Providing climate services for climate change adaptation – challenges and solutions

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Abstract. Information on the observed and projected regional climate (changes) is in demand for assessing climate impacts and developing relevant adaptation strategies. Particularly climate information related to future change is connected with considerable uncertainties that practicioners often perceice as paralyzing. Here, we introduce the approach of providing climate data and related services within the German climate adaptation project REGKLAM (developing and testing an integrated regional climate adaptation program for the model region Dresden). Selected challenges and some possible solutions are discussed to share experiences with forthcoming regional climate adaptation projects.

Key words

Uncertainty, multi-model-ensemble, bandwidth, future climate change, adaptation options.

Introduction

The unavoidable changes of climate demand specific adaptation measures to be taken in almost all regions of the world. Generally, such climate adaptation measures are derived based on downscaled climate projections. Such climate projections are no predictions like a weather forecast, but are based on several assumptions, e.g., on the future rise in radiative forcing due to emitted greenhouse gases. Thus they are connected with considerable uncertainties that have to be accounted for, e.g., by using multi-model ensemble approaches. These uncertainties are often perceived as a major obstacle in adaptation planning, as many stakeholders are used to plan with concrete values derived for a climate normal period. This contribution introduces how climate data and services are provided within the regional climate adaptation project REGKLAM (Heidenreich et al., 2013). Furthermore, arising challenges and solutions are discussed.

Results and discussion

Challenge 1 – Amount and variety of available data

Manifold web pages provide data on regional climate projections that may be used for running impact models, assessing the possible future climate of a region and deriving necessities and options for adapting different sectors to the expected changes. Practitioners that are used to work with one observation climate dataset are completely overstrained by this variety and have problems in assessing and selecting appropriate data sets for their applications. Using only one climate model is generally insufficient, due to the manifold uncertainties inherent to climate projections such as natural climate variability – particularly for highly variably climate elements like precipitation –, assumptions about the future socio-economic development, incomplete understanding of the climate system, and unresolved processes within the models. Thus, only the use of an ensemble of climate projections allows a reasonably "robust" estimation of the possible bandwidth of future climate and related impacts.

Solution 1 – Database and user guidelines

A joint database was build within the REGKLAM-project, where practitioners can access and download data of climate observations as well as data of an ensemble of selected regional climate models via a graphical user interface. Furthermore, guidelines for using climate projection data within the project were developed. They give the users an overview of the uncertainties connected with climate projections and explain how to work with the ensemble of provided climate data. The joint database ensures that the adaptation options developed for different sectors are all based on the same data, and assumptions can be integrated over different economic sectors.

Challenge 2 – Mismatches between expectations and reality

The demands of practitioners that are often derived from the previous experience with handling climate observation data collide with the limited precision of climate projections. Experiences within the project show that users generally demand climate projection data to be:

a) reliable, whereby uncertainties are often used as an excuse for the ‚*wait-and-see*' attitude,
b) usable as input for currently used impact models,
c) applicable for extreme value analysis and
d) provided, analyzed and interpreted in a manner that is easily understood by non-scientists.

Those demands relate to several sub-challenges (2a–d) that are discussed in the following paragraphs in more detail.

2a) Uncertainties: The challenge of dealing with uncertainties is strongly connected with the already discussed first challenge. Practitioners need to be educated in the opportunities and limitations of climate modeling to understand the necessity of thinking in bandwidths of possible climate futures. Innovative ways of altering their perception of uncertainties from the current '*paralyzed feeling*' to a more open attitude that even takes advantage of them are needed as uncertainties due to natural variability and assumptions about the future development of human civilization cannot be reduced. Humans are used to make decisions under uncertainties in all areas of life, but they tend to forget about it, when discussing about climate change, its impacts and adaptation options. Despite all the uncertainties we know more than enough to act properly.

2b) Model biases: No climate model is free of systematic deviations to observational data (e.g., Jacob, 2007). Such deviations may strongly influence the usability of those data for impact modeling. The relevance of the different biases depends on the specific application and on the type of impact model. Furthermore, the biases in different climate parameters may offset one another leading to misinterpretations of the results. It is sufficient for some applications to work with change signals (delta-method) and to compare the climate model output for a future period to the signal of the same model in the reference period, while other applications demand climate model time series as input. In this case bias correction methods are applied, but these methods relate to new challenges such as losing the consistency of the data set (e.g., Ehret et al., 2012) and introducing even more uncertainties in climate impact studies.

2c) Extreme events: Generally, the interest in the future frequency and intensity of extreme events is higher than the one in average climate change signals, as those extremes are connected with the most severe impacts and financial losses. The analysis of extreme events is challenging even for observation data, as there are – per definition – only a few cases available for the analysis. Furthermore, the available time series are often short and affected by inhomogeneities. To derive robust trends for extremes is therefore almost impossible. The uncertainty connected with extreme event analysis even increases for climate model data, as those models are in many cases not capable to resolve the relevant processes triggering extreme events. Therefore, only generalized statements about the future development of weather extremes can be made, which are based on our understanding of the climate system and recent observations.

2d) Utilization of results: Experiences within REGKLAM show the difficulties in conveying the variety of results and their limitations to the level of implementation. Stakeholders in local administration and industry do not comprehend many basic scientific terms, such as climate projection, and often even have difficulties to discern climate from weather. Therefore, basic statements on the future climate development and clearly arranged maps are requested; yet these simplified messages often bear the risk of neglecting uncertainties and related bandwidths of change. On the other hand, there is the risk of delivering '*highly-resolved errors*'. Both courses of action may potentially lead to mal-adaptation. Thus, the following questions have to be repeatedly posed to optimally utilize the results of climate projects for climate change adaptation:

- What is the sensitivity of a specific application and what are relevant climate parameters and impacts?
- What is the added value of more detailed information for a specific application?
- Are the accustomed tools and procedures suitable for dealing with climate projection data or are new approaches needed?
- Can we take advantage from the uncertainties?

Solution 2 – Intensive two-way communication

The challenges connected to the mismatch between the practitioners' expectations and the capabilities of climate models are only to be overcome by intensive communication and mutual learning, the expenditures of which – in both time and personnel – are often underestimated. Table 1 summarizes the tools applied within REGKLAM.

Table 1. *Communication tools within REGKLAM and related experiences*

Communication tools	Experiences/ Evaluation
Oral: • Individual consulting (by phone or on-site) • Workshops & meetings	• Direct interaction → allows for education and discussion • Specific regard to user applications • Highly time-consuming
Written: • Survey on data/ information needs • Guidelines for using climate projections • Reports and information brochures	• Users had difficulties in expressing their data and information needs in advance • Guidelines proved to be a valuable tool • User friendly publications (appropriate language) were a major source of information for many users and decision makers (also outside the project) • Concise and plain information sheets were highly valued

Generally, written material is a good start, but it is not sufficient to stimulate the necessary changes in the attitude of stakeholders towards climate projections and to ensure the appropriate usage of downscaled climate model data in practical applications. Intensive communication in both directions is in demand to foster the mutual understanding and to find practical adaptation solutions.

Conclusions

Working with bandwidths of future climatic conditions is a necessity for successful climate adaptation and helps avoiding a misallocation of finances that may result from an inappropriate confidence in the model results. It still remains a challenge to convince practitioners that the bandwidths of projected climate changes do not necessarily have to delay or inhibit concrete adaptation measures, but may even be perceived as an expansion in the options for the general development of a region. Intensive two-way communication and mutual learning are needed to overcome the presented challenges in using regional climate projection data for climate change impact and adaptation studies. Finally, climate adaptation has to be perceived as a process and not an '*on-off effort*'. This demands rethinking the common procedures used to derive climate-related decisions.

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