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Potential state shifts in terrestrial ecosystems related to changes in El Niño-Southern Oscillation dynamics

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The El Niño-Southern Oscillation (ENSO) phenomenon is regarded as a policy-relevant tipping element of the Earth's climate system. It has a prominent planetary-scale influence on climatic variability and it is susceptible to anthropogenic forcing, which could alter irreversibly its dynamics. Changes in frequency and/or amplitude of ENSO would have major implications for terrestrial hydrology and ecosystems. The amount of extreme events such as droughts and floods could vary regionally, as well as their intensities. Here, we use an intermediate complexity climate model, namely the Planet Simulator (PlaSim), to study the potential impact on Earth's climate and its terrestrial ecosystems of changing ENSO dynamics in a couple of experiments. Initially we investigate the global effects of a permanent El Niño, and then we analyse changes in the amplitude of the fluctuation. We found that PlaSim model yields a sensible representation of current large-scale climatological patterns, including ENSO-related variability, as well as realistic estimates of global energy and water budgets. For the permanent El Niño state, there were significant differences in the global distribution of water and energy fluxes that led to asymmetrical effects on vegetation production, which increased in the tropics and decreased in temperate regions. In terrestrial ecosystems of regions such as western North America, the Amazon rainforest, south-eastern Africa and Australia, we found that these El Niño-induced changes could be associated with biome state transitions. Particularly for Australia, we found country-wide aridification as a result of sustained El Niño conditions, which is a potential state in which recent wildfires would be even more dramatic. When the amplitude of the ENSO fluctuation changes, we found that although mean climatological values do not change significantly, extreme values of variables such as temperature and precipitation become more extreme. Our approach aims at recognizing potential threats for terrestrial ecosystems in climate change scenarios in which there are more frequent El Niño phenomena or the intensities of the ENSO phases change. Although it is not enough to prove such effects will be observed, we show a consistent picture and it should raise awareness about conservation of global ecosystems.