Supplement of

Impact of future land cover changes on HNO₃ and O₃ surface dry deposition

T. Verbeke et al.

Correspondence to: J. Lathière (juliette.lathiere@lsce.ipsl.fr)

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A. Sensitivity Tests

Sensitivity tests were carried out in order to investigate the relationship between each land type and dry deposition calculation in the LMDz-INCA model, giving keys and insights to better understand the impact of future land-use changes and climate on dry deposition.

Set-Up

One set of five simulations is performed in order to assess the sensitivity of dry deposition to land cover types. Each run uses a different vegetation map containing only one land-type covering the whole Earth continental surface (except over main desertic regions like Sahara, Gobi, Antarctica and Arctic regions): agriculture (A), grassland (G), deciduous forest (D), coniferous forest (C) and barren land (B). We use the present-day climate, biogenic and anthropogenic emissions in every sensitivity tests. We mention that a shift in type of surface involving agriculture expansion is considered as a land cover change (LCC) and is not associated with a change in nitrogen oxides due to the use of fertilizers (LU). The rest of the set-up is the same than present-day simulation presented in the core of the paper.
Sensitivity tests show a hierarchy in the type of land covers regarding deposition efficiency throughout the whole year and in every continental region: the calculated HNO3 dry deposition is maximal over forests (deciduous and coniferous) and minimal over bare soil (entire ranking: Deciduous, Coniferous > Agriculture > Grasslands > Bare soil). This is due to the strong dependency of $V_d$HNO3 to surface roughness over land (typically, $z_0=1m$ for forests and $z_0=0.001-0.1m$ for agriculture), when highest surface roughness combined with high wind speed give a high HNO3 deposition velocity (Walcek et al., 1986). On the other hand, O3 dry deposition is maximal over small canopies vegetation and minimal over bare soil too (entire ranking: Agriculture > Grasslands > Deciduous > Coniferous > Bare soil). Values found in tests
of sensitivity are also consistent with typical ozone deposition velocities exposed in the review by Wesely and Hicks, [1999]. For instance, in Europe and North America, we calculated a maximum December-February mean \( O_3 \) dry deposition velocity of 0.4 cm/s and 0.8 cm/s on average during the June-August period over cropland. Over deciduous forests, \( VdO_3 \) maximum value is about 0.2 cm/s and 0.5 cm/s respectively corresponding to the winter and summer periods.

B. Monthly means of dry deposition, surface concentrations and deposited fluxes in January and July for \( O_3 \) and \( HNO_3 \) (present-day simulation)
O3 Deposition rate JANUARY (cm.s⁻¹)

O3 Deposition rate JULY (cm.s⁻¹)

Surface O3 concentration JANUARY (ppb)

Surface O3 concentration JULY (ppb)

Deposition Flux O3 JANUARY (g.cm⁻².s⁻¹)

Deposition Flux O3 JULY (g.cm⁻².s⁻¹)