KLIMATSKI POTENCIJAL TURIZMA U HRVATSKOJ I UTJECAJ KLIMATSKIH PROMJENA

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Turistički klimatski indeks (TCI)

Mieczkowski, 1985: The tourism climatic index, a method of evaluating world climates for tourism

Meteorološki elementi

- temperatura
- vlaga
- oborina
- osunčavanje
- vjetar

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Klimatski indeks za turizam (CIT)

De Freitas et al, 2008: A second generation climate index for tourism (CIT) specification and verification

$$CIT = f\,[T, A, P]$$

Atmosferski aspekti:
T – toplinski osjet (energetska ravnoteža tijelo-atmosfera)
A – estetski (stanje neba)
P – fizički (oborina i jaki vjetar) (moguć prevladavajući efekt)

VAŽNO
CIT treba biti pokazatelj kvalitete klimatskih prilika za one turističke aktivnosti za koje je posebno konstruiran

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Toplinski osjet

Fiziološka ekvivalentna temperatura (PET) (Mayer and Höppe, 1987, Höppe, 1999) određena na temelju jednadžbe ravnoteže između tijela i okoline:
ekvivalentna temperaturi zraka pri kojoj bi se osoba koja sjedi u zatvorenom prostoru osjećala jednako kao u stvarnim vanjskim uvjetima.

Meteorološki parametri za računanje PET:

- temperatura zraka
- vlažnost (relativna vlažnost ili tlak vodene pare),
- brzina strujanja
- zračenje, ili naoblaka ako podaci zračenja nisu dostupni

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ASHRAE skala osjeta ugode

PET (°C)	Toplinski osjet
< 4	vrlo hladno
4–8	hladno
8–13	svježe
13–18	ugodno svježe
18–23	ugodno (neutralno)
23–29	ugodno toplo
29–35	toplo
35–41	vruće
> 41	vrlo vruće

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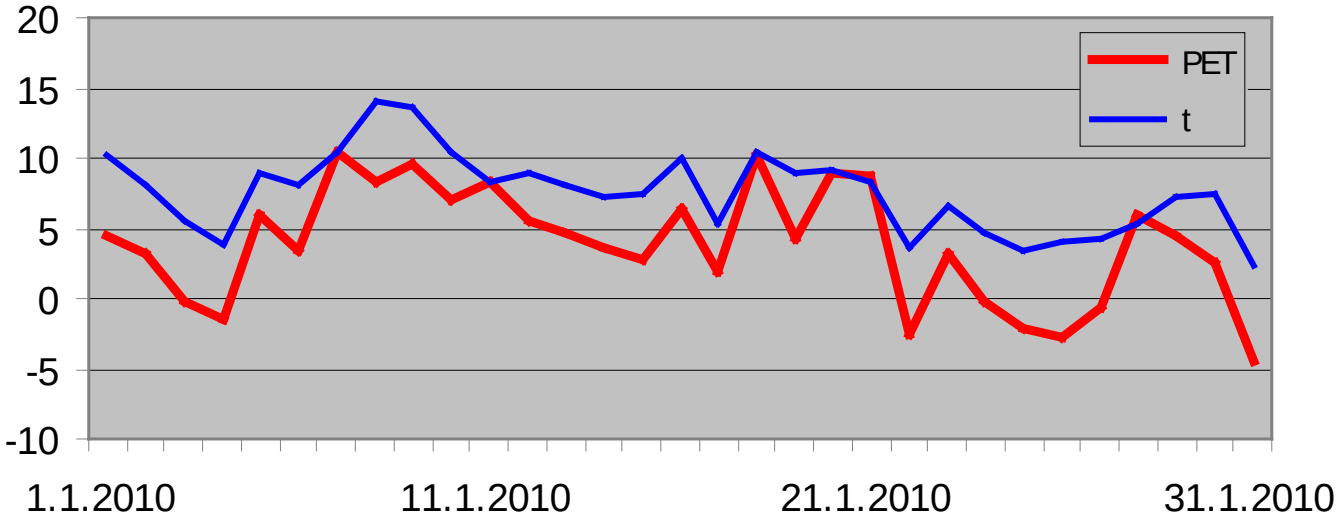
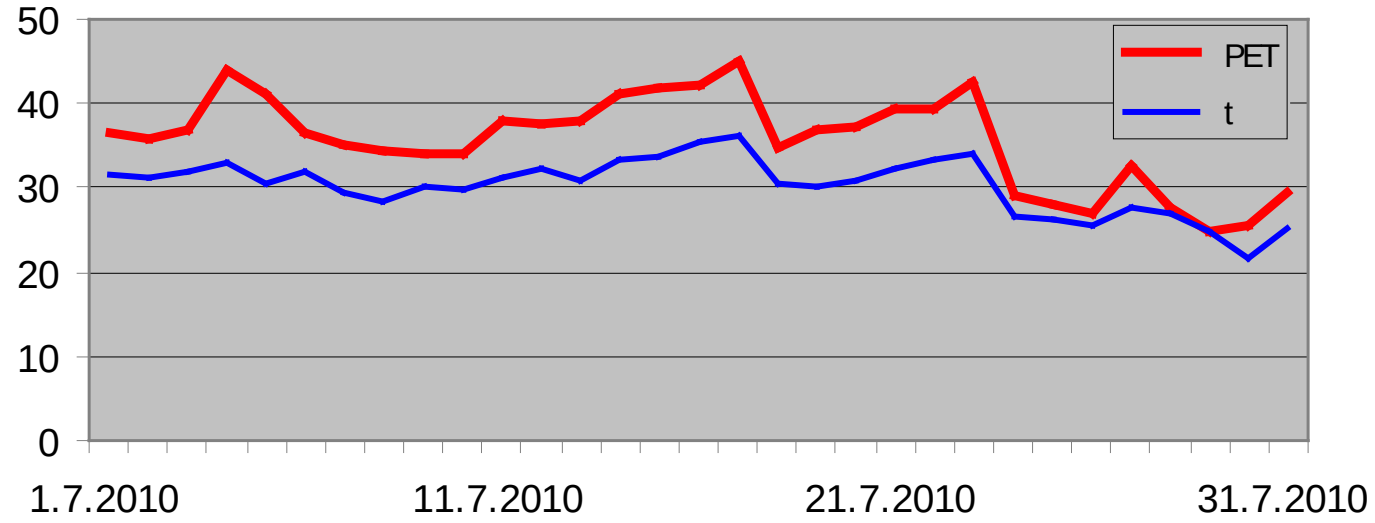
Mali Lošinj

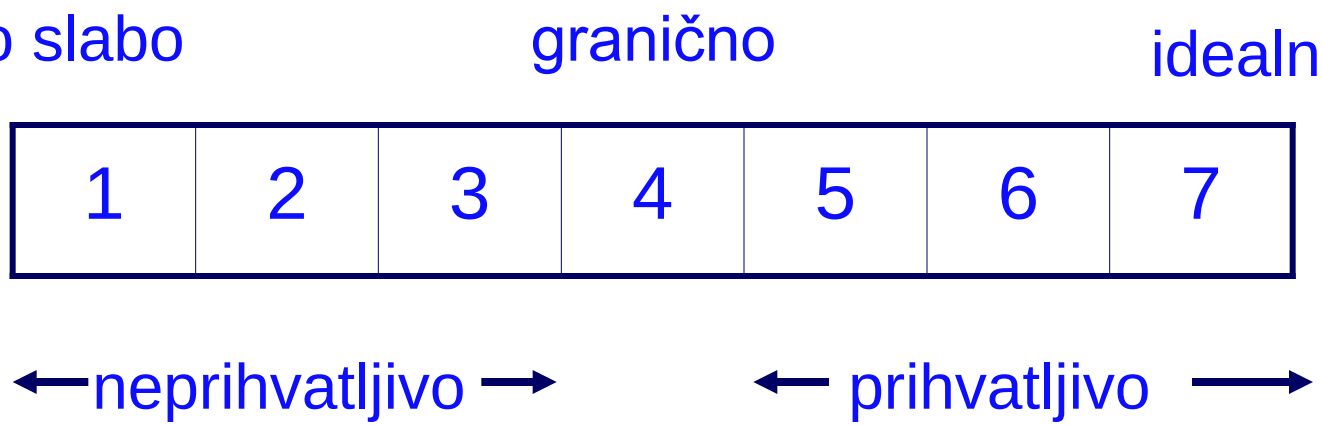
ZIMA



LJETO



Toplinsko (T) i estetsko (A) stanje se kombiniraju u vremensku tipološku matricu i tvore klasifikaciju s klasama od 1 do 7.



Ako su premašene granične vrijednosti bilo kojeg od fizičkih aspekata (vjetar i oborina), tada fizička komponenta P poništava T i A.

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Anketa među turistima o meteorološkim uvjetima za piknik na otvorenom (beach tourism, 3S tourism – sun, sea, sand tourism)

N=331 (De Freitas et al, 2008)

Najbolji uvjeti za boravak na otvorenom

Toplinski osjet

- ugodno toplo i toplo CIT=6-7 idealno
- ugodno i vruće CIT=4-5 prihvatljivo

Naoblaka - ≤4/10

Prevladavajući efekti za nepovoljne uvjete (CIT 1-2):

- oborina – dulje od 30 min
- vjetar – dulje trajanje brzine ≥6 m/s

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CIT za boravak na otvorenom
(3S tourism sun, sea, sand; beach tourism, piknik)

Toplinski osjet	Naoblaka (≤4/10)	Naoblaka (≥5/10)	Oborina (> 3mm)	Vjetar (≥6 m/s)
vrlo vruće				
vruće				
toplo				
ugodno toplo				
ugodno				
ugodno svježe				
svježe				
hladno				
vrlo hladno				

Ocjena	1	2	3	4	5	6	7

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Bafaluy D., Amengual A., Romero R., Homar V., 2014: Present and future climate resources for various types of tourism in the Bay of Palma, Spain, Reg Environ Change (2014)14:1995–2006

Procjena skupa vremenskih pragova (toplinskih, estetskih i fizičkih aspekata) za različite vrste turizma - aktivnosti su podijeljene u dvije skupine, ovisno o tome da li je za njih potrebna neka oprema.

1. grupa – biciklizam, golf, nautički sportovi
   konzultirani su stručnjaci i oni koji se njima bave
2. grupa – kulturni turizam, nogomet i pješačenje
   mnogo je teže odrediti pragove za povoljne prilike i moguće prevladavajuće meteorološke uvjete – dogovor s ekspertima i korisnicima

Problem – dobro pripremljena anketa koja bi se provela na većem broju ispitanika omogućila bi mnogo pouzdanije rezultate (slično kao što je napravljeno za 3S turizam, de Freitas, 2008).

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Toplinski uvjeti

Izraženi kao toplinski osjet od vrlo vrućeg do vrlo hladnog (ASHRAE skala sa devet klasa) (**ASHRAE** - American Society of Heating, Refrigerating and Air-Conditioning Engineers

Naoblaka

$\leq$ 4/10 i $\geq$ 5/10 (za sve vrste turizma)

Oborina

3 mm (3S)
5 mm (kulturni, pješačenje)
10 mm (biciklizam, nogomet, golf)
20 mm (plovidba, jedrenje)

Vjetar

4 m/s (golf)
6 m/s (3S)
8 m/s (biciklizam, nogomet)
10 m/s (kulturni, planinarenje)
15 m/s (plovidba)
5 -15 m/s (jedrenje)

3S

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

nogomet

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

plovidba

Thermal perception	Cloudiness (≤4/10)	Cloudiness (≥5/10)	Rain (>20 mm)	Wind (≥15 m/s)
very hot				
hot				
warm				
sligh. warm				
comfortable				
sligh. cool				
cool				
cold				
very cold				

biciklizam

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

golf

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

jedrenje

Thermal perception	Cloudiness (≤4/10)	Cloudiness (≥5/10)	Rain (>20 mm)	Wind 5 or≥15 r
very hot				
hot				
warm				
sligh. warm				
comfortable				
sligh. cool				
cool				
cold				
very cold				

kulturni i pješačenje

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

1	2	3	4	5	6	7
neprihvatljivo			prihvatljivo			idealno

Bafaluy D., Amengual A., Romero R., Homar V., 2014: Present and future climate resources for various types of tourism in the Bay of Palma, Spain, *Reg Environ Change* (2014) 14:1995–200

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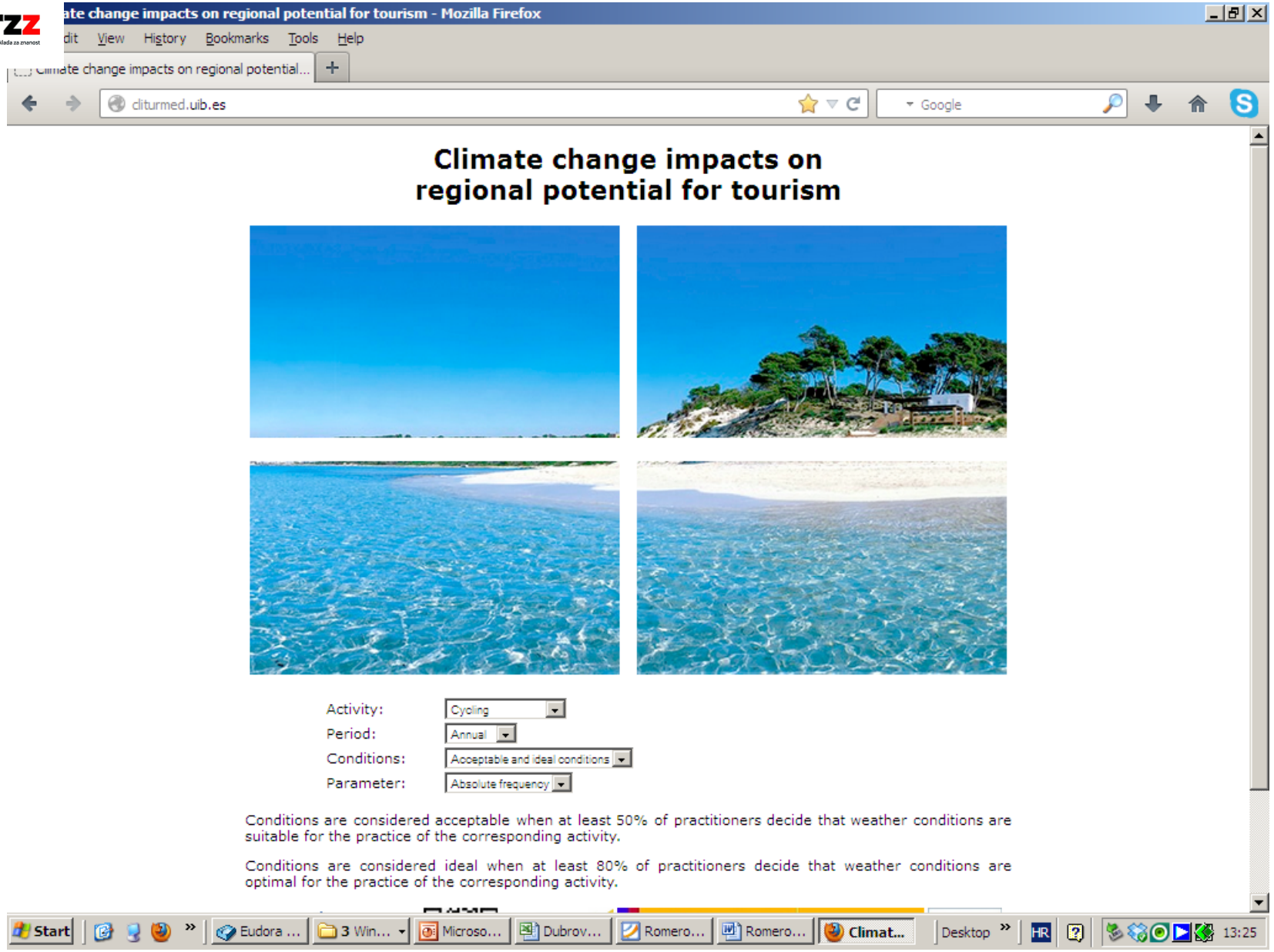

http://cliturmed.uib.es/

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imate change impacts on regional potential for tourism - Mozilla Firefox

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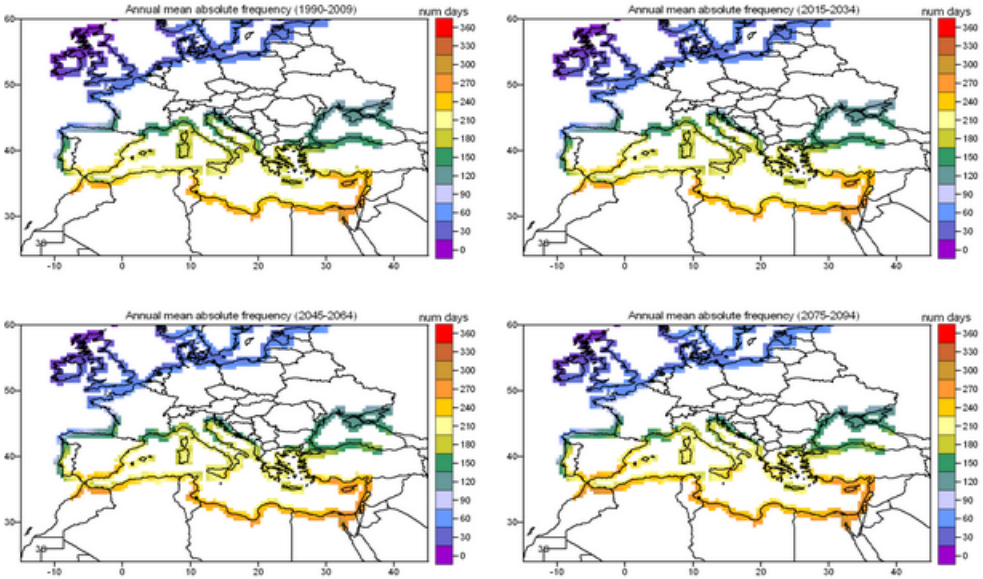
Climate change impacts on regional potential for tourism



Activity: Sun, sea and sand

Period: Annual

Conditions: Acceptable and ideal conditions

Parameter: Absolute frequency

Conditions are considered acceptable when at least 50% of practitioners decide that weather conditions are suitable for the practice of the corresponding activity.

Conditions are considered ideal when at least 80% of practitioners decide that weather conditions are optimal for the practice of the corresponding activity.

Start | Eudora ... | 3 Win... | Microso... | Dubrov... | Romero... | Romero... | 2 Firef... | Desktop | HR | 13:11

3S TURIZAM ljeto

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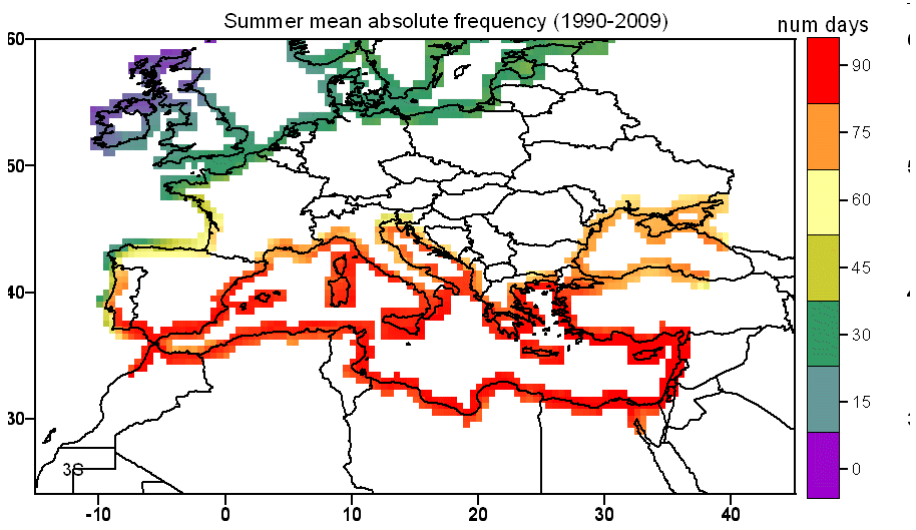
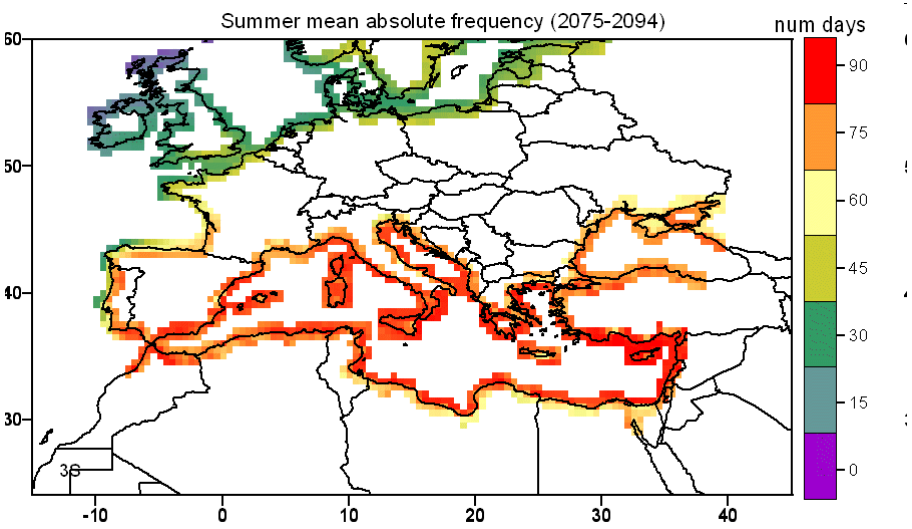
1990-2009



2075-2094

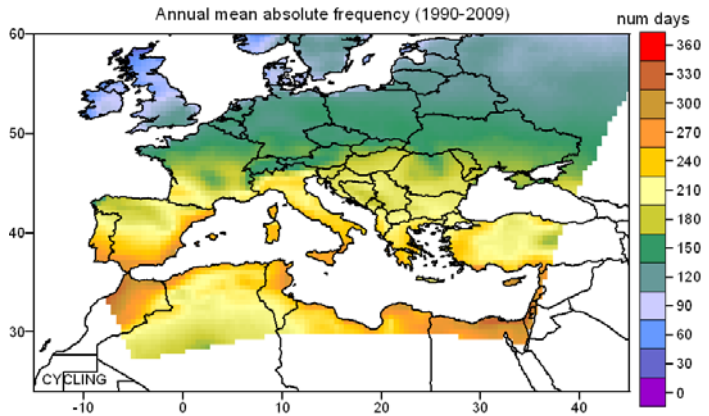


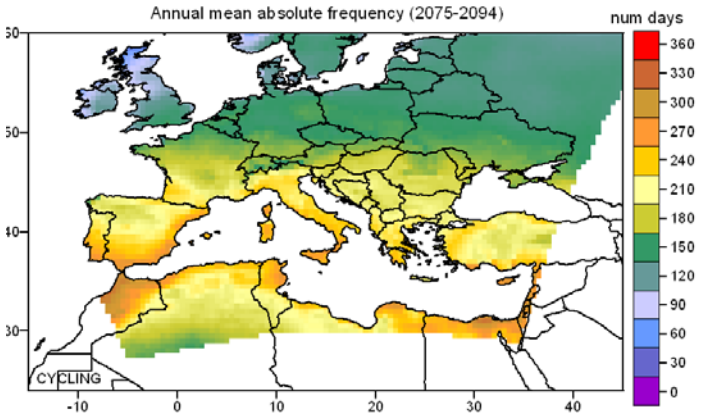
BICIKLIZAM

1990-2009

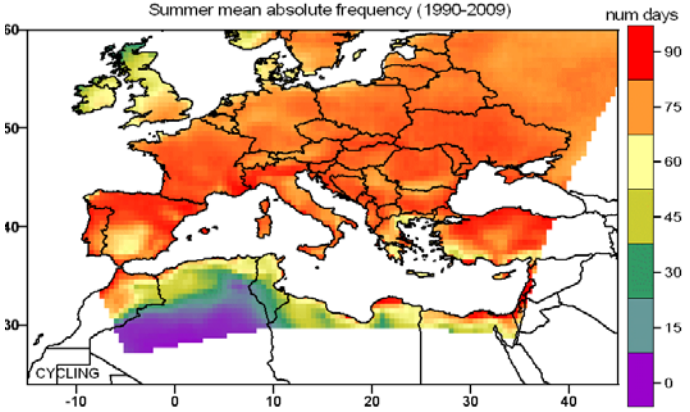
2075-2094

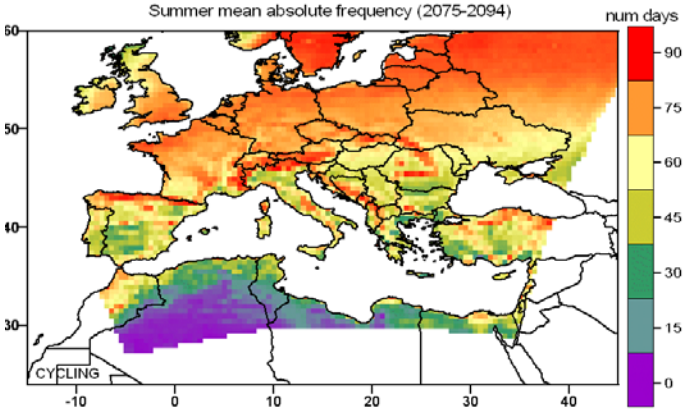
godina





ljeto





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CIT za različite turističke aktivnosti u Hrvatskoj

Data: 6 meteoroloških postaja u različitim klimama

Metoda: Učestalost pogodnosti klimatskih prilika za turizam tijekom godine

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Biciklizam (14 h)

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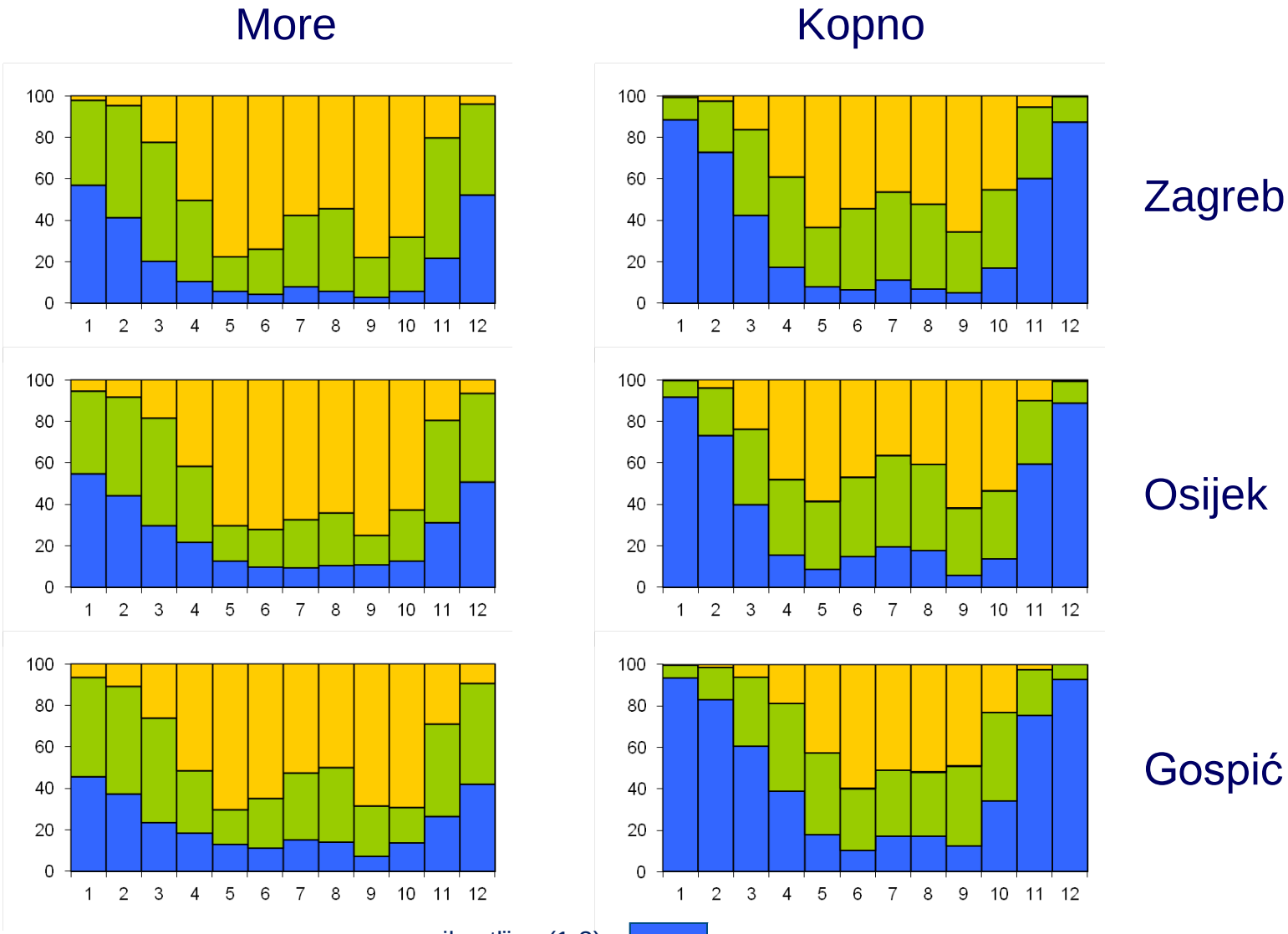
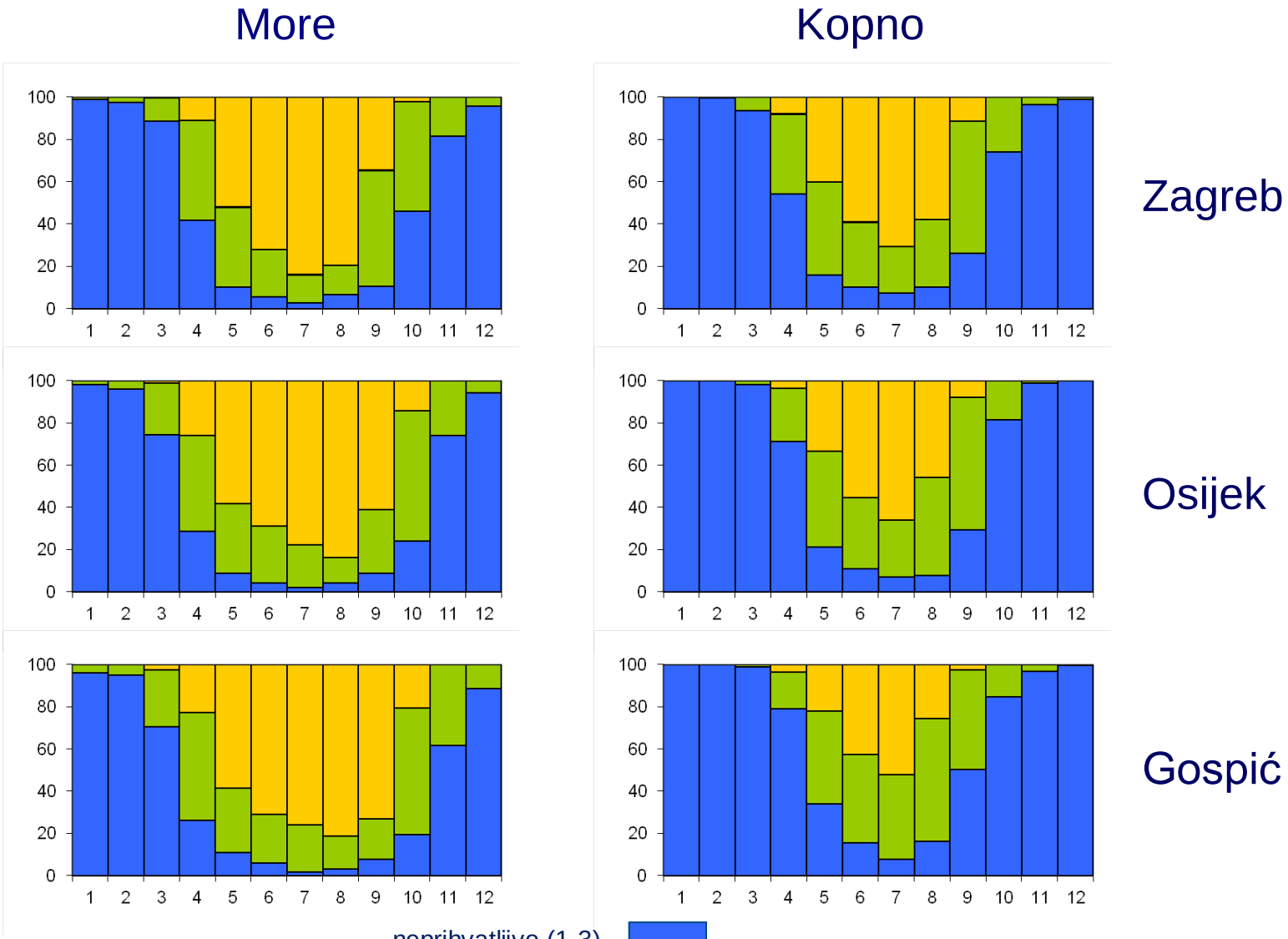


neprihvatljivo (1-3)
prihvatljivo (4-5)
idealno (6-7)

Biciklizam (7 h)



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Modeliranje klimatskih promjena

Ansambl pet simulacija klime iz baze podataka CORDEX projekta

Regionalni klimatski model (RCM) **SMHI-RCA4** je forsiran pomoću pet CMIP5 globalnih circulacijskih modela atmosfera-ocean (GCM) **HadGEM-ES, CNRM-CM5, EC-EARTH, IPSL-CM5a-MR i MPI-ESM-LR**

Horizontalna rezolucija 12.5 km
Domena pokriva gotovo čitavu Europu
Korišteni su podaci polja za 12 UTC

Prilagodba za 3 razdoblja
P0: 1971-2000
P1: 2011-2040
P2: 2041-2070

← Scenariji emisije: IPCC RCP4.5 i RCP8.5

CIT – srednjak ansambla 5 simulacija

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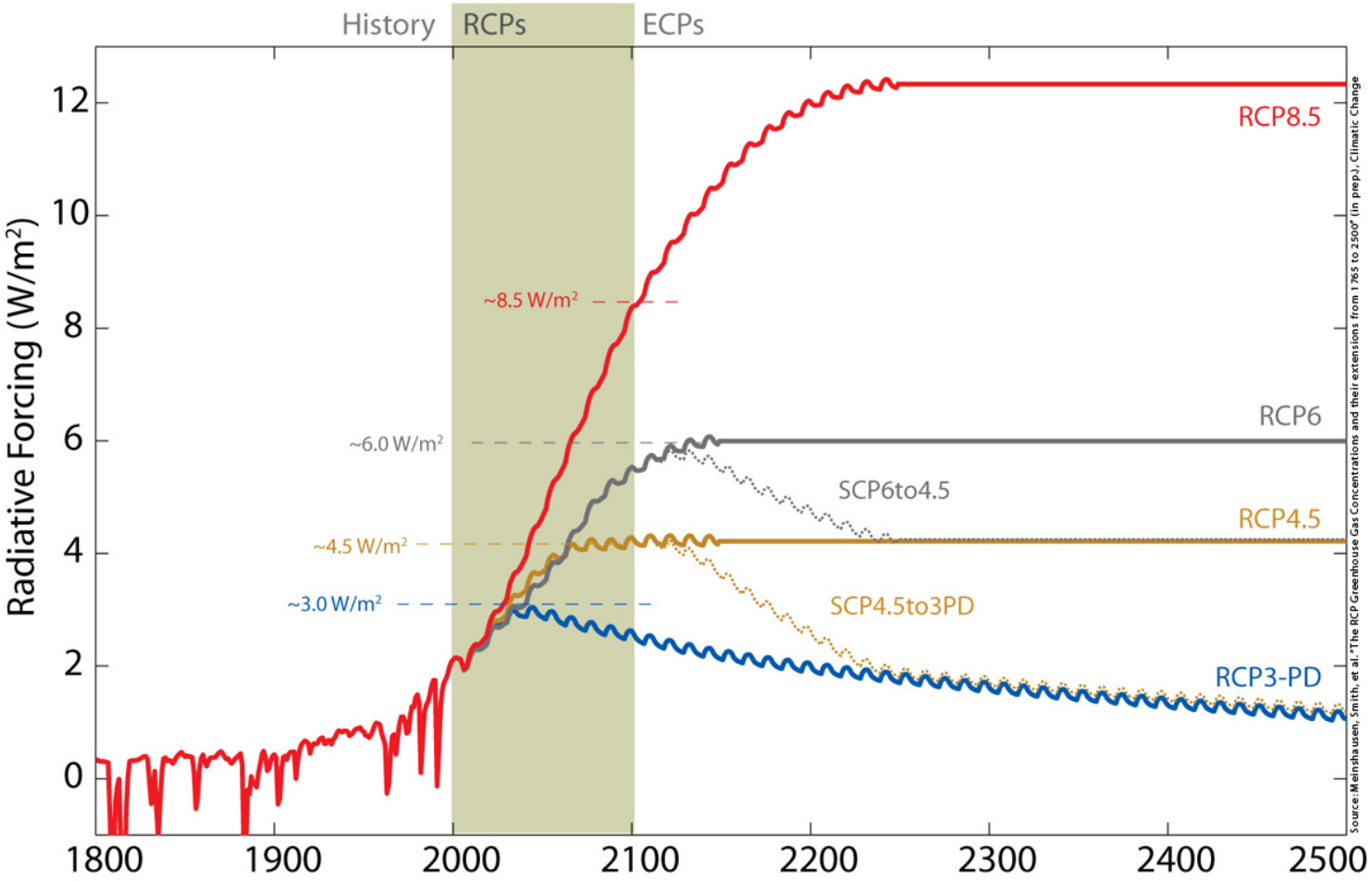

http://www.pik-potsdam.de/~mmalte/rcps/

RCP 4.5 – srednje niska emisija stakleničkih plinova

RCP 8.5 – visoka emisija stakleničkih plinova

Pješačenje u **realnoj** sadašnjoj klimi (14 h)

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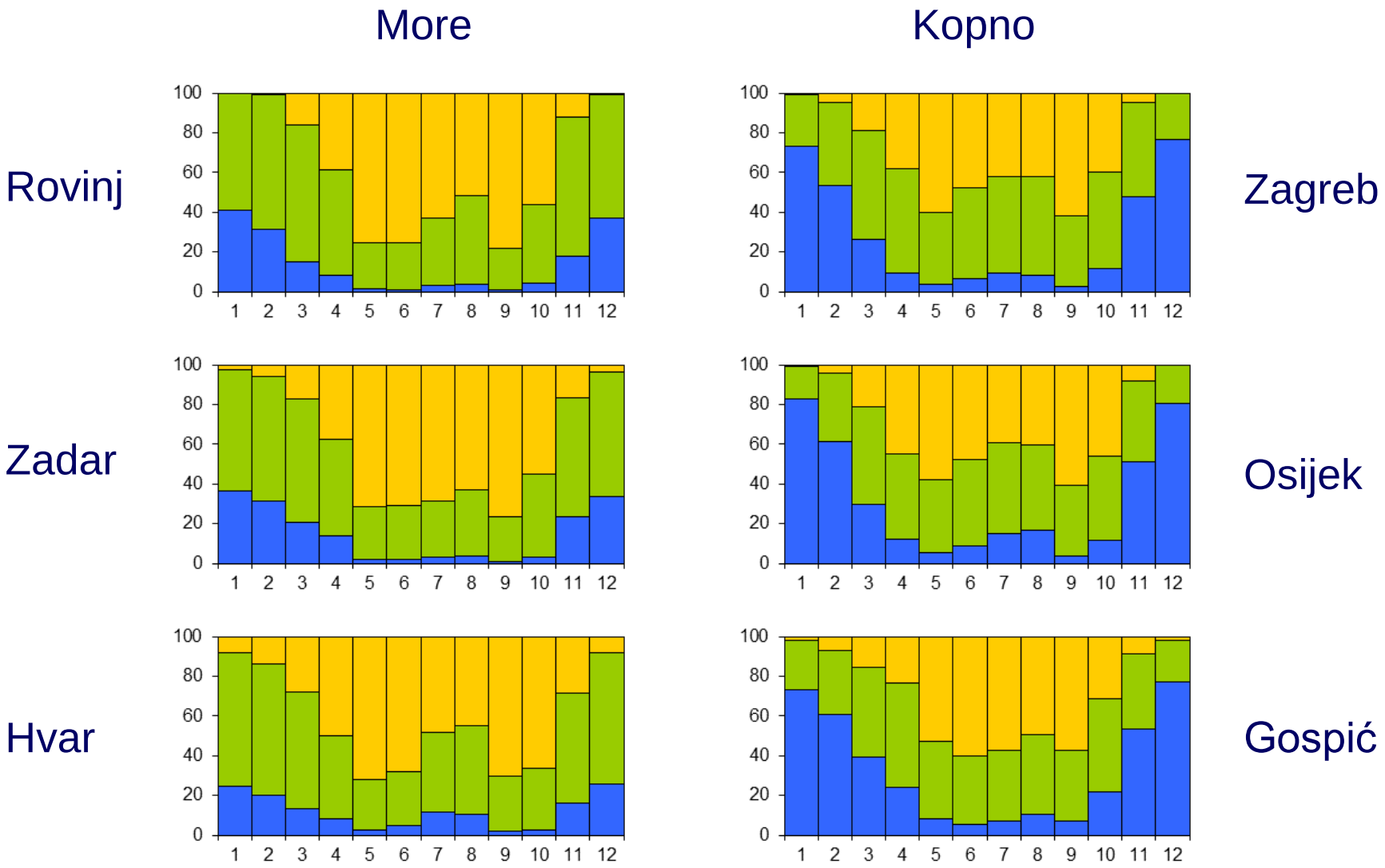

Pješačenje u **simuliranoj** sadašnjoj klimi (12 UTC, 13h)

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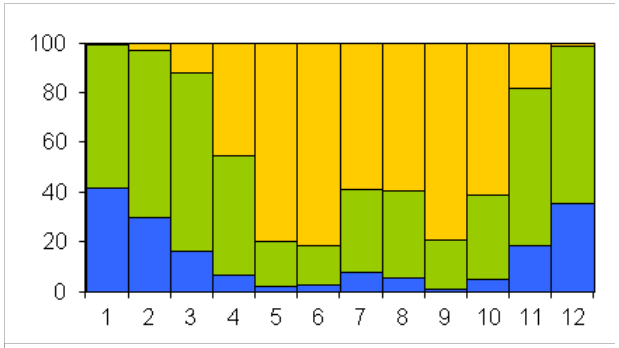
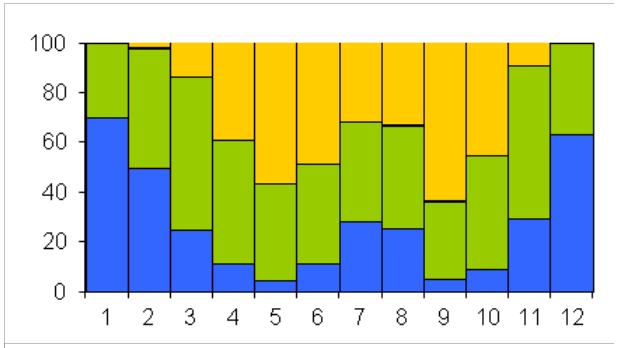
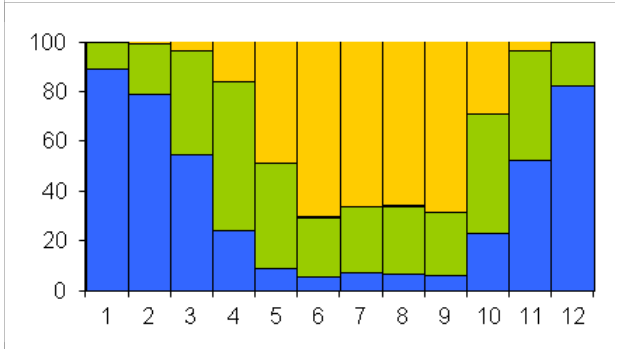
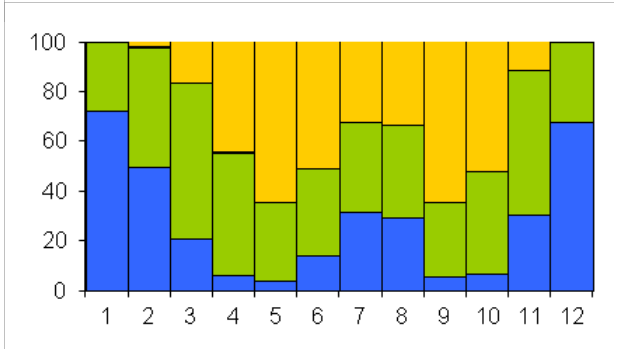
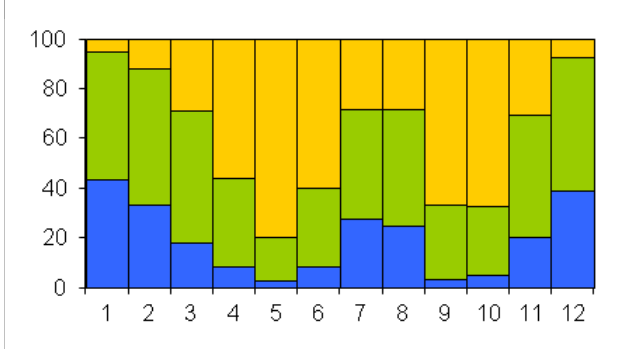
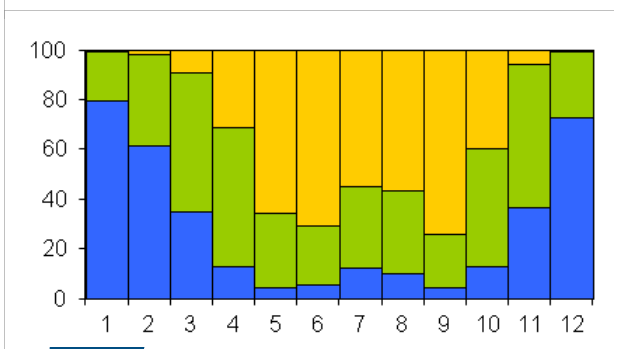
	More	Kopno	
Rovinj			Zagreb
Zadar			Osijek
Hvar			Gospić

neprihvatljivo (1-3)
prihvatljivo (4-5)
idealno (6-7)

Pješačenje 2011-2040 za RCP 4.5

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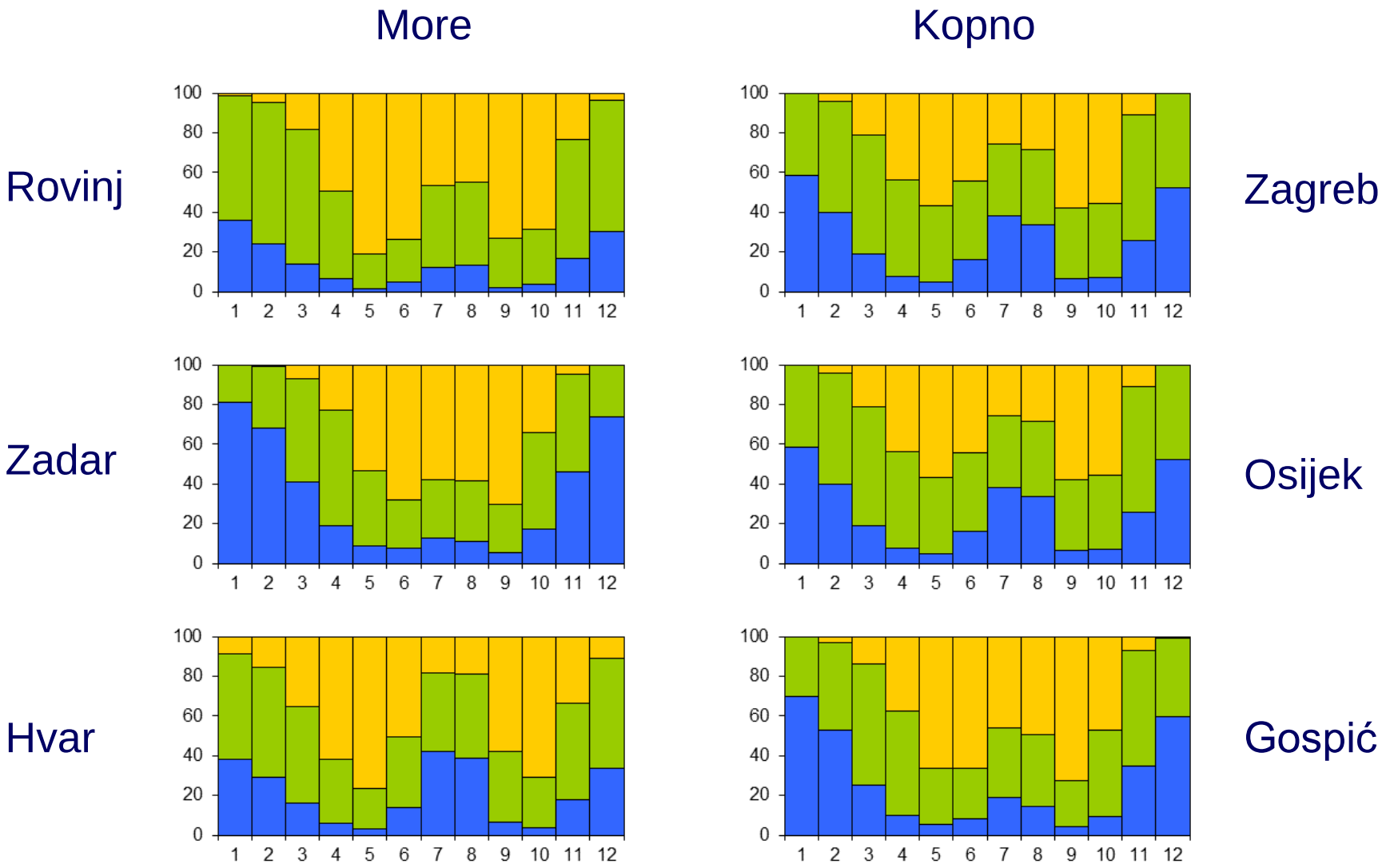

Pješačenje 2041-2070 za RCP 4.5

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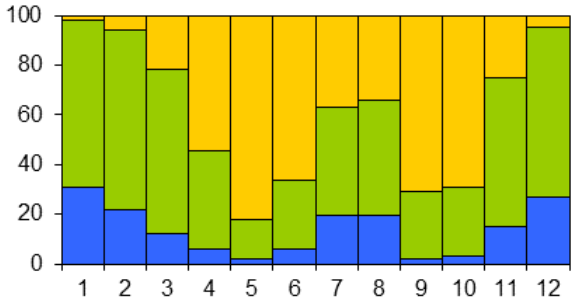
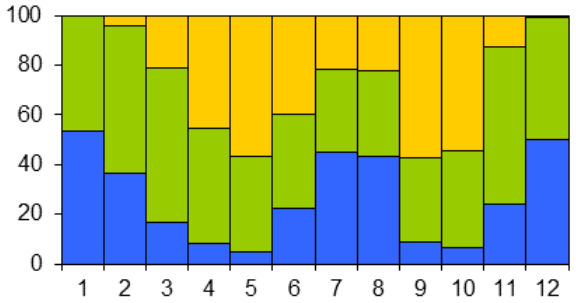
Kopno

More

Rovinj



Zagreb



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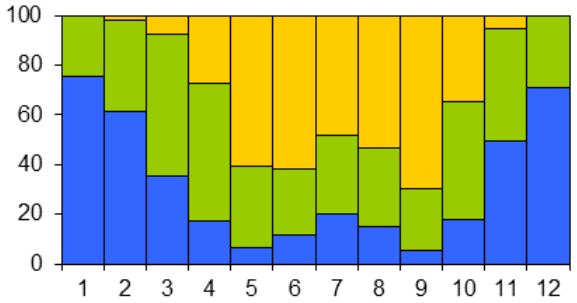
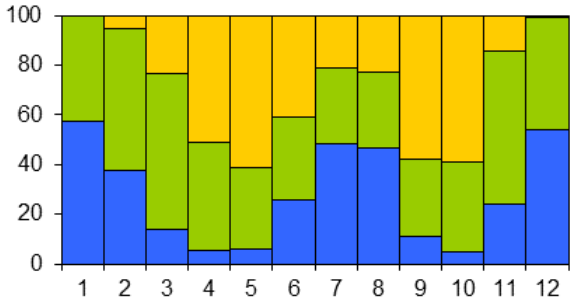
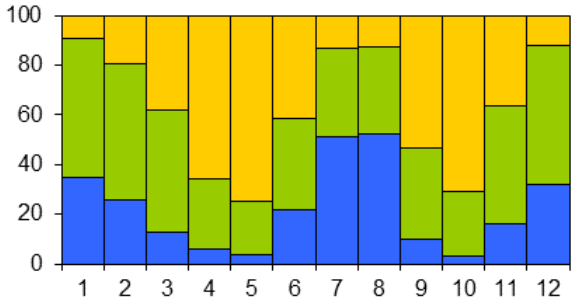


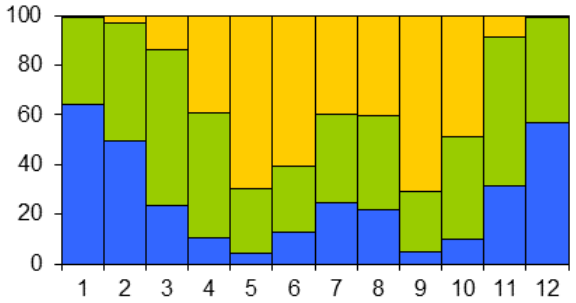
Osijek



Hvar



Gospić



neprihvatljivo (1-3)
prihvatljivo (4-5)
idealno (6-7)

Pješačenje 2011-2040 za RCP 8.5

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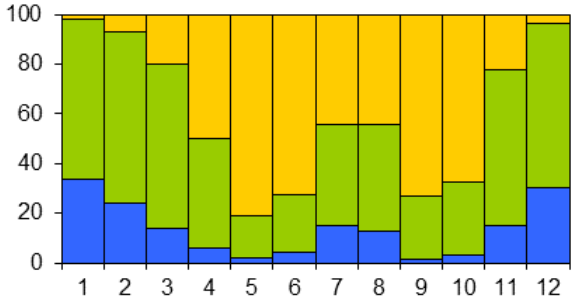
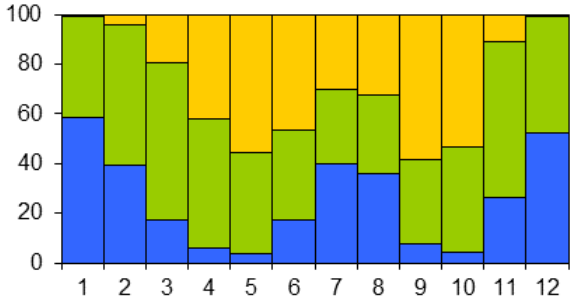
More

Kopno

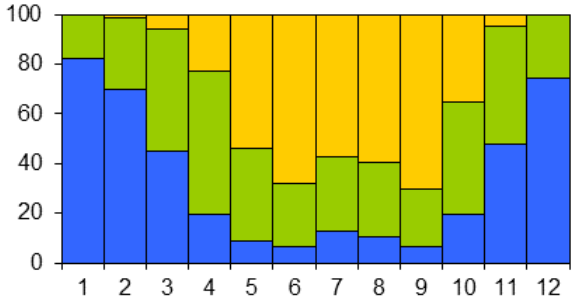
Rovinj



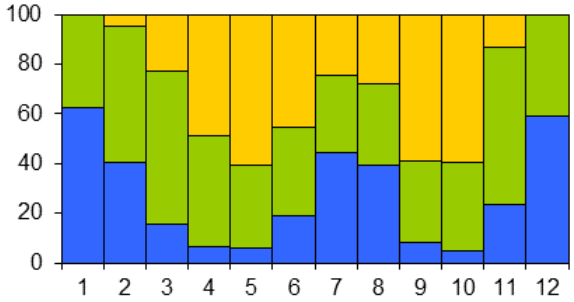
Zagreb



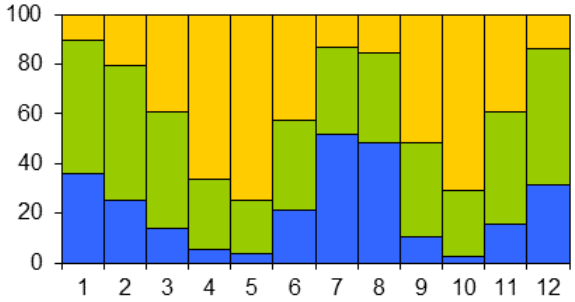
Zadar



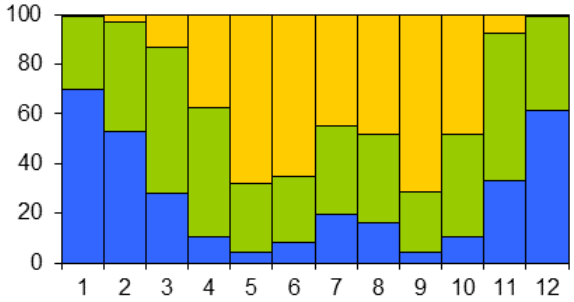
Osijek



Hvar



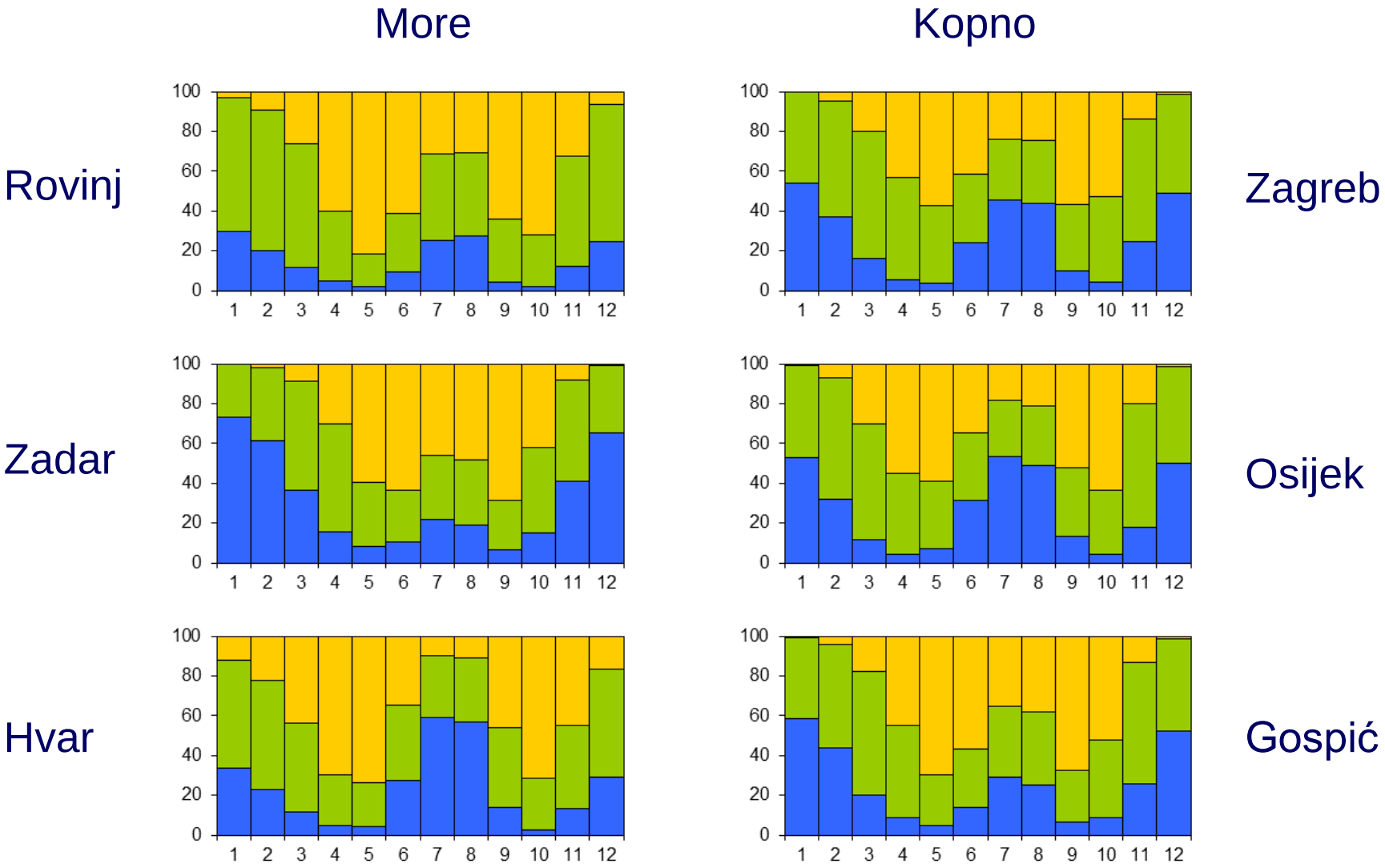
Gospić



neprihvatljivo (1-3)
prihvatljivo (4-5)
idealno (6-7)

Pješačenje 2041-2070 za RCP 8.5

Ksenija Zaninović, Državni hidrometeorološki zavod



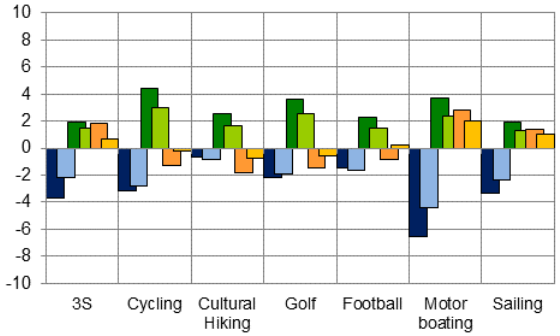
Razlike **godišnje** učestalosti CIT između buduće i sadašnje klime za **RCP 4.5**

Ksenija Zaninović, Državni hidrometeorološki zavod

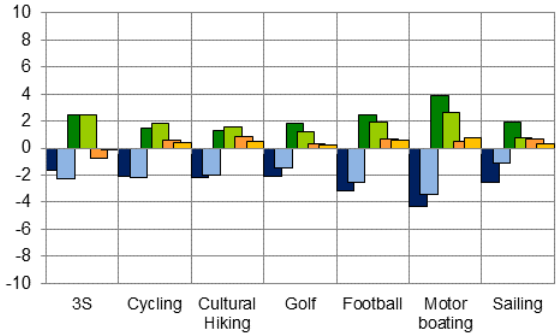
More

Kopno

Rovinj



Zagreb



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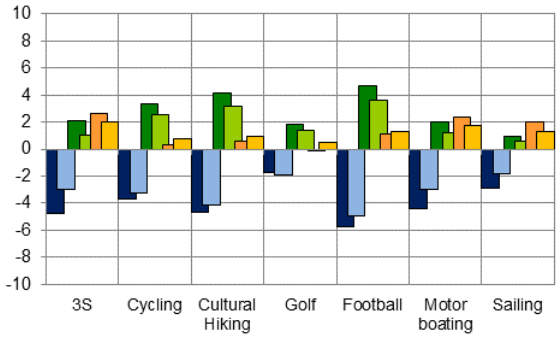

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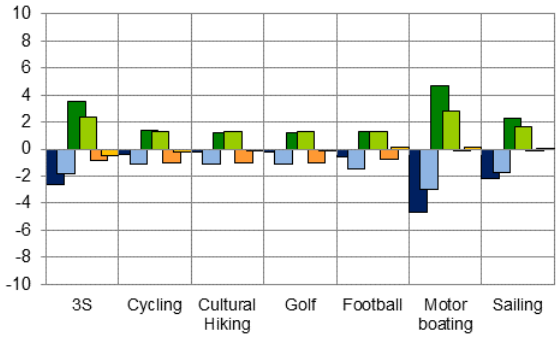
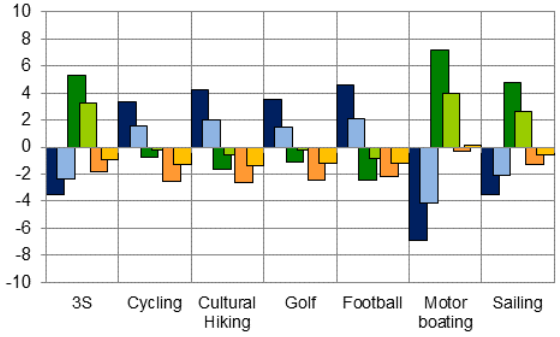
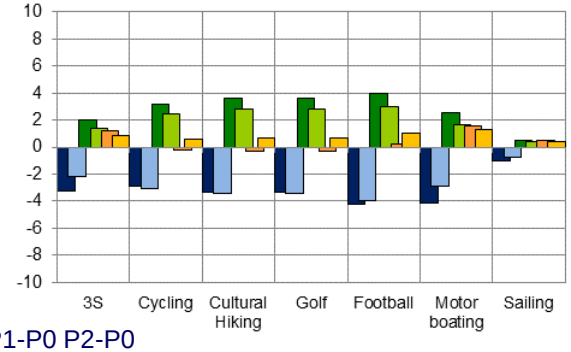


Hvar



Gospić



P1-P0 P2-P0

neprihvatljivo (1-3)
prihvatljivo (4-5)
idealno (6-7)

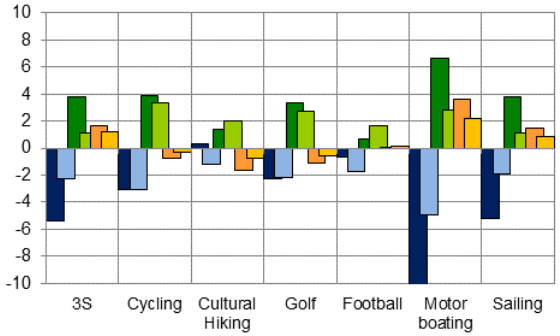
Razlike **godišnje** učestalosti CIT između buduće i sadašnje klime za **RCP 8.5**

Ksenija Zaninović, Državni hidrometeorološki zavod

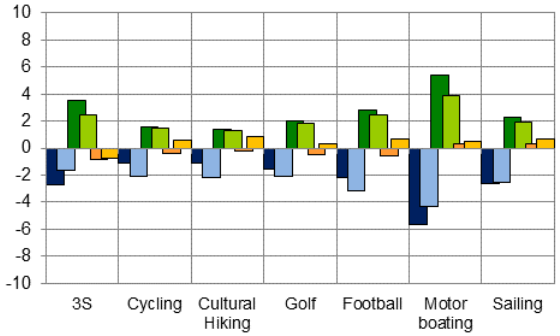
More

Kopno

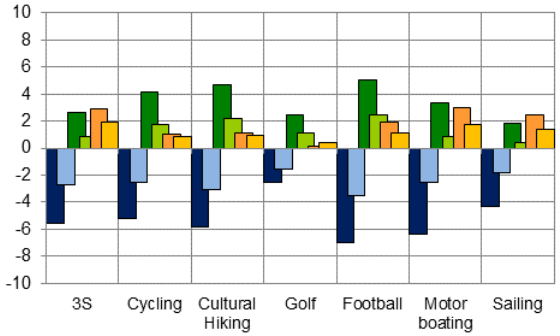
Rovinj



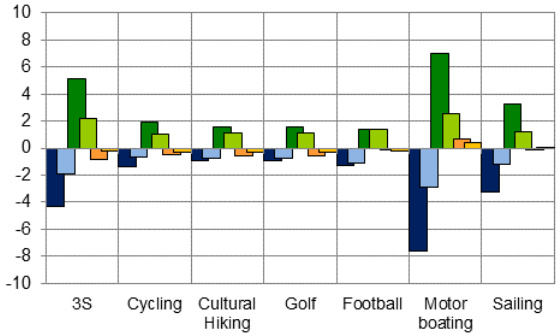
Zagreb



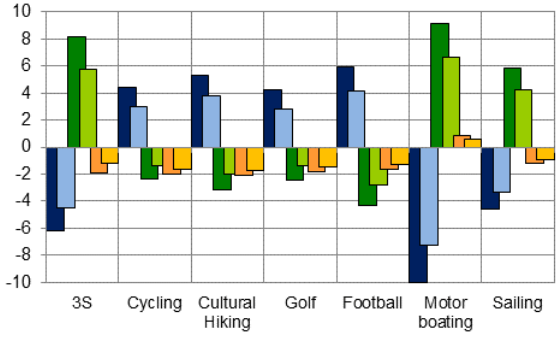
Zadar



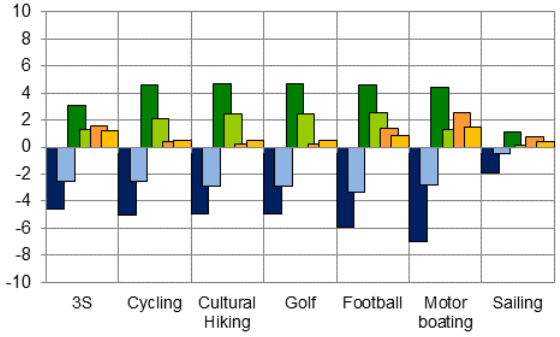
Osijek

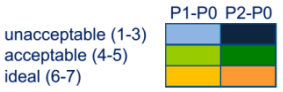


Hvar



Gospić





U realnoj klimi za 14h javlja se bimodalna razdioba CIT u svim dijelovima Hrvatske osim gorskih, s maksimumom idealnih uvjeta u proljeće i jesen za sve vrste rekreacije osim tipičnih ljetnih aktivnosti 3S, plovidba i jedrenje. To je izraženije na južnom Jadranu. Prema simuliranim podacima za 12 UTC (13h) bimodalna razdioba je izraženija nego u realnoj klimi, a neprihvatljivi uvjeti su češći.

U budućnosti bimodalna razdioba bit će izraženija, a pojavit će se i u planinskim dijelovima. To će biti izraženije za RCP 8.5 nego za RCP 4.5 te u daljoj budućnosti (2041-2070).

Ksenija Zaninović, Državni hidrometeorološki zavod

Razlike u razdiobi CIT između sadašnje i buduće klime za cijelu godinu pokajuzu smanjenje učestalosti neprihvatljivih uvjeta za sve aktivnosti u većem dijelu Hrvatske, a najveće su u planinskim dijelovima. Izuzetak je povećanje neprihvatljivih uvjeta za većinu aktivnosti na južnom Jadranu osim za ljetne aktivnosti (3S, plovidba i jedrenje). Najveće su razlike do za RCP 8.5 u razdoblju 2041-2070.

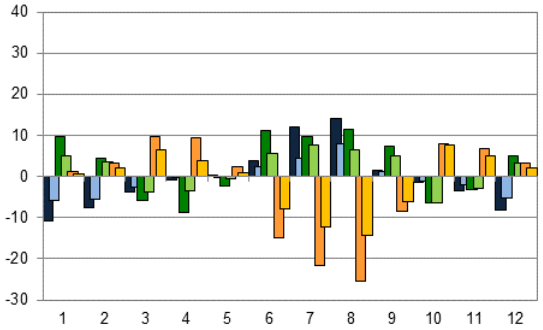
Razlike **mjesečne** učestalosti CIT za **pješačenje** Između buduće i sadašnje klime za **RCP 4.5**

Ksenija Zaninović, Državni hidrometeorološki zavod

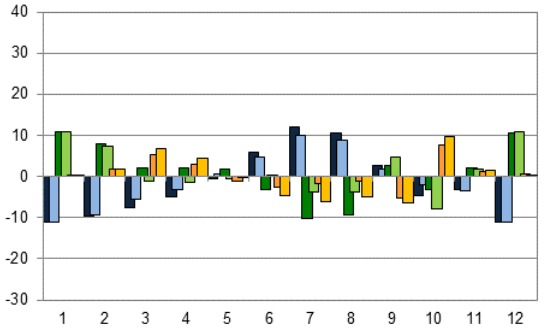
More

Kopno

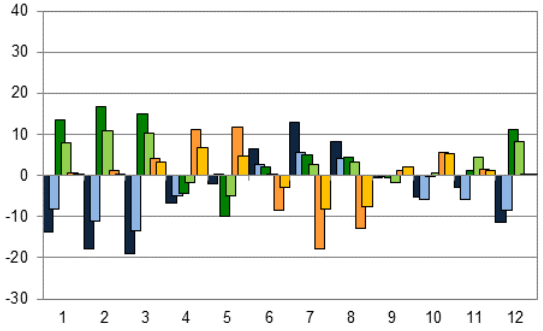
Rovinj



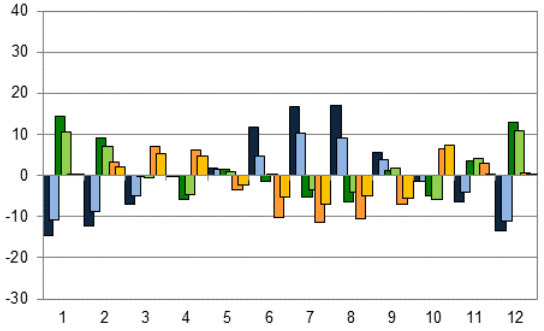
Zagreb



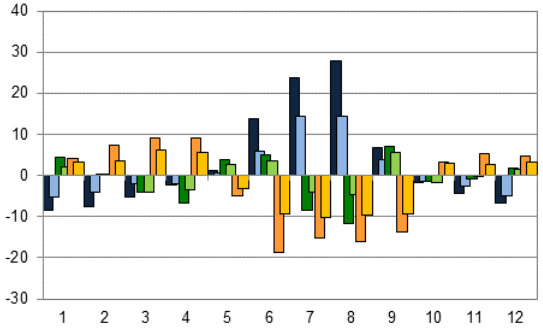
Zadar



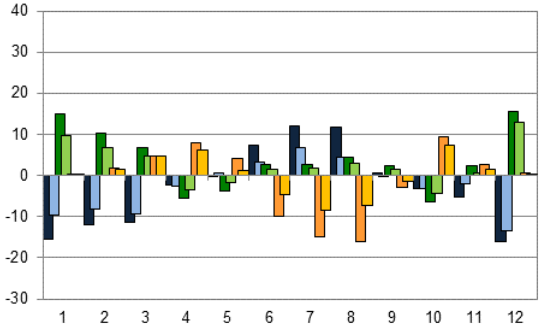
Osijek

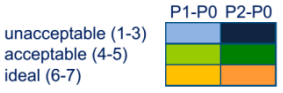


Hvar



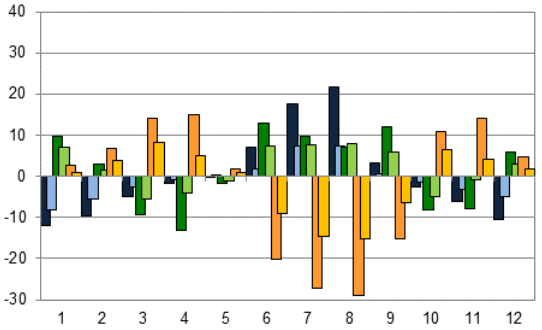
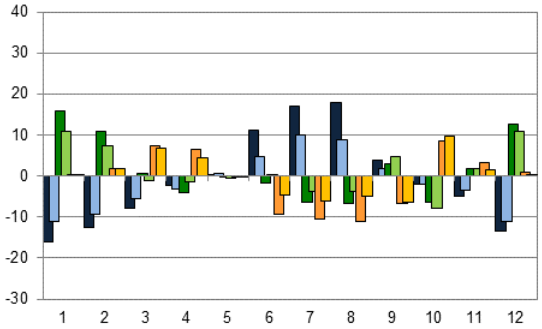
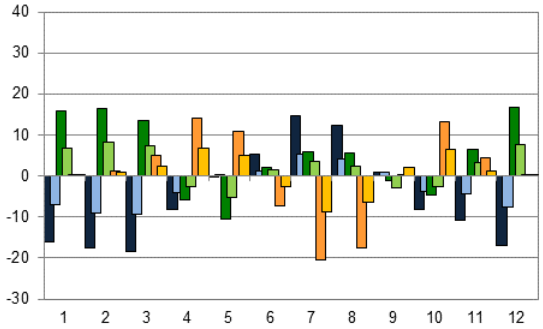
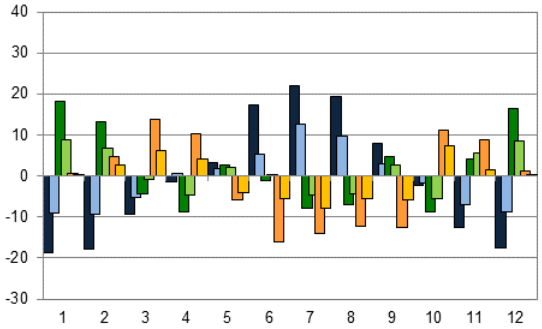
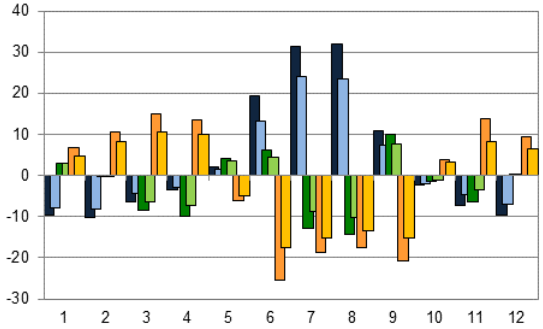
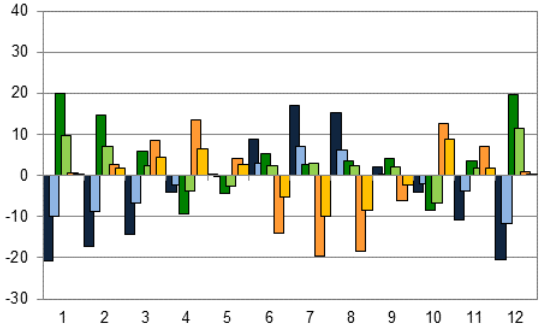
Gospić





Razlike **mjesečne** učestalosti CIT za **pješačenje** između buduće i sadašnje klime za **RCP 8.5**

Ksenija Zaninović, Državni hidrometeorološki zavod

	More	Kopno	
Rovinj			Zagreb
Zadar			Osijek
Hvar			Gospić

P1-P0 P2-P0

neprihvatljivo (1-3)
prihvatljivo (4-5)
idealno (6-7)

Ksenija Zaninović, Državni hidrometeorološki zavod

Analizirajući po mjesecima razlike su veće (u nekim slučajevima do 30%) a slični obrazac promjena javlja se u svim područjima. Ljeti se povećanje idealnih uvjeta javlja u budućim klimatskim razdobljima za 3S, plovidbu i jedrenje. Za ostale oblike rekreacije, klimatski uvjeti će se u budućnosti poboljšati u proljeće i jesen, ali će postati nepovoljniji ljeti. Međutim, iako to s jedne strane može uzrokovati nepovoljne posljedice na ljetni turizam, s druge strane može doprinijeti pomicanju i produljenju turističke sezone u proljeće i jesen.

CIT u 7h (06 UTC)

Ksenija Zaninović, Državni hidrometeorološki zavod

RegCM3 (ICTP, Trieste) je forsiran pomoću globalnog cirkulacijskog modela ECHAM5-MPIOM

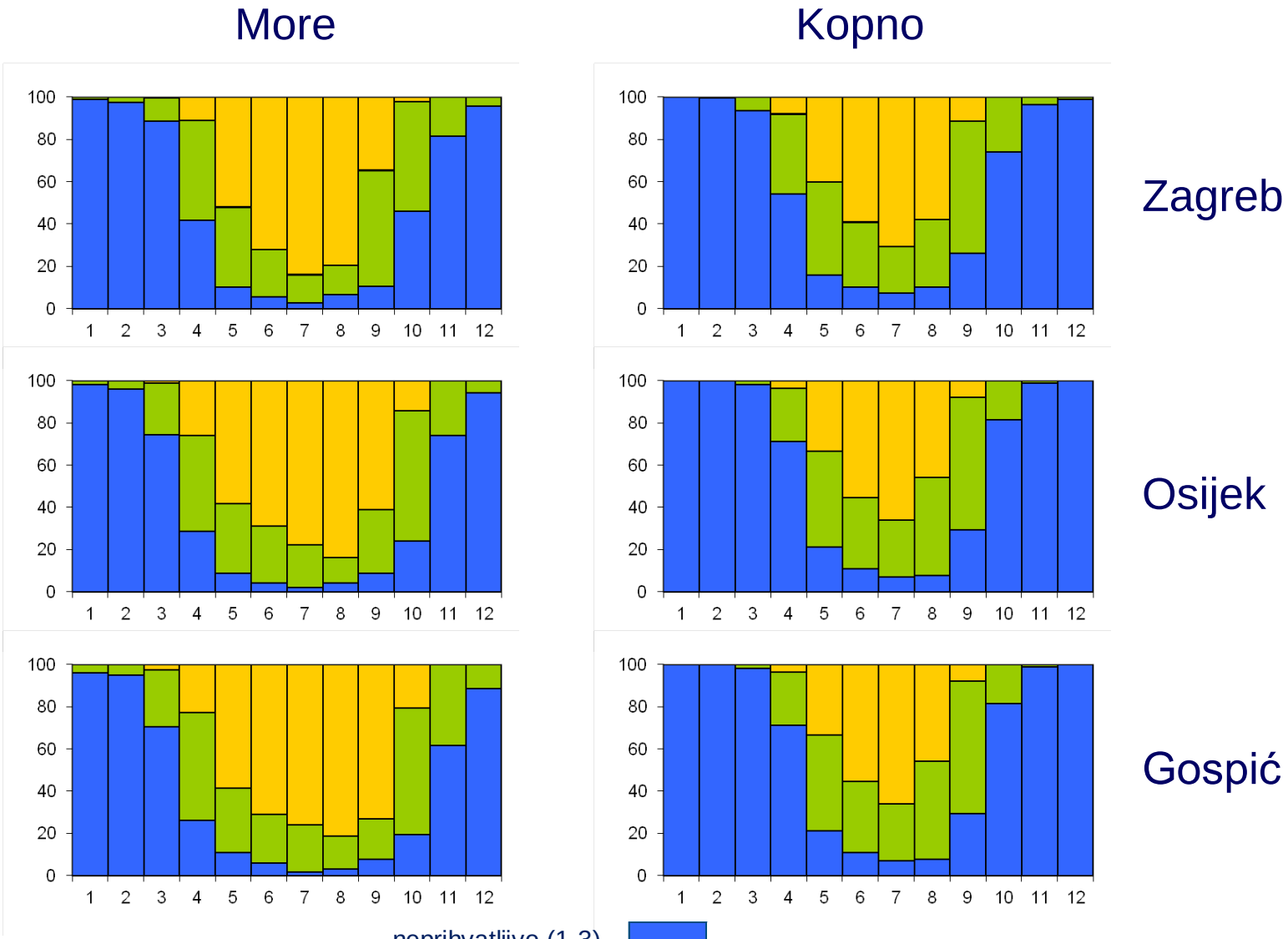
Horizontalna rezolucija 35 km

Prilagodba za 3 razdoblja
P0: 1961-1990
P1: 2011-2040
P2: 2041-2070

Scenarij emisije: IPCC SRES A2
(sličan RCP 8.5)

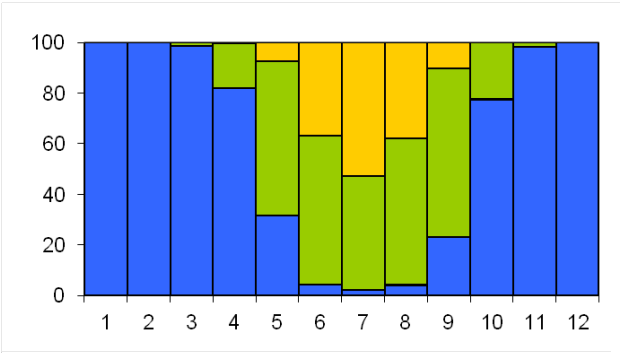
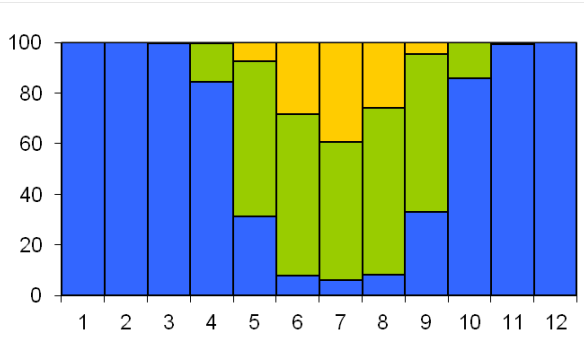
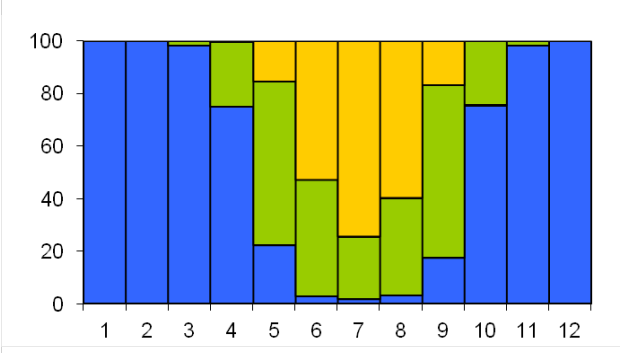
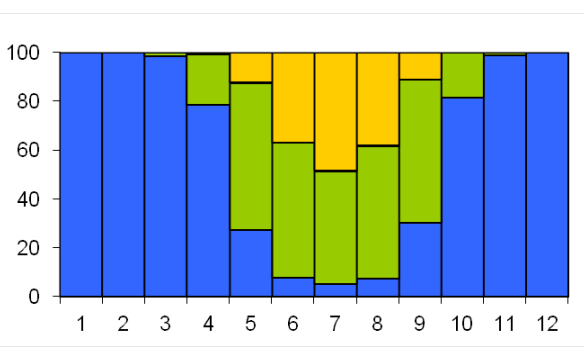
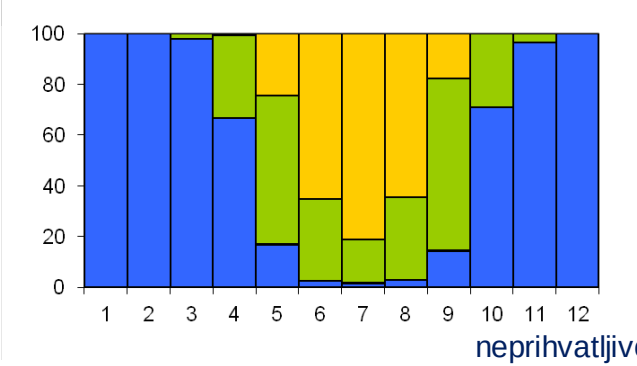
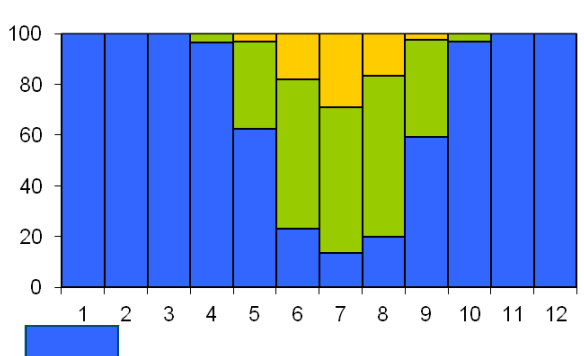
Biciklizam u **realnoj** sadašnjoj klimi (06 UTC, 07h)

Ksenija Zaninović, Državni hidrometeorološki zavod



Biciklizam u **simuliranoj** sadašnjoj klimi (06 UTC, 07h)

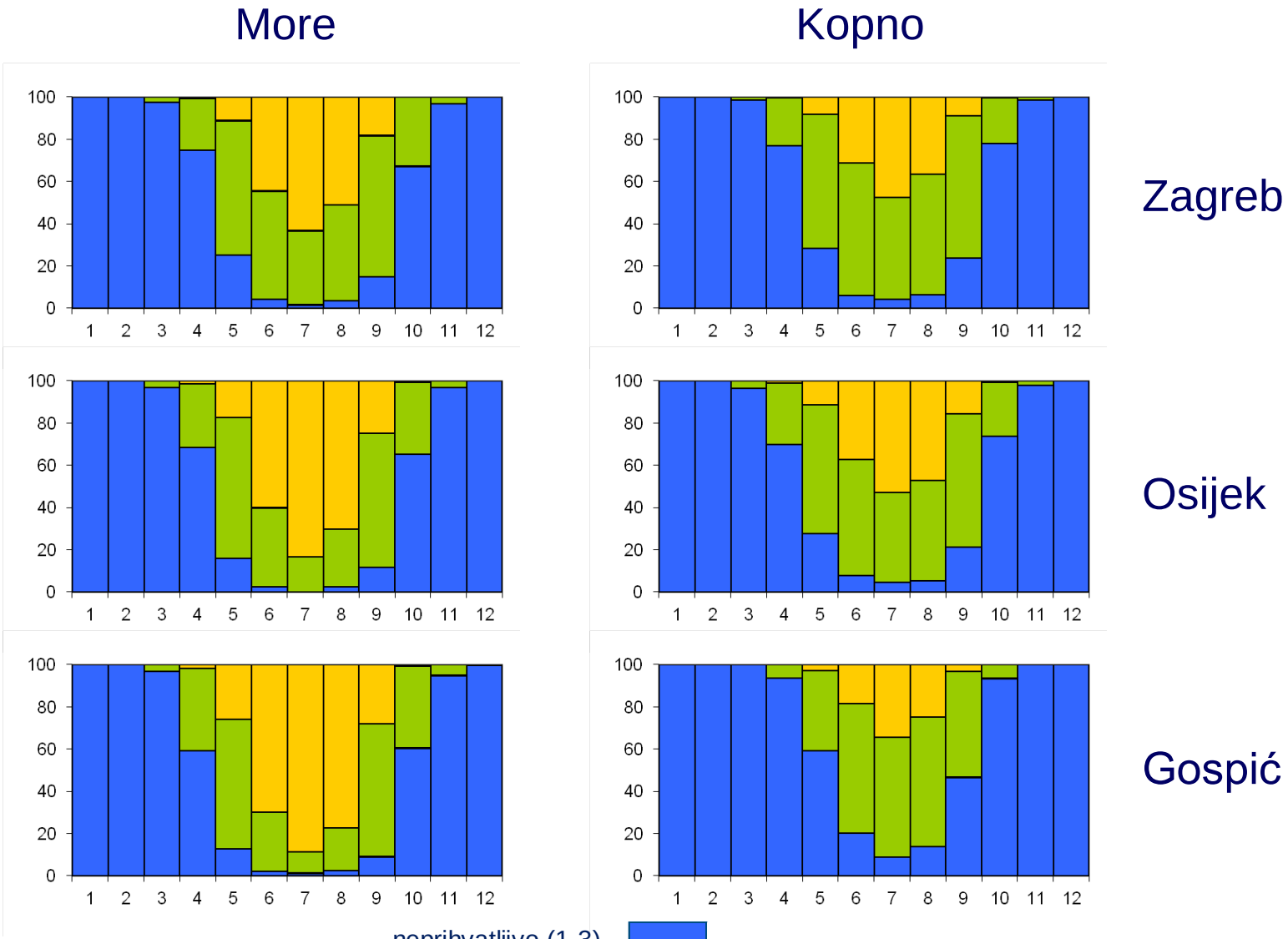
Ksenija Zaninović, Državni hidrometeorološki zavod

	More	Kopno	
Rovinj			Zagreb
Zadar			Osijek
Hvar			Gospić

neprihvatljivo (1-3)
prihvatljivo (4-5)
idealno (6-7)

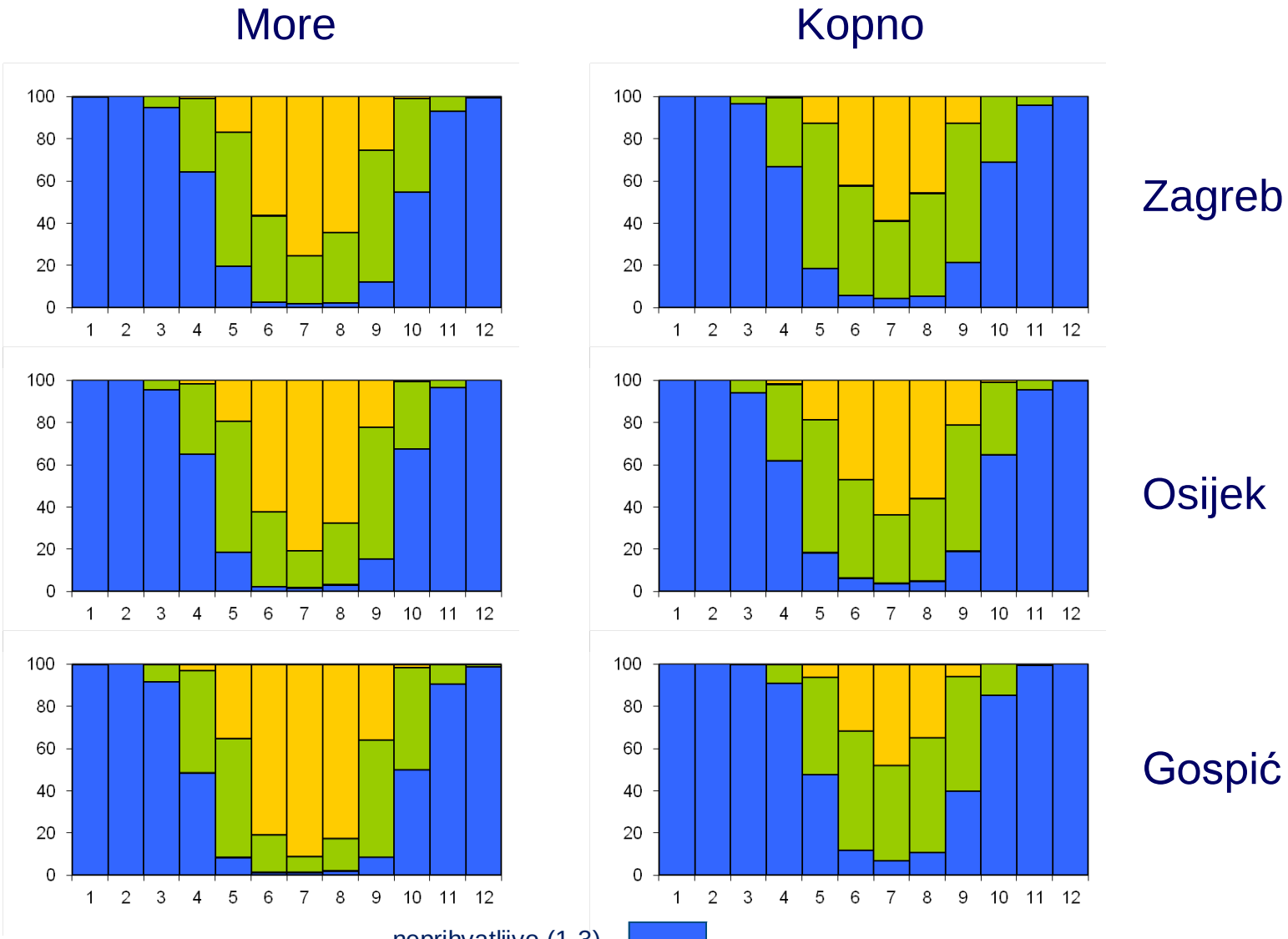
Biciklizam 2011-2040 (06 UTC, 07h)

Ksenija Zaninović, Državni hidrometeorološki zavod



Biciklizam 2041-2070 (06 UTC, 07h)

Ksenija Zaninović, Državni hidrometeorološki zavod



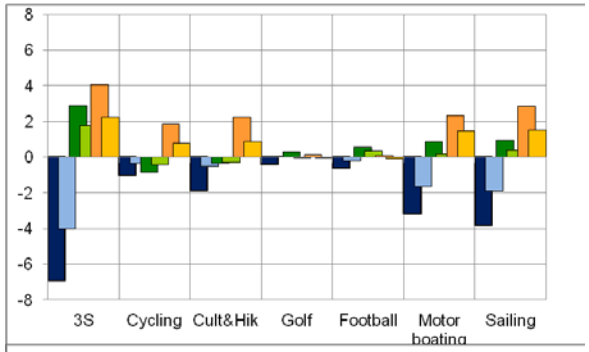
Razlike **godišnje** učestalosti CIT između buduće i sadašnje klime za različite aktivnosti (06 UTC, 7h)

Ksenija Zaninović, Državni hidrometeorološki zavod

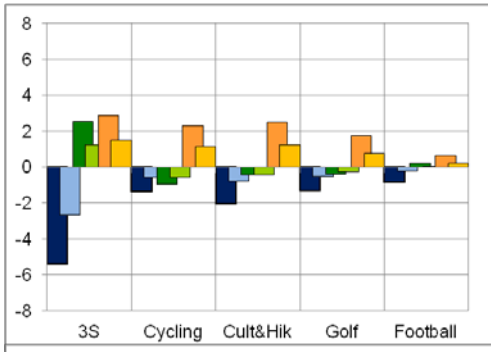
More

Kopno

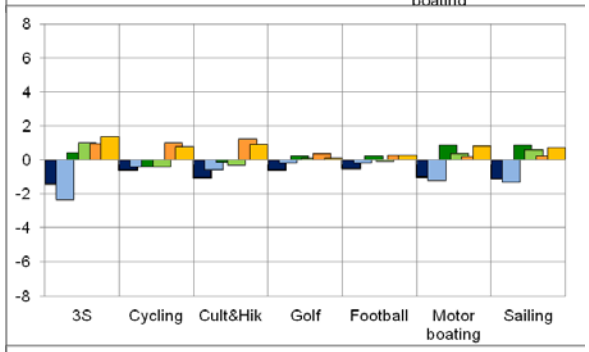
Rovinj



Zagreb

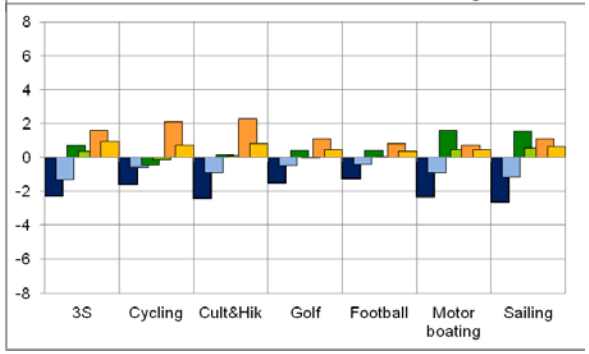


Zadar

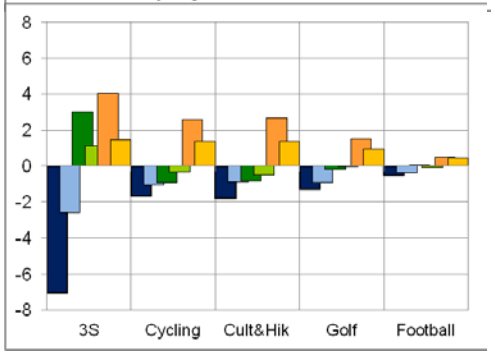


Osijek

Hvar



Gospić

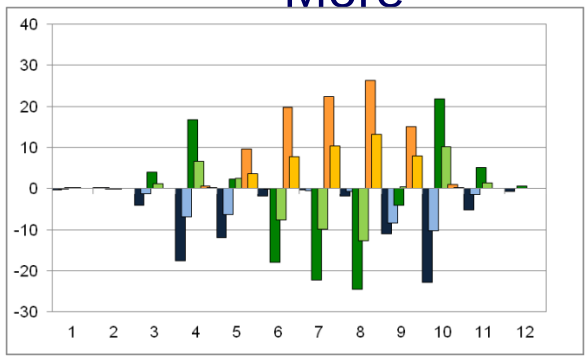
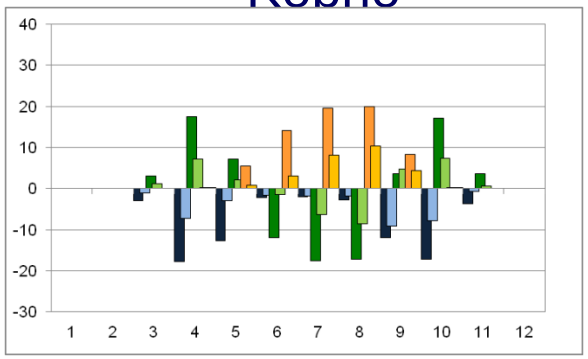
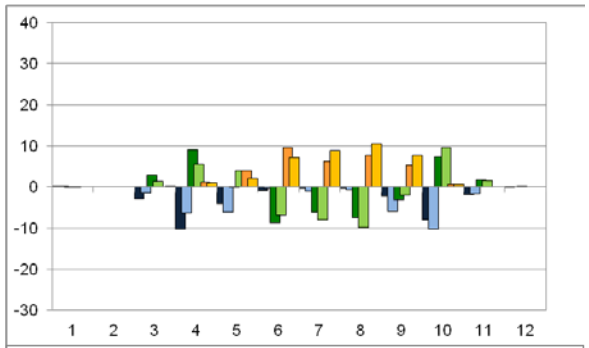
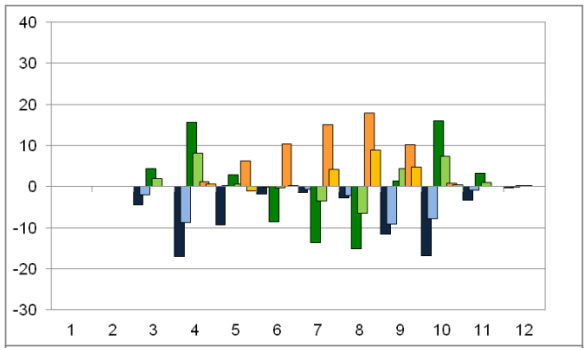
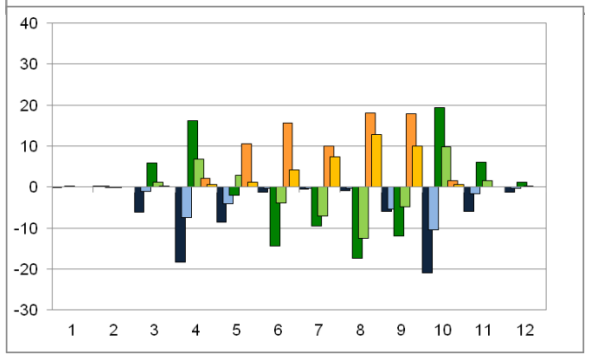
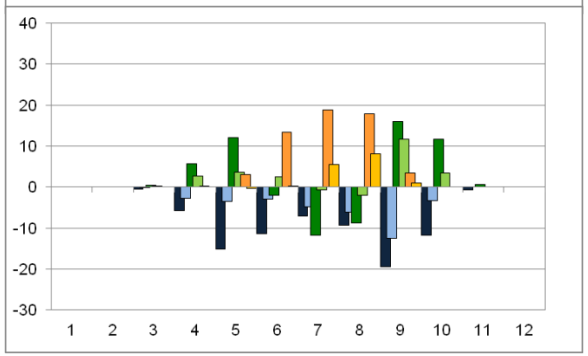


P1-P0 P2-P0

neprihvatljivo (1-3)
prihvatljivo (4-5)
idealno (6-7)

Razlike **mjesečne** učestalosti CIT za **biciklizam**
Između buduće i sadašnje klime (06 UTC, 07h)

Ksenija Zaninović, Državni hidrometeorološki zavod

	More	Kopno	
Rovinj			Zagreb
Zadar			Osijek
Hvar			Gospić

P1-P0 P2-P0

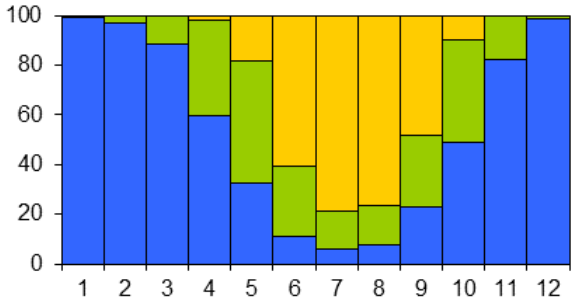
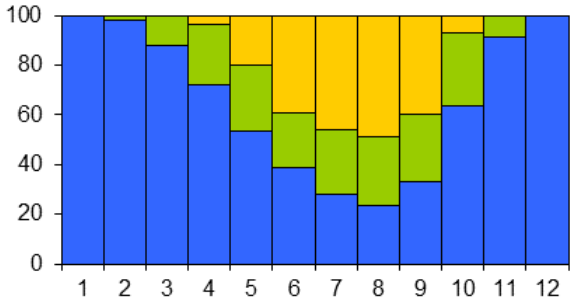
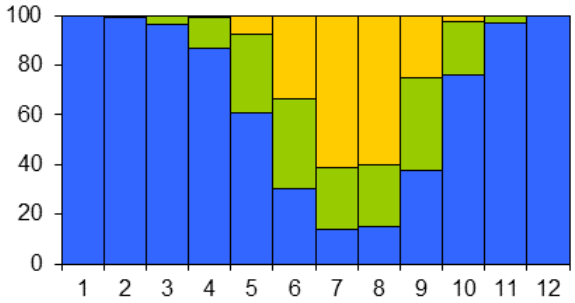
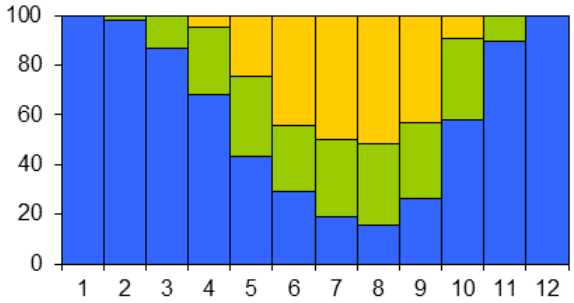
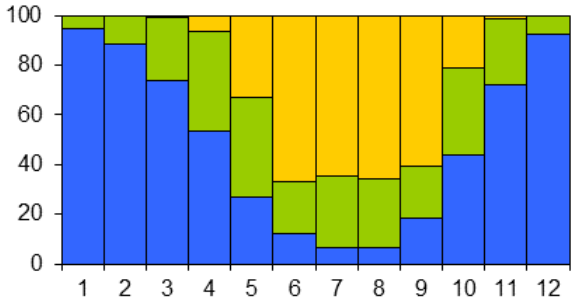
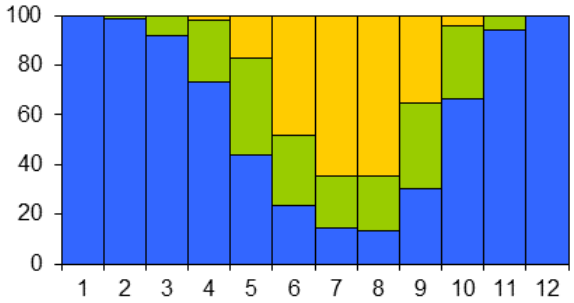
neprihvatljivo (1-3)
prihvatljivo (4-5)
idealno (6-7)

Ksenija Zaninović, Državni hidrometeorološki zavod

U 6 UTC u budućnosti se može očekivati poboljšanje klimatskih uvjeta za sve tipove turizma tijekom cijele godine, a najizraženije od svibnja do rujna.

3S u **simuliranoj** sadašnjoj klimi (12 UTC, 13 h)

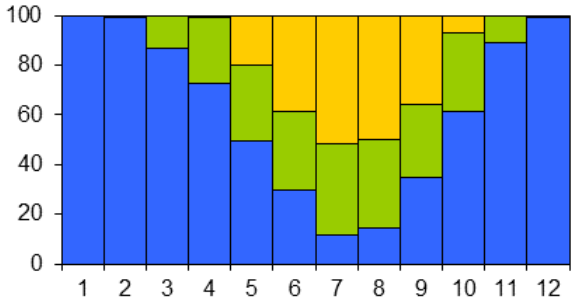
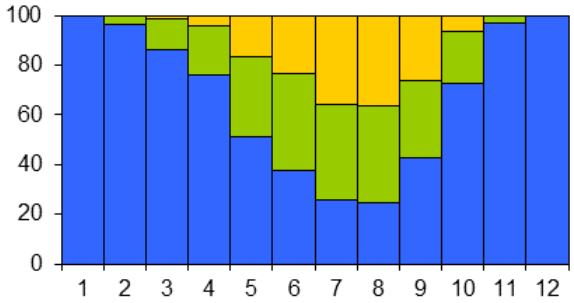
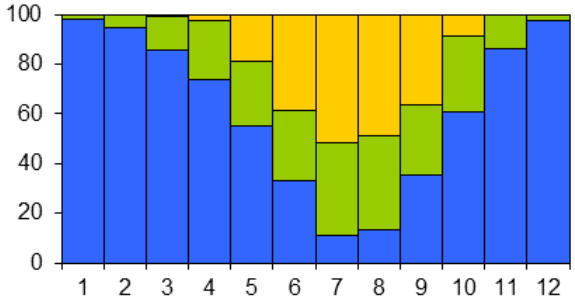
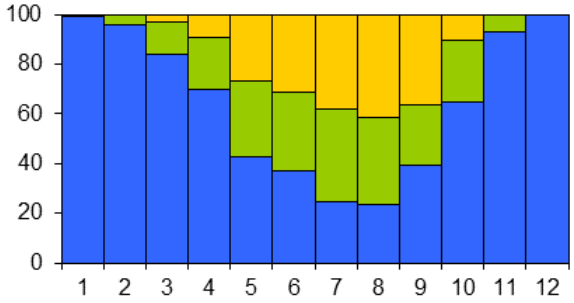
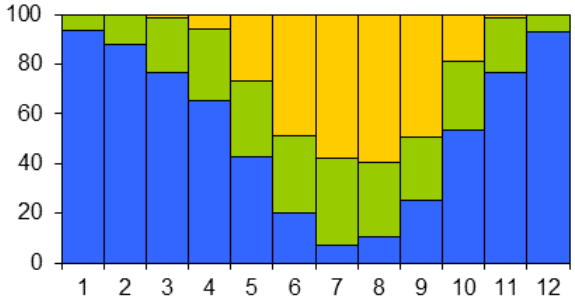
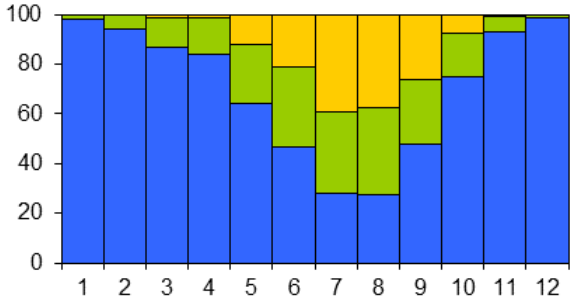
Ksenija Zaninović, Državni hidrometeorološki zavod

	More	Kopno	
Rovinj			Zagreb
Zadar			Osijek
Hvar			Gospić

neprihvatljivo (1-3)
prihvatljivo (4-5)
idealno (6-7)

3S u **realnoj** sadašnjoj klimi (14 h)

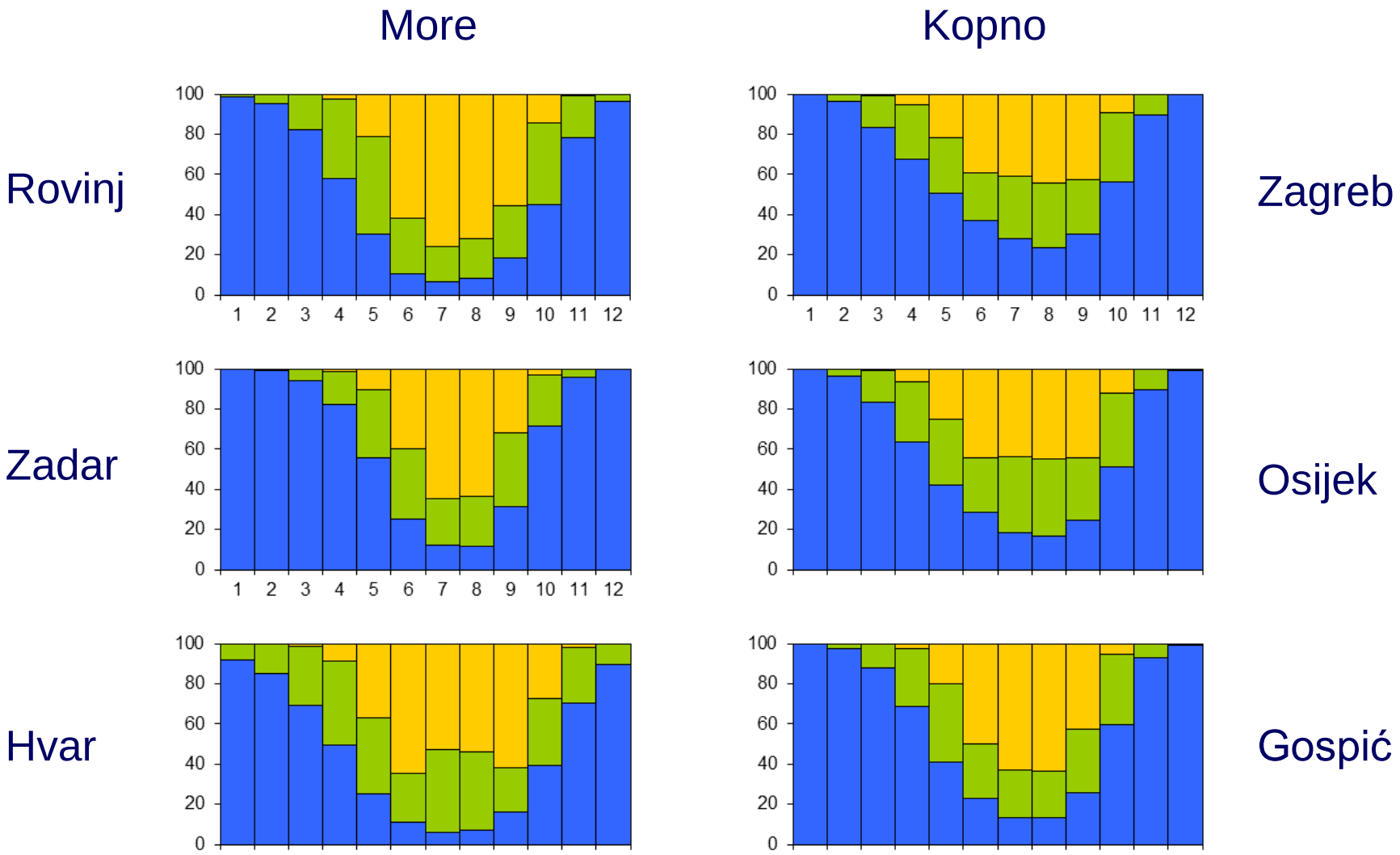
Ksenija Zaninović, Državni hidrometeorološki zavod

	More	Kopno	
Rovinj			Zagreb
Zadar			Osijek
Hvar			Gospić

neprihvatljivo (1-3)
prihvatljivo (4-5)
idealno (6-7)

Simulacija 3S 2011-2040 (14 h) za RCP 4.5

Ksenija Zaninović, Državni hidrometeorološki zavod



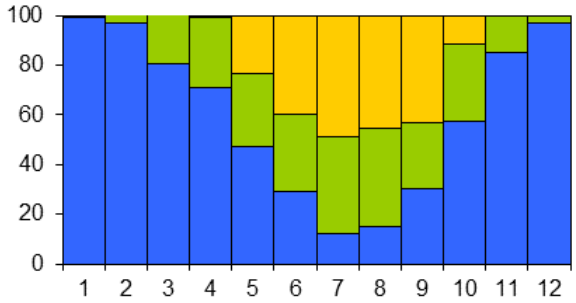
Procjena 3S 2011-2040 (14h) za RCP 4.5

Ksenija Zaninović, Državni hidrometeorološki zavod

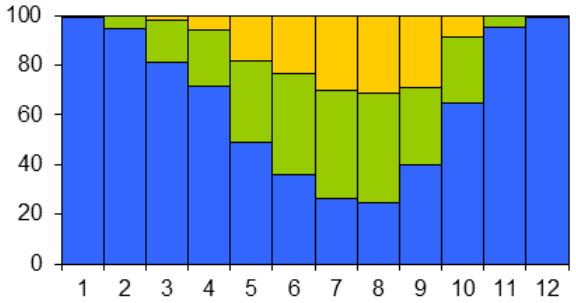
More

Kopno

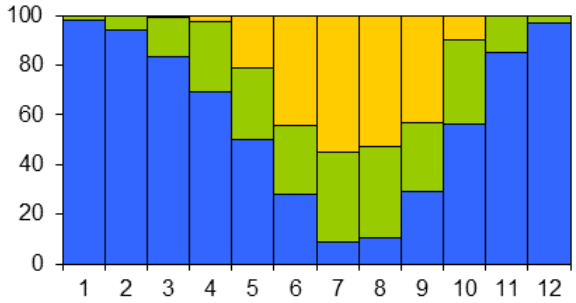
Rovinj



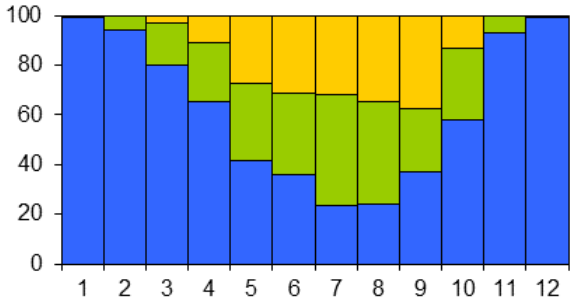
Zagreb



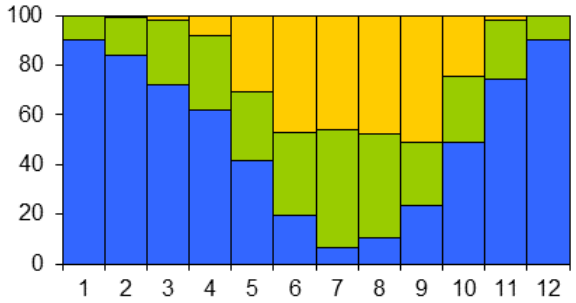
Zadar



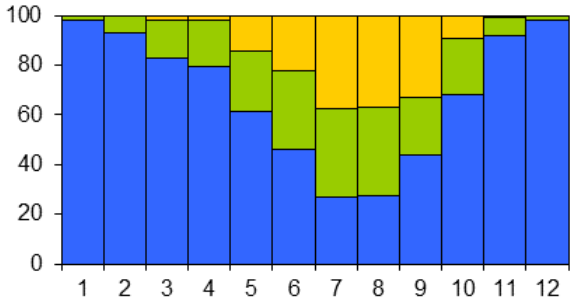
Osijek



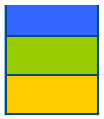
Hvar



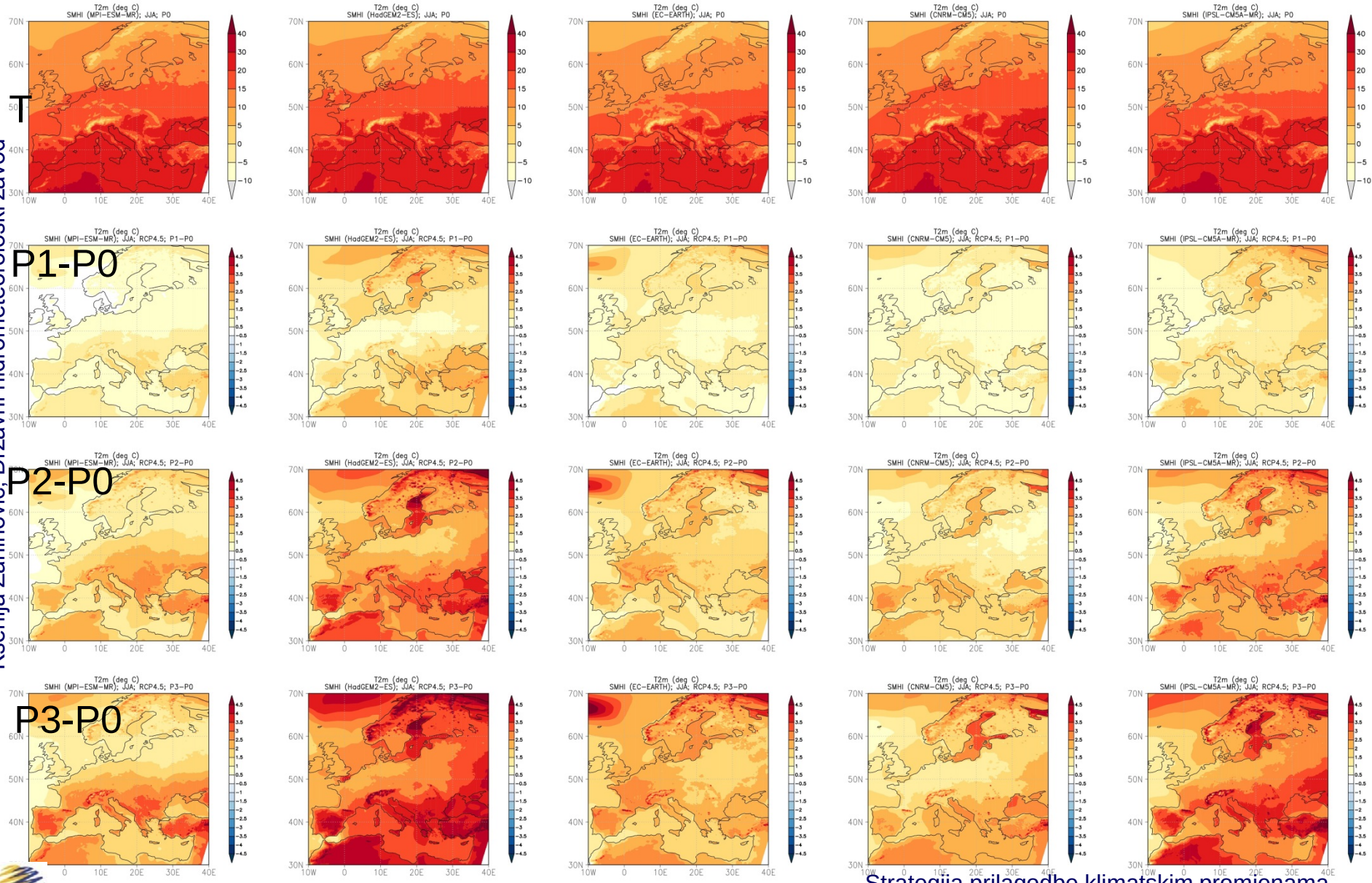
Gospić



neprihvatljivo (1-3)
prihvatljivo (4-5)
idealno (6-7)

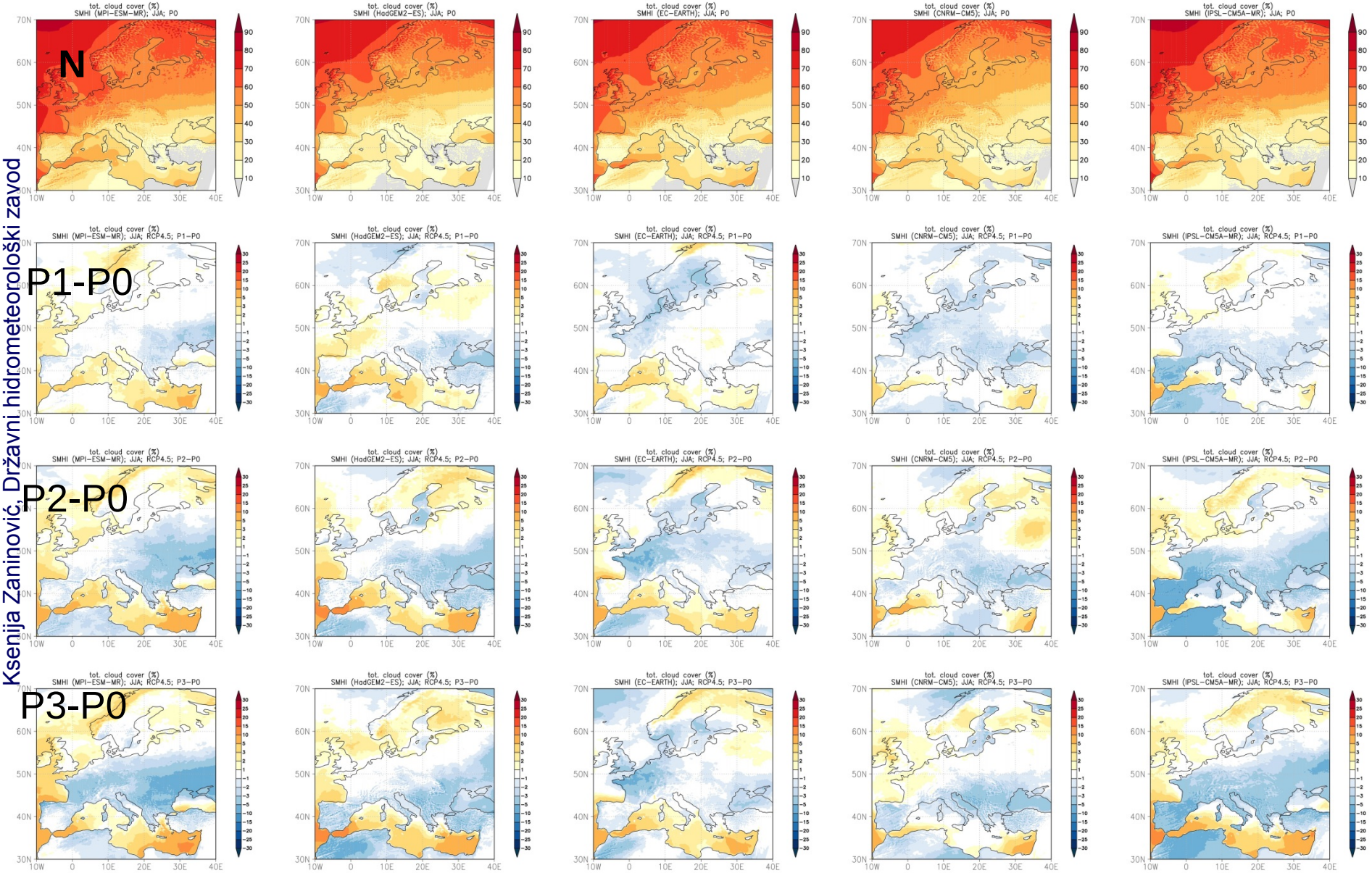


Temperatura ljeto



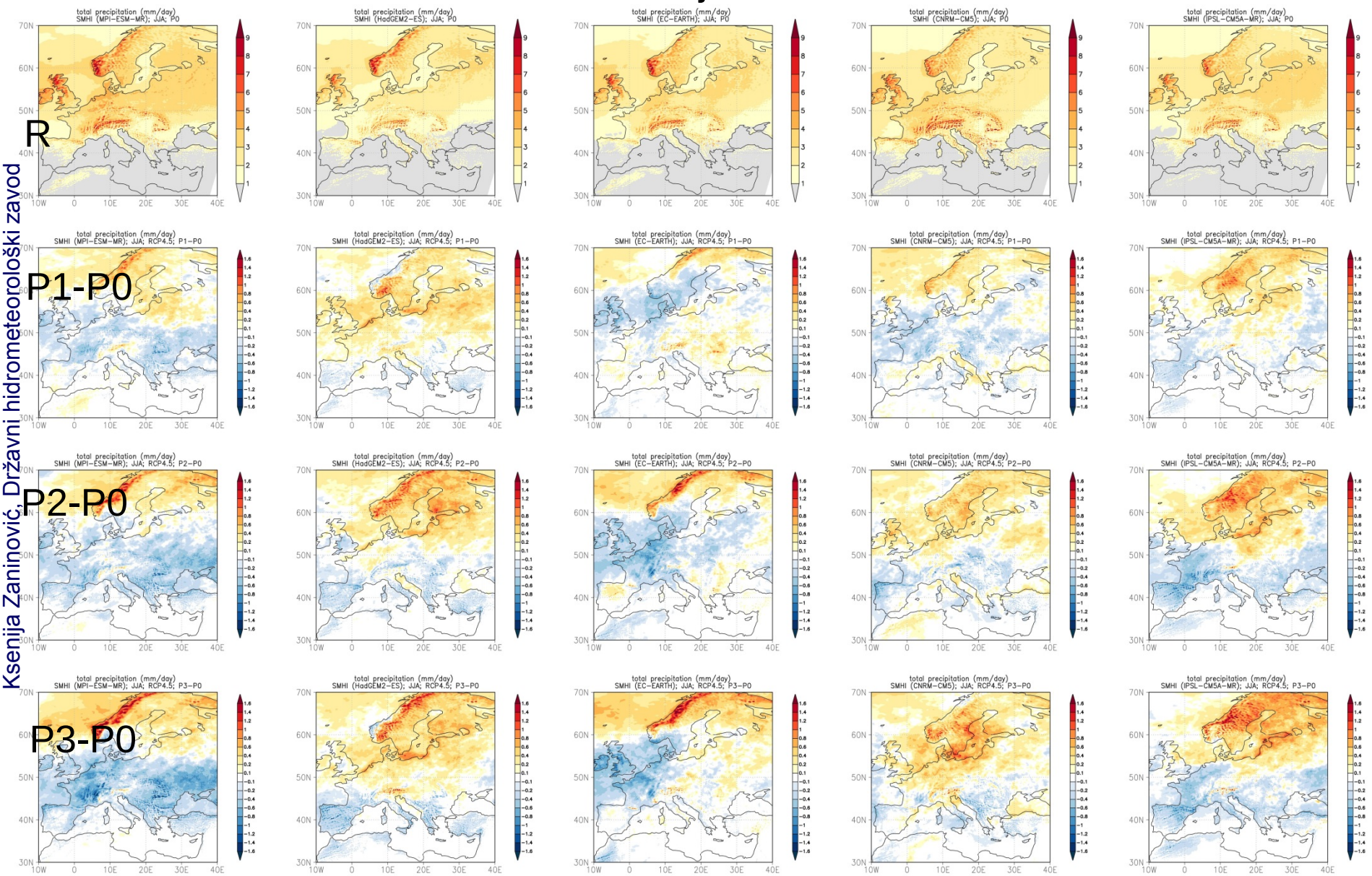
Ksenija Zaninović, Državni hidrometeorološki zavod

Naoblaka ljeto



Ksenija Zaninović, Državni hidrometeorološki zavod

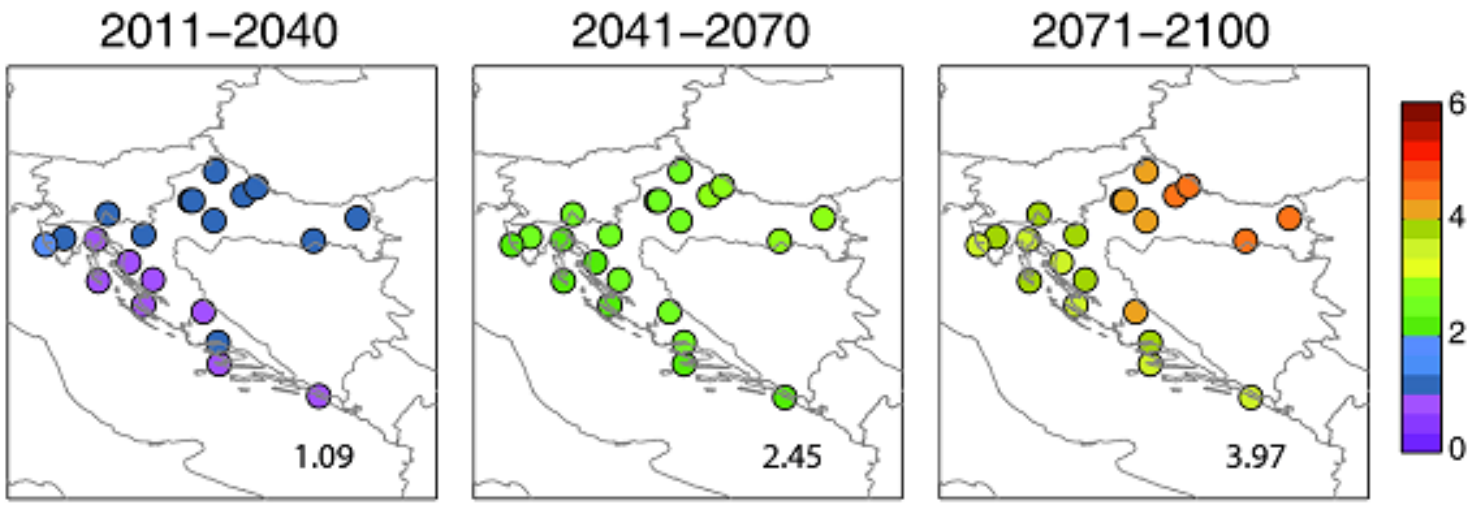
Oborina ljeto



Ksenija Zaninović, Državni hidrometeorološki zavod

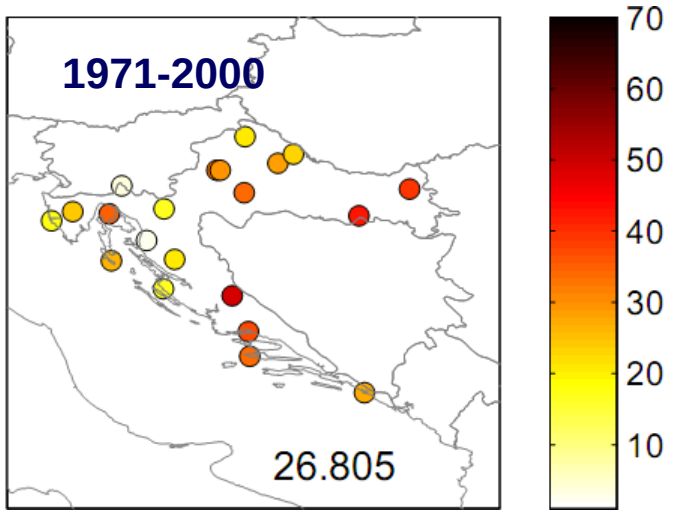
Klimatske promjene toplinskog osjeta

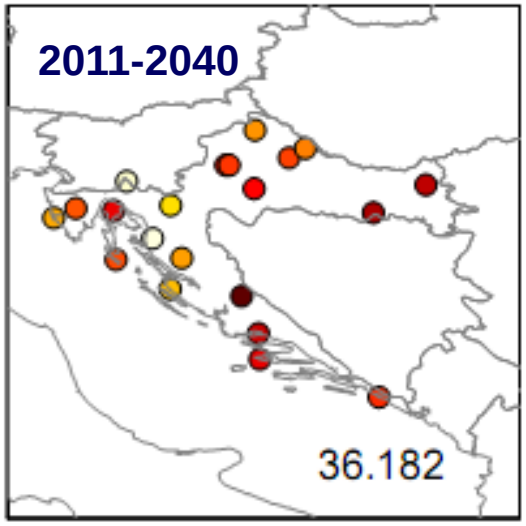
Promjene PET u budućim klimatskim razdobljima u odnosu na referentno klimatsko razdoblje 1971-2000.

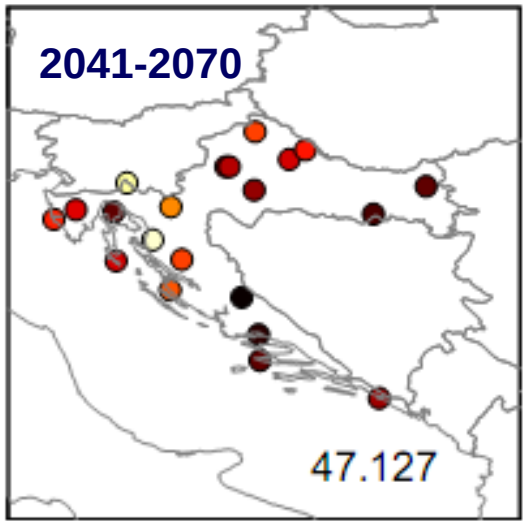


Ksenija Zaninović, Državni hidrometeorološki zavod

(PET > 35°C)







Ksenija Zaninović, Državni hidrometeorološki zavod

ZAKLJUČAK

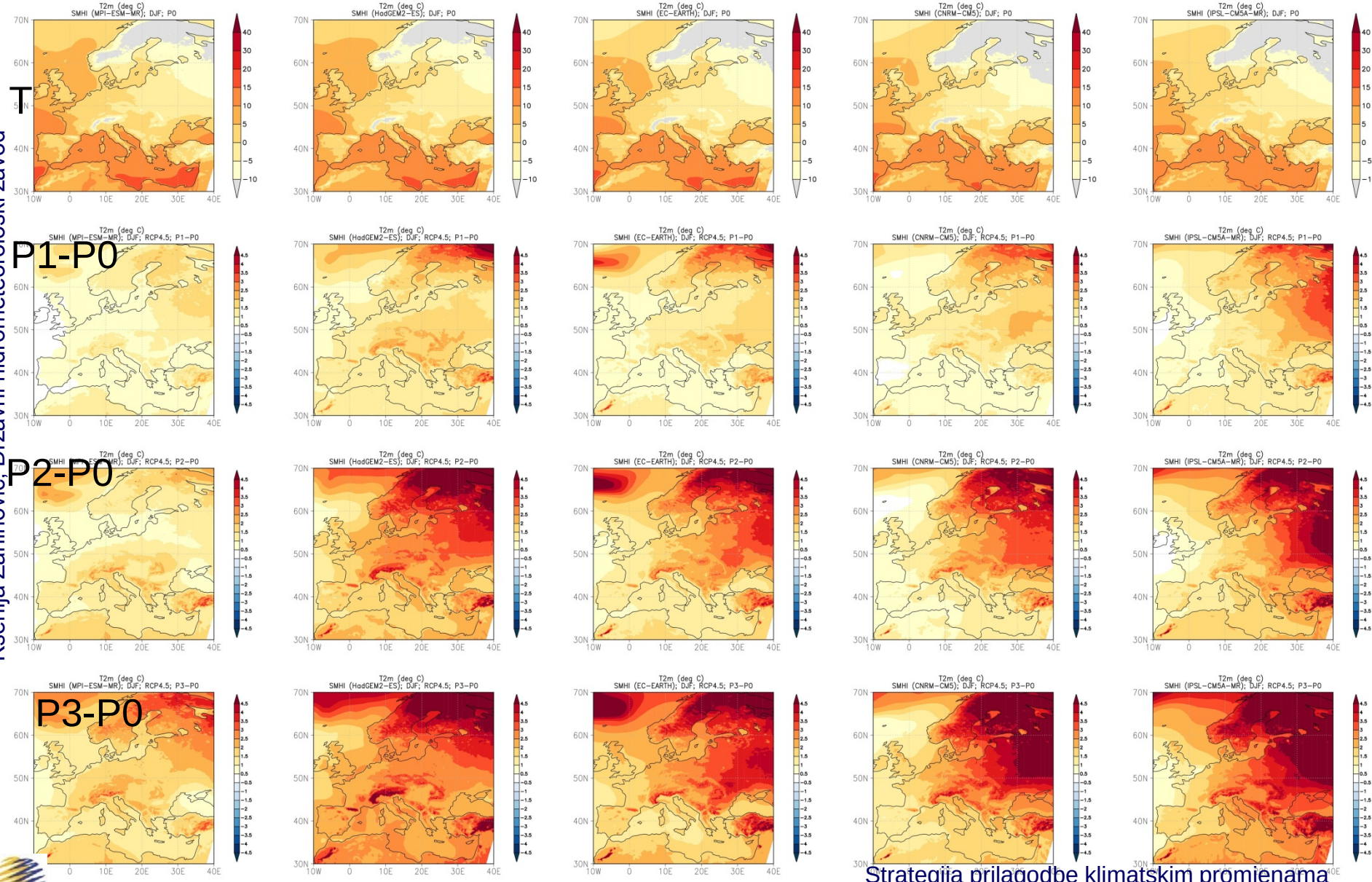
U najtoplijem dijelu dana rezultati ukazuju na pomak najpovoljnijih uvjeta za većinu aktivnosti s ljeta na proljeće i jesen. Sezona 3S turizma će se produljiti, s izuzetkom južnog Jadrana gdje se ljeti može očekivati smanjenje idealnih prilika.

Ujutro se može očekivati poboljšanje najpovoljnijih klimatskih prilika za sve vrste turističkih aktivnosti tijekom cijele godine .

Ovakvi rezultati mogu omogućiti prilagodbu klimatskim promjenama svim sudionicima u turističkom sektoru i osigurati promjene i poboljšanje različitih turističkih ponuda.

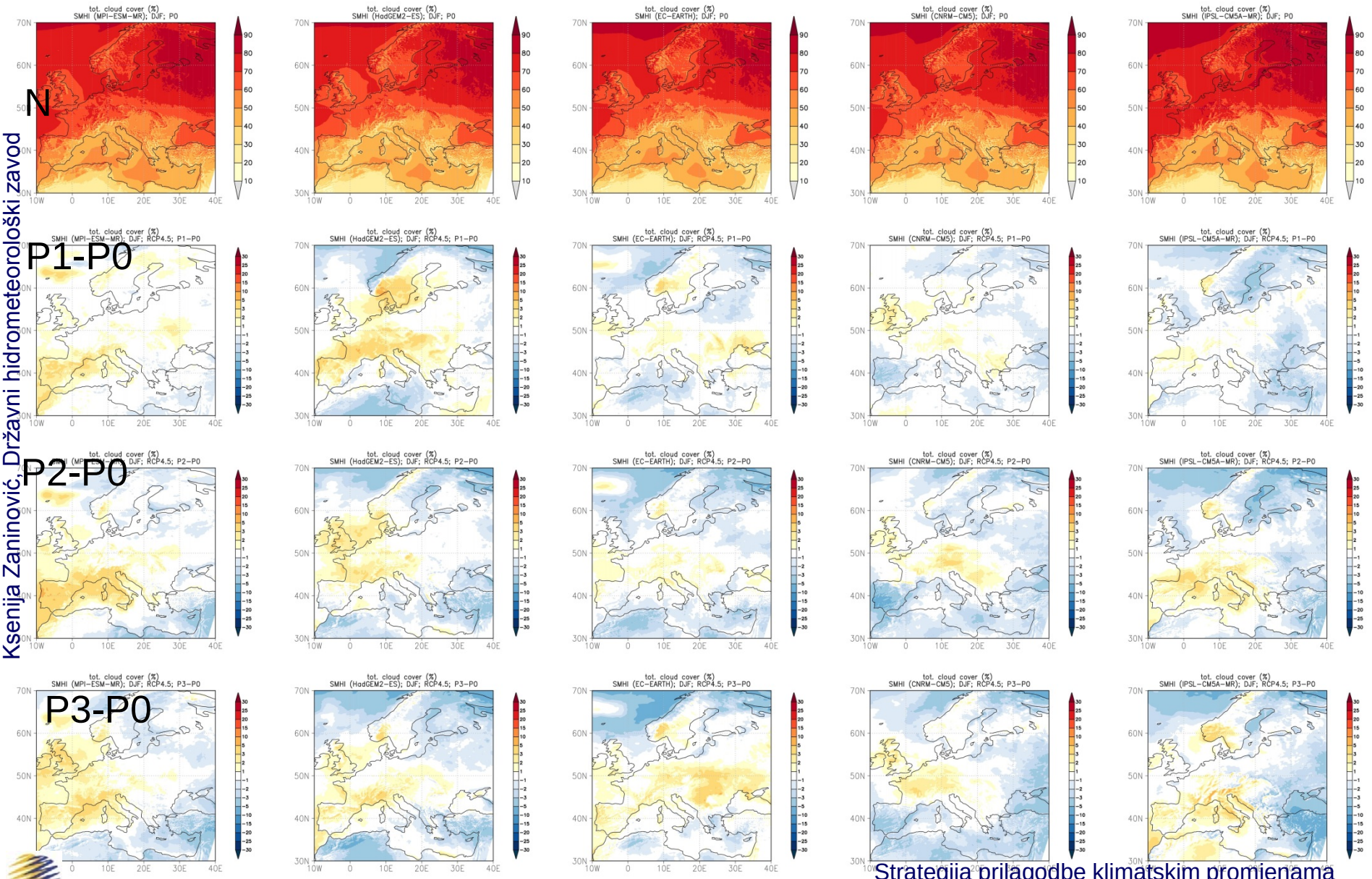
Ksenija Zaninović, Državni hidrometeorološki zavod

Temperatura zima



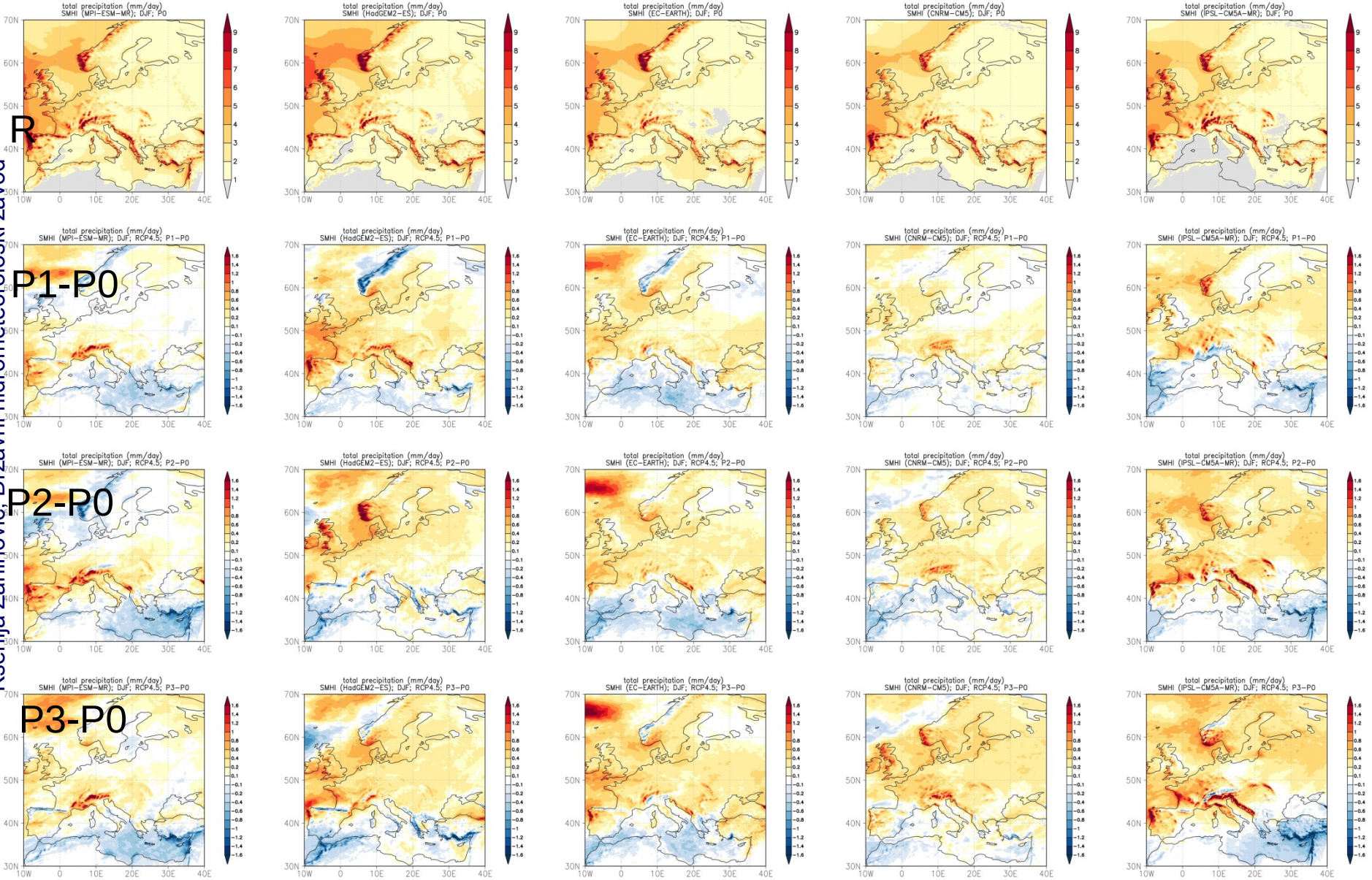
Ksenija Zaninović, Državni hidrometeorološki zavod

Naoblaka zima



Ksenija Zaninović, Državni hidrometeorološki zavod

Oborina zima



Ksenija Zaninović, Državni hidrometeorološki zavod