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Evaluation of NO_2, O_3, PM_{10}, and $PM_{2.5}$ in the city of Buenos Aires, Argentina using WRF-Chem model

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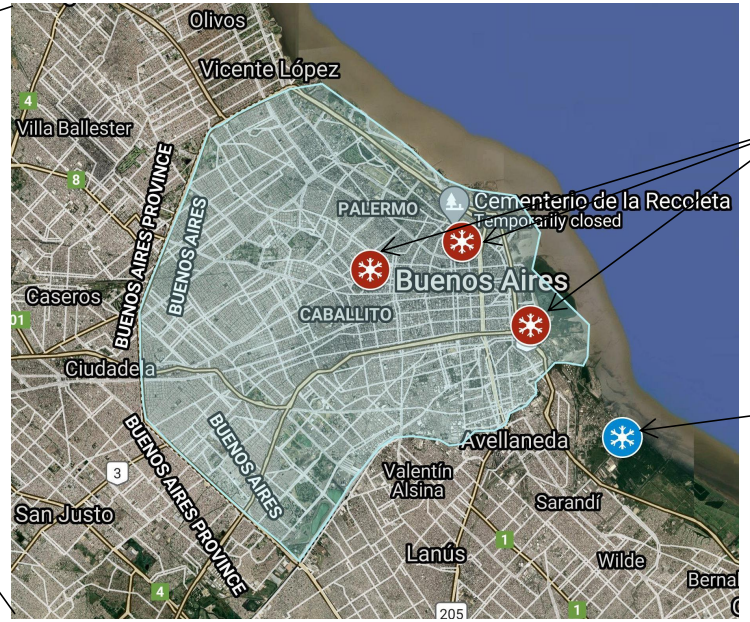
Main Goal

Evaluate the WRF-Chem model sensitivity to different anthropogenic emission inventories, implementing the GEAA high-resolution inventory for Argentina (GEAA-AHRI) compared to the EDGAR-HTAP global inventory. Model performance is assessed by comparison with in-situ and satellite observations.

Highlights

- Global Low-resolution and local High-resolution inventory for Argentina are compared.
- First high-resolution WRF-Chem air quality modeling study over Buenos Aires.
- Use of anthropogenic emissions with hourly temporal profiles might improve agreement with observations.
- Importance of development of high-resolution input (e.g. emissions inventories, land use map) for regional air quality simulation on WRF-Chem.



Air quality monitoring stations

- Autonomous City of Buenos Aires monitoring network (CBA):
  st. Cordoba,
  st. Centenario
  st. La boca
- Acumar monitoring network:
  st.EMC-I

Methodology

- WRF-Chem model V4 (Grell et al., 2005) is used to perform three simulations with different anthropogenic emissions:

Simulation Id	Description
EDGARnp	EDGAR-HTAP (~10x10km) database for anthropogenic emissions.
GEAAnp	GEAA-AHRI (2.5x2.5km) database for anthropogenic emissions inside Argentina and EDGAR-HTAP outside.
GEAAprf	Hourly emission profile applied to GEAA-AHRI.

- Comparison against surface observations in the Autonomous City of Buenos Aires (CABA).

- Comparison of NO_2 tropospheric column against satellite- product (Sentinel-5P - TROPOMI).

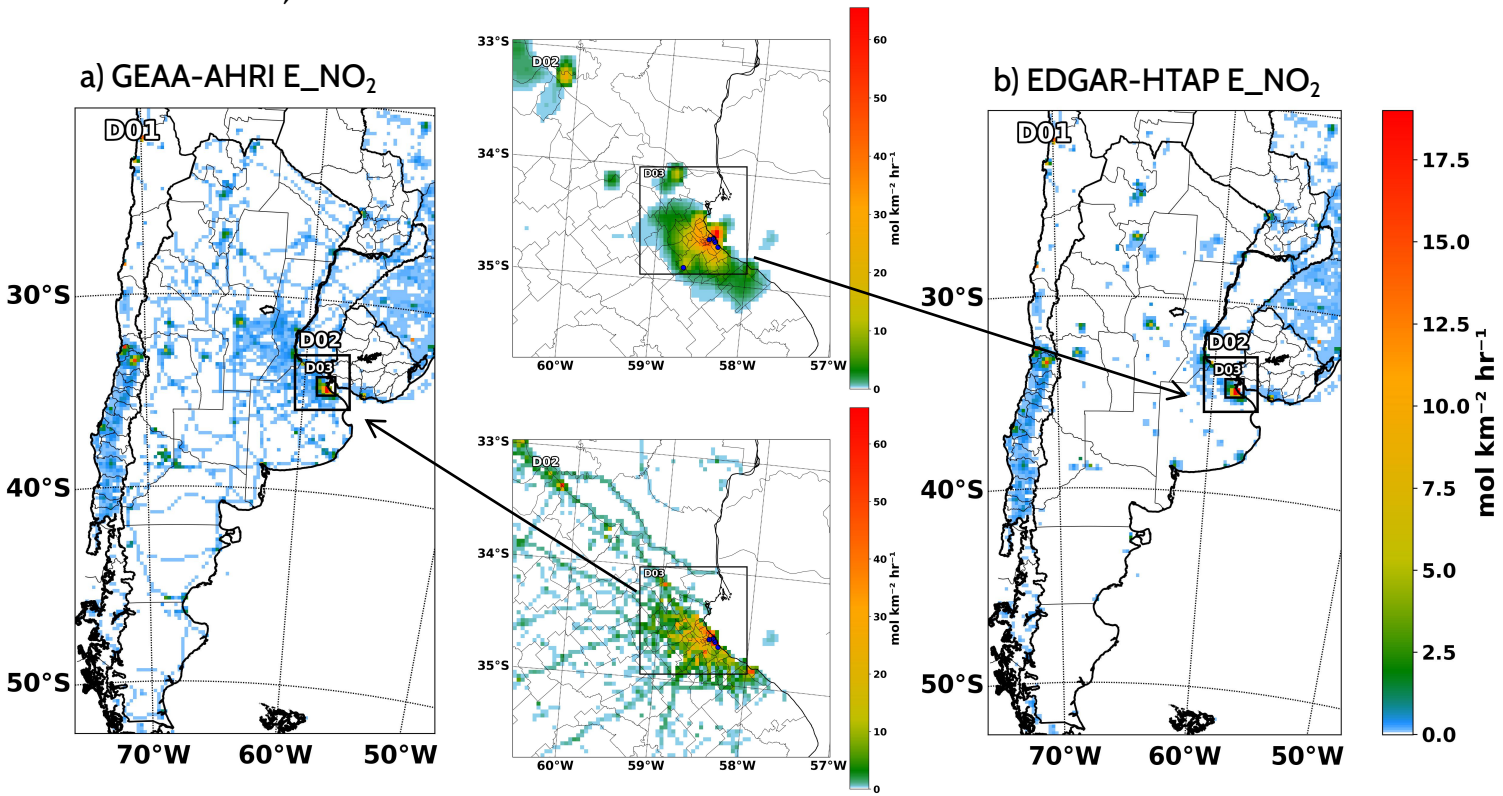
WRF-Chem model configuration

Simulation period	May 17 to June 8, 2018.
Study area	Buenos Aires, Argentina.
Horizontal Resolution	D01: 20km, D02: 4km, D03: 1.3km.
Gas-phase scheme	MOZART.
Aerosol scheme	GOCART.
Anthropogenic emmision inventories	Global: EDGAR-HTAP (~10x10km) Local: GEAA-AHRI (2.5x2.5km)
Fire emission	FINN.
Chemistry initial & boundary conditions	CAM-Chem (Fernandez et al., 2014).

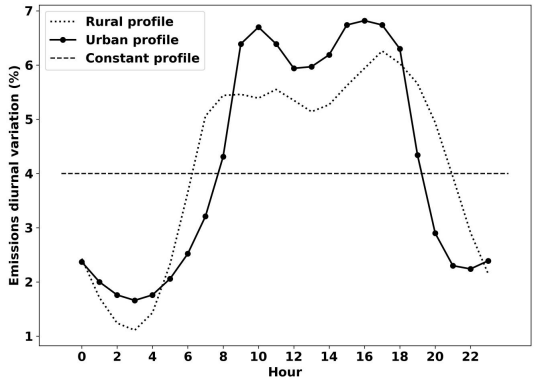
Methodology

- We use the athro_emiss tool version modified by Fernandez et al. (2017) and Schiavone et al. (2017) (*available upon request*).
- Also an updated WPS to include the implementation of Political and Time-zone maps, as well as high-resolution land use and terrain height static fields.
- This allows to:

1. Combine/Merge regional emissions both from global inventories, as well as from local emission inventories.

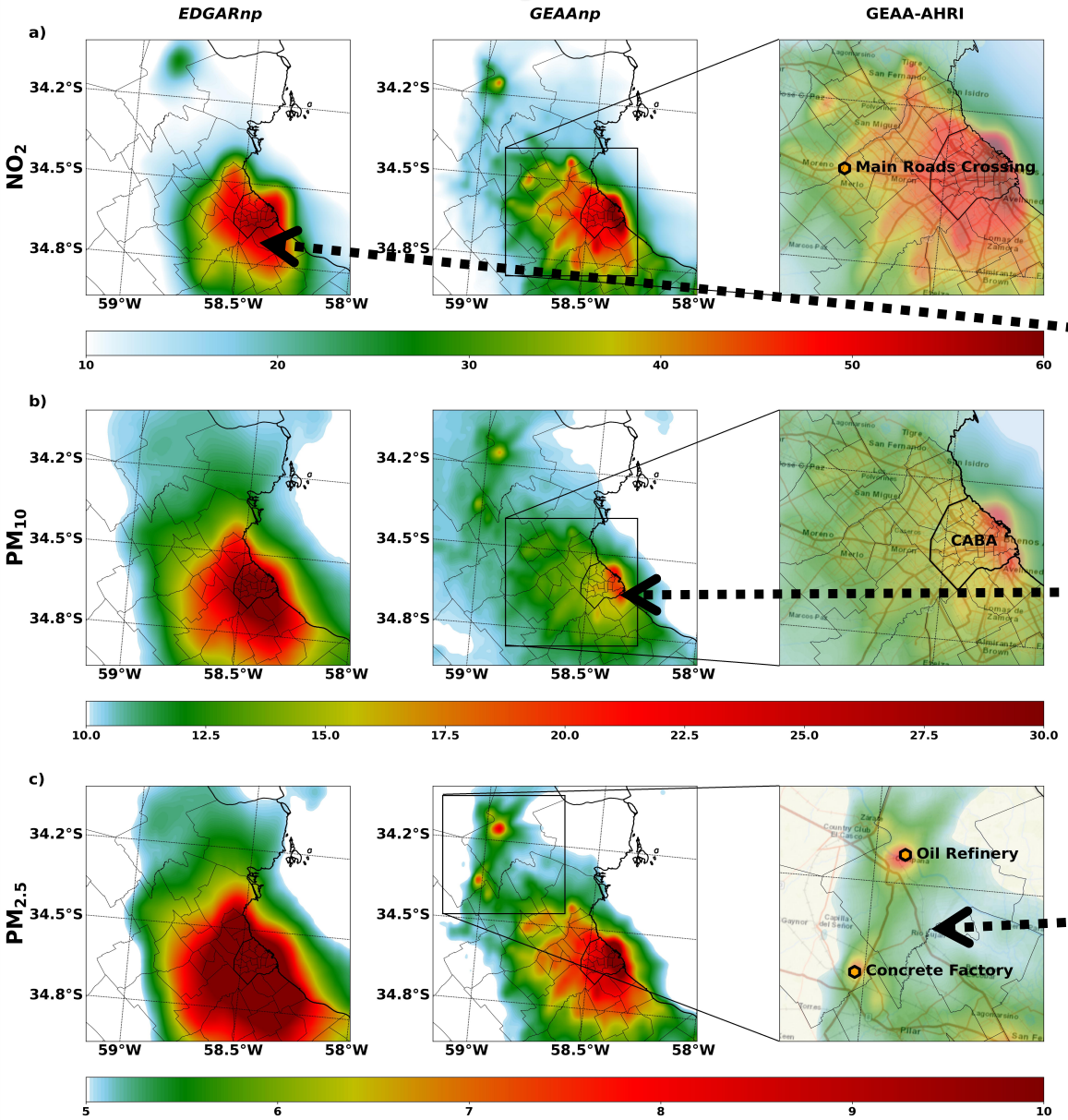


2. Include different types of temporal profiles depending on the land-use.



3. Vertical emission redistribution for local scale and point sources.

Spatial Distribution of Pollutants



The highest modeled concentrations are located in the main urban area (CABA) for both simulations.

EDGARnp :

High and homogeneously distributed concentrations in the city and surroundings.

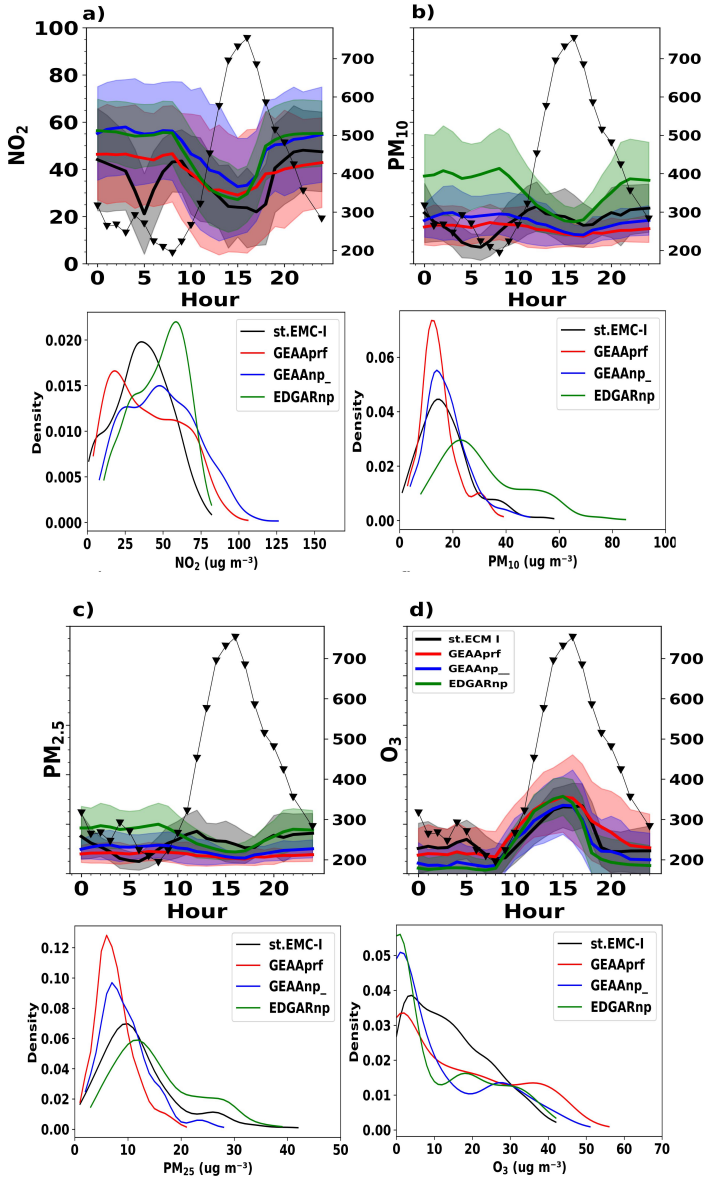
GEAAnp:

Agglomerated concentrations in the emission sources (city center) and smoothly distributed values in the suburban area.

Distinction of highways and points of high concentrations (e.g. Oil Refineries, Concrete Factory).

Temporal variation of pollutants

EMC-I station



NO_2

- Concentration was in general overestimated, but bias decreased when GEAAprf was used (figs. a,e).
- Agreement with bi-modal diurnal cycle pattern.
- when temporal profile is included (GEAAprf), improves the agreement for the lower concentrations.

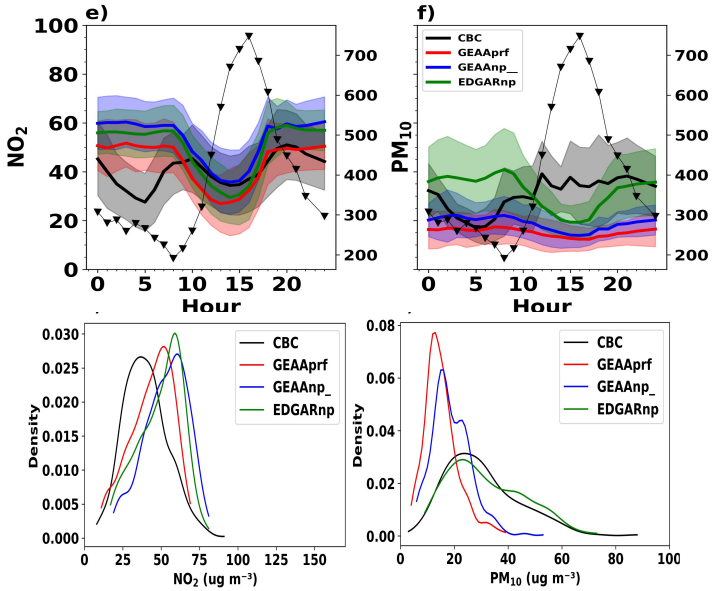
PM

- Mean PM_{10} values at EMC-I (fig. b) for GEAAnp were closer to the observations.
- At CBC the best agreement for PM was achieved by EDGARnp.

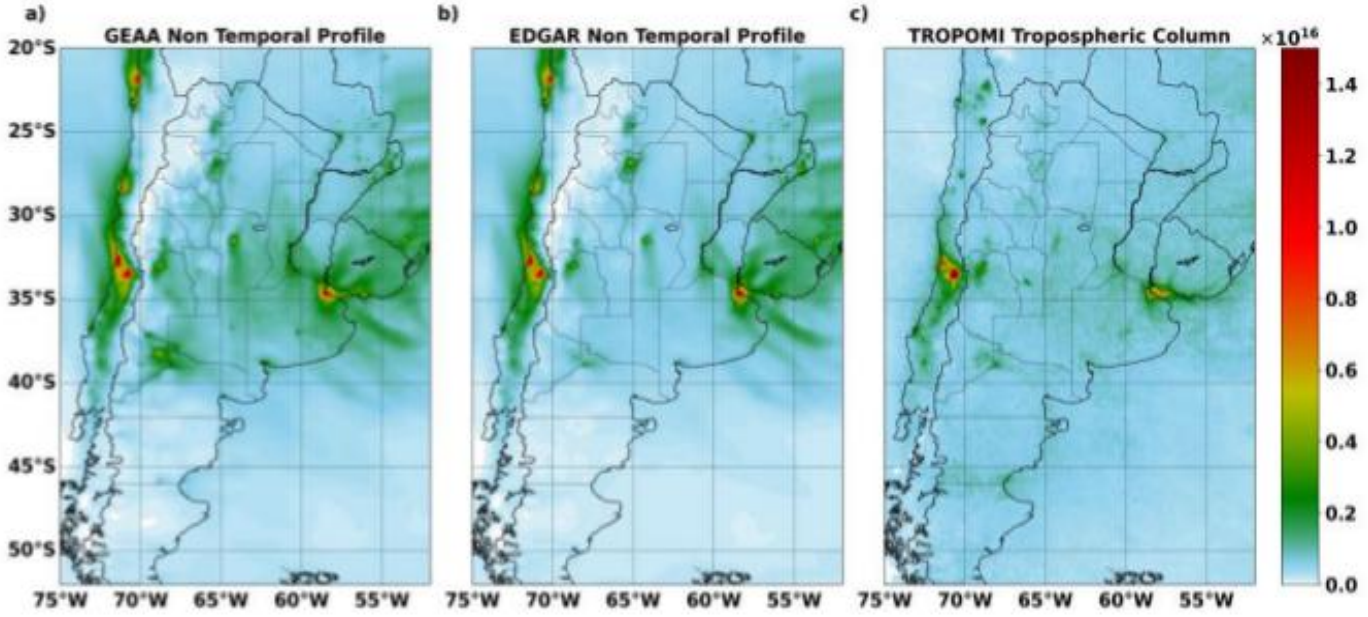
O_3

- GEAAnp and EDGARnp, had similar frequency distribution (fig. d).
- GEAAprf presented a decrease in the distribution of the smallest concentrations.

CBC station



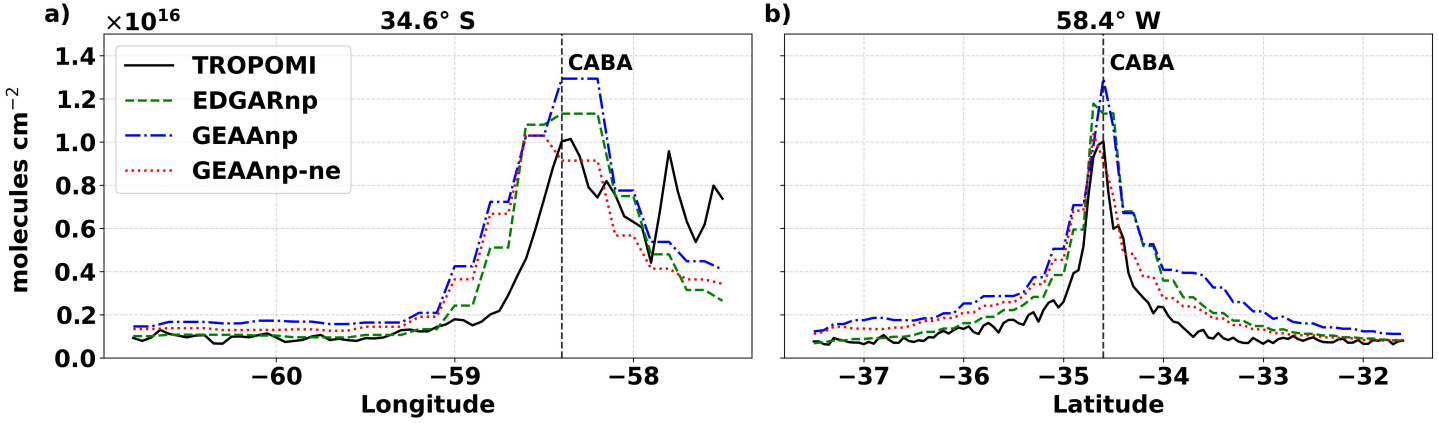
NO_2 Tropospheric column



- Similar background levels between all simulations and the TROPOMI dataset.
- The main polluted area over CABA is well represented.

Longitudinal and Latitudinal sections performed across CABA city center (34° 36' 651 S, 58°24' W).

Both inventories provide an adequate representation of the main pollutant plumes for Buenos Aires and its surroundings.



General Remarks

- The GEAA High-resolution inventory coupled with the EDGAR-HTAP global database (for areas with unavailable high-resolution information) were succesfully included as input data into the WRF-Chem model.

- A close relation is observed between the emission inventory spatial distribution and the resulting simulated surface concentrations. An improved urban-scale spatial representation is achieved when considering the GEAA-AHRI emission dataset.

- Statistically acceptable performance was achieved for all simulations.

- Although high resolution topographic information has been included in this model setup, features such as building heights and sizes are not included explicity, which results in a limitation when model output is compared against surface monitoring stations.

The modified anthro_emiss tool is available upon request, please refer to the author's e-mail for further information.

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