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Assessing the strength of regional changes in near-surface climate associated with a global warming of 2 ºC

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The objective of Article 2 of the United Nations Framework Convention on Climate Change formulated in 1992 is “to achieve stabilization of greenhouse gas concentrations in the atmosphere that would prevent dangerous anthropogenic interference with the climate system”. In accordance with this, the Council of the Ministers for the Environment in the European Union laid down in a statement dated October 17, 2002, that in order to obtain this objective “global efforts should be guided by a long-term objective of a global temperature increase of 2 °C over pre-industrial levels and a stabilization of CO2 concentrations below 550 ppm.”.

In this study, the strength of the regional changes in near-surface climate associated with a global warming of 2 °C with respect to pre-industrial times is assessed, distinguishing between 26 different regions. Also, the strength of these regional changes in climate is compared to the strength of the respective changes associated with a markedly stronger global warming exceeding 4.5 °C. The magnitude of the regional changes in climate is estimated by means of a normalized regional climate change index, which considers changes in the mean as well as changes in the interannual variability of both near-surface temperature and precipitation. This index is particularly suited for comparing both the strength of the climatic changes in the different regions with each other and the strength of the changes in regional climate associated with the relatively weak global warming of 2º C with the strength of the respective changes related to a markedly stronger global warming exceeding 4.5 °C for individual regions. While the first comparison highlights those regions that are especially vulnerable to climatic changes, the second indicates to which extent the strength of the regional changes in climate is characterized by a non-linear behaviour, considering the magnitude of the underlying global warming.

The study is based on two sets of four ensemble simulations with the ECHAM5/MPI-OM coupled climate model, each starting from different initial conditions. In one set of simulations (1860-2200), the greenhouse gas concentrations and sulphate aerosol load have been prescribed according to observations until 2000 and according to the SRES A1B scenario after 2000. In the other set of simulations (2020-2200), the greenhouse gas concentrations and sulphate aerosol load have been prescribed in such a way that the simulated global warming did not exceed 2 ºC with respect to pre-industrial times.