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Development of ocean model LSOMG

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The purpose of this contribution is to present the ocean general circulation model LSOMG. It originates from the LSG (Maier-Reimer and Mikolajewicz, 1992) ocean model, however, significant number of changes has been made. LSOMG is a z-coordinate baroclinic ocean model which solves the primitive equations under the Boussinesq approximation. We intend to use the model for a various geophysical applications with the focus on paleoclimate studies. Hence, the model is not as complex as the current state-of-art climate models, such as the Modular Ocean Model or NEMO models. On the other hand, it is less computationally demanding.

The changes and improvements in the code will be reported. One of the obvious changes is that the governing equations are no more discretized on the Arakawa E grid. The whole model has been rewritten on the Arakawa C grid. The main motivation is to avoid a coexistence of two solutions on the grid that evolve independently of each other. A more natural treatment of boundary conditions and simpler structure of the grid are additional advantages. Another significant change is the treatment of time tendencies. The system of equations is split to barotropic and baroclinic subsystems. Both subsystems may either be discretized at the same time points (as in the original LSG model), or their discretizations may be staggered in time as described in Griffies (2004). The original fully implicit barotropic time stepping scheme was found to significantly dissipate energy. Three different time stepping schemes are available instead. Namely, the predictor-corrector scheme of Griffies (2004), the generalized forward-backward scheme of Shchepetkin and McWilliams (2008) and the implicit free surface scheme of Campin et al. (2004). The first two schemes are intended to be used with the split-explicit model configuration for short-term studies whereas the third scheme is suitable for long-term studies, e.g. paleoclimate studies. The short-term studies may also benefit from the incorporation of the tidal forcing which has been adopted from the DEBOT model (Einspigel, 2012). The tidal forcing is expressed in terms of the second-degree tidal potential and the ephemerides' positions are computed by the package of subroutines NOVAS F3.1 (Kaplan et al., 2011). The advection scheme for tracers has not been changed, it is the third order advection scheme Quick. However, the state equation has been improved. The original UNESCO state equation of sea water (UNESCO, 1981) is replaced by the state equation of Jackett et al. (2006). The newly implemented state equation is more accurate, less computationally expensive and it is formulated in terms of the potential temperature instead of the in-situ temperature. The model is paralellized using the OpenMP standard, however, the GPU paralellization using the OpenACC has also been tested.