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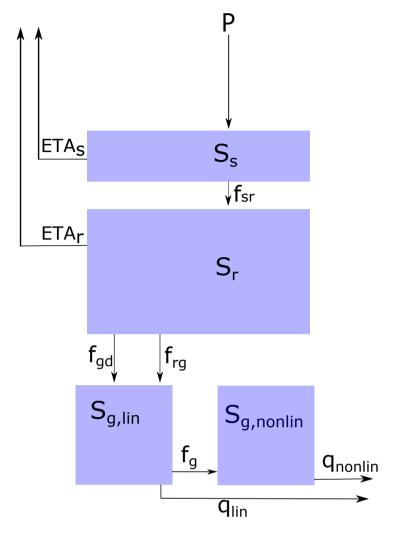


FIGURE 2 Elder Creek model wiring diagram.

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

state variable	description
$\overline{S_{\mathrm{s}}}$	soil moisture storage
S_{r}	unsaturated fractured rock storage
$S_{\mathrm{g,lin}}$	linear groundwater reservoir storage
$S_{g,nonlin}$	nonlinear groundwater reservoir storage

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	TABLE 2	Elder	Creek	model	fluxes.	ΑII	fluxes	have	units of	f mm	/h.
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flux	description	type
Р	precipitation	external
ETP	total potential evapotranspiration	external
ETA _s	actual evapotranspiration from the soil	external
ETA _r	actual evapotranspiration from the unsaturated fractured rock	external
q _{lin}	discharge from the linear groundwater reservoir	external
q _{nonlin}	discharge from the nonlinear groundwater reservoir	external
f _{sr}	overflow leakage from soil to unsaturated fractured rock	internal
f_{gd}	gravity drainage from unsaturated fractured rock to groundwater	internal
f_{rg}	overflow leakage from unsaturated fractured rock to groundwater	internal
f_{g}	flow from linear to nonlinear groundwater reservoir	internal

TABLE 3 Elder creek model parameters.***Note: three 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, k_{sat} in this manuscript represents k_{fc} in the code, and r in this manuscript represents f 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}	mm h ⁻¹	saturated hydraulic condutcivity of fractured rock, which controls rate of gravity drainage to groundwater	4 - 1000
a	$h^{-1}(mm)^{1-b}$	coefficient for nonlinear groundwater reservoir	5e-5 - 0.125
b	-	exponent for nonlinear groundwater reservoir	0.5 - 3
k_1	h^{-1}	coefficient which controls the discharge of the linear groundwater reservoir	5e-5 - 0.125
k ₁₂	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

$$\frac{\Delta S_s}{\Delta t} = P - ETA_s - f_{sr} \tag{1}$$

$$ETA_{s} = \frac{S_{s} - S_{s,max} \cdot s_{wilt}}{S_{s,max}} \cdot \frac{1}{1 - s_{wilt}} \cdot r \cdot ETP$$
(2)

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

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

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

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

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

$$(7)$$

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

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

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

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

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