



(b)

OPTION 1
Calonne coupled

OPTION 2
Calonne decoupled

OPTION 3
Hansen

CC_3DOF

Heat/Vapor/Deposition rate solver

$$\begin{cases} (\rho C_p)^{eff} \partial_t T - \partial_z (k^{eff} \partial_z T) = L_m c \\ (1 - \Phi_i) \partial_t \rho_v - \partial_z (D^{eff} \partial_z \rho_v) = -c \\ c = s \alpha v_{kin} (\rho_v - \rho_v^{eq}) \end{cases}$$

$$T^{n+1}, \rho_v^{n+1}, c^{n+1}$$

OR

CC_2DOF

Heat/Vapor solver

$$\begin{cases} (\rho C_p)^{eff} \partial_t T - \partial_z (k^{eff} \partial_z T) = L_m s \alpha v_{kin} (\rho_v - \rho_v^{eq}) \\ (1 - \Phi_i) \partial_t \rho_v - \partial_z (D^{eff} \partial_z \rho_v) = -s \alpha v_{kin} (\rho_v - \rho_v^{eq}) \end{cases}$$

$$T^{n+1}, \rho_v^{n+1}$$

Deposition rate diagnostic

$$c = -(1 - \Phi_i) \partial_t \rho_v + \partial_z (D^{eff} \partial_z \rho_v)$$

$$c^{n+1}$$

CD_PC

Heat solver

$$(\rho C_p)^{eff} \partial_t T - \partial_z (k^{eff} \partial_z T) = L_m c$$

$$T^{n+1}$$

Vapor solver

$$(1 - \Phi_i) \partial_t \rho_v - \partial_z (D^{eff} \partial_z \rho_v) = -s \alpha v_{kin} (\rho_v - \rho_v^{eq})$$

$$\rho_v^{n+1}$$

Deposition rate diagnostic

$$c = -(1 - \Phi_i) \partial_t \rho_v + \partial_z (D^{eff} \partial_z \rho_v)$$

OR

$$c^{n+1}$$

CD_FD

Heat solver

$$(\rho C_p)^{eff} \partial_t T - \partial_z (k^{eff} \partial_z T) = L_m c$$

$$T^{n+1}$$

Vapor solver

$$(1 - \Phi_i) \partial_t \rho_v - \partial_z (D^{eff} \partial_z \rho_v) = -c$$

$$\rho_v^{n+1}$$

Deposition rate diagnostic

$$c = s \alpha v_{kin} (\rho_v - \rho_v^{eq})$$

$$c^{n+1}$$

H_MF

Heat solver - mixed form

$$\begin{cases} \partial_t H - \partial_z \left[\left(D^{eff} L_m \frac{d\rho_v^{eq}}{dT} + k^{eff} \right) \partial_z T \right] = 0 \\ H = (\rho C_p)^{eff} (T - T_0) + (1 - \Phi_i) L_m \rho_v^{eq} \end{cases}$$

$$H^{n+1}, T^{n+1} \mid \rho_v^{n+1} = \rho_v^{eq}(T^{n+1})$$

Deposition rate diagnostic

$$c = -(1 - \Phi_i) \frac{d\rho_v^{eq}}{dT} \partial_t T + \partial_z \left(D^{eff} \frac{d\rho_v^{eq}}{dT} \partial_z T \right)$$

OR

$$c^{n+1}$$

H_TF

Heat solver - T-form

$$\begin{cases} \left((\rho C_p)^{eff} + (1 - \Phi_i) L_m \frac{d\rho_v^{eq}}{dT} \right) \partial_t T - \\ \partial_z \left[\left(D^{eff} L_m \frac{d\rho_v^{eq}}{dT} + k^{eff} \right) \partial_z T \right] = 0 \end{cases}$$

$$T^{n+1} \mid \rho_v^{n+1} = \rho_v^{eq}(T^{n+1})$$

Deposition rate diagnostic

$$c = -(1 - \Phi_i) \frac{d\rho_v^{eq}}{dT} \partial_t T + \partial_z \left(D^{eff} \frac{d\rho_v^{eq}}{dT} \partial_z T \right)$$

$$c^{n+1}$$