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How large is the contribution of cropland and grazing lands to the global dust cycle?

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Large parts of the Earth's land surface have undergone significant modification by humans due to, for example, urbanization and agriculture. Anthropogenic changes in land use due to cultivation and grazing can enhance the emission of soil mineral dust, the most abundant aerosol in mass originating from land sources, and thereby affect weather and climate.

The contribution of anthropogenic sources to the global soil dust load has been under debate over more than two decades with estimates ranging from 10 – 50%. Main reasons for this large uncertainty are (1) deficits in the representation of small-scale anthropogenic dust sources (cropland, pasture, and rangeland); (2) a lack of data available to constrain the global dust load; (3) deficits in the model representation of parameters affecting dust emission as well as of the dust emission process itself. Using a high-resolution ($0.1^\circ \times 0.1^\circ$) satellite estimate of atmospheric column dust load for dust source identification and land use maps for source attribution, a recent estimate suggests that 25% of global dust emissions originate from anthropogenic sources.

Here we hypothesize that a combination of the recent advances on source identification and attribution with state-of-the-art integrated numerical modeling and a diverse set of global dust observations will help to better address the following core questions:

- What are the relative contributions of natural and anthropogenic sources to global dust emissions depending on land use classification?
- How large is the uncertainty of natural and anthropogenic dust emissions?
- What are the key processes affecting this uncertainty?

We use NMMB-MONARCH, the Multiscale Online Nonhydrostatic AtmospheRe CHemistry model, to conduct multiple global model simulations. We thoroughly evaluate and constrain the model results based on measurements of dust concentration, deposition, and optical depth to obtain a model best estimate and to quantify the global natural and anthropogenic emission and deposition along with their uncertainty. We discuss the challenges of constraining the anthropogenic fraction of dust and identify model deficits that we are going to address in the future.