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Mécanismes physiques du nuage d'orage et de l'éclair/The physics of thundercloud and lightning discharge

Comment on "The physical origin of the land–ocean contrast in lightning activity" [C. R. Physique 3 (2002) 1277–1292] ☆

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In the article in question [1], Williams and Stanfill (WS) present "a critical re-examination of the validity of the thermal [2] and aerosol [3–5] hypotheses that have been proposed in order to explain the land–ocean contrast in lightning activity. Their analysis seems to us insufficiently documented, thus leading to questionable conclusions. As an example, these authors conclude that "the weight of the evidence favors the traditional thermal hypothesis as the primary explanation for the land–ocean contrast in lightning activity". This conclusion is mainly based upon the behavior of the annual thunder day number (ATD number), observed at given islands, plotted versus the corresponding island areas that "despite considerable scatter over all, does show clear evidence for a transitional area in the range of 10^2–10^3 km^2 between oceanic and continental thunder day behavior" (Fig. 4 of the article in question [1]). However, our observations in Caribbean islands (Guadeloupe and Martinique), suggest that all thunder days observed there are related to pre-existing deep convection (passage of large and meso-scale perturbations (easterly waves, tropical storms and Intertropical Convergence Zone debries)) enhanced by the island's relief forcing and have nothing to do with local thermal convective developments. Further, the careful examination of the ATD, island surface and corresponding elevation data set used by WS reveals a gap in the island elevations that correspond to the above mentioned transitional area (10^2–10^3 km^2). It seems, therefore, that the transitional area observed by WS and used as a validation argument in favor of the "thermal hypothesis" is an artefact due to the absence of islands with appropriate elevations in this area range and the resulting local enhancement absence of pre-existing deep convection. All other arguments presented by WS in order to strengthen their conclusion support both the thermal hypothesis as well as the aerosol hypothesis. As a conclusion, the WS analysis fails to prove the validity of the thermal hypothesis. Most probably, both hypotheses hold and are complementary. It appears, however, that additional investigations are necessary in order to test their respective validity. Such investigations could be based upon the comparison of observed global lightning distributions and numerical calculation results obtained by general circulation models using electrical flash frequency parameterizations related to one or the other of these hypotheses. WS are encouraged to revisit these issues, as analyses of this kind are scarce and could help in better understanding the global circuit mechanisms. A detailed discussion along these lines has been submitted for publication to C. R. Geoscience.

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