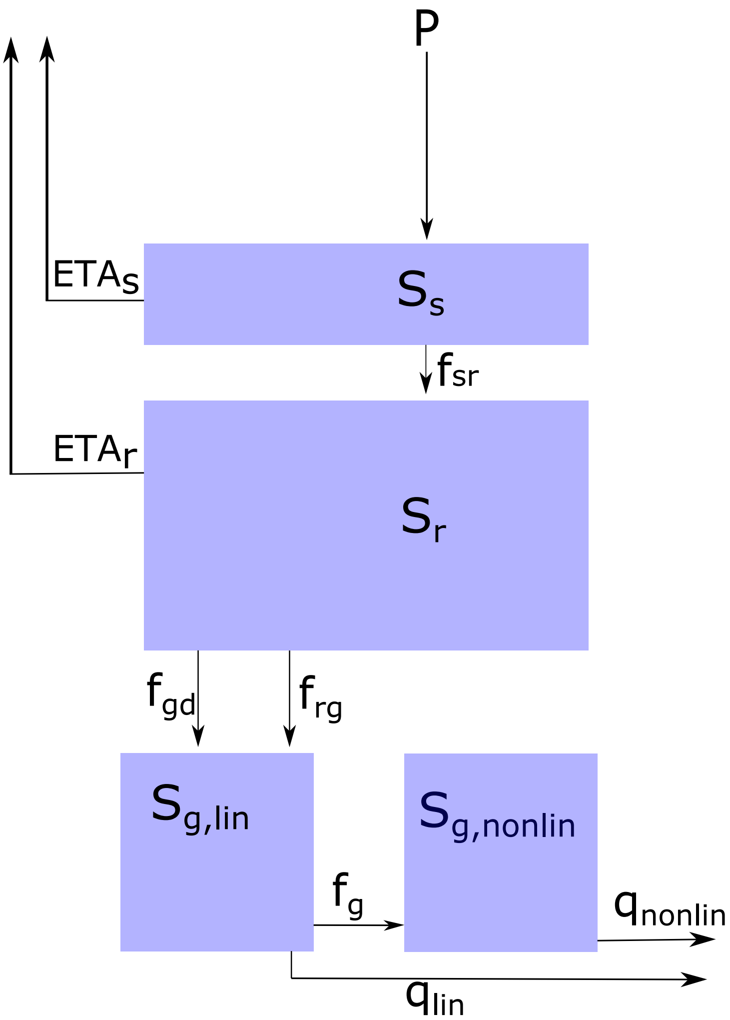

FIGURE 2 Elder Creek model wiring diagram.

TABLE 1 Elder Creek model state variables. All state variables have units of mm.

state variable	description
S_s	soil moisture storage
S_r	unsaturated fractured rock storage
$S_{g,lin}$	linear groundwater reservoir storage
$S_{g,nonlin}$	nonlinear groundwater reservoir storage

TABLE 2 Elder Creek model fluxes. All fluxes have units of mm/h.

flux	description	type
P	precipitation	external
ETP	total potential evapotranspiration	external
$\mathrm{ETA_s}$	actual evapotranspiration from the soil	external
$\mathrm{ETA_r}$	actual evapotranspiration from the unsaturated fractured rock	external
$\mathrm{q_{lin}}$	discharge from the linear groundwater reservoir	external
$\mathrm{q_{nonlin}}$	discharge from the nonlinear groundwater reservoir	external
$\mathrm{f_{sr}}$	overflow leakage from soil to unsaturated fractured rock	internal
$\mathrm{f_{gd}}$	gravity drainage from unsaturated fractured rock to groundwater	internal
$\mathrm{f_{rg}}$	overflow leakage from unsaturated fractured rock to groundwater	internal
$\mathrm{f_g}$	flow from linear to nonlinear groundwater reservoir	internal

TABLE 3 Elder creek model parameters.***Note: two parameters here have different names than in the code, for the purpose of code clarity: s_{wilt} in this manuscript represents θ_{wilt} in the code, and k_{sat} in this manuscript represents k_{fc} in the code. This is explained in the code.***

parameter	units	description	calibration range
r	-	relative root density; controls distribution of ET between soil and unsaturated rock stores	0.001 - 1
$S_{s,max}$	mm	maximum soil water storage; controls threshold at which soil leakage begins, as well as correction of ET	1 - 1000
$S_{r,max}$	mm	maximum unsaturated rock water storage; controls threshold at which leakage to groundwater begins, rate of gravity drainage from unsaturated rock to groundwater, and correction of ET	500 - 20000
s_{wilt}	-	relative moisture of $S_{r,max}$ and $S_{s,max}$ below which no actual evapotranspiration comes from the unsaturated rock	0 - 0.5
b_{fc}	-	power controlling shape of gravity drainage from unsaturated rock to groundwater	1 - 40
k_{sat}	$\mathrm{mm\ h^{-1}}$	saturated hydraulic condutcivity of fractured rock, which controls rate of gravity drainage to groundwater	4 - 1000
a	$\mathrm{h^{-1}(mm)^{1-b}}$	coefficient for nonlinear groundwater reservoir	5e-5 - 0.125
b	-	exponent for nonlinear groundwater reservoir	0.5 - 3
k_1	$\mathrm{h^{-1}}$	coefficient which controls the discharge of the linear groundwater reservoir	5e-5 - 0.125
k_{12}	$\mathrm{h^{-1}}$	linear groundwater reservoir coefficient which controls the rate at which water flows from the linear saturated store to the nonlinear saturated store	5e-5 - 0.125

$$\frac{\Delta \mathrm{S_s}}{\Delta t} = \mathrm{P} - \mathrm{ETA}_s - \mathrm{f_{sr}} \tag{1}$$

$$\mathrm{ETA_s} = \frac{\mathrm{S_s} - S_{s,max} \cdot s_{wilt}}{S_{s,max}} \cdot \frac{1}{1 - s_{wilt}} \cdot r \cdot \mathrm{ETP} \tag{2}$$

$$\mathrm{f_{sr}} = \begin{cases} (\mathrm{S_s} + (\mathrm{P} - \mathrm{ETA_s}) \cdot \Delta t - S_{s,max})/\Delta t & \text{if } \mathrm{S} + (\mathrm{P} - \mathrm{ETA_s}) \cdot \Delta t > S_{s,max} \\ 0 & \text{if } \mathrm{S} + (\mathrm{P} - \mathrm{ETA_s}) \cdot \Delta t \leq S_{s,max} \end{cases} \tag{3}$$

$$\frac{\Delta \mathrm{S_r}}{\Delta t} = \mathrm{f_{sr}} - \mathrm{f_{rg}} - \mathrm{f_{gd}} - \mathrm{ETA_r} \tag{4}$$

$$\mathrm{ETA_r} = \max(0, \ \frac{\mathrm{S_r} - S_{r,max} \cdot s_{wilt}}{S_{r,max}} \cdot \frac{1}{1 - s_{wilt}} \cdot (1 - r) \cdot \mathrm{ETP}) \tag{5}$$

$$\mathrm{f_{gd}} = k_{sat} \cdot (\mathrm{S_r}/S_{r,max})^{b_{fc}} \tag{6}$$

$$\mathrm{f_{rg}} = \begin{cases} (\mathrm{S_r} + (\mathrm{f_{sr}} - \mathrm{ETA_r} - \mathrm{f_{gd}}) \cdot \Delta t - S_{r,max})/\Delta t & \text{if } \mathrm{S_r} + (\mathrm{f_{sr}} - \mathrm{ETA_r} - \mathrm{f_{gd}}) \cdot \Delta t > S_{r,max} \\ 0 & \text{if } \mathrm{S_r} + (\mathrm{f_{sr}} - \mathrm{ETA_r} - \mathrm{f_{gd}}) \cdot \Delta t \leq S_{r,max} \end{cases} \tag{7}$$

$$\frac{\Delta \mathrm{S_{g,lin}}}{\Delta t} = \mathrm{f_{gd}} + \mathrm{f_{rg}} - \mathrm{q_{lin}} - \mathrm{f_g} \tag{8}$$

$$\mathrm{q_{lin}} = k_1 \cdot \mathrm{S_{g,lin}} \tag{9}$$

$$\mathrm{f_g} = k_{12} \cdot \mathrm{S_{g,lin}} \tag{10}$$

$$\frac{\Delta \mathrm{S_{g,nonlin}}}{\Delta t} = \mathrm{f_g} - \mathrm{q_{nonlin}} \tag{11}$$

$$\mathrm{q_{nonlin}} = a \cdot (\mathrm{S_{g,nonlin}})^b \tag{12}$$