Incorporation of a physically-based melt pond scheme into the sea ice component of a climate model

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The extent and thickness of the Arctic sea ice cover has decreased dramatically in the past few decades with minima in sea ice extent in September 2005 and 2007. These minima have not been predicted in the IPCC AR4 report, suggesting that the sea ice component of climate models should more realistically represent the processes controlling the sea ice mass balance. One of the processes poorly represented in sea ice models is the formation and evolution of melt ponds. Melt ponds accumulate on the surface of sea ice from snow and sea ice melt and their presence reduces the albedo of the ice cover, leading to further melt. Towards the end of the melt season melt ponds cover up to 50% of the sea ice surface. We have developed a melt pond evolution theory. Here, we have incorporated this melt pond theory into the Los Alamos CICE sea ice model, which has required us to include the refreezing of melt ponds. We present results showing that the presence, or otherwise, of a representation of melt ponds has a significant effect on the predicted sea ice thickness and extent. We also present a sensitivity study to uncertainty in the sea ice permeability, number of thickness categories in the model representation, melt water redistribution scheme, and pond albedo. We conclude with a recommendation that our melt pond scheme is included in sea ice models and the number of thickness categories should be increased and concentrated at lower thicknesses.