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A proposed correction of a systematic bias in early instrumental temperature series in Central Europe.

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The instrumental period in climatology usually is regarded to have started shortly after the mid 19th century. Respective benchmarks are the starting point of the global mean temperature timeseries in the 1850s or the founding of many of the national meteorological services in the following 2 to 3 decades. But there is a considerable and valuable amount of measured climate data decades to a century earlier. The added value of having another century of directly measured climate information is great, particularly as these data bridge the pre-anthropogenic to anthropogenic forcing eras. But the demands on these early instrumental data in terms of their comparability with modern data are increasingly difficult to fulfil progressively back in time. Decreasing network density makes mathematical homogeneity testing and adjusting less reliable and the equipment as well as the measuring and data processing philosophy were in some aspects rather different to the recent one. The proposed contribution shows one of these "early instrumental" (EI) problems and proposes a solution for a region which may be regarded the richest in EI-data globally.

Instrumental temperature recording in the Greater Alpine Region (GAR, 4-19°E, 43-49°N) began in the year 1760. Prior to the 1850-1870 period, after which screens of different types protected the instruments, thermometers were insufficiently sheltered from direct sunlight so were normally placed on north-facing walls or windows. It is likely that temperatures recorded in the summer half of the year were biased warm and those in the winter half biased cold, with the summer effect dominating. Because the changeover to screens often occurred at similar times, it has been difficult to determine the scale of the problem through relative homogeneity testing, as all neighbour sites were likely to be similarly affected. This study uses simultaneous measurements taken for eight recent years at the old and modern site at Kremsmünster, Austria to assess the issue. The temperature differences between the two locations (screened and unscreened) have caused a change in the diurnal cycle, which depends on the time of year. Using the orientation angle of the buildings (sites across the GAR in the range from NE to NW) different adjustments to the diurnal cycle are developed for each location. The effect on the 32 sites across the GAR varies due to different formulae being used by NMSs to calculate monthly means from the two or more observations made at each site each day. These formulae also changed over the years, so considerable amounts of additional metadata have had to be collected to apply the adjustments across the whole network.

Overall, the results indicate that summer (April to September) average temperatures are cooled by about 0.4°C before 1850, with winters (October to March) staying much the same. The effects on monthly temperature averages are largest in June (a cooling from 0.21° to 0.93°C, depending on location) to a slight warming (up to 0.3°C) of some sites in February. In addition to revising the temperature evolution during the past centuries, the results have important implications for the calibration of proxy climatic data in the region (such as tree ring indices and documentary data such as grape harvest dates). A difference series across the 32 sites in the GAR indicates that summers since 1760 have warmed by about 1°C less than winters.