Geophysical Research Abstracts
Vol. 14, EGU2012-9849, 2012
EGU General Assembly 2012

Dry deposition modelling of air pollutants over urban areas

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More than one-half of the world's inhabitants lives in urban areas. Consequently, the evolution of pollutants inside these urban areas are problems of great concern in air quality studies. Though the dry deposition fluxes of air pollutants, which are known to be significant in the neighborhood of sources of pollution, like urban areas, have not been modeled precisely until recently within urban areas.

By reviewing the physics of the processes leading to the dry deposition of air pollutants, it is clear that atmosphere turbulence is crucial for dry deposition. Urban areas, and particularly buildings, are known to significantly impact flow fields and then by extension the dry deposition fluxes. Numerous urban schemes have been developed in the past decades to approximate the effect of the local scale urban elements on drag, heat flux and radiative budget. The most recent urban canopy models are based on quite simple geometries, but sufficiently close to represent the aerodynamic and thermal characteristics of cities.

These canopy models are generally intended to parameterize aerodynamic and thermal fields, but not dry deposition. For dry deposition, the current classical "roughness" approach, uses only two representative parameters, z_0 and d, namely the roughness length and the zero-plane displacement height to represent urban areas. In this work, an innovative dry deposition model based on the urban canyon concept, is proposed. It considers a single road, bordered by two facing buildings, which are treated separately. It accounts for sub-grid effects of cities, especially a better parameterization of the turbulence scheme, through the use of local mixing length and a more detailled description of the urban area and key parameters within the urban canopy. Three different flow regimes are distinguished in the urban canyon according to the height-to-width ratio: isolated roughness flow, wake interference flow and skimming flow regime. The magnitude of differences in dry deposition fields between both classical "roughness" model and the more complete model developed here is investigated. For instance, the dry deposition fluxes are underestimated by the new model in comparison to the classical one during the day, but are overestimated during the night. This approach also provides spatially segregated dry deposition fields within the urban area which cannot be obtained from the classical "roughness" approach.