indicating the possibility of a perfect fit. The PEV statistic assumes values between $-\infty$ and +1. Values < 0 indicate very poor performance of the interpolation procedure; a value of zero suggests that the interpolation is no better than using the mean; and values > 0 suggest a useful result in the sense that the error variance is smaller than the variance of the original data set (Gyalistras 2003).

Results

Annual cycles of t_n and t_x

Annual cycles of the predicted temperatures at each of the 190 stations were compared with their associated measured station data. A subset of six selected sites is discussed below. The locations represent four typical climate regions in Switzerland: Jura (la Brevine), central Alps (Interlaken and Jungfraujoch), the midlands (Basel and Zurich), and the pre-Alps (Hörnli).

The cross-validation results and analyses of station data shows that over 91% of all errors were less than 1°C (annual mean as computed from the daily values). The annual cycles of Basel, Interlaken and Zurich SMA show a really high matching: COR_t for Basel is 0.9701 (minimum temperature) resp. 0.9882 (maximum temperature, for Interlaken 0.9249 resp. 0.9529, and for Zurich SMA 0.9142 resp. 0.9758). La Brevine illustrates large positive t_n biases (3.5°C) well, and the inability of the model to simulate the lowest temperatures that are observed in this area; la Brevine can be classified as the Siberia of the Switzerland. The temperature at the Jungfraujoch (the highest station at 3580 m.a.s.l.) station is generally too high (1.35°C), but the pattern corresponds quite well with the measured data. If we analyse the Hörnli station, we can identify an interesting phenomena in the pre-Alps. To interpolate the temperature, *Daymet* uses observed values of surrounding stations; most are located in the lowlands. As a result, it is not possible to simulate the appropriate amplitude; therefore the curves are too even.

Conclusions

The constructed 40-year data set enables analyses of the joint space-time variability of the Swiss temperature fields at a high spatial and temporal resolution. The accuracy of the provided point estimates at the grid point locations varies strongly as a function of the geographical location and time of year. The results imply that model evaluation using only monthly averages of mean minimum and maximum temperatures may mask severe errors in the simulation (Moberg and Jones 2004).

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Trends of air temperature in the mountain regions of the central Peruvian Andes

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The Mantaro River Basin, in the Central Peruvian Andes, is one of the highest places inhabited by people, and one of the most important production centers of potato in Peru. Its topography has allowed the generation of hydroelectric energy, providing about 50% the energy needed by the country. An increase of extreme cold temperatures could produce serious damage to crops and pastures, and rising temperatures could change snow cover and impact water supplies for agriculture and energy production.

Diverse studies show that trends of daily maximum and minimum temperatures in the last decades are asymmetric for most regions in the world: minimum temperatures have risen three times faster than maximum temperatures, and therefore the Diurnal Temperature Range (DTR), which is the difference of daily maximum and daily minimum temperature, has a negative trend (Karl *et al.* 1993; Weber *et al.* 1997). This asymmetric behavior was found for Peru, using monthly means of daily maximum and minimum temperature for 25 locations for the period

1960–2002, except in two regions: the Amazon Basin and the Central Peruvian Andes, where there was no trend for minimum temperature, but a positive trend of maximum temperature (Lagos, 2003).

The lack of a trend of minimum temperature in the Central Peruvian Andes indicates that global warming has had little influence in the trend of monthly means of this variable. In this case, the analysis of extreme values of temperature and the growing season length (GSL) can be valuable and important indicators of climatic changes. Extreme temperature events are of major concern since they are directly related to socioeconomic impacts, and the GSL (the period during which the daily mean temperature remains above 5°C) is related to crop yields (Yan *et al.* 2002; Robeson 2002).

This paper analyzes the asymmetry of daily maximum and minimum temperature trends, and the trends of the DTR, GSL and extreme cold and warm events, using daily maximum and minimum temperature data recorded in the Central Peruvian Andes during the period 1925–2003, with the purpose of detecting the impact of climate change in this mountain region.

Methodology

For all the trend analyses, a standard linear regression technique (LRT) was applied to the 1925–2003 data. In addition, three reference periods (1951–1980, 1961–1990 and 1971–2003) were analyzed in order to understand the effect of the observed global climate shift in late 1970s on the trends.

In order to analyze the trends of daily maximum, minimum and diurnal temperature range (DTR), the climatological mean of daily maximum and minimum temperature was calculated. To analyze the extreme temperature events (warm and cold), the average temperature for each day was estimated, then for each day the temperature anomalies were ranked and thresholds were defined corresponding above the 90th and below the 10th percentiles. The growing season length was estimated for each year as the number of days during which the running 5-day daily mean temperature remains above 5°C.

Results

Maximum and minimum temperatures trends analyses indicate a rise of the maximum temperature, a slight decrease of the minimum temperature and an increase of DTR for the period 1925–2003. Taking account different periods (1951–1980, 1961–1990, 1971–2003), it was found that the maximum temperature rose during these periods, with the highest rate during 1961–90. The minimum temperature trend decreased slightly for 1951–1980 and 1961–1990, and increased from 1971 to 2003.

The analysis of extreme temperatures (cold and warm events) shows that the annual frequency of warm and freeze events has increased, especially from 1961 to 1990.

There is a decrease of the growing season length (GSL), which would mean that crops might not fully mature, resulting in lower yields.

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Characteristics of frosts in the central Andes of Peru (Mantaro Basin) for the last 40 years

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A large national project regarding Vulnerability and Adaptation to Climate Change has been developed in three main areas of Perú since November 2003. One of these areas is the Mantaro Basin, located in