

General comments

By using the Large Ensemble Single Forcing Model Intercomparison Project (LESFMIP) and the Atmospheric Model Intercomparison Project (AMIP) simulations, this study investigates drivers and physical mechanisms of the summer circulation trends in the Northern Hemisphere during recent decades. Analysis of the single-forcing experiments shows that historical anthropogenic aerosol forcing leads to responses that have some pattern similarity with the observed changes in atmospheric circulation although with an underestimated magnitude of the trends in models. These results suggest that the observed spatial structure of trends is at least partially caused by anthropogenic aerosol emissions and is not the result of global warming caused by greenhouse gas emissions and highlight important inconsistencies between models and observations. Another important aspect of the study is the assessment of roles in solar, ozone, and volcanic forcings. The study is a good contribution in understanding recent summer circulations changes in the northern hemisphere and the paper is well written. Therefore, the paper is acceptable for publication after minor revisions by addressing the following specific comments.

We want to thank the reviewer for the valuable feedback provided, which helped improve the quality of the manuscript. Following the received comments, our plan to address these in a revised manuscript is the following:

1. It seems that a recent study of Dong and Sutton (2025) is relevant. They reported an important role of atmospheric circulation on European warming in observations during recent decades. CMIP6 all forcing experiments underestimated atmospheric circulation trends (their Fig. 6) and these trends in model simulations were due to aerosol forcings (their Fig. S15) although they focused on the Atlantic sector. Dong, B. and Sutton, R. T. (2025) Drivers and mechanisms contributing to excess warming in Europe during recent decades. *npj Climate and Atmospheric Science*, doi: 10.1038/s41612-025-00930-3

Thank you for the recommendation. We will reference the paper in two separate contexts where it is relevant.

Introduction: Line 30 : *“Some examples include the underestimation of summer temperatures and extremes trends over Europe due to trends in southerly flow (Vautard et al. (2023)) or changes in the zonal wind structure and sea surface pressure (Dong and Sutton (2025)) being underestimated in models”*

Results: Lines 118-119 *“This structure is present and significant in reanalysis (Fig.1a) and is consistent with the findings in (Dong and Sutton (2025)).”*

1. Lines 91-94. For model simulations, it might be helpful for readers if authors can list each individual forcing experiments analysed in this study.

We will add explicit forcings as indicated:

Line 92: *“Each individual member of both LESFMIP (including historical all-forcings, aerosol, GHG, volcanic, solar, natural and totalO3 only experiments) and AMIP simulations.”*

Line 94: Change *“forcing”* for *“forcing experiment”* for consistency and clarity.

2. Figure 1 caption. It would be helpful if authors can add information about regions that are used to calculate the area-weighted Pearson pattern correlation.

Thank you for the suggestion. However, Figure 1 does not include any calculation of the spatial correlation. Therefore, we believe that it could be better to add the corresponding information in Figures 3-6 to avoid making interpretation of Figure 1 less clear. In Figures 3,5,6 we will add: “*for the whole northern hemisphere midlatitudes (30°N - 60°N, 180°W - 180°E)*”. In figure 4 we will add the corresponding region latitudes and longitudes: “*for the NA-Atl region (30°N - 60°N, 100°W - 0°E) (a) and Eurasia (30°N - 60°N, 15°E - 110°E) (b).*”

3. Line 169. “the idea” to “conclusion drawn in previous sections”.

Line 169: We will change “*idea*” to “*conclusion drawn in previous sections*”.

4. Lines 170-171. Not a complete sentence.

Thank you for pointing this out. We propose the following change: Line 170-171: Change “*As*” to “*We reach this conclusion because*”.

5. Line 174. “Z200” to “Z200_az”.

Line 174: Change “*Z200*” to “*Z200_az*”.

6. Figure 6 caption. This is for the period of 1979-2014. Please specify.

Yes, this is for the period 1979-2014. We would change the caption accordingly (Figure 6 caption: Add “*during the 1979-2014 period*”).

7- Lines 213-214. “Notably, aerosol-only forced runs are able to match to a large degree the changes in Z200_az from historically forced runs and to a lesser extent reanalysis data.”.

Please rephrase it since the meaning is not very clear.

We agree the sentence's meaning is unclear, therefore, we plan to restructure it as follows: “*Notably, aerosol-only forced runs present very similar changes in Z200_az compared to historical runs with all forcings and (to a lesser extent) reanalysis data.*”.