Namelist Guide for the GFDL Cloud Microphysics

Shian-Jiann Lin and Linjiong Zhou

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1 General

mp_time

Real: Time step of GFDL cloud microphysics (MP). If **mp_time** isn't divisible by physics time step or is larger than physics time step, the actual MP time step becomes $dt/\text{NINT}[dt/\text{MIN}(dt, mp\_time)]$. The unit is s. 150 by default.

tice

Real: Freezing / melting temperature. The unit is K. 273.16 by default.

fix_negative

Logical: $.true.$ to fix negative water species using nearby points. $.false.$ as default.

fast_sat_adj

Logical: $.true.$ to adjust cloud water evaporation (cloud water $\rightarrow$ water vapor), cloud water freezing (cloud water $\rightarrow$ cloud ice), cloud ice deposition (water vapor $\rightarrow$ cloud ice) when fast saturation adjustment is activated (**do_sat_adj** = $.true.$ in **fv_core_nml** block). $.true.$ by default.

2 Conversion Time Scale

tau_v2l

Real: Time scale for condensation of water vapor to cloud water. Increasing / decreasing **tau_v2l** can decrease / boost condensation of water vapor to cloud water (water vapor $\rightarrow$ cloud water). The unit is s. 150 by default.

tau_v2g

Real: Time scale for deposition of water vapor to graupel. Increasing / decreasing **tau_v2g** can decrease / boost deposition of water vapor to graupel (water vapor $\rightarrow$ graupel). The unit is s. 21600 by default.

tau_l2v

Real: Time scale for evaporation of cloud water to water vapor. Increasing / decreasing **tau_l2v** can

decrease / boost deposition of cloud water to water vapor (cloud water → water vapor). The unit is *s*. 300 by default.

tau_l2r

Real: Time scale for autoconversion of cloud water to rain. Increasing / decreasing **tau_l2r** can decrease / boost autoconversion of cloud water to rain (cloud water → rain). The unit is *s*. 900 by default.

tau_r2g

Real: Time scale for freezing of rain to graupel. Increasing / decreasing **tau_r2g** can decrease / boost freezing of rain to graupel (rain → graupel). The unit is *s*. 900 by default.

tau_i2s

Real: Time scale for autoconversion of cloud ice to snow. Increasing / decreasing **tau_i2s** can decrease / boost autoconversion of cloud ice to snow (cloud ice → snow). The unit is *s*. 1000 by default.

tau_imlt

Real: Time scale for cloud ice melting. Increasing / decreasing **tau_imlt** can decrease / boost melting of cloud ice to cloud water or rain (cloud ice → cloud water or rain). The unit is *s*. 600 by default.

tau_smlt

Real: Time scale for snow melting. Increasing / decreasing **tau_smlt** can decrease / boost melting of snow to cloud water or rain (snow → cloud water or rain). The unit is *s*. 900 by default.

tau_g2v

Real: Time scale for sublimation of graupel to water vapor. Increasing / decreasing **tau_g2v** can decrease / boost sublimation of graupel to water vapor (graupel → water vapor). The unit is *s*. 900 by default.

tau_g2r

Real: Time scale for graupel melting. Increasing / decreasing **tau_g2r** can decrease / boost melting of graupel to rain (graupel → rain). The unit is *s*. 600 by default.

3 Subgrid Variability

dw_land

Real: Base value for subgrid deviation / variability over land. 0.2 by default.

dw_ocean

Real: Base value for subgrid deviation / variability over ocean. 0.1 by default.

z_slope_liq

Logical: *.true.* to turn on vertically subgrid linear monotonic slope for autoconversion of cloud water to rain. *.true.* by default.

z_slope_ice

Logical: *.true.* to turn on vertically subgrid linear monotonic slope for autoconversion of cloud ice to snow. *.false.* by default.

4 Fall Speed

const_vi

Logical: *.true.* to use constant cloud ice fall speed. *.false.* by default.

const_vs

Logical: *.true.* to use constant snow fall speed. *.false.* by default.

const_vg

Logical: *.true.* to use constant graupel fall speed. *.false.* by default.

const_vr

Logical: *.true.* to use constant rain fall speed. *.false.* by default.

vi_fac

Real: Tunable factor for cloud ice fall or the constant cloud ice fall speed when **const_vi** is *.true.*. The unit is 1. 1 by default.

vr_fac

Real: Tunable factor for rain fall or the constant rain fall speed when **const_vr** is *.true.*. The unit is 1. 1 by default.

vs_fac

Real: Tunable factor for snow fall or the constant snow fall speed when **const_vs** is *.true.*. The unit is 1. 1 by default.

vg_fac

Real: Tunable factor for graupel fall or the constant graupel fall speed when **const_vg** is *.true.*. The unit is 1. 1 by default.

vi_max

Real: Maximum fall speed for cloud ice. The unit is m/s. 0.5 as default.

vs_max

Real: Maximum fall speed for snow. The unit is m/s. 5.0 as default.

vg_max

Real: Maximum fall speed for graupel. The unit is m/s. 8.0 as default.

vr_max

Real: Maximum fall speed for rain. The unit is m/s. 12.0 as default.

5 Conversion Threshold

ql_mlt

Real: Maximum value of cloud water allowed from melted cloud ice (cloud ice → cloud water or rain). Exceedance of which will become rain. Increasing / decreasing **ql_mlt** can increase / decrease cloud water and decrease / increase rain. The unit is $kgkg^{-1}$. 2.0×10^{-3} by default.

qs_mlt

Real: Maximum value of cloud water allowed from melted snow (snow → cloud water or rain). Exceedance of which will become rain. Increasing / decreasing **qs_mlt** can increase / decrease cloud water and decrease / increase rain. The unit is $kgkg^{-1}$. 1.0×10^{-6} by default.

ql_gen

Real: Maximum value for cloud water generated from condensation of water vapor (water vapor → cloud water). Increasing / decreasing **ql_gen** can increase / decrease cloud water. The unit is $kgkg^{-1}$. 1.0×10^{-3} by default.

qi_gen

Real: Maximum value of cloud ice generated from deposition of water vapor (water vapor → cloud ice) or freezing (cloud water → cloud ice). Increasing / decreasing **qi_gen** can increase / decrease cloud ice. The unit is kgm^{-3}. 1.82×10^{-6} by default.

ql0_max

Real: Threshold of cloud water to rain autoconversion (cloud water → rain). Increasing / decreasing **ql0_max** can increase / decrease rain and decrease / increase cloud water. The unit is $kgkg^{-1}$. 2.0×10^{-3} by default.

qi0_max

Real: Maximum value of cloud ice generated from other sources like convection. Exceedance of which will become snow. Increasing / decreasing **qi0_max** can increase / decrease cloud ice and decrease / increase snow. The unit is $kgkg^{-1}$. 1.0×10^{-4} by default.

qi0_crt

Real: Threshold of cloud ice to snow autoconversion (cloud ice → snow). Increasing / decreasing **qi0_crt** can increase / decrease cloud ice and decrease / increase snow. The unit is kgm^{-3}. 1.0×10^{-4} by default.

qs0_crt

Real: Threshold of snow to graupel autoconversion (snow → graupel). Increasing / decreasing **qs0_crt** can increase / decrease snow and decrease / increase graupel. The unit is kgm^{-3}. 1.0×10^{-3} by default.

qc_crt

Real: Minimum value of cloud condensate to allow partial cloudiness. Partial cloud can only exist when total cloud condensate exceeds **qc_crt**. The unit is $kgkg^{-1}$. 5.0×10^{-8} by default.

qi_lim

Real: Cloud ice limiter to prevent large ice built up in cloud ice freezing (cloud water → cloud ice) and

deposition (water vapor → cloud ice). The unit is 1. 1 by default.

rh_inc

Real: Relative humidity increment for complete evaporation of cloud water and cloud ice. The unit is 1. 0.25 by default.

rh_ins

Real: Relative humidity increment for minimum evaporation of rain. The unit is 1. 0.25 by default.

rh_inr

Real: Relative humidity increment for sublimation of snow. The unit is 1. 0.25 by default.

rthresh

Real: Critical cloud water radius for autoconversion (cloud water → rain). Increasing / decreasing of **rthresh** makes the autoconversion harder / easier. The unit is mm. 1.0×10^{-5} by default.

6 Conversion Efficiency

c_cracw

Real: Accretion efficiency of cloud water to rain (cloud water → rain). Increasing / decreasing of **c_cracw** can boost / decrease the accretion of cloud water to rain. The unit is 1. 0.9 by default.

c_psaci

Real: Accretion efficiency of cloud ice to snow (cloud ice → snow). Increasing / decreasing of **c_psaci** can boost / decrease the accretion of cloud ice to snow. The unit is 1. 0.02 by default.

c_pgacs

Real: Accretion efficiency of snow to graupel (snow → graupel). Increasing / decreasing of **c_pgacs** can boost / decrease the accretion of snow to graupel. The unit is 1. 2.0×10^{-3} by default.

c_paut

Real: Autoconversion efficiency of cloud water to rain (cloud water → rain). Increasing / decreasing of **c_paut** can boost / decrease the autoconversion of cloud water to rain. The unit is 1. 0.55 by default.

sat_adj0

Real: Adjust factor for condensation of water vapor to cloud water (water vapor → cloud water) and deposition of water vapor to cloud ice (water vapor → cloud ice). The unit is 1. 0.9 by default.

7 Cloud Fraction

do_qa

Logical: $.true.$ to activate inline cloud fraction diagnosis in fast saturation adjustment. $.false.$ to activate inline cloud fraction diagnosis in major cloud microphysics. $.true.$ as default.

rad_rain

Logical: *.true.* to consider rain in cloud fraction calculation. *.true.* by default.

rad_snow

Logical: *.true.* to consider snow in cloud fraction calculation. *.true.* by default.

rad_graupel

Logical: *.true.* to consider graupel in cloud fraction calculation. *.true.* by default.

cld_min

Real: Minimum cloud fraction. If total cloud condensate exceeds $1 \times 10^{-6} kgkg^{-1}$, cloud fraction cannot be less than **cld_min**. The unit is 1. 0.05 by default.

8 Sedimentation

use_ppm

Logical: *.true.* to use PPM fall scheme. $.false.$ to use time-implicit monotonic fall scheme. $.false.$ by default.

mono_prof

Logical: *.true.* to turn on terminal fall with monotonic PPM scheme. This is used together with **use_ppm** = *.true.*. *.true.* by default.

do_sedi_heat

Logical: *.true.* to turn on heat transport during sedimentation. *.true.* by default.

sedi_transport

Logical: *.true.* to turn on horizontal momentum transport during sedimentation. *.true.* by default.

do_sedi_w

Logical: *.true.* to turn on vertical motion transport during sedimentation. $.false.$ by default. [Not supported in GFS phsycis]

9 CCN

prog_ccn

Logical: *.true.* to activate prognostic CCN. $.false.$ by default. [Not supported in GFS phsycis]

use_ccn

Logical: *.true.* to compute prescribed CCN. It should be *.true.* when **prog_ccn** is $.false.$. *.true.* by default.

ccn_l

Real: Base CCN over land. Increasing / decreasing **ccn_l** can on the one hand boost / decrease the autoconversion of cloud water to rain (cloud water → rain), on the other hand make the autoconversion harder / easier. The unit is cm^{-3}. 270 by default.

ccn_o

Real: Base CCN over ocean. Increasing / decreasing **ccn_o** can on the one hand boost / decrease the autoconversion of cloud water to rain (cloud water → rain), on the other hand make the autoconversion harder / easier. The unit is cm^{-3}. 90 by default.

10 Options

icloud_f

Integer: Flag (0, 1, or 2) for cloud fraction diagnostic scheme. See the "GFDL Cloud Microphysics" document for more detail. Generally, from 0 to 2, cloud fraction increases. 0 by default.

irain_f

Integer: Flag (0 or 1) for cloud water autoconversion to rain scheme. 0: with subgrid variability; 1: no subgrid variability. 0 by default.

11 Others

alin

Real: Parameter a in Lin et al., (1983). Constant in empirical formula for U_R. Increasing / decreasing **alin** can boost / decrease accretion of cloud water by rain (cloud water → rain) and rain evaporation (rain → water vapor). The unit is $cm^{1-b}s^{-1}$. 842 by default. This value follows Hong and Lim (2006).

clin

Real: Parameter c in Lin et al., (1983). Constant in empirical formula for U_S. Increase / decreasing **clin** can boost / decrease accretion of cloud water by snow (cloud water → snow), accretion of cloud ice by snow (cloud ice → snow), snow sublimation and deposition (snow ↔ water vapor), and snow melting (snow → cloud water or rain). The unit is $cm^{1-d}s^{-1}$. 4.8 by default.

t_min

Real: Temperature threshold for instant deposition. Deposit all water vapor to cloud ice (water vapor → cloud ice) when temperature is lower than **t_min**. The unit is K. 178 by default.

t_sub

Real: Temperature threshold for sublimation. Cloud ice, snow or graupel stops / starts sublimation (cloud ice → water vapor, snow → water vapor, graupel → water vapor) when temperature is lower / higher than **t_sub**. The unit is K. 184 by default.

mp_print

Logical: *.true.* to turn on GFDL cloud microphysics debugging print out. *.false.* by default. [Not supported in GFS phsycis]

de_ice

Logical: *.true.* to convert excessive cloud ice to snow to prevent ice over-built from other sources like convection scheme. *.false.* by default. [Not supported in GFS phsycis]

For more detail of the namelist, please refer to the document "GFDL Cloud Microphysics".