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Climatic trends at high mountains sites of central Austria during the period 1961-2006

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During the last decades observed atmospheric warming in the European Alps was two to three times higher compared to the global average. In this study, monthly values of four different climatic elements (mean temperature, precipitation sum, sum of freshly fallen snow and maximum snowdepth) from 45 meteorological stations were analysed for quantifying climatic trends over a 46 year period (1961-2006) at six high-altitude areas in the mountains of central Austria. These six areas (5 in the Hohe Tauern Range, 1 in the Niedere Tauern Range) are investigated by a project focussing on the effects of climate change on high mountain environments (www.alpchange.at). The trends of the four climatic elements were investigated by applying different statistical approaches. Correlation analysis was used for filling data gaps, linear regression to calculate the conditions at reference altitude 2500 m asl, the overall linear trend and mean difference of the two 23-year periods (1961-83 versus 1984-2006). The statistical significance was tested with signal-to-noise ratios and Student´s t-tests (95% confidence limit). Our results indicate a significant temperature rise of mean annual temperatures of 1.3 to 1.4°C since 1961 in all six areas. The highest increase in temperature occurred during the summer season (JJA) with Ĩ.9°C. May experienced the highest warming of all months with values of up to 2.4°C. Mean annual precipitation trends are not significant at all six sites. However, the annual precipitation sum seem to have decreased in two of the six areas (-75mm) whereas in one area it increased substantially (+160mm). Only the autumn season (SON) reveals an increase in precipitation at all sites. The trends of the annual sum of freshly fallen snow as well as the maximum snow depth reveal no statistical significance. Despite this fact, the annual sum of freshly fallen snow decreased in all areas by 10 to 230 cm. The annual maximum snow depth decreased in all areas by 40 to 210 cm, which is principally based on the reduction of summer values of up to 180 cm. Furthermore some differences of freshly fallen snow and maximum snowdepth are significant particularly in summer. Generally, the overall linear trends were confirmed by the mean difference of the two 23-year periods. Amongst other environmental effects, these trends caused substantial glacier retreat and perennial snow field reduction as well as permafrost degradation at all six sites.