Alpine ecosystems under global change

Auswirkungen langfristiger Umweltveränderungen auf alpine Ökosysteme

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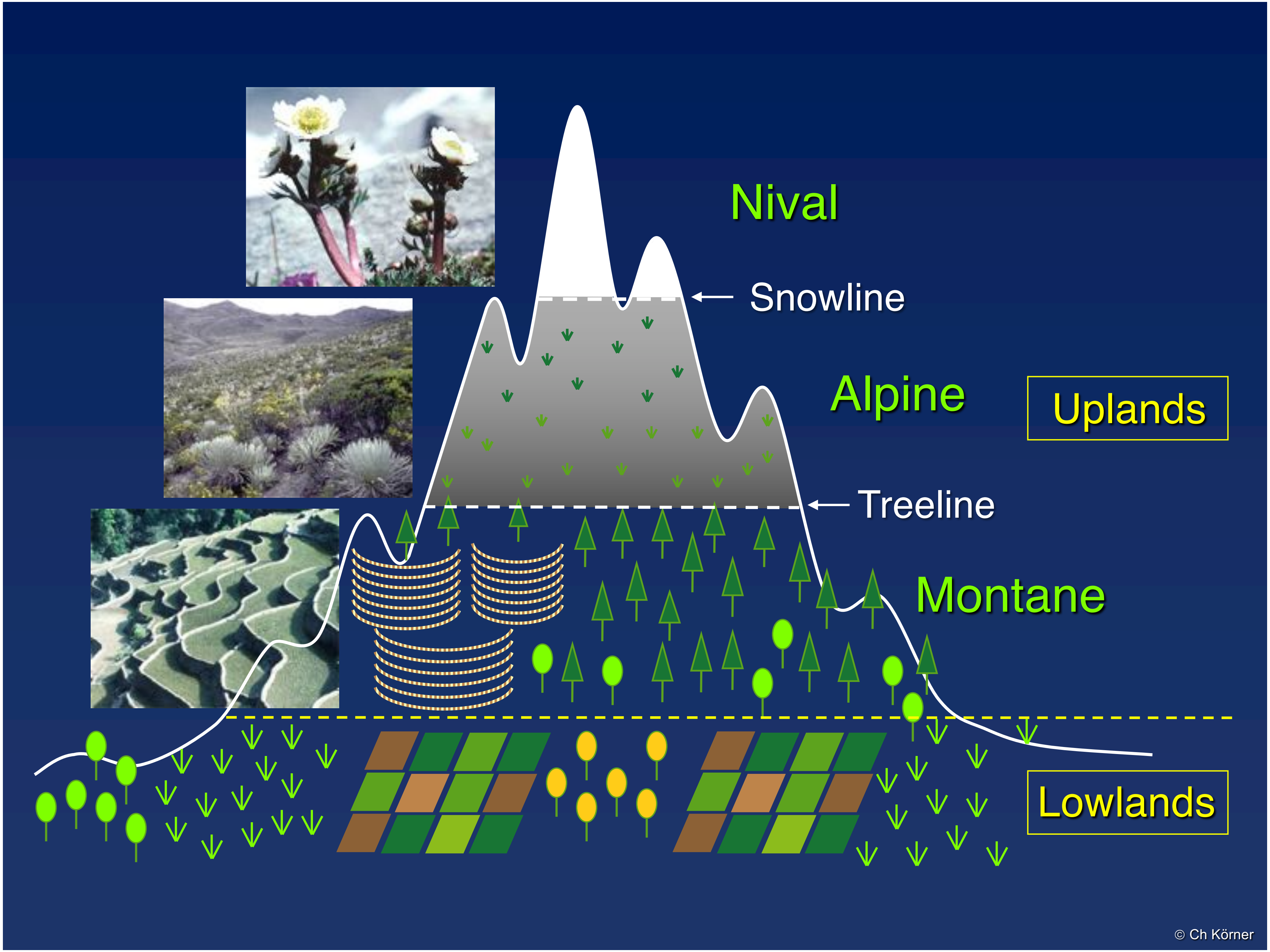
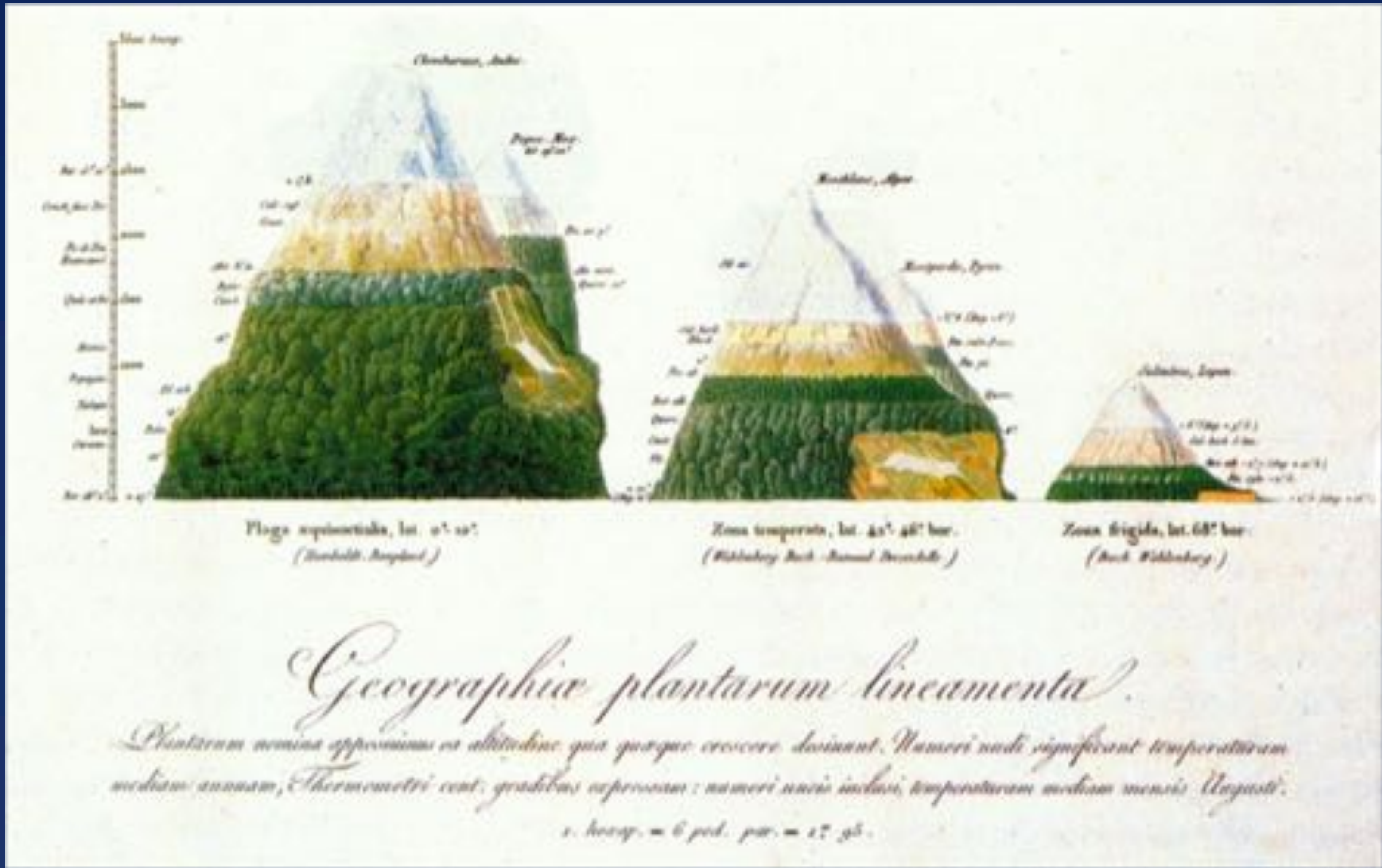

Nival
Snowline
Alpine
Uplands
Treeline
Montane
Lowlands
© Ch Körner

Alexander von Humboldt‘s 250th birthday

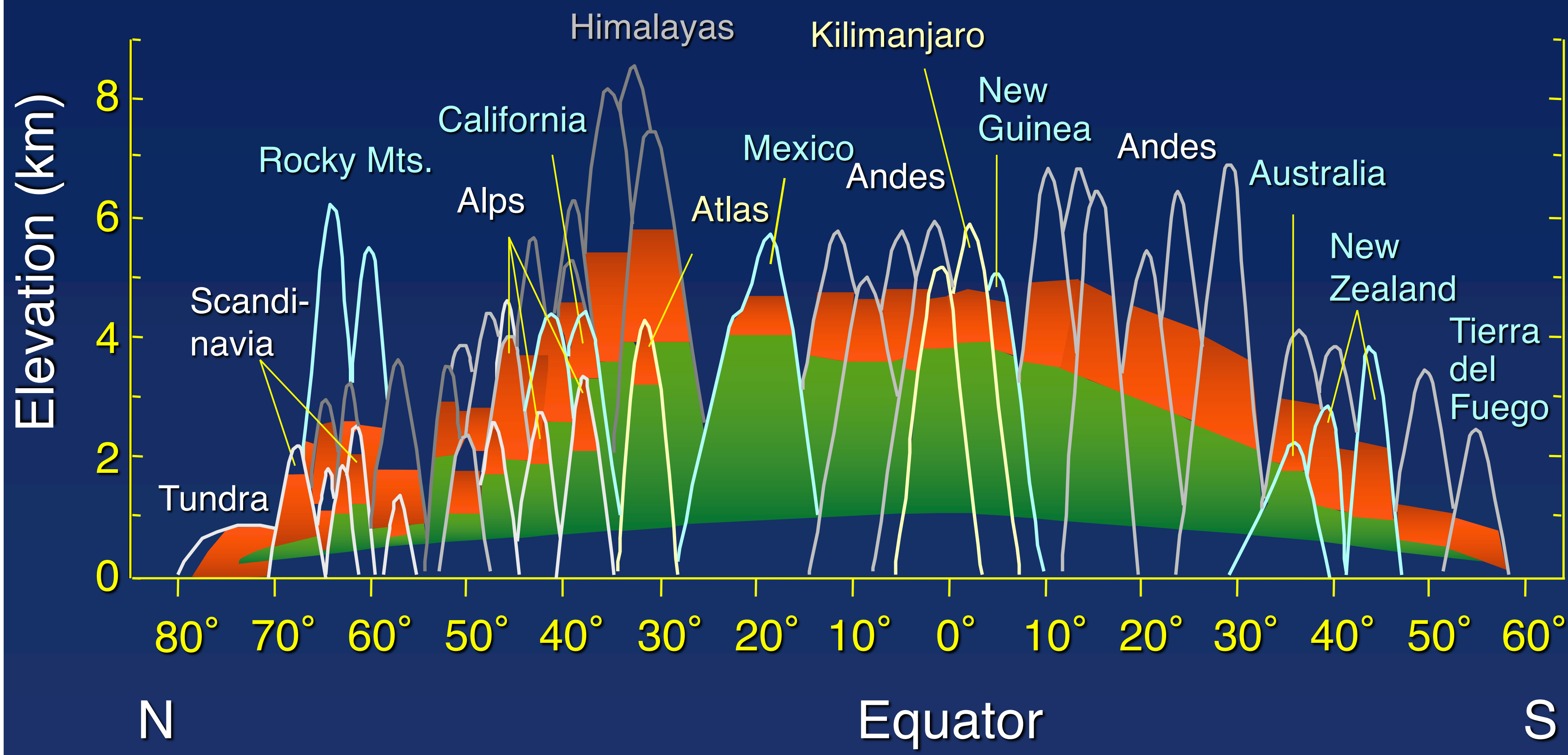
→ Humboldt invented the isotherm concept



Elevation *per se* does not matter. What matters is climate

Humboldt‘s ‚Naturama‘ redesigned: the wold is connected through mountains

The alpine and montane belts globally



Körner C (2003) Alpine plant life. Springer, Berlin

Mountains are more biodiverse than expected by their area

Number of named species at 2500 m, 350 m above treeline, across 1 km^2

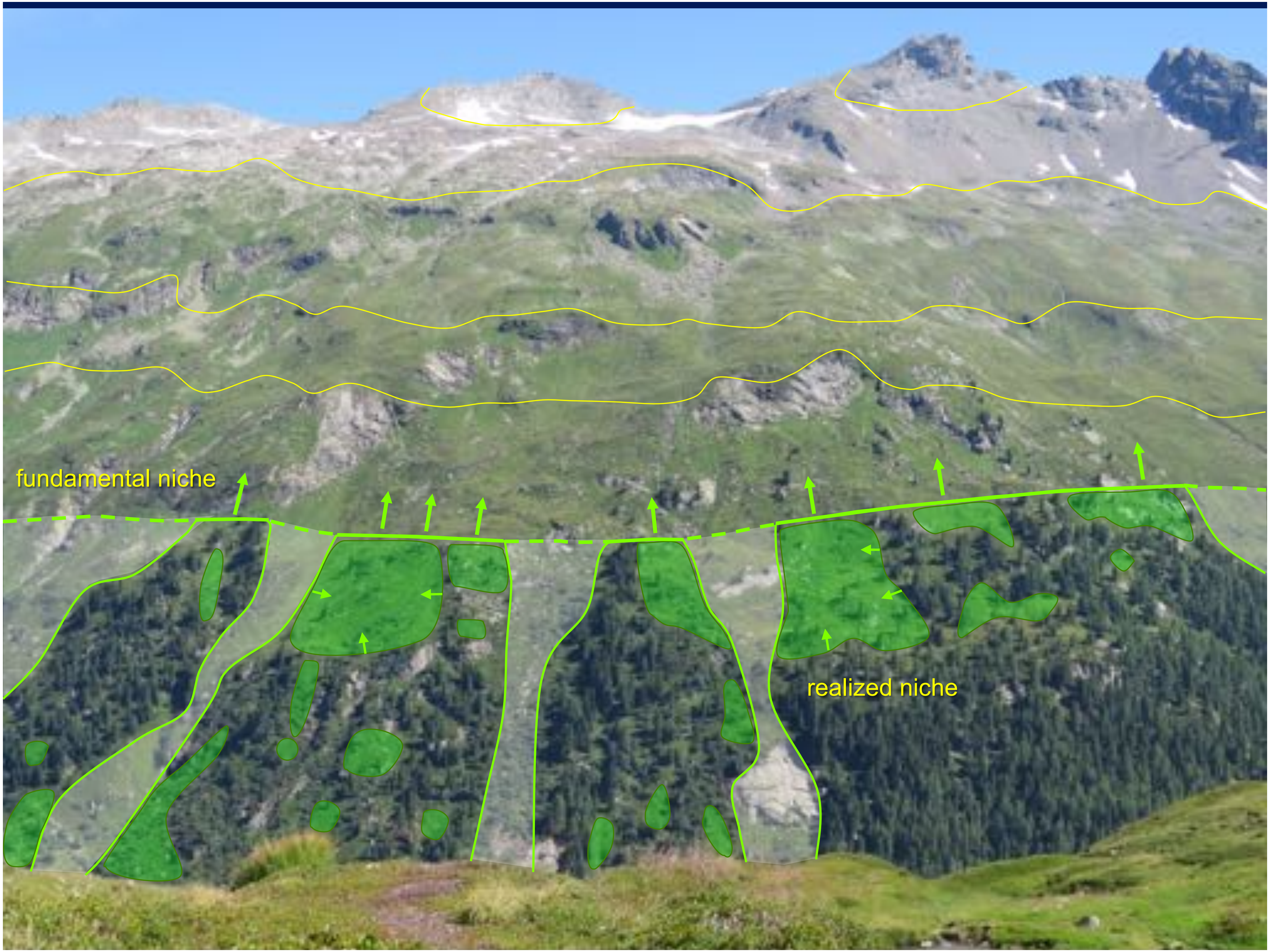
554 Insects (incl. chilopods)
313 Fungi (Basidio-, Asco-, Glomeromycota)
304 Flowering plants
300 Lichens
215 Diatoms
166 Mosses
128 Spiders and Mites
30 Vertebrates (birds, rodents, amphibia, reptiles)

In total 2098 species

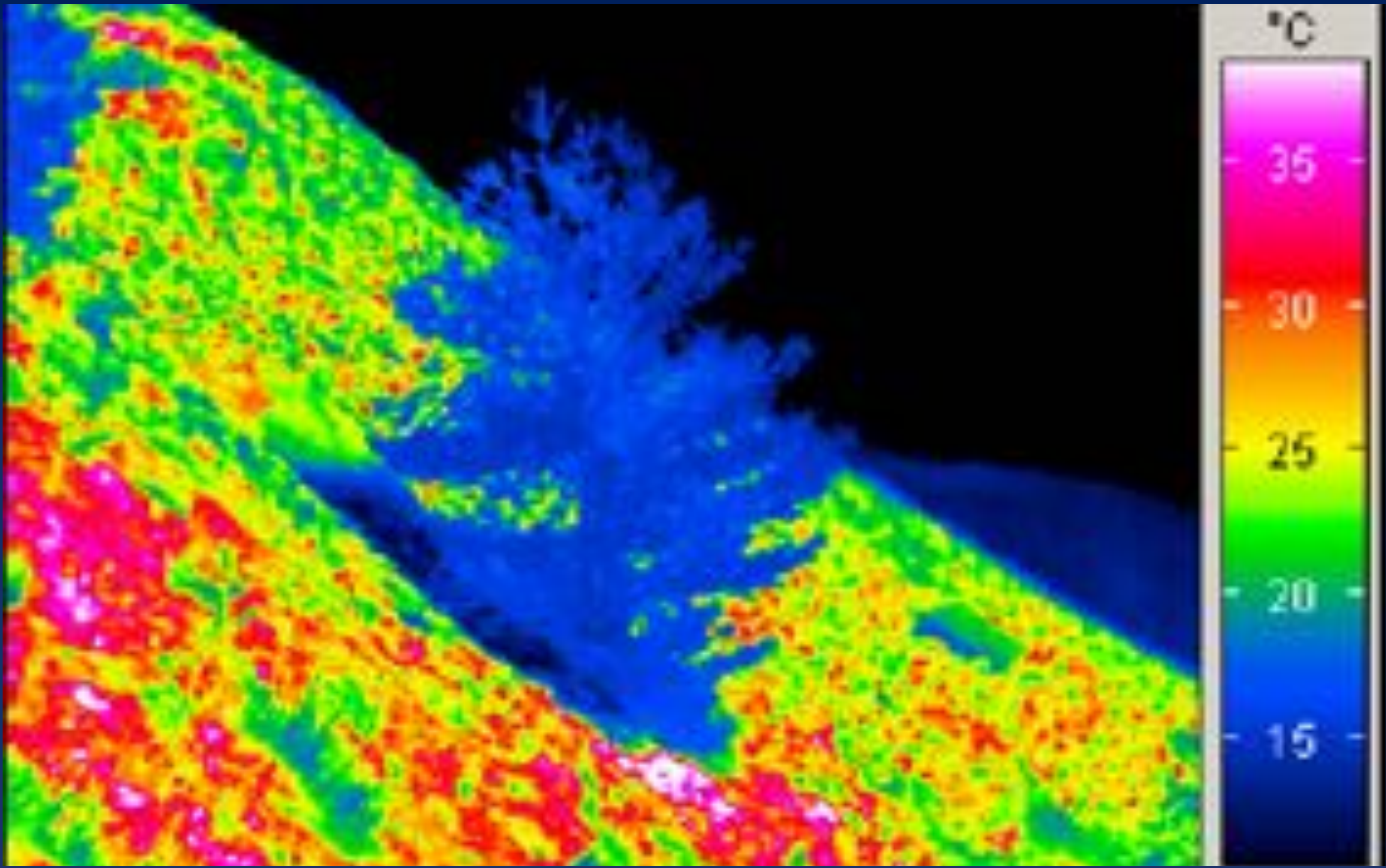
excluding
Bacteria
Nematodes
Collembols

Hotspot Furka
Hiltbrunner E, Körner C (2018)

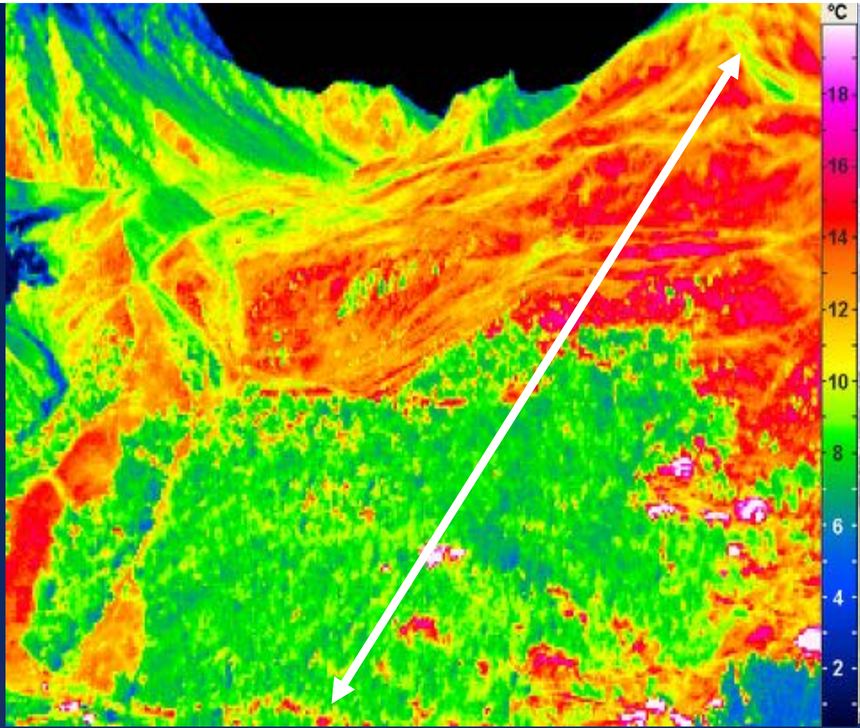
Climatic warming opens new land

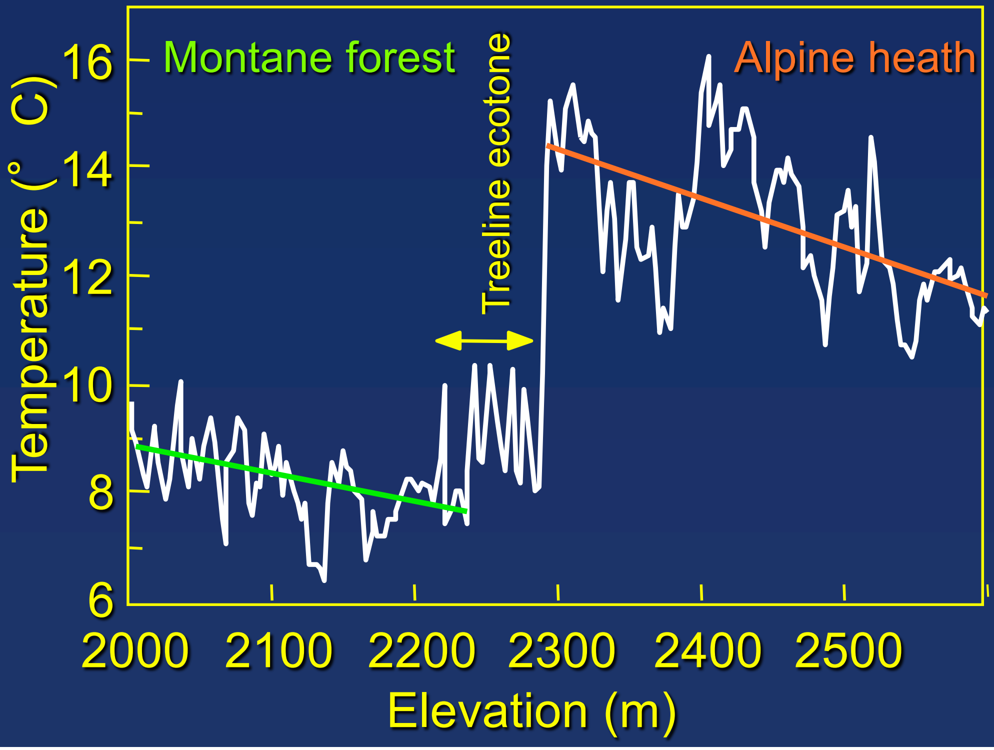

fundamental niche
realized niche

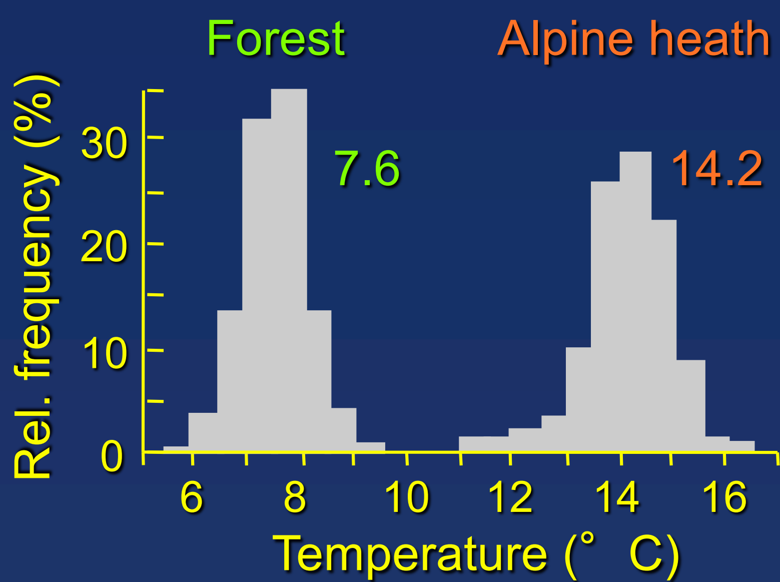
No question, alpine organisms do in large not experience the climate weather stations report, but trees do ...



That is why the treeline is a perfect reference for defining life zones in mountains



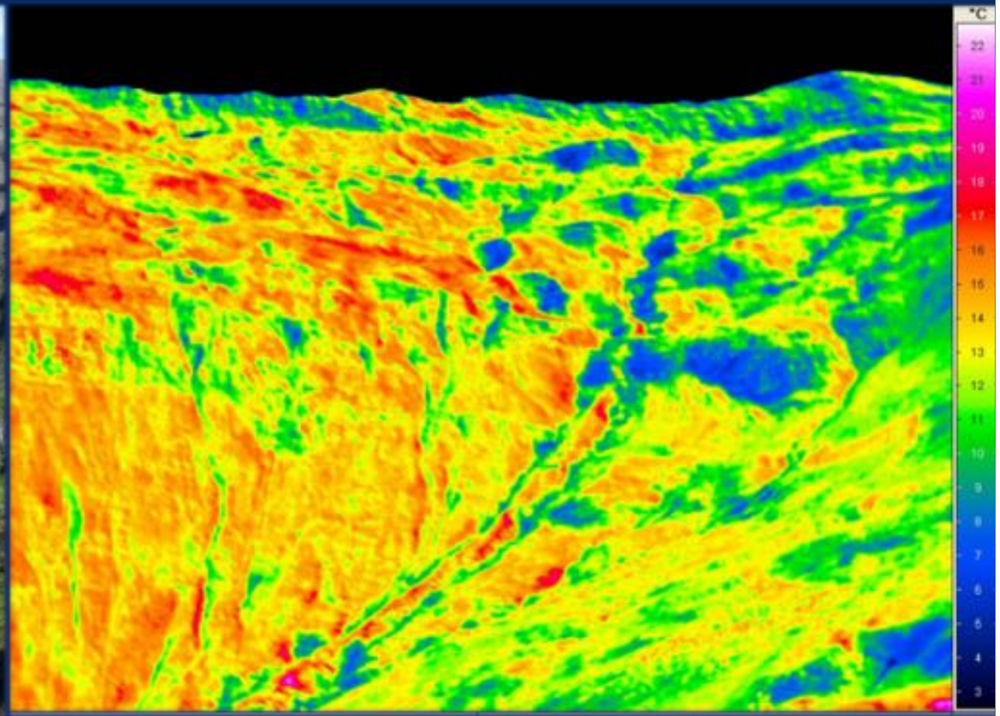


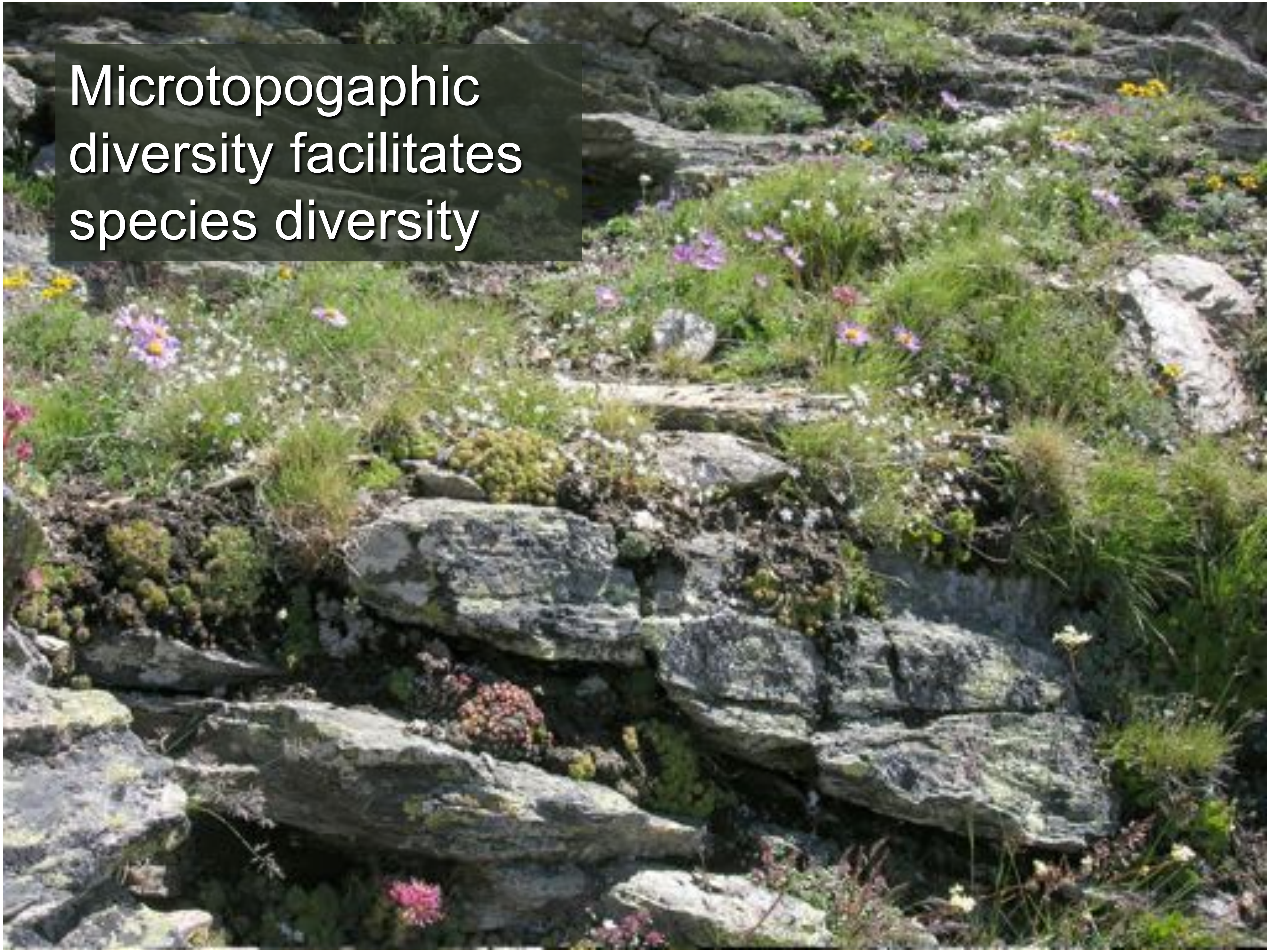


C Körner (2007) Erdkunde 61:316

Habitat diversity is the regional driver of biodiversity

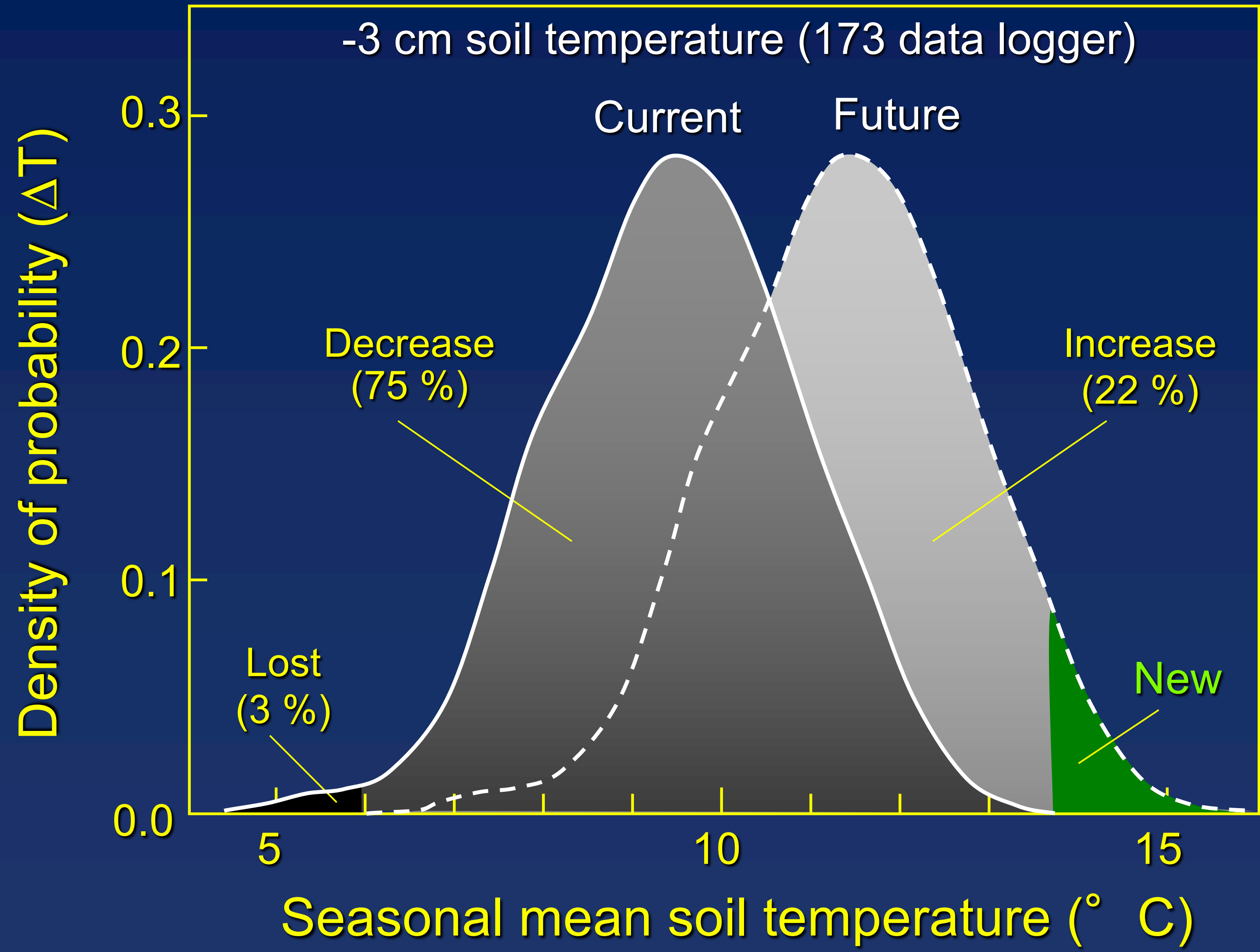
→ a safeguard against species loss



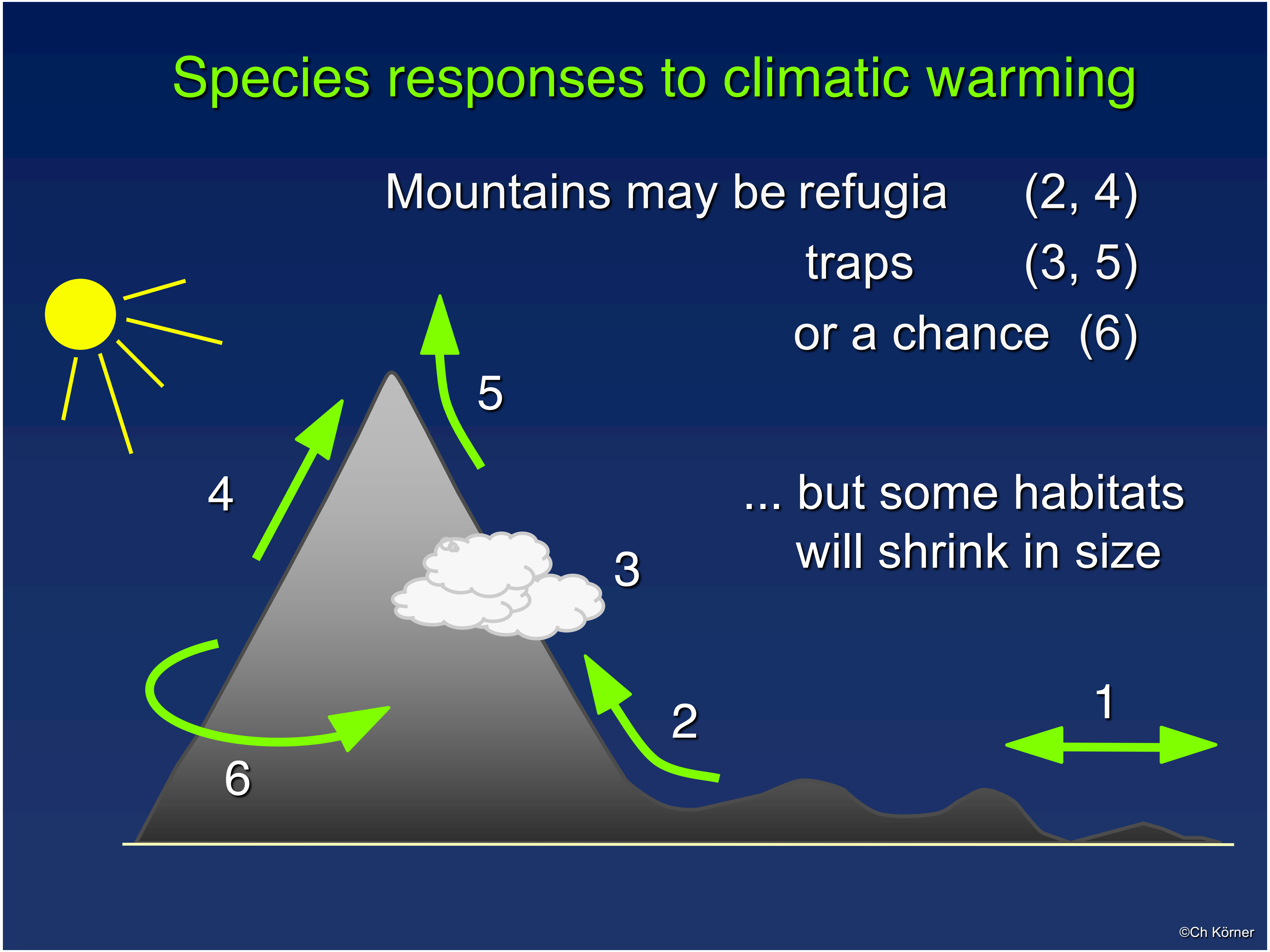

Microtopogaphic
diversity facilitates
species diversity

Habitat loss due to climate warming

(assuming proportionality between air temperature and plant temperature)



Scherrer D & Körner C (2011) J Biogeogr 38:406


Species responses to climatic warming
Mountains may be refugia (2, 4)
traps (3, 5)
or a chance (6)
... but some habitats will shrink in size
5
4
3
2
1
6
©Ch Körner

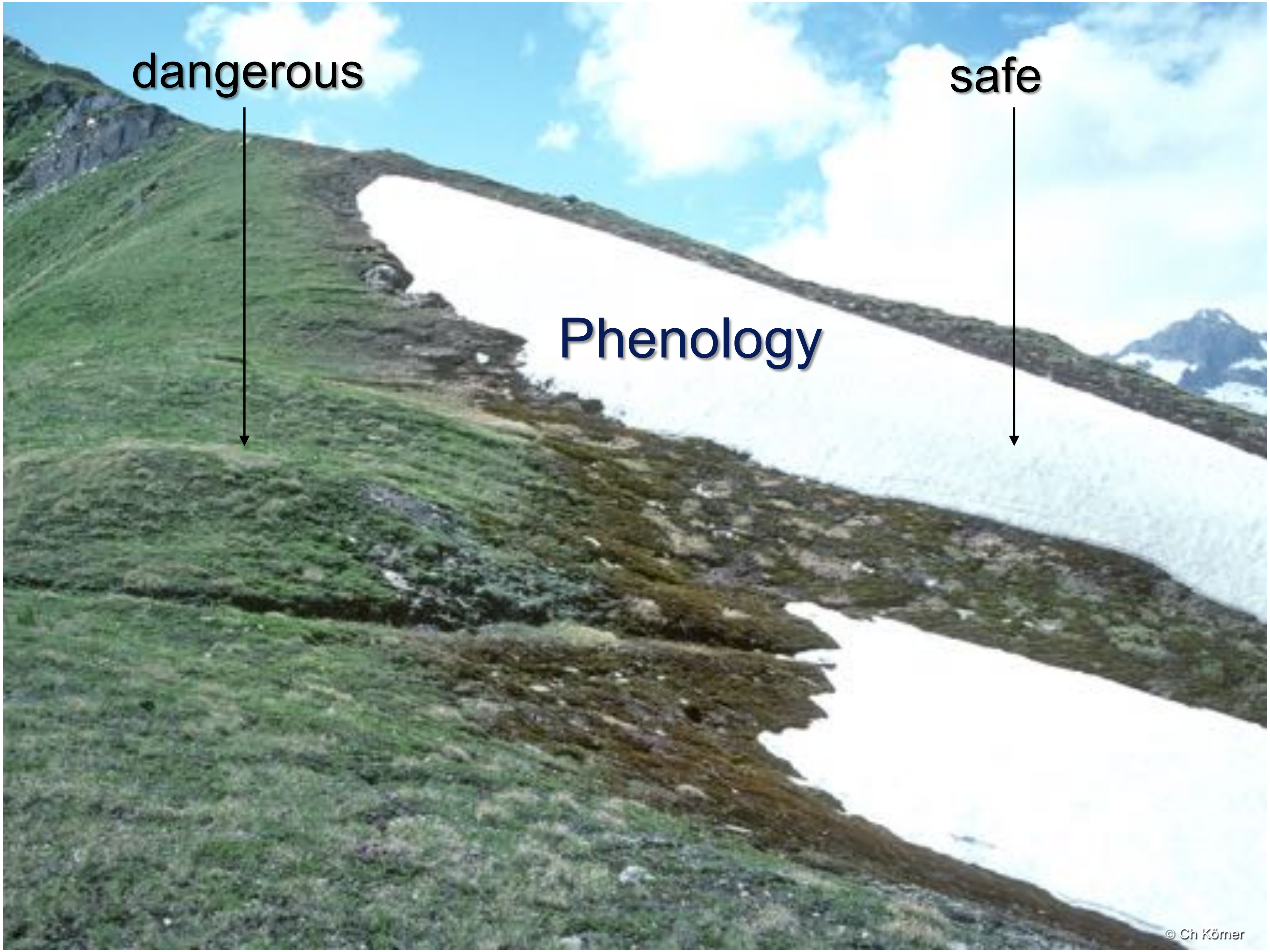
Projections of longterm effects of climate warming depend on spatial resolution

Surface temperature (IR) bright days and daylight hours only

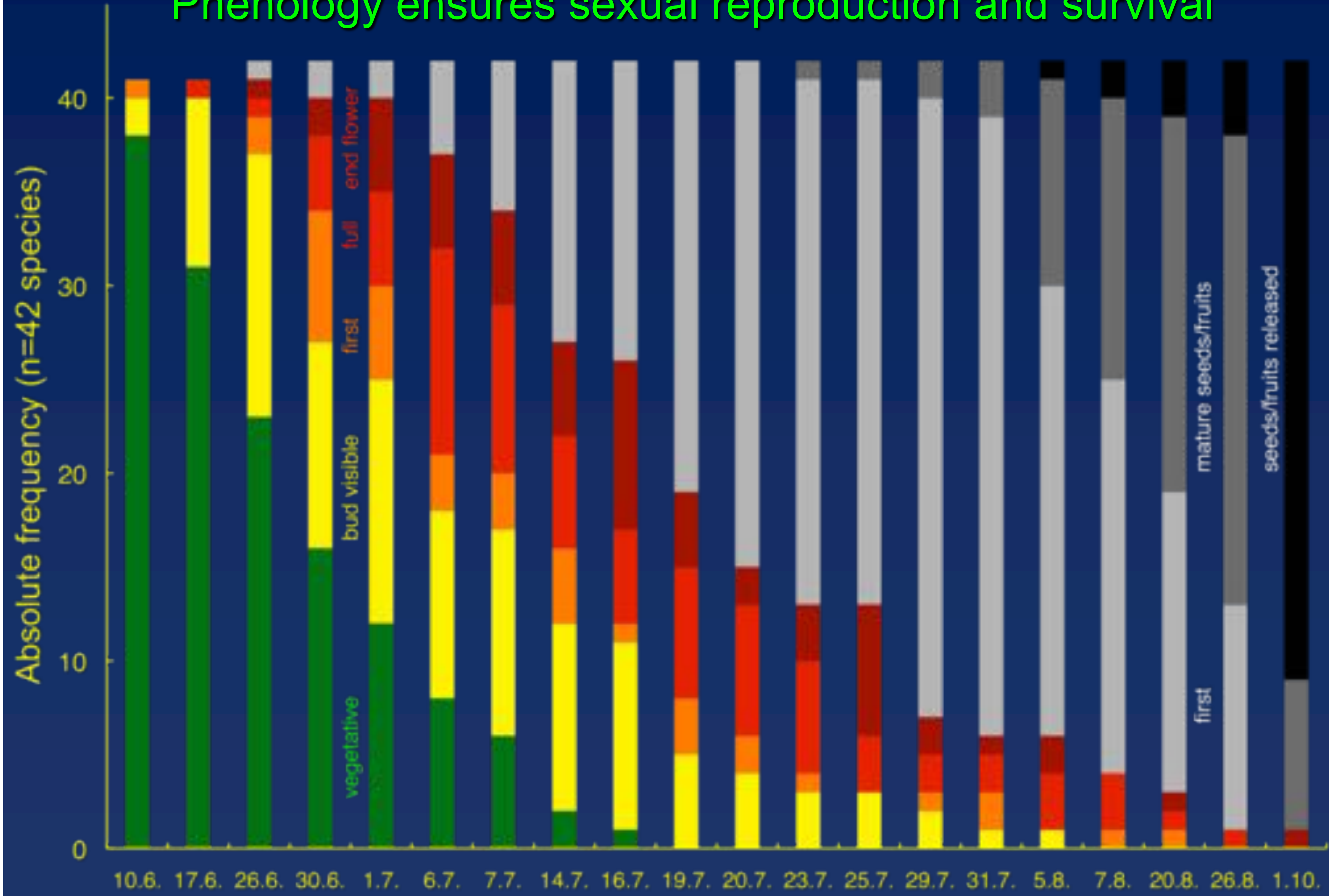
Spatial resolution (m^2)	2 K scenario habitat loss (%)	3 K scenario habitat loss (%)	4 K scenario habitat loss (%)
1 x 1	<u>7.5</u> ± 0.9	<u>20.3</u> ± 8.0	<u>40.4</u> ± 19.0
5 x 5	16.8 ± 9.9	40.0 ± 22.2	57.5 ± 30.0
10 x 10	17.4 ± 7.6	42.8 ± 20.1	67.1 ± 24.3
25 x 25	44.1 ± 24.3	68.1 ± 25.6	86.2 ± 11.3
100 x 100	<u>64.7</u> ± 28.9	<u>95.5</u> ± 3.7	<u>100</u> ± 0.0

Means for three different slopes at 2200 - 3000 m of elevation in the Alps

Scherrer D et al. (2011) J Biometeorology, see also CF Randin *et al* (2009) GCB 15:1557


dangerous
safe
Phenology
© Ch Körner

Phenology ensures sexual reproduction and survival

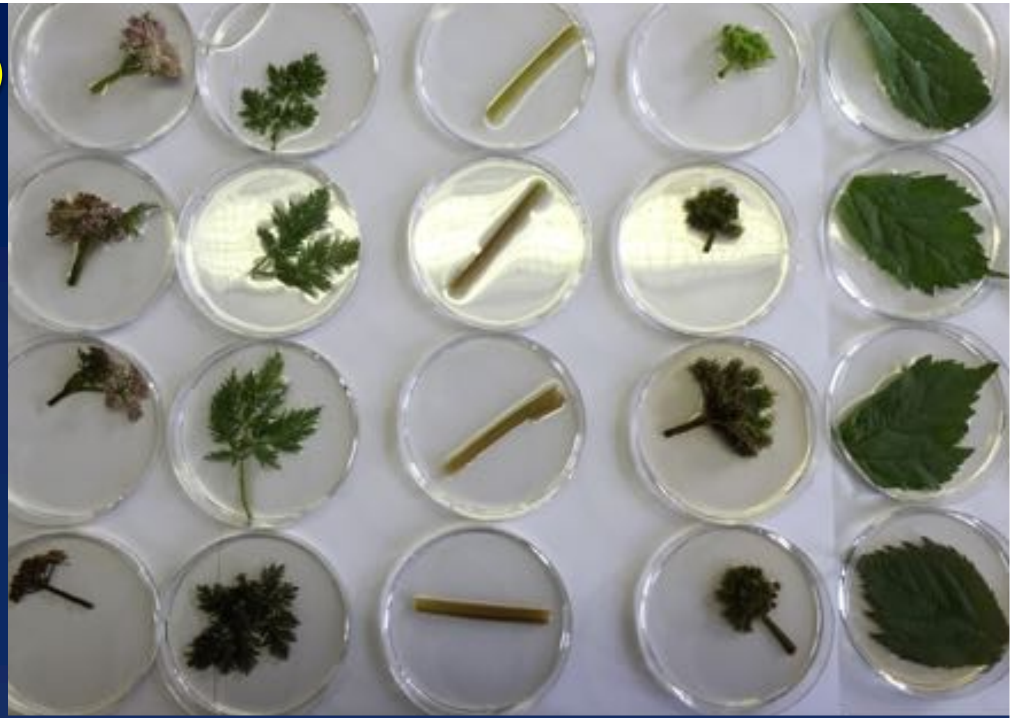


Flowering phenology at 2440 m in 2015


Half of the high alpine/nival taxa are 'opportunistic‘, the other half is strongly controlled by photoperiodism

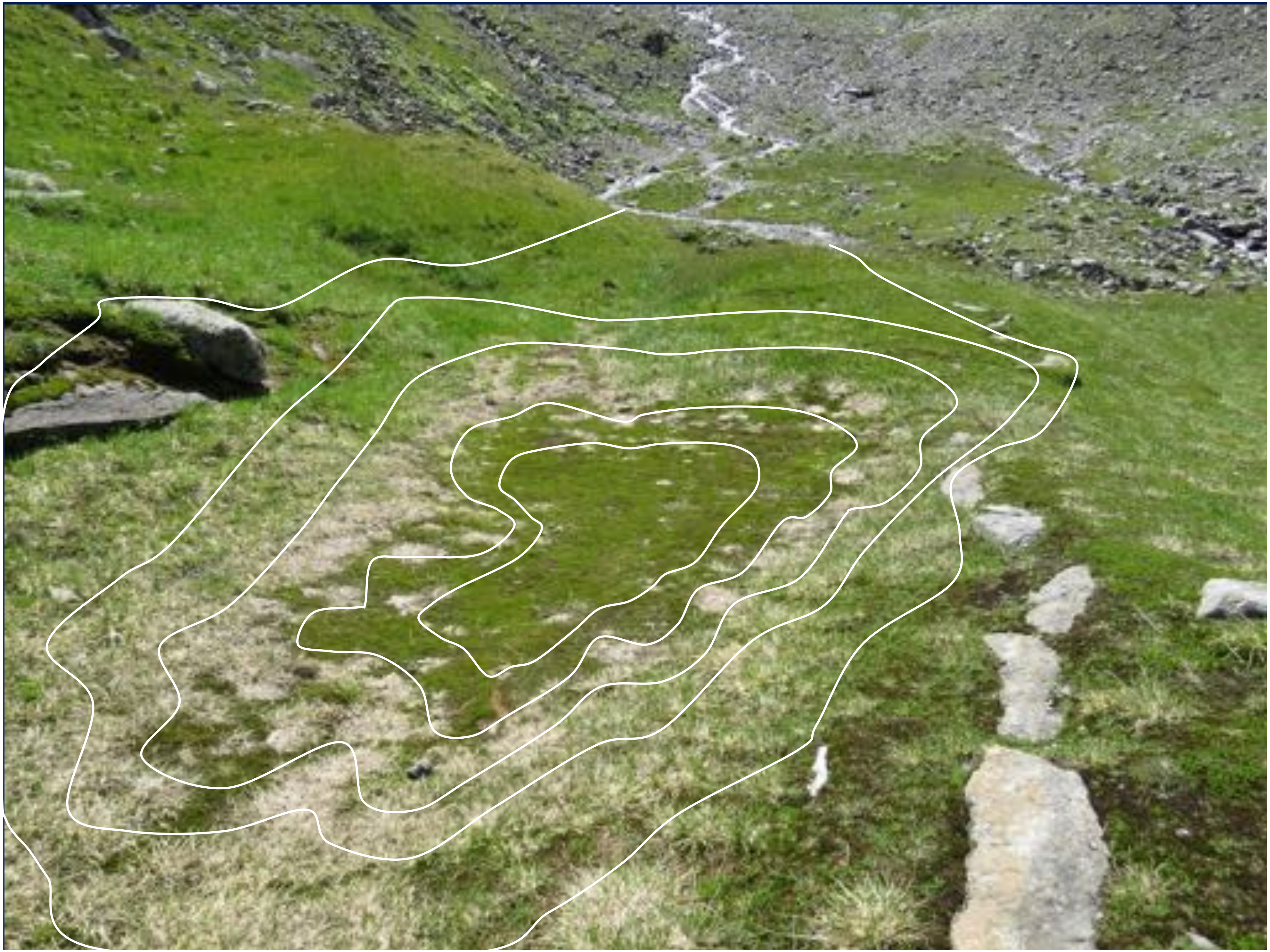

There are options for selection: later flowering
← G. purpurea


Damage between -3 and -12 ° C (summer)
depending on species and tissue type

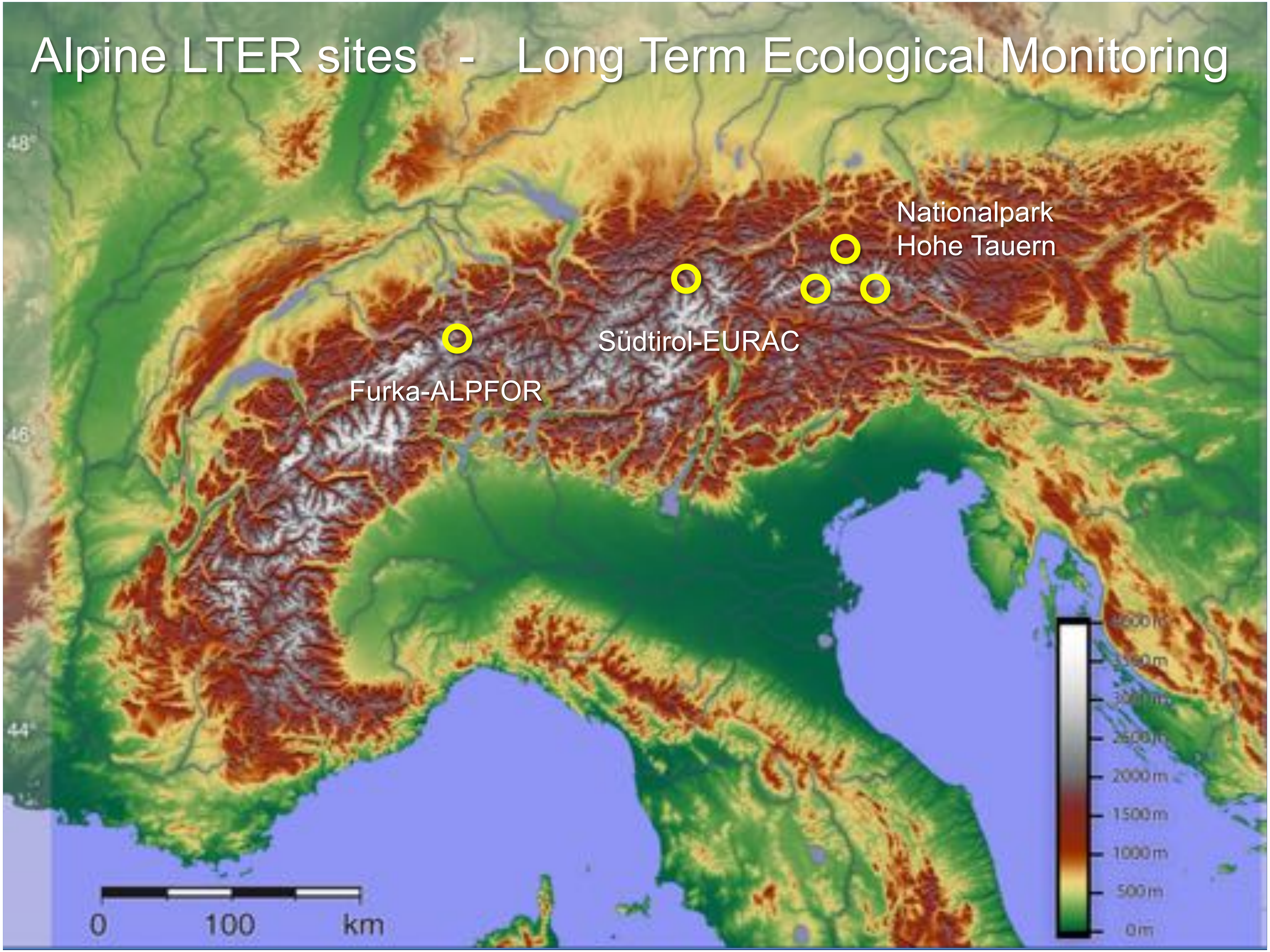



Heat waves can induce drought even in alpine plants

Sharp snow-melt gradients: range limits at small scale



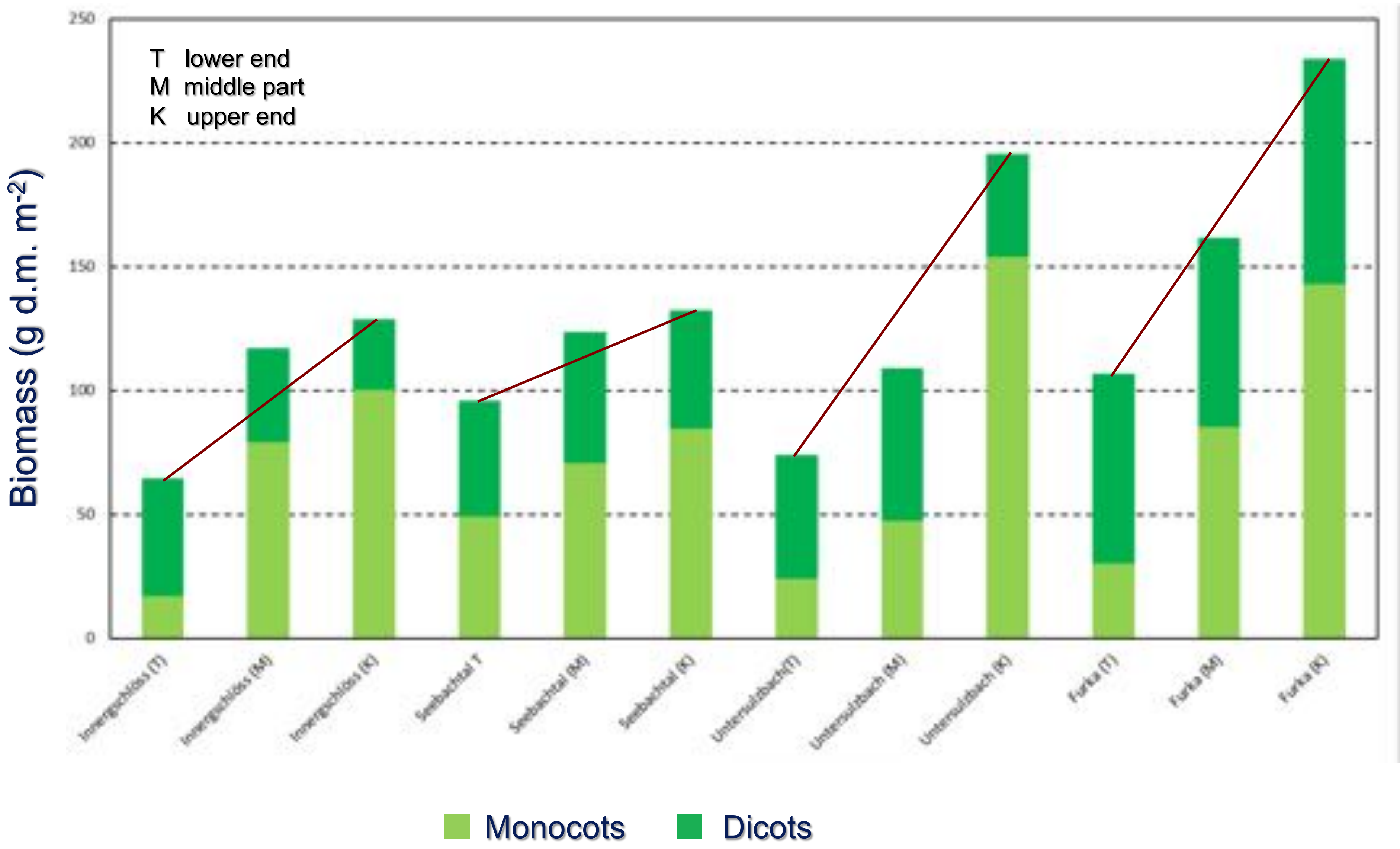
Alpine LTER sites - Long Term Ecological Monitoring



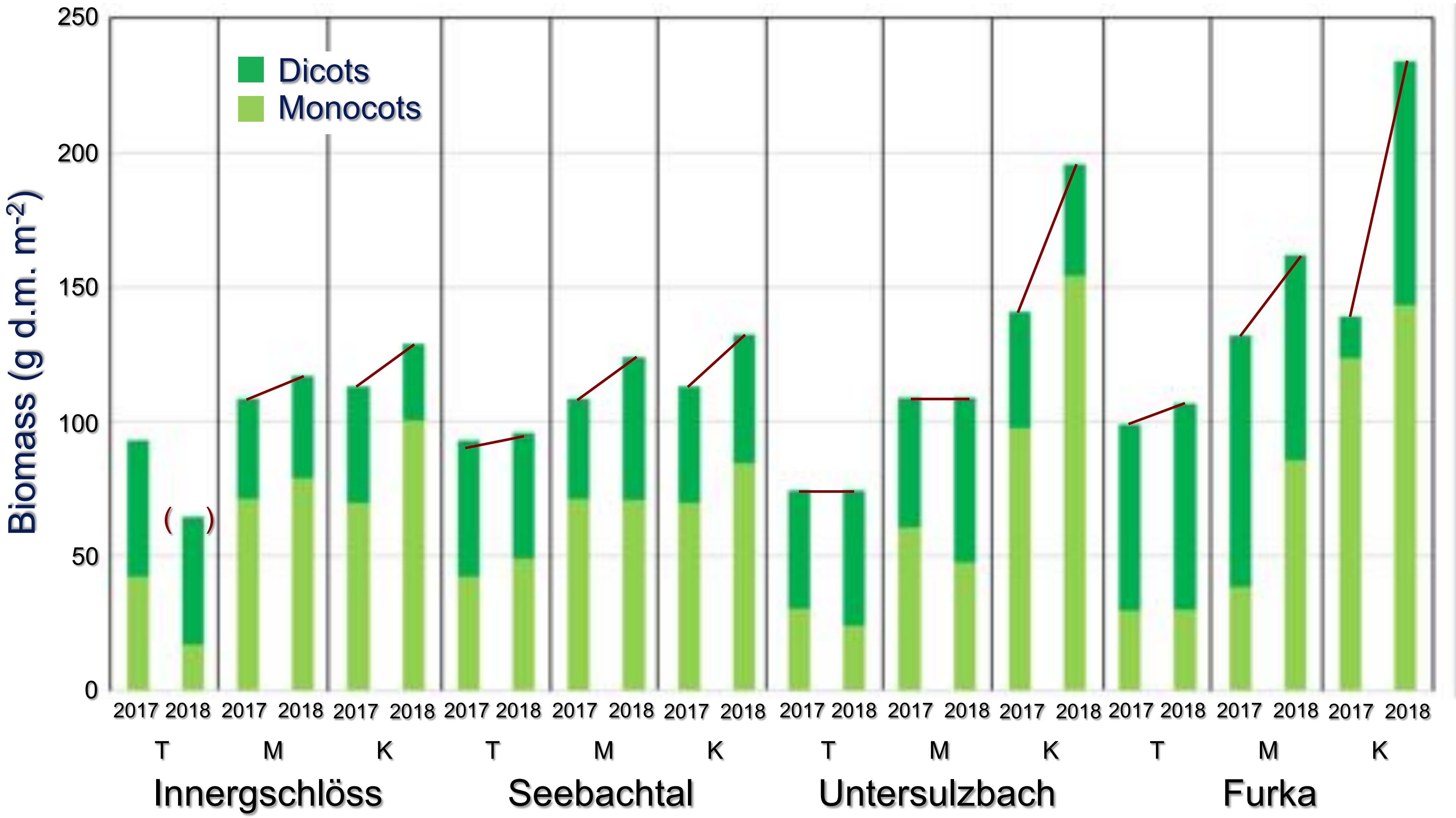
Top of transect

Bottom of transect

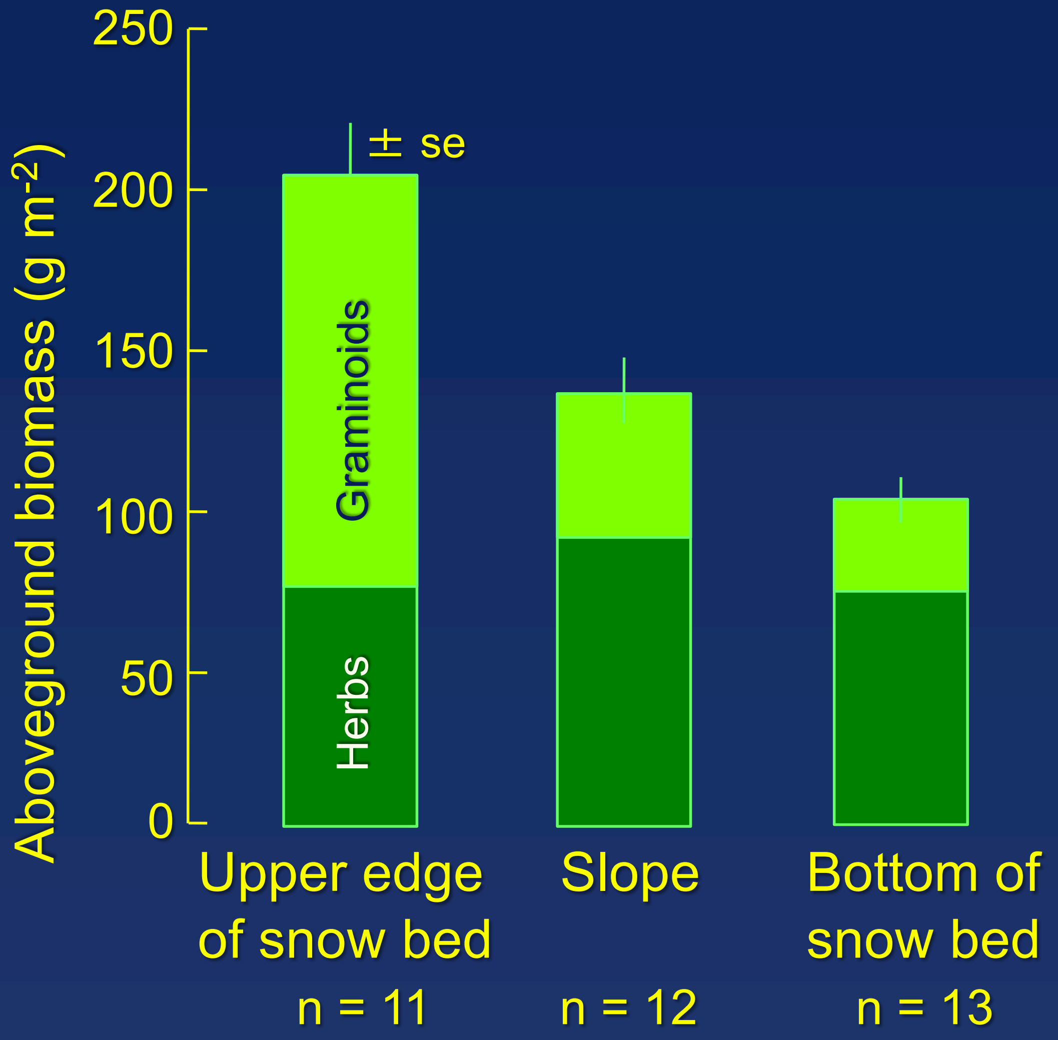
Biomass across snow melt gradient in 2018



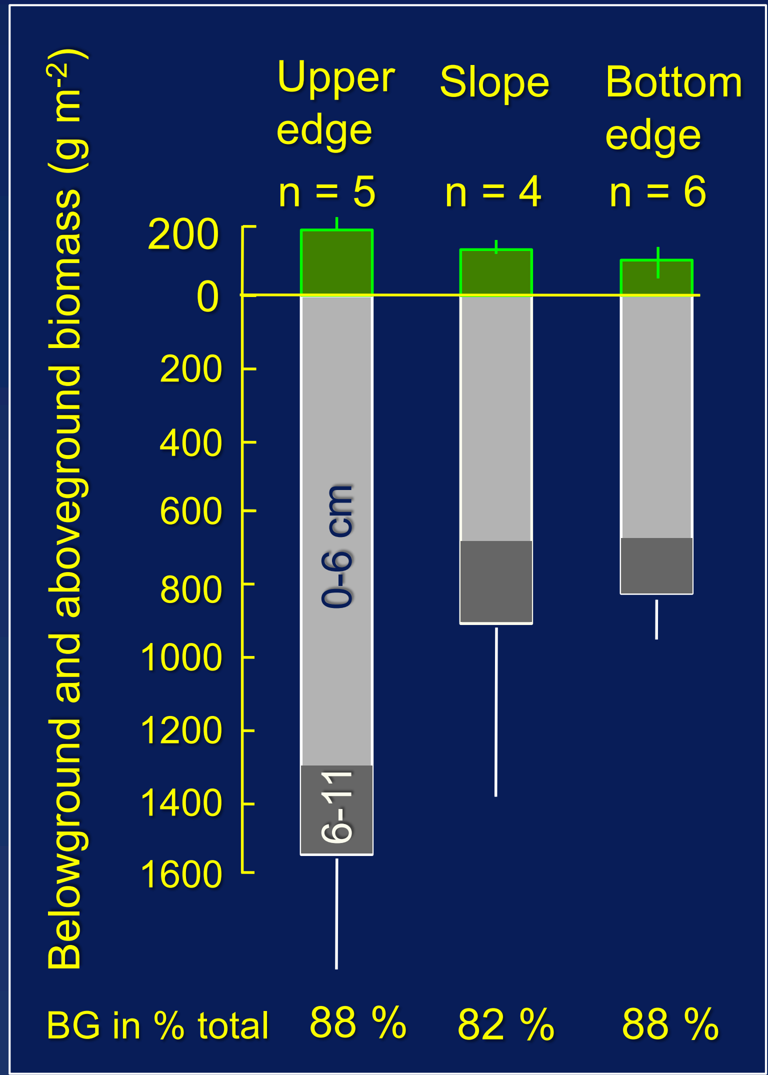
Peak season plant biomass at 2300 – 2500 m asl
Comparison between 2017 and 2018



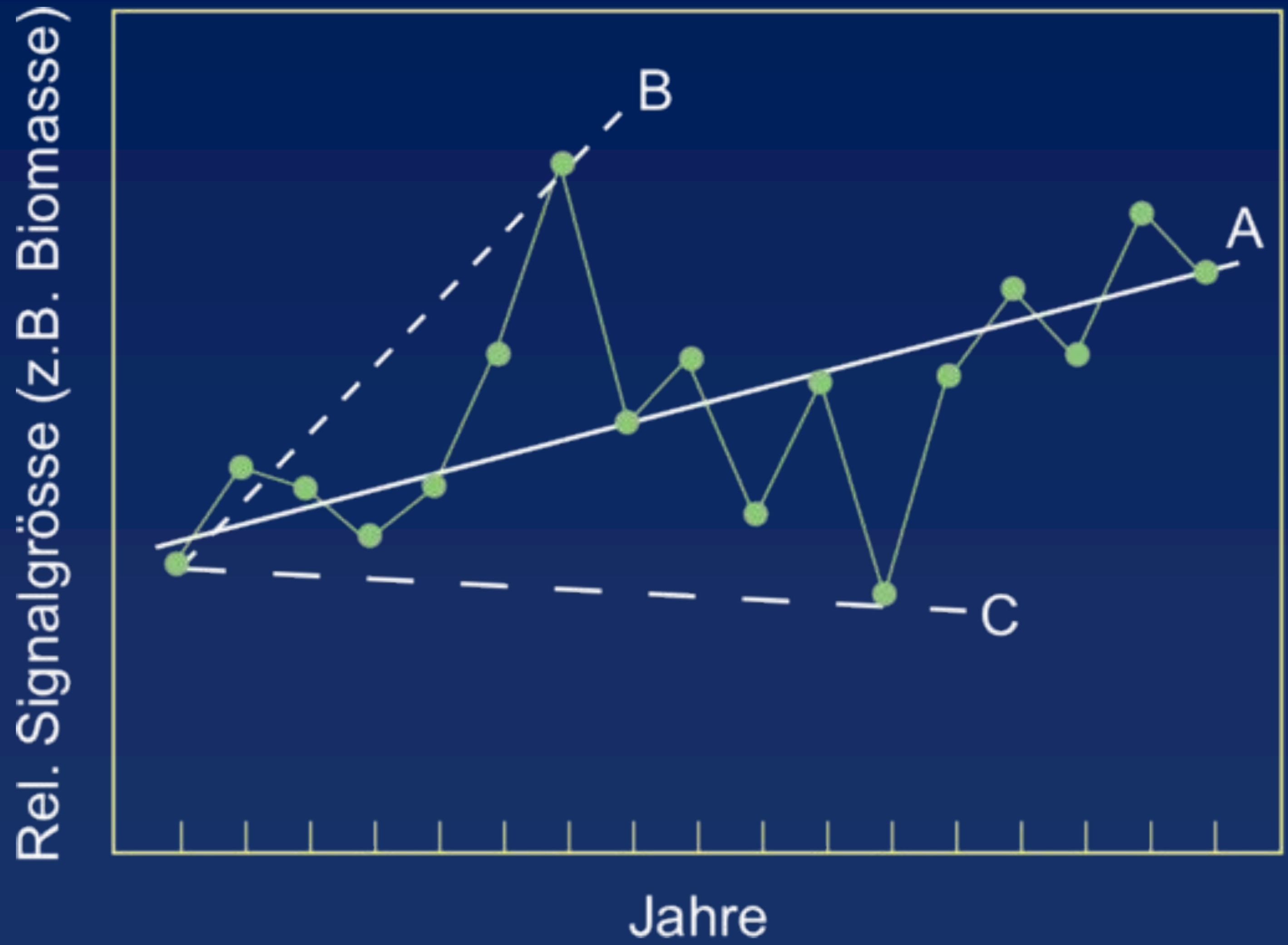
Plant biomass production along a snow-melt gradient in summer 2017, Furka-Pass, Switzerland, 2467 m a.s.l.



Gradient of snow duration

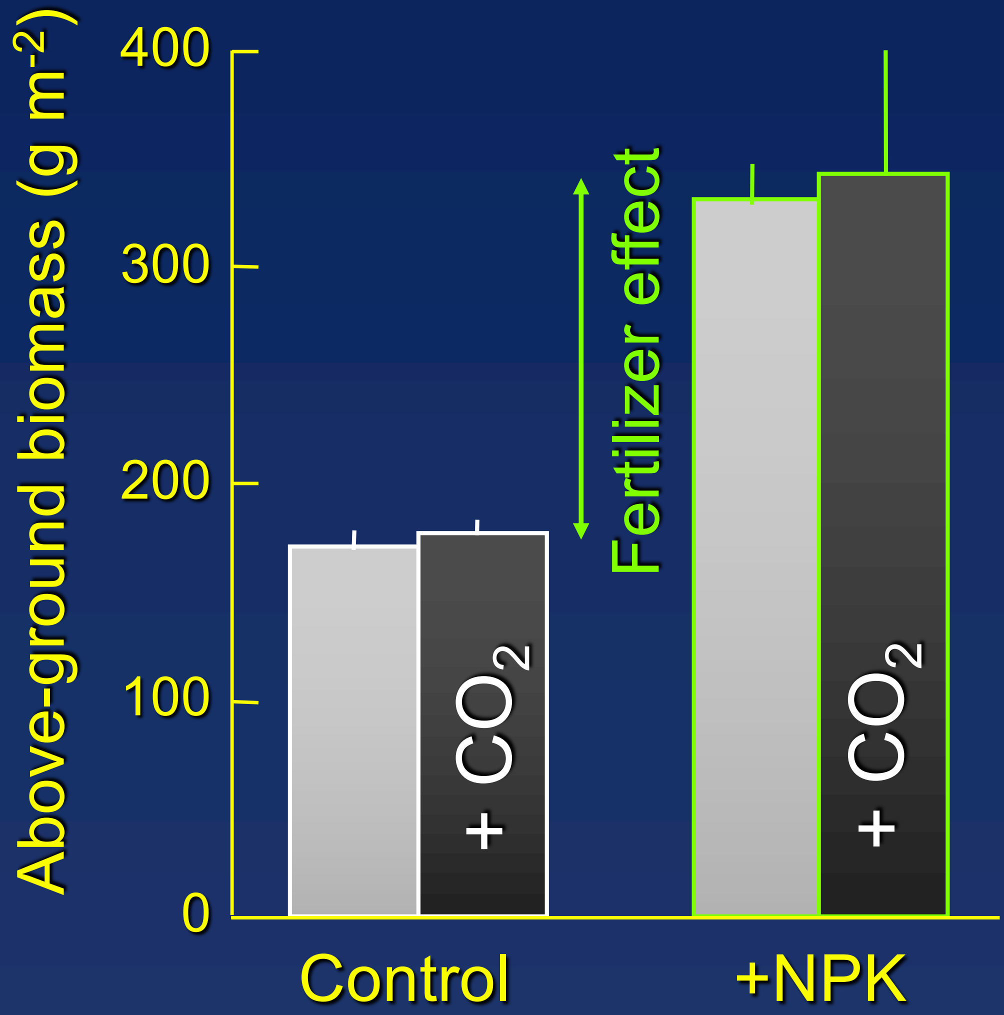


Vertical Biomass allocation along a snow melt gradient



The problem of year to year variation of productivity in long-term observations with too large census intervals. Conclusions B and C differ strongly from the trend in A.

Elevated CO_2: No growth stimulation in 4 years in alpine grassland (2500 m)



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

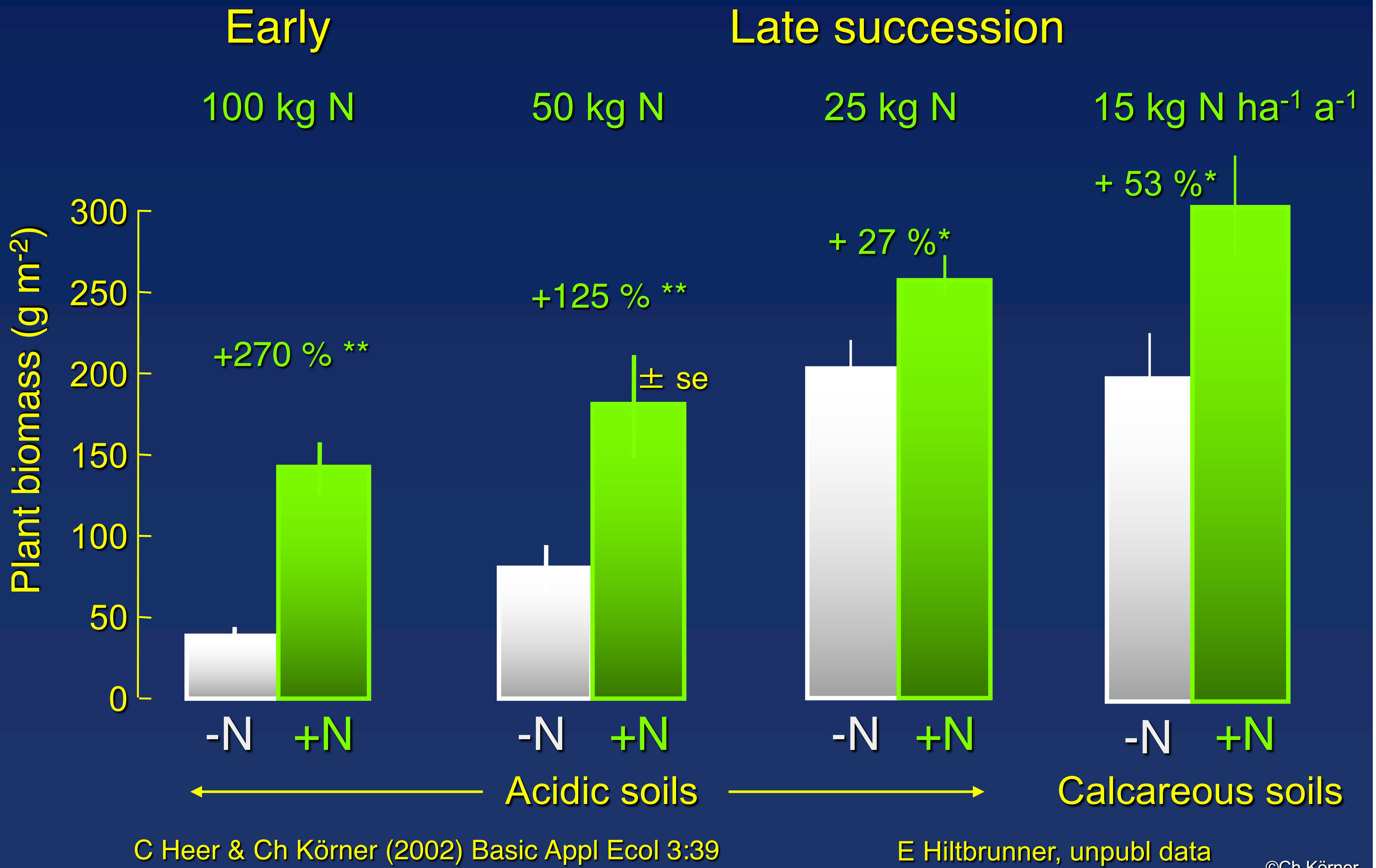
Glacier forefield plants:

No growth stimulation by eCO_2 in 3 years despite NPK-addition, some species grew even less

N Inauen *et al* (2012) GCB 18:985

The effect of N deposition on alpine plants

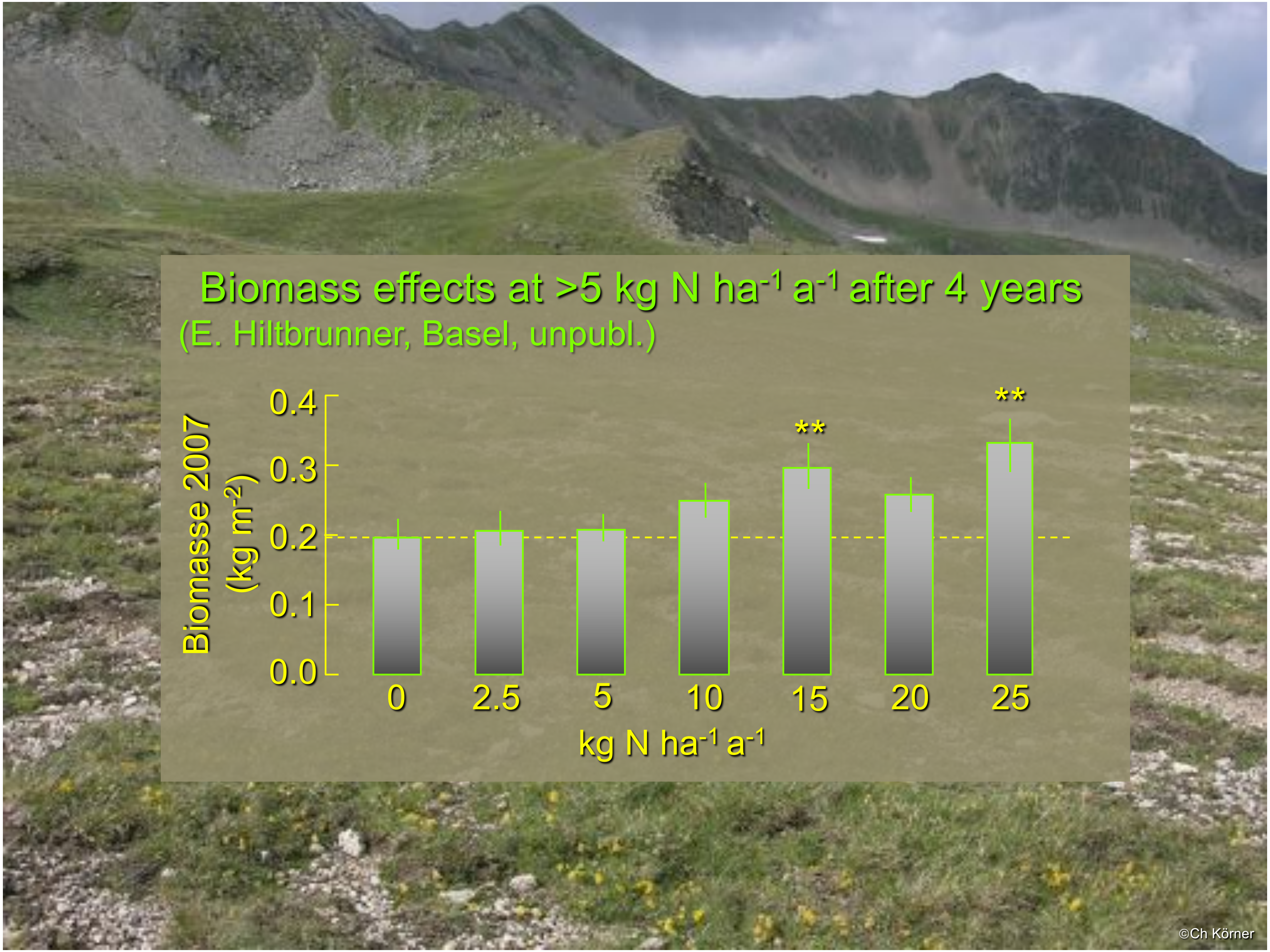
Swiss Alps, 2500 - 2600 m, critical load 5 -10 kg N ha^{-1} a^{-1}




Furka
N-Deposition, both from NW and SE (the Po-Region)
NASA

Nitrogen deposition: winners and losers

E. Hiltbrunner, Basel


Biomass effects at >5 kg N ha-1 a-1 after 4 years
(E. Hiltbrunner, Basel, unpubl.)
Biomasse 2007 (kg m-2)
0.4
0.3
0.2
0.1
0.0
**
**
0
2.5
5
10
15
20
25
kg N ha-1 a-1
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Summary

- Alpine plants, ‘engineer‘ their microclimate
- 10K contrast of seasonal mean T over few m
- Phenology x snow cover x freezing matters
- Alpine plants are not carbon limited
- N deposition is more influential than changes in mean temperature
- Most alpine plants not more ‘vulnerable‘


Alpine Plant Ecology
Summer School on Alpine Plant Life
Swiss central Alps, 12- 18 July 2020
Erika Hiltbrunner, Christian Körner, Jürg Stöcklin
University of Basel
www.alpfor.ch
Location:
ALPFOR
Alpine Research and Education Station
Furka, 2440 m a.s.l., Swiss central Alps
Registration: PhD students register at franziska.grob@unibas.ch, at MOnA (Univ. of Basel students) and PSC PhDs at PSC. Pre-registration (with motivation letter) until 28 Feb. 2020.
Acceptance information: 3 April 2020, confirmed registration: 29 May 2020.

‘Experiments‘ by nature: opportunities for basic research and conservation