Reply to Reviewer 2

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1 General Comments

This paper deals with the statistical and dynamical characteristics of an interesting diurnal mesoscale phenomenon (namely the foehn that sometimes is mentioned even in the non-specialist literature of the area). This paper is well written and the mesoscale analysis, including a detailed description of the different stages of the phenomenon, is rather convincing. Therefore, I consider this paper as worth of publication in Atmospheric Chemistry and Physics, but with a minor revision, taking into account my comments below

Thank you for the very insightful review. Your comments helped to improve the paper. Responses to individual comments are provided below. Reviewer's comments are in italic.

2 Specific Comments

C1 - Page 5, section 2.5: this section should be converted into an appendix (of course keeping here only the definition of symbols used below), because it contains just a summary of the reduced-gravity theory of shallow flow over obstacles (to be referenced below in paper), with no original aspects.
A) Thank you very much for your comment. You are right, this is just a summary of the reduced-gravity theory of shallow flow. However, we think that this explanation is helpful for the reader to fully understand the paper, as this theory is applied to explain the observed phenomena. We think that moving part of the section to the appendix, but keeping the symbols and definitions here, does not increase the readability of the paper.

C2 - Page 6, from line 6 to line 10: the Jerusalem temperature is used as representative of T at the "crest". However, Jerusalem is located at about 50 km north of the cross-section of Fig. 1. Moreover, in the same sentence a "downstream station" is mentioned with no additional specification. Below, the Masada station is probably identified as such downstream station. The entire paragraph is rather involved and needs better explanation/phrasing.
A) Thank you for this comment. We rephrased the paragraph to make clear which downstream stations are used. Regarding your concern about the distance of Jerusalem to the stations, we agree that we make the assumption that the conditions at the crest just above Ein Gedi are the sames as in Jerusalem. However, we think that the temperatures in Jerusalem are also representative for the crest 50km south, as the larger scale conditions are the same and landscape/vegetation are similar.
T) The wind regimes are identified using the ~~temperature difference~~ potential temperature difference ($\Delta\Theta$) between the crest (Jerusalem, 810 m amsl~~) and a downstream station~~, Fig. 1 a) and two downstream stations, one at the slope (Masada, -7 m amsl, Fig. 1 a) and one in the valley (Ein Gedi Beach, -427 m amsl, Fig. 1 a), as well as the wind speed at the respective downstream station. The only parameter which has to be set prior to the fully automatic classification is the wind direction sector indicating "downslope". ~~Probabilities that a downslope flow is density-driven were calculated for two stations, one at the slope (Masada, -7 m amsl, downslope sector~~ For Masada, this is 200-315° ~~) and one in the valley (~~and for Ein Gedi Beach ~~, -427 m amsl, downslope sector~~ 220-320~~degrees) (Fig. 1 a).~~°.

C3 - Page 6, line 13: please specify the temperature differences (T crest minus T valley?).
A) The potential temperature difference was specified in the text. It's $\Delta\Theta = \Theta_{crest} - \Theta_{valley}$
T) . This leads to a stable stratification and therefore to a positive potential temperature difference between the

crest and the valley ($\Delta\Theta = \Theta_{crest} - \Theta_{valley} > 0$).

C4 - Page 6, lines 13-15: this sentence is unclear. Most probably, "were" should be "where", but even with this correction, still the sentence needs to be improved a little.

A) The sentence was rephrased

T) This coincides with literature values ~~were maximum wind velocities are around~~ of 1-5 m s^{-1} for the maximum wind velocities of radiative driven downslope flows (Whiteman, 2000; Zardi and Whiteman, 2013).

C5 - Page 8, line 11: please refer to Fig. 1 for the radiosonde location. Moreover, "the other side" is ambiguous – it is probably the eastern side of the DS: please clarify.

A) The reference to Fig.1 was added and the sentence changed to clarify that the eastern side is meant with "other side".

T) However, radiosondes launched at the eastern shore of the DS (Fig. 1), indicate that the foehn reached ~~towards the other side~~over the DS towards the eastern shore.

C6 - Page 9, lines 20-21 (and somewhere else): here the word "inversion" refers to the profile of potential temperature Θ (fig. 8). However, normally the word inversion is used to denote temperature T increasing with height. It is not obvious if the stable layer of fig. 8 implies an increase of T with height. There is an ambiguity across the paper in the use of the word "inversion" that should be avoided unless a real "T inversion" is implied. A similar ambiguity is also in the use of "warmer" or "cooler": such words should refer only to T and not to Θ.

A)Thank you for this comment. In fact the stable layers discussed in this paper are all connected to temperature inversions, meaning an increase of temperature with height. However, the temperature profiles are not shown additionally to the potential temperature profiles. As we only show potential temperature in the paper we revised the paper and rephrased the critical sentences.

(i)In the morning a strong temperature inversion, marked the height of the ~~vally~~ valley ABL at 900 m amsl, resulting in a well defined capping stable layer (Fig. 8 a).

(ii)The strong vertical wind shear between the easterly lake breeze and the strong westerly large scale flow caused mechanically induced turbulence (Ri¡0.25), which led to a downward mixing of warmer air into the layer between 350 and 900 m amsl between 9:00 and 13:00 LT, which also increased potential temperature (Fig. 8 a). ~~An inversion of 2 K~~ A temperature inversion formed at around 550 m amsl~~and a secondary weak~~, resulting in a stable layer with a potential temperature increase of 2 K. A secondary weaker inversion at 1200 m amsl represented the former ABL top at 13:00 LT.

(iii)At the same time at the mountain ridge the ~~CBL became warmer~~ potential temperature of the CBL increased by 3 K and CBL height increased from 735 m agl to 910 m agl.

(iv)At that time ~~the boundary layer inversion~~ model results show that the potential temperature at the CBL top increased by 4.1 K over the coastal plains and at the mountain ridge ~~strengthened to 4.1 K and~~ by 5.0 K~~, respectively, and the~~. The mean wind speed within the ABL increased to 5.1 m s^{-1} near the coast and 7.7 m s^{-1} at the ridge.

C7 - Page 9, line 26: Fig. 11 is introduced here, while Fig. 10 is referenced only below in sect. 3.3.3 for the first time. This should be avoided: I think that figures should be numbered in the order of citation.

A) Thank you for pointing that out. Indeed we agree that figures should be numbered in order of citation. We changed the figure order accordingly.

C8 - Page 10, line 18: any hint for the cause of the earlier cooling in the COSMO model?

A) We assume that this earlier cooling is just introduced through the coarse time resolution of the output data, which forced us to interpolate between the output time steps. Output was only available every 3 h.

C9 - Page 12, lines 1-3: "depends on diurnal local and mesoscale processes": please try to be more specific - for instance the MSB is mentioned below (line 30) as the main cause of the westerly flow from which the foehn takes its energy. However, in sect. 3.3 a synoptic-scale pressure gradient is invoked as being important, at least for the strongest cases. I think it is not made clear enough to what extent the MSB alone is sufficient to initiate the DS foehn.
A) We rephrased the sentence being more specific.
T) This already shows that it is not synoptically driven but depends on diurnal local and mesoscale processes , such as the delayed development and cooling of the valley ABL or the MSB reaching the Judean mountains in the afternoon, both leading to a horizontal temperature gradient across the mountain range.

C10 - Page 12, line 18: is "the ridge cooling" due to radiation or also to cold air advection from the Mediterranean (arrival of MSB)?
A) this cooling was caused by radiative cooling. In this case the MSB did not reach the ridge (see also Fig 10c).
T) At the ridge radiative cooling set in and eroded the inversion below ridge height.

C11 -Page 13, lines 5-7: however, in a warming scenario, temperature may increase also upstream and not only within the valley, so the impact on T profile is not obvious (or perhaps it is implicitly assumed that, the MSB being important, the Mediterranean sea temperature will increases more slowly that the continental temperature?).
A) Concerning the warming scenario it is indeed assumed that the Mediterranean Sea temperatures will increase more slowly than continental temperatures, and the second point refers to the shrinking of the DS a shrinking water surface will result in increased sensible heat flux and thus increased temperatures in the valley.

C12 -Fig. 1: perhaps the left panel (the map) should be enlarged.
A) We have enlarged the map.

C13 -PFig. 3: please specify in the captions where crest and valley temperatures are measured, respectively (or refer precisely to the text where this is explained).
A)The caption was changed.
T) Left: Probability of foehn (colors) for wind velocity and potential temperature difference ($\cancel{\Delta T = T_{crest} - T_{valley}}\Delta\Theta = \Theta_{crest} - \Theta_{valley}$). The crest station is Jerusalem and the valley stations are Masada and Ein Gedi (Fig. 1). Right: Relative frequency of foehn occurrence with a detection probability of more than 75 %. Sunrise and Sunset are marked as red lines.

C14 -Fig. 12 a: this is a laudable attempt to synthesize a conceptual model in a picture. However, it is difficult to appreciate the different hatchings in the green area, unless one enlarges the page on a (large) screen. Moreover, the small rectangles in the inset below (the legend) are not sufficiently clear.
A) Thank you for this remark. We enlarged the picture and furthermore added an explanation to the caption
T) CAPTION: Conceptual model describing the different boundary layer processes in the valley on 16 August 2014. (a) The temporal evolution of the different layers and wind systems~~is given~~. The coloured areas refer to the distinct layers detected. Hatched areas describe distinct processes described in the text, and red arrows in the legend show the main wind direction in the respective layer. (~~a~~b) ~~. The~~ shows the wind systems (arrows) and the ongoing processes (shaded areas) leading to the next stage for morning, noon, afternoon, and evening~~, are shown in (b)~~.

C15 - Typo: p. 2, line 4: depend.
A) corrected

C16 - Typo: p.2, line 9: "and MAP" in place of "or MAP".
A) corrected

C17 - Typo: p. 5, line 15: drop comma after "hereby".
A) corrected

References

Whiteman, C. (2000). Mountain Meteorology: fundamentals and applications. Oxford Univ. Press, New York.

Zardi, D. and Whiteman, C. D. (2013). Diurnal Mountain Wind Systems. In Chow, K. F., De Wekker, F. S., and Snyder, J. B., editors, Mountain Weather Research and Forecasting: Recent Progress and Current Challenges, pages 35–119. Springer Netherlands, Dordrecht.