The tourism climate of Engadin, Switzerland

Christine Ketterer and Andreas Matzarakis

Meteorological Institute, Albert-Ludwigs-University of Freiburg, Germany

Abstract

Tourism is vitally important for the economy in Engadin, Switzerland. Climate and weather are presumed to be a natural capital of the region and therefore an economic capital. The context of climate change poses the question on the change of the tourism climate in Engadin. Using measured data of MeteoSwiss and the climate models REMO and CLM the thermal, physical and aesthetical facets are analyzed during the time period 1961–2100 and visualized by the Climate-Tourism-Information Scheme (CTIS). The consequences of climate warming are going to be more distinct from mid-century to 2100 than in the future years. The number of days with thermal comfort is going to increase, while the number of days with cold days is going to decrease. This trend is more distinctive using the A1B scenario than using B1 scenario. Increasing thermal comfort and decreasing duration and frequency of precipitation is going to be of particular importance for the summer tourism. For the winter tourism Engadin is going to feature snow reliable conditions, even if the probability of snow high over 30 cm is going to decrease - especially the snow conditions in early and late winter worsen- in Engiadina Bassa more than in the higher Engadin`Ota around St. Moritz.

1. Introduction

The economic branch of tourism is vitally important for Engadin, because tourism creates 68 % and 59 % of the regional added value in Engadina`Ota and Egadina Bassa (Kronthaler und Cartwright 2008). Jobs and income, preservation of the agriculture were preserved through tourism and rural exodus can be stopped (Schweizer Tourismus Verband 1999). Landscape, flora and fauna, climate and the existing infrastructure provide a basis for tourism, but the weather can be seen as the Achilles-heel.

Tourists react to weather forecast as well as on the weather on site or the commercial: St. Moritz promotes with *sun* as a protected trademark for the climate favour of Engadin since 1930. Climate and weather are presumed to be a natural capital of the region and therefore as economic capital. If the weather is not as good as expected, the tourists avoid outdoor activities or even cancel their stay. The weather on sight can be separated in different aspects, the integrated thermal aspects, considered using the thermal index *Physiologically Equivalent Temperature*, the physical aspect, like sun, wind or rain and aesthetical aspects, as sunshine duration or cloudiness (de Freitas 2003).

In the context of climate change pose a question on the change of the tourism climate and its potential in Engadin.

2. Method

Therefore the tourism climate of Engadin is analyzed using existing data of the netwok of MeteoSwiss and data of the climate models REMO (A1B, B1 scenario) and CLM (A1B scenario) over the period 1961-2100. The regional climate model REMO has been performed by Max Planck Institute for Meteorology and encompasses the region of Germany, Austria and Switzerland ((Jacob 2001; Jacob et al. 2001). Based on the local model of the Deutschen Wetterdienst CLM has a resolution of 18 km (Steppeler et al. 2003; Böhm et al. 2006).

To control the quality of the climate models, its data were compared with the measuring data of Buffalora, Scoul, Sta. Maria and Sils Maria.
Following parameters matter for the tourists: thermal comfort, snow, precipitation, sunshine duration and wind. The thermo-physiological perception has been calculated with the aid of the thermal Index *Physiologically Equivalent Temperature*, based on the human energy balance. Furthermore the conditions for winter sport, like snow high and skiing potentials and their future change should be studied.
At the end the results are presented as frequencies and exceeding of thresholds in a climate-tourism-information scheme (CTIS) (Matzarakis 2007).

Tab. 1: Parameter and their Thresholds used for CTIS

Parameter	**Thresholds**	**literature**
cold stress	PET < 0 °C	Mayer und Matzarakis (1999)
Thermal acceptability	18 °C < PET < 29 °C	Matzarakis (2007)
Heat stress	PET > 35 °C	Matzarakis und Mayer (1996)
Sunshine	Cloud Cover < 4/8	Gómez Martín (2004)
Wind	v > 8 m/s	Gómez Martín (2004)
Light Rain	RR > 1 mm	Matzarakis (2007)
Long rain	RR > 5 mm	Matzarakis (2007)
Ski potential	Snow > 30 cm	Uhlmann et al (2009), OECD (2007)

3. Exemplary results

The climate model CLM describes the climatic conditions not so appropriate than REMO. CLM underestimates precipitation about 50% and more. REMO pictures air temperature, precipitation, wind velocity and air moisture in the highly reliefed region with acceptable variations. The measured air temperature average 2.5 °C in Sils Maria over a period of 1998 - 2008 and the calculated air temperature 2.6 °C, the measured precipitation 1047 mm und the estimated 952 mm. In Sta. Maria the averaged air temperature is 5.4 °C and the estimated 5.1 °C from1961 – 90, the measured precipitation 791 mm and the estimated is 773 mm. The seasonal characteristic of precipitation can be seen in the model data, but the precipitation in winter is overestimated and so also the snow depth is twice high as measured.
The averaged annual PET is -7.1 °C on the 3300m high Mountain Corvatsch, in Sils Maria 0.7 °C, in Samedan 2.4 °C, on Buffalora 3.7 °C and in Scoul 7.8 °C. The rang of PET ranges from -62 °C on the top of Corvatsch to 31 °C in Scoul and Sils Maria during 1981 – 2000.

Over a period 1981 – 2000 the winter sport in Engadin profits by low rainfall and plenty of sunshine. PET values under -10 °C are no rareness at noonday in Engadin. In Sils Maria has to be anticipated PET values under -10 °C to 65 %, in Scoul to 20 % and on the mountain Corvatsch to 90 %.

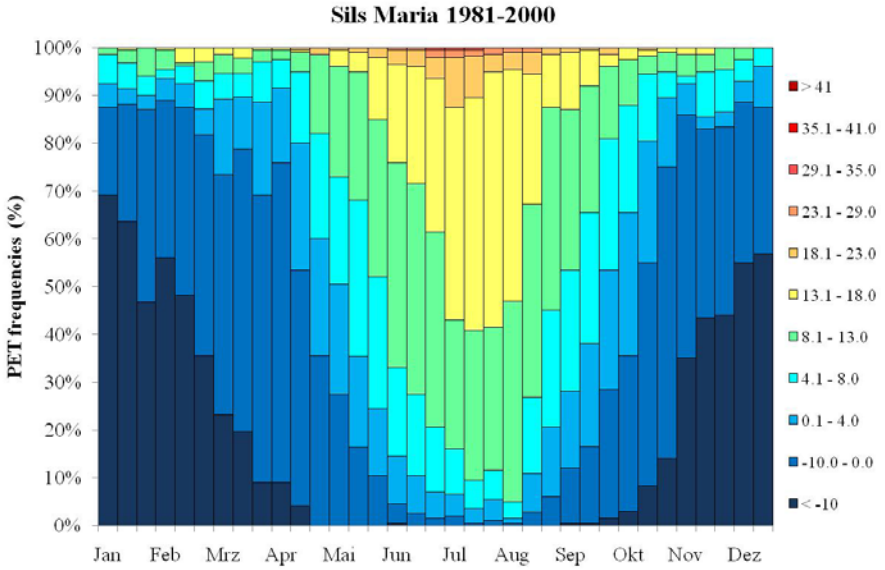

Fig. 2: Frequencies of the appearance of different PET classes in Sils Maria during the time period 1981 - 2000

Ski potential persists from November to April in Engadin` Ota and in Engadina Bassa from December to April. February features the best snow conditions, less precipitation and also warmer air temperatures. On the top of the mountains has to be bargained with an occurrence of 50 % with wind velocity stronger than 8 m/s.
Thermal acceptability appear on 64% of the days in Engadina Bassa from June to August, in Engadin`Ota in contrast only on maximal four days a month. The highest probability of cloudiness, rain duration and frequency occurs over summer. Indeed colder but dry conditions may be expected during September and October. The so called *Malojawind* can lead especially during summer to high wind velocity, which can be drop down the valley. On the mountains the wind velocity is over summer smaller than in winter.

The number of days with cold stress is expected to decrease mainly in early and late winter due to climate warming till 2025. Ski potential regresses in early winter most intensely under use of A1B scenario but in late winter using B1scenario. Nevertheless can be expected a probability over 98 % with a snow depth over 30 cm in Sils Maria and to 80 % in Scoul. Increasing rainfall duration and frequency during winter can lead to a higher danger of avalanches.
Using A1B Scenario the probability of days with thermal acceptability is increasing during summer. Using B1 Scenario minor increasing of the warming is expected. The precipitation is decreasing from May to September, with the exception of July. Heat stress is irrelevant in Engadin. In autumn climatic conditions, rainfall duration and precipitation change for ore pleasant conditions.
Classic winter tourism cannot be bargained for any more in Engadina Bassa, because the snow deph over 30 cm will only be exceed in a likelihood of 33 % in December and 58 % in February using B1 scenario till end of the century. Using A1B the maximal likelihood is 25 %. Because of the warming the participation of cold stress decreases and snow fall changes into rainfall and at the same time the rain duration will increase.

A high ski potential over 85 % using B1 and 65 % using A1B scenario consists furthermore In Engadin`Ota from January to.

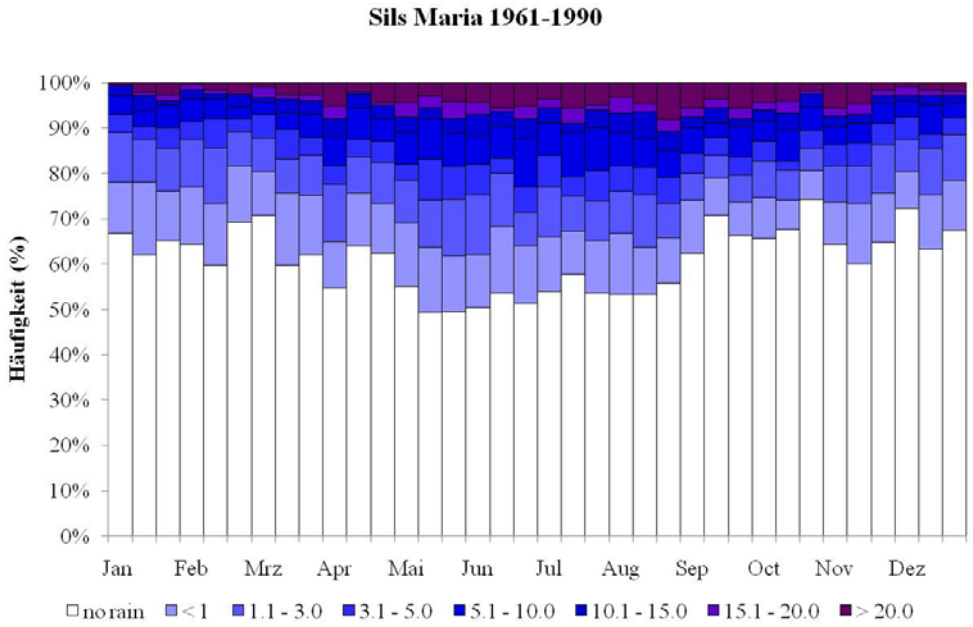

Fig. 3: Frequencies of the appearance of rain duration classes and the monthly rain sum (mm) in Sils Maria during the time period 1961 - 1990

The tourist during summer can expect optimal conditions in Engadin. The likelihood of thermal acceptability is about 60 % in the valley and rainfall amount is declining. In Engadina Bassa heat stress can occur to only 4 %, so that Engadin profits from the climate warming in contrast to low-lying or southern regions (Zaninovic and Matzarakis 2009, Matzarakis and Endler 2008). Especially Engadin`Ota exhibits a higher ski potential than other low-lying ski destinations in future years (Bürki et al. 2007). But problems like warm periods over winter and a higher avalanches risk can cause a bad image.

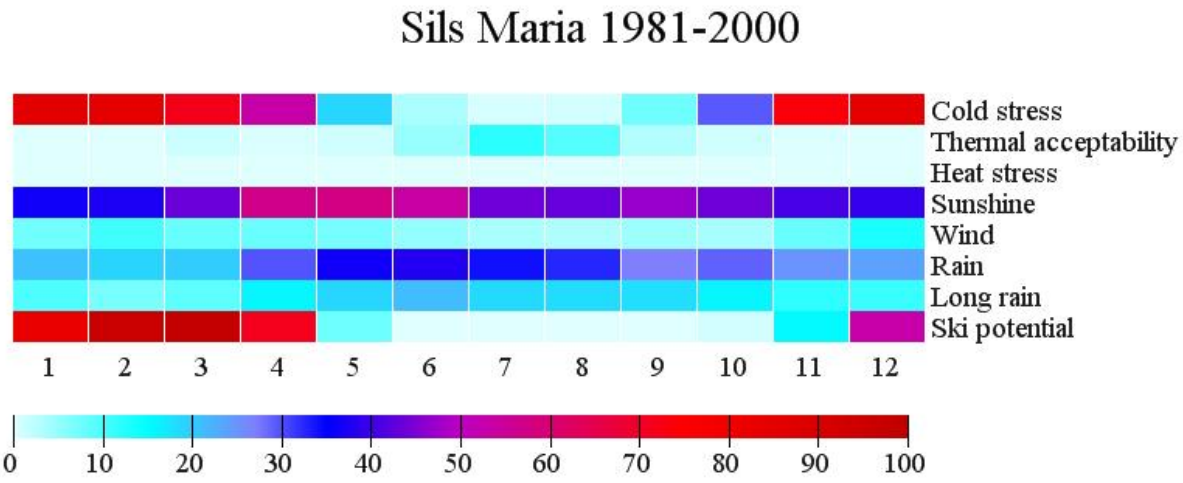

Fig. 4: Climate-Tourism-Information-Scheme for Sils Maria, based on measuring data of MeteoSwiss for the time period 1981-2000

5. Conclusions

Tourism adds 5% to the world wide CO_2 emission. Ascending level of motorisation, short breaks and secondary residences have a share to the Emissions in the Alps. Tourism as a part of the causes of climate change and also sufferer should not only react, but also see the change as Chance.

In the Alps and in Engadin are lots of good practice examples, like the project "Clean Energy St. Moritz", which was started 2003 on the occasion of the Ski WM. It contains the provision of energy sources like water, sun, biogas and geothermal energy from 1770 to 3057 m height. Photovoltaic-installations profit from 322 days with sunshine and temporary increase in efficiency through albedo-effects caused by snow cover at about 50 %. The first hotel of St. Moritz and one school covers 80 % and 70 % of their energy needs with the aid of heat pump installation, which extracts energy of the 4 °C warm water of Lake St. Moritz.
In Scoul snowmaking installations were built to the value of CHF 2.5 Mio. Climate and weather are important factors for visitors and tourism.

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Authors' address:

Christine Ketterer (christine.ketterer@gmx.de)
Meteorological Institute, Albert-Ludwigs-University of Freiburg
Werthmannstr. 10, D-79085 Freiburg, Germany

Prof. Dr. Andreas Matzarakis (andreas.matzarakis@meteo.uni-freiburg.de)
Meteorological Institute, Albert-Ludwigs-University of Freiburg
Werthmannstr. 10, D-79085 Freiburg, Germany