C3S Climate Projection Workshop

1. Introduction

This document presents a summary of the "Copernicus Climate Projection" Workshop which was held in Reading Town Hall on 20 and 21 April 2015.

ECMWF has been entrusted by the European Commission to implement the Copernicus Climate Change Service (C3S). The aim of the C3S is to provide European stakeholders, including public authorities, businesses and citizens, with access to authoritative information about climate change and its impact on society.

The C3S portal and underlying Climate Data Store (CDS) will act as a distributed facility for providing information about past, present and future climate in terms of Essential Climate Variables and derived climate indicators. The CDS will include data from observational datasets, re-analyses, multi-model seasonal forecasts and climate projections at global and regional scales.

2. Workshop description

This workshop was held to explore the potential use of existing climate model projections at global and regional level for development of C3S applications and services, and to identify initial C3S information requirements in this area. The workshop also explored what kind of technical support is needed to bolster existing data access facilities in order to meet C3S operational service requirements. Specific topics for discussion included the current state of internationally coordinated activities on climate change projections, their future developments, and how to establish an effective synergy between C3S activities and current international programmes and facilities. The workshop was attended by 60 participants from European institutions, national meteorological services, research institutes and companies from around 15 countries.

The format of the workshop was a mixture of presentations and working group sessions. The detailed workshop programme is given in Appendix 1. The 16 presentations were organized along the following themes:

- Identifying users' needs;
- Regional aspects;
- Current capabilities;
- Scientific spectrum;
- Regional perspectives.

A set of suggested questions were prepared for each of the two days for the three Working Groups to discuss, with all groups addressing the same topics on a given day. They covered two broad areas:

Monday 20 April: "Operationalization" of climate projection information;
Tuesday 21 April: How does the level of science affect the delivery of climate information.

The complete sets of questions are given in Appendix 2.

3. Summary of discussion and recommendations

The discussion during the first day of the working group meetings was mainly focussed on what C3S could (or should) deliver in terms of access to climate projection data, on top of what is already provided by institutions acting as links between researchers and the user community.

In referring to the “user community”, it was pointed out that different categories of users should be considered, with different expertise and needs in terms of data access, post-processing and visualizations. Existing data facilities (eg ESGF nodes) and analysis tools are mostly suited to users with advance scientific knowledge and technical skills. However, C3S should also cater for operators in application sectors, who may have limited knowledge of climate modelling issues but need high-resolution data in specific domains, or media operators and policy makers, who may just be interested in graphical output.

Therefore, an important function for C3S is to provide a variety of tools to post-process and summarize information on climate projections at pan-European level, with appropriate quality control and documentation (from relevant meta-data to media-oriented summaries). In view of the considerable amount of raw data potentially accessible through the Climate Data Store, the generation of products which summarize and display the most important statistical aspects of the model output is an essential component of C3S. It is also expected that such products will allow a sufficient degree of flexibility to suit the needs of different users (for example, rainfall categories relevant for farmers are likely to be different from those required in flood warning).

Specifically, C3S is expect to provide reliable information on the uncertainties associated with the projected climate change signals. For global projections, such uncertainties arise as a result of three main factors: a range of possible emission scenarios, differences in the formulation of numerical climate models, and internal variability of the climate system (the latter being proportionally more important for shorter lead times, eg 2030-2050, and smaller spatial domains). There was consensus on the need to properly quantify the different uncertainty sources, which may require a focus on a high-quality subset of all projections available from the CMIP5 archive (CMIP6 in the future).

C3S is expected to deliver updated information from the most recently available projections. Since the production of projection runs tends to follow a schedule dictated by the CMIP and IPCC cycles, it was debated whether C3S should follow such a schedule or require more frequent updates. A large majority of participants agreed that there was no need to request the production of more frequently updated runs on top of those available from internationally coordinated project. Instead, a useful role might be played in filling current gaps in the data produced by different centres (for example, in terms of availability of a range of emission scenarios).

One specific example was the need of filling the “matrix” of projections from regional models. Apart from the choice of a specific geographical domain, such projections depend on both the emission scenario and the specific general circulation model (GCM) providing boundary conditions. A minimum set of scenarios and driving GCMs should be pursued, and the possibility of C3S providing resources for filling “holes” in the 3-D matrix (RCM-GCM-scenario) should be explored. In terms of geographical domains, both the current Euro-CORDEX and Med-CORDEX domains are important for EU Member States, and coordination with future CORDEX activities should be pursued.

During the second day, specific scientific requirements were discussed, with a focus on the pathway for a gradual improvement in the quality and quantity of C3S deliverables in going from the pre-operational to the operational phase.

Issues related to downscaling and the quantification of uncertainties were further debated. It was pointed out that downscaling (either statistical or dynamical) introduces further sources of uncertainties, which should also be quantified and documented. It was also noted that the selection of a limited number of GCMs for the provision of boundary conditions to RCMs tends to reduce the spread among regional projections. As a result, estimates of uncertainties derived from CORDEX runs are smaller than those obtained from the full range of CMIP5 models (although not necessarily wrong).

C3S could contribute to improve the delivery of regional projections in a number of ways. First of all, the experimental set-up should be should be properly designed in C3S in order to answer relevant scientific questions. In order to estimate model uncertainty for regional models, all RCMs should run downscaling experiments with boundary conditions from a specified set of (at least one) global model. Also, a range of emission scenarios should be covered (for example, RCP2.6 is not currently covered but it is important for users).

It was pointed out that filling the GCM/RCM matrix is a resource issue. Human and computational resources are needed not only to run experiments but also to manage data input and storage/documentation of results. It was recommended that C3S should provide additional resources, at least for data management and documentation. Suggested measures include the provision of reference GCM data as boundary conditions for regional downscaling in the C3S data store, as well as facilitating storage of output data according to CORDEX standards. As far as boundary conditions are concerned, the recent development of coupled regional models requires the provision of boundary conditions for the ocean/sea-ice state in addition to atmospheric variables.

On the general topic of whether C3S should set more stringent scientific targets than those currently set in CMIP5 or CORDEX, three specific issues was debated: the importance of fidelity (i.e. closeness to observations) in model mean climate and variability, the relevance of model resolution, and the need for a minimum ensemble size.

With regard to fidelity, there was a broad consensus on the difficulty of setting specific thresholds. However, it was recommended that full model fields should be provided to the CDS in addition to bias-corrected anomalies and tendencies. This is important to assess the physical consistency and reliability of the projected changes, and decide whether a specific GCM is suitable for providing boundary conditions in downscaling experiments. Adequate metrics should be available to C3S user to evaluate model fidelity for a range of domains and phenomena.

The trade-off between using resources to increase model resolution or to increase ensemble size was debated, although it was evident that no specific recipe exists to find the optimal balance. Such a balance is likely to depend on the space/time scale of interest and the specific research or application sector. However, there was a broad consensus on the need of a minimum ensemble size for scenario runs in order to estimate uncertainty sources. This issue should be addressed in planning the requirements for the operational phase of C3S.

Finally, the ‘maturity’ of initialized multi-decadal simulations for estimating climate change in the next few decades was discussed, with arguments both in favour and against an inclusion of these experiments in the C3S database. Overall, a widely accepted position was that data from initialized predictions should still be considered as experimental at the present time, but are likely to reach a mature stage by the time C3S moves to the operational phase. It was therefore recommended that C3S should support a proper assessment of the advantages of initialize predictions at decadal time scale, versus the disadvantages of estimating climate change signals while the model climate is shifting from the prescribed initial state to its own attractor.

Annex: list of questions addressed by the working groups during the Climate Projections workshop:

DAY 1

Operationalisation of climate projection information

Q1: What should/could C3S deliver in terms of data access on top of already existing facilities? **('existing facilities' include centres and institutions that act as a link between researchers and the user community).**

Q2: Should updated climate projections be available with a higher frequency than that associated with the CMIP/IPCC cycles? What are the user expectations?

Q3: Should C3S targets be different from those agreed in CMIP (e.g. larger ensemble size)?

Q4: How can C3S resources best be used to improve the delivery of climate scenario information?

DAY 2

How does the level of science affect how we deliver climate information?

Q1: How should we improve the quantification of uncertainty? How should the scientific limitations of our estimates be communicated?

Q2: How could the link between global and regional projections be improved?

Q3: How does the resolution of climate models affect the range of applications in which their data can be used?

Q4: Should C3S be more stringent on scientific quality? Should the output from different models be weighted according to "model fidelity", or should a quality threshold be established?

Q5: What timescales should C3S put emphasis on? What science is needed to achieve this?

Q6: Should C3S actively support technical development towards EUCPxx? In which ways? What time frame?

Q7: (please provide exact text) What kind of tools/facilities are needed to merge climate information from different sources?