CSU – RAMS – SCM

Comprehensive Variable List

This document contains single-column-model (SCM) information and the full list of input/output variables that RAMS microphysics-radiation-aerosol SCM requires and produces.

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Getting Started

1. Unpack the RAMS SCM code.

2. The SCM driver program is named “main.f90”. The primary code sits within the directory named something like “6.3.02”. The primary code directory structure mimics the RAMS directory tree.

2. Alter the “Makefile” section “Include Definitions” to have correct paths and same compiler and compiler flags as RAMS. Type “make” to compile the code. The executable will be something like “rams-6.3.02”

3. Alter the default name-list “RAMSIN” to your specifications. Most of the flags are the same as in the RAMS name-list, so please consult the RAMS name-list documentation if you need help. Flags custom to the SCM have comments in the SCM name-list. The name-list must be named “RAMSIN”.

4. By default, the SCM reads input files from directory “scm.in” and writes to directory “scm.out”. To run the full (non-customized) SCM you need the “scm.in” single-column text files that are generated from RAMS as discussed below. If you already have these input files in the “scm.in” directory and you have created the output directory “scm.out”, then you can run the SCM by running the executable. Text format output files should be created in the “scm.out” directory. If you run for more than 1 time step, the files are appended over time.

5. A set of directories with input/output files for testing are included in the SCM package (“scm.in.test” and “scm.out.test”) so that you can test the code with the default RAMSIN name-list file. These test directories contain the initial column data before and after a physics time step from a single column in a RAMS supercell simulation at a particular time step. Copy the files from “scm.in.test” to “scm.in”. The “scm.out” directory should be initially empty (the SCM code will automatically remove any old files in “scm.out”). After you compile and run the SCM, you will see output in the “scm.out” directory. This will contain the variables updated after 1 time step (unless you specify more time steps in RAMSIN). You can compare the files from input and output to see how things have changed within a single physics time step by running the bash script as “z.diff.sc 1”. You can compare your test output in “scm.out” to that in “scm.out.test” to see how your results compare to the default test output by running the bash script as “z.diff.sc 2 scm.out scm.out.test”. (Use of a different compiler will likely give slightly different results.)

Introduction

a. The RAMS SCM stand-alone model runs the RAMS aerosol, Harrington radiation, and microphysics packages. The SCM must be fed a number of required input fields as text format single column files, runs the single column physics, and then outputs updated fields each time-step as new appended text files. The main RAMS model has name-list flags that can be used to generate the text files that drive the SCM. When turned on, the user chooses what time and which I,J (X,Y) column is output to the text files. A different file is generated for each needed variable such as “up.txt”, “wp.txt”, “theta.txt”, “cccnp.txt”, etc. Each file contains data for the single chosen column. RAMS produces the text files before the calls to physics into directory “scm.in” and then produces a set of files after all the physics calls into directory “scm.out”. By doing this, one can compare the variable columns before and after the chosen time step. Also, the output text files can be used to verify that RAMS and the SCM produce the same physics results. The user needs to make sure the directories “scm.in” and “scm.out” are present in the runtime RAMS directory.

b. There is no feedback from the microphysics to the dynamics (UP, VP, WP, PP) or total water field (RTP), but the radiation and physics does update the temperature (THP, THETA) due to radiative heating and latent heating/cooling, and RTP is updated due to sedimentation only. The physics will update hydrometeor mixing ratios and diagnose water vapor (RV), but these must remain in balance with total water (RTP). This means that running the SCM for multiple time steps without feedbacks will limit some applications. The SCM is physics only; no vertical transport occurs, but hydrometeor sedimentation allows particles to fall. The SCM can be run multiple time steps for testing physics, such as sedimentation, but the user must anticipate which testing applications will have limitations due to lack of feedbacks.

c. The SCM name-list “RAMSIN” has flags that allow the user to turn microphysics processes on and off for testing purposes. The user is responsible for understanding the implications of turning some processes on and off. For example, if you turn off everything but sedimentation and but still have NaN checking turned on, then you may end up crashing the model since RTP, RV, and hydrometeor mixing ratios may get unbalanced. But in this example, you do not care about RTP and RV; your focus is on falling hydrometeors only which do not need information on RTP or RV.

Specific Details

1. Note that in the variable list below, the variables labeled as “INPUT” need to be passed to the SCM physics if interfaced to another parent model or read in via text format single column files if using SCM as a stand-alone physics model. As discussed above, the main RAMS model can be used to generate the input text files for driving the SCM. (Some caveats to this are explained below.)

2. For the pressure variable, RAMS initializes with PI0 and PP, but there is a flag in the name-list and code to input PRESSURE (rather than PI0 and PP) if that is what is available from the parent model. This associated RAMSIN name-list variable is IPRESS.

3. For the temperature variable, RAMS initializes and prognoses with THP, but there is a flag in the name-list and code to input THETA (rather than THP) if that is what is available from the parent model. However, THETA and THP are equal at time=0 when no condensate exists. So, THP will become the prognostic variable since it is required within the RAMS microphysics, and the model will diagnose THETA from updated THP. The associated RAMSIN name-list variable is ITHETA.

4. For the moisture variable, RAMS initializes and prognoses with RTP, but there is a flag in the name-list and code to input RV (rather than RTP) if that is what is available from the parent model. However, RTP and RV are equal at time=0 when no condensate (liquid or ice) exists. So, RTP will become the prognostic variable since it is required within the RAMS microphysics, and the model will diagnose RV from updated RTP and prognostic condensate mixing ratios. The associated RAMSIN name-list variable is IRV.

5. The remainder of the non-input variables that are custom to RAMS physics are dynamically allocated with their given names as at the beginning of the SCM code. The SCM is set up to be able to be called separately for each column by a parent model. It could be adapted to run over a parallel-subdomain in the horizontal as is done in the main RAMS model. Variables are currently set up as 3D variables (z,x,y), as is done in RAMS, but with x=y=1, and z varies with the number of vertical levels.

6. The vertical coordinate is a sigma-Z coordinate. This is absolutely required in the RAMS physics for hydrometeor sedimentation. Model levels heights are also used in several other areas of the physics including radiation, dust/sea-salt lofting, and aerosol deposition. These physics packages are designed around a sigma-Z coordinate. The sigma-Z coordinate is terrain following by definition; however, over terrain, an adjustment is made to squeeze the layers together so that the model top level is flat. This requires input of topography on T (scalar) levels (Arakawa-C type vertical grid stagger).

7. To customize the input for the SCM you can add your own routines as needed or use the subroutine “init_custom” in file “micro/mic_init_scm.f90”. For example, you could input a specified rain mixing ratio and number concentration for a single grid cell, turn off everything but sedimentation in the name-list, and run sedimentation for many time steps and see the progression of rain mixing ratio and number concentration over time as drops fall through the column. In this example, many of the input files would not be needed (such as U,V,W, etc), but the user needs to consider these sorts of things before proceeding.

SEE THE VARIABLE LIST BELOW

RAMS Variables			
ASCII Name	dimensions	units	Description
(5) INPUT GRID AND TOPOGRAPHY			
GLAT	nx,ny	deg	(INPUT) Latitude
GLON	nx,ny	deg	(INPUT) Longitude
ZT	nz	m	(INPUT) Vertical grid point elevation above ground on vertical staggered scalar T-grid
ZM	nz	m	(INPUT) Vertical grid point elevation above ground on vertical staggered M-grid
TOPT	nx,ny	m	(INPUT) topography height at scalar grid point

(11) DYNAMICS & THERMODYNAMICS			
PI0	nx,ny,nz	J/(kg*K)	(INPUT) Base state PI = Exner function * Cp, where Exner-function = T/Θ = (p/p00)^(Rd/Cp)
PP	nx,ny,nz	J/(kg*K)	(INPUT) Past perturbation Exner function (PI-prime)
PRESSURE	nx,ny,nz	Pa	(INPUT) Air pressure
UP	nx,ny,nz	m/s	(INPUT) Past U (zonal) wind component
VP	nx,ny,nz	m/s	(INPUT) Past V (meridional) wind component
WP	nx,ny,nz	m/s	(INPUT) Past W (vertical) wind component
THP	nx,ny,nz	K	(INPUT) Theta-IL, ice-liquid potential temperature
RTP	nx,ny,nz	kg/kg	(INPUT) Total water mixing ratio (water vapor + condensate) (prognostic variable)
THETA	nx,ny,nz	K	(INPUT) Potential temperature
RV	nx,ny,nz	kg/kg	(INPUT) Water vapor mixing ratio
DN0	nx,ny,nz	kg/m^3	(INPUT) reference state air density

(4) SURFACE CHARACTERISTICS			
(There are 2 surface patches: 1=water/ocean, 2=land)			
LEAF_CLASS	nx,ny,np	#	(INPUT) vegetation class
PATCH_AREA	nx,ny,np	fraction	(INPUT) patch fractional area
SOIL_WATER	nx,ny,nzg,np	m^3/m^3	(INPUT) volumetric soil moisture
SOIL_TEXT	nx,ny,np	#	(INPUT) soil textural class

(19) HYDROMETEOR MIXING RATIOS, NUMBER CONCENTRATION, ENERGY			
RCP	nx,ny,nz	kg/kg	cloud mixing ratio
RDP	nx,ny,nz	kg/kg	drizzle mixing ratio
RRP	nx,ny,nz	kg/kg	rain mixing ratio
RPP	nx,ny,nz	kg/kg	pristine ice mixing ratio
RSP	nx,ny,nz	kg/kg	snow mixing ratio
RAP	nx,ny,nz	kg/kg	aggregates mixing ratio
RGP	nx,ny,nz	kg/kg	graupel mixing ratio
RHP	nx,ny,nz	kg/kg	hail mixing ratio
CCP	nx,ny,nz	#/kg	cloud droplet number concentration
CDP	nx,ny,nz	#/kg	drizzle droplet number concentration
CRP	nx,ny,nz	#/kg	rain drop number concentration
CPP	nx,ny,nz	#/kg	pristine ice particle number concentration
CSP	nx,ny,nz	#/kg	snow particle number concentration
CAP	nx,ny,nz	#/kg	aggregates number concentration
CGP	nx,ny,nz	#/kg	graupel particle number concentration
CHP	nx,ny,nz	#/kg	hailstone number concentration
Q2	nx,ny,nz	J/kg	rain internal energy
Q6	nx,ny,nz	J/kg	graupel internal energy
Q7	nx,ny,nz	J/kg	hail internal energy

(24) AEROSOLS MASS MIXING RATIOS AND NUMBER CONCENTRATION			
CCCNP	nx,ny,nz	#/kg	ccn number concentration
GCCNP	nx,ny,nz	#/kg	gccn number concentration
DUSTFRAC	nx,ny	fraction	Grid cell dust erodible fraction

MD1NP	**nx,ny,nz**	**#/kg**	**sub-micron dust number concentration**
MD2NP	**nx,ny,nz**	**#/kg**	**super-micron dust number concentration**
ABC1NP	**nx,ny,nz**	**#/kg**	**Absorbing carbon (1% BC, 99% OC) number concentration**
ABC2NP	**nx,ny,nz**	**#/kg**	**Absorbing carbon (2% BC, 98% OC) number concentration**
SALT_FILM_NP	**nx,ny,nz**	**#/kg**	**sea-salt film drop number concentration**
SALT_JET_NP	**nx,ny,nz**	**#/kg**	**sea-salt jet drop number concentration**
SALT_SPUM_NP	**nx,ny,nz**	**#/kg**	**sea-salt spume drop number concentration**
REGEN_AERO1_NP	**nx,ny,nz**	**#/kg**	**sub-micron regenerated aerosol number concentration**
REGEN_AERO2_NP	**nx,ny,nz**	**#/kg**	**super-micron regenerated aerosol number concentration**
CCCMP	**nx,ny,nz**	**kg/kg**	**ccn mass mixing ratio**
GCCMP	**nx,ny,nz**	**kg/kg**	**gccn mass mixing ratio**
MD1MP	**nx,ny,nz**	**kg/kg**	**sub-micron dust mass mixing ratio**
MD2MP	**nx,ny,nz**	**kg/kg**	**super-micron dust mass mixing ratio**
ABC1MP	**nx,ny,nz**	**#/kg**	**Absorbing carbon (1% BC, 99% OC) mass mixing ratio**
ABC2MP	**nx,ny,nz**	**#/kg**	**Absorbing carbon (2% BC, 98% OC) mass mixing ratio**
SALT_FILM_MP	**nx,ny,nz**	**kg/kg**	**sea-salt film drop mass mixing ratio**
SALT_JET_MP	**nx,ny,nz**	**kg/kg**	**sea-salt jet drop mass mixing ratio**
SALT_SPUM_MP	**nx,ny,nz**	**kg/kg**	**sea-salt spume drop mass mixing ratio**
REGEN_AERO1_MP	**nx,ny,nz**	**kg/kg**	**sub-micron regenerated aerosol mass mixing ratio**
REGEN_AERO2_MP	**nx,ny,nz**	**kg/kg**	**super-micron regenerated aerosol mass mixing ratio**
CIFNP	**nx,ny,nz**	**#/kg**	**ice nuclei number concentration (Meyers, DeMott-limited schemes)**

(38) AEROSOLS TRACKING			
IFNNUCP	nx,ny,nz	#/kg	ice nuclei already nucleated
IMMERCP	nx,ny,nz	#/kg	ice nuclei within cloud droplets
IMMERDP	nx,ny,nz	#/kg	ice nuclei within drizzle droplets
IMMERRP	nx,ny,nz	#/kg	ice nuclei within rain droplets
CNMCP	nx,ny,nz	kg/kg	total aerosol mass within cloud droplets
CNMDP	nx,ny,nz	kg/kg	total aerosol mass within drizzle
CNMRP	nx,ny,nz	kg/kg	total aerosol mass within rain
CNMPP	nx,ny,nz	kg/kg	total aerosol mass within pristine ice
CNMSP	nx,ny,nz	kg/kg	total aerosol mass within snow
CNMAP	nx,ny,nz	kg/kg	total aerosol mass within aggregates
CNMGP	nx,ny,nz	kg/kg	total aerosol mass within graupel
CNMHP	nx,ny,nz	kg/kg	total aerosol mass within hail
DNMCP	nx,ny,nz	kg/kg	total dust mass within cloud droplets
DNMDP	nx,ny,nz	kg/kg	total dust mass within dizzle
DNMRP	nx,ny,nz	kg/kg	total dust mass within rain
DNMPP	nx,ny,nz	kg/kg	total dust mass within pristine ice
DNMSP	nx,ny,nz	kg/kg	total dust mass within snow
DNMAP	nx,ny,nz	kg/kg	total dust mass within aggregates
DNMGP	nx,ny,nz	kg/kg	total dust mass within graupel
DNMHP	nx,ny,nz	kg/kg	total dust mass within hail
DINCP	nx,ny,nz	kg/kg	dust mass within cloud droplets via ice nucleation
DINDP	nx,ny,nz	kg/kg	dust mass within dizzle via ice nucleation
DINRP	nx,ny,nz	kg/kg	dust mass within rain via ice nucleation
DINPP	nx,ny,nz	kg/kg	dust mass within pristine ice via ice nucleation
DINSP	nx,ny,nz	kg/kg	dust mass within snow via ice nucleation
DINAP	nx,ny,nz	kg/kg	dust mass within aggregates via ice nucleation
DINGP	nx,ny,nz	kg/kg	dust mass within graupel via ice nucleation

DINHP	**nx,ny,nz**	**kg/kg**	**dust mass within hail via ice nucleation**
SNMCP	**nx,ny,nz**	**kg/kg**	**total soluble aerosol mass within cloud droplets**
SNMDP	**nx,ny,nz**	**kg/kg**	**total soluble aerosol mass within dizzle**
SNMRP	**nx,ny,nz**	**kg/kg**	**total soluble aerosol mass within rain**
SNMPP	**nx,ny,nz**	**kg/kg**	**total soluble aerosol mass within pristine ice**
SNMSP	**nx,ny,nz**	**kg/kg**	**total soluble aerosol mass within snow**
SNMAP	**nx,ny,nz**	**kg/kg**	**total soluble aerosol mass within aggregates**
SNMGP	**nx,ny,nz**	**kg/kg**	**total soluble aerosol mass within graupel**
SNMHP	**nx,ny,nz**	**kg/kg**	**total soluble aerosol mass within hail**
RESOL_AERO1_MP	**nx,ny,nz**	**kg/kg**	**sub-micron regenerated aerosol soluble mass mixing ratio**
RESOL_AERO2_MP	**nx,ny,nz**	**kg/kg**	**super-micron regenerated aerosol soluble mass mixing ratio**

(28) PRECIPITATION			
PCPVR	**nx,ny,nz**	**kg/m^2/s**	**rain precipitation rate (3D)**
PCPVP	**nx,ny,nz**	**kg/m^2/s**	**pristine ice precipitation rate (3D)**
PCPVS	**nx,ny,nz**	**kg/m^2/s**	**snow precipitation rate (3D)**
PCPVA	**nx,ny,nz**	**kg/m^2/s**	**aggregates precipitation rate (3D)**
PCPVG	**nx,ny,nz**	**kg/m^2/s**	**graupel precipitation rate (3D)**
PCPVH	**nx,ny,nz**	**kg/m^2/s**	**hail precipitation rate (3D)**
PCPVD	**nx,ny,nz**	**kg/m^2/s**	**drizzle precipitation rate (3D)**
PCPRR	**nx,ny**	**kg/m^2/s**	**surface rain precipitation rate**
PCPRP	**nx,ny**	**kg/m^2/s**	**surface pristine ice precipitation rate**
PCPRS	**nx,ny**	**kg/m^2/s**	**surface snow precipitation rate**
PCPRA	**nx,ny**	**kg/m^2/s**	**surface aggregates precipitation rate**
PCPRG	**nx,ny**	**kg/m^2/s**	**surface graupel precipitation rate**
PCPRH	**nx,ny**	**kg/m^2/s**	**surface hail precipitation rate**

PCPRD	**nx,ny**	**kg/m^2/s**	**surface drizzle precipitation rate**
ACCPR	**nx,ny**	**kg/m^2**	**accumulated rain over the course of the simulation**
ACCPP	**nx,ny**	**kg/m^2**	**accumulated pristine ice over the course of the simulation**
ACCPS	**nx,ny**	**kg/m^2**	**accumulated snow over the course of the simulation**
ACCPA	**nx,ny**	**kg/m^2**	**accumulated aggregates over the course of the simulation**
ACCPG	**nx,ny**	**kg/m^2**	**accumulated graupel over the course of the simulation**
ACCPH	**nx,ny**	**kg/m^2**	**accumulated hail over the course of the simulation**
ACCPD	**nx,ny**	**kg/m^2**	**accumulated drizzle over the course of the simulation**
PCPG	**nx,ny**	**kg/m^2**	**microphysics precipitation per timestep (for water, kg/m^2 = mm), Used by LEAF/SIB surface models**
QPCPG	**nx,ny**	**J/m^2**	**microphysics precipitation energy per timestep, Used by LEAF surface model**
DPCPG	**nx,ny**	**m**	**microphysics precipitation depth per timestep, Used by LEAF surface model**
ACCPDUST	**nx,ny**	**kg/m^2**	**surface accumulated mass of aerosols identified as dust (via nucleation and wet scavenging)**
ACCPAERO	**nx,ny**	**kg/m^2**	**Total surface accumulated mass of aerosols (via nucleation and wet scavenging)**
PCPRDUST	**nx,ny**	**kg/m^2/s**	**surface accumulation rate of aerosols identified as dust (via nucleation and wet scavenging)**
PCPRAERO	**nx,ny**	**kg/m^2/s**	**Total surface accumulation rate of aerosols (via nucleation and wet scavenging)**

(11) RADIATION			
FTHRD	**nx,ny,nz**	**K/s**	**radiative heating rate**
BEXT	**nx,ny,nz**	**km**	**visibility**

SWUP	**nx,ny,nz**	**W/m^2**	**upwelling shortwave radiation**
SWDN	**nx,ny,nz**	**W/m^2**	**downwelling shortwave radiation**
LWUP	**nx,ny,nz**	**W/m^2**	**upwelling longwave radiation**
LWDN	**nx,ny,nz**	**W/m^2**	**downwelling longwave radiation**
RSHORT	**nx,ny**	**W/m^2**	**surface downwelling shortwave radiation**
RLONG	**nx,ny**	**W/m^2**	**surface downwelling longwave radiation**
RLONGUP	**nx,ny**	**W/m^2**	**(INPUT) surface upwelling longwave radiation**
AODT	**nx,ny**	**unitless**	**Aerosol optical depth in visible radiation band-3**
ALBEDT	**nx,ny**	**fraction**	**(INPUT) surface albedo**

(14) BUDGET VARIABLES for IMBUDGET >=1

All budgets are accumulated (Total) values unless otherwise noted as being instantaneous values. Accumulated budgets are summed each timestep between analysis (A) output file writes and then reset. They are not reset for LITE or MEAN file outputs. "Total" budgets end with a "T". Instantaneous budgets have the same name but without the "T".

LATHEATVAPT	**nx,ny,nz**	**dΘ or dT**	**change in (T or Θ) due to vapor diffusion and cloud & ice nucleation**
LATHEATFRZT	**nx,ny,nz**	**dΘ or dT**	**change in (T or Θ) due to collision-coalescence and melting routines**
LATHEATVAP	**nx,ny,nz**	**dΘ or dT**	**Instantaneous / single timestep (T or Θ) due to vapor diffusion and cloud & ice nucleation**
LATHEATFRZ	**nx,ny,nz**	**dΘ or dT**	**Instantaneous / single timestep (T or Θ) due to collision-coalescence and melting routines**
NUCCLDRT	**nx,ny,nz**	**kg/kg**	**nucleation of cloud and drizzle water mixing ratio**
NUCICERT	**nx,ny,nz**	**kg/kg**	**nucleation of pristine ice mixing ratio from all nucleation mechanisms**

VAPLIQT	**nx,ny,nz**	**kg/kg**	**vapor deposition summed for all liquid hydrometeor species (this can be + or - depending on growth or evaporation)**
VAPICET	**nx,ny,nz**	**kg/kg**	**vapor deposition summed for all ice hydrometeor species (this can be + or - depending on growth or evaporation)**
MELTICET	**nx,ny,nz**	**kg/kg**	**melting of all ice species in melting routine (these are the category mass transfers due to melting)**
CLD2RAINT	**nx,ny,nz**	**kg/kg**	**cloud water transferred to rain via collection**
RIMECLDT	**nx,ny,nz**	**kg/kg**	**cloud water collected by all ice species (rcx values; see mic_coll.f90) (mass transfer from cloud)**
RAIN2ICET	**nx,ny,nz**	**kg/kg**	**rain water collected by ice species (rcx values; see mic_coll.f90) (mass transfer from rain)**
ICE2RAINT	**nx,ny,nz**	**kg/kg**	**ice melting due to collection of rain (rcy values; see mic_coll.f90) (mass transfer ice to rain)**
AGGREGATET	**nx,ny,nz**	**kg/kg**	**ice amount transferred to aggregates via collection**

(29) BUDGET VARIABLES for IMBUDGET >=2

All budgets are accumulated (Total) values unless otherwise noted as being instantaneous values. Accumulated budgets are summed each timestep between analysis (A) output file writes and then reset. They are not reset for LITE or MEAN file outputs. "Total" budgets end with a "T".

INUCHOMRT	**nx,ny,nz**	**kg/kg**	**homogeneous droplet freezing ice nucleation**
INUCCONTRT	**nx,ny,nz**	**kg/kg**	**contact freezing ice nucleation**
INUCIFNRT	**nx,ny,nz**	**kg/kg**	**condensation/immersion freezing ice nucleation from ice nuclei**
INUCHAZRT	**nx,ny,nz**	**kg/kg**	**haze droplet nucleation tied to aerosol concentration**
VAPCLDT	**nx,ny,nz**	**kg/kg**	**vapor diffusion / evaporation on cloud droplets**
VAPRAINT	**nx,ny,nz**	**kg/kg**	**vapor diffusion / evaporation on**

			rain
VAPPRIST	**nx,ny,nz**	**kg/kg**	**vapor diffusion / evaporation on pristine ice**
VAPSNOWT	**nx,ny,nz**	**kg/kg**	**vapor diffusion / evaporation on snow**
VAPAGGRT	**nx,ny,nz**	**kg/kg**	**vapor diffusion / evaporation on aggregates**
VAPGRAUT	**nx,ny,nz**	**kg/kg**	**vapor diffusion / evaporation on graupel**
VAPHAILT	**nx,ny,nz**	**kg/kg**	**vapor diffusion / evaporation on hail**
VAPDRIZT	**nx,ny,nz**	**kg/kg**	**vapor diffusion / evaporation on drizzle droplets**
MELTPRIST	**nx,ny,nz**	**kg/kg**	**mass transfer from pristine ice due to melting**
MELTSNOWT	**nx,ny,nz**	**kg/kg**	**mass transfer from snow due to melting**
MELTAGGRT	**nx,ny,nz**	**kg/kg**	**mass transfer from aggregates due to melting**
MELTGRAUT	**nx,ny,nz**	**kg/kg**	**mass transfer from graupel due to melting**
MELTHAILT	**nx,ny,nz**	**kg/kg**	**mass transfer from hail due to melting**
RIMECLDSNOWT	**nx,ny,nz**	**kg/kg**	**mass transfer from cloud due to riming by snow**
RIMECLDAGGRT	**nx,ny,nz**	**kg/kg**	**mass transfer from cloud due to riming by aggregates**
RIMECLDGRAUT	**nx,ny,nz**	**kg/kg**	**mass transfer from cloud due to riming by graupel**
RIMECLDHAILT	**nx,ny,nz**	**kg/kg**	**mass transfer from cloud due to riming by hail**
RAIN2PRT	**nx,ny,nz**	**kg/kg**	**mass transfer from rain due to collisions with pristine ice**
RAIN2SNT	**nx,ny,nz**	**kg/kg**	**mass transfer from rain due to collisions with snow**
RAIN2AGT	**nx,ny,nz**	**kg/kg**	**mass transfer from rain due to collisions with aggregates**
RAIN2GRT	**nx,ny,nz**	**kg/kg**	**mass transfer from rain due to collisions with graupel**
RAIN2HAT	**nx,ny,nz**	**kg/kg**	**mass transfer from rain due to collisions with hail**
AGGRSELFPRIST	**nx,ny,nz**	**kg/kg**	**mass transfer to aggregates due to pristine ice self-collection**
AGGRSELFSNOWT	**nx,ny,nz**	**kg/kg**	**mass transfer to aggregates due to snow self-collection**

AGGRPRISSNOWT	**nx,ny,nz**	**kg/kg**	**mass transfer to aggregates due to pristine ice / snow collisions**

<table>
<tr><th colspan="4">(4) BUDGET VARIABLES for IMBUDGET >=3</th></tr>
<tr><td colspan="4">All budgets are accumulated (Total) values unless otherwise noted as being instantaneous values. Accumulated budgets are summed each timestep between analysis (A) output file writes and then reset. They are not reset for LITE or MEAN file outputs. “Total” budgets end with a “T”.</td></tr>
<tr><td>DUST1CLDRT</td><td>nx,ny,nz</td><td>kg/kg</td><td>nucleation of cloud droplet mixing ratio from dust mode 1</td></tr>
<tr><td>DUST2CLDRT</td><td>nx,ny,nz</td><td>kg/kg</td><td>nucleation of cloud droplet mixing ratio from dust mode 2</td></tr>
<tr><td>DUST1DRZRT</td><td>nx,ny,nz</td><td>kg/kg</td><td>nucleation of drizzle droplet mixing ratio from dust mode 1</td></tr>
<tr><td>DUST2DRZRT</td><td>nx,ny,nz</td><td>kg/kg</td><td>nucleation of drizzle droplet mixing ratio from dust mode 2</td></tr>
</table>