LACE working plan for physics 2011

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1. Introduction

From the point of view of the quality of the NWP models the proper description of the physical processes of the atmosphere is crucial (which is mostly ensured by the physical parameterization packages of the numerical weather prediction models). The present ALARO physical package allows us to produce operational forecast down to the resolution around 5 km mesh-size, but certainly the interest to move into higher resolutions down to 1 km exists.

Km-scale model simulations permit to better describe such local (extreme) weather phenomena, which endangers life and property, therefore the application of such models are crucial for the public services of the national meteorological services. The resolution increase should correspond with the further development of sophisticated physics packages, for instance with the further enhancements of the ALARO physical parameterization package already successfully used for a coarser resolution.

Therefore, in the next years the efforts to achieve a scale-independent ALARO physics package will be continued. The challenges are to go with 3MT concept until the kilometric scales (precipitation convection can not be fully resolved with 2-3 km mesh-sizes), to have moist boundary layer parameterization with a single additional prognostic variable (TKE) and a unique description of cloudiness (in all schemes radiation, turbulence, 3MT). Research inside LACE is going to focus on few selected parameterizations schemes.

Outcomes from the project “Operational ALARO configuration at scales around 5 km mesh-size” also confirm this orientation. So tasks in the year 2011 are mainly devoted to the improvement of turbulence, radiation and cloudiness schemes, which are at different development stages, and to 3MT as well. The quality of the model prediction can be further improved with including better description of the surface processes and interaction between surface and atmosphere (validation of SURFEX and prognostic lake model). It will be encouraged (as always so far) and supported that novelties enter the operational applications.

2. Research and development working plan

2.1 Development of the schemes

2.1.1 Turbulence scheme TOUCANS

The TOUCANS concept of turbulence will be further developed. In order to complete the scheme some additional developments are still needed, e.g. introduction of the parameterization of third order moments terms (largely responsible for non-local transport

properties of convective motion) and their effects on PBL; the re-introduction of the diffusive transport of cloud liquid and ice water, on the basis of the shallow convective formulation. It will be attempted to achieve these developments along the lines suggested by the new multi-conservative moist entropic potential temperature of Pascal Marquet.
Contributors: I. Bašták Ďurán (Sk), F. Váňa (Cz)

2.1.2 3D-1D extension of turbulence scheme
The idea to simulate the 3D effects of turbulence is based on extension of the vertical turbulence scheme (TOUCANS, based on prognostic TKE and QNSE theory) by consistent components for the horizontal part. Technically the horizontal part is realized in the SL interpolation stencil, i.e. outside the model physics. Due to this fact the present model data flow doesn't need to be modified in the way that physics remains still single column.
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. Naturally, some careful evaluation of the existing scheme including its role to the realistic shallow and deep convections simulation is highly desirable.
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2.1.3 Radiation scheme
The existing radiation scheme with a low computational cost will be improved. According to the ALARO validation results at 5km fits of gaseous broad band transmission functions for the thermal part should be rechecked. Fits for the solar part, where small improvements are expected, will be implemented. Radiative cloudiness and water content can be computed at the initial call of the adjustments process including also information on shallow and deep convection cloud part. These adaptations will be evaluated, also together with other schemes to check the feed-backs.
Contributor: P. Kuma (Sk)

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. One task is also to keep the recent incorporated Rash-Kristjansson condensation scheme in 3MT compatible with latest developments in TOUCANS and radiation where scientific and technical support will be given.

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. Focus will be on the transition from shallow to deep convection, using the new concept of virtual unresolved updrafts (VUU) and Bjerknes buoyancy sorting. Work on design and implementation of the closure will be also important.

It will be invested into well organized code (modularization, stabilization and cleaning). Some task will be devoted to complete the modularization of the updraft and downdraft computation. Cellular automaton approach of Lisa Bengtsson-Sedlar (where some stochasticity is added in the physics) will be introduced technically in the code.

One important and difficult task will be the overall validation of all the developments together. 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 a thorough validation is still needed, and additionally also the numerical efficiency has to be tested.

Studies how to improve the diagnosis of the screen level parameters (2m temperature and humidity) will continue. Deficiencies are noticed in stable weather situations, in mountains, in valleys where cold pools are appearing. Impact of orographic roughness and wind on 2m temperature will be studied as well.

The effect of large lakes in the AROME forecasts will be studied with the prognostic lake model Flake implemented in SURFEX. The work will continue with case studies which are focus on a large shallow lake (Balaton) impact on the forecast, especially for convective phenomena and fog or low level cloud situations. With the help pf these studies lake scheme can be improved (one already known weakness is the treatment of snow during winter).

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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) and ZAMG (4.8 km, 60 model levels). EARS have regular daily computations at resolutions of 4.4 km and there is a plan to start with operational use in 2011. The operational setup will be renewed also in SHMU. Other centers are going to decide 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. 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. The first four ones are the continuation from the Project "Operational ALARO configuration at scales around 5km mesh-size" and the last two ones are new.

D1: Turbulence scheme TOUCANS:
Finish coding and phasing it to cycle CY37.
Test it in 1D model, then in 3D model.
Prepare for testing in parallel suite.
Estimated efforts: 6 person x month (3m LACE stay)
Where: CHMI, Comenius University in Bratislava
Staff: I. Bašták Ďurán(Sk), F. Váňa (Cz)

D2: Improvements in the radiation scheme:
Review of the fits of gaseous broad band transmission functions for thermal band.
The new fits of gaseous broad band transmission functions for solar band.
Prepare for parallel suite.
Estimated efforts: 2 person x month (2x0,5 m LACE stay)
Where: CHMI, Comenius University in Bratislava
Staff: P. Kuma (Sk)

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

D4: Guidance with the recommendations for the operational use
Estimated efforts: 0.5 person x month
Where: EARS
Contributor: N. Pristov (Si)

D5: 3MT in high resolution
start work on closure
Estimated efforts: 3 person x month (0.75 m LACE stay)
Where: CHMI, NMA
Proposed contributors: R. Brožková (Cz), D. Banciu (Ro)

D6: SURFEX in ALARO
first validations
Estimated efforts: 4 person x month
Where: HMS, EARS, ZAMG
Proposed contributors: L. Kullmann (Hu), J. Cedilnik (Si), S. Schneider (At)

4. Summary of resources/means

2011	Planed (person/month)	
LACE funding (stays)	5	
Networking, supevision	5	
Developments	20	+ flat rate (1+0.75+0.75+1)
total	30	

LACE long stays:

Ivan Bašták Ďurán: TOUCANS, Prague, 17 January -11 February
Peter Kupa: General gaseous transmission functions for radiative transfer - a cost vs. accuracy study, Prague, 28.3.-8.4.2011
Ivan Bašták Ďurán: TOUCANS, Prague, 4 weeks, June
Ivan Bašták Ďurán: TOUCANS, Prague, 4 weeks, late summer
Peter Kupa: General gaseous transmission functions for radiative transfer - a cost vs. accuracy study, Prague, 2 weeks, late summer
Doina Banciu: Validation of the last developments in deep convection parameterization, Prague, 3 weeks, second half of the year
Neva Pristov: Networking, Prague, 1 week

Flat-rate stays:

Laszlo Kullmann: SURFEX: externalization, analysis of the numerics of the Best&al. Interface, Brussel, 1 month
Doina Banciu: Deep convection, Brussel, 0.75 month
Joris Van den Bergh: Microphysics, Prague, 0.75 month
Rafiq Hamdi: Climate modelling: radiation; including SURFEX in climate runs with ALARO,.Prague, 1 month

Workshops:

Neva Pristov: ALADIN/HIRLAM workshop, EWGLAM and SRNWP meetings, ALADIN-HIRLAM Strategy meeting
One person from the TOUCANS team: the ECMWF/GABLS Workshop on "Diurnal cycles and the stable atmospheric boundary layer ", Reading, 7 to 10 November 2011

The SURFEX Working week, Brussels, 18-12 April 2011

Laszlo Kullmann, Stefan Schneider, Jure Cedilnik