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Storylines of atmospheric circulation change for European regional climate impact assessment

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There is increasing interest to understand the regional implications of different global warming targets and quantify the benefits of limiting global warming at 1.5 vs 2 degrees. However, several regional climate impacts depend on the atmospheric circulation, whose climate response remains substantially uncertain and not interpretable in a probabilistic sense in multi–model ensemble projections. We here show that these limitations can be addressed by adopting a storyline approach where regional climate change is analysed as a function of carbon emissions conditional on plausible storylines of atmospheric circulation change. In particular, the approach is applied to analyse European impact—related climate change aspects in the CMIP5 models projections, with a focus on Mediterranean precipitation and Central European windiness change.

The results will show that different storylines of circulation change can be defined according to the response of three remote drivers of atmospheric circulation: the tropical and polar amplification of global warming and the strength of the stratospheric vortex. The projected Mediterranean precipitation decline is enhanced in the storyline associated with high tropical amplification and a strengthening of the stratospheric vortex. Storylines conditioned on the stratospheric vortex response also affect the projections of Central European windiness change. Crucially, the proposed framework enables us to separate and compare the uncertainty due to different global warming levels against the uncertainty due to the different plausible storylines of atmospheric circulation change. It is shown that for these analysed European climate aspects, the benefit of limiting global warming at 1.5 vs 2 degrees strongly depends on what storyline of circulation change will be realised. On the other hand, if the storyline followed by the real world could be identified, Euro-Atlantic atmospheric circulation uncertainty could be constrained and the associated regional climate impacts refined.