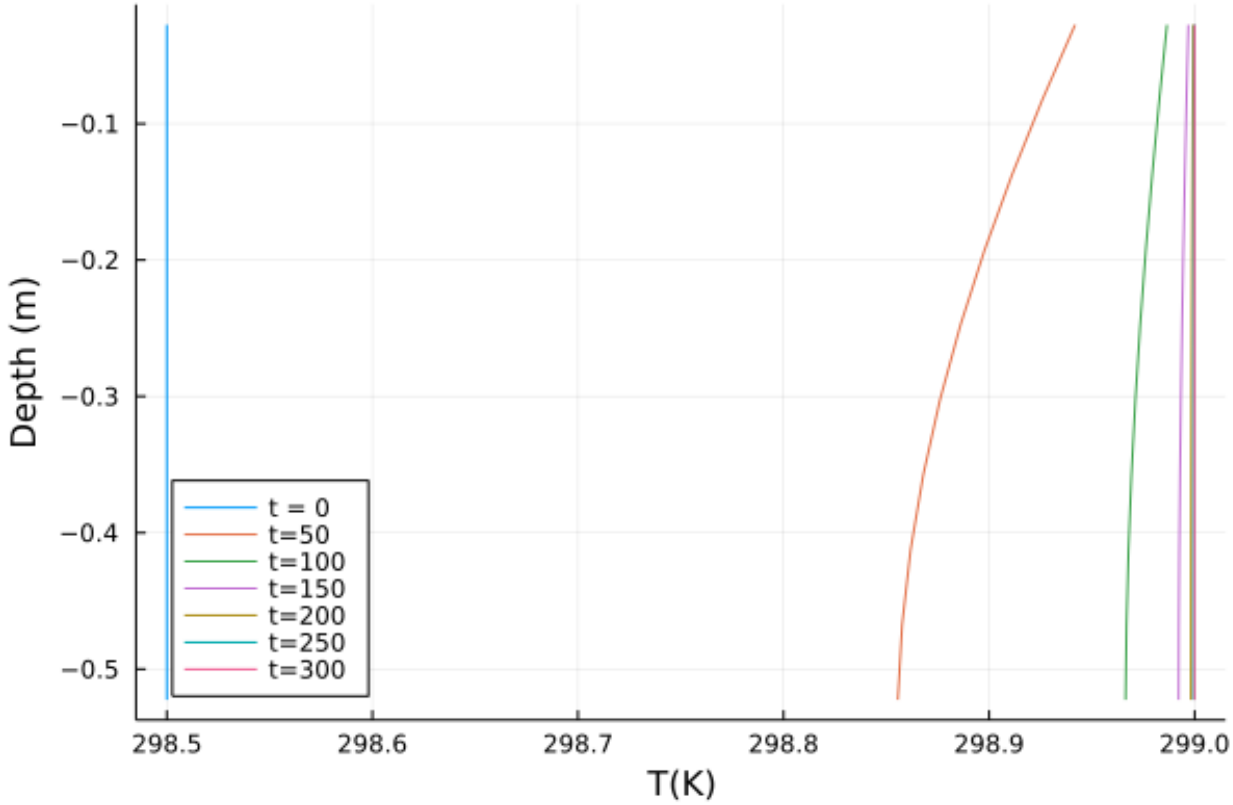
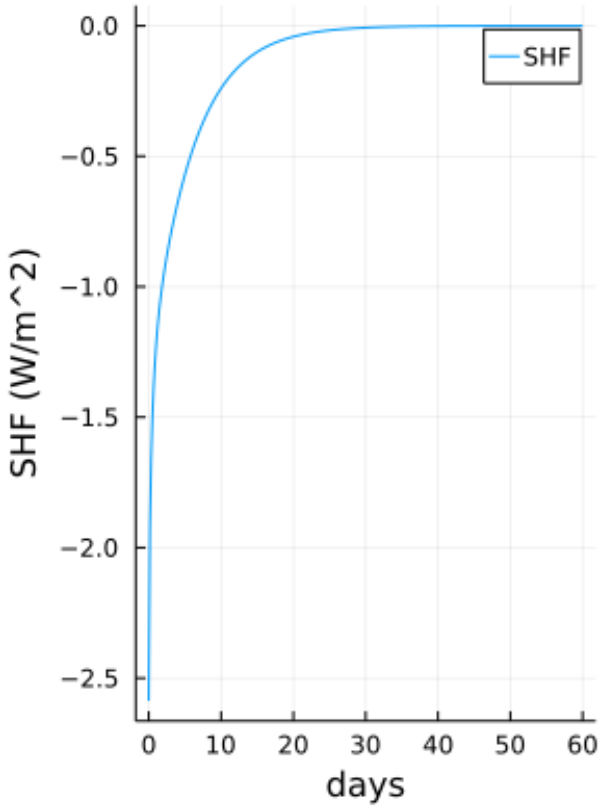
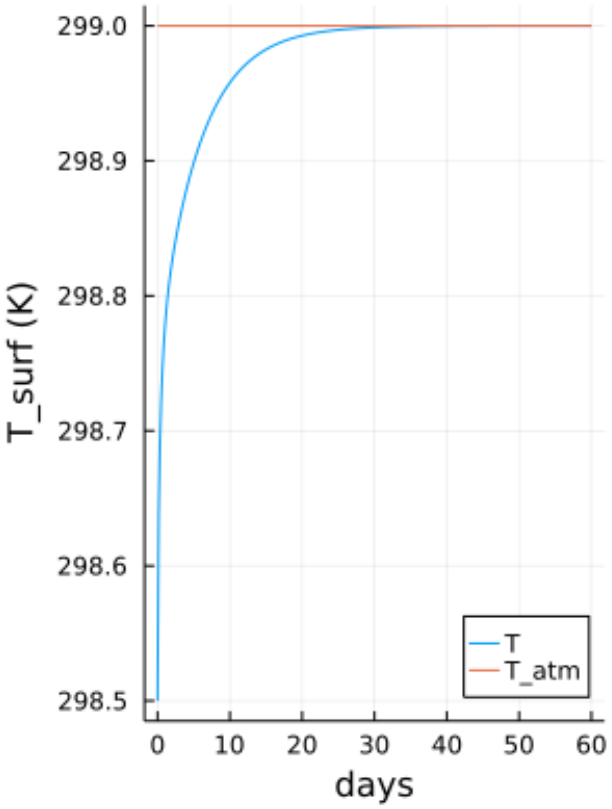
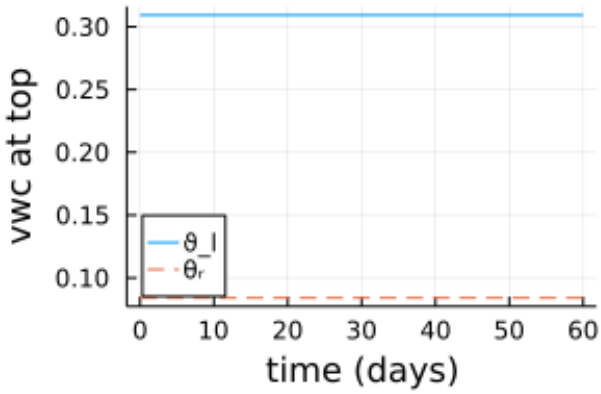
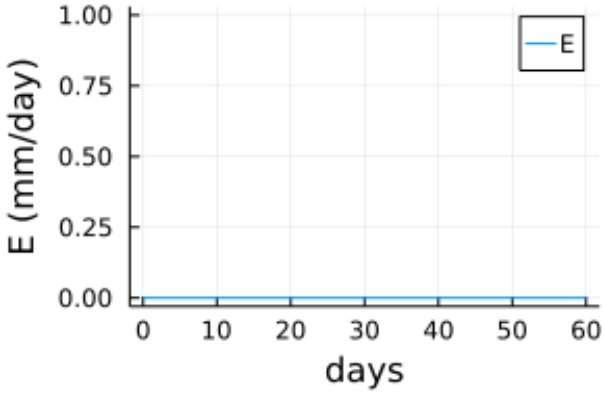
Set E = 0. Soil heat and water. Water in HE, no flux at bottom. SHF at top, no flux at bottom
Outcome: as we expect - temperature rises to T_atm at the top first, then the rest of the domain. E = 0, VWC stays the same (HE).

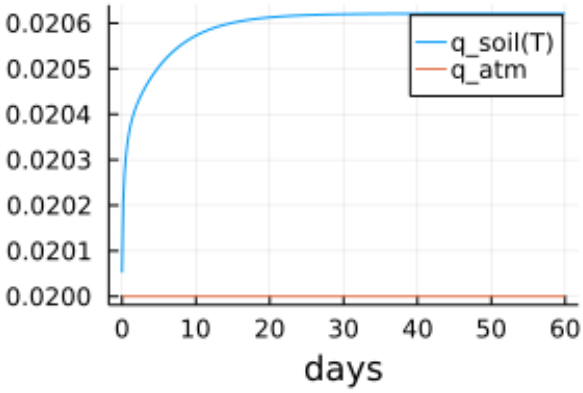






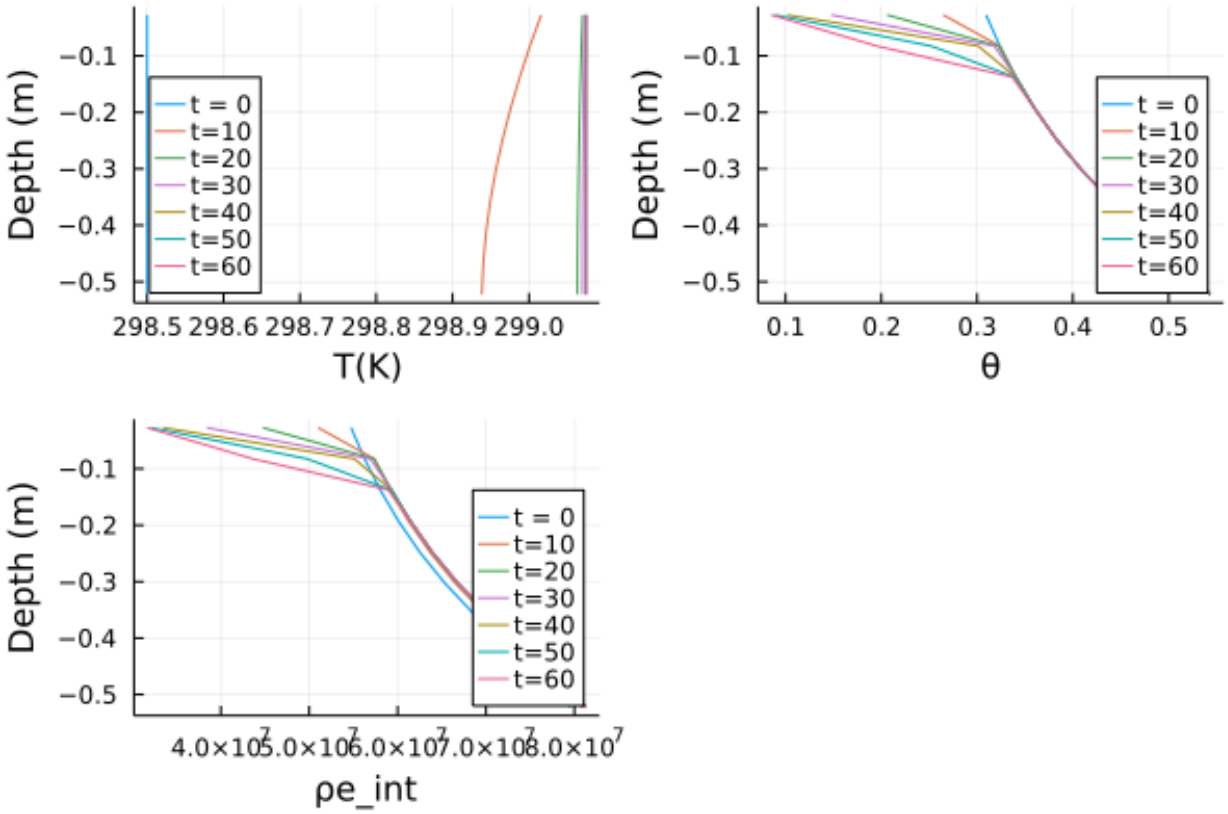

vwc at top
0.30
0.25
0.20
0.15
0.10
θ_l
θr
0
10
20
30
40
50
60
time (days)

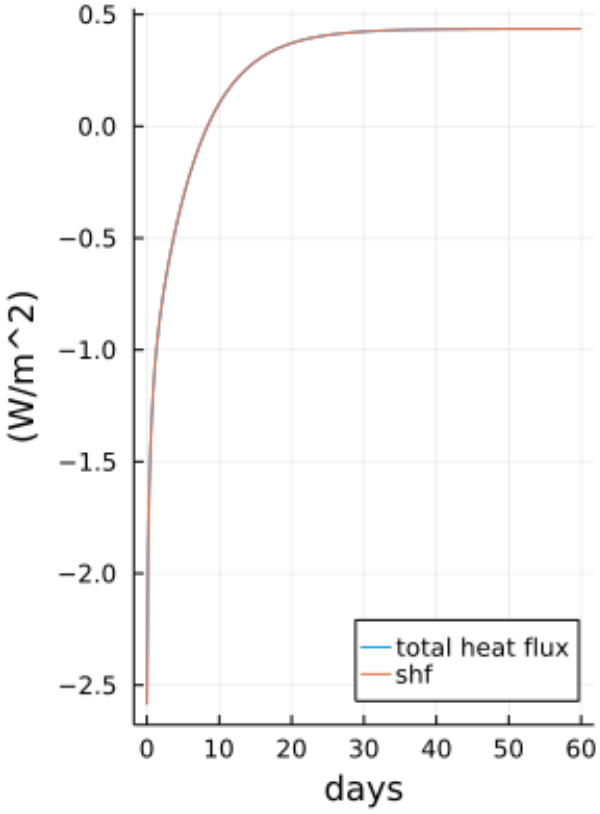

E (mm/day)
1.00
0.75
0.50
0.25
0.00
E
0
10
20
30
40
50
60
days

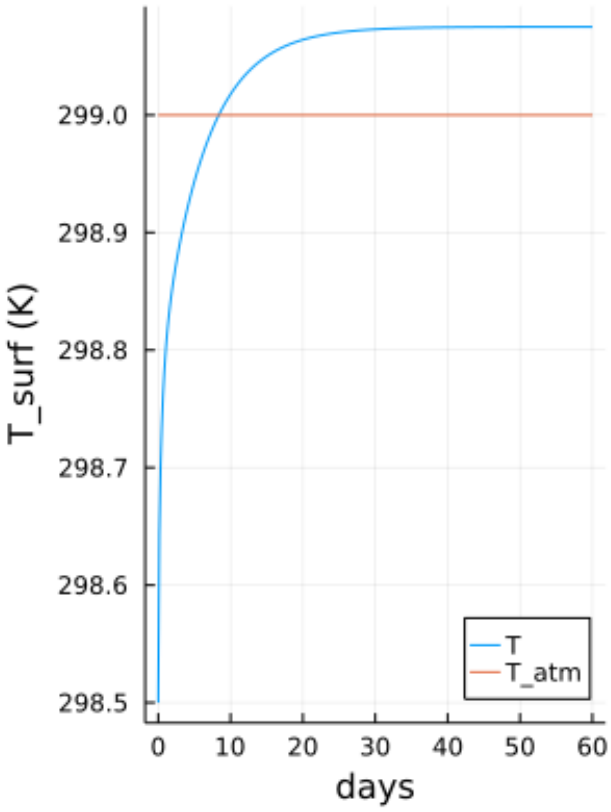

0.0206
0.0205
0.0204
0.0203
0.0202
0.0201
0.0200
q_soil(T)
q_atm
0
10
20
30
40
50
60
days

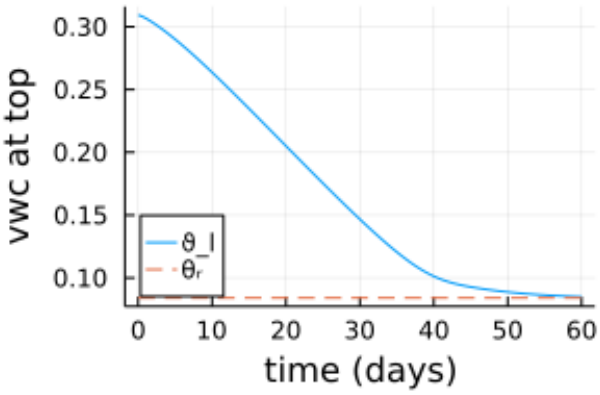
Next: Heat flux = SHF, E = E
This looks wrong - the temperature of the soil > T_amtosphere. Looking in detail near where the SHF becomes positive (T soil > T atm), it checks out. The soil is losing heat. It is also losing water. If you take the -div(water flux) and the -div(heat flux) and compute these using the boundary fluxes (which look correct), you get that the soil is losing *so* much water that the decrease in volumetric heat capacity creates a larger decrease in energy than occurs, so the temperature needs to increase to make: de = vhc(water)*(T-T0)d(vwc) +vhc(soil)dT.

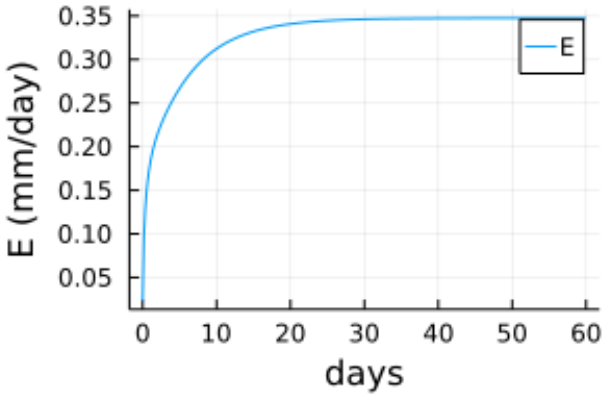
That said, this isn't correct, right? If the soil is losing heat due to a temperature gradient and because it is losing water (which has its own internal energy), both of those pieces need to be accounted for in the boundary condition for internal energy. That is, the boundary condition for the heat equation should be
Heat flux = SHF + volumetric internal energy of water * E

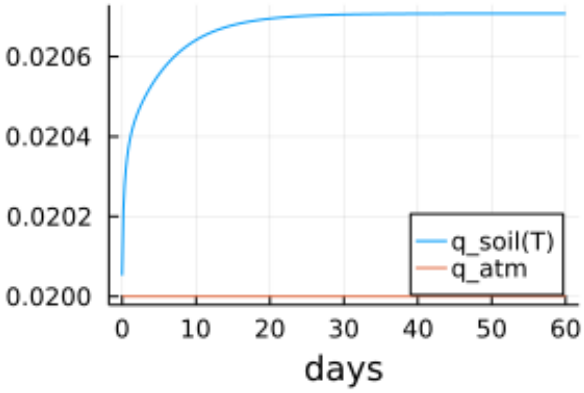



0.5
0.0
−0.5
−1.0
−1.5
−2.0
−2.5
(W/m^2)
total heat flux
shf
0
10
20
30
40
50
60
days

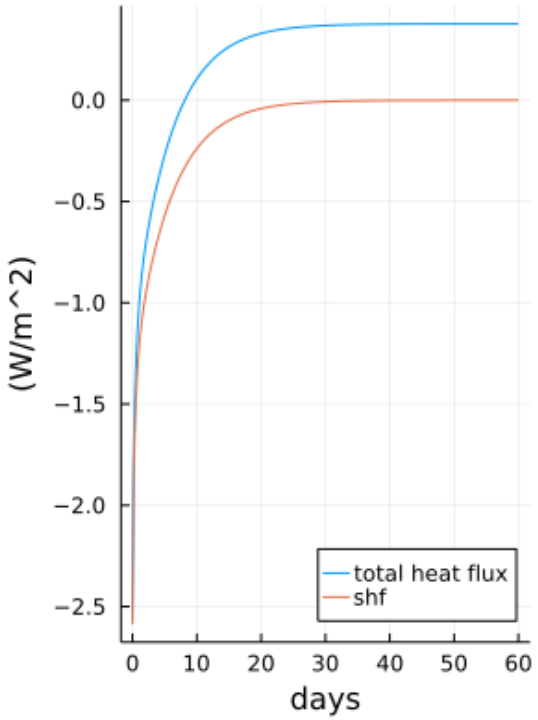

299.0
298.9
298.8
298.7
298.6
298.5
T_surf (K)
T
T_atm
0
10
20
30
40
50
60
days

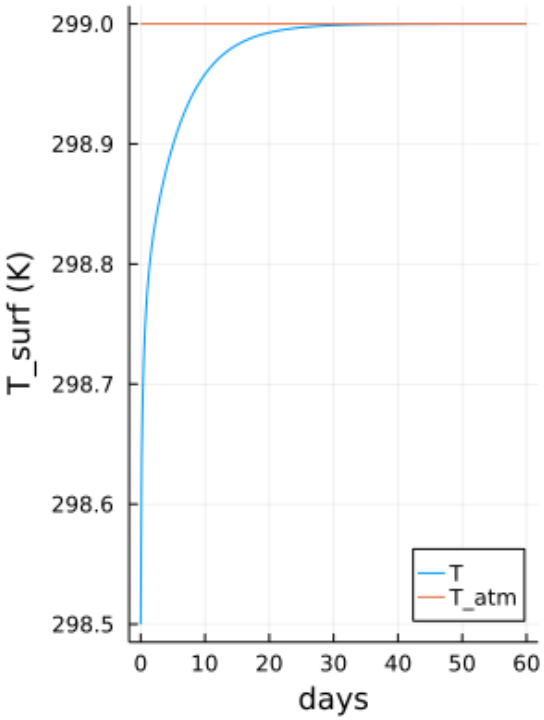

0.30
0.25
0.20
0.15
0.10
vwc at top
θ_l
θr
0
10
20
30
40
50
60
time (days)

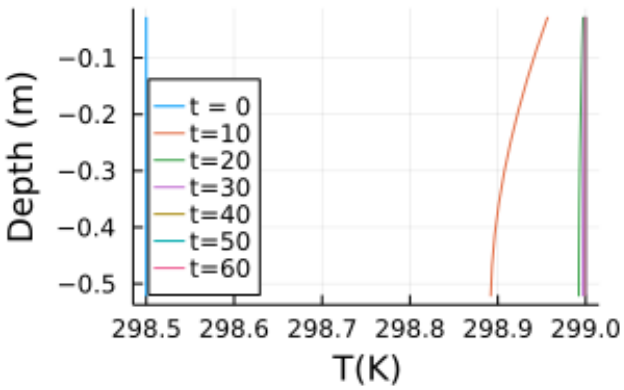

0.35
0.30
0.25
0.20
0.15
0.10
0.05
E (mm/day)
E
0
10
20
30
40
50
60
days

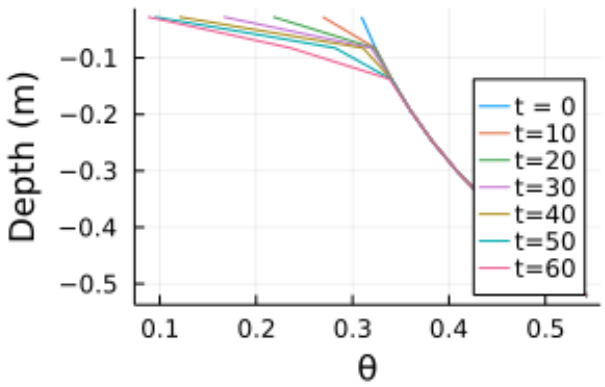

0.0206
0.0204
0.0202
0.0200
q_soil(T)
q_atm
0
10
20
30
40
50
60
days

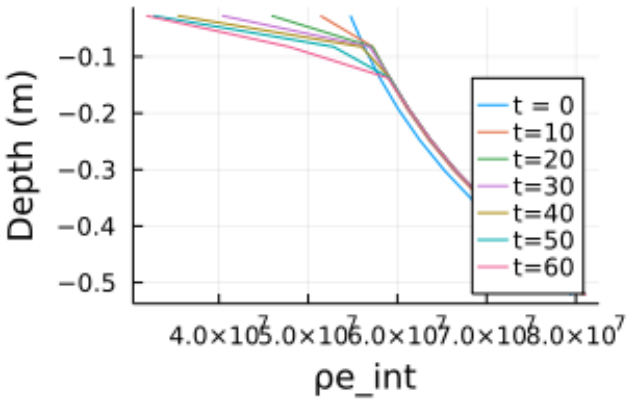
Set Heat flux = SHF + volumetric internal energy of liquid water in soil *E
Evaporation = E

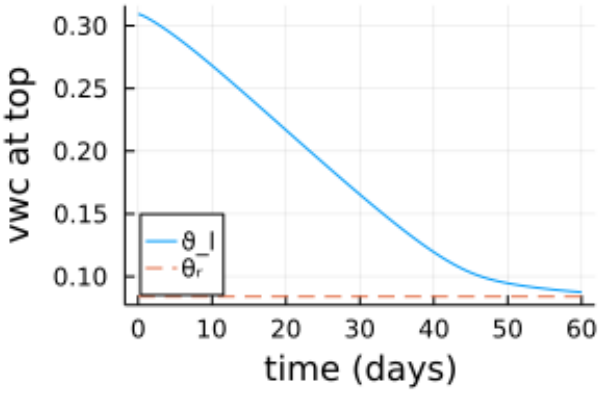


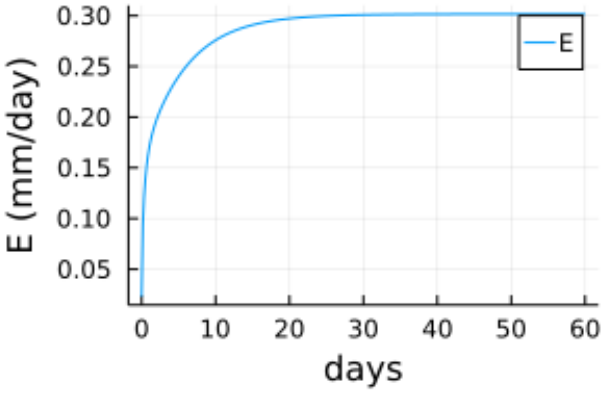


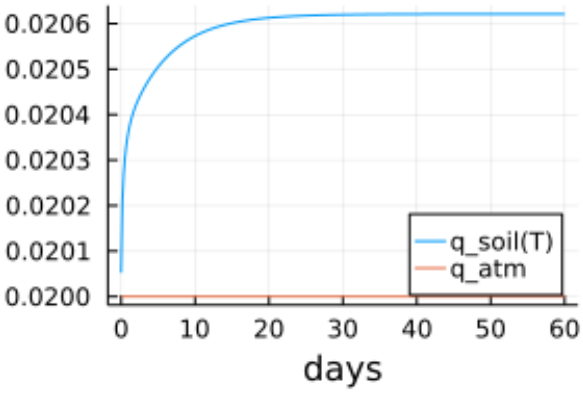




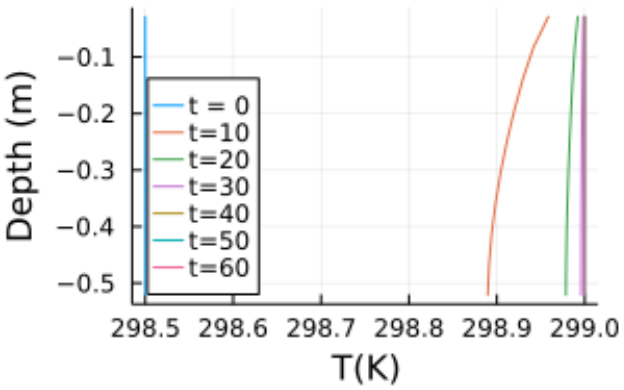


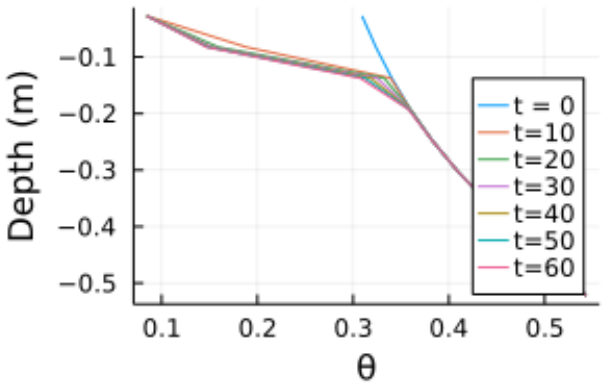

vwc at top
0.30
0.25
0.20
0.15
0.10
ϑ_l
θr
0
10
20
30
40
50
60
time (days)

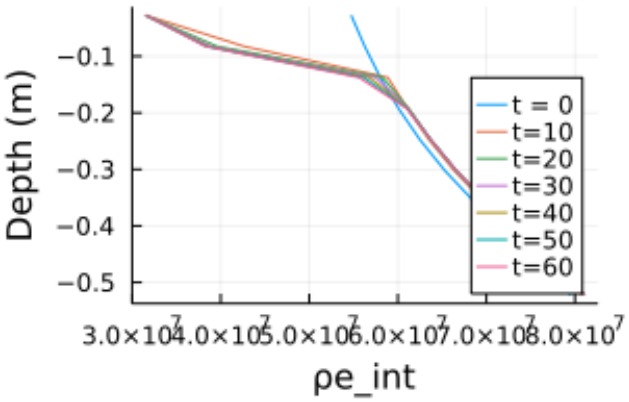

E (mm/day)
0.30
0.25
0.20
0.15
0.10
0.05
E
0
10
20
30
40
50
60
days

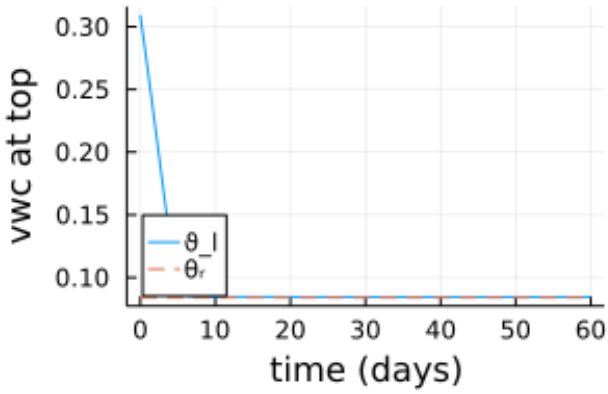

0.0206
0.0205
0.0204
0.0203
0.0202
0.0201
0.0200
q_soil(T)
q_atm
0
10
20
30
40
50
60
days

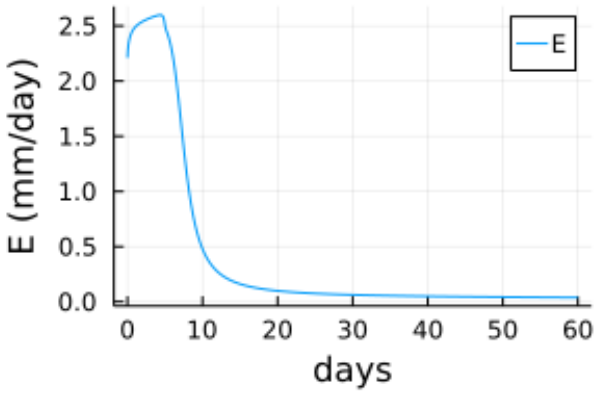
Now, try putting back in the factor decreasing the q_soil -> q_soil (T, theta). Increase difference between q soil and q_atmos.(0.02-> 0.015)

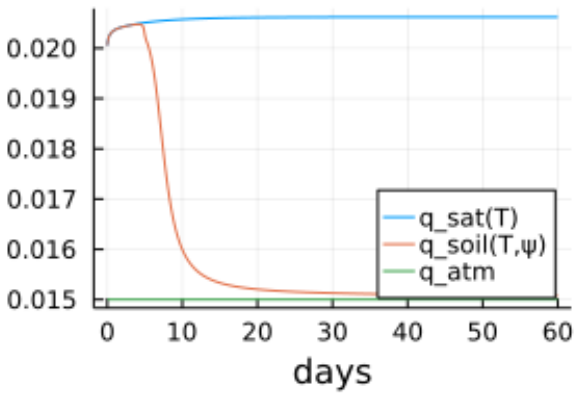


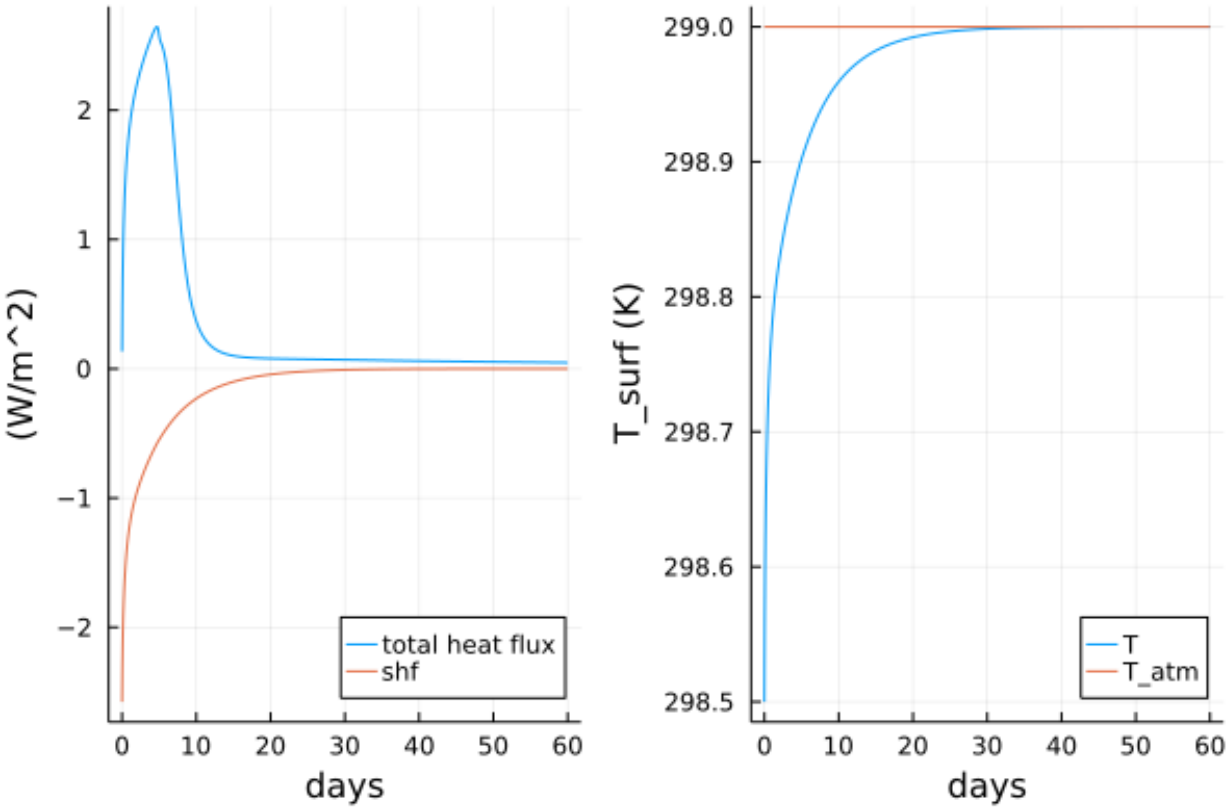










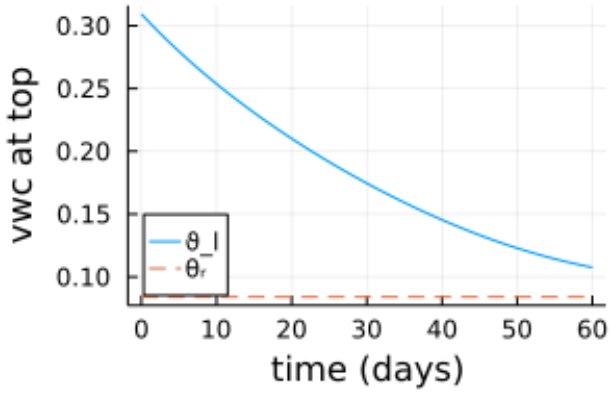


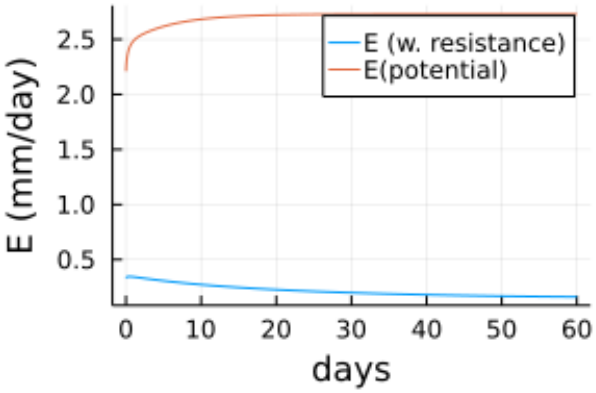
Try again, bump up evaporation rate by decreasing q_atm more. It ran fine at q_atm = 0.01. Trying at 0.

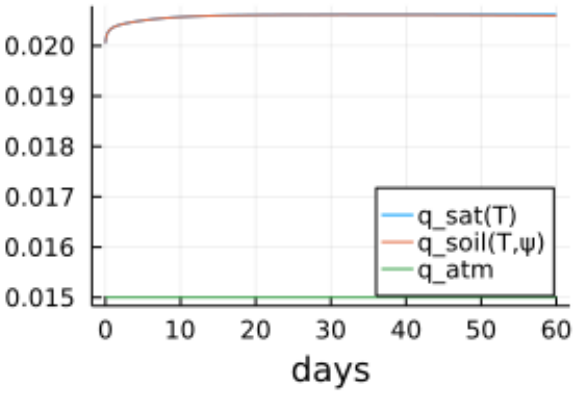
Still fine!

Also works if soil is saturated and in HE.

Next try adding in resistance:







The Lehmann approach has E as a function of E0 (without soil resistance, the potential rate). To evaluate this, we'd need to compute E0 (qsurf = qsat) with surface fluxes, and then compute E (simple explicit function). But, if E affects theta_v*, u*, etc, they won't be consistent between the values consistent with E0. So how would we get SHF?