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A multi-scale analysis of rainfall estimation products over West Africa: from the seasonal to the convective system scale

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The AMMA program contributed to acquire relevant ground observations in the West African monsoon area to validate satellite rainfall estimation products at several temporal and spatial scales. A comparison of rainfall estimates retrieved from several IR/MW combined algorithms with precipitation accumulations derived from rain gauge measurements was performed at the seasonal scale (pre and post onset of the 2006 monsoon) in the Sahelian band, and at daily time scales. A diurnal cycle analysis over three regions of Western Africa to help understanding strengths and weaknesses of rainfall algorithms according to regional rainfall characteristics is presented. Furthermore, a power spectrum study is carried out in those three regions over the whole rainy season for a qualitative comparison of the validation datasets with the three rainfall estimate products. Finally a selected meso-scale convective event is analyzed in details.
We used the datasets of three satellite rainfall products: TMPA (0.25°-3 hours), GsMap-MVK (0.1°-1h) and EPSAT-SG (0.1°-15mn). The various scales of this study have required several validation datasets : - gridded rainfall estimates from the CILSS rain gauge network over the Sahelian band at the 1°-10-day scale; a dataset of high resolution (0.01°-1h) gridded precipitation estimates over three regions of Western Africa elaborated from dense gauge networks near Niamey (Niger), Kopargo (Benin) and Dakar (Senegal). Two additional fine scale validation datasets have been used for the case study: the 5-minute krigged rain gauge dataset and the 7-minute rainfall estimates dataset at 1.5 km of altitude retrieved from the Ronsard radar observations during the AMMA experiment.

The study reveals significant differences between the satellite and ground rainfall estimates depending on the temporal scales, the period in the rainy season (monsoon's pre/post onset) and regional specificities. In particular, the large spatial variability found in the ground rainfall diurnal cycles indicates how difficult it is to tune an algorithm to give realistic rain estimation on a global scale and be able to reproduce local rainfall characteristics.
Finally, this multi-scale analysis helps to develop tools in order to assess the performance of the future Megha-Tropiques rainfall estimation combined product, to define its future characteristics in the context of the GPM constellation and formulate recommendations for its validation plan.