ForEdgeClim

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In this report an overview of the model *ForEdgeClim* is written down. *ForEdgeClim* is a process-based microclimate model that is initially written to simulate microclimate gradients along transect lines from a forest's core towards its edge.

The model follows a mechanistic approach to microclimate modelling, grounded on the principle of energy conservation, which states that energy cannot be created or destroyed under normal conditions. Semi-opaque surfaces in the environment, such as the canopy and the ground, absorb solar radiation while simultaneously emitting thermal radiation. These surfaces also exchange sensible heat with the air and experience latent heat fluxes (here, cooling by evapotranspiration). Additionally, the ground stores and releases energy, contributing to the overall energy balance.

Since each component of the energy budget depends on temperature, they are all are included in an iterative loop until energy balance convergence is reached and this for a steady state, single moment in time. [Note: this convergence is persued for the surface (i.e., forest structural) temperature. Air and soil temperature are also modelled, but are updated by the updated surface temperature. Therefore, there is no convergence criterion for air and soil temperature. (See further for more explanation.)]

The assumption of a steady-state condition is valid here because our objective is to model temperature between consecutive hourly time steps, and thermal equilibrium is reached much faster than the hourly time step we apply. There is therefore no temporary heat accumulation or delayed temperature response. We could make the model dynamic, which could be interesting for studying temporal dynamics related to heat storage or soil dynamics. However, our current focus is on modelling temperature through processes such as radiation, latent heat, sensible heat, and ground flux, all of which reach equilibrium more quickly than the hourly time step.

The use of an iterative loop is necessary because no closed-form mathematical solution exists for the energy budget equations. All processes in the microclimate model continuously influence each other, and only through repeated updates can a stable and physically realistic temperature distribution be achieved. One of the complex interdependency is for example the relationship between surface heating and sensible heat exchange.

The model starts by simulating shortwave radiative transfer (RTM) that calculates shortwave radiation in two directions: vertical and lateral. The RTM is therefore two-dimensional. Next, it attempts to close the energy balance by reducing the energy balance closure error (E_{bal}) to less than 1 W/m^2. This equation (eq. 1) balances the net radiation (R_n), sensible heat flux (H), and latent heat flux (LE) for the forest structure. Ground heat flux (G) is also modelled but is not part of the energy balance of the forest structure. Ground heat flux is (currently) only used to simulate ground temperature, which in turn influences air temperature. Net radiation consists of both shortwave and longwave radiation in 2D. Sensible heat flux is calculated in 3D, whereas latent heat flux and ground flux are calculated in 1D (vertically). The processes are carried out between voxels in 3D. Each voxel contains a density value, determined from terrestrial laser scanning (TLS) data to account for the forest structure.

$$E_{bal} = R_n - H - LE = 0 \tag{1}$$

Solving the energy balance

Within the iterative loop to converge the energy balance per voxel, and therefore for the entire system, net radiation, sensible heat flux, latent heat flux, ground heat flux, air temperature and soil temperature are updated by an updated surface temperature. Further down, the equations for these processes/variables are presented.

Based on the *SCOPE 2.0* model, Newton's method is used to update surface temperature values between successive iteration steps. This method utilizes the energy balance closure error (E_{bal}) and its derivative with respect to forest temperature (see eq. 2). In this equation, W is a weighting for the step size.

$$T_{new} = T_{old} - W \cdot \frac{E_{bal}(T)}{\frac{\delta E_{bal}(T)}{\delta T}} \tag{2}$$

The derivative of the energy balance closure error to the surface temperature can further be written as:

$$\frac{\delta E_{bal}(T)}{\delta T} = \frac{\delta R_n(T)}{\delta T} - \frac{\delta H(T)}{\delta T} - \frac{\delta LE(T)}{\delta T} \tag{3}$$

And from the formulas in the sections below, it follows that eq. 3 can be further expanded as:

$$\frac{\delta E_{bal}(T)}{\delta T} = -4 \cdot e_f \cdot \sigma \cdot T^3 - \rho \cdot g_f - \rho \cdot \alpha \cdot (-4 \cdot e_f \cdot \sigma \cdot T^3) \cdot \frac{s}{s+\gamma} + \rho \cdot \alpha \cdot R_n \cdot \frac{dF(T)}{dT} \tag{4}$$

with

$$\frac{dF(T)}{dT} = \frac{\frac{ds(T)}{dT} \cdot (s+\gamma) - s \cdot \frac{ds(T)}{dT}}{(s+\gamma)^2} \tag{5}$$

and

$$\frac{ds(T)}{dT} = \frac{4098 \cdot \frac{de_s(T)}{dT} \cdot (T+237.2)^2 - 2 \cdot (T+237.3) \cdot 4098 \cdot e_s(T)}{(T+237.3)^4} \tag{6}$$

and

$$\frac{de_s(T)}{dT} = 0.6108 \cdot exp(\frac{17.27 \cdot T}{T+237.3}) \cdot \frac{(T+237.3) \cdot 17.27 - 17.27 \cdot T}{(T+237.3)^2} \tag{7}$$

In eq. 5, 6 and 7, T is the surface temperature in °C. (If not mentioned otherwise, T is expressed in K.)

Modelling temperatures

As mentioned before, *ForEdgeClim* models three temperature values. First and foremost, the surface temperature is modelled. This temperature represents the temperature of the forest surface structures within the voxel grid, i.e., leaves, branches and stems. In the model, Newton's method is applied, as described above, to update the surface temperature between successive iteration steps.

In addition to surface temperature, both air temperature and soil temperature are modelled. Air temperature represents the temperature of the air within each voxel. Since each voxel has a certain density value representing the structure, the remaining density (1 - density) represents the air. Soil temperature is a single-layer temperature, effectively representing the ground surface temperature. Below, further explanation is provided on how air and soil temperature are modelled.

Air temperature

Modelling air temperature is a non-trivial task, and in *ForEdgeClim* it is done via a linearisation, similar to the approach used in the microclimate model *microclimf* by Ilya Maclean. This method is mostly valid when there are small temperature differences between air temparature and surface temperture, when there is sufficient air streaming, when the net radiation or the humidity is not extreme and when the forest structure is quite homogeneous.

Air temperature is derived as shown in eq. 8. In this equation w refers to weight, g to conductance (actually combined conductance and convection) and T to temperature. The subscript m refers to macro environment, s to soil and f to forest surface. mX and mZ further refer to the macro environment along the X-axis (lateral) and the Z-axis (vertical), respectively.

The weights w are defined as exponential weightings of the boundary distances. All definitions of w have the same structure, an example for w_s is given in eq. 9. Here, d_s is the distance to the forest soil surface and α_s is defined in eq. 10. In this equation, i_s is the 'distance of influence'. i_s is defined as the distance over which the influence of soil temperature on air temperature is reduced by 50%. Exponential weighting is well-suited for microclimate modelling as it naturally represents the gradual decline in influence with distance, aligning with physical heat transfer principles. It ensures smooth transitions between temperature sources, accommodates varying spatial scales, and integrates well with convection and conduction processes. Additionally, it prevents unrealistic temperature fluctuations and maintains numerical stability.

The conductances g and the distances of influence i are input parameters and T_f is the to be modelled forest surface temperature. If a voxel does not contain forest structure (and therefore has no T_f), the average surface temperature of the corresponding X-, Y- and Z-planes is used.

$$T_{air} = \frac{(w_{mX} + w_{mZ}) \cdot g_m \cdot T_m + w_s \cdot g_s \cdot T_s + w_f \cdot g_f \cdot T_f}{(w_{mX} + w_{mZ}) \cdot g_m + w_s \cdot g_s + w_f \cdot g_f} \tag{8}$$

$$w_s = e^{\alpha_s \cdot d_s} \tag{9}$$

$$\alpha_s = log(0.5/i_s) \tag{10}$$

Soil temperature

There is (currently) no detailed model for simulating soil temperature. Instead, ground temperature (T_s) is modelled using a time lag on the macrotemperature. The ground temperature is determined from the ground heat flux (G), the air temperature (T_{air}), and a temperature correction for the time lag of the soil temperature relative to the macrotemperature (T_{lag}) (see eq. 11).

$$T_s = \frac{G}{g_s} + T_{air} - T_{lag} \tag{11}$$

G is explained further down and T_{lag} is defined by a sinus function that simulates macrotemperatures based on the maximum (Max) and minimum (Min) daily (or seasonal macrotemperatures). The sinus simulating the macrotemperature is given in eq. 12. Here t_{max} is the moment (hour) at which Max is reached (around 14h). The current macrotemperature can then be obtained by substituting the current time into t. The near-surface (= ground) temperature at that moment is defined as the macrotemperature from 6 hours ago, meaning the ground temperature has a time lag of 6 hours. The difference between the current and the lagged temperature is called T_{lag} and is used in the definition of T_{soil} (eq. 11).

$$T = \frac{Max + Min}{2} + \frac{Max - Min}{2} \cdot cos(\frac{2 \cdot \pi}{24}) \cdot (t - t_{max}) \tag{12}$$

Radiative transfer model

The radiative processes are simulated in 2D (vertical and lateral) and use the two-stream radiative transfer model, based on the version also used in the *ED 2.2* model. (See the report Two-stream Radiative Transfer Model of ED 2.2 for a detailed description of the model.)

In short, for the shortwave RTM, the model simulates multi-scatter radiative transfer along a single column, where direct and diffuse sunlight interact with a layered structure containing density values. Direct beam radiation ($I_b^{\downarrow}$) is represented by an exponential decaying process, and the RTM solves for diffuse upward and downward radiation ($I^{\downarrow}$ and $I^{\uparrow}$) in each canopy layer using a linear matrix equation. Equations 13, 14 and 15 present the equations for the direct and diffuse radiation components. Table 1 explains the parameters used in these equations.

$$\frac{dI_b^{\downarrow}}{dx} = -K_b I_b^{\downarrow} \tag{13}$$

$$\frac{dI^{\downarrow}}{dx} = -[1 - (1-\beta)\omega]K_d I^{\downarrow} + \beta\omega K_d I^{\uparrow} + (1-\beta_0)\omega K_b I^{\downarrow}_{sky,b} e^{-K_b x} \tag{14}$$

$$\frac{dI^{\uparrow}}{dx} = [1 - (1-\beta)\omega]K_d I^{\uparrow} - \beta\omega K_d I^{\downarrow} - \beta_0\omega K_b I^{\downarrow}_{sky,b} e^{-K_b x} \tag{15}$$

Table 1: Prameters used in the two-stream RTM

parameter	explanation
K_b	direct radiation extinction coefficient
K_d	diffuse radiation extinction coefficient
ω	scattering coefficient
β_0	backscattering coefficient for direct radiation
β	backscattering coefficient for diffuse radiation

The choice of values for the parameters in table 1 is not random. For example, in temperate forests, direct sunlight is significantly weakened by the presence of leaves, branches, and other structures that lie directly in the light path. Values for K_b in the vertical direction of around 0.75 correspond to the shading and absorption by dense canopies. Diffuse sunlight is less strongly attenuated because it comes from multiple directions and some of it can penetrate through small openings in the canopy. This results in a lower attenuation coefficient. The attenuation coefficients are, in principle, season-dependent; for instance, in winter, the attenuation coefficient can be lower due to the absence of leaves. Lateral attenuation coefficients are lower because light travelling horizontally passes through a shorter path within the tree structure, often encountering fewer obstacles.

The parameters in table 1, along with the values of direct and diffuse solar radiation from the above canopy and the ground reflectance (ω_g), serve as input parameters for the shortwave two-stream RTM model.

This model is a 'single-column' model. To achieve a 2D RTM for our 3D grid, this model is applied to every vertical column (fixed XY) and every horizontal column (fixed YZ).

Process 1 — Net radiation R_n

Net radiation is described in equation 16 and consists of three terms derived from the shortwave RTM ($I_b^{\downarrow}$, $I^{\downarrow}$ and $I^{\uparrow}$), as well as two terms representing incoming and outgoing longwave radiation ($L^{\downarrow}$ and $L^{\uparrow}$). Both longwave radiative terms are described using an analogous two-stream RTM model as for the shortwave radiation. Yet, here, the direct beam radiation terms are removed, and a source of thermally emitted radiation is added. The equations governing the longwave terms are given in eq. 17 and eq. 18. In those equations, ϵ and σ represent the emissivity and the Stephan-Boltzmann constant, respectively. All other parameters are similar as in eq. 14 and 15.

$$R_n = I^{\downarrow} - I^{\uparrow} + I_b^{\downarrow} + L^{\downarrow} - L^{\uparrow} \tag{16}$$

$$\frac{dL^{\downarrow}}{dx} = -[1 - (1-\beta)\omega]K_d L^{\downarrow} + \beta\omega K_d L^{\uparrow} + \epsilon\sigma T_f^4(1-\beta)\omega K_d \tag{17}$$

$$\frac{dL^{\uparrow}}{dx} = [1 - (1-\beta)\omega]K_d L^{\uparrow} - \beta\omega K_d L^{\downarrow} + \epsilon\sigma T_f^4(1-\beta)\omega K_d \tag{18}$$

Process 2 — Ground heat flux G

Ground flux is modelled as a percentage (p) of the net radiation at ground level and is given in eq. 19. Here ρ is the forest density.

$$G = p \cdot (1-\rho) \cdot R_n \tag{19}$$

Process 3 — Sensible heat flux H

A surface heated by solar radiation transfers some of this heat to the surrounding air. According to the laws of energy conservation, the air absorbs this heat. This process is known as sensible heat exchange. In *ForEdgeClim* sensible heat exchange is conducted in 3D and simulates 1) heat convection (C) between the air of adjacent neighbouring voxels using the formula for heat transfer by convection (eq. 20 (Newton's law of cooling) and 21) and 2) heat conductance (actual sensible heat exchange) from the forest surface to the surrounding air (eq. 22). At the edges of the grid, there is also a transfer of heat with the macro environment and forest soil.

In eq. 20, h is the thermal convection coefficient of air, A the surface area of one voxel face and ΔT_{air} the difference in air temperature between neighbouring voxels. In eq. 21, c_p is the specific heat of air, ρ_{air} the density of air and V the voxel volume.

In eq. 22, ρ is the forest density, g_f the forest conductance, T_f the forest surface temperature and T_{air} the air temperature. H is actually simulated via 'convective conductance' and g_f actually functions as an 'effective conductance' that accounts for both conduction within the leaf boundary layer and convection around it.

$$C = h \cdot A \cdot \Delta T_{air} \tag{20}$$

$$T_{air-new} = T_{air-old} - \frac{C}{c_p \cdot \rho_{air} \cdot V} \tag{21}$$

$$H = \rho \cdot g_f \cdot (T_f - T_{air}) \tag{22}$$

Process 4 — Latent heat flux LE

Latent heat flux is modelled using the empirical Priestley-Taylor method (eq. 23). This is a simplified version of the Penman-Monteith equation that simulates the potential evapotranspiration and where all aerodynamic variables are encapsulated in a single parameter, α. In this equation, it is assumed that the aerodynamic term (the advective component) is negligible. As a result, evapotranspiration can be calculated based on the available net radiation energy and the psychrometric constant. It performs well under specific climatic and environmental conditions. Some important conditions include negligible advective processes, surfaces with unlimited water availability, radiation being the dominant factor for evaporation, and relatively stable atmospheric conditions (i.e., no extreme wind, pressure, or humidity variations).

$$LE = \rho \cdot \alpha \cdot R_n \cdot \frac{s(T_f)}{s(T_f) + \gamma} \tag{23}$$

In eq. 23, γ is the psychrometric constant and s represents the slope of the saturation pressure curve in kPa/K and is further defined in eq. 24.

$$s(T_f) = 4098 \cdot \frac{e_s(T_f)}{(T_f + 237.3)^2} \tag{24}$$

Here, e_s is the saturated vapor pressure. It is calculated using the empirical formula by Tetens (see eq. 25). The formula by Tetens is an empirical approximation of the Clausius-Clapeyron equation and works well for temperatures between -40°C and 50°C.

$$e_s(T_f) = 0.6018 \cdot exp(\frac{17.27 \cdot T_f}{T_f + 237.3}) \tag{25}$$

In all these equations, T_f is expressed in °C.

Numerical approach

ForEdgeClim employs a grid-based numerical approach to simulate microclimate temperature and energy exchange in fragmented forests. Given the structured nature of the 3D voxel-based representation of the forest, a grid-based method is a logical choice, ensuring spatially explicit calculations and allowing for efficient computation of radiative and heat transfer processes.

The model integrates two numerical methods: the Finite Difference Method (FDM) and the Finite Volume Method (FVM). FDM is utilised for air-to-air convective heat transfer, where temperature gradients are approximated using finite difference schemes. This allows for an efficient discretisation of heat diffusion processes within the voxel grid. Meanwhile, FVM is applied to solve the energy balance equation, ensuring conservation of energy fluxes at the voxel scale. FVM is particularly advantageous in this context as it explicitly accounts for energy exchange between adjacent voxels, which is essential for accurately modelling the interactions between forest structure, air, and soil.

The choice of a grid-based approach over particle methods (like Monte Carlo methods) or mesh-based methods is motivated by the structured nature of forest transects in the model. A voxel-based discretisation aligns well with available 3D structural data, such as LiDAR-derived forest density maps, allowing for direct incorporation of empirical data. Furthermore, grid-based methods facilitate efficient coupling of radiative transfer, heat exchange, and evapotranspiration processes within a unified computational framework. This hybrid FDM-FVM approach balances computational efficiency with physical accuracy, making it well-suited for simulating spatially heterogeneous microclimates in complex forested environments.

Input variables and model parameters

As input variables, the macrotemperature, latitude, longitude, date & time, direct shortwave radiative flux, diffuse (shortwave and longwave) radiative fluxes, and forest structure (density) are used.

As can be derived from this report, there are several parameters that we can change to calibrate and validate our model. An overview of the input variables and model parameters is shown in table 2. (Some parameters are actually physical constants and are therefore not parameters to be tweaked.) The RTM parameters are used for both the longwave RTM and the shortwave RTM, but they are assigned different values. However, in the longwave RTM, no direct beam parameters (K_b and β_0) are used. Additionally, the longwave RTM has three extra parameters that represent the emissivity of the atmosphere and the forest, as well as the Stefan-Boltzmann constant. Input variables that are currently not included in the table are the maximum (Max) and minimum (Min) macrotemperature and the hour of the maximum macrotemperature (t_{max}). These variables are currently needed to determine the soil temperature. In a future version, soil temperature might be modelled in a more physically accurate way.

Some first results

The structure grid used in the simulation below is the TLS scan taken from the transect in Gontrode forest in June 2023. An illustration can be found in figure 1 in 2D. The forest edge is located on the right side, in the east, at the maximum X-position. We assume that there is more forest to the north, west, and south. Hence, in the 2D RTM, radiation enters from above and from the right side. The density of each voxel is normalised and ranges between 0 and 1. In the transect, we observe a gap around the X = 50m position. This is due to ash dieback, caused by a chronic fungal disease affecting ash trees in Europe, characterised by leaf loss and crown dieback in infected trees. The transect consists mainly of ash trees between X min and X = 50, while beyond X = 50, it is predominantly composed of beech and

Table 2: Input variables and model parameters

Input variable		Model parameter		
variable	example value	parameter	example value	submodel
T_{macro}	25°C	K_b (vertical)	0.75	SW RTM
$I^{\downarrow}_{sky,b}$	600 W/m^2	K_d (vertical)	0.3	RTM
$I^{\downarrow}_{sky}$	200 W/m^2	K_b (lateral)	0.5	SW RTM
$L^{\downarrow}_{sky}$	400 W/m^2	K_d (lateral)	0.2	RTM
latitude	50.980°	β	0.3	RTM
longitude	3.816°	β_0	0.2	SW RTM
datetime	2023-06-23 12:00:00	ω	0.85	RTM
		ω_g (vertical)	0.2	RTM
		ω_g (lateral)	0	RTM
		ϵ_a (atmosphere)	0.2	LW RTM
		ϵ_f (forest)	0.95	LW RTM
		σ	5.67e-8 $W/m^2/K^4$	LW RTM
		h	15 $W/m2/K$	H
		Voxel length	1 m	H
		c_p	1000 $J/kg/K$	H
		ρ_{air}	1.225 $kg/m3$	H
		α	1.26	LE
		γ	0.066 kPa/K	LE
		p	0.1	G
		g_f	10 $W/m^2/K$	H & T_{air}
		g_s	10 $W/m^2/K$	T_{air}
		g_m	10 $W/m^2/K$	T_{air}
		i_f	6 m	T_{air}
		i_s	5 m	T_{air}
		i_m	30 m	T_{air}

oak trees. In the figure, we also see a higher structure to the right of the gap. This is the flux tower located within the transect. We furthermore observe a higher density in the upper right part of the gap. A healthy oak is taking advantage of the ash dieback to expand its canopy.

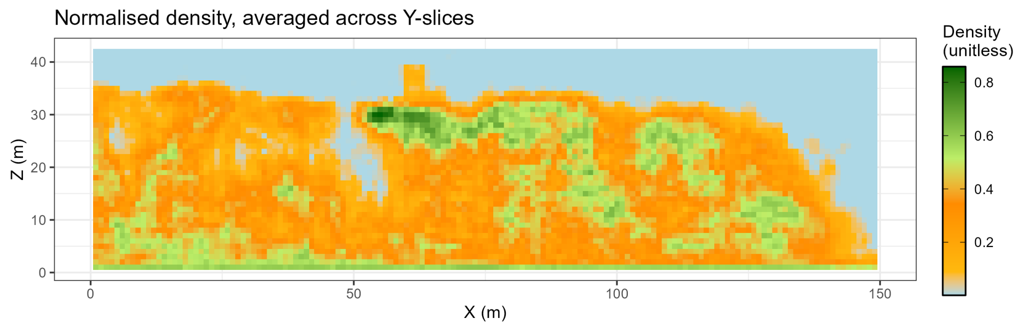

Figure 1: Cross-sectional density plot of 3D grid in 2D

Figure 2 shows the digital terrain model derived from the TLS scans. Along the western side, we see a small river running from north to south, while on the eastern side, there is a road. The terrain slopes upward from west to east, meaning the road is at a higher elevation than the river. The parallel lines are furrows, a common technique used to improve drainage in wet forests. These furrows are very old and were likely established before the 1650s. Trees could be planted on the elevated and therefore drier ridges.

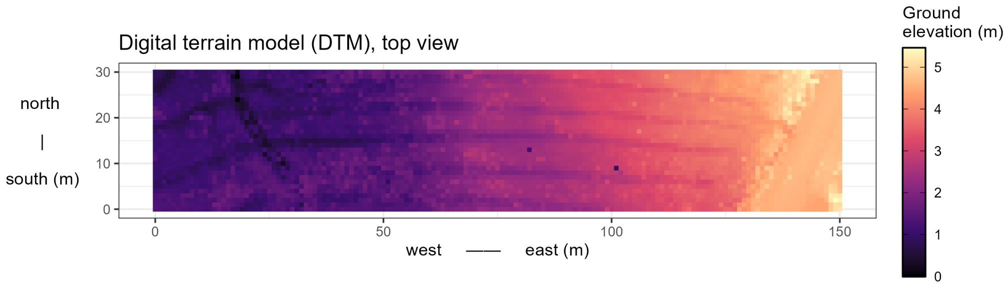

Figure 2

In the simulation discussed below, the microclimate surface and air temperature are modelled for the location Gontrode in Belgium on June 23, 2023, at 12:00:00 UTC. Input variables and model parameters similar to the ones mentioned in table 2 are used in this simulation.

Figure 3 shows the total shortwave downward radiation for both the vertical and lateral direction (averaged over Y-slices). We observe that a significant amount of radiation is present at the top of the canopy, and at the forest edge, but also the gap can be distinguished.

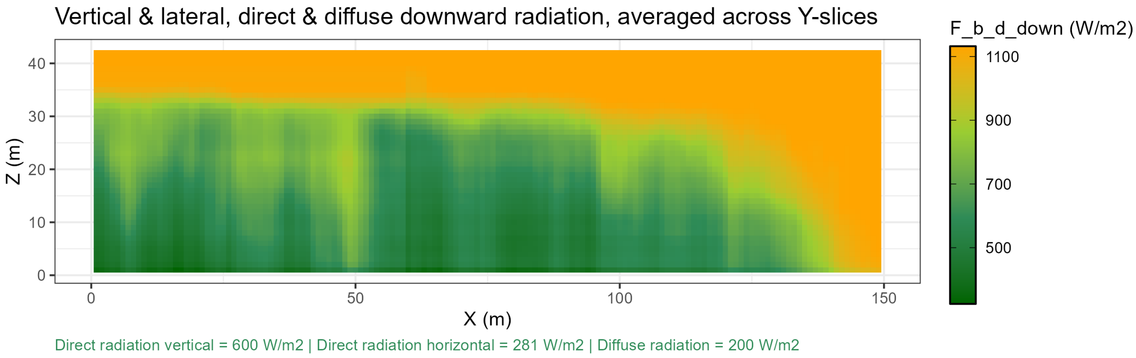

Figure 3

In figure 4, you can see the air temperature averaged over Y-slices along the transect. We see that the macrotemperature outside the forest transect is indeed 25°C, as expected, since the macrotemperature is set to 25°C. At the top of the canopy, we observe warming due to the leaves absorbing and re-emitting radiation. Beneath the canopy, along the ground, there is a clear cooling effect. We also observe that in the gap, the warmer macrotemperature penetrates deeper to the ground compared to the surrounding areas.

Figure 5 displays the surface temperature. Here too, we observe higher temperatures at the top of the canopy and lower temperatures deeper in the forest and along the ground. Compared to the air temperature shown in figure 4, we observe that temperatures in the canopy are higher (up to 30°C). The temperature distribution of the surface temperature is therefore considerably wider compared to the one of air temperature.

If we then plot the air temperature for the voxels at 5m height along the transect (again averaged over Y-slices, i.e., horizontal plane at 5m height), we obtain figure 6. Here, we observe

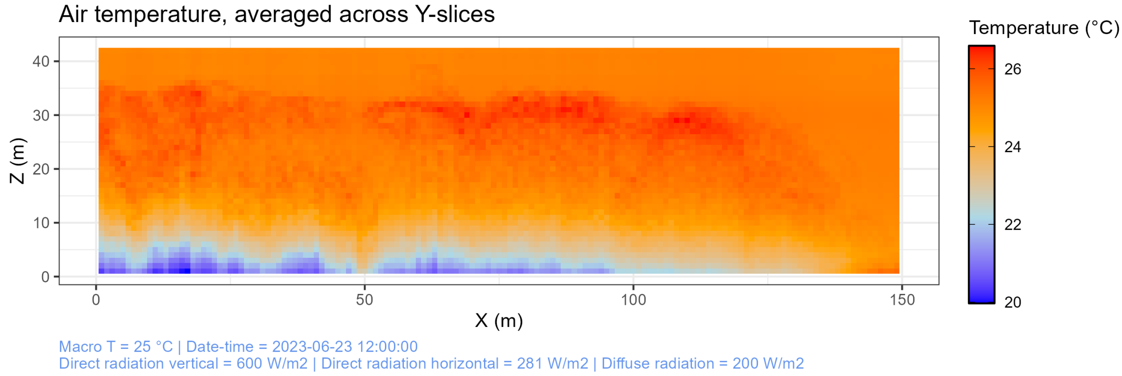

Figure 4

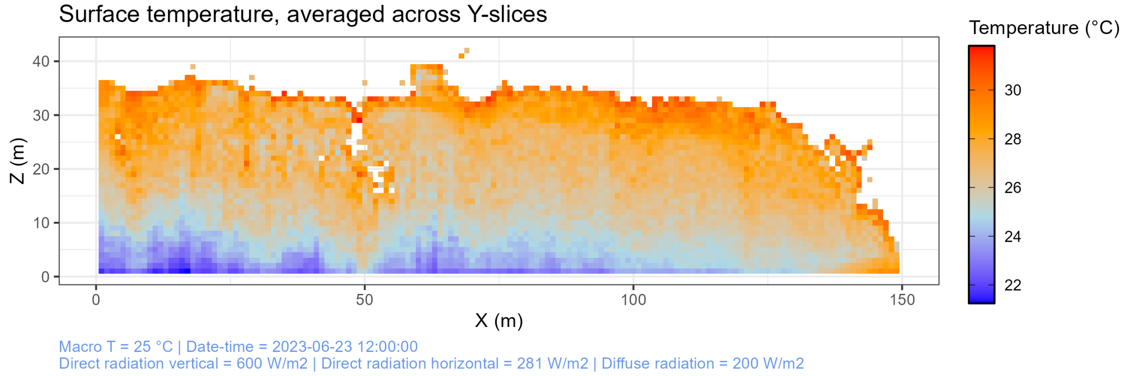

Figure 5

two notable features. First, there is a temperature increase in the gap, mainly resulting from radiative heating of the surface. Second, a clear decrease in temperature from the edge to the interior can be observed. In the first 15 m from the edge, there is no forest yet, so the modelled temperature still corresponds to the macrotemperature above the road. As we enter the forest at X = 135m, we observe a sharp temperature decrease. This is due, among other factors, to the shading capabilities of the forest, which ensure that radiative heating primarily occurs in the top canopy rather than in the lower structures, unless there is a gap in the forest (such as around 50m on the X-axis in this case). Additionally, the heat transfer buffering effect of the forest structure plays a role, bringing warm macro air in along the edge but preventing it from being conducted all the way to the core.

Figure 7 shows the ground temperature, just below the lowest Z-grid layer. Here, we observe that the highest temperatures are located at the forest edge, where a road is present. As we move further into the forest, we see a cooling effect, with a slight warming occurring where the forest gap is located.

ForEdgeClim also produces plots that display the various fluxes. An example of the net radiation is shown in figure 8. Here, we see that most radiation is absorbed at the top of the canopy, along the forest edge, and in the canopy layers around the gap.

Figures 9 and 10 show the air temperature during a summer night. Compared to figures 4 and 6, there are far fewer fluctuations, with the most prominent feature being the steady temperature increase from the forest edge to the core. This corresponds to the expected weaker temperature differences between the forest and the macro environment during colder periods.

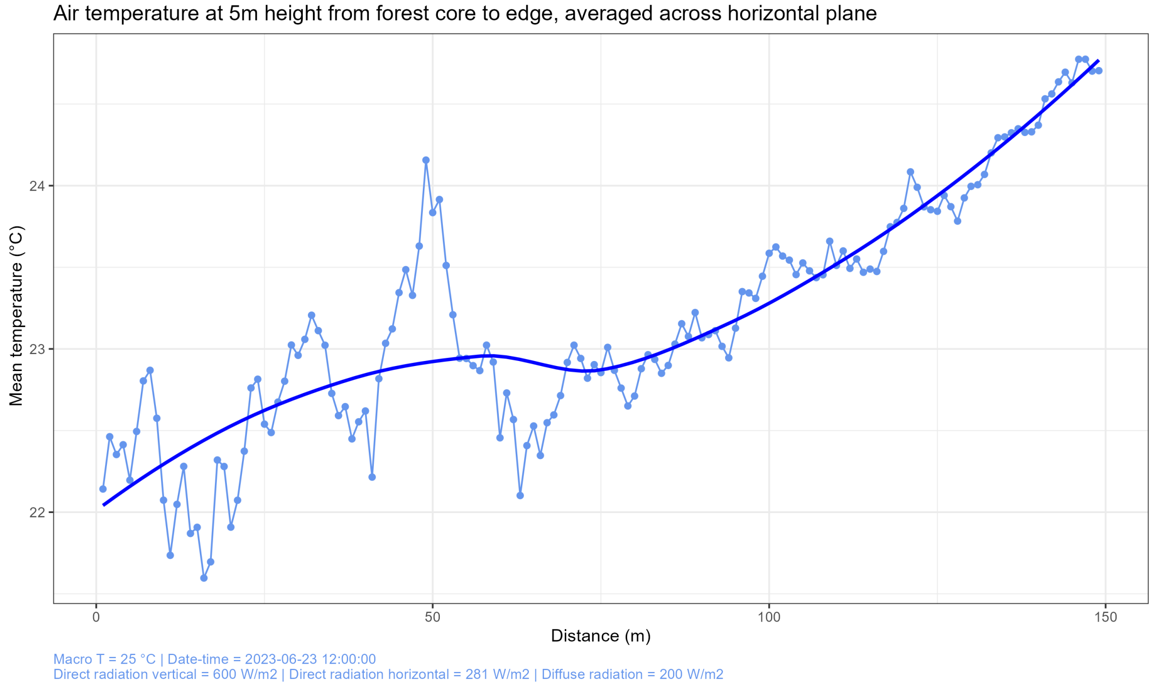

Figure 6

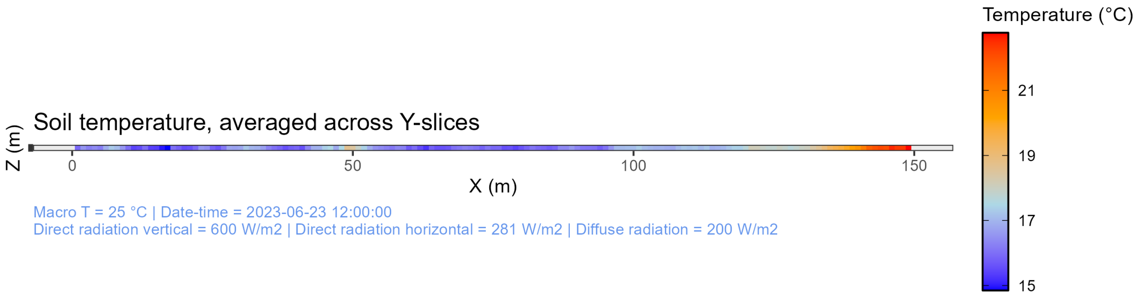

Figure 7

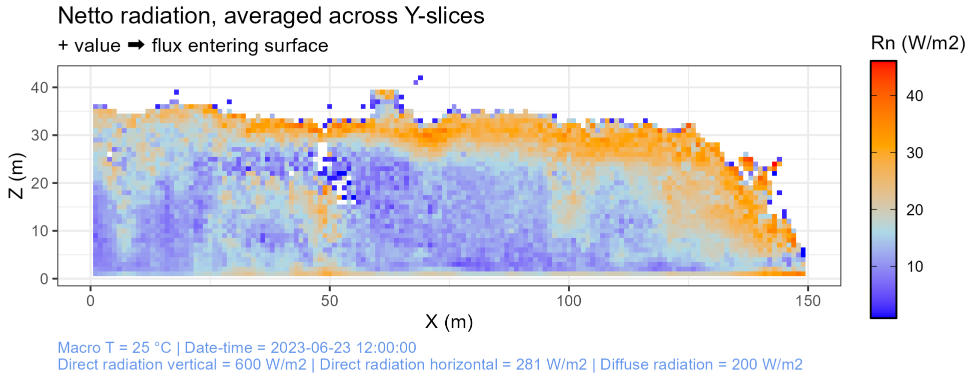

Figure 8

Final remarks

The *ForEdgeClim* model, as described in this report, aims to simulate microclimate/ -temperature in a (temperate) forest in a physically realistic manner, given macro input variables and forest

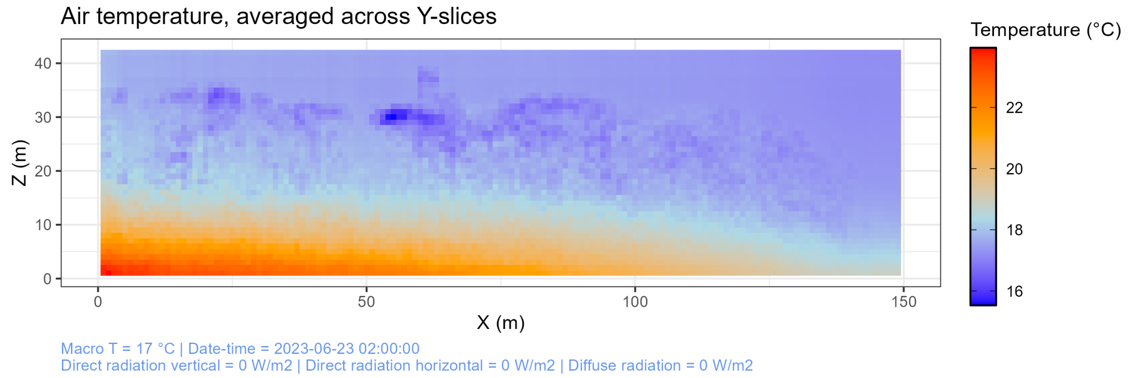

Figure 9

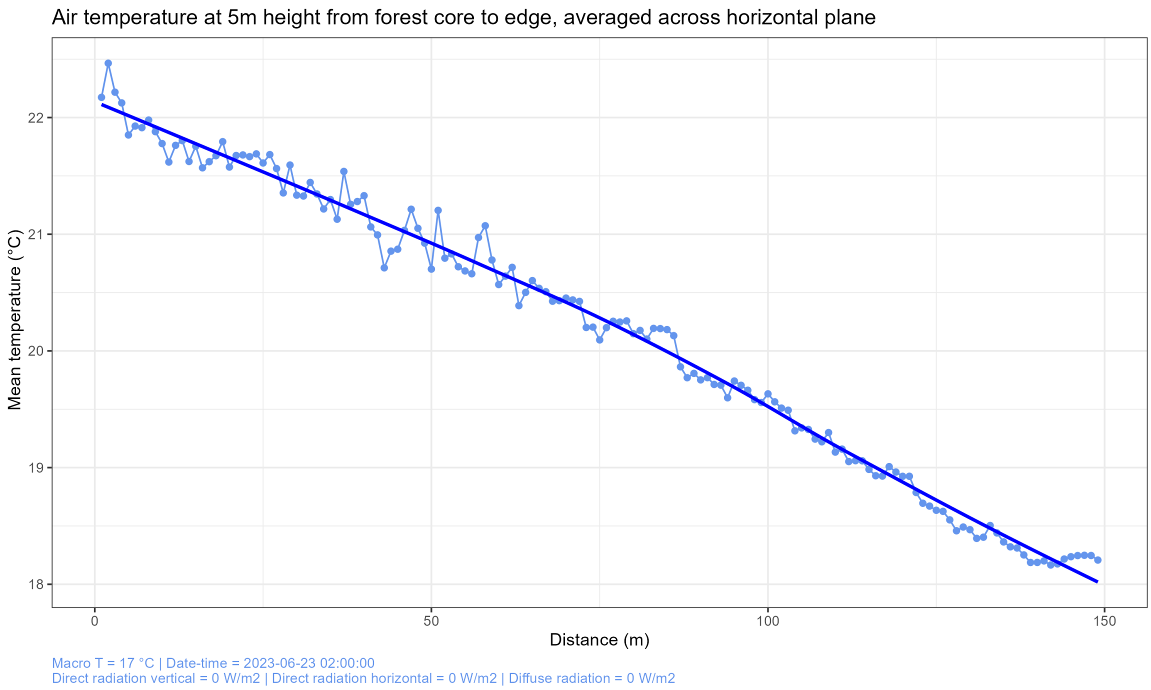

Figure 10

structure. To achieve this, key contributing processes were identified and considered in terms of how they could be modelled in a physically accurate way. When selecting processes and their mathematical implementation, a balance was sought between detail and relevance.

ForEdgeClim is therefore not an extremely detailed microclimate model that accounts for all microclimatic ecosystem processes. However, the model currently appears to generate physically realistic output. In future versions, processes such as soil heat flux, (lateral) wind, and hydrological processes seem to be among the top priorities for inclusion.

Next steps

- Compare with observations and start calibrating parameters using sensitivity analysis
- Write model description paper :)
- Validate with independent datasets (different periods/seasons and other locations)

References

- *microcimf* model by Ilya Maclean
- *SCOPE 2.0* model by Wim Verhoef & Christiaan van der Tol
- *ED 2.2* model by the *ED 2.2* development team