MODULE OVERVIEW

Once adult bark beetles emerge and attack a nearby tree, they introduce blue stain fungi to the xylem, effective occluding it by spreading over time. The spread of this fungi within the xylem is a function of temperature-dependent growth rate. Therefore, we fit a blue stain fungal growth model to recently reported temperature-dependent growth rates (Moore and Six 2015), using a least-squares fit to a Gaussian function:

$$GR = ae^{\left[-0.5\left(\frac{AT-b}{c}\right)^2\right]}$$

In the above equation, GR represents fungal growth rate ($mm^2\ d^{-1}$), AT represents mean daily air temperature (°C), and a ($mm^2\ d^{-1}$), b (°C), and c (°C) are best-fit model coefficients. Fungal biomass (FBM) is allowed to accumulate through the growing season, and at each time step, FBM is equal to the sum of GR for that time step and all previous time steps following the onset of beetle attack.

The fungal growth rate model is used to downscale xylem water flux over time at each site. The relative decline in sap flux due to blue stain fungal occlusion of the xylem (xylem scalar – XS) is determined using observed ratios of mean daily sap flux for beetle attacked trees to unaffected trees. The XS ranges from 100% (no impact) to 0% (full xylem occlusion) at any given time step, which is used to downscale sap flow over time and ultimately stomatal conductance. The XS is determined at each time step as a function of simulated blue stain fungal biomass (based on observed temperature data) using a least squares fit to observed sap flux decline data (observed XS) to a logistic function that allowed sap flux to decline as fungal biomass increased.

$$XS = 100 * \frac{1}{1 + a_2 e^{b_2 * FBM}}$$