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EVALUATING BRAMS FORECASTS OF CARBON MONOXIDE FOR TIJUCA AND IRAJÁ STATIONS DURING THE 2016 OLYMPIC GAMES

Ariane Frassoni[1], Daniela de Azeredo França[1], José Roberto Rozante[1], Júlio Barboza Chiquetto[2], Bruno Bôscaro França[3], Débora Alvim[1], Angel Chovert[1], **Jayant Pendharkar[1]**

[1]*Center for Weather Forecasting and Climate Studies, National Institute for Space Research, Cachoeira Paulista, SP, Brazil*
[2]*Department of Geography, University of São Paulo, São Paulo, SP, Brazil*
[3]*Prefeitura da Cidade do Rio de Janeiro, Secretaria Municipal de Meio Ambiente - SMAC, Rio de Janeiro, RJ, Brazil*

Ariane.frassoni@inpe.br

Abstract: Rio de Janeiro was the hosting city of the Olympic Games in 2016. Monitoring and forecasting the air quality in the Metropolitan Area of Rio de Janeiro (MARJ) became a priority in order to support government agencies and population during this period. For that, the air quality forecast system for MARJ (AQFS-MARJ) in high resolution (1km of grid space) was implemented in 2016 using the Brazilian developments on the Regional Atmospheric Modeling System (BRAMS) version 5.2 in the Center for Weather Forecasting and Climate Research of the National Institute for Space Research (CPTEC/INPE). In this work, we analyze the performance of BRAMS forecasts for carbon monoxide comparing to observation data from Irajá and Tijuca ground stations provided by the local government agency (Secretaria Municipal do Meio Ambiente – SMAC). It was used 3 different versions during the games: 20km (operational version), 5km and 1km dedicated to the Olympic period. The results indicated BRAMS model forecasts better represent the observed concentrations during the morning and early afternoon, clearly underestimating the observed nighttime behavior.

INTRODUCTION

The city of Rio de Janeiro in Brazil welcomed the Olympic and Paralympic Games during August and September 2016, respectively.

Rio is one of the biggest cities in Brazil, located in a complex terrain beside the sea, which experiences poor air quality due to high concentrations of vehicular pollution, specially in densely populated areas.

To support government agencies and population during the Olympic Games, the Center for Weather Forecasting and Climate Studies of the National Institute for Space Research (CPTEC/INPE) implemented in 2016 the air **quality forecast system (AQFS)** for the Metropolitan Area of Rio de janeiro (MARJ) in high resolution (1km of grid space) using the Brazilian developments on the Regional Atmospheric Modeling System (BRAMS) version 5.2 (Frassoni et al., 2016).

To quantify the improvements of the AQFS-MARJ compared to the operational version of BRAMS for air quality forecasts, we performed objective evaluation for CO in 24h and 48h forecast lengths for Irajá and Tijuca air quality monitoring ground stations in the Rio de Janeiro City during the period August 01 to September 30 in 2016.

METHODOLOGY

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

Period of evaluation: August-September 2016

Both model data and observations from Prefeitura do Rio de Janeiro (SMAC) were used to compute mean diurnal cycles for 24h and 48h for the two stations;

The model was run over Metropolitan Area od Rio de Janeiro (RJ)

The 24 h forecast length (03Z to 00Z with 1-hour intervals) was called F24h, as well as F48h for the second integration day.

The AQFS-MARJ consisted in forecasts in three spatial resolutions: the operational version with a 20km grid resolution over the limited area domain of South America (47S, 12N/25W, 87W), a 5km grid resolution in a limited area domain over part of Southeast Brazil (25,5S, 18,5S/37W, 49W) and a 1km grid space limited area domain over MARJ (24S, 21,5S/45W, 41,5W) (Fig. 1).

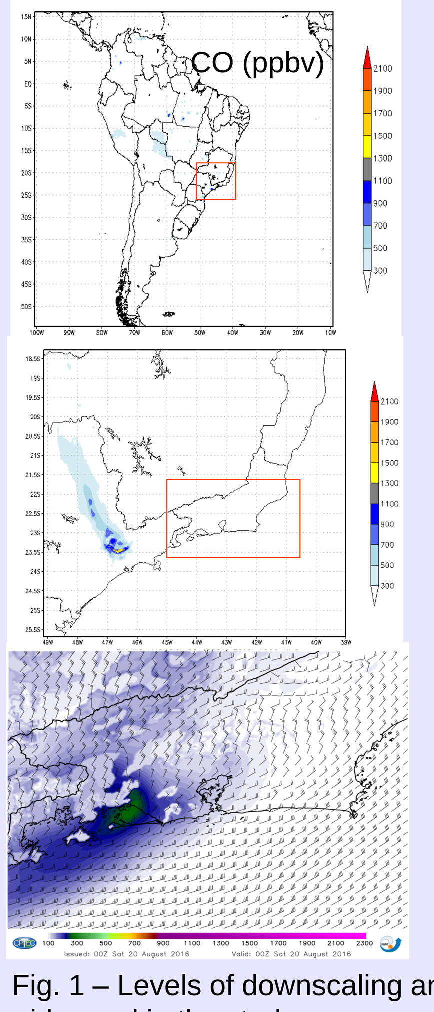

Fig. 1 – Levels of downscaling and grids used in the study.

Model description

Grid spacing
- Horizontal: 20km->5km->1km

Model domain
- Grid points: 336 x 240 x 45 (for 1km grid space)

Forecast length
- 2 days, starting at 00 UTC, outputs each hour

IC/BC
- IC/BC from interpolation of GFS model forecast for 20m km grid space

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)
- JULES surface model and urban parameterization (Silva, 2016) in the MARJ

Emissions: PREP-CHEM-SRC (Freitas et al., 2011)
- Urban/Industrial: Retro, EDGAR HTAP
- Biogenic: GEIA/ACCENT, MEGAN
- Biomass Burning: 3BEM, GFED
- Georeferenced emissions for five different types of roads in the MARJ were included (Chovert et al., 2016)

RESULTS

According to the SMAC, winter is the season with highest CO concentrations in Tijuca station, followed by autumn and spring, with main peaks occurring around 9h local time and secondary peaks around 20h local time, with concentrations around 0.3 ppm for both peaks. Analysis of the observed diurnal cycle during August-September 2016 indicate a main peak at 10h local time and a secondary peak with the same magnitude at 18h, in accordance with previous studies (Fig. 2a).

Irajá has the highest CO concentration during autumn, followed by winter, summer and spring, with main peaks at 8h and secondary peaks at 20h local time (Nacaratti, 2013). The mean diurnal cycle for August-September 2016 indicates a main peak at 20h local time and the secondary peak in the morning, between 7h-8h local time (Fig.2b). Both concentration peaks in the ground stations coincide with the increase of vehicular activity during the morning and also during early night rush hours.

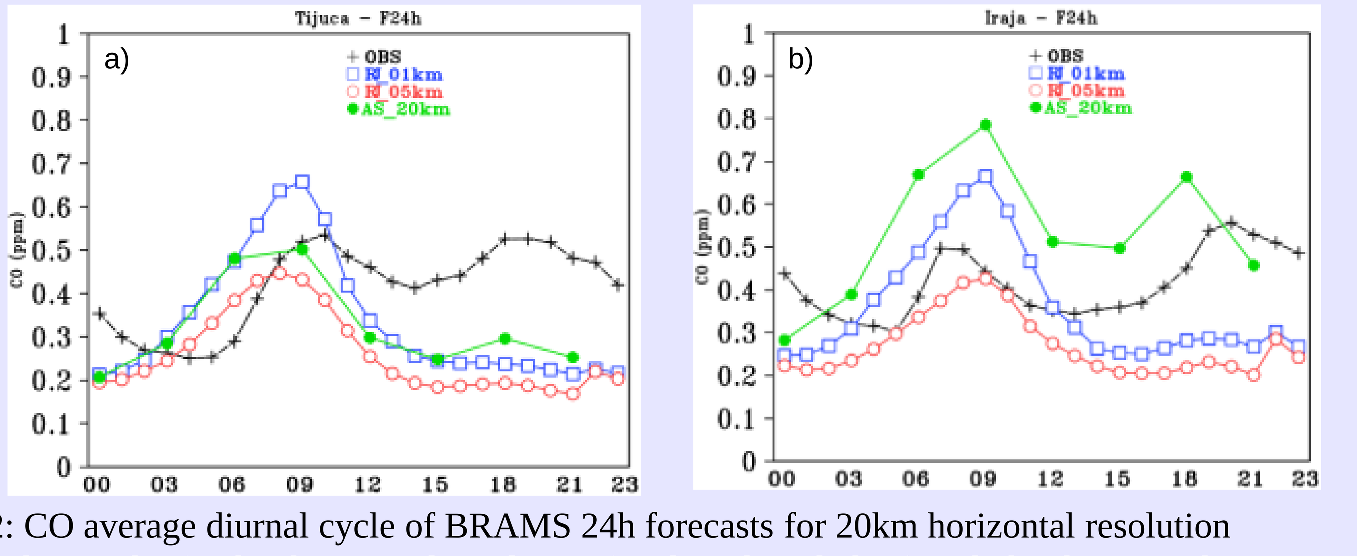

Fig.2: CO average diurnal cycle of BRAMS 24h forecasts for 20km horizontal resolution (dotted green line), 5km horizontal resolution (circle red circle line) and 1km horizontal resolution (squared blue line), and observation (cross black line) for: a) Tijuca and b) Irajá ground stations.

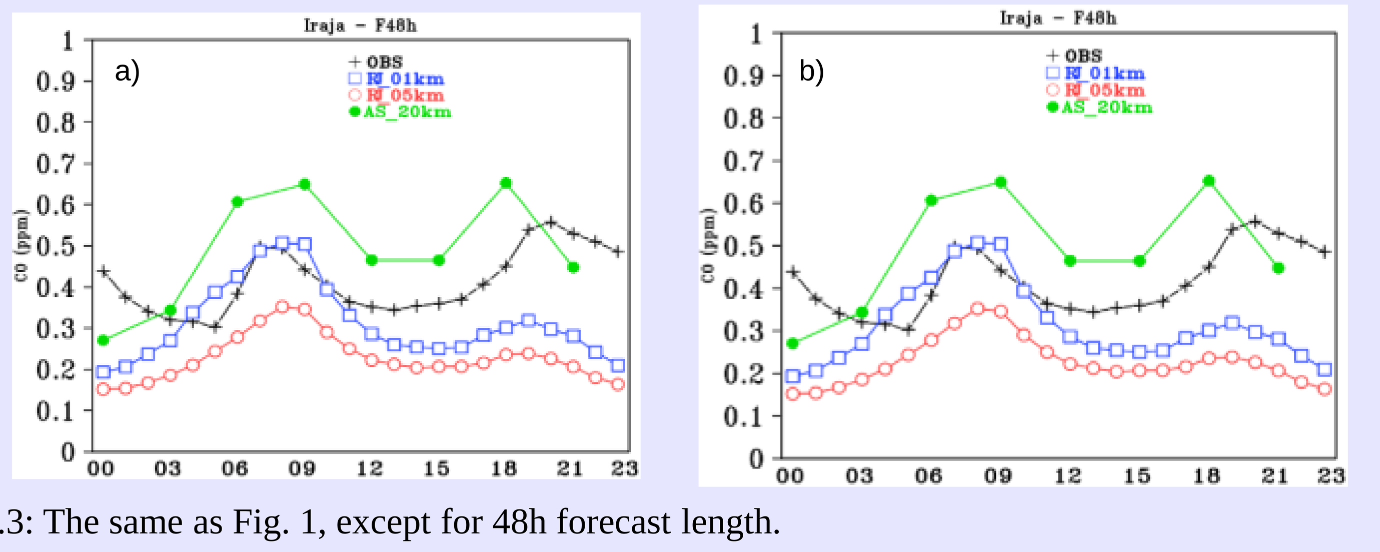

Fig.3: The same as Fig. 1, except for 48h forecast length.

The mean diurnal cycle of 24h CO forecasts (Fig. 2) indicates BRAMS better simulated the diurnal behavior for both stations, specially in the morning hours. Clearly the higher resolution model versions lacks in the representation of nighttime concentrations. The 48h forecast (Fig. 3) had better skill compared with 24h forecast also for Tijuca station, with decrease of the bias, but the same characteristics with 24h simulation were observed.

CONCLUSIONS

- The observed diurnal cycle of CO concentrations for August-September 2016 indicate highest concentrations during the morning and early evening hours, associated to the increase in vehicular traffic, the main emission sources of CO in the analyzed regions.
- The BRAMS model forecasts better represent the observed concentrations during the morning and early afternoon, clearly underestimating the observed nighttime behavior. Future investigation will be conducted to identify the model limitations in representing CO concentrations during nighttime.

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