*~~Wetness Index 1~~*

~~Free water is considered water content that is above field capacity (pressure head 3.37 m), up to complete saturation of the soil. From the soil characteristics, the volume of free water capacity (FWC) can be calculated from the volume at porosity (saturation) and the volume at field capacity.~~

~~FWC = Porosity – Field Capacity~~

~~Within the succession photosynthesis calculations, as cohort sublayers are processed for growth, the volumetric water content of the soil is tracked as water gets added (precipitation, melting) and removed (transpiration, leakage, evaporation) from the soil. At any point, the quantity of free water (FW) can be calculated as the difference between current water volume and field capacity, with a limit that FW cannot be <0.~~

~~A wetness index (WI) can be calculated as the ratio of FW:FWC. Completely saturated soils will have a WI value of 1, and soils at or below wilting point will have a WI value of 0, with a linear change between the two points for intermediate water volumes. Values of WI are constrained to range between 0 and 1. Example calculations of WI can be found in “Wetness Index.xlsx”.~~

~~The WI value used in timestep averaging when the pressure head is above MinPH is 0. This limitation denotes conditions when soils are too dry (high pressure head) to support pathogen growth.~~

*Wetness Index*

Cook (1973) reported optimal growth for *P.* *cinnamomi* at water potentials of - 5 bars, and Weste and Ruppin (1977) found that soils with water potential lower than -5 bars began to limit populations, with potentials of -10 or lower reduced populations to zero. A wetness index (WI) is calculated as 1.0 for water potential greater than -5 bars (wetter), and 0.0 for water potential less than -10 bars (drier). WI scales linearly from 0 to 1 for water potential between -10 bars (102 m pressure head) and -5 bars (51 m pressure head).

*Average WI*

An average Wetness Index (WIavg) is calculated for each succession timestep, across all cohorts for all growing season months in the timestep, with limitations based on soil temperature. A minimum infection temperature parameter (MinSoilTemp) defines a soil temperature below which pathogen populations drop and do not cause infection. For any month with soil temperatures below MinSoilTemp, the WI value used in averaging is 0. This limitation denotes conditions when soils are too cold to support pathogen growth.

Soil texture is believed to impact the soil moisture conditions that influence pathogen populations through differing abilities to hold water in the soil (CITE). We added a soil modifier to WI to account for differences in soils. We used the data from Weste and Ruppin (1977; Figures 4-6) and fit a linear regression model relating the population index PDI (rescaled to range 0-1) to estimated WI (from water potential) and soil field capacity, estimated from site soil descriptions including soil depth and texture. Calculations from Saxton and Rawls (CITE) used texture class and percent clay to estimate soil field capacity (cm water) for the sites: Wilson’s Promontory = 6.53 cm, Brisbane Ranges = 1.96 cm, Narbethong = 44.64 cm. The fitted relationship between rescaled PDI, WI and FC (with an interaction between WI and FC) had an adjusted-R2 of 0.3134 and p-value of 0.0001999.

*Soil Temperature*

Soil temperature, at depth of 0.1m, is estimated using the same methods presented in Gustafson et al. (In Prep). *T*soil at month *m* is estimated as described for the LPJ DGVM in the appendix of Sitch et al. (2003):

where *T*ave is average air temperature for month *m*, *A* is the amplitude of air temperature over the previous 12 months, *d* is the damping depth (m), and Ω the angular frequency of oscillation (radians/month). The damping depth, *d*, and angular frequency of oscillation (Ω) are calculated as:

[2]

[3]

where *k* is the thermal diffusivity (mm2 mo-1) of the soil.

Thermal diffusivity (*k*) is estimated using the methods of Jong van Lier and Durigon (2013) and Farouki (1986), with inputs of total porosity (m3/m3), water content (m3/m3) and fraction clay (proportion), which make it dynamically dependent on the soil texture and its water content each month.

*Transition of Susceptible to Infected*

The probability of S transitioning to I is equal to the PDIavg, which accounts for both soil moisture and soil temperature thresholds.

*Transition of Infected to Diseased*

The probability of I converting to D [p(I→D)] is bimodal. The probability at pressure head values below MinPH follow the value of PDIavg as used above, except with the minimum probability constrained to be at or above the parameter minProbID. Probability also increases from minProbID at phDry to 1 at phMax.