LACE working plan for physics 2012

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1. Introduction

The present ALARO physical package allows us to produce operational forecast down to the resolution around 5 km mesh-size, but certainly there is place and interest for their improvement. The resolution increase (down to km-scale) correspond with the further development of sophisticated physical parameterizations. Therefore, in the next years the efforts to achieve a scale-independent ALARO physics package will be continued.
The research inside LACE in 2012 is going to focus on few selected parameterizations schemes: improvement of turbulence, radiation and cloudiness schemes. Turbulence scheme TOUCANS and improved radiation scheme ACRANEB will be prepared for the operational use, while novelties in description of downdraft and updraft in 3MT have to be incorporated and extended validated.
The quality of the model prediction can be further improved with including better description of the surface processes and interaction between surface and atmosphere, so validation and implementation of SURFEX is an important task. It will be encouraged (as always so far) and supported that novelties enter the operational applications.
In 2012 ALARO-1 working days will be organized. After two years it is time to gather again, prepare an overview and spread knowledge to wider community.

2. Research and development working plan

2.1 Development of the schemes

2.1.1 Turbulence scheme TOUCANS
The turbulence scheme TOUCANS which consists the full TKE scheme is available for further testing and validation. Different options can be used: RANS or QNSE approach, various mixing length closures. The scheme is designed to work for all stability regimes and also treats the effect of shallow convection. Bug corrections, tuning, extensive testing both in 1D and 3D environment, especially from the point of view of the moist part, are still needed before implementation. Preparation for operational use also requires validation in parallel suites. Scientific and technical documentation will be prepared.
Contributors: I. Bašták Ďurán (Sk), F. Váňa (Cz)

2.1.2 1D-2D extension of turbulence scheme

The aim is to simulate the 3D effects of turbulence in the model. This can be achieved with the extension of vertical turbulence scheme TOUCANS by consistent components for horizontal part obtained from SL interpolation stencil.

A first version of this 2D extension of the present 1D turbulence scheme is available in the model. However the experience from running any such 3D-like schemes of turbulence in typical NWP resolutions between 100 m and 3 km (where the horizontal eddies should already play a role) and highly anisotropic grid with vertical resolution being fairly finer compared to the horizontal one is rather minimal. So first task is validation of the existing code and inter-comparison with some LES and/or academic simulations to get experience how the TOUCANS and 3D extension behaves. Later real case high resolution simulations with full 3D environment (convection, radiation and good surface parametrization) can follow. The aim would be to study the effects of transition from turbulence to (deep) convection and its role to the realistic shallow and deep convections simulation.

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2.1.3 Radiation scheme

Some parts of the radiation scheme (ACRANEB) with a low computational cost have been improved in 2011, few further steps are needed to obtain final scheme (most important are implementation of separate spectral weights for cooling to space term and retuning of statistical weights for bracketing). All these advanced adaptations will be validated in full model together with other schemes to check the feed-backs, tests in parallel suites will follow.

A possibility to compute radiative cloudiness and water content at the initial call of the adjustments process including also information on shallow and deep convection cloud part should be tested.

Better description of broadband saturation can be obtained with two sets of thermal weights (one for cooling to space, another for remaining exchanges). Work on this topic started very recently.

Gaseous transmissions can be further improved by updating the composition of CO2+ (denoting mixture of CO2, CH4, N2O, CO and O2 gases), where still the values valid 20 years ago are used. It will however require re-creation of tool for line by line computations, which is not a trivial task. Some modifications (more than 2 spectral bands) are possible to improve also climate simulations. But here again the key issue is update of atmospheric composition.

Contributors: J. Mašek (Cz), P. Kuma (Sk), R. Brožková (Cz)

2.1.4 Cloud scheme

Sub-grid scale cloud treatment is essential to achieve the necessary harmony between physical parameterization schemes (convection, turbulence and radiation). The aim is to arrive to a unified cloud scheme. Tasks will be addressed to the computation of cloudiness and cloud water content needed in the radiation scheme and deep and shallow convective cloud-covered parts in 3MT and TOUCANS. The physical properties of the cloud scheme and the microphysical properties need to be harmonized, contributions from turbulence and convection have to be taken into account.

Contributors: R. Brožková (Cz), N. Pristov (Si)

2.2 Scientific maintenance

Research will continue also on other schemes inside ALARO physics package: the studies how to make 3MT more scale-independent, more advanced description of microphysics and condensation/evaporation associated processes. Inside LACE these developments will be

followed and contribution is planned in the procedure of final code implementation and validation. Foreseen contribution are on the following topics:

- The 3MT should be improved to describe the deep convection at even higher resolutions, down to a few hundreds of meters, where balance between sub-grid and the resolved explicit part should still assure consistent behavior. Validation of the new concepts (more realistic downdraft scheme, novelties in updraft description) with the academic simulations will continue. Implementation, optimization, validation in 3D model should follow.

- Rash-Kristjansson condensation scheme, previously used in HIRLAM, were implemented in ALARO in order to investigate whether this could improve the representation of clouds in the model. In 2012 testing and tuning will start. The work needs to be closely coordinated with the developments of TOUCANS, in particular the shallow convective clouds computation and microphysics., so scientific and technical support will be given.

- In 2011 a cellular automaton approach of Lisa Bengtsson-Sedlar describing self organization of cells depending on a neighborhood rule, was coupled to the closure assumption of the 3MT deep convection scheme. The main purpose is to introduce stochasticity, memory and lateral communication between adjacent grid boxes in the convection parameterization, in order to enhance deep convection organization. In 2012 the scheme will be evaluated and tuned to work with additional components of ALARO physics.

- Inclusion of ICE3 microphysics in the ALARO framework (aplpar) is a long term aim. First step is to study how to include computation of graupels in a prognostic way in the current microphysics.

It will be also invested into well organized code (modularization, stabilization and cleaning). Some task will be devoted to complete the modularization of the updraft and downdraft computation.

Turbulence scheme TOUCANS and radiation scheme with new fits of transmission functions in thermal and solar band will be evaluated and validated together. The interaction between schemes and the feed-backs will be checked, tests in parallel suites will be performed before operational use.

The overall validation of all the developments together is important and difficult task. Additional to current methods new validation methods will be prepared for the evaluations at higher resolution.

Testing and evaluation will continue with the simulations on higher resolution horizontal mesh size around 2km. Comparison with other models will be also carried out. The strengths and weaknesses will show quality of the model and direction of further developments.

The surface scheme ISBA will be replaced with SURFEX scheme in the model setups using ALARO physics. Technically ALARO can be already coupled with SURFEX scheme, but still adaptation for the coupling between SURFEX and TOUCANS scheme are needed. Validation and testing of the numerical efficiency will continue.

Studies how to improve the diagnosis of the screen level parameters (2m temperature and humidity, 10 m wind) will continue. It is expected that use of TOUCANS turbulence scheme and improvement in the radiation scheme should bring some improvement. Studies of wind gusts diagnostics will continue.
ACRANEB will be included in the HARMONIE radiation comparison.

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2.3 Operational implementation

The model configurations with resolutions below 5 km using ALARO physics package are in the operational use at CHMI (4.7 km, 87 model levels), ZAMG (4.8 km, 60 model levels) and ARSO (4.4 km, 43 model levels). Regular daily computations at resolutions of 2.5 km started in summer 2011 in Croatia. The operational setup is going to be renewed in SHMU. ALARO physics is used in LACE-LAEF and in ensemble system at HMS.
Services decide about their operational model suites according to the computer possibilities and their interest. It is very important to well design the operational setup which is adapted to the local environment and approved with extensive validation so support to local implementation will be available and the exchange of information will be coordinated.

Contributors: local teams, Area Leader for physics

3. Detailed description of deliverables

Based on the developments listed above the following deliverables are planned to be obtained.

D1: Turbulence scheme TOUCANS:
Ready for operational use
Theoretical and technical documentations, scientific publications
Estimated efforts: 6 person x month (2 month LACE stay)
Where: CHMI, Comenius University in Bratislava
Staff: I. Bašták Ďurán(Sk), F. Váňa (Cz, only 2 weeks), R. Brožková (Cz)

D2: Improvements in the radiation scheme:
Ready for operational use
Adaptations to improve also climate simulations
Estimated efforts: 5 person x month
Where: CHMI
Staff: J. Mašek (Cz), P. Kuma (Sk), R. Brožková (Cz)

D3: Cloud scheme:
Finish analysis of harmonization (unification of cloudiness).
Coding, make first tests.
Estimated efforts: 2 person x month
Where: CHMI, ARSO
Proposed contributor: R. Brožková (Cz), N. Pristov (Si)

D4: 1D-2D extension of turbulence (cont. in 2013)
Evaluation
Estimated efforts: 2 person x month
Where: CHMI
Proposed contributor: I. Bašták Ďurán(Sk)

D5: 3MT in high resolution
implementation and validation
operational use (2013)
Estimated efforts: 3 person x month (1 month LACE stay)
Where: CHMI, NMA
Proposed contributors: R. Brožková (Cz), D. Banciu (Ro)

D6: SURFEX in ALARO (cont. in 2013)
validations, ready for operational use
Estimated efforts: 4 person x month
Where: ARSO, ZAMG, HMS
Proposed contributors: J. Cedilnik (Si), S. Schneider (At), M. Szűcs (Hu)

4. Summary of resources/means

2012	Planed (person/month)	
LACE funding (stays)	3	ALARO-1 working days
Networking, supevision	5	
Developments	24	+ flat rate stays
total	32	

LACE long stays:
Ivan Bašták Ďurán: TOUCANS, Prague, 2 months
Doina Banciu: Validation of the latest developments in deep convection parameterization, Prague, 1 month
Neva Pristov: Networking, Prague, 1 week (optional)

Organization and preparation of the ALARO-1 Working days, 13-15 June 2012 in Ljubljana.

Workshops:
ALADIN/HIRLAM workshop, EWGLAM and SRNWP meetings,
SURFEX working days, September Brussells

Stable boundary layer - an international workshop ALADIN/HIRLAM second half 2012
The ECMWF workshop on moist physics, November 2012
COST Activity ES0905 "Basic concepts for convection parameterization in weather forecast and climate models" : Workshop Concepts for Convective Parameterizations in Large-Scale, Savona, Italy, 20-22 March 2012