STATISTICAL EVALUATION OF THE URBAN ATMOSPHERIC DISPERSION MODEL DAUMOD-GRS TO ESTIMATE NO_2 CONCENTRATIONS USING NEW AVAILABLE DATA FROM BUENOS AIRES

Andrea L. Pineda Rojas [1] and Rafael Borge [2]

[1] Centro de Investigaciones del Mar y la Atmósfera (CIMA/CONICET-UBA), UMI-IFAECI/CNRS, Universidad de Buenos Aires, Argentina

[2] Environmental Modelling Laboratory, Department of Chemical & Environmental Engineering, Universidad Politécnica de Madrid (UPM), Spain

MOTIVATION & OBJECTIVES

The urban scale air quality model DAUMOD-GRS [1] results from coupling the atmospheric dispersion model DAUMOD [2] and the simplified photochemical scheme GRS [3]. Previous statistical evaluations of DAUMOD-GRS, considering observations from short term (2-3 weeks) monitoring campaigns, have shown an acceptable performance to estimate hourly concentrations of nitrogen dioxide (NO_2) and ozone at different sites of Buenos Aires [4]. Recent long term (several years) hourly NO_2 concentration data measured at three air quality (AQ) sites of the city allow a new and more detailed evaluation of the model.

Objectives:

1) To assess the performance of the DAUMOD-GRS model to estimate urban background NO_2 concentrations considering 4 years of observations.

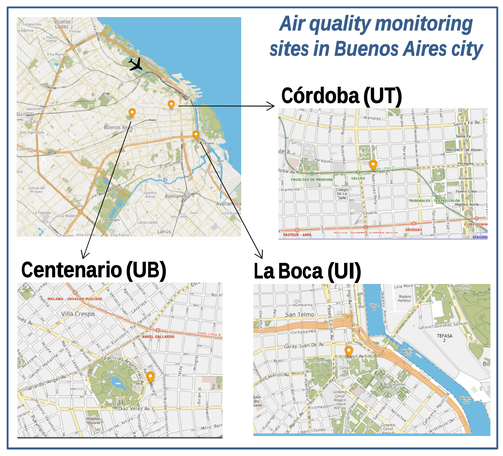
2) To identify potential causes for discrepancies between model results and measurements.

METHODOLOGY

➢ Data from the local environmental protection agency: NO_2 hourly concentrations measured at three air quality monitoring stations: Centenario (UB: urban background), Córdoba (UT: urban traffic), La Boca (UI: urban industrial).

➢ Simulations are performed in a 85 km x 75 km domain considering:

- Hourly surface meteorological data (2009-2012) from the station located at the Domestic Airport.
- Area source NO_x and VOC emissions from the high resolution (1 km^2, 1 h) inventory developed for the MABA [5]
- A regional background O_3 concentration ($[O_3]_r$) of 20 ppb and clean air levels for NO_x and VOCs.



➢ The statistical comparison is performed considering modelled (C_p) and observed (C_o) values paired both in space and time, and different aggregation: i) by monitoring station, and ii) by diurnal/nocturnal hours, using the **BOOT package** [6] to compute metrics:

$$NMSE = \overline{(C_o - C_p)^2} / \overline{C_o}\ \overline{C_p}$$

$$CORR = \overline{(C_o - \overline{C_o})(C_p - \overline{C_p})} / \sigma_{C_p} \sigma_{C_o}$$

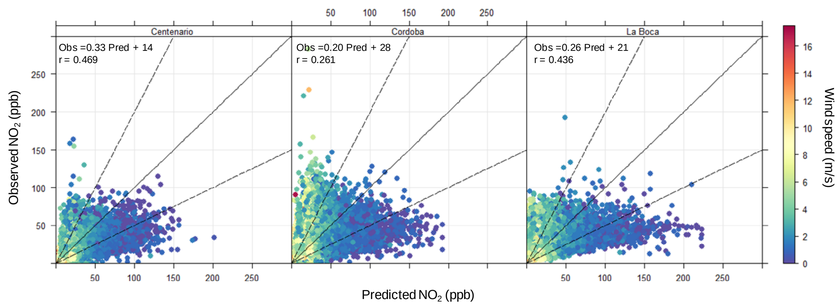
$$FA2 = \%\ of\ data\ that\ satisfy\ 0.5 \leq C_p / C_o \leq 2.0$$

$$FB = (\overline{C_o} - \overline{C_p}) / 0.5(\overline{C_o} + \overline{C_p})$$

➢ Temporal variation graphs of modelled and observed NO_2 concentrations are obtained using the **Openair software** [7].

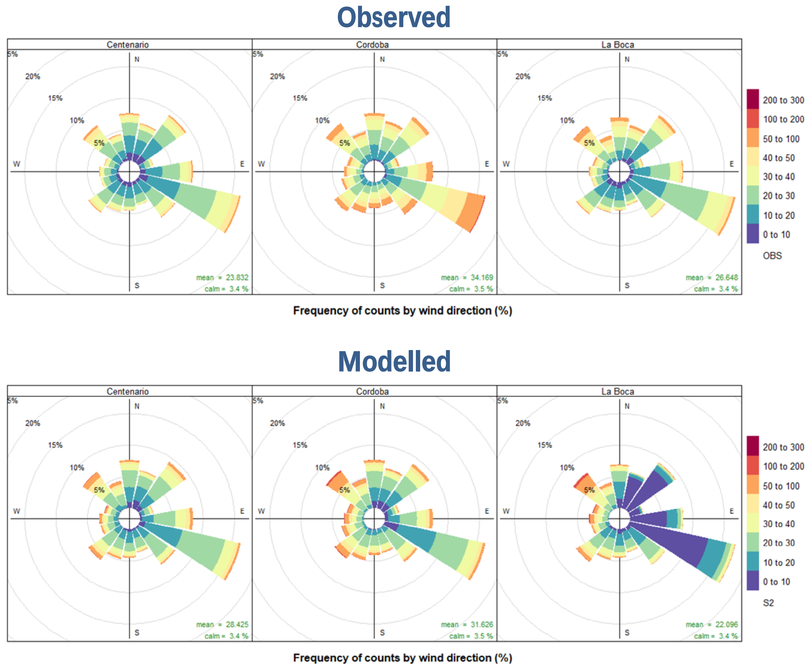
RESULTS

Scatter plot of observed and modelled NO_2 hourly concentrations, grouped by wind speed, at each AQ monitoring site



NO_2 concentration distributions by wind direction, at each AQ monitoring site

Observed



Modelled

Metrics obtained from the statistical comparison between observed and modelled NO_2 hourly concentrations (ppb):

i) By monitoring station

	Mean	Std. Dev.	NMSE	CORR	FA2	FB
All (N=76336)						
OBS	27.8	14.4				
MOD	27.2	20.5	0.53	0.382	0.708	0.022
Centenario (N=28093)						
OBS	23.8	11.9				
MOD	28.4	17.0	0.39	0.469	0.824	-0.176
Córdoba (N=22359)						
OBS	34.2	16.4				
MOD	31.6	21.3	0.51	0.26	0.738	0.077
La Boca (N=25884)						
OBS	26.7	13.1				
MOD	22.1	22.2	0.73	0.437	0.556	0.187

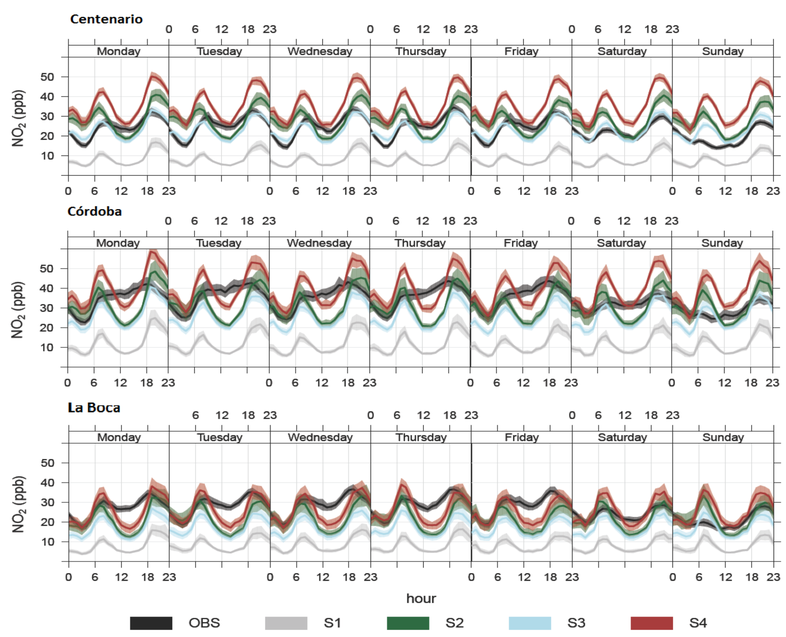
ii) By diurnal / nocturnal hours

	Mean	Std. Dev.	NMSE	CORR	FA2	FB
Diurnal (N=34471)						
OBS	29.0	14.9				
MOD	23.1	14.3	0.49	0.309	0.709	0.227
Nocturnal (N=41865)						
OBS	26.8	13.9				
MOD	30.6	23.9	0.56	0.478	0.707	-0.131

Sensitivity simulations

Hourly mean observed and modelled NO_2 concentrations at each AQ site, considering different model settings:

S1: without chemistry
S2: standard simulation ($[O_3]_r$ = 20 ppb)
S3: standard simulation without memory
S4: Idem S3 with $[O_3]_r$ = 40 ppb



CONCLUSIONS

◆ The metrics obtained at the three AQ stations are within acceptable ranges, being better at the UB site as expected, with a slight tendency to overestimate the night-time values and underestimate the diurnal ones.

◆ The night-time overestimation appears to be caused by the memory component of the model, which in turn presents little impact on the diurnal values.

◆ Potential DAUMOD-GRS model improvements could result from: a better characterisation of the emissions around the UI site, an improved estimate of the ozone regional background concentration and removal of the memory component from the model.

REFERENCES

[1] Pineda Rojas, A.L. and Venegas, L.E. 2013. Upgrade of the DAUMOD atmospheric dispersion model to estimate urban background NO_2 concentrations. *Atmos. Res.*, 120-121, 147-154.
[2] Mazzeo, N.A. and Venegas, L.E., 1991. Air pollution model for an urban area. *Atmos. Res.*,26, 165-179.
[3] Azzi, M., Johnson, G. and Cope, M., 1992. An introduction to the generic reaction set photochemical smog model. In: Proc. 11th Int. Clean Air Conf., pp. 451-462.
[4] Pineda Rojas, A.L., 2014. Simple atmospheric dispersion model to estimate hourly ground-level nitrogen dioxide and ozone concentrations at urban scale. *Environ. Modell. Softw.*, 59, 127-134.
[5] Venegas, L.E., Mazzeo, N.A. and Pineda Rojas, A.L. 2011. Chapter 14: Evaluation of an emission inventory and air pollution in the Metropolitan Area of Buenos Aires. En: D. Popovic (ed.) Air Quality-Models and applications, Editorial In-Tech, 261-288.
[6] Chang, J.C. and Hanna, S.R., 2004. Air quality model performance evaluation. *Meteorol. Atmos. Phys.*, 87, 167-196.
[7] Carslaw, D.C. and Ropkins, K., 2012. Openair - An R package for air quality data analysis. *Environ. Modell. Soft.*, 27–28 (0), 52–61.