Projections of the climate potential for tourism in Platja de Palma, Spain

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Abstract

The System of Platja de Palma (SPdP) is located on the south-western Majorcan coast. It is one of the most popular tourist areas in the Mediterranean with more than 1.2 million nights spent per year. The main socioeconomic activities developed in the setting are very closely linked with its climatology. Therefore, the optimization of its social and economic opportunities in the mid- and long-term should necessarily take into account the close dependence between the evolution of the main atmospheric parameters in a climate change era, and the 'sun-sea-sand' (3S) tourism. In order to quantify the tourist potential of this setting, the characterization of the environmental conditions favoring leisure and 3S tourist outdoors activities becomes essential.

To this aim, the second generation climate index for tourism (CIT) has been used. CIT is an empirically-derived index that allows estimating the 3S tourist experience as a function of weather conditions. Indeed, it integrates the effects of thermal, aesthetic and physical facets of climate and renders a quantitative measure of the satisfaction experienced by the 3S tourist in terms of three categorizations: unacceptable, acceptable and ideal conditions.

In first place, we have analyzed the evolution of CIT during a 36-year recent (1973-2008) period by using observed data provided by the automatic weather station located at the international airport of Palma de Mallorca. In second place, climate change projections have been used to assess its impact on the tourist potential of the System of Platja de Palma. To this aim, CIT has been calculated for a 30-year future (2021-2050) period and the A1B emissions scenario (SRES) by employing the regional database available from the ENSEMBLES European project. Daily observed and simulated series of temperatures, precipitation, relative humidity, cloudiness and wind speed are necessary to derive the tourist potential of SPdP.

Observations point out an increase in the number of annual days with acceptable conditions for 3S tourism, but a decrease in the current frequency of ideal conditions. Projections would indicate a marked decrease in the number of annual days with ideal conditions, as well as a remarkable increase in terms of both acceptable and unacceptable conditions for the early to mid 21st century. Therefore, these changes would indicate the need of elaborating and implementing adaptation plans in order to mitigate the already observed and the projected climate change consequences on the 3S tourist potential for the System of Platja de Palma.

Keywords Climate change • Tourism climate index • Regional climate models • Statistical downscaling • Social, economic and environmental adaptation

Introduction

Observations show that the global mean surface temperature has increased notably during the 20th century. The rate of global surface warming from 1979 to 2005 is estimated at 2.68 ºC per century (IPCC 2007). Furthermore, the estimated trends at regional scale for this interval show a high spatial variability and, for the Mediterranean area as a whole, IPCC settles this trend between 2.5 and 3.5 ºC per century. Simultaneously to the global warming, it has been observed a redistribution of the rainfall and other atmospheric variables (e.g. pressure, wind, cloudiness), with even higher spatial variability than temperature. For the precipitation over the Mediterranean, observations for the same period indicate a loss in this resource roughly up to 3 % (IPCC 2007).

Albeit climate change is a problem of global causes and consequences, its impacts become apparent locally. For the Balearic Islands, observations show a decrease in annual rainfall amounts at a rate of 16.6 mm per decade during the 1951-2006 interval. Minimum and maximum temperatures have risen at a rate of 0.51 and 0.48 ºC per decade, respectively, during the 1976-2006 period with a very high statistical confidence. This warming is more noticeable in spring and summer (Homar et al. 2010).

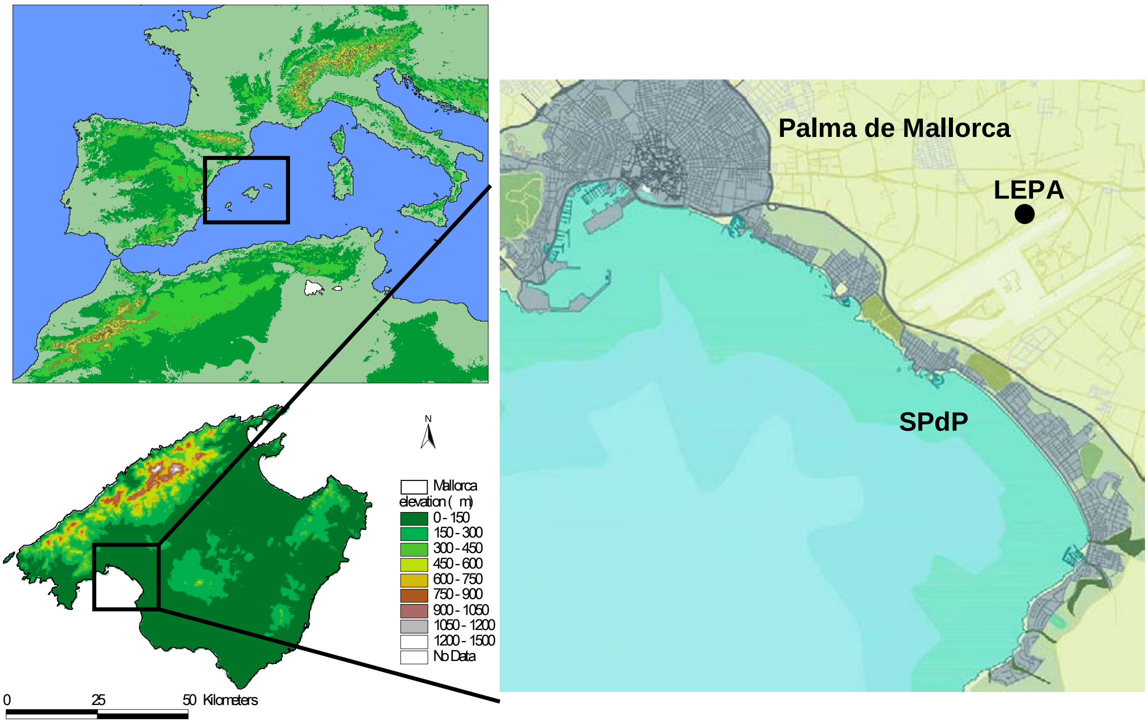


Figure 1 Geographical location of the System of Platja de Palma (SPdP) in the western Mediterranean region. It is located in Mallorca, the biggest of the Balearic Islands. Major topographic features of the entire region and Mallorca Island are shown. The location of the automatic weather station (indicative LEPA) is also displayed.

The Consortium of Platja de Palma was set up with the aim of promoting the refurbishment of hotels, complementary tourism services, and in general, the System of Platja de Palma, the main resort in the Balearics (SPdP; further information at: http://consorcioplayadepalma.es). The Consortium has geared its work towards configuring a different vision and contemplating a new tourism model that can be renowned world-wide. Major guidelines for the Consortium are the next key issues: sustainability, climate and global change, and social and residential cohesion. Therefore, the assessment of the impact of climate change and the subsequent implementation of adaptation strategies has turned one of the key issues to address the renovation and sustainability of this geographical environment to the needs of the 21st century (Fig. 1; Amengual et al. 2010a and b).

Within this framework, it must be evaluated which are the most suitable weather conditions for the optimum achievement of outdoors activities related with the 'sun-sea-sand' (3S) tourism, the main economic activity carried out in the SPdP. Furthermore, the environmental conditions are also a key issue for assessing the competitiveness of this tourist destination. To this aim, a study of the effects of climate change on the tourist potential has been carried out in this work. Specifically, we assess the impacts of the observed and projected daily series for the main atmospheric parameters on the climate potential for tourism.

The strong relationship between the main favourable atmospheric variables and the 3S outdoors activities can be linked by means of empirically derived climate indices for tourism. The second generation climate index for tourism (CIT; De Freitas et al. 2008) is a climate index that allows estimating the satisfaction of 'sun-sea-sand' (3S) tourism destinations as a function of the daily weather conditions. The CIT integrates the thermal (T), aesthetic (A) and physical (P) facets of the weather and derives a measure of the perceived satisfaction for the tourist. This satisfaction is then categorized as: unacceptable (i.e. CIT=1, 2 and 3); acceptable (CIT=4 and 5) and ideal (CIT=6 and 7) conditions (Fig. 2).

Observed and projected daily series of the following meteorological parameters are necessary in order to derive the CIT: 2-m maximum temperature, accumulated precipitation, 2 m mean relative humidity, mean cloud cover and 10 m mean wind speed. Regarding the future projections, we have used daily data provided by several regional climate models (RCMs). RCMs have been run within the ENSEMBLES European project under the A1B emissions scenario (SRES). The use of such multimodel approach is adopted to account for uncertainties arising from model error formulations –i.e. the representation of physical processes within RCMs–, and the inaccuracies found in their boundary conditions as well. However, it has not been possible to take into account those uncertainties originating from the emissions scenarios –mainly related to the expected evolution of socioeconomic conditions and world development guidelines– by using a multiscenario approach. To properly manage the RCMs data at such local scale, we have applied a statistical downscaling method for each RCM output described in detail by Amengual et al. (2010b).

The rest of the paper is structured as follows: section 2 contains a brief description of the observed and simulated databases used, as well as an evaluation of the statistical downscaling approach; section 3 presents the observed and projected trends and the annual and seasonal mean regime changes of the potential tourist; and finally, section 4 provides an assessment of the main results and their implications.

(a)

(b)

Thermal facet	Aesthetic facet		Physical facet	
ASHRAE scale TSN [T]	Cloud (< 45%) [A]	Cloud (≥ 45%) [A]	Rain (> 3mm) [P]	Wind (≥ 6m/s) [P]
Very hot (+4)	4	**3**	**2**	**3**
Hot (+3)	6	5	**2**	4
Warm (+2)	7	5	**2**	4
Slightly warm (+1)	6	4	**1**	4
Indifferent (0)	5	**3**	**1**	**2**
Slightly cool (-1)	4	**3**	**1**	**2**
Cool (-2)	**3**	**2**	**1**	**2**
Cold (-3)	**2**	**2**	**1**	**1**
Very cold (-4)	**1**	**1**	**1**	**1**

Figure 2 It is shown the climate index for tourism (CIT) rating scale (extracted from De Freitas et al. 2008) (*a*); and the weather typology matrix to produce each climate satisfaction rating class (adapted from De Freitas et al. 2008) (*b*).

1. Database, methodology and validation

Observations have been obtained from the automatic weather station deployed in 1973 by the Spanish Meteorological Agency (AEMET) at the international airport of Palma de Mallorca (indicative LEPA; 39.37 ºN, 2.43 ºE). No significant changes have occurred near this station, since it operates at the head of the runaway, far from any urban development (Fig. 1). Therefore, local effects from urbanization, such as heat island warming or precipitation sheltering are safely negligible. Besides, its proximity to the System of Platja de Palma –less than 4 km– makes it an ideal dataset to address the objectives of the present work. To calculate the tourist potential of the

SPdP, complete daily series of the main atmospheric variables for the entire 1973-2008 period (36 years) have been used. That is, 2 m maximum temperature, accumulated precipitation, 2 m mean relative humidity, mean cloud cover and 10 m mean wind speed.

To compute the CIT, it is necessary, first, to calculate the thermal facet of the atmospheric environment. The thermal sensation is a function of the body-environmental thermal state that has been accounted for by using the RayMan model (Matzarakis et al. 2007; Matzarakis and Rutz 2007). This model accounts for the body-atmosphere energy budget schemes and it derives the physiologically equivalent temperature (PET). To derive the thermal component, it is necessary to set up in the RayMan model the following conditions: maximum temperature, humidity, wind speed, short- and long-radiation, and cloud cover. In addition, RayMan also accounts for the subsequent thermo-physiological parameters: the human activity, the body heat production and the heat transfer resistance of clothing. Mean radiant temperature is an output of the RayMan model –which is required in the energy balance model of humans– and yields the physiologically equivalent temperature (PET) as a thermal index. Finally, the CIT requires expressing this thermal facet of climate as a thermal sensation (TSN) by using the standard nine-point ASHRAE scale (ASHRAE 2004). The physical and aesthetic facets of climate are combined with the thermal facet and the CIT is derived according to the weather typology matrix shown in Fig. 2b (De Freitas et al. 2008).

In order to derive the tourist potential from the future projections, we have used the regional simulations database available from the ENSEMBLES European project. Daily climate data from 18 different RCMs run from 1973 to 2050 for the A1B SRES have been considered. These experiments were performed using a horizontal domain of 25 km grid-length resolution which entirely spans over Europe, besides the eastern part of the Atlantic, northern Africa and western Asia. These RCMs experiments were only run under the A1B SRES. Therefore, it has not been considered those uncertainties arising from different SRES (Hewitt and Griggs 2004; further information at: http://ensembles-eu.metoffice.com). Daily-averaged simulated variables for each model have been bilinearly interpolated to LEPA.

To properly manage the CIT-derived RCMs data at such local scale, we have applied a novel statistical downscaling (SD) method for each RCM output which is presented in Amengual et al. (2010b). First, the discrete distribution of the daily CIT values is transformed to a continuous version by means of a stochastic transformation using a flat kernel centered on each discrete value. Then, the statistical downscaling consists of calculating the changes in the continuous cumulative distribution functions (CDFs) of the daily CIT values between a 15-year past simulated period (control; 1973-1987) and successive 15-year simulated time-slices from 1994 until 2050. These variations are corrected and then transferred to the observed CDFs for the same control period, thus obtaining new calibrated CDFs which convey the climate signal for the subsequent time intervals. It is worth to recall that the use of such multimodel strategy for the whole set of RCMs accounts for the uncertainties arising from model errors.

We have evaluated the performance of the statistical downscaling method by comparing the multimodel mean raw and calibrated data percentiles against the observed percentiles. To this aim, we have selected a 15-year validation period comprising from 1994 to 2008. Figure 3 shows the observed, uncalibrated and calibrated cumulative distribution functions for the validation period. It is observed an overall improvement of the calibrated versus uncalibrated CDFs for the climate index for tourism. That is, the calibrated and observed CIT rating scales are fairly identical for unacceptable and ideal conditions. A slight divergence is found between the calibrated and the observed CIT percentiles for acceptable conditions. Even so, the errors found in CIT values derived from raw data are clearly corrected. Figure 3 also evidences that the application of the statistical downscaling approach results in a significant improvement of the simulated perceived satisfaction of weather conditions by 3S tourists.

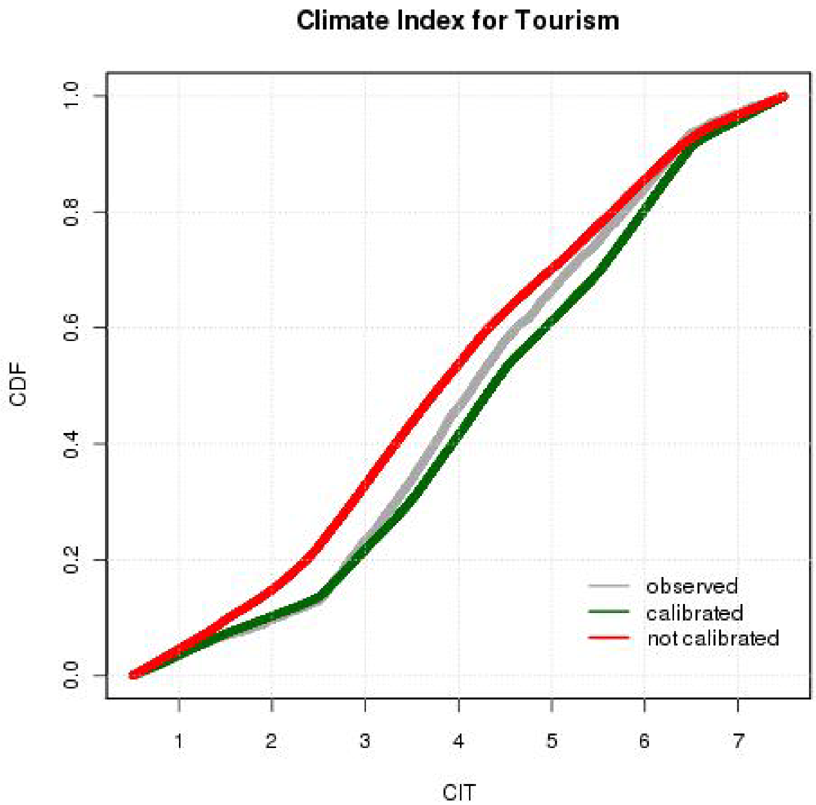


Figure 3 Observed, raw and calibrated CIT cumulative distribution functions (CDFs) for the independent 15-year (1994-2008) validation period.

The quantile-quantile (Q-Q) plot emphasizes the benefits of the statistical downscaling as well (Figure 4). The calibrated CIT data are barely diverted from the diagonal. Furthermore, the approach properly corrects the excessive spread (i.e. slope less than 1 for the uncalibrated dada) found in the raw data for the climate index for tourism.

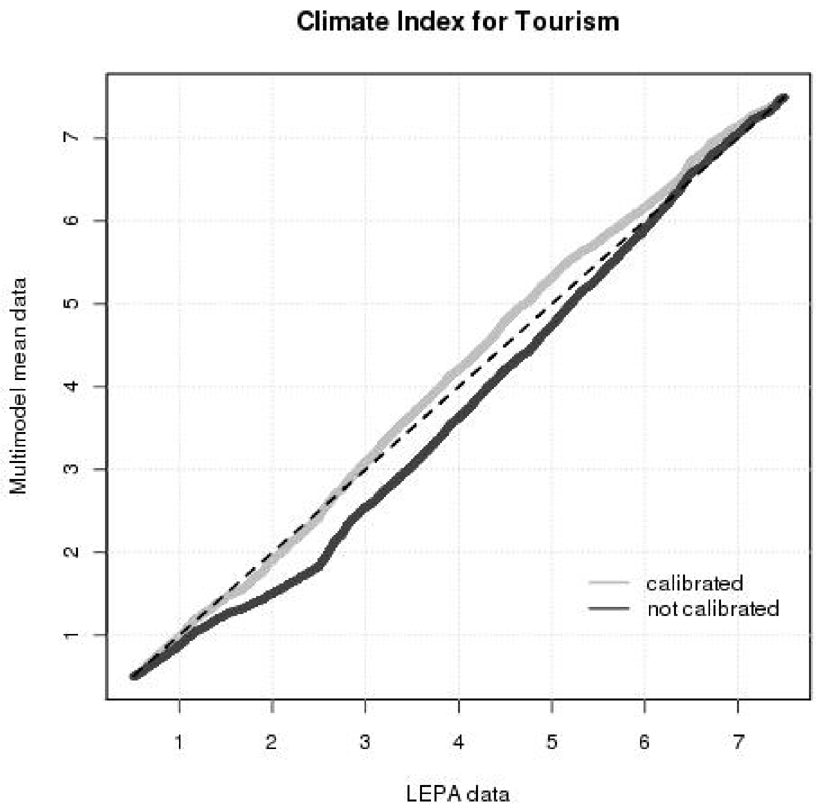


Figure 4 Raw and calibrated CIT quantile-quantile (Q-Q) plots for the independent 15-year (1994-2008) validation period.

2. Results

2.1 Description of the present state of the tourist potential

Recall that we have derived the current state of the tourist potential for the System of Platja de Palma from daily observations registered at the automatic weather station LEPA from 1973 to 2008 (36 years). This period has been divided into two 18-year subintervals: the recent past (1973-1990) and the present (1991-2008). Table 1 displays the variations in the annual mean regimes for the CIT rating classes by comparing these two time-slices. When analyzing the changes found between the recent past and present periods, it can be noticed a fall in the annual mean frequency of 14.6 days for ideal conditions, and an increase in the annual frequency of 7.8 days for acceptable conditions. It is worth to note that the number of days with unacceptable conditions per year has risen up to 6.8.

Figure 5 displays the frequency distribution of the whole CIT rating classes (see Fig. 2). Acceptable conditions for outdoors activities related with 3S tourism clearly dominate in the present annual mean regimes –up to 40.0 % of the total amount–, followed by the unacceptable (32.4 %) and the ideal (27.6 %) conditions. Furthermore, when accounting for the acceptable and ideal conditions, the overall frequency of climate satisfaction for 3S tourist activities reaches up to 67.6 %. It seems clear that the Mediterranean climate of Mallorca –cold winters, cool to mild springs, temperate autumns and hot summers– is the main asset for the social, economic and environmental activities related with tourism.

Number days	1973-08 (36 yrs)	1973-90 (18 yrs)	1991-08 (18 yrs)	Δ CIT
CIT = 1	26.1	26.7	25.5	-1.2
CIT = 2	22.1	22.5	21.7	-0.8
CIT = 3	70.3	65.9	74.7	+8.8
CIT = 4	86.4	86.1	86.8	+0.7
CIT = 5	59.6	56.1	63.2	+7.1
CIT = 6	74.5	79.4	69.6	-9.8
CIT = 7	26.2	28.6	23.8	-4.8

Table 1 Observed annual mean frequency of the tourist potential of System Platja de Palma for the whole 1973-2008 period and the recent past (1973-2008) and present (1991-2008) time slices. Last column indicates the change between recent past and present time-slices. Changes in annual mean regimes are displayed for all the climate satisfaction rating classes.

With respect to the seasonal mean regimes, the fall in the number of days per year with ideal conditions is more remarkable for summers (4 days per year) and autumns (close to 10 days per year; figures not shown). Furthermore, the number of ideal days in spring does not change significantly, but a moderate growth in the number of days per year with acceptable conditions for these seasons is detected (i.e. 2.7, 2.8 and 1.2 days per year for springs, summers and autumns, respectively).

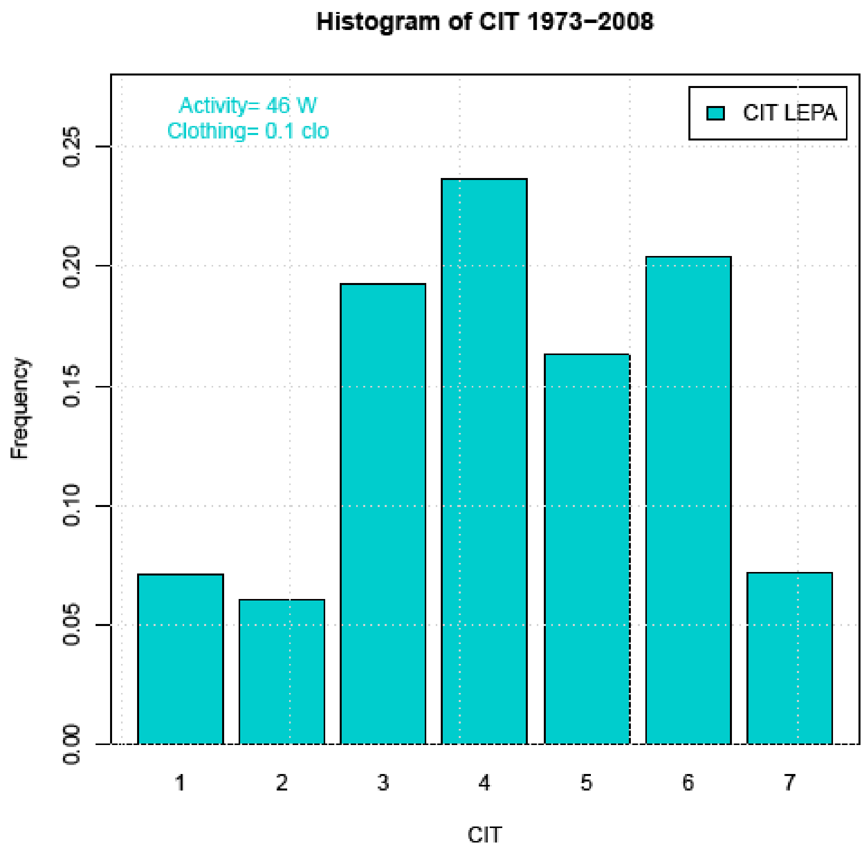


Figure 5 Histogram of the daily observed CIT classes for the 1973-2008 period. The thermo -physiological parameters used in RayMan model for the derivation of PET are indicated.

Figure 6 depicts the observed trends for the whole 36-year period. These trends reassert the previous results. Concretely, the annual frequency of ideal conditions is decreasing at a rate of 6.6 days per year and decade, whereas an increment of 4.3 days per year and decade is found in acceptable conditions. These results show a very high statistical significance for the current trends of the tourist potential. According to the nomenclature used by the IPCC, the rates of change have been classified as virtually certain for the ideal conditions and, as extremely likely, for the acceptable conditions (IPCC 2007).

It is worth mentioning that linear trends computed by using standard ordinary least squares (OLS) methods provide linear model parameters with the least variance amongst all unbiased linear estimators as long as the residuals are independent, normally distributed and with no bias. Deviations in the data from these assumptions make this property to not persist and alternative trend estimation methods must be adopted to reach prudent and reliable conclusions. Therefore, we have used robust statistics methods that emulate the OLS framework, but which are not unduly affected by small departures from model assumptions. We have calculated linear trends by means of an algorithm based on MM-estimator and an efficient iteratively re-weighted least squares procedure (Homar et al. 2010).

CIT conditions	Change in number of annual days per decade	Statistical confidence in change rate	95% interval confidence	
			Lower limit	Higher limit
Unacceptable	+1.86	Likely	-1.34	+5.06
Acceptable	+4.31	Extremely likely	+0.55	+8.08
Ideal	-6.56	Virtually certain	-10.52	-2.60

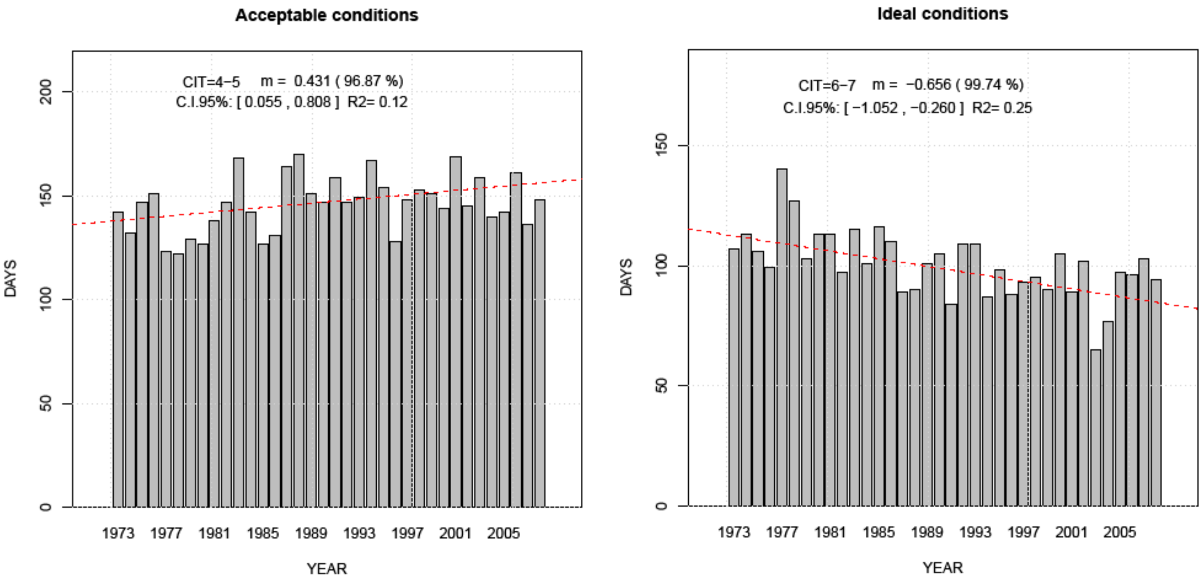
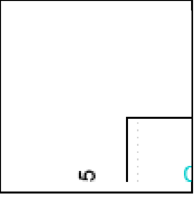


Figure 6 Present trends for the number of days with acceptable and ideal conditions –in terms of the change in the number of annual days per decade– for the 1973-2008 period. Note that figures indicate the slopes of the fitted linear trends (red dashed lines), their statistical significances as percentage (between brackets), the 95 % statistical confidence intervals and the coefficients of determination.

1.1 Projections of the future state of the tourist potential

Once RCM outputs have been statistically downscaled to the System of Platja de Palma from the daily values of the main atmospheric parameters provided by 18 regional climate models (RCMs) and for the A1B SRES scenario, we have analysed the impact of the climate change signal on its tourist potential.

To this aim, we have examined the changes found between observations for a 30-year present (1979-2008) and the projected multimodel mean for a 30-year future (2021-2050; early to mid 21st century) time-slice. Table 2 displays the expected changes in the annual mean regimes for all CIT rating classes. An average loss of 31.6 days per year could be expected for ideal conditions together with an increase of 8.2 days per year in acceptable conditions. It is note worthy that projections point out a growth of 23.3 days per year with unacceptable conditions.



Number days	LEPA 1979-2008 (30 yrs)	Multi-model mean 2021-50 (30 yrs)	Δ variables
CIT = 1	25.2	24.7	-0.5
CIT = 2	22.5	23.4	+0.9
CIT = 3	71.7	94.6	+22.9
CIT = 4	87.4	97.5	+10.1
CIT = 5	60.6	58.7	-1.9
CIT = 6	73.1	48.9	-24.2
CIT = 7	24.7	17.3	-7.4

Table 2 Changes in the projected annual mean regimes for the tourist potential of the SPdP between the 1979-2008 (present) and 2021-2050 (early to mid future) time-slices. The variations in the annual mean regimes are shown for all climate satisfaction rating classes.

In addition, projections would indicate a decrease in the annual number of days with ideal conditions for all seasonal mean regimes (i.e. 0.5 and close to 3 days per year for springs and autumns, respectively; figures not shown). Concretely, a marked loss in the number of days per year with ideal conditions could be found in summertime (more that 10 days per year), as well as a moderate increase in the annual number of days with acceptable conditions for all seasons (i.e. 2.1, 2.2 and 4.9 days per year in springs, summers and autumns, respectively)

Figure 7 displays the current and projected distributions of frequencies for all CIT climate satisfaction rating classes. Acceptable conditions still dominate the annual mean regime for the early to mid 21st century (with an expected increase from 40.5 % to 42.8 % in the total amount). Unacceptable conditions for outdoors activities linked with 3S tourism could be expected to steadily increase, changing from the current 32.7 % to the future 39.1 % of the whole annual mean regime. Therefore, mean annual days with ideal conditions would notably fall about the mid 21st century (changing from the present 26.8 % to the projected 18.1 %). In addition, a total amount decrease, exceeding 6 %, could be estimated in the annual number of days with acceptable and ideal conditions (from the current 67.3 % to the projected 60.9 %).

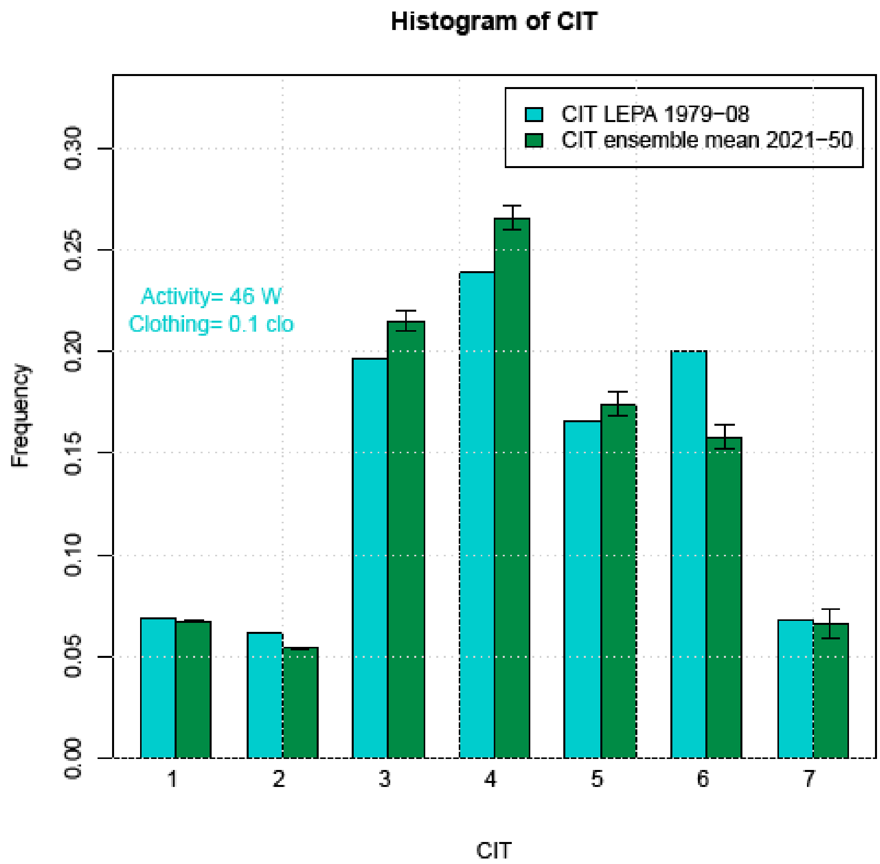


Figure 7 Histogram of the observed and multimodel mean projected CIT for the present (1979-2008) and future (2021-2050) time-slices. Error bars indicate the uncertainties associated with the multimodel mean and are expressed as its standard deviation for all CIT rating classes. The thermo-physiological parameters used in RayMan model for calculating PET are indicated.

It is worth to recall that an overall increase of temperatures is projected during the 21st century. IPCC (2007) settles the annual mean warming between the 1980-1999 and 2080-2099 periods varying from 2.2 ºC to 5.1 ºC in southern Europe and Mediterranean region for the A1B SRES. In addition, Amengual et al. (2010b) points out an increase in the annual mean regimes for maximum temperature of 0.7 ºC and 1.8 ºC for the early and mid 21st century over SPdP, respectively. Moreover, projections would indicate a change in the extreme regime of maximum temperatures for the next decades. Therefore, it could be anticipated that the annual number of heat waves affecting the SPdP in summertime will constantly increase. This natural hazard would clearly result in a worsening of the thermal comfort situations for local residents and tourists, as well as in a degradation of the main social and economic asset of the System of Platja de Palma.

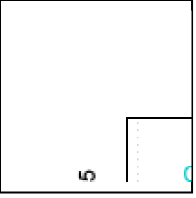


Figure 8 depicts the projected CIT trends for the future (2021-2050) time-slice. These trends reaffirm the previous results. Concretely, the number of annual days per decade with unacceptable conditions is increasing at a rate of 2.6, with a relatively high statistical confidence in the change rate (i.e. likely). It is even more notable the trend in the increase of the number of annual days per decade of acceptable conditions with a strong statistical confidence in the change rate (virtually certain). The projected trend for ideal conditions is rather uncertain, and although it could be foreseen a steady decrease in the number of annual days per decade, the statistical confidence in the change rate is very weak (more unlikely than likely).

CIT conditions	Change in number of annual days per decade	Statistical confidence in change rate	95% interval confidence	
			Lower limit	Higher limit
Unacceptable	-2.62	Likely	-5.64	+0.41
Acceptable	+3.51	Virtually certain	+1.14	+5.58
Ideal	-0.50	More unlikely than likely	-2.03	+1.02

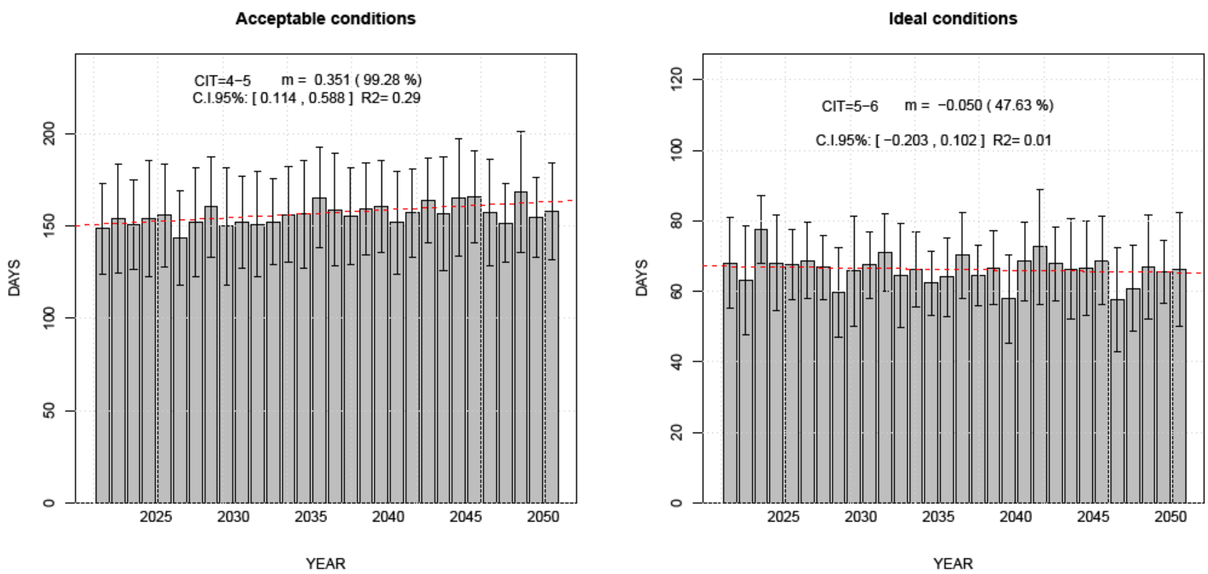


Figure 8 Annual frequencies of the projected series for the number of annual days per decade with acceptable and ideal conditions during the 2021-2050 interval. Note that figures indicate the slopes of the fitted linear trends (red dashed lines), their statistical significances as percentage (between brackets), the 95 % statistical confidence intervals and the coefficients of determination.

4. Conclusions

Within the framework of the Consortium of Platja de Palma –an agreement signed by the Balearic Islands Administration and the Ministry of Industry, Commerce and Tourism of the Spanish Government for the redesign and suitability to the needs of the 21st century of this important tourist resort–, a study of the impact of climate change on the tourist potential of the System of Platja de Palma has been carried out. Key issues for the Consortium are: sustainability, climate and global change, and social and residential cohesion. Basically, the seek of a new model for a new destination. Therefore, the assessment of the effects of climate change over this geographical setting has emerged as one of the most important concerns in order to address its renovation and appropriateness to the social, economic and environmental demands of the 21st century.

To this aim, daily observed and simulated series of maximum temperature, precipitation, relative humidity, cloud cover and wind speed have been used to derive the second generation climate index for tourism. Regarding future projections, a multimodel approach has been adopted to cope with the uncertainties arising from model errors. However, other potential sources of uncertainty including those related to different emissions scenarios have not been considered: available meteorological data came from the last generation regional climate models simulations run within the ENSEMBLES project under A1B emissions scenario. To properly use this regional database at such local scale, we have applied a novel statistical downscaling post-process to the daily outputs of the regional climate models.

Observed mean regimes (1973-1990/1991-2008)	Acceptable conditions	Ideal conditions
Annual	⇧ ⇧	⇩⇩⇩
Winter	⇧	⇩
Spring	⇧	⇔
Summer	⇧	⇩
Autumn	⇧	⇩ ⇩

Table 3 Observed changes in the annual and seasonal mean regimes of acceptable and ideal conditions for 3S leisure activities in the SPdP. These variations have been calculated by comparing the mean regimes between recent past (1973-1990) and present (1991-2008) time-slices. One, two and three arrows denote changes up to 5, 10 and more than 10 days per year in mean regimes, respectively.

The present and future evolution of the tourist potential has been evaluated, first, in terms of the changes in the annual and seasonal mean regimes for the CIT and, second, in terms of the observed and projected linear trends. Therefore, the impacts of climate change on the tourist potential have been assessed to better guide the experts in charge of the proposals for the future planning and exploitation of the tourist activities of this resort. Projections have yielded important changes in the annual and seasonal mean tourist potential regimes. Tables 3 and 4 highlight the main results for the System of Platja de Palma in order to help local policymakers to better develop new adaptation plans.

Projected mean regimes (1979-2008/2021-2050)	**Acceptable conditions**	**Ideal conditions**
Annual	⇧⇧⇧	⇩⇩⇩
Winter	⇧	⇩
Spring	⇧	⇩
Summer	⇧	⇩⇩⇩
Autumn	⇧	⇩

Table 4 Projected changes in the annual and seasonal mean regimes of acceptable and ideal conditions for 3S leisure activities in the SPdP. These variations have been calculated by comparing the mean regimes between present (1979-2008) and future (2021-2050) time-slices. One, two and three arrows denote changes up to 5, 10 and more than 10 days per year in mean regimes, respectively.

Consortium stakeholders should take into consideration the already observed and the future expected impacts of climate change on the tourist potential when adapting this setting to the early to mid 21st century. As an example, it would be highly recommendable the introduction of mitigation measures that could help to reduce the impact of an increase of the thermal sensation for residents and tourists, such as the design of appropriate infrastructures and refurbishment.

Furthermore, other major possible impacts of climate change should be taken into account such as the possible seasonality adjustment of the incoming tourist fluxes. Nowadays, the peak demand is mainly centered in the summery season for the Balearics. This fact can be ascribed to several factors, but the most important of them is the temporal coincidence of the state holidays (in July and August) –the institutional seasonality– and the suitable weather conditions to carry out outdoors 3S tourism activities owing to the natural seasonality of the Mediterranean climate.

Policymakers should be aware of a possible future imbalance between both factors as a direct consequence of a notable increase of temperatures. It should be considered not only their possible negative consequences on the thermal conditions for the Mediterranean basin, but also their probable positive effects for the summer climatic conditions in western and northern Europe, currently the major source region of Mediterranean tourists.

As a matter of fact, this work has already stated a fall in the observed annual frequency of days with ideal conditions for carrying out 3S tourism leisure activities in the System of Platja de Palma. It would be highly advisable to diversify the tourist supply by introducing new leisure activities not so strongly dependent on the summer season as the 'sun-sea-sand' tourism. This and other measures are going to be essential to adapt the main socioeconomic and environmental assets of this setting to the projected climate evolution for the early to mid 21st century.

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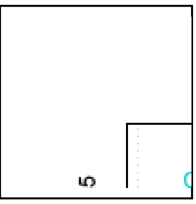

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