Microphysics in BLASIUS

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Previously, the switch LOVAPR had been defined in the *parms.h* file as follows:

LOVAPR: Moisture flag
= 0 Q not carried
= 1 Q passive
= 2 Q active

This has not changed; however, if LOVAPR=0, the original subroutine SOURCE is called from MODEL. Otherwise, subroutine NEWSOURCE is called. This is essentially the same as SOURCE, except that it includes the calculation of source terms for liquid water, rain water, ice, cloud, and graupel.

If LOVAPR$\neq$0, subroutine LATHEAT is called. This is based on the LEM subroutine LATHEAT, where the rate of liquid water production due to condensation is calculated. For a given temperature, pressure, and mixing ratios of vapour and liquid, a new liquid water mixing ratio (QLNEW) is calculated.

Similarly, the switch LOLQUD had previously been defined in the *parms.h* file as follows:

LOLQUD: Liquid water flag
= 0 not carried
= 1 CODE NOT WRITTEN YET

In this version, the switch LOLQUD controls the type of microphysics used, and is similar to the switch IRAINP in the LEM, in that values of 1, 2, and 3 select the warm-rain parameterizations of Kessler, Lee, and Swann respectively, all of which are contained in subroutine MPHYS (called from NEWSOURCE). For three-phase microphysics parameterizations, LOLQUD must be set to 4. This ensures that subroutine MICRO is called from MPHYS. If LOLQUD=0, subroutine MPHYS is not called. The new options for LOLQUD are:

LOLQUD: Liquid water flag
= 0 not carried
= 1 warm rain - Kessler
= 2 warm rain - Lee
= 3 warm rain - Swann
= 4 three-phase microphysics

Note that subroutine MPHYS is based on the LEM subroutine of the same name, while subroutine MICRO is based on the LEM subroutine MICROX. For descriptions of the approaches, see *Version 2.3*

of the Met Office Large Eddy Model: Part III Software Documentation, Section 6. However, in order to incorporate the different three-phase schemes (denoted by the variable NQP in the LEM and described in the LEM documentation) into BLASIUS, a new switch (LONQP) has been added to the *parms.h* file. The options are:

LONQP	Type of 3-phase scheme
0	none (LOLQUD≠4)
4	single-moment, no graupel
5	single-moment, graupel
6	single-moment, double-moment ice
7	double-moment, no graupel
8	double-moment
9	triple-moment 'hail'

The value of NSCLRP, the number of scalar fields carried, will also change. If three-phase microphyics are being used (*i.e.* LOLQUD=4), NSCLRP will depend on the value of LONQP. Values of NSCLRP for all possible combinations of scalar fields are given in Table 1.

The COMMON blocks

The following common blocks have been added to *comblks.h.*

TTEMP:

This carries the source term for temperature, and is only included if LOTEMP≠0.

ST(0:IIP+1,0:JJP+1,0:KKP+1): Temperature source term

UFZX:

This carries arrays required for the source terms in the warm-rain microphysics, and is only included if LOVAPR≠0.

SQV(0:IIQP+1,0:JJQP+1,0:KKQP+1): Vapour mixing ratio source term
SQL(0:IIQLP+1,0:JJQLP+1,0:KKQLP+1): Liquid mixing ratio source term
SQR(0:IIQRP+1,0:JJQRP+1,0:KKQRP+1): Rain mixing ratio source term
QSTN(0:IIQP+1,0:JJQP+1,0:KKQP+1): Saturated vapour mixing ratio

UFZX2:

This carries additional arrays required for the warm-rain microphysics, and is only included if LOLQUD≠0. For details, see *Version 2.3 of the Met Office Large Eddy Model: Part III Software Documentation, Section 6.*

NSCLRP	TKE	TRCR	TEMP	VAPR	LIQ	RAIN	LONQP					
							4	5	6	7	8	9
1	x											
		x										
			x									
2	x	x										
	x		x									
		x	x									
			x	x								
3	x	x	x									
	x		x	x								
		x	x	x								
			x	x	x							
4	x	x	x	x								
	x		x	x	x							
		x	x	x	x							
			x	x	x	x						
5	x	x	x	x	x							
		x	x	x	x	x						
	x		x	x	x	x						
6	x	x	x	x	x	x						
7			x	x	x	x	x					
			x	x	x	x		x				
8	x		x	x	x	x	x					
		x	x	x	x	x	x					
	x		x	x	x	x		x				
		x	x	x	x	x		x				
			x	x	x	x			x			
			x	x	x	x				x		
9	x		x	x	x	x			x			
		x	x	x	x	x				x		
	x	x	x	x	x	x	x					
	x	x	x	x	x	x		x				
10	x	x	x	x	x	x			x			
	x	x	x	x	x	x				x		
			x	x	x	x					x	
11	x		x	x	x	x					x	
		x	x	x	x	x					x	
			x	x	x	x						x
12	x	x	x	x	x	x					x	
	x		x	x	x	x						x
		x	x	x	x	x						x
13	x	x	x	x	x	x						x

Table 1: Values of NSCLRP for combinations of scalar fields carried.

QWSDEF(0:IIQP+1,0:JJQP+1,KKQP):	Water saturation deficit
QDOWNFLUX(0:IIQRP+1,0:JJQRP+1,KKQRP):	Rain flux
RAINSOURCE(0:IIQRP+1,0:JJQRP+1,KKQRP)	Source of rain from liquid water
RAINSINK(0:IIQRP+1,0:JJQRP+1,KKQRP)	Sink of rain to vapour
ABLTEMP(0:IITP+1,0:JJTP+1,KKTP)	
QTHRESH(0:IIQRP+1,0:JJQRP+1,KKQRP)	
PUDDLE(0:IIQRP+1,0:JJQRP+1,4)	

UFZX3:

This carries additional arrays required for the three-phase microphysics, and is only included if LOLQUD=4.

SQSNW(0:IIQSP+1,0:JJQSP+1,KKQSP):	Snow source term
SQICE(0:IIQIP+1,0:JJQIP+1,KKQIP):	Ice source term
SQGRP(0:IIQGP+1,0:JJQGP+1,KKQGP):	Graupel source term
SQNSNW(0:IIQNSP+1,0:JJQNSP+1,KKQNSP):	Snow number concentration source term
SQNICE(0:IIQNIP+1,0:JJQNIP+1,KKQNIP):	Ice number concentration source term
SQNGRP(0:IIQNGP+1,0:JJQNGP+1,KKQNGP):	Graupel number concentration source term
SQVGRP(0:IIQVGP+1,0:JJQVGP+1,KKQVGP):	Graupel volume source term

UFZX5:

This carries parameters required for the three-phase microphysics, and is only included if LOLQUD=4. For details, see *Version 2.3 of the Met Office Large Eddy Model: Part III Software Documentation, Section 6.*

RW:	Gas constant for water vapour
THCOND:	Thermal conductivity of air
DIFFWV:	Diffusivity of water vapour in air
VISAIR:	Kinematic viscosity of air
CWATER:	Specific heat capacity of liquid water
CICE:	Specific heat capacity of ice
RNA_R, RNB_R, ALPH_R:	Intercept and shape parameters for rain
RNA_S, RNB_S, ALPH_S:	Intercept and shape parameters for snow
RNA_G, RNB_G, ALPH_G:	Intercept and shape parameters for graupel
ALPH_I:	Intercept-shape parameters for ice
C_S, D_S:	Mass-diameter relationships for snow
C_R, D_R:	Mass-diameter relationships for rain
C_G, D_G:	Mass-diameter relationships for graupel
C_I, D_I:	Mass-diameter relationships for ice
A_R, B_R, F_R:	Fallspeed-diameter relationships for rain
A_S, B_S, F_S:	Fallspeed-diameter relationships for snow
A_I, B_I, F_I:	Fallspeed-diameter relationships for ice
A_G, B_G, F_G, G_G:	Fallspeed-diameter relationships for graupel
RMI0:	Mass of pristine ice crystal
RNA0:	Constant in aerosol concentration equation
DIMAX:	Maximum mean diameter of ice crystals before conversion to snow
DI2S:	Diameter of ice crystals that convert to snow
DRMELT:	Mean diamter of rain from melt
EGS_WET,EGI_WET:	Collection efficiencies
ERW,ERG,ERS,ERI,ESW,EGW,EIW:	Collection efficiencies
EGS1_DRY,EGI1_DRY,ESI1,EII1:	Collection efficiencies
EGS2_DRY,EGI2_DRY,ESI2,EII2:	Collection efficiencies
ESS1,ESS2:	Collection efficiencies
RNC:	Liquid cloud droplet concentration
RLC:	Temporary variable

MICROST:

This carries arrays required for the three-phase microphysics, and is only included if LOLQUD=4.

PHYS1D(0:KKQRP,78):	Coefficients
PHYSCAL(11):	Exchange coefficients

Other files required

Revised versions of the following files are needed:

comblks.h
chgprms.h
setup.F
model.F
diags.F

and the following new files:

newsource.F
latheat.F
mphys.F
micro.F