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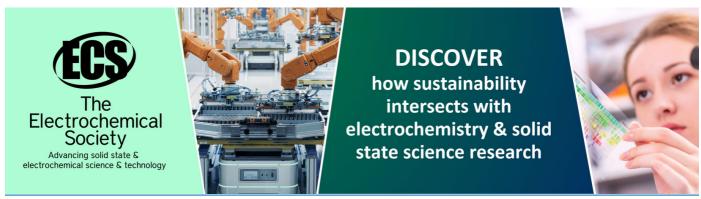
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The Arctic cryosphere in the mid-Pliocene and the future

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The mid-Pliocene (around 3 million years ago) was a relatively warm period, with increased atmospheric CO2 relative to pre-industrial. It has therefore been highlighted as a possible palaeo-analogue for the future. However, changed vegetation patterns, orography, and smaller ice sheets also influenced the mid-Pliocene climate. Here, using a General Circulation Model and ice sheet model, we determine the relative contribution of vegetation and soils, orography and ice, and CO2 to the mid-Pliocene arctic climate and cryosphere. We find that compared to pre-industrial, increased mid-Pliocene CO2 contributes 35% of arctic temperature change, lower orography and ice sheet feedbacks 42%, and vegetation changes 23%. The simulated mid-Pliocene Greenland ice sheet is substantially smaller than that of modern, due mostly to the higher CO2. However, our simulations of future climate change indicate that the same increase in CO2 is not sufficient to melt the modern ice sheet substantially. We conclude that although the mid-Pliocene resembles the future in some respects, care must be taken when interpreting it as an exact analogue due to vegetation and ice sheet feedbacks. These act to intensify mid-Pliocene Arctic climate change, and act on a longer timescale than the century scale usually addressed in future climate prediction.

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