Project: **882**

Project title: **CESM1 (Community Earth System Model) as a new MESSy basemodel: Evaluation and further development**

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Summary

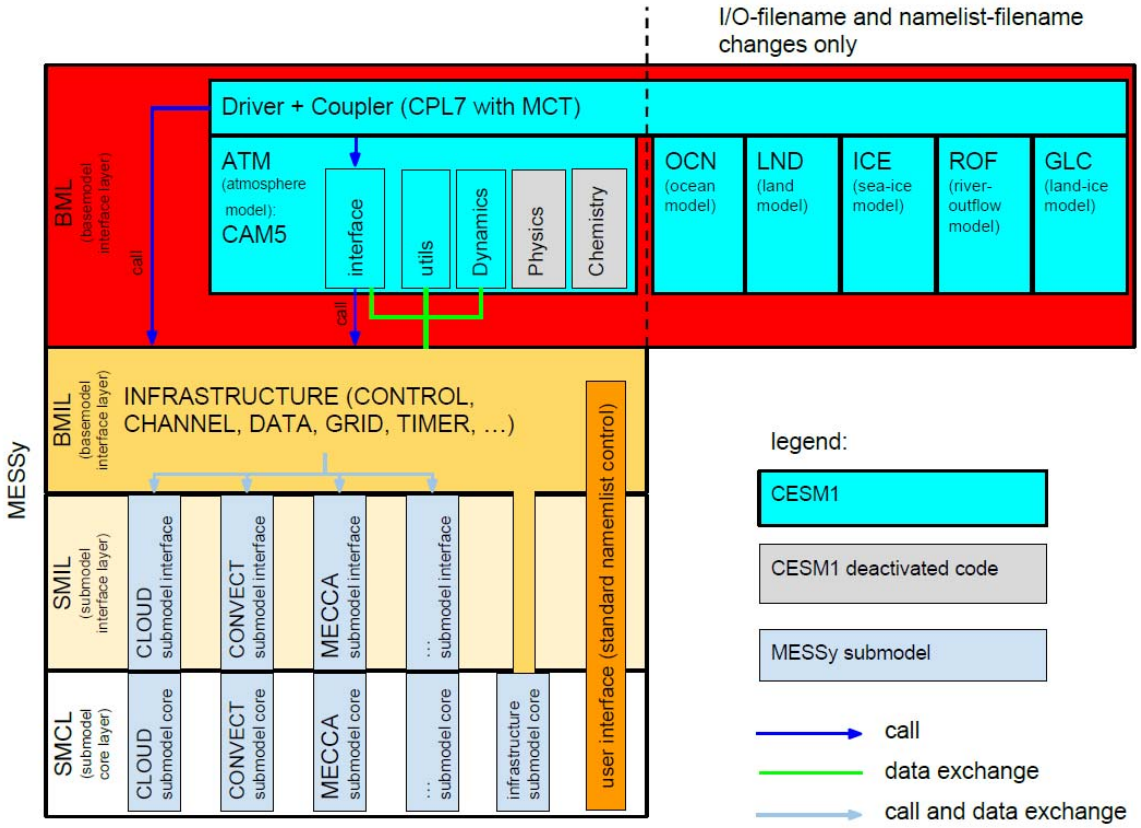
Very good progress has been made in terms of the necessary developments and the evaluation. Additional to the ECHAM dynamical core, MESSy now has the capability to run with the CESM1/CAM5 spectral element and finite volume dynamical cores. The developments have been checked into the main code trunk. Evaluation simulations have been performed with all three cores. The developments and a brief evaluation have been published in the journal GMDD. The article is currently in the discussion phase. Some further developments as well as data analysis might be necessary for the GMD version of the paper.

Performed developments

The following developments were performed:

1. Rewrite of the CAM5 vertical diffusion scheme as a MESSy submodel
2. Data structures for spectral element core were implemented
3. Adjustments to chemistry submodels and radiation for full chemistry feedback to dynamics
4. Adjustments to the MESSy and CESM1 timer systems
5. Integration of CESM1 components into autoconf and make system of MESSy

Diagram of CESM1 integration into MESSy[1]:



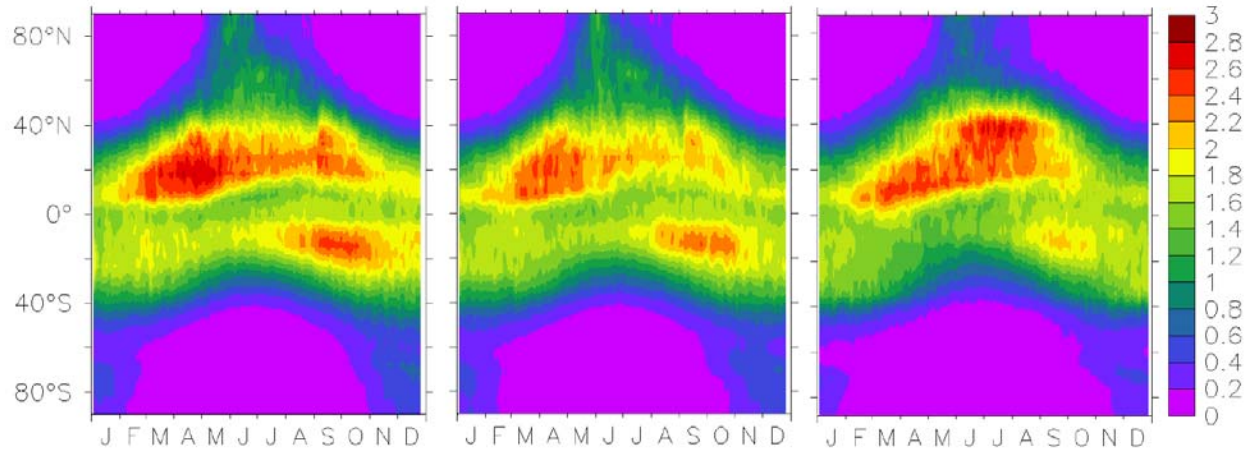
[1] See also http://www.messy-interface.org/current/messy_interface.html for the generic MESSy interface structure.

Evaluation simulations

The following simulations have been performed:

- CESM1/MESSy with spectral element core (CMAC-SE)
  - Troposphere setup with interactive chemistry
- CESM1/MESSy with finite volume core (CMAC-FV)
  - Troposphere setup with interactive chemistry
  - Middle atmosphere setup with interactive chemistry
- ECHAM5/MESSy simulations (maEMAC)
  - Middle atmosphere setup with interactive chemistry

For details, see Baumgaertner (2015). As an example, the following figure shows the zonal mean OH number concentration (10^6 molecules cm^{-3}) at the surface for the year 2000 from CMAC-FV (left), CMAC-SE (middle) and maEMAC (right) simulations:



Scientific highlights (example): Tropospheric methane lifetime

Tropospheric OH concentrations are important for the tropospheric methane lifetime (τ_{CH4}). With τ_{CH4}=7.61 years CMAC-FV is more reactive than maEMAC (τ_{CH4}=8.24 years), whereas CMAC-SE is less reactive (τ_{CH4}=10.46 years). This finding highlights the large influence τ_{CH4} of the dynamical core.

Code availability

As planned in the proposal, all developments have been checked into the main trunk of the MESSy code and are available with version 2.52 (released in July 2015).

References

Baumgaertner, A. J. G., Jöckel, P., Kerkweg, A., Sander, R., and Tost, H.: Implementation of the Community Earth System Model (CESM1, version 1.2.1) as a new basemodel into version 2.50 of the MESSy framework, Geosci. Model Dev. Discuss., 8, 6523-6550, doi:10.5194/gmdd-8-6523-2015, 2015

Baumgaertner, A. J. G.: Comparison of CESM1/MESSy and ECHAM5/MESSy (EMAC), doi:10.5281/zenodo.18846, 2015