Rain on Small Tropical Islands

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The idea

We are interested in how deep convection is forced, and in how the spatial scale of the forcing determines its effectiveness. Islands offer a view into this as they provide a constant forcing with a well-defined spatial scale. We use TRMM PR data to determine how different is climatological rainfall over islands compared to that over the surrounding ocean. We focus here on the Indo-Pacific maritime continent, though fig. 8 shows results for the Caribbean.

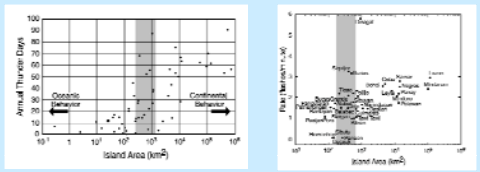

FIGURE 1: Williams et al. (2004, *JGR*), Williams and Stanfill (2002, *C. R. Phys.*) addressed this question in terms of lightning, and found a significant island enhancement for islands with areas larger than a few hundred km^2.

Data

We use TRMM PR, gridded to an 0.05 x 0.05 degree lat-lon grid. We construct a climatology using the entire data set – no segregation by annual or diurnal cycle (to maximize sample size). The PR is uniquely suited to this work as it is available over both land and ocean with minimal relative bias and high spatial resolution. Digital elevation to define islands and topography from NOAA NGDC GLOBE.

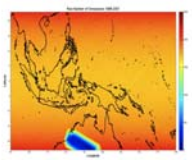

FIGURE 2: Total number of overpasses in the data set, per 0.05x0.05 degree pixel, for the maritime continent.

Results

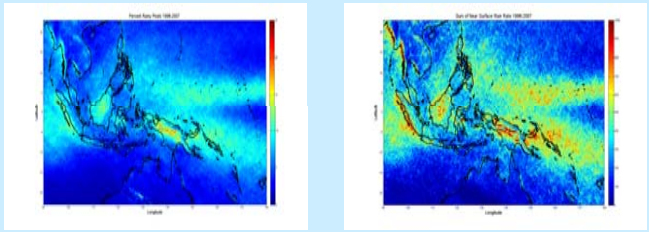

FIGURE 3: Percent of observations at each location for which rain is measured (left) and total rainfall over the data set (right).

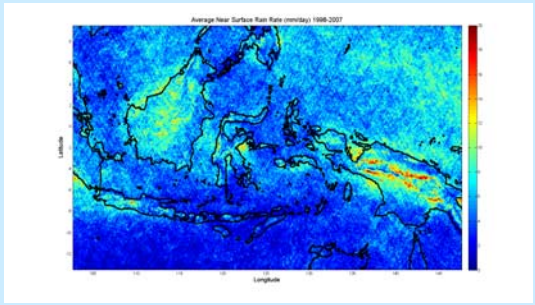

FIGURE 4: Zoomed-in plot of climatological mean mear-surface rain rate over a subset of the domain.

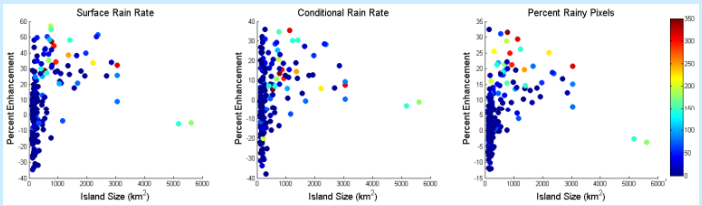

FIGURE 5: Scatter plots of mean rain rate (left), conditional rain rate (middle) and percent rainy pixels(right). Color of each pixel is 75th percentile of island elevation at 2 km resolution. Rain rate is expressed as a difference of the mean island rainfall minus that of a surrounding ocean area about 3 times the size of the island, normalized by the island plus ocean rainfall to give a result in percent.

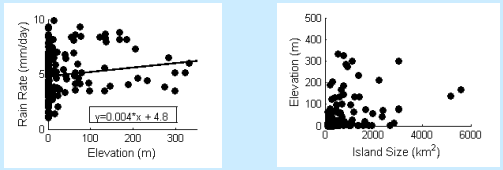

FIGURE 7: rain rate vs. elevation (left), and elevation vs. island size, for the maritime continent region.

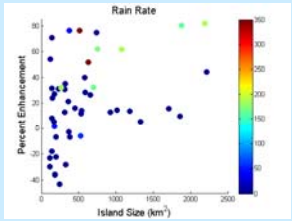

FIGURE 8: rain rate vs. island size for the Caribbean. Note greater orographic enhancement (colors) compared to maritime continent results in fig. 6.

Conclusions

Mean rainfall is enhanced over small tropical islands compared to the surrounding ocean. The enhancement is typically 30-40%, and occurs for islands whose areas Exceed a few hundred km^2, consistent with Williams et al.'s earlier analysis of lightning. There are roughly equal contributions from enhancements in rain frequency and conditional rain rate.

The results are robust to differences in products; reflectivity and log(Z). For example, give very similar results (not shown) to retrieved rainfall.

For the maritime continent, there is not a strong relationship between the rainfall enhancement and island orography. A preliminary analysis of the Caribbean, on the other hand, appears to show a much more important role for orography. In ongoing work we are analyzing this more closely, as well as looking at island-ocean differences in the magnitude of the diurnal cycle.