Folgeantrag auf Mistral für EU Projekt CRESCENDO

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Report for 2016

In the original CPU time application for 2016, several simulations were planned for the second half of the year 2016. For many of those planned simulations, the final and official CMIP6 version of MPI-ESM 1.2 must be used. As release date of this final version has been delayed, these simulations and their subsequent evaluation were delayed as well.

The main CRESCENDO work in 2016 was related to model developments. On one hand, these development contributed to the CMIP6 version of MPI-ESM 1.2, on the other hand, developments were dedicated to CRESCENDO targets of complete biogeochemical cycles of carbon and nitrogen. JSBACH has been equipped with nitrogen, and this JSBACH-CN version for CMIP6 was recalibrated and a manuscript on the nitrogen implementation (Goll et al., GMD, tbs) is in the internal review at MPI-M. The land use component of JSBACH is updated and linked to the CN version. Decision on the land use transition sites used for chronosequences has been done, the prototype experiments with JSBACH have been published (Nyawira et al., BG, 2016).

In Hagemann et al. (2016, ESD), we investigated how the representation of cold region physical soil processes, especially the effects of freezing and thawing of soil water influences thermal and hydrological states and processes. In this study, the coupled atmosphere-land models MPI-ESM have been driven by prescribed observed SST and sea ice in an AMIP2-type setup with and without newly implemented cold region soil processes in the JSBACH land surface scheme (JSBACH-PF; Ekici et al., 2014, GMD). Results show a large improvement in the simulated discharge. On one hand this is related to an improved snowmelt peak of runoff due to frozen soil in spring. On the other hand a subsequent reduction of soil moisture enables a positive feedback to precipitation over the high latitudes, which reduces the model’s wet biases in precipitation and evapotranspiration during the summer. This is noteworthy as soil moisture – atmosphere feedbacks have previously not been in the research focus over the high latitudes. These results point out the importance of high latitude physical processes at the land surface for the regional climate.

Several developments have been made for JSBACH that are applicable in JSBACH-offline and AMIP simulations based on MPI-ESM 1.2:

- We have further improved the JSBACH-PF version that has been equipped with cold region processes. The organic layer was placed in the upper soil layer instead of on top of the soil, and it was limited to forested areas. Currently this placement is combined with permafrost areas. Several bug fixes were conducted that were necessary after the spatial limitation of the organic layer. In addition, the handling of frozen carbon in permafrost areas has been implemented.

- A model for the representation of wetland extent dynamics (WEED) has been implemented into JSBACH that is based on Stacke and Hagemann (2012, HESS). Initial results in an AMIP2-type setup showed a reasonable distribution of wetlands with some underestimation of wetland extend over the high latitudes.
- Initial tests with several of the LS3MIP offline forcings have been conducted with JSBACH. The JSBACH-offline version has been improved with regard how the offline forcing is used.

Several developments were conducted for the HAMOCC, the ocean biogeochemistry component of MPI-ESM1.2. Following recommendations in the biogeochemical protocols for OMIP, the carbonate chemistry was updated to

- use the total pH scale
- include alkalinity from phosphorous, silicic acid in total alkalinity
- use the equilibrium constants recommended for best practices by Dickson et al. 2007; Dickson, 2010

In addition, updated gas transfer velocities and Schmidt numbers (Wanninkhof, 2014) are now used for the gas-exchange.

New developments comprise the implementation prognostic nitrogen fixers, which have been only diagnostic before. Simulations of integrated biomass show a reasonable agreement with the existing sparse observations. Further, the sinking velocity is now parameterized as a function of depth, which leads to improved simulated distributions of organic sediment.