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User-oriented development of global emission inventories: Bottom-up modeling of emissions from land transport, aviation and shipping in the DLR project ELK

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The transport sector accounts for about one quarter of worldwide anthropogenic carbon dioxide emissions. Since a robust growth in transport activity is expected over the coming decades, reducing associated emissions to mitigate human-caused climate change is a particular challenge. In order to achieve high-quality comparative monitoring, to develop scenarios for future emissions, and to enable a robust assessment of climate protection measures, the allocation of emissions to the subsector level is a necessary prerequisite. The DLR project ELK – EmissionsLandKarte (en.: emission map) contributes here in several respects: (1) requirements are specified in an application-based manner, i.e. compatibility with existing inventories, such as the ones generated for IPCC, is ensured and insufficiencies in spatial resolution and methodological detail are addressed, (2) an input database congruent with both statistical data and SSP scenarios is provided, and (3) bottom-up calculations are performed that allow attribution of climate impacts to specific transport services, as well as prospective analyses where, for example, activity levels change or alternative fuels affect regional emission factors. The resulting prototype global gas and particle emission inventories for land transport, aviation and shipping reflect the status quo as of 2019.

For land transport, fine-grained activity and vehicle fleet data as well as technology-specific emission factors are applied. This allows emissions from passenger and freight transport to be disaggregated by mode and vehicle type. New approaches for spatial disaggregation of emissions will increase transparency of the methodology. For aviation, calculations are based on fleet composition and transport performance for both passenger and cargo traffic at the airport pair level, while real flight tracks serve as the foundation for spatial allocation. For both transport sectors, complementary analyses are performed to characterize particulate emissions in order to fill gaps in data availability. For shipping, transport performance on inland waterways and

maritime routes are considered, including technical data describing propulsion and bunkering. Finally, all mode-specific results are subjected to an innovative uncertainty assessment aligned with the needs of other emission inventory creators through a detailed evaluation per uncertainty factor, as well as aggregated values for climate modelers and practitioners. The consistent assessment of uncertainty factors along the entire calculation chain, such as activity levels, emission factors, and proxy data used for spatial or temporal disaggregation, promotes comparability across all transport sectors. In this paper, we outline the new methodological approaches for mapping transport emissions and present first results.