THE SPATIAL DISTRIBUTION OF THE TROPICAL CYCLONE PRESSURE USING MACHINE LEARNING TECHNIQUE

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ABSTRACT
Accurate modeling of storm surges induced by typhoons is crucial for effective disaster preparedness and mitigation. To simulate storm surges caused by typhoons, external forces include 10-meter winds and sea-level pressure fields are essential. Typically, such data is obtained using either parametric models, which utilizing simple mathematical parameters for modeling, or numerical weather prediction (NWP) models, interpreting physical processes numerically for predictions. Parametric models, despite being less accurate than NWP's full physics models, are often preferred in situations where rapid predictions are crucial due to their computational efficiency. However, parametric models, relying on statistical equations formulated from past observed data, may fall short in accurately describing the complex and nonlinear relationships between prediction variables related to typhoons using current simplistic statistical relationships. Additionally, parametric models, with their typical radial distribution, may inadequately represent the terrain impacts in regions distant from the center of a typhoon.

Therefore, this study employed a Convolutional Neural Network (CNN) model, beneficial for spatial information in image pattern analysis, to derive pressure fields based on wind fields alone. A dataset was constructed by Image-processed wind and pressure data of past typhoons with a temporal resolution of 1 hour and spatial resolution of 30 km. Subsequently, the CNN model was utilized to learn and verify the relationship between wind and pressure fields. The spatial features of typhoons were effectively extracted by applying only wind fields into the CNN model, improving the accuracy of typhoon pressure fields.

To evaluate performance, used the parametric model was the Holland 1980 formula as the parametric model which has been widely adopted in storm surge modeling. In comparison to the results from the Holland model and NWP, the CNN model in our study exhibited satisfactory performance. The pressure field obtained through CNN exhibits similar accuracy to the NWP model and from the perspective of considering spatial distribution, this model had an advantage over the holland model. Combining more diverse datasets can further enhance the accuracy of pressure field estimation, allowing for a more generalized understanding of the relationship between typhoon wind and pressure fields.

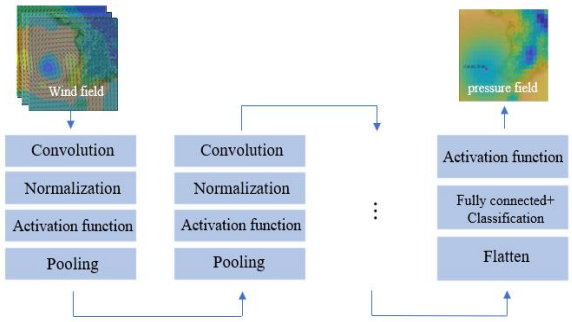

Figure 1 - CNN structure plot

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