Impact of melt ponds on Arctic sea ice simulations from 1990 to 2007

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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 (closely matched in 2011). 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 form on Arctic sea ice during the melting season and their presence affect the heat and mass balances of the ice cover. Towards the end of the melt season melt ponds cover up to 50% of the sea ice area, decreasing the value of the surface albedo by up to 20%. We have developed a melt pond model that is suitable for forecasting the presence of melt ponds based on sea ice conditions. This model has been incorporated into the Los Alamos CICE sea ice model, the sea ice component of several IPCC climate models. Simulations for the period 1990 to 2007 are in good agreement with observed ice concentration. In comparison to simulations without ponds, the September ice volume is nearly 40 % lower. Sensitivity studies within the range of uncertainty reveal that variations of optical properties, the critical lid depth and the amount of snowfall have the strongest impact. We conclude that melt ponds will play an increasingly important role in the melting of the Arctic ice cover and their incorporation in the sea ice component of Global Circulation Models is essential and crucial for future sea ice forecasts.