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PRELIMINARY ASSESSMENTOF THE CCATT-BRAMS MODEL PERFORMANCE OVER BOGOTÁ

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1. INTRODUCTION

Although Bogotá's air is one of the most polluted in Latin America, the city does not count with a robust air quality model that allows designing effective air quality management strategies. A number of studies have been conducted to explain the behavior of Bogotá's atmosphere, pollutants emission, formation, transport and fate and population exposure levels. Furthermore, different approaches have been used to analyze and model air quality, including gaussian models, geostatistical interpolation of air quality data, and photochemical simulations for a scenario based on 2002 (Zarate, 2007), but without any successfully implementation as an air quality management instrument. (Rojas 2010).

This work is the first approaching step to the use of regional model air quality CCATT-BRAMS (Coupled Chemistry, Aerosol and Tracer Transport model to the Brazilian Developments on the Regional Atmospheric Modeling System) (Longo&Freitas 2007) for Bogotá, given its need for acquiring a robust scientific tool to describe and explain the behavior of the atmosphere and transport processes, formation and removal of contaminants.

2. METHODOLOGY

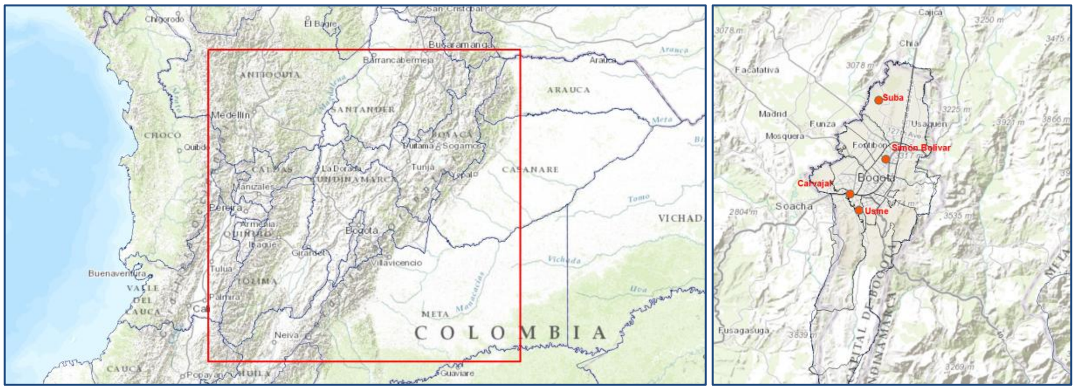
CCATT-BRAMS model has been developed at the *Centro de Previsão de Tempo e Estudos Climáticos* (CPTEC - INPE) of Brazil, as an analysis tool for air quality community building, with features tailored to settings tropical conditions, which was established as a selection criteria for its use in this study compared to other simulation systems developed and refined for different latitudes.

This study conducted exploratory simulations of relevant pollutants over the Bogotá region, considering two independent spatial domains with 20 vertical levels,a coarse domain of 10km and a finer one, of 3km grid resolution, each one containing 50 xy points, for a simulation corresponding to 7 and 8 July 2007, including its stabilization phase. Atmospheric boundary conditions for the model were taken from reanalysis fields of CPTEC Global model. Pollutant emissions were based on Global inventories, highlighting RETRO (REanalysis of the TROpospheric chemical composition over the past 40 years) and EDGAR (The Emissions Database for Global Atmospheric Research), adapted on the regional inventory performed for South American megacities (Alonso et al 2010). The performance of selected meteorological parameters and concentration assessmentwas compared with the measurements obtained by the Network of Air Quality in Bogotá (RMCAB) for those available:Simón Bolivar (central area of city), and Usme (south – relative humidity only).

3. RESULTS

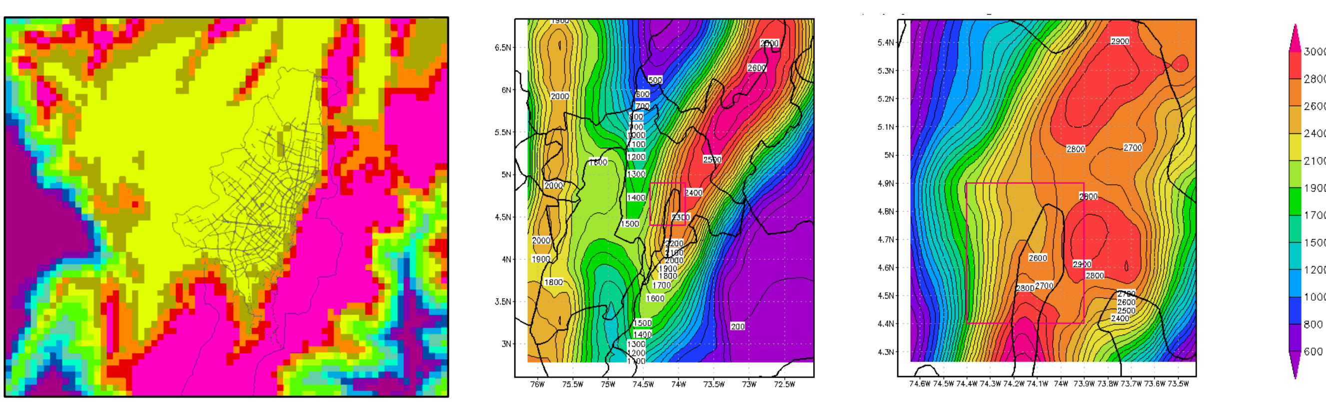
Bogotá's Capital District is located on a plateau between 2.550 and 2.620m on the eastern branch of the Colombian Andes, with a total area of 163.659 ha, of which 41.388 are urban and 122.271 rural land, those features are viewed within the model coarse and fine domains on Fig 1.

Fig.1 Coarse and fine domain of simulation



As Figure 2 shows, some elevation features appear to be lower than the satellite representation, mainly the eastern mountains, whose slope values result lower than the real ones. Consequently, a portion of the flat area of Bogotá's plateau was removed by the model. Such effects are produced by the model average topographic scheme, which softened the topographical data by interpolation.

Fig. 2 topography Satellite visualization and model representation for 10km and 3 km grid resolution



Regarding meteorological variables, the model represented the main features of mean diurnal cycle for temperature, showing a general overestimation on the peaks and underestimation on valleys (Fig 4). The spatial distribution of maximum and minimum temperatures episodes is presented, showing a tendency of overestimating temperature as the grid resolution is lower (Fig 4). Similarly, the relative humidity modeled at the south of city, do not show the peak values that are observed (Fig 6). This could be related with the topographic representation and the lower humidity estimated by the model caused by the simulated temperature.

Fig. 4 Temperature (°C) time series(UTC) and diurnal cycle at Simón Bolivar station

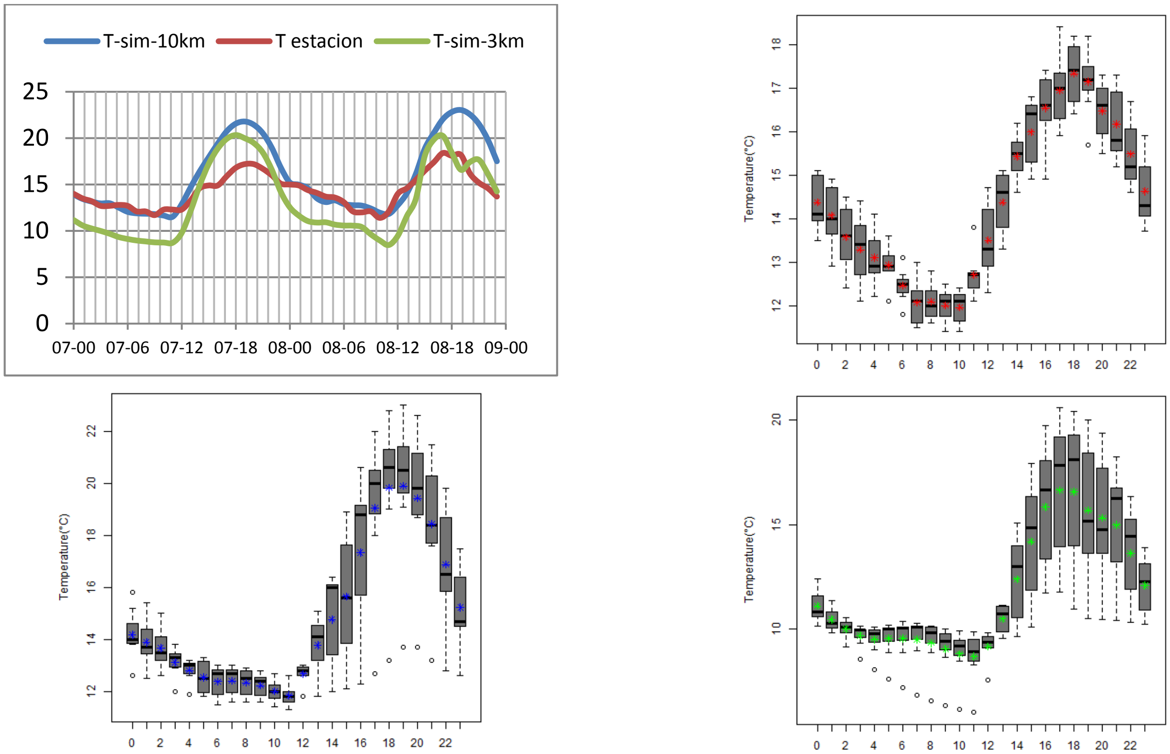


Fig. 5Modeled minimum (left pair) and maximum (right pair) temperature (°C) spatial distribution, with 10km and 3km grid resolution for analyzed days.

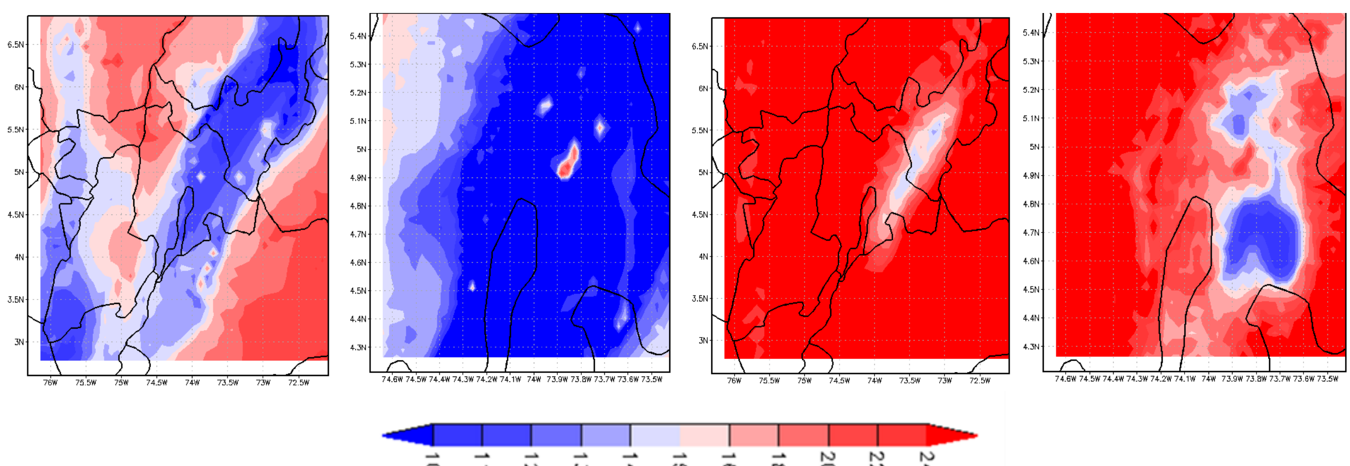
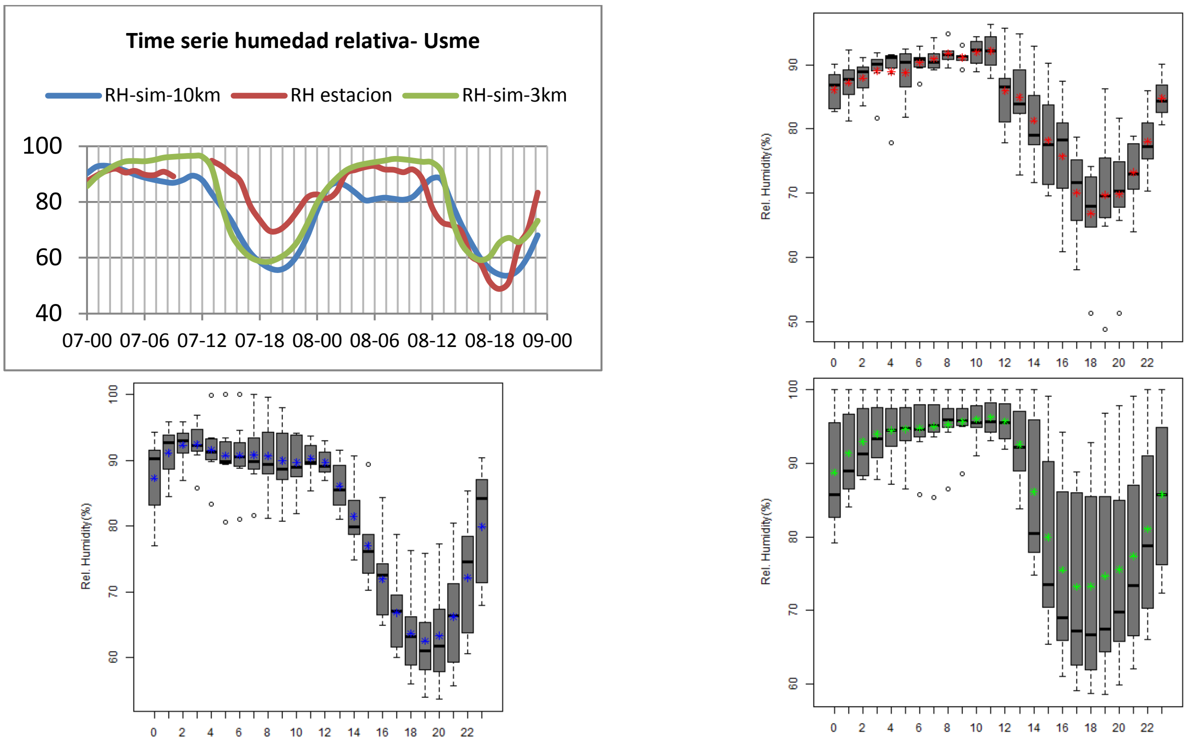
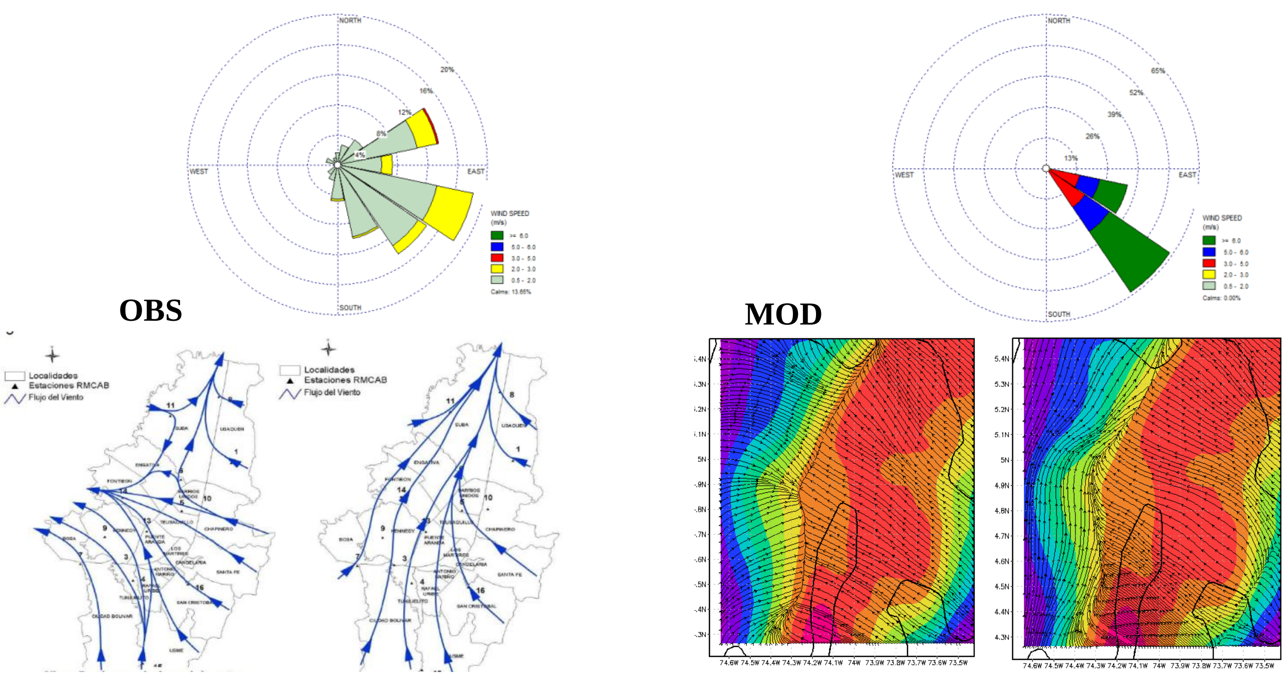


Fig. 6 Relative humidity (%) time series (UTC)and diurnal cycle at Simón Bolivar station



CCATT-BRAMS represented the large scale wind field, but did not capture the local mountain-valley breeze that reaches the city and recirculate pollutants towards it in the afternoon, as showed in figure 7.Wind speed distribution is, in general, overestimated by the model at the Simon Bolivar Station monitoring site.

Fig. 7 Observed and modeled wind speed and wind flow direction patterns morning (left) – afternoon (right), shadowed areas depicts modeled topography features.



Carbon Monoxide is transported downwind from the city. Nevertheless, the local wind pattern pushes the pollutant to the west, without any backward effect (Fig 8). In addition, the model strongly underestimates the CO mixing ratio, given the emission resolution used within the input data (Fig. 9). Ozone mixing ratios are mainly overestimated by the model, although the cycle of formation and consumption is well represented by the model, being more consistent at high resolution levels (Fig 10).

Fig. 8 Carbon monoxide average maximum (left) and minimum (right) spatial distribution on Simón Bolivar station 1ppbv

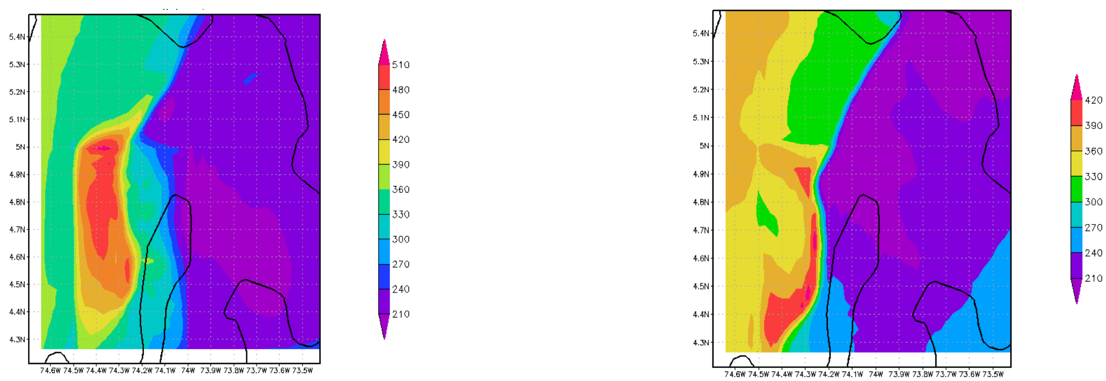


Fig. 9 Carbon monoxide time series (UTC) and diurnal cycle depiction on Simón Bolivar station (ppm)

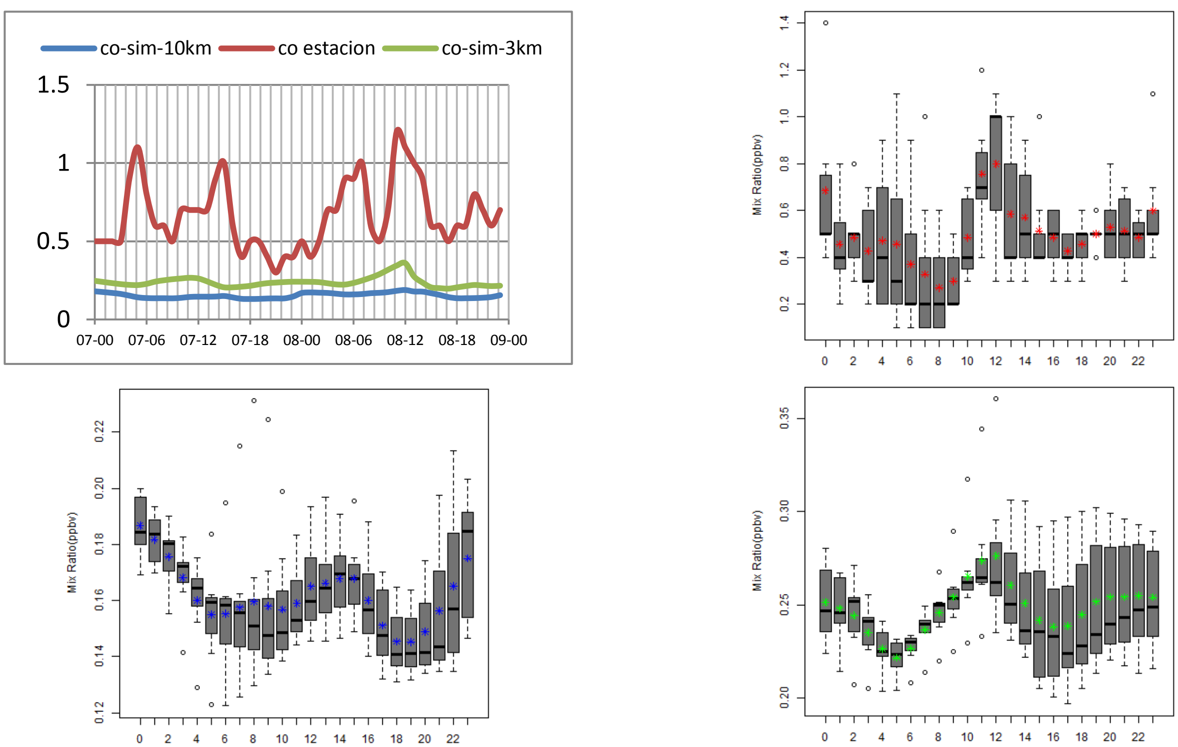
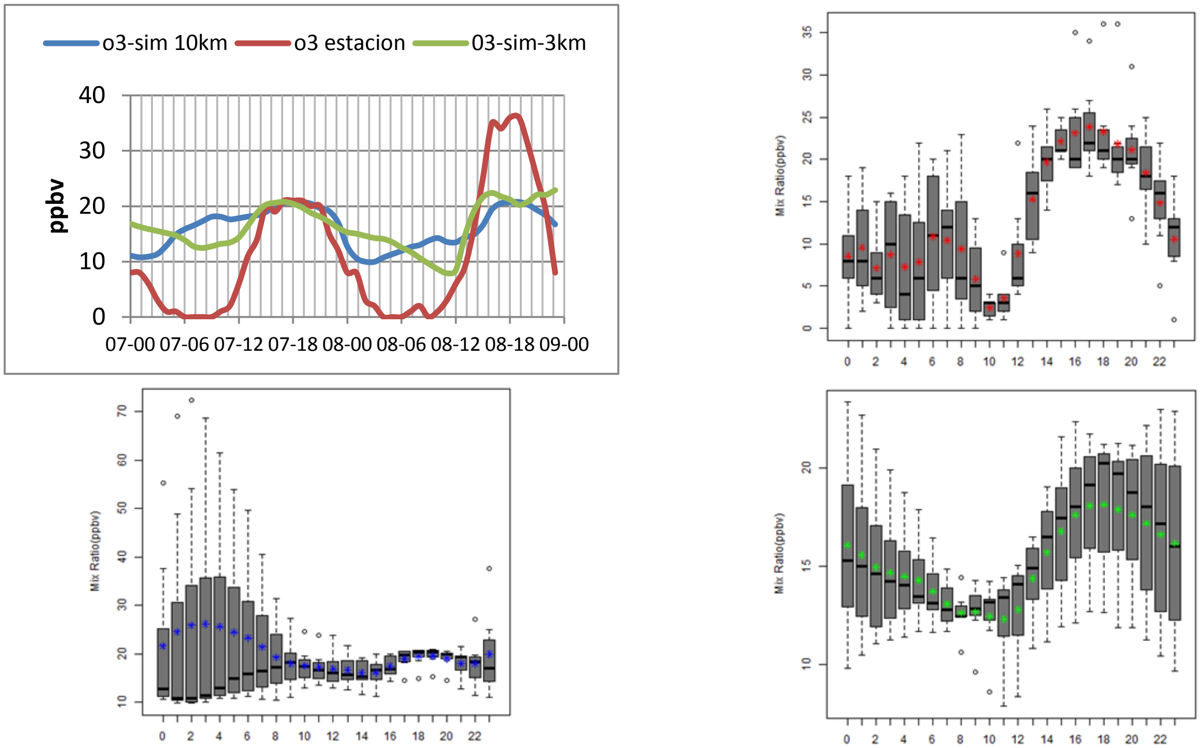


Fig. 10 Ozone time series (UTC) and diurnal cycle depiction on Simón Bolivar station (ppbv)



4. CONCLUSION

A preliminary assessment of Bogota air quality performed with CCATT-BRAMS model, revealed its capabilities to represent average temperature and relative humidity cycles, although its accuracy decreased at the final hours of the day Modeled elevations were strongly influenced by the grid resolution and the topographical scheme, creating softened hill-valley features, which affected wind flow patterns, as well as the magnitude and spatial distribution of meteorological variables. Carbon monoxide mixing ratios were mainly underestimated and its average daily cycle was not exact, presumably due to underestimated emissions. Therefore, a refined emission inventory data is needed to improve the model's performance. Carbon monoxide transport follows the wind flow pattern, represented as a plume oriented toward the West and Southwest. Ozone mixing ratios were overestimated by the model, especially for low observed values. In addition, hourly averages showed smoothed trends in ozone concentrations through the day, with poor correlation for low-resolution simulations and great variability for higher resolution. Therefore, conducting additional simulations for testing chemical model configuration in order to refine its results is needed.

5. FURTHER WORK

As further work, experiments would be conducted first to test meteorology representation with sensitivity analysis for topographic schemes, grid resolution, nesting strategy, and soil humidity initialization, as well as the refining of the assessment of pollutant concentration and chemical behavior by the implementation of spatial and temporal emission data and chemical mechanism configuration testing.

6. REFERENCES

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