Table Input parameters for SUTRA and the analytical solutions

Parameter	Symbol	Value	Units
Hydraulic properties			
Porosity	ϵ	0.50	-
Relative permeability [a]	k_{rel}	off	-
Darcy velocity (downwards)	v	10, and 100	m yr^{-1}
Gravity	g	0	m s^{-2}
Water saturation (total)	S_w	1	-
Sat. available for freezing (S_w-S_{res})	S_{wf}	1 (for solutions)	-
Thermal properties			
Thermal conductivity of thawed zone	λ	1.839	W m^{-1} °C^{-1}
Heat capacity of thawed zone	$c\rho$	3.201×10^{6}	J m^{-3} °C^{-1}
Thermal diffusivity of thawed zone	α	5.743×10^{-7}	m^2 s^{-1}
Thermal diffusivity of frozen zone	α_f	1.205×10^{-6}	m^2 s^{-1}
Thermal dispersivity	-	0 [b]	m
Density of water	ρ_w	1000	kg m^{-3}
Specific heat of water	c_w	4182	J kg^{-1} °C^{-1}
Heat capacity of water	$c_w\rho_w$	4.182×10^{6}	J m^{-3} °C^{-1}
Latent heat of fusion for water	L_f	334,000	J kg^{-1}
Other thermal settings			
Specified temperature	T_s	1	°C
Initial temperature	T_i	0 [c]	°C
Freezing temperature (solutions)	T_f	0	°C
Residual freezing temp. (SUTRA)	T_{res}	-0.0005	°C
Residual liquid saturation	S_{res}	0.0001	-
Slope of freezing function	b	1999.8	°C^{-1}
SUTRA solver settings and spatiotemporal discretization			
SUTRA element height	-	0.001	m
Number of time steps to 20 days	-	~ 7,000,000	-
SUTRA time step size	-	0.00001-0.0001	hr

[a] Note that because a water flux is specified at the top and bottom of the model, the actual permeability is irrelevant. For the sake of simplicity, we assumed no reduction in permeability due to pore ice formation.

[b] Thermal dispersivity is a parameter included in many models of coupled subsurface water and energy transport. Thermal dispersion is a thermal homogenizing process that arises due to the tortuous flow path traveled by groundwater. This phenomenon is not considered in the analytical solutions, and thus thermal dispersivity should be set to zero.

[c] The initial temperature for each of the analytical simulations was set to 0°C. The initial temperature could not be set at exactly 0°C in SUTRA, or the medium would be initially fully thawed. Thus the initial temperature was set at a value (-0.001°C) slightly below the residual freezing temperature T_{res}.