EGU22-12847
https://doi.org/10.5194/egusphere-egu22-12847
EGU General Assembly 2022

Deep Learning for rainfall detection in a data scarce context: an application to the Sahelian Savanna

Monica Estebanez Camarena, Riccardo Taormina, Nick van de Giesen, and Marie-Claire ten Veldhuis
TU Delft, Water Resources, Netherlands (m.estebanezcamarena@tudelft.nl)

The economy of West Africa largely relies on rain-fed agriculture, making economic growth and food security in this region highly dependent on rainfall and the knowledge of rainfall patterns. However, accurate rainfall information is currently missing due to a sparse rain gauge distribution and challenges in data transmission. Satellites could offer a solution, but existing products show poor correlation with rain gauge data. Possible reasons for this are the specific atmospheric characteristics of West Africa and rainfall processes still not fully understood.

To address this challenge, a new satellite rainfall product has been developed at TU Delft, within the Schools and Satellites (SaS) CSEOL project, funded by the European Space Agency through the IHE Institute for Water Education. SaS had the goal of producing reliable rainfall information for West Africa by combining Earth Observation, Deep Learning (DL) and Citizen Science. The focus area was the North of Ghana. The resulting product, RainRunner, performs rainfall detection at a 3-hour temporal and 0.03° x 0.03° spatial resolution, based only on TIR Meteosat Second Generation data. Two DL architectures have been designed: one using only Convolutional Neural Networks (CNN) and another one featuring a Convolutional Long Short-Term Memory layer before a CNN architecture. We have also introduced a methodology to train DL models when accurate high-density data are missing on the ground, that employs point-based instead of gridded rainfall data. RainRunner uses rain gauge data from the Trans-African Hydro-Meteorological Observation (TAHMO) as target data. A secondary validation with daily manual rain gauge data gathered by the SaS Citizen Observatory in the North of Ghana demonstrated that RainRunner has a remarkable generalization ability.

We will show that RainRunner achieves performance very close to that of Global Precipitation Measurement (GPM) Integrated Multi-satellitE Retrievals for GPM (IMERG) and outperforms the well-established Precipitation Estimation from Remotely Sensed Imagery Using an Artificial Neural Network Cloud Classification System (PERSIANN-CCS). Advantages of RainRunner are that it is fully data-driven, simpler to deploy, operating on a regional scale in quasi real-time, i.e., it can be applied as soon as GEO IR images become available.

This work illustrates the potential of DL for satellite rainfall retrieval in a data scarce context. To the best knowledge of the authors, this is the first study in which a DL-based rainfall detection model is trained locally over a region in Africa. This work could set a stage towards better rainfall information in areas of the world where it is currently missing, ultimately contributing to climate adaption worldwide.