Evaluating and improving ice sheet clouds, radiation, and precipitation in the Community Earth System Model

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A53D-03: Evaluating and improving ice sheet clouds, radiation, and precipitation in the Community Earth System Model (Invited)

Friday, 14 December 2018
14:10 - 14:25
Walter E Washington Convention Center - 152A

Clouds exert a pivotal control on the mass balance of the Greenland and Antarctic Ice Sheet and therefore their contribution to global sea level. Clouds transport moisture onto the marginal ice sheet, where steep topographic gradients force the air to rise and cool, inducing strong orographic precipitation and leaving the interior ice sheet dry ("polar desert"). Clouds further regulate the radiation balance at the surface and, consequently, surface melt. Depending on their frequency, phase, and structure, clouds not only mute incoming solar radiation but also enhance longwave radiation at the surface. With the advent of novel observations from space (CloudSat-CALIPSO) and in the field, we now have tools to start evaluating the representation of clouds, precipitation, and ice sheet surface radiation in climate models. Here we evaluate the Community Earth System Model version 1 (CESM1(CAM5)) to represent (1) precipitation frequency and phase, using a CALIPSO cloud simulator; (2) cloud radiative effect comparing to a CloudSat-CALIPSO based product; and (3) snowfall amounts and surface mass balance, comparing to CloudSat, in-situ observations, and regional climate model results. After discussing outstanding cloud biases in CESM1(CAM5), we present our efforts to reduce these in the recently released version 2 (CESM2). We show that clouds are considerably better represented in CESM2, leading to improvements in surface radiation, melt, and surface mass balance, although biases in precipitation phase persist. Our work demonstrates the need for high-quality, long-term observations of clouds and their effect on the ice sheet surface to enable continued climate model improvement.

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