RC2: 'Comment on egusphere-2025-4923', Anonymous Referee #2, 27 Nov 2025

The authors investigated the role of paleogeography on large-scale circulation during the early Eocene. They analyzed cyclone tracks and blocking systems of the early Eocene in an atmosphere-only CESM1.2 simulation. The results show that, paleogeographic features of the early Eocene enhanced cyclonic activity at northern mid-latitudes while reduced it at southern mid-latitudes compared to modern conditions. Overall, this paper has clear structure with enough contents. I think it can be published after revision.

We thank the Reviewer for their comments and suggestions. We revised the manuscript in accordance to the Reviewers comments. Below we list our answers and the changes in the manuscript according to each comment.

Lines 3-4, Apart from these two, are there any other factors?

We agree that there are also other factors, through our analysis we found, that these two have the most influence on our subjects (cyclones and blockings). We rephased the sentence to emphasise that these are the ones we chose to focus on. “In our analysis we highlight the influence of the epicontinental West Siberian Sea as well as the impact of the lack of the Antarctic Circumpolar Current on mid-latitude cyclones and blocking events.”

Lines 8-9, the details of experiments can be deleted in the abstract.

Thank you for your suggestion, we simplified this part of the abstract and deleted the not necessary details.

Line 38, ‘At this time in the past’, it is unclear.

We changed the sentence, now it states that we are refering to the early Eocne.
“During the early Eocene there were no currents connecting the Arctic to the Pacific basin, as the Bering Strait was closed, thus oceanic heat transport from the tropics to the Arctic flow through the West Siberian Sea (Akhmetiev et al., 2012).”

Line 65, for the first part, this paper does not separate the signals related to paleogeography and CO_2, please check.

Thank you for this remark, it is right this paper does not separate signals, but focuses on paleogeography related changes, we corrected the sentence and also clarified it in the paragraph detailing our previus results in this topic.

Now the first goal sentence is:

“1. To understand the early Eocene global circulation and climate. The better understanding of large-scale circulation patterns and their changes related to paleogeography helps the interpretation of proxy records.”

Line 85, why the authors use the results from the atmosphere-only model but not the coupled CESM, please state the advantages.

We note that the published coupled simulations (Zhu et al., 2019) do not have high-frequency output for cyclone and blocking event analysis. In the present study, we re-create these simulations in an efficient atmosphere-only configuration with additional 6-hourly output to track and investigate weather events.

We included the following text in the manuscript: "The atmosphere-only configuration was sufficient for our study, as we are focusing on atmospheric processes, and do not expect the ocean, which reached equilibrium in the DeepMIP simulation, to change notably in the timeline of our relatively short simulations."

Line 120, what is the relationship between cyclone distribution and the number of cyclones? For example, under early Eocene conditions, the distinction between two sets of Northern Hemispheric cyclone paths becomes less pronounced, and the number of cyclones decreases in the Northern Hemisphere.

The number of cyclones are higher under early Eocene conditions in the Northern Hemisphere, so the wider spatial ditribution of similar track density values are in line with higher cyclone numbers. We clarified it now in the text:

"However, under early Eocene conditions, the spatial distribution of cyclone tracks becomes more balanced as the distinction between the Pacific and Atlantic paths becomes less pronounced (Figure 3b). Also, there is an increase in cyclone tracks passing over land areas, especially over Europe. In contrast, in the Southern Hemisphere there are fewer cyclone tracks under early Eocene conditions compared to pre-industrial, and the track climatology shows several small density centres around Antarctica (Figure 3d), which is due to the more fragmented Southern Ocean basin. These changes are also reflected in the number of cyclones (Figure 4), with an average annual increase of 36% in the Northern Hemisphere and a decrease of 32% in the Southern Hemisphere. This makes the cyclone distribution between the hemispheres more balanced, although the average annual cyclone number is still higher in the south than in the north."

Figure 6c and d, in the northern high latitudes, the cyclone track density and high precipitation do not completely overlapping, why?

The cyclone track density only follows the cyclone center thus the whole cylone covers a larger area, and generally cyclones precipitate more over marine surface than over land, due to higher available moisture in the atmosphere.

We included now a sentence in the manuscript mentioning this: "They generally produce more precipitation over oceanic regions than over land due to greater moisture availability.

Moreover, enhanced precipitation also occurs when mid-latitude cyclones encounter orographic barriers, and orographic lifting takes place.”

Line 153, how to compare the latent and sensible heat fluxes over the Eurasian region?

We now included the latent heat and sensible heat fluxes separately, which makes easier to assess their contribution, which was very similar in case of the West Siberian Sea, while the latent heat flux is more pronounced over the Tethys Ocean.

We also changed the text to:

“Comparing the latent and sensible heat fluxes over the Eurasian region reveals that over the West Siberian Sea the two fluxes are of comparable magnitude, thus the Western Siberian Sea enhances thermal contrast and act as a moisture source, whereas over the Tethys Ocean the surface energy exchange is dominated by latent heat flux (Fig. 8).”

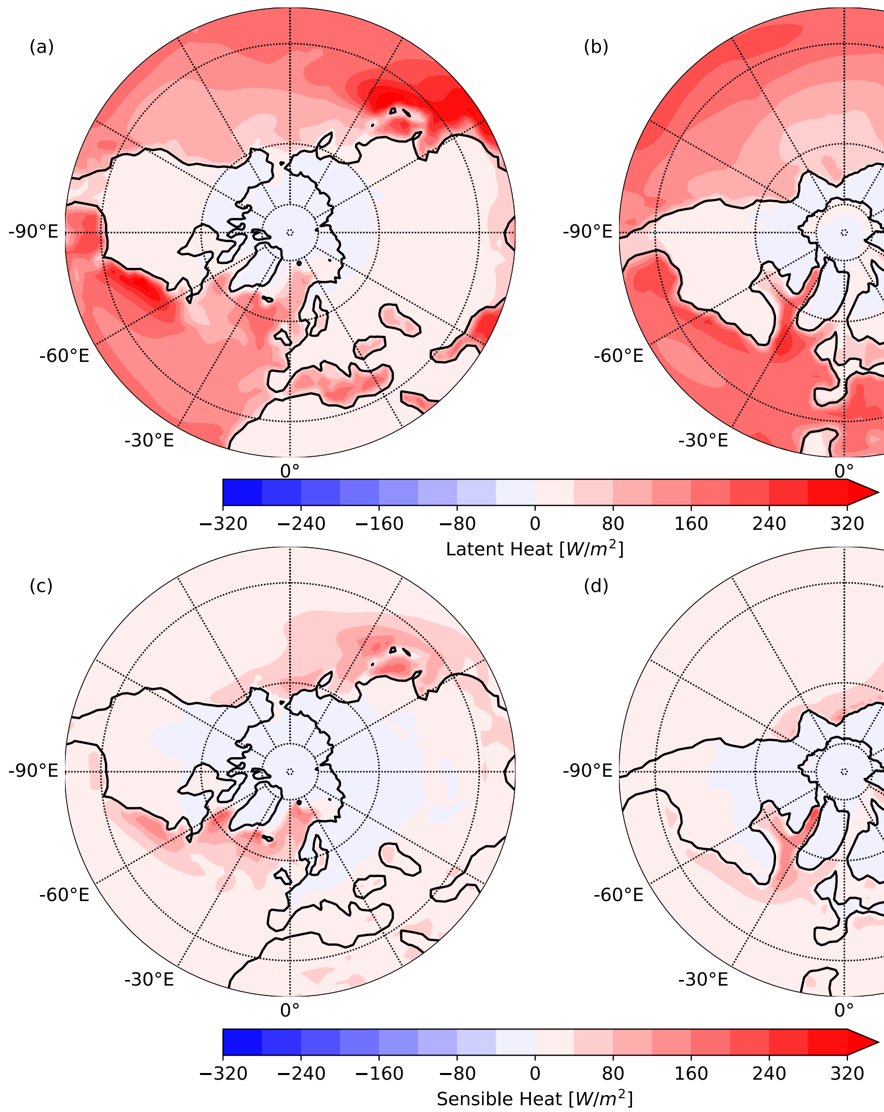

Figure 8. Latent heat (a, b) and sensible heat (c, d) fluxes during boreal winter over the Northern Hemisphere in the pre-industrial (a, c) and early Eocene (1xCO2) (b, d) simulations.