# ALARO-0 baseline

*December 2012*

Before introducing new important development blocks of ALARO-1 (TOUCANS, new radiation code and new "incremental" convection), we conclude the ALARO-0 version. In this document we shortly describe the last developments still in ALARO-0 over the past year 2012.

## Thermodynamic adjustment

In ALARO-0 we recommend to use the Xu-Randall (*LXRCDEV*) type of thermodynamic adjustment, although there are other options available (Smith-Gerard: *LSMGCDEV*, Rash-Kristjansson: *LRKCDEV*, and since CY38T1 also pure Smith scheme: *LSMITH_CDEV*).

For the Xu-Randall case we modified dependency of the relative critical humidity on the horizontal model resolution; it approaches its maximum value (1.) more slowly with decreasing *dx*. This change was made necessary by the tested behavior in ARPEGE and the tuning led to a smaller evolution at high resolutions.

The combined length scale for liquid and ice is computed as follows:

$$L = \frac{1}{\frac{FONICE(T)}{SCLESPS^{RHCEXPDX}} + \frac{1 - FONICE(T)}{SCLESPR^{RHCEXPDX}}}$$

Where *FONICE* is ice fraction computed as function of temperature. Other parameters are in namelist *NAMPHY0* and their tuning is now:

*SCLESPR= 248000.,*

*SCLESPS=15500.,*

*RHCEXPDX=0.3*

Critical relative humidity *RHCRIT* is computed as the combination of its vertical profile given by *PHUC* (computed in APLPAR and not modified recently) and horizontal mesh size factor:

$$RHCRIT = (HUCRED\ PHUC + 1 - HUCRED)\ \frac{(\Delta x_s)^{RHCEXPDX}}{(\Delta x_s)^{RHCEXPDX} + L}$$

Where tuning parameter *HUCRED=1.*, and $\Delta x_s$ is true mesh distance (the map one divided by map factor).

In the condensation scheme, distribution between liquid and solid cloud water portions is done to end up at *FONICE(T)* equilibrium (before *FONICE(T)* was used to partition condensate increments only, but with the possibility of cloud water sedimentation it was not possible to stay with the incremental approach).

## Cloudiness and Thermodynamic adjustment

For both radiative cloudiness and thermodynamic adjustment we made retuning of *QXRAL*:

*QXRAL=130.*

For completeness, we have to say that the parameter *QXRTGH* depends on vertical resolution and it has to be tuned. In the version with 87 levels, its value is 1.6, while in the version of 43 levels it was 3.5.

For just diagnostic cloudiness (without impact on other model results) we keep the weighted maximum-random overlap:

*LACPANMX=.TRUE.,*

*WMXOV=0.8*

## Microphysics

In microphysics, we added the sedimentation of cloud water and ice. Cloud droplets and crystals sediment with relatively small speeds of 0.02 m/s (droplets) and 0.08 m/s (crystals); in the cycle CY36T1 this option and constants are coded inside APLMPHYS (*LLSED*, *ZFVL* and *ZFVI*) while in the cycle CY38T1 they are available in the namelist (*LSEDCL*, *TFVL* and *TFVI*).

Sedimentation of graupel is now solved independently from rain; this has an impact when variable speed (and statistical sedimentation) is used, since the fall speed depends in this case on the amount of falling element.

Auto-conversion rate was returned to half its previous value:

*RAUTEFR=1.E-03*,

*RAUTEFS=1.E-03*,

and Wegener-Bergeron-Findeisen (WBF) effect was reinforced by setting:

*RWBF1=1600.,*

Otherwise we could get rain at quite negative temperatures especially in the mountains. This was due to auto-conversion of super-cooled droplets into rain rather than into snow, and with no time to freeze when falling. More intense WBF process helped to cure this problem.

A vertical integral of graupel *PGRVINT* is calculated as new diagnostics, which may indicate presence of hail; this is in the code ready at the level of APLPAR, but the post-processing is not yet finished.

## Moist Deep Convection

There are a couple of modifications and tunings to improve diurnal cycle of convection and/or to correct some weaknesses.

### Entrainment

Entrainment profile is parameterized also as a function of the vertically integrated buoyancy – buoyant clouds entrain less. We introduced further modulation of entrainment by the vertically integrated relative humidity of the environment (this vertical integral is buoyancy weighted and thus is at the same vertical depth like the cloud). Higher relative humidity of the environment means less difference of moisture between cloud and environment and therefore less effective entrainment.

This effect is activated by setting GENVSRH higher than 0., recommended value is:

*GENVSRH=1.*

Because relative humidity of environment is about two thirds, it is necessary to increase the entrainment coefficient GCVALFA in the inverse proportion to:

*GCVALFA=4.5E-05,*

instead of 3.E-05.

## Adaptive detrainment – option LENTCH

The parameter *GCVNU*, driving adaptive detrainment and thus indirectly depth of convective cloud, is made dependent on past precipitation activity, via vertically integrated total evaporation rates. In this way the convective activity could be maintained a bit longer (a kind of parameterization of the cold-pool effect). This option is activated by the switch *LENTCH* (which was meant first for "historic convective entrainment"), with tuning constant *GPEFDC*:

*LENTCH=.TRUE.,*

*GPEFDC=0.18,*

Because we have to transfer the evaporation rate to the next time-step, the associated GFL array *YUEN* has to be activated:

*YUEN_NL%LGP=.T.,*

*YUEN_NL%LADVF=.F.,*

*YUEN_NL%LREQOUT=.F., (in production, when cycled it is .T. in relevant namelists, like guess computation and canari)*

*YUEN_NL%NREQIN=1 (when cycled, otherwise 0)*

## Closure

In 3MT, like previously in the case of the old convective scheme, closure is based on convergence of moisture. However, in 3MT, we may modulate it, where part of converging moisture is consumed in condensation, and part is enhancing a reservoir of moist static energy. This modulation means in a way a mixed type of closure (between moisture convergence for intense convection and CAPE for weak convection). The switch activating this option is LCVGQM with tuning coefficient RMULACVG (lower RMULACVG means less immediate consumption in condensation):

*LCVGQM=.TRUE.,*

*RMULACVG=15.,*

## Convective condensation and cloudiness

There is a correction in the condensation, preventing the presence of condensates below the cloud base. This limits creation of negative condensate values in subsequent transport.

Convective cloudiness entering microphysics is not anymore the instantaneous one (local switch LLNEBINS is set to .FALSE. in ACCVUD and ACUPU), but the one which has time relaxation GCVTAUDE set to:

*GCVTAUDE=900.,*

This choice yields smoother response of microphysics, which depend on the cloud fraction.

## Downdraft

Since sub-grid scale evaporation in downdrafts happens after main microphysical computations (where sedimentation and phase changes of precipitation are handled together) it is necessary to make a supplementary correction of fluxes including both effects (sedimentation and downdraft evaporation). This computation was corrected from a bug, most influential in the tropics and not too much in mid-latitudes.

There are new recommended tunings for downdraft efficiency, entrainment and friction:

*GDDEVF=0.12,*

*TENTRD=1.6E-04,*

*TDDFR=0.0012*

## Miscellaneous

In ACCVUD the discretization to compute mass-flux was corrected from a bug without much impact (suppression of an unjustified implicit scaling of the convective condensation/evaporation rates, while they are divergences of quantities already correctly treated implicitly). In APLPAR, setting of GFL arrays *YUNEBH* (convective detrained fraction) and *YUEN* (now used for evaporation rate, see under “adaptive detrainment”) to zero at the beginning of the integration was removed. GFL arrays should be initialized either from the file or by their namelist attributes (*NREQIN*, *REFVALI*). To have less spin-up, it is recommended to cycle both *YUNEBH* and *YUEN* within the assimilation.