Contributi locali e non locali agli inquinanti nella Pianura Padana: dal caso particolare a una discussione generale sui modelli di composizione dell'atmosfera

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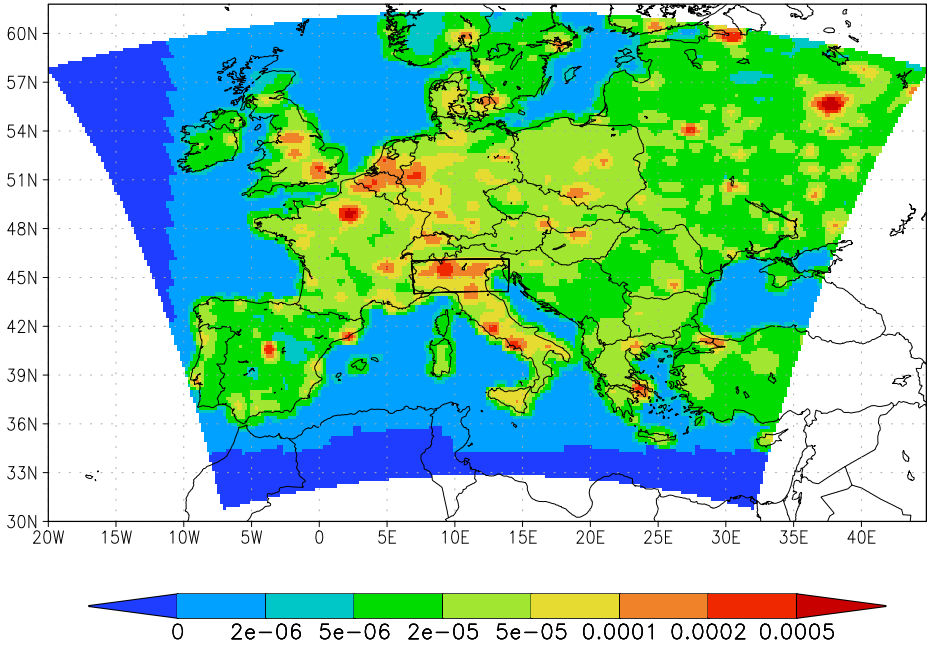
The budget of an European hot spot

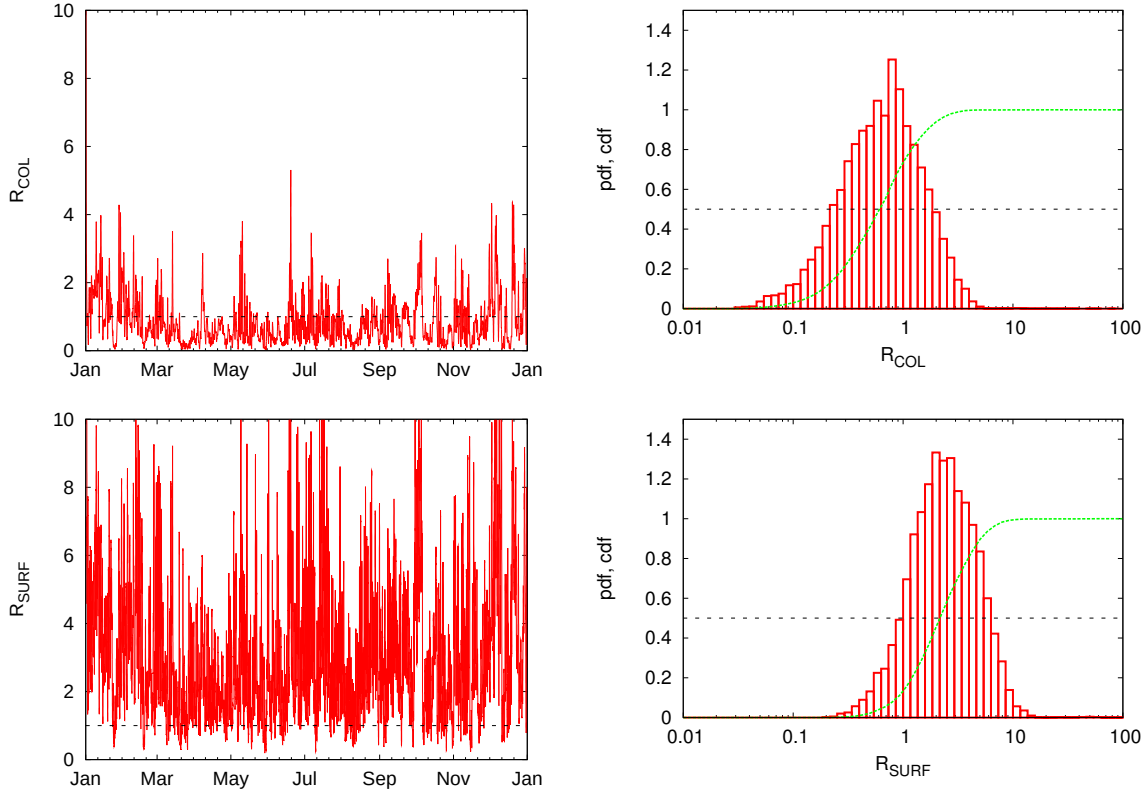
European hot spots: BENELUX-Ruhr area, Po Valley area, are considered as sources of pollutants for the surrounding areas. In the frame of FP7 project CITYZEN budgets have been evaluated, considering the different meteorological (namely, transport) features (Jakobs and Memmesheimer, 2011; Maurizi et al., 2013). See also the results from the companion FP7 project MEGAPOLI (Sofiev et al., 2011).



Yearly averaged emissions of CO in Europe expressed in $\mu g m^{-2} h^{-1}$.

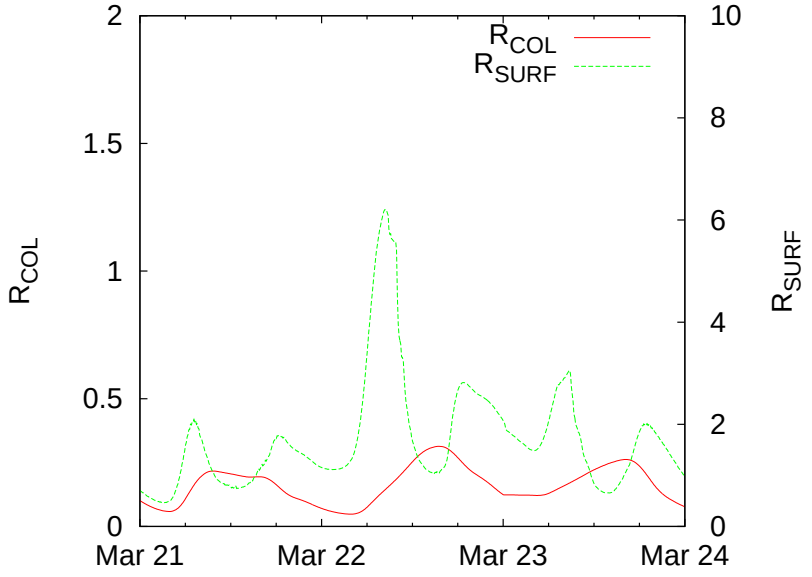
The tracer experiment

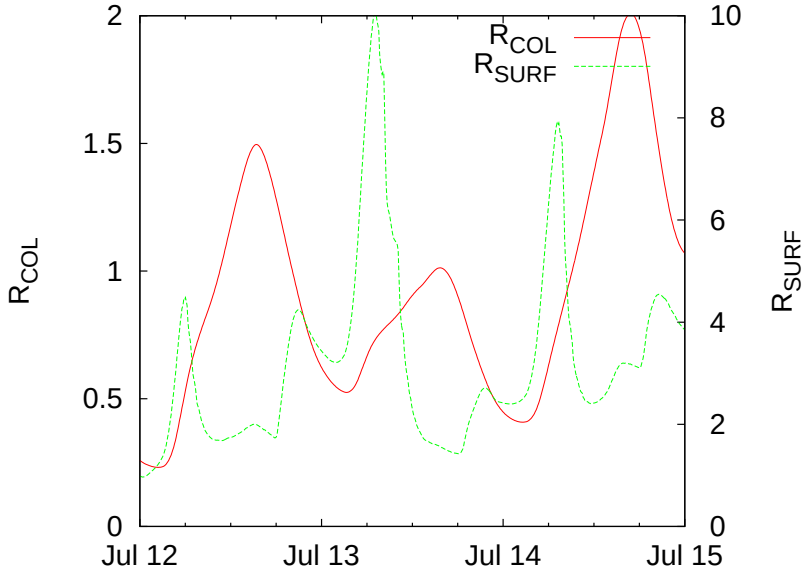
From Maurizi et al. (2013): simulations for year 2007. PV: tracer from emissions in the Po Valley; NPV: tracer from outside.



$R_{COL} = mass\ of\ PV / mass\ of\ NPV$ averaged over the entire tropospheric depth over the Po Valley. R_{SURF} the same for the lowest model layer (about $60\ m$ thick)

Effects of vertical transport





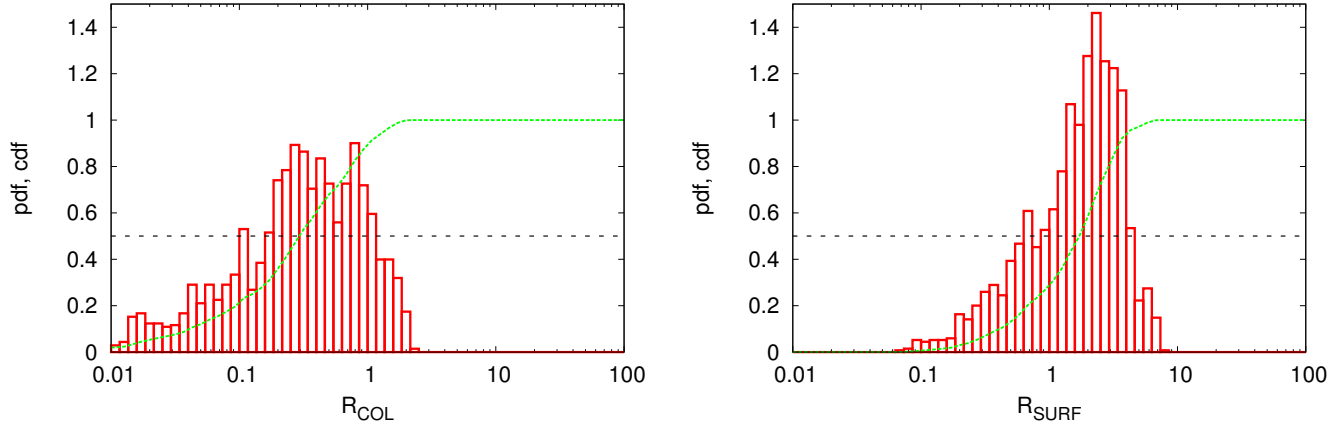
Surface peak in the late night (SBL), increase aloft during convective conditions.

The full chemistry exp.: PM10 results

Complete emissions, chemistry, deposition. Let consider here the $\mathrm{PM10}$ behaviour.
Linearity index $I = (mass\ of\ PV + mass\ of\ NPV)/mass\ STANDARD$:

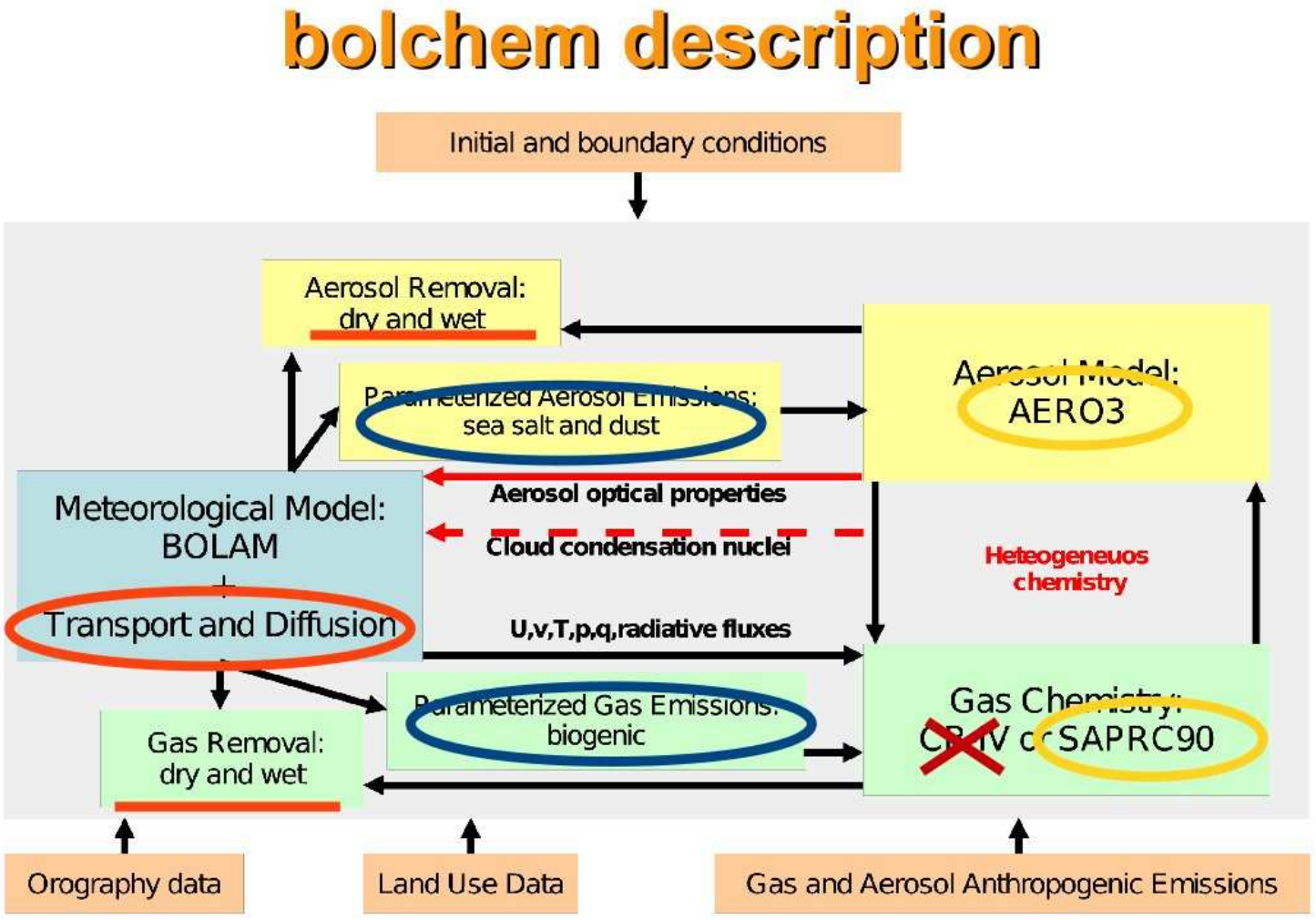
- almost linear behaviour $I \sim 1$, confidence interval ± 0.1
- otherwise, nonlinear effects are important (for instance chemical transformations, secondary aerosol production, ...)

Frequent occurrences of small nonlinearity in winter and spring. Sea salt at intermediate tropospheric level enhances the NPV contribution to columnar values.
For winter months (DJF) and small nonlinearity conditions



Left: column; right: surface

The model structure



Some basic aspects

The role of simulators in atmospheric sciences: to reproduce and to forecast

- interactions among dynamics, radiation, components (gas and particles) => on-line modeling
- which is the level of description of the basic processes necessary to obtain a given level of skill in the simulation?

The problem of evaluation of the skill

- weather forecast: rain; temperature; wind ...
- air quality: concentration near the ground ...
- climate simulations: ...
- ...

Uncomplete knowledge

an endless feedback: theory => observation => simulation => theory

- the geophysical problem: experiments (in the Galileian sense) cannot be made
- the need of simulators (numerical models)
- the need of complete observation sets oriented towards specific problems (the role of so-called 'supersites')
- the need of a deep understanding of the basic phenomena

examples:

- microphysics: aerosol as condensation nuclei in clouds
- wind-sea wave interaction and the exchange processes at the sea surface (momentum, but also sea salt particles)
- turbulence and waves in stable boundary layers
- resuspension (quantify Sahara dust source)

A list of problems (far to completeness)

- PBL parameterisation: vertical fluxes, exchange of momentum (simulation of wind intensity: airplane landing and take-off, wind energy); of heat (temperature near the ground, icing problems on roads); of tracers (pollutant concentration near the ground, exchange of CO2 and VOCs over vegetated surfaces)
- cloud convection (rainfall and in general precipitation)
- aerosols as condensation nuclei and their interaction with radiation; heterogeneous formation of particles
- dry and wet deposition processes
- natural emissions (sea salt; desert dust)
- the termodynamic behaviour of terrain

Warning!

- Nature can never be completely described, for such a description of Nature would have to duplicate Nature. (From ”Tao Teh King” by A. J. Bahm)
- In that Empire, the Art of Cartography attained such Perfection that the map of a single Province occupied the entirety of a City, and the map of the Empire, the entirety of a Province.
  In time, those Unconscionable Maps no longer satisfied, and the Cartographers Guilds struck a Map of the Empire whose size was that of the Empire, and which coincided point for point with it. (From ”Del rigor en la ciencia” by J. L. Borges)

Conclusioni

- sviluppo del modello
- misure estese nel tempo e spazialmente rappresentative: validazione/identificazione dei problemi
- misure ’caso di studio’ specifiche per il problema
- identificazione degli obiettivi della simulazione
- sviluppo del modello
- ...

References

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Maurizi, A., F. Russo, and F. Tampieri, 2013: Local vs. external contribution to the budget of pollutants in the po valley (italy) hot spot. *Science of the Total Environment*, **458-460**, 459465.

Sofiev, M., M. Prank, S. Finardi, J. Vira, J. Soares, A. D'Allura, P. Radice, C. Silibello, I. Konovalov, M. Beekmann, I. Kuznetsova, A. Yurova, A. Zvyagintsev, A. S. Zakey, F. Solomon, F. Giorgi, and A. Baklanov, 2011: Influence of regional scale emissions on megacity air quality, Deliverable D5.5, FP7 Megapoli.