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Limiting the risks of novel and disappearing climates

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Will climate change bring my hometown the climate of my holiday resort? The concept of spatial climate analogues – the idea of identifying a location with a present-day climate similar to the one projected elsewhere – is potentially very powerful in communicating climate change. We use 35 CMIP5 models to test the suitability of the spatial analogue concept and rigorously quantify uncertainties induced by internal variability and model uncertainties.

For individual seasons and individual meteorological variables such as temperature or precipitation, good analogues can be found for many places across the world. However, we demonstrate that when accounting for seasonal cycles in both temperature and precipitation, it is impossible to find good analogues for many places across the world. This implies that these locations experience the emergence of novel climates with respect to the seasonal cycle of temperature and precipitation. For strong levels of warming, major densely populated land fractions, primarily in the tropics and subtropics, are expected to experience novel climates with seasonal cycles of temperature and precipitation we have not experienced before. For a global temperature increase of 1.5°C the global land fraction experiencing novel climates is limited to one fourth, whereas the land fraction quickly rises to one third at 2°C warming and almost to half of the global land fraction at 3°C warming. Likewise, a considerable fraction of today's climates, mainly found in the polar north, but also in the tropics and subtropics, are anticipated to disappear without strong mitigation actions. The global land fraction of disappearing climates at 1.5°C, 2°C and 3°C global warming is remarkably similar to the fraction of novel climates. While the exact locations of novel and disappearing climates somewhat differ across models, the overall latitudinal gradients and the land fractions affected for a certain level of global warming are remarkably consistent across models. This illustrates that limiting the level of warming to 1.5°C strongly reduces the land fraction of novel and disappearing climates, thereby avoiding potential major ecological and socio-economic risks induced by climate states we do not currently experience anywhere on Earth.