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

Reply to the comment on "The physical origin of the land–ocean contrast in lightning activity" [C. R. Physique 5 (2004) 155] ☆,☆☆

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In a recent Comment [1] by Pontikis et al. on Williams and Stanfill (WS) [2], questions are raised about the conclusions drawn concerning the physical basis for lightning activity on islands. Near the end of their Comment [1], the authors encourage a revisitation of these issues. In fact, the analysis of islands presented in WS has been revisited [3] using optical observations of lightning from space with the NASA TRMM satellite [4], instead of the annual thunder day number. This follow-up study [3] provided access to a larger number of islands throughout the tropics, including Guadeloupe and Martinique. These observations also provide the spatial distribution of lightning on islands, and enabled investigation of the diurnal variation of lightning activity. This work provides a stronger basis for addressing various criticisms [1] here.

If island lightning activity "has nothing to do with local thermal convective developments" [1], then why are substantial enhancements in activity observed during daylight hours when sunlight is heating the island? How is the diurnal variation of island lightning activity to be explained by the aerosol hypothesis [5]? Why should a substantial contribution for the enhanced lightning activity over islands in easterly waves be expected from the aerosol mechanism when the island–ocean aerosol contrast is likely much diluted by this synoptic influence? Why are similar transitional island areas (10^2 to 10^3 km^2) found in this improved analysis [3], using different lightning parameters (mean flash rate, areal flash density, peak flash rate) and different collections of islands than used in WS?

WS do not claim to have proven anything. Instead, both WS and [3] have tested two hypotheses with observations and find consistent results in favor of the thermal hypothesis. Further experimental investigation of the aerosol hypothesis in Brazil [6] casts further doubt on its primary role in the lightning activity. There are reasons for skepticism that present General Circulation Models will provide compelling evidence on this issue because GCM's generally gloss over the details of microphysics (including those details involving aerosol) and thermodynamics that are crucial to cloud electrification. Nevertheless, we invite Pontikis and colleagues to present evidence (in the promised detailed discussion in C. R. Geoscience) of value in distinguishing the thermal and the aerosol hypotheses.

References

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