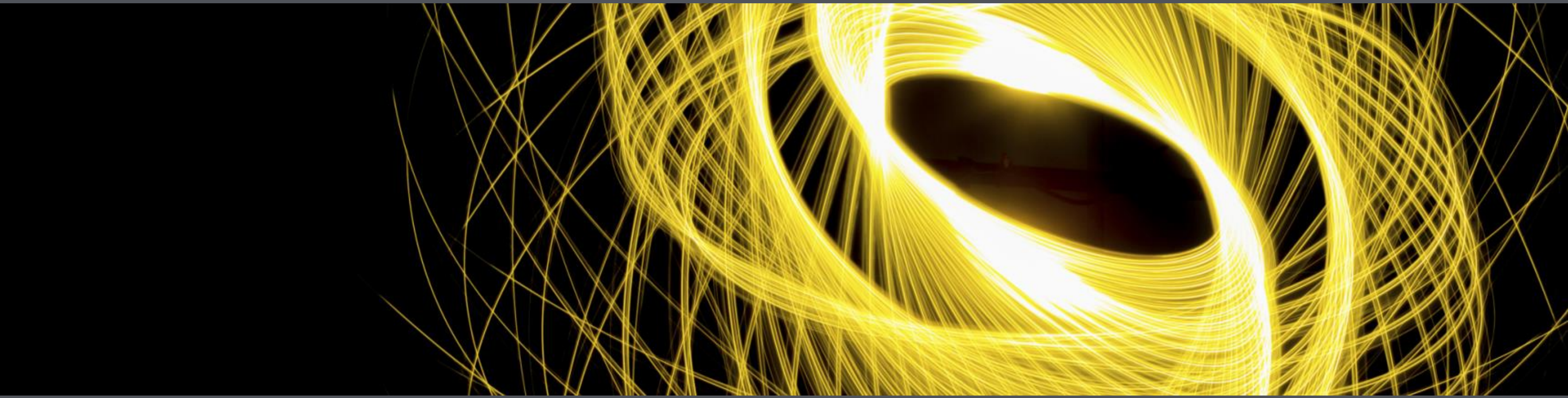
Department of Computer Science

Detecting Tropical Cyclones using Deep Learning Techniques



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Scenario DOCTORAL TRAINING PARTNERSHIP

UKRI Natural Environment Research Council

Introduction and Aims

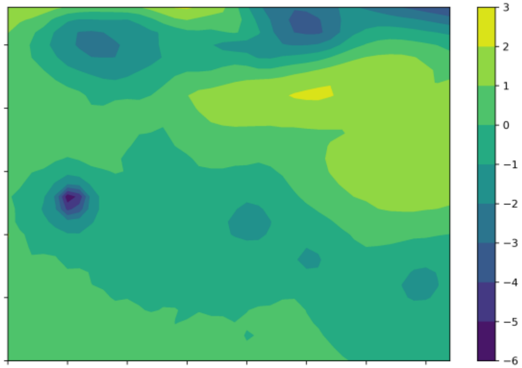
- Tropical Cyclones are events that leave devastating effects
- The effects of a changing climate on TCs are being investigated by long General Circulation Model (GCM) simulations
- Each simulation produces large amounts of data which can be inefficient to store and analyse
- The first step to reducing the amount of data is to create a filtration method, which is what is going to be presented.

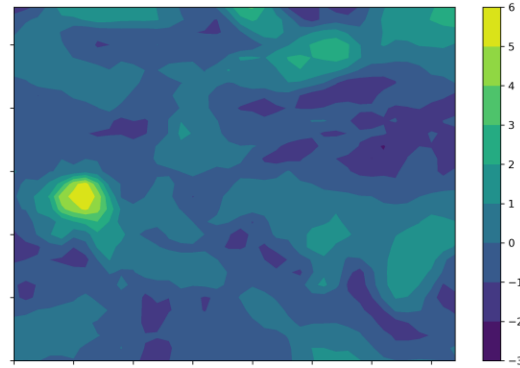
Data

- ERA-Interim reanalyses dataset
- Each timestep split into 8 regions
- Training Set: January 1979 – July 2017 (450944 cases)
- Testing Set: August 2017 – August 2019 (24352 cases)
- Fields used: 10m wind speed; MSLP; Vorticity at 850hPa, 700hPa, 600hPa at a resolution of 2.8^{o} (sixteenth of the original resolution) with spherical harmonic filtering
- Labels obtained from the IBTrACS database

Example of data used: Hurricane Katrina on 28/08/2005 at 18Z at strength of Cat5

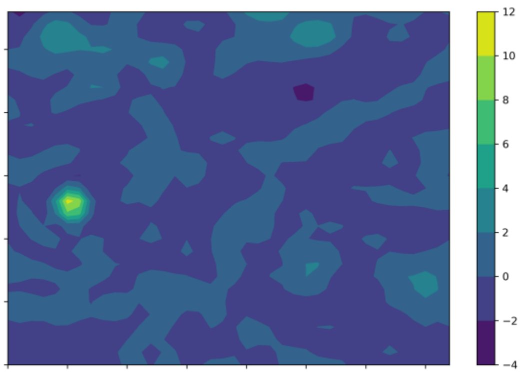
MSLP

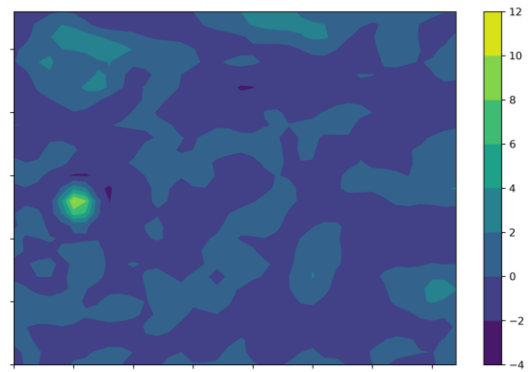




10m wind speed

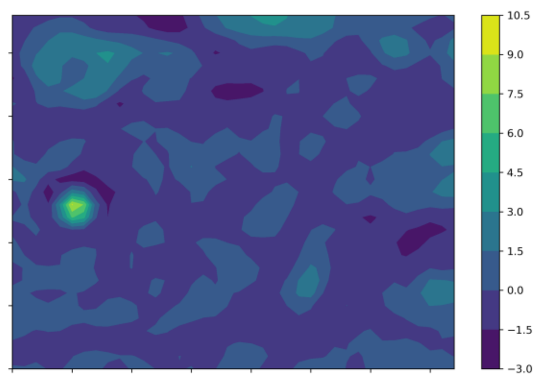
Vorticity at 850 hPa





Vorticity at 700 hPa

Vorticity at 600 hPa



Results

- An accuracy of 90.65% was obtained when testing on data from August 2017 until August 2019
- Recall of 91.73% (1231 out of 1342 positive cases) were correctly classified

		Identified	
		Yes	No
Ground Truth	Yes	1231	111
	No	2166	20844

Results: TC Category

- Positive cases were split by the maximum category of TC, as given by IBTrACS according to the Saffir-Simpson scale, present in the case.
- The metric of recall, was used to check how well each category was classified as it is defined as the percentage of positive cases correctly classified.

Category	1	2	3	4	5
Recall	88.02%	91.53%	94.19%	94.64%	100.00%

Results: Model Generalization

- The Deep Learning model performs best on cases from the Western Atlantic and Western Pacific regions, with a recall of 93.00% and 96.80% respectively
- All regions achieved a recall rate of higher than 80%, except for that bounded by 180^{o}E – 260^{o}E in the Southern Hemisphere, which obtained a recall rate of 42.31%

Results: Others

- The effect of the size of the training dataset was queried
  - Given that AUC-PR increased and loss decreased with increasing amounts of data, more data would probably have produced a better performing model
- Feature Importance was carried out to determine the most influential fields
  - Vorticity at 850hPa was the most influential
  - Vorticity at 600hPa was the second-most influential
  - Hence, it could be argued that the model is looking for deep convection

Conclusions and Future Work

- A Deep Learning model aimed at detecting the presence or absence of a Tropical Cyclone in weather data has been presented
- It achieved an accuracy of 90.65%, with a recall of 91.73% on a test set spanning from August 2017 until August 2019
- Work has started to implement this model into the UK Met Office's Unified Model (MetUM) for it to act as a data filtration method that can work during the MetUM's execution, rather than after

Acknowledgements

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