SRNWP Expert Team on Predictability and EPS
Proposed Workplan until end 2009

21th April 2008

Composition of Expert Team
For the two-year period the following members of the Expert Team are:

Consortium	Core Member	Additional Member
ALADIN	*Alex Deckmyn*	*Laurent Descamps, Alain Joly*
COSMO	*Chiara Marsigli (Co-Chair)*	*Pierre Eckert*
HIRLAM	***Trond Iversen (Chair)***	*Jan Barkmeijer*
MetOffice	*Ken Mylne*	
RC LACE	*Yong Wang*	*Edit Hagel*

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Introduction
Research and operational development in short-range predictability and probabilistic forecasting is still young compared to activities in medium-range forecasting. There is now a swiftly growing level of activity in Europe, both at level of the consortia and in several individual countries. This is very welcome. The multitude of developments nevertheless produces risks of duplication of efforts. This could and should be avoided by scientific communication and operational co-ordination, including real-time exchange of products as far as technically possible. Since the production of ensembles of numerical weather prediction is too computationally expensive for many countries, operational co-ordination and real-time sharing of products is particularly important for probabilistic forecasting.

On the EUMETNET (SRNWP) -level the "Poor-man's EPS" (PEPS) is the first attempt at this. PEPS combines existing short-range NWP products in real time, but otherwise does not involve any specific developments for a systematic design. In March 2007 EurEPS was proposed as a pan-European activity to the EUMETNET Council – see Annex. The proposal received moral support, but it was decided to postpone its initiation and financial support until after the parallel proposal of Interoperability has become active. Two major elements in EurEPS were (1) establishing a pan-European short-range EPS, and (2) investigating the benefits and drawbacks of such a pan-European system with a number of systems in smaller and non-overlapping domains using higher resolution. Financing a dedicated person to be hired at ECMWF for developing and maintaining a data and product centre for the activity was proposed.

List of topics
The following scientific and operational/technical topics should be addressed by the expert team until end 2009:

1. Give an overview of planned and existing activities in the consortia, with identification of overlapping activities, and recommend sharing of tasks between the consortia (October 2008 - EWGLAM);
2. Identify potential challenges related to computer power and real-time exchange of data across European countries (October 2008 - EWGLAM);
3. Monitor the development and exploitation of PEPS (ongoing);

4. Identify elements in the Interoperability Programme which facilitate operational EPS cooperation, e.g. in view of the future EurEPS Programme (see Annex) (October 2008 - EWGLAM);
5. Identify requirements for an upcoming Verification Programme for an operational EPS cooperation, e.g. in view of the future EurEPS Programme (see Annex) (October 2008 - EWGLAM);
6. Give overview of existing and (if needed) propose new techniques for initial state perturbations suitable for short-range EPS (end 2008), including techniques for clustering of global or larger-scale EPS used as input;
7. Give overview of existing and (if needed) propose new techniques for open lateral BC perturbation for European short-range EPS (end 2008), including techniques for clustering of global or larger-scale EPS used as input;
8. Collect experience from model physics perturbations and lower boundary data and propose alternatives to be investigated (April 2009);
9. Give overview of existing or planned techniques for calibration of multi-model EPS (spread-skill relation, 1st and 2nd moment bias removal, Bayesian model averaging (BMA), Bayesian processor of forecast (BPF), etc.) (October 2009);
10. Overview of probabilistic production, verification and validation in short-range forecasting in Europe (October 2009);
11. Identify and synthesize tasks for investigating optimal design of short-range EPS in Europe, taking into account the following aspects:
    - Size of integration domain
    - Horizontal and vertical resolution
    - The number of ensemble members
    - The frequency of new EPS forecasts
    - The forecast range

    This is a natural follow up for a new EurEPS proposal.
12. Establish and maintain a link with the TIGGE-LAM Panel, which could act both ways: the ETEPS should coordinate the European cooperation on LAM-EPS to fulfil TIGGE-LAM requirements and should promote the European needs on the subject within the TIGGE-LAM Panel.

Task-sharing between the 5 Consortia

Within the list of topics above there are several tasks which require considerable work. The Expert Team will aim at recommending to share such tasks between the consortia, in order to avoid unnecessary duplication and to secure a wide diversity of methods within the SRNWP EPS. Thus, different approaches to ensemble perturbations - including surface and model physics – should be coordinated so that each consortium develop and test different ideas with a sharing of results. Furthermore, as a test-bed for addressing topic 11 in particular, an inter-comparison of existing short-range ensemble systems amongst the consortia could be made through standard object verification.

Proposal for workshop(s) to be organised.

Short range EPS will have sessions during EWGLAM/SRNWP general assemblies. A dedicated workshop in the continuation of the Italian series from the former SRNWP is tentatively proposed in June 2009. The last workshop was in Rome in December 2007, and the one before that was in Bologna

in April 2005. The venue if the June 2009 workshop could either be in Exeter, UK or in Oslo, Norway. The decision will be reported to the SRNWP Programme Manager.

Any additional idea to improve the communication, coordination and efficiency.
The Expert Team will aim at following up the annexed EurEPS proposal as soon as the Programme Manager of SRNWP finds it appropriate.

Proposal for thematic session for the annual EWGLAM/SRNWP meeting.
In the meeting in Spain in October 2008, the Expert Team aims at having a session on short-range probabilistic forecasting. All consortia and individual countries with operational experience will be invited. The status of topics 1 through 5 will be reported.

ANNEX

A proposal for a EUMETNET / SRNWP Project for The Realization of an Operational LAM-EPS in Europe - EurEPS

Submitted to EUMETNET by the Norwegian Meteorological Institute, Norway - 28/02/2007

Short Summary

The Overall Aim *of EurEPS is to understand and quantify the benefits of the combination of a multi-centre ensemble of ensemble systems (grand ensemble), and to investigate the practical and technological feasibilities for real-time combination of several decentralized ensemble forecast systems, for the purpose of guiding real-time operational short-range probabilistic weather forecasting over Europe.*

The purpose of EurEPS is, over a two-year perspective, to find qualified answers to issues which are fundamental for taking decisions for operational short-range probabilistic forecasting in Europe. It is believed that a probabilistic NWP based on ***a grand ensemble: a "multi-centre" ensemble of ensembles,*** is well suited for utilizing the unevenly distributed computer resources amongst the NMSs, and that a grand ensemble should provide access to more skilful and more frequent ensemble forecasts to participants than single countries could produce on their own. EurEPS aims at investigating these presumptions by *inter alia*:

- gaining pre-operational experience with a pan-European distributed prototype grand LAM-EPS based on existing plans in the consortia;
- quantifying benefits for operational probabilistic forecasting of a grand pan-European ensemble system compared to benefits of sub-European ensemble systems that NMS can afford to run individually.

Deliverables Strongly based on existing developments in consortia and NMSs, EurEPS should deliver:

1. A document defining a set of verification methods, weather parameters and thresholds to be verified, and a set of cases or periods for verification to allow the objectives to be answered.
2. A database of a range of ensemble forecasts and observations, some of which to be combined to a grand ensemble. Population of this database is likely to be completed after the project.
3. A report on the benefits of a grand LAM-EPS for the prediction of high-impact weather events, as opposed to benefits of running simpler distributed systems at single NMSs.
4. Definition of a European contribution to TIGGE-LAM.

Deliverables 2 and 3 are based on products in consortia and NMSs; EurEPS will not develop its own new LAM-EPS. Deliverables 3 and 4 depend strongly on participation by a number of NMSs with resources to run ensembles, but does not require contributions by all Europan NMSs.

A EurEPS data centre needs to be established in order to collect the model data produced decentralized, the observations needed for verification, and to develop systems for calibration, verification and presentation. It is proposed that the bulk part of the EUMETNET funding to EurEPS should be used to support ***a contract with ECMWF to develop the facilities for a EUMETNET centre for EurEPS***. ECMWF already has a strong capability in ensemble forecasting and dissemination of data in real time, so this will make efficient use of resources.

Budget Summary (per year):

Full time consultant at the data centre (ECMWF) (subject to inflation):	eur 128'000
Salary of the Project Manager, 25% of the working time (0.25 x 90'000 eur):	eur 22'500
Travel costs (estimate to be adjusted according to level of participation):	eur 12'500
Total per year:	**eur 163'000**

The sum "Total per year" (estimated to EUR 163'000) will be the figure on each contract signed between the Responsible Member and a Participating Member. A table, annexed to the contract, will show the amount for each Participating Member.

A proposal for a EUMETNET / SRNWP Project for The Realization of an Operational LAM-EPS in Europe - EurEPS

by

Trond Iversen (Norway – HIRLAM); Leader of Redaction Team
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Yong Wang (Austria – LACE)

Submitted to EUMETNET by the Norwegian Meteorological Institute, Norway.

Overall Aim

To understand and quantify the benefits of the combination of a multi-centre ensemble of ensemble systems (grand ensemble), and to investigate the practical and technological feasibilities for real-time combination of several decentralized ensemble forecast systems, for the purpose of guiding real-time operational short-range probabilistic weather forecasting over Europe.

Formal background for the proposal

A possible long-term vision for the future of forecasting in Europe was set out in a paper presented to the 24th EUMETNET Council in April 2005 by the UK Met Office. One of the main elements of this proposal was the exchange of LAM-EPS products between the various National Meteorological Services (NMSs) and Consortia to create an *operational grand "multi-centre" ensemble for probabilistic prediction of high-impact weather events*, for the benefit of all European nations. The `NWP Scoping Meeting´ in November 2005 elaborated the vision further: "*The European Meteorological Infrastructure* will evolve and strengthen its skills and capabilities to enable the meteorological services within Europe to provide the best meteorologically related environmental forecast possible"* [*The European Meteorological Infrastructure (EMI) is comprised of EUMETNET, the individual EUMETNET Members, ECMWF, ECOMET and EUMETSAT.]

As a follow-up, the `NWP Vision Meeting´ in March 2006 recommended to increase or initiate collaboration on 6 different themes in Europe. One of the themes was: *"European interactive multi-model LAM"*, which included the following two concrete proposals:

- Evaluate the potential for multi-model ensembles to give the best predictions for Europe
- Engage in THORPEX discussions on the specification of TIGGE-LAM, to ensure that European requirements are being met.

The EUMETNET Council forwarded the proposals from the NWP Vision Meeting at its 27th Meeting in April 2006 for evaluation within the context of the SRNWP programme. At the annual SRNWP meeting in October 2006 it was decided to seek strengthening of SRNWP activities by the definition of selected specific EUMETNET projects, aimed at achieving the proposals of the vision meeting, and to be carried out under the umbrella of SRNWP. One of the themes selected was the creation of a grand European LAM ensemble.

The project: "***The realization of an operational European LAM-EPS***" – abbreviated to ***EurEPS*** – is hereby applied for. It follows up the two recommendations in the bullets above, and in particular aspires to be a strong European contribution to TIGGE-LAM.

The purpose of EurEPS

Provided that the technology for real-time data communication between EurEPS participants enables such a solution, probabilistic NWP based on ***a grand ensemble: a "multi-centre" ensemble of ensembles***, is thought to be well suited for utilizing the computer resources distributed amongst the NMSs. Such a grand ensemble would potentially give all countries access to more skilful and frequent ensembles than single countries could anticipate running on their own. Before taking decisions for an operational pan-European grand ensemble system, both the implied operational challenges and the benefits for operational probabilistic forecasting need to be investigated.

The purpose of EurEPS, in a two-year perspective, is to establish potentials and identify practical obstacles for a pan-European grand short-range ensemble system, compared to the alterative of using several sub-European and less populated ensemble systems which single NMSs could run on their own. This includes obtaining practical pre-operational experience with a pan-European distributed prototype grand LAM-EPS based on existing plans for grand ensemble systems in the consortia. A successful EurEPS depends strongly on participation by a number of NMSs with resources to run ensembles, but does not require contributions by all Europan NMSs.

The need for short-range probabilistic NWP

Accurate weather prediction is limited by unstable atmospheric dynamics which cause unavoidable approximation errors to grow over hours and days until they saturate at a maximum range for predictions. For free turbulent flows, the prediction range decreases with decreasing spatial scales. Since high-impact weather frequently - but not always - is connected with smaller-scale phenomena (jet streaks, shallow vortices, sharp fronts, squall lines, convective systems), their prediction is particularly challenging. On the other hand, flow phenomena forced by ground surface contrasts and topography (lee vortices, breaking mountain waves, hydraulic shocks, sea-breeze fronts, coastal jets) can be predicted beyond the range for free flows, provided that the ground surface properties are adequately represented in the NWP models. These two scientifically established properties of atmospheric predictability both emphasize the need for a probabilistic approach and leave considerable optimism with respect to skill for high resolution NWP in the short range.

A deterministic forecast of a high-impact event can be correct in situations with high predictability, or simply by luck. Statistically over many cases, the luck factors are cancelled and only the highly predictable cases contribute to forecast quality. Qualified information about the possible occurrence of less predictable events is thus lost in a deterministic system, whereas with a well calibrated EPS they can be forecast in terms of probability. Instead of simply excusing that deterministic forecasts fail to forecast some events due to the chaotic nature of the weather, the probabilistic approach takes this into account by estimating probabilities of such events. Such excuses are indeed very poor if, due to a badly designed NWP system, life and property are lost in unforeseen events, or large resources are wasted in protective actions due to false alarms.

The potentials for alternative short-range LAM-EPS in Europe

Visions and recommendations from meetings between EUMETNET members and co-operators document that the potential for probabilistic forecasting is widely realized by NMSs in Europe. Considerable operational, quasi-operational, and scientific competence for short range NWP has also

been established in recent years. Much of the research and development of methods for constructing cost-effective ensembles accounting for actual uncertainties is done for medium-range NWP. Until recent years, uncertainties pertaining to model approximations and prescribed boundary forcing have received less attention than uncertain initial data. A quite straightforward way to take into account the uncertainty within the model formulation is to use a multi-model / multi-centre approach in which the model diversity is assumed to reflect the degree of uncertain representation of physical processes in models. Supported by research evidence (although limited), the combination of different EPS outputs to form multi-centre ensembles can lead to improved probability forecasts. Similar methods are already being employed for seasonal forecasting in the EUROSIP system, following the successful results of the DEMETER project, and are being tested for medium-range forecasting in the THORPEX TIGGE programme.

The distributed multi-centre approach permits to partly increase the population of the ensemble and the diversity of its members by comprehensively accounting for error sources, and to partly reduce each centre's computational effort and the time required to produce a probabilistic forecast. The intention with a multi-centre solution is to enable increased benefits for similar total cost, since resources are used to produce complementary information rather than data duplication.

To fully realize the benefits of a distributed system, the integration domain must be common and sufficiently large to cover the interests of every participant. Furthermore, the effective use of grand LAM-EPS for operational short-range prediction requires frequent and swift real-time exchange of large data amounts across Europe. These add costs and cause delay of real-time products compared to non-distributed systems.

This proposed EurEPS project sets forth to compare the benefits of a European grand ensemble with a few planned or existing single-centre LAM-EPSs using fewer ensemble members on geographically smaller domains. Experiments will start by using a common platform with shared computer resources at ECMWF. The goal for the two year period starting from January 2008 is to gain solid experience with a distributed system run close to real-time. Rational decisions for a fully operational implementation in real time can only be taken after this careful study.

Existing and planned LAM-EPS in Europe for short range NWP exist in several NMSs, or consortia of NMSs, in Europe. Some of these are operational or near operational, while others are predominantly under research and development.

Within ***HIRLAM, ALADIN and LACE***, a distributed multi-centre operational system is planned under the name of GLAMEPS. A laboratory phase is presently being developed as a grand ensemble in a pan-European domain based on existing national operational systems (Norway (TEPS and NORLAMEPS) and Spain (SREPS)) and considerable competence in several countries (e.g. the Netherlands, Austria, Hungary, Croatia, France, Sweden, Denmark, and more). Grid resolution aimed for is ca. 10 km. The number of ensemble members is a trade-off with other demands such as forecast frequency,

In ***COSMO*** a high-resolution downscaling of the medium range ECMWF EPS (COSMO-LEPS) has been run operationally for many years, and a new multi-boundary model-perturbed system for the short-range is being developed (COSMO-SREPS), with a 10km spatial resolution and 16 ensemble members.

At the ***UK Met Office*** an advanced quasi-operational short-range system MOGREPS provides a 24-member ensemble using a regional version of the Unified Model covering the N. Atlantic and Europe

at 24km resolution. MOGREPS uses Ensemble Transform Kalman Filter (ETKF) perturbations and employs stochastic perturbations to model physics to account for model error, is scheduled to become fully operational during 2007.

The "Poor man's" EPS (PEPS) produced operationally on behalf of the SRNWP Programme by DWD, is not a part of EurEPS as it is not an "ensemble of ensembles" and has a non homogeneous domain overlap.

GLAMEPS, which is already a grand ensemble, COSMO-SREPS, and MOGREPS can be devised as a fully common grand ensemble system in EurEPS, even if only a minority of NMSs contibute.

Project Objectives

The overall aim can not be reached within a 2-year EUMETNET Project alone. The proposed project therefore relies heavily on already existing and planned activities in European NMS and NMS-Consortia. It is designed to add considerable value to these existing activities through a co-ordinated approach. EurEPS sets forth to put in place a system capable of achieving the overall aim in a scientifically sound way. To reach the overall aim, the necessary objectives for EurEPS are:

- To co-ordinate LAM-EPS issues to avoid duplication of efforts by EurEPS participants.
- To develop a prototype setup for a multi-centre European grand LAM-EPS based on existing developments in the consortia.
- To establish the practical feasibility of and identify obstacles to real-time collection of all necessary LAM-EPS data for combination into grand LAM-EPS forecasts to be disseminated to all EurEPS participants.
- To collect probabilistic forecast results from single-centre LAM-EPS run by individual NMSs
- To demonstrate the skill and value of the grand LAM-EPS for probabilistic prediction of high-impact events, compared to the single-centre LAM-EPS which are possible to operate by individual NMSs. This should make use of available high-resolution observations to optimize the validation for high-impact events.

Interdependencies with other proposed EUMETNET/SRNWP projects

Two other themes were selected by SRNWP for which proposals as EUMETNET projects are being defined in parallel to EurEPS: one on Verification and one on Interoperability of NWP systems. Both have potentially strong synergies with the current project, giving the opportunity for a well co-ordinated SRNWP programme. In particular:

- ***Interoperability***: in order to set up an effective exchange of LAM-EPS forecast data, and allow product development from multi-centre ensembles, it is necessary to use common formats and grids for the data storage, and to develop and share effective and efficient software for conversion between data formats, grid systems, etc. used in different centres. This is similar to the work required for interoperability to allow LAMs to be run from different sources of lateral boundary conditions, to allow products to be generated from the outputs of different LAMs, and to verify different LAMs in the same way. The ambition to contribute to TIGGE also puts restrictions on formats. Collaboration with the Interoperability project is therefore crucial.

- ***Verification:*** this project involves setting up a system for verification of weather forecasts with European LAM systems. Verification of probabilistic forecasts should be included in this project. The project will also collect the maximum amount of high-resolution observational data available. This will be very useful for the verification of high impact weather events, such as forecasted probabilistically by any EPS. It is therefore proposed that the EurEPS project collaborates with the Verification project to make such data available in common formats (providing a further link with the project on Interoperability) and make use of them in objective verification.

Deliverables

Strongly based on the existing developments in consortia and NMSs, EurEPS should deliver:

1. A document defining a set of verification methods, weather parameters and thresholds to be verified and a set of cases or periods for verification to allow the objectives to be answered. This document will also need to define a number of enabling capabilities and address issues such as:
   a. common data formats,
   b. common output grids,
   c. available observation types;
   d. definition of events, absolute or relative to climatology;
   e. definition of climatology;
   f. testing significance of results;
   g. use of statistical post-processing (including bias correction and ensemble spread bias correction) prior to verification and combination;
   h. methods for optimal combination of ensembles to assess the quality of the multi-centre grand LAM-EPS.
2. A database of a range of ensemble forecasts and observations, some of which to be combined to a grand ensemble. Population of this database is likely to be completed after the project.
3. A report on the benefits of a grand LAM-EPS for the prediction of high-impact weather events, as opposed to benefits of running simpler distributed systems at single NMSs. The success will depend strongly on participation by a minimum number of NMSs with resources to run ensembles.
4. Definition of a European contribution to TIGGE-LAM.

The risks associated with deliverables 1, 2, and 4 are low to moderate, whilst the risk of failure for deliverable 3 is high within the defined project timescale since extensive experimentation is necessary with various models and model versions using different formats and grids. Nevertheless, the completion of the deliverables 1 and 2 would put systems in place capable of completing no. 3 after the end of the initial project.

EurEPS relies fundamentally on contributions from NMSs who are able to provide results from their own single EPS production runs. The LAM-EPS planned in EurEPS basically combines these existing systems after adjustments. Deliverables 2 and 3 are thus based on production in consortia and NMSs, i.e. EurEPS will not develop a new LAM-EPS. A EurEPS-financed person will create software for storing and combining EPS output, will apply a product presentation package, and will apply a probabilistic verification package. Analysis and discussion of results will include all contributors.

Tasks

In order to deliver the above it will be required to undertake the following tasks:

Task 1. Create a Project Leader Team (PLT) with one representative from each LAM-EPS consortium. The leader of the PLT should be the Project Manager coming from the Responsible Member.

Task 2. Define and establish:

- Common data formats and grids for data exchange following TIGGE recommendations;
- Verification domains;
- Set of test periods for verification;
- Verification methodology;
- Reference climatology;
- Key parameters and thresholds, defined in absolute values or relative to climatology;
- Set of observations suitable for verifying the chosen forecasts;
- Bias correction and post-processing policy;
- Ensemble combination methodologies;
- Requirements for fast real-time data-exchange of data between EurEPS participants.

Task 3. Set up a probabilistic verification system using the defined standards, which is capable of verifying and diagnosing key properties of all the systems - including the combined multi-centre ensemble - in exactly the same way.

Task 4. Establish a standard package for presentation of probabilistic forecast products, which can be used by EurEPS participants to access EurEPS-generated data and products at a common data centre.

Task 5. In collaboration with NMSs and Consortia, to set up a system for collecting results from a number of distributed sub-European and pan-European LAM-EPS, including a system for the combination of the different pan-European ensemble members to construct the grand ensemble.

Task 6. In collaboration with NMSs and Consortia, to run all ensembles over agreed common test periods. Create and populate a database (for an agreed set of weather parameters and cases/periods) of:

- LAM-EPS forecasts from different centres
- High-resolution observations.

Task 7. In collaboration with NMSs and Consortia, to conduct the defined verification and report on conclusions.

Task 8. In collaboration with NMSs and Consortia, to experiment with real-time collection of LAM-EPS from EurEPS participants for the grand ensemble and dissemination of probabilistic forecasts back to the NMSs.

EurEPS Governance and leadership

EurEPS is planned as a Project under the new planned SRNWP programme under EUMETNET. A steering body for the EurEPS could be the Council itself, or a body established under SRNWP.

Responsible Member. It is recommended that the Responsible Member preferably is selected amongst EUMETNET Members who have operational experience in running LAM-EPS and participate actively in relevant activities in their Consortia.

Project Leader Team (PLT). Given the distributed and decentralized nature of EurEPS and the practical challenges of operational real-time co-operation, it is recommended that EUMETNET establishes a Project Leader Team. The PLT members should be central persons in the LAM-EPS work of each of the 5 Consortia (ALADIN, COSMO, HIRLAM, LACE, UK Met Office).

Each member of the PLT will: (1) actively participate in leading the work in EurEPS; (2) have a delegated responsibility to follow and ensure that progress and delivery from the LAM-EPS work in the Consortia they represent, are being made; (3) report immediately to the PLT-leader (i.e. the Project Manager, see below) any practical and scientific problem in the work of their Consortium which may influence the progress towards the overall aim of EurEPS.

Project Manager. The Project Manager is to be elected by the Council upon recommendation by the Responsible Member. The Project Manager will also be the leader of the PLT. It is recommended that the Project Manager has adequate scientific competence and is central in the EPS-work in one of the Consortia. The duties of the Project Manager are: (1) to lead EurEPS; (2) to ensure and report to the Responsible Member and to the SRNWP Programme Manager the progress of work in Tasks 1-8; (3) with assistance from EurEPS participants (see below) and the PLT: to address and solve scientific and practical problems in the work progress and decide on alternative solutions if needed. The Project Manager will have to devote 25% of its working time for EurEPS in addition to relevant LAM-EPS work already allocated for his/her Consortium.

EurEPS Participants. Any EUMETNET Member is eligible to be participating in EurEPS. If a NMS who are not EUMETNET Member wants to participate in EurEPS, an application should be submitted to the EUMETNET Council who will decide eligibility. It is recommended that as many as possible of the EUMETNET Members and Associates become EurEPS Participants.

Every EurEPS Participant should: (1) allocate personnel and resources for their contributions to the distributed work on LAM-EPS; (2) deliver LAM-EPS and observational data to the central data-base for further production and analysis centrally, and for further downloading and use by all Participants in real time; (3) when necessary, allocate parts of its national quota at ECMWF computers to EurEPS work.

Meetings It is planned to hold up to 5 physical meetings for the Project Leader Team during the two-year period, one approximately every 6 months, and the first in January 2008. Additional meetings will be taken *ad hoc* as Telecon. The first, and up to two more of the physical meetings will be all-staff meetings in which EurEPS participants should send at least one responsible person.

Budget and delivery

The total work included in Tasks 1-8 and behind the deliverables goes well beyond what is possible to achieve with the additional funding expected to be available from EUMETNET only. In particular, the Tasks 5, 6, 7, and 8 are impossible without considerable dedicated work by EurEPS participants. The tasks are nevertheless considered achievable because much of the implied work is already planned and underway by NMSs within the Consortia. Since EurEPS base itself on these existing activities, its success depends critically on a minimum EurEPS participation from the NMSs who work actively with short-range LAM-EPS.

Within the SRNWP Consortia in Europe, the work-load defined as common in the consortia is presently ca. 19 person-years annually for scientists and high-level technical personnel:

- HIRLAM: 4 (+ additional national activities),
- ALADIN and LACE: 3 (+ additional national activities),
- COSMO: 3 (+ additional national activities),
- UK Met Office: 9

Note that the "additional national activities" are probably considerably larger than the given numbers for the common work in the consortia. It goes beyond the ability of the redaction committee to give a full overview of the pure national activities.

The EurEPS key additional work which is required for reaching the overall aim of EurEPS, includes the activities mentioned under Tasks 1-4, plus contributions to Tasks 5-8 in close co-operation with EurEPS participants. Much of this work is consistent with the requirements of the other two proposed SRNWP projects on Interoperability and Verification, which makes the total set of tasks achievable.

A EurEPS data centre needs to be established in order to collect the EPS model data and observations for verification, develop the system for calibration, verification and presentation. This centre should make efficient use of facilities and capabilities already available to EurEPS participants. It is proposed that the bulk part of the EUMETNET funding to EurEPS should be used to support ***a contract with ECMWF to develop the facilities for a EUMETNET centre for EurEPS***. ECMWF already has a strong capability for the generation and verification of ensemble forecasts in the medium range and longer, and a long-standing experience in professional dissemination of data in real time to its member countries, so placing the contract here will make efficient use of resources and capability.

The funding should be used to hire a highly competent person capable to address the key additional work for EurEPS as detailed under Tasks 2, 3, and 4, and to co-operate with the EurEPS participants on Tasks 5, 6, 7, and 8.

The cost for an ECMWF consultant is at the time of writing 128'000 Euro/year including salary, all taxes and social costs, and overhead. The sum may increase a couple of percents due to inflation. The contract with ECMWF should be established legally with the Responsible Member.

In addition there will be a need for travels and meetings due to the distributed nature of the project and the need for dedication. We stipulate this to 600 Euro per EurEPS participant per year, except for those EurEPS participants who have PLT members, for whom the costs are stipulated to 1'000 Euro per year per person, and 1'500 Euro per year for the Project Manager. In the budget table below we have preliminary estimated this networking costs to 12'500 Euro per year.

Salary compensation for the Project Manager is stipulated to be 25% of the cost for a person-year, presuming that he/she in addition will be involved on the level of ca. 50% or more in the relevant LAM-EPS work of his/her consortium.

Budget Summary. Thus the total contribution of the Participating Members to the Responsible Member will be per year:

Full time consultant at the ECMWF (subject to inflation):	eur 128'000
Salary of the Project Manager, 25% of the working time (0.25 x 90'000 eur):	eur 22'500
Travel costs (estimate to be adjusted according to level of participation):	eur 12'500
Total per year:	**eur 163'000**

The sum "Total per year" (EUR 163'000) will be the figure on each contract signed between the Responsible Member and a Participating Member. A table, annexed to the contract, will show the amount for each Participating Member.