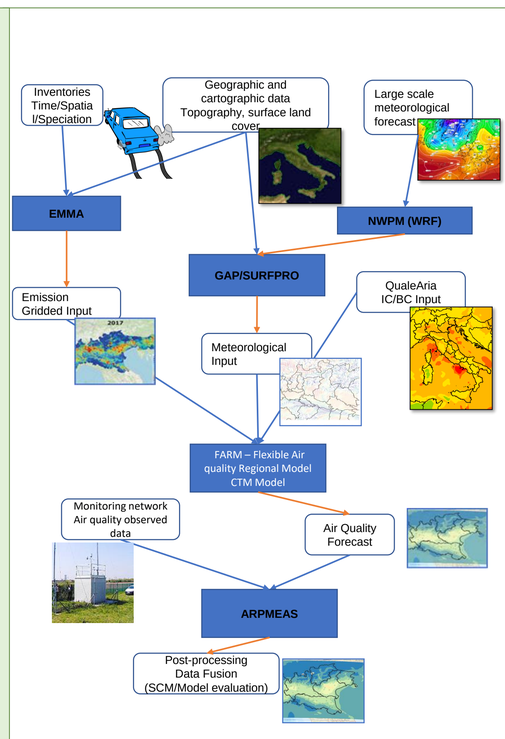
$PM_{2.5}$ WINTERTIME SENSITIVITY TO CHANGES IN NO_X, SO_X AND NH_3 EMISSIONS IN LOMBARDY REGION

L. Colombo, A. Marongiu, G. Fossati, G. Malvestiti, E. Angelino
ARPA Lombardia, U.O. Modellistica della Qualità dell'Aria e Inventari, via Ippolito Rosellini 17, 20124, Milano, Italy.

Introduction

The aim of this work is to identify the chemical regimes where secondary inorganic PM is formed over the Lombardy Region on the wintertime period. The work, which is part of a Lombardy Region project focused on the role of agricultural sector on air quality, is to evaluate the effects on $PM_{2.5}$ concentrations with a reduction of the emissions of NH_3, NO_x and SO_X in the whole Po basin.

Methods



Domain: 836 x 416 km^2
Horizontal resolution: 4 x 4 km
Vertical discretization: 16 levels up to 4960 a.g.l.
Simulation period: 1 January – 31 March 2019.
CTM model: FARM
BC: http://www.qualearia.it
Meteo model: WRF
Emission data: PREPAIR, INEMAR, EMEP, ISPRA
The contribution linked to the practice of the spreading livestock manure is time-dependent following 1) Nitrate Directive 91/676/CE which regulates the distribution over different areas in Lombardy and 2) meteorological conditions (i.e. the distribution is forbidden during the rainy day and over the frozen ground)

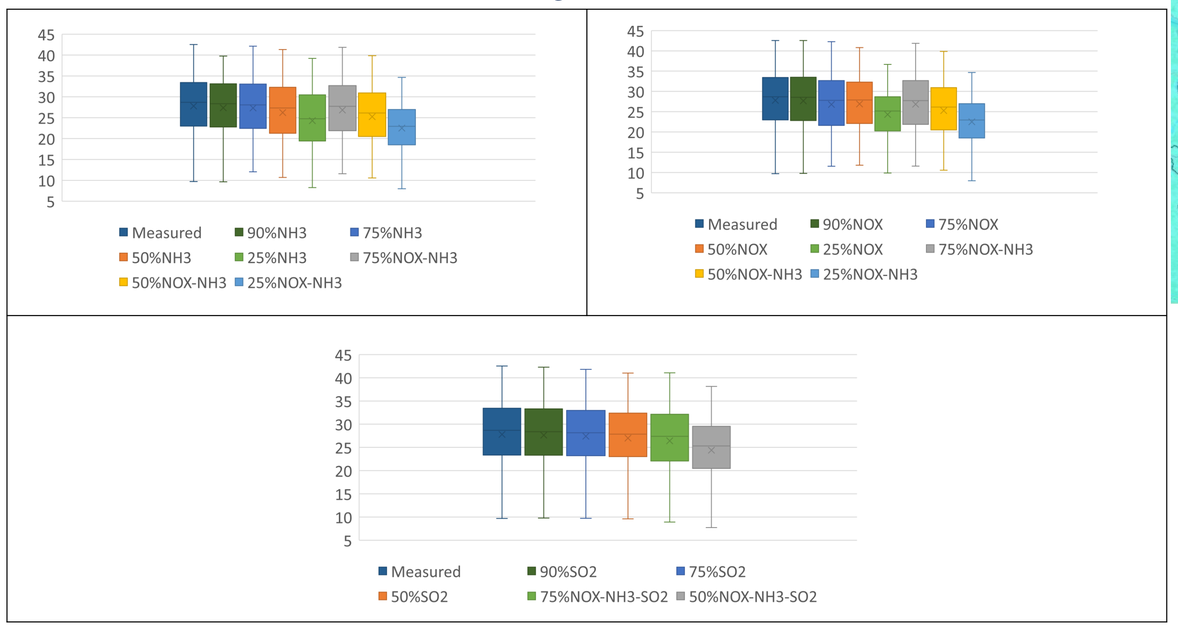
In this work, we simulated a series of 16 scenarios where NO_X, NH_3 and SO_X emissions were reduced independently or simultaneously by 10, 25, 50, 75 % with respect to the base case emission reference level.

Scenarios (name)	NO_X (emissions)	NH_3 (emissions)	SO_X (emissions)
Base case	100%	100%	100%
Sc_u_1a	90%	0	X
Sc_u_2a	0%	90%	X
Sc_u_1b	75%	0	X
Sc_u_2b	0	75%	X
Sc_m_1	75%	75%	X
Sc_u_1c	50%	0	X
Sc_u_2c	0	50%	X
Sc_m_2	50%	50%	X
Sc_m_2bis	25%	25%	X
Sc_u_3a	0	0	90%
Sc_u_3b	0	0	75%
Sc_m_3	75%	75%	75%
Sc_u_3c	0	0	50%
Sc_m_4	50%	50%	50%
Sc_u_f1	25%	0	X
Sc_u_f2	0	25%	X

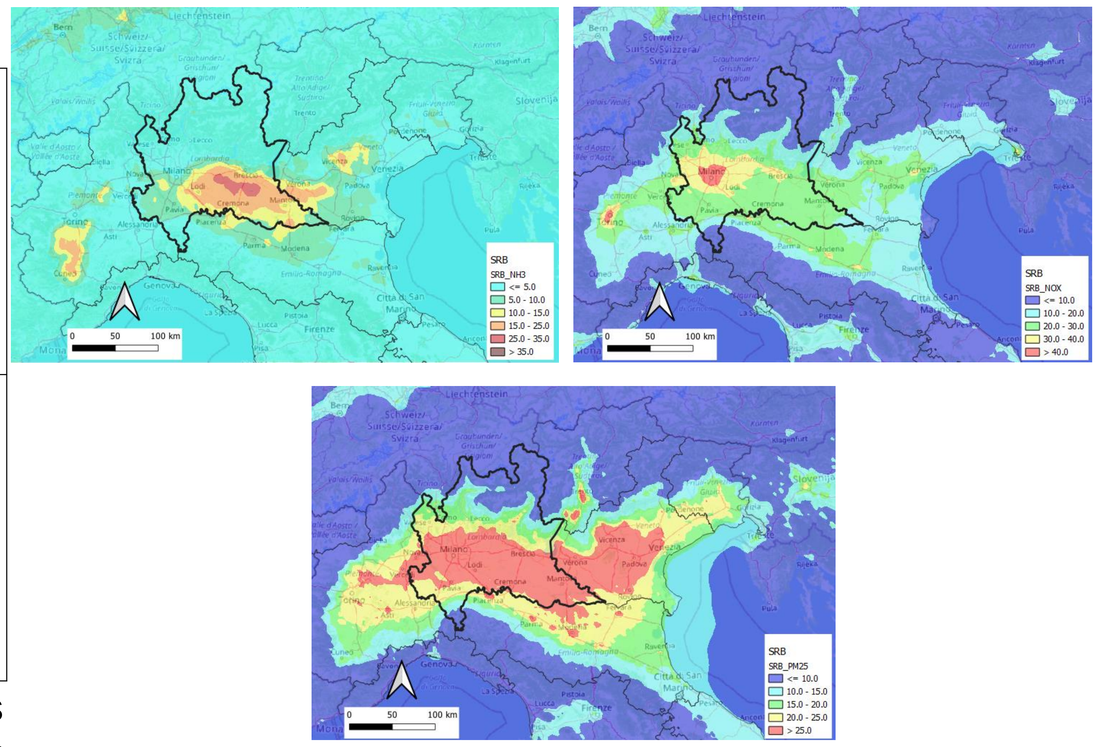
Case of study

Results

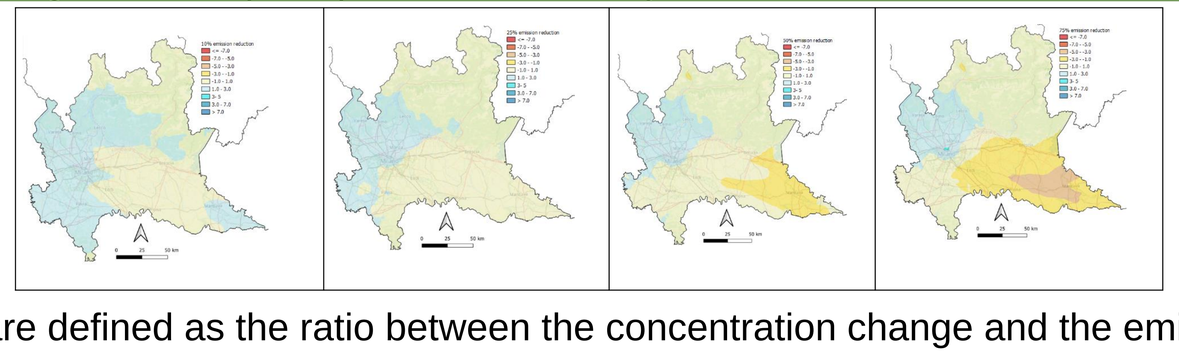
PM2.5 wintertime averages concentrations ($\mu g/m^3$): boxplots of observed and predicted concentration for background stations in the Po basin



Boxplots of $PM_{2.5}$ show that the higher decreasing of precursors the higher decreasing of $PM_{2.5}$ concentrations is. It is worth noting that the reduction is more consistent with coupled precursors reduction rather than singular but in principle with no linearity.



Spatial concentration ($\mu g/m^3$) of the wintertime period of the NH_3, NO_2 precursors and $PM_{2.5}$ concentrations



Wintertime chemical-regimes obtained at a reduction level of 10-25-50-75%. The maps represent the $P^{\alpha}_{NH3} - P^{\alpha}_{NOX}$ in $\mu g/m3$ indicator that shows the NO_X- sensitive (from yellow to red) and NH_3- sensitive (from light to dark blue) areas. The light yellow represents areas sensitive to both precursors' reduction.

Potential impacts (P) are defined as the ratio between the concentration change and the emission reduction intensity $P^{\alpha}_{NH3} = \frac{\Delta C^{\alpha}_{NH3}}{\alpha}$ $P^{\alpha}_{NOX} = \frac{\Delta C^{\alpha}_{NOX}}{\alpha}$ where ΔC^{α}_{x} is the PM concentration change resulting from a reduction of the NH_3 and NO_X emissions respectively.

It is possible to detect the areas where a $PM_{2.5}$ stronger reduction is obtained with a similar emission reduction of precursors. By using a difference between P^{α}_{NH3} and P^{α}_{NOX} a chemical regime can be defined: if the difference will be positive a reduction of NH_3 is more effective whereas on the contrary (negative difference) areas will be NO_X-sensitive

Conclusion

It can be observed that 1) the decreasing of precursors favors a diminishing of $PM_{2.5}$ concentrations and the reduction is more consistent with coupled precursors rather than a singular reduction; 2) areas NH_3-sensitive don't correspond to those where the ammonium release is higher; 3) for higher reduction of the precursors (moving from 25% to 75%) there are as many areas NO_X-sensitive as NH_3-sensitive, but important is mainly to reduce coupling NO_X-NH_3.The main finding is that in wintertime in urbanized areas the NH_3-sensitive areas are predominant with respect to the NO_X ones.