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Atmospheric Chemistry and Physics
Discussions

# *Interactive comment on* "The roles of island size and orography on tropical convection and aerosol transport" *by* Stacey Kawecki and Susan van den Heever

**Anonymous Referee #2**

Received and published: 22 July 2019

Title: The role of island size and orography on tropical convection and aerosol transport
Authors: Stacey Kawecki and Susan van den Heever

Recommendation: Reject and resubmit

In this study several idealized simulations with varying island diameter size, orographic height and zonal wind speed are run to investigate their impact on precipitation, convective organization and aerosol transport. Results show that orographic height is a larger controlling factor than island size, in the presence of both weak and strong zonal winds. In my opinion the analysis performed is extremely shallow, and not suitable for publication in ACP. Most of the results presented in this study have been extensively discussed



in previous literature. The paper lacks of any sort of quantitative analysis: no attempt is made to consider the thermodynamic and diabatic feedbacks between the developing circulations and convection (CAPE, CIN, vertical wind shear, entrainment/detrainment, etc..). The figures are limited to a few snapshots and diagrams showing where clouds form and how much it rains. However, the attempt to treat altogether several complex processes such as land/sea breezes, upslope/downslope winds, lee-side convergence, diurnal cycle of solar radiation, etc. . . makes this one a potentially interesting study. I therefore encourage resubmission after a more in-depth and quantitative analysis is performed, and after a few major flaws highlighted below are fixed.

Major comments:

(1) The analysis performed in this study is extremely shallow, and needs substantial revision. Most of the results (see also L. 552-555 or L. 615-620 in Section 4.0) are well known in the field. No attempt whatsoever is made to understand how environmental variables such as CAPE and CIN change in the different simulations. Studies over orography demonstrated, for instance, that sometimes CAPE is not a good precursor for convective activity, and that local circulations dominate the scene. . . is it the case in your simulations too? Furthermore: how important is, for instance, shallow cumulus detrainment over the island to precondition the environment for deep convection initiation (see also Kirshbaum 2011)? None of these aspects are addressed, not even mentioned. The analysis is based solely on: wind speed, clouds and precipitation. What wind regimes develop over the island (obvious and well known), how these winds affect clouds and precipitation (very well known), and consequently aerosol transport. That's it.

(2) The introduction is severely lacking review and citation of essential literature, which probably justifies why you felt like writing in the abstract that "unlike many of the previous island flow investigations, the full three-dimensional flow over and around islands is resolved". What about the study by Tim Cronin et al. published in 2015? Their publication is without doubt a milestone in the field. There are also several studies focusing

on flow around three-dimensional mountains: I will mention here Hassanzadeh et al. 2016, simply because their analysis and figures are very similar to those in your paper, but you will find more. Papers such as Panosetti et al. 2016 already demonstrated the importance of cold pools for the propagation of convection in studies over orography. By reading these and other studies you will understand that most of the results presented in your paper are absolutely no news to the community.

(3) Along with what above, fundamentally all your 3.x sections and as well Section 4.0 are very long, repetitive and basic. What about combining Figure 2 and 3, or/and Figure 4, into one, unique figure, described in a short and straight-to-the-point section, since they do not show any surprising or not-yet-known result, to save text and figure space for a more in-depth analysis of convection? Also, I recommend proofreading the text for English, since in several circumstances (few highlighted below) the text is difficult to read.

(4) Your domain is way too small. You state this yourself at L. 283-285. And this is based on analysis of moist quantities, but it could be that the circulations associated to the single convective cells in fact start interacting with each other even before 16:20. For the sake of clarity, this should be remarked in the model description, for example at L. 160-161: "Each simulation is run for one full diurnal cycle, but the analysis is performed only until XX:XX due to . . ..". But I expect that you rerun the simulations on a larger domain. There's a lot more happening after 16ish that can/needs to be discussed, and I am not even sure that the results that you are currently presenting are not affected by the small domain.

(5) Experience running idealized simulations shows that these tend to be quite sensitive to the initial perturbations. Because you are running over such a short time scale (less than a day): did you try running initial perturbation ensembles to check for robustness of your results?

(6) Wouldn't using westerly winds in both STRONG-EXP and WEAK-EXP make the



whole analysis easier to interpret? At the end of the day, you are running in an idealized setup, it should not take long to redesign WEAK-EXP with westerly winds. . . what is the motivation not to do so?

Minor comments:

L. 29: mixed out → transported out? Section 2.0: what is your model output frequency? How is turbulence treated in your simulations? L. 288-290: Cloud top height cannot "expand horizontally", nor it can "converge". Also, it can increase, but "vertically" is meaningless. L. 290: obvious → evident? L. 293: Also convection cannot "converge". . . Nor it can happen "within shallow clouds", shallow cumulus clouds are one of the many manifestations of convection. L. 351: Higher → deeper L. 354-355: Deep convection repeated twice in the same sentence L. 380: "Circumnavigating the island" literally means "travelling all the way around the island". Why would a precipitation-driven cold pool do that? What is causing the cold pool to circumnavigate the island instead of pointing at a specific direction? Explain L. 382-383: "the background surface winds interact with the downslope winds". . . aren't you analyzing the flat island case? Where do the downslope winds come from? L. 542: investigation → study L. 549: what does "the surface flux response to the meteorology" mean? L. 551-552: Of course! Why would a bigger island result in a different flow pattern? It is still a case study with a zonal wind impinging over an idealized circular island. . . Table 1 and Table 2: are these tables really necessary? If yes, how about redrawing them in a more professional layout? Figures 6,7,10 and 11: labels unreadable

References:

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Kirshbaum, D. J., 2011: Cloud-resolving simulations of deep convection over a heated mountain. J. Atmos. Sci., 68, 361-378, doi: 10.1175/2010JAS3642.1.

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