**Contrasted hindcast performances demonstrate the need for more realistic models**

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Process-based models are expected to improve predictions of species range shifts under novel environmental conditions, wherein the trustworthiness of correlative approaches is questioned. However, this assumption has never been properly verified.

Using paleoclimate simulations, we compared several versions of process-based and correlative species distribution model projections with fossil pollen records of various tree species in Europe. We then evaluate prediction uncertainties under future climate change.

The performance of both correlative and process-based models decreased under past climates, but one approach stood out and provided the best predictions. However, by the end of the century, none of these methods will likely provide reliable projections in growing non-analogous environments.

Our results provide an evaluation of the transferability of species distribution models, and a clear identification of the tenets of model robustness. Our work also highlights a promising perspective to scale up complex models and spread their use in a rapidly changing world.