Collaborative Project

CLIM-RUN

Climate Local Information in the Mediterranean region Responding to User Needs

WP 5 – Tourism

Task 5.4 Development of guidelines and information material for stakeholders

Cross-cutting conclusions

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Introduction

Tourism, weather and climate

The tourism sector is particularly sensitive to weather and climate conditions. It faces different types of impacts (Scott at al, 2012):

- direct impacts on tourist safety, comfort and health (social impacts): heat waves, storms, heavy rains, forest fires, urban pollution etc.;
- indirect impacts via environmental and landscape concerns: scarcity of resources (e.g. water resources), loss of resources (e.g. biodiversity, coral reefs, snow cover);
- financial impact (loss of revenues, heating-cooling costs) ;
- institutional impacts (e.g. risk of losing good reputation).

Risks are mainly seasonal but may also affect the viability of a destination at longer timescales. If, on the one hand, the tourism sector highlights a growing perception of climate change as a key issue affecting ongoing and future development, there is, on the other hand, a very low level of awareness and use of climate services.

The tourism system is complex, with a combination of public and private, tourism and non-tourism players at all scales. Due to a great variety of tourism stakeholders (tour operators, tourism and destination offices, professional organizations, planners, practitioners, receptive agencies, tourists etc.), tourism activities (bathing, trekking, etc.), host environments and climate locations (coastal, mountain, rural etc.), the potential demand for climate services may be very different from one stakeholder to another. This, quite contrasted, situation somehow limits stakeholder involvement. Lack of interest is often justified by climate change uncertainties, by the contrast between long term climate impact and immediate priorities, or the argument that the tourism activity is not much dependent on climate. On the other hand, the availability of impact-assessment surveys and adaptation strategies helped to develop an interest for climate change. For instance, in Tunisia, the Ministry of the Environment together with the German cooperation agency (GIZ), supported the elaboration of a climate change adaptation strategy specific to the sector.

Even if there are currently few users of climate services, there is s a growing interest for this kind of products, as shown in the tourism case studies carried out in the CLIM-RUN project.

The tourism work package

The objective of this document is to present the cross-cutting conclusions of CLIM-RUN tourism case studies. In accordance with the project general objectives, this document does not include a detailed assessment of the vulnerability of the Mediterranean

tourism sector to climate change. It is more focused on specific needs of the tourism sector in the climate services debate. What are the current demands for climate services in the Mediterranean tourism? What are the best ways to understand these demands and to establish long-term relationships with stakeholders? How can climatologists co-ordinate among themselves so as to answer these needs?

More concretely, this deliverable 5.4 synthesizes the main outputs of CLIM-RUN tourism case studies, in terms of methods (development and implementation of the protocol), outputs (developing concrete climate products) and recommendation for a future climate services architecture in the Mediterranean. It constitutes the work package 5 final report, which should be read together with its annexes (workshop reports, product sheets, etc.).

WP5 considered four case studies:

- The Savoy region in the French Alps, focusing on summer tourism conditions ;
- Tunisia, focusing on beach tourism with some diversification aspects (desert tourism, golf, etc.);
- Croatia, also a seaside tourism destination, with a clear focus on diversification (beach tourism, yachting, winter and snow tourism, cultural tourism);
- Cyprus, also a seaside tourism destination, with some rural locations in the hinterland.

During the project, about 60 face-to-face interviews and 8 workshops (two per case study) have been conducted to identify and respond to the stakeholders' needs about past and future climate information and services. 13 products have been completed for the whole work package. They are presented in appendix.

Among the diversity of the requests we can identify more precisely common issues and recommendations for an improved involvement of stakeholders and to design future perspective on climate services in the Mediterranean Region.

I. Developing the CLIM-RUN protocol: the tourism case studies

This section provides some feedback on the development and implementation of the CLIM-RUN protocol for case studies. This protocol attempts to explore various ways of defining the needs of potential users of climate services and then to develop climate products adapted to these needs. Within the CLIM-RUN, stakeholders' needs were adapted across various sectors (energy, tourism, forest fires and integrated cases studies) and various Mediterranean environments.

This document should be read in conjunction with other deliverables:

- *workshop reports of case studies (2 workshops per case study)*
- *"product sheets" presenting, to our view, most useful results for stakeholders considered in this work package;*
- *general description of the CLIM-RUN protocol, as provided in WP4 report.*

The boxes across the main text highlight some specific results or present/discuss tools used for this project.

Engaging stakeholders

Stakeholders coordination

For the consistency of the CLIMRUN project, it appeared fundamental to have a WP4 dedicated to the coordination of case studies, which efficiently provided:

- clear objectives and scopes of the project;
- a general methodology to select and engage the stakeholders;
- planning the implementation of the whole process;
- communication channels that are *a priori* needed;
- a toolkit.

Strong coordination is needed to ensure an effective implementation of the protocol. The role of the coordinator of a WP was central to collecting inputs and to maintaining the deadlines, but also to maintain the dynamics of the whole process. This was in particular true in WP5, where case studies were conducted mainly by climatologists, and therefore not specialists for tourism issues.

The WP5 coordinator has proposed a **"step by step protocol" for tourism case studies** (see Appendix 1). These guidelines were provided to the case study leaders.

Stakeholder identification and selection

The tourism sector is diversified and complex. Each destination offers a combination of stakeholders depending on its specialization, markets, institutional scheme, etc. It was quite difficult to provide systematic guidelines for the process that would be appropriate to all tourism case studies. This eventually became an opportunity to explore and test different methods and tools.

A need for a transparent process of stakeholder identification and selection

In the process of selection, the aim was to target the most influential and representative actors and/or groups of actors at the destination level, whatever their scale of activity or profile (public or private, for instance). However, the work program also focused on identifying "resource persons" and "key operators", who are in a good position to liaise with others in their area of activity, or act as "middlemen" between several different

areas. In other words, they should have been important links in transmitting and spreading the information about the aims of the project.

The identification was mainly based on:

- detecting key actors in a region's tourism industry, using a classic institutional analysis (literature review, consultation of institutional websites or other sources, collection of key data, contacting key organizations that could provide further information, etc.)
- identifying key climate services providers (when existing) ;
- carrying out informal identification procedures using a regional/national expertise (Institute of Alpine Geography for Savoy, for instance) or networks.

Mapping the stakeholders system

For Savoy and Tunisia, a systematic classification of stakeholders was proposed. This visualization tool allows to better understand what the tourism system at the destination level is, and who the key players are. Depending on their level of involvement (local, regional, national, international) and the background they belong to (private/ public / civil society; climate/tourism), they are located on a synthetic graph. Results are presented in Figure 1.

Similar approach was applied in the Croatia's case study where potential stakeholders were identified at different levels: a) **state or governmental** - Ministry of Tourism, Institute for Tourism, National Tourist Board, Chamber of Economy, various associations (Association of travel agencies or Association of employers in hotel industry), hospitality consulting companies, b) **regional** - all county tourism offices, national parks, c) **local** - some local tourism offices, local authorities, hotel groups, individual hotels.

Figure 1: Mapping the tourism stakeholder and system: Savoy

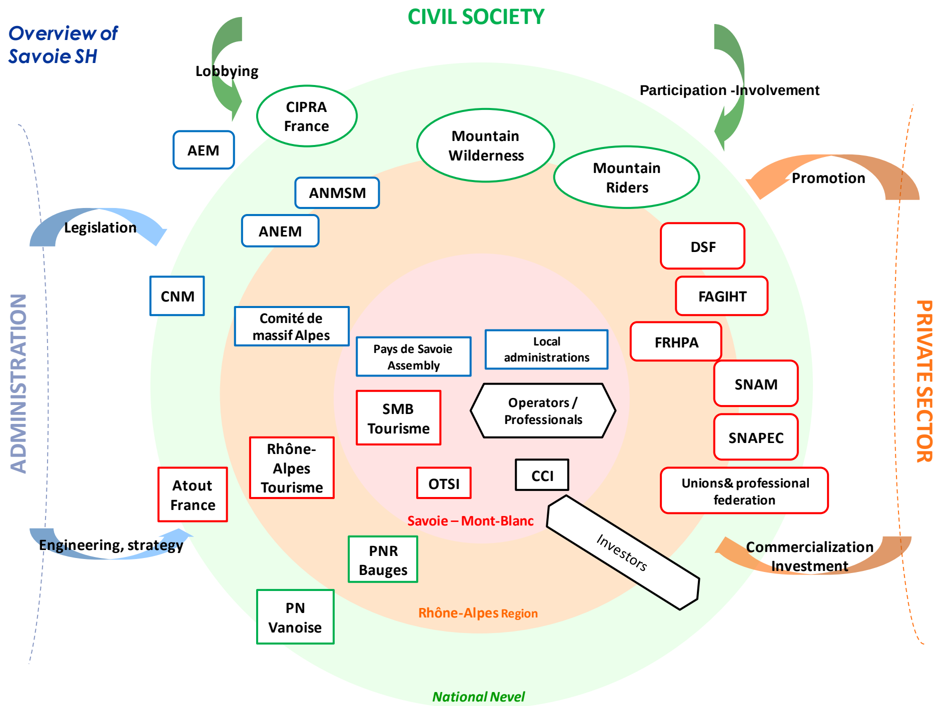
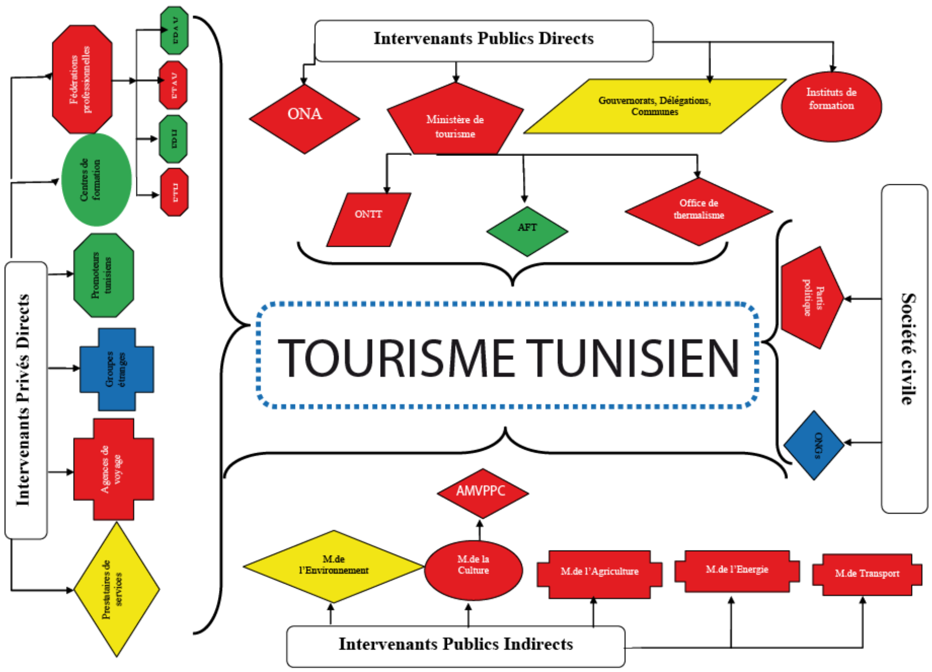


Figure 2 : Mapping the tourism stakeholder and system: Tunisia



Institutional analysis coupled with expert advice allows the best estimate of a range of representative actors. However, this method is qualitative and does not identify all possible representative stakeholders. To attain a certain representative choice, a sampling method should have been applied; however, this was beyond the scope of this work.

Mapping the climate services providers

A similar method was proposed to map the stakeholders involved, formally or informally, in the production of climate information. Results are presented in Figure 3.

Figure 3: Overwiew of climate services structuration in Savoy

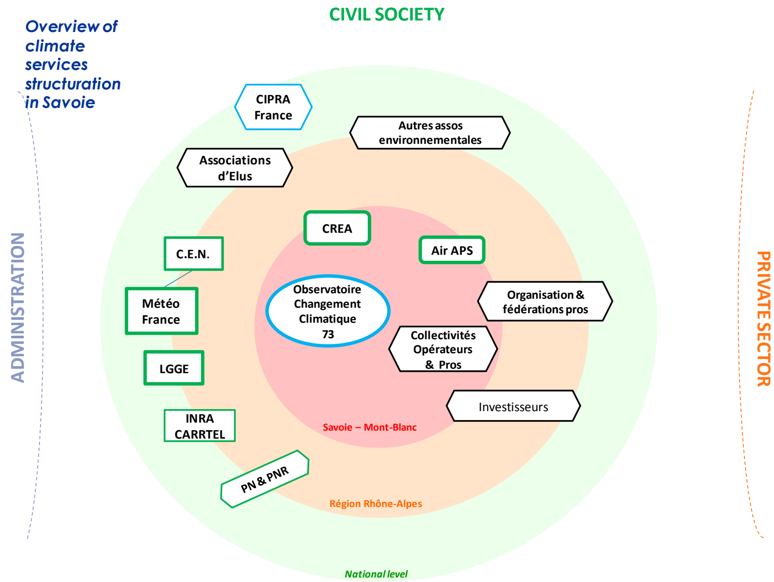
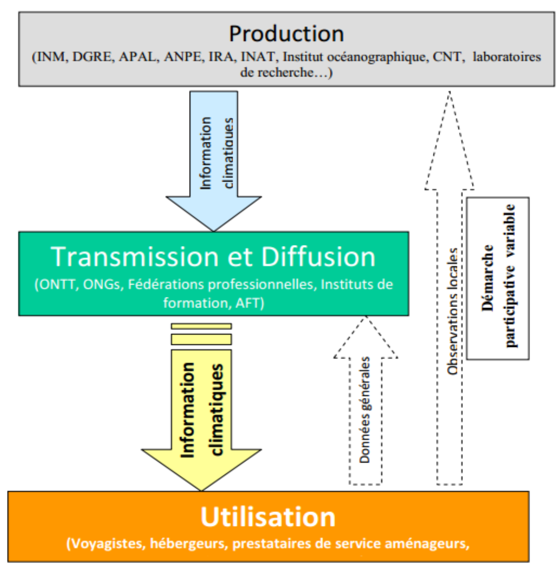


Figure 4: The main actors involved in climate information flow in Tunisia



Stakeholder consultation and communication process

The process of interacting with stakeholders is always a context-specific process. Obviously, the techniques, methods, approaches and timetables have to be tailored for the local situation and the type of stakeholders being consulted. Some general feedback can however be derived.

Limited or wide consultation process?

The survey scope was probably not clearly enough defined: was it a qualitative or a quantitative panel? However, no beforehand experience or expertise was available that we could rely upon and build our further steps. In practice, WP5 established a survey instrument using semi-structured interviews, adapted to small qualitative sample (here between 10 to 50 stakeholders interviewed, depending on case studies). The consultation was very rigorous in Savoy (a training student spent 4 months meeting, interviewing, transcripting and mapping the results) and more sporadic in Tunisia (a series of interviews were led, but at a period coinciding with the Tunisian revolution, where stakeholders had something else to do). A series of 7 face-to-face interviews with potential stakeholders was also conducted in Croatia by an external consultant. In addition, the first Croatia's workshop contributed to further identify potential stakeholders. The consultation in Cyprus was limited to the participation in the workshop.

Another issue is that stakeholders considered themselves as not being party to the CLIM-RUN project. This might finally be a weakness as it appeared very difficult to convince people to be fully involved during the whole project. Creating a stakeholder board within the project may be useful to strengthen the process of interaction and communication and to analyze deeply the needs and answers. This is, for example, achieved in the EUPORIAS project on seasonal forecasting.

Communicating with stakeholders: the role of social science experts

WP4 recommended for each case study that a *stakeholder expert* and a *climate expert* should be proposed, coordinating each side of the case, reporting at the sector work package level (WP5, 6, 7, 8).

In practice, in Cyprus and Croatia, the climate expert teams were in charge of leading the case studies by themselves, whereas in Savoy and Tunisia it was decided to involve at an early stage a tourism expert during the key stages of the project in order to help climatologists to :

- understand the tourism system at the destination level;
- ensure a good representativeness of key players;
- collect easily the names (addresses) of relevant contacts in different organization;
- generate and maintain interest of potential stakeholders during the project;
- adapt the CLIM-RUN protocol and communication to the interests of the tourism sector;
- participate in the consultation phase.

This second approach appeared much more robust and effective to ensure a good representativeness and to identify the key players at an early stage. An initial attempt to engage an expert on the stakeholder side was also made in Croatia; however, the Horwath HTL consulting (http://horwathhtl.com/) prepared only a long list of various contacts and could not accept further involvement due to the lack of resources. Thus, in contrast to Savoy and Tunisia, climate experts from Croatia and Cyprus reported their difficulties due to a lack of expertise and resources for such activities (lack of understanding, time-consuming, etc.). Tourist expert may have the key contacts and will be a catalyst to the process of interaction at all stages of the project (identification /keys contacts/language, etc).

Example of Croatia

"The failure to gather more potential stakeholders indicates that, as far as tourism is concerned, some sort of "targeted" communication between CLIM-RUN project and potential stakeholders would be needed. Since the Croatian partner had no resources or expertise for such an activity, a possible improvement may be expected by engaging communication experts for the tourism sector."

Assessing the sector needs: climate versus tourism workshops

Meeting format

The CLIM-RUN experience has shown that, regardless of the efforts undertaken and the links of case-study participants with the sector, it was very difficult to mobilize tourism stakeholders on the specific topic of climate services to participate in dedicated workshops. As a cross-cutting issue of all the sectors, it is particularly marked for the world of tourism (very short-term vision, many SMEs, etc.). A very few participants (real stakeholders) attended the CLIM-RUN tourism workshops each time (5/10 max by workshop, other participants being scientists or climate services providers). Therefore, TEC, as WP leader, requested that the workshops be preceded or followed by a series of

face to face interviews, which was done in Savoy and Tunisia and at a later stage in Croatia and Cyprus.

For future similar projects, climate scientists should get involved with tourism stakeholders in the different way, rather than creating dedicated meetings. This possibly implies organizing special sessions on climate issues within (general) tourism meetings which may generate more discussion and interest with a larger assembly.

Animation methods and tools

The method of interaction has to be improved too. For instance, quite "formal" approach was used during the meetings (formal climate expert presentations followed by discussion), which can probably be explained by the background of the meeting conveners. However, more participatory methods could have been used: the introduction of short participation exercise or interaction construction process like in Savoy workshop are quite interesting to collect more results (process of co-design of the priority ranking needs etc.).

Approaching the organization level: face-to-face interviews versus online survey

Individual consultations can provide a more detailed expression of needs. In Tunisia and in Savoy the workshops were preceded by a series of preparatory interviews using a shortened version of the perception questionnaire (see WP4), allowing an initial presentation of stakeholders' demands, collective discussion, prioritization of issues with truly informed stakeholders.

In Croatia and Cyprus, the questionnaire was send out with the invitation for the workshops (around 60 stakeholders in the case of Croatia), with, in both cases, a low response rate (7 in Croatia), and a limited participation to the workshop. This is common to other WPs: given the low number of respondents, the questionnaire should not be used for a quantitative assessment (i.e. the results should not be processed quantitatively), but more as a guideline for interviews and organization of workshops. This inadequate use of the proposed tools can possibly be explained by the lack of social scientists involved in the project.

The proposed program was intended to encourage the maximum involvement of the actors in the project right from the initial phases. The interviews made possible a direct contact and dialogue with stakeholders. They therefore appear to be the most appropriate method in a "bottom-up" approach, as they eliminate the "distance" that can be created by sending written questionnaires by mail.

Method for implementing the face-to-face interviews : the Savoy case study example

Generally speaking, the field survey phase took place as follows

- Making appointments
    - Initial email contact, including a brief explanation of the process and request for an appointment (with a recommendation letter from CLIM-RUN/TEC attached)
    - Follow up email, with more detailed information on the project and its relevance for the person if required.
    - If the person did not reply, the email was followed up with a telephone call explaining the procedure.
- Meetings
    - Interviewers travelled to places convenient for the interviewees whenever this was possible (for example, their office or another location).
    - Dates were fixed beforehand: they varied depending on the region.
- Follow-up
    - During interviews, interviewees were told a workshop would take place.
    - After the interviews were completed, invitations to the workshop were sent out. Follow-up emails were sent if interviewees did not reply.

Assessing users need: short tailored questionnaire versus extended one

WP4 provided a comprehensive questionnaire, which included most relevant items for the discussion that could arise from an interaction with a stakeholder. WP5 shortened this questionnaire for a more fluid interaction with the interviewees. This shortened version was used in Savoy and Tunisia case studies. In Croatia, the shortened version was used too, but it was also translated into the Croatian from the original English version.

- Interviews were conducted and analyzed in a "comprehensive" manner. The information collected is therefore not suitable for statistical analysis. The

interviews usually began with general questions, before moving onto more concrete questions dealing with technical details and/or with the climate. Some questions could be used to obtain clearer information or focus the interviewee on the main issue at hand when required. This is typical from the semi-structured interview method.

- Interviews can sometimes be impaired by too many technical questions (several technical questions can suffice). This hinders dialogue and interrupts the flow of the interview. As a result, the interviewee's interest/involvement in the process decreases.

- It is important to avoid falling into this trap with interviewees who lack expert knowledge of climatology, or those not used to dealing with climate data. This can be done by finding a good balance of information, or "translating" or even explaining some technical questions. However, care must be taken not to lose sight of the information being collected.

To get around this issue, interviewers developed an interview scenario adapted to the different kinds of actors they met with. For "technical" questions on climate information needs, interviewers used a card listing different climate documents. This made it possible to present some examples of existing products and models' outputs. It also prompted interviewees to express their needs/opinions in terms of climate information.

Example of material presented to stakeholders, for Savoy consultation

Seasonal temperature projections, 2070-2099, (Météo-France, IMFREX).

Winter rainfall (compared to the 1961-1990 base period average) in the alpine sectors (including the Northern/Southern Alps and Central Alps) (Météo-France).

The percentage drop in snow depth according to climate evolution scenarios (Météo-France).

Good ski conditions in the Swiss Alps: current and future climate conditions (Elsasser, Messerli 2001).

Key factors for a successful interaction

Overall, the following key factors seem to be critical to ensure a good interaction with stakeholders, and the follow-up in the project:

- transparency of the objectives of the project: CLIM-RUN is a research project, its outputs are based on scientific methods and may not be expected to be deceptive, etc. ;

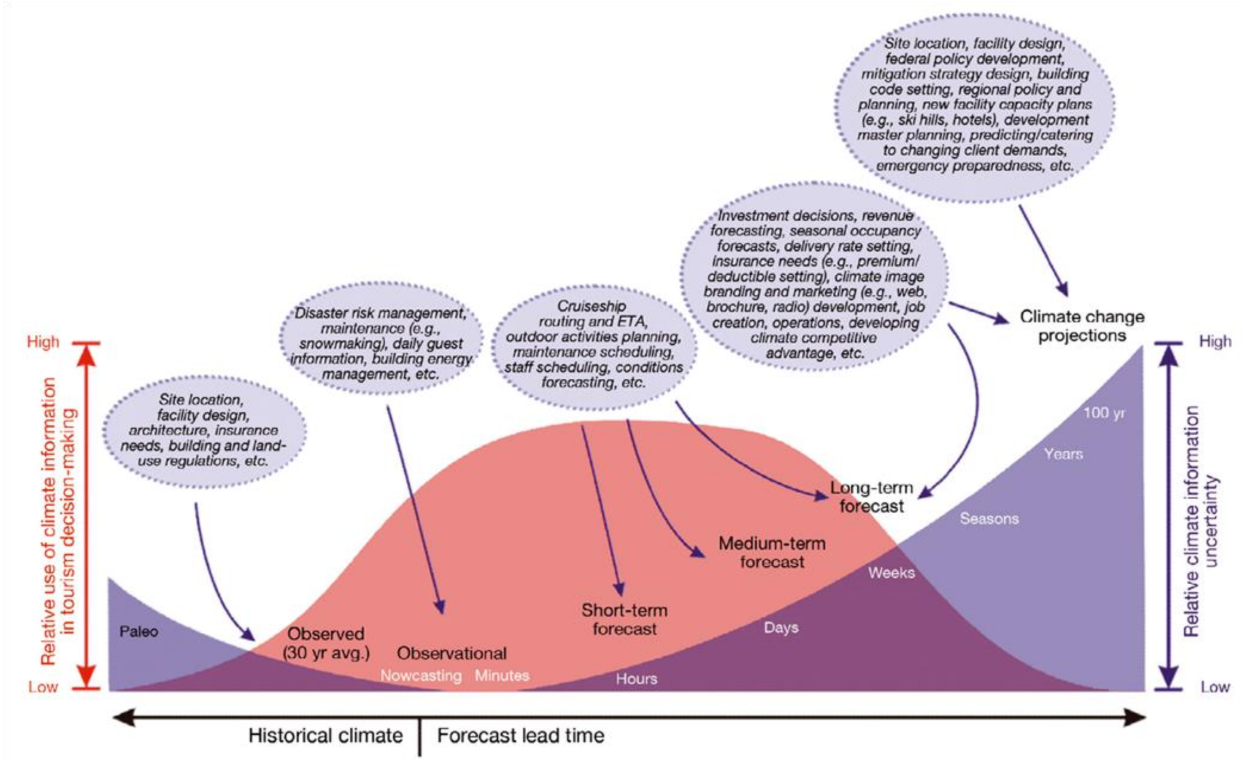
- providing feedbacks on the results: keeping stakeholders updated even if delays are observed;
- targeted communication: stakeholder dependent (non-technical vocabulary, translation in a local language if necessary, move away from technical to pedagogical approach, etc.);
- bi-directional communication: both sides have the opportunity to exchange information and have their issues addressed.

Stakeholder and risk perception analysis

Conceptualizing the tourism-climate services relationship

Scott at all (2012) provides a conceptual framework on how to deliver climate information and services and how to interact with end users in the tourism sector. As it is shown in Figure 5, climate information can influence the decision-making process from different types of activities: operational destination management (outdoor activities planning, maintenance scheduling, etc.), marketing and communication plans (brand, brochure, etc.), long-term investments and strategies (hotel facilities). Using climate information could represent an economic advantage in some situations and would minimize the risk of losses in other situations. That means that every tourism stakeholder could be a potential user of climate information predictions. This potential interest of the sector varies, however, depending on time-horizons and their associated uncertainty.

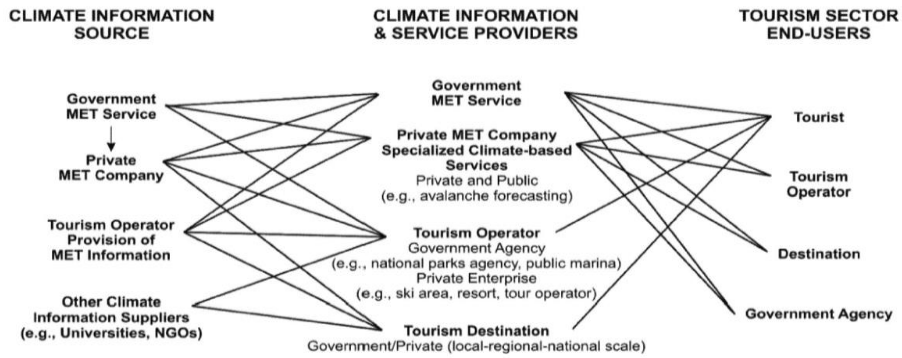
Figure 5 : Potential uses of weather and climate information by tourism operators and travel planners



Source : Scott et al., 2012.

This study also illustrates the diversity of interaction between data providers and end-users (Figure 6), and the main interfaces. National meteorological services (NMSs) and private meteorological companies (e.g. la chaîne météo – the weather channel) are the primary sources of data. Even if the quantity of weather and climate services provided by NMSs to the tourism sector is currently limited, these offices are key players in providing climate information to the mass media and other tourism-specific outlets (tourist guides, travel planning websites, etc.). For short-term forecasts, "Private-sector climate service providers have led the way in terms of innovation of specialized climate services tailored to specific tourism destinations, individual tourist activities and subsectors", e.g. iSki App, The North Face® Snow Report, SkiResort, and SnoCountry, boating (TideApp), surfing (Oakely® Surf Report), and fishing (Fishing Calendar).

Figure 6 : Conceptual framework of climate information in the tourism industry



Source : Scott at al, 2012.

Stakeholder classification and targeted communication

Within the project, a classification of stakeholders was made regarding:

- preliminary stakeholder analysis (climate risks effects on the decision making processes, interaction between stakeholders and climate providers, assessing the awareness, etc.);
- level of interest of the tourism organization to take part in the project with, for instance, filling the questionnaire. The questionnaire was handed out at the end of the first round of Workshops and a classification by desired degree of involvement has been made (high/medium/low).

For the Savoy case study, Figure 7 provides an example of classification made during the first consultation phase.

Figure 7 : Classification of stakeholder interest (Savoy Case study)

Very interested +++	interested ++	A bit interested +	Not interested -
MITRA	PN Vanoise	CDT73	ASADAC73
SMBT	PNR Bauges	Chamoniarde-PoleMontagneRisk	*Camping Sierroz/FRHPA*
MDP-ObsCC	CC Vallée Chamonix	Compagnie des Guides	Orexios
CCI73	OT Vallée Chamonix	DSF	*Refuge Fournache*
Hémisph'Air	SNGM	*Refuge Plan Sec*	Mountain Riders
Camping Lanchettes (FRHPA)	SNAM	Mountain Wilderness	
CIPRA France	SNAPEC		

A targeted communication was recommended at the end of the first consultation phase with the key players identified at the destination level. Several communication channels were used:

- on-line consultation on drafts products with key players;
- an additional focus group was considered in Savoy to bringing together actors for discussions; it was abandoned given the low availability of stakeholders;
- supplementary interviews on specific product(s): detailed requirements, final layout desired…
- specific Wiki page (Savoy).

Savoy wiki page

To make it easier for actors and the CLIM-RUN team to get information on the project, an interface has been developed. The idea was to provide a platform open to contributions from different groups which would be integrated into the existing CLIM-RUN website if possible.

It would provide actors with some climate data information on the project (information flows from CLIM-RUN => actors), and collect raw data (information flows from actors => CLIM-RUN). In this way, any partner in other CLIM-RUN work packages could consult and provide information to the platform.

Access to the platform would be limited to the Savoy actors who had chosen to get involved in the project (there was no public access or broadcasting of the platform).

Understanding needs

Identification of users' needs

The identification of users' needs was sometimes rendered difficult for several reasons, some arising from the protocol and its accompanying tools, some linked to the nature of the tourism activity:

- It was realised that the questionnaire was somehow too generic, and assumed that the users knew their needs *a priori*: it was based on the assumption that stakeholders had already identified their needs and can expressed them in a technical way (variables, temporal and geographical scale, data format, etc.). For most of tourism stakeholders, this was not the case. They faced difficulties to express their needs due to low awareness or lack of vision of the potential value of climate service. This was the case even if they are very affected by climate change impacts. Several stakeholders have expressed their needs clearly, but sometimes they were not realistic, due to the lack of climate background (demands too precise, need of temporal and spatial resolution that will never be obtained).
- The CLIM-RUN project was, on one hand, too ambitious, and, on the other, too narrow :
    - the field of climate information to explore (from observed climate to the long-term future climate change) is too large, while stakeholders generally refer to weather forecasts or seasonal forecasts;
    - the project focuses on climate change variables, while stakeholders request some information on weather and climate impacts (e.g. they are primarily interested in snow cover rather than in snow fall);
    - the qualitative nature of the results, due to the lack of representativeness of the sample interviewed, limits the capacity to generalise results.

Some room for improvement could have been found in a stronger involvement of climate researchers, so as to provide more appropriate material and better interact with users.

- On the Climate experts team (CET) side:
    - Climate experts could have provided examples (e.g. with tailored products) on how appropriate climate information can improve the decision making process (good practice that has been observed and potential benefits for the organisations/companies in the tourism sector, with examples of

climate products presented in a non-technical manner). In particular, the use of better visualisation tools would have improved this consultation process;

- They should, in particular during the workshop, present the limits of research: what climate science can presently do with emphasis on actual limitations and what would be possible improvements in the coming years. This could help the SET to assess the needs regarding to their relevance, and what can be reasonable produced during the project duration (to avoid disinterest and disappointment of potential stakeholders)

- On the Stakeholders expert team (SET side):
    - "Translated" climate questions into questions not related directly to climate should have been the questions that do not relate to climate but rather to the decision processes, vulnerabilities, critical thresholds and examples.
    - The questionnaire could have been improved by focusing better on the objective of interviews, i.e. focusing on smaller panel (assess in depth the needs of a small group of stakeholders and then extend the assessment to a larger group).

Translation of user needs and priority ranking

Translated the demand into the language of climatologists

The SET has made a work of translation and expression of the user needs, especially in Savoy and Tunisia, during the face-to-face interviews. The last part of the questionnaire provided by WP4 was used in a simpler way to translate the needs (see the figure below) to the climate team, but it was not used during the discussion with the stakeholder. The SET has had time restrictions to translate the needs, especially in terms of the temporal and geographical resolutions, and the format was not so easy to determine too.

Figure 8 : Example of tools for expression and translation of needs (Tunisia case study)

Main actors	Expectations	Variables	Temporal horizon	Resolution	
				Spatial	Temporal
-Public administration - Seaside tour operators	**Trend and evolution of the coastline**	- Sea level - temperature and salinity of seawater	10 to 50 years	regional	Annual average and trend

- Hoteliers -public administration	**The issue of water in Tunisia and especially in the South and along the coast**	-Rain - surface water -Evaporation - water needs - coastal acquifers water(volume and salinity)	5 - 20 years	-national -regional -Local	Year and season
Hosts (in the Tunisian south)	**Summer heat**	-air temperature -energy requirements for air-conditioning	5 - 20 years	Region and sub-region	Season
-tour operators -Planners -private investors	**Winter and intermediary seasons' Climate comfort level**	-air temperature - comfort index -sea water temperature	5 - 20 years	-region and sub region and transmitting countries (comfort index)	Season
*seaside hosts *tour operators -Planners	**Change margins of the tourist season**	-air temperature and sunshine - water temperature	10 to 50 years	Region and sub region	Month
-providers of recreational outdoor activities -hosts	**Climatic Conditions day/night**	-Temperature -comfort index -air humidity	5 to20 years	Region and sub-region	Day/night
-Planners and administrators - Experts	**Tourists' future climate requirements**	- temperature - sunshine - comfort index	50 to10 years	Transmitting countries	Season

Defining product and priority ranking at the case study level

The SET has tried to make a specification of products and a ranking of priorities based on the first data requirement assessment. These products aim to determine precisely the user needs and they are linked to the specific users but also to the benefits in terms of adaptation for the end users.

The priorities have been defined in a subjective way, mainly during the first workshops with the stakeholders. The method is subjective because only few stakeholders attended the meetings.

The specification was divided into two groups: past and present needs and future needs.

Example of specification for the Savoy and Tunisia case studies

Product 1 Tunisia: Seasonal Forecast: developing seasonal forecasting (1-3 months) as a means of support for decision making in the field of short-term planning.

Seasonal forecasting emerges as a highly desired service by tourism actors who emphasize the value of having this type of information needed for short-term planning (one to three months).

The focus is mainly on seasonal forecasting of temperature in Tunisia but also in the tourists' source countries. The temperature difference, especially in winter, between the country of origin and the destination is a factor for choosing this destination.

In Tunisia, climate seasonal forecasting, especially rain, is performed by the National Institute of Meteorology (NIM) by the model ARPEGE-climate. The results of this forecast, which is mainly qualitative and applied to rain, are also not disclosed.

It seems that tourism actors and primarily travel agencies find it quite important to have information on the particular temperature, the month or two to three months ahead, at the country's level as well as at the transmitting countries. The regional forecasting would be quite valuable here.

Product 2 Savoy – "SPRING CONDITIONS IN MID- AND HIGH-MOUNTAIN AREAS": Taking opportunities resulting from an earlier start of the summer season

In the future, the spring shoulder season could become more popular than the summer season for some outdoor activities (if conditions are optimal in terms of sunshine, temperatures etc.). Changing practices are already being observed. This can pose problems for tourism operators (in terms of logistics for camping grounds and refuges, for instance), who are not prepared for an early summer season.

Having access to forecasts on spring conditions (temperatures, sunshine and snowfall) would allow institutional actors to develop a strategic vision for these two seasons, and help actors in the field to get ready and improve organization for any significant increases in the number of visitors at that period.

Defining cross-cuttings needs

After the consultation phase, the SET team has analysed the different data and products requirement and the occurrence of parameters. Then, the common needs and specific products have been classified.

Delivering products

Apart from assessing the users' needs, CLIM-RUN experienced some innovative ways of developing and delivering the requested climate information.

The CET classification of the products

The first task of the CET was to confront users' demands to data availability, but also to human resources required and to the priority in terms of research. Some case studies highlighted some interesting methods to better classify the needs, as transparently as possible. Figure 9 gives an example for the Croatian case. However, the study also revealed a need to be more transparent on the development choices made by the climate organization (which of the products was finally retained, etc.), with a better communication flow with the SET.

Figure 9 : Classification of the needs, the Croatian example

1: Already available

2: Easy to provide

3: Able to provide but with a lot of work

0: Not possible (not currently used in table)

Climate variable	Observations	Model simulations	Comments
Temperature	**1** DHMZ can provide station data and digitized maps from the climate atlas. Also reanalysis (ERA-40 and ERA-interim) and gridded (E.OBS) data.	**1** Available now (to daily resolution) – ENSEMBLES and RegCM.	Essential
Precipitation	**1**	1	Essential/desirable

	DHMZ can provide station data and digitized maps from the climate atlas. Also reanalysis (ERA-40 and ERA-interim) and gridded (E.OBS) data.	Available now (to daily resolution) – ENSEMBLES and RegCM.	
Extreme events, e.g., heavy rainfall, frosts, heat waves, very hot days/nights	**1/2** Available now or with relatively little additional work from datasets listed above Derived indices subject to fewer restrictions than raw station data.	**1/2** For climate change simulations (see above), available now or with relatively little additional processing of model output	Desirable/essential. Not specified in detail – but assume that standard indices (i.e., subset of ETCCDMI) will be appropriate.
Wind speed	**2/3** Wind atlas (ALADIN downscaling, 1 hourly, 1992-2001 – see energy case study). Station data?	**2/3** Some wind data will be provided by WP2 to WP7. Some DHMZ downscaling of ALADIN/HR has already been done.	Desirable/essential. Spatial and temporal resolution desired (not yet specified) may be an issue. Additional issues with respect to the nautical tourism application?
Wind direction	**2/3**	**2/3**	Desirable/nice to have/essential.

	Wind atlas (ALADIN downscaling, 1 hourly, 1992-2001 – see energy case study). Station data?	Some wind data will be provided by WP2 to WP7. Some DHMZ downscaling of ALADIN/HR has already been done.	Spatial and temporal resolution desired (not yet specified) may be an issue. Additional issues with respect to the nautical tourism application?
Wind consistency	What data do DHMZ have/know about? How to define/characterise 'consistency'	**3** Some wind data will be provided by WP2 to WP7. Some DHMZ downscaling of ALADIN/HR has already been done.	Essential/nice to have/desirable. Spatial and temporal resolution desired (not yet specified) may be an issue. Additional issues with respect to the nautical tourism application?
Other weather variables	**2/3** Various data are measured and observed at meteorological and climatological stations – to be catalogued by DHMZ. Reanalysis (ERA-40, ERA-interim) data.	**2/3** Should be possible to provide but questions about reliability.	Desirable. Not always specified, but included: radiation, sunshine, cloudy days, relative humidity. These are all needed in their own right and as input to comfort indices (see below).
Marine and coastal variables	**3**		Desirable/essential/nice to have.

	Measured SST data are available for around ten locations on the Croatian side of the Adriatic. Maybe Institute for Oceanography and Fisheries, Split, has some additional data	Need to discuss this with the Venice CET members.	Not always specified but included: sea level, SST, storm surge, wave height. How useful is SST as an indicator of bathing sea water temperature?
Weather-related indices and events	**3** Biometeorological indices could be computed for all locations where measured/observed input parameters are available (main meteorological and climatological stations – from DHMZ). Snow parameters are available as well.	**3** WP6 is looking at fire risk – but need observed data to identify risk thresholds. Feasibility of constructing thermal/comfort indices depends in part on variables required. Snow is output from models but how reliable?	Desirable/essential/nice to have. Not always specified but included: thermal perception and risk (i.e., biometeorological indices), fire risk, snow (depth/duration of cover, season length, number of days). It is assumed that the thermal indices relate to the various available comfort and biometeorological indices. The number of days with snowfall is captured reasonably well for most of Croatia in RegCM (Branković et al. 2012). The problem is a narrow mountain region near the coast where higher horizontal resolution is required.

Producing the user-relevant products

A constant need of research

Another important issue is that the delivery of tailored climate products requires scientific and technical expertise. If climate services were to be developed to a satisfactory level, researcher must be in charge of scientific development of products, but not only on the fundamental research and this fact must be anticipated and funded by climate providers.

General CET-SET frameworks

The process of producing the user-relevant end products requires first a general comment: the interaction protocol defined between the CET and SET was probably too complex. For each individual case study a stakeholder expert was coordinating the interaction with stakeholders, liaising with the WP leader. Some SET meetings were, at the WP4 level, supposed to coordinate this interaction. At the same time, a climate expert is in charge of liaising with the rest of the climatologists potentially involved in the production of the required products, and some CET meeting occurs in WP2 and WP3 (in charge of providing existing data and improving models), so as to coordinate this effort).

In practice, the WP5 experienced a more disorganized situation: climate and stakeholder experts were sometimes the same persons (Tunisia, Croatia), they could be identified but inactive, the communication was not always adequate and it was difficult to know what was being developed by whom. The CET-SET interaction was perhaps too complicated.

Successes…

One interesting point is the co-design of some product information sheets (see all the products' sheets in appendix) between SET and CET and key players (Savoy observatory of Climate Change for instance): this was a real interdisciplinary result. Moreover, climatologists of the CET were often associated to the second round of workshops, so as to present the results in detail, included the methods used, to the stakeholders.

…and weaknesses

On the other hand, one can note:

- the excessive need of specification and some insufficient communication and creativity in this process: the climatologists cannot be the final producers without any input, and must be more "risk taking", choosing parameters or defining thresholds by himself;

- some practical constraints due, in particular, to climate data availability (for instance, when observational data was theoretically available, but not usable due to complex internal institutional rules);
- the lack of interaction with stakeholders: In practice, during the product development phase, in WP5 the interaction occurred more between CET and SET, but rarely with the 'outside world'. This can be explained primarily by the technical nature of discussions, but also by the lack of experience of the project participants since the CLIM-RUN may be also regarded as an experiment. Should the demand be more real and the products really operating on a permanent basis, the stakeholders would probably be more involved in the process. EUPORIAS, which endeavors to develop fully operational prototypes, will help answering this question.

Products relevance

The relevance of the end products, i.e. whether they are adequate to the stakeholders' needs, obviously depends on the products themselves. Some potentially good products, even though delivered as pilot studies (not on a permanent basis) could be of direct use for stakeholders, for instance, the seasonal forecasts for Tunisia.

Some other products could have been relevant, but for various reasons were made in the format or at time scales not adapted to the user needs. All the Savoy products were asked at short to mid-term horizons and provided at a long term horizon (40+ years). Others would have required to run impact models to be really usable (e.g. the lake model product in Savoy).

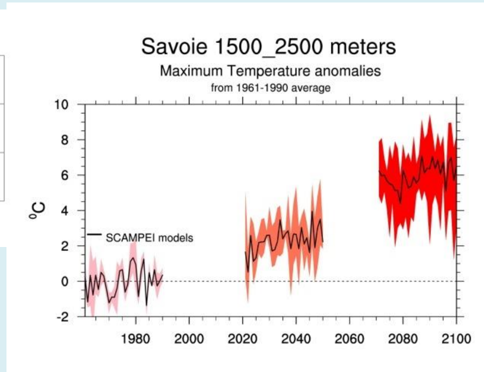
Example of relevance of the product "evolution of temperature in high mountain area"

The stakeholders request to know more about the future evolution of temperatures in high-mountain areas so as to better imagine and anticipate its impacts on the conditions of practice outdoor activities (e.g. mountaineering, glacier hikes etc.). It simply seeks to provide information about the future evolution of the freezing level height (isotherm 0), in relation with glaciated areas.

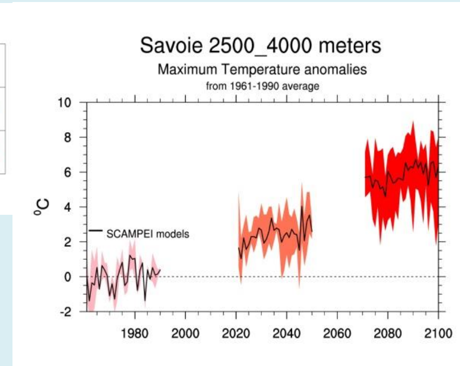
Provision

Meteo France used the SCAMPEI project, the highest high resolution (8km) projections for mountain areas, to illustrate temperature increase at some altitude ranges.

°C	T_{min}	T_{mean}	T_{max}
2021 -2050	1.1	2.3	3.7
2071 -2100	3.8	6.0	7.7



°C	T_{min}	T_{mean}	T_{max}
2021 -2050	1.3	2.4	3.6
2071 -2100	3.8	5.8	7.4



Model ensemble mean (black line) for the T°C maximum. The envelop represents the minimum and maximum changes obtained by the different simulations.

Assessment

More simple information, i.e. the future level of the isotherm 0°C, would probably be better. we could expect for example a representation of a kind of temperature profile according to the altitude. However, due a) to the type of visualization of results chosen, b) to the fact that the model grid did not include enough grid points above the isotherm 0 in summer (since very high mountains have a limited spatial extension), the initial objective could not be attained.

II. Tourism and climate services in the Mediterranean

This section presents, in a synthetic manner (the workshop reports and product sheets detail these results) some more concrete results on the tourism sector: the current demand of climate services in Mediterranean tourism, and the general characteristics of the products requested and developed.

The current demand for climate services in tourism

The specifics of tourism

The current practical demand on climate services has some common features in the tourism sector:

- Low, in spite of some obvious interest (high presence of SMEs, short-term concerns, the lack of R&D department in private and public institution): tourism is one of the most seasonally-sensitive sectors and is highly dependent on climate parameters (e.g. snow/ski, temperature, etc.).

- Unclear - without guidance stakeholders have difficulties to express their needs; when confronted with examples they realize there might be an interest for their activities.

- Highly concentrated on small geographical areas demanding high resolution products (often unreachable). For instance, the quality of the sea bathing water is requested, i.e. beyond available SSTs. To get this information, some very local models, downscaling SST, accounting for shoreline, sand and breeze effects would be needed. Similarly, climate conditions in very high mountains are often absent, even from the more recent models, and therefore statistical downscaling to particular location seem to be particularly adapted to these cases.

- Focused on impact more that climate variable (e.g. lake model). CLIM-RUN did not propose the impact modelling. As it was initially envisaged, some of the subjects of the project were a little deceptive for stakeholders. However, assessing the impacts may lead to some additional uncertainties, which, combined with the demand for high resolution, might make objectives unreachable.

- Focused on the short to mid-term time horizons. Very high demand for seasonal up to decadal forecast. Few direct assets are planned beyond twenty years (if one excludes spatial planning and infrastructures related to tourism)

- Taken all these characteristics together, the demand or needs are quite heterogeneous, in obvious relation with the diversity of the tourism sector itself.

The emergence of commons products

Two common field of concern emerged: seasonal forecasts and the development of tourism specific indices, like the Tourism comfort index (TCI).

Seasonal forecasts

The demand is primarily focused on predicting seasonal temperature not only at destination level but also in the home market. The temperature difference between the country of origin and the destination is a factor which may affect the choice of a particular destination. For instance, if the climate is particularly rainy and stormy in the UK in spring and summer, the Britons may wish to travel more to Cyprus, and it is therefore valuable information for the Cyprus tourism offices, tour operators and travel agencies. The regional scale of the forecast is really desired here.

Seaside tourism – indicators of bathing seasons

An important expectation of stakeholders concerns is the **sea surface temperature** (including very local values, immediately along the beach). Besides the comfort, this request is also related to the problem of jellyfish that is becoming increasingly alarming for some bathing locations (especially in Tunisia and Cyprus) and also as assistance in planning beach activities on the fringe of the main season. The downscaling of SST to sea bathing temperature could be an innovative task for the community of statistical downscaling

Mountain tourism – Indicators for summer seasons

In line with the "seasonal assessment culture" (Philippe Bourdeau, Stakeholder expert of the Savoy case) underlying much of the Savoy tourism industry, an important request has been formulated by the tourism stakeholders. They would like to combine seasonal climate assessments with seasonal economic assessment. The seasonal climate assessment could be improved by taking into account users' expectations in terms of variables: rainfall, temperatures, and extreme weather events. At the same time, the economic assessment could be reworked to show the direct impacts of climate observations on economic activity (customer behaviors, steady activities, and negligible activities). Even if this tailored product is mainly focused on the past season, one could also plan activities for the coming season. A seasonal forecast for air temperature would be potentially very relevant for the winter season.

Tourism comfort index (TCI)

This demand was clearly expressed in Tunisia and Croatia and mentioned in Savoy workshop. There is a need to improve existing tourist comfort indices that usually combine several climate parameters such as temperature, humidity, wind, sunshine. The TCI is based on oriented tourism activities sensitive to weather and climate and should be based on the knowledge of the climatic requirements of tourists through a survey that targets different categories of tourists and tourist activities (TEC-CREDOC, 2008, ongoing protocol within the CLIMRUN Tunisia case study).

These indices should be able to express the level of comfort from seasonal to decadal scales for different countries and to model changes in tourist flows regarding changes in climate conditions. The improvements could help exploiting the climate potential of the destination and diversify the tourism products. This concerns particularly intermediate seasons (spring, autumn), which could offer opportunities for tourism in a warmer future climate.

Various climate data requirements (from 5 to 20 years)

Among the case studies, there are specific climate parameters or derived indices requested by stakeholders. Here is a sample of requests that concerns the short and medium term (approximately 15-20 years):

- High mountain future climate conditions (air temperature) for hiking and mountaineering during the summer season;
- Alpine lakes and rivers climate conditions (wind for sailing, temperature for bathing, hydrological regimes for floods and natural disasters);
- Accelerated sea level rise along the coast and beach erosion (seaside tourism/ hotel facilities and resort, coastal infrastructure – e.g. inappropriate sewage will be affected by sea level rise);
- Extremes events for all the case studies (heavy precipitations, heat waves, droughts, etc. for the nature sports, for instance, in Savoy);
- Spring conditions in the middle and high mountains (temperature, precipitation, sunshine duration) to seize the opportunities of a possible advance (extension) of the summer season.

The ability of climatology to answer tourism needs

Seen from WP5, some interesting results are derived from tourism case studies. WP2 and WP3, which primarily objectives are to deliver data and products, will likely comment on that point more.

The benefits of a "network production" of products

The CLIM-RUN project gathered some high profile research teams, amongst the main active in the modelling of Mediterranean climate. When answering users' needs, WP2 (and to a certain extent WP3) 'dispatched' requests and allocated resources to the teams which expertise appeared the most adapted. This is very promising, including for the future structuring of climate services in Europe. Indeed, it may benefit from the best European expertise at the given time and promises some transfer of the know-how and capacity building across Europe. For instance, on SST and seasonal forecasts, ENEA and IC3 teams were respectively mobilized to fulfill the Tunisian needs.

When the user needs may trigger model development

Surprisingly, the work on model improvements could be (in the future) prompted by users demands, e.g. when:

- the request of Savoy stakeholders met the willingness of Meteo France and others to improve the modelling of alpine lakes, which has led to a quick development;
- the request of more information on the evolution of the 0 isotherm helped assessing the model capabilities (the SCAMPEI project appeared to be not relevant for very high mountain and only statistical downscaling could perhaps meet this need);
- in the case of TCI, the statements of a common concerns led to a collaborative research which will improve the future developments

Usability and reliability of TCI for the Mediterranean: a CLIM-RUN collaborative task

The tourism comfort index topic gathered several CLIM-RUN researchers to present several case studies on the improvement (adaptation to measured climate preferences of tourists, data issues, uncertainty assessment, etc.). This resulted in writing and the submission of a joint paper.

Figure 1: TCI calculated for the ENSEMBLES mean (left) and for the nine different models over the period 1971-2000 during the summer season.

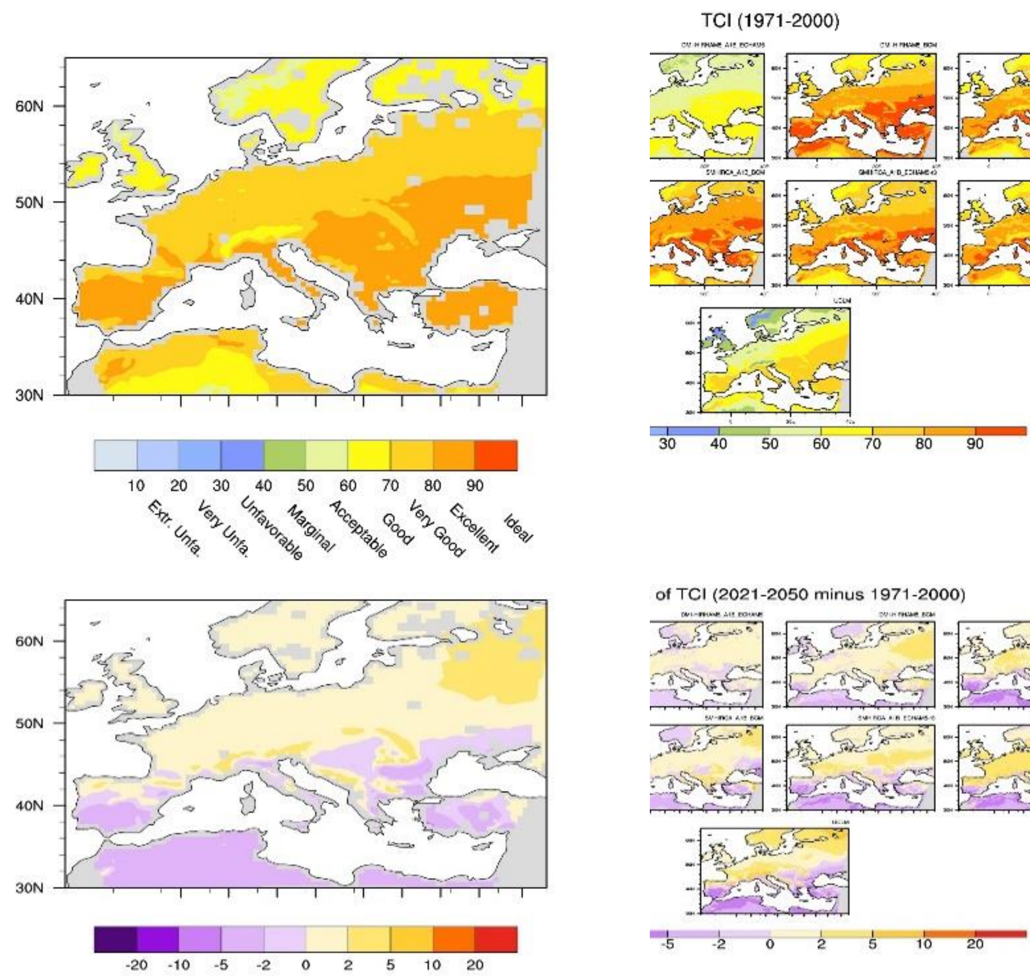
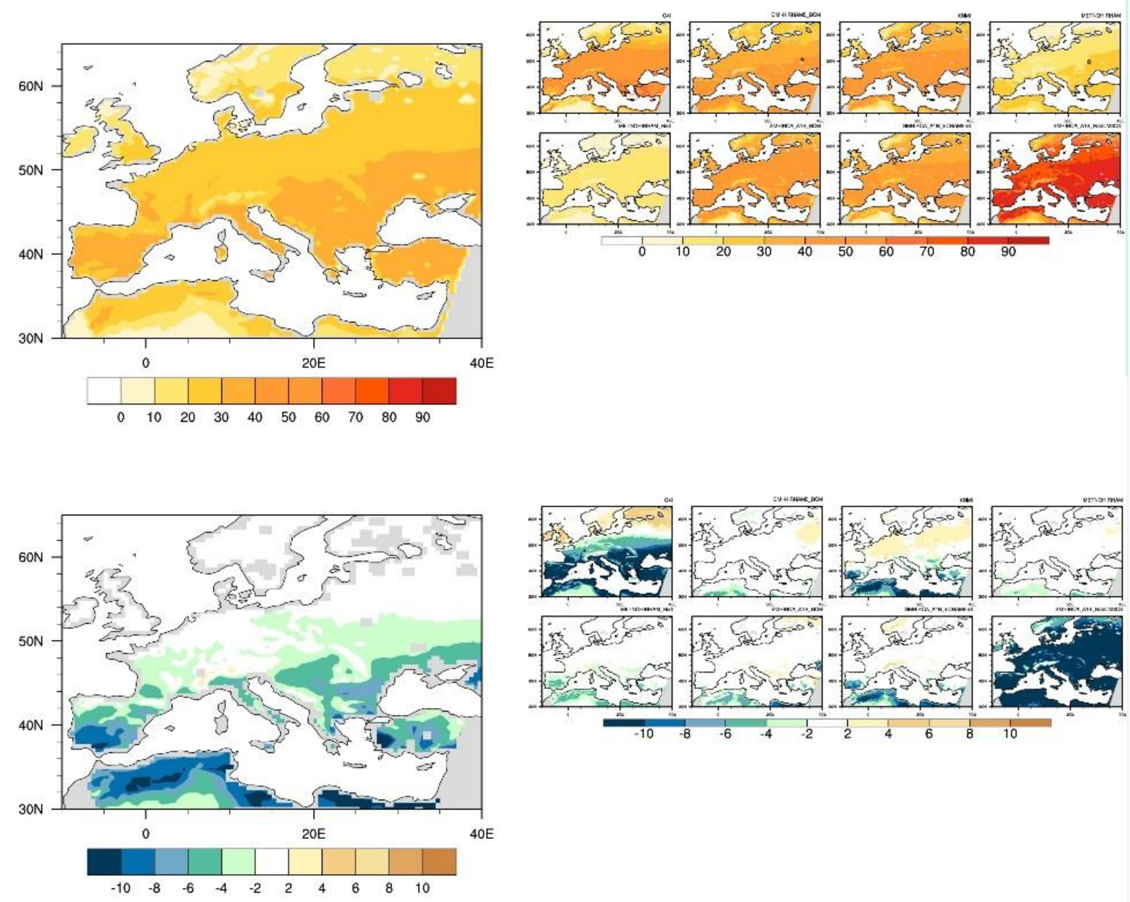


Figure 2: Number of days where the TCI is greater than 70 over the summer season for the period 1971-2000. Left (ensembles mean), right (individuals models). (One model has no TCI greater than 70 during the summer months). Source : Meteo France, from the ENSEMBLES project



Dubois G., Alaouane T., Cauchy A., Casanueva A., Ceron J.P, Dubois C., G, Henia L., Hlaoui Z., Dolores-Frias M.D, Giannakopoulos C., Paci D., Bigano A., Zaninovic K. *Usability and reliability of tourism comfort indice(s) for the Mediterranean.*

Limitations

The capacity to answer to the user needs had several limitations:

- limits related to the lack of data (observational data, modeling data, etc.);

- limits related to the models that cannot provide the desired information (e.g. potential improvement for the lake models);
- costs and humans resources to answer the user needs (e.g. seasonal balance product for the Savoy case study);
- current and/or intrinsic unpredictability of some phenomena or their unavailability at certain time horizons (current incapacity to answer frequent request at decadal timescales).

III. Moving towards Mediterranean-wide climate services

Starting from the tourism case, this section provides more general recommendations on the potentials and future architecture of climate services in the Mediterranean. It discusses the 'business model' of climate services, the possible contribution of tourism to the development of Mediterranean climate services, and finally some institutional issues.

The business model of climate services

By 'business model', we refer to here is the 'three tier' model proposed by WP1: a climate service should articulate a climate tier, a stakeholder tier, with a key role of an intermediary tier, to translate needs and make the research products accessible to stakeholders.

Climate tier

The development of climate services will increasingly include a demand-driven climatology. Therefore, climatologists will have to adapt to this opportunity, opening more their work to the end users. Several statements and recommendations can be derived from the tourism case studies.

- There is obvious interest at the European and Mediterranean scale. Given the expertise required to develop products and the existence of the centres of excellence across Europe (e.g. IC3 for seasonal forecasting, ENEA for sea modeling…) in tourism, like in other sectors, the 'network production' of climate products is very desirable. Since each request may be specific, there will always be an added value in sharing this expertise. This is even truer when the Mediterranean is considered: the cooperation between countries opens the door for some capacity building and transfers of know-how. In terms of efficiency it will, however, require some careful planning of human resources.

- The need to estimate human resources and to include some common resources, beyond a particular project like CLIM-RUN, with the aim to dedicate some resources to the development of climate services. It is likely that climatologists would need to allocate their time in the future between fundamental research and more applied developments. This has to be anticipated. One could, for instance, imagine a European scheme, in which each institution would provide some resources, say 50-100 working days per annum, in common network. This time would be devoted to the development of climate products, with priorities defined by the network. This could be one way to create a permanent framework based on the experience by CLIM-RUN.

- The need to propose some technology transfer and some capacity building in particular in Southern and Eastern Mediterranean countries.

- The need for better communication with stakeholders: improving the awareness, developing of cases, prototypes and convincing examples is critical to persuade stakeholders, in particular in the tourism sector. Very practical examples need to be provided to end users and some resources should be devoted to that. This requires some willingness (sometimes absent in the academic world), but also some training, so as to improve communication skills and visualization tools.

- The contrasted situation is often found with national weather services, which beyond their forecasting role, sometimes act as research centres and sometimes as consultants.

Intermediaries tier

The presence of intermediaries acting as the catalyst between scientists and the end users is of importance for the future.

The mission of these intermediaries should be twofold:

- Raising the awareness on climate services of public and private stakeholders, understanding needs and liaising with climatologists;

- Tailoring climate products, providing useful visualization tools, with a true sense of communication.

The legal status and business model can vary:

- Public agencies (e.g. region development agencies, tourism development agency…, regional climate observatory) can help create a 'culture' and positive attitude towards climate services in each sector;

- Private consultants could be in charge of some more technical aspects: tailoring climate information, providing some expertise so as to interpret the data, … To enable their emergence, barriers like data access rights should be removed. Presently, a substantial amount of data is only available for non-commercial use. National meteorological services should clearly define their role with respect to climate services and the role of consultants, which should not exclude some potential overlaps and competitions. A potential competition should be fair and not limited by monopoly on the data ownership.

Finally, the climatologists should discuss training needs of intermediaries, and assess the feasibility of possible accreditation schemes to ensure the appropriate use of climate data.

Stakeholder tier

In general, tourism is characterized by a high proportion of SMEs and insufficient research and development departments, be it in public or private operators. This involves several comments:

- the role of intermediaries will remain critical in this sector;
- there is some doubts on the possibility of paying schemes for climate services, unless very tailored products are developed (e.g. seasonal forecasts for snow in the Alps)

The contribution of tourism to the Mediterranean climate services architecture

In theory a good case…

Tourism could be considered a good test case for the development of a climate services architecture, given:

- its economic importance, especially in the Mediterranean;
- its high dependence on climate parameters;
- the awareness of tourism stakeholders of climate change issues;
- the diversity of climate parameters, spatial domains and time horizons potentially involved.

But perhaps too complicated and unprepared for in-depth climate services development

This capacity is, however, limited by high proportion of SMEs; the lack of innovation in the sector; predominant short-term visions and a strong focus on economic concerns and (the current) post-crisis recovery; the general lack of public support to the sector, contrary to other economic branches, like agriculture.

In detail, several factors can explain the difficulty to engage stakeholders:

- no immediate added value of the CLIM-RUN project is seen that would contribute to their daily activities: CLIM-RUN is a research project that could not really promise some final products like climate change impact assessment, only the provision of data and indicators;

- some unforeseen factors can explain some difficulties encountered: In Tunisia the Janurary 2011 revolution, for instance, created a deep tourism crisis, and therefore stakeholder minds were focused on immediate economic recovery and political transition than on long-term climate issues during the research;
- complex relationships between tourism and climate: Tourism does not rely on a single parameter (like, for example, the production of wind energy) but on a series of parameters affecting the personal comfort (sun insolation, heat, humidity) or resources on which tourism relies upon (snow cover, seal level rise and beach erosion). Some of them are affected by human perception, like for example, perceived temperature rather than measured one. It may be difficult for stakeholders to observe the complexity of this links, and can lead to some discouragement;
- importance of SMEs in the sector: may entail the engagement of representative players (professional associations, tourism offices), rather than individual stakeholders. On the other hand, even “big” players (for instance Club Med, contacted in the perspective of seasonal predictions) expressed some skepticism about the usefulness of climate services for their activity, even if some added value seems obvious (ability to foresee the next tourism season in advance, etc.);
- low level of innovation within the sector: even big players do not have a R&D department, or do not commission external researches, therefore, the receptivity of new topics/tools can be weaker than for instance in some other branches of the industry.

Therefore, there is an obvious need to associate tourism in future partnerships, particularly in the Mediterranean, but the tourism itself is not likely to take the lead.

Institutional perspectives

Involving national leaders on a permanent basis

Significant actors at the national level (ministry, national tourism offices, industry players, key federations, etc.) should be involved on a permanent basis, for instance though a commission. As in many activities, sector leaders are more likely to be innovative in the field of climate services, and could play a prominent role to raise the awareness of others stakeholders. This can be achieved through pilot case studies. In 2006, Météo France ran an experiment with the Ministry of Tourism, for instance, providing seasonal forecast for the temperatures and precipitations during the winter season, with an update each month. Even if no formal assessment have been made, this experience has permitted to show a potential for adapting the activities to the climate forecast (change in terms of management and activities were observed).

In an interaction with tourism experts, a major breakthrough has been attained at the state institutional level in Croatia by including some aspects of climate change in the first ever Strategy of Croatia's tourism (the tourism industry contributes, on average, to about 15% of Croatia's GDP). The Strategy has been produced by the Institute for Tourism at the request of the Croatian Government. Although it is made only up to the year 2020, i.e. for the period when no major climate-related changes are envisaged, the Strategy nevertheless refers to the future climate changes having potential impact on the development of the tourism sector in Croatia (e.g. hot summers, potential extension of the main season to shoulder seasons, sea level rise). It is hoped that the issues of climate and climate change will hereafter remain as the permanent point of concern in future tourism strategies.

Preparing national met services

National meteorological services should be considered as key players of any future architecture of climate services. They have the knowledge, a rich history, some experience of the relationship with users and customers, even though developing climate services can involve new scientific and economic challenges. Several recommendations can be drawn from the tourism case:

- the need to create, if not existing, a tourism commission (section) in the national weather services: the Météo France tourism commission, for instance, is in charge of defining the needs for products like beach weather forecast, snow forecasts, etc. The commission gather some public and private stakeholders from all over the country;
- the mission of such commissions could be extended to climate issues;
- the need to identify the person in charge of climate services in the organization, and to allocate a dedicated working time to research departments.

Acting on a regional (NUTS2) level…

The key role for the creation and implementation of climate services should be assigned and planned at a country's regional level (here the term regional is in the sense of administrative unit) because:

- the legal competences are relatively high at the regional level;
- European regions are close to end-users to include their needs efficiently, and large enough to hold the expertise necessary to play an intermediary role between the data producers and users. Regional tourism offices have an increasing expertise for engineering in this sector;

- regions increasingly tend to provide climate data and support the development of action plans at local level

….Providing resources and expertise at the European level

The scientific part of climate services should be developed at the European level, given the complexity and level of expertise required, but also the fact that applications developed in one place can easily be transferred to other parts of Europe. Beyond the current project, this requires the development of a permanent scheme.

Appendices

Appendix 1: Tourism case studies step by step methodologies

Objectives	Methods	CLIM RUN partners involved
3.1 Mapping the issues (MM1-3)		
Assessment and conceptualization of: - the relationships of the activity with climate parameters, at present and in the future (climate change); - the current use of climate information by stakeholders; - the existence of nucleus of climate services in the activity (relations between climatologists, sporadically or permanently). The objective is to work both at a general level (each theme, e.g tourism) and at the very local level of case studies (e.g. Tunisia, Cyprus…).	Stakeholder institutional analysis Literature, desk research Face to face interviews of key stakeholders Collection of sector-specific data (basic economic data for each case study…)	WP 5 to 7 leader + case studies local team
3.2 Stakeholders' involvement (MM 2-5)		
CLIM RUN relies on the consultation of stakeholders, from various origins : - Scientists not specialized of CC, but expert in their field (e.g. tourism, forest fires, energy…); - Socio-economic stakeholders: economic operators, inhabitants, civil servants, elected people… To ensure a quality consultation, each team will have to secure the participation of a sufficient group of willing stakeholders, which might prove more or less difficult	Depending on each case, the involvement of stakeholders can be more or less long, costly and formal : - Informal involvement of colleagues (scientists, experts, socio-economic operators), through each team's network; - More formal involvement/ invitation, for instance through the	WP 5 to 7 leader + case studies local team

depending on case studies	participation of a ministry or any other institution, inviting stakeholders to participate, or through the subcontracting of sample constitution to a poll institute.	
3.3 Workshop n°1 (MM 6)		
A first stage setting Workshop (climate data requirements) will focus on the comparison between data demand and supply - A sample of stakeholders and experts will be invited to present their ideal data requirements in the framework of climate and climate change - In collaboration with the CET, WP2-3 experts will be invited to present advanced research in climate downscaling to illustrate what climate models can currently provide - The workshop will prepare the choice of key criteria and simulations for WP2 and 3 to consider so as to respond to users' needs. .	Facilitation of workshop Live + online consultation of participants before and after the workshop	Organisation: WP 5 to 7 lead, in relation with WP4, WP 2 and WP3
3.4 Iterative consultation (MM6-20)		
Each case study manager will then participate to the iterative process of producing new climate information, allowing : - to precise some needs expressed in previous phases - to evaluate the value of the climate information produced by WP2 and WP3, at intermediary steps. If necessary refining needs	On-line consultation Questionnaires, Conference calls	WP2 and 3 + WP 5 to 7

3.5 Provision of data and modeling tools answering stakeholders' need (MM6-20)		
As a follow-up of stakeholders' consultation, WP2 (new modeling tools) and WP3 (provision of existing data and climate projections) will try to adapt their supply to stakeholders' demand. By doing so they must constantly keep in mind the data requirements of stakeholders, and the form of output desired (type of graphs, mapping of uncertainty, for instance)	Provision and adequate presentation of existing data Downscaling of existing climate projections Development of new modeling tools for specific questions	WP 2 and 3
3.6 Workshop n°2 (MM20)		
A second workshop will consolidate the interaction between climate specialist and stakeholders, allowing a collective analysis of : 1) the relevance of the analysis, simulations and tools produced to address users' needs 2) the usefulness of data produced to improve climate change impact assessment 3) the quality of the interactions between climate experts and stakeholders 4) the possibility to extend these interactions and establish more permanent institutional links and procedures towards the development of a climate service network..	Workshop facilitation	WP 5 to 7 leader + case studies local team,+ WP2 to 3 (presentation of results) + WP4 (coordination)
3.7 Synthesis and recommendations (MM20-30)		
Lessons will be learnt from case studies following a bottom-up approach : - findings and recommendations from each local case study - cross-cutting results for each theme (tourism…). Recommendations for guidelines and standards (e.g. improvement of sector climate indexes…)	Desk research Conference call Seminars (lessons learnt)	WP 5 to 7 leader + case studies local team + CET-SET Transfer to WP1

- cross-cutting conclusions of all CLIM RUN case studies - Transfer to WP1, towards recommendations for future climate services		

Appendix 2: Information sheets

CLIM-RUN Product Information Sheet: June 2013

Bathing Water in mountain lakes

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CLIM-RUN

Key words : Savoie, Tourism, Mountains, Future climate change, Temperature, Lake

Target groups

- **Tourism institutions**
- **Professional organisations and federations**
- **Outdoor activity operators and professionals**

Context

Savoie's lakes (for example, Bourget Lake) support many different water sports, including water skiing, sailing, wakeboarding and swimming. The evolution of water temperatures affects those activities and the Lake ecosystem. This information is therefore particularly relevant to tourism actors, providing them data to anticipate increasing tourist numbers (as other areas become less attractive from a climate point of view) and develop activities in conjunction with future evolutions.

The approach

4 Lakes have been targetted in Savoie : Annecy, Aiguebelette, Leman and Bourget. The evolution of water temperature has been measured using a lake model (FLAKE, Mironov, D.V., 2008).
The model is validated off-line using different forcing issue from reanalysis and climat simulation over the past period. Observations are collected by Inra Thonon, CALB,SILA and CIPEL at different depths.
For the scenarios, the surface forcing are coming from the 12 kms resolution simulation (ALADIN-CLIMAT) carried out at the CNRM or by the fully coupled model from ICTP within the CLIM-RUN and MED-CORDEX project. Two emissions scenarios are used RCP4.5 and RCP8.5 from 2006 to 2050 and an historical simulations from 1950 to 2005.

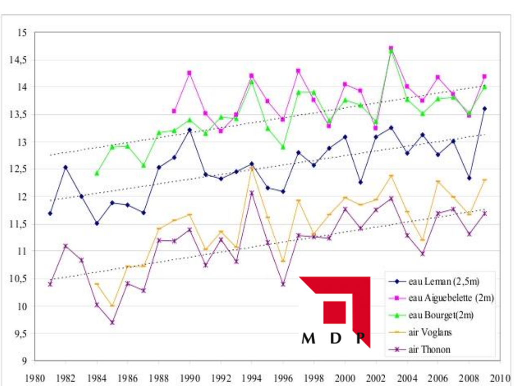
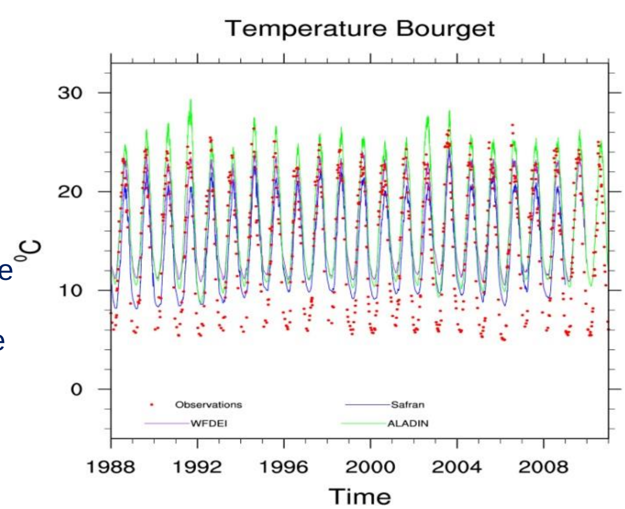


Fig.2 : Evolution de la température moyenne annuelle de l'eau mesurée à 2m de profondeur dans trois lacs alpins comparée aux températures au sol de deux stations météorologiques.
INRA (CARRTEL), Météo-France, analyse C. Chaix. (Voglans = aéroport de Chambéry).
On observe la très bonne correspondance entre les signaux.

The model reproduced well the daily temperatures. The winter temperatures are slightly overestimated.



Mironov, D. V., 2008: Parameterization of lakes in numerical weather prediction. Description of a lake model. COSMO Technical Report, No. 11, Deutscher Wetterdienst, Offenbach am Main, Germany, 41 pp.

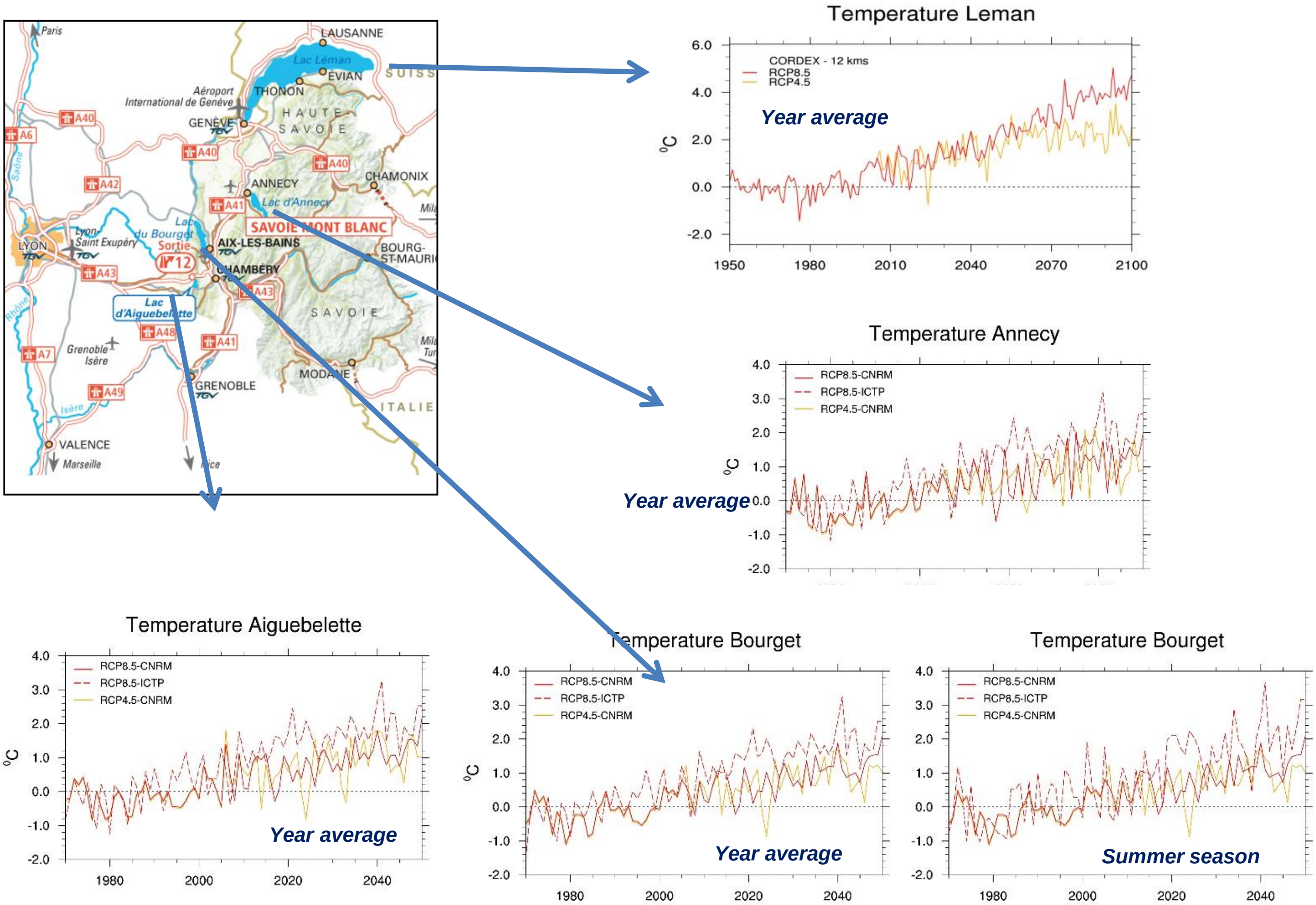
The observations data are provided by the: Base de données SOERE-INRA de Thonon-les-Bains, Données CISALB/CIPEL/SILA-INRA and MDP73, Observatoire du climat (www.MDP73.fr)

CLIM-RUN Product Information Sheet: June 2013

Bathing Water in mountain lakes

Product example

The figures represent the evolution of the surface water temperature for the 4 different lakes. The temperatures are in anomalies compared to the reference period 1971-2000.



In all 4 lakes, the temperatures show an increase in surface temperatures between 2°C and 4°C.

Making the Product Usable

The future generation of regional climate models will be coupled with a lake model.

This product appears as a good starting point to analyze the effects of climate change on bathing water conditions. This should be coupled with a detailed analysis of the impacts on water quality in order to collect opportunities and threats in the near and far future for outdoor activities.

This product will be disseminated to stakeholders, in particular through the Savoyard Climate Change Observatory.

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CLIM-RUN Product Information Sheet: June 2013

Evolution of temperatures in high mountain areas

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Key words : Climate projections, Tourism, High Mountains, Savoie, Temperature

Target groups

- **Professional organisations and federations**
- **Tourism institutions**
- **Regional authorities**

Relevance to the Case-Study Requirements

This product aims to give information on the future evolution of temperatures in high-mountain areas. The temperatures in high mountains is crucial for the practice of outdoors activities in this environment (e.g. mountaineering, glacier hikes etc.).

It simply seeks to provide information about the future evolution of the freezing level height, in relation with the glacier and alpines conditions.

The Approach

Simulations of climate change over mountainous regions have been carried out within the **ANR/SCAMPEI project** (http://www.cnrm.meteo.fr/scampei/presentation_scampei/index.php). They give an answer of the climatic response over mountainous regions. The simulations were carried out by the LMD, LGGE and CNRM at Météo France using high resolution regional climate models at a 12 kms horizontal resolution. After a statistical analysis is applied to take into account the complex orography in mountainous regions. The simulations have been run over 3 different period: the present period (1961-1990), the near future (2021-2050) and the far future (2071-2100).
Those simulation have already been used and exploited for stakeholders. One project was command by Atout France which promote France aboard and adapt the French offer to the tourist demand.

Using this existing data base, the models outputs corresponding to specific user needs in terms of parameters (mean-max-mean temperatures) and altitude ranges (1500-2500 meters and 2500-4000 meters) have been designed in terms of representation to make it relevant and usable by stakeholders. In fact, a huge issue was to represent in a simple way the trend of future temperature evolution but also the scale of uncertainty around this trend. Also, it appears relevant to include in terms of representation the values of models (mean, max and mean) for the different times scale in order to guide the decision making process. Even if maps have been provided and can be a good way of communication for large public communication, graphs are most comprehensible for most of stakeholders.

Those simulations allow the have an good representation of the future evolution of the temperature for different altitude ranges. However, the resolution of the different models (12 kms) has its highest grid cell at 3300 m. This altitude is too weak to give information of the evolution of the isotherm in the summer season. The 0°C level is above this altitude is the summer time in future climate change simulations.

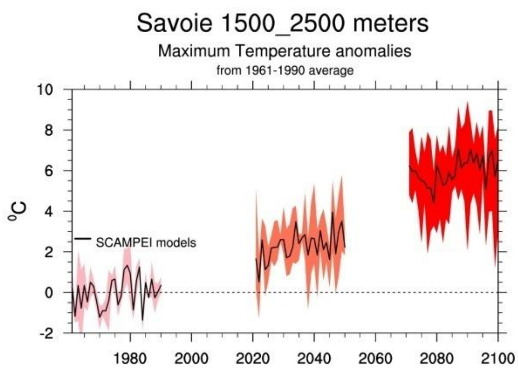
Evolution of temperatures in high mountain areas

CLIM-RUN

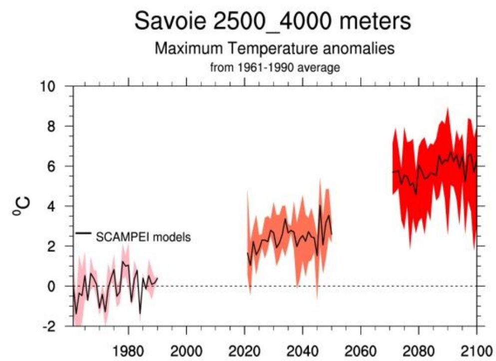
Example of product

Here, we present the change in maximum temperatures during the summer season in Savoie for different two altitude ranges: 1500-2500 and 2500-4000. The reference period is 1961-1990. The near future is the period 2021-2050 and the far future 2071-2100.

°C	T_{min}	T_{mean}	T_{max}
2021 -2050	1.1	2.3	3.7
2071 -2100	3.8	6.0	7.7



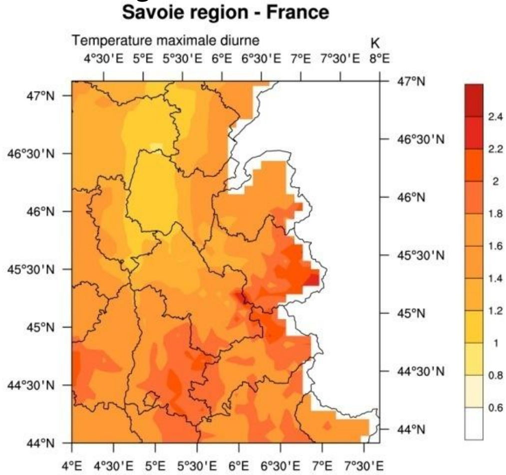
°C	T_{min}	T_{mean}	T_{max}
2021 -2050	1.3	2.4	3.6
2071 -2100	3.8	5.8	7.4



Model ensemble mean (black line) for the T°C maximum. The envelop represents the minimum and maximum changes obtained by the different simulations.

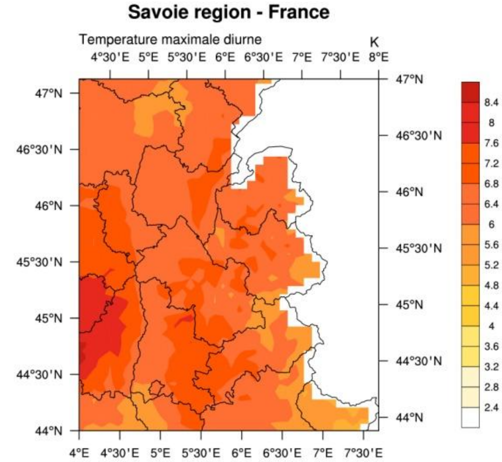
Changes in near future

Savoie region - France



Changes in far future

Savoie region - France



The maximal temperature is increasing in the future for all altitude ranges and models. The increase in stronger by the end of the century. The mean of the model is around +6°C with an uncertainty between +4°C to 8°C. This information can be translated by the stakeholders who are familiar with the local climatic conditions. An raise of 6°C will give a rise of 0 ° C isotherm of about 600 meters.

Making the Product Usable

This product will be useful in the hands of policy makers and professional organizations in order to rise awareness of large public especially to those who are practicing outdoors activities. Most of the stakeholders are aware of climate change and are already adapting to changing conditions or reorient their activities. This product could be integrated in the DRIAS portal, where figures with the mean trend and the uncertainties associated are useful for stakeholders. Recommendations will be addressed to them in terms of improvements of the representation of models outputs (graphs, means of the models for maps etc.).

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CLIM-RUN Product Information Sheet: June 2013

SPRING CONDITIONS IN SAVOIE

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CLIM-RUN

Key words : Climate projections, Mid-century, Tourism, Mountain, Savoie, Temperature, Precipitation, Snow, Radiation

Target groups

- **Tourism institutions**
- **Professional organisations and federations**
- **Regional authorities**

Relevance to the Case-Study Requirements

In the future, the spring shoulder season could become more popular than the summer season for some outdoor activities (if conditions are optimal in terms of sunshine, temperatures etc.). Changing practices are already being observed. This can pose problems for tourism operators (in terms of logistics for camping grounds and refuges, for instance), who are not prepared for an early summer season. Having access to forecasts on spring conditions (temperatures, sunshine and snowfall) would allow institutional actors to develop a strategic vision for these two seasons, and help actors in the field prepare themselves and improve organisation for any significant increases in clients at that period.

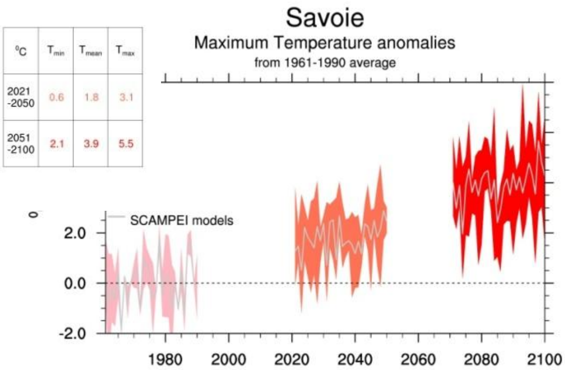
The approach

Simulations a climate change over mountainous regions have been carried out with the **ANR/SCAMPEI project** (http://www.cnrm.meteo.fr/scampei/presentation_scampei/index.php). They give an answer of the climatic response over mountainous regions. The simulations were carried out by the LMD, LGGE and CNRM at Météo France using high resolution regional climate models at a 12 kms horizontal resolution. After a statistical analysis is applied to take into account the complex orography in mountainous regions. The simulations have been run over 3 different period: the present period (1961-1990), the near future (2021-2050) and the far future (2071-2100).
Those simulation have already been used and exploited for stakeholders. One project was command by Atout France which promote France aboard and adapt the French offer to the touristic demand.
The simulations coming from the SCAMPEI project are available on the project webpage (http://www.cnrm.meteo.fr/scampei) as well as through the DRIAS portal (http://www.drias-climat.fr/). They have already been exploited in a project order by Atout France which promote France aboard and adapt the French tourist offer to the demand. This project was realized by the DIRSO/DEC and DCLIM at Météo France.
Using this existing data base, the models outputs corresponding to specific user needs in terms of parameters (mean-max temperatures, snow falls, solar radiation) and spatial scale (Savoie) have been designed in terms of representation to make it relevant and usable by stakeholders. In fact, a huge issue was to represent in a simple way the trend of future temperature evolution but also the scale of uncertainty around this trend. Also, it appears relevant to include in terms of representation the values of models (mean, max and mean) for the different times scale in order to guide the decision making process.

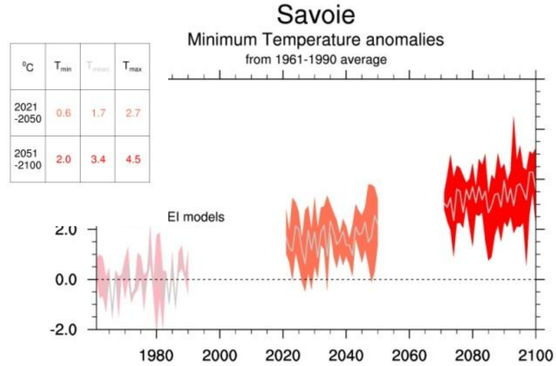
Product Example

Here, we present the change in maximum and minimum temperatures and snow falls during the spring season in Savoie. The minimum and maximum temperatures are both increasing in the future. The increase is stronger in the far future. The maximum temperature are increasing more than the minimum temperatures. By the end of the century, the increase is on average 3.35°C for the minimum temperatures and 3.91°C on average for the maximum temperatures.
According to the trend of the temperature, snow falls during the spring season are expected to decrease with a strong correlation of the models by the end of century.

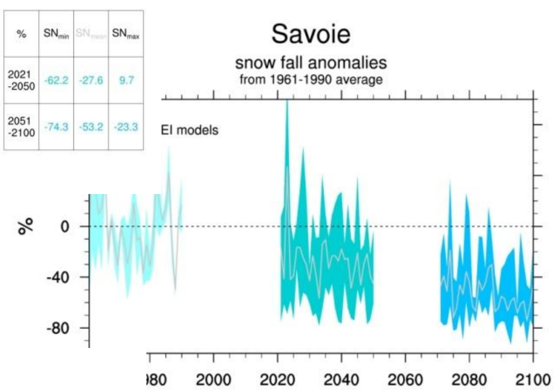
SPRING CONDITIONS IN SAVOIE



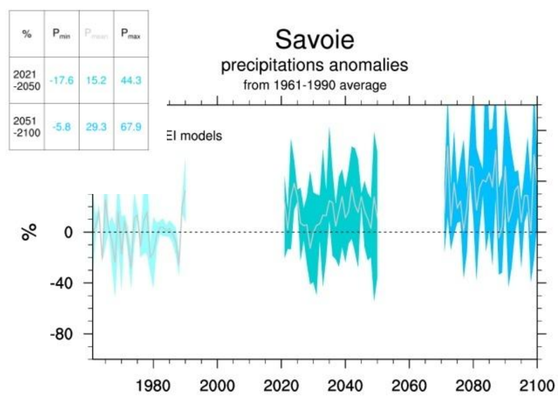
°C	T_{min}	T_{mean}	T_{max}
2021-2050	0.6	1.8	3.1
2051-2100	2.1	3.9	5.5



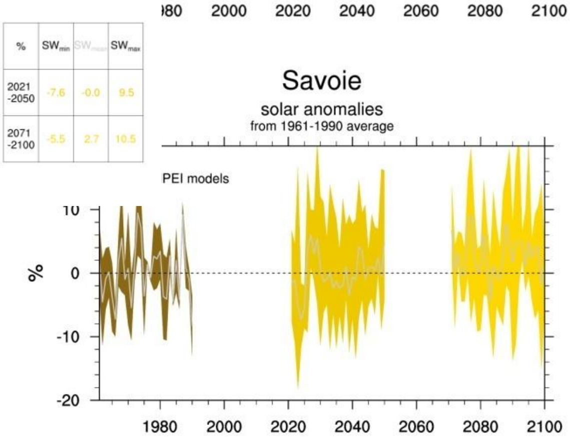
°C	T_{min}	T_{mean}	T_{max}
2021-2050	0.6	1.7	2.7
2051-2100	2.0	3.4	4.5



%	SN_{min}	SN_{mean}	SN_{max}
2021-2050	-62.2	-27.6	9.7
2051-2100	-74.3	-53.2	-23.3



%	P_{min}	P_{mean}	P_{max}
2021-2050	-17.6	15.2	44.3
2051-2100	-5.8	29.3	67.9



%	SW_{min}	SW_{mean}	SW_{max}
2021-2050	-7.6	-0.0	9.5
2071-2100	-5.5	2.7	10.5

The temperatures are increasing both for the maximum and minimum temperatures. This imply a drecrease in the snow fall. The precipitation are increasing. Not significant trend is found for the solar radiation.

Making the Product Usable

This product will be useful in the hands of policy makers and professional organizations in order to rise awareness of large public especially to those who are practicing outdoors activites. This product could be integrated in the DRIAS portal, where figures with the mean trend and the uncertainties associated are useful for stakeholders. Recommendations will be addressed to them in terms of improvements of the representation of models outputs (graphs, means of the models for maps etc.).

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CLIM-RUN Product Information Sheet: May2013

RISK POSED BY EXTREMES

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CLIM-RUN

Key words : Climate projections, End-of-century , Tourism, Moutains, Savoie, Extremes

Target groups

- **Professional organisations and federations**
- **Tourism institutions**
- **Regional authorities**

Relevance to the Case-Study Requirements

Outdoor activites, campsite, etc. are very vulnerable to extreme climate events, especially concerning their effects both in an economical (less attractivity of the destination) and in a natural hazards management point of view .
Thus, stakeholders request an other product focused on extreme events in the future, to improve their anticipation skills.

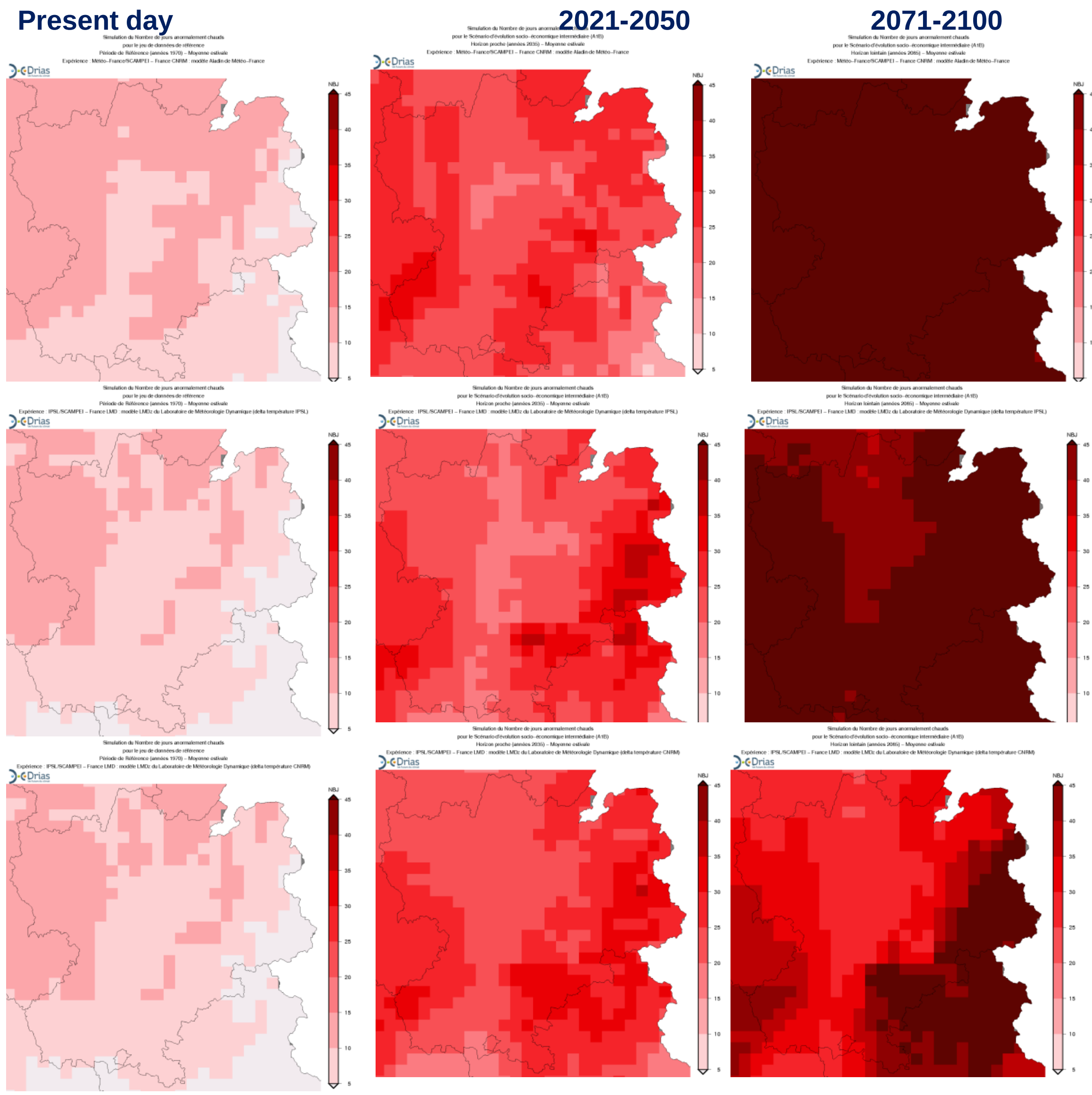
The Approach

Simulations of climate change over mountainous regions have been carried out with the **ANR/SCAMPEI project.** They give an answer of the climatic response over mountainous regions. The simulations were carried out by the LMD, LGGE and CNRM at Météo France using high resolution regional climate models at a 12 kms horizontal resolution. After a statistical analysis is applied to take into account the complex orography in mountainous regions. The simulations have been run over 3 different period: the present period (1961-1990), the near future (2021-2050) and the far future (2071-2100).
Those simulations are coming from the SCAMPEI project are available on the project webpage (http://www.cnrm.meteo.fr/scampei). A first design of a web portal have been created to answer the need on information about climate change. This web portal can be found though the DRIAS portal (http://www.drias-climat.fr/).
Many indices related to extremes are available on DRIAS Portal. Concerning temperature,precipitation. Few indices about heat wave, number of hot days greater than 25°C, cold days lower than the normal by 5°C, frozen days.n be found. Information about precipitations can also be found such as cumulative precipitation, precipitation greater than 20 mm/day.

Product Example

Here, we present an example of what is available on the DRIAS Portal : change in number of hot days (> 5°C° to the seasonal mean) during the summer season in Savoie for different models.

RISKS POSED BY EXTREMES



Those figures show a clear increase in the numbers of hot days in the futur for the 3 different models. The response is stronger in the model which is represented in the top right.

Making the Product Usable

It appears more relevant to stakeholders to design those products in an other format. In fact, a huge issue is to represent in a simple way the trend of the extreme parameter but also the scale of uncertainty around this trend. Graphs seems to be more appropriate. Also, it appears relevant to include in terms of representation the values of models (mean, max and mean) for the different times scale in order to guide the decision making process. Recommendations will be addressed to DRIAS team in terms of improvements of the representation of models outputs (graphs,).

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CLIM-RUN Product Information Sheet: February 2013

INDICATORS OF BATHING SEASON IN TUNISIA

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Key words : Seasonal forecasts, Tunisia, Tourism, Coasts, SST

Target groups

- **Seaside tour operators**
- **Hosts**
- **Tourists**

Relevance to the Case-Study Requirements

The intra-annual variability of sea surface temperatures (SST) largely determines the length of the Tunisian summer bathing season. It is currently unknown how much the SST could vary from one summer season to the next. The assumption is therefore made that long-term intra-annual SST is constant and therefore that future bathing season length will reflect the past. However, if the length of future bathing seasons are significantly different over space and time, the tourism sector could adapt to exploit the opportunity of a longer season, or manage the risk of a shorter season.

The Approach

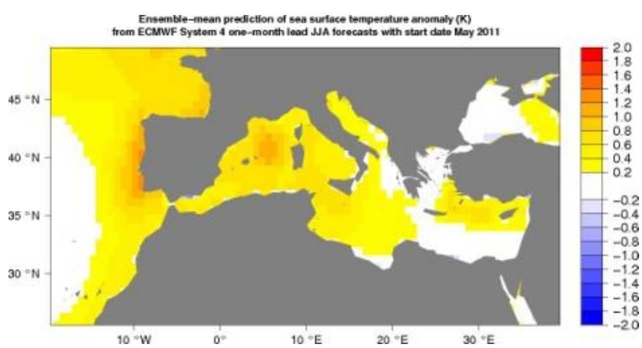
Seasonal SST estimates are currently inferred from archives of global weather forecasts and in-situ observations of, e.g., the past 10 years, and reanalysis data of e.g. the past 30 years, when no direct observations are available. The statistical components (moving means etc.) of this data enables SST to be forecast for weeks or months ahead, although with inherently large uncertainty. Seasonal climate forecasts can help to reduce this uncertainty i.e. to improve a longer-term forecast above the current observational estimate used. It achieves this by looking beyond the trend of the statistical components and assessing the variability of the climate means over past timescales.

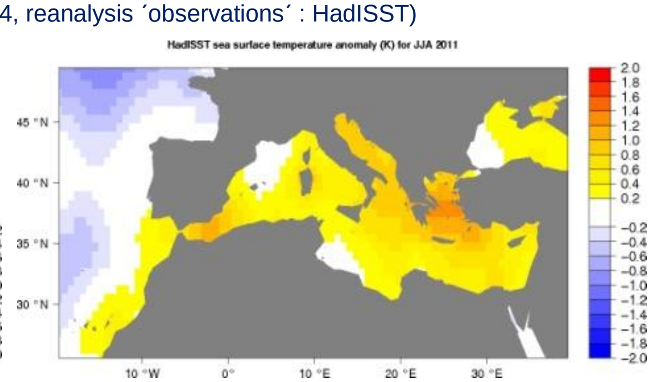
Seasonal SST forecasts are divided into two stages: first, a climate forecast system produces seasonal SST predictions (3 months for each season) for as many cases in the past as possible (typically using a baseline period of 1981-2012). These predictions are based on the monthly means and include an estimate of their uncertainty, depending upon the spread of the forecast ensemble members and their ability to reproduce the observations. This measure of uncertainty is used to assess the forecast quality of the system (i.e. the skill). Second, probabilistic future SST information is produced as an operational tool that shows the distribution of the forecast ensemble members over three categories: above normal, below normal and normal SST, and the probability of the event to happen, based upon the number of forecast members within each of the categories.

Product Example

Seasonal SST forecasts for Summer (June, July, August)

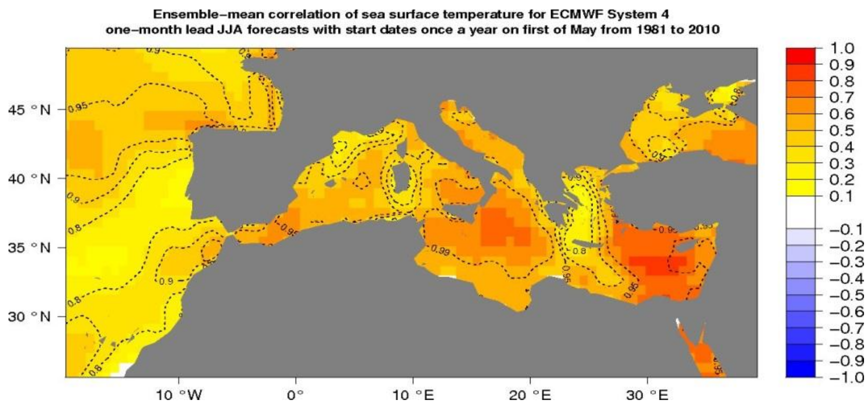
STAGE 1 : An estimate of the climate forecast system quality is made, by producing SST predictions for as many cases in the past as possible._(Climate forecast system : ECMWF S4, reanalysis ´observations´ : HadISST)





INDICATORS OF BATHING SEASON IN TUNISIA

Figure 2. SST (K) climate forecast system anomaly correlation (AC) skill (based on the correspondence of figure 1a v figure 1b)



Result : High skill is observed across the Mediterranean where the direct model output reaches approximately AC 0.8.

STAGE 2 : Operational predicitons are issued that enables probabilistic future SST information

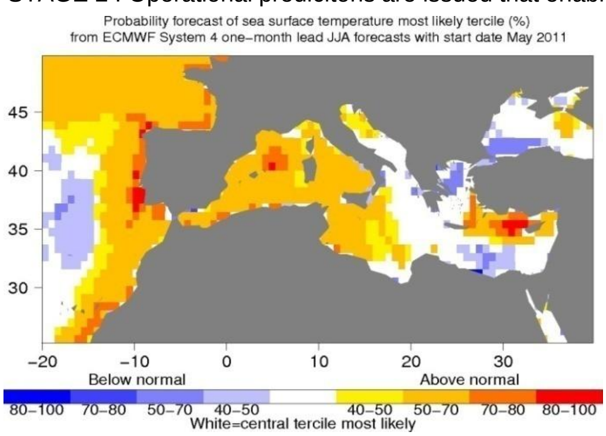


Figure 3. Probabilistic three category, summer 2011 forecast for SST (from ECMWF S4). The colour shows the tercile that contains more forecast members than any other two and the probability (%) of the event to happen (except for near normal).

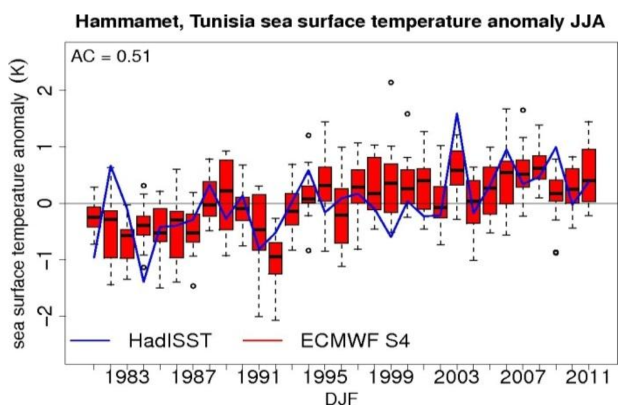


Figure 4. The distribution of the 15 climate forecast members during summer vs. reanalysis ´observations´at a grid point in Hammamet, Tunisia

Result : Good skill (AC) is seen, when predicting the SST variations for the summer months each year, of 0.51 (where 1 corresponds to a perfect forecast and 0 to a no informative system).

Making the Product Usable

The high skill of the climate forecast system (figure 2) suggests that an operational, probabilistic SST seasonal forecast (figure 3) contains useful information for risk management when planning the tourism season in Tunisia. The probabilistic forecast for Hammamet, Tunisia (figure 4) shows a reasonable forecast, although a few years show little or no correspondence. The skill of 0.51 for a summer SST forecast over all years (1981-2011) highlights the potential for using seasonal SST forecast information to determine the length of future bathing seasons. This type of exercise is to be produced by the National Institute of Meteorology (INM), which already doing seasonal forecasting of air temperature and precipitation. Contacts with the INM have been made to this topic.

CLIM-RUN Product Information Sheet: May 2013

Changes in temperature, precipitation and sea level in 2050 in Tunisia

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Key words : Climate projections, Mid-Century, Tourism, Tunisia, Temperature, Precipitation, Sea Level Rise

Target Groups

- **Planners**
- **Investors**
- **Travels agents**

Relevance to the Case-Study Requirements

This product is designed to respond to stakeholders needs on future climate information specifically on the Climate Change (CC) and the future tourism climate. Most stakeholders perceive CC as a threat rather than an opportunity.Threats they fear are:

- **Beach erosion**: it increases with rising sea level and the increased frequency of storms as part of the CC. The threat affecting a fundamental natural productive capital to the Tunisian seaside tourism.

- Increased the summer heat: which will adversely impact on the sector:

✓Increased need for air conditioning energy
✓Increased water needs

- **Increased frequency of extreme weather events** (storms, floods ...)

But Climate Change (CC) can be seen as an opportunity :

❖The opportunity relates to improving the level of comfort in the winter and the offseason,

❖ This improvement allow tourism stakeholders to diversify their tourism product in order to remedy its seasonality.

The Approach

❖The team used the products of the European research program "ENSEMBLE" (http://www.ensembles-eu.org).

❖Reminder: The ENSEMBLES program (contract number GOCE-CT-2003-505539) is funded by the 6th Framework Programme of the European Commission (2004-2009) under the theme "Global Change and Ecosystems".

❖ It allows to adapt the results of global climate models at regional scales (downscaling)

Product Example

Foreseen changes in summer and winter temperature and precipitation over Tunisia

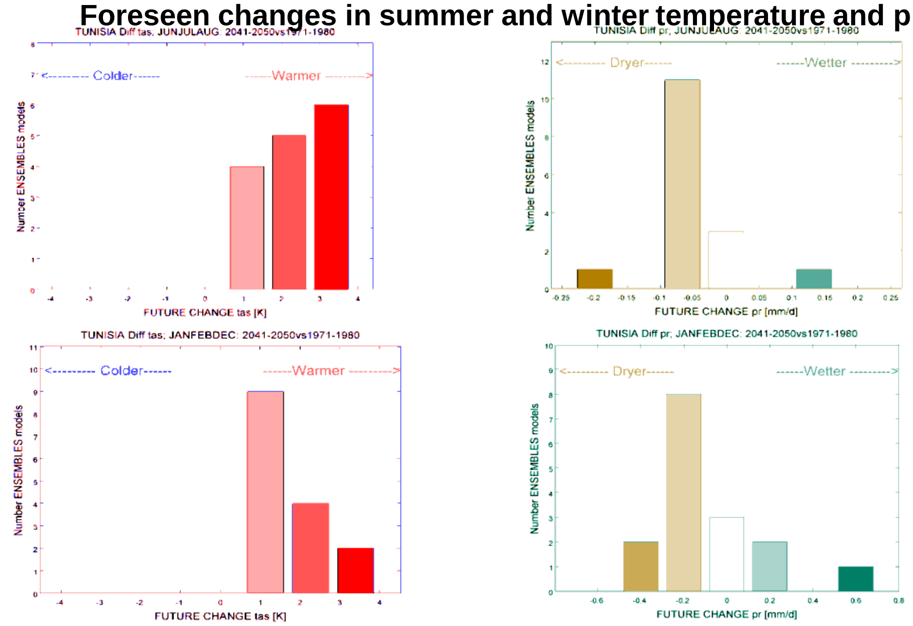

Fig1: Histogram of ENSEMBLES : Regional Climate Models (RCMs) for foreseen changes in summer (top) and winter (bottom) precipitation and temperature over Tunisia. The grafic shows the mean of air surface temperature tas (a) and precipitation pr (b) for the 2041-2050 period against 1971-1980 in IPCC A1B scenario simulations.

CLIM-RUN Product Information Sheet: May 2013

Changes in temperature, precipitation and sea level in 2050 in Tunisia

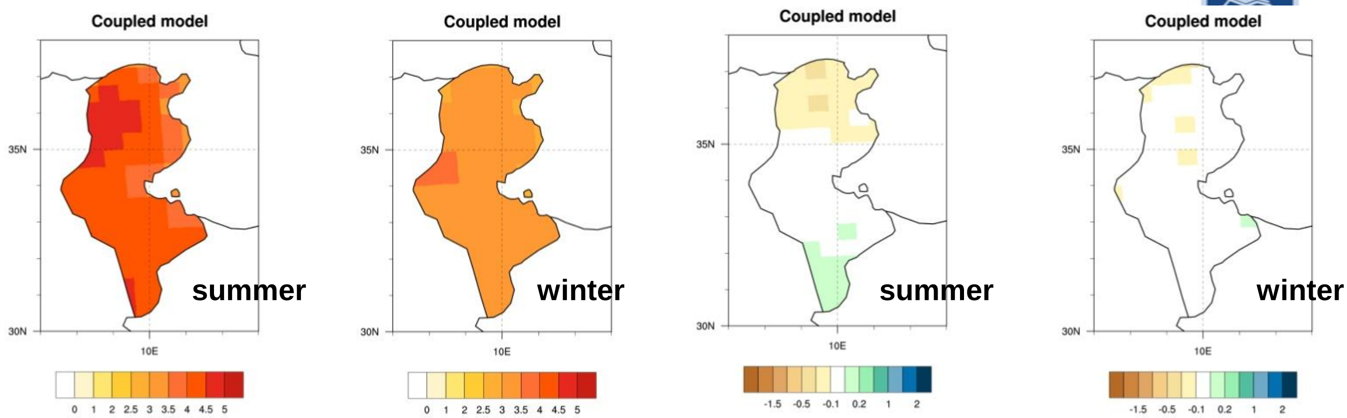

Fig. 2: Changes in temperatures in ° C(left) and precipitations (right) in mm/day in summer and winter with the ALADIN-Climat/NEMO-MED8 model for the RCP8.5. We report the 2071-2100 period against 1976-2005

Limitation: the response should be looked at in more models to have a better representation of the uncertainties.

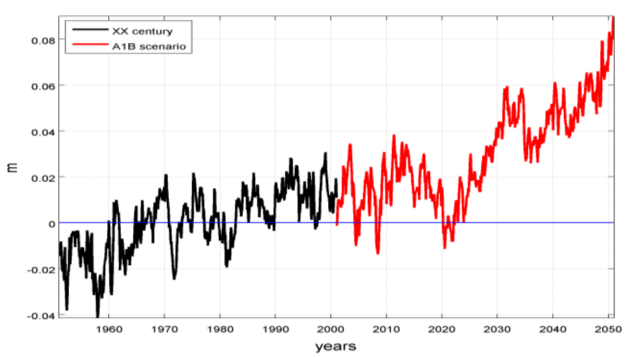

Fig 2 :Time series of sea level anomalies (in meters) in ENEA-PROTHEUS 1951-2050 simulation (IPCC scenario SRES A1B) over the box 8W-16W; 30N-38N

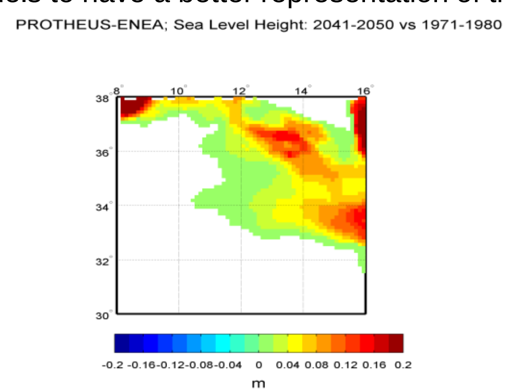

Fig 3 : Maps of Sea level anomalies (in meters) in ENEA-PROTHEUS 1951-2050 simulation (IPCC scenario SRES A1B) over the box 8W-16W; 30N-48N. We report the 2041-2050 period against 1971-1980

Making the Product Usable

Tourism stakeholders find that the content of this product is interesting. However, they think it is difficult to understand by non-specialists in climatology. They prefer to have results in the form of scenarios (two extreme scenarios and an average scenario).

Future work : improve the format of the product and publish it on the website of the National Agency of Environmental Protection.

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CLIM-RUN Product Information Sheet: May 2013

The Tourism Climate Comfort Index (ICT) In Tunisia

Latifa Hénia
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CLIM-RUN

Key words : Present climate, Tourism, Tunisia, tourism climate confort index (ICT),

Target Groups

- Tourism institutions
- Professional organisations and federations
- Investissors, planners
- Outdoor activity operators

Relevance to the Case-Study Requirements

ICT allow to better know the Tourism climate and its variation in the spatial and seasonal scale in order to make better use of the country's potential climate and diversification of tourism products.
ICT is one of the most requested products by stakeholders of the Tunisian tourism according to a survey.

The Approach

The form of the ICT adopted here is based on the results of a questionnaire survey among tourists during their stay in Tunisia.

Aims are :

- An ICT that relies on tourists' expectations in terms of climate,
- Assess the relative importance of each climate element in the perception of climate comfort by the tourist
- Assess the importance of personal factors of tourists (country of origin, age, gender) in the perception of the tourism climate comfort.

The survey:

- Investigated by direct contact, conducted among tourist guides and animators (supervised by climatologists of GREVACHOT).
- It has targeted tourists from different nationalities, different age groups, both sexes and various tourist activities.
- It was conducted in two phase high season (bathing season) and low season (winter).
- The questionnaire (one page) is formulated in several languages (English, French, German, Italian, Spanish, Russian and Arabic).
- A quota sampling method (by nationality, age, gender, type of outdoor activity ...).

The results of the survey show that:

- The sunlight, humidity and wind come almost equally with the temperature in the determination of climate comfort for tourists.
- Thresholds for assessing the effect of different climate elements on the level of comfort vary substantially depending on the nationality of the tourist, so according to the emitters countries.

The form of the tourism climate comfort index (ICT) :

- ICT value is the sum of the five climatic indices determinant of climate-tourist atmosphere:

ICT= iT + iH + iS + iV + iP

iT = temperature index; iH = index of the air relative humidity; iS =sunshine index; iV = wind index (wind of sand or strong wind); iP = rain index.

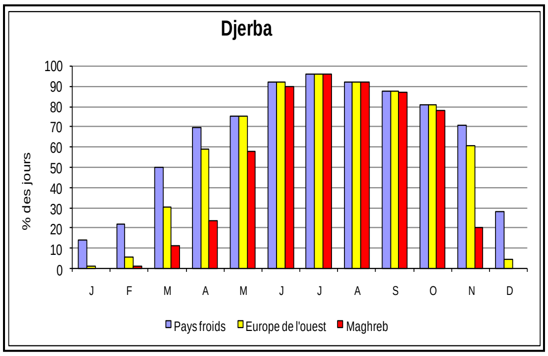
- The index "i" values are coded 0 for negative, 2 for without impact and 4 for favorable
- The data used are: temperature, humidity, sunshine duration , wind speed, sand wind (duration) and rain. The calculation is made in three hourly scale for the period 2000-2010 (data source: National Institute of Meteorology). From ICT tri-hours, are then calculated ICT day and night, at the seasons, months and year levels.

The Tourism Climate Comfort Index (ICT) In Tunisia

CLIM-RUN

Product example

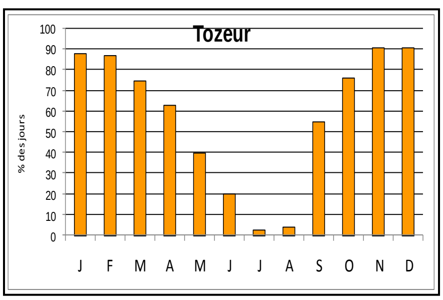
1/ Monthly frequency comfortable and very comfortable days for beach tourism



Tunisia offers favorable conditions for beach tourism over a long period of years. The tourists from cold countries can go to the beach and swim in Tunisia even in winter.

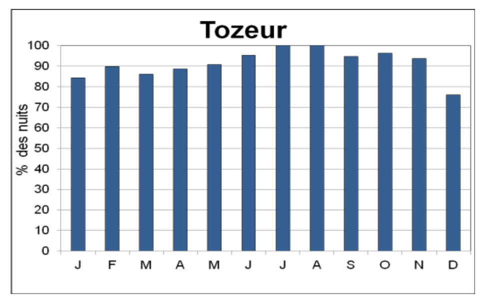
2/ Monthly frequency of comfortable and very comfortable days and nights for Saharan tourism

Day

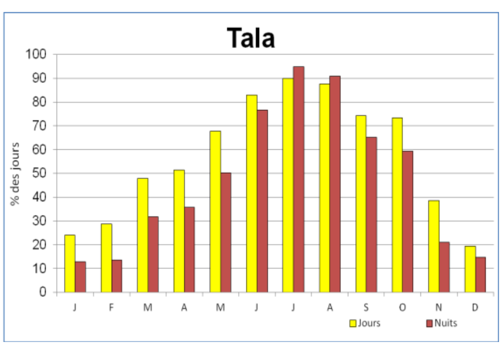


Winter and nights in southern Tunisia are ideal for desert tourism

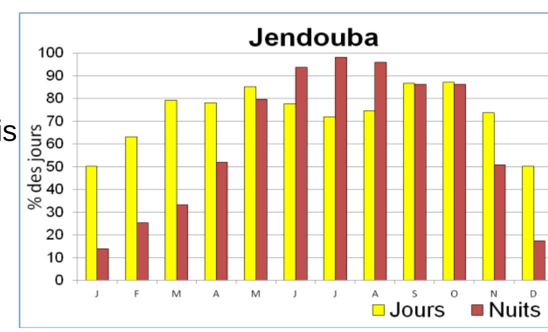
Night



3 / Monthly frequency of comfortable and very comfortable days and nights for outdoor activities



The interior of Tunisia is rich in tourism climatology shades



Making the Product Usable

-This product appears as a good starting point to become familiar with the tourism climate of Tunisia

-To better respond to stakeholders needs, ICT should be part of a bulletin of weather forecasting in the short term to publish each day by the National Institute of Meteorology (INM)

-This product will be disseminated to actors first by a paper brochure, waiting to see with the administration of the tourism sector or/ and INM, the opportunity to publish it on theirs websites

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CLIM-RUN Product Information Sheet: June 2013

Climate index for tourism in Croatia

Ksenija Zaninović
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Keywords: climate index for tourism, beach tourism, cycling tourism

Target Groups

- **Tourism institutions**
- **Tourism stakeholders**

Relevance to the Case-Study Requirements

Complex influence of climate variables on tourism can be expressed by quantitative estimate (or an index) of suitability of climate for wide range of tourist activities and leisure. Such an index would enable the assessment of climate attractiveness in order to choose a destination and time for different types of tourism.

The Approach

De Freitas (2008) defined the climate index for tourism (CIT) that integrates thermal (T), aesthetic (A) and physical (P) facets of atmospheric environment important for tourism:

$$CIT = f\,[(T, A) * P]$$

T is a measure of the body-atmoshpere energy balance expressed by some modern biometeorological indices that integrate environmental and physiological thermal variables and is expressed as thermal sensation (e.g. from very cold to very hot) rather than an energy value. The aesthetic component includes sky condition, ranging from clear to overcast. The physical components are wind and rain which can have an overriding effect when certain values are exceed. Thermal and aesthetic states are combined in a weather typology matrix and produce the rating class ranging from 1 to 7. If any physical threshold (wind and rain) is exceeded, than P overrides T and A.

very poor			marginal		ideal	
1	2	3	4	5	6	7
unacceptable			acceptable		optimal	

CIT should be a descriptor of the quality of climate conditions for a tourism activity for which the index is specifically designed as indicated for the two examples below.

Thermal perception	Cloudiness (≤4/10)	Cloudiness (≥5/10)	Rain (>3 mm)	Wind (≥6 m/s)
very hot	4	3	2	3
hot	6	5	2	4
warm	7	5	2	4
sligh. warm	6	4	1	4
comfortable	5	3	1	2
sligh. cool	4	3	1	2
cool	1	1	1	1
cold	1	1	1	1
very cold	1	1	1	1

Thermal perception	Cloudiness (≤4/10)	Cloudiness (≥5/10)	Rain (>10 mm)	Wind (≥8 m/s)
very hot	3	2	3	2
hot	4	3	3	2
warm	6	5	4	2
sligh. warm	7	7	4	3
comfortable	7	6	4	2
sligh. cool	6	5	3	2
cool	6	4	3	1
cold	4	3	2	1
very cold	3	2	1	1

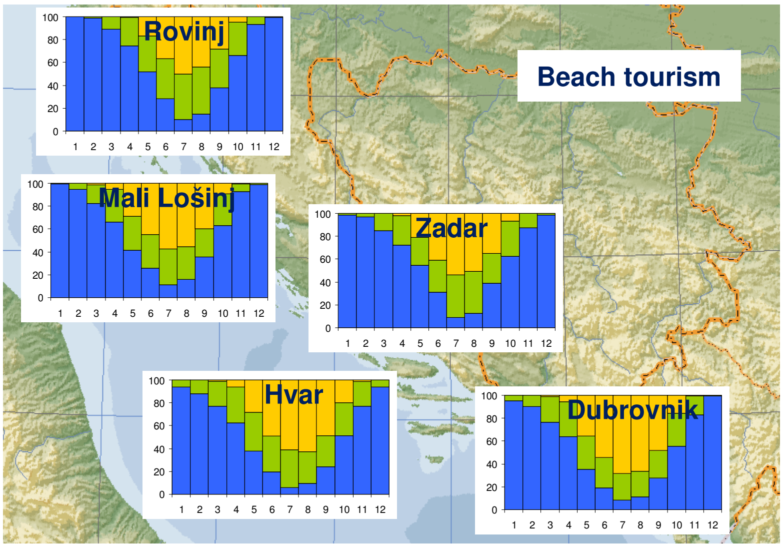
Fig. 1. Climate index for tourism (CIT) for beach tourism (left) and cycling (right) (according to de Freitas, 2008, Bafaluy et all, 2013)

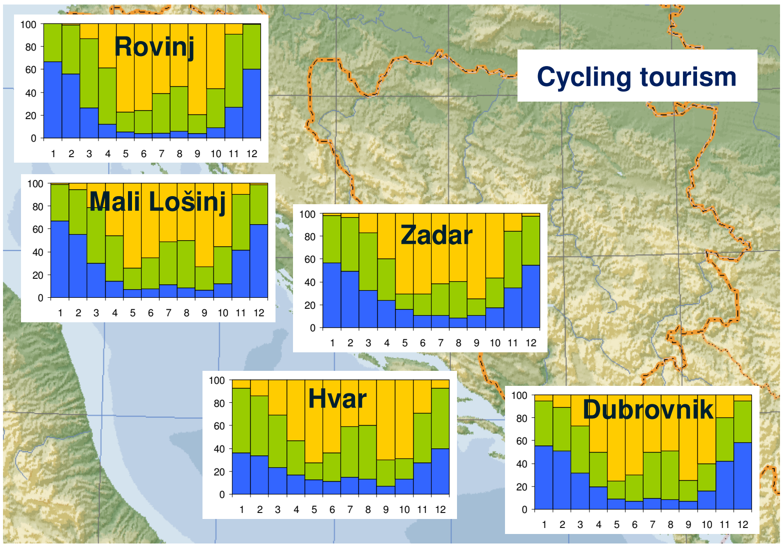
CLIM-RUN Product Information Sheet: June 2013

Climate index for tourism in Croatia

CLIM-RUN

Product Example





- optimal (6-7)
- acceptable (4-5)
- unacceptable (0-3)

Fig. 2. Annual course of probabilities for suitability of climate conditions for beach and cycling tourism at 2 p.m. period 1981-2010. (stations' data)

The suitability for different types of tourism based on CIT differ along the Adriatic coast. For example, more favourable (ideal and acceptable) conditions for beach tourism are to be found in more southern locations; for cycling tourism, the differences among various locations are small.
Acceptable conditions for beach tourism (≥50% of all days) prevail from June to September in the northern Adriatic, but are extended from May to October in the southern part.
The acceptable period for cycling tourism lasts longer along the whole coast. The conditions for cycling are characterised as unacceptable only during the winter (DJF) and the most suitable period is from May until October. In July and August conditions for cycling are a little less optimal because of unfavourable thermal effect.

References

De Freitas et al, 2008: A second generation climate index for tourism (CIT) specification and verification, Int. J. Biometeorol, 52: 399-407

Bafaluy D., Amengual A., Romero R., Homar V., 2013: Present and future climate resources for various types of tourism in the Bay of Palma, Spain, Reg Environ Change, DOI 10.1007/s10113-013-0450-6

Making the Product Usable

The climate index for tourism gives the information on suitability of climate for different types of tourism. It enables tourists to choose the best period for holidays depending on their interest. This information can be included in touristic leaflets which can be available on internet, touristic information desks, distributed among tourists with other material, or as posters that can be placed in hotels, tourist offices or at other public places.

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Thermal component of climate potential for tourism in Croatia

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Keywords: thermal environment, physiologically equivalent temperature, tourism, projections

Target Groups

- **Tourism institutions**
- **Tourism stakeholders**

Relevance to the Case-Study Requirements

As a natural resource for tourism climate determines the attractiveness of a region and therefore it has a limiting function on the "tourism potential". For Croatia, benefiting primarily from beach tourism, the climate-related change of thermal component of climate potential will become increasingly important. Adaptation to climate change is important not only for tourists but also for many other involved actors in tourism sector.

The Approach

The balance between human body and the thermal environment is complex and depends on air temperature, wind, humidity, solar and terrestrial radiation, but also on the gender, metabolism and clothing. The thermal impact on humans is determined by biometeorological index: physiologically equivalent temperature (PET) which is derived from the equation of thermal balance between the human body and the environment and by taking into account all the components of this relationship. PET is defined as the equivalent temperature at which a person being indoors would feel as in real outdoor conditions. The advantage of this index is that it uses a widely known unit (degree C) thus making the interpretation of the results easier. Besides, is also includes a thermal sensation scale ranging from "very cold" to "very hot".

The PET index was also calculated for the two future climate periods. The mean values for the PET input data were obtained from two randomly chosen runs of the RegCM3 regional climate model which was forced by the ECHAM5-MPIOM GCM under the IPCC SRES A2 emission scenario. The RegCM3 horizontal resolution was 35 km. The PET was computed for 2 p.m. local time assuming that this is the time when most of the tourists are outdoors and therefore mostly exposed to atmospheric conditions.

The quantification of the changes in the climate tourism potential was made by applying the changes in the number of days with the heat stress and the frequency of occurrence of the different thermal sensations.

It has to be emphasised that there are uncertainties as well as limitations in simulating future climate (IPCC 2007). For example, the application of more than one emission scenario as well as simulations from more climate models are recommended (Amelung and Viner 2007; IPCC 2007; Matzarakis and Amelung 2008). A single model approach, as in our study, does not allow a full estimate of uncertainties and therefore would have some limitations. But even then, we demonstrate the potential of the PET method and its application. Another, limitation is the model 35 km spatial resolution, which may be regarded as too coarse for complex orography at the Adriatic coast (Brankovic et al. 2012).

References

Branković Č, Patarčić M, Güttler I, Srnec L (2012) Near-future climate change over Europe with focus on Croatia in an ensemble of regional climate model simulations. Clim Res 52:227–251

Amelung B, Viner D (2007) The vulnerability to climate change of the Mediterranean as a tourist destination. In: Amelung B, Blazejczyk K., Matzarakis A (Eds.) Climate Change and Tourism – Assessment and Coping Strategies, 41-54.

IPCC (2007) Climate Change 2007: The Scientific Base – Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Editors: Solomom S, Quin D, Manning M, Chen Z, Marquis M, Averyt KB, Tignor M, Miller HL. Cambridge University Press, Cambridge, UK and New York, USA.

Thermal component of climate potential for tourism in Croatia

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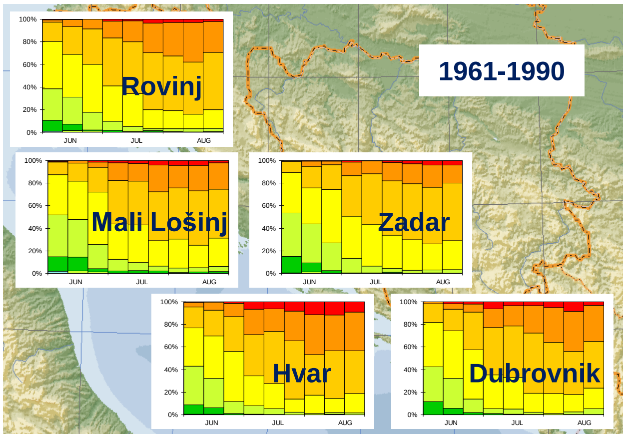
Product Example



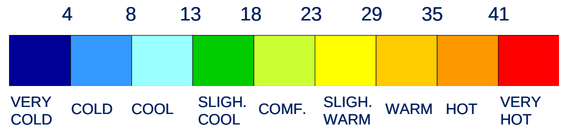


Fig. 1. Distribution of thermal perception (PET) for JJA at 2 p.m. (station data for the period 1961-1990).

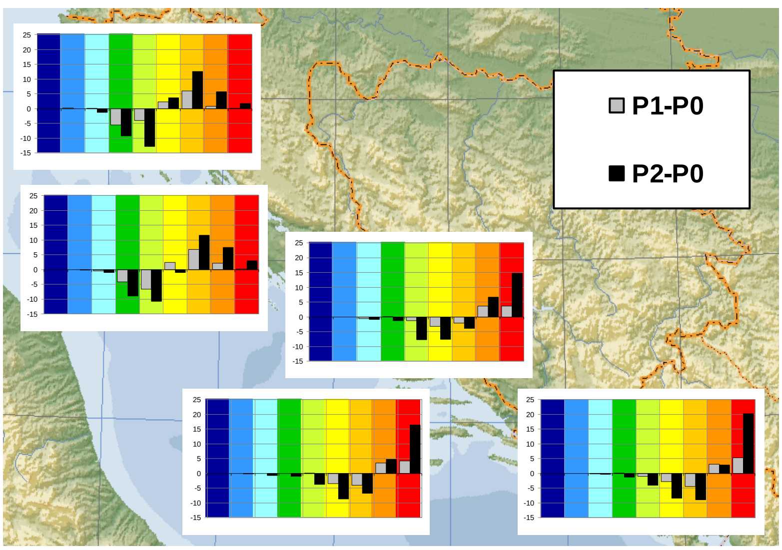


Fig. 2. Differences in probabilities of thermal perception between 1961-1990 (P0), 2011-2040 (P1) and 2041-2070 (P2), 12UTC (1 p.m.)

In the northern Adriatic there is an increase from slightly warm to the hot thermal perception.
In the southern Adriatic there is even a decrease in the occurrence of the warm thermal perception, but an increase in the hot and very hot thermal perceptions.

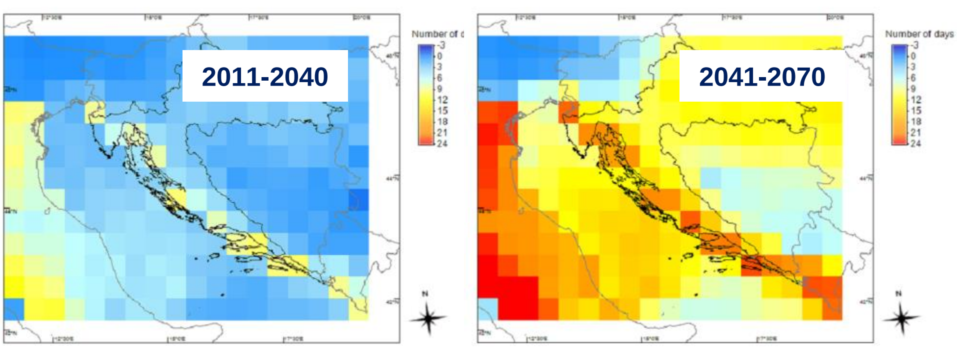


Fig. 3. Changes in number of days with heat stress (PET>35°C)

In the period 2011-2040 heat stress may be expected for 9 more days than in the reference climate along the coast, but in fewer days over some islands in the north and in the southern part. In 2041-2070, the increase in number of days with heat stress varies between 18 to 24 days.

Making the Product Usable

The results already point to hot conditions for outdoor activities in summer during afternoons along the Croatian Adriatic coast resulting in a reduction of the climate tourism potential. In the future, this trend is projected to increase, indicating that the tourism sector in Croatia would need to adapt and make new strategies, especially for the southern Adriatic.

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CLIM-RUN Product Information Sheet: July 2013

PRODUCT – Heat Waves and Energy Requirements for Space Cooling in a Warmer World

TOURISM CASE STUDY
Cyprus

CLIM-RUN

Target groups

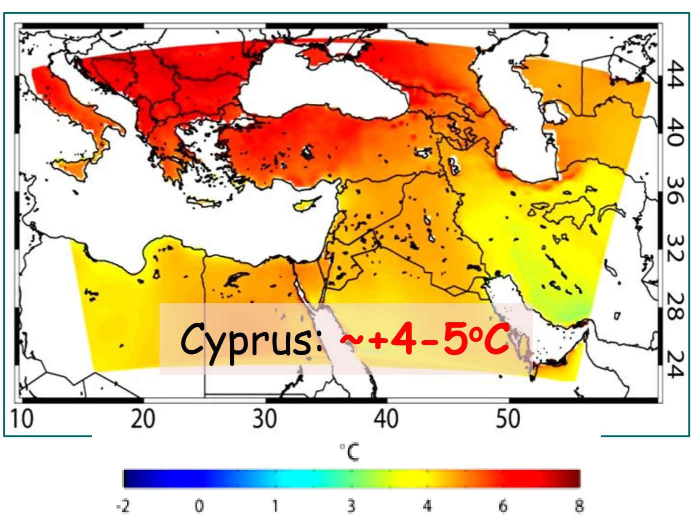
- **Tourism industry**
- **Tourism operators**
- **Hotel managers**
- **Energy/electricity providers**

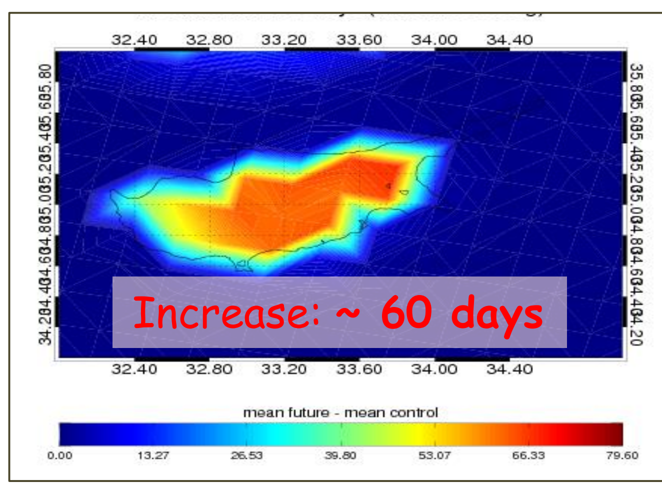
Context

Cyprus and the Eastern Mediterranean, are expected to be particularly hard hit by anticipated changes in climate conditions. This will especially relate to even higher summer temperatures and the duration of warm spells. The Warm Spell Duration Index depicts periods of time with at least six consecutive days with maximum temperatures (T_{max}) in the upper one-tenth of the overall temperature distribution for a particular place (T_{max} > 90th percentile). During summer, extremely warm days (and nights) are less comfortable and require additional energy for space cooling (air conditioning). This results in higher costs for hotel/tourism operators and higher CO_2 emissions for electricity generation..

The Approach

Projections of future climate development can be obtained by running numerical climate models. Such models aim to quantitatively depict dynamic processes in the atmosphere as well as interactions between the atmosphere, the oceans and land surfaces. They are driven by greenhouse gas emission scenarios (for instance: CO_2-emissions), which have been obtained by envisioning changes in world population, major economic parameters and technology developments for specific regions of the world over the next decades. Since climate models are run on a global scale, their spatial resolution is often insufficient to provide adequate information on future climate on a regional or national scale. This renders such model results less useful for decision makers in politics, commerce and industry. To address this deficiency, global model results are used as boundary conditions in regional climate models (RCM), which provide information on the scale of a few kilometers to some tens of kilometers. We have used the PRECIS RCM to derive detailed information on future climate conditions for Cyprus and the Eastern Mediterranean (Figures below)





Left: Patterns of changing mean summer (June, July, August) maximum temperatures, calculated from PRECIS output for 2070-2099 relative to the 1961-1990 control period; source: Lelieveld et al, (2012); Right: Increase of days with T_{max} > 35°C for Cyprus for 2070-2099 relative to reference temperatures for 1961-1990 of about 60 days); source: Giannakopoulos et al., 2008

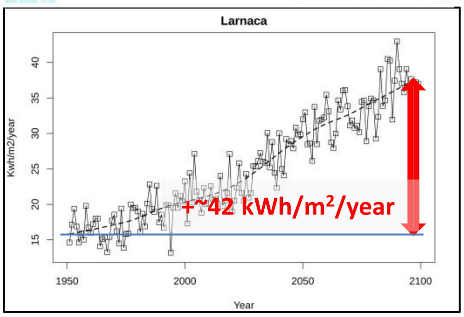
These results have further been refined to depict projections of a number of parameters for individual Cypriot cities (Famagusta, Kyrenia, Larnaca, Limassol, Nicosia, Pafos): Warm Spell Duration Index (WSDI), Cooling Degree Days (CDD), Cooling Load (CLOAD) and the Cooling Load Ratio (ratio).

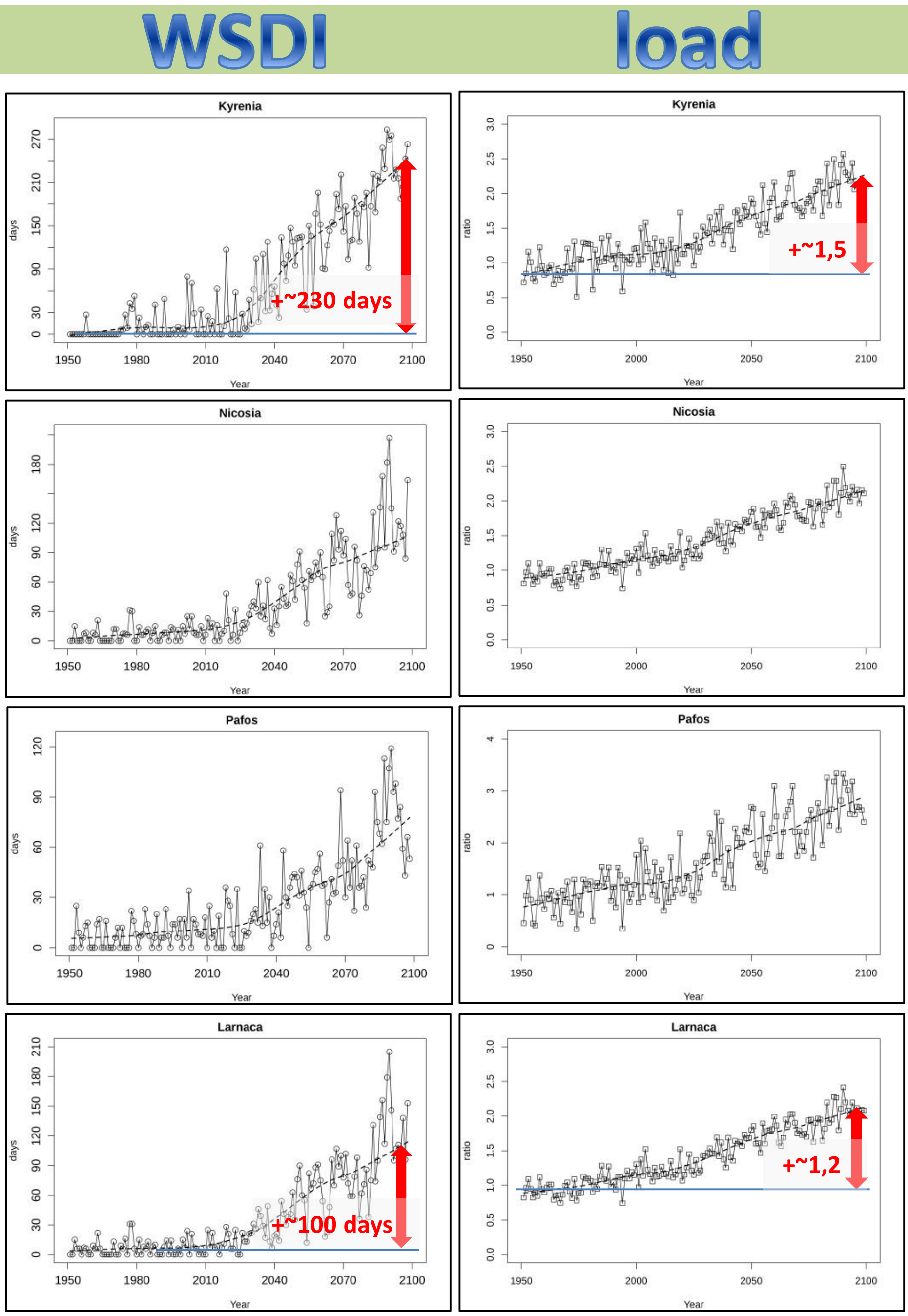
PRODUCT N°Fxx – Heat Waves and Energy Requirements for Space Cooling in a Warmer World

TOURISM CASE STUDY
Cyprus

CLIM-RUN

Some Results:





Definitions:
WSDI = Annual count of days with at least 6 consecutive days when Tmax > 90th percentile (Fisher et al,, 2010; Lelieveld et al., 2013);
CLOAD = (1W/m^2/K * CDD*K * 24h *)/1000, units of Kwh/m^2/year; CLOAD_RATIO Cooling load of each year divided by cooling load of reference period 1951-2000 mean; **ratio**= Cooling load of each year divided by mean cooling load of reference period 1951-2000

The results of our model calculations impressively depict a significant increase in the Warm Spell Duration Index (WSDI, left column), the energy need for additional space cooling (CLOAD; above, only for Larnaca) and the ratio in cooling loads for the coming years relative to the mean cooling load of reference period 1951-2000 (ratio; right column). WSDI values rise by appr. 100 to 230 days, while the cooling load ratios at the end of the century are about 1,2 to 1,5-times the present value. The absolute increase in cooling energy amounts to an additional 42kWH/m^2/year (for Larnaca). This implies an extra energy need of appr. 14,7 MWh/year for an assumed standard house of 10m×15m×4m.

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CLIM-RUN Product Information Sheet: June 2013

TOURISM CLIMATE INDEX OVER THE MEDITERRANEAN

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Key words : Climate projections, Mid-century, Tourism, Mediterranean, TCI

Target groups

- **Tourism planning authorities**
- **Tourist offices**
- **Tourism investors**
- **Tourism operators**

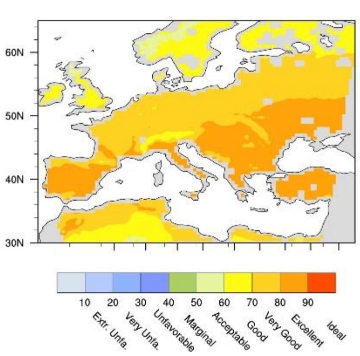
Relevance to the Case-Study Requirements

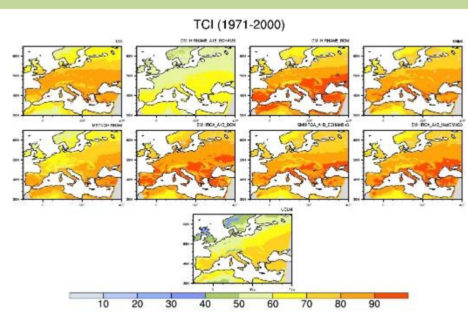
Tourism climate indexes (TCI) are commonly used to describe the climate conditions suitable for tourism activities, in a planning, investing or weather forecasting perspective. The 'reference' TCI was defined by Mieczkowski (1985). In a context of pressing climate change, there is a renewed need for applications in a long term perspective, notably to estimate the economic impacts of climate change on tourism. The economic consequences of these applications can be substantial. Therefore, it is important to understand better users' needs and data issues, so as to specify better indexes and detail their conditions of use.

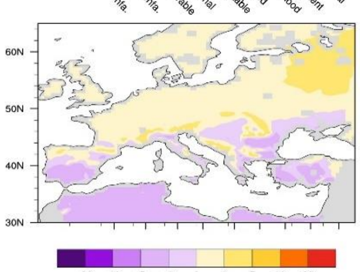
The Approach

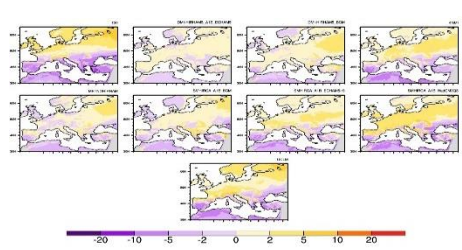
High resolution simulation over the Mediterranean region is used to represent the local and diverse orograply over the region. 9 atmospheric regional climate models climate change simulations have been carried out within the FP7/ENSEMBLES. Only a limiter number of models have been used to calculated the TCI as many variables are needed to calculate it. The evolution of the TCI and the number of days with a TCI greater than 70 is looked at in present climate and their respective evolution in the near futur. The simulations are at 25 kms horizontal resolution and follows the A1B emissions scenarios.

Product Example





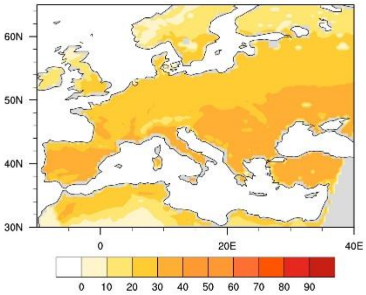


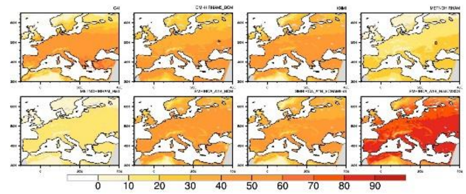


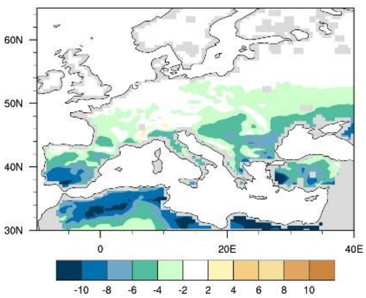
The TCI is calculated for 9 different models over the period 1971-2000 in summer (ensemble mean on the left and individuals models on the right).The orange to red color represent a confortable index.

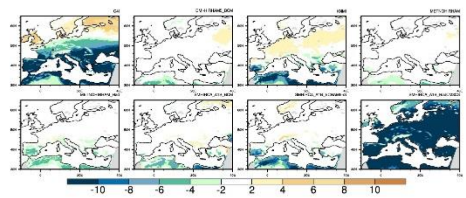
The evolution of the summer TCI over the period 2021-2050 show a decrease of the TCI around the Mediterranean bassin in the futur (figure at the bottom). The spatial strucutre is quite similar in all individual model with a decrease around the bassin and an increase in Northern Europe.

TOURISM COMFORT INDEX OVER THE MEDITERRANEAN









The number of days with a TCI greater than 70 is calculated for 8 different models over the period 1971-2000 (ensemble mean on the left and individuals models on the right). One model never has valeu of TCI above 70.

The evolution of the number of days greater than 70 over the period 2021-2050 show a decrease of the TCI around the Mediterranean bassin in the futur.

Making the Product Usable

Using the ENSEMBLES simulations give a better representation of the uncertainty. However, the TCI was calculated only for a limited number of models as some of the variables necessary to calculate it were not available. The new simulations carried out within the MED-CORDEX initiative should all have the necessary variable to calculate it.

Also, on a mediterranean level they s not data availble to calculated a TCI over large region and on climatic scale. This limitation does not allow us to do a biais correction on the model output. This should really do in the ftur and hopefully more data would be available.

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CLIM-RUN Product Information Sheet: June 2013

Sea Surface Temperature in Coastal Region

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CLIM-RUN

Key words : Climate projections, Mid-century, Tourism, Coasts, Mediterranean, SST

Target groups

- **Tourism institutions**
- **Seaside tour operators**
- **Tourists**

Relevance to the Case-Study Requirements

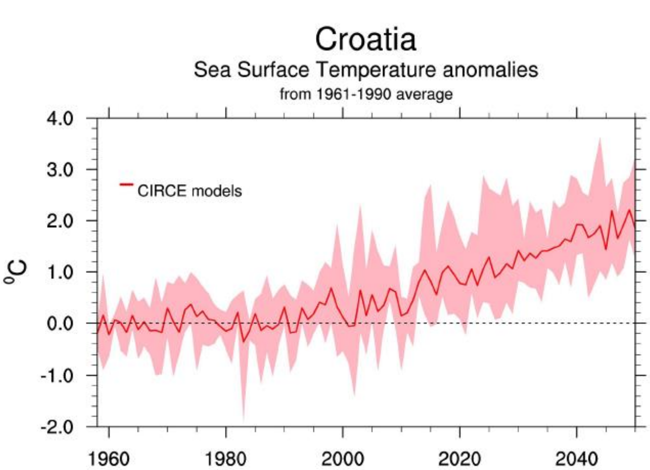
Under climate change, bathing conditions are expecting to change. Those changes can have strong impacts on the seaside activities. They can be positives if we look at the opportunity to extend the bathing season as well as negatives taking into consideration the possible proliferation of jellyfish.
Consequently Tourism stakeholders expressed the needs for climate information about the possible change of the sea surface temperature in the surrounding sea.

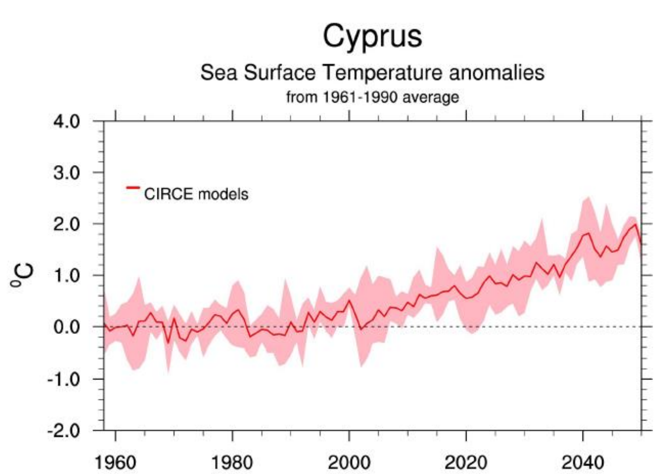
The Approach

A high spatial resolution of the Mediterranean sea is required to represent the local and complex bathymetry of the Mediterranean coast. Five coupled atmosphere-ocean regional climate change simulations over the Mediterranean sea have been carried out within the FP7/CIRCE project. Those simulations illustrate the possible climate change for the period 1950 to 2050 in the future following the A1B emissions scenarios with respect to a reference period 1961-1990. The simulations were carried out by different institutes: ENEA, MPI, INGV, LMD and CNRM using high resolution coupled atmosphere-ocean regional climate models (10 km horizontal resolution in the ocean). Here, we present the change in the sea surface temperature (SST) over the period 1950-2050 at 4 different sites: Croatia, Cyprus, North Adriatic and Gulf of Gabes.

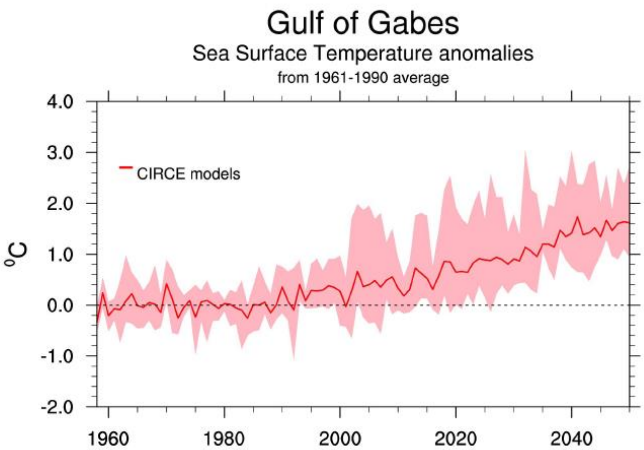
Product Example

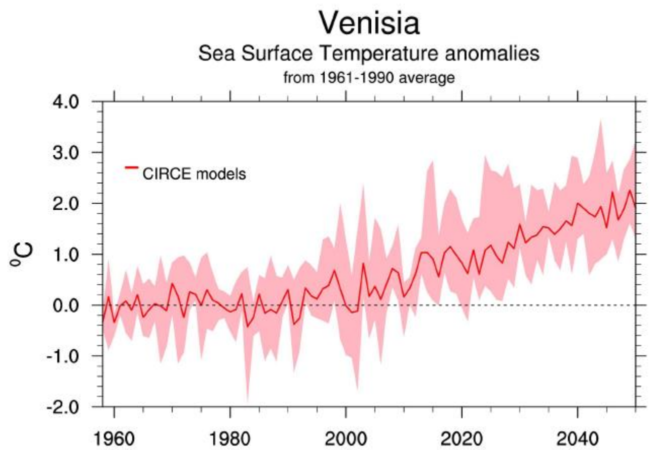
Evolution of the yearly sst at the different sites over the 21st century compare to the reference period 1961-1990.





Sea Surface Temperature in Coastal Regions





The SSTs are increasing in the future at all sites. The increase is stronger at the end of the 21st century. By the end of the century, the increase is on average between 1.8 to 2°C. The warming is stronger in North Adriatic and Croatia regions.

Making the Product Usable

We are aware that the products delivered here may underestimate the uncertainty due to the use of only 5 AORCMs and 1 scenario. Especially those simulations were the first realized with AORCMs over the Mediterranean sea. However we think that the new generation of high resolution AORCMs will give more reliable results to better answer the evolution of the SST in complex bathymetry of the Mediterranean sea. In the coming year, new simulations coming from the MED-CORDEX project can be used. More climate models are carrying out high resolution climate simulations over the 21st century under different emissions scenarios. Those simulations are covering a larger ensembles of the uncertainties under climate change. If observations timeseries were collected at those sites statistical corrections could be applied. This could also give us the possibility to create a bathing indice.

From a stakeholder point of view, this product appears as a good starting point to analyze the effects of climate change on bathing water conditions. It should be coupled to a detailed analysis of the impacts on water quality in order to collect opportunities and threats in the far future for outdoor activities.

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