The application of high-resolution atmospheric modelling to weather and climate variability in vineyard regions

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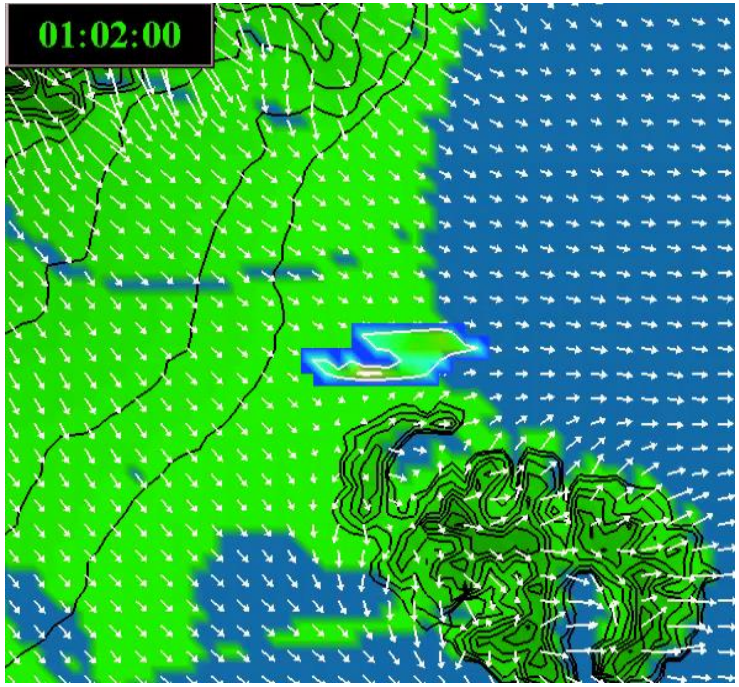
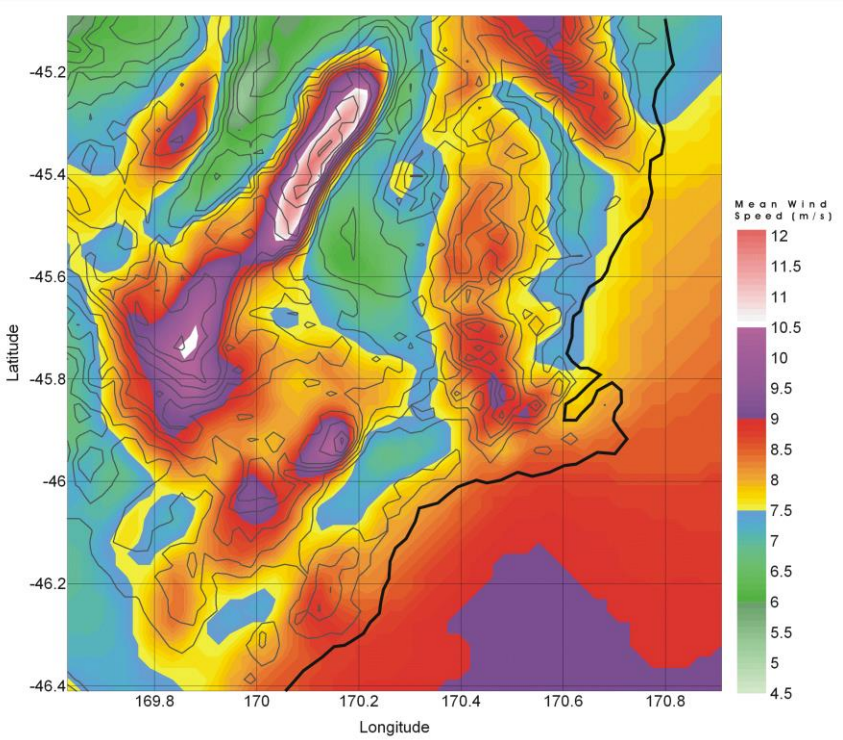
INTRODUCTION

Background and previous work in modelling local and regional weather and climate





RESEARCH CONTEXT

- The temporal and spatial variability of weather and climate within vineyard regions has an important influence on grapevine response and therefore wine production (quality and quantity).
- To understand the potential impact of climate change on viticulture in regions of complex terrain it is important to investigate this influence across a range of time and space scales in order to appropriately manage future risks to the local wine industry.

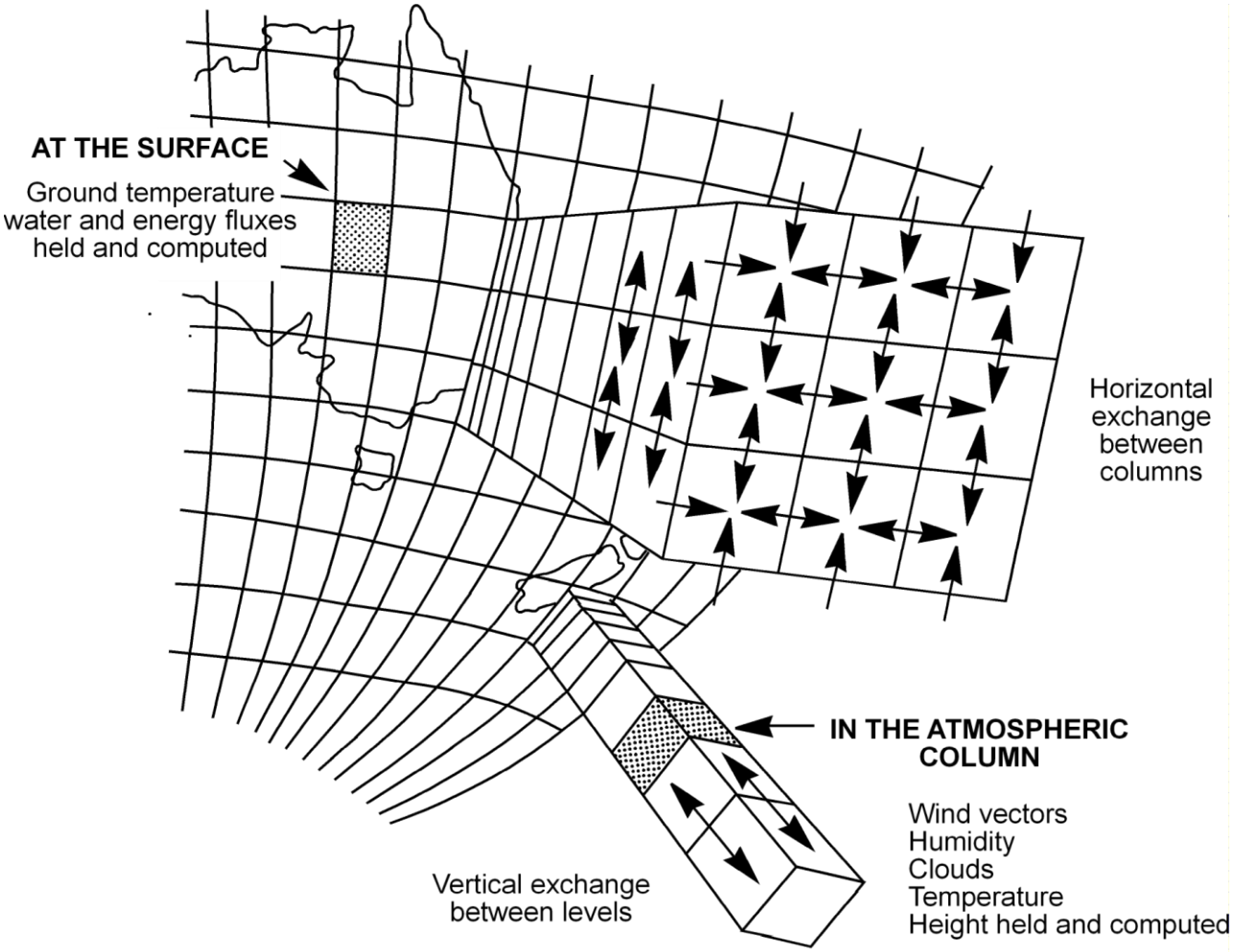
RESEARCH CONTEXT

- BUT…… many vineyard regions have a poor record of meteorological (as well as phenological) observations, so we need to explore other ways of investigating the variation of weather and climate across wine-producing regions and its influence on the grapevine at the vineyard scale.
- Mesoscale, physics-based atmospheric numerical models are tools that can be used to provide a good understanding of the fine-scale variability of weather and climate across a vineyard area, even in regions of complex terrain.

MAIN RESEARCH QUESTION:

What can mesoscale numerical models tell us about weather/climate variability at vineyard scale and its influence on grapevine response?

SCHEMATIC ILLUSTRATION OF A WEATHER PREDICTION MODEL



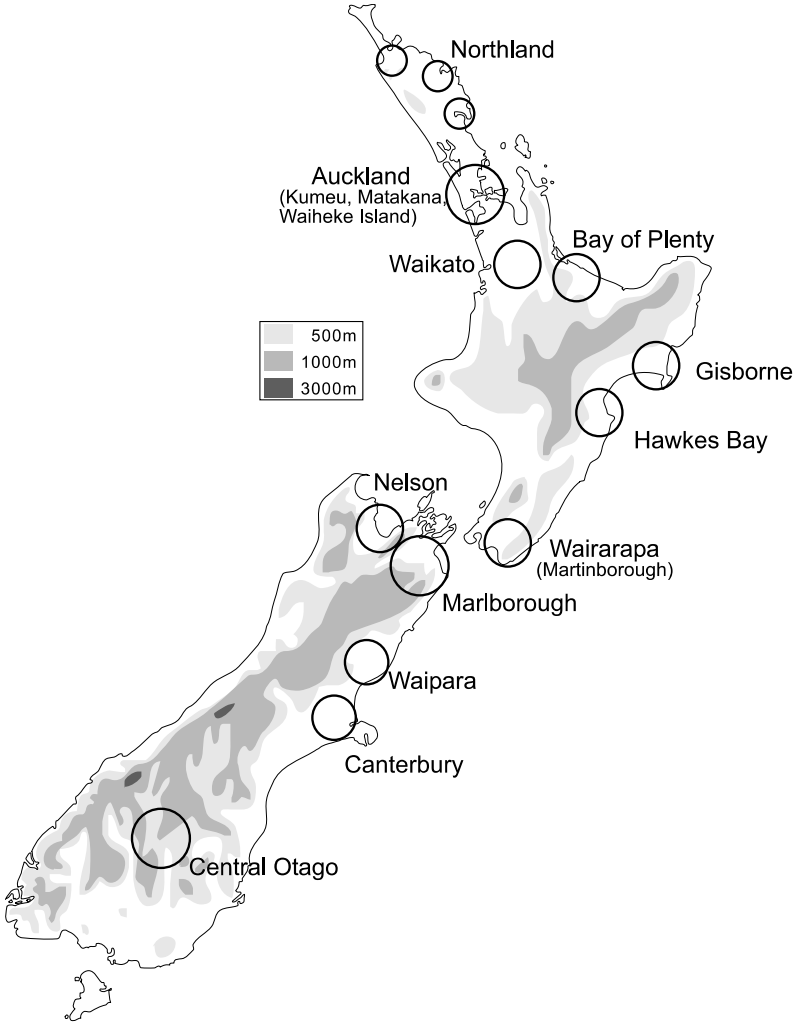
RESEARCH METHODOLOGY

Application of the Weather Research and Forecasting (WRF) model to simulate local weather/climate in vineyard regions in complex terrain for:

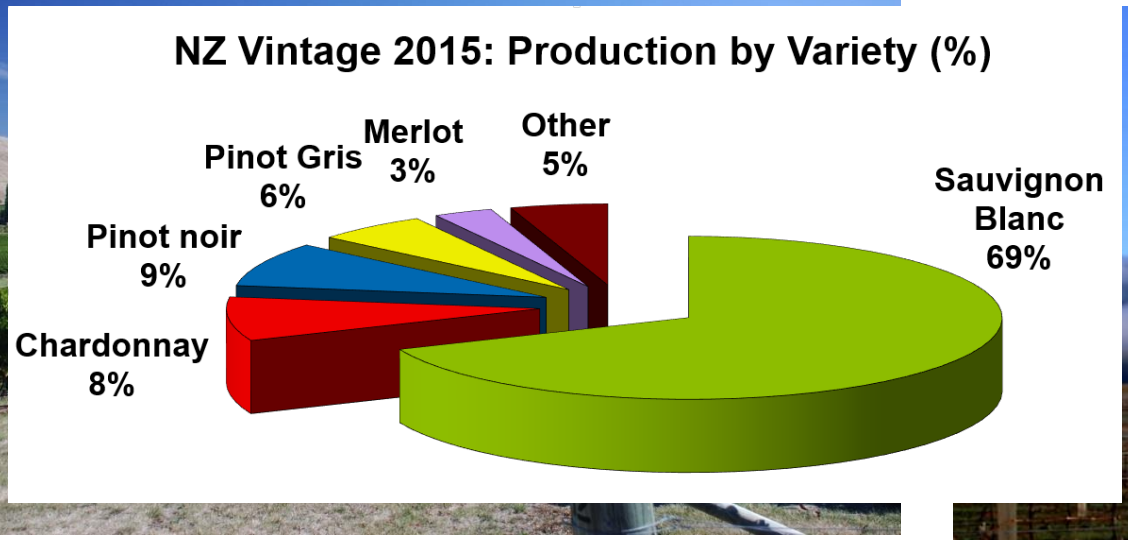
1. Short term weather forecasting
2. Longer term investigation of vineyard scale climate variability
    - Identification of the major influences on local weather and climate (sea breezes, foehn effect, cold air drainage and ponding, etc.) in vineyard regions
    - Analysis of relationship with grapevine response and climate risk factors

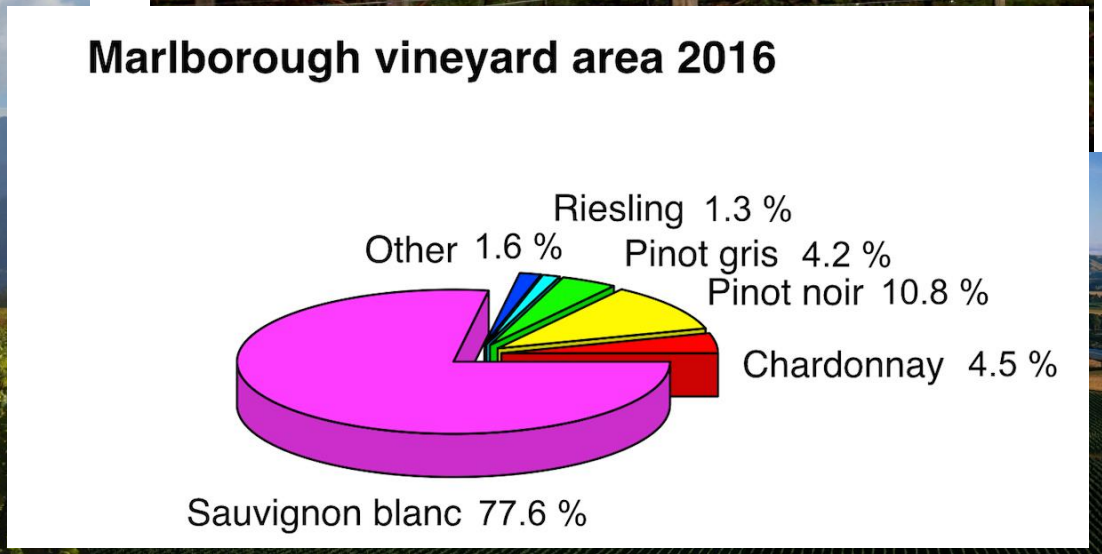
NEW ZEALAND VINEYARD REGIONS

Vineyards extend from the sub-tropical north to the cooler South Island and are mostly located near the coast, except for Central Otago. Most vineyards are located in or close to complex terrain.



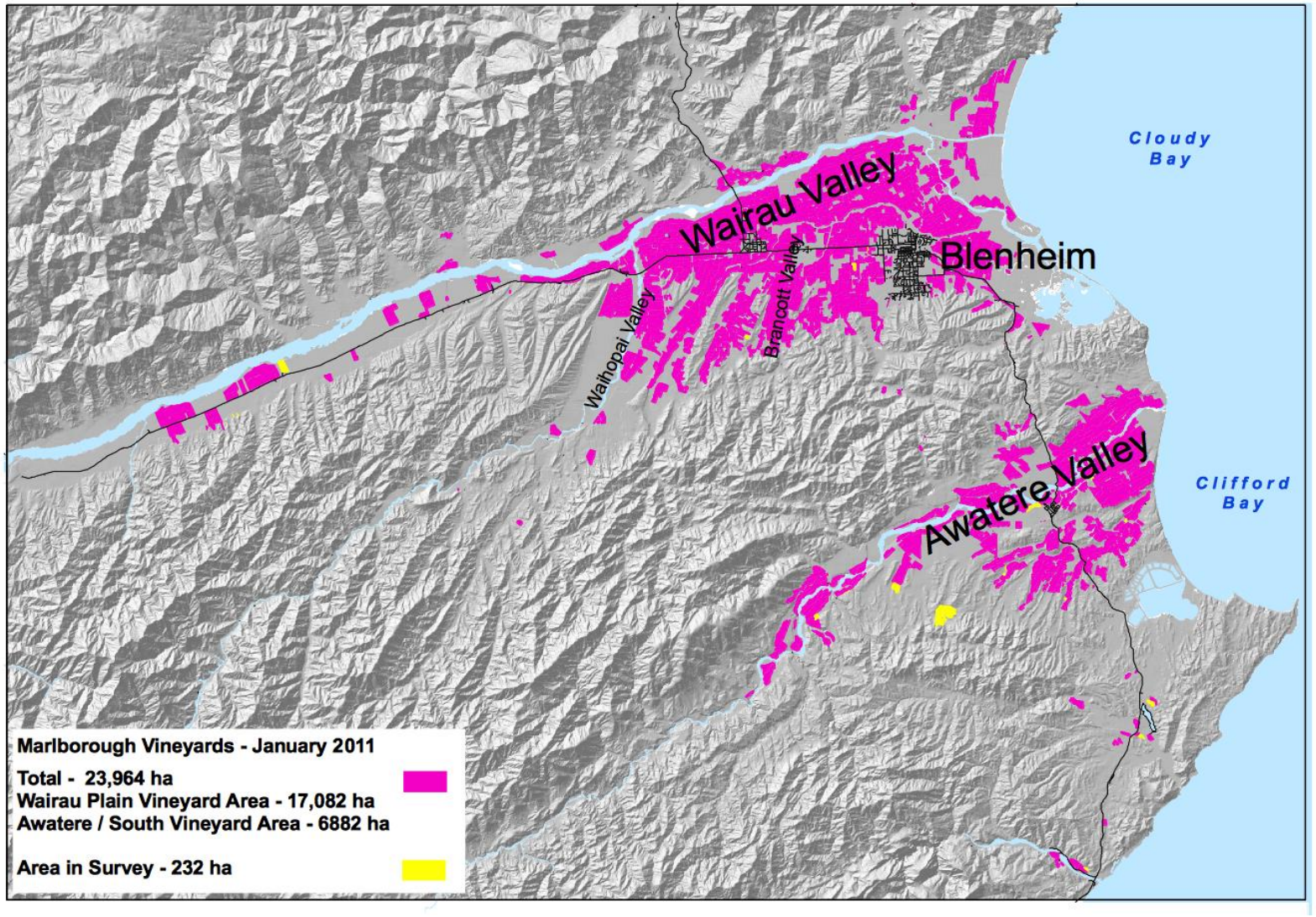
MARLBOROUGH VINEYARD REGION





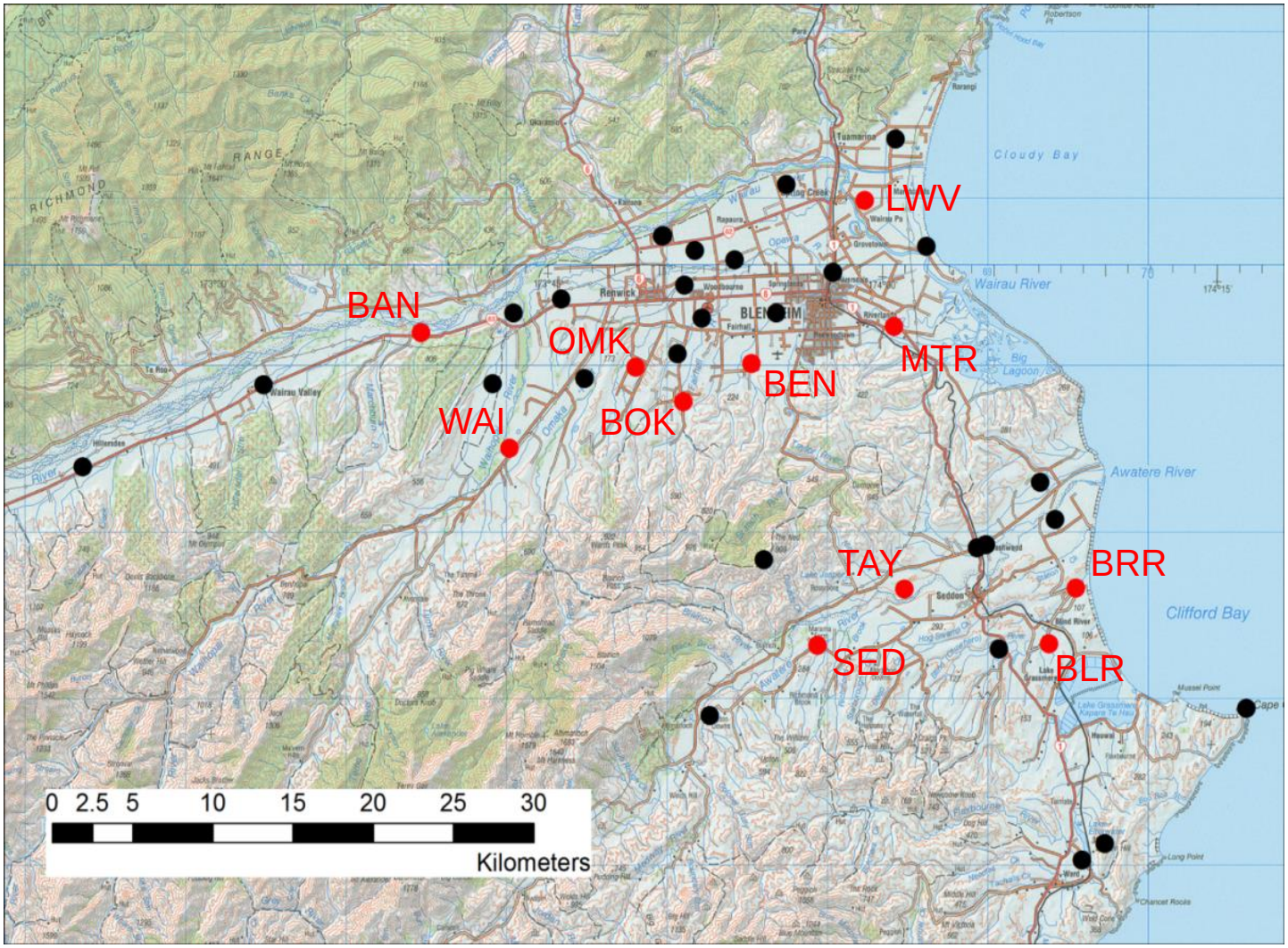
MARLBOROUGH VINEYARD REGION

MARLBOROUGH VINEYARD AREA



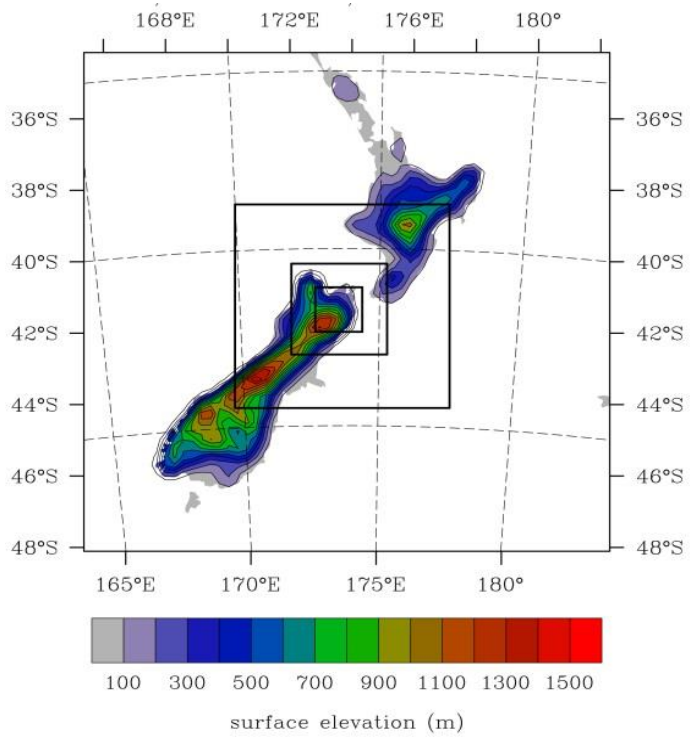
(Source: Marlborough District Council)

AUTOMATIC WEATHER STATION NETWORK 2013-2015

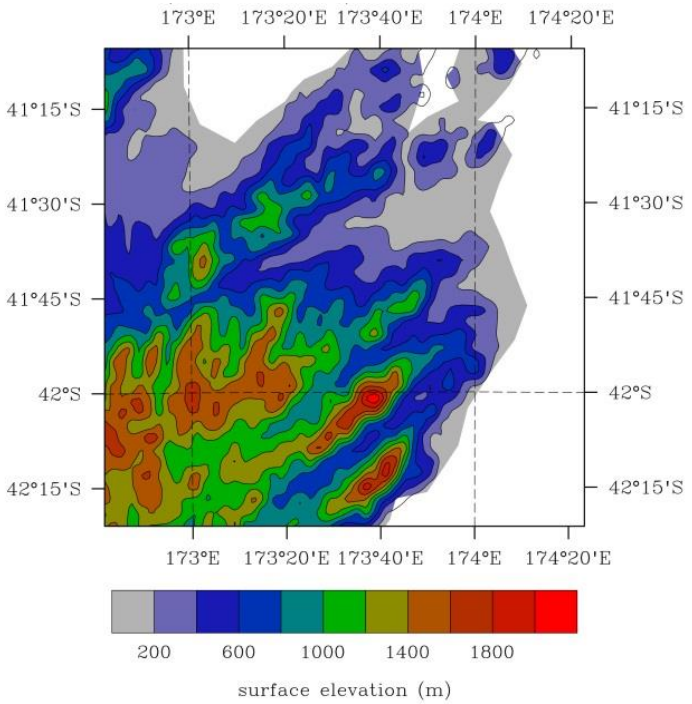


WEATHER RESEARCH AND FORECASTING MODEL SETUP FOR MARLBOROUGH

a)



b)



Weather Research and Forecasting (WRF) model nested grid configuration, showing terrain height, a) for all four grid domains (27, 9, 3 and 1 km), and b) the high-resolution domain.

SHORT TERM FORECASTING AND ANALYSIS OF VINEYARD SCALE WEATHER DURING THE CURRENT GROWING SEASON

WINE CLIMATE WEB SITE

HOME | MARLBOROUGH REGION | WAIPARA REGION | CLIMATE CHANGE ADAPTATION STRATEGIES | PUBLICATIONS | ABOUT THE RESEARCH PROJECT | CONTACT US

HOME

The climate and viticulture research project being conducted by the Centre for Atmospheric Research (University of Canterbury), Plant and Food Research, the University of Rennes 2 (France) and NIWA aims to help the development and improvement of tools to assist the viticulture industry to adapt to variations in climate.

Recent results of our research will be displayed on this web site, including scientific publications and practical tools, such as operational local weather forecasts and bioclimatic indices that are provided on a daily basis.

For the Marlborough wine-growing region, we are currently providing:

- A regional weather forecast for air temperature, wind speed and wind direction based on the Weather Research and Forecasting model
- Maps displaying GDDs (growing degree days) for the Marlborough wine-growing region based on the Grapevine Flowering Véraison (GFV) model

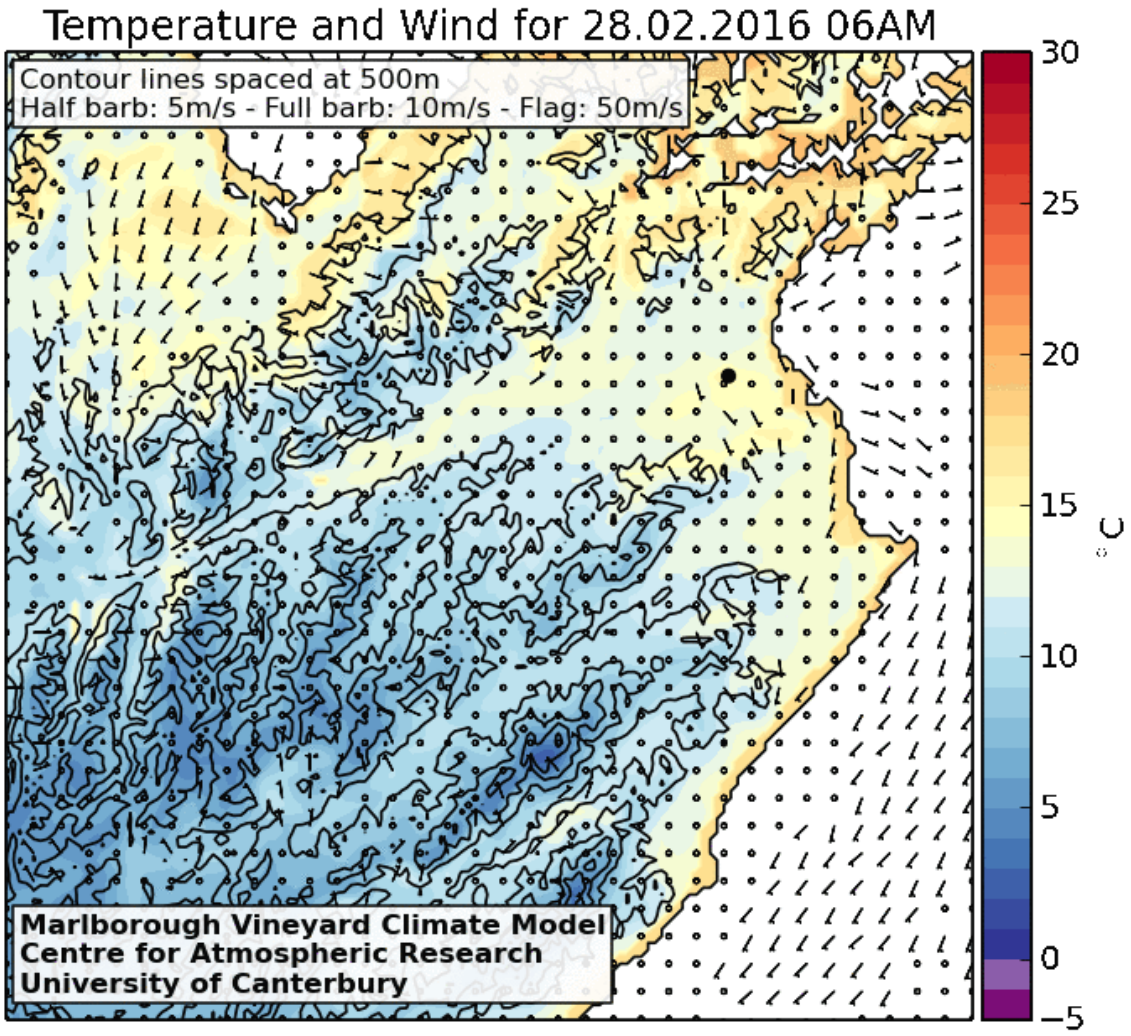
We also plan to add graphs showing the GDD trends in different parts of the Marlborough region.

Similar tools are under development for the Waipara wine-growing region. So far, we are providing:

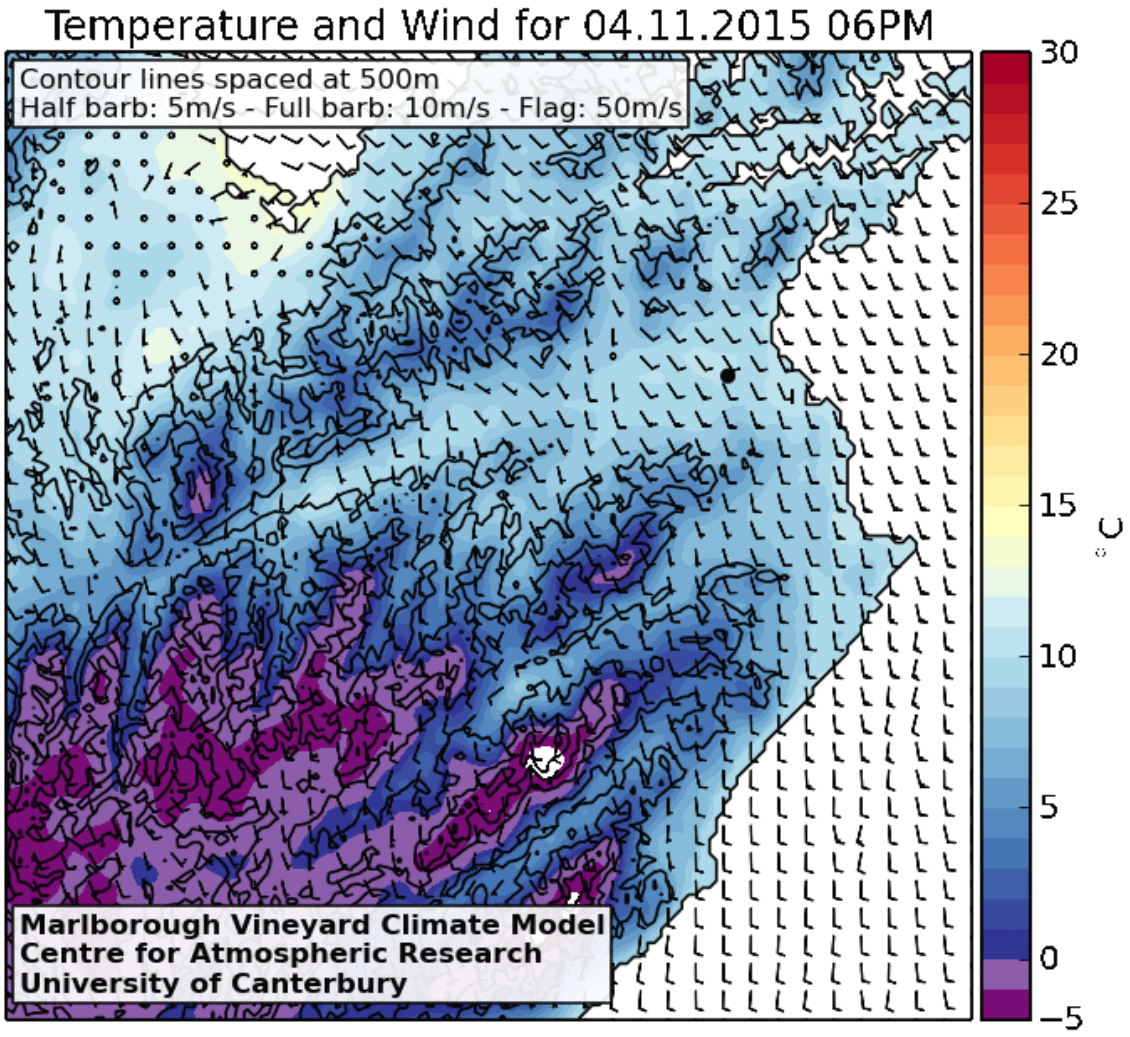
- A regional weather forecast for air temperature, wind speed and wind direction based on the Weather Research and Forecasting model
- A map that displays GDDs (Growing Degree Days) for the Waipara wine-growing region based on the GFV model

www.wineclimate.co.nz

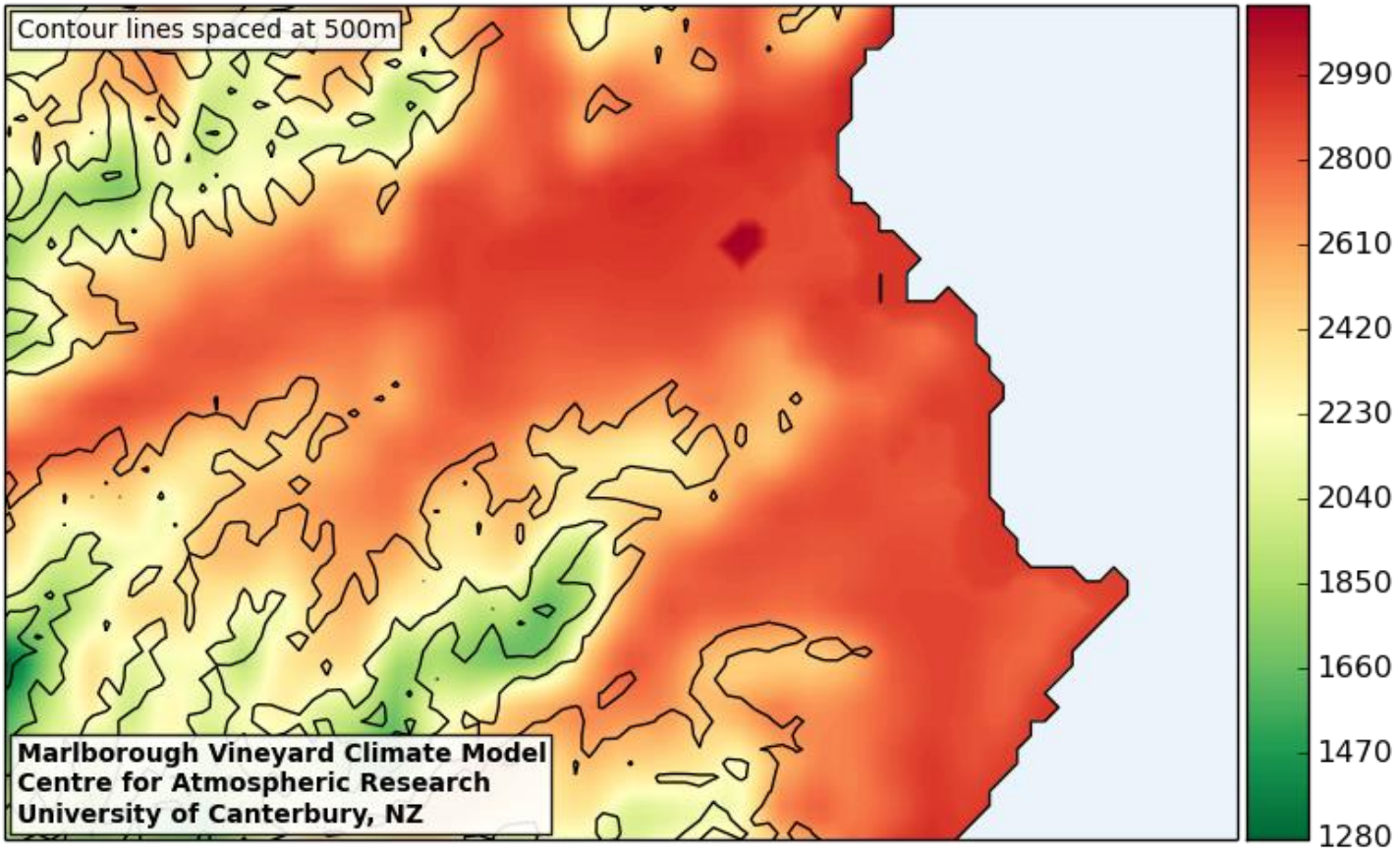
OPERATIONAL MODEL OUTPUT – SEA BREEZE & FOEHN EFFECTS



OPERATIONAL MODEL OUTPUT – A LATE FROST EVENT

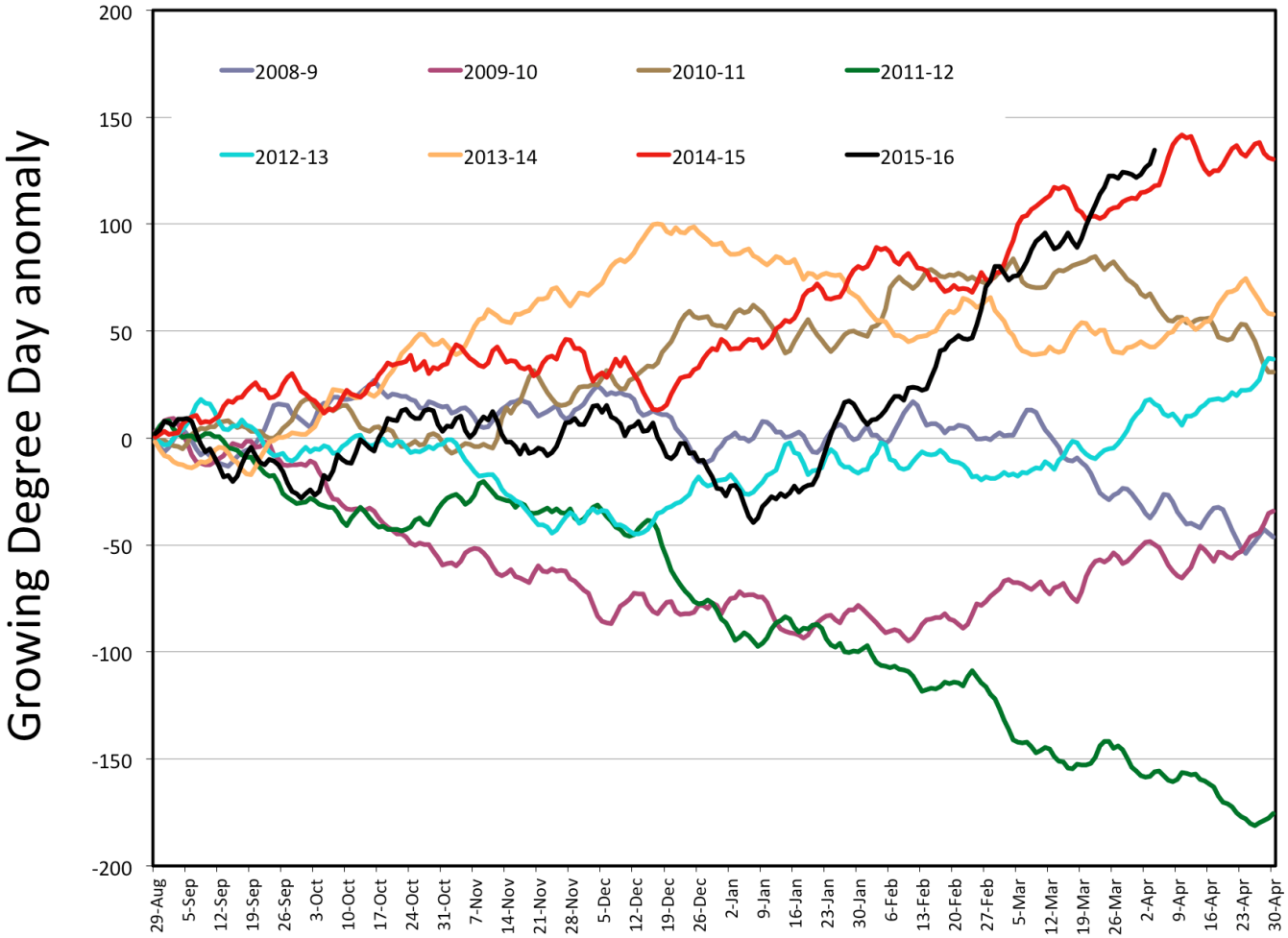


OPERATIONAL MODEL OUTPUT – GROWING DEGREE DAYS



Example of growing degree day accumulation map of the Marlborough vineyard region for 22 March 2016 derived using the Grapevine Flowering Véraison model (Parker et al. (2011, 2013): threshold = 0°C, start date = 29 August 2016) based on Weather Research and Forecasting model temperatures.

GROWING DEGREE DAY ANOMALY GRAPH FOR MARLBOROUGH



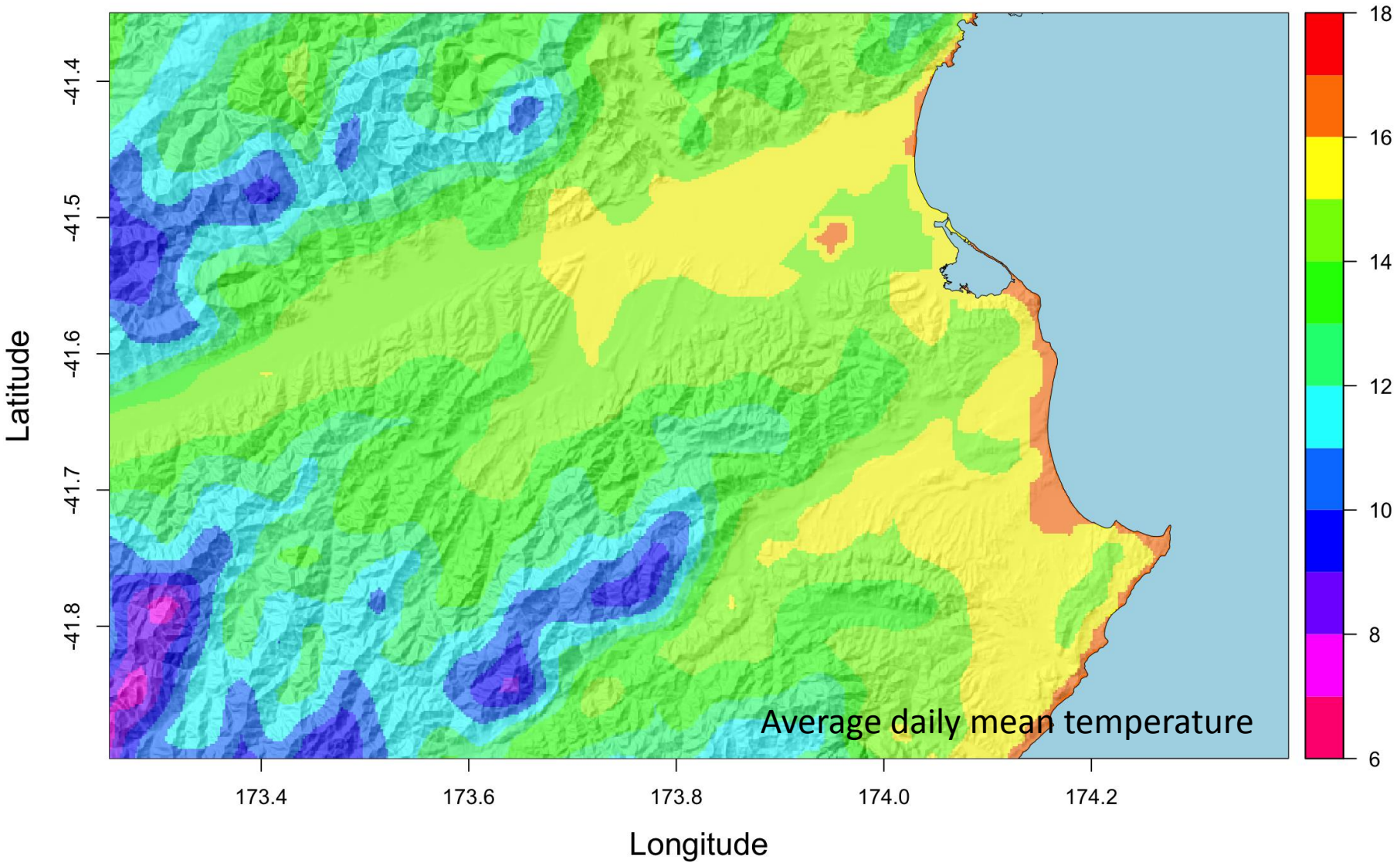
Example of growing degree day anomaly graph from the Marlborough vineyard region for 23 March 2016 derived using the Grapevine Flowering Véraison model (threshold = 0°C, start date = 29 August 2016). The black line is for the current season.

LONGER TERM INVESTIGATION OF VINEYARD SCALE CLIMATE VARIABILITY

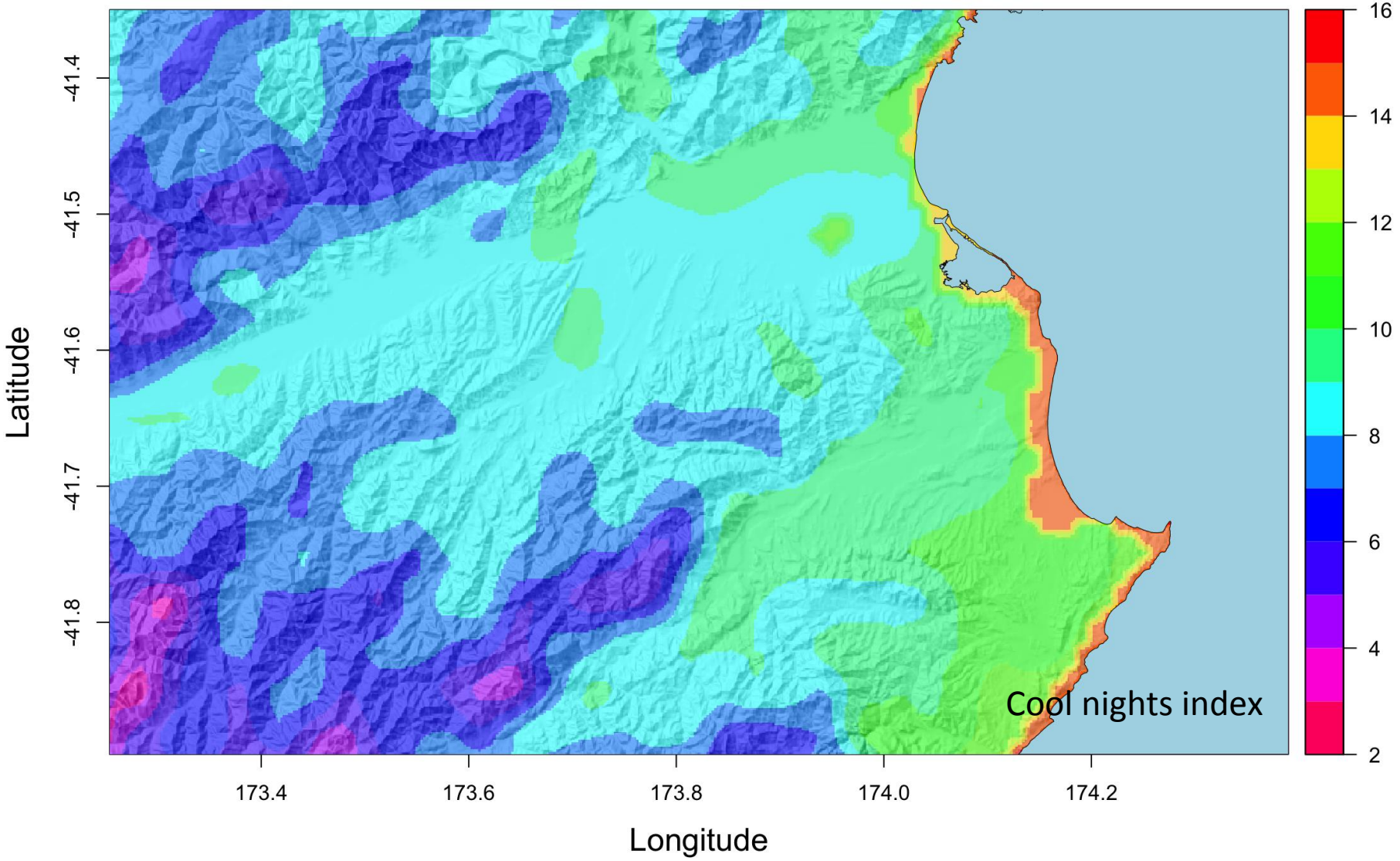
BIOCLIMATIC INDICES

- Mean growing season temperature (1 October to 30 April)
- Grapevine Flowering Véraison model (29 August to 30 April)
- Huglin index (1 October to 31 March)
- Cool nights index (March mean minimum temperature)

MAPS OF WRF AIR TEMPERATURES - 2008/9 to 2013/14 GROWING SEASONS



MAPS OF WRF BIOCLIMATIC INDICES - 2008/9 to 2013/14 GROWING SEASONS



MAPPING VARIABILITY OF GRAPEVINE DEVELOPMENT PHASES AT VINEYARD SCALE

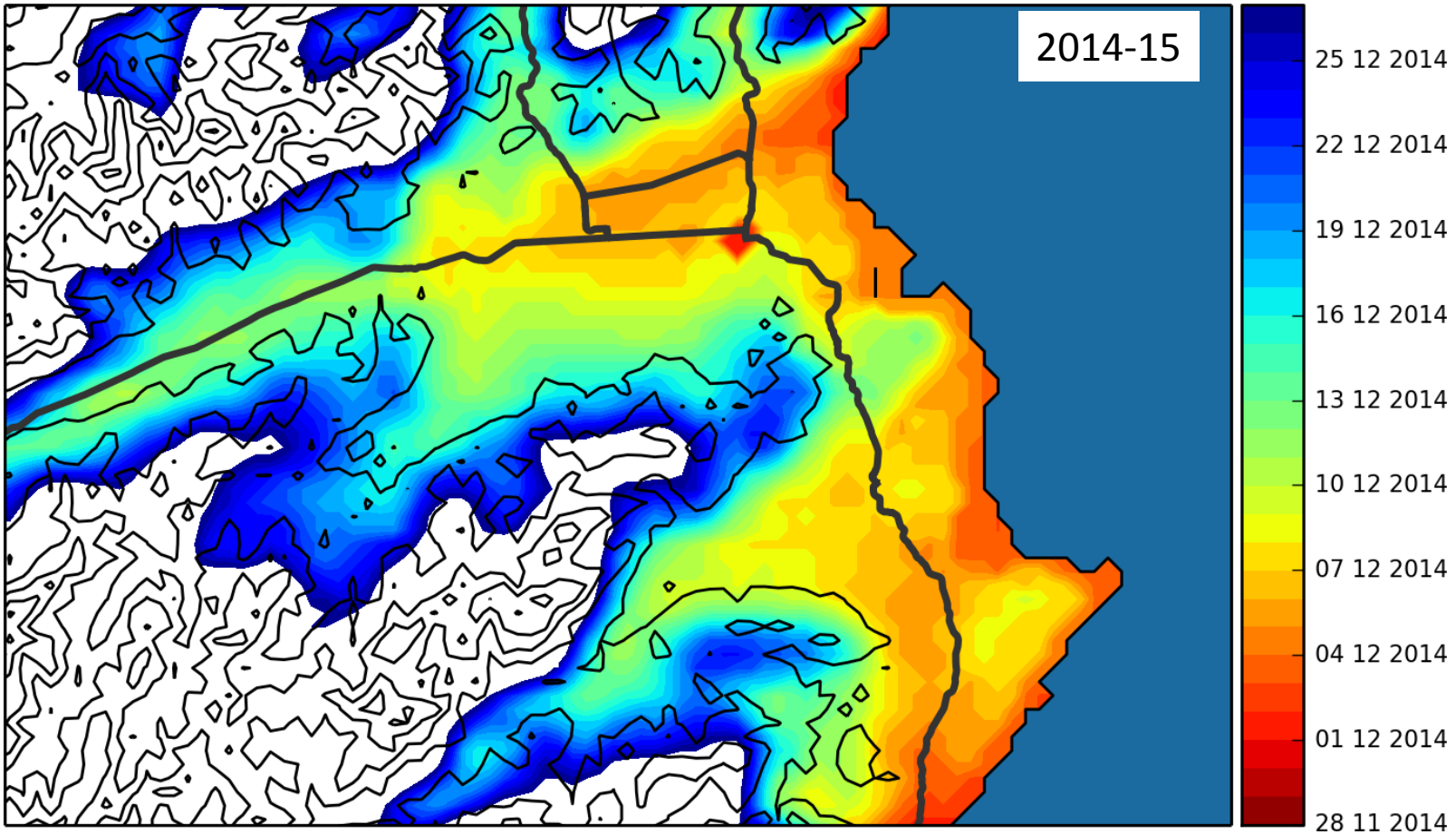
INTEGRATION OF WRF WITH THE GFV MODEL: 50% FLOWERING/VÉRAISON DATES

The Grapevine Flowering Véraison (GFV) model has the following parameters for prediction of flowering and véraison for different grape varieties:

Variety	*F** [1] flowering	*F** véraison
Sauvignon blanc	1282	2528
Chardonnay	1217	2547
Pinot noir	1219	2511
Riesling	1249	2590
Merlot	1269	2636
Syrah	1279	2601
Cabernet Sauvignon	1299	2689
Mourvèdre	1354	2706

[1] *F** is the critical degree-day sum (above 0°C, starting on the Northern Hemisphere 60th day of the year - 29 August in the Southern Hemisphere)

50% FLOWERING DATES PREDICTED BY COUPLING WRF WITH GFV

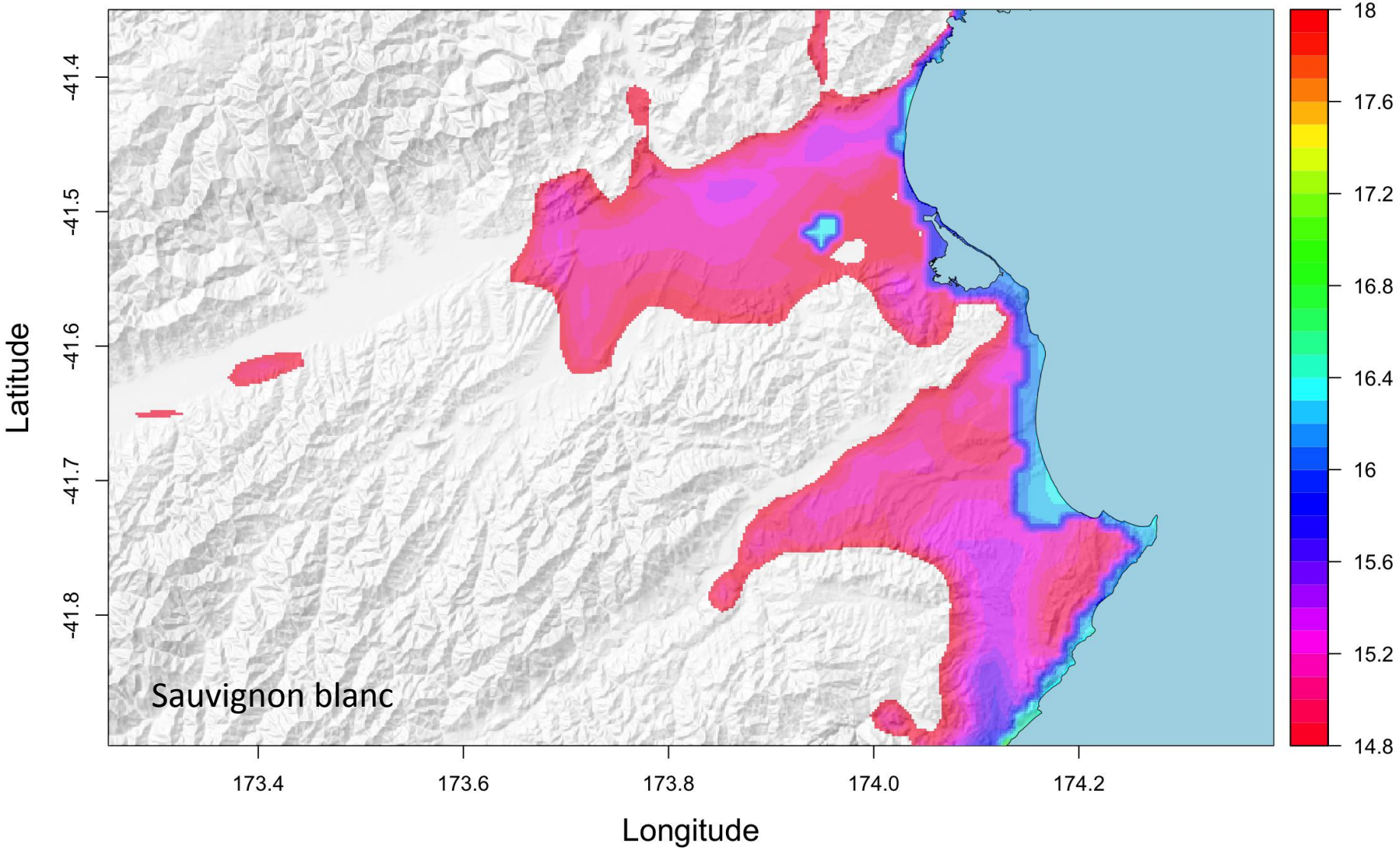


OPTIMAL MEAN GROWING SEASON TEMPERATURES FOR KEY MARLBOROUGH GRAPE VARIETIES

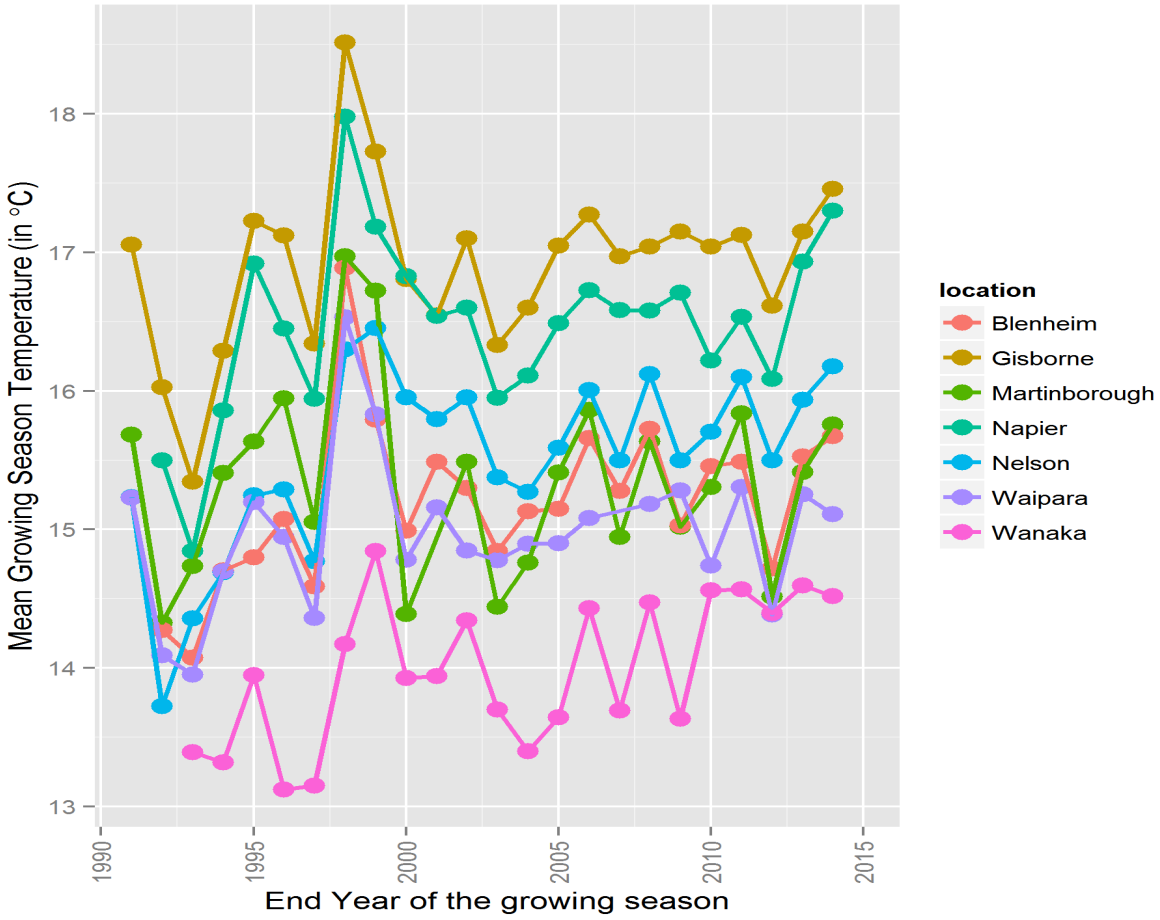
- Sauvignon blanc [14.8 – 18 °C]
- Pinot noir [14 – 16.2 °C]
- Chardonnay [14.2 – 17.2 °C]
- Pinot gris [13 – 15.2 °C]

Approximate values based on Jones (2006)

DEFINING OPTIMAL AREAS FOR KEY GRAPE VARIETIES BASED ON GROWING SEASON TEMPERATURES 2008-2014



TEMPERATURE VARIATION IN NEW ZEALAND VINEYARD REGIONS – growing seasons 1990-1 to 2013-14



September to May

CONCLUSIONS

Application of mesoscale weather/climate models to vineyard regions allows:

1. Improved knowledge of unique local features of the weather/climate (sea breezes, foehn winds, mountain/valley winds, cold air ponding, etc.) and their contribution to the 'terroir'.
2. Analysis of the relationship between weather/climate and key phases of grapevine development at vineyard scale within wine-producing regions.
3. Investigation of the variability of climate across vineyard regions at high resolution, allowing identification of optimal/marginal areas for winegrape production and climate risk assessment based on various bioclimatic indices.
4. Assessment of the robustness of vineyard regions to longer term climate change – how much change would it take to make the region unsustainable with respect to specific grape varieties?

POSTSCRIPT

- WRF model assessment of the suitability of specific grape varieties in the Marlborough region suggests that we need to improve understanding of the relationship between climate parameters and grapevine response to be able to assess the future of quality wine production in specific areas in response to changing climate. The effects of manipulation of t
at vineyard scale should also be integrated into m
modelling systems.
- Global Climate Models provide only a general ide
in climate likely to occur in vineyard regions over
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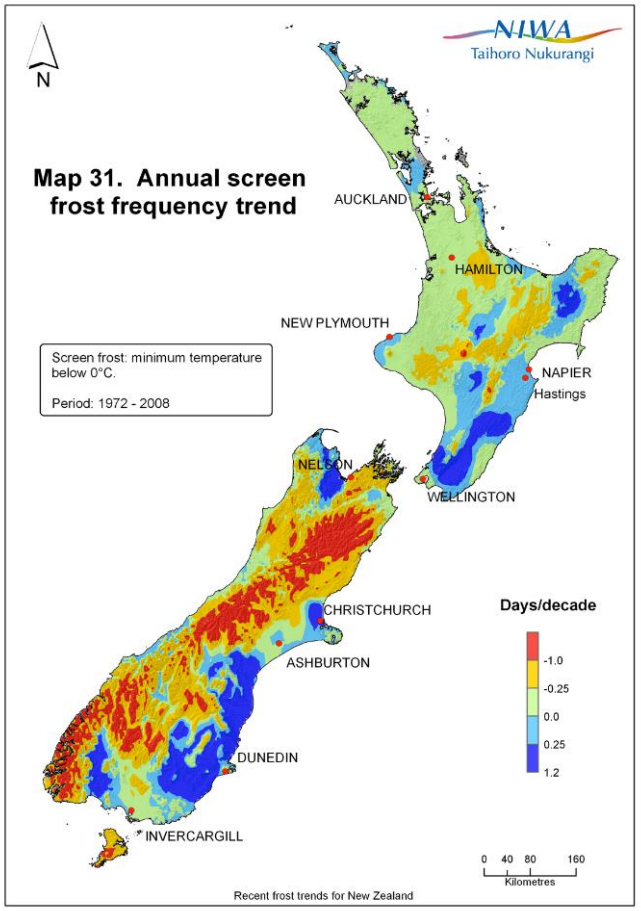


Source: Clark, A. and Sturman, J. 2009 Recent frost trends for New Zealand.

ACKNOWLEDGEMENTS

The research team are grateful for the funding provided for this research by the Ministry for Primary Industries (New Zealand), and ongoing support of the Department of Geography at the University of Canterbury, Plant & Food Research and the Marlborough Wine Research Centre, Lincoln University, and the COSTEL Laboratory at the University of Rennes 2 (France). James Sturman's assistance with the final graphics is also much appreciated. We would also like to thank the organisers of the ClimWine2016 Symposium for the opportunity to present our work.

Thank you for your attention !!

And there is more (from Mike) ……

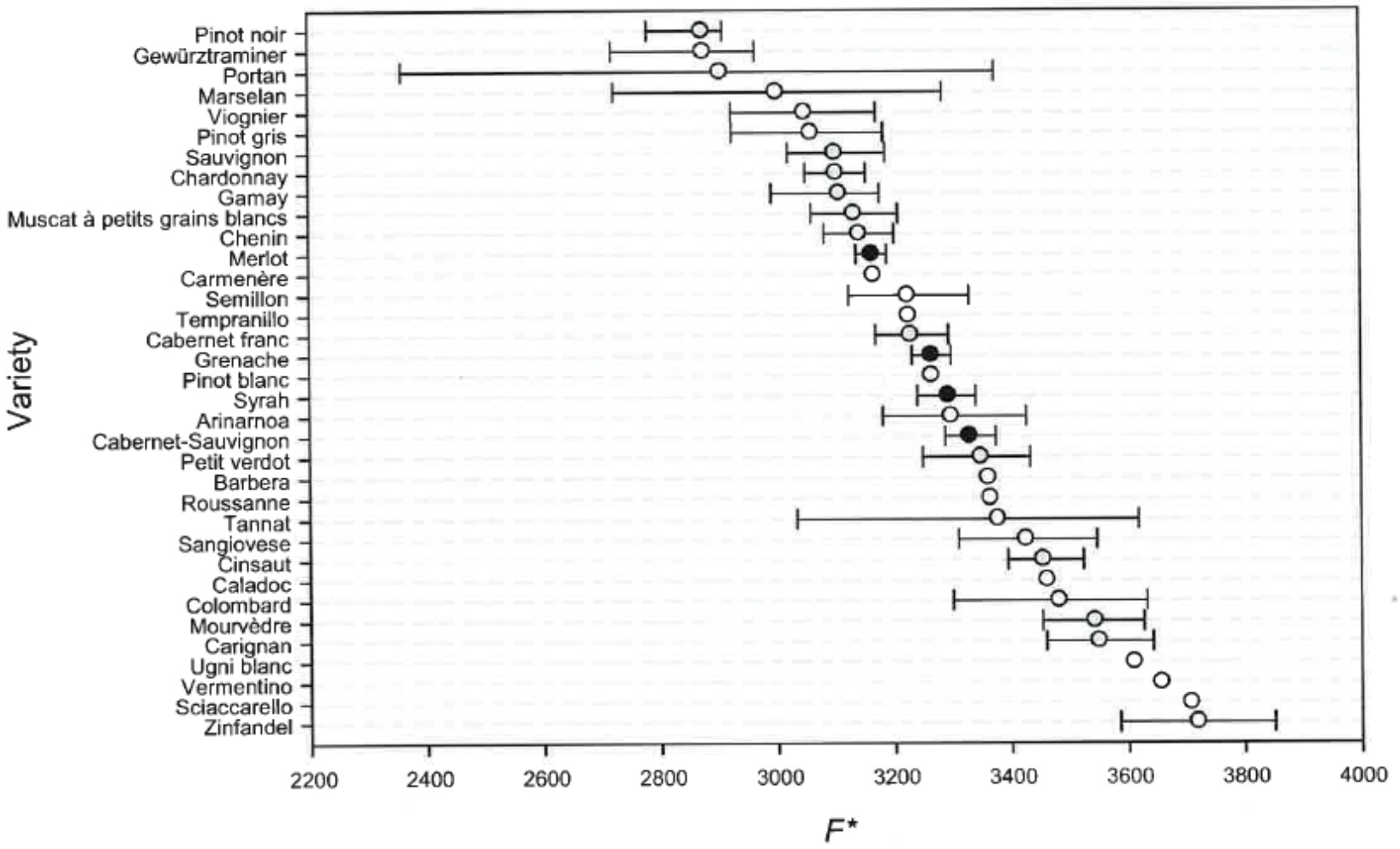
The suitability does depend on the style of wine, and Marlborough Sauvignon blanc is generally harvested at a commercial soluble solids (SS) of 20.5 to 21.5. Other regions and styles will require higher SS and therefore take longer to achieve that target.

As part of her PhD, Amber classified varieties by the degree-days (base 0°C and starting from 29 August) time to reach 20 °Brix. Her thesis figure is attached. My interpolation of the data is:

Pinot noir	2775 to 2906 degree days
Pinot gris	2912 to 3175
Sauvignon blanc	3012 to 3175
Chardonnay	3043 to 3150
Merlot	3125 to 3181

That would fit reasonably well into your figure below, or even better into today's (1 April) figure – we are in the process of harvesting fruit at about 20 °Brix ☺, last week it was at 18 °Brix.

And there is more……



*F** values required to reach a sugar concentration of 200 g/l (Amber Parker)

And there is more……