

# Climate change and adaptation in the Carpathians

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# Carpathians

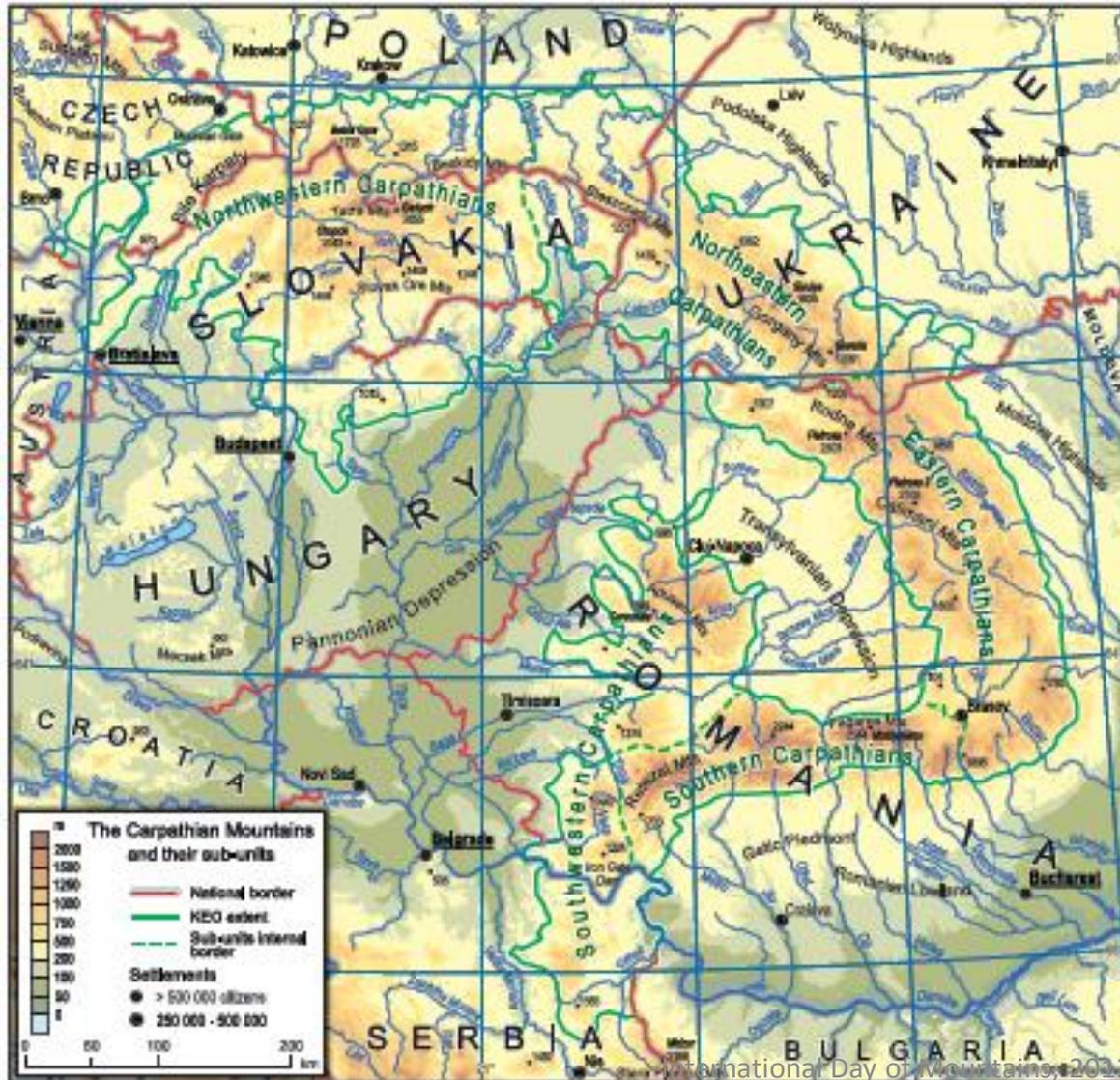
- Length about 1500 km<sup>2</sup> , second longest in Europe
- Highest peak is 2655 m
- Area is 190000 km<sup>2</sup>

# Location



International Day of Mountains, 2012

# Map of the Greater Carpathian Region



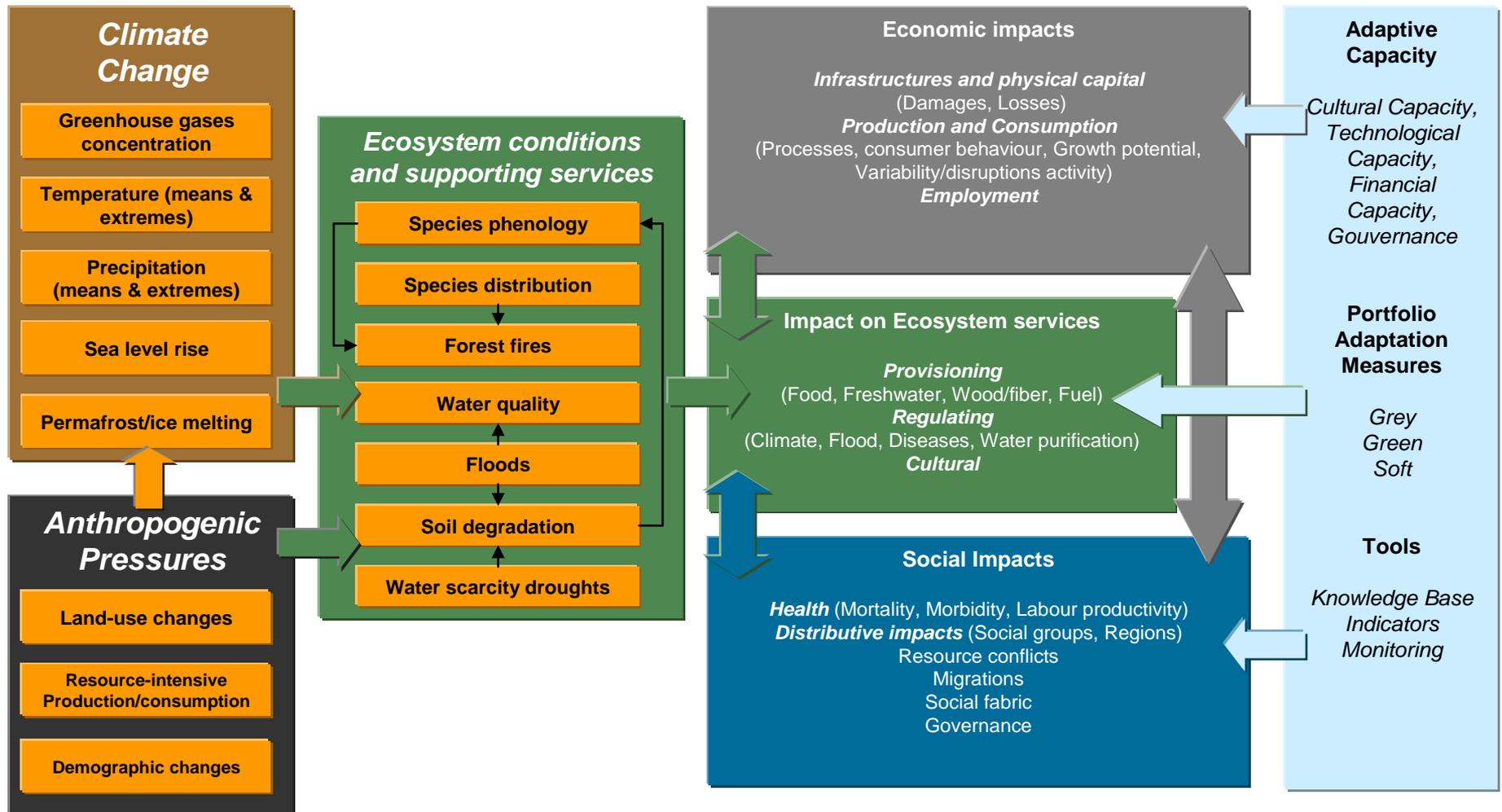
Area of the square around is about 500000 km<sup>2</sup> (appr. the territory of Spain)

# Problems

- Less studied regions
  - Carpathians
  - Southeastern-Europe
- Smaller countries mostly with complex topography
- Specific climatological and meteorological effects:
  - The basin is open to south
  - Could water pillow
  - Summer drying
  - etc.

# Environmental pathway of vulnerability and adaptation

Jacques Delsalle, Evdokia Achilleos, DG Environment, Unit D1 – Protection of Water Resources



# EU Carpathian projects

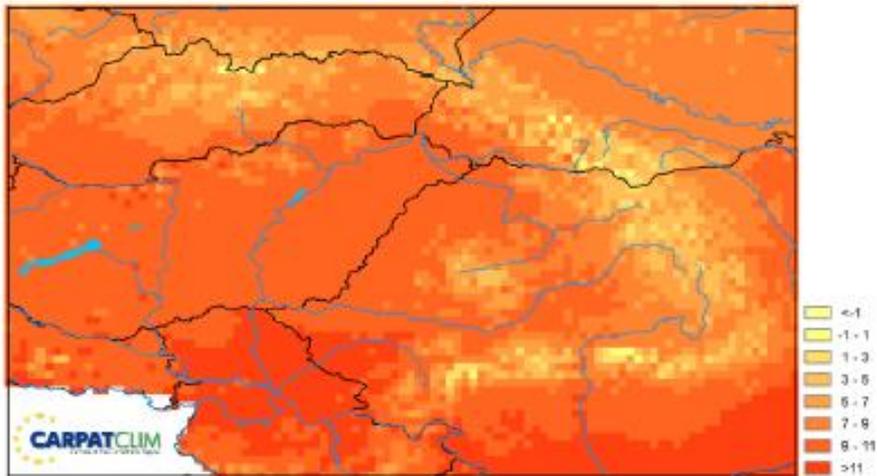
- Climate of the Carpathian Region (CARPATCLIM)
- Integrated assessment of vulnerability of environmental resources and ecosystem-based adaptation measures (Service contract CARPIVIA)
- In-depth assessment of vulnerability of environmental resources and ecosystem-based adaptation measures (Framework contract CarpathCC)

# CARPATCLIM results

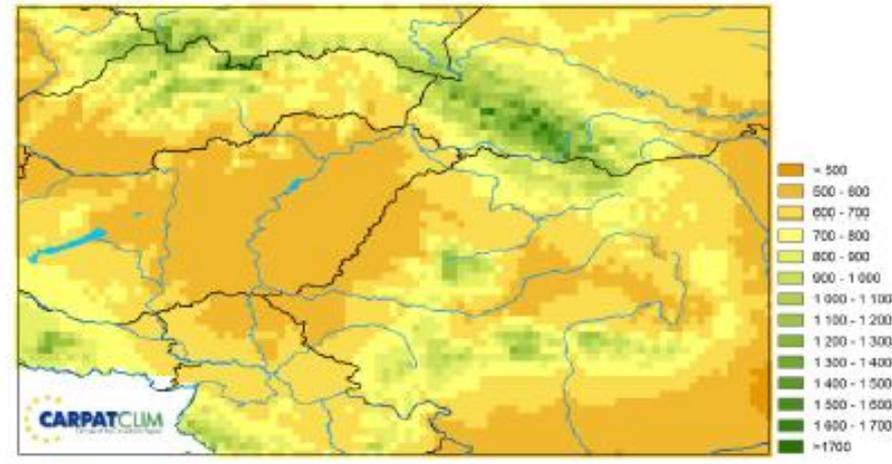
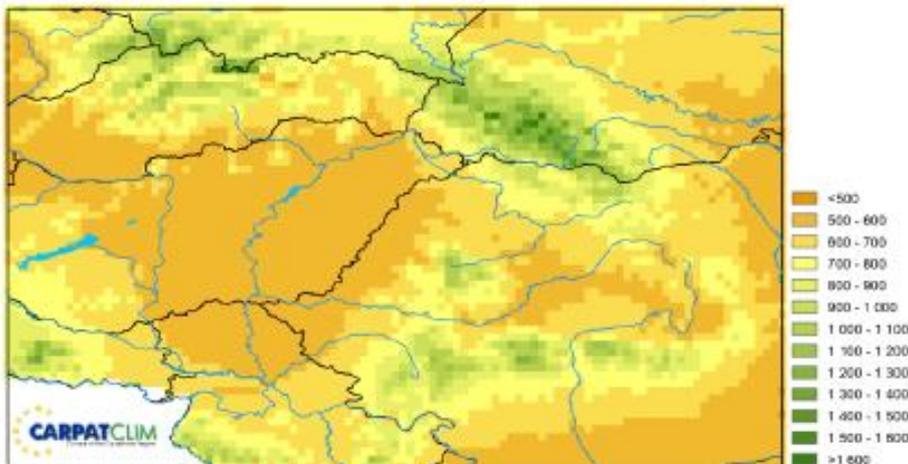
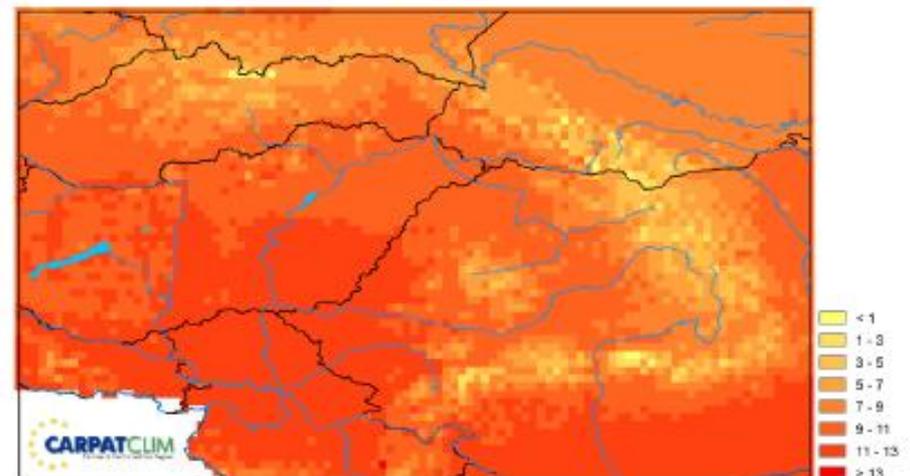
- High-resolution (10 km\*10 km) freely available databases
- Data availability on monthly and daily level
- Time frame: 1961-2010
- Results shown below based on Lakatos et al., 2012

# Temperature and precipitation averages

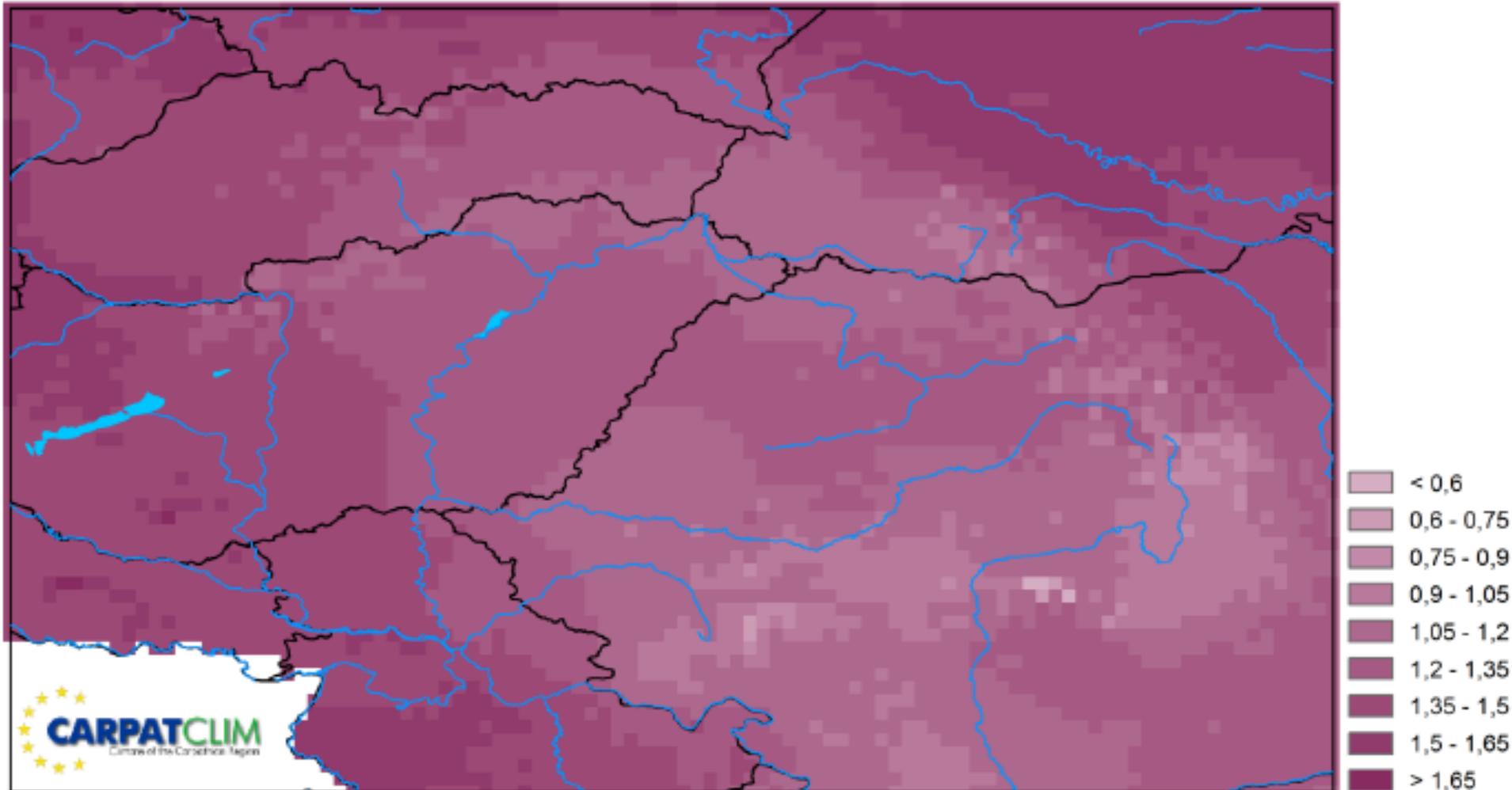
**1961-90**



**1981-2010**

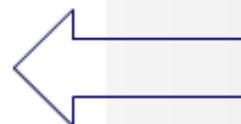
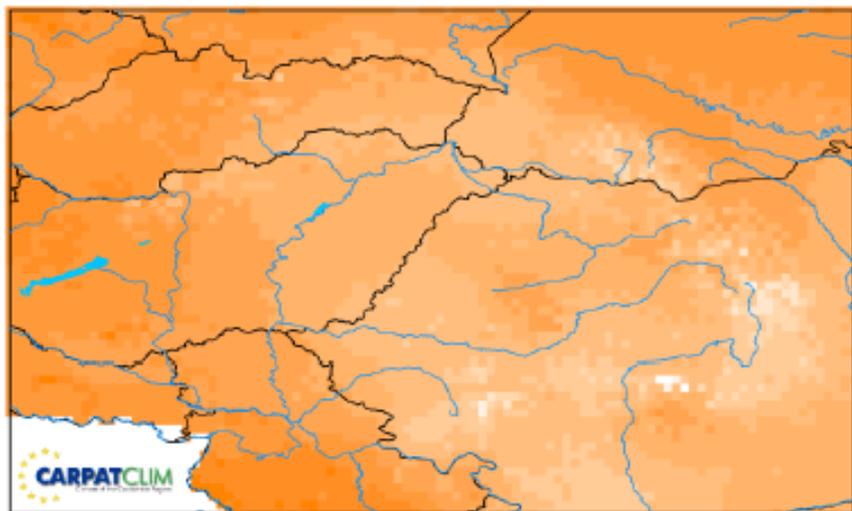


# Temperature changes, 1961-2010



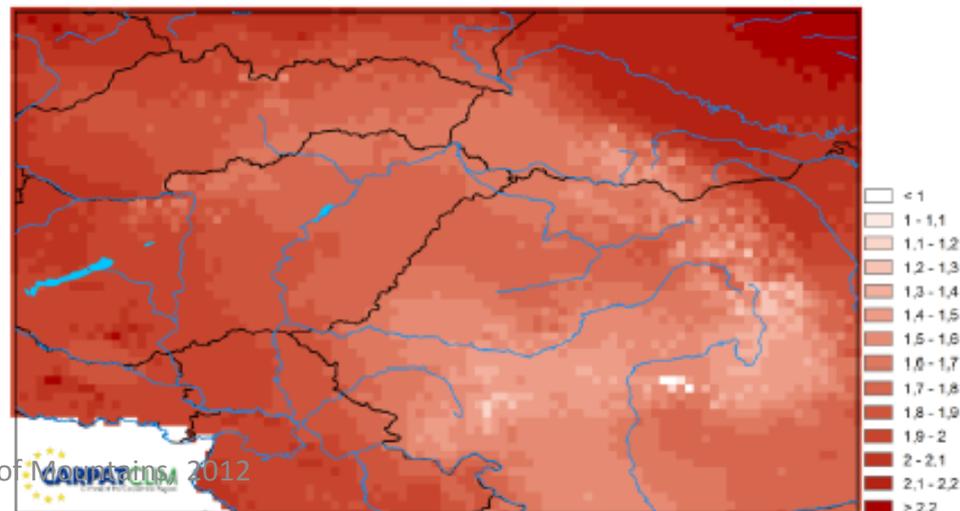
International Day of Mountains, 2012

# Estimated temperature changes according to the bounds of the 0.1 significance confidence interval, yearly, 1961-2010

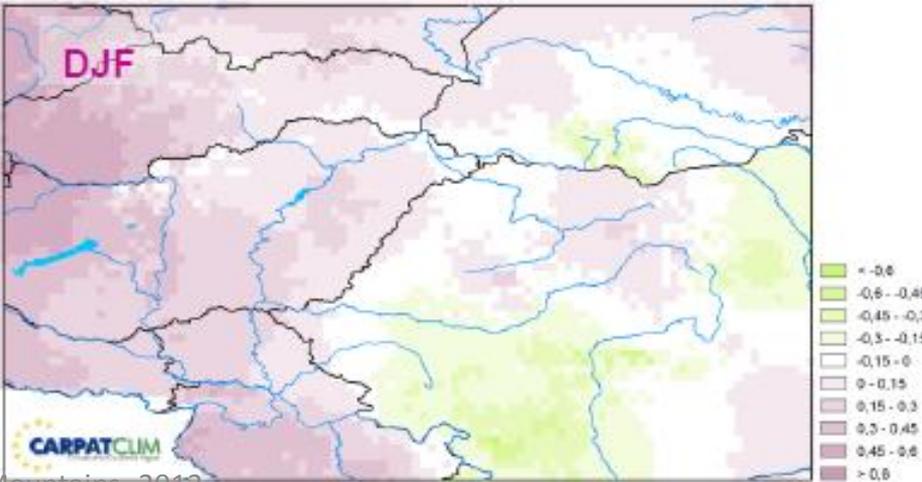
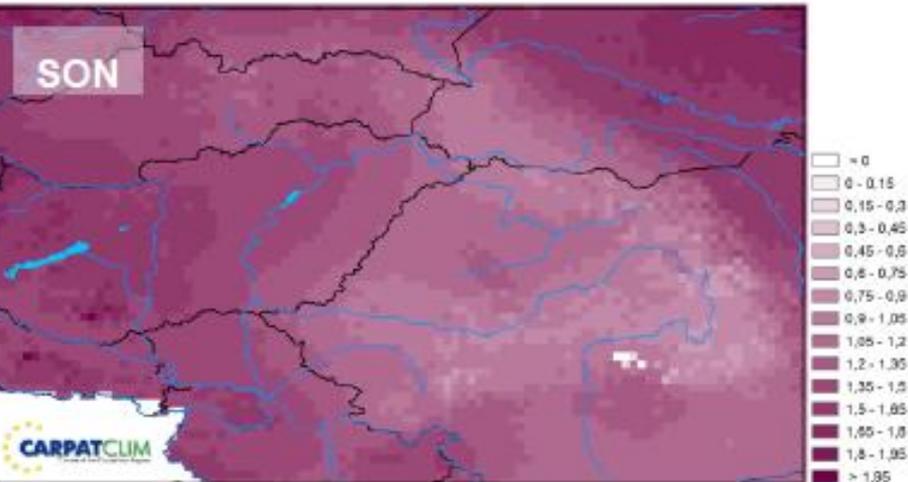
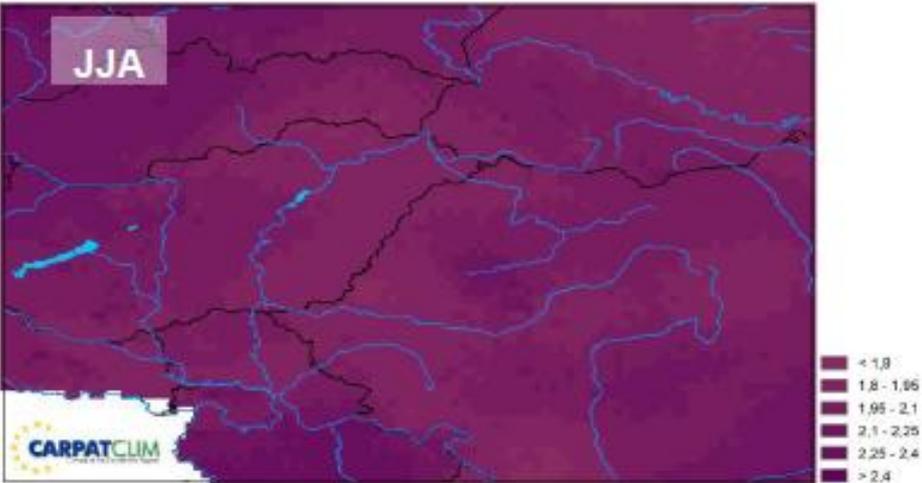
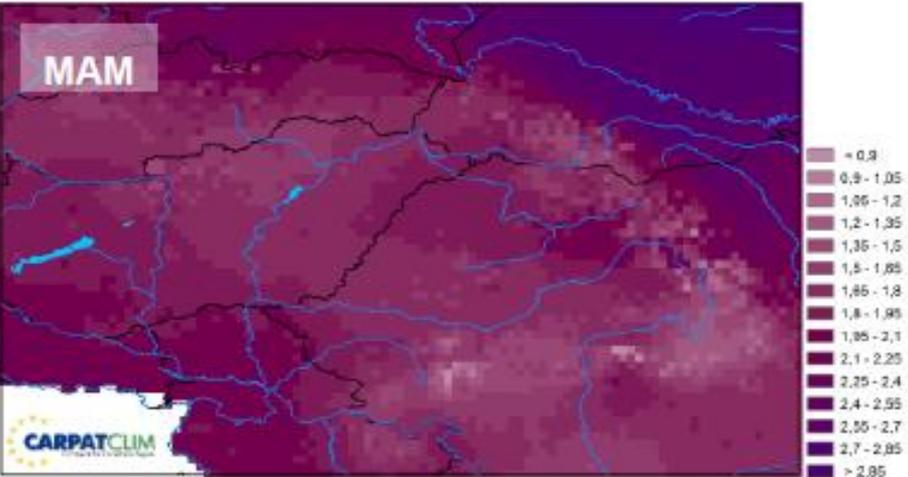


lower bound estimation

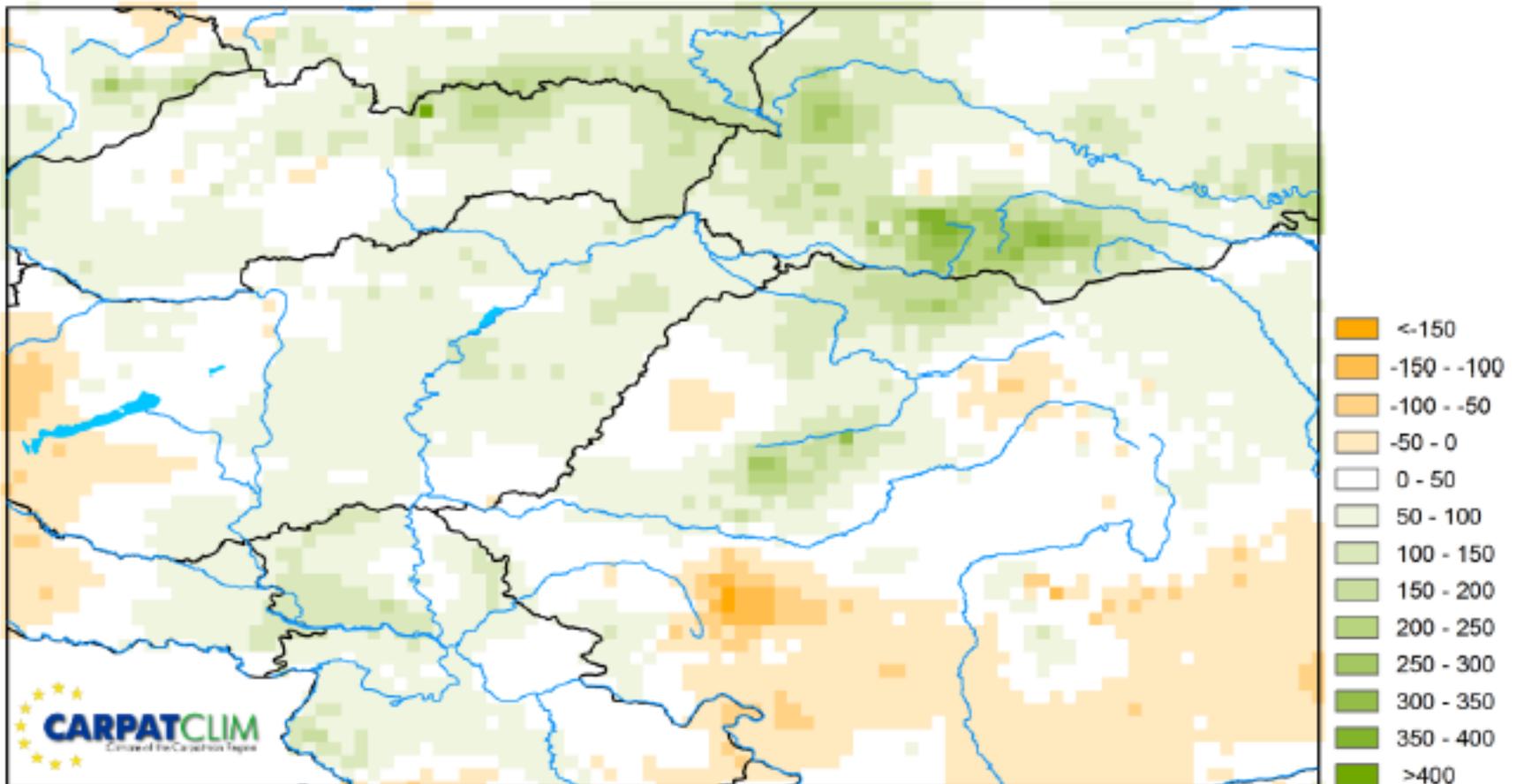
upper bound estimation



# Seasonal temperature changes, 1961-2010



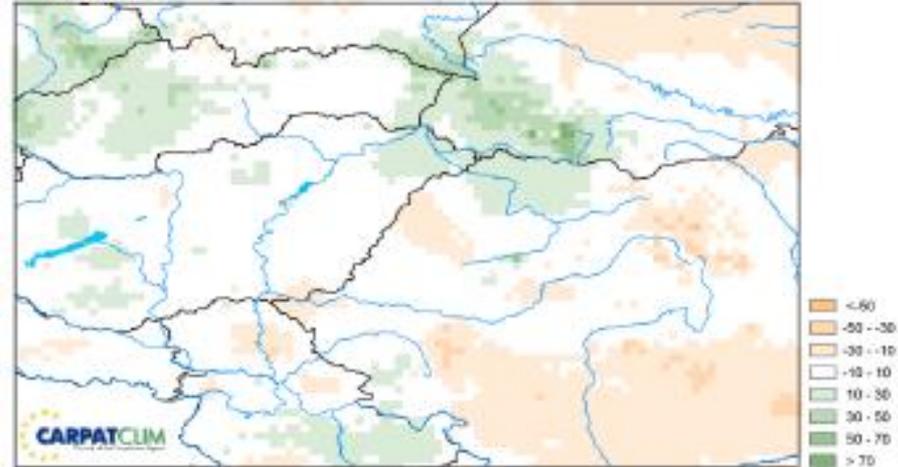
# Change of the annual precipitation sum 1961-2010



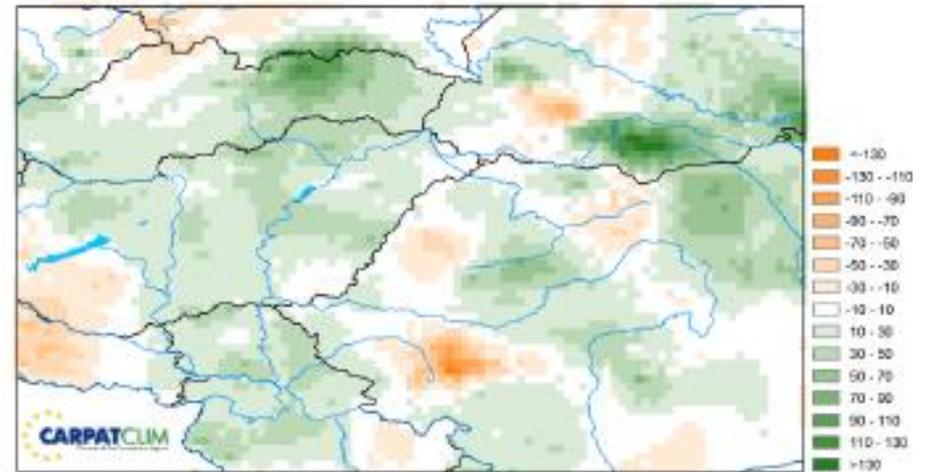
International Day of Mountains, 2012

# Change of the seasonal precipitation sums 1961-2010

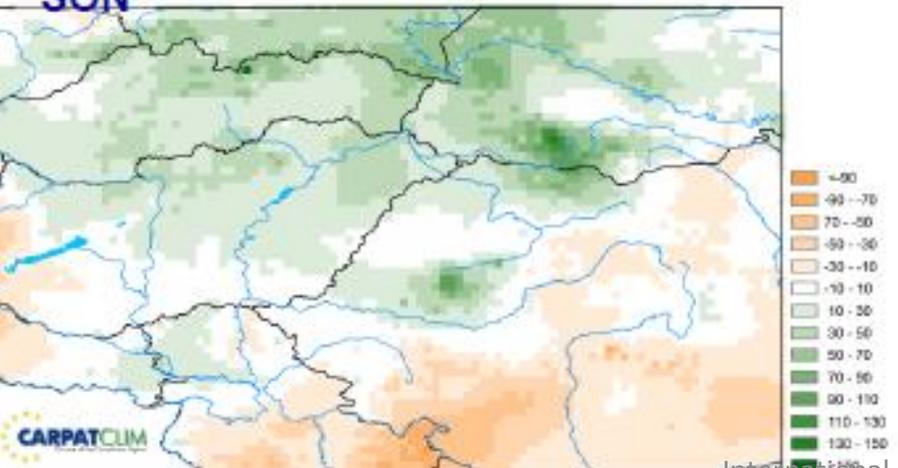
MAM



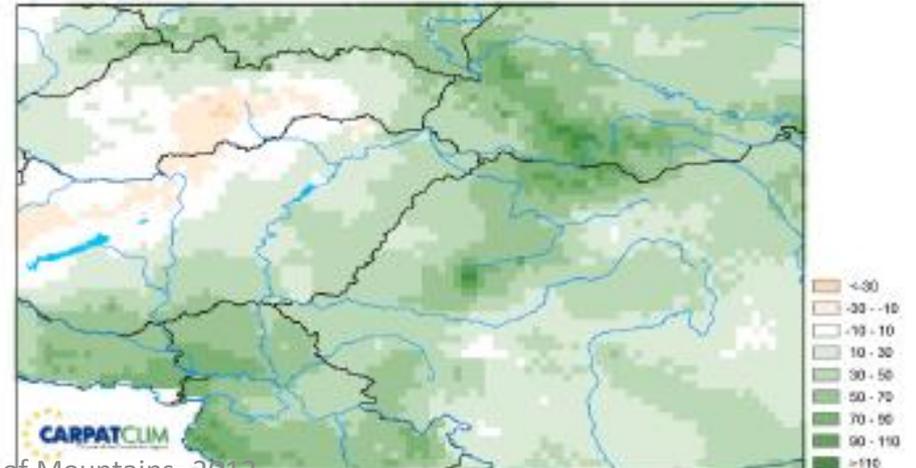
JJA



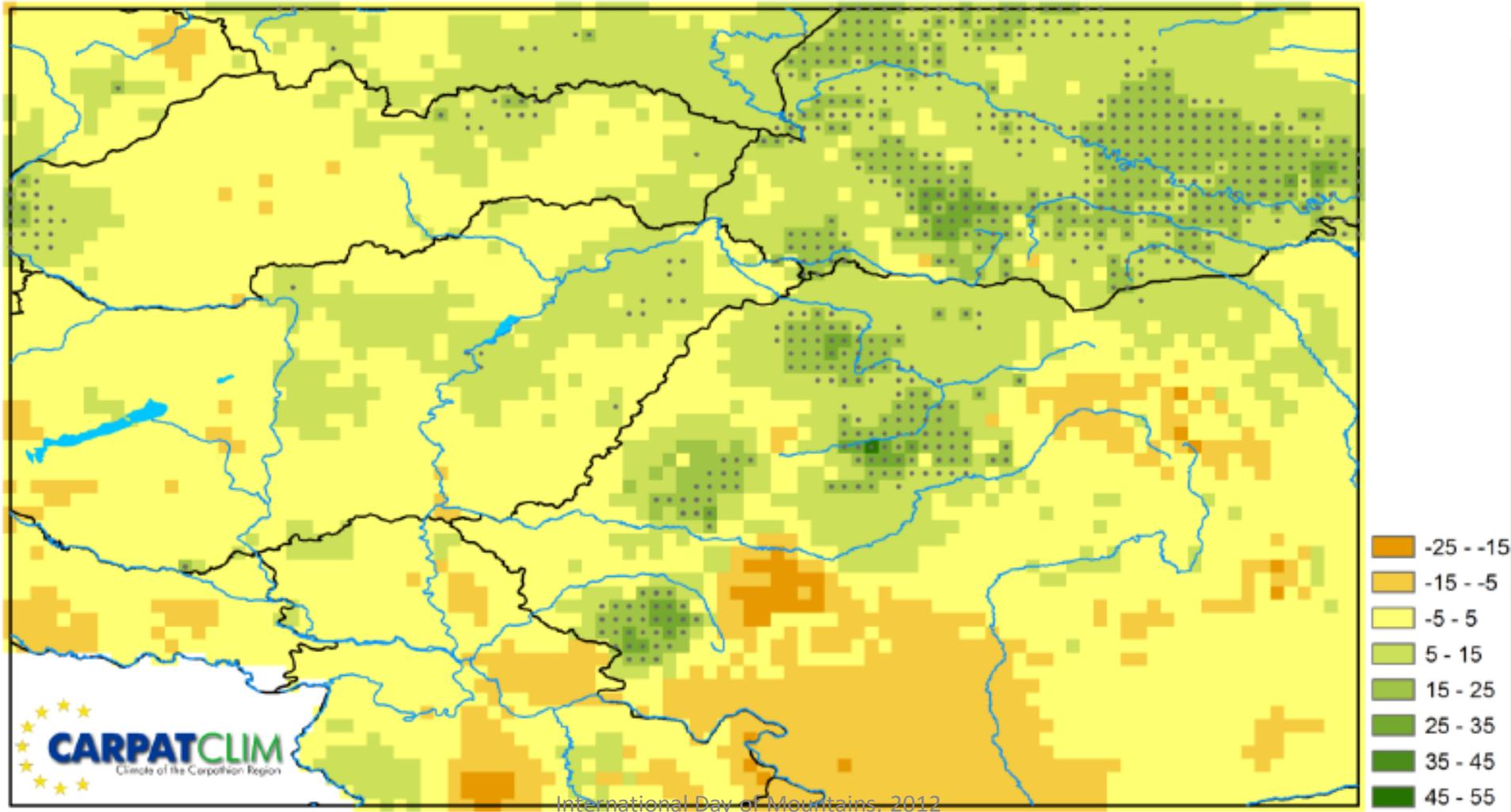
SON



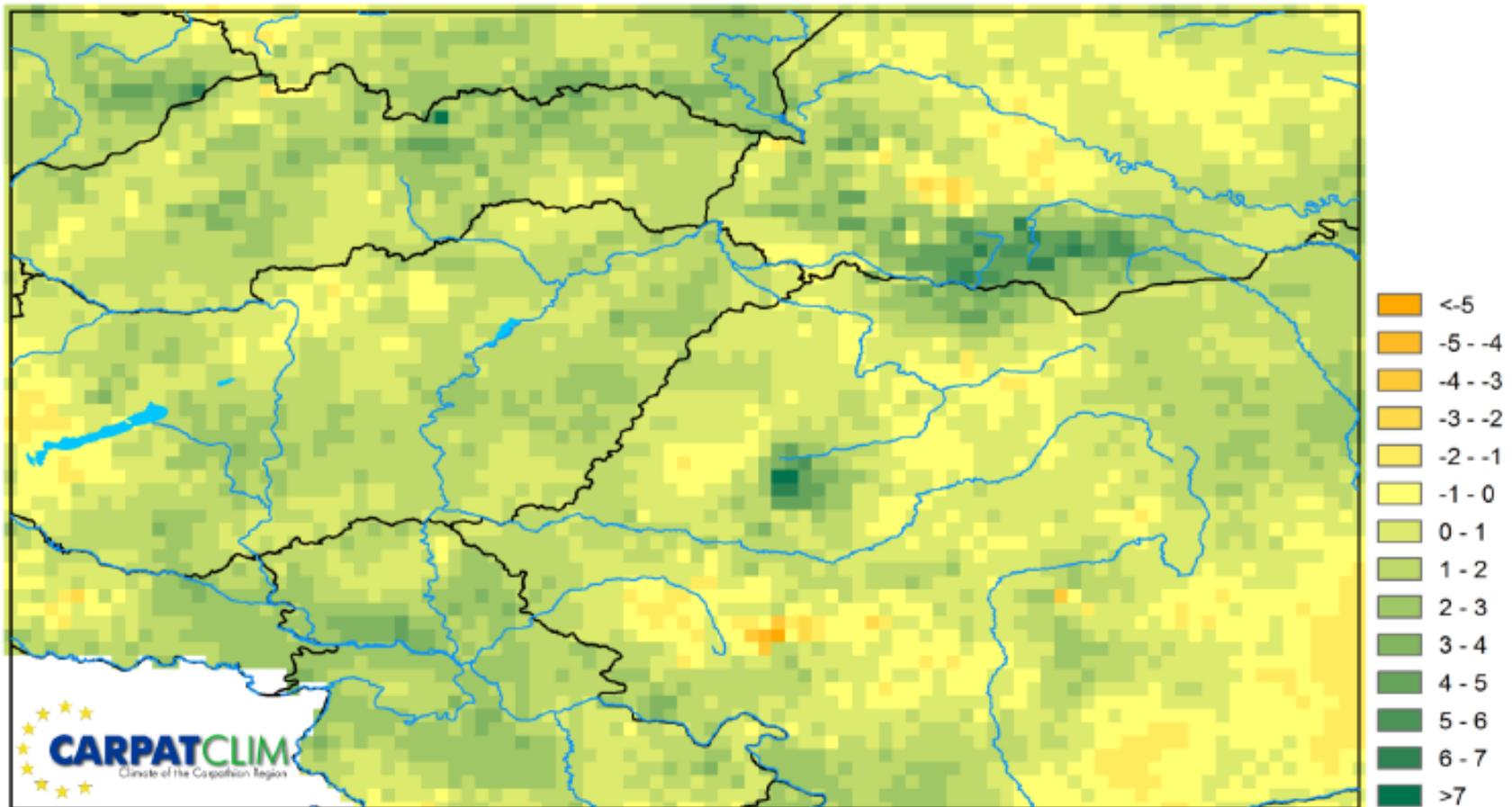
DJF



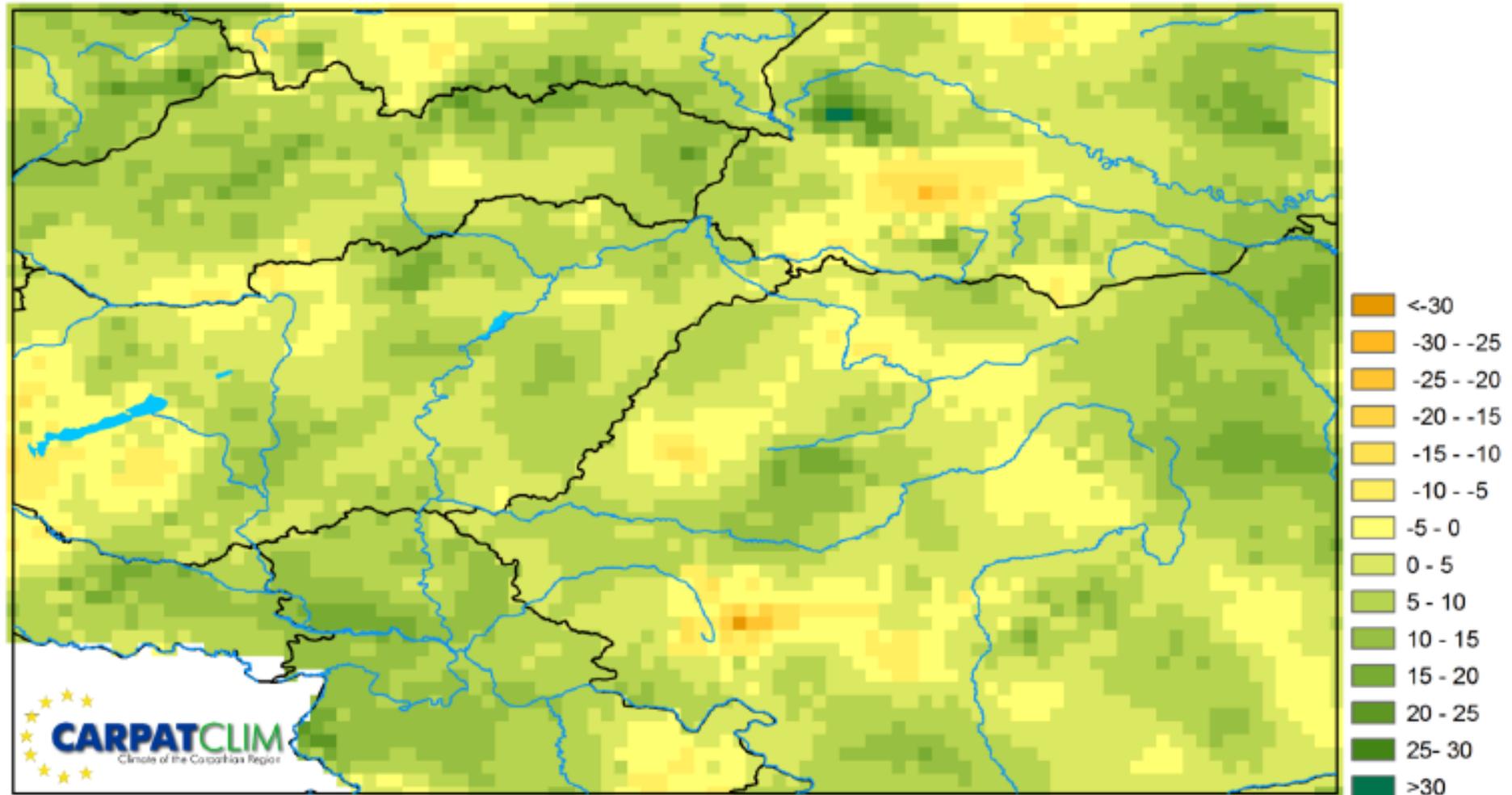
# Change in the number of wet days 1961-2010



# Change in the number of days with precipitation above 20 mm, 1961-2010



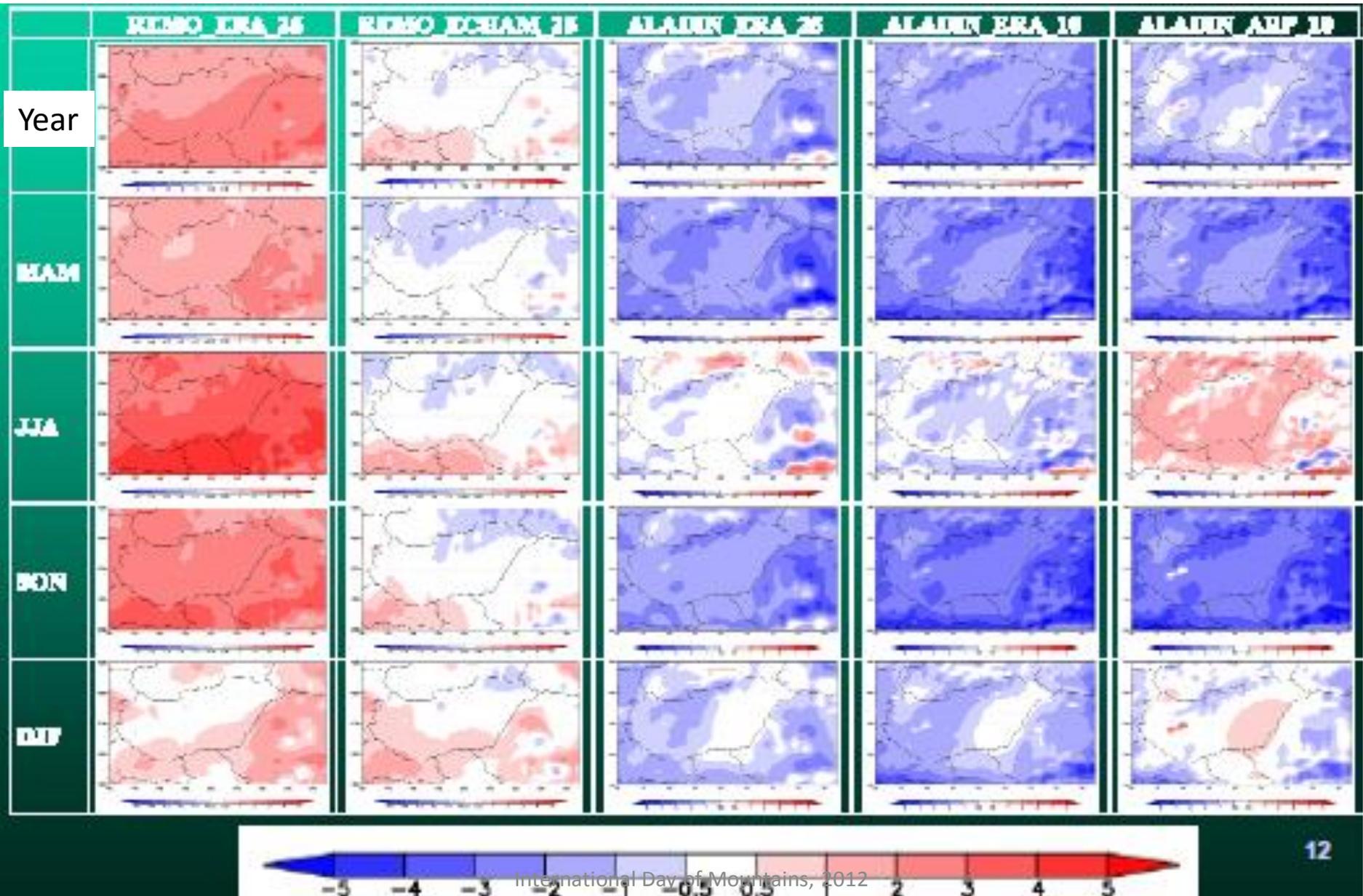
# Change in the maximum daily precipitation sum, 1961-2010



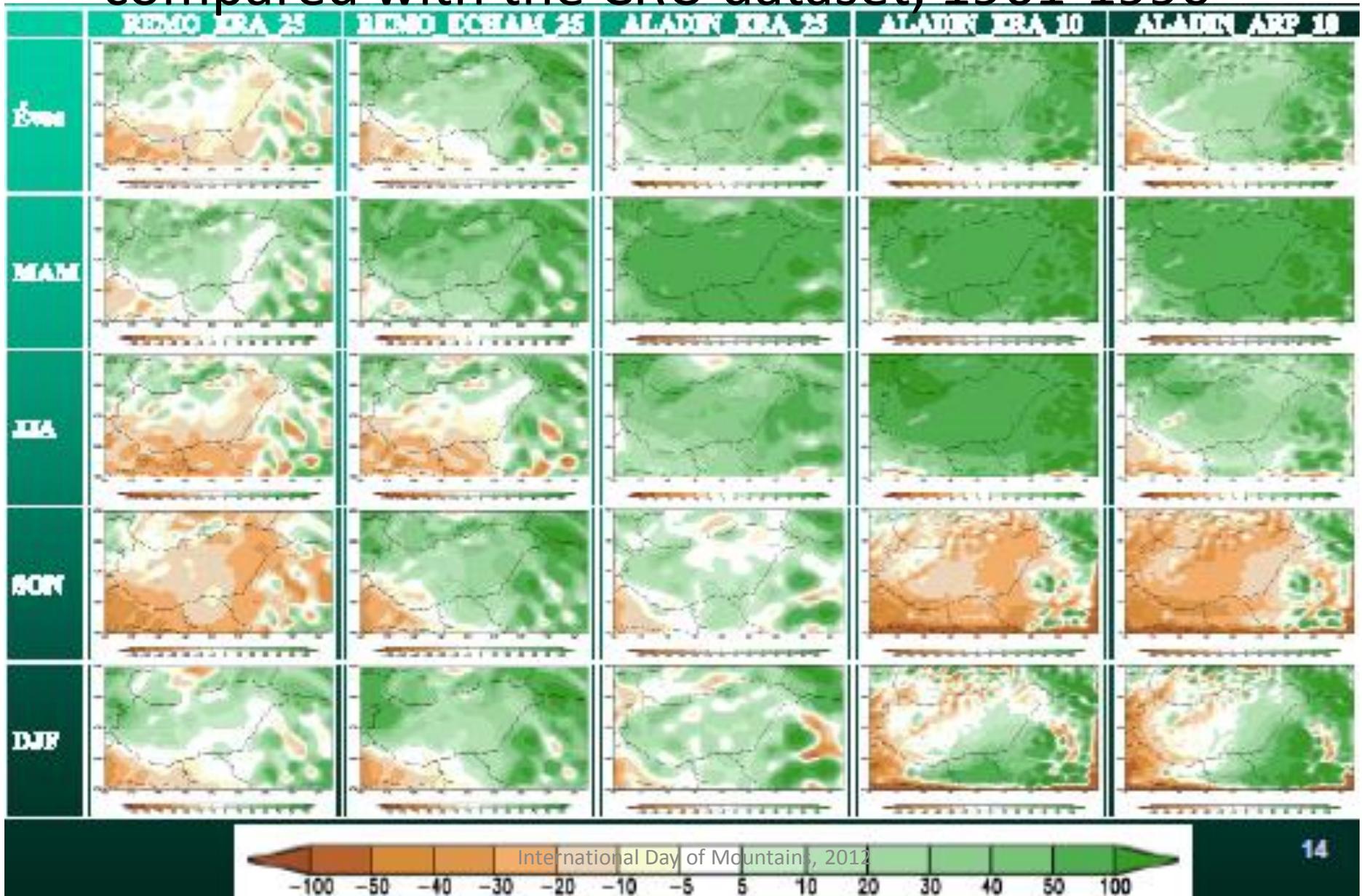
# **FUTURE**

**(SZABÓ, P. ET AL, 2010)**

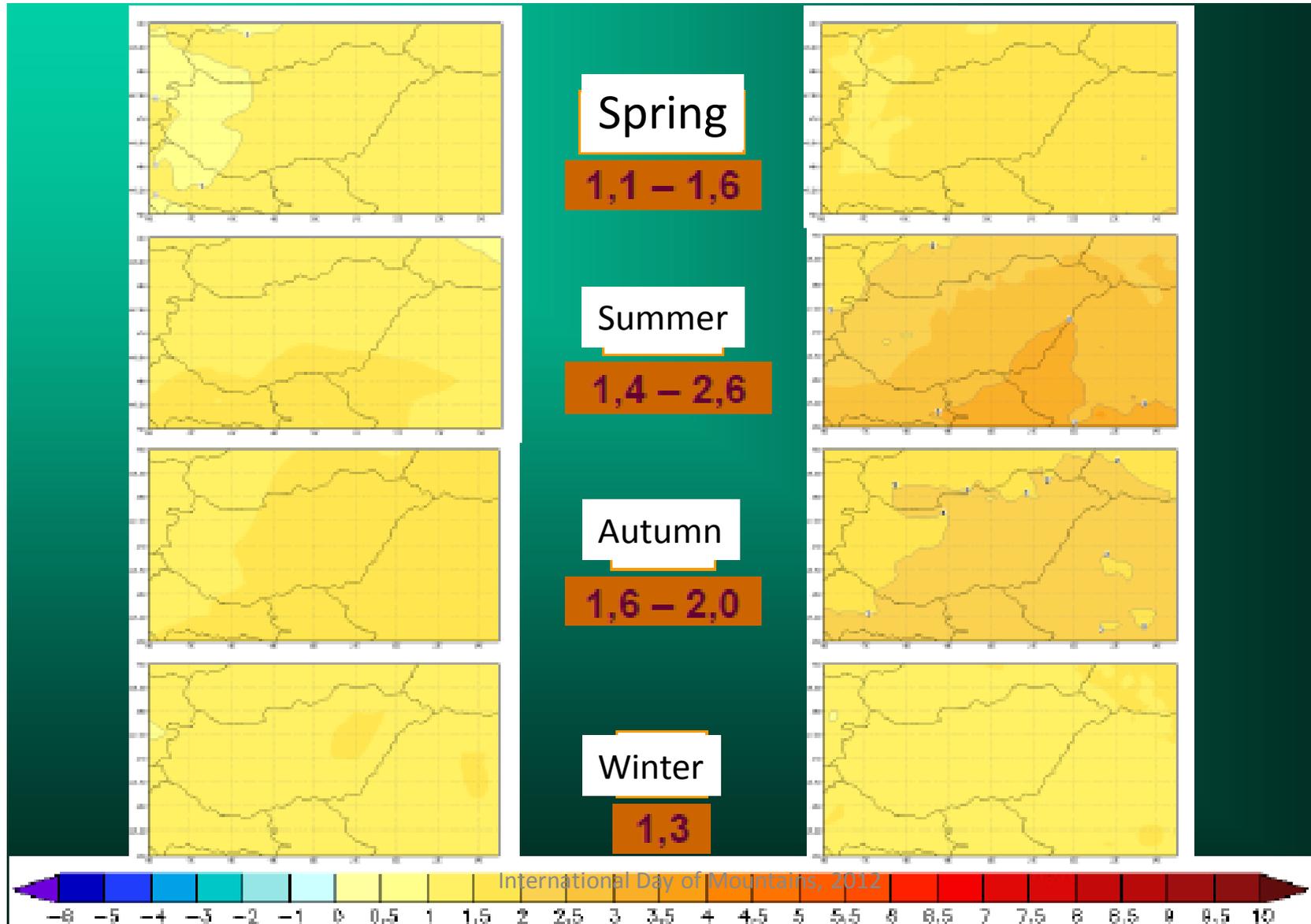
# Model outcomes for 1961-1990, compared with the CRU dataset



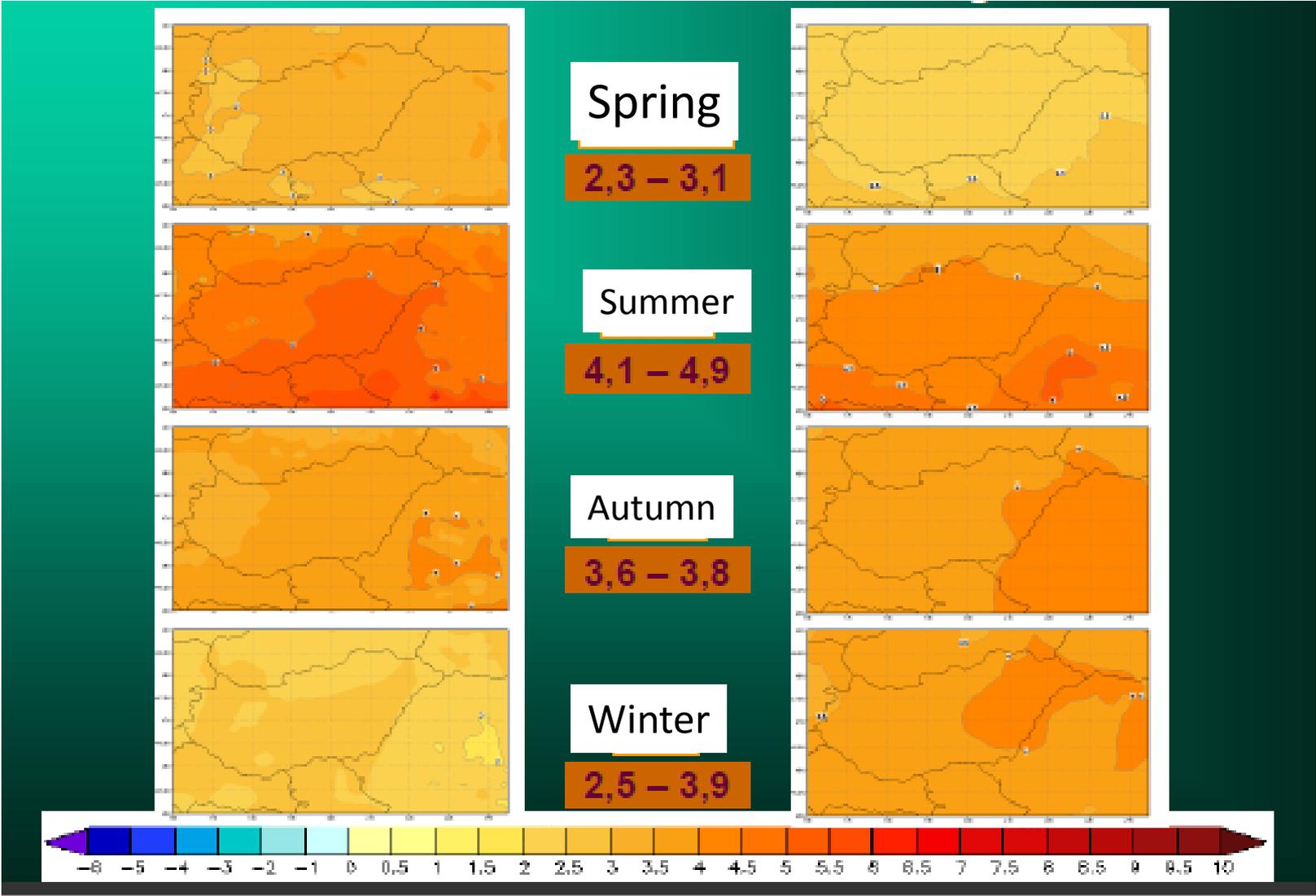
# Modelling of the present precipitation climate compared with the CRU dataset, 1961-1990



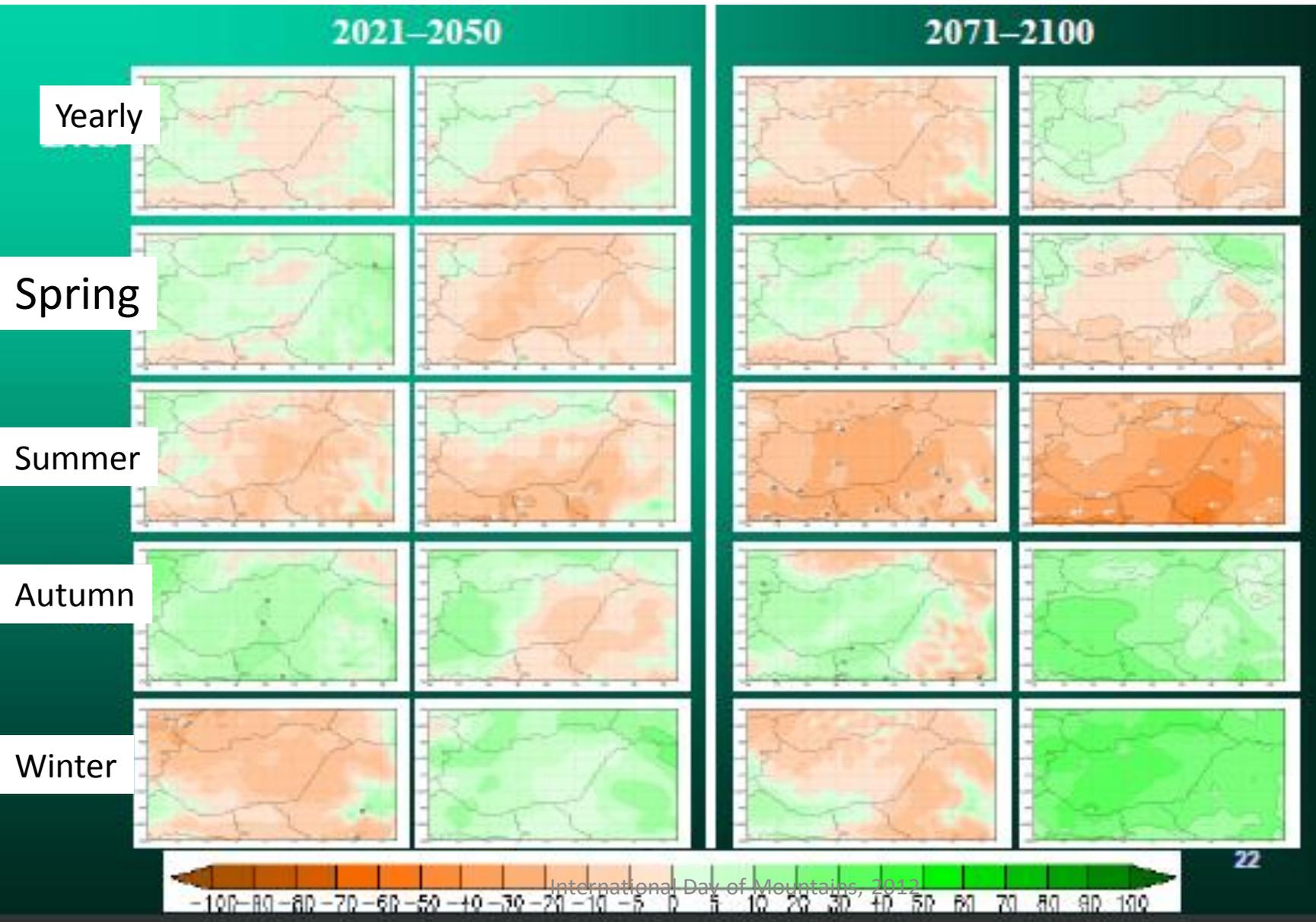
# Seasonal temperature change for 2021-2050 compared to 1961-1990



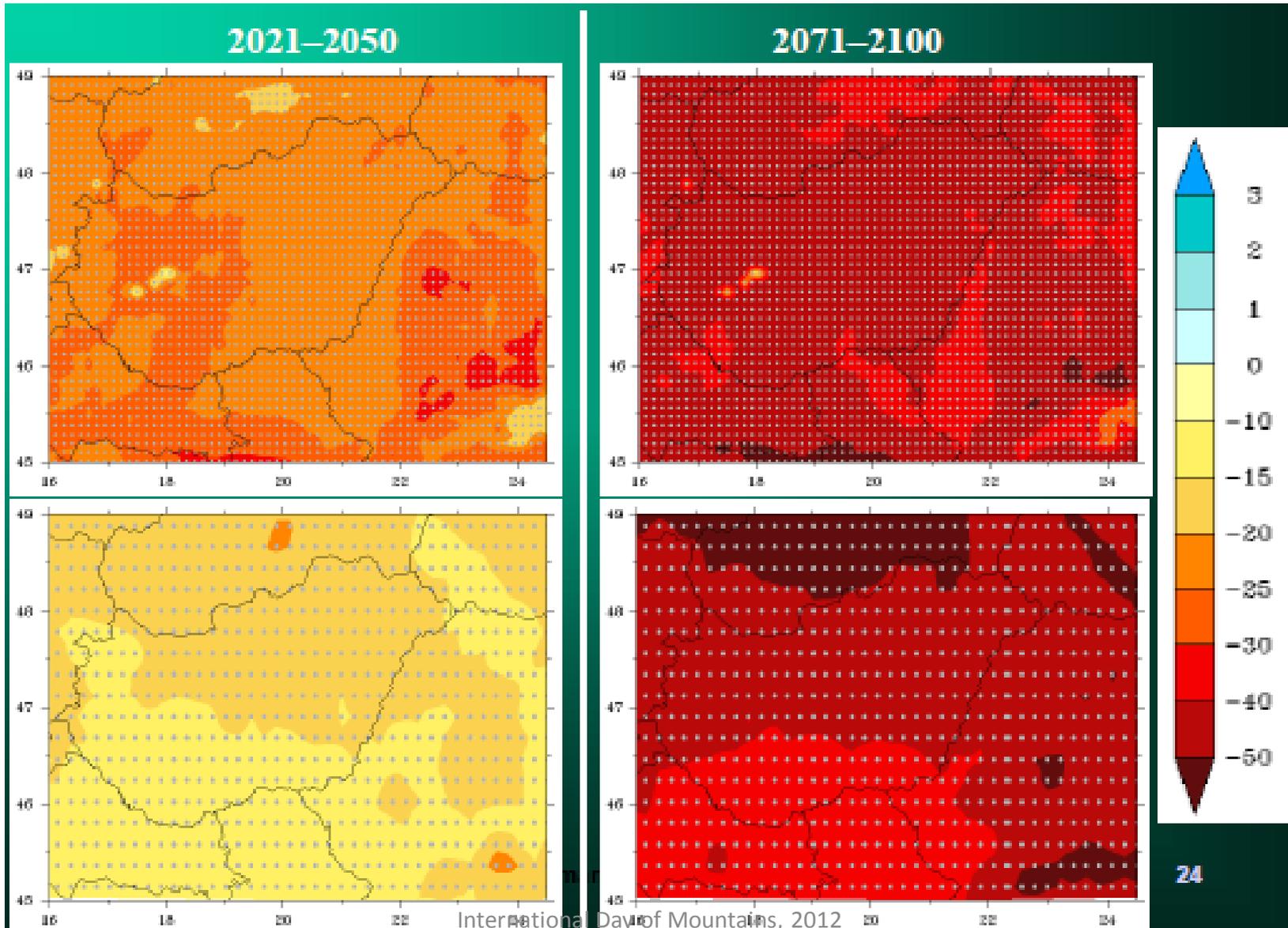
# Seasonal temperature change for 2071-2100 compared to 1961-1990



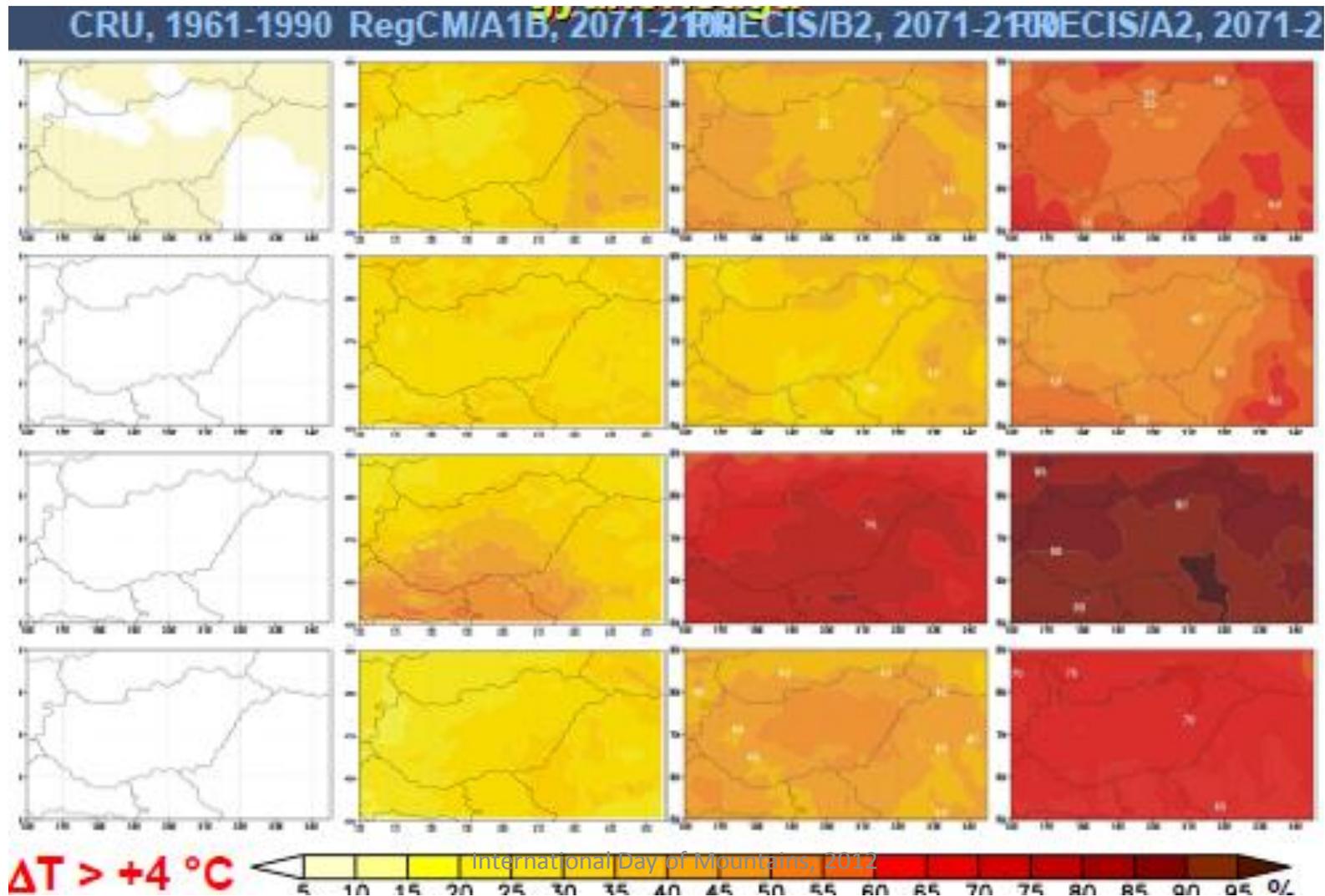
# Seasonal and yearly precipitation change for 2021-2050 and 2071-2100 compared to 1961-1990



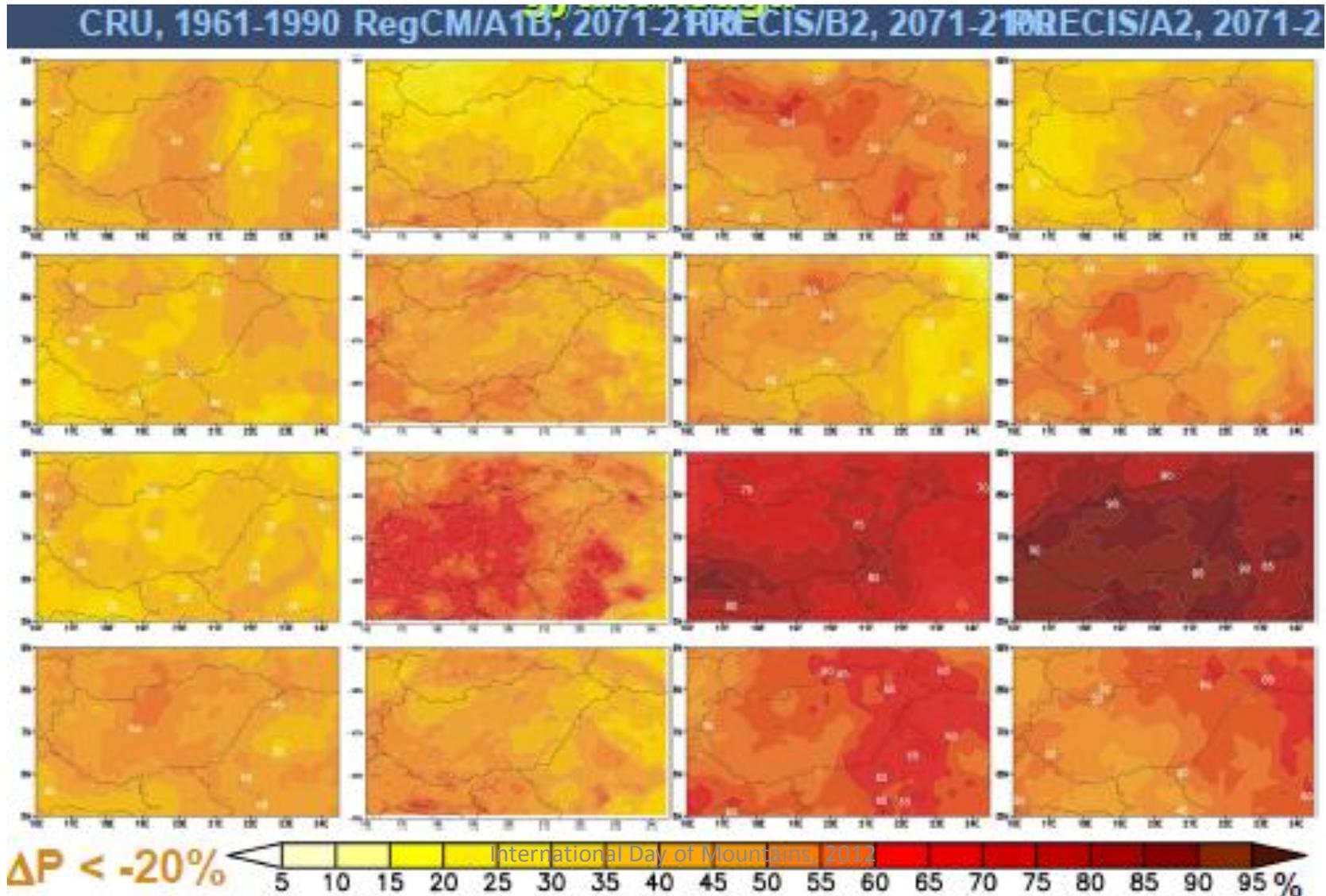
# Change of the number of frost days



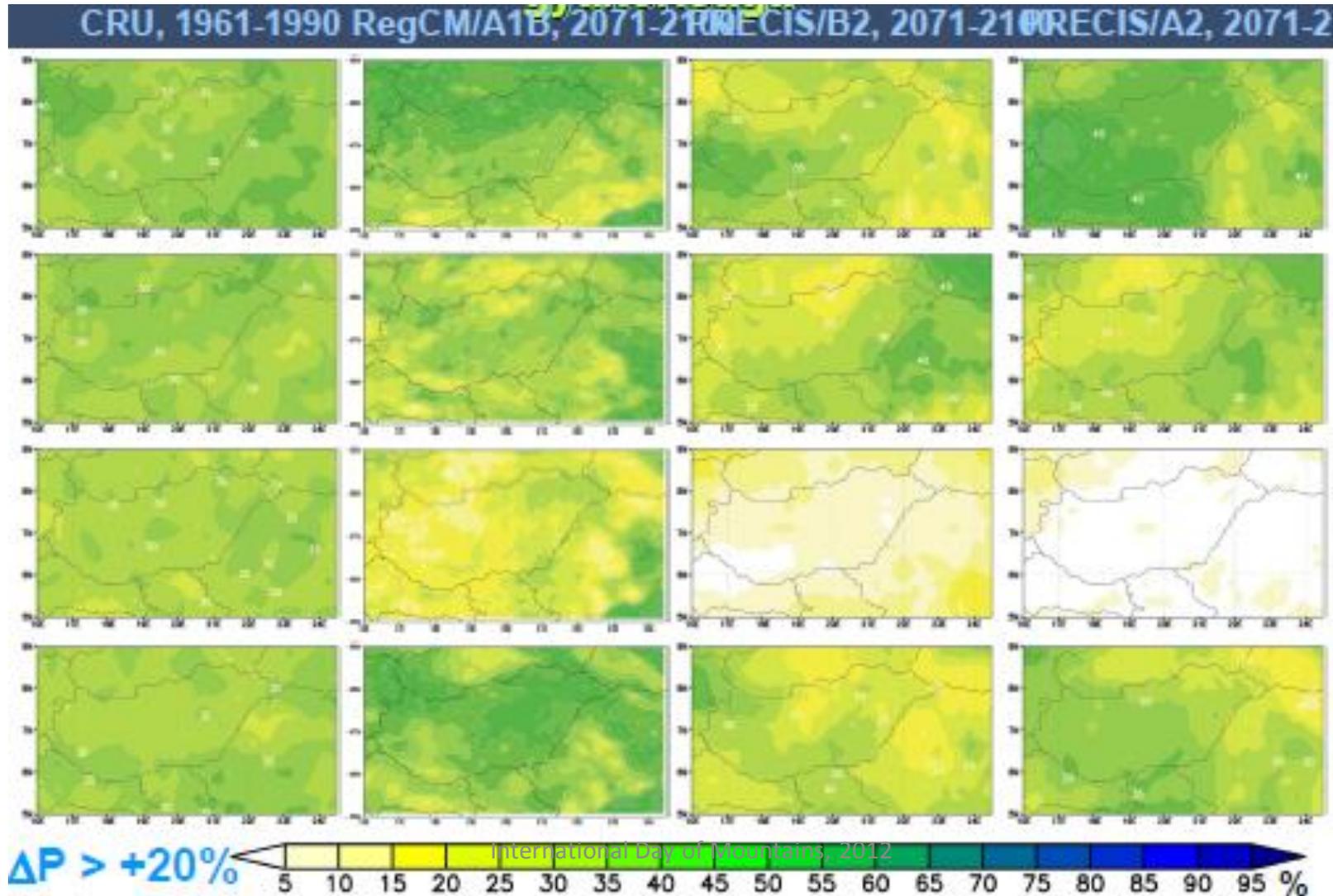
# Change of the frequency of the months with anomaly at least 4°C (Bartholy et al., 2010)



# Change of the frequency of the months with precipitation deficit at least 20% (Bartholy et al., 2010)



# Change of the frequency of the months with precipitation surplus at least 20% (Bartholy et al., 2010)



**AT:** Increasing coastal erosion and flooding; stressing of marine bio-systems and habitat loss; increased tourism pressure on coasts; greater winter storm risk and vulnerability of transport to winds

**BO:** Water logging; eutrophication of lakes and wetlands; increased coastal flooding and erosion; increased winter storm risk; reduced ski season; severe fires in drained peatland

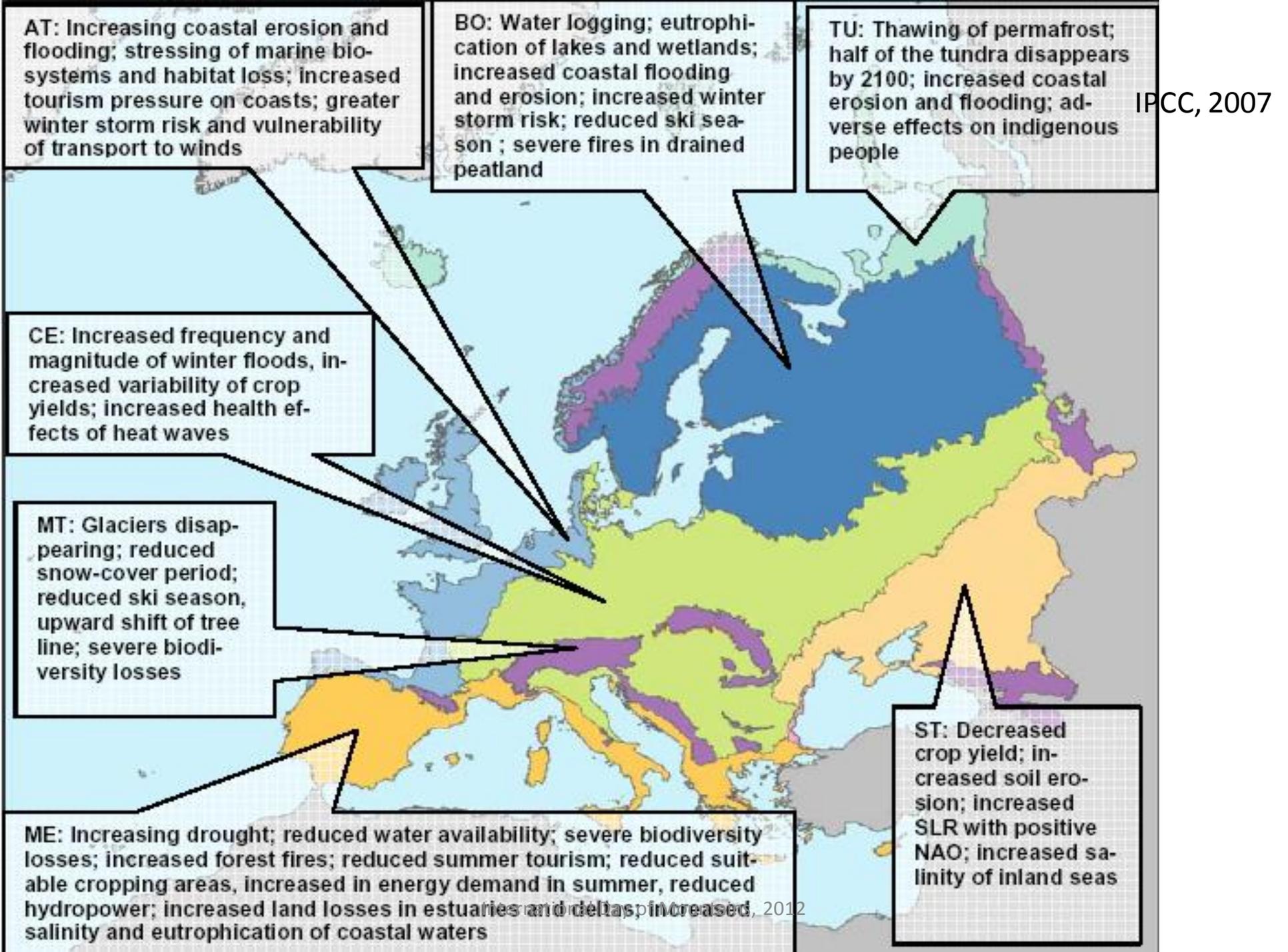
**TU:** Thawing of permafrost; half of the tundra disappears by 2100; increased coastal erosion and flooding; adverse effects on indigenous people

**CE:** Increased frequency and magnitude of winter floods, increased variability of crop yields; increased health effects of heat waves

**MT:** Glaciers disappearing; reduced snow-cover period; reduced ski season, upward shift of tree line; severe biodiversity losses

**ME:** Increasing drought; reduced water availability; severe biodiversity losses; increased forest fires; reduced summer tourism; reduced suitable cropping areas, increased in energy demand in summer, reduced hydropower; increased land losses in estuaries and deltas; increased salinity and eutrophication of coastal waters

**ST:** Decreased crop yield; increased soil erosion; increased SLR with positive NAO; increased salinity of inland seas



# Impacts on nature connected sectors

- Impacts on Forests
- Impacts on Grasslands
- Impacts on Wetlands
- Impacts on Agriculture
- Impacts on Water
- Impacts on Tourism
- Risks to Governmental Policy Objectives

# Sectorial climate change impacts

(Example)

Event	Water resources	Agriculture, ecosystems	Health	Industry and society
Heavy precipitation	<ul style="list-style-type: none"> <li>- floods</li> <li>- decreasing water quality</li> <li>-- decreasing quantity of available water</li> </ul>	<ul style="list-style-type: none"> <li>-yield losses</li> <li>- delay in the agricultural works</li> <li>- soil erosion</li> </ul>	<ul style="list-style-type: none"> <li>- increasing number of fatalities and accidents</li> </ul>	<ul style="list-style-type: none"> <li>-damages of the infrastructure</li> <li>- problems in operation and traffic</li> </ul>
Increasing temperature	<ul style="list-style-type: none"> <li>-increasing temperature of the surface water</li> <li>- increasing evapotranspiration</li> <li>- change in the precipitation types</li> <li>-earlier snow melt</li> </ul>	<ul style="list-style-type: none"> <li>-less available water</li> <li>- increasing vegetation period</li> <li>- change in the ecosystem compositions</li> <li>-shifting of areas</li> <li>- forest- and bushfires</li> <li>-Invazive species</li> </ul>	<ul style="list-style-type: none"> <li>-new illnesses</li> <li>- heat waves</li> <li>-pollen caused allergy</li> </ul>	<ul style="list-style-type: none"> <li>-worsening of the fresh water quality</li> <li>-melting of permafrost and it s effects on the infrastructure</li> <li>- fires</li> </ul>

# Climate Change adaptation WG at Carpathian Convention

- Decision COP3/15 on Climate change of the COP 3 of the Carpathian Convention: a Working Group on Adaptation to Climate Change under the Carpathian Convention has been established

# Workplan

- Preparation of strategic agenda on adaptation in the Carpathians
- Planning of adaptation measures
- Develop communication strategy
- Realization of a clearing house for the Carpathians in the wider EU context

# Conclusions

- High spatial variability of the changes
- The models may have problems with the description of tendencies of some basic climate elements
- Strong capacity building is requested
- Establishment/improvement of monitoring and early warning systems
- Further research is needed, but on a more coordinated way

**Thank you for your attention!**