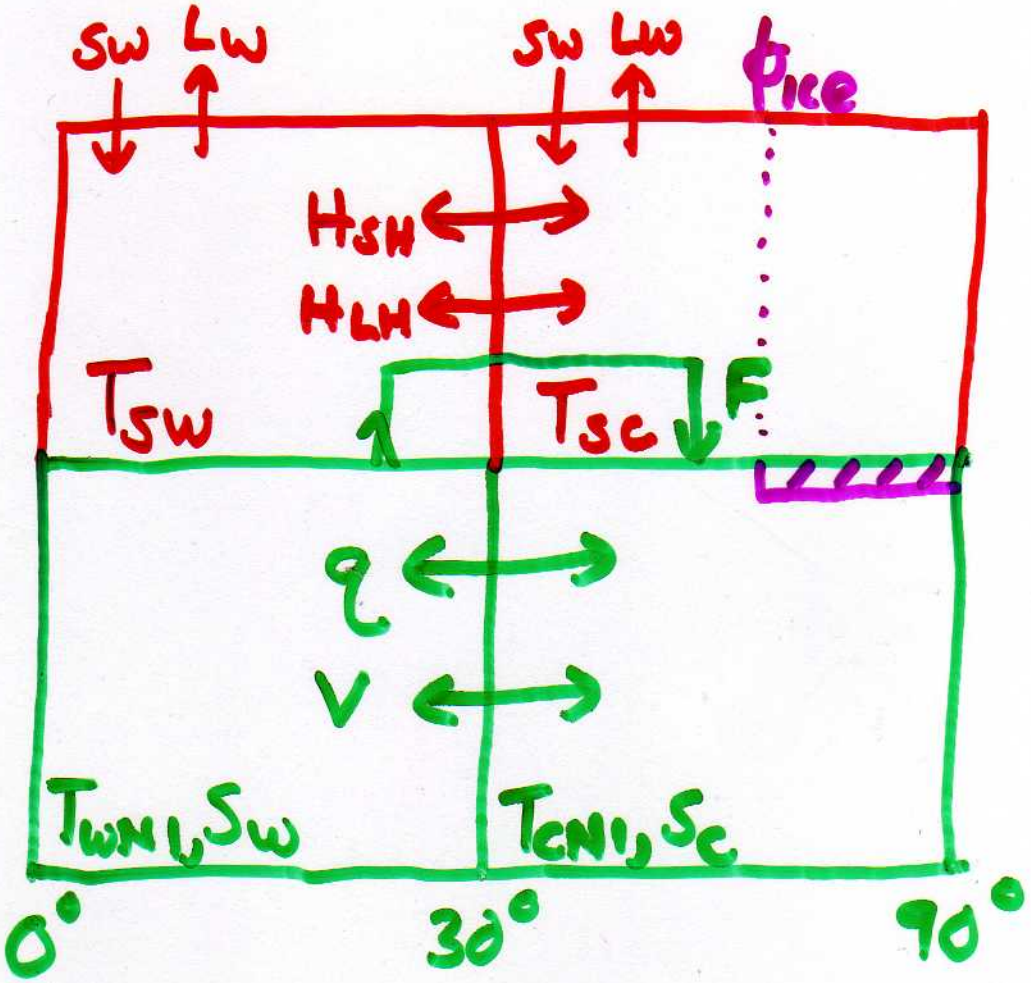
4 Box, Coupled Climate Model



As in 2 Box, Energy Balance Model:

$SW(x,T)$, $LW = A + BT$

$\alpha(x,T)$, $T(x) = C_1 + C_2 P_2(x)$

$T_i = -10°C$, where $x = \sin\phi$

As in the 2 Box, THC model with a "wind-driven circulation" V:

$$q = k^{-1}\left[\alpha_{ES}(T_{WN1} - T_{CN1}) - \beta_{ES}(S_W - S_C)\right]$$

Heat transport in the THC, H_Q, is $|Q|(T_{WN1} - T_{CN1})$

Heat transport in the WDC, H_V, is $V(T_{WN1} - T_{CN1})$

T_{WN1}, T_{CN1} are equal to mean temperatures in the "ice-free" parts of the atmosphere boxes but also have a lower bound of $T_f = -1.8^{\circ}C$.

The WDC is parameterized as:

$$V = \chi_1 (T_{sw} - T_{sc})$$

(wind strength → Sverdrup Trans.)

Sensible heat transport, H_{sw}, is:

$$\chi_2 (T_{sw} - T_{sc})$$

Latent heat transport, H_{LW}, is:

$$\chi_3 L_v \exp(-5420/(T(30^\circ)+273))(T_{sw} - T_{sc})$$

where L_v is the latent heat of vaporization and $T(30^\circ)$ is atmosphere T at 30° latitude

(uses the Clausius - Clapeyron relation)

Atmospheric moisture transport, F, is:

$$X_3 \exp(-5420/(T_{(30')}+273)(T_{sw}-T_{sc}))$$

For given solar constant, pCH_4 and pCO_2, stable steady state solutions are found by simultaneous iteration to satisfy energy and salt balance

Values for k and X_{1-3} are chosen so that simulations match observed energy and moisture transports.