Geophysical Research Abstracts
Vol. 16, EGU2014-4200, 2014
EGU General Assembly 2014

Precipitation estimates from MSG SEVIRI daytime, night-time and twilight data with random forests

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We introduce a new rainfall retrieval technique based on MSG SEVIRI data which aims to retrieve rainfall rates in a continuous manner (day, twilight and night) at high temporal resolution. Due to the deficiencies of existing optical rainfall retrievals, the focus of this technique is on assigning rainfall rates to precipitating cloud areas in connection with extra-tropical cyclones in mid-latitudes including both convective and advective-stratiform precipitating cloud areas.

The technique is realized in three steps: (i) Precipitating cloud areas are identified. (ii) The precipitating cloud areas are separated into convective and advective-stratiform precipitating areas. (iii) Rainfall rates are assigned to the convective and advective-stratiform precipitating areas, respectively. Therefore, considering the dominant precipitation processes of convective and advective-stratiform precipitation areas within extra-tropical cyclones, satellite-based information on the cloud top height, cloud top temperature, cloud phase and cloud water path are used to retrieve information about precipitation.

The approach uses the ensemble classification and regression technique random forests to develop the prediction algorithms. Random forest models contain a combination of characteristics that make them well suited for its application in precipitation remote sensing. One of the key advantages is the ability to capture non-linear association of patterns between predictors and response which becomes important when dealing with complex non-linear events like precipitation. Using a machine learning approach differentiates the proposed technique from most state-of-the-art satellite-based rainfall retrievals which generally use conventional parametric approaches. To train and validate the model, the radar-based RADOLAN RW product from the German Weather Service (DWD) is used which provides area-wide gauge-adjusted hourly precipitation information.

Beside the overall performance of the technique, the performance of each step (rain area detection, rain process separation, rainfall rate assignment) is investigated as well. The technique either can be used as general retrieval scheme or each retrieval step as standalone algorithm to detect rain area, discriminate convective and advective-stratiform precipitating cloud areas or rainfall rate assignment for nowcasting or climate purpose.