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Review paper

20 GODINA SUDJELOVANJA HRVATSKE U ALADIN I RC LACE PROJEKTIMA

20 years of Croatian participation in ALADIN and RC LACE projects

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Sažetak: U radu je dan kratak osvrt na povijest sudjelovanja Hrvatske u ALADIN i RC LACE projektima. Hrvatski doprinos razvoju ALADIN modela obavlja se u okviru rada RC LACE grupe, pa je posebna pažnja posvećena upravo RC LACE suradnji. Naglašen je znanstveni i stručni doprinos hrvatskih znanstvenika na pojedinim temama, učešće Hrvatske u organizaciji ALADIN I RC LACE sastanaka, radionica i seminara. Od uključenja Hrvatske u ALADIN i RC LACE projekte realizirano je 68 dugotrajnijih boravaka 19 hrvatskih meteorologa u meteorološkim službama zemalja članica. U razdoblju od uspostave ALADIN/HR operative u Hrvatskoj do kraja 2014. godine 22 hrvatska meteorologa je radilo ukupno 593 mjeseci na temama razvoja modela i razvoju i održavanju lokalnog operativnog prognostičkog ALADIN sustava. Rezultat toga je, između ostalog, znatan broj znanstvenih i stručnih radova, te doprinos mnogobrojnim domaćim i međunarodnim znanstvenim projektima.

Ključne riječi: ALADIN, RC LACE, numerička prognoza vremena

Abstract: The paper gives a brief overview of the history of Croatian participation in the ALADIN and RC LACE projects. Croatian contribution to the development of the ALADIN model is carried out in the framework of RC LACE cooperation. Therefore, the special emphasis is given to the research and development activities in RC LACE group. Detailed information are given on the scientific contribution of Croatian scientists to specific topics and Croatian role in ALADIN and RC LACE management and meetings, seminar and workshops organizations. From the beginning of ALADIN and RC LACE cooperation 19 Croatian scientists realized 68 visits to consortium countries. In the period from 2000 (start of the pre-operational run in Croatia) to 2014, 22 Croatian meteorologists worked a total of 593 months on model development as well as development and maintenance of the local operational ALADIN weather prediction system. The result is, among others, a substantial number of scientific papers and contributions to numerous national and international scientific projects.

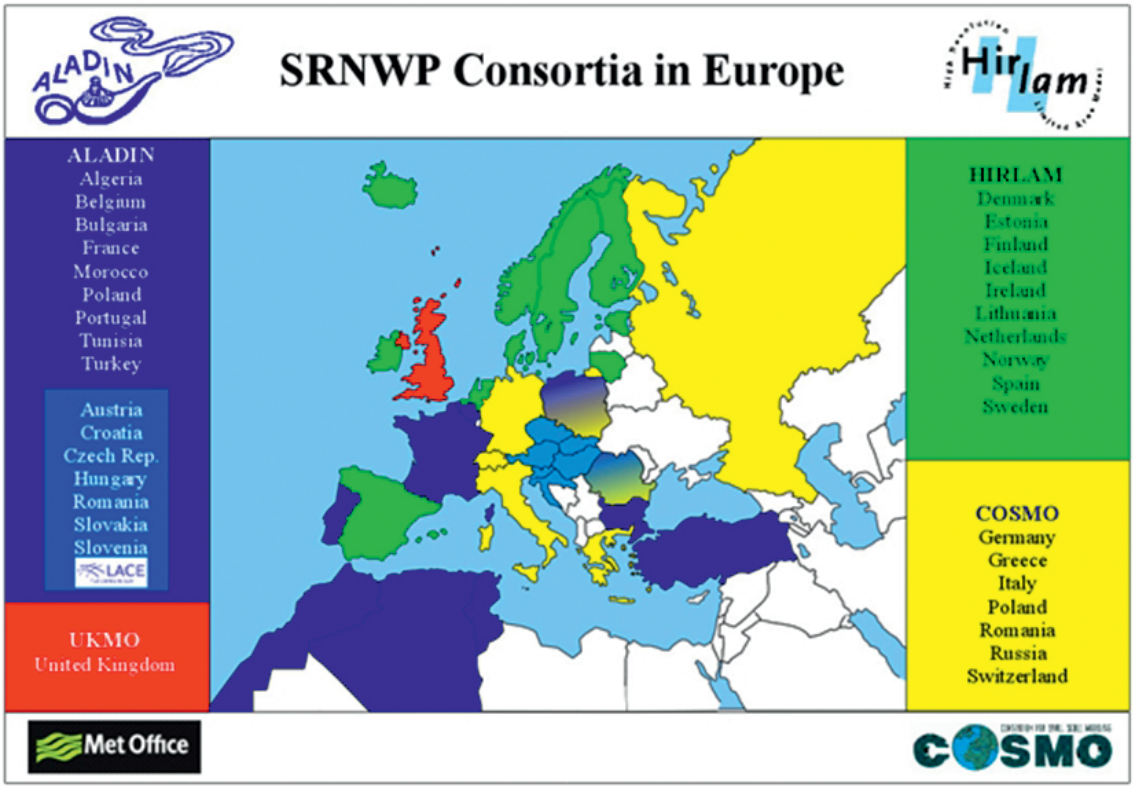
Key words: ALADIN, RC LACE, numerical weather prediction

1. UVOD

Suvremena prognoza vremena se temelji na primjeni numeričkih modela koji pomoću diferencijalnih jednadžbi opisuju stanje i promjene u atmosferi. Takav pristup prognozi vremena zahtjeva vrlo kompleksan sustav koji uključuje brzu komunikaciju potrebnu za prikupljanje podataka i značajne računalne kapacitete za složene proračune. Razvoj takvog prognostičkog sustava nije jednostavan i može se provesti samo suradnjom velikog broja meteorologa i informatičkih stručnjaka. Zbog toga se nacionalne meteorološke službe udružuju u konzorcije koji djeluju kao dio EUMETNET-ovog (značenje svih kratica dano je u prilogu 1) programa kratkoročne numeričke prognoze vremena SRNWP. Hrvatska je dio ALADIN konzorcija (slika 1) zajedno s Alžirom, Austrijom, Belgijom, Bugarskom, Republikom Češkom, Francuskom, Mađarskom, Marokom, Poljskom, Portugalom, Rumunjskom, Slovačkom, Slovenijom, Tunisom i Turskom (http://www.cnrm.meteo.fr/aladin/).
Unutar ALADIN konzorcija postoji posebno uspostavljena suradnja zemalja Srednje Europe nazvana RC LACE (*Regional Cooperation*

1. INTRODUCTION

Modern short-range weather forecasting is based on the application of numerical models that describe the way the atmosphere changes using differential equations. This approach requires very complex weather forecasting system with fast communications (to gather the observations) and significant computer resources (to carry out the large number of calculations). Developing such a system is not easy task and could not be done without engagement of significant number of meteorological and IT experts. Therefore, national meteorological services in different countries gather in consortiums under the EUMETNET's (meaning of abbreviations is given in supplement) Short Range Numerical Weather Prediction Project (SRNWP), that develop and maintain common numerical short-range weather forecasting system for operational use by the participating institutions. Meteorological and Hydrological Service (DHMZ) of Croatia participates in ALADIN (Aire Limitée Adaptation Dynamique Développement InterNational) consortium (Figure 1) together with Algeria, Austria, Belgium, Bulgaria, Czech Republic,



Slika 1. Europski konzorcij programa SRNWP (Short Range Numerical Weather Prediction).

Figure 1. SRNWP (Short Range Numerical Weather Prediction) consortia in Europe.

for Limited Area modelling in Central Europe) u koju su uključene nacionalne meteorološke službe Austrije, Hrvatske, Republike Češke, Mađarske, Rumunjske, Slovačke i Slovenije (http://www.rclace.eu/).

Cilj ALADIN i RC LACE suradnje je unaprijediti nacionalne sustave prognoze vremena i upozorenja na opasne meteorološke prilike zasnovane na operativnoj primjeni atmosferskih modela za numeričku prognozu vremena za ograničeno područje, koji mogu razlučiti procese horizontalnih dimenzija ispod 30 km i poboljšati prognozu meteoroloških fenomena kao što su obilne oborine, intenzivna olujna nevremena i olujni vjetar. To uključuje sljedeće aktivnosti:

- razvoj i održavanje sustava numeričke prognoze vremena na ograničenom području uz optimalne informatičke resurse u članicama konzorcija;
- zajedničko istraživanje i razvoj na temelju zajedničkog strateškog plana i plana rada s ciljem održavanja ALADIN modela na aktualnoj svjetskoj znanstvenoj i tehničkoj razini;

France, Hungary, Morocco, Poland, Portugal, Romania, Slovakia, Slovenia, Tunisia and Turkey (http://www.crnm.meteo.fr/aladin/). Within the ALADIN consortium exists group of members called RC LACE (Regional Cooperation for Limited Area modeling in Central Europe). The participants are the National Meteorological Services of Austria, Croatia, Czech Republic, Hungary, Rumania, Slovakia and Slovenia (http://www.rclace.eu/).

The goal of the ALADIN and RC LACE Collaboration is to improve the value of the meteorological, hydrological and environmental warning and forecast services delivered by all Members to their users, through the operational implementation of a NWP system capable of resolving horizontal scales under 30 km, improving the prediction of severe weather phenomena such as heavy precipitation, intensive convection and strong winds.
This objective is fulfilled through following activities:

- To develop and maintain a NWP system for use in limited area, requiring optimal computational power in the member countries;

Slika 2. Sudionici zajedničkog sastanka ravnatelja meteoroloških službi uključenih u ALADIN i HIRLAM konzorcije održan 2.12.2014. u Readingu u Velikoj Britaniji.

Figure 2. Participants of joint ALADIN General Assembly and HIRLAM Council meeting hold in Reading, UK on 2nd December 2014.

- razmjenu znanstvenih rezultata, programskih kodova, relevantnih znanja i ekspertiza, uz uvjet da svi članovi ALADIN konzorcija koriste iste alate kod operativnih i istraživačkih aktivnosti.

Nakon 2000. godine pokrenuta je suradnja HIRLAM i ALADIN konzorcija. Na ALADIN sastanku direktora nacionalnih meteoroloških službi održanom u Splitu 2004. godine potpisana je rezolucija o suradnji ALADIN i HIRLAM konzorcija na znanstvenim temama i razvoju numeričkog modela atmosfere za ograničeno područje (http://www.cnrm.meteo.fr/aladin/IMG/pdf/ResolutionAH.pdf). Razvoj te suradnje doveo je do deklaracije kojom se definira namjera uspostave jedinstvenog konzorcija, koji će raditi na razvoju jedinstvenog prognostičkog sustava za ograničeno područje, imajući u vidu dosadašnja iskustva i zajedničke ciljeve. Deklaracija je donesena na prvom zajedničkom sastanku opće skupštine ALADIN i HIRLAM konzorcija održanom 2.12.2014. u Readingu u Velikoj Britaniji (slika 2). Ovom se suradnjom stvorila jedinstvena prilika da ALADIN i LACE znanstvenici surađuju s HIRLAM članicama, posebno na području asimilacije podataka.

Više od stotinu znanstvenika iz 16 zemalja, svaki sa svojim specifičnim tehničkim i računalnim mogućnostima i znanjem, neprekidno doprinosi napretku numeričke prognoze vremena unutar ALADIN sustava. Oni zajednički rade na modernom numeričkom modelu atmosfere koji zaslužuje istaknuto mjesto među suvremenim europskim atmosferskim modelima za numeričku prognozu vremena, te razvijaju i održavaju lokalne operativne prognostičke sustave. Doprinos hrvatskih meteorologa razvoju ALADIN-a odvija se u okviru RC LACE projekta kojem ćemo ovdje posvetiti posebnu pažnju.

2. POVIJESNI PREGLED ZNANSTVENOG DOPRINOSA LACE GRUPE U ALADIN PROGRAMU

LACE je program suradnje nacionalnih meteoroloških službi Središnje Europe koje od 1990. godine surađuju na razvoju i primjeni numeričkog modeliranja. U prvoj fazi, suradnja se usredotočila na kreiranje Regionalnog centra za numeričko modeliranje na ograničenom području s operativnim produktima (RC

- Joint research and development activities, on the basis of the common strategic and related work plan, with the aim of maintaining the ALADIN model at scientific and technical "state of the art" level within the NWP community;
- Sharing scientific results, numerical codes, related expertise and know-how is necessary for all ALADIN Consortium members to conduct operational and research activities with the same tools.

The international meteorological context is steadily changing, specifically with the merger of the ALADIN and the HIRLAM Consortia. The resolution on ALADIN-HIRLAM cooperation was adopted at the ALADIN Assembly meeting held in Split 2004. The resolution defines the ALADIN and HIRLAM cooperation on scientific exchange and common LAM code (http://www.cnrm.meteo.fr/aladin/IMG/pdf/ResolutionAH.pdf). Progress of the cooperation leads to the declaration proclaimed at the 1st joint ALADIN Assembly and HIRLAM Council meeting in Reading, UK on 2nd December 2014 (Figure 2). This cooperation encourages the unique opportunity for ALADIN and RC LACE scientists to cooperate with the HIRLAM members, especially in the field of data assimilation.

More than one hundred scientists from sixteen countries, each with its own specificity in resources and knowledge, are permanently contributing to the progress of the ALADIN NWP system. They are working together on numerical code of the atmosphere, that definitely deserves its proper place between the European state-of-the-art NWP models, and developing local operational forecasting systems. Croatian contribution takes place within the RC LACE project that is introduced in next chapters with more details.

2. HISTORY OF LACE SCIENTIFIC CONTRIBUTIONS TO THE ALADIN PROJECT

LACE project is cooperation of national meteorological services of Central Europe on cooperation at development and applied Numerical weather prediction since 1990. LACE cooperation firstly was established as Regional Center for numerical modeling with aim to provide operative LAM products (RC LACE

LACE 1996. - 2002.). Kasnije (od 2003. do danas) je LACE reorgaiziran u Regionalnu koordinaciju za numeričko modeliranje (RC LACE). U početku je LACE imao šest članica iz meteoroloških službi Austrije, Republike Češke, Hrvatske, Mađarske, Slovačke i Slovenije. Rumunjska se kao sedma članica 2006. godine pridružila LACE-u.

Razdoblje od druge polovice 1980-ih i početka 1990-ih godina bilo je vrlo aktivno u europskoj meteorološkoj zajednici. Uz doprinos koji se na području razvoja atmosferskih modela globalne cirkulacije događao u široj zajednici, kao posljedica uspostavljanja rada Europskog centra za srednjoročne prognoze vremena (ECMWF) u Readingu, europska akademska zajednica postavljala je temelje numeričkog modeliranja na ograničenom području. Imajući u vidu moć regionalnog udruživanja, koji je dokazan kroz razvoj grupe HIRLAM u Skandinaviji krajem 1980-ih godina, LACE je započeo regionalno umrežavanje NWP grupa meteoroloških službi Srednje Europe, s ciljem razvoja i primjene modela za ograničeno područje visoke razlučivosti.

Ambicija LACE-a je bila da potpomogne i razvije znanstvena iskustva i znanja, te da osigura uvjete i udruži snage oko operativne primjene LAM-a i pridruženih aplikacija u Srednjoj Europi, koji bi kvalitetom svojih produkata trebali nadvisiti kvalitetu produkata globalnih atmosferskih modela. LACE inicijativa je početkom 1990-ih godina našla partnera u meteorološkoj službi Francuske, koja je radila na uspostavi LAM-a kao dijela nadgradnje globalnog atmosferskog modela ARPEGE, te stvorila tim za razvoj ALADIN-a upravo partnerstvom s mnogim meteorološkim službama Srednje i Istočne Europe.

2.1. LACE i razvoj LAM modela prilagođenog operativnoj primjeni

U kreiranju ALADIN modela poštovani su sljedeći principi: modularnost, skalabilnost, efikasnost i portabilnost aplikacije. Osnova ALADIN-a je globalni atmosferski model ARPEGE koji je usklađen s globalnim ECMWF IFS modelom. Stoga su u razvoju ALADIN-a korišteni najviši stupnjevi znanja iz polja fizike i dinamike atmosfere, numeričkih metoda i računalnog programiranja.
U prvoj fazi uspostavljen je LAM visoke razlučivosti pomoću modificiranih spektralnih

1996-2002). Afterwards, LACE was transformed to Regional cooperation on ALADIN numerical modeling at Central Europe - Regional Cooperation LACE (RC LACE onwards year 2003). Initially LACE group were six meteorological services of: Austria, Czech Republic, Croatia, Hungary, Slovakia and Slovenia, since 2006 Romania has joined as seventh member.

Second half of eighties and beginning of nineties in the twenty century were very proactive period for European scientific meteorology community. At the time when European Center for Medium-Range Weather Forecasts (ECMWF) in Reading was established, global atmospheric circulation models were developed. Thanks to the obtained results European academic community established the basic principles for the limited area modeling (LAM models). Recognizing a power of regional cooperation, that was proved by development of HIRLAM group at Scandinavia at the end of eighties, LACE started with aim to gather regional NWP teams of meteorological services at Central Europe for the joint development of operative applied LAM at highest resolution grid size.

LACE ambition was that on the base of LAM development, improve and develop scientific competence and experience at LAM, to ensure conditions and join efforts around operative and applied LAM and downstream applications at Central Europe, with product that should over-perform the global atmospheric model outputs. LACE initiative had meet partner at Meteo Service of France - Meteo France that started a development of LAM model as part of branch development on the global meteorological model ARPEGE. Meteo France established first group of ALADIN model developers in partnership with scientists from Central and Eastern European meteo services.

2.1. LACE and development of LAM model for operative purposes

At the creation of ALADIN model the following principles were applied: modularity, scalability, efficiency and portability of final application. Taking into account that ALADIN model is a part of global model

jednadžbi iz globalnog dinamičkog modela. Izrađena je nehidrostatska verzija dinamike u modelu. Također je razrađena metoda povezivanja (*eng. coupling*) rubnih djelova LAM modela s globalnim modelom. Usporedno s time veliki su se napori ulagali u razvoj dijagnostike NWP modela, kako bi imali set alata za praćenje razvoja modela i objektivnih metoda za usporedbu globalnih modela i LAM-a.

Prve operativne aplikacije ALADIN modela bile su ALADIN/Francuska, ALADIN/LACE, ALADIN/Maroko i ALADIN/Rumunjska (1996. godine). Za potrebe razvoja tih modela intenzivno se radilo i na podešavanju fizikalnih parametara lokalnim klimatskim prilikama.

U prvoj operativnoj fazi izračun ALADIN/ /LACE modela radio se na računalima u Meteo-France-u (20 km horizontalne rezolucije, +48 sati prognostičke integracije) kao dinamička prilagodba, koristeći početne uvjete iz ARPEGE modela i bez asimilacije mjerenih podataka. Paralelno se u LACE-u formirala grupa znanstvenika koji su razvijali metode početnih uvjeta LAM-a putem optimalne interpolacije prizemnih podataka i 3D varijacijske metode asimilacije (3DVar) visinskih polja.

2.2. RC LACE Prag - centralizirani operativni i znanstveni centar

Osnivanjem Regionalnog centra LACE u Pragu, 1998. godine, koji je bio jedinstveni operativni centar za mezoskalnu numeričku prognozu, započinje nova faza znanstvenog doprinosa ALADIN/LACE-a pod okriljem češke meteorološke službe. Prvi puta se i operativna primjena razdvaja od istraživačkog centra ALADIN-a u Meteo France-u, te se stvara NWP istraživački centar unutar RC LACE-a u Pragu. LACE je za potrebe razvoja i koordinacije LAM istraživanja osnovao LACE znanstveno vijeće (LSC), postavio je u LACE upravi znanstvenog koordinatora (*LACE Scientific Officer - LSO*) i koordinatora za održavanje znanstvenih i tehničkih doprinosa središnjoj ALADIN aplikaciji (*ALADIN System coordinator*). Uvedena je obaveza da svaka zemlja članica doprinosi RC LACE centru u Pragu s radom znastvenika u obimu od najmanje 4 mjeseca rada godišnje.
Ova obaveza je doprinjela povećanju broja znanstvenika uključenih u rad na području nu-

ARPEGE, that is also linked to ECMWF IFS modular code system, at the ALADIN development was following a top-end achievements at atmospherics physics and dynamics, numerical methods and computer programming.
As the first step, high resolution LAM was established on the base of modification of the spectral space equations from global dynamical model. The non-hydrostatic dynamics of LAM version was developed. LAM boundary parts were coupled with global atmospheric model. In the same time a great efforts were made at development of NWP model diagnostic, in order to provide tools for monitoring model developments and the objective methods for inter comparison of global and LAM model features.

The first operative model configurations were ALADIN/France, ALADIN/LACE, ALADIN /Morocco and ALADIN/Romania (in 1996). For the development of those operative versions, an intensive work was performed in development of LAM model climatology and high resolution model orography.

ALADIN/LACE at its first operative set-ups were executed at Meteo France mainframe computer (20 km grid size, +48 hours integration), and only as dynamical adaptation of ARPEGE initial conditions, without data assimilation. At the same time, the team of scientists were formed at LACE who started development of methods for LAM initialization, through development of surface analyses methods by objective interpolation and 3D variational techniques (3DVar) for upper atmosphere methods.

2.2. RC LACE Prague - centralized operative and research center

Establishing of Regional Center LACE in Prague in 1998, hosted by Czech meteo service, brings a new phase of LACE operative application but also started a LACE scientific contribution. For the first time, operative application was separated from ALADIN research center at Meteo France, and the NWP research center were organized as part of RC LACE Prague, coordinated by RC LACE management group. For the purpose of scientific development and coordination, LACE scientific committee (LSC) was established.

meričke prognoze vremena, što je bilo omogućeno i mnogobrojnim dodatnim usavršavanjem unutar RC LACE u Pragu, te posebnim radionicama s Meteo-France stručnjacima (osiguranim od strane LACE i ALADIN projekta za usavršavanje znanstvenika *ALADIN Training Network ALATNet*).

Teme na kojima se radilo u RC LACE centru su bile: testiranje metoda modela orografije za visoku razlučivost, razvoj i testiranje metoda gnježđenja za spektralne modele na ograničenom području, razvoj novih produkata LAM-a vezanih uz atmosferske procese na maloj skali (udari vjetra, dinamički parametri stabilnosti, itd), razvoju dijagnostika i metoda za tretiranje parametara temperature i vlažnosti tla u modelu, unapređenje i prilagodbe fizikalnih parametrizacija konvektivnih procesa za klimatske prilike Srednje Europe i Sredozemlja.

RC LACE Prag je bio i glavni istraživački centar za razvoj i testiranje nehidrostatske dinamike modela koja je trenutna operativna dinamička jezgra u konfiguracijama AROME i ALARO.

RC LACE je razvio i nove metode početnih uvjeta ALADIN modela kao što je *blending* (razdvajanje i filtriranje valnih doprinosa globalne i lokalne skale u početnim uvjetima digitalnim filtrom), testiranje i prilagodba varijacijske asimilacije podataka (3DVar), te njihova međusobna prilagodba.

Uvažavajući intenzitet znanstvenog djelovanja u RC LACE-u posebna se pažnja pridavala razvoju metoda i alata za verifikaciju produkata modela za znanstvenu i operativnu primjenu.

Operativna konfiguracija ALADIN/LACE modela korištena je u operativnoj fazi MAP projekta 1999. godine kao jedan od prognostičkih modela za koordinaciju istraživačkih mjerenja i akcija MAP IOP (*Meso-scale Alpine Programme Intensive Operative Period*). ALADIN/LACE model sudjelovao je također i u MFSTEP (*Mediterranean Forcasting System for Environmental Prediction*) projektu kao atmosferski prognostički model koji je korišten kao gornji rubni uvjet oceanografskih modela na Sredozemlju 2002. - 2004. ALADIN/LACE je bio primjer meteorološkoj službi

LACE implemented the position of LACE scientific officer (LSO) at LACE management and ALADIN System coordinator officer for maintenance scientific and technical contribution at central ALADIN application. Furthermore, LACE put demand to all LACE members to dedicate scientists contribution for at least 4 months yearly.

That new obligation for the all LACE members required the enlargement of NWP teams, and permanent training of the NWP newcomers at RC LACE Prague center, at dedicated trainings for LACE members at Meteo France, financed by LACE or by ALADIN project for training of scientists (ALADIN training network - ALATNet).

Topics of research at RC LACE Prague were: testing the methods for orography in model at high resolution, developing and testing techniques of coupling for spectral LAM models, developing new products related to small scale atmospheric processes (wind gusts, dynamical stability parameters, etc), developing tools and methods for testing model soil temperature and humidity, improvement and tuning of physical parameterization of convective processes for climate condition over Central Europe and Mediterranean.

RC LACE Prague was the leading research center for developing and testing a new non-hydrostatic spectral model (NH ALADIN), currently operative NH dynamical core at ALADIN, AROME and ALARO models.

RC LACE has developed also new initialization methods for ALADIN model, such as blending (separation and spectral filtering of large and small scale increments in the model initial conditions by digital filter), testing and adapting of variable data assimilation techniques (3DVar), as well as their mutual adaptation.

Taking into account the intensive scientific engagements at RC LACE, the dedicated efforts were put at the development of methods and tools for model verification, as for scientific and operative purposes.

ALADIN/LACE model was one of the operative models during the MAP IOP project

Maroka pri razvoju regionalne verzije ALADIN-a za Zapadnu i Sjevernu Afriku (ALADIN NORAF, od 2003. do danas) čiji se produkti emitiraju i radiovalovima šalju u druge zemlje regije.

2.3. RC LACE znanstveno operativna koordinacije poslije 2002. godine

Promjenom ciljeva program LACE je nakon 2002. godine uspostavio i novu strukturu. Definirana su 3 područja znanstvene djelatnosti: asimilacija podataka i prediktabilnost, usavršavanje numeričkih shema i programskih kodova te poboljšanje fizikalnih parametrizacija u modelu. Rad na svakom području koordinirao je odabrani ekspert kao dio LACE uprave. Uz koordinatora za održavanje znanstvenih i tehničkih doprinosa središnjoj ALADIN aplikaciji (*ALADIN System coordinator*) uveden je koordinator za podatke (*Data Manager*) na poslovima inicijalizacije ugnježđivanja modela, asimilacije podataka i verifikacije.

Kako je novom strukturom prestao postojati jedinstveni znanstveni i operativni centar RC LACE u Pragu, sve LACE članice su počele lokalni razvoj uz rad na dogovorenim znanstvenim temama. U cilju poticanja suradnje znanstvenika iz različitih zemalja RC LACE je uveo i poseban fond za znanstveni razvoj koji se koristio za financiranje gostujućih znanstvenika, prvenstveno za zajednički rad NWP LACE timova i za rad u Meteo France-u.

Prve godine decentraliziranog rada omogućile su pojedinim LACE NWP timovima specijalizaciju za različite teme: Mađarska i Republika Češka za teme asimilacije podataka, Slovenija i Republika Češka za fizikalne parametrizacije u modelu, Slovačka i Republika Češka za rad na numeričkim shemama i programskim kodovima, Austrija i Mađarska za metode prediktabilnosti, Hrvatska i Slovačka za inicijalizaciju modela, Slovenija i Hrvatska za evaluaciju modela, itd. Od 2006. godine LACE uvodi i četvrtu znanstvenu grupu za prediktabilnost i postavlja LACE koordinatora za tu aktivnost.
2003. godine u ALADIN-u dolazi do dva velika pomaka u kojima LACE aktivno surađuje. Razvoj konvektivno razlučivog NWP modela AROME fine rezolucije od 2.5 km u Meteo-France-u, koji je utemeljen na nehidrostatskoj dinamici i asimilaciji ALADIN-a i fizikalnim shemama Meso NH modela. LACE sudjeluje u

(Meso-scale Alpine Programme Intensive Operative Period) in 1999. It was also used in MFSTEP project (Mediterranean Forecasting System Toward the Environmental Predictions) as atmospheric model to force oceanographic models over Mediterranean (2002-2004). ALADIN/LACE was the rule model for the Moroccan Met Service to develop operative ALADIN model for the West and North Africa (ALADIN NORAF, since 2003), that disseminates LAM products via radio signal to the wide area of undeveloped countries.

2.3. RC LACE scientific and operative coordination after year 2002

Changing the aims of LACE program, it was decided to start independent operative national setups of ALADIN model in 2002. LACE structure defined 3 areas of scientific activities: data assimilation and predictability, refining numerical schemes and model physics and improvement of model physical parameterizations. The work in every filed was coordinated by dedicated experts, as a part of LACE management group. As some level of operative coordination and optimization were still required, LACE on top of ALADIN System coordination manager, introduced Data Manager Expert, dedicated to the topics related to model initialization, coupling, data assimilation and verification issues.

As, with the new structure, common scientific center RC LACE Prague was closed, all LACE members started with the development of local operative applications, and local research tasks. For the purpose to promote group work on scientific topics, RC LACE introduced special fund for research and development that was dedicated to finance scientists in visits, preferably to the mutual work of LACE NWP teams and Meteo-France.

The first few years of decentralized work were an opportunity for LACE NWP teams to specialize on the topics: Hungary and Czech Republic on data assimilations, Slovenia and Czech Republic on model physics, Slovakia and Czech Republic on model dynamics, Croatia and Slovakia on model initialization, Slovenia and Croatia on verification, etc. Since 2006 LACE introduced fourth research group on predictability and put LACE expert coordinator on the issue.

razvoju AROME fizike i najavljuje razvoj fizikalnih parametrizacija modela horizontalne razlučivosti između 10 i 2.5 km metodama iz programskog koda „Meso NH“, imajući u vidu ograničene računalne resurse ALADIN članica. Taj je novorazvijeni fizikalni „paket“ primjenjiv na svim rezolucijama, prenosiv za razna računala i efikasan u numeričkom pogledu, ali se na kraju odustalo od AROME verzije za navedene skale.

Pod vodstvom osnivača ALADIN konzorcija Jean-Francois Gelayna, “oca” i znanstvenog voditelja ALADIN projekta, 2004. godine započinje nova inicijativa za razvoj ALARO fizikalnog paketa, koordinirana između Meteo-France-a, Belgije i LACE-a. Spomenuta inicijativa rezultirala je uspostavom ALARO referentnog LACE centra koordiniranog od strane Republike Češke i Slovenije u cilju razvoja operativne NWP fizike za 5 km i bolju horizontalnu razlučivost, prikladne za operativnu primjenu. Glavni zadatak ALARO referentnog centra je da se u jedinstvenom okruženju objedine i testiraju svi decentralizirani razvoji elemenata fizikalnog paketa (shema zračenja, višeskalabilna konvektivna shema, turbulencija), provjere fizikalne relevantnosti rezultata na rezoluciji od 5 km i dobije efikasan i prenosiv ALARO model.

U cilju centralizacije istraživanja, 2005. godine LACE uspostavlja pred-operativni ALADIN LAM EPS (*Ensamble Prediction System*) model za Srednju Europu, kao standard za ocjenu prediktabilnosti ALADIN modela na rezoluciji od 18 km (uz korištenje ansambla od 16 perturbacija modela) i usporedbu s rezultatima ECMWF EPS sustava na rezoluciji od 100 km (ansambla od 50 perturbacija modela).

LACE razvoj i testiranje 3DVar i ostalih asimilacijskih metoda je nastavljen u decentraliziranom okruženju. Kako je ALADIN 3DVar u pred-operativnoj fazi bio aktivan samo u mađarskoj meteorološkoj službi, vrlo mali broj znanstvenika je bio obučen za rad na toj temi. Stoga LACE organizira seriju radionica na temu asimilacijskih metoda, alata i rada s različitim tipovima mjerenih podataka.

Od 2004. godine LACE je i koordinator aktivnosti vezanih uz udruživanje ALADIN i HIRLAM konzorcija, te ugošćuje HIRLAM znanstvenike u nizu znanstvenih boravaka i radionica i u zemljama članicama HIRLAM-a.

In year 2003 ALADIN program announced two big steps were LACE actively contribute: Meteo France introduced a new 2.5 km convection resolving/recognition model AROME, based on NH dynamics core and data assimilation from ALADIN, and physics from “meso NH” research group. At the same time ALADIN announced new model physics development for 10 km and 2.5 km horizontal resolution. Although those versions of both resolutions were applicable for various IT main frames and efficient in the numerical view, at the end AROME version for both scales were canceled.

Under the leadership of Jean-Francois Gelayn, “father” and the scientific leader of ALADIN program, in 2004 started an initiative for a development of new ALARO model physics package, coordinated between Meteo France, Belgium and LACE. As a support LACE established ALARO referent center, coordinated between Czech and Slovenian teams, targeted to develop an operative NWP physics for 5 km grid size. The main task of ALARO referent center was to establish the uniform technical environment for testing and phasing all decentralized research of the physic modules (radiation scheme, multi-scale convection schemes, models of turbulence). In coordination with LACE team, testing was not just physical relevance of model physics at “gray zone resolution” of 5 km, but also provided efficient and portable ALARO model.

With the aim to centralize research, in 2005 LACE established pre-operative ALADIN LAM EPS (Ensemble Prediction System) for Central Europe, as a standard for ALADIN predictability tests at 18 km grid size (16 perturbed members) and for the comparison with ECMWF EPS, that was at 100 km grid size (50 perturbed members).

In decentralized structure, LACE has continued developing and testing 3DVar and other assimilation methods. As 3DVar pre-operative setup was active just at Hungarian meteo service, a very few LACE members were trained to contribute to data assimilation research. To spread the knowledge, LACE organized set of workshops on data assimilation topics (methods, tools, use of satellite data, etc).

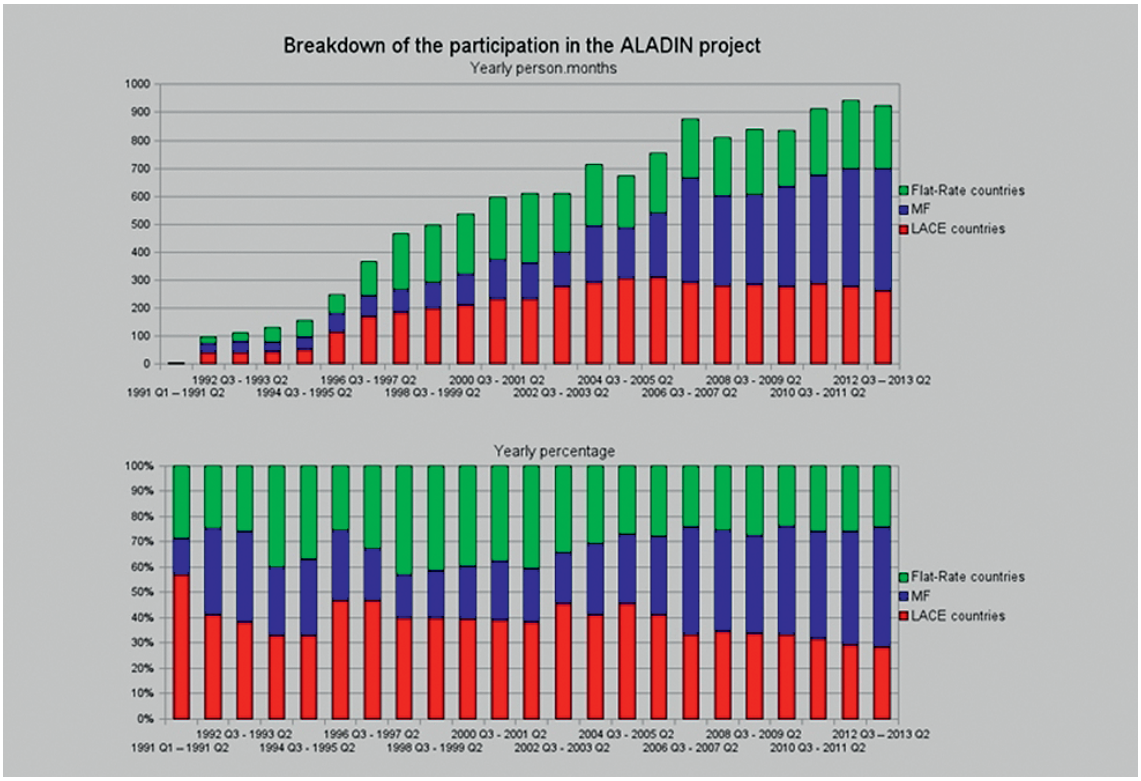
Potaknuti inicijativom za vrednovanje HIRLAM programa, 2006. godine Skupština RC LACE-a donosi odluku o vrednovanju LACE projekta, kako bi dobili stručnu i neovisnu ocjenu uspješnosti i potreba za suradnjom. LACE evaluatori, prof. Peter Lynch (Irska) i prof. Detlev Majewski (Njemačka), ocjenjuju LACE suradnju vrlo uspješnom u polju znanstvene suradnje, ali predlažu više specijalizacija i dijeljenja resursa u operativnoj suradnji između LACE članica (*Lace Evaluation Report* u dokumentima na www.rclace.eu). Kao posljedica tih primjedbi LACE od 2008. godine uvodi još jedan oblik suradnje i koordinacije na dijeljenju operativnih aplikacija, te uspostavlja „LACE centre" za teme vezane uz asimilaciju podataka, prediktabilnost modela, numeričke metode i fizikalne parametrizacije u modelu.

Od 2008. godine, u novoj strukturi, LACE uvodi dvije operativne aplikacije:

1. OPLACE - operativno predprocesiranje i praćenje kvalitete i kvantitete prizemnih, vi-

Since 2004 LACE is coordinating a convergence of ALADIN and HIRLAM consortia, NWP teams, hosts HIRLAM scientists and management, as well as organizing chain of working weeks and workshops for HIRLAM scientists.

Learning from HIRLAM practice, in 2006 RC LACE Council decided to evaluate LACE program, to gain expert and independent expertise of LACE performances and usefulness of cooperation. LACE evaluators, Prof Peter Lynch (Ireland) and Prof Detlev Majewski (Germany) judged LACE cooperation exceptionally successful at the scientific fields, but suggested even more specialization of the teams and sharing of the resources at operative practice between LACE members. As the consequence of the evaluation document, the new form of cooperation and coordination on sharing the operative applications and established "LACE Centers" for data assimilation, predictability, model dynamics, model physics were introduced.



Slika 3. Učešće LACE-a (crveno) u ALADIN projektu u razdoblju od 1990. do 2012. godine. Gore: čovjek/mjesec godišnje, dolje: godišnji postotak učešća.

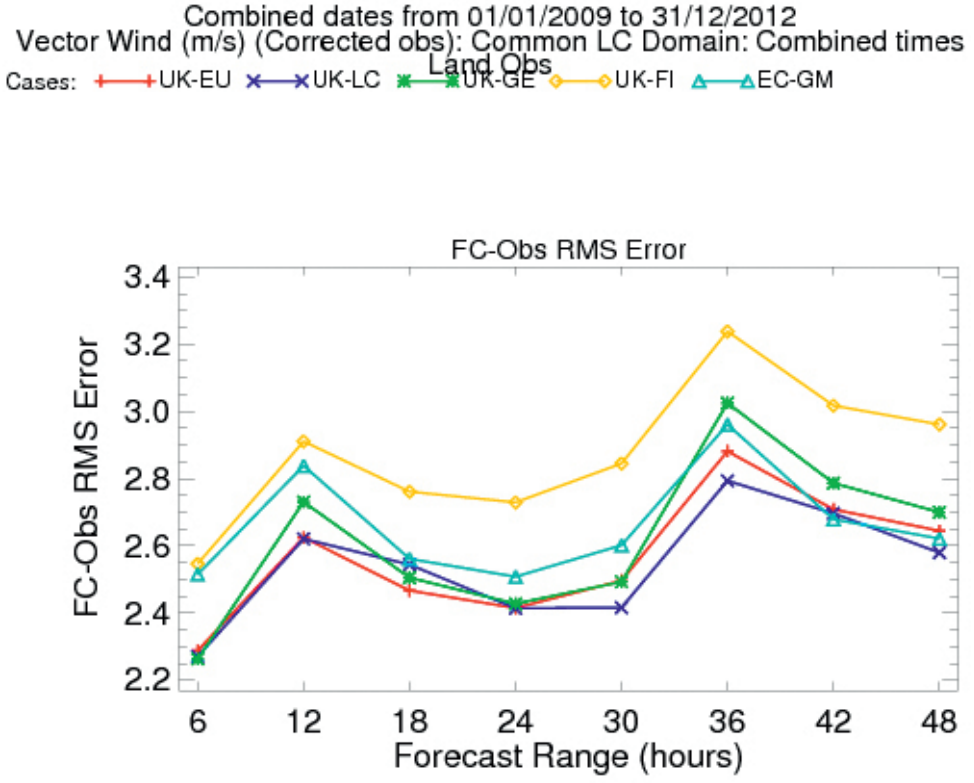
Figure 3. Breakdown of the LACE (red) participation in the ALADIN project. Top: yearly person per month, bottom: yearly percentage.

sinskih i satelitskih mjerenja za potrebe asimilacije podataka čime je optimiziran rad s podacima, a LACE članice su dobile značajnu pomoć pri uspostavi lokalnih operativnih asimilacija podataka;
2. LAEF - Operativni ALADIN LAM EPS sustav utemeljen na originalnoj LACE „breeding- blending“ metodi perturbacija LAM početnih i rubnih uvjeta i fizikalnih parametara.

U svojoj Strategiji razvoja LACE članice zahtijevaju da novi modeli pružaju pravovremene i pouzdane parametre za izradu sustava upozorenja na opasne meteorološke i složene hidrometeorološke pojave za tri dana unaprijed. Kao rezultat rada niza znanstvenika i LACE ALARO referentnog centra, 2009. godine ALADIN-ALARO na rezoluciji od 4.5 km dobio je svoju temeljnu operativnu inačicu. Od 2010. godine sve članice operativno provode neku od verzija 3DVar asimilacije podata-

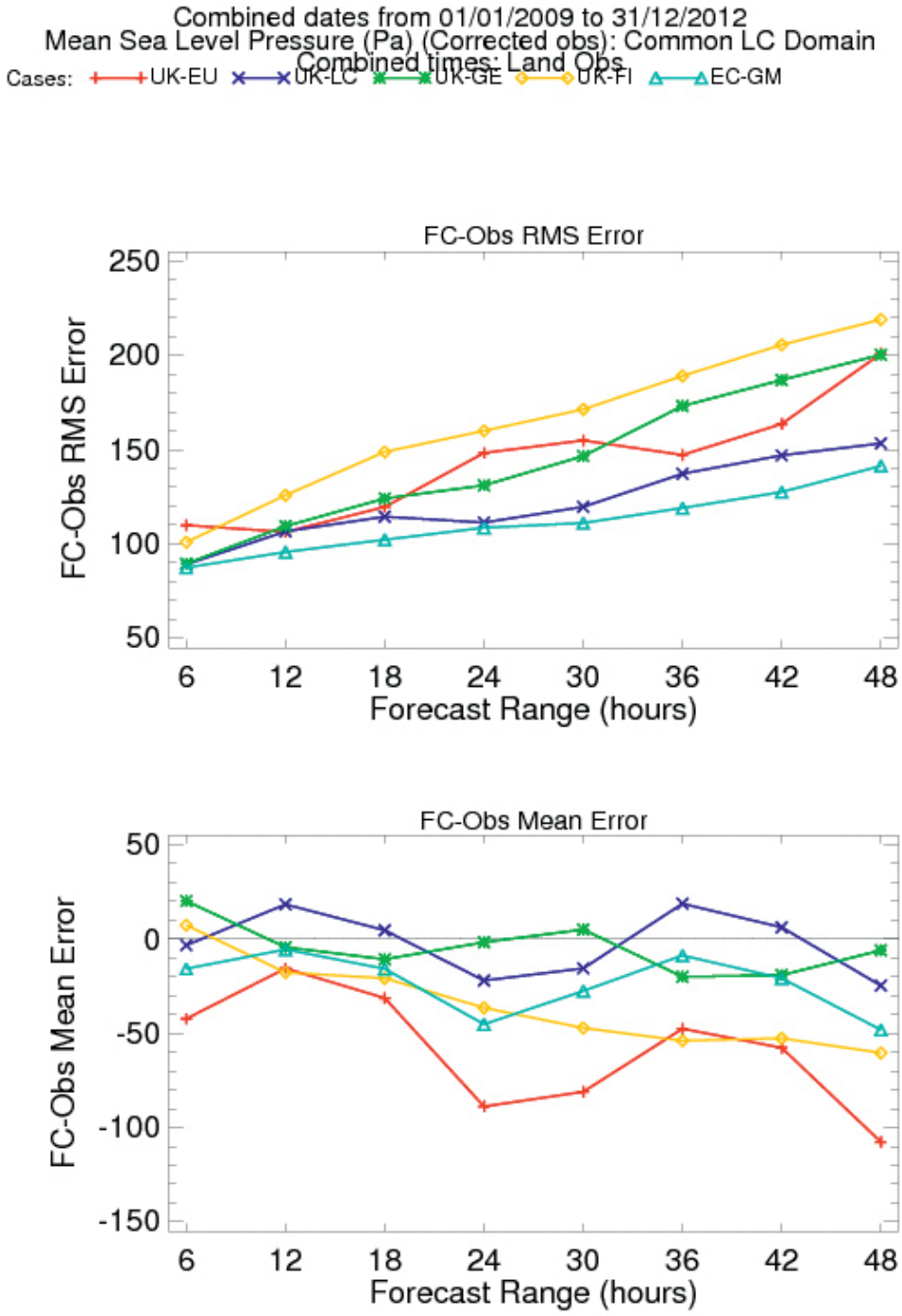
Since 2008, the new LACE structure was introduced for two operative applications:
1. OPLACE - operative preprocessing and monitoring quality and quantity of observations (surface, remote and satellite measurements) for data assimilation purposes, that should optimize data handling and help LACE members to start national operative data assimilation configurations;
2. LAEF - Operative ALADIN LAM EPS system, based on the original LACE “breeding-blending” method of perturbation of LAM initial, lateral boundary conditions and parameters at model physics.

At LACE Strategy document (www.rclace.eu), members expressed demand that new models should be not just superior to the global atmospheric model, but also they should provide reliable parameters for high impact weather warnings on time and other hydrometeo related extreme events three days



Slika 4. SRNWP-V verifikacija europskih operativnih NWP sustava u razdoblju 1.1.2009. - 31.12.2012., Met office LAM (crveno), ALADIN-ALARO LACE (tamno plavo), DWD LAM (zeleno), HIRLAM LAM (žuto), ECMWF (svijetlo plavo). Srednja pogreška vektora vjetra na 10 m.

Figure 4. SRNWP-V verification of operative European NWP models between 1.1.2009 - 31.12.2012, Met office LAM (red), ALADIN-ALARO LACE (light blue), DWD LAM (green), HIRLAM LAM (yellow), ECMWF (light blue). RMS error of 10 m wind vector.



Slika 5. SRNWP-V verifikacija europskih operativnih NWP sustava u razdoblju 1.1.2009. - 31.12.2012., Met office LAM (crveno), ALADIN-ALARO LACE (tamno plavo), DWD LAM (zeleno), HIRLAM LAM (žuto), ECMWF (svijetlo plavo). Srednja pogreška i srednje odstupanje prizemnog tlaka zraka.

Figure 5. SRNWP-V verification of operative European NWP models between 1.1.2009 - 31.12.2012, Met office LAM (red), ALADIN-ALARO LACE (light blue), DWD LAM (green), HIRLAM LAM (yellow), ECMWF (light blue). RMS error and BIAS of MSLP.

ka s produktima OPLACE-a. Ocjena LACE doprinosa istraživanju i razvoju u razdoblju 2008. - 2010. pokazuje ukupno 267 mjesec/čovjek doprinosa ALADIN projektu, s 22 znanstvena rada u citiranim stručnim i znanstvenim časopisima i 1 znanstvenim doktoratom. Uvidom u statistiku doprinosa LACE programa u fazama ALADIN razvoja, vidljiv je LACE doprinos s 37% (slika 3) što potvrđuje da je LACE vitalan i važan dio ALADIN zajednice. Doprinos LACE-a fizici ALARO modela se procijenjuje na 60% ukupnog doprinosa razvoju, što je iznimno važno imajući u vidu da se ALARO fizika koristi i u klimatskim simulacijama ne samo u ALADIN grupi, već i unutar HIRLAM konzorcija.

LACE produkti su dokazali da kvalitetom ne zaostaju za sličnim LAM sustavima u Europi. Tako je u organizaciji EUMETNET-ovog SRNWP-a nastao projekt SRNWP-V jedinstvene numeričke usporedbe operativnih NWP modela Europe. Verifikacija na četverogodišnjem nizu produkata, provođena nad područjem Europe, dokazala je kvalitetu ALADIN-ALARO modela u usporedbi sa sličnim operativim NWP sustavima u Europi što potvrđuju i primjeri usporedbe vrijednosti srednje kvadratne pogreške (RMSE) vektora vjetra i prizemnog tlaka zraka za prognostičko razdoblje od 48 sati (slike 4 i 5).

Danas RC LACE nove izazove nalazi u poboljšavanju i razvoju ALARO fizikalnog paketa za horizontalnu razlučivost oko 2 km, na razvoju metoda asimilacije podataka pogodnih za visoke prostorne razlučivosti, uvođenju novih tipova daljinskih mjerenja, te na operativnim izazovima LAEF prognoza na razlučivosti od 5 km. Zahtjevi za približavanje ALADIN NWP aplikacija za potrebe vrlo kratkoročne prognoze vremena i praćenje stanja atmosfere definirat će iduće korake u razvoju RC LACE programa.

3. HRVATSKI DOPRINOS ALADIN I RC LACE PROJEKTIMA

Osnivanjem Srednjoeuropske inicijative (CEI) 1989. godine otvorena je mogućnost suradnje zemalja članica na mnogobrojnim projektima. Tako je u Beču 1990. godine održan sastanak predstavnika zemalja članica CEI-a na kojem je razmatrana mogućnost osnivanja regionalne suradnje na razvoju numeričkog

ahead. As a result of work of many scientists and LACE referent center, in 2009 ALADIN-ALARO physical package got basic operative setup. Since 2010 all LACE members has been running some version of 3DVar or similar assimilation system with initial products from OPLACE center. Evaluation of LACE in the period between 2008 and 2010 showed 267 person per month contribution, 22 scientific articles in scientific journals and one PhD theses. At the total, statistic of all ALADIN members contributions during different ALADIN program cycles, LACE is covering 37% and it is important part of ALADIN community. LACE contribution to development of ALARO physical package is approximately 60% of all contributions. Its importance is even more recognized since ALARO physics is a part of LAM climate model, applied not only in ALADIN but also in HIRLAM community (Figure 3).

LACE products have proved to be of the same value as other similar LAM systems in Europe. Organized by EUMETNET SRNWP program, the SRNWP-V project was founded for unified numerical inter-comparison of operative NWP systems. Four year verification of products, over the common covered European domain, proved a quality of ALADIN-ALARO model over the similar operative systems, shown at inter-comparison of root-mensquare error for wind and surface pressure (Figure 4 and 5).

Today RC LACE find challenges in developing ALARO physical package at 2 km grid, in introducing the new methods for data assimilation suitable for very high resolution and rapid update cycles, in introducing new type of observations in data assimilation as well as in operative options for LAEF ensemble forecasts for 5 km horizontal resolution. The next step of RC LACE program will be focused on demands for the ALADIN NWP applications for the nowcasting purposes and real time monitoring of atmospheric state.

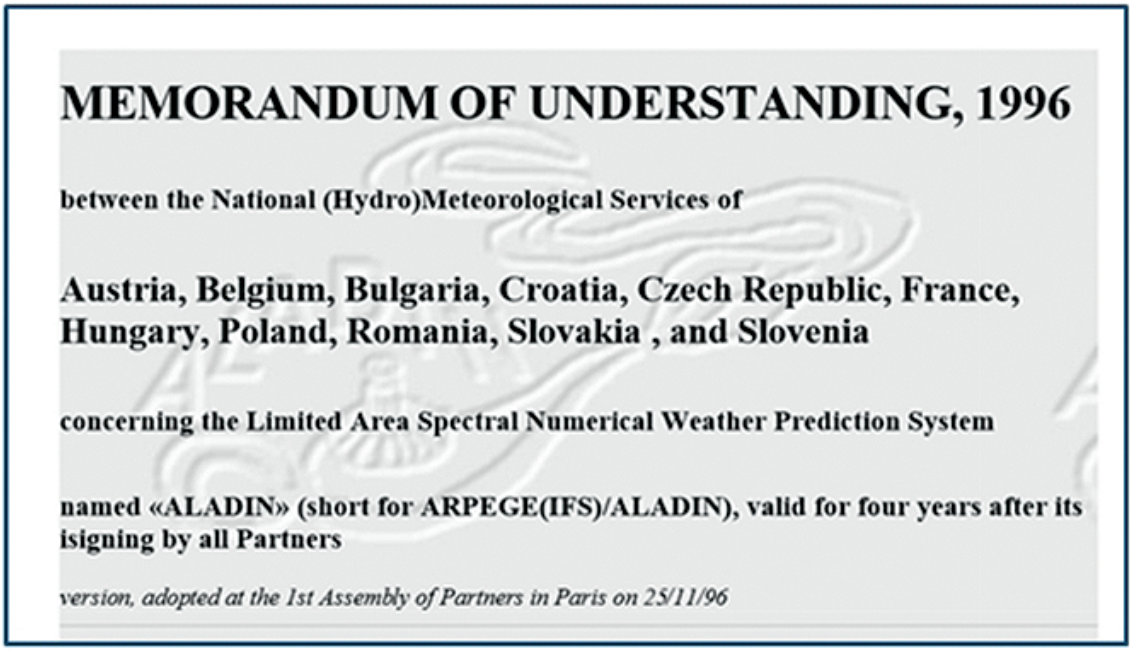
3. CROATIAN CONTRIBUTION TO THE ALADIN AND RC LACE PROJECTS

The opportunity for cooperation of the Central European countries was encouraged by forming the Central European Initiative (CEI) in 1989. In 1990, at the meeting in Vien-

modela atmosfere za ograničeno područje. Hrvatska delegacija u sastavu Branko Gelo, Alica Bajić i Lidija Cvitan na tom je sastanku iskazala interes za sudjelovanje u projektu. Ključni korak za uključenje Hrvatske u ALADIN projekt bio je prvi sastanak SRNWP programa održan 1994. godine u Švedskoj na kojem je kontaktom Meteo France-a (Jean Francois Geleyn) i hrvatskih predstavnika (Dijane Klarić i Dražena Glasnović) dogovorena razmjena pisama namjere između Ministarstava vanjskih poslova Francuske i Hrvatske.
Na temelju konvencije koju je 1994. godine potpisalo 6 država Središnje Europe - Austrija, Republika Češka, Hrvatska, Mađarska, Slovačka i Slovenija, Hrvatska je postala jedna od osnivačica i punopravnih članica Srednjoeuropskog regionalnog prognostičkog centra RC LACE. Hrvatska se istodobno (1.4.1995.) pridružuje međunarodnom razvojno-istraživačkom projektu ALADIN. Koordinator ALADIN tima u Hrvatskoj postaje Dražen Glasnović. Sporazum o suradnji na razvoju ALADIN projekta potpisan je 25. studenog 1996. u Parizu (slika 6). Njime su definirani ciljevi i uređeni odnosi te međusobne obveze zemalja članica projekta.

U prvoj fazi projekta hrvatsko sudjelovanje sastojalo se najvećim dijelom u sudjelovanju naših znanstvenika u razvoju LAM-a u francuna the possibility of establishing a Regional Centre for limited-area high-resolution modeling of the atmosphere for operational forecasting was discussed. Croatian delegation (Branko Gelo, Alica Bajić and Lidija Cvitan) showed interest to participate in the RC LACE project. A key step to embrace Croatia into the ALADIN project was the first SRNWP meeting held in 1994 in Sweden. At the meeting, Meteo France's (Jean-Francois Geleyn) and Croatian representatives (Dražen Glasnović and Dijana Klarić) were agreed to exchange letters of intention between the Ministries of Foreign Affairs of France and Croatia.

Based on convention signed in 1994 by 6 Central European countries - Austria, Czech Republic, Croatia, Hungary, Slovakia and Slovenia, Croatia became one of the founder and full member of the Central European regional forecasting center RC LACE. At the same time Croatia joined the ALADIN project on 1st April 1995. The Croatian ALADIN team coordinator was Dražen Glasnović. The first Memorandum of Understanding for the ALADIN project cooperation was signed on 25th November 1996 in Paris (Figure 6). The Memorandum defines goals, relationships and mutual obligations of the member countries.


MEMORANDUM OF UNDERSTANDING, 1996

between the National (Hydro)Meteorological Services of

Austria, Belgium, Bulgaria, Croatia, Czech Republic, France, Hungary, Poland, Romania, Slovakia , and Slovenia

concerning the Limited Area Spectral Numerical Weather Prediction System

named «ALADIN» (short for ARPEGE(IFS)/ALADIN), valid for four years after its isigning by all Partners

version, adopted at the 1st Assembly of Partners in Paris on 25/11/96

Slika 6. Naslovna stranica prvog ALADIN sporazuma o suradnji potpisanog 25.11.1996. godine.

Figure 6. Cover page of the 1th ALADIN Memorandum of Understanding signed on 25th November 1996

skoj meteorološkoj službi. Tako su od 1996. do 2000. godine Nedjeljka Brzović, Meriem Zitouni i Dijana Klarić iz Državnog hidrometeorološkog zavoda, te Maja Telišman Prtenjak, Antun Marki i Zvjezdana Bencetić Klaić s Geofizičkog odsjeka Prirodoslovno matematičkog fakulteta u Zagrebu boravili u Meteo France-u ukupno 13 mjeseci.

Predoperativni svakodnevni proračun ALADIN modela u Državnom hidrometeorološkom zavodu započeo je krajem 2000. godine, a početak potpunog operativnog ALADIN/HR NWP sustava prijavljen je u ožujku 2002. godine.

Već na početku suradnje, hrvatski tim je pod vodstvom Dražena Glasnovića u ALADIN grupi promovirao kvalitativno novu metodu za dopunsko procesiranje i obradu izlaznih podataka suvremenih prognostičkih modela atmosfere. Ona se zasniva na primjeni dijagnostičkog izentropskog modela HRID (Glasnović 1990), a namijenjena je izradi objektivne prognoze vremena na proizvoljno odabranim lokalitetima. Model je implementiran najprije u Meteo-France i od 1995. godine operativno se primjenjuje u više zemalja učesnica multilateralnog međunarodnog projekta ALADIN (Glasnović i sur. 1994; Brzović i Glasnović 1997; Glasnović i sur. 1997; Glasnović 1990). U izradi operativnih prognoza HRID se koristio kao dopuna konvencionalnoj metodi prikaza prognostičkih polja na standardnim razinama tlaka zraka. Ta je metoda uvela i novi pogled na produkte NWP-a, pa je kao prvi operativni produkt ALADIN-a nastao set "Pognostičkih TEMP ALADIN-a", kao niz standardnih fizikalnih veličina vertikalne strukture atmosfere za sve vertikalne nivoe integracije modela i za sve vremenske prostorne korake. Prvi ALADIN Pseudo temp podaci uvedeni su u operativnu primjenu za LACE članice već 1995. godine, kao testni produkt i služili su u operativi DHMZ-a u vremenu „burne" 1995. godine, dajući prognoze za razdoblje od +36 sati. Prostorni i vremenski presjeci su postali dio operativnih produkata svih ALADIN zemalja, a veliku primjenu su imali zbog malog obujma progostičkih podataka, što je u doba oskudnih IT komunikacija i lokalnih IT servera te godine imalo veliku važnost. Vremenski i prostorni presjeci, kao standardni produkt ALADIN i ARPEGE modela, omogućili su dokazivanje prednosti LAM-a pred produktima globalnih atmosferskih modela.

At the beginning the Croatian contribution to the ALADIN project consists mainly from the scientific visits to Meteo France. In the period from 1996 to 2000 Nedjeljka Brzović, Dijana Klarić and Meriem Zitouni from the Meteorological and Hydrological Service and Maja Telišman Prtenjak, Antun Marki and Zvjezdana Bencetić Klaić from the Geophysical Department of the Faculty of Natural Sciences spent in total 13 months working on research and development themes.

Pre-operational ALADIN/HR set-up in the Meteorological and Hydrological Service of Croatia was declared at the end of 2000 and the fully operational runs started in March 2002.

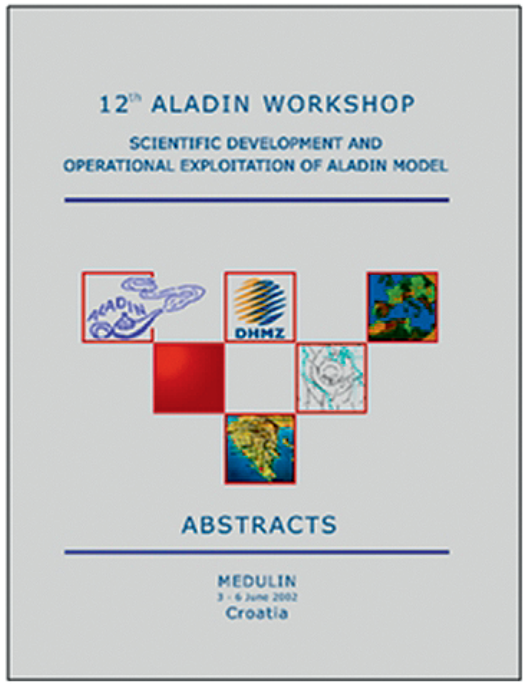
Already at the beginning of cooperation, Croatian team guided by Dražen Glasnović promoted in-depth diagnostics methods of spatial and temporal development of meteorological parameters, through the introduction of HRID temporal and spatial vertical cross-sections in the ALADIN model. Method has been implemented in Meteo-France and from 1995 it has been implemented in many ALADIN countries (Glasnović at al. 1994; Brzović and Glasnović 1997; Glasnović et al. 1997, Glasnović, 1990). HRID has been used in the operative forecasts as an enhancement to conventional representations of meteorological fields at the standard isobaric levels. This method has introduced a new look at NWP products, and the "Forecasted TEMP ALADIN" was created as the first operational ALADIN product. This pseudo-TEMP contains a series of standard meteorological parameters for all vertical model levels and all temporal and spatial steps. The first ALADIN pseudo-TEMP data were introduced into LACE members operational applications in 1995. It served in the Croatian meteorological service during „turbulent" times in 1995 giving valuable forecasts 36 hours ahead. The spatial and temporal cross-sections have become part of the operative products of ALADIN countries and were extensively used. Because of small computer demands in the time of limited IT communications and computer resources this product had very important role. Temporal and spatial cross-sections, as standard ALADIN and ARPEGE product, proved advantage of LAM models over global atmospheric models.

Dio djelatnika DHMZ-a je radio na rukovodećim zadacima RC LACE u Pragu. Tako je od 1.5.1999. do 31.12.2002. Dijana Klarić bila zamjenica voditelja RC LACE projekta, a od 2003. do 2012. u dva mandata i voditeljica projekta. U razdoblju od 2002. do 2004. Stjepan Ivatek-Šahdan je radio kao RC LACE koordinator za podatke. Voditelj ekspertnog tima za asimilaciju podataka u razdoblju od 2010. do 2012. bio je Tomislav Kovačić, koji je u posljednjih 10 godina i predstavnik Hrvatske u LACE nadzornom odboru. Nezaobilazan je i doprinos Martine Tudor u ALADIN CSSI odboru (Committee for Scientific and System maintenance Issues) kao člana zaduženog za područje numeričke efikasnosti modela.

Kao ravnopravna članica ALADIN i RC LACE grupacija Hrvatska je bila zadužena i za organizaciju niza sastanaka, radionica i skupova (tablica 1). Posebno izdvajamo organizaciju 12. ALADIN radionice održane 2002. u Medulinu na kojoj je sudjelovao 51 učesnik iz 10 ALADIN zemalja (slika 7) kao i 29. EWGLAM i 14. SRNWP sastanak održan 2007. u Dubrovniku sa 70 sudionika iz 26 zemalja (slika 8). Hrvatska je ugostila i mnogobrojne radionice, od kojih je posljednja, posvećena asimilaciji podataka održana u rujnu 2014. (slika 9). Kao posebno priznanje radu i znanstvenom

Croatia contributed to ALADIN and RC LACE not only with a high dedication to the research and development activities, but was a part of RC LACE management too. In the period from 1st May 1999 till the end of 2002 Dijana Klarić was the Project Manager Deputy, and from 2003 until 2012 she worked in two mandates as LACE Project Manager. The LACE Data Manager in the 2002-2004 period was Stjepan Ivatek-Šahdan. Tomislav Kovačić worked as LACE coordinator of Data Assimilation expert team from 2010 to 2012 and represents Croatia in the LACE Steering Committee during past 10 years. The contribution of Martina Tudor in the ALADIN CSSI (Committee for Scientific and System maintenance Issues) as a member dedicated to numerical efficiency issues is indispensable.

As a member of the ALADIN and RC LACE group Croatia was responsible for organizing the series of meetings, workshops and conferences (Table 1). We especially emphases organization of the 12th ALADIN workshop held in 2002 in Medulin with 51 participants from 10 ALADIN countries (Figure 7) as well as the 29th EWGLAM and 14th SRNWP meeting held in 2007 in Dubrovnik with 70 participants from 26 countries (Figure 8). Croatia hosted numerous workshops. Most recent one



Slika 7. Naslovna stranica zbirke sažetaka s 12. ALADIN radionice održane u Medulinu 3.-6.6.2002.

Figure 7. Cover page of the abstract book from 12th ALADIN workshop hold in Medulin on 3-6 June 2002

Slika 8. Sudionici 29. EWGLAM sastanka održanog 9.-12.10.2007. u Dubrovniku.

Figure 8. Participants of 29th EWGLAM meeting hold in Dubrovnik, 9-12 October 2007

Slika 9. Radionica na temu asimilacije podataka, Zagreb 22.-23.9.2014.

Figure 9. Data assimilation working days, Zagreb, 22-23 September 2014

Slika 10. Sudionici BRAC HR (BRainstorming on AdvanCed method of High Resolution modelling) ALADIN-HIRLAM radionice održane u Supetru na Braču 17.-20.5.2010.

Figure 10. Participants of the BRAC HR ALADIN-HIRLAM workshop organized in Supetar on the Island Brač, 17-20 May 2010

doprinosu Hrvatska dobiva LACE organizaciju BRAC HR (*BRainstorming on AdvanCed method of High Resolution modelling*) ALADIN-HIRLAM radionice o strategijii razvoja LAM modela visoke rezolucije, na kojem su uz LACE, ALADIN i HIRLAM sudjelovali predstavnici meteorološke službe Velike Britanije (UKMO), Njemačke (DWD) i ECMWF-a (slika 10).

RC LACE zajednički cilj suradnje u znanstvenom unapređenju NWP modeliranja i njihova operativna primjena uvijek je bio potpomognut od svih članica, pa tako i od Hrvatske, bez obzira što je kroz povijest LACE nekoliko puta modificirao svoje neposredne ambicije i oblike organizacije.

Hrvatski znanstvenici aktivno su sudjelovali u radu na razvoju i primjeni ALADIN modela, kako u sjedištu francuske meteorološke službe u Toulousu, tako i u radu operativnog RC LACE centra u Pragu kao dio znanstvenog rada na temama asimilacije podataka, fizikalnih shema i numeričkih postavki modela, te dijagnostike znanstvenih metoda i operativnih produ-

dedicated to data assimilation was organized in September in Zagreb in 2014 (Figure 9). To acknowledge the work and scientific contribution to the project, Croatia organized BRAC HR (BRainstorming on advanced method of High Resolution modeling) ALADIN-HIRLAM workshop on LAM high resolution models strategy with participants from LACE, ALADIN, HIRLAM consortia, ECMWF, meteorological services of Great Britain (UKMO) and Germany (DWD) (Figure 10).

RC LACE common goal to develop NWP model and its operational applications always has been supported by all member countries regardless of LACE organizational structure.

Croatian scientists participate in the research and development activities, among others, with visits in Meteo-France in Toulouse and in RC LACE operational center in Prague. Their work has been mostly devoted to data assimilation, model physics and dynamics and diagnostic of scientific methods and operational products (Figure 11). Since the beginning of Croatian participation in ALADIN and RC

Tablica 1. ALADIN i RC LACE sastanci i događanja organizirani u Hrvatskoj.

Table 1. ALADIN and RC LACE meetings, workshops and seminars organized in Croatia.

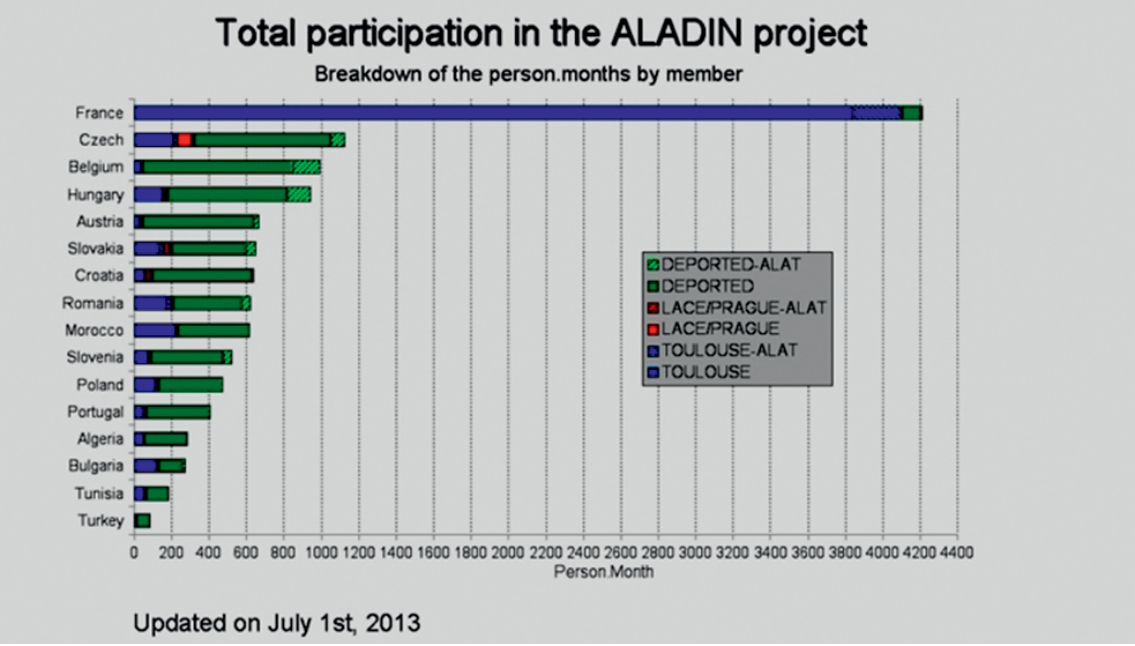
Datum **Date**	**Mjesto** **Place**	**Događanje** **Event**
23.4.1996.	Opatija	3rd RC LACE Council
16.10.1996.	Opatija	RC LACE Scientific committee meeting
25.9.2000.	Zagreb	10th RC LACE Council
19.4.2002.	Dubrovnik	Meeting of the Working Group for cooperation with non-member African NMS's
3.-6.6.2002.	Medulin	12th ALADIN Workshop
14.2.2003.	Zagreb	1st RC LACE Steering Committee meeting
17.4.2002.	Dubrovnik	13th RC LACE Council
21.10.2004.	Split	18th RC LACE Council
21.-23.10.2004.	Split	9th Assembly of ALADIN partners
28.-29.9.2006.	Zagreb	7th RC LACE Steering Committee meeting
5.-6.12.2006.	Zagreb	SRNWP Mini Workshop on Numerical Techniques
7.10.2007.	Dubrovnik	CSSI meeting
11.10.2007.	Dubrovnik	3th ALADIN Local Team Managers meeting
12.10.2007.	Dubrovnik	9th RC LACE Steering Committee meeting
8.-12.10.2007.	Dubrovnik	29th EWGLAM and 14th SRNWP Meetings
17.-20.5.2010.	Brač	BRainstorming on Advanced Concepts on High Resolution modelling workshop (BRAC HR WS)
22.-23.9.2014.	Zagreb	23th RC LACE Steering Committee meeting
24.-26.9.2014.	Zagreb	RC LACE Data Assimilation working days

kata (slika 11). Od uključenja Hrvatske u ALADIN i RC LACE program realizirano je 68 boravaka 19 hrvatskih meteorologa u suradničkim meteorološkim službama (tablica 2) u trajanju od 1 tjedna do 12 mjeseci.

Početkom predoperativnog rada ALADIN modela započelo je sustavno tromjesečno izvještavanje voditeljice lokalnog ALADIN tima (LTM) Alice Bajić o obavljenim poslovima i utrošenom vremenu po pojedinom djelatniku. Analiza izvještaja pokazuje da je u razdoblju od 2000. do 2014. godine 22 hrvatski meteorolog (slika 12) radio ukupno 593 mjeseci na razvoju modela kao i na razvoju i održavanju lokalnog operativnog prognostičkog ALADIN sustava. Danas se razvoj i operativna primjena ALADIN modela provodi u Služ-

LACE projects 68 visits of 19 scientists were realized in cooperated countries (Table 2). Systematic reporting started at the beginning of pre-operational ALADIN runs by Local team manager Alica Bajić on work and time involvement in the project. The analysis of those reports shows that 21 Croatian scientists worked in total 593 months on model development as well as improvement and maintenance of local operational ALADIN system (Figure 12). Research and development activities in the NWP field nowadays are placed in the Department for meteorological research and operational numerical prediction models development (Figure 13).

Croatia has participated in many LACE research and development activities. Besides the



Slika 11. Učešće pojedinih zemalja u ALADIN projektu - čovjek/mjesec zaključno s 1.7.2013.

Figure 11. Total participation in the ALADIN project - breakdown of the person/months per member until 1st July 2013

Tablica 2. Boravci hrvatskih znanstvenika u meteorološkim službama ALADIN i RC LACE članica u periodu 1995.-2015. u trajanju od najmanje 1 tjedan.

Table 2. Croatian scientific visits to ALADIN and RC LACE countries in period 1995-2015 (at least one week long).

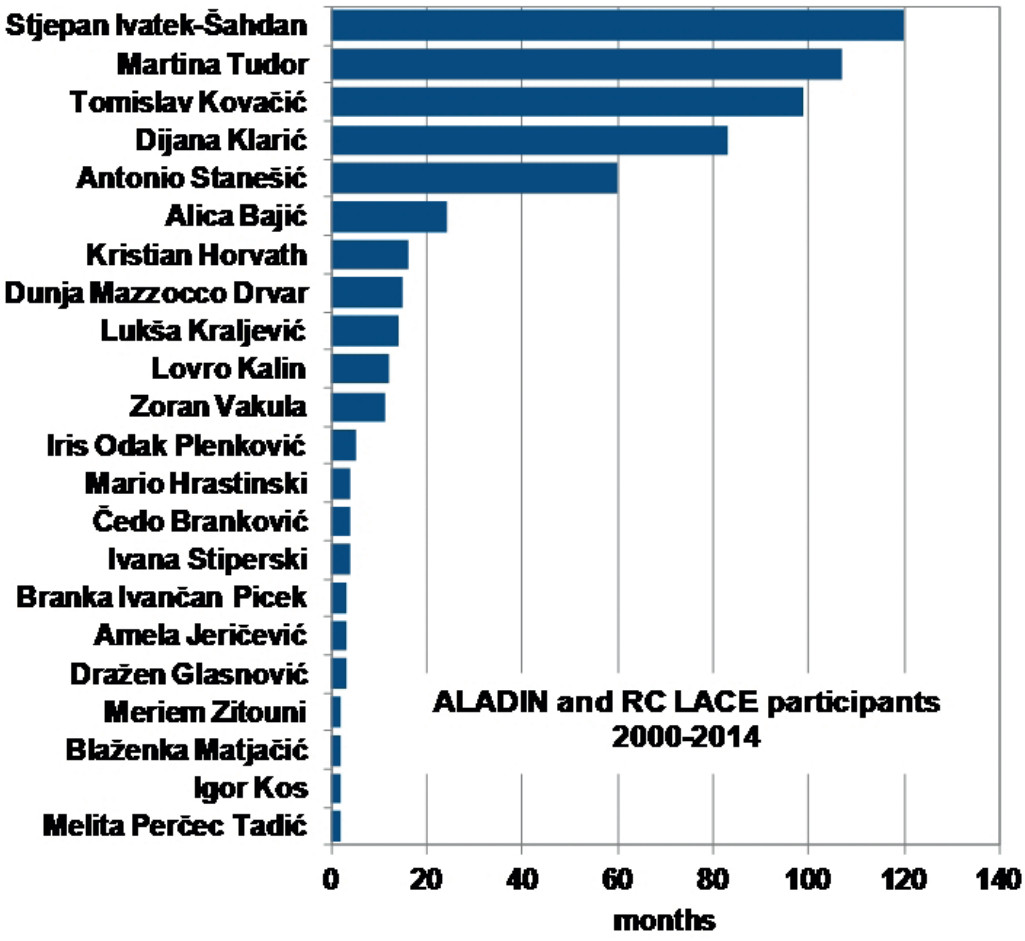
Godina **Year**	**Mjesto** **Place**	**Znanstvenik** **Scientist**
1995	Toulouse	Nedjeljka Brzović
1996	Toulouse	Nedjeljka Brzović, Dijana Klarić
1997	Toulouse	Nedjeljka Brzović, Maja Telišman Prtenjak, Meriem Zitouni, Antun Marki
1998	Toulouse	Meriem Zitouni, Zvjezdana Bencetić Klaić
1999	Toulouse	Meriem Zitouni
	Prague	Dijana Klarić, Stjepan Ivatek-Šahdan
2000	Toulouse	Meriem Zitouni, Stjepan Ivatek-Šahdan, Igor Kos
	Prague	Dijana Klarić, Stjepan Ivatek-Šahdan, Martina Tudor, Melita Perčec Tadić, Meriem Zitouni
2001	Toulouse	Blaženka Matjačić, Alica Bajić, Stjepan Ivatek-Šahdan, Martina Tudor
	Prague	Dijana Klarić, Zoran Vakula, Martina Tudor, Stjepan Ivatek-Šahdan
2002	Toulouse	Stjepan Ivatek-Šahdan
	Prague	Dijana Klarić, Stjepan Ivatek-Šahdan, Martina Tudor, Dunja Drvar
	Ljubljana	Lovro Kalin

Godina Year	Mjesto Place	Znanstvenik Scientist
2003	Toulouse	Dijana Klarić, Dunja Drvar, Martina Tudor, Tomislav Kovačić
	Budapest	Kristian Horvath
	Prague	Martina Tudor
2004	Toulouse	Tomislav Kovačić, Martina Tudor, Stjepan Ivatek-Šahdan
	Prague	Martina Tudor
2005	Toulouse	Ivana Stiperski, Lukša Kraljević
	Prague	Ivana Stiperski
	Budapest	Kristian Horvath
	Ljubljana	Lovro Kalin, Dunja Drvar
2006	Toulouse	Lukša Kraljević, Tomislav Kovačić, Stjepan Ivatek-Šahdan
	Prague	Martina Tudor
	Brussels	Martina Tudor
	Ljubljana	Dunja Drvar, Lovro Kalin
	Wien	Stjepan Ivatek-Šahdan
2007	Toulouse	Tomislav Kovačić, Stjepan Ivatek-Šahdan
	Prague	Tomislav Kovačić
	Ljubljana	Lovro Kalin
2008	Toulouse	Tomislav Kovačić, Antonio Stanešić
	Wien	Lovro Kalin
2009	Wien	Lovro Kalin
2011	Helsinski	Tomislav Kovačić
	Oslo	Tomislav Kovačić
2015	Brussels	Martina Tudor

bi za meteorološka istraživanja i razvoj prognostičkih modela Državnog hidrometeorološkog zavoda (slika 13). Detalji o operativnom sustavu prognoze ALADIN modela opisani su u radu Tudor i suradnici (2015 a).

Doprinos hrvatskih znanstvenika uveden je u ALADIN operativni sustav. Osim HRID-a opisanog na početku ovog poglavlja, primjer je i doprinos Dijane Klarić i Stjepana Ivatek-Šahdan uvođenjem u LACE operativnu konfiguraciju (2000. godine) metode spektralnog miješanja

HRID described in previous chapter, other Croatian research results started to be part of operational ALDIN system. Dijana Klarić and Stjepan Ivatek-Šahdan participated in the development of ALADIN spectral and surface blending method (Brozkova, Klarić, Ivatek-Šahdan and others 2001) for the limited area model initialization that has entered to LACE operative configuration since the year 2000. It has been one of the main components of data assimilation set up in some LACE countries. The blending has become the back-bone of



Slika 12. Učešće hrvatskih znanstvenika u ALADIN i RC LACE projektima u razdoblju od 2000. do 2014. godine.

Figure 12. Croatian participants in the ALADIN and RC LACE projects in the 2000-2014 period.

(eng „spectral blending“) u inicijalizaciju LAM modela (Brozkova i sur. 2001). Ova je metoda još uvijek jedna od osnovnih komponenti sustava asimilacije podataka u nekoliko LACE članica. Isto je tako i sastavni dio metoda inicijalnih perturbacija u ALADIN-LAEF (*ALADIN-Limited Area Ensamble Forecast*) ansambl prognostičkom sustavu (Wang i sur. 2011).

Hrvatski tim sudjeluje u radu na parametrizaciji fizikalnih procesa i prilagodbi “MesoNH” parametrizacije na rezolucijama od 10 km i 5 km, numeričke nestabilnosti ALADIN parametrizacije (Drvar i sur. 2005; Tudor i sur. 2005; Tudor 2010; Catray i sur. 2007; Tudor 2013) i alternativnim formulacijama uključenja rubnih graničnih uvjeta u model za ograničeno područje (Tudor i Termonia 2010, Tudor 2015).
Pažnja se posvećuje i razvoju sustava asimilacije podataka, tj. dijagnozi i prilagodbi poza-

the initial perturbation method for limited area model ensemble prediction system ALADIN-LAEF in its operational configuration. Furthermore, Ivatek-Sahdan helped to set up ALADIN-LAEF (Wang et al. including Ivatek-Šahdan 2011).

Croatian team worked on tests of sub-grid scale orography representation, the horizontal diffusion, radiation and cloudiness parameterization of ALADIN and adjustment of the Meso NH parametrisation to 10 km and 5 km horizontal scale (Drvar et al. 2005, Tudor et al. 2005; Tudor 2010; Catray et al. including Tudor, 2007; Tudor 2013). Martina Tudor worked on flux-conservative thermodynamic equations in a mass-weighted framework (Catray et al. including Tudor 2007), alternative formulations for incorporating Lateral Boundary Data into Limited-Area Models

Slika 13. Služba za meteorološka istraživanja i razvoj operativnih prognostičkih modela s lijeva na desno: Igor Horvat, Tomislav Kovačić, Matea Gospodinović, Mario Hrastinski, Iris Odak Plenković, Kristian Horvath, Antonio Stanešić, Alica Bajić, Stjepan Ivatek-Šahdan, Martina Tudor, Emil Ivanković (snimljeno 2015. godine)

Figure 13. Department for meteorological research and development of operational NWP models. Left to right: Igor Horvat, Tomislav Kovačić, Matea Gospodinović, Mario Hrastinski, Iris Odak Plenković, Kristian Horvath, Antonio Stanešić, Alica Bajić, Stjepan Ivatek-Šahdan, Martina Tudor, Emil Ivanković (Photo taken 2015)

dinske statističke pogreške u sustavu asimilacije podataka (Boloni i Horvath 2010; Stanešić 2011). ALADIN-LAEF sustavu ansambl prognoze vremena doprinijeli su i Stjepan Ivatek-Šahdan i Lovro Kalin.

Sudjeluje se i u razvoju zajedničkog verifikacijskog alata, čiji je operativni rad centraliziran u Ljubljani, a kojem je značajan doprinos dao Lovro Kalin, uzimajući u obzir potrebe i iskustva operativnih prognostičara.

Rad Tomislava Kovačića na primjeni dijagnostičkog paketa DDH (Diagnostics en Domaines Horizontaux) za ALARO i AROME doveo je do realizacije primjene tog alata ne samo u zemljama ALADIN konzorcija već i u HIRLAM članicama.

Specifičnost klime Hrvatske i mogućnost ALADIN-a da prognozira opasne vremenske pojave, posebno olujni vjetar poput bure i juga

(Tudor and Termonia 2010) and investigation on numerical instability and stiffness in the ALADIN parameterization (Tudor 2013) etc.

Attention is paid to the development of data assimilation systems, i.e. diagnosis and tuning of the background error statistics in variation data assimilation system (Boloni and Horvath 2010, Stanešić 2011). Significant contributor to the common ALADIN verification tool located in Slovenian meteorological service in Ljubljana was Lovro Kalin with its experience as a forecaster.

Work of Tomislav Kovačić on implementation of DDH (Diagnostics en Domaines Horizontaux) tool for ALARO and AROME has led to the application of DDH in HIRALM countries.

Specific Croatian climate and ALADIN possibility to forecast extreme weather phenomena such as severe winds like bura and sirocco and

i intenzivna konvektivna nevremena, pobudila je znanstveni interes ALADIN tima. Analizirane su mnogobrojne vremenske situacije, vremenske prilike tijekom meteoroloških i hidroloških projekata, i objavljen je znatan broj znanstvenih i stručnih radova s rezultatima tih istraživanja (Ivančan-Picek i Jurčec 2002, 2003; Ivančan-Picek i sur. 2003, 2005; Horvath i Ivančan-Picek 2003; Ivatek-Šahdan i Tudor 2004; Vukičević i sur. 2005; Beg Paklar i sur. 2005; Ivatek-Šahdan i Ivančan-Picek 2005, 2006; Kuzmić i sur. 2005; Ivančan-Picek i sur. 2006; Kozarić i Ivančan-Picek, 2006; Bajić i sur. 2007; Bencetić Klaić i sur. 2009; Martin i sur. 2009; Rixen i sur. 2009; Vandenbulcke i sur. 2009; Vilibić i sur. 2008; Horvath i sur. 2009, 2011; Tudor i Ivatek-Šahdan 2010; Stiperski i sur. 2011; Renko i sur. 2012; Mazzocco Drvar i sur. 2012; Tudor i sur. 2013; Mihanović i sur. 2013; Janeković i sur. 2014; Kalin i sur. 2015).

Znanje stečeno na zajedničkom ALADIN i RC LACE radu na razvoju i operativnoj primjeni ALADIN modela, kao i lokalno iskustvo operativnog rada i analize specifičnih atmosferskih procesa na području Hrvatske, temeljni su dio znanstvenih i primijenjenih međunarodnih i domaćih projekata. Rezultati i stečeno znanje u radu na ALADIN programu prvi put su korišteni u projektu "Oluje i prirodne katastrofe u Hrvatskoj" (financiranom od strane Ministarstva znanosti, obrazovanja i sporta pod voditeljstvom Branke Ivančan -Picek) tijekom kojeg je više meteorologa diplomiralo, magistriralo (Ivatek-Šahdan 2007; Tudor 2007) i doktoriralo, koristeći znanje stečeno pri razvoju modela ALADIN ili rezultate modela (vidi hrvatsku znanstvenu bibliografiju na https://bib.irb.hr/). Ovdje treba napomenuti da je ALADIN model bio okosnica našeg sudjelovanja u mnogobrojnim međunarodnim projektima od kojih izdvajamo upravo završene projekte financirane od Europske Unije. To su WILL4WIND (*Weather Intelligence for wind energy*; http://www.will4wind.hr) i ENHMES-Buildings (*Enhancement of Research, Development and Technology Transfer Capacities in Energy Management System for Buildings*; www.enhems-buildings.fer.hr), te trenutno aktivan HORIZON2020 projekt EU-CIRCLE (*A pan-European framework for strengthening Critiacl Infrastructure resiliense to climate change*; www.eu-circle.eu).

intensive convections aroused scientific interest of Croatian team. Thus, many case studies, weather analysis during meteorological and hydrological international projects have been carried out and resulted with significant number of scientific papers (Ivančan-Picek and Jurčec 2002, 2003; Ivančan-Picek et al. 2003, 2005; Horvath and Ivančan-Picek 2003; Ivatek-Šahdan and Tudor 2004; Vukičević et al. 2005; Ivančan-Picek et al. 2005; Beg Paklar et al. 2005; Ivatek-Šahdan and Ivančan-Picek 2005, 2006; Kuzmić et al. 2005; Ivančan-Picek et al. 2006; Bajić et al. 2007; Kozarić and Ivančan-Picek 2006; Bencetić et al. 2009; Martin et al. 2009; Rixen et al. 2009; Vandenbulcke et al. 2009; Vilibić et al. 2008; Horvath et al. 2009, 2011; Tudor and Ivatek-Šahdan 2010; Stiperski et al. 2011; Renko et al. 2012; Mazzocco Drvar et al. 2012; Tudor et al. 2013; Mihanović et al. 2013; Janeković et al. 2014; Kalin et al. 2015).

Knowledge gained on the common ALADIN and RC LACE work on the development and operational implementation of the ALADIN model, as well as local experience of operational work and the analysis of specific atmospheric processes is the base for work on many national and international scientific projects. The results and knowledge achieved in the ALADIN work was first used in the "Storms and natural disasters in Croatia" project (funded by the Ministry of Science, Education and Sports) coordinated by Branka Ivančan Picek. Many Croatian meteorologists graduated and obtained M.Sc. (Ivatek-Šahdan 2007; Tudor 2007) and Ph.D. degree (see Croatian scientific bibliography on https://bib.irb.hr/).
The ALADIN model was the back-bone of Croatian participation in the international projects. We would like to highlight two just finished projects financed by European Union: WILL4WIND (Weather Intelligence for wind energy) (http://www.will4wind.hr) and ENHMES-Buildings (Enhancement of Research, Development and Technology Transfer Capacities in Energy Management System for Buildings) (www.enhems-buildings.fer.hr), as well as currently active HORIZON2020 project EU-CIRCLE (A pan-European framework for strengthening Critical Infrastructure resilience to climate change) (www.eu-circle.eu).

ALADIN/HR produkti su postali prepoznatljivi i korišteni od strane mnogobrojnih korisnika, počevši od državnih institucija do opće javnosti. Državni hidrometeorološki zavod izdaje veliki broj prognostičkih produkata, poput upozorenja na opasne vremenske prilike, opću, pomorsku, biometeorološku i agrometeorološku prognozu za javnost i medije, koji se temelje na ALADIN/HR rezultatima. Razvijeni su i specijalistički produkti namijenjeni raznim gospodarskim sektorima: sigurnosti zračnog, kopnenog i pomorskog prometa, planiranju proizvodnje i korištenju energije (osobito iz obnovljivih izvora), poljoprivrednoj proizvodnji, zaštiti od požara otvorenog prostora, planiranju i održavanju događanja na otvorenom prostoru i slično.

Detaljan uvid u trenutni operativni ALADIN prognostički sustav, kao i neki od rezultata znanstvenih i primijenjenih istraživanja temeljene na ALADIN modelu, prikazani su u ostalim radovima u ovom broju Hrvatskog meteorološkog časopisa.

ALADIN/HR products have became well known and widely used in our user community started from governmental institution to general public. Meteorological and Hydrological Service of Croatia produce large number of forecast products based on ALADIN/HR results including severe weather warnings and general, marine, biometeorological and agrometeorological forecasts for general public and media. The special forecast products have been developed for different economic sectors: air safety, land and maritime transport, energy production and energy planning (especially renewable energy resources), agriculture, open space fires protection, planning open space events and many others.

Detailed insight into the current operational version of ALADIN system in Croatia and some results based on ALADIN model are given in papers that follow in this number of the Croatian Meteorological Journal.

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Prilog 1. Značenje skračenica korištenih u tekstu

Supplement 1. Acronyms used in text

ALADIN	Air Limitee Adaptation dynamique Developpment InterNational - Consortium in which participant countries use ALADIN model and the name of the model - ime konzorcija u kojem sudjeluju zemlje koje koriste ALADIN model i ime modela
ALARO	Physical parametrization in ALADIN model for operational use for horizontal resolutions between resolution of ALADIN and AROME modles - fizikalna parametrizacija u ALADIN modelu za operativnu primjenu na horizontalnoj razlučivosti modela između razlučivosti ALADIN i AROME modela
ALATNet	ALADIN Training Network - ALADIN mreža treninga
AROME	Application of Research to Operations at MesoscalE - upotreba i prilagodba fizikalnih shema modela Meso-NH za ALADIN model
ARPEGE	Action de Recherche Petite Echelle Grande Echelle - ime globalnog modela francuske meteorološke službe
BRAC-HR	BRainstorming on AdvanCed method of High Resolution modelling - radionica o naprednim metodama modeliranja visoke razlučivosti
CEI	Central European Initiative is a forum of regional cooperation in Central, Eastern and South Eastern Europe. It is committed to support European integration through cooperation among its Member States -regionalan međuvladin forum zadužen da potpomogne europsku integraciju zemalja članica foruma
CSSI	Committee for Scientific and System maintenance Isuues - Savjet za znanstvena pitanja i pitanja održavanja sustava
DWD	Deutsche WetterDienst - Meteorološka služba Njemačke
ECMWF	European Center for Medium Range Weather Forecasts - Europski centar za srednjoročne prognoze vremena
EPS	Ensamble Predicition System - sustav ansambl prognoze vremena
EUMETNET	The Network of European Meteorological Services - mreža nacionalnih europskih meteoroloških službi
EWGLAM	European Working Group fpr Limited Area Modelling - Europska radna grupa za modeliranje na ograničenom području
HIRLAM	High Resolution Limited Area Model; NWP consortia - model za ograničeno područje visoke razlučivosti i ime konzorcija koji koristi HIRLAM model
HRID	High resolution isentropic diagnosis - izentropska dijagnoza visoke razlučivosti
IFS	Integrated Forecasting System - globalni meteorološki model ECMWF-a
IOP	Intensive Observation Period - razdoblje intenzivnih motrenja
LAM	Limited Area Model - meteorološki model za ograničeno područje
LSC	Lace Steering committee - LACE nadzorni odbor
LAEF	Operational ALADIN LAM EPS system - Operativni ALADIN LAM EPS sustav
LSO	LACE Scientiffic Officer - LACE znanstveni koordinator

LTM	Locall team manager - voditelj lokalnog ALADIN tima
MAP	Meso-scale Alpine Programme - mezoskalni alpski program
Meso-NH	Non-Hydrostatic Mesoscale atmospheric model - francuski nehidrostatski model atmosfere
Meteo France	France meteorological service - ime francuske meteorološke službe
MFSTEP	Mediterranean Forecasting System Toward Environmental Predicition project - ocenografski projekt predoperativne oceanografske prognoze na Sredozemlju u svrhu zaštie okoliša
NORAF	ALADIN cooperation with the Northern African countries - ALADIN suradnja sa sjevernoafričkim zemljama
NWP	Numerical Weather Prediction - numerička prognoza vremena
RC LACE	Regional Cooperation for Limited Area modelling in Central Europe - regionalna suradnja zemalja srednje Europe
SRNWP	Short Range Numerical Weather Prediction Programme - program kratkoročne numeričke prognoze vremena
SRNWP-V	Short Range Numerical Weather Prediction Programme - Verification - Program kratkoročne numeričke prognoze vremena - verifikacijski program
UKMO	United Kingdom Met Office - meteorološka služba Velike Britanije