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Overly persistent circulation in climate models contributes to overestimated frequency and duration of heat waves and cold spells

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The study examines links of summer heat waves and winter cold spells in Central Europe to atmospheric circulation and specifically its persistence in an ensemble of regional climate models (RCMs). We analyse 13 RCMs driven by the ERA-40 reanalysis and compare them against observations over 1971–2000. Using objective classification of circulation types and an efficiency coefficient with a block resampling test, we identify circulation types significantly conducive to heat waves and cold spells. We show that the RCMs have a stronger tendency to group together days with very high or low temperature and tend to simulate too many heat waves and cold spells, especially those lasting 5 days and more. Circulation types conducive to heat waves in summer are characterized by anticyclonic, southerly and easterly flow, with increasing importance of warm advection during heat waves. Winter cold spells are typically associated with easterly and anticyclonic flow, and the onset of cold spells tends to be linked to northerly and cyclonic flow with cold advection. The RCMs are generally able to reproduce the links between circulation and heat waves or cold spells, including the radiation-to-advection effect for heat waves and the opposite advection-to-radiation effect for cold spells. They capture relatively well also changes of mean temperature anomalies during sequences of given circulation types, namely the tendency towards an increase (decrease) of temperature during the types conducive to heat waves (cold spells).
Since mean lengths of all circulation supertypes are overestimated in the RCMs, we conclude that the overly persistent circulation in climate models contributes to the overestimated frequency of long heat waves and cold spells. As these biases are rather general among the examined RCMs and similar drawbacks are likely to be manifested in climate model simulations for the 21st century, the results also suggest that climate change scenarios for spells of days with high or low temperatures should be interpreted with a view to the models' performance limitations in simulating the recent climate.

Reference:
Plavcová E., Kyselý J., 2016: Overly persistent circulation in climate models contributes to overestimated frequency and duration of heat waves and cold spells. Climate Dynamics, doi 10.1007/s00382-015-2733-8.