TROPICAL CYCLONE INTENSITY ESTIMATION USING TEMPORAL ANALYSIS AND SPATIAL FEATURES IN SATELLITE DATA

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Abstract

- Developing new automated techniques to estimate the TC intensity and to overcome the existing errors in estimation is still a challenge.
- We have developed and tested an automated method to estimate TC intensity based on existing historical data.
- The intensity estimation algorithm has two parts: temporal analysis and image feature analysis.
- The focus of this study is on the temporal analysis.
- Temporal information provides a priori estimates of TC intensity before using any satellite analysis.
- It uses the age of the cyclone, 6, 12 and 24 hours prior intensities as predictors of the expected intensity.
- Several tests are implemented to statistically validate the proposed algorithm using k-Fold Cross-Validation.

Goal/Motivation

- Tropical cyclones (TCs) are a significant threat to life and property.
- Hypothesize that discovering unknown regularities and abnormalities that may exist in the large group of past observations could help human experts interpret TC intensity changes from various points of view.
- Provide a data mining tool that increases the ability of human experts to analyze huge amount of historical data for TC intensity estimation.

Introduction

- Estimating tropical cyclone intensity (INT) from:
  \[ INT = f(\text{MSW}_0, \text{MSW}_1, \text{MSW}_2, \text{MSW}_3, \text{AGE}) \]
- In this mapping, the spatial interpolation of satellite imagery \( g \) is constrained in time \( t \) by some function, \( f \).
- This is similar to Dvorak intensity estimation, where T-numbers are constrained in time to estimate current intensity (C1).
- The primary focus of this poster is on the temporal constraint function, \( f \).

Temporal Estimation

- TC intensity may describe as a function of the prior maximum sustained wind (MSW) speed.
  \[ INT = f(\text{MSW}_0, \text{MSW}_1, \text{MSW}_2, \text{MSW}_3, \text{AGE}) \]

Selected Features (Predictors)

- Classification of Dvorak intensities (Training Data)
- Classification of Dvorak intensities (Testing Data)
- Original Dvorak Intensities

Dvorak TC Intensity (C1, C2, C3)

Confusion Matrices

Preliminary Spatial Analysis

- The biases show that the DT underestimates intensities when TCs have intensities between 35 and 55 kt and greater than 125 kt.
- DT overestimation of intensities occurs between 75 and 105 kt.
- For the proposed technique the underestimates occur especially for intensities greater than 115 kt.
- The MAEs and RMSEs are lower for weak storms and larger for the higher intensities which are similar for both techniques.

Conclusion/Future work

- The proposed technique has a great potential to provide new temporal constraints on satellite analyses (e.g., the Dvorak technique).
- The current analysis has the ability to decrease the Dvorak error from 11.7 kt to nearer the current temporal estimate of 8.2 kt, as an upper limit. It shows improvement between 30% to 55%.
- We will fuse temporal analysis with satellite image analysis for more accurate TC intensity estimation.

References


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