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Evaluation of rainfall retrievals from SEVIRI reflectances over West Africa using TRMM-PR and CMORPH

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Abstract. This paper describes the evaluation of the KNMI Cloud Physical Properties – Precipitation Properties (CPP-PP) algorithm over West Africa. The algorithm combines condensed water path (CWP), cloud phase (CPH), cloud particle effective radius (r_e), and cloud-top temperature (CTT) retrievals from visible, near-infrared and thermal infrared observations of the Spinning Enhanced Visible and Infrared Imager (SEVIRI) onboard the Meteosat Second Generation (MSG) satellites to estimate rain occurrence frequency and rain rate. For the 2005 and 2006 monsoon seasons, it is investigated whether the CPP-PP algorithm is capable of retrieving rain occurrence frequency and rain rate over West Africa with sufficient accuracy, using Tropical Monsoon Measurement Mission Precipitation Radar (TRMM-PR) as reference. As a second goal, it is assessed whether SEVIRI is capable of monitoring the seasonal and daytime evolution of rainfall during the West African monsoon (WAM), using Climate Prediction Center Morphing Technique (CMORPH) rainfall observations. The SEVIRI-detected rainfall area agrees well with TRMM-PR, with the areal extent of rainfall by SEVIRI being ~10% larger than from TRMM-PR. The mean retrieved rain rate from CPP-PP is about 8% higher than from TRMM-PR. Examination of the TRMM-PR and CPP-PP cumulative frequency distributions revealed that differences between CPP-PP and TRMM-PR are generally within +/−10%. Relative to the AMMA rain gauge observations, CPP-PP shows very good agreement up to 5 mm h^{-1}. However, at higher rain rates (5–16 mm h^{-1}) CPP-PP overestimates compared to the rain gauges. With respect to the second goal of this paper, it was shown that both the accumulated precipitation and the seasonal progression of rainfall throughout the WAM is in good agreement with CMORPH, although CPP-PP retrieves higher amounts in the coastal region of West Africa. Using latitudinal Hovmüller diagrams, a fair correspondence between CPP-PP and CMORPH was found, which is reflected by high correlation coefficients (~0.7) for both rain rate and rain occurrence frequency. The daytime cycle of rainfall from CPP-PP shows distinctly different patterns for three different regions in West Africa throughout the WAM, with a decrease in dynamical range of rainfall near the Inter Tropical Convergence Zone (ITCZ). The dynamical range as retrieved from CPP-PP is larger than that from CMORPH. It is suggested that this results from both the better spatio-temporal resolution of SEVIRI,

as well as from thermal infrared radiances being partly used by CMORPH, which likely smoothes the daytime precipitation signal, especially in case of cold anvils from convective systems. The promising results show that the CPP-PP algorithm, taking advantage of the high spatio-temporal resolution of SEVIRI, is of added value for monitoring daytime precipitation patterns in tropical areas.

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