

EGU2020-15058, updated on 07 Jul 2022

<https://doi.org/10.5194/egusphere-egu2020-15058>

EGU General Assembly 2020

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## Did a Beringian ice sheet once exist?

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Did a Beringian ice sheet once exist? This question was hotly debated decades ago until compelling evidence for an ice-free Wrangel Island excluded the possibility of an ice sheet forming over NE Siberia-Beringia during the Last Glacial Maximum (LGM). Today, it is widely believed that during most Northern Hemisphere glaciations only the Laurentide-Eurasian ice sheets across North America and Northwest Eurasia became expansive, while Northeast Siberia-Beringia remained ice-sheet-free. However, recent recognition of glacial landforms and deposits on Northeast Siberia-Beringia and off the Siberian continental shelf has triggered a new round of debate. These local glacial features, though often interpreted as local activities of ice domes on continental shelves and mountain glaciers on continents, could be explained as an ice sheet over NE Siberia-Beringia. Only based on the direct glacial evidence, the debate can not be resolved. Here, we combine climate and ice sheet modelling with well-dated paleoclimate records from the mid-to-high latitude North Pacific to readdress the debate. Our simulations show that the paleoclimate records are not reconcilable with the established concept of Laurentide-Eurasia-only ice sheets. On the contrary, a Beringian ice sheet over Northeast Siberia-Beringia causes

feedbacks between atmosphere and ocean, the result of which well explains the climate records from around the North Pacific during the past four glacial-interglacial cycles. Our ice-climate modelling and synthesis of paleoclimate records from around the North Pacific argue that the Beringian ice sheet waxed and waned rapidly in the past four glacial-interglacial cycles and accounted for ~10-25 m ice-equivalent sea-level change during its peak glacials. The simulated Beringian ice sheet agrees reasonably with the direct glacial and climate evidence from Northeast Siberia-Beringia, and reconciles the paleoclimate records from around the North Pacific. With the Beringian ice sheet involved, the pattern of past NH ice sheet evolution is more complex than previously thought, in particular prior to the LGM.