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The role atmosphere-ocean-ice interactions in Arctic sea ice response to CO_2 increase.

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Arctic sea ice change is the result of the coupled interaction between the atmosphere, ocean and sea ice. However, the processes driving this coupled interaction are not well understood. In this study we disentangle this coupled interaction, by removing the ocean circulation change impact from the surface flux exchange between the atmosphere and ocean using a partially-coupled simulation, and decomposing ocean-ice heat fluxes into components driven by surface heat fluxes and ocean circulation changes. The comparison of the ocean-ice heat flux components in the partially and fully coupled simulations, allow the isolation of the individual roles of the atmosphere, ocean and their coupling, in the time evolution of Arctic sea ice following CO_2 quadrupling. Results show that the atmosphere play a greater role in Arctic sea ice loss in the short term (first decade) through an increase in summer sea ice top melt. The ocean plays a greater role in long term and stabilizes Arctic sea ice loss through its circulation changes, driving anomalous winter heat transport into the Arctic and winter ice growth. Through its coupled interaction with the atmosphere in the subpolar Atlantic, ocean circulation changes stabilizes Arctic sea ice loss, causing further weakening of the AMOC and a large cooling of subpolar Atlantic, which weakens the anomalous heat transport into the Arctic, and increases winter growth later. Our results suggest a greater role for atmosphere-ocean coupling than ocean-ice coupling in driving Arctic changes.