wcd-2020-31: Response to comments by Ségolène Berthou

Comment #2:

- You use averaged distributions across grid-points whereas we first pool the data across the region and then plot the distribution. Both methods are equivalent in a flat homogeneous region but not in region with varied topography. You may be smoothing out more the tail of the distribution than we do. Both methods are valid, I'm just highlighting a difference. - We use a new set of bins compared to Klingaman (2017) and Berthou (2018), defined in Berthou et al. (2019) for two reasons: – we wanted pure exponential increase in the bin size so that all the bins have the same size in a log scale and area below the curve is the mean. It's not quite the case in Klingaman and Berthou but it does not make a huge difference. – The other reason was that the Klingaman method had too many bins at the start of the distribution for E-OBS, which does not have a continuous precipitation distribution. I wonder how you managed to have such a smooth distribution for E-OBS, maybe the newer version is improved. Or the spatial averaging of distributions does the job. The equation and the difference between the two sets of bins is shown in Fig. S5 here: https://agupubs.onlinelibrary.wiley.com/action/downloadSupplement?doi=10.1029%2F2019GL083544&file=grl59801 sup-0001-agusuppinfo_revised.pdf

Response: Unfortunately there was an error in the method section describing the ASoP analysis. We actually pooled all grid points across the region prior to ASoP calculations. We have made changes accordingly in the text. An updated version of the section describing ASoP analysis is provided below.

Regarding the bins; we find the arguments for using exponential bin sizes (as used in Berthou et al. 2019) interesting and especially in the case of E-OBS that does not have continuous intensity distribution. In order to increase the readability of the figures, we applied a filter to the resulting distributions to reduce the noise. We've made sure that the smoothed data did not affect the interpretation of the results. However, we failed to include this procedure in the description of ASoP analysis. This has now been corrected for (see text below).

Comment #3

- From your explanation in the method section and the y-axis on the ASoP figures, it seems like you are computing the fractional contribution. This would mean that you care about the shape of the distribution only. However, the figures do show some curves almost always above E-OBS and the integral of the differences is not 0 but >0 (e.g. Fig. 2 SC and ME) : this cannot happen if you normalise each curve by mean precipitation, unless you are normalising all curves by mean precipitation in E-OBS? In Demory et al. 2020, we chose to use actual contributions as we wanted information of both mean and distribution at the same time, to show which bins contribute to mean biases. From your discussion, it seems like you are also discussing actual contributions. Please clarify what you did.

Response: The labels on the Y-axis were not correct unfortunately. All ASoP figures (except Fig. 4) show actual contributions and not fractional contributions. We have updated the figures and clarified in figure texts what is shown (please see attached figures).

Updated text in Method section, describing ASoP analysis:

"To investigate the effect of model grid resolution on the full distributions of daily precipitation intensities, we use the ASoP (Analysing Scales of Precipitation) method (Klingaman et al., 2017; Berthou et al., 2018). ASoP involves splitting precipitation distributions into bins of different intensities and then provides information of the contribution from each precipitation intensity separately to the total mean precipitation rate (i.e. given by all intensities taken together). In the first step, precipitation intensities are binned in such a way that each bin contains a similar number of events, with the exception of most intense events, which are rare. The actual contribution (in mm) of each bin to the total mean precipitation rate is obtained by multiplying the frequency of events by the mean precipitation rate. The sum of the actual contributions from all bins gives the total mean precipitation rate. The fractional contribution (in %) of each bin is further obtained by dividing the actual contributions by the mean precipitation rate. In this case, the sum of all fractional contributions is equal to one, thus the information provided by fractional contributions is predominantly about the shape of the distribution. Taking the absolute differences between two fractional distributions and sum over all bins gives a measure of the difference in the shapes of the precipitation distributions. This is here called the "Index of fractional contributions". Since E-OBS precipitation intensities, in contrast to model data, are not continuous the resulting ASoP factors for E-OBS tend to be noisy, especially for lower intensities. In order to facilitate the interpretation of the results, the regionally averaged ASoP factors for E-OBS were smoothed to some extent by using a simple filter.

The ASoP method is here applied to grid points pooled over target regions (Fig. 1) separately and the result is a distribution for each model showing the probability of different precipitation intensities based on daily precipitation. Most results presented here concern the actual contributions, both to limit the number of figures and because these factors conveniently provide information on both shape of distributions as well as the mean values. The ASoP distributions of all analysed models are used to compare model behaviour and performance. In particular to see how changing the grid resolution affects different parts of the distribution, for example if contributions from low and high precipitation intensities are different."

Updated figures:

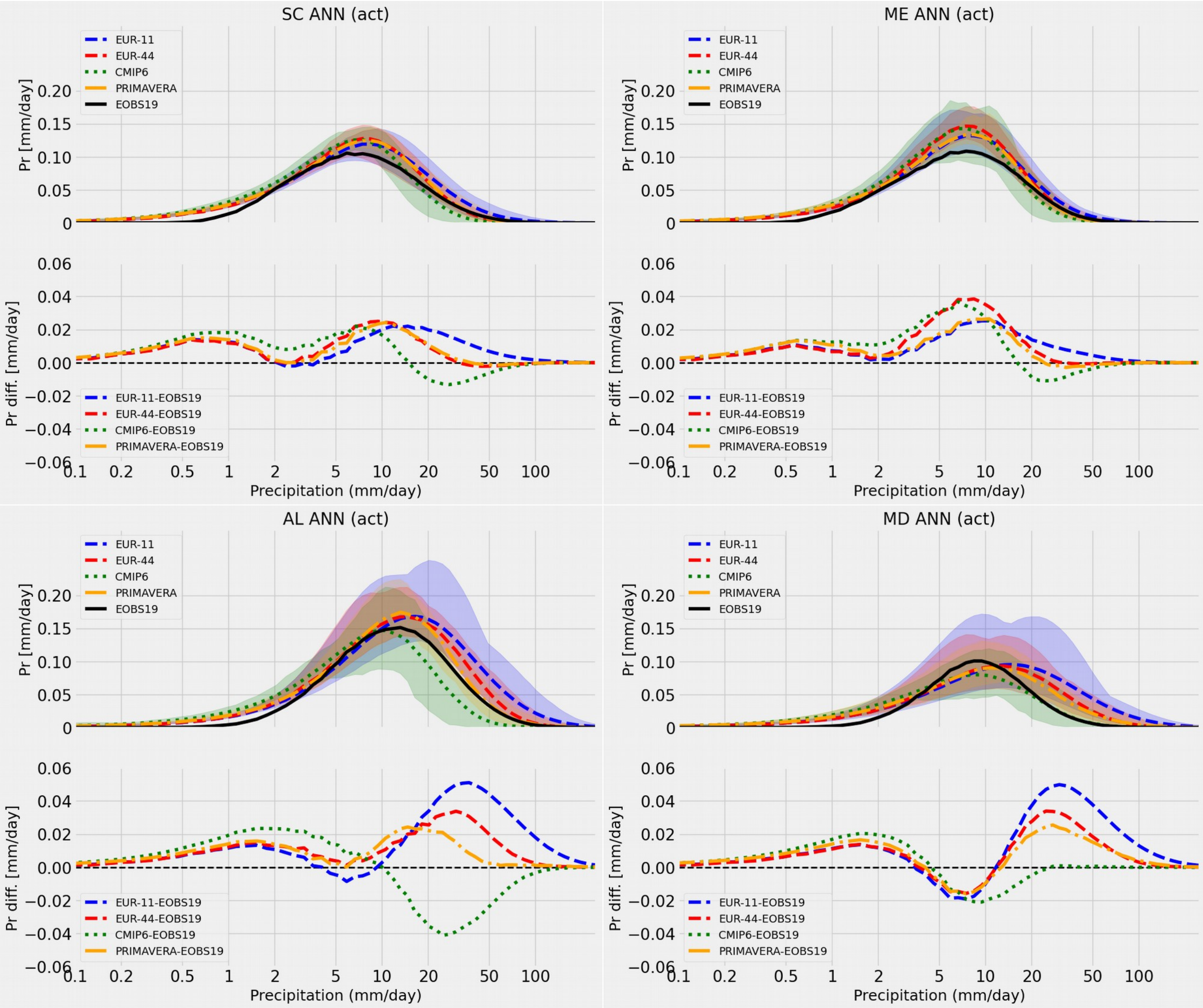

Figure 2: ASoP actual contributions (act) from daily annual (ANN) precipitation intensities in the CMIP6 (green dotted lines and shading), PRIMAVERA (orange dashed-dotted lines and shading), CORDEX low resolution (red dashed lines and shading) and CORDEX high resolution (blue dashed lines and shading) ensembles. Results are shown for Scandinavia (SC, top left), mid-Europe (ME, top right), the Alps (AL, bottom left) and the Mediterranean (MD, bottom right). Coloured shadings represent the minimum and maximum value in respective ensemble. Black solid lines are E-OBS observations.

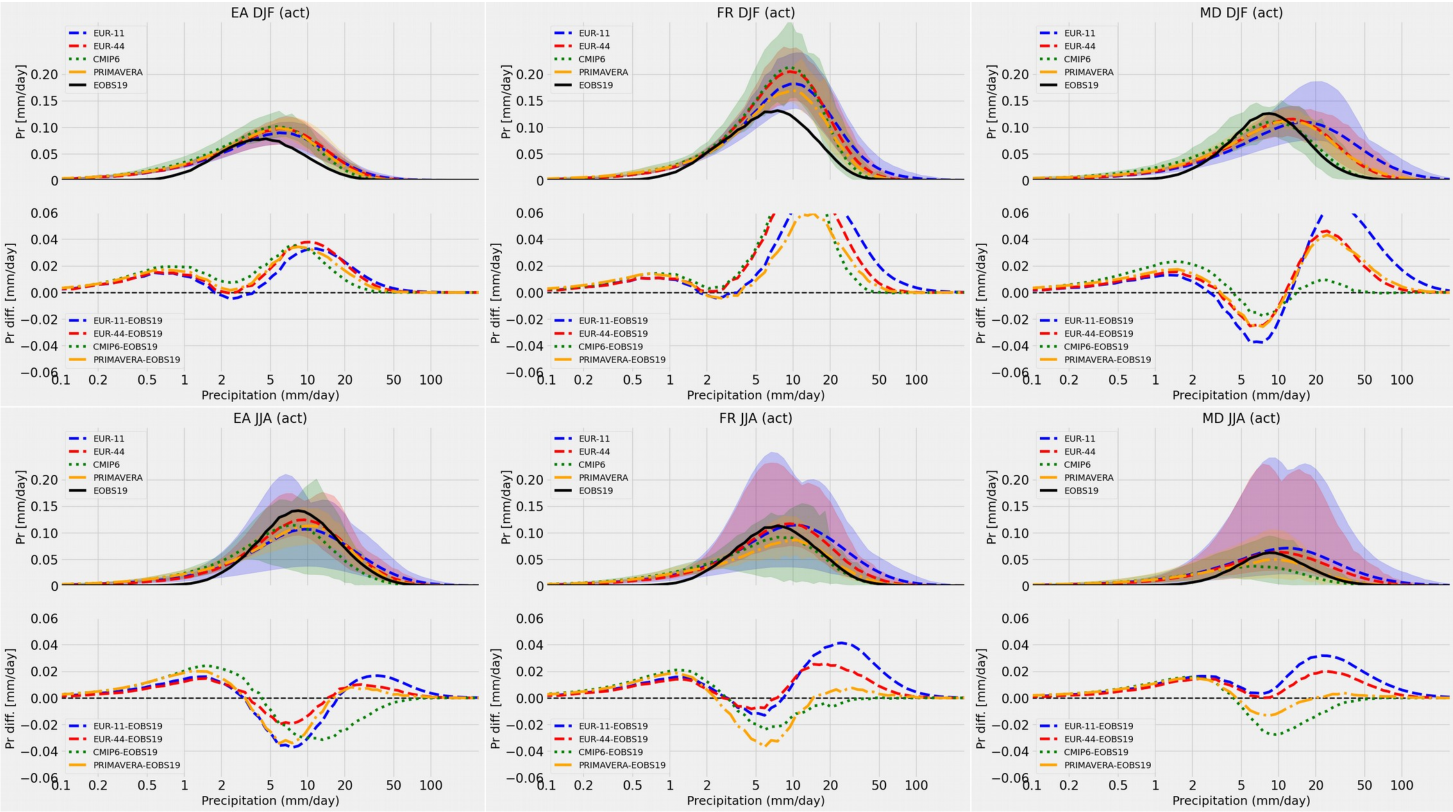

Figure 3: ASoP actual contributions of DJF (top row) and JJA (bottom row) daily precipitation intensities in the CMIP6 (green dotted lines and shading), PRIMAVERA (orange dashed-dotted lines and shading), CORDEX LR (EUR-44, red dashed lines and shading) and CORDEX HR (EUR-11, blue dashed lines and shading) ensembles for eastern Europe (EA, left), France (FR, middle) and the Mediterranean (MD, right). Coloured shadings represent the minimum and maximum value in respective ensemble. Black solid lines are E-OBS observations.

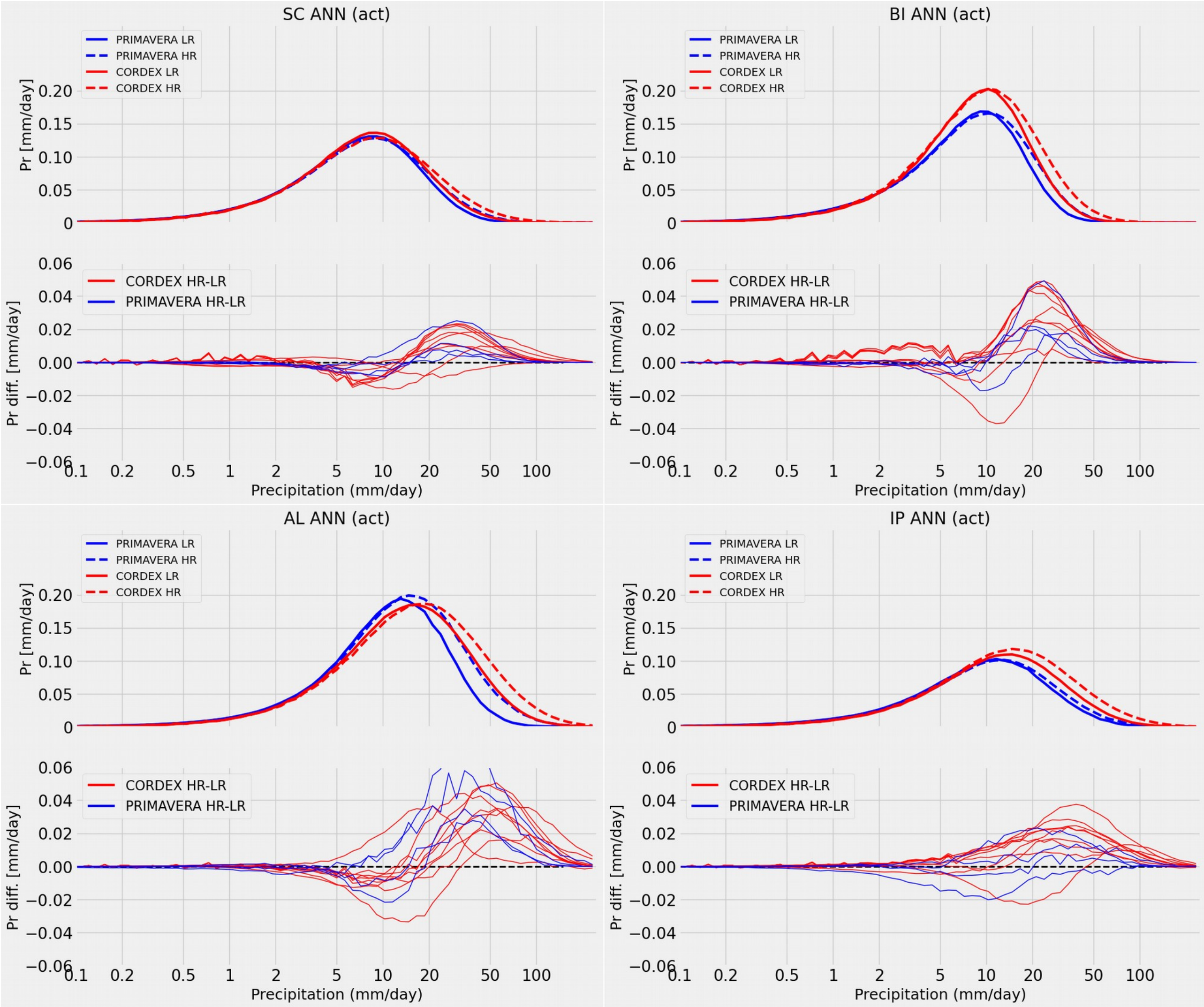

Figure 5: ASoP actual contributions of ANN daily mean precipitation intensities in CORDEX (red lines) and PRIMAVERA (blue lines) low- (solid lines) and high-resolution (dashed lines) models for the Scandinavia (SD, top left), British Isles (BI, top right), the Alps (AL, bottom left) and Iberian peninsula (IP, bottom right) regions. Thick lines in upper part of each panel represent the ensemble means, while in the lower part each thin line represents differences between each high- and low-resolution model pair.