

## ***Interactive comment on “Climatology of Vb-cyclones, physical mechanisms and their impact on extreme precipitation over Central Europe” by M. Messmer et al.***

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Review of manuscript for Earth System Dynamics

Title: Climatology of Vb-cyclones, physical mechanisms and their impact on extreme precipitation over Central Europe

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Recommendation: Minor revisions needed

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### General Comments:

The authors identify Vb cyclones based on ERA-Interim data using a cyclone tracking algorithm and analyse their role on the occurrence of heavy precipitation events in the Alpine region. Although Vb cyclones are rare events, they often lead to floods over Central Europe/Alpine region. The study is pertinent and well-motivated, and fits nicely within the scope of ESD. The results presented are very interesting and some insights are new and/or have not been discussed before in detail. However, several aspects of the study are not well explained or needed to be revised before the publication. The comments below should help the authors revise the manuscript and re-submit the paper to ESD.

### Main Comments:

A: In my opinion it is very important to state clearly that Vb cyclones often trigger heavy precipitation on the NORTHERN SIDE of the Alpine range (and Central Europe). In order to have a heavy precipitation event on the southern Alpine range, Vb cyclones are not needed, a deep upper-level trough over the Western Mediterranean and Genova cyclogenesis is “sufficient” (e.g., Martius et al., 2006; Winschall et al., 2012; Pinto et al., 2013). In particular, the primary importance of Vb-cyclones for the northern side of the Alps is not clearly stated in the abstract (page 908, line 3), and it should be (it is mentioned later in the paper though, page 922). A related issue has to do with the sentence on page 908, line 11, where it is stated that “only 23% of all Vb events are associated with extreme precipitation (in the Alps)”. A Vb cyclone may cause heavy precipitation elsewhere (e.g. Eastern Germany) and comparatively less over the Alps (e.g. 2002 Elbe flood, Ulbrich et al., 2003), and so the statement could be misleading. Please enhance.

B: The methodology connecting Vb cyclones with precipitation in the Alpine region is currently placed in section 3.2. A clear separation between the methodology and the results would be helpful in my opinion.

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C: On page 916, line 1-2 the use of spherical cap ( $23^\circ$ ) is not well explained. For example, are the cyclones “rotated” for compositing (e.g. Catto et al., 2010)? On page 918, line 6-11 it is difficult to follow the reasoning about the flexible radius lengths. Since the radius is not always the same the figures it gets a bit confusing. Please state clearly which radius length is shown on each figure (Fig 6, 9, 10, 11).

D: It is stated in the text that Vb cyclones have a peak occurrence during spring especially in April. Why is this month is not used in the extended summer statistics? On Figure 4 the two PDFs are very similar (or the same?). Instead of using extended summer and winter I would suggest making one figure using the PDF concerning the whole year, and denote the accumulated precipitation of Vb cyclones for all four seasons with different colours (e.g. DJF blue, MAM green, etc). Please enhance and adapt text.

Minor Comments:

#1 Page 909, line 1: I would suggest using a more general reference(s) here, maybe Kron et al. (2012) and Held et al. (2013).

#2: Page 909, lines 5-6: Please rephrase, maybe something like “(…) is associated with the occurrence of Vb cyclones”

#3: Page 910: it is interesting to note that the authors do not discuss the May/June 2013 event. I am aware that the associated cyclones were not typical Vb-systems (e.g. Grams et al., 2014), but it would still be worth discussing this here. See also major point A.

#4: Page 910, line 23: I am not sure if 100% of the Vb cyclones have their genesis in the Genova Gulf, some may for example start earlier. I would prefer to state “main origin area” here.

#5: Page 911, line 4: I would also add Giorgi (2006) here.

#6: Page 911, line 20-23: See also Zappa et al. (2014).

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#7: Page 913, line 24-26: As the authors are surely aware of, this is not always true for Mediterranean cyclones (see results of the IMILAST project that the authors have access to). Please be more specific.

#8: Page 914, lines 1-11: Just for interest, was there a reason why local minima of 850 hPa geopotential height were preferred to 850 hPa relative vorticity as the key variable?

#9: page 914, line 12-27: the filtering of the field and the testing of different geopotential fields could be mentioned earlier, i.e., before the exact chosen method is introduced (around line 3). The lifetime criteria (line 9) would be more logical to appear after the description of the tracking method.

#10: Page 915, line 1: please write “(or not pass)”.

#11: Page 915, line 5: how often happens that a cyclone directly cross the Alps? Is the restrictive box really necessary?

#12: Page 916, line 9: I would suggest changing “over Europe” to “over the Mediterranean and Europe”.

#13: Page 916, line 17: the notation “15%(14%)” is not clear at first. It would be better if “ERA Interim (E-OBS)” would be mentioned earlier in the sentence. The same applies to the sentence on page 918, line 26-29.

#14: Page 917, lines 12-15 and Fig. 3: the HPEs and WPEs are not yet introduced at this stage. Please indicate you are only discussing the upper panel of Fig. 3.

#15: Page 917, line 21: it is stated “the mature state of the Vb-cyclones is not bound to any box.”, but on Fig.2 an End box is defined. Please explain

#16: Page 917, line 25: Please rephrase, awkward start.

#17: Page 920, lines 2-14: see major comment A, a Vb cyclone may lead to a lot of precipitation further north over Central Europe but have limited impact over the Alps.

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#18: page 920, line 15-21: it is not described how the connection of MED and ATL moisture fluxes to Vb cyclones are defined.

#19: Page 920, lines 25-28: What about the possible role of Eastern Europe (e.g. Grams et al., 2014)?

#20: page 920, line 28 there is a typo, LPEs instead of WPEs.

#21: Page 921, lines 4-5: Please weaken this statement.

#22: Page 921, line 20: It sounds strange to speak about a “weak depression (at upper levels)”. Actually, it is the trough at 300 hPa that is weaker (or maybe a cut-off). Please rephrase.

#23: Page 922, line 3: Fig. 6 and Fig. 11 are very similar, the moisture flux and the wind field at 850 hPa have a very similar pattern. Does it necessary to include both figures? I would suggest removing Fig. 11.

#24: Page 922, line 21: the authors refer to the southern side of the Alps, although the composite figures do not have the geographical references. How does one determine if the precipitation has fallen on the southern side of the Alps?

#25: Page 923, lines 10-22: Difficult to follow, please rephrase.

# 26: Page 924, lines 1-14: interesting discussion, please enhance / be more explicit. For example, where is the exact position of the “cut-off”?

#27 Page 924, line 20-25: the results from Zappa et al. (2013) could mentioned here.

#28: Page 924, line 27: Please add “towards Europe” at the end of the sentence.

#29: Page 925, line 2: “confirms” sounds like a very strong statement, please weaken, maybe “point in the same direction”, or “are in line with”?

#30: Page 925, line 11-12: “(..) in the Alpine region, where (..)”

#31; Page 925, line 18: I would suggest referring to the CORDEX initiative here (e.g.

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Jacob et al., 2014).

#### Suggested References

Catto, J., et al. (2010) Can climate models capture the structure of extratropical cyclones? *J. Climate*, 23, 1621–1635. doi: 10.1175/2009JCLI3318.1

Giorgi, F. (2006), Climate change hot-spots, *Geophys. Res. Lett.*, 33, L08707, doi:10.1029/2006GL025734.

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Kron W, et al. (2012) How to deal properly with a natural catastrophe database analysis of flood losses. *Nat Hazards Earth Syst Sci* 12:535–550. doi:10.5194/nhess-12-535-2012

Martius, O., et al., (2006), Episodes of Alpine heavy precipitation with an overlying elongated stratospheric intrusion: A climatology, *Int. J. Climatol.*, 26, 1149–1164. DOI: 10.1002/joc.1295

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26, 5846-5862. doi: 10.1175/JCLI-D-12-00573.1

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Winschall, A., et al. (2012) Impact of North Atlantic evaporation hot spots on southern Alpine heavy precipitation events, *Q. J. Roy. Meteorol. Soc.*, 138, 1245–1258. doi: 10.1002/qj.987

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