The wine industry

a model for climate change attribution and adaptation studies

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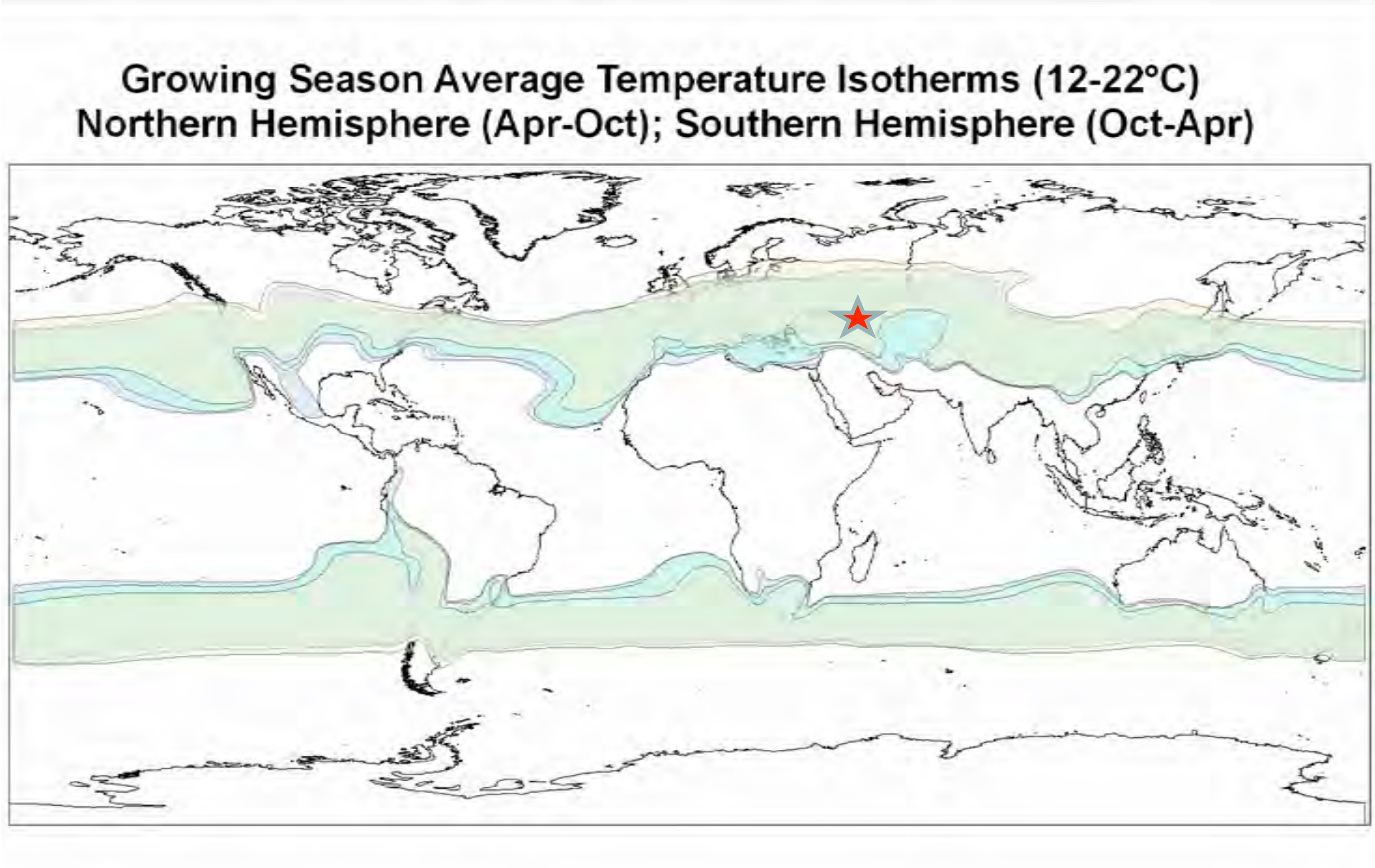
Viticulture – *the canary in the coalmine*




Evolution of *Vitis vinifera*

- *Vitis vinifera evolved in Caucasus Mountains- Georgia*
- *In close proximity to Mesopotamia –the cradle of civilization*
- *Integal part of early diets ! with- wheat, rye ,barley –beer*

Wine grape culture is practiced internationally within a narrow latitude band and temperature range



(Jones 2005)

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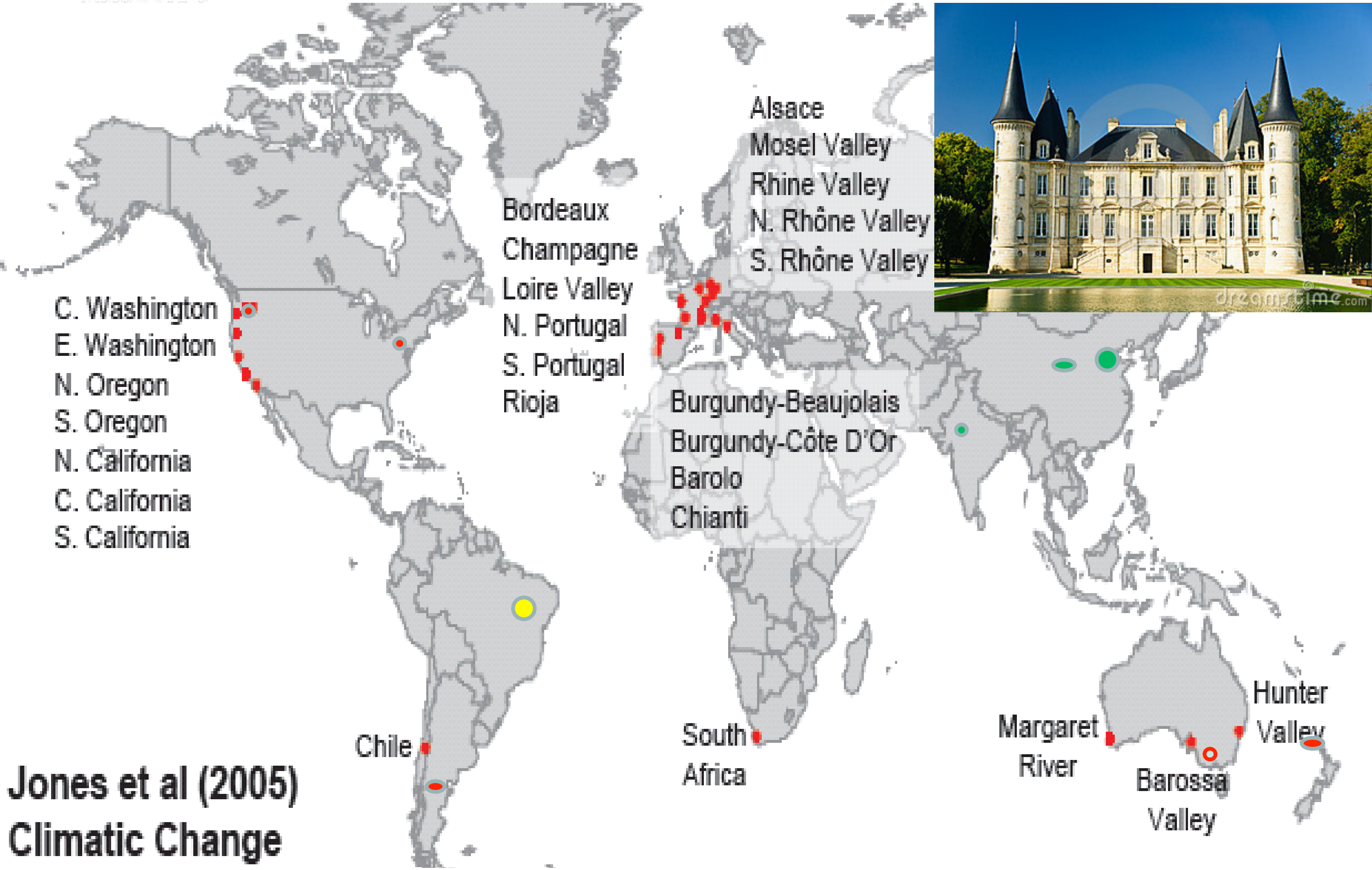
Global Wine Industry
founded by French on concept of Terroir



Jones et al (2005) Climatic Change

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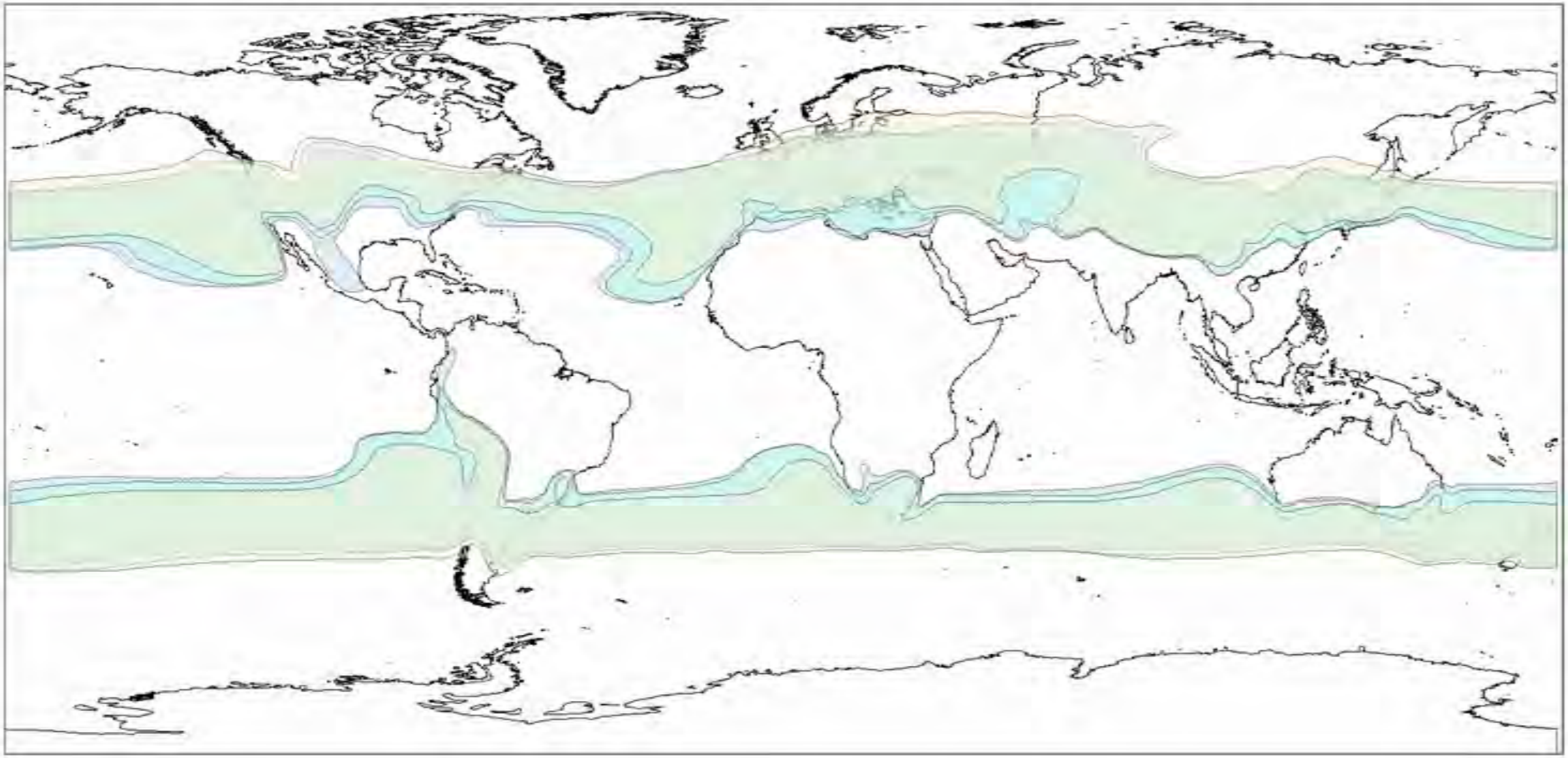
What happens when Terroir moves !

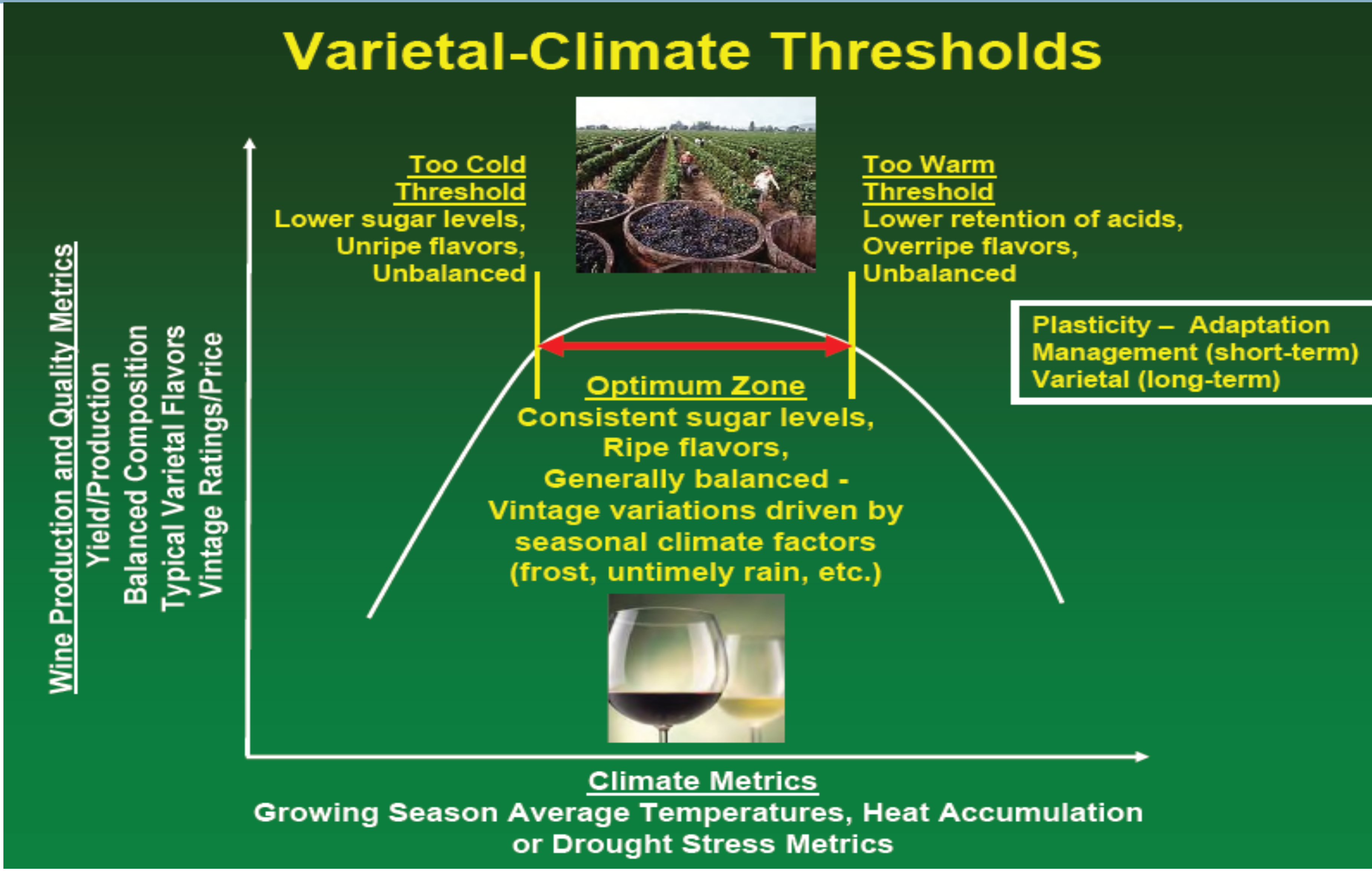
Growing Season Average Temperature Isotherms (12-22°C)
Northern Hemisphere (Apr-Oct); Southern Hemisphere (Oct-Apr)



2050 ***Isotherms move poleward by 150-300km - NH area expands ,SH declines***

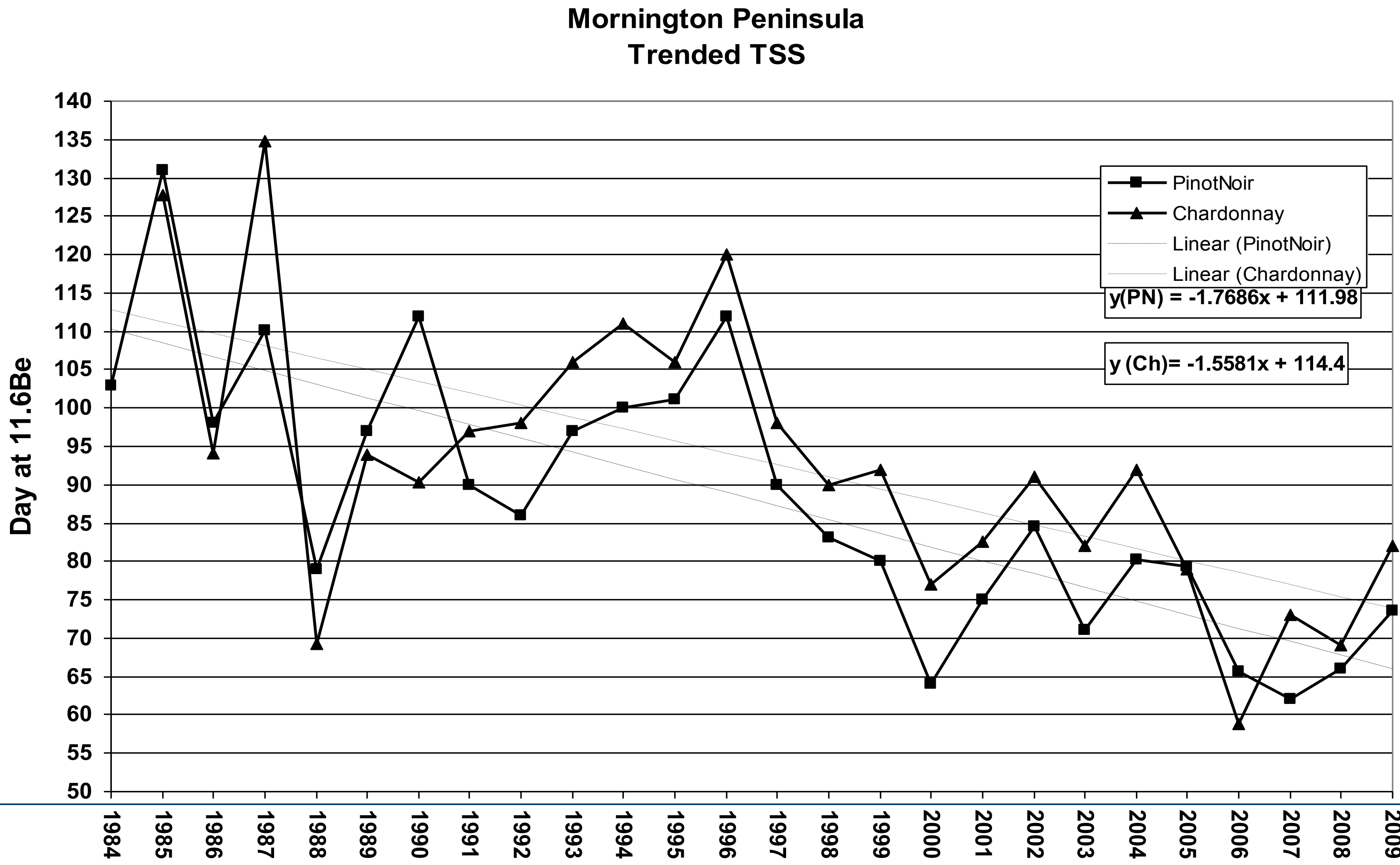
Why is Terroir Important

Varietal Expression necessary for quality wine

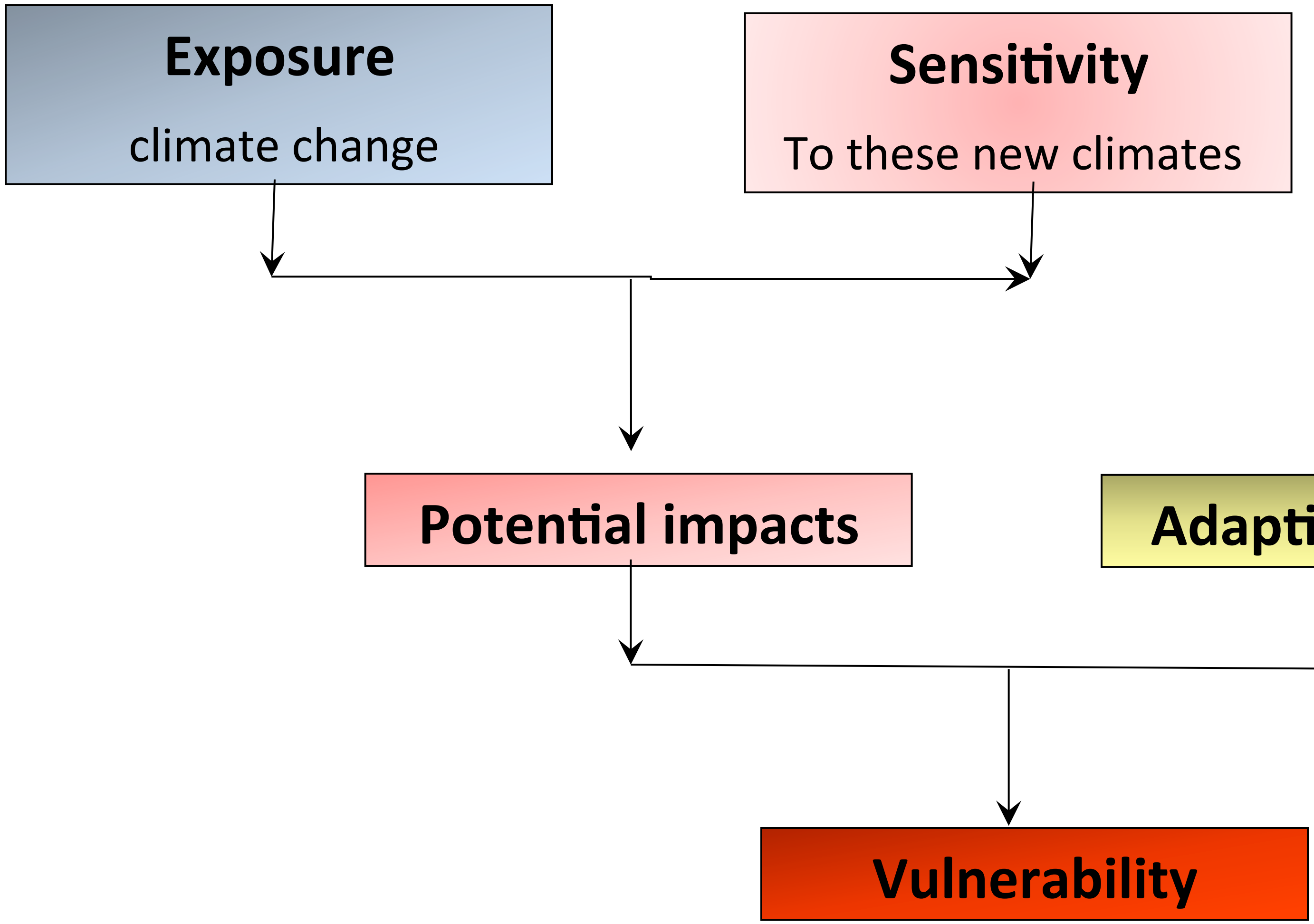


Grapevine Phenology Influenced by CC

Globally vintages are moving forward in most regions under climate change
Some Australian regions have moved forward by 1.6 days per year over past 25 years



Climate Change Adaptation
a risk management framework



Grapevine Varieties are grouped according to their climate suitability - Terroir

GROUP	*TEMPERATURE (MJT)	VARIETY BEST SUITED
1	15.8-19 °C	Pinot Noir Chardonnay Sauvignon Blanc
2	19.1-20.1 °C	Cabernet Sauvignon Merlot Cabernet Franc
3	20.2-20.6 °C	Many suited. No best suited.
4	20.7-22.2 °C	Shiraz Semillon Muscadelle
5	22.3-23.3 °C	Malbec Riesling Traminer Verdelho
6	23.4-24.8 °C	Chenin Blanc Ruby Cabernet Colombard

MJT – Mean January Temperature

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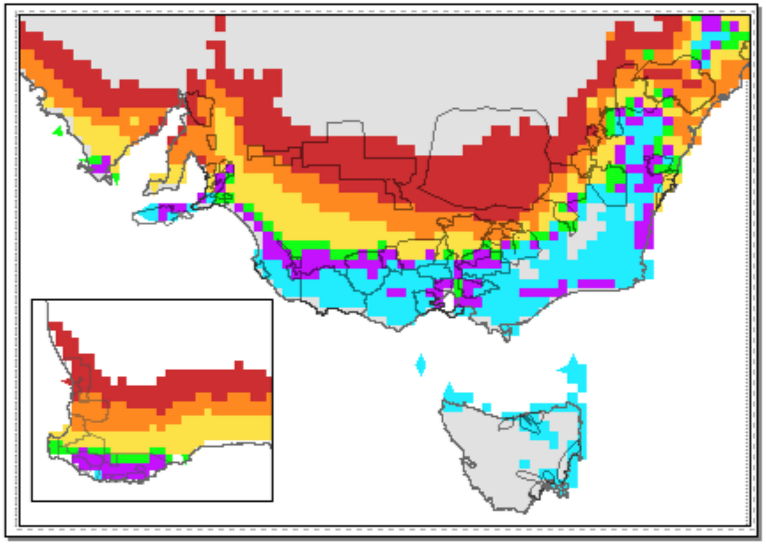
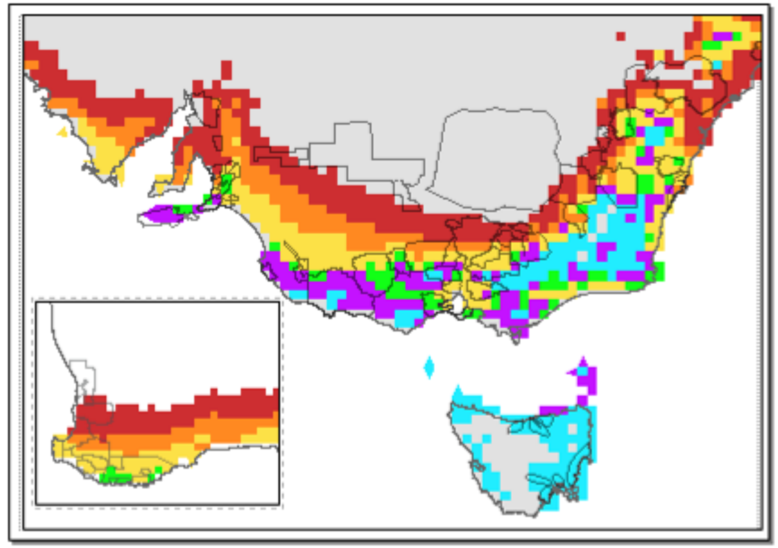
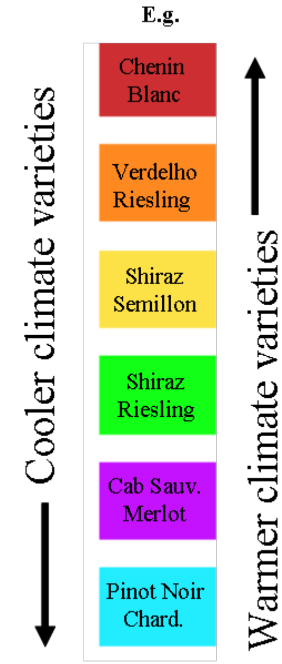
Case Study 1: Imagining the future Changing the Terroir



Present Climate



Year 2050 mid warming



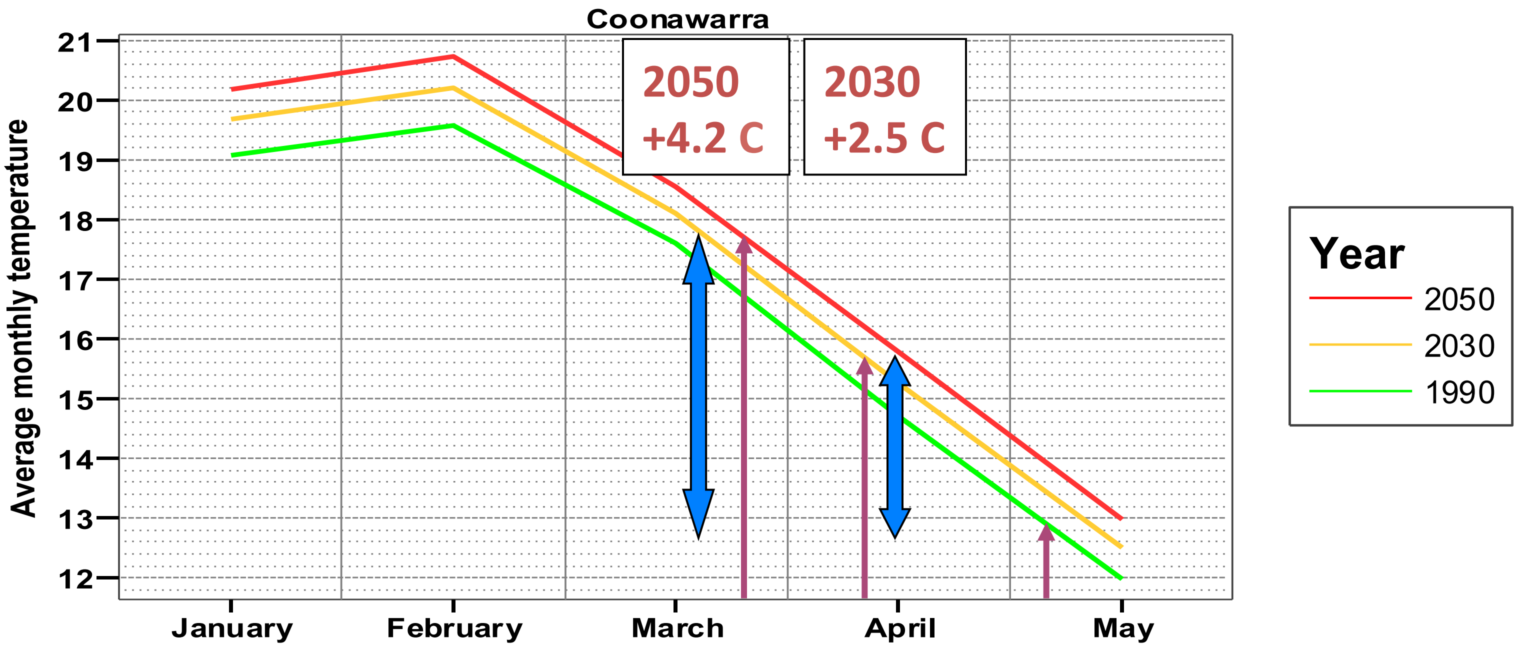
Adaptation Options

Stay where you are and change varieties.

or

Move to suitable climate for existing variety.

Potential Impacts of Climate Changes in Grape Maturity



+ -Altered fruit composition

--Vintage compression

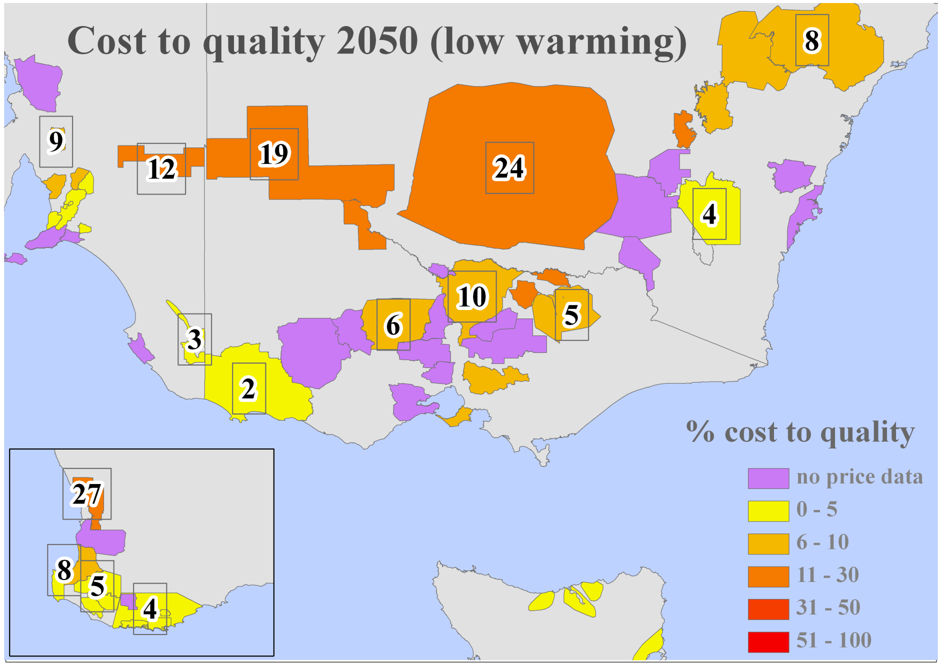
--Pressure on winery infrastructure

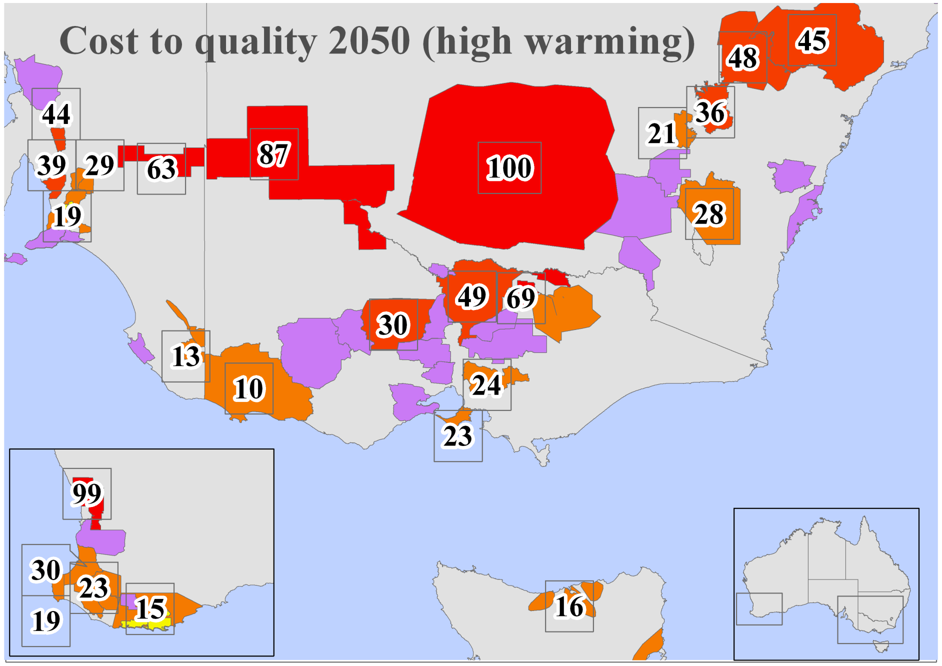
+--Higher Alcohol wine

Webb, Whetton,Barlow(2007)

Potential Impacts of Climate Change on Grape Quality in major Australian wine regions

Potential Impacts -*without Adaptive measures*





Webb, Whetton, Barlow(2008)

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Case Study 2:Managing extreme events

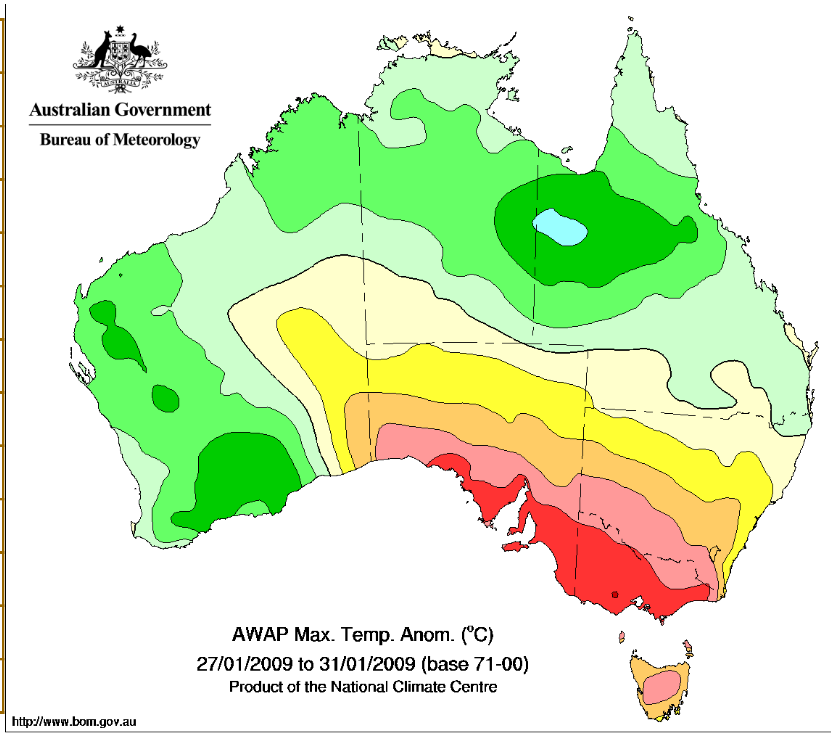
Capture and codify what we already know

Maximum temperature anomalies

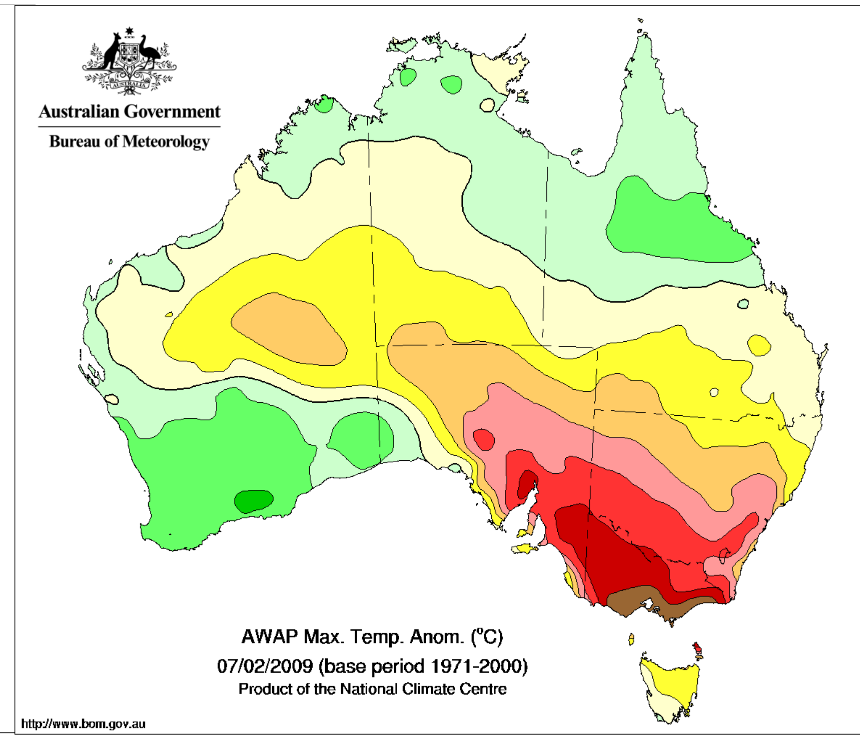
(differences from the 1971-2000 average)

°C	°F
18	64.4
15	59
12	53.6
9	48.2
6	42.8
3	37.4
0	32
-3	26.6
-6	21.2
-9	15.8
-12	10.4
-15	5
-18	-0.4

27-31 January 2009



7 February 2009

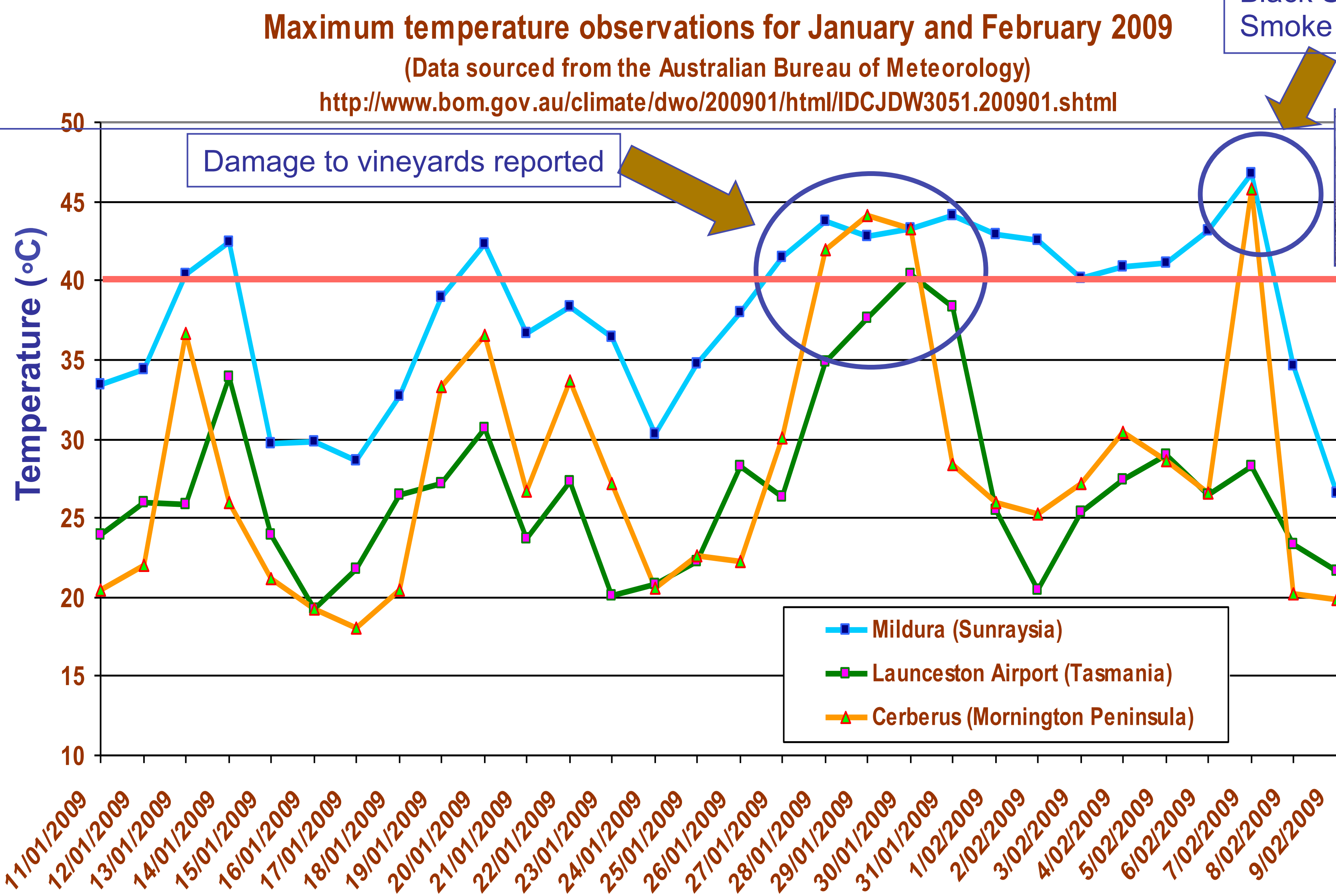


Source: http://www.bom.gov.au/climate/current/statements/scs17d.pdf

Vineyard temperatures in heat wave

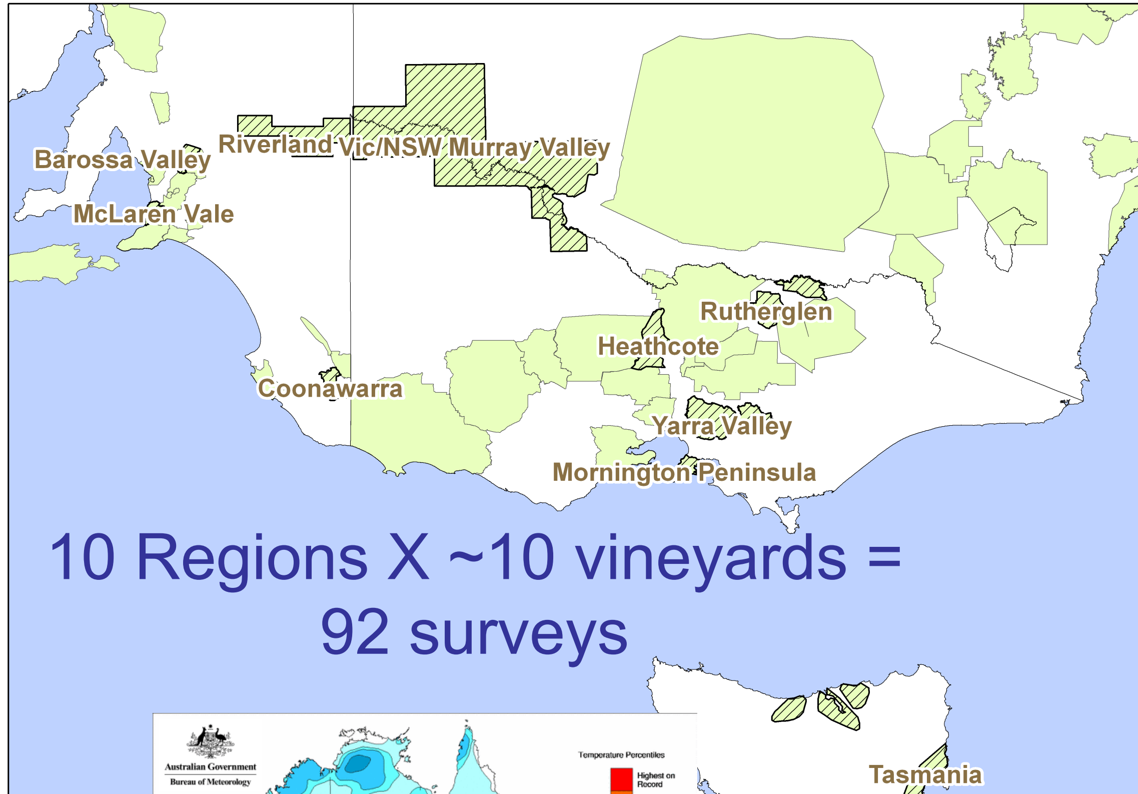
Black Saturday
Smoke taint?

Damage to vineyards reported

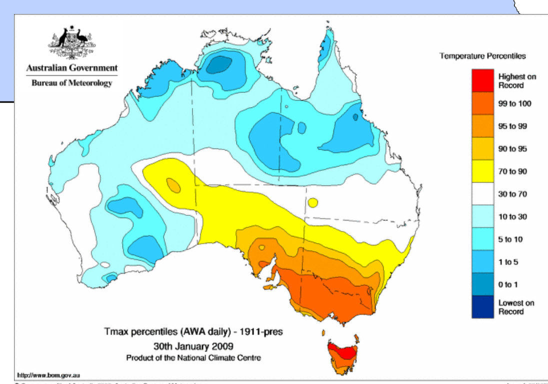


Adaptation Approach
Post event survey

Documenting regional and inter-regional variation of <u>viticultural impact</u> and <u>management input</u> surrounding the 2009 summer heatwave in SE Australia.

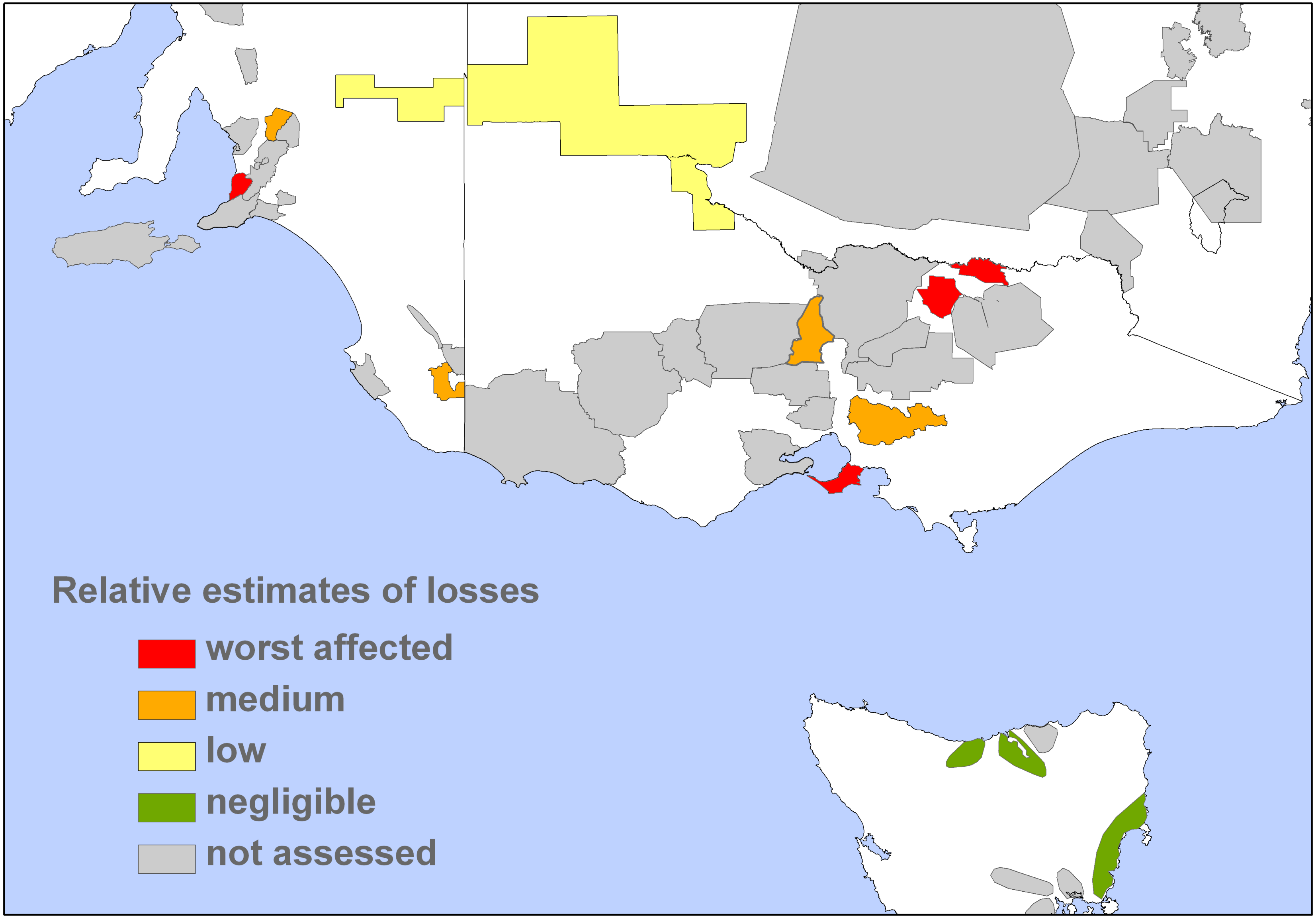


10 Regions X ~10 vineyards = 92 surveys

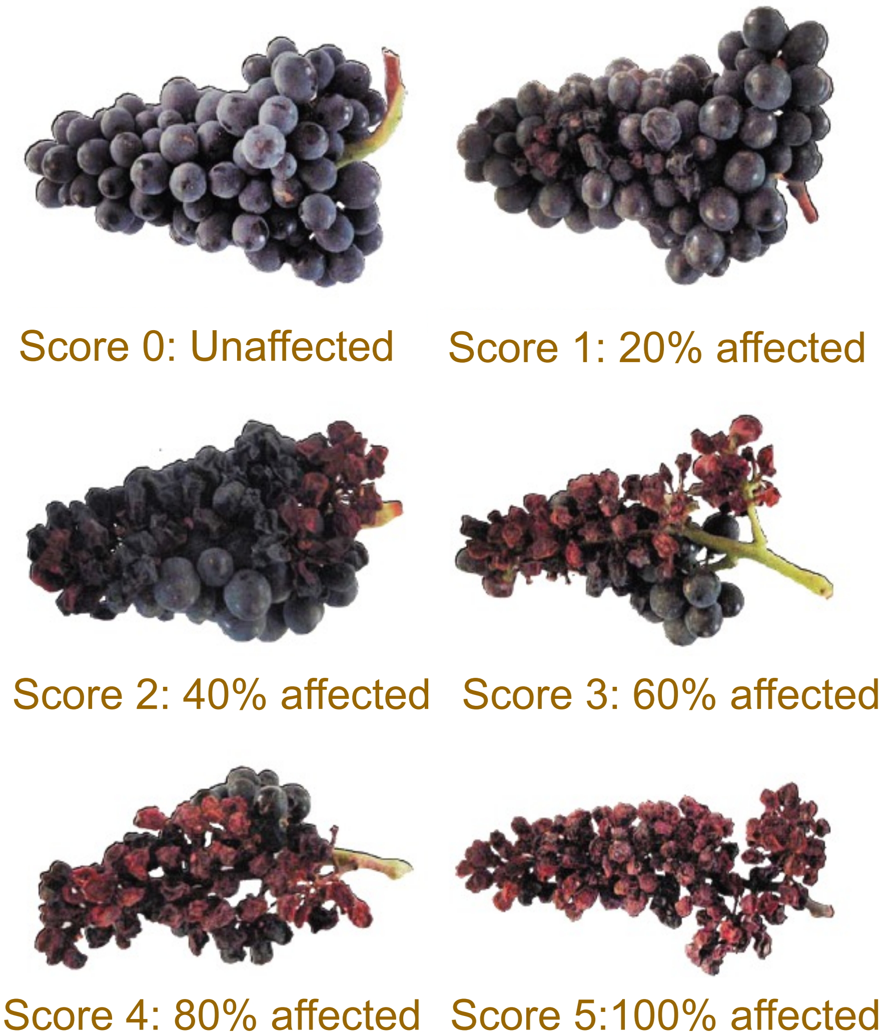


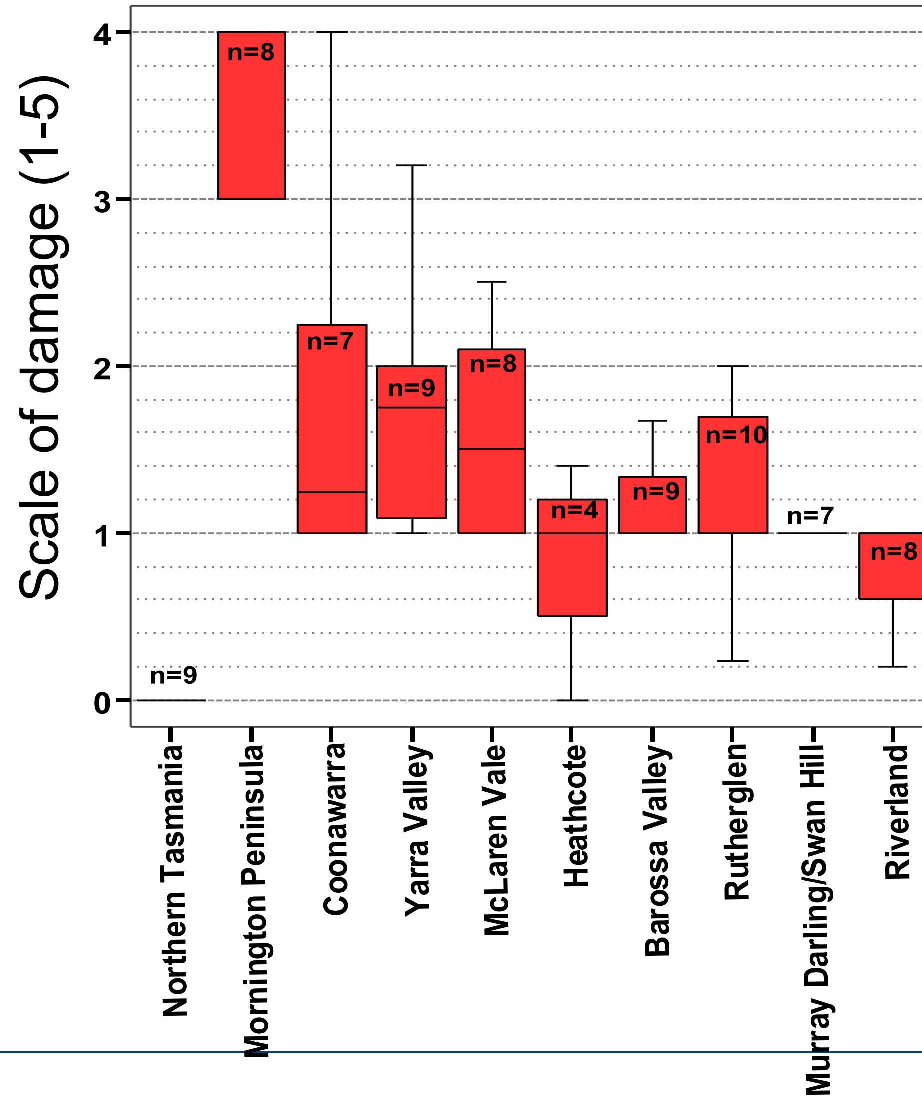
1. **Weather Awareness**
2. **Vineyard impact**
3. **Management strategies**
4. **Self assessment: what worked/ what didn't**

Regional variation of reported damage



Variation in regional impact





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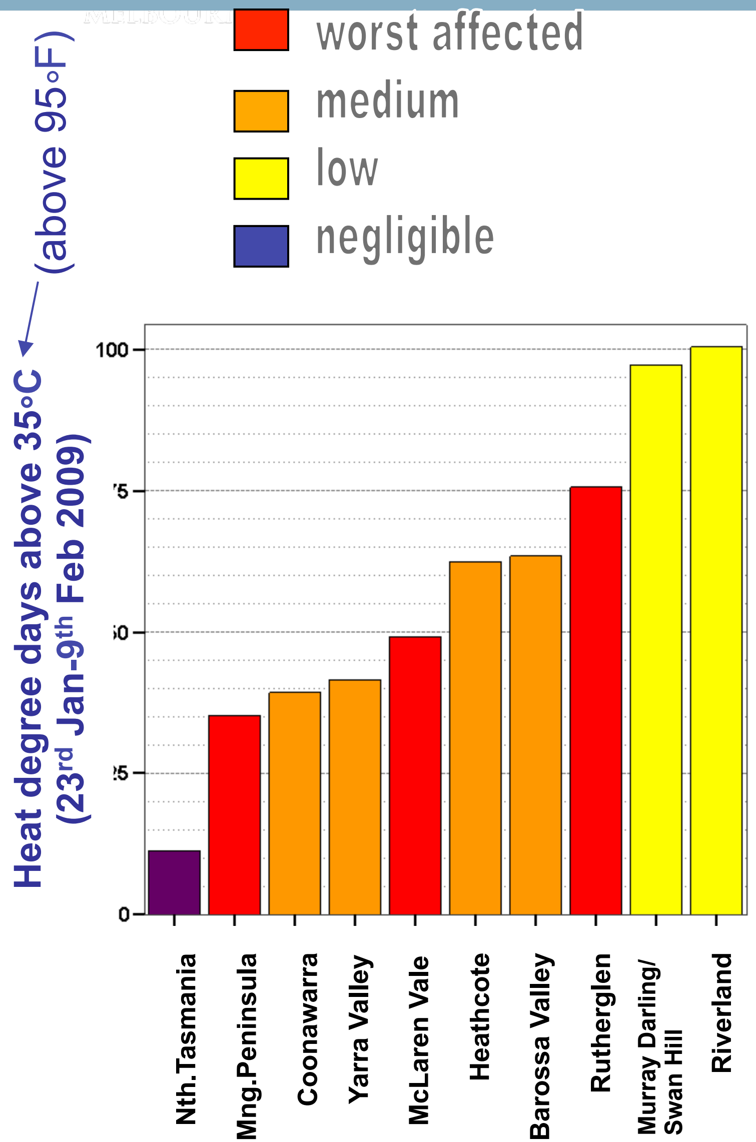
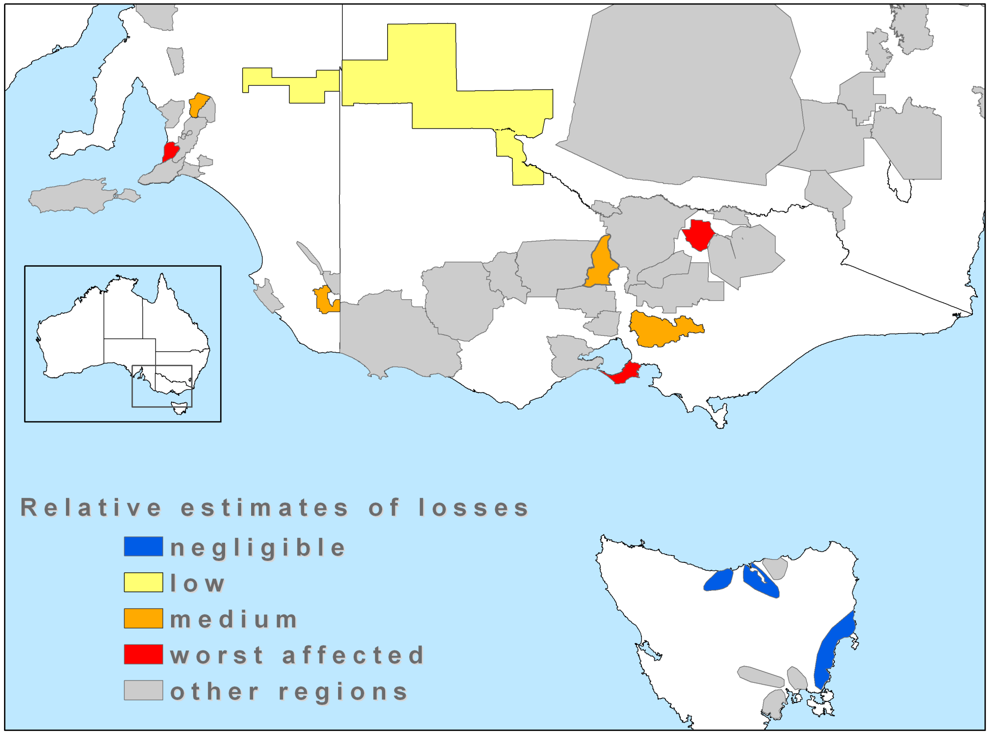
Correlation with heat exposure?





What really affected the impact!

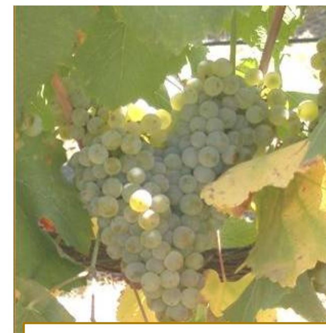
1. Water access/ availability
   - Irrigation PRIOR to the event
   - Rootstock/graft (canopy)
   - Soil type/structure and water holding capacity

• Row orientation:
   - More damage on west aspect of NS rows

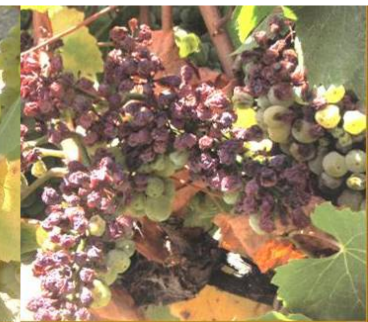
1. Phenological stage
   - Pre or Post Veraison?

2. Canopy/ inter-row cover
   - Good canopy growth early
   - Leaves protecting berries
   - Mulch had positive effect

Limestone pan- poor root penetration



NS orientation- east



NS orientation- west

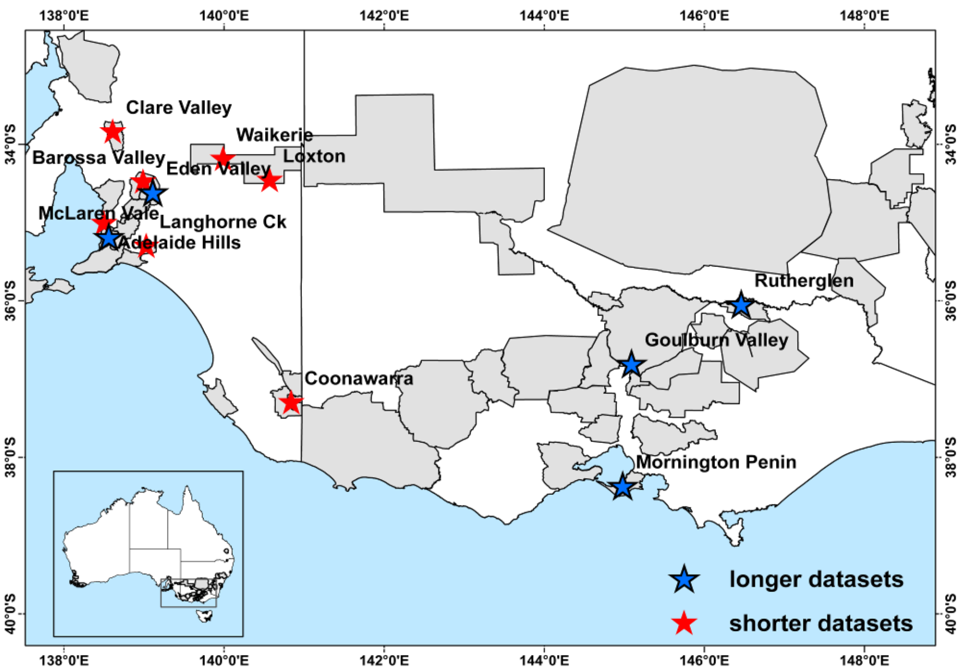
Shaded bunches

Case study 3
Testing the results of modeling studies

- Models need to be tested with real data
- This data is often hard to obtain
- Engagement with the industry is a key approach to getting this data

Long term data sets

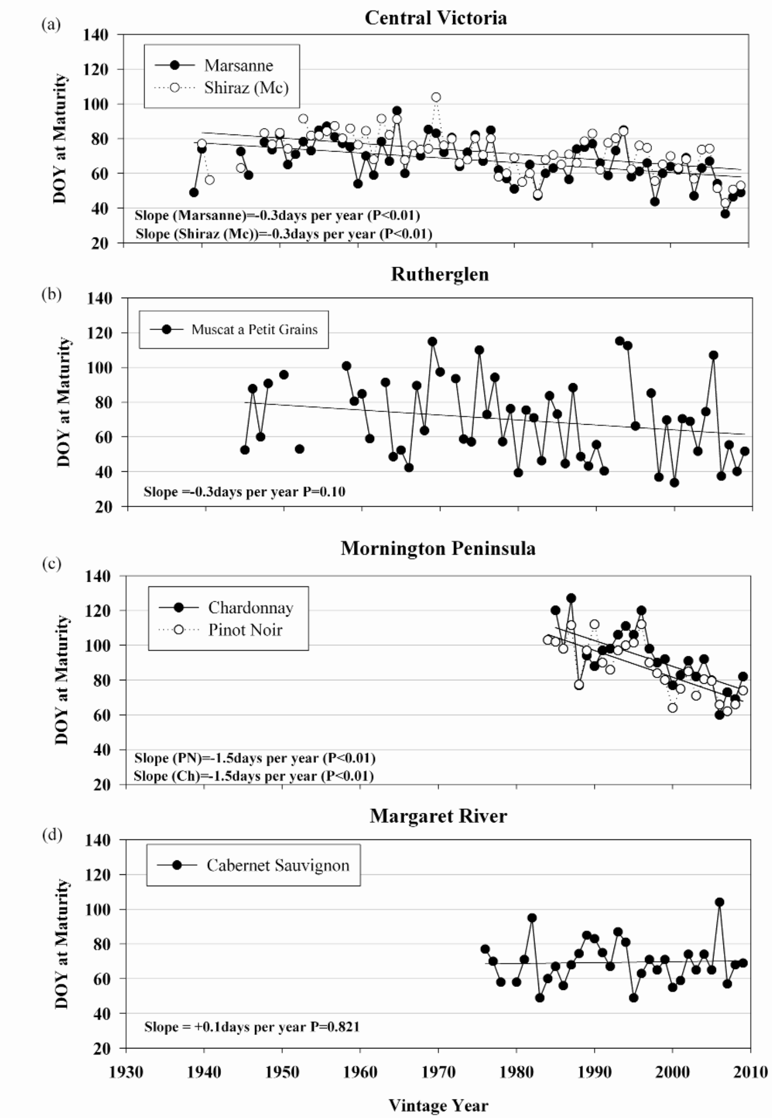
- For this assessment vintage records from 40 vineyard blocks in 11 winegrape growing regions from south-eastern Australia have been accessed.



Winegrowing sites (12 sites) in 11 regions (grey) in south–east Australia from where data was accessed (stars: blue >25yrs, red <20yrs).

Data extend back from 2009 for at least 25 yrs (ave~51yrs) for 8 of the blocks and for 32 blocks an avg~17yrs.

Observed Changes in Maturity



A trend to earlier maturity of winegrapes was observed in 43 of the 44 vineyard blocks.

This trend was significant for six out of the 11 ***long-term*** *blocks for the complete time period for which records were available.*

For the period 1993-2009, 35 of the 44 vineyard blocks assessed displayed a statistically significant trend to earlier maturity.

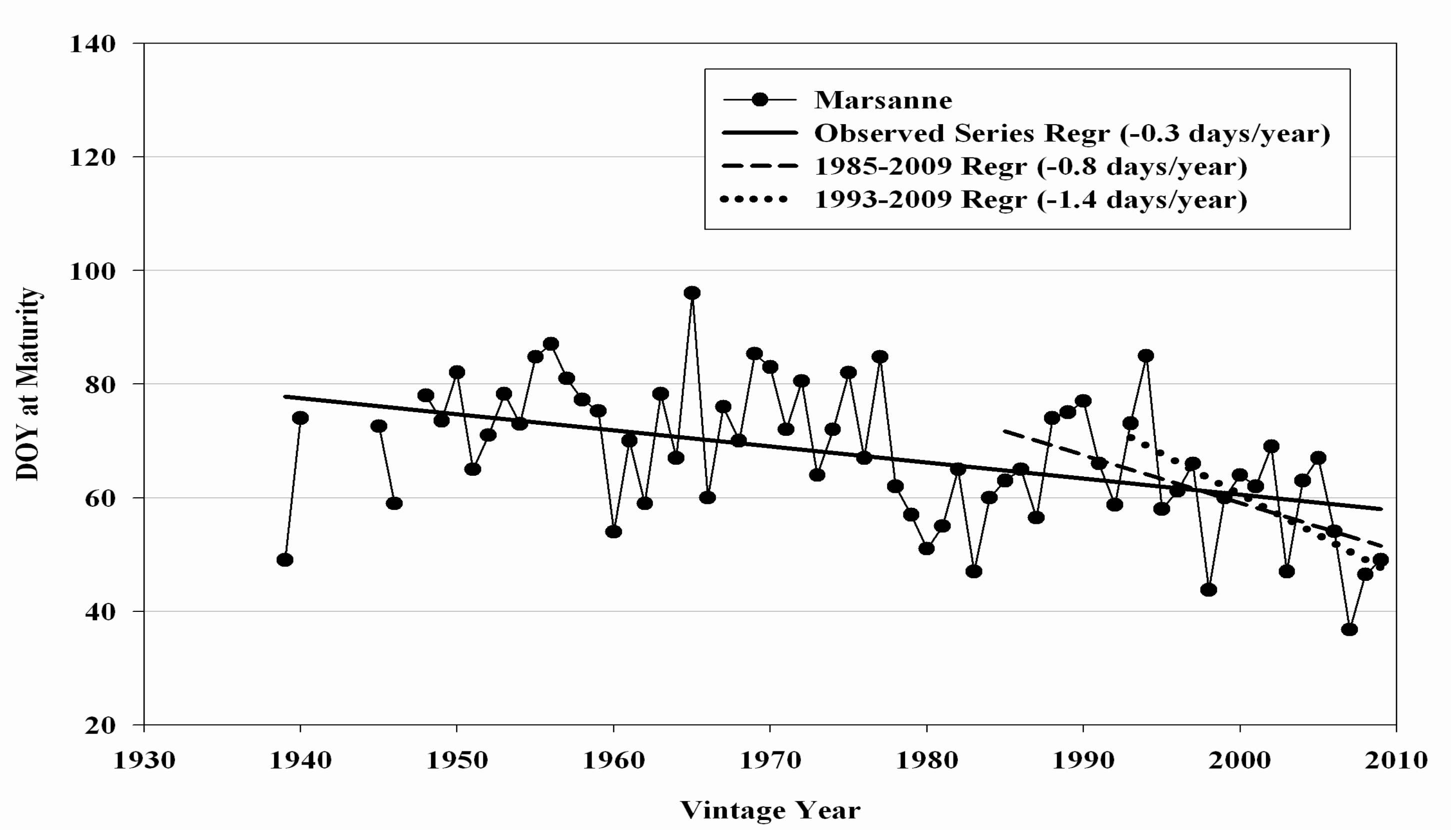
Webb, Whetton and Barlow(2011)

Rate of change in Maturity increases with time

Average rate of Advance

1985-2009: 0.8 days/yr

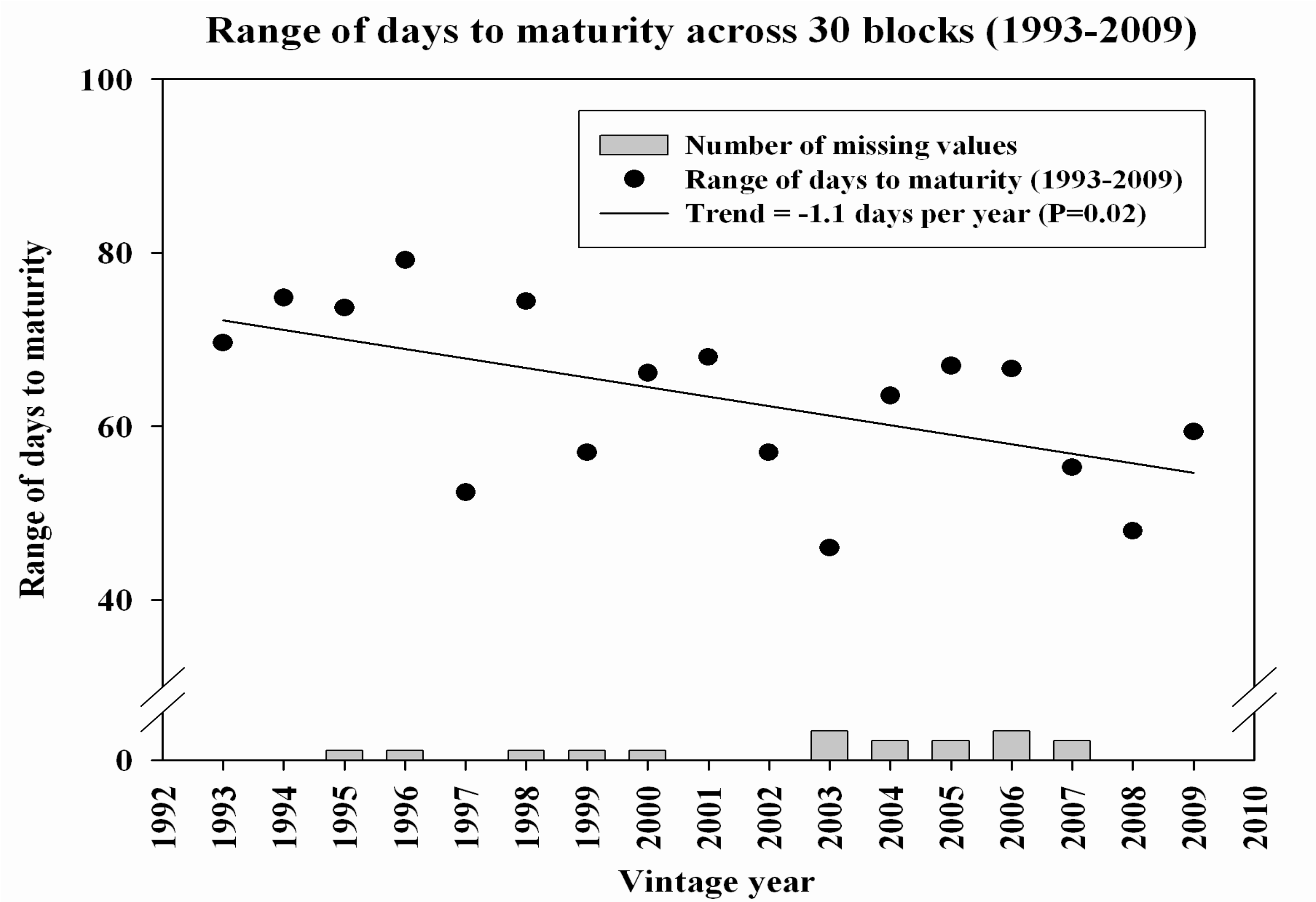
1993-2009: 1.7 days/yr



Webb, Whetton and Barlow(2011)

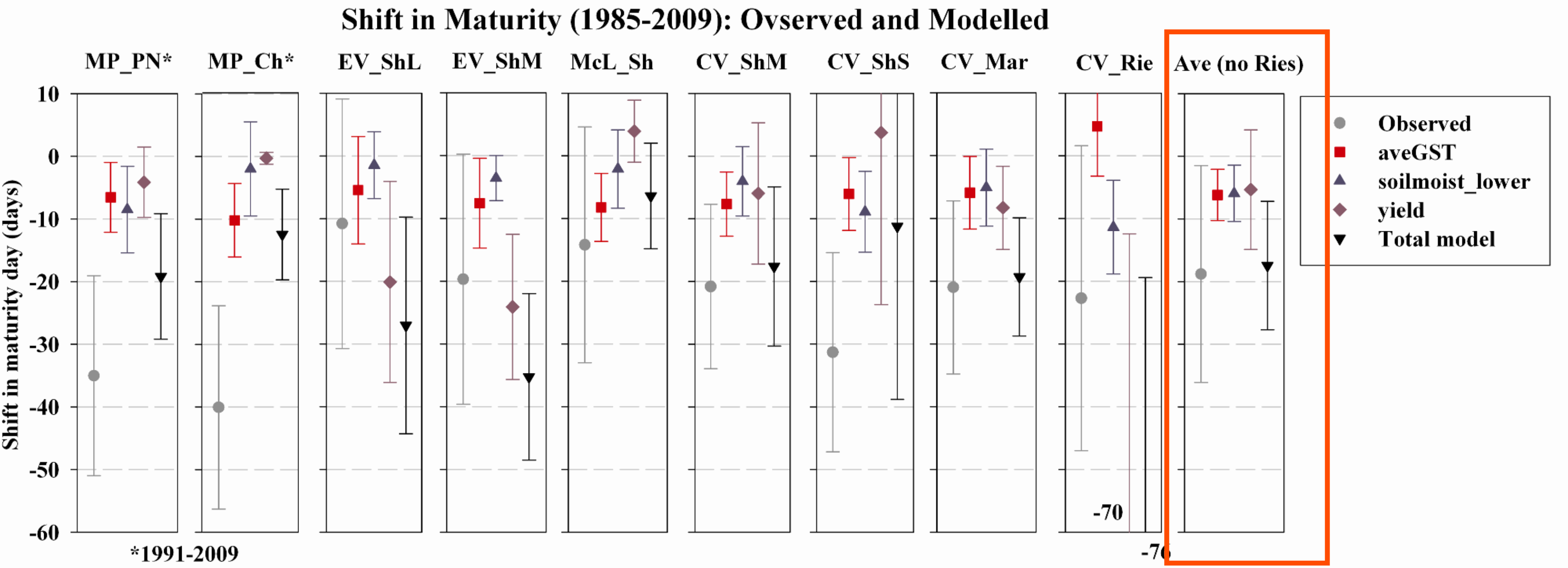
Vintage compression

A significant reduction of 1.1 days per year in the range of days to maturity



Webb, Whetton and Barlow(2011

Drivers of maturity shifts



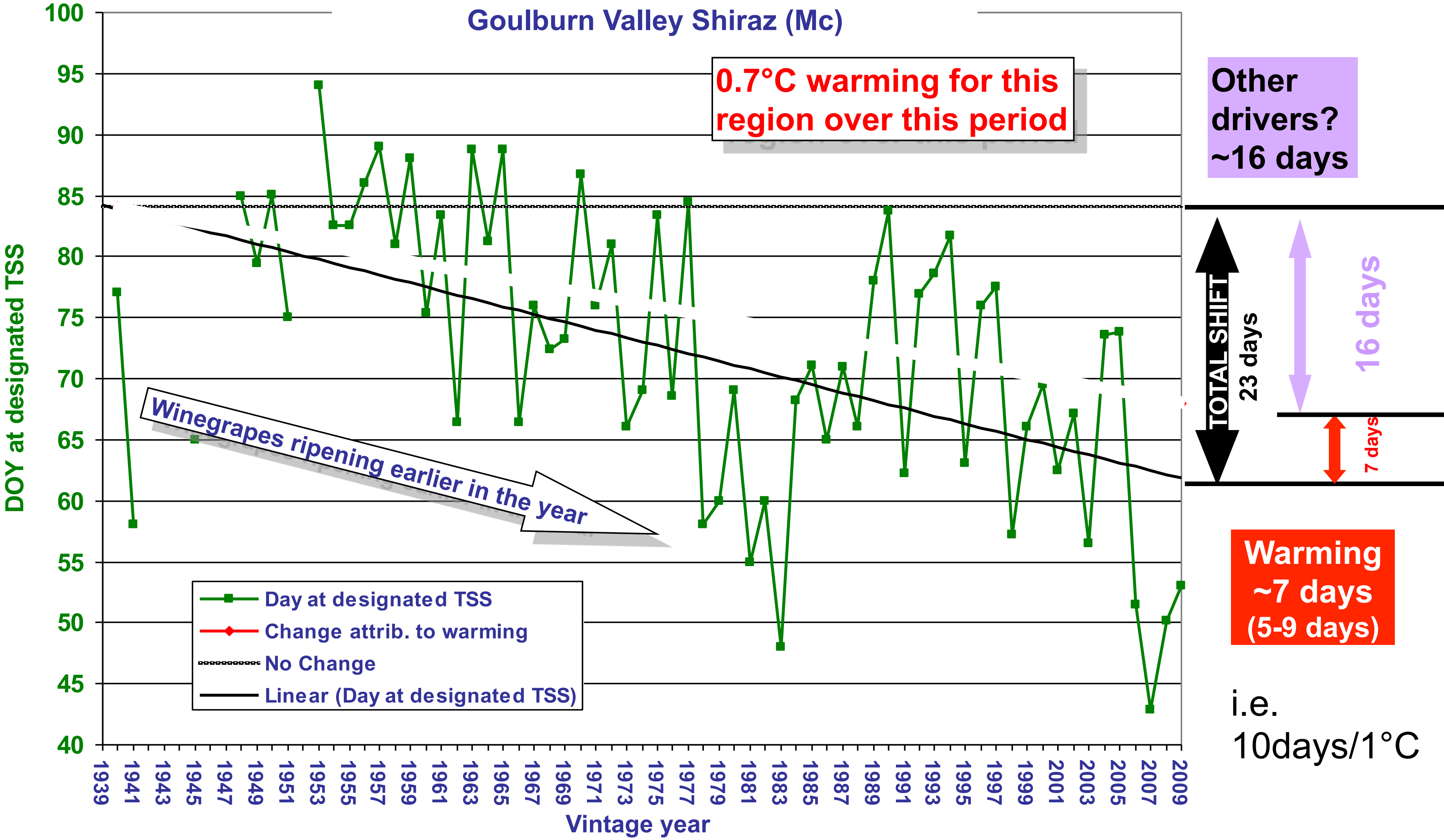
Average observed shift = ~19 days earlier/25years (0.76days/year)

- GST_{model}= 6.2 days earlier / 25 years (7.7days earlier per °C aveGST rise)
- $Soil_{model}$= 5.9 days earlier / 25 years
- $Yield_{model}$ = 5.3 days earlier / 25 years (0.9 days later per t/ha increase)

- $Total_{model}$ = ~17 days earlier / 25 years

Webb et al. 2012

Time series of day of year grapes reached a designated sugar ripeness



~30% of the 'total' shift in time to a designated TSS is attributed to warming

Possible ADAPTATION potential

We suggest management practices may have inadvertently evolved to promote the vines capacity to accumulate carbon, hence ripen faster:

- Manipulation of identified management practices may enable reversal of some of the undesirable trend to earlier ripening.

Yield changes **Irrigation practices** **Canopy/rootstock** **Vine health** **CO_2?**

Conclusions

- *Trends in maturity observed across majority of regions*
- *These trends related to observed growing season temperature changes*
- *Maturity trends were accelerating with climate change*
- *Significant harvest compression*

•*Major drivers for change were*

  - *Growing season temperature (GST)- 36%*
  - *Seasonal subsoil moisture -34%*
  - *Yield manipulation -30%*

•*Adaptation strategies to minimize maturity shifts allows 64% of the drivers to be manipulated by vineyard management*

• *3 approaches , modeling impacts, field assessment of adaptation and attribution analysis based on industry data have established significant engagement with Australian wine industry*

• *>85% of industry accept CC and are developing adaptation strategies*