Working Area Physics

Work Plan

Prepared by:	Area Leader Neva Pristov
Period:	2016 (and further)
Date:	25 February 2016

1 Introduction and background

Already for some years, the focus of the research and developing activities inside LACE is to achieve a scale-independent ALARO physics package which allows us to produce operational forecast at the resolution between 10 and 2 km mesh-size. A baseline version of the ALARO-0 (available in December 2012), is still mostly used in the operational applications, it is expected to be replaced with newer package named ALARO-1 (version A, available in December 2014). First operational version of ALARO-1 does not yet fully profit from the scientific developments so its extended validation will continue.

2 Goals

The highest priority is to optimize the performance of the LAM for resolutions in the 2 to 5 km range. Quality of simulations can be improved with better representation of clouds, as they are treated by a combination of different schemes (input to radiation, turbulence). With including of the refinements of the parameterization of the convective drafts it is expected to achieve seamless solutions across a wide range of horizontal resolutions, including the grey zone of moist deep convection, down to 1km.

Research will continue to enhance the description of physical processes also at sub-km resolutions (study of turbulence at grey zone, two-moment microphysics scheme). Experiments in very fine resolution (with ALARO and AROME) will indicate the problems which should be tackled. Additionally enhanced description of atmosphere-surface link available in SURFEX should be implemented. Better description of the (stable) boundary layer behaviour, low cloudiness, daily cycle of precipitation and convection under unstable circumstances are one of the most wished improvements.

It will be encouraged (as always so far) and supported that novelties enter the operational applications. ALARO physics package is already used regional clime simulations, in LAEF, Hungarian ALADIN-EPS and GlamEPS ensemble system and is tested in a convection-permitting ensemble system.

Time will be also devoted for the support to new researcher in order to get familiar with the schemes on turbulence (TOUCANS), convection (CSD) and microphysics (LIMA).

3 Main R&D activities

Action/Subject: **Turbulence scheme TOUCANS**

Description and objectives:

The turbulence scheme TOUCANS is integrated into ALARO-1 version. The selected set-up for the pre-operational is conservative; some options remained the same as in ALARO-0. Further validation is needed to profit from other available important novelties. The important task is verification of wind forecast quality and the improvement wind gust diagnostics.

Research and developments continue on prognostic mixing length and computation of shallow convection cloudiness. A target is to obtain a complete scheme with many modern options for computation of turbulent fluxes of momentum, heat, water vapour and cloud condensed water.

Actions in 2016:
- tests with new computation of shallow convection cloudiness;
- check and examine coding of some part of TOUCANS (TOMs, ...);
- test available options for mixing length computation and continue developments on prognostic mixing length;

Proposed contributors, Estimated efforts: R. Brožková (Cz), P. Smerkol (Si), M. Hrastinski (Hr) 6 months, 1+0.5 month LACE stays

Planned timeframe: whole year

Planned deliverable: code modification, documentation updates

Action/Subject: Radiation scheme

Description and objectives:

Radiation scheme ACRANEB2 is integrated into ALARO-1 version. Its validation will continue in 2016, some fine tuning and code optimization is planed. Improvements in the cloud-radiation interaction are planed by taking into account better information on cloud cover (especially shallow convection cloudiness from turbulence scheme) and (in future) by getting microphysical cloud condensates into radiation scheme. Adaptation of NER statistical model for cloudy case has very low priority, since usage of intermittent exact computation of bracketing weights has good results. Some additional tests are foreseen while preparing a scientific paper on

the long wave radiation part of ACRANEB2. Parameterization of an impact of cloudiness on broadband surface albedo, which is an important issue for the schemes using single SW interval, will be prepared.

The ACRANEB2 scheme is part of the HARMONIE radiation comparison. Adaptations to improve also climate simulations will be studied.

Actions in 2016:
- *more realistic cloud inputs (topic is moved under cloud scheme);*
- preparing a paper on long-wave radiation part with additional tests (revision of the bracketing method inside NER when clouds are included, ...);
- validation of delta-scaled and true direct fluxes, study whether observation operator is needed for verification against measurements
- parameterization of an impact of cloudiness on broadband surface albedo;

Proposed contributors, Estimated efforts: J. Mašek (Cz), 6 months

Planned timeframe: whole year

Planned deliverable: code modifications, theoretical and technical documentation, scientific paper on long wave radiation part

Action/Subject: Cloud scheme

Description and objectives:

The objective is an unification of the cloud-cover concept within ALARO-1. After careful analysis, it was decided not to aim at a single computation of cloudiness, like for instance in Tompkins (2002), but go for an alternative approach, to build bilateral correspondences and/or combinations for all cases where two parameterisations interact at the level of the cloud-cover definition. For example, in precipitation process combination of stratiform and deep convective cloudiness is used.

Relatively small upgrades with respect to current ALARO-1 version are needed. This transversal change is touching many feed-back loops, hence its practical consequences is quite unpredictable.

Action in 2016:
tests with usage of shallow convection cloudiness diagnosed in turbulence scheme as an input to radiation and microphysics

Proposed contributors, Estimated efforts: R. Brožková (Cz), J. Mašek (Cz), 4 months

Planned timeframe: whole year

Planned deliverable: code modification, testing and validation

Action/Subject: Microphysics

Description and objectives:

Current microphysics schemes in AROME are ICE3 and ICE4. The ICE3 sensitivity to the time step length has been reduced recently, while ICE4 is under re-evaluating procedure as some bugs related to hail were fixed inside ICE4 in Meso-NH.

LIMA is a two-moment microphysics scheme, focusing on the aerosol-cloud interactions. At the moment is under validation process in Meso-NH, research version is going to be implemented in AROME, the operational application of the scheme at Météo-France is planned by the end of 2016. When a first working prototype in AROME is available, testing and further tuning can start.

Action in 2016:
Testing of LIMA scheme in the research version of AROME;

Proposed contributors, Estimated efforts: V. Homonnai (Hu), 7 months, 1 month LACE stay

Planned timeframe: whole year

Planned deliverable: testing and validation

Action/Subject: 1D2D turbulence scheme

Description and objectives:

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 parameterization) 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.

Action in 2016: nothing planned

Proposed contributors, Estimated efforts:

Planned timeframe: low priority, activity is postponed

Planned deliverable: scientific validation, academic case

Action/Subject: **Operational applications: from ALARO-0 to ALARO-1, SURFEX**

Description and objectives:

The ALARO-0 baseline version is used in operational or pre-operational applications in all LACE countries. Its evaluation by the users shows strength and weaknesses of the model simulations. Some weaknesses (diurnal cycle of precipitation, light precipitation pattern) are improved in the first version of ALARO-1, while quality of temperature and moisture forecast at 2m should be improved. Local teams will continue to validate and test ALARO-1 version for the (pre-)operational use and also perform experiments at resolutions around 2 km. Support will be available.

For the model description of the surface/canopy layer and below, the externalized SURFEX framework of coupled models (for snow and ice, lake and sea, urban environment, forest and vegetation, heat and moisture fluxes in the soil etc.) is used ALADIN/AROME. As the first version of ALARO-1 is now available some effort should be put to SURFEX implementation. Link between ALARO-1 and SURFEX should be checked, some adaptations are probably needed, after validations should start.

Validation and sensitivity study of the parameterization of orographic shadowing in radiation with respect to the primary (radiation fluxes, temperature) and secondary (convection, low stratus in valleys, local circulation) will continue. This parameterization will be tested also within ALARO-1vA physics coupled with SURFEX .

Actions in 2016:
- validation and operational use of ALARO-1vA in local applications;
- the interpolation method from model levels to screen level (2m temperature and rel. humidity) should be revised;

- preparations for the SURFEX usage with ALARO;
- implementation of the ororad scheme in the ALARO-1vA/SURFEX system;
- validation and sensitivity studies to understand better influence of ororad scheme on upper air atmosphere;

Proposed contributors, Estimated efforts: R. Brožková (Cz), N. Pristov (Si), C. Wittmann (At), M. Derkova (Sk), M. Szucs (Hu), M.Tudor (Hr), I. Odak Pleskovic (Hr), S.Briceag (Ro), C. Wastl (At), M. Dian (Sk), 6+1+2+2 months

Planned timeframe: whole year

Planned deliverable: report

Action/Subject: **The ALARO-1 version**

Description and objectives:

The first ALARO-1 version (ALARO-0, ACRANEB2, TOUCANS, some updates in microphysics) is available for validation and pre-operational testing. Next step is to assemble the unsaturated downdrafts (an extra extension for the 3MT scheme), and if developments are ready also improved description of cloud cover and prognostic graupl.

In the second stage then all other planed developments; i.e. CSD, TOUCANS evolution, prognostic graupl, thermodynamic adjustment, unified cloud treatment. CSD stands for the complementary sub-grid draft (research work of Luc Gerard, including both up- and down- drafts) scheme which enable a more realistic transition from parameterized to explicit convection when going to higher resolutions. Tuning of this scheme in the ALARO-1 environment will be needed.

The validation will be in the range 5 km to 2 km and suitable validation testbeds (common with AROME and ARPEGE) for facilitating cross testing of various parameterizations should be also prepared.

Actions in 2016:
- implementation of unsaturated down draft into ALARO-1;
- validation of prognostic graupl computations;
- preparations and validation of CSD;

Proposed contributors, Estimated efforts: R. Brožková (Cz), S.Briceag (Ro), 6 months (1 month LACE stay)

Planned timeframe: whole year

Planned deliverable: code, documentation

Action/Subject: **Interfacing physics parameterizations**

Description and objectives:

Impact study and validation of the physics-dynamics interface has high priority in ALADIN community. Scientific and practical constrains for redesign of physics interfaces (APL_AROME and APLPAR), which should enable the various physics packages (and also to exchange their individual parameterization schemes) are proposed. Actions are spread among many people, LACE contribution is to adopt ALARO part of computations in APLPAR routine. Radiation scheme in already in proper shape, code linked to turbulence and shallow convection should be analyzed and adopted. Very demanding part on 3MT will follow after.

Action in 2016: Support to phasing TOUCANS scheme will be available.

Proposed contributors, Estimated efforts: R. Brožková (Cz), 0.5 month

Planned timeframe: whole year

Planned deliverable: code, documentation

Action/Subject: Various products for users (forecasters)

Description and objectives:

Many requests from the user side, mainly forecasters, asking for additional forecast parameters has arrived. For this new features should be coded in post-processing part which would enable output of model fields. Continuation of this topic is foreseen on the base of good experience with enlarged convection diagnostics. The methods for lightening diagnostics have still to be evaluated and final solution should be proposed. Additional diagnostic meteorological parameters can be added: UV index, icing parameter, freezing rain, snowfall line, computation of real snow height.

Actions in 2016:
- evaluation of lightening diagnostics
- implementation of icing parameter and freezing rain

Proposed contributors, Estimated efforts: J. Cedilnik (Si), C. Wittmann (At), N. Pristov (Si), 2 month (0.5 month LACE stay)

Planned timeframe: second half of the year

Planned deliverable: code, documentation

Action/Subject: **Very Fine Resolution Experiments**

Description and objectives:

More and more teams are now able to perform VFR experiments with ALADIN NH-based models (with AROME and ALARO physics, within or without HARMONIE framework).

Some teams have started experiments at higher horizontal resolutions with AROME, experiments can be done now also ALARO-1 package (to be used also at the kilometric and hectometric scales). Several aspects on high resolution should be investigated (low stratus in valleys, initiation of convection over orography, etc.).

Study of the turbulence in the grey zone (resolved and parameterized description of eddies) is performed as part of PhD work of Dávid Lancz. The aim is to modify the EDKF scheme used AROME in such way that parametrization of non-local eddies in the planetary boundary layer extinguish with higher horizontal model resolution and are handled by the model's dynamics.

Actions in 2016:
- preparing PhD thesis based on the experiments with modified EDKF scheme;
- preparation of VHR model set-up, comparison ALARO-1 (4 km -2 km -1 km), AROME;

Proposed contributors, Estimated efforts: D. Lancz (Hu), J.Cedilnik (Si), M.Tudor (Hr), 6+4 months

Planned timeframe: whole year

Planned deliverable: report

4 Summary of resources

Subject	Manpower	LACE	ALADIN
TOUCANS	**6**	**1.5**	
Radiation	**6**		
Cloud scheme	**4**		
Microphysics	**7**	**1**	
ALARO-0/ALARO-1/SURFEX	**11**	**1.25**	**0.5**
ALARO-1	**6**	**1**	**0.25**
Physics interface	**0.5**		
Additional fields	**2**	**0.5**	
VFR Experiments	**10**		
Total:	**52.5**	**5.25**	**0.75**

The total sum is quite high, this is comming out as some researchers (RB, JM, DL, VH) are working on physics topics for more than half of their working time.

LACE scientific stays:

- Clemens Wastl (at), Orographic radiation parameterization with ALARO, Prague, 2 weeks
- Simona Briceag (ro), Unsaturated downdraft, Prague, 1 month, June
- Peter Smerkol (si), TOUCANS - code validation of TOMs, Prague, 2 weeks, March
- Jure Cedilnik (si), Lightening diagnostics or Wind forecast validation, Vienna, 2 weeks, August

- Viktoria Homonnai (hu), AROME microphysics (ICE4 and two-moment scheme), Toulouse, 4 weeks, October/November
- Martin Dian (sk), Improving the computation of screen level fields (temperature, moisture),Prague, 3 weeks, April
- Mario Hrastinski (hr): Turbulence related topic, Prague, 4 weeks, March

ALADIN Flat-Rates Stays:

- Luc Gerard: Convection, Prague, 0.25 month
- Rafiq Hamdi: SURFEX in ALARO, Prague, 0.5 month

5 Meetings and events

1) 25st ALADIN Workshop and & HIRLAM All Staff Meeting, 2016, Lisabon, Portugal
2) 38th EWGLAM & 23rd SRNWP joined meetings, 2016, Rome, Italy
3) ALARO-1 working days, 12-14 September 2016 in Brussels (active in scientific part of organization)
4) Working week(s) organized by ALADIN/HIRLAM community:
   cloud meeting
   working group on radiation
5) Web meetings
   physics-dynamics interface; geospatial data in NWP;

6 Risk and constrain

Few colleagues left our group, Ivan Bašták Ďurán (who developed TOUCANS) left CHMI and Doina Banciu (who helped with CSD validation) is retired. Fortunately, there are quite some interested researcher to learn more about TOUCANS, deal with convection and also microphysics. But they will also need some time to get familiar with the schemes.

It is crucial to continue good collaboration with other ALADIN/HIRLAM partners. Good examples are small working groups on parameterization of orographic effects on radiation into SURFEX and HIRLAM radiation group. Opportunity is cloud working group where LACE scientists could become more active.