World Academy of Science, Engineering and Technology
International Journal of Environmental and Ecological Engineering
Vol:16, No:05, 2022

Combining Multiscale Patterns of Weather and Sea States into a Machine Learning Classifier for Mid-Term Prediction of Extreme Rainfall in North-Western Mediterranean Sea

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Abstract : Heavy precipitation constitutes a major meteorological threat in the western Mediterranean. Research has investigated the relationship between the states of the Mediterranean Sea and the atmosphere with the precipitation for short temporal windows. However, at a larger temporal scale, the precursor signals of heavy rainfall in the sea and atmosphere have drawn little attention. Moreover, despite ongoing improvements in numerical weather prediction, the medium-term forecasting of rainfall events remains a difficult task. Here, we aim to investigate the influence of early-spring environmental parameters on the following autumnal heavy precipitations. Hence, we develop a machine learning model to predict extreme autumnal rainfall with a 6-month lead time over the Spanish Catalan coastal area, based on i) the sea pattern (main current-LPC and Sea Surface Temperature-SST) at the mesoscale scale, ii) 4 European weather teleconnection patterns (NAO, WeMo, SCAND, MO) at synoptic scale, and iii) the hydrological regime of the main local river (Rhône River). The accuracy of the developed model classifier is evaluated via statistical analysis based on classification accuracy, logarithmic and confusion matrix by comparing with rainfall estimates from rain gauges and satellite observations (CHIRPS-2.0). Sensitivity tests are carried out by changing the model configuration, such as sea SST, sea LPC, river regime, and synoptic atmosphere configuration. The sensitivity analysis suggests a negligible influence from the hydrological regime, unlike SST, LPC, and specific teleconnection weather patterns. At last, this study illustrates how public datasets can be integrated into a machine learning model for heavy rainfall prediction and can interest local policies for management purposes.

Keywords : extreme hazards, sensitivity analysis, heavy rainfall, machine learning, sea-atmosphere modeling, precipitation forecasting
Conference Title : ICEES 2022 : International Conference on Environmental Earth Sciences
Conference Location : Barcelona, Spain
Conference Dates : May 26-27, 2022