SRNWP Interoperability Programme proposal

Prepared by:	UK Met Office
Purpose:	To present the SRNWP Interoperability Proposal
Action proposed:	Council to consider, comment, approve and decide on appropriate actions.
Majority required:	Programme continuation decision: Simple majority and participation of at least a third of EUMETNET's Members Core programme decision: unanimity

The UK Met office sent a straw-man proposal to be used as a kick-off for discussion at the 31st Council meeting. C31 agreed that a new, more detailed proposal for the SRNWP Interoperability programme should be presented by the Met Office in spring 2008. Now the full proposal is ready to be presented to the C33

SRNWP Interoperability

Met Office Proposal to become Responsible Member

May 2008

Contents:

1. Background

A discussion about the future of Numerical Weather Prediction (hereafter NWP) in Europe was initiated by "*A vision for Numerical Weather Prediction in Europe*", a document by Dr. David Rogers (former Chief Executive of the Met Office). This highlighted the need for '*greater collaborative effort between National Meteorological and Hydrological Services*' (hereafter NMHS). EUMETNET council then sponsored a vision workshop at the European Centre for Medium range Weather Forecasting (hereafter ECMWF, March 15th-17th 2006) where a working group identified a set of relevant cooperation themes. The first theme on the list was '*increasing interoperability between the European modelling systems*', abbreviated to '*interoperability*'.

a. EUMETNET Council Decision

At the 30th EUMETNET Council meeting (Aberdeen 12th-13th April 2007) the Council agreed to the proposed Programme to create a new EUMETNET Optional Programme for Interoperability between the European Modelling Systems, hereafter known as Interoperability.

b. Call to become responsible member

In consequence the Coordination Officer was tasked to open the call for proposals to become Responsible Member. No proposals were received by the deadline of 15th July 2007.

c. The Met Office position

The Met Office had considered submitting a bid to become Responsible Member; however it was felt that the scope of the programme proposal presented at the 30th Council meeting was too ambitious and that further discussion was required on whether some of the deliverables were needed. The Met Office raised these concerns with fellow C-SRNWP members and following discussion and agreement the UK were asked to provide a bid based on the outcomes of these discussions. The Met Office subsequently presented a strawman proposal to become Responsible Member for discussion at the 31st EUMETNET Council meeting. As a result the Council invited the Met Office to submit a full proposal in the spring of 2008. A workshop of C-SRNWP members was held at ECMWF in January 2008 to discuss the proposal and the way forward. This document is based on the feedback and discussion from that workshop.

2. Why Interoperability?

Within Europe, four different global models [1] and four different types of limited area models[2] (hereafter LAMs) are operated. The four LAMs are being maintained and run by five Consortia (ALADIN and LACE both run the ALADIN model, but will act together for the purposes of this proposal). Each NMHS which belongs to a specific consortium runs the corresponding LAM with a configuration specific to its own modelling system. There are many possible different interpretations of the term 'interoperability'. For the purposes of this proposal we are using the word 'interoperability' in the context of data interoperability. More specifically post-processing interoperability — the ability to display or use the forecast output within the

[1] IFS (ECMWF), Arpège (Météo-France), UM global (UK Met Office), GME (DWD)
[2] ALADIN, UM LAM, HIRLAM, COSMO

NMHS's own system. This will provide NMHS access to other European LAM data for forecast visualisation purposes, for operational back-up and support a common approach to verification as set out in the EUMETNET verification proposal. This work should also enable any future multi-model ensemble activities in Europe. Ultimately the aim is for any one LAM to be able to be run from any one of the four global models or any other LAM, but it has to be recognised that this is a much more complex task. As a result, the project is aiming for completion in a three year timeframe.

Figure 1 shows a typical LAM production suite, indicating all the stages typically included in such a suite.

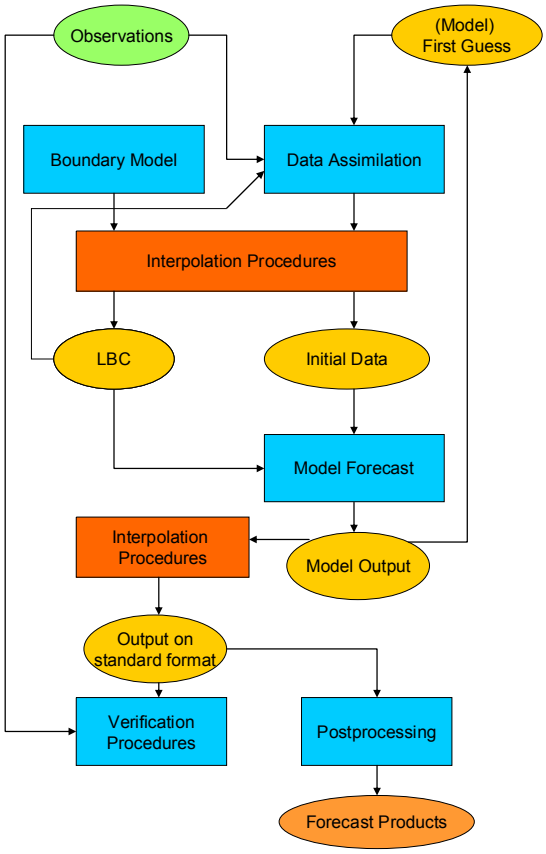


Figure 1: Schematic of a typical LAM NWP Production Suite

Figure 2 includes how interoperability fits in to a simple NWP forecast suite and illustrates the points at which conversion to a common format can be applied within the system. In order to achieve this interoperability we need to define a standard output format. The definition of this standard output format includes the file format to be used as well as the definition of horizontal and vertical grids to be supported. At the January 2008 workshop an initial agreement was

reached for GRIB2[3] to be used as the underlying file format, with the proviso that a staged migration to using netCDF[4] (as that file format develops) should not be precluded. Annex 1 gives further details on each of the data formats which are under consideration for this work.

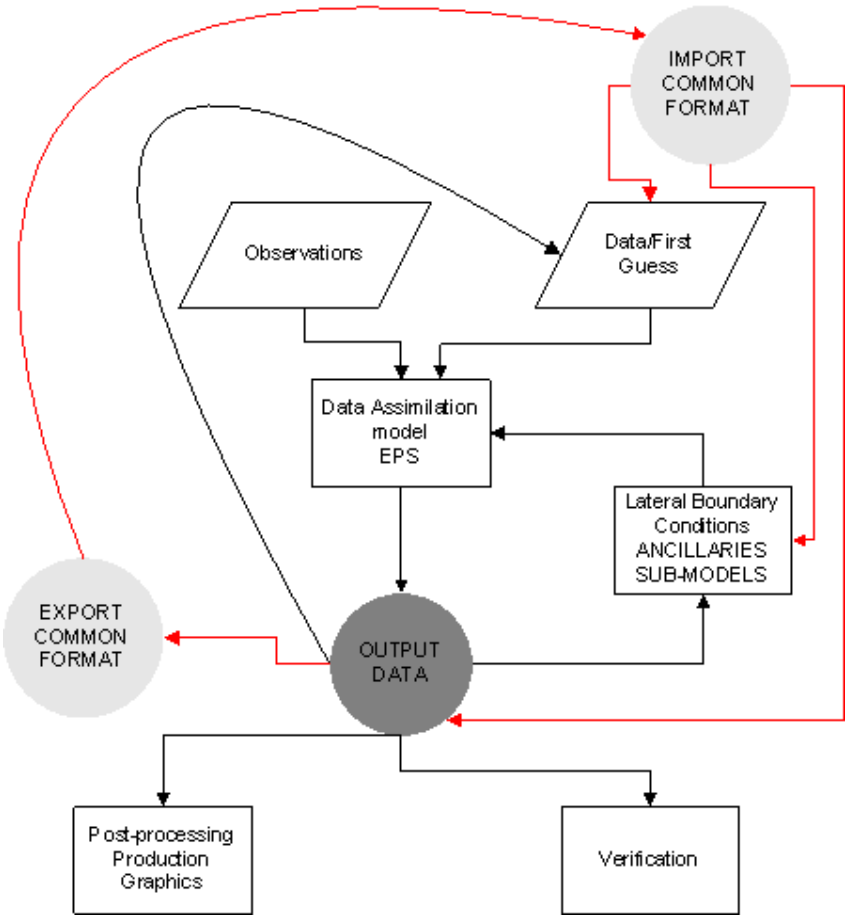


Figure 2. Typical NWP suite plus imported or exported data in the common format

SRNWP Interoperability is an important work programme which will facilitate greater collaboration between the NMHS in Europe. It is important however to have a realistic attitude to implementing this strategy and to note that there are myriad complexities which have the potential to slow progress. Effective project coordination is one way to mitigate against potential delays, but adequate effort and the will to succeed from the individual consortia are vital to achieving these aims.

3. Proposed Programme Manager

As Responsible Member the Met Office proposes to provide a Programme Manager (PM) to run the programme. The Programme Manager will manage and coordinate the technical work and produce the reports for EUMETNET council at 0.35 of a full-time equivalent. Each NWP

[3] http://www.wmo.int/pages/prog/www/WMOCodes/Guides//GRIB/GRIB2_062006.pdf
[4] http://www.unidata.ucar.edu/software/netcdf/

consortium[5] will carry out the necessary work to its own system under the coordination of the programme manager. The proposed Programme Manager (PM) is Rachel North. For her CV, experience and career history see Annex 2.

4. Proposed Work Plan

4.1 Overview

This is a three year programme of work aiming to define a standard format for exchanging data, and to deliver software which can convert any of the listed LAM model output to that standard format. Software to enable each LAM to run from any of the listed global models, or from any of the other LAMs, will also be developed.

4.2 Project Key Deliverables

The project deliverables are:

D1: A report documenting the standard output format and including a list of parameters for which the output format is to be applied. An initial plan for ongoing maintenance of the standard will be provided. The standard format will not preclude the addition of processed observation information at a later date.

D2: Documentation describing the requirements and specification for the adaptor software (software tools for conversion between different data formats and model grids; hereafter called adaptors). This document will include identification of the methods that can be used for implementing the adaptors and for maintenance of the software in connection with the consortia. The UK Met Office will coordinate the work in consultation with the global model providers.

D3: Four 2-way adaptors that transform the output from every LAM to the standard output format and vice versa. Documentation will also be provided. Each consortium will be responsible for the provision of the 2-way adaptor to convert between the output format of its LAM and the standard output format.

D4: Enhancements to existing software tools that enable all LAMs to process data from the four Global Model providers. This includes the documentation as well as the software. The Global Model providers will be asked to write adaptors to transform their model output to the standard format. Make enhancements to existing software tools that enable all LAMs to process data from any other LAM. This work will be the responsibility of the individual consortia.

[5] ALADIN and LACE are considered here as one consortium due to both basing their NWP effort on the same underlying ALADIN model

4.3 Project Milestones and Timetable

Project milestones are as follows:

Year 1

M1: Complete an inventory of existing model output formats, conversion tools and contact points.

M2: Definition of a set of common output parameters which are to be exchanged for verification and/or post-processing purposes.

M3: Definition of the standard output format.

M4: Plan for maintenance of the standard format.

M5: Identification of methods to implement adaptors.

M6: Agree adaptor software maintenance method.

Year 2

M7: Provision of an adaptor that transforms relevant model parameters from each LAM to the standard output format.

M8: Provision of a sample data set in the common output format from each consortium in order to test each adaptor.

M9: Documentation of the adaptor and a user guide.

M10: Agree on surface field (ancillary) definitions for the standard format.

M11: Provide a list of parameters required for lateral boundary conditions.

M12: Agree list of parameters to start LAM forecasts (to be supplied in the standard format).

M13: Provide a report to EUMETNET Council covering issues relating to data policy and likely uptake of software within NMHSs.

Year 3

M14: Provision of software by each of the consortia enabling them to use lateral boundary conditions from the model of another consortium (global or LAM).

M15: Provision of software by each of the consortia which will enable them to start a LAM forecast using data from alternative global model or LAM provided in the standard format.

The programme will be established for three years from the start date (estimated September 2008). The work programme, which is predominantly continuous in nature, will carry on throughout. An example detailed work plan (that the UK Met Office intends to follow) lists those tasks which need completing for successful delivery of the objectives listed in section 4.2 and is attached at Annex 3. It lists the tasks that need completing to achieve D1 to D3 and a preliminary task list for D4 (this will change after further discussion and agreement) and gives an initial timescale over which each of these will be completed. It should be noted that to successfully achieve D4 some coordination work will be required.

Summary

Reach M1 and M2 within 6 months of project start-up (estimated end of February 2009).

Deliver D1 passing milestones M3 and M4 within 9 months of the project start date (estimated end of May 2009)

Deliver D2 within 12 months (estimated end of August 2009).

Deliver D3 by the end of two year period (estimated end of August 2010)

Refine the work plan for delivery of D4 ready for the start of Year 3 (September 2010).

5. Financial Information – Costs

It is an implicit assumption in this proposal that consortia (and ECMWF) will be providing resources to complete the work to deliver the software adaptors. We have tried to summarise below an estimate of the expected costs to be incurred by each consortium. (ALADIN and LACE would act as a single consortium in the project).

Table 1

Estimated Costs (per Consortium)	
Total Cost for Effort	~2 man years
EUMETNET contribution	18,7K EUR
Expected costs incurred	~ 80K EUR

Full costs of programme management (€30K) will be given to the Responsible Member (€20K for 0.35 FTE plus €10K for travelling expenses). The rest of the budget will be split equally between the four model consortia in order to provide a financial contribution to facilitate prioritisation of the software development work within each. The budgeted financial contributions to consortia are intended as a subsidy rather than to facilitate full development costs of the tools required to achieve the key milestones of the project – the consortia themselves will be expected to contribute remaining costs. There is an expectation that in Years 2 and 3 the contributions by individual NMHS will decrease as a result of increased participation in the programme. ECMWF would like to be considered as full partner in the proposal. ECMWF has run the "Optional Project Boundary Conditions" for many years now

and have experience in the issues which will arise in trying to fully achieve D4. ECMWF therefore is willing to spend some of its human resources from the "Optional Project Boundary Conditions" (around one third of the time of the person working for the BC project) on working on software that will allow the provision of standard global data sets according to the SRNWP Interoperability proposal. This should allow ECMWF to finish its work for milestone M15 well ahead of the planned schedule and provide a service, initially for test data, to the Consortia during year 2 of the project.

Table 2 Summary of EUMETNET contribution to programme costs

Project task	Activity Year1/Year 2/Year 3	Year 1 Sep 2008 – Sep 2009	Year 2 Sep 2009 – Aug 2010	Year 3 Sep 2010 – Sep 2011
Project Management	0.35my/0.35my/ 0.3my Travel Costs	20K Euros 10K Euros	20K Euros 10K Euros	20K Euros 10K Euros
Financial Contribution to each Consortium (software development)	Assumes 5 consortia	18,7K Euros	18,7K Euros	18,7K Euros
Total		123,5K Euros	123,5K Euros	123,5K Euros

Note: Full years given here start from the beginning of the project, and are not financial years.

6. Additional issues

EUMETNET Council should be aware that there are several issues relating to full delivery of this programme. The work plan has been set out to deliver benefits year on year, and a natural break point occurs at the end of year 2 at which point Council may wish to review progress and assess the continued relevance and affordability of the project. This programme contains enabling work which will create usable software. In order to maximise the benefits from this programme some follow-on work will be needed. In particular the consortia members need to

decide how to exchange the data. No provision has been made in this proposal neither to set up a structure for data exchange nor to create a central data repository. It is suggested to Council that these issues be considered and discussed through SRNWP members within this project and that a report be collated on how NHMS propose to use this software. Approval to proceed with Year 3 activities would then be dependent on a report from the Programme Manager that sound plans are in place to deliver some operational benefit (see Milestone 13).

Given the nature of the programme it will deliver benefits to all members of EUMETNET therefore Council is asked to consider whether it should become a core activity.

6.1. Context of the Project

European NMHSs are already involved in other projects which aim to facilitate interoperability, or for which interoperability will be necessary or desirable (for example GMES, INSPIRE). The teams working on these projects at each NMHS should ensure they are in contact with each other so that each project is undertaken with the needs of the related project in mind.

6.2. Data Exchange Policy

Finally, it should be made clear that as a result of this programme, consortia will be expected to make native resolution model data freely available for testing. Downstream there will be a requirement to transfer these same data into operations at each NHMS which in itself may incur significant costs in the NHMS concerned. It is recommended that this is considered as soon as possible.

6.3. Maintenance

This project aims to deliver a standard format for data exchange and adaptors to convert to this format. It should be noted that maintenance will be required. The first aspect will be to ensure the standard format and its documentation are kept up to date and evolve as necessary. It is proposed that this is managed through SRNWP. Responsibility for maintenance of the second will fall on the consortia themselves, including ECMWF, to keep the adaptors updated and fully working given the inevitable model upgrades which will occur.

6.4. Licensing

The intention is for the adaptor software to exist as freeware. Ownership of the intellectual property rights will rest with the consortium members, and therefore responsibility for licensing lies with each consortium.

6.5. Relation to the C-SRNWP Programme

Although this Interoperability Programme is formally acting independently from the C-SRNWP EUMETNET Programme (with specific deliverables and financial means) the Programme in practise will be acting under the C-SRNWP Programme. This will mean that the Programme will also deliver its reports to the C-SRNWP Programme Manager and to its Advisory Committee, who might have comments on the execution of the Programme. Furthermore it is expected that the progress of the Programme will also be reported during the annual EWGLAM/SRNWP meeting.

ANNEX 1

Details on the file formats proposed for the standard output format

GRIB 2

- WMO Standard
  - Developed by WMO for the exchange of gridded data
- Allows detailed description of a huge variety of grids, parameters and processes all represented by codes that reference external tables
- It is portable (implemented as octets, groups of 8 bits)
- Fine control on numerical accuracy of grid values
- Good compression (Lossless JPEG)
- GRIB is a record format
  - Many GRIB messages can be written in a single file
- GRIB Edition 2 is template based
  - It can easily be extended

NetCDF

- Developed by Unidata to facilitate the access and sharing of array-oriented data in a form that was self-describing and portable
- Simple, but flexible, data model based around variables, dimensions and attributes.
- NetCDF is a file format
  - Merging/splitting NetCDF files is non-trivial
- Need to agree on a convention (CF)
  - Climate and Forecast (CF) convention developed for sharing climate model and NWP forecast data offers a widely-used standard for metadata.
  - Unidata provide library of routines for interacting with NetCDF files.
  - Only lat/long and reduced grid so far. Work in progress for adding other grids to the CF
  - There is no way to support multiple grids in the same file
- Simple packing possible, but only a convention
  - 2 to 8 times larger than GRIB2

Both formats are machine independent, but GRIB2 is not fully self-describing – the user needs reference tables in order to correctly decode the header information. GRIB2 has advantages in both compression and its sequential record-based access, meaning that if transmission fails for some reason the whole file does not need to be re-sent. NetCDF files would need to be fully re-transmitted in such a case. However, GRIB2 needs the whole file to be parsed in order to index the file whereas the NetCDF 'header' provides direct access. GRIB2 is also limited to 2D data (although grouping fields can provide alternate dimensions), whereas NetCDF is n-dimensional.

ANNEX 2

CURRICULUM VITAE

Post: Research Scientist, Meteorology Research & Development.

Employer Met Office

Name **Rachel North**

Profession Research Scientist

DOB 9 September 1974

Years with current employer: 7 Nationality : British

Professional affiliations to associations/groups :

Associate Member of the Institute of Physics

Specific Skills :

- Graphics and visualisation tools used within the UK Met Office.
- Manipulation of data formats used within the UK Met Office.
- Analysis of limited area model forecasts from the UM.
- Setting up and running UM forecast model experiments.
- Data retrieval from the local UK Met Office archives.

Principal qualifications and experience :

Formal Qualifications:

2001 Ph.D. from the Department of Physics and Astronomy (Probing the System Parameters of Cataclysmic Variable Stars)
University of Southampton, United Kingdom.

1997 1st class honours degree in Astronomy from the Department of Physics and Astronomy, University College London, United Kingdom.

Professional Experience :

2004 to present - Senior Modeller/Analyst (Meteorology Research & Development)
2001 – 2004 - Numerical Weather Prediction Diagnostic Scientist (NWP)
2001 - Joined Meteorological Office.

Languages :

English : mother language
Spanish : conversational
French : lapsed conversational

Recent/Relevant Experience:

2004 - Project Manager for limited area NWP model case study rerun for external clients.

2002 - Development of the data retrieval interface to the UK Met Office data archive in the UK Met Office version of the ECMWF Metview software.

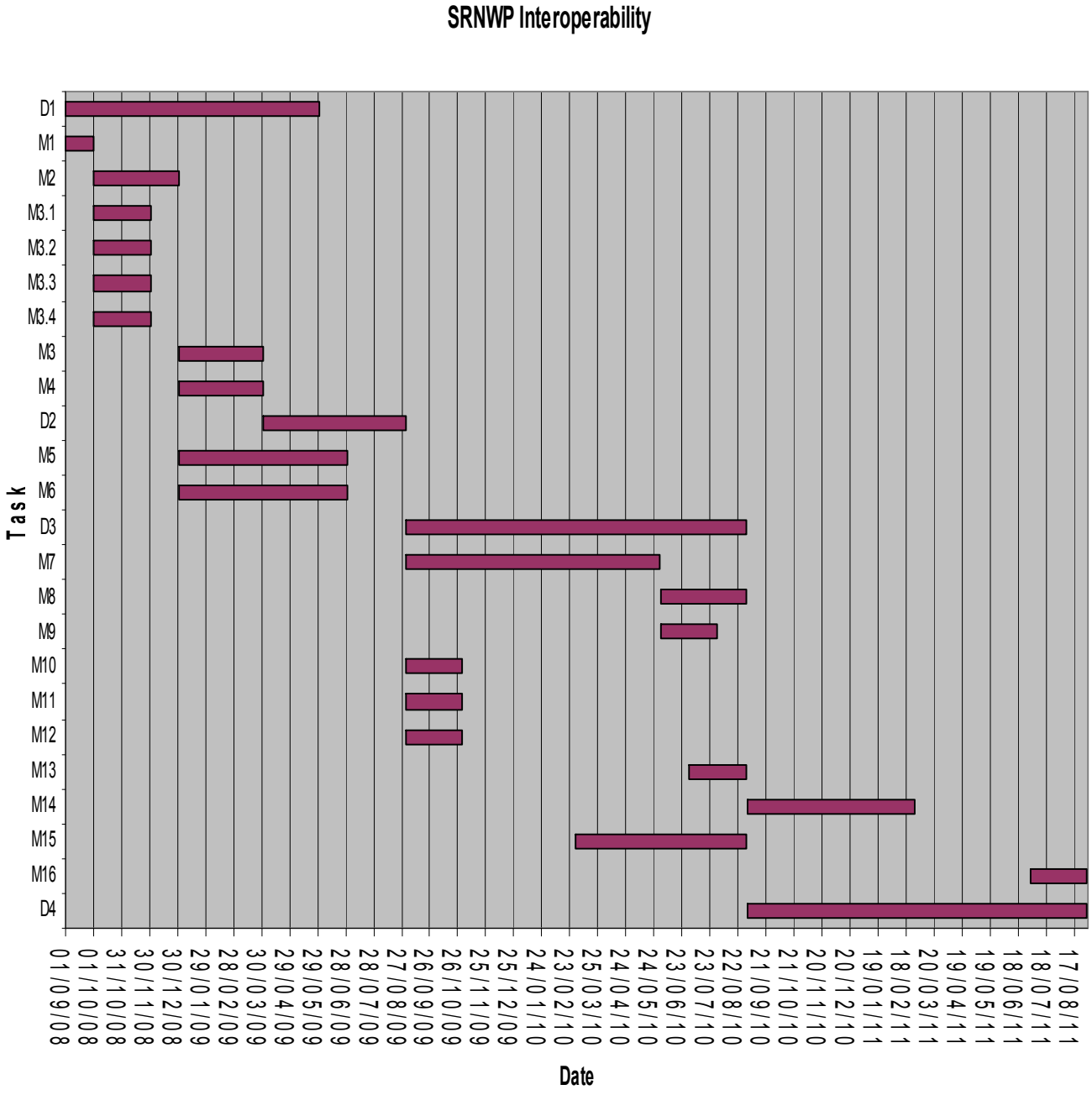
ANNEX 3

Sample Task List for the UK Met Office

SRNWP Interoperability Year 1	Month											
	Sep-08	Oct-08	Nov-08	Dec-08	Jan-09	Feb-09	Mar-09	Apr-09	May-09	Jun-09	Jul-09	Aug-09
D1: A report documenting the standard output format and including a list of parameters for which the output format is to be applied. An initial plan for ongoing maintenance of the standard will be provided.		M1 W1	??		M2			M3 M4	D1			
W1: Workshop to discuss M2 & M3												
M1: Complete an inventory of existing model output formats, conversion tools and contact points												
M2: Definition of a set of meteorological parameters to be exchanged for post-processing and/or verification purposes												
M3: Definition of the standard output format												
M3.1: Decision on data file format to use												
M3.2: Definition for vertical grids												
M3.3: Definition for horizontal grids												
M4: Outline plan for maintenance of the standard format												
D2: Documentation describing the requirements and specification for the adaptor software. This document will include identification of the methods that can be used for implementing the adaptors and for maintenance of the software in connection with the consortia.										M5 M6		D2
M5: Identify methods to implement adaptors					start					M5		
M6: Agree software maintenance method					start					M6		

SRNWP Interoperability Year 2	Month											
	Sep-09	Oct-09	Nov-09	Dec-09	Jan-10	Feb-10	Mar-10	Apr-10	May-10	Jun-10	Jul-10	Aug-10
D3: Four adaptors that transform the output from every LAM to the standard output format and vice versa. Documentation will also be provided.		W2	M10 M11 M12						M7		M8	M9 D3 M13
W2: Workshop to finalise agreement on parameter lists for D4												
M7: Provision of an adaptor that transforms relevant model parameters from each LAM to the standard output format.												
M8: Provision of a sample data set in the common output format by each consortium for testing with the software adaptors												
M9: Documentation of the adaptor and how to use it												
M10: Final agreement on surface field (ancillary) definitions for the common format												
M11: Final agreement on list of parameters required for lateral boundary conditions												
M12: Agree on list of parameters required to start LAM forecast (to be supplied in standard output format)												
M13: Report covering progress to date, analysis of data policy issues and likely software uptake												

SRNWP Interoperability Year 3	Month											
	Sep-10	Oct-10	Nov-10	Dec-10	Jan-11	Feb-11	Mar-11	Apr-11	May-11	Jun-11	Jul-11	Aug-11
D4: Enhancements to existing software tools to enable all LAMs to process data from the four Global Model Providers. This includes documentation as well as software. Enhancements to existing software to enable all LAMs to process data from any other LAM.												
M14: Provision of software (by each consortium) to start their LAM forecast using data from other global or limited-area models provided in the standard format.												
M15: Provision of software (by each consortium) to enable use of lateral boundary conditions from the model of another consortium provided in the standard format.												
M16: End of project report.												


SRNWP Interoperability
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