ATMOSPHERIC MEASUREMENT TECHNIQUES
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Self-Nowcast Model of Extreme Precipitation Events for Operational Meteorology.

General comments:
This manuscript presents a neural network-based algorithm for the automated nowcasting of convective rain around Rio de Janeiro´s International Airport. Despite being an important subject that deserves more attention and investment by the meteorological community, there are several issues that must be addressed before considering this manuscript ready for publication. For that reason my recommendation is for a **major revision**.
Below the authors will find more detailed comments.

Title:
The term "*Self-Nowcast*" is not adequate to describe the automated model developed for nowcasting because it gives the (meaningless) idea that 'the model nowcasts itself'. The term should be replaced by something like "An automated nowcasting model…". Secondly, this work does not really deal with extreme precipitation events (see my detailed comments in page 4 below), so the authors should refrain from using the expression "extreme precipitation events" in the title and throughout the text.

SECTION 1: Introduction:

Major issue 1: In this section the authors make an effort to describe an *extreme meteorological event* (EME) but their approach is biased towards extreme meteorological events associated with convective precipitation. This is partially understandable because heavy rain is the target of the study, but because not all EMEs are associated with extreme precipitation, the authors must rephrase several sentences in order to emphasize that their interest lies on the EMEs that cause heavy rainfall, and not on EMEs related to other variables (such as strong wind gusts). For example, in line 11 it is stated that "*Teixeira and Satyamurti (2007) studied EME occurrences in southeastern Brazil…*". This should be rephrased as "Teixeira and Satyamurti (2007) studied EMEs associated with heavy precipitation in southeastern Brazil…".

Lines 5 to 7:
"*According to Marengo et al. (2004), an EME is defined as a rare meteorological phenomenon with very low statistical distribution in a particular place*."
Marengo *et al*. (2004) provides no definition for an extreme meteorological event and this sentence should be removed.

In addition, the authors cite several climatological studies addressing EMEs, while their study is on nowcasting. Therefore, there is a serious conceptual mismatch in their literature review.

Major issue 2:
In lines 15 to 17, the authors indicate that "*EME phases […] fall into a nowcasting time scale, implying a short-term forecast*."
There are several problems with the statement above.

First.
The concept of EME is strongly associated with the climatology and statistical distribution of the meteorological variables for a given region. An EME is related with the idea of a rather rare event, and, therefore, only trough climatological studies can one determine what is an EME for a

given region and time of the year. In fact, when the authors first introduce the term "nowcasting" in the text, it comes right after a number of articles that investigate EMEs from a climatological standpoint. Now, how does nowcasting relate to those climatological/statistical studies? In operational nowcasting, do we need to determine if a given weather event is an EME (from a statistical perspective) in order to issue a warning? The authors submit a manuscript on the nowcasting of extreme precipitation events, but two-thirds of their Introduction offers a general overview on the concept of EME, citing a number of articles on the climate perspective of extreme precipitation. Is this review about EMEs really necessary for an article on nowcasting?

Second:
Only "EMEs" associated with convective weather (or winter weather) can be addressed through nowcasting in the operational setting. EMEs are not synonym for convective weather. In fact, the forecast of EMEs and their stages of evolution — even those associated with heavy precipitation — can be addressed through a myriad of approaches ranging from climate prediction (e.g., seasonal forecast; "Are we expecting more frequent and intense South American Convergence Zone this Summer?"), to medium-range forecasting (e.g., "How much rain should we expect from a given tropical/subtropical/extratropical cyclone?"), and finally down to the nowcasting range. Hence the statement "EME phases […] fall into a nowcasting time scale, implying a short-term forecast" is not accurate and should be eliminated, or entirely rephrased.

What are the nowcasting techniques available for convective storms capable of producing heavy rain? The authors only mention (briefly!) Mueller et al. (2003) and Mass (2012), while the nowcasting field has a vast literature, including the important topic of assimilation of radar data on NWP models (e.g., Sun and Wilson, 2003).

Lines 25 and 26:
The authors state that "*The present numerical prediction models do not satisfactorily model EMEs in location-specific and short-term scales.*" Is this an opinion from the authors, or is it a general result from past studies? If in the second case, where are the references? What are the objectives and shortcomings of high resolution NWP?

Finally, how their approach to the nowcasting of heavy rain **differs** from previous studies?

In short, the authors must rewrite their entire Introduction section to better relate to the main topic of the study.

SECTION 2: Meteorological data sets and study region:

There is no mention about the period of study in the text; only Table 1 provides this information. This information must be indicated in the text as well.

TEMP and METAR are not time series *per se*, but meteorological codes. The authors should replace "…*four time series*" by "…four data sources" or "…four datasets".

"*TEMP represents the upper atmospheric profile for…*"
No. TEMP is the meteorological code employed to report profiles of atmospheric variables.

"*The TEMP time series was obtained…*"
Should be replaced by "Time series of TEMP-coded data was obtained…"

"*…where SB and GL mean Brazil and Galeão, respectively.*"

Not a relevant information. Remove this sentence.
"*…SBGL is the only one of the stations that collects atmospheric profiles in a daily basis…*"
Poor writing.
Replace by "…SBGL is the only station where hourly meteorological data are reported regularly…"
The expression "atmospheric profiles" makes no sense if one refers to METAR data which contain surface reports only.

Replace "*metropolitan region*" by "metropolitan area", which is a more common usage.

The network of 29 rain gauges is operated by/belongs to which institution? Providing the internet link is not enough; the authors must name the institution.

"*…distributed around the Rio de Janeiro metropolitan region.*"
Poor writing.
Replace by "…distributed over Rio de Janeiro metropolitan area."

Caption of Figure 1 is badly drafted and does not provide credits to the image provider. It should read: "Satellite image of Rio de Janeiro´s metropolitan area. Yellow triangles [Red squares] indicate location of the twenty-nine rain gauges from *{add here the institution that runs that network}* [five airport meteorological stations]. Satellite image from Google Earth."

"*…lightning reports […] characterize each occurrence by its location…"*
Poor writing.
Replace by "…lightning reports […] indicating location…"

"*Table 1 summarizes…*"
Poor writing in this full sentence.
Replace by: "Table 1 summarizes the data sources {or datasets} utilized to train and validate the nowcasting algorithm in this study."

Caption of Table 1 is also very badly drafted. It should read: "Datasets and meteorological variables used in the distinct stages of development of the neural network-based automated nowcasting algorithm. Lightning data is used only during the validation stage of development."
Information such as "*This is not important, since it is used only for validation*" is irrelevant and, thus, unnecessary in the caption.

Table 1:
Replace "*Time series*" by "Dataset".
What is "*Data-time*"? Do the authors mean "Date-time"?
Third-line Third-column: wind is missing in the list of variables.
Footnote 1: K-index formulation uses (T@700hPa – Td@700hPa), not (T@700hPa – Td@500hPa) as indicated in the footnote. The definition of lapse rate is mistaken.

Observation: **(Major issue 3)**
Henceforth, I will not provide further suggestions for improving poor writing in the manuscript, because there are just too many passages to improve/correct. Not only are there grammatical errors, but also the authors abuse in the use of unnecessary comments, such as "*The problem with this is…*". Other expressions are translations of idioms typically used by native portuguese speakers, but that are very unusual (or sound very strange) in english. The authors ought to hand the manuscript to a native english speaker or to a professional translator to improve the text.

SECTION 3: Method. ***{Very badly written}***
The title of this section should read: "**Methodology and algorithm description".**

"*Figure 2 represents a typical neural network.*"
Figure 2 alone does not help describing a neural network at all. This sentence should be removed.

Variables and coefficients in equation (1) must be described in more detail. What are the weights? What do the indices M and D represent? What is σ?

3.1 Data processing.
Page 6, line 9: "*…consisted of three simple tasks.*"
It is not clear what the authors mean by "simple tasks". This must be rephrased or clarified.

Page 6, line 10: "*…and their consistency observed…"*
It should read "…and their consistency checked…"; but how was data consistency checked? Was there also a quality control procedure applied to the datasets? This is relevant information that deserves to be addressed in the text.

Page 6, line 11: "*…meteorological recordings.*"
Replace by "…meteorological records."

Major issue 4:
Page 6, lines 11 to 13: "*…the rain rate time series, based on RR* h^{-1}*, was used to classify the meteorological recordings into four classes…*"
The authors did not describe the methodology used to determine the thresholds for null, light, moderate and heavy rain episodes. The 9.9 mm h^{-1} threshold for heavy rain does not seem appropriate (note: Teixeira and Satyamurty (2007) present a brief but good review of criteria usually employed to define 'heavy rain'). Since the authors are interested in highlighting the nowcasting of extreme precipitation events, a detailed reasoning must be presented in support of the 9.9 mm h^{-1} threshold for heavy rain. Wilks (2006) describe distinct procedures to characterize extreme weather events based on objective statistical methods, but it appears to me that the authors have chosen a subjective approach that led to a far than adequate criterion to discriminate extreme precipitation. As a matter of fact, if the 9.9 mm h^{-1} threshold is to be used to discriminate 'heavy rain', then the authors must refrain from using the expression 'extreme precipitation events' when referring to these precipitation episodes.

3.1 Input and outout.
Major issue 5:
Page 6, lines 24 to 26: The authors state that "*The SNM's purpose is to nowcast EMEs; therefore all input (or predictors) should indicate EME phases, i.e., initialization, growth and decay.*"
First, the authors do not explain **how** the different phases or stages of the precipitation events were determined based on the dataset they have. Without that information it is impossible to complete an assessment of the methodology used. Second, are the set of predictors utilized to train the neural network to forecast the distinct stages of evolution of the precipitation episode? In other words, was it also a goal to predict the demise of the precipitation event? Third: the authors did not explain why they did not include, in the screening stage, candidate predictors coming from numerical model output or weather radar data (Rio de Janeiro state does have operational meteorological radars), and non-local candidate predictors. All these issues must be clarified in the methodology section.

For which atmospheric layer(s) is computed the lapse rate? The authors do not indicate this information in the text, only in a 'hard-to-read' footnote of Table 1 (and there is a typo in that definition).

Page 7, line 6: What do the authors mean by "*quite constructive*"?

Page 7, line 7: "*After a simple correlation test…*"
First question: a "correlation test" of what sort? Second question: what exactly is the predictand variable? Accumulated rainfall? The time derivative of hourly rainfall? This stage in the development of the algorithm has to be better described.

Page 7, lines 9 and 10:
"These variables were initially judged the best data set to transmit atmospheric conditions during neural network training"
This sentence must be fully rephrased because it does not make sense. For example, what do the authors mean by "*to transmit atmospheric conditions*"? And there should be a table indicating all fifty seven atmospheric variables/parameters that 'survived' the first predictor screening.

Page 7, lines 15 to 17:
"The latter is responsible for converting the input (or predictors) in the event that all four RR classes occur."
I could not understand this passage, especially where it reads "*in the event that all four RR classes occur*". The authors must clarify this methodological approach.

3.3 Neural network training.
Page 7, lines 20 and 21:
It is not clear what the authors mean by "*It requires previous knowledge of the phenomenon in conjunction with the experience of the training team.*" I can only guess that they refer to the stage when atmospheric variables were assessed as predictors from a physical basis, but this needs to be clarified.

Page 7, lines 21 and 22:
"EMEs are characterized by thermodynamic atmospheric patterns represented by local meteorological recordings."
Not only EMEs are characterized by 'atmospheric patterns'. Any meteorological event, including non-EMEs, can be related to an atmospheric pattern. In addition, the characterization of atmospheric patterns, either in the synoptic scale or in the mesoscale, require a (non local) two-dimensional analysis of the meteorological variables. The authors do not explain how this is performed given that datasets they employ.

Page 8, lines 2 and 3:
"*The EME is defined as a nowcast corresponding to "yes=class three (RR > 9.9mm h^{-1})" or "no=class one, two, or three"*.
I think there is a mistake here. I think the authors meant to say "no = class zero, one, or two".

I am convinced that at the end of this subsection the reader will not feel well informed about how the neural network algorithm was trained.

3.4 Validation and other procedure steps.
I am not sure if the expression "*other procedure steps*" makes sense.

Major issue 6:
In this subsection the authors describe the method with which the neural network algorithm was validated. Three distinct data sources were used to verify the neural network´s automated forecasts, but the methodology is flawed.

The authors group a set of METAR observation codes (namely, R+, R+F, RW, RW+, T, TL, TRW-, TRW, TRW+; Table 2) into the same 'class 3' in which the hourly rainfall rate (as measured with rain gauges) is above 9.9 mm h^{-1}. However, what is the relation between any of those METAR observation codes with quantitative precipitation? Why should one consider the observation code R ('moderate rain' in the METAR code) to be representative of the same 'class 2' in which, according to the authors, the hourly rainfall rate is below 9.9 mm hr^{-1}? Continuous moderate stratiform rain can produce a rainfall amount reaching more than 10 mm within 1 hour, and an aerodrome observer could still report it correctly as moderate rain, receiving the METAR code R.

Even worse, while the observation code T alone means 'thunderstorm with no rain being reported', this observation is grouped in the same 'class 3' as rainfall rate above 9.9 mm hr^{-1} ("extreme precipitation event"). This is contradictory.

Moreover, the authors also added 'lightning reported inside a 50 km radius centered at Galeão Airport during a one-hour period' as representative of a 'class 3' event. Again, what is the relation between lightning occurrence and quantitative precipitation? How about lightning flash rates? The authors do not mention anything about flash rates. This suggests that, regardless of the number of lightning flashes occurring within the hour in a 50 km radius, the authors grouped the lightning event in the same 'class 3' even if the nearby thunderstorm is producing little rain (and, thus, not representing an "extreme precipitation event"). As a matter of fact, the authors do acknowledge this potential inconsistency further ahead in the text, in subsection 4.1.3.

In addition, the authors state that "*weather conditions reported in a METAR represent an observation by the meteorologist in an instant of time (ten minutes before the hour); therefore, sometimes it does not correctly represent an entire one-hour period, which is the minimum time interval for an SNM forecast*". This is not entirely correct. Meteorological observers in aerodromes do not have to wait until the top of the hour to report significant weather conditions (as thunderstorms, for example). A SPECI weather report, which follows the same METAR coding, is issued immediately whenever significant weather conditions occur at or around the airport. Therefore, the dataset used by the authors can be improved by including SPECI reports.

In summary, the methodology chosen by the authors to discriminate "extreme precipitation events" in the validation of the algorithm is not conceptually coherent with the idea of an extreme precipitation event, and has serious implications for the interpretation of the results.

Principal criteria	Excellent (1)	Good (2)	Fair (3)	Poor (4)
Scientific significance: Does the manuscript represent a substantial contribution to scientific progress within the scope of Atmospheric Measurement Techniques (substantial new concepts, ideas, methods, or data)?		x		
Scientific quality: Are the scientific approach and applied methods valid? Are the results discussed in an appropriate and balanced way (consideration of related work, including appropriate references)?				x
Presentation quality: Are the scientific results and conclusions presented in a clear, concise, and well-structured way (number and quality of figures/tables, appropriate use of English language)?				x