Project: **1257**

Project title: **Daily air quality forecasts for São Paulo**

Principal investigator: **Adrien Deroubaix**

Allocation period: **2023-07-01 to 2024-6-31**

The resources allocated for have been employed to forecast the air quality in São Paulo. Predicting air quality in megacities is difficult due to the diversity and variability of emission sources, as well as the specific meteorology and photochemistry occurring in the urban boundary layer. São Paulo is by far the largest city in South America, located near the coast and on a plateau at about 800 m above sea level, in a tropical climate. A megacity such as São Paulo is a challenge for regional air quality models, which must be used at a resolution high enough to sufficiently accurately represent the processes leading to the high concentrations and high diurnal variability of the main pollutants.

The measurement network is made up of 26 stations in the main urbanized area, and 63 stations in the São Paulo region, which constitutes an excellent support for evaluating the model outputs. The daily air quality forecasts made at MPI for the project are performed with the WRFchem model (10 km resolution) every day for the next three days over Brazil. Seven variables are analyzed, including five trace gases (CO, NO2, O3, SO2 and Ox) and aerosols (PM2.5 and PM10).

Our strategy consists in assuming that, in a highly urbanized environment (megacity), the biases between the observed and modeled concentrations are mainly due to the biases of anthropogenic emissions. So, it is possible to correct the concentrations by modifying the anthropogenic emissions, scaled to the ratio:

- for primary pollutants: **Concentration [OBS] / Concentration[MOD]**
- for ozone, a secondary pollutant, the bias is due to the VOC bias, so too much modelled O3 implies that there is too much VOC

Two emission corrections are made: (i) scaling of the emission using daily averages, therefore a correction for the emission of the day, (ii) scaling of the emission using hourly averages, therefore 24 corrections for the emission of the day. Then, the evolution of the biases can be studied after several weeks.

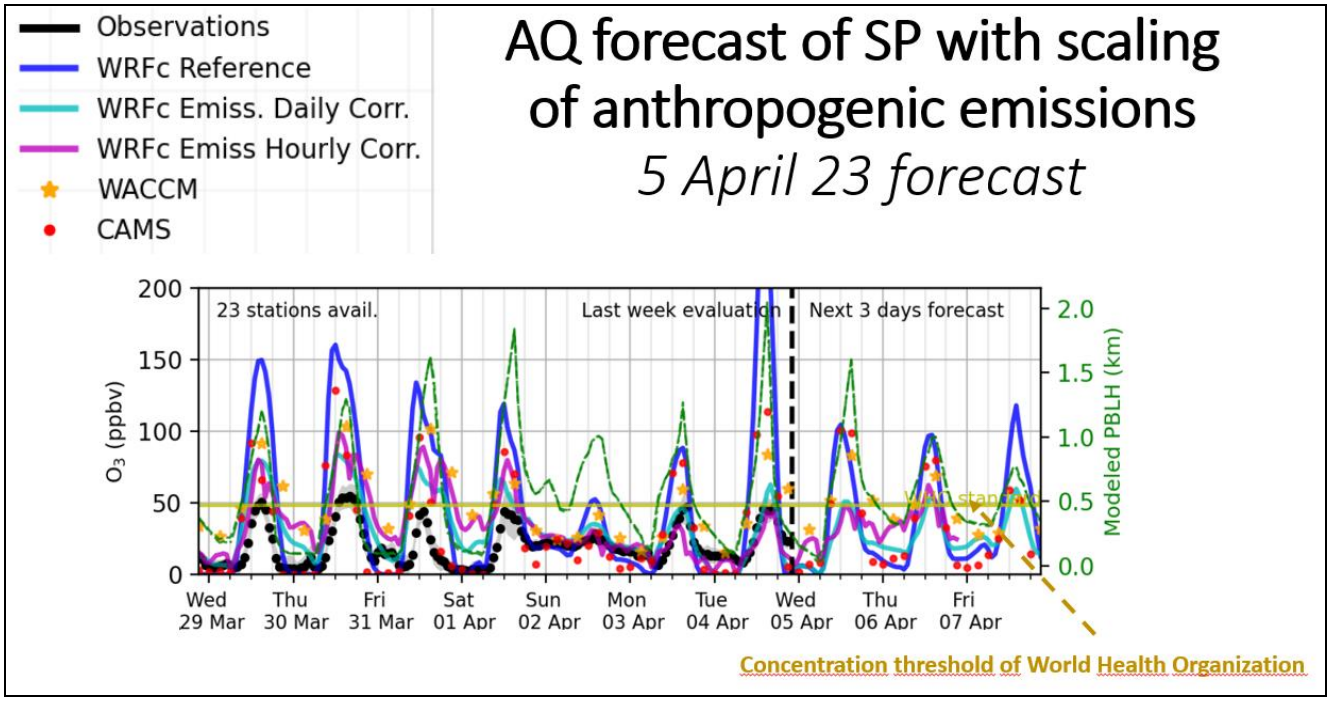

Figure 1: Air quality forecasts in the center of Sao Paulo with two weekly scaling of anthropogenic emissions (daily simulation in light blue and hourly simulation in purple, and reference simulation without scaling in dark blue) compared to observed concentrations. The simulated planetary boundary layer height (PBLH) is the green dashed line.

We present the forecast made on 5 April for ozone (O3) for the next three days (right part of Figure 1). The part (on the left of Figure1) with the observations correspond to the past 7 days allows to see that the two corrections are clearly improving the modeled hourly concentrations of ozone, and especially during daytime when ozone reach almost every day a maximum.

Evolution of the emission factors

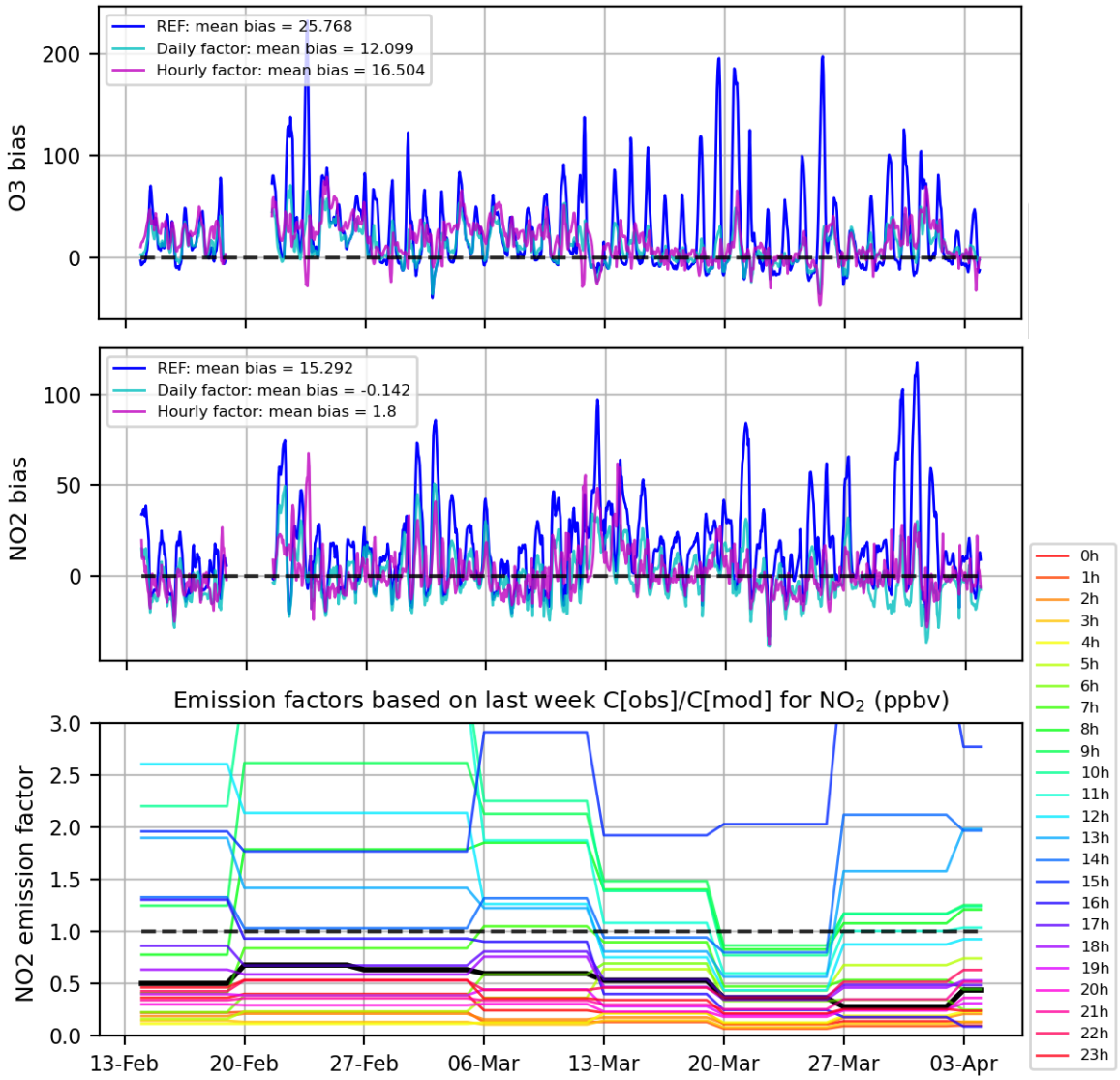

Figure 2: (top) Evolution of O3 and NO2 biases after seven weeks of forecasts, and (bottom) weekly evolution of emission factors (daily in black and hourly with a color for each hour).

After a few weeks of forecast (Figure 2), the emission factors are reduced, however we note that the hourly correction increases the emission factors in the morning, probably linked to the peak of traffic emissions which is underestimated.

These good results have been recently presented during the KLMAPOLIS symposium in Natal in Brazil (https://www.klimapolis.net/klimapolis-symposium-natal-2023-agenda-en) with the title ***Air quality Prediction System for the Metropolitan Region of São Paulo***, and an article is in preparation.