

Rainfall nowcasting using deep learning method in southeast of Brazil

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Introduction

- In several regions, floods are responsible for causing major catastrophes.

Historically, southeastern Brazil has been very affected by flash floods

Flash floods respond quickly. This type of flood is located mainly in small and medium hydrographic basins, being difficult to predict.



Source: <http://floodlist.com/america/brazil-sao-paulo-floods-march-2019>



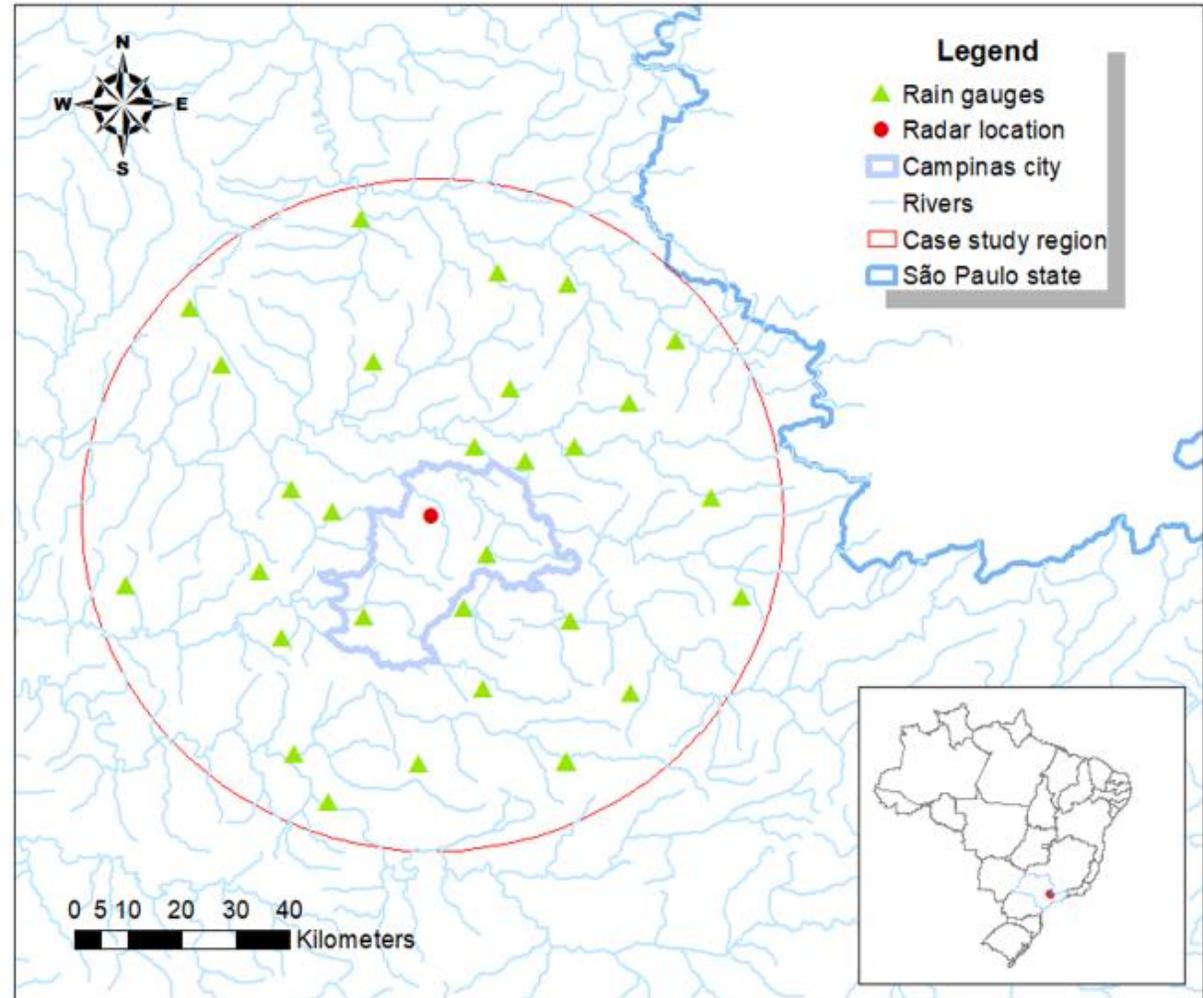
Aims of this study

- Can the latest rainfall observation measured by weather radar help to generate rainfall nowcasting?
- What is the capacity of deep learning methods to forecast extreme rain events?

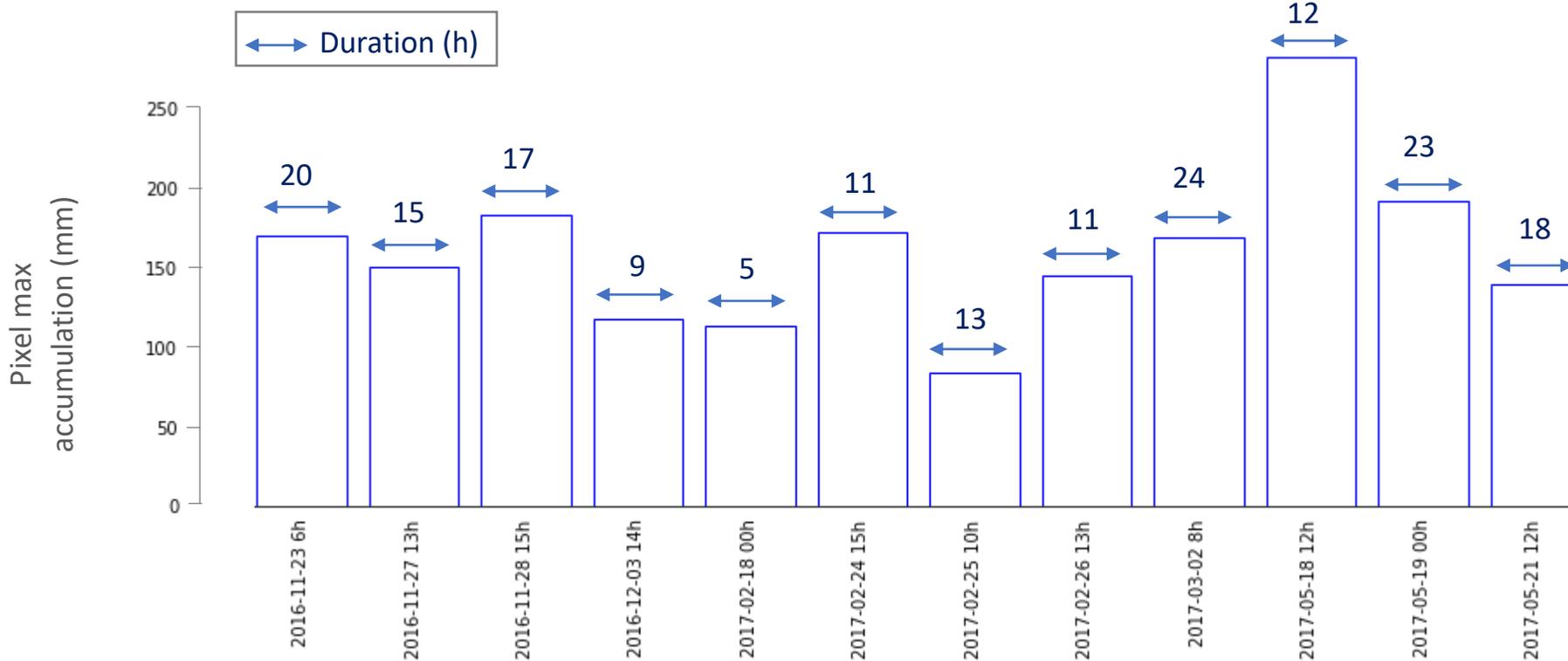
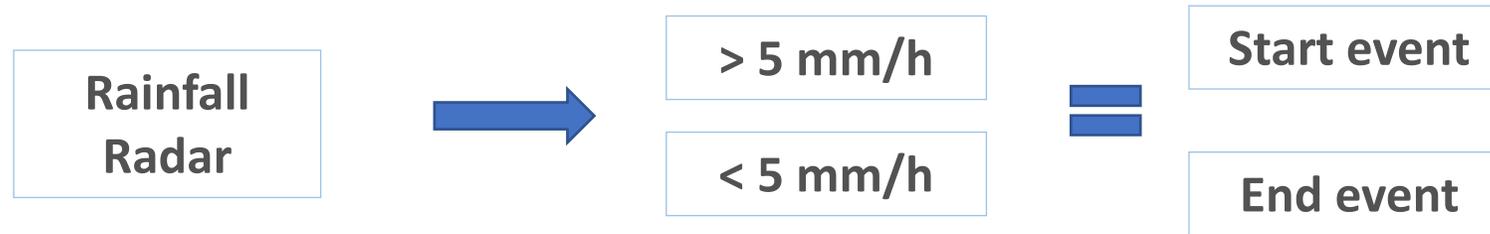
Generate short-term rainfall nowcasting using the LSTM method using convolutional recurrent neural networks

Study area and main data

- **Study Area:**
Campinas city, São Paulo
- **Data:**
Radar 1 km²
(10 min time steps)
- **Period:**
2016 and 2017 years



Extreme Rainfall Events Selected



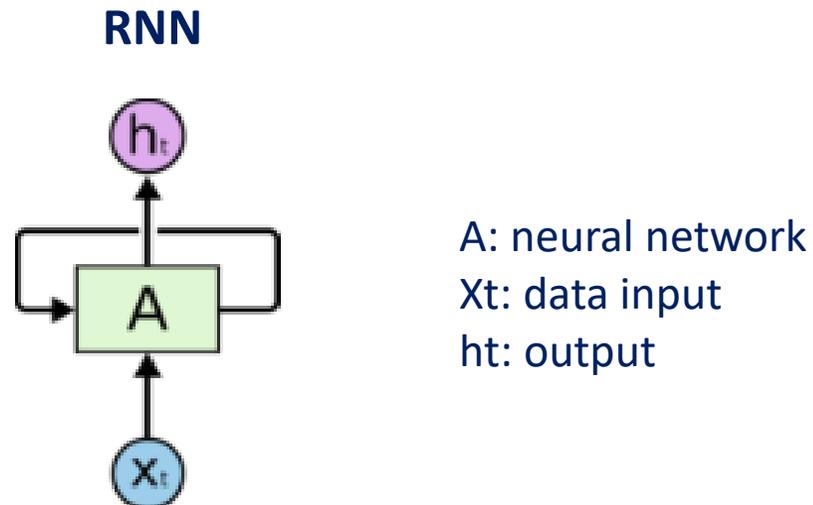
- **Max (pixel) accumulation:** 83 mm to 282 mm
- **Duration:** 5 to 24 hours

Generating rainfall nowcasting fields

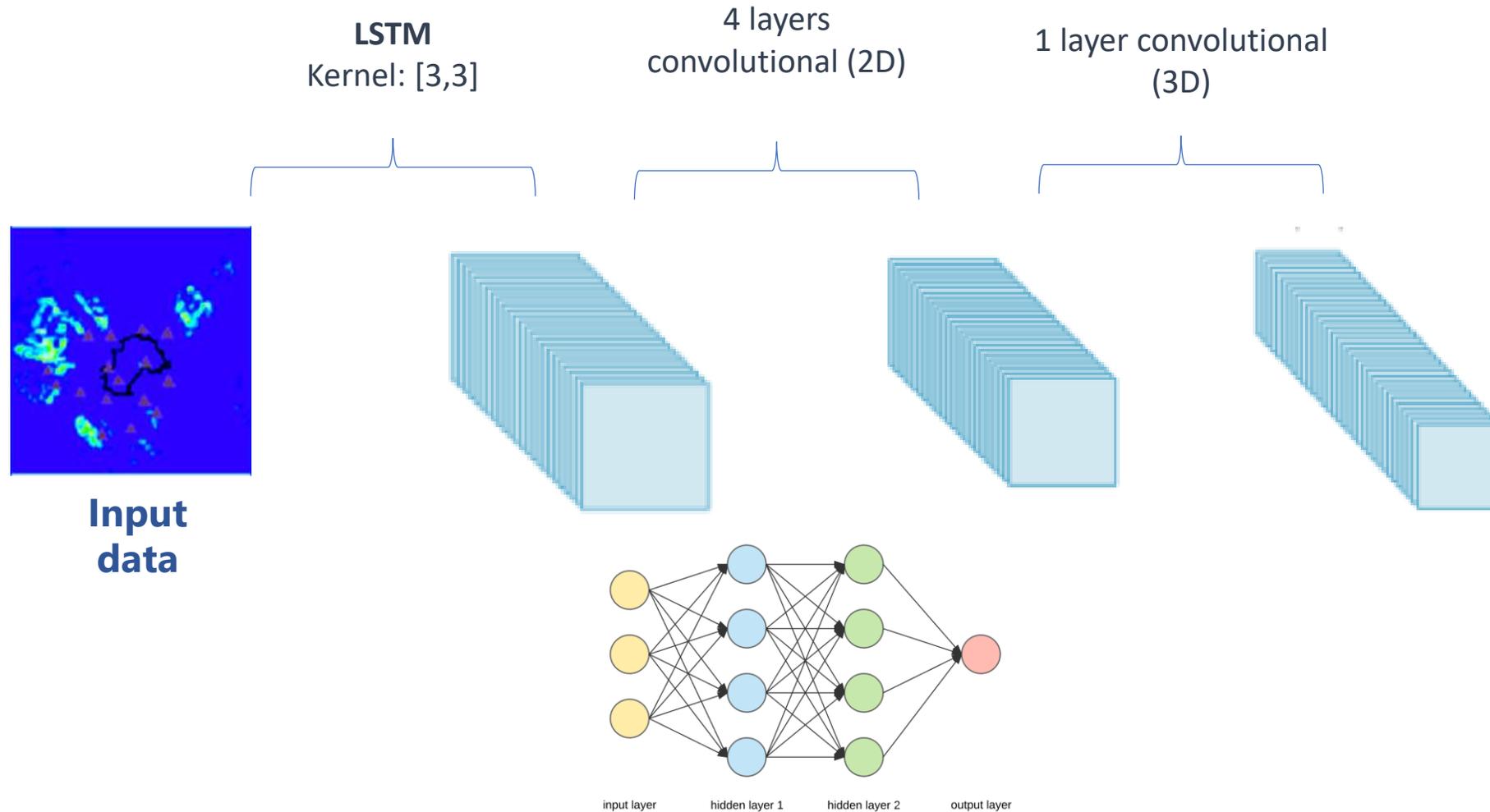
Deep Learning: is a branch of machine learning based on a set of algorithms using neural networks.

Long Short-Term Memory (LSTM)

Based on recurrent neural network (RNN). The information from input data can be stored from a cell. This cell makes decisions about what to store, and when to use the information through “gates”.

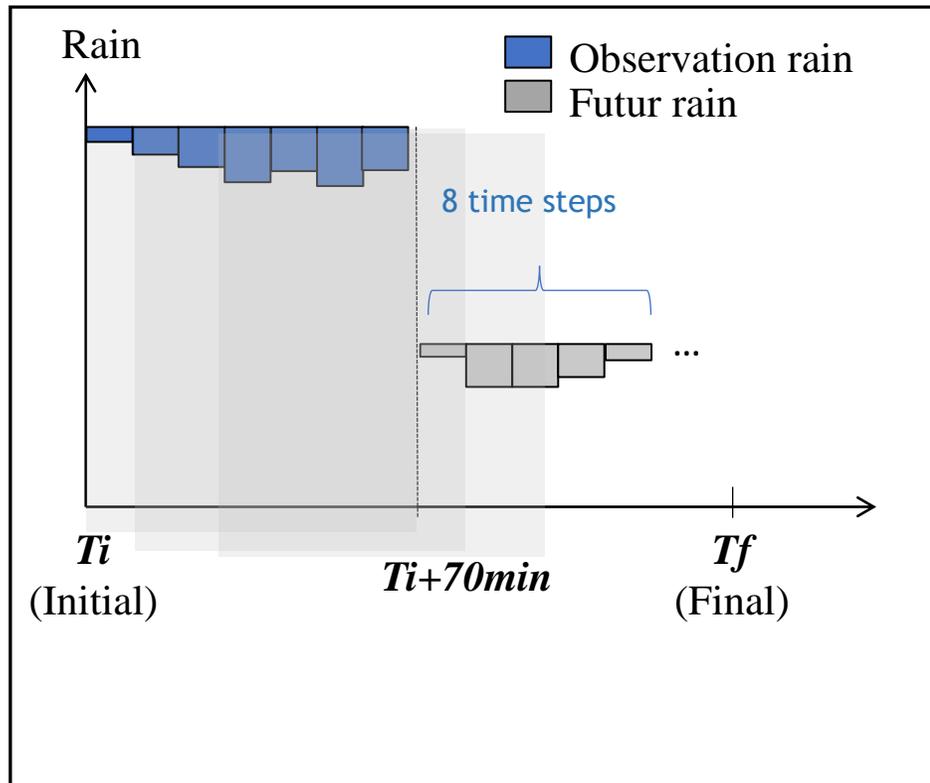


Defining the layers of neural networks



Model training methods

M7images



Sliding Windows

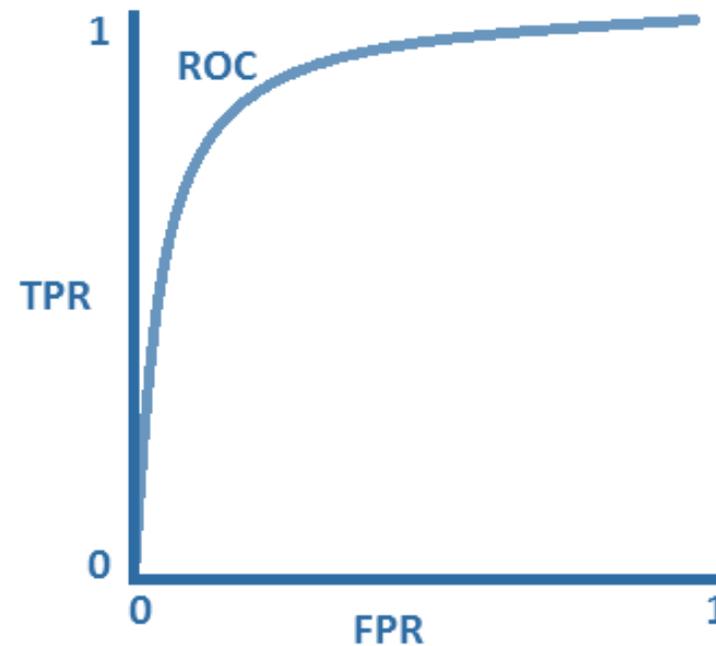
To train the model, two different sizes of sliding windows were considered:

- **M5images:** 9 events used in the training, 883 series of images (every 10 min), each with 5 images.
- **M7images:** 9 events used in the training, 883 series of images (every 10 min), each with 7 images.

Evaluation of the rainfall prediction

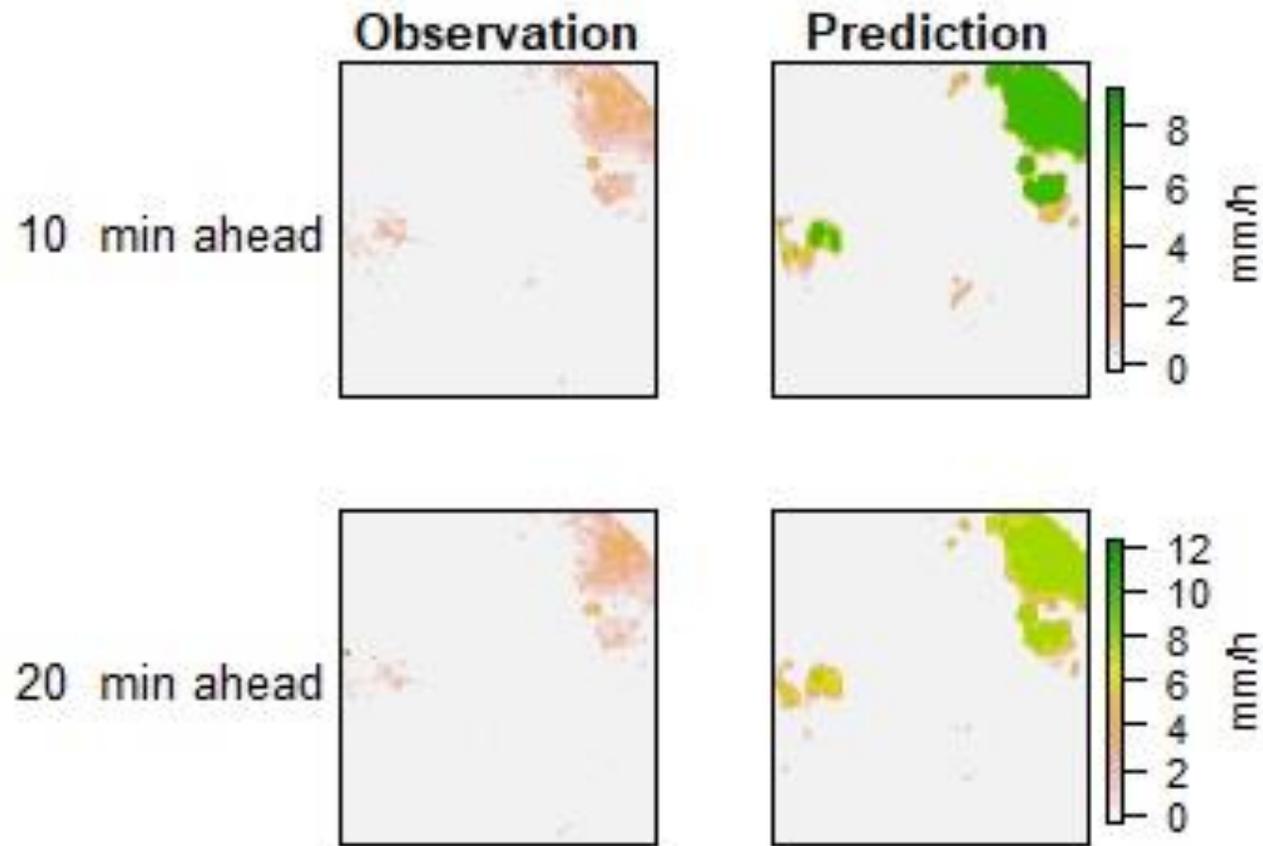
Nowcasting are evaluated against:

- the weather radar observations (3 events to validation);
 - the persistence prediction, repeat the last radar observation
-
- **ROC:** illustrates the performance of prediction considering a threshold. The true positive (TPR) and the false positive rate (FPR) and plotted. In this study we used the area under the ROC curve, or AUC, to evaluate the predictions.



Visualisation of generated nowcasting fields

M7images method



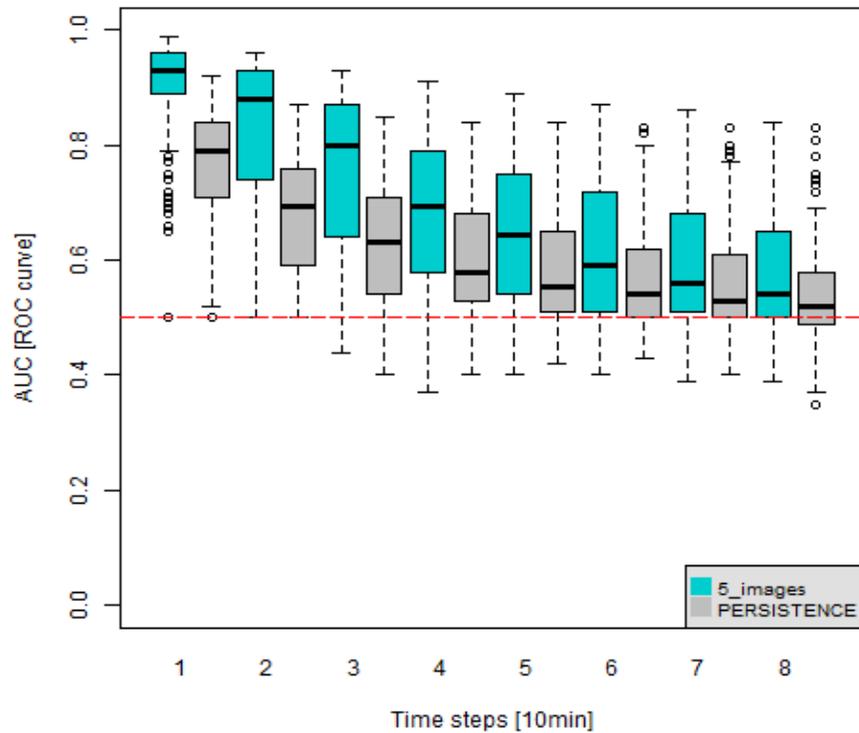
- Up to 80 minutes forecast

Evaluation ensemble nowcasting

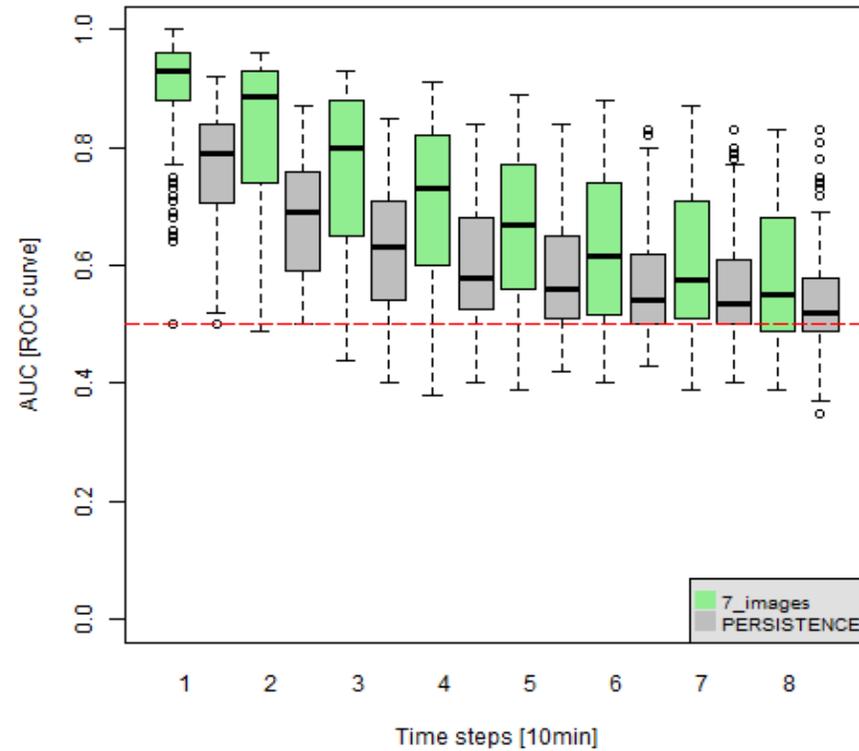


Good performance (ROC AUC) up to 80 minutes, considering a threshold of 1 mm/h

M5images



M7images

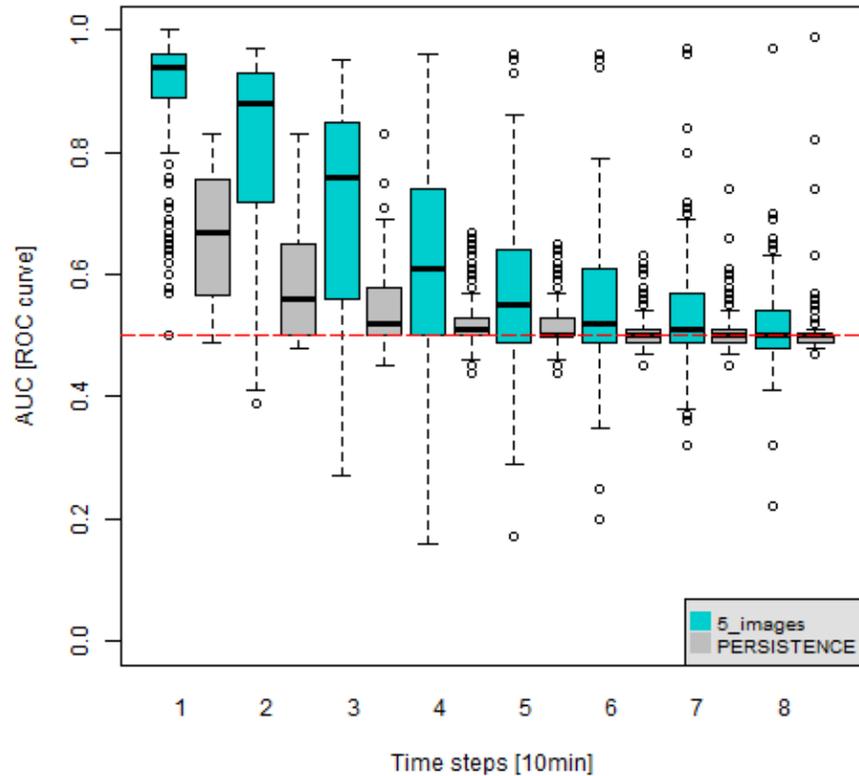


Evaluation ensemble nowcasting

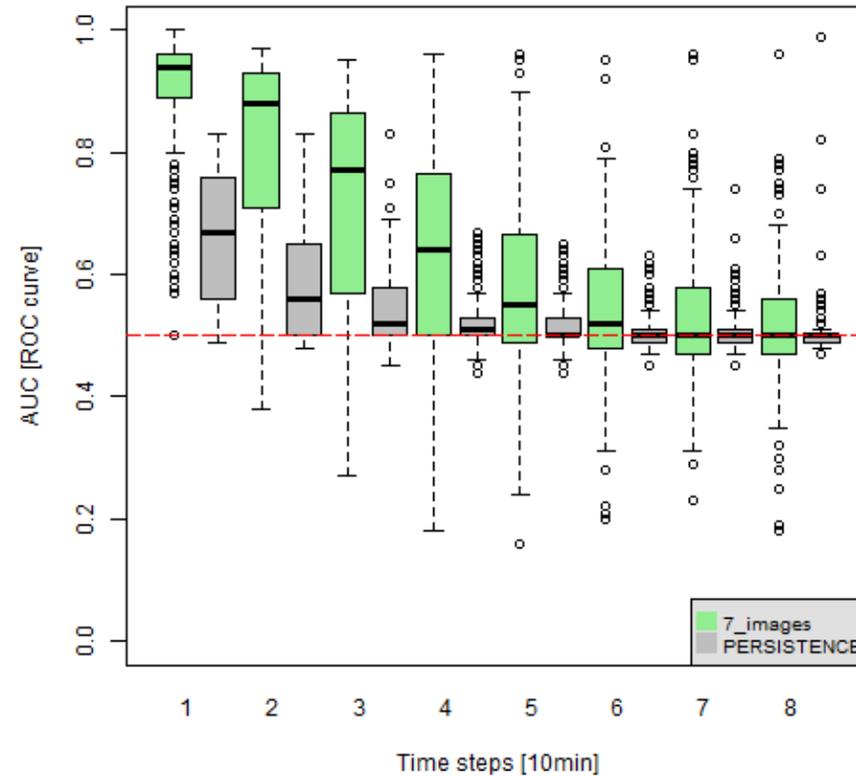


Good performance (ROC AUC) up to 60 minutes, considering a threshold of 5 mm/h

M5images



M7images



Conclusion

- Both M5images and M7images methods performed better than the persistence. The M7images method showed more satisfactory results.
- This approach can be one of the solutions to nowcasting and real-time monitoring of severe rainfall events.

Future works

- Create perturbations in the forecast model, considering the rain gauges data, in order to generate ensemble rainfall nowcasts.
- Use the rainfall nowcasting as input in a flood model prediction based on neural networks.

Thank you for your attention!

Do you have any questions?

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