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Why Earth System Models be better modular: 12 years of experience with the Modular Earth Submodel System (MESSy) in a nutshell

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Earth System Models (ESMs) for simulating the past and future of climate become increasingly more complex through the incorporation of more sub-domains and more detailed process descriptions. Most of the currently available ESMs are continuously further developed from legacy codes, of which some have been initiated decades ago. In many cases, these codes have grown over time into "monolithic monsters", which increasingly impede scientific progress, for mainly two reasons:
(1) The implementation of improved (or at least alternative) process descriptions or parameterizations is cumbersome and requires an in-depth knowledge of many details of the legacy code.
(2) The available high-performance computing (HPC) environment has been - and still is - undergoing - dramatic changes, which require numerous refactorizations of the historically grown codes.
The larger and the more complex the legacy code, the less efficient and more difficult is its improvement.

In 2005 we proposed a modular approach to overcome the "legacy monoliths", namely the Modular Earth Submodel System (MESSy), which we consequently pursued over the years. The new model system quickly gained (and still does) new developers contributing to the code and users. The developments enabled us to participate with our flagship, the EMAC (ECHAM/MESSy Atmospheric Chemistry) model, in the Chemistry Climate Model Initiative (CCMI).

We present the basic ideas and design concepts of MESSy (the highly structured Modular Earth Submodel System), its current status, we review briefly its development, also in view of the 10 year anniversary of GMD, and we share our practical experiences.