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Constraining projections of summer Arctic sea ice

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We examine the recent (1979–2010) and future (2011–2100) characteristics of the summer Arctic sea ice cover as simulated by 29 Earth system and general circulation models from the Coupled Model Intercomparison Project, phase 5 (CMIP5). As was the case with CMIP3, a large intermodel spread persists in the simulated summer sea ice losses over the 21st century for a given forcing scenario. The 1979–2010 sea ice extent, thickness distribution and volume characteristics of each CMIP5 model are discussed as potential constraints on the September sea ice extent (SSIE) projections. Our results suggest first that the future changes in SSIE with respect to the 1979–2010 model SSIE are related in a complicated manner to the initial 1979–2010 sea ice model characteristics, due to the large diversity of the CMIP5 population: at a given time, some models are in an ice-free state while others are still on the track of ice loss. However, in phase plane plots (that do not consider the time as an independent variable), we show that the transition towards ice-free conditions is actually occurring in a very similar manner for all models. We also find that the year at which SSIE drops below a certain threshold is likely to be constrained by the present-day sea ice properties. In a second step, using several adequate 1979–2010 sea ice metrics, we effectively reduce the uncertainty as to when the Arctic could become nearly ice-free in summertime, the interval [2041, 2060] being our best estimate for a high climate forcing scenario.