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# Precipitation estimates from L-Band Radiometer Sea Surface Salinity

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The Soil Moisture and Ocean Salinity (SMOS) satellite mission measures sea surface salinity (SSS) since 2010 with a spatial resolution of about 50 km. Since 2015, Soil Moisture Active and Passive (SMAP) mission also provides SSS with a similar resolution. In rainy regions, at local and short time scales, the spatio-temporal variability of SSS is dominated by rainfall. The relationship between sea surface freshening and rain rate (RR) has been highlighted in the Pacific intertropical convergence zone (Boutin et al., *JGR*, 2014). This study investigates the rainfall characteristics that may be inferred from SMOS and SMAP SSS based on a statistical approach, and to which extent this information is complementary to IMERG (Integrated Multi-satellite Retrievals for Global Precipitation Measurement mission) interpolated product. The IMERG algorithm intercalibrates, merges and interpolates "all" satellite passive microwave precipitation estimates ($R_{PMW}$), together with microwave-calibrated infrared (IR) satellite estimates ($R_{IR}$) (Huffman et al., 2015) . The product contains the merged RR ($R_{mPMW}$) as well as the $R_{PMW}$ and $R_{IR}$ individual estimates used by the algorithm.

Salinity anomalies ($\Delta$S) associated with rainfall events are first estimated. A reference salinity (i.e. an estimate of the salinity preceding the rainfall event) is inferred from the SSS statistical distribution within 3°x3° region. It is derived from a Gaussian distribution fitted onto the highest part of the distribution (quantile>0.8) taking advantage on the fact that rainfall creates an asymmetrical SSS distribution towards low values. A RR retrieval algorithm is then developed that combines SMOS $\Delta$S and IR information. In case of IR detects rain, SMOS rain rate, $R_{SMOS}$ is derived from SMOS $\Delta$S. We infer the relationship between $R_{SMOS}$ and SMOS $\Delta$S using colocations within 30mn between SMOS $\Delta$S and $R_{PMW}$ contained in IMERG product during the 2015 year. Correlation coefficient (r) between $R_{SMOS}$ and $R_{PMW}$ is equal to 0.75 (0.78 when the colocation radii is decreased to 3mn). In case there is no $R_{PMW}$ at less than 1h20mn from $R_{SMOS}$, r is decreased to 0.62. We then compare the $R_{SMOS}$ with the IMERG merged product ($R_{mPMW}$). In case there are $R_{PMW}$ at less than 30mn (3mn) from SMOS pass, correlation coefficients remain about the same as previously. In case there is no $R_{PMW}$ at less than 1h20mn from $R_{SMOS}$, r between $R_{SMOS}$ and $R_{mPMW}$ becomes equal to 0.72. This demonstrates that the merging of $R_{PMW}$ with IR information by IMERG improves the rain detection with respect to taking into account only $R_{PMW}$ but remains poorer than $R_{PMW}$ measurements. This is confirmed by triple collocations between $R_{SMOS}$, $R_{IR}$ and $R_{PMW}$.

We then evaluate the quality of the retrieval at monthly time scales from August 2014 to July 2016. Hovmöller diagrams show a very good consistency between IMERG and SMOS monthly rain estimates during this period (correlation of 0.92).

The SMOS RR retrieval algorithm is also applied to SMAP SSS measurements from January 2016 to July 2016. SMAP rain estimates ($R_{SMAP}$) are compared with $R_{SMOS}$. At monthly time scales, correlation between $R_{SMAP}$ and $R_{SMOS}$ is 0.96.