# Issues to be considered for strategic adaptation to climate evolution


Hans R. Schultz Hochschule Geisenheim University

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1. Where is the water going?
2. Variability and continuity
3. soils: the unknown half

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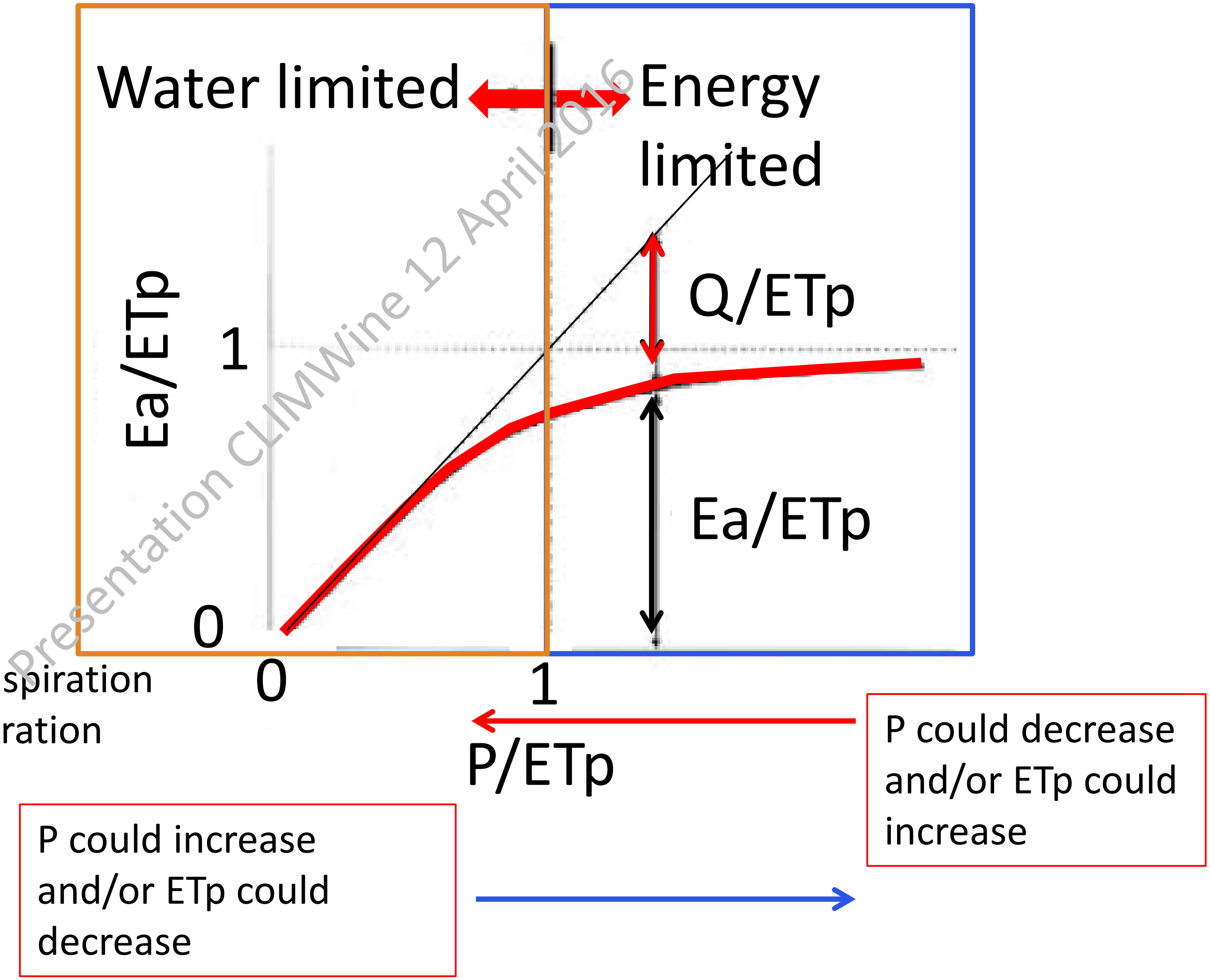
1. Is it really getting dryer?
2. The question of precipitation and evaporation (theory and facts)

summer winter

# The Budyko curve

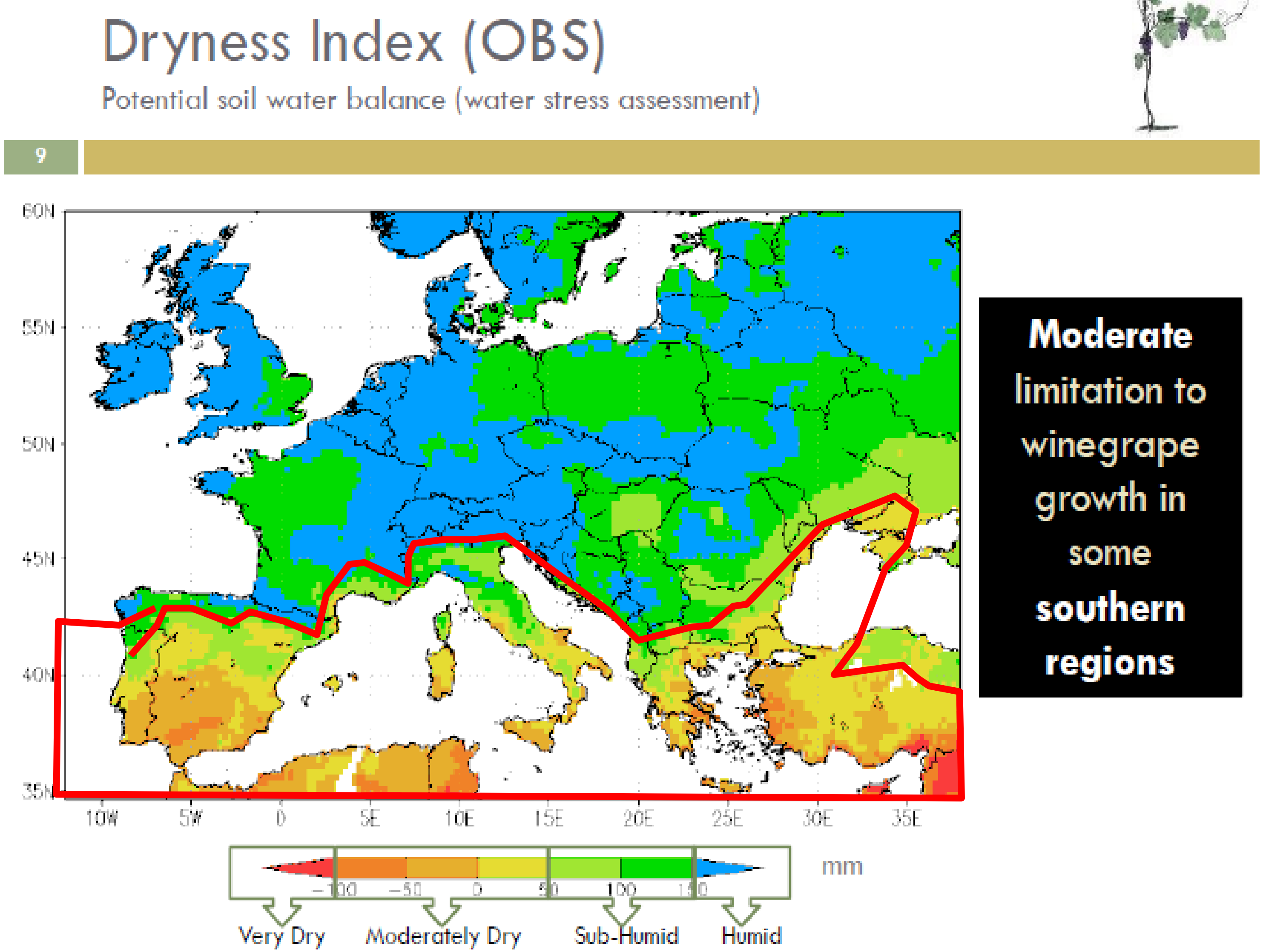





P = precipitation,
ETp = potential evapotranspiration
Ea = actual evapotranspiration
Q = runoff

Adapted from Farquhar and Roderick (2007) Water and the environment, Pontifical Academy of Science, Scripta Varia, Vatican City

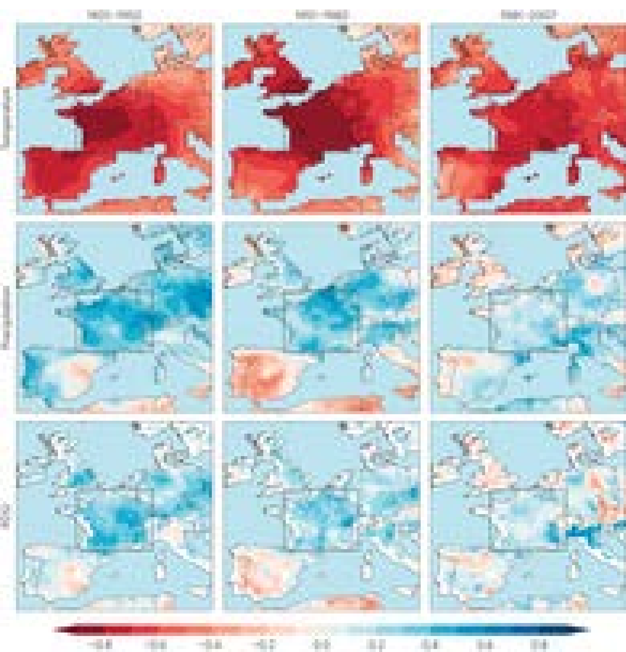
# Dryness indices are only rough indicators of current and past vulnerability

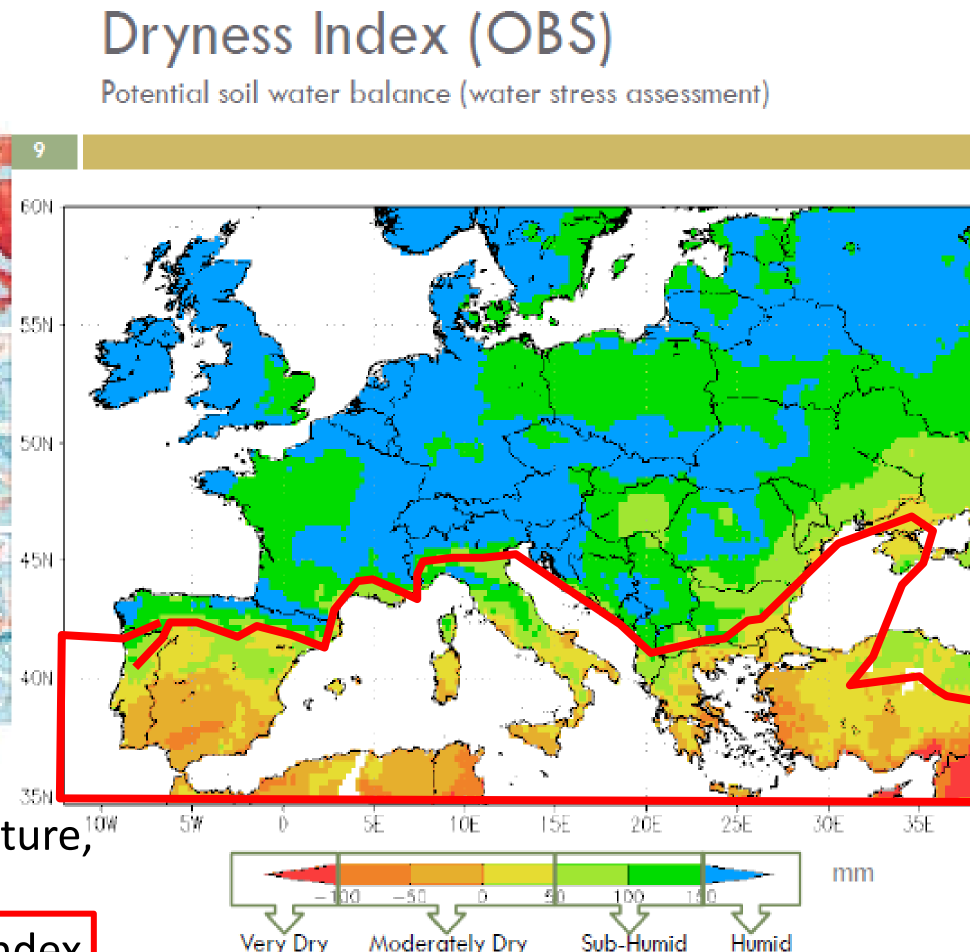



**Moderate** limitation to winegrape growth in some **southern regions**

Santos et al. (2012) Macroclimate and viticultural zoning in Europe. Clim.Res. 51: 89-103

# Dryness indices are only rough indicators of current and past vulnerability






**Moderate** limitation to winegrape growth in some **southern regions**

Cook and Wolkovich (2016) Nature, March 21 2016

Problematic: Palmer drought index
Thornthwaite ETo calculation

Santos et al. (2012) Macroclimate and viticultural zoning in Europe. Clim.Res. 51: 89-103

The Clausius-Clapeyron relationship tells us, a 1°K (or 1°C) warming at 15 °C means about a 7% increase in evaporation but it also means a 1-2% increase in precipitation!

The average precipitable water column on earth is about 28.5mm (Farquhar and Roderick 2007) which would mean that 1° C warming would increase evaporation by only roughly 2mm! (All other things being equal). Therefore regional effects need to be studied carefully.

# Warming has occurred and continues to do so – what are the effects on P and ETp?

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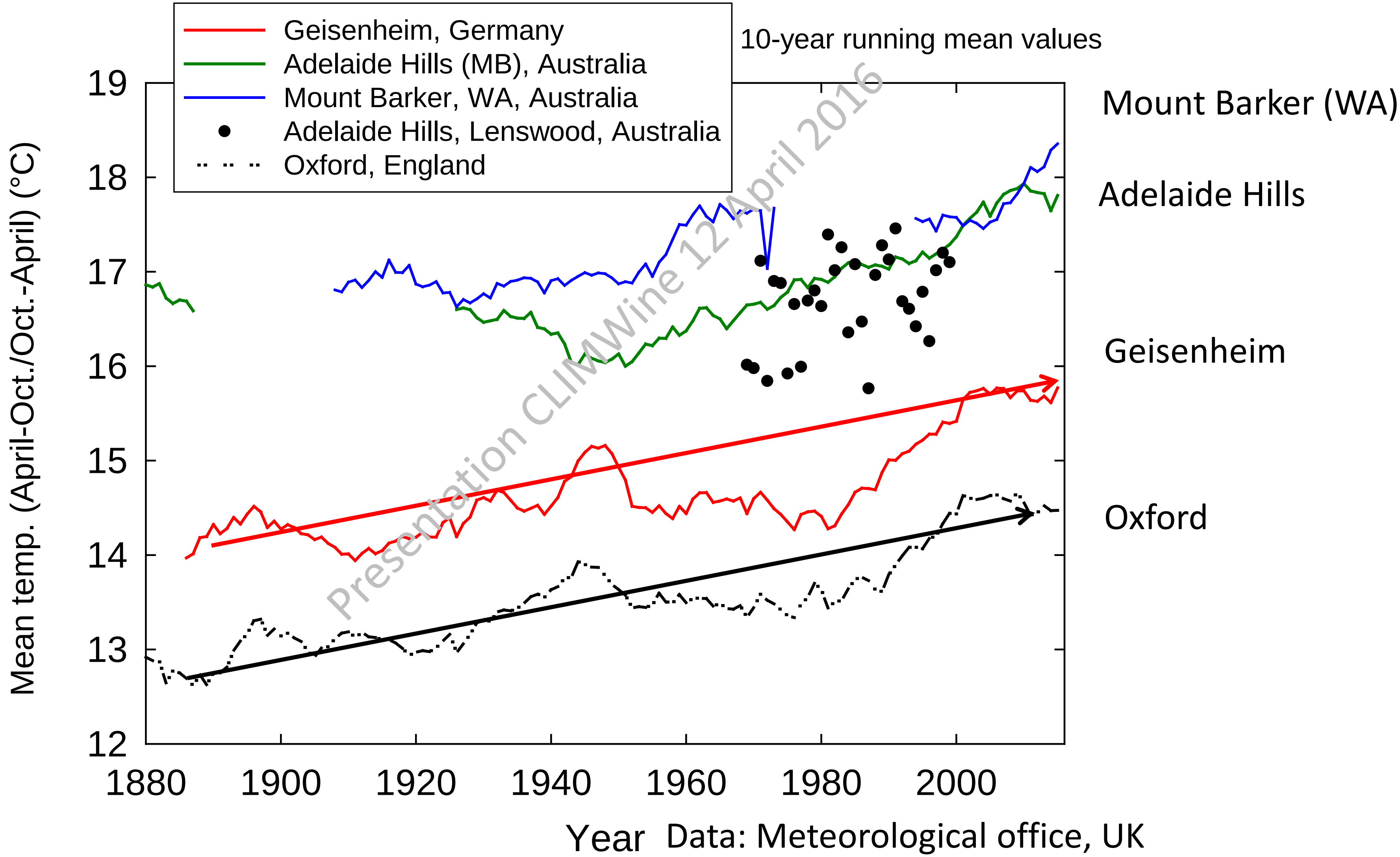


Data: Meteorological office, UK
Deutscher Wetterdienst
Australian Government, Bureau of Meteorology



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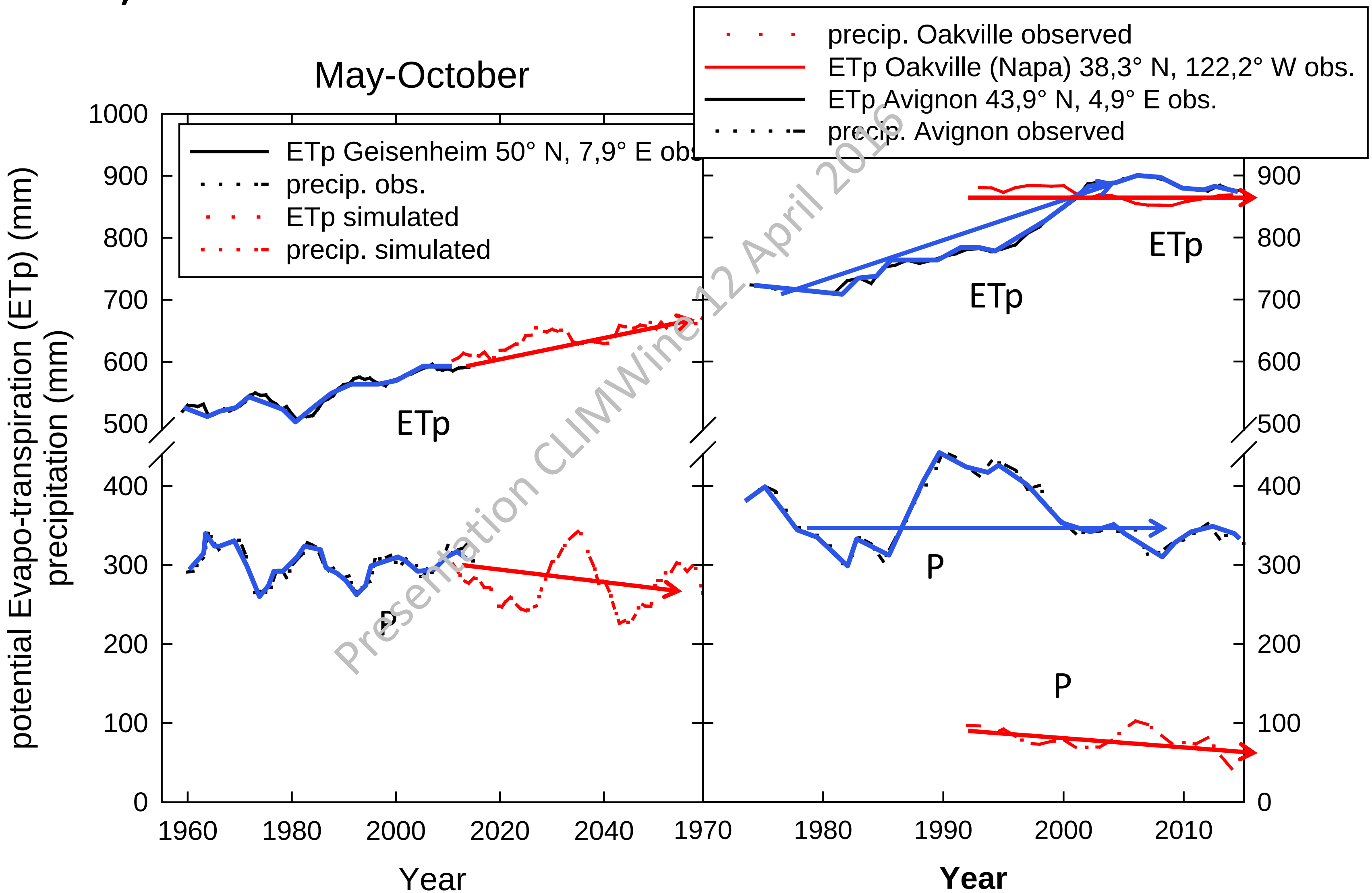
What is happening in water limited areas, what happens in enery limited areas

What is happening in energy limited parts of the season, and what in water limited parts of the season

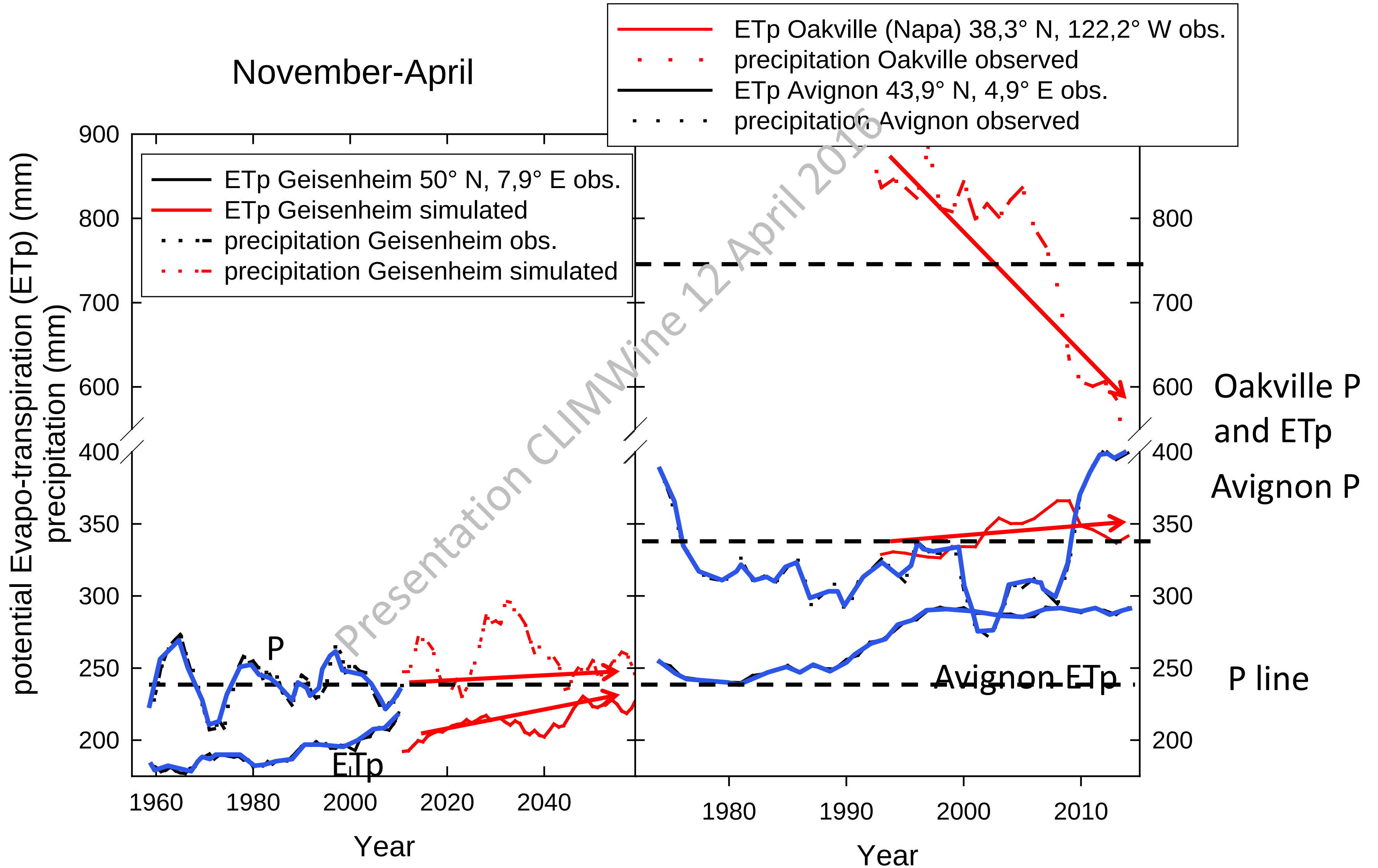
# Observations and simulations (hydrological summer)






French data: DB, CLIMATIK, Agroclim, INRA
German data: Deutscher Wetterdienst
US data: IPM set, Univ. of Calif. Davis

# Observations and simulations (hydrological winter)




French data: DB, CLIMATIK, Agroclim, INRA
German data: Deutscher Wetterdienst
US data: IPM set, Univ. of Calif. Davis

In the warm regions (esp. US and Australia no change in ETp) (in southern France, small to no change during the past 20 years)

In China annual ETp has decreased 1-3% since 1966 (Liu et al. 2014, Hydrol. Earth Syst. Sci. 18, 2803-2813) and run-off increased by 1-6% (Budyko curve moves to energy limited)!

In South Africa ETp (pan evaporation) in the Cape Floristic regions has declined substantially between 1974 and 2005 on 16 of 20 climate stations (Hoffmann et al. 2011 Pan evaporation and wind run decline in the Cape Floristic region. Climate Change 109:437-452)

What are the reasons?

# Observations cool areas (*a priori* energy limited)

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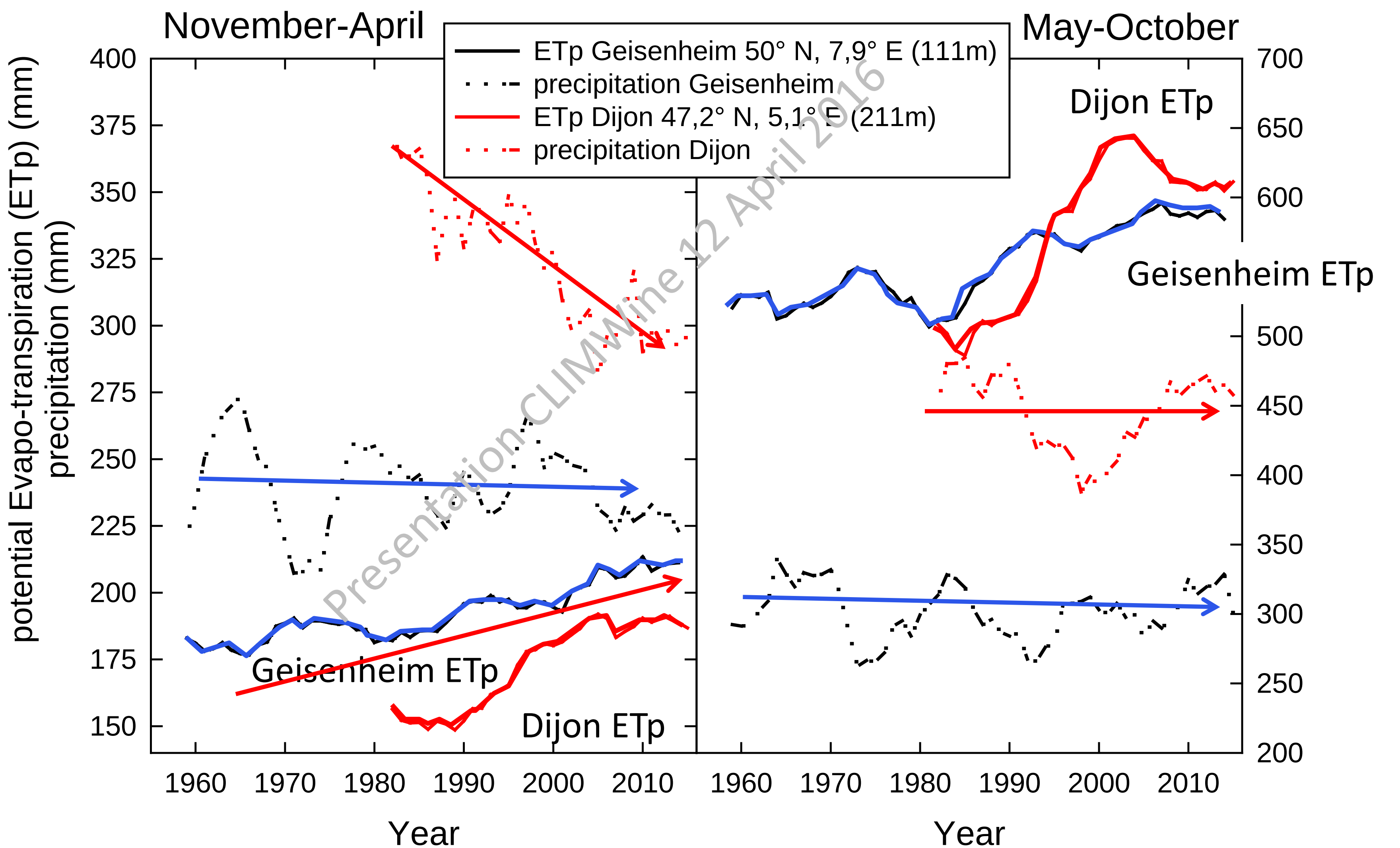




French data: DB, CLIMATIK, Agroclim, INRA
German data: Deutscher Wetterdienst

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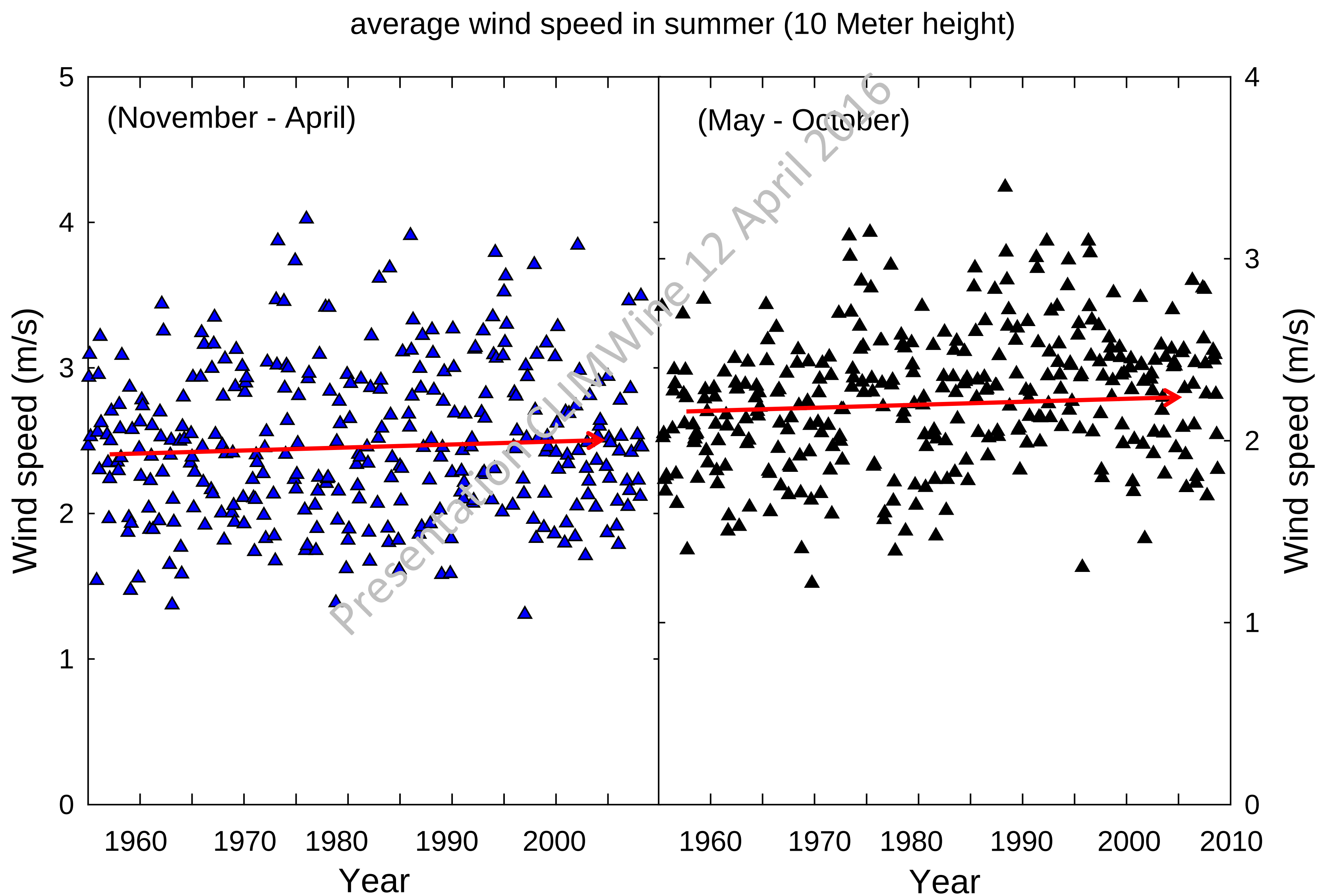
What are the reasons for increased ETp in some, declining or stable ETp in other regions? ?

Aerosol impact on solar radiation could be a factor in some regions (i.e. China)

In China and South Africa, wind speed has declined between 25 and 29% since the beginning of the seventies! In Australia similar effects are observed.

# Average wind speed in Geisenheim




Data source: Deutscher Wetterdienst

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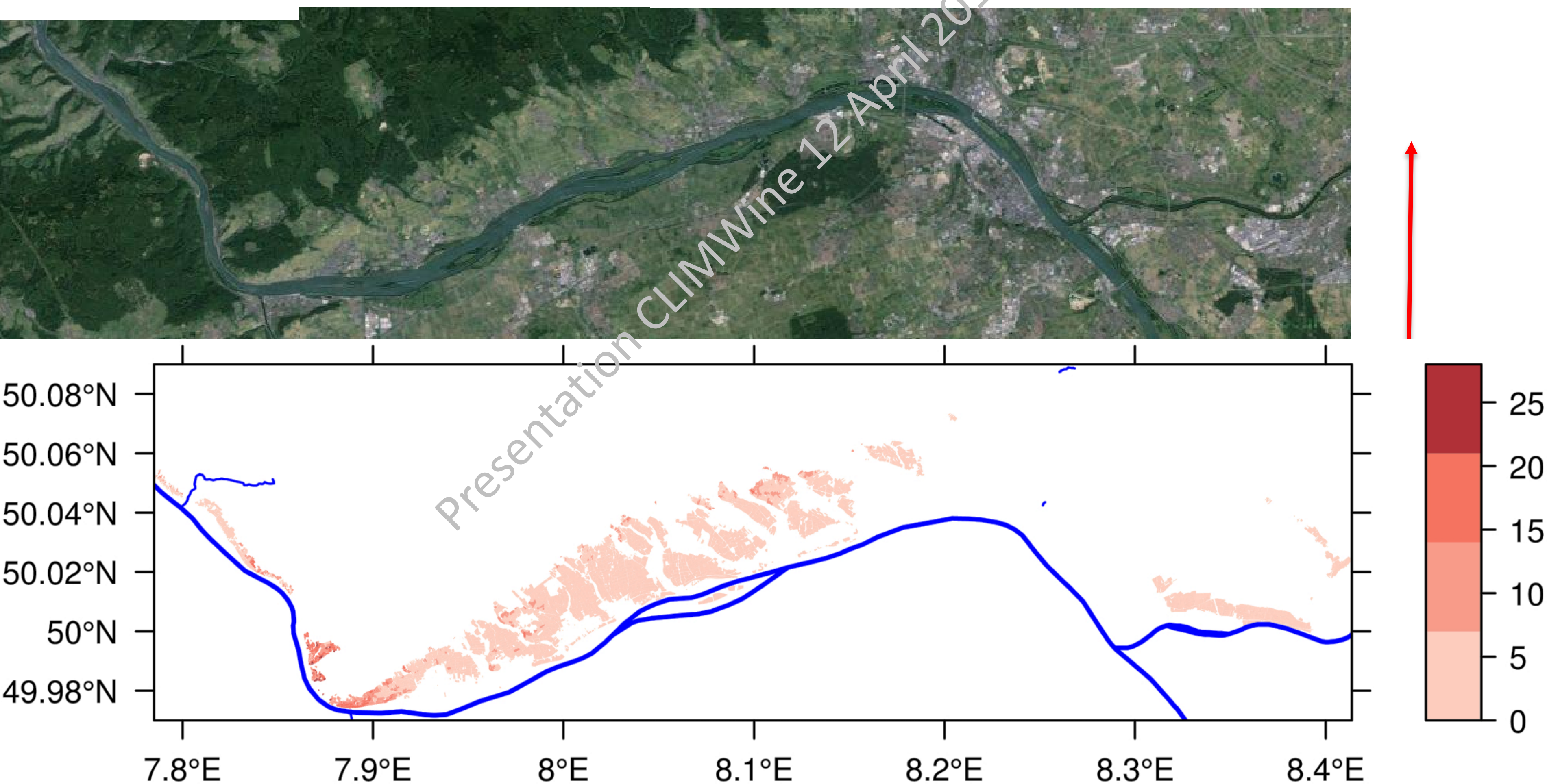
These differences are also one of the resons we need specific regional based modelling efforts

Expl. REMO-UBA, changes in drought days 2041-2070 minus abseline 1971-2000, region Rheingau, Germany






Marco Hofmann et Hans Reiner Schultz unpublished

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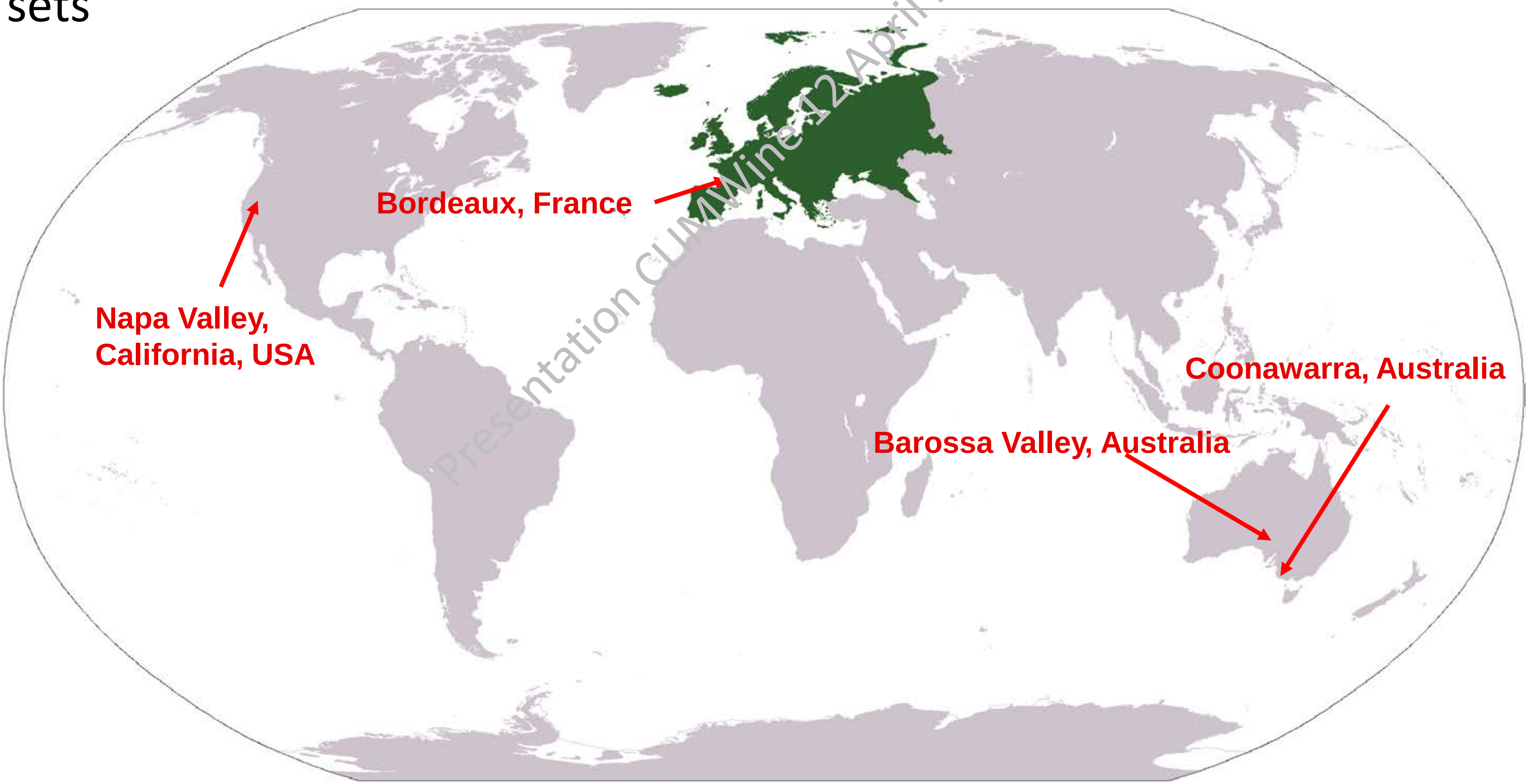
The variety question is alway launched during the climate change debate.

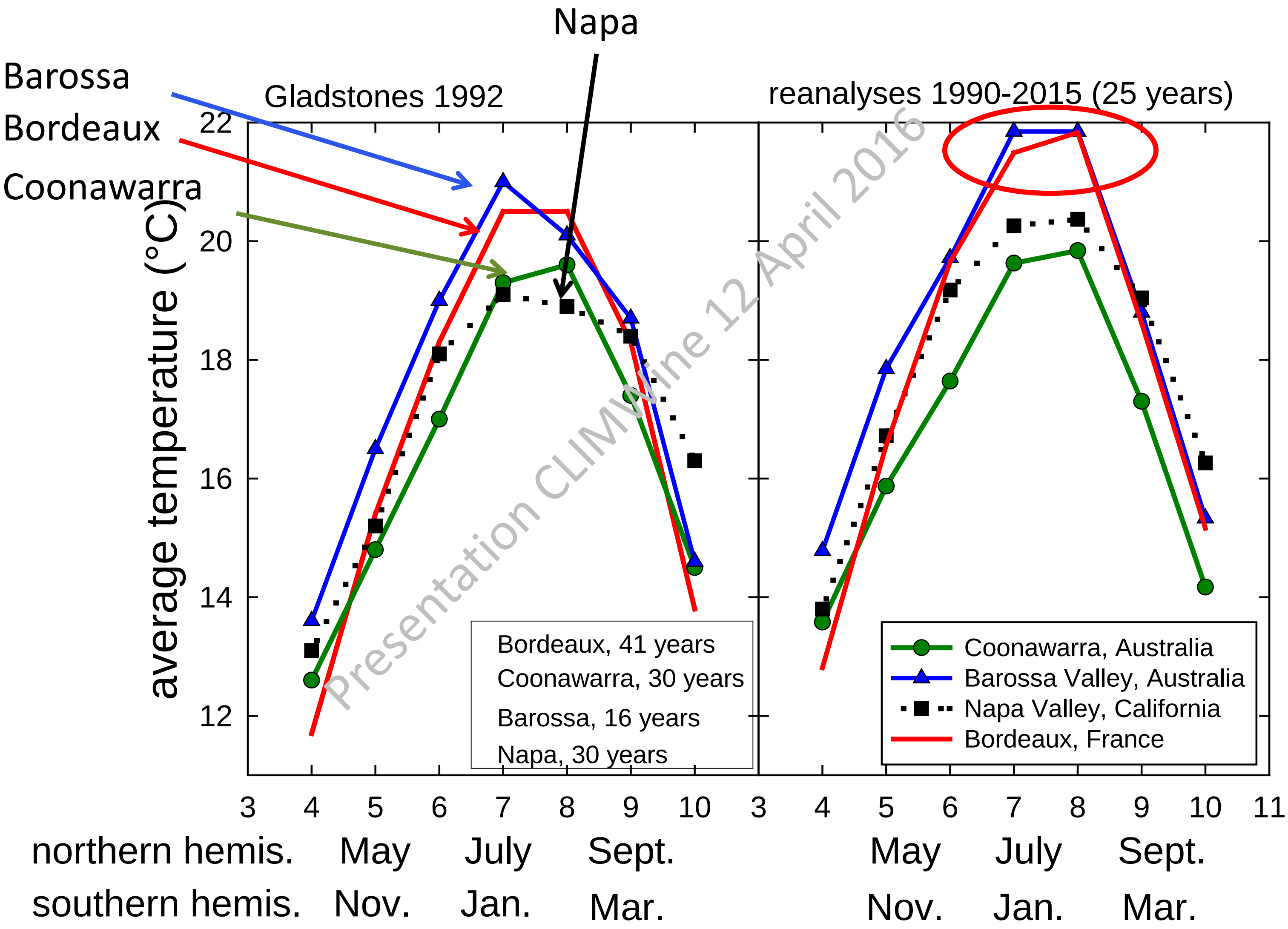
Cabernet Sauvignon regions – what has changed?

The variety question is alway launched during the climate change debate.

Cabernet Sauvignon regions – what has changed? A re-analysis of John Gladstones (1992 Viticulture and Environment, Winetitles) climate data sets



# Average temperature

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# Maximum temperature

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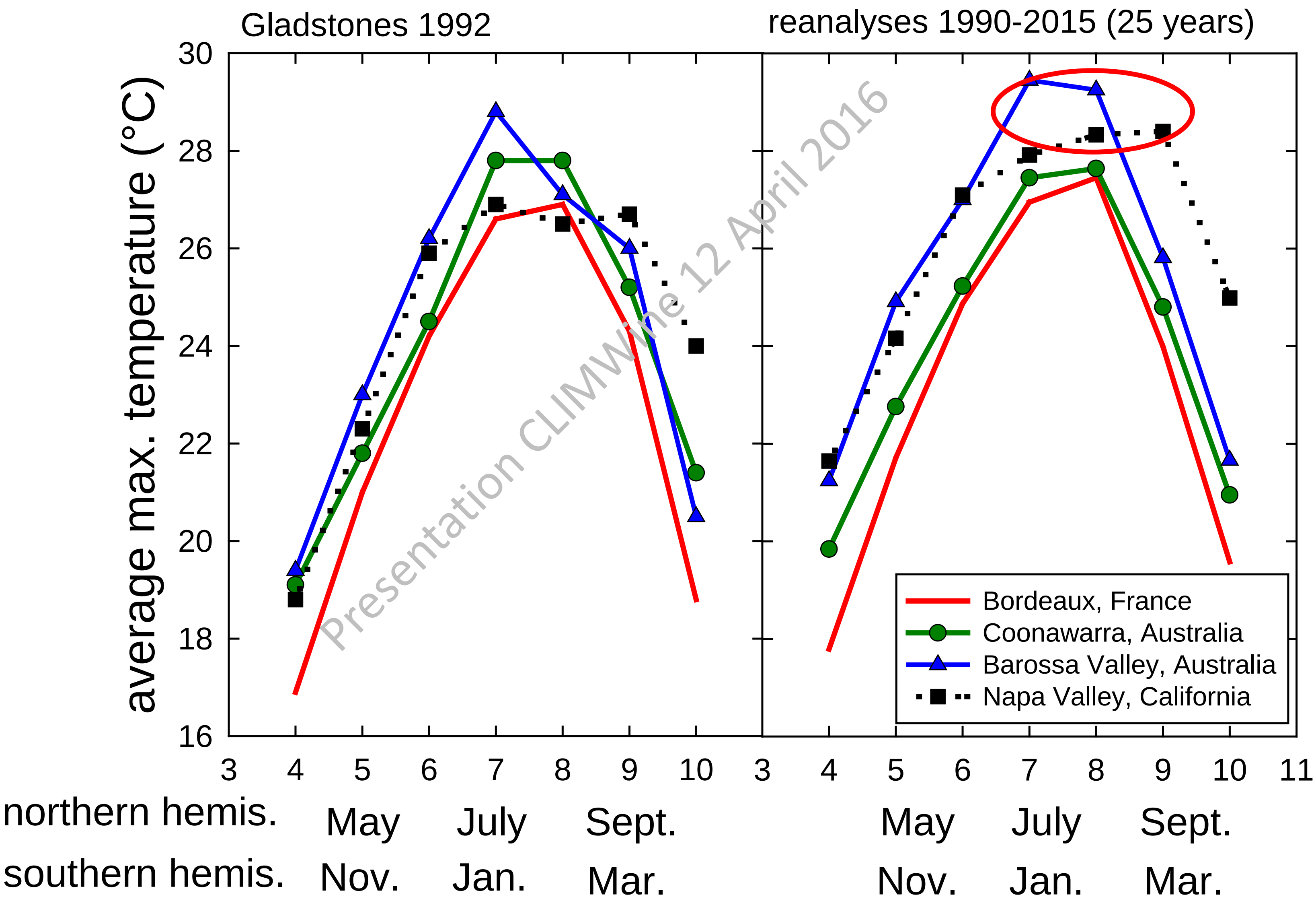
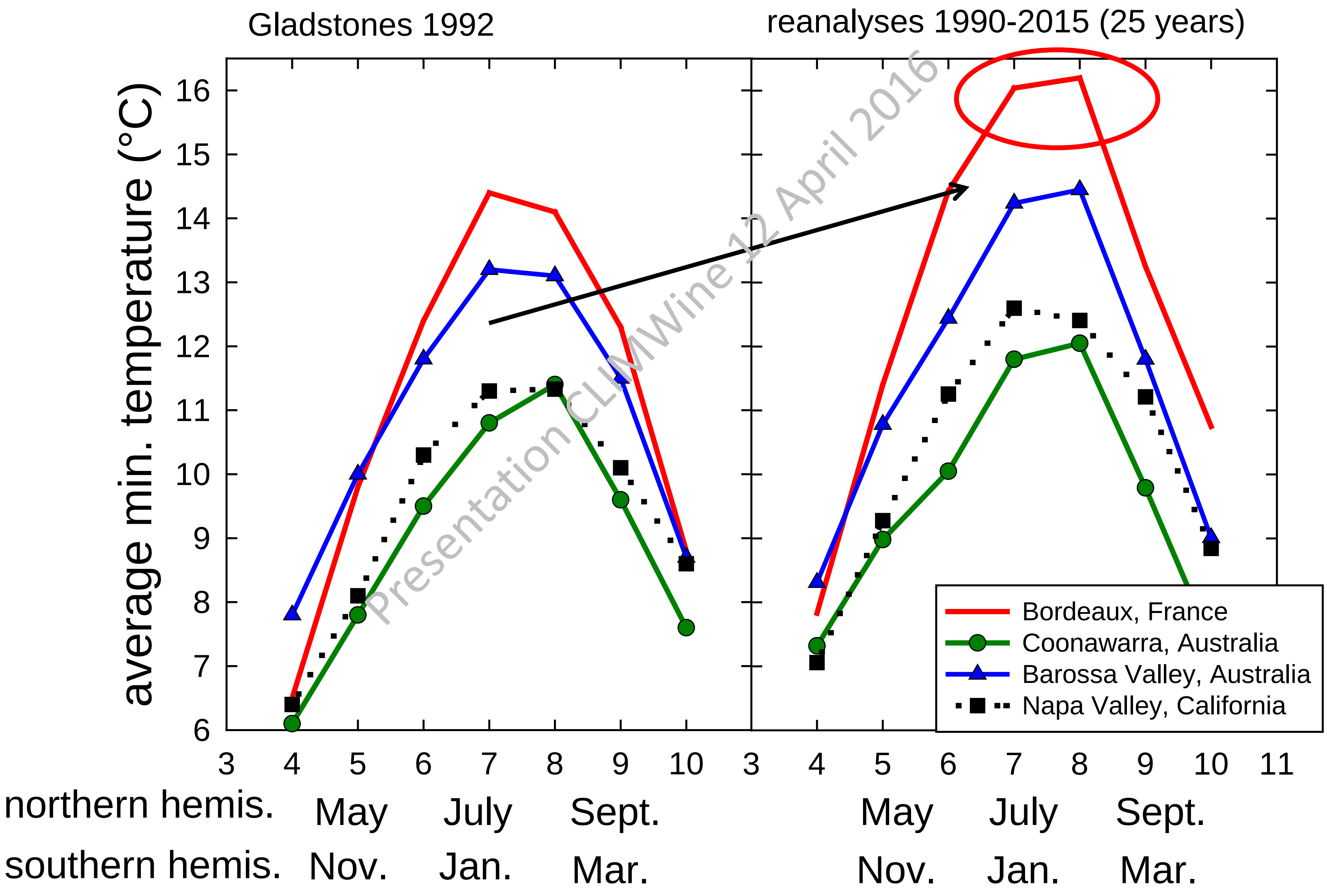
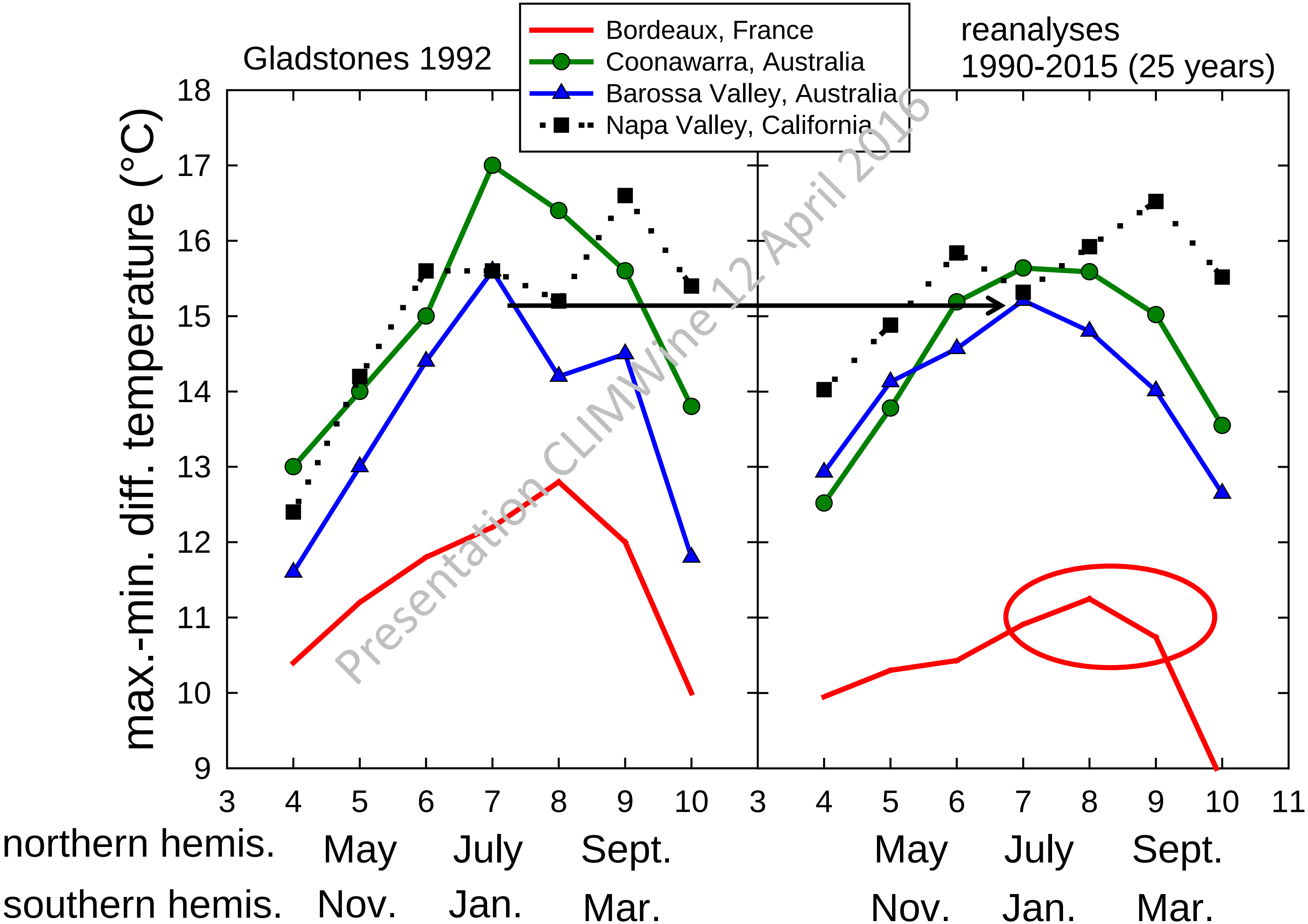


# Minimum temperature



# Day-night temperature difference



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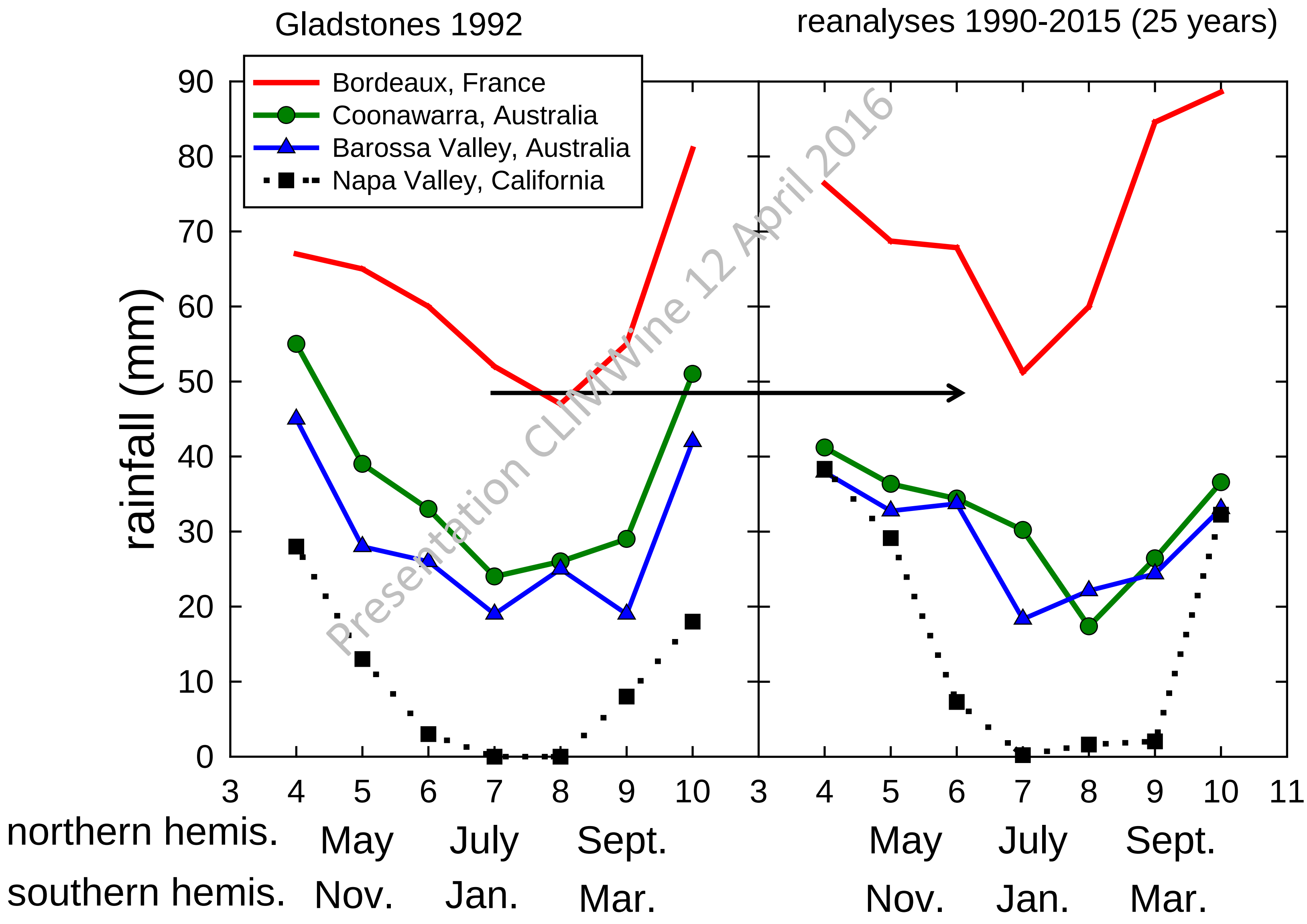
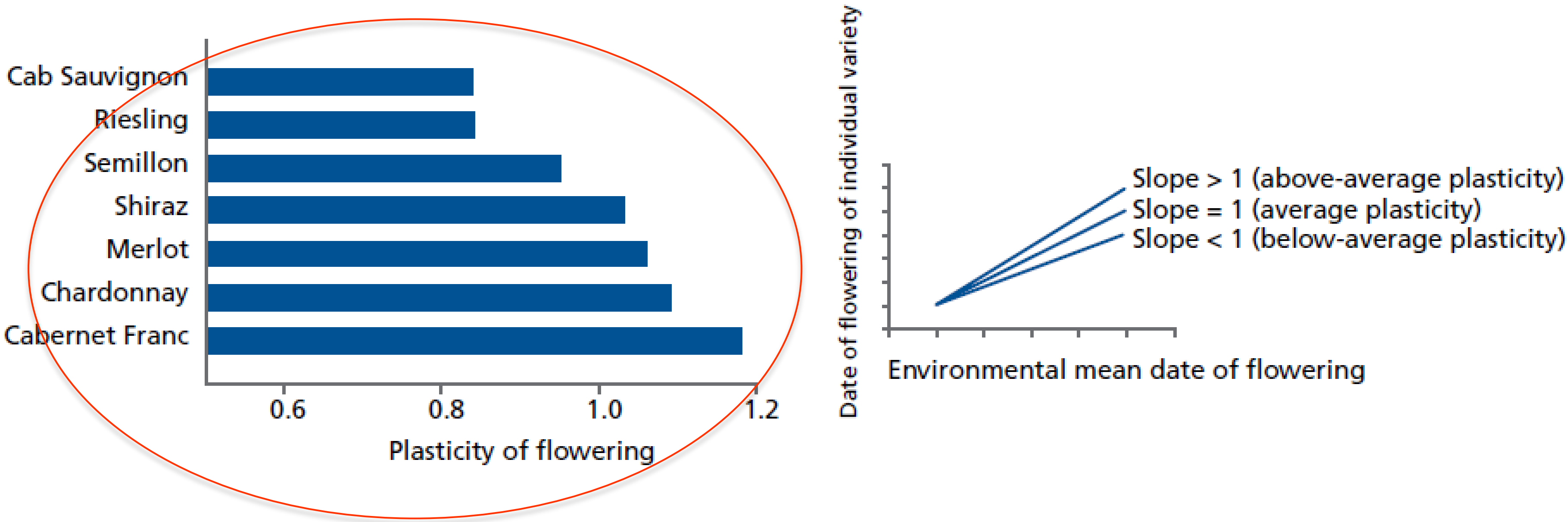
# rainfall



Gladstones 1992
reanalyses 1990-2015 (25 years)
Bordeaux, France
Coonawarra, Australia
Barossa Valley, Australia
Napa Valley, California
rainfall (mm)
90
80
70
60
50
40
30
20
10
0
3 4 5 6 7 8 9 10 3 4 5 6 7 8 9 10 11
northern hemis. May July Sept. May July Sept.
southern hemis. Nov. Jan. Mar. Nov. Jan. Mar.
Presentation CLIMWine 12 April 2016

# We need to research the plasticity of varieties more

**FIGURE 3** Plasticity of flowering of grapevine varieties in southeastern Australia. Plasticity is calculated as the slopes of the lines relating date of flowering of each variety and the environmental mean date of flowering (inset). Adapted from Sadras *et al.* (2009).




Sadras, Schultz, Girona, Marsal (2012): FAO crop responses to water

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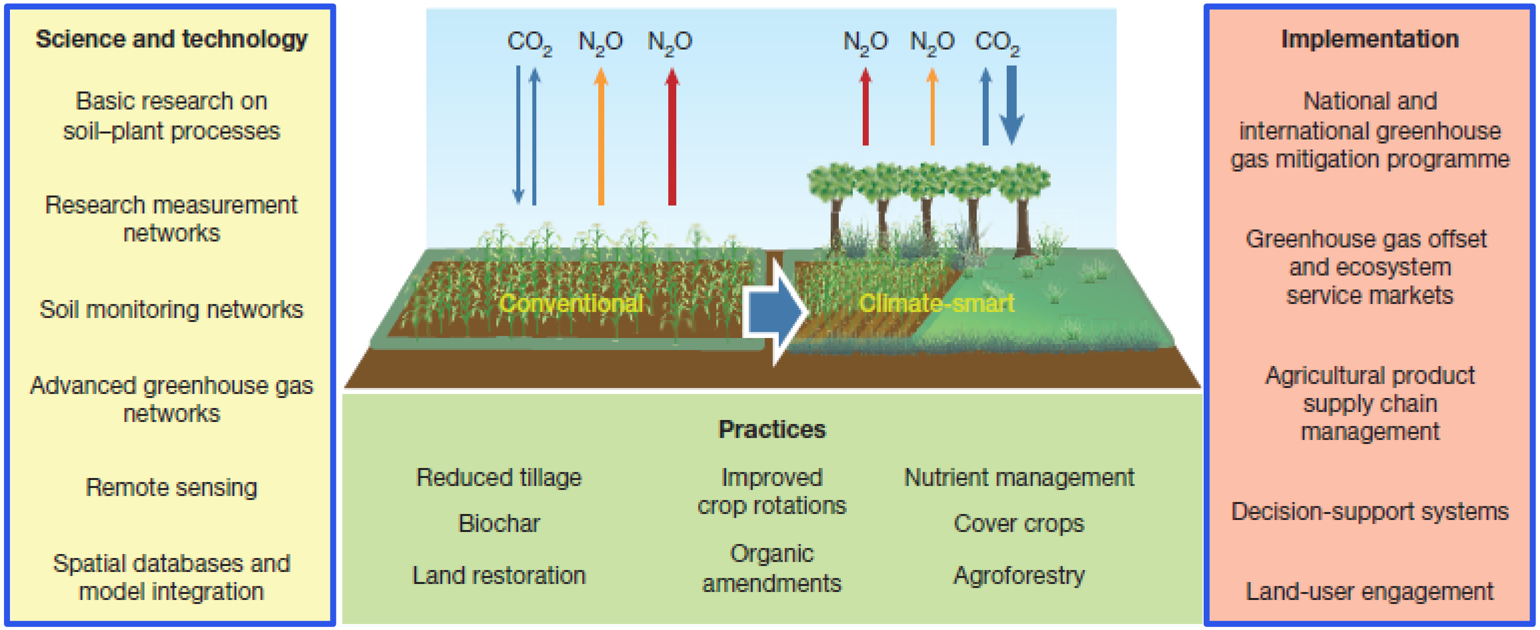
# 3. Soils the unknown half

Our most valuable resource is a very large climate player but we do know little about it




Expanding the role of agricultural soil GHG mitigation will require an integrated research support and implementation platform (a more intensive monitoring network is needed)

Paustian et al. (2016) Climate-smart soils, Vol. 532, 49-57, Nature

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# 3. Soils are the key to sustainability

We need to learn more about GHG emission and mitigation, water, fertilizer, carbon and nutrient management

It takes 2000 years to build 10 cm of soil

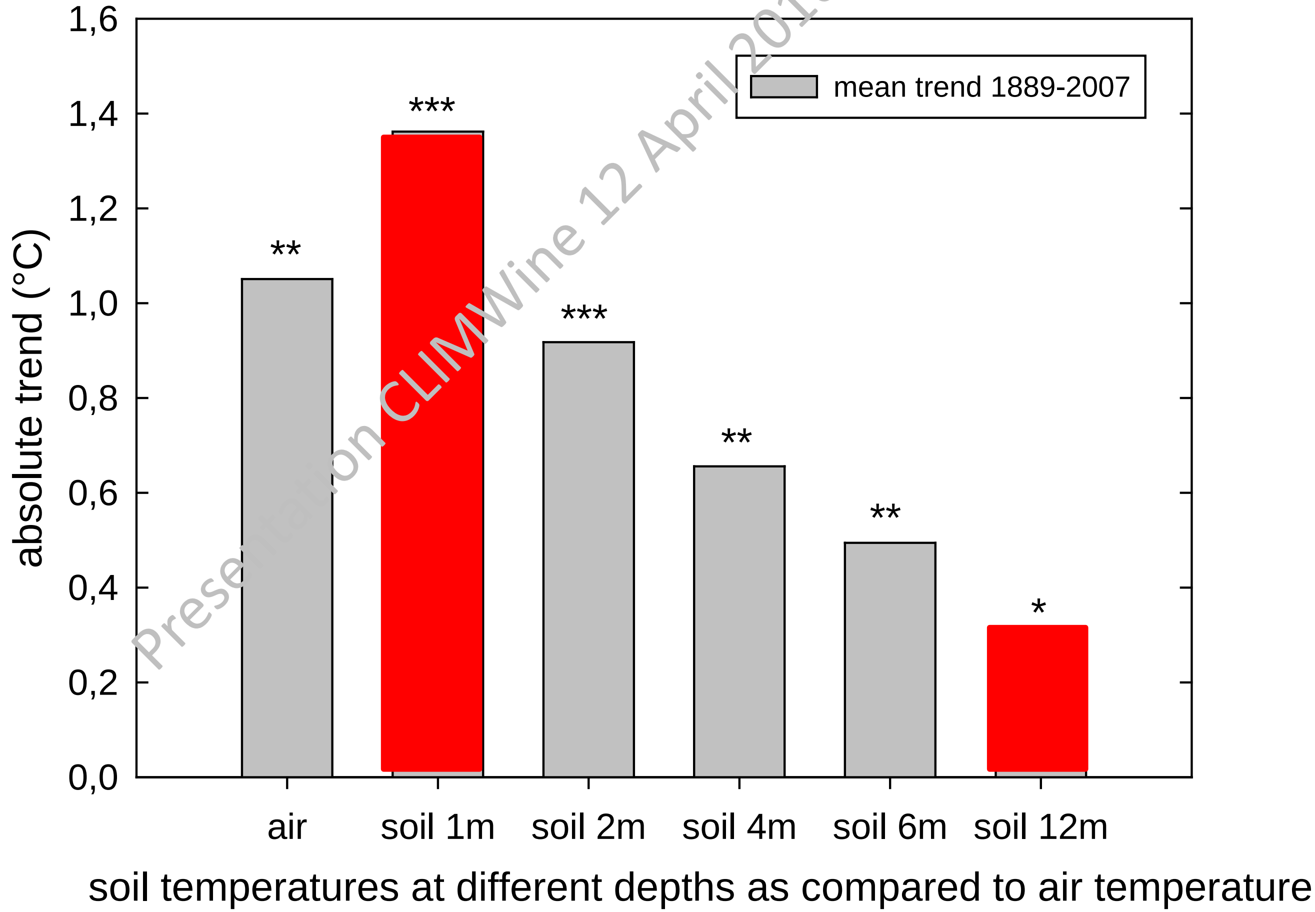
Every year we loose 24 Billion Tons of soil due to erosion (extreme events will increase this number)

This is 3.4 tons per person and year and is equivalent to 60€ per person and year = 420 Billion € per year

# Climate effects on soils, strong increase in **soil temperature** (the Potsdam time-series)

Since 1889 strong warming May-August (1m depth **2.4° - 3.2°C !!**)

Trend in °K




Böhme und Böttcher, Klimastatusbericht des Deutschen Wetterdienstes 2011

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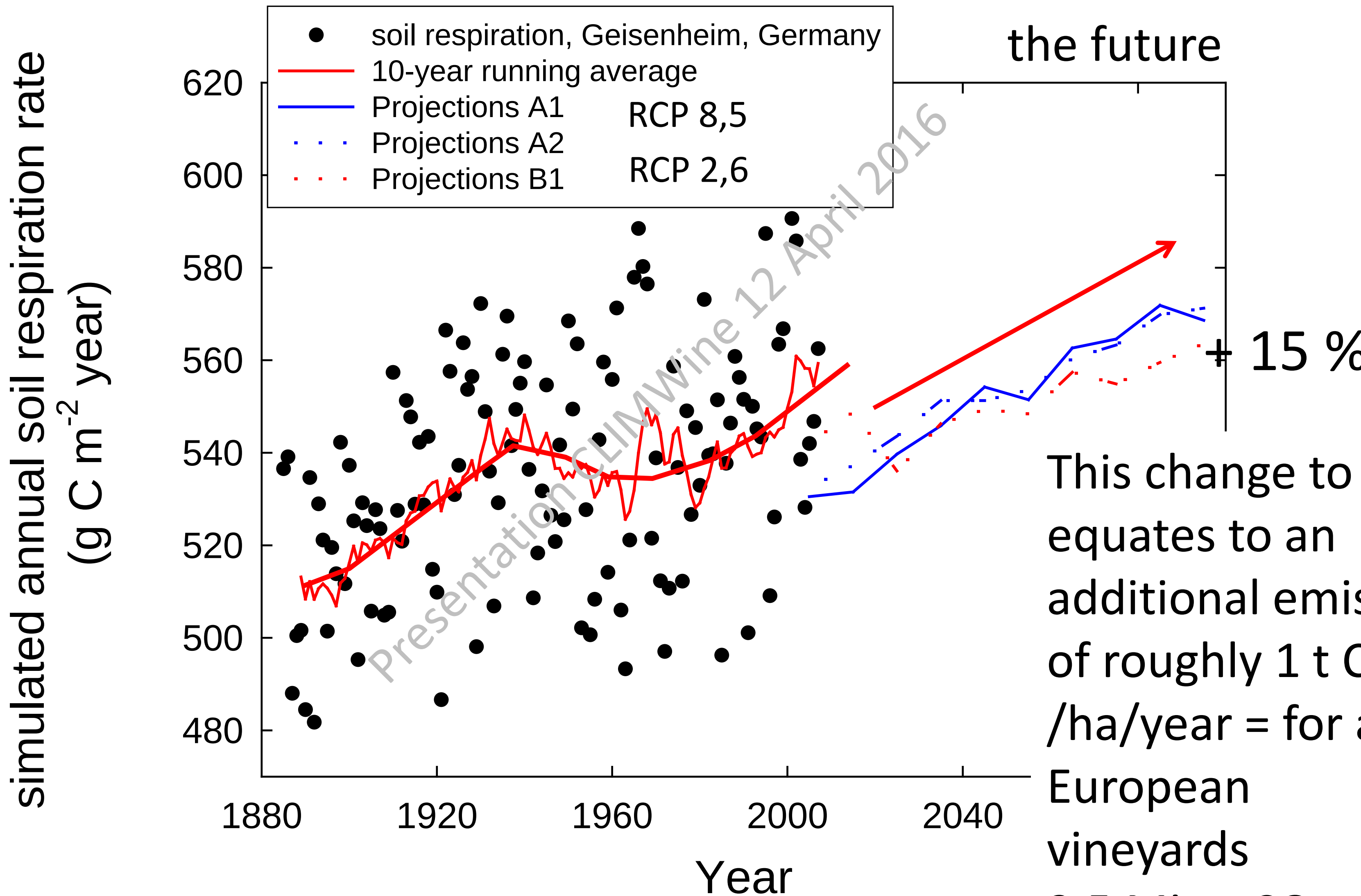
# soil GHG emission estimation




This change to date equates to an additional emission of roughly 1 t $CO_2$ /ha/year = for all European vineyards 3.5 Mio t $CO_2$

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# soil GHG emission estimation

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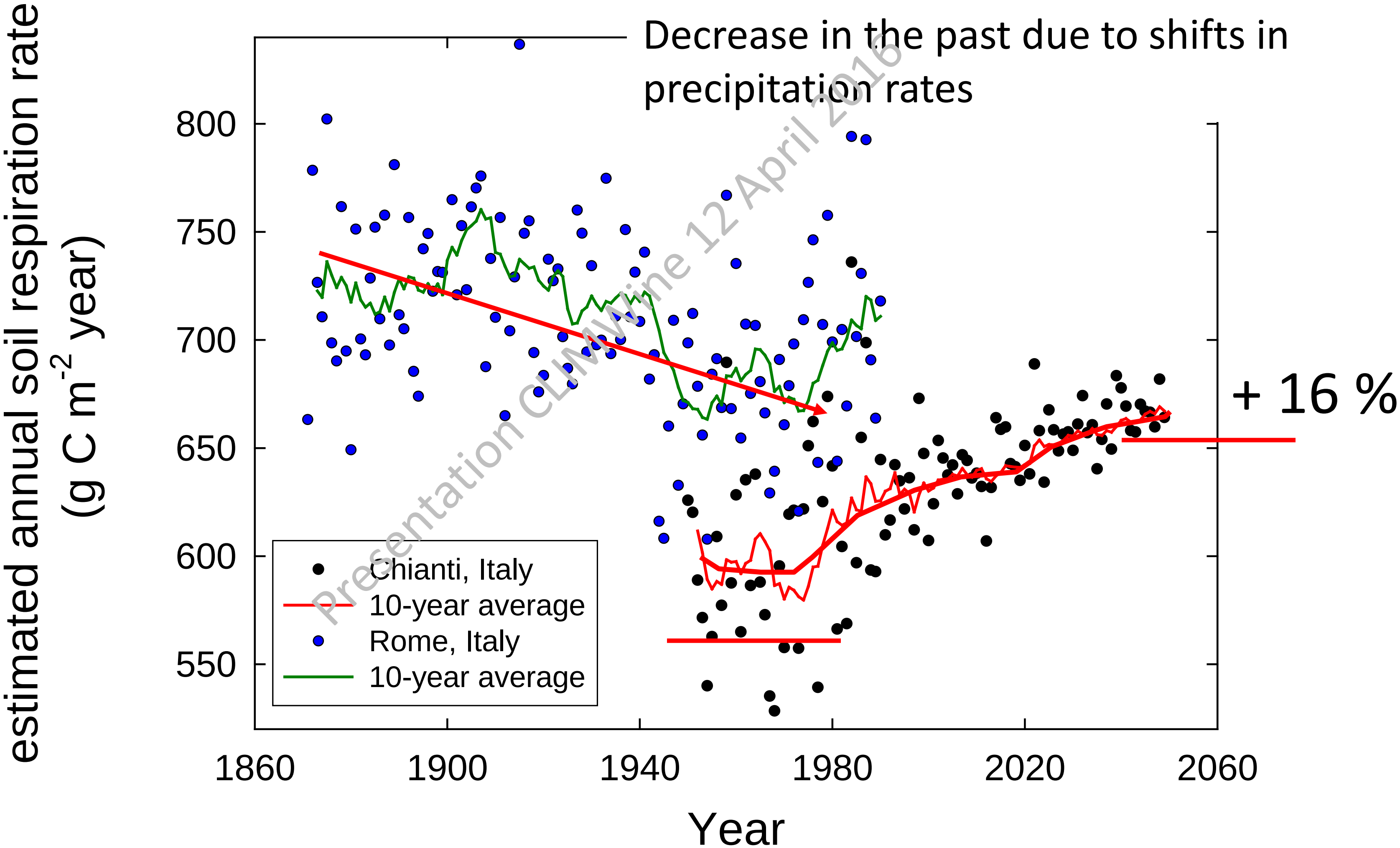
## Italian data

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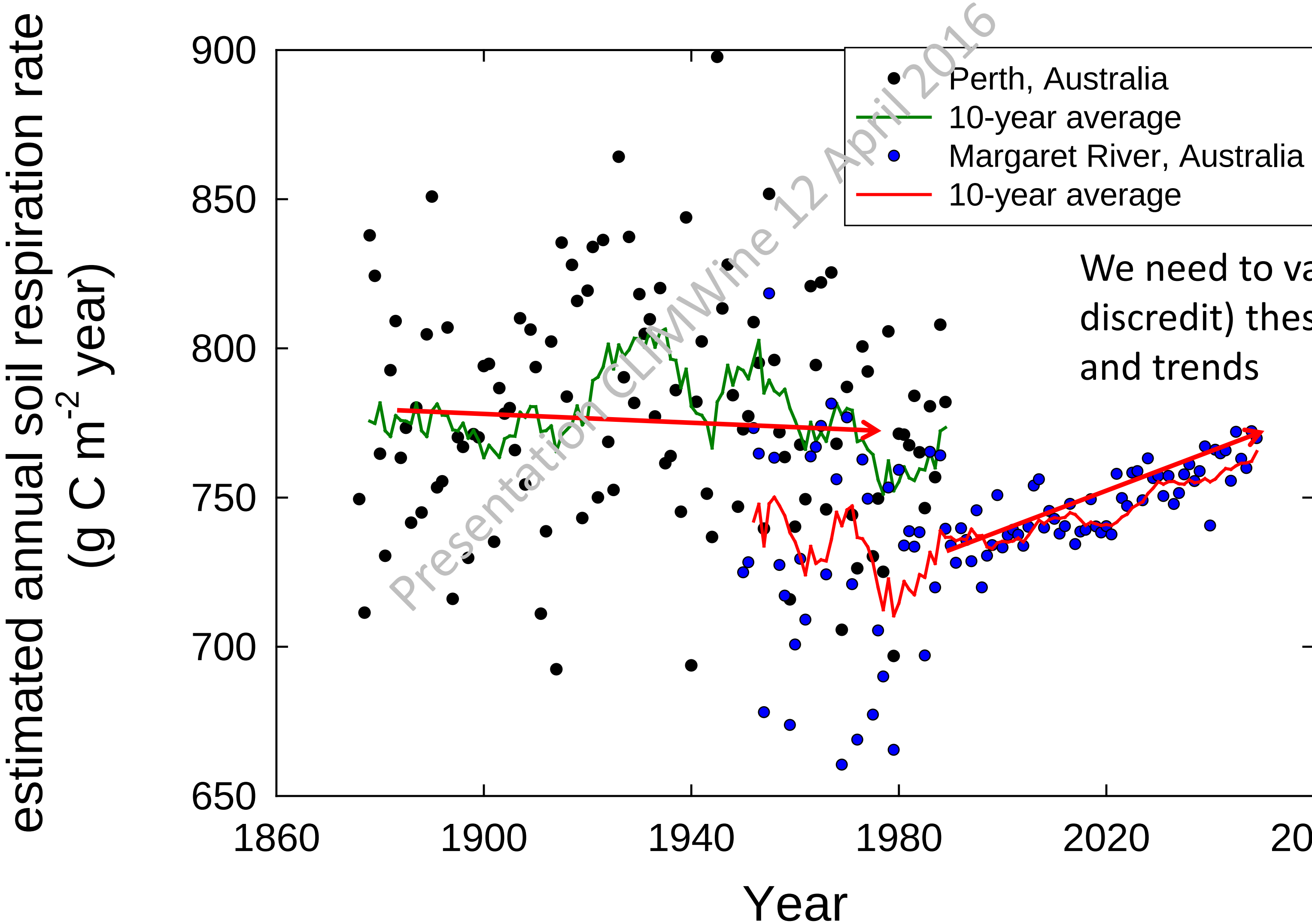
# soil GHG emission estimation

## Australian data






We need to validate (or discredit) these models and trends

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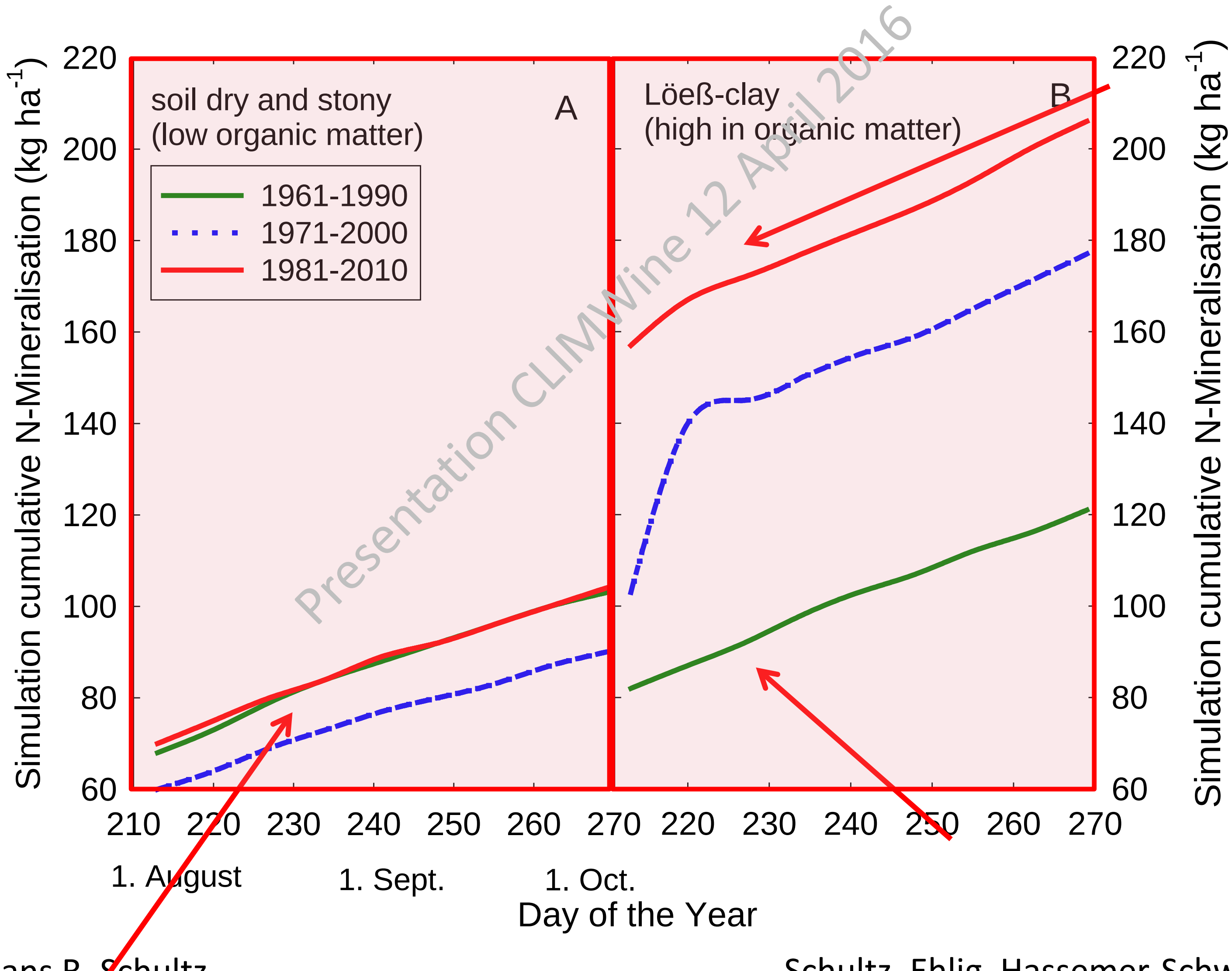
# Modeling of soil nitrogen dynamics (first estimates)

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Schultz, Ehlig, Hassemer-Schwarz unpublished

# Sumary

We need to analyse all climate data region by region for strategic decisions with respect to water

Varietal plasticity needs to be studied

As scientists we need to focus more on the soil

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# Merci pour votre attention



Thank you for the invitation; and

Marco Hofmann for his modelling efforts
Inaki Garcia de Cortazar Atauri for acess to French climate data