ACCDEV Documentation

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1 Purpose

The routine ACCDEV is responsible for the computation of stratiform condensation fluxes. This can be done with the ACPLUIE_PROG formula (LXRCDEV=.TRUE.) or the Smith-Gerard-scheme (LSMGCDEV=.TRUE.). For LSTRAPO=.TRUE. external routine APLMPHYS is called for the calculation of precipitation fluxes and connected pseudo-fluxes. In this case ACCDEV is also returning these fluxes.

2 Condensation, Evaporation computation

After initializing the (pseudo-)fluxes of liquid condensation minus evaporation P_{lc} (ZFCSQL) and solid condensation minus sublimation P_{sc} (ZFCSQN) by setting them to zero in the highest level, latent heat for sublimation L_s and vaporization L_v (ZLHS, ZLHV) are calculated by using temperature dependent function FOLH. In the following, two options can be chosen to accomplish retrieval of condensation fluxes:

2.1 SWITCH LXRCDEV=.TRUE.

P_{lc} (ZFCSQL), representing the flux of condensation minus evaporation and P_{sc} ZFCSQN, being the equivalent flux for solid condensation, are given by

$$P_{lc[jlev]} = P_{lc[jlev-1]} + \frac{\Delta p}{g\Delta t}\mathsf{ZCONL} \tag{1}$$

and

$$P_{sc[jlev]} = P_{sc[jlev-1]} + \frac{\Delta p}{g\Delta t}\mathsf{ZCONI}, \tag{2}$$

where calculation of liquid (ZCONL) and solid part of (ZCONI) of actual condensation is described in the following. An adjustment of water vapour specific humidity q_v^* (ZQVN) is formulated as

$$q_v^* = q_w \left(RH_c(1-n)+n\right). \tag{3}$$

It is obtained from the saturation hypothesis for the cloudy part (q_v^* becomes equal to q_w for cloud cover n=1, PNEBCOND) and from critical relative humidity RH_c in clear-sky part (q_v^* becomes equal to RH_c for $n = 0$). In the case of condensation taking place (now represented through $q_t > q_v^*$), the actual condensation ZCONL and its solid counterpart ZCONI is diagnosed through

$$\begin{aligned} \mathsf{ZCONL} &= (1-\alpha_i)\mathsf{ZDQVN}, && (4)\\ \mathsf{ZCONI} &= \alpha_i\mathsf{ZDQVN}, && (5)\\ & && (6) \end{aligned}$$

with ZDQVN ($= q_v - q_v^*$) being the change of q_v adjusted by (3) and α_i (PRMF) the proportion of ice retrieved via function FONICE. In the case of evaporation/sublimation ($q_t \leq q_v^*$), decrease of condensate is given through the existing proportions of solid and liquid condensate q_l (PQL) and q_i (PQI)

$$\begin{aligned} \mathsf{ZCONL} &= -q_l && (7)\\ \mathsf{ZCONI} &= -q_i && (8) \end{aligned}$$

In the case of calling the microphysics routine APLMPHYS outside 3MT environment (LSTRAPRO = .TRUE.,L3MT=.FALSE.), values of q_l, q_i and q_v are corrected according to the actual condensation/ evaporation rates ZCONL and ZCONI.

2.2 SWITCH LSMGCDEV=.TRUE.

In this case the condensation fluxes P_{lc} and P_{sc} (ZFCSQL and ZFCSQN) in the actual layer are written as

$$P_{lc[jlev]} = P_{lc[jlev-1]} + \frac{\Delta p}{g\Delta t}\mathsf{ZDQL} \tag{9}$$

and

$$P_{sc[jlev]} = P_{sc[jlev-1]} + \frac{\Delta p}{g\Delta t}\mathsf{ZDQI}, \tag{10}$$

with ZDQL and ZDQI representing actual condensation and evaporation/sublimation rates respectively. These rates are retrieved through following algorithm:
In the first step condensation amount q_c (ZQC) is retrieved through a Smith-typed formula

$$q_c = 6\left(\frac{RH-1}{1-RH_C}\right) + \left(1 - \frac{RH-1}{1-RH_c}\right)^3 \quad \text{for} \quad RH \geq 1 \tag{11}$$

and

$$q_c = \left(1 + \frac{RH-1}{1-RH_c}\right)^3 \frac{1}{\sqrt{6}} \quad \text{for} \quad RH < 1, \tag{12}$$

with total specific humidity q_t (ZQTOT), critical relative humidity RH_c (ZRHC) and a kind of adjusted value for relative humidity

$$RH = \mathsf{max}\left(\mathsf{min}\left(2 - RH_c, \frac{q_t}{q_{sat}}\right)\right) \tag{13}$$

which is used in order to synthesize the various cases used in Smith's scheme by adopting big and small values for $\frac{q_t}{q_{sat}}$ (ZRATQ) to the next thresholds. A provisional condensation amount q_c is finally written as

$$q_c = q_c\sigma_s \tag{14}$$

with σ_s (ZSIGS) representing according to Smith the standard deviation of the assumed triangular distribution for describing q_c. σ_s is scaled by the saturation deficit and several other variables like liquid-frozen temperature T_l (ZTLIQ). The repartition of liquid and solid condensate is again done through function FONICE, yielding the provisional condensation amounts q_l^* (ZQL) and q_i^* (ZQI)

$$q_l^* = (1-\alpha_i)q_c \quad \text{and} \quad q_i^* = q_c - q_l^*, \tag{15}$$

with α_i (ZICE) representing the ice fraction. After the retrieval of the provisional condensation amount, some safety and limiting aspects are considered. First of all, condensation amount q_c is limited by a maximum temperature change allowed through the condensation/evaporation process, which is represented by namelist parameter RSMDTX. Second, activating namelist switch LSMNIMBT allows to forbid melting of existing ice condensate q_i (PQI) for temperatures T (PT) below treble point temperature T_t (RTT)

$$q_i^* = q_i{*}\mathsf{min}\left(1, \frac{q_c}{q_i + q_l}\right) \quad \text{for} \quad T < T_t \quad \text{and} \quad q_i^* \leq q_i. \tag{16}$$

Referring back to the final formulation of condensation fluxes for the actual layer (10 and 11), ZDQL and ZDQI can be written as

$$\mathsf{ZDQL} = q_l^* - q_l \quad \text{and} \quad \mathsf{ZDQI} = q_i^* - q_i, \tag{17}$$

with q_l and q_i representing the already existing amount of solid and liquid condensed species (PQL and PQI). In case of calling the microphysics routine APLMPHYS outside 3MT-environment (L3MT=.F.), values of q_l, q_i and q_v are corrected according to actual condensation/ evaporation rates ZDQL and ZDQI.

Table 1: Subroutine **ACCDEV**

Purpose:	COMPUTATION OF STRATIFORM CONDENSATION AND/OR PRECIPITATION FLUXES (WATER AND SNOW); COMPUTATION OF PSEUDO-FLUXES LINKED TO STRATIF. PRECIPITATION (WATER AND SNOW)
Called by:	APLPAR

Incoming arguments/fields:

0D		
	KIDIA	START OF HORIZONTAL LOOP
	KFDIA	END OF HORIZONTAL LOOP
	KLON	HORIZONTAL DIMENSION (NPROMA)
	KTDIA	START OF VERTICAL LOOP IN PHYSICS
	KLEV	END OF VERTICAL LOOP AND VERTICAL DIMENSION
2D		
	PAPRS	PRESSURE ON HALF LEVELS
2D		
	PAPRSF	PRESSURE ON FULL LEVELS
	PCP	SPECIFIC HEAT AT CONSTANT AIR-PRESSURE
	PDELP	LAYER THICKNESS IN PRESSURE UNITS
	PQ	SPECIFIC HUMIDITY OF WATER VAPOUR
	PQW	SPECIFIC HUMIDITY OF THE WET THERMOMETER
	PT	TEMPERATURE
	PQI	RATIO OF SUSPENDED ICE
	PQL	RATIO OF LIQUID WATER
	PR	AIR GAS CONSTANT
	PNEBCOND	STRATIFORM CLOUDINESS
	PHCRICS	CRITICAL RELATIVE HUMIDITY
	PQSATS	SATURATION SPECIFIC HUMIDITY
	PRMF	RESOLVED CONDENSATE ICE FRACTION
	PQN	RATIO OF SNOW
	PQR	RATIO OF RAIN WATER

Outgoing arguments/fields:

2D		
	PFPLSL	STRATIFORM PRECIPITATION AS RAIN
	PFPLSN	STRATIFORM PRECIPITATION AS SNOW
	PFASL	STRATIFORM AUTO CONVERSION (LIQUID)
	PFASN	STRATIFORM AUTO-CONVERSION (SOLID)
	PFCSQL	STRATIFORM CONDENSATION (LIQUID)
	PFCSQN	STRATIFORM CONDENSATION (SOLID)
	PFESL	STRATIFORM EVAPORATION OF RAIN
	PFESN	STRATIFORM EVAPORATION OF SNOW

Used Modules:

YOMPHY, YOMCST, YOMPHY0, YOMPHY2

References

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