Artificial snow making in the Southern Black Forest

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Abstract

Ski resorts react to warm winter seasons by investing in snowmaking. But snowmaking in warm winter seasons is at risk, because sufficiently low temperatures become less frequent in the future. In the study area of the Black Forest, Germany the region of Feldberg is the biggest ski area in Baden-Württemberg with 14 lifts and 16 ski slopes. The impact of climate change is extraordinary important, because for the whole area the winter tourism is the main source of revenue. The study area is in an altitudinal range from 850m – 1450 m. At the moment in 1/3 of the Feldberg area it is possible to work with artificial snowmaking. In the near future, till 2020, an artificial snowmaking of the whole Feldberg area is planned. On the basis of this, more detailed investigations of season length and the needed volume of produced snow are necessary. A ski season simulation model ("SkiSim 2.0") developed at the Department of Geography University Innsbruck, Austria was applied in order to assess the snow potential of natural and technical snow for today and for the climate scenarios A1B and B1 based on the regional climate models (REMO and CLM). In addition the model has been fitted with climate data from stations of the German Weather Service. The model operates and produces the monthly changes from 1961-2100 of the two emission scenarios (A1B and B1). These changes are downscaled to each weather station with a weather generator ("LARS-WG") producing daily data as input for SkiSim which calculates snow depth (natural and technically produced snow) and the required amount of artificial snow for 100 m altitudinal bands.

1. Introduction

Ski tourism has been identified as highly vulnerable to climate change (Abegg 1996, Breiling et al. 1997, Scott et al. 2003, 2006). Less snow, a shorter ski season, an increase of the snow line up to 1500m are the negative impacts of climate change on ski tourism (Beniston 2003, Breiling et al., 1997).

The most common method to define snow-reliability is the 100-days-rule stating that ski resorts can be considered as snow-reliable "if in 7 out of 10 winters, a sufficient snow covering of at least 30-50 cm is available for ski sport on at least 100 days between December 1 and April 15" (Abegg 1996). This methodology was adopted by the recent OECD study (Abegg et al. 2007) with the result that – with a 2 °C warming – only 60 % of today's existing ski areas in the European Alps will remain snow-reliable. Technical development outdated this methodology, as today snowmaking is widely spread all over the Alps and the adjacent low mountain regions – in the Feldberg area, for example, 1/3 of the skiing area is covered by snowmaking facilities. In the near future, till 2020, an artificial snowmaking of the whole Feldberg area is planned.

2. Methods

The chosen study area is the region of the Feldberg, Germany. The Feldberg is the highest point (1492 m) in the low mountain range Black Forest in Baden-Württemberg which is in the southwest of Germany (Willmanns, 2001).

For the present analyses the following stations are selected: Feldberg, Freiburg, Hinterzarten and Titisee (Fig.1.). These stations are representative for the ski destinations in the region of Feldberg.

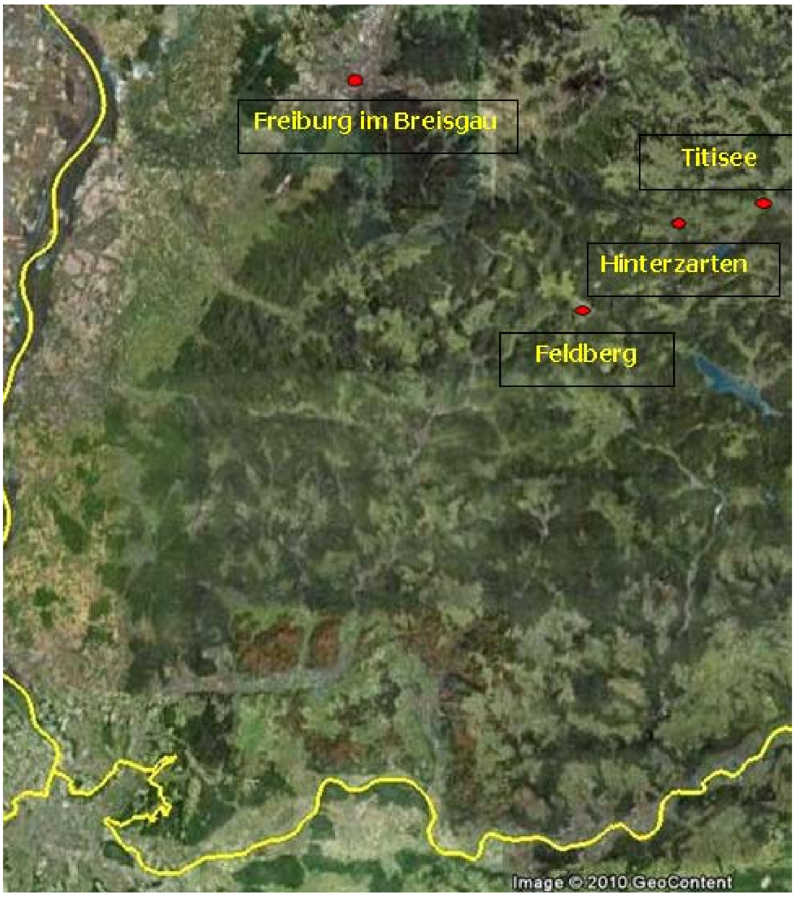

Fig. 1: Study area

For the computation of the snow potential the A1B and the B1 scenarios are used. The calculation is carried out by use of the regional climate model REMO from the Max-Planck-Institute of Meteorology in Hamburg with a spatial resolution of 10 km and data is available from 1950 until 2100. The period 1961 until 1990 is used as the reference period for future climate change (Jacob et al., 2007, Röckner et al., 2003, Will et al., 2006).

To assess the snow potential of natural and technical snow for today and for the climate scenarios A1B and B1 a ski season simulation model ("SkiSim 2.0") developed at the Department of Geography University Innsbruck, Austria was applied.

The model operates with monthly changes from 1961 until 2100 of the two emission scenarios A1B and B1. These changes are downscaled to each weather station with a weather generator ("LARS-WG") producing daily data as input for "SkiSim" which calculates snow depth (natural and technically produced snow) and the required amount of artificial snow for 100 m altitudinal bands (Steiger 2009).

For the computation of the snow potential the A1B and the B1 scenarios are used. The calculation is carried out by use of the regional climate model REMO from the Max-Planck-Institute of Meteorology in Hamburg with a spatial resolution of 10 km. Monthly changes of temperature and precipitation of two future time frames – 2030s

(2021-2050) and 2080s (2071-2100) – compared to the 1961-1990 baseline period are downscaled to each weather station with the “LARS-WG” weather generator (Semenov, 1997). The resulting daily weather data is used as input for SkiSim 2.0 calculating snow depth (natural and technically produced snow) and the required amount of artificial snow for 100 m altitudinal bands (Steiger, 2009).

3. Results

The results are shown for the station on Feldberg (modelled height: 1076 m). The Feldberg represents the area with 14 lifts and 16 slopes and is the highest point and is taken as case study being the largest and most important ski area of the study area.

Table 1: Potential ski days for the whole winter season in time period from the 1st November to the 30th April for thirty year periods for each altitudinal range (e.g. Alt_min means the “Talstation” 945m)

	SD_SM_BASE	SD_SM_A1B_2030	SD_SM_A1B_2080	SD_SM_B1_2030	SD_SM_B1_2080
Alt_min	50	27	5	33	12
Alt_mid	130	117	42	123	81
Alt_max	140	130	64	134	108
Weighted	113	92	26	100	56

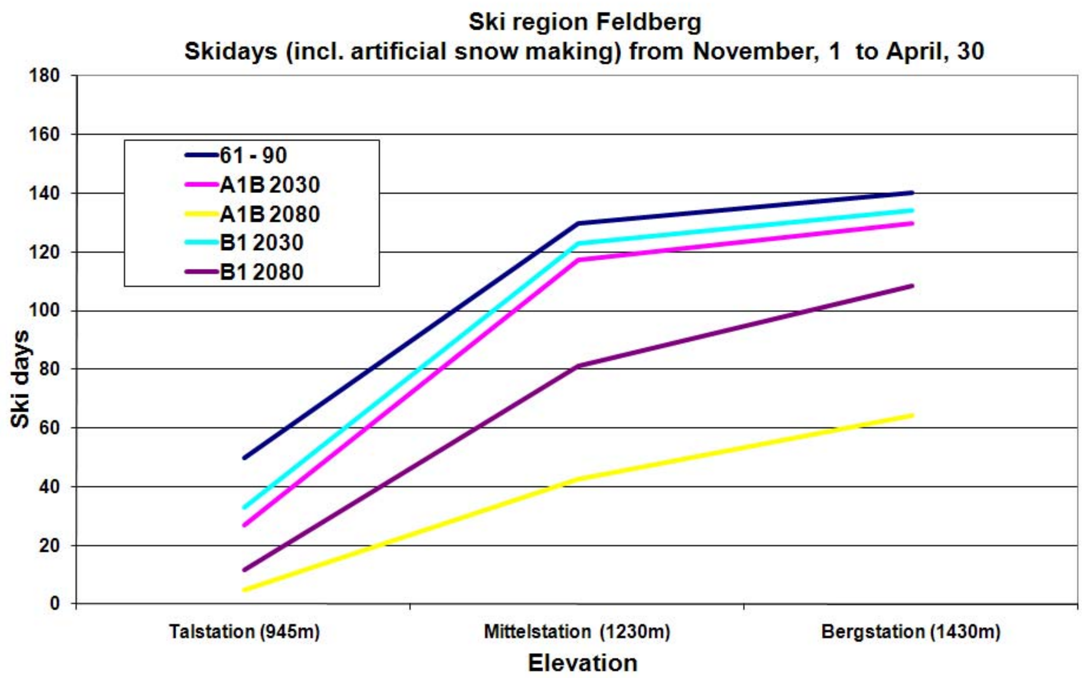

Fig. 2: Possible ski days for the whole winter season in time period from the 1st November to the 30th April each year for each altitudinal range (e.g. Alt_min means the “Talstation” 945 m)

Table 1 and Figure 2 show equally like Table 2 and Figure 3 the potential ski days for the whole winter season in the time period from the 1st November to the 30th April for a thirty year period for each altitudinal range. On the basis of the number of the possible ski days a conclusion is possible if ski operation is cost-covering or not. These results are shown that in the whole winter season the possible ski days decreases rapid until the year 2100 in each climate scenario. In the particular one the possible ski days in the lower ranges decreases even much more important than the possible ski days in the higher ranges. The numbers of the possible ski days are shown, that despite artificial snowmaking a cost covering manage which is reach with a number of ski days from more than 100 is not in guarantee in every altitudinal range.

Table 2: Possible ski days for the whole winter season in time period from the 1st November to the 30th April each year for each altitudinal range

ALT	SD_SM_BASE	SD_SM_A1B_2030	SD_SM_A1B_2080	SD_SM_B1_2030	SD_SM_B1_2080
900	50	27	5	33	12
1000	78	46	8	53	20
1100	102	69	13	80	36
1200	118	99	25	107	57
1300	130	117	42	123	81
1400	140	130	64	134	108

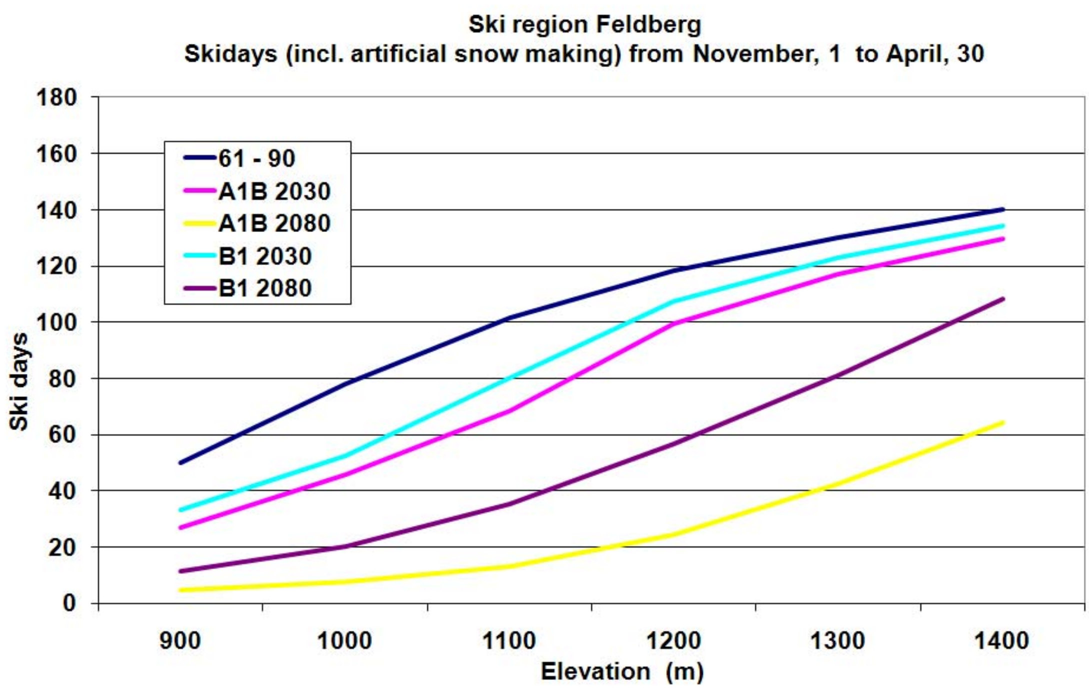

Fig. 3: Possible ski days for the whole winter season in time period from the 1st November to the 30th April each year for each altitudinal range

4. Discussion and conclusions

In general it is to be determined that a considerable change in season lengths only appears in the time period from 2050 to 2100. On a closer analysis it is evident, that the season lengths for each climate scenarios (A1B and B1) differ significantly. The decline of the season length is especially distinctive in climate scenario A1B. In the A1B scenario even the peak of the highest ski area of the study region falls below the 100 operation days. In the B1 scenario only the peak remains snow reliable while the rest of the ski area is projected to fall below the 100-days threshold. Even in high elevated ski resorts of the Feldberg area it is not secured, that the ski resorts has more than 100 operating days. Therefore artificial snowmaking is not the cure-all strategy. On the basis of this the whole Feldberg region and the adjacent ski resorts should think about an alternative strategy to the dominant ski tourism in the winter month.

Acknowledgement

Thanks to the Federal Ministry of Education and Research (BMBF) for funding the sub research project "*Weather and Climate Analysis*", which is part of the joint research project CAST (promotional reference: 01LS05019) within the scope of the research initiative klima*zwei*.

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