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Atmospheric Chemistry and Physics
Discussions

Interactive comment on "A case study of sea breeze blocking regulated by sea surface temperature along the English south coast" *by* J. K. Sweeney et al.

Anonymous Referee #1

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This paper discusses a specific case of the formation of a sea breeze along the English South coast. Simulations using the Met Office Unified Model at 1km resolution are performed and compared to observations, which demonstrate the model's capability to simulate the sea breeze realistically. The sensitivity of the strength and onset time of the sea breeze to uniform +/-1K perturbations of the SST is tested. The focus of the discussion lies on the formation of a calm zone in Lyme Bay and the relevance of orographic blocking for its formation. It is observed, that at this location the partial blocking of the flow is reduced and therefore the sea breeze strengthened. It is argued that a warmer SST reduces the stability of the atmospheric boundary layer and therefore the

partial blocking of the flow by the mountains is weakened, which overcompensates the tendency the weaker land-ocean temperature contrast to reduce sea breeze strength.

The paper is interesting to read and the detailed, insightful investigation of the influence of the SST on stability of the boundary layer and thereby on partial blocking by orography adds a novel aspect to the understanding of sea breezes. This aspect might be of relevance for many other coastal regions with steep orography as well. A few issues should be discussed and some aspects, stated below, should be discussed more extensively. Then I would be happy to see this article published.

General comments:

- As the slopes mostly face south, the landmass likely is less heated in the experiments without topography and therefore the temperature contrast is reduced. The slightly reduced wind speeds and the weaker inland extent mostly west of Lyme bay in the runs without topography support this (overview plots as well as cross sections). I don't think this is critical to the overall conclusion, but it complicates the comparison of runs with and without topography and should be discussed. By how much does the land-sea temperature contrast change? Is it of a similar magnitude as the change of the SST?

- Many recent studies demonstrate that downward mixing of momentum into the surface layer crucially depends on SST, an effect which strongly affects 10m winds: Over warmer waters the downward mixing is increased, while it is reduced over colder waters. By how much are the surface wind velocities affected? Figs. 6a and 6b indicate a slight decrease over the colder SST.

Samelson, R. M., E. D. Skyllingstad, D. B. Chelton, S. K. Esbensen, L. W. O'Neill, N. Thum, 2006: On the Coupling of Wind Stress and Sea Surface Temperature. J. Climate, 19, 1557–1566.

Chelton, Dudley B., Michael G. Schlax, Roger M. Samelson, 2007: Summertime Coupling between Sea Surface Temperature and Wind Stress in the California Current

System. J. Phys. Oceanogr., 37, 495–517.

O'Neill, Larry W., Dudley B. Chelton, Steven K. Esbensen, 2010: The Effects of SST-Induced Surface Wind Speed and Direction Gradients on Midlatitude Surface Vorticity and Divergence. J. Climate, 23, 255–281.

- The transition from the calm zone immediately offshore to strong winds inland appears very sharp. If the flow is blocked, I would expect the blocking to extend at least partially inland. Why is this not seen? Is this because the calm zone does not extend sufficiently deep into the boundary layer and thus the momentum from the upper part of the boundary layer is immediately mixed down to the surface due to the weak stratification over the heated landmass? What controls the extent of the calm zone?

- What is the reason for choosing this particular case? Certainly the shallow pressure distribution, the light northerly winds and the weak daily cycle of SST provide ideal conditions. Are there other reasons? A few sentences argueing in favor of this particular choice of the case study might fit into section 3 giving the case study overview. Also it would help the reader if date and length of the case study would be mentioned early in the methodology section.

- Promote the novel aspects - in particular the at first sight counter-intuitive interplay of SST and blocking orography - more prominently both in the abstract and the last paragraph of the interoduction.

Specific comments:

- p. 24786, l. 5: As the effect of the SST is felt mostly close to the shore, while the overall sea breeze is not influenced dramatically (up to the slightly offset in the onset time) I would rephrase the sentence such that it becomes clear that the major effect is local, restricted to sea immediately offshore. This does not decrease the importance of the effect, but it is more honest. The shift in the onset time deserves its own phrase.

- p. 24787, l. 17: NOAA-AHVRR should read NOAA-AVHRR

- p. 24787, l. 17: add "... by midday if SST is kept constant."

- p. 24788, l. 7: What do you mean by "climatological"? Long-term monthly climatology? Monthly mean? Specify this more clearly here and elsewhere in the paper, as it is not obvious.

- p. 24788, lines 10-15: Omit the rather technical details such as the use of the OSTIA SST product and the description of the chosen approach. It is sufficient here to briefly state that simulations are performed to study the sensitivity of the sea-breeze circulation to SST variations. Mention the new aspects of sea-breeze circulation that have obtained not much attention so far and are addressed in this study.

- p. 24788, lines 28-29: Remove the introductory phrase to the Section (likewise in Sections 3 and 5). This is not needed as the information is contained in the section title and the outline at the end of the introduction.

- p. 24789: Specify here what measurements are used.

- p. 24792, lines 6, 19: As you give a value in section 4 for the inshore extent of the sea breeze in the simulation, what is the estimated value from the satellite image? Most readers might not be sufficiently trained to estimate distances from satellite images and therefore a number would be nice. How does it compare to the value obtained from the simulation? For instance East of Weymouth the sea breeze in the simulation appears to extend less deep towards inland areas as compared to the satellite image.

- p. 24793, l. 12: Remove sentence...

- p. 24793, l. 15: It is worth mentioning here, that this is in line with the weaker flow acceleration expected from eq. (4) in Miller et al. (2003). It is interesting that when the sea breeze has been fully established, the resulting wind speed is practically the same for all three simulations at Portland Harbour.

- p. 24793, l. 25ff: Remove the last two sentences of this paragraph.

- p. 24794 and 24795: When mentioning the change of sea breeze structure, highlight that the differences are restricted to close to the shore.

- p. 24795: I can not reproduce your numbers given for the vertical potential temperature gradient. According to the legend of Fig. 8 the contouring interval is 0.5 K, which roughly gives an increase of 3.5K/200m in the cold and 2 K/200m in the warm case. For the elevation something like 150 m is used? For the argument to work, it is not critical that the Froude number is around 1, it is sufficient that it is larger in the warm SST case.

- p. 24796, l. 12: Instead of recapitulating what was shown in other studies, highlight more specifically how your results differ from those of the previous studies.

- p. 24797, l. 6: "... can have dramatic consequences for the structure of sea breeze circulation on small scales, while the overall sea-breeze structure is not significantly altered."

- p. 24797, l. 9: replace "is crucial" by "can be crucial"

- Figs. 2 and 5: Move the information by whom the measurements were provided to the methods section.

- Fig. 3: The yellow box is only a subdomain of the 1-km MetUM domain. State this explicitly in the legend.

- Figs. 4 and 6: For the color shading a scale extending to the maximum velocity should be used (i.e. > 5 m/s) in order to see differences between the runs better.

- Figs. 2,4,6: Choose the same scale in x and y axes. Then the calm zone should look a bit less narrow. In particular in Fig. 4 it is pretty much squeezed in north-south direction.

Interactive comment on Atmos. Chem. Phys. Discuss., 13, 24785, 2013.