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Extremely low seasonality in the Late Cretaceous Arctic Ocean simulated by the Earth system model.

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In greenhouse world conditions, low seasonality in the polar region can have significant effects on paleobotanical proxy data interpretation of environmental conditions in the Arctic region. Here we present two simulations with a Maastrichtian (∼70 Ma) set-up that differ only by atmospheric CO_2 levels, applying the Earth system model COSMOS in a coupled atmosphere-ocean configuration. In the first simulation with a CO_2 level of 280 ppm (C-280) we observe a strong surface temperature contrast of ∼20-25 °C between the summer and winter seasons over the Arctic Ocean. In the second experiment with a CO_2 level of 1120 ppm (C-1120) the contrast is highly reduced to ∼3 °C. Most of this seasonal temperature contrast reduction stems from relatively warm and sea ice free Arctic winter conditions in C-1120. The key to these winter conditions is the summer warming of the Arctic basin in C-1120 that effectively stores energy due to sea ice free conditions compared to ice covered conditions during summer in C-280. During the winter months, this heat reservoir and associated surface heat fluxes are sufficient to sustain relatively mild Arctic conditions and prevent sea ice formation during polar night. In this context, extremely low seasonality associated with relatively warm winters could have created unusual climatic conditions in the greenhouse Arctic. Therefore, Late Cretaceous sub/arctic plants could have been well adapted to such mild non-actualistic climate environments.