RECENT RESEARCH ACTIVITIES

Is there a stratospheric pacemaker controlling the daily cycle of tropical rainfall?

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No matter where you live, rain seems to fall more often at certain times of day, whether it is seen in the daily afternoon rainstorm or a typical overnight shower. Indeed, statistically, long-term average rainfall tends to cluster at certain times of the 24-hour cycle, but that time frame varies depending on location. Notably, rainfall in the tropics exhibits a large, 12 h Sun-synchronous variation with coherent phase around the globe. A long-standing, but unproved, hypothesis for this phenomenon is excitation by the prominent 12 h atmospheric tide, which itself is significantly forced remotely by solar heating of the stratospheric ozone layer.

We investigated the relative roles of large-scale tidal forcing and more local effects in accounting for the 12 h variation of tropical rainfall. A model of the atmosphere run with the daily cycle of solar heating artificially suppressed below the stratosphere still simulated a strong coherent 12 h rainfall variation (~50% of control run). This finding demonstrates that stratospherically forced atmospheric tide propagates downward to the troposphere and contributes to the organization of large-scale convection.

As an example, Figure 1 shows the daily cycle of rainfall over the Maritime Continent (Indonesia and its surrounding oceans). Observed rainfall (blue curve) shows two peaks, separated by roughly 12 hours, indicating of a 12 h variation. Modeling results with and without the daily cycle solar heating of ozone layer (red and black curves, respectively) show that the double peak of rainfall is accounted for only if the 12-hour atmospheric tidal wave, which is largely excited by the ozone heating, is included.

We found that a daily disturbance from the upper atmosphere leaves its footprints on tropical rainfall. The present results could also lead to the understanding of the excitation of tropical atmospheric waves by moist convection, to the evaluation of climate models, and to the understanding of the recently discovered lunar tidal rainfall cycle. [1]

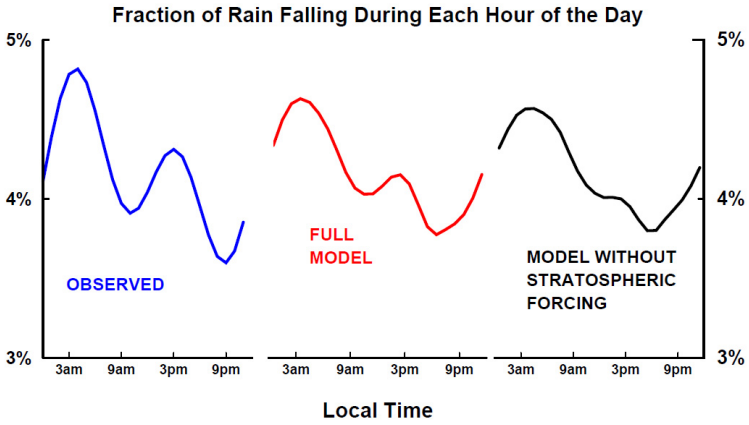

Figure 1. Fraction of the total rainfall, as a function of time of day, for a region including much of Indonesia and its surrounding oceans. Observations show strong peaks at early morning and mid-afternoon. Our modeling captures the observed modulation, only when upper atmospheric forcing that excites atmospheric tidal wave is included.

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Reference

[1] Sakazaki T., K. Hamilton, C. Zhang, and Y. Wang, “Is there a stratospheric pacemaker controlling the daily cycle of tropical rainfall?”, *Geophysical Research Letters*, 44, 1998-2006, doi:10.1002/2017GL072549, 2017.