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Impact of Northern Hemisphere polar gateways on the Arctic Ocean climate during the latest Cretaceous as simulated by an Earth System Model.

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Using the Earth System Model COSMOS, we simulate the Late Cretaceous climate with different gateway configurations in the Arctic Ocean region under constant CO_2 level of 1120 ppm (4 x pre-industrial). Based on the Maastrichtian paleogeography, we modify gateway configurations in the Arctic region according to different scenarios recorded from the Campanian – Maastrichtian (∼83-66 Ma). Our simulation with the Greenland-Norwegian Sea even as deep as 1.5 km in the Campanian produces consistent salinities in the Greenland-Norwegian Sea and in the surface Arctic Ocean, with the proxy-based salinity reconstructions. Towards the end of the Maastrichtian the gateway became shallower but didn't close entirely before the K-Pg boundary. During entire interval, the simulated salinity in the Arctic Ocean was well stratified, in agreement with the data. The surface ocean became progressively fresher, starting from the moderately brackish conditions in the Campanian to the (almost) freshwater conditions around the K-Pg boundary. Arctic gateways configuration changes cannot reproduce cooling trends as reconstructed by the proxy data during the Campanian – Maastrichtian interval. Our additional sensitivity tests with the different CO_2 levels (1-6 x pre-industrial) and fixed (Maastrichtian) paleogeography show that a doubling of atmospheric CO_2 concentration from 560 ppm to 1120 ppm results in an increase in the zonal mean surface air temperature in the polar regions by as high as ∼10ºC. This suggests that the CO_2 level decline, rather than gateway configuration changes, was responsible for the cooling trend toward the end of the Maastrichtian. The research was supported from the grant of the National Science Center in Poland based on the decision DEC-2012/07/N/ST10/03419.