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Eurasian Ice Sheet at the Last Glacial Maximum – combining evidence from geomorphology with high-resolution climate and ice sheet modelling

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In this study we analyze the roles of the North Atlantic and North Pacific sea surface temperatures (SSTs) in controlling the westward and eastward extents of the former Eurasian ice sheet (EIS). Using a wide range of global and regional climate models in combination with global high-resolution ice-sheet modeling, we have identified the EIS as the most sensitive indicator of the climate state at the Last Glacial Maximum (LGM) among all former ice sheet complexes. On the one hand, our results show that the westernmost extents of the EIS (the British-Irish Ice Sheet counterpart) are consistent with low summer SSTs in the North Atlantic region due to weakening of the Atlantic Meridional Overturning Circulation (AMOC). This finding receives additional support from our inference of an inverse relation between the summer conditions across two regions bordering the westernmost and easternmost counterparts of the EIS. We have used regional and global climate simulations to show that cooling of the North Atlantic at the LGM triggers warmer summer conditions across the European parts of Arctic Russia and vice versa, providing a plausible explanation of the fact that during the last glacial cycle glaciations in the Kara Sea region were out of phase with the global glacial maxima. On the other hand, our results link the absence of large-scale glaciations in Siberia throughout the last glacial cycle to a large-scale reorganization of stationary pressure systems that maintained heat transport from the North Pacific to Arctic Siberia during spring and summer months, enabling modern-like Siberian summer conditions in this region. The above findings have been validated against ocean proxy data in the North Atlantic and North Pacific regions, land proxy data across Alaska, the Russian Arctic and Europe and geochronological constraints on former glacial extents.