



Evaporation and reference evapotranspiration trends in Spain

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Interest is growing in the trends of atmospheric evaporation demand, increasing the need for long-term time series. In this study, we first describe the development of a dataset on evaporation in Spain based on long-term series of Piché and pan measurement records. Piché measurements have been reported for >50 stations since the 1960s. Measurements of pan evaporation, which is a much more widely studied variable in the literature, are also available, but only since 1984 for 21 stations. Particular emphasis was placed on the homogenization of this dataset (for more details, we refer to Sanchez-Lorenzo et al., 2014, *Clim Res*, 61: 269–280). Both the mean annual Piché and pan series over Spain showed evaporative increases during the common study period (1985–2011). Furthermore, using the annual Piché records since the 1960s, an evaporation decline was detected from the 1960s to the mid-1980s, which resulted in a non-significant trend over the entire 1961–2011 period. Our results indicate agreement between the decadal variability of reference evapotranspiration (Vicente-Serrano et al., 2014, *Glob Planet Chang*, 121: 26–40) and surface solar radiation (Sanchez-Lorenzo et al., 2013, *Glob Planet Chang*, 100: 343–352) and the evaporation from Piché and pan measurements since the mid-1980s, especially during summer. Nevertheless, this agreement needs attention, as Piché evaporimeters are inside meteorological screens and not directly exposed to radiation. Thus, as Piché readings are mainly affected by the aerodynamic term in Penman's evaporation equation and pan records are affected by both the heat balance and aerodynamic terms, the results suggest that both terms must be highly and positively correlated in Spain. In order to check this hypothesis, the radiative and aerodynamic components were estimated using the Penman's equation. The results show that the relationship with the radiative components is weaker than that with the aerodynamic component for both pan and Piché evaporation measurements. In addition, both component series show an increase during the period 1985–2011, but the aerodynamic term is larger than the radiative term. These results indicate that the increase in evaporation over Spain since the mid-1980s can be related to changes in both terms of the Penman's equation, especially the aerodynamic component, possibly due to a strong decrease in relative humidity in the last decades and a noticeable increase in air temperature (Vicente-Serrano et al. 2014, *Water Resour Res* 50: 8458–8480)