

Climatological Features of the Vento Norte Phenomenon in the Extreme South of Brazil

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Answer to Reviewer 2

General comments

This work studies the phenomenon known as “Vento Norte” by analysing 16 years of weather stations in Southern Brazil. The manuscript brings an interesting overview of this system and, also, some valuable characteristics that could help understanding and improving the prediction of such events. However, in my point of view, some aspects must be improved and better discussed as pointed out below. In addition, a careful English grammar revision must be done in the entire manuscript. I have pointed out some mistakes, but in some point of my reading I just gave up of pointing out English mistakes to suggest a review of the whole text. Therefore, I consider that the manuscript have potential to be published after considerations on what I just exposed.

We thank the Reviewer for the useful comments and suggestions that improved the interpretation of the obtained results and the clarity of the manuscript. In the following are detailed responses to specific comments. It was really improved the English in this new version of the paper with help of the co-authors. The modifications and new text insertions on the manuscript are presented in “Track changes” tool of “MS Word” and add line numbers.

Please, add line numbers when submitting a manuscript. I added to my version and for reference the title started at the 3rd line. For reference, L79 means line 79.

Specific comments

1. L79: “another” is not the correct word here. . . you may use “other human activities”.

In the new version of the manuscript, the sentence has been changed accordingly.

2. L81-82: Improve English.
 In the new version of the manuscript, the English has been improved and the sentence now reads: *“The city of Santa Maria (SM) is located in the center of the state of Rio Grande do Sul (RS) in the south of Brazil and is characterized by a particular topography. [...]”*

3. L86-88: Improve the use of pronoun “a”. Also, you may write “. . . strong northerly gusts”. L89: Drop the “the”.
 In the new version of the manuscript, the sentences have been rewritten as follows: *“[...]. Among the many significant weather patterns affecting this region, the occurrence of strong northerly gusts, accompanied by an abrupt increase in temperature and a drop in the relative humidity, is a common pattern known as “Vento Norte” [...]”*

4. L111-114: The two sentences here do not have verbs. Please, from what I read so far, the text must go through a careful English review before being ready for publication.
 The referee is right! We have rephrased that sentence that now reads: *“The geographical location of the meteorological data used in this study refers to South America, east of the Andes. [...]”*

5. L124-126: Improve English.
 In the new version of the manuscript, the English has been improved and the sentence now reads: *“[...]. Hourly meteorological data used in this study were obtained from INMET stations at 10 m above the ground for velocity and 2 m for temperature measurements during seventeen consecutive winters between 2004 and 2020 (from 21/06 to 21/09).”*

6. L159: “well above” – It enforces the need for a deep revision of English.
 We have rephrased that sentence that now reads: *“[...]. These strong gusts are accompanied by temperatures much higher than the climatological normal for winter, and such characteristics are commonly referred to as the VNOR phenomenon [...]”*

7. L169: It is not clear the second line of the 3rd criteria. Could you better explain that, please?
 We have rephrased that sentence that now reads: *“III. Surface air temperature: maximum air temperature with values above the 90% percentile (90P) for the respective time and month during at least half of the VNOR event;”*

8. L174: Here is the first time you relate VNOR with storm, before that you mentioned that VNOR is associated with strong winds and warm air advection... I suggest that you give some insights of this relationship of VNOR and storms in the introduction.

In the first version of the manuscript we mistakenly wrote “wind storm” instead of “windstorm”. Thank you for pointing this out. In our earlier studies we usually refer to VNOR as VNOR windstorm (see for example: [1, 2, 3]).

In the new version of the manuscript, we have referred to VNOR as VNOR windstorm:

- **Abstract:** “[...] .The VNOR *windstorm* episodes, identified by intense wind gusts and warm air advection from the northern direction [...].”

- **Introduction:** “Although the VNOR *windstorm* is a frequent phenomenon, widely known in southern Brazil [...].”

- **Introduction:** “This study aims to perform a temporal statistical analysis of hourly atmospheric observations in the city of SM, covering the winter period from 2004 to 2020, in order to obtain a local climatology of the VNOR *windstorm* phenomenon. [...]”

9. L190: What do you mean by “global approach”?

In this context, the “global approach” refers to a methodology proposed by Abatzoglou et al. 2021 [4] that identifies downslope winds globally. To avoid misinterpretation, the sentence has been changed as follows: “[...] *by analyzing local and regional atmospheric patterns (Stefanello et al. 2020; da Rosa et al. 2022) and identifying them globally by using reanalysis data (Abatzoglou et al. 2021). [...]*”.

10. L196: Could you discuss the high CPF in temperature anomalies (Fig 3A) from south and southeast?

A same pattern in the temperature is observed in Fig. 2 of Stefanello et al. (2020). However, in an analysis based on INMET meteorological data, we prefer not to draw conclusions that would be highly speculative. We intend to investigate this further in future work!

11. L196: I think you should improve the discussion of Figure 3.

Thanks for your comment. In the new version of the manuscript, the following sentences have been added. “[...] *The conditional probability function (CPF) is an effective method for providing information on the high percentile of atmospheric variables that can help identify unseasonable patterns, such as the VNOR windstorm.*” “[...] *Moreover, it can be seen that there are T_{max} and P_{max} anomalies in the southwest quadrant, but not in RH_{max} . It is important to note that this last variable is not included in the criteria for detecting VNOR (section 2.1). Still, it may help in identifying and characterizing the phenomenon since T_{max} , P_{max} , and*

RH_{max} have simultaneously significant anomalies in the northern quadrant.”

12. L196: Another thing to pay attention: when you mention “anomaly”, what is your reference? Climatology? The whole time series you are working? The specific winter of that particular case? Please, clarify this in the text.

Thanks for the question. In the new version of the manuscript we have specified and clarified these points by introducing the following paragraphs:

- **In section 2.1:** *“Heat wave episodes in southern Brazil are identified using the methodology proposed by dos Reis et al. (2019). Briefly, this methodology defines a heat wave as an interval of more than four days in which the daily maximum temperature is above the percentile (P90) of daily temperature anomalies. The authors determined the P90 for the 1981-2010 reference period.”*

- **In section 3.1:** *“[...]. Here, this downslope windstorm is studied using the anomaly of the main atmospheric variables for the winter months in the 2004-2020 reference period.”*

13. L215: This work would be more robust if you could relate this 120 cases with the synoptic pattern occurring during each case. Are there any preferable situation to occur VNOR? Could we predict it by looking for large scale patterns? You could do this by using reanalysis. Get this as a suggestion, at least, for future works on the subject.

This is a very good point, thank you! In the new version of the manuscript, the following sentence was added to the introduction: *“[...]. The large-scale synoptic environmental conditions responsible for the development of the VNOR flow can be associated with a cyclogenesis in the La Plata Basin and a high-pressure system near the coast of southern Brazil, as shown by Stefanello et al. 2020.”*

We intend to investigate in future work the large-scale synoptic environmental conditions associated to the VNOR cases deteted here.

14. Figure 3: To keep the same pattern, use lower or upper case for a/b/c in the figures and legend/text.

In the new version of the manuscript, the text of the figures has been changed accordingly.

15. Figure 4: English (ex. of wrong English construction: “about the winter years”)

The sentence has been modified as follows: “[...] B. Cases of VNOR observed in the seventeen consecutive winters from 2004 to 2020.[...]”

16. Figure 5: Please, use light color instead of “clear” in the legend/label.
Changed!

References

- [1] Cinara Ewerling da Rosa, Michel Stefanello, Douglas Stefanello Facco, Débora Regina Roberti, Fábio Diniz Rossi, Ernani de Lima Nascimento, and Gervásio Annes Degrazia. Regional-scale meteorological characteristics of the vento norte phenomenon observed in southern brazil. *Environmental Fluid Mechanics*, pages 1–19, 2022.
- [2] Cinara Ewerling da Rosa, Michel Stefanello, Ernani de Lima Nascimento, Fábio Diniz Rossi, Debora Regina Roberti, and Gervásio Annes Degrazia. Meteorological observations of the vento norte phenomenon in the central region of rio grande do sul. *Revista Brasileira de Meteorologia*, pages 1–10, 2021.
- [3] Michel Stefanello, Ernani de Lima Nascimento, Cinara Ewerling da Rosa, Gervasio Degrazia, Luca Mortarini, and Daniela Cava. A micrometeorological analysis of the vento norte phenomenon in southern brazil. *Boundary-Layer Meteorology*, pages 1–25, 2020.
- [4] John T Abatzoglou, Benjamin J Hatchett, Paul Fox-Hughes, Alexander Gershunov, and Nicholas J Nauslar. Global climatology of synoptically-forced downslope winds. *International Journal of Climatology*, 41(1):31–50, 2021.