STARTPAGE

HUMAN RESOURCES AND MOBILITY (HRM) ACTIVITY

MARIE CURIE ACTIONS
Research Training Networks (RTNs)

"Interdisciplinary and Intersectorial"

Call: FP6-2004-Mobility-1

PART B

STAGE 1 – OUTLINE PROPOSAL

STORMNET

Table of Content for the Outline Proposal

B1 PARTNER LIST

Participant number	Participant Organisation legal name and Department	Country
1	Meteo-France National Meteorological Research Centre	France
2	Central Institut for Meteorology and Geodynamics Department of Synoptical Meteorology	Austria
3	Royal Meteorological Institute (of Belgium) Meteorological Research and Development	Belgium
4	Meteorological and Hydrological Service, Republic of Croatia Research and development division	Croatia
5	Czech Hydro-Meteorological Institute Numerical Weather Prediction	Czech Republic
6	Finnish Meteorological Institute Department of Research	Finland
7	German Weather Service Research Department	Germany
8	Hungarian Meteorological Service Department for Research and Development	Hungary
9	Met Eireann, The Irish Meteorological Service Marine Unit	Ireland
10	Royal Netherlands Meteorological Institute Research on Models	The Netherlands
11	Norwegian Meteorological Institute	Norway
12	National Meteorological Administration	Romania
13	Slovak Hydro-Meteorological Institute Meteorological service	Slovakia
14	Swedish Meteorological and Hydrological Institute Research Department	Sweden
15	Federal Office of Meteorology and Climatology (MeteoSwiss) Models Process	Switzerland
16	Met Office Numerical Weather Prediction	United Kingdom

B2 OUTLINE PROPOSAL

INTRODUCTION

1. A short presentation of the STORMNET project

STORMNET (Scientific Training for Operations and Research in a Meteorological NETwork) aims at building a European training network for local short-range high-resolution numerical weather prediction and its applications.

European meteorological services now have to face the challenge of a quick march towards very high resolution applications for limited-area modelling and short-range prediction. Beside the research work specific to numerical weather prediction (NWP), the increased complexity of equations and the huge amount of data to handle at a reasonable cost will raise new problems in numerics and code organisation. The positive feedback on downstream applications like hydrology or air-pollution modelling will have to be checked too. As experts are spread among many small teams, an enhanced transfer of knowledge through training actions is needed.

The following institutes are willing to join the STORMNET research training network: Meteo-France / National Meteorological Research Centre, Central Institut for Meteorology and Geodynamics (Austria), Royal Meteorological Institute of Belgium, Meteorological and Hydrological Service of the Republic of Croatia, Czech Hydro-Meteorological Institute, Finnish Meteorological Institute, German Weather Service, Hungarian Meteorological Service, Irish Meteorological Service, Royal Netherlands Meteorological Institute, Norwegian Meteorological Institute, National Meteorological Administration (Romania), Slovak Hydro-Meteorological Institute, Swedish Meteorological and Hydrological Institute, Federal Office of Meteorology and Climatology (MeteoSwiss*)*, Met Office of United Kingdom.

2. Short-range numerical weather prediction in Europe

Today's NWP models have reached a degree of complexity that makes it difficult for any country, even a large one, to develop and test with its own resources all the modules of a leading edge numerical model for the high-resolution simulation of the atmospheric processes, inclusive of the difficult determination of adequate initial conditions from the observations and consideration of computing cost. One the other side, European NWP teams are usually small, around 7 persons on average, but down to 3 in some countries. As a consequence, several groups of national weather services (NWS) have gathered together, to share the development work and further maintenance of 4 world-class limited-area models, used operationally for weather forecasting at horizontal scales in the range 5-15 km.

These 4 groups, or consortia, are:

- the ALADIN consortium (http://www.cnrm.meteo.fr/aladin/), including the weather services of Austria, Belgium, Bulgaria, Croatia, Czech Republic, France, Hungary, Moldova, Morocco, Southern Poland, Portugal, Romania, Slovakia, Slovenia, Tunisia, who built and use the ALADIN model;
- the COSMO consortium (http://cosmo-model.cscs.ch/public/), including the weather services of Germany, Greece, Italy, Northern Poland, Switzerland, who built and use the LM model;
- the HIRLAM consortium (http://hirlam.knmi.nl/), including the weather services of Denmark, Finland, Iceland, Ireland, The Netherlands, Norway, Spain, Sweden, who built and use the HIRLAM model;
- the NWS of the United Kingdom of Great Britain (http://www.metoffice.com/research/nwp/), who takes care alone of the UM model.

Each group has its own identity and specific work relation between partners, but in all cases a quite efficient networking has been established over the years.
At a higher level, on a European scale, cooperation between NWP teams started 26 years ago, via the informal EWGLAM (European working group on limited-area modelling) network, reinforced 10 years ago with the creation of the SRNWP (short-range numerical weather prediction) programme to foster exchanges (http://srnwp.cscs.ch/). Within these networks, around 3 scientific meetings are organized each year, on the general progress or specific scientific issues of short-range high-resolution NWP. SRNWP in its present form has proven its usefulness, but attempts to go further in exchanges at this level were not as successful as expected. There is still significant effort required to establish a very close cooperation between NWS, in practice between consortia, while preserving decentralization, which is mandatory for local operational applications.

RESEARCH PROGRAM

1. Relevance of the research objectives

The need for better regional and local short-range weather predictions is continuously increasing in our society, not only in the agricultural, industrial and economic fields but also in relation with outdoor leisure activities. Of prime importance is the prediction of risks, for human life and heavy damages. Not only storms must be better forecasted, but also severe weather which may cause disruptions (in water and power distribution, surface and air transportation, ..), like the occurrence of heavy rain, snowfalls, or fog. The forecast of such weather elements is to be improved, in regards to their intensity and location, with an increased precision both in time and space.
Such an increasing demand impacts directly on numerical weather prediction, since NWP models, especially high-resolution limited-area ones, are now a major tool for weather forecasting. All models and each team have now got to make headway towards very high resolution, typically horizontal scales around 1-3 km. Besides, assuming that the performances of computers will keep increasing as they did in the past, it is realistic to envisage, within 3 to 4 years, horizontal resolutions of 2-3 km for NWP operational models, though on small targeted domains first. By most partners, the main operational applications should stay a little behind, with horizontal resolutions between 5 and 8 km.
However, NWP, at such scales, has to address new problems, linked either to the increased complexity of equations required for a better description of phenomena, or to the very large amounts of data the models will need (mainly meteorological observations) and produce. And, at each step and level, one will have to find compromises between scientific ambitions and the capacity of operational forecasting suites.
The STORMNET research plan can be described following 4 main directions, which may be considered in parallel in spite of many common points or interactions.

2. Deterministic forecasting at very high resolution

This domain combines the 3 main historical issues of limited-area NWP.

a) “Dynamics”

There is now a general agreement that non-hydrostatic aspects must be taken into account at horizontal scales below 5 km, and even that a fully compressible system of equations should be used. Such features are implemented in all 4 European limited-area NWP models, though at different levels of achievement.
However, some debates are still open, between modelling groups or simply for improving any model: type of horizontal projection, finite-differences vs spectral methods, Eulerian vs semi-

Lagrangian advection, from explicit to fully implicit time-stepping, choice of the vertical coordinate and the prognostic model variables, formulation of the lower and upper boundary conditions... Answering these questions, if possible, requires significant further work.
Besides, as horizontal or vertical resolution increases, new problems are likely to emerge, as concerns accuracy, stability or efficiency. Thus, some present choices for the very basic set of model equations may be reconsidered in the near future.

b) “Coupling”

The driving of a limited-area model through its lateral boundary conditions by a global or a coarser limited-are model, must be carefully designed to allow a good representation of large scales, not described by the model itself. All models are presently using the same formulation, the pragmatic Davies' relaxation scheme. It presents some known conception problems, but is quite simple and robust.
Though research in this domain started several years ago, there is still significant work required to implement a better alternative in operations, especially for spectral models. Once this difficult problem solved, more sophisticated algorithms could be addressed, if necessary.
The time-dimension of coupling is also to be reconsidered when facing very high resolution and short-range forecasts.

c) “Physical parameterizations”

Model equations have also to describe the radiative and orographic forcings and exchanges with the surface, as well as the moist and subgrid-scale processes. This part of the model will undergo an important transformation, since one shall have to get rid simultaneously of two currently widely used key assumptions.
First of all, there will be less and less need to take into account details of the flow organisation internal to the mesh-box. Typically, organised convection and details of the subgrid scale underlying topography will cease to generate fluxes of magnitude comparable to those produced by explicit computations between neighbouring grid-points (this aspect deserving special attention at the intermediate resolutions). Secondly, the forcing of parameterizations will cease to be treated as horizontally homogeneous, which means that the 3 space-dimensions will play a role in the computation of turbulent and radiative fluxes. Besides, some aspects which have been neglected up to now because of the too coarse horizontal resolution, such as the impact of lakes or towns on the low atmosphere, will have to be parameterized.
This revolution in the perception that NWP code designers have of “physics” will also have a strong influence the way the parameterization codes are treated algorithmically. Old sources of inaccuracies and of latent instabilities will disappear, while one can safely anticipate that they shall be replaced by new ones, and interfacing with dynamics may have to be reconsidered. Exchanges with external experts should also be encouraged, to improve the description of air-sea exchanges, the impact of aerosols on radiation, the parameterization of run-off, etc ... or even couple directly the NWP model with another one (a procedure which is also likely to favour the emergence of problems).

d) “Time-stepping”

The interaction of physical and large-scale forcings with dynamics will have to be revisited in some models. Two main challenges can be considered. The first one, dealing with the organisation of the time-step, should optimally allow to use various packages of physical parameterizations, and even combinations, with variants of the dynamics, while ensuring accuracy, stability and efficiency for the whole system. The second one is the progressive introduction of 3-dimensional aspects in physical parameterizations (typically for turbulence), which will lead to significantly more complex interactions between physics and dynamics.

3. Improved use of local observations for model initialization

A very good model is useless when run with bad initial conditions. Moreover the refinement of the initial state using meteorological observations, usually called data assimilation, is all the more important since the forecast model is sophisticated, and improvements of both systems must always be kept consistent. One has to note that developments in data assimilation should provide not only more reliable initial conditions for a local high-resolution weather forecast, but also analytical tools to exploit the information from local high-density observation networks. Enhanced links with nowcasting (i.e. very short-range – a few hours- forecast of extreme events) are also expected.
A wider range of horizontal scales, say 1-10 km, is considered here, since there are still significant improvements to be brought to the present operational data assimilation systems (i.e. at scales around 10 km, on average) while one starts from scratch at very high resolution, but the following list of research topics concentrates on issues specific to limited-area models.

a) Use of new observations, improved use of conventional observations

Work will continue on the use of global-coverage data, with emphasis put on the specific pre-processing algorithms required for very dense observations and limited domains. Satellite data of various kind will be injected, at the highest possible resolution. Special attention will be paid to cloud or rain-affected data. However final products designed by specialized centres (SAF) will be used whenever possible.
Local remote-sensing observations, such as radar (reflectivities, 3d or radial winds) and GPS data, will also be assimilated. They are likely to provide useful information on humidity, and the initialization of moist variables is a crucial but very difficult issue at high resolution. The corresponding work has already started in some NWS, using more or less sophisticated assimilation tools, which allows to be confident on a future operational use.
Synoptic surface data, the most conventional observation type, will gain an extra interest. Indeed, the surface network remains a fairly cheap and dense source of informations for the surface and near-surface atmospheric conditions (e.g. snow coverage, precipitations, temperature and humidity at 2 m height, ...).
To end with, attention will be paid to the qualification of observations errors and to their representativeness.

b) Three-dimensional analysis of atmospheric fields

Three major issues are considered here: the description of background errors, analysis algorithms, and the problem of initialization (filtering of spurious numerical modes).
The proper specification of the “background” error covariances is a major issue in modern data assimilation, whatever the analysis algorithm. These functions control the spatial filtering and the space propagation of analysis increments and provide balance conditions. The assumptions used up to now to prescribe them will have to be revisited at very high resolution, where balance conditions are different and moist processes play an increased part. Developments will concern the five main following aspects: sampling (error estimation techniques), covariance representations (on which space, with which level of simplification, ...), balance conditions, flow dependence, and tunings.
Though the simple nudging technique is used by a few teams, there is now a general trend to rather consider variational methods (3D-Var here). Apart from optimization issues, some topics should receive an increasing interest : time dimension (higher frequency of analyses versus semi-continuous systems), choice of adequate lateral boundary conditions, ensemble filters, and coupling of high-resolution limited-area and global synoptic-scale data assimilation systems.
Little is known about the actual need for a specific initialization, in the sense of an extra filtering of analysis fields, before launching a high resolution forecast. New diagnostic tools to evaluate the

level of "noise" in analyzed fields have to be developed, while addressing the problem of the actual physical balance conditions present at very high resolution in the atmosphere.

c) Four-dimensional analysis and related issues

4D-Var techniques have been very successful and are widely used operationally for global data assimilation and also, recently, for operational data assimilation in a model at 10 km resolution, at the Japanese Meteorological Agency. Theoretical arguments are in favour of 4D-Var also on the mesoscale, knowing for example the importance of the time dimension and of moist processes, i.e. of physics. Many of the processes on the mesoscale are strongly non-linear, however, and this may be critical for 4D-Var, which makes heavy use of tangent-linear approximations. Multi-incremental methods (with re-linearizations) may help to circumvent this inherent problem.

A major issue is to settle a numerically efficient dynamical core: tangent-linear and adjoint formulations of the semi-Lagrangian time-stepping need to be developed (done already by the HIRLAM community). In fact, 4D-Var is and will stay expensive, as concerns computing cost and development work. A second important issue is to assess the minimum level of required simplified regular physics. It is likely that at least a boundary-layer description and micro-physics are needed.

Any 4D-Var system operating at 10 km or below is worth testing in research mode. These tests should also include derived applications such as gradient computations, sensitivity studies using the adjoint model, and a-posteriori retuning. Comparisons with three-dimensional assimilation schemes are certainly relevant in the early stages.

d) "Surface analysis"

Two rather independent issues are to be considered here. Firstly, the initialization of the prognostic variables describing soil and surface (temperature and humidity).The present trend towards an off-line variational assimilation (since the associated time-scales are longer than for atmospheric process) will be maintained, trying to simultaneously go to more sophisticated algorithms, use new observation types (remote-sensing data), and keep the overall computing cost within safe limits. Secondly there will be an increasing interest for diagnostic analyses, using observations of any type close to the surface, in order to provide a fine description of the boundary layer. This will help forecasters in nowcasting, and may provide forcing to off-line models. As a first step, very basic evaluations will be required, such as the comparison of several pragmatical approaches, based on existing techniques.

4. Evaluation of the reliability of forecasts

This domain is of major importance, since the overall objective is the supply of improved local weather forecasts to any end-user. However, here one has also to consider the present, coarser, operational resolution, since the first following issues are at their first stage of development.

a) Short-range predictability: the use of ensemble forecasting and other techniques

Predictability is the net result of several distinct sources of uncertainty: (i) the use of imperfect models; (ii) the use of observations that imperfectly sample the past and present state of the system, both properties that, to some extent, can be controlled, and (iii) a fundamental intrinsic property of the atmosphere itself, which, very much like other state parameters, can at best be measured but cannot be changed.

One popular way of figuring out predictability is ensemble forecasting. Other ways consist of coupling observations to the data assimilation system (adaptive observation) or to assimilate observations depending of predictability-related properties (adaptive assimilation).

The following issues should be addressed: (i) initialization of an ensemble forecast relevant to mesoscale, short-range prediction; the techniques should become able to take into account uncertainties in the humidity fields, surface conditions (soil wetness); (ii) the direct extension of forecast error representation as done in synoptic scale ensembles to convective processes is non trivial; (iii) assess the respective importance of the initial errors and those resulting from the diversity of coupling scenarios; (iv) the validation of an ensemble forecast tool, especially on the mesoscale, depends on the statistical of the ensemble with respect to some climatological reference; the usual approaches suffer from two major drawbacks related to the small number of validation cases and the kind of climatological reference; ways to improve on these methods using event-based approaches should be studied (v) the interpretation and use of an ensemble forecast is an open question; while probabilistic forecasts are directly usable in cost-loss models with explicit weather parameters and their uncertainty, their application to natural disaster management remains a challenge; (vi) since there are theoretical arguments on the inability of the current ensemble strategy (which is a kind of "clever under-sampling") to deal with extreme events, research on alternative approaches such as adaptive assimilation or observation should be extended to the mesoscale.

b) Verification of model forecasts

An obvious way to control the skill of NWP models is to compare the observations of a meteorological network with the respective model values, using more or less advanced interpolation methods. However, this method has already reached its limits at the present operational scales, especially when forecasts of precipitation and cloudiness are to be evaluated. The presently used sample of observations is quite coarse, and smooth models are favoured: typically a good forecast of the intensity of a storm with a time-shift of a few hours is penalized against the prediction of a far weaker event at the right time. The use of ensemble prediction systems cannot prevent from addressing the development of new methods for the verification of deterministic forecasts (and also for probabilistic ones). In particular, there is a need for a method that values phase errors properly; such a method will probably be using modern pattern-recognition techniques. This involves common research work with data assimilation issues, for the comparison to new observations.

c) Coupling with other environmental applications

A meaningful evaluation of the quality of meteorological forecasts has to consider their impact on downstream applications. The output of NWP models is a major source of information when running air-pollution, hydrological, oceanographic or sea-state models. A closer cooperation with the corresponding research teams will help in the qualification of the forecast skill of NWP models as well as in the evaluation of the relevance of new developments.

d) Validation

This is the upstream counterpart of verification, many developments will be common ones. Modellers will have to define new diagnostic tools, better suited to very high resolution, and to face ensuing new problems. Besides, intensive numerical experimentation, combining forecast and assimilation, will be required.

5. Complementary aspects

Today NWP is much more than a model code: it is an ensemble of programmes with many and deep interactions between them, possibly running on several platforms. Moreover, with the substantial increases in horizontal and vertical resolution that we experience, the amount of data we have to deal with becomes a problem in itself.

Therefore, NWP centres are facing some challenging issues which need a joint effort :

* code organisation, normalization, optimization and portability, which would ensure efficiency and a significant lifetime of NWP codes;
* large scale data-handling, including fast data-bases accesses, format standardisation and data sharing between the NWP community;
* building and extension of frameworks to enable user-friendly applications of NWP system for

research and operations: the research method would be to investigate, further develop, and implement new techniques, e.g. derived from GRID technology, and/or PRISM specifications;
The problem of code organisation and data handling is found in many disciplines and activity types. Research on this subject therefore has a very strong interdisciplinary content and intersectorial dimension. It requires the development and implementation of methods from ICT, based on a thorough understanding of specific meteorological requirements.

TRAINING PROGRAM

1. Needs

In Europe, the conditions of recruitment of young researchers in numerical weather prediction (NWP) teams vary significantly from one national (hydro)meteorological service (NMS) to another, and even from person to person. New researchers may come from other departments of the NMS (including associated schools for a few institutes), or be recruited at Universities, not necessarily from a faculty teaching meteorology. Several European NWP experts had an initial training in mathematics or theoretical physics for instance. Furthermore the level of recruitment is not uniform, with or without a PhD degree (mostly without), with or without a diploma allowing to start a PhD degree.
Apart from an eventual general training in meteorology, additional training for newcomers is usually required, on the specific basics of NWP, their mathematical background, and also usually informatics. NWP teams are responsible not only for research but also for its efficient application to daily weather forecasts. In most NMS, the same persons are simultaneously in charge of education, development and operational duties, including part of the maintenance of the computing system, the design of products for end-users, administration, etc. This requires knowledge in a wide range of domains.
Up to now, new researchers were trained locally or via initiatives internal to each consortium, such as: annual training courses on Local Model (LM) for the COSMO group; stays abroad, training courses on various topics, and the past ALATNET research training network (contract n° HPRN-CT-1999-00057 of the 5th FP, http://www.cnrm.meteo.fr/alatnet/) for the ALADIN group. The success of the above-mentioned initiatives (on average 70/20/55 students from 5/10/15 countries attending the respective training courses) clearly confirm a steady need for training. Coordinated training initiatives were not the rule for the HIRLAM group, but during the latest years some partial steps were taken e.g. within the framework of Baltic HIRLAM (http://hirlam.fmi.fi/Baltic), which also involved partners from Russia, Estonia and Lithuania.
The increased effort which is now required from the different teams, to quickly jump to operational applications at very high resolution, reinforces the need for a transfer of knowledge in every domain, and necessarily between countries because of the spread of expertise over all Europe.
There are sometimes external opportunities, such as seminars arranged by international organisations (e.g. NATO, ECMWF), but attendance is not so easy. As was the case in the past, one cannot rely only on such events.

2. Experience

By joining their efforts, European NWP scientists managed to build world-class NWP limited-area models, though experts were spread among many small teams. Most of them have also a significant experience in teaching and supervising the work of students or early stage researchers, in their institute or at University, even if only few of these scientists have the corresponding official titles. Cooperation between NMS and Universities often includes also a common research work.

Experience from the last 10 years shows that joint training initiatives of NWP teams can succeed at a small scale, and that stays of PhD students abroad with a shared supervision do foster exchanges of ideas between teams and allow to start durable cooperations. Most of the teams which either are members of the COSMO group or were involved in ALATNET, whatever their group, as full partners or since they sent young researchers, were willing to join STORMNET, so as to continue and enlarge such fruitful cooperations. Independently 9 European teams, representing 18 institutes and universities, recently joined the Nordic Network on Fine-scale Atmospheric Modelling (NetFAM, http://hirlam.fmi.fi/NetFAM), funded during 2005-2007 by NordForsk. Close cooperation between the two networks is anticipated, all the more since 4 STORMNET partners (NWS of Finland, Norway, Sweden, France) also belong to NetFAM.

3. Training steps

The STORMNET training program considers the following 4 levels of training :

a) Local training

Local training of early stage researchers (ESR) is organized by their respective host teams.
This includes the familiarization of the ESR with the local working environment, the minimum additional training to allow them starting his research project (depending on background), attendance to internal seminars, and external education, typically in foreign languages.
The attendance at international training courses dedicated to the use of the model(s) running operationally in the host team is included in local training.

b) Training by research work

Research training is organized by the host team under the supervision of the network.
The length of most stays proposed to ESR will be between 2 and 3 years, in order to allow them to effectively defend a PhD thesis. Even if this may not be mandatory for all of them, this shall help them in their further career. Based on the experience of past exchanges, 2 types of employment will be proposed, on a case by case basis to better take into account the student's constraints.
The first one ("full-time") is a quite standard one, where the ESR accomplishes one stay in the host team, roughly 30-36 months long. This is rather simple to manage, and allows to concentrate freely on a research topic.
The second one ("shared-time", not part-time !) has also proven fruitful in the past. The ESR shares research time between home and the host team, typically 6 months long stays in each country. Only stays abroad are supported by the network of course. Work home may be supported by NMS or University grants. This is sometimes better suited to familial and professional constraints. Work is less continuous, but benefits from more intense exchanges of ideas. This may, or not, be combined with "co-tutelle" PhD, for which there is a shared supervision of the research work and the final diploma is delivered by Universities in the home and host countries. The total length of grants would be 18-24 months in such a case.
32 such ESR positions have been identified, with a smooth distribution among the 16 teams : most often 2 per team, 1 for the smallest or less experienced ones, more in the big ones. Three calls should be issued, the first one as soon as possible once the project is accepted, the other ones so as to allow smoothing of the effort all along the 4 years, and overlapping but not too much between stays. Here one has to find a compromise between the need of ESR to share experience and everyday work with other students, and the constraints of the (often small) host teams.
Besides, a few short, 3 months long, grants will be proposed to ESR who cannot go abroad for a long period, allowing transfers of knowledge on a more ad-hoc basis, through work with an expert on a specific research topic.

c) Training for research and operations

This is achieved through international training courses organized by the network.
Such training courses will be organized once or twice per year and be typically 1-2 weeks long. They are expected to provide further knowledge on the main scientific or technical domains of interest for NWP. The following topics (historical, emerging or "side" ones) were considered as quite useful: dynamics (mainly non-hydrostatic dynamics), physics (description of moist and subgrid-scale processes), coupling (between models of different spatial resolutions, between NWP and external models, ...), data assimilation (methods, use of observations), numerical techniques (for dynamical adaptation and data assimilation), predictability, data and source code management (portability and optimization issues), downstream applications (e.g. hydrology, pollution, wave-models).
Besides, a few shorter seminars will focus on particular problems of short-range high-resolution NWP, such as modelling over complex orography or very cold regions, and verification/validation methods.
All employed ESR of the network are expected to attend these training courses and seminars, as students, or, where appropriate, as teachers. Besides intensive training, this will give them an opportunity to meet each other and exchange ideas.
All STORMNET partners are expected to send teachers, according to their expertise. Special care will be given to the partition of teachers among the consortia, so that each "school of thought" may be represented and the students are given an objective overview of the present status of research. External experts will also be invited, either from other NWP groups (e.g. working on global models) or from other research domains (e.g. oceanography, hydrology, air pollution).
The training courses will be open widely: to researchers from the involved teams or other weather services, to students working in close domains. Hence the organisation costs will receive care, since this aspect is often the limiting factor for participation.

d) Training within the research world

ESR will be given the opportunity to attend general or specialized NWP workshops organized at the European level, in the framework of the SRNWP network or consortia, at least once per year of employment. There, they will meet members from all European NWP teams, learn about the latest developments and problems, and present their own results (in a quite friendly atmosphere).
Attendance to more international workshops may also be possible, on a case by case basis because of the inherent stronger constraints.
The other side of communication, documentation, will also be considered. ESR will be asked to report on their research work every 6 months, in a dedicated newsletter, or, in case of short grants, at the end of their stay. This is an efficient training for the redaction of a PhD thesis, and for further similar tasks, whatever the chosen career afterwards. Publications in international reviews will also be strongly encouraged.

3. STORMNET as a means to overcome frontiers

Apart from fulfilling a real need for training and transfer of knowledge between teams, STORMNET is strongly expected to help pulling down some historical walls in and around the NWP world. First, sending ESR, with a priori no very strict opinion on most scientific issues, on each side, second, gathering teachers with different backgrounds in common training actions, should ease the establishment of stronger and durable exchanges of ideas and data. The main relationships considered here concern the "academic world", i.e. Universities and pure research institutes, joint departments or external services responsible for environmental applications, computer departments, and, over all, other consortia, i.e. other NWP models and "schools of thought". Hence the following aspects deserve special attention.

<u>a) A wider range of scientific domains</u>

As described above, the training courses will enlarge the usual domain of training for NWP, which used to cover only: dynamics and some numerics, physical parameterizations and data assimilation. Even if to a less extent, the first research topics for ESR proposed independently by the different teams show a similar evolution. About half of them concern rather new research domains, such as short-range predictability or the verification of forecasts at high resolution, technical aspects, "horizontal" studies (covering all subjects), and interactions with hydrology or pollution.
Besides, special attention will be paid to advertising on the open positions at each call, so as to draw ESR with different backgrounds, i.e. with initial training not only in meteorology, but also in other earth and atmosphere sciences, or in mathematics, informatics, ...

<u>b) The expression of more opinions and a stronger implication of the academic world</u>

The 16 STORMNET partners come from the 4 consortia : 8 from ALADIN (out of 15), 2 from COSMO (out of 5), 5 from HIRLAM (out of 8) and the British team, which achieves a nice balance between the existing models.
Five research and education institutes will cooperate to the training effort (shared supervision of ESR and lectures) as associated partners, going a step beyond their bilateral cooperation with a weather service. These are the University of Zagreb (Andrija Mohorovicic Geophysical Institute, Faculty of Science) in Croatia, the National Scientific Research Centre (Laboratoire d' Aérologie, Observatoire Midi-Pyrénées) in France, the University College Dublin in Ireland, the Comenius University (Faculty of Mathematics, Physics and Informatics, Department of Astronomy, Geophysics and Meteorology) in Slovakia, and the Swiss Federal Institute of Technology Zurich (Institute of Geodesy and Photogrammetry) in Switzerland.
Besides, specialists from every "school of thought", i.e. from each consortium, from both applied and pure research, will be invited as teachers for each STORMNET training course or seminar. External experts, from other countries or in other domains, will also be invited whenever suitable.
To end with, the parity between women and men is not fully obtained in the STORMNET coordination group, with 7 women out of 16 scientists. However this aspect was not mentioned in the call for candidacies, so that the present ratio sounds encouraging for the future. Due attention will be given to this issue when appointing ESR.

<u>c) An adequate coordination of training actions</u>

Besides the reference "vertical" coordination, with one scientist in charge per partner (or per country), an "horizontal" one will be organized, with :
- one scientist in charge responsible for training in each domain: supervising the content of corresponding training courses and controlling the progress of the research work of ESR on related issues; she/he will be chosen according to her/his scientific background;
- one scientist in charge of relationships with each NWP consortium, responsible for its participation to training initiatives, and chosen among the scientists of the corresponding group.
Plurality of responsibilities will be avoided, unless there is a clear lack of volunteers for some coordination tasks.

<u>d) Main differences with past initiatives</u>

The size of the network is far bigger: 16 partners and 4 associated ones, instead of 5 for ALATNET (RTN funded by the 5th FP) and not more than 6 countries sending students to COSMO training courses;
Training courses cover a quite wider range of topics, including technical or "side" ones.
Training (and research) no longer focus on one specific tool (e.g. ALADIN or LM in the examples above), but considers all the European limited-area models equally.
Pure research and education institutes play a more active part.

ENDPAGE

HUMAN RESOURCES AND MOBILITY (HRM) ACTIVITY

MARIE CURIE ACTIONS
Research Training Networks (RTNs)

"Interdisciplinary and Intersectorial"

Call: FP6-2004-Mobility-1

PART B

STAGE 1 – OUTLINE PROPOSAL

STORMNET