

Reply to Referee #3

Impact of 3D groundwater dynamics on heat events in historical regional climate simulations over Europe

We thank the referee for the review and for the comments and suggestions. We provide a point-by-point reply below, where the reviewer comments are repeated in black. The replies to the reviewer's comments are in blue. The revised text is given in italics and in quotation marks.

General remarks

- The study aims to improve understanding of how groundwater dynamics affect regional heat events by comparing the simulation results from TSMP and those from the CORDEX. In general, this is a well-organized paper. The topic and method are interesting.
Thank you for the encouraging feedback.
- However, some issues shall be paid more attention. First, the research aim is not presented clearly in the abstract.
Thank you for the suggestion. We revised the abstract of the paper and clearly stated the purpose of the study as suggested.
“By comparing summer heat events statistics (i.e. a series of consecutive days with a near-surface temperature exceeding the 90th percentile of the reference period) from TSMP and those from GCM-RCM simulations with simplified groundwater dynamics from the Coordinated Regional Climate Downscaling Experiment (CORDEX) for the European domain, we aim to improve the understanding of how 3D groundwater dynamics affect regional heat events over Europe.”
- It's a bit difficult to follow the results as the author mixed EURO-CORDEX, TSMP, and other GCM-RCM (e.g., REMO RCM, REMO2015 driven by IPSL-CM5A-LR, CCLM forced by MPI-ESM-LR).
Thank you for your remark. We revised the text to ensure consistent notations, please see the revised version of the manuscript.
- In addition, since the study focuses on the impact of 3D groundwater dynamics on heat events, the related mechanisms are missing, which could better-assisting understanding the effect.
Thank you for the comment. The introduction of the manuscript contains the paragraphs devoted to the description of the groundwater dynamics and related processes, as well as their relation to heat events based on previous studies (please see pp.3-4 in the manuscript). In addition, references to the TSMP modelling platform and its component models can be found throughout the text. Therefore, we believe that it gives the reader a sufficient overview of the subject of the paper.

Specific Comments

1. (Line 50, page 2) please give the full name of GCM and RCMs here when it is presented for the first from the main text.

Thank you for the remark. We corrected the sentence as suggested.

“In the context of climate impact assessments, dynamical downscaling of global climate models (GCMs) with regional climate models (RCMs)...”

2. (Line 130-145) References are missing in this part.

The references were added as suggested.

3. (Line 255, page 10) “Hence the spatial pattern of the TG90p index significantly differs between different GCM-RCMs and the results from RCMs driven by the same GCMs show a rather similar behaviour.” I found it challenging to get this result. Please explain it.

Thank you for your comment. We rephrased this statement in the revised version of the manuscript.

“... the uncertainty in simulated near-surface temperature in summer is strongly controlled by the large-scale atmospheric circulation imposed by the GCM boundary conditions, with the largest impacts occurring in the southwestern PRUDENCE regions (e.g., Déqué et al., 2012; Evin et al., 2021). For this reason, the spatial pattern of the TG90p index in RCMs driven by the same GCMs show a rather similar behaviour.”