ALADIN NEWSLETTER 34

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CONTENT

1. EDITORIAL

1.1. Foreword

Dear reader,

These are interesting times for NPWers.

We live in the year 2008, the year when AROME becomes operational. This is a remarkable milestone for different reasons. It is the first example in our community of a major link with academia, an action point that has become quite hot on the agenda of the joint HIRLAM-ALADIN collaboration. The ALADIN community, in particular the GMME group of Météo-France already has a particular experience to offer. Indeed, Meso-NH has been developed in close collaboration with universities. This led to a state-of-the-art research tool in atmospheric sciences. In 2002, it was decided to use the physics of this model as a contribution to a new complete NWP system for the kilometre scales. We are witnessing it now becoming operational. This is the best proof that academic research can find its way downstream to operations in Europe.

This leads us to the second reason. The literature on the properties of physics-dynamics coupling is very thin. We know from a few publications and work in the IFS model that the physics-dynamics coupling is relatively sensitive to the details of the numerics. This suggests that such an exercise is not straightforward. One may make some compromise on the stability aspect of the coupling, but at least regarding the accuracy the concern seems pertinent. In fact from the results from the AROME model we should now say “seemed”. Indeed, the endeavour that is now nearing its completion in AROME has been nothing else than plugging a new physics packages as a whole into the NH dynamics of the ALADIN model, while avoiding the main associated traps. Personally I consider this a major step and we should all be very proud of that.

At the same time, 2008 is the year when some ALADIN models will be running operationally in some countries with the new ALARO-0 package with the so-called 3MT solution. This package addresses several problems. A remarkable one of the three M’s stands for *Multiscale*.

Physicists have been realizing for a long time that nature does not have some preferred scale. They are trying to describe nature with as few as possible of them (think of the Planck scale for instance). This led to several formulations of nature’s laws that are scale independent. For instance the quantum theories describing the electro-weak and the strong interactions have the same formulation at all scales. What changes going from one scale to another is a *renormalization* of the physical quantities, in particular some constants such as, for instance, the electric charge.

Meteorologists have a very strong intuitive feeling for scale dependency but are not familiar with this concept of re-normalization; the atmosphere seems not to be re normalizable at first sight. For instance, the equations of fluid mechanics as we use them in the laboratory are simply not valid at our very familiar mesoscale: we need physics parameterizations. We know that all too well. Nevertheless, the following scientific question is a very challenging one: could we start from the large scales and formulate parameterizations that scale back to the Navier-Stokes equations in the high-resolution limit? In my opinion it is scientifically a very pertinent one and it transgresses the borders between meteorology and physics. A positive answer to this might raise the interest of scientists outside the meteorological community.

A few years ago this question seemed totally crazy. The tests with ALARO-0 give a first glimpse that this may not be so crazy after all. ALADIN with ALARO-3MT can run both at 10 km *and* in the grey zone and produces results that are coherent between the scales. That is not just a small feat, this is a major test. What's more, it has been done in our community. No doubt, we should be proud of that too.

So now comes the next challenge: can we keep the strength of both these developments? There are different aspects of this. The most pressing one is their operational implementation. But not less important is to anticipate *now* how to foster such future scientific developments. Because the final word has not been said nor written about the numerics of coupling different packages in models, nor about kilometre scales and the grey zone. And related to that, there are the technical *and* the scientific maintenance. These are big challenges. Their success will be crucially depend on our capacity to realize what we know as *Interoperability.*

And this brings us to another issue that makes 2008 particular. Interoperability has been one of the reasons for EUMETNET to refresh the C-SRNWP concept that coordinates the NWP networking activities of the MetOffice, COSMO and HARMONIE (ALADIN, HIRLAM and RC-LACE). This is now in the hands of András Horányi, who became the SRWNP coordinator. Knowing him as our ALADIN colleague (yes, once an aladinist always an aladinist) and what he did for our community in the past, we know he will do an excellent job. Congratulations András.

So, given all that, let us realize the wealth of what we got and be careful not to lose any of these treasures. Will we be able to cope with it? I don't have a crystal ball. But indeed, these are truly interesting times.

Piet Termonia

1.2. EVENTS

ALADIN/HIRLAM WORKSHOP Brussels Belgium 7-10 April 2008

Workshop “Convergence” Toulouse 24-25/09/08

LACE STEERING COMMITTEE 11-12 September 2008 Bratislava, SK

EWGLAM/SRNWP 6-9 October 2008 Madrid, Spain
http://www.aemet.es/en/anuncios/congresos/detalles/ewglam2008/

News from Bulgaria: Awarding of Mr. Bisch with a medal for fruitful cooperation.

Signing a new convention between METEO-FRANCE and NIMH. (Mr. Tcankov and Mr. Bisch)

Le WEDDINGGGGGGGGGGGGGGGGGGGG
(and no more single ....)

1.3. ANNOUNCEMENTS

13th GA 6-7 October 2008 Lisbon, Portugal
HAC 20-21 November 2008 Toulouse, France

2. OPERATIONS

2.1. CYCLES

(joel.stein@meteo.fr)

The description of the validation of the new e-suite 2008_01 will be described in the next issue of the ALADIN Newsletter. This e-suite includes the adding of the AIRS and IASI data together with HIRS data of METOP. Some GPS data have been added up to 25 km. This e-suite also includes the modification of the gravity wave drag and a modification of the turbulence exchange coefficients near the ground for stable conditions. The main result of the validation corresponds to a reduction of the error in the stratosphere which is now comparable to that of ECMWF stratosphere.

2.2. BULGARIA

2.2.1. CHANGES IN OPERATIONAL SUITE OF ALADIN-BG

(andrey.bogatchev@meteo.bg)

Several changes occurred in the operational suite of ALADIN-BG after the workshop in Oslo.

During the second half of 2007 we got a new machine. Due to very long reconstruction of the computing hall of our institute, real work with this machine started in December 2007.

The machine is a LINUX cluster, containing four nodes, each node has two processors Intel Glovertown E.5310 at clock rate 1.8 GHz, Quad core. Thus, we have eight kernels per node. Each node has 4144787456 bytes memory and 250 GB local disk storage.

There is additional server with four processors and a 1.4 TB disk storage. It is hosting several servers running on it - DNS, DHCP, NFS, http (web), the software managing, the RAID controller. The front end machine is a virtual one running on two processors of this server. It is also hosting the common file system visible and accessible for the front end machine and the nodes. For MPI exchange the nodes are connected via Infini Band switch, inside nodes shared memory is used, and 1GB switch for NFS. For MPI is used mvapich2-0.9.8-15 release of MPI2. Compilers are Intel FORTRAN and C 10.1.012, 64 bit release. The operating system is 64 bit LINUX 2.6.18-53.1.13.el5xen #1 SMP.

Cycle 31t1op1 was ported to the cluster. Some bugs were fixed in calls to FA routines. Fixes were sent to the Toulouse system support team. Routine sueqlimsat.F90 was modified with the aim to be used under B level parallelization. Compilations were done on the front end machine, using gmkpack. LAPACK, BLAS and EMOS library 2.63 also were ported. Integration of 72 hours forecast is performed for 13 minutes on cluster, using 32 processors (cores) on A level of parallelization, which is 9.8 times faster, then the integration on the two processors LINUX PC.

In early spring 2008 operations switched to the cluster.

During January 2008, a new high resolution telecom domain for SELAM was created (Many thanks to Martin Janousek for his help). A set of coupling files for tests from 15.01.2008 to 25.01.2008 00 UTC run up to 54 hours forecast range on three hours coupling. The tests were run in two versions 60 to 46 levels and 60 to 60 levels. All the tests were successful.

A set of GRIB files for use in SYNERGIE in Bulgaria was prepared.

The switch to the new couplers happened on the 04 of June 2008. Since that date there is a parallel suite running on 60 levels. It is configured to run using B-level parallelization, which increases the performance by 27.35%. The integration time with B-level is 725s, and the time with only A-level 998s. Thus the integration time with 60 levels on vertical using B-level parallelization is exactly the same as for 46 levels with A-level parallelization.

ALADIN CLIMAT 4.6 was ported on the cluster for the purposes of the regional climate simulations. The ERA40 runs from 1958 to 2000 were performed and results were presented on CECILIA project meeting in Varna, May 2008.

2.3. FRANCE

(F. Bouttier, 21 Oct 2008)

Feb 2008 cy32T2 update of ARPEGE, ALADIN, PEARP, ALADIN-Réunion and ARPEGE-Tropics:

- increase of horizontal and vertical resolutions in ARPEGE/ALADIN: the vertical resolution in both models is increased from 46 to 60 levels, with the extra resolution concentrated near the tropopause; the ARPEGE forecast model resolution is increased from T358 (i.e. from 134 to 23km, depending on the location; model timestep is 15mn) to T538 (i.e. from 90km in the South Pacific to 15km in Western Europe); the ARPEGE 4DVar horizontal resolution of increments is increased from T159 to T224(i.e. 90km).
- introduction of a vertical discretisation based on vertical finite elements (as is done at ECMWF)
- implementation of a variational bias correction scheme for satellite radiances
- background error covariances for the variational assimilations are precomputed from an ensemble of ARPEGE assimilations.
- Scatterometre winds: assimilation of Metop ASCAT, revision of the bias correction for Quikscat and ERS2 data.
- Real-time monitoring of 314 radiance channels from the IASI instrument on MetOp-A satellite
- increase of the parametrised vertical diffusion in the free atmosphere
- implementation of a more efficient (pdf-based) precipitation sedimentation algorithm in the parametrisation of resolved microphysical processes.
- ALADIN-specific modifications: Assimilation of AIRS radiances from the Aqua satellite; SEVIRI radiances are not subject to the variational bias correction; revision of the digital filter initialisation (new one is incremental); reduction of the statistical weight given to observations in 3DVar

Changes to the PEARP ensemble forecasting system are:

- change to the model vertical resolution from 46 to 55 levels, i.e. like the ARPEGE 60 levels, but truncated at the top (at 50km altitude), and no change to the horizontal resolution (which stays at T358c2.4)
- the initial perturbations of the ensemble now are a combination of singular vectors and evolved perturbations of the previous PEARP run (10 perturbations from 24h earlier)
- introduction of a flow-dependent background error estimate in the computation of singular vectors
- the singular vectors are now a combination of targeted singular vectors over Europe-North Atlantic (16 vectors at resolution T95L55), the Northern, Southern Hemispheres and the Tropics (10,20 and 10 vectors, respectively, at T44L55 resolution).
- the number of non-linear ARPEGE forecasts remains at 11. The output is disseminated to the THORPEX/TIGGE database since Nov 2007.

The impact of this change is a marked improvement to the dispersion of the ensemble over the whole globe (previously it was restricted to a neighbourhood of Europe).

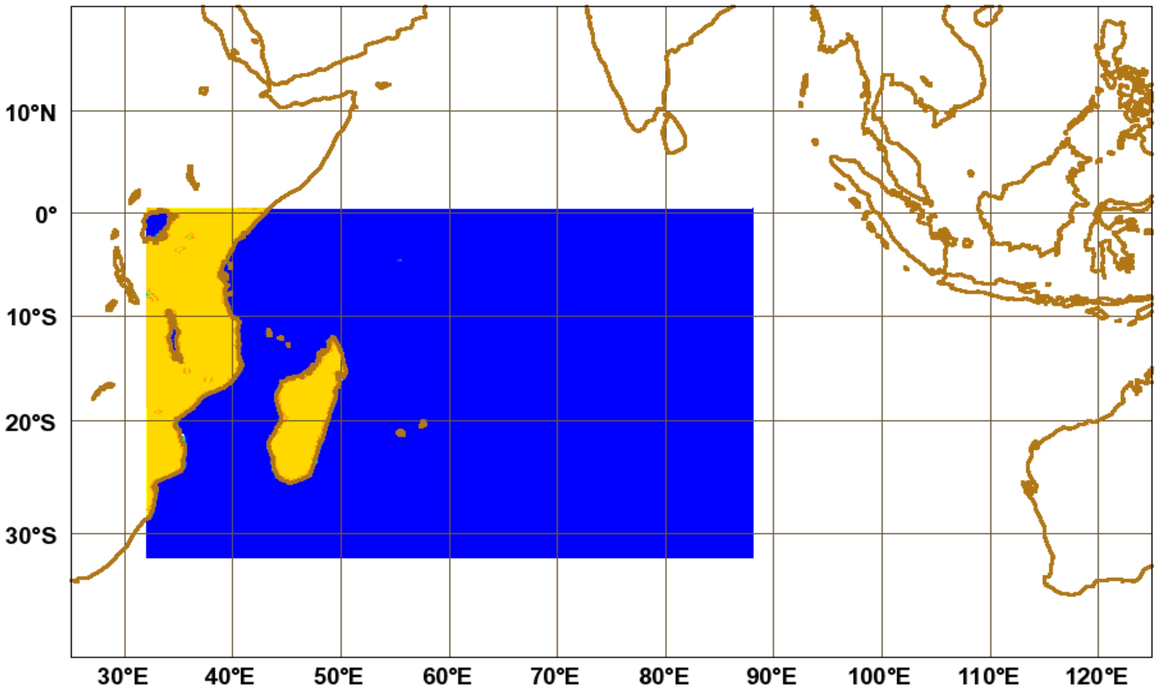
Introduction of a new ensemble data assimilation system:

6 ARPEGE members with 3D-FGAT assimilation, the variances are used in the main

ARPEGE data assimilation suite (in Jb & the screening).

Changes to the tropical model system:

- the global ARPEGE-Tropics model (at uniform resolution) is now initialised from the ARPEGE-France T538L60C2.4 analysis, and the previous ARPEGE-Tropics 4DVar assimilation suite is removed. The production from ARPEGE-Tropics is not changed.
- the horizontal and vertical resolution of ARPEGE-Tropics increases to 10km and L60, in line with the other ARPEGEs and ALADIN-France.
- the geographical domain of the regional ALADIN-Réunion modelling system is enlarged (see the following picture), and its vertical resolution increases to L60, in line with the other models.
- ALADIN-Réunion is coupled to ARPEGE-France (i.e. no longer to ARPEGE-Tropics)



June 2008 cy33T0 upgrade of ARPEGE/ALADIN:

- assimilation of more satellites radiances: Metop/IASI (50 channels) and Metop/HIRS radiances; more Aqua/AIRS channels in the troposphere; DMSP-F14/SSMI microwaves; Meteosat-9/SEVIRI clear-sky water vapour radiances in ARPEGE (SEVIRI raw radiances are already used in ALADIN);
- assimilation of surface-sensitive microwave channels over land using a new representation of land surface emissivities (for AMSU-A, AMSU-B, MHS from NOAA and Metop satellites)
- assimilation of more tropospheric GPS radio-occultations and more aircraft reports
- 4D-Var background error variances are flow-dependent and derived from the ensemble

data assimilation system (6 ARPEGE 3DVar-FGAT assimilations at T358L60c1 resolution with perturbed observations)

- blacklist night time T2m and HU2m observations in ALADIN
- physics: improve the low-level vertical diffusion in stable conditions, the subgrid orographic drag parametrisation, and snowmelt in the precipitation scheme.
- ALADIN only: timestep changed to 450s, post processing change over lakes, variational bias correction for Meteosat/SEVIRI radiances.
- ARPEGE Tropics only: upgrade resolution to T539L55 i.e. 37km uniform horizontal resolution, and retire ARPEGE-Tropics assimilation (forecasts are now initialized from the variable resolution ARPEGE 4DVar assimilation)

cy33T1 update of ARPEGE/ALADIN/AROME: test suite started in summer 2008, implementation planned for January 2009:

- new vertical diffusion / boundary layer scheme in ARPEGE/ALADIN: CBR prognostic 1D turbulent kinetic energy coupled with Kain-Fritsch (KF) shallow convection scheme (through a dedicated thermal production term, and convection-sensitive turbulent length scale
- damping of deep convection scheme in order to avoid double-counting with KF scheme
- new 'ECUME' sea surface flux parametrisation in ARPEGE/ALADIN
- assimilate more IASI channels, particularly over land and sea ice
- assimilate cloudy AIRS radiances using CO2-slicing technique to derive cloud parameters
- assimilate EARS Modis wind data
- operational implementation of the AROME system is expected in Nov 2008 (see likely content below)

Status of AROME-France

Recent changes include:

- retuning of the horizontal diffusion, which used to cause excessive divergent winds and cooling under large convective clouds.
- a subgrid model ('Canopy') of the 1D boundary layers at low levels has been implemented, which cures biases in the vertical interpolations of wind, temperature and humidity to measurement heights.
- implementation of a subgrid non-precipitating convection scheme (EDKF), which cures problems of excessive "herringbone" organisation of low-level winds in weakly convective boundary layers. EDKF is derived from the EDMF (eddy damping/mass flux) and KFB (Kain Fritsch Bechtold) concepts.
- the SLHD horizontal diffusion has been reintroduced (in a very different form from the original one used in 2006)
- assimilation of doppler radial winds from the French network.

Current known problems include biases in soil moisture, a lack of clouds and precipitation over sea (due to overly dry ALADIN lateral boundary conditions), spurious precipitations near the model lateral boundary (due to discontinuities in the orography), an overestimation of strong precipitation quantities, wind-speed biases near mountain crests and valleys.

2.4. HUNGARY

(kullmann.l@met.hu)

There were only small changes in the operational version of the ALADIN/HU model during the first half of 2008:

- We use ATOVS (AMSU-A and MHS) data from the NOAA18 satellite operationally.
- An automatic update of ATOVS bias correction files was implemented.
- We run our Dynamical adaptation reference parallel suite on the operational SGI machine on cy30t1.
- Our post processing is based on the output of the production forecast at 15 min. frequency.
- We use the high resolution ARPEGE LBC files (as all the members do).

The main characteristics of the recent deterministic operational suite:

- ALADIN cycle: cy30t1
- Horizontal resolution: 8 km
- Vertical levels: 49
- Grid: linear
- Data assimilation: 3d-var with 6h cycling
- Observations: SYNOP (geopotential), TEMP (temperature, wind components, humidity, geopotential), AMDAR (temperature, wind components), ATOVS:AMSU-A and AMSU-B radiances, MSG/GEOWIND (AMV), SYNOP SHIP, WINDPROFILER.
- Production is performed 4 times per day: 0 UTC (+54h), 6 UTC (+48h), 12 UTC (+48h), 18 UTC (+36h).

The quasi-operational dynamical downscaling of Meteo France's PEARP system by the ALADIN model started in February.

The main characteristics of this ALADIN model version are as follows:

- Horizontal resolution: 12 km
- Domain covering basically the continental Europe (LACE domain)
- Vertical resolution: 46 levels
- Integration once per day to 60h starting from the 18 UTC data
- Boundary conditions updated every six hours by the ARPEGE EPS (PEARP) system.

At present work is going on in the field of visualization and verification of this ALADIN LAMEPS system.

Parallel suites during the period:

- Dynamical adaptation as a reference to 3d-var system at same vertical and horizontal resolution (moved to the operational SGI machine and based on cy30t1).
- An atmospheric 3d-var + surface OI (Canari) data assimilation suite was run and compared to the operational 3d-var suite.

2.5. POLAND

Marek Jerczyński *(zijerczy@cyf-kr.edu.pl)*

During the first half of 2008 many minor changes and improvements were made in the operational software. Among them, enhancement of ALADIN operational environment reliability and robustness, modification of visualization methods and a few NWP products – mainly meteograms, local bases, intra/extranet www pages. Some developments were carried out to prepare operational production of input data for INCA nowcasting system. During the period pre-operational runs of ALADIN configuration with 10km resolution was also launched.

ALADIN operational suite:

- version: AL29T2mxl
- domain: 2270 x 2270 km
- grid size: 169 x 169 x 31 (180 x 180 x 31 with extension zone)
- resolution: 13.5 km
- grid type: quadratic
- timestep: 600 sec.
- range: 54 hours
- coupling model: ARPEGE
- coupling frequency: 3-hour frequency
- runs: 2 / day
- hardware: SGI Altix 3700 – 8/16 Itanium2 CPU's

2.6. PORTUGAL

Maria Monteiro, João Rio, Manuel Lopes, Nuno Lopes, Lígia Amorim, Vanda Costa,
João Batista, Gonçalo Santos, Ricardo Ramos, Victor Prior
(for details: cppn@meteo.pt)

2.6.1. Introduction

During the first half of 2008 we started implementing several important changes in the NWP operational systems in Portugal. First and mostly, the ALADIN 32T3 package was installed on the new IBM p575 system. This new HPC platform should allow the integration of the ALADIN model within a bigger domain than the actual one, therefore encompassing a large area covering the Atlantic Islands of Madeira and Azores of the Portuguese territory. With the local version of the model we intend to take advantage of ARPEGE coupling resolution increase at the requested geographical area. Moreover, we are working to increase the number of model levels from 37 to 46, as well as the number of surface coupling variables. With these new features we have planned to increase the model resolution from a 12,7km mesh size to 9km. On the other hand, all the technological infra-structure for data processing, archival and visualization was upgraded and a new multicore system was implemented, based on a cluster of Dell PowerEdge 2950 server and an upgraded version of the Linux distribution Paipix/IM and the locally-deployed NWP database TIDB2 (a database API for real-time and historical archiving). The Dell system was prepared as a front-end device to the IBM HPC, and ECMWF's SMS software is being used for batch job scheduling from a Dell machine to the HPC cluster. ECMWF's Metview and MAGICS will still be the main tools for data visualization. As a side effect of that upgrade, the team is planning the modelling on the Atlantic Islands, and therefore AROME was installed in test mode and prepared for the first trial experiences. Up to the end of the year, the new NWP system should start its operations; however, there already are several new f end-products delivered to clients through parts of the new system, such as Internet-available information.

We also point out that the validation of the new cycle against the current one has taken place and will be reported in further publications.

Finally, several training courses have been prepared by the team at IM, both for local participants, as well as for a wider (international) community.

2.6.2. Operational system

On 12 UTC run of June 6^{th} this year, 28T3 of ALADIN/Portugal entered into operation. This system was the result of the main changes reported herein:

- actual computer environment: Alpha server cluster ES40, 667MHz, 3Gb memory True64 (V5,0); native F90, F77 and C compilers;
- actual model characteristics: new geographical area using as central point of domain (long=350.9ºE; lat=39.8ºN), most SWestern point (long=345.2ºE,lat=34.76ºN), most NEastern point (long=356.6ºE,lat=44.84ºN), resolution=0.12, number of points along lat=85, number of points along long=96.

2.6.3. Pre-operational system

• <u>new computing environment</u>:

IBM HPC p575 cluster: 10 nodes with 16 power 5 CPUs, 32GB memory each, 2TB total disk space, IBM AIX operational system.

Dell PowerEdge 2950 cluster: 10 duo quad-core Intel Xeon 2.66GHz CPUs, 4x2 GB memory each and 8TB total disk space each.

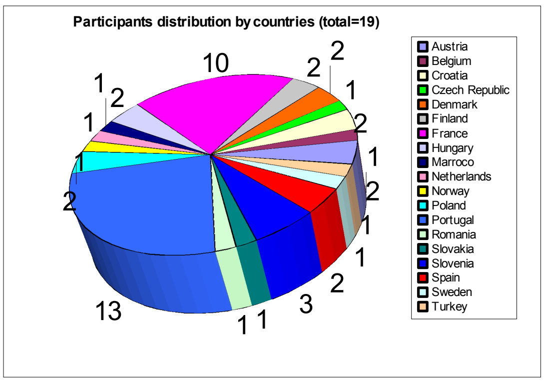
- new model characteristics: cycle 32T3; new geographical area using as central point of the domain (lon=341,52ºE; lat=37,32ºN), most SWestern point (long=323ºE; lat=28,0ºN), most NEastern point (long=0,04ºE; lat=46,64ºN), resolution 0.9, number of point along lat=463, number of point along long=233, time step: ~415,vertical levels=46, integration frequency=twice a day, forecasts range=72, coupling model=ARPEGE, coupling frequency=3 hours.
- available configurations: 001, ee917, 701 and dynamical adaptation for three different domains: North, Centre and South of main land in Portugal.

2.6.4. 4. AROME training course

From March 4th to March 7th 2008, the 2nd AROME training course was held at IM headquarters in Lisbon, as a joint organization of the Portuguese meteorological service and Météo-France.

This training course attempted to be a natural answer to the Portuguese Universities' interest in setting up collaboration with the ALADIN community, in particular on the development of the new generation models.

Lectures on theoretical aspects on Méso-NH physics, AROME settings, NH dynamics in "A-models", radar assimilation, RUC in AROME, DDH, SURFEX and on how to run AROME in the real-time weather forecast and research modes were balanced with tutored activities with 1D and 3D exercises performed remotely using ECMWF computer resources.



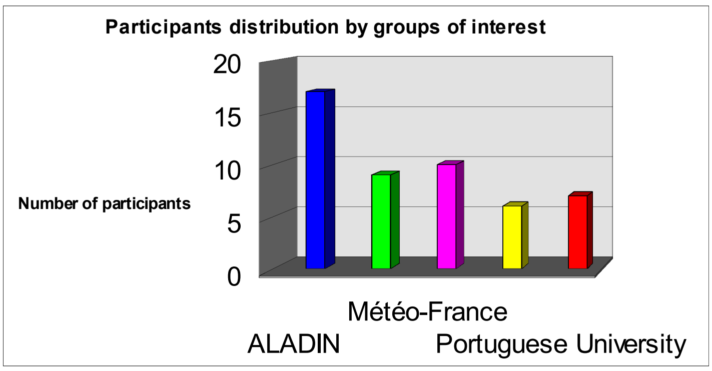


Figure – Statistics on the participants: a) by countries; b) by groups of interest

Participant statistics are illustrated in Figures A and B. Some of the general discussion points abridged during this training course have shown that:

- inclusion of tutorial classes add value to this kind of training courses;
- manpower on high-resolution modelling critical points is required to keep collaboration with ECMWF;
- there is an open door for research interaction with academia, but more (and better) documentation is needed; besides this, data formats should take into account the research environments (netcdf instead of lfa/grib);
- there is a need to find both an efficient way to communicate inside the AROME user community as well as planning an AROME users' meeting for the near future.

2.6.5. Foreseen activities

We expect to implement into operations, by the end of the year, the new ALADIN systems described in section 3. Furthermore, additional efforts should take place to find a modelling solution for the Atlantic Islands of Portugal, in particular using the AROME implementation already prepared. Some attention will be paid to verification tools and some initial planning should start for the creation of a data assimilation scheme.

2.7. ROMANIA

(for details doina.banciu@meteoromania.ro)

The operational suite is almost untouched. The changes concern only;

- The implementation of the new Aladin statistical adaptation (*Otilia Diaconu*)
- The reorganization of the Aladin operational verification (Cristina Cretu, Otilia Diaconu)

It includes descriptive diagrams (scatter plots, histograms, box plots) and confidence intervals for all computed scores. The precipitation scores are carried out only for 6 hours cumulated amounts with respect to the observation data from synop stations. The verification of the 24 hours cumulated precipitation is anticipated by including the observation from the hydrological stations.

2.8. SLOVAKIA

2.8.1. Status of ALADIN operational activities at SHMI (changes between 02/2007 and 08/2008) oldrich.spaniel@shmu.sk

HARDWARE
* Computer [no change]:

- IBM Regatta
- 32 CPUs of 1.7 GHz
- 32 GB RAM
- 1.5 TB disk array

* Archiving facility [no change]:

- IBM Total Storage 3584 Tape Library with IBM Tivoli Storage Manager
- current capacity of tapes around 30 TB
- used for automatic backup of ICMSH files, GRIBs and selected products

OPERATIONAL SUITE

* Domain and geometry [no change]:
- 309 x 277 points (C + I zone)
- dx = 9.0 km
- quadratic truncation
- 37 vertical levels

* Operational model version [no change]:

- cy32t1 - ALARO with 3MT

* Integrations [no change]:

- 4 runs per day (00, 06, 12 UTC up to 72 hours, 18 UTC up to 60 hours)

* Pseudo assimilation cycle (Upper air spectral blending)

- 4 runs per day (00, 06, 12, 18 UTC up to 6 hours with long cut-off ARPEGE LBCs)
(Assimilation guess is used to copy new hydro-meteor fields, TKE and new 3MT prognostics fields)

OTHER OPERATIONAL ACTIVITIES

* INCA precipitation analysis is in operational mode every 15 minutes.
* Upgrade of run_app and monitoring system of the operational applications.

ARPEGE LBC DOWNLOAD

Both assimilation and production LBC are downloaded 4 times per day. Primary channel is internet/ BDPE. Backup of production LBC is done via ECMWF and ZAMG.

2.9. SLOVENIA

(more details neva.pristov@rzs-hm.si)

The new computer, a SGI Altix ICE 8200 system (for the detailed description see the previous newsletters), has allowed us to renovate our ALADIN operational suite. The decision was made to migrate in two steps. The aim of the first one was to move ALADIN operational production to the new HPC infrastructure only with some adaptation and to switch off the previous cluster as soon as possible (electricity, air-condition demands). In the second step the extension of the operational suite with the model cycling and higher resolution is planed.

After few months of testing in parallel suite, the suite became operational on 16. June 2008. The main characteristics are: domain is unchanged (9.5 km, 258*244 points), number of vertical levels has increased from 37 to 43, a linear grid is used instead of a quadratic one, ALADIN code cy32t3, ALARO-0 with 3MT, use of prognostic albedo and snow density, 4 runs per day (additional run at 06), time-step is 400s, range of forecast depends on the run - 72 hour for 00 and 12 run, initial and lateral boundary conditions from ARPEGE, coupling at every 3 hours, digital filter initialization.

Some changes and adaptations were done also in production of various products. It can be mentioned that the domain for dynamical wind is slightly larger, also all vertical levels are used.

Previous concept for triggering of suite tasks in SMS, which was more sequential has been revisited. Many tasks can now run simultaneously already during the model integration.

The model integration is using now 64 processors on 8 nodes, the 72 hour forecast is finished in half an hour, optimal with the coupling files availability. The whole production suite is completed in an hour.

Cy32t3 with the 3MT patch (April 2008) was compiled with Intel 10.1 Fortran compiler, em64t architecture using gmkpack 6.2b2. However, running unoptimized code is causing crashes during grib packing (NVGRIB=2 in NAMFA). Therefore (mostly for testing reasons) an additional patch by Ulf Andrae was used as a remedy. There are some issues with ee927: the configuration does not work on more than one node (8 processors).

Any higher level of optimisation than -O1 causes some variability at the less significant decimals of the norms with configuration 001. This occurs even when repeating the same run with exactly the same input data.

ODB with CANARI package has been successfully tested (for SYNOP data), following instructions and script by Alena Trojakova.

Rfa (and Rgrib) packages for visualisation was adapted for contemporary state borders and the maximum size for reading the file was increased.

INCA analysis and nowcasting system is routinely running in pre-operational mode every hour and every half an hour for precipitation and precipitation-derived products. During the last five months it has been subject to validation from forecasters and interested users. The operational suite has been implemented into the SMS supervision system. Some additional products (mainly convective indices and convection-related atmospheric parameters) have been included. Further evaluation is planned.

2.10. TURKEY

Ersin Kucukkaraca

2.10.1. Summary

CY32T3 was successfully installed on TSMS's IBM computer system. TSMS has been running ALADIN CY32T3 in pre-operational mode. Fully operational implementation is still in progress.

2.10.2. Operational design of Aladin-Turkey:

Model version: CY32T3

- **Model geometry**
  - 10 km horizontal resolution
  - 259 X 389 grid points
  - 46 vertical model levels
  - Linear spectral truncation
  - Lambert projection
- **Forecast settings**
  - Digital filter initialization
  - 415 sec time-step
  - LBC coupling at every 3 hours
  - Hourly post-processing
  - 2 runs per day (00 and 12 UTC) with 48 hours forecast lengths
- **Hardware**
  - Main Computer: IBM p690 (16 CPU, 32 GB memory)
  - Archive System: 20 TB Disk storage, 165 TB Tape storage

3. RESEARCH & DEVELOPMENTS

3.1. FRANCE

(F. Bouttier, 21 Oct 2008)

Here is but a mere summary of the manifold NWP-related MF R&D.

3.1.1. Algorithmics - model

Karim Yessad has spent several month at ECMWF, where several problems linked to the NH dynamics have been solved, with the help of some partners. Now ECMWF has a working global version of the Aladin-NH dynamical core, which is deemed suitable for subsequent NH developments for the IFS. Current global NH tests exhibit scores similar to the hydrostatic IFS'. The stratospheric scores require further work, which is likely to include development of NH vertical finite elements, possibly involving changes of prognostic variables. ECMWF also plans to work on the NH core's computational efficiency.

Test have been performed on high vertical resolution AROME runs. Different options for the AROME dynamics have been considered, the d4 2-TL SI has been selected.

Tests are beginning for the future ARPEGE T799L70c2.4 high resolution version, with a whopping ~10km resolution over Europe, due for implementation in 2009.

AROME developments have focused on finalising the 1st operational version of AROME-France, the highlights are listed in the 'Operations - France' section of this Newsletter.

The rotated Mercator ALADIN geometry has been implemented in cooperation with our HIRLAM colleagues.

Fabrice Voitus' Ph.D is nearing completion, with interesting results that will still require considerable work before practical applications can be envisaged.

3.1.2. Algorithmics - assimilation

The CONGRAD preconditioning has considered developments contributed by CERFACS.

The ensemble data assimilation has been implemented and is now used operationally. There are 6 3D-Var FGAT ARPEGE assimilations, perturbed by adding noise to the observations. Research goes on regarding the optimal filtering of background statistics, as well as the use of the ensemble for research and obs targeting.

The ALADIN Jb has seen the implementation of new balances, investigations on the humidity analysis, and on wavelets.

The AROME-France assimilation has been finalised with a 3-hourly 3D-Var cycle, some work on spinup issues (with help from some visitors), and a starting Ph.D (Pierre Brousseau) on studies of the temporal behaviour of the AROME assimilation, where some problems have been investigated.

An AROME 3DVar FGAT configuration has been prepared in OLIVE for future evaluation, as well as an 'empty-shell' ALADIN 4D-Var with our partners (Cz, Sweden).

Incremental DFI initialization, and limited-area CANARI surface assimilation have been finalized for ALADIN.

ECMWF's variational bias correction is now operational for all our models, with excellent results.

3.1.3. Algorithmics - computing and miscellaneous

NWP software can now be installed on MF 64-bit PCs, Linux servers and a Linux cluster.

Gmkpack work is ongoing despite difficulties with growing external modules. Preparations have started for the imminent migration of MF production from the NEC SX8 to the SX9 machine which is looming ahead. Performance optimisation of NWP codes on NECs is concentrating on disk I/O issues.

SURFEX fullpos developments are ongoing.

Remote access to the OLIVE experimentation tool has been opened to select outside users, interested scientists should apply through Claude Fischer: although current ad hoc resources are fully booked, there may be more later.

3.1.4. Cooperation-oriented R&D activites

A major event has been the February 2008 school on Arome, in Lisbon, with special thanks to our IM colleagues. Special software installation has been prepared for the AROME practicals.

A landmark workshop on 'physics convergence' has been organised in Toulouse in Sept 2008. The work on improving the physics/dynamics software is going on.

Physics diagnostic software development has focused on creating a new dataflow in the AROME/MesoNH physics library, so that it may be interfaced with e.g. DDH-like Arome diagnostics, or the MAPFI project. A wide consultation on its specifications has been performed, which has raised some ECMWF interest.

Facilities have been setup for the optional coupling of ALADIN-France to the IFS, and for the experimentation of ALADINs over French oversea territories (namely, Southern Pacific and the West Indies). Some glitches in the climatology preparation software are being worked upon.

We mourn the departure of Bernard Chapnik to a more civilised city, and welcome Mrs Gaëlle Kerdraon who will replace him in the GMAP/COOPE team.

3.1.5. Physics

A large revamping of the ARPEGE/ALADIN-France physics has been prepared, with a brand new prognostic turbulence + shallow convection package (CBR+KFB), which improves a lot the model boundary layer, and with benefits for AROME, too. This is in pre-operational tests with other new physics improvements (e.g. a new sea-surface flux parametrisation), with very good results, including a reduction of spurious extra-tropical cyclone prediction. Another version of the physics is being prepared, which will be common with the MF climate model.

The evaluation of the deep convection representation by the 3MT scheme has proceeded, with many original tests, notably an aqua-planet experiment (see article by Olivier Rivière in this Newsletter) as well as ALARO tests at various resolutions compared against ALADIN, with several options for the convective schemes. Results suggest that 3MT exhibits some interesting behaviour, which should be further investigated in relation with other aspects of the physics, namely the turbulence and shallow convection schemes, since they, too have some outstanding effect on precipitation forecasts. 3MT integration into ARPEGE/ALADIN-France is being investigated.

AROME has successfully been implemented for tests at very high resolutions (down to 100m) over the Alps; an ad hoc upper boundary scheme has been developed. A high resolution AROME (dx=1km) has been tested in real time over several months.

The explicit modelling of convection in AROME is being investigated in order to reduce the current over-prediction of strong rain events. The problem is related to the dynamics, with a large sensitivity to the spectral truncation. An academic test bed has been set up, with a COPS rain case to validate the conclusions on a real event. Other tests involve new physics options in Méso-NH.

SURFEX development is proceeding, e.g. with a new sea representation, and the new lake 'FLake' prognostic model.

3.1.6. Observations

Metop data: IASI radiances are now assimilated; GRAS assimilation is awaiting suitable data production. Metop/HIRS and ASCAT are used. Work on cloud-affected IR radiances is making progress. More AIRS channels, and more scatterometre winds are now assimilated. Meteosat SEVIRI clear sky radiances are assimilated in ARPEGE and ALADIN.

Additional land-affected microwave channels have been enabled in the assimilation thanks to a novel parametrisation of microwave emissivities. Research has been done on snow&ice-affected microwave radiances. The SSMI F14 instrument is now assimilated. Work is starting on the Megha-Tropiques and ADM-Aeolus satellites.

We are involved in three field experiments: Concordiasi over Antarctica, AMMA over tropical Africa, and COPS/MAPDPHASE over Europe.

Other optimizations have been done to the use of GPS (space- and land-based) and conventional data.

New results have been obtained from a Ph.D on satellite image processing for the assimilation of bogusses of extra-tropical cyclones in ARPEGE, and from another Ph.D on the assimilation of bogusses for tropical cyclones in ALADIN.

Radar data: doppler winds are beneficial for AROME, and neutral for ALADIN. Reflectivity assimilation on AROME (using bayesian humidity retrievals) shows promising results.

3.1.7. Ensembles

A major upgrade of the ARPEGE ensemble prediction system has been implemented (see the section on MF operations), with a marked improvement of the ensemble dispersion and scores over the globe. Current work is on increasing the ensemble size and accounting for model error, among other things.

An innovative ensemble data assimilation system has been implemented (see above), it is planned to investigate its coupling with the ARPEGE ensemble prediction system.

3.2. HUNGARY

(kullmann.l@met.hu)

The main scientific orientation of the Hungarian Meteorological Service for the ALADIN project is unchanged: data assimilation, short range ensemble prediction and high resolution meso-gamma scale modelling (AROME model).

The main scientific developments for the first half of 2008 can be summarized as follows:

3.2.1. DATA ASSIMILATION:

- The main development during the first half of 2008 was the implementation of the Canari surface OI assimilation in our service. After the validation of conf. 701 a parallel suite was run for 2 months during the early summer period. The reference was the operational data assimilation suite where we use the Arpege analysis on the surface. As the scores (against observations) show a benefit of the local Canari assimilation, an operational implementation is planned soon.
- We kept doing tests with SEVIRI and SYNOP T and RH data over the winter period of 2007. Our aim was to reproduce similar results obtained by Alena Trojáková for the summer period of 2006 (neutral classical scores and promising QPF scores for precipitation). This was done without success, i.e., with worsening classical scores due to the use of SEVIRI and SYNOP (T,RH) data. Finally, promising attempts were done to tune humidity standard deviations (both background and observation) resulting in an emphasized improvement of RH classical scores using both SEVIRI and SYNOP data.

3.2.2. LAMEPS:

With the stay of Richard Mladek, work has been continued with the ALADIN singular vectors. After a careful check of the singular vectors it seems that they are realistic and can be used for creating initial perturbations for a LAMEPS system. First tests were made to create initial condition perturbations based on the method applied at Meteo France.

3.2.3. AROME:

- In Surfex there are three possible ways to diagnose the screen level fields (T2m, RH2m and wind at 10m): Paulson, Geleyn and Canopy scheme. The verification against observation was done for all three schemes. Canopy and Paulson schemes have similar scores while the Geleyn scheme has a cold bias in temperature during stable situations. A new interpolation formula was introduced based on the Geleyn scheme and a new stability function proposed by Gratchev et al. The new formula improves significantly the verification scores with respect to the original Geleyn scheme and gives similar results as the other two schemes. Since the Canopy scheme is a prognostic scheme it is not usable as observation operator in a 3dVar assimilation. The idea is to use Canopy scheme for the direct obs operator and use the new formula for its TL and adjoint.
- To investigate the use and applicability of Flake in SURFEX for the Lake Balaton, a large, shallow lake, we have compiled a database of relevant observations. The collection of data required the cooperation of various research institutes, academia, and environmental monitoring agencies. The database allows us to test Flake using a known atmospheric forcing and assess its performance for this particular lake. We have conducted a preliminary off line test using data for the summer of 2006.

3.3. MOROCCO

3.3.1. NUMERICAL WEATHER PREDICTION

❑ A brief summary of Research development and main Operational Changes

The operational system consists of two parts (figure 1):

ALADIN NORAF: This configuration covers the area of North Africa to the equatorial belt with a resolution of 31km. It is used to provide NWP products to the ACMAD countries. In fact Morocco was engaged to produce forecasts over North Africa with lower resolution than other NWP models actually in use in those countries. ALADIN NORAF is also used to provide the boundary conditions to an overlapping model ALBACHIR.

ALADIN MAROC (ALBACHIR): Centred on Morocco with a finer resolution of 16km, this model is used by local operating services (short and medium range forecast, marine and aeronautic) and for other products for specifics users.

The two NWP suites run on a super calculator IBM (RS/6000 SP). This machine is constituted by three nodes with 36 processors of 1.5 GFPLOS each (54 GFLOPS on the whole).

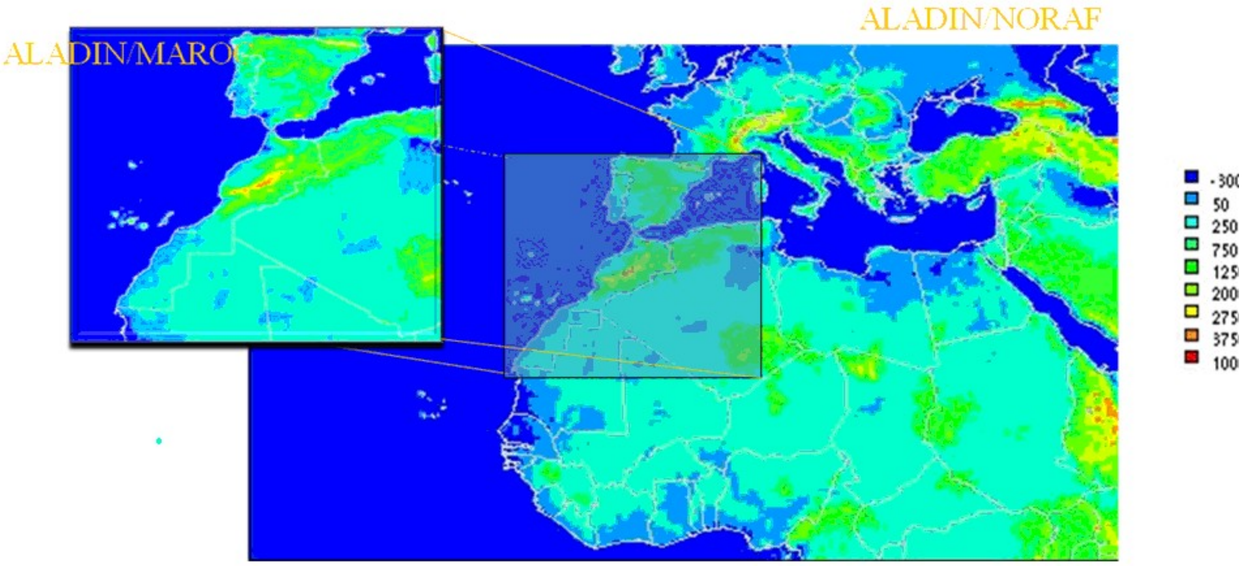


Figure 1: ALADIN NORAF and ALADIN MAROC domains

In parallel to the work on the operational models ALADIN NORAF and ALADIN MAROC, the numerical prediction team carried out several research projects in the aim to validate new suite and to prepare futures changes. In 2007 the Moroccan NWP team focuses on three projects:

- Upgrade of the resolution of ALADIN NORAF and ALADIN MAROC
- Implementation and tests of ALARO and AROME
- 3DVAR assimilation of locally received satellite data (ATOVS AMSU-A and AMSU-B)

❑ Research & Development in Data Assimilation and Numerical Forecasting

3DVAR assimilation of locally received satellite data in ALADIN NORAF:

Satellite observations seem to be a good complement for conventional observations. In fact they are characterised by a global cover, a good spatial resolution and a high frequency.

Recently, The Moroccan meteorological service acquired a local system to receive ATOVS radiances. The system is composed of antenna and software (TECNAVIA SCYCEIVER_MSG) for data processing and visualisation. It's especially dedicated to receive MSG imagery but it allows also the reception of other satellites data like ATOVS from HRPT stations.

The figure below shows the ATOVS data locally received over a time window of six hours (from 03UTC to 09UTC)

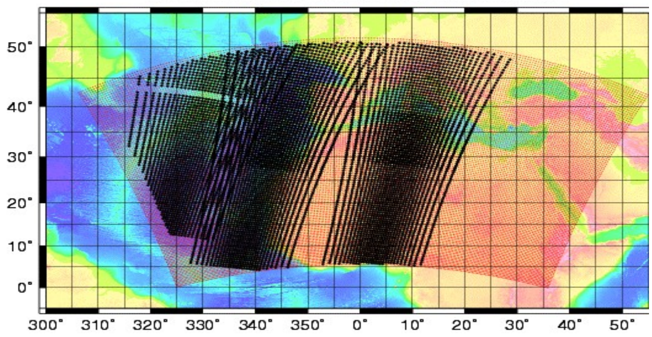


Figure2: ATOVS data over ALADIN NORAF domain

One case study was performed for first November 2006 at 06UTC. The observations used are AMSUA radiances from NOAA 15-16 and 17 (see figure 2). Conventional observations are not used in this experiment, and analysis increments are due only to AMSUA radiances. Figure 3 shows that for many parameters, increments cover ocean and the south of the domain. This means that the assimilation process is efficient on these regions.

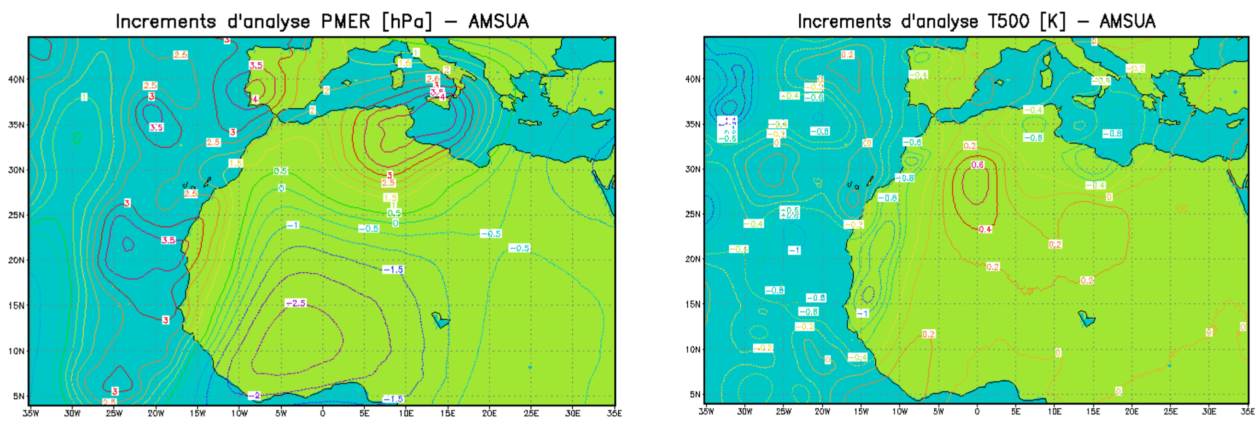


Figure 3: Analysis increments of mean sea level pressure (left) and 500hPa temperature (right)

Impact studies are needed to better adjust the use of ATOVS radiances (bias correction, thinning, observation error) in order to increase their contribution to the quality of ALADIN NORAF model.

Installation of CY32T3 on IBM/RS6000

Main differences:

The main differences between the last cycle (CY29T2) and the new cycle (CY32T3) concern:

Physics:

Non hydrostatic (NH) code re organisation and cleaning

HIRLAM physics

AROME and ALARO-0 physics

Surface:

New surface data structure

SURFEX in ALADIN

Observations:

NEW ODB structure

Data selection inside BATOR

Observation data in ASCII, BUFR or GRIB format

The installation of CY32T3 concerns not only ALADIN NORAF and ALADIN MAROC but also ALARO and AROME. In fact, this cycle includes AROME and ALARO code which makes it possible to build the executables related to these two models using the same pack.

Hardware configuration:

The system is an RS/6000 SP with 54 Giga Flops composed of 3 Nodes High (Night Hawk 2)

- Two nodes of 16 processors for computing
- One node of 4 processors for file managing

The processor is a Power 3-II with 375 Mhz and develop a power of 1.5 Giga Flops.

The global machine central memory is 19 Go

The storage space (RAID 5 discs) is 1019.2 Go

Software configuration:

AIX 5.1 ML3, XLF 8.1.1.1, C compiler 6.0, ESSL, MASS, LoadLeveler 3.1.0.21

List of compilation projects in al32T3 at that moment:

ald, arp, tal, tfl, ost, coh, sat, xrd, uti and odb

Compilation:

- Gmkpack.5.7 was used

❑ Research & Development Results for Application of NWP Products

Verification of Aladin rainfall using CPC information

Verification procedures are very important to evaluate the quality of numerical models. The objective control of ALADIN/NORAF and ALBACHIR is currently performed by the calculation of bias and root mean square error (RMS) using two references: Observations (SYNOP and TEMP) and ARPEGE analysis. Since the ALADIN/NORAF model area is very large, the SYNOP and TEMP observations are not sufficient to achieve a good control. The use of satellite observations is then very important.

The NOAA Climate Prediction Centre (CPC) has developed an algorithm to estimate rainfall on Africa by using satellite data and ground-based measurements of rain. This algorithm produces binary and graphical output files with a resolution of 0.1° and spatial extent from 40°S-40°N and 20°W-55°E. The daily CPC total precipitation can provide a good validation tool for

ALADIN/NORAF and ALBACHIR precipitation.

The validation of ALADIN precipitation by CPC can be subjective, comparing the two maps of precipitation, or objective by calculating statistical parameters. Because of the discontinuous character of precipitation, the objective validation may take the form of category using contingency tables. Several scores are computed from these tables: bias, ACCuracy forecast (**ACC**), Probability of Detection (**POD**), False Alarm Rate (**FAR**), Equitable Threat Score (**ETS**), Heidke Skill Score (**HSS**)…

❑ Outstanding Research & Development Activities related to Improvement of the Operational System

As mentioned above, the operational NWP system in Morocco is composed of two parts:

1] **ALADIN NORAF**: it covers the North Africa area and aims to respond to ACMAD demand in terms of forecast products with fine resolution. the domain concerned is between 44.8° North, -1.9° South, -35.3° West and 57.2°East with a horizontal resolution of 31km. The vertical resolution is given by 37 layers. We use a time step value equal to 900s. The integration frequency is twice a day (00 and 12 UTC). The forecasting range is 72 hours and the post-processing is performed every six hours. The coupling files coming from the French ARPEGE global model (via a fast connection with Toulouse (128kb)) are transformed into a 31km resolution on the above mentioned area thanks to a post-processing configuration called e927.

2] **ALADIN MAROC (ALBACHIR)**: it is centred on Morocco with a resolution of 16.7km. Vertical resolution is 37 layers. Couplings files are provided by ALADIN NORAF model. The initial state is that of ALADIN NORAF transformed to the ALBACHIR domain tanks to the same procedure used for coupling file: the ee927 configuration. GRIB files are produced every 3 hours and are transmitted to the operating centre and to the four regional meteorological centres in Morocco for local use.

Concerning research and future improvements, the Moroccan NWP service starts the process to buy a new computing system with sufficient power needed for the planned improvements in the operational suite.

1] ALADIN NORAF and ALADIN MAROC: It is projected to upgrade the horizontal resolution of ALADIN NORAF from 31km to 20 km and from 16km to 7km for ALADIN MAROC. The vertical resolution will reach 46 levels.

2] ALARO 5km: The ALARO concept is oriented towards the cost-efficient algorithmic solutions and the use of existing well-proven method, offering a multi-scale solution. All this involves a coherent set of governing equations, specific coding rules and a high level of modularity-flexibility.

The components of the ALARO version concern the governing equations set, the horizontal diffusion (SLHD), turbulent diffusion (a pseudo-prognostic TKE scheme), radiation, the microphysical processes (more sophisticated and efficient parameterization including new prognostic variables - cloud liquid and solid water, rain, snow – all treated through the use of the PDF-based sedimentation method) a unified and coherent solution for the treatment of moist processes (cascading call of different parameterizations, prognostic convective updrafts and downdrafts, convective and resolved processes treated in a spirit of common handling of the water vapour resource, with downdrafts having their closure separated from the one of the updrafts).

The version of ALARO tested by the NWP team covers Morocco with 5km horizontal resolution and 46 vertical levels. Time step is 240 seconds and forecast range is 48hours.

3] AROME 2.5km: Continuous improvements on the accuracy of the forecasts are needed to answer different users requirements:

- More accuracy on the NWP products (extreme events for public safety)
- More diversity of the external applications (chemistry, hydrology, air pollution, …)

To meet such kind of demands, a new generation of NWP models is needed to work at horizontal scales where convection is explicit but with complex physical parametrisations and with data assimilation of a new kind of data (radar-satellite).

The first test of AROME in Morocco concerns the running of a forecast experience over Tadla domain. Initial conditions (dynamical adaptation and lateral boundaries) were provided by the ALADIN-MAROC 7 Km forecasts.

The AROME domain covers a small area [30.8°-34.1°N,8.7°-4.2°W] including Casa-Mohamed V airport, Binelouidane dam, Casablanca urban area, Tadla agricultural region, High Atlas mountains over 3700m (see figure 4).

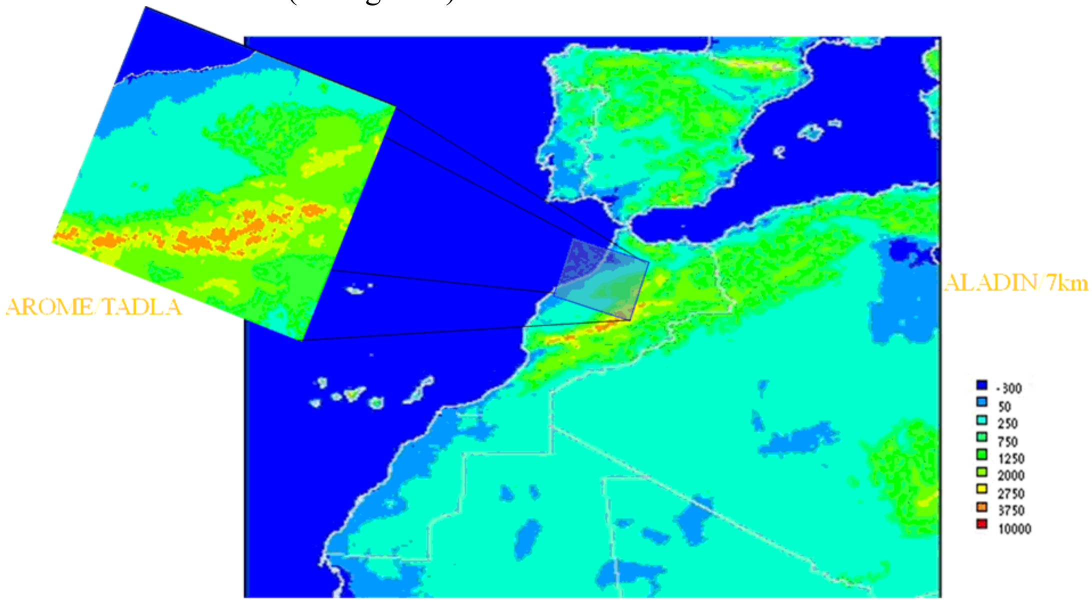


Figure 4: ALADIN 7km and AROME domains

AROME is especially useful to simulate small scale precipitation. Figure 5 shows that AROME model predicts heavier and better located run cells than ALADIN 7km. But there is still a problem of frequent intense precipitation (over estimation of precipitation). The AROME model allows explicit resolution of the deep convection. The target is to enhance thunderstorms prediction in the future over the TADLA region. More impact studies are needed to validate AROME model forecasts in Morocco.

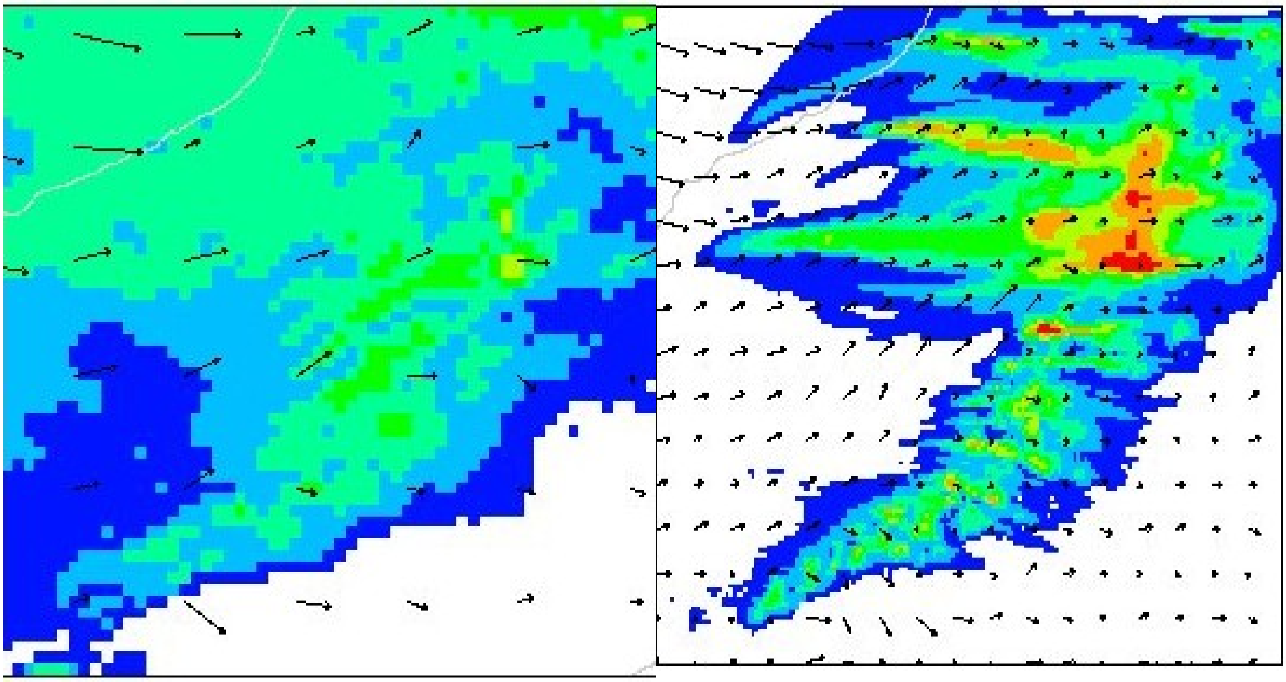


Figure 5: 24 hours forecast of wind and run by ALADIN 7km (left) and AROME (right)

REFERENCES

Jean-Francois Geleyn: ALARO-0 1st training course, Radostovice March 2007

Gwenaëlle Hello: AROME 1st training course, Poiana Brasov November 2005

Karam Essaouini, Hassan Haddouch: 18th ALADIN training course, Brussels April 2008

3.4. ROMANIA

(for details doina.banciu@meteoromania.ro)

- ***Semi-operational implementation of ALADIN-Bucharest (****Mihaela Caian)*

  - The Aladin model is integrated over an area covering Bucharest and its surroundings at a resolution of 3.5 km. A dynamical adaptation at 1.5 km is further performed.

  - Validation of the PBL parameters at local scale (Bucharest peri-urban area) against measurements (sodar and lidar data).

- ***Set-up of the AROME reference for Romania*** (*Doina Banciu – Toulouse stay*)

  - 3 AROME domains were prepared: one at 2.5 km covering Romania and two others covering Bucharest area (at 3.5 resolution – in fact almost the same domain as for Aladin Bucharest, and respectively 1.5 km).
  - AROME was integrated up to 30 hours, for an intense convective case (April 22, 2008), using the latest version of the model for the two domains: at 2.5 and 3.5 km. The ALADIN integration (for the operational Romanian domain, 10 km resolution) with the same set up as ALADIN France provided the initial and lateral boundary conditions.
  - A quick analysis of the 24 h precipitation forecast showed the good performance of the AROME model. Further analysis of the results is required for the evaluation of the AROME skill to simulate local scale phenomena in this situation,

- ***Ensemble prediction system*** (*Simona Tascu, Mihaela Caian)*

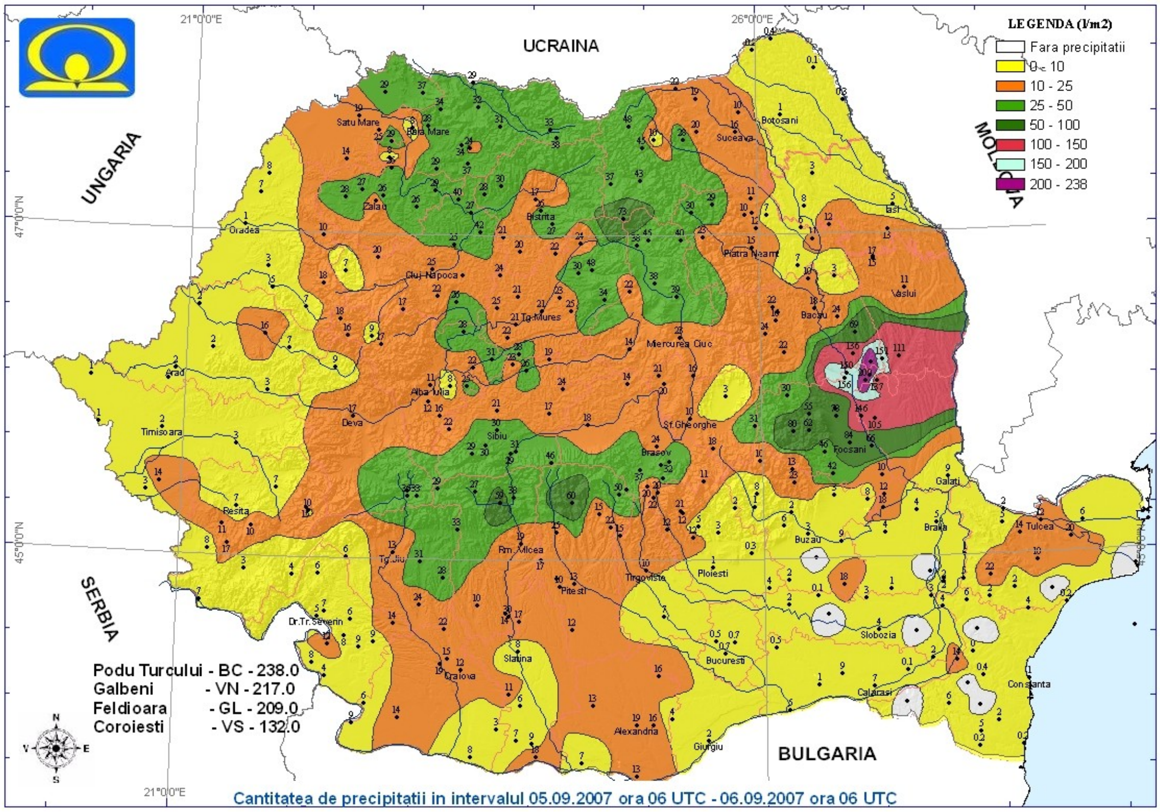
  - Further development of multi-model (ALADIN&COSMO) ensemble prediction system in order to put it into operations.

  - Severe weather case studies using mono (ALADIN), multi-model ensemble prediction system, downscaling of ECMWF EPS.

  - Contribution to a combined ARPEGE&ECMWF EPS downscaling (*Simona Tascu, LACE stay in Vienna*)

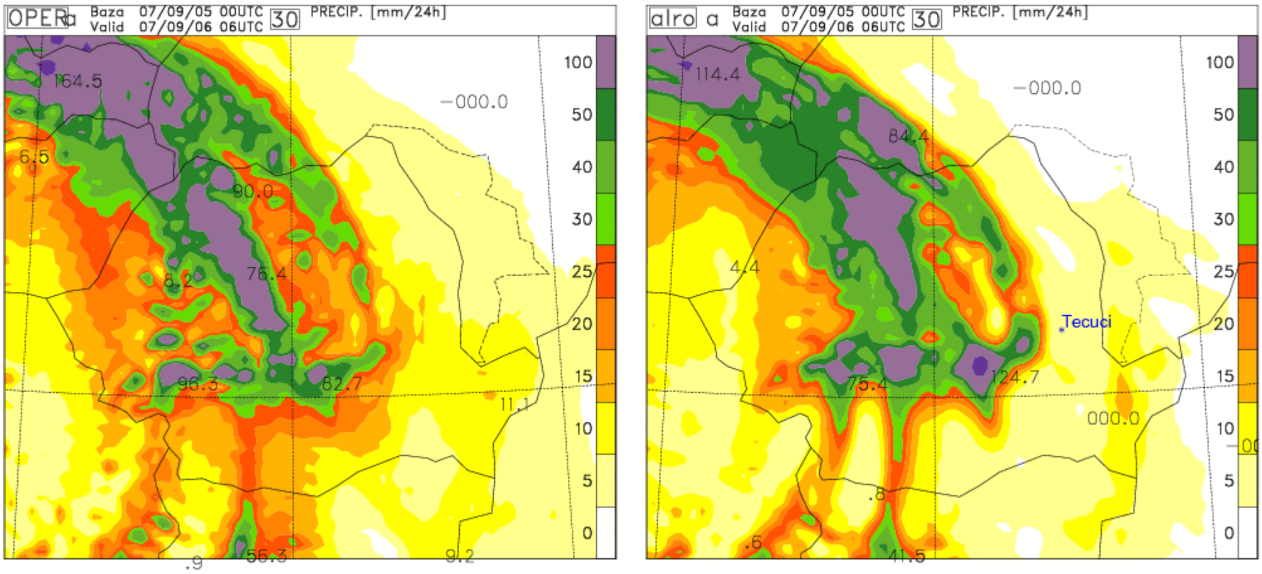
- ***Validation of precipitation forecasts*** (*Doina Banciu, Florinela Popa, Simona Tascu)*

Due to lack of computer power, the ALARO double suite was not set up as foreseen. Only few cases of severe weather in Romania were studied by using both ALADIN and ALARO models. For all cases the ALARO forecasted precipitation field structure and position were closer to the observations than the ALADIN forecast. Regarding the precipitation amount, the ALARO performance (under or over estimation) depends on the local or large scale forcing that prevailed.



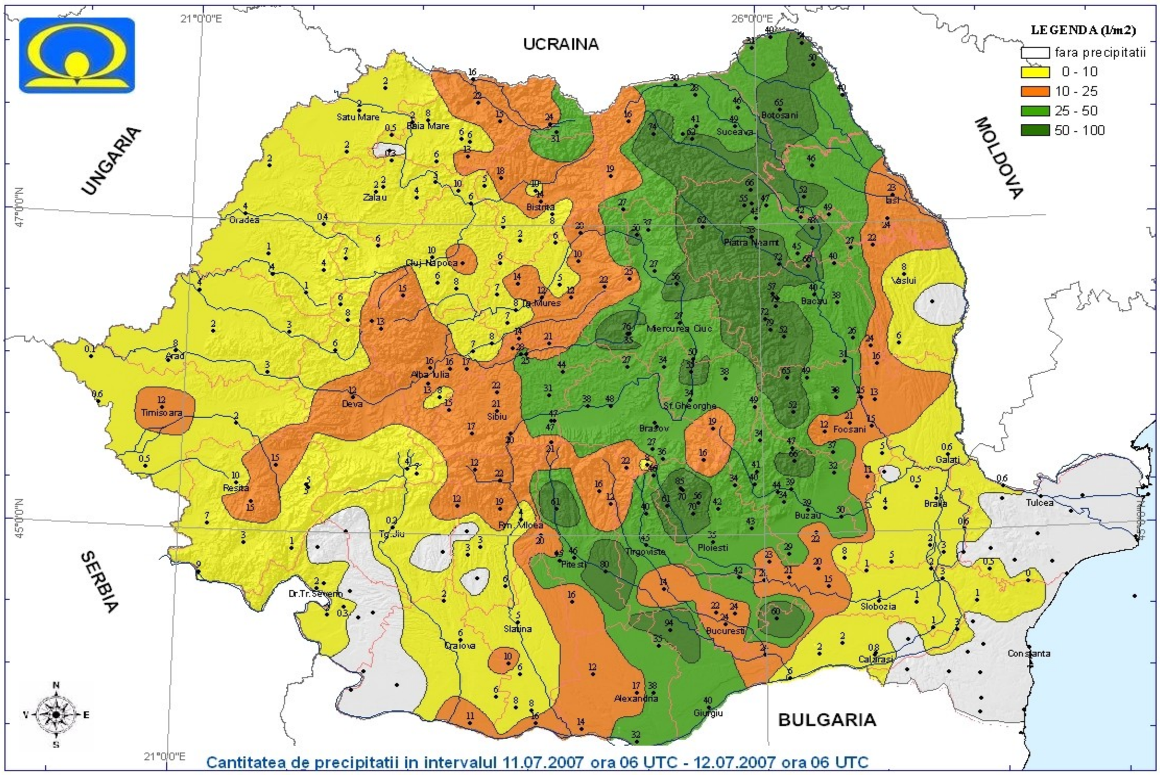
171 l/m ^{2} / 3 h ; 238 l /m ^{2} /24h

Frontal low-level jet along the mountain ridge;convective topographic stationary cells

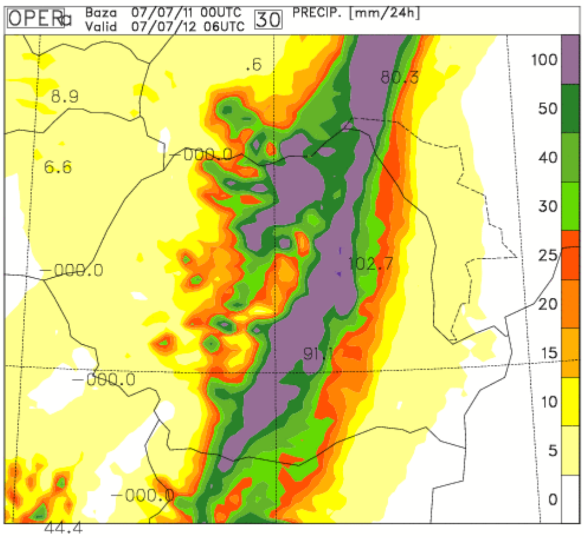


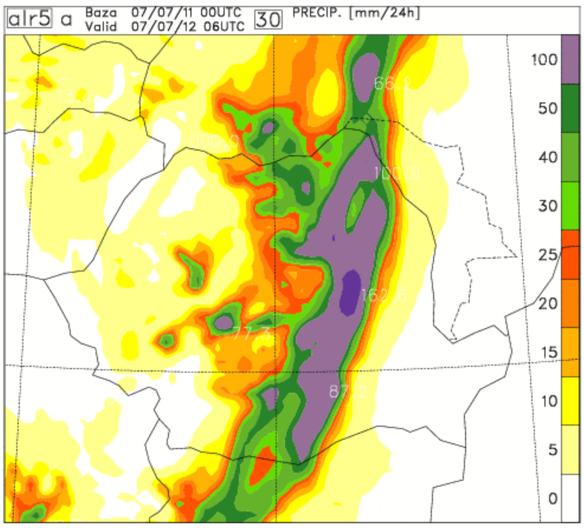
<u>OPERATIONAL ALADIN</u> (CY28T3, dx=10 km) **max. precipitation 82.7 l /m^2/24h**	**<u>ALARO INCLUDING 3MT</u>** **max. precipitation 124.7 l /m^2/24h**

Septembre 5, 2007



Obs. max: 94 l /m²/24h (near Bucharest); **79 l/m²/24h** in Moldavia (NE Romania)
A cold front, approaching from the west, merged with he squall line that developed in a tropical air mass.

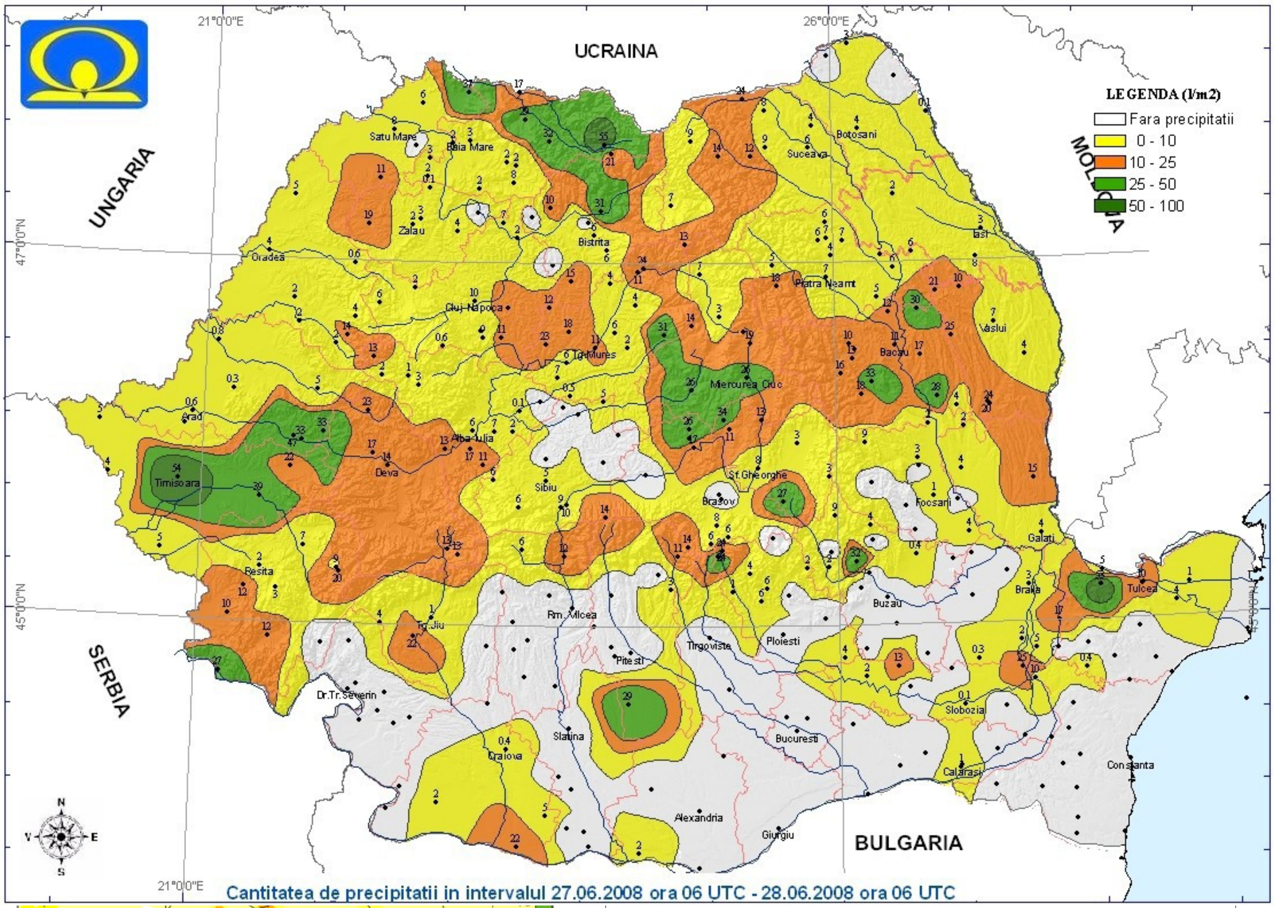


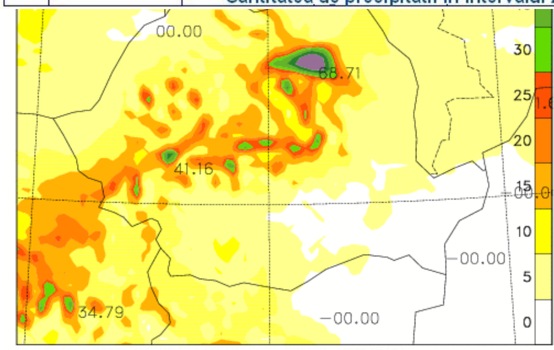


OPERATIONAL ALADIN **(CY28T3, dx=10 km)**
max. 94 /m²/24h (Bucharest)
102 l/m²/24h (Moldavia)

ALARO INCLUDING 3MT
max. 87 l /m²/24h (Bucharest)
162 l /m²/24h (Moldavia)
better position of the precipitation band (further eastwards)

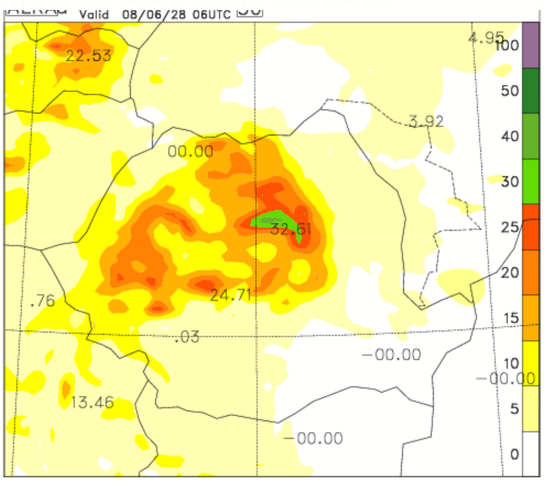
JULY 11, 2007

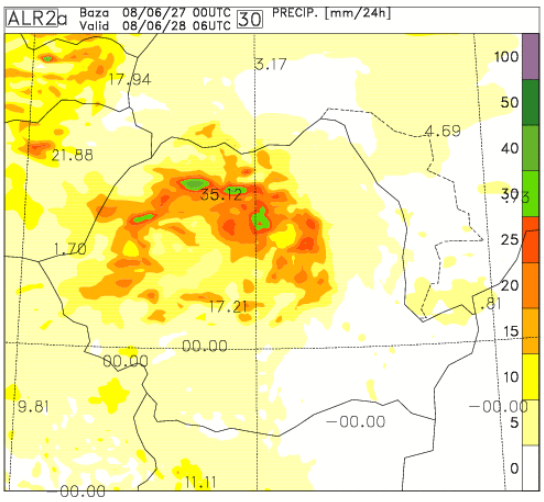




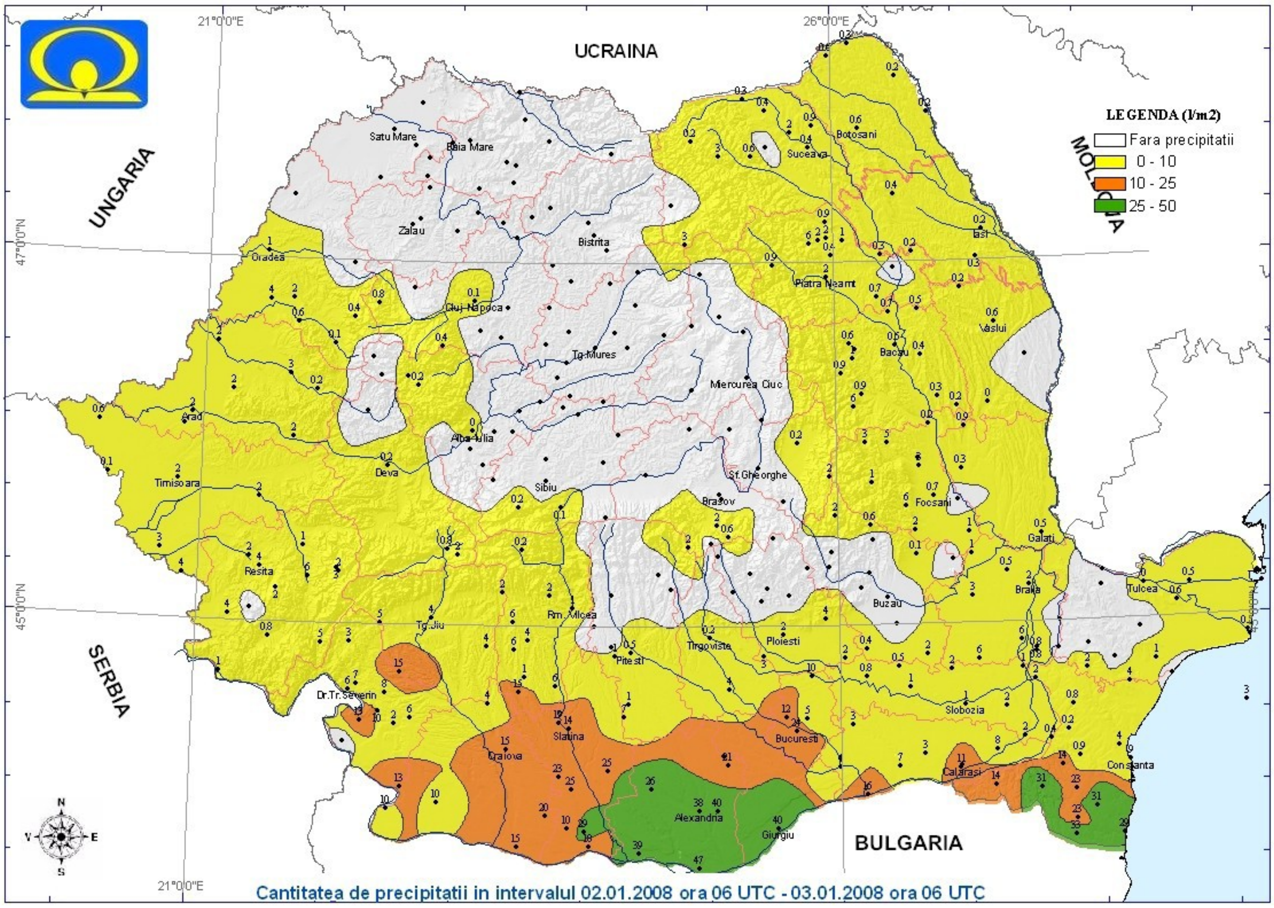
Juin 27, 2008

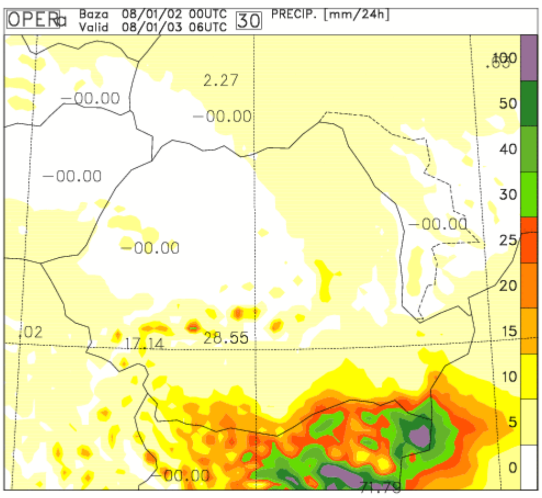
OPERATIONAL ALADIN (CY28T3, dx=10 km)
over estimates the precipitation maximum (71.1 l /m^2/24h), not so well positioned.

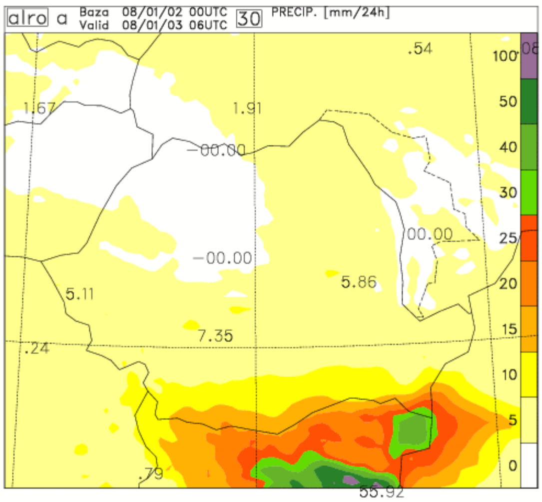




ALARO INCLUDING 3MT (dx=10 km – left, dx=5km - right)
Better forecast of precipitation amount unchanged when passing from 10 to 5 km (~33 =>35), better and better structured by increasing resolution (compared with radar data).







ALADIN and ALARO INCLUDING 3MT (dx=10 km): similar precipitation forecast over Romania, positioned too much towards south. ALARO is slightly better, with a smoother precipitation field and less intense precipitation in the mountain area (closer to the observation).

January 2, 2008

3.5. SLOVENIA

During his one month stay in Toulouse, Benedikt Strajnar was working on the implementation and testing of spatially varying background error variances.

The amplitude of analysis increments is basically determined by standard deviations of background error. In ARPEGE/IFS/ALADIN, the minimization procedure is performed in spectral space, but in this case, the errors have no geographical dependency. To retrieve this dependency in the computation, the vorticity background errors were applied in grid point space and estimated either climatologically or in a flow-dependent way, using an ensemble of ARPEGE analyses. In addition, the humidity background errors were made flow dependent by using an empirical formula, depending on background temperature and relative humidity. The comparisons inside ALADIN FRANCE 3DVAR were first carried out between climatological (constant) background error values and the reference spectral normalization. Finally, the daily "flow dependent" values of background errors were used, and compared to the operational reference.

Experiments with background "errors of the day" are considered being successful. Different diagnostic and performance checks show generally a good performance of minimization using such background error specification. The climatological errors might soon be used in operations, even though they do not improve forecasts significantly. At least the background error specification is more realistic. Further improvement could be gained by calculating seasonal background errors. Impact in using "errors of the day" on forecast quality is generally slightly positive globally (some high error peaks are reduced etc.). A promising result was obtained for precipitation, showing a considerable improvement in verification against SYNOP. Once the ARPEGE ensembles is run in operations, there will be a possibility to compute and also use the daily grid point background errors.

Evaluation of the 3MT scheme has continued on few strong convective cases which occurred in Slovenia during the summer. These case studies showed that the scheme is performing well, also simulations on higher resolution produce realistic features.

During these studies the issue of a proper length of the time-step has been repeatedly raised, or to rephrase this sentence: should Δt be a tuning parameter?

Severe thunderstorms which occurred late on August 15th 2008 were simulated with a 4.4km configuration of ALADIN with 3MT. The model, based on a 15th 00UTC analysis and cold run reproduced the main features of the situation quite well. Several convective cells, embedded in a SSW flow travelled northwards from the northern Adriatic well into continental Slovenia. In order to be able to properly follow the model evolution simulated radar reflectivity was computed from ALADIN precipitation field in an external post-processing module. The computation takes into account liquid and solid precipitation at all model levels as well as the height of the 0 degree isotherm, which influences the reflectivity through melting of the snow. The column maximum value (dBZ_max) is plotted in the figures below.

The model performance was tested against the length of the time step. Normally, 200 seconds are used for this resolution. Two additional runs were performed using 100 and 50 seconds. Ideally, once the time step is sufficiently short its further shortening should not affect the results. As it is shown here (Figures 1, 2) this is not true for Δt=200s. Furthermore, the subjective evaluation of the results clearly indicates that:

i. simulated field structure is best with the shortest time step
ii. the differences between 200 and 100 seconds are much larger than those between 100 and 50 seconds, indicating that the later is probably short enough. No tests were made to see whether the quality of the simulation degrades if the time step is even shorter.

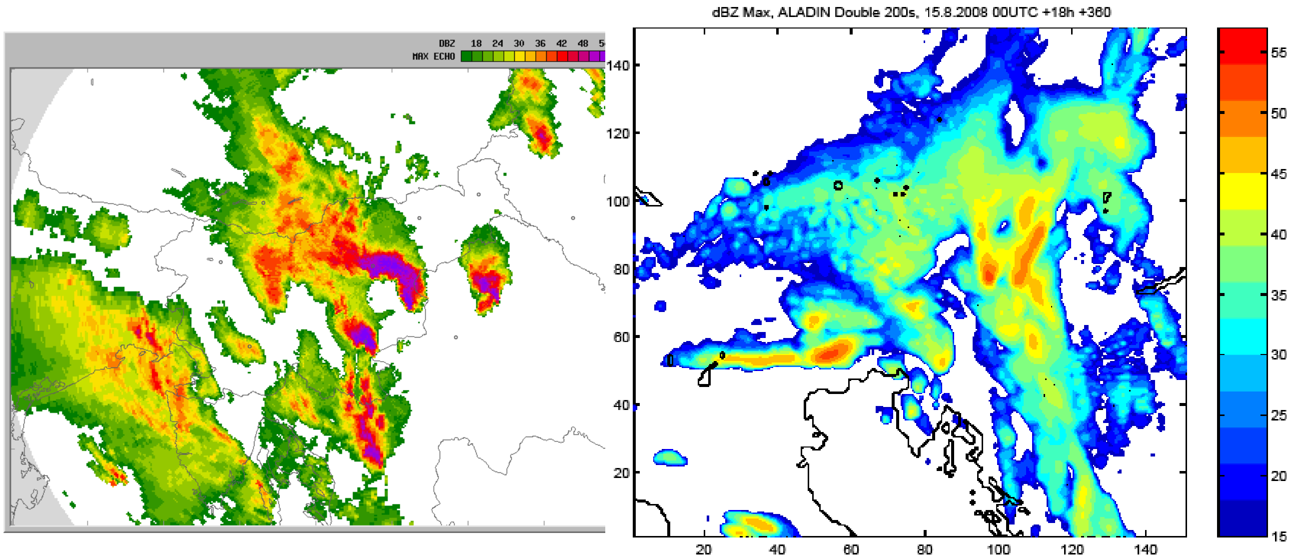


Figure 1: Observed radar reflectivity on 16th August 2008, 00UTC (left), simulated radar reflectivity at 2008/08/15 00UTC+24h using time-step Δt=200s (right).

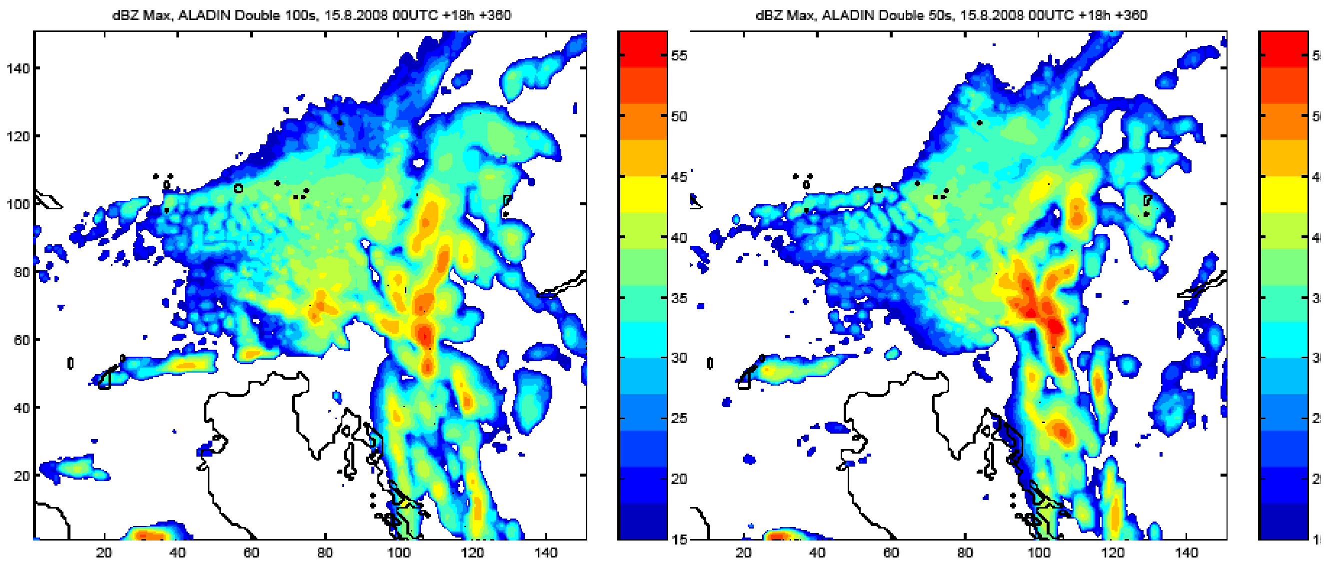


Figure 2: Simulated radar reflectivity at 2008/08/15 00UTC+24h using time-step Δt=100s (left) and time-step Δt=50s (right).

ALADIN verification project

Regular monitoring of the model and observation data has been achieved. There was a problem with the mail server for a few days at the beginning of January. Emails have been received since then without delays so the idea to switch to ftp protocol is still waiting for implementation.

The model data are arriving daily from Austria, Croatia, Czech Republic, Hungary, Slovakia and Slovenia, each month from France and Poland, in longer time interval from Romania for the present time.

4. PAPERS and ARTICLES

4.1. Note on case with over predicted convective activity (23-27 May 2007)

Ján Mašek, SHMÚ

4.1.1. Introduction

During the last decade of May 2007, severe problem with convective precipitation over central European region occurred in operational ALADIN/SHMU application, which used pre-ALARO physics at that time. During daytime, model produced almost purely convective precipitation over a wider horizontal area than was observed in reality. Since the problem was common to all LACE operational applications and comparison of soundings with pseudo TEMP profiles revealed too much humidity below 2 km, it was speculated that the source of the problem might be too moist ARPEGE LBC. Availability of 3MT scheme within ALARO-0 package enabled to recompute this case. Results obtained with prognostic convection scheme call for revisiting old conclusions.

4.1.2. Model results

Old results obtained with pre-ALARO physics are shown in Figure 1. It should be noted that there was very little resolved precipitation in the model, which means that almost all precipitation comes from diagnostic convection scheme. Comparison with radar composite in Figure 4 reveals that convective activity in the model was strongly overestimated. Actual weather conditions in central Europe were dominated by clear sky, with only few convective cells occurring during the day. Because of strong discrepancy between reality and model seen primarily in precipitation and cloudiness fields, forecasters at SHMU were complaining and classified ALADIN/SHMU forecast in this particular period as unusable for our territory.

Figure 2 shows the model forecast obtained with ALARO-0 physics minus 3MT scheme, which was tested in parallel suite at SHMU during Mar-Apr-May 2007. It is no surprise that the problem persists and results are very similar to pre-ALARO ones, since in purely convective situation new microphysics which handle resolved part of water cycle remain inactive, hence the precipitation field is generated by the old convection scheme.

On the 01 July 2008, the parallel suite with ALARO-0 plus 3MT scheme and upper air blending was launched at SHMU. On this occasion forecast from 24-May-2007, 00 UTC was recomputed using 3MT scheme (to be consistent with old results, experiment was run in dynamical adaptation mode). Obtained precipitation field is shown on figure 3. It can be seen immediately that activation of prognostic convection scheme reduced the precipitation area dramatically. Precipitation field decays into cell-like structures and smaller precipitation amounts around disappear. Horizontal extent of forecasted precipitation is still too large, but precipitation field is clearly superior to that obtained with diagnostic convection scheme.

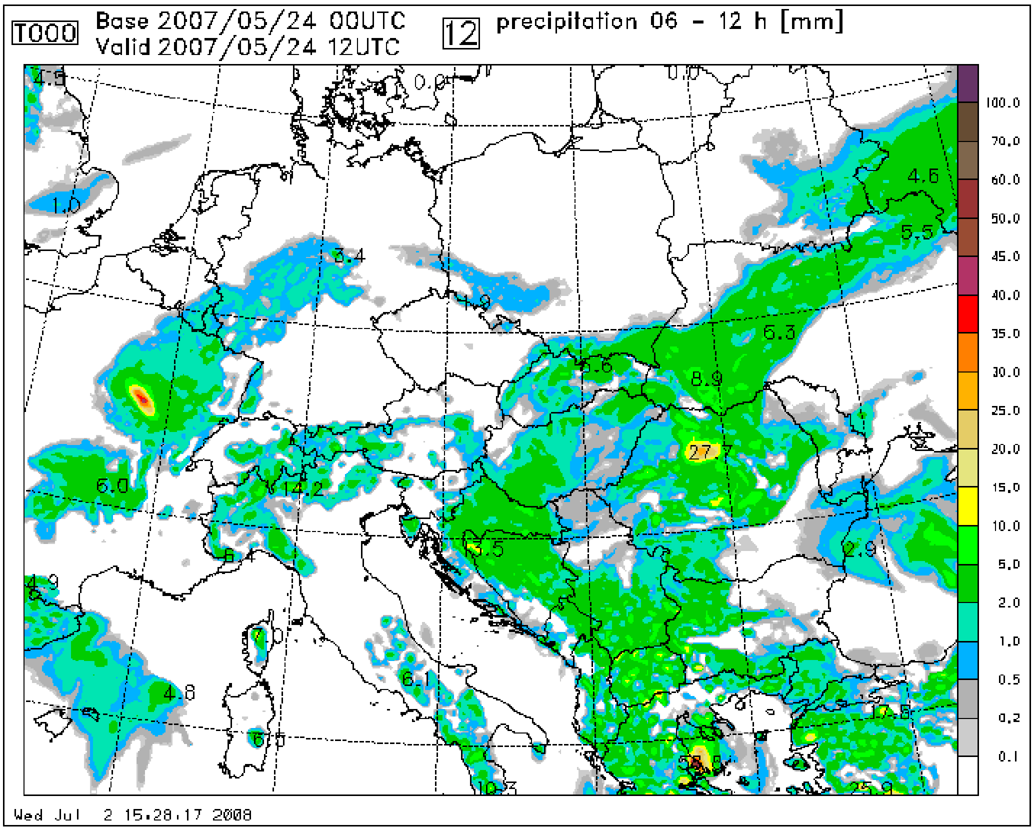


Figure 1: Operational ALADIN/SHMU forecast using pre-ALARO physics, starting on 24-May-2007, 00 UTC. Cumulated precipitation for period +06 to +12 h.

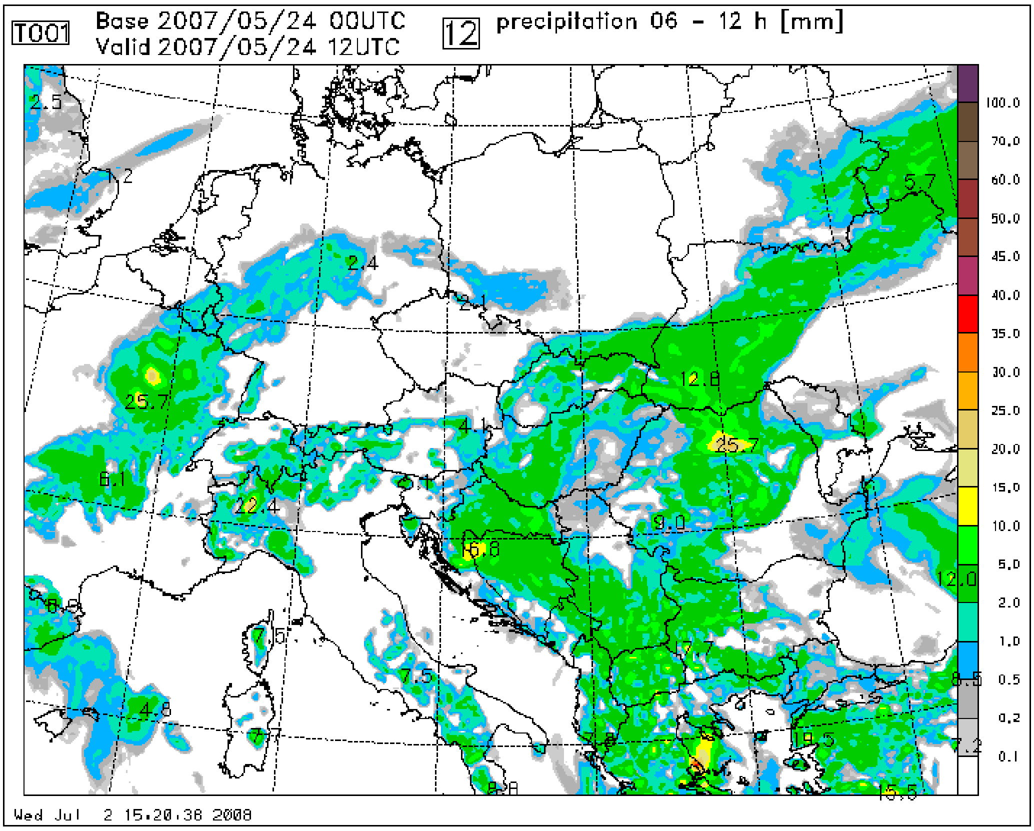


Figure 2: Same as figure 1, but with ALARO-0 physics minus 3MT.

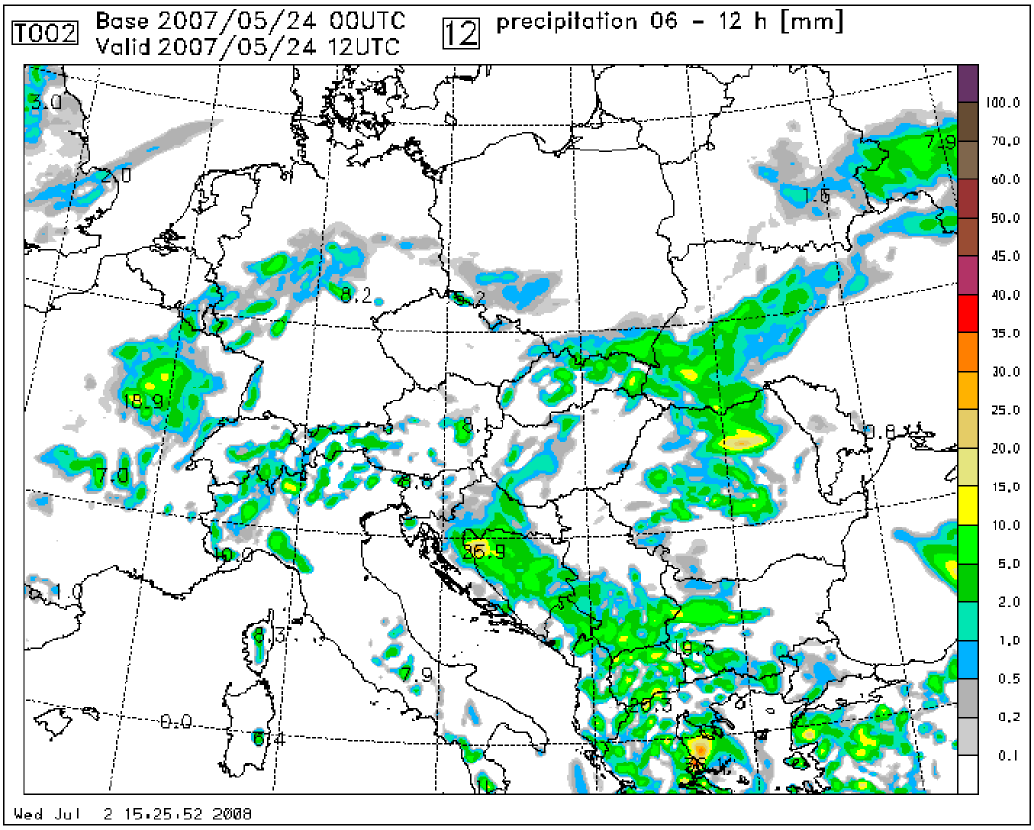


Figure 3: Same as figure 1, but with ALARO-0 physics plus 3MT.

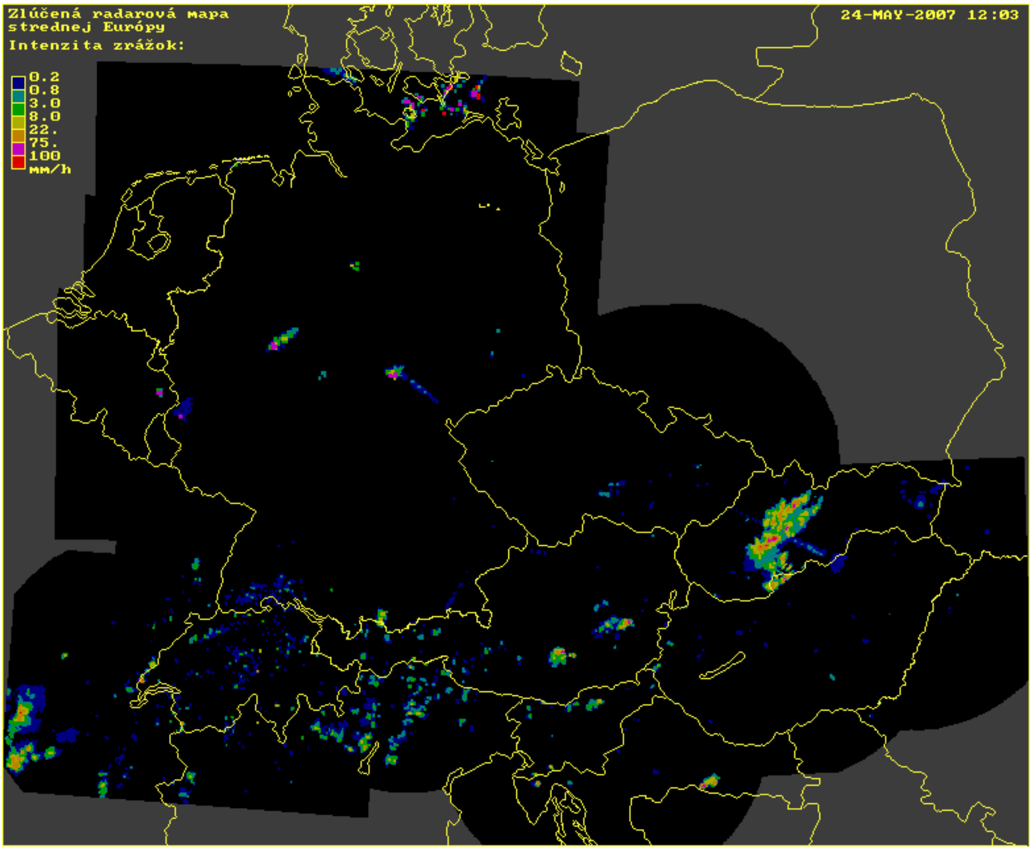


Figure 4: Radar reflectivities from CERAD, valid for 24-May-2007, 12 UTC. Some storms which developed over central Slovakia during morning can be seen, elsewhere convective activity is only weak.

4.1.3. Conclusions

The activation of the 3MT scheme reduces over-predicted convective precipitation considerably, which indicates that the problem comes mainly from diagnostic handling of water cycle in parameterized convection. Further improvement can be expected by introducing historic entrainment, which should have a positive impact on the convection diurnal cycle.

4.2. Investigating the impact of advection on TKE

Jure Cedilnik (Meteorological Service, Environmental Agency of Slovenia)

4.2.1. Introduction

The purpose of this paper is to investigate the impact of the advection of TKE at different model resolutions, particularly focusing on scale at around 2 km.

There are no papers covering this subject in a deeper extent and it seems that in general not much is known about the magnitude of the advection term of the TKE equation:

$$\frac{\partial \overline{e}}{\partial t} = -U\frac{\partial \overline{e}}{\partial x} + \frac{g}{\overline{\Theta}}\overline{w'\Theta'} - \overline{u'w'}\frac{\partial \overline{U}}{\partial z} - \frac{\partial \overline{w'e}}{\partial z} - \frac{1}{\overline{\rho}}\frac{\partial \overline{w'p'}}{\partial z} - \epsilon$$

There were some field studies performed, where the TKE components were measured in real atmosphere. From them it is quite evident that the TKE advection is an important component of TKE budget. See for example airborne measurements during VTMX 2000 over Salt Lake Valley [http://fluid.ippt.gov.pl/vtmx]. Though it says indeed nothing about dependency of TKE advection to the model resolution.

In the first part I try to estimate the relative importance of advection term by using a very easily adjustable and applicable NWP model – COAMPS [http://www.nrlmry.navy.mil/coamps-web/web/home]. The second part is focused on experiments done with AROME, where I use the property of GFL structure that enables the switching of advection on and off for different variables.

4.2.2. Introductory tests with COAMPS

COAMPS is a model developed by the US Navy and its main advantage (and the reason it was used in this case) is the ease of use and simple applicability of the model at different resolutions (no climate files, etc.). It uses non hydrostatic compressible equations in sigma-z vertical coordinate and C grid.

For my purpose, I have chosen a case with rather strong warm advection by southerly wind in the region of Adriatic sea. The point taken into account was on a flat terrain near the coast. The integration was performed from a cold start and many different resolutions were used. Relative importance of advection term in the TKE equation was deducted by taking a max norm of the values from the TKE equation's terms evolution. This is presented in Table 1.

Table 1: Relative ratio of advection term to right hand side for TKE equation depending on the resolution.

Horizontal resolution [km]	Relative ratio of horizontal advection term vs. RHS in TKE equation
27	Less than 1%
18	Less than 1%
9	~5%
6	~5%
3	~15%
2	~12%
1	~25%

If one was to draw conclusions based on numbers in Table 1, a rather safe statement would be to say, that the impact of the advection of TKE is significant only at resolutions finer than 10km. Of course there are some deficiencies in using these tests. The problem is, that our grid point might not be exactly at the same place in the domains with different resolutions – this is partially overcome by taking a max norm in time. Another argument of discussion is whether it is perfectly okay to use the same model physics for such a spectra of resolutions.

For figures of evolution of the advection term of TKE equation and evolution of the entire right hand side, see the Appendix of this paper.

4.2.3. Experiments with AROME

A more precise investigation was focused on a 2.5km resolution and used AROME model as a tool. The GFL structure in ARP/IFS permits a very easy way for setting up an experiment, either with or without the use of advection for a certain variable.

The AROME Fran4 domain (512x512 points, 41 vertical levels) was used. The evolution of TKE for 7 different grid points was stored – this had to be done in such a way, that all the fields (the entire historical file) were stored at every time step. The experiment started at 00 on 19.11.2007 from an interpolated ALADIN analysis (cold run). For the initialization of TKE values, a default value 10^-6 is used. The domain used and the points chosen for the time evolution output are presented in Figure 1. Additionally, the information about the chosen grid points is summerized in Table 2.

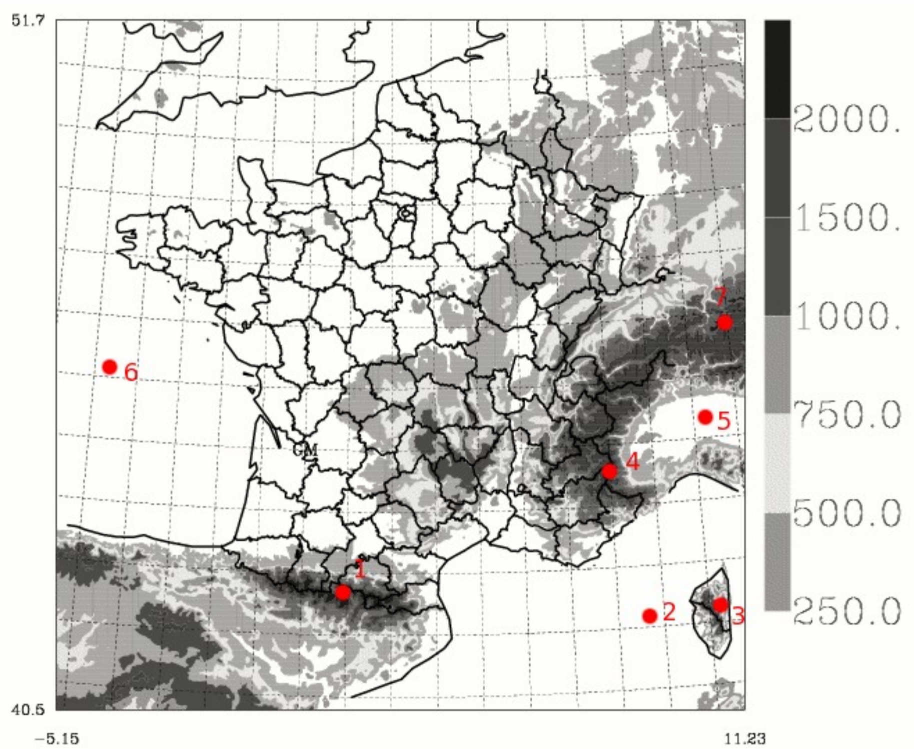


Figure 1: The domain (512x512 points and 41 vertical levels), that was used for the experiments. Red dots present the grid points, where the time series of TKE were studied – see Table 2.

Table 2: Description and coordinates of points were time series of TKE were studied.

Point No	Description	LAT	LON	I (index in LAT)	J (index in LON)
1	Pyrenees – south of Toulouse	42.72	1.27	220	87
2	Mediterranean sea – west of Corsica	42.18	8.24	450	70
3	Corsica – eastern slopes	42.10	9.45	490	70
4	Alps – east of Briançon	44.75	7.28	411	182
5	Po valley	45.50	9.62	482	217
6	Bay of Biscay	46.33	- 4.7	40	270
7	Alps – near Innsbruck	46.72	10.40	500	278

Besides the two obvious experiments (with and without advection), a third one was designed to test the impact of the interpolator in the SL scheme. The default is to use the quasi monotonous (QM) interpolator for TKE, but in my experiments, there was also a test without quasi monotonous interpolator. This also required some minor changes in the code: after the advection of variables, TKE values lower than 10^-6 were set to this value (similarly to what is done at initial step), to avoid negative TKE values. Such a step is nothing unusual – a similar security check is performed after the solver in physics.

The results for the three experiments are shown in Figures 2 (first part) and 3 (second part).

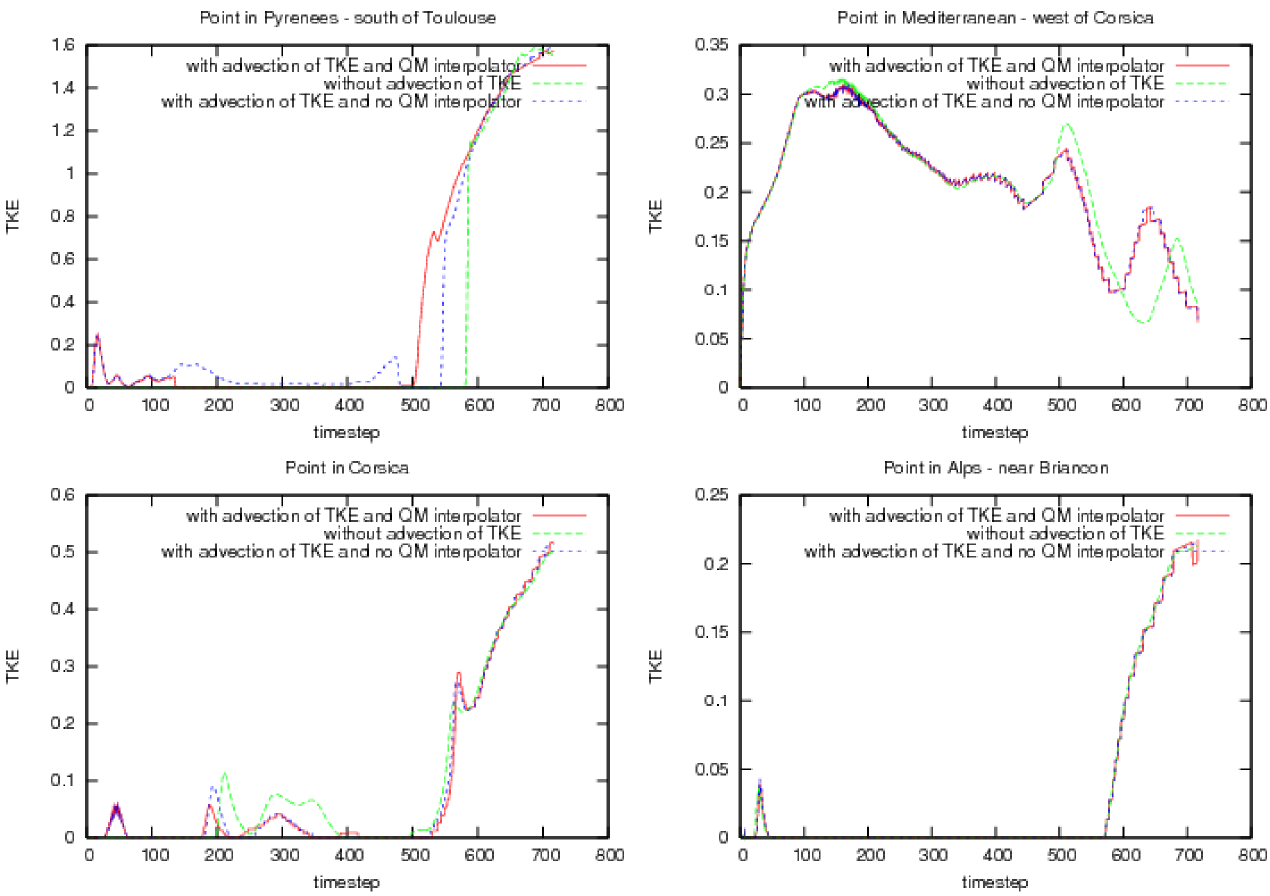


Figure 2: Time evolution of TKE at the lowest model level for three different experiments (advection of TKE with quasi monotonous interpolator, no advection and advection without quasi monotonous interpolation) for grid points 1 to 4 (see Table 2). The scale for TKE is different for each plot.

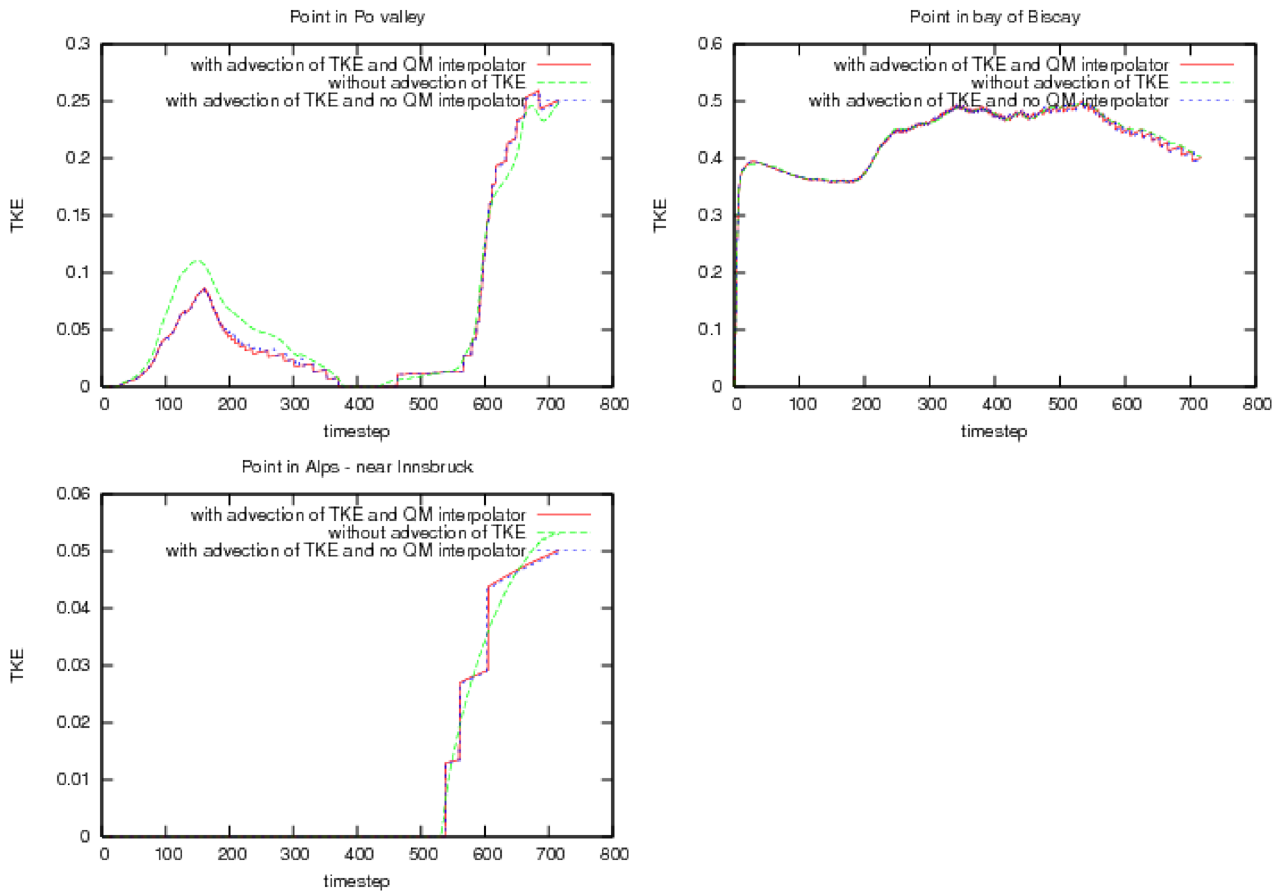


Figure 3: Same as Figure 2, but for grid points 5-7 (see Table 2).

For most of the time, TKE values seem to be in very close agreement. An interesting difference can be seen at point no.1 (Figure 2, above left) – on the ridge of the Pyrenees mountains. At some moment the TKE value for the run with advection starts to increase and it takes some time – roughly 100 minutes, until the no-advection run 'catches up'. In case of no advection of TKE, TKE still feels some advection, but indirectly – through general advection of other properties of airmass. The points where the two TKE values are quite different at least for some time are points in the Mediterranean (Figure 2, above right), Corsica (Figure 2, below left) and Po valley (Figure 3, above left).

The diurnal cycle of TKE is well expressed on all the land grid points: there is a significant increase in TKE around sunrise.

The unusual stepping in the pattern of evolution of TKE – seen particularly in point near Innsbruck (Figure 3, bottom left) – is thought to be a consequence of the interpolation scheme, since the layers above are also taken into account during spatial interpolation. To prove that, on would need to see a time series of vertical profile of TKE above such a point. It is argued that for points not so close to the surface this effect should be diminished.

The interesting point is that whilst the peak of TKE in Corsica (Figure 2, bottom left) is well captured by both advection runs and only poorly by the non-advection one, the peak near Briançon (Figure 2, bottom right) is unanimously captured by all three runs.

Another variable where the impact of (non)advection of TKE could potentially have a large impact is temperature. Figures 4 (part 1) and 5 (part 2) show the temporal evolution of temperature at the lowest model level for the experiment with and without TKE advection. Here the influence can still be seen, but to a much lesser extent. The biggest difference is in point near Corsica, where it reaches around 1K for period shorter than one hour.

An interesting feature of Figure 4 (especially point in Corsica – bottom left) are rather big oscillations, which are present in both cases. However, this paper is not intended to give an explanation for this.

4.2.4. Conclusion

It is quite clear that the advection of TKE plays a rather important role at the model resolution of 2km for the values of TKE itself. Already after a few hours of integration, the two TKE values can be up to 100% different (Figure 2, top right).

There was no significant difference observed when using QM or non-QM interpolator for advection.

The influence of (non)advection of TKE on temperature is much less pronounced and it reaches 1K at its maximum.

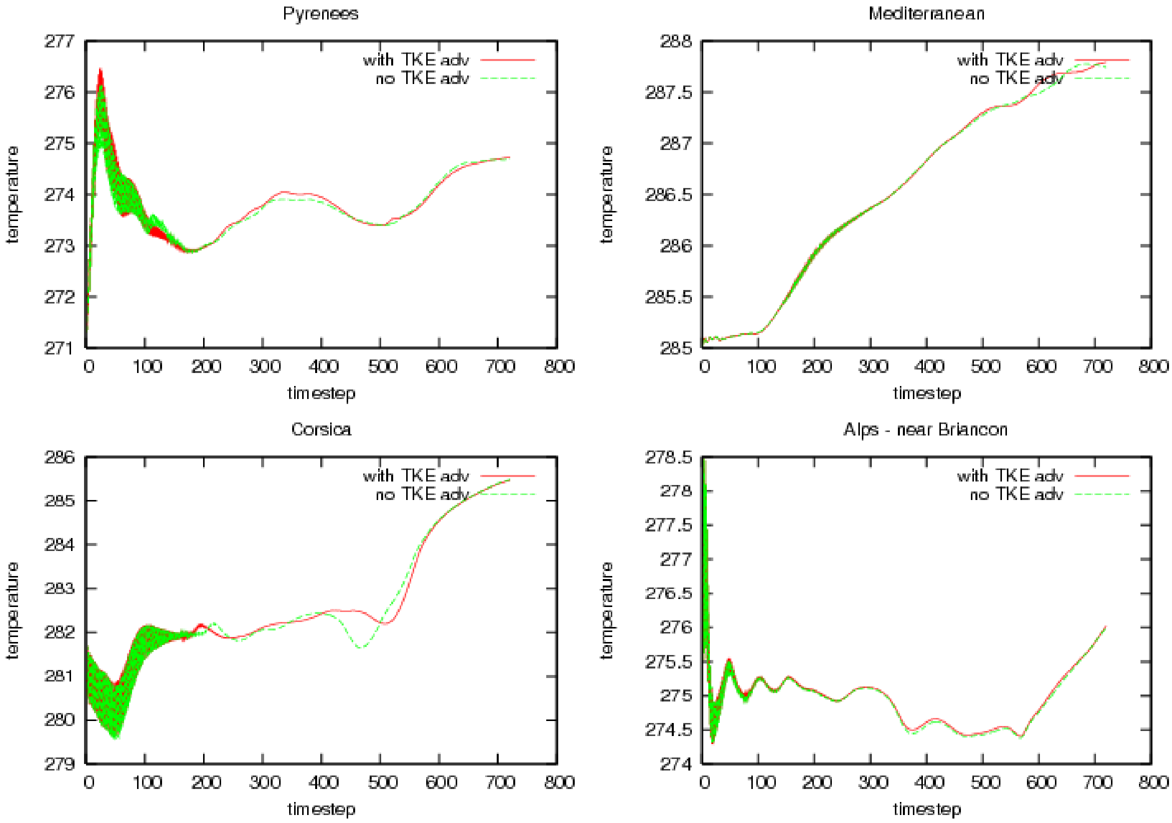


Figure 4: Time evolution of temperature at the lowest model level for experiment with advection of TKE (red) and without (green) for grid points 1 to 4 (see Table 2). The interpolator used with advection was the quasi monotonous one. The scale for temperature is different for each plot.

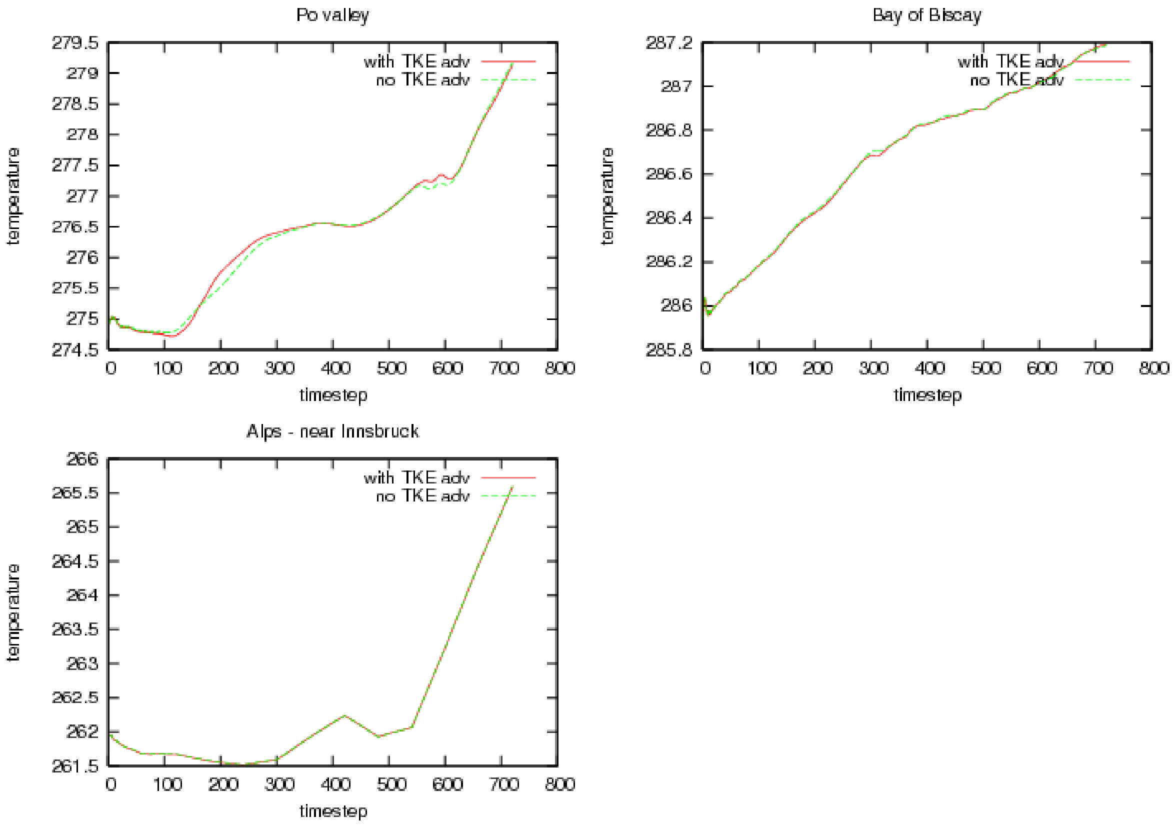


Figure 5: Same as figure 4, but for grid points 5 to 7 (see Table 2).

APPENDIX

Temporal evolution of advection term in TKE equation (Figure 6) and entire right hand side (RHS) of the TKE equation (Figure 7). Different colours depict different resolutions used.

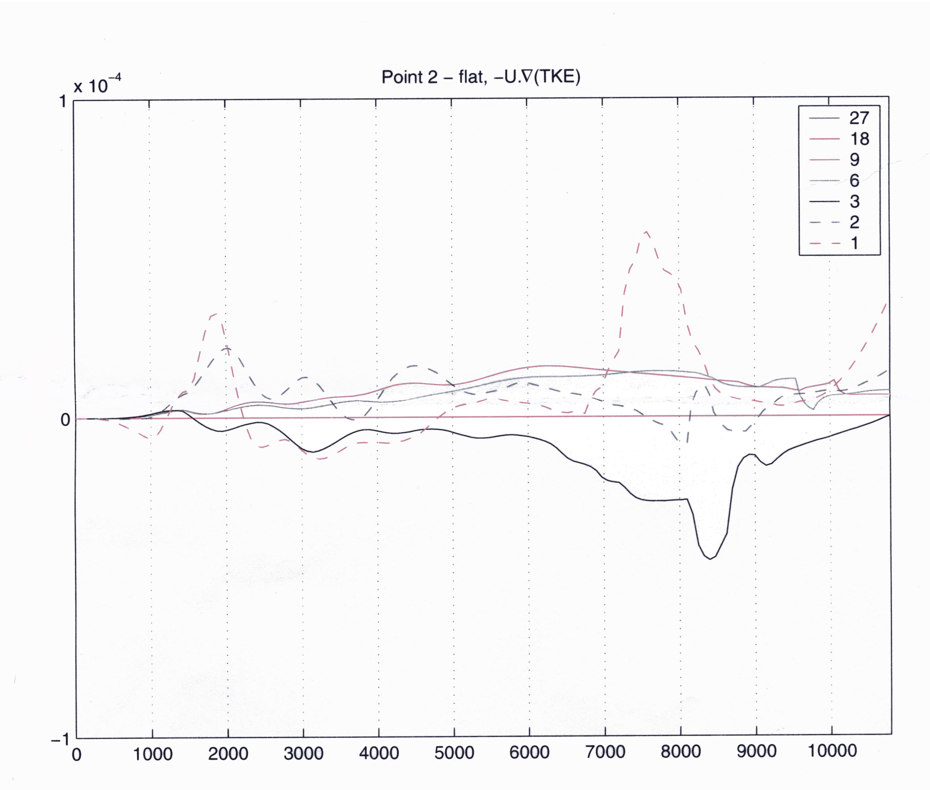


Figure 6: Evolution of advection term for the roughly the same grid point for several different resolutions.

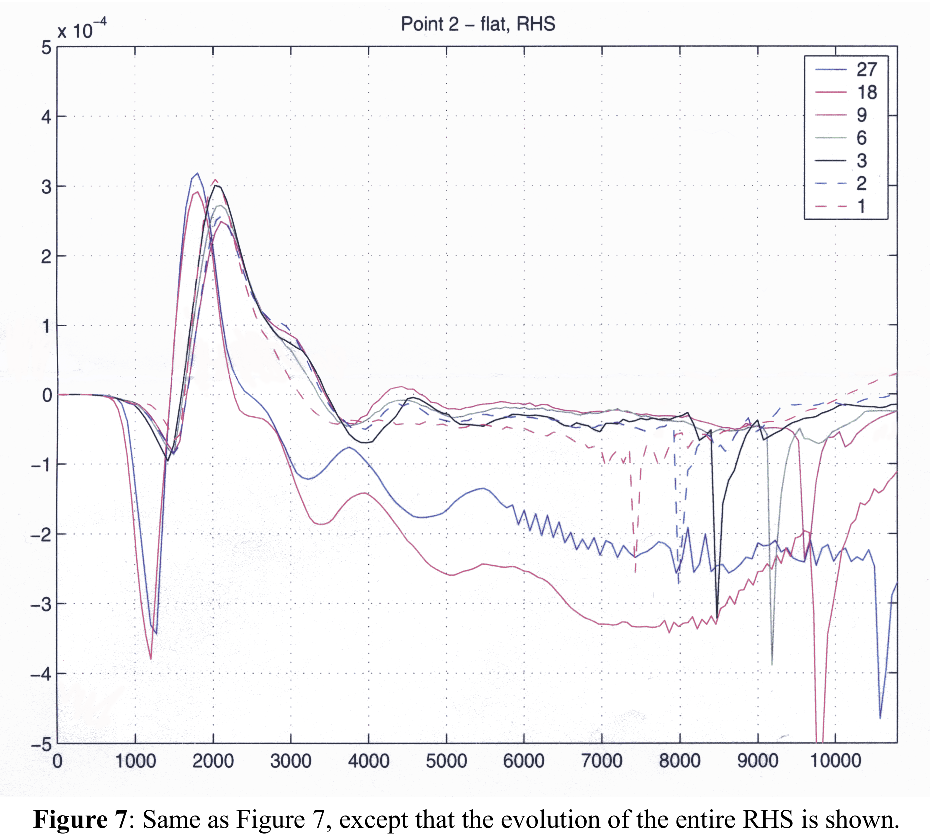


Figure 7: Same as Figure 7, except that the evolution of the entire RHS is shown.

4.3. A tropical storm reaching Iberian Peninsula

Belo Pereira M., N. Moreira, P. Pinto, A. Carvalho, M. Vargas and I. Soares

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4.3.1. Introduction

Hurricane Vince formed on 9 October 2005, in North Atlantic, Northwest of the Madeira Island, over ocean waters with sea surface temperature (SST) as low as 23-24ºC. Furthermore, Vince was one rare tropical storms which made landfall in the Iberian Peninsula.

Figure 1 shows the Cloud type image from MSG at 15:00 UTC of 9 October 2005, when Vince has been classified as a tropical storm by National Hurricane Centre (NHC). An eye, located near 34ºN, 19ºW, surrounded by deep convection is clearly visible.

Vince genesis was related to a frontal depression which was located near Azores at 00:00 UTC 5 October. In the next 36 hours the depression remained over the area (Carvalho *et al.*, 2008). Afterwards, it started to move south east, towards the west of Madeira Island. According to NHC report (Franklin, 2006) Vince was classified as a tropical storm at 12:00 UTC 9 October and as a hurricane at 18:00 UTC the same day, with a mean sea level pressure (MSLP) of 988 hPa and maximum sustained surface winds of 65 kt.

On 10 October Vince started to decay and to move towards Iberian Peninsula, making its landfall in the Andaluzia coast (Spain), between 09:00 UTC and 09:40 UTC of 11 October 2005, according with radar products (Carvalho *et al.*, 2008).

The surface observations obtained between 00:00 and 12:00 UTC on 11 October in Algarve region (Portugal) showed that the highest hourly precipitation values were observed in Faro (7.0 mm between 05:00 and 06:00 UTC) and Vila Real de Santo António (6.0 mm between 07:00 and 08:00 UTC). Regarding wind gust, the highest values were also observed in Faro and Vila Real de Santo António (68 km/h, 04:00-05:00 UTC and 06:00-07:00 UTC, respectively). According to the Spanish meteorological service, the most significant precipitation amount occurred in Córdoba (84 mm between 12:00 and 16:00 UTC on 11 October, with an hourly maximum of 54.2 mm).

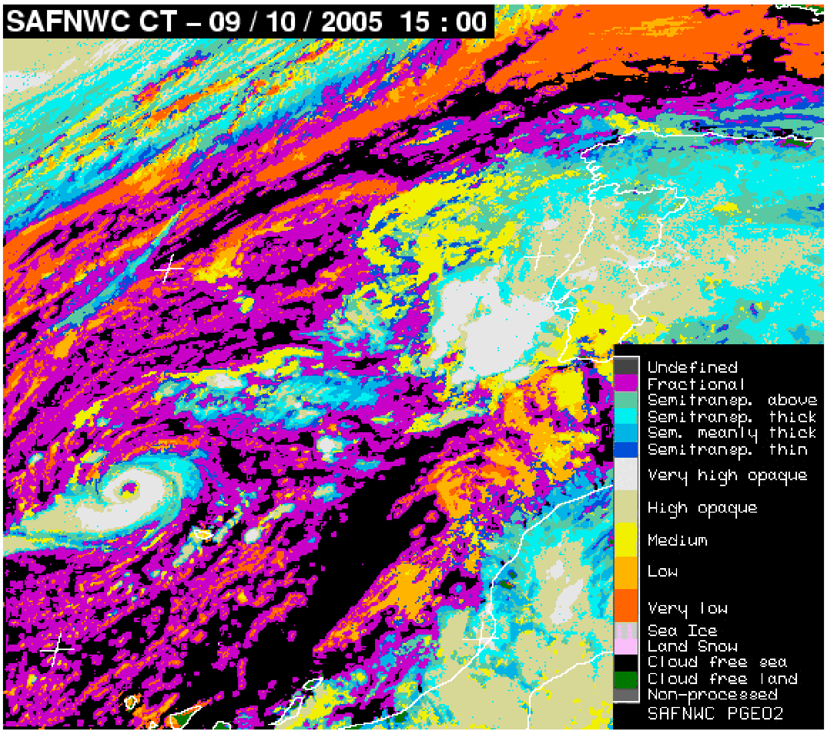

Figure 1 - Cloud type from MSG at 15:00 UTC on 9 October 2005. The coordinates of the crosses are (40ºN, 20ºW), (40ºN, 10ºW), (30ºN, 20ºW) and (30ºN, 10ºW), respectively for the upper left, upper right, lower left and lower left crosses.

4.3.2. ALADIN Performance

The version cy29t2 of ALADIN was integrated in hydrostatic mode, with 41 vertical levels and equivalent grid spacing of 12.6 km. Its initial and lateral boundary conditions were obtained from Arpège forecasts (grid spacing of approximately 21 km), with a coupling frequency of 3 hours. The integration domain covers the Iberian Peninsula and the Azores and Madeira Islands (figure 2). ALADIN simulations were initialized at 12:00 UTC, from 7, 8 and 9 October and integrated for 48h.

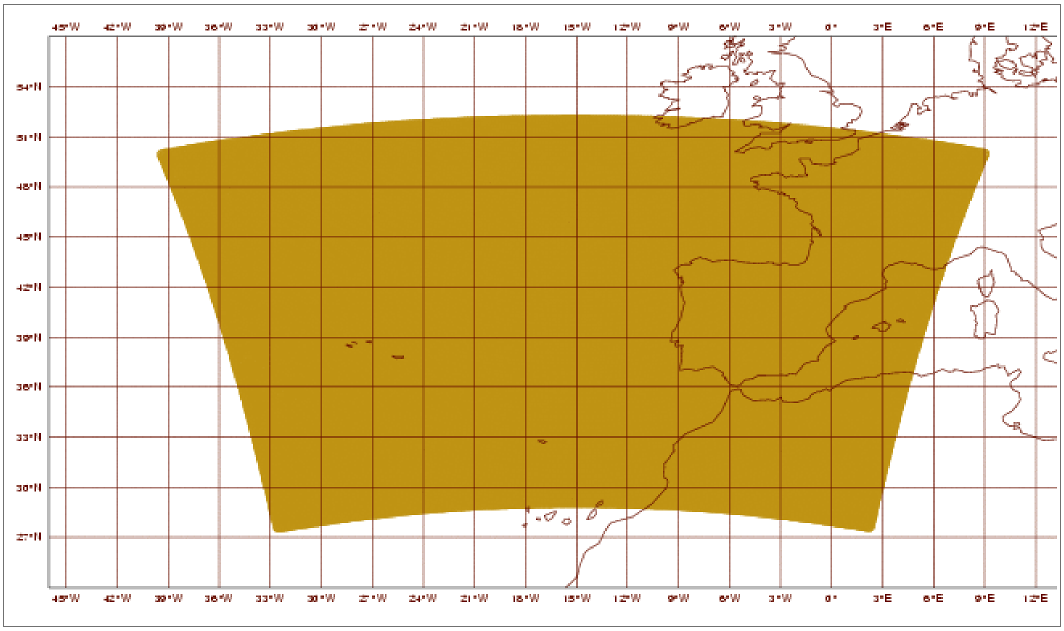

Figure 2 – ALADIN integration domain.

Figure 3 shows MSLP and clouds forecasts valid at 15:00 UTC 9 October. The MSLP locates the storm around 34ºN 19ºW, which was confirmed by the HRV image (Carvalho *et al.*, 2008, Fig.1) and by the Cloud type from MSG (Fig.1). However, from the comparison between Figure 1 and 3, it is clear that ALADIN underestimates the cloud depths associated to Vince.

Vince trajectories given by ALADIN ans NHC forecasts are compared in Fig.4. ALADIN closely agrees with NHC track until 10 October. Afterwards, the forecasted trajectories deviate significantly from the observed one, placing landfall around the Lisbon area rather than Andaluzia (Spain).

It is important to refer that ALADIN forecasts strongly underestimate the deepening of the system, between 9 and 10 October (figure 5). This underestimation is maximum during the hurricane stage (reaching 17-18 hPa). Furthermore, between 8 and 10 October, the maximum wind speed forecasted by ALADIN was 25-30 kt, while according to NHC the values of wind speed vary between 35 and 65 kt.

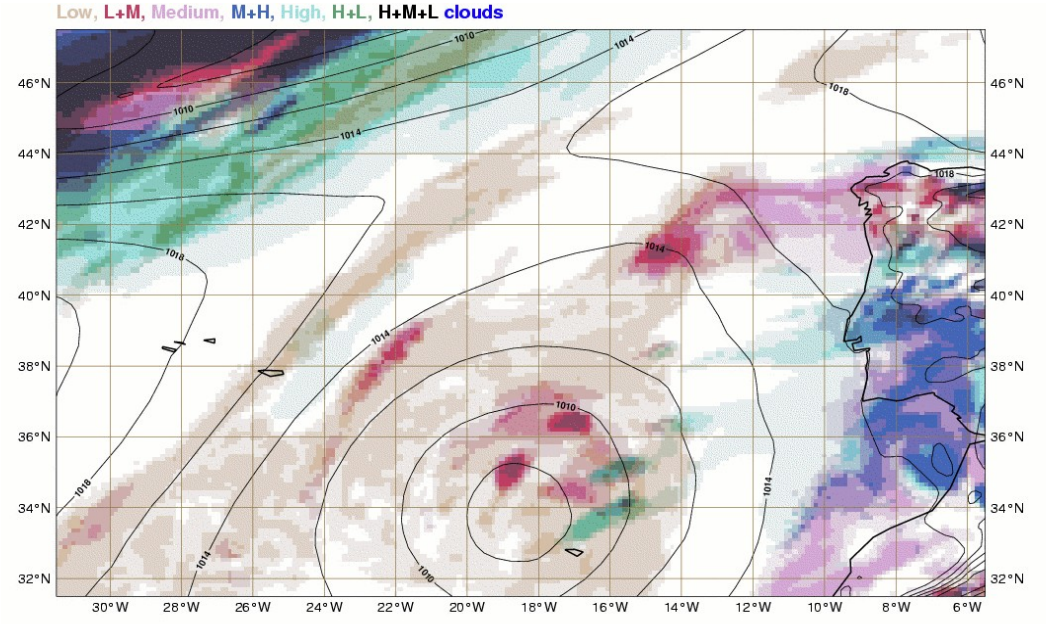

Figure 3. MSLP (contour interval is 2 hPa) and cloud layers (Low (*L*), Medium (*M*), High (*H*), *L+M*, *M+H*, *L+H* and *L+M+H*), valid at 15:00 UTC 9 October 2005 (27 hours ALADIN forecast).

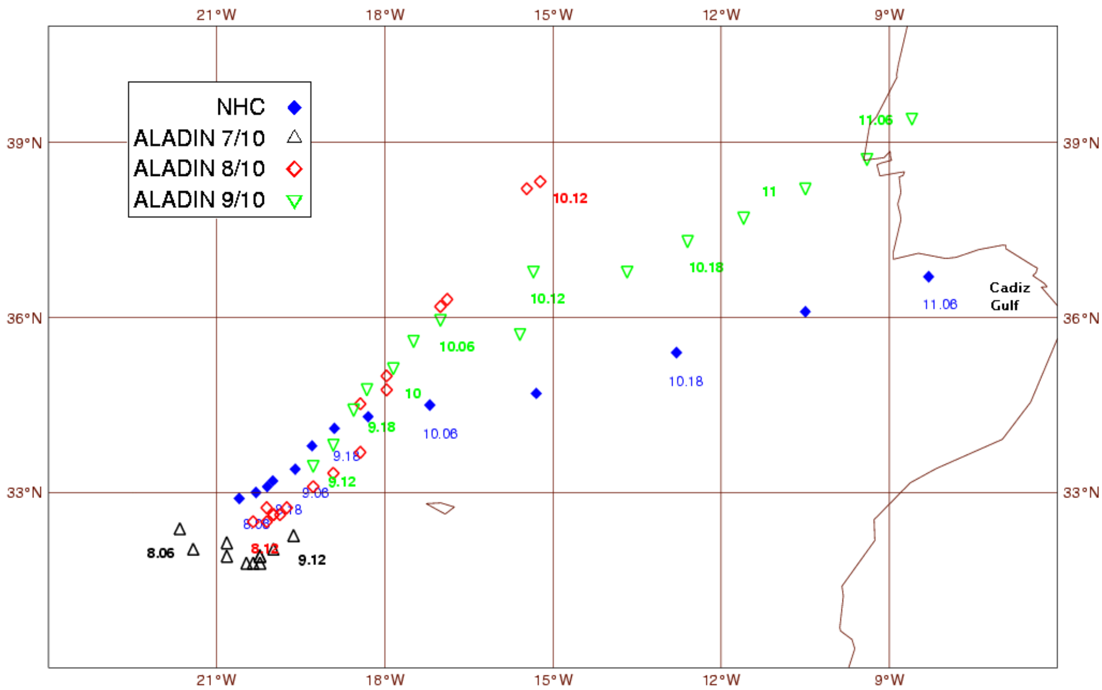

Figure 4. NHC trajectory from 06:00 UTC 8 October until 12:00 UTC 11 October, with a 6 hour interval, is shown in blue. Vince trajectory forecasted by ALADIN from 06:00 UTC 8 October until 12:00 UTC 9 October, starting at 12:00 UTC 7 October, is shown in black. The 48 h integrations starting at 12:00 UTC 8 October and at 12:00 UTC 9 October are shown, respectively, in red and green. The trajectories forecasted by ALADIN are shown with a 3 hour interval.

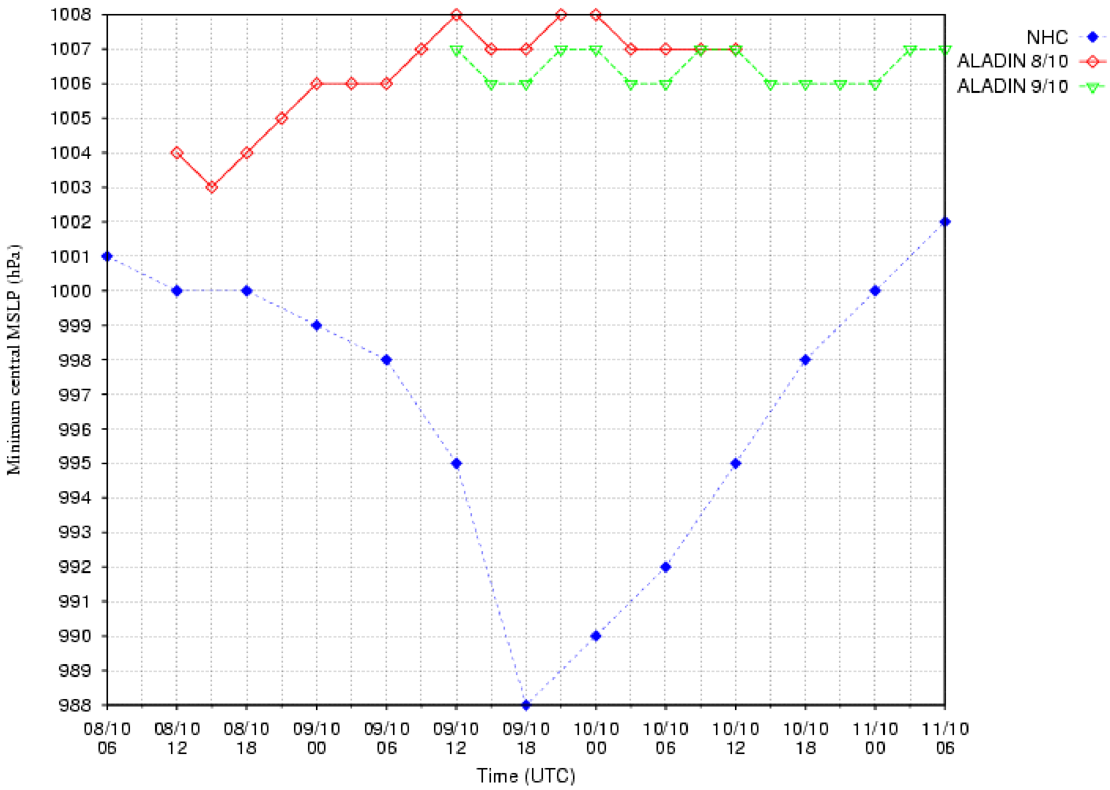

Figure 5 – Minimum central pressure (hPa) of Vince forecasted by ALADIN (red and green curves) and estimated by NHC (blue curve).

4.3.3. Final remarks and perspectives

Vince developed north of 30ºN, over ocean waters with observed SST as low as 23-24ºC, being a rare tropical storm which made landfall in the Iberian Peninsula.

The trajectories forecasted by ALADIN are consistent with NHC up to the Madeira area. However, in its path from Madeira to the Iberian Peninsula, the forecasted trajectories significantly deviate from NHC, foreseeing landfall around Lisbon area rather than Andaluzia.

Vince reached the hurricane stage with a MSLP of 988hPa, however, ALADIN was not able to forecast such deepening. Furthermore, ALADIN underestimates the development of convection associated to Vince.

It would be interesting to study the performance of ALARO and AROME in this case.

References

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Franklin, J., 2006: Tropical Cyclone Report, Hurricane Vince, 8-11 October 2005, National Hurricane Centre.

4.4. Aquaplanet tests of the 3MT convection scheme : sensitivity to resolution on the stretched Arpege grid.

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4.4.1. Introduction

Tests of the 3MT scheme are performed within the Arpege model at T320 resolution with the stretched grid in order to assess the sensitivity of the 3MT scheme to the horizontal resolution. Preliminary studies of impact on the convection scheme on tropical variability are also presented. This paper is organized as follows : in the next section, we briefly describe the experimental setup. Then we compare the sensitivity to horizontal resolution in the tropics and in the mid latitudes in Arpege with 3MT and Bougeault convection schemes. Section 4 examines the probability density of rainfall for both schemes. In section 5, we study the tropical variability of Arpege by performing spectral analysis of equatorial waves with these two different convection schemes. Finally conclusions are drawn.

4.4.2. Experimental setup

The Arpege model was used at T320c2.5 resolution in Aquaplanet conditions. The following analytical expression for SST was chosen :

$$T_s(\varphi)= \max\left(27\left(1 - \sin^2\left(1.5\varphi\right)\right), 0\right)°C$$

With such SST, no double ITCZ was observed. The inter-comparison has been made only between Alaro with and without 3MT (named thereafter +3MT and -3MT experiment). In -3MT experiment Bougeault's convection scheme is used. In both cases the same radiation scheme is used. In order to start from a balanced basic state, each experiment is started after a 100 day run of the model with the same namelist. Experiments were performed on two sets of stretched grids at the same resolution but with different poles, the first over the Equator (Grid 1 figure 1a) the second over France (Grid 2, figure 1b))

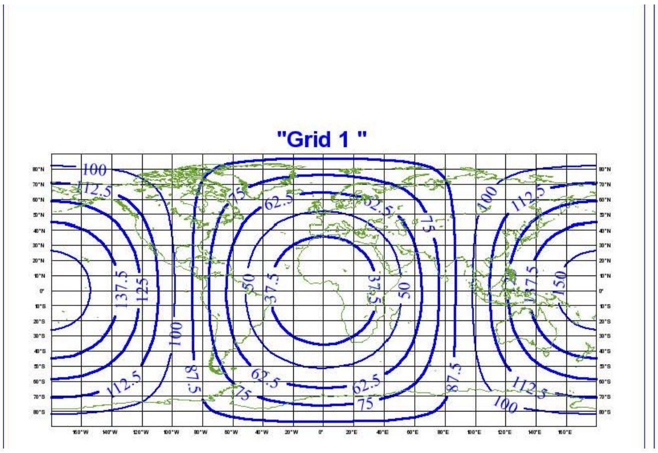


Fig. 1 – Horizontal resolution (km) on Arpege's stretched grid 1 (left) with stretching pole on the equator and grid 2 (right) with stretching pole over France. For both cases truncature is equal to T320 and stretching coefficient is set to 2.5

4.4.3. Sensitivity to resolution in the tropics (grid 1)

In this section, the first stretched grid "grid 1" will be used. For the -3MT experiment, Fg. 2 shows a clear increase of mean precipitation with horizontal resolution in the tropics. This dependence to the grid's size almost totally disappears in the +3MT experiment.

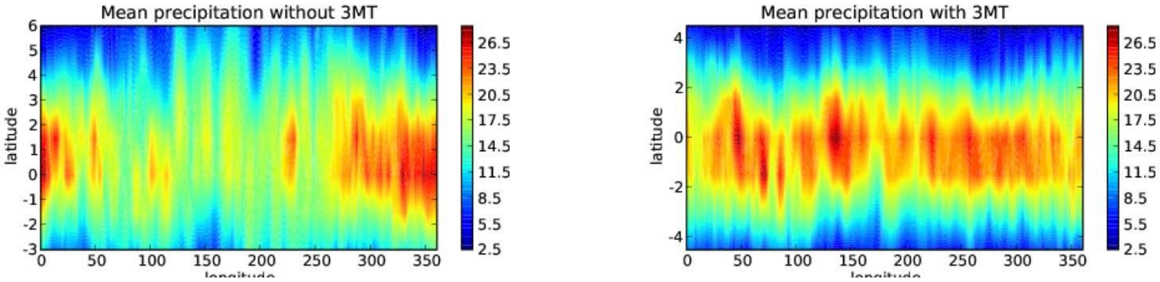
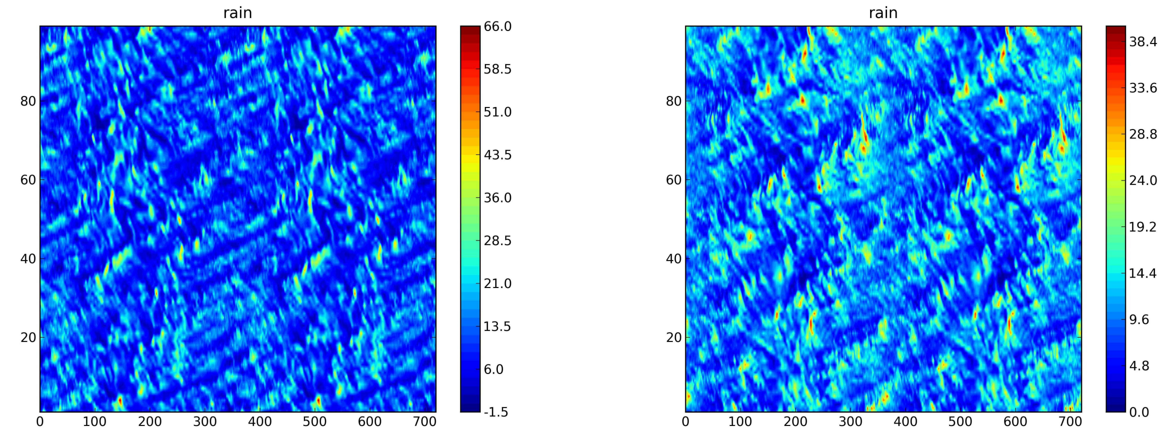


Fig. 2 – Mean daily precipitation (mm/day) averaged between ± 10˚N for -3MT a) and +3MT b) experiments over 100 days. Grid used by the model is stretched over equator (Grid1)

On the Hovmoeller diagrams over 100 days associated with both cases (Fig. 3) fields also seem more homogeneous for +3MT than for -3MT experiment. It is noteworthy that all fields do not present the same robustness to resolution, OLR or zonal velocity exhibit a marked longitudinal dependence for the +3MT experiment (no shown).

The tropical band between ±9˚N was divided into four regions with different horizontal resolutions and in each region histograms of daily precipitation were computed for the 100 days period. From the results displayed on Fig. 4 a) and 4 b) for -3MT and +3MT experiments, precipitation histograms are much more similar in the different regions with 3MT which is a logical consequence of what has been shown previously.

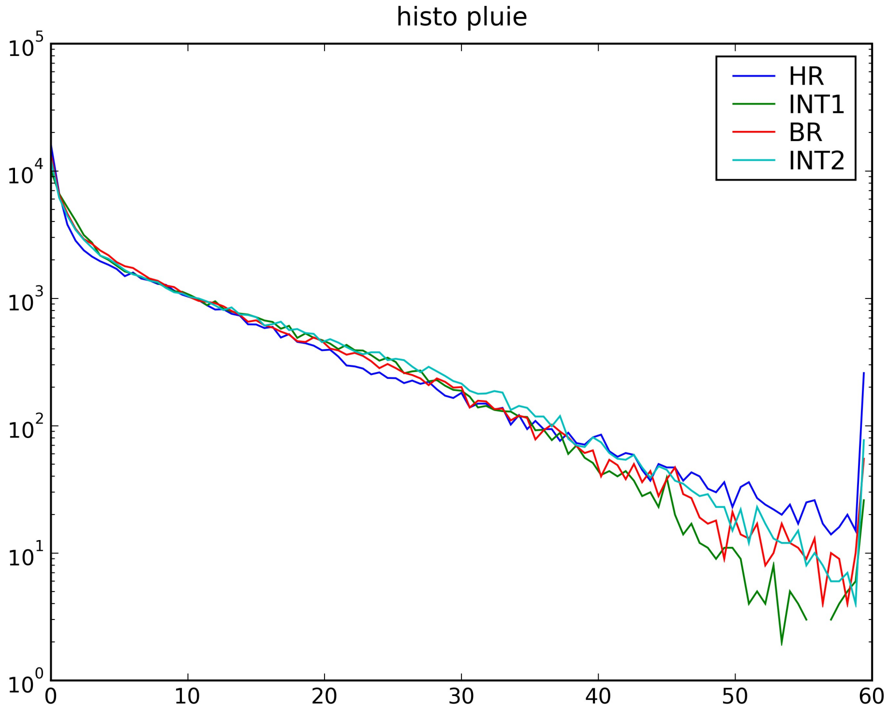
Same conclusions can be drawn using Grid 2 stretched over France (not shown).



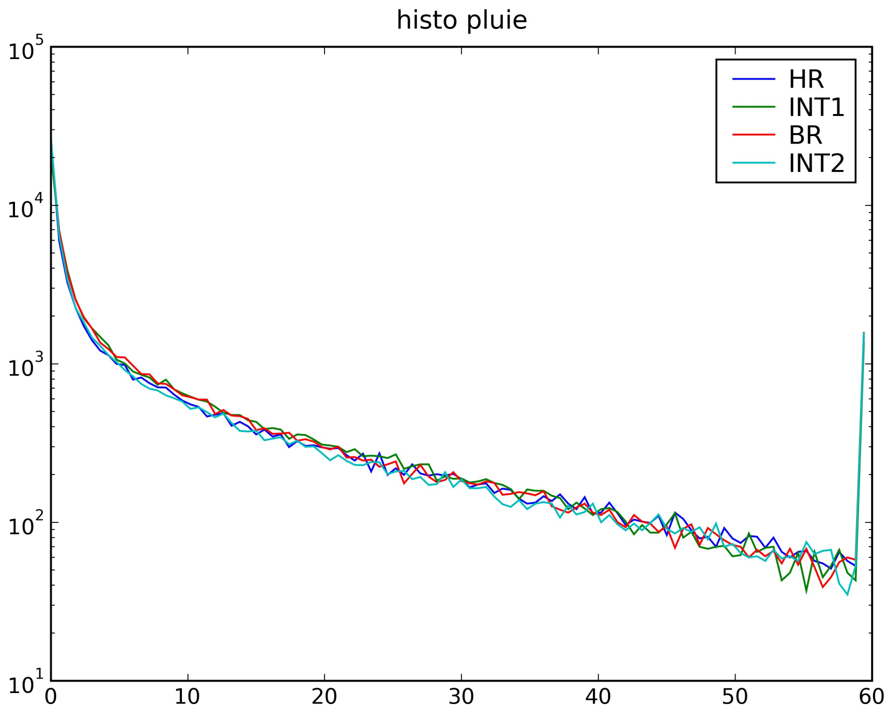
(a) +3MT

(b) -3MT

Fig. 3 – Hovmoeller (X-T) diagram for precipitation averaged between ± 9˚N in +3MT experiment. The x-axis which represents longitude covers twice the earth.



(a) -3MT

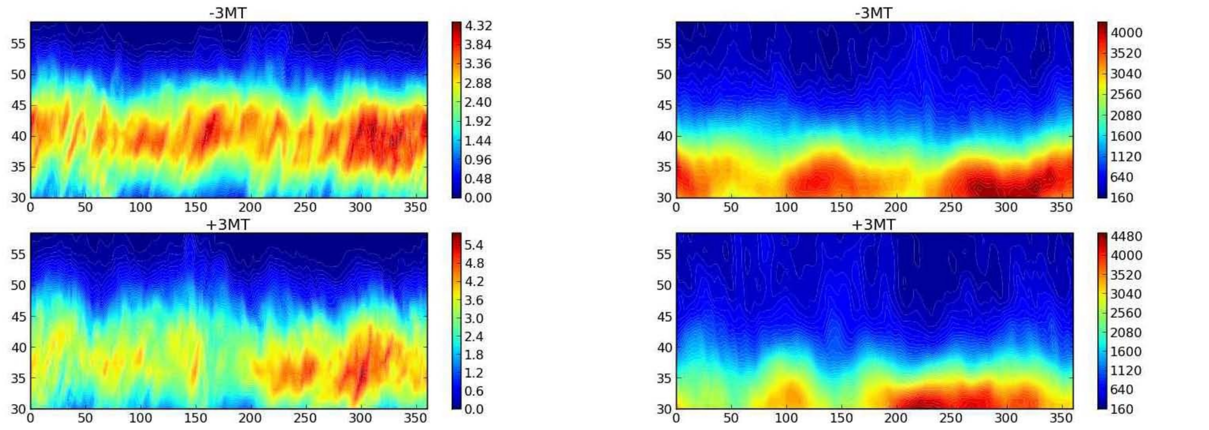


(b) +3MT

Fig. 4 – Histograms (Number of occurrences=f(amplitude)) of precipitation between ±10˚N (linear and log scale) for -3MT exp (a) and +3MT (b). The region between ±10˚N has been divided into 4 zones of different resolutions : HR (45W,+45E), BR(135E,225E),INT1 (45E,135E),INT2 (225E,-45W)

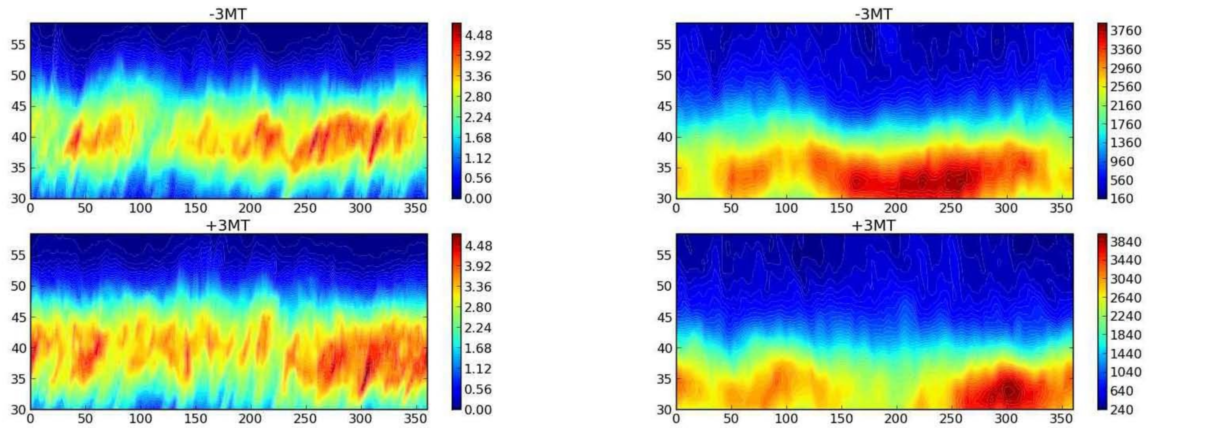
4.4.4. Sensitivity in the mid latitudes

Fig 5 displays for both convection schemes the time averaged total precipitation in the Northern Hemisphere in parallel to the time averaged squared horizontal velocity at 300 hPa which gives an overview of the strength of the jet in order to get a rough estimate of baroclinic activity. Indeed in mid latitudes, precipitation mainly occurs within baroclinic perturbations and cyclogenesis is sensitive to the properties of the mean flow.



(a) Time averaged precipitation (mm/day) (b) Time averaged ($u^2 + v^2$) at 300 hPa (m/s)

Fig. 5 – Horizontal maps of precipitation (left column) and 300 hPa velocity (right) fields averaged in time for experiments ± 3MT performed on Arpege's grid stretched over the equator (Grid 1)



(a) Time averaged precipitation (mm/day) (b) Time averaged ($u^2 + v^2$) at 300 hPa $(m/s)^2$

Fig. 6 – Horizontal maps of precipitation (left column) and 300 hPa velocity (right) fields averaged in time for experiments ± 3MT performed on Arpege's grid stretched over France (Grid 2)

Fig. 5 presents results obtained using Grid 1 stretched over the equator (Fig. 1a). With 3MT, the jet at 300 hPa exhibits strong longitudinal dependence and so does the mean precipitation, the maximum of precipitation being located slightly westward of the resolution pole. On the same grid with the Bougeault scheme, as well mean precipitation than the 300 hPa velocity field have strong zonal properties. On grid 2 stretched over France (Fig. 1b) where resolution is higher in the Northern hemisphere compared with grid 1, the jet and the mean precipitation are no longer zonal in the -3MT experiment. Both exhibit a maximum between 200E and 250E (Fig. 6). With 3MT (Fig. 6), mean precipitation is less sensitive to resolution than on grid 1, but the jet intensity is still maximum around 250E. We can therefore intuit that resolution was locally too low in the mid latitudes when using grid 1 in order for 3MT to behave independently of grid's size.

As stated above evaluating sensitivity of a given convection scheme to local resolution is more difficult in the mid latitudes because of strong dependence of precipitation to global circulation . However, the comparison of results obtained using two different sets of grids has shown that local resolution seems to be a critical ingredient for 3MT to behave well. This has been confirmed from tests performed at lower resolution on a stretched grid (not shown). From both experiments, the critical resolution can be estimated to be around 120 km by comparing the minimum resolution between both grids in the mid latitudes.

4.4.5. Qualitative comparison of rain histograms in the tropics

As shown on the histograms of equatorial precipitation (fig 7), 3MT allows more occurrence of cases with no precipitation (less than a mm/day). In the range of precipitations between 1 and 30 mm/day, 3MT show less occurrence than -3MT and for larger precipitation +3MT is dominant (we can see with the y logarithmic scale that in the -3MT case, we have an e^{-X} probability law for all precipitations thresholds.). This may have to do with the behaviour of the Bougeault scheme with the moisture convergence. In aquaplanet conditions, moisture supply is important and so does the Bougeault scheme almost continuously trigger convection whereas in 3MT we have a prognostic scheme for updraft and downdraft velocity as well than a prognostic closure.

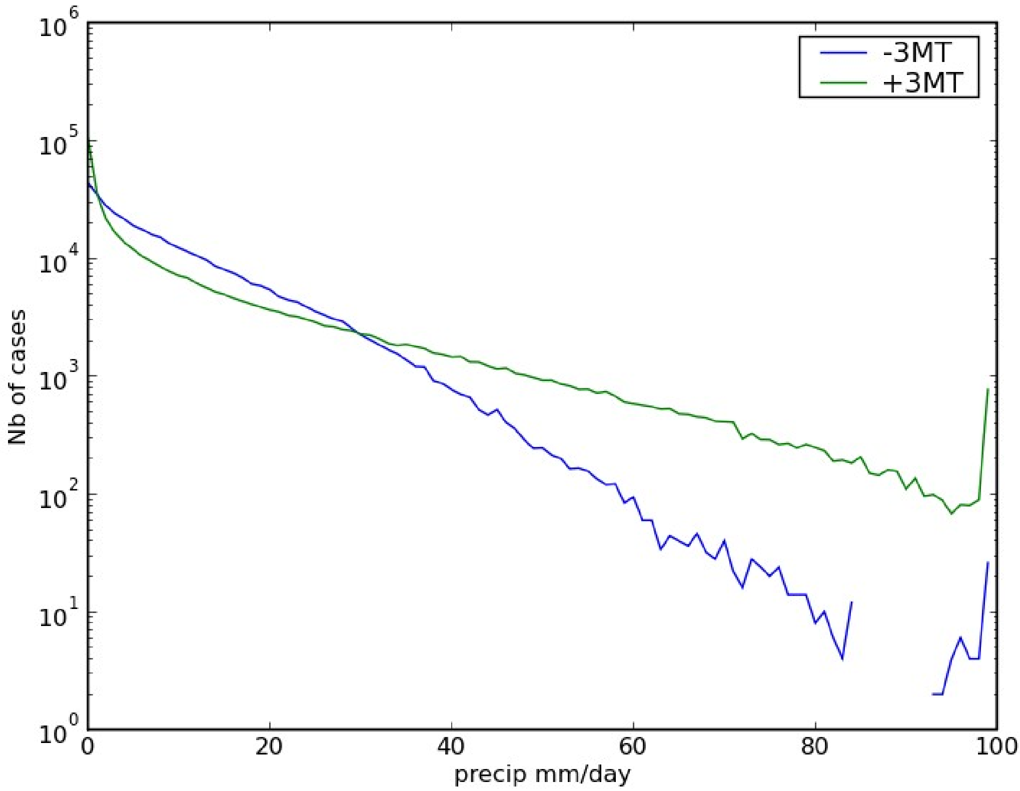
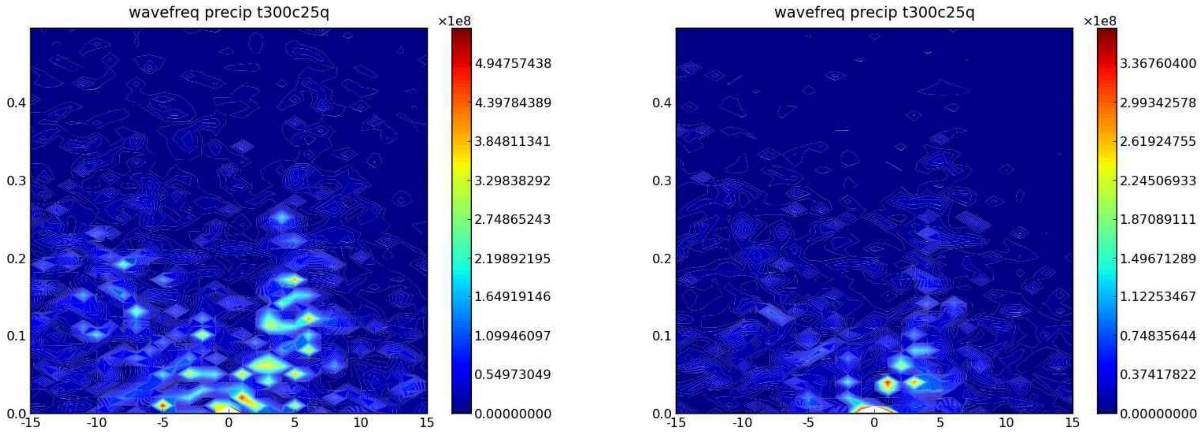


Fig. 7 – Histograms of precipitation between ± 6°of latitude in ± 3MT cases.



(a) +3MT (b) -3MT

Fig. 8 – Frequency-wave-number diagrams for +3MT (upper graph) and -3MT (lower graph) experiments. X-axis represents total zonal wave-number and Y-axis represents frequency (day. $^{-1}$). Positive wave-number on the x-axis means eastward propagation.

4.4.6. Tropical variability : spectral analysis of equatorial waves

In this section we study the equatorial waves in the spectral space in order to see if 3MT can improve some aspects of variability in the tropics and provide an accurate description of the various time and space scales of tropical convection, an important aspect in NWP. Similar work was done at the ECMWF (Technical Note n°556) and also in the framework of the APE (Aqua-Planet Experiment) project.

Figure 8 shows the spectrum (only symmetric part of the signal) in ω-k space of precipitation between ± 10°N over a period of 100 days[1] (for those who are not familiar with such plots we refer to the paper of Wheeler and Kiladis 1999 (JAS) from which figure 9 is taken) :

- first of all there is no obvious signal in both cases corresponding to the MJO. However with a period of more than 30 days, the MJO may not be sampled in a reliable way during only 100 days. It is also not clear from the theoretical studies I read if one can expect to get an MJO signal without ocean coupling...
- the eastward propagating signal (that was interpreted at low resolution as a possible MJO) corresponds to equatorial Kelvin waves. These waves are coupled with convection and their representation depends strongly on the convection scheme used. Comparison between both graphs shows that they are more represented with 3MT which reproduces more time and spatial scales. Knowing that parametrizations are known to reduce the spectrum of represented scales and thus variability it is highly interesting to see that 3MT increases the tropical variability. In the IFS model, improvements in Kelvin wave activity was also observed when switching to cy32r3 (see Technical Note n°556 from ECMWF for details) after changes in the formulation of convection among others...

1Spectral analysis has been performed only on raw data over 100 days with no particular smoothing which explains why the signal can be noisy.

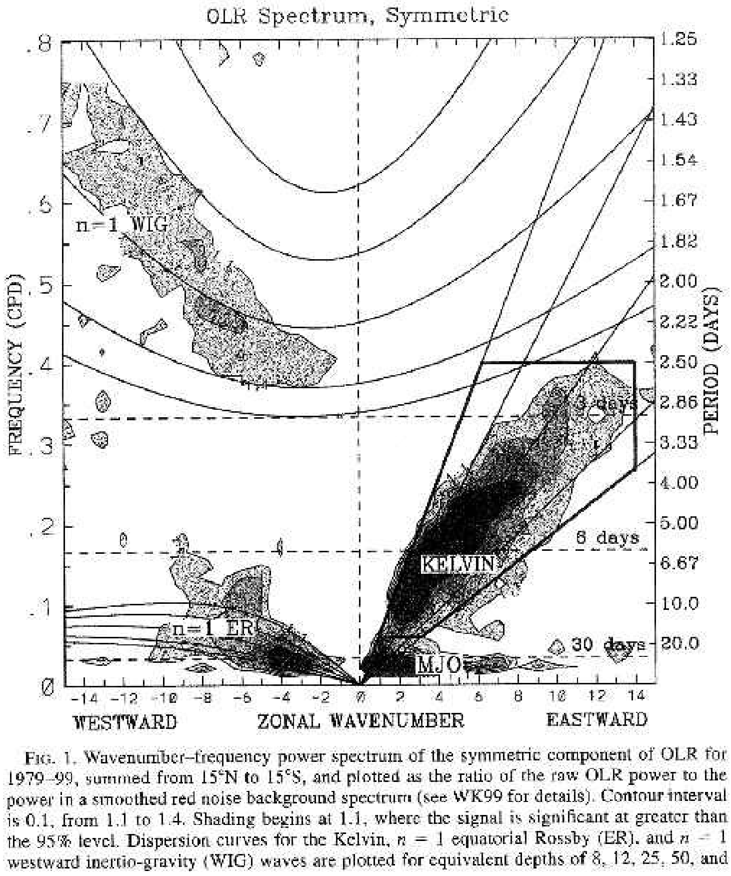


Fig. 9–(ω − k) plot from Wheeler at al (1999)

In the future, future studies on the evaluation of the tropical variability of Arpege are planned.

4.4.7. Conclusion

In the tropics where the sensitivity to resolution is the largest in the -3MT case (i.e with Bougeault convection scheme), the 3MT scheme shows almost no dependency to resolution on the stretched grid. This is an important point for a scheme thought to be used as well in the grey zone (resolution less than 10 km) than for climatic applications (with resolution above 100 km). Under a given resolution reached in the mid-latitudes when stretching pole is over the equator, 3MT scheme gives precipitation more dependent to resolution with a jet which varies more with longitude than without 3MT. A possible explanation could be a stronger coupling between convection and dynamics which affects dynamical fields in the mid-latitudes. When resolution is high enough (i.e with a grid size less than around 100-150km) in the mid latitudes, precipitation shows less dependency to resolution (although zonal circulation does not, which may turn to be a problem for forecast and impact of the 3MT scheme on dynamics shall be investigated in the future.). Comparison between the two schemes also shows that 3MT produces much more variability in terms of equatorial waves. Precipitation histograms were qualitatively different for both convection schemes : 3MT is more likely to produce in the tropics cases with precipitation close to zero or larger than 30 mm/day than Bougeault scheme. If we know that the convection scheme plays a dominant role in tropical variability, it seems difficult to distinguish which part of the improvements seen in the +3MT experiment comes from ”3MT microphysics cascade” or from the fact that this scheme is associated with prognostic equation for up and down drafts with a prognostic closure. It remains also unclear which part the prognostic closure plays in the 3MT scheme especially in aqua-planet conditions where moisture convergence may occur almost permanently. In the future, we also plan to further develop tools for testing tropical variability with different convection schemes in order to have a better understanding of coupling between dynamics and convection.

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- Branković Č, B. Matjačić, St Ivatek-Šahdan, and R. Buizza: Downscaling of ECMWF Ensemble Forecasts for Cases of Severe Weather: Ensemble Statistics and Cluster Analysis. *MWR,* **136,** 3323.

6. PhD STUDIES

Tudor M.: Numeričke nestabilnosti fizikalnih parametrizacija u prognostičkom modelu ALADIN (Numerical instability of the physical parameterization schemes in the NWP version of the ALADIN model), Master Thesis @ The University of Zagreb, defended 16.07.2007.

SUMMARY

Until recently, physical parameterizations have been considered crude and numerical methods used for solving them received little attention. Simplifications introduced in parameterizations have introduced significant errors so the numerical error was considered less important. Moreover, since the numerical scheme is usually an integral part of the parameterization scheme, it is difficult to distinguish between the numerical and physical error. Among the physical parameterization schemes, numerical issues related to vertical diffusion parameterization have received the most attention. Some operational models have build-in mechanisms that stabilize the vertical diffusion scheme when used with long time-steeps, and these models include Arpége and Aladin.

Simultaneously, considerable development of the numerical schemes used to integrate the dynamical part of the model has lead to wide usage of the two-time-level semi-implicit semi-lagrangian schemes in many meteorological models used for the operational weather forecast. Their computational efficiency allows faster computation of the weather forecast.

Stability analysis of a scheme used to solve a particular parameterization in a model is usually done with an isolated and simplified (linearized) version of the scheme. Since the parameterization is usually non-linear and interacts with the rest of the model, there is a need for a stability check of the true non-linear scheme inside the meteorological model. The method is based on the particular instability properties that may affect certain meteorological model. The aim of the method is to activate hiden sources of instability and to recognize their effect on the evolution of the model variables.

Physical parameterizations used in Aladin and Arpége models have been checked for the signs of the numerical instability. The existence of non-linear instability in deep convection and gravity wave drag parameterizations has been confirmed. These schemes have been modified in order to prevent further occurrence of the non-linear instability in them.

The large scale precipitation scheme has found to be stiff due to the value of the ration between the speed of evaporation of ice crystals and water droplets.

Ivatek-Šahdan S.: Dinamička adaptacija mezoskalnim meteorolškim modelom ALADIN (Dynamical adaptation using hydrostatic version of the ALADIN model), Master Thesis @ The University of Zagreb, defended 18.12.2007.

SUMMARY

Impact of a very high-resolution dynamical adaptation using hydrostatic version of the ALADIN model on the wind field forecast in the low troposphere for several cases of severe weather in Croatia is described. The method used here was developed by M. Žagar and J. Rakovec in 1999 for wind field in Ljubljana basin. Following assumptions were used: the flow is stationary, the moist and radiation processes and local thermal circulation have negligible influence to the air flow. These assumptions are valid for the strong down-slope flow. Model fields are interpolated to a higher resolution first. Numerical model is run using only part of the physical parameterization package to adapt model fields to the new terrain on higher resolution. Dynamical adaptation is run sequentially for each output file (forecast range) while the quasi-steadiness is achieved.

Sensitivity study is presented that explores the impact of the neglected processes in dynamical adaptation to 10m wind field and to horizontal wind field in low troposphere. Reduced number of the model levels (from 37 to 15) and usage of DFI before the start of dynamical adaptation are not significant. Optimal number of integration steps for dynamical adaptation is between 20 and 30, depending on the weather situation. If down-slope wind is strong, then 20 time-steps are enough to achieve the quasi-steadiness. While for wind speed less than 10m/s, state closest to quasi-steadiness is achieved with 30 time-steps. Between 30 and 45 steps are needed to achieve quasi-steadiness higher in the atmosphere, in the layer 1000m above ground. Influence of the excluded physical parameterizations, the moist and radiation processes on the forecast of the 10m wind field and in the layer 1000m above ground is not significant. Flow structure is preserved. Because dynamical adaptation is run sequentially for each output file, results were compared to the full integration on 2 km horizontal resolution. Results show significant difference in some areas away from orographyc obstacle. It is caused by reduction in the number of model levels of the full 2 km integration.

Comparison of the 2 km dynamical adaptation and 8 km model results with surface and upper-air measurements show that wind field forecasts are improved by dynamical adaptation if processes at 8 km are forecasted.

Usage of computationally cheap dynamical adaptation procedure allows quality wind field forecast early enough to issue warnings for approaching severe weather.

Kristian Horvath: Dynamical processes in the upper-troposphere and lee cyclogenesis in the western Mediterranean, Doctoral Thesis @ The University of Zagreb, defended 26.09.2008.

SUMMARY

Cyclones that appear in the Adriatic Sea basin strongly influence the climate and weather conditions in the area. A classification various types of cyclones tracks on the meso-β scale was performed based on the analysis of four years (2002 – 2005) of operational ECMWF T511 dataset. The analysis indicates that four types of cyclones over the Adriatic Sea can be identified: (1) Type A: Genoa cyclones, with subcategories (I) continuous track and (II) discontinuous track. (2) Type B: cyclones developed in situ over the Adriatic Sea without any connection with other pre-existing cyclones in the surrounding area, with subcategories (I) northern Adriatic cyclones and (II) middle Adriatic cyclones. (3) Type AB: two cyclones co-exist and stride over the Apennines ("twin" or "eyeglass" cyclones). (4) Type C: cyclones moving from the Mediterranean Sea, but not from Gulf of Genoa (non-Genoa cyclones), with subcategories (I) continuous track and (II) discontinuous track. The results reveal that the greatest number of cyclones that appear in the Adriatic are initiated in the lee side of mountain ranges in the western Mediterranean (such at the Alps, the Atlas, the Pyrénées and the Apennines), associated with an upper-level trough traversing over the mountain range.

The influence of the upper-level trough on the life cycle of the typical Mediterranean cyclone initiated to the lee of the Alps (12-15 Nov 2004) is investigated through a numerical analysis with the use of factor separation and piecewise potential vorticity inversion methods. The upper-level trough is shown to be the necessary ingredient of the event and primary deepening factor in the mature stage of cyclone development. However, the Atlas orography is the main contributor to the deepening in the first phase of deepening. Therefore, despite the differences in synoptic setting, creation of thermal anomaly and deepening result suggest the dynamical resemblance of the cyclogenesis to the lee of the Atlas and the Alps. In addition, the analysis of the ensemble of simulation with macroscale and mesoscale perturbations to the upper-level potential vorticity anomaly suggest that cyclone track and intensity are controlled the most by the strongest mesoscale upper-level potential vorticity anomaly cores (local maximums of potential vorticity) embedded in the trough.

The sensitivity of the MAP IOP 15 Genoa lee cyclogenesis event (06-09 Nov 1999) to the initial-analysis uncertainties in the upper-level precursor is numerically analyzed thought the ensemble of sensitivity simulations. Modifications in the initial conditions are created with the use of 90^{th} percentile of derived potential vorticity global model analysis error statistics, reflecting uncertainty in both intensity and position of the upper-level trough. The maximal spread of intensities in the ensemble reaches almost 50% of the cyclone intensity in the control run, and occurs during the most rapid deepening phase of the cyclone. In contrast, the strongest spread of cyclone centre positions is present in the late mature and dissipation phase, reaching up to 750 km, due to different upper-level cut-off dynamics, modified by the Alpine orography. The Bora strength is strongly sensitive to the cyclone intensity and position, but also to the properties of the background flow, with a resulting spread of wind speed of ±30% compared to the Bora intensity in the control run. The variability of the background flow throughout the ensemble of simulations evidenced through the (non)existence of synoptic critical levels and their varying altitudes as well as a span of the integral background Froude number over several flow regimes. Therefore, the initial-analysis uncertainties in the macroscale dynamics propagate to a range of smaller-scale phenomena in a chain of dynamically related mesoscale events, having a strong potential to decrease the mesoscale numerical forecast accuracy in the region. This suggests that the considerable improvement of the quality of the mesoscale numerical weather prediction in the area is very likely to be reached through a limited area model ensemble prediction system.