1676B for Kristina Pistone (2)

Radiative impacts of further Arctic sea ice melt: using past observations to inform future climate impacts

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The Arctic region has seen dramatic changes over the past several decades, from polar amplification of global temperature rise to ecosystem changes to the decline of the sea ice. While there has been much speculation as to when the world will see an ice-free Arctic, the radiative impacts of an eventual disappearance of the Arctic sea ice are likely to be significant regardless of the timing. Using CERES radiation and microwave satellite sea ice data, Pistone et al (2014) estimated the radiative forcing due to albedo changes associated with the Arctic sea ice retreat over the 30 years of the satellite data record. In this study, we found that the Arctic Ocean saw a decrease in all-sky albedo of 4% (from 52% to 48%), for an estimated increase in solar heating of 6.4 W/m2 between 1979 and 2011, or 0.21 W/m2 when averaged over the globe. This value is substantial--approximately 25% as large as the forcing due to the change in CO_2 during the same period. Here we update and expand upon this previous work and use the CERES broadband shortwave observations to explore the radiative impacts of a transition to completely ice-free Arctic Ocean. We estimate the annually-averaged Arctic Ocean planetary albedo under ice-free and cloud-free conditions to be 14% over the region, or approximately 25% lower in absolute terms than the Arctic Ocean cloud-free albedo in 1979. However, the question of all-sky conditions (i.e. including the effects of clouds) introduces a new level of complexity. We explore several cloud scenarios and the resultant impact on albedo. In each of these cases, the estimated forcing is not uniformly distributed throughout the year. We describe the relative contributions of ice loss by month as well as the spatial distributions of the resulting changes in absorbed solar energy. The seasonal timing and location—in addition to magnitude—of the altered solar absorption may have significant implications for atmospheric and ocean dynamics in the Arctic and at lower latitudes; this observationally-based estimate of the large-scale characteristics of an ice-free Arctic thus provides a valuable tool to complement and validate model-based assessments of future climate.