How does densification versus urban sprawl affect air pollution?

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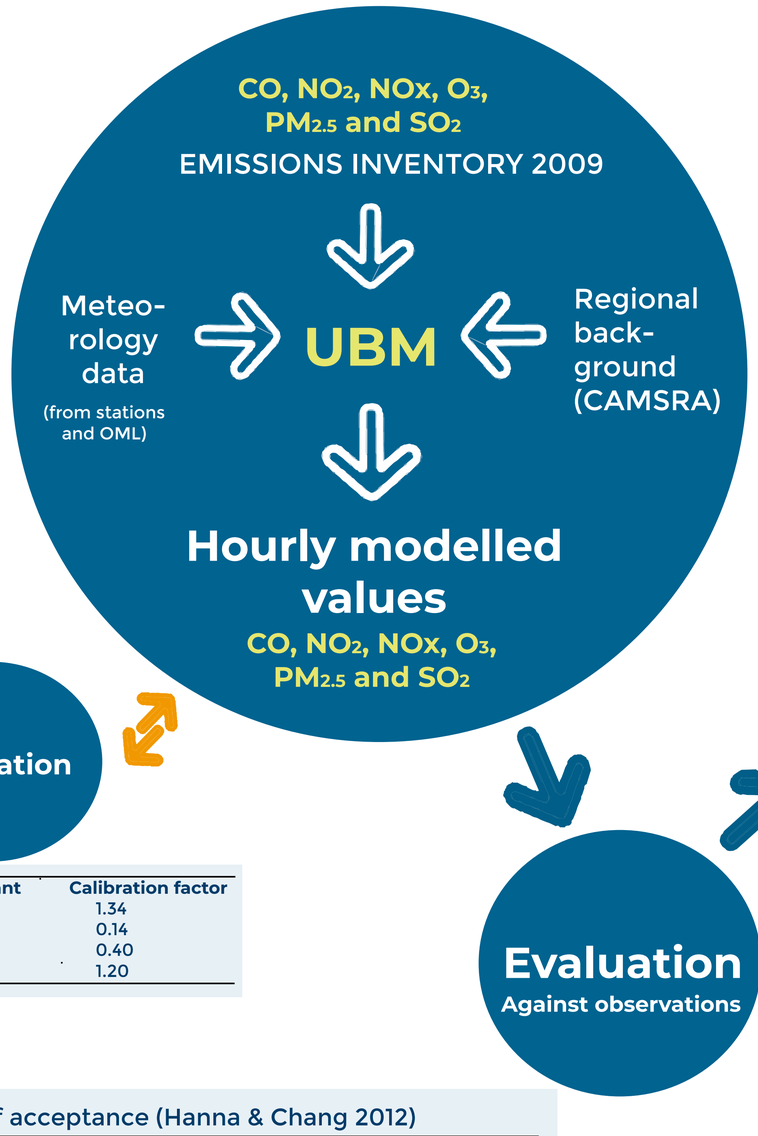
abstract

This study apply the Urban Background Model (UBM) developed by Aarhus University to estimate air pollution concentrations at urban background level for Quito, Ecuador.
Concentrations of CO, NO_2, NO_x, O_3, $PM_{2.5}$ and SO_2 are computed for the years 2008, 2009 and 2010 at the location of six monitoring stations

method



Pollutant	Calibration factor
CO	1.34
SO2	0.14
NOx	0.40
PM2.5	1.20

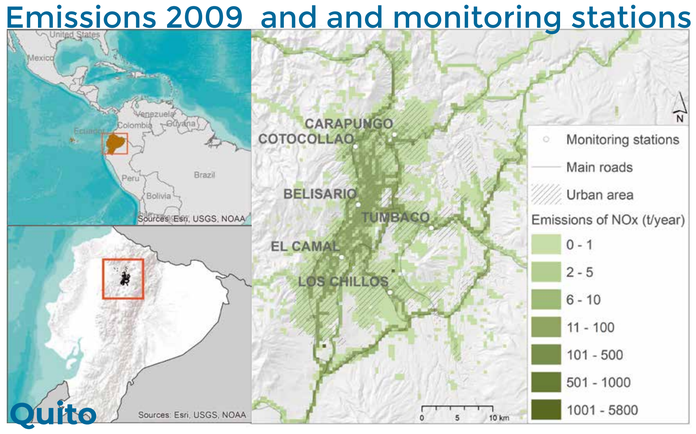
Criteria of acceptance (Hanna & Chang 2012)

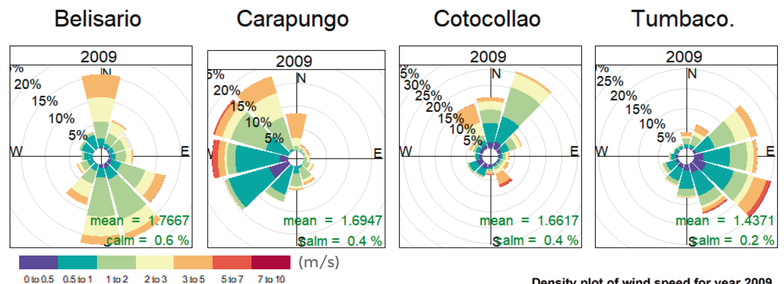
Criteria of acceptance	Description
FAC2 > 0.3	More than 30% of the predictions within a factor of two of the observations
FB < ±0.67	A relative mean bias less than a factor of two
NMSE < 6	The random scatter less than 2.4 times the mean
NAD < 0.5	The fractional area for errors less than 0.5

Years 2008 and 2010 are modelled with emissions and calibration factors from 2009 and corresponding meteorology data

context

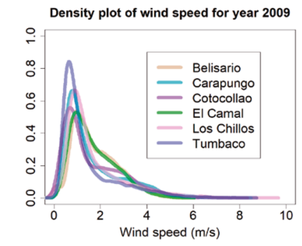
Emissions 2009 and and monitoring stations



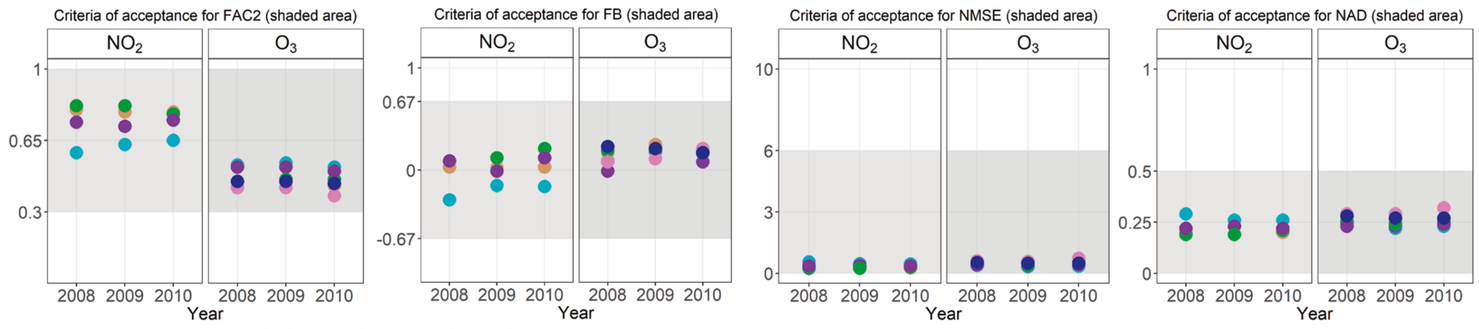


Inventory of emissions for the area of study for year 2009 (Baca et al., 2010)

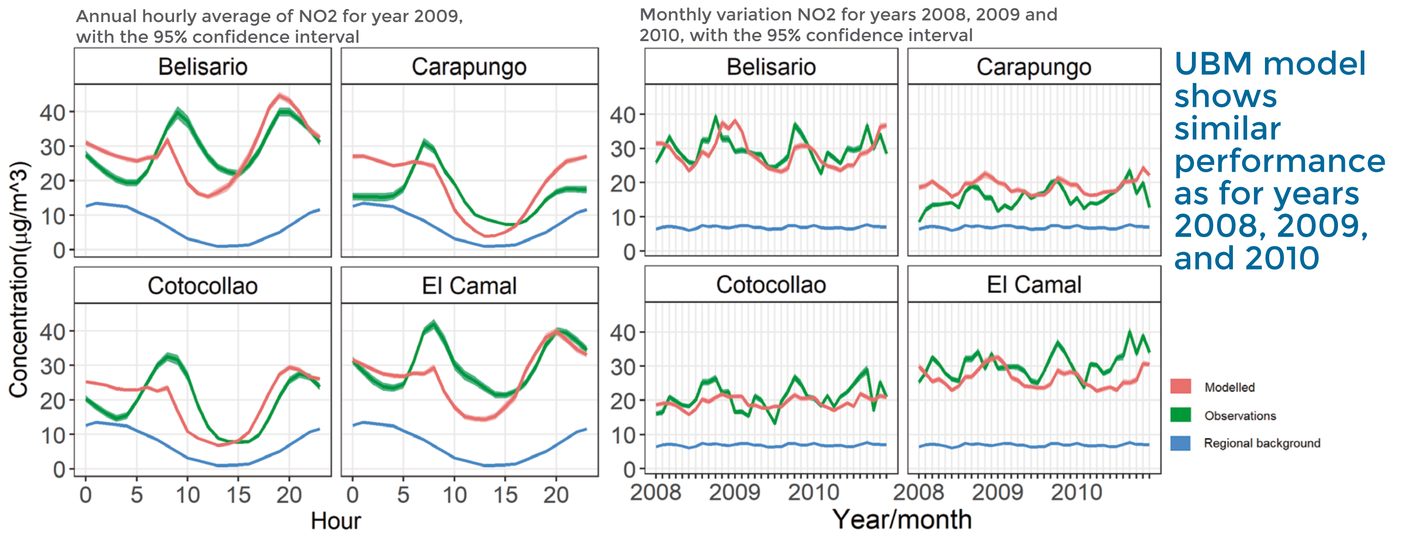
Source	CO (t/y)	SO_2 (t/y)	NO_x (t/y)	$PM_{2.5}$ (t/y)
Mobile	111,899	1,860	20,564	818
Point	2,927	4,899	13,465	1,284
Area	1,383	10	745	708
Total	116,208	6,769	34,774	2,809



results



Modelling of CO, NOx, NO_2, O_3 and $PM_{2.5}$ accomplishes with criteria of acceptance for the six locations of study. Although modelled SO_2 exceed NAD criteria for two stations



UBM model shows similar performance as for years 2008, 2009, and 2010

conclusions

UBM model successfully estimates concentrations for Quito for CO, NO_2, NO_x, O_3 and $PM_{2.5}$. Unsatisfactory results for SO_2 suggest that the emissions data must be revised.

Best performance when using meteorological data retrieved from the same location of simulation, although satisfactory results are obtained when using the same meteorological data for the six locations of analysis

Spatial modelling of urban growth and its influence on air pollution: Evaluation of vertical versus horizontal growth of the city of Quito
Supervisors: Matthias Ketzel, Gregor Levin, Ole Hertel

Sources
Location maps: ESRI, USGS, NOAA. Emissions map: Environment Secretary of the Municipality of Quito, Ministery of Agriculture and Farming of Ecuador
Hanna, S., Chang, J., 2012. Acceptance criteria for urban dispersion model evaluation. Meteorol. Atmos. Phys. 116, 133-146. https://doi.org/10.1007/s00703-011-0177-1.
Baca, J.C., Alemán, P., Díaz, V., 2010. Inventario de emisiones atmosféricas del Distrito Metropolitano de Quito 2009. Quito

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