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The sea ice component of the coupled climate model HadGEM1

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HadGEM1 is a new coupled climate model developed at the Met Office's Hadley Centre. The sea ice model used in HadGEM1 is more sophisticated than that used in our previous climate model (HadCM3). We describe the improvements to the sea ice submodel and the impact on the simulation of the mean sea ice state and variability within a climate integration forced by pre-industrial levels of atmospheric carbon dioxide.

A zero-layer thermodynamics model, combined with a multiple ice thickness category model is used to simulate the sub-gridscale ice thickness distribution. Ice velocities are computed assuming an Elastic-Viscous-Plastic rheology, and ice is allowed to flow across the North Pole. A ridging scheme is included to convert thinner ice to thicker ice and create open water within a gridbox. The ice albedo parameterisation is based on SHEBA observations.

The distribution of ice depth in the Arctic compares well with observations, with the deepest ice banked up against the north Greenland coast and the Canadian Archipelago. The amplitude of the seasonal cycle of ice area compares well with observations in the Antarctic, but is larger than observed in the Arctic. Winter ice concentration in the Northern Hemisphere displays a realistic response to forcing from the North Atlantic Oscillation. However, in the Southern Hemisphere, the ice responds only weakly to the Southern Oscillation due to an inadequate representation of ENSO in HadGEM1.

The spatial pattern of ice velocities is improved. In the Arctic, the coherent southward flow of ice either side of Greenland is captured, and there is a realistic volume of

ice flow through the Fram Strait. In the Antarctic the improved ice dynamics ensures strong ice formation at the fronts of the major ice shelves followed by rapid northward transport.