EGU2020-4558
https://doi.org/10.5194/egusphere-egu2020-4558
EGU General Assembly 2020

Real-world laboratories for studying anthropogenic aerosol impacts on clouds and Earth's climate

Velle Toll, Heido Trofimov, and Jorma Rahu
Institute of Physics, University of Tartu, Tartu, Estonia (velle.toll@ut.ee)

The cooling of the Earth's climate through the effects of anthropogenic aerosols on clouds offsets an unknown fraction of greenhouse gas warming. We discuss how causal relationship between aerosols and clouds can be derived from contrast between clouds polluted by anthropogenic aerosols and nearby unpolluted clouds. Ship tracks have been long considered to be real-world laboratories of aerosol-cloud interactions. More recently, polluted cloud tracks induced by aerosols emitted from volcanoes and wildfires and various industrial sources - such as oil refineries, smelters, coal-fired power plants, and cities have been analysed (Toll et al. 2019; Nature, https://doi.org/10.1038/s41586-019-1423-9). In this research, we extend satellite observations of polluted cloud tracks from Toll et al. (2019) with analysis of smaller and larger scale polluted cloud areas detected in satellite images.

Polluted clouds are detected in MODIS and SEVIRI satellite images as areas with strongly increased cloud droplet number concentrations. Polluted cloud tracks can be utilized to study frequency and magnitude of anthropogenic cloud droplet number perturbations and subsequent cloud adjustments. Anthropogenic aerosol perturbations on liquid-water clouds are detected in various major global industrial areas. Both tens of kilometres wide ship-track-like polluted cloud tracks and hundreds by hundreds of kilometres wide polluted cloud areas show that cloud water can both increase and decrease in response to aerosols depending on meteorological conditions. On average, there is relatively weak decrease in cloud water. Polluted cloud tracks also show that cloud fraction can both increase and decrease compared to nearby less polluted clouds. Applicability of pollution tracks to study impact of absorbing aerosols situated above clouds on below-lying clouds is discussed. We expect that utilization of real-world laboratories of aerosol impacts on clouds will lead to improved physical parameterizations in global climate models and more reliable projections of the future climate.