

# **CSU – RAMS**

## **Comprehensive Analysis File Variable List**

**This document contains the full list of output variables as they appear in the native HDF5 output analysis files. Included are the name, units, and description of the variables. Note that not all of the listed variables are available from every simulation. Variables are not output unless the physics schemes they are associated with are turned on in the simulations via user choices in the RAMSIN namelist.**

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**Last updated: 30 August 2023 (for v6.3.04)**

<b>RAMS Variables (prior to REVU post-processing)</b>			
<b>ASCII Name</b>	<b>dimensions</b>	<b>units</b>	<b>Description</b>
<b>(4) GRID AND TOPOGRAPHY</b>			
GLAT	nx,ny	deg	Latitude
GLON	nx,ny	deg	Longitude
TOPT	nx,ny	m	topography height
TOPZO	nx,ny	m	topographic roughness length

<b>(15) DYNAMICS &amp; THERMODYNAMICS</b>			
PI	nx,ny,nz	J/(kg*K)	PI = Exner function * Cp, where (Cp=1004 J/kg/K in RAMS) Exner-function = $T/\theta = (p/p00)^{(Rd/Cp)}$
PIO	nx,ny,nz	J/(kg*K)	(INPUT) reference state PI
UP	nx,ny,nz	m/s	Past U (zonal) wind component
VP	nx,ny,nz	m/s	Past V (meridional) wind component
WP	nx,ny,nz	m/s	Past W (vertical) wind component
PP	nx,ny,nz	J/(kg*K)	Past perturbation Exner function (PI-prime)
UC	nx,ny,nz	m/s	Current U wind component
VC	nx,ny,nz	m/s	Current V wind component
WC	nx,ny,nz	m/s	Current W wind component
PC	nx,ny,nz	J/(kg*K)	Current perturbation Exner function (PI-prime)
THP	nx,ny,nz	K	Theta-IL, ice-liquid potential temperature (prognostic variable)
RTP	nx,ny,nz	kg/kg	Total water mixing ratio (water vapor + condensate) (prognostic variable)
THETA	nx,ny,nz	K	Theta, potential temperature
RV	nx,ny,nz	kg/kg	Water vapor mixing ratio
DN0	nx,ny,nz	kg/m <sup>3</sup>	reference state air density

<b>(6) SURFACE FILE INPUT CHARACTERISTICS</b>			
<b>(Used by both LEAF &amp; SIB)</b>			
<b>(LEAF always runs PATCH=1, which is water/ocean)</b>			
SOIL_TEXT	nx,ny,nzg,np	#	dominant soil textural class
LEAF_CLASS	nx,ny,np	#	vegetation class

PATCH_AREA	nx,ny,np	fraction	patch fractional area
VEG_NDVIP	nx,ny,np	#	past NDVI (NDVI = Normalized Difference Vegetation Index)
VEG_NDVIC	nx,ny,np	#	current NDVI
VEG_NDVIF	nx,ny,np	#	future NDVI

**(8) SURFACE CHARACTERISTICS (LEAF3 / SIB)**  
**(Diagnostic for both)**

PATCH_ROUGH	nx,ny,np	m	net roughness
SOIL_ROUGH	nx,ny,np	m	soil roughness
VEG_FRACAREA	nx,ny,np	fraction	vegetation fractional area
VEG_LAI	nx,ny,np	m <sup>2</sup> /m <sup>2</sup>	green leaf area index
VEG_TAI	nx,ny,np	m <sup>2</sup> /m <sup>2</sup>	total leaf area index
VEG_ROUGH	nx,ny,np	m	vegetation roughness length
VEG_HEIGHT	nx,ny,np	m	vegetation / canopy height
VEG_ALBEDO	nx,ny,np	fraction	vegetation albedo

**(16) SURFACE CHARACTERISTICS (LEAF3 / SIB)**  
**(Prognostic for both)**

SOIL_WATER	nx,ny,nzg,np	m <sup>3</sup> /m <sup>3</sup>	volumetric soil moisture
SOIL_ENERGY	nx,ny,nzg,np	J/kg	soil energy (used to compute soil temperature)
SFCWATER_NLEV	nx,ny,np	#	number of snow (or surface water) levels
SFCWATER_MASS	nx,ny,nzs,np	Kg/m <sup>2</sup>	surface water mass (snow + surface water)
SFCWATER_ENERGY	nx,ny,nzs,np	J/m <sup>3</sup>	surface water energy (used to compute surface water temperature)
SFCWATER_DEPTH	nx,ny,nzs,np	m	surface water depth
USTAR	nx,ny,np	m/s	ustar
TSTAR	nx,ny,np	K	tstar
RSTAR	nx,ny,np	kg/kg	rstar
STOM_RESIST	nx,ny,np	s/m	leaf stomatal resistance
VEG_WATER	nx,ny,np	kg/m <sup>2</sup>	vegetation moisture
VEG_TEMP	nx,ny,np	K	vegetation temperature
CAN_RVAP	nx,ny,np	kg/kg	canopy mixing ratio
CAN_TEMP	nx,ny,np	K	canopy temperature
GROUND_RSAT	nx,ny,np	kg/kg	saturation mixing ratio of the top soil/snow surface
GROUND_RVAP	nx,ny,np	kg/kg	Without snowcover, ground_rvap is the effective saturation mixing ratio of soil

## (40) SURFACE CHARACTERISTICS (SIB only)

(CAS = Canopy Air Space)

RCO2P	nz,nx,ny	mass fraction	CO2 concentration (divide by 1.51724e-6 to get CO2 in ppm) (1.51e-6 = 44(g/mol) / (29g/mol) / 1.e6) where CO2 molar mass = 44 g/mol and Air molar mass = 29g/mol
SNOW1	nx,ny,np	kg/m <sup>2</sup>	vegetation snow
SNOW2	nx,ny,np	kg/m <sup>2</sup>	ground surface snow
CAPAC1	nx,ny,np	kg/m <sup>2</sup>	vegetation liquid store
CAPAC2	nx,ny,np	kg/m <sup>2</sup>	ground surface liquid store
PCO2AP	nx,ny,np	Pa	canopy air space CO2 concentration
CO2FLX	nx,ny,np	mol/m <sup>2</sup> /s	surface CO2 flux (CAS to first atmospheric level) a.k.a. Net Ecosystem Exchange (NEE)
SFCSWA	nx,ny,np	fraction	surface albedo
UPLWRF	nx,ny,np	W/m <sup>2</sup>	surface longwave upward radiation
ASSIMN	nx,ny,np	umol/m <sup>2</sup> /s	uptake of CO2 by canopy plants
RESPG	nx,ny,np	umol/m <sup>2</sup> /s	ground respiration flux
RSTFAC1	nx,ny,np	# (0->1)	leaf-surface humidity resistance stress
RSTFAC2	nx,ny,np	# (0->1)	soil moisture resistance stress
RSTFAC3	nx,ny,np	# (0->1)	temperature resistance stress
ECT	nx,ny,np	W/m <sup>2</sup>	transpiration flux
ECI	nx,ny,np	W/m <sup>2</sup>	canopy interception flux
EGI	nx,ny,np	W/m <sup>2</sup>	ground interception flux
EGS	nx,ny,np	W/m <sup>2</sup>	ground surface layer evaporation
HC	nx,ny,np	W/m <sup>2</sup>	canopy (veg) sensible heat flux
HG	nx,ny,np	W/m <sup>2</sup>	ground surface sensible heat flux
RA	nx,ny,np	s/m	CAS to lowest atmos layer aerodynamic resistance
RB	nx,ny,np	s/m	leaf surface to CAS aerodynamic resistance
RC	nx,ny,np	s/m	total canopy resistance
RD	nx,ny,np	s/m	ground to CAS aerodynamic resistance
ROFF	nx,ny,np	mm	water runoff (surface and subsurface)

GREEN	nx,ny,np	fraction	greenness fraction
APAR	nx,ny,np	fraction	absorbed fraction of photosynthetically active radiation
VENTMF	nx,ny,np	kg/m <sup>2</sup> /s	ventilation mass flux
PCO2C	nx,ny,np	Pa	leaf chloroplast CO2 concentration
PCO2I	nx,ny,np	Pa	leaf internal CO2 concentration
PCO2S	nx,ny,np	Pa	leaf surface CO2 concentration
PCO2M	nx,ny,np	Pa	lowest atmospheric level CO2 concentration
EA	nx,ny,np	hPa	canopy water vapor pressure
EM	nx,ny,np	hPa	reference level vapor pressure
RHA	nx,ny,np	fraction	CAS relative humidity
RADVBC	nx,ny,np	W/m <sup>2</sup>	visible direct radiation
RADVDC	nx,ny,np	W/m <sup>2</sup>	visible diffuse radiation
RADNBC	nx,ny,np	W/m <sup>2</sup>	near infrared direct radiation
RADNDC	nx,ny,np	W/m <sup>2</sup>	near infrared diffuse radiation
PSY	nx,ny,np	hPa/deg	psychrometric constant

### (32) HYDROMETEOR MIXING RATIOS, NUMBER CONCENTRATION, ENERGY

SBM = Spectral Bin Model, mixr = mixing ratio

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
RIPP	nx,ny,nz	kg/kg	plates mixing ratio (SBM only)
RICP	nx,ny,nz	kg/kg	columns mixing ratio (SBM only)
RIDP	nx,ny,nz	kg/kg	dendrite mixing ratio (SBM only)
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
CIPP	nx,ny,nz	#/kg	plates number concentration (SBM only)
CICP	nx,ny,nz	#/kg	columns number concentration (SBM only)
CIDP	nx,ny,nz	#/kg	dendrites number concentration (SBM only)
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
FFCD	nx,ny,nz,nkr	kg/kg	cloud mixing ratio distribution (SBM only) (d(mixr)/dln(r))
FFIP	nx,ny,nz,nkr	kg/kg	plates mixing ratio distribution (SBM only) (d(mixr)/dln(r))
FFIC	nx,ny,nz,nkr	kg/kg	columns mixing ratio distribution (SBM only) (d(mixr)/dln(r))
FFID	nx,ny,nz,nkr	kg/kg	dendrites mixing ratio distribution (SBM only) (d(mixr)/dln(r))
FFSN	nx,ny,nz,nkr	kg/kg	aggregates mixing ratio distribution (SBM only) (d(mixr)/dln(r))
FFGL	nx,ny,nz,nkr	kg/kg	graupel mixing ratio distribution (SBM only) (d(mixr)/dln(r))
FFHL	nx,ny,nz,nkr	kg/kg	hail mixing ratio distribution (SBM only) (d(mixr)/dln(r))

## (27) AEROSOLS MASS MIXING RATIOS AND NUMBER CONCENTRATION

CN1NP	nx,ny,nz	#/kg	CCN mode-1 number concentration
CN2NP	nx,ny,nz	#/kg	CCN mode-2 number concentration
DUSTFRAC	nx,ny	fraction	Grid cell dust erodible fraction
MD1NP	nx,ny,nz	#/kg	sub-micron dust number

			<b>concentration</b>
<b>MD2NP</b>	<b>nx,ny,nz</b>	<b>#/kg</b>	<b>super-micron dust number concentration</b>
<b>ABC1NP</b>	<b>nx,ny,nz</b>	<b>#/kg</b>	<b>Absorbing carbon (1% BC, 99% OC) number concentration</b>
<b>ABC2NP</b>	<b>nx,ny,nz</b>	<b>#/kg</b>	<b>Absorbing carbon (2% BC, 98% OC) number concentration</b>
<b>SALT_FILM_NP</b>	<b>nx,ny,nz</b>	<b>#/kg</b>	<b>sea-salt film drop number concentration</b>
<b>SALT_JET_NP</b>	<b>nx,ny,nz</b>	<b>#/kg</b>	<b>sea-salt jet drop number concentration</b>
<b>SALT_SPUM_NP</b>	<b>nx,ny,nz</b>	<b>#/kg</b>	<b>sea-salt spume drop number concentration</b>
<b>REGEN_AERO1_NP</b>	<b>nx,ny,nz</b>	<b>#/kg</b>	<b>sub-micron regenerated aerosol number concentration</b>
<b>REGEN_AERO2_NP</b>	<b>nx,ny,nz</b>	<b>#/kg</b>	<b>super-micron regenerated aerosol number concentration</b>
<b>CN1MP</b>	<b>nx,ny,nz</b>	<b>kg/kg</b>	<b>CCN mode-1 mass mixing ratio</b>
<b>CN2MP</b>	<b>nx,ny,nz</b>	<b>kg/kg</b>	<b>CCN mode-2 mass mixing ratio</b>
<b>MD1MP</b>	<b>nx,ny,nz</b>	<b>kg/kg</b>	<b>sub-micron dust mass mixing ratio</b>
<b>MD2MP</b>	<b>nx,ny,nz</b>	<b>kg/kg</b>	<b>super-micron dust mass mixing ratio</b>
<b>ABC1MP</b>	<b>nx,ny,nz</b>	<b>#/kg</b>	<b>Absorbing carbon (1% BC, 99% OC) mass mixing ratio</b>
<b>ABC2MP</b>	<b>nx,ny,nz</b>	<b>#/kg</b>	<b>Absorbing carbon (2% BC, 98% OC) mass mixing ratio</b>
<b>SALT_FILM_MP</b>	<b>nx,ny,nz</b>	<b>kg/kg</b>	<b>sea-salt film drop mass mixing ratio</b>
<b>SALT_JET_MP</b>	<b>nx,ny,nz</b>	<b>kg/kg</b>	<b>sea-salt jet drop mass mixing ratio</b>
<b>SALT_SPUM_MP</b>	<b>nx,ny,nz</b>	<b>kg/kg</b>	<b>sea-salt spume drop mass mixing ratio</b>
<b>REGEN_AERO1_MP</b>	<b>nx,ny,nz</b>	<b>kg/kg</b>	<b>sub-micron regenerated aerosol mass mixing ratio</b>
<b>REGEN_AERO2_MP</b>	<b>nx,ny,nz</b>	<b>kg/kg</b>	<b>super-micron regenerated aerosol mass mixing ratio</b>
<b>CIFNP</b>	<b>nx,ny,nz</b>	<b>#/kg</b>	<b>ice nuclei number concentration (Meyers/DeMott-limited schemes)</b>
<b>RIFNP</b>	<b>nx,ny,nz</b>	<b>kg/kg</b>	<b>ice nuclei mass concentration (SBM CNT scheme)</b>

<b>FNCN</b>	<b>nx,ny,nz,nkr</b>	<b>kg/kg</b>	<b>ccn mass mixing ratio distribution (SBM-only) (d(mixr)/dln(r))</b>
<b>FFIN</b>	<b>nx,ny,nz,nkr</b>	<b>kg/kg</b>	<b>ccn mass mixing ratio distribution (SBM only) (d(mixr)/dln(r))</b>

### (38) AEROSOLS TRACKING

<b>IFNNUCP</b>	<b>nx,ny,nz</b>	<b>#/kg</b>	<b>ice nuclei already nucleated</b>
<b>IMMERCp</b>	<b>nx,ny,nz</b>	<b>#/kg</b>	<b>ice nuclei within cloud droplets</b>
<b>IMMERDP</b>	<b>nx,ny,nz</b>	<b>#/kg</b>	<b>ice nuclei within drizzle droplets</b>
<b>IMMERRP</b>	<b>nx,ny,nz</b>	<b>#/kg</b>	<b>ice nuclei within rain droplets</b>
<b>CNMCP</b>	<b>nx,ny,nz</b>	<b>kg/kg</b>	<b>total aerosol mass within cloud droplets</b>
<b>CNMDP</b>	<b>nx,ny,nz</b>	<b>kg/kg</b>	<b>total aerosol mass within drizzle</b>
<b>CNMRP</b>	<b>nx,ny,nz</b>	<b>kg/kg</b>	<b>total aerosol mass within rain</b>
<b>CNMPP</b>	<b>nx,ny,nz</b>	<b>kg/kg</b>	<b>total aerosol mass within pristine ice</b>
<b>CNMSP</b>	<b>nx,ny,nz</b>	<b>kg/kg</b>	<b>total aerosol mass within snow</b>
<b>CNMAP</b>	<b>nx,ny,nz</b>	<b>kg/kg</b>	<b>total aerosol mass within aggregates</b>
<b>CNMGP</b>	<b>nx,ny,nz</b>	<b>kg/kg</b>	<b>total aerosol mass within graupel</b>
<b>CNMHP</b>	<b>nx,ny,nz</b>	<b>kg/kg</b>	<b>total aerosol mass within hail</b>
<b>DNMCP</b>	<b>nx,ny,nz</b>	<b>kg/kg</b>	<b>total dust mass within cloud droplets</b>
<b>DNMDP</b>	<b>nx,ny,nz</b>	<b>kg/kg</b>	<b>total dust mass within drizzle</b>
<b>DNMRP</b>	<b>nx,ny,nz</b>	<b>kg/kg</b>	<b>total dust mass within rain</b>
<b>DNMPP</b>	<b>nx,ny,nz</b>	<b>kg/kg</b>	<b>total dust mass within pristine ice</b>
<b>DNMSP</b>	<b>nx,ny,nz</b>	<b>kg/kg</b>	<b>total dust mass within snow</b>
<b>DNMAP</b>	<b>nx,ny,nz</b>	<b>kg/kg</b>	<b>total dust mass within aggregates</b>
<b>DNMGP</b>	<b>nx,ny,nz</b>	<b>kg/kg</b>	<b>total dust mass within graupel</b>
<b>DNMHP</b>	<b>nx,ny,nz</b>	<b>kg/kg</b>	<b>total dust mass within hail</b>
<b>DINCP</b>	<b>nx,ny,nz</b>	<b>kg/kg</b>	<b>dust mass within cloud droplets via ice nucleation</b>
<b>DINDP</b>	<b>nx,ny,nz</b>	<b>kg/kg</b>	<b>dust mass within drizzle via ice nucleation</b>
<b>DINRP</b>	<b>nx,ny,nz</b>	<b>kg/kg</b>	<b>dust mass within rain via ice nucleation</b>



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 drizzle
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

### (37) PRECIPITATION

PCPVR	nx,ny,nz	kg/m <sup>2</sup> /s	rain precipitation rate (3D)
PCPVP	nx,ny,nz	kg/m <sup>2</sup> /s	pristine ice precipitation rate (3D)
PCPVS	nx,ny,nz	kg/m <sup>2</sup> /s	snow precipitation rate (3D)
PCPVA	nx,ny,nz	kg/m <sup>2</sup> /s	aggregates precipitation rate (3D)
PCPVG	nx,ny,nz	kg/m <sup>2</sup> /s	graupel precipitation rate (3D)
PCPVH	nx,ny,nz	kg/m <sup>2</sup> /s	hail precipitation rate (3D)
PCPVD	nx,ny,nz	kg/m <sup>2</sup> /s	drizzle precipitation rate (3D)
PCPVIP	nx,ny,nz	kg/m <sup>2</sup> /s	plates precipitation rate (3D);

			<b>SBM only)</b>
<b>PCPVIC</b>	<b>nx,ny,nz</b>	<b>kg/m<sup>2</sup>/s</b>	<b>columns precipitation rate (3D; SBM only)</b>
<b>PCPVID</b>	<b>nx,ny,nz</b>	<b>kg/m<sup>2</sup>/s</b>	<b>dendrites precipitation rate (3D; SBM only)</b>
<b>PCPRR</b>	<b>nx,ny</b>	<b>kg/m<sup>2</sup>/s</b>	<b>surface rain precipitation rate</b>
<b>PCPRP</b>	<b>nx,ny</b>	<b>kg/m<sup>2</sup>/s</b>	<b>surface pristine ice precipitation rate</b>
<b>PCPRS</b>	<b>nx,ny</b>	<b>kg/m<sup>2</sup>/s</b>	<b>surface snow precipitation rate</b>
<b>PCPRA</b>	<b>nx,ny</b>	<b>kg/m<sup>2</sup>/s</b>	<b>surface aggregates precipitation rate</b>
<b>PCPRG</b>	<b>nx,ny</b>	<b>kg/m<sup>2</sup>/s</b>	<b>surface graupel precipitation rate</b>
<b>PCPRH</b>	<b>nx,ny</b>	<b>kg/m<sup>2</sup>/s</b>	<b>surface hail precipitation rate</b>
<b>PCPRD</b>	<b>nx,ny</b>	<b>kg/m<sup>2</sup>/s</b>	<b>surface drizzle precipitation rate</b>
<b>PCPRIP</b>	<b>nx,ny</b>	<b>kg/m<sup>2</sup>/s</b>	<b>surface plates precipitation rate (SBM only)</b>
<b>PCPRIC</b>	<b>nx,ny</b>	<b>kg/m<sup>2</sup>/s</b>	<b>surface columns precipitation rate (SBM only)</b>
<b>PCPRID</b>	<b>nx,ny</b>	<b>kg/m<sup>2</sup>/s</b>	<b>surface dendrites precipitation rate (SBM only)</b>
<b>ACCPR</b>	<b>nx,ny</b>	<b>kg/m<sup>2</sup></b>	<b>accumulated rain over the course of the simulation</b>
<b>ACCPP</b>	<b>nx,ny</b>	<b>kg/m<sup>2</sup></b>	<b>accumulated pristine ice over the course of the simulation</b>
<b>ACCPS</b>	<b>nx,ny</b>	<b>kg/m<sup>2</sup></b>	<b>accumulated snow over the course of the simulation</b>
<b>ACCPA</b>	<b>nx,ny</b>	<b>kg/m<sup>2</sup></b>	<b>accumulated aggregates over the course of the simulation</b>
<b>ACCPG</b>	<b>nx,ny</b>	<b>kg/m<sup>2</sup></b>	<b>accumulated graupel over the course of the simulation</b>
<b>ACCPH</b>	<b>nx,ny</b>	<b>kg/m<sup>2</sup></b>	<b>accumulated hail over the course of the simulation</b>
<b>ACCPD</b>	<b>nx,ny</b>	<b>kg/m<sup>2</sup></b>	<b>accumulated drizzle over the course of the simulation</b>
<b>ACCPIP</b>	<b>nx,ny</b>	<b>kg/m<sup>2</sup></b>	<b>accumulated plates over the course of the simulation (SBM only)</b>
<b>ACCPIC</b>	<b>nx,ny</b>	<b>kg/m<sup>2</sup></b>	<b>accumulated columns over the course of the simulation (SBM only)</b>
<b>ACCPID</b>	<b>nx,ny</b>	<b>kg/m<sup>2</sup></b>	<b>accumulated dendrites over the course of the simulation (SBM only)</b>

PCPG	nx,ny	kg/m <sup>2</sup>	microphysics precipitation per timestep (for water, kg/m <sup>2</sup> = mm), Used by LEAF/SIB surface models
QPCPG	nx,ny	J/m <sup>2</sup>	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 <sup>2</sup>	surface accumulated mass of aerosols identified as dust
ACCPAERO	nx,ny	kg/m <sup>2</sup>	Total surface accumulated mass of aerosols
PCPRDUST	nx,ny	kg/m <sup>2</sup> /s	surface accumulation rate of aerosols identified as dust
PCPRAERO	nx,ny	kg/m <sup>2</sup> /s	Total surface accumulation rate of aerosols

## (12) RADIATION

FTHRD	nx,ny,nz	K/s	radiative heating rate
BEXT	nx,ny,nz	km	visibility
SWUP	nx,ny,nz	W/m <sup>2</sup>	upwelling shortwave radiation
SWDN	nx,ny,nz	W/m <sup>2</sup>	downwelling shortwave radiation
LWUP	nx,ny,nz	W/m <sup>2</sup>	upwelling longwave radiation
LWDN	nx,ny,nz	W/m <sup>2</sup>	downwelling longwave radiation
RSHORT	nx,ny	W/m <sup>2</sup>	surface downwelling shortwave radiation
RLONG	nx,ny	W/m <sup>2</sup>	surface downwelling longwave radiation
RLONGUP	nx,ny	W/m <sup>2</sup>	surface upwelling longwave radiation
AODT	nx,ny	unitless	Aerosol optical depth in visible radiation band-3
ALBEDT	nx,ny	fraction	surface albedo
COSZ	nx,ny	unitless	cosine of the solar zenith angle

## (11) TURBULENCE AND FLUXES

TKEP	nx,ny,nz	m <sup>2</sup> /s <sup>2</sup>	turbulent kinetic energy (from Mellor-Yamada and Deardorf schemes only)
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<b>HKH</b>	<b>nx,ny,nz</b>	<b>m<sup>2</sup>/s</b>	<b>horizontal eddy diffusivity coefficient for heat for scalar quantities (un-density weighted)</b>
<b>VKH</b>	<b>nx,ny,nz</b>	<b>m<sup>2</sup>/s</b>	<b>vertical eddy diffusivity coefficient for heat for scalar quantities (un-density weighted)</b>
<b>RHKM</b>	<b>nx,ny,nz</b>	<b>m<sup>2</sup>/s</b>	<b>horizontal eddy diffusivity coefficient for momentum</b>
<b>RVKM</b>	<b>nx,ny,nz</b>	<b>m<sup>2</sup>/s</b>	<b>vertical eddy diffusivity coefficient for momentum</b>
<b>RVKH</b>	<b>nx,ny,nz</b>	<b>m<sup>2</sup>/s</b>	<b>vertical eddy diffusivity coefficient for heat for scalar quantities</b>
<b>SFLUX_U</b>	<b>nx,ny</b>	<b>Pascals</b>	<b>surface U-momentum flux</b>
<b>SFLUX_V</b>	<b>nx,ny</b>	<b>Pascals</b>	<b>surface V-momentum flux</b>
<b>SFLUX_W</b>	<b>nx,ny</b>	<b>Pascals</b>	<b>surface W-momentum flux</b>
<b>SFLUX_T</b>	<b>nx,ny</b>	<b>(K*kg) / (m<sup>2</sup>*s)</b>	<b>surface temperature flux (multiply by Cp [~1004 J/(kg*K)] to get surface sensible heat flux in W/m<sup>2</sup>)</b>
<b>SFLUX_R</b>	<b>nx,ny</b>	<b>kg / (m<sup>2</sup>*s)</b>	<b>surface moisture flux (multiply by Lv [~2.5e6 J/kg] to get surface latent heat flux in W/m<sup>2</sup>)</b>

## **(12) CUMULUS PARAMETERIZATION FIELDS**

<b>THSRC</b>	<b>nx,ny,nz</b>	<b>K/sec</b>	<b>convective parameterization heating rate</b>
<b>RTSRC</b>	<b>nx,ny,nz</b>	<b>kg/kg/sec</b>	<b>convective parameterization moistening rate</b>
<b>ACONPR</b>	<b>nx,ny</b>	<b>kg/m<sup>2</sup></b>	<b>convective parameterization total accumulated precipitation</b>
<b>CONPRR</b>	<b>nx,ny</b>	<b>kg/m<sup>2</sup>/sec</b>	<b>convective parameterization precipitation rate</b>
<b>RCSRC</b>	<b>nx,ny,nz</b>	<b>kg/kg/sec</b>	<b>convective cloud water mixing ratio tendency (KF scheme only)</b>
<b>RRSRC</b>	<b>nx,ny,nz</b>	<b>kg/kg/sec</b>	<b>convective rain mixing ratio tendency (KF scheme only)</b>
<b>RPSRC</b>	<b>nx,ny,nz</b>	<b>kg/kg/sec</b>	<b>convective pristine ice mixing ratio tendency (KF scheme only)</b>

RSSRC	nx,ny,nz	kg/kg/sec	convective snow mixing ratio tendency (KF scheme only)
W0AVG	nx,ny,nz	m/s	a running mean average of vertical velocity (KF scheme only)
W0AVGLT	nx,ny,nz	m/s	a running mean average of the horizontal components of the contravariant vertical velocity (KF scheme only)
NCA	nx,ny	m/s	integer counter keeping track of number of time steps that convective tendencies maintained (KF scheme only)
CONVGO	nx,ny	m/s	integer which keeps track if pre-convection checks satisfied (KF scheme only)

### **(17) 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".

WP_BUOY_THETA	nx,ny,nz	m/s	instantaneous vertical velocity contribution from Theta-V buoyancy computation
WP_BUOY_COND	nx,ny,nz	m/s	instantaneous vertical velocity contribution from condensate loading
WP_ADVDIF	nx,ny,nz	m/s	instantaneous vertical velocity contribution by the combination of both advection and diffusion
LATHEATVAPT	nx,ny,nz	d $\Theta$ or dT	change in (T or $\Theta$ ) due to vapor diffusion and cloud & ice nucleation
LATHEATFRZT	nx,ny,nz	d $\Theta$ or dT	change in (T or $\Theta$ ) due to collision-coalescence and melting routines
LATHEATVAP	nx,ny,nz	d $\Theta$ or dT	Instantaneous / single timestep (T or $\Theta$ ) due to vapor diffusion and cloud & ice nucleation
LATHEATFRZ	nx,ny,nz	d $\Theta$ or dT	Instantaneous / single timestep (T or $\Theta$ ) 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 condensation summed for all liquid hydrometeor species
VAPICET	nx,ny,nz	kg/kg	vapor deposition summed for all ice hydrometeor species
EVAPLIQT	nx,ny,nz	kg/kg	evaporation summed for all liquid hydrometeor species
EVAPICET	nx,ny,nz	kg/kg	sublimation summed for all ice hydrometeor species
MELTICET	nx,ny,nz	kg/kg	melting of all ice species in melting routine (these are the category mass transfers due to melting)
MELTINGT	nx,ny,nz	kg/kg	Total melting computed alongside latent heating routines in association with all phase changes from ice to liquid. Can include fractional changes (partial melting)
FREEZINGT	nx,ny,nz	kg/kg	Total freezing computed alongside latent heating routines in association with all phase changes from liquid to ice to. Can include fractional changes (partial 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". "Instantaneous" budgets for this set do not currently exist.

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
INUHAZRT	nx,ny,nz	kg/kg	haze droplet nucleation tied to aerosol concentration
VAPCLDT	nx,ny,nz	kg/kg	vapor condensation on cloud droplets
VAPRAINT	nx,ny,nz	kg/kg	vapor condensation on rain
VAPPRIST	nx,ny,nz	kg/kg	vapor deposition on pristine ice
VAPSNOWT	nx,ny,nz	kg/kg	vapor deposition on snow
VAPAGGRT	nx,ny,nz	kg/kg	vapor deposition on aggregates
VAPGRAUT	nx,ny,nz	kg/kg	vapor deposition on graupel
VAPHAILT	nx,ny,nz	kg/kg	vapor deposition on hail
VAPDRIZT	nx,ny,nz	kg/kg	vapor condensation on drizzle
EVAPCLDT	nx,ny,nz	kg/kg	evaporation of cloud droplets
EVAPRAINT	nx,ny,nz	kg/kg	evaporation of rain
EVAPPRIST	nx,ny,nz	kg/kg	sublimation of pristine ice
EVAPSNOWT	nx,ny,nz	kg/kg	sublimation of snow
EVAPAGGRT	nx,ny,nz	kg/kg	sublimation of aggregates
EVAPGRAUT	nx,ny,nz	kg/kg	sublimation of graupel
EVAPHAILT	nx,ny,nz	kg/kg	sublimation of hail
EVAPDRIST	nx,ny,nz	kg/kg	evaporation of drizzle
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

#### (4) BUDGET VARIABLES for IMBUDGET >=3

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 for this set do not currently exist.

DUST1CLDRT	nx,ny,nz	kg/kg	nucleation of cloud droplet mixing ratio from dust mode 1
DUST2CLDRT	nx,ny,nz	kg/kg	nucleation of cloud droplet mixing ratio from dust mode 2
DUST1DRZRT	nx,ny,nz	kg/kg	nucleation of drizzle droplet



			mixing ratio from dust mode 1
DUST2DRZRT	nx,ny,nz	kg/kg	nucleation of drizzle droplet mixing ratio from dust mode 2

#### (44) KPP Ocean Mixed Layer Model Variables

Some of these KPP variables are required for history restart and must be output. Others are simply diagnostics. See RAMSIN flags and KPP code to control how many optional output variables are written to file.

KPP_OLD	nx,ny	index	Index to ID past value of Us,Vs
KPP_NEW	nx,ny	Index	Index to ID new value of Us,Vs
KPP_JERLOV	nx,ny	jerlov cat	Ocean optical clarity category
KPP_OCDEPTH	nx,ny	m	Ocean depth
KPP_HMIX	nx,ny	m	Mixed-layer depth
KPP_BOTTOMT	nx,ny	Celsius	Ocean bottom temperature
KPP_SREF	nx,ny	o/oo	Reference salinity
KPP_FREEZ_FLAG	nx,ny	fraction	Fraction of levels prevented from freezing
KPP_RESET_FLAG	nx,ny	Index	Flag to indicate isothermal column, reset T/S to climo
KPP_FLX_UST	nx,ny	N/m2	Sflux(1) zonal surface wind stress
KPP_FLX_VST	nx,ny	N/m2	Sflux(2) meridional surface wind stress
KPP_FLX_NSW	nx,ny	W/m2	Sflux(3) Net surface shortwave radiation
KPP_FLX_NLW	nx,ny	W/m2	Sflux(4) non-shortwave radiation (lwdn-lwup-sensible-latent)
KPP_FLX_ICE	nx,ny	Not used	Sflux(5) melting of sea ice
KPP_FLX_PCP	nx,ny	mm/sec	Sflux(6) net freshwater (precip-evaporation)
KPP_SWDK_OPT	nx,ny,nkppz	fraction	Solar shortwave flux fraction on DM depths
KPP_wB	nx,ny,nkppz	m2/s3	w'B' total kinematic buoyancy flux
KPP_wU	nx,ny,nkppz	m2/s2	w'U' turbulent zonal velocity flux
KPP_wV	nx,ny,nkppz	m2/s2	w'V' turbulent meridional velocity flux
KPP_wXt	nx,ny,nkppz	C * m/s	w'T' turbulent temperature flux
KPP_wXs	nx,ny,nkppz	o/oo * 1/s	w'S' turbulent salinity flux
KPP_wXNTt	nx,ny,nkppz	C * m/s	w'T'(NT) non-turbulent temperature flux

KPP_SWFRAC	nx,ny,nkppz	fraction	Solar shortwave flux fraction on ZM depths
KPP_TINC_FCORR	nx,ny,nkppz	K	Temperature increment from flux correction with depth
KPP_SINC_CORR	nx,ny,nkppz	o/oo	Salinity increment from flux correction with depth
KPP_SAL_CLIM	nx,ny,nkppz	o/oo	3D salinity climatology (can be time updated)
KPP_OCNT_CLIM	nx,ny,nkppz	Celsius	3D temperature climatology (can be time updated)
KPP_BUOY	nx,ny,nkppz	m/s2	buoyancy
KPP_RHO	nx,ny,nkppz	kg/m3	Ocean density
KPP_CP	nx,ny,nkppz	J/kg/K	Ocean specific heat capacity
KPP_U	nx,ny,nkppz	m/s	Latest value of ocean U current
KPP_V	nx,ny,nkppz	m/s	Latest value of ocean V current
KPP_U_init	nx,ny,nkppz	m/s	Initial value of ocean U current
KPP_V_init	nx,ny,nkppz	m/s	Initial value of ocean V current
KPP_US0	nx,ny,nkppz	m/s	Contains old/new U current
KPP_VS0	nx,ny,nkppz	m/s	Contains old/new V current
KPP_US1	nx,ny,nkppz	m/s	Contains old/new U current
KPP_VS1	nx,ny,nkppz	m/s	Contains old/new V current
KPP_X_T	nx,ny,nkppz	Celsius	Latest ocean temperature
KPP_X_S	nx,ny,nkppz	o/oo	Latest ocean salinity (+sref)
KPP_XS_T0	nx,ny,nkppz	Celsius	Contains old/new temperature
KPP_XS_T1	nx,ny,nkppz	Celsius	Contains old/new temperature
KPP_XS_S0	nx,ny,nkppz	o/oo	Contains old/new salinity
KPP_XS_S1	nx,ny,nkppz	o/oo	Contains old/new salinity

<b>CUSTOM TRACER VARIABLES</b>			
TRACERP001	nx,ny,nz	mixing ratio units needed	customizable by the user
TRACERP002, etc...			