We would like to thank the Anonymous Referee #2 for her/his comments and suggestions, which helped us to better focus the paper and improve its overall structure and readability.

Please notice that the referee's comments below are in blue, while authors' replies are in black. At the end of the document we also provide a table summarizing the changes we propose to make to the paper structure.

Anonymous Referee #2

(A) General comments:

The paper deals with a case study about a subject that has extensively been studied earlier (as can be seen in the references) and largely confirms the results of earlier studies. The major critique is due to the lack of new research goals or new findings, that would be expected from a case study like this. Such a goal / finding are suggested in the abstract (19123, line 7 ff, air quality forecasts, comparison with high resolution modeling) but their discussion is missing throughout the rest of the paper. Furthermore the structure of the paper (especially section 5 – discussion of results) must be advanced. It is suggested to reorganize the paper substantially and to perform a major revision.

Reply. We clarified in the revised manuscript the differences between the different papers dealing with the Ora del Garda wind, by focusing the new literature review on this wind and highlighting the peculiarities of each of the works, included the present one. In particular, we critically compared the contents of Laiti et al. (2013b) and of the present work (see reply to Comment 1 by Anonymous Referee #1 at pag. 2-3). Thanks to the availability of two flights performed on the same day and to a greater number of surface observations, the present paper focuses on the lake-breeze front propagation in the shore area and on the gap flow occurring at the junction between the Lakes and the Adige valleys. The study of air quality conditions and the comparison with numerical simulations are not cited in the abstract as research goals, but as envisaged applications and future research directions, as recommended by ACP guidelines (see also the reply to Comment 2 by Anonymous Referee #1 at pag. 3 and the reply to the next Comment below). Such applications are of course

beyond the outreach of the present paper, but are expected to benefit from the results presented in it. This view has been better clarified in the new abstract and in the new "Introduction" section.

(B) Specific comments:

1. Abstract is rather extensive and to some extent contains a lot of detail. Specific research goals or specific findings are not or only very briefly formulated. There is no discussion of the last paragraph in the abstract throughout the paper. Accordingly this section should go to some other section (most likely to the conclusions).

Reply. We shortened the abstract and reformulated the specific research goals. As to the last paragraph, a brief overview of research applications and future developments was explicitly required by ACP author guidelines[1], but we are available to delete it if the Editor agrees (see also the reply to Comment 2 by Anonymous Referee #1, pag. 3). In the "Conclusions" section these issues are discussed in more detail at page 19148, lines 8-23.

2. Introduction is extensive and mainly composed by a review of literature and a discussion of earlier results. Only a very small section is focusing on the specific paper (19125, line 17-24) and how it is organized (last paragraph of introduction). Additionally, the specific goals of the research work (and this paper) should be well formulated in this section. Also section 2 (about the Ora del Garda wind) could be incorporated into the introduction as it contains a literature review again and it is dealing generally with this type of Alpine valley wind. Another suggestion is to combine it with section 3.3 (Weather Conditions) as it is truly a typical wind system that is only active during these specific weather conditions. Section 3.3 could as well go to Section 5. Results when dealing with the synoptic situation during the measurement campaign.

Reply. We shortened the "Introduction" by referring to the literature review in Laiti et al. (2013b). We kept only the literature more directly connected with the Ora del Garda wind, and merged old sections 1 ("Introduction") and 2 ("The Ora del Garda wind") into a new

[1] Source: http://www.atmospheric-chemistry-and-physics.net/submission/manuscript_preparation.html

"Introduction" section. The formulation of the specific goals of the paper was improved and moved to the end of the new "Introduction", immediately before the description of the paper structure. The "Weather Conditions" section was moved to the beginning of the new "Results" section, as suggested. See also the replies to Comments 4 (pag. 4-5) and 7 (pag. 6) by Anonymous Referee #1.

3. Section 4 is shortly explaining the post-processing techniques, that are already described in the earlier papers (Laiti 2013a and Laiti 2013b). They should either be expanded in a full explanation (especially the RK method) or be shortened to the essence of the reference (Laiti 2013b).

Reply. Following the referee's suggestion, we decided to shorten the description of the methods used in the data analysis by citing Laiti et al. (2013a, 2013b). See also the reply to Comment 8 at pag. at 7 by Anonymous Referee #1.

4. Structure of Section 5: Results and Discussion should be separated and the subdivision into diurnal cycle (5.1), dominant (5.2) and fine scale (5.3) structure is not ideal. It is irritating to jump up and down the valley. In the current state a lot of the observed phenomena are explained repeatedly a couple of times in a different context. I'd rather suggest to show the results for each of the areas together (Lower Sarca, Lakes, Adige ...). Thus it might be easier to coherently explain the observed development status of the Ora del Garda propagation and the specific structures of ABL and at specific locations. Additionally, there is an extensive amount of detail explained in all the section 5, that are shown in the figures. This makes the text heavy to read. I suggest to concentrate on the important features at each location, making the text more fluent. The Discussion could be another Section.

Reply. We followed the referee's suggestion, splitting the old "Discussion of results" section into separate "Results" and "Discussion" sections. We also reorganized the new sections according to geographic sub-regions, as suggested by the referee. Accordingly, results and explanations now follow the spatial development of the Ora del Garda wind, from the coastal area to the junction of the Lakes and Adige valleys. At the same time, we reduced the amount

of detail in order to make the text more easily readable. See also the reply to Comment 7 at pag. 6 by Anonymous Referee #1.

5. Section 6, Conclusions, is extensive as well and contains to a large amount of information already found in the Abstract and Introduction. The last 2 paragraphs (especially the very last one) could be extended and improved, the first paragraph could serve as a starting point for the section Discussion.

Reply. We shortened the “Conclusions” section as suggested by the referee, removing the information already mentioned in the abstract and “Introduction” and maintaining only a very brief recap. The first paragraph was used at the beginning of the new “Discussion” section, while the last two paragraphs were further developed and used as a basis for the new “Conclusions” section, which also includes a brief comparison to previous literature (e.g. Laiti et al. 2013b). See also the reply to Comment 3 at pag. 3 by Anonymous Referee #1.

C) Minor and technical comments

1. Sentences are frequently long and convoluted. This makes a fluent reading hard.

Reply. We worked at making the text more readable by simplifying the structure of the longest sentences.

2. Section 1, page 19124, line 16: explain “thermotopographycally driven”

Reply. We substituted the expression “thermotopographically driven” with “thermally-driven”.

3. Section 1, page 19124, line 22. further (farther)

Reply. We substituted “farther inland” with “further inland”.

4. Section 2, page 19127, lines 24 ff: what is the importance of the small lakes. Btw. They are mentioned later again, but there is no discussion of their influence or importance to the paper.

Reply. We mentioned the small lakes as an essentially geographic information characterizing the target area. Unfortunately, their effect on the local microclimatic conditions cannot be analyzed in detail with a quantitative approach on the sole basis of the data forming the present dataset. Their effects on local circulation and local ABL processes will be explored on the basis of future numerical simulations of the flight days. Based on the above reasoning, we decided to eliminate the parts dealing with the small lakes, leaving it as an open research question in the "Conclusions". See also the reply to Comment 5 by Anonymous Referee #1 at pag. 5.

5. Section 2, page 19128, line 6: the formation of potentially colder air is not explained here.

Reply. In the revised text we added a sentence explicitly explaining the origin of the potentially colder air wedge. It is formed by the air advected by the Ora del Garda across the Terlago gap into the Adige Valley. This air is potentially colder than the Adige Valley air for it comes from above Lake Garda surface.

6. Section 3.2. page 19139, line 7: too much detail about stations

Reply. We guess the referee was referring to pag. 19130. We reduced this part by referring to Table 2 and Figure 2 for position and technical specifications of the surface stations.

7. Section 3.2. page 19139, line 19: rephrase to something like: . . . the station at Roncafort was equipped with an ultrasonic anemometer . . . + why Roncafort and not RON

Reply. RON and Roncafort are two nearby but different stations (cf. de Franceschi et al., 2002). For the sake of clarity, we decided to change their names: RON became RON1 (routine station) and Roncafort was renamed RON2 (intensive measurement site). Therefore, we modified the sentence recalled by the reviewer as follows: "An ultrasonic anemometer was installed at RON2 site". We accordingly changed the names of the two stations throughout the revised text.

8. Section 4. page 19131 ff. Methods for pseudo-soundings and RK are explained, but not for eddy-correlation technique. This seems inconsistent.

Reply. We reduced the "Methods" section to brief explanations at the end of paragraphs forming the "Experimental dataset" section. We did not describe any method in detail, but used adequate literature references (e.g. Laiti et al., 2013a for RK). We did the same for the eddy correlation technique used for the analysis of the ultrasonic anemometer data. See also the reply to Comment 8 by Anonymous Referee #1 at pag. 7.

9. Section 5.1, page 19133, line 19. The discussion of the phenomena seen from data . . ..

Reply. We changed the text as suggested by the reviewer.

10. Section 5.1.1, page 19134, line 11: "high resolution" (higher resolution is misleading)

Reply. We changed the text as suggested by the reviewer.

11. Section 5.1.1., page 19134, line 24: what is "standard"? In the Sarca valley the standard diurnal cycle associated with fair weather is characterized by Ora.

Reply. We modified the text, explaining in an explicit way that we refer to the diurnal cycle usually observed in mountain valleys where relatively large lakes are not present, i.e. "standard" stands for "without lake effect". We used fig. 9 from Giovannini et al. (2013) as a reference. See also Comment 13 by Anonymous Referee #1 at pag. 20-21.

12. Section 5.2.1, page 19138, line 18: can the subsidence be seen somewhere from data or is it a possible explanation?

Reply. The vertical structures of the ABL observed are compatible with the expected subsidence on the basis of the works by Kuwagata and Kimura (1995, 1997), Rampanelli et al. (2004), Serafin and Zardi (2010a, 2010b, 2011), as we speculate in the paper. Unfortunately, the lack of measurements of vertical wind velocity does not allow any

conclusive evidence of that. This will be a goal of future investigations from numerical simulations.

We modified the text as follows:

"*This might be an effect of the local* subsidence that is *known to be* induced *at the valley center* by cross-valley compensation circulations (*see* Kuwagata and Kimura, 1995, 1997; Rampanelli et al., 2004; Serafin and Zardi, 2010a, 2010b, 2011)."

13. Section 6, page 19145, line 22: explain "typical textbook pattern"

Reply. In the revised text we substituted this expression with "typical temperature daily cycle without any lake-effect". We also explained better that the "typical" pattern includes a fast morning heating phase after sunrise, a peak in the mid-afternoon and a slow temperature decay extending from the afternoon to the early morning. On the contrary, the typical cycle for the Ora del Garda shows a heating phase interruption due to the arrival of colder air. See also the reply to Comment 11 above.

14. Figure 1, add a symbol for Udine

Reply. We removed the reference to UDN sounding in the text.

15. Figure 6: Dashed lines are not distinguishable, grey might be hard to recognize.

Reply. We changed the colors of the profiles displayed in Figs. 5 and 6, in order to improve the readability of the two plots.

References

de Franceschi, M., Rampanelli, G. and Zardi, D.: Further investigations of the Ora del Garda valley wind. Preprints, 10th Conference on Mountain Meteorology and MAP Meeting 2002, Park City, UT, 2002.

Giovannini, L., Zardi, D., de Franceschi, M., and Chen, F.: Numerical simulations of boundary-layer processes and urban-induced alterations in an Alpine valley, Int. J. Climatol., doi: 10.1002/joc.3750, 2013.

Kuwagata, T. and Kimura, F.: Daytime boundary layer evolution in a deep valley. Part I: Observations in the Ina Valley, J. Appl. Meteorol., 34, 1082-1091, 1995.

Kuwagata, T. and Kimura, F.: Daytime boundary layer evolution in a deep valley. Part II: Numerical simulation of the cross-valley circulation, J. Appl. Meteorol., 36, 883-895, 1997.

Laiti, L., Zardi, D., de Franceschi, M., and Rampanelli, G.: Residual Kriging analysis of airborne measurements: application to the mapping of atmospheric boundary-layer thermal structures in a mountain valley, Atmos. Sci. Lett., 14, 79-85, 2013a.

Laiti, L., Zardi, D., de Franceschi, M., and Rampanelli, G.: Atmospheric boundary-layer structures associated with the Ora del Garda wind in the Alps as revealed from airborne and surface measurements, Atmos. Res., 132-133, 473-489, 2013b.

Rampanelli, G., Zardi, D. and Rotunno, R.: Mechanisms of up-valley winds, J. Atmos. Sci., 61, 3097-3111, 2004.

Serafin, S. and Zardi, D.: Structure of the atmospheric boundary layer in the vicinity of a developing up-slope flow system: A numerical model study, J. Atmos. Sci., 67, 1171-1185, 2010a.

Serafin, S. and Zardi, D.: Daytime heat transfer processes related to slope flows and turbulent convection in an idealized mountain valley, J. Atmos. Sci., 67, 3739-3756, 2010b.

Serafin, S. and Zardi, D.: Daytime development of the Boundary Layer over a plain and in a valley under fair weather conditions: a comparison by means of idealized numerical simulations, J. Atmos. Sci., 68, 2128-2141, 2011.

Structure of the paper

OLD STRUCTURE	*NEW STRUCTURE*	*NOTES*
1 Introduction	**1 Introduction**	• Literature review reduction using Laiti et al. (2013a, 2013b) references • (Brief) literature review on breeze fronts and gap winds / hydraulic jumps • Summary of key results from Laiti et al. (2013b) • Formulation of SMART goals and motivations
2 The Ora del Garda wind		
3 The experimental dataset	**2 The experimental dataset**	
3.1 Measurement flights	2.1 Measurement flights	• Airborne data analysis method: Laiti et al. (2013a)
3.2 Surface observations	2.2 Surface observations	• References for eddy correlation technique
3.3 Weather conditions	3.1 Weather conditions	• was moved to new Results section
4 Methods	Removed	
4.1 Extraction of pseudo-soundings from airborne data		
4.2 Residual kriging mapping of airborne data		

<table>
<tr><td>5 Discussion of results</td><td>3 Results</td><td>• “Weather conditions” was added</td></tr>
<tr><td>5.1 OdG diurnal cycle at surface</td><td rowspan="3">3.2 Lower Sarca Valley</td><td rowspan="2">Formed by parts of old:
• 5.1.1
• 5.2.1
• 5.3.1</td></tr>
<tr><td>5.1.1 Lower Sarca Valley</td></tr>
<tr><td>5.1.2 Lakes Valley</td></tr>
<tr><td>5.1.3 Adige Valley – south of Trento</td><td rowspan="3">3.3 Lakes Valley</td><td rowspan="3">Formed by parts of old:
• 5.1.2
• 5.2.1
• 5.3.2</td></tr>
<tr><td>5.1.4 Adige Valley – north of Trento</td></tr>
<tr><td>5.2 Dominant vertical structure of ABL</td></tr>
<tr><td>5.2.1 Lower Sarca and Lakes Valley</td><td rowspan="5">3.4 Adige Valley</td><td rowspan="5">Formed by parts of old:
• 5.1.3 and 5.1.4
• 5.2.2
• 5.3.3</td></tr>
<tr><td>5.2.2 Interaction area</td></tr>
<tr><td>5.3 Fine-scale 3-D structure of the ABL</td></tr>
<tr><td>5.3.1 Lower Sarca Valley – Spiral A1</td></tr>
<tr><td>5.3.2 Lakes Valley – Spirals B1 and C1</td></tr>
<tr><td>5.3.3 Interaction area – Spirals D2 E2</td><td></td><td></td></tr>
<tr><td rowspan="2">6 Conclusions</td><td>4 Discussion</td><td>• Formed by parts of old sec. 5-6
• Critical comparison with results from Laiti et al. (2013b)</td></tr>
<tr><td>5 Conclusions</td><td>• More concise than old Conclusions section</td></tr>
</table>