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Detection of precipitation over the sea in satellite climatologies

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For the understanding and modeling of the global climate system an excellent knowledge of the global water cycle is necessary. Measuring the required quantities is, however, still a challenging task especially over the global oceans due to difficulties to measure precipitation under high wind speeds on moving platforms. Satellite platforms may fill in this gap providing the opportunity to retrieve global data sets with an equally dense spatial distribution also over sea. Passive microwave detectors in space allow to derive precipitation fields with an acceptable accuracy over the global oceans.

State-of-the-art satellite retrievals and reanalysis data sets to a fairly large extend disagree on global precipitation amounts, patterns, variability and temporal behavior. This is especially valid for case studies of individual precipitation events where no common agreement exists on precipitation detection over the oceans with consistent patterns and quantitative amounts. Hence, satellite based retrievals for estimation of instantaneous pixel-level precipitation need to be ground validated to ensure for quality control and the ability to detect all systems that lead to precipitation.

This calls for ship based precipitation validation data using instruments capable of measuring quantitative amounts of rain even under high wind speed conditions. Instruments meeting these requirements, a ship rain gauge (SRG) and an optical disdrometer (ODM 470), had been developed at the IFM-GEOMAR. They had been tested comprehensively at different locations over land and sea.

Measurements of both instruments over sea can be used with the aim of point to area collocation against the satellite derived climatology HOAPS-3 (Hamburg Ocean Atmosphere Parameters and fluxes from Satellite data). For validation we used ODM 470 measurements on R/V Polarstern, R/V Meteor, and R/V Ron Brown at a resolution of 1 minute. These data are gained in 1996 and 1997 over areas of the Atlantic and tropical Pacific Ocean. Ship rain gauges were used on a number of merchant ships to derive precipitation fields over the Baltic Sea. Ship rain gauge data have a temporal resolution of 8 minutes, or, for a typical ship's speed, a spatial resolution of about 5km. All instruments were mounted on masts on the pilot deck or at the craw's nest to ensure a minimum of flow distortion.

Decorrelation lengths were estimated directly from observations, allowed distances between collocated data are 30 min in time and 25km in space. It came out that HOAPS is able to detect precipitation in about two third of all cases with observed precipitation rates of more than 0.3mm/h. Considering precipitation events exceeding 0.5mm/h only, detection rate increases to more than 70%. Although it is not possible to compare precipitation rates directly because the measurement's data base allows no areal estimate comparable to the satellite data, average precipitation rates could be compared. At all satellite data show an underestimation of 30% in precipitation rate compared to observations for the Baltic Sea area. However, HOAPS data don't give precipitation rates of less than 0.3 mm/h, which alone accounts for about 10% of total precipitation based on long term ship observations.