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Limitations of the AMIP protocol to investigate extratropical climate events at seasonal timescale: the 2003 european heat wave as a case study

Christophe Cassou[†]; Soline Bielli; Herve Douville; Eric Maisonnave
[†] CNRS-CERFACS, France
Leading author: cassou@cerfacs.fr

Summer is a critical season in the Northern Hemisphere midlatitudes due to the possible occurrence of major heat waves/droughts leading to strong socio-economico-ecological impacts. The present study is embedded in the IRCAAM project funded by the French National Research Agency, which aimed at understanding the influence of the tropics on the extratropical North-Atlantic/Europe (NAE) atmospheric circulation as well as the impact of the ocean-atmosphere coupling in the NAE intraseasonal-to-interannual climate variability. A series of atmospheric global circulation model (ARPEGE) experiments either nudged towards the ERA40 re-analysis within the tropical band or forced by observed sea surface temperature (SST) anomalies, a.k.a. the AMIP protocol, or coupled to a 1D mixed layer ocean (NEMIX) model, have been conducted to investigate the possible origins and mechanisms that favored the occurrence and strength of the 2003 European heat wave. We confirm that the tropical forcing, especially from the Caribbean regions in June, plays a primary role in setting the large-scale NAE anomalous circulation associated with the extreme heat event. We provide evidence that the observed extratropical NAE SST anomalies should be understood as the reponse to the anomalous atmospheric circulation and not as a forcing for the latter. We show that AMIP protocol experiments could lead to warm conditions over Europe but for wrong reasons and wrong physics ; those should therefore be used and interpreted with great caution to analyse midlatitude climate variability from intra-seasonal to interannual timescale. Evidence is finally presented here that even if extratropical SST anomalies can not be considered as trigger for warm European conditions, their positive feedback to the anomalous NAE atmospheric circulation by moistening and warming the air advected over land and by increasing in fine the downward longwave radiation at the surface, is crucial to enhance the sole dynamical effect of the atmosphere.