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SkiSim - A semi-distributed model to assess the impact of climate change on ski season length and snowmaking

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Winter tourism is highly sensitive to climate change. The altitudinally- dependent line of natural snow reliability (e.g. Abegg et al. 2007) is losing its relevance for skilift operators, as for example in Tyrol 70% of the ski slopes are already covered by technical snow production. Less snowfall at lower altitudes and rising temperatures increase the demand for technical snow. Simultaneously, periods cold enough for snowmaking will get shorter and less frequent. Studies incorporating snowmaking are still rare and there is need for an assessment of the suitability of snowmaking as a successful adaptation strategy. The aim of this study is to assess the development of ski season lengths and snowmaking requirements under different climate change scenarios for ski areas in North and South Tyrol.

A semi-distributed ski season model "SkiSim" was developed based on the temperature-index snow model of Kleindienst (2000) and the ski season model of Scott et al. (2007). As input variables only daily minimum and maximum temperature and precipitation are needed. Additionally, measured snowfall and snow depth are used for the calibration of the snowfall temperature at each climate station. Further snow model parameters (e.g. degree-day factor, snow metamorphosis) were adopted from Kleindienst (2000) and tested at all stations. Snowmaking module parameters were derived from interviews with ski area managers based on the methodology of Scott et al. (2007).

Daily data (1960-2100) of the high resolution climate model REMO (10x10km) was used to produce climate change scenarios for four time horizons (2020s, 2030s, 2050s, 2080s) under two emission scenarios (A1B and B1). The climate change signal for change in temperature, (in standard deviation of temperature, in precipitation and in dry and wet spells) was processed on climate station data by the LARS weather generator. In winter (DJF), the change signal for daily average temperature from the 2020s to 2080s compared to 1971-2000 is +1,4°C to +3,5°C in the B1 scenario, and from +1,2°C to 5,7°C in the A1B scenario. Precipitation change in the A1B scenario is between +5% and +10%, in B1 it is +5% to +20%.

The synthetic daily data produced by LARS-WG is the input data for the ski season model. Temperature and precipitation are distributed for each 100m altitude band, ranging from the lowest to the highest point of the ski area. The ski season model produces results for the whole ski area and not just for one single point (e.g. the lowest point in a ski area). Thus it is possible to assess the impact of climate change on ski season length and snowmaking in much greater detail than in previous studies.

Based on these results, the consequences for winter tourism destinations can be assessed. Following the methodology of Breiling et al. (1997, 2008), the contribution of winter tourism to the regional economy and the number employments in tourism serve as an indicator for the vulnerability of communities and regions to climate change.

In total 120 ski areas in North and South Tyrol are investigated in the running project. Results of three ski areas, different in size and altitude, will be presented.

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