ALARO-1 actions (ongoing and planned)

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In the following sections we shall try and present an itemisation of both the ongoing or additionally planned actions and of the (now sometimes more ambitious) motivations behind them.

The foreseen steps

A) Separating nearly completely the physics time step (still in cascading mode) in 3 parts:

(i) Radiative cloud properties and radiative fluxes' computation
(ii) (Moist) turbulence and diffusive transport
(iii) Condensation/evaporation associated processes (including deep convection)

Nothing concrete was yet coded, but the conditions continue to look favourable for such an important step, especially since some new track appeared for a stable and consistent computation of the buoyancy term of 'moist turbulence' (see below in the comment about the second bullet of 'B').

B) In (i), three actions:

- new radiative transmission functions for the thermal spectrum and use of ARPEGE-type aerosols' optical properties;

Second part done, first one still ongoing (a solution exists but creates opposite biases to the previous ones). This is in fact an ALARO-0 'left-over'.

- early computation of a shallow convective cloud-cover;

Two solutions were tested in a kind of 'stand alone' mode. One reproducing as closely as possible the current operational solution of ALARO-0 and one based on the recent proposal of Pascal Marquet for a new moist potential temperature, conserved in both advective and diffusive transports. Preliminary results indicate a good numerical stability of the second solution, which would have many algorithmic and consistency advantages with respect to the first one if confirmed as a safe baseline for this step.

- 'radiative' cloudiness and cloud water content computed from an initial call of the adjustment process, with protection against re-evaporation in both deep and shallow convective cloud-covered parts.

Nothing yet tried in this direction.

C) In (ii), six actions:

- keeping from p-TKE the solver and the sequence of updates, but going otherwise for a full TKE scheme; the 'moist' aspect will entirely be related to a change of the Richardson number consistent with the value of the shallow convection cloud-cover;

Done but not yet fully validated, owing to the need of a complete set-up for that.

- introduction of a parameterisation of Third Order Moments (TOMs) effects (sometimes abusively called 'counter-gradient fluxes'); the discretisation shall resemble the one of a mass-flux approach, alike in EDMF-type schemes;

This has till to be coded and tested. The preparatory steps have been done and some time was spent on the algorithmic characteristics of the additional 'solver' to be imbedded in the vertical diffusion computations.

- a posteriori correction of the final value for the prognostic TKE in order to take into account TOMs effects and the implicit character of the diffusive fluxes' solver;

Nothing yet done here.

- jump from stability functions from the Louis-type to a simplified Reynolds Stress Modelling (RSM) framework or (more likely) to a QNSE declination in this simplified-RSM 'model';

Done and consolidated in all aspects relative to the use in the 'moist turbulent case', hopefully.

- introduction of a panoply of flow-dependent mixing-length formulations;

Done and even harmonised with the possibility to have various ways to look at the 'moist' problem.

- re-introduction of the diffusive transport of cloud liquid and ice water, but on the basis of the shallow convective formulation and not any more on that of the adjustment process.

This has yet to be done. Some past unhappy evolutions of the code made it more complicated than foreseen.

D) In (iii), three actions:

- redoing the adjustment computations (in the same conditions as at the beginning) but with an input modified by the (moist) turbulent diffusion (also incorporating TOMs' effects);

Here nothing was done yet.

- modifying the deep convective computation in order that the solutions with and without its activation converge at very high resolution;

The 'stand alone' preparations are well advanced, but implementation will be seriously delayed because a set of bugs were discovered in the treatment of the downdraft in the ALARO-0 codes. The retuning at the ALARO-0 level will be delicate and the new baseline may ask for readjustments in the work already performed for ALARO-1.

- making this modification such that, at the 'end of the grey zone' (dx~1.5 km), the scheme acts selectively, in order to treat only non-resolved convective motions.

This is in stand-by, for the above-mentioned reasons. In fact the correction of the bugs reopens the issue of the possible use of the 'historical entrainment' concept of Jean-Marcel Piriou (an ALARO-0 delayed action, because of missing impact, for reasons now better understood!). This might be

quite beneficial, but in that case at the price of some further delay.

E) Making the recent incorporation of the Rash-Kristjansson condensation scheme of HIRLAM in 3MT compatible with the steps 'B', 'C' and 'D' above.

This has to be considered once TOUCANS is confirmed as a fully promising package. However some 'paper study' should have already been initiated, but this is unfortunately not the case.

F) Not forgetting to include a '3D minus 1D' turbulent part, by extension and diversification of the existing SLHD functionalities.

This has progressed quite well, in parallel to all the rest. It is however too early to draw firm conclusions yet (and it would be dangerous to think of some concretisation prior to the installation of TOUCANS in ALARO-1).

Motivations

The aim of 'A' is obvious. After the preparatory step of ALARO-0, concentrated on the best possible introduction of the 3MT concept (targeted at grey-zone scales), one wishes to rationalise the physics time-step organisation.

Confirmed

The first bullet of 'B' corresponds to a long indentified and rational need. But the realisation was blocked by the existence of compensating errors between the present radiation computations and other parts of the physics. Hence the 'improvement' of the radiative code should happen together with other important changes.

Still true, even if the hope to dissociate this step from TOUCANS at the occasion of the discovery of the bugs in the downdraft computations did not find any concretisation

The second and third bullets of 'B' are related to the codification of a paradigm already 'announced' by 3MT: in the case of convective clouds one puts cloudiness where the condensation mechanism has been detected, while in the case of stratiform clouds one computes condensation where clouds are diagnosed.

Confirmed

The first, fourth and fifth bullets of 'C' show the concretisation of a long-term (first of academic-type and progressively application-oriented) investment in the understanding of (moist) turbulent processes. This investment was done in parallel to the heuristic step that p-TKE represented within ALARO-0. The result should reflect a very modern view of prognostic turbulence in dry as well as cloudy environments.

Confirmed, especially since the proposal of Pascal Marquet offers even wider perspectives in terms of 'universality' of the envisaged solutions

The second and third bullets of 'C' correspond to an additional parameterisation step aimed at suppressing the main weaknesses detected in our present parameterisation of boundary layer fluxes, i.e. the lack of heat and moisture vertical convergence below inversions, especially cloud-related

ones.

Confirmed

The sixth bullet of ‘C’ and the first bullet of ‘D’ are meant to consistently ‘close the loop’ between the three parts of the physics time step. The numerical robustness of this step may have to be improved after experimentation, despite the care now taken to have the best possible data flow between the said three parts.

Confirmed

The second and third bullets of ‘D’ are supposed to cure problems detected when using 3MT at the ‘high resolution border’ of the so-called ‘grey-zone’, i.e. mesh sizes of 2km to 3 km.

‘Since the Rash-Kristjansson condensation scheme adds new possibilities and sophistication, it should become available also in the reorganised code. This raises new problems that cannot be solved by simple means. 'E' can then be seen as an effort made in consequence of a deliberate policy to favour modularity and flexibility and to share this aim with interested partners.

‘F’ corresponds to an old dream that did not yet materialise for lack of an application field. Now (according to most specialists) time seems to be ripe for such a concrete realisation. The tuning aspects might however be quite hard to master and the whole step towards a harmonious behaviour of ‘vertical-type’ turbulence and SLHD-type smoothing will surely take time.

Confirmed, even if the path to a definitive solution will surely be a long one