

Response to reviewers

We thank the reviewers for their positive and constructive reviews. We have two points which were questioned by all reviewers, which are addressed in the “General” section below and then proceed to answer the reviewers point by point.

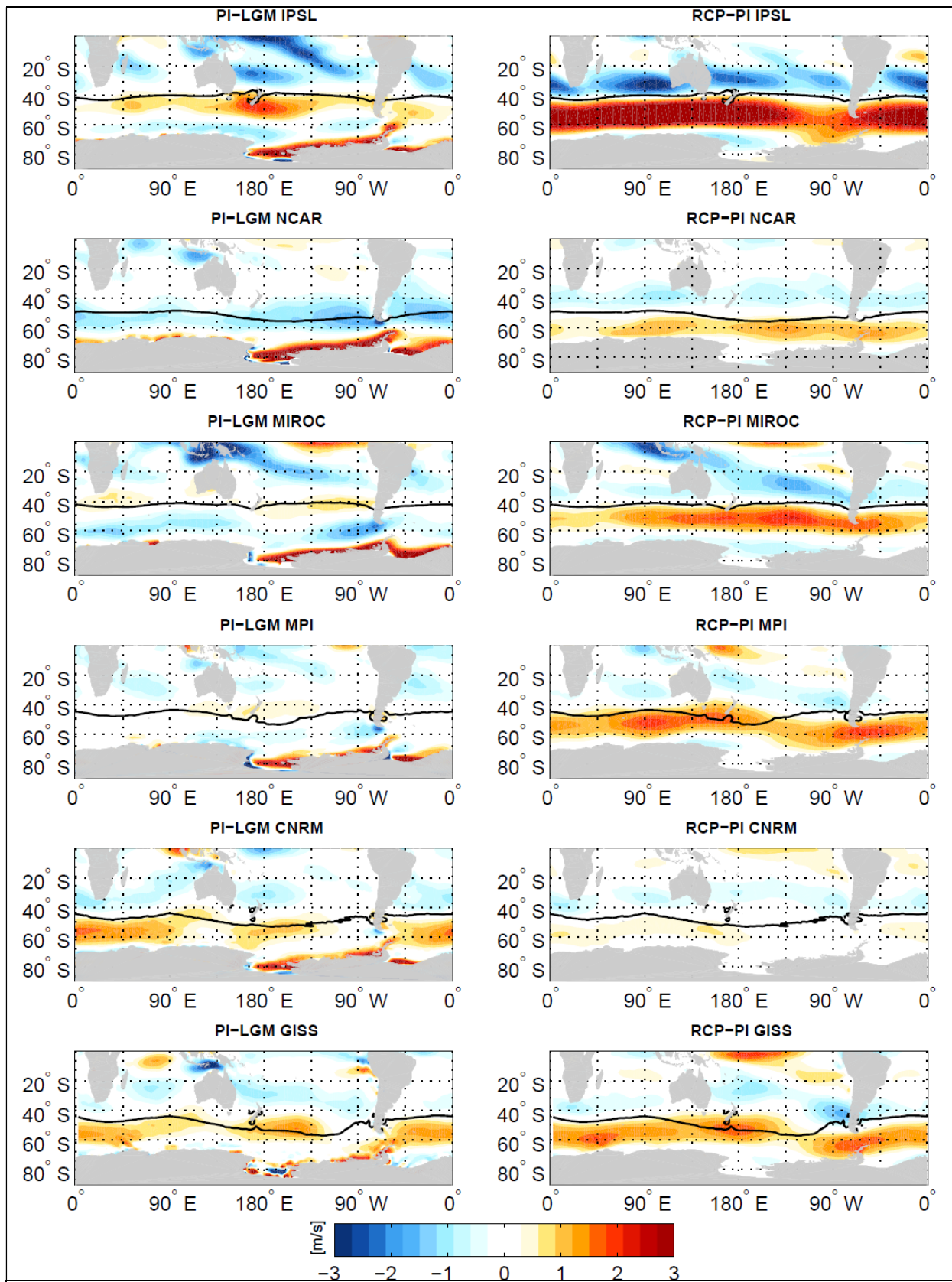
General:

A. Figure 2, wind changes.

Following suggestions by the reviewers, Figure 2 (showing maps of the future and past wind changes over the Southern ocean at 850 hPa) has been redone with the following changes:

- The blue / red lines (showing the mean jet position at the LGM and future, respectively) have been removed: they were hard to read and mostly added confusion.
- The color scale has been tightened, to make the anomalies for most models stand out more.
- Continents have been shaded with light gray, as a lot of the signal was due to spurious large anomalies linked to interpolation below the orography.

The new figure is shown below.



New Figure 2

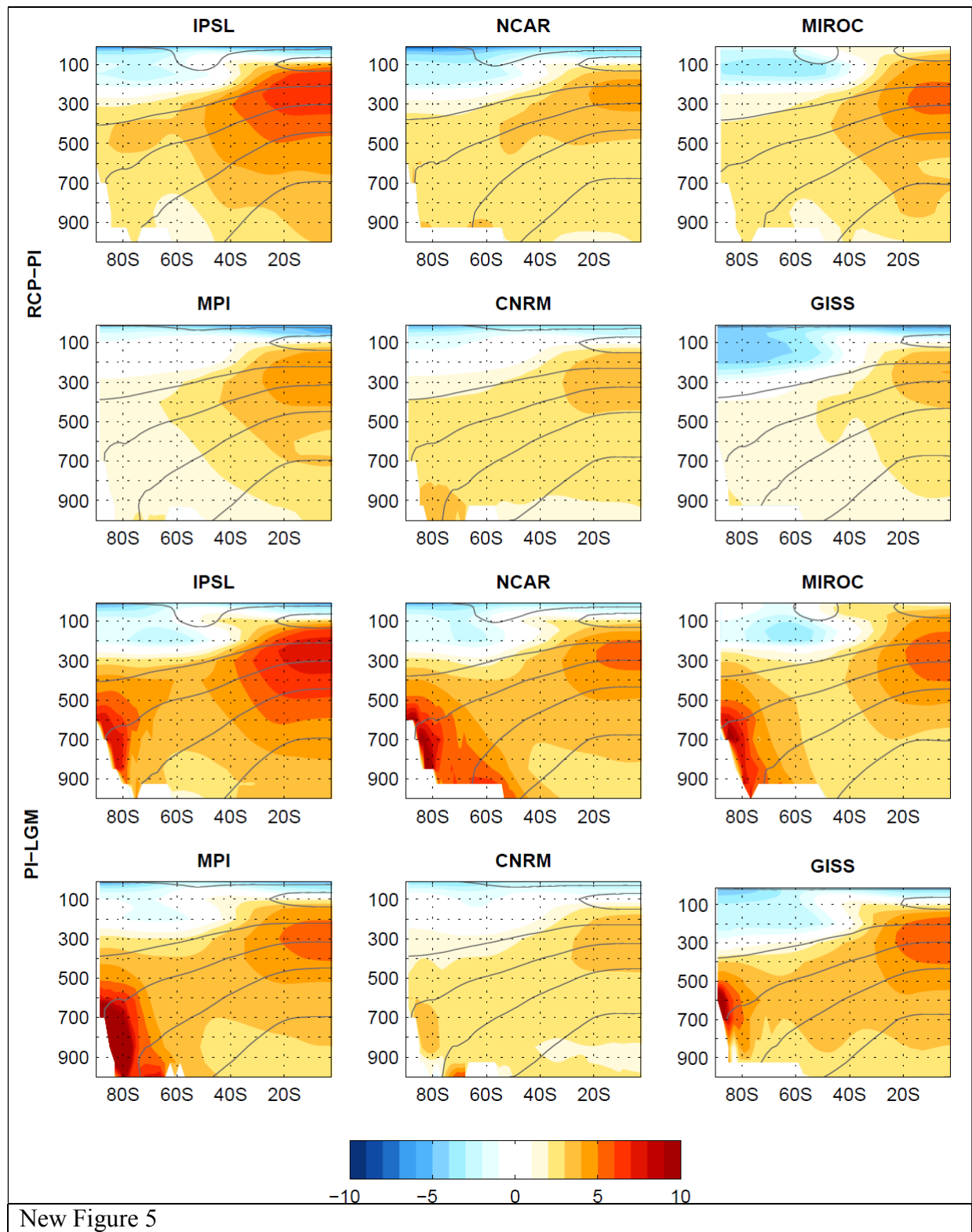
The position of the jet (latitude of maximum wind) was computed with a quadratic interpolation using grid points around the one of maximum mean wind. This has been precised in the text.

B. Mean temperature changes

Figure 5 (showing latitude-pressure cross-sections of the zonal-mean temperature changes) has been redrawn with the following changes:

- As asked by several reviewers, the panels have been reorganized to group future changes on top, and past ones at the bottom, instead of grouping by model.
- Grid points below orography are treated in an inconsistent way in the different model outputs, with some having missing data and others extrapolating from above. To apply a consistent treatment and plotting, we put all data at pressure levels below the local surface pressure to missing value.

This new figure 5 is shown below.



New Figure 5

Note that the latter treatment of missing values was already used for computing indices of temperature averaged over the polar or tropical regions, there is thus no change in these results.

Response to reviewer 1:

P3695, 118: The authors cite Russel et al. (2006b) at this point to support their statement that research on SH westerlies is currently being hampered by poor representation in climate models. The Russel et al. paper deals with CMIP3 models. Has the representation improved at all in the CMIP5 models used in this study? Consider quantifying this, or at least including a reference to a CMIP5 study.

The CMIP5 models still have as a group an equatorward bias in the jet position, although it has improved in some cases considered in this study. We added a reference studying CMIP5 jets in the Southern Hemisphere, in the context of response to ozone recovery (Wilcox et al, 2012)

P3698, 122 (Figure 1): Despite the different ice sheet data, GISS actually looks very similar to IPSL/NCAR/MPI, and similar to MIROC, although MIROC appears to have lower horizontal resolution. Do you have any ideas as to why CNRM looks so different?

P3699, 12: Do you have any ideas about why the altitude differences would be so much smaller in CNRM? The spatial pattern doesn't look too dissimilar..

We agree with the reviewer that GISS, although using a different ice-sheet altitude data set, looks more similar to IPSL/NCAR/MP/MIROC than the CNRM output. We are in contact with the CNRM group to answer this question.

P3699, 18: Out of a total of 12 models, the authors use 3 IPSL models. How independent are these models? RCP-PI IPSL has very large future anomalies relative to the other models shown. The left panel of Figure 6 shows that one of the additional models also has a relatively large position response. Is this a related IPSL model? If so, do the authors worry that the choice of this model in such a small sample is unfairly influencing their correlation coefficients?

Correlation coefficients are in fact computed with 18 cases (differences between simulations) including 4 IPSL ones. We checked that the correlation coefficients are similar if using only the original 12 cases (inc. 2 IPSL), in fact it can be seen on the rightmost panel of Fig 6 that two of the IPSL cases are in the “middle of the pack”, and that part of the good correlation comes from the 3 PI-LGM cases with close to zero jet change.

We included these extra IPSL versions because they are both different models in some ways: one (green filled square) has a different horizontal resolution, and a poleward mean position of the jet. The other (light blue filled square) has the same resolution but a different physical parameterizations package, and a lower sensitivity to CO₂.

An explanation of the differences between the IPSL models has been added in section 2.1 (CMIP5 simulations).

P3699, 110: The decision to analyse the 850hPa jet is justified. However, the authors have not made it clear exactly how they are defining the jet stream. Is it the location of the maximum in the 50 year mean of zonal wind at 850hPa? A clear definition at this stage would also allow the authors to refer simply to the ‘jet’ or ‘jet stream’ throughout the remainder of the paper, rather than the ‘maximum jet position’ and the confusing ‘jet position maximum’

The position of the 850-hPa jet is computed as follows: we take the zonally averaged zonal wind, and look for the grid point at which it is maximum. We then do a quadratic interpolation to find the latitude of the mean jet, as well as its maximum speed. We checked that taking the zonal average after computing the latitude and speed at each longitude had little impact.

Details of the technique have been added in section 2.2 (Jet stream definition), and we tried to simplify the language in the rest of the paper.

Figure 5: It seems more logical to me to group the panels in this figure so that the top two rows are PI-LGM and the bottom two are RCP-PI...

This was done (see general point B.)

Figure 2: It is extremely difficult to identify the red line in the RCP-PI IPSL panel.

The red line was removed, see main point A.

P3702, 11: "The stratospheric cooling is maximum at high latitudes". This cannot be concluded from Figure 5, which only shows temperature from 1000-100hPa and therefore excludes the low latitude stratosphere...

Replaced by "showing high-latitude stratospheric cooling" with no mention of the location of this maximum.

Figure 6: What do the filled green and blue squares show?

They are the two extra IPSL models (see response to 2nd point above). The figure legend has been modified to specify this.

All of the other technical corrections suggested have been made.