Documentation on the modification set ALARO-0-1 based on CY32T1 export

This modification set contains mostly fixes of bugs, technical and or conceptual, small cleanings and improvements. The list of modified routines follows:

Arp/canari:

cacsts.F90
There is a bugfix for pointers of 2-d prognostic fields for CANARI, where CLSTEMPERATURE and CLSHUMI.RELATIVE were used instead of CLSVENT.ZONAL and CLSVENT.MERIDIEN for calculation of coefficient ZV10M.

can1.F90, **caprsurf.F90**
Introduction of prints helping to check surface fields involved in CANARI.

casgra.F90
Introduction of the NEC directive NOVECTOR before one loop to have a safe code, but it may not be necessary in the end.

Arp/phys_dmn:

accvud.F90, **acupm.F90**, **acupu.F90**, **acupd.F90**, **acmodo.F90**
There is a cleaning and correction of small errors of the 3MT scheme.

aplmphys.F90, **acevmel.F90**, **accdev.F90**

Correction for the partial cloud geometry categories (aplmphys) and modification of the sublimation of snow as well as some simplifications in the computation of evaporation plus melting/freezing (acevmel) were introduced to eliminate the conceptual bugs. More details can be found in a dedicated piece of documentation. In addition, a test to melt suspended ice when brought to positive Celcius environment temperature by advection within previous time-step, completed the accdev routine.

acraneb.F90
Dependency on temperature gradient between the surface and the lowest model level to compute the exchange term of the lowest model level with the surface was introduced.

accoefk.F90
For the option with interactive computation of mixing length (either ARPEGE or ALARO versions), the vertical profiles of USURIC and USURID still followed the old definition of the mixing length. This weakness was corrected.

achmt.F90
Computation of gz0h term is put to the CY29T2 version of ALARO-0. It could not have been phased yet in the main cycle due to missing TL/AD coding of this term definition.
The moist gustiness (LRRGUST) block was moved after the anti-fibrillation treatment (a small bug already corrected in the past in ACCOEFK but left-behind in ACHMT).

aplpar.F90
Modified calls to 3MT routines and accoefk.

hl_aplpar.F90
Modified call to accoefk.

Arp/namelist:

namphy0.h
Introduction of namelist options for microphysics: it was forgotten in the phasing exercise to move these options from the temporary "namcloud0.h" file to namphy0.h file.

Arp/pp_obs:

mpobseq.F90
Initialization of YGOMEC(:)%ECEMIS necessary for LAM was added.

Arp/setup:

su_surf_flds.F90
Bugfix for pointer of number of extra 2D prognostic fields was made.

sugridf.F90
Introduction of prints helping to check surface fields involved in CANARI.

Arp/utility

wrgp2fa.F90
Treatment of the extension zone values of the grid-point fields to avoid unphysical extremes.

Scientific documentation of the two conceptual bugs present in the microphysics of the original version of ALARO-0-minus-3MT

There were two conceptual bugs in the original microphysics set-up of ALARO-0, which were somehow compensating each other in their overall effects (but not in some of their more specific manifestations, see below). One will not investigate here whether this global compensation is fortuitous or not.

The first (and more serious) bug had to do with the geometrical handling of partial cloudiness. In Appendix 9 of the .doc documentation of APLMPHYS, it was for instance written: "***Each layer is divided in four parts. The three we are interested in are the top-seeded part of the cloud, the non-top-seeded part of the cloud and the precipitation covered part of the clear air fraction.***". Fatal error indeed, the fourth part (the clear air one not seeded by precipitations issued from a cloud above) being also of some interest as we shall see now. When doing prognostic microphysics with the PDF-based sedimentation scheme, the P1-generated part of

the precipitation corresponds to snow flakes or water drops created from cloud water in previous time-steps and that continue to fall, not having yet reached the surface. But then, since there was advection in between and since clouds may have appeared or disappeared since the previous time-steps, this P1-type part has no more specific localisation in the grid box and may fall anywhere, including where there is neither a cloud locally nor any cloud 'above'. It was thus simply forgotten that the falling water in the 'no cloud here + no cloud above' part must also be subject to evaporation and melting/freezing. This bug lead to snow precipitation patches in summer (!), to slightly too much precipitations in general and to a less stable behaviour of the scheme with the maximum overlap option than with the random overlap option (in the second case the covered area for the ‘fourth’ case diminishes very rapidly as layers pile up, but this does not happen in the first case). In fact in some specific non-operational configurations, the bug lead to model’s blow-up cases. Linking together these various consequences was not easy and it indeed took a while before realising that there was a single bug to be accounted for them.

The second (still conceptual) bug had to do with a too superficial study of the rain to snow extension of formulae. Alike in the ‘old’ ACPLUIE, the tuning parameters for evaporation and melting/freezing were supposed to vary like the inverse square root of the average fall-speed. But all other dependencies followed the ones proposed by Lopez 2002 and it was overseen that the Lopez formulae for evaporation (the process which steers in our case the one for melting/freezing) did not encompass any such dependency. Indeed, in the leading term of the sublimation computation of Lopez, two direct effects of the fall-speed compensate each other: if snow falls slower it has more time to sublimate but it is less ventilated. Also, and in a more complex manner, two effects of the (temperature dependent) number of flakes compensate each other. Hence it was decided to have now all ‘ice phase => solid phase’ ratios like in the Lopez scheme, by suppressing the fall-speed dependency on the rates of evaporation (sublimation) and melting/freezing. Of course this correction means less evaporation in general and this explains the global compensation with the one of the other conceptual bug. But of course the bugs were not compensating each other when it came to the summer snow patches or to the instability syndromes. Anyhow the topic of evaporation and sublimation in the microphysics of ALARO-0 will need a more in-depth revisit at some stage.