Deep learning in spaceborne GNSS-R: Correcting the geophysical effects on wind speed products

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Abstract

Deep learning techniques have shown the capability for GNSS reflectometry and significantly improved the quality of ocean wind speed retrieved from the Delay-Doppler Maps (DDMs). The model trained by a deep learning neural network based on convolutional layers and fully connected layers extract features from the bistatic radar cross-section (BRCS) DDMs observed by NASA Cyclone GNSS (CYGNSS) satellite system with information extracted from ancillary technical parameters. This model predicts ocean windspeed with higher accuracy in comparison to the officially operational retrieval algorithm.

However, from the theoretical knowledge, several error sources are known and associated with bias in the predicted result. For example, rain splash on the ocean affects the surface roughness of the ocean, which alters the GNSS scattering patterns, resulting in a considerable bias in GNSS-R wind products. This bias is not easy to correct because of its nonlinear dependency on different environmental and technical parameters. Deep learning is potentially able to learn such trends and correct the associated biases. Therefore, we explore how deep learning-based fusion on precipitation data can correct the effect of precipitation and improve the windspeed predictions. Our new model tested on a dataset with precipitation effect(>1mm) shows a better result than the previous model and reduces the RMSE of wind speed prediction, especially in high wind speed interval (>10m/s) and very low wind speed interval (< 3m/s).