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Structure and principles of the Modular Earth Submodel System (MESSy)

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Substantial improvements have been achieved in the modelling of the terrestrial climate system. The complexity of the applied Earth System Models is continuously increasing due to mainly three reasons: First, more and more processes are taken into account. Second, the representation of the processes by numerical schemes is increasingly detailed, and third, the coupling between different processes (feedbacks) often turns out to be essential for a realistic description of the system. The efficient development towards such comprehensive Earth System Models requires adequate software infrastructures and standardisations for the entire work-chain: the formulation of algorithms representing the processes of the terrestrial climate system, their implementation as efficient codes usable on various hardware platforms, a test-bench for alternative approaches, a flexible and user-friendly production environment to perform simulations for specific scientific purposes, and appropriate tools for the data analysis (data mining, visualisation and statistics). The overall challenge is to provide a multi-developer, multi-user, multi-purpose infrastructure combining contributions from several fields of expertise. The Modular Earth Submodel System (MESSy), awarded with the "Heinz Billing Award for the Advancement in Scientific Computation" in 2005, represents an approach for the transformation/expansion of existing general circulation models into comprehensive Earth System Models. We present the technical concept, the infrastructure, and the implementation of the various components of MESSy.