**Climate
of the Past
Discussions**

Interactive comment on "Southern westerlies in LGM and future (RCP4.5) climates" *by* Y. Chavaillaz et al.

Anonymous Referee #2

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This paper compares and contrasts the change in SH surface westerlies from the Last Glacial Maximum to Pre-Industrial and from the Pre-Industrial to the equilibrated response to the RCP4.5 scenario. As expected, and demonstrated by other studies, the future response to the RCP4.5 scenario is a poleward shifting of the jet. But, perhaps unexpected is that associated with the warming from LGM to pre-industrial there was not a consistent poleward shift among the models. Some shifted poleward and some shifted equatorward. The authors discuss possible reasons for this and in particular draw our attention to the fact that from LGM to Pre-Industrial there was a relatively strong warming over Antarctica near the surface and that such a signal is not really present in the future warming scenario. Multiple-linear regression of the jet shifts onto (a) the tropical temperature anomaly throughout the depth of the troposphere and (b) the high latitude lower tropospheric temperature is performed. The regression coeffi-

cients are successful at demonstrating a fairly convincing relationship between the jet shift and the combination of these two temperature anomalies and this I think is a nice result. I found the paper to be well written and clear, with the exception of a few wording issues for which I have suggested alterations below which the authors can take or leave. I think that this paper is acceptable for publication in CPD but I do suggest the following minor revisions first.

Revisions:

(1) p3696 l19. The discussion of the Braconnnot et al 2007 paper. What is meant by "discrepancies" in the models' response to LGM boundary conditions? Do you mean that there is a large amount of variability between the model responses? If so, I would describe it that way rather then there being discrepancies.

(2) p3698 para 2. I think this paper will be of interest to people, like myself, who are not so familiar with the palaeoclimate literature or the set up of the PMIP simulations. Since you are proposing that the behaviour of the ice sheets is key to the differences between model simulations I think it would be helpful here to have more of a discussion on what's going into the models, in particular in terms of the ice sheet. As far as I can tell, the ice sheet is prescribed? There is no dynamic ice sheet model in these simulations? So how then does the ice sheet end up being different in the different simulations? Is it to do with the interpolation onto the model grid and the horizontal resolution. Perhaps I am misunderstanding the PMIP website and there is indeed an ice sheet model, but either way I think a clarification of this in this paragraph would be helpful.

(3) p3700 the section on jet stream definition. I think some clarification of how the jet stream is defined is necessary. Is it simply the latitude of the maximum surface westerlies after interpolation onto a finer latitude grid or have you done some sort of quadratic fitting to the points around the jet maximum as in e.g. Kidston and Gerber (2010). It should also be clarified that you are looking at annual means?

(4) Figure 2. The degree symbols haven't turned out right.

(5) Figure 2. I'd suggest using a colour other than red for the right hand panels. It doesn't show up well for IPSL against the large zonal wind changes. It might also be helpful include more contours since it's hard to see the anomalies for CNRM and the blue anomalies for some of the other models.

(6) Figure 2. I'm a bit confused how you can end up with more than one jet latitude at a given longitude. e.g. for GISS the blue line seems to split and you have two jet latitudes from about 180E to 90W. The same is true for other models around New Zealand. What's going on there and how is this incorporated into your jet latitude differences?

(7) p3701 paragraph 2. I think some clarification of how you define the EOF is needed. This is calculated using the the whole years data? And it's the EOF of what? Zonal mean zonal wind on the 850hPa level? I assume this is the case from the caption of Fig 4 but I think this should be clarified in the text.

(8) Fig 4 caption. Suggest re-wording because at first glance it looks like this should be showing zonal wind on the 850hPa level. Perhaps something like. "Characteristics of the variability and response of zonal mean zonal wind on the 850hPa level for each of the models. Black lines: anomalies from 1sigma of the first (solid line) and second(dashed like) EOF of zonal mean zonal wind variability of the PI simulations......etc"

(9) Table 1 caption: clarify here that these are the first and second EOFs of zonal mean zonal wind variability on the 850hPa level.

(10) p3702 l16-17: IPSL doesn't look all that different from NCAR, MIROC and MPI at high latitudes. Is it more the warming from 60S-70S at 900-1000hPa that you are referring to? If so, this should be stated explicitly in the text. People will be drawn to looking at what is going on over Antarctic and I think they will not agree that IPSL is behaving differently from those models. e.g. over the Antarctic continent IPSL and MIROC look very similar.

(11) Figure 5. Firstly it would be much easier to compare the models if you group the plots by scenario rather than by model. Secondly, there appears to be some inconsistency in how the Antarctic topography is dealt with and since you are concerned with temperatures over Antarctica I think this needs to be clarifeid. Four of the models (IPSL, NCAR, MIROC and GISS) appear to have NaN's under the Antarctic surface and so there won't be any temperature anomalies from e.g. 600hPa-1000hPa and 80S-Pole included in the temperature anomalies for fig 6. But, MPI and CNRM don't have NaN's under the Antarctic surface and so it appears that some different form of pressure level interpolation has been done. I'm a bit concerned about this since e.g. for MPI, you might be including large temperature anomalies in the high latitude lower troposphere that are actually below the Antarctic surface. Are MPI and CNRM on model levels? This should be checked over I think and it should be made sure that each of the models are being dealt with in the same way. Also, is the averaging done by pressure weighting or not? I'm not sure it matters either way, but if it is pressure weighted then this should be stated.

(12) Figure 6. What do the filled green and blue squares mean? Also, it should be clarified in the caption that the blue symbols are only accompanied by their model names in the left panel e.g. "The blue symbols (accompanied by model names in the left panel) are the PI-LGM results.

(13) p3705 l16. I would suggest softening the wording here a bit. It is true that comparing the different models gives you an indication of the factors that are important. But, it still doesn't unambiguously identify the causality e.g. maybe the Antarctic or equatorial temperatures are different because the jet shift is different. And there are also other ways in which you can test which factor is important within a single model e.g. running simulations with and without changes in the Antarctic ice sheet.

Typos and wording:

P3694 l20:the word 'precisely' seems unnecessary

p3694 l24:i feel like feedback should be two separate words in the context (?)

p3694 l24:"help maintaining" –> "help in maintaining" or "help maintain"

p3696 l1: "get a better" –> "gain improved"

p3696 l18: remove comma between "changes" and "between".

p3698 l5: lengthscale –> length scale

p3698 l22: shown "on" Fig –> shown "in" Fig

p3698 l27: "than for PI), as it is the case" –> "than for PI). The same is true for"

p3700 l2: suggest removing "both taken"

p3700 l3: "are for all models a" –> "for all models is a"

p3701 l6: define SAM as Southern Annular Mode.

p3701 l9: comma's around "by contruction"

p3701 l11: momentum is mis-spelled.

p3701 l15: "on Fig" –> "in Fig"

p3701 l24: "zonal temperature" –> "zonal mean temperature"

p3702 l22: "upper troposphere" –> "upper tropospheric"

p3703 l5: "counted positive poleward" –> " with the sign convention that positive is poleward"

p3703 l7: I think the first bracket should be "left panel" rather than "right panel"

p3703 l8: suggest putting "(red symbols)" after "RCP case"

p3703 l21: I think it should be right panel instead of left panel.

p3704 l11: "an" –> "a"