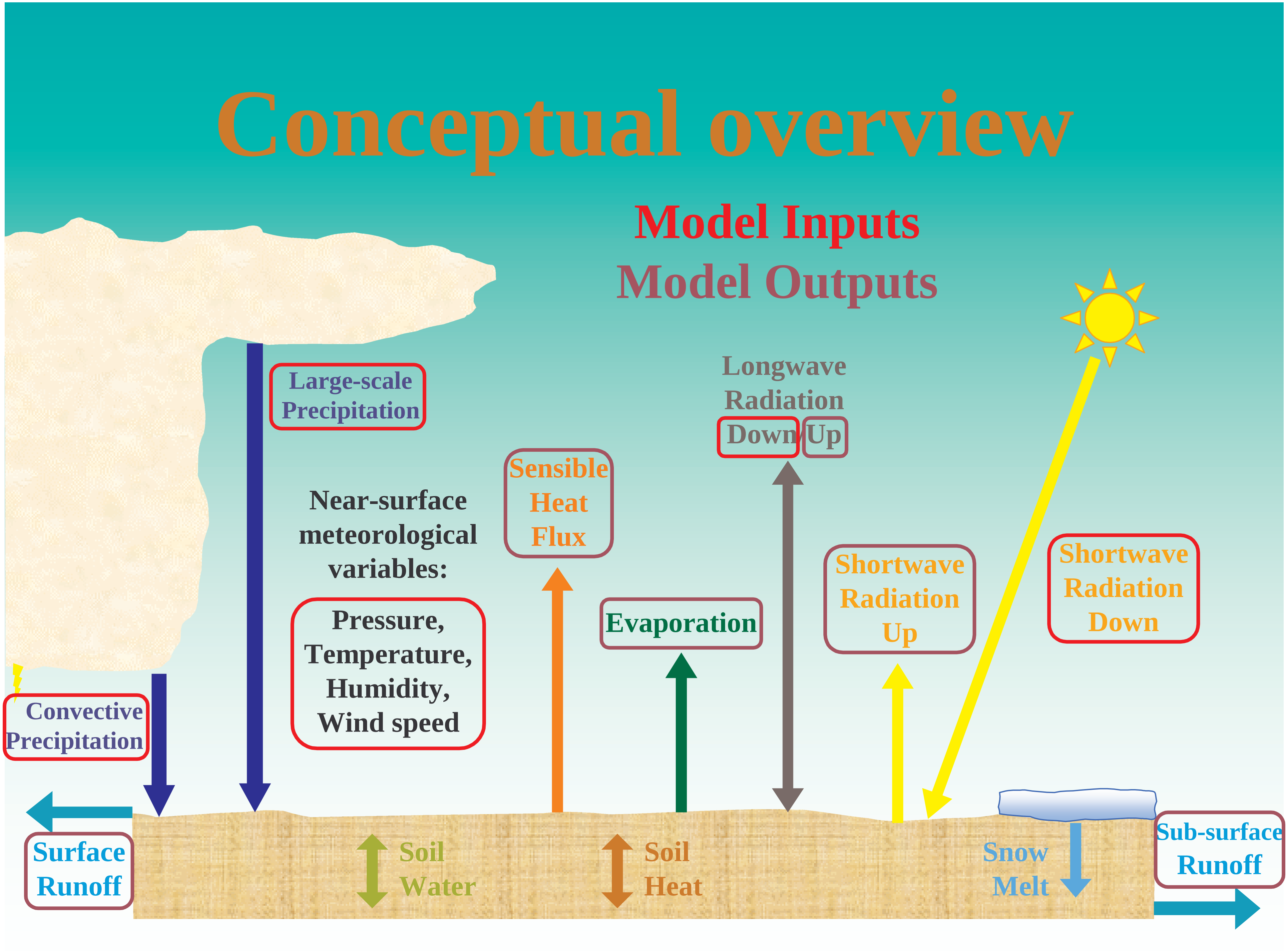
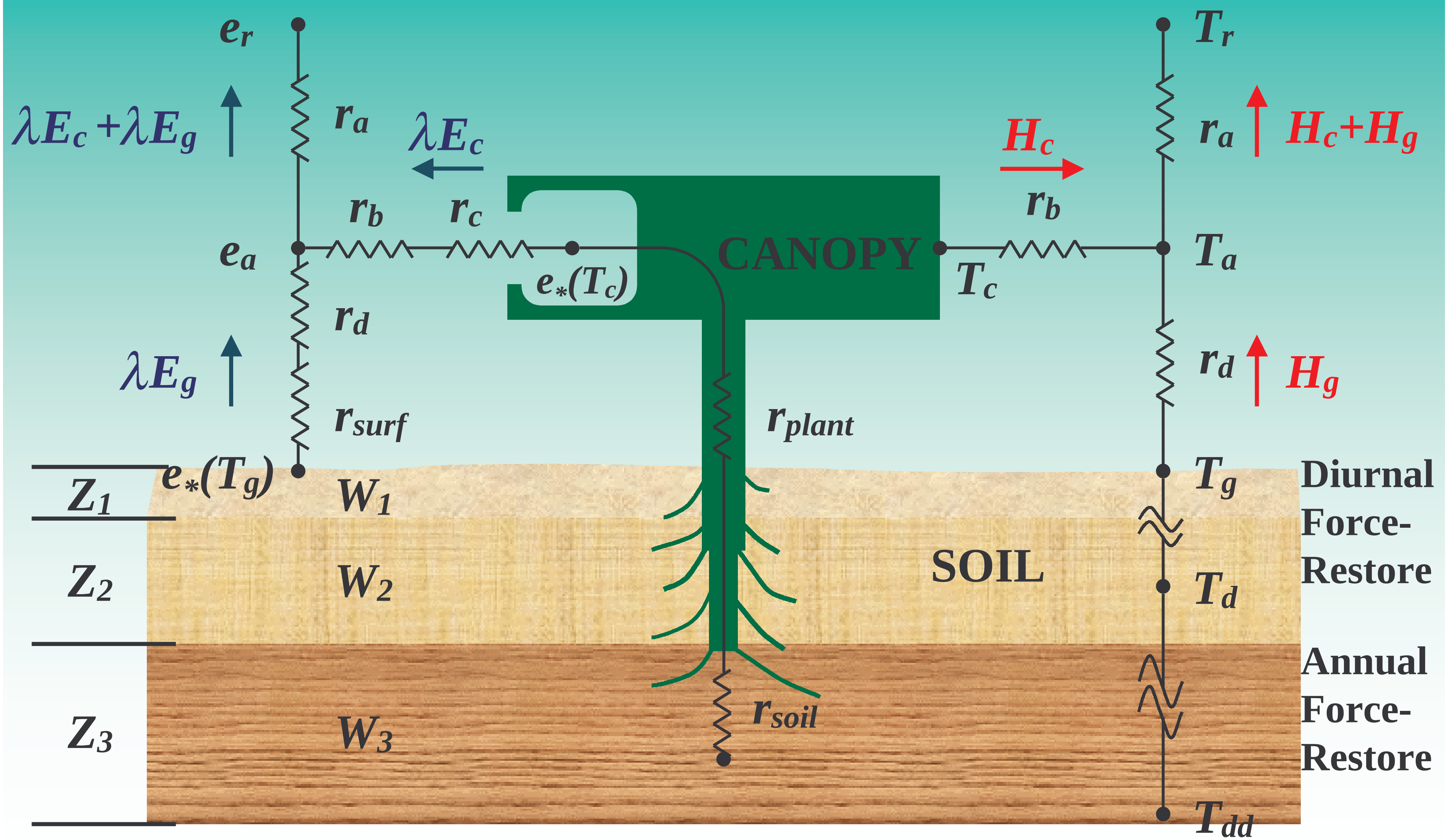
HY-SSiB – The Model

1. General overview
2. Required datasets
3. Vegetation and soils
4. Snow physics package
5. Solution pathway
6. Linkages


Conceptual overview
Model Inputs
Model Outputs
Large-scale Precipitation
Longwave Radiation
Down
Up
Sensible Heat Flux
Near-surface meteorological variables:
Pressure, Temperature, Humidity, Wind speed
Evaporation
Shortwave Radiation Up
Shortwave Radiation Down
Convective Precipitation
Surface Runoff
Soil Water
Soil Heat
Snow Melt
Sub-surface Runoff

Surface layer schematic



Temperature Equations

Canopy:

$$C_c \frac{\partial T_c}{\partial t} = Rn_c - H_c - \lambda E_c$$

Ground:

$$C_g \frac{\partial T_g}{\partial t} = Rn_g - H_g - \lambda E_g - \frac{2\pi C_g}{\tau}(T_g - T_d)$$

C = Heat capacity
T = Temperature
t = time

Rn = Net Radiation
H = Sensible Heat Flux
E = Evaporation

λ = latent heat of vaporization
τ = 86400 sec

Sensible Heat Equations

Canopy:

$$H_c = \frac{2(T_c - T_a)}{r_b}\rho c_p$$

Ground:

$$H_g = \frac{(T_g - T_a)}{r_d}\rho c_p$$

H = Sensible Heat Flux
$\boldsymbol{r_b}$ = Bulk boundary layer resistance
$\boldsymbol{r_d}$ = Ground to Canopy air resistance

T = Temperature
$\boldsymbol{\rho}$ = Density of air
$\boldsymbol{c_p}$ = Specific Heat of air

Evaporation Equations

Canopy:

$$\lambda E_c = (e_*(T_c) - e_a)\frac{\rho c_p}{\gamma}\left[\frac{W_c}{r_b} + \frac{1-W_c}{r_b + r_c}\right]$$

Ground:

$$\lambda E_g = (f_h e_*(T_g) - e_a)\frac{\rho c_p}{\gamma}\frac{1}{r_{surf} + r_d}$$

e = Vapor pressure ($_*$ = saturation at ***T***)
γ = Psychrometric constant
$\boldsymbol{r_c}$ = Bulk stomatal resistance
$\boldsymbol{W_c}$ = Canopy wetness fract.
$\boldsymbol{r_{surf}}$ = Bare soil surface resistance
$\boldsymbol{f_h}$ = Soil surface air humidity

Net Radiation Equations

Canopy:

$$Rn_c = F_c - 2\sigma_s T_c^4 V_c \delta_t + \sigma_s T_g^4 V_c \delta_t$$

Ground:

$$Rn_g = F_g - \sigma_s T_g^4 + \sigma_s T_c^4 V_c \delta_t$$

F = Sum of absorbed shortwave and longwave components

$\boldsymbol{\sigma_s}$ = Stefan-Boltzmann constant

$\boldsymbol{V_c}$ = Vegetation cover fract.

$\boldsymbol{\delta_t}$ = Canopy transmittance for thermal IR radiation

Snow physics schematic