Universitat de les Illes Balears

Institut Mediterrani d'Estudis Avançats

Projeccions climàtiques per al Sistema Integral Platja de Palma

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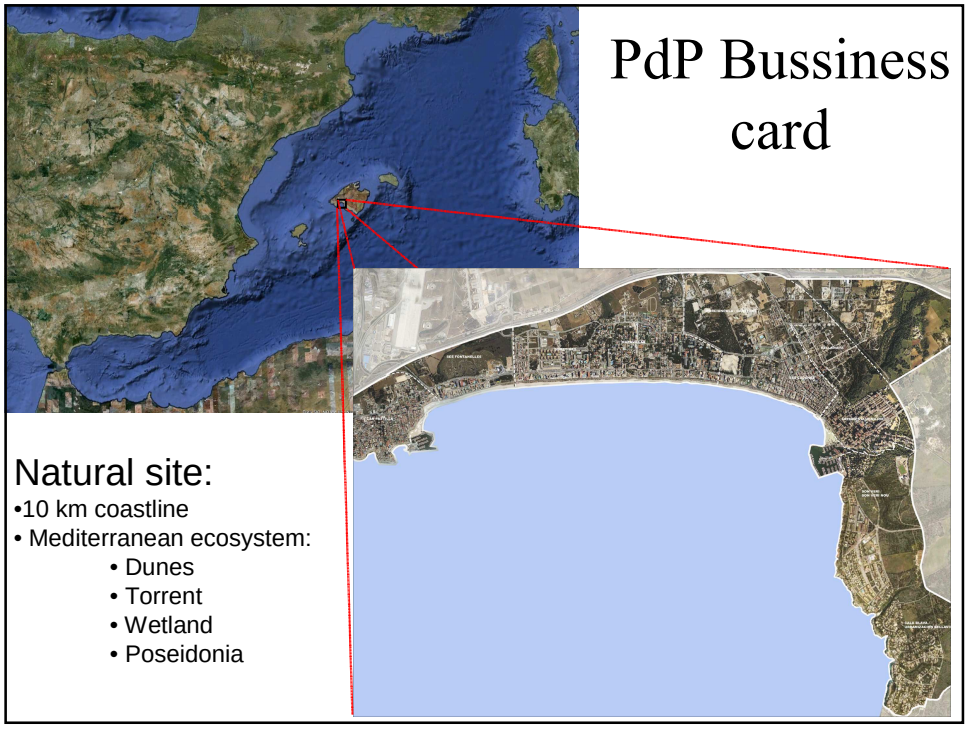


PdP Bussiness card

Natural site:

•10 km coastline
• Mediterranean ecosystem:
  • Dunes
  • Torrent
  • Wetland
  • Poseidonia

PdP Bussiness card

Tourist resort:

• 60 years in bussines
• 1.6 Milion tourists per year
• 122+ hotels
• 40000 accomodations
• 34000 residents

Remodelation project

PLATJA de PALMA
CONSORCI

"… queremos convertir Platja de Palma en un destino innovador, próspero y sostenible que sirva como referente mundial para otros destinos turísticos maduros."

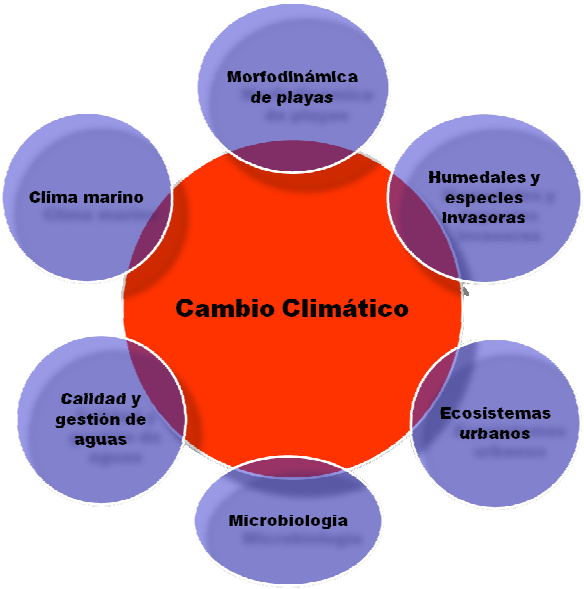
2009	8,500,000€
2010-2012	240,000,000€

Remodelation project

7 Strategic lines

Remodelation project

"Adaptación al cambio climático y Preservación de los sistemas naturales"



REQUIREMENTS:

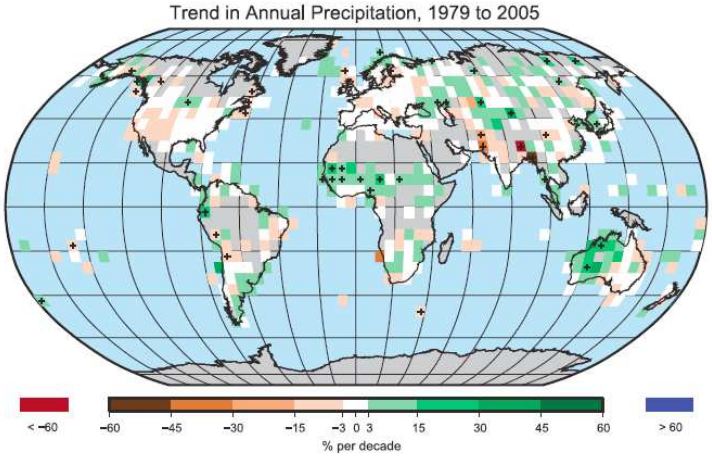
Climate Projections for *Platja de Palma:*

- From daily values to decadal magnitudes
- Time span: 2050
- Mean values and extremes
- Standard variables:
  - Temperature
  - Precipitation
  - Wind
  - Relative Humidity
  - Cloud cover
- Climate Index for Tourism

Past evidences of climate change in *Platja de Palma*

Climate change: global evidences

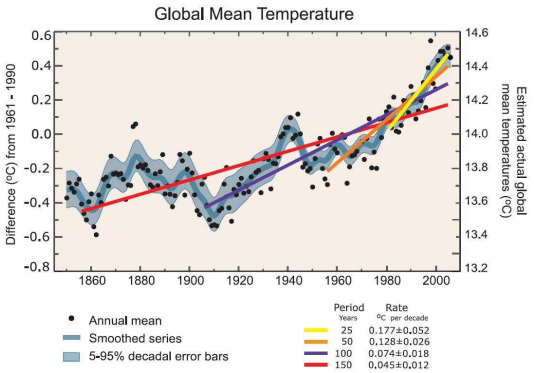
• Total annual rainfall shows increasing trends in many regions of Europe. Over the Mediterranean, several regional studies points out a neutral or decreasing trend

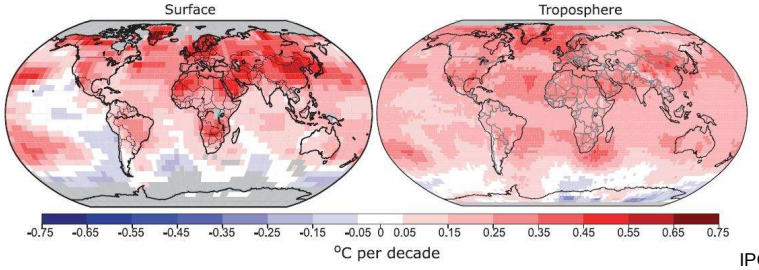


IPCC, 2007

Climate change: global evidences

• Global mean surface air temperature has risen over 0.64 ºC during the 1956-2005





IPCC, 2007

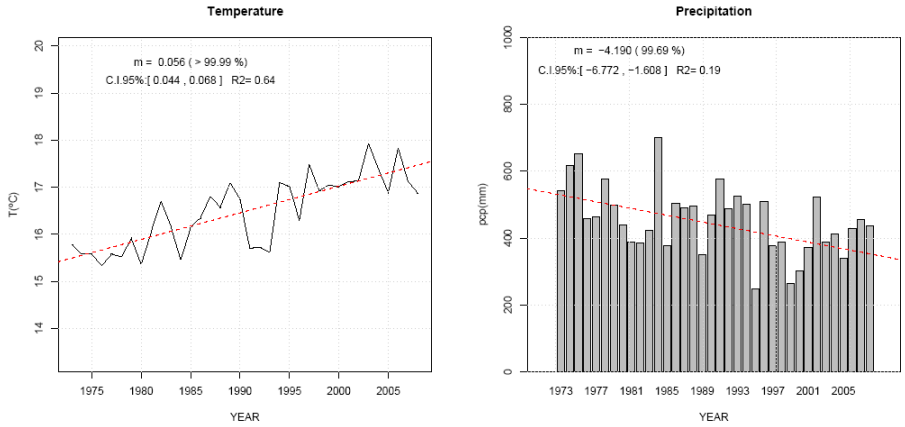
Local available information

AEMET Station LEPA
Records from 1973

Observed annual mean regimes (1973-2008)

Mean regimes	1973-2008 (36 yrs)	1973-1990 (18 yrs)	1991-2008 (18 yrs)	Δ variables
T (ºC)	16.5	16	16.9	+ 0.9 ºC
T min (ºC)	10.3	9.8	10.8	+ 1.0 ºC
T max (ºC)	22.3	22	22.6	+ 0.6 ºC
pcp (mm)	454.4	490.3	418.5	-14.6 %
Hr (%)	76.5	77.3	75.7	-2.1 %
clt (%)	44.5	42.3	46.8	+ 10.6 %
wss (m/s)	2.9	2.8	3.0	+ 7.4 %

SPdP: observed annual mean trends (1973-2008)



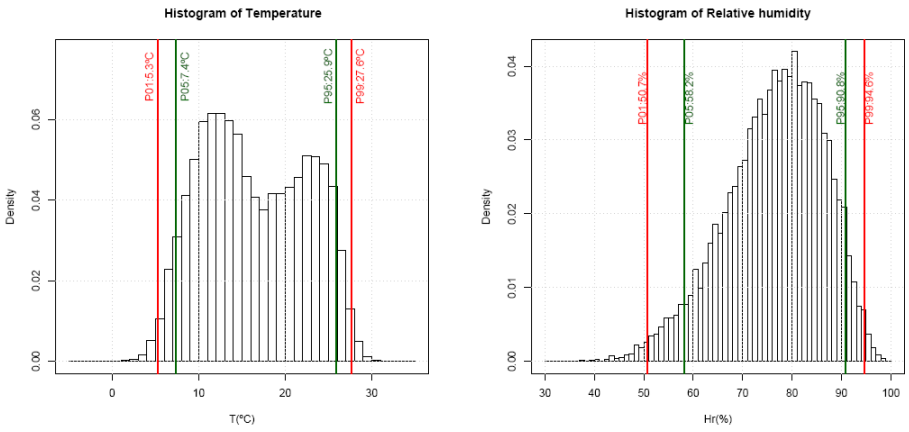
Likelihood terminology table (IPCC, 2007)

Terminology	Probability of the occurrence
Virtually certain	>99%
Extremely likely	>95%
Very likely	>90%
Likely	>66%
More likely than unlikely	>50%
More unlikely than likely	<50%
Unlikely	<33%
Very unlikely	<10%
Extremely unlikely	< 5%
Exceptionally unlikely	< 1%

SPdP: observed annual mean trends (1973-2008)

variable	Change rate (per decade)	Statistical confidence in sign	95% interval confidence	
			Lower limit	Higher limit
T (ºC)	+0.56	Virtually certain	+0.44	+0.68
T min (ºC)	+0.69	Virtually certain	+0.57	+0.82
T max (ºC)	+0.43	Virtually certain	+0.26	+0.60
pcp (mm)	-41.90	Virtually certain	-67.72	-16.08
Hr (%)	-1.20	Virtually certain	-1.82	-0.58
clt (%)	+2.46	Virtually certain	+1.94	+2.98
wss (m/s)	+0.14	Virtually certain	+0.06	+0.21

Frequency of annual extreme events (1973-2008)



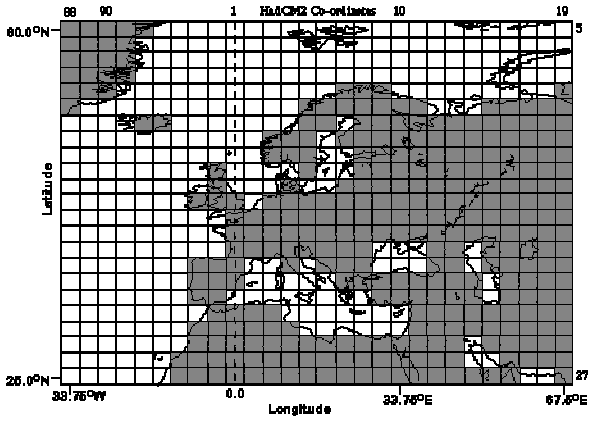
SPdP: trends of annual frequency of extreme events (1973-2008)

variable	Percentile	Trend in frequency (days/year per decade)	Statistical confidence in sign	95% interval confidence	
				Lower limit	Higher limit
T (ºC)	< P05 (7.4 ºC)	-4.44	Virtually certain	-7.34	-1.54
	> P95 (25.9 ºC)	+5.75	Extremely likely	+1.26	+10.23
T min (ºC)	< P05 (0.1 ºC)	-6.36	Virtually certain	-8.89	-3.84
	> P95 (20.0 ºC)	+5.42	Virtually certain	+3.59	+7.24
T max (ºC)	< P05 (13.2 ºC)	-3.96	Extremely likely	-6.93	-0.99
	> P95 (32.7 ºC)	+2.26	Likely	-0.43	+4.95
pcp (mm)	= 0 mm	-2.30	Likely	-5.74	+1.15
	> P95 (24.9 mm)	-0.35	Likely	-0.81	+0.12
Hr (%)	< P05 (58.2 %)	+7.79	Virtually certain	+5.78	+9.80
	> P95 (90.8 %)	-0.39	Very unlikely	-2.64	+1.87
clt (%)	< P05 (6.2 %)	-4.25	Virtually certain	-5.80	-2.70
	> P95 (85.6 %)	+2.10	Extremely likely	+0.57	+3.64
wss (m/s)	< P05 (0.9 m/s)	-11.05	Virtually certain	-12.87	-9.23
	> P95 (6.0 m/s)	-0.18	Unlikely	-2.82	+2.46

Climate projections until 2050 for *Platja de Palma*

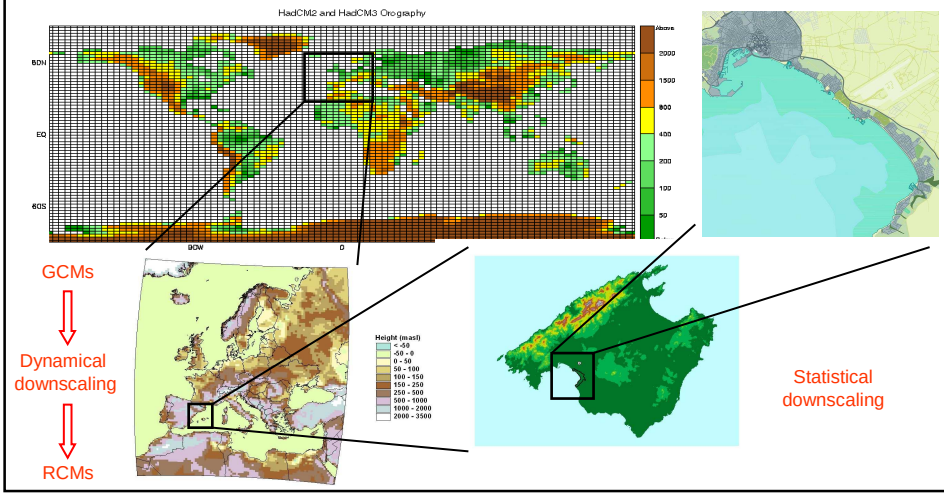
Tools for the analysis of climate projections

- Atmosphere-ocean coupled global climate models (GCMs) are well established tools to study future climate change
- Their application to the study of regional climate processes is limited because of their coarse spatial resolution



Tools for the climate change study

- To improve our understanding from global climate model outputs to regional and local spatial scales:
- Regional scales: Dynamical downscaling. Regional Climate Models (RCMs)
- Local scales: Statistical downscaling and model calibration from RCMs

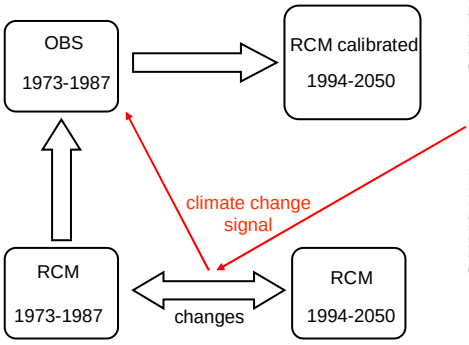


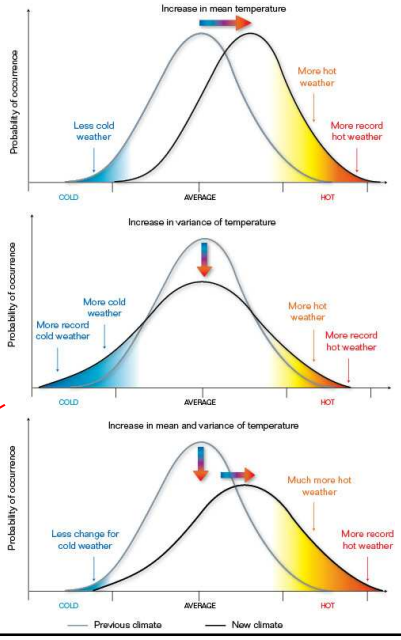
Statistical downscaling of RCM outputs

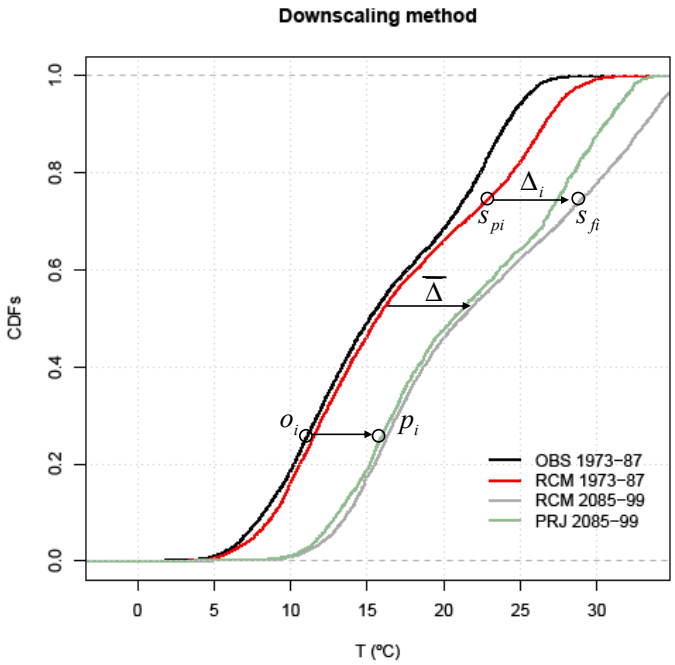
• Calibration period (1973-1987): application of changes between past and present RCM time-slices to the past observed climate

• Verification period (1994-2008): comparison between RCM calibrated data and present observed climate

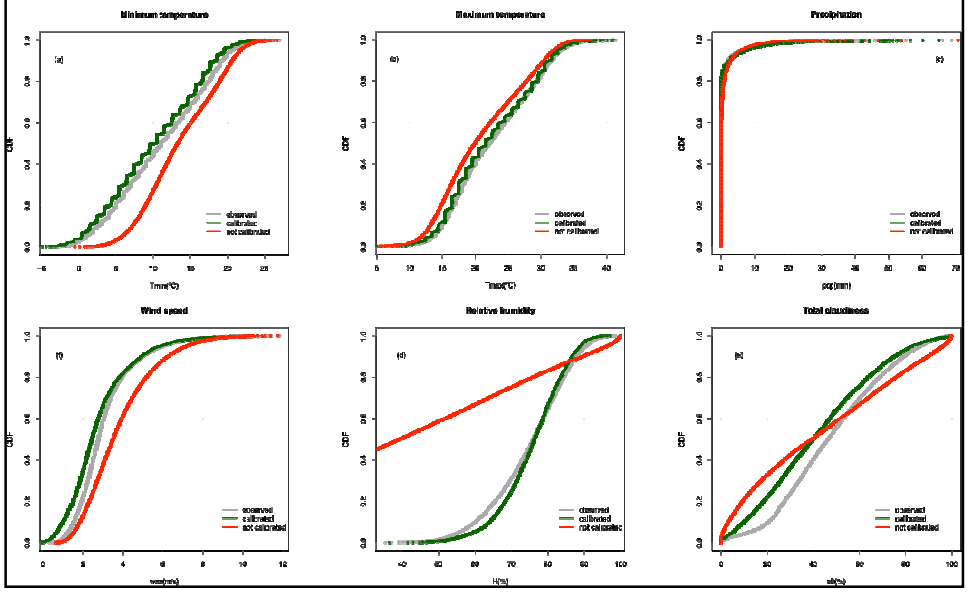
• RCMs calibrated period (2009-2050): application of changes between past and future RCM data to past observed climate







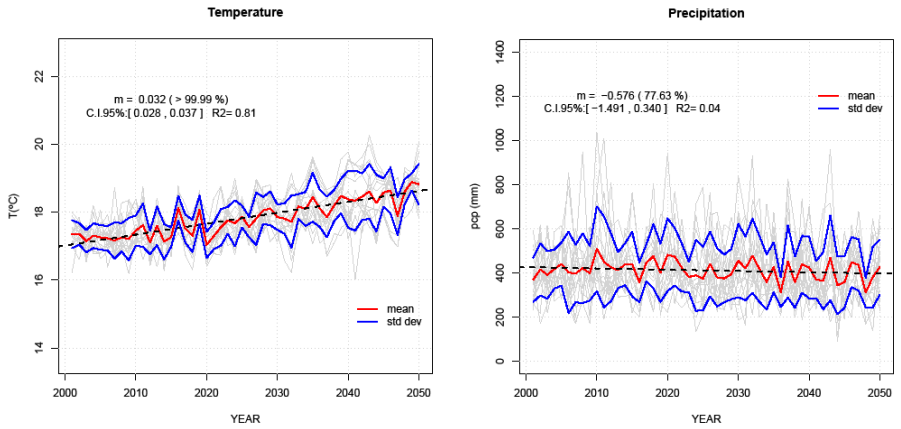
Verification results (1994-2008)



Observed versus projected annual multi-model mean regimes (1979-2008/2021-50; SRES A1B)

Mean regimes	LEPA 1979-2008 (30 yrs)	Multi-model mean 2021-50 (30 yrs)	Δ variables
T (ºC)	16.6	18.1	+1.5 (ºC)
T min (ºC)	10.5	12.0	+1.5 (ºC)
T max (ºC)	22.5	23.7	+1.2 (ºC)
pcp (mm)	435.0	403.3	-7.3 (%)
Hr (%)	76.5	74.5	-2.6 (%)
clt (%)	45.2	48.1	+6.4 (%)
wss (m/s)	3.0	2.9	-3.3 (%)

Projected annual multi-model mean trends (2001-50, SRES A1B)



Projected annual multi-model mean trends (2001-50, SRES A1B)

variable (multi-model mean)	Change rate (per decade)	Statistical confidence in change rate	95% interval confidence	
			Lower limit	Higher limit
T (ºC)	+0.32	Virtually certain	+0.28	+0.37
T min (ºC)	+0.31	Virtually certain	+0.26	+0.36
T max (ºC)	+0.33	Virtually certain	+0.29	+0.38
pcp (mm)	-6.98	Likely	-16.39	+2.43
Hr (%)	-0.11	Virtually certain	-0.18	-0.04
clt (%)	-0.16	Very likely	-0.33	+0.01
wss (m/s)	-0.01	Virtually certain	-0.02	-0.01

Trends in annual frequency of extreme events (1979-2008/2021-2050)

variable	Percentile	Trend in frequency (days/year per decade)	Statistical confidence in sign	95% interval confidence	
				Lower limit	Higher limit
T (ºC)	< P05 (7.4 ºC)	-1.56	Virtually certain	-2.48	-0.63
	> P95 (26.1 ºC)	+7.22	Virtually certain	+5.09	+9.35
T min (ºC)	< P05 (0.6 ºC)	-2.00	Virtually certain	-3.11	-0.90
	> P95 (20.0 ºC)	+7.83	Virtually certain	+5.42	+10.24
T max (ºC)	< P05 (13.4 ºC)	-2.39	Virtually certain	-3.51	-1.28
	> P95 (33.0 ºC)	+5.56	Virtually certain	+3.68	+7.43
pcp (mm)	pcp = 0 mm	+2.23	Very likely	+0.01	+4.45
	> P95 (24.4 mm)	-0.04	Unlikely	-0.28	+0.20
Hr (%)	< P05 (57.5 %)	+0.77	Likely	-0.59	+2.13
	> P95 (91.1 %)	-0.31	More likely than unlikely	-1.15	+0.52
clt (%)	< P05 (6.7 %)	-0.65	Unlikely	-4.30	+3.00
	> P95 (85.8 %)	+0.69	Likely	-0.52	+1.90
wss (m/s)	< P05 (1.0 m/s)	+0.21	Likely	-0.21	+0.64
	> P95 (6.1 m/s)	-0.10	Unlikely	-1.04	+0.84

Main conclusions (I)

Past climate in PdP

Observed mean regimes

- Increase in minimum and maximum temperatures
- Decrease in annual precipitation amounts

Observed annual trends

- Annual mean temperature trend: +0.56 ºC/decade (1973-2008)
- Annual precipitation trend: -41.90 mm/decade (1973-2008)

Frequency in extreme events

- Decrease in the number of cold days and increase in the number of warm days
- Decrease in the number of days with extreme rainfall amounts (weak and intense)

Main conclusions (and II)

Climate projections for PdP

Projected mean regimes

- Increase in minimum and maximum temperatures
- Decrease in annual precipitation amounts

Projected annual trends

- Annual mean temperature trend: + 0.32 ºC/decade (2001-2050)
- Annual precipitation trend: -6.98 mm/decade (2001-2050)

Frequency in extreme events

- Decrease in the number of cold days and increase in the number of warm days
- Increase in the number of days without precipitation
- Decrease in the number of days with intense rainfall

PB2.8: "Projeccions de potencial turístic per al Sistema Integral Platja de Palma"