ALARO CMC

Configuration ALARO-1vB: list of modifications on top of ALARO-1vA

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Introduction

The first well-tuned ALARO-1 configuration was ALARO-1vA, available in February 2015 (export cy40t1, also modset for cy38t1). In May 2016, the improvement of the screen-level diagnostics was distributed (modset for cy40t1 and cy38t1). Next well-tuned configuration named ALARO-1vB has been prepared in 2016. Its ingredients on top of ALARO-1vA with the new screen-level diagnostics are: mass flux type of shallow convection in TOUCANS, exponential-random cloud overlap in radiation and cloud diagnostics, improved diagnostics of sunshine duration and direct solar flux at surface, and 10m wind interpolation in cases where the lowest model level is below 10m height. These new developments are available in cy43t2, and a modset for cy40t1 has been prepared at the beginning of 2017. Latest versions of these cycles contain also correction of serious bug in lateral coupling when LQCPL=.T. (quadratic interpolation of LBC in time), that has entered official release after cy38t1 and remained unnoticed until recently. Bug in coupling has nothing to do with ALARO, being fully on the dynamics side. Here it is mentioned for completeness.

Changes in the namelist

The first operational configuration ALARO-1vA, containing new radiation scheme ACRANEB2 and turbulence scheme TOUCANS, is described in the document:

Radmila Brožková, 2015: ALARO 1 Configuration with ACRANEB2 and TOUCANS Scheme - Version A
http://www.rclace.eu/File/ALARO/alaro1versionA_tourad_docnote.pdf

Here the namelist changes needed for going from ALARO-1vA to ALARO-1vB are described.

Exponential-random cloud overlap in radiation and cloud diagnostics (ACRANEB2, ACNPART)

Namelist NAMPHY/NAMPHY0 changes:

Switch	New value	Old value	Default value	Remark
LRNUMX	TRUE	TRUE	FALSE	calculation of maximum-random cloud overlap
LRNUEXP	TRUE	none	FALSE	use of exponential-random cloud overlap (interpolation between random and maximum-random overlaps)
LACPANMX	FALSE	TRUE	FALSE	use of nearly maximum-random overlap in diagnostic cloud cover
RDECRD [Pa]	0.	20000.	20000.	static decorrelation depth for microphysics (ignored if zero or negative)
RDECRD1 [Pa]	10000.	none	10000.	minimum value of decorrelation depth
RDECRD2 [Pa]	20000.	none	20000.	maximum variation of decorrelation depth
RDECRD3 [1]	0.30	none	0.30	change of decorrelation depth with solar declination
RDECRD4 [rad]	0.45	none	0.45	parameter determining width of latitudinal distribution of decorrelation depth
RDECRDRED [1]	0.4	none	1.	reduction factor for decorrelation depth in diagnostic cloud cover
WMXOV [1]	unused	0.8	1.	weight for nearly maximum-random overlap

In ALARO, cloud overlap hypothesis is used on 3 places: in microphysics (APLMPHYS), when dealing with geometry of clouds and falling precipitation; in radiation (ACRANEB2); and in cloud cover diagnostics (ACNPART). Historical developments lead to the state where three different cloud overlap hypotheses were used simultaneously – exponential-random in microphysics, maximum-random in radiation and nearly maximum-random in cloud cover diagnostics. Such treatment is inconsistent, so there was a strong desire for unification. So far it was achieved fully between microphysics and radiation, and partially with cloud cover diagnostics.

Exponential-random cloud overlap was first implemented in microphysics, using static pressure decorrelation depth given by variable RDECRD. This option was kept for backward compatibility. In radiation and cloud diagnostics, pressure decorrelation depth depends on latitude and season according to expression motivated by Oreopoulos et al. (2012):

RDECRD1 + RDECRD2*EXP[-((ZLAT – RDECRD3*ZDEC)/RDECRD4)**2]

ZLAT and ZDEC are latitude and solar declination in radians. Setting RDECRD <= 0. forces to use the same decorrelation depth also in microphysics, which is a **recommended setting.** On the other hand, the static decorrelation depth is used everywhere by setting RDECRD1=RDECRD>0 and RDECRD2=0.

Verification of radiation cloud cover from ALARO-1vB showed that it is systematically underestimated with respect to SYNOP observations. For this reason, possibility to scale pressure decorrelation depth in diagnostic cloud cover by factor RDECRDRED was introduced. Value RDECRDRED=0.4 was found reasonable, increasing diagnostic cloud cover by pushing overlaps more towards random. Before, the problem was addressed by using nearly maximum-random overlap, activated by setting LACPANMX=.T. with the weight WMXOV=0.8. However, such cloud overlap treatment is not compatible with radiation and was abandoned. Moreover, tuning of WMXOV can be subject to number of vertical levels.

Exponential-random cloud overlap is activated by setting LRNUEXP=LRNUMX=.T. and LACPANMX=.F. Keeping LRNUMX=.T. is necessary, since the exponential-random cloud overlap combines redistribution weights calculated under LRNUMX option with random redistribution weights that are obtained trivially.

Direct solar flux at the surface and sunshine duration (ACRANEB2)

Besides exponential-random cloud overlap, treatments of direct solar flux at the surface 'SURFRAYT DIR SUR' and of sunshine duration 'SUNSHI. DURATION' were improved in ACRANEB2 radiation. Before, sunshine duration was determined from gridbox averaged DNI (Direct Normal Irradiance) at the surface. Such methodology was wrong, leading to severe overestimation of sunshine duration in conditions with partial cloud cover. New methodology evaluates sunshine condition separately in the clearsky and cloudy parts of gridbox, taking into account subgrid variation of DNI at the surface. The change is not kept under logical key, since the sunshine duration is a relatively new product and the old way of diagnosing it was faulty.

As for direct solar flux at the surface, old setting LRTRUEDIR=.F. still provides its delta-scaled value, that is greater than the true (unscattered) solar flux. Meaning of LRTRUEDIR=.T. has changed. Before it provided truly unscattered direct solar flux at the surface, now it applies delta-scaling in the clearsky part of gridbox in order to better correspond to measurements. Further refinement of LRTRUEDIR option is planned according to the proposal of P. Räisänen, it should make correspondence with measurements even better. It should be noted that option LRTRUEDIR has no impact on the surface global radiation, it affects only its split into direct and diffuse components. Key LRTRUEDIR is set in namelist NAMPHY:

Switch	New value	Old value	Default value	Remark
LRTRUEDIR	TRUE	FALSE	FALSE	activates direct solar flux at the surface better corresponding to measurements

New shallow convection scheme (TOUCANS)

The new version of shallow convection closure has been introduced. It is based on a computation of moist buoyancy flux by interpolating between “dry” (i.e. without condensation) and fully saturated limits. The interpolation factor is obtained from a simplified mass flux type profiles. This parameterization replaces the estimation of moist buoyancy flux from the so-called Ri*, modified moist Richardson number, requiring the use of a moist anti-fibrillation treatment. Choice of the shallow convection closure is controlled by the following NAMPHY switches:

Switch	New value	Old value	Default value	Remark
LCOEFK_MSC	TRUE	none	FALSE	shallow convection cloudiness diagnostics based on mass-flux approach
LCOEFK_RIS	FALSE	TRUE	TRUE	shallow convection cloudiness based on Ri*

Screen-level interpolation (TOUCANS)

TOUCANS use its own version of screen-level interpolation subroutine ACTKECLS (activated by setting LCOEFK_SURF=.T. in namelist NAMPHY), derived from original subroutine ACNTCLS. First version of ACTKECLS used mixture of Geleyn (1988) and Kullmann (2009) solutions in stable conditions. It suffered from T2m oscillations, coming from Kullmann (2009) solution and enhanced by the construction of mixing weights. The problem was cured by consistent application of Geleyn (1988) methodology to simplified Gratchev et al. (2007) stability function. The new solution is smooth (non-oscillating), with one tunable parameter a. Setting $a = 0$ gives back Geleyn (1988) solution (lower T2m limit), $a = 1$ corresponds to unmodified stability function (recommended) and $a \rightarrow \infty$ gives the upper T2m limit. Interpolation in unstable conditions is not influenced, here the Geleyn (1988) solution seems satisfactory. New screen-level interpolation is a diagnostic issue, but it affects model integration as soon as it is used in CANARI surface assimilation (impact via observation operator).

New screen-level interpolation is activated by setting in NAMPHY1:

Parameter	New value	Old value	Default value	Remark
LCLS_HS	TRUE	None	FALSE	new 2m temperature/humidity interpolation in stable conditions
ACLS_HS	1	None	1	tuning parameter "a" in the new heat stability function for stable conditions

Additional tunings

New version of cloudiness overlaps and its unification in radiation and microphysics required a retuning of the critical relative humidity profiles. The goal has been to keep the resulting critical relative humidity profile in the thermodynamic adjustment as close as possible to the original one. Here below are the recommended NAMPHY0 tuning changes:

Parameter	New value	Old Value	Default value	Remark
HUCOE	1.	1.4	2.	
HUCRED	1.2	1.	1.	
HUTIL2	0.5	1.1	1.1	
SCLESPS	5100.	15500.	15500.	

Comments

Few additional comments linked to physics can be consider when preparing namelist for local application.

Diagnostics of wind gusts should be tuned (FACRAF) to local needs, be careful also with time interval settings LXTGST, LXXGST.

Parameter QXRTGH used in Xu-Randall should be adopted according to number of vertical levels (see document on ALARO-0 baseline).

Tuning of the RCTVEG(3) (inverse coefficient of thermal resistance of low vegetation; resistance is a bit enhanced with higher value) can be considered.

Calculation of clearsky radiation fluxes (LFRRC=.TRUE., frequency NRADFR=1) is not yet optimized (ACRANEB2 is called twice).

Reproducibility of results with physics is monitored by NPHYREP. Default value 1 is useful for validations from reproducibility point of view. Recommended value -4 means some CPU savings in radiation, namely solar calculations during night are skipped (LRAYPL=.T. with NPHYREP=-4) delivering zero fluxes anyway.