LACE Working Group for Physics

Progress in research, January-September 2007
Outlook for 2008

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Contents

1 Introduction

In this document a preliminary summary of the work realized in the field of physics in 2007 is presented, following the structure of the research plan. In the last part an outlook for research topics in 2008 is included.

2 Research topics

An overview of the current status of research and development is presented. The work is still ongoing on some topics and will continue in the next year.
The progress of prognostic convection, in short 3MT (Modular Multi-scale Microphysics and Transport) should be pointed out. The code is implemented and the validation of the scheme is almost ready. A few problems are still under investigation but it is expected that stable code version will be available this year. Verification scores are good and structure of precipitation is better. This fast validation of 3MT would not be possible without DDH tool which has been adapted to ALARO-0.

2.1 Parameterization schemes

Developments on ALARO-0 physics parameterization are motivated to simulate processes at the higher resolutions (from 10km down to 3km). Special care is put to computational cost efficiency, numerical stability, modular structure. This is a well designed basis for further developments and tuning of the schemes inside.
Improvements in turbulent scheme, study of gravity wave drag are presented. A lot of effort has been put to coding and validation of 3MT. Cloudiness description is revised and new methods which can profit from from new prognostic water condensates proposed.
Work is coordinated inside ALADIN project with other non-LACE countries (Be,Pt).

Moist processes
- microphysics

During the e-suite ALARO-0 without 3MT (setup LSTRAPRO, cy32t1) in Prague it was noticed that snow can reach ground even at quite high temperature. The problem was linked to the geometry of clouds and precipitation (in case when there is no more cloud above the existing rain and snow fall to ground without further evaporation/melting). After correcting this bug moist bias appeared in the high levels and another conceptual bug was discovered in the description of evaporation (sublimation) of snow.

Martin Janoušek has been studying various details of the statistical sedimentation scheme. It is intended to re-assess currently unused combinations of formulations of individual components of the sedimentation process. Slightly modified distribution function derived from the Marshall-Palmer distribution was proposed and is now tested in the 1D model.

Estimated efforts: 2? person x month, local work
Contributor: R. Brožkova (Cz), M. Janoušek (Cz), *J.-F. Geleyn*
Status: on going
Documentation: bugfix documentation

- 3MT

The 3MT scheme allows a consistent treatment of the subgrid deep convective processes and their combination with the resolved cloud and precipitation schemes. Its main components are prognostic mass-flux schemes for deep convection, an interface of the latter through transport and condensation fluxes, a cascading approach to combine the resolved and subgrid moist processes.

Implementation of the 3MT code was demanding process. At the begin of year tests showed it produced insufficient precipitation, while the scores over a 10-days period were quite deceiving. The intensive research effort performed from April to October revealed several sources for these problems, including : bugs in the coding; unexpected behaviour, such as the evaporation by the resolved scheme of the convective cloud generated at the previous time step, because after advection it was assumed to mix with the entire grid-box; problems of numerical consistency; approximations in the formulation which together appeared more harmful than expected.

After the modification of the condensation computation to be fully compatible with that of updraft transport one (upstream implicit) and the inversion of the sense of the downdraft transport computation, the syndrome of negative liquid water correction disappeared and better temperature and humidity equilibrium were achieved for medium troposphere.

An important difference of the sensitivity of diagnostic and prognostic convection on the entrainment parameters was revealed. A preliminary tuning of the auto conversion rate parameters was done. On the other hand low sensitivity of prognostic convection on varying other parameters like friction parameter in the prognostic updraft velocity was found. A special attention was given to the computation of the condensation rate within the updraft ascent.

A few problems are still under investigation. Residual problem is linked with local reduction of the updraught mass flux around the triple point level, where precipitation melting cools the environment. Scalability has to be more thoroughly assessed.

We have to point out that DDH was used during this validation and become essential tool, progress was faster. Also availability of a reference version ALARO0minus3MT (so called LSTRAPRO) with old diagnostic deep convection scheme and prognostic microphysics was crucial and has been extendedly used for comparison and testing.

Estimated efforts: 4? person x month, local work, stay in Prague
Contributor: R. Brožkova (Cz), D. Banciu (Ro), *L. Gerard (Be)*
Status: on going
Documentation:

Grawity wave drag

The detailed analysis of the effects of envelope suppression was performed. The envelope removal has a negative impact on the scores of surface quantities and deteriorates the geopotential field due to mass redistribution as the directional forcing of a new parameterization is not equivalent to that of envelope. Consequently, the associated geostrophically balanced circulation induces temperature anomalies at higher levels. Based on this results, it was concluded that present scheme is exerting too much drag.

To improve the scheme many modifications has been tried: implementation of integration of turbulent drag into lift mechanism to obtain a more realistic representation of the lift effect; a new tuning which reduces the form-drag part of the total drag; multi-directional modification approach. All these attempts has not improved satisfactory the verification scores. But the gained knowledge on sensitivity and response of the scheme to new tunings and modifications is valuable base for further developments.

Estimated efforts: 3 person x month, local work
Contributor: T. Kral (Cz)
Status: completed
Documentation: Study of parametrisation of physical effects of unresolved orography in numerical prediction model with use of situation of wind storm in Tatras 19/11/2004, Graduation Theses

Radiation
Completing the work in the radiation scheme on transmission functions (see plan for 2006)

Estimated efforts: 1 person x month, local work
Contributor: T. Kral (Cz)
Status: start in November
Documentation:

Turbulence sheme

The convergence from the existing Louis scheme towards the scheme scientifically similar to CBR scheme in AROME is in progress. The main goal is to preserve the existing good features of the well proven Louis scheme. First step was already coded pseudo-prognostic TKE scheme (pTKE) with the introduction of new prognostic quantity – the diagnostic TKE. The pTKE equation is simplified form of full (1D) TKE equation where source terms (buoyant and mechanical production/destruction plus dissipation) are represented by relaxation towards Louis scheme. The second step is to compute TKE from the TKE equation instead of diagnosed one which request a lot of effort. The third step is to use more sophisticated computation of mixing length based on TKE.

Numerical stability test of pTKE scheme (see plan for 2006) is still missing. On the other hand new developments (see next paragraphs) can already significantly reduced numerical oscillations related to the computation of the mixing length and conversion from the exchange coefficients K to the TKE.
Estimated efforts: 1 person x month, local work
Contributor: M. Tudor (Hr)
Status: ongoing
Documentation:

One of the sources for numerical instability is conversion from the exchange coefficients K to the TKE. We assume that introduction of a locally varying conversion factor can solve the problem.
Estimated efforts: 1 person x month
Contributor: M.Tudor (Hr) *(backup J. Cedilnik (Si))*
Status: has not started
Documentation:

Theoretical study has been performed to find out how to consistently complete pTKE scheme (second step). The description of source terms (buyont, mechanical production/destruction and dissipation) can be the same as in CBR, while the exchange coefficient are derived from the prognostic TKE equation being in stationary state (without advection and transport terms). With this approach the terms of the full TKE equation which are diagnosed from the Louis scheme in pTKE can be computed and added to pTKE scheme.

Development has been implementated to the code (new version of ACCOEF). Now first test with 1D model will be prepared.
Efforts: 2 person x month, stay in Prague, local work
Contributor: I.Bastak (Sk)
Status: ongoing
Documentation: short stay report, detailed one in preparation

Last year formulation of the mixing length computation which is a merge of the previous empirical formula and of Bougeault-Lacarrere parameterization (BL89) was proposed. After additional studies it was found out that original BL89 can be implemented to pTKE scheme.
BL89 mixing length has been coded and reasonable results are produced, algorithmic part has still to be confirmed followed by validation.
Efforts: 1 person x month, local work
Contributor: F. Vana (Cz)
Status: ongoing
Documentation:

Cloudiness parameterizations

Current computation and use of cloudiness was studied and described. Cloudiness computations are inside radiation, turbulent vertical diffusion, evaporation/condensation and microphysical process. Values for total, stratiform and convective cloud cover are defined in separate routines.
An alternative way of computing total cloud cover based on combination of stratiform and convective cloudiness has been prepared. Two ways of combining are proposed and coded in the new ACCDEVM routine. First method is based on the idea around critical vertical profile, the second is linked with appointed values inside Xu-Randall modified scheme which is used for stratiform cloudiness computation. At the moment first method is coded (new ACCDEVM routine). Validation tests shows that amount of clouds are smaller at all levels compared with current version, although the pattern is correct. Suspicious are still high values of convective cloudiness, contrast between cloudy and clear sky areas.

Efforts: 3 person x month, stay in Prague, local work
Contributor: J. Rio (Pt)
Status: completed
Documentation: stay report, http://www.rclace.eu/?page=99

2.2 ALARO-0 evaluation

Short overview of present status:
ALARO-0without3MT, cy29t2:
operational: Cz (till 3 Sep)
parallel suite: Hr, Si, Sk
ALARO-0without3MT, cy32t1:
compiled: At, Cz, Hr, Si, Sk, Ro
parallel suite: Cz,At
operational: Cz (since 3 Sep), At (since 12 Sep)
validation ongoing (slower or faster)

Model results (ALARO-0without3MT) from Cz(oper) (cy29t2 or cy32t1), Si(doub) (cy29t2) are

available in common ALADIN verification application. In Slovakia they have parallel run for period (Mar-May 2007) with subjective evaluation of basic fields and point verification of 2m scores over Slovakia.
In Austria they have parallel or test suites with cy32t1: ALAROminus3MT one with LNEBXR and LRNUMX and one without, one with 'Lopez' microphysics and one with 'old' diagnostic precipitation and cloud physics. Verification is ongoing.
A way of initialization of new prognostic variables is simply with 0, except in Cz (blending).

Proposed comparison of precipitation with INCA analysis is now feasible. Iwona Lelatko from Poland is the new contact person for QPF-based score computations on ALADIN precipitation outputs. She has been discussing the scientific and technical issues with Eric Bazile during her stay in Toulouse. She has already installed software, adaptation and optimization to local environment is now in process. She is ready to compute verification scores. Our task is to prepare INCA analysis and requested input files with model precipitation. Proposed periods are March 2007, June 2006 and July 2006.

Efforts:
Contributor: At, Cz, Hr, Ro, Si, Sk
Status: ongoing
Documentation:

2.3 Diagnostic tool DDH

Problem which appeared in AROME DDH in cy32 has been studied. DDH has worked in "variables only" mode, but has crashed in "variables and full budget of prognostic variables" mode in CPCUDDH. The code has been debugged and it was showed that DDH subroutines specific for AROME were not cause of the problem.
DDH was tested also on new computer (tori). Some compilation errors were removed, but during validation some fluxes had suspicious values. Code was corrected in such way that in parallel execution in DO loop in CPG each thread uses its own part of APFT array.

The DDH diagnostic package has been extended to the ALARO-0 physics. Modification in the code (cy32t1) has been done that DDH tools can be also used for new moist variables and equations. Instruction for users has been written. Scripts computing budgets and drawing were also prepared with help of Tomas Kral.
At the moment modified routines are available for cy32t1 in Prague and will be phased in model cycle cy32t3.

Efforts: 3 person x month stay in Toulouse and Prague, local work
Contributor: T. Kovačić (Hr); supervisors J.-M. Piriou
Status: completed
Documentation: draft version of the two reports

2.4 Multiphasic reference equation system

Miklos Voros (Hu) intended to study multiphasic reference equation system as his PhD work. Mean time he decided to change the topic.

This subject is now available for somebody interested but have no high priority in the planed activities.

2.5 INCA

Statistics study of an inversion height for the inner-alpine radiosonde station (Innsbruck) has showed a strong seasonal dependence of inversion height. This is going to be implemented in INCA.
A test version for an estimation of icing potential on structures (COST 727) has been implemented but not yet verified.
The idea to replace the fixed weights for the merge of the nowcast with the ALADIN forecast by the adaptive weights responding to the most recent (last hours) forecast error of the ALADIN model has been tried. The aim is to avoid the artificial suppression and delay of convection in the simple advection nowcast shortly before the formation of the first cells. Method is not successful because the ALADIN forecast of convective precipitation is not skilful enough to have a smaller error than the simple advection nowcast.

The export version of INCA (without the cloudiness and global radiation) is almost completed. Whole process of domain specification, creation of proper header files etc. is more or less automated (a new domain can be set up in half an hour). The local implementation is not strait forward so it is still necessary to come to ZAMG for 1-2 days to get familiar with the package.
INCA-SI domain was created and will be implemented in Slovenia this year.
An operational INCA verification program has been developed.

3 ALARO-0 training

To learn and spread information about latest developments in ALARO-0 the training course was organized from 26 March till 30 March 2007 in Radostovice, Czech Republic. Local organizer was CHMI, the program was coordinated by ALADIN program manager and assisted by physics WGL of LACE. 27 participants from 12 countries attended the course.
Programme was divided in three parts: 17 lectures, practical work in 9 exercise hours and 6 working group sessions on the documentation and other related issues (ALARO-0 experiences (porting, case studies) at services). Responsible persons were nominated for the preparation of documentation on various topics. It was prepared in advanced and presented during the working group sessions. The quality of the preparatory work on the documentation was very high and it contributed to a balanced shape between upstream science, algorithmics and their code concretizations.

List of documentation:

- Generic equations and their concrete code translations (Martina Tudor)
- Microphysics (i) condensation sources + sedimentation (Christoph Wittmann)
- Adjustment processes, cascading and protection against negative water species (Luc Gerard)
- Radiation (NER method + cloud optical properties (Jan Masek)
- Turbulence (p-TKE + its shallow convection consequences + the J_q_l/i problem) (Filip Vana)
- Cloudiness under its 'n' shapes (stratiform, radiative, turbulent, convective, microphysical) (Joao Rio)
- Microphysics (ii) autoconversion + collection + evaporation/melting (Jure Cedilnik,

Neva Pristov)
Precipitating convection (i) updrafts (closure + M-T oriented output) (Siham Sbii)
Precipitating convection (i) downdrafts (closure + M-T oriented output) (Doina Banciu)

Efforts: 7 person x month,
Contributors: D. Banciu (Ro), R. Brožkova (Cz), J. Cedilnik (Si), M. Janoušek (Cz), J. Mašek (Sk), N. Pristov (Si), M. Tudor (Hr), F. Vana (Cz), C. Wittmann (At), B. Catry (Be), *J.-F. Geleyn, L.Gerard (Be), J.-M. Piriou (Fr)*
Status: completed
Documentation: http://www.rclace.eu/?page=99

Participants from LACE countries:
D. Banciu (Ro), R. Brožkova (Cz), J. Cedilnik (Si), D. Drvar (Hr), M. Janoušek (Cz), J. Mašek (Sk), N. Pristov (Si), F. Vana (Cz), C. Wittmann (At)
S. Leroch (At), D. Klarić (Hr), T. Kovačić (Hr), A. Stanešič (Hr), M. Voros (Hu), R. Habrovsky (Sk), E. Larrieu Rosina (Sk), B. Strajnar (Si)

4 Summary

A short overview of the current status, planned effort and its realization and LACE support for period Jan-Sep 2007 is in the table below:

Topic	**Status**	**Estimated effort** (person x month) planned/realized	**LACE support** (person x month) planned/realized
Parameterization schemes:			
– turbulence	ongoing	3/3	1/1
– GWD	completed	3/3	
– radiation	waiting	1/0	1/-
– microphysics	ongoing	-/2	
– 3MT	ongoing	2/4	1.5/1.5
– cloudiness	completed	3/3	*1.5/1.5*
Validation, evaluation of ALARO-0	ongoing	6/?	
DDH	completed	3/3	1.5/2.5
Multiphasic equat.	cancelled	4/-	
INCA	permanent	6/?	
ALARO-0 training	completed	7/7	
Total			**5+1.5/5+1.5**

List of stays:

Tomislav Kovačić – Toulouse – 1.2.-16.3. (6 weeks) – DDH AROME
Tomislav Kovačić – Prague – 21.5.-15.6. (4 weeks) – DDH ALARO-0
Doina Banciu – Prague – 12.8.-29.9. (6 weeks) – 3MT
Ivan Bastak – Prague – 4.6.-29.6. (4 weeks) – turbulent scheme

Joao Rio – Prague – 18.3.-4.5. (6 weeks) – cloudiness - from ALADIN Flat-rate

Financial support:

1 participant per country - ALARO-0 training
Mark Žagar - Workshop on Cloud covered Boundary Layer

List of events:

Joint NetFAM / COST-722 Workshop on Cloud-covered Boundary Layer 12-14 March 2007, Toulouse, France
ALARO-0 Training course, 26-30 March 2007, Radostovice, Czech Republic
HIRLAM ALADIN Workshop, 23-27 April 2007, Oslo, Norway
HARMONIE workshop, 10-14 September, Helsinki, Finland
EWGLAM and SRNWP Annual Meeting 2007, Dubrovnik, Croatia

4 Outlook for the year 2008

List of proposed and possible topics:

- ALARO-0 parameterizations:
  - turbulent scheme
    - to complete pTKE scheme (cont.)
    - enhancement with turbulent potential energy
    - study impact of current shallow convection (Geleyn, 1987)
  - extend vertical diffusion to ql/qi within the LDIFCONS option
  - radiation
    - modularisation of the code
    - work in the direction of 'new' intermittency
    - better aerosol model
    - better intermediate price solution for the Voigt extension
    - improving the 'multi-cloud' aspect of the so-called 'cloud-band-model'
  - 3MT:
    - examine resolution independence,
    - examine life-cycle of convection clouds,
    - triggering of convection,
    - extension to dry and to shallow convection in the longer term
  - microphysics:
    - revisit the topic of evaporation and sublimation
  - cloudiness
    - total cloudiness computation – cont. with second proposed method
- DDH

  English documentation
- INCA

  focus on precipitation analysis and nowcasting,
  priority will be given to the convective cell development algorithm
- SURFEX

Information on CADSES project
A detailed proposal for the CADSES project is in preparation. Partners in the project are all LACE countries and Poland. The idea for this project is that everybody gets the INCA export version as a starting point. Local developments are carried out, depending on the interests and priorities of the individual partners. The end product should be an improved INCA that is run decentralized in each country and which can be put together into a large central/eastern European domain for applications on the internet.