LACE Physics

Progress in research, in the year 2009

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Content:

1 Short overview of the current status of the project (only work done in 2009)

Project name: Operational ALARO configuration at scales around 5km mesh-size
Responsible person: Areal leader for Physics
Responsible Center: CHMI

Task: 1.1 Turbulence scheme
Description: Further sophistication of the current turbulence scheme (pTKE).
Realization:

The work continued on the improvements of the eTKE scheme which should be equivalent to full TKE scheme for the non-discretised equations. eTKE scheme (emulating full TKE) is an extension of pTKE scheme. eTKE keeps time-step organization, staggering and solver of pTKE, but uses TKE closure. Implementation is based on two stability dependency function (chi3(Ri), phi3(Ri)) which are derived from TKE equation, the mixing length computation is based on the TKE, assuming the anisotropy and conservation of TKE+TPE.

Code is well organized so each part of the schemes can be controlled separately, other turbulence scheme (for example CCH, QNSE) can be emulated by eTKE and can be easily compared. For the mixing length computation there are available 5 methods based on the TKE. Experiments show that they all outperform the current GC mixing length used in ALARO-0.

It was decided that fTKE code, which was prepared to confirm that eTKE can mimic full TKE scheme, will not be maintained any longer.

At some intermediate state 3D test were done. The best performance is seen when using BL89 mixing length and emulation QNSE approach. Scores show improvement in the PBL, above it are slightly worse. They are better in winter cases than during summer, which is probably related to convection activity.

Work on sophistication for the turbulence description has continued with studies how to include the influence of moisture. The aim is to introduce also third order momentum (TOM) terms into the eTKE scheme which has to be changed in a such way that there are no medications of exchange coefficients Km and Kh after their calculation from stability

functions Fm and Fh. One change is in anti-fibrillation scheme for shallow convection where it is applicated through modification of Richardson number instead of modification of vertical diffusion exchange coefficients. The second change is in moist gustiness parametrisation where the correction is made on mixing lengths and not on vertical diffusion exchange coefficients. With this modification it is also possible to include shallow convection, shallow convection cloudiness can be defined with modified Richardson number which is a result of shallow convection parametrisation and 'moist' AF scheme

Consequence of all these development and ideas is the code reorganization, standalone eTKE code is not needed, TKE equation is solved by the pTKE solver, parts of turbulence and convection compilations are combined. So the turbulence scheme got also new name TOUCANS (Third Order moments Unified Condensation-Accounting and N-dependent Solver). Some parts (mixing length computations, solver) were included into the cycle cy36t2. Inside is also link to SURFEX scheme via the surface drag coefficient computation.

Efforts: 11.5 pm
Contributors: I. Bašták (Sk), F. Váňa (Cz), J.-F. Geleyn, Daan Degrauwe (Be)
Documentation: PhD thesis, poster at ALADIN workshop, permanent updates of internal document, report for stays in Prague

Task: 1.2 Radiation scheme
Description: Implementation of new transmission functions and improvement in aerosol's optical properties.
Realization: in 2009

- a new option for using 6 different aerosol types, apart from a single standard one, has been introduced in ACRANEB radiation scheme. The optical properties of continental, maritime, desert, urban, volcanic and stratospheric aerosol types are accounted for in both thermal and solar bands. The optical depths of aerosols are taken from the climatology.
- validation with the new transmission functions, improved optical depth computation and aerosol model has been done. Warming in the lower part was observed in the scores of parallel suite. This warming is most probably the consequence of the compensating errors of other physical parametrization.

Fits of gaseous broad band transmission functions should be done also for the solar part, where small improvements are expected. Otherwise developments are completed, still there is place for further improvements.

Efforts: 0.75 pm
Contributors: T. Král (Cz)
Documentation: not available yet

Task: 1.3 Cloudiness scheme
Description: The prognostic water species are now available in the model and the description of cloudiness should take this into account. Method should be revised, also link between clouds and radiation. Maybe unified cloud scheme can be proposed, find out if same clouds can used in the radiation scheme or not.
Realization:

In order to improve cloudiness diagnostics for total, low, medium, high (and convective) cloud cover in the case with maximum overlap option for the adjacent cloud parts (LRNUMX=.TRUE. which is used within ALARO environment) a “near maximum overlap” version for ACNPART has been developed. This version became the operational one at ZAMG on 7 April 2009.

Efforts: 0.75 pm
Contributors: C. Wittman (At)
Documentation: report, code is available on forum

The new proposed idea how to treat moist turbulence required to reorganize the physics time step. At the beginning of the physics time-step a 'shallow convective cloud cover' is computed, for this the parametrisation by adapting a modified Richardson number was prepared. This cloudiness should be later used in the effective cloudiness estimation for radiative computations. Same time also the adjustment part is modified, the resolved thermodynamic adjustment is performed after the vertical turbulent diffusive transport has taken place in order to mix the advective and diffusive inputs to non-deep-convective condensation/evaporation processes.

Efforts: 1.25 pm
Contributors: M. Vanandruel (Be), J.-F. Geleyn,
Documentation: report in preparation

T**ask:** 2.1 Code optimization
Description: Stabilization of the 3MT code, solving some already know weaknesses, code cleaning.
Realization:

- ACRANEB routine with radiation computation has been modularized and optimized, it performs with same efficiency as the original code (TK 0.5)
- phasing and testing prognostic entrainment development from previous year (LENTCH option) (RB 1.5)
- completion and checking of variables update inside the 3MT cascade, (DB 0.25, RB 0.25)
- cleaning the LUDEN option (DB 0.25)
- preparing 3MT environment for the Rasch-Kristjansson large scale condensation implementation. (DB 0.25)
- phasing to the cycle CY36T1 (RB 0.5)

Efforts: 3.5 pm
Contributors: R. Brožková (Cz), T. Král (Cz), D. Banciu (Ro),
Documentation:

Task: 2.2 Validation, tuning
Description: Validation of the historic entrainment. Study of the prognostic entrainment, which is foreseen/anticipated to be needed at higher resolutions.
Realization:

Algorithmic part of the prognostic entrainment has been review at the begin of the year and is available in cy35t1plus local branch in Prague.

Algorithm was upgraded with re-initialization of the historical variable (PENTCH) in case of a non physical solution, new diagnostics and tunning. Results show some improvement in the vertical distribution of the entrainment rate but again does not improve diurnal cycle.

It is still expected that with prognostic entrainment diurnal cycle of convection and onset of convection can be described better, namely convection in the model very often starts to soon and is to intense. The study continued with the sensibility study of the variation of characteristics time of downdraft. Unexpectedly influence was very small.

It was suspected that the root of the problem is in an algorithmic choice because some prognostic process is already incorporated in downdraft fractional area. Test, where in the computation of the variable "zeta", which is involved in the prognostic entrainment

formulation, the downdraft fractional area was replaced by its positive variation, confirmed this. Even with this modification it was not possible to improve the convective diurnal cycle. The continuation of the work on prognostic entrainment will be decided only after the incorporation of the new developments of Luc Gerard.

Efforts: 4.5 pm
Contributors: D. Banciu (Ro), R. Brožková (Cz)
Documentation: Stay report

Task: 2.3 Evaluation (5 km mesh-size)
Description: Examine the performance at scale around 5km mesh-size, recognize good/weak/bad behavior while studying position and the amount of (convective) precipitation, life cycle of convection (diurnal cycle), triggering of the convection.
Realization:

- ALARO verification: SAL based verification for ALARO 4.9km (H/NH)

First conclusion after checking verification scores for surface variables (t2m, rh2m, msl pressure, wind) can be there are no significant differences (in terms of MAE, BIAS, RMSE over 2 month period) between hydrostatic and non-hydrostatic version of ALARO 5km. The same is valid for precipitation scores (SAL), especially in flat/lowland areas. A very weak/slight tendency for better amplitude scores but worse structure scores of NH version in mountainous areas may be seen. (When moving towards single case studies one can find some cases with bigger differences.)

- ALARO-0 evaluation at 5 km resolution for near surface parameters

Model setup for the Madeira island was prepared and comparison has been done against the operational ALADIN model (9 km) in Portugal. The benefit for the most of the considered parameters (in particular for 2m relative humidity, wind speed and direction) is visible, exception is 2 m temperature where quality is worse and cold bias during night is observed.
More detailed evaluation was done over Austria where result were also compared with the operational 9.6 km version. Significant improvements are seen by MSL pressure, 2 m relative humidity, especially in mountainous areas, a (slight) positive impact in rather flat terrain. For wind speed the scores are rather neutral in flatland areas, but slightly worse in the mountains where stronger negative bias is seen. Scores are neutral for precipitation and cloudiness. For temperature the impact of high resolution is neutral in flatland areas. For stations located in higher elevations or in alpine valleys/basins there is a general tendency for a significant cold bias for night time temperatures (in stable conditions). This is caused by an overestimation of near surface inversion during nights characterized by radiative cooling and gets more important for the 4.9 km version. The cold bias can be significantly reduced (to the bias of the operational 9.6 km model) if a modified interpolation formula from model levels to measurement height (Kullmann 2009 and operationally used by CZ) is used.
Two additional conclusions can be pointed out based on this studies. The influence of horizontal resolutions (topography) on the inversion (9.6 km, 4.9 km, 2.5 km) seems to be stronger than the vertical resolution (which has very low impact). Switching of the interpolation of wind speed from the lowest model level to measurement height is beneficial for wind speed in mountainous areas.

Efforts: 2 pm
Contributors: C. Wittman (At)
Documentation: report, stay report Portugal, EMS on-line journal (submitted), presentation

The model configuration with resolution of 6.5 km has been prepared and validated in Romania after successful implementation of cy35t1. Comparison with operational ALADIN model (10 km cy26t3) gave better results. Subjective evaluation was focused on

precipitation, wind and minimum temperature due to the often severe blizzards events during last winter. Improvements can be seen in precipitation structure, in position and evolution of the precipitation bands. Generally precipitation amount is better, but there is still tendency to overestimate the precipitation amounts. Also wind direction, position of high speed areas and their evolution are described better. Forecast of maximum wind speed improved as well even if it is still underestimate for strong winds.

Efforts: 0.75 pm
Contributors: D. Banciu (Ro), M.Pietrisi (Ro)
Documentation:

Deliverables

Status of the relevant deliverables for the mid 2009:
the following two are available:
D2: improvements in the radiation scheme ready for inclusion into ALADIN library (mid 2009)
D4: modularized version of the radiation scheme (ACRANEB) (mid 2009)

the following are in procedure (see task realization for details):
D1: improvements in the TKE scheme ready for inclusion into ALADIN library (mid 2009)
D5: stabilization, modularisation and cleaning of the 3MT code (2009)
D6: the entrainment rate formulation and its tuning parameters (2009)
D7: regular implementations of validated 3MT code including the latest developments (2009)
D8: local configuration of the model setup at scale around 5 km at services (2008-2010)

List of ALARO contributions and optimizations to the cycle CY36T1 (October 2009):

- turbulence scheme (mixing length, solver) (F. Váňa , I. Baštak)
- Rasch-Kristjansson condensation scheme under 3MT (L. Bengtsson)
- corrections in historic entrainment (3MT) and terms needed for the Rasch-Kristjansson condensation scheme. Cleaning of the LUDEN option (special updraft environment) (D. Banciu)
- completing the 3MT cascade a moving it from aplpar to the updating routines after each main process (R. Brožková)
- new aerosols in ACRANEB (T. Král)
- geometry in cloudiness diagnostics for the output (acnpart routine only) (C. Wittmann)
- fix in radiation setup due to SURFEX (T. Král)

D9:
The four main weaknesses of ALARO-0 obtained from running ALARO-0 with and without 3MT at various resolutions:

- compensating errors between radiative forcing and moist physics;
- a too simplistic and heuristic formulation of the boundary layer representation;
- deficiencies in 3MT's behaviour when used at the 'finer 'border' of the grey-zone;
- the absence of a unifying concept for the cloud representation.

2 Developments not linked to the project

Lake modeling in SURFEX

The performance of a standalone version of FLake model (with default settings) by using observations and atmospheric model data has been evaluated for lake Balaton. Surface temperatures are well performed, while the bottom water temperatures and stratification are captured less well. An article was submitted to Boreal Environment Research.
The work with on-line experiments in the AROME has started, first the difference when Flake is used or not is going to be evaluated.
Efforts: 4 person x month
Contributor: M. Vörös (Hu)
Status: ongoing
Documentation: Paper accepted in Boreal Environment Research (www.borenv.net)
Special issue - 2010, Vol 15, No. 2

ALARO-0 evaluation

Short overview of the status (ALARO-0 use) at the end of the year:
ALARO-0without3MT, cy32t1:
operational: Hr (8 km)
ALARO-0with3MT, cy32t1, cy32t3:
operational:
Sk (since 19 August 2008), 'pseudo' assimilation cycle (9 km)
ALARO-0with3MT, cy35t1 (with local modifications):
operational:
Cz (change of the cycle 15 April 2009), assimilation cycle (9 km)
Si (change of the cycle 16 July 2009), initialization with 0 (9.5 km)
At (since 7 April 2009), initialization with 0 (9.6 km)
pre-operational:
Ro , initialization with 0 (6.5 km)
Hr, initialization with 0 (8 km)
implementation and testing:
Hu (8 km) planed for the begin of 2010 (cy35, new computer)

The new formula for diagnostics of screen level temperature was included into operation in Prague in December 2008. Temperature and humidity at 2 m have more realistic values under stable stratification conditions but retuning was needed to be equally well also during warm season. This was done with the change of the parameter a_h (ZAH) in the interpolation formula, new set value is 35 instead of previous theoretical value 5. This change was tested in parallel suite and was introduced into operational in May. (RB 0.75)
This method is in testing procedure in Austria, verification against measurements over Austria was performed. (CW 0.25)
The cloud covers distribution for various model configuration inside LACE has been compared. It is clearly seen the difference between those using maximum or random overlap for the adjacent cloud parts. With the first option there are not enough cases with cloud cover near 100%. (NP 0.25)
Some studies were performed to identify cause for an overestimation of minimum temperature for most of the days in summer 2009, which sometimes reached about 5 deg. in Prague. Operational surface analysis was suspected but tests showed that is behaving reasonably well. It is still unclear whether the source of the problem is surface analysis, surface model scheme (ISBA) or interaction of the surface with upper-air physics. (AT 0.5)

The impact of different computation of the inter-layers ETA(L) (LREGETA switch) and initialization of the hydrometeors were studied. Case studies and one month cycling were performed. The switch LREGETA=.F keeps the structure of the total precipitation fields almost unchanged, while total precipitation amounts are slightly lower. For all situations is definitely seen that non-zero initial values of the hydrometeors leads to increasing of the total precipitation in the first hours, while differences are not so significant for longer forecast ranges. (LT, NP 1.0)

Efforts: 2.25
Contributor: At, Cz, Si,
Status: ongoing
Documentation: reports available on rclace web page and forum, stay report from Lora Taseva

3 Summary

A short overview of the status, planed effort for 2009 against realization (9months) and LACE support, is in the table below:

Topic	**Status**	**Effort** (person x month) planed09/realized	**LACE support** (person x month) planned/realized
Project			
WP1 – development of the schemes			
1.1 Turbulence scheme	ongoing	2.0/11.5	1+2 / 2
1.2 Radiation scheme	completed	4.5/0.75	-
1.3 Cloudiness	ongoing	4.0/2.0	0 / 1
WP2 -Scientific maintenance			
2.1 Code optimization	ongoing	6.0/3.5	-
2.2 Validation, tuning	ongoing	4.0/4.5	1.5/1.5
2.3 Evaluation	ongoing	7.5/2.75	-
Other developments			
Validation, evaluation of ALARO-0	ongoing	5.0/3.0	
FLake	ongoing	5.0/4.0	

It can be noticed that work on radiation was done much quicker than it was estimated. Small part is still missing namely the work on gaseous transmission functions for the solar band. T. Král from Czech Republic is currently working at ECMWF (for one year) and will continue to work on this topic after his return (end 2010).
A lot of progress was done on turbulence scheme also the scope of developments become wider. One of the main contributors is Ivan Bašták who was working as a student. He defended his PhD thesis in September and is from the begin of October employed at University.

In the table below is an overview of effort in person months by topics and countries for the year 2009:

	sum	At	Cz	Hr	Hu	Ro	Si	Sk	
Task 1.1	11.5		3.5 (FV)					8(IB)	
Task 1.2	0.75		0.75 (TK)						
Task 1.3	2	0.75 (CW)							*1.25 (MV)*
Task 2.1	3.5		0.5(TK) 2.25 (RB)			0.75 (DB)			
Task 2.2	4.5		1 (RB)			3.5 (DB)			
Task 2.3	2.75	2 (CW)				0.75 (DB,MN)			
ALARO-0 oper	3	0.25 (CW)	0.75 (RB) 0.5 (AT)				0.75 (NP)		*0.75(LT)*
FLake	4				4 (MV)				

List of stays:

Ivan Bašták – Prague – 16 February – 13 March (4 weeks) – turbulence scheme
Doina Banciu – Prague – 17. August – 25 September (6 weeks) – entrainment in 3MT
Ivan Bašták – Prague – 17 August – 12 September (4 weeks) – turbulence scheme
Ivan Bašták – Prague – 4 – 27 November (4 weeks) – turbulence scheme
Martin Vanandruel – Prague – October (4 weeks) – physics time step organization

from ALADIN Flat-rate: topics linked with ALARO-0

Prague: Meral Sezer, 18May-30June, Numerical instability in physics
Ljubljana: Lora Taseva, ALARO validation, 15 Nov – 12 Dec
Lisabon: Christoph Wittmann, 1.-31. October, ALARO validation for Madeira on high resolution

List of short visits:

Christoph Wittmann – Prague – 16-17 September 2009 – ALARO1
Neva Pristov – Prague – 8-17 September 2009 – ALARO1

Financial support:

Neva Pristov, Doina Banciu – Moist Processes in Future High Resolution NWP Models (Cloud09), 15-17 June 2009, Norrköping, Sweden

List of events:

- Workshop on concepts for convective parameterisations in large-scale models II: "Entrainment and Detrainment in Convective Plumes", CHMI, 25-27 March 2009, Prague, Czech Republic
- 19th ALADIN and HIRLAM Workshop, 12-15 May 2009, Utrecht, the Netherlands
- Moist Processes in Future High Resolution NWP Models (Cloud09), 15-17 June 2009, Norrköping, Sweden
- EWGLAM and SRNWP Annual Meeting, 28 September -1 October 2009, Athens, Greece

Reports and documents:

- Christoph Wittmann, 2009: “Near maximum overlap” for ACNPART
- Christoph Wittmann, 2009: Evaluation of ALARO-0 5km over Madeira , ALADIN-FR/LACE stay at the Institute for Meteorology (IM), Portugal, October 2009
- Christoph Wittmann, 2010: Evaluation of ALARO-5km near surface parameters over Austria with special emphasis on 2m temperature
- Doina Banciu, 2009: Convection diurnal cycle and prognostic entrainment in the ALARO framework, report from stay 17 August - 25 September 2009 in Prague
- Lora Taseva, Neva Pristov, Jure Cedilnik, 2009: Sensitivity/Validation of the operational ALADIN model in Slovenia (ALADIN_SI) & Some preliminary results from the local implementation of CANARI snow analysis scheme in the ALADIN_SI , Appendix, ALADIN-FR/LACE stay at the EARS, Slovenia, 15 November -12 December 2009
- Ivan Bašták, 2009: eTKE scheme and preparations for TOMs , stays 17 February - 13 March, 17 August - 12 September, 4 - 27 November in Prague

PhD thesis

- Ivan Bašták, 2009: “Turbulent scheme eTKE”

Articles:

- Gerard, L., J.-M. Piriou, R. Brožkova, J.-F. Geleyn, D. Banciu, 2009: Cloud and precipitation parameterization in a meso-gamma scale operational weather rediction model , Monthly Weather Review: In Press
  http://ams.allenpress.com/perlserv/?request=get-abstract&doi=10.1175/2009MWR2750.1

Presentations:

- Jean-François Geleyn: Towards a common framework for (i) extensions of the Louis formalism, (ii) the RANS aspect of the QNSE theory and (iii) the class of ’No Ri(cr)’ Reynolds-type prognostic TKE schemes?, 19th ALADIN and HIRLAM Workshop, 12-15 May 2009, Utrecht, the Netherlands
- Tomas Král: Revitalization of gaseous transmission functions in ACRANEB radiation scheme utilizing RRTM database, 19th ALADIN and HIRLAM Workshop, 12-15 May 2009, Utrecht, the Netherlands
- Ivan Bašták Ďurán: From ’p-TKE’ to ’e-TKE’: suppressing restrictive conditions, validating the extension of the ALARO-0 approach and exploring links with other methods, 19th ALADIN and HIRLAM Workshop, 12-15 May 2009, Utrecht, the Netherlands
- Laszlo Kullmann: New interpolation formula in stable situation for the calculation of diagnostic fields at measurement height, 19th ALADIN and HIRLAM Workshop, 12-15 May 2009, Utrecht, the Netherlands
- Neva Pristov: ALARO physics developments, 31st EWGLAM and 16th SRNWP Annual Meeting, 28 September -1 October 2009, Athens, Greece