Simulating the effect of extreme climatic events on tree architecture with a minimal FSPM

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Studying extreme climatic events

Empirical studies and climate predictions highlight that climate change is associated with increasing occurrences of extreme climatic events. As trees develop a perennial structure, their effects on it can be critical but complex to assess and to predict.

We aim to use a minimalist FSPM in order to point out the key assumptions that drive virtual tree responses to extreme climatic events (modelled as climate conditions that drastically reduce carbon assimilation).

DRAFT: one more FSPM

How to model tree growth and development with only 6 parameters?

Growth cycle decomposition

1. Growth Unit growth
2. Branching
3. C. assimilation
4. C. allocation per compartment
5. Ring development
6. Bud allocation

Main assumptions
● Delayed branching
● Preformed shoots
● No early wood
● No sex

Draft is a set of equations that can be simulated or analytically studied

Analytical study of the effect of an extreme climatic event

Key assumptions: $Biomass\ assimilation_t = a_t \cdot \sum_i \text{Shoot length}_i$

$\text{Shoot Length}_t = \text{cf. Shoot initial diameter}$

Consequences: $\text{Shoot Length}_{t+p} \propto \prod_{i=1}^{p} a^{1/3} \cdot \text{Shoot Length}_i^{1/3}$

Conclusion: Assimilation and shoot allometry modelling choices are critical to deal with extreme climatic events

Simulation of the impact of extreme climatic event timing

Virtual plants simulated with Xplo. Red dots provide the location of GUs that were produced during the year that follows the extreme event. (left: t=4; right=15)

Quantitative results. Vertical dashed lines correspond to the timing of the negative extreme event (see proceedings for details).

Conclusion: Extreme event affects simulated tree architecture for several years and younger trees appear more sensitive to an extreme event than older ones

Perspectives

Empirical studies focused on shoot allometry responses to extreme climatic events may strongly improve modelling accuracy in the climate change context.


Xplo: http://amapstudio.cirad.fr