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Analog Forecasting of Extreme-Causing Weather Patterns Using Deep Learning

Wednesday, 7 October 2020 16:00 (30 minutes)

Numerical weather prediction (NWP) models require ever-growing computing time and resources, but still, have sometimes difficulties with predicting weather extremes. We introduce a data-driven framework that is based on analog forecasting (prediction using past similar patterns), and employs a novel deep learning pattern-recognition technique (capsule neural networks, CapsNets) and an impact-based auto-labeling strategy. Using data from a large-ensemble fully coupled Earth system model, CapsNets are trained on mid-tropospheric large-scale circulation patterns (Z500) labeled $0-4$ depending on the existence and geographical region of surface temperature extremes over North America several days ahead. The trained networks predict the occurrence/region of cold or heat waves, only using Z500, with accuracies (recalls) of $69\%-45\%$ ($77\%-48\%$) or $62\%-41\%$ ($73\%-47\%$) $1-5$ days ahead. Using both surface temperature and Z500, accuracies (recalls) with CapsNets increase to $\sim 80\%$ (88%). In both cases, CapsNets outperform simpler techniques such as convolutional neural networks and logistic regression, and their accuracy is least affected as the size of the training set is reduced. The results show the promises of multi-variate data-driven frameworks for accurate and fast extreme weather predictions, which can potentially augment NWP efforts in providing early warnings.

Thematic area

1. Machine Learning for Model Identification and Development - Including Model identification, Fast Emulation of Parameterisations, Data driven Parameterisations

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