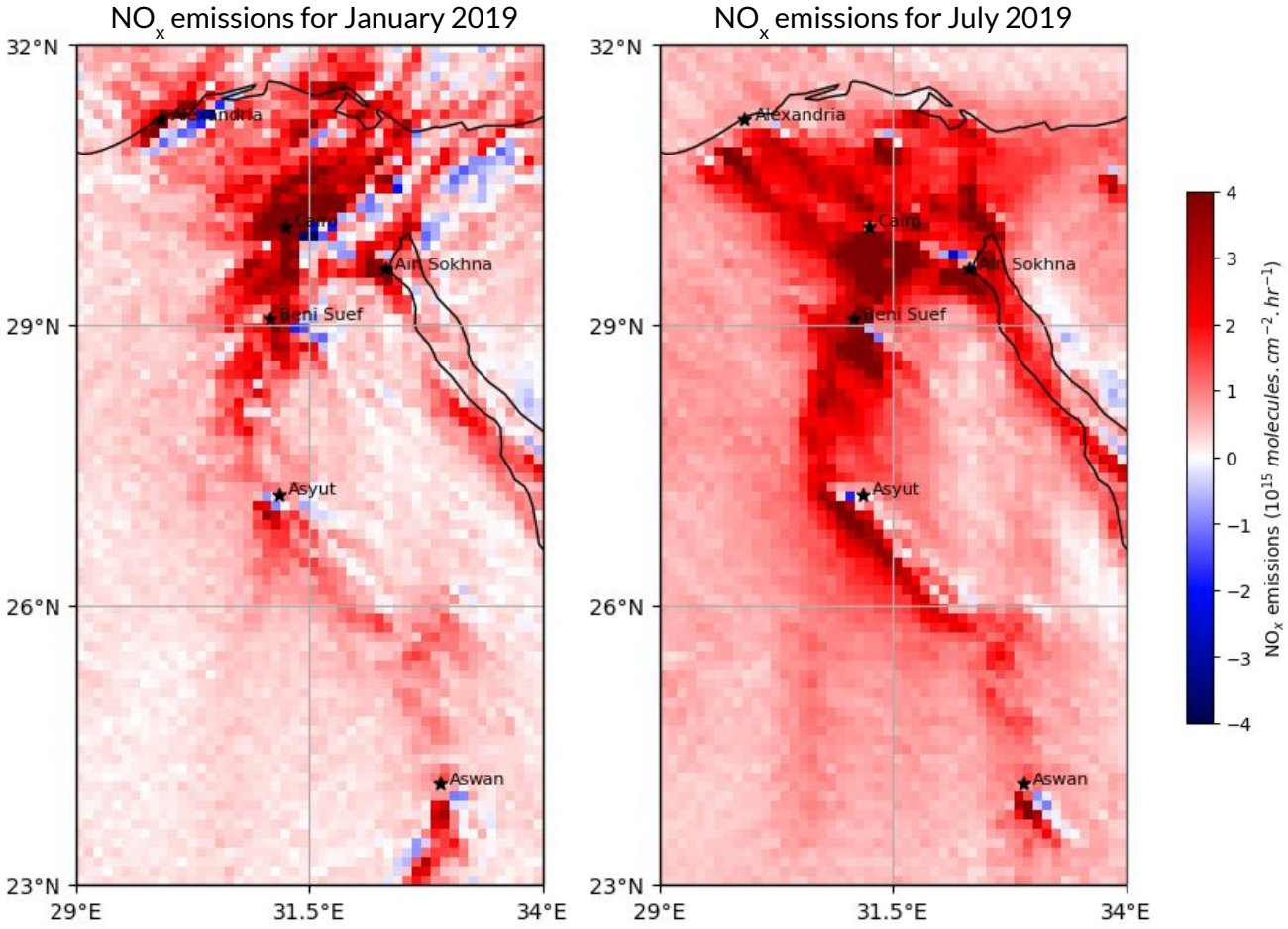
Distribution of NO_x emissions

Observations :

- Emissions located in large cities and industrial areas
- Higher emissions during summer

Remarks :

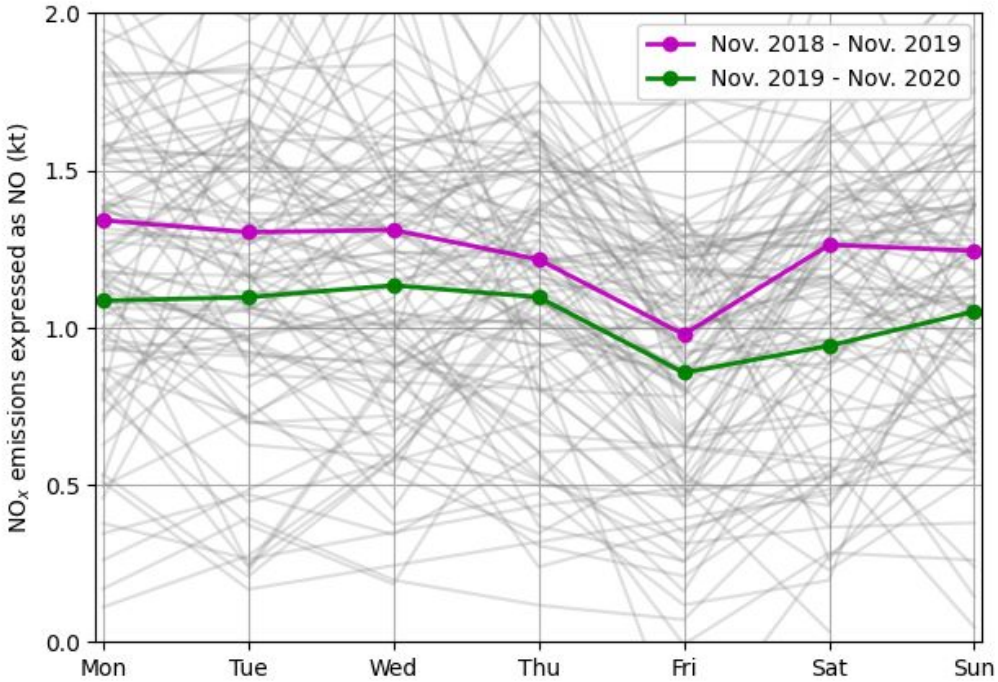
- Top-down model very sensitive to OH concentration and wind module/direction
- Neglect of vertical processes



Weekly cycle

- Monday-Thursday : working days
- Friday : official resting day
- Saturday-Sunday : partial rest

Day	Ratio
Monday	1.066/7
Tuesday	1.055/7
Wednesday	1.076/7
Thursday	1.020/7
Friday	0.808/7
Saturday	0.965/7
Sunday	1.010/7



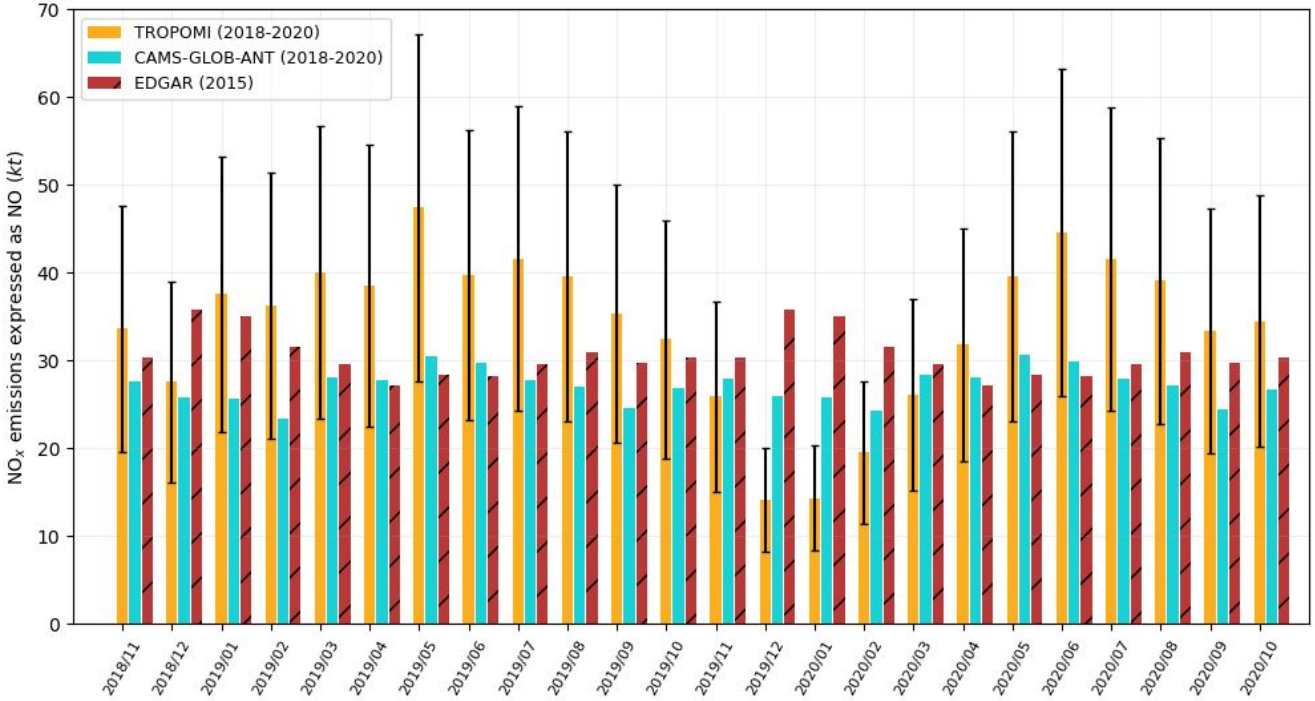
Annual cycle

Seasonal cycle analysis :

- Different dynamics than in the inventories
  - High cycle amplitude
  - Abnormally low values for winter 2019/2020

Interpretation:

- Consistent with the electricity consumption in the country
- Potentially inconsistent with road transport and industrial activity



Has COVID-19 impacted emission levels in the country ?

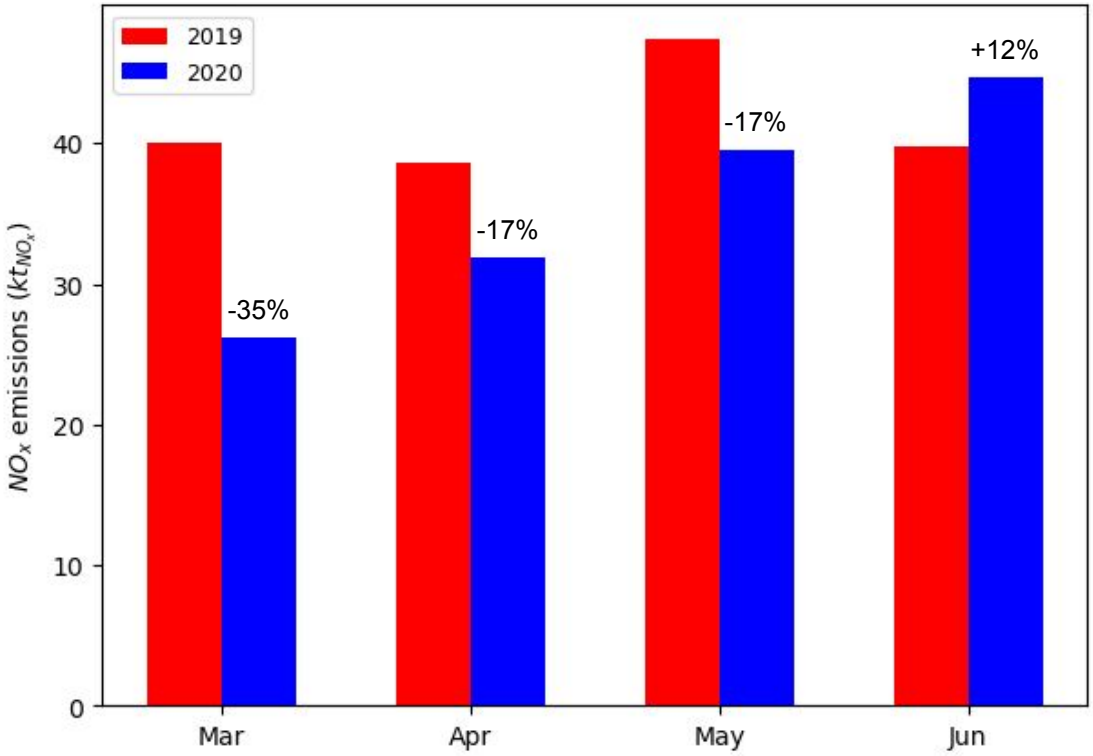
Partial lockdown from March 15th

- Closing of public areas
- Suspension of religious activities in mosques and churches
- Full lockdown for Easter and Eid

→ drop of the activity

- Lift of some restrictions from June 1st

→ catch-up of the activity



What about other countries ?

Example of Qatar:
Electricity entirely provided by gas power plants
→ Main source of energy consumption of the country