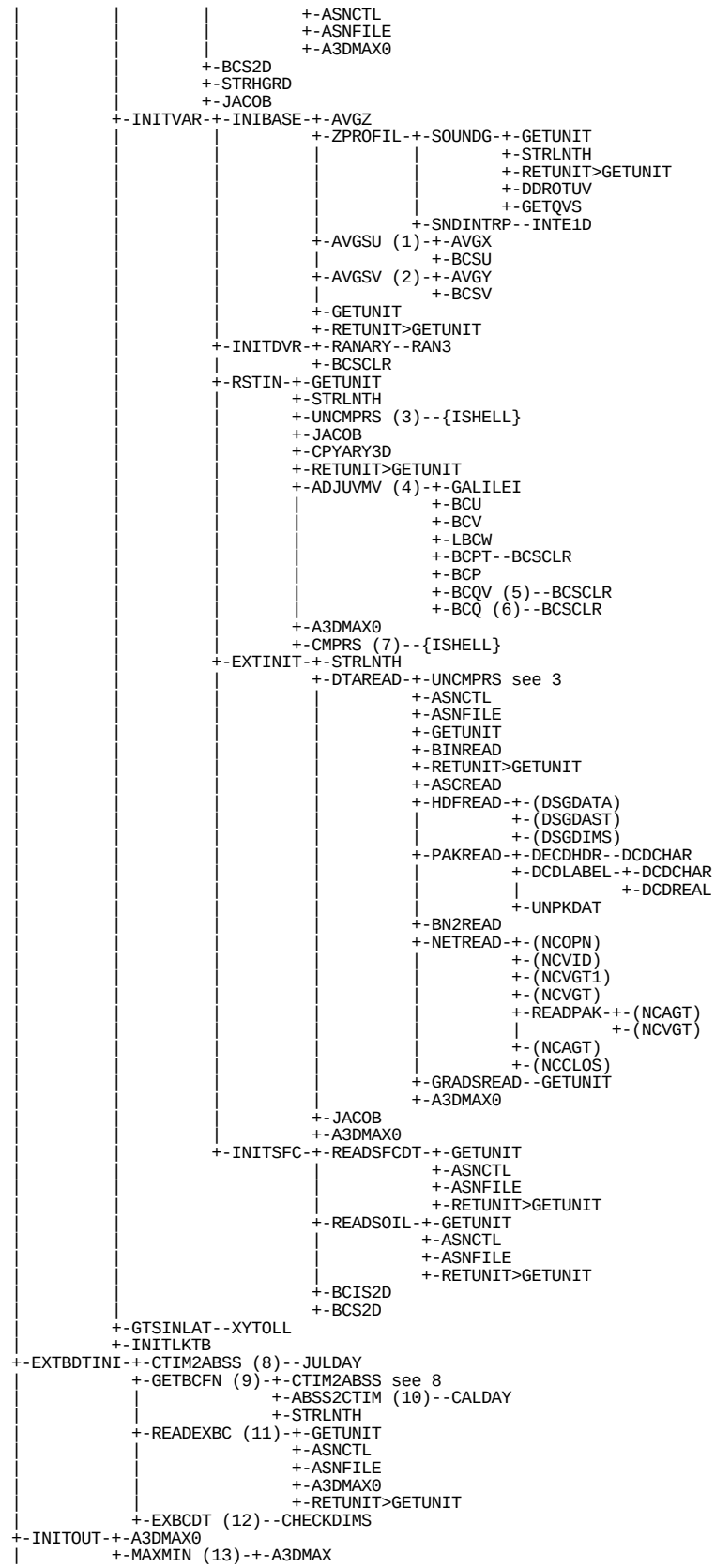
Model Structure Reference Guide

In this section the user is provided with an outline of the organizational structure of the ARPS 4.0 computer code. It is intended to help the user in finding and identifying the subroutines of the code in terms of function and of interrelationship with other modules of the code. It should also be noted that such information is provided, in terms of comment lines, in the source coding for the code itself. Section 5.1 contains the "calling tree" of ARPS 4.0, while Section 5.2 supplies a short functional description of each of the components of the code (program and subroutine glossary). Section 5.3 gives a list of the files and the program / function / subroutines that these files contain. Section 5.4 presents the ARPS code structure again in a flowchart form. Finally, Section 5.5. gives equation schematic charts that indicate in which subroutine that individual terms in the equations are calculated.

5.1. Subroutine Calling Tree for ARPS 4.0

The following is a subroutine "calling tree" generated by the FORTRAN source code analysis tool **flint** available on the NCAR Cray Y-MP. It presents information on the calling sequence of subroutines and functions in ARPS. Those enclosed inside curly brackets are external library routines. For example, DSGDATA is an HDF library function. Within the tree structure, sequential numbers in parentheses designate routines are called repeatedly. Subsequent use of them is indicated by a reference to the previously designated number.

```
ARPS40-+-INITIAL-+-INITPARA-+-GTLFNKEY
       |         |          +-JULDAY
       |         |          +-STRLNTH
       |         |          +-PRTLOG-+-GTLOGFN--FNVERSN
       |         |                   +-GETUNIT
       |         |                   +-STRLNTH
       |         |                   +-RETUNIT>GETUNIT
       |         +-INIT0
       |         +-INIGRD-+-SETGRD-+-SETMAPR
       |         |        |        +-LLTOXY
       |         |        |        +-SETORIG-+-XYTOLL
       |         |        |                  +-LLTOXY
       |         |        +-READTRN-+-GETUNIT
```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+-BCS2D
+-STRHGRD
+-JACOB
+-INITVAR-+-INIBASE-+-AVGZ
+-ZPROFIL-+-SOUNDG-+-GETUNIT
+-STRLNTH
+-RETUNIT>GETUNIT
+-DDROTUV
+-GETQVS
+-SNDINTRP--INTE1D
+-AVGSU (1)-+-AVGX
+-BCSU
+-AVGSV (2)-+-AVGY
+-BCSV
+-GETUNIT
+-RETUNIT>GETUNIT
+-INITDVR-+-RANARY--RAN3
+-BCSCLR
+-RSTIN-+-GETUNIT
+-STRLNTH
+-UNCMPRS (3)--{ISHELL}
+-JACOB
+-CPYARY3D
+-RETUNIT>GETUNIT
+-ADJUVMV (4)-+-GALILEI
+-BCU
+-BCV
+-LBCW
+-BCPT--BCSCLR
+-BCP
+-BCQV (5)--BCSCLR
+-BCQ (6)--BCSCLR
+-A3DMAX0
+-CMPRS (7)--{ISHELL}
+-EXTINIT-+-STRLNTH
+-DTAREAD-+-UNCMPRS see 3
+-ASNCTL
+-ASNFILE
+-GETUNIT
+-BINREAD
+-RETUNIT>GETUNIT
+-ASCREAD
+-HDFREAD-+-(DSGDATA)
+-(DSGDAST)
+-(DSGDIMS)
+-PAKREAD-+-DECDHDR--DCDCHAR
+-DCDLABEL-+-DCDCHAR
+-DCDREAL
+-UNPKDAT
+-BN2READ
+-NETREAD-+-(NCOPN)
+-(NCVID)
+-(NCVGT1)
+-(NCVGT)
+-READPAK-+-(NCAGT)
+-(NCVGT)
+-(NCAGT)
+-(NCCLOS)
+-GRADSREAD--GETUNIT
+-A3DMAX0
+-JACOB
+-A3DMAX0
+-INITSFC-+-READSFCDT-+-GETUNIT
+-ASNCTL
+-ASNFILE
+-RETUNIT>GETUNIT
+-READSOIL-+-GETUNIT
+-ASNCTL
+-ASNFILE
+-RETUNIT>GETUNIT
+-BCIS2D
+-BCS2D
+-GTSINLAT--XYTOLL
+-INITLKTB
+-EXTBDTINI-+-CTIM2ABSS (8)--JULDAY
+-GETBCFN (9)-+-CTIM2ABSS see 8
+-ABSS2CTIM (10)--CALDAY
+-STRLNTH
+-READEXBC (11)-+-GETUNIT
+-ASNCTL
+-ASNFILE
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+-RETUNIT>GETUNIT
+-EXBCDT (12)--CHECKDIMS
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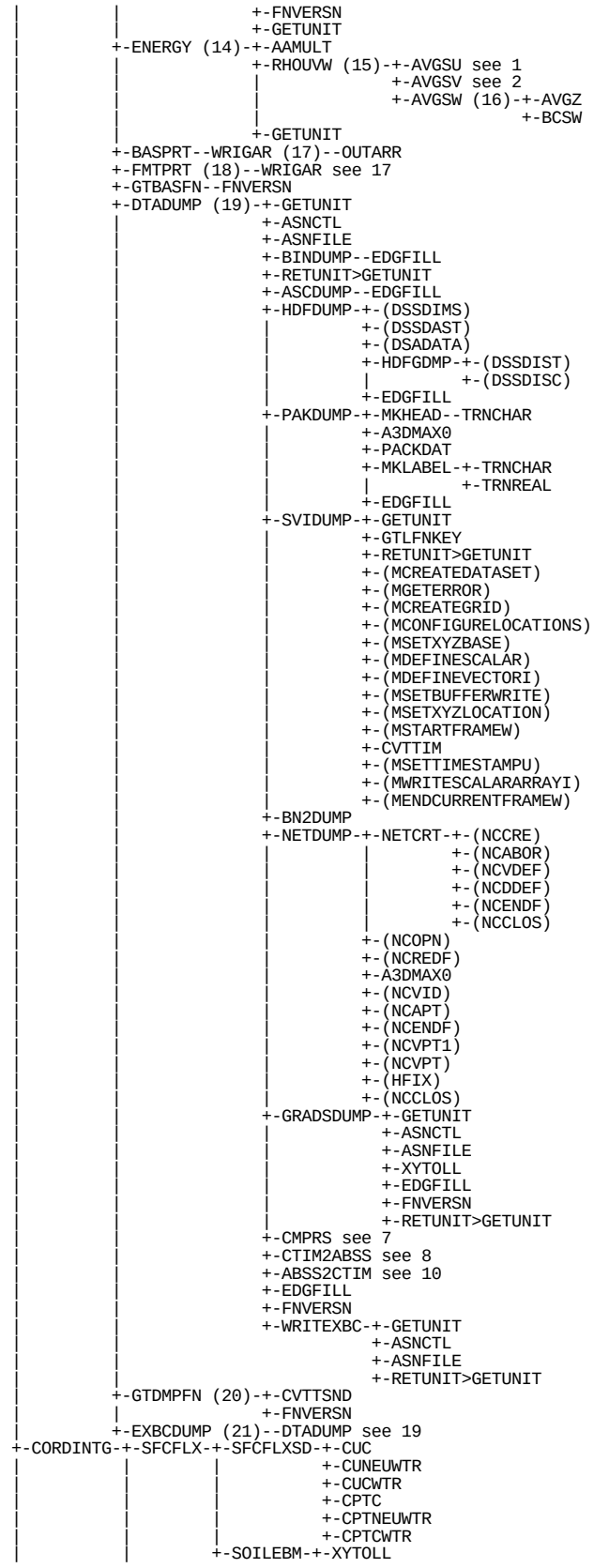
+-MAXMIN (13)-+-A3DMAX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+-ENERGY (14)-+-AAMULT
+-RHOUVW (15)-+-AVGSU see 1
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+-GETUNIT
+-BASPRT--WRIGAR (17)--OUTARR
+-FMTPRT (18)--WRIGAR see 17
+-GTBASFN--FNVERSN
+-DTADUMP (19)-+-GETUNIT
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+-ASNFILE
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+-ASCDUMP--EDGFILL
+-HDFDUMP-+-(DSSDIMS)
+-(DSSDAST)
+-(DSADATA)
+-HDFGDMP-+-(DSSDIST)
+-(DSSDISC)
+-EDGFILL
+-PAKDUMP-+-MKHEAD--TRNCHAR
+-A3DMAX0
+-PACKDAT
+-MKLABEL-+-TRNCHAR
+-TRNREAL
+-EDGFILL
+-SVIDUMP-+-GETUNIT
+-GTLFNKEY
+-RETUNIT>GETUNIT
+-(MCREATEDATASET)
+-(MGETERROR)
+-(MCREATEGRID)
+-(MCONFIGURELOCATIONS)
+-(MSETXYZBASE)
+-(MDEFINESCALAR)
+-(MDEFINEVECTORI)
+-(MSETBUFFERWRITE)
+-(MSETXYZLOCATION)
+-(MSTARTFRAMEW)
+-CVTTIM
+-(MSETTIMESTAMPU)
+-(MWRITESCALARARRAYI)
+-(MENDCURRENTFRAMEW)
+-BN2DUMP
+-NETDUMP-+-NETCRT-+-(NCCRE)
+-(NCABOR)
+-(NCVDEF)
+-(NCDDEF)
+-(NCENDF)
+-(NCCLOS)
+-(NCOPN)
+-(NCREDF)
+-A3DMAX0
+-(NCVID)
+-(NCAPT)
+-(NCENDF)
+-(NCVPT1)
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+-(HFIX)
+-(NCCLOS)
+-GRADSDUMP-+-GETUNIT
+-ASNCTL
+-ASNFILE
+-XYTOLL
+-EDGFILL
+-FNVERSN
+-RETUNIT>GETUNIT
+-CMPRS see 7
+-CTIM2ABSS see 8
+-ABSS2CTIM see 10
+-EDGFILL
+-FNVERSN
+-WRITEXBC-+-GETUNIT
+-ASNCTL
+-ASNFILE
+-RETUNIT>GETUNIT
+-GTDMPFN (20)-+-CVTTSND
+-FNVERSN
+-EXBCDUMP (21)--DTADUMP see 19
+-CORDINTG-+-SFCFLX-+-SFCFLXSD-+-CUC
+-CUNEUWTR
+-CUCWTR
+-CPTC
+-CPTNEUWTR
+-CPTCWTR
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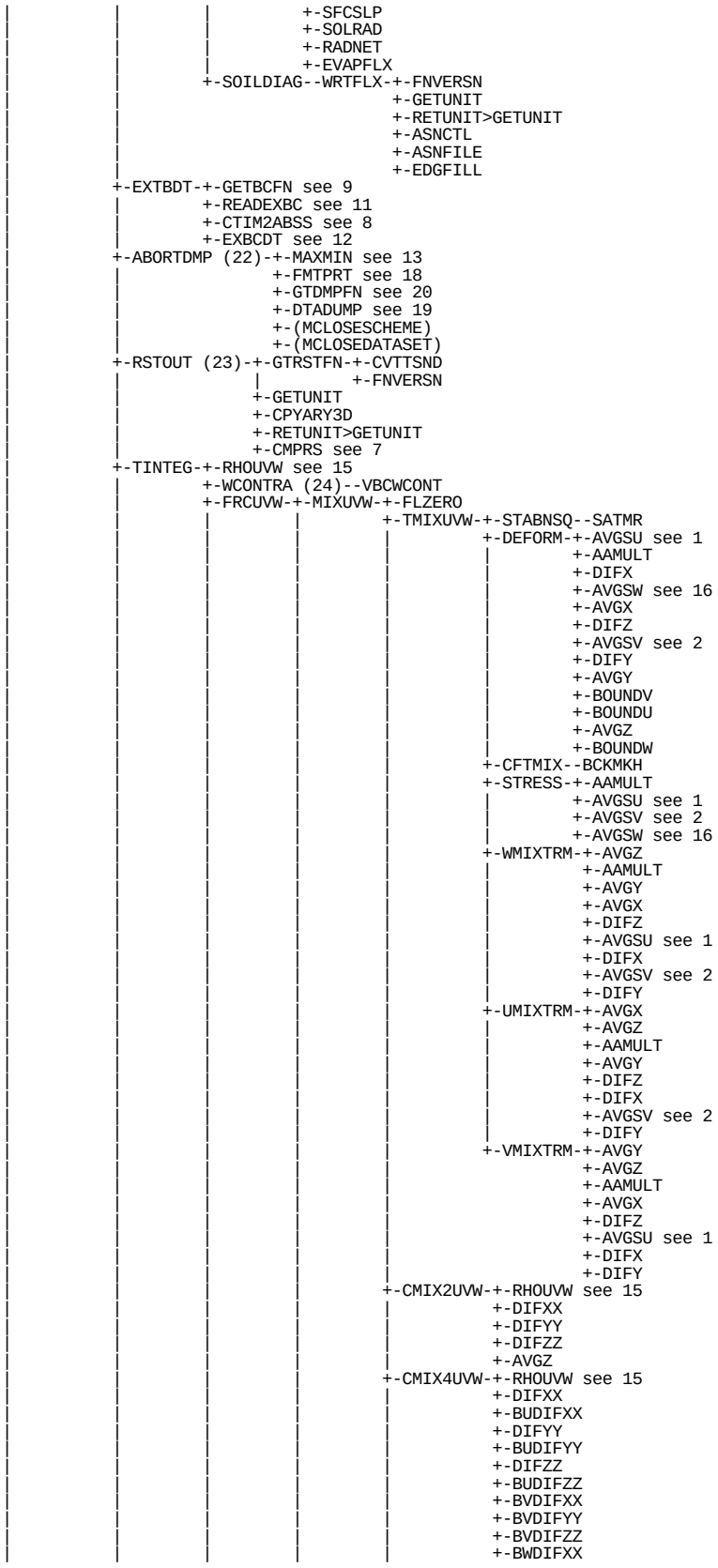
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+-EDGFILL
+-EXTBDT-+-GETBCFN see 9
+-READEXBC see 11
+-CTIM2ABSS see 8
+-EXBCDT see 12
+-ABORTDMP (22)-+-MAXMIN see 13
+-FMTPRT see 18
+-GTDMPFN see 20
+-DTADUMP see 19
+-(MCLOSESCHEME)
+-(MCLOSEDATASET)
+-RSTOUT (23)-+-GTRSTFN-+-CVTTSND
+-FNVERSN
+-GETUNIT
+-CPYARY3D
+-RETUNIT>GETUNIT
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+-TINTEG-+-RHOUVW see 15
+-WCONTRA (24)--VBCWCONT
+-FRCUVW-+-MIXUVW-+-FLZERO
+-TMIXUVW-+-STABNSQ--SATMR
+-DEFORM-+-AVGSU see 1
+-AAMULT
+-DIFX
+-AVGSW see 16
+-AVGX
+-DIFZ
+-AVGSV see 2
+-DIFY
+-AVGY
+-BOUNDV
+-BOUNDU
+-AVGZ
+-BOUNDW
+-CFTMIX--BCKMKH
+-STRESS-+-AAMULT
+-AVGSU see 1
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+-DIFZZ
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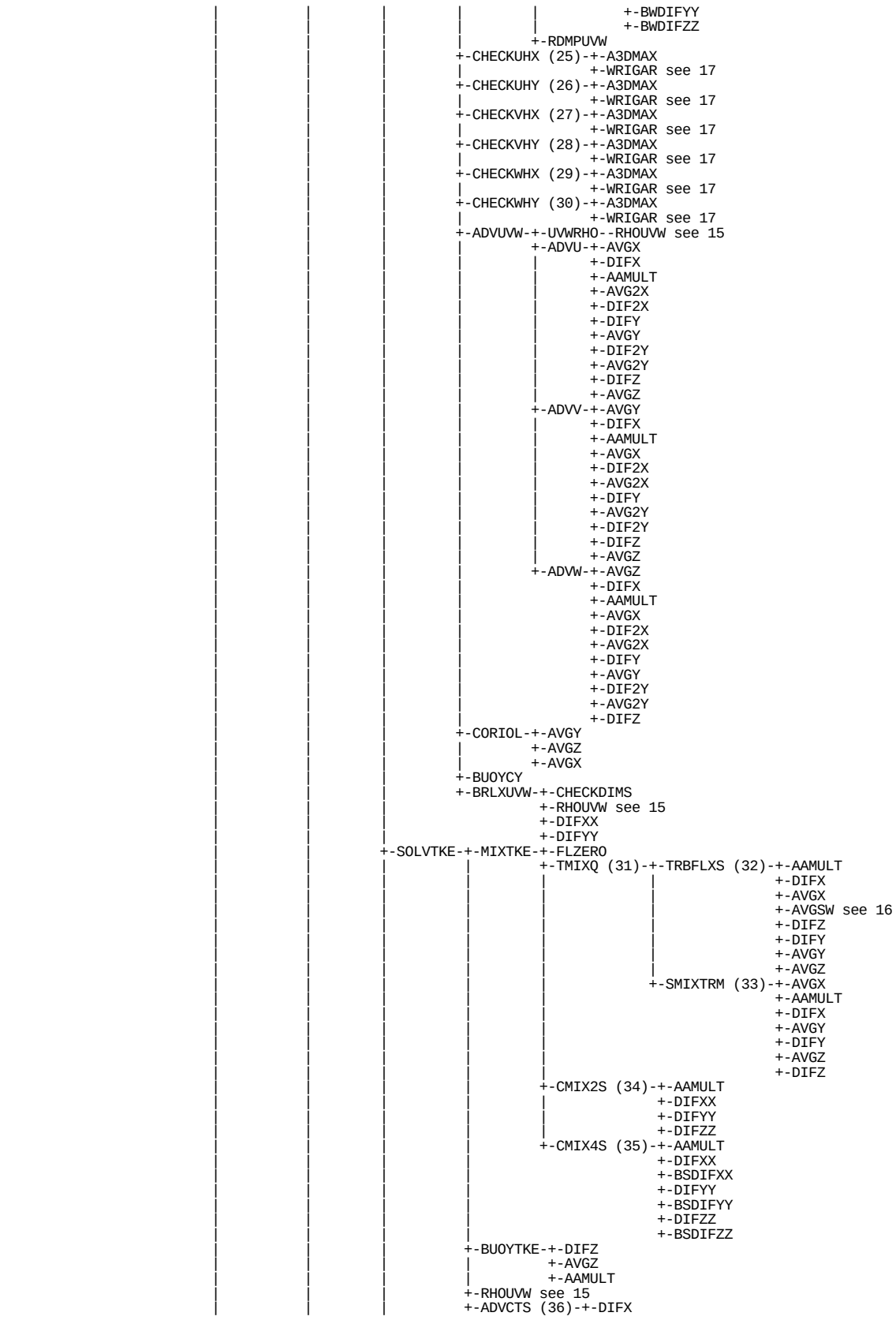
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+-CHECKUHY (26)-+-A3DMAX
+-WRIGAR see 17
+-CHECKVHX (27)-+-A3DMAX
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+-CHECKVHY (28)-+-A3DMAX
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+-SOLVTKE-+-MIXTKE-+-FLZERO
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+-AVGSW see 16
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+-AVGY
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+-AVGZ
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+-DIFYY
+-DIFZZ
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+-DIFXX
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+-DIFYY
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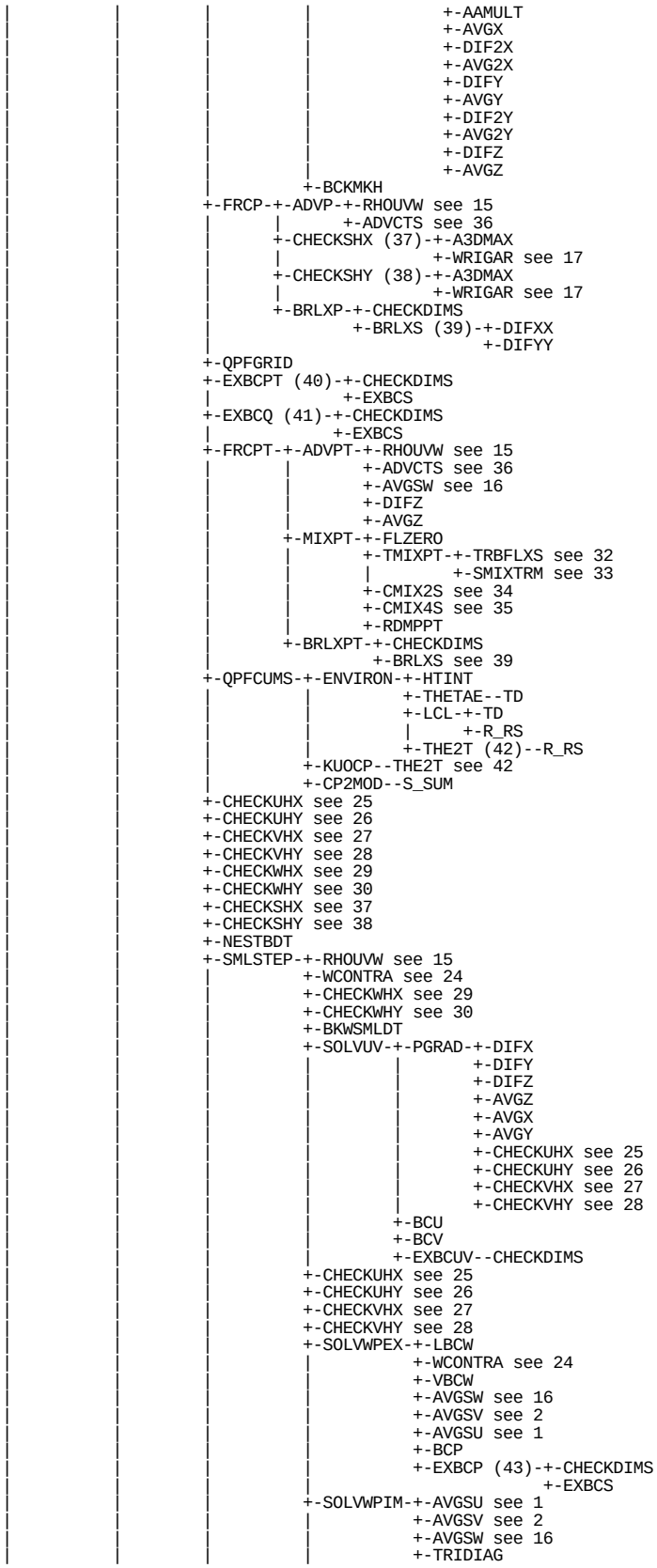
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+-ADVCTS see 36
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+-DIFYY
+-QPFGRID
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+-SMIXTRM see 33
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+-BRLXS see 39
+-QPFCUMS-+-ENVIRON-+-HTINT
+-THETAE--TD
+-LCL-+-TD
+-R_RS
+-THE2T (42)--R_RS
+-KUOCP--THE2T see 42
+-CP2MOD--S_SUM
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+-CHECKWHX see 29
+-CHECKWHY see 30
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+-SMLSTEP-+-RHOUVW see 15
+-WCONTRA see 24
+-CHECKWHX see 29
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+-BKWSMLDT
+-SOLVUV-+-PGRAD-+-DIFX
+-DIFY
+-DIFZ
+-AVGZ
+-AVGX
+-AVGY
+-CHECKUHX see 25
+-CHECKUHY see 26
+-CHECKVHX see 27
+-CHECKVHY see 28
+-BCU
+-BCV
+-EXBCUV--CHECKDIMS
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+-CHECKVHY see 28
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+-VBCW
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+-AVGSV see 2
+-AVGSU see 1
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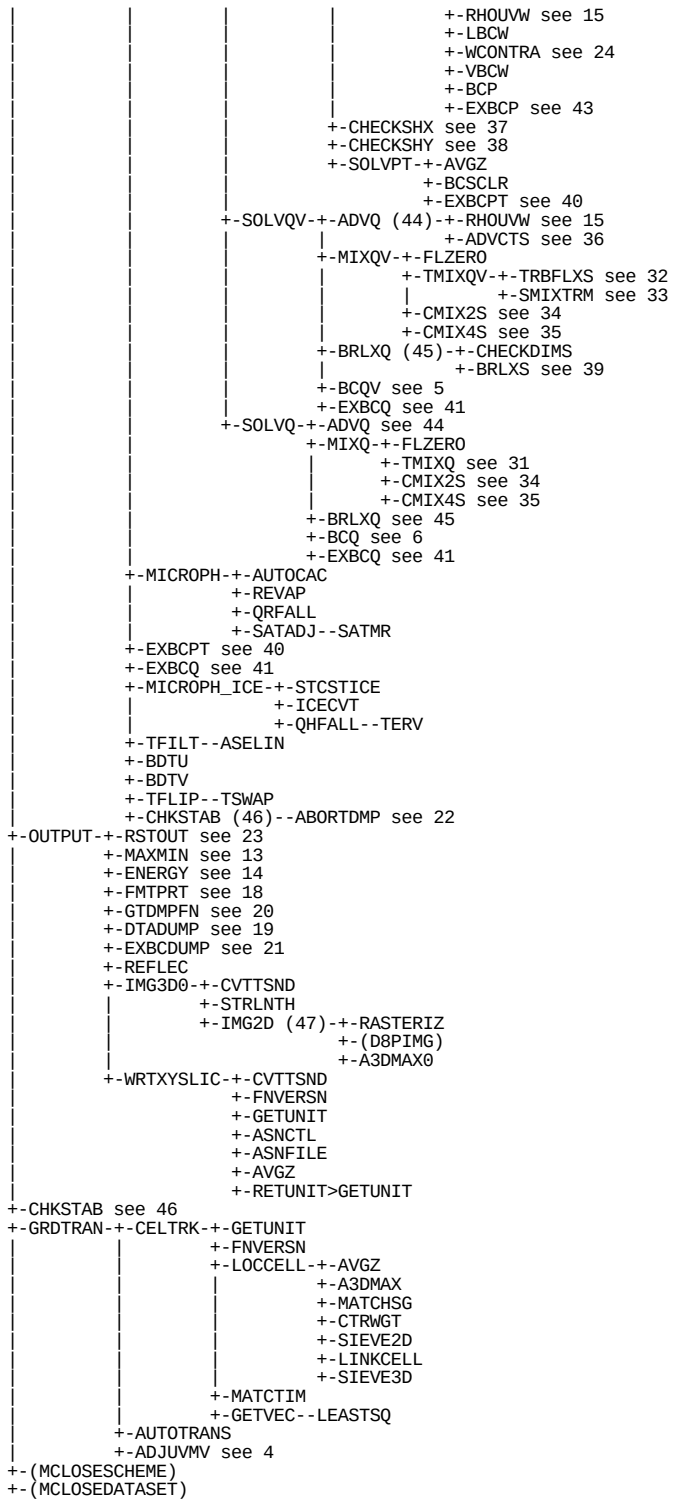
+-TRIDIAG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+-BRLXQ see 45
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+-MICROPH-+-AUTOCAC
+-REVAP
+-QRFALL
+-SATADJ--SATMR
+-EXBCPT see 40
+-EXBCQ see 41
+-MICROPH_ICE-+-STCSTICE
+-ICECVT
+-QHFALL--TERV
+-TFILT--ASELIN
+-BDTU
+-BDTV
+-TFLIP--TSWAP
+-CHKSTAB (46)--ABORTDMP see 22
+-OUTPUT-+-RSTOUT see 23
+-MAXMIN see 13
+-ENERGY see 14
+-FMTPRT see 18
+-GTDMPFN see 20
+-DTADUMP see 19
+-EXBCDUMP see 21
+-REFLEC
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+-STRLNTH
+-IMG2D (47)-+-RASTERIZ
+-(D8PIMG)
+-A3DMAX0
+-WRTXYSLIC-+-CVTTSND
+-FNVERSN
+-GETUNIT
+-ASNCTL
+-ASNFILE
+-AVGZ
+-RETUNIT>GETUNIT
+-CHKSTAB see 46
+-GRDTRAN-+-CELTRK-+-GETUNIT
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+-MATCHSG
+-CTRWGT
+-SIEVE2D
+-LINKCELL
+-SIEVE3D
+-MATCTIM
+-GETVEC--LEASTSQ
+-AUTOTRANS
+-ADJUVMV see 4
+-(MCLOSESCHEME)
+-(MCLOSEDATASET)

5.2. Program / Subroutine Glossary

This section provides a description of the programs and subroutines in ARPS. All subroutines used by auxiliary programs are not included.

PROGRAM	DESCRIPTION
ARPS40	This is the main driver program of ARPS 4.0.
ARPSCVT	Convert standard ARPS history dump data from one format to another.
ARPSDIFF	Compute difference between two ARPS history files and writes the difference as a history file.
ARPSPLT	A vector graphics analysis program for ARPS gridded data output based ZXPLOT.
ARPSPRT	Read in ARPS history data files and print out selected 2-D slices of the 3-D arrays in tabulate form.
ARPSR2H	Read in ARPS restart data and write them into ARPS history format data files.
ARPSSFC	Prepare surface characteristics data from the surface data base for ARPS.
ARPSSOIL	Process soil temperature and other soil properties and write out a soil model input data for ARPS.
ARPSTERN	Terrain data pre-processor for ARPS.
DIR1DEG	Convert 1 degree terrain elevation data in ASCII format into a direct access file.
DIR30SEC	Convert 30 second terrain elevation data in ASCII format into a direct access file.
DIR5MIN	Convert 5 minute terrain elevation data in ASCII format into a direct access file.
EXT2ARPS	Convert an external gridded data set to the ARPS grid and write out the data out in ARPS history data format. The output data can be used to initialize ARPS.
ARPSEXTSND	Extract a sounding profile from ARPS model history data.
ARPSPLTMAX	Produce graphic plots of the time series of the maximum and minimum of u, v, w, θ', p' and the water variables.

ROUTINE	DESCRIPTION
A3DMAX	Find the maximum, minimum and the index locations of an array in a specified subdomain.
A3DMAX0	Find the maximum and minimum of a 3-D array in a specified subdomain.
AAMULT	Calculate the element-wise product of 2 arrays.
ABSS2CTIM	Convert the absolute time to calendar day and time (seconds since 00:00:00 UTC, Jan. 1, 1960).
ADJUVMV	Adjust the model variables per change in the domain translation speed.
ADVCTS	Calculate the scalar equation advection terms.
ADVP	Calculate the advection of perturbation pressure.
ADVPT	Calculate the advection of total potential temperature.
ADVQ	Calculate water/ice advection.

ADVU	Calculate the advection terms of the *u*-equation.
ADVUVW	Coordinates the calculation of the advection terms *uadv, vadv* and *wadv* of the *u, v* and *w* equations.
ADVV	Calculate the advection terms of the *v*-equation.
ADVW	Calculate the advection terms of the *w*-equation.
ASCDUMP	Write history data in ASCII format.
ASCREAD	Read history data in ASCII format.
ASELIN	Apply Asselin time filter.
ASNFILE	Dummy subroutine to substitute for Cray function ASNFILE.
ASNFILE	Dummy subroutine to substitute for Cray function ASNFILE.
ASNUNIT	Dummy subroutine to substitute for Cray function ASNUNIT.
ASNUNIT	Dummy subroutine to substitute for Cray function ASNUNIT.
AUTOCAC	Calculate the autoconversion of cloud water to rainwater and the accretion (collection) of cloud droplets by rain drops.
AUTOTRANS	This subroutine computes the optimum (least squares) pattern translation speed based on vertical velocity data.
AVG2X	Perform a spatial average operation on an array in the *x* direction. Averaging is over a $2\Delta x$ distance.
AVG2Y	Perform a spatial average operation on an array in the *y* direction. Averaging is over a $2\Delta y$ distance.
AVG2Z	Perform a spatial average operation on array a in the z direction. Averaging is over a $2\Delta z$ distance.
AVGSU	Average a scalar array to *u*-points, up to the *x* boundary.
AVGSV	Average a scalar array to *v*-points, up to the *y* boundary.
AVGSW	Average a scalar array to *w*-points, from $k=1$ to $k=nz$.
AVGX	Perform a spatial average operation on an array in the *x* direction.
AVGY	Perform a spatial average operation on an array in the *y* direction.
AVGZ	Perform a spatial average operation on an array in the *z* direction.
BASPRT	Print out base state fields in FORTRAN output unit 6.
BRLXP	Calculate the boundary relaxation and computational mixing for p' in the boundary zone.
BRLXUVW	Calculate the boundary relaxation and computational mixing for *u*, *v*, and *w* in the boundary zone.
BCIS2D	Set the boundary conditions for a 2-D integer scalar array.
BCKMKH	Set the boundary conditions for a scalar. Zero gradient is assumed except for the periodic boundary condition case.
BCP	Set the boundary conditions for the pressure perturbation, p'.
BCPT	Set the boundary conditions for the potential temperature perturbation, θ'.
BCQ	Set the boundary conditions for all of the water quantities.
BCS2D	Set the boundary conditions for a 2-D scalar.
BCSCLR	Set the boundary conditions for a scalar.
BRLXPT	Calculate the boundary relaxation and computational mixing for potential temperature perturbation in the boundary zone.
BRLXQV	Calculate the boundary relaxation and computational mixing for water vapor mixing ratio in the boundary zone.
BCSU	Set the *x*-boundary conditions for an array that has been averaged from scalar points to *u*-points.

BCSV	Set the *y*-boundary conditions for an array that has been averaged from scalar points to *v*-points.
BCSW	Set the top and bottom boundary condition for an array that has been averaged from scalar points to *w*-points.
BCU	Set the boundary conditions for the *u*-velocity component.
BCV	Set the boundary conditions for the *v*-velocity component.
BDMPDOMN	Set the start and end indices of the model subdomain in which the data is dumped out.
BDMPSKIP	Set data skip parameters for data dump.
BINDUMP	Write history data as unformatted binary data.
BINREAD	Read in binary data set created by ARPS using history dump format No. 1.
BKWSMLDT	Compute the time tendencies of u and v on the lateral boundaries using Klemp and Wilhelmson type radiation boundary condition implemented inside the small time steps.
BN2DUMP	Write history data as unformatted binary data. This routine can dump the data arrays in a model subdomain and at selected data points.
BN2READ	Read in binary data set created by ARPS using history dump format No.6.
BOUNDU	Set the boundary conditions for a quantity at the first and last *u* points in the *x*-direction.
BOUNDV	Set the boundary conditions for a quantity at the first and last *v* points in the *y*-direction.
BOUNDW	Set the boundary conditions for a quantity at the first and last *w* points in the *z*-direction.
BSDIFXX	Set the east and west boundary values of $\partial^2 S/\partial x^2$ for the 4th order computational mixing term of the scalar equations.
BSDIFYY	Set the north and south boundary values of $\partial^2 S/\partial y^2$ for the 4th order computational mixing term of the scalar equations.
BSDIFZZ	Set the top and bottom boundary values of $\partial^2 S/\partial z^2$ for the 4th order computational mixing term of the scalar equations.
BUDIFXX	Set the east and west boundary values of $\partial^2(u-\bar{u})/\partial x^2$ for the 4th order computational mixing term of the *u*-equation.
BUDIFYY	Set the north and south boundary values of $\partial^2(u-\bar{u})/\partial y^2$ for the 4th order computational mixing term of the *u*-equation.
BUDIFZZ	Set the top and bottom boundary values of $\partial^2(u-\bar{u})/\partial z^2$ for the 4th order computational mixing term of the *u*-equation.
BUOYCY	Calculate the total buoyancy.
BUOYTKE	Compute the buoyancy production term in the TKE equation.
BVDIFXX	Set the east and west boundary values of $\partial^2(v-\bar{v})/\partial x^2$ for the 4th order computational mixing term of the *v*-equation.
BVDIFYY	Set the north and south boundary values of $\partial^2(v-\bar{v})/\partial y^2$ for the 4th order computational mixing term of the *v*-equation.
BVDIFZZ	Set the top and bottom boundary values of $\partial^2(v-\bar{v})/\partial z^2$ for the 4th order computational mixing term of the *v*-equation.
BWDIFXX	Set the east and west boundary values of $\partial^2 w/\partial x^2$ for the 4th order computational mixing term of the *w*-equation.

BWDIFYY	Set the north and south boundary values of $\partial^2 w/\partial y^2$ for the 4th order computational mixing term of the *w*-equation.
BWDIFZZ	Set the top and bottom boundary values of $\partial^2 w/\partial z^2$ for the 4th order computational mixing term of the *w*-equation.
CALDAY	Computes the calendar month and day from the Julian day.
CFTMIX	Calculate the turbulent mixing coefficient, K_m, with the modified Smagorinsky formulation.
CHECKSHX	Check the west-east symmetry of a field defined at a scalar point on the level containing the maximum magnitude of that field.
CHECKSHY	Check the south-north symmetry of a field defined at a scalar point on the level containing the maximum magnitude of that field.
CHECKSX	Check the west-east symmetry of a field defined at a scalar point on the *y*-*z* plane containing the maximum magnitude of that field.
CHECKSY	Check the south-north symmetry of a field defined at a scalar point on the *x*-*z* plane containing the maximum magnitude of that field.
CHECKUHX	Check the west-east symmetry of a field defined at a *u*-point on the level containing the maximum magnitude of that field.
CHECKUHY	Check the south-north symmetry of a field defined at a *u*-point on the level containing the maximum magnitude of that field.
CHECKUX	Check the west-east symmetry of a field defined at a *u*-point on the *y*-*z* plane containing the maximum magnitude of that field.
CHECKUY	Check the south-north symmetry of a field defined at a *u*-point on the *x*-*z* plane containing the maximum magnitude of that field.
CHECKVHX	Check the west-east symmetry of a field defined at a *v*-point on the level containing the maximum magnitude of that field.
CHECKVHY	Check the south-north symmetry of a field defined at a *v*-point on the level containing the maximum magnitude of that field.
CHECKVX	Check the west-east symmetry of a field defined at a *v*-point on the *y*-*z* plane containing the maximum magnitude of that field.
CHECKVY	Check the south-north symmetry of a field defined at a *v*-point on the *x*-*z* plane containing the maximum magnitude of that field.
CHECKWHX	Check the west-east symmetry of a field defined at a *w*-point on the level containing the maximum magnitude of that field.
CHECKWHY	Check the south-north symmetry of a field defined at a *w*-point on the level containing the maximum magnitude of that field.
CHECKWX	Check the west-east symmetry of a field defined at a *w*-point on the *y*-*z* plane containing the maximum magnitude of that field.
CHECKWY	Check the south-north symmetry of a field defined at a *w*-point on the *x*-*z* plane containing the maximum magnitude of that field.
CHKSTAB	Check the stability of the time integration. If unstable, dump out the model data and stop the model run.
CMIX2S	Generic routine to calculate the second order computational mixing for a scalar.
CMIX2UVW	Calculate the second order computational mixing terms for the momentum equations. Computational mixing is applied to velocity perturbations only. These terms are placed in the arrays *umix*, *vmix* and *wmix*.
CMIX4S	Generic routine to calculate the fourth order computational mixing for a scalar.

CMIX4UVW	Calculate the fourth order computational mixing terms for the momentum equations.
CMPRS	Call UNIX standard utility **compress** or **gzip** to compress or decompress a file within the FORTRAN program.
CNVSND	Converts data extracted from ARPS history file to sounding data.
COLINT	Interpolates ARPS history data in the horizontal to create a column of data located at point (*xpt*, *ypt)*. Bilinear interpolation is used.
COMLNTH	Return the length of the non-blank part of a character string.
CORDINTG	Coordinate the forward integration of all model time-dependent variables.
CORIOL	Calculate the Coriolis force terms in the u, v and w equations.
CPYARY3D	Copy the contents of array *ain* into array *aout.*
CTIM2ABSS	Convert a calendar date and time to absolute time in seconds since 00:00:00 UTC, Jan. 1, 1960
CVTTIM	Convert time, given in seconds, into a 6-character string containing time in the hour/minute/second format.
CVTTSND	Convert time, given in hour/minute/second format, into a 6-character string containing time in seconds.
DCDCHAR	Decode an integer vector which describes a character string within the header and label fields of an ARPS packed-format data file. The integers represent the ASCII number of the character.
DCDLABEL	Decode character information stored in integer array label, which was read from an ARPS packed-format file by PAKREAD. The label information describes the data field that follows the label vector in the file.
DCDREAL	Recover a real number which has been stored as a sequence of two integers, an exponent (i*nt1*) and a mantissa (*int2*).
DDROTUV	Rotate wind from earth direction to map orientation.
DECDHDR	Decode character information stored in an integer array *ihead* that was read from an ARPS packed-format file by PAKREAD.
DEFORM	Calculate the deformation tensor components D_{ij}.
DIF2X	Perform a centered finite difference operation on an array over double grid interval in *x* direction.
DIF2Y	Perform a centered finite difference operation on an array over double grid interval in *y* direction.
DIFX	Perform a finite difference operation on an array in the *x*-direction. The output variable is defined at the midpoint between the two points whose values are differenced.
DIFXX	Calculate the second order difference of an array in the *x*-direction. The operator is defined as $\partial^2 a/\partial x^2$.
DIFY	Perform a finite difference operation on an array in the y-direction. The output variable is defined at the midpoint between the two points whose values are differenced.
DIFYY	Calculate the second order finite difference of an array in the *y*-direction. The operator is defined as $\partial^2 a/\partial y^2$.
DIFZ	Perform a finite difference operation on an array in the *z*-direction. The output variable is defined at the midpoint between the two points whose values are differenced.
DIFZZ	Calculate the second order finite difference of an array in the *z*-direction. The operator is defined as $\partial^2 a/\partial z^2$.
DTADUMP	Coordinate the history data dump in various data formats.
DTAREAD	Coordinate the reading of history data of various formats.

EDGFILL	Fill in the edges of a data array from the valid interior grid points so that the arrays are completely filled.
ENERGY	Compute the density-weighted domain average of grid-scale kinetic energy, momentum, potential temperature and potential temperature variance.
EVAPFLX	Calculate evaporation and transpiration from ground surface and leaves.
EXBCDT	Calculate the linear time-dependent tendencies of external boundary data.
EXBCDUMP	Dump interpolations of the EXBC fields at history dumping time.
EXBCP	Calculate the external boundary conditions for pressure perturbation.
EXBCPT	Calculate the external boundary conditions for potential temperature perturbation.
EXBCQV	Calculate the external boundary conditions for water vapor mixing ratio.
READEXBC	Read in arrays for use as external boundary conditions.
EXBCUV	Calculate the external boundary conditions for *u* and *v*.
EXBCW	Calculate the external boundary conditions for *w*.
EXTBDT	Read in predicted variables from external boundary file to calculate the time-dependent tendencies at boundaries.
EXTBDTINI	Read in predicted variables from the first available external data sets to calculate the time-dependent tendencies at boundaries.
EXTINIT	Read in the initial fields from an externally supplied initial data file.
FINDLC	Searches in *x* and *y* to find index location of point (*xpt, ypt)*.
FLZERO	Fill in an entire array with zeros.
FMTPRT	Produce formatted print out of selected data arrays in FORTRAN output unit 6. By default, the *x-y*, *x-z* and *y-z* slices through the domain center are printed.
FNVERSN	Append the file version number to a file name if the named file already exists.
FRCP	Calculate the advection and other source/sink terms in the pressure equation. These terms are invariant during the small time-step integration.
FRCPT	Calculate gravity wave or inactive acoustic wave terms in the potential temperature equation.
FRCUVW	Calculate the inactive acoustic forcing terms in the momentum equations. These forcing terms include the advection, mixing, Coriolis force and buoyancy terms.
GALILEI	Adjust past time level values of all the time dependent variables such that their local time derivatives in the new moving reference frame satisfies the Galilean transformation.
GETBCFN	Get the external boundary data file name.
GETMAPR	Get the constants for the current map projection, which are stored in the common block named /*projcst*/.
GETQVS	Calculate the saturation mixing ratio using Teten's formula.
GETUNIT	Find a free FORTRAN I/O unit from a list and return that unit.
GRADSDUMP	Write history data in the GrADS format.
GRADSREAD	Read history data in the GrADS format.
GTBASFN	Return a unique name for the grid and base state array dump file.
GTDMPFN	Return a unique name for the history data dump at a given time for a given data format.
GTLFNKEY	Find out the number of characters to be used to construct output file names.
GTLOGFN	Return a unique name for the input log file.
GTRSTFN	Return a unique name for the restart data dump at a given time.
HDFDUMP	Produce a history data file in the NCSA HDF data format.

HDFGDMP	Set up one-dimensional arrays for storing the coordinate values as HDF scale vectors. Call appropriate HDF routines to write the scale vectors.
HDFREAD	Read in history data in the NCSA HDF format.
HDFSCRD	Convert HDF "scale" information into ARPS coordinate arrays.
ICECVT	Calculate and apply the microphysical contributions to the water, ice and temperature fields.
IMG2D	Create an HDF image file for a 2-D field.
IMG3D	Produce 2-D HDF images for specified slices of a 3-d array.
IMG3D0	Produce 2-D HDF images for specified slices of a 3-d array.
INIBASE	Initialize the base-state variables.
INIGRD	Initialize the model grid variables.
INIT0	Initialize all model arrays with zeros.
INITBDT	Set the time tendency of certain time dependent variables on the lateral boundaries for the initial time step.
INITDVR	Initialize the model time dependent variables.
INITIAL	Initialize the model parameters and variables, including base state variables, dependent variables and grid structure.
INITOUT	Handles the model data output at the initial time.
INITPARA	Initialize the model control parameters. Most of them are read in from an input file.
INITSFC	Initialize the surface data and soil model variables.
INITVAR	Initialize the model array variables.
INTE1D	Interpolate data from sounding to a model grid-column with uniform grid spacing.
JACOB	Calculate transformation Jacobians J_1, J_2 and J_3.
JULDAY	Compute Julian day from year, month, and day in a history file.
LATTOMF	Determine the map scale factor at a given latitude.
LBCW	Set the lateral boundary conditions for the *w*-velocity component.
LLTOXY	Determine *x* and *y* coordinates on map projection from the given latitude and longitude.
MAXMIN	Calculate the maximum and minimum of the time dependent fields and write them into an output file.
MICROPH	Calculate and apply the microphysical contributions to the water and temperature fields, using the Kessler warm rain microphysics parameterization.
MICROPH_ICE	Calculate and apply the microphysical contributions to the water, ice and temperature fields, using an ice microphysics parameterization scheme.
MIXPT	Calculate the total mixing (turbulent mixing and an externally imposed computational mixing) for the potential temperature equation.
MIXQ	Calculate the total mixing term (which includes the turbulent mixing as well as externally imposed computational mixing) for all water substance equations except water vapor.
MIXQV	Calculate the total mixing term (externally imposed computational mixing and turbulent mixing) for the water vapor mixing ratio equation.
MIXUVW	Calculate the total mixing (turbulent mixing and the externally imposed computational mixing) for the momentum equations. This subroutine also calculates the turbulent mixing coefficients.
MKARPSVAR	Interpolate 3-D data from an external file to ARPS grid location. Then compute the mean and perturbation quantities.
MKHEAD	Take information needed for packed data file header and convert into integer*4 vector which will be written as the first record in the packed data file.

MKLABEL	Take information needed for the data label and convert it into an integer*4 vector which will be written in the data file just before the data array.
MNSOUND	Calculate the mean value of input variable across each model vertical level over the specified range of indices.
NESTBDT	Set the time tendency of an array on the lateral boundaries for a nested grid.
NETDUMP	Write a NetCDF file that has been previously created by NETCRT, with the values from all the arrays.
NETREAD	Read a NetCDF history file.
OUTPUT	Coordinate the output of model data at a particular time.
PACKDAT	Two to one packing of a real data vector into an integer vector.
PAKDUMP	Write history data as packed integers. The resultant packed history file is about half the size of a binary history file.
PAKREAD	Read in data from a packed binary history data set created by ARPS.
PARSLN	Parse user input line and pull off character strings in ASCII range A-Z or 1-9. Input line should be capitalized BEFORE calling this routine.
PGRAD	Calculate the pressure gradient terms in the momentum equations. These terms are evaluated every small time step.
PRTLOG	Print a log file compatible with the namelist format
PTSTARC	Compute a temperature scale defined as surface heat flux divided by the friction velocity.
PTSTARCNEU	Compute a temperature scale defined as surface heat flux divided by the friction velocity at neutral state.
QHFALL	Calculate the fall-out speed of hydrometers and apply this effect to a hydrometer field.
QRFALL	Calculate the fall-out speed of rainwater and apply this effect to rainwater field.
RADNET	Calculate the net radiative flux at the earth's surface.
RANARY	Generate a 2-D array of machine-independent random numbers between -*amplit* and +*amplit* with average value equal to zero.
RDEXTFIL	Read in an external file to be processed by EXT2ARPS, a program that converts external files to ARPS variables and format.
RDMPPT	Apply Rayleigh sponge to the perturbation potential temperature.
RDMPUVW	Apply Rayleigh sponge to vertical velocity *w*, and to perturbations of horizontal velocities *u* and *v* in the momentum equations.
READTRN	Read the terrain data into model array *hterain* from a terrain data file.
REFLEC	Compute the radar reflectivity factor following Kessler (1969).
RETUNIT	Return a freed unit to the list.
REVAP	Calculate the rainwater evaporation rate. Apply these changes to q_r and q_v and then adjust the potential temperature due to the evaporative cooling.
RHOUVW	Average *rhostr* to *u*, *v* and *w* points.
RSTIN	Read in data from a restart file to initialize model dependent variables.
RSTOUT	Dump out a model restart file at a specified model time.
SATADJ	Perform the saturation adjustment (condensation and evaporation between q_v and q_c).
SDMPDOMN	Set the start and end indices of the model subdomain in which the data is dumped out.
SDMPSKIP	Set data skip parameters for data dump.
SECTHRZ	Interpolate 3-D data to a specified horizontal level.
SECTVRT	Interpolate a 3-D data to a specified 2-D vertical plane.
SETGRD	Set up the ARPS model grid.

SETMAPR	Set constants for map projections, which are stored in the common block named /*projcst*/.
SETORIG	Set the origin for the map projection.
SFCFLX	Calculate the surface momentum, heat and surface moisture fluxes.
SFCFLXSD	Calculate the surface momentum, heat and surface moisture fluxes using a stability dependent formulation.
SFCSLP	Compute the terrain slope vector in terms of magnitude and direction.
SMIXTRM	Calculate the turbulent mixing term for a scalar from the turbulent fluxes.
SMLSTEP	Coordinate the integration of the acoustically active parts of the dynamic equations.
SNDINTRP	Interpolate the input sounding profile to the model grid system.
SOILDIAG	Calculate and print out diagnostics for the surface processes.
SOILEBM	Predict the soil surface temperature and moisture contents by solving the surface energy and moisture budget equations.
SOLRAD	Calculate the solar radiation and zenith angle.
SOLVPT	Coordinate the time integration of the potential temperature equation.
SOLVQ	Coordinate the time integration of the equations for the water substance quantities except for the water vapor mixing ratio.
SOLVQV	Coordinate the time integration of the equation for water vapor mixing ratio.
SOLVTKE	Integrate the turbulent kinetic energy TKE equation forward by one time step.
SOLVUV	Perform the time integration of u and v momentum equations.
SOLVWPEX	Coordinate the time stepping of the *w* momentum and pressure equations using the explicit time integration scheme.
SOLVWPIM	Perform the time integration of *w* and pressure equations using the implicit scheme in vertical direction.
SOUNDG	Specify the sounding profiles for wind, temperature, pressure and water vapor using analytical functions or an external sounding file.
SRCPT	Calculate the source/sink terms in the potential temperature equation.
STABNSQ	Calculate the static stability parameter N^2 (Brunt-Väisälä frequency squared).
STRCAP	Capitalize any letters found in input character string *inline* and put result in character string *outline*.
STRESS	Calculate the stress tensor τ_{ij} from deformation tensor D_{ij}.
STRHGRD	Construct a vertically stretched grid.
STRLNTH	Return the length of the non-blank part of a character string.
STRLNTH	Return the length of the non-blank part of a character string.
STRMIN	Minimize a string length by removing consecutive blank spaces.
SVIDUMP	Dump a data file for the visualization program Savi3D.
TERV	Compute the terminal velocities of rain water, snow and hail.
TFILT	Apply the Asselin time filter to all time-dependent variables.
TFLIP	Update the time levels for all time-dependent variables.
TINTEG	Orchestrate the time integration of the dynamics of the basic governing equations.
TMIXQ	Calculate the turbulent mixing term for a water substance equation.
TMIXQV	Calculate the turbulent mixing term for the water vapor mixing ratio equation.
TMIXUVW	Calculate the turbulent mixing terms for the momentum equations.
TRBFLXS	Calculate the turbulent fluxes in *x, y* and *z* direction for a scalar.
TRIDIAG	Solve a tridiagonal linear equation.

TRNCHAR	Translate a character string into an integer vector so that each character in the string is represented by its ASCII value.
TRNREAL	Translate a real variable, *rvar*, into two integers, *int1* and *int2*, so that real variable can be expressed as *rvar=int2 * 2**int1*.
TSWAP	Update the time levels of a time-dependent variable.
UMIXTRM	Calculate the turbulent mixing term in *u* equation.
UNCMPRS	Make a system call to uncompress a file using **uncompress** or **gunzip**.
UNPKDAT	Unpacks an integer vector into a real data vector.
USTARC	Compute the friction velocity u_*.
USTARCNEU	Compute the friction velocity u_* at the neutral state.
UVETOMP	Transform *u, v* wind from earth coordinates to map coordinates.
UVMPTOE	Transform *u, v* wind from map coordinates to earth coordinates.
UVROTDD	Convert wind components *u, v* in map coordinates to wind direction and speed in earth coordinates.
UVWRHO	Compute *ustr=u*rhostr*, *vstr=v*rhostr*, *wstr=wcont*rhostr*.
VBCW	Set the top and bottom boundary conditions for *w*.
VBCWCONT	Set the top and bottom boundary conditions for *wcont.*
VMIXTRM	Calculate the turbulent mixing term in *v* equation as the divergence of the turbulent momentum fluxes.
WCONTRA	Calculate *wcont*, the contravariant vertical velocity (m/s).
WIRFRM	Use NCAR graphic routine ISOSRF to generate 3-D wireframe plot.
WMIXTRM	Calculate the turbulent mixing term in *w* equation as the divergence of the turbulent momentum fluxes.
WRIGAR	Orchestrate the formatted printing of selected 2-D slices from 3-D arrays.
WRITEXBC	Output arrays for use as external boundary conditions. In general these data come from another model.
WRTFLX	Write surface fields in GrADS format for diagnostic purposes.
WRTXYSLIC	Write out an *x-y* slice from a 3-D array for a given height.
XYTOLL	Determine latitude and longitude given *x, y* coordinates on map projection.
XYTOMF	Determine the map scale factor given *x, y* in the projected space.
ZPROFIL	Compute the initial sounding profile at regularly-spaced grid levels.

5.3. List of All Files and Programs / Subroutines / Functions within ARPS

File	Program/Subroutine/Function
arps40.f	PROGRAM ARPS40
arpscvt11.f	PROGRAM ARPSCVT
arpsdiff12.f	PROGRAM ARPSDIFF
arpsextsnd.f	PROGRAM EXTSND
arpsplt47.f	PROGRAM ARPSPLT
arpspltmax.f	PROGRAM PLTMAX
arpsprt12.f	PROGRAM ARPSPRT
arpsr2h30.f	PROGRAM ARPSR2H
arpsread.f	PROGRAM ARPSREAD
arpssfc12.f	PROGRAM ARPSSFC12
arpssoil.f	PROGRAM ARPSSOIL
arpstern12.f	PROGRAM ARPSTERN
dir1deg.f	PROGRAM DIR1DEG
dir30sec.f	PROGRAM DIR30SEC
dir5min.f	PROGRAM DIR5MIN
ext2arps.f	PROGRAM EXT2ARPS
pltgrid.f	PROGRAM PLTGRID
advct3d.f	SUBROUTINE ADVUVW
advct3d.f	SUBROUTINE ADVP
advct3d.f	SUBROUTINE ADVQ
advct3d.f	SUBROUTINE ADVU
advct3d.f	SUBROUTINE ADVV
advct3d.f	SUBROUTINE ADVW
advct3d.f	SUBROUTINE ADVPT
advct3d.f	SUBROUTINE ADVCTS
arpscvt11.f	SUBROUTINE FLZERO
arpscvt11.f	SUBROUTINE STRIPDIR
arpsdiff12.f	SUBROUTINE DIFFIELD
arpsdiff12.f	SUBROUTINE SUBTR
arpsextsnd.f	SUBROUTINE FINDLC
arpsextsnd.f	SUBROUTINE COLINT
arpsextsnd.f	SUBROUTINE CNVSND
arpslib3d.f	SUBROUTINE RANARY
arpsplt47.f	SUBROUTINE VPROFIL
arpsplt47.f	SUBROUTINE RUNLAB
arpsplt47.f	SUBROUTINE DRAWMAP
arpspltlib.f	SUBROUTINE CTR3D
arpspltlib.f	SUBROUTINE CTR2D
arpspltlib.f	SUBROUTINE CTRINC
arpspltlib.f	SUBROUTINE VTR3D
arpspltlib.f	SUBROUTINE VTR2D
arpspltlib.f	SUBROUTINE VTRUNT
arpspltlib.f	SUBROUTINE STRM3D
arpspltlib.f	SUBROUTINE STRM2D
arpspltlib.f	SUBROUTINE CTRSFC
arpspltlib.f	SUBROUTINE CTRSF1C
arpspltlib.f	SUBROUTINE OVERLAY
arpspltlib.f	SUBROUTINE STYXRT
arpspltlib.f	SUBROUTINE FILZERO
arpspltlib.f	SUBROUTINE TEMPER
arpspltlib.f	SUBROUTINE SATMR
arpspltlib.f	SUBROUTINE EQUIPT
arpspltlib.f	SUBROUTINE SLENGTH
arpspltlib.f	SUBROUTINE XVECTK1
arpspltlib.f	SUBROUTINE KNTARY
arpspltlib.f	SUBROUTINE CLIPWD
arpspltlib.f	SUBROUTINE ENCODWD
arpspltlib.f	SUBROUTINE UNIGRID
arpspltlib.f	SUBROUTINE INTE1D
arpspltlib.f	SUBROUTINE COLFIL
arpspltlib.f	SUBROUTINE LABEL
arpspltlib.f	SUBROUTINE CTRCOL
arpspltmax.f	SUBROUTINE strlnth
arpsprt12.f	SUBROUTINE FLZERO
arpsprtlib.f	SUBROUTINE STRCAP
arpsprtlib.f	SUBROUTINE PARSLN
arpsprtlib.f	SUBROUTINE KNTARY
arpssfclib.f	SUBROUTINE GTSFCDT
arpssfclib.f	SUBROUTINE GTSOILTYP
arpssfclib.f	SUBROUTINE GTVEGTYP
arpssfclib.f	SUBROUTINE GTLAI
arpssfclib.f	SUBROUTINE GTNDVI
arpssfclib.f	SUBROUTINE GTRFNS
arpssfclib.f	SUBROUTINE GTVEG
arpssoil.f	SUBROUTINE CALDAY
arpstern12.f	SUBROUTINE SETGRID
arpstern12.f	SUBROUTINE GETTER
arpstern12.f	SUBROUTINE READTER
arpstern12.f	SUBROUTINE BARNES
arpstern12.f	SUBROUTINE RMSDIF
arpstern12.f	SUBROUTINE RESPONSE
arpstern12.f	SUBROUTINE STRLNTH
barnes3d.f	SUBROUTINE DIFFNSTAT
barnes3d.f	SUBROUTINE BARQC
barnes3d.f	SUBROUTINE BAROBS
barnes3d.f	SUBROUTINE BARGRID
bc3d.f	SUBROUTINE BCU
bc3d.f	SUBROUTINE BCV
bc3d.f	SUBROUTINE LBCW
bc3d.f	SUBROUTINE VBCW
bc3d.f	SUBROUTINE BCP
bc3d.f	SUBROUTINE BCPT
bc3d.f	SUBROUTINE BCQ

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bc3d.f          SUBROUTINE BCQV         cumulus3d.f     SUBROUTINE QPFCUMS
bc3d.f          SUBROUTINE BCSCLR       cumulus3d.f     SUBROUTINE KUOCP
bc3d.f          SUBROUTINE BCSU         cumulus3d.f     SUBROUTINE CP2MOD
bc3d.f          SUBROUTINE BCSV         cumulus3d.f     SUBROUTINE ENVIRON
bc3d.f          SUBROUTINE BCSW         cumulus3d.f     SUBROUTINE LCL
bc3d.f          SUBROUTINE VBCWCONT     cumulus3d.f     SUBROUTINE THE2T
bc3d.f          SUBROUTINE BCS2D        cumulus3d.f     SUBROUTINE HTINT
bc3d.f          SUBROUTINE BCIS2D       cumulus3d.f     SUBROUTINE THETAE
bc3d.f          SUBROUTINE BOUNDU       cumulus3d.f     SUBROUTINE ES_CAL
bc3d.f          SUBROUTINE BOUNDV       dir1deg.f       SUBROUTINE STRLNTH
bc3d.f          SUBROUTINE BOUNDW       dir30sec.f      SUBROUTINE STRLNTH
bcdif3d.f       SUBROUTINE BUDIFXX      dir5min.f       SUBROUTINE STRLNTH
bcdif3d.f       SUBROUTINE BUDIFYY      dump3d.f        SUBROUTINE DTADUMP
bcdif3d.f       SUBROUTINE BUDIFZZ      dump3d.f        SUBROUTINE BINDUMP
bcdif3d.f       SUBROUTINE BVDIFXX      dump3d.f        SUBROUTINE ASCDUMP
bcdif3d.f       SUBROUTINE BVDIFYY      dump3d.f        SUBROUTINE EDGFILL
bcdif3d.f       SUBROUTINE BVDIFZZ      dump3d.f        SUBROUTINE BN2DUMP
bcdif3d.f       SUBROUTINE BWDIFXX      energy3d.f      SUBROUTINE ENERGY
bcdif3d.f       SUBROUTINE BWDIFYY      exbc3d.f        SUBROUTINE EXTBDTINI
bcdif3d.f       SUBROUTINE BWDIFZZ      exbc3d.f        SUBROUTINE EXTBDT
bcdif3d.f       SUBROUTINE BSDIFXX      exbc3d.f        SUBROUTINE EXBCDT
bcdif3d.f       SUBROUTINE BSDIFYY      exbc3d.f        SUBROUTINE EXBCUV
bcdif3d.f       SUBROUTINE BSDIFZZ      exbc3d.f        SUBROUTINE EXBCW
celtrk3d.f      SUBROUTINE CELTRK       exbc3d.f        SUBROUTINE EXBCPT
celtrk3d.f      SUBROUTINE LOCCELL      exbc3d.f        SUBROUTINE EXBCP
celtrk3d.f      SUBROUTINE MATCHSG      exbc3d.f        SUBROUTINE EXBCQ
celtrk3d.f      SUBROUTINE CTRWGT       exbc3d.f        SUBROUTINE EXBCS
celtrk3d.f      SUBROUTINE SIEVE2D      exbc3d.f        SUBROUTINE BRLXUVW
celtrk3d.f      SUBROUTINE SIEVE3D      exbc3d.f        SUBROUTINE BRLXPT
celtrk3d.f      SUBROUTINE LINKCELL     exbc3d.f        SUBROUTINE BRLXP
celtrk3d.f      SUBROUTINE MATCTIM      exbc3d.f        SUBROUTINE BRLXQ
celtrk3d.f      SUBROUTINE GETVEC       exbc3d.f        SUBROUTINE BRLXS
celtrk3d.f      SUBROUTINE LEASTSQ      exbc3d.f        SUBROUTINE CHECKDIMS
chksym3d.f      SUBROUTINE CHECKSX      exbcio3d.f      SUBROUTINE READEXBC
chksym3d.f      SUBROUTINE CHECKUX      exbcio3d.f      SUBROUTINE GETBCFN
chksym3d.f      SUBROUTINE CHECKVX      exbcio3d.f      SUBROUTINE WRITEXBC
chksym3d.f      SUBROUTINE CHECKWX      exbcio3d.f      SUBROUTINE EXBCDUMP
chksym3d.f      SUBROUTINE CHECKSY      extlib3d.f      SUBROUTINE SETEXTIN
chksym3d.f      SUBROUTINE CHECKUY      extlib3d.f      SUBROUTINE HRZINT
chksym3d.f      SUBROUTINE CHECKVY      extlib3d.f      SUBROUTINE EXTMNSND
chksym3d.f      SUBROUTINE CHECKWY      extlib3d.f      SUBROUTINE MKARPSVAR
chksym3d.f      SUBROUTINE CHECKSHX     extlib3d.f      SUBROUTINE ADJUVW
chksym3d.f      SUBROUTINE CHECKUHX     force3d.f       SUBROUTINE FRCUVW
chksym3d.f      SUBROUTINE CHECKVHX     force3d.f       SUBROUTINE FRCP
chksym3d.f      SUBROUTINE CHECKWHX     force3d.f       SUBROUTINE FRCPT
chksym3d.f      SUBROUTINE CHECKSHY     force3d.f       SUBROUTINE CORIOL
chksym3d.f      SUBROUTINE CHECKUHY     force3d.f       SUBROUTINE BUOYCY
chksym3d.f      SUBROUTINE CHECKVHY     force3d.f       SUBROUTINE PDIVRG
chksym3d.f      SUBROUTINE CHECKWHY     force3d.f       SUBROUTINE PGRAD
cmix3d.f        SUBROUTINE CMIX2UVW     force3d.f       SUBROUTINE UVWRHO
cmix3d.f        SUBROUTINE CMIX2S       force3d.f       SUBROUTINE RHOUVW
cmix3d.f        SUBROUTINE CMIX4UVW     genlib3d.f      SUBROUTINE ASNCTL
cmix3d.f        SUBROUTINE CMIX4S       genlib3d.f      SUBROUTINE ASNUNIT
craylib3d.f     SUBROUTINE DUMMY        genlib3d.f      SUBROUTINE ASNFILE
craylib3d.f     SUBROUTINE CMPRS        genlib3d.f      SUBROUTINE CMPRS
craylib3d.f     SUBROUTINE UNCMPRS      genlib3d.f      SUBROUTINE UNCMPRS
cumulus3d.f     SUBROUTINE QPFGRID      gradsio3d.f     SUBROUTINE GRADSREAD
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gradsio3d.f     SUBROUTINE GRADSDUMP   maproj3d.f      SUBROUTINE UVMPTOE
grdtrns3d.f     SUBROUTINE GRDTRAN     micro3d.f       SUBROUTINE MICROPH
grdtrns3d.f     SUBROUTINE ADJUVMV     micro3d.f       SUBROUTINE AUTOCAC
grdtrns3d.f     SUBROUTINE GALILEI     micro3d.f       SUBROUTINE REVAP
grdtrns3d.f     SUBROUTINE AUTOTRANS   micro3d.f       SUBROUTINE QRFALL
hdfio3d.f       SUBROUTINE HDFREAD     micro3d.f       SUBROUTINE SATADJ
hdfio3d.f       SUBROUTINE HDFSCRD     micro3d.f       SUBROUTINE SATMR
hdfio3d.f       SUBROUTINE HDFDUMP     micro3d.f       SUBROUTINE SATMRPT
hdfio3d.f       SUBROUTINE HDFGDMP     micro_ice3d.f   SUBROUTINE
ibmlib3d.f      SUBROUTINE ASNCTL      MICROPH_ICE
ibmlib3d.f      SUBROUTINE ASNUNIT     micro_ice3d.f   SUBROUTINE QHFALL
ibmlib3d.f      SUBROUTINE ASNFILE     micro_ice3d.f   SUBROUTINE ICECVT
ibmlib3d.f      SUBROUTINE CMPRS       micro_ice3d.f   SUBROUTINE TERV
ibmlib3d.f      SUBROUTINE UNCMPRS     micro_ice3d.f   SUBROUTINE STCSTICE
img3d.f         SUBROUTINE IMG3D       ncarg3d.f       SUBROUTINE PLOT
img3d.f         SUBROUTINE IMG3D0      netio3d.f       SUBROUTINE NETREAD
img3d.f         SUBROUTINE IMG2D       netio3d.f       SUBROUTINE READPAK
img3d.f         SUBROUTINE RASTERIZ    netio3d.f       SUBROUTINE NETDUMP
inibase3d.f     SUBROUTINE INIBASE     netio3d.f       SUBROUTINE NETCRT
inibase3d.f     SUBROUTINE ZPROFIL     operat3d.f      SUBROUTINE AAMULT
inibase3d.f     SUBROUTINE SOUNDG      operat3d.f      SUBROUTINE AVGX
inibase3d.f     SUBROUTINE SNDINTRP    operat3d.f      SUBROUTINE AVG2X
inibase3d.f     SUBROUTINE GETQVS      operat3d.f      SUBROUTINE AVGY
inibase3d.f     SUBROUTINE INTE1D      operat3d.f      SUBROUTINE AVG2Y
init3d.f        SUBROUTINE INITIAL     operat3d.f      SUBROUTINE AVGZ
init3d.f        SUBROUTINE INIGRD      operat3d.f      SUBROUTINE AVG2Z
init3d.f        SUBROUTINE STRHGRD     operat3d.f      SUBROUTINE DIFX
init3d.f        SUBROUTINE JACOB       operat3d.f      SUBROUTINE DIF2X
init3d.f        SUBROUTINE INITVAR     operat3d.f      SUBROUTINE DIFY
init3d.f        SUBROUTINE INITDVR     operat3d.f      SUBROUTINE DIF2Y
init3d.f        SUBROUTINE EXTINIT     operat3d.f      SUBROUTINE DIFZ
init3d.f        SUBROUTINE INITSFC     operat3d.f      SUBROUTINE DIFXX
init3d.f        SUBROUTINE INIT0       operat3d.f      SUBROUTINE DIFYY
init3d.f        SUBROUTINE FLZERO      operat3d.f      SUBROUTINE DIFZZ
init3d.f        SUBROUTINE INITLKTB    operat3d.f      SUBROUTINE AVGSU
init3d.f        SUBROUTINE GTSINLAT    operat3d.f      SUBROUTINE AVGSV
initpara3d.f    SUBROUTINE INITPARA    operat3d.f      SUBROUTINE AVGSW
initpara3d.f    SUBROUTINE PRTLOG      out3d.f         SUBROUTINE INITOUT
initpara3d.f    SUBROUTINE SETGRD      out3d.f         SUBROUTINE OUTPUT
intfield.f      SUBROUTINE INTSCLRS    out3d.f         SUBROUTINE CHKSTAB
intfield.f      SUBROUTINE INTONEF     out3d.f         SUBROUTINE MAXMIN
iolib3d.f       SUBROUTINE WRTSOIL     out3d.f         SUBROUTINE BASPRT
iolib3d.f       SUBROUTINE READSOIL    out3d.f         SUBROUTINE FMTPRT
iolib3d.f       SUBROUTINE WRTSFCDT    out3d.f         SUBROUTINE ABORTDMP
iolib3d.f       SUBROUTINE READSFCDT   out3d.f         SUBROUTINE WRTXYSLIC
iolib3d.f       SUBROUTINE WRITTRN     outlib3d.f      SUBROUTINE A3DMAX0
iolib3d.f       SUBROUTINE READTRN     outlib3d.f      SUBROUTINE A3DMAX
maproj3d.f      SUBROUTINE SETMAPR     outlib3d.f      SUBROUTINE WRIGAR
maproj3d.f      SUBROUTINE GETMAPR     outlib3d.f      SUBROUTINE OUTARR
maproj3d.f      SUBROUTINE SETORIG     outlib3d.f      SUBROUTINE GTBASFN
maproj3d.f      SUBROUTINE XYTOLL      outlib3d.f      SUBROUTINE GTDMPFN
maproj3d.f      SUBROUTINE LLTOXY      outlib3d.f      SUBROUTINE GTRSTFN
maproj3d.f      SUBROUTINE LATTOMF     outlib3d.f      SUBROUTINE GTLOGFN
maproj3d.f      SUBROUTINE XYTOMF      outlib3d.f      SUBROUTINE FNVERSN
maproj3d.f      SUBROUTINE DDROTUV     outlib3d.f      SUBROUTINE STRLNTH
maproj3d.f      SUBROUTINE UVROTDD     outlib3d.f      SUBROUTINE STRMIN
maproj3d.f      SUBROUTINE UVETOMP     outlib3d.f      SUBROUTINE COMLNTH
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outlib3d.f      SUBROUTINE CVTTIM      soilebm3d.f     SUBROUTINE EVAPFLX
outlib3d.f      SUBROUTINE CVTTSND     solve3d.f       SUBROUTINE SOLVUV
outlib3d.f      SUBROUTINE GTLFNKEY    solve3d.f       SUBROUTINE SOLVWPEX
outlib3d.f      SUBROUTINE GETUNIT     solve3d.f       SUBROUTINE SOLVWPIM
outlib3d.f      SUBROUTINE SECTHRZ     solve3d.f       SUBROUTINE TRIDIAG
outlib3d.f      SUBROUTINE SECTVRT     solve3d.f       SUBROUTINE WCONTRA
outlib3d.f      SUBROUTINE REFLEC      solve3d.f       SUBROUTINE SOLVPT
pakio3d.f       SUBROUTINE PAKREAD     solve3d.f       SUBROUTINE SOLVQV
pakio3d.f       SUBROUTINE UNPKDAT     solve3d.f       SUBROUTINE SOLVQ
pakio3d.f       SUBROUTINE DECDHDR     sviio3d.f       SUBROUTINE SVIDUMP
pakio3d.f       SUBROUTINE DCDLABEL    thermo3d.f      SUBROUTINE ARPS_BE
pakio3d.f       SUBROUTINE DCDCHAR     thermo3d.f      SUBROUTINE SINDEX
pakio3d.f       SUBROUTINE DCDREAL     thermo3d.f      SUBROUTINE POTBE
pakio3d.f       SUBROUTINE PAKDUMP     thermo3d.f      SUBROUTINE THWXN
pakio3d.f       SUBROUTINE PACKDAT     thermo3d.f      SUBROUTINE CALCLI
pakio3d.f       SUBROUTINE MKHEAD      thermo3d.f      SUBROUTINE INTRPR
pakio3d.f       SUBROUTINE MKLABEL     thermo3d.f      SUBROUTINE
pakio3d.f       SUBROUTINE TRNCHAR                     OLAPS_DERIV
pakio3d.f       SUBROUTINE TRNREAL     thermo3d.f      SUBROUTINE SMTH
pltgrid.f       SUBROUTINE DRAWMAP     timelib3d.f     SUBROUTINE JULDAY
pltgrid.f       SUBROUTINE STRLNTH     timelib3d.f     SUBROUTINE CALDAY
raydmp3d.f      SUBROUTINE RDMPUVW     timelib3d.f     SUBROUTINE CTIM2ABSS
raydmp3d.f      SUBROUTINE RDMPPT      timelib3d.f     SUBROUTINE ABSS2CTIM
rdextfil.f      SUBROUTINE RDEXTFIL    tinteg3d.f      SUBROUTINE CORDINTG
rdextfil.f      SUBROUTINE STRLNTH     tinteg3d.f      SUBROUTINE TINTEG
rdextfil_laps.f SUBROUTINE RDEXTFIL    tinteg3d.f      SUBROUTINE SMLSTEP
rdextfil_laps.f SUBROUTINE GETHT       tinteg3d.f      SUBROUTINE TFILT
rdextfil_ruc.f  SUBROUTINE RDEXTFIL    tinteg3d.f      SUBROUTINE ASELIN
read3d.f        SUBROUTINE DTAREAD     tinteg3d.f      SUBROUTINE TFLIP
read3d.f        SUBROUTINE BINREAD     tinteg3d.f      SUBROUTINE TSWAP
read3d.f        SUBROUTINE ASCREAD     tke3d.f         SUBROUTINE SOLVTKE
read3d.f        SUBROUTINE BN2READ     tke3d.f         SUBROUTINE BUOYTKE
read_obs.f      SUBROUTINE READ_OBS    tke3d.f         SUBROUTINE BCKMKH
rst3d.f         SUBROUTINE RSTOUT      tmix3d.f        SUBROUTINE MIXUVW
rst3d.f         SUBROUTINE RSTIN       tmix3d.f        SUBROUTINE MIXPT
rst3d.f         SUBROUTINE CPYARY3D    tmix3d.f        SUBROUTINE MIXQV
setbdt3d.f      SUBROUTINE NESTBDT     tmix3d.f        SUBROUTINE MIXQ
setbdt3d.f      SUBROUTINE BKWSMLDT    tmix3d.f        SUBROUTINE MIXTKE
setbdt3d.f      SUBROUTINE BDTU        tmix3d.f        SUBROUTINE TMIXUVW
setbdt3d.f      SUBROUTINE BDTV        tmix3d.f        SUBROUTINE STABNSQ
sfcphy3d.f      SUBROUTINE SFCFLX      tmix3d.f        SUBROUTINE CFTMIX
sfcphy3d.f      SUBROUTINE SFCFLXSD    tmix3d.f        SUBROUTINE DEFORM
sfcphy3d.f      SUBROUTINE CUC         tmix3d.f        SUBROUTINE STRESS
sfcphy3d.f      SUBROUTINE CPTC        tmix3d.f        SUBROUTINE TMIXPT
sfcphy3d.f      SUBROUTINE CUCWTR      tmix3d.f        SUBROUTINE TMIXQV
sfcphy3d.f      SUBROUTINE CPTCWTR     tmix3d.f        SUBROUTINE TMIXQ
sfcphy3d.f      SUBROUTINE CUNEUWTR    tmix3d.f        SUBROUTINE TRBFLXS
sfcphy3d.f      SUBROUTINE CPTNEUWTR   tmix3d.f        SUBROUTINE SMIXTRM
smooth3d.f      SUBROUTINE SMOOTH9P    tmix3d.f        SUBROUTINE UMIXTRM
smooth3d.f      SUBROUTINE SMOOTH25P   tmix3d.f        SUBROUTINE VMIXTRM
smooth3d.f      SUBROUTINE SMOOTH3D    tmix3d.f        SUBROUTINE WMIXTRM
soildiag3d.f    SUBROUTINE SOILDIAG    wirfrm.f        SUBROUTINE WIRFRM
soildiag3d.f    SUBROUTINE WRTFLX      wirfrmstub.f    SUBROUTINE WIRFRM
soilebm3d.f     SUBROUTINE SOILEBM     xncar.f         SUBROUTINE XDEVIC
soilebm3d.f     SUBROUTINE SFCSLP      xncar.f         SUBROUTINE XDSPAC
soilebm3d.f     SUBROUTINE SOLRAD      xncar.f         SUBROUTINE PPENUP
soilebm3d.f     SUBROUTINE RADNET      xncar.f         SUBROUTINE ZFILLN
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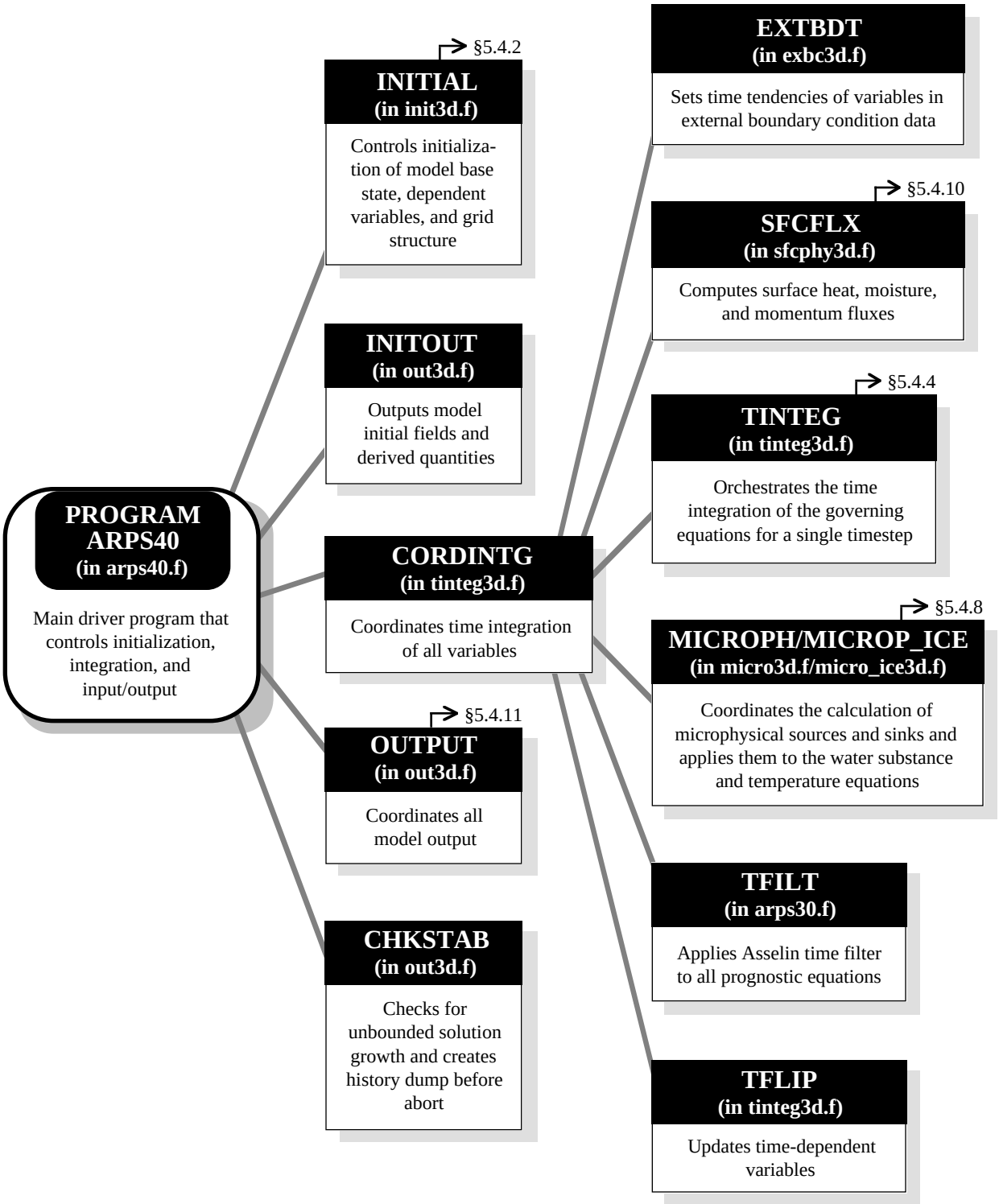
xncar.f          SUBROUTINE XICHAR       cumulus3d.f     FUNCTION TD
xncar.f          SUBROUTINE XDFCLRS      cumulus3d.f     FUNCTION S_SUM
xncar.f          SUBROUTINE STRMLN       intfield.f      FUNCTION AINT3D
xncar.f          SUBROUTINE COLOR        intfield.f      FUNCTION AINT2D
xncar.f          SUBROUTINE SETCOLORS    nohdfio3d.f     FUNCTION D8pimg
xpost.f          SUBROUTINE SETCOLORS    rdextfil_laps.f FUNCTION TCTOTV
xpost.f          SUBROUTINE COLOR        rdextfil_laps.f FUNCTION QVTOMXR
                                         thermo3d.f      FUNCTION TCTOTV
arpsextsnd.f     FUNCTION AINT2D         thermo3d.f      FUNCTION WMR2TD
arpslib3d.f      FUNCTION RAN3           thermo3d.f      FUNCTION TSA_FAST
arpspltlib.f     FUNCTION XFINC          thermo3d.f      FUNCTION W_FAST
cumulus3d.f      FUNCTION R_RS
```

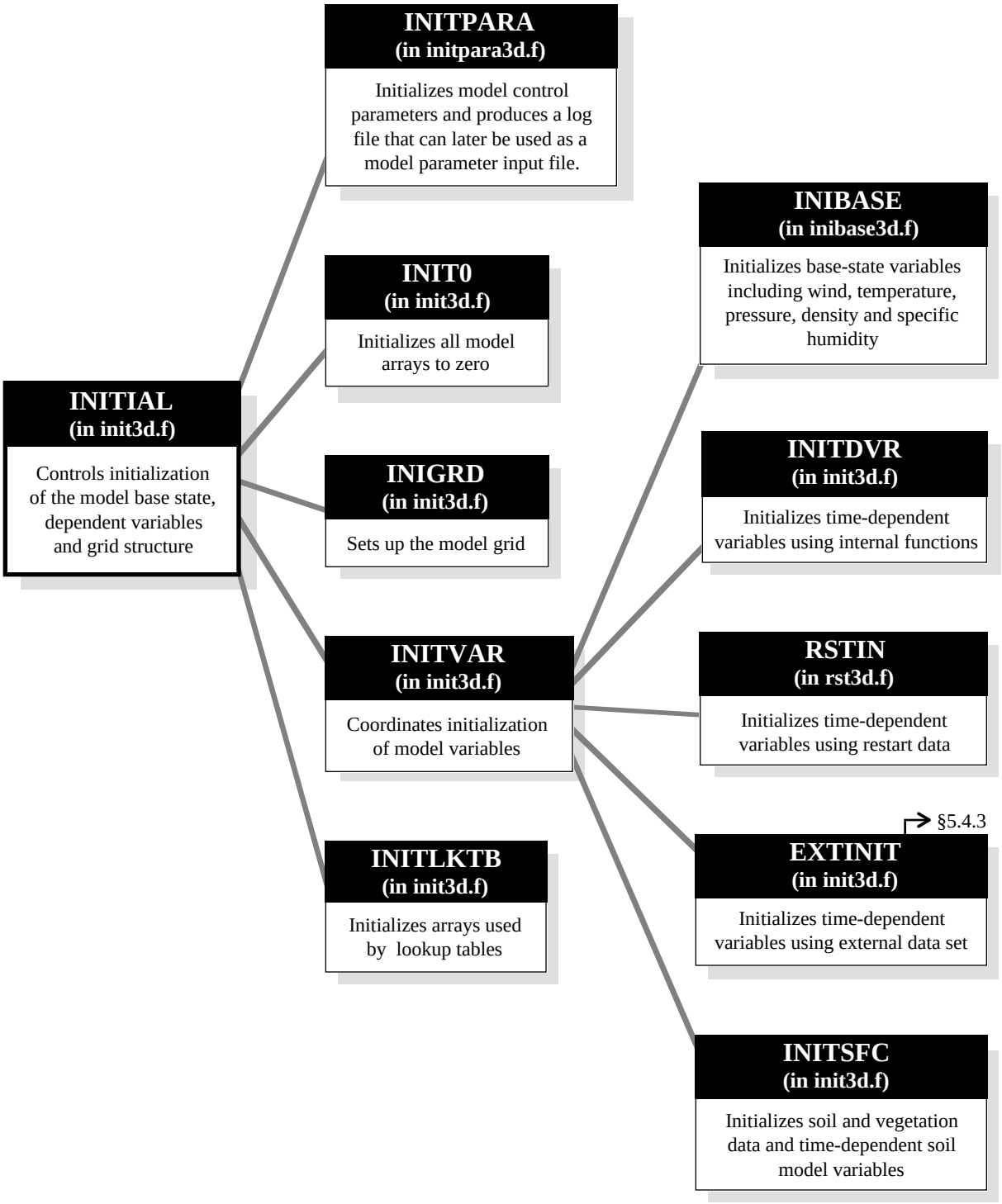
5.4. Model Structure Flow Charts

This section presents a number of flow charts describing the model code structure. Solid lines issuing from the right side of an upper level subroutine indicates that a lower level subroutine is being called. The order in which the subroutines are presented in the charts indicate in general the order of the subroutine calls in the code. Some of the boxes are expanded into subcharts, and the number of the subcharts are indicated inside the corresponding boxes. The subroutine names are in capital letters, and files that contain them are indicated by file.f.

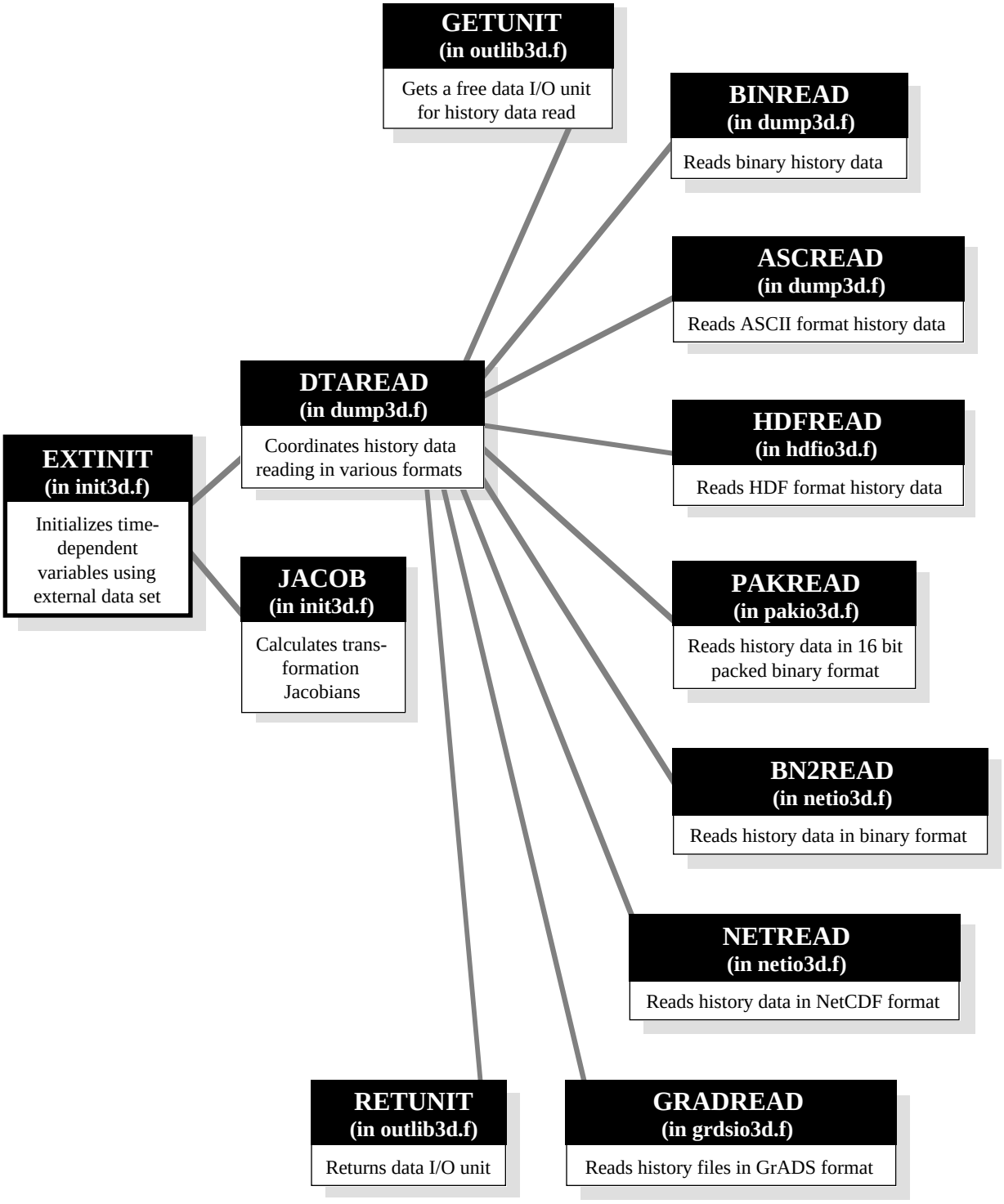
5.4.1. Basic Model Control



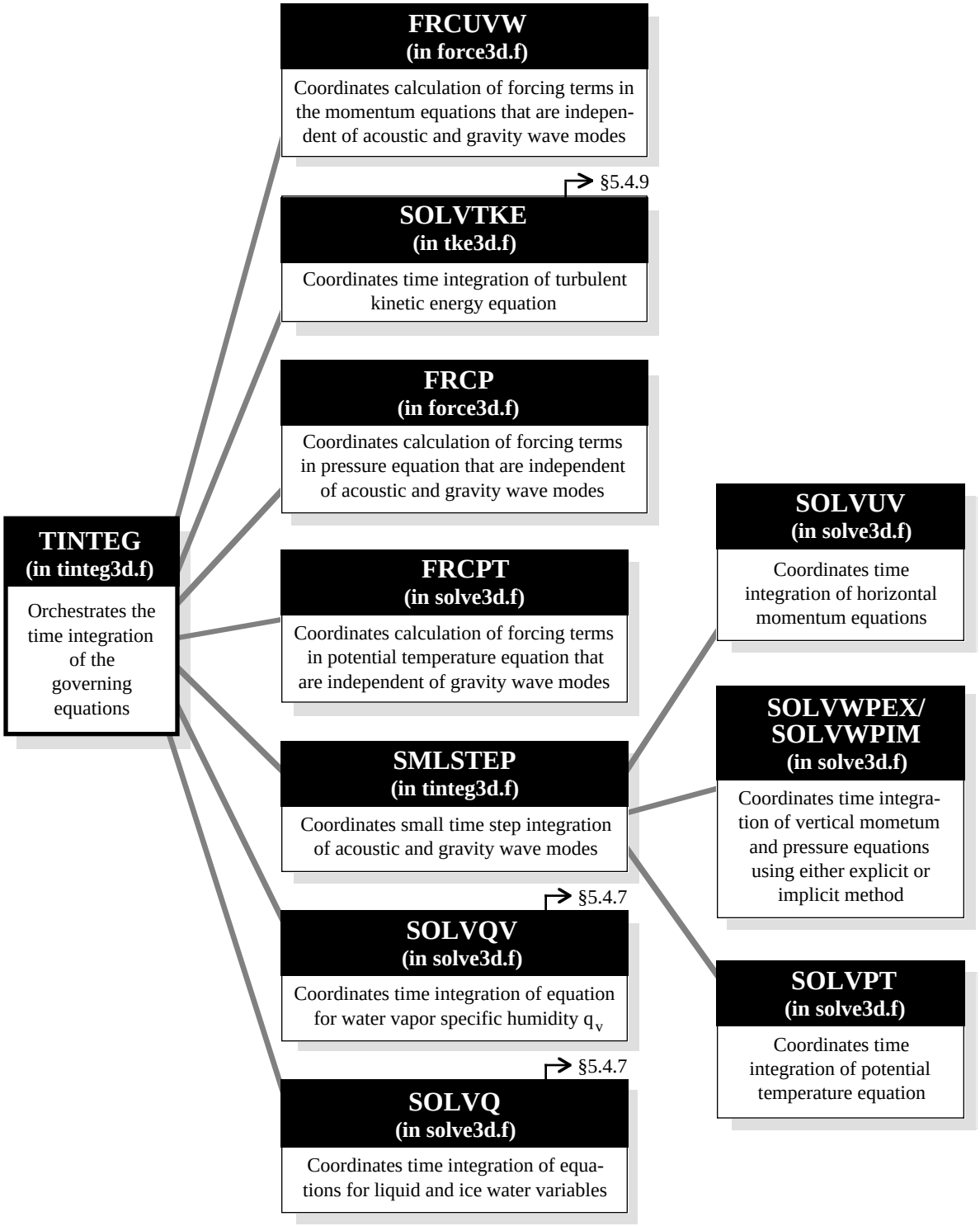
5.4.2. Model Initialization



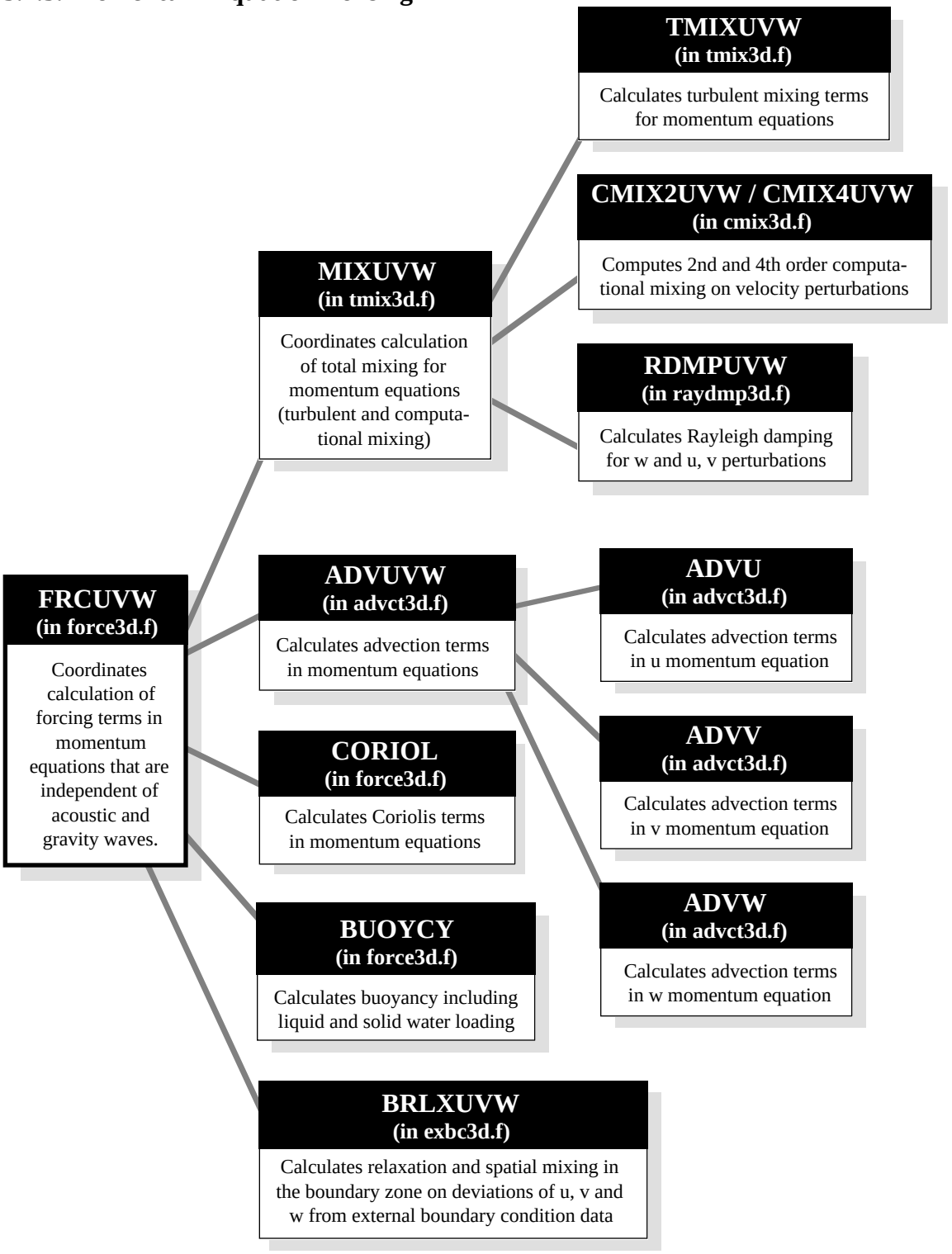
5.4.3. Initialization Using ARPS External Data Files



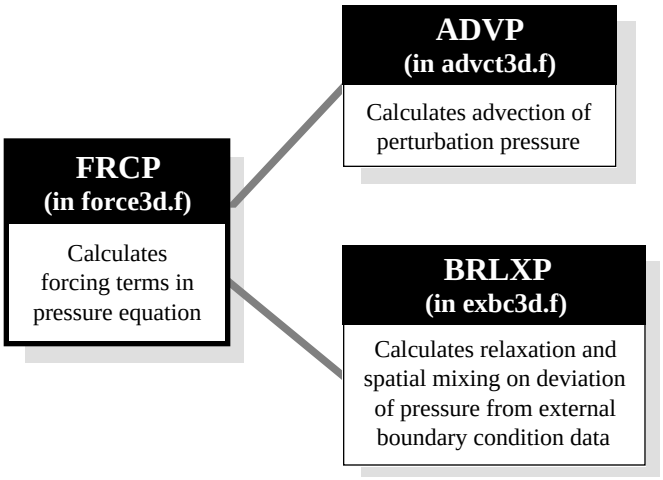
5.4.4. Integration of Dynamic Equations

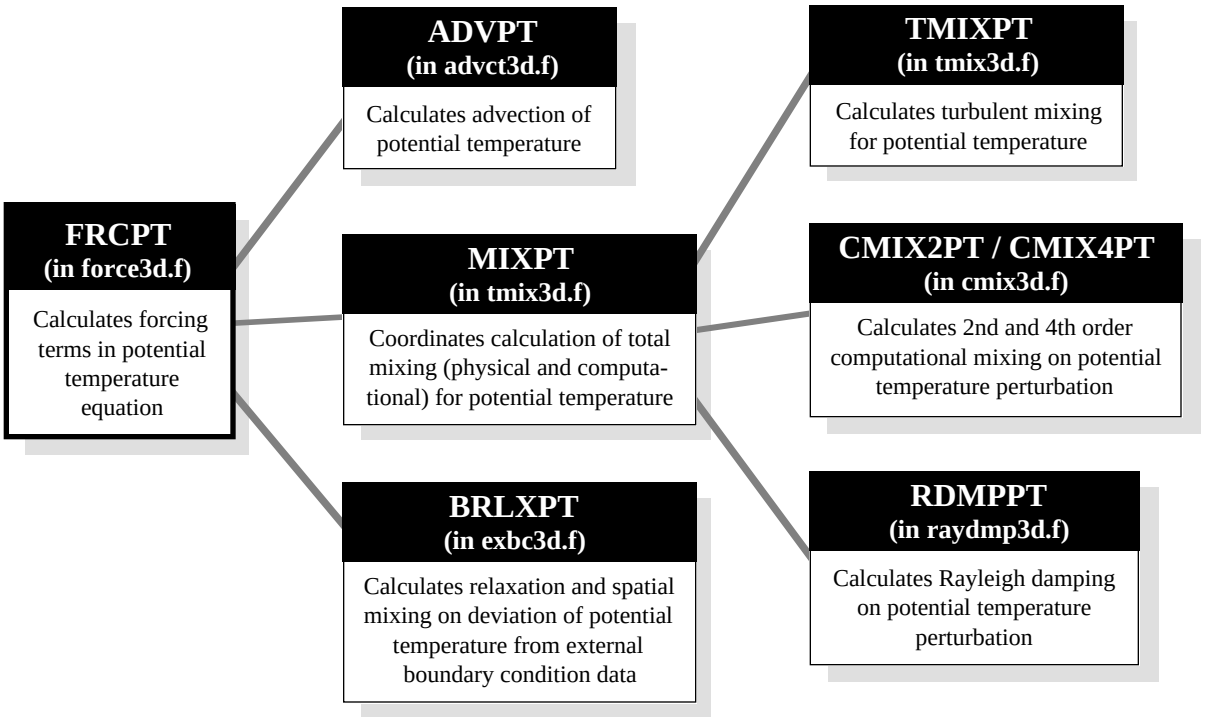


5.4.5. Momentum Equation Forcing

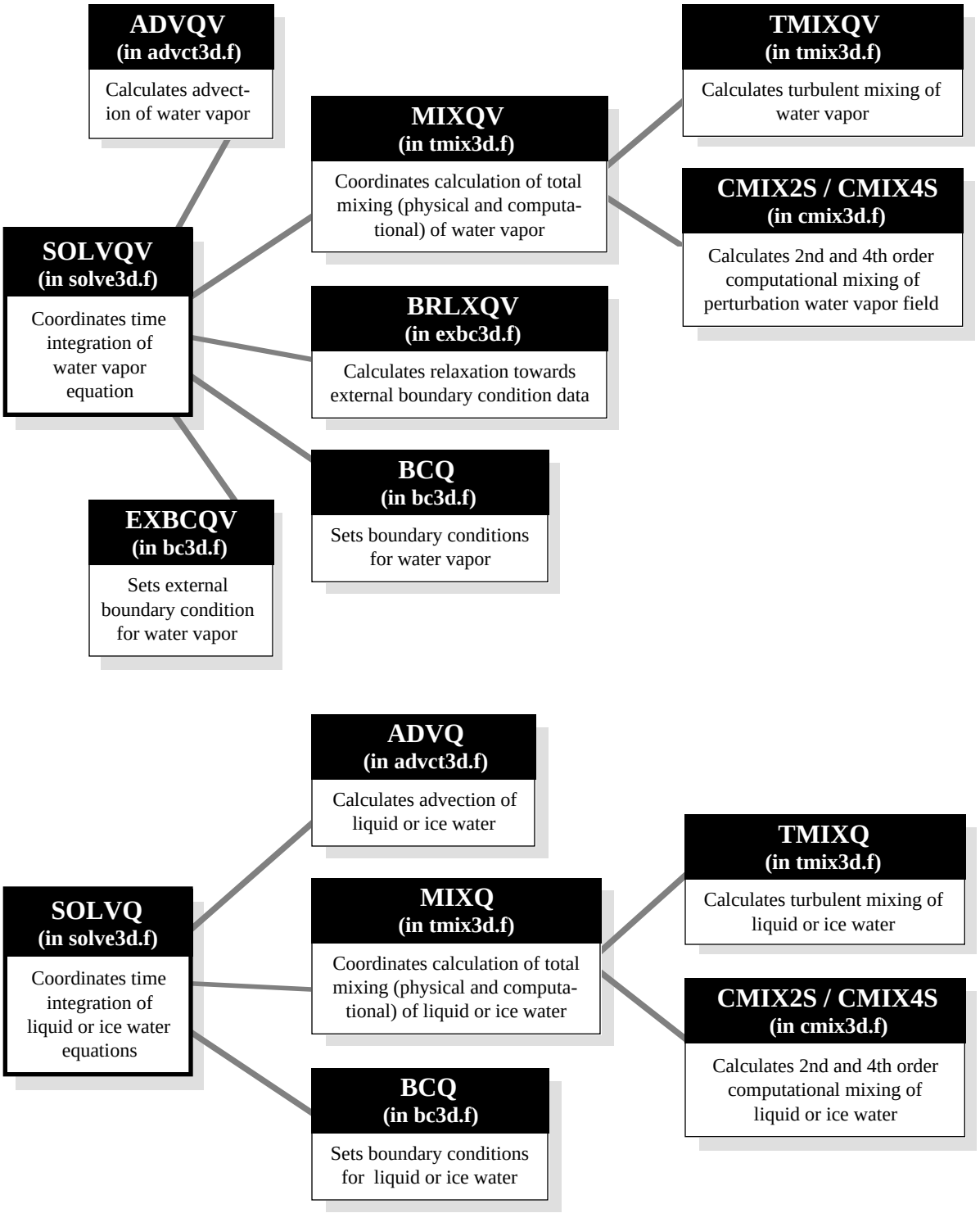


5.4.6. Forcing in Pressure and Potential Temperature Equations

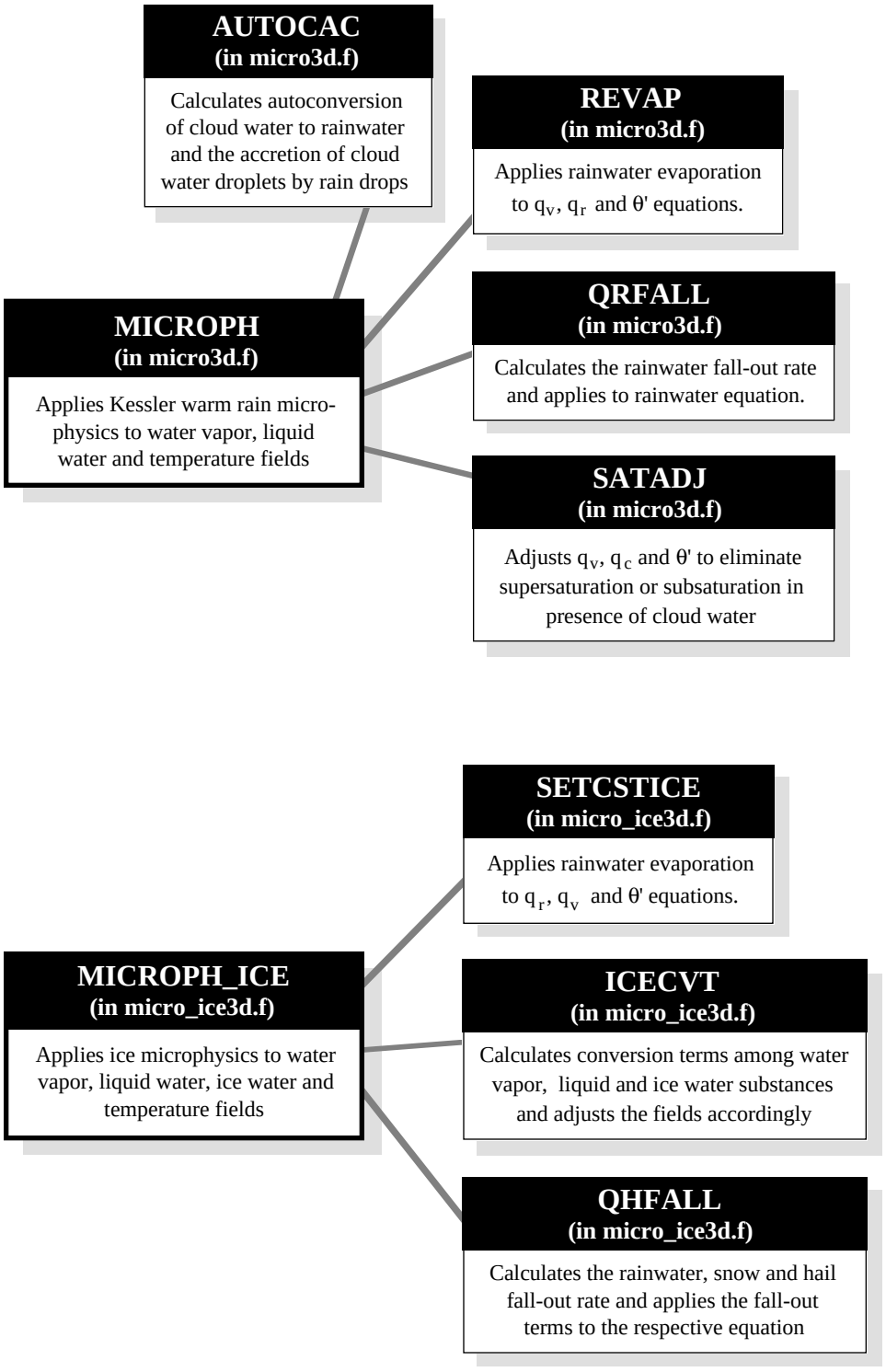




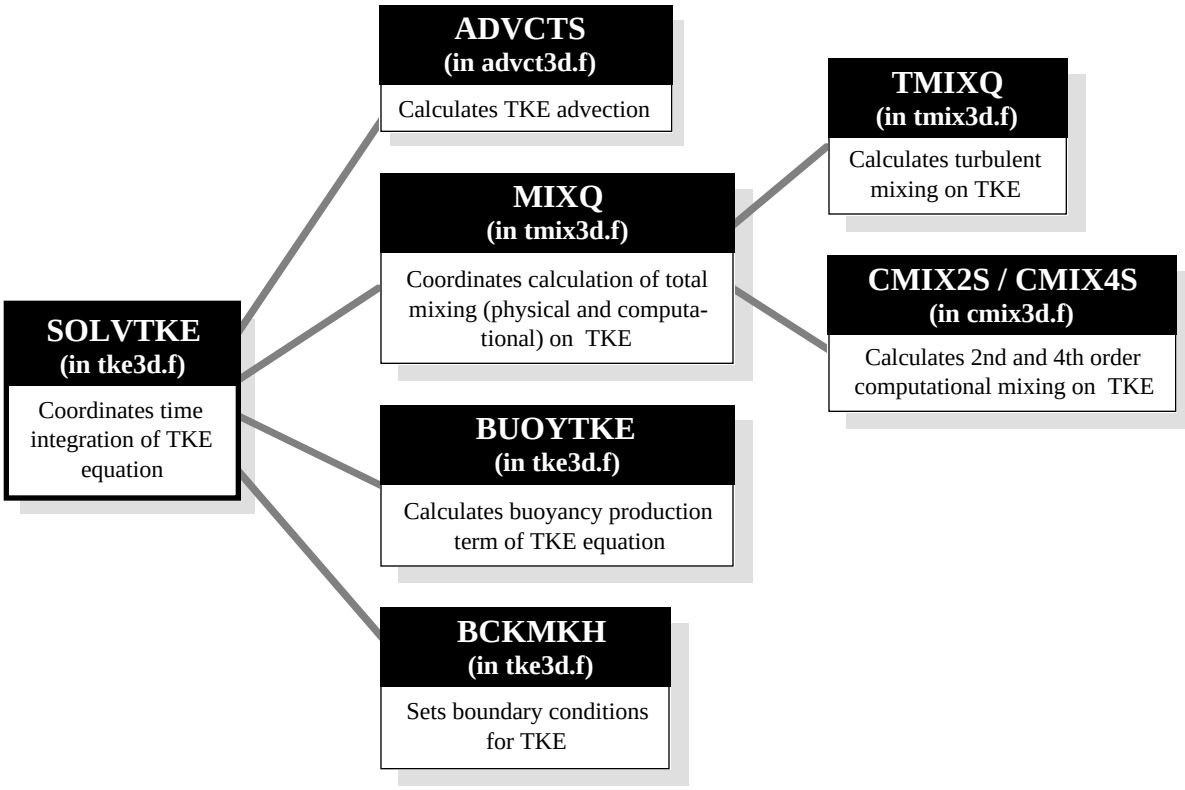
5.4.7. Water Vapor, Liquid and Ice Water Equations



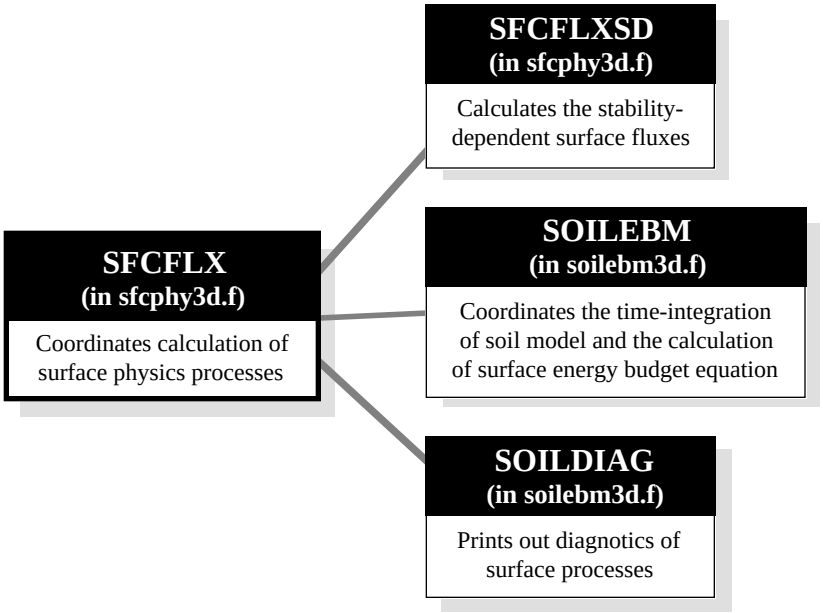
5.4.8. Microphysics



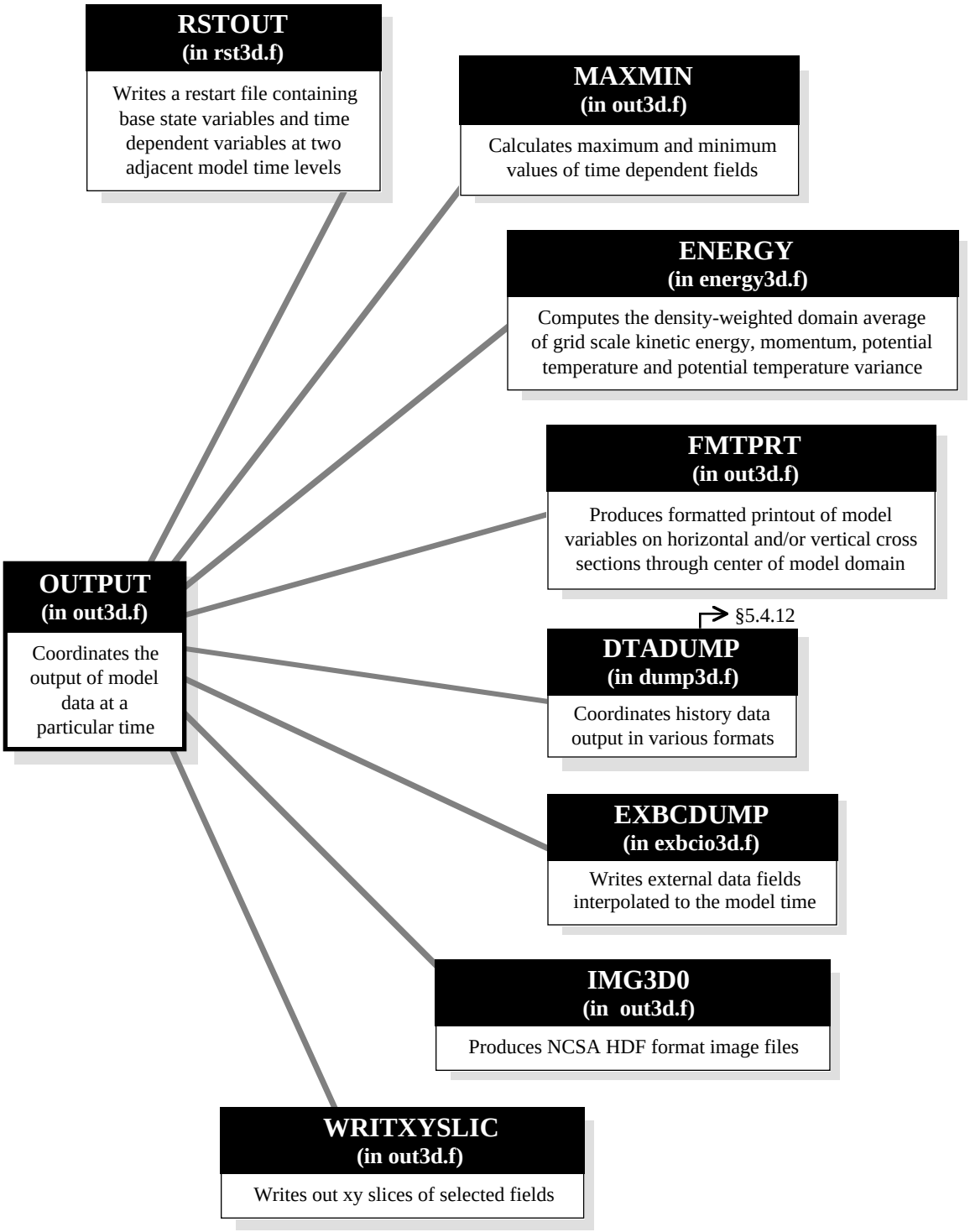
5.4.9. Turbulence Kinetic Energy Equation



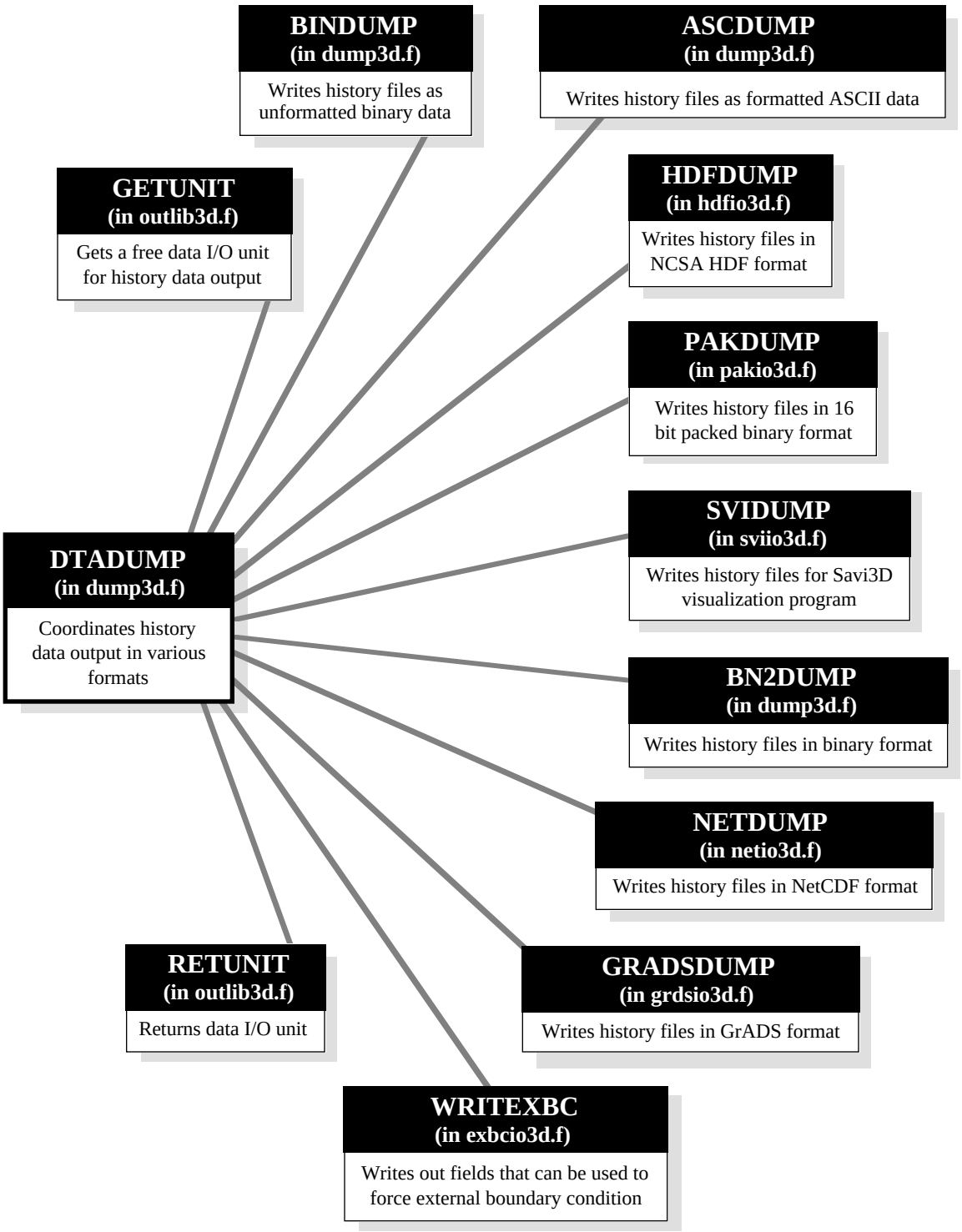
5.4.10. Surface Physics



5.4.11. Model Output

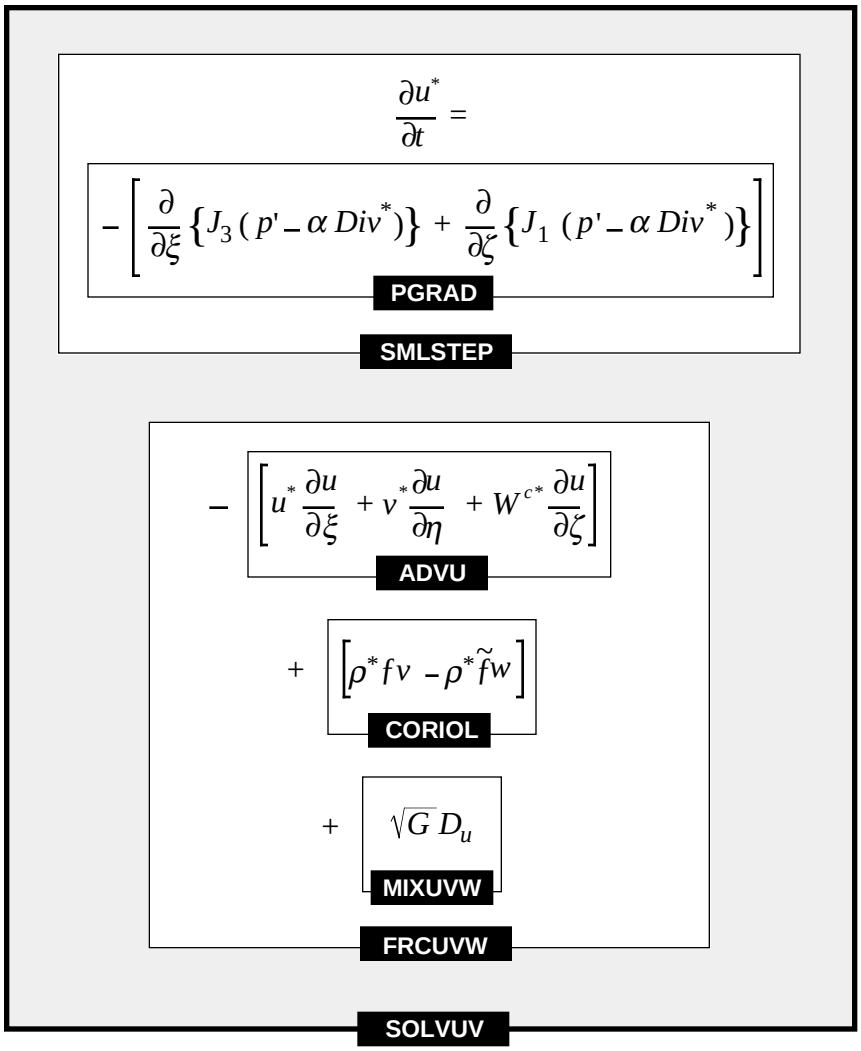


5.4.12. History Data Output

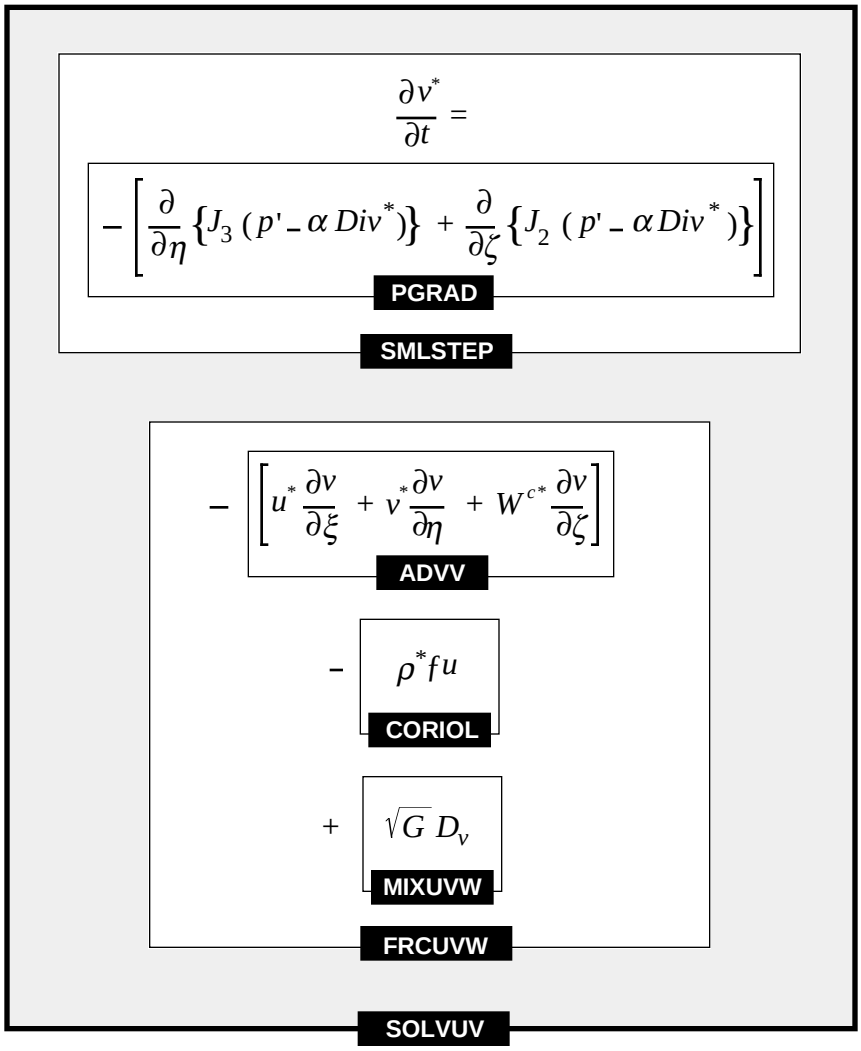


5.5. Equation Schematic Charts

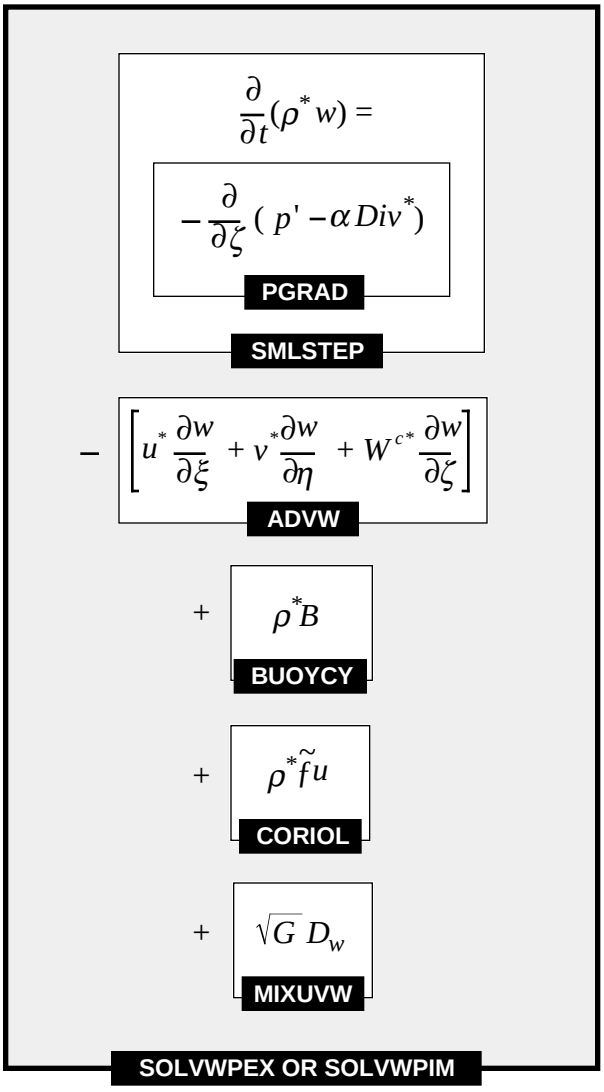
5.5.1. Momentum Equation in X Direction



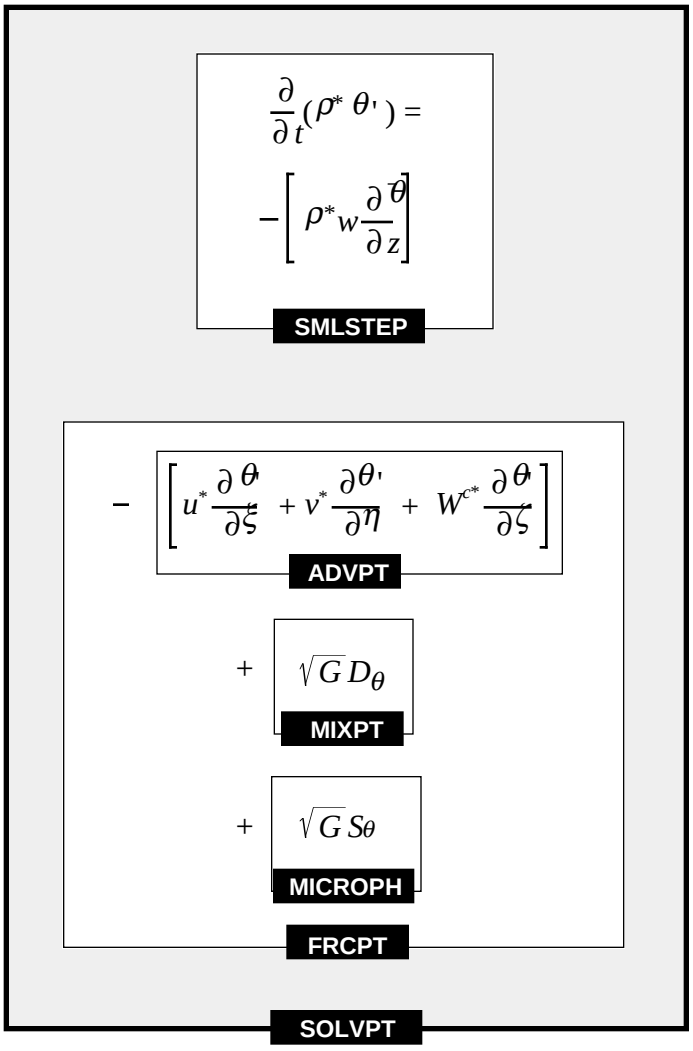
5.5.2. Momentum Equation in Y Direction



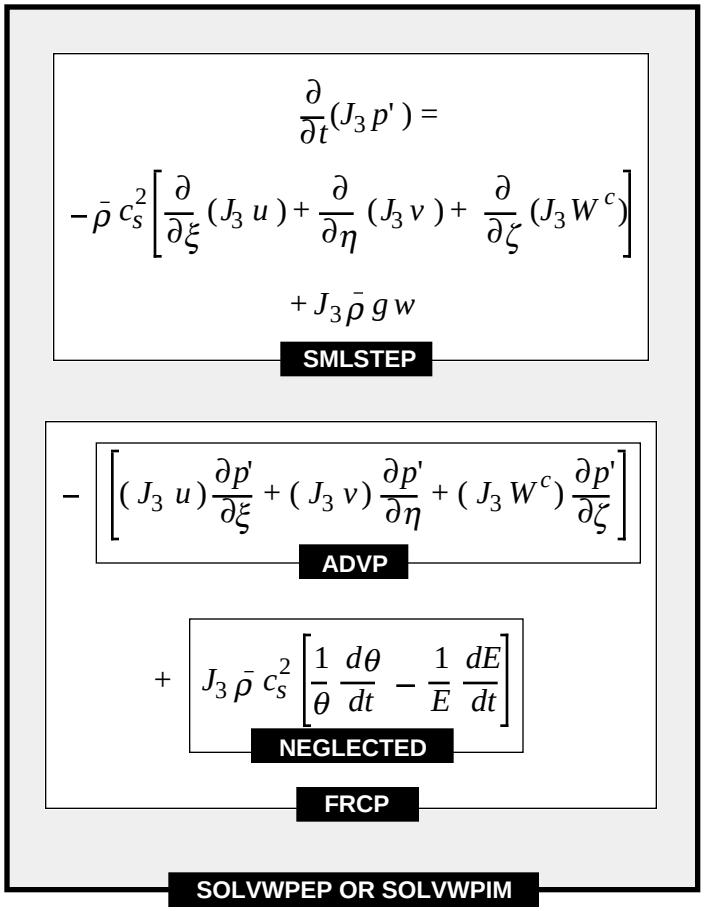
5.5.3. Vertical Momentum Equation



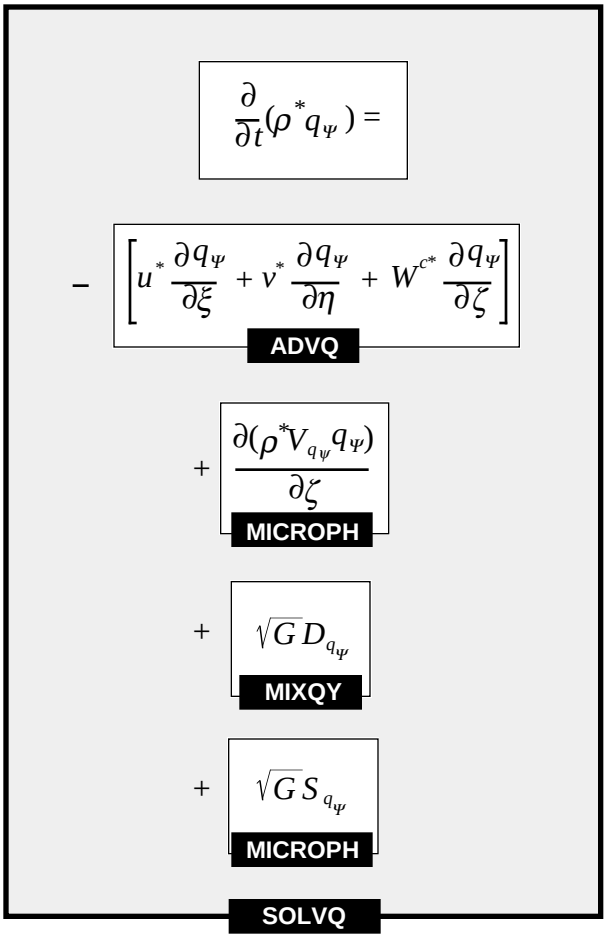
5.5.4. Potential Temperature Equation



5.5.5. Pressure Equation



5.5.6. Conservation Equation for Water Substances



5.5.7. Turbulent Kinetic Energy Equation