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**PRIMAVERA**

Grant Agreement 641727

**PRocess-based climate sIMulation: AdVances in high resolution modelling and European climate Risk Assessment**

# Deliverable D11.4

# PRIMAVERA Data Viewer

| | |
|---|---|
| Deliverable Title | *PRIMAVERA Data Viewer*<br>*(The original name of this deliverable was "Energy Sector Visual Prototype". The requested name change was submitted to the EC through the portal on 10-09-2019, and was made to show that the viewer is more than just a tool for a single sector, but can be applied across many systems and sectors.)* |
| Brief Description | **Updated description:** The Data Viewer prototype is a data visualisation platform presenting indicators and indices of interest to a diverse user base. It provides a visual exploration of results obtained from different global climate models highlighting the improvements in climate information from higher resolution.<br>***Original description:*** *The prototype will be a visual illustration and background information of climate projections and impacts up to 2050, communicated in an experimental, quasi-operational mode for this [energy] sector.* |
| WP number | WP11 |
| Lead Beneficiary | *BSC* |
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| | |
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| V1 | 03/01/2020 | D. Bojovic | |
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| V2 | 08/01/2020 | M. García | |
| V2 update | 10/01/2020 | E. Palin | |
| V3 | 29/01/2020 | D Bojovic | Submitted to the project coordinator |

PRIMAVERA

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# 1. Executive Summary

The objective of this deliverable was to develop and test the PRIMAVERA Data Viewer (https://uip.primavera-h2020.eu/data-viewer). The Data Viewer illustrates the project results, focusing on the visualisation of different models' resolutions. We selected several well-known indices to present these data in an interactive map. In the interactive map, data from two different global climate models (GCMs), or from the same model run with different spatial resolution, is represented simultaneously, separated by a slider. In the "mirror" option two maps with different datasets are visible on the screen. This allows the user to compare high and low resolution models in order to easily visualize the detail added by the high resolution. Alternatively, two different models of similar resolution can also be compared.

The report provides a short description of the Data Viewer and details the prototype evaluation process. For the latter, we used a well-established user experience approach called evaluation heuristics. This allowed us to obtain users' perspective on the usability of the developed interface. Following the common usability principles classification, we organised the users´ feedback under the major and minor usability problems. The interaction with users helped us design and propose best approaches to address these problems. Suggestions and ideas obtained through the interactions with users served to develop an improved Data Viewer prototype with a user-friendly interface.

## 2. Project Objectives

With this deliverable, the project has contributed to the achievement of the following objectives (DOA, Part B Section 1.1) WP numbers are in brackets:

| No. | Objective | Yes | No |
|---|---|---|---|
| A | To develop a new generation of global high-resolution climate models. *(3, 4, 6)* | | x |
| B | To develop new strategies and tools for evaluating global high-resolution climate models at a process level, and for quantifying the uncertainties in the predictions of regional climate. *(1, 2, 5, 9, 10)* | | x |
| C | To provide new high-resolution protocols and flagship simulations for the World Climate Research Programme (WCRP)'s Coupled Model Intercomparison Project (CMIP6) project, to inform the Intergovernmental Panel on Climate Change (IPCC) assessments and in support of emerging Climate Services. *(4, 6, 9)* | | x |
| D | To explore the scientific and technological frontiers of capability in global climate modelling to provide guidance for the development of future generations of prediction systems, global climate and Earth System models (informing post-CMIP6 and beyond). *(3, 4)* | | x |
| E | To advance understanding of past and future, natural and anthropogenic, drivers of variability and changes in European climate, including high impact events, by exploiting new capabilities in high-resolution global climate modelling. *(1, 2, 5)* | | x |
| F | To produce new, more robust and trustworthy projections of European climate for the next few decades based on improved global models and advances in process understanding. *(2, 3, 5, 6, 10)* | | x |
| G | To engage with targeted end-user groups in key European economic sectors to strengthen their competitiveness, growth, resilience and ability by exploiting new scientific progress. *(10, 11)* | x | |
| H | To establish cooperation between science and policy actions at European and international level, to support the development of effective climate change policies, optimize public decision making and increase capability to manage climate risks. *(5, 8, 10)* | x | |

# 3. Detailed Report

The original title of this deliverable – “Energy sector visual prototype” – was amended to “PRIMAVERA Data Viewer”, with approval from the project’s Technical Officer at the EC, to better reflect the results that we wanted to achieve in this task. Namely, the PRIMAVERA Data Viewer goes beyond presenting the data only relevant for the energy sector. Instead, the indices it presents can be useful to other sectors too, for example health and transport. The prototype Data Viewer is ready and accessible online. It is linked to the PRIMAVERA User Interface Platform, providing additional information relevant for users and promoting the exploration and interaction of users with some of the PRIMAVERA results. It will be updated in the coming months as new project data becomes available.

Due to the delay of the delivery of the forcing data from the CMIP6 initiative, that we needed for conducting future model runs, the project was extended for nine months. Accordingly, D11.4 as well as some of the other project deliverables, was postponed to the project month 51 (from the original 36).

## 3.1 The Data Viewer initial prototype

An initial prototype was developed using the available data produced in the project and the knowledge on climate indices and indicators relevant for different users.

The data viewer is seamlessly integrated in the UIP as a new section in the main header/menu.

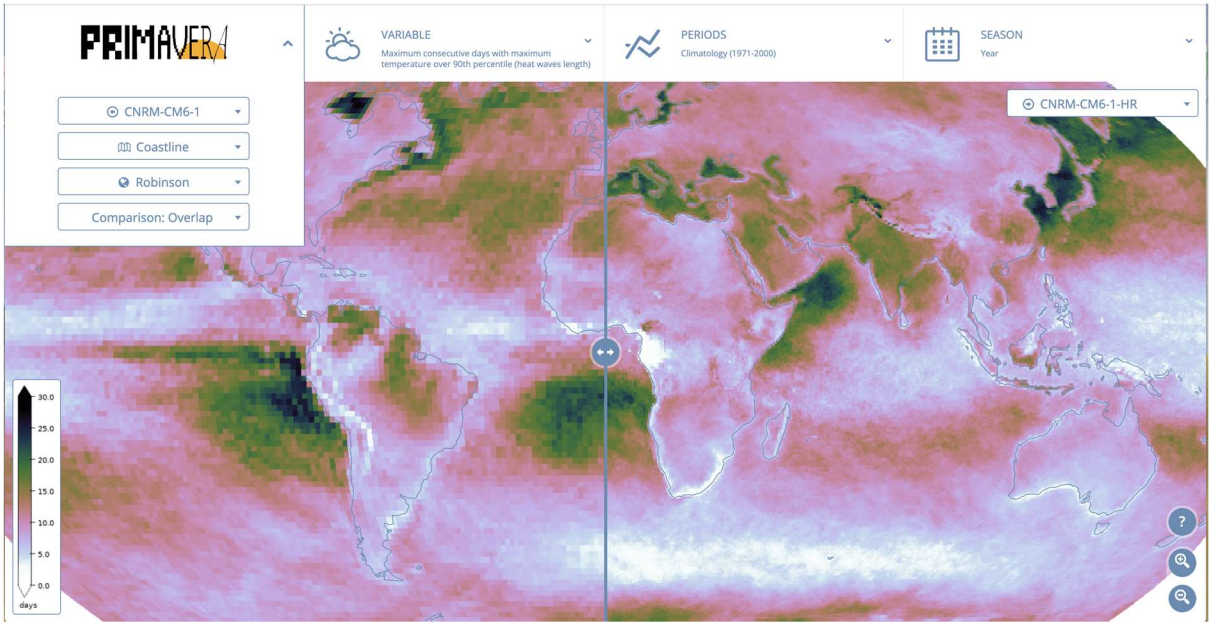


Fig. 1 First prototype of the Data Viewer

## 3.2. Data Viewer evaluation for getting a user-tailored prototype

### 3.2.1 The evaluation approach

The Data Viewer prototype (DV) has been developed using a co-design approach. After the first prototype had been developed, we used a heuristic evaluation, *a usability inspection* method for computer software that helps to identify usability problems in the user interface (UI) design and define best approaches to address these problems (Nielsen and Molich, 1990; Nielsen 1994). The evaluation is done through interviews that include the examination of the interface, judging its compliance with recognized usability principles (the "heuristics").

The 10 key heuristics are: Visibility of system status; Match between system and the real world; User control and freedom; Consistency and standards; Error prevention; Recognition rather than recall; Flexibility and efficiency of use; Aesthetic and minimalist design; Help users recognize, diagnose, and recover from errors; Help and documentation.

We grouped the 10 key heuristics into three categories: (I) Major usability problems, (ii) Minor usability problems and (iii) No usability problems.

The main objectives of the evaluation process were to:

1. Discover the main problems while navigating the Data Viewer (DV).

2. Discover how the user interacts with the platform and see what information is missing

3. Work on the changes needed to make the interface clear and easy to use.

We conducted six in-depth evaluation interviews (the interview guide is available in Annex 1) with participants with different backgrounds: a climate scientist, a social scientist, a computer scientist, a participant with technical non-academic background, a participant with non-scientific and non-technical background, and a master student in sustainability studies.

Combining the heuristic evaluation approach with the interviews, we were able to make the Insight Statements (Section 3.2.2.1). This helped us create a recommendation list and finally a mock-up proposal where we can see visually the ways to approach the recommendations.

### 3.2.2 Results of the evaluation

After the interviews, we created an affinity map (Fig. 2), where we could see the patterns in the main problems in the platform and how the users were responding to them.

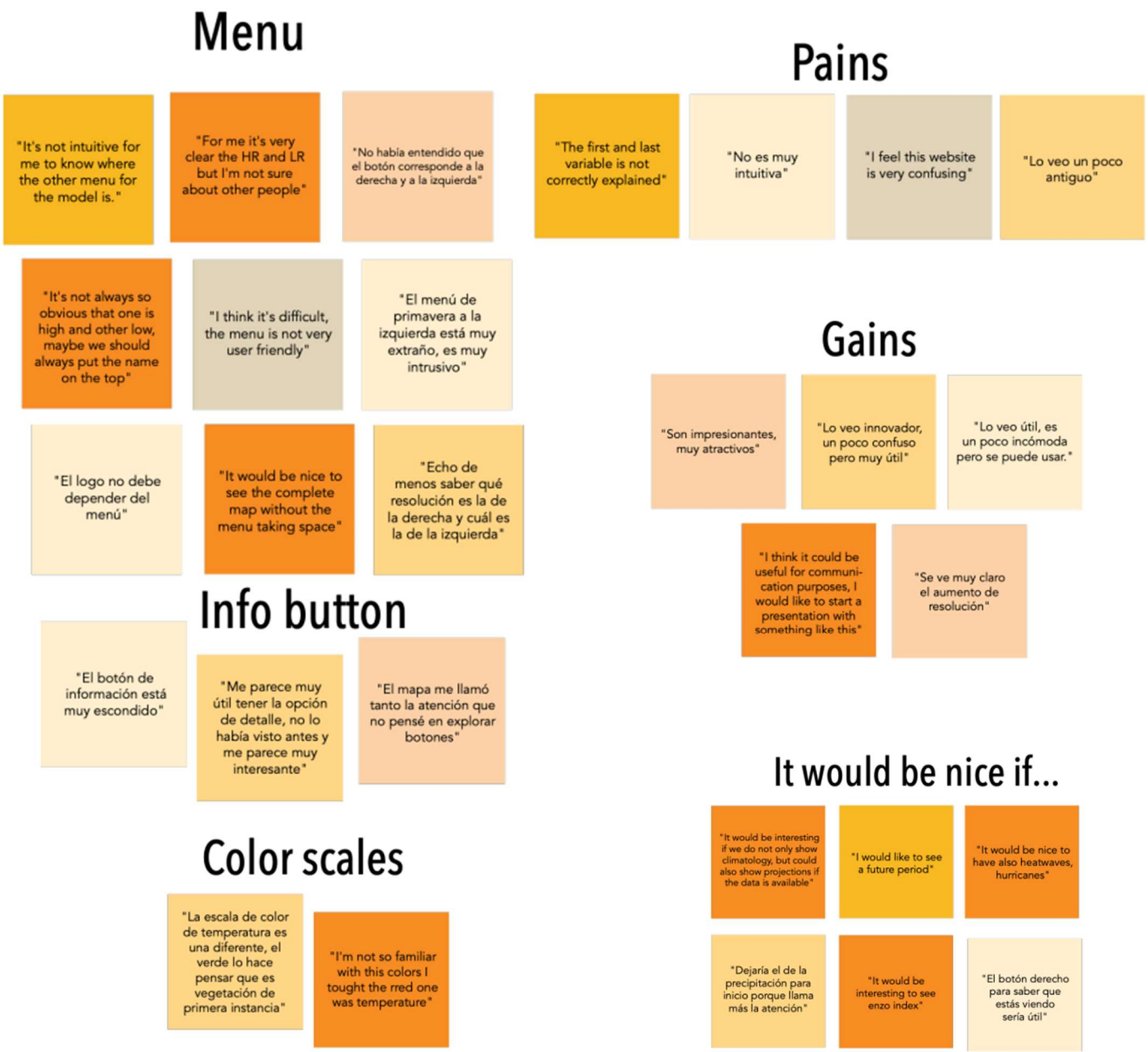


Figure 2. Affinity map based on the results from the interactions with users

### 3.2.2.1. The general insights

The most important general insights obtained from the interviews were the following:

1. Users found the comparison and data very useful and innovative.
2. Info button **"?"** was not well located. Users could not easily find it and its purpose was not clear.
3. The menu was not intuitive. The climate model selectors should be visible in the same range so the users know they can choose the model on each side of the screen.
4. Users found the first index (95$^{th}$ percentile of daily precipitation) the most attractive. The green colour palette in the "90th percentile of daily maximum temperature" index

reminded the users of vegetation, they were used to the red colour for presenting temperature-related indices.
5. Users found it difficult to associate the information from the pop-up window with the variables they chose.
6. Users missed information about what the comparison was about.

The main usability strengths recognised by the users are the flowing:
1. The colour-scale is colour vision deficiency friendly;
2. Slider is intuitive;
3. Details are useful and interesting;
4. Zoom is intuitive with trackpad;
5. Comparing GCMs is very useful.

#### *3.2.2.2. Usability problems*

Interactions with the users and results obtained from the interviews helped us organise the platform usability problems in three categories. Here we show in which category and why each of the 10 common usability principles (heuristics) pertains, based on the DV first prototype evaluation.

The interviewed users recognised three **Major Usability Problems:**
1. Visibility of the system state – the system should always keep users informed about what is going on, through appropriate feedback within reasonable time.
2. User control and freedom – Users sometimes choose system functions by mistake and need a clearly marked "emergency exit" to leave the unwanted state without having to go through an extended dialogue.
3. Help and documentation – the first prototype lacked help and documentation. Any such information should be easy to search for, focus on the user's tasks, list and define used concepts, and not be too long.

Identified **Minor Usability Problems** are the following:
1. Aesthetic and minimalistic designed – every extra unit of information in a dialogue competes with the relevant units of information and diminishes their relative visibility.
2. Match between the system and the real world – the system should use the users' language, with words, phrases and concepts familiar to users, rather than system-oriented terms. The portal should thus follow real-world conventions, making information appear in a natural and logical order.
3. Consistency and standards – the platform should follow established conventions, when it comes to terms, situations, or actions on the platform.

The interviewees found **No Usability Problems** regarding:
1. Error prevention – a careful design which prevents a problem from occurring in the first place is better than good error messages.
2. Flexibility and efficiency of use – highly usable systems are flexible enough to be efficient for experts and friendly for new users. Usable systems let the user choose their methods of interaction.
3. Help users recognise, diagnose and recover from errors – error messages should be expressed in plain language (no codes), precisely indicate the problem, and constructively suggest a solution.
4. Recognition rather than recall – minimize the user's memory load by making objects, actions, and options visible. Instructions for use of the system should be visible or easily retrievable whenever appropriate.

Besides recognising certain usability problems, after testing the prototype, the general impression of the users was positive. We provide below some quotes from the interviews:

> *"I see it very innovative, perhaps still a bit confusing, but potentially very useful"*
>
> *"I think it could be useful for communication purposes, I would like to start a presentation with something like this"*
>
> *"Very impressive and attractive"*
>
> *"The increase of resolution can be seen very clearly"*
>
> *"I was so attracted by the map, that I didn't even think of exploring the buttons"*
>
> *"I would like to see a future period"*

### 3.2.3. Recommendations from the evaluation process

We explored possible solutions to address the issues recognised by the users and presented under the main insights and the usability problems. For this purpose, we developed an interface mock-up, where we could experiment with the suggested changes and search for the best solutions (Fig. 3). The data viewer interface is being updated based on the recommended solutions (Fig. 4). The following five changes are adopted in the improved DV prototype (https://uip.primavera-h2020.eu/data-viewer).

1. The **?** button is moved to a more visible place. In addition, an "Info" icon is added to suggest the function of it.

2. The menu is redesigned, providing different information in different order. We used the header for the menu, where all the variables can be selected. The models selection functionality is modified and the selection options are provided at the same eye-level, while selected model's name stays visible while performing activities on the portal.

3. The default display is the index that users found the most intuitive: "95th percentile of daily precipitation".

4. The colour palette originally used for the "90th percentile of daily maximum temperature" reminded the users of vegetation, since they were used to red as the warmest temperature colour. To solve this, we changed the colour palette.

5. We added an information page named "About". This page provides information about the platform, definitions of the indices, and the link to the PRIMAVERA project website with more information about presented GCMs and the PRIMAVERA model experiments. The information is provided in the form of FAQs. This is a living page and it will be updated during the lifetime of the project when the new content is provided or feedback received from users or partners in the consortium. In addition, and based on recommendation from the project consortium, we added a disclaimer: "The PRIMAVERA Data Viewer is intended for illustrative purposes only – the climate model simulation results shown are not intended for use in decision-making. [More information at the About page].

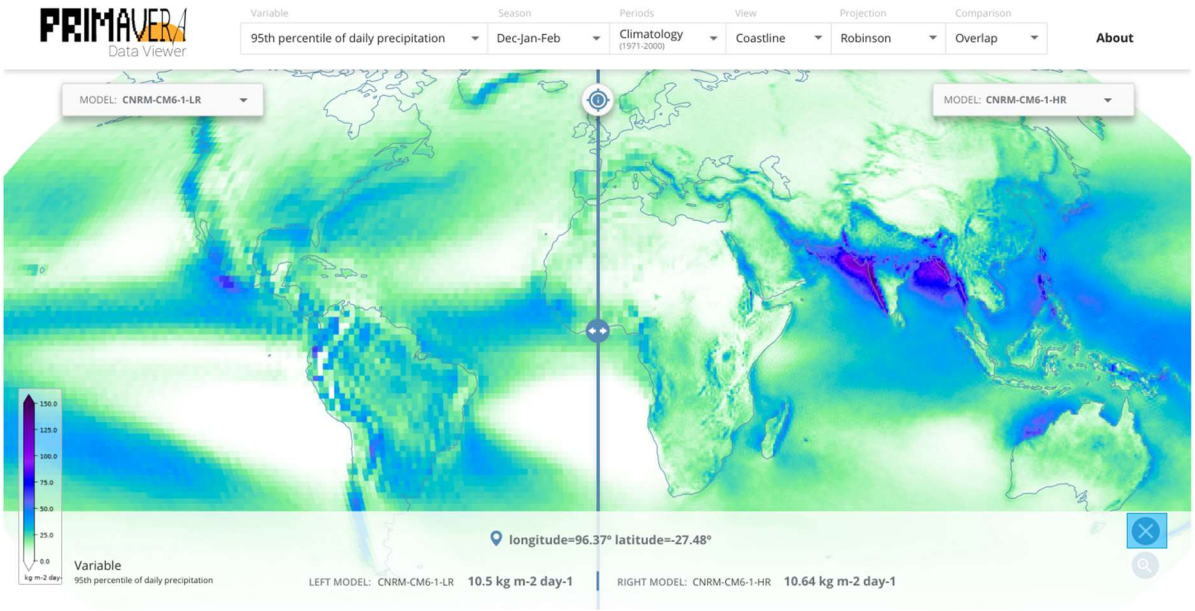


Figure 3. A mock-up interface with the solutions for the recognised usability problems

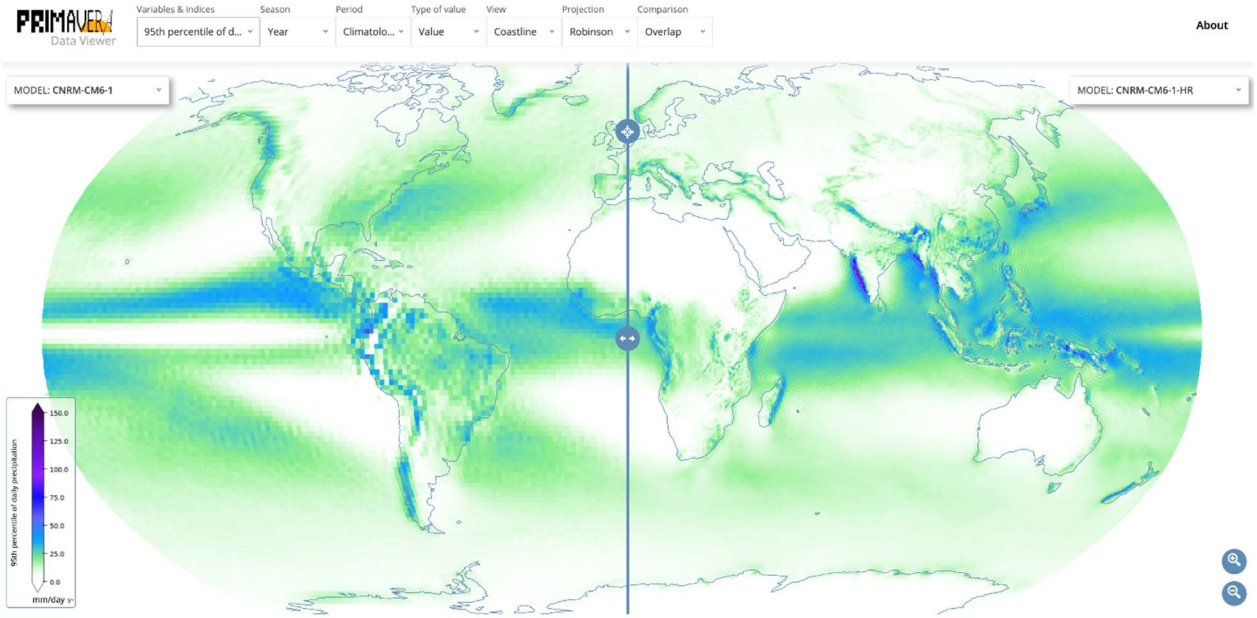


Figure 4. Updated Data Viewer

## 4. Lessons Learnt

Visually presenting data from the GCMs was a challenging task. But once the first prototype was available, it was well received, not only by scientists involved in the PRIMAVERA project, but also by users. Having an intuitive tool that provides a visual comparison of different model resolutions was pointed out as a useful dissemination tool that can be also used for presentations and talks.

The lessons learnt are related to three different aspects of the work.

1. Working with high resolution global climate data:
    - A fast WMS server with netCDF support (adaGUC) was used to enhance the viewer responsiveness.
    - We learnt how to use JASMIN HPC cluster to access the data and to compute the indices.
    - Daily frequency data from high resolution GCMs required memory efficient workflows so it did not fill the memory of the computing cores.
2. Visual presentation of global climate data:
    - While selecting the indices, we opted for well-known ones and those that can be visually presented in a meaningful way. Selecting the colour scheme was yet another challenge.
    - The scheme we used, cubehelix (Green, D.A. 2011), has been chosen in line with the colour palette used by IPCC. It proved very intuitive for some indices, while less user-friendly for the others.
    - Precipitation 95$^{th}$ percentile has its own colour scheme, which was positively evaluated.
3. Heuristic evaluation of the user interface design:
    - The experience from conducting the heuristic evaluation was very positive.
    - It is a practical approach for providing, in a systematic manner, user feedback to the interface usability, contributing to the co-design of the portal.
    - This methodology, however, demands face-to-face interaction and is time intensive, asking for motivated users who have time available to devote to the evaluation.

## 5. Links Built

This deliverable was supported by participants from WP10, who provided the project results presented in the DV and additional information. Additionally, we collaborated with other project partners, from different WPs, including WP9, to obtain data and indices.

## References

Green, D. A. (2011). A colour scheme for the display of astronomical intensity images. arXiv preprint arXiv:1108.5083.

Nielsen, J., and Molich, R. (1990). Heuristic evaluation of user interfaces, Proc. ACM CHI'90 Conf. (Seattle, WA, 1-5 April), 249-256.

Nielsen, J. (1994). Heuristic evaluation. In Nielsen, J., and Mack, R.L. (Eds.), Usability Inspection Methods. John Wiley & Sons, New York, NY.

# Annex 1 The interview guide

## Purpose of this document

This document lists out the tasks and topics that will be covered during the research sessions with scientists, researchers and different users of the Primavera Data Viewer taking place at BSC on November 2019. This document is a rough guide towards the points that will be covered and the order in which they will be discussed. It is not verbatim script so that the moderator may have a more natural conversation with participants and may explore points of interest, both expected and unexpected, as they arise.

## Overall research parameters

| | |
|---|---|
| **Role** | Scientific and research users |
| **Session duration** | 25 min |
| **No. of Participants** | 1 |
| **Logistical requirements** | Desk-based interview, recorder, laptop with internet |
| **Product** | Primavera viewer |
| **Prototype** | No prototype, user interview with actual tool (nov 2019) |
| **Notes to moderator** | Current state of tool<br>Think out loud |

## Pre evaluation interview

| No | Section Title | Objectives | Priority | Duration |
|---|---|---|---|---|
| 1 | Introduction | - Greet and explain the purpose of the study<br>- Ensure the participant feels comfortable<br>- Start recording | Low | 3 min |
| 2 | Background | - Understand participant background and experience with the tool | Medium | 5 min |
| 3 | Think out loud excersice | - Understand how the user interacts with the tool and get to know what i on his/her mind while using the tool | High | 10 min |
| 4 | Wrap up | - Final comments, discussions and thank you | Low | 5 min |

# 1 Introduction

Thanks so much for coming!

You will be helping me to evaluate the Primavera Data Viewer in its current state.

We are going to talk about different aspects of the processes you go through when analysing and looking for content in the Primavera Data Viewer. At certain points in our discussion I'm going to ask you to complete some tasks using the current platform.

Our objective is to get a clear view of how you use the tool, in which kind of situations and how to improve the tool to meet your needs. To get the best results, I'd like to ask you to use a technique called 'think out loud'. This means I'd like you to tell me what you are thinking, feeling and doing whenever you are completing a task. It may feel a bit unnatural at first, but it gets easier as you go ahead.

If you feel uncomfortable at any stage, just let me know and we can stop the session. I'm not evaluating you; I'm evaluating the tool, so there are no wrong answers. Please be as honest as you can, and don't worry if you get stuck - it just means you've found a problem with the tool, which will help us to make it better.

I'll be recording the session using software records audio and video, as well as what you do in the tool. The recording will be used only for research purposes, it is confidential and will not be shared. Is that OK with you?

Do you have any questions before we start?

# 2 Background

Can you tell me about yourself, where do you work?

What's your role there?

Can you tell me about your daily routine and in which moment would you interact with the tool?

For what purpose do you use it for?

What do you do with the information you get from the tool?

What's your biggest challenge when using the tool?

Which are your other information sources beside the PRIMAVERA Data Viewer?

What apps/websites? why do you like them?

Can you show me how you would use the tool in a regular task? (please remember to think out loud while navigating.)

What do you think we should change? How can it help you to meet your objectives as a user?

If you'd have to give it three adjectives what would they be?

## 3 Think out loud task

Can you show me how would you start using it?

What would you be searching for?

Could you please compare 2 models?

What were your expectations while using that index? Why?

Is there any information you would like to see in this moment? Why?

How do you do that? Is it easy to find it? Why?

What do you think about the presented information? What calls more attention? why?

Is there something you don’t understand?

## 4 Wrap up

Thank you very much for your cooperation with this exercise.

Do you have any final comments or questions?