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EVALUATING BRAMS CARBON MONOXIDE OPERATIONAL FORECASTS OVER THE METROPOLITAN AREA OF SÃO PAULO

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Abstract: BRAMS model carbon monoxide (CO) operational forecasting for 24h, 48h and 72h forecast lengths were evaluated using measurements from Osasco and Congonhas monitoring stations of the State Environmental Company (CETESB). The studied period ranges from May 2012 to December 2015. Annual averages, diurnal and monthly annual mean cycles were analysed, and results show that CO concentrations have been decreasing over time, which was not reproduced by the BRAMS model forecasting. All forecasting lengths represent the diurnal cycle properly, showing the two concentration peaks of the rush hours as in observed data. It is possible to conclude that CO forecasting by the BRAMS model is reliable enough to be potentially used as a tool to aid population and policymakers on air quality public policies. More research including other localities and pollutants are still necessary for a better evaluation of the BRAMS model.

INTRODUCTION

Vehicular emissions and industrial activity are very common sources of air pollution in urban areas. Carbon Monoxide (CO) is one of the polluting gases produced by burning fossil fuels. The bidirectional interactions between chemistry and climate over CO is evident. Specifically, the CO balance in the atmosphere affects methane destruction and the production of CO_2, ozone and sulphate aerosol. Which, in turn, affect climate, and the resulting changes in climate affect the CO-CH_4 balance again, through the effects over H_2O and temperature.

Air pollution is a public health issue. In the Metropolitan Region of São Paulo (MRSP), the impact of air pollution over each inhabitant is equivalent to smoking three cigarettes per day. This translates into a higher risk of chronic bronchitis, aggravation of asthma attacks and cardiovascular disease, low birth weight, stillbirths, and a decrease in life expectancy. Due to the non-linear behaviour of atmospheric chemistry and the relevance of emissions which vary spatially in the regional scale, it is critical to evaluate the temporal evolution of CO with both surface observations and state-of-the-art atmospheric models.

The objective of this work is to evaluate the performance of the BRAMS model in forecasting CO concentrations in the MRSP for two selected surface stations (Osasco and Congonhas stations). Results from this study, besides enabling improvements in the model code, will generate products of higher reliability for the society, promoting improvements in the environmental management and in public health of urban areas, specially those characterized by dense urbanization.

METHODOLOGY

Locations (Fig.1): selected due economic importance and higher pollution concentrations emitted by the vehicular fleet and industrial activity

Period of evaluation: May 2012 to December 2015;

Both model data and observations were used to compute mean diurnal, monthly and annual cycles and also annual averages for 24 h, 48 h and 72 h for the two stations;

The model was run over South America, and evaluated for 24h, 48h and 72h of forecast length;

The 24 h forecast length (03Z to 00Z with 3-hour intervals) was called F24h, as well as F48h and F72h for the second and third integration days.

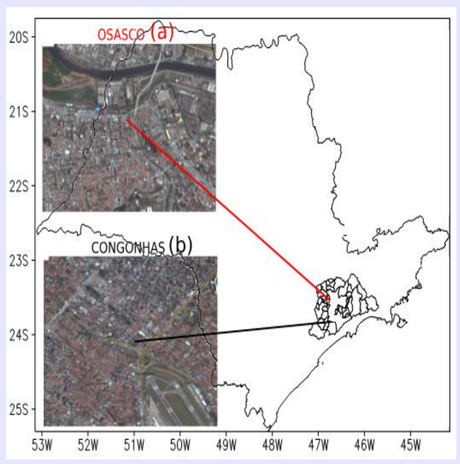

Fig. 1 – Locations used in the study.

Model description

Grid spacing
- Horizontal: 25km
- Vertical: 80m
- Vertical grid stretch ration: 1.13

Model domain
- Grid points: 336 x 336 x 38

Forecast length
- 3 days, starting at 00 UTC

IC/BC
- IC/BC from interpolation of GFS model forecast.

Physics:
- MY 2.5 turbulence scheme;
- 2-moments cloud microphysics with 7 water species;
- Modified CARMA long/short wave radiation scheme (Longo et al., 2013)
- Grell&Dévényi convective parameterization (2002).

Emissions: PREP-CHEM-SRC (Freitas et al., 2011)

- Urban/Industrial: Retro, EDGARv4.2
- Biogenic: GEIA/ACCENT, MEGAN
- Biomass Burning: 3BEM, GFED
- Volcanoes: AEROCOM
- Biofuel use, charcoal prod and burning of agricultural waste: Yevich and Logan (2003)

RESULTS

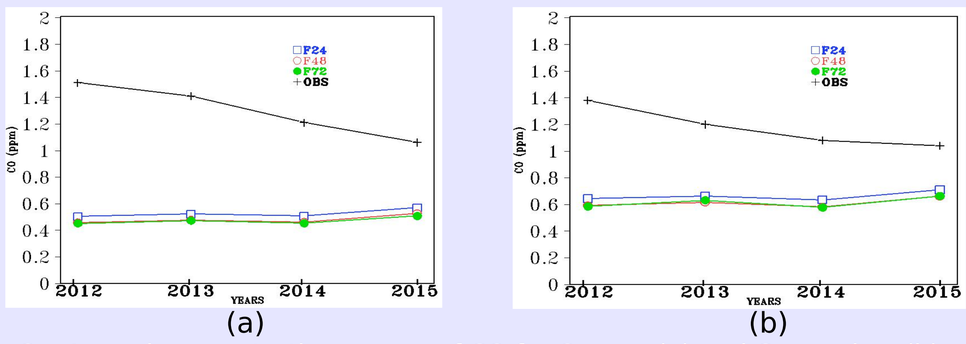

Fig.2 – Annual concentration means of CO for Osasco (a) and Congonhas (b) locations. Observations (black line) and forecasts of 24, 48 and 72 hours, in blue, red and green,, respectively.

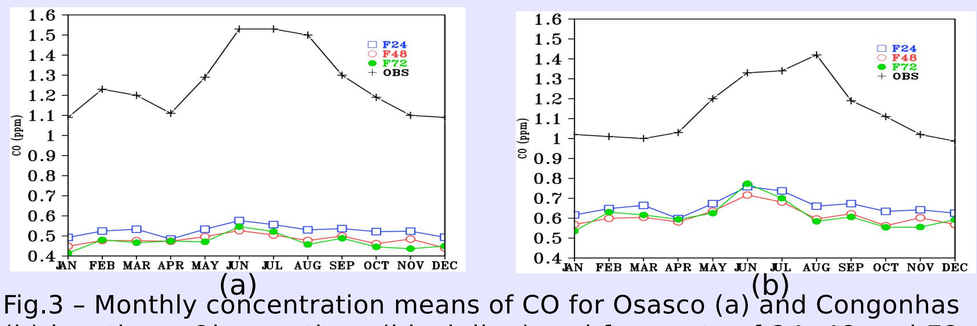

Fig.3 – Monthly concentration means of CO for Osasco (a) and Congonhas (b) locations. Observations (black line) and forecasts of 24, 48 and 72 hours, in blue, red and green,, respectively..

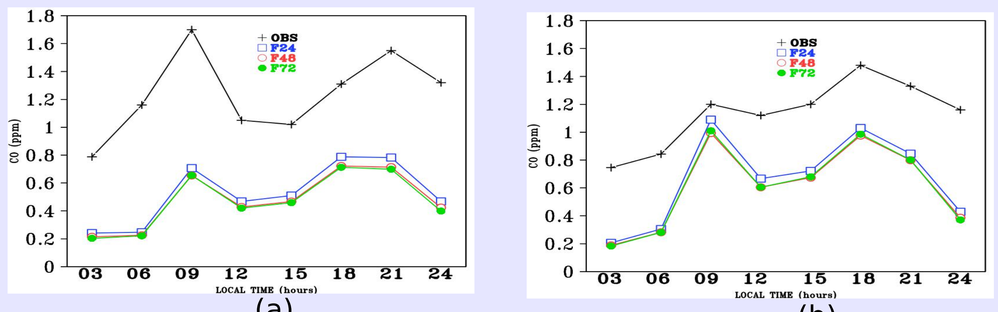

Fig.4 - Mean diurnal cycle of CO for Osasco (a) and Congonhas (b) locations. Observations (black line) and forecasts of 24, 48 and 72 hours, in blue, red and green,, respectively..

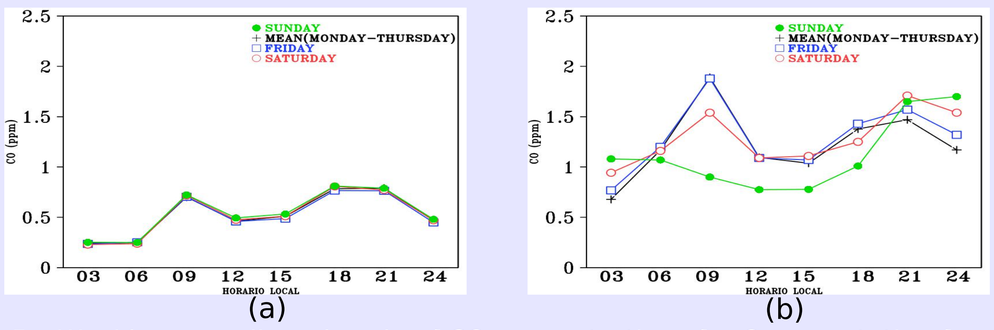

Fig.5 – Weekly mean diurnal cycle of CO concentrations for Osasco station for the forecasts of 24 h (a) and observations (b).

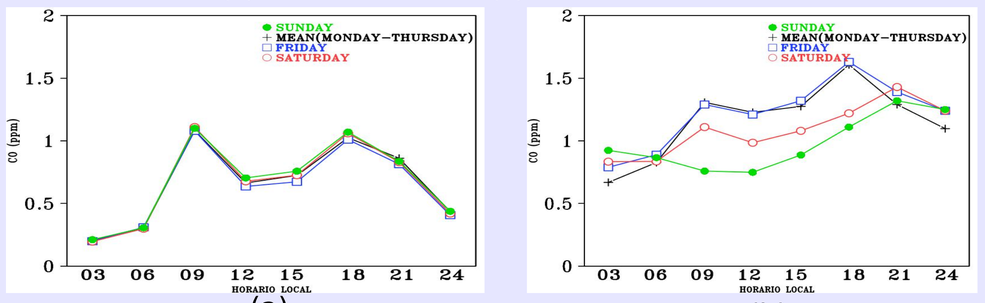

Fig.6 - Weekly mean diurnal cycle of CO concentrations for Osasco station for the forecasts of 24 h (a) and observations (b).

CONCLUSIONS

- BRAMS model indicates a good reproduction of seasonal, monthly and diurnal CO concentration in the MRSP. The diurnal cycle peaks in the morning and at end of the day due to intense vehicle traffic are well reproduced by the model. However, the model underestimates concentration, indicating that anthropogenic emissions are possibly underestimated for this study region.
- The weekly cycle shows the clear impact of the vehicle fleet in the diurnal variation of CO. On weekdays, similar behaviours of CO concentration levels were obtained, except after 20 hours.

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