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Thematic Priority: Global Change and Ecosystems

Deliverable D2B.18: Technical protocol for the construction of ENSEMBLES statistical downscaling and scenario generator tools

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Dissemination Level		
PU	Public	x
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the Consortium (including the Commission Services)	

D2B.18: Technical protocol for the construction of ENSEMBLES statistical downscaling and scenario generator tools

Version 1: Clare Goodess, UEA (November 2007)

1. INTRODUCTION

Statistical downscaling methods and tools, together with scenario generation methods, are being developed in ENSEMBLES RT2B in consultation with users in RT6 and outside ENSEMBLES, including appropriate stakeholders. These publicly available tools and methods will provide a valuable resource for the wider climate, seasonal forecasting and impacts communities.

While tailoring of outputs for applications users was seen as a priority from the start and the development of tools was mentioned in the original ENSEMBLES Description of Work, the emphasis on the latter has grown during the course of ENSEMBLES. In particular, discussions during the RT6 meeting held in June 2005 and subsequent email discussions by the RT2B and RT6 co-ordinators and others, identified a desire from applications users and others for statistical downscaling software tools (as much as statistically downscaled scenarios themselves), together with regional scenario generator tools. This change of emphasis is reflected in the annual updates of the RT2B detailed implementation plan.

A first prototype of a web service for statistical downscaling was, for example, developed during the first 18 months of ENSEMBLES. The prototype portal, for downscaling seasonal-to-decadal hindcasts, had several limitations, such as the restricted geographical area (the Iberian Peninsula) and the limited computing resources (the portal ran in a single machine). Considerable funded and unfunded effort has, therefore, been devoted since month 18 to extend the portal taking into account users' feedback (see Section 3).

The development of tools is seen as desirable because they give users the potential to construct their own tailored outputs rather than being reliant on the scenario developers. This is increasingly important, given the growing demand for scenario projections for many diverse impacts applications. For ENSEMBLES, it allows wider dissemination of RT2B outputs both during and after the end of the project.

Shifting the emphasis of the RT2B statistical downscaling (SDS) work to meet users' demands has, however, raised a number of issues and questions which were identified towards the end of year two, including:

1. The potential dangers of using tools as a 'black box'
2. The need for user documentation and education
3. The need to specify user requirements, especially output formats, in detail
4. Can multiple SDS methods be combined in a single tool?
5. Is it possible to incorporate more sophisticated data/computer intensive SDS methods (e.g., neural network methods) in such a tool?

6. Does the ENSEMBLES web-based downscaling service provide a suitable focus for SDS tool development, or are additional tools required?
7. What predictor/predictand datasets should/can be incorporated in the tool(s)?
8. What case-study regions should/can the tool(s) be tested in?
9. How can SDS tools be combined with scenario generator tools?
10. For example, should techniques for weighting be included in the statistical downscaling tools – or only in scenario generator tools?

Question 3 is a main focus of this deliverable. It was addressed using a questionnaire covering this particular question and a number of other issues related to the set of questions. The questionnaire was designed by UEA (in consultation with RT2B partners) and widely circulated in RT2B and to other RTs in early December 2006. Partners were also encouraged to circulate the questionnaire outside ENSEMBLES. Several reminders were sent out through early and spring 2007 and a total of 18 replies were eventually received. These came primarily from people involved in RT2B and RT6 – thus from what can be regarded as more technical users. The questionnaire results are summarised in Section 2.

Questions 4-8 are being explored as part of work on the statistical downscaling web service (see Section 3) which is also addressing points 1 and 2.

From the questionnaire responses (Section 2) and wider discussion (Section 4), it is clear that we are still some way from answering questions 9 and 10. A number of recommendations relating to these and the other questions and issues are made in Section 5.

2. ENSEMBLES USER REQUIREMENTS

The Users' Requirements Questionnaire is reproduced in the Appendix. As noted above, 18 responses were received. All but one respondent is an ENSEMBLES partner, primarily involved in RT2B and/or RT6. All described themselves as academic researchers, though not necessarily with climate science as their main area of expertise. Two also described themselves as stakeholders, and two noted they had strong stakeholder links or worked closely with stakeholders. The limited number of responses and the skewness of the sample should clearly be considered in interpreting the questionnaire results.

The most relevant sections of the questionnaire for this deliverable are Part 2 on requirements of regional scenarios and Part 3 on statistical downscaling and scenario generator tools. The findings from these sections are summarised here.

	Summary of responses
Requirements of regional climate projections:	
Proposed use	Impacts of extremes: health, forest fire risk, tourism, wind, farming, energy, flood, heat stress, structural design of built environment, windstorm losses, hydrology and water management, Rhine, Danube. Regional CC assessment (e.g., water resources, coastal areas, biodiversity). Impacts of CC on agriculture: Mediterranean,

	Emilia Romagna (including irrigation), crop yield and nitrogen leaching. Chemistry transport modelling (CTM). Impacts of CC on forests: bark beetle, frost damage. Statistical & dynamical downscaling – and comparisons.
Summary of requirements	A number of requests for raw RCM data, from multiple GCMs/RCMs, i.e., emphasis on uncertainty. Inputs to applications models: crop yield models, crop and soil simulation models, Daisy, CTMs, IPS bark beetle model, SBI frost model, hydrometeorological model. Changes in 50-year return values. Extreme value analysis (critical thresholds, return levels, exceedences).
Time periods and temporal resolution of interest	Main stated interest is CC rather than s2d timescales. Some want snapshots (2020s, 2050s, 2080s), others transient 1951-2100. Nearly all want time series. Predominantly daily (and/or monthly/seasonal). 3 requests for sub-daily (3/6 hours). 1 request for hourly (at high vertical resolution).
Geographical regions and spatial resolution of interest	Europe Nordic countries (Finland), N Germany, Mediterranean, N Italy, N Sea & Baltic Sea, Rhine, E Mediterranean, Greece, Alps, C/E Europe, Romania, Iberia & Balearics, Canary Islands *(18/20/)* 25/50 km gridded 'As good as possible' Station resolution
Essential variables needed	Tmean, Tmax, Tmin, Precipitation, 10m u & v mean/max wind, snow, MSLP, relative humidity, soil moisture, evaporation, PET, cloud cover, SW radiation, sunshine, *T/P upper air, 500hPa GPH, SH@ 5 levels, wind direction, soil temperature*
Suggestions for additional variables	Combinations, e.g., precipitation intensity & wind speed, T & wind speed. Boundary layer height.
Essential indices needed (e.g., extremes)	Heatwaves, Drought, daily PDSI, Flooding (duration and intensity), Daily max. precipitation total/intensity, max. 5-day rainfall, max. dry/wet spell, Fire, Blocking, NAO, Cyclones (will calculate)
Suggestions for additional indices	See above
Requirements in terms of spatial and temporal consistency	This question may not have been clear: 4 - don't know to all or no answer; 2 - no to all. For the rest, consistency is important. Spatial consistency is slightly more important than temporal consistency for multi-site information.

Preferred formats for probabilistic projections (i.e., PDFs, CDFs, maps, time series, percentiles, threshold exceedences, response surfaces, joint probabilities, other)	Time series: 10 definitely. PDFs, threshold exceedences: 7 definitely. Maps: 6 definitely. Percentiles: 4 definitely. Joint probabilities: 3 definitely. CDFs: 2 definitely. Response surfaces: 1 definitely. A lot "maybe" and "don't know", but not so many "no". Very few examples of joint probability: seasonal T/P change.
Preferred format for numerical output (e.g., ASCII, GRIB, NetCDF….)	NetCDF: 9 ASCII, GRIB: 6 xls, txt: 4 Most chose more than 1, e.g., several both NetCDF and GRIB.
Awareness of existing tools	
ENSEMBLES web-based downscaling service:	14 aware, 3 used it. 7 very likely to use it for s2d / 8 for CC. A lot "quite likely" & "maybe", fairly few "unlikely" & "definitely not" Requested additions: neural network approach, a weather generator (as a separate tool), random generated extremes outside the observed range
Direct access to downscaled output	10 very likely to access raw RCM output. 4 quite/maybe likely to access it. 2 unlikely. 5 very likely to access SDS time series. 7 quite/maybe likely to access it. 3 unlikely, 1 definitely not. 9: access to these data archives is sufficient. 1: likely sufficient, 1: don't know if sufficient.
Climate Explorer	8 aware, 2 used it. 5 definitely / 6 maybe useful to integrate it. Several "don't know".
ENSEMBLES R software for extremes	3 aware, 2 used it. 6 definitely / 4 maybe useful to integrate it. Several "don't know".
STARDEX extremes indices software	9 aware, 2 used it. 6 definitely / 3 maybe useful to integrate it. Several "don't know".
Scenario generator tools	
Usefulness of scenario generator tools	Definitely: 6, Maybe: 4. Don't know: 4, No answer: 3. No: 1.
Preferred outputs from such tools	Definitely/maybe: PDF/CDF: 8, Exceedences: 7, Percentiles, Maps &

	Time Series: 6. Joint probabilities: 6 definitely/maybe, 2 don't know (e.g., seasonal T/P). Response surfaces: 1 definitely, 3 maybe and 3 don't know.
Suggested capabilities of such tools.	To work on both Windows and Linux. To load RCM output and obtain higher-resolution output for user-specified locations.

CC = climate change. s2d = seasonal to decadal. SDS – statistical downscaling.

Analysis of the questionnaire responses, together with discussions at various ENSEMBLES and other meetings during year 3 (e.g., the WP6.2 meeting in April 2007), indicates that users are largely happy with the proposed ENSEMBLES outputs in terms of temporal and spatial resolution and variables covered. Clearly, access to daily time series output, whether from RCMs or statistical downscaling, is vital. A few users also want sub-daily information. Many users are happy to work with gridded outputs at 25 or 50 km, while several want station resolution information. Most users are happy with 'standard' variables (temperature, precipitation, wind and SLP are the most commonly requested), although some impacts applications, e.g., crop and chemistry transport modelling, require more complex inputs. The most complex requests were generally for inputs to statistical downscaling. Overall, there were no unexpected requests, e.g., with respect to extremes and indices, or geographical region.

In terms of preferred formats for probabilistic projections, the most requested format was time series, followed by both PDFs and threshold exceedences. There was also some interest expressed in maps, percentiles and joint probabilities (e.g., seasonal temperature and precipitation). These needs raise some challenges and contradictions which are returned to in Sections 4 and 5.

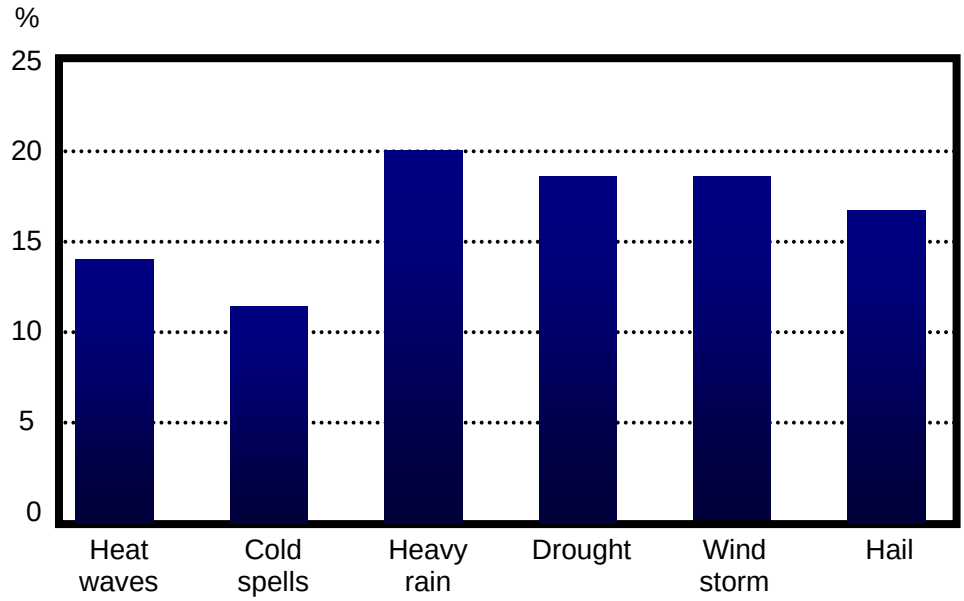
Users generally seem to show high awareness of existing ENSEMBLES and other relevant tools, such as the web-based downscaling service and Climate Explorer, although relatively few people have used them yet. There is also general support for better integration of these tools with ENSEMBLES climate model outputs. Perhaps reflecting the technical expertise of the respondents, there is also strong willingness to use raw RCM output and statistically downscaled time series directly. This is also consistent with the interest expressed in tools for analysis of extremes.

The responses on scenario generator tools were rather mixed and suggest that it is premature for either developers or applications users to know what capabilities would be most appropriate and useful. While six respondents thought a scenario generator tool would definitely be useful and one thought if would not, 11 were unable to give a definite answer. This comment indicates why it was understandably difficult for people to answer this set of questions: 'This sounds great but I have no idea how probabilistic regional scenarios exactly look like and what to expect from it. For example, in the case of a PDF of a time series, is the probabilistic regional scenario then a PDF of that PDF or a PDF of a time series?'. These difficulties are discussed further in Section 4.

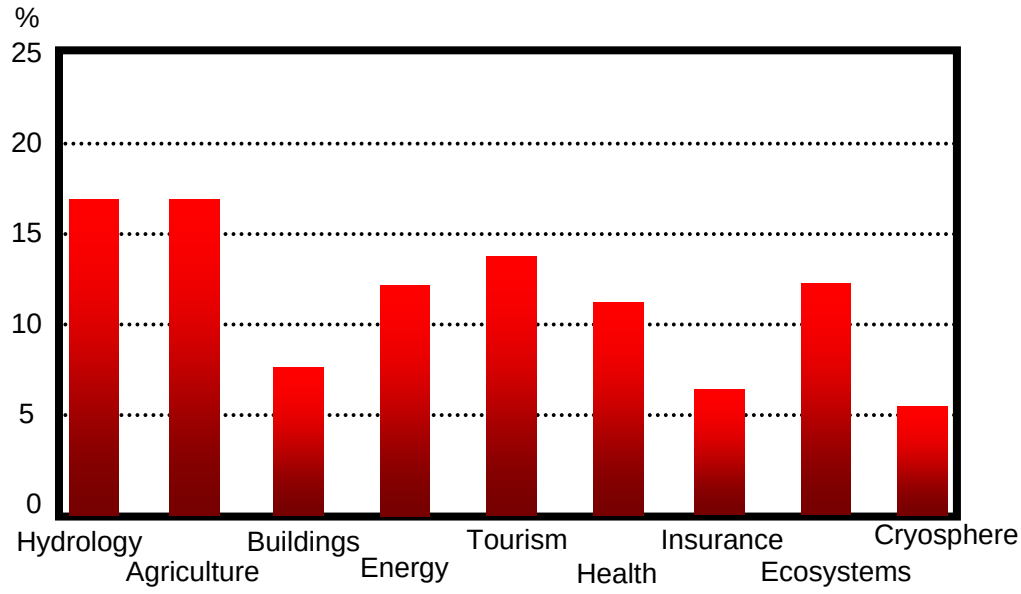
Finally in this section, we briefly report feedback from users who took part in the RT8 workshop on 'Climatic Change and Impacts in Eastern and Central Europe' which took place

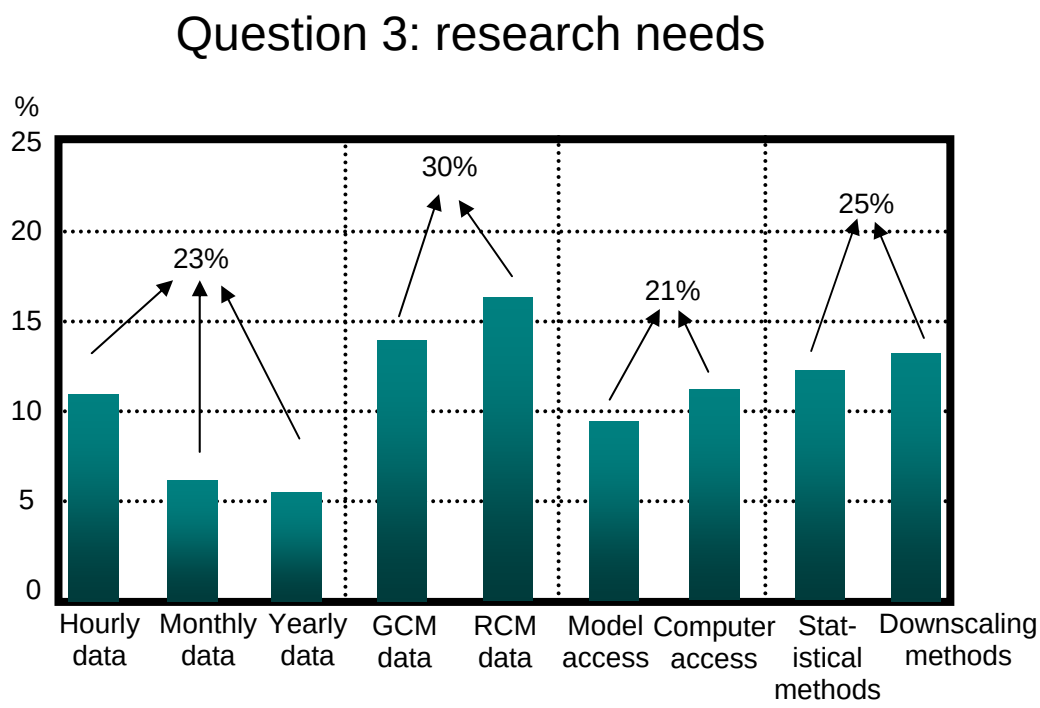
in Romania in September 2006. Participants came from 10 countries (Albania, Bulgaria, Croatia, Czech Republic, Hungary, Moldova, Poland, Romania, Russia, Ukraine). They were asked three questions and the responses are summarised below. The RT2B questionnaire was subsequently sent to all workshop participants, but no completed responses received. One general email reply said that the information about existing tools was very helpful and thought that integration of tools and standardisation of formats was very important, but noted that low-speed internet access can be a problem in some countries.

Question 1: importance of extreme events



Question 2: severity of impacts





3. ENSEMBLES STATISTICAL DOWNSCALING TOOLS

As reported in Section 1, the ENSEMBLES web-based downscaling service has recently been extended, as described in deliverable D2B.19, to take account of some known limitations and users' feedback. The resulting extensions to the portal are described in deliverable D2B.19 and the new version of the portal can be accessed from http://www.meteo.unican.es/ensembles.

The users' feedback comes primarily from two case-study applications by RT6 partners:

- Electricité de France (EDF), contact person Laurent Dubus:
  The aim of this user was to downscale DEMETER and ENSEMBLES S2D (seasonal to decadal) hindcasts to get daily maximum and minimum temperatures for a small network of stations (about a dozen) to make electricity demand forecasts.

- Joint Research Centre (JRC), contact person Fabio Micale:
  The aim was to downscale S2D hindcasts to get daily precipitation, radiation, wind speed, and maximum/minimum temperatures to perform crop yield modeling in Europe using the JRC dataset of gridded observations with a resolution of 0.5º (hundreds of locations).

Deliverable D2B.19 outlines how the following issues raised by the users have been addressed in the revised web service:

- The need to upload and update their own data into the portal in a simple form.
- The possibility to run perfect-model experiments (with reanalysis input predictors), obtaining an objective validation of the downscaling methods.
- The convenience of running several downscaling tasks simultaneously.

A number of extensions have also been implemented with respect to:

- Geographical area (now Europe, with ongoing discussions on extension to other areas)
- Statistical downscaling methods (a number of methods have been added, with ongoing discussions with RT2B partners on including further methods, e.g., ARPA-SIM CCA method)
- Computing architecture (now a local cluster with GRID computing capabilities)
- Data management (e.g., an OpenDAP client is now used to connect to the ECMWF ENSEMBLES data archives).

A new interface has also been designed to allow the user to check, profile and monitor all completed and pending tasks.

The web-based service also incorporates a data access tool, giving access to predictors for statistical downscaling. Predictors based on ERA-40 are currently available, as described in deliverable D2B.13. Predictors based on climate change GCM runs are now being obtained (for deliverable D2B.17), and the downscaling service extended to climate change timescales.

Here, we consider the extent to which work on the downscaling service has answered the following questions listed in Section 1:

4. *Can multiple SDS methods be combined in a single tool?*
   - Yes. In addition to the analog-like clustering algorithm included in the first version of the portal, a package of standard downscaling methods based on the MeteoLab Machine Learning Matlab Toolbox has now been included.

5. *Is it possible to incorporate more sophisticated data/computer intensive SDS methods (e.g., neural network methods) in such a tool?*
   - The computing architecture has undergone major revision recently and now allows multiple jobs from different users to be run simultaneously. This is achieved by using a local cluster with GRID computing capabilities, rather than a single machine. This increase in computing capacity gives the potential to incorporate more demanding methods.

6. *Does the ENSEMBLES web-based downscaling service provide a suitable focus for SDS tool development, or are additional tools required?*
   - Yes. Discussions with RT2B statistical downscaling groups will take place to study the requirements for including additional methods (e.g., the CCA method from ARPA-SIM) in the web service.
   - But additional tools may also be developed, e.g., GKSS conditional stochastic weather generator for marine surface wind. One ENSEMBLES partner has expressed a wish for a ‘free-standing’ weather generator for crop modelling applications.

7. *What predictor/predictand datasets should/can be incorporated in the tool(s)?*
   - Predictors are already available for ERA-40 and NCEP, together with the ENSEMBLES stream 1 and DEMETER seasonal hindcasts (through the ECMWF OpenDAP server).
   - Predictors for climate change stream 1 simulations from one GCM have been obtained, and others are being/will be obtained. This work has been delayed due to problems with data availability in the CERA database.

- All predictors for the downscaling methods included in the service are available, and a set of standard predictors is available for other users through the data access tool.
- Users have the option to select publicly available predictand datasets, e.g., the JRC gridded dataset, or to upload their own restricted datasets which are hidden from other users. The ENSEMBLES observed daily gridded dataset will be included in the service once it is available.

8. What case-study regions should/can the tool(s) be tested in?

- The downscaling service is currently operational over Europe. Discussions with RT6 partners and others have started to explore the extension of the service to other world regions (e.g., South America, West Africa, India, etc.) depending on the availability of observations. The extension to West Africa has been recommended in the context of AMMA/ENSEMBLES linkages.

4. DISCUSSION

Section 2 indicates that, although the response to the RT2B questionnaire was limited and focused on technical users, the replies are generally positive and encouraging, indicating that the approaches to the provision of regional climate information being taken in RT2B are appropriate and useful. No major gaps have been identified. Similarly, Section 3 indicates that the statistical downscaling web service is providing a valuable and evolving tool which is responsive to user needs. It has already developed into a much more major product and focus of work than anticipated at the start of the project. This is largely due to the considerable amount of unfunded effort put in by UC.

The questionnaire and other ongoing discussions within ENSEMBLES do, however, indicate a number of areas where more effort is needed.

It is evident, for example, that users are not always very certain about what sorts of probabilistic output they require or which are most appropriate for their particular application. There are also some challenges and contradictions – particularly concerning the strong desire for time series data, alongside probabilistic products such as PDFs and threshold exceedences. The emphasis on time series data may, in part, reflect the fact that the respondents are all rather technical users and most are happy and able to work with large data sets and to undertake their own detailed, quantitative analyses. Many stakeholders, in contrast, might be expected to be happier with simpler graphical outputs, with more emphasis on products such as maps.

Similar issues have arisen in development of the next national UK climate scenarios, UKCIP08, which will be probabilistic. The author of this report is on the UKCIP08 steering group and exchange of information and experiences between ENSEMBLES and UKCIP has proved very useful for both parties. In 2006, UKCIP undertook a detailed user consultation on preferences for the UKCIP08 package of information. The consultation was undertaken through a web-based survey and a series of workshops and meetings. The consultation clearly demonstrated that different users have very different needs. It was concluded that the design of the climate change information (and the delivery mechanism) cannot assume a uniform audience, and that to the user the package should appear only as complex as necessary. Thus UKCIP08 will provide users with information at three different levels: headline messages, published material, and customisable output. The User Interface will include an integrated

weather generator (Kilsby et al., 2007) that will allow daily and hourly 'time series' output for 5 km grid boxes to be produced by sampling from pre-prepared probability distributions (constructed by the Hadley Centre at 25 km resolution).

The preparations for UKCIP08, together with work in other UK research programmes (Goodess et al., 2007; SKCC Briefing Papers), also demonstrate the importance of good communication and the development of appropriate user guidance. The latter is something already taken on board with respect to the ENSEMBLES web-based downscaling service. In this case, experience from the user case studies (see Section 3) is informing the production of on-line user guidance and documentation.

The section of the RT2B questionnaire which users found most difficult to complete was that concerning scenario generator tools – suggesting that it is premature for either developers or applications users to know what capabilities would be most appropriate and useful (see Section 2). This is evident from the scarcity of definite answers and by the different responses on preferred output formats compared with the Part 2 questions on user requirements (respondents were offered the same set of choices in both cases). In the case of response surfaces, for example, the replies indicated more willingness to consider them as part of a scenario generator tool – three people thought they might be useful and three didn't know, together with one who thought they were definitely useful. Work is ongoing in WP6.2 to evaluate the utility of response surfaces for a number of simple example applications, so it is not surprising that people felt unable to provide more certain answers here.

The questionnaire did not attempt to outline what a scenario generator tool might do and no respondents were able to indicate the capabilities and facilities they would like such a tool to have (apart from one comment about computing platforms and another relating more to downscaling). Given the major methodological issues, such as model weighting (see deliverable D2B.8, for example) and modification of statistical downscaling methods for the construction of probabilistic projections (see deliverable D2B.14), which need to be resolved before such tools could be implemented, this lack of response from both potential developers and users is not surprising.

5. CONCLUDING REMARKS AND RECOMMENDATIONS

Concluding Remarks

Users clearly have a variety of requirements, but the strong focus in ENSEMBLES on extreme weather events puts the emphasis on climate information at high temporal (daily, and even sub-daily) and spatial (25/50 km and station) resolutions. There seems to be reasonable consistency between what RT2B is proposing to produce and user requirements. The web-based statistical downscaling service, in particular, is evolving well to meet user needs, addressing both seasonal forecasting and longer climate change timescales.

Without further testing of different output formats and approaches to impacts assessments (such as response surfaces) it is considered too early to produce a technical protocol for scenario generator tools. Such a protocol can also not be developed until major methodological issues such as weighting are more fully addressed.

Here, it should be noted that there has been no explicit discussion on the timescales that should be encompassed by scenario generator tools. However, the original proposal came

from WP6.2 and the main interest of questionnaire respondents was in climate change timescales. A number of assimilation, model weighting and debiasing techniques are already available for combining single-model predictions within a multi-model seasonal prediction ensemble (see, for example, deliverable D2B.12 – which also discusses user needs). Thus the implicit assumption (which may be challenged) is that such tools would focus on the longer timescales.

Although it has not been possible to meet all the original objectives of this deliverable, the work undertaken for it has helped to develop linkages between the developers and users of RT2B outputs and hopefully will help to ensure that the outputs produced over the final two years of the project are better tailored to user needs. More emphasis will also be given to the production of practical guidance on how to construct and use probabilistic regional projections – something which is recognised as still lacking (Fowler and Wilby 2007; Fowler et al. 2007). Recommendations for how this and some of the other issues raised here might be addressed are given below.

Recommendations

- This deliverable should provide one of the key starting points for work on the joint RT2B/RT6 deliverable: 'Recommendations and guidance on methods for the construction of probabilistic regional climate projections and their application in impact modelling'.

- More illustrative, working examples of probabilistic outputs should be made available to allow users to explore the utility of different output formats.
  (e.g., http://www.cru.uea.ac.uk/projects/ensembles/crupdfs/).

- The potential for integrating the facilities offered by existing tools for processing climate data (such as Climate Explorer, the ENSEMBLES R software for extremes and the STARDEX extremes indices software) with ENSEMBLES regional scenario outputs should be explored.

- Wherever possible, ease of access to data archives should be facilitated by, for example, using standard and consistent output formats (in terms of variables, domains, grids etc.). Use of OpenDAP and other methods for allowing remote and transparent use of large data archives should be encouraged.

- The regional scenarios web portal should continue to be updated and expanded as a resource for developers and the more technical users of regional projections.

- Further development of the web-based statistical downscaling service should be supported and, if possible, additional funding sought.

- Concerted effort is needed to address outstanding methodological issues such as weighting and PDF construction. The questions posed for the Prague cross-cutting workshop on Weighting, credibility, reliability, together with those discussed at a joint WCRP/ENSEMBLES/NCAR working lunch in July 2007, are very relevant here.

- RT2B cannot be expected to directly meet the needs of all users, particularly those outside ENSEMBLES, but can provide the building blocks, i.e., access to datasets together with appropriate guidance on methodologies and their use and, where possible, practical tools.

User-driven guidance, including underlying assumptions and caveats, is essential to prevent any such tool being used as a black box.

- Thus there should be as much emphasis on the development of recommendations and guidance (e.g., deliverable D2B.26) as on the projections themselves (e.g., deliverable D2B.33).

- The expected final outputs of RT2B need to be more clearly defined. Thus M2B.18 (Agreement on who will be producing probabilistic projections for which case-study regions/variables/temporal/spatial scales, how and from what GCM/RCM inputs) at month 42 is considered an important milestone for both RT2B partners and users.

6. REFERENCES

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Fowler, H.J., Blenkinsop S. and Tebaldi, C., 2007: Linking climate change modelling to impacts studies: recent advances in downscaling techniques for hydrological modelling. *International Journal of Climatology*, **27**, 1547-1578.

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Kilsby, C.G., Jones, P.D., Harpham, C., Burton, A., Ford, A.C., Fowler, H.J., Smith A. and Wilby, R.L., 2007: A daily weather generator for use in climate change studies. *Environmental Modelling and Software*, **22**, 1705-1719.

ENSEMBLES regional scenarios portal:
http://www.cru.uea.ac.uk/projects/ensembles/ScenariosPortal/
ENSEMBLES web-based downscaling service: http://www.meteo.unican.es/ensembles

SKCC Briefing Paper 1: Probabilistic climate information for the built environment and infrastructure:
http://www.k4cc.org/events/copy_of_0workshops/SKCC%20briefing%20paper%201.pdf/view
SKCC Briefing Paper 2: Applying probabilistic climate information for the built environment and infrastructure – the issues and challenges:
http://www.k4cc.org/events/copy_of_0workshops/SKCC%20briefing%20paper%201.pdf/view

UKCIP08: http://www.ukcip.org.uk/scenarios/ukcip08/
UKCIP08 user consultation : http://www.ukcip.org.uk/scenarios/ukcip08/consultation.asp

APPENDIX – The Users Requirement's Questionnaire

ENSEMBLES

Tailoring of ENSEMBLES regional climate scenario outputs to user needs: a questionnaire for users, stakeholders and scenario developers

ENSEMBLES RT2B (http://www.cru.uea.ac.uk/projects/ensemblesrt2b/) is responsible for the production of regional climate scenarios for impacts assessments. One of the primary objectives of RT2B is:

- To construct probabilistic high-resolution climate scenarios and hindcasts for European case-study regions and sub-regions and for Europe as a whole for indicators of extremes and standard surface variables, in formats which are appropriate for input to the RT6 assessments of the impacts of climate change as well as for more general end users and stakeholders.

This questionnaire is intended to assist in this objective, by seeking information about user needs and requirements for climate scenario data and tools.

Please do not feel obliged to complete all parts of the questionnaire, or to answer all questions within each part.

Please return completed questionnaire to Clare Goodess by 8 January 2007

Email: c.goodess@uea.ac.uk Fax: 44 1603 507784
Climatic Research Unit, University of East Anglia, Norwich, NR4 7TJ, UK

Part 1: About you

Name of institute and respondent (including email address)

If ENSEMBLES partner: partner number and work package number(s)

Your role: would you describe yourself as an academic researcher or stakeholder or both?

Part 2: Requirements of regional climate scenarios

Short description of work (including impacts sectors and impacts model(s) to be used)

Summary of requirements - an outline of how regional scenarios will be used quantitatively and/or qualitatively and the extent to which you aim to explore different sources of uncertainty in the emissions to impacts chain of uncertainty

Time periods of interest (e.g., seasonal-to-decadal, 2020s/2050s/2080s, next 20/50/100 years) and temporal resolution of data (e.g. daily, monthly, seasonal) ***Do you require time series data? Yes/no*** ***If Yes, please indicate resolution (e.g., daily/monthly)***

Geographical region(s) of interest and spatial resolution [e.g., station-scale, grid-box (please give preferred grid-box resolution and, if relevant, coordinate system)]

Essential climate variables needed (e.g., temperature, precipitation…)

Suggestions for additional climate variables (e.g., wind speed, sunshine…)

Essential climate indices needed (e.g., maximum 5-day rainfall and other specific indices of extremes, cyclones…)

Suggestions for additional climate indices (e.g., fire, blocking, heatwaves and other specific indices of extremes…)

Spatial and temporal consistency of data:

Do you need temporally consistent series (i.e. temperature/precipitation covariance should be realistic)? Yes / no / don't know

Do you need spatially consistent multi-site information (i.e., with similar spatial pattern to the observations)? Yes / no / don't know

Do you need temporally consistent multi-site information (i.e., with realistic daily inter-site correlations) Yes / no / don't know

Preferred formats for probabilistic regional climate scenarios

These scenarios can be presented in a number of different output formats. Please indicate which of the following are likely to be useful to you. Examples of some of these formats are available here: http://www.cru.uea.ac.uk/cru/projects/cranium/.

Probability density functions	Definitely / maybe / no / don't know
Cumulative density functions	Definitely / maybe / no / don't know
Percentile values of change (e.g., 10^{th}, 50^{th}, 90^{th})	Definitely / maybe / no / don't know
Probability of exceeding specified threshold(s)	Definitely / maybe / no / don't know
Response surfaces	Definitely / maybe / no / don't know
Maps	Definitely / maybe / no / don't know
Time series	Definitely / maybe / no / don't know
Joint probabilities (give examples of variables if possible)	Definitely / maybe / no / don't know
Any other(s) – please specify	

Preferred format for numerical (e.g., time-series) data (e.g. xls, dbs, ASCII, txt, CSV, GRIB, NetCDF)

Any other comments/questions

Part 3: Availability of observed climate data

RT2B will be focusing on a number of different case-study areas. The following have been suggested: The Alps, the Mediterranean, the Balkans/Danube Basin, the Rhine basin, the Baltic region, Scandinavia, as well as Europe as a whole. We are also aware that some ENSEMBLES partners, particularly those working on seasonal-to-decadal timescales in RT6, are interested in non-European regions, in particular Western and Southern Africa and India.

Observed climate data is important for calibrating and validating both climate and impacts applications models. The European 25 km gridded daily dataset being developed by RT5 will provide a valuable resource for this work. However, station data, or high-resolution gridded data, is required for some applications. Therefore RT2B is compiling a detailed catalogue of data (including metadata of quality etc.) for the ENSEMBLES regions of interest. This catalogue will be made available from the RT2B regional scenario web portal (to be launched by March/April 2007). Where possible, the data themselves will also be made available via the portal.

If you have access to any appropriate data sets that you are happy to be listed in the catalogue (but not necessarily the data themselves placed in the public domain), please could you complete the table below.

Observed data for ENSEMBLES regions of interest

Region covered by data set	
Number of stations or details of grid	
Variables	
Time period	
Has any data quality checking been carried out (e.g., checking for outliers)?	Yes/No/Don't know If Yes, please give details if possible.
Has any data homogeneity work been carried out (e.g., checking for breakpoints, comparison of neighbouring series)?	Yes/No/Don't know If Yes, please give details if possible.
Data restrictions	Are the data available for use: - by the respondent only - by ENSEMBLES partners only - unrestricted
Are the data available from a web site/data server?	If yes, please give details if possible
Publications describing the dataset	
Contact person for the data set	

Part 4: Statistical downscaling and scenario generator tools

Discussions with ENSEMBLES partners have identified a strong desire from applications users and others for statistical downscaling software tools (as much as statistically downscaled scenarios themselves), together with regional scenario generator tools. Thus we are seeking information about what people would expect from such tools and how they might use them. Based on this information as well as discussions amongst RT2B partners, a technical protocol for such tools will be produced in February 2007. The extent to which the RT2B description of work and implementation plans can be modified to implement the recommendations will require careful consideration.

The ENSEMBLES web-based statistical downscaling service:
http://grupos.unican.es/ai/meteo/ensembles/

Are you aware of this service? Yes/no
Have you used it? Yes/no

An extended version will be launched in February 2007, with further extensions to include more downscaling methods, and climate change timescales (currently it allows downscaling of seasonal-to-decadal hindcasts).

Do you think that you are likely to use such an extended tool?

a) For seasonal-to-decadal forecasts:
Very likely / quite likely / maybe / unlikely / definitely not

b) For climate-change timescales:
Very likely / quite likely / maybe / unlikely / definitely not

Are there any features/facilities you would like to see in future versions?

Are there additional statistical downscaling tools that you would like to have access to?
Yes / no
If yes, please specify (e.g., a weather generator, any additional variables…):

Any additional comments/questions:

Direct access to downscaled output:

Dynamically downscaled climate change scenario runs will be stored in the DMI central data archive http://ensembles-eu.metoffice.com/secure/confidential_deliverables_months13_24/D2B.3_central_server_hosting_RCM_output_data.pdf – which will be based on the PRUDENCE data archive (http://prudence.dmi.dk/).

Dynamically downscaled seasonal-to-decadal hindcasts (produced by INM) are being archived in the ECMWF MARS - http://www.ecmwf.int/services/archive/.

How likely is it that you will access 'raw' RCM output directly from these archives? Very likely / quite likely / maybe / unlikely / definitely not.

Statistically-downscaled time-series output can be made available, e.g., in a similar format to the STARDEX project (http://www.cru.uea.ac.uk/cru/projects/stardex/cda/).
How likely is it that you would access such 'raw' output:
Very likely / quite likely / maybe / unlikely / definitely not.

Is access to these data archives sufficient for your purposes, or would you prefer access to additional tools for processing the data and generating probabilistic scenario information?
Sufficient / would like additional tools

Any additional comments/questions:

Existing web tools for processing climate data

Climate Explorer
KNMI have developed the Climate Explorer http://climexp.knmi.nl/ which allows anyone to undertake various temporal and spatial analyses of climate data.

Are you aware of this service? Yes/no
Have you used it? Yes/no

Do you think that it would be useful to integrate the facilities offered by Climate Explorer with ENSEMBLES regional scenario outputs?
Definitely / maybe / no / don't know

ENSEMBLES R software for extremes
As part of ENSEMBLES RT4, UREADMM and NERSC have developed and tested statistical methods for exploring extreme events in gridded data sets - http://ensembles-eu.metoffice.com/secure/confidential_deliverables_months13_24/D4.3.1_software_J-LD.pdf. Software for these methods has been coded up in the R language and can be freely obtained from http://www.met.rdg.ac.uk/cag/rclim.

Are you aware of this software? Yes/no
Have you used it? Yes/no

Do you think that it would be useful to integrate the facilities offered by this extremes software with ENSEMBLES regional scenario outputs?
Definitely / maybe / no / don't know

STARDEX diagnostic extremes indices software
This STARDEX software is available from http://www.cru.uea.ac.uk/cru/projects/stardex/ and calculates 57 annual and seasonal extremes indices (such as percentiles, growing season length and wet/dry day duration) from daily temperature and precipitation time series. The two software elements (a Fortran subroutine that calculates all the indices for a single location and a Fortran program that uses this subroutine to process station data in a standard input format) are accompanied by a user information document.

Are you aware of this software? Yes/no
Have you used it? Yes/no

Do you think that it would be useful to integrate the facilities offered by the STARDEX extremes software with ENSEMBLES regional scenario outputs?

Definitely / maybe / no / don't know

Any additional comments/questions:

Scenario generator tools and outputs

A scenario generator tool would process dynamically and/or statistically downscaled output for user-specified locations, variables and time periods in a fairly transparent manner – presenting probabilistic regional scenarios in the desired format(s).

Would such a tool be useful to you:

Definitely / maybe / no / don't know

The outputs could be presented in a number of different formats. Please indicate those that would be useful:

Probability density functions	Definitely / maybe / no / don't know
Cumulative density functions	Definitely / maybe / no / don't know
Percentile values (e.g., 10^{th}, 50^{th}, 90^{th})	Definitely / maybe / no / don't know
Probability of exceeding specified threshold(s)	Definitely / maybe / no / don't know
Response surfaces	Definitely / maybe / no / don't know
Maps	Definitely / maybe / no / don't know
Time series	Definitely / maybe / no / don't know
Joint probabilities (give examples of variables if possible)	Definitely / maybe / no / don't know

Ideally, what capabilities/facilities would you like such a tool to have?

Any additional comments/questions: