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Present and LGM permafrost from climate simulations : contribution of statistical downscaling

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We quantify the agreement between permafrost distributions from PMIP2 (Paleocli- mate Modeling Intercomparison Project) climate models and permafrost data. We evaluate the ability of several climate models to represent permafrost and assess the inter-variability between them.
Studying an heterogeneous variable such as permafrost implies to conduct analyses at a spatial scale smaller than climate models resolution. Our approach consists to derive Eurasian permafrost distribution from high-resolution climatology of surface air tempera- ture (SAT) using the conditions from Renssen and Vandenberghe (2003). The local-scale SAT are produced by a statistical downscaling method (SDM) applied on large- or regional- scale atmospheric variables provided by climate models. In a first validation step on present climate (CTRL period), we show that the relationship from Renssen and Vandenberghe (2003) does not provide enough information for local permafrost distribution and leads to a close dependence between temperature and permafrost.
So, we develop an alternative method of statistical downscaling (based on Multinomial Logistic Regression), which directly models the probabilities of local permafrost indices and builds a new relationship between permafrost and climate variables. The obtained permafrost distributions appear in a better agreement with data with a low inter-variability between climate models. This also proves that a simple relationship between permafrost and the SAT only is not always sufficient to represent local permafrost.
Finally, we apply each method on a very different climate, the Last Glacial Maximum (LGM) time period, in order to quantify the ability of climate models to represent LGM permafrost. Our SDMs do not significantly improve permafrost distribution and do not reduce the inter-variability between climate models, at this period. We show that LGM permafrost distribution from climate models strongly depends on large-scale SAT. The errors between permafrost distribution from climate models and LGM permafrost data, larger than in the CTRL period, reduce the contribution of downscaling. These errors are the byproduct of several factors deserving further studies.