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Decline of the Arctic 'ice factories' delayed by negative feedbacks

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Over the past few decades, Arctic sea ice volume has been decreasing faster in summer than winter; winter sea ice growth has been increasing, helping to restore the ice pack, despite the fact that Arctic warming is most intense in the winter. This raises the questions: why? And for how long can we expect winter ice growth to keep increasing? We pose these questions with a regional focus on the Kara and Laptev seas. These seas are often termed the ice factories of the Arctic because of their outsized contributions to the Arctic sea ice budget, a consequence of their divergent settings. Using the CESM climate model ensemble, we separate out the influence of different levers on ice factory productivity (the ice growth rate), and show that 20th Century and RCP8.5 changes can be skilfully reconstructed by a linear model incorporating 2 m temperature, snow thickness, September sea ice area, total (gross) divergence and ice export. Ocean temperatures, meanwhile, help to explain the timing of the onset of freezing. Increasing air temperatures naturally decrease the growth rate, while positive contributions to growth rate are made by a decreasing September sea ice area, increasing divergence and increasing export. These positive influences are all associated with a thinning, more mobile ice pack: they are negative feedbacks on sea ice loss. In CESM, once the September sea ice area in the Kara-Laptev seas approaches zero, the year-on-year productivity of the ice factories starts to decline. We place these results in the context of observations and discuss the prospects for the productivity of the Arctic Ocean's ice factories.