INPE Nowcasting system: Steps toward an automatic severe storm forecasting system in Brazil

Calheiros, AJP; Machado, LAT; Stephan, S.; Vila, D.; Santos, R. et al

alan.calheiros@inpe.br
National Institute for Space Research (INPE)

Abstract
A new team has been created to develop a storm nowcasting system in INPE (National Institute for Space Research in Brazil). We have implemented more than 50 products addressing the four phases of nowcasting: pre-convective, convective initiation, mature storms and forecasting. However, one of their main objectives is to create a nowcasting tool based on AI and it is a work in progress. Several field campaigns were carried out collecting data (i.e. meteorological satellites and radar, numerical weather models, automatic weather stations and lightning sensors) of severe convective events in Brazil. Analysis are being done to characterize these extreme events and create a dataset. The characterization is defined by the gathered information of different observations during the life cycle of those events using a tracking system developed by INPE (ForTraCC). All this information will feed machine learning models to determine regional predictors and methodologies for the automatic system. Since nowcasting can be an abundant area for research and application of AI, it will provide a great opportunity for us to cooperate and share knowledge with different research groups and institutions to develop and evaluate new tools for weather prediction.

Phases:
1. Pre-convective condition?
2. Convective initiation?
3. Storm Severe? And 4. Let’s tracking and predict...

Preliminary Results:

Pre-Convective Prediction: Satellite NWP observations
- Prediction of convective activity and/or electrical discharge occurrence using numerical model forecasts (Almeida et al, accepted). In this approach, training phase employs electric discharge data, machine learning algorithm is either a specific neural network or a random forest. Tests performed using numerical models Eta and BRAMS for antecedences of 24 to 72 hours. Approach is currently being refined in order to undergo further tests and validation.
- Different studies are carrying out to develop new tools to predict the pre-convective condition based on machine learning techniques using WRF as well.

Examples of AI in INPE:
- EDDA - Estimation of density of electrical discharge occurrences; Cesar Strauss, Stephan, Stephany. This licensed software generates a smooth spatio-temporal field of density of occurrence of electrical atmospheric discharges using kernel estimation according to user-defined parameters like smoothing parameter or integration time period. (DOI: 10.3152/j.atmosrev.2015.07.008). Followed by EDDA-G (DOI: 10.1016/j.atmosrev.2013.07.008) and EDDA-chau (Estimation of convective precipitation, DOI: 10.1002/wci.453); Garcia, JVC, Strauss, C, Stephany, S);
- e-sensing (http://www.ewsensing.org/);
- Spatial-Temporal Segmentation Applied to Optical Remote Sensing Image Time Series. Warderson S Costa, Leila Fonseca, Thales John Korting, Hugo N.Benedini, Ricardo CM de Sousa. This is a method for image segmentation applied to time series of the Earth Observation data, in which we adapted the traditional region growing method to detect homogenous regions in space and time combining image processing techniques and the Dynamic Time Warping (DTW) algorithm. DOI: 10.1109/IGRS.2018.2819194

Forecasting System: Lightning
Lightning forecasting system based on extrapolation methods
- Both the thresholds and the life cycle of the systems are affecting the forecasts.

Acknowledgments:

The Largescale Teleconection by Complex Network

CNpq 438310/2018-7