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Understanding Changes in the Arctic Basin Sea Ice Mass Budget as Simulated by CCSM4- Implications from Melt Season Characteristics and the Surface Albedo Feedback

Daniel Pollak (1,3), Marika Holland (2), and David Bailey (2)

(1) Pennsylvania State University (Penn State), University Park, PA, USA, (2) NCAR- National Center for Atmospheric Research, Boulder, Colorado, USA, (3) SOARS Program, NCAR, Boulder, Colorado, USA

Observations reveal alarming drops in Arctic sea ice extent, and climate models project that further changes will occur that could have global repercussions. An important aspect of this change is the surface albedo feedback, driven by the contrast between the albedos of snow/ice and the open ocean. This feedback causes ice to melt and overall albedos to decrease, amplifying surface warming in the Arctic. NCAR's newly released, fully coupled Community Climate System Model Version 4 (CCSM4) is used to assess long-term changes in the Arctic sea ice mass budget. Analysis of monthly-averaged mass budget time series from the 20th and 21st centuries revealed drastic changes from 1980-2050, the focus years of this study. While numerous factors determine the Arctic sea ice mass budget, we focus on the surface melt terms as they are most closely related to the surface albedo feedback. During the study period, annually averaged difference plots of sea ice thickness and area both revealed substantial decreases across the entire Arctic domain. Helping to clarify these long-term changes, new daily output data from this model allowed for the examination of melt season characteristics such as onset and cessation dates as well as season duration. One of the most interesting aspects was the shift to earlier onset dates throughout the Arctic Basin. This shift, coupled with the seasonal solar cycle has substantial implications. Earlier onset dates imply an earlier decrease of albedo that overlaps with the seasonal maximum of downward shortwave radiation. This leads to increases in shortwave absorption and results in amplified ice melt, subsequently intensifying the surface albedo feedback. The strong relationship between earlier melt onset dates and increased absorbed radiation does exist and therefore is a key factor leading toward Arctic amplification.