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Compilation of a guideline providing comprehensive information on freely available climate change data and facilitating their efficient retrieval

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ABSTRACT

This paper deals with the subject of elaborating a guideline on the use of climate data, which have been made available to the climate-change and climate-impact community as well as to the general public. The therein descripted data is a gridded dataset on 1 km nominal resolution for Austria, consisting of observational data as well as of bias corrected climate model output. It covers the area of Austria. The aim of this paper is to make reference to this guideline that is by now accessible for those interested in using the dataset as well as for those creating datasets planning to provide guidance to their data users.

1. Background, motivation

There is a high demand for regional climate change data (Roessler et al., 2017) including especially temperature, precipitation, wind speed, global radiation and relative humidity. High spatial and temporal resolution is asked. In 2016, a climate dataset for Austria was made publically available with the aim to provide a new standard to which climate and climate impact researchers may refer to in order to attain higher levels of comparability amongst findings accomplished in various studies. This dataset is called 'ÖKS15' (Chimani et al., 2016; data.ccca.ac.at) and consists of regional climate model output for Austria provided by EURO-CORDEX (Jacob et al., 2014) that has been further downscaled by a modified Quantile Mapping technique named 'Scaled Distribution Mappings' (Switanek et al., 2017). When ÖKS15 was first issued it contained 13 regional-scale, daily based, climate change projections on a 1 km grid across Austria for each of the three following Representative Concentration Pathways (van Vuuren et al., 2011) – RCP2.6, RCP4.5, RCP8.5 as well as observational gridded datasets used for their generation. Later it was enlarged through model runs of the SRES-Scenarios from the ENSEMBLES-project and others based on reanalyses.

Freely available websites offer such high resolution datasets based on different methods and assumptions but often provide contradictory results (Hewitson et al., 2014). As no information is available to guide the users on the choice and the correct way to use the data they are often chosen e.g. on basis of availability or convenience of format (Barsugli et al., 2013). The demand on background information of guidance about the dataset's potential applicability by the users was also visible during discussion with stakeholders, interested in making use of the ÖKS15 dataset. This set the floor for the creation of a guideline tailored narrowly to user needs.

The guideline is designed in order not only to provide users with information on how to conveniently access the data, but also to supply them with important facts regarding their aptitude and limitations in various applications in a comprehensive and easily understandable manner. Particularly the second objective is of outstanding importance, since mere technical feasibility of generating data in various spatial and temporal resolutions often disregards the scales on which underlying physical equations are valid and draw meanings. Such lack of insight inevitably entails significant losses in resources, for instance, due to the conductance of broad research endeavours based on data unsuitable for conclusive inferences and, even worse, results that shouldn't be used unquestioned. Therefore, great attention has been devoted to characterizing ÖKS15 data in terms of quality, applicability, and so forth. Another aspect that had to be borne in mind when compiling information in a user-friendly way is the degree of user acquaintance with

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climate change in general. And there is, in fact, considerable diversity in this respect. Thus, we felt it reasonable to offer not only facts about the data itself but also background information on climate change in a rather broad sense.

2. General outline of the guideline

The guideline consists of three independent parts and further contains a list of abbreviations as well as short explanations of less familiar terms. General information on climate change related topics (e.g. climate models, uncertainties, downscaling) are elaborated in the first part of this guideline. Most fundamental and important facts are summarized in colored boxes providing an overview that is potentially sufficient for the purpose of users who are not interested in details. Further boxes marked with an exclamation mark contain more details. These, thus, provide additional information that is of conceivable value to a broad scope of users. While this information is available in other sources as well (guidelines, webpages, e.g. EURO-Cordex-Guideline (EURO-Cordex-Community, 2017), IPCC-Data Distribution Center (http://www.ipcc-data.org/),…), they were included in order to make the product more convenient to the reader. The advantage of including this information is the easy access, as it is provided together and with information on the dataset they plan to use. Moreover, as the users have been involved in the process as stakeholders, they know that the information is available and how to access it.

The guideline's second part deals with results characterizing ÖKS15 as well as datasets used in its generation. Hence, this part treats both, evaluations and a showcase from agriculture and is – according to the datasets used – organized in three sections: (i) observational gridded data, (ii) climate projection and (iii) showcase results. Subsections deal with answers to questions posed at their start on various important issues essential for respective datasets. These subsections' structure is similar to that of the first part. The topics dealt with in this part vary from simple statistical performance indicators (e.g. mean errors), to more complex questions like effects of meteorological conditions, different regions and periods on data quality (Figs. 1 and 2). The showcase deals with the uncertainties caused by different ensemble members (Fig. 3) and the effect of changes in spatial resolution. This part is the main part of the guideline as this information is not easily accessible in any other way. Scientific publication need more time to be published and are not easily access- and understandable for all data users. As the dataset ÖKS15 is intended as a dataset that should help to create comparable studies on climate change and its impacts, it is essential that the evaluation of the dataset is available as quickly and easily accessible as possible in order to ensure reliable analyses based on this data.

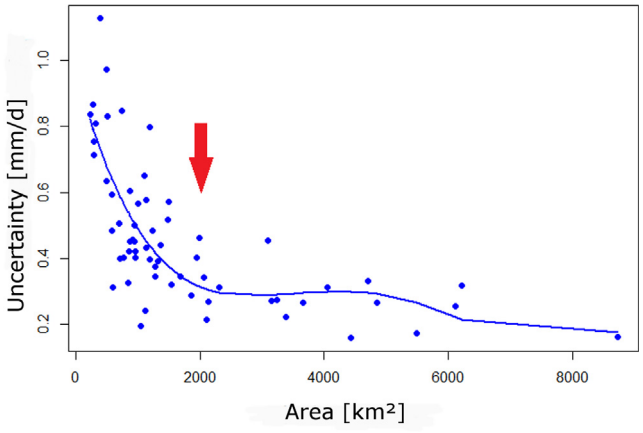

Fig. 1. Uncertainty of daily precipitation values for river catchments (y-axis), dependent on the catchment areas (x-axis). The graphic shows the influence of spatial resolution (represented by the catchment areas) on the reliability of the observational precipitation data set. Each uncertainty estimate is given by the standard deviation of a 100-member ensemble of the areal averages of daily precipitation for a given catchment over a period of 9 years. The ensemble is based on the geostatistical method described by Frei and Isotta (2019). The arrow marks the area which can be associated with the effective resolution of the data set. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

The third part addresses questions raised by stakeholders or occurred throughout developing of the guideline. This chapter shows a somewhat different structure, since every question is answered in a separate subsection, without giving a summary or additional information. This way, as well as by the use of a more personal style of writing compared to the other parts, we account for requests of the majority of users who demanded detailed and understandable descriptions. It covers topics as pros and cons of different kind of datasets, how to handle netcdf-datasets and unrealistic number of days within a year in the model output. The questions have been chosen according to our experience in the cooperation with data users as well as from questions raised during the work in the project and the workshops.

Linkages between the different parts are made clearly visible by cross-references between different chapters and parts. The appendix contains additional information on data providers, contact persons, sources for information and references.

3. User interaction and workflow

At a relatively early stage during the establishment of the guideline, a first workshop was planned. In order to engage as broad an audience as possible invitations were sent out via e-mail to potential participants from various fields, which somehow could be related to the topic and to whom some interest in ÖKS15 could be attributed. Attached to this invitation was a short general questionnaire, which we asked the recipients to complete. From the returns knowledge on stakeholder groups, their background and needs were gathered in order to set an agenda for the first workshop that best serves them. This allowed focused discussions on the structure of the guideline and on topics to be covered within. Such the first workshop offered opportunities to present one's own ideas, get feedback on them and collect recommendations and requests from participants (e.g. where to get dependable information on climate matters; the request to keep the guideline as simple as possible in order to make the contents understandable for laypersons). Moreover, the possibility to combine this first workshop with another workshop on climate data made it easier for users to actually participate e.g. without having to cover additional travel costs.

In assessing potential users, our cooperation with the Climate Change Center Austria (CCCA, ccca.ac.at) to which most climate research facilities are linked, has proofed useful through enabling easy identification. The final selection encompassed researchers as well as governmental officials, working in climate communication.

Inputs from questionnaire and workshop have been used to set up the list of topics to be dealt with in the guideline.

Through a number of meetings amongst the teams involved in processing the guideline we coordinated the work on various topics. This procedure also enabled the early recognition of questions arising due to the interdisciplinary nature of this cooperation. As not only the work on the guideline itself took place but also the expansion of the ÖKS15-Dataset, used in the comparison, the whole process took about 2 years.

At the second workshop towards project completion, content and structure of the guideline as well as outcomes of the data evaluation regarding their suitability in various applications were presented. In discussions, participants were given the opportunity to draw attention to topics that they felt as missing and, propose more in-depth and detailed treatment of subjects dealt with already. Apart from this occasion (after required adjustments like reformulations towards easier understandability, or layout issues e.g. regarding used icons had been made)

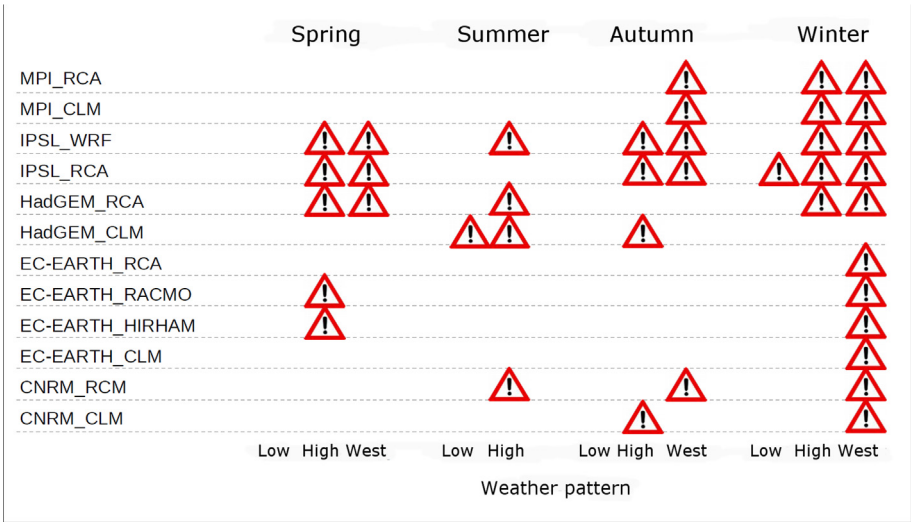

Fig. 2. Differences between models (y-axis) regarding the occurrence frequency of weather patterns significantly affecting the Alpine region (Area influenced by a low pressure system, influenced by a high pressure system and influenced by westerly winds) throughout the annual cycle (x-axis). Symbols mark model-results under- or over-estimating observed frequencies (1979–2011) by at least 40%.

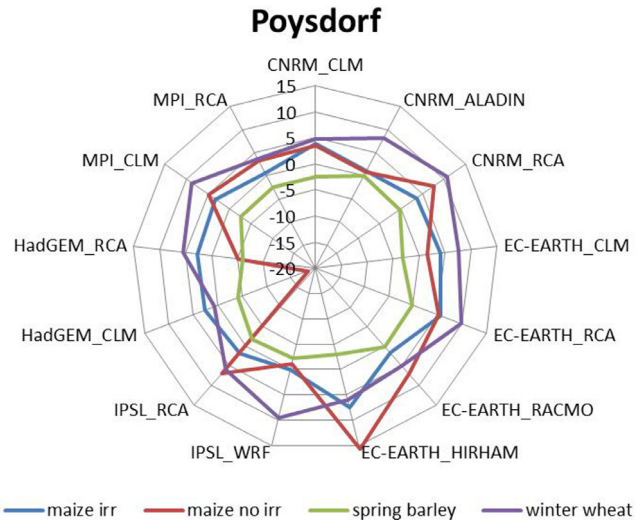

Fig. 3. The influence of the different climate model results on three different crops (one of them under different growing conditions (irr…irrigated; no irr… not irrigated); colours) has been analysed. The diagram shows the percentual difference between calculated crop yield using climate model data compared to the use of observational data for the period 1981–2010. The DSSAT (Jones et al., 2003; Hoogenboom et al., 2019a, 2019b) growing model was used for different locations (shown Poysdorf).

the revised version was sent to all stakeholders for an additional feedback round as well as to several international experienced research colleagues. The latter were provided with a questionnaire specially prepared for this purpose since they haven't been involved in this process so far. The questionnaire covered the content, the understandability and the presentation, leading to some further improvements.

4. Conclusions

On the basis of the replies received, the guideline appears well suited to its purpose.

The process of generating the guideline consisted of three steps:

1. Questionnaire and first workshop: On the basis of the information gathered from the questionnaire sent out to a significant amount of previously identified potential users, it was possible to work out an agenda effectively tailored to the mutual transfer of knowledge that was efficiently carried out in the workshop. Therefore, the first workshop provided valuable and comprehensive output for the development of the guideline and helped addressing several topics that might have been left out otherwise as well as to refine the intended structure.
2. The according design of the guideline consisted of:
   *) essential background information on climate, climate change and methods;
   *) specific evaluations of the datasets (that accounted for the experience of the users and their demand);
   *) further support directed towards frequently asked questions not only concerning the ÖKS15 dataset, but also a broad variety of practical questions.
   While the interdisciplinary cooperation allowed for first hand insights into needs of data users, it also highlighted the importance of addressing potential misunderstandings early during the process.
3. Second workshop and additional feedback circles: in order to get feedback on the guideline at different stages (content, comprehensibility, user friendliness).

The final feedback rounds have been essential in assuring positive acceptance of the guideline by potential users. Thus, in the case a desired response falls short of expectations, it appears worthwhile to undertake a further, more specified effort. As for instance by adding a purpose-developed questionnaire.

5. Access to the guideline

The Guideline, regarded dataset and the report on the creation of the dataset are available at the data store of the CCCA-Data Centre (https://ccca.ac.at/fileadmin/00_DokumenteHauptmenue/02_Klimawissen/Guideline_STARC_Impact_2018.pdf).

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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