Climate and tourism potential in Freiburg

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Abstract

In our study, the modelled data, based on the A1B and B1 scenarios, is carried out by the regional climate model REMO from the Max-Planck-Institute of Meteorology in Hamburg. The data has a high spatial and temporal resolution and are available from 1950 until 2100. In that way, the periods 1961-1990 and 1971-2000 of the A1B scenario are used as the reference period for future climate change, respectively. Additionally data from the stations of the German Meteorological Service (Deutscher Wetterdienst, DWD) for the period 1961-2000 has been used. The analysis based on the A1B simulation shows a strong increase in heat and thermal stress as well as in humid-warm conditions. Cold stress, thermal acceptability, and ski potential are clearly reduced by the end of the 21st century. In general, the results of B1 are lower compared to A1B.

1. Introduction

Climate and tourism are strong correlated. The high discussed topic of climate change is focused in the tourism climatology as well. In the last century, global warming refers to an air temperature increase of 0.74 °C on average. The IPCC Fourth Assessment Report (AR4) declares a possible span of global air temperature increase of about 1.1 °C in the best case (B1) and 6.4 °C in the worst case (A1FI) by the end of the 21st century. The South West of Germany is more affected by a rising air temperature expecting an increase of about 3.5 °C (IPCC, 2007).

In every country, tourism and recreation build an economic factor. In Germany, for example, the tourism sector values about 10 %. The German tourism potential becomes also noticeable in the Black Forest (Southern Germany). Considering the climate change discussion, Southern Germany will be affected more amongst others by increasing air temperature. The city of Freiburg is the entrance of the visitors to the famous Black Forest (Fig. 1). Beside to the local income, the tourism and recreation sector builds an important economic factor. Therefore, climate change discussion and impacts on tourism scare tourism industry and local authorities. They want and have to be informed about the possible damages and future climate conditions.

Therefore, we analysed exemplarily the climate potential for tourism purposes and its variation of Freiburg. Freiburg states an interesting study site for climate and tourism research being located at the foothills of the Black Forest. Additionally, Freiburg is one of the most important and visited city in the Black Forest.

2. Methods and data

Initially, we used the regional climate model REMO in a high spatial resolution of 10 km for Germany (Jacob, 2001; Jacob et al., 2007). These model calculations have been conducted on behalf of the Federal Environment Agency (Umweltbundesamt, UBA).

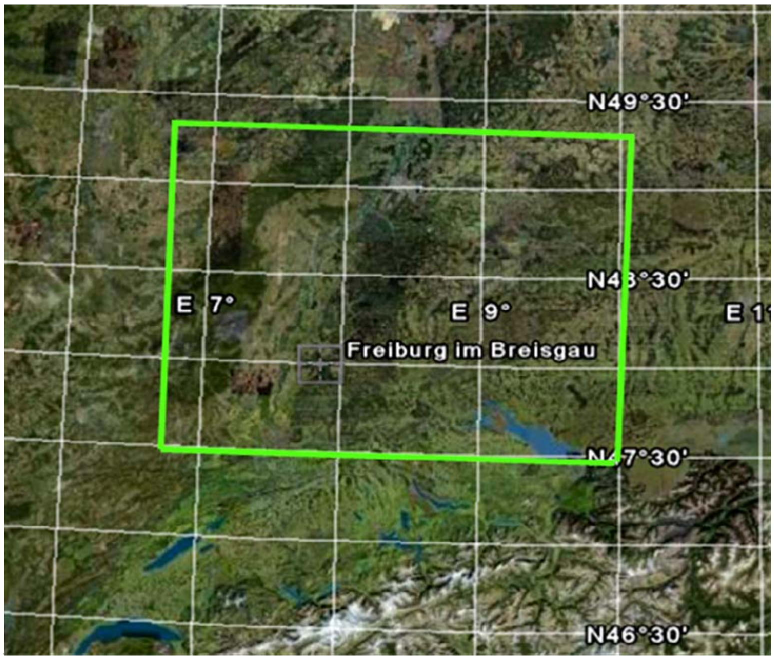

Fig. 1: Extract of the REMO model region with the location of Freiburg.

Table 1: Selected meteorological parameters and their thresholds for describing and calculating the climatic tourism potential (* *PET = Physiologically Equivalent Temperature)*

Parameter	Threshold
Thermal acceptance*	18 °C < PET < 29 °C
Heat stress*	PET > 35 °C
Cold stress*	PET < 0 °C
Sunny	Cloud cover < 5 octas
Fog	Relative humidity > 93 %
Sultry	Vapour pressure > 18 hPa
Less precipitation	Precipitation < 1 mm
Long rain	Precipitation > 5 mm
Strong wind	Wind velocity > 8 ms^{-1}
Ski potential	Snow cover > 10 cm

Within the analysis the data will be used for the analysis of tourism potential for 1961-1990 and 1971-2000, respectively, and for future climate trends (2021-2050). Hence, the SRES scenarios A1B and B1 will be considered. REMO data builds the base for thermal, physical, and aesthetic computations being used for the validation of both thermal comfort and tourism and recreation potential (de Freitas, 2003). The thermal component is expressed by the Physiologically Equivalent Temperature (PET; Höppe, 1999, Matzarakis et al., 1999). Moreover, frequency classes and frequencies of extreme weather events are generated based on a monthly interval. The derived results, in terms of climate tourism information schemata (CTIS), and maps shall be allocated for stakeholders (Matzarakis, 2007).

Here, we only present the CTIS. Our analysis of the climatic tourism potential is based on particular thresholds and meteorological parameters (Table 1, e.g. Matzarakis and Mayer, 1996; Matzarakis 2007).

3. Results

The REMO data for the area of Freiburg (9 grid points have been used in order to get the mean conditions for the area of Freiburg) have been processed for the A1B- and B1-scenario. Fig. 2 and 3 show the climatic tourism potential in terms of CTIS for observed and modelled data respectively. The underlying thresholds of each parameter are listed in Table 1.

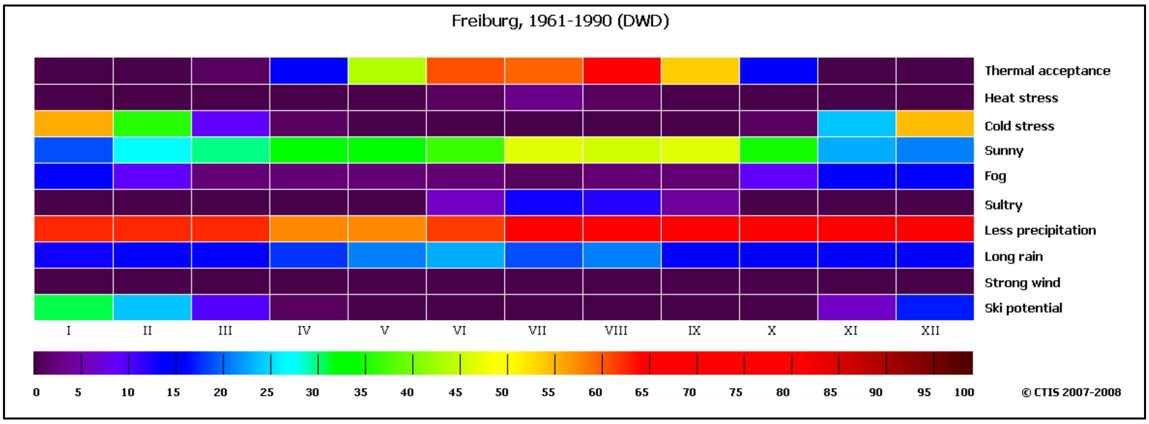

Fig. 2: Climate-Tourism-Information-Scheme for Freiburg for the base period 1961-1990 based on observed data (German Weather Service, DWD)

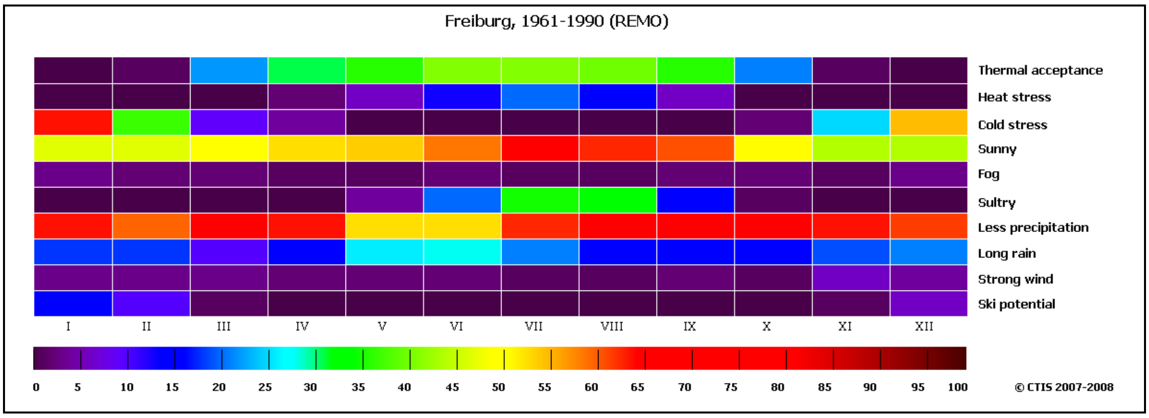

Fig. 3: Climate-Tourism-Information-Scheme for Freiburg for the base period 1961-1990 based on modelled data (REMO)

The thermal acceptance (based on observed data) occurs from April to October with maximum frequencies in August (up to 70 %). Heat stress and strong wind conditions are negligible; humid-warm (sultry) conditions occur only in July and August with a frequency of 15 % and fog is predominately present in winter months with a frequency of 15 % as well. Sufficient winter sport conditions range from November to March with a maximum occurrence of 30 % in January.

Considering the modelled results (Fig. 3) some differences are obvious. Although REMO simulates heat stress with a maximum percentage up to 20 % in July compared to DWD, thermal acceptance is underestimated about 20 % by REMO. Cold stress is more frequent in January (about 10 %). Sultriness is occurring from June to September with frequencies between 15 and 35 %. The modeled precipitation shows the same magnitude compared to observed data, except in May and June being slightly moister. The ski potential is underestimated about 15 % by REMO.

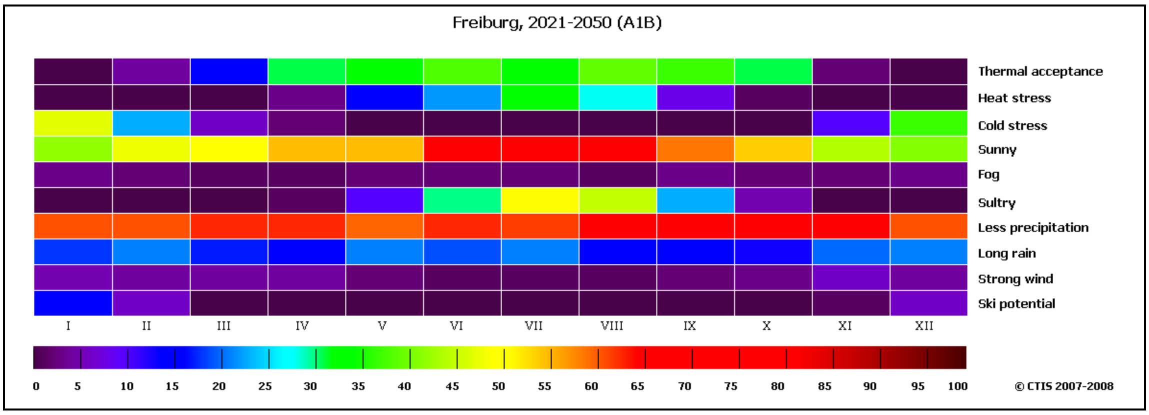

Fig. 4: Climate-Tourism-Information-Scheme for Freiburg for future projections 2021-2050 based on emission scenario A1B (REMO)

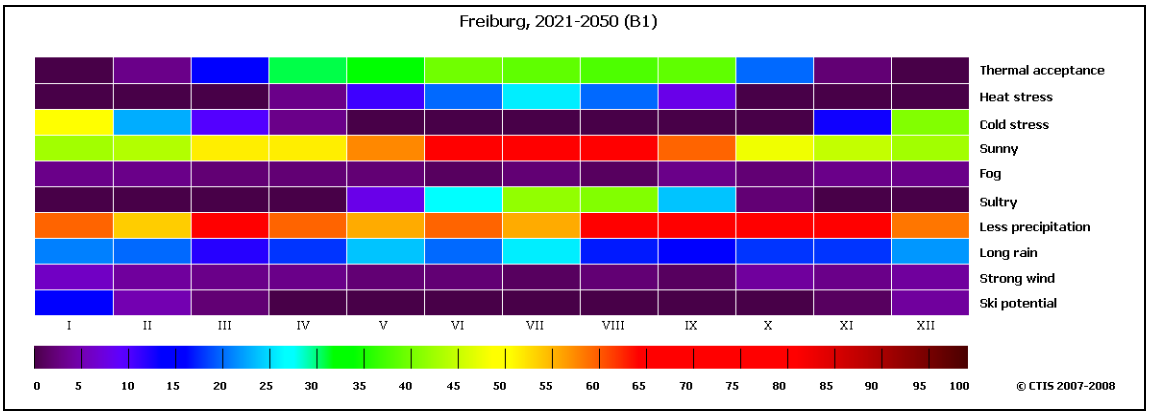

Fig. 5: Climate-Tourism-Information-Scheme for Freiburg for future projections 2021-2050 based on emission scenario B1 (REMO)

Figs. 4 and 5 represent the future climatic tourism potential for the A1B and B1 scenario, respectively. In both scenarios, thermal comfort will slightly decline in spring and autumn. Heat stress will rise by 5 % in B1 and 10 % in A1B, respectively with maximum values occurring in July. Cold stress will significantly decrease by approx. 15 % in winter time in both scenarios. Humid-warm (sultry) conditions will increase about 15 % in A1B and between 5 and 10 % in B1. Considering precipitation, the months May and June will become dryer with an increment of10 %. In contrast, the months February and March will become moister. In general, the climate, modelled by B1, is moister, except in June. Stormy and foggy conditions do not show any changes in A1B as well in B1.

5. Conclusions

REMO underestimates snow cover and thermal comfort whereas overestimates heat and cold stress as well as sultriness (compared to observed data). Precipitation intensities are in the same magnitude, except in May and July being slightly moister in REMO. Differences can be explained by averaging over an area of 10 km x 10 km. In general, changes according to A1B and B1 follow the same trend. Due to global warming human will indeed less frequently be stressed by cold, but in return more by heat stress and humid-warm conditions. Fog and storm events will not obviously occur. The increase in thermal discomfort will affect tourism and recreation as well. Adaptation measures have to be developed to guarantee the pleasant climate.

Acknowledgement

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