

CLIMATE CHANGE: FACTS, CHALLENGES & FIRST

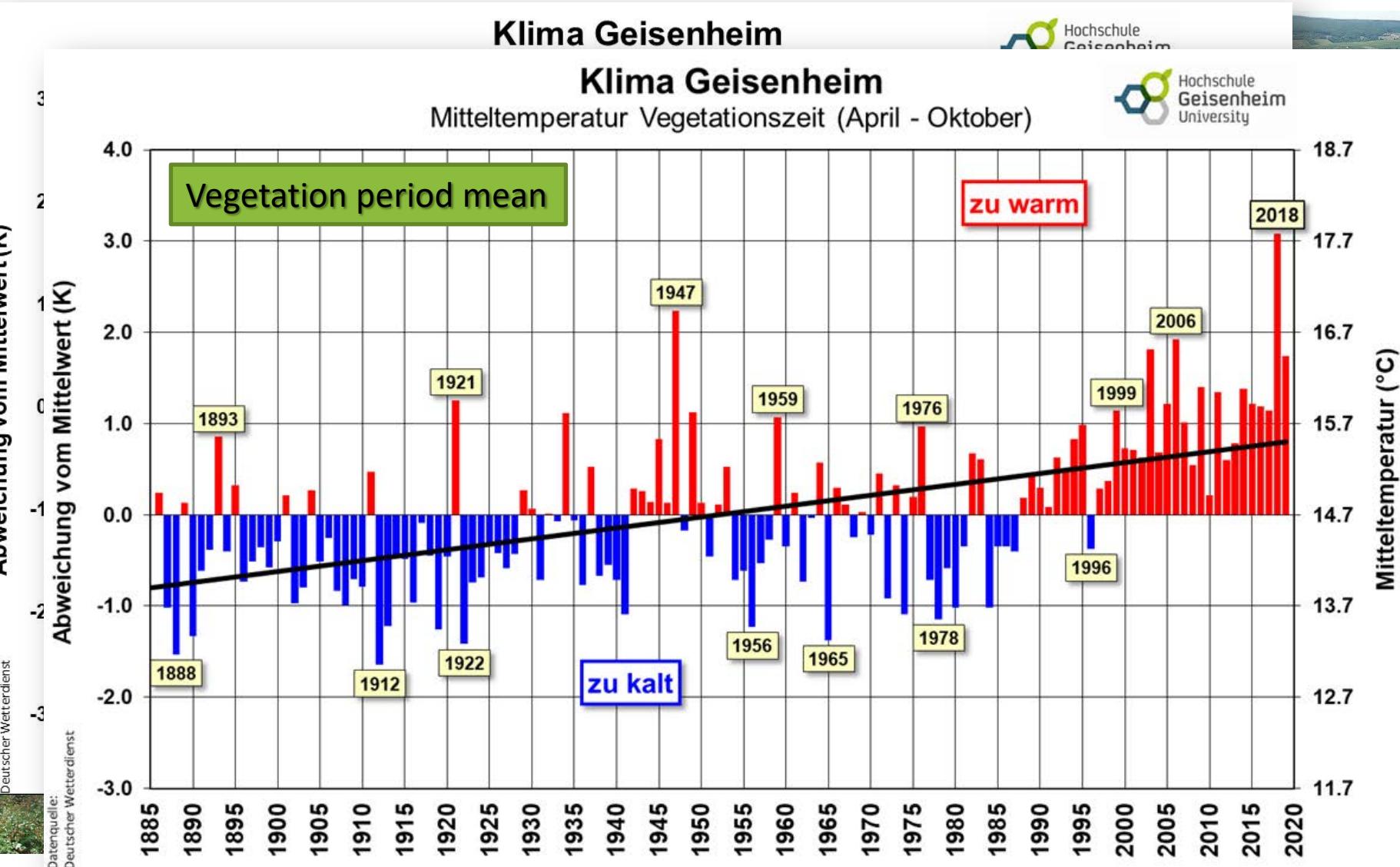
RESULTS FROM THE GEISENHEIM VINEYARD FACE

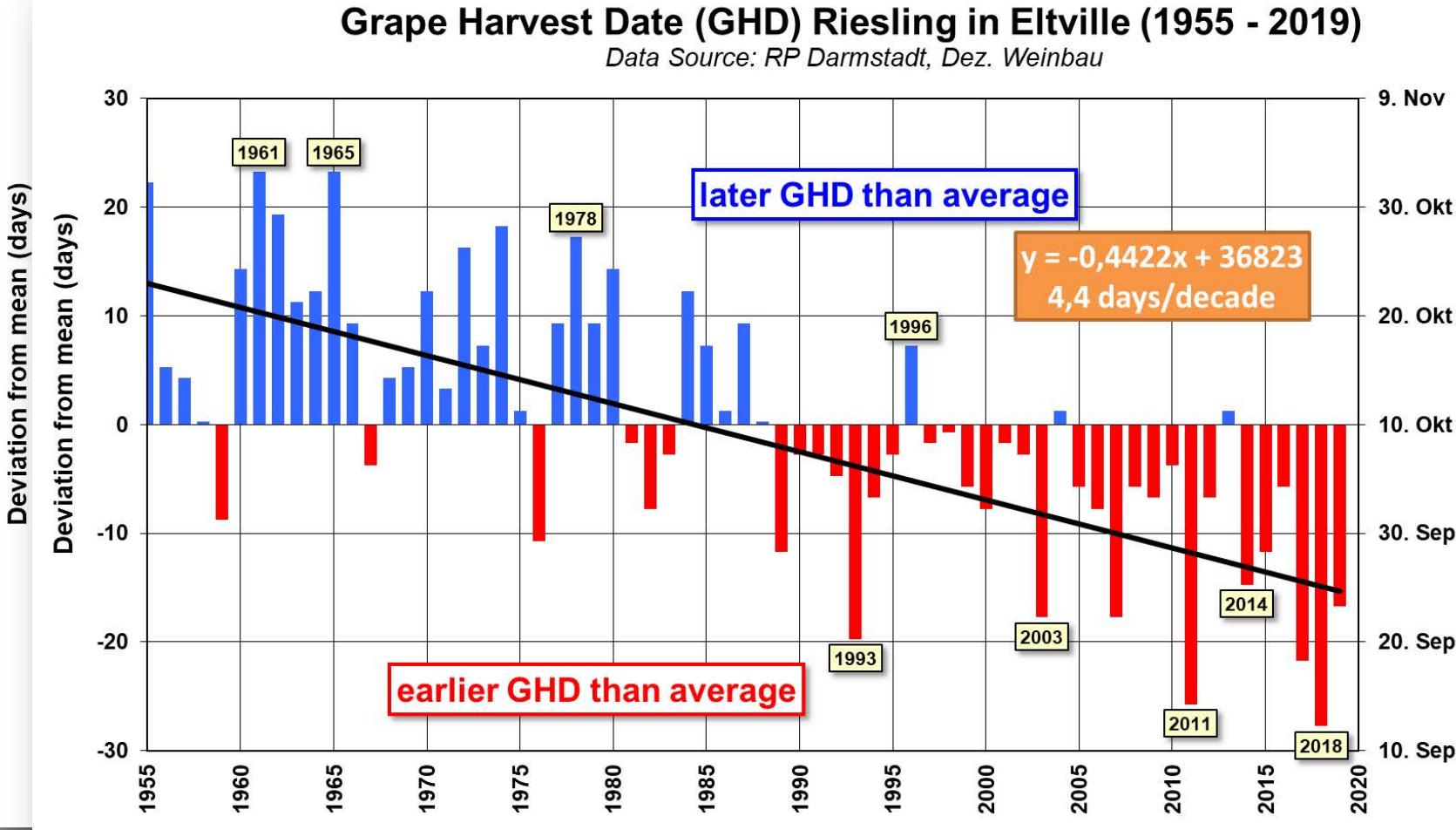
(INTO A CO₂-ENRICHED FUTUREAND BACK AGAIN?)

ProWein Summit, 21. November 2019, Geisenheim University



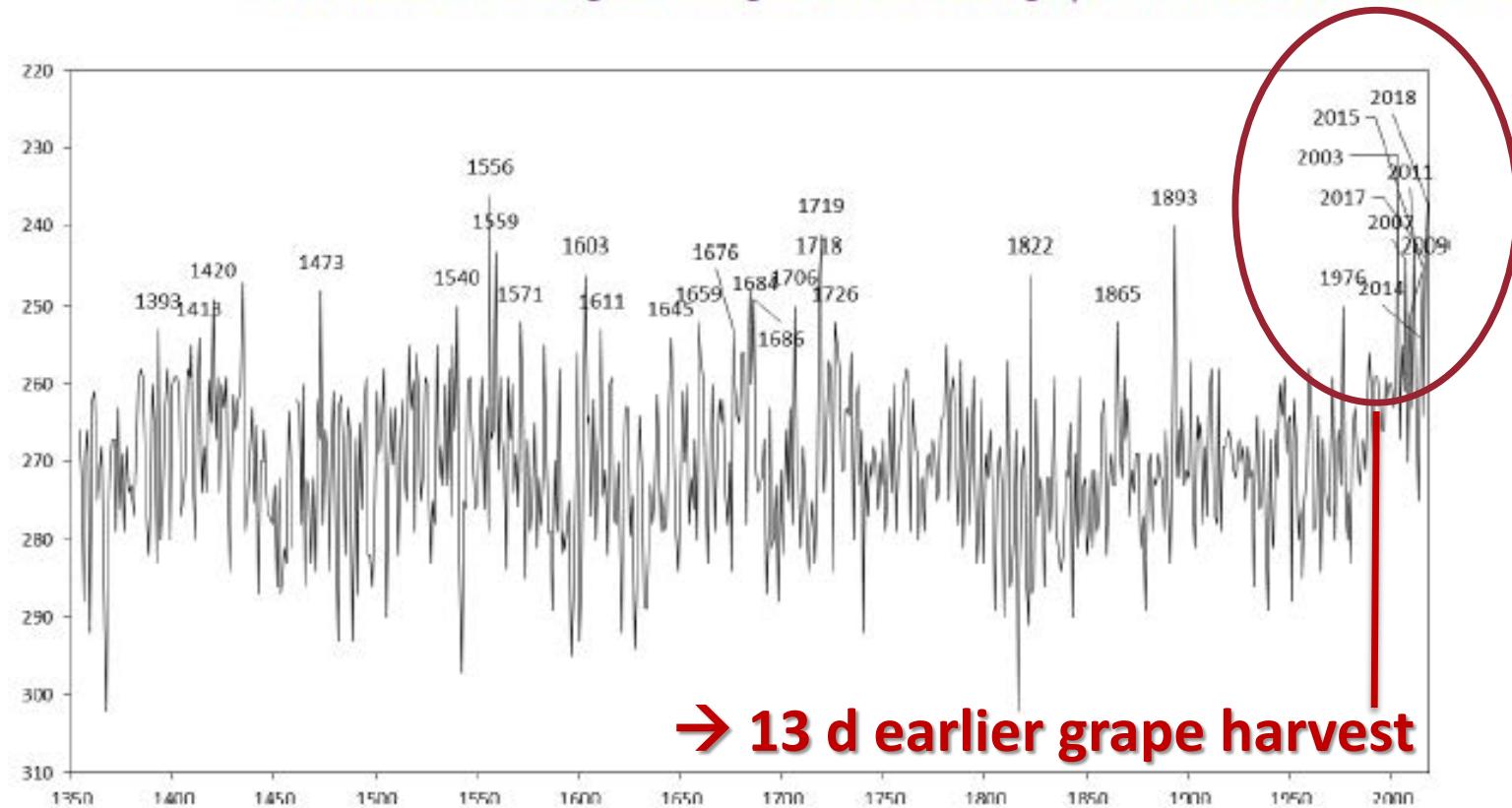
*Claudia Kammann, Department of Applied Ecology, Hochschule Geisenheim University
(Contributions/Projects: Yvette Wohlfahrt, Susanne Tittmann, Jason Smith, Manfred Stoll, Annette Reineke, Moustafa Selim, Otmar Löhnertz, Daniel Papsdorf, Ilona Leyer)*





1496

T. Labb  et al.: The longest homogeneous series of grape harvest dates, Beaune 1354–2018



Earliest 5% of all GHDs:

- 1354 – 1719: 21 cases = every 17,4 years
- 1720 – 1987: 4 cases = every 66,8 years
- 1988 – 2018: 8 cases = every 3,8 years

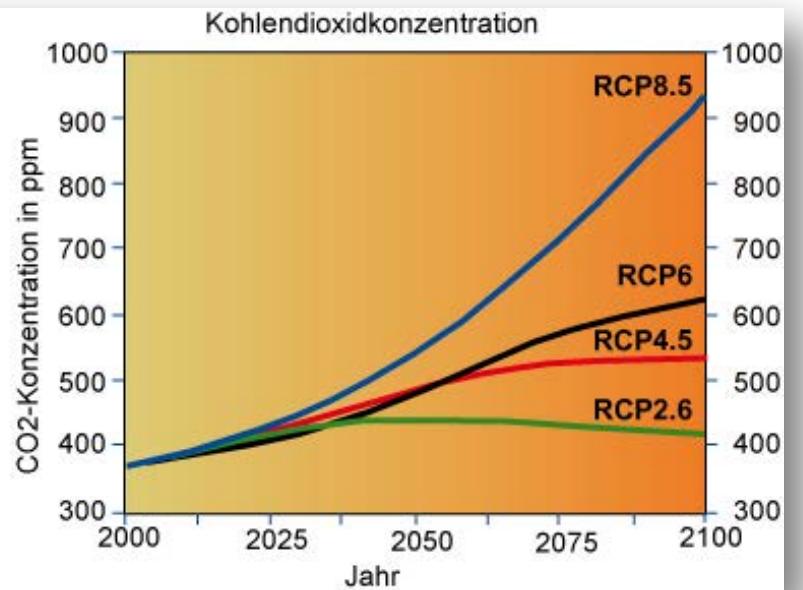
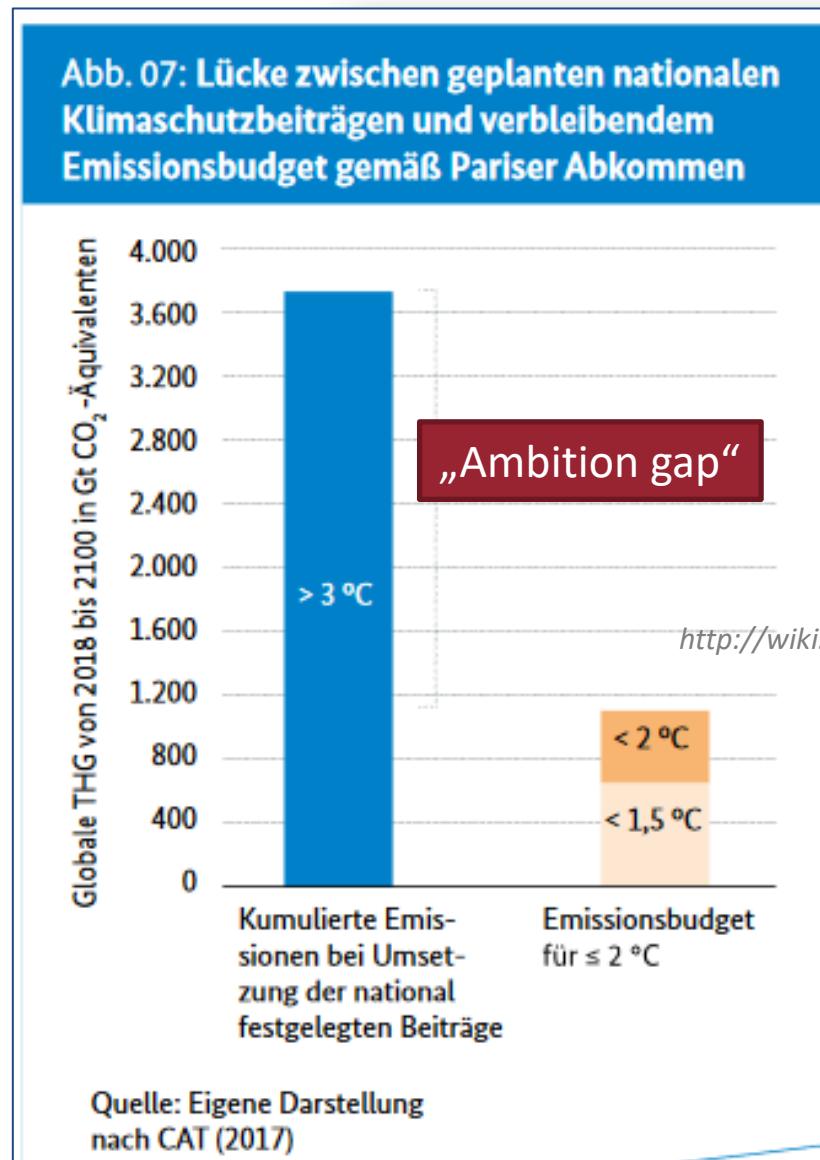
Since 2003: 8 out of 16 years
were within the 5% earliest
GHD (every 2nd year)

KNOWN EFFECTS OF CLIMATE CHANGE: THE PHENOLOGICAL CLOCK



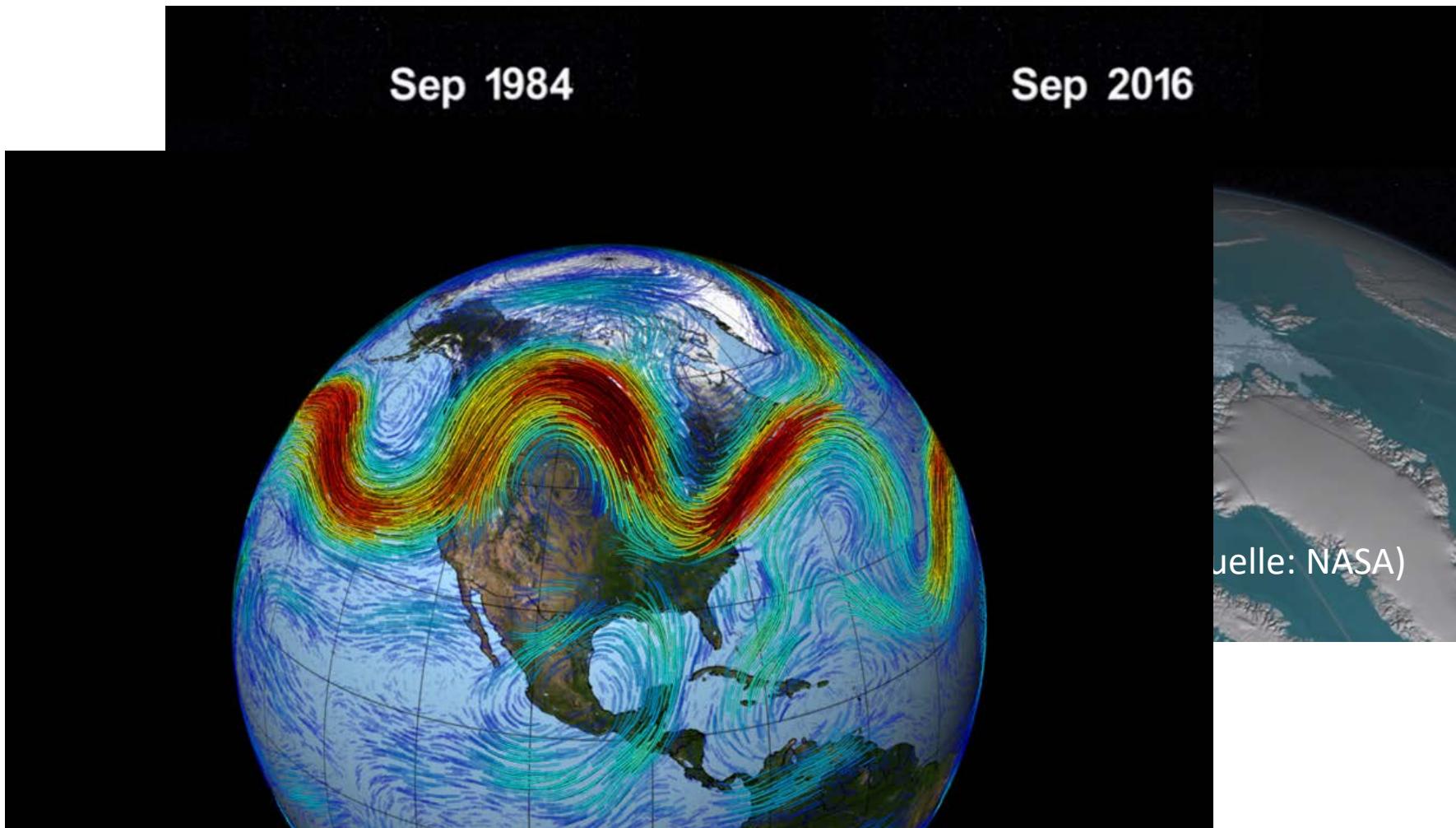
Climate trends

- Winters milder, more precipitation
- N mineralisation in winter
- Dormancy shorter
- Earlier leaf emergence: frost danger
- Accelerated development with $T \uparrow$ (Plant+Pest)
- Kind of new: „sunburn“



NDCs: it's not enough!!

MECHANISMS OF CLIMATE CHANGE ON WEATHER PATTERNS: CHANGE IS UNDERWAY



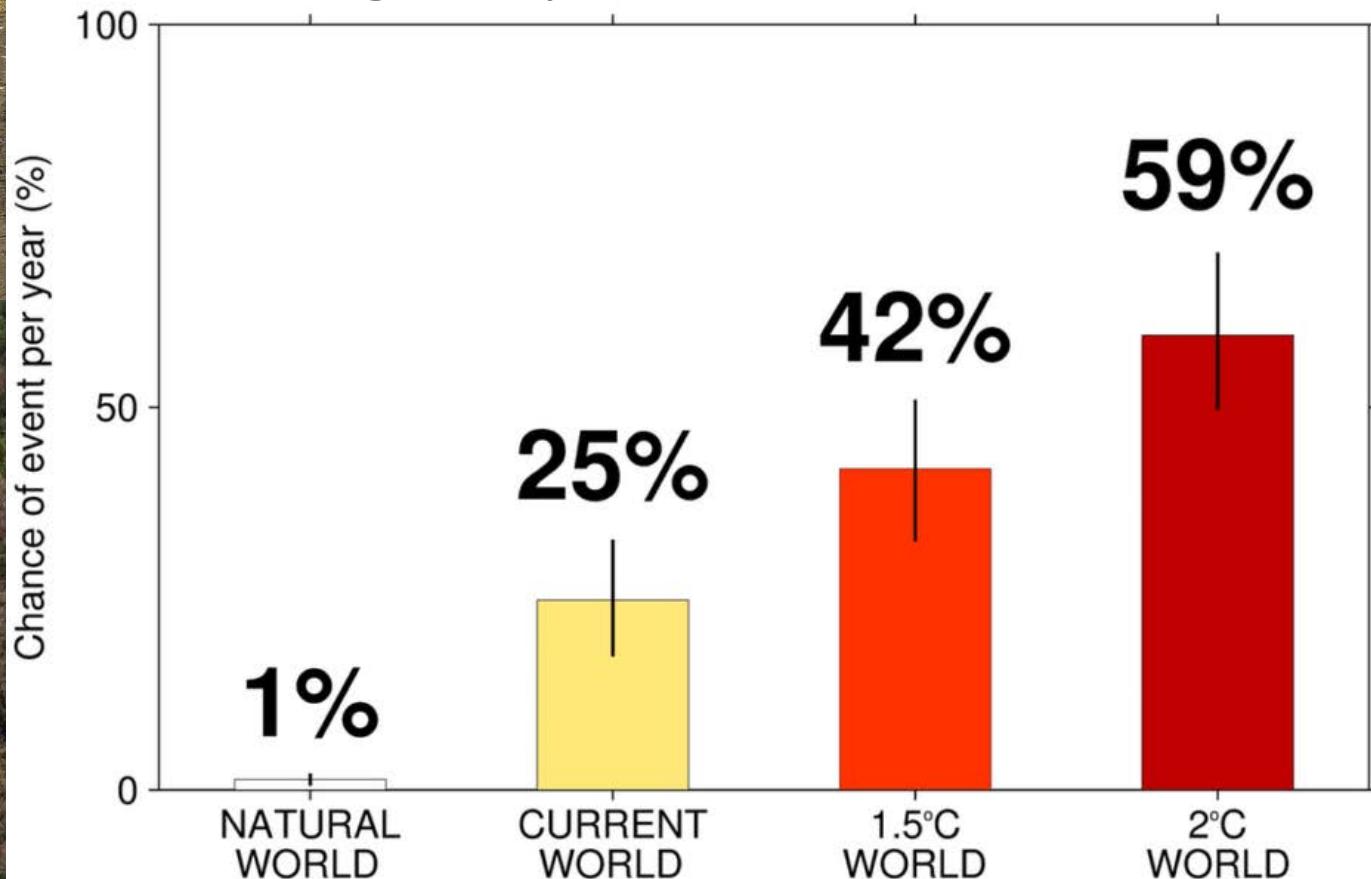
Visualisation of the polar Jetstream:

<https://svs.gsfc.nasa.gov/10902>

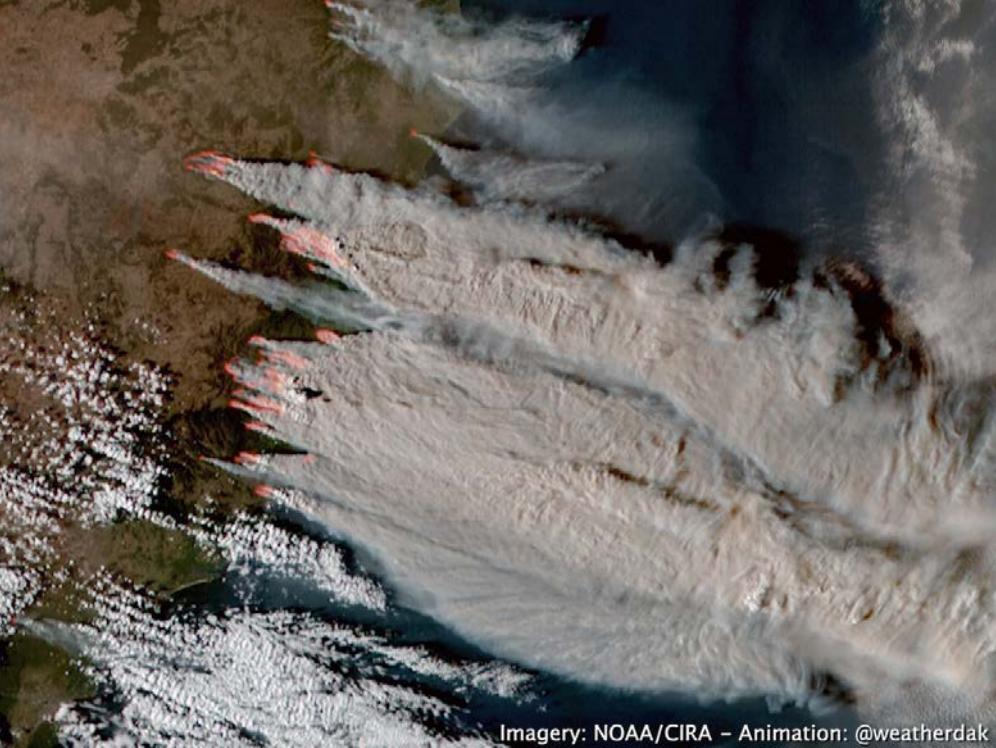
„SUMMERS LIKE 2018 HAVE ARRIVED TO STAY....“

Central European hot summers like 2003 under global warming

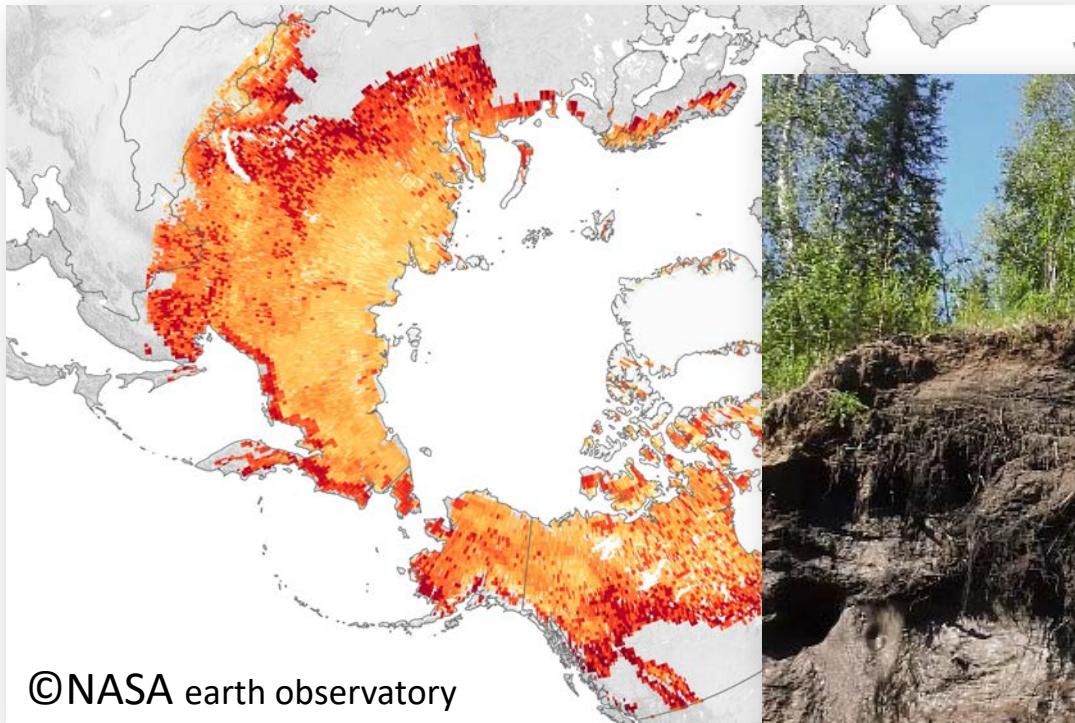
Aus: King & Karoly 2017, Environmental Research Letters



HITZEWELLE & BRÄNDE IN AUSTRALIEN



TAUENDER PERMAFROST: WINTER-CO₂-EMISSIONEN > SOMMER-C-FIXIERUNG



Natali et al. 2019
(Nature Climate Change)



Permafrostböden: C-Senke wird zur C-Quelle – im Winter mehr CO₂-Freisetzung als im Sommer C-Fixierung

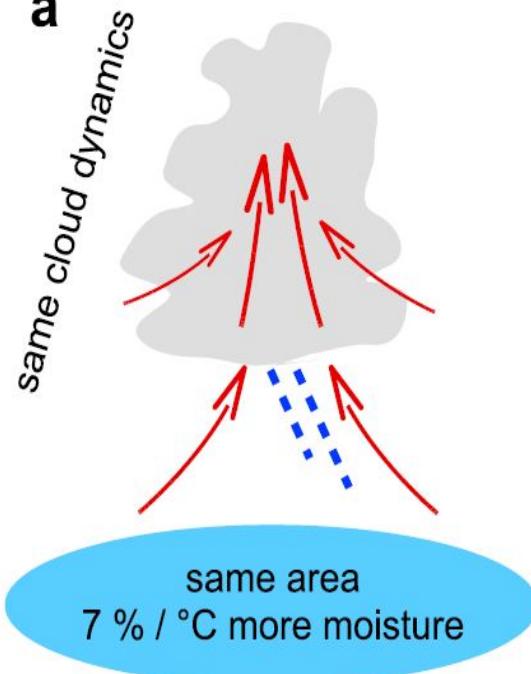
<https://earthobservatory.nasa.gov/images/145880/permafrost-becoming-a-carbon-source-instead-of-a-sink?src=eoaeiotd>

HEAVY PRECIPITATION – WHY EXTREME EVENTS INCREASE IN FEROCITY

Heavy precipitation – three cases:

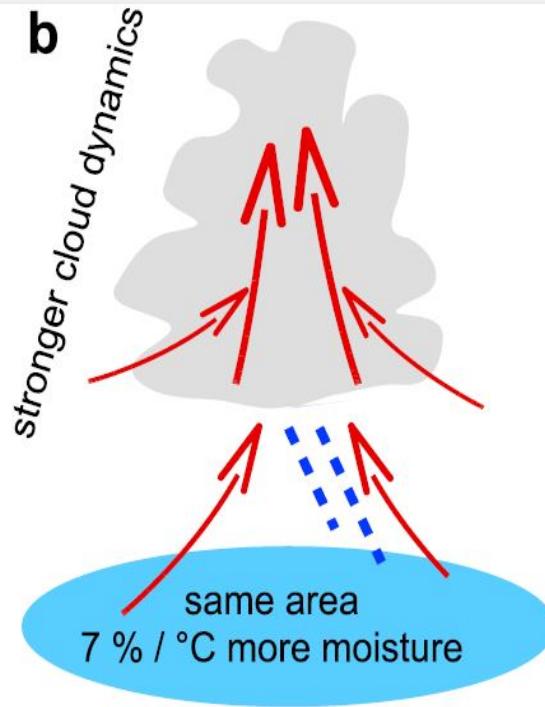
Increase (in tendency) with warming (not everywhere, not in every season).

a



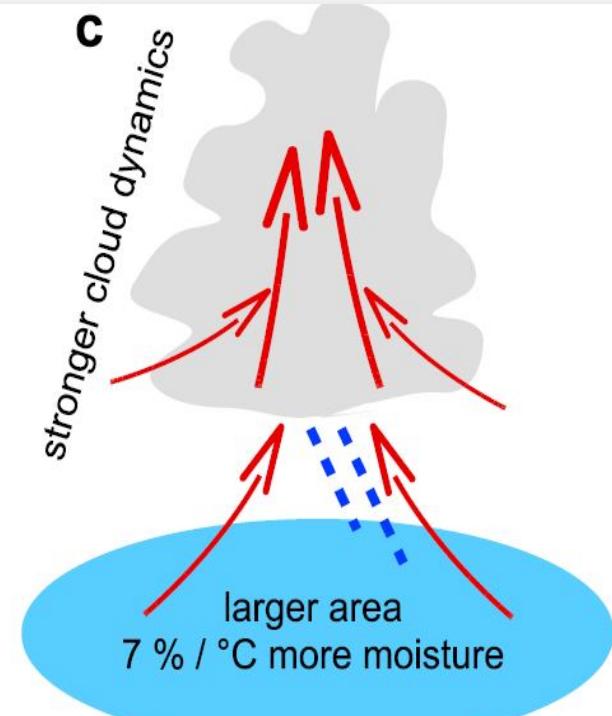
+7% per 1°C increase

b



+7%, shorter time

c



>7%, larger collection area

Quelle: Westra et al., Reviews of Geophysics 2014. Mit freundlicher Genehmigung des Bildautors Geert Lenderink.

Text und Graphik entnommen: https://scilogs.spektrum.de/klimalounge/wp-content/blogs.dir/204/files/Lehmann_2015.jpg

Autor Dr. Stefan Rahmstorf, PIK Potsdam

HEAVY PRECIPITATION INCREASES ALREADY....



ATTRIBUTION SCIENCES – HOW MUCH „CLIMATE CHANGE“ IS THERE IN EXTREME WEATHER EVENTS?



Quelle: Spiegel



Quelle: Deutschlandfunk

**Prof. Dr. Friederike Otto, Physics,
Klimatology, PhD Philosophy; Head of the
Environmental Change Institute of the
University of Oxford**

Founder of the new field of research

Attribution Science: „How much Climate Change...“ → Attributing costs and responsibilities for extreme weather events

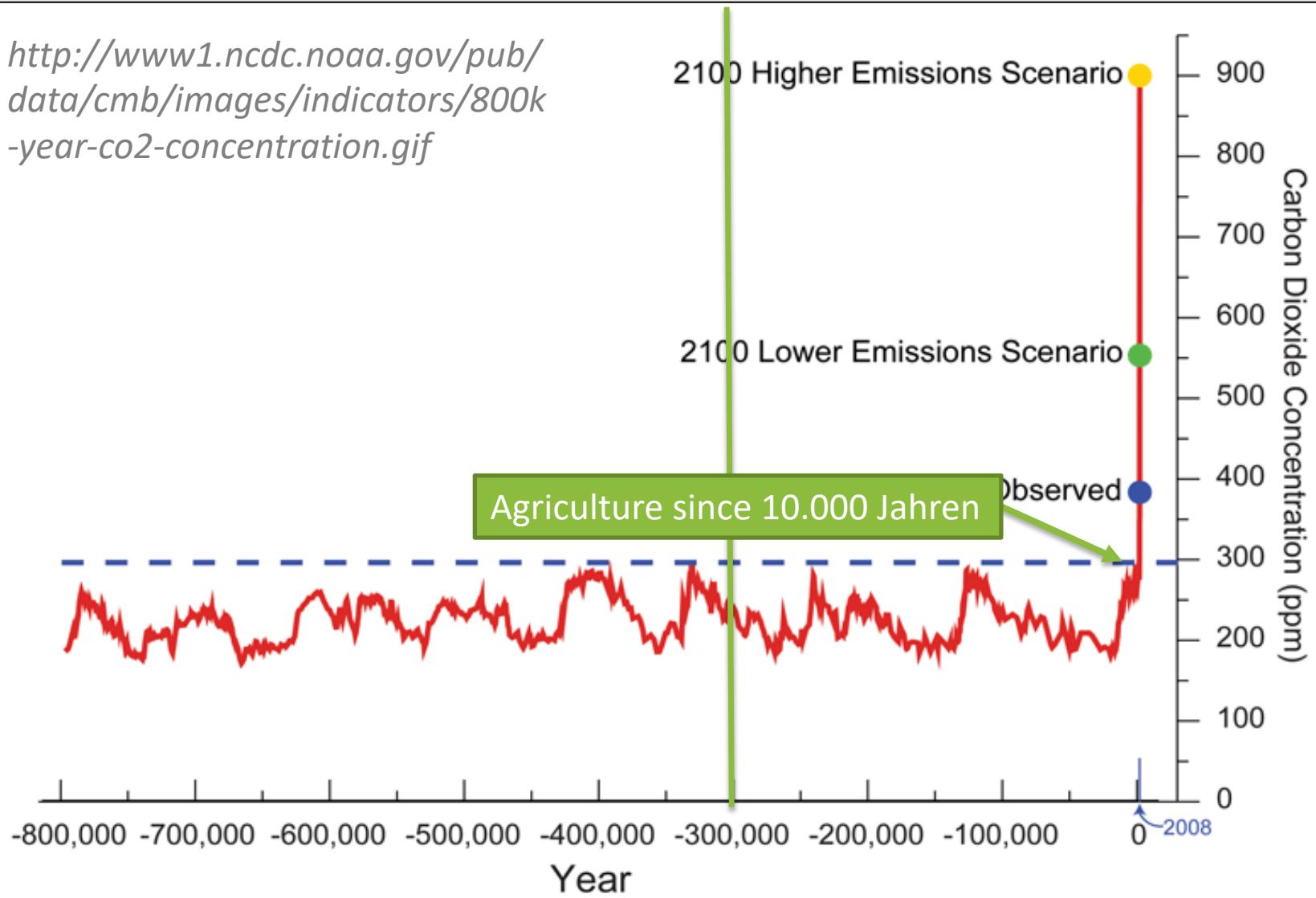
Recourse claims...? Munich-Re!

VITICULTURE IN CALIFORNIA: A HOT TOPIC? (EXTENSION OF THE FIRE SEASON WELL INTO DECEMBER)



A SHORT HISTORY OF ATMOSPHERIC CO₂

[http://www1.ncdc.noaa.gov/pub/
data/cmb/images/indicators/800k
-year-co2-concentration.gif](http://www1.ncdc.noaa.gov/pub/data/cmb/images/indicators/800k-year-co2-concentration.gif)



What does eCO₂ do, usually....?

The CO₂-fertilizing effect under optimal conditions!

17 years in foil greenhouses (+/- 300 ppmv), drip irrigation, + nutrient solution
 Start 1987 (S.B. Idso & B. Kimball)

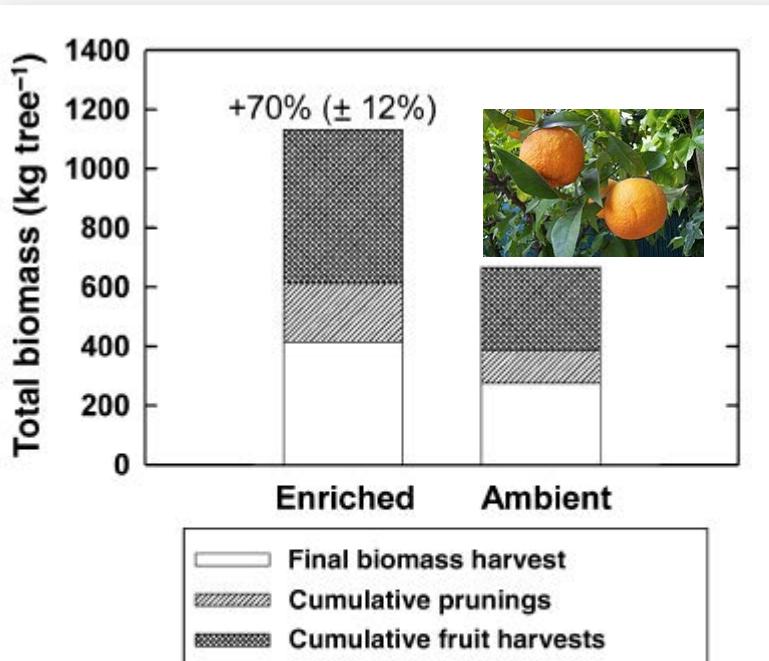


Fig. 3 Total biomass produced over the 17 years by the sour orange trees at enriched and ambient levels of CO₂ from cumulative fruit harvests, cumulative prunings, and the final biomass harvest.

Kimball et al. (2007) *Global Change Biology*



Adam et al. (2004) *New Phytology*

CO₂-fertilizing effect and crop quality changes

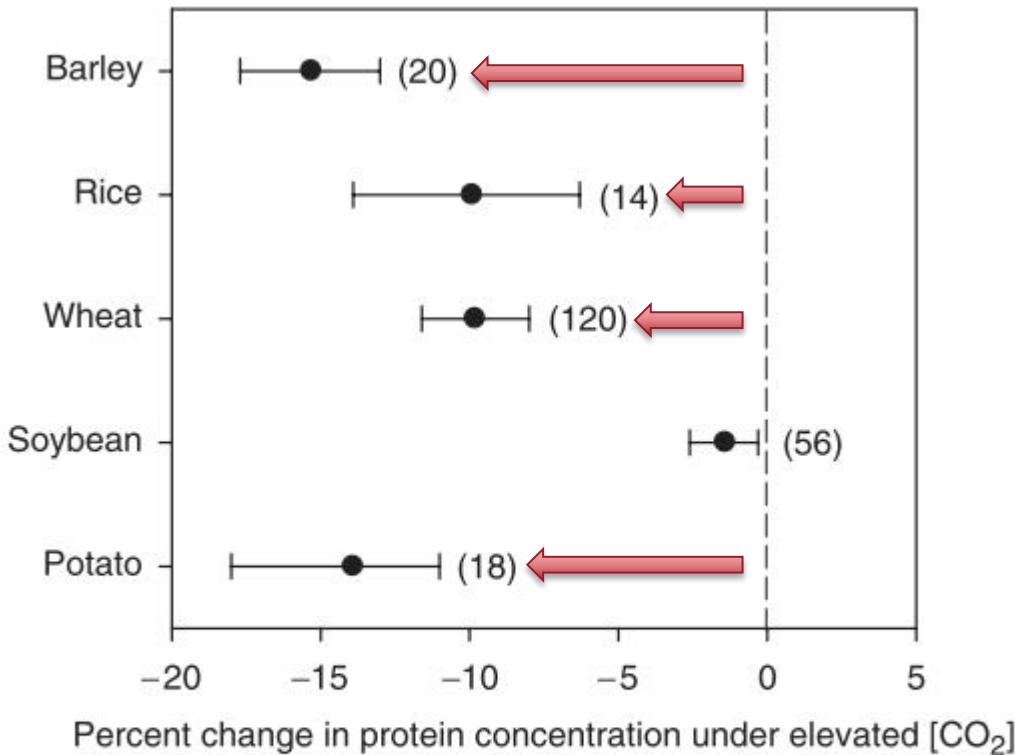


Fig. 1 Response of crop protein concentrations to growth at elevated CO₂ for five major crops. Means and 95% confidence limits are depicted. Numbers of experimental observations for each species are in parentheses.

Meta-Analysis: Taub et al. 2008, *Global Change Biology*

SET-UP VINYARD FACE GEISENHEIM

Six ring systems ($\varnothing 12\text{ m}$), n=3 per CO₂ level

aCO₂ – ambient CO₂ 400 ppm

eCO₂ – elevated CO₂ +20 % (480 ppm)

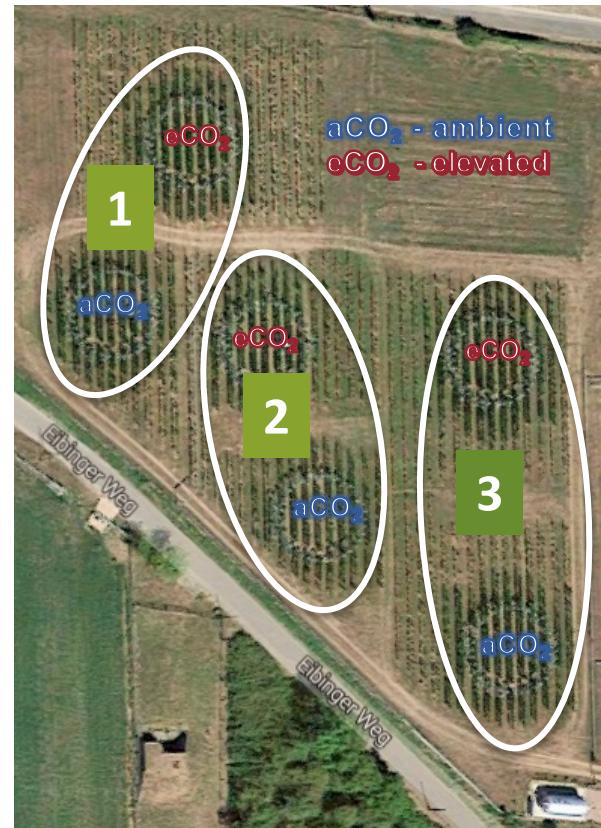
Cultivars: **Riesling Kl. 198-30 Gm, SO4**

Cabernet Sauvignon, 161-49

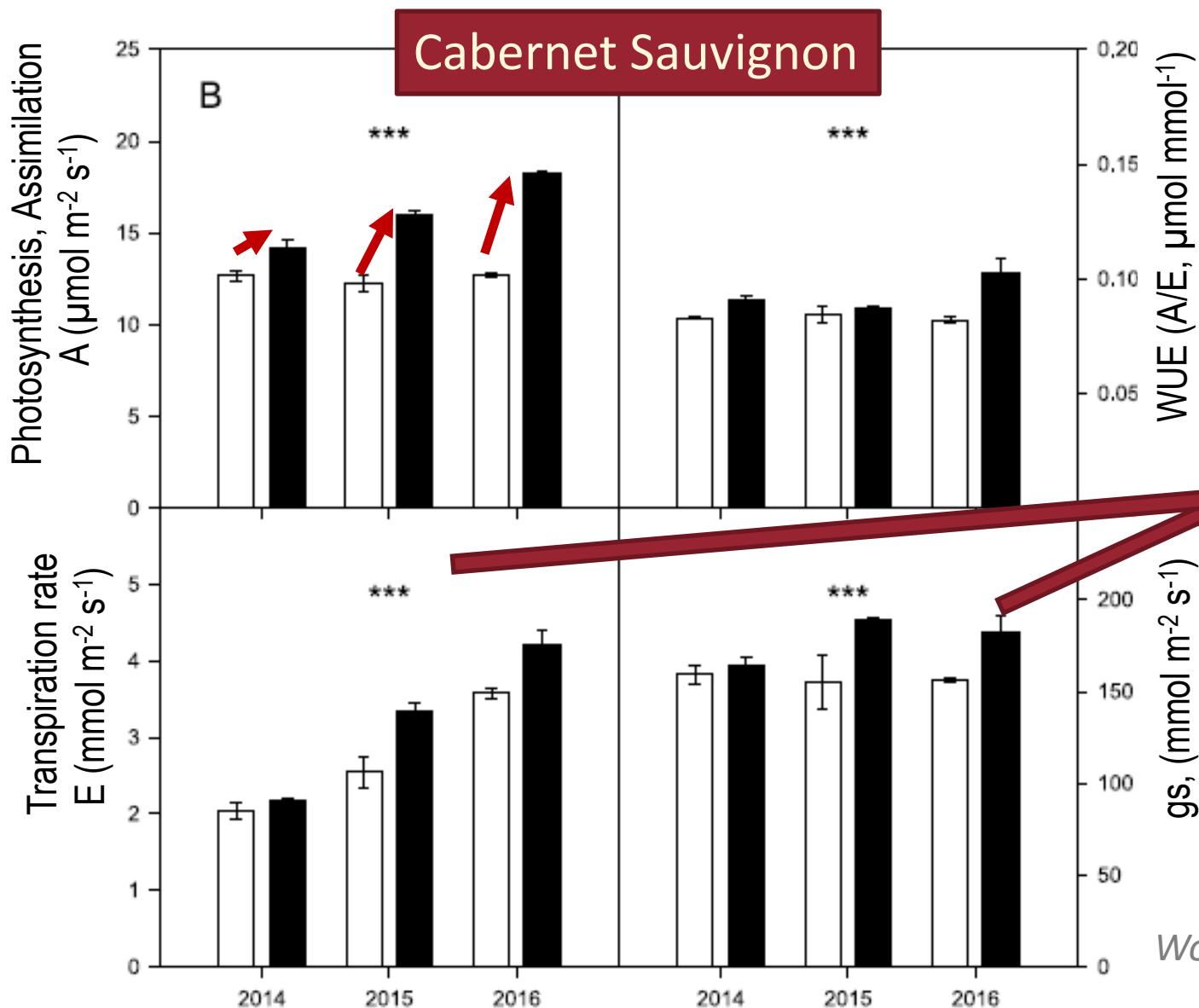
Planting: 2012; First vintage year: 2013

Planting density: 1.80 m x 0.9 m / 1.60 m² per vine

Pruning to: 5 buds/m²



Increased assimilation rate, but also higher transpiration / stomatal conductivity



Our FACE grape-vines didn't read the textbook!



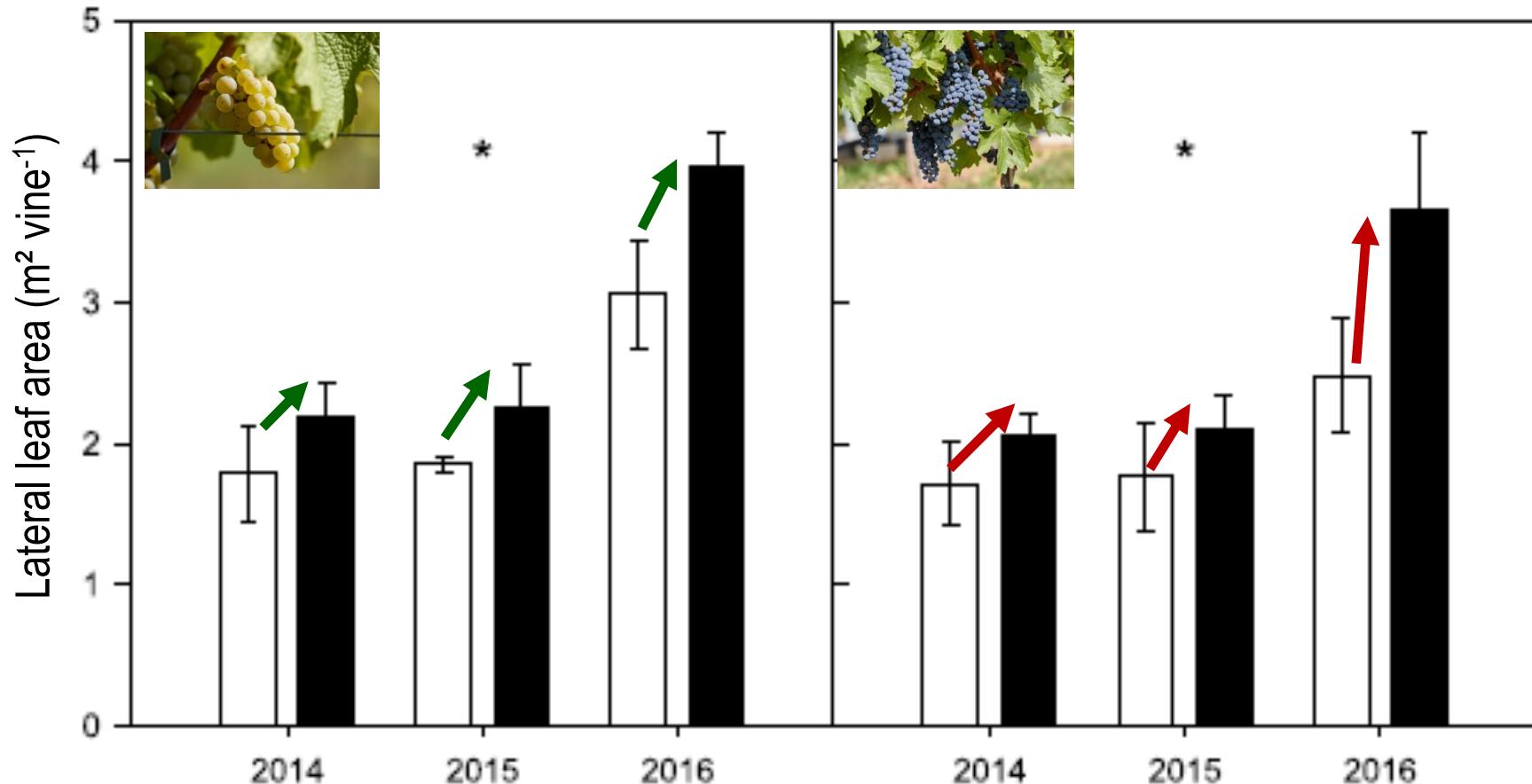
Wohlfahrt et al., 2018

Lateral leaf area: More biomass production

- pruning biomass not (so) significantly higher



Wohlfahrt et al., 2018



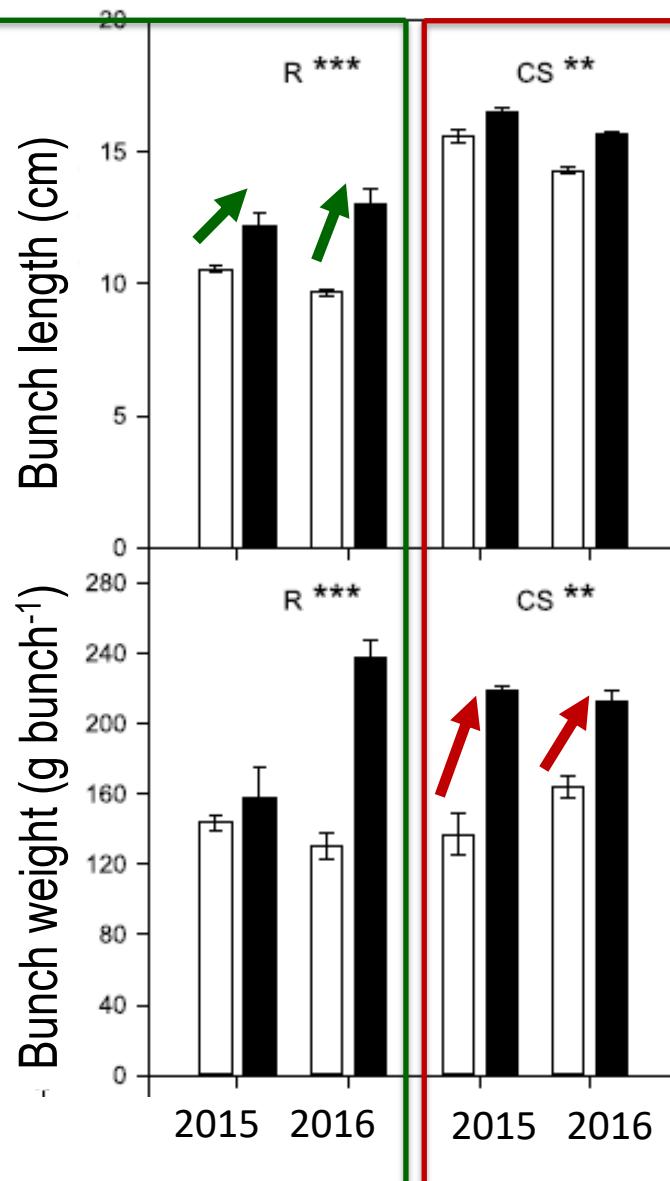
Changed bunch morphology, increased grape & sugar yields (but not concentration!)



No change in
bunch
number/vine

Riesling
Increase in
berry numbers
per bunch

Cabernet Sauv.
No change



Wohlfahrt et al., 2018

Grape yield increase (excl. *B. cinerea*)
Riesling

2015: 10.4% (9.0%)
2016: 17.8% (15.3%)

Cabernet Sauvignon:

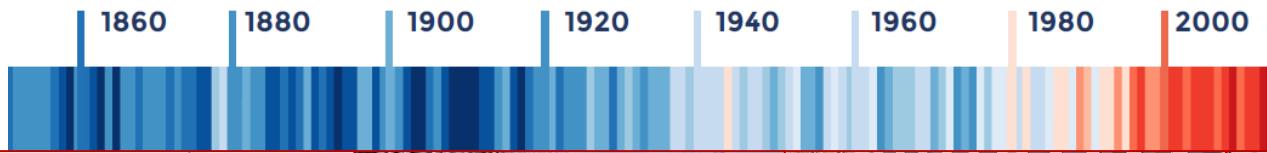
2015: 17.3% (16.9%)
2016: 10.1% (10.1%)

*...Sugar concentration was
unchanged*

→ *Increased sugar yield per ha*

Summary: Global warming....

-*is well underway*
-*is not going away, it is not going to stop*
- ...*is not just a leap to a „new (steady) climate“*
-*changes will accelerate*
- *We HAVE to adapt – not just production systems*
- *More importantly: We have to MITIGATE (...yesterday)!*
- *Reduce your CO₂ footprint, Go sustainable, Support Biodiversity and let's TALK ABOUT IT – Let's SELL IT!!!!*



Thanks for your attention – Questions?

