[Authors]

Siyuan Wang, Hui Yang, Sujan Koirala, Matthias Forkel, Markus Reichstein, Nuno Carvalhais

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Understanding Disturbance Regimes from Patterns in Forest Biomass

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Appendix S1. Parameterization of disturbance regimes

In the equation 9, the number of disturbance events (n_z) at a specific event size z is following a power law mechanism, the lower α represents that the disturbance events would be more clustered, exhibiting the characteristics of large disturbing events but with rare occurrences in the domain; in contrast, the higher α will distribute the total disturbed areas more evenly and simultaneously increase the occurrences of small-sized events in the domain.

In the equation 10, the event sizes are prescribed as a numerically discrete series from 2^0 cells to half the size of the domain, capped at 2^{19} cells. Stepwise values follow the mechanism of powers of 2, leading to twenty classes of event sizes. Due to the discrete nature of the event sizes and the pseudo-random amount of the corresponding events, a limited uncertain gap remains between the total disturbed area after the generation process and the prescribed value. In an attempt to limit this gap, we performed an error threshold to regulate this randomness: the difference between generated total area and prescribed value as a percentage of total domain area should be lower than 0.001% (10 pixels to a 1000-width domain). When the gap has exceeded the threshold, the new event amount sequence will be recalculated until the condition is met. In very rare cases, it is difficult to compute an amount sequence satisfying the threshold of 0.001%, so in which circumstances, the acceptable gap is relaxed to 0.002% (20 pixels to a 1000-width domain).

In the equation 11, the parameter β controls the slopes of the logarithmic function for describing the relationship between the disturbance's intensity and its size. We descend from Chambers' description of the quantitative relationship between the average mortality rate and disturbance size (Chambers et al. 2013), inheriting a constant intercept parameter b = 0.22684 but varying interval of slope parameter β, from 0.03 to 0.5. For the same size of disturbance events, a larger β indicates a greater intensity, causing more carbon loss during the dynamic carbon cycling simulation. In practice, it is possible for the value of intensity to exceed 1, which usually happens for the big beta and large events. In those cases, all intensity exceeding 1 should be limited back to 1 as per the reality of the situation.

The disturbance generator produced 153 disturbance reference cubes (9 μ and 17 α) in total to generate spatial references for disturbance. Each cube represented a distinct combination of μ and α and comprised 200 snapshots that simulated diverse scenarios of different disturbance event spatial distribution. Notably, these snapshots are all binary (occurs or not) lacking information on intensity, which means that they only provide the spatial reference information under specific μ and α combinations.

The disturbance events, represented by independent patches with flag of True, are meant to be randomly distributed across the whole domain without overlapping or overstepping boundaries (Figure 1c-d), and intensity is then assigned according to the corresponding β values.

Reference

Chambers, Jeffrey Q., Robinson I. Negron-Juarez, Daniel Magnabosco Marra, Alan Di Vittorio, Joerg Tews, Dar Roberts, Gabriel H. P. M. Ribeiro, Susan E. Trumbore, and Niro Higuchi. 2013. "The Steady-State Mosaic of Disturbance and

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