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Geoscientific Model Development Discussions

Interactive comment on "Implementing spatially explicit seed and pollen dispersal in the individual-based larch simulation model: LAVESI-WIND 1.0" *by* Stefan Kruse et al.

Anonymous Referee #1

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General comments:

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The authors present approaches how to include wind-dependent seed dispersal and direction-dependent pollination into a mono-species, spatially explicit, small scale forest model. They verify whether the new implementation behaves as expected and evaluate the distance and direction dependent seed dispersal and pollen input probability in comparison to wind direction and speed.

The two new submodels are novel and could also be transferred to other spatially-explicit models. This is the main merit of the study. In particular by the pollination

model the field of forest modelling is substantially advanced.

The manuscript is well structured and in large parts well written. Equations and parameters are given.

Sometimes more explanations would be very helpful, in particular concerning the pollination module.

In the introduction and discussion a lot of weight is put on migration processes and the inability of large-scale models to deal with it. In this context it seems at least a bit strange that the authors restrict their simulation to one plot of at maximum 200m*200m. It would be more convincing to make clear that you started with a detailed small scale model which later could maybe inform larger scale models and in particular can enhance understanding of gene flow in forests.

The question remains: how can this approach be adopted by models running on a larger scale? Can, for example, the detailed simulation of individual seeds and trees be upscaled? Does it make sense to use approaches as discussed in (Snell, 2014, Using dynamic vegetation models) ? Please discuss.

As already pointed out using only a small area of 4 ha for studying migration processes seems weird. Also the circular boundary conditions might confound results of spatial processes because spatial gradients disappear. (Maybe I got that wrong, but then it indicates that a better explanation is needed!)

It also seems to me that ignoring the size or age of father trees, and by that the relative amount they contribute to the pollen cloud, can affect the results.

A lot would be clarified by more detailed captions of the figures.

In general, more clarifications are needed in many parts. All my questions below indicate unclear formulations which should be improved.

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Specific comments

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Throughout the text: avoid the term “pollination of seeds”. Biologically the ovules are pollinated, and this yields the seeds. Or at least clarify that you mean the ovules in this context.

L36: There are forest models for all scales, not only for stands. Omit “stand”.

L37: Between forest stand models and DGVMs, there are forest landscape models, which incorporate seed (whereas not pollen) dispersal (c.f. , Snell et al, 2014, Using dynamic vegetation models; Shifley et al., 2017) and have been applied also to the arctic (e.g. TreeMig, Epstein et al, 2007) .

L50: what do you mean by “at the molecular level”? The genes? The coded proteins? Or the resulting traits?

L50: Why does high gene flow constrain local adaptation? I would assume that it enhances it. Omit “high”, or exchange “constrain” by “influence”.

L51: I do not understand how local adaptation prevents negative consequences (which ones?) due to founder effects. Clarify

L63: commonly -> sometimes. E.g. concerning DGVMs, to my knowledge up to now Rebecca Snell’s LPJ-GUESS version is the only one with something a bit similar to dispersal. Forest Landscape models of course contain dispersal, but believe it or not, it is very often switched off!

L101: strict = absorbing?

L08: It would biologically be more logical to start with pollination and describe seed dispersal afterwards

L111: the formula is hard to read, one has to guess: (1/2)*distanceratio*(rand)**1.5

???

L116: height of the tree top?

L120: Unclear: Probably you mean: wind speed and direction, which were randomly selected from a set of observations

L121: Start with a general conceptual description of the pollination and refer to fig. 1.

L122: Is the pollination simulated really for each individual ovule? Idea for an upscaling: Would it be possible to do that more in a "share" approach per tree (assuming that all ovules are of the same genotype): Of N seeds of the tree, the share p1 are pollinated with pollen from father 1, p2 from father 2,...

L124: now you confuse me: tree or seed?

L131: make the reference to fig. 1 more prominent, I overread it several times, and found fig. 1 just by chance.

L138: “pollen distribution” , isn’t it rather the overall pollination probability of a seed?

L140: Please make explicit if and how the pollen amount comes into play and how it depends on tree size or age or weather. How is a father tree defined by the variables above? How does its distance to the mother tree come into play? I see it in fig. 1, but not in the formulae

L160: runaway line âĂČ L187: What is the difference between the two parallelisations A and B?

L189-205: I’m confused. What is the difference between the implemented dispersal function and the full model? Isn’t the dispersal function implemented into the full model? So, where can differences come from? Why do you need this verification? Please clarify.

L239: Why do you undergo the effort to calculate the wind-direction-dependent pollen

transport, to then take father trees randomly from any direction???? Why not using the father trees in the different directions? Or did I misunderstand that? Do you really sample the father trees with uniform probability?

L260: Why do you mention the times? Because the RAM adds up over time, or because the numbers of trees and seeds increase over time?

L284: and forest landscape models, in particular individual based ones like Iland (Seidl et al, 2012)

L312: Unclear. What would slow down the recent potential migration rate? And how?

L358: This would require simulations on very large areas or long transects, for which the current approach is (still) too slow. Some simplification/upscaling would be required.

L365-370: This is the real step forward, I would even emphasize it more!

Fig. 3: Please extend the caption, explaining in much more detail what was recorded. In particular the directions need to be explained. I guess, for wind and seeds, the direction means in which direction they go, in contrast for pollination the direction refers to where the father trees are?

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Additional literature:

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Epstein, H.E., Yu, Q., Kaplan, J.O. & Lischke, H. (2007) Simulating future changes in Arctic and subarctic vegetation. Computing in Science & Engineering, 9, 12-23.) .

Seidl, R., Rammer, W., Scheller, R.M. & Spies, T.A. (2012) An individual-based process model to simulate landscape-scale forest ecosystem dynamics. Ecological Modelling, 231, 87-100.

Snell, R.S., Huth, A., Nabel, J.E.M.S., Bocedi, G., Travis, J.M.J., Gravel, D., Bugmann, H., Gutiérrez, A.G., Hickler, T., Higgins, S.I., Reineking, B., Scherstjanoi, M., Zurbriggen, N. & Lischke, H. (2014), Using dynamic vegetation models to simulate plant range shifts. Ecography, 37, 1184-1197)

Shifley, S.R., He, H.S., Lischke, H., Wang, W., Jin, W., Gustafson, E.J., Thompson, J.R., Thompson III, F.R., Dijak, W.D. & Yang, J. (2017) The past and future of modeling forest dynamics: From growth and yield curves to forest landscape models. Landscape Ecology, 32, 1307-1325.)

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