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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 #2

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General comments:
This paper uses a high-resolution convection-permitting numerical model (UK Met Office UM) to study the sensitivity of sea breezes to sea surface temperature (SST) changes and to coastal orography, using a set of limited area numerical simulations for a region of the English South Coast. This extends the previous works on this topic, notably that of Tang (2012). Overall these results are of interest and eventual publication can be recommended.

Specific comments:

(1) Tang (2012) considered a neighbouring region of the English South Coast also using the UM model, and examined the effect of diurnal and spatial variations of the ocean SST on the sea breeze. In this paper, the SST is fixed and uniform in each simulation, and the sensitivity to SST is explored only by raising and lowering the SST value by $1^o\,K$ from the control run. More interestingly, each of these three simulations was repeated with the land orography removed. The results are compared with some rather limited observations. Not surprisingly, the simulations with no orography show very little effect of varying the SST. For this reviewer, there are two findings of interest: (a) the presence of a "calm zone" in the sea breeze just offshore, evident only in the runs with orography, and most apparent as the ocean SST is lowered; (b) the rather deeper penetration of the sea breeze in the presence of orography, especially to the west of Lyme Bay. Both effects are clearly seen in figure 6 for instance. The authors focus on (a) but hardly mention (b), which seems counterintuitive.
(2) There seems that there is also a weak "calm zone" at Portland Harbour, although this is not mentioned in the text. In general, the chosen region has a variable coastline, and quite strongly variable orography, and this makes it a bit difficult to interpret the results.
(3) The authors explanation of the "calm zone" at Lyme Bay is not very convincing, although it can be agreed that it is counterintuitive at first sight, especially as this is more apparent for the lower ocean SST. The explanation offered is that the sea breeze is partially blocked by the orography, but more detail is needed here. Figure 8 suggests that the "calm zone" is present for all three SST runs, but becomes stronger as the ocean SST is decreased. This figure also shows that orography deepens the sea breeze, which is consistent with slower wind velocities, but does not seem to show that the location of the sea breeze front has changed very much due to the orography. The Froude number argument is sketchy. Blocking usually occurs when the Froude number $F < 1$, that is for subcritical flow, but here the estimates are that $F \approx 1$ at Lyme Bay, and $F > 1$ elsewhere. It is claimed that the temperature gradient is $5^o\,/100\,m$ in the cold experiment, but only $2^o\,/100\,m$ in the warm experiment. This is not very apparent

in figure 8, and also, at what location where these estimates made? More detail is needed here, and plots of temperature profiles across the sea breeze front would be useful here.
(4) At the top of page 10, the authors mention that “the sea-breeze spreads more rapidly offshore than inland. The reasons for this are not clear and to the authors’ knowledge have not been investigated in the literature but are likely due to the inherent differences between the sea-breeze front (which exhibits gravity current behavior) and the broader, weaker, rearward side of the circulation”. In fact this issue has been studied in the literature, see the papers “Numerical modelling of the offshore extent of sea breezes”, Raymond W. Arritt, Q. J. Roy. Met. Soc., 115, 1989, 547–570, the reference Finkele (1998), and the recent “Idealized WRF model sensitivity simulations of sea breeze types and their effects on offshore windfields”, C. J. Steele, S. R. Dorling, R. von Glasow and J. Bacon, Atmos. Chem. Phys., 13,2013, 443–461, and the references in these papers.
(5) It needs to be pointed out that when diurnal variation of the ocean SST is allowed, as in Tang (2012) then the SST may well have increased by $1 - 2^o K$ at the time in the afternoon when the sea breeze is strongest, making the simulation here with the warmer SST the more relevant in practice. This would then diminish the “calm zone”.

Technical comments:
(1) In the literature the phrase “calm zone” in the context of a sea breeze usually means one that is induced by a synoptic wind opposing the sea breeze. That is not the case here, and so the authors should be careful when they use this term.
(2) Although overall well written, there are a few very minor typos, e.g. ” instead of “, The Isle $\cdots$ instead of the Isle, etc.