Expected climate changes in dry spells over Croatia

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Introduction

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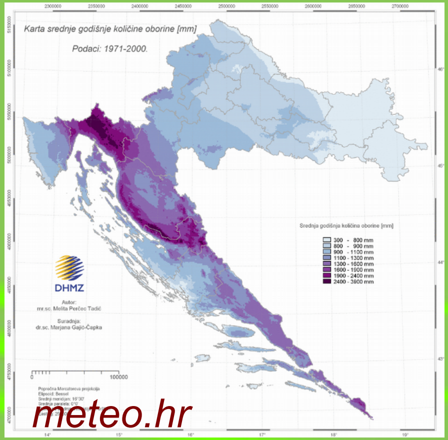
Introduction

- The precipitation regime in Croatia is caused by the general circulation of atmosphere over northern middle latitudes & strongly modified by local factors (Mediterranean & Adriatic Sea, Dinaric Alps).
- Significant spatial differences in average precipitation amounts and frequency between the continental, mountainous and coastal areas.
- Croatia belongs to the transitional area between northern Europe with an increase in average precipitation & drying Mediterranean.



Recent studies…

- Trends of extreme precipitation indices
  Gajić-Čapka et al. (TAC, 2014) → 132 stations in Croatia, 1961-2010 → decreasing trend in annual precipitation is caused by a statistically significant increased frequency of dry days (prec. < 1 mm)

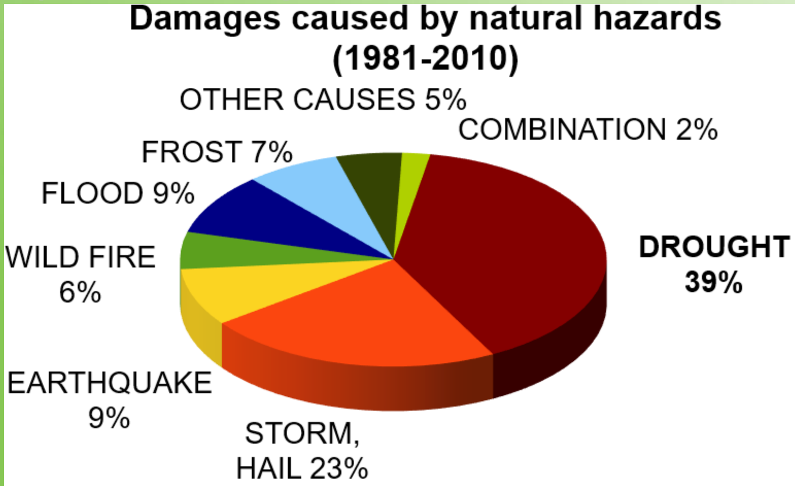
- Dry spell → one of the extreme precipitation indices
  Monitoring of dry spells during a month/ season provides another insight into particular precipitation → useful in engineering studies that deal with agricultural, irrigation or field operations systems

- Very few dry spell studies in Croatia
  Cindrić et al. (TAC, 2010) → 25 stations in Croatia, 1961-2000 → DS climate & DS trends → MEAN and MAX dry spell durations → (mostly) negative trend for autumn; (mostly) positive trend for other seasons and whole year (prec. < 0.1,1,5,10 mm)

→ no systematic climatological analysis of dry spells!

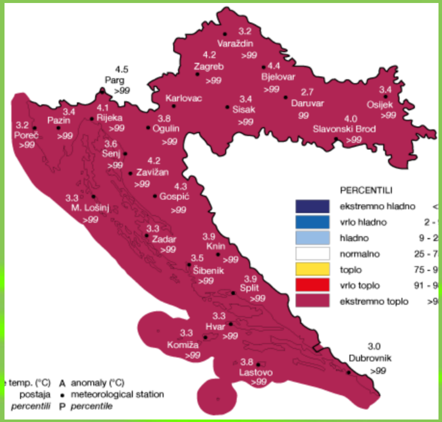
Drought in Croatia

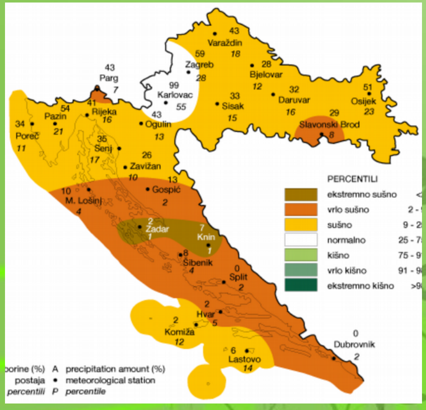
- Causes the highest economic losses (39 %) inflicting serious damages, especially in agricultural sector



- **2003** – damage on drought was 90 %
- **2011/2012** (Cindrić et al. 2014, TAC)
- **2015** (Ionita et al. 2017, HESS);

- **2017**
  more than 100 consecutive days (prec. < 5 mm)
  & large precipitation deficit
  & extremely high air temperature
  during summer months





Drought in Croatia

- **Main goal of this study**:
  - systematic spatial & temporal analysis of dry spells (DS) in Croatia for the extended period 1961–2015
  - projections and future changes in the DS statistics

  → for establishing the **drought risk assessment**

Drought 2017, Croatia

- **DriDanube** - Drought risk in Danube Region
  - to improve the drought emergency response
  - prepare better for the next drought
  - (search for the poster) ☺

Interreg
Danube Transnational Programme
DriDanube

Data → observation

- **Daily** precipitation data
- **132** stations
  (Croatian Meteorological and Hydrological Service - DHMZ)
- Time period: **1961-2015**

Data → model

- Regional climate model (RCM)
  - from EURO-CORDEX initiative: **RegCM4** (Giorgi et al. 2012)
  - forced by the four CMIP5 global climate models (MOHC-**Ha**dGEM2-ES, **CN**RM-CERFACS, ICHEC-**EC**-EARTH, **MP**I-M-MPI-EMS-MR)
  - European domain at the **12.5-km** horizontal resolution (realistic orography & land-sea structures)

- 3 periods: **1971–2000** ; **2011–2040** & **2041–2070**

Data → 7 regions

Reg1: **Eastern mainland** → Osijek

Reg2: **Western mainland** → Zagreb

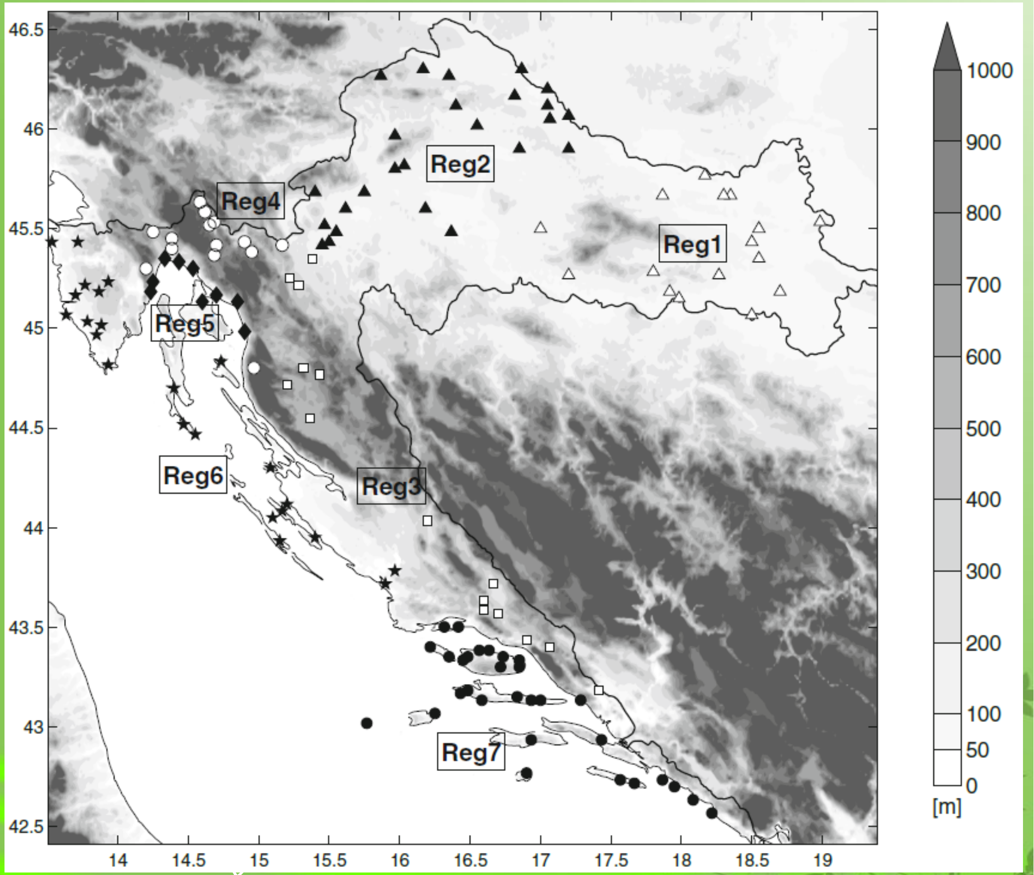
Reg3: **Central hinterland** → Ličko Lešće

Reg4: **Mountainous region** → Ravna Gora

Reg5: **Mountainous littoral** → Rijeka

Reg6: **North Adriatic coastal** → Mali Lošinj

Reg7: **Central & South Adriatic coastal** → Split



Gajić-Čapka et al. 2014, TAC

Methods → observation

- **Dry spells (DS) –** consecutive sequences of days having daily precipitation less than the given threshold (1, **5**, 10 mm)
  - DS beginning in one season but extending to the next is accounted in the season in which it started (Buishand, 1978)

- **Analysis** of DS duration:
  - MAX & Mean
  - Annual & seasonal (DJF, MAM, JJA, SON)

Methods → trends

- Means of **Kendall' tau** method (Sen 1968; Zhang et al. 2004)

  → statistically robust and resistant

- Non-parametric **Mann–Kendall** test (Gilbert 1987)

  → statistical significance of Kendall's tau trend

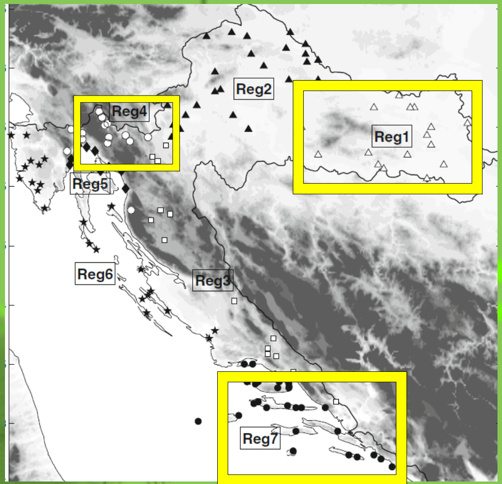
- Innovative **partial trend** methodology (Öztopal and Şen, 2016)
  - MAX & Mean annual DS duration days
  - Comparation: 1961-1985 & 1986-2010

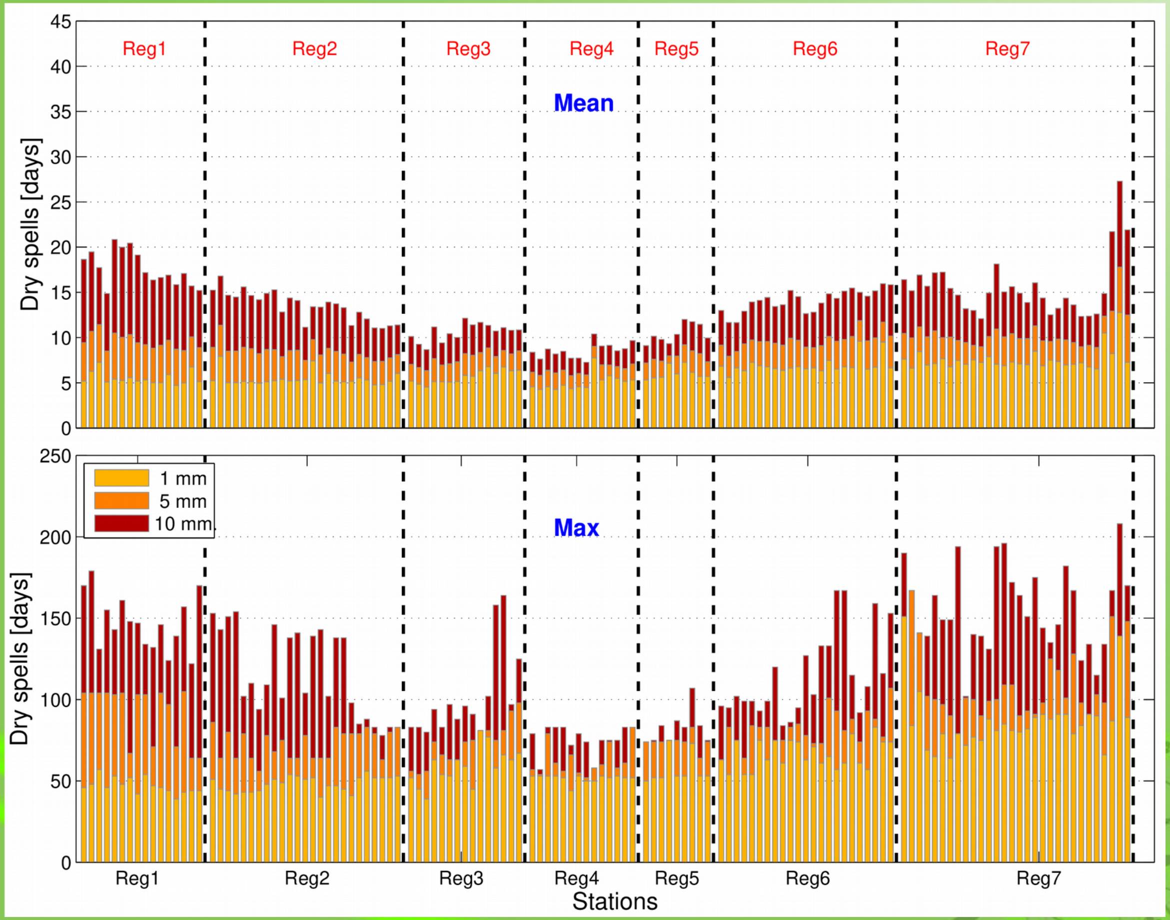
Methods → model

- 4 global models → **RegCM4**
- 1 station (grid cell) from each region
- Mean DS (5 mm)
- seasonal and annual timescale
- present & 2 future periods
- RCP4.5 & RCP8.5 scenario

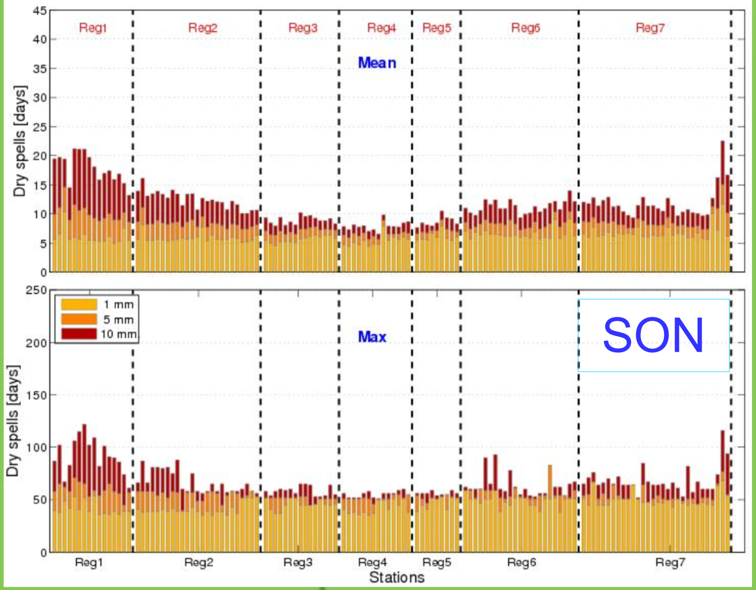
Results & Discussion

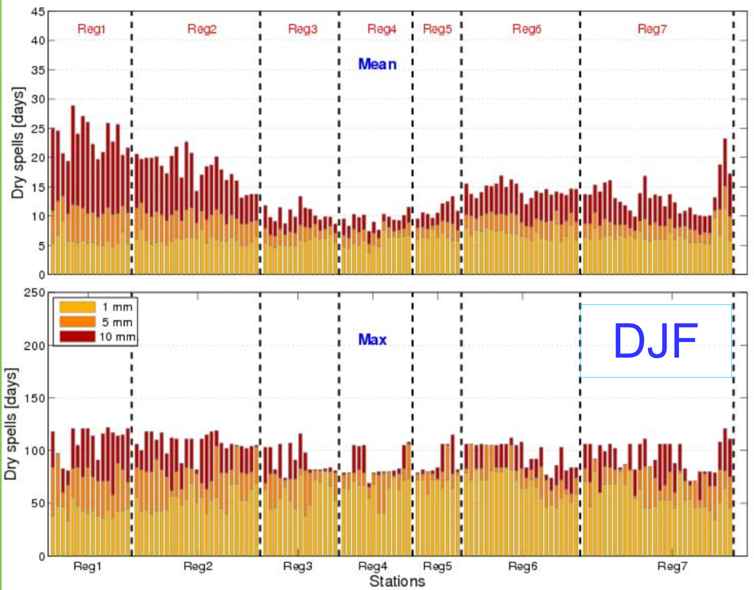
- Annual Mean & MAX DS
- 3 categories (1, 5 and 10 mm)
- Reg 4 – the shortest DS
- Reg 1, 7 – the longest DS
- 1 mm – small differences
- 10 mm – large difference



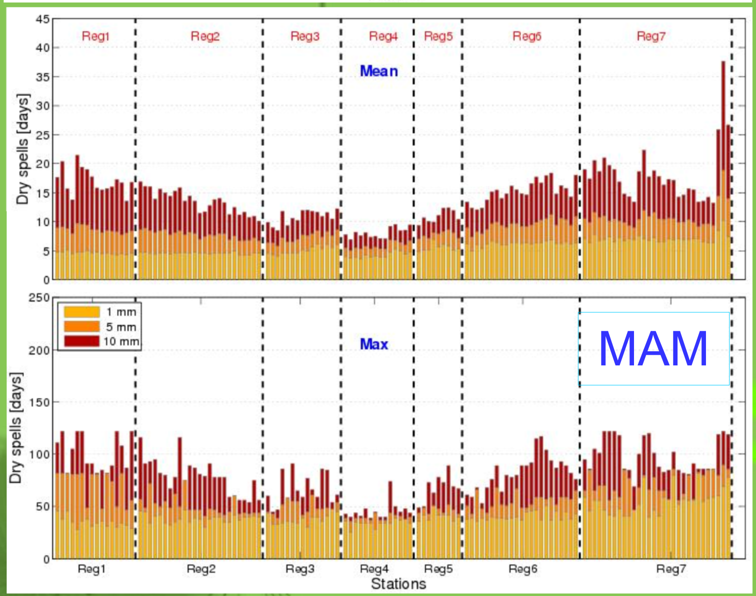


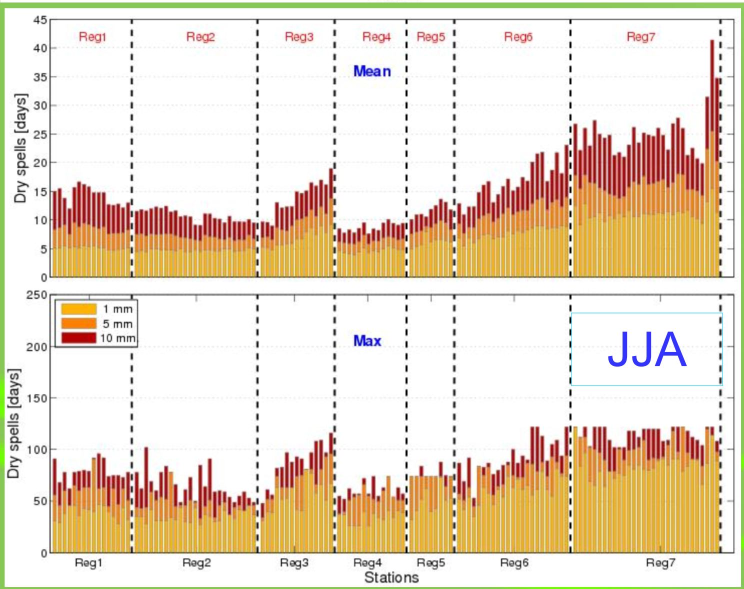
Longer DS:





Continental regions



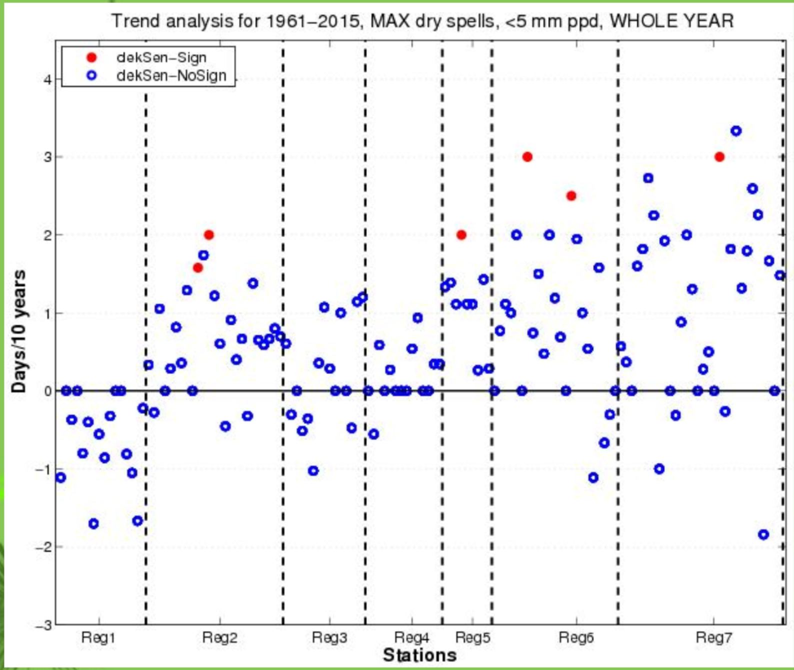


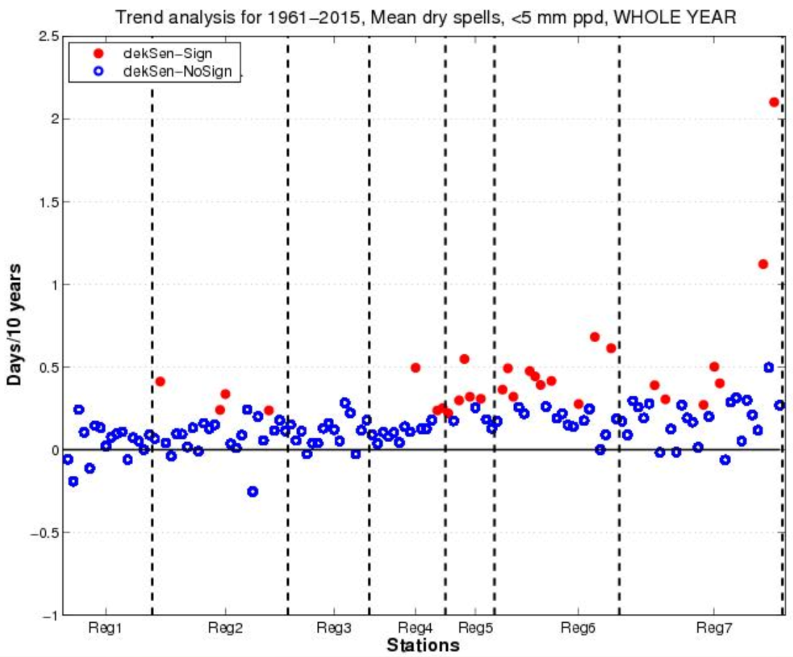
Adriatic region (south)

Results → trends

- Annual MAX & Mean DS durations days per decade
- prevailing POSITIVE trends

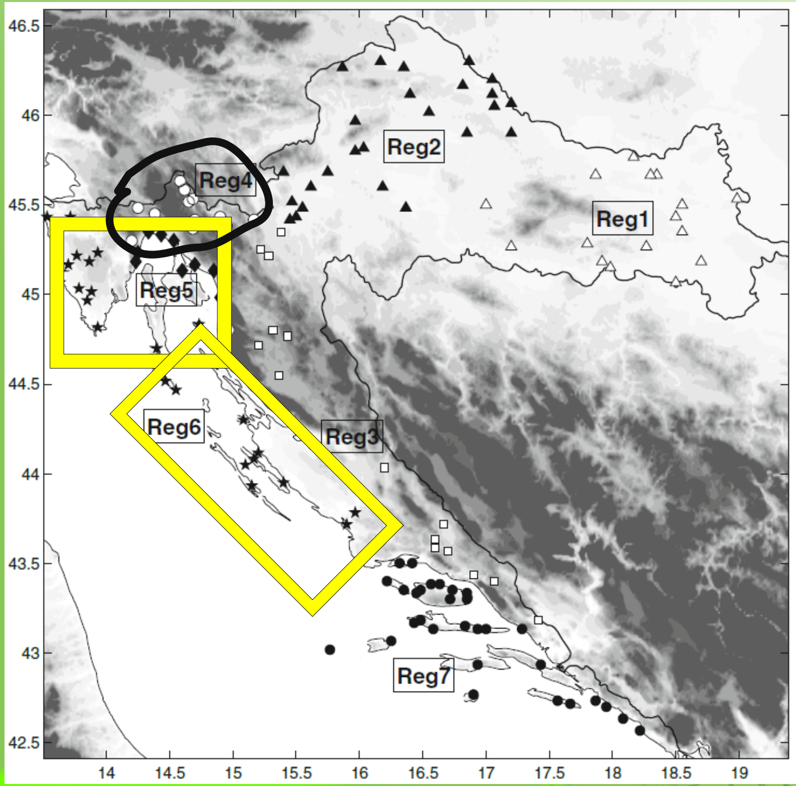
→ few sign. in MAX; prevailing sign. in Mean – Reg 5 & 6





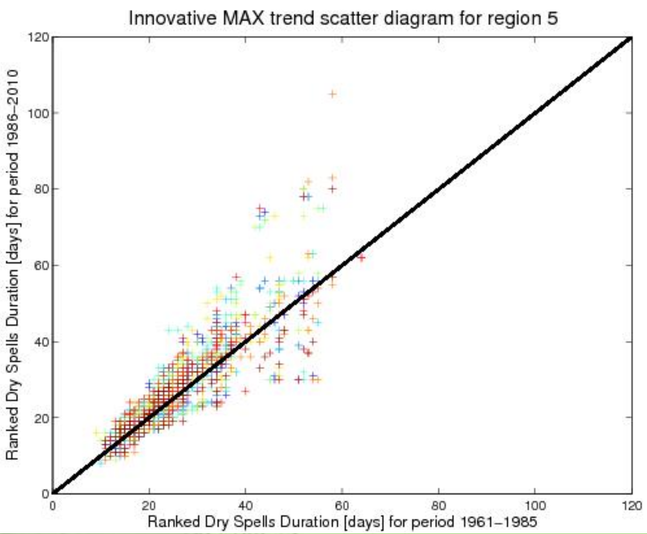
Results → trends

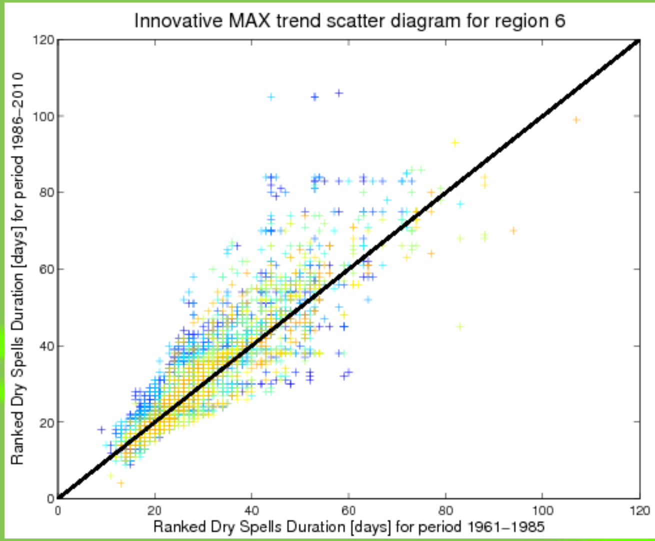
	SON	DJF	MAM	JJA	Year
MAX	–	+ 0 (R7)	+ 0 (R7)	+	+
SIGN. Reg.	4			5, 6	
Mean	0	0	+	+	+
SIGN. Reg.			5, 6	5, 6	5, 6

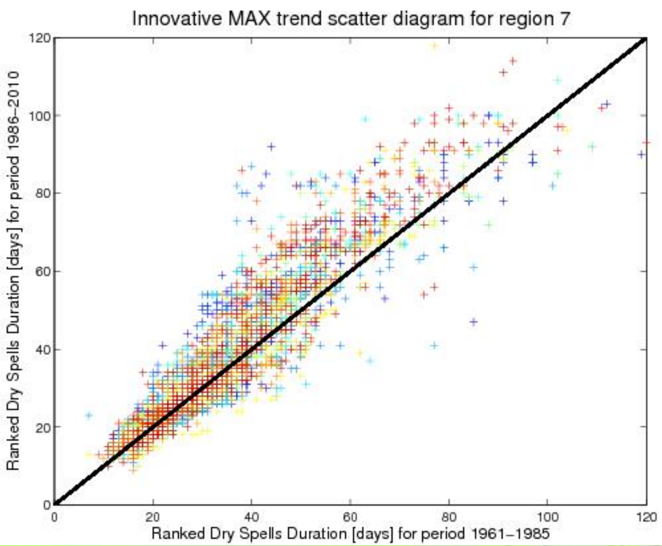


Results → partial trends

- MAX & Mean DS → similar results
- **1986-2010** (y axis) vs **1961-1985** (x axis)
- prevailing POSITIVE trends in recent period → Adriatic coastal (Reg **5,6,7**)
- trend is not clear → continental & mountainous regions (Reg **1 – 4**)

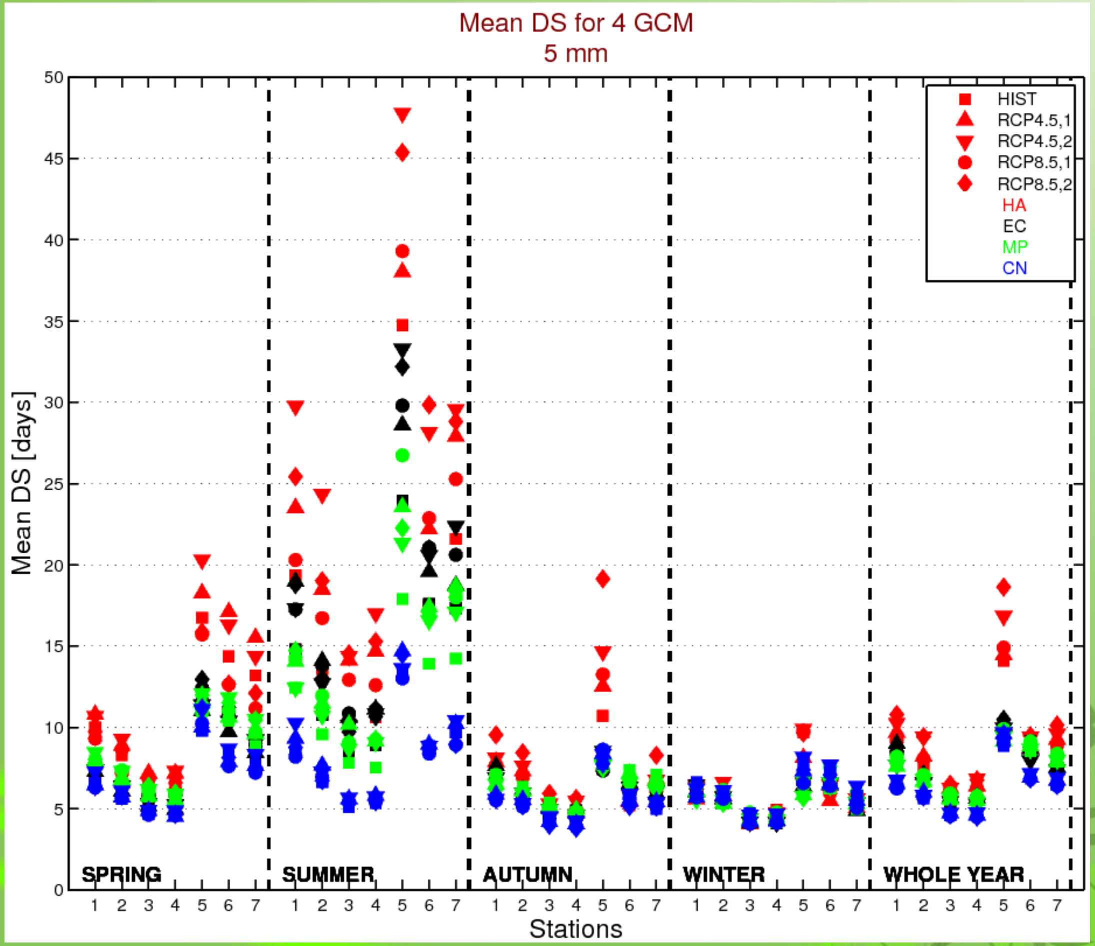






Results → model

- **SUMMER** → increase in DS duration (especially for 2nd period, ▼♦)
→ in agreement with general reduction of the total precipitation amount in **RegCM4** projections
- **WINTER** → no clear signal
- Reg **3** & **4** → the **driest** one → diversity of Croatia is well captured in models
- Station Rijeka in Reg **5**
- **HA** → the driest one
- **CN** → the wettest one



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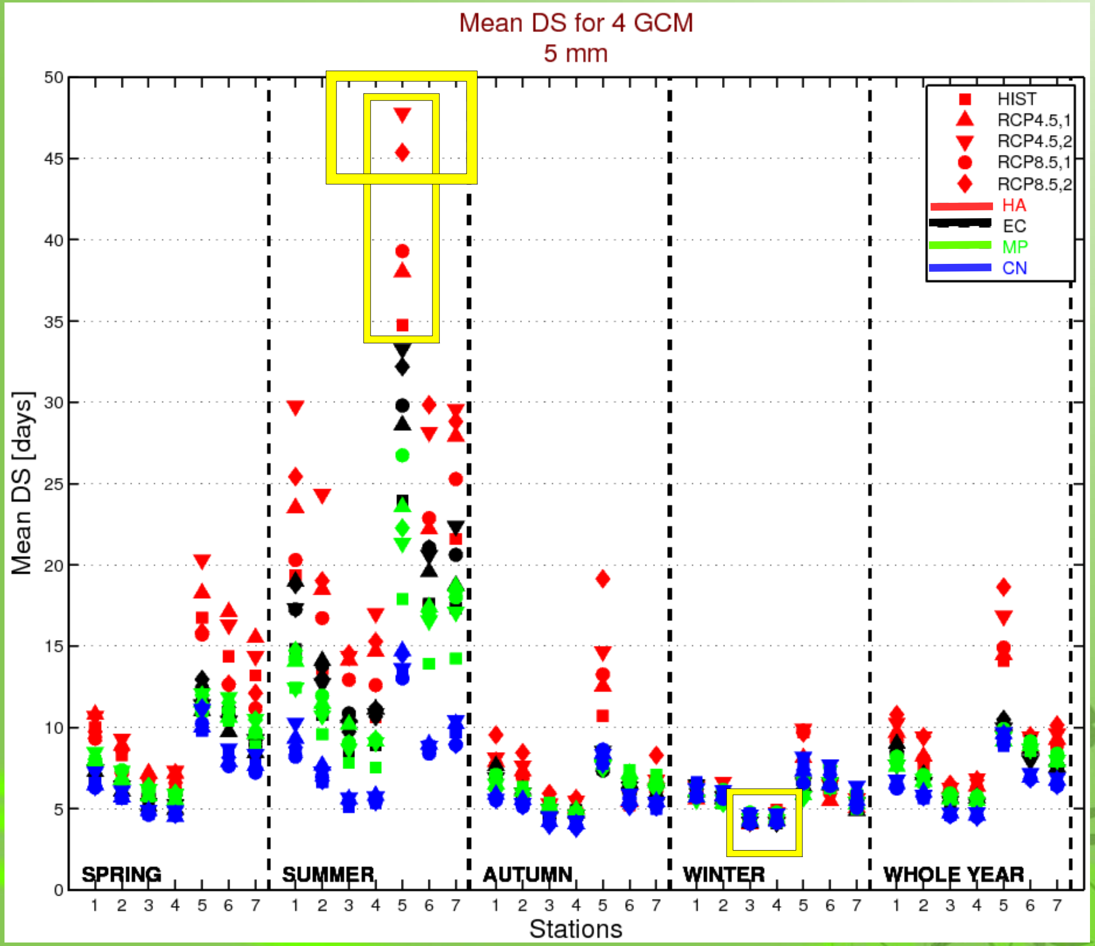

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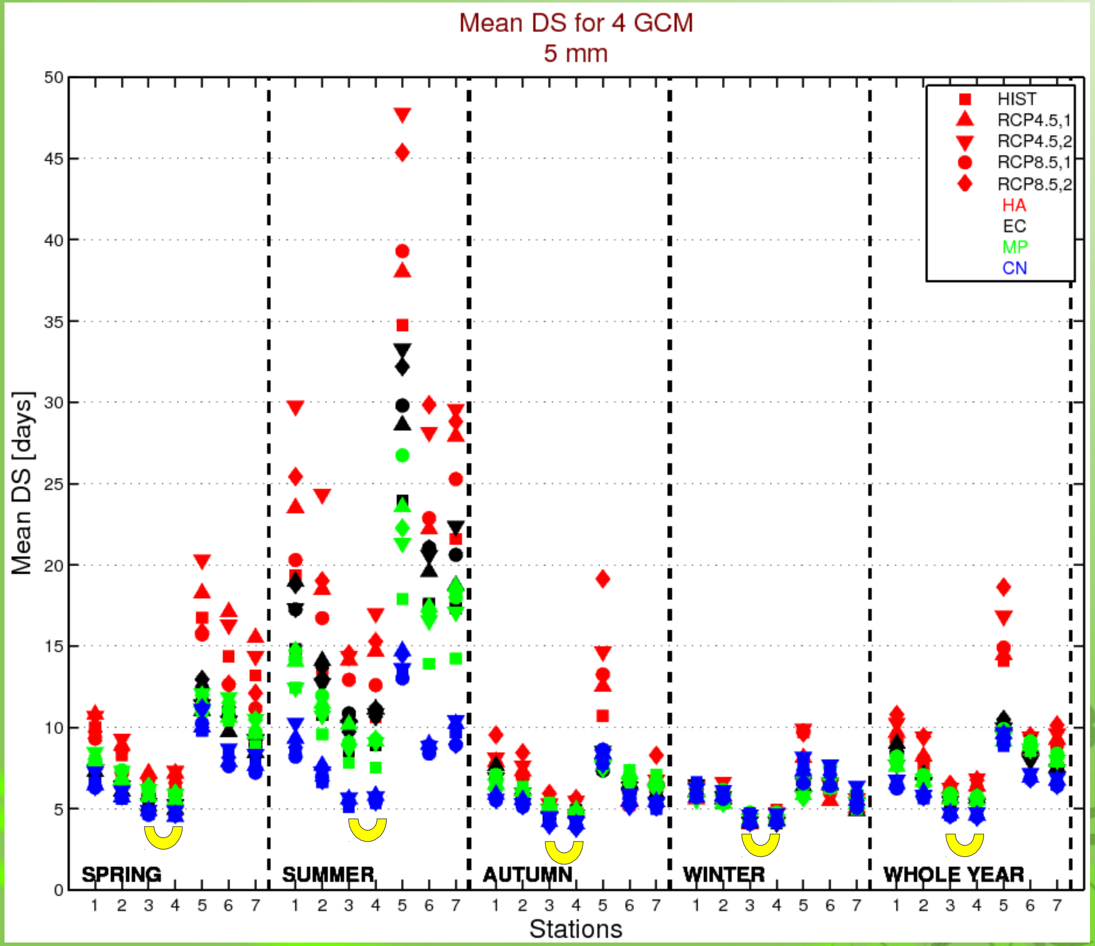

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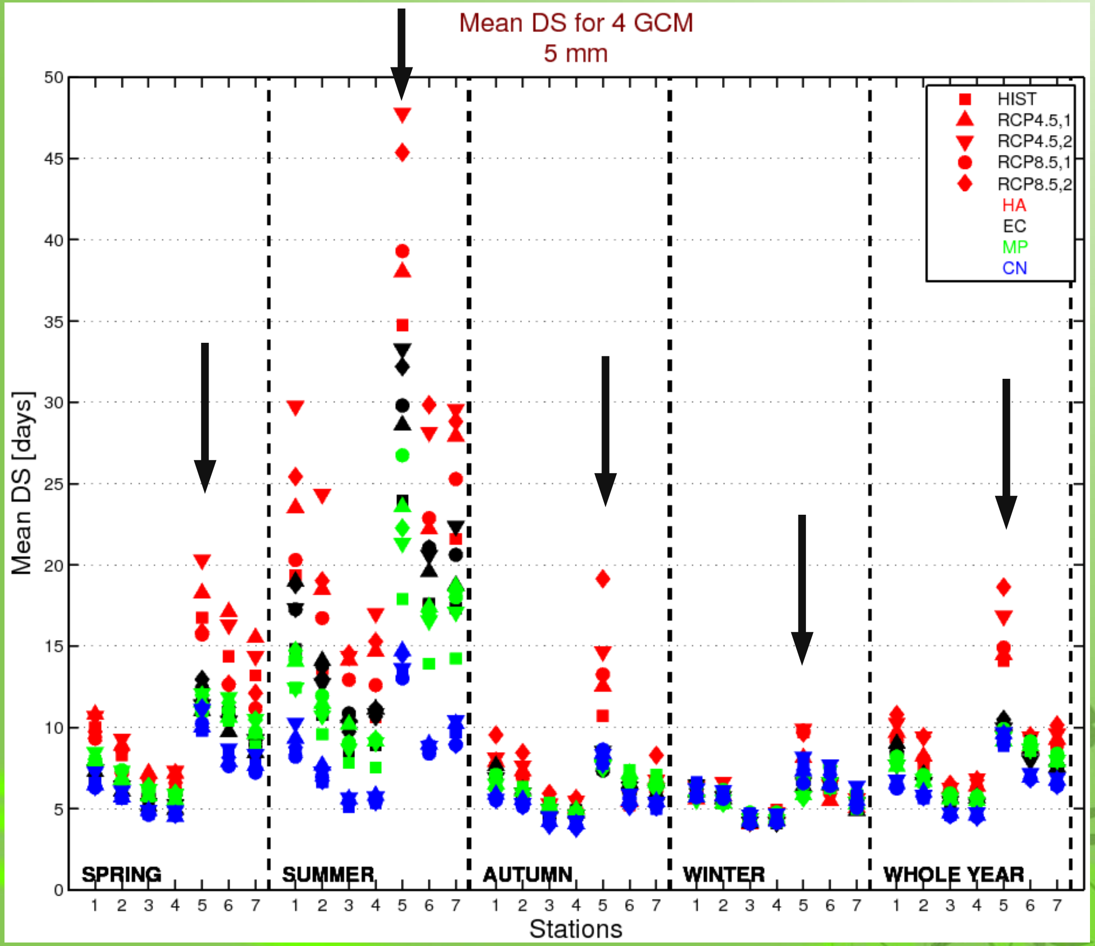
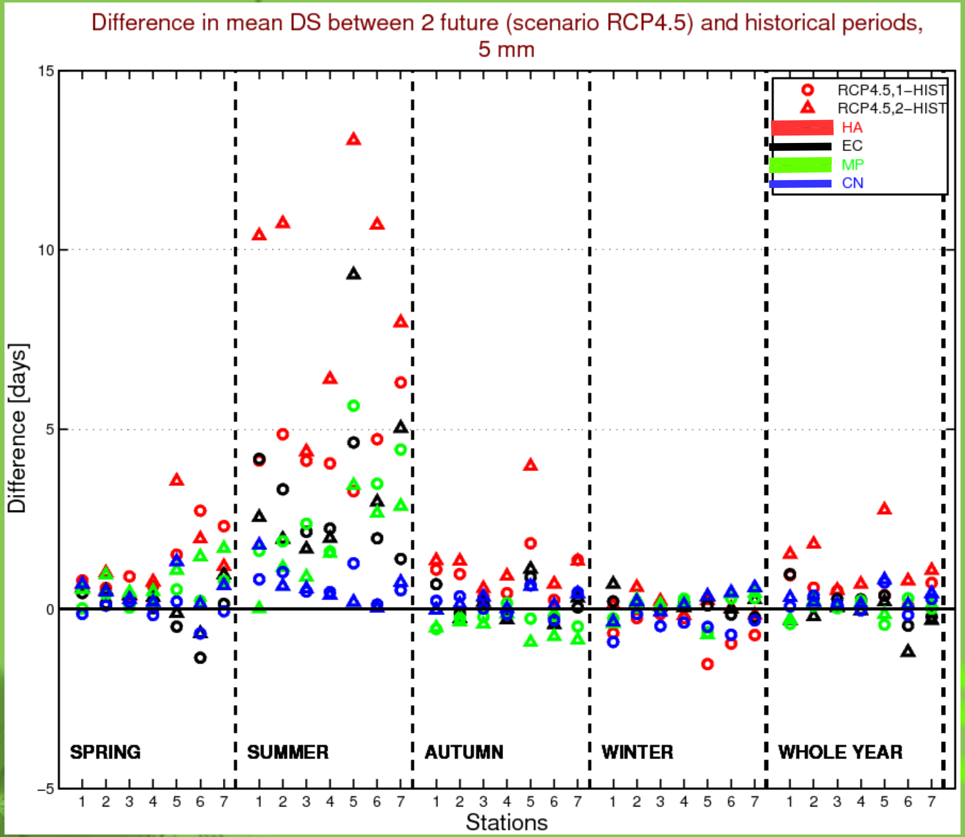
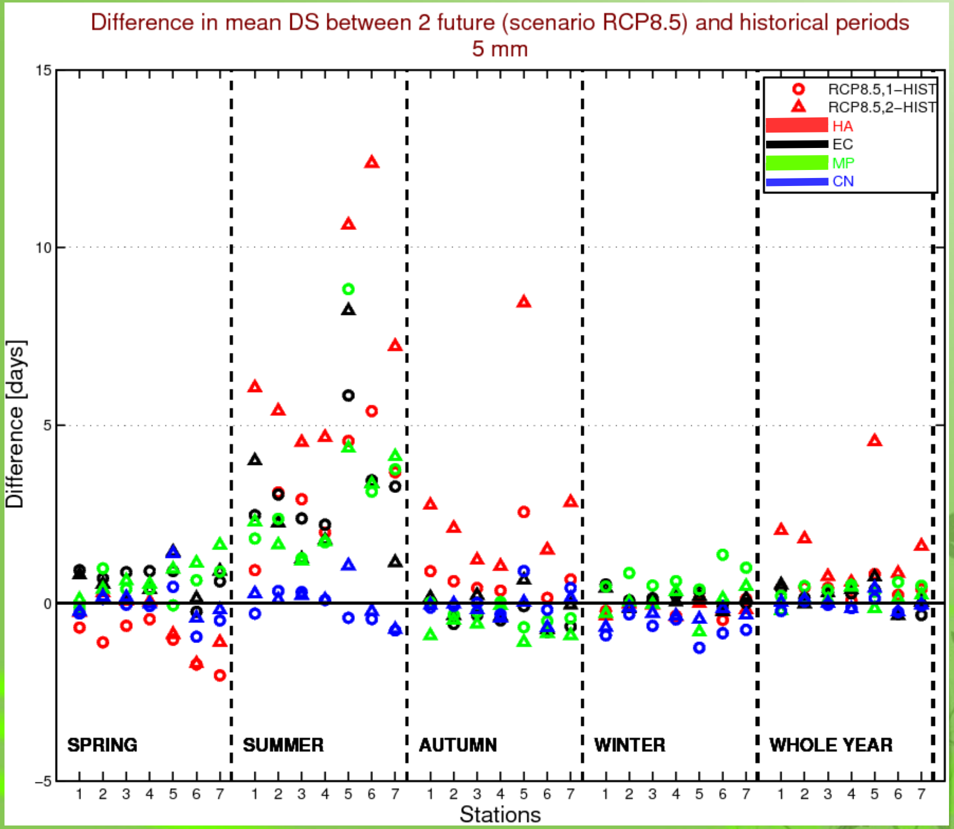


(Future) – (Present) → DS (2nd period, Δ) > DS (1st period, o)

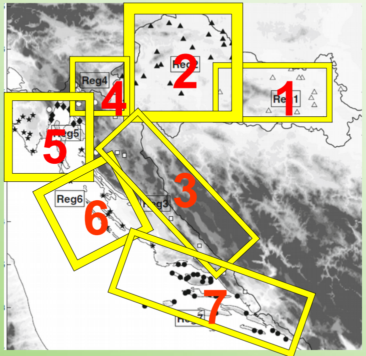
DS (RCP4.5) ≈ DS (RCP8.5)

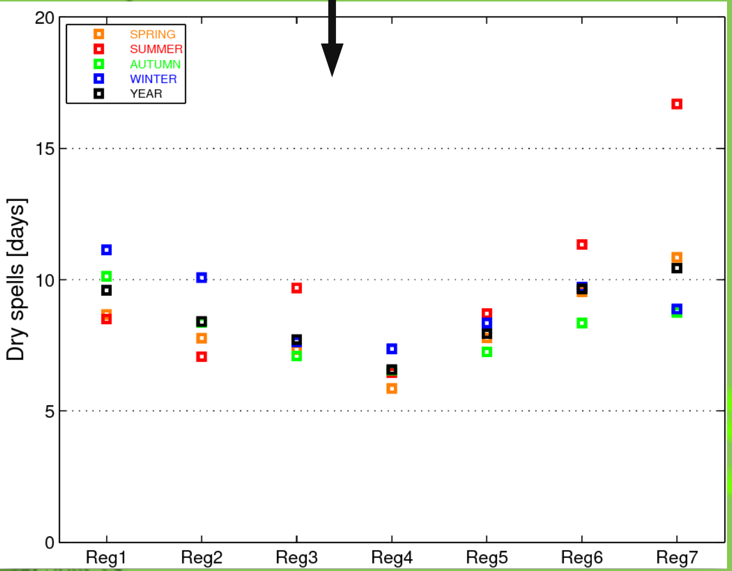


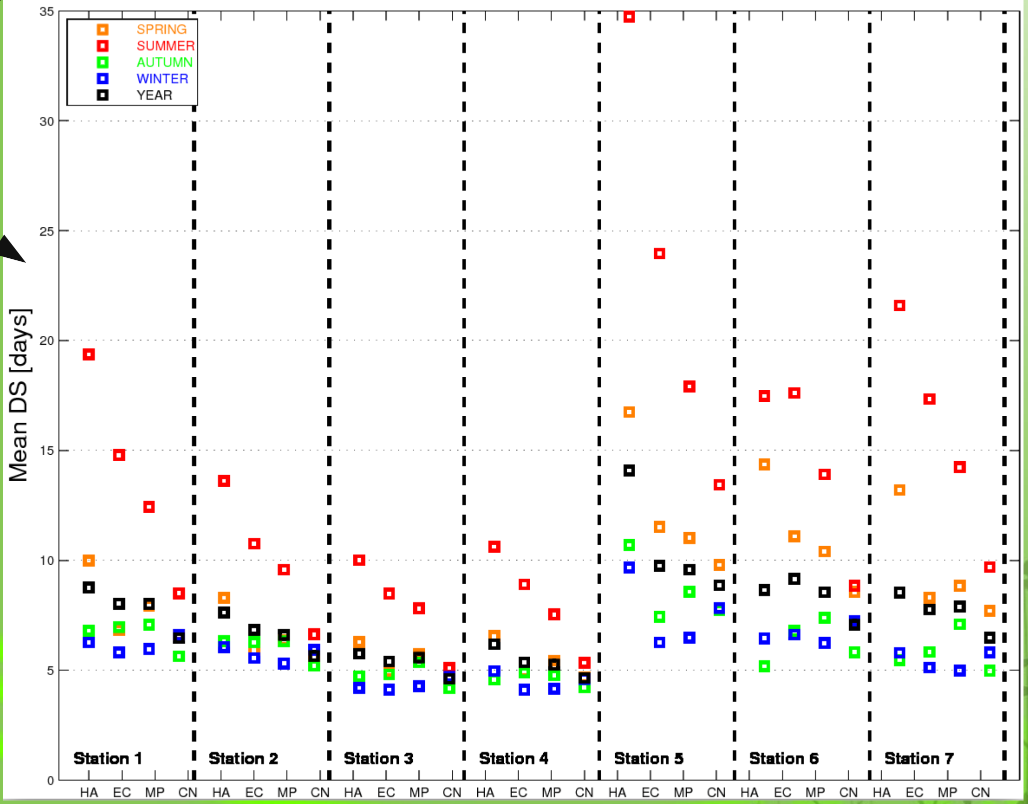


Regions	Observation	Models
	1961 – 2015	1971 – 2000
	Region's mean	1 grid cell in region
Continental (1,2,4)	**SON, DJF**	**MAM, JJA**
Adriatic coastal (3,5-7)	**JJA**	**MAM, JJA**

Drier parts of the year







Conclusion

- **DRY SPELL analysis**
  - MAX & Mean, seasonal & annual timescale, 7 regions in Croatia
  - the **shortest** DS → in mountainous region
  - the **largest** DS → in continental (SON, DJF) & Adriatic region (MAM, JJA)
  - significant **positive** trend → in mountainous region in MAM, JJA
  - consistent **negative** trend → in SON in whole Croatia, **sign**. in mountainous region
- Climate models indicate DS **increase** in SUMMER, particularly for later period
- DS (2nd period) **>** DS (1st period)
- DS (RCP4.5) **≈** DS (RCP8.5)
- **Future work** → to include more RCMs (CLM & RCA4) in analysis to estimate uncertainties related to the selection of the RCM-GCM couple

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Thank you for your attention!

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Drought on island Korčula, Croatia, 2017







“U izradi ovog dokumenta korišteni su rezultati regionalnog klimatskog modela RegCM4 dobiveni u sklopu projekta „Jačanje kapaciteta Ministarstva zaštite okoliša i energetike za prilagodbu klimatskim promjenama te priprema Nacrta Strategije prilagodbe klimatskim promjenama (Broj ugovora: TF/HR/P3-M1-O1-010)” koji se financira sredstvima iz Prijelaznog instrumenta tehničke pomoći EU.”