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The impact of the implementation of new sea ice processes in CNRM-CM5 on the simulation of the Arctic and Antarctic sea ice cover

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Gelato5 is a multi-category and multi-layer sea-ice model coupled with NEMO1° and ARPEGE-Climat, within CNRM-CM5, one of the CMIP5 / COMBINE-Stream 1 global coupled climate models. In comparison with CNRM-CM3, which produced climate simulations in the framework of CMIP3, the sea ice model contains new features. Sea ice salinity is now interactive, and the ice specific heat, enthalpy and vertical heat diffusion coefficient are functions of ice temperature and salinity.

A 10-member set of 1850-2012 coupled simulations including this new sea ice model was carried out with CNRM-CM5. In contrast with CNRM-CM3, CNRM-CM5 better reproduces the recent sea ice depletion trend observed in the Arctic. However, a comparison of modeled sea ice in the Arctic with observations and thickness products such as PIOMAS reveals that the sea ice simulated by CNRM-CM5 is too thin during the 1990-2009 period. In order to try and understand this bias, the ocean-sea ice component of CNRM-CM5 (NEMO-Gelato) was forced with an ERA-Interim-based forcing data set during 1990-2009. In this forced experiment, ice thickness biases are small, and the ice edge is very well simulated. Comparing the detailed energy balance of sea ice in the forced and coupled experiments led to the conclusion that the sea ice thickness bias in CNRM-CM5.1 is mainly due to the overestimated surface incoming solar radiation.

In order to contribute to the COMBINE-Stream 2 of experiments, new features were introduced in Gelato. In particular, an explicit melt pond scheme was developed, and the ocean-sea ice coupling was revised in order to improve the conservation of salt and water in the coupled system. These new features lead to improved sea ice simulations in both hemispheres, particularly during the Antarctic summer. However, the solar bias is still obvious during the Arctic summer.