

1 Comments by Heini Wernli (CC1)

- Thanks for submitting the interesting results about your novel Eulerian approach to WCD. I have one concern after looking at the paper, which is related to the model simulations, in particular, the resolution and number of simulated years. If I understand correctly, then your results are based on 5-year simulations with T42 spectral resolution. Such a resolution is very low, and the simulations are short given the substantial interannual variability. With a T42 simulation, you hardly capture atmospheric fronts, atmospheric rivers, tropical cyclones, etc. Also, orographic precipitation is strongly underestimated due to the smooth topography. I am very supportive of doing idealized and semi-realistic numerical studies, but then the limitations of such an approach should be kept in mind and made transparent to the readers.
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- 10 You mention in one sentence that you compared with T85, but this is still low resolution. Keep in mind that ERA5 reanalyses, which were used in some of the previous studies about water age, are based on IFS simulations with T639 spectral resolution. I do not assume that you can easily repeat your simulations with a much higher resolution, but I would like to invite you to make it much more transparent that your results are based on T42 simulations (in the abstract, in the conclusions, and maybe even in the title) and to discuss the limitations when it comes to the representation of essential precipitation systems across the globe.
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- Also, if I am not mistaken Fig. 3 shows your 5-year climatology of E and P - these fields do not look very realistic to me, can you compare these fields critically with observation-based climatologies?
- In the abstract you provide very specific values for the mean WV age etc. and it is important that the reader understands that these values result from coarse resolution and short simulations.
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Dear Heini Wernli,

Thank you for your comments. We appreciate your input and interest in our manuscript.

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- We agree with you that the limitations of our implementation, mainly due to the resolution, were not made clear enough, especially in the abstract and discussion. We want to make sure that it is clear that our manuscript is a proof of concept of our Eulerian age moments tracers. We addressed both issues by modifying the abstract (around line 10) accordingly and adding a short section about it in the discussion (around line 500)

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- We would also like to highlight that although our experiments are at much lower resolutions than previous calculations made with re-analysis products. Our globally averaged values for the mean WV age and mean age of precipitation were 7.06 and 7.33 days, which are within the range reported in Gimeno et. al. 2021. Furthermore, the scaling rates of 5.10% and 3.20% per degree of global warming (they were recalculated during these revisions based on the fitting parameters instead of the discrete calculation) were also within the well-established 3 to 6 % range.
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- Figure 1 shows the 10-year average of evaporation (A) and precipitation (B) from JRA. When we look at evaporation, the general pattern seems to be similar, but we note some overestimation on our part around Central America and Southeast Asia. For precipitation, the general pattern is respected, but values are lower in general. Similarly to evaporation, there is a strong overestimation around Central America and Southeast Asia. But the regions of high and low precipitation align well. Possible reasons for the disagreement we see could be the bucket land parametrization, resolution, lack of ocean parametrization, etc. We mention this again in the discussion of our results.
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Climatological monthly-mean precipitation (E ; panel A) and evaporation (P ; panel B) from JRA for 1948-1957. Values are in $\text{mm} \cdot \text{day}^{-1}$.

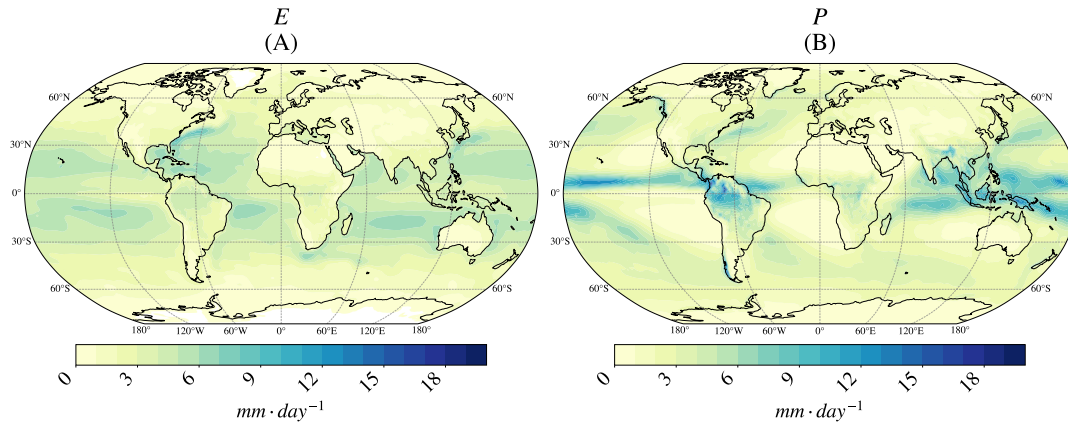


Figure 1. 10-year averages of evaporation (A) and precipitation (B) from JRA re-analysis data KOSAKA et al. (2024)

References

- 45 KOSAKA, Y., KOBAYASHI, S., HARADA, Y., KOBAYASHI, C., NAOE, H., YOSHIMOTO, K., HARADA, M., GOTO, N., CHIBA, J., MIYAOKA, K., SEKIGUCHI, R., DEUSHI, M., KAMAHORI, H., NAKAEGAWA, T., TANAKA, T. Y., TOKUHIRO, T., SATO, Y., MATSUSHITA, Y., and ONOGI, K.: The JRA-3Q Reanalysis, *Journal of the Meteorological Society of Japan*. Ser. II, 102, 49–109, <https://doi.org/10.2151/jmsj.2024-004>, 2024.