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Local downscaling of temperature projections for energy planning purposes in an Alpine area

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Medium- and long-term energy planning at regional scale requires, among others, the estimate of the future energy demand driven by expected heating and cooling needs of buildings, according to the local impact of changing climate. To support the development of the 2021-2030 Energy Plan of the Province of Trento in the Alps, temperature projections provided by EURO-CORDEX Regional Climate Models (RCMs) were downscaled at 11 weather stations, representative of altitudes between 0 and 700 m a.m.s.l., to estimate the future values of a set of parameters that are commonly used to model the energy demand of buildings, such as: Heating and Cooling Degree Days (HDDs and CDDs), Test Reference Years (TRYs) and Extreme Reference Years (ERYs). A dataset of temperature and solar radiation hourly measurements, taken at the stations starting from 1983, was quality-controlled and analyzed to estimate statistics and observed trends for both variables, as well as degree days, reference years and climate change indices from the ETCCDI set. A hybrid downscaling approach (combining statistical and dynamical techniques) is then applied to temperature projections, based on the application of the *morphing method* to the results of an ensemble of 16 RCMs, allowing the estimate of future TRYs, ERYs and degree days in 2030 and 2050 at the selected sites (notice that no significant variation associated with climate change was assumed for solar radiation). According to historical observations (1983-2019), the warming tendency for monthly mean temperatures is clear and falls around 0.06 °C year^{-1}, slightly higher than reported at national level. The increase is more pronounced in spring and summer than in autumn and winter, with minima in December and especially May. No significant trend is observed for solar radiation trends. As for HDDs, stations at different altitudes show comparable reductions, of around -10 HDDs year^{-1}, with an apparent tendency to accelerate in the most recent years. The increase of CDDs can be quantified in less than 5 CDDs year^{-1}. The ensemble of temperature projections estimate temperature increases of 0.5 °C between 2016 and 2030 and 1.3 °C between 2016 and 2050 on average (0.03-0.04 °C year^{-1}), implying further future reductions of HDDs (between -4 and -11% at 2030, between -10 and -21% at 2050) and increases of CDDs (between 12 and 36% at 2030, between 36 and 87% at 2050). Such changes will correspond to major modifications in the seasonal profile of the energy demand associated with the winter heating and summer cooling of buildings in the Alpine area.