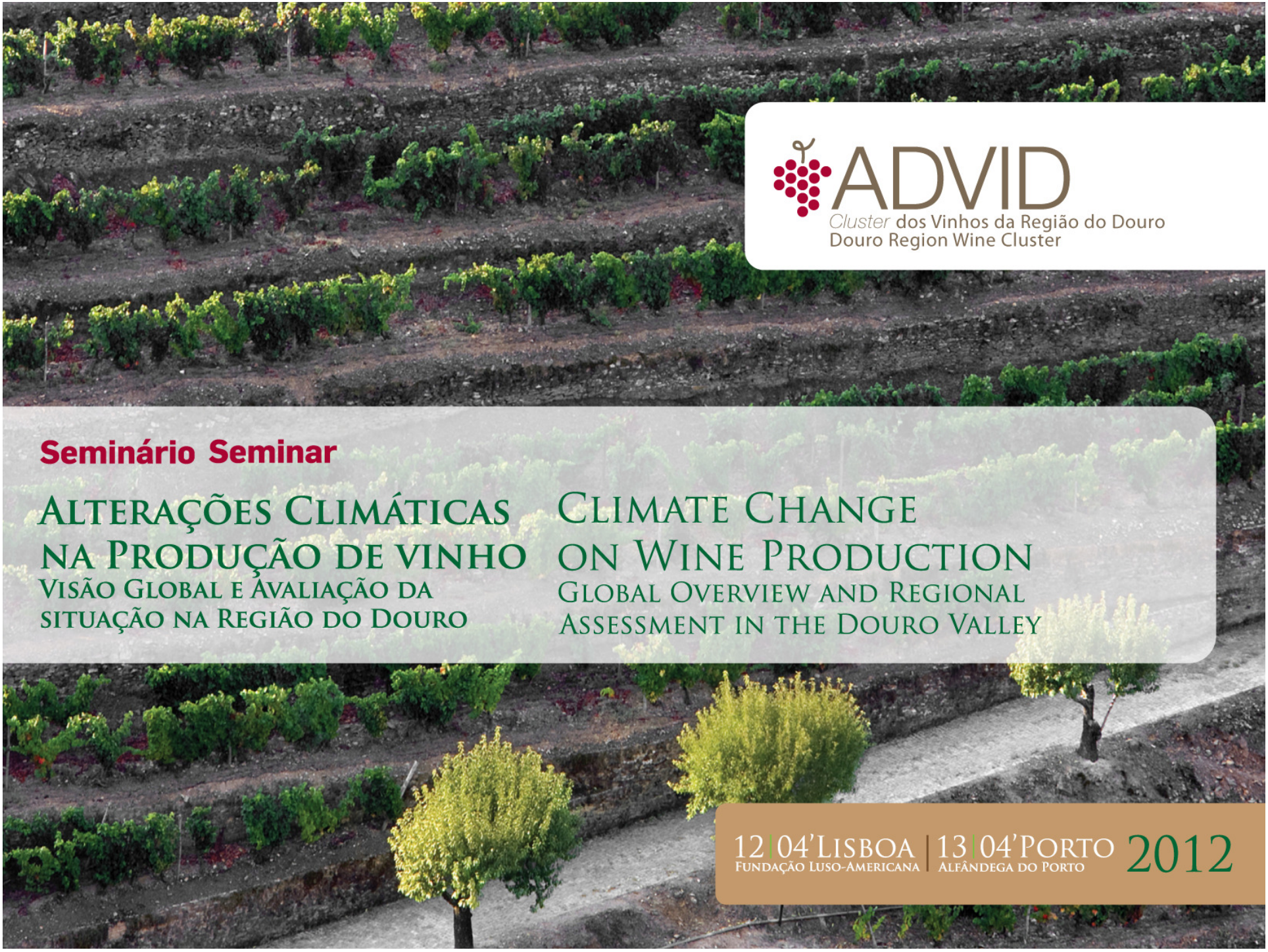


ADVID
Cluster dos Vinhos da Região do Douro
Douro Region Wine Cluster

Seminário Seminar

Alterações Climáticas na Produção de Vinho
Visão Global e Avaliação da situação na Região do Douro

Climate Change on Wine Production
Global Overview and Regional Assessment in the Douro Valley

12|04' Lisboa | Fundação Luso-Americana
13|04' Porto | Alfândega do Porto
2012

Climate Change and Wine Production: A Global Overview

Gregory V. Jones
Department of Environmental Studies
Southern OREGON UNIVERSITY

In Collaboration with:

Association for Viticultural Development in the Douro Valley (ADVID)

Talk Outline

- Climate Influences, Risks, and Challenges on Wine Production
- Climate Structure and Suitability for Quality Wine Production
- General Overview of Climate Change Impacts on Wine Production
- Climate Change Observations and Projections for Global Wine Regions
- Summary

Climate Influences, Risks, and Challenges

Weather and Climate present three distinct spatial and temporal scales of influences and risks to viticulture and wine production:

- Individual Weather Events (short-term/localized)
  - Hail, frost/freezes, heavy rain, etc.

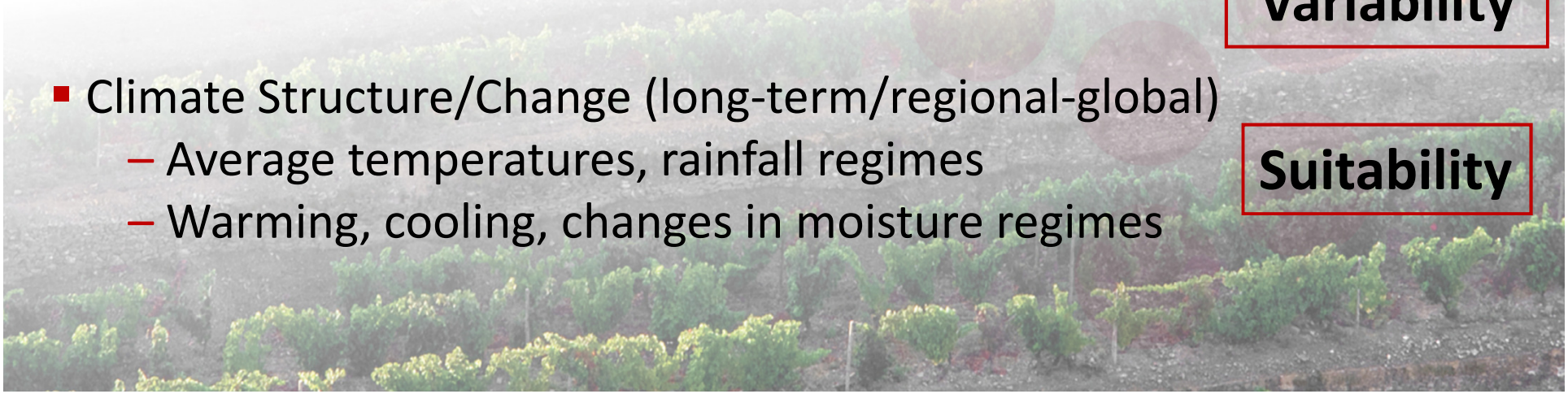
Crop Risk

- Climate Variability (seasonal-decadal/regionalized)
  - Dry or wet & warm or cold periods

Production & Quality Variability

- Climate Structure/Change (long-term/regional-global)
  - Average temperatures, rainfall regimes
  - Warming, cooling, changes in moisture regimes

Suitability



Climate Structure and Suitability

Variety-Climate Thresholds

Too Cold Threshold
Lower sugar levels,
Unripe flavors,
Unbalanced

Too Warm Threshold
Lower retention of acids,
Overripe flavors,
Unbalanced

Plasticity – Adaptation
Management (short-term)
Varietal (long-term)

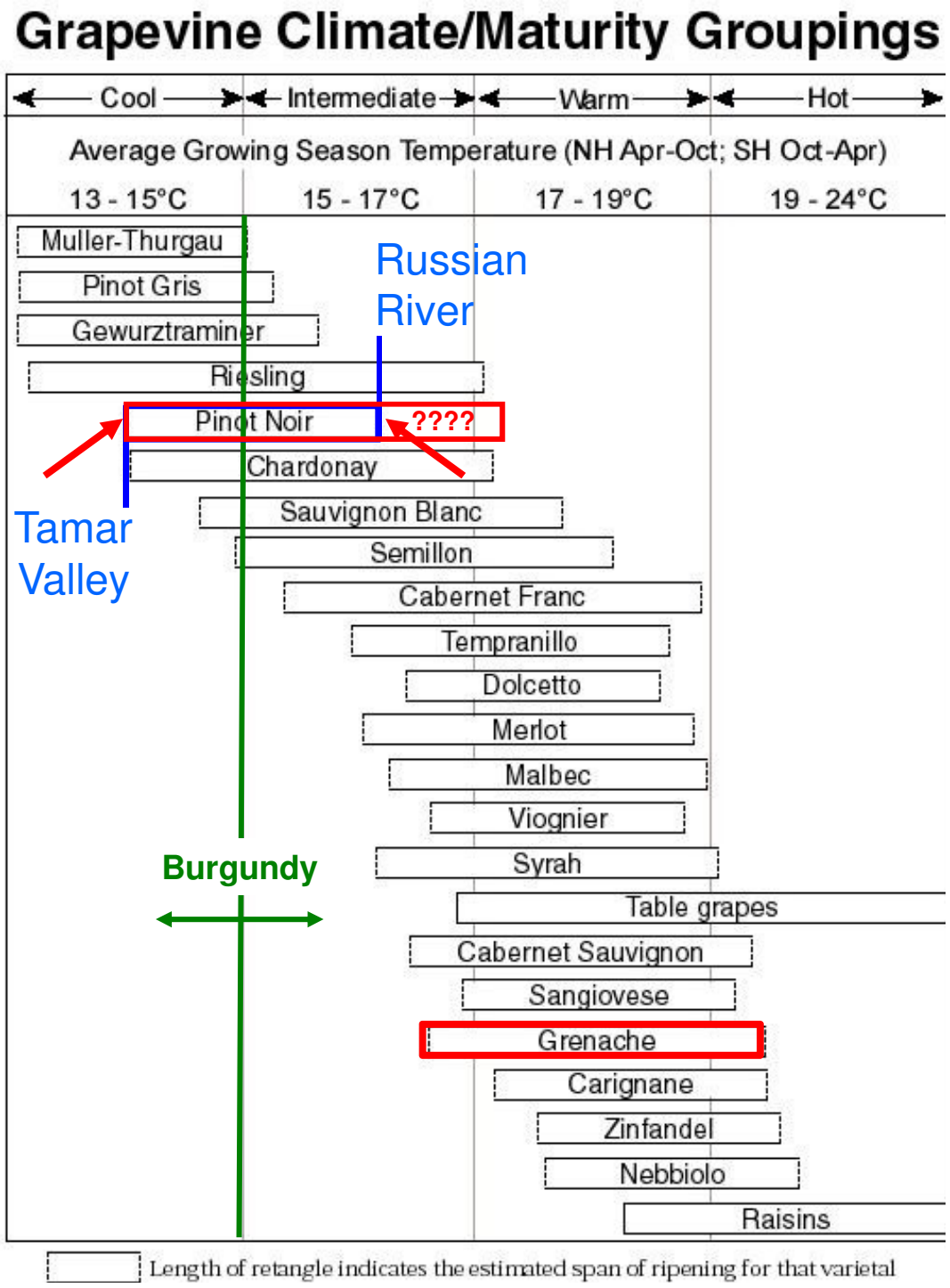
Optimum Zone
Consistent sugar levels,
Ripe flavors,
Generally balanced -
Vintage variations driven by
seasonal climate factors
(frost, untimely rain, etc.)

Wine Production and Quality Metrics
Yield/Production
Balanced Composition
Typical Varietal Flavors
Vintage Ratings/Price

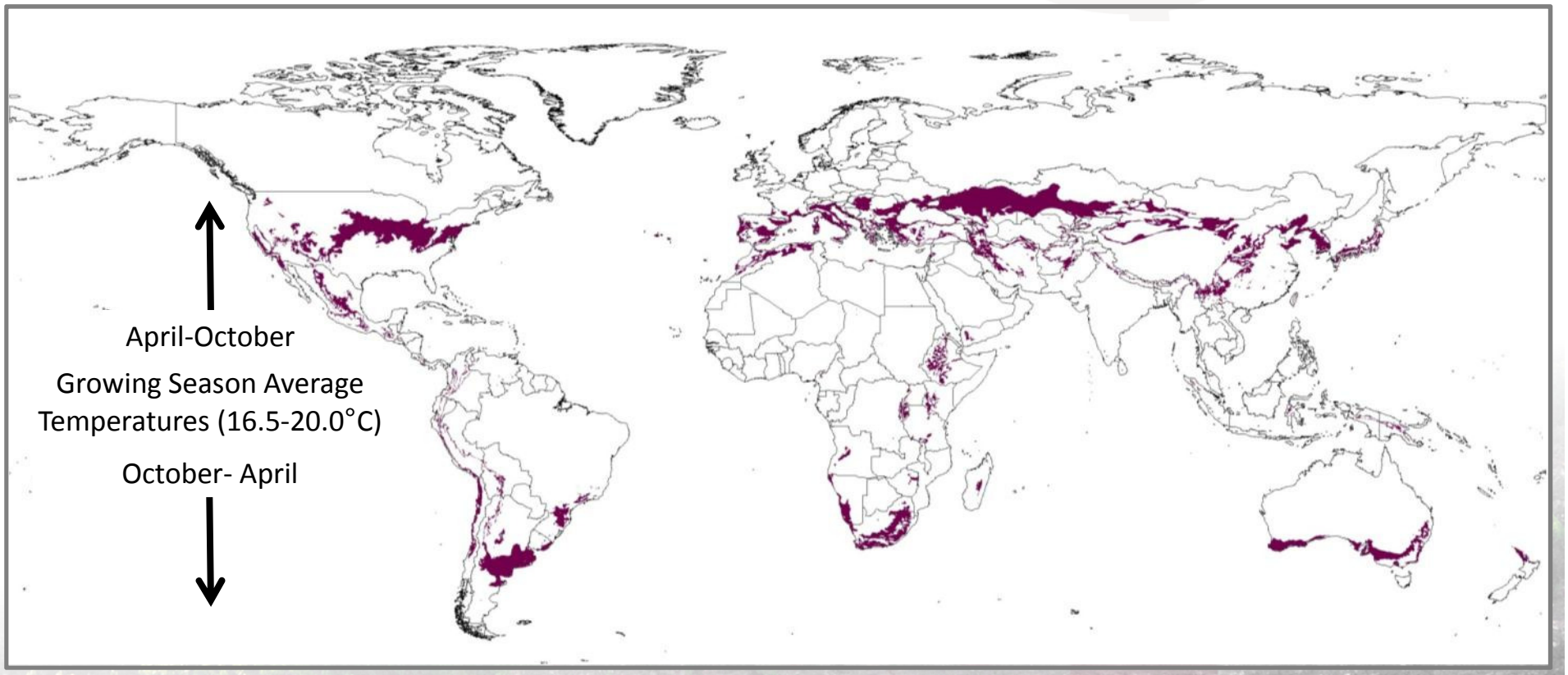
Climate Metrics
Growing Season Temperatures, Heat Accumulation

- All varieties have inherent climatic thresholds for optimum quality and production characteristics
- Pinot Noir exhibits one of the most narrow climatic niches for premium quality production
- From what we know about today's Pinot Noir regions, growing season average temperatures range from ~14-16°C, or ~ a 2°C climatic niche

Jones, 2006



Grenache Climates Worldwide

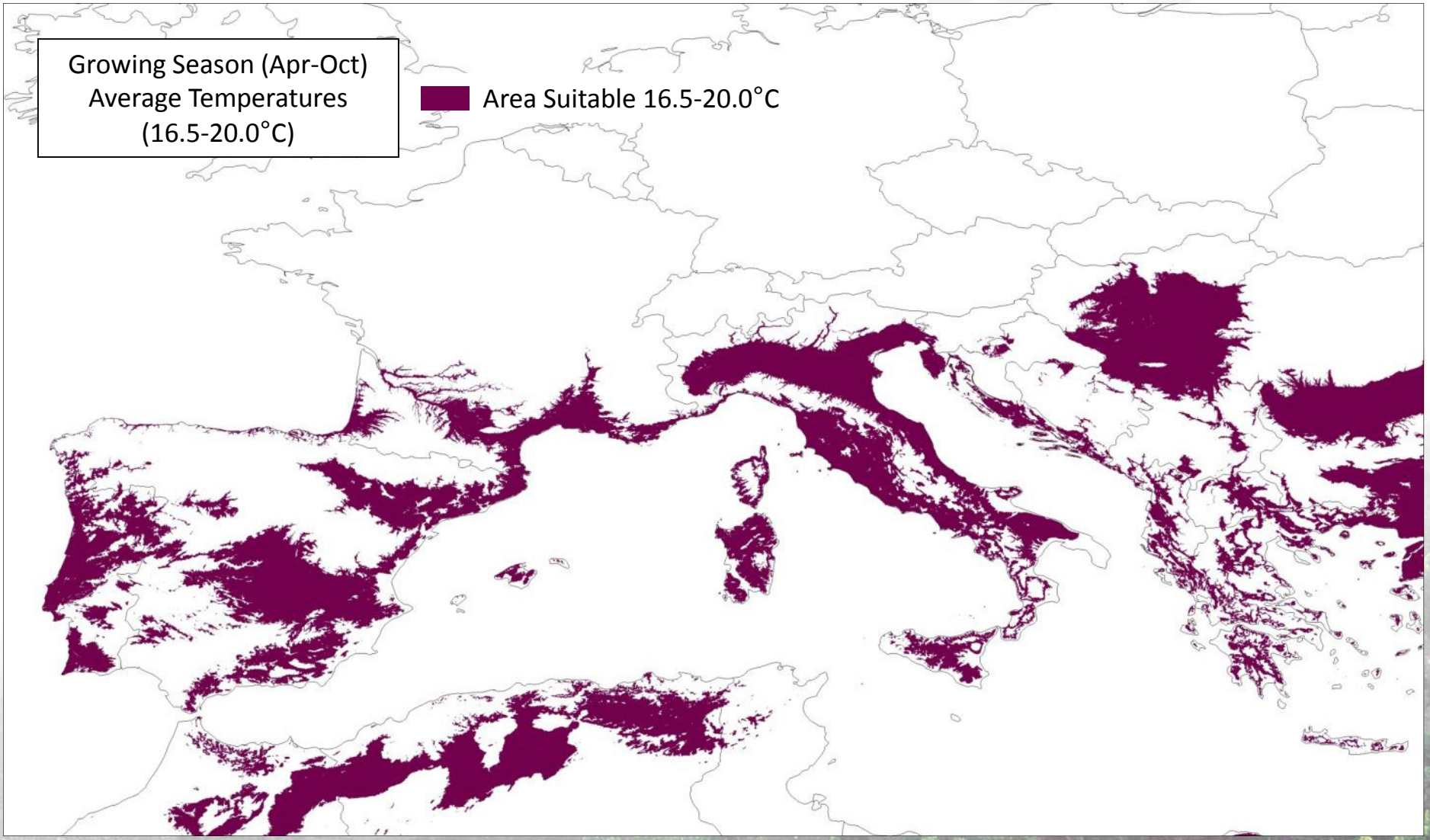


Area Suitable 16.5-20.0˚C

Represents 1950-2000 Average Growing Season Temperatures
(WorldClim database, 1 km resolution)

Gregory Jones, PhD

Grenache Climates in Europe



Represents 1950-2000 Average Growing Season Temperatures
(WorldClim database, 1 km resolution)

Gregory Jones, PhD

Climate Change – Observations

Climate Change Effects on Viticulture/Wine

- Changes in average climate structure and variability
- Warmer and longer growing seasons
- Warmer dormant periods
- Reduced frost damage (in some areas)
- Altered ripening profiles
- Earlier phenology (plant growth events)
- Altered/new disease/pest timing and severity
- Changes in soil fertility and erosion
- CO_2 fertilization … but wine effects?
- Water availability and timing of irrigation
  (some places drier, some wetter)

Observed Changes across the Globe

27 Wine Regions over 1950-2000

- Average growing season warming of 1.3°C
- Average dormant season warming of 1.4°C
- 18 of 27 regions showed increased variability (↑ variance)
- Warming trends are more significant and of greater magnitude in the N. Hemisphere vs. S. Hemisphere

Jones et al (2005) Climatic Change

Observed Changes in Europe

6 days earlier

11 days earlier

15 days earlier

17 days earlier

14 days shorter

8 days shorter

10 days shorter

15 days shorter

12 days shorter

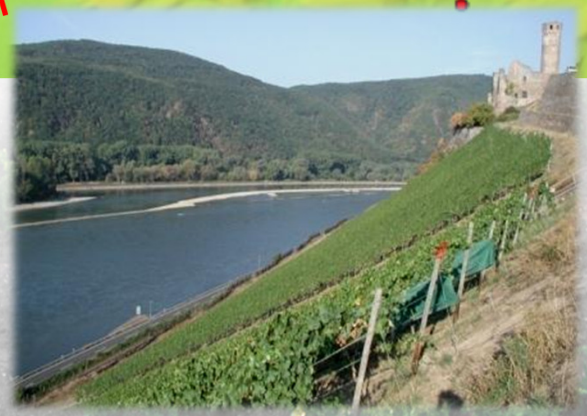
17 days shorter

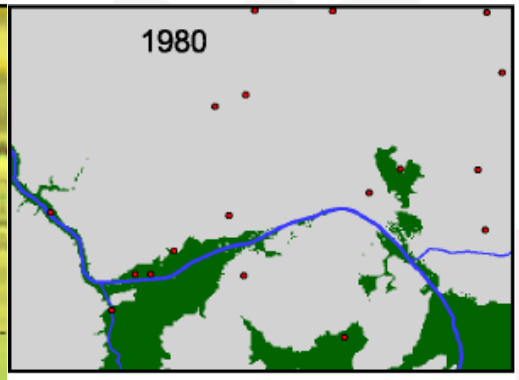
1950-2004

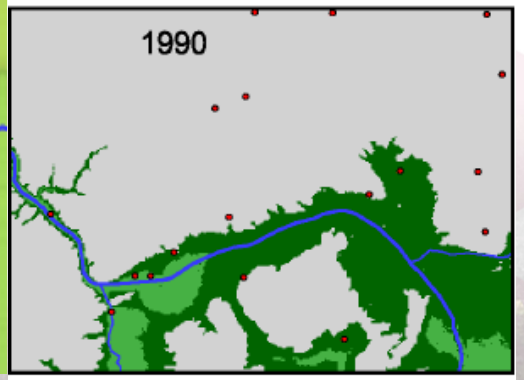
- Growing Season Temperatures +1.7°C
- Driven by changes in minimum not maximum temperatures
- Decline in the # of days below freezing in all seasons (6-32 days)
- Earlier last spring frost (9-38 days)
- Later first fall frost (4-18 days)
- Longer frost-free period (13-41 days)
- Annual and seasonal precipitation levels are highly variable (no trends)
- Phenology relationships over numerous varieties and locations show a 5-10 day response per 1°C of warming

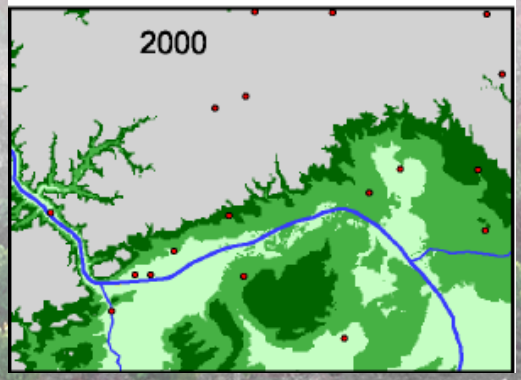
Jones et al (2005) GESCO

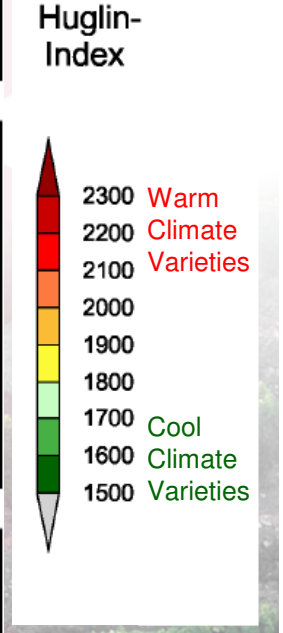
Observed Changes in the Rhine Valley, Germany







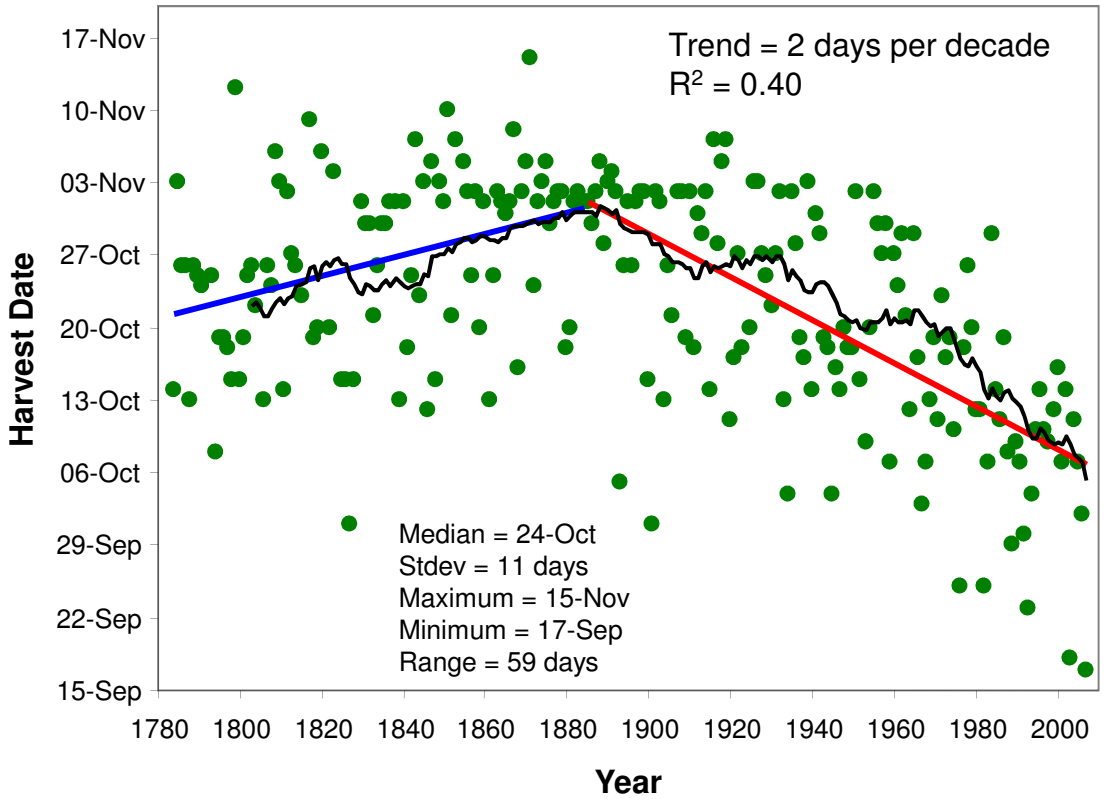




Stock et al. (2007) PIK-Report 106

Observed Harvest Dates in the Rhine Valley

Schloss Johannisberg



Jones and Schultz in progress (2011)

Composition Changes in the Mosel Valley

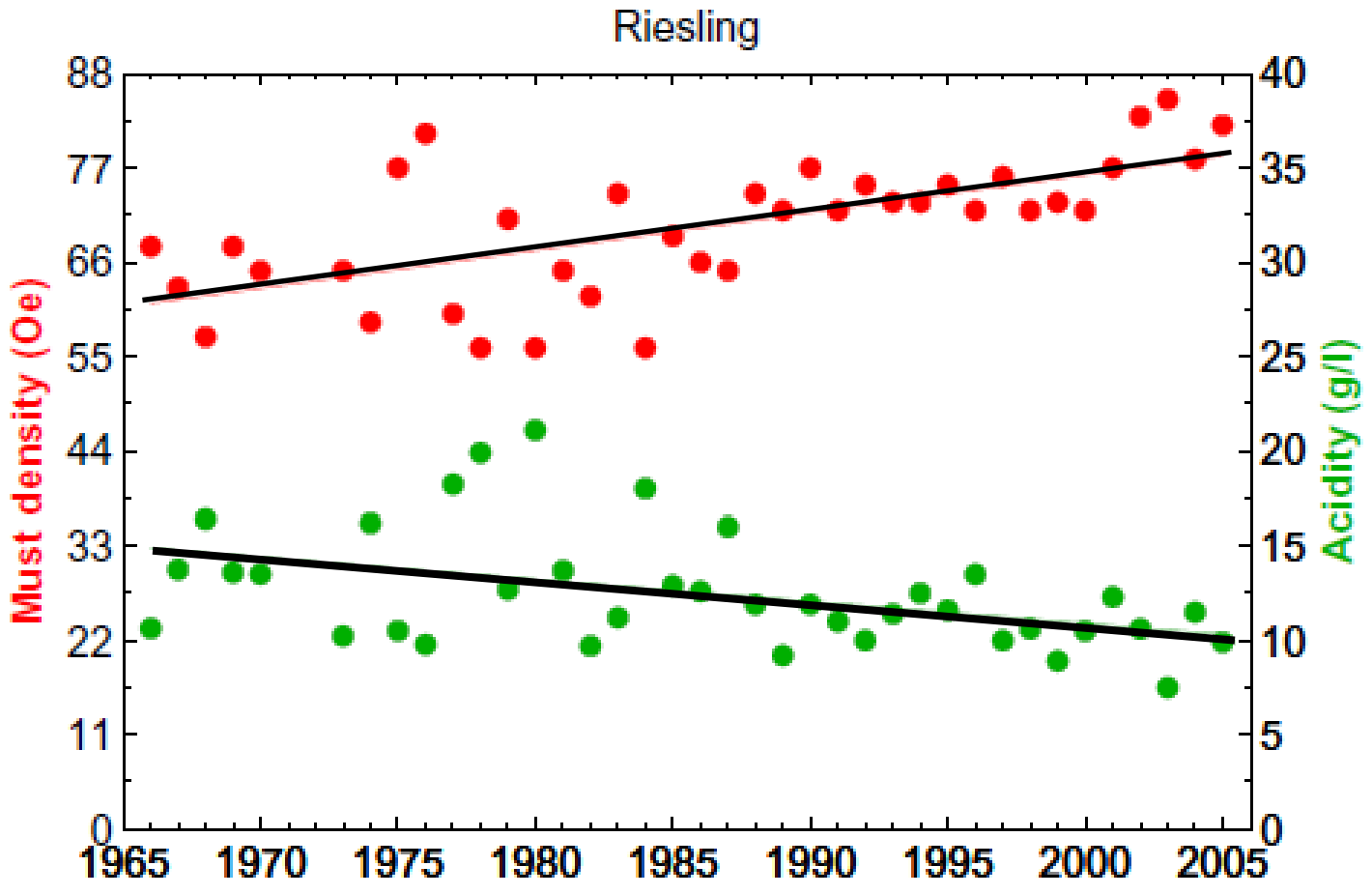
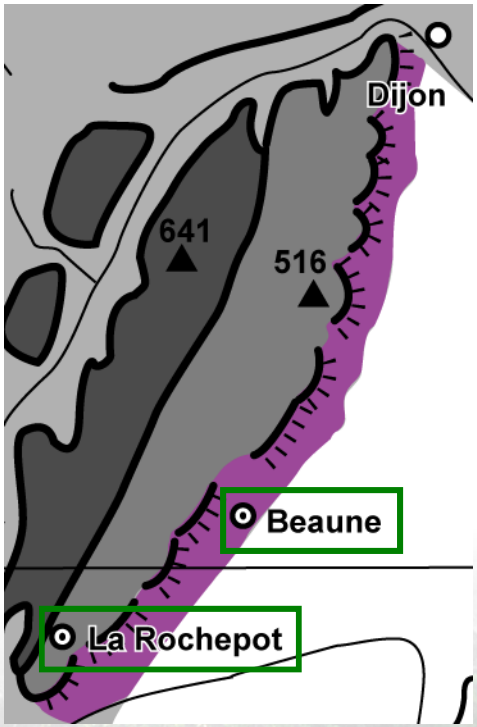


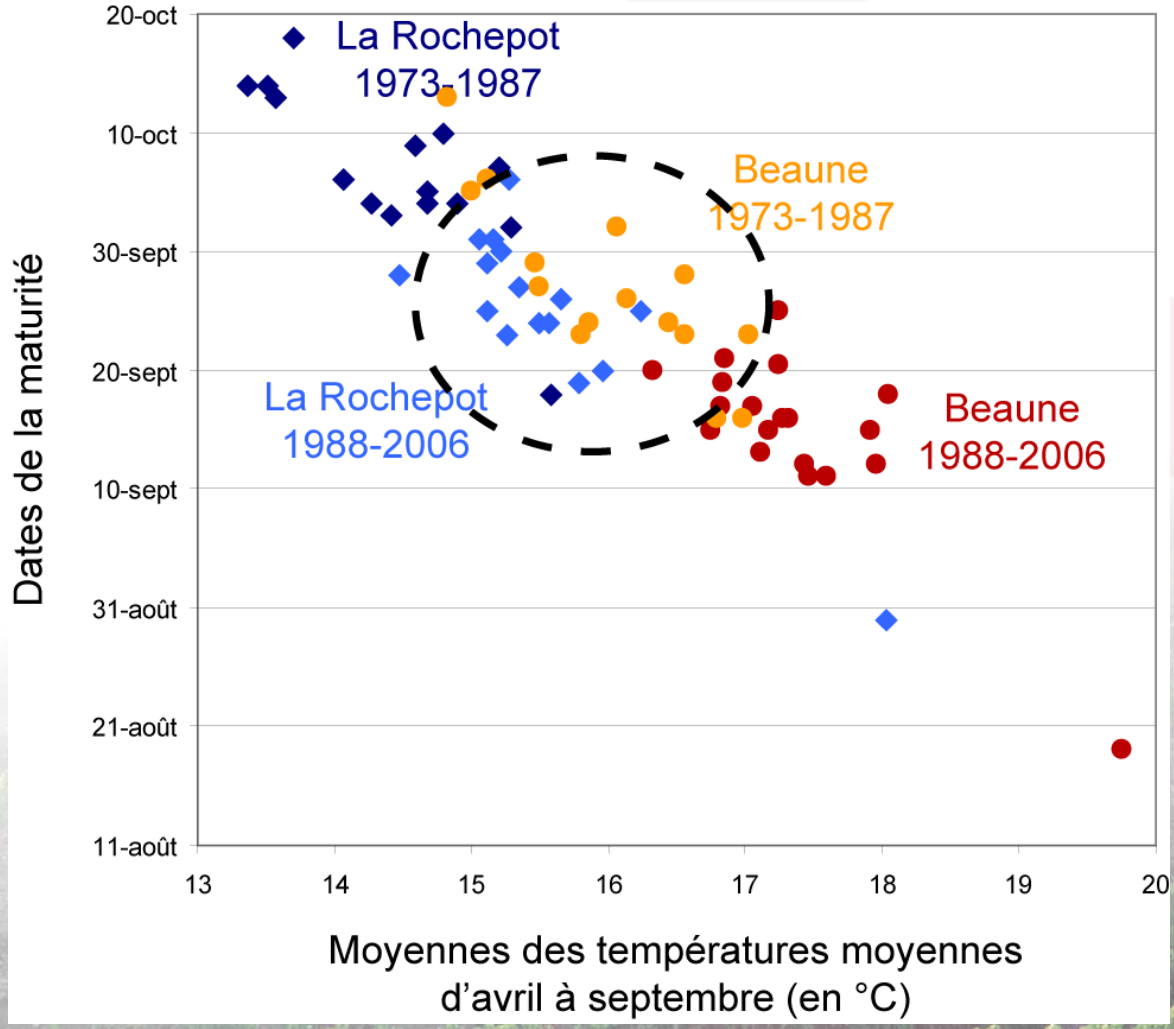
Fig. 11 Time series of must density (red) and acidity (green) with linear trends of the Riesling vine.

Urhausen et al (2010)

Observed Elevational Changes in Burgundy



~ 200 m elevation difference

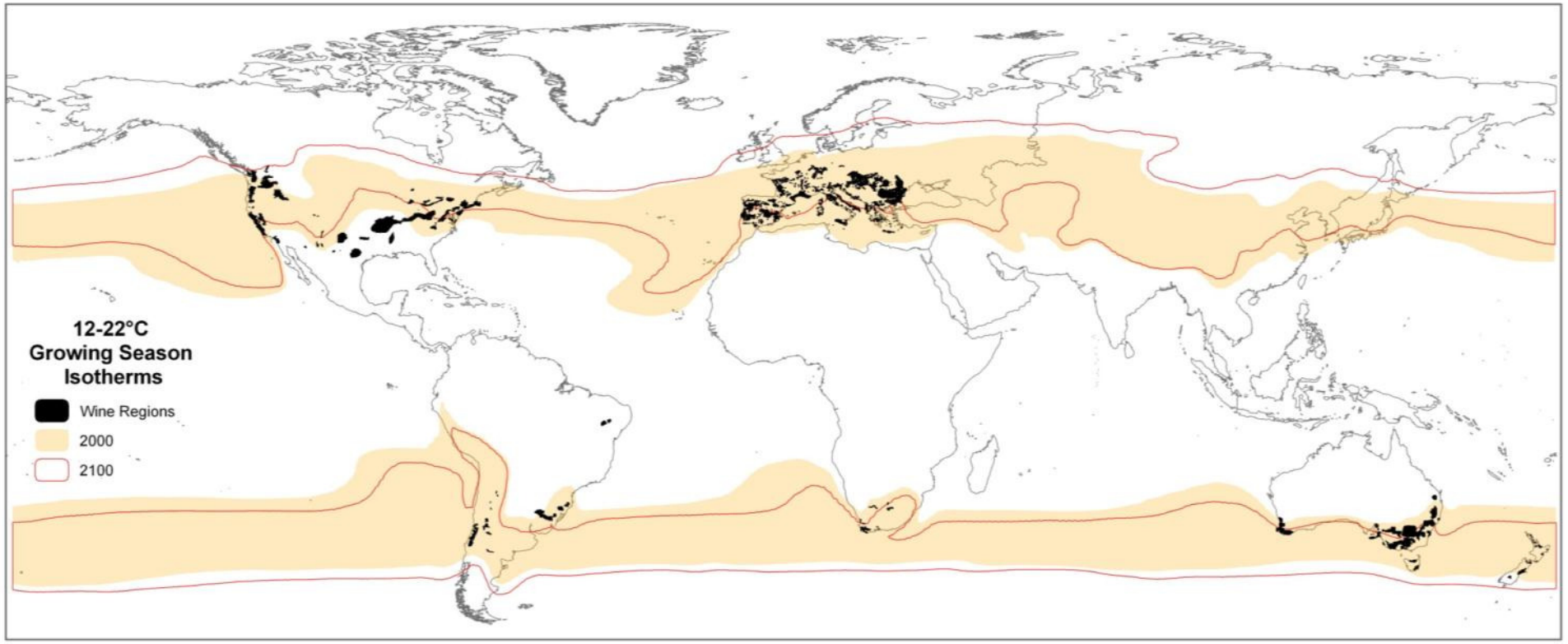


Chabin and Madelin, 2007

Climate Change – The Future

Global Viticulture Zones

Growing Season Average Temperature Isotherms (12-22°C)
Northern Hemisphere (Apr-Oct); Southern Hemisphere (Oct-Apr)

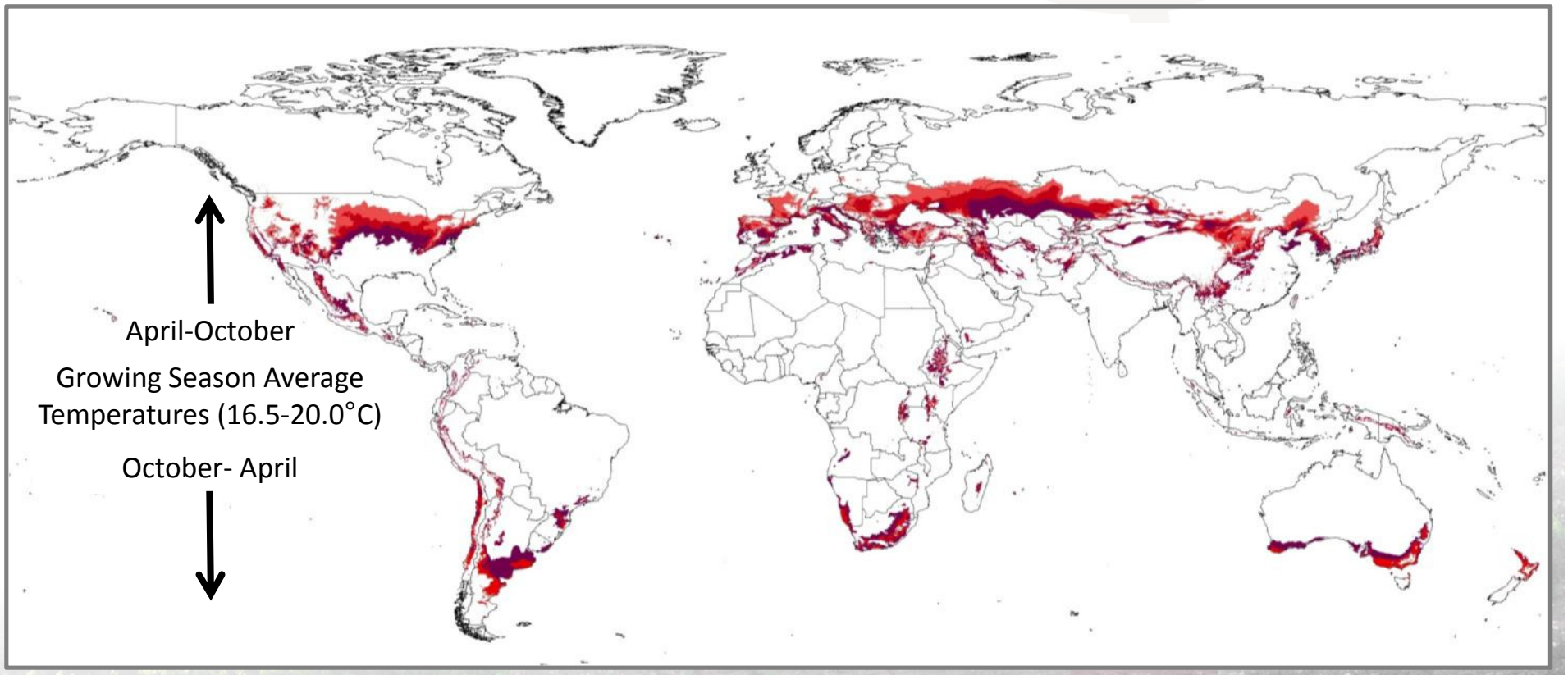


Isotherms shift poleward ~280-500 km (from 2000)
Some expansion NH, mostly declines SH

National Center for Atmospheric Research's
Community Climate System Model (CCSM)
A1B (mid-range scenario): 1.4° x 1.4° Lat/Lon

Jones, 2007

Grenache Climates Worldwide +2°C

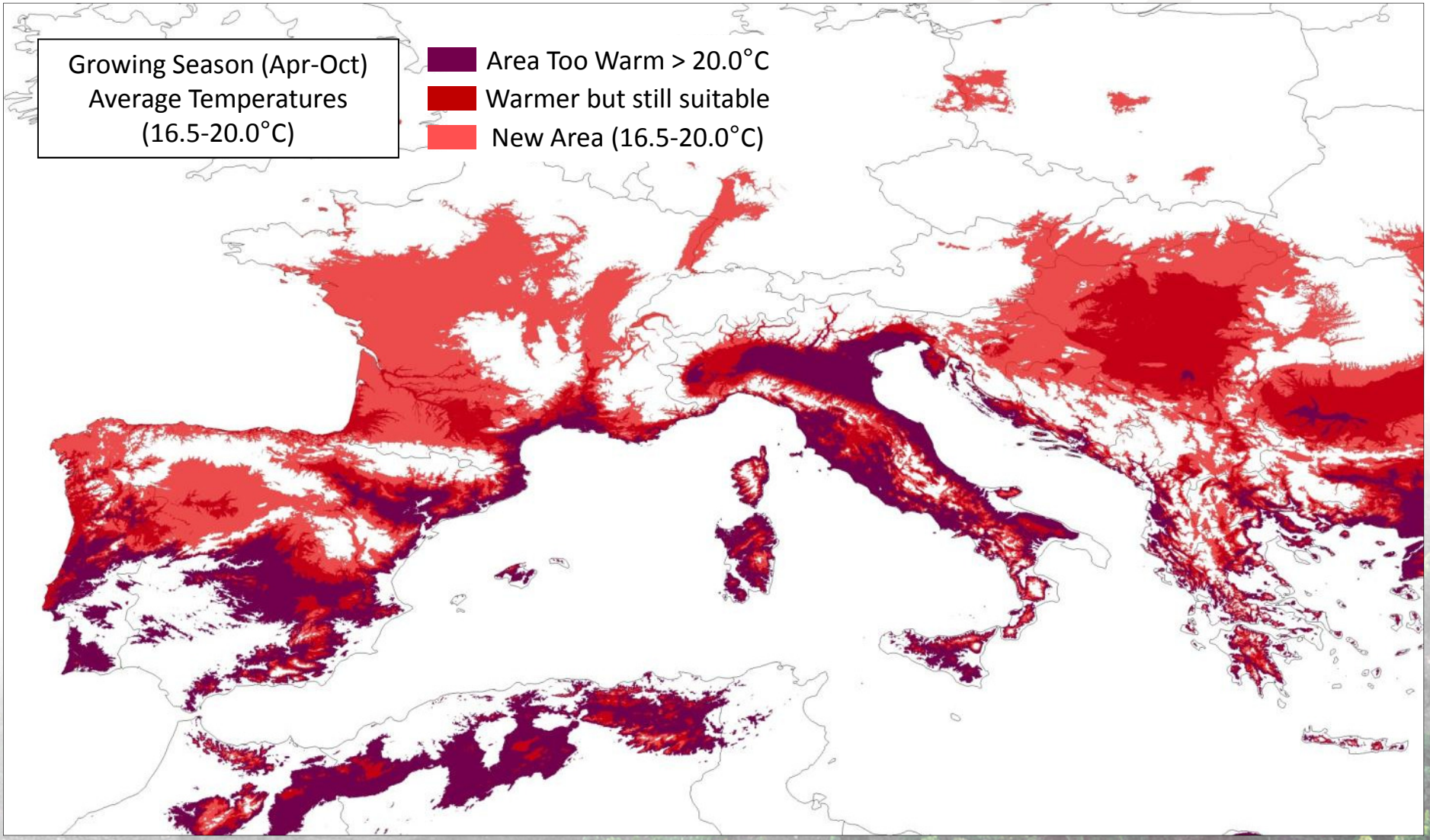


Area Too Warm > 20.0°C
Warmer but still suitable
New Area (16.5-20.0°C)

Represents ~2°C warming from the1950-2000 time period for Average Growing Season Temperatures, based on an A1B emission scenario for 2050

Gregory Jones, PhD

Grenache Climates in Europe +2°C



Represents ~2°C warming from the1950-2000 time period for Average Growing Season Temperatures, based on an A1B emission scenario for 2050

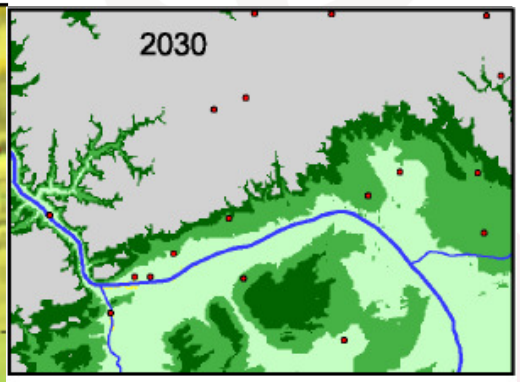
Gregory Jones, PhD

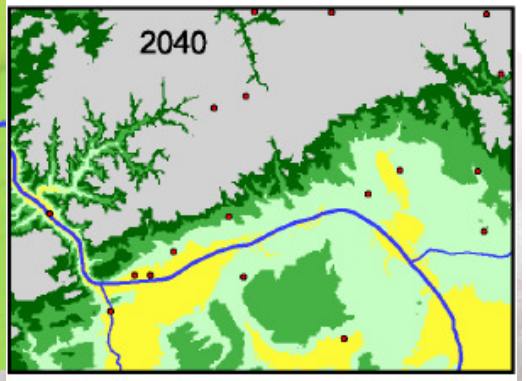
Predicted Changes across the Globe

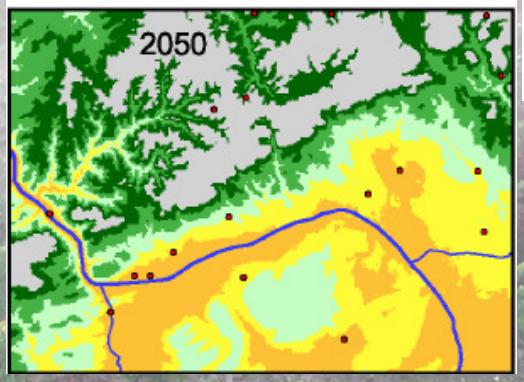
27 Wine Regions for 2000-2050

- All regions show growing season warming with trends ranging 0.2-0.6°C per decade and an average warming of 2.0°C/50 years
- South Africa lowest (0.9°C/ 50y), Iberia the highest 2.8°C/ 50y)
- 20 of 27 regions showed increased variability (↑ variance)
- N.H. (2.1°C/50 years) > S.H. (1.7°C/50 years)

Predicted Changes in the Rhine Valley, Germany





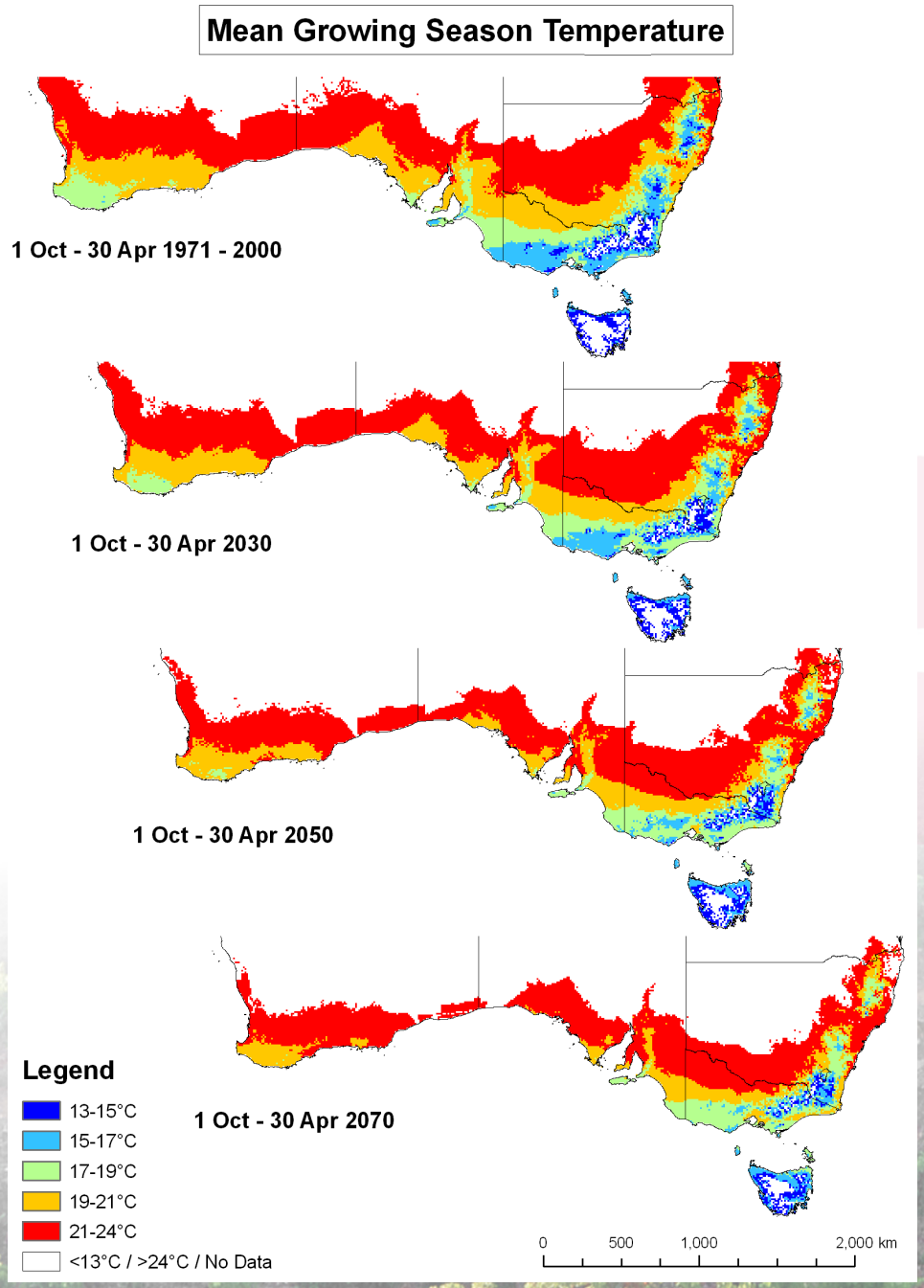


Huglin-
Index

2300 Warm
2200 Climate
2100 Varieties
2000
1900
1800
1700 Cool
1600 Climate
1500 Varieties

Stock et al. (2007) PIK-Report 106

Projections in Spatial Changes in Suitable Zones for Australian Wine Regions



Cool climate suitability

Intermediate climate suitability

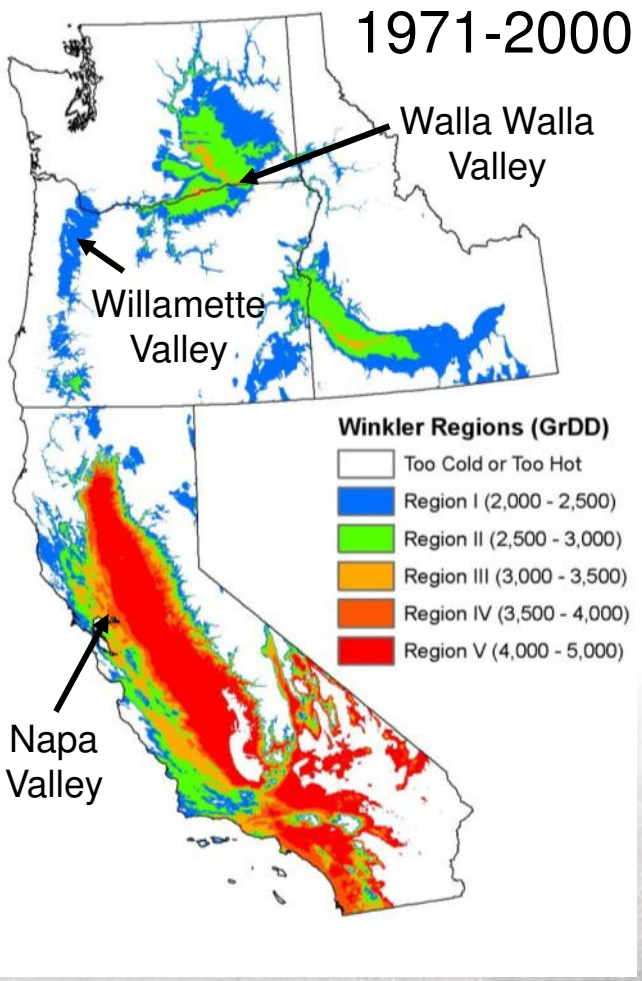
Warm climate suitability

Hot climate suitability

Very Hot climate suitability

Hall and Jones (2009) AJGWR

Temporal & Spatial Changes in Growing Degree-Days



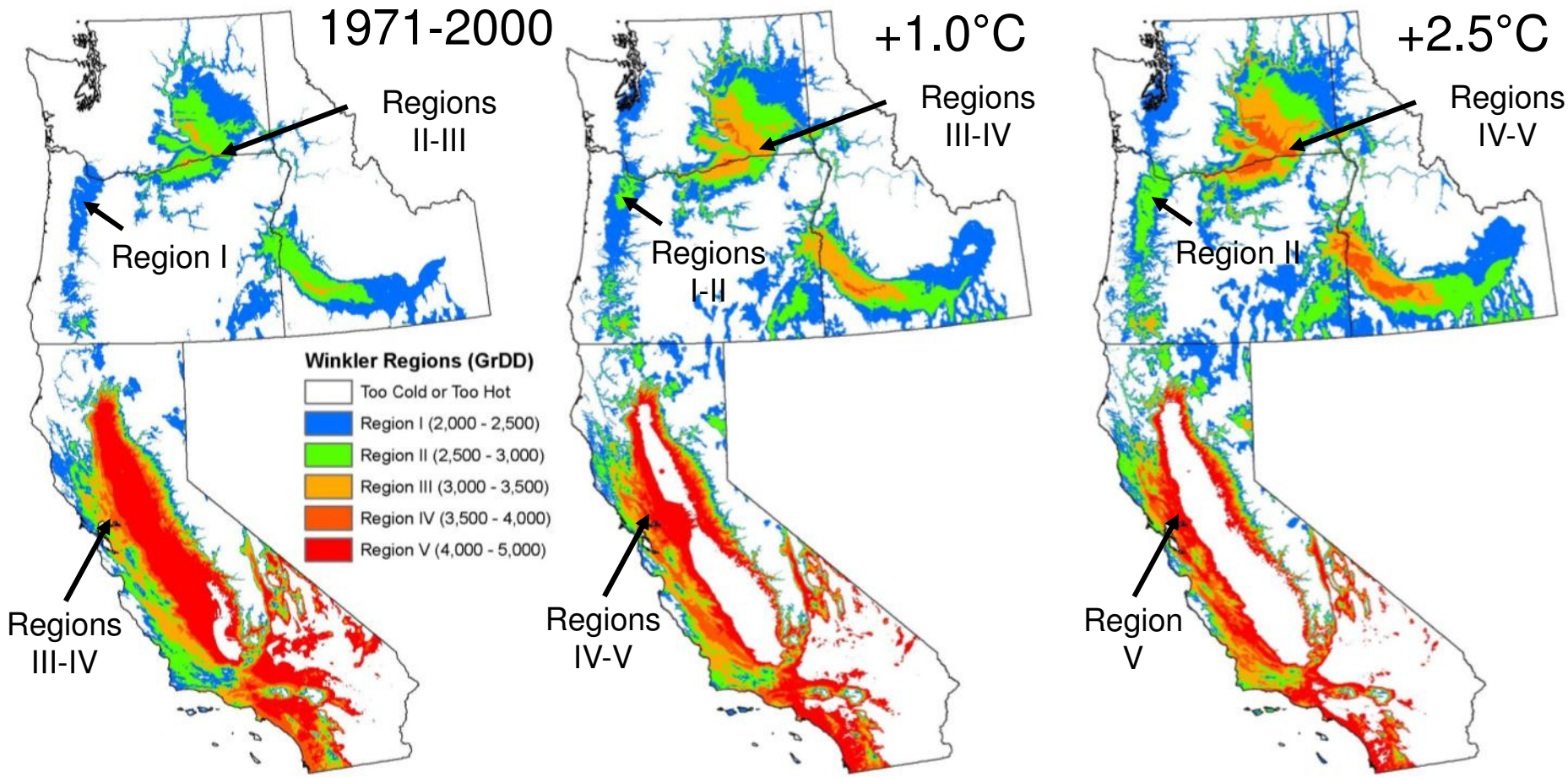
Blue – Cool climate varieties such as Pinot Noir, Chardonnay

Orange – Warm climate varieties such as Merlot, Cabernet Sauvignon

Red – Hot climates for bulk wine and table grapes

Jones, 2007

Temporal & Spatial Changes in Growing Degree-Days



Blue – Cool climate varieties such as Pinot Noir, Chardonnay

Orange – Warm climate varieties such as Merlot, Cabernet Sauvignon

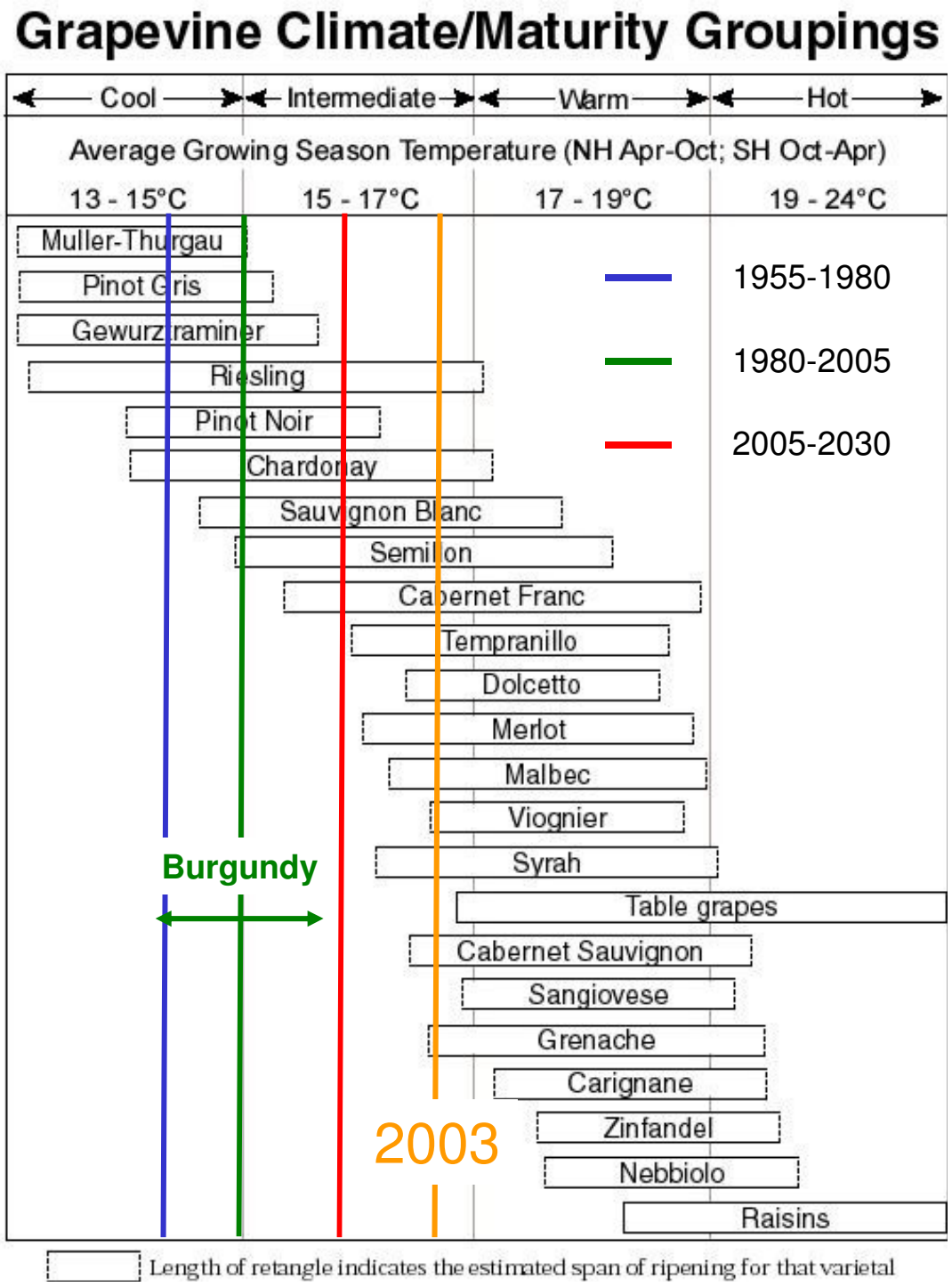
Red – Hot climates for bulk wine and table grapes

Jones, 2007

… Burgundy's past and projected future climate change …

- Growing season temperatures from 1955-1980 where on average like the coldest years during 1980-2005
- Growing season temperatures in 2005-2030 are projected to be like the warmest of years during 1980-2005
- Is 2003 an analog of future <u>average</u> or <u>extreme</u> conditions?

Jones, 2006



Overview and Potential Implications

- Wine production is a climatically sensitive endeavor
- Narrow zones provide the most optimum quality and production characteristics
- As such the industry incurs greater risk from climate variations and change than other broadacre crops

Climate Structure and Suitability

- We still have an incomplete picture of global structure and suitability for all varieties
- We have a better understanding of cool climate thresholds, however much uncertainty exists in the upper limit thresholds of most varieties

Overview and Potential Implications

Climate Variability

- Wine region climate variability plays a dominant role in production and quality variations, and therefore strongly influences economic risk
- Climate variability in the majority of wine regions has been more pronounced in the last 15-20 years and models project continued increases in variability, bringing further risk on top of the average changes in climate

Overview and Potential Implications

Climate Change

- Observed warming is evident, some benefits and opportunities, but negative impacts have occurred
- Continued warming is likely for the planet as a whole
- Meta-Analysis indicates a ~1.5-2.5°C warming in wine regions globally by 2050, but uncertainties exist

Risk and Adaptive Capacity/Strategies

- Growers/Producers continually undergo tactical and strategic changes to climatic conditions, but not in isolation
- Growers/Producers operate in a multi-risk environment (climate, markets, policy) and the status of adaptation determines future vulnerabilities
- The gradual nature of climate change should provide growers/producers sufficient time to develop/utilize adaptation strategies to enhance sustainability
- However, research/innovation/technology transfer must be done to minimize vulnerability and maximize adaptive capacity

Important Areas of Research

Physical Science

- Understanding cultivar suitability and adaptability
- Carbon source/sink issues (FACE, etc)
- Traditional plant breeding and genetics
- Vineyard management adjustments
- Winery processing, fermentation, etc

Social Science

- Cultural vulnerability and adaptability to change
- Economic sustainability
- Market issues, brand recognition and its adaptability
- Carbon issues … cap-and-trade, regulation, etc


Thank You!
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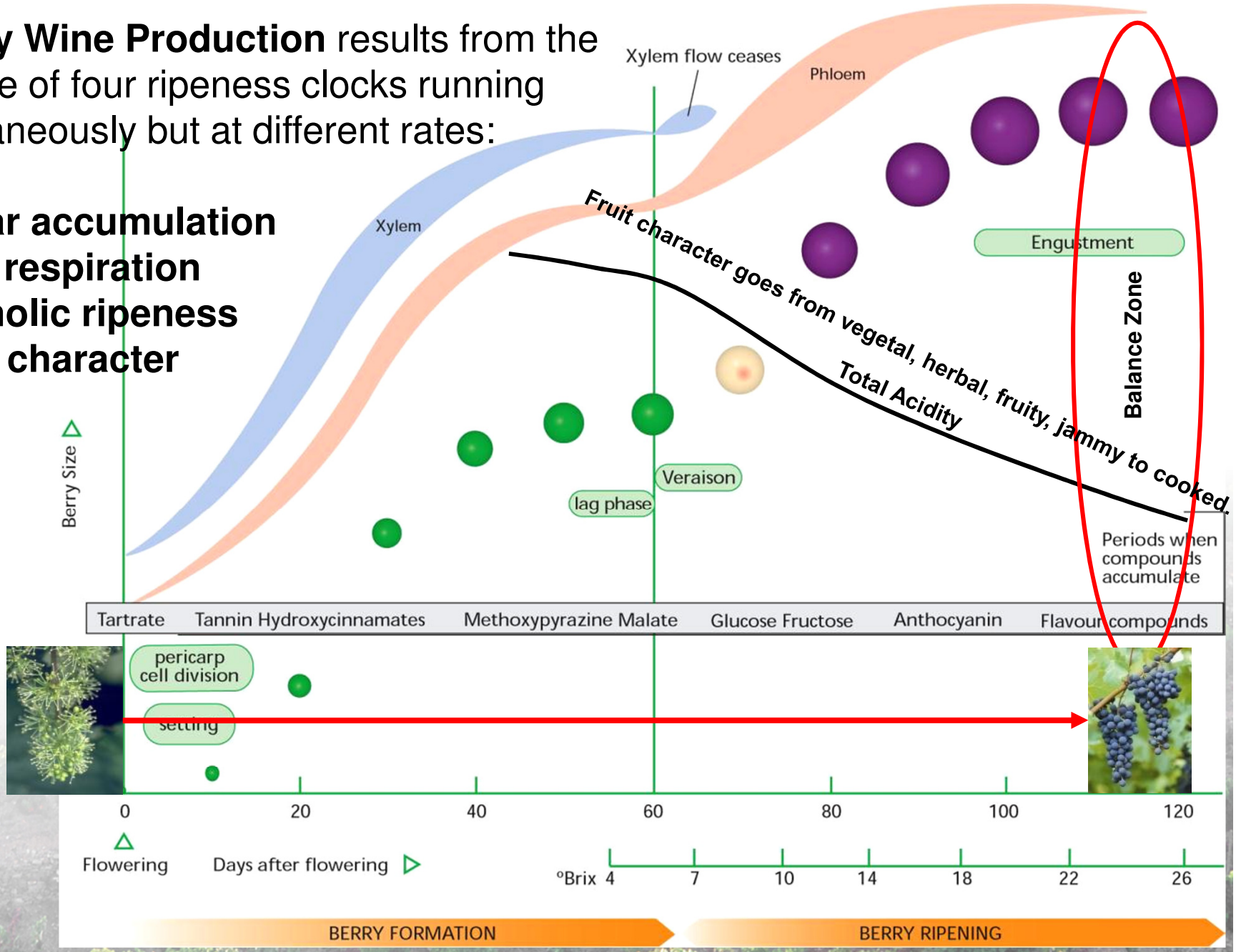
Quality Wine Production results from the balance of four ripeness clocks running simultaneously but at different rates:

- **Sugar accumulation**
- **Acid respiration**
- **Phenolic ripeness**
- **Fruit character**



Australian Viticulture from text: "Ripening berries – a critical issue" by Dr. Bryan Coombe and Tony Clancy (Editor, *Australian Viticulture*), March/April 2001. Illustration by Jordan Koutroumanidis and provided by Don Neel *Practical Winery and Vineyard*

Climate Influences on Vine Growth, Productivity, and Quality

Harvest	Bud Break	Flowering	Véraison	Harvest
				
Slow hardening of vines, sufficient chilling units, low impact from winter extreme temperatures	Combined effects of soil/air temperature and day length changes, but low frost risk	Optimum daytime maximum temperatures, high solar potential, low cloud cover and rainfall	Optimum heat accumulation, low temperature variability, low heat stress	Diurnal temperature range, truncation of season, day length changes, low rainfall

Uncertainties and Likely Issues

Climate Change uncertainty issues include:

- Climate system sensitivity
- Emission scenario (already at upper end)
- Changes in extremes (↑ frost, heat, precipitation, etc)
- Variability in the climate system (↑↑)

For Many Wine Regions the major issues will be:

- Warming at night, during the day or both? (+/-)
- Coastal zone cooling versus inland warming? (+/-)
- Water for irrigation and/or its seasonal availability
- What effect will population growth, land use changes, and continued irrigation use have?