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Homogeneous sub-daily temperature series for Switzerland - a physics-based approach

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Long-term homogeneous climate series are fundamental for studying climate change. In addition, high temporal resolution in climate data is desirable to address trends and variability in the mean climate and in climatic extremes. Recently digitized sub-daily station data from Switzerland (DigiHom III) reach back to the mid of the 18th century and thus are counted among the longest climate series available. However, like most climate series they are also affected by inhomogeneities.

Modification of instruments or station relocations often affect the characteristics of a measurement system which become evident in an altered energy balance, before and after a change, and therefore may produce a non-climate related artificial shift. These effects are assumed to depend heavily on the ambient weather conditions. We therefore apply an empirical model that reflects the main physical processes affecting the energy balance of the measurement system at any given time, e.g. radiation and ventilation, in the correction step of our homogenization procedure. We set up a simple radiation balance model, including a snow-cover-model to account for snow albedo, to model net-radiation (short- and longwave) on the surface of a measurement system, such as a radiation shield. The model requires only cloud cover and wind speed for each day, but detailed site-specific information is necessary. This model can be used in the correction procedure to distribute a mean annual step-size of an artificial break, determined using conventional homogenization techniques, to every single measurement. Hence, the correction amount is different for each single measurement and depends on net-radiation and on wind speed. In this way, the correction model accounts for non-linear processes that create inhomogeneities. The method allows a physics-based approach to correct inhomogeneities, which may lead to more realistic correction results.

Our method does not rely on reference series in the correction procedure (other than for the determination of the step size), rather, it is based on physical environmental conditions at the time of measurement and - at least – a crude understanding of the error. The application of this physics-based method for adjusting inhomogeneities in high-resolution temperature series enables to address higher order artificial variations for different break points. This is crucial for the correct analysis of e.g. climate extremes. With this physics-based approach Swiss sub-daily temperature records are being homogenized. The resulting homogeneous sub-daily temperature series are presented.