1. Rain gauge incertitude and approach limitations

Based on the prior findings, most P-datasets have shown positive bias and high RMSE scores, with a clear deficiency in underestimating the frequency of dry months and overestimating high-intensity precipitation. However, the magnitude of errors could also be a result of rain gauge uncertainty. Employing various sizes and shapes of orifice and gauge heights not strictly comparable with WMO standards are expected to underestimate actual precipitation by 5% to 40%, with a bias of 9% on average. Furthermore, the majority of rain gauges in DRB are not equipped with windshields and evaporation losses are expected to influence instrument accuracy. In this sense, estimating the systematic gauge-measuring incertitude on the basis of weather information from synoptic stations may confirm the error proneness of a given P-dataset. National Direction of Meteorology maintains one station accredited by the World Meteorological Organization (WMO) delivering data with relatively high-quality standards and temporal completeness. The Monthly precipitation data from Ouarzazate meteorological and gauge station for a period of 38 years from January 1983 to December 2020 was extracted. Measures of similarity were obtained using both Taylor Diagram and frequency histogram (Figure 8a and 8b). Based on the results, it can be inferred that the ground-observations share similar patterns with correlation values greater than 0.90. Gauge station underestimate the precipitation recorded by the meteorological station of Ouarzazate by 10 %.

As shown in Figure 8b, ERA5-Land and MSWEP V2.8 have the highest correlation values (0.77 and 0.71), followed by CHIRPS V2.0 (0.65), while PERSIANN-CSS-CDR and TAMSAT V3.1 share the same correlation values (0.52). The high RMSE shown by PERSIANN-CSS-CDR confirms its low performance found in Ouarzazate basin. In terms of occurrence percentage, the performance of most P-datasets was considered better compared to the previous assessment based on the corresponding gauge data. However, underestimating no rain range (<1 mm) still characterizes all five datasets. CHIRPS V2.0 has low performance with non-dry month during all the 38 years, but detect months with moderate precipitation intensity satisfactorily. On the other, hand MSWEP V2.8 is more adequate for precipitation below 12.5 mm and ERA5-Land during important precipitation (>12.5 mm).

Uneven distribution of rain gauge stations across DRB, particularly in the Middle Drâa and lower terrains, limits our understanding of precipitation patterns. Indeed, a large part of DRB with complex topography and precipitation variability are still unobserved which make it difficult to accurately assess the limitations of a given P-dataset. On the other hand, this study evaluated P-datasets at monthly, seasonal, and sub-seasonal scales. However, the lack of daily records, especially in the Middle Drâa basin where there are no daily precipitation records, hampers our ability to assess the effectiveness of P-datasets in hydrological studies, such as rainfall–runoff modeling. Besides, further studies at the hourly scale are still necessary considering that rain events in DRB as many arid regions occur within a very short time, such as a few hours.

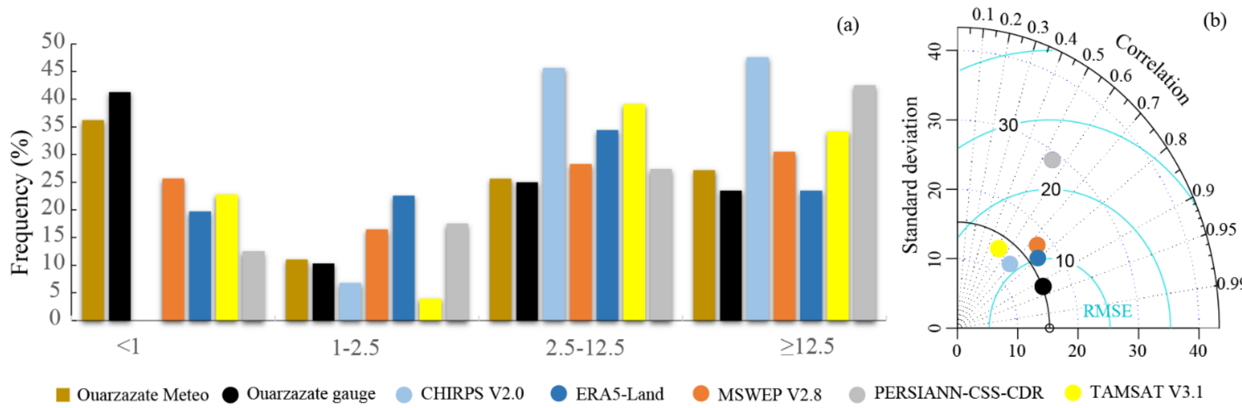

Figure. Taylor diagram and precipitation distribution for different intensity of the five P-datasets using the meteorological station of Ouarzazate as reference.