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Evidence of a warm early instrumental period found in temperature related water isotope records from high elevation Alpine ice cores

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The variability of water isotopes (delta-O18 or delta-D) preserved in Alpine glacier ice may provide mid-latitude temperature proxy records supplementing respective information from other archives. In order to archive long term records (i.e. exceeding 100 years) the limited glacier depth at suitable Alpine drill sites requires a relatively low net accumulation rate. In this respect, the cold glacier saddle Colle Gnifetti (CG) is the unique drilling site in the European Alps offering ice core records substantially exceeding the instrumental period. However, the unique low net accumulation at CG is characterised by strong spatio-temporal variability causing depositional noise that strongly challenges the interpretation of the ice core isotope records in terms of net temperature change.

Here we present our findings from comparing stable water isotope records of the CG multi core array to a site-specific temperature time series. The latter is synthesized from high elevation stations of the instrumental HISTALP network considering among others the temperature shift from the accumulation bias towards growing seasons. Within the last century dedicated time series analysis reveals a common signal in the (supra-) decadal components of the instrumental temperature and isotope records. Extending the comparison over the entire 250 years instrumental period, systematic discrepancies are found within the early instrumental period (EIP). The delta-O18 record shows an overall decreasing trend from 1760 to 1890 AD, which is not reflected in the temperature record. However, using high Alpine summer temperature lacking the latest EIP adjustment, the long-term trends between isotope and instrumental data are in better agreement. The overall mean of the isotope based temperature in the EIP indicates substantially warmer levels than the EIP-corrected instrumental temperature. It differs, however, not significantly with respect to the non-EIP-corrected temperature mean.

Although the main reason for the systematic discrepancies within the EIP is not settled, we discuss their implications with respect to performing a calibration of the ice core isotope thermometer against instrumental data over the entire instrumental period. In order to illustrate dating uncertainties and the intricate role of snow deposition, the inter-core isotope comparison is supplemented by impurity time series, including a tentative look at evidence of volcanic eruptions within the EIP. Finally, newest ice core isotope evidence is evaluated in the light of inconsistencies between the multi-decadal temperature variability derived from instrumental and other proxy sources, including the possibility of the EIP-correction of instrumental data being overestimated, at least, with respect to the high Alpine air temperature.