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Implementation of the Chemical-Transport Model LOTOS-EUROS in Northwest South America for the identification of ecosystems affected by contaminant deposition

Andres Yarce (1,2,3), Santiago Lopez-Restrepo (1,2), Nicolas Pinel (3), Olga Lucia Quintero (1), Arjo Segers (4), Martijn Schaap (4), and Arnold Heemink (2)

(1) Mathematical Modelling Research Group, Universidad EAFIT, Medellin Colombia, (2) Electrical Engineering, Mathematics and Computer Science, Applied Mathematics, TuDelft University, Delft The Netherlands, (3) Biodiversity, Evolution and Conservation Research Group, Universidad EAFIT, Medellin Colombia, (4) TNO Department of Climate, Air and sustainability, Utrecht The Netherlands

The deposition of atmospheric contaminants such as nitrogen dioxide NO_2, ammonia (NH_3) and ozone (O_3), transported from the sources to distant locations, alters chemical fluxes in natural ecosystems, with potential subsequent severe impacts such as biodiversity loss. Chemical Transport Models (CTMs) simulate dynamics like emissions, reactions, transport and depositions of various chemical compounds, essential for estimating the magnitude of this alterations.

This work presents the first regional implementation of the LOTOS-EUROS CTM on Northwestern South America, and focused on Colombia, with the objective of identifying potential vulnerable areas as a result of the deposition of atmospheric pollutants. Meteorology inputs for the year 2016 (the most complete at the time of initiation of the present work) were obtained from the European Centre for Medium-Range Weather Forecasting (ECMWF). The default topography was updated to the global GTMED2010 global digital elevation model. Default land cover data were updated to the LCCCI2009 data. Due to the lack of a regionally detailed and updated emissions inventory, emission input data were obtained from the Emission Database for Global Atmospheric Research (EDGAR) inventory and the depositions were calculated using the DEPosition of Acidifying Compounds (DEPAC) module. Simulation results were cross-referenced with the latest available cartographic data on protected areas and ecosystems maps.

Average annual total nitrogen and ozone deposition in Colombia in 2016 amounted to 4.2 (0.8-18.9) and 36.0 (7.7-109.4) $Kg \cdot ha^{-1} \cdot y^{-1}$ respectively. Seasonal minimal ozone deposition occurred in May and July, and maximal in June and December-January. Weighted average annual total nitrogen deposition in nationally protected areas and *páramos* (a critical ecosystem for the water cycle in Colombia) amounted to 2.61 (0.0-18.5) and 4.11 (2.2-14.2) $Kg \cdot ha^{-1} \cdot y^{-1}$, respectively. Total nitrogen deposition at or above 5 $Kg \cdot ha^{-1} \cdot y^{-1}$ occurs in 60% of the declared protected areas, and in over 13% of the total *páramo* area. Weighted average annual total ozone deposition in nationally protected areas and *páramos* amounted to 19.8 (0.0-99.3) and 24.8 (13.2-62.4) $Kg \cdot ha^{-1} \cdot y^{-1}$, respectively. Despite the lack of updated emission inventories, the simulations revealed areas with potential vulnerabilities due to the deposition of pollutants. The presented qualitative/quantitative spatio-temporal analyses of model results illustrate how updates in topography and land cover data impact the deposition predictions. Natural protected areas with noticeable changes in deposition between the default and updated input data were identified, emphasizing the importance of a careful characterization of the terrain in terms of the parameters that have direct influence on the velocity and flux deposition values before a chemical transport model implementation over a region, so as to be able to obtain the most accurate estimates from the modeling results.