

RESEARCH ARTICLE

Identification of tropical cyclone centre based on satellite images via deep learning techniques

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Abstract

A tropical cyclone (TC) is a highly destructive natural disaster. Accurate identification of key parameters of TCs is prerequisite for most TC-related research and practices. The centre position is one of TC's basic parameters. However, comparison of TC best track data released by different meteorological institutes usually indicates a noticeable discrepancy for this parameter among varied data sources. In this study, efforts are made towards identifying the centre location of TCs via deep learning techniques, based on TC satellite cloud images (SCIs). Six deep learning models are analysed and compared. YOLOv4 model achieved a confidence of 99.84%, which is better than other models. In addition, we further explore the factors affecting the positioning accuracy of the YOLOv4 model and its application to the location identification of multiple TCs and the tracking of individual TCs. Results demonstrate that the YOLOv4 model has a probability exceeding 99% for identifying multiple TC locations and also performs well for single TC tracking.

KEYWORDS

deep learning, identification of tropical cyclone centre, satellite image, tropical cyclone, YOLOv4

1 | INTRODUCTION

Tropical cyclones (TCs) are highly destructive natural disasters that can cause severe economic losses and human casualties every year especially in coastal regions (Wang *et al.*, 2016). Results from many researches also indicate that TC hazards may become even more severe in the future owing to the effects of climate change (Wang and Zhou, 2008; Wang *et al.*, 2019).

Accurate identification of key parameters of TCs is a prerequisite for disaster prevention and mitigation research. The centre position exists as one of TC's basic parameters. However, comparison of TC best track data released by different meteorological institutes usually suggests a noticeable discrepancy for this parameter among varied data sources. Taking TCs over northwestern Pacific Ocean for

example, the statistical difference (in terms of standard deviation) of the centre location for 184 TCs from 2014 to 2019 during their lifecycles between TC best track datasets issued by China Meteorological Administration (CMA) and National Oceanic and Atmospheric Administration (NOAA) in the United States reaches 0.61° in longitude and 0.18° in latitude (Yu *et al.*, 2007; Meng and Liu, 2020). The difference becomes even more evident for TCs after landfall when they usually impact the coastal areas most severely. The inaccurate identification of TC centre may result in markedly amplified errors/uncertainties in the prediction of wind field and rainfall especially around the inner core region (Jones *et al.*, 2019; He *et al.*, 2022).

During the past decades, various instruments have been developed and exploited for TC studies. Among them, meteorological satellites have been receiving

Techniques Of Climatology

Robert V. Rohli, Anthony J. Vega



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