Natural Hazards
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Sciences

Discussions

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Interactive comment on "Synoptic and Mesoscale atmospheric features associated with an extreme Snowstorm over the Central Andes in August 2013" *by* Marcelo Zamuriano et al.

Anonymous Referee #2

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General comments:

This paper presents an analysis of a snowstorm event that occurred over the central Andes. The aims are to characterise the synoptic evolution and mesoscale processes leading to the event as well as to determine the specific roles of the orographic features and lake Titicaca. ERA-Interim reanalysis data and observations are used for the synoptic analysis whereas WRF model simulations including sensitivity studies are used to analyse the mesoscale features and the roles of the orography and lake. The authors have synthesised an impressive collection of reanalysis data, model output and observational data. This synthesis yields a two-stage mechanism for the synoptic evolution

and information on the factors controlling the mesoscale details of the snowfall regions. The topic appears suitable for NHESS. However, the paper requires fairly substantial polishing before it will be ready for publication. The text is perfectly understandable, but has many small English language errors (some, but not all of which, I've indicated below). Some of the figures also need correcting/improving. In several places I struggled to relate the figures to the associated interpretation in the text. Finally, the novelty of the work, its implications, and its relationship to other studies needs to be made clearer. I was left wondering how much the findings could be generalised to other mountain ranges and cases or were unique to this specific event.

Major specific comments:

p6, L7: Here you infer cloud formation and cover from plots of water vapour imagery brightness temperature. I think you need to translate for the reader - i.e. cold brightness temperatures imply high cloud tops. I am also struggling to relate your text to the figures: e.g., you say that on the 22nd there is cloud formation over northern Bolivia but the brightness temperature is relatively warm there. Why do you not instead show the visible image at a suitable time as you do for the analogue case in fig. 5c? Also, why do you not use the same colour scale as in fig. 9d and h which is also GOES-13 data?

p6, L11: Similarly, here you discuss the total water column displacement and a quasi-stationary cold front relating to Fig 2. But, what you show in fig. 2 is θ_e, winds and precipitable water. Please help the reader by relating the features you discuss in the text to the fields plotted and also avoid changing terminology e.g. between total column water to precipitable water.

p6, L20: Here you say that the position of the cold front is characterised by high sea level pressure – yes I can see that there are mean sea level pressure contours that align with the Andes but I'm afraid that I can't work out where the cold fronts

are from them and as the projection of this plot (and days shown) differ from that used in fig. 2 it's hard to work out exactly where the cold fronts are. Perhaps you could mark them on the plots?

p6, L21: What exactly do you mean by "in phase with Rossby wave trains"? The PV structure on the 15th looks very different to that on the 23rd but your text implies that they are similar. Also it is the -2 PVU contour which marks the wave train rather than air with PV less than -2PVU (which instead indicates stratospheric air). Also change "portrayed by PVU lower than -2 units" to "portrayed by the -2 PVU surface".

Section 3.1.1: You show several plots of model fields in this section but don't state in the captions where the data is from; presumably it is from ERA-Interim reanalysis. Please be clearer about which plots use ERA-I and which your WRF model runs.

Conclusions: At the end of the discussion and conclusions sections I'm still unclear as to the novel results that have come out of your study. Yes, you have addressed the goals laid out in your introduction (to study this event at both the synoptic and mesoscales and to assess the importance of the orography height and lake). However, it's not clear the extent to which this synoptic evolution and the more local impacts of lakes and the orographic height were already known. Please can you more clearly state the novel contributions of your study.

Minor specific comments:

Abstract: The abstract describes the work completed and findings well. However, I'm left wondering about the implications of the work - could the authors add a final sentence that answers the "so what" question?

General: The text is often written as lots of short paragraphs rather than being grouped together into longer paragraphs on a specific top (see especially the introduction

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which consists of 9 paragraphs, mostly 2 or 3 sentences long each). I appreciate that this is perhaps the writing style of the authors, but it comes across as note like rather than final text. The text would be easier to read if written as fewer, longer paragraphs.

p5, L13: Change "resolution" to "grid spacing" — the scale of features that a model can resolve is several times (often taken as at least 6 times) the grid spacing.

p28, table 1: This table doesn't seem to add anything to the details given in the text in section 2.2.2 and could be omitted.

Figure 1: It would help readers for the countries and regions mentioned in the text to be labelled on one of the maps, perhaps best on Fig. 1a.

Figure 2: Is the dashed line indicating where the weak winds are masked? This line encompasses the Andes so is it actually where the winds are weak or instead where the 850 hPa surface is below the ground surface? Also note that the acronym PW isn't defined anywhere.

Fig 4e and f: The symbols and text on these panels are very small and I had to zoom in on the pdf to be able to work out which set of joined symbols corresponded to which date - can you make this clearer please? Also, presumably the larger square and circle refer to some start date with the subsequent symbols 6 hours apart until an end date. Please explain this more clearly in the caption.

Figure 6: The labelling on these figure panels is useful but it's quite hard to read black text on a grey background (and the text is also quite small in places) Also, panels a and d have "July" written on them whereas the caption says that they are for August.

Section 3.2.1.: Here you discuss results from your control WRF run but this discussion would probably be better included in the following section (3.3) where you discuss

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other results from your WRF control run.

Figure 7 e-h: The y-axis label is wrong as the hours are not UTC (the numbers exceed 24). However, for comparison with the text it would be more useful to have the numbers in UTC. Also, I'm confused by the labelling of night and day on these panels. The caption says that the first red dashed line is 0 UTC on the 23rd and so the space between the 1st and 2nd red dashed line covers 0-12 UTC on the 23rd which according to the text (p7, L31) should be night time, but it is labelled as day. Presumably instead the top of the y-axis is at 0 UTC?

Figure 8: In the text (start of section 3.3.1) it says that the 850 hPa θ_e gradient is used to indicate the front location which is fine. However, the plot instead shows a single isentrope of θ_e. A small section of this isentrope is then "highlighted by a blue dashed ellipse" to indicate the front position. I'm afraid that I don't understand how the position of the front can be determined from this small contour section. Nor do I understand how a small highlighted region indicates the location of a large-scale, generally linear feature such as a front.

Figure 9: The font size used for the numbers on the colour bars in this figure particularly are tiny. Please can the text be enlarged. I encourage the authors to look again at the font size used in all of their plots as there are other places too where the font size (particularly on labels) is too small to be easily read in a printed version of the paper. Also, what is the blue shading (particularly over the ocean) and underlying grey shading on panels a-c and e-g? Do they indicate water and topography, respectively? Please label Titicaca lake and La Paz city on one of the plots as these locations are mentioned in the corresponding text.

p8, L25: Here it says that the convergence zone over the western Cordillera appears to propagate eastwards during the night. From Fig. 9 though it appears more that the convergence simply weakens during the night.

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p8, last two paragraphs: The description of "night" in these paragraphs is somewhat inconsistent with the earlier definition of local day as being 12-0 UTC and night 0-12 UTC. The corresponding figure panels from which the nighttime evolution is described are at 18, 0, and 6 UTC. Would it be better to show them at 0, 6, and 12 UTC?

Figure 11: Please label the axes.

p6, L16: Here it says that "the lake doesn't seem to exert a significant impact on atmospheric instability". However, Fig, 11d-f shows that θ_e decreases in height immediately above the lake, particularly on the 23 Aug. Hence this air is potentially unstable.

p10, L11: Please mark CP also on one of the maps in figure 12.

p11, L5: The phrase "high-level PV fields propagated downwards from a trough axis" doesn't make sense. I think you mean that air with high PV values propagated downwards, but I'm also not sure that "propagating" is an appropriate term here.

p11, L9: The phrase "The relationship PV streamers/cold surges were . . . " is missing a word. Do you mean "The relationship between PV streamers and cold surges were . . . "?

Technical errors:

Note that not all of the small English language errors are included here.

Abstract and elsewhere: Usually adjectives should be hyphenated before a noun e.g. "large-scale analyses", "low-level blocking". This seems to have been done a bit randomly in the abstract at least (i.e. sometimes the adjectives are hyphenated and other times they are not).

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Abstract and p3, L9: Change "2013's" to "2013".

p2, first line: change semicolon to a comma.

p2, L13: change "circulation" to "circulations".

p2, L18: remove comma after gap.

p2, L29: change "emergency state" to "state of emergency".

p3, L8: change "introdude" to "introduce".

p3, L10 and 11: change "contain" to "contains", "summarize" to "summarizes", and "include" to "includes".

p3, L15: Change to "For this study about heavy snowfall over complex orography we used the following datasets".

p3, L17: Add space after "Andes".

p3, L29: Remove brackets around "SENAMHI".

p4, L4: Change "conditions" to "condition".

p4, L8: Change to "for a spatial assessment of cloud cover".

p4, L10: Change "asses" to "assess".

p4, L12: Change to "from the surface".

p4, L:23 Add space after "processes".

p5, L15: Change "runs" to "run".

p5, L22: Spelling "lengths".

p5, L28: Remove "it".

p5, L29: Replace "are described" by "is".

p6, L15: Change "correspond" to "corresponds".

p6, L26: Change "by" to "on".

p7, L26: Change to "we remind the reader that".

p8, L28: Change "this" to "these".

p9, L5: Change "shows" to "show".

p9, L7: Change "origination" to "originating".

p9, L9: Change "follows" to "follow.

p9, L20: Change "shows" to "show".

p10, L5: Remove full stop after "24".

p10, L7: Change "restrict" to "restricts".

p10, L15: Change "shows" to "show".

p10, L16: Change "than" to "to".

p11, L13: Add "the" after "for".

p11, L23: Change "them" to "it".

p11, L26: Change "suggest" to "suggests".

p11, L28: Change "confirm" to "confirms".

p11, L29: Change "shifted" to "shifting".

p12, L3: The punctuation in this paragraph and the following is confused. For example a list following a colon needs to be separated by commas or semicolons.

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