



Climate change impact on thunderstorms: Using high-resolution COSMO-CLM simulations to determine changes in thunderstorm occurrences

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It is generally assumed that temperature increase associated with global climate change will lead to increased thunderstorm intensity and associated heavy precipitation events. In the present study it is investigated whether the frequency of thunderstorm occurrences will in- or decrease and how the spatial distribution will change for the A1B scenario for mid-Europe.

Hourly model data of the COSMO-CLM is used with a horizontal resolution of 0.04° ($\sim 4.5\text{km}$) for mid-Europe. The simulations were carried out for two different periods: 1971-2000 (C20) and 2071-2100 (A1B). The two-step nesting chain starts with a CCLM run with 18km resolution covering whole Europe nested in ECHAM5 runs, then a run with a resolution of 4.4km has been performed for mid-Europe. Thunderstorm indices are applied to detect potential thunderstorms and differences in their frequency of occurrence in this periods. The indices used are CAPE (Convective Available Potential Energy), SLI (Surface Lifted Index), and TSP (Thunderstorm Severity Potential), which combines deep-layer-shear and the maximum vertical velocity. The significance of a potential climate signal was tested with a t-test and a power analysis was performed to quantify the uncertainty of the signal. The focus of this study is the Saar-Lor-Lux region (Saarland, Lorraine, Luxembourg).

The investigation of the present and future thunderstorms shows that the regional averaged frequencies will decrease in general, but several regions like the Saarland and especially elevated areas will have a potential increase in thunderstorm occurrences and intensity. Statistically, regions of the Alps, the Netherlands and Belgium show significant climate signals. The power analysis yields low power to detect changes of severe thunderstorms but high power for classes with no to light thunderstorms. In conclusion, our study shows that the frequency of severe thunderstorm is not likely to increase during the next century.