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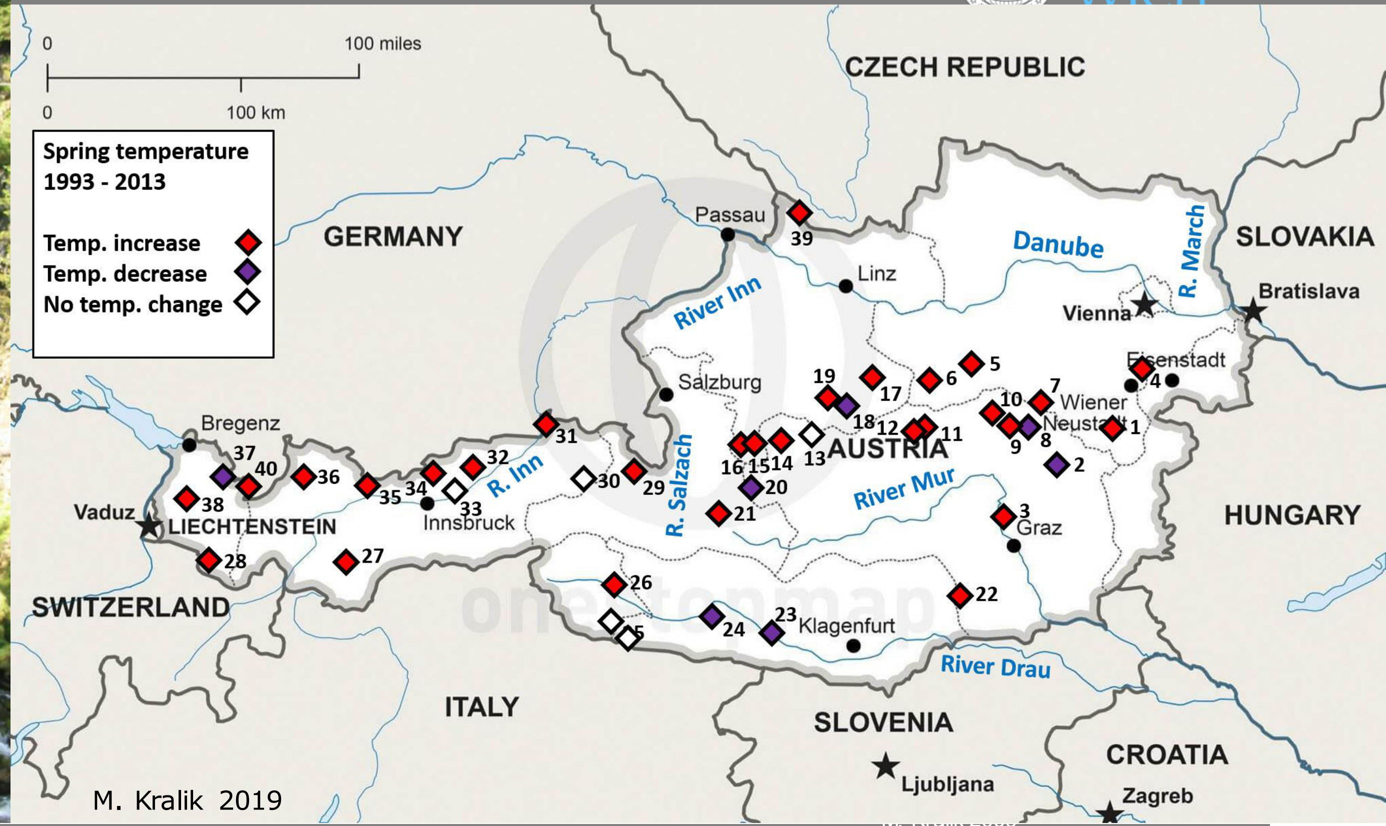
Winnerfall, Golling; Foto: M. Kralik



Alpine Spring Water and Global Change

Evidence from Temperature, Chemistry and O-18 measurements

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Content

- Austrian Hydrological Network of Discharge, Temperature, EC (ehyd)
- Austrian Water Quality Network (GZÜV)
- Austrian Isotope Network (ANIP)
- Trend Analysis (1993-2013)
- Conclusions

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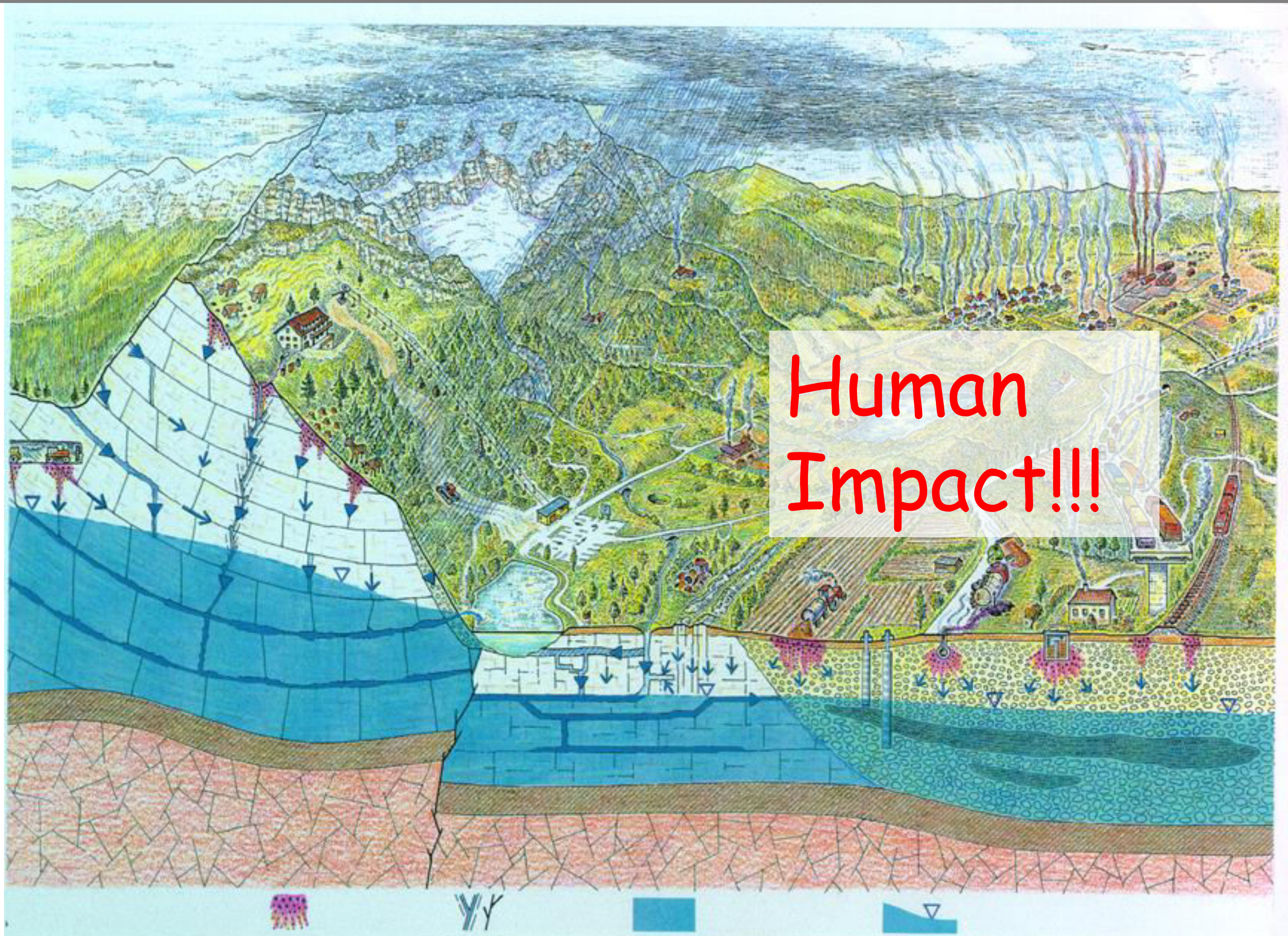

Human
Impact!!!

Springwater

Porous Groundwater

100% Groundwater

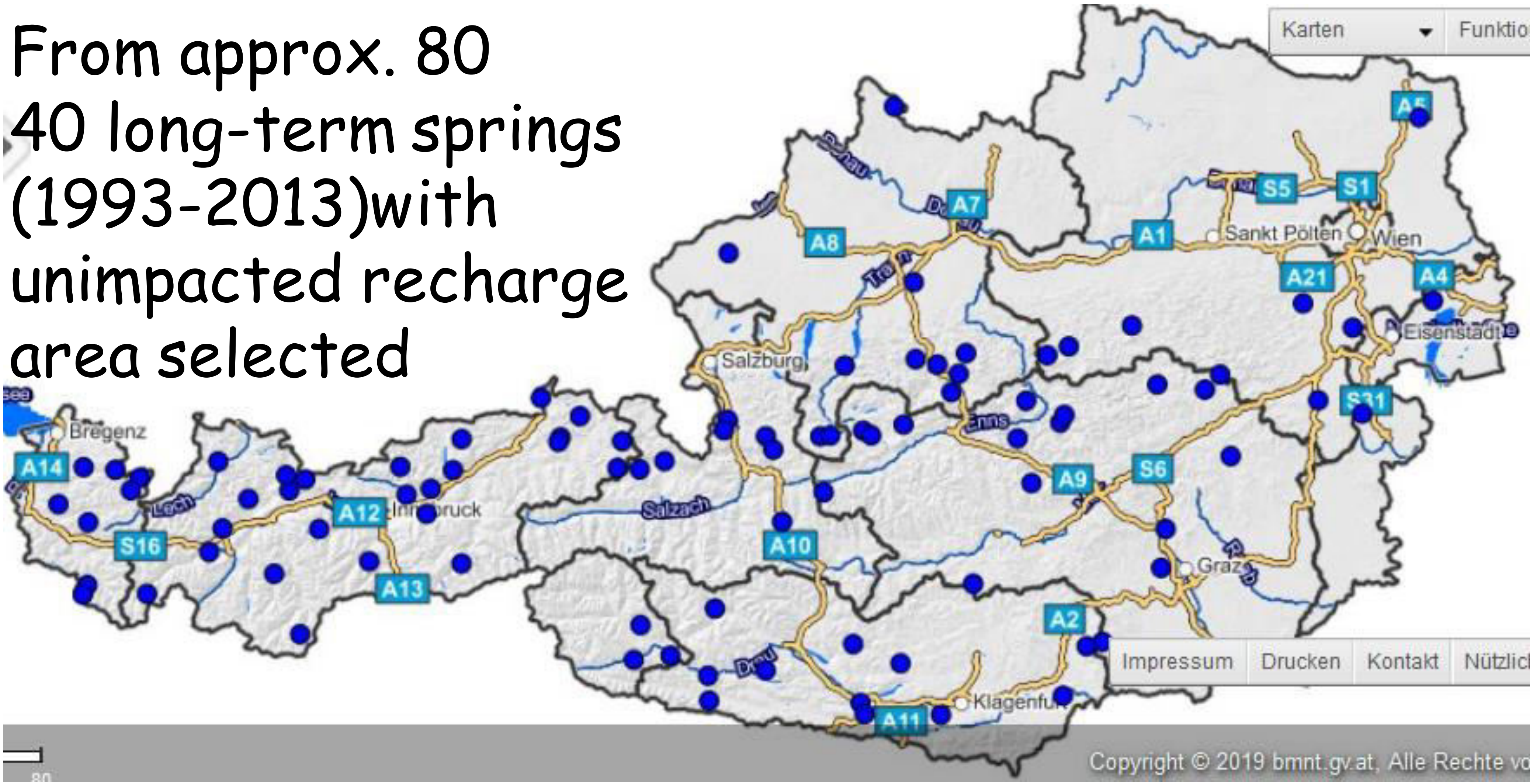
50% : 50% Drinking water supply

Hydrological on-line Data (ehyd):
L/s - °C - EC (µS/cm, 25°C)
Every 15 min. > daily mean

Ehyd - data

18 Rettenbach S. Foto Hydrographischer Dienst

From approx. 80
40 long-term springs
(1993-2013)with
unimpacted recharge
area selected



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36 Lehnbach S.


29 Friedlbrunn S.


7 Wasseralm S.


37 Goldbach S.


Winnerfall, Golling; Foto: M. Kralik


30 Schreiender Brunnen

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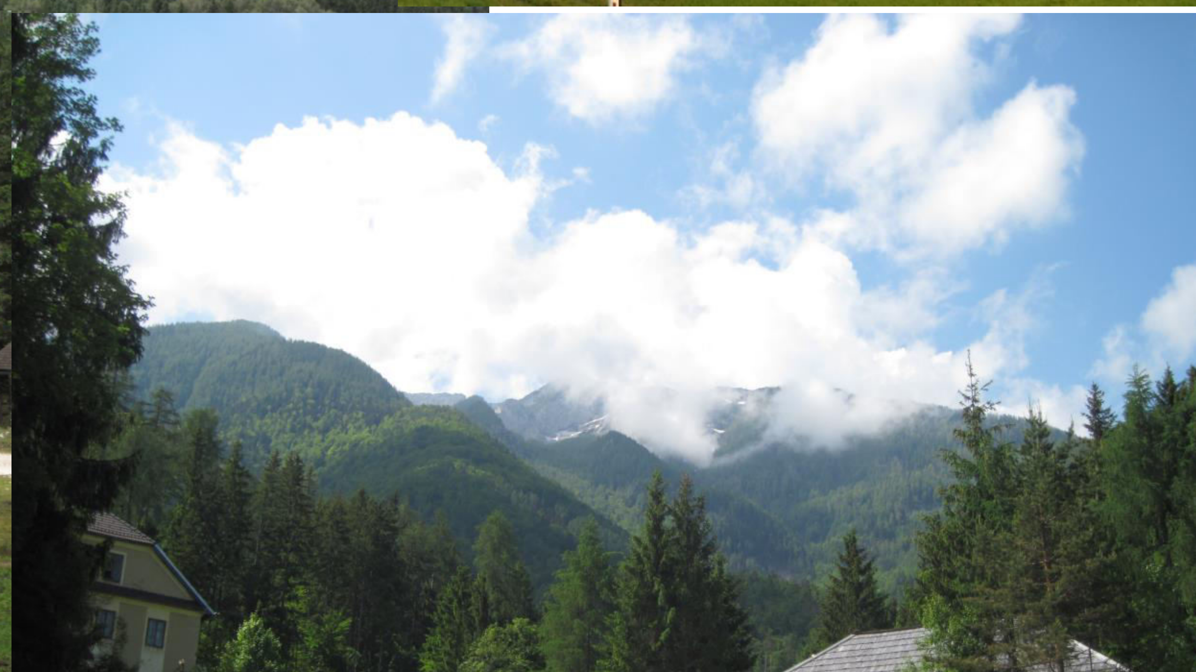

Water quality data (GZÜV):

°C,EC,pH,O_2

Ca,Mg,Na,K,H_2O_3,SO_4,Cl,NO_3

4x / year

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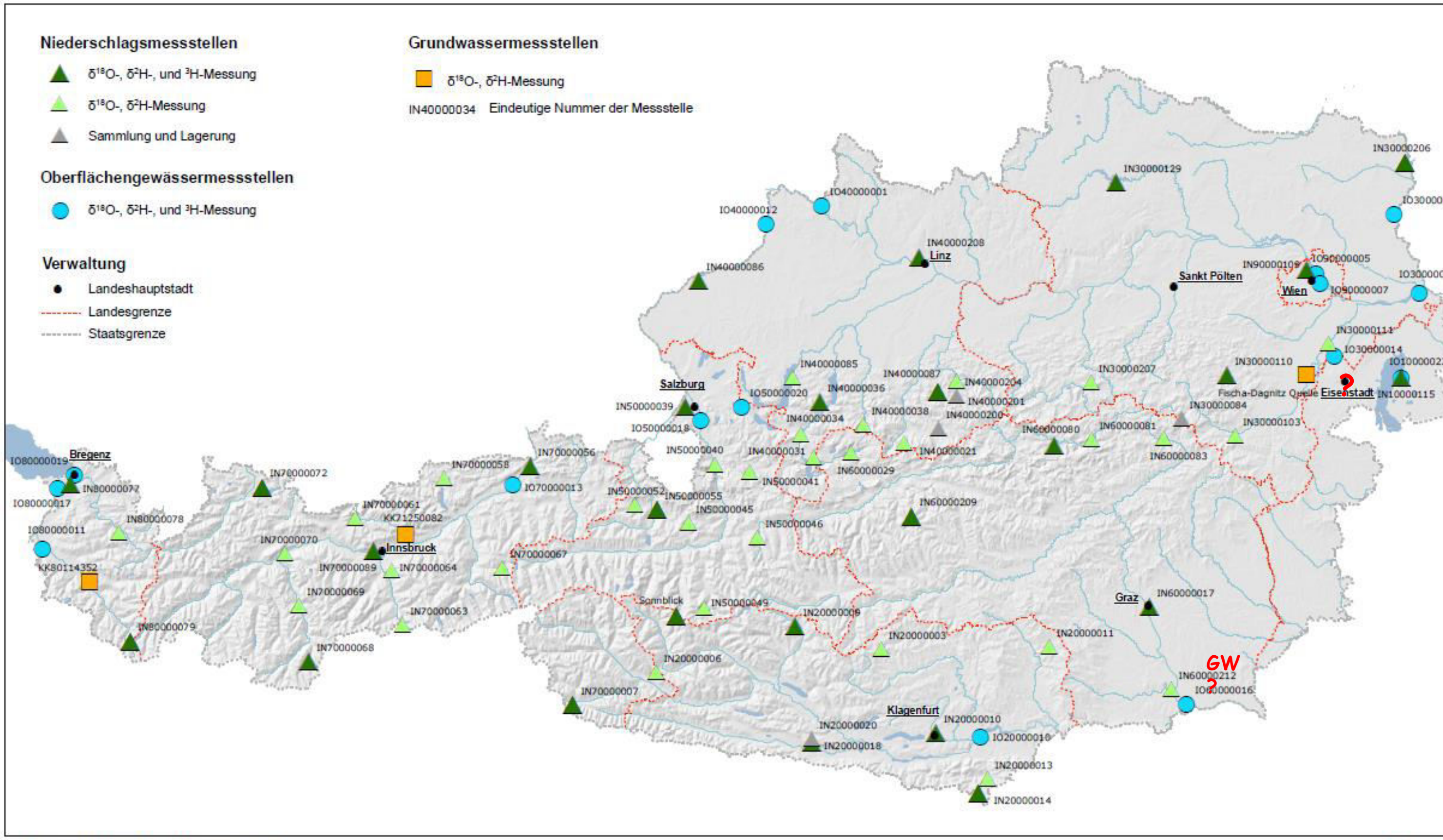
Austrian Network of Isotopes in Precipitation, Surfacewater and Groundwater „Input"

ANIP: Austrian Network of Isotopes

Isotopen - Messstellen 2016 - 2018

Arbeitskarte

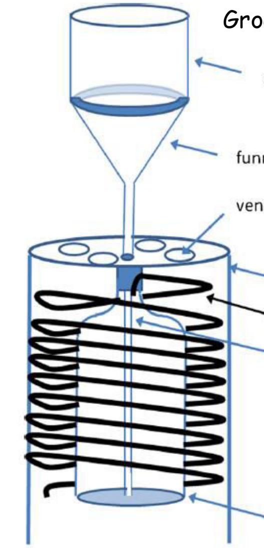


Quelle: Gewässerzustandsüberwachungsverordnung (GZÜV) BGBl. Nr. 479/2006 i.d.g.F.; BMLFUW, Sektion IV, Abteilung IV 3 Nationale und internationale Wasserwirtschaft; Ämter der Landesregierungen;

Auswertung/Graphik: Umweltbundesamt GmbH, 2015

Brielmann 2015

umweltbundesamt



Groening et al. 2012

Fig. 3. Schematics of the precipitation water sampler. Marked in black

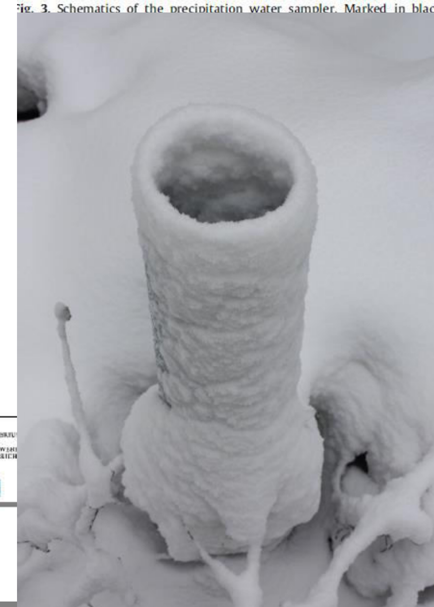


Foto: Kralik

Trends:

More than 235,000 on-line measurements and 11,500 chemical analyses of 40 springs with natural recharge areas were evaluated for trends (1993 - 2013)

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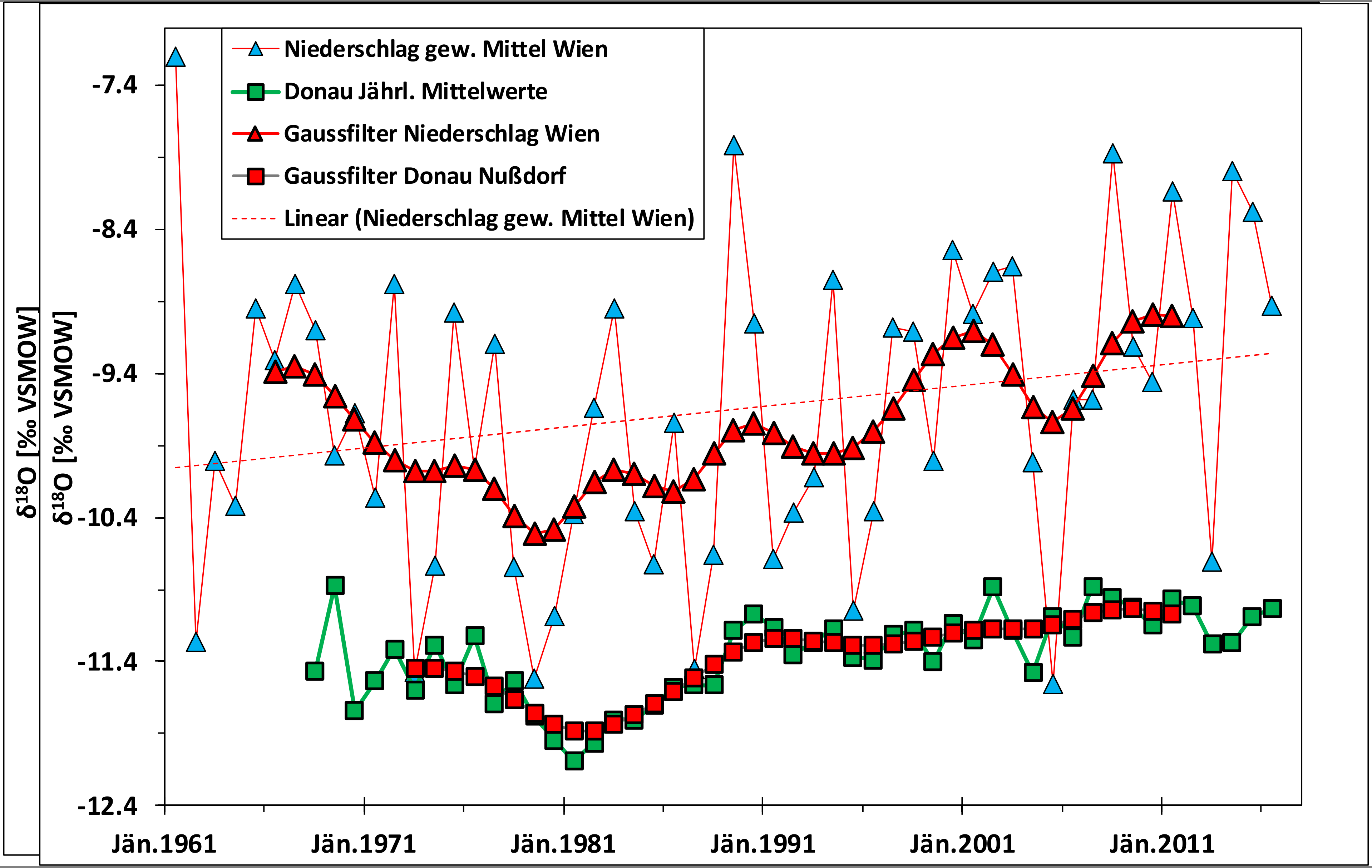
Trends: Gauss - Filter



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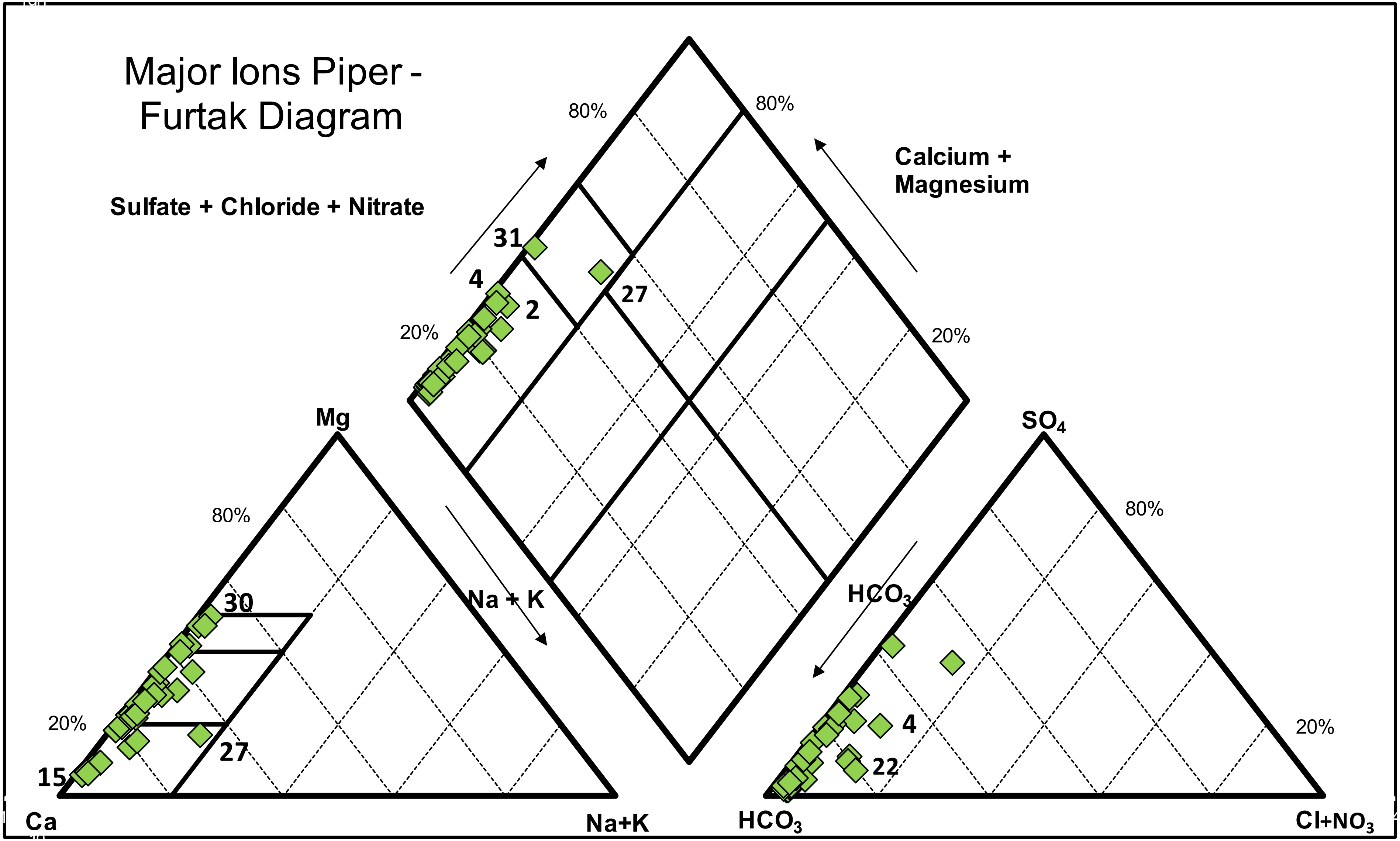
Results:

Major ion - chemistry



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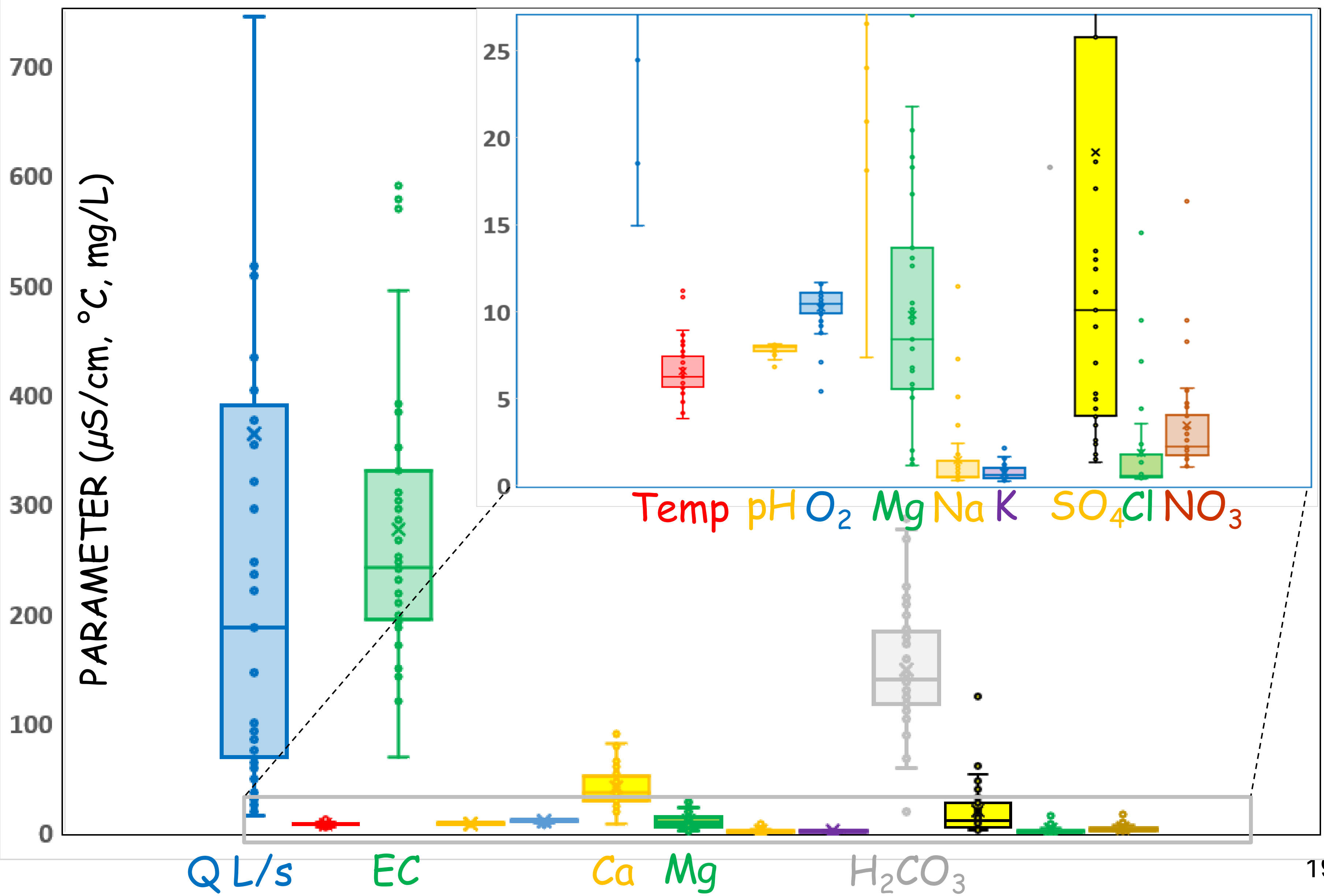
Major parameter



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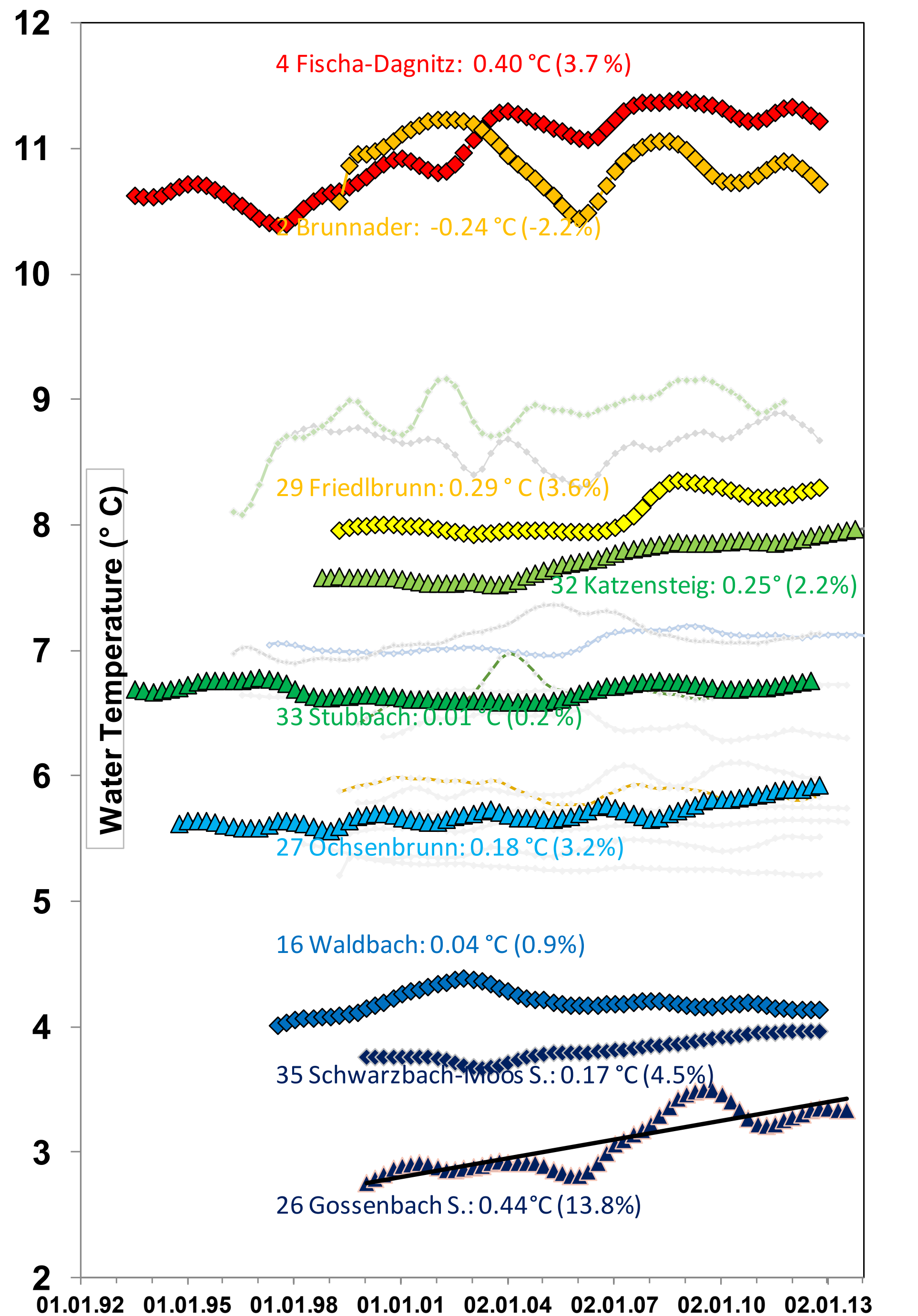
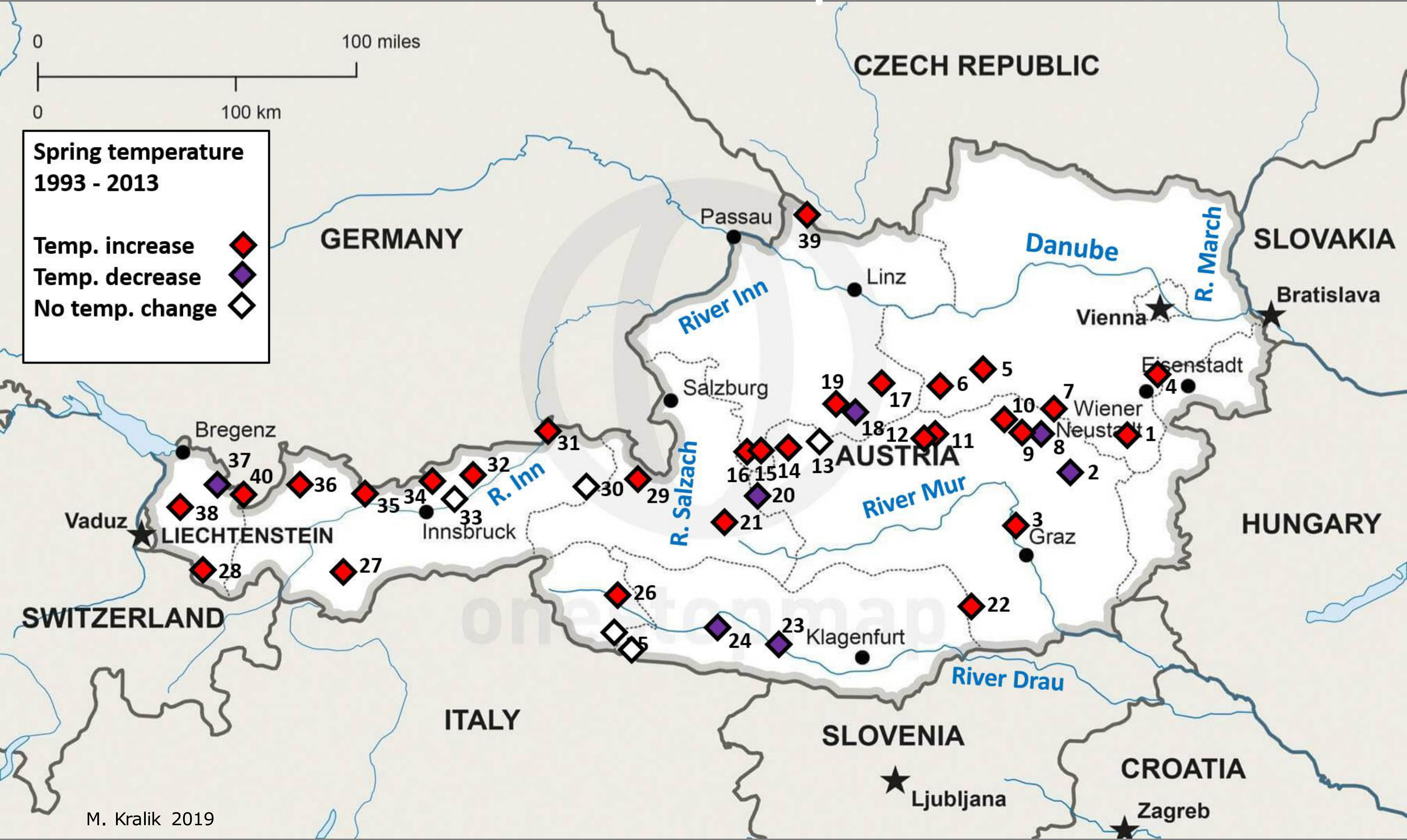


29 (74%) of the selected 40 springs show a significant increase in water temperature with a mean of 0.34 °C (0.06 – 1.03) during 20 years (1993 – 2013)

› 0.17 °C per decade

Trends: Water temperature



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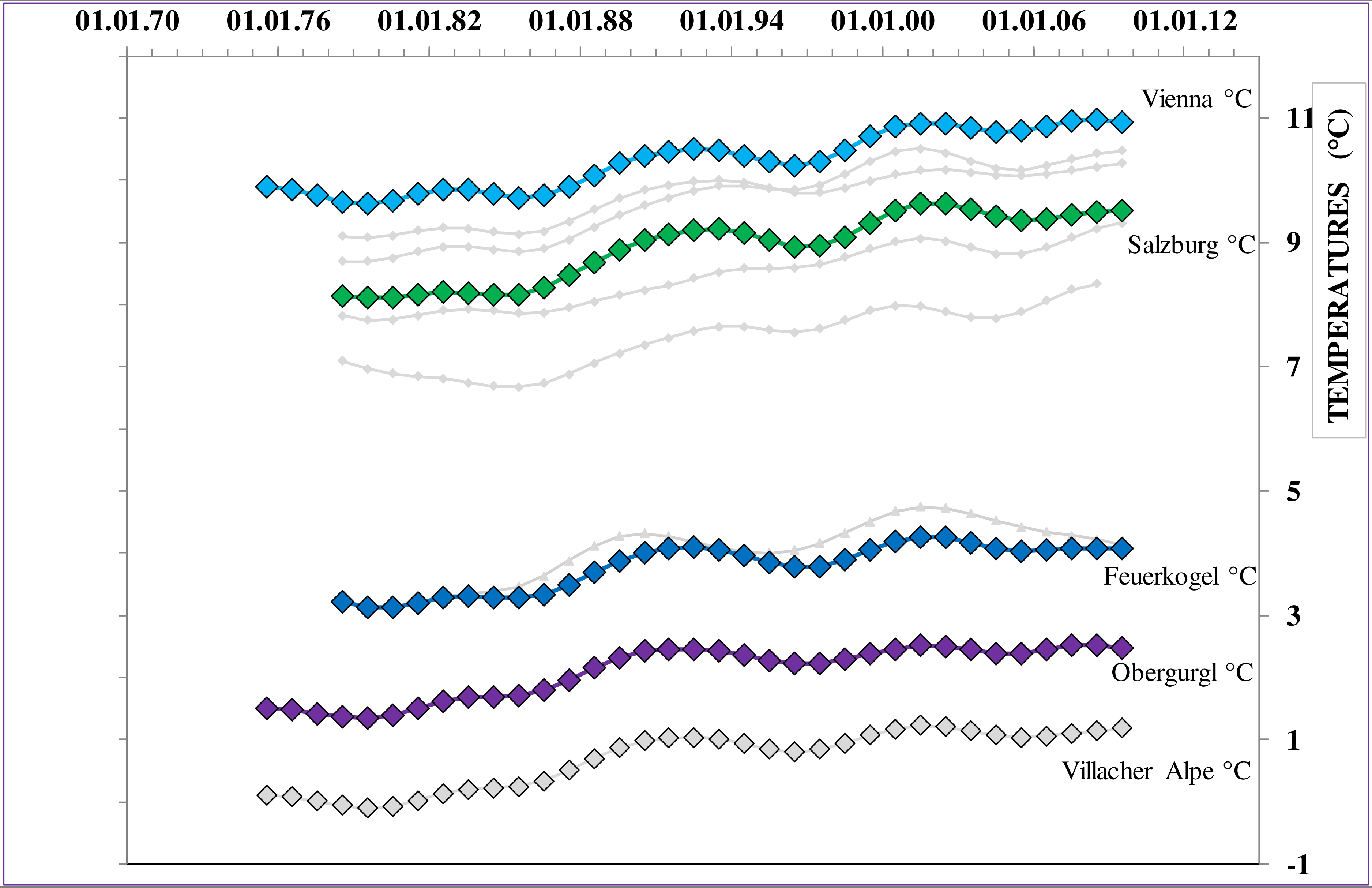
Trends: Air-Temperatures



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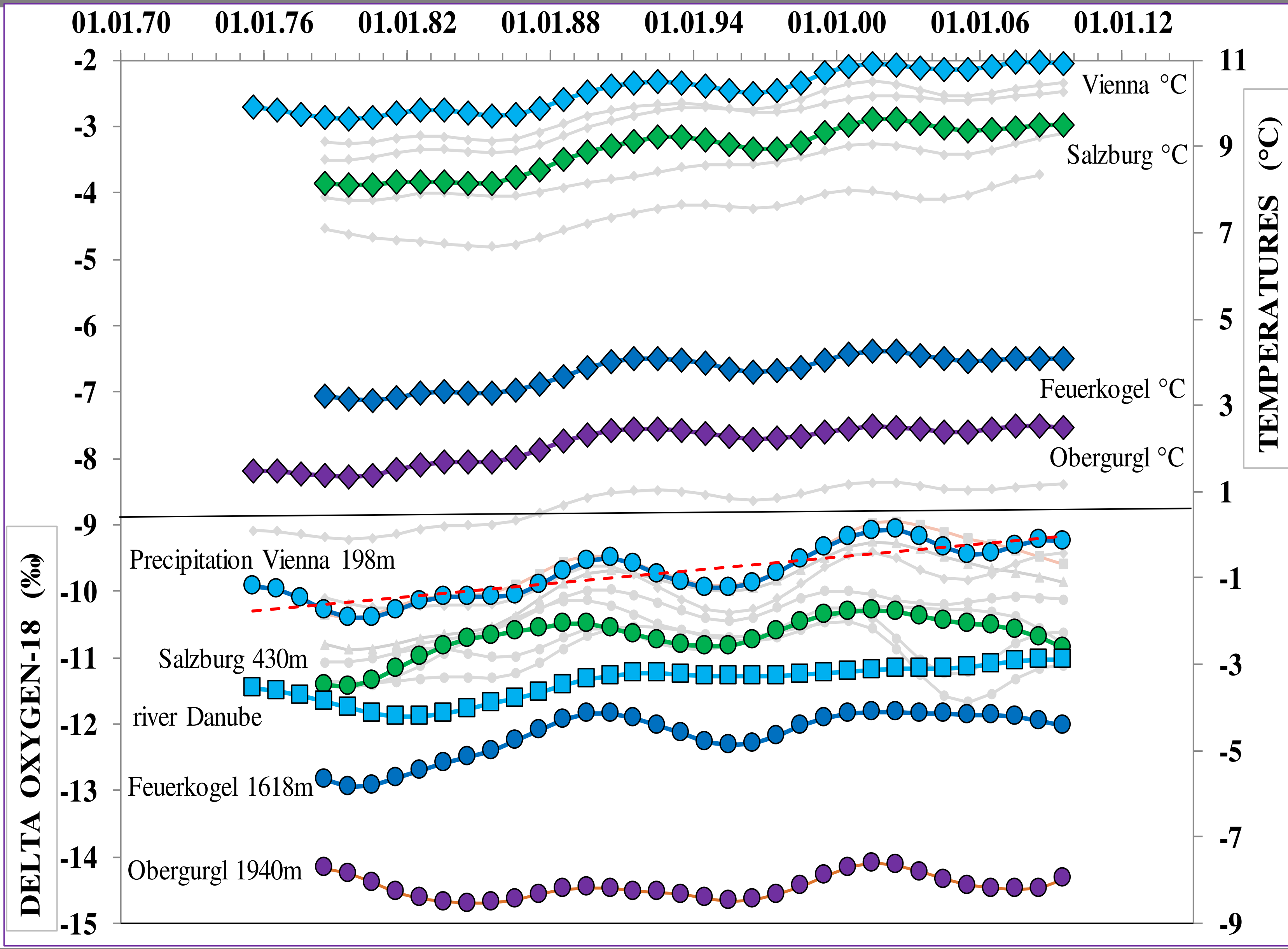
Air-Temp. - $\delta^{18}O$ Precipitation



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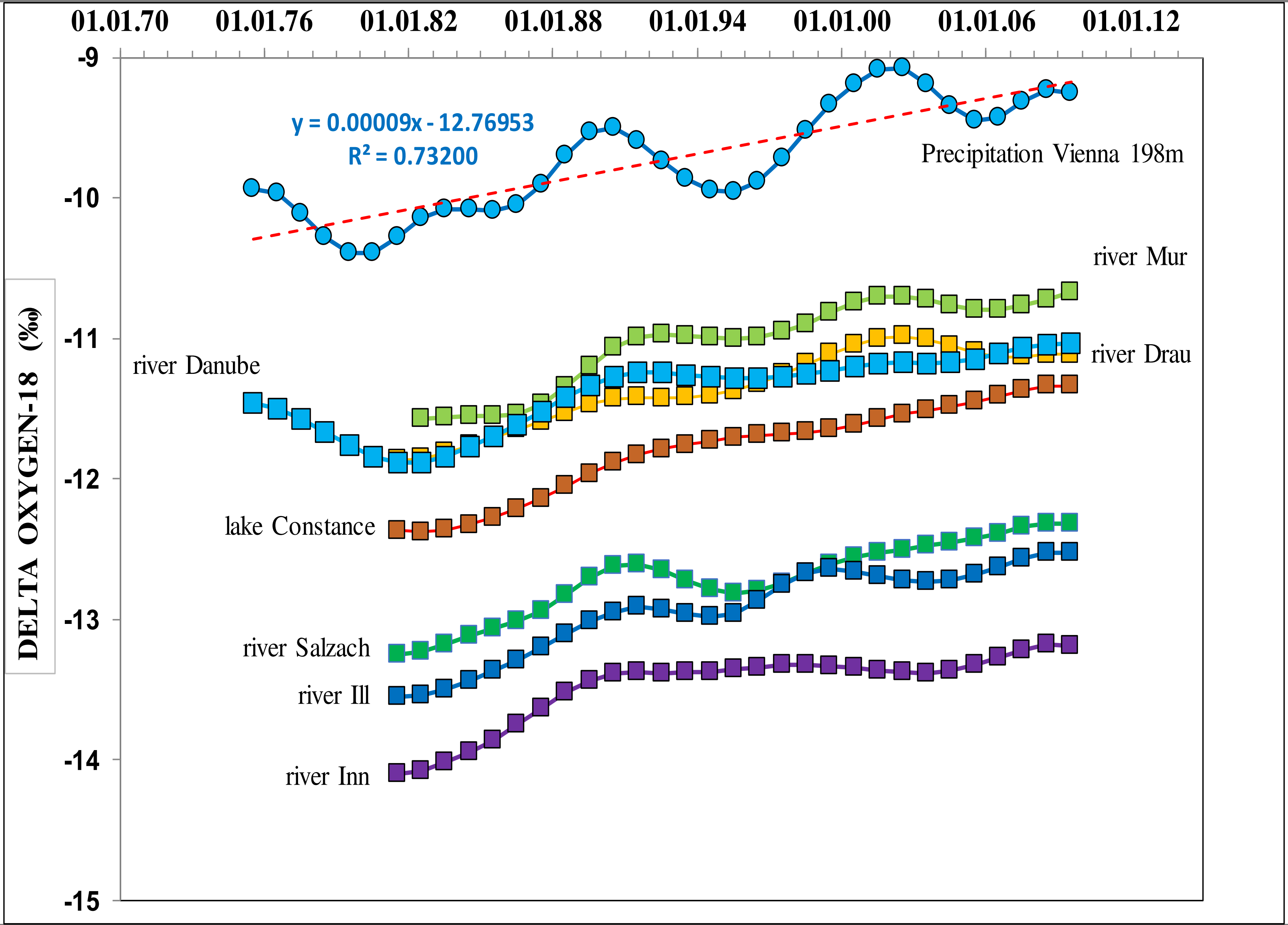
Trends: δ18O Rivers - Lakes



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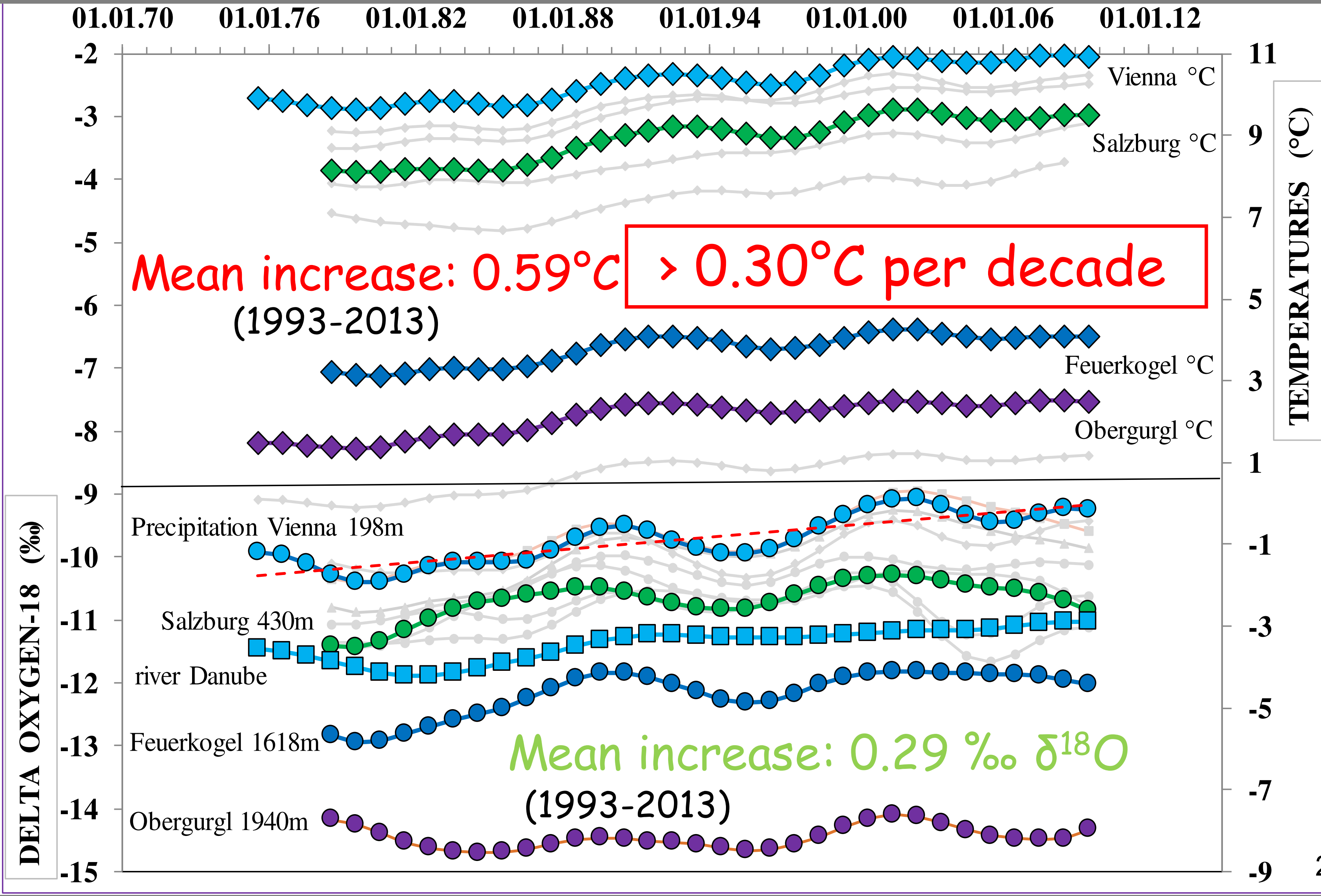
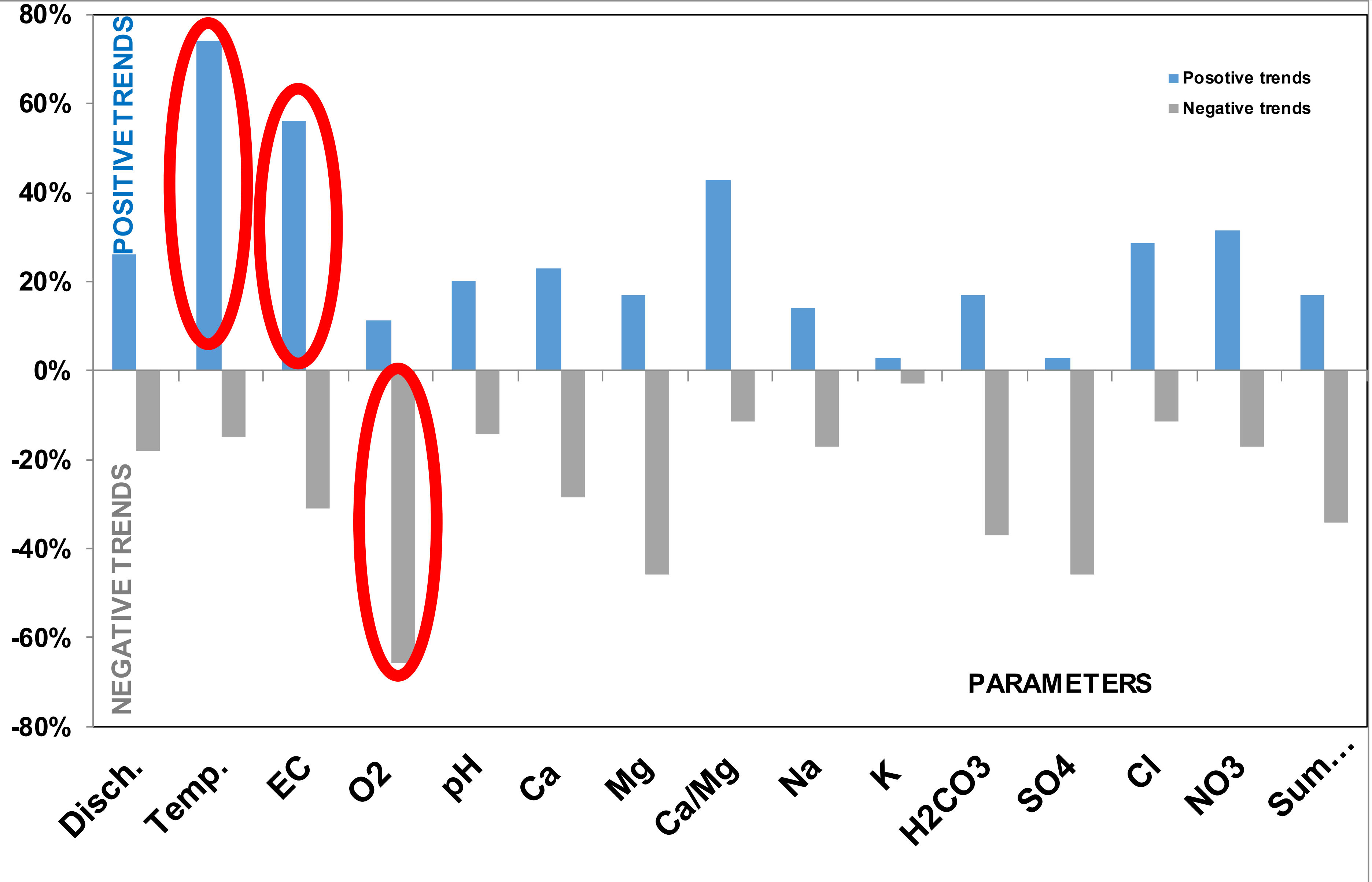
δ¹⁸O increase→ Global Warming?



Positive + negative trends (40 springs)



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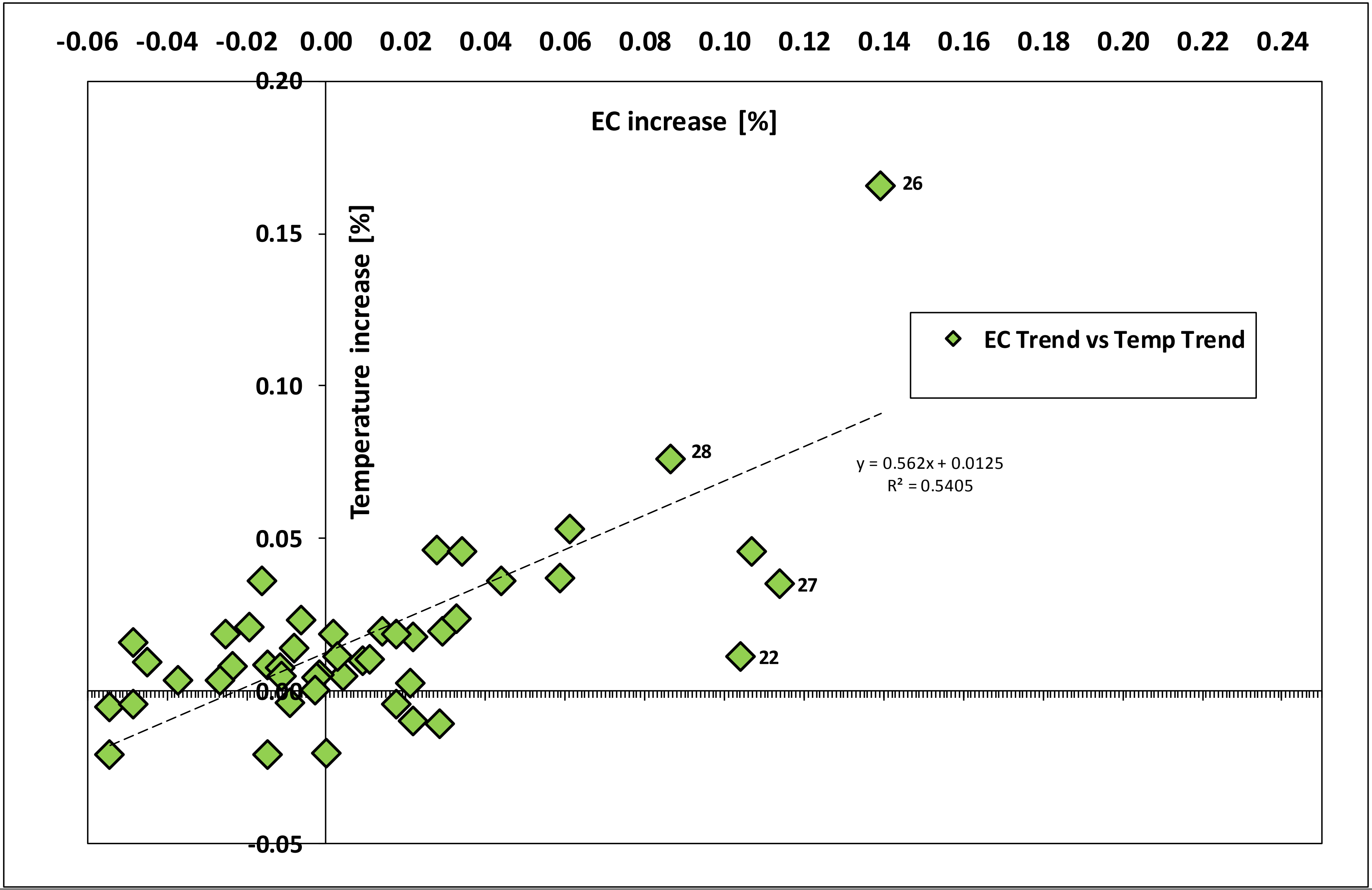
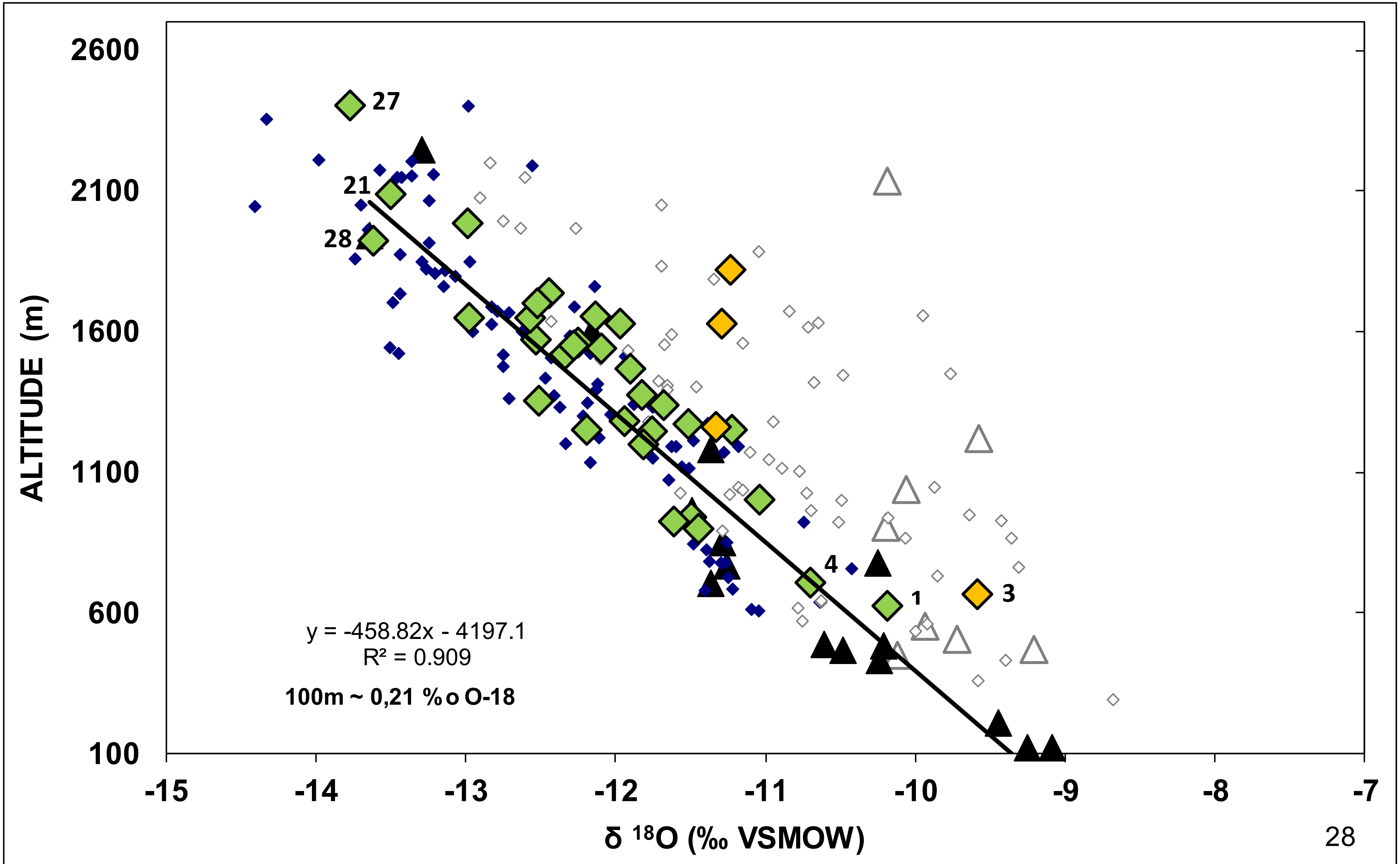
%: EC - Temp. increase



Trend δ18O - altitude of recharge



Conclusions:

- More than **235,000** on-line measurements (ehyd) and **11,500** chemical analyses (GZÜV) of **40** springs with natural recharge areas were evaluated for trends (1993 - 2013)
- 29 (74%) of the selected springs show a significant increase in water temperature with a mean of 0.34 °C (0.06 - 1.03). This means a decadial temperature increase of 0.17 °C / 10 years.
- 34 (77%) Meteorological stations and surface waters close to the recharge areas show a nearly dobble mean temperature increase of 0.59 °C (0.13-1.19) over the the same time range
- The electric conductivity (EC) linearly increased in 21 (55%) of the investigated springs at about 4%.
- In 23 (72%) springs the content of dissolved oxygen decreased over these 20 years at about 9%.


Thank you for your attention !
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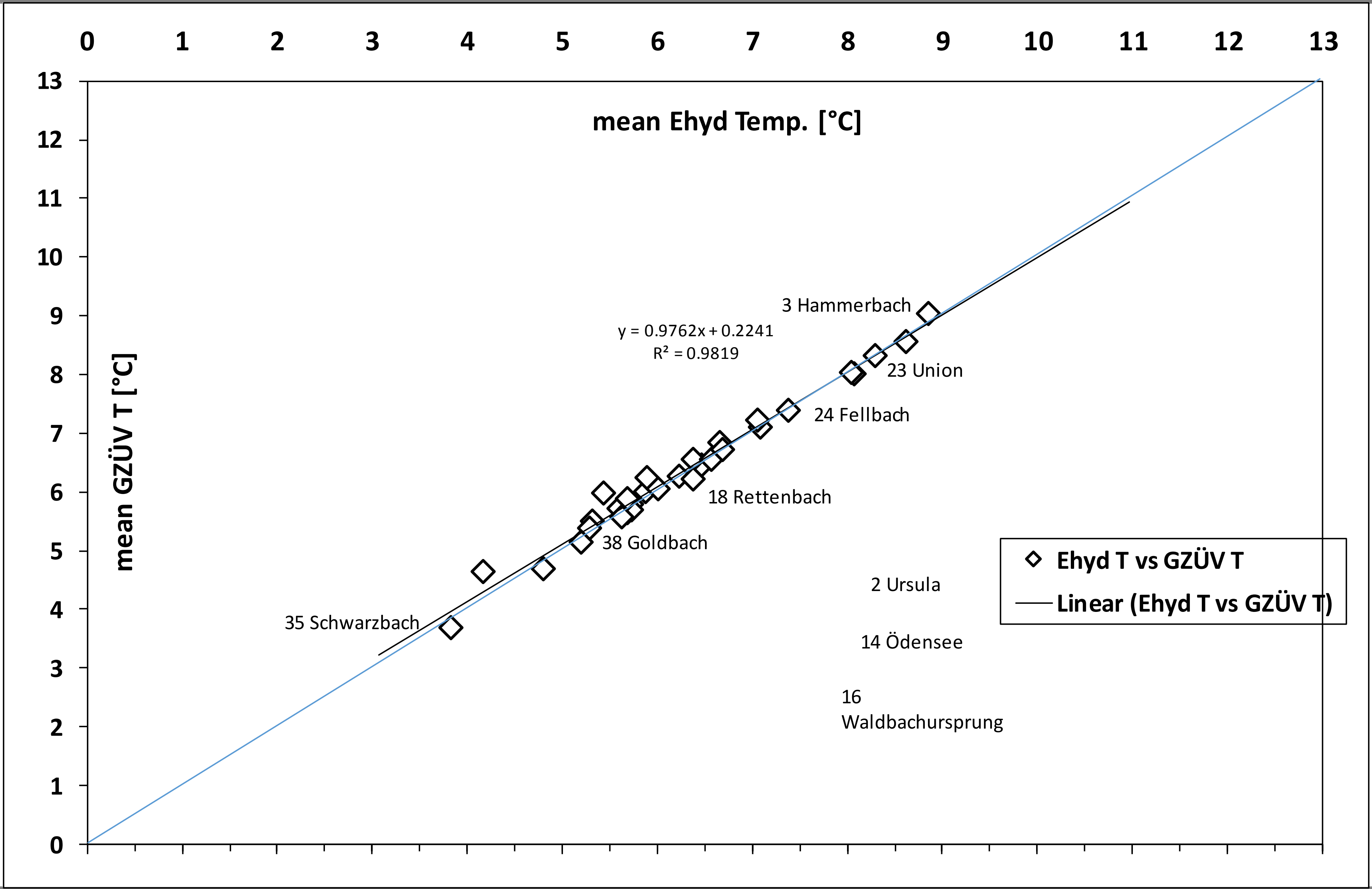
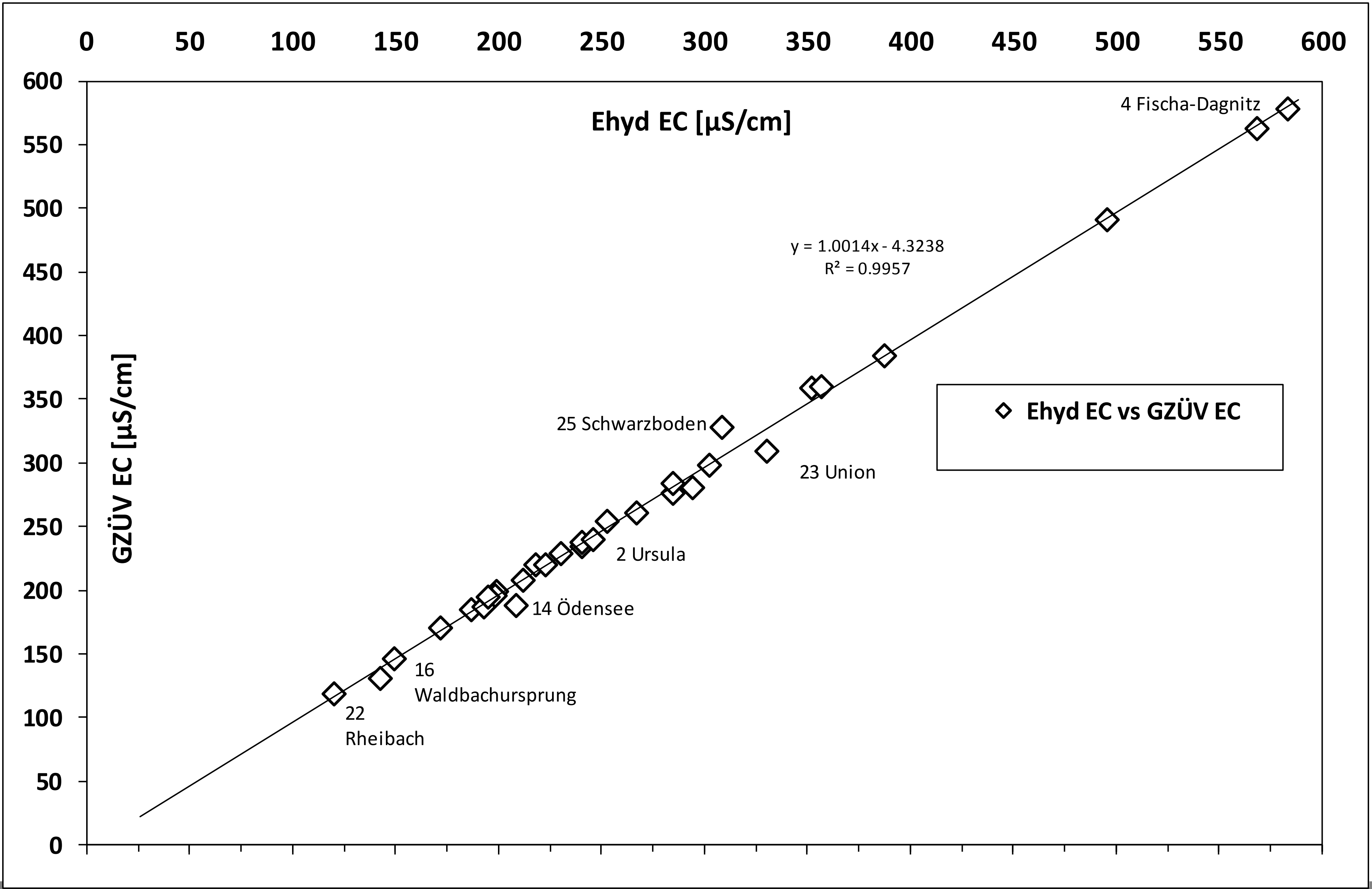
Lake Constance, M. Kralik 2009
ANIP – Austrian Network of Isotopes in Precipitation (2019):
SEhyd – Hydrographische Daten (2019): Bundesministerium für Nachhaltigkeit und Tourismus;
Gewässerzustandsüberwachungsverordnung (GZÜV; BGBl. II Nr. 479/2006 i.d.g.F.


mean Ehyd Temp. [°C]
mean GZÜV T [°C]
0 1 2 3 4 5 6 7 8 9 10 11 12 13
y = 0.9762x + 0.2241
R² = 0.9819
3 Hammerbach
23 Union
24 Fellbach
18 Rettenbach
38 Goldbach
35 Schwarzbach
2 Ursula
14 Ödensee
16
Waldbachursprung
Ehyd T vs GZÜV T
Linear (Ehyd T vs GZÜV T)



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