Working Area Physics

Progress Report

Prepared by:	Area Leader Neva Pristov
Period:	January – December 2013
Date:	February 2014

1 Progress summary

The efforts towards the achievement of a scale-independent ALARO physics package have continued in 2013.

Two research activities can be pointed out. The TOUCANS turbulence scheme is under extensive testing, validation of new ingredients which enable the emulation EFB approach is ongoing. The radiation scheme is substantial updated, many new achievements are included. After some years of development ACRANEB2 baseline version is now concluded. According to these developments it is foreseen that the first assembling step of ALARO-1 physics package can start soon.

The ALARO-0 baseline version is in the operational use or in pre-operational testing phase in almost all services. The quality of the model forecast has increased, good performance has been seen during the extreme precipitation event in June (flooding in parts of Austria and Czech Republic). ALARO-0 took part in the WGNE grey-zone inter-comparison experiment defined by WGNE group (simulation of North Sea cold-air outbreak case at various resolutions from 16km to 1km without and with parameterised moist deep convection). Based on the evaluation results, it can be seen that ALARO behaves very consistently across the resolutions.

2 Scientific and technical main activities and achievements, major events

Action/Subject/Deliverable: Turbulence scheme TOUCANS

Description and objectives:

Work continued to obtain a complete TOUCANS scheme. Theoretical studies, coding, testing and validation are ongoing on the various components with the aim to find suitable computation of turbulent fluxes.
Novelties in this year are listed below:

- Introduction of additional prognostic variable total turbulent energy (sum of potential and kinetic turbulent energy,
- Introduction of stability functions to emulate EFB (energy and flux budget, Zilitinkevich et al. 2012) approach,
- Revised parametrisation of TOMs (where non-local diffusion of heat and moisture is done now separately),
- Tests with prognostic handling of mixing length.

All above with influence of moisture on turbulence. In order to complete the scheme, new computation of shallow convection cloudiness needs to be finished (Current computation relies on JFG's shallow convection parametrisation via 'moist' Ri - Ri*)."

Regarding code, bug corrections, cleaning are done. Additionally new elements were inserted into code, such as emulation of the EFB and CBR scheme, a new more accurate fit of QNSE scheme. Developments are still done in cy36 but will now continue in higher cycles.

Besides, scientific evaluation and validation of this additional option, tuning of various options, extensive testing both in 1D and 3D are ongoing.

Influence of mixing length on quality of wind forecast was tested during the stay in Ljubljana. The analyses of few case studies shows improvement of wind forecast when using mixing length based on TKE, which does not overestimate mixing in situation with strong wind. However the change in turbulent mixing leads to cold bias in 2 meter temperature forecast. Also diagnostic of wind gust computed from TKE was examined. The “default” TKE based wind gust diagnostic tends to underestimation, so a modification of the formula was proposed (in order to account for skewness of the wind gust distribution) and tested in one month winter period in Slovenia.

First scientific paper on TOUCANS was prepared and submitted in JAS in July, submission of revision was in December 2013.

Comments: hard to beat current pseudo-TKE, still ongoing work to solve “moist issues”

Efforts: 10 person months

Contributors: I. Bašták Ďurán (Cz)

Documentation: technical documentation, stay report, poster at SRNWP PHYS-EPS, scientific paper submitted to JAS

Status: ONGOING, available for tests in pre-operational use

Action/Subject/Deliverable: Radiation scheme

Description and objectives:
During 2013, work on ACRANEB2 radiation scheme continued and at the end of the year its baseline version was ready. There are many new achievements, some unplanned developments proved to be necessary for the good performance. Short descriptions of major developments are listed:

- Some fundamentals of NER scheme were revisited; solution for computation of longwave gaseous transmissions (from 2012) proved to be sufficient;
- NER statistical model had to be reformulated in order to achieve required accuracy in clearsky case, still it cannot be used in cloudy case where modification of bracketing weights depending on cloudiness will be necessary;

- As a backup solution, more costly "exact" computation with two level intermittency was implemented in NER scheme - cloud optical properties are updated at every time step, while gaseous transmissions and bracketing weights are updated only from time to time (numerical experiments showed that 1 hour / 3 hour update frequency is sufficient for gaseous transmissions / bracketing weights);
- Broadband gaseous transmissions were refitted against reference based on more recent HITRAN 2008 spectroscopic data, CO2+ composition was updated to 2010 concentrations;
- Cloud simulation model from 2005 was updated in order to recalculate the fits against new and more reliable ice cloud data, this modification improved both solar/thermal heating rates with respect to FMR/RRTM references;
- Saturation of Rayleigh scattering was parameterized;
- Computation of direct surface albedo was modified by generalizing Geleyn's formula for its dependency on solar zenith angle (used in ISBA case) and tuning for newly introduced proportion of Lambertian reflection was delivered for sea, land and snow.
- Clean ACRANEB/ACRANEB2 interfacing with SURFEX was prepared, it ensures consistent use of single solar band in surface scheme and correct handling of direct/diffuse solar fluxes delivered by radiation scheme, as well as albedos coming out from surface scheme;

ACRANEB2 code was phased into cy40t1. There, it is also merged with new flexible physics-dynamics interface and, as a part of this exercise, ACRANEB2 was also placed under APL_AROME, so it can be called with AROME physics as well.

Currently, ACRANEB2 scheme is tested extensively in cy38t1. It is difficult to draw conclusions from offline 3D tests yet, since activation of ACRANEB2 brings up biases which may be related to broken error compensations. Retuning is not straightforward, because sensitive quantity - water vapour amount - has complex feedbacks with radiation, clouds, precipitation and surface processes.

Efforts: 9.5 person months

Contributors: J. Mašek (Cz*), P. Kuma (student)*

Documentation: CZ poster at ALADIN workshop, report

Status: ONGOING, ACRANEB2 baseline version was finalized and its recommended NWP setup was delivered.

Action/Subject/Deliverable: 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.

Efforts: 0.5 person months

Contributors: I. Bašták Ďurán (Cz), R. Brožková (Cz)

Documentation: Document with roadmap

Status: ONGOING, started with shallow convection cloudiness

Action/Subject/Deliverable: 1D2D turbulence scheme

Description and objectives:

Efforts: none

Contributors: none

Documentation: no

Status: POSTPONED TO 2014
Nothing new, this task has lower priority, can start when the first ALARO-1 version is available.

Action/Subject/Deliverable: Baseline of the ALARO-0 version

Description and objectives:

The ALARO-0 baseline physics is in the operational use in CHMI since December 2012, at ZAMG since January 2013, in Hungary and in Romania since 1 January 2014. Retuning of soil vegetation thermal index and few small corrections were implemented at CHMI; extra adjustments regarding the diagnostic computation of 2m temperature are done at HMS; the SK-scheme ALARO for better low stratus forecasts is used at ZAMG. In Slovakia and Slovenia e-suites are prepared with ALARO-0 baseline physics with cy38. . Plan in Croatia is to make first an upgrade to cy38 and include ALARO-0 baseline physics into their 8 and 2 km simulations.

There were many evaluations with ALARO-0 baseline physics: pre-operational validation and posting to cy38, in Austria tests with 90 vertical levels (overestimation of weak convection over orography is stronger), on request of Austrian's forecasters new domain in Himalaya was created. The model performance in the extreme orographical conditions will be studied.

Some attempts were done to improve diurnal cycle of soil temperature and by consequence diurnal cycle of air temperature at 2m including minimum and maximum values. One of the reasons is that the radiation cloud model current tuning is not optimal and will be improved only in new ACRANEB2 version. Proposal is to check soil vegetation thermal index. Retuning of only low vegetation part was done in Prague. Evaluation in Austria showed that deep soil humidity is the main problem during hottest days.

Some outcomes from ALARO-0 baseline validation are: very good forecast of the extreme precipitation event (begin of June) with flooding in Austria and Czech Republic; verification scores indicates improvements in the precipitation forecast (the fraction of correct forecasted events is higher for all precipitation classes, the very light unrealistic precipitation is reduced); prediction of low cloudiness and inversions during winter period are sometimes good, sometimes problematic; problems with T2m temperature (especially Tmax), development of the cold pool night is missing in mountainous areas which is the reason for bad Tmin values; snowfall line was sometimes too low as ALARO has the tendency to be too cold in the lower atmosphere.

ALARO-0 was used to participate at grey-zone inter-comparison experiment defined by WGNE group (`http://www.knmi.nl/samenw/greyzone/index.html`). North Sea cold-air outbreak case was simulated at various resolutions: 16km, 8km, 4km, 2km and 1km without and with parameterised moist deep convection. It can be seen that 3MT behaves very consistently across the resolutions, and even at 2km the resolved case solution gets closer to the 3MT one. The ALARO way to approach the grey-zone challenge seems to be approved.

Efforts: 5.5 person month

Contributors: local teams

Documentation: presentation and posters at ALADIN workshop, Documentation on the e-suite AJS

Status: PERMANENT, quality of NWP products is improved

Action/Subject/Deliverable: The ALARO-1 version

Description and objectives:

The last developments of Luc Gerard concerning the complementary sub-grid updraft and non saturated downdraft were implemented in the ALARO model, version CY36T1_op8, operational at CHMI (stay in Prague Luc Gerard and Doina Banciu).
Intensive tests were performed and several options were considered:

- advection of the draft mass flux instead of draft vertical velocity;

- choice of 'quasi monotonic' or 'shape preserving' for advection of draft velocity, draft mesh fraction and pseudo-historical convective cloudiness, in order to prevent the negative values;
- re-scaling the draft mesh fraction after advection

The validation of these options and the free parameter tuning were carried out for a ten days period (June-July 2009, with a special attention for July 29). Based on this results, selection of options which will be included in the code will be done.

The first assembling step (TOUCANS, ACRANEB2, unsaturated downdrafts) is postponed to next year.

Efforts: 1 person months

Contributors: D.Banciu (Ro)

Documentation: stay report

Status: waiting for the ACRANEB2

Action/Subject/Deliverable: SURFEX with ALARO

Description and objectives:

Coupling SURFEX_V7.3 to ALARO within cycle CY38T1 was the task of R. Hamdi during his stay in Prague. Compilation of the code, generation of two input files needed by SURFEX (PGD (surface physiographic parameters) file of the LACE domain and the initial file for the prognostic variable of SURFEX) and simulations with different options (SURFEX with ISBA 2L, ISBA 3L, ISBA 3L & TEB) were performed and compared with the operational ALARO. The coupling between SURFEX and TOUCANS scheme was also implemented (similar as it was done in cy36). The interface is done via the neutral drag coefficient Cdn. To achieve this 6 routines in upper air physics and 46 SURFEX routines have to be modified. Environment is prepared, scientific validation should follow.

There was no other action on the validation and preparation of SURFEX usage in the LACE teams.

Efforts:

Contributors:

Documentation: stay report

Status: slow progress, no LACE contribution

Action/Subject/Deliverable: Various products for users (forecasters)

Description and objectives: Mixed layer CAPE, storm motion vector, vertical wind shear, relative helicity and lightning diagnostics, where coded, but evaluation is still needed except for mixed layer CAPE which is already in operational use in Austria.

Vertical integral of graupel, which may serve as indicator for hail occurrence, is diagnosed in ALARO microphysics. Modifications were made to the code to obtain the maximum over a given period as an instantaneous flux.

An index indicating a chance of light snowfall in low stratus situations was implement in Austria.

Efforts: 3 months

Contributors: J. Cedilnik (Si), C. Wittmann (At), R. Brožková (Cz)

Documentation: reports

Status: Ongoing

Action/Subject/Deliverable: List of cases suitable for validation of schemes

Description and objectives:

Efforts:

Contributors:

Documentation:

Status: Nothing new

3 List of actions, deliverables including status

Subject: Turbulence scheme TOUCANS

Deliverables: paper submitted to JAS, implementation into ALADIN library

Status: ONGOING

Subject: Radiation scheme

Deliverables: first ACRANEB2 version, implementation into ALADIN library CY40

Status: ONGOING

Subject: Cloud scheme

Deliverables:

Status: PENDING

Subject: 1D2D turbulence scheme

Deliverables: -

Status: POSTPONED TO 2014

Subject: ALARO-0 baseline (operational implementation)

Deliverables:

Status: PERMANENT

Subject: The ALARO-1 version

Deliverables:

Status: ONGOING

Subject: SURFEX in ALARO

Deliverables: -

Status: ONGOING

Subject: Various products for users (forecasters)

Deliverables: code for computation of mixed layer CAPE

Status: ONGOING

Subject: List of cases suitable for validation of schemes

Deliverables:

Status: PENDING

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4 Documents and publications

List of reports:

Bašták Ďurán I. 2013: Report from stay in Ljubljana, 5 May - 31 May 2013 (TOUCANS local implementation, mixing length testing, wind gust diagnostics)

Cedilnik J., C. Wittmann, 2013: Extending the functionality of "convection diagnostics" in the ALADIN/ALARO/AROME FullPos software, part 2, Report from stay in Vienna, 19 - 30 August 2013 (TOUCANS local implementation, mixing length testing, wind gust diagnostics)

Mašek J., 2013: New gaseous transmissions in ACRANEB, presentation at meeting in Prague, 6-7 March 2013

Wittmann C., J.Cedilnik, 2013: Extending the functionality of "convection diagnostics" in the ALADIN/ALARO/AROME FullPos software, part 1, Report from stay in Ljubljana, 10 - 21 June 2013

Hamdi R., 2013: Coupling SURFEX_V7.3 to ALARO within cycle CY38T1, Report from stay in Prague, 4 - 18 December 2013

Scientific paper:

Bašták Ďurán I., J.-F. Geleyn, F. Vána: A compact model for the stability dependency of TKE production-destruction-conversion terms, valid for the whole range of Richardson numbers. submission of revision to JAS in December 2013.

List of presentations:

Bašták Ďurán I.: TOUCANS: Modular turbulent scheme enabling multiple settings for stability functions, mixing lengths and shallow convection parametrisation, Joint SRNWP Workshop on Model Physics and Ensemble Prediction Systems Madrid, 18 to 20 June 2013, AEMET, available online: http://srnwp-eps.aemet.es/wp-content/uploads/2013/02/Book-of-abstracts-PHYEPS2013.pdf, poster

Brožková R.: ALARO-0 baseline: status and latest results on convective diurnal cycle an overview , Joint 23rd ALADIN Workshop & HIRLAM All Staff Meeting, 2013, 15-19 April, 2013, Reykjavik, Iceland
available online: http://www.cnrm.meteo.fr/aladin/spip.php?article165

Geleyn J.-F.: Scanning basic parametrization choices in a state-of-the-art NWP high-resolution model, with respect to their basic potential for generating stochasticity, Joint SRNWP Workshop on Model Physics and Ensemble Prediction Systems Madrid, 18 to 20 June 2013, AEMET, available online: http://srnwp-eps.aemet.es/?page_id=29

Pristov N.: Possibilities of the ALARO Physical Package for the use in EPS, Joint SRNWP Workshop on Model Physics and Ensemble Prediction Systems Madrid, 18 to 20 June 2013, AEMET, available online: http://srnwp-eps.aemet.es/?page_id=29

Pristov N.: ALARO-1 an overview , Joint 23rd ALADIN Workshop & HIRLAM All Staff Meeting, 2013, 15-19 April, 2013, Reykjavik, Iceland
available online: http://www.cnrm.meteo.fr/aladin/spip.php?article165

Pristov N.: ALARO physics developments , 35th EWGLAM & 20th SRNWP joined meetings, 30 September - 3 October, 2013, Antalya, Turkey, available online: http://srnwp.met.hu/Annual_Meetings/2013/download/wednesday/Neva_Pristov.pdf

National posters at Joint 23rd ALADIN Workshop & HIRLAM All Staff Meeting, 2013, 15-19 April, 2013, Reykjavik, Iceland: Austria, *Croatia*, *Czech Republic*, Hungary, Slovakia, Slovenia, *and Romania*, available online: http://www.cnrm.meteo.fr/aladin/spip.php?article165

National posters at 35th EWGLAM & 20th SRNWP joined meetings, 30 September - 3 October, 2013, Antalya, Turkey: Austria, Croatia, Czech Republic, Hungary, Romania, Slovakia and Slovenia, available online:http://srnwp.met.hu/ Annual meetings 2013

5 Activities of management, coordination and communication

Meetings:

- 23st ALADIN Workshop and & HIRLAM All Staff Meeting 2013, 15-19 April, 2013, Reykjavik, Iceland (participation of Neva Pristov).
- Joint SRNWP Workshop on Model Physics and Ensemble Prediction Systems Madrid, 18 to 20 June 2013, AEMET (participation of Jean-Francois Geleyn, Neva Pristov).
- 35th EWGLAM & 20th SRNWP joined meetings, 30 September - 3 October, 2013, Antalya, Turkey (participation of Neva Pristov).
- Networking, visit at CHMI and LSC meeting, 6 - 12 March ,CHMI, Prague, Czech Republic (participation of Neva Pristov)
- Web meetings on physics-dynamics interface (participation of Radmila Brožkova, Neva Pristov, Jan Mašek)

6 Summary of resources/means

Subject/Action/deliverable	Resource		LACE		ALADIN Flat-rate	
	planned	realized	planned	realized	planned	realized
TOUCANS	5	10	1	1	0.5	
Radiation	4	9.5				
Cloud scheme	2	0.5				
1D2D turbulence	2	-				
ALARO-0	3	6.5				
ALARO-1	4	1	1	0.75	1.75	1.25
SURFEX with ALARO	4					0.5
Additional fields	2	3	1.5	1		
List of cases	1					
Total:	**27**	**30.5**	**3.5**	**2.75**	**2.25**	**1.75**

LACE scientific stays:

Ivan Bašták Ďurán: TOUCANS, Ljubljana, 1 month (5-31 may 2013)

Doina Banciu: ALARO-1 assembling step 1, Prague, 0.75 month (24 Nov - 14 Dec 2013)

Christoph Wittman: Additional post-processed products, Ljubljana, 0.5 month (10 - 21 June) (*0.5 month moved to 2014)*

Jure Cedilnik: Additional post-processed products, Vienna, 0.5 month (19-30 August)

ALADIN Flat-Rates Stays

Michiel Vanginderachter: Cleaning of 3MT routines, replacement of the use of moist static energy in convective computations, Prague, 0.25 month (4-8 February)

Michiel Vanginderachter: Prognostic graupl, Prague, 0.25 month (8-15 December)

Joris Van der Bergh: Microphysics – aspects of cloud and precipitation geometry – a sensitivity study, Prague, 0.5 month, (15-30 June)

Luc Gerard: Further consolidation of new developments in convection, Prague, 0.25 month, (24-29 November)

Rafiq Hamdi: TOUCANS with SURFEX, Prague, 0.5 month (4- 18 December 2013)