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Technical Note: Coupling of chemical processes with the Modular Earth Submodel System (MESSy) submodel TRACER

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Abstract. The implementation of processes related to chemistry into Earth System Models and their coupling within such systems requires the consistent description of the chemical species involved. We provide a tool (written in Fortran95) to structure and manage information about constituents, hereinafter referred to as tracers, namely the Modular Earth Submodel System (MESSy) generic (i.e., infrastructure) submodel TRACER. With TRACER it is possible to define a multitude of tracer sets, depending on the spatio-temporal representation (i.e., the grid structure) of the model. The required information about a specific chemical species is split into the static meta-information about the characteristics of the species, and its (generally in time and space variable) abundance in the corresponding representation. TRACER moreover includes two submodels. One is TRACER_FAMILY, an implementation of the tracer family concept. It distinguishes between two types: type-1 families are usually applied to handle strongly related tracers (e.g., fast equilibrating species) for a specific process (e.g., advection). In contrast to this, type-2 families are applied for tagging techniques. Tagging means the artificial decomposition of one or more species into parts, which are additionally labelled (e.g., by the region of their primary emission) and then processed as the species itself. The type-2 family concept is designed to conserve the linear relationship between the family and its members. The second submodel is TRACER_PDEF, which corrects and budgets numerical negative overshoots that arise in many process implementations due to the numerical limitations (e.g., rounding errors). The submodel therefore guarantees the positive definiteness of the tracers and stabilises the integration scheme. As a by-product, it further provides a global tracer mass diagnostic. Last but not least, we present the submodel PTRAC, which allows the definition of tracers via a Fortran95 namelist, as a complement to the standard tracer definition by application of the TRACER interface routines in the code. TRACER with its submodels and PTRAC can readily be applied to a variety of models without further requirements. The code and a documentation are included in the electronic supplement.

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