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Supplement of

How well is Rossby wave activity represented in the PRIMAVERA coupled simulations?

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Analysis of transient LWA anomaly:

In this document we provide another picture of the LWA analysis combined with WR, considering the transient LWA anomalies instead of the full transient LWA field. The transient LWA anomaly is computed as the composites of total transient LWA in each WR minus the climatology of transient LWA in all days (DJF mean). Figure 1 shows the transient LWA anomaly for the four WRs for ERA5 in colour, whereas black contours are the Montgomery streamfunction *M* anomalies. It can be observed how the LWA anomalies' spatial patterns for each regime resembles the M anomalies almost completely apart from a latitudinal shift. This is due to the partly Lagrangian nature of LWA, which is defined in the equivalent latitude space in the meridional coordinate, while M is a fully Eulerian field. Note also how in the NAO+ and AR regimes a positive and a negative LWA anomaly are found in the North Pacific, while the same signal is weaker in terms of M anomalies.

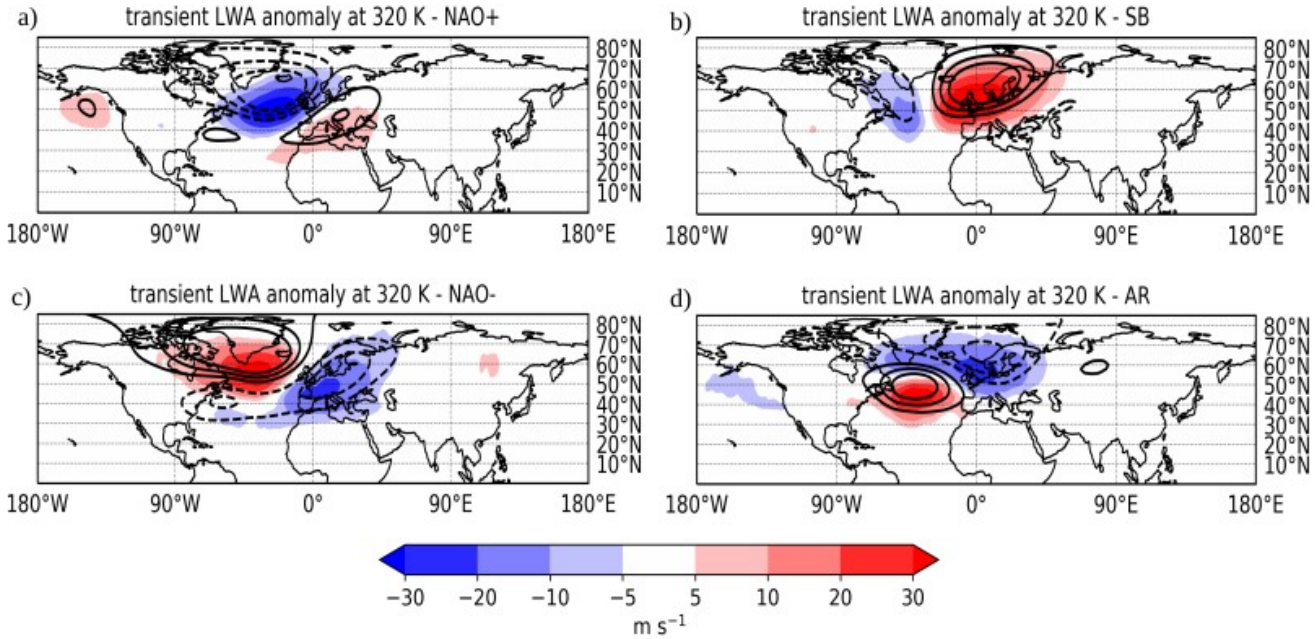

Figure 1: transient LWA anomaly (colour, units m s^{-1}) and Montgomery stream function anomalies (black contours at 500, 1000, 1500 m^2 s^{-2}, dashed contours represents negative values, the zero contour is omitted) at 320 K associated with the four WR over the EAT sector during winter in ERA5.

Figures 2-5 show the LWA anomalies for each regime (colour) in the PRIMAVERA models and contours of the transient LWA anomalies for ERA5 as reference (i.e. the analogous of Figs.8-11 of our manuscript but considering the LWA anomaly).

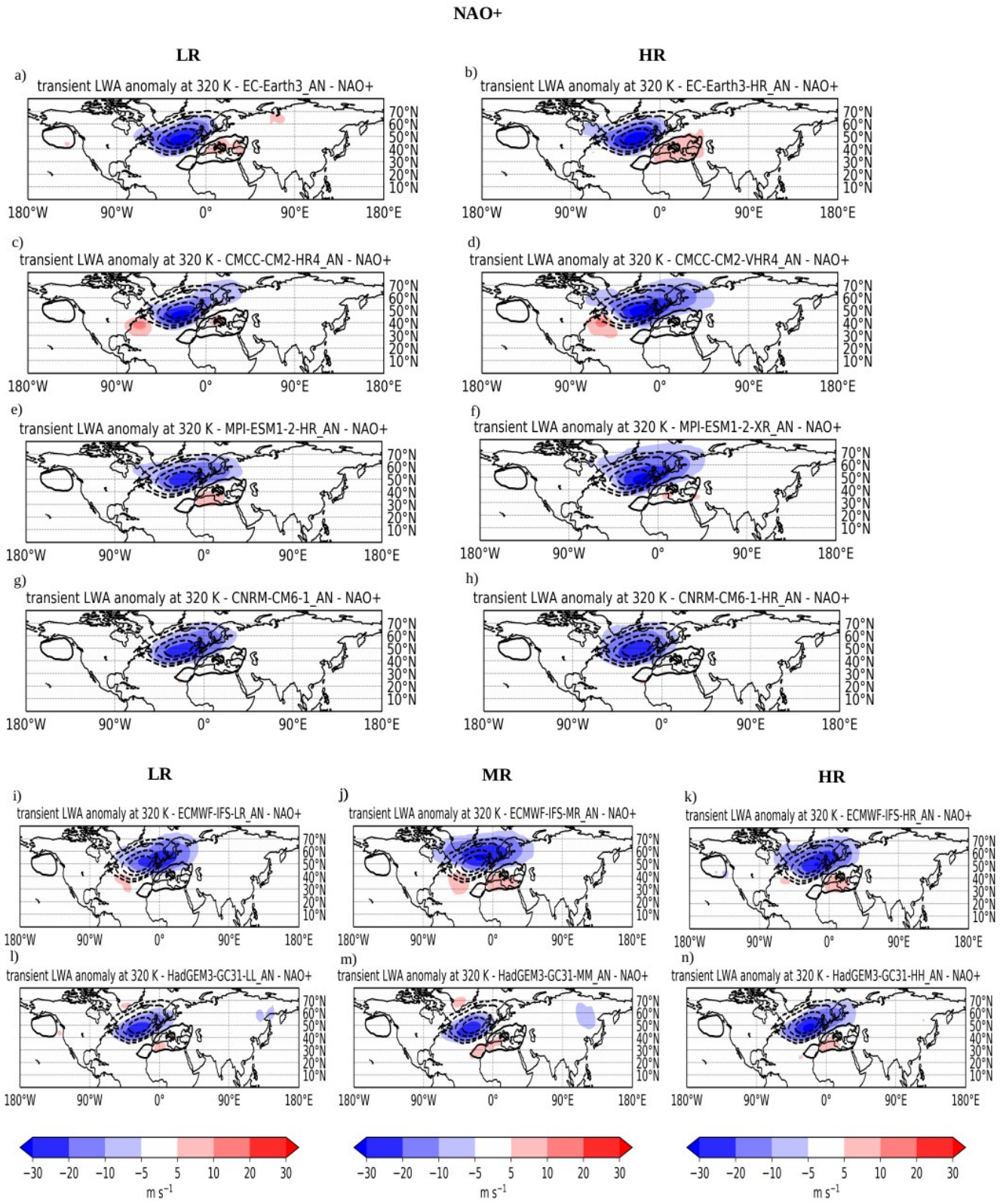

Figure 2: Transient LWA anomaly for PRIMAVERA (colour, units m s^{-1}) and ERA5 (black contours at 5, 10, 20 and 30 m s^{-1}, dashed contours represent negative values; zero contour is omitted) at 320 K associated with NAO+.

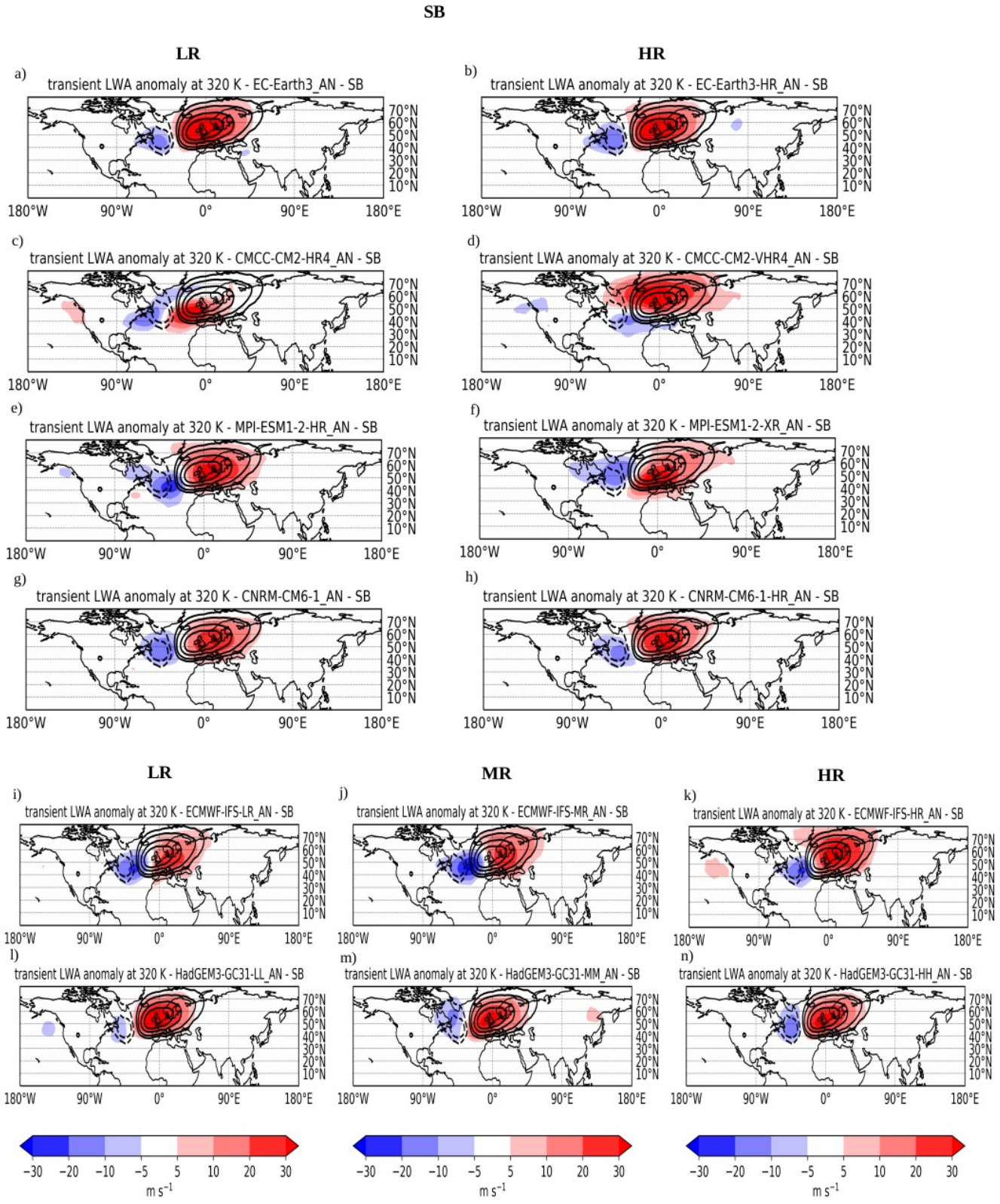

Figure 3: as in Figure 2 but for SB.

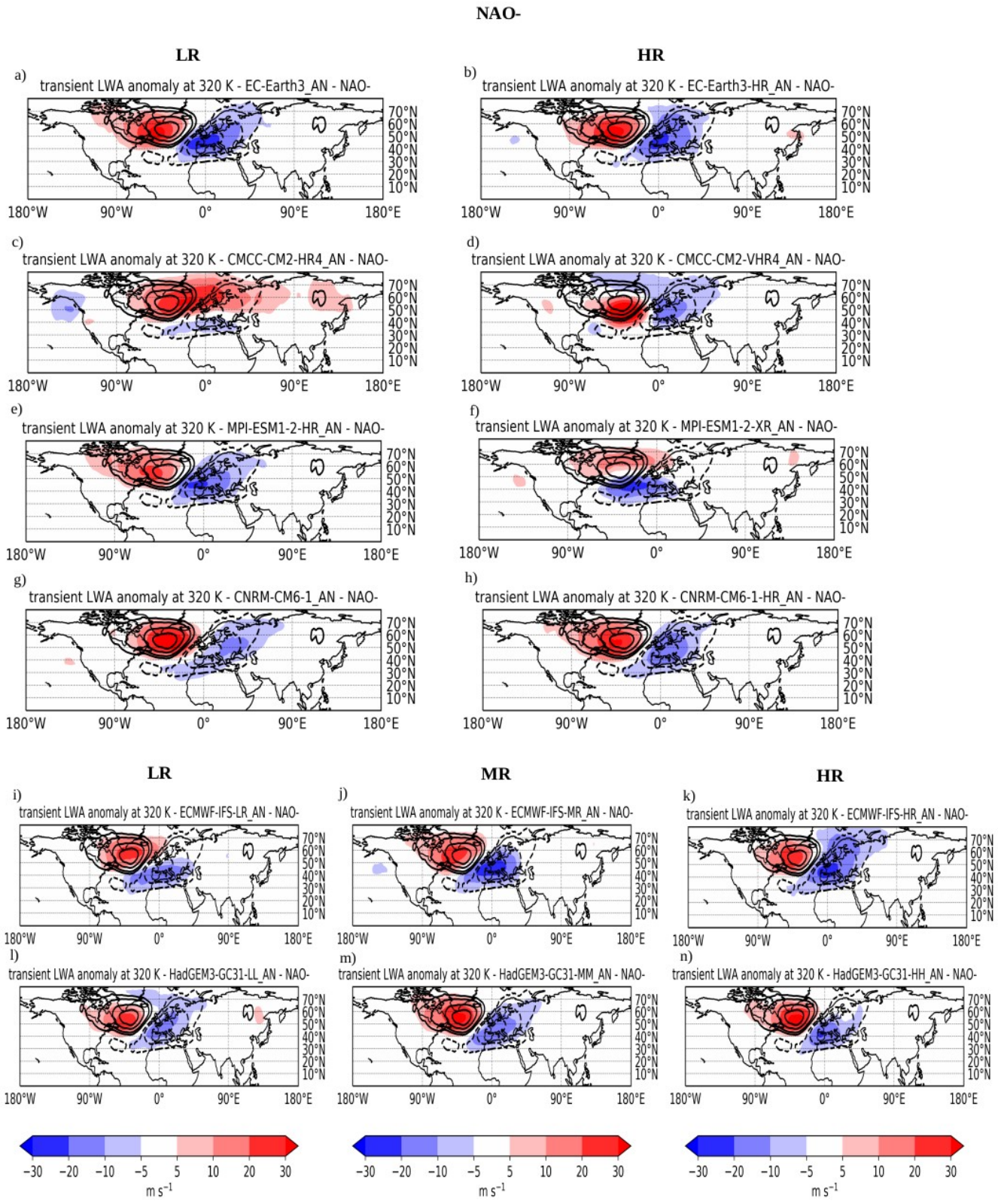

Figure 4: as in Figure 2 but for NAO-.

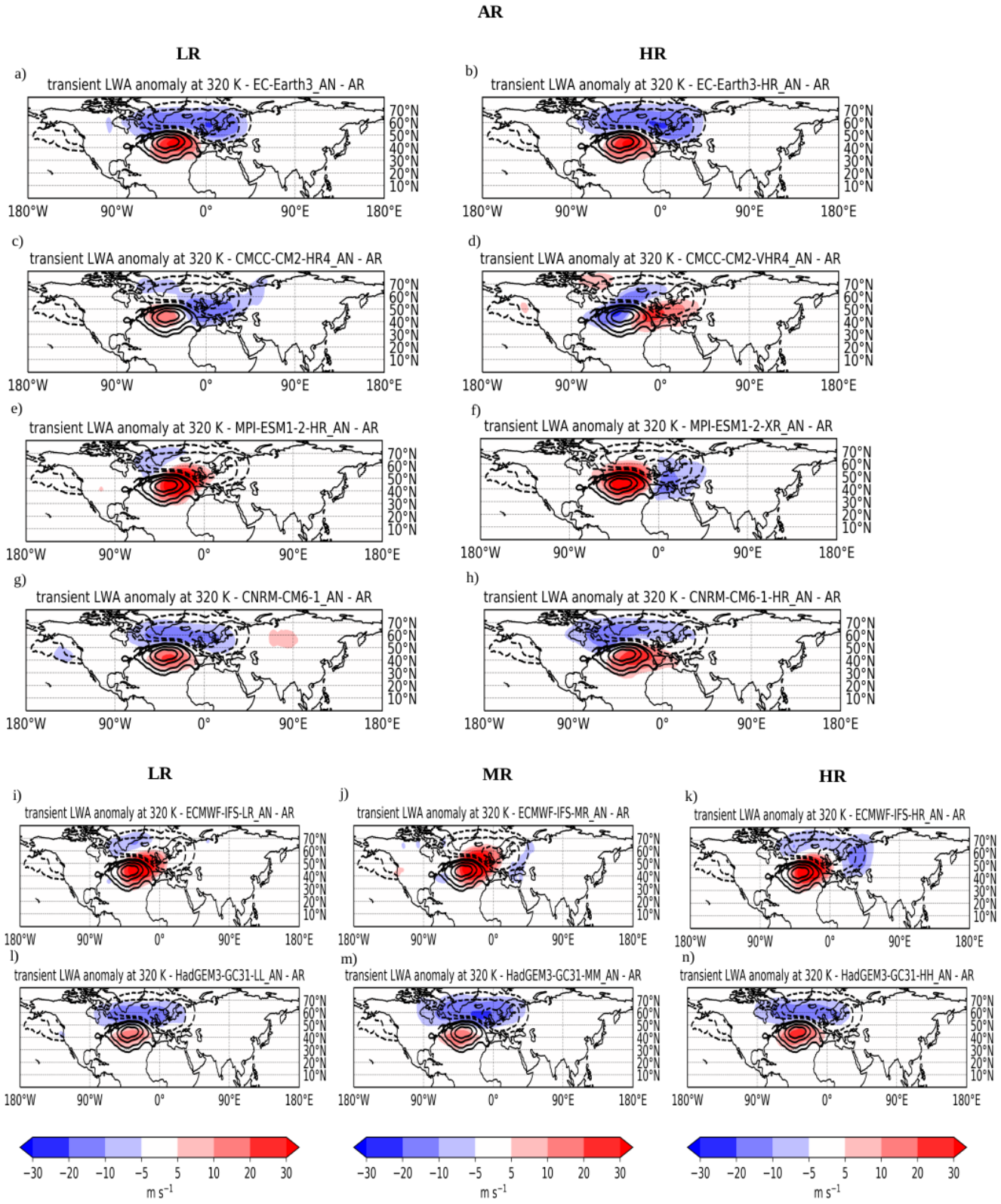

Figure 5: as in Figure 2 but for AR.

Figures 2-5 present another perspective on the analysis of Anomalous Rossby wave activity in the PRIMAVERA models and confirm what was observed analysing the full field of transient LWA or the HR generally reduces the model bias. Also in this case a notable exception is observed in the HR run of the CMCC model for the AR (Fig.5 (d)) in which the regime pattern is completely wrong in the HR run.

Finally, the spatial correlation of anomalous transient LWA between model and observations is presented in Figure 6 (the analogous of Fig.7 in the manuscript).

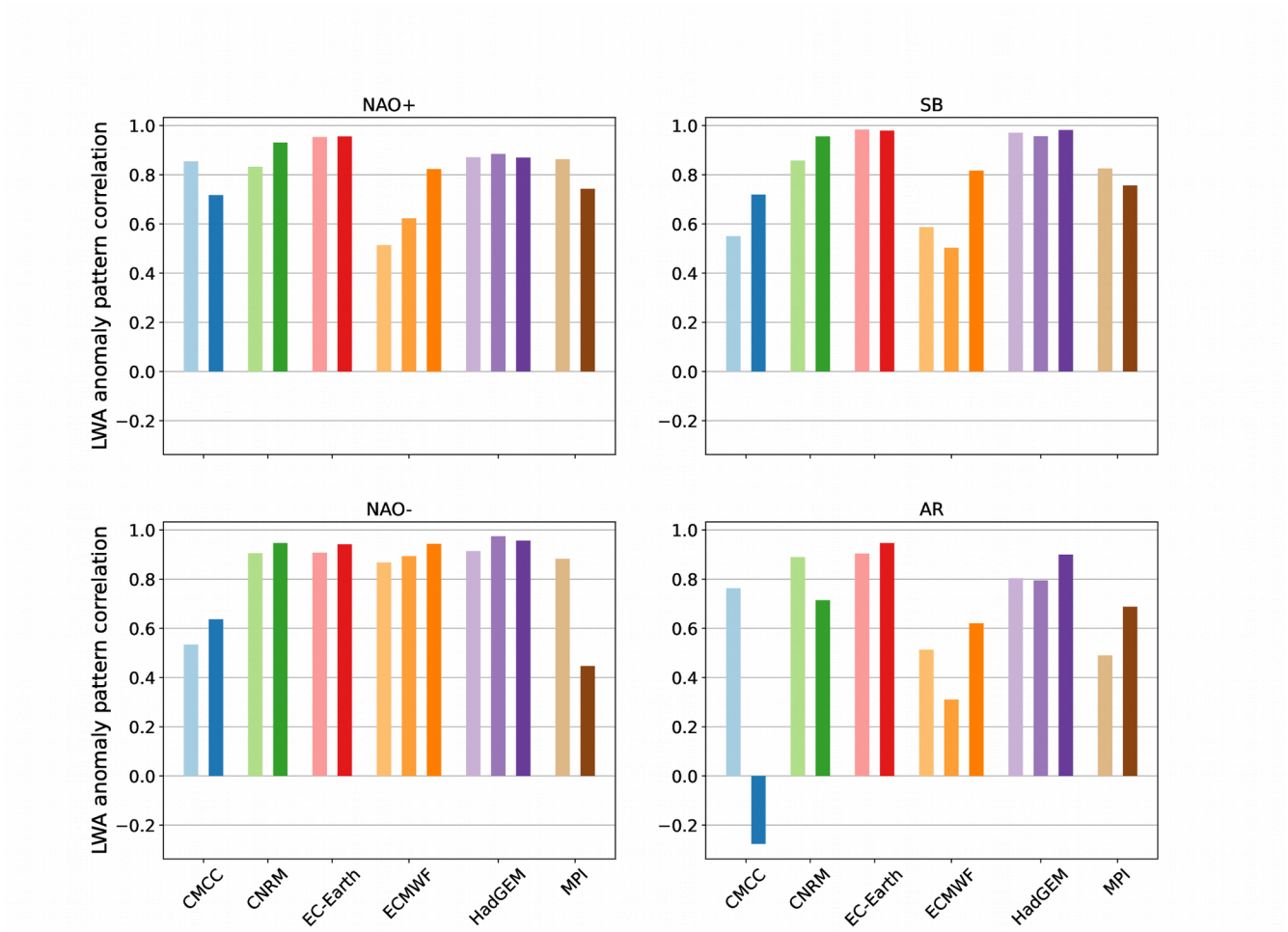

Figure 6: Pattern correlation of transient LWA anomaly on the 320 K isentropic surface associated with the four WR over the EAT sector during winter. Lighter colours are the LR simulations whereas darker colours are the HR ones.

The pattern correlations considering the LWA anomaly generally have comparable values to the ones obtained considering the full transient LWA (manuscript Fig. 7), but individual differences (both positive and negative) can be seen and are due to the removal of the model mean state. Note how the CMCC HR has a negative correlation for the AR regime, arising from the fact that the typical regime pattern is flipped in terms of LWA anomaly compared to ERA5 (Fig 5 (d)).