

# COMMISSION OF THE EUROPEAN COMMUNITIES

## COOPERATION IN SCIENCE AND TECHNOLOGY WITH CENTRAL AND EASTERN EUROPEAN COUNTRIES

### APPLICATION FORM FOR SCIENTIFIC NETWORKS

**1. Scientific theme :** Very fine scale short range numerical weather forecasting, special attention being paid on Central and Eastern European specific weather elements.

**2. Title :** Validation and pre-operational evaluation of a fine-mesh spectral limited area numerical weather prediction model used in dynamical adaptation mode.

**3. Acronym :** ALADIN : Aire Limitée Adaptation dynamique Développement International.

(Part of the more general ARPEGE project at Météo-France).

**4. Name and organization of the project coordinator :**

GELEYN Jean-François -Groupe d'Etude de l'Atmosphere à Moyenne Echelle - Centre National de Recherches Météorologiques - Météo-France - Toulouse - FRANCE.

**5. Summary of motivations, objectives and major initiatives :**

The National Meteorological Services of Bulgaria, Hungary, Poland, Romania and Czechoslovakia (Czech part) have agreed to pool their research manpower in Numerical Weather Prediction in order to develop the ALADIN model together with the NWP team of Météo-France.

For the future, validation and pre-operational assessment of the model's potential become a prerequisite for any future use for the benefit of the Central and Eastern European Countries. Considering this point, it is highly wishable that people from Central and Eastern Europe are associated to this phase also. This association has both scientific and technical advantages.

The scientific aspects bear on the validation and improvement of the model itself. The technical aspects involve the preparatory steps towards operational use of the model by participating Countries. It must be realised that such a forecasting system cannot run on its own : it needs other, larger scale, forecasts that only one of the EC Countries involved in the project (France or Denmark) can provide and transmit operationally via relevant telecommunication means.

The EC support would be a decisive factor of acceleration and of improvement for these goals.

**6. Cost summary table :**

Proposers	Institution	Country	Requested EC contribution	Total	1st year
Laursen	Dan. Met. Ser.	Danemark	?		?
Batka	Charles Univ.	Czech Republic	?		?
Janousek	Czech Met. Ser.	Czech Republic	?		?

Spacek	Czech Met. Ser.	Czech Republic	?	?
Cordoneanu	Ro. Met. Ser.	Romania	?	?
Ivanovici	Ro. Met. Ser.	Romania	?	?
Pescaru	Ro. Met. Ser.	Romania	?	?
Devenyi	Hung. Met. Ser.	Hungary	?	?
Ihasz	Hung. Met. Ser.	Hungary	?	?
Radnoty	Hung. Met. Ser.	Hungary	?	?
Spiridonov	Bu. Met. Ser.	Bulgaria	?	?

## 7. Major milestones and proposed reports :

The first milestone of the ALADIN project (i.e. the first test run of the model) will have taken place before the pre-operational action (for which support is asked here) may start. As explained later, the effort will then be split between basic studies on one side and tests of operational feasibility as well as first evaluations of the objective forecasting performance on the other side.

Parallely a comparison with a similar model (HIRLAM) developed by the Nordic Countries, the Netherlands and Ireland will be carried out between Toulouse and Copenhagen.

During the two years for which this network set-up is envisaged one hopes

- (i) to show the objective advantages of dynamical adaptation for certain classes of meteorological phenomena (1st year) ;
- (ii) to prove, in Toulouse, the quasi-operational feasibility of a suite coupling ALADIN to its global ARPEGE counterpart (mid-second year) ;
- (iii) to use the HIRLAM vs. ALADIN comparison to improve and further validate both models (2nd year) ;
- (iv) to accumulate ideas about the ALADIN model's general behaviour for idealised cases first and for operational conditions afterwards (both years, with a reassessment of priorities after the first six months).

## 8. Name, date and signature of the coordinator on behalf of all joint proposers :

## 9. Administrative information about proposers :

## 10. Objectives of the scientific network and motivation :

Following an initiative launched in November 1990 by the French National Meteorological Service, Météo-France, the National Meteorological Services of Bulgaria, Hungary, Poland, Romania and Czechoslovakia (Czech part) are participating, since mid-1991, to the development of a new, scientifically advanced Limited Area Model (LAM) for Numerical Weather Prediction (NWP) named ALADIN. The main scientific aims of this on-going development effort are the following :

\* to verify in ALADIN the anticipated advantages of the spectral technique originally proposed by scientists from the Danish Meteorological Institute (Dr. B. Machenhauer and his team inside the HIRLAM project, see below) for the LAM application ;

to further investigate whether some of the problems associated with "rigid-type" lateral boundary conditions in finite-difference LAMs can be alleviated with this new technique based on bi-periodicization of all fields via an extension zone.

\* to validate all the necessary software tools to be able to run ALADIN in an operational mode : coupling with informations provided by a global model and cautiously interpolated to the finer grid of the LAM, balancing of the initial (and coupling ?) fields, consistent restitution of forecast results outside the influence of the extension zone, etc ; it should briefly be mentioned here that the balancing part (so-called "initialization") will rely on the new technique of "digital filters", another outcome of the HIRLAM project (Irish and Danish National Meteorological Services).

\* to tackle more in-depth problems associated with ALADIN and some possible extension of its scope from meso-scale dynamical adaptation (its current status) to other possible functions. We shall not elaborate on that point here since it is quite far from the aims of this "network" proposal and will be carried through thanks to an independent support from the French Ministry for Research and Space (Réseau Formation Recherche).

Indeed the objectives of the current proposal are to concentrate on the application side of ALADIN. It will be used from the end of 1992 in "dynamical adaptation mode", which means without reanalysis of the initial state at the finer resolution of the LAM, the initial conditions being simply interpolated like the lateral boundary conditions. The horizontal resolution will thus be higher than the one of the "coupling" global model (in principle the ARPEGE code of Météo-France) and the domain of integration hardly wider than the area of interest for the forecasts. Within this imposed framework (owing to choices made at the beginning of the program) the main issues for the scientific/technical work linked with the current network proposal are as follows :

\* to validate the general quality of the numerical products produced by the procedure "ARPEGE => coupling => ALADIN => post-processing" ; to identify advantages and disadvantages with respect to the similar products obtained directly from ARPEGE.

\* to concentrate on well documented case studies relevant to Central and Eastern European crucial meteorological situations (the orographic influence will obviously be a paramount factor here) and to evaluate the potential of ALADIN on them. This action will also be automatically extended to weather events interesting for the French and Danish parties, as part of the comparison exercise between the ALADIN and spectral-HIRLAM codes.

It must be briefly mentioned here (see Part 19 for more details) that this action creates a link between the current proposal and a "Human Capital and Mobility" network proposal recently submitted by HIRLAM participants and the National Meteorological Services of France and Spain under coordination of the Danish Meteorological Institute. Thus the two EC proposers of the current application would act as a link between the two projects and ensure no unnecessary duplication of efforts. A logical consequence of that fact is that nearly all the mobility support asked inside the current proposal would be spent on network members from Central and Eastern European Countries, to allow them travelling to Toulouse and Copenhagen. Only a small amount of return "information" visits of French and Danish network members to Central and Eastern European members are planned. No Toulouse Copenhagen or Copenhagen Toulouse trip for the French or Danish people would be financed on this proposal.

\* in the light of the results of the two previous points, to propose and revalidate modifications to the scientific choices made for the different parts of the procedure (interpolation, initialization, coupling, parameterized representation of the atmospheric physics, post processing). This exercise might appear trivial at first sight, but the deep interdependency of all these aspects and their entangled influences on the final product makes it, on the contrary, a very difficult and manpower consuming one.

The underlying aim of all this is of course to create between all the proposers a scientific/technical community able to **run** ALADIN, to **understand** its behaviour and to **use** its products. This is in fact, for any NWP system, in any country of the world, a never achieved goal but towards which all aims are concentrated. The relevant means are multiple :

\* pursuit, during the maintenance phase of the code, of the close scientific contacts that have been established during the development phase ; these contacts should allow to minimize the manpower dedicated to the maintenance of the codes and, in that particular case, to profit from further developments inside the ARPEGE/IFS project. It is indeed necessary to precise here that ALADIN has been conceived as a derived version of the ARPEGE code (thus sharing with it many items : parameterization, "vertical" dynamics, interpolation, post processing, ...) and that ARPEGE itself is developed jointly by Météo-France and the European Centre for Medium Range Weather Forecasts (ECMWF), the project name being IFS at ECMWF (Reading, UK). This particular situation can be considered as a very strong point for the stability and the perennity of this anticipated network action.

\* training, through the validation-modification-revalidation process, of the people that should be associated in the future with the operational assessment and organization of the operational use of ALADIN in Central and Eastern Europe. This point is quite difficult to handle since the kind of resolution that would be obtained for ALADIN products would represent a big quantitative (and hopefully qualitative) leap from the current situation in the relevant National Meteorological Services. Such a

transition is never easy and the people that would have been trained inside the network would bear the responsibility to make it as smooth and efficient as possible ; we shall not elaborate further on that point since it is difficult to anticipate all the relevant hurdles but the proposers are well aware of its crucial importance.

\* exploratory steps and planning for pre-operational and operational use of ALADIN (in this case, for an area covering Central and Eastern Europe) ; several possibilities can be envisaged here, depending where the main computations are done, but they all involve heavy use of telecommunication means, either to "pass" initial and lateral boundary conditions from ARPEGE to ALADIN, or to disseminate ALADIN results.

In a pre-operational phase the computing would obviously be performed in Toulouse and some results disseminated via the already existing RETIM system (satellite dissemination of the meteorological products of Météo-France, also used for dissemination to some foreign partners in the framework of bilateral actions, notably all Central and Eastern European proposers for this network). Success of this pre-operational phase would call for another, more systematic and more expensive solution, to be chosen between several possible ones ; it is neither our purpose here to already instruct and make such a difficult choice, nor to ask for anticipated financial support for the necessary infrastructures ; the EC financial support of the network would simply ensure that contacts between the relevant experts would be as close and as efficient as for the scientific part of the plan. If possible and acceptable from the point of view of the people following our progress from the EC side, a new demand of support would be made in due time.

In summary, the motivation of the proposed network is to allow Central and Eastern European National Meteorological Services to build on their existing expertise in NWP in order, with the scientific and technical help of their counterparts in two EEC-Countries, to access numerical products produced by state-of-the-art software tools, after contributing to the development of the latter. The objectives envisaged for the two-years period for which the current proposal is drawn are essentially pre-operational and oriented towards the pursuit of the common scientific work, the training in maintenance and use of the ALADIN code and the preparatory steps for an operational application.

This perspective would create a strong link between proposers, as an operational ALADIN system cannot produce weather forecasts on its own, but needs daily data that only the largest centres of the EC Countries can provide.

## **11. Rules proposed for the incorporation of new members :**

There is in principle no reason not to accept new members among the National Meteorological Services of those Countries for which the program "Cooperation in Science and Technology with Central and Eastern European Countries" is foreseen. In fact, the renewed links between Baltic Countries National Meteorological Services and their Nordic counterparts would make the Danish participation to this network a convenient anchor point for an integration of these Countries, provided they are interested in the project and willing to follow its objectives. This applies of course also to any other potential candidate.

## **12. Plan of joint activities and costs :**

The planned activities are all ordered around the validation, maintenance and improvement of the ALADIN code and the comparison of its results with those of the spectral-HIRLAM code (see part 10 for all details). Given the current status of technical facilities in Central and Eastern European National Meteorological Services, it is obvious that the work in these area can only be carried through if the network participants from Central and Eastern European Countries have the possibility to travel to Toulouse and Copenhagen for stays of a few months. The main body of the requested financial support would therefore be used for covering marginal costs (on a basis corresponding to per-diem for internal missions of the agents of the local Meteorological Services, i.e. of the order of 1400 ECU per month). Some other money would be used to finance shorter visits, either from management people from Central and Eastern European National Meteorological Services to Toulouse or Copenhagen or from the French and Danish people involved in the network to Central and Eastern Europe. The current experience of the ALADIN development work (financed by the interministerial MICECO funds of the French government for the stays of Central and Eastern European NWP specialists in Toulouse) indicates that the cost of these trips does not exceed 10 to 15 % of the total cost of the action. Furthermore, the same experience indicates that the necessary overall work to be done to reach the objectives of the program can be evaluated to about 80 man-month over the two years period. The different figures that have been mentioned lead to an overall marginal cost for the network of 130000 ECU for the two years 1993 and 1994. The splitting of this figure in Part 6 is more indicative than absolute, but roughly corresponds to an extrapolation of the current degree of implication of each of the participating National Meteorological Service, with some adjustment owing to the interest expressed in the joined letters.

## **13. Existing and planned infrastructures :**

Concerning the Central and Eastern European Countries, their contributions to that Part can be found in the letters put at the end of this Annex.

The research department of Météo-France (Centre National de Recherches Météorologiques - CNRM) has a long tradition in NWP. Since the pioneering times, models for the "large" scales of motion were developed and put into operation for daily

routine forecasting. The involvement with deterministic "fine-mesh" forecasting dates back to the launching of the PERIDOT project, that became operational in February 1985. At that time, the chosen solutions were all of a very advanced type (35 km mesh size -the smallest for an operational model, still for a long time afterwards- ; data assimilation at the full model resolution with direct use of satellite radiance information ; analysis on the model levels and with horizontal meso-scale character ; full package of parameterization schemes ; ...). Since 1985, parallelly to the maintained effort towards global scales (linked with more basic climate-type studies) people at CNRM have concentrated onto three subjects around the PERIDOT code :

- assessment of the damaging effect of Lateral Boundary Conditions on the internal forecasting potential of the model, via both dynamical and physical constraints ;
- study of deep convection processes, the ones among the parameterized processes that are most influential on the forecasting potential of such models ;
- evaluation of the remaining predictability potential, at even finer meshes, when starting from the results of a meso-a scale data assimilation.

Results in all these actions lead to the basic concepts of the ARPEGE project, launched in 1987 and scheduled for operational implementation at the turn of 1993. This project, centred on a global spectral model with variable resolution, on a parameterization package totally redesigned for better moist thermodynamics as well as for total "plug-compatibility" and on a data assimilation strategy of progressive evolution towards variational methods, puts Météo-France in a good position to progress without contradiction in two independent directions :

- using the results of operational application of this rather revolutionary approach (fine-mesh with LBCs at infinity) to improve our understanding of NWP in the domains of dynamics, of parameterized processes and of very fine scale data assimilation ;
- to open partnerships with other teams interested in the same subject but working with the more conventional LAM approach, drawing for that on the very flexible character of most ARPEGE developments and on the special care given to the "model-environment" all along the code evolution -the code being conjointly developed with ECMWF under the IFS name there-. The parallel development, launched in 1991, of the spectral limited area version of ARPEGE, ALADIN, is the culminating effort of that aspect that also involves partnership with the HIRLAM project.

Experience of the joint ALADIN scientific development between Météo-France and five Central and European Meteorological Services has shown, since September 1991, that the local technical infrastructures in Toulouse are sufficient to allow this type of partnership to be tried on such a large scale (up to 11 visitors at the beginning of the action). Furthermore, the Central and Eastern European partners of this proposal have started to get some fine mesh NWP products concerning their own area via the RETIM system : in February 1991, following a technical development carried through in partnership with the Moroccan National Meteorological Service, the area of integration of the PERIDOT model was extended towards the South and towards the East and new products were added to the RETIM dissemination list (on new sub-domains of interest for Maghreb Countries on one hand and for Central and Eastern European Countries on the other hand). The fact that ALADIN is very close to ARPEGE means in fact that the two aspects that have just been mentioned will become increasingly connected once the PERIDOT numerical products have been replaced by the ones of ARPEGE at the turn of 1993.

Concerning the Danish Meteorological Institute, its research department has about 40 employees and is organized in three sections. The main task of the section going to participate in the present project is to develop, maintain and use numerical models of the atmosphere for weather forecasting and climate research. In order to achieve this, the department is cooperating with several other parties. Thus, DMI has been a participant in the HIRLAM project since its beginning in 1985. The main objective of this project was to develop a High Resolution Limited Area Model (HIRLAM) and data-assimilation system. During the last two years the HIRLAM system has been running operationally on DMI's CONVEX computer. DMI has continued the development of the HIRLAM system in cooperation with the other participants in the HIRLAM group.

Also, a climate modelling project has been established at DMI. In cooperation with the Geophysical Institute at the University of Copenhagen a Danish climate model was developed based on a version of the spectral model developed at ECMWF. Over the years a number of changes and modifications have been introduced in this model, in order to make it more useful as a climate model.

Since 1990 DMI has been participating in the European Community project "The Climate of the 21st Century" in cooperation with 17 other research organizations within EC. DMI is involved in several of the sub-projects, utilizing both the HIRLAM model and the global climate model. The activities are financially supported by EC and DMI has reasons to believe that some of the activities will be supported after a second round of application to EC. Through this project, DMI has established cooperation with several of the leading laboratories in Europe dealing with climate research including Max Planck Institute für Meteorologie in Hamburg and Centre National de Recherches Météorologiques in Toulouse.

Leif Laursen, chief of Meteorology and Oceanography Research Division, is responsible for the proposed project at DMI and he has a long experience in this field of research. At present, the staff of the section include about 15 persons involved in numerical modelling of the atmosphere. Within the present project especially Drs. Jens Hesselberg Christensen and Xiang-Yu

Huang are going to contribute.

#### **14. Infrastructural needs and costs :**

As already mentioned, these would only become relevant in an operational phase and, if necessary, a new proposal would have to be submitted at that time, after consultation of the people of the Commission of the European Communities that would have followed the progress of the pre-operational phase for which the current proposal is drawn.

#### **15. Workplan for setting up the initial Scientific and Technical network and its operation:**

In fact the network, seen at the level of contacts between the different National Meteorological Services and their Research Departments, already exists through the MICECO-financed action on the scientific preliminary development of ALADIN. The main necessary administrative procedures, mostly going through the french CIES body, are well in practice and most of the anticipated participants have either been in contact directly or indirectly with the project. As already mentioned, EC support is now asked to allow the continuation of the project, not only on a scientific basis (already financed by the French Ministry for Research and Space) but also with concrete longer term operational aims.

The necessary procedures to make the travels to Copenhagen possible will have to be worked out at a later stage, since this aspect should start a bit later (see Part 7) ; however the EC proposers do not foresee any basic difficulty for that point.

#### **16. Management of the Scientific and Technical network :**

The centralised character of the proposed action will make it rather easy for the coordinator to carry through the network management (if fact, as for point 15, the mechanisms already exist in Toulouse, with the coordinator taking care of the contacts with the relevant National Meteorological Services and getting the help of three people of the Météo-France staff -A. Joly, V. Ducrocq and S. Malardel- for all what concerns the scientific and day-to-day problems linked with the project). If people refereeing this proposal wish, they may obtain some working papers and intermediate reports from A. Joly, in charge of the scientific coordination of the ALADIN project (same address as the coordinator). Obviously, some extension of the organisation towards more operational aspects of the work will be necessary as the work of the network progresses during 1993 and 1994, but the relevant contacts have already been taken inside the operational department of Météo-France and the necessary manpower resources should become available in due time.

Concerning the links between L. Laursen in Copenhagen (coordinator of the proposed "Human Capital and Mobility" network -see above-) and J.-F. Geleyn in Toulouse, the framework set-up for the collaboration between HIRLAM and Météo-France should be sufficient to ensure the necessary coordination before steps are taken on either side that may influence the envisaged intercomparison.

#### **17. Proposal of a workplan for the extension of the Scientific and Technical network to other members, including joint activities, infrastructure and probable costs :**

This point is irrelevant owing to the answers to points 11, 12, 14 and 15.

#### **18. Financial proposal :**

The justifications for this proposal have been indicated in Part 12. The first idea about the split between the different participating Services has been indicated in Part 6 (there only one coordinating person for each Service was indicated). All costs are marginal ones so that the demand for EC financing amounts to 100 % of the costs, i.e. 130000 ECU, with the following repartition :

80 man-month of visits to M-F or DMI :	112000 ECU
shorter "management" trips to M.-F. or DMI :	6000 ECU
"information" visits to C. & E. Europe :	12000 ECU
<b>Total :</b>	<b>130000 ECU</b>

#### **19. Relations with other projects or programmes and finance received or expected from other sources :**

As already mentioned the basic research ALADIN counterpart of this proposal has received the support of the French Ministry

for Research and Space within the action "Réseaux Formation-Recherche" for an amount of 480000 FF for a similar period of two years.

Also already mentioned was the application for a "European Research Network on High Resolution Numerical Weather Forecasting" submitted under the program "Human Capital and Mobility" by the National Meteorological Services of Denmark, Finland, France, Iceland, Ireland, Netherlands, Norway, Sweden and Spain. The application is for a sum of 275000 ECU over three years. Although the two subjects are quite close, and indeed interrelated through the use of the same spectral method for LAM NWP, their working procedure should be quite different, owing to the quite homogeneous level of technical facilities between the participants to the "Human Capital and Mobility" network. As already stated the current proposal excludes support for direct contacts between Copenhagen and Toulouse (and leaves them to be supported by the other proposed network's financing) so that no overlap should exist between the financing of the two activities, should they both be supported by the EC.

Concerning the potential scientific overlap of the three above-mentioned activities, it is obvious that they should not be disconnected from one another, but that it will be the responsibility of the coordinators to prevent both any unnecessary duplication of work and any drift towards a situation where the individual specifications of the three actions would become less and less obvious.

## **20. Scientific reference information on the proposers :**

Concerning the Central and Eastern European Countries, their contributions to that Part can be found in the letters put at the end of this Annex.

### Danish Meteorological Institute ; principal proposer Leif Laursen :

\* Education : Technical Meteorologist at the Danish Meteorological Institute finished 1970.

\* Employment record : Institute for Theoretical Meteorology, University of Copenhagen 1970-1984, assistant in meteorology and numerical modelling.

Danish Hydraulic Institute 1984-1985, consultant in numerical modelling.

Geophysical Institute, University of Copenhagen 1985-1988, assistant in meteorology and numerical modelling.

Danish Meteorological Institute 1988- , project coordinator, deputy head of research ; from 1991 chief of Meteorological and Oceanographic Research Division.

\* Experience : during the last twenty years has been working with numerical models of the atmosphere and during the last years especially with the organization and application of the Danish Climate Model. Most of this work has been carried out in cooperation with professor Erik Eliassen, University of Copenhagen. Since appropriate computing facilities are essential for numerical models, has been heavily involved in the establishment of a modern super computing environment at DMI, including network and graphics.

### Météo-France ; network coordinator Jean-François Geleyn :

\* Education : Ecole Polytechnique, Paris

Ecole Nationale de la Météorologie, Paris

J. Gutenberg Universität, Mainz

\* Employment record : 1975-1976 : Research Department of the French Meteorological Service, scientist ;

1976-1982 : ECMWF Research Department, scientist ;

1982-1985 : Research Department of the French Meteorological Service, scientist ;

1985- : same affiliation, head of the NWP research branch ; since 1991 head of the ARPEGE project.

\* Other items : Member of the International Radiation Commission ; member of the Scientific Advisory Committee at ECMWF ; member of the CAS/JSC Working Group on Numerical Experimentation ; chairman of the WMO/CAS Group of rapporteurs on medium- and long-range forecasting.

