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Daily to Sub-daily precipitation downscaling based on multiple datasets using artificial neural networks in Brazil

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Precipitation is an extremely important variable for society. While intense and persistent rainfall are responsible for causing floods and landslides, its absence is also a factor of concern, such as droughts. For an efficient rainfall monitoring over a certain region, sub-daily measurements of this variable are required to understand the physical processes which modulate the so-called Precipitation Diurnal Cycle (PDC). Over Brazil, due to the low density of ground observational data, both from rain gauges networks (most of them available on daily basis) and weather radars, it is necessary to use satellite-based rainfall estimation products. However, the error for those techniques on sub-daily scale are still high. In this context, this study analyzes Artificial Intelligence techniques, specifically Artificial Neural Networks (ANN), for downscaling daily to a sub-daily scale precipitation data using multiple datasets. The main information from daily retrievals comes from a satellites-based technique corrected by rain gauges, called MERGE which was developed by INPE in Brazil. MERGE has an available dataset of 20 years. In order to better represent the characteristics of the diurnal cycle and the physical processes of the different regions of the country we applied two different types of ANN, the Deep Neural Network (DNN) and the Recurrent Neural Network (RNN). The target is a sub-daily rainfall with temporal resolution of 3 hours. Meteorological variables with physical relationship with the rain in previous studies were selected, like infrared brightness temperature from GOES satellite, hourly precipitation estimates from microwave sensors (IMERG), and environmental data (e.g. humidity, wind, etc) from ERA reanalysis. Also, we used topography and location information for the whole area. Each of the chosen variables was pre-processed, producing averages (or accumulated) values and other 3-hour temporal resolution measurements. Correlation between them and the accumulated observed rain at the same time were analyzed. The results were evaluated for different regions, seasons, and times. Results obtained by the ANNs are in a better agreement when compared to IMERG product (the reference). For results with less input data (e.g. without wind information), to save computer time, the DNN has the best performance, especially when trained with data from all regions. DNN obtained an MSE of 11.09 mm and RNN shows a value of 11.88 mm. However, the rain screening (areas with rainfall) is slightly better for IMERG, but with a superestimation of the precipitation. Also, DNN shows better results for all the different regions of Brazil as well as for the different seasons. BIAS for RNN is better for hours with low precipitation, while DNN and IMERG are better for rainy periods (18 and 21 GMT). However, BIAS differences between DNN and RNN are very small and MSE shows a slightly better values to DNN for all times. Therefore, DNN was

chosen as the best ANN. Sensitivity tests will be carried out to determine the best DNN configuration without considering computational costs. For its improved version, with the inclusion of more meteorological variables, DNN performed better in all aspects, including rain screening, when compared to IMERG.