Studies on adaptation capacity of Carpathian ecosystems/landscape to climate change

Science for the Carpathians

CARPATHIAN CONVENTION COP5
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S4C

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The CARPATCLIM project

- Climate Atlas of the Carpathian Region www.carpatclim-eu.org
- 16 meteorological variables

- 10 selected variables:
  - minimum, mean, and maximum temperature,
  - daily temperature range,
  - precipitation,
  - cloud cover,
  - relative sunshine duration,
  - relative humidity,
  - surface air pressure, and
  - wind speed at 2m.

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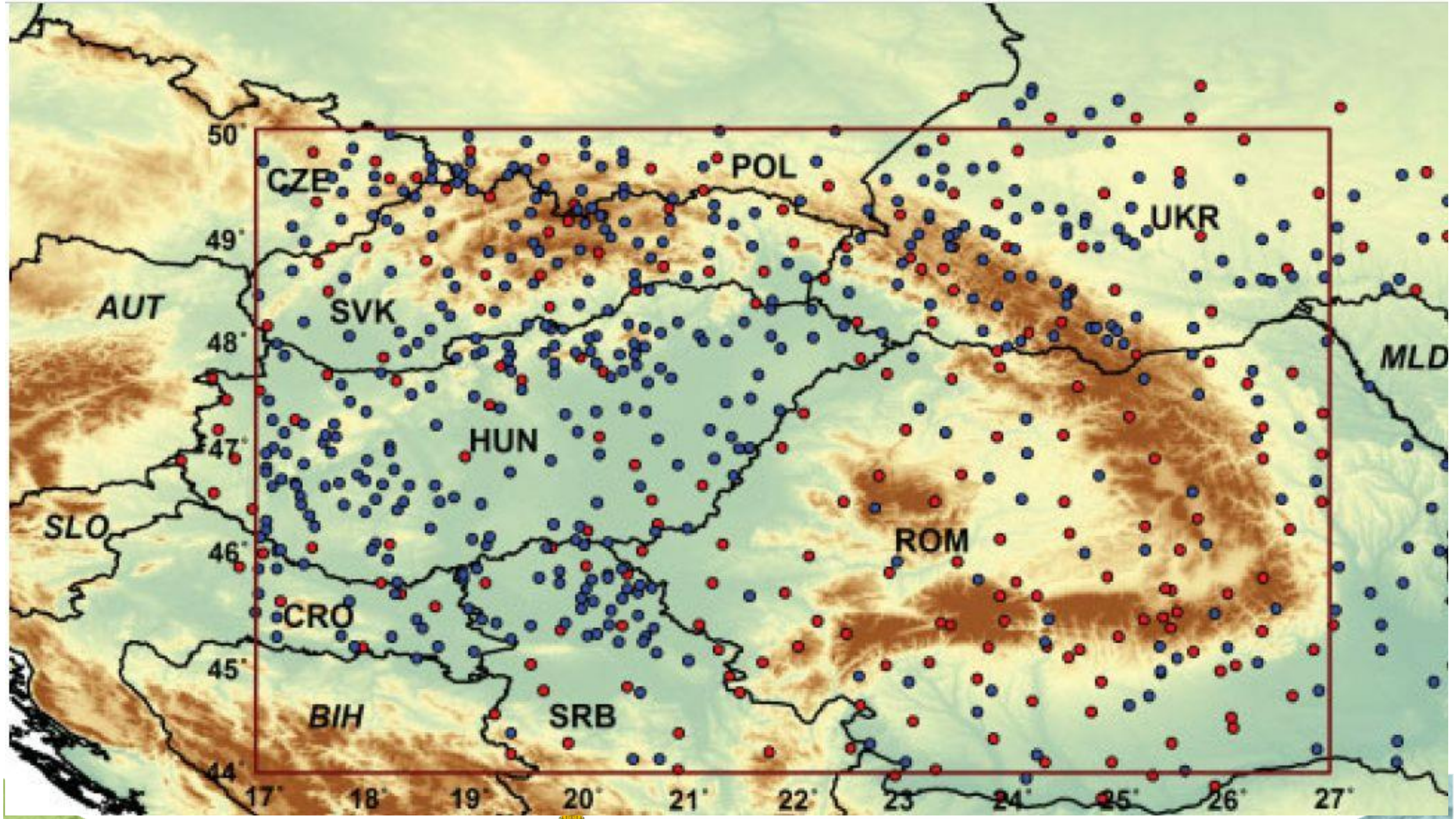
- ✓ **Temperature** ↑ in every season
  - ✓ in particular in the last three decades, confirming the trends in Europe;
- ✓ **Wind speed** ↓ in ever season;
- ✓ **Cloud cover and relative humidity** ↓ in spring, summer, and winter, and ↑ in autumn,
- ✓ **Relative sunshine duration** behaved in the opposite way;
- ✓ **Precipitation and surface air pressure** showed no significant trend, though they ↑ slightly on an annual basis.

*positive and negative sunshine duration anomalies are highly correlated to the corresponding temperature anomalies during the global dimming (1960s and 1970s) and brightening (1990s and 2000s) periods.

Spatial distribution of the climatological (red) and precipitation only stations (blue)



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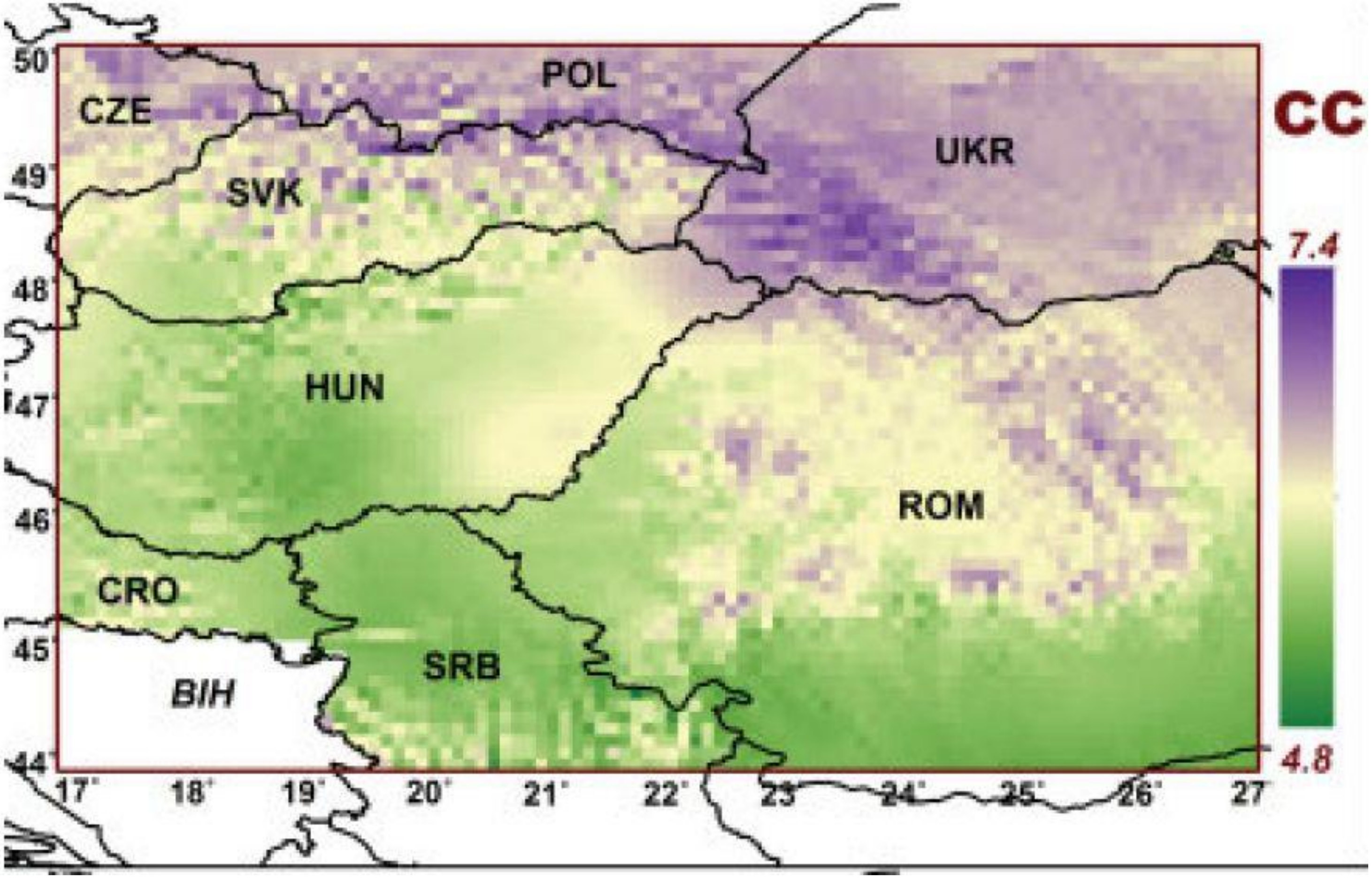
Spinoni et al., 2014

Cloud cover

period 1961–2010



- The average ***cloud cover*** (CC) is lower in summer than in winter.
- In summer, CC is **high on mountain peaks** (up to 7.2 tenths) and **low in plains** (down to 3.6 tenths), while in winter the situation is reversed.

Spinoni et al., 2014

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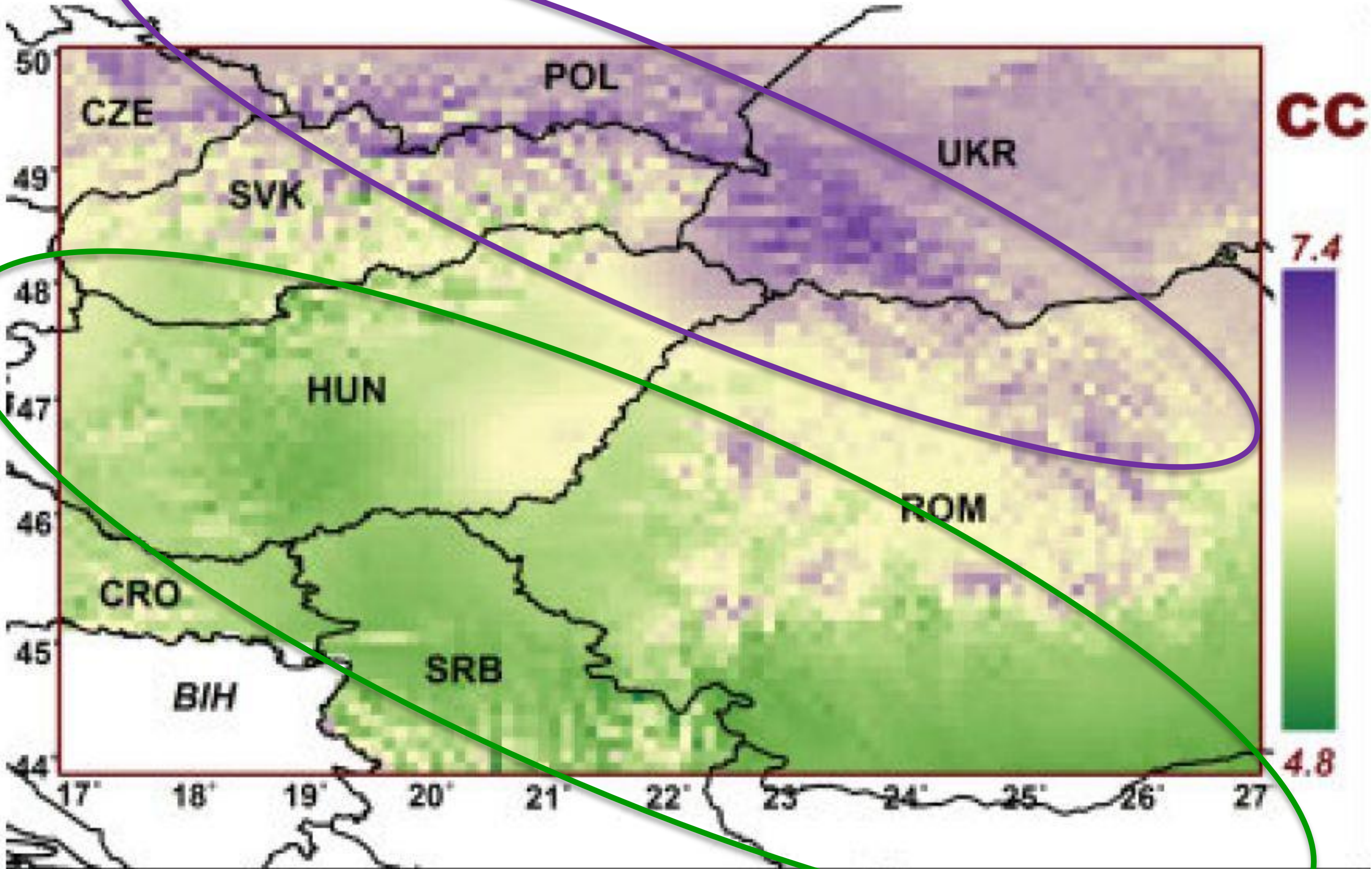

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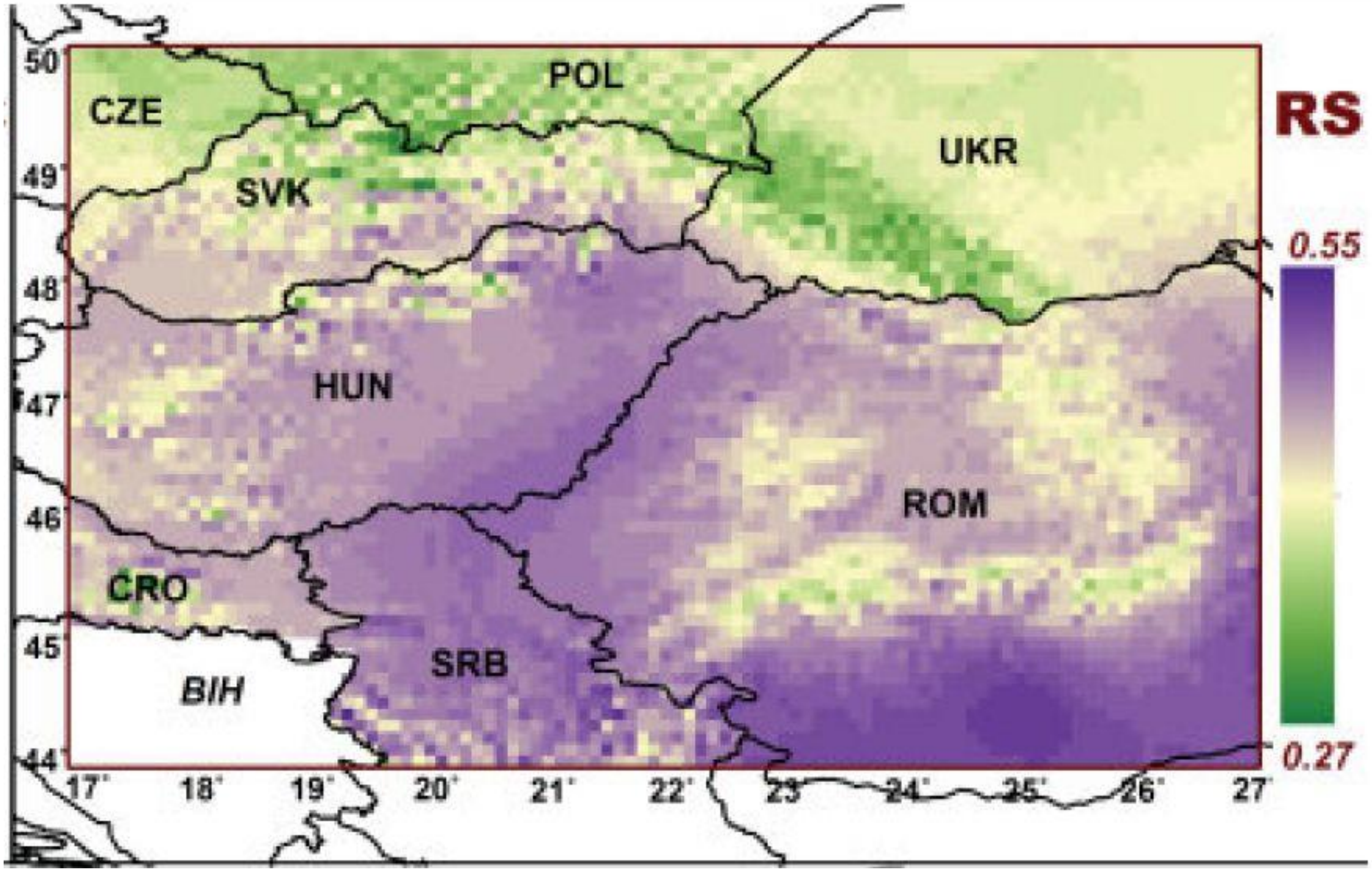
Relative Sunshine Duration

period 1961–2010.

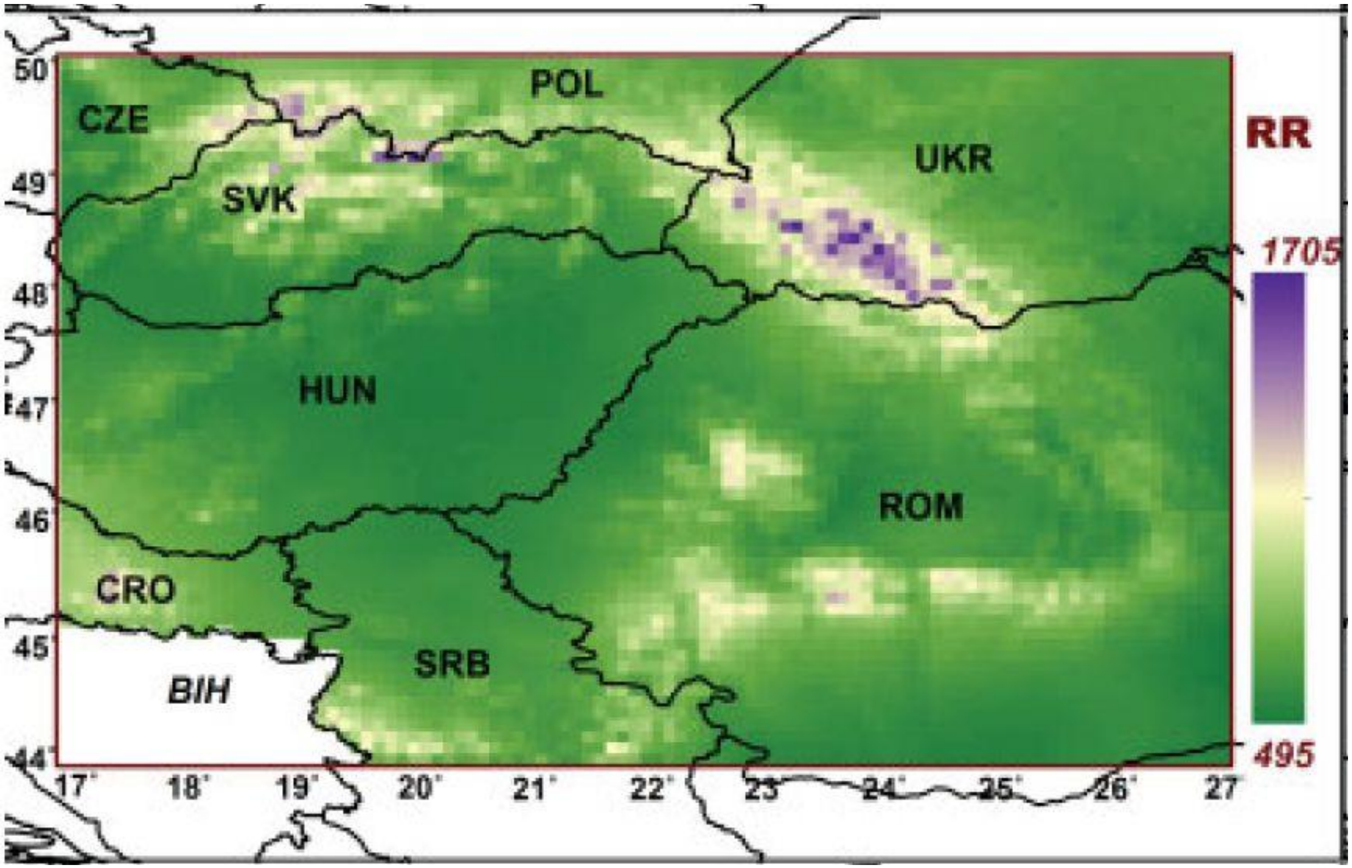


The ***relative sunshine duration*** **(RS)** behaves conversely to CC.

Spinoni et al., 2014

Precipitation

period 1961–2010.



- The rainy season lasts from May to July.
- In every season, there is more precipitation over the mountains than in the plains.
  - (up to 1650mm in the Ukrainian Carpathians and in the Tatra Mountains)
- The **lowest annual precipitation totals occurs in eastern Hungary** (550 mm), **the lowest summer totals in Serbia** (80 mm), and **the lowest winter totals in northern Romania** (70

Precipitation

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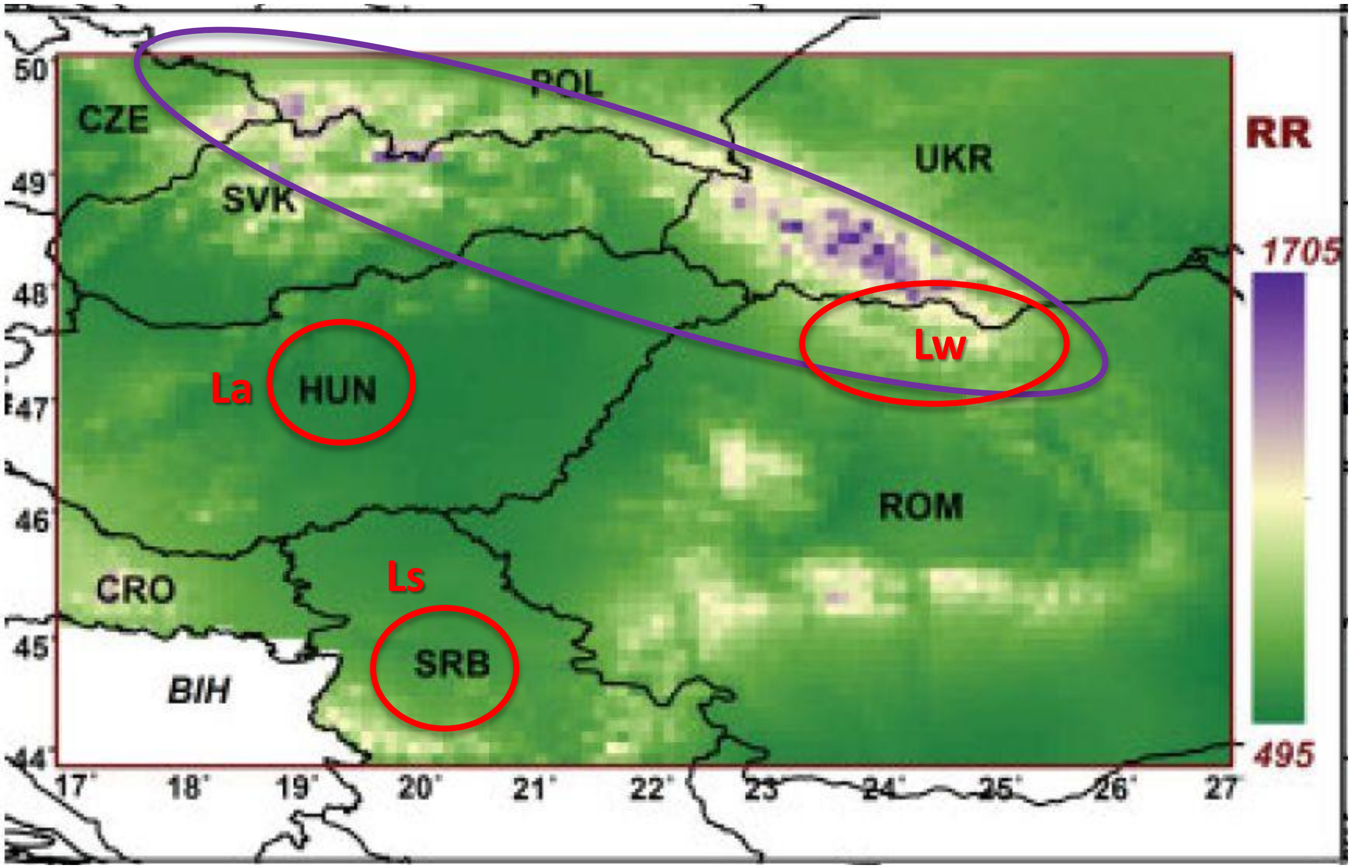

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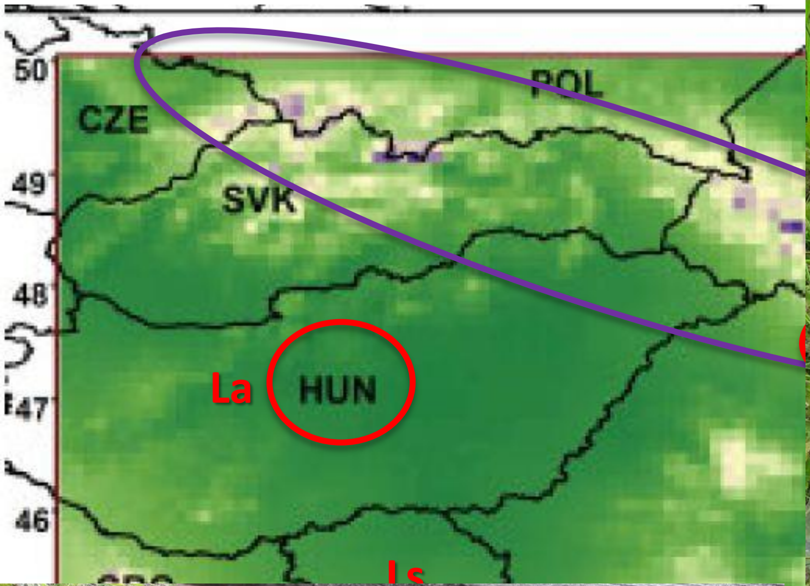
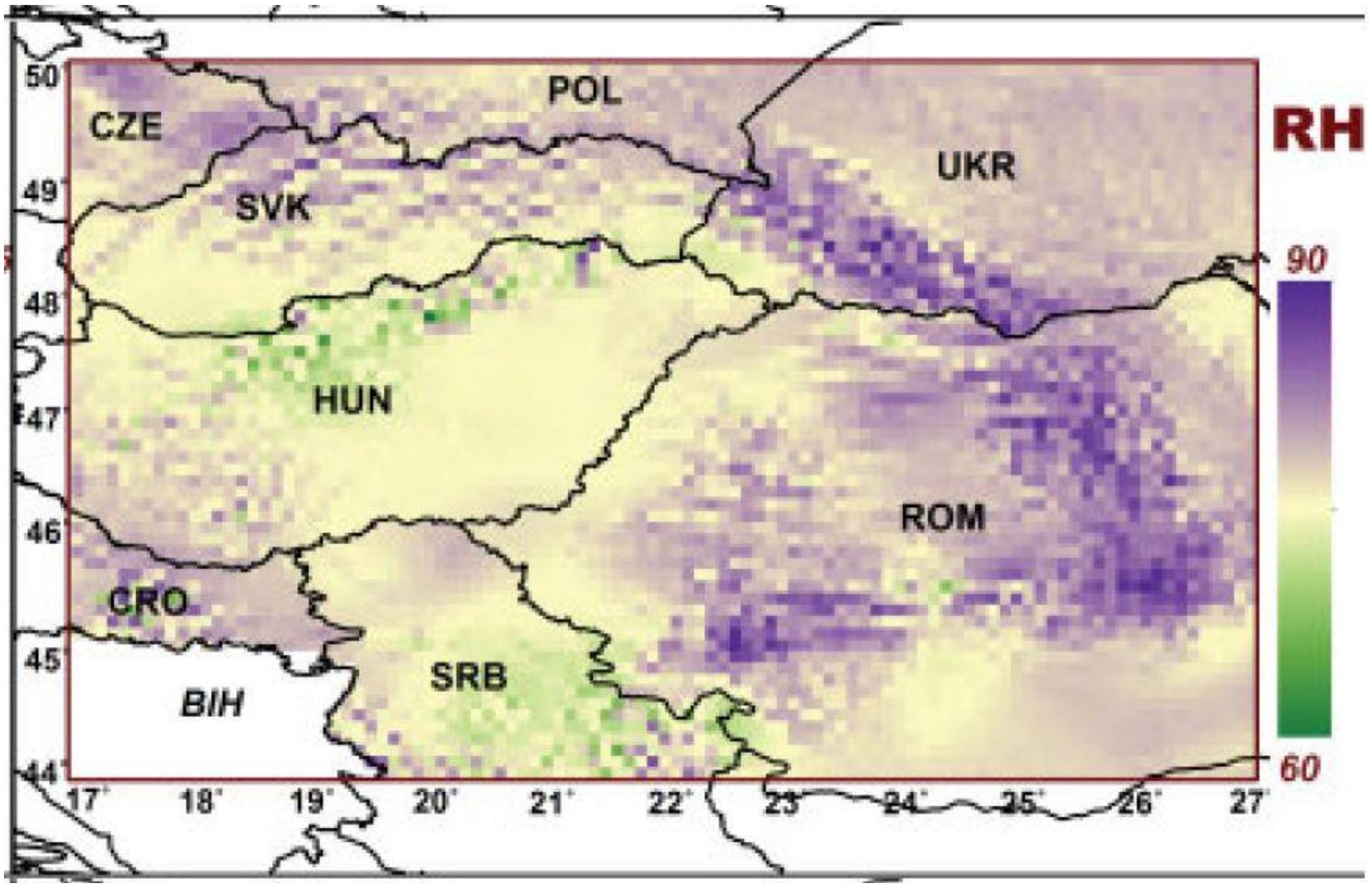


Relative Humidity

period 1961–2010

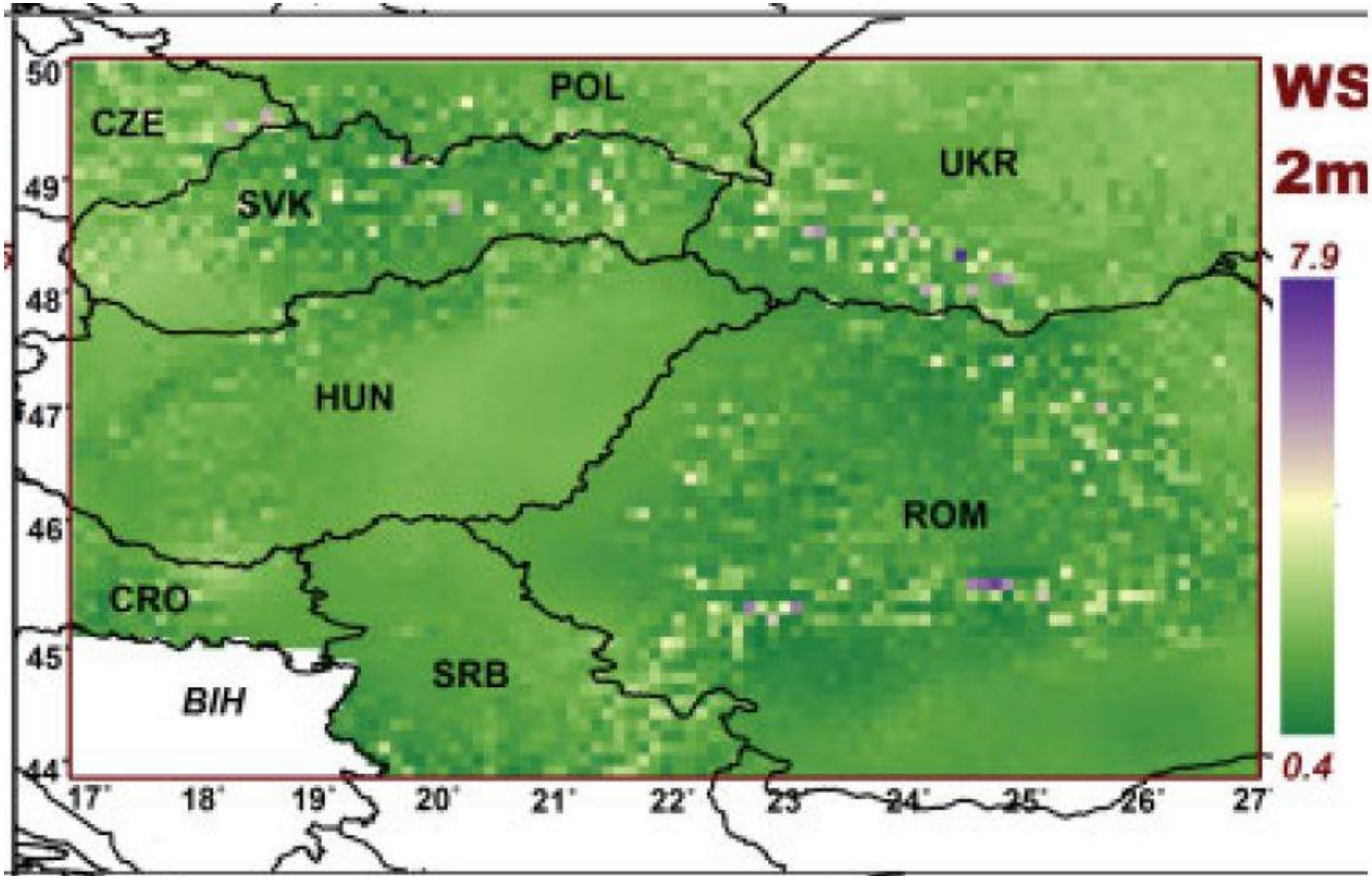


- The ***relative humidity* (RH)** is **highest above 1500m** (excluding the Tatra Mountains), while **RH is lowest in northern Hungary, Hungarian Plain, and Serbia** (70–75%).
- On average, April shows the lowest RH (70.8%) and December the highest RH (85.6%).

Spinoni et al., 2014

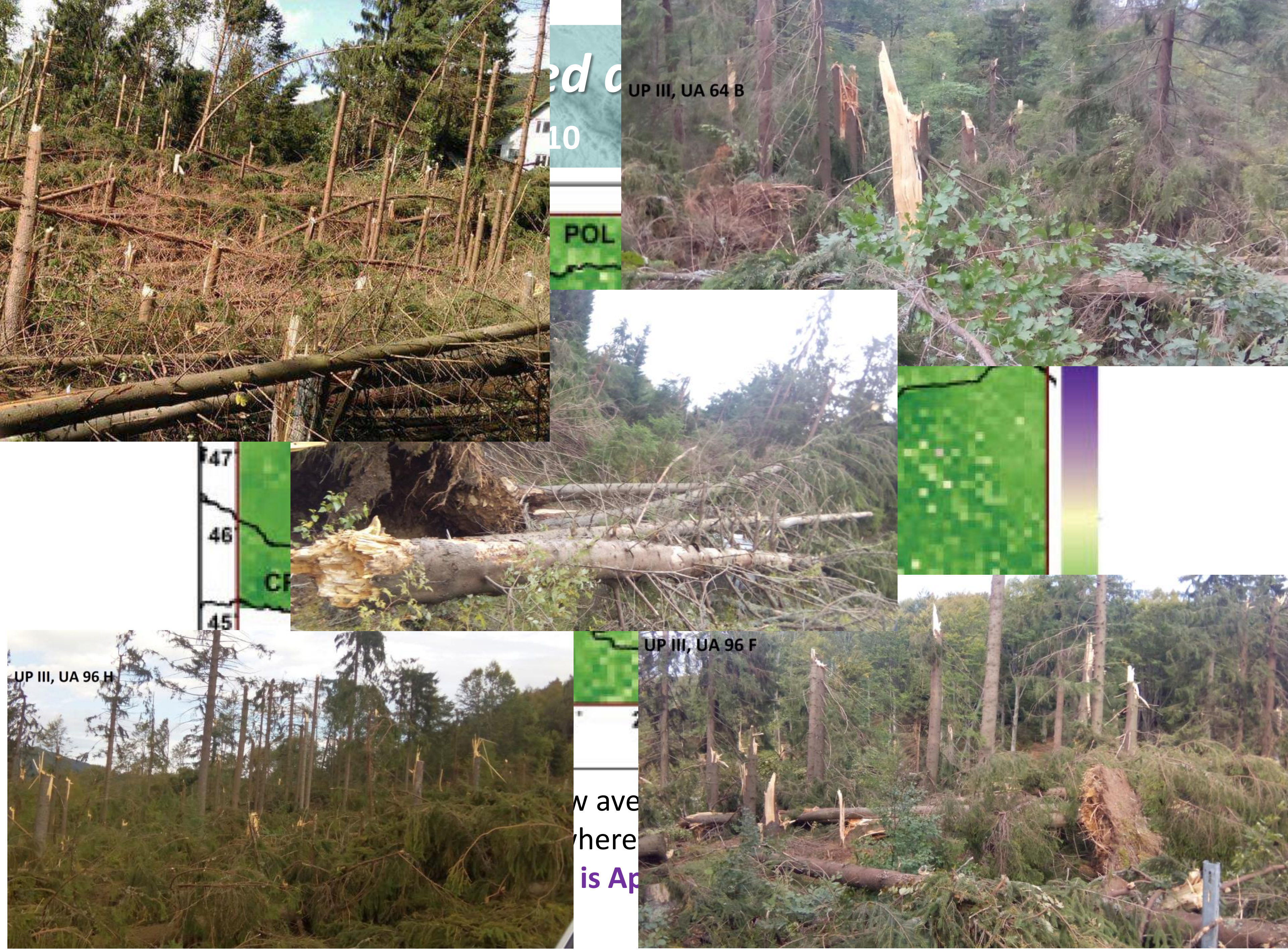
Wind speed at 2m

period 1961–2010



- The Carpathian Region shows low average ***wind speed at 2m* (WS)** (0.7–2.5ms), excluding the mountain peaks, where the wind blows up to 12–13 ms in winter.
- On average, the **windiest month is April** (RH is conversely the lowest) and August the calmest.

Spinoni et al., 2014


UP III, UA 64 B
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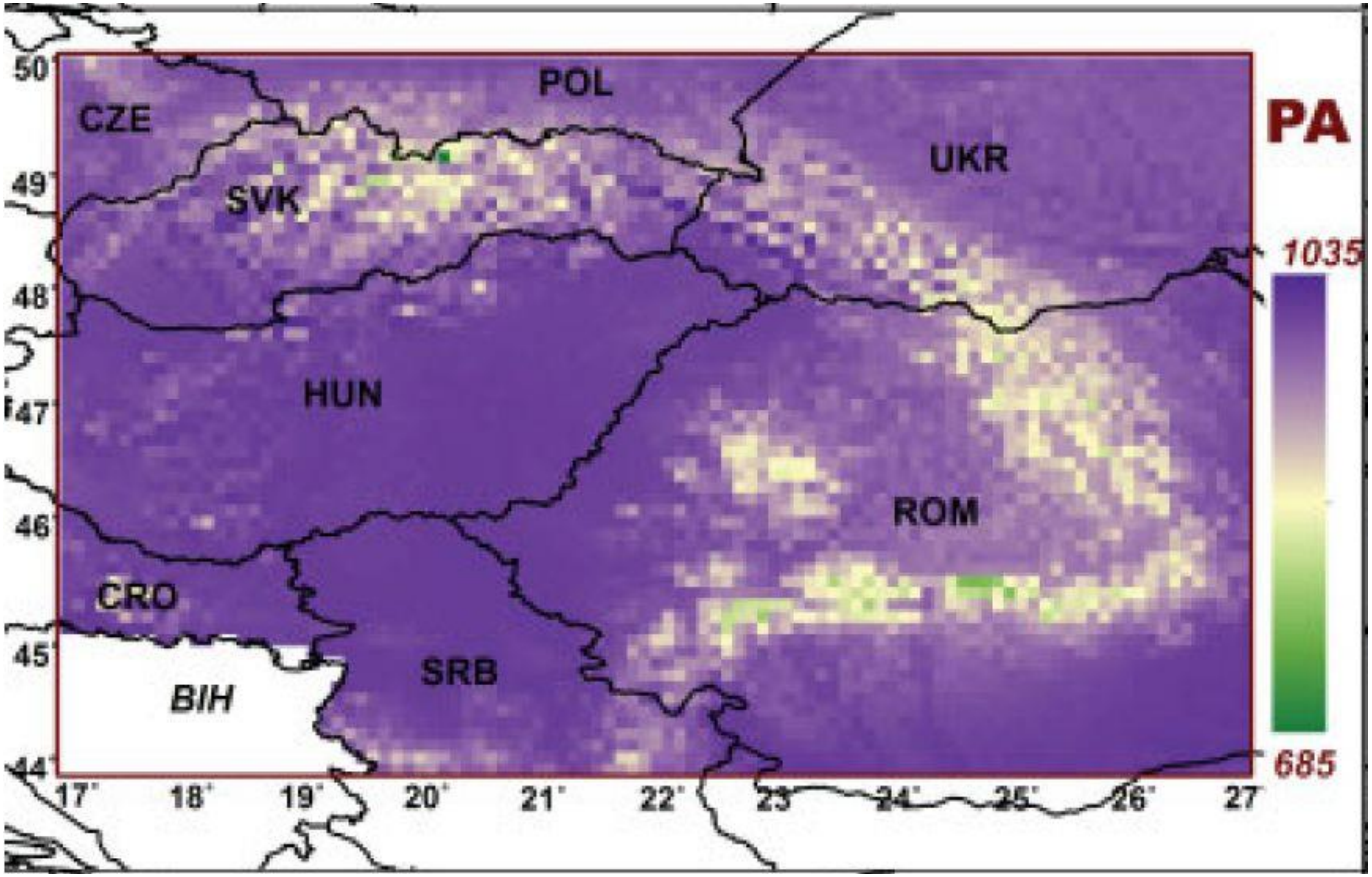
Surface air pressure

period 1961–2010.



The ***surface air pressure (PA)*** ranges from 680 to 1040 mbar.

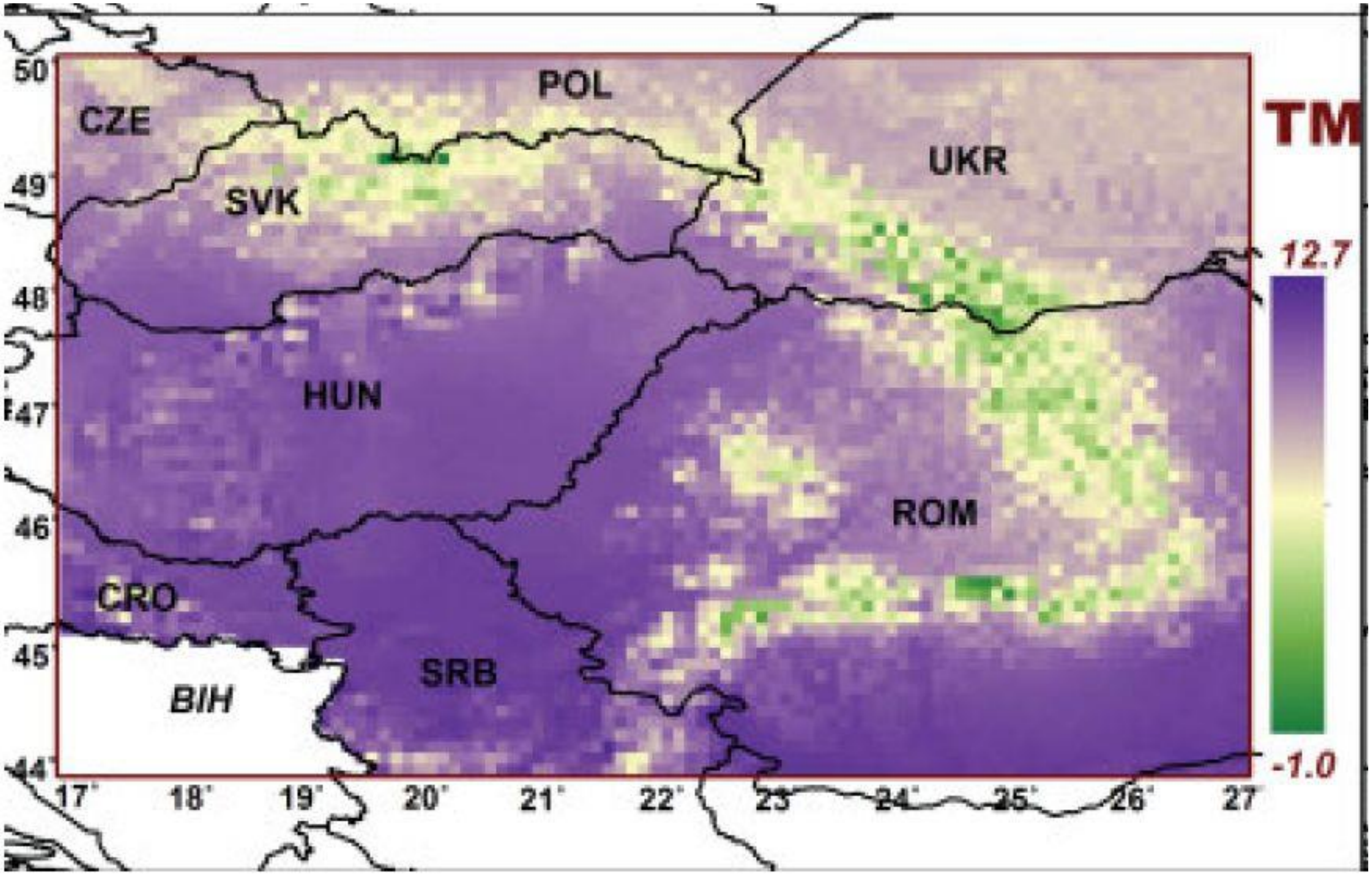
It strongly depends on elevation but no other geographical patterns

The average PA is **generally lower in summer (rainy season) than winter**.

Spinoni et al., 2014

Mean temperature

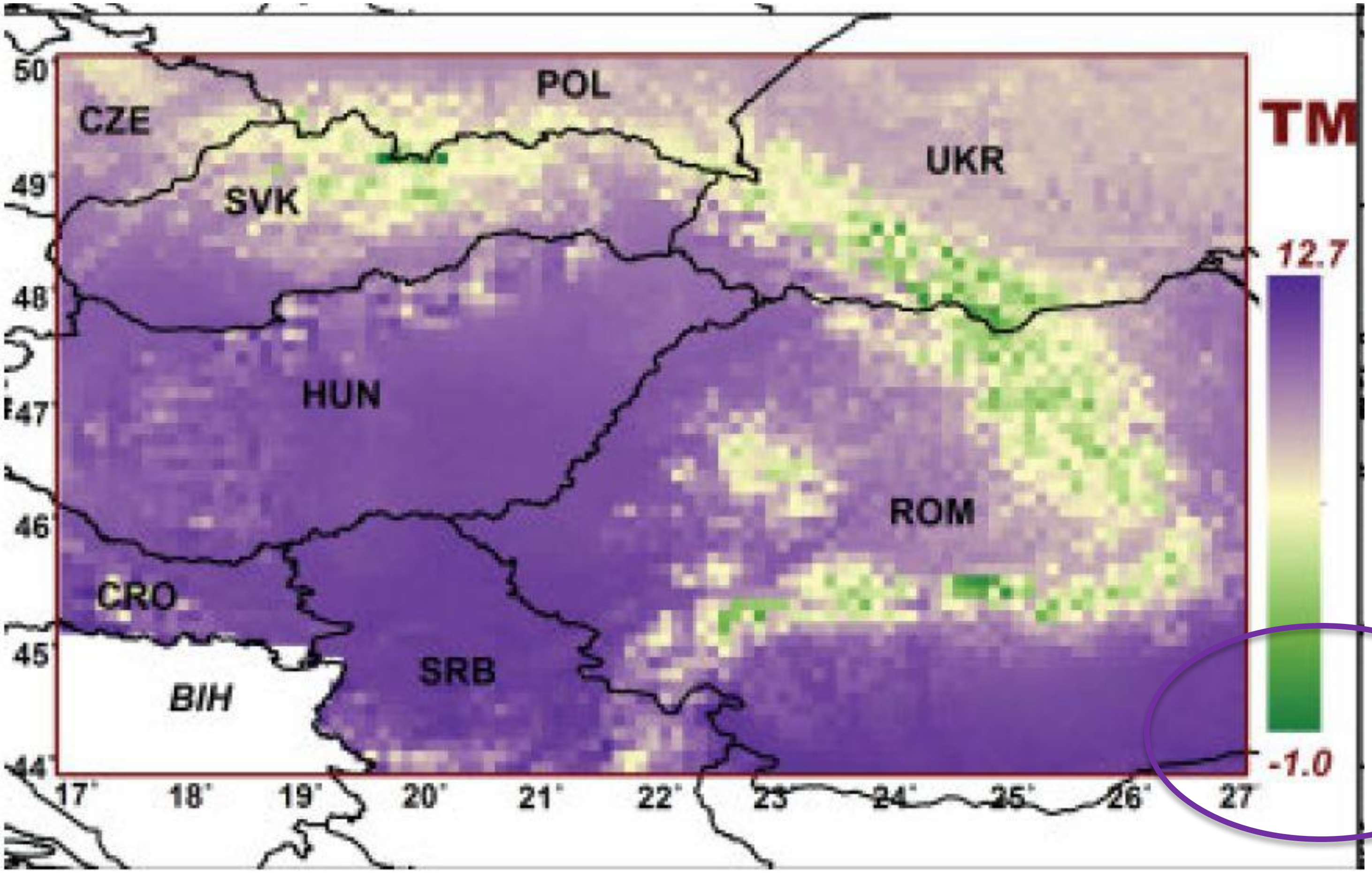
period 1961–2010



- ***Mean temperature* (TM)** mainly depends on elevation and follows an annual cycle
- The **hottest area is the south-eastern corner of the region, in Romania**.

Spinoni et al., 2014

Mean temperature
period 1961–2010



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Spinoni et al., 2014

Examples of current research issues

- **ROMANIA**
  - Six meteorological variables tested for trends at annual scale (1961-2013)
  - **Results:** significant climatic changes at annual scale in Romania.
    - Air temperature - ↑ at all stations.
    - Sunshine hours - ↑ at most stations
      - except in the mountainous regions of Southern and Curvature Carpathians
    - Wind speed - significantly ↓
      - overall tendency of terrestrial stilling
    - The annual precipitation - rather stable
      - increasing in North-Western Romania
      - decreasing in the Danube Delta
    - Cloud cover - generally ↓
    - Relative humidity - mixed trends.

Marin et al., 2014

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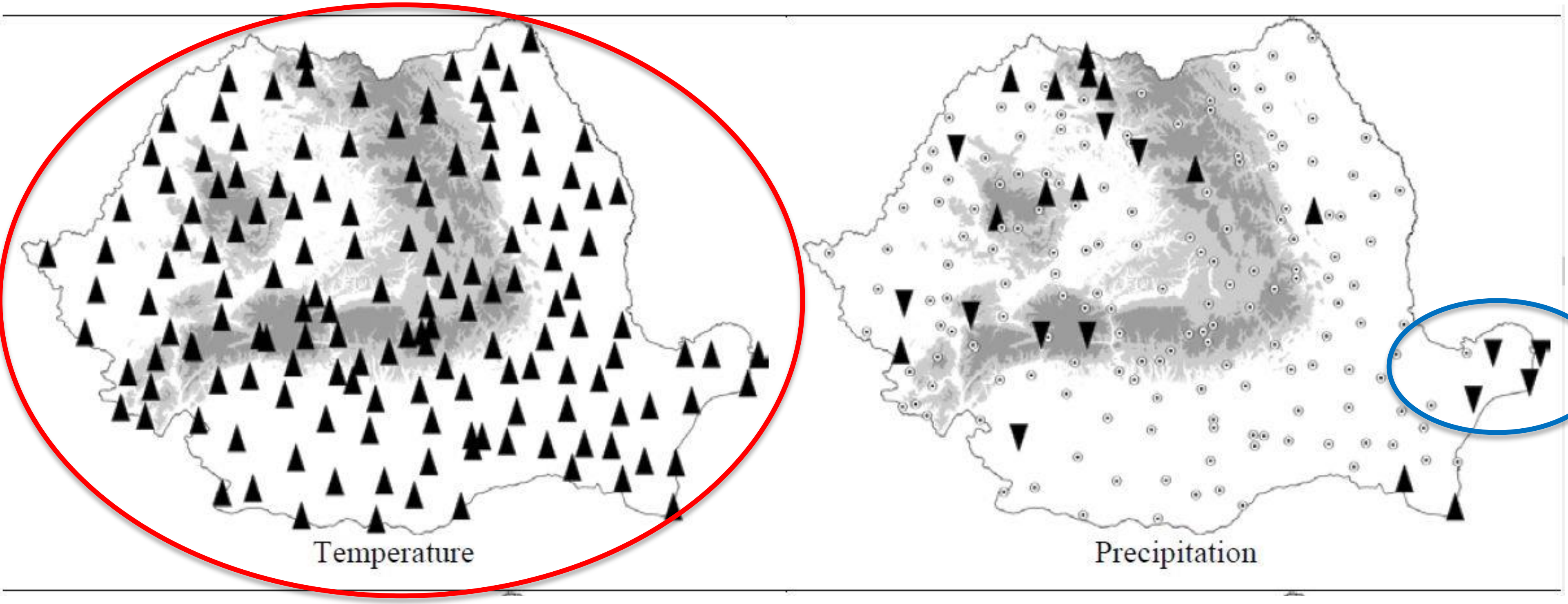
ROMANIA: Annual trends (1961-2013)



Marin et al., 2014

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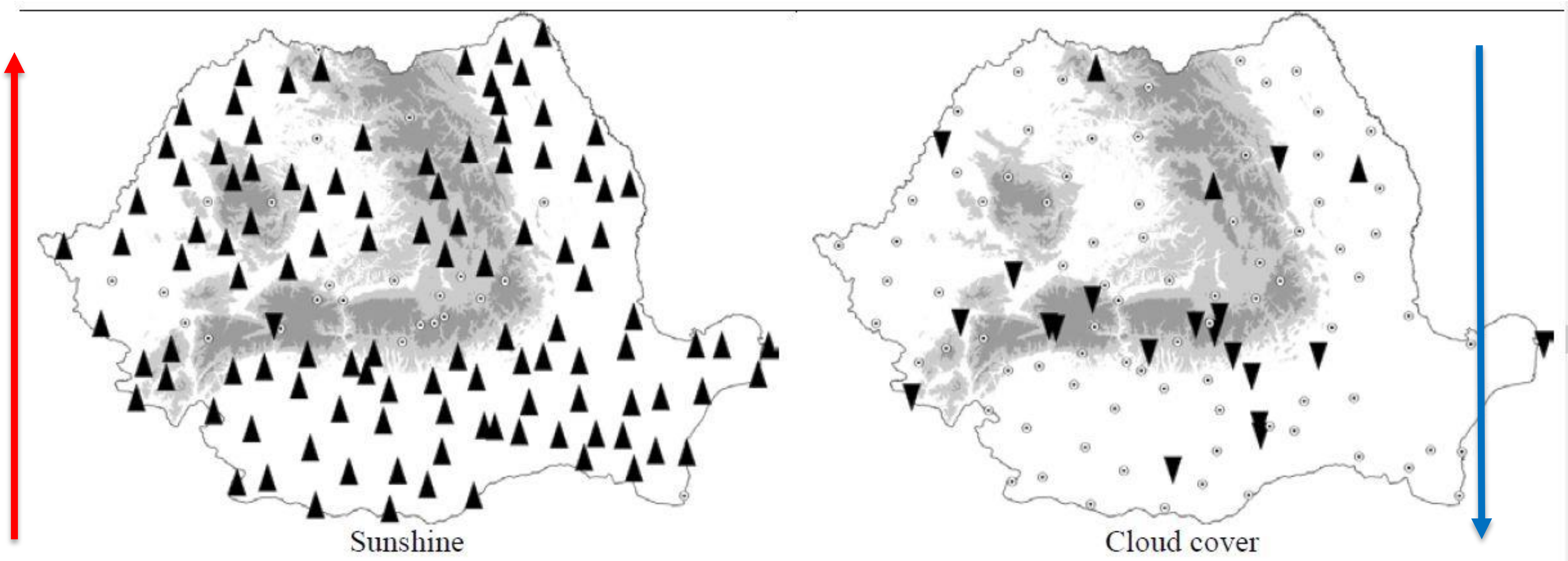

Marin et al., 2014

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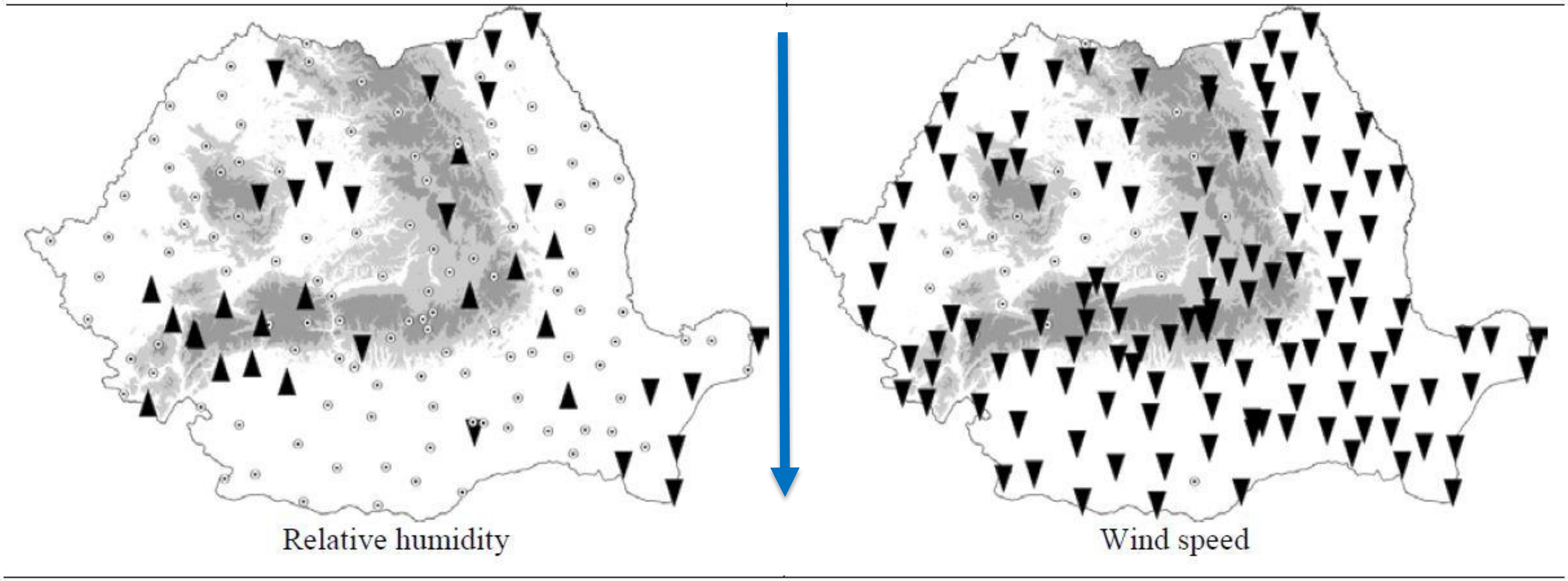
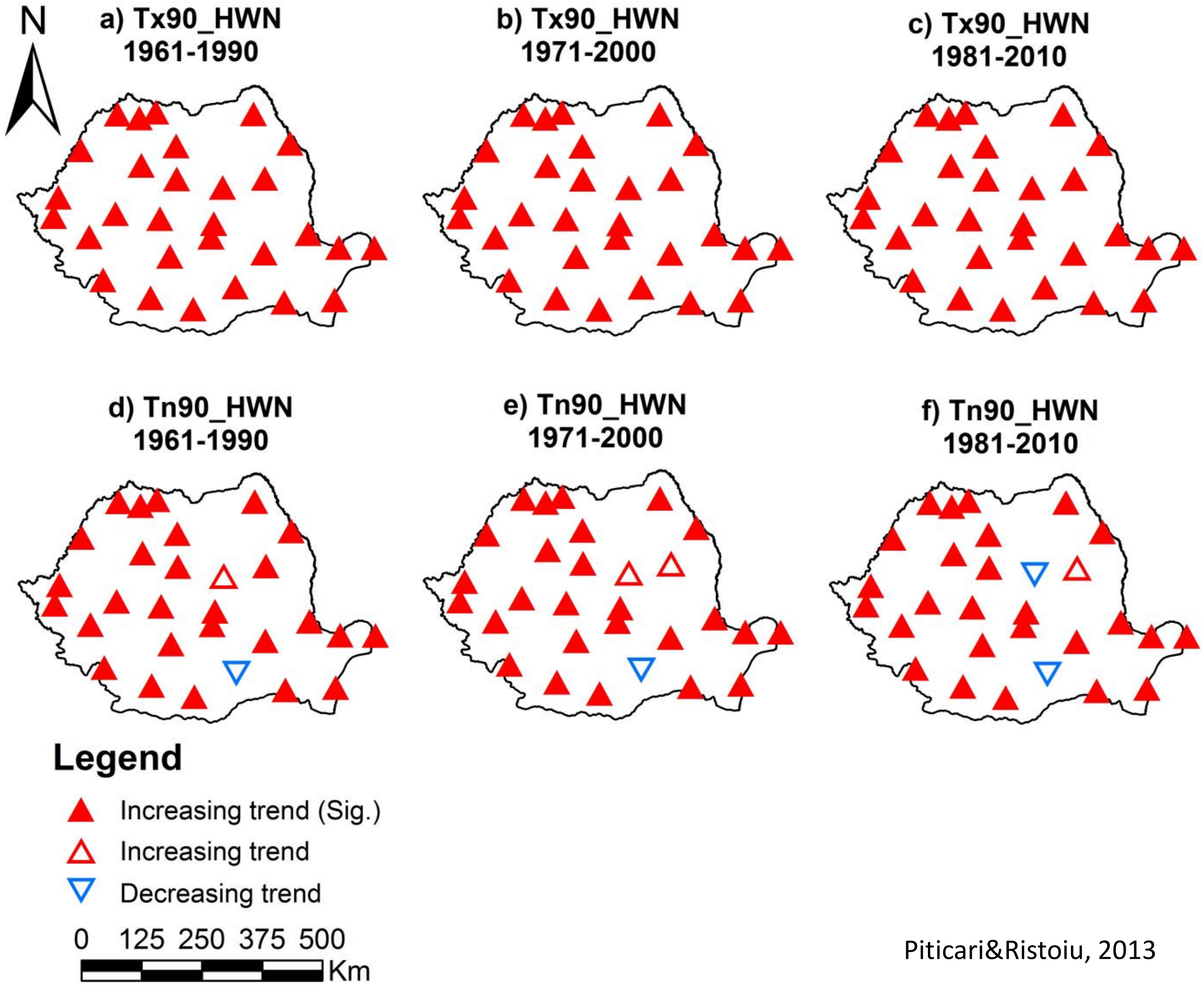


Marin et al., 2014

Romania: Number of Heat Weaves (1961-2010)



Piticari&Ristoiu, 2013

Examples of current research issues

Extreme precipitation in the Polish Carpathians, 1881–2010

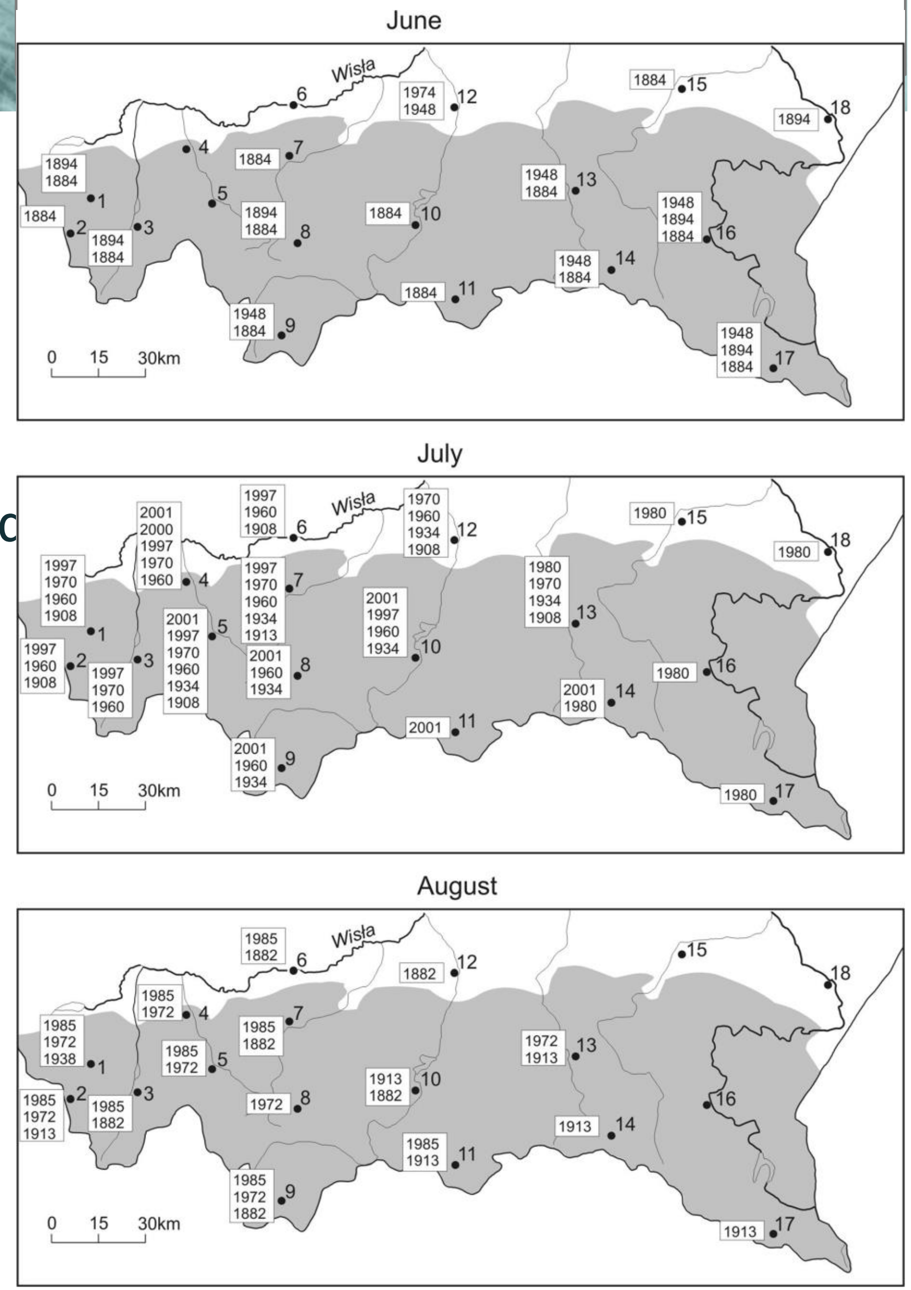
- monthly totals of precipitation
- 18 stations
- **Anomalously Heavy Precipitation (AHP)**

Twardosz et al. 2016

AHP months in summer

Conclusions:

- most AHP spatially limited to 1-2 stations (typically neighbouring)
- local conditions, as well as circulation-related factors, influenced their occurrence
- May - **<u>largest</u>** area coverage (5 stations on average)
  - May 1940 and May 2010 recorded at all stations
  - both triggered catastrophic floods
- November - **<u>smallest</u>** coverage (2 stations on average)



Twardosz et al. 2016

Paleoclimate variability studies

- The study of vegetation dynamics based on fossil records
  - Clarifying aspects from the past, building scenarios for the future
- Carpathian Mountains - major biodiversity area, with “hotspots”
  - Refuge for various taxa during the Pleistocene glaciations
- **Aim:** establish general and particular traits of forest evolution
  - study area: Carpathian region
  - time frame: the last glaciation (interval Middle-Upper Pleniglacial – Preboreal)

(Fărcaş et al. 2006, Feurdean & Tanţău 2016, Jamrichová et al. 2017).

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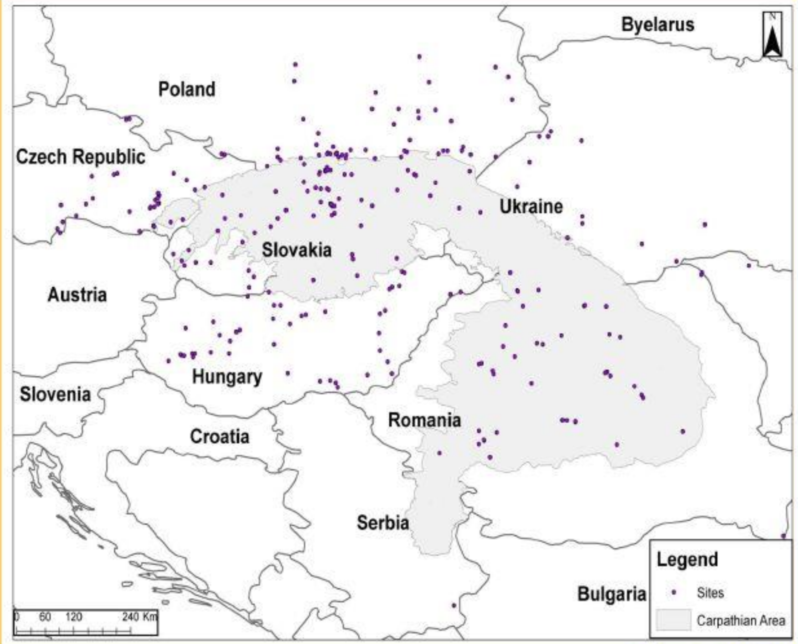
Farcas et al., 2017

Paleoclimate variability studies in the Carpathian region

- Analyzed the records of **pollen, plant macrofossils and charcoal**
- Selected sites from the Carpathian area
- Result: preliminary database of **250 sites**
- **18 arboreal taxa**
- **Distribution maps for each of these taxa in the selected time intervals**

Farcas et al., 2017



Tab. 1. Sites location corresponding to the selected periods

Nr.	Carpathian Region	Pleniglacial	Last Glacial Maximum	Late Glacial	Preboreal
1	Czech Republic	12	4	19	17
2	Slovakia	4	4	13	14
3	Poland	34	6	43	44
4	Ukraine	5	3	9	7
5	Hungary	14	11	29	21
6	Romania	10	3	25	31
7	Serbia	-	-	1	-

Conclusions

- The **diversity of relief and dynamic interplay between North Atlantic, continental, and Mediterranean atmospheric circulation** patterns that characterize the Carpathian–Balkan region are clearly reflected in the extreme habitat fragmentation and exceptional biodiversity.

- **Past environmental dynamics are significantly understudied**, although these characteristics currently feature **as key topics in conservation policies, land-use management and sustainability**

- The region, and particularly the **Carpathian area is often pictured as a blank-spot in regional climate reconstructions,** although new palaeoclimatic records are continuously being reported

- **A denser network of records sustained by multi-proxy investigations is needed** for improving knowledge in the field of past and current climate change research, biodiversity patterns and dynamics, or human spread and related cultural–technological interchanges

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Conclusions

- ✓ **Central Eastern Europe** (CEE) lies at the *(climatic) transition between* Western Europe and the large continental mass extending beyond the Carpathian range

- ✓ The **Carpathian range** act as a boundary between the *two major climatic influences acting within the European continent*.

- ✓ The **diversity of landforms**, particularly of those with glacial, periglacial or paraglacial origins, and underground cavities (e.g., caves and caves with lakes), provide *opportunities for palaeoclimate and palaeoenvironment reconstructions*.

- ✓ Prior to **the last two decades**, the CEE was *largely unrepresented in large data reviews*.

- ✓ **More recently**, as new palaeoclimatic records are continuously being generated, the area is no longer a blank spot in climate reconstructions.

- ✓ **Lake sediment and glacial deposits-based palaeoclimatic** research in the region has been aided by the publication of two databases comprising all glacial lakes and glacial cirques from the Romanian Carpathians (Mîndrescu, 2016; Mîndrescu et al., 2016a).

Key messages

- **Protect our Carpathians environment**. Climate change threatens the European protected areas and in the Carpathians there are many natural conservation areas and 'vulnerable' eco-regions. <u>Carpathian environment can not be considered an economical target</u>.
- **Protect our Carpathians forests and their biodiveristy** for ecosystem services. **Acting more for reforestations**. Though the conservation of mountain areas is well maintained in the Carpathians and forests there have enlarged since the end of the World War II, they are subject to <u>air pollution and other threats linked with climate change</u>.
- **Encourage people to live in the Carpathians** region and to mentaian and preserve their traditional way to live (which is not harmfull for the environment).
- **Better management of the resources** in the Carpathians especially for <u>water, soil, forest and pasture</u>. Water scarcity and climatic extreme events (e. g. extrem winds, cold and warm waves etc.) would be a problem in the future.