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Geoscientific Model Development Discussions

Interactive comment on "The generic MESSy submodel TENDENCY (v1.0) for process-based analyses in Earth System Models" *by* R. Eichinger and P. Jöckel

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Thank you very much for your valuable comments and questions. Our answers are:

1. As it is now implemented, the submodel TENDENCY is directly portable only to other MESSy basemodels (i.e., models equipped with the MESSy infrastructure), since it utilizes two other MESSy infrastructure submodels: CHANNEL for memory management and I/O (Jöckel et al., 2010: Development cycle 2 of the Modular Earth Submodel System (MESSy2)) and TRACER for chemical constituents (Jöckel et al., 2008: Technical Note: Coupling of chemical processes with the Modular Earth Submodel System (MESSy) submodel TRACER).

   The *concept*, however, is portable to other model systems, as well. For this, large parts of the code can be reused as well, since only the CHANNEL based memory management and the TRACER infrastructure need to be replaced.

   In any case, the list of prognostic (non-TRACER) variables, which depends on the basemodel, needs to be adapted, which is, however, technically a minor modification.

   This comment was indeed very helpful, we will clarify this throughout the manuscript and add some text to Section 2.

2. This is apparently a misunderstanding mixing the "unaccounted" object with the closure test:

   - An "unaccounted" object (as explained in Section 3.1, User interface) is created for each user defined pair of *prognostic variable* and *corresponding list of processes or sums*. This is to ensure that the TENDENCY budget is always closed. For example, if the user defines only one specific process he/she is interested in, the "unaccounted" object will contain the sum of all other processes. The other way around, if the user specifies all processes explicitely, the "unaccounted" object will contain zero.
   - The closure test (as explained in Section 3.2) is completely independent of this and serves a different purpose: The closure test, if activated, checks if all submodels modify the prognostic variable tendencies correctly via TENDENCY. If, what can in Fortran technically not be prohibited, a submodel (as classically done!) USEs (by Fortran USE) a prognostic variable tendency directly and modifies it without calling the corresponding TENDENCY routines, TENDENCY will detect a discrepancy against its internal bookkeeping at the end of the time step and create an error message.

   We will recheck the manuscript, in order to detect, how this misunderstanding can evolve and clarify this point.

3. See previous point.
   The closure test will at the end of the time step detect a discrepancy between its internal book-keeping of correctly modified tendencies with the overall modified tendency, which contains also the contribution of the new submodel. This will trigger an error message.

4. TENDENCY is designed for the book-keeping of individual process tendencies, thus it is directly related to the "granularity" of the process descriptions. If a process can be subdivided into further sub-processes each calculating a distinct contribution to the tendency, those sub-process-tendencies can be handled by TENDENCY. This implies that intermediate tendencies within an implicit scheme cannot be captured by TENDENCY, unless they are explicitely calculated within the scheme.

   This is a limitation by design, and an important point. We will add an explanation to this at the beginning of Section 3.

   In order to follow production/loss rates from chemical schemes MESSy provides additional tools, based on the tagging principle, for instance:

   - Grewe, V., 2013: A generalized tagging method
   - Gromov et al., 2010: A kinetic chemistry tagging technique and its application to modelling the stable isotopic composition of atmospheric trace gases

5. See also our answer to your question 1. The set of prognostic variables is defined by the basemodel, including their units. If a basemodel can be operated, e.g., with different dynamical cores defining different sets of prognostic variables, this needs to be taken into account in TENDENCY. TENDENCY does not perform any unit checks.

   The example with the scaled and unscaled winds sharing the same memory (or variables) you are referring to, is an ECHAM inheritance of EMAC.

6. No, developers do not have to take parallelisation into account, because TENDENCY operates within the parallel decomposition, i.e., locally in each grid box.

Interactive comment on Geosci. Model Dev. Discuss., 7, 2217, 2014.