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Evaluation of satellite, gauge and reanalysis precipitation products over Aotearoa, New Zealand

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Understanding precipitation variability is challenging, particularly in regions such as New Zealand, where the local topography strongly controls precipitation. This study provides a comprehensive evaluation of mean and extreme precipitation features over Aotearoa, New Zealand, using six merged satellite-gauge, five reanalysis, and three in-situ products, using station data as a reference. We find that all products show similar features in depicting the mean precipitation pattern with a clear maximum over the Alpine regions and a strong west-east gradient across the South Island. However, there are differences in the magnitude of mean precipitation estimates amongst different products at various regions on a seasonal timescale. Investigating the frequency of wet days shows that GPCP has the lowest count of all the satellite-based products, likely due to its coarse grid size, while MSWEP depicts the highest frequencies over the wettest region. Similarly, for reanalysis, MERRA-TP likely overestimates the frequency of occurrence west of the Alps compared to MERRA-PCORR, although the former showed better similarity with other datasets in terms of mean precipitation pattern. Moreover, statistical tests such as the Pearson correlation coefficient of the spatiotemporal pattern revealed that amongst the satellite-based products, MSWEP and GPM-IMERGE outperform other products with values of 0.9 and 0.66 with a mean wet-bias of 0.37 and 0.89 mm/day over the entire country. At the same time, ERA-5 and BARRA-R perform better in the suite of reanalysis products with a mean correlation coefficient of 0.87 and 0.74 with a mean wet-bias of 0.43 and 0.76 mm/day, respectively. This presentation also incorporates a set of precipitation indices approved by the ETCCDI committee to facilitate an intercomparison of different products in capturing the extreme tail of the distribution. Substantial differences especially over the West Coast in the South Island were observed in the interannual variability of the indices among different products. A closer examination of the percentile-based indices such as R95P and R99P revealed a contrasting pattern between different products in geographical regions. For instance, all the satellite-based products consistently showed wet bias as compared to the reanalysis products that depicted dry bias in all seasons. The MSWEP and BARRA-R datasets had the smallest relative percentage difference compared with the station data for most of the indices, suggesting their potential use for capturing both the mean and extremes

characteristics of precipitation quite well in this region.