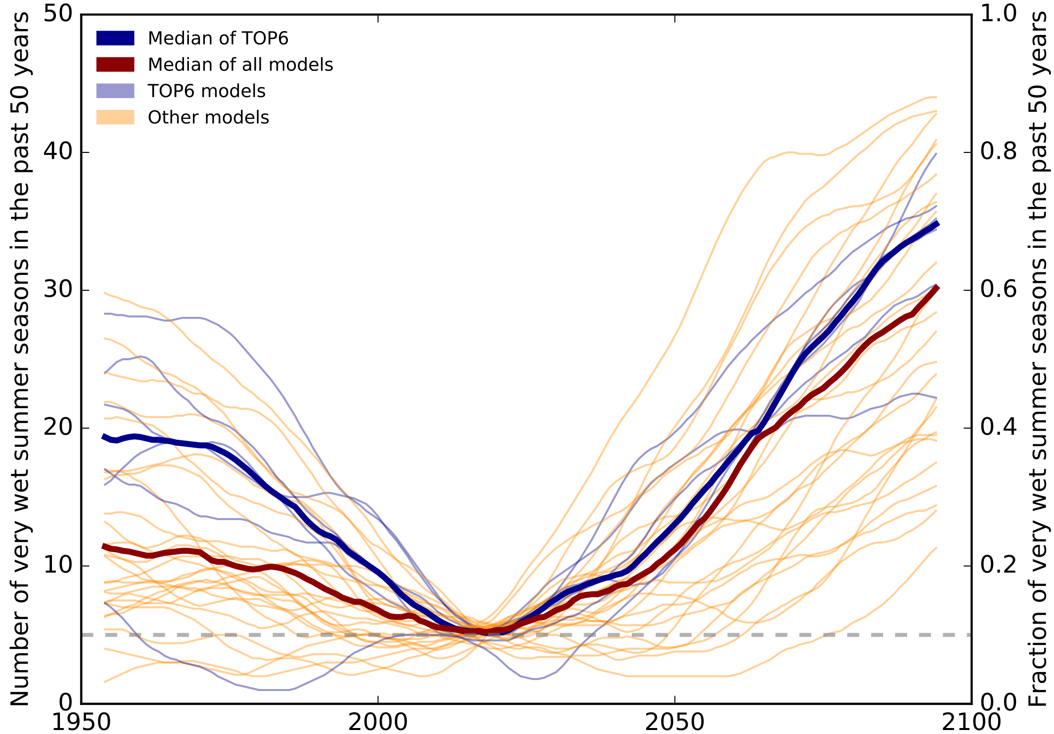

Figure 13. Increase of extremely wet monsoon seasons under unabated climate change (SSP5-8.5). TOP6 models are shown in blue, other CMIP6 models in orange. The reference period is 1965-2015 where per definition 5 out of 50 years were extremely wet.

4 Discussion and Conclusion

In this study, we use 34 CMIP6 models in order to analyse their future projections under climate change regarding the East Asian Summer Monsoon. We identify models that capture the EASM characteristics in the reference period best as TOP6 models and use them for our main analysis. The CMIP6 models have a tendency to overestimate the EASM rainfall which is in line with previous studies (Jiang et al., 2020). This is different from other Asian monsoon regions, e.g. in the Indian monsoon region models tend to underestimate the seasonal rainfall (Katzenberger et al., 2021, 2022). All TOP6 models robustly project an increase of rainfall under all four emission scenarios. The projected multi-model mean increase until 2081-2100 is 16.5% under SSP5-8.5, 11.8% under SSP3-7.0, 12.7% under SSP2-4.5 and 9.3% under SSP1-2.6. The rainfall-intensifying tendency is also confirming the results presented by the IPCC, AR6 classifying the increasing trend as 'highly certain' (Masson-Delmotte et al., 2021). The projected increase is also in line with CMIP5 projections, though even stronger increases are projected in CMIP6 (Qu et al., 2014; Chen and Sun, 2013; Kitoh et al., 2013). But it has to be noted, that there are differences in the methods between the studies, preventing direct comparison of the results. The projections for the near-term depend on the implementation and efficiency of future air pollution control that is difficult to predict (Wilcox et al., 2020) adding further

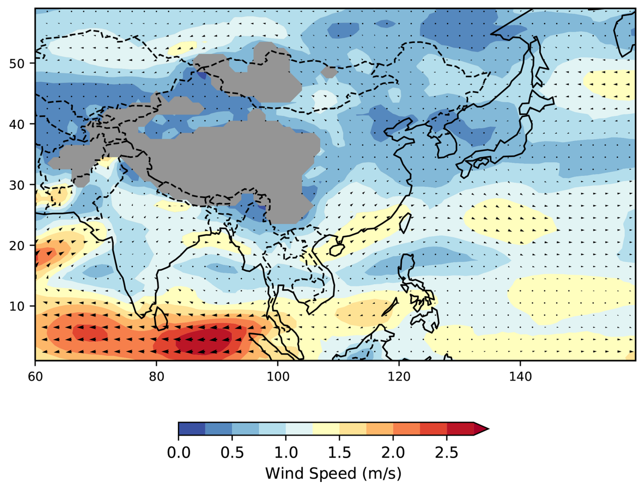

Figure 11. Change in wind vectors (850 hPa) and wind speed ($m\,s^{-1}$) in 2081–2100 (SSP5-8.5) compared to the reference period. The multi-model mean of the TOP6 models is shown. Individual model results are presented in Fig. A4.

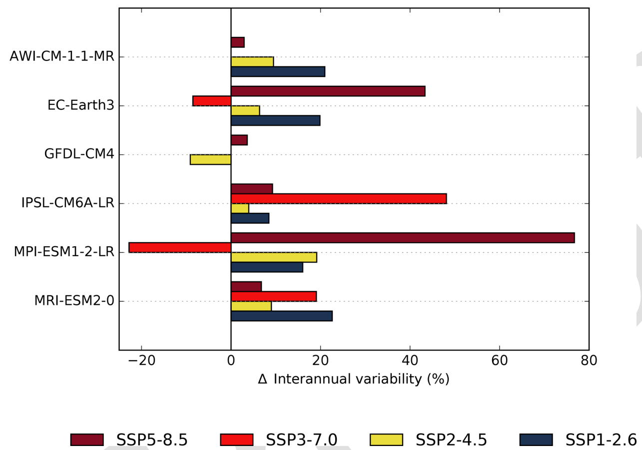

Figure 12. Change (%) in interannual variability between 2051–2100 and 1965–2014 for the EASM seasonal rainfall under four emission scenarios for the TOP6 models.

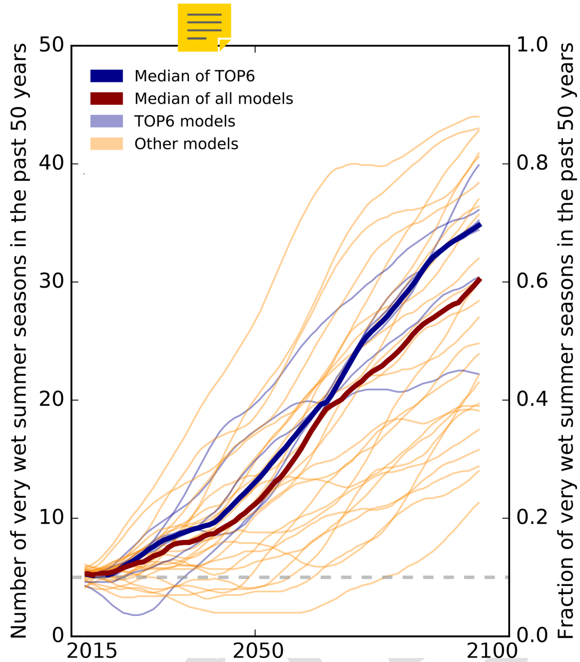

Figure 13. Increase in extremely wet monsoon seasons under unabated climate change (SSP5-8.5). The TOP6 models are shown in blue, while other CMIP6 models are shown in orange. The reference period is 1965–2014, where (per definition) 5 out of 50 years were extremely wet.

Asia, pointing to the dominant contribution from the thermodynamic component. Indeed, this is in line with the CMIP6 study of Li et al. (2021), who quantified the role of the different components contributing to the EASM increase throughout the 21st century. In East China (Japan and Korean Peninsula region) over the long term, they quantify the change in moisture advection to be +9.6 % (+9.2 %), evaporation to be +19.9 % (+16.1 %) and moisture convergence to be +70.6 % (+74.4 %). Additionally, they split the moisture convergence term into a term that relates to circulation changes (dynamic changes), one that refers to moisture content changes (thermodynamic changes) and a residual term that can be assumed to be small. In East China (Japan and Korean Peninsula region) over the long term, the thermodynamic term clearly dominates with +98.1 % (+153.0 %) over the dynamic term of +3.0 % (−34.9 %). The authors find that the dynamic term might even be canceled out due to the large intermodel spread (Li et al., 2021). This intermodel spread might also at least partly explain the fact that the dynamic component has been found to contribute both positively and negatively to the budget (Wang et al., 2014; Li et al., 2015; Lee et al., 2017; Li et al., 2021). However, most studies coincide with the dominant thermodynamic role in the region (Li et al., 2015; Lee et al., 2017; Li et al., 2021), but there is also one study that finds that the dynamic component might be dominating in the region with 67 % over the 33 % of the thermodynamic component (Xue et al., 2023). However, as pointed out by the authors of this study, the projections are based on a single model (CESM2) that in our study was also not among the best performing regarding the EASM characteristics. The relevance of evaporation and moisture convergence has already been reported in the context of CMIP5 (Seo et al., 2013; Qu et al., 2014). Seo et al. (2013) found that these changes are induced by the (north)westward shift in the North Pacific subtropical high. Along the northern and northwestern flank of the strengthened high, intensified southerly or southwesterly winds led to an increase in moisture convergence, intensifying precipitation particularly over the Baiu region to the east of Japan and the continental region to the north of the Korean Peninsula. Qu et al. (2014) also add the increased vertical transport of moisture in the EASM region and the capacity of warmer air to hold more moisture following Clausius–