CONSORTIUM FOR SMALL SCALE MODELING

COSMO

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

DWD

3 Years of Interoperability
Results and Leftovers

Review Talk for
Expert Team on System Aspects
33rd EWGLAM / 18th SRNWP Meeting

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Topics of Interest for the ET

- Besides Interoperability there are only few topics of interest, which were discussed (mainly bilateral)
- Implementation aspects and new computer architectures
  - see presentations by UKMO and COSMO
- Software maintenance: inspired by the UKMO presentation last year (Testing code changes for the Met Office), COSMO puts up a “Standard Technical Test Suite”, which can be used by everybody to test that new versions still fulfill all technical requirements (parallelization, reproducibility, functionality of restart runs, etc.)
- List of “Operational NWP Systems in Europe”.

Interoperability Tasks for the ET System Aspects

- Work coordination within the consortias
- To maintain the standard output format and the lists of parameters:
  - Grib2 issues: we are NOT the experts for Grib2, but can try to coordinate discussions between the consortias and with ECMWF
  - Update the lists of parameters to be exchanged, if necessary
  - Keep the documentation of these lists up to date (not only: *which parameter is it*, but also: *what does it really stands for*; cloud ice for example is treated and interpreted different in different models)
- To maintain and test the Interoperability software, the adaptors:
  - Exchange test data once a year and check the adaptors
  - Best before the EWGLAM / SRNWP Meetings

Outlook

- The ET on System Aspects could ensure the useability of the Interoperability Software in the next years. This will depend on the future structure of SRNWP/EWGLAM
- Exchange of information and experiences will be interesting also in the next years

Thank you for your attention

Review Talk for Systems Aspects:

Three Years of Interoperability: Results and Leftovers

for 33rd EWGLAM and 18th SRNWP Annual Meeting 2011
10th – 13th October 2011 Tallinn, Estonia

Mike Bush, Rachel North, Tom Green

Outline of talk

- **Status of the current phase of SRNWP Interoperability (SRNWP-I) .**
- **SRNWP-I Continuation proposal**

SRNWP-I: Status of current phase

Background to SRNWP-I

- SRNWP Interoperability (SRNWP-I) was approved as a EUMETNET activity under the umbrella of the SRNWP programme in 2008.
- One of its aims was to provide software to facilitate running one limited-area model (LAM) using initial conditions from another model.
- It was proposed to do this by defining a ‘standard format’.
- This standard format would then be able to assist with another of the programme aims; to facilitate post-processing interoperability within European National Meteorological and Hydrological Services

Summary table

Deliverable [Milestone]	Target	Description	D	ND
A [M1]	Year 1	Complete inventory of existing model output formats, conversion tools, contact points	D1	-
B [M2]	Year 1	Define set of common output parameters to be exchanged for Verif/Post Processing	D1	-
C [M3]	Year 1	Define standard output format	D1	-
D [M4]	Year 1	Maintenance plan for standard format	D1	-
E [M6]	Year 1	Agree adaptor software maintenance method	D2	ND0
F [M7]	Year 2	Provide adaptor that transforms model parameters from LAM to standard format & vice versa	D3	-
G [M8]	Year 2	Provide sample data in common output format to test adaptors	D3	-
H [M9]	Year 2	Document adaptor and user guide	D3	ND0
I [M10]	Year 2	Agree surface field (ancillary) definitions in standard format	D1	-
J [M11]	Year 2	Provide a list of parameters required for Lateral Boundary Conditions	D1	-
K [M12]	Year 2	Agree a list of parameters to start LAM forecasts (in standard format)	D1	-
L [M13]	Year 2	Report to EUMETNET on data policy issues and uptake of software	?	?
M [M14]	Year 3	Provide software to allow use of LBC's from the model of another consortium (global or LAM)	D4	ND1
N [M15]	Year 3	Provide software to allow a LAM forecast using data from alternative global model or LAM	D4	ND1
O [ ]	Year -	Provision of a plan discussing options for long term sustainability of the technical solutions	D5	ND0
-	Year -	Each consortium can encode/decode their model output into WMO GRIB2 format	D6	-

* [M5] was a year 1 target to "Identify methods to implement adaptors". This was not given a deliverable letter.

** Deliverable O was a late addition: "Provision of a plan discussing options for long term sustainability of the technical solutions".

*** D6 became a new deliverable during phase 1: "Each consortium can encode/decode their model output into WMO GRIB2 format".

Status of Deliverable D1

- **Deliverable D1: A report documenting the definition of a standard output format (hereafter 'standard format'), including a list of parameters for which the standard format will be applied. An initial plan for maintenance of this standard will be provided.**
- D1 has been achieved and the document can be found in the Interoperability working area on the EUMETNET portal

Deliverable [Milestone]	Target	Description	D	ND
A [M1]	Year 1	Complete inventory of existing model output formats, conversion tools, contact points	D1	-
B [M2]	Year 1	Define set of common output parameters to be exchanged for Verif/Post Processing	D1	-
C [M3]	Year 1	Define standard output format	D1	-
D [M4]	Year 1	Maintenance plan for standard format	D1	-
I [M10]	Year 2	Agree surface field (ancillary) definitions in standard format	D1	-
J [M11]	Year 2	Provide a list of parameters required for Lateral Boundary Conditions	D1	-
K [M12]	Year 2	Agree a list of parameters to start LAM forecasts (in standard format)	D1	-

Status of Deliverable D2

- **Deliverable D2: Documentation describing the requirements and specification for the adaptor software (software tools for conversion between different data formats and model grids; hereafter referred to as 'adaptors').**
- In the initial stages of the programme it became obvious that D2 would be best suited to completion as the programme matured.
- Each consortium had a different idea of how to design and implement their adaptor, and several had a change of plan half way through the development process.
- The most recent (draft) document can be found on the EUMETNET portal.

Deliverable [Milestone]	Target	Description	D	ND
E [M6]	Year 1	Agree adaptor software maintenance method	D2	ND0

Deliverable D2 (continued)

- In principle it is agreed that, it is the responsibility of Consortia to maintain their own adaptor to support the encoding/decoding of their operational model output to/from the standard format and to maintain their own adaptor to support the decoding of other Consortia standard format for use by their systems.
- The SRNWP Interoperability programme view is that upon completion of the programme adaptor governance should become the responsibility of the SRNWP System Aspects ET.
- There will be a review/testing of adaptors by each consortium prior to the SRNWP annual meeting.
- The SRNWP Expert Team accepts this.

Status of Deliverable D3

- **Deliverable D3: Four adaptors that transform the output from every LAM to the standard format and vice versa. Documentation will also be provided. Each consortium is responsible for provision of the software.**
- The software aspects to D3 have been completed, with all consortia now able to convert their LAM output to the standard format, and convert a file containing the standard format on a latitude-longitude grid back to the format required for ingestion into their model.
- H: All consortia have now started to compile documentation.

Deliverable [Milestone]	Target	Description	D	ND
F [M7]	Year 2	Provide adaptor that transforms model parameters from LAM to standard format & vice versa	D3	-
G [M8]	Year 2	Provide sample data in common output format to test adaptors	D3	-
H [M9]	Year 2	Document adaptor and user guide	D3	ND0

Status of Deliverable D3 (continued)

Status of D3: LAM initial conditions → LAM forecast

	ALADIN	COSMO	HIRLAM	UM
ALADIN				
COSMO				
HIRLAM				
UM				

Key:
black – not applicable
grey – intend to complete by Phase 1 end (December 2011)
blue – already complete
red – Expect to complete during continuation project
white – not intended to be completed by phase 1 end

- HIRLAM => ALADIN. Complete.
- UM => COSMO. Able to convert NAE data to the COSMO-Model. Not yet tried to run the COSMO-Model from this data, but hope to do so by the end of the year.

Status of Deliverable D4

- **Deliverable D4: Deliver enhancements to existing adaptors to enable LAMs to process data from the four global model providers. This includes documentation. In addition, deliver enhancements to existing adaptors to allow LAMs to process data from any other LAM. This work is the responsibility of each consortium.**
- M: It has been agreed that this will not be completed as intended as a result of delays incurred from the GRIB2 development.
- N: This is the current focus for all consortia.

Deliverable [Milestone]	Target	Description	D	ND
M [M14]	Year 3	Provide software to allow use of LBC's from the model of another consortium (global or LAM)	D4	ND1
N [M15]	Year 3	Provide software to allow a LAM forecast using data from alternative global model or LAM	D4	ND1

Status of Deliverable D4 (continued)

Status of D4: Global Lateral Boundary Condition provider → LAM forecast

	ECMWF	ARPEGE	DWD ICON	UM
ALADIN				
COSMO				
HIRLAM				
UM				

Key:
black – not applicable
grey – intend to complete by Phase 1 end (December 2011)
blue – already complete
red – Expect to complete during continuation project
white – not intended to be completed by phase 1 end

- ICON data is not yet available yet.

Status of Deliverable D5

- At the 33rd meeting of the EUMETNET Council, a request was made to add a fifth deliverable:
- **Deliverable D5: Provide a plan for the long term sustainability of the project outputs.**
- O: Report on long term sustainability of the technical solutions.

Deliverable [Milestone]	Target	Description	D	ND
O [ ]	Year -	Provision of a plan discussing options for long term sustainability of the technical solutions	D5	ND0

Status of Deliverable D6

- **Extra Deliverable D6: Each consortium can encode/decode their model output into WMO GRIB2 format.**
- At the time of writing the original proposal, an assumption was made that all the consortia were familiar with the WMO GRIB2 format and were already encoding and decoding it. This turned out to be optimistic.
- A pragmatic decision was taken to use the ECMWF GRIB API software to ensure that the developed adaptors shared a common code base for encoding and decoding into the chosen data format, which would remove this factor as a potential source of error.
- D6 has been achieved

Deliverable [Milestone]	Target	Description	D	ND
-	Year -	Each consortium can encode/decode their model output into WMO GRIB2 format	D6	-

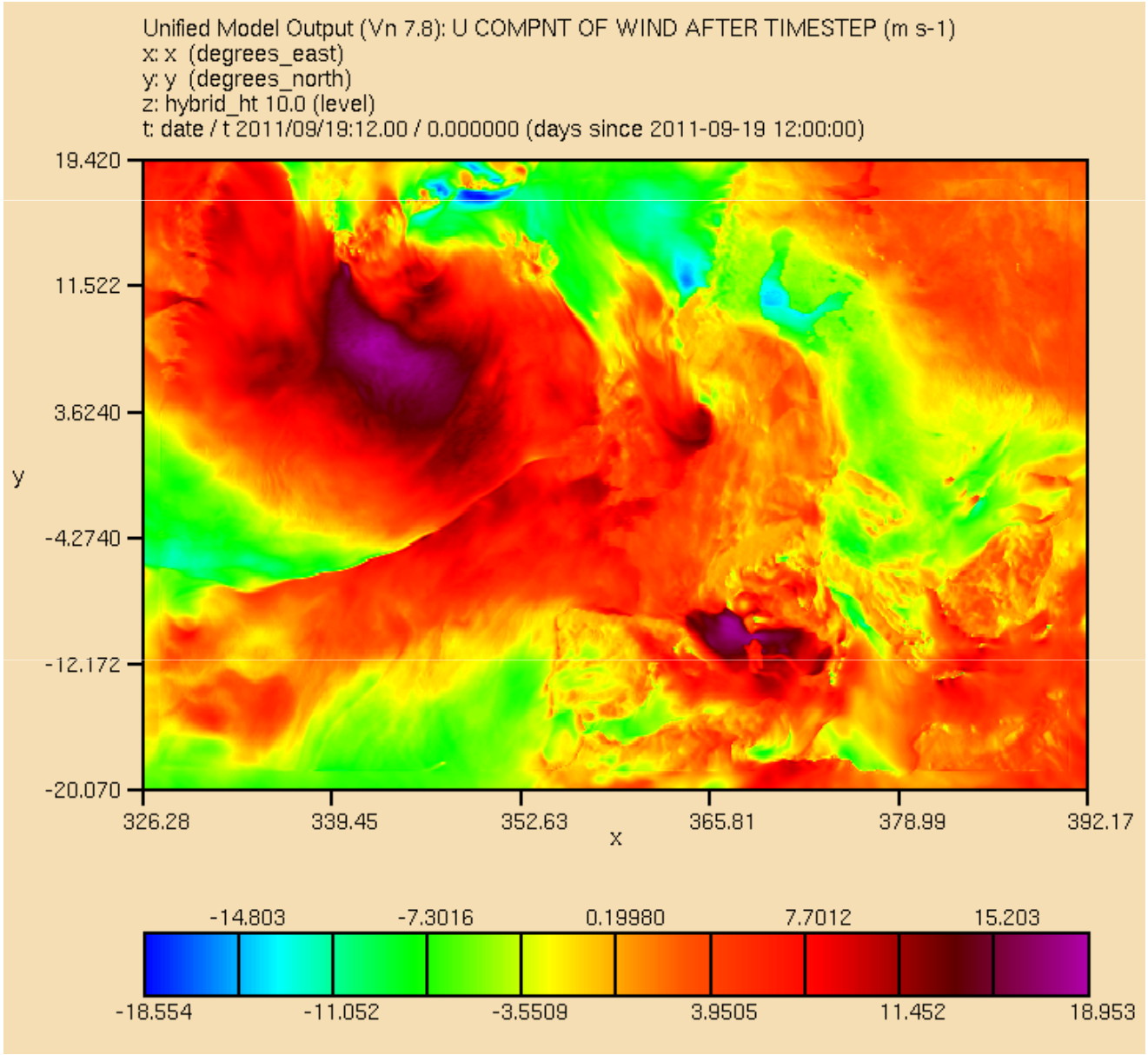
New vertical coordinate codes

- Prior to the project starting no-one had been encoding hybrid height data into the GRIB2 format.
- After discussions involving several interested parties, a proposal to WMO initiated from ECMWF recommended that the vertical coordinate hybrid code be split into two to distinguish models being described by hybrid pressure or hybrid height coordinates.
- This was accepted, and the new vertical coordinate codes 118 and 119 can now be used instead of the ambiguous 105 value.
- COSMO proposed a generalized vertical coordinate (typeOfLevel=150) by providing a 3D field with the height of every grid point.
- This also includes the description of the SLEVE coordinate

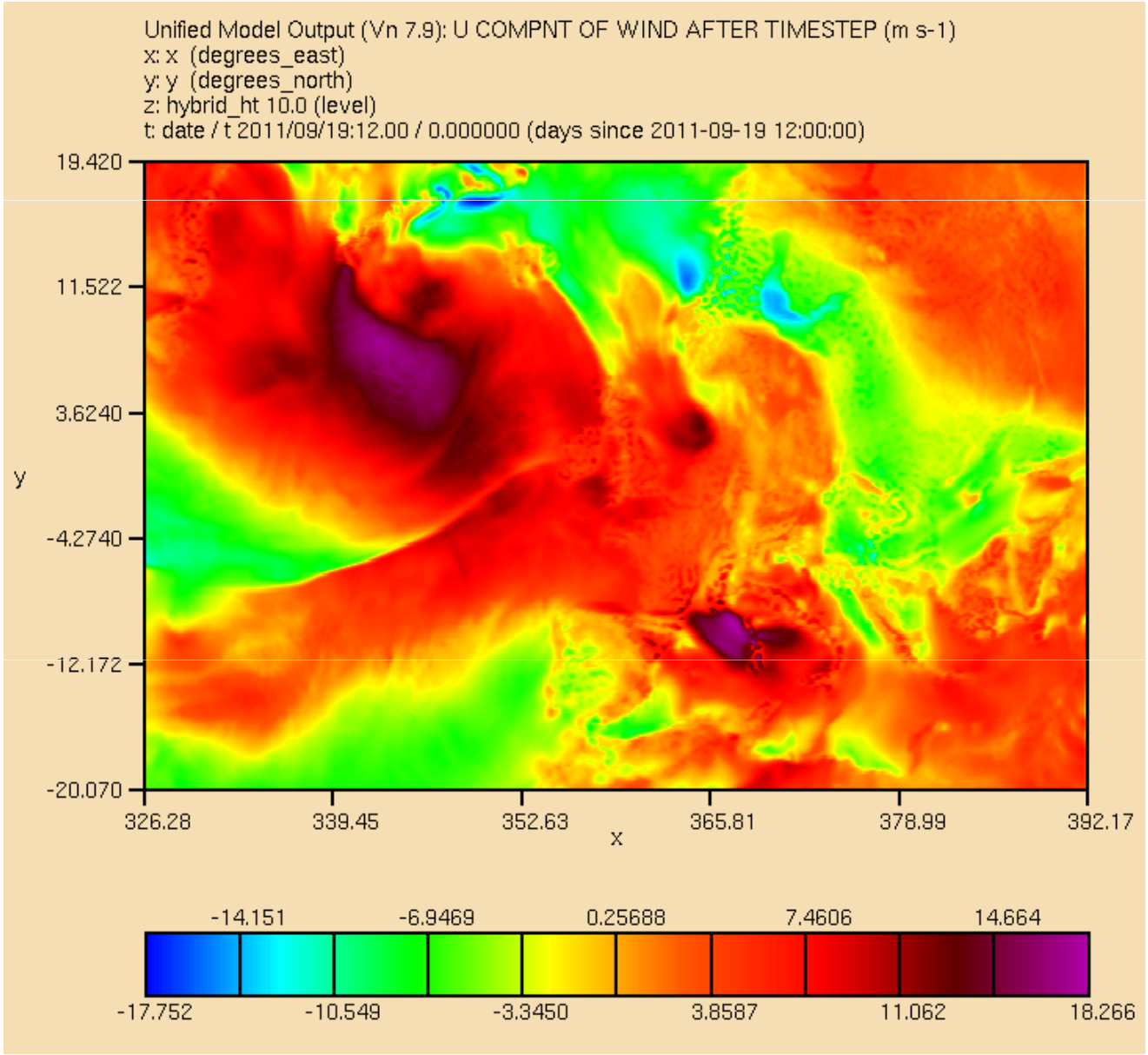
Recent Met Office progress

- The Met Office Interoperability adaptor has now been incorporated into the operational source code for the NWP model.
- In practice, this means that the adaptor software is now under revision control and thus any subsequent revisions to the code will be clearly documented.
- It should ensure that collaborators will be able to gain easy access to the latest version of the source.
- It also contributes to the longevity of the code, as it will now included in the test harness, and thus should be kept up to date.
- The Met Office report that they are able to deliver ensemble products to the forecasters in a more timely fashion as a result of the SRNWP-I adaptor software being incorporated into the UM framework.

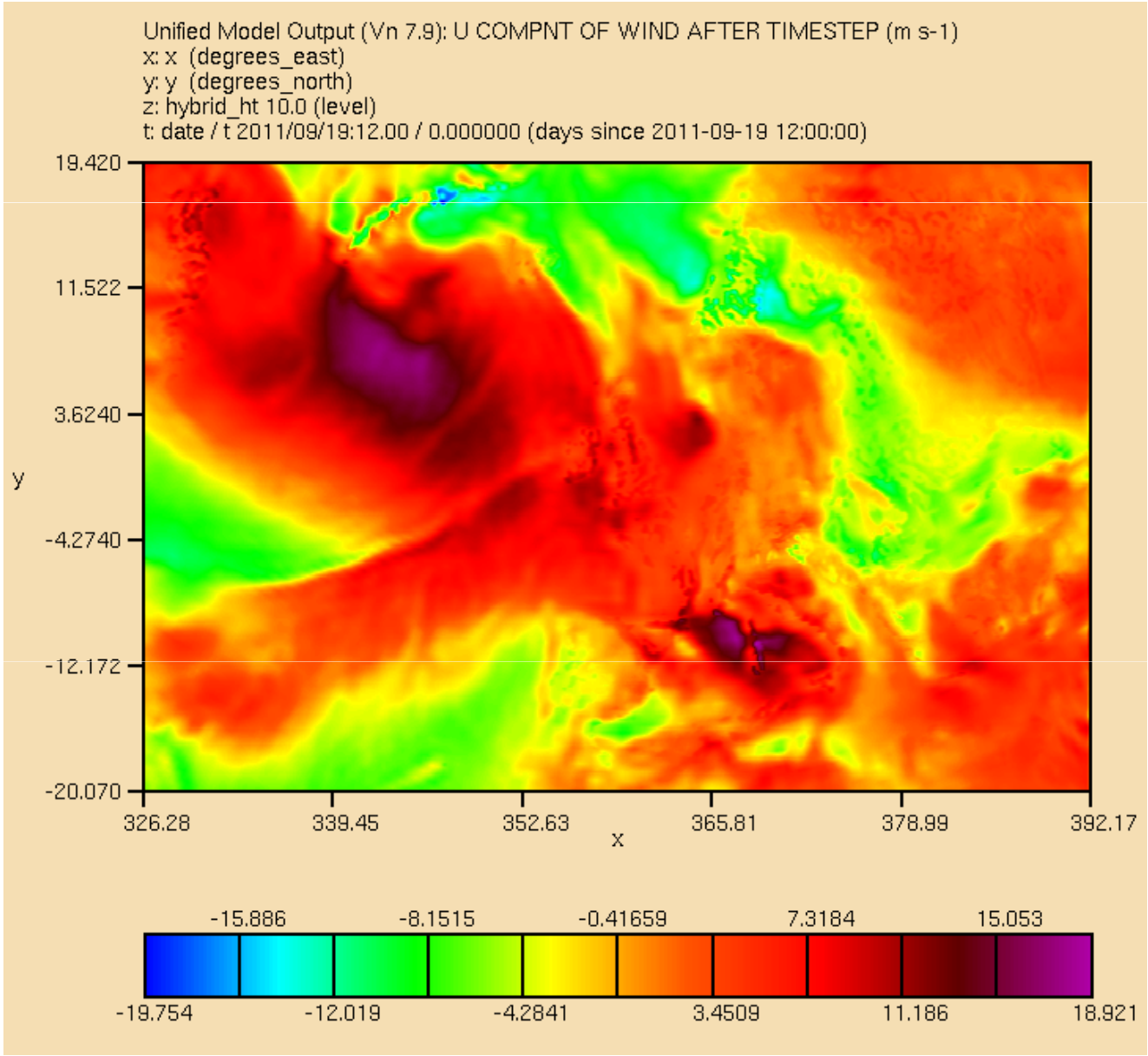
Example: NAE Operational T+0 dump u wind on model level 1



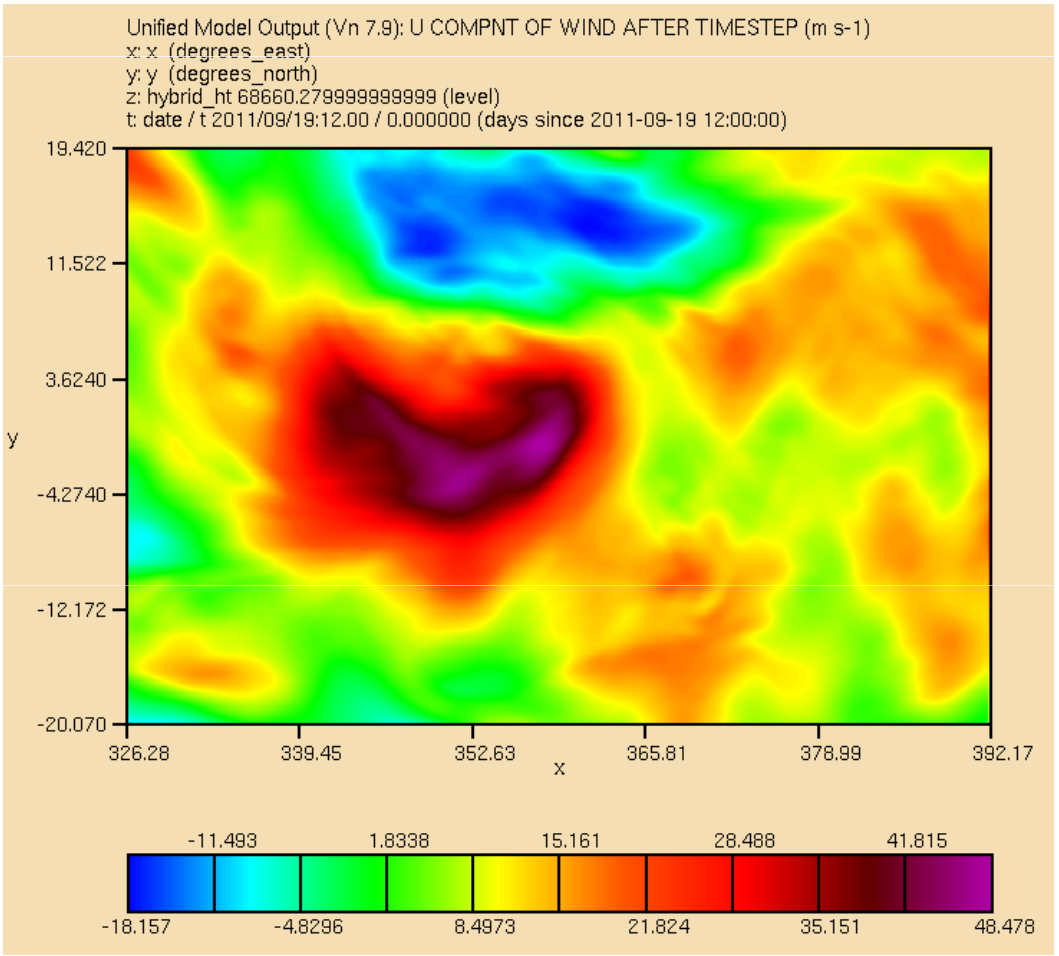
Example: NAE Reconfigured from Global u wind on model level 1

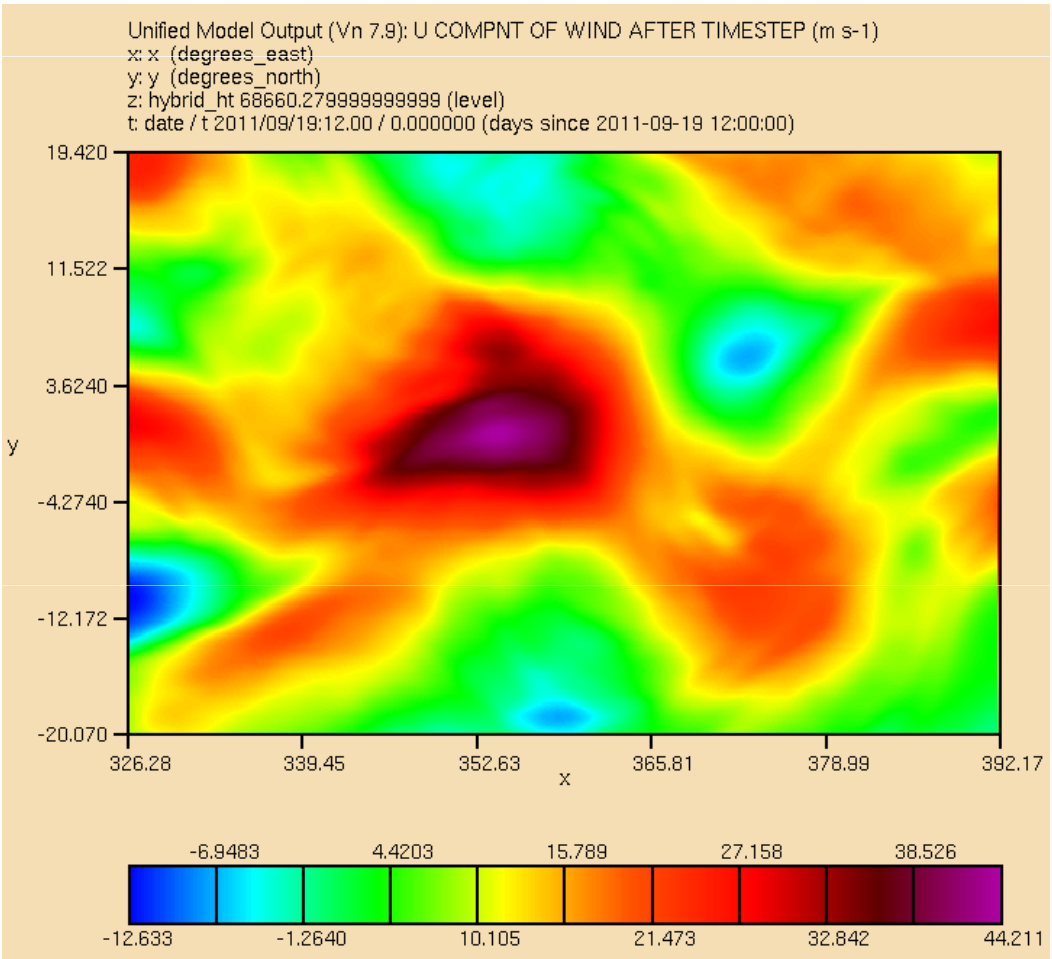


Example: NAE Reconfigured from ECMWF u wind on model level 1



NAE Reconfigured from Global (left) and ECMWF (right)
u wind on model level 69





SRNWP-I Continuation proposal

Summary of deliverables

- Deliverable ND0: To deliver an agreed support and maintenance plan for the software adaptors.
- Deliverable ND1: To extend existing software tools that enable a model (global or LAM) to provide lateral boundary conditions to drive an embedded LAM.
  - Agreed format for lateral boundary files
  - Delivery of post-Aug 2011 adaptors as highlighted in Annex 1 Table 2 (same as table for D4).
  - Documentation of adaptors including file formats and usage.
- Deliverable ND2: Work into extension of the surface provision in the standard format.

ALADIN-LACE ND1

- Our goal is to develop the adapters defined in Phase I. For this purpose, we will have to code a new software solution for the input mode (from other consortia's model data to Aladin data), since investigations in Phase I have shown that the present conversion software (so-called 901) would not support the full requirements for Interoperability.
- Therefore, the main steps during the continuation would be:
- 1. code and evaluate a prototype adapter within the new solution (already started)
- 2. add new algorithmic solutions when required (de-staggering, recognition of new grids, computation of interpolation weights for the new geometries)
- 3. perform basic technical tests

ALADIN-LACE ND1 (continued)

- The work would be scheduled starting from the simpler (with an Aladin target format in mind) input formats to the more complex ones, which might be a mixed order of LAM-to-LAM and Global-to-LAM converters.

  For the output mode (from global Arpège and Aladin data to GRIB2), a specific throughput will be completed and maintained.

  Work in ND1 will restrict to full fields both in input and output adapters (as opposed to frames).

COSMO ND1

- For the ICON grid the usage of bitmaps will be investigated, in order that only the points necessary for a specific LAM are stored and transmitted.
- For the ICON and the COSMO grid the usage of FRAMES will also be tested to further reduce the size of GRIB files.

HIRLAM ND1

- Due to the current transition from the HIRLAM model to the HARMONIE system the HIRLAM consortia will shift the focus within the I-SRNWP program to develop and maintain adaptors for HARMONIE rather than HIRLAM.
- Since we share much of the code base with ALADIN we have several points of connections although the full NWP systems as a whole run by the two consortia are different.
- The aim for ND1 is to coordinate with ALADIN where applicable and make sure that we can handle the different geometries delivered by the different consortia in the common format. We shall further develop and maintain a converter from HARMONIE output files to the common format.

Met Office ND1

- Investigate the use of FRAMES data to reduce size of GRIB files for LBC generation. This is where the parts of the horizontal grid in the fields from the driving model which are not required for LBCs is set to missing data indicator and the data can be packed much more efficiently. We currently perform this to archive data that is required to re-generate LBCs for LAM ensembles.
- Currently LBCs are needed for the following fields which we would like to make sure we can fill with sensible data:
  - Orography (Orog) (STASH Sect 0 Item 33 - Single unspecified level)
  - U (STASH Sect 0 Item 2 - Rho levels 1 to TOP)
  - V (STASH Sect 0 Item 3 - Rho levels 1 to TOP)
  - W (STASH Sect 0 Item 150 - Theta levels 0 to TOP)
  - Density (Rho) (STASH Sect 0 Item 253 - Rho levels 1 to TOP)
  - Potential Temperature (Theta) (STASH Section 0 Item 4 - Theta levels 1 to TOP)
  - Specific Humidity (Q) (STASH Section 0 Item 10 - Theta levels 1 to TOP)
  - Specific cloud water content (QCL) (STASH Section 0 Item 254 - Theta levels 1 to TOP)
  - Specific cloud ice content (QCF) (STASH Section 0 Item 12 - Theta levels 1 to TOP)
  - Exner pressure (Exner) (STASH Section 0 Item 255 - Rho levels 1 to TOP+1)

Met Office ND1 (continued)

- Currently in the UM, LBCs external to the domain are produced. This was done so that the LBC updating mirrored some aspects of the parallelisation within the domain. However, there are disadvantages in doing this and it is more accurate and efficient to specify all the LBCs within the domain and/or to just keep 1 external value.
- This would allow the current LBC size to reduce by around 30% (on top of an approximately 20% reduction by removing the advecting winds). The LBC updating will also be more efficient when the normal wind components are held at the domain boundaries (v-at-the-poles in a global configuration).
- Currently the reconfiguration (the program to set up the fields ready for the main atmosphere model) and makebc (the program to produce the boundary conditions) require treatment of certain fields to be the same – for example when we reconfigure input fields we have to treat fields in a similar fashion to make sure the initial start dump and the LBCs are consistent.

ALADIN-LACE ND2

- During Phase I, the soil wetness index (SWI) solution was coded within the old adapter framework. Basic feasibility studies were then conducted. The SWI needs to be also coded in the new adapter software, with basic tests for each of the input model data.
  SWI needs also to be provided in the output mode adapter (Aladin-to-GRIB2).

COSMO ND2

- Investigate how the SWI can be used to interpolate soil moisture from other LAMs. Study the external parameters (soil type, root depth, …) and corresponding values (“tuning” parameters) of the other models.

HIRLAM ND2

- A first SWI solution is implemented in the HARMONIE system for e.g. input data from the HIRLAM model. A similar solution will be coded in the new adaptor framework and tests should be conducted to make it sure it properly handles the characteristics of the different input models.

Met Office ND2

- Currently the reconfiguration (which sets up the model start fields) performs very basic sanity checks on the soil data to make sure the bounds of the soil moisture are within the limits of sensible values (e.g. taking into account wilting/critical/saturated water etc.).
- To further improve this a soil wetness index would be used to try and transition other model's soil data into the UM.
- It is desirable to be able to use surface data which is consistent with the atmosphere data. To make surface data interoperable will sometimes require more than reconfiguration.
- We will try to use ECMWF SST's, sea ice, land ice and snow cover to demonstrate the feasibility of the approach and to see how beneficial it is in model runs.

Proposed cost

Proposed Cost to be applied to the EUMETNET budget in 2012:

Item	Cost per annum
Programme Management (0.35 FTE)	25,000€
PM Travel & Subsistence	1,500€[1]
Subsidy payment to participating consortia to ensure continued priority of the work	24,250€ per consortium (x4[2])
Total costs per annum:	**123,500€**

- In the extension phase, no payment is anticipated to ECMWF.
- The anticipated workload for ECMWF is considered to be small and the support work in relation to the use of ECMWF's GRIB_API software and the continued maintenance of the test data repository will be provided as part of ECMWF's general support to its Member States.

Some issues for the future

- The regular exchange of current operational data was always out of the scope of this project.
- But how do we exchange data without the legal departments starting to jump up and down?
- Do we need bilateral agreements between Met Services?
- Do we need to escalate this through our directors?
- Variable resolution wasn't included when we started SRNWP-I, but now it is operational, maybe we should supply some test data…
- New grids e.g. COSMO SLEVE grid…

Latest news

- EUMETNET STAC meeting held in Darmstadt on 05/10/11.
- Consideration of SRNWP-I continuation proposal
- Outcome of meeting?

Questions?