

AIT Austrian Institute of Technology



Control of origin of Tyrolean milk by stable isotope analyses

Micha Horacek, Wolfgang Papesch
Austrian Institute of Technology GmbH,
2444 Seibersdorf, Austria
micha.horacek@ait.ac.at

Aim of the project

- Customers are willing to pay more for goods (especially food) coming from certain regions.
- Tools need to be installed to control the origin of (food-) products to ensure the correct declaration of origin.
- Customers must be confident that the origin of the (food-) products they are buying is controlled.

Stabile isotopes

- Most elements exist in forms of different weight (variable numbers of neutrons in the atomic core)= **isotopes**
- Abundance of the heavy isotopes with respect to the light isotope of an element is expressed as
→ „**isotope ratio**“
- Many isotopes are stable (no radioactive decay, no radiation)

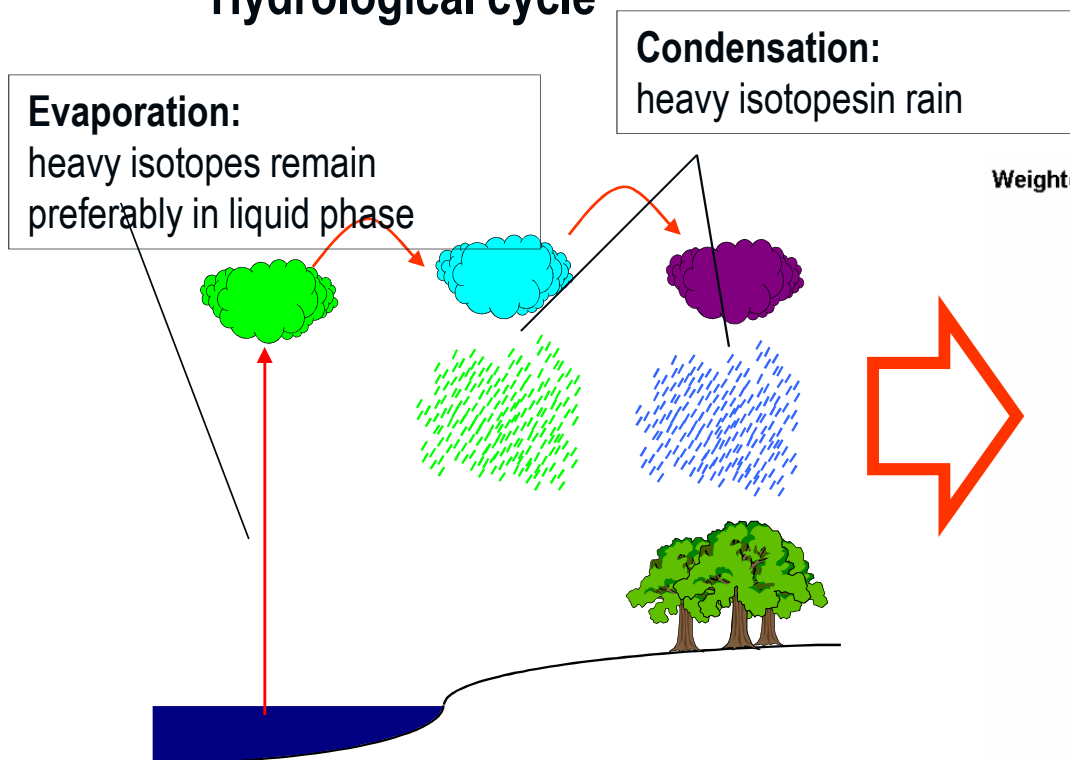
Table 1 Natural Abundances of Stable Isotopes (atom %)

^1H	99.985	^2H	0.015
^{12}C	98.892	^{13}C	1.108
^{14}N	99.6337	^{15}N	0.3663
^{16}O	99.759	^{17}O	0.0374
		^{18}O	0.2039
^{32}S	95.018	^{34}S	4.215

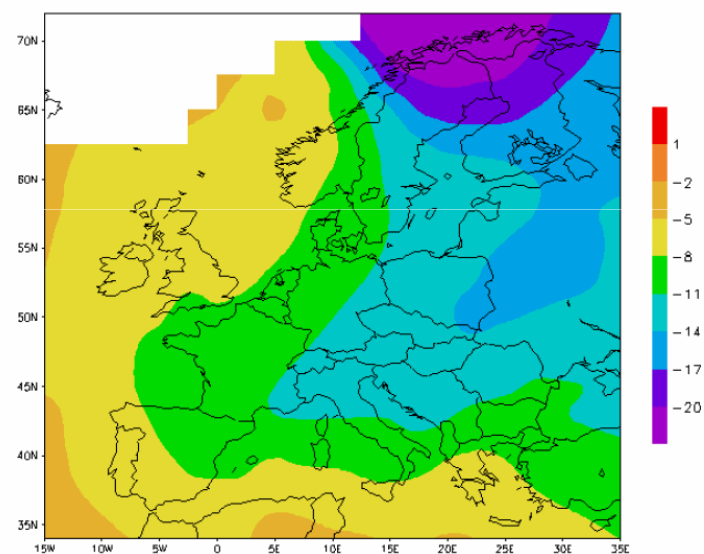
Atommasse

Reasons for isotopic fractionation (H and O): water cycle

Hydrological cycle



Weighted Jan. $\delta^{18}\text{O}$



Reasons for isotopic fractionation (C): photo synthesis

C₃-plants (Calvin-cycle)

$$\delta^{13}\text{C} = -20 \dots -30$$

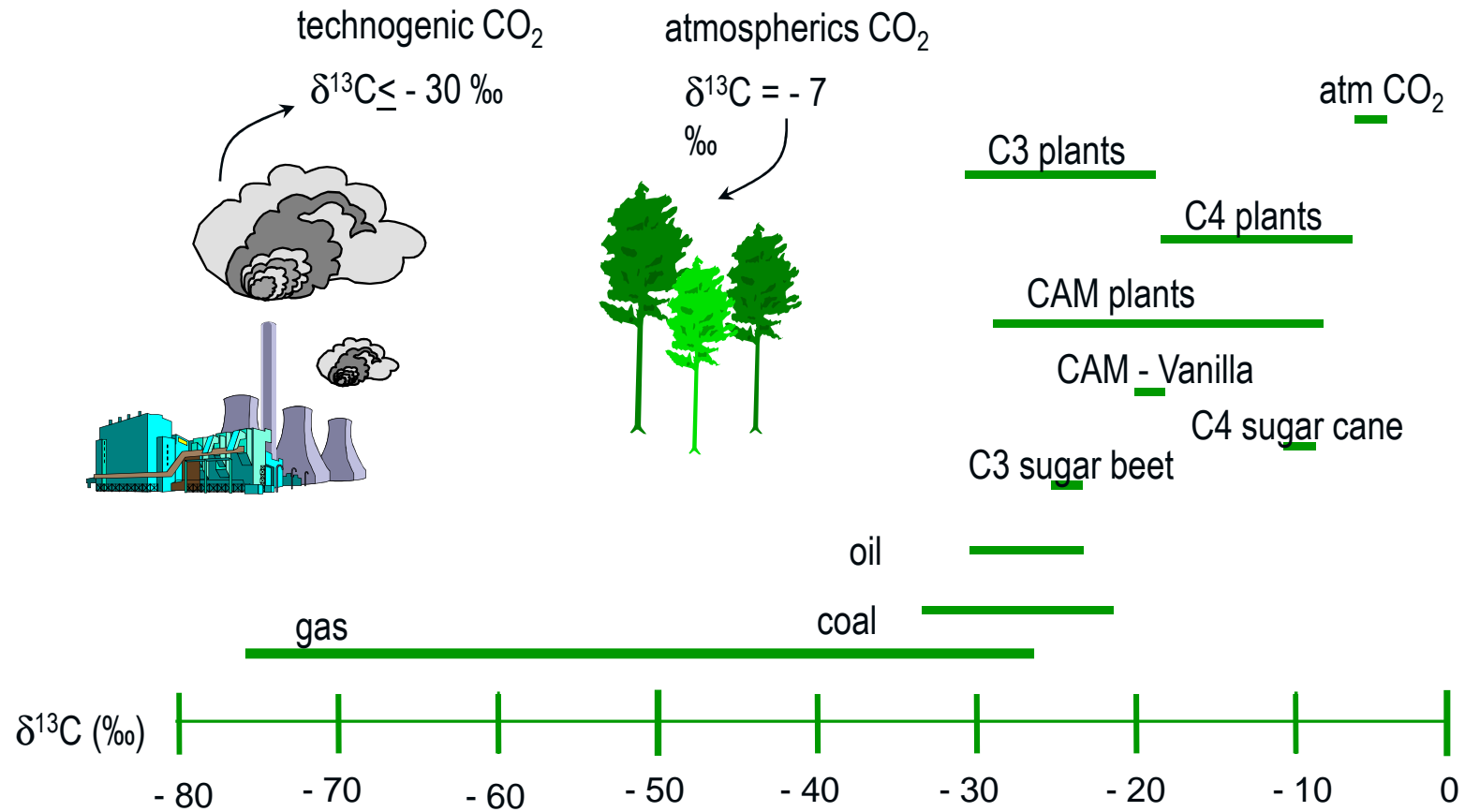
C₄-plants (Calvin-Z. + Hatch-Slack-Pathway)

e.g. corn, cane

$$\delta^{13}\text{C} = -10 \dots -15$$

water availability,
drought stress

Relative abundancy of the stable ^{13}C -isotopes (after Wietzerbin, 2001, modified)



Reasons for isotopic fractionation (N): origin of N

- $\delta^{15}\text{N}$ ratio in plants depends on nitrogen isotope ratio in the soil. Fertilizers influence and often dominate the $\delta^{15}\text{N}$ signal of the soil.
- N_{air} and N fixed by leguminoses has a different isotopic composition than N fixed in soil.
- Animals are more enriched in d^{15}N than the food they feed on (food chain).

Sulfur isotopes ($\delta^{34}\text{S}$)

Reasons for isotopic fractionation: geogenic parameter

- S is incorporated into biological material without significant fractionation. Thus the isotopic composition of S is determined by the soil $\delta^{34}\text{S}$ composition, which is determined by the sulfur isotopic composition of the rock weathered to soil plus immissions from the atmosphere or anthropogenic sources (e.g.: fertilizer).

Influences on isotope ratios in plant products

Biological

- Species
- Photosynthesis rate
- Genetic variability
- Age
- State of development

Environmental

- Water availability
- Salinity
- CO₂-Concentration
- Altitude
- Radiation
- Temperature
- Air pollution

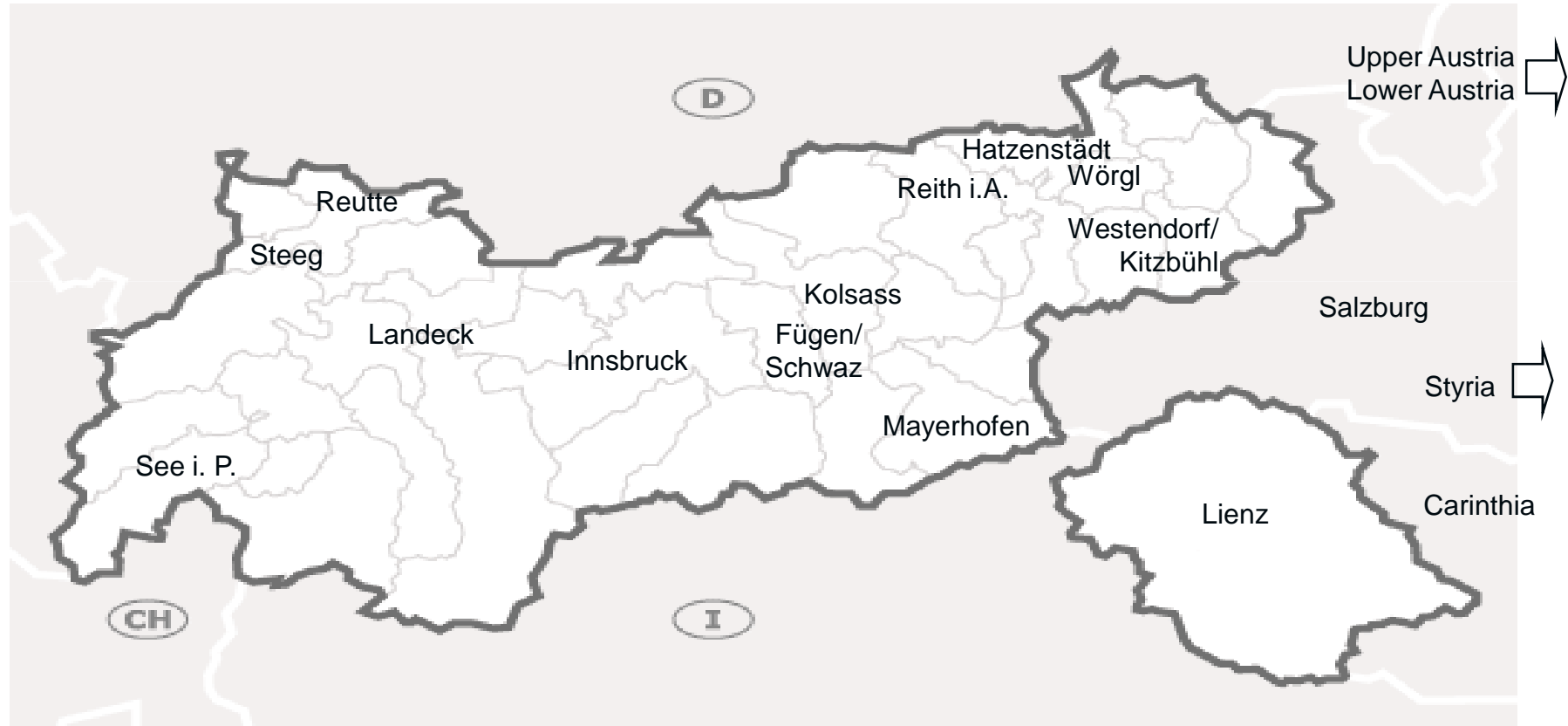
What can isotopic parameters reveal from a sample?

Stable isotope abundance	is influenced by...	and can therefore demonstrate...
$^{13}\text{C}, ^2\text{H}$	Metabolism (C3, C4, CAM)	Additions of sugar, ethanol etc. from other plants
$^{18}\text{O}, ^2\text{H}$	Origin of water	Dilution with tap water
$^{13}\text{C}, ^2\text{H}$	Chemical synthesis	Additions of artificial substances
$^2\text{H}, ^{18}\text{O}, ^{15}\text{N}, ^{13}\text{C}, ^{34}\text{S}$	Geographical origin	Mislabelling

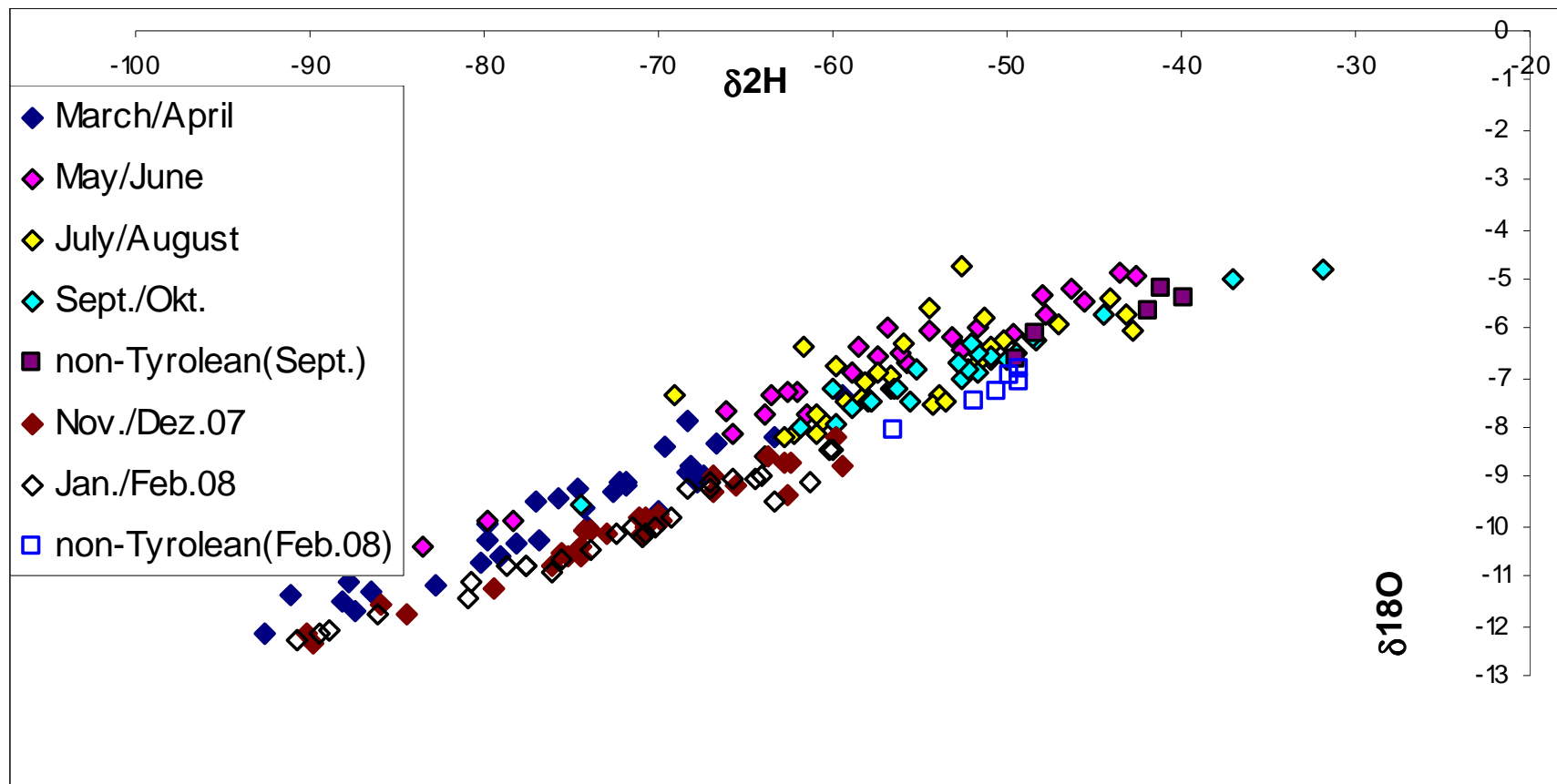
Tyrolean milk study

- More than 200 milk samples were collected over a one year period on a monthly base from 15 Tyrolean dairies, covering the entire Tyrol state. The milk samples were processed and analysed for hydrogen, oxygen, carbon and nitrogen isotopes.
- A few non-Tyrolean samples were collected, processed and analysed the same way.

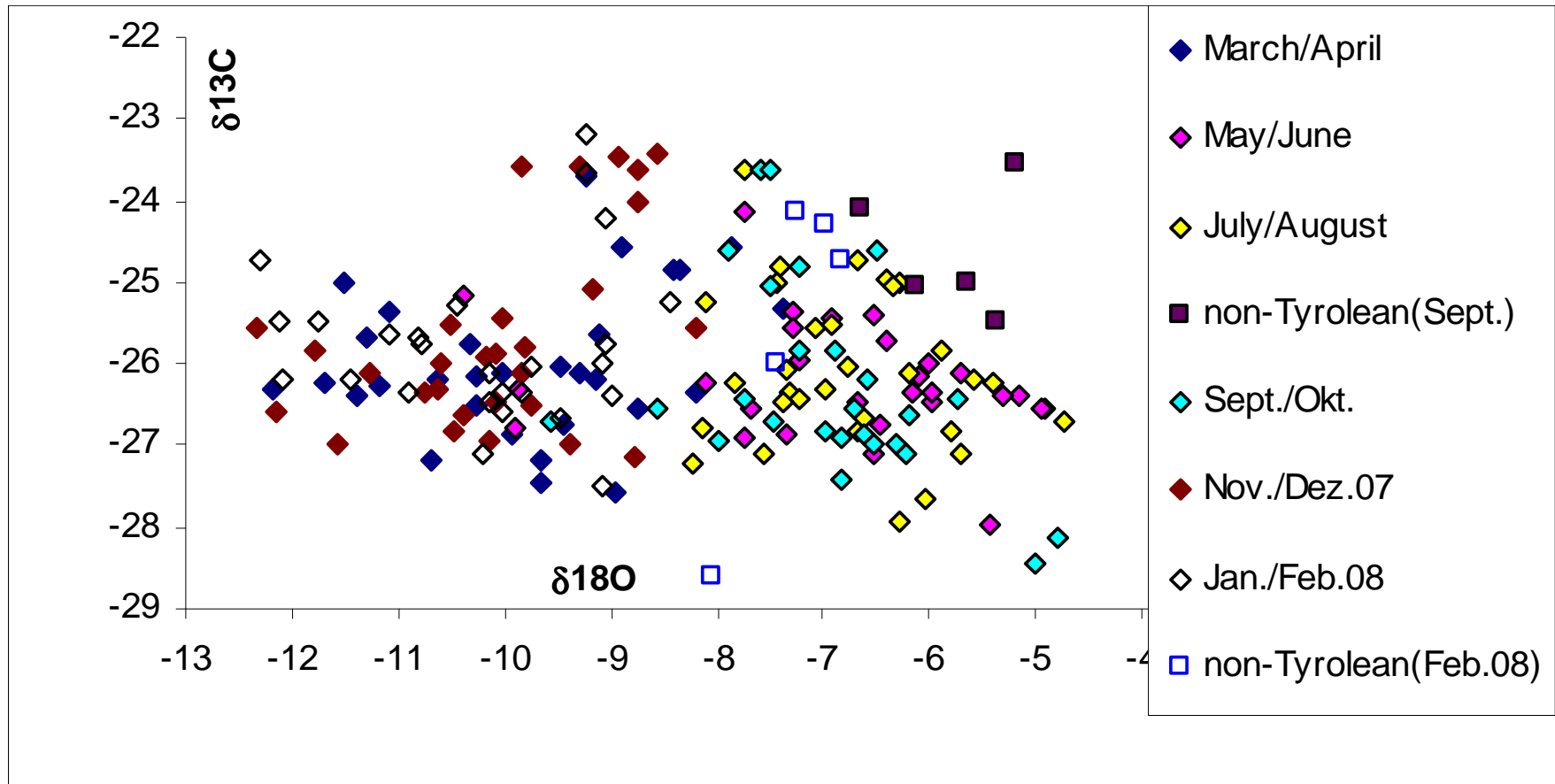
Tyrolean dairies



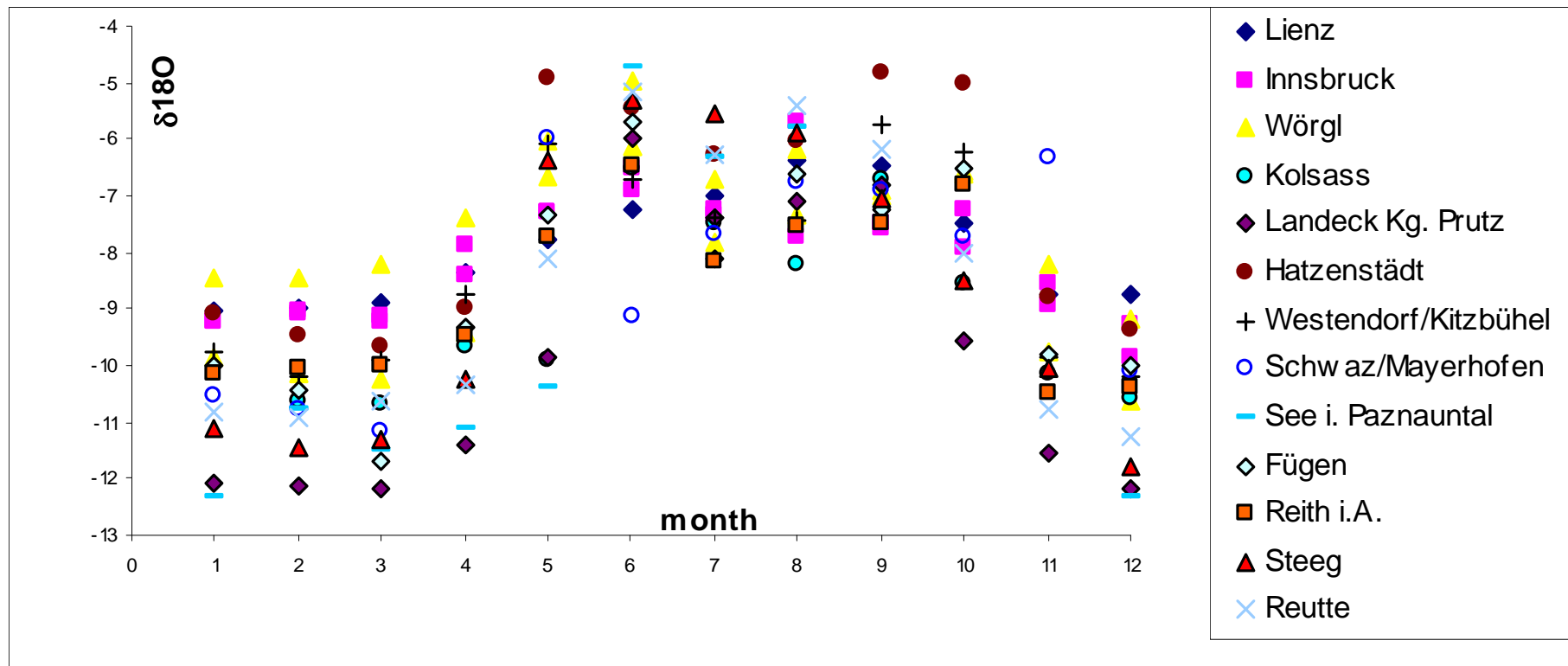
Results: $\delta^2\text{H}/\delta^{18}\text{O}$



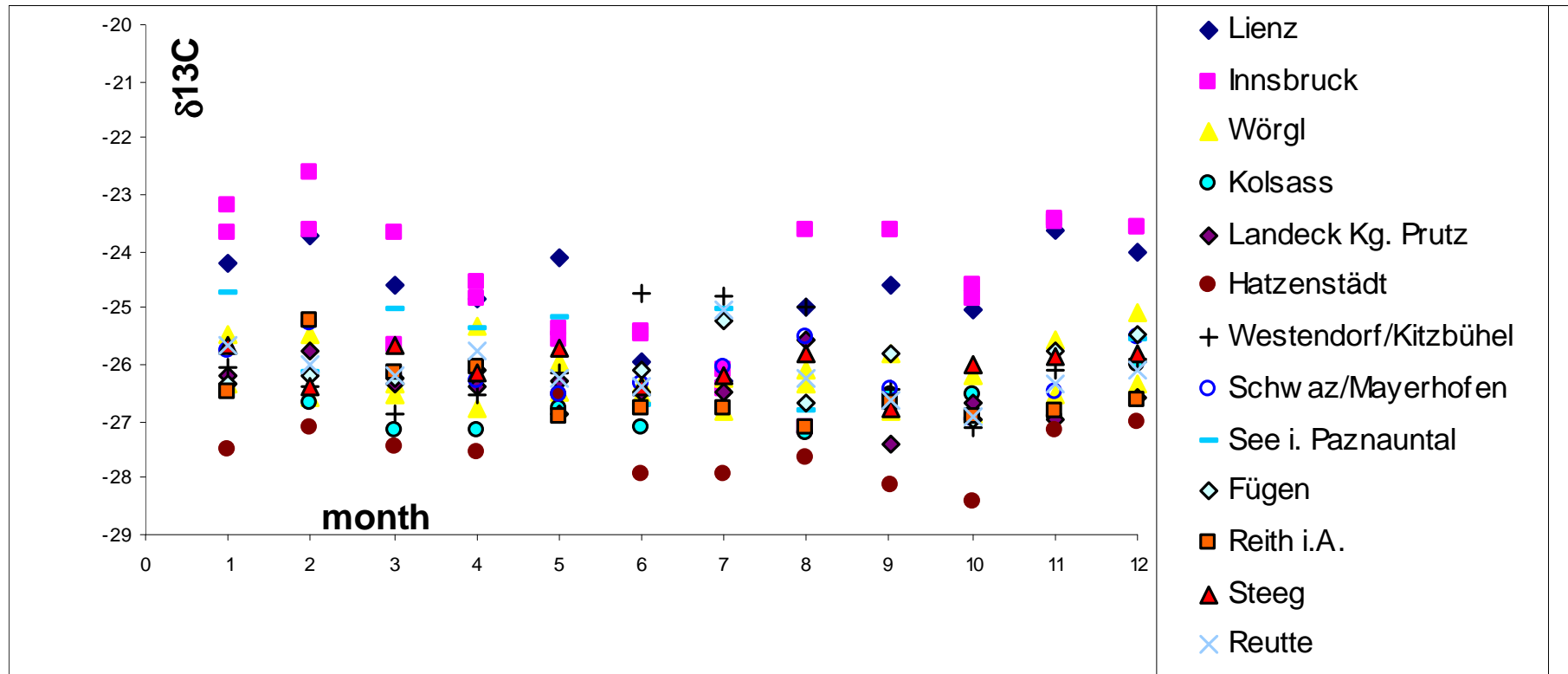
$\delta^{13}\text{C}/\delta^{18}\text{O}$



d18O from 03.07-02.08

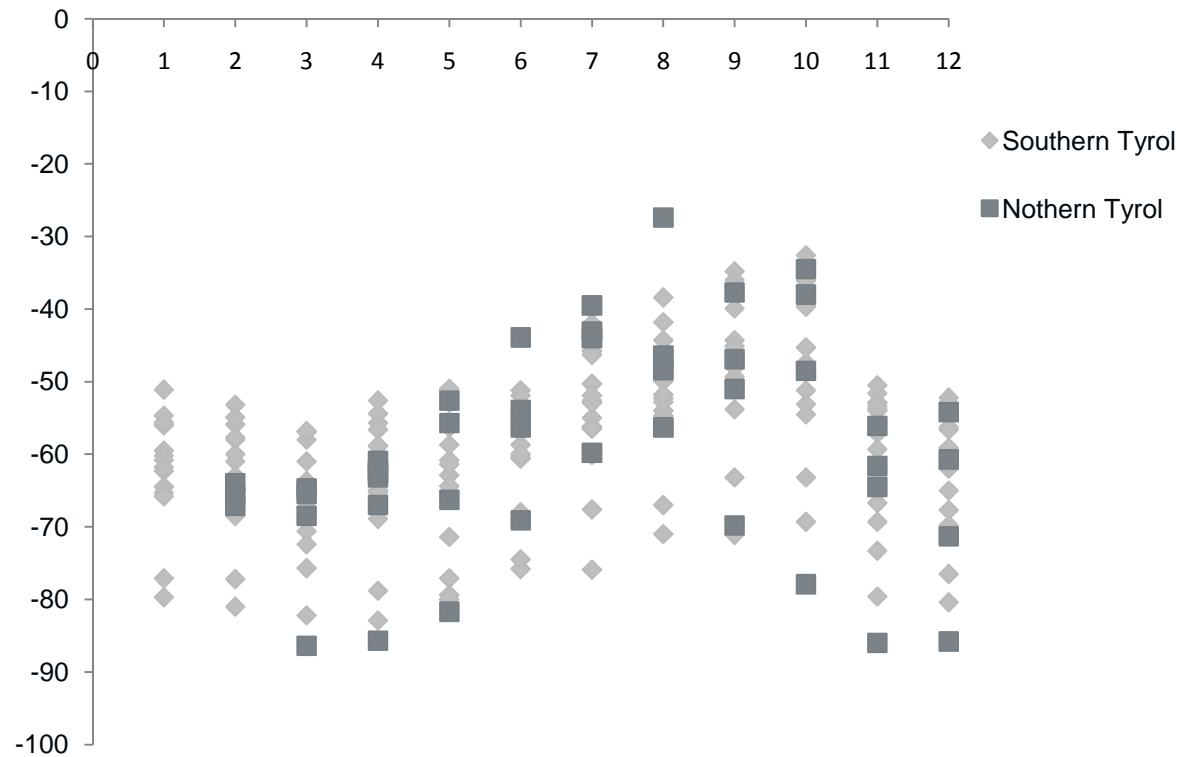


$\delta^{13}\text{C}$ from 03.07-02.08



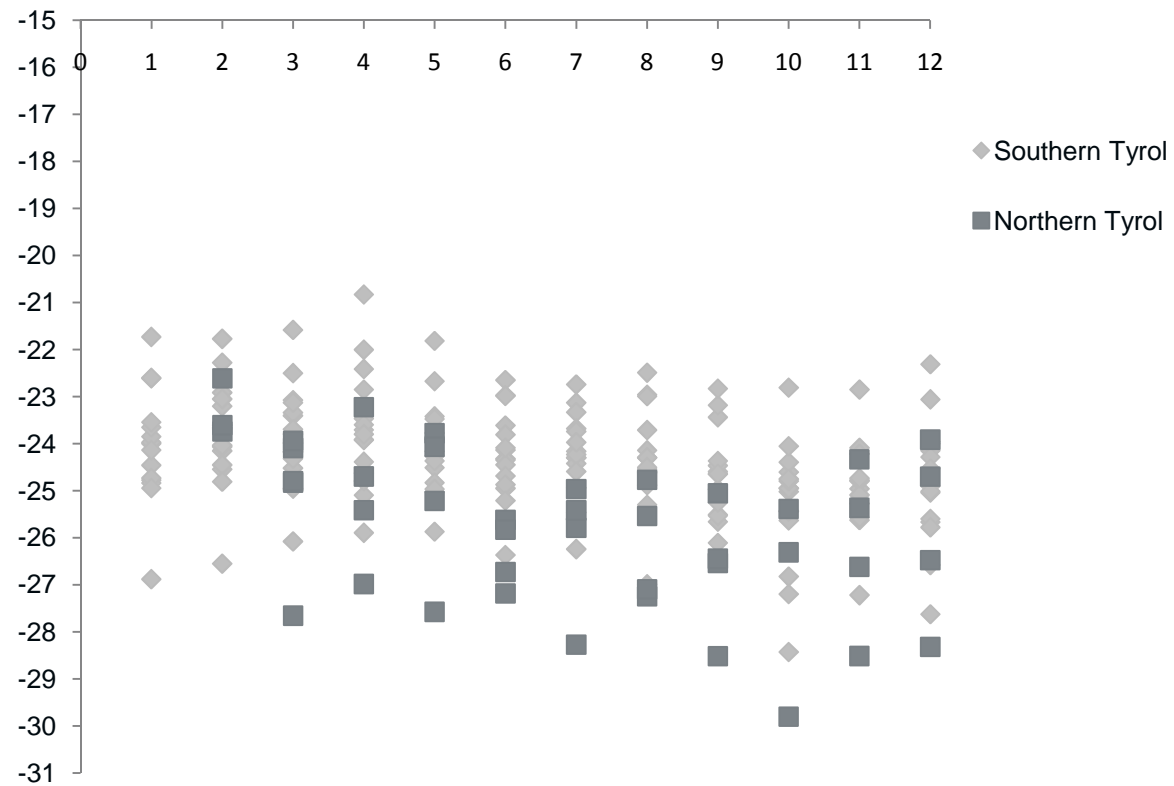
Comparison of Northern and Southern Tyrolean milk (2008)

- Hydrogen isotopes



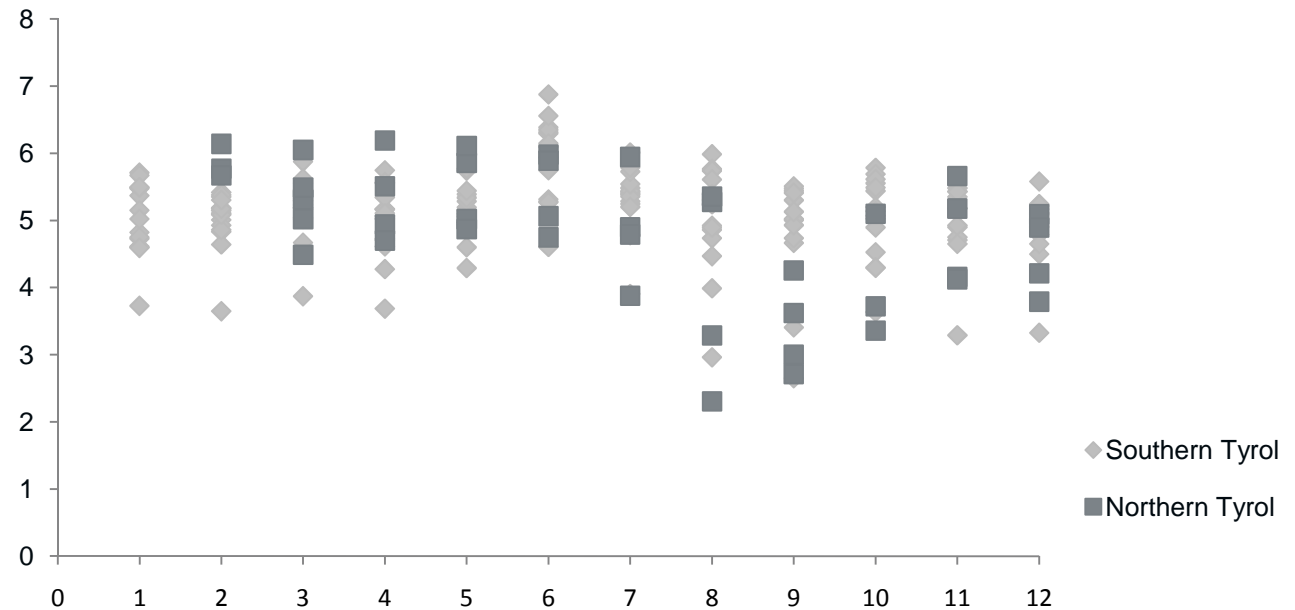
Comparison of Northern and Southern Tyrolean milk (2008)

- Carbon isotopes



Comparison of Northern and Southern Tyrolean milk (2008)

Nitrogen isotopes



Conclusions I

- Tyrolean milk (Northern and Southern) can be discriminated from non-Tyrolean milk.
- Northern Tyrolean cannot be discriminated from Southern Tyrolean milk without exact declaration of local/regional origin.
- Results for the milk should also be applicable to other fresh milk products (joghurt, cream, sweet cheese)
- Summer-milk from cows in stables can be discriminated from cows grazing on meadows (different feed)
- Organic milk can be discriminated from conventionally produced milk (however, potentially declaration problem)

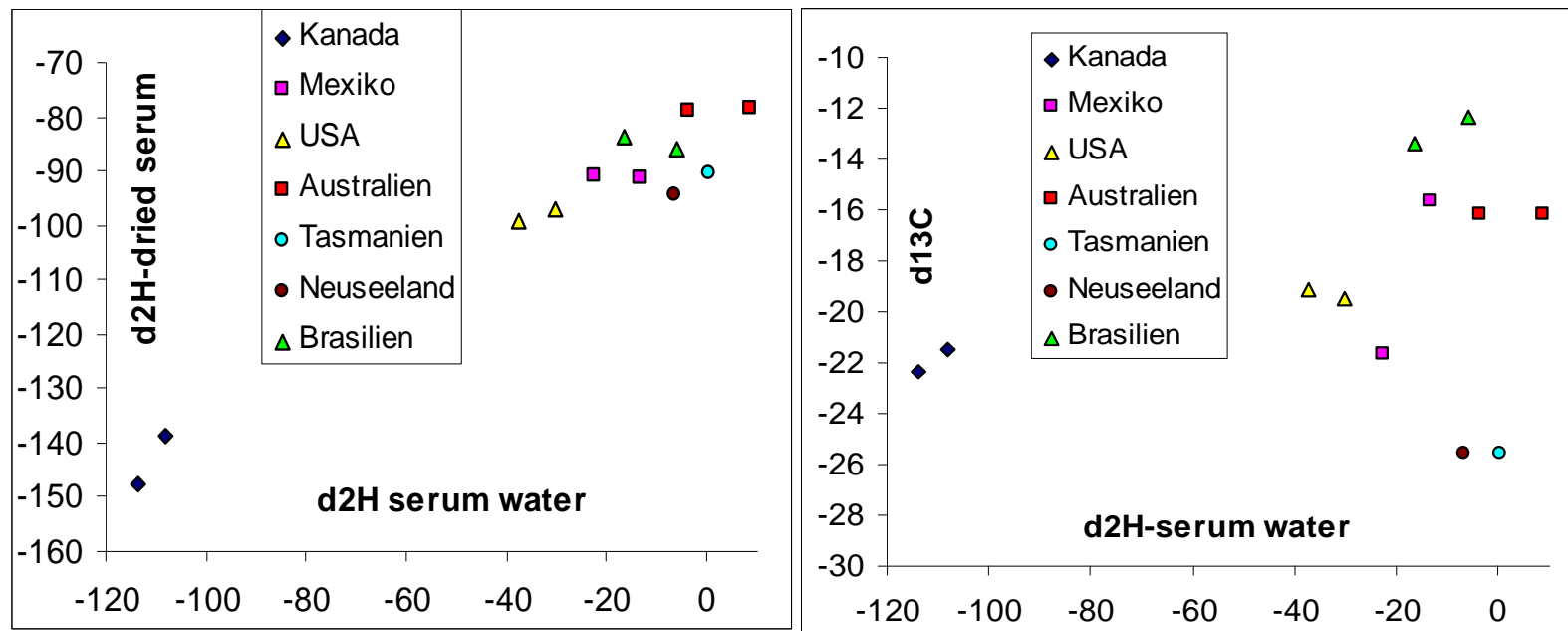
Conclusions II

- Stable isotope analysis is also applicable to milk products with longer shelf life (e.g. cheese), however, the annual variation in stable isotope composition has to be kept into account (unless the cheese is only produced during a certain period of the year).
- The use of maize as feed component can be controlled by carbon isotope composition (see Camin et al., 2008).

Thank you for
your attention!



Control of origin of bovine serum



Control of grape must authenticity

Präsentationstitel

Subtitel

Kapiteltrennfolie 24pt

Subheadline 18pt

Headline, einzeilig 24pt

- Blindtext auf einer PPT-Folie, ein Text ohne weitere Bedeutung, allein der Visualisierung eines grafischen Konzeptes dienend. (18pt, Zeilenabstand 1, vor Absatz 0)
- An dieser Stelle eine rote Hervorhebung im Text, sofern eine solche benötigt wird. Blindtext auf einer PPT-Folie, ein Text ohne weitere Bedeutung, allein der Visualisierung dienend.
- Kurzer Blindtext auf einer Folie
 - Nur wenn unbedingt notwendig, auch eine dritte Ebene
 - Graue Aufzählungszeichen in dritter Ebene, 80% vom Text

Headline, einzeilig 24pt

Subtitel, einzeilig 20 pt

- Blindtext auf einer PPT-Folie, ein Text ohne weitere Bedeutung, allein der Visualisierung eines grafischen Konzeptes dienend. (18pt, Zeilenabstand 1, vor Absatz 0)

- An dieser Stelle eine rote Hervorhebung im Text, sofern eine solche benötigt wird.
Blindtext auf einer PPT-Folie, ein Text ohne weitere Bedeutung, allein der Visualisierung dienend.

- Kurzer Blindtext auf einer Folie
 - Nur wenn unbedingt notwendig, auch eine dritte Ebene
 - Graue Aufzählungszeichen in dritter Ebene, 80% vom Text

Bild groß



Bild klein



Bildtitel

- Blindtext auf einer PPT-Folie, ein Text ohne weitere Bedeutung, allein der Visualisierung eines grafischen Konzeptes dienend. (16pt)
- Blindtext auf einer PPT-Folie, ein Text ohne weitere Bedeutung, allein der Visualisierung dienend.