NOTES AND CORRESPONDENCE

Comment on "A Study of a Non-Deepening Tropical Disturbance"

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Having had the opportunity to read the paper by Simpson *et al.* (1967) before its publication (see article pp. 237–254), we wish to offer a suggestion regarding a possible triggering mechanism that might explain some of the events of 16 August which are described in this interesting paper. Our particular interest in tropical rainfall had its origin in the recent report of Brier (1966) that the variations in the amplitude of the 12-hr pressure oscillation S_2 at Batavia, as reported by Holloway *et al.* (1955), were significantly correlated to changes in the magnitude of the lunisolar tidal forces. The suggestion was then made "that the forces producing an ampli-

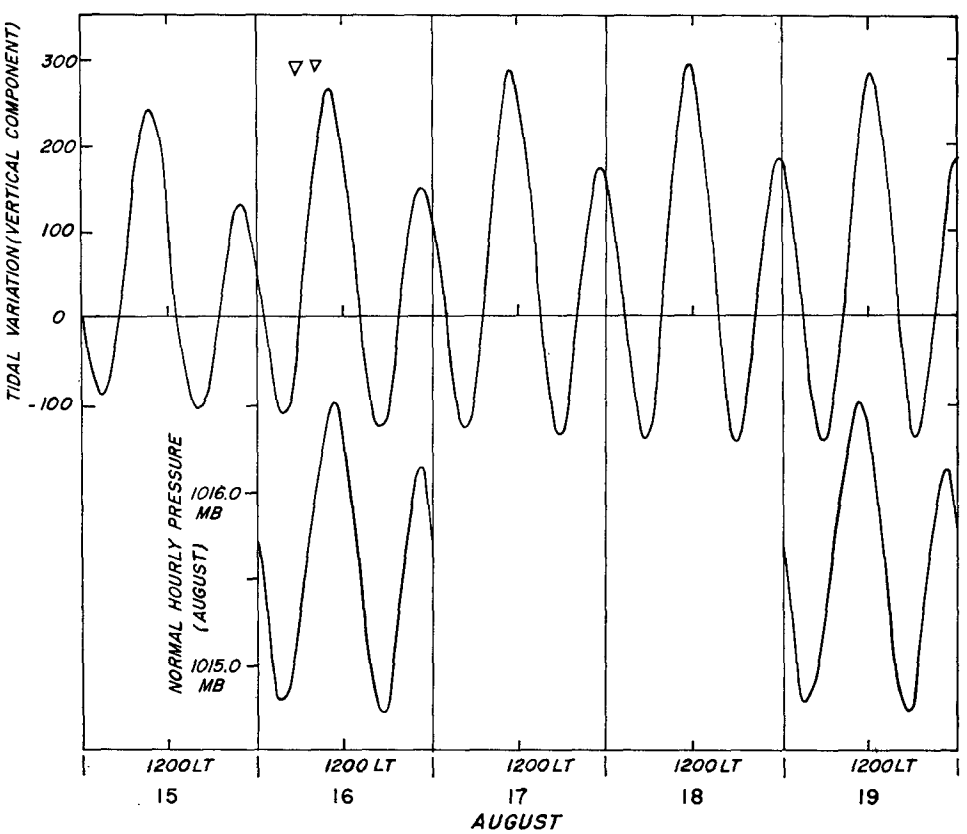

FIG. 1. Variation of the vertical component of the tidal force at Barbados during the period 15–19 August 1965 for comparison with the normal hourly pressure (lower curves) for a typical day in August. Scale for the tidal variations is in arbitrary units.

fication of the S_2 oscillation are linked to . . . circulation changes through mechanisms involving increased cloudiness and precipitation." Earlier, Gold (1913) had concluded that overall cloudiness variations in the tropics can be sensitive to small changes in the mean vertical motion comparable to those which could be induced by the divergence-convergence field of the S_2 tidal wave. Recently, we have found significant lunisolar tidal effects in the monthly precipitation tota!s for Batavia, and Berson and Deacon (1965) have reported evidence that heavy rainfalls during the monsoon seasons at Djakarta (Batavia) and Mangalore occur more frequently at certain epochs of the lunar synodic cycle than at others. Also, Bradley (1964) has shown a lunar component in the formation of tropical hurricanes and his findings are confirmed by the addition of more recent and independent data.

Therefore, upon reading this paper by Simpson *et al.*, it seemed quite appropriate to inquire whether there was anything of interest in the tidal variation on 16 August, especially between the hours of 0400 and 0800 local time in the Barbados area where a considerable amount of rain activity was reported. The nautical almanac showed that at the noontime the sun was directly overhead at the latitude of Barbados, thus permitting a maximum possible amount of heating. On the same day, the moon crossed the plane of the ecliptic while at the same time it reached its furthest northern declination. The phase of the moon was two days before new moon, the time of maximum possible tidal force. A high-speed electronic computer was used to determine the vertical component of the lunisolar tidal force F_v for each hour from 12 August to 23 August for a grid of points in the Barbados area. The formulas used were those derived by Schureman (1941). Except for a translation in time due to the Earth's rotation, the values were pretty much the same for all locations. The time graph for Barbados, the center of the grid used, is shown in the top curve of Fig. 1. The most interesting aspect of this curve is the major maximum occurring at 1000 local time on 16 August, the time of the normal pressure maximum for the tropics. For comparative purposes, the normal hourly surface pressure curve for August at Miami is shown in the lower part of the chart. On 16 August, the general form and phase of the two curves are practically identical. This would be true for no other day during the month, and by 19 August, for example, they are out of phase by nearly 3 hr. The tidal variations are shown in arbitrary units, since we are not concerned here with absolute magnitudes but rather with phase relationships and the time at which the rate of increase is a maximum [see Brier (1965)]. It may be significant to note that the rainfall occurred during the period at which the rate of increase of the vertical component was a maximum. This would be expected if some trigger mechanism producing a change in state of a system is involved.

We feel that this particular case along with much other evidence pointing in the same direction calls for a careful examination and serious consideration of the possible effects of tidal perturbations on atmospheric processes, especially in the tropics where these perturbations are of greater amplitude and regularity. Furthermore, we feel that Simpson *et al.* have made an important contribution by pointing the way as to how satellite cloud observations can be used to "add new dimensions to such studies." Some additional investigations along these lines are now being planned, making use of the remarkable pictures from ESSA I and ESSA II.

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