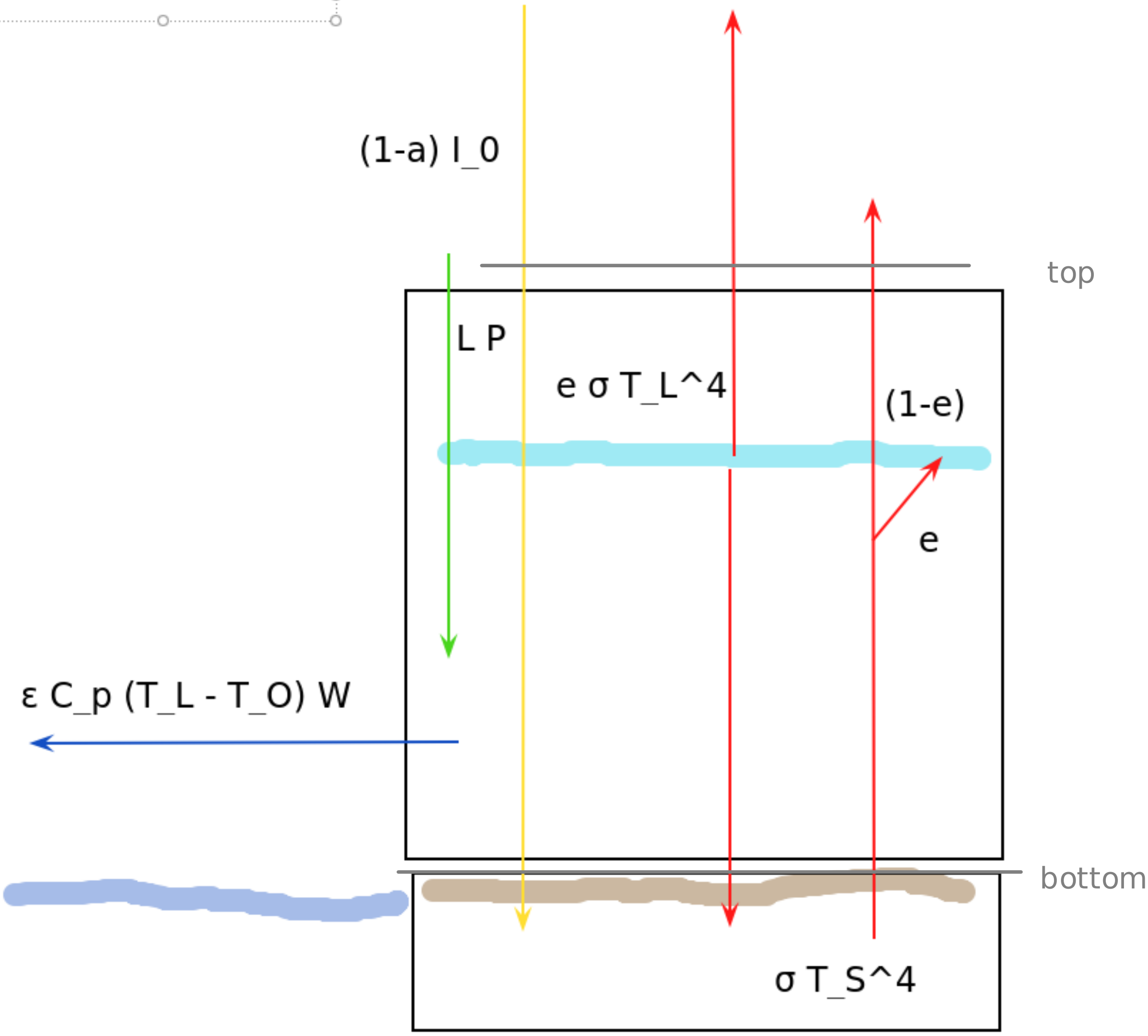


$$R = R_{top} - R_{bottom} = -2 e \sigma T_L^4 + \sigma T_S^4 = \sigma (T_S^4 - 2 e T_L^4)$$

$$(1 - a) I_0 + e \sigma T_L^4 = \sigma T_S^4 \qquad [A]$$

$$R = (1 - a) I_0 - e \sigma T_L^4 = (1 - (a_0 + \Delta a)) I_0 - e \sigma T_L^4 + \Delta a * I_0 = R_0 - \Delta a * I_0$$

[D]

$$R_0 = (1 - a_0) I_0 - e \sigma T_L^4$$

$a = a_0 + \Delta a$ $\qquad$ $\Delta a = 0.3 - 0.1 = 0.2$ $\qquad$ $R = R_0 - 70$ W/m^2

$I_0 = 340$ W / m^2

$$L P - \varepsilon C_p W (T_L - T_O) + (1 - a) I_0 - e \sigma T_L^4 = 0 \qquad [B]$$

$$P - \varepsilon W \rho (q_O - q_L) = 0 \qquad [C]$$

$$W = \alpha (T_L - T_O) \qquad [E]$$

$$P = \beta q_L \qquad [F]$$

$$W^3 + \frac{\beta}{\epsilon\rho}W^2 - \frac{\alpha}{\epsilon C_p}(\mathcal{L} q_O \beta + R) \cdot W - \frac{\alpha\beta}{\epsilon^2 \rho C_p} \cdot R = 0. \qquad \mathbf{[5]}$$

Finding q_L from [C] and [F]

$$\beta q_L - \varepsilon W \rho (q_O - q_L) = 0$$

$$(\beta + \varepsilon W \rho) * q_L - \varepsilon W \rho * q_O = 0 \qquad [*]$$

$$q_L = \varepsilon W \rho q_O / (\beta + \varepsilon W \rho) = q_O / (1 + \beta / \varepsilon W \rho)$$

Finding T_L from [E]

M1

$$T_L = T_O + W / \alpha$$

Rewriting [B]

$$L \beta q_L - \varepsilon C_p W^2 / \alpha + (1-a) I_0 - e \sigma (T_O + W / \alpha)^4 = 0$$

Using q_L from [*]

$$L \beta q_O / (1 + \beta / \varepsilon W \rho) - \varepsilon C_p W^2 / \alpha + (1-a) I_0 - e \sigma (T_O + W / \alpha)^4 = 0$$

Taylor expansion

$$(T_O + W / \alpha)^4 = T_O^4 * (1 + W / (\alpha T_O))^4 = \text{appr.}$$

$$T_O^4 * (1 + 4 * W / (\alpha T_O))$$

$$(1 + x)^n = 1 + n x + 1 / 2 * x^2 + 1/ (2 * 3) * x^3 + \ldots = \text{appr. } 1 + n x$$

$$L \beta q_O / (1 + \beta / (\varepsilon W \rho)) - \varepsilon C_p W^2 / \alpha + (1-a) I_0$$

$$- e \sigma T_O^4 - (4 e \sigma T_O^3 / \alpha) * W = 0$$

$$1 / (1 + \beta / \varepsilon W \rho) = W / (W + \beta / \varepsilon \rho)$$

$$L \beta q_O * W - \varepsilon C_p W^2 / \alpha * (W + \beta / (\varepsilon \rho)) + [(1-a) I_0 - e \sigma T_O^4] * (W + \beta / \varepsilon \rho)$$

$$- 4 e \sigma T_O^3 / \alpha * W * (W + \beta / \varepsilon \rho) = 0$$

$$L \beta q_O * W - \varepsilon C_p W^3 / \alpha - \beta / (\varepsilon \rho) * \varepsilon C_p W^2 / \alpha$$

$$+ [(1-a) I_0 - e \sigma T_O^4] * W + [(1-a) I_0 - e \sigma T_O^4] * \beta / (\varepsilon \rho)$$

$$- 4 e \sigma T_O^3 / \alpha * W^2 - 4 e \sigma T_O^3 * \beta / (\alpha \varepsilon \rho) = 0$$

Divide by $- \varepsilon C_p / \alpha$

$$W^3 + [\beta / (\varepsilon \rho) - 4 e \sigma T_O^3 / (\varepsilon C_p)] * W^2$$

$$+ [-\alpha L \beta q_O / (\varepsilon C_p) - [(1-a) I_0 - e \sigma T_O^4] * \alpha / (\varepsilon C_p)] * W$$

$$+ 4 e \sigma T_O^3 * \beta / (C_p \varepsilon^2 \rho) - [(1-a) I_0 - e \sigma T_O^4] * \alpha \beta / (C_p \varepsilon^2 \rho)$$

$$R_0 = (1-a) I_0 - e \sigma T_O^4$$

$$W^3 + [\beta / (\varepsilon \rho) - 4 e \sigma T_O^3 / (\varepsilon C_p)] * W^2$$

$$+ [-\alpha L \beta q_O / (\varepsilon C_p) - R_0 * \alpha / (\varepsilon C_p)] * W$$

$$+ 4 e \sigma T_O^3 * \beta / (C_p \varepsilon^2 \rho) - R_0 * \alpha \beta / (C_p \varepsilon^2 \rho) = 0$$

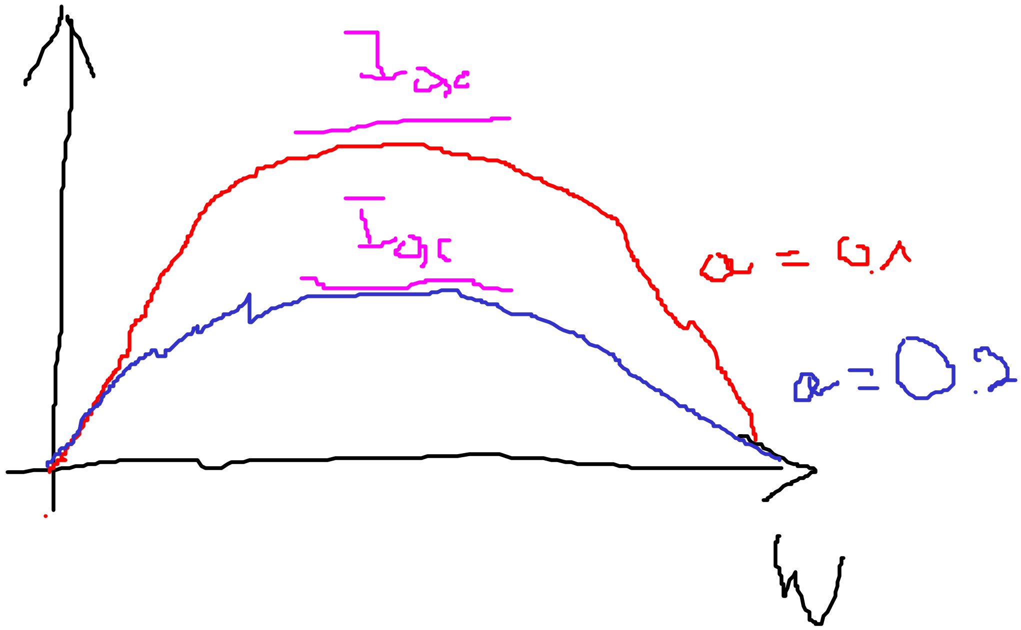
$$L \beta q_L - \varepsilon C_p W^2 / \alpha + (1-a) I_0 - e \sigma (T_O + W / \alpha)^4 = 0$$

M2

$$I_0 = 1 / (1-a) * [-L \beta q_O / (1 + \beta / \varepsilon W \rho) + \varepsilon C_p W^2 / \alpha + e \sigma (T_O + W / \alpha)^4]$$

$= g(W)$]

$I_0 = f(W)$



$$w \equiv W\epsilon\rho/\beta$$

$$r \equiv R \cdot \epsilon\alpha\rho^2/(C_p\beta^2)$$

$$l \equiv (\epsilon\alpha\rho^2\mathcal{L}q_O)/(C_p\beta) = (\mathcal{L}q_O\beta)/(C_p\beta^2/(\epsilon\alpha\rho^2)).$$

w^3 + (1 - 4 e σ T_O^3 ρ / (β C_p)) w^2 - (l + r_0) w - r_0 - 4 e ε σ T_O^3 ρ / (β C_p)

r -> r_0 - delta a * I_0

r_c -> r_c - delta a * I_0

The effect of changed albedo is change of R

R -> R - delta a * I_0

a = 0.3 - v(P) * 0.2

v(P) = gamma * P

Original: w^3 + w^2 - (l+r) w - r = 0

Modified: r' = r - a * I_0 * constant = r - (0.3 - gamma * P * 0.2) * I_0 * constant

w^3 + w^2 - (l+r') w - r' = 0

p = w / (1 + w)