Variability in atmospheric chemistry modeling of primary and secondary particles for application in environmental footprint calculations

Study using atmospheric fate model data and modeling techniques for detailed global-scale impact predictions

Level: Master
Start: Anytime
Project duration: 6 months
Project form: Modeling
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The aim of this research is to investigate the spatial variability of the atmospheric fate of fine particulate matter and ozone formation, to come to applicable factors for use in life cycle assessment (LCA).

LOTOS-EUROS is a chemical transport model (CTM) developed in collaboration with RIVM, PBL and TNO (Manders et al. 2017). With the model, the formation and dispersion of ozone, particulate matter, nitrogen dioxide, heavy metals and persistent organic pollutants across Europe can be calculated. The standard model resolution is approximately $25x25km^2$. The model makes the connection between emissions and the following concentrations and deposition. The model offers the scope to zoom in on specific urban, rural and industrial areas and it was selectively parametrized for other continents in the world.

Previous research showed that stack height (e.g. emissions from cars versus emissions from industry chimney pipes) influenced deposition and concentration, as well as the location of emissions, i.e. rural or urban areas. In a previous student project, these variations were studied for particulate matter emissions in Europe. However, other continents and atmospheric pollutants were not investigated.

Currently, the ReCiPe methodology for life cycle impact assessment includes fate factors for a number of countries, or groups of countries worldwide, distinguishing primary and secondary PM2.5 (fine particulate matter with a diameter of less than 2.5 µm) emissions (Huijbregts et al. 2017; Van Zelm et al. 2016). However, differences in low and high stack emissions, rural and urban emissions, as well as larger particles are not included. Therefore, this research focusses on the application of a smaller resolution model to obtain fate factors that better capture spatial global variability.

The following aspects are suggested to be addressed:

1. A division in high and low emission sources, as well as rural and urban emissions for ozone precursors
2. Analyses for particulate matter and ozone of other continents than Europe to come to applicable recommendations for worldwide fate factors

Literature

Huijbregts, M.A.J., Steinmann, Z.J.N., Elshout, P.M.F., Stam, G., Verones, F., Vieira, M., Zijp M., Hollander A., van Zelm, R. 2017. ReCiPe2016. A harmonized life cycle impact assessment method at midpoint and endpoint level. International Journal of LCA 22(3): 138-147. https://doi.org/10.1007/s11367-016-1246-y

Manders AMM, et al. 2017. Curriculum vitae of the LOTOS–EUROS (v2.0) chemistry transport model, Geosci. Model Dev., 10, 4145-4173, https://www.geosci-model-dev.net/10/4145/2017/

Van Zelm R, Preiss P, Van Goethem T, Van Dingenen R, Huijbregts MAJ. 2016. Regionalized life cycle impact assessment of air pollution on the global scale: damage to human health and vegetation. Atmospheric Environment 134, 129-137. https://doi.org/10.1016/j.atmosenv.2016.03.044