Response to interactive comment on "Marine boundary layer over the subtropical southeast Pacific during VOCALS-REx – Part 2: Synoptic Variability" by D. A. Rahn and R. D. Garreaud.

We wish to thank the reviewer for their comments and address the individual comments below:

Major issue: Concern was raised that biases of MBL depth in WRF have an impact on the results. While laying out these biases openly by comparing them to observations, we neglected to explicitly discuss what these mean quantitatively to our findings using the WRF. As was pointed out by the reviewer, there can be biases up to 1-5 mm s^{-1}.

During large changes in MBL depth, these biases are dwarfed by the much greater environmental changes. Referring to Section 3.3 that explores examples of rising, lowering, and stable MBL height, the magnitude of advection is on the order of 1-3 cm s^{-1} (Figs. 10-13) at a particular time. Of course, these are the most extreme cases.

Another indicator that there does not appear to be a large effect is that near the coast, the standard deviation of MBL depth is not seen to be significantly larger (even when we normalize it by MBL height). If the bias of shallow MBL depth located primarily near the coast (70-75°W) increases the MBL gradient, this enhances advection for a given cross-gradient wind. As a result, the near-coast strip should show higher standard deviations. Instead, higher standard deviations are found west of 75°W and tied closely to mid-latitude disturbances.

Focus was also put on points farther offshore like point omega (20°S, 80°W) to diffuse this issue somewhat since at this distance from the coast, there are smaller biases in the MBL and its gradient in the area around the point. It is recognized that there is still influence of this bias especially when there is a persistent easterly component advecting the shallower MBL height located near shore westward. However, when there is a significant easterly wind, this is associated with a strong synoptic event.

The bias is small compared to the overall signal. This statement is more robust during periods of large synoptic changes offshore and less so during quiescent periods near shore. However, when

there is little synoptic forcing, the wind is less likely to have large cross-gradient components, diminishing any advection anyways and allowing variations in the subsidence and entrainment velocity to more directly control the height, as the last point in the summary stated.

To address this issue in the manuscript, we include some more discussion on this right before section 3.1 and make use of your comments, including the example of the 500 m/500 km bias to address this issue:
"Another possible source of error in the model is the enhanced gradient (as compared to observations) in MBL height near the shore (75-70°W) that enhances advection. Given an east-west bias as great as 500 m / 500 km (Fig. 3) and cross-gradient winds from 1-5 m s^{-1}*, there can be biases up to 1-5 mm* s^{-1} *in the advection. As will be seen later on, these changes can be small compared when there is a large signal driven by synoptic forcing (on the order of 1-3 cm* s^{-1} *for the more extreme cases). Since the major biases are in the near coast region, focus is on points farther offshore to help diffuse the impact of these biases on the conclusions drawn from WRF."*

Minor editing and technical points:

Page 26064; Abstract: This has been rewritten to: "*In the prognostic local MBL height equation the height change, the horizontal MBL height advection, and the large scale vertical velocity at MBL top are calculated explicitly from the simulation. The entrainment velocity is calculated as the residual of the other terms in the equation."*

Page 266065; line 5: We have added "The."

Page 26065; line 8: Schubert et al. (1979) is cited with the advective term. The Lilly (1968) reference is moved to cite the mixed layer model.

Page 26066; line 3: Changed analysis to analyses.

Page 26066; line 8: Removed extra words and tightened up this sentence to: *"As in Part I, observations and the WRF are used to depict the MBL variability and are compared to evaluate model performance."*

Page 26068; line 10: Weak is used without reference to the sign since it is more important to show the lack of stronger downward motion that is present at other times. We use a non-linear scale to cover the large range. When we used a finer scale it produced more noise in the plot, making it somewhat harder to read. The figure is meant to be a full page since there is a lot of information. We will work with the editors to ensure readability and enlarge the fonts if the image is not a full page.

Page 26069; line 9: Added "a random or incoherent variation" to the text. Discussion on the errors introduced by the E-W bias of the MBL is not put here, but in the following section since it seemed to fit better there. Details were discussed in the major point section above.

Page 26069; line 24: We changed the Lilly (1968) reference to the Schubert (1979) reference that includes the advective term.

Page 26070: We have included a statement referring the reader to Section 2.2 of Part I that explains how MBL depth is found from the model is found. In a nutshell, we use the temperature profile to find the base of the inversion.

Page 26070; line 7: We have changed nine-point smoother to *"spatial nine-point smoother (weights of 1, 0.5, and 0.3 to the center, sides, and corner points)"* to be more concise.

Page 26070; line 14: Examples of other factors that may be contained in the residual are now provided: *"…(e.g., instantaneous change of height is calculated over three hours, the smoothed w_{LS} may not be entirely representative of the larger scale subsidence, wind velocity in the advective term is somewhat sensitive to large wind shear near the inversion, etc.)…"*

Page 260074. Changed to just "Case studies"

Page 26075; lines 10-11: This has been reworded to be a little more rigorous to clarify the point that advection just moves the column and is not a mechanism that raises or lowers the MBL depth in a Lagrangian sense. It now reads: *"Granted, the advection of lower or higher heights only represents a translation of MBL depth from one location to another and it is not a basic mechanism that changes the MBL depth in a Lagrangian sense."*

Pages 26075-6: Parts of section four are now rewritten and unnecessary parts deleted for readability.

Pages 26077; lines 17-18: Addressed in major comments. We have included the following statement to acknowledge this issue in the summary: *"In the near coast region (75-70°W) the zonal gradient in MBL depth is greater than observations, but the errors introduced by this bias are small during large synoptic changes and have a smaller impact for locations offshore, which were the focus of this study."*

Figure 4: In the caption it now states*: "The one-to-one line is the bold line and the linear fit is the dashed line."*

Figures 10-13: Point Omega is now shown in Figs. 10-13.