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Title: *2009/2010 Eurasian Cold Winter and Loss of Arctic Sea-ice over Barents/Kara Sea*

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In 2009/2010 winter, a few extreme cold events and heavy snowfall occurred over central North America, north western Europe, and East Asia exerting a severe social and economic impacts. In this study, we performed modeling experiments to examine the role of substantially reduced Arctic sea-ice over Barents/Kara Sea on the 2009/2010 cold winter. Although several previous studies investigated cause of the extreme events and emphasized the large snow-covered area over Siberia in autumn 2009, we note that the area extent of Arctic sea-ice over Barents/Kara sea in autumn 2009 was anomalously low and the possible impact from Arctic for the extreme cold events has not been presented. To investigate the influence from the Arctic, we designed three model runs using Community Atmosphere Model Version 3 (CAM3). Each simulation differs by the prescribed surface boundary conditions: (a) CTRL - climatological seasonal cycle of sea surface temperature (SST) and sea ice concentration (SIC) are prescribed everywhere, (b) EXP_SIZ - SST and SIC inside the Arctic sea-ice zone are replaced by 2009/2010 values. Elsewhere, the climatology is used, (c) EXP_BK - Same with (b) except that SIC and SST are fixed only over Barents/Kara Sea where the sea-ice area dropped significantly in 2009/2010 winter. Model results from (b) and (c) commonly showed a large increase of air temperature in the lower troposphere where Arctic sea-ice showed a large reduction. Also, compared with the observation, model successfully captured thickened geopotential height in the Arctic and showed downstream wave propagation toward midlatitude. From the analysis, we reveal that this large dipolar Arctic-midlatitude teleconnection pattern in the upper troposphere easily propagate upward and played a role in the weakening of polar vortex. This is also confirmed in the observation. However, the timing of excitation of upward propagating wave in (b) and (c) were different and thus the timing of weakening of polar vortex also differs in each experiment. Unlike with our expectation, both (b) and (c) did not capture the abrupt increase of snow-cover in the observation over Siberian region in autumn 2009. Therefore, given the successful reproduction of key observed features of cold winter 2009/2010 by simulations, we conclude that Arctic sea-ice in autumn 2009 played a key role for the subsequent development of 2009/2010 cold winter and the role was largely independent with the autumn snow-cover.