Cooling of the Northern Hemisphere triggered by Northeast Atlantic opening at the Eocene – Oligocene Transition

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The Eocene – Oligocene Transition (~33.7 million years ago), marks the largest step transformation within the Cenozoic cooling trend, and is characterized by a sudden growth of the Antarctic ice sheets. The role of changes in oceanic basin configuration and the evolution of key oceanic gateways in triggering these climatic variations remains disputed. Here we implement a new state-of-the-art paleogeography model in the Norwegian Earth System Model (NorESM-F) to investigate the effect of oceanic gateway changes on the Eocene – Oligocene climate. We run different cases using realistic max/min depth configurations of the Atlantic – Arctic oceanic gateways, the Tethys Seaway, and the Southern Ocean gateways, and investigate the ocean and climate sensitivity to these changes. In addition, we run separate simulations investigating the impact on the carbon cycle. The models show that changes in the Atlantic – Arctic gateways (i.e. Greenland – Scotland Ridge and the Fram Strait) cause the most significant changes in ocean circulation and climate compared to the Southern Ocean gateways or the Tethys Seaway. The Iceland mantle plume caused depth variations on the Greenland – Scotland Ridge at this time, and our model result indicate that variations in dynamic support from the Iceland plume could have played a key role in the Eocene – Oligocene climate transition. Essentially, reduced dynamic support from the plume deepen the Greenland – Scotland Ridge and cause freshwater leakage from the Arctic Ocean which inhibits deep water formation in the North Atlantic, reducing the AMOC and ultimately cool the Northern Hemisphere.