Thompson Microphysics

Autoconversion

$$\frac{dq_r}{dt} = \frac{2.7 \times 10^{-2} q_c \left[\frac{1}{16} \times 10^{20} D_{\text{mean}}^4 (1 + \upsilon)^{-0.5} - 0.4 \right]}{\frac{3.7}{\rho_a q_c} [0.5 \times 10^6 D_{\text{mean}} (1 + \upsilon)^{-1/6} - 7.5]^{-1}},$$

$$D_{\text{mean}} = \left(\frac{6 \rho_a q_c}{\pi \rho_w N_c} \right)^{1/3}$$

ν - gamma distribution shape parameter

Accretion of Rain Water

$$P_{\mathrm{racw}} = \frac{\pi}{4} a_{\mathrm{r}} \rho q_{\mathrm{c}} E_{\mathrm{cr}} N_{\mathrm{o,r}} \frac{\Gamma(3 + b_{\mathrm{r}})}{\lambda^{3+b_{\mathrm{r}}}}$$

Fallout

$$P_{x\text{рг}c} = -\frac{\partial \bar{U}_x \rho g q_x}{\partial \sigma}$$

$$\bar{U}_x = \frac{a_x \Gamma(4 + b_x)}{6\lambda_x^{b_x}}$$

Evaporation

$$P_{\text{revp}} = \frac{2\pi N_{0,\text{r}}(S_{\text{w}} - 1)}{A' + B'} \left\{ \frac{0.78}{\lambda_{\text{r}}^2} + 0.31 \left(\frac{a_{\text{r}}\rho}{\mu} \right)^{\frac{1}{2}} \frac{\Gamma(b_{\text{r}}/2 + 5/2)}{\lambda_{\text{r}}^{b_{\text{r}}/2+5/2}} \right\}$$

Ice Initiation

$$P_{\text{ifzc}} = B'[\exp\{A'(T_0 - T)\} - 1]\frac{\rho q_c^2}{\rho_w N_c}$$

$$P_{\text{ifzc}} = \frac{q_c}{2\Delta t} \qquad N_{\text{ifzc}} = \frac{N_c}{2\Delta t}$$

$$P_{\text{idep}} = \frac{q_v - q_{\text{vsi}}}{q_{\text{vsw}} - q_{\text{vsi}}} a_1 (m_i)^{a_2} N_i / \rho$$

Aggregation of Snow

$$\Delta\tau = \frac{N_i(m_{so} - m_i)}{P_{idep} + P_{i.iacw}}; \qquad m_{so} = (4\pi/3)\rho_s r_{so}^3$$

Depositional Growth

$$N_{iag} \equiv C N_{is}^{Ag} = \frac{q_i}{\Delta\tau_1},$$

$$\Delta\tau_1 = -\frac{2}{C_1}\log\left(\frac{r_i}{r_{so}}\right)^3$$

$$C_i = \frac{\rho q_i a_i E_{ii} X}{\rho_i}$$

Aggregation Growth

Aggregation of Graupel

$$P_{\text{gdep}} = \frac{2\pi N_{\text{o,g}}(S_{\text{i}} - 1)}{A' + B'} \left\{ \frac{0.78}{\lambda_{\text{g}}^2} + 0.31 \left(\frac{a_{\text{g}}\rho}{\mu} \right)^{\frac{1}{2}} \frac{\Gamma(b_{\text{g}}/2 + 5/2)}{\lambda_{\text{g}}^{b_{\text{g}}/2+5/2}} \right\}$$

Depositional Growth

$$P_{\text{sacw}} = \frac{\pi a_{\text{s}} q_{\text{c}} E_{\text{cs}} N_{\text{o,s}}}{4} \frac{\Gamma(b_{\text{s}} + 3)}{\lambda_{\text{s}}^{b_{\text{s}}+3}}$$

$$P_{\text{gacw}} = \frac{\pi a_{\text{g}} q_{\text{c}} E_{\text{cg}} N_{\text{o,g}}}{4} \frac{\Gamma(b_{\text{g}} + 3)}{\lambda_{\text{g}}^{b_{\text{g}}+3}}$$

Riming

Accretion

$$N_{sag} = \frac{-I(b_s)a_s E_{ss}}{4 \times 720} \pi^{\frac{1-b_s}{3}} \rho^{\frac{2+b_s}{3}} \rho_s^{\frac{-2-b_s}{3}} q_s^{\frac{2+b_s}{3}} N_s^{\frac{4-b_s}{3}}$$

Snow and Ice

$$P_{sacr} = \pi^2 E_{rs} \sqrt{(\alpha \bar{U}_r - \beta \bar{U}_s)^2 + \gamma \bar{U}_r \bar{U}_s} \frac{\rho_w}{\rho} N_{o,r} N_{o,s} \left(\frac{5}{\lambda_r^6 \lambda_s} + \frac{2}{\lambda_r^5 \lambda_s^2} + \frac{0.5}{\lambda_r^4 \lambda_s^3} \right)$$

Rain Water and Snow

Melting

$$P_{\mathrm{smlt}} = -\frac{2\pi N_{\mathrm{o,s}}}{L_{\mathrm{f}}} K_{\mathrm{a}}(T - T_0) \left\{ \frac{0.65}{\lambda_{\mathrm{s}}^2} + 0.44 \left(\frac{a_{\mathrm{s}}\rho}{\mu} \right)^{\frac{1}{2}} \frac{\Gamma(b_{\mathrm{s}}/2 + 5/2)}{\lambda_{\mathrm{s}}^{b_{\mathrm{s}}/2+5/2}} \right\}$$