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## The link between temperature mean and variance trends in summer in France and Spain and its evolution

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In a previous work (Parey et al. 2010, [1]) a link had been identified between the trends in temperature mean and variance in Europe, with geographical and seasonal differences, and the climate models at the time performed poorly in representing the observed link. In this study, we update the results for summer temperature and go further in looking for possible causes of the observed differences between France and Spain. Then, the performance of the last CMIP6 models in representing the link is assessed in order to anticipate how this link could evolve in the future.

More precisely, in summer in France the trends in mean and variance are generally positively correlated: variance increases when mean increases, whereas in Spain the reverse behavior is generally found. This behavior has been confirmed with recent observation data: individual timeseries as well as the gridded EOBS database. We show that this can be explained by the fact that summers in Spain are more constantly hot, and the variance is explained by the occurrence of milder spells, while in France, summers are mild and the variance is explained by the occurrence of hot spells. The evolution of the link throughout the 1950-2022 period has been studied and revealed that parts of the south of France recently turned toward a similar behavior as Spain, with a decrease in variance when mean increases. The investigated question then is the following: will French summers resemble Spanish summers in the future? To answer the question, the ability of CMIP6 models to represent the observed link is first assessed, and then, the evolution projected by the best performing ones toward the end of the century is studied.

Better understanding the evolution of this link is important to anticipate future hot temperature extremes in France in the long term for adaptation. Owing to the larger impact of variance compared to mean on the intensity of the extremes, this question is crucial for the anticipation of future hot extremes. Do we need to anticipate a general hot summer climate in the second half of the century, or will the summers become warmer with more frequent heat waves and possible large deviations to very hot temperatures?

Reference:

[1] Parey S., Dacunha-Castelle D., Hoang T.T.H. : Mean and variance evolutions of the hot and cold temperatures in Europe; *Clim Dyn* (2010) 34:345–359, DOI 10.1007/s00382-009-0557-0

