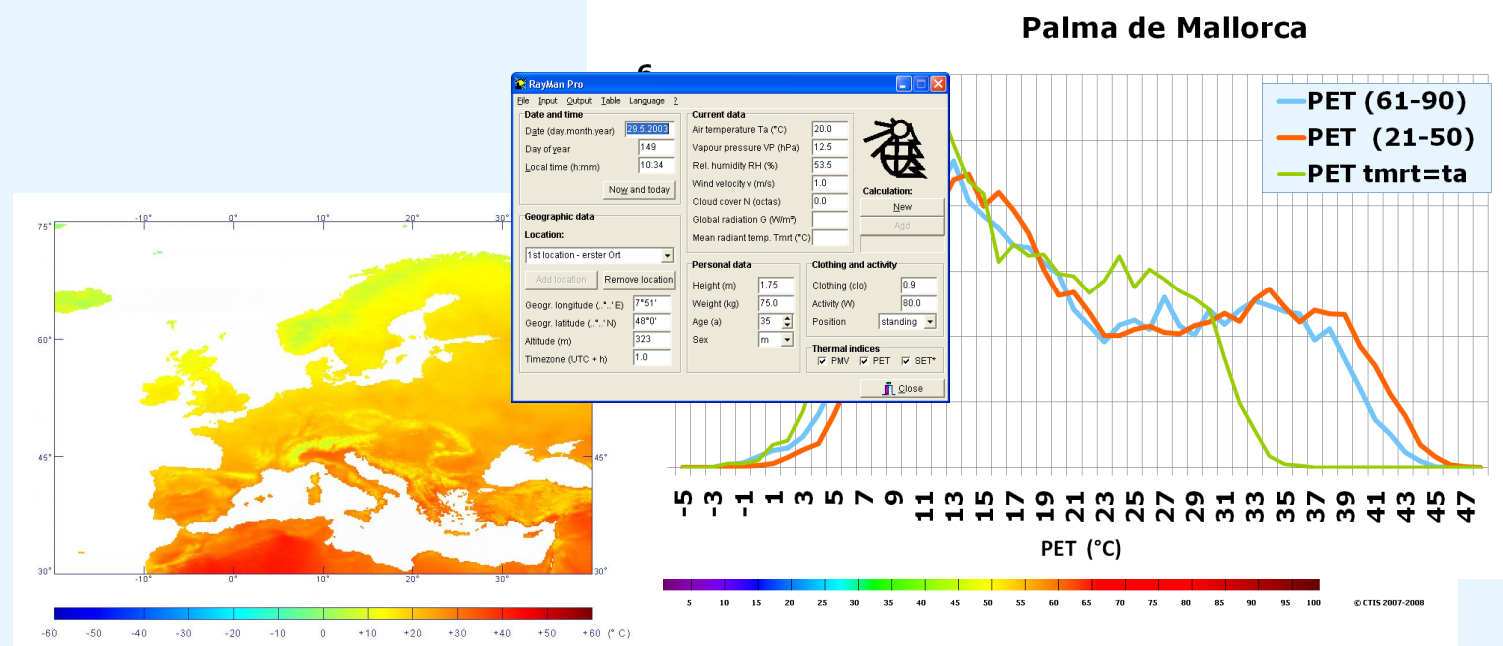




Canvi climàtic i turisme: l'adaptació al temps atmosfèric, el canvi climàtic i el clima extrem

Climate Change and Tourism: Adaptation to weather, climate and climate extremes



Prof. Dr. Andreas Matzarakis



Contents

- ▶ Introduction
- ▶ Methods for assessment of Climate for Tourism
- ▶ Examples
 - ▶ Trees and Climate Change
 - ▶ Climate scenarios – climate manipulation
 - ▶ Perfect day
- ▶ Conclusions



My nightmare ! ! – modification of microclimate



Arten von Tourismus

Kinds of Tourism

Institute
Sciences



Tourismus W dient primär der Erholung und Freizeitgestaltung. Wenn Reisende selbst planen sind es Individualreisen W - standardisierte Angebote von Reiseveranstaltern W dagegen Pauschalreisen W. Je nach Neigung, Interessen und Bedürfnissen gibt es eine Vielfalt von Reisearten:

Abenteuerreise W, Agrotourismus W, Aktivurlaub W, Autoreise, Badeferien W, Bahnreise W, Bildungstourismus W, Blaue Reise W, Busreise W, Butterfahrt W, Camping W, Caravaning W, Cluburlaub W, Drogentourismus W, Ethnotourismus W, Event-Tourismus W, Radreisen W, Fernreise W, Flusskreuzfahrt W, Flugreise W, Forschungsreise W, Frauenreise W, Golfreise W, Gruppenreise W, Heliskiing W, Incentive Reise W, Jugendreisen W, Kaffeefahrt W, Katastrophentourismus W, Kreativurlaub W, Kreuzfahrt W, Kulturtourismus W, Kur W, Kinderreisen W, Ökotourismus W, Outgoing-Tourismus W, Reiterferien W, Rucksacktourismus W (Backpacking W), Rundreise W, Safari W, Sanfter Tourismus W, Segeltörn W, Seniorenreise W, Sextourismus W, Singlereise W, Sportreise W, Schienenkreuzfahrt W, Sprachreisen W, Surfreise W, Survival Tour W, Sportreise W, Städtereise W, Studienreise W, Tauchreise W, Therapeutisches Reisen W, Trekking Tour W, Wanderreise W, Wellnessreise W, Weltraumtourismus W, Weltreise W, Wintersport W, Wohnmobilreisen W.

Sekundäre Arten des Tourismus sind:

- Geschäftsreisen W (Reisen aufgrund eines wirtschaftlichen Zweckes)
- Pilgerreise W (religiöse Motivation)
- Missionsreise W (Ausbreitung des Glaubens)
- Forschungsreise, Expedition W (Reisen aufgrund eines wissenschaftlichen Zieles)
- Entdeckungsreise W (historische Bedeutung, Entdeckungsreisen in unbekannte Teile der Welt z.B. durch Marco Polo W, Christoph Kolumbus W, Vasco da Gama W, Ferdinand Magellan W und James Cook W)

GlobalTravel Magazin

Let's travel around the world

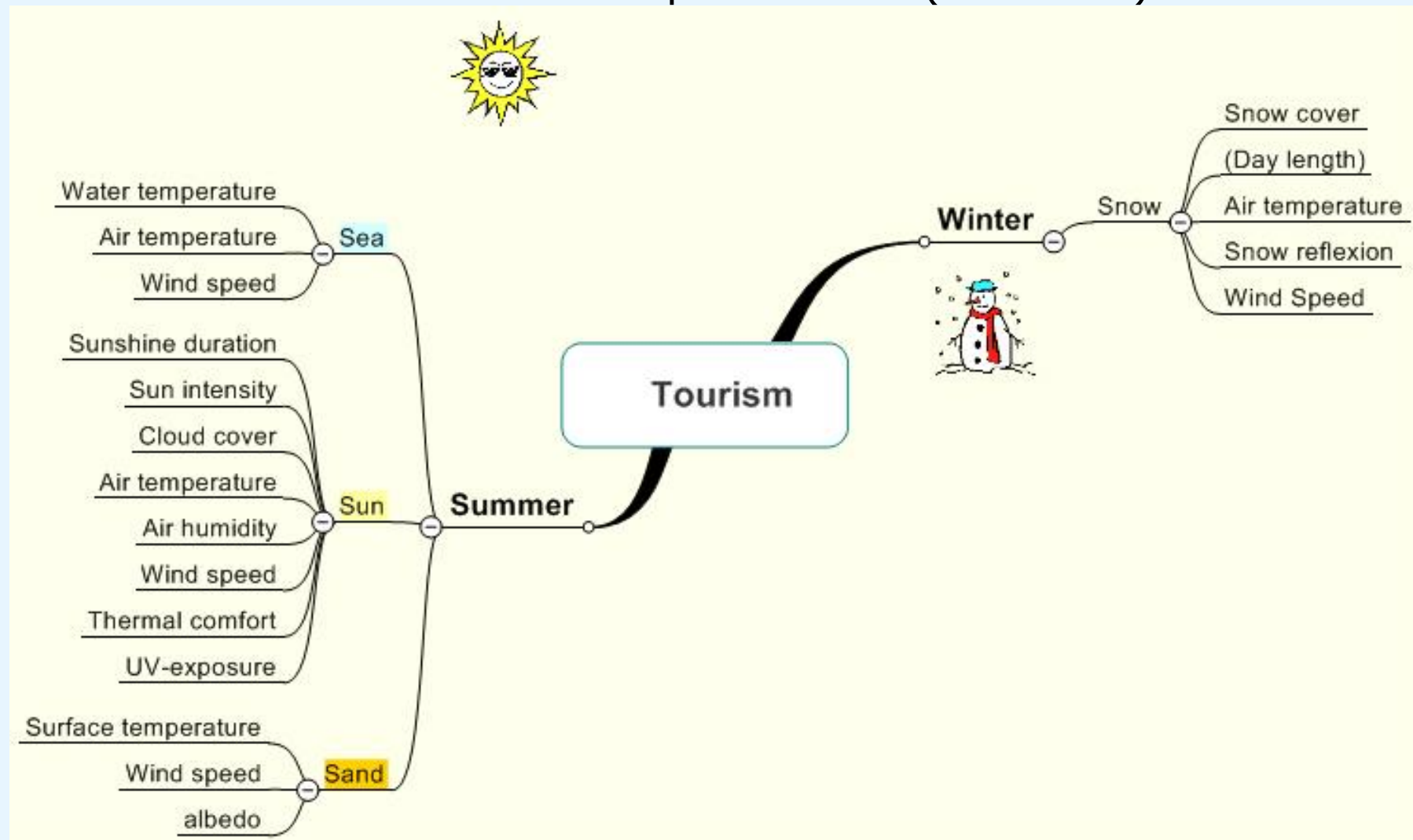
Missing: Scientific tourism



Weather, Climate, Climate Extremes

- ▶ Weather - current situation (storm two days ago)
- ▶ Climate - means and sums
- ▶ Climate - max, min and higher statistical moments
- ▶ Climate - frequencies, possibilities
- ▶ Climate Change: trends and possibilities

Tourism und climate parameters (Selection)





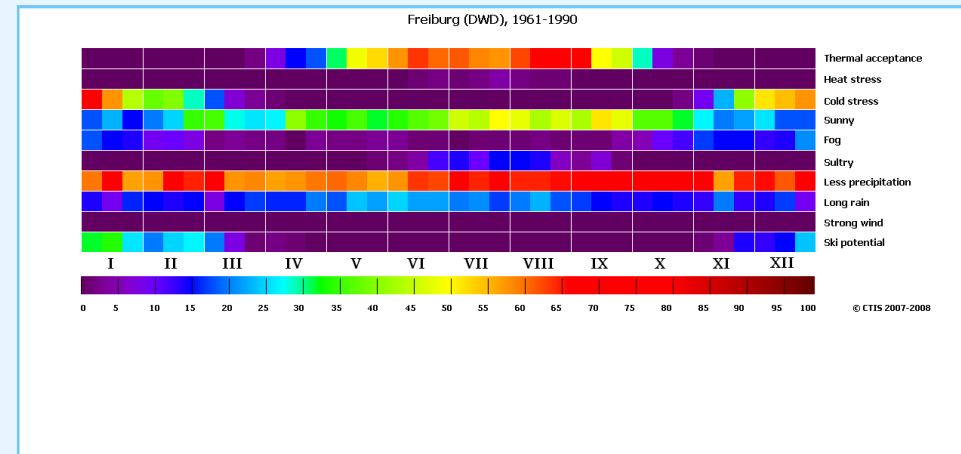
Quantification of Climate in Tourism

Facet of climate	Significance	Impact
Aesthetic Sunshine/cloudiness Visibility Day length	Quality of experience Quality of experience Convenience	Enjoyment, attractiveness of site Enjoyment, attractiveness of site Hours of daylight available
Physical Wind Rain Snow Ice Severe weather Air quality Ultraviolet radiation Odours Noise	Annoyance Annoyance, charm Winter sports/activities Danger Annoyance, danger Annoyance, danger Danger, attraction Annoyance Annoyance	Blown belongings, sand, dust Wetting, reduced visibility, enjoyment Participation in sports/activities Personal injury, damage to property All of above Health, physical wellbeing, allergies Health, suntan, sunburn Attractiveness of site Attractiveness of site
Thermal Integrated effects of air temperature, wind, solar radiation, humidity, long wave radiation, metabolic rate, clothing.	Thermal comfort Therapeutic, restorative	Environmental stress Physiological strain Hypothermia Hyperthermia Potential for recuperation

CTIS (Climate-Tourism-Information-Scheme)

Threshold values for (Freiburg):

- Thermal acceptability (PET 18 °C and 29 °C)
- Heat stress (PET > 35 °C),
- Cold stress (PET < 0 °C),
- Sunny (< 5 octas),
- Fog (based on rel. humidity > 93 %),
- Sultriness (based on vapour pressure > 18 hPa),
- Dry day (precipitation < 1 mm),
- Wet day (precipitation > 5 mm),
- Windy (> 8 m/s),
- Ski potential (based on snow cover > 10 cm).





... others

Thermal Air Pollution

ÉAir temperature

ÉAir humidity

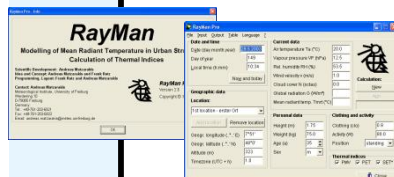
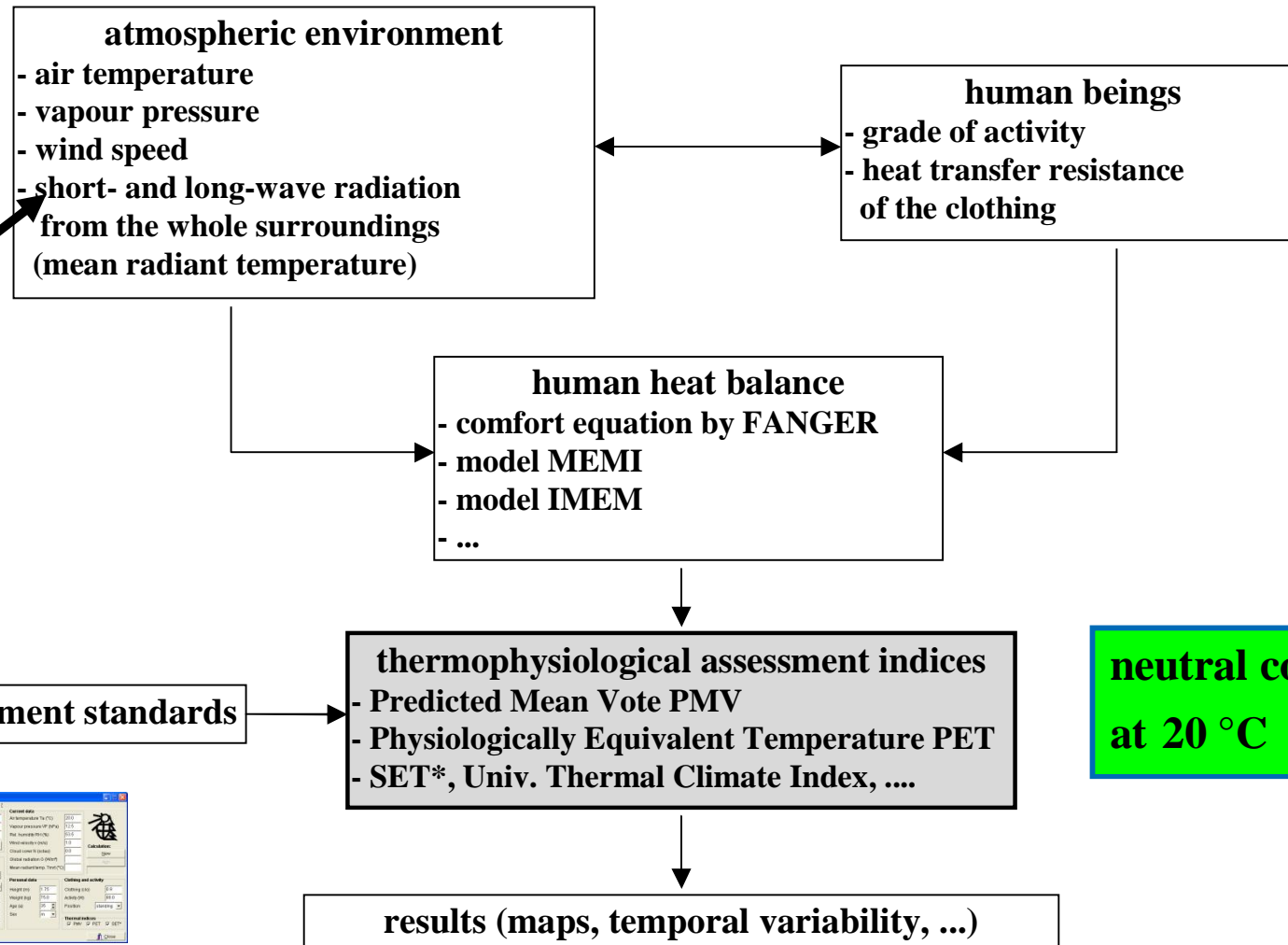
ÉWind speed

ÉShort and long wave radiation

É...



Human-Biometeorological Assessment of the Thermal Component of Different Climates





Thermal indices (PMV, PET), Thermal perception, Physiological stress

PET	Thermal Sensivity	Grade of Physiologic Stress
	very cold	extreme cold stress
4 °C	-----	-----
	cold	strong cold stress
8 °C	-----	-----
	cool	moderate cold stress
13 °C	-----	-----
	slightly cool	slight cold stress
18 °C	-----	-----
	comfortable	no thermal stress
23 °C	-----	-----
	slightly warm	slight heat stress
29 °C	-----	-----
	warm	moderate heat stress
35 °C	-----	-----
	hot	strong heat stress
41 °C	-----	-----
	very hot	extreme heat stress

Threshold values of thermal indices PMV and PET for different grades of thermal sensitivity of human beings and physiological stress on human beings

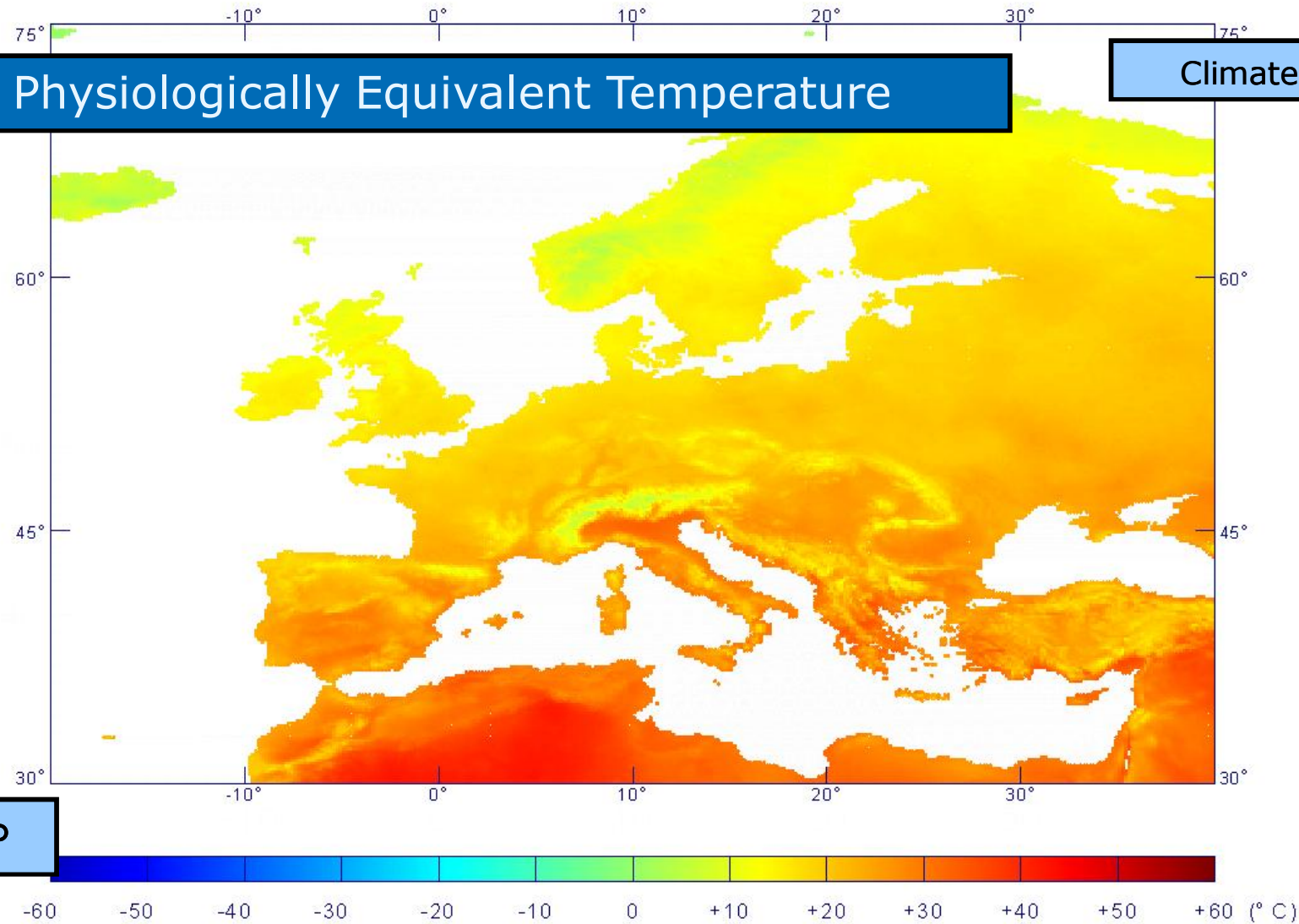
(according to Matzarakis and Mayer, 1996)



July

Physiologically Equivalent Temperature

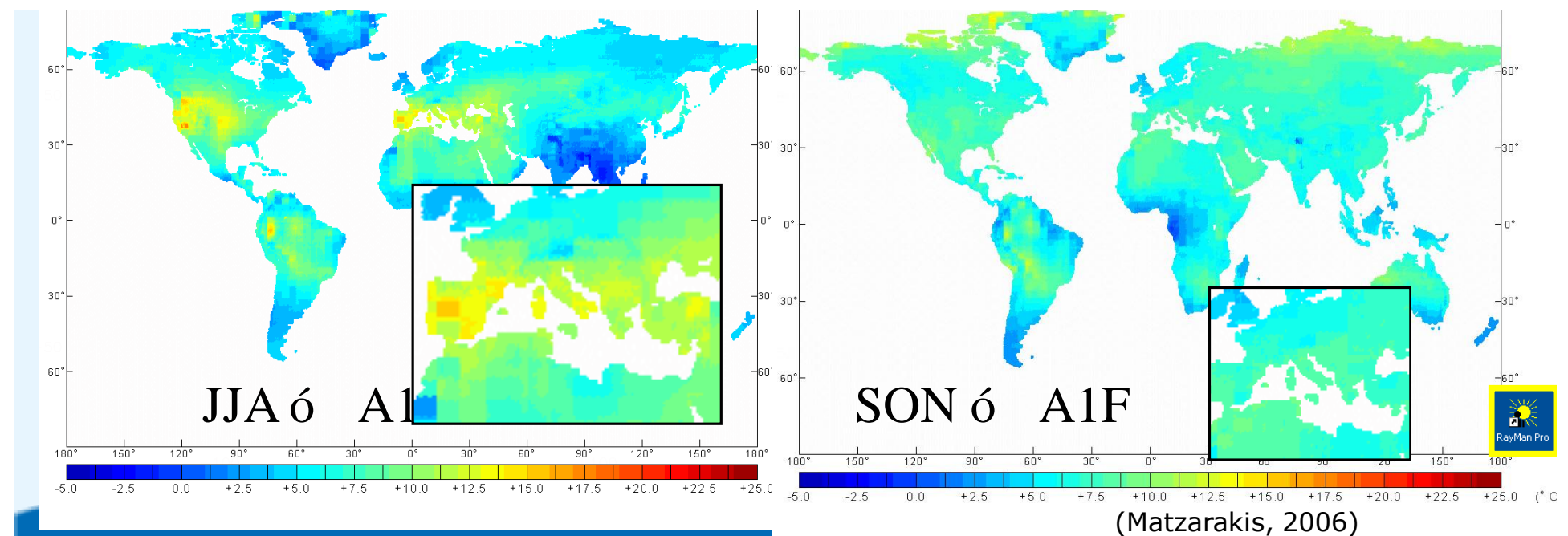
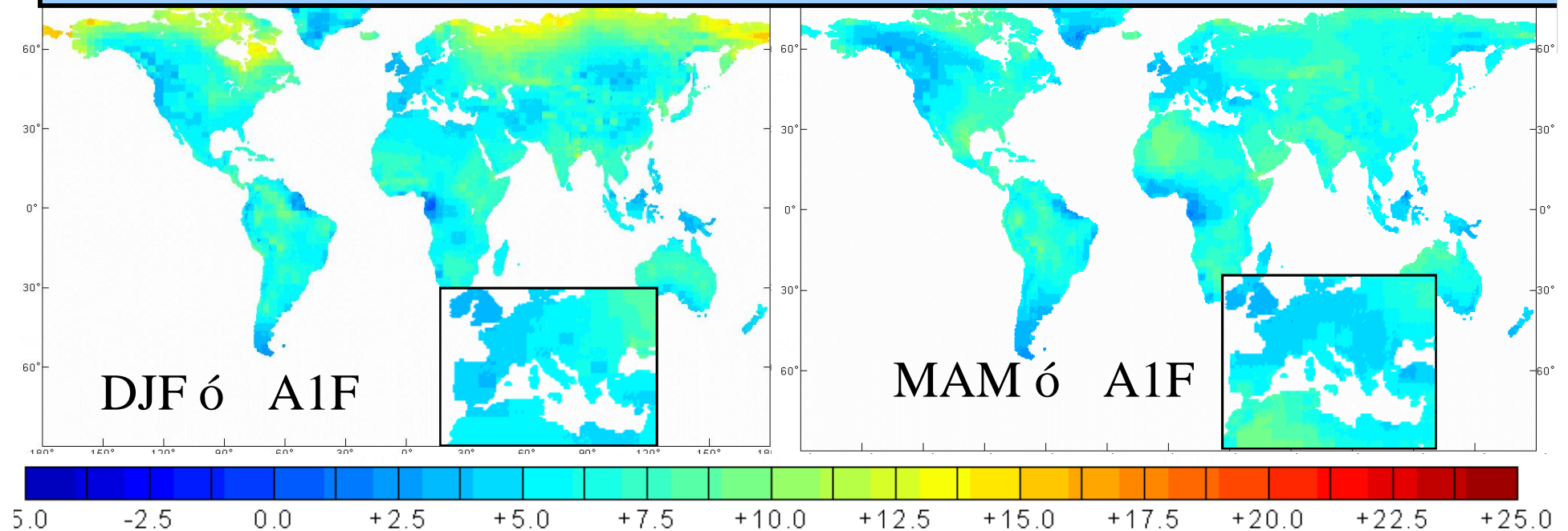
Climate model



Results: thermal

Matzarakis, Georgiadis, Rossi, 2007, Il Nuovo Cimento C

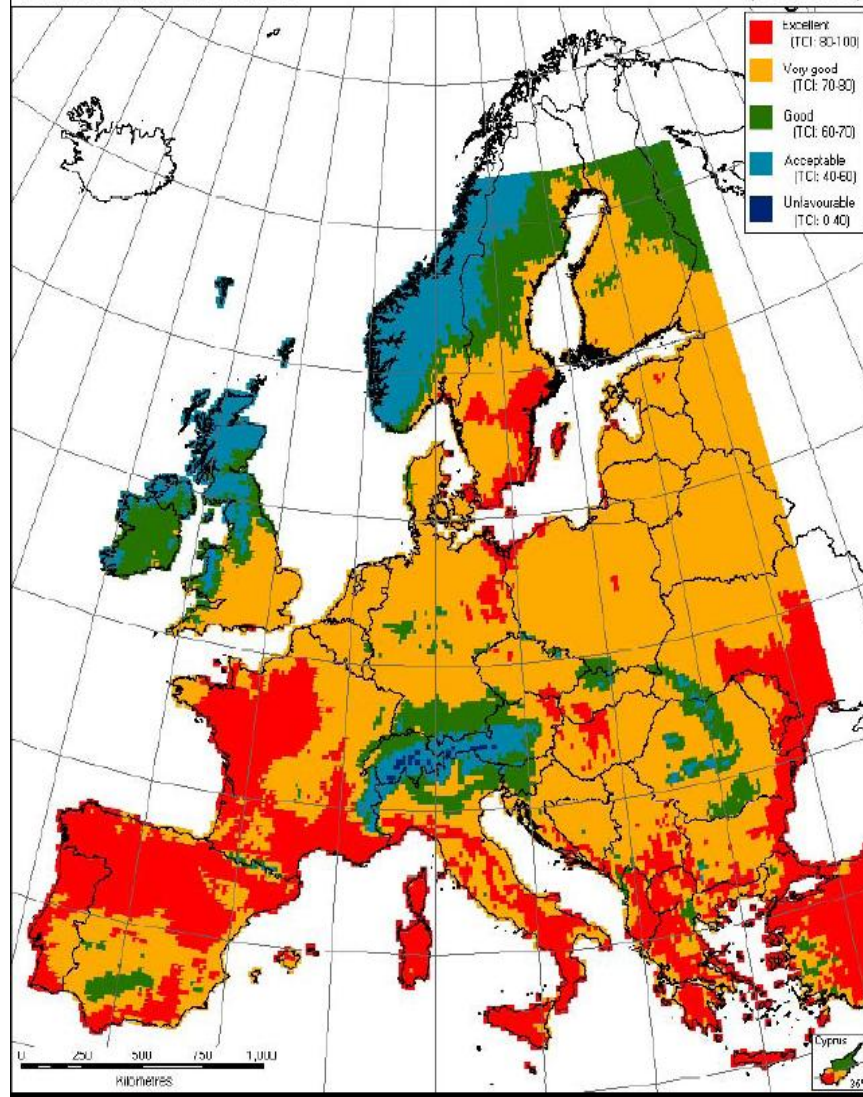
Seasonal PET ---- A1B (2070-2100) – Base (1960-1990)





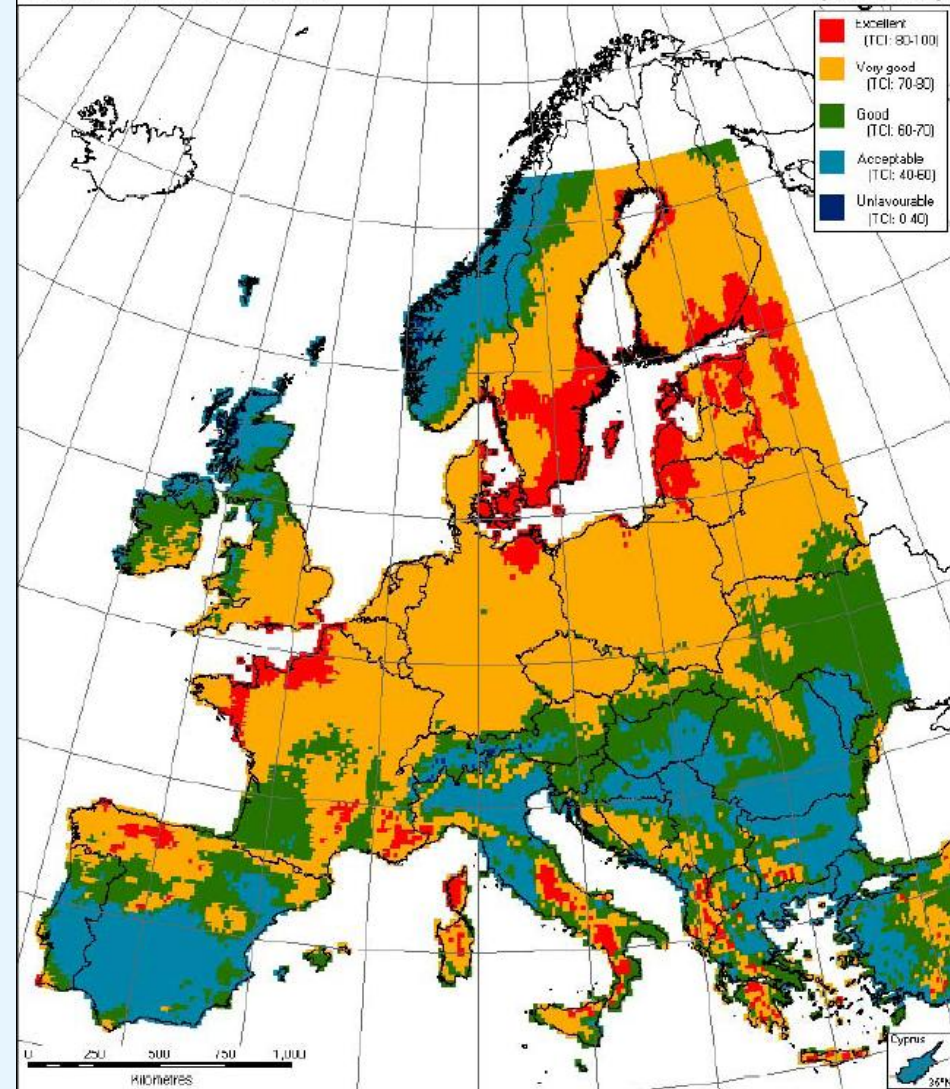
Tourism Climate Index (TCI)

(1961-1990)



Tourism Climate Index (TCI)

(2071-2100)





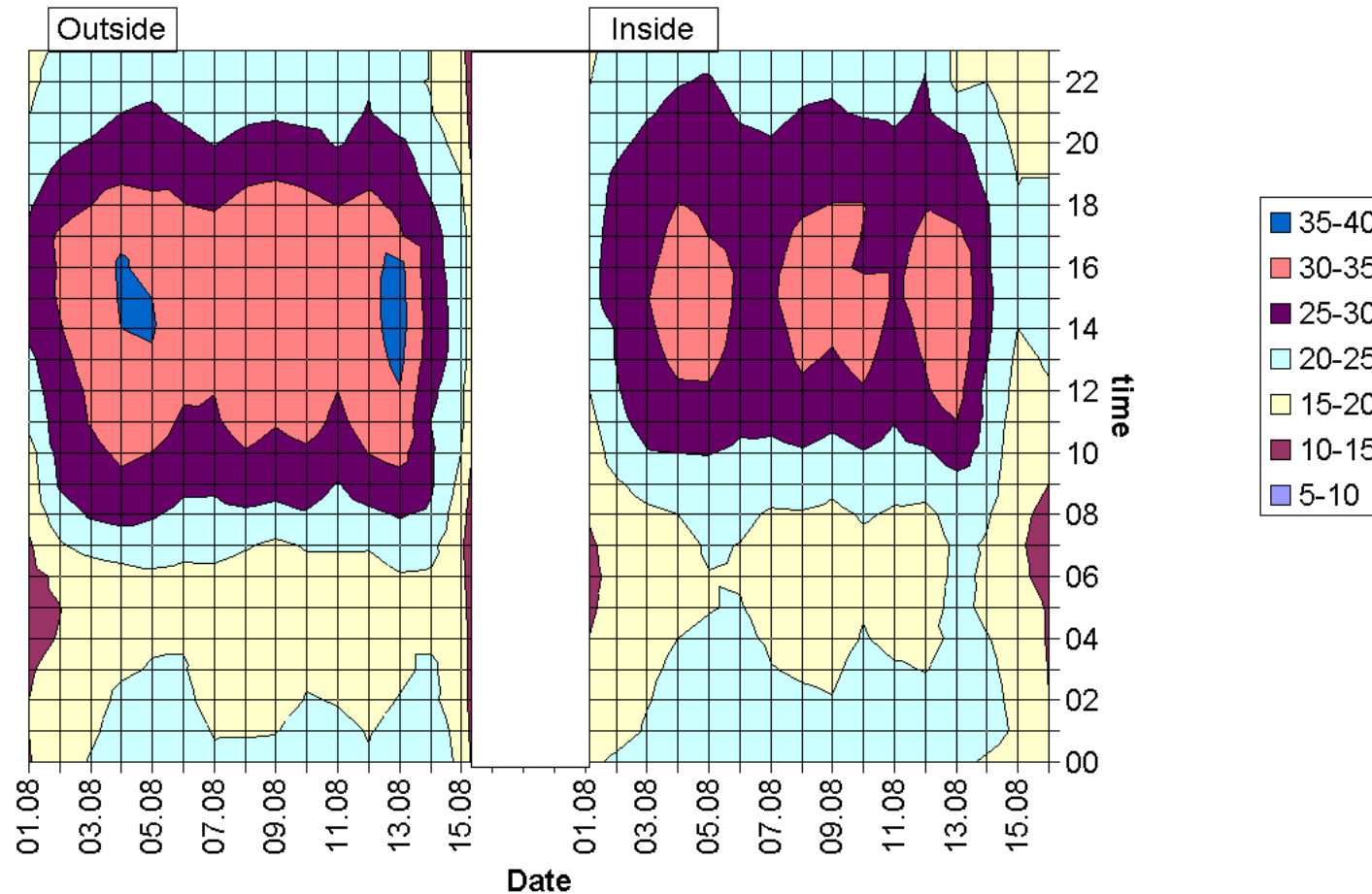
Weather and heat waves





Forests and Air Temperature

T_a (°C) - Forestclimate Station Freising

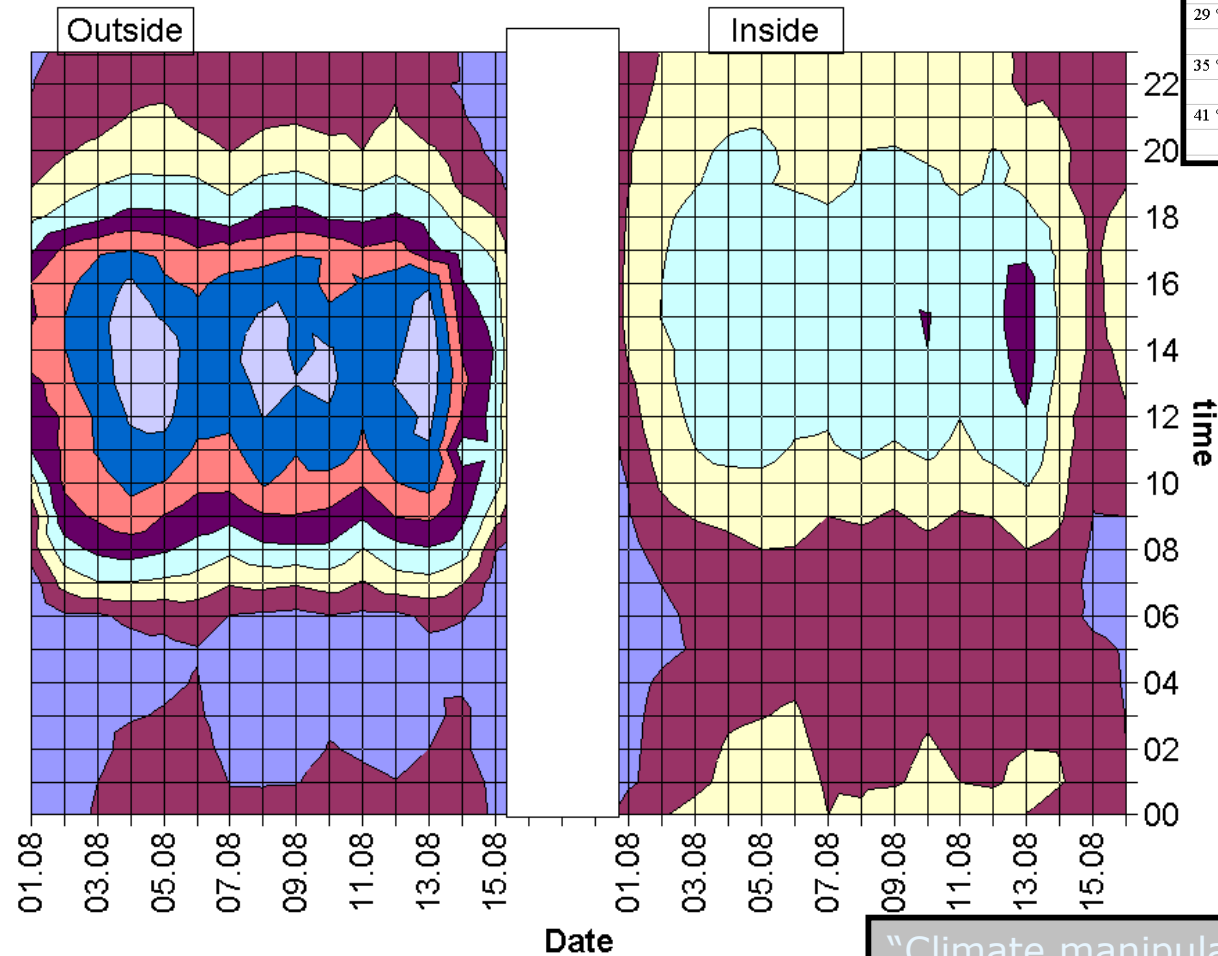


Data: Bavarian Agency of Forestry. Freising – Munich
Question: Forests and Bioclimate during heat waves



Forests and Bioclimate

PET (°C) - Forestclimate Station Freising



PET	Thermal Sensivity	Grade of Physiologic Stress
	very cold	extreme cold stress
4 °C	cold	strong cold stress
8 °C	cool	moderate cold stress
13 °C	slightly cool	slight cold stress
18 °C	comfortable	no thermal stress
23 °C	slightly warm	slight heat stress
29 °C	warm	moderate heat stress
35 °C	hot	strong heat stress
41 °C	very hot	extreme heat stress

"Climate manipulation":

Create a better microclimate



Climate: Quantification for Tourism

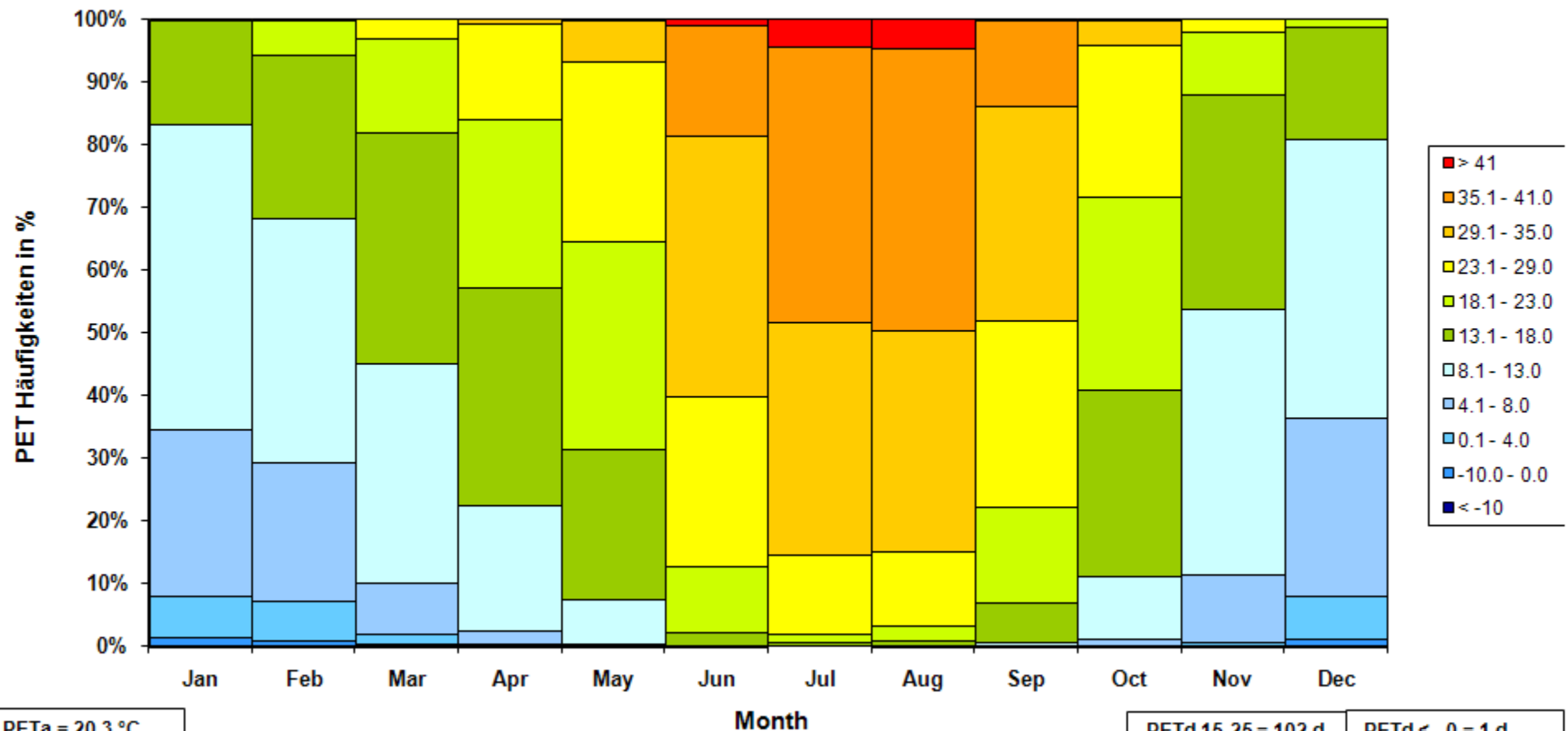
- **CC new destinations**
- **North Europe**
- **New Med.**
- **Shifting of tourism flows**
- **CC = 3 °C**





CLM, A1B – Climate Scenario

Palma de Mallorca, 1961-1990



PETa = 20.3 °C

PETmax = 44.3 °C

PETmin = -2.9 °C

PETd 15-25 = 102 d

PETd 18-23 = 47 d

PETd 18-29 = 96 d

PETd < 0 = 1 d

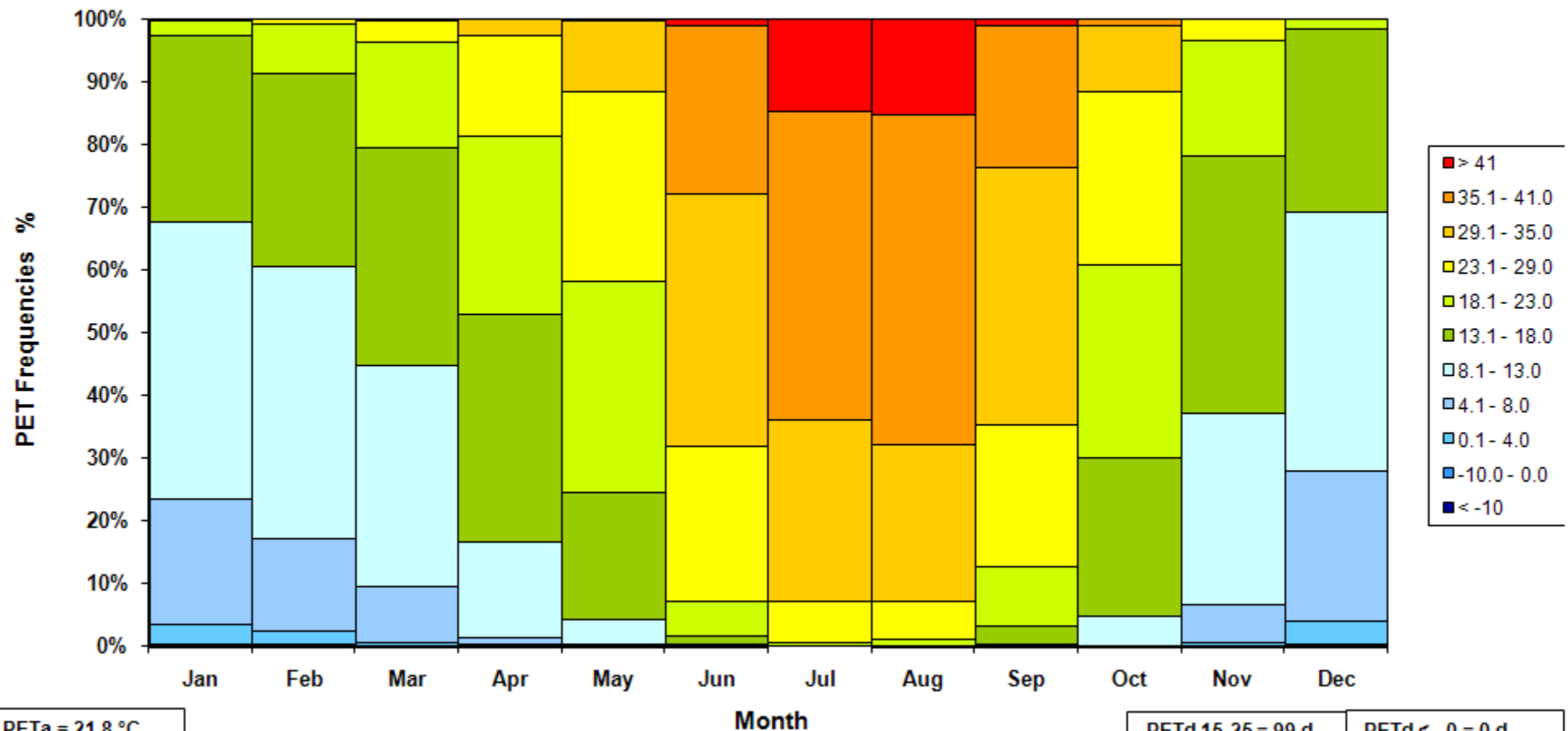
PETd > 30 = 83 d

PETd > 35 = 40 d



CLM, A1B – Climate Scenario

Palma de Mallorca, 2021-2048

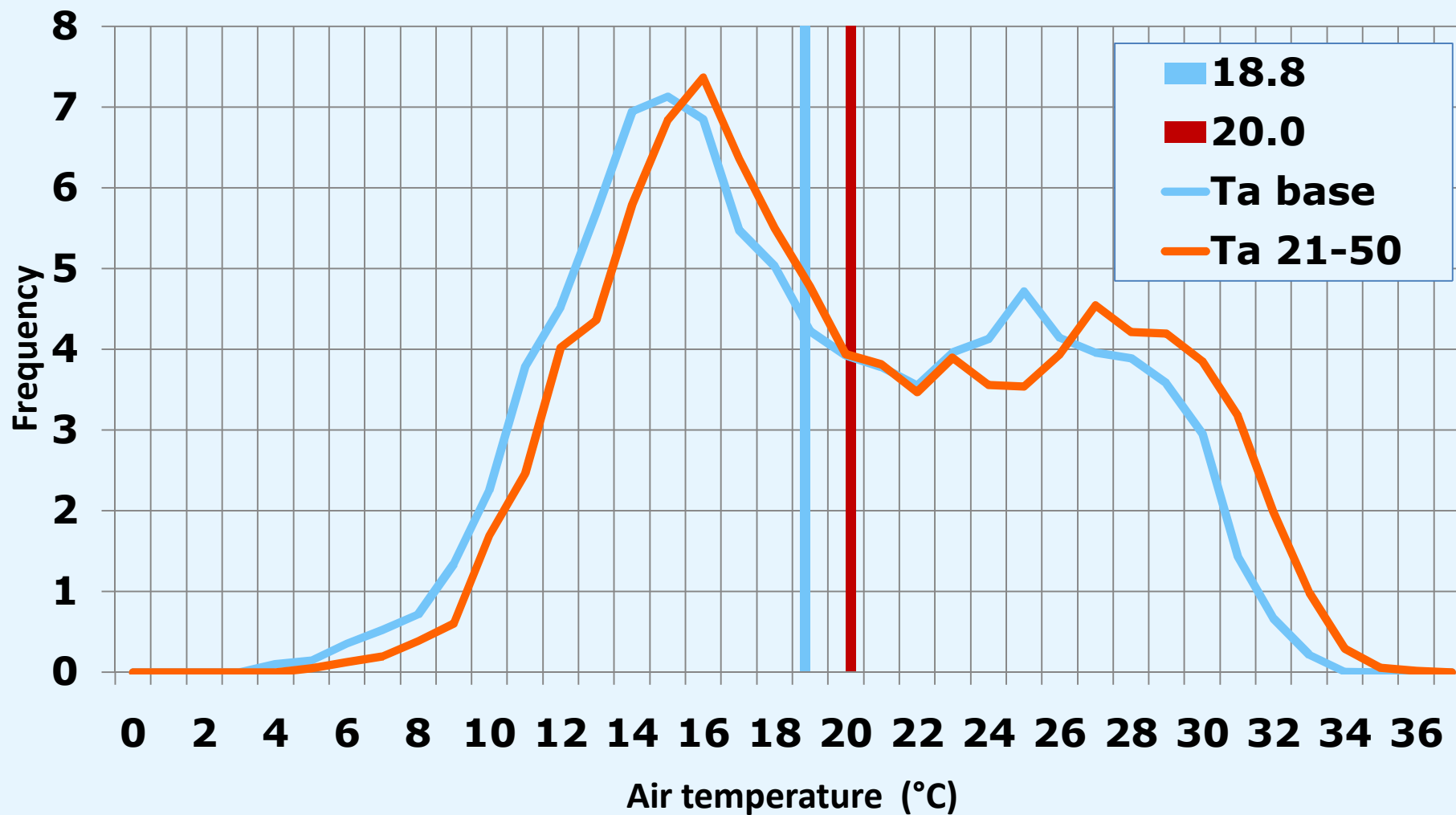


PETa = 21.8 °C
PETmax = 46.1 °C
PETmin = -1.3 °C

PETd 15-25 = 99 d	PETd < 0 = 0 d
PETd 18-23 = 45 d	PETd > 30 = 93 d
PETd 18-29 = 87 d	PETd > 35 = 52 d

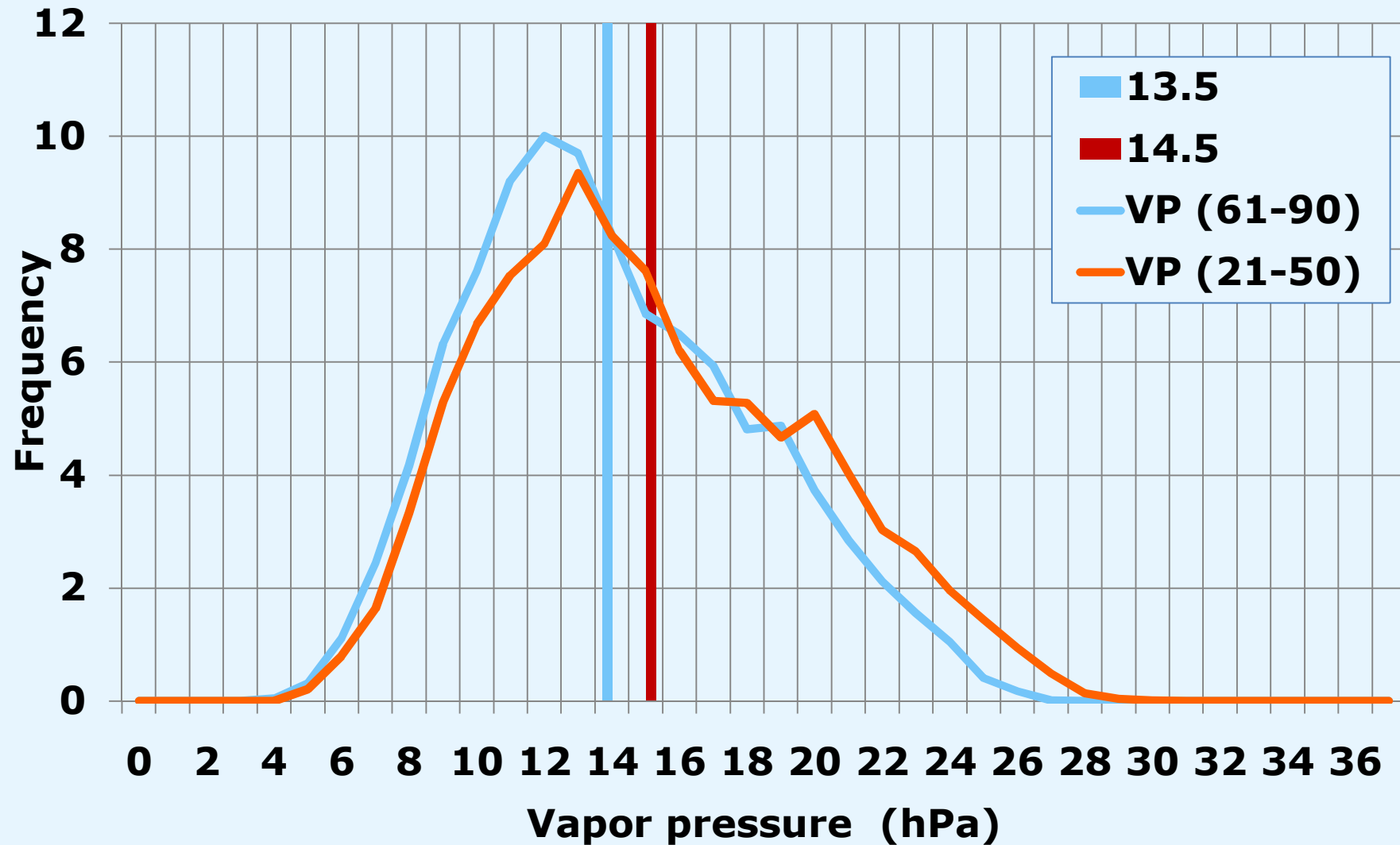


Palma de Mallorca



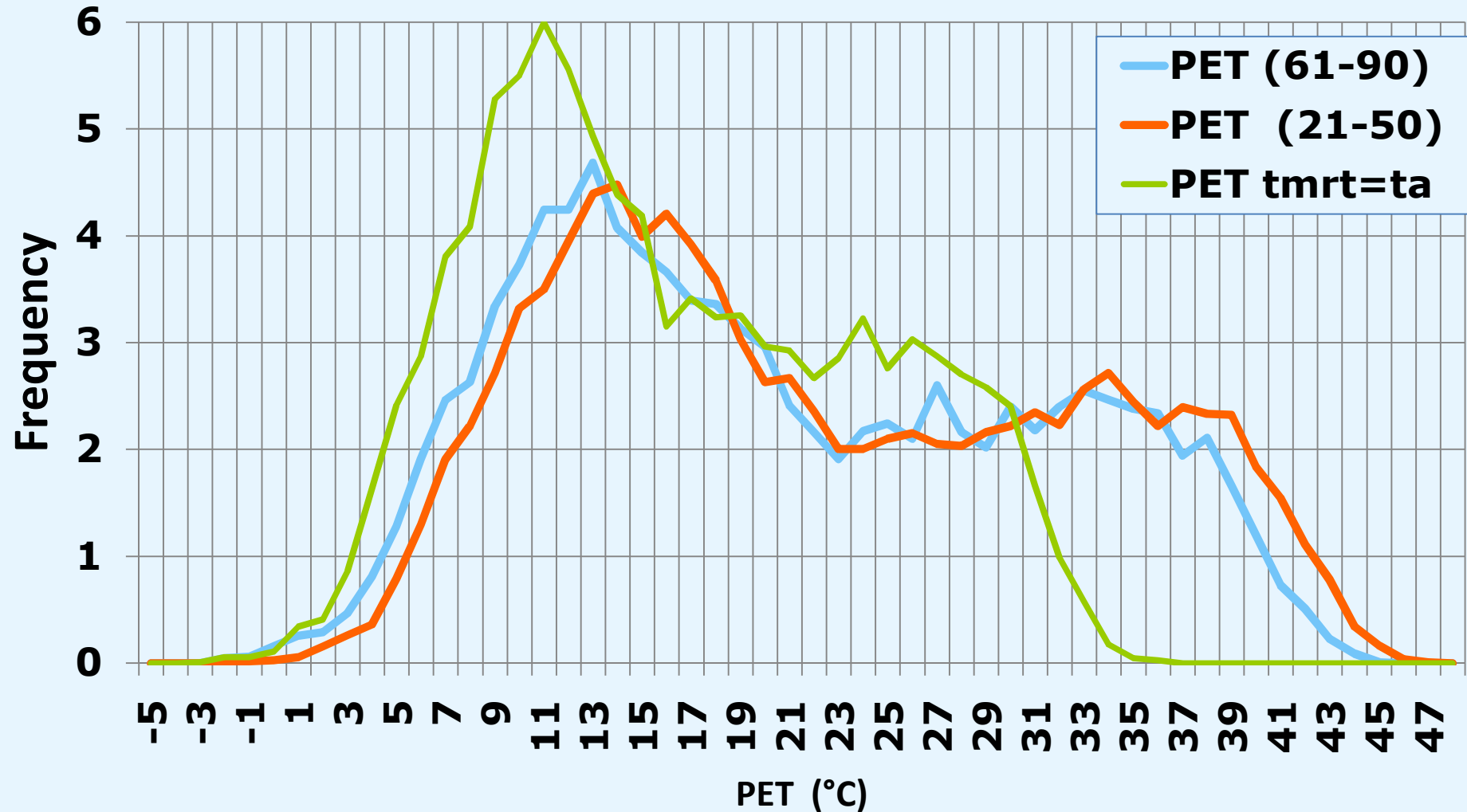


Palma de Mallorca



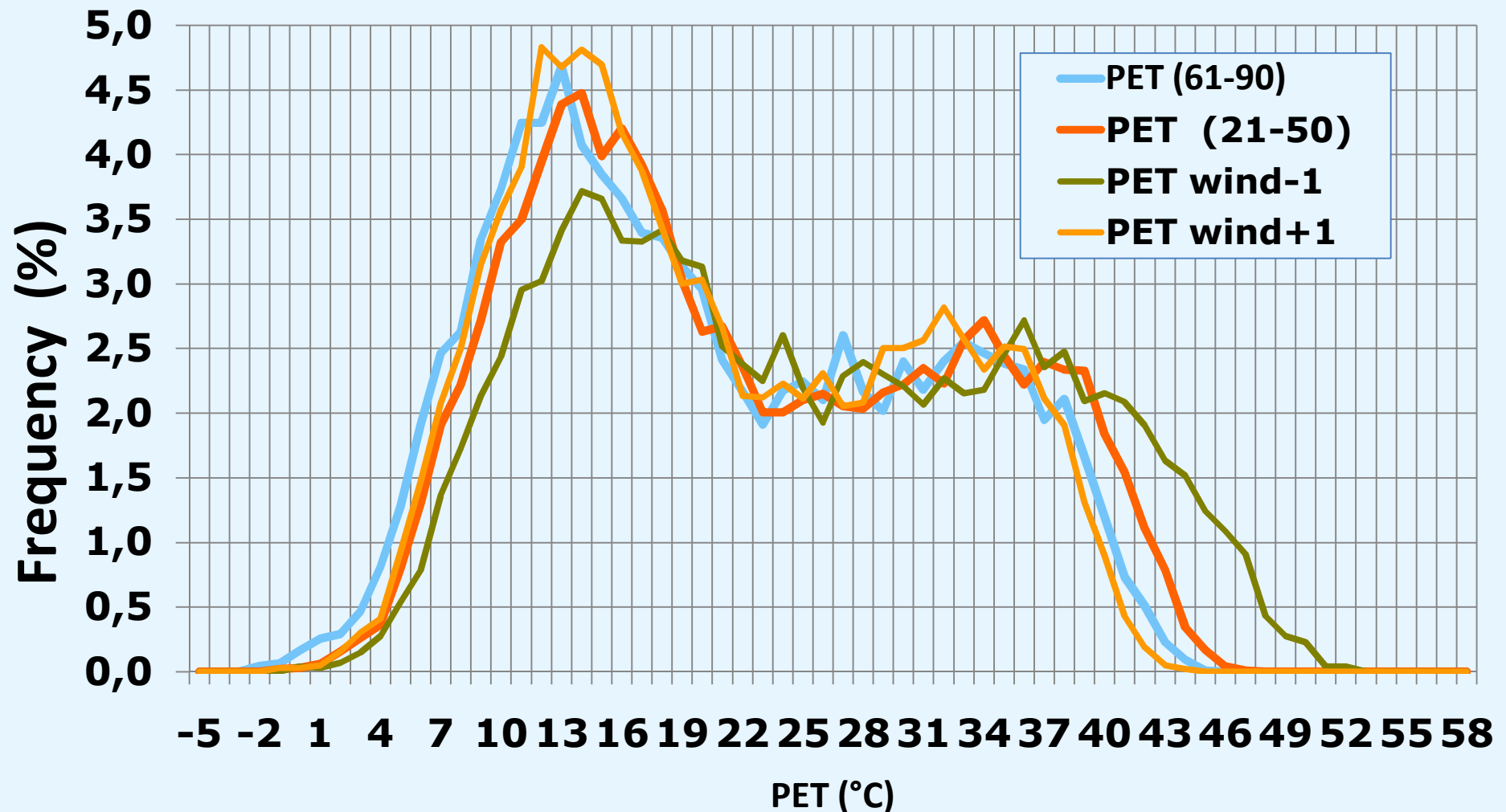


Palma de Mallorca





Palma de Mallorca





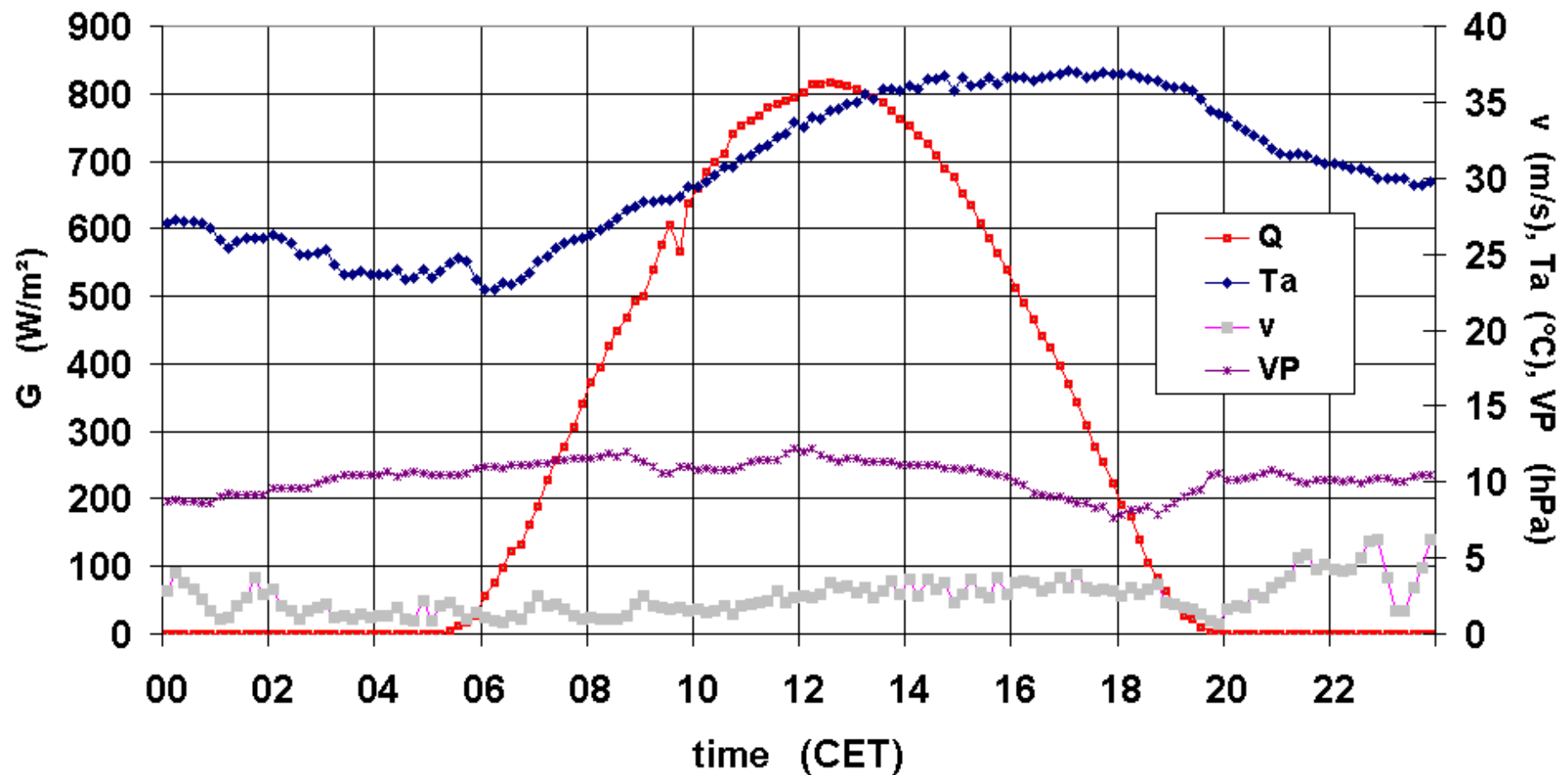
Climate extremes





Perfect day

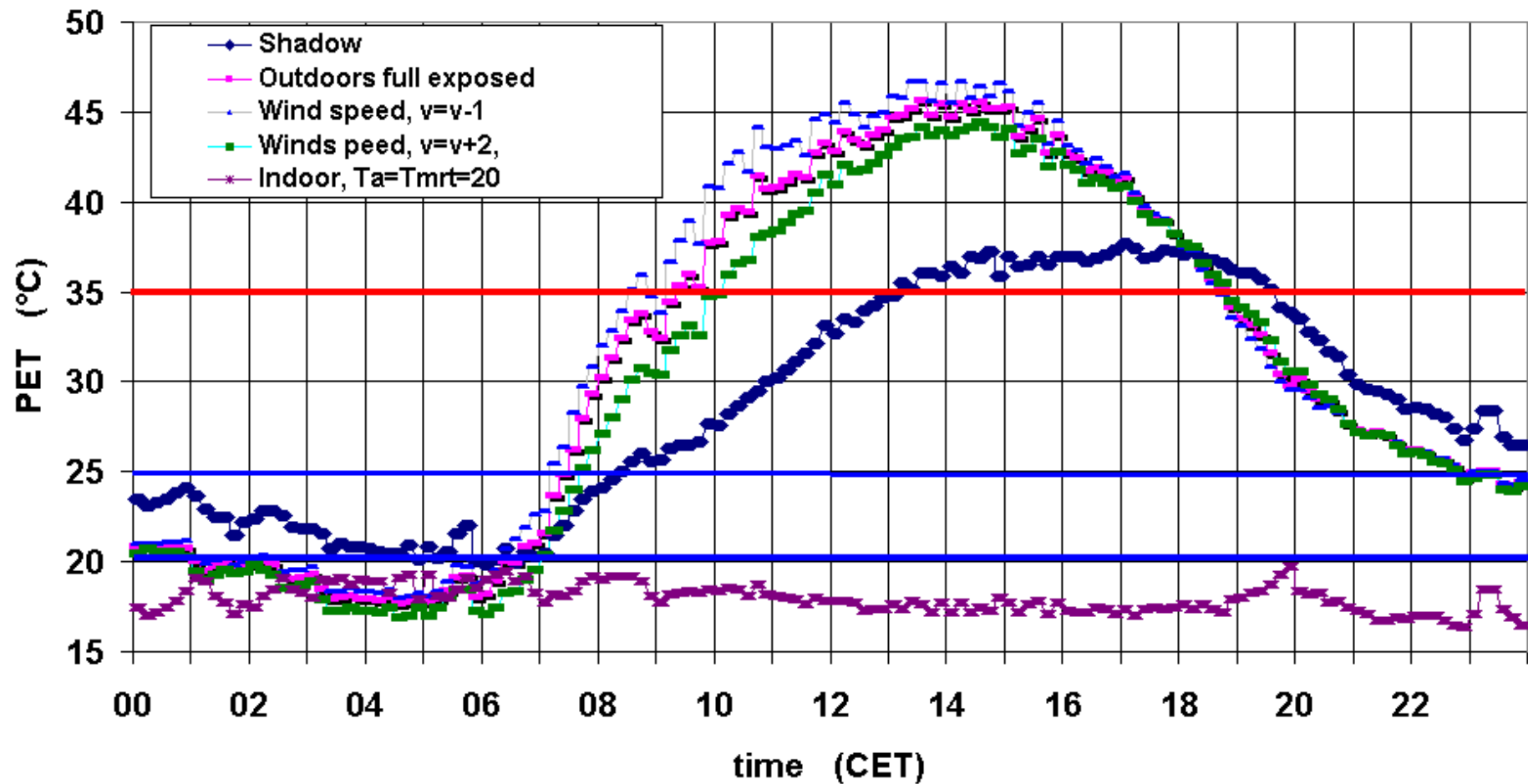
Freiburg, 12. August 2003





Perfect day and bioclimate

12. August 2003





Aspects of bioclimate and others direct and indirect effects

- ▶ Radiation modification
- ▶ Wind modification
- ▶ Infrastructure protection
- ▶ Reduction energy costs
- ▶ Protection humans (UV)
- ▶ Modified micro climate (indoor and outdoor)
- ▶ Education (long time)
- ▶ Language between (long time)
- ▶ Information
- ▶ Natural ventilation
- ▶ Climate adapted architecture
- ▶ Climate adapted behavior
- ▶ Cool Biz
- ▶



Global tourism emissions for 2005: only CO₂

<u>Sub-Sectors</u>	CO ₂ (Mt)	
Air Transport *	522	40%
Car Transport	418	32%
Other Transport	39	3%
Accommodation	274	21%
Activity	52	4%
Total World	1,307	
Global (IPCC, 2007)	26,400	
Tourism contribution	4.95 %	

Transportation
of Tourists = 75%
of Sector Emissions

* - does not include
non-CO₂ emissions
and impact on climate

UNWTO, 2007/8



► First Step to CO₂ . neutral City

World Future Energy
Summit

(Jan. 2008, Abu Dhabi):
Norman Foster presents
first CO₂ und waste free
city (Masdar, Abu Dhabi;
6 km²); Costs of Eco-
City Project:
22 Mrd. \$

Zero energy house
Burj Al Taqwa, Bahrein





Conclusions

- ▶ Effects and changes (CC) occur in local level
- ▶ Many information/tools from applied climatology for planners/Authorities/NGOs
- ▶ *Climate is on facet – air pollution, noise, UV - synergies*
- ▶ *Future conditions !*
- ▶ *Quality of Life (Remember 2003 and 2007)*
- ▶ Cooperation science and authorities
- ▶ **Connection: Indoor and Outdoor**
- ▶ **Finally: Flexibility - because of variability Æ not only from climate**

Models and Tools

The screenshot displays the RayMan software interface, which is used for simulating radiation and thermal conditions in urban environments. The main window is divided into several panels:

- Map View (Top Left):** A 2D map showing a city layout with buildings (grey polygons) and trees (green dots). The map is oriented with North (N) at the top. A cursor is positioned at x: 169.00 and y: 141.00. The map scale is 200 m.
- Configuration Panels (Right):**
 - Building Model:** Includes options for "Building", "Deciduous tree", and "Coniferous tree", all of which are checked. The "Obstacle #" is set to 0. The "Rotate obstacles" section has an "Angle (°)" of 0 and a "Rotate" button. The "Location" is set to a red dot, and the "Altitude (m)" is 1.00. The "Scale (m/pixel)" is 1, and the "Yardstick (m)" is also 1. An "Apply" button is present.
 - Calculation:** Includes input fields for "a)", "b)", and "t (°C)". A "Calculation:" section has "New" and "Add" buttons.
 - Clothing and activity:** Includes input fields for "Clothing (clo)" (0.9), "Activity (W)" (80.0), and a "Position" dropdown menu set to "standing".
 - Thermal indices:** Includes checkboxes for "PMV", "PET", and "SET*", all of which are checked. A "Close" button is at the bottom.
- 3D View (Bottom Right):** A perspective view of the city layout, showing buildings and trees in 3D. A "Close" button is visible.
- Table (Bottom Right):** A table showing simulation results for different locations and times. The table has columns for "height: 1.75", "of sunr.", "sunset", "r", "h:mm", "h:mm", and "h:mm".

Table Data:

height: 1.75	of sunr.	sunset	r	h:mm	h:mm	h:mm
96.0	343.4	2137.0	352.0	89.9	23.0	
98.4	347.7	2176.3	557.5	90.7	23.2	
8:17	16:53	400.9	350.1	2196.7	562.4	91.5 23.4
8:16	16:54	403.5	352.7	2218.2	567.7	92.4 23.7

RayMan ó www.mif.uni-freiburg.de/rayman

International Society of Biometeorology

COMMISSION ON CLIMATE, TOURISM & RECREATION

Do you undertake research, (or intend to) on the relationship between climate and tourism/recreation?
Do you undertake research, (or intend to) on the economic impacts of climate variability or the implications of climate change on tourism/recreation?
Then, we invite you to join us!

Aims

The Commission on Climate, Tourism and Recreation (CCTR) was founded by the International Society of Biometeorology (ISB) in 1996. The aim of the CCTR is to facilitate the integration of the link between climate and tourism/recreation by promoting research in tourism climatology and recreation climatology (Figure 1).

The objectives of the CCTR are to facilitate research and dissemination of data in the following:

- Identification of the relationship between climate and tourism/recreation
- Implications of extreme atmospheric events for tourism and recreation
- Tourism and climate
- Climate change and tourism/recreation
- Tourism and the use of climate adaptation of travelers

Research Themes

Tourism is one of the world's largest and fastest growing industries, and is the basis of economic livelihoods in many places. Climate is also a key (important) factor in many public and business decisions. Tourism and recreation are activities that are sensitive to climate. The CCTR focuses on the following:

- **Understanding Human Behaviour**

Although weather and climate are among the most important factors influencing tourism in a particular place, they are also critical to the tourism industry. Tourism-related climate and weather data and the personal experiences of tourists, different places have different tourism patterns, yet weather and climate can act both as barriers and enablers in a place's tourism industry. Together with the CCTR examine these barriers and enablers, particularly with regard to the following:

- the choice of destination
- the type of activity, activity package
- the duration of activity seasons
- the comfort, behaviour and experiences of visitors
- the way a destination is promoted and
- the profitability of tourism-related industries

Impacts

Weather/climate has a variety of effects on the physical wellbeing of visitors. In particular, there are CCTR focuses on three key areas related to health. The first is the medicinal role of climate (e.g., sea climate for asthma), an area that is receiving increasingly more attention. The second is the negative impact of climate on visitor experiences (e.g., heat and cold stress, sunburn) and

Implications of Climate Change

Global climate change has significant implications for sustainable tourism. In addition, the impact of climate change on the tourism sector and climate-sensitive tourism resources (e.g., glaciers, coastal ecosystems, mountain ecosystems, etc.) are also being studied. Research is needed to assess the impact of climate change on tourism and recreation, particularly with regard to the following:

- the choice of destination
- the type of activity, activity package
- the duration of activity seasons
- the comfort, behaviour and experiences of visitors
- the way a destination is promoted and
- the profitability of tourism-related industries

Impacts of Climate Change

In the field of tourism/climate research, there is still a need for the potential usefulness of climate information for planning and decision-making purposes, e.g., location of new recreational facilities, choice of swimming pools, recreation (operating seasons). Research has shown that the inclusion of climate data may not be sufficient to make appropriate tourism and recreation-related decisions. The CCTR encourages research that will contribute to our understanding of how climate data is used and how its dissemination can be improved, especially as it relates to the scheduling, planning and promotion of destinations, activities, and recreation of visitors' expectations to certain locations.

Contacts

ISB - International Society of Biometeorology
UNIVERSITY OF FREIBURG, Germany
Tel: +49-761-305-6021, Email: isb@uni-freiburg.de

ISB - International Society of Biometeorology
UNIVERSITY OF AUCKLAND, New Zealand
Tel: +64-9-373-7999 ext. 2000, Email: isb@uni-auckland.ac.nz

ISB - International Society of Biometeorology
UNIVERSITY OF WATERLOO, Ontario, Canada
Tel: +1-519-885-4907 ext. 3447, Email: isb@uwaterloo.ca

www.isb.uni-freiburg.de/isb

Bas Amelung - Krzysztof Blazejczyk - Andreas Matzarakis

Climate Change and Tourism Assessment and Copying Strategies



Maastricht – Warsaw – Freiburg, 2007
ISBN: 978-00-023716-4

ological Institute nmental Sciences



Price: 0 "

Developments in Tourism Climatology

A. Matzarakis, C. R. de Freitas and D. Scott
(Eds.)



Commission on Climate, Tourism and Recreation
International Society of Biometeorology

Freiburg, December 2007

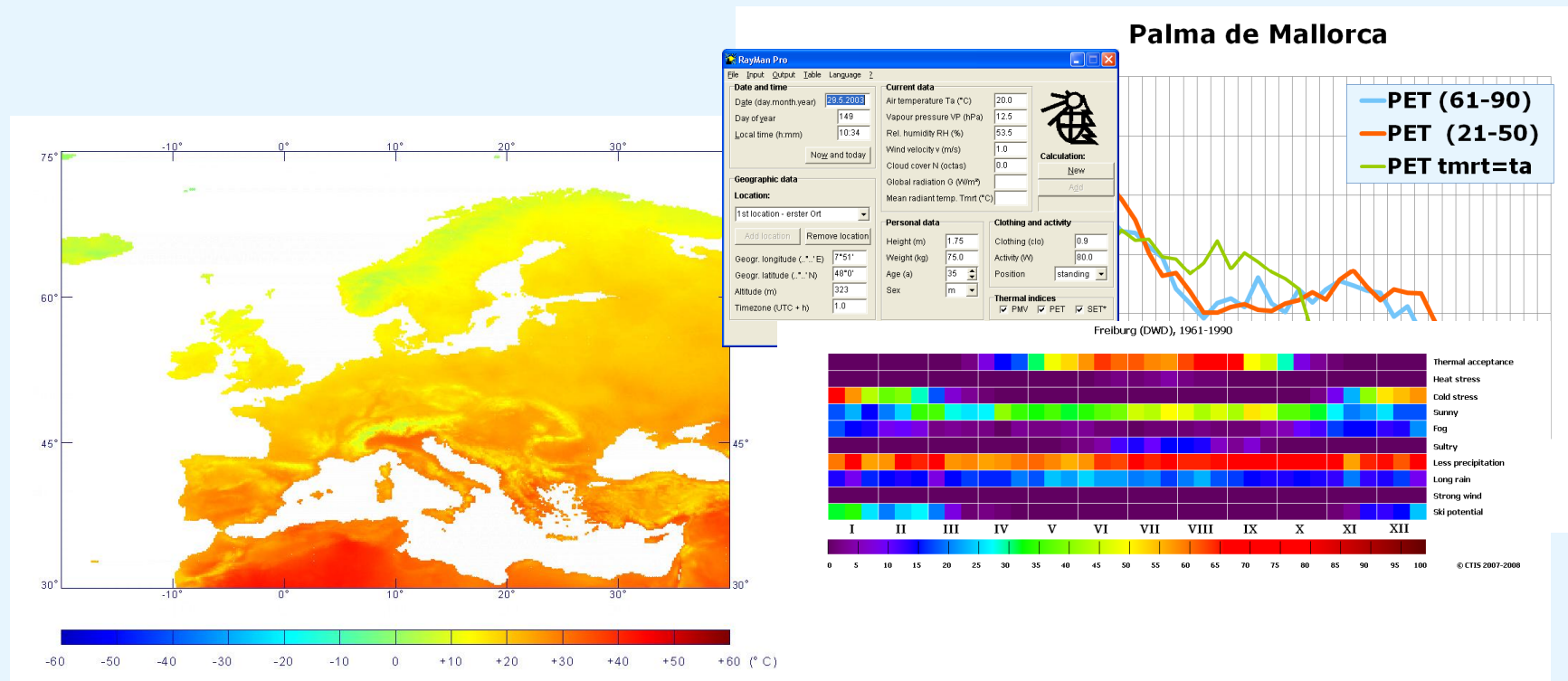
ISBN: 978-3-00-024110-9

www.urbanclimate.net/climtour





Climate Change and Tourism: Adaptation to weather, climate and climate extremes



Prof. Dr. Andreas Matzarakis



Thermal indices (PMV, PET), Thermal perception, Physiological stress

PMV	PET	Thermal Sensitivity	Grade of Physiological Stress
-3,5	4 °C	very cold	extreme cold stress
-2,5	8 °C	cold	strong cold stress
-1,5	13 °C	cool	moderate cold stress
-0,5	18 °C	slightly cool	slight cold stress
0,5	23 °C	neutral (comfortable)	no thermal stress
1,5	29 °C	slightly warm	slight heat stress
2,5	35 °C	warm	moderate heat stress
3,5	41 °C	hot	strong heat stress
		very hot	extreme heat stress

Threshold values of thermal indices PMV and PET for different grades of thermal sensitivity of human beings and physiological stress on human beings

(according to Matzarakis and Mayer, 1996)