

**PŘESNOST POZOROVÁNÍ ZMĚN
HYDROLOGICKÉ BILANCE
Z HLEDISKA
VYUŽITELNÝCH VODNÍCH ZDROJŮ**

Radek Vlnas

Podzemní vody ve vodárenské praxi
Dolní Morava, 1. a 2. dubna 2015

DATA

a) bilanční veličiny z Hydrologické bilance (vyhláška MZe č. 431/2001 Sb.) ČHMÚ

- srážkové úhrny
- zásoba vody ve sněhu
- teplota a relativní vlhkost vzduchu
- potenciální a aktuální evapotranspirace
- pozorované a přirozené průtoky

měsíční krok, 1979–2013, 74 povodí a 10 bilančních oblastí

Trend měsíční a roční průměrných hodnot

(b) data ze zpracování přírodních zdrojů podzemních vod ČHMÚ

- **pozorovaný průtok a základní odtok**

161 vodoměrných stanic, denní časový krok, 1971–2011

separace zo podle Eckardta (2005) s roční korekcí parametru BFI

měsíční agregace

Trend měsíční a roční průměrných a minimálních hodnot (vyhlazení 7d klouzavé průměry)

(c) vydatnosti pramenů a stavy hladin v mělkých vrtech hlásné sítě ČHMÚ

převážně 1971–2011

Trend měsíční a roční průměrných a minimálních hodnot (změna standardní odchylky (SD))

METODA

Mann-Kendall test (existence trendu)

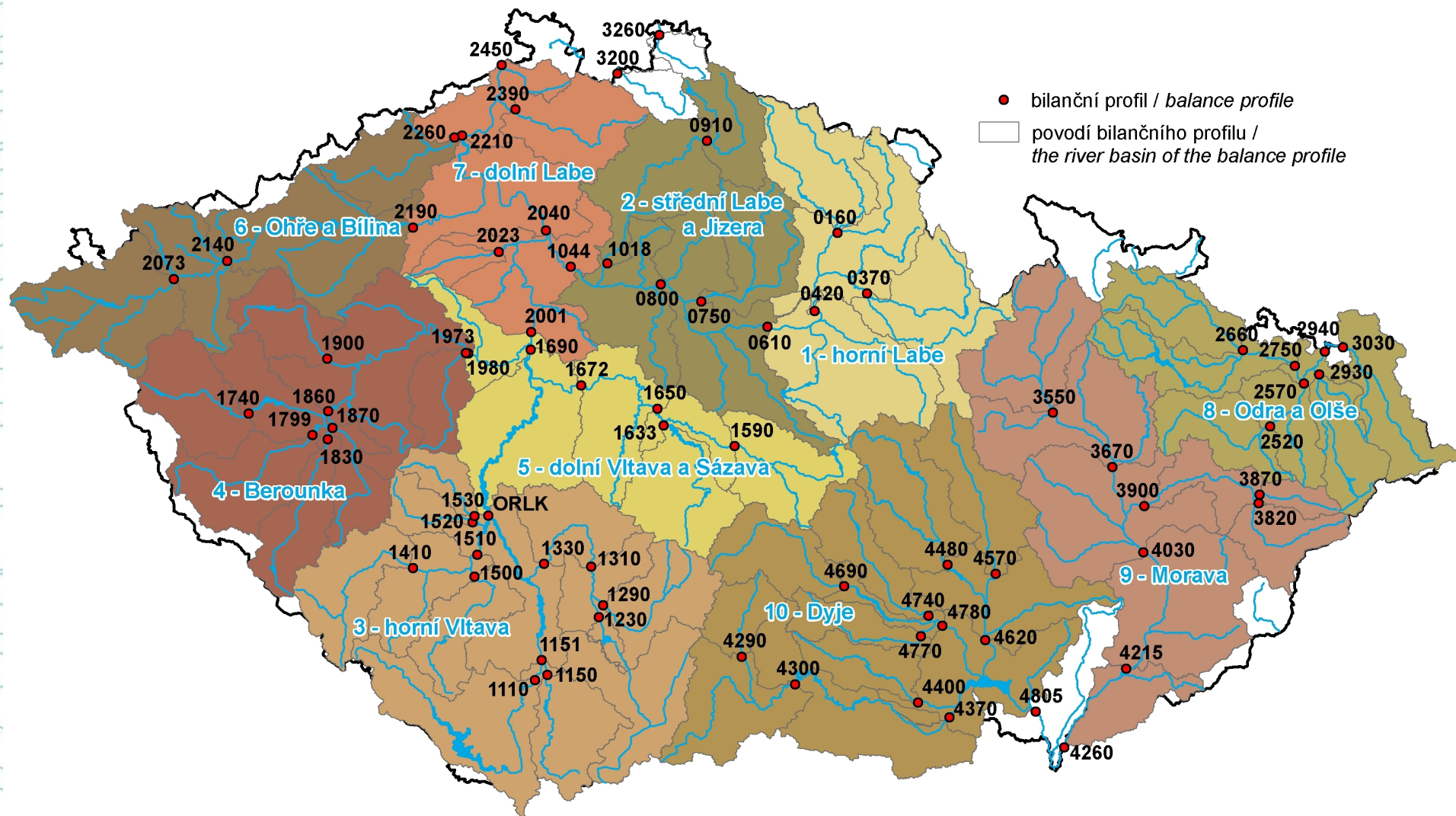
Sen testu (velikost trendu)

Statistická významnost trendu testována na hladině 0,05

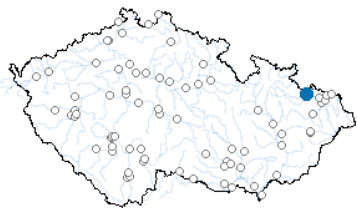
Výsledný trend uváděn jako průměrná změna za 10leté období

BILANČNÍ VELIČINY

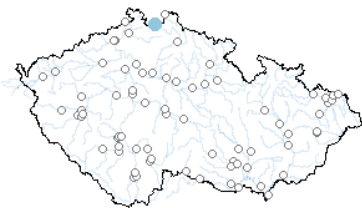
74 povodí



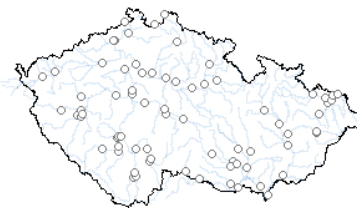
Srážky 1



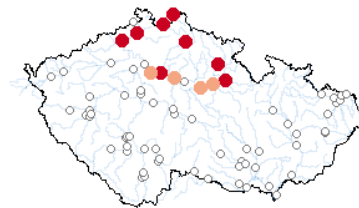
Srážky 2



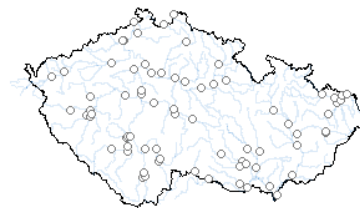
Srážky 3



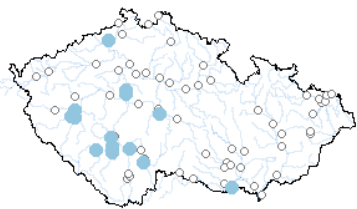
Srážky 4



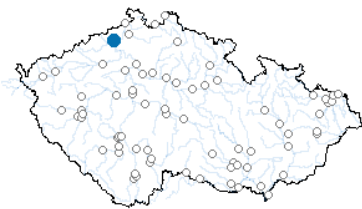
Srážky 5



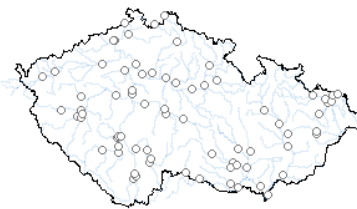
Srážky 6



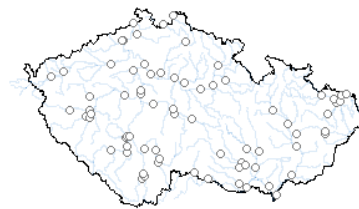
Srážky 7



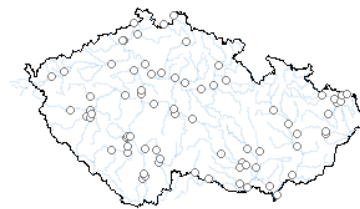
Srážky 8



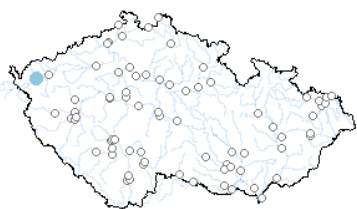
Srážky 9



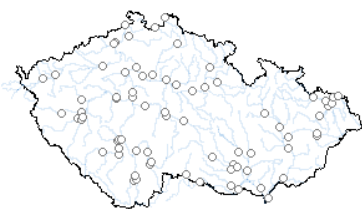
Srážky 10



Srážky 11



Srážky 12



%

- -25 až -15
- -15 až -5
- ~0
- 5 až 15
- 15 až 25

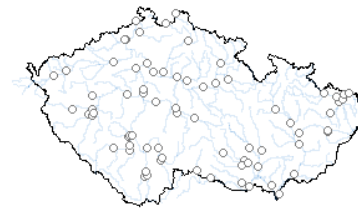
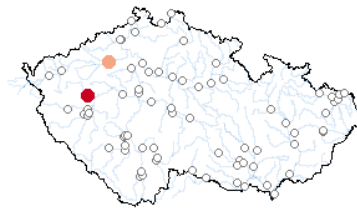
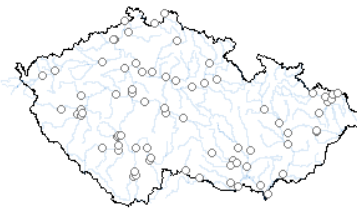
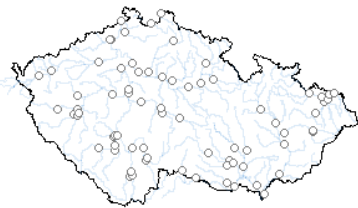
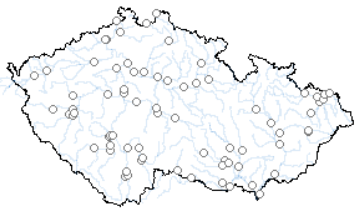
Sníh 1

Sníh 2

Sníh 3

Sníh 4

Sníh 5



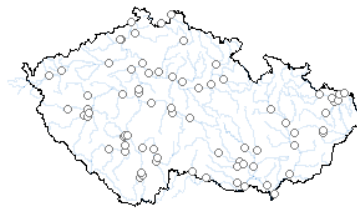
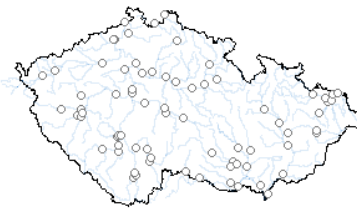
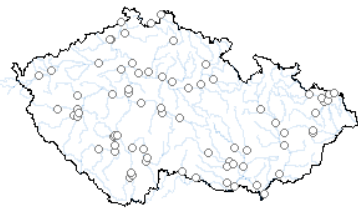
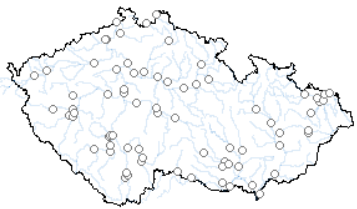
Sníh 6

Sníh 7

Sníh 8

Sníh 9

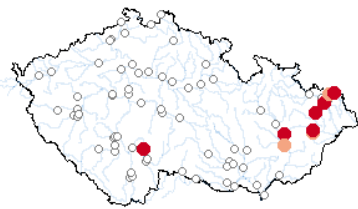
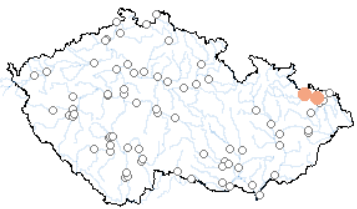
Sníh 10



Sníh 11

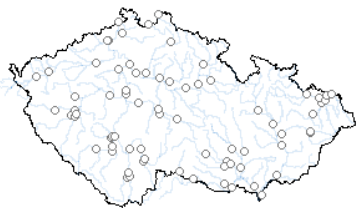
Sníh 12

%

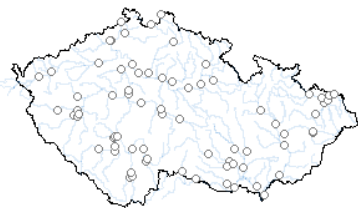


- -40 až -20
- -20 až -5
- ~0
- 5 až 20
- 20 až 40

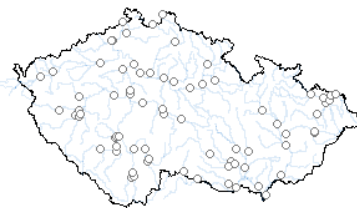
Teplota 1



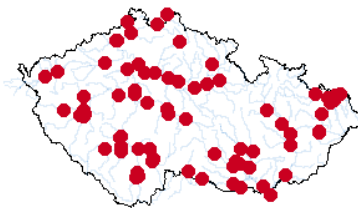
Teplota 2



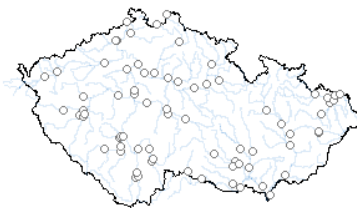
Teplota 3



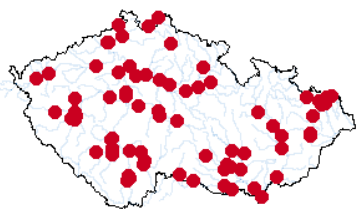
Teplota 4



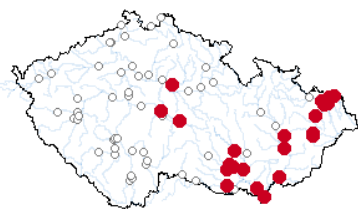
Teplota 5



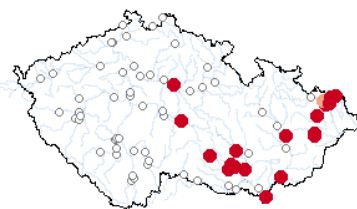
Teplota 6



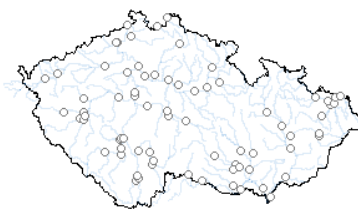
Teplota 7



Teplota 8



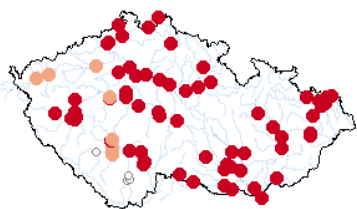
Teplota 9



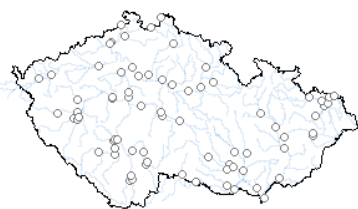
Teplota 10



Teplota 11



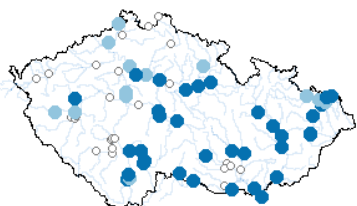
Teplota 12



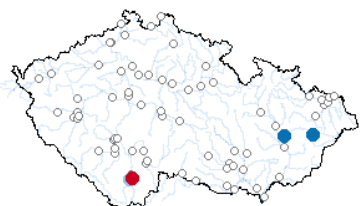
°C

- -1 až -0,5
- -0,5 až 0,2
- ~0
- 0,2 až 0,5
- 0,5 až 1

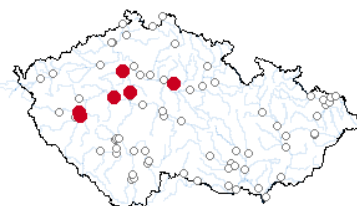
Vlhkost 1



Vlhkost 2



Vlhkost 3



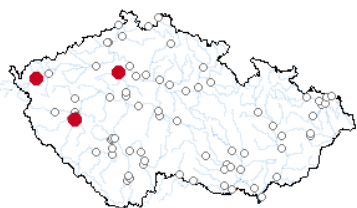
Vlhkost 4



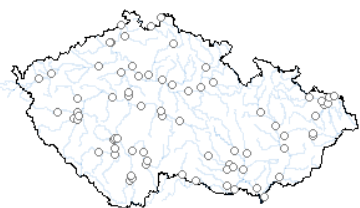
Vlhkost 5



Vlhkost 6



Vlhkost 7



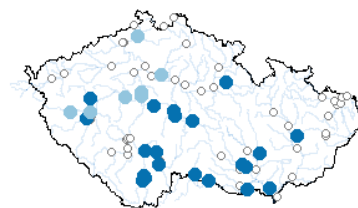
Vlhkost 8



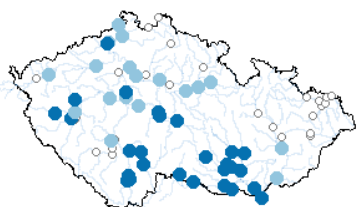
Vlhkost 9



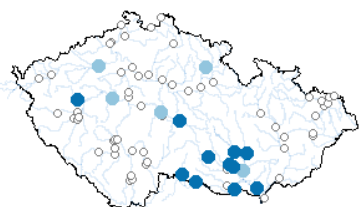
Vlhkost 10



Vlhkost 11



Vlhkost 12



%

- -3 až -1
- -1 až -0,5
- ~0
- 0,5 až 1
- 1 až 3

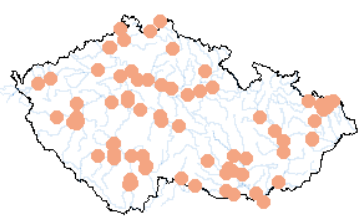
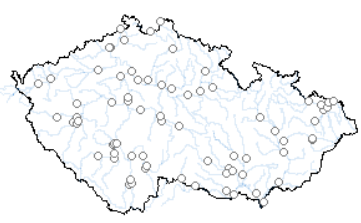
Pot. ET 1

Pot. ET 2

Pot. ET 3

Pot. ET 4

Pot. ET 5



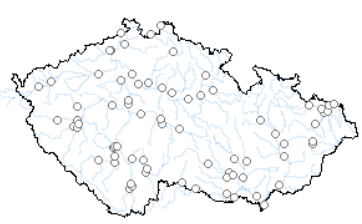
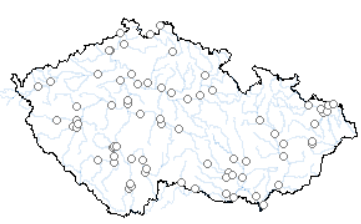
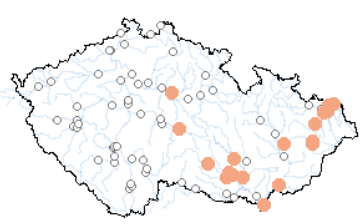
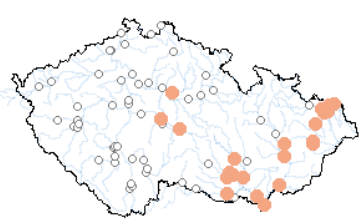
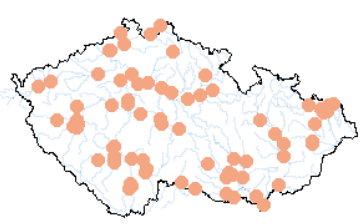
Pot. ET 6

Pot. ET 7

Pot. ET 8

Pot. ET 9

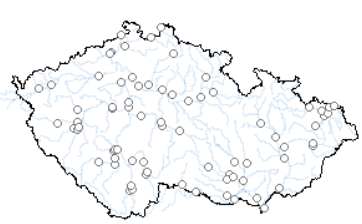
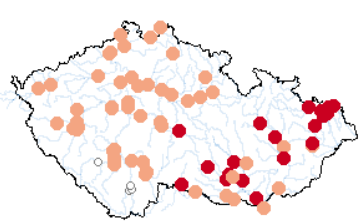
Pot. ET 10



Pot. ET 11

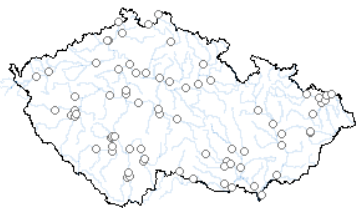
Pot. ET 12

%

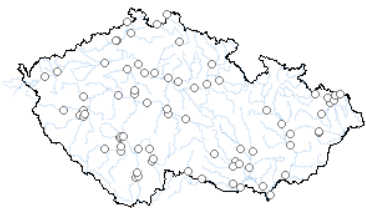


- -15 až -10
- -10 až -2
- ~0
- 2 až 10
- 10 až 15

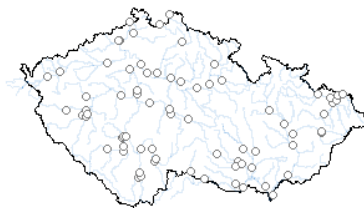
Akt. ET 1



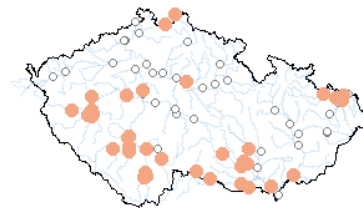
Akt. ET 2



Akt. ET 3



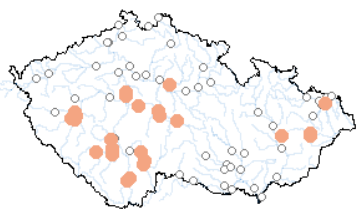
Akt. ET 4



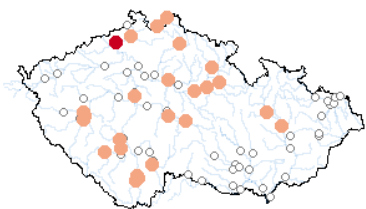
Akt. ET 5



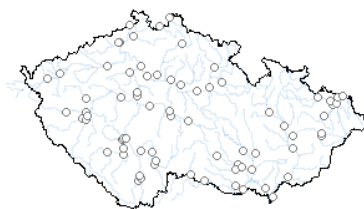
Akt. ET 6



Akt. ET 7



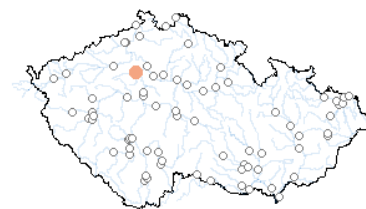
Akt. ET 8



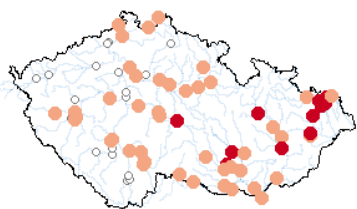
Akt. ET 9



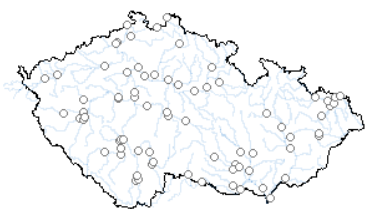
Akt. ET 10



Akt. ET 11



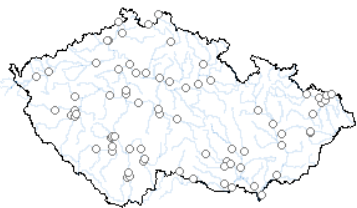
Akt. ET 12



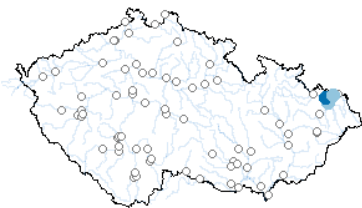
%

- -15 až -10
- -10 až -2
- ~0
- 2 až 10
- 10 až 15

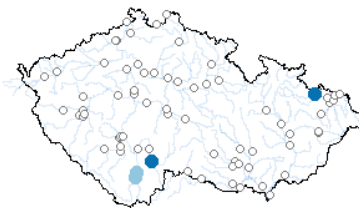
Q_měř. 1



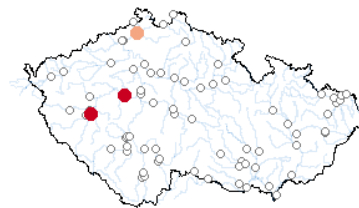
Q_měř. 2



Q_měř. 3



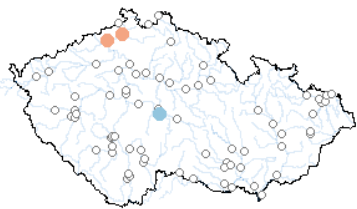
Q_měř. 4



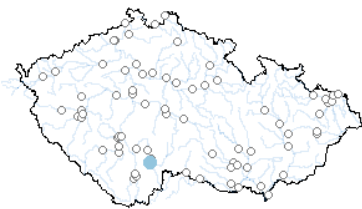
Q_měř. 5



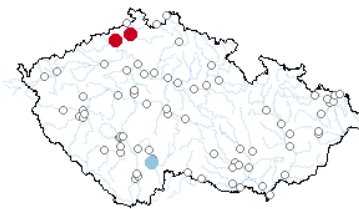
Q_měř. 6



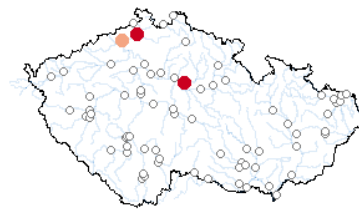
Q_měř. 7



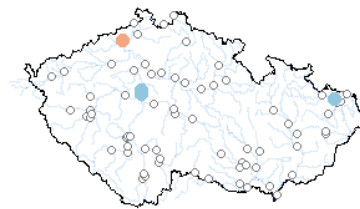
Q_měř. 8



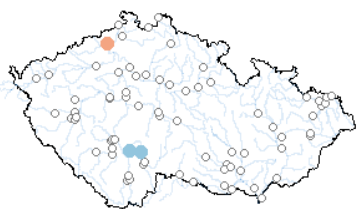
Q_měř. 9



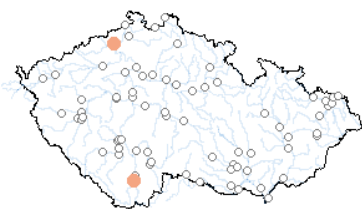
Q_měř. 10



Q_měř. 11



Q_měř. 12



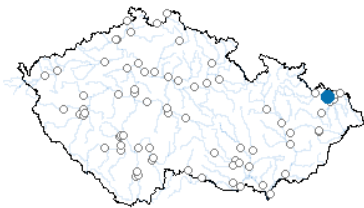
%

- -25 až -15
- -15 až -5
- ~0
- 5 až 15
- 15 až 25

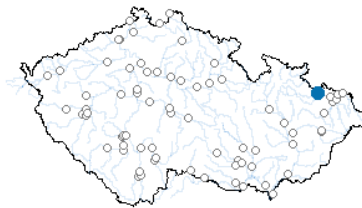
Q_přir. 1



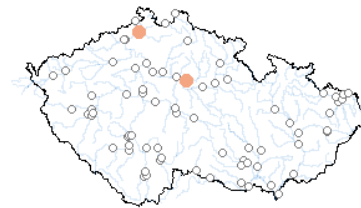
Q_přir. 2



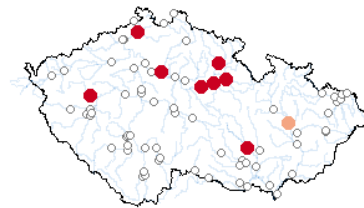
Q_přir. 3



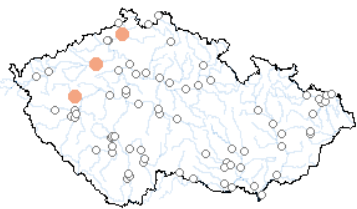
Q_přir. 4



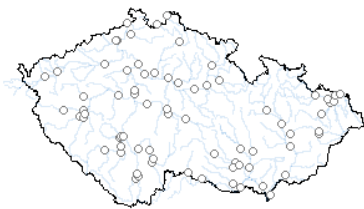
Q_přir. 5



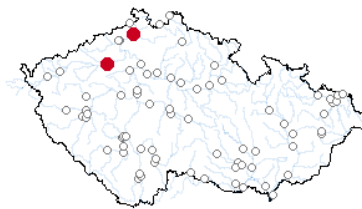
Q_přir. 6



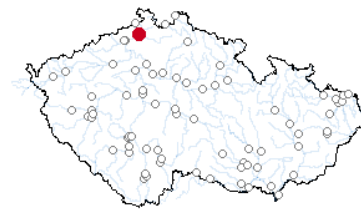
Q_přir. 7



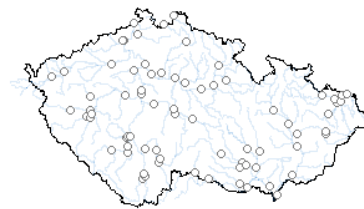
Q_přir. 8



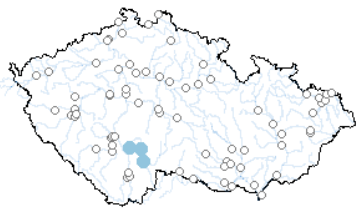
Q_přir. 9



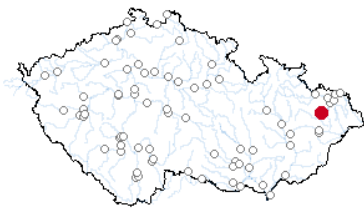
Q_přir. 10



Q_přir. 11



Q_přir. 12

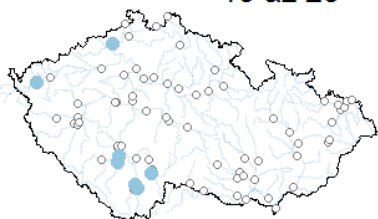


%

- -25 až -15
- -15 až -5
- ~0
- 5 až 15
- 15 až 25

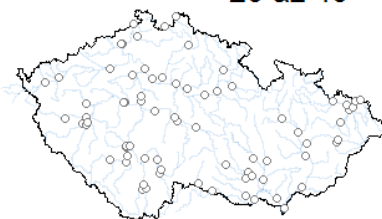
Srážky (%)

- -25 až -15
- -15 až -5
- ~0
- 5 až 15
- 15 až 25



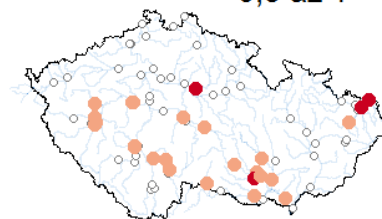
Sníh (%)

- -40 až -20
- -20 až -5
- ~0
- 5 až 20
- 20 až 40



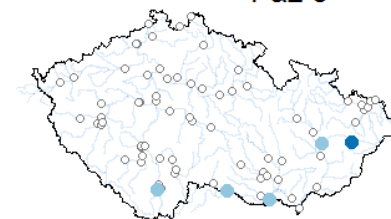
Teplota (°C)

- -1 až -0,5
- -0,5 až 0,2
- ~0
- 0,2 až 0,5
- 0,5 až 1



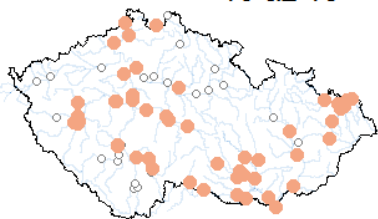
Vlhkost (%)

- -3 až -1
- -1 až -0,5
- ~0
- 0,5 až 1
- 1 až 3



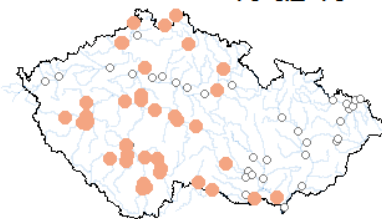
Pot. ET (%)

- -15 až -10
- -10 až -2
- ~0
- 2 až 10
- 10 až 15



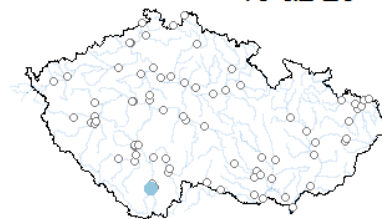
Akt. ET (%)

- -15 až -10
- -10 až -2
- ~0
- 2 až 10
- 10 až 15



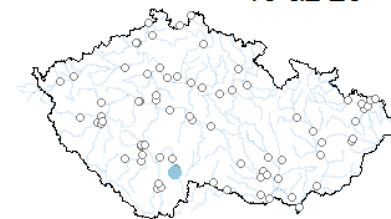
Q_přir. (%)

- -25 až -15
- -15 až -5
- ~0
- 5 až 15
- 15 až 25



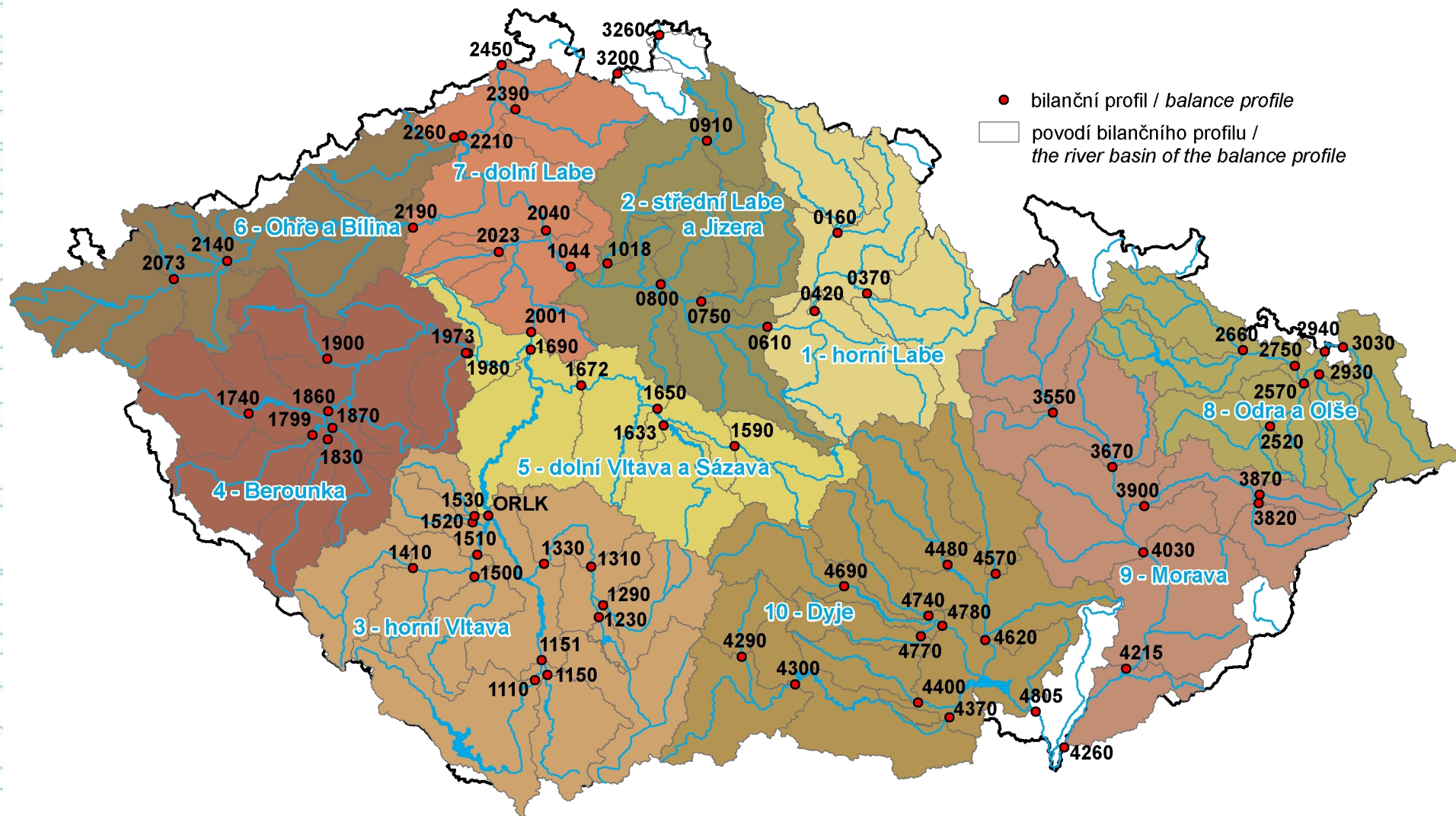
Q_měř. (%)

- -25 až -15
- -15 až -5
- ~0
- 5 až 15
- 15 až 25

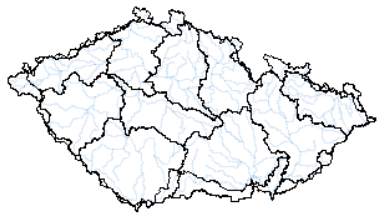


BILANČNÍ VELIČINY

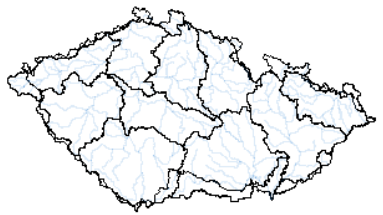
10 bilančních oblastí



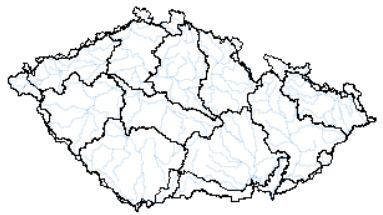
Srážky 1



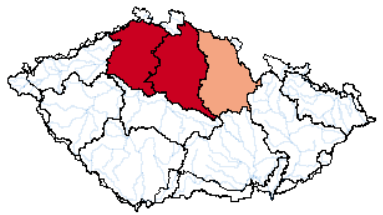
Srážky 2



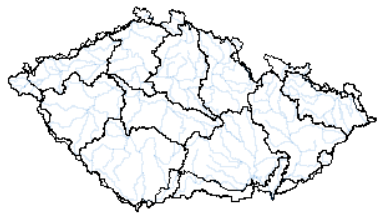
Srážky 3



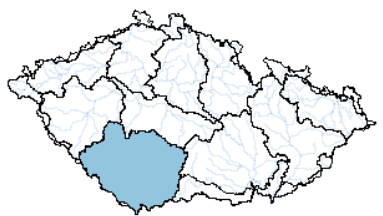
Srážky 4



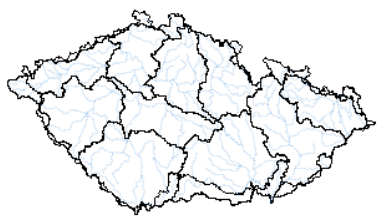
Srážky 5



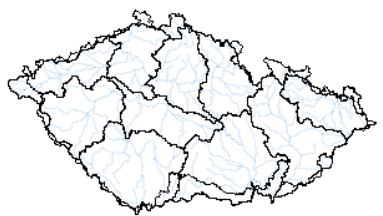
Srážky 6



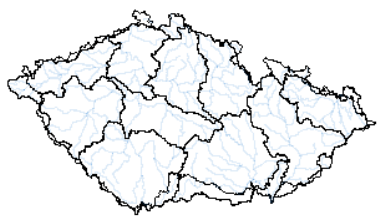
Srážky 7



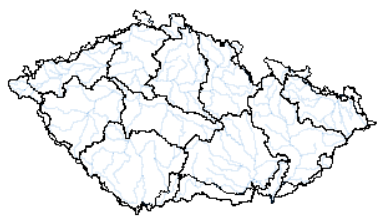
Srážky 8



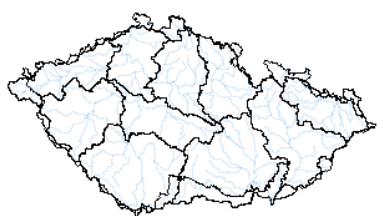
Srážky 9



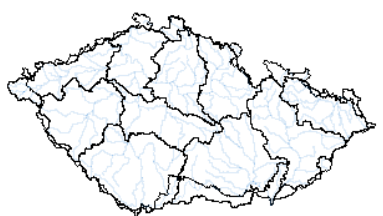
Srážky 10



Srážky 11



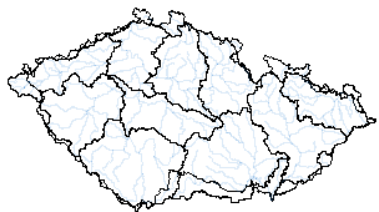
Srážky 12



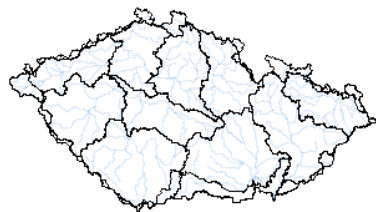
%

- -25 až -15
- -15 až -5
- ~0
- 5 až 15
- 15 až 25

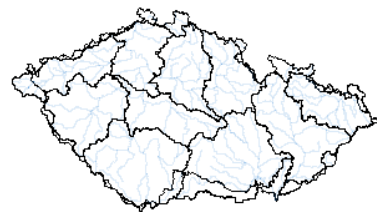
Sníh 1



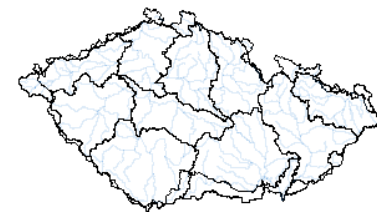
Sníh 2



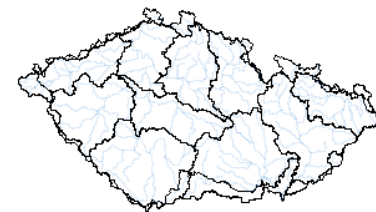
Sníh 3



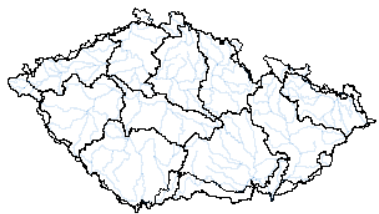
Sníh 4



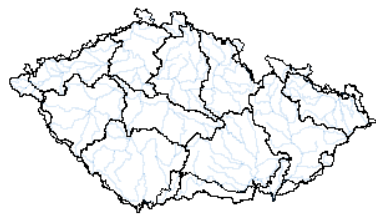
Sníh 5



Sníh 6



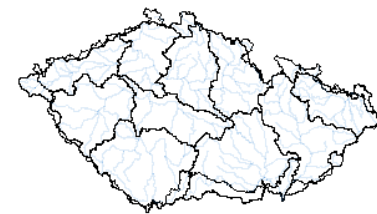
Sníh 7



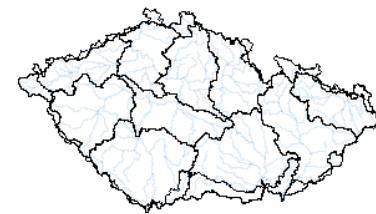
Sníh 8



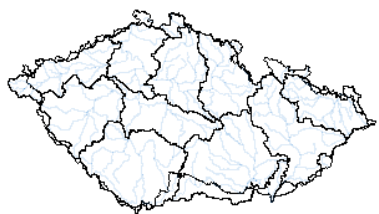
Sníh 9



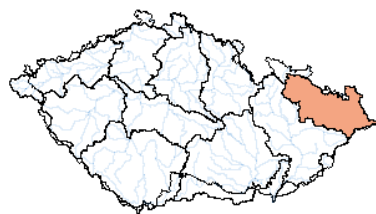
Sníh 10



Sníh 11



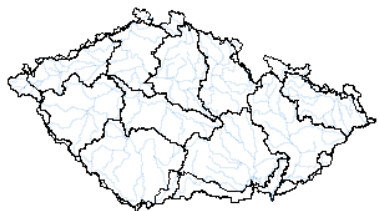
Sníh 12



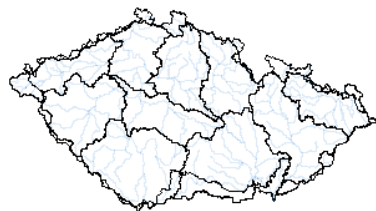
%

- -40 až -20
- -20 až -5
- ~0
- 5 až 20
- 20 až 40

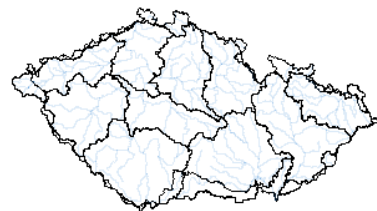
Teplota 1



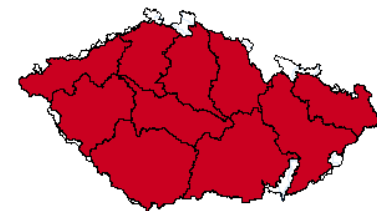
Teplota 2



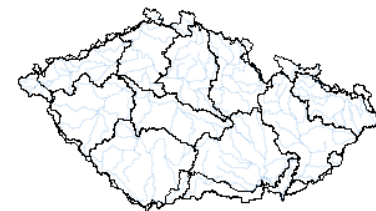
Teplota 3



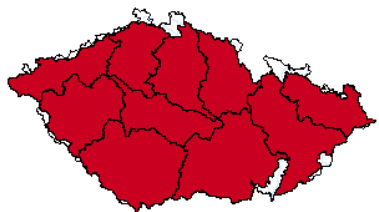
Teplota 4



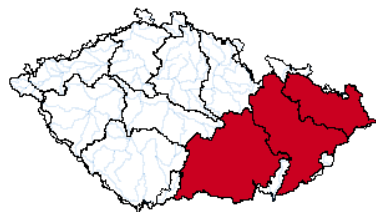
Teplota 5



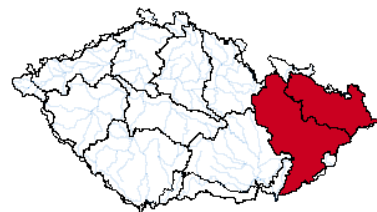
Teplota 6



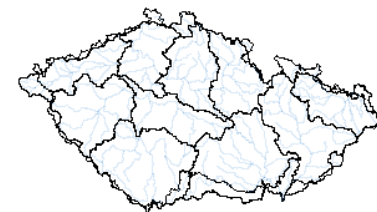
Teplota 7



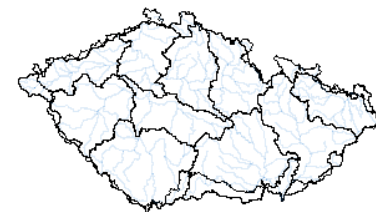
Teplota 8



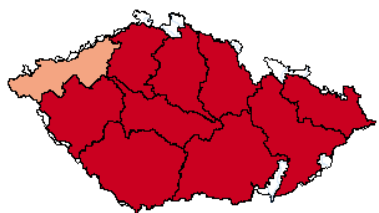
Teplota 9



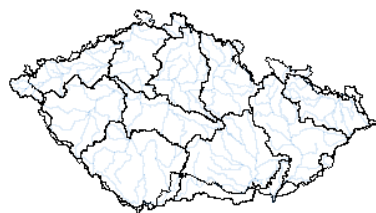
Teplota 10



Teplota 11



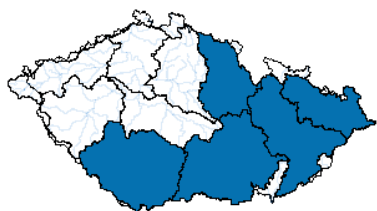
Teplota 12



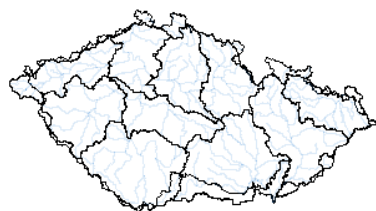
°C

- -1 až -0,5
- -0,5 až 0,2
- ~0
- 0,2 až 0,5
- 0,5 až 1

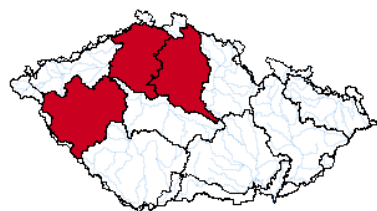
Vlhkost 1



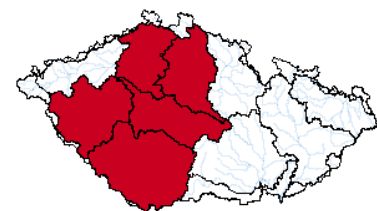
Vlhkost 2



Vlhkost 3



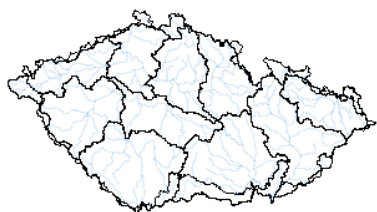
Vlhkost 4



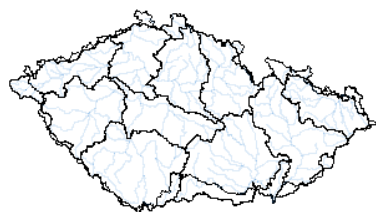
Vlhkost 5



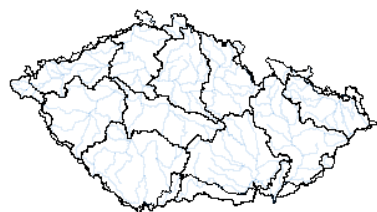
Vlhkost 6



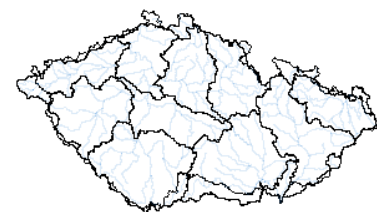
Vlhkost 7



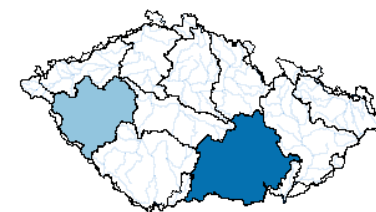
Vlhkost 8



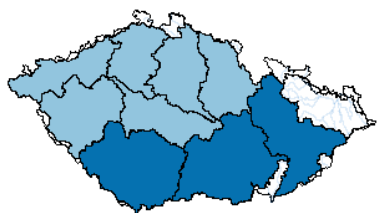
Vlhkost 9



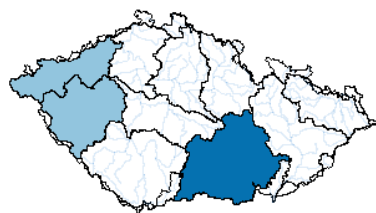
Vlhkost 10



Vlhkost 11



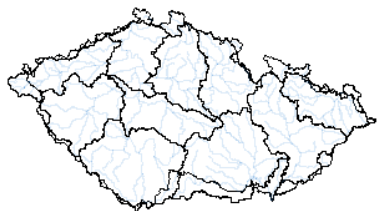
Vlhkost 12



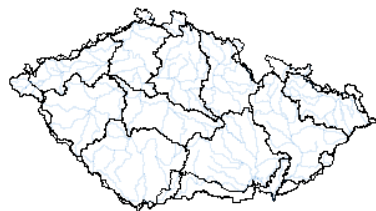
%

- -3 až -1
- -1 až -0,5
- ~0
- 0,5 až 1
- 1 až 3

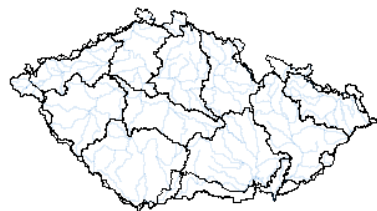
Pot. ET 1



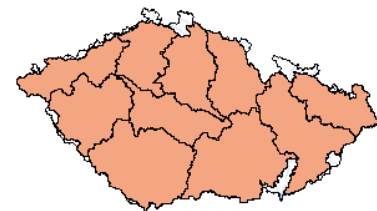
Pot. ET 2



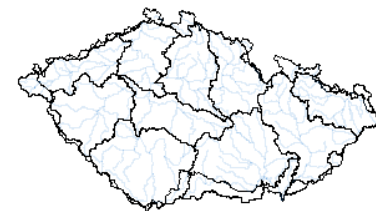
Pot. ET 3



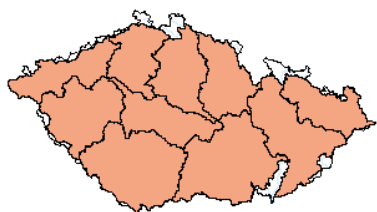
Pot. ET 4



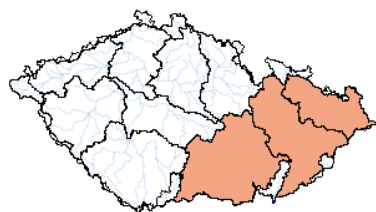
Pot. ET 5



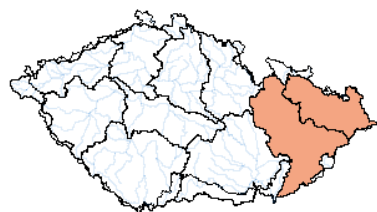
Pot. ET 6



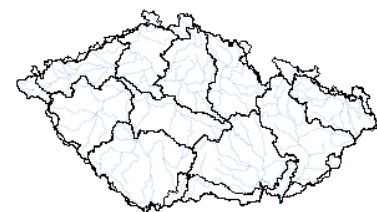
Pot. ET 7



Pot. ET 8



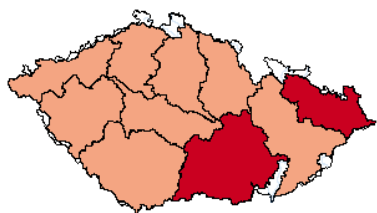
Pot. ET 9



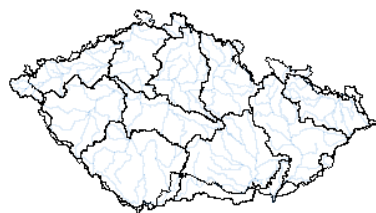
Pot. ET 10



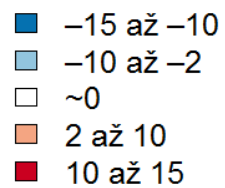
Pot. ET 11



Pot. ET 12



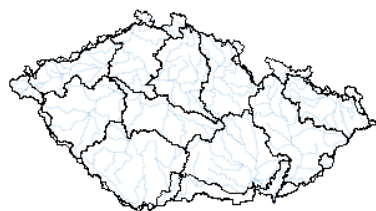
%



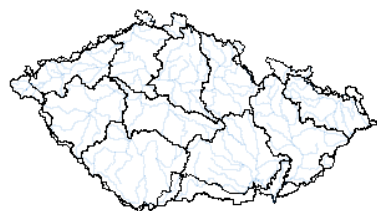
Akt. ET 1



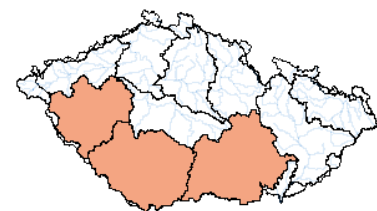
Akt. ET 2



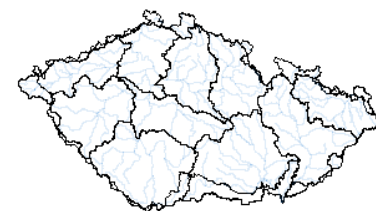
Akt. ET 3



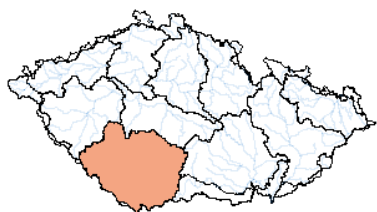
Akt. ET 4



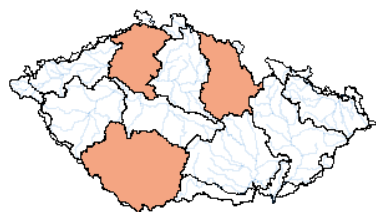
Akt. ET 5



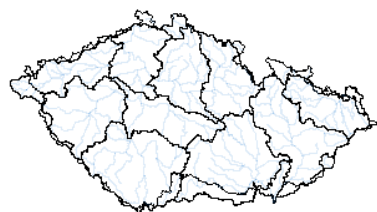
Akt. ET 6



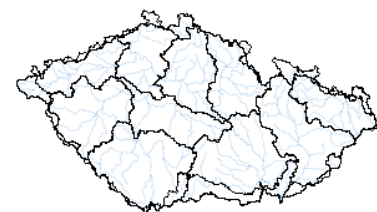
Akt. ET 7



Akt. ET 8



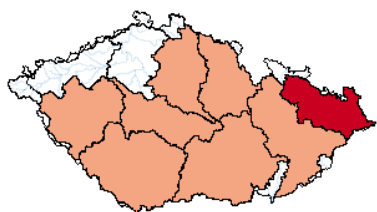
Akt. ET 9



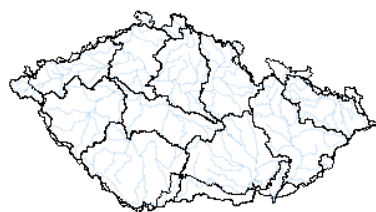
Akt. ET 10



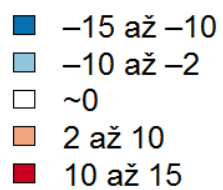
Akt. ET 11



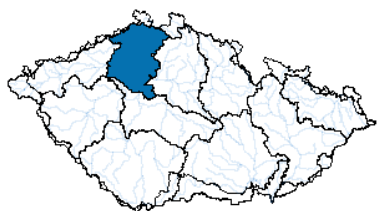
Akt. ET 12



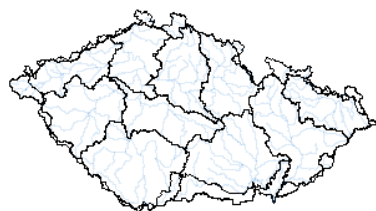
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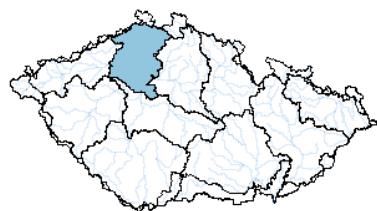
Q_měř. 1



Q_měř. 2



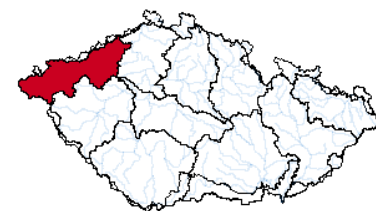
Q_měř. 3



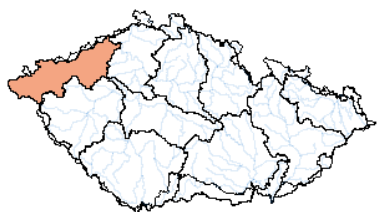
Q_měř. 4



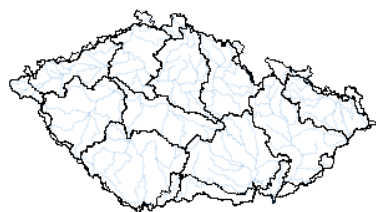
Q_měř. 5



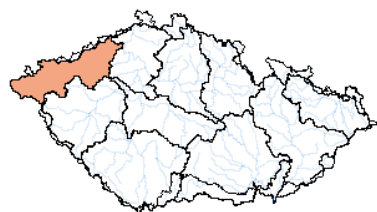
Q_měř. 6



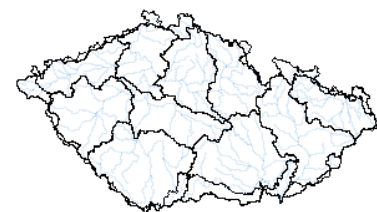
Q_měř. 7



Q_měř. 8



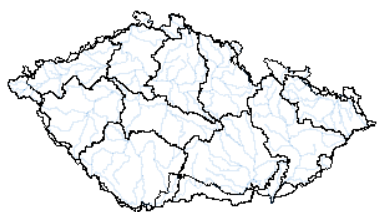
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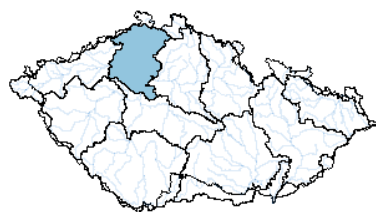
Q_měř. 10



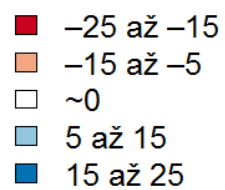
Q_měř. 11



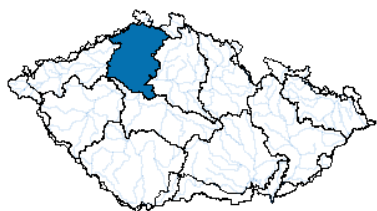
Q_měř. 12



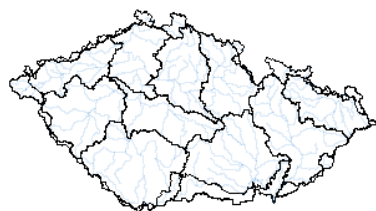
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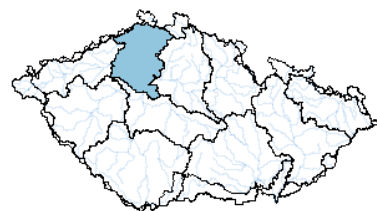
Q_přir. 1



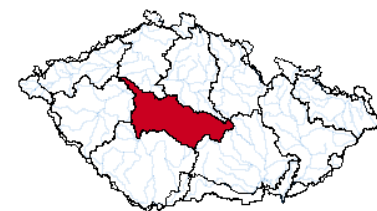
Q_přir. 2



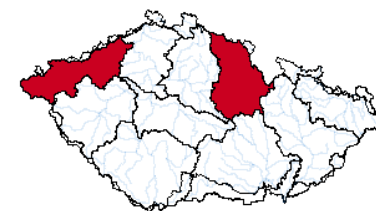
Q_přir. 3



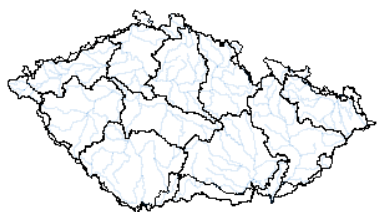
Q_přir. 4



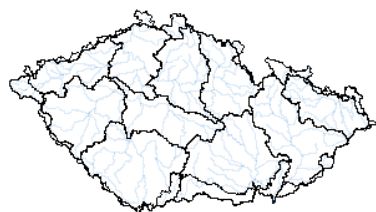
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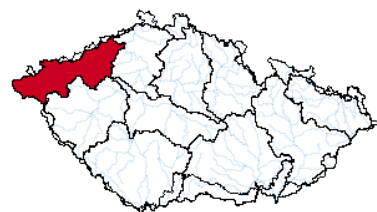
Q_přir. 6



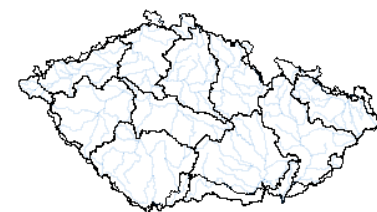
Q_přir. 7



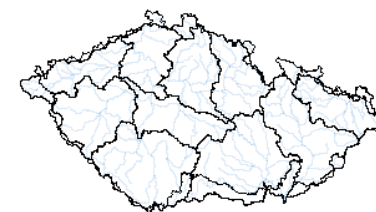
Q_přir. 8



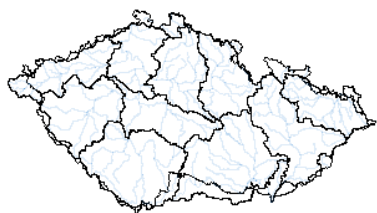
Q_přir. 9



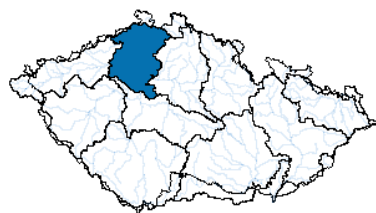
Q_přir. 10



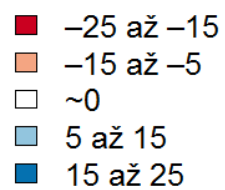
Q_přir. 11



Q_přir. 12

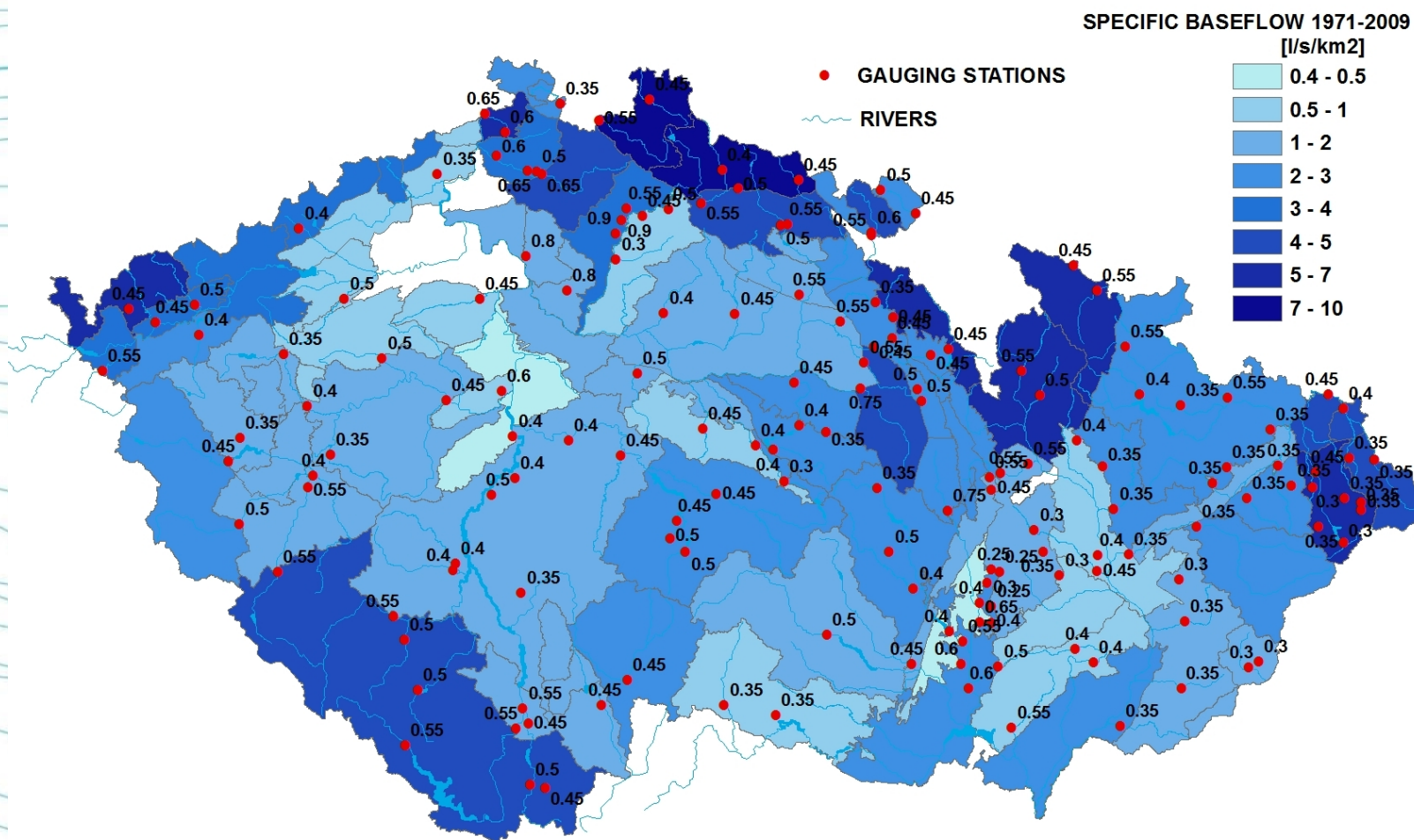


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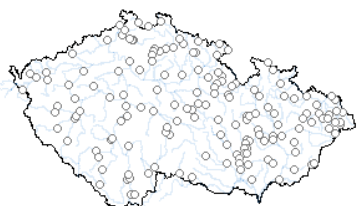
DENNÍ PRŮTOK ZÁKLADNÍ ODTOK

VÚV
TGM

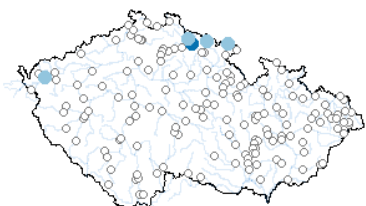


PRŮMĚRNÝ PRŮTOK

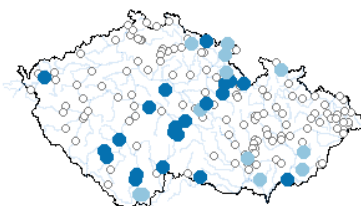
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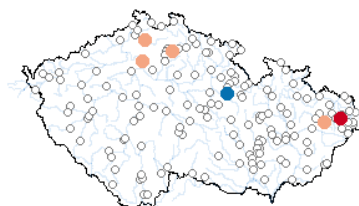
Qd 2



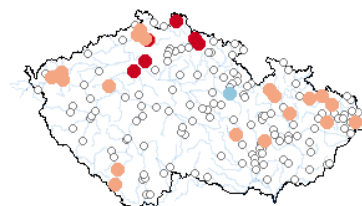
Qd 3



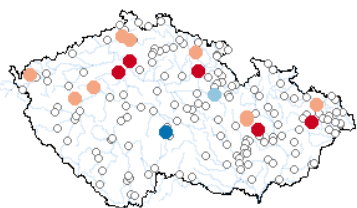
Qd 4



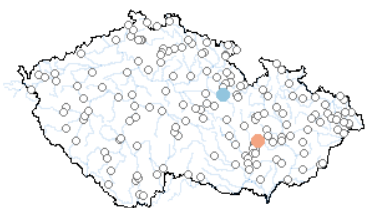
Qd 5



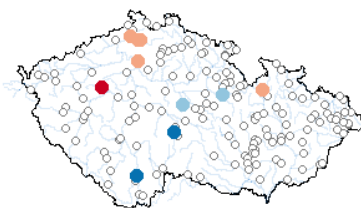
Qd 6



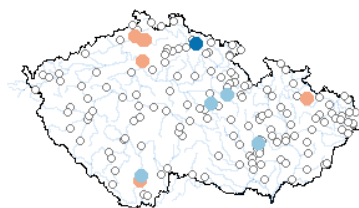
Qd 7



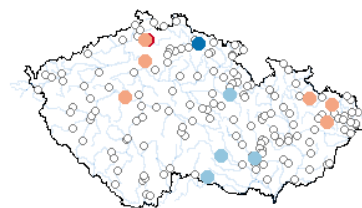
Qd 8



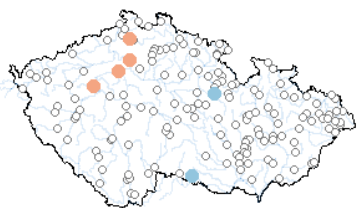
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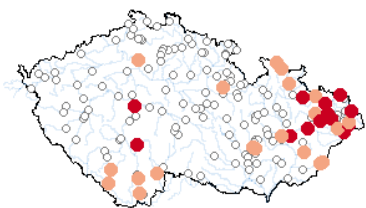
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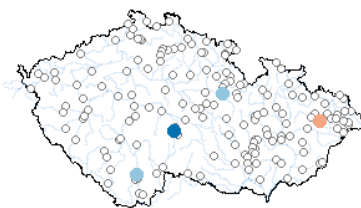
Qd 11



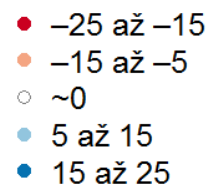
Qd 12



Qd A

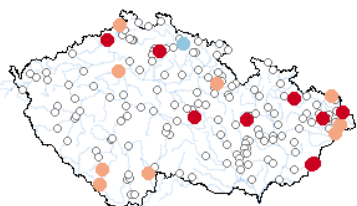


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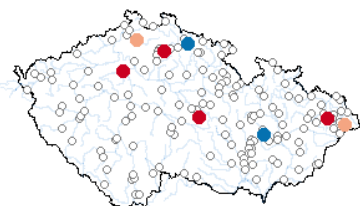


PRŮMĚRNÝ ZO

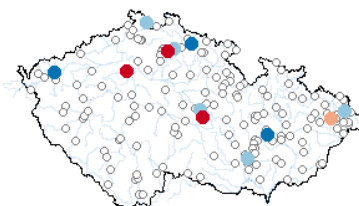
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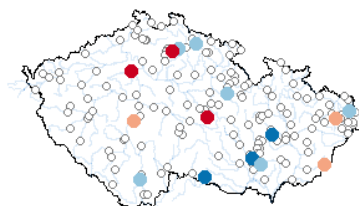
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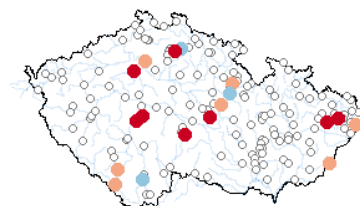
zo 3



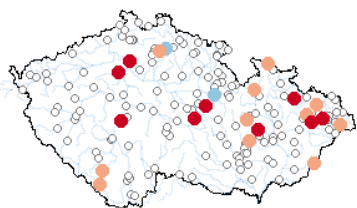
zo 4



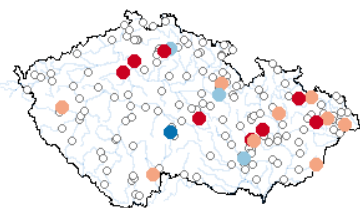
zo 5



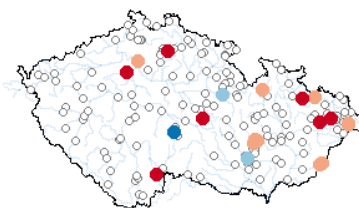
zo 6



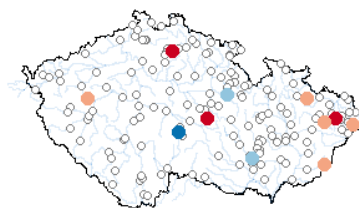
zo 7



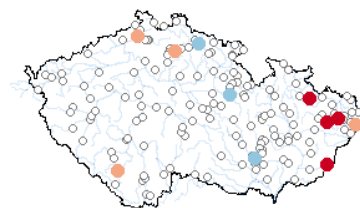
zo 8



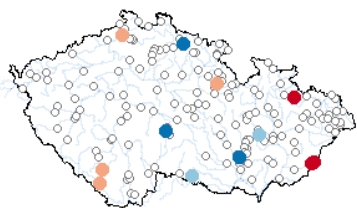
zo 9



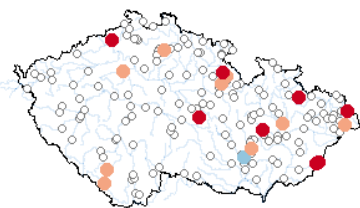
zo 10



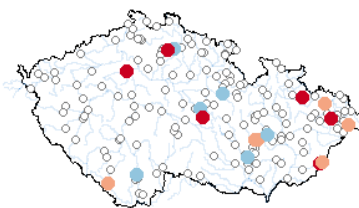
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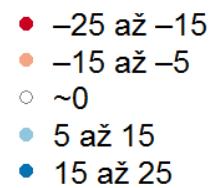
zo 12



zo A

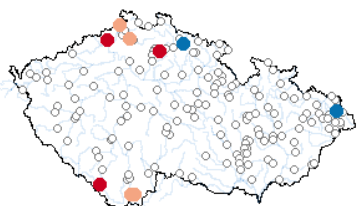


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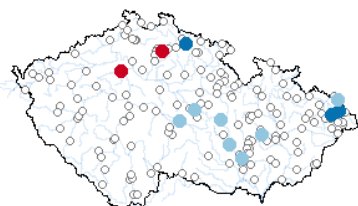


MINIMA PRŮTOKU

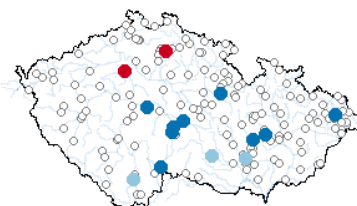
Qd 1



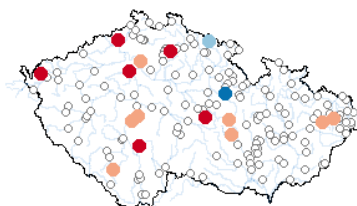
Qd 2



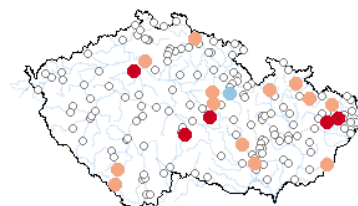
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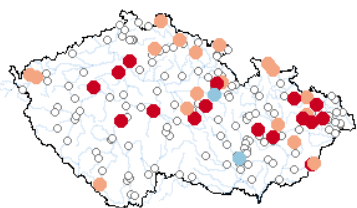
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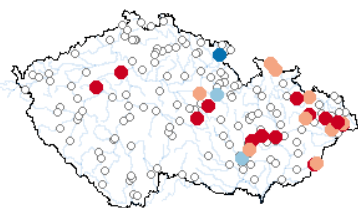
Qd 5



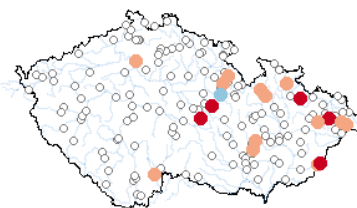
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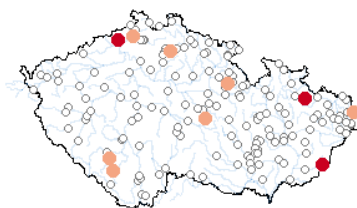
Qd 7



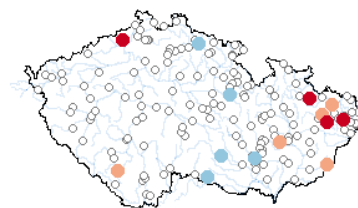
Qd 8



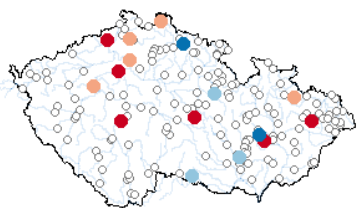
Qd 9



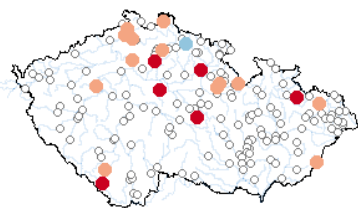
Qd 10



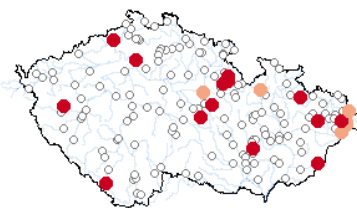
Qd 11



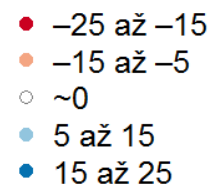
Qd 12



Qd A



%



MINIMA ZO

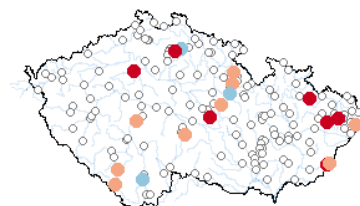
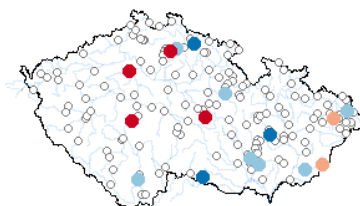
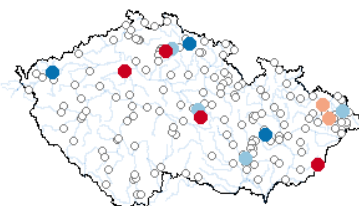
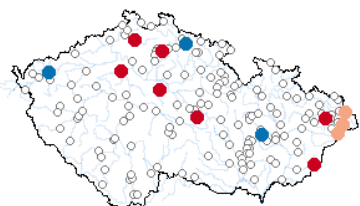
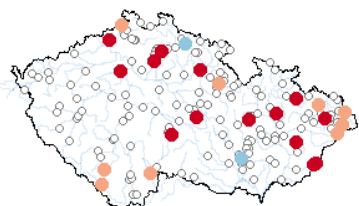
zo 1

zo 2

zo 3

zo 4

zo 5



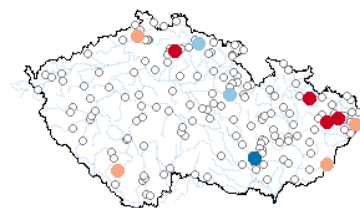
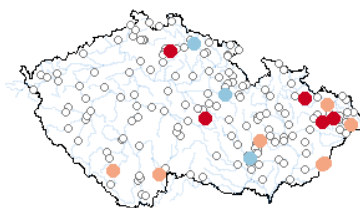
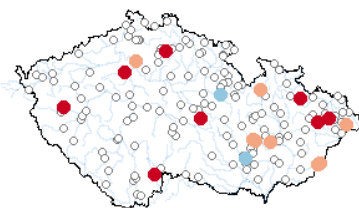
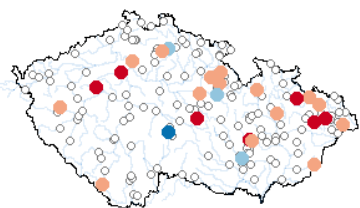
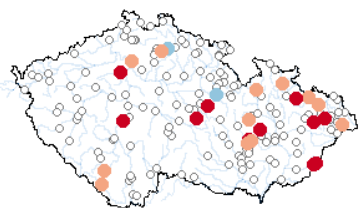
zo 6

zo 7

zo 8

zo 9

zo 10

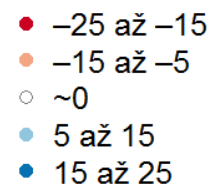
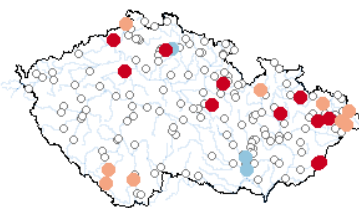
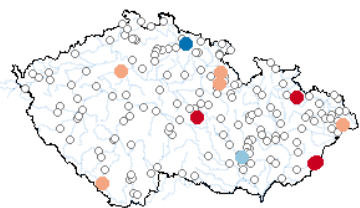
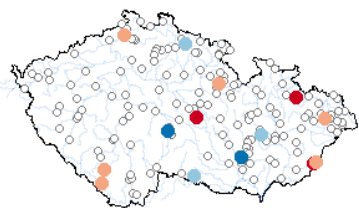


zo 11

zo 12

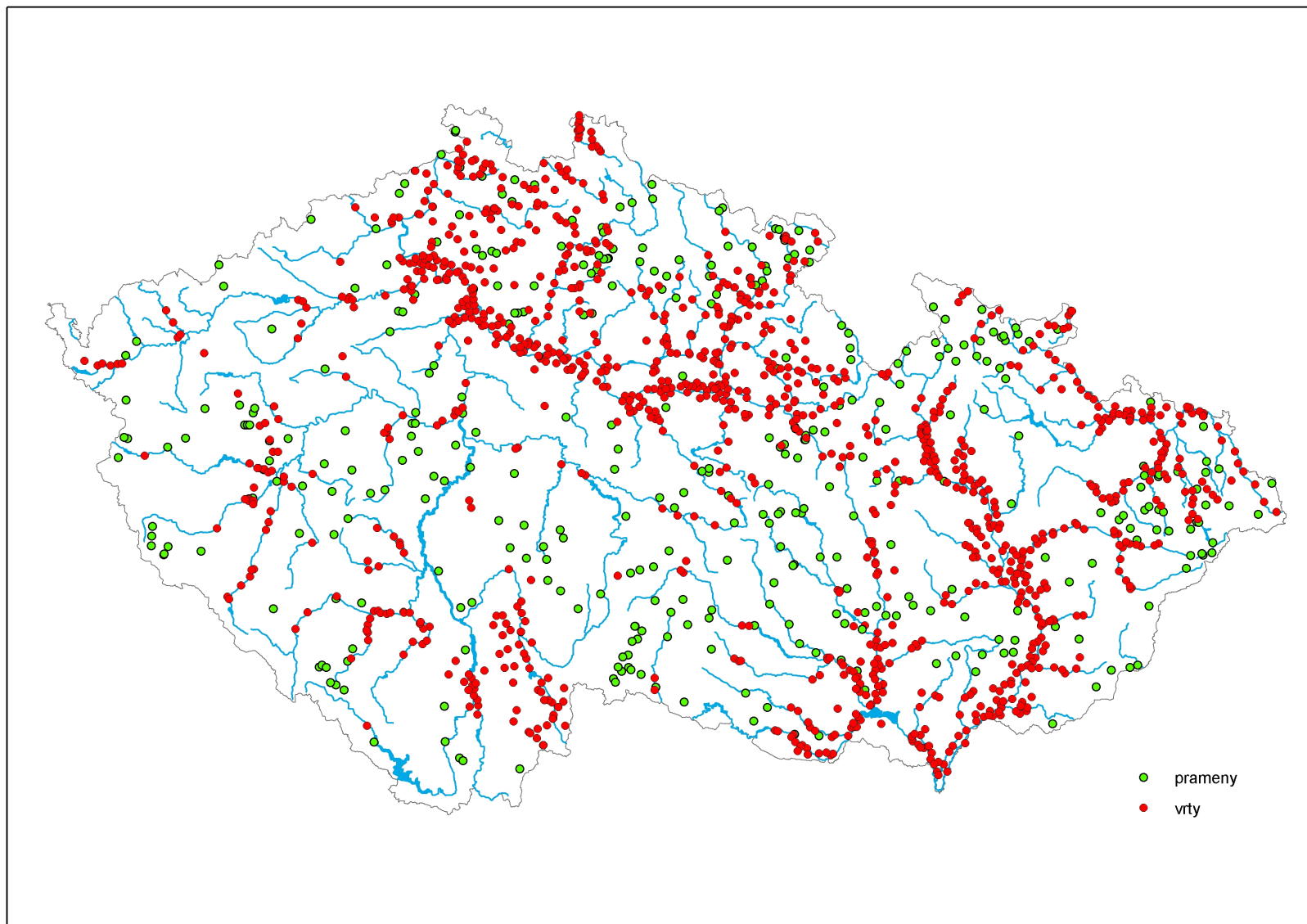
zo A

%



VYDATNOST PRAMENŮ HLADINY VE VRTECH

VÚV
TGM



PRŮMĚRNÉ VYDATNOSTI

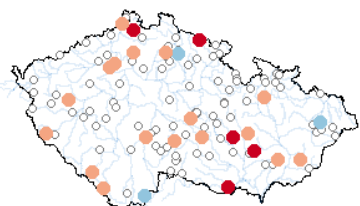
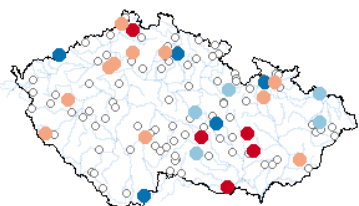
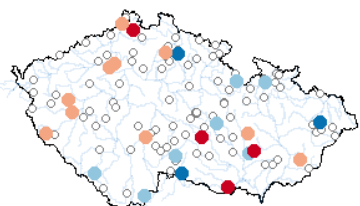
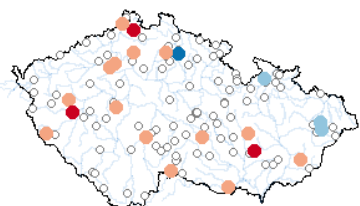
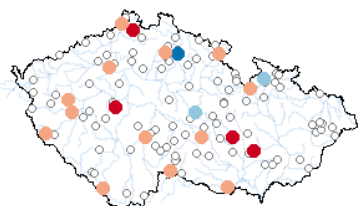
pram 1

pram 2

pram 3

pram 4

pram 5



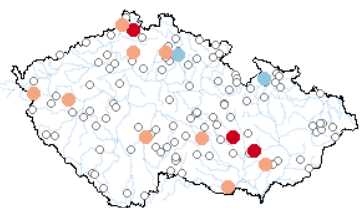
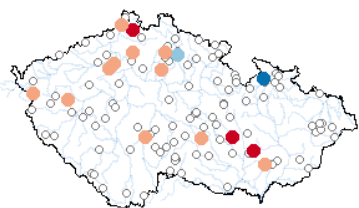
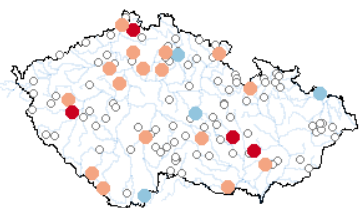
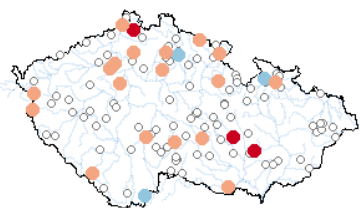
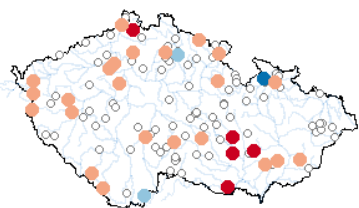
pram 6

pram 7

pram 8

pram 9

pram 10

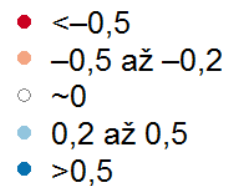
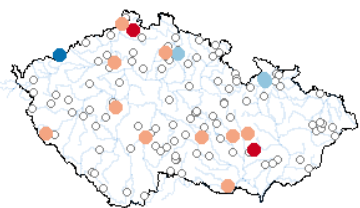
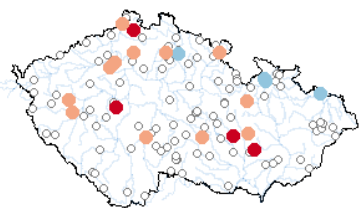
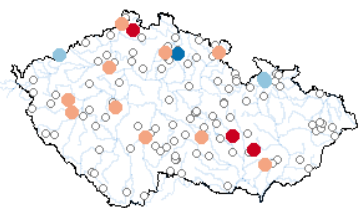


pram 11

pram 12

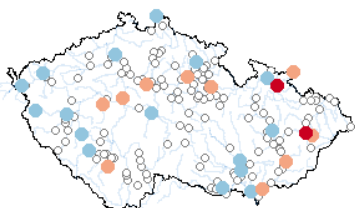
pram A

SD

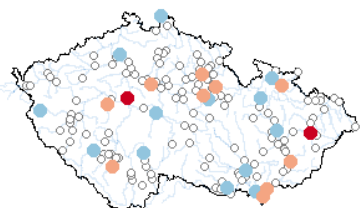


PRŮMĚRNÉ HLADINY

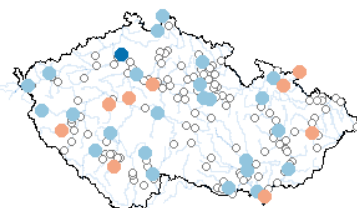
vrty 1



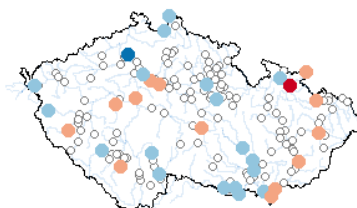
vrty 2



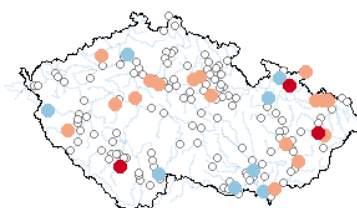
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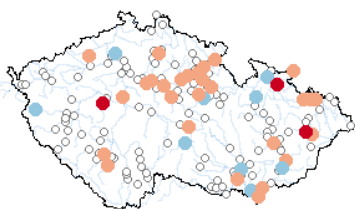
vrty 4



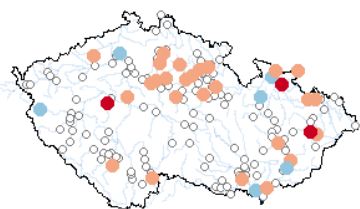
vrty 5



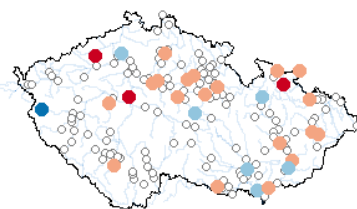
vrty 6



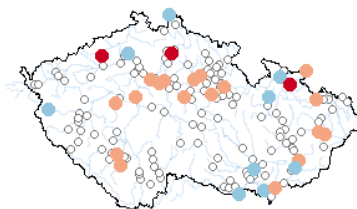
vrty 7



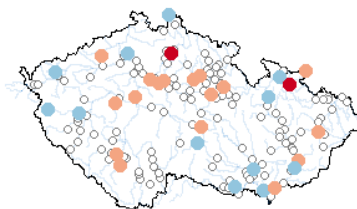
vrty 8



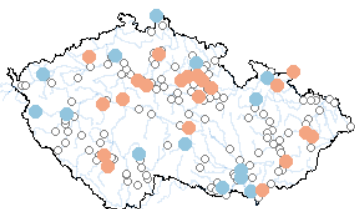
vrty 9



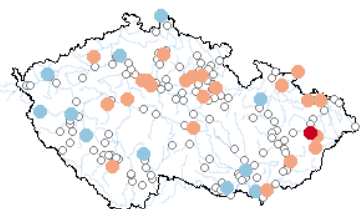
vrty 10



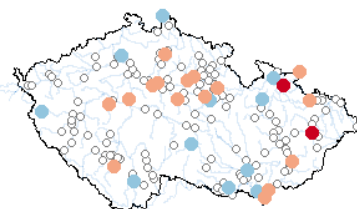
vrty 11



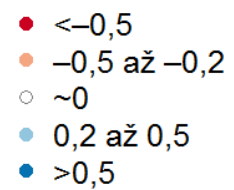
vrty 12



vrty A



SD



MINIMA VYDATNOSTI

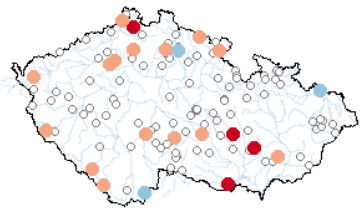
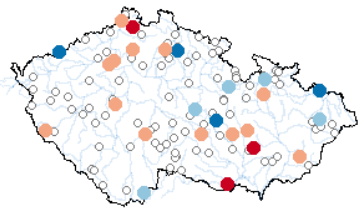
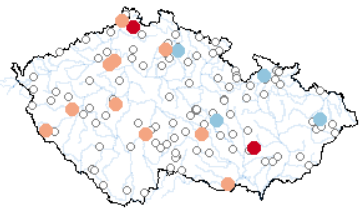
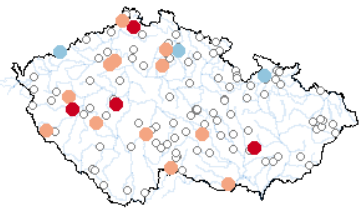
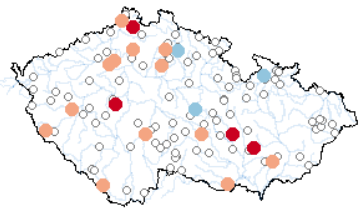
pram 1

pram 2

pram 3

pram 4

pram 5



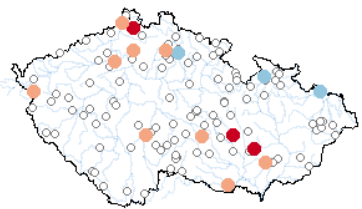
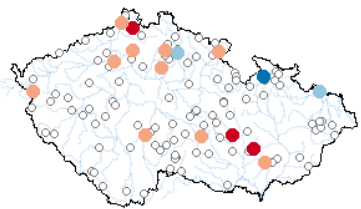
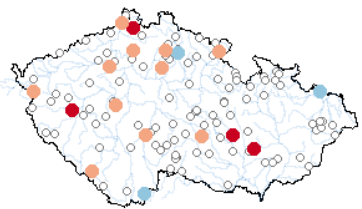
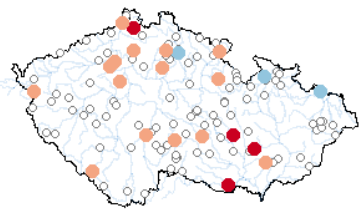
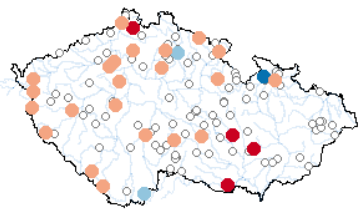
pram 6

pram 7

pram 8

pram 9

pram 10

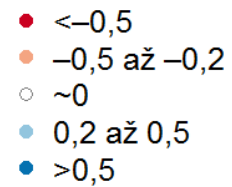
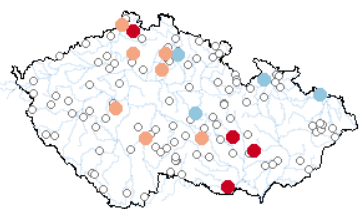
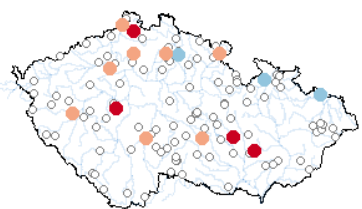
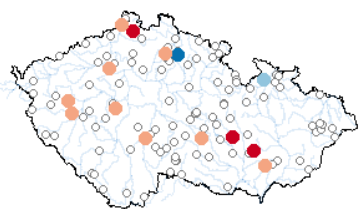


pram 11

pram 12

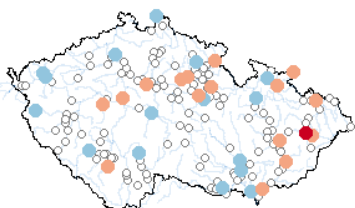
pram A

SD

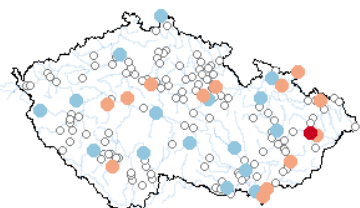


MINIMA HLADIN

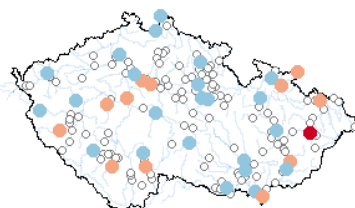
vrty 1



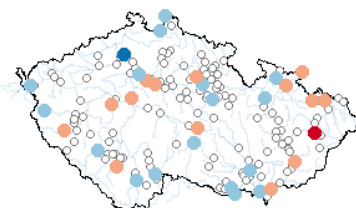
vrty 2



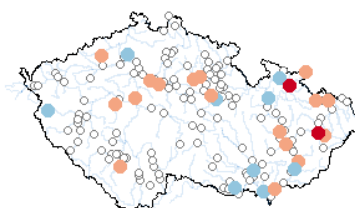
vrty 3



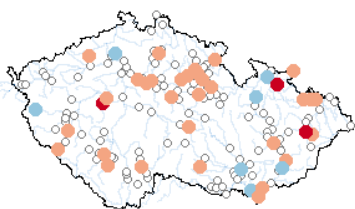
vrty 4



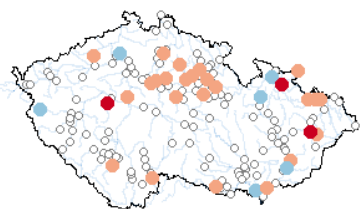
vrty 5



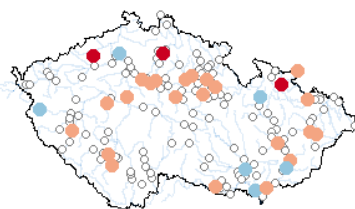
vrty 6



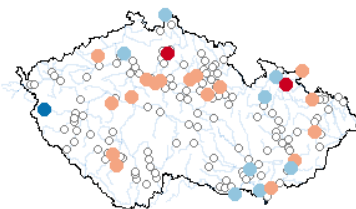
vrty 7



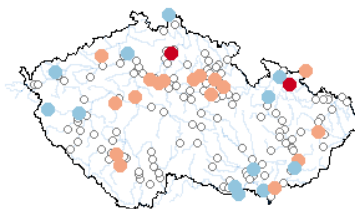
vrty 8



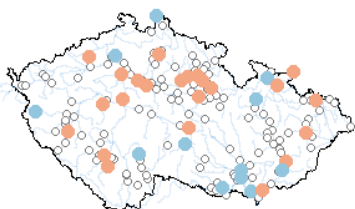
vrty 9



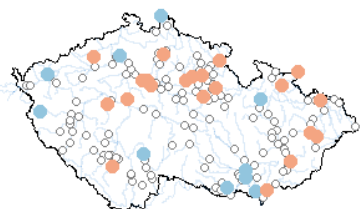
vrty 10



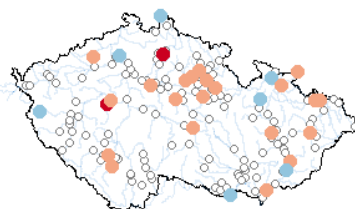
vrty 11



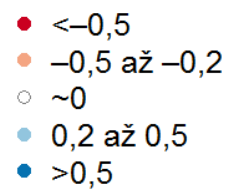
vrty 12



vrty A



SD



ZÁVĚR



ROČNÍ ZMĚNA

- nárůst teplot až o 1 °C, v j-z Čechách místy nárůst srážek až o 15 %
- nárůst evapotranspirace až o 10 % především v Čechách
- pokles minim průtoků a základního odtoku (data b.) u řady stanic převážně v s-v části ČR (až o 25 %)
- často pokles vydatností pramenů a hladin vrtů (data c.) (převážně do 0,5 SD), jak v průměrných hodnotách tak i v minimech. Lokálně u části objektů nárůst (až o 0,5 SD) vydatností i hladin

ZMĚNA ROČNÍHO CHODU

- V měsíčních agregacích denních průtoků lze u řady stanic sledovat nárůst v březnu (až 25 %) a pokles v květnu, červnu a prosinci (o 15 % i více), u minim jsou poklesy výraznější a četnější na úkor nárůstu (Obr. 2), k poklesům dochází např. i v červenci, což se celkově promítá do výše zmíněného celkového ročního poklesu minim. U základního odtoku byl zjištěn převážně pokles minim v průběhu celého roku (až 25 %), ale vyskytují se i nárůsty, které jsou však kompenzovány poklesy v jiných částech roku.

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V průběhu roku (všechny měsíce) byl u vydatností celé řady pramenů zjištěn pokles (převážně do 0,5 SD), místy ale i nárůst v březnu a dubnu. U minimálních vydatností zřetelně převažují poklesy nad nárůsty (Obr. 3). Trend hladin v mělkých vrtech je podobný trendu pramenů, poklesů je méně, vzestupů hladin více (jarní měsíce), nicméně i v tomto případě převažují poklesy.

Děkuji za pozornost

Data poskytl Český hydrometeorologický ústav

