

Title: Bridging the gap: a new module for human water use in the Community Earth System Model version 2.2.1

Summary

The paper presents a new module for human water use in CESM. This module integrates sectoral water abstractions for multiple sectors, conserving water by integrating abstractions from the land component with river component flows and dynamically calculating daily water scarcity based on local demand and supply. The findings emphasize the importance of including all sectors for water scarcity assessment capabilities and highlight areas for potential future refinement.

Overall, the paper makes a significant contribution to the field of Earth system modeling by enhancing the representation of human water use in CESM. The detailed methodology, comprehensive validation, and insightful analysis make it a valuable resource for researchers and policymakers interested in sustainable water management. However, I found adding some more discussion could improve the manuscript.

I was invited to review this paper in the second round. Please let me know if there are any conflicts with comments or suggestions raised in the first round.

Major comments:

1. **Validation:** The paper is well-written and novel in that the module integrates multiple sectors, providing a holistic view of water use and scarcity. The model is validated against historical data and known water scarcity hotspots. However, more validation could be done, for example, using stream gauge data, evapotranspiration data, and satellite land surface temperature datasets. Alternatively, it could be discussed whether such validation will be done in future work and how it would benefit the model.
2. **Groundwater Abstractions:** The model currently focuses only on river water abstractions, potentially underestimating groundwater use in arid regions. The authors might need to discuss future model development plans or explain why river water abstractions are more important than groundwater use. The study found that non-irrigative sectoral consumption has an insignificant effect on regional climate. Could this be because the study neglects groundwater use?
3. **CESM Coupling:** In this paper, only offline CLM simulations have been done, but the title mentions "CESM." The authors might need to discuss whether there are future plans to use this new module in coupled CESM simulations and what potential issues might arise when coupling with atmospheric or other models.
4. **Introduction Enhancement:** The introduction could benefit from an overview of global hydrological models (e.g., WaterGAP, GHM, PCR-GLOBWB), including whether and how human water use has been modeled and what the limitations are compared to land

surface models (LSMs). This is particularly important since there are discussions on GHMs in the Results and Discussion sections but not in the Introduction.

Minor comments:

[The line number refers to the version without tracked change.]

Line8: have-> has

Line 61 “the” land-use and land-cover change (LULCC)

Line 77: Maybe change “is focused” to “focuses”

Line 105: It might be worth mentioning why CLM on a 0.9x1.25° grid is chosen. Is it for future application in coupled CESM, or to match the input data? Also, please add "" throughout the manuscript.

Line 111: have-> has

Line 113: Is “missing part” the “shortfall”?

Line 140: CFTs

Line 163: “The” same approach

Line 164: being-> is

Line 183: indicating-> meaning?

Line 185: will depend-> depends

Line 186: little losses-> few losses

Line 190: is -> are

Line 192: What if the land grid consists only cropland and/or urban?

Line 299: show?

- How does the new module deal with iced rivers/iced soil if there is human water use?
- Be consistent with "grid cell" or "gridcell." Are they referring to different things?