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The local impact of climate change on the alpine mountains Zugspitze and Sonnblick

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In the past decades, the alpine region indicates a high sensitivity to the impact of climate change, as one can see in a higher increase in surface air temperature in the alps compared to the surrounding area. Beside the effect on temperature, a change on the components of the hydrological cycle may be expected, which can be critical for mankind in many areas, where the alpine region provides water security or ensures economical income due to, for example, winter tourism. Changes in certain meteorological variables will also have effects on the alpine ecosystem itself. In this study, some of these quantities and their development under changing climate boundary conditions are examined for the meteorological stations Zugspitze and Sonnblick. Temperature, precipitation, wind and humidity were evaluated at the Zugspitze station, which is located in the northern part of the alps, temperature and precipitation at the Sonnblick Observatory, which is located in the center of the Alps. For the impact analysis, a statistical downscaling (SD) approach was developed to find a link between the large scale atmosphere and the respective local effect. The SD framework is based on the artificial neural network (ANN) method.
Models are calibrated for each season on a daily time scale using the 20th century reanalysis dataset as a substitute for atmospheric observational data. The developed ANN setups and configurations show promising results, e.g. up to 90% of explained variance (R^2) for temperature and up to 60 % R^2 for precipitation and relative humidity, while wind strength reaches with about 30% the lowest performance values. The identified ANN setups are afterwards driven with scenario data from five general circulation models (GCMs) from CMIP5 and additionally with two further realizations of one of the GCMs. As representative concentration pathways, two radiative forcings, 4.5 and 8.5 Watts, are selected. All future projections show a continuing increase in temperature throughout the 21st century for both stations and all seasons. The impact on precipitation is more differentiated: While for all seasons of the Zugspitze station, increased precipitation is simulated (highest in winter), the Sonnblick station shows a decrease in summer. Relative humidity at the Zugspitze is expected to decrease slightly throughout the year and wind strength at the Zugspitze station is projected with a slight increase in winter and spring and a slight decrease in summer and autumn. Further analyses will consider the synoptic interpretation of the interdependency between large scale circulation and the respective local impact, to figure out the cause of the local climatic behavior in the 21st century. Therefore, classification algorithms will be applied as reference class forecast models for a quantitative evaluation.