Mountain biota and global change

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NAS Darwin Symposium, Washington, February 12, 2009



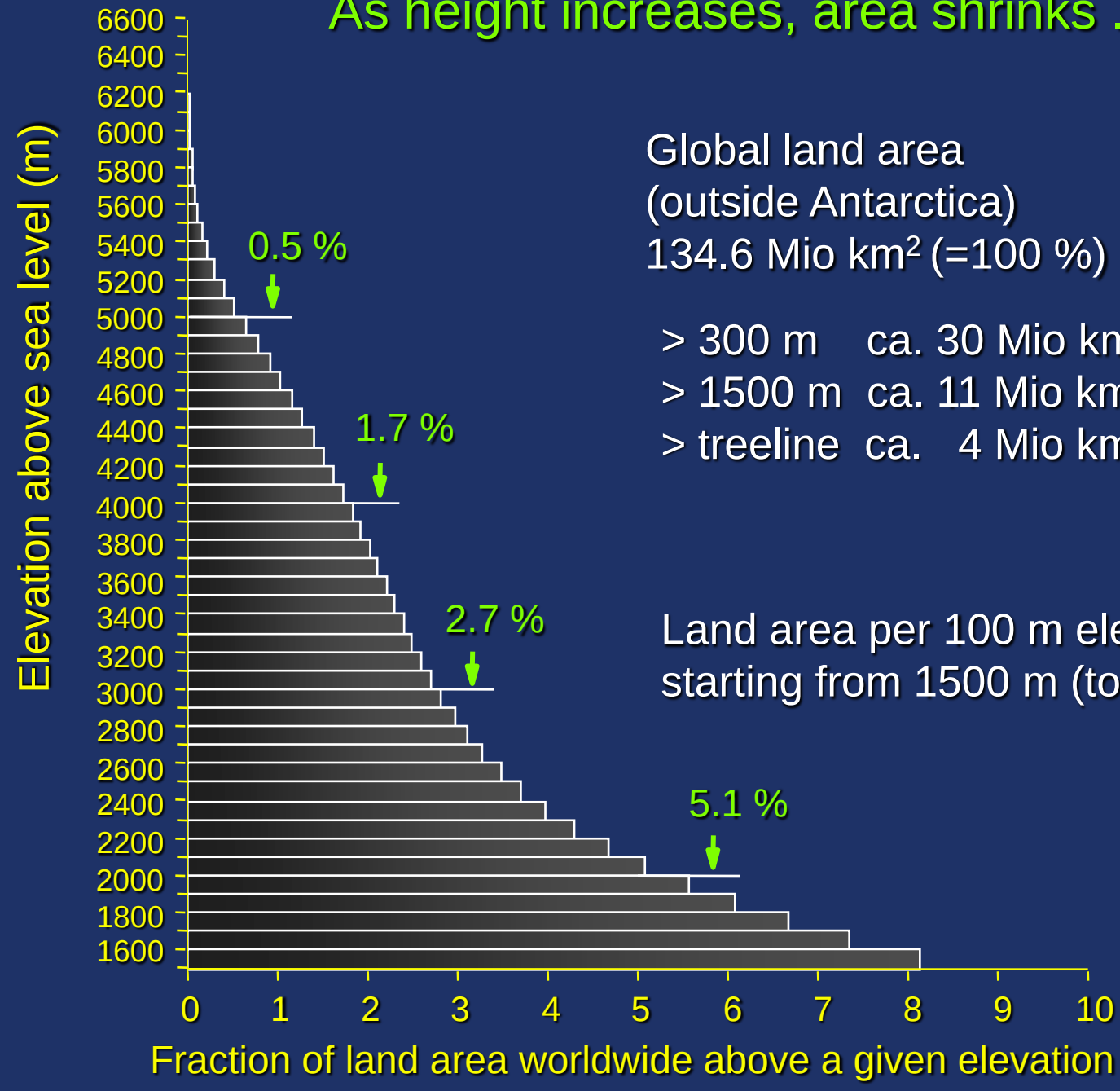









As height increases, area shrinks ...



Global land area
(outside Antarctica)
134.6 Mio km^2 (=100 %)

> 300 m ca. 30 Mio km^2
> 1500 m ca. 11 Mio km^2
> treeline ca. 4 Mio km^2

Land area per 100 m elevation steps starting from 1500 m (total = 11 Mio km^2).

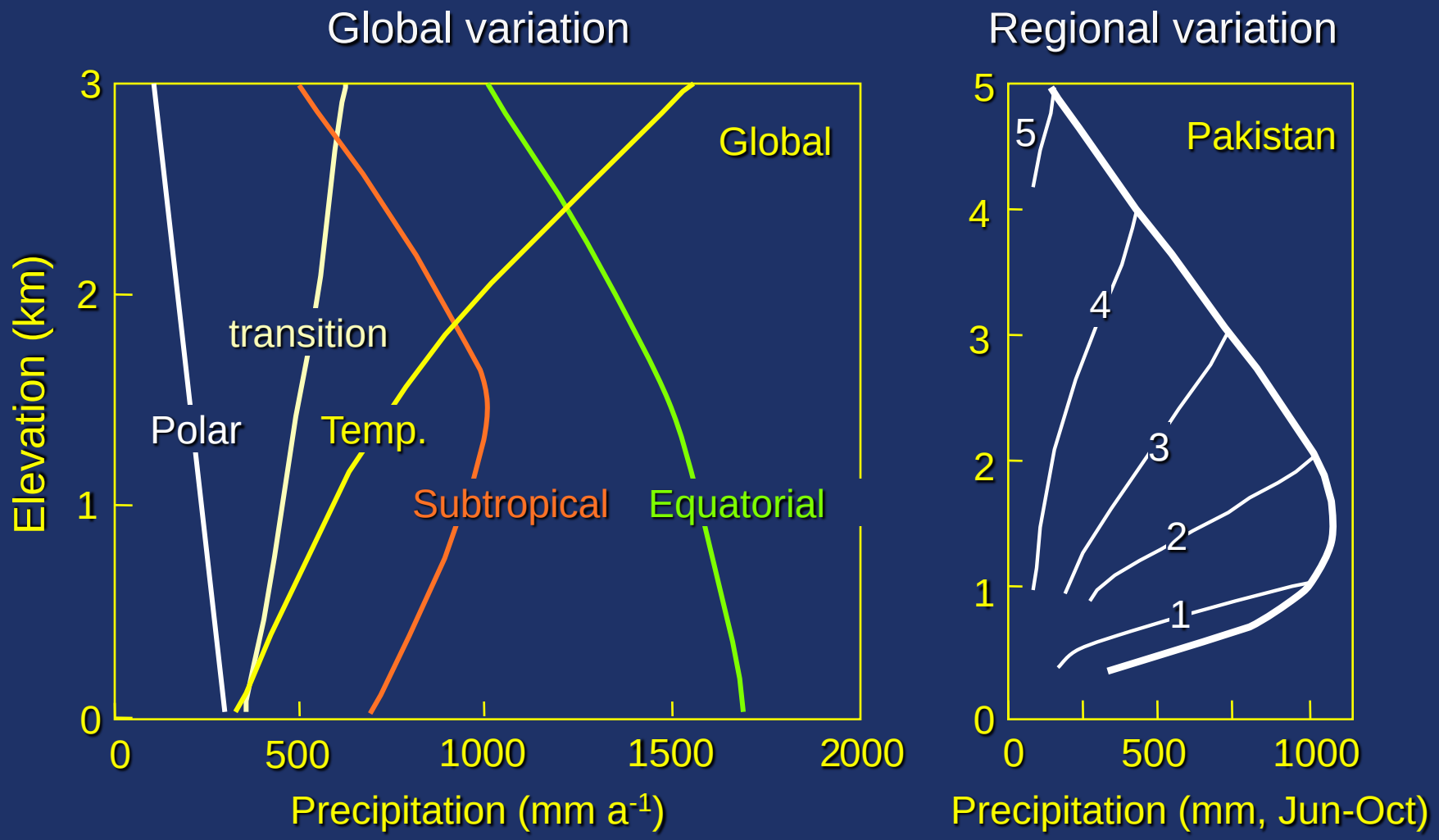
C Körner (2007)
TREE 22: 569

The area of influence is far greater

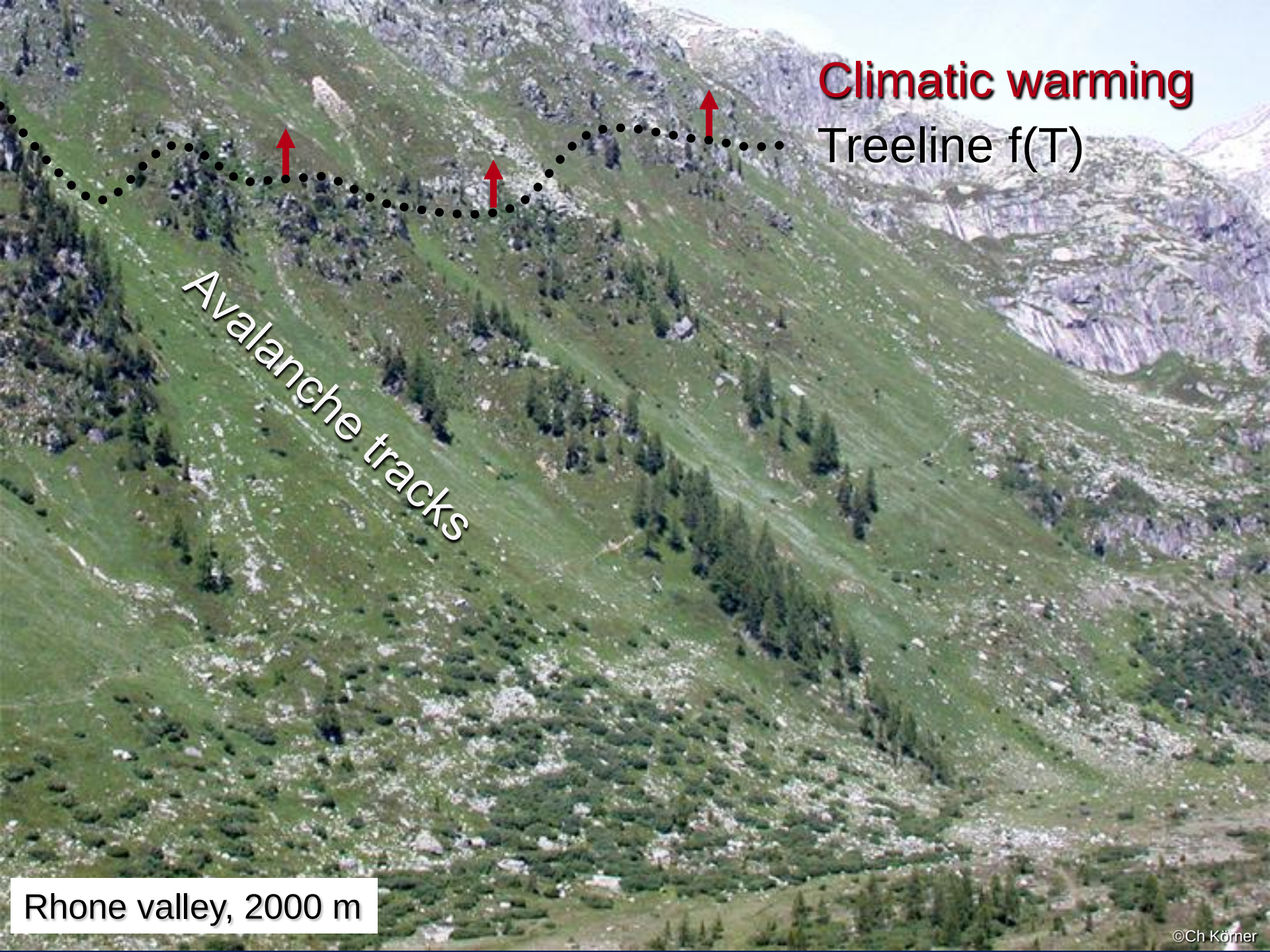
Through river systems, half of the terrestrial surface is influenced.

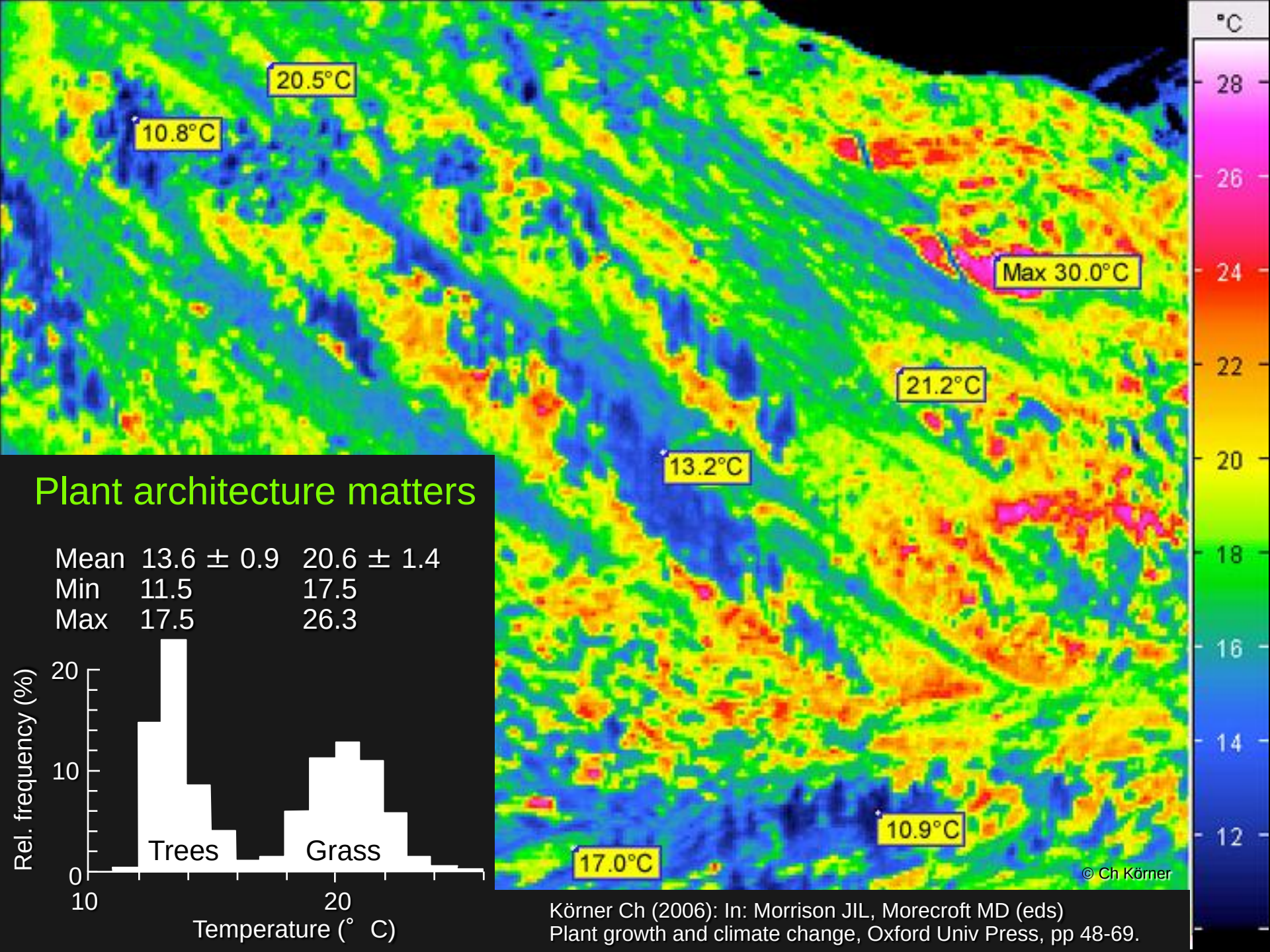
Through effects on regional climate most of the world is influenced.

- uniform gradients in temperature
- variable gradients in precipitation



C Körner (2007) The use of 'altitude' in ecological research.TREE 22: 569

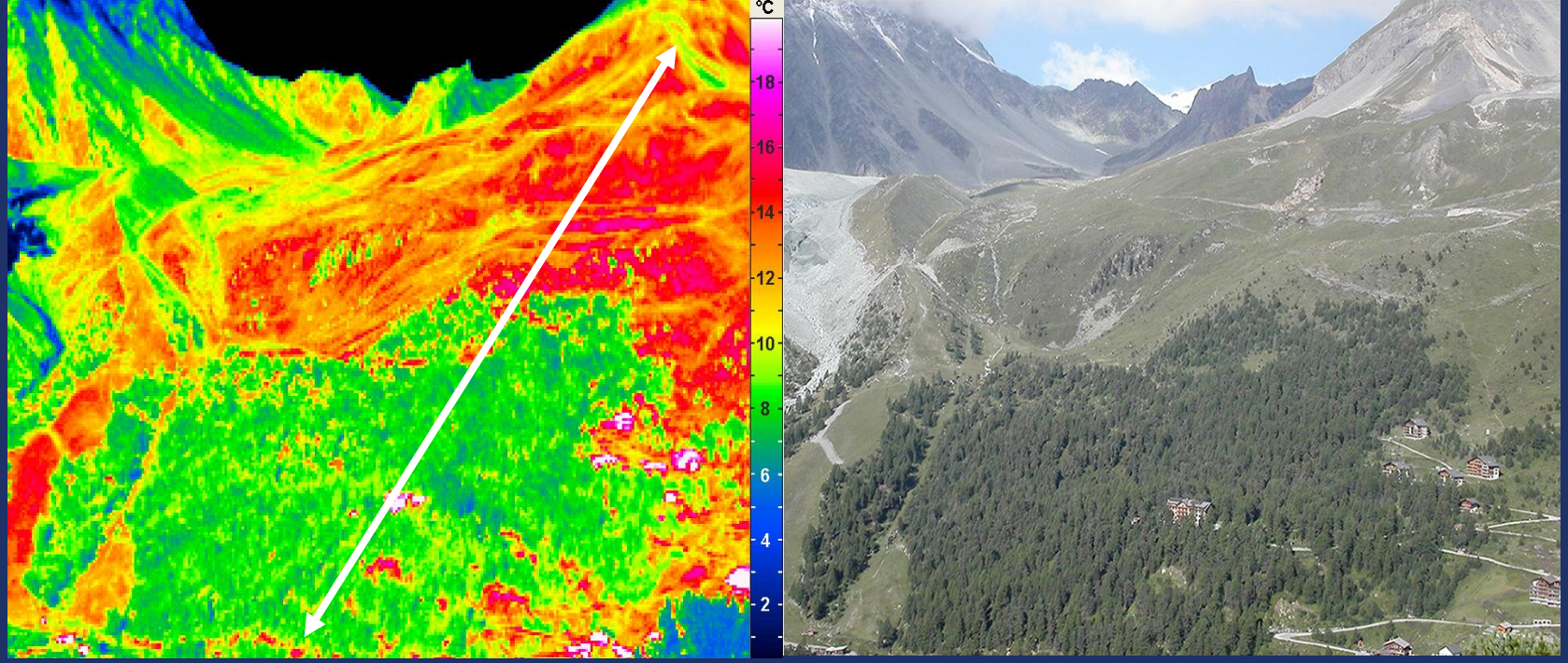

Climatic warming
Treeline f(T)
Avalanche tracks
Rhone valley, 2000 m
©Ch Körner

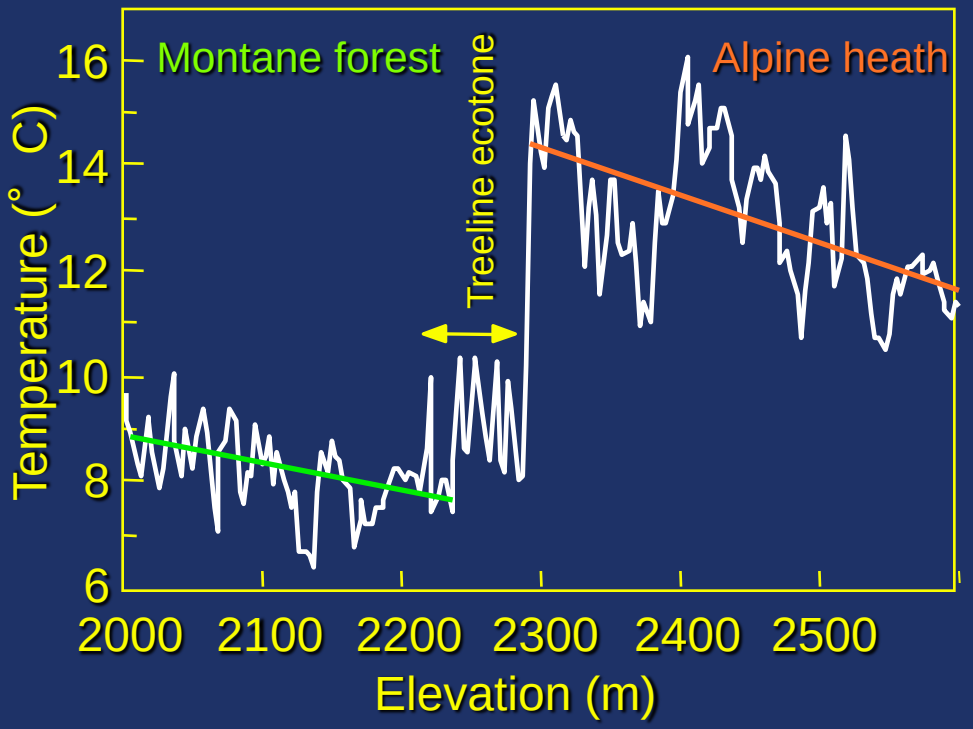


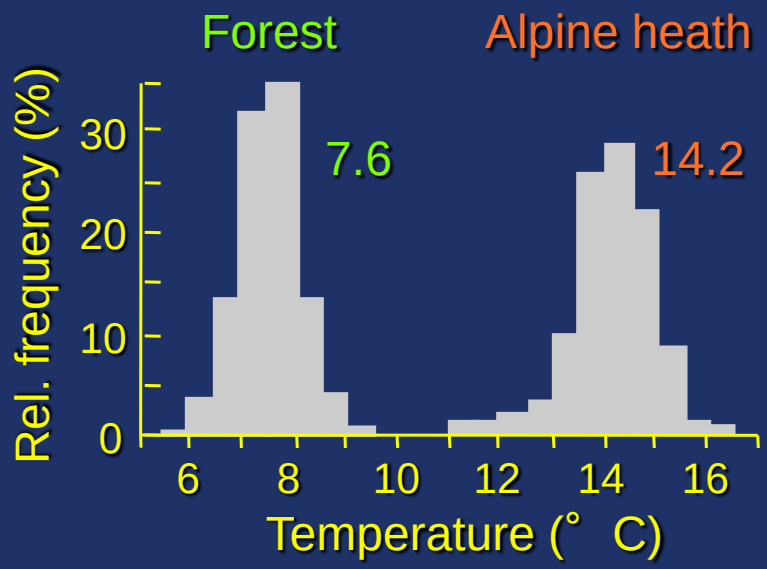
Plant architecture matters

Mean	13.6 ± 0.9	20.6 ± 1.4
Min	11.5	17.5
Max	17.5	26.3

Körner Ch (2006): In: Morrison JIL, Morecroft MD (eds)
Plant growth and climate change, Oxford Univ Press, pp 48-69.

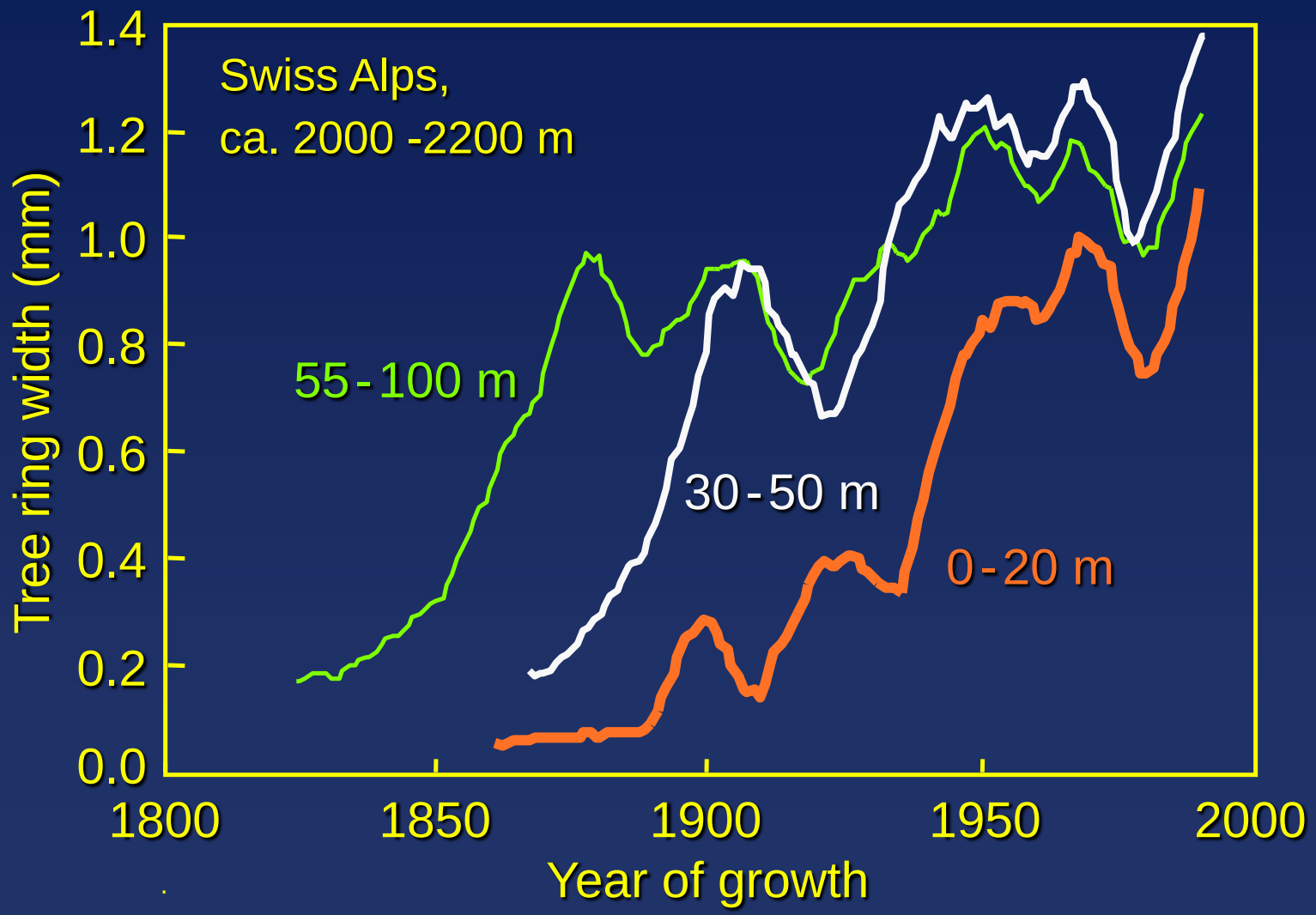






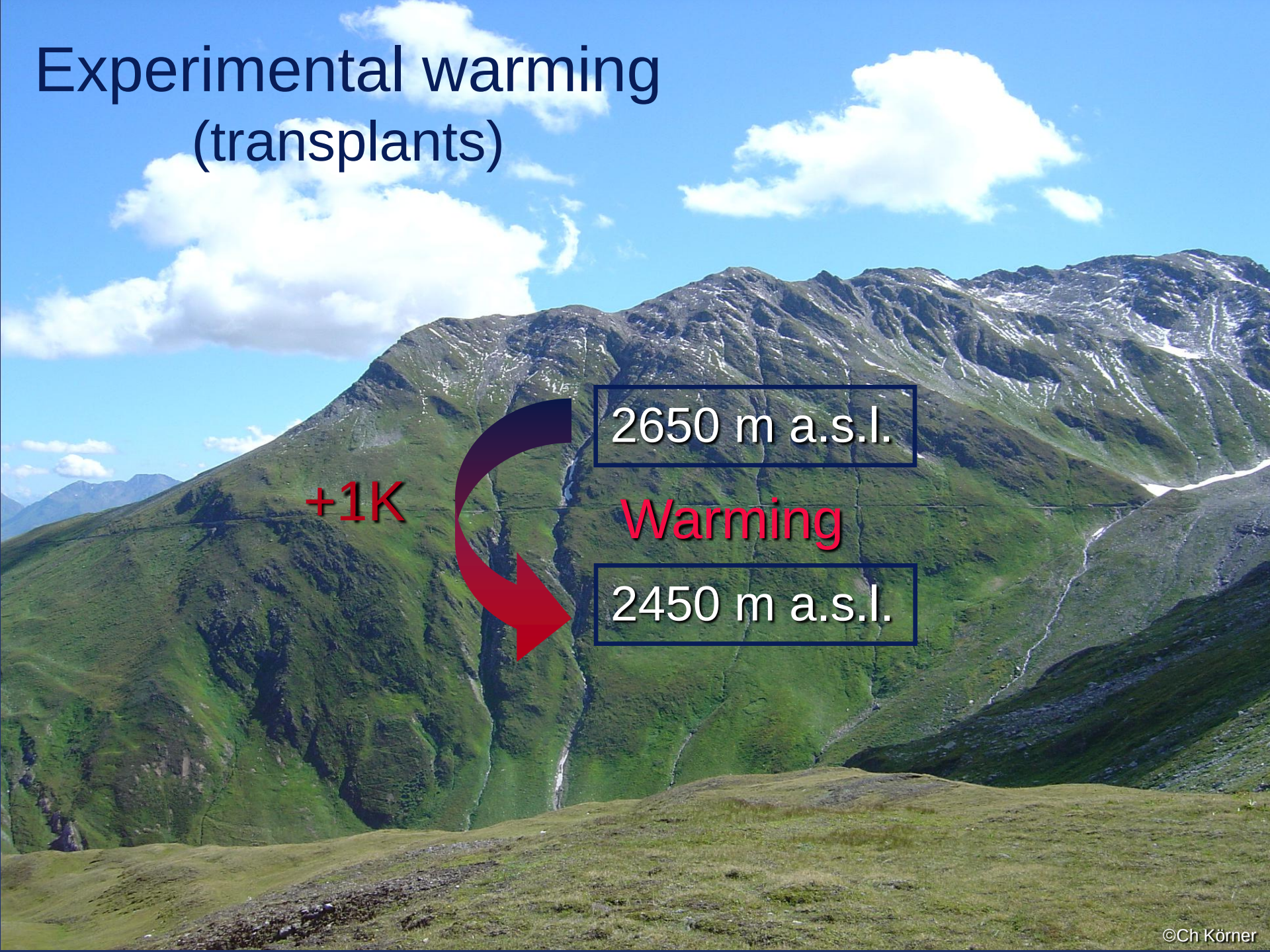
C Körner (2007) Erdkunde 61:316

Treeline trees grow faster in response to recent warming



Paulsen J *et al*. (2000) Arct Antarct Alp Res 32:14-20

Experimental warming (transplants)



E Hiltbrunner, unpubl

After 4 years:

cool → cool
cool → warm
n = 10

Biomass (g m^{-2})

Sedges

100
50
0

N-addition: ↑ p < 0.001
Warming n.s.

Grasses

100
50
0

N-addition: n.s
Warming: ↓ p < 0.01

Forbs

100
50
0

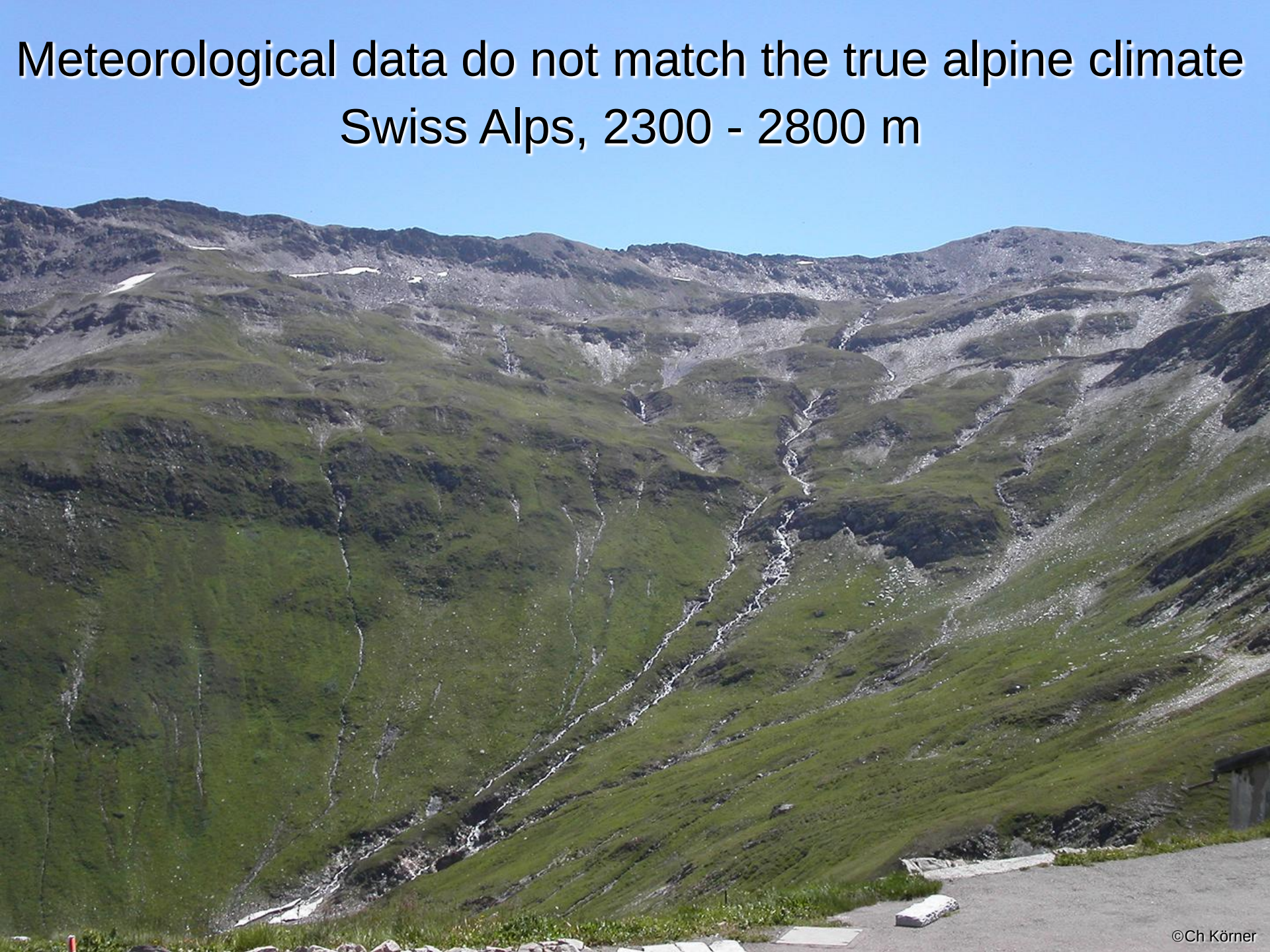
N-addition: n.s
Warming: ↓ p = 0.08

-N +N

N-addition: 25 kg N ha^{-1} a^{-1}

Meteorological data do not match the true alpine climate

Swiss Alps, 2300 - 2800 m




°C
19
18
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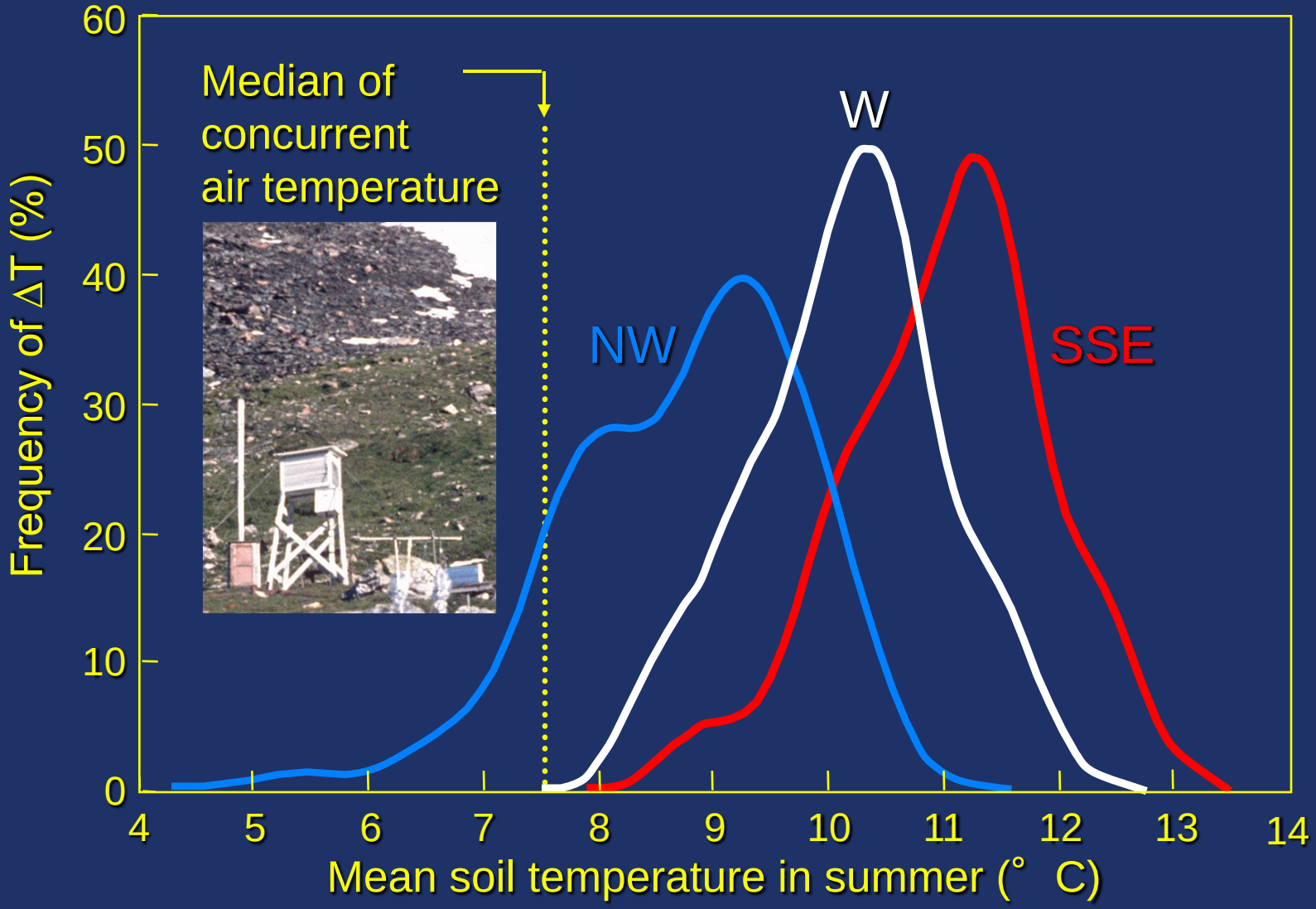
Effect of exposure on growing season root zone root temperature

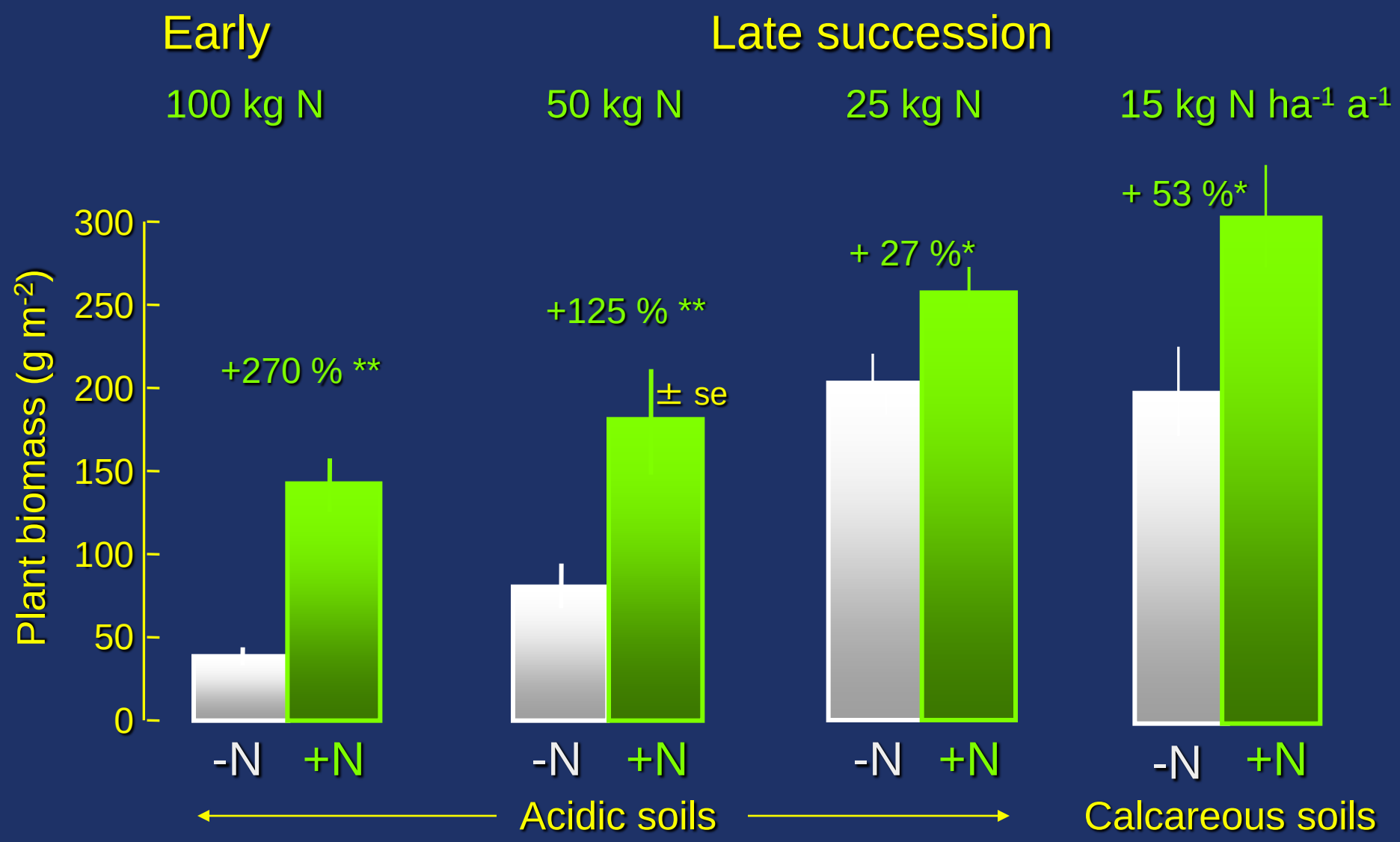
Central Alps, 2500 m



D Scherrer & Ch Körner, unpubl

The effect of N deposition on alpine plants

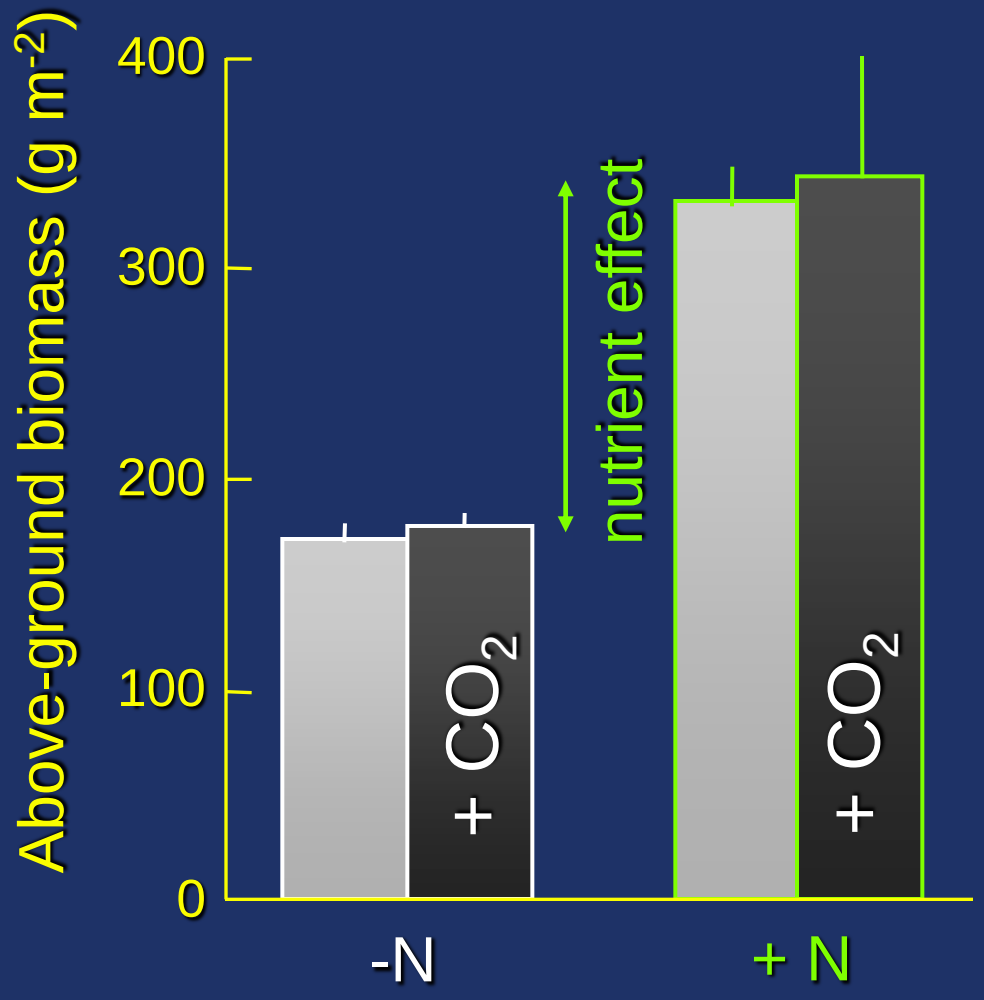
Furka, 2500 - 2600 m



C Heer & Ch Körner (2002) Basic Appl Ecol 3:39

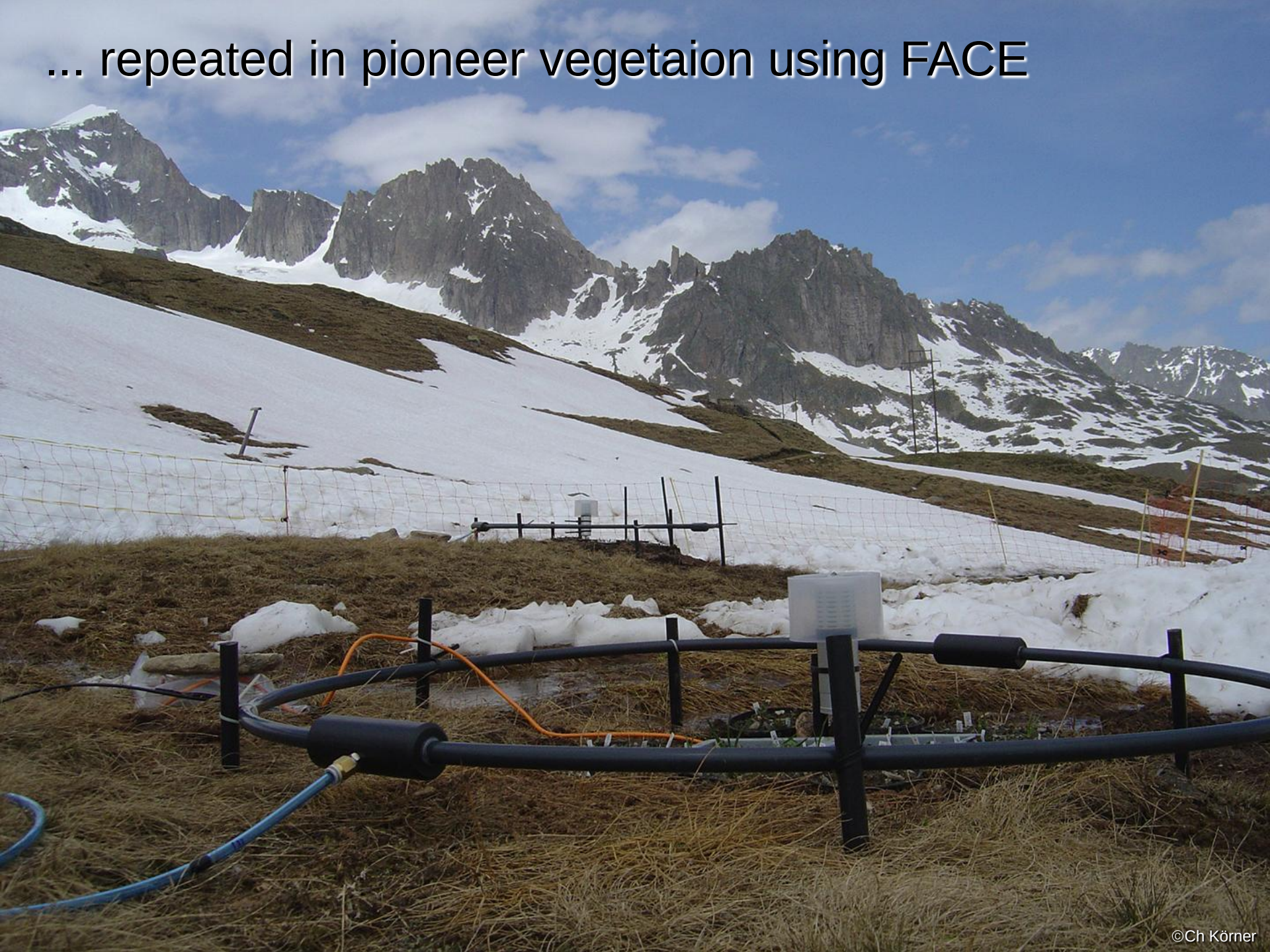
E Hiltbrunner, unpubl data

No biomass responses of alpine grassland to 4 years of CO_2-enrichment (Alps, Furkapass, 2500 m)



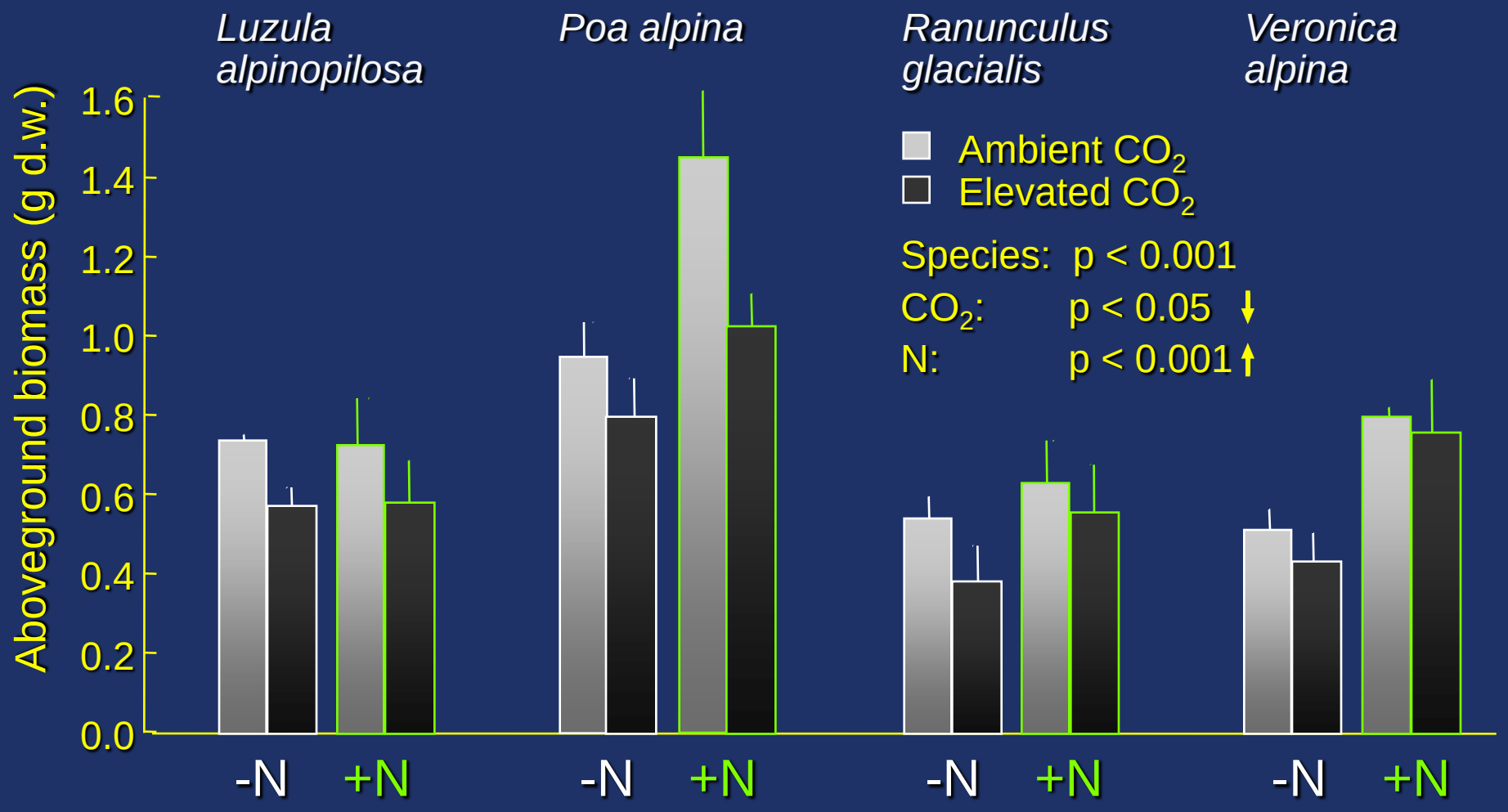
Ch Körner *et al*. (1997) Acta Oecol 18:165

... irrespective of nutrition


... repeated in pioneer vegetaion using FACE
©Ch Körner

Negative effect of elevated CO_2 on plant growth

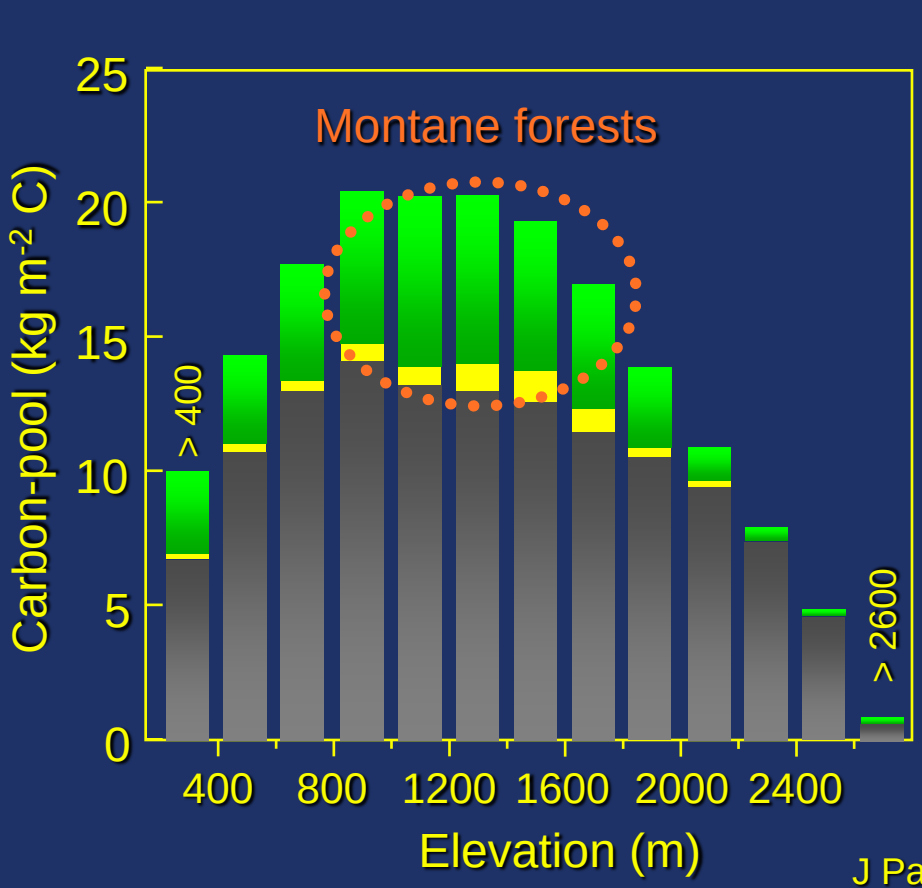
FACE-Glacier forefield plants, Furka, 2500 m

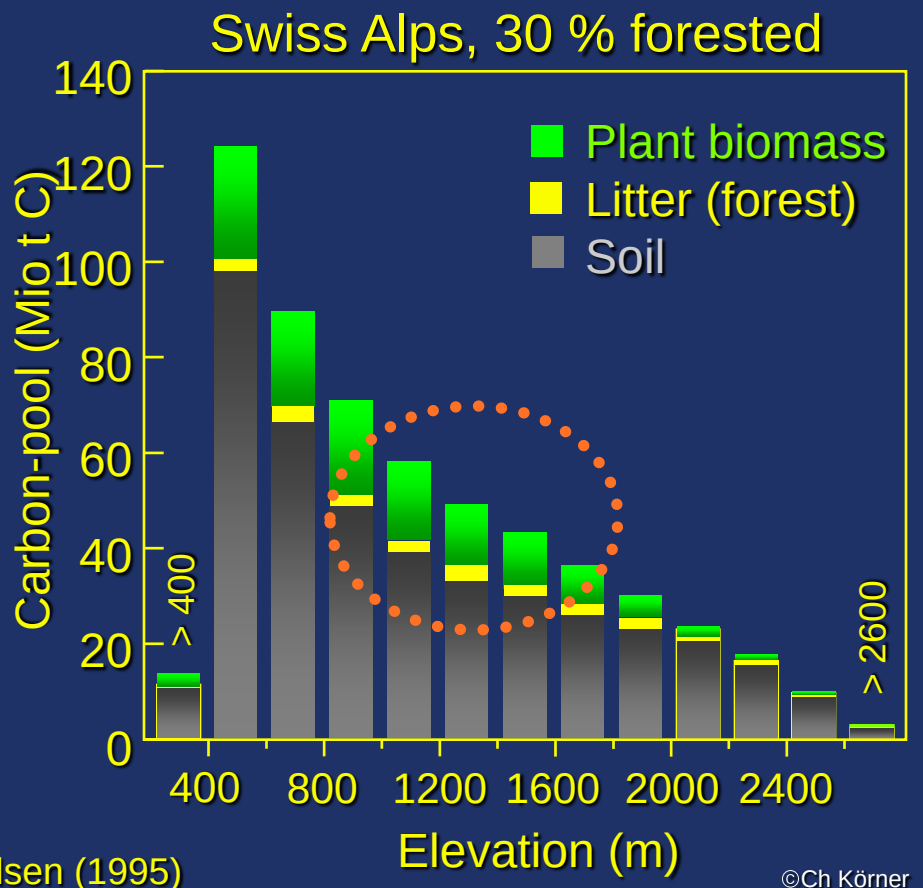


N Inauen, E Hiltbrunner & C Körner, in prep.

- No stimulation of montane spruce (Hättenschwiler *et al* 1996, PCE)
- No CO_2 stimulation of treeline pine (Handa *et al* 2006, GCB)
- Young treeline larch is stimulated, at least initially

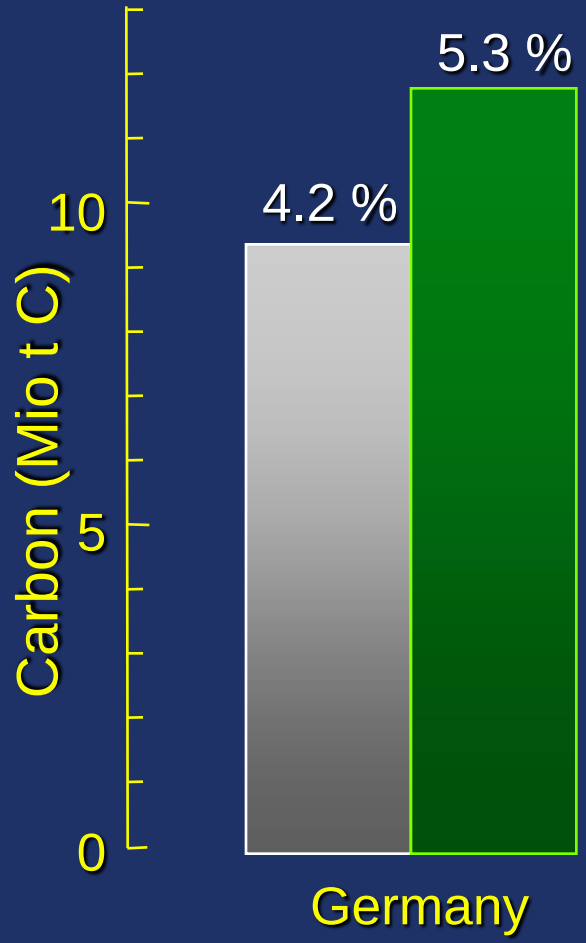
... but forest C-pools per m^2 peak in montane forests





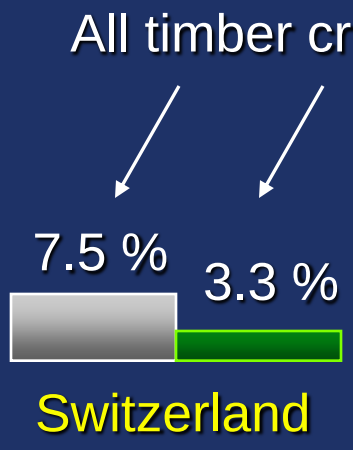
J Paulsen (1995)

Substitution potential of fossil C by forest biomass and energy crops is very small



100 % = annual consumption of fossil C

- Annual timber yield (C)
- 10 t C ha^{-1} a^{-1} biomass production on 10 % of current crop land



3-4 % of all electric energy used in households is used for drying cloth

3-5 % fossil C-saving can be achived by driving with 8.1 (Germany) or 8.3 (Switzerland) instead of 8.6 liter gasoline per 100 km.

Ch Körner (2004) Nova Acta Leopoldina NF 91, 339:287

International Herald Tribune
Friday, April 18, 2008

For Earth's sake, drying has come full cycle

By Elisabeth Rosenthal

AURORA, Ontario: Rob and Laurie Cook are not prone to breaking the law, but these days they have been given to a regular act of civil disobedience: hanging their laundry to dry out in the backyard. The deed to their home — like most in this upscale suburb — prohibits outdoor clotheslines as eyesores.

"I thought people passing by couldn't see it, and the developers wouldn't see it, so it didn't bother my conscience too

Arantxa Cedillo for The New York Times

in her backyard in Aurora, Ontario. Electric dryers waste energy, she maintained.

prove efficiency," with sensors and the like, said Allison Eckelkamp, public relations manager for General Electric's consumer division.

But she added: "When it comes to

onment, but the houses here are so close together, you don't really want to look at your neighbor's laundry," said Danielle DeCastro, 28, who was walking in the Great Gulf Homes develop-

Clotheslines should be subsidized:

→ 300 kWh per household per year are wasted

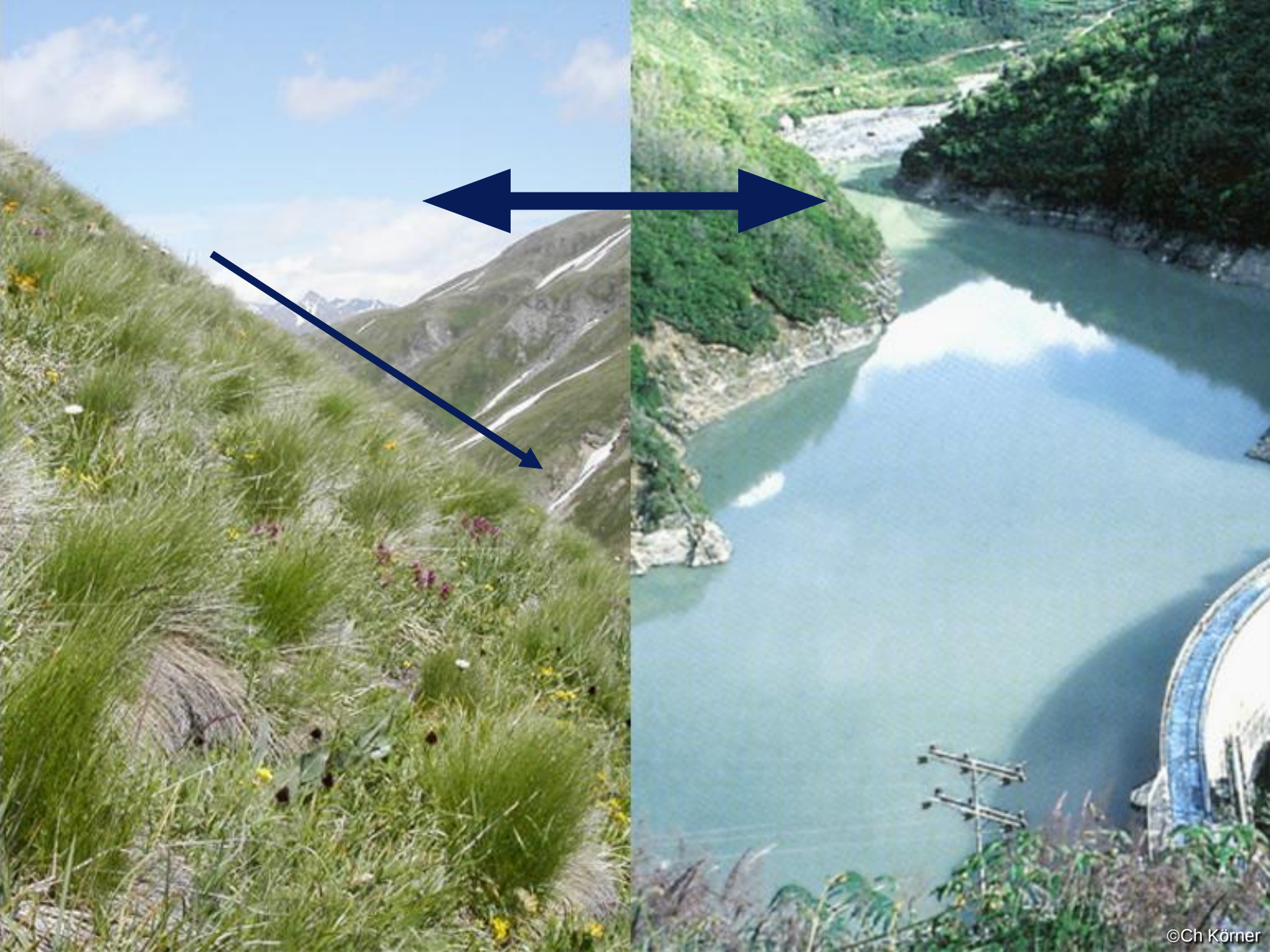

©Ch Körner

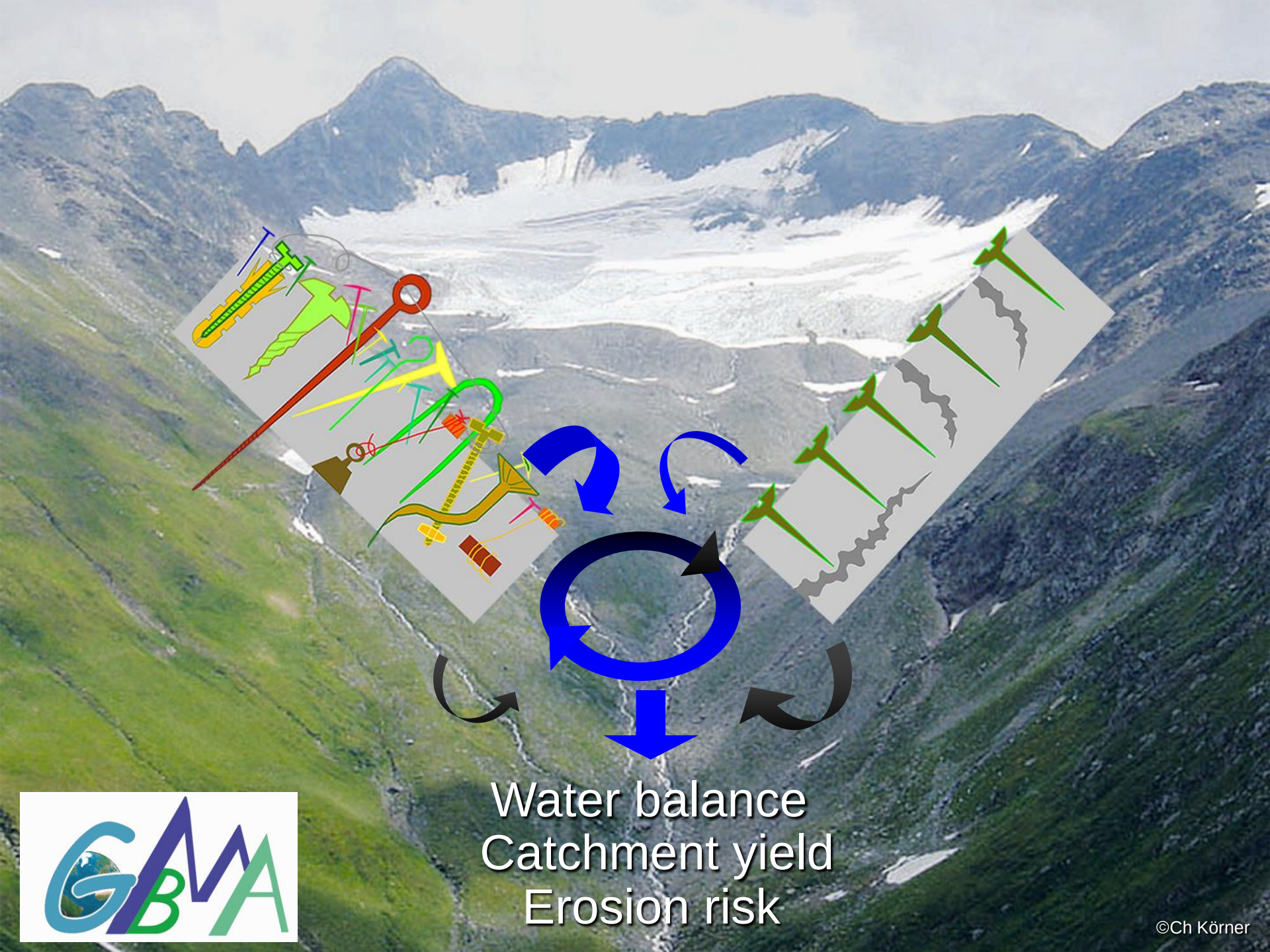
Hydrological benefits of grazing: 5-10 % more yield

Grazed, dense, alpine swards lose less water by evapotranspiration than long grass.

At 2500 m grazing induced, enhanced seepage corresponds to an increased electric power yield of 150$ ha^{-1} a^{-1}.

➞ sustainable grazing can increase catchment value.


©Ch Körner

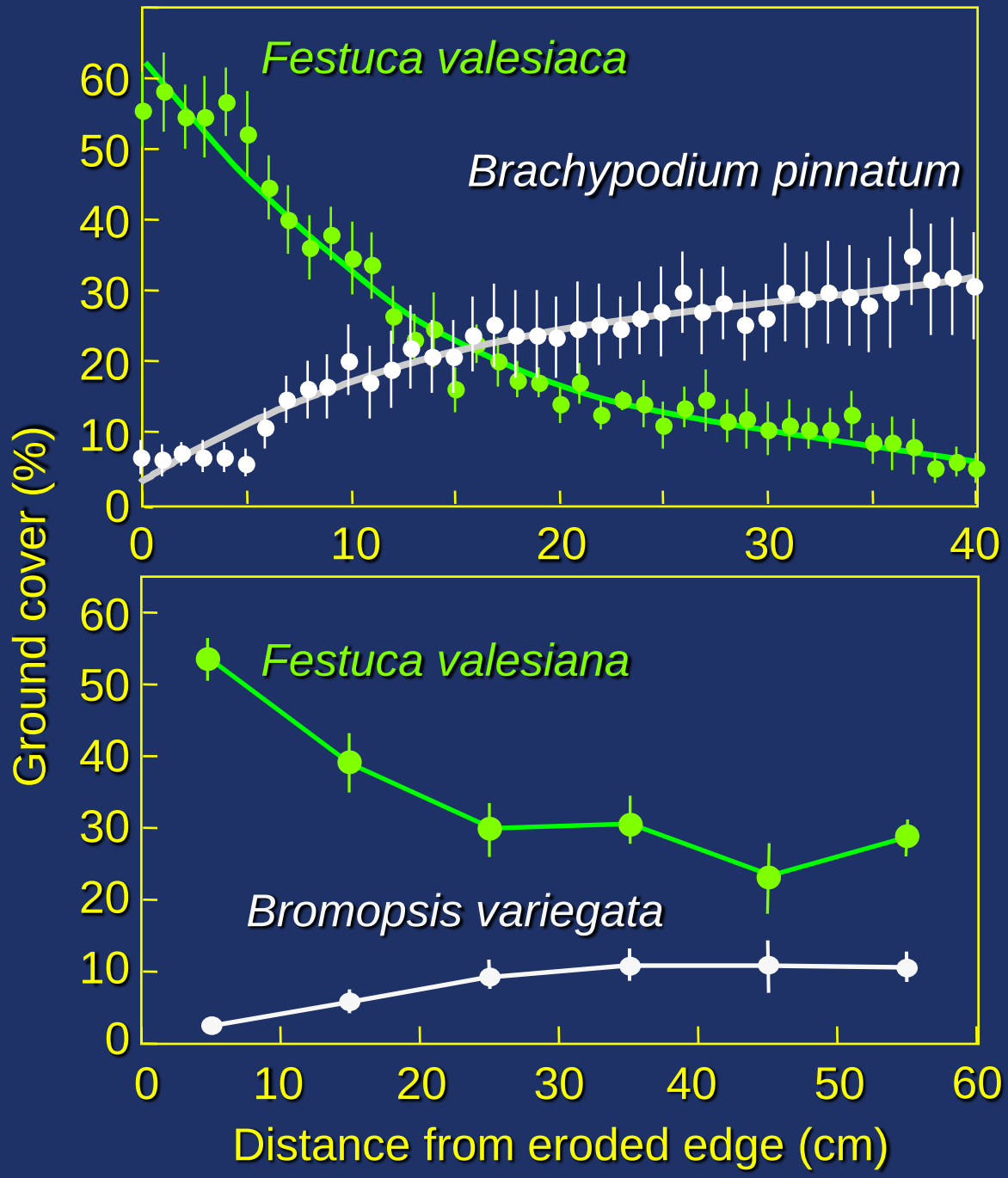


Nothing makes sense in mountain ecology, except in an hydrology-erosion context.


Mountains are hotspots of biodiversity
Do we ‘need‘ all those species?
©Ch Körner


Great Caucasus, 1500 m
©Ch Körner

A single species controls the edge



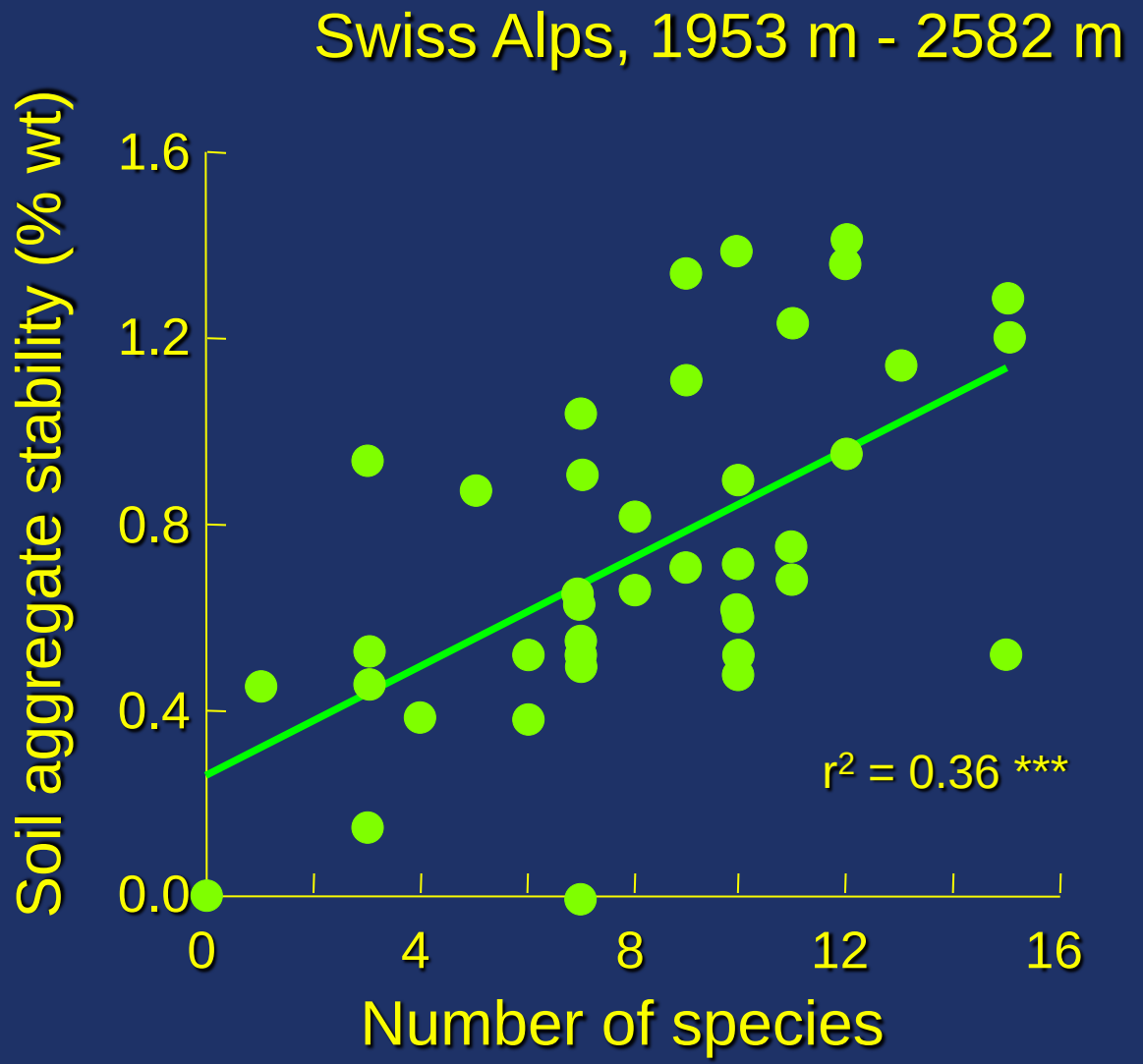
Keystone species may engineer landscapes

Central Swiss Alps

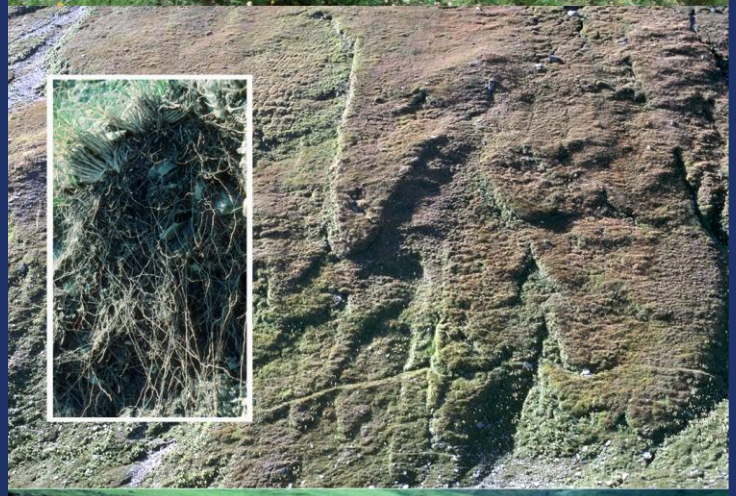
C Huck *et al*, unpubl data

Central Caucasus

R Caprez *et al*, unpubl data



M Pohl *et al.* Higher plant diversity enhances soil stability in alpine ecosystems. (submitted)



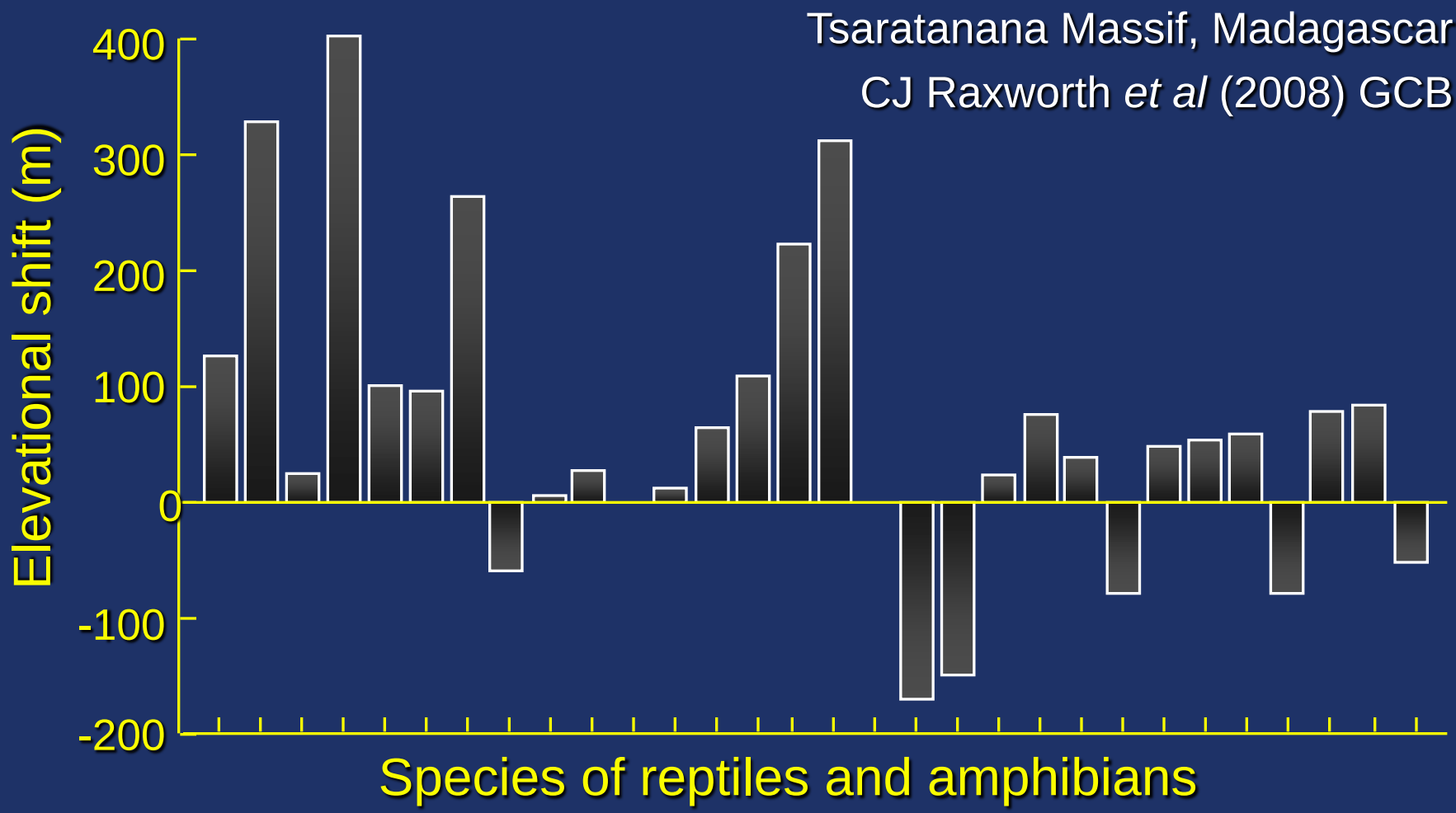
Mountain biodiversity secures catchments

- Catchment value depends on soil stability.
- Soil stability depends on a dense plant cover.
- A dense plant cover is secured by high plant species diversity.

©Ch Körner

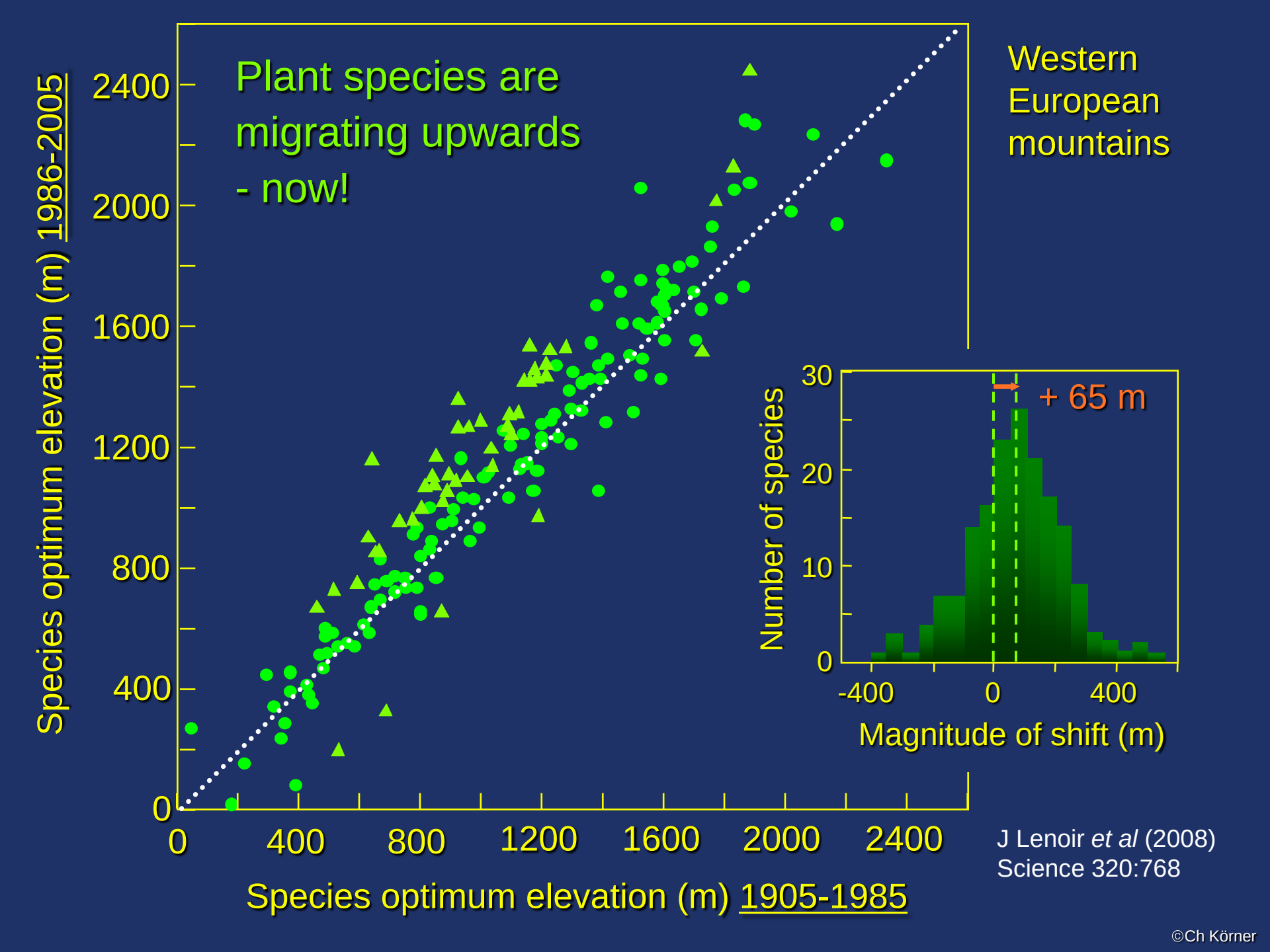
The most fragile systems

Many taxa escape upslope ...



... but many became already extinct, e.g. in Costa Rica,
JA Pounds *et al* (2006) Nature

Climatic change driven fire frequency on Kilimanjaro reduces water yield (Hemp 2005, GCB)



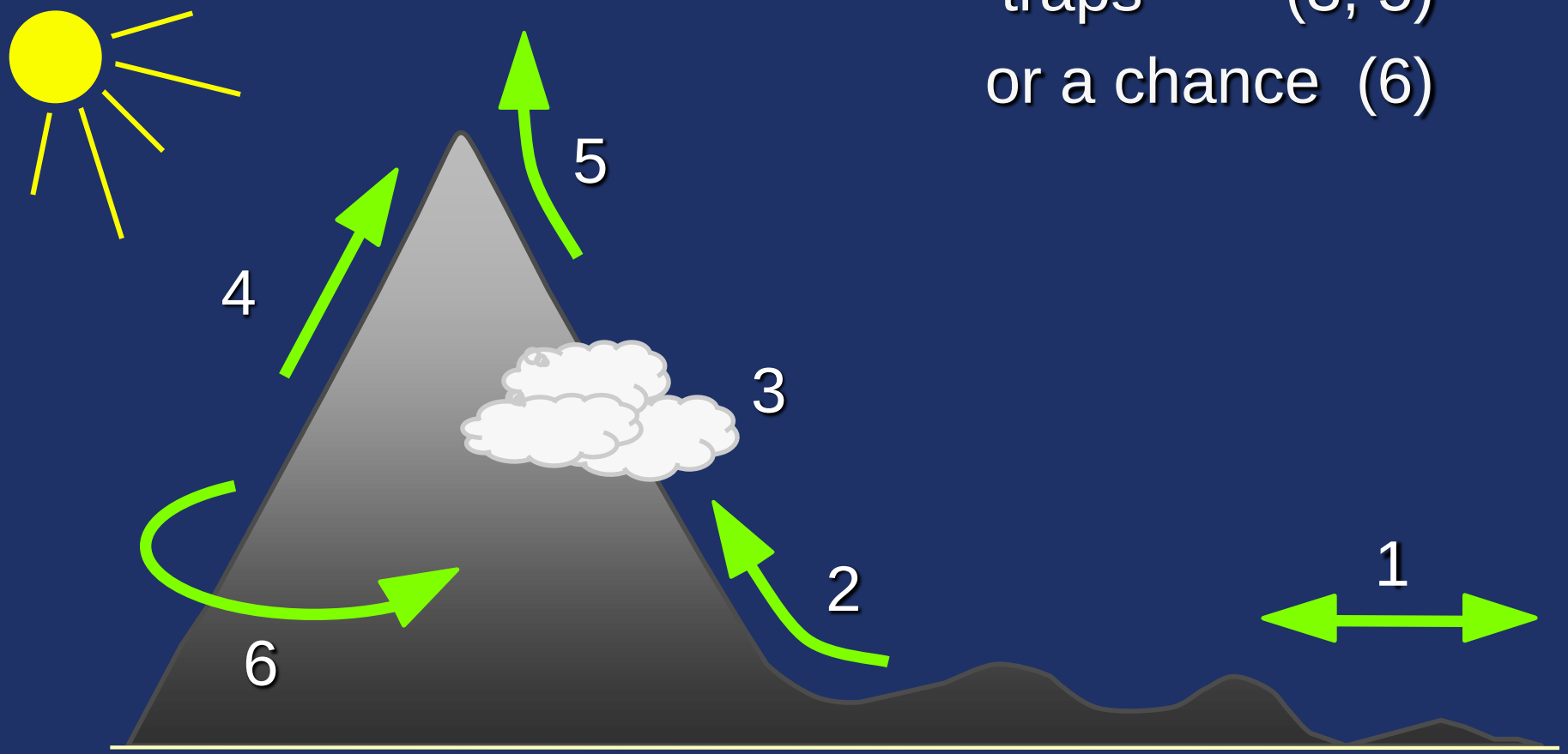
J Lenoir *et al* (2008)
Science 320:768

Species responses to climatic warming

Mountains may be refugia (2, 4)

traps (3, 5)

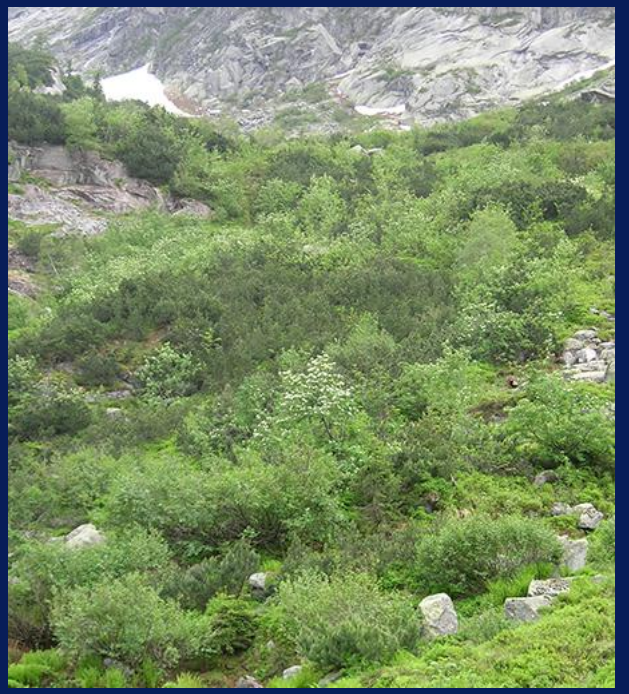
or a chance (6)

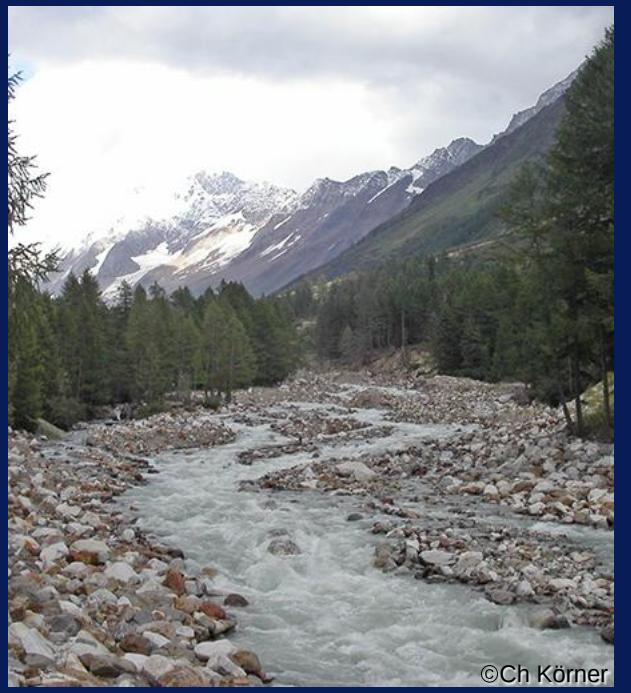


At high elevation...

- elevated CO_2 does not stimulate growth
- warming reduces growth in the Alpine increases growth at treeline
- N-deposition: winners and losers!
- land use may outrange any other effect



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