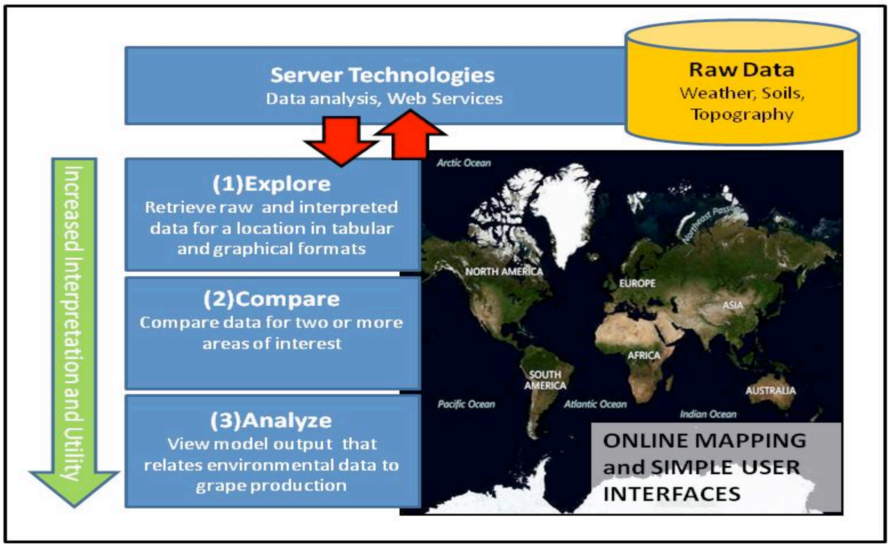

Figure 3. Visual display of system functionality and levels of interaction.

There is an increased level of interpretation as the user interacts with the technology lending to the uniqueness of the system. Users can now interact, visualize, and interpret factor variations between locations to make decisions about where to grow specific varieties or what varieties are best suited for a particular location. Figure 3 outlines a complete description of the system, displaying the levels of user interaction and increased interpretive utility. Our models will provide a brief demonstration of the system by exploring a scientific approach towards determination of adapted varieties to a particular location.

4 CONCLUSION

Data acquisition, visualization and modeling of information in viticulture was used to determine varieties most suited to a particular site and sites most suited to particular varieties. By implementing dynamic web-based technology, viticulturist and researchers can access geographic information and data using a standard desktop computer without installing expensive GIS software. A centralized database of environmental variables allows instant access to data and information for any location in the world. User interpretation of data and model results allows for extrapolation in order to delineate locations most suited for growing a particular variety. Exploratory and comparative analysis of environmental variation between locations is one of the key aspects of the system technology. Moreover, future developments of this web application will address a fully customizable GUI with statistical and analysis tools beyond the current descriptive indices.

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Identifying New Zealand Sauvignon blanc terroirs

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ABSTRACT

The concept of terroir is well established in the 'old world' wine industry but its use is still relatively new in New Zealand. Marlborough Sauvignon blanc has become a benchmark for Sauvignon blanc around the world. However, under *The NZ Geographical Indications (Wines and Spirits) Registration Act 2006,* this label covers all the Sauvignon

blanc wines from Marlborough irrespective of brand, sub-region or production method. This is not atypical for a young industry, as it takes many years to understand the subtleties of a 'terroir' with its own ecophysiological conditions.
To identify distinctive terroirs, a collaborative project with New Zealand Sauvignon blanc grape producers has been initiated. This study investigates the typicality of individual commercial juices. About 100 Sauvignon blanc juices have been collected from throughout New Zealand during harvest 2011, but with the majority coming from Marlborough. Sub-samples of these juices were analysed for a number of compounds and 700-ml ferments wines were made. Fermentation characteristics were recorded and all wines were chemically analysed. A grower survey on vineyard practices was conducted. GIS technology was used to map vineyard practices, soil type and the geological and climatic conditions as well as juice and wine characteristics. The information that has been gathered will help to define identifiable New Zealand terroirs.

Key Words: Terroir, Marlborough, Sauvignon blanc, GIS.

1 INTRODUCTION

Terroir is a key-concept in viticulture [1] that is widely recognized to explain variations in wine quality and wine style. Terroir is the combination of soil composition, microclimate and topography of the vineyard site (zones) interacting with a specific grape variety, crop management and winemaking. Aspects of zoning in the wine industry have been investigated for many years [2]. While originally the concept of terroir was mainly used to guarantee the authenticity of the product [3], more recently terroir is used for differentiation between wine styles and as a marketing tool [4].With the development of new technologies, more rigorous standards have been imposed for both the origin (soils and climate) and the quality of the wines. Extensive research has been done around the world on differentiating terroirs. A comprehensive review by Deloire [5] discusses different approaches to the study of terroir. Scientists have been looking at soil factors [6-11], climate, [12], or both [1]. Other studies have focused mainly on the sensory specifics of wines[4, 13-15 and combination of these methodologies[16-18] and development of methods for fingerprinting wines [19].

New Zealand has become one of the leading producers of Sauvignon blanc in the world, with 16000 ha. Marlborough is the main production region and the specific flavour and aroma profiles of New Zealand Sauvignon blanc [20, 21] are often identified with the Marlborough region. However, under *The NZ Geographical Indications (Wines and Spirits) Registration Act 2006,* the Marlborough label covers all the Sauvignon blanc wines from Marlborough irrespective of brand, sub-region or production method. Banks [22] found that with the New Zealand wine industry aiming at the high quality market, the sense of regionality was strongly supported. Within the Marlborough region, differences are suggested between the sub-regions of the Wairau valley, the Awatere valley and the Southern valleys.

For our investigation, we have chosen to use a combination of methods that over time will give us a better understanding of what determines the characteristics of different New Zealand Sauvignon blanc wines.

2 MATERIALS AND METHODS

Wineries from all regions in New Zealand provided Sauvignon blanc juices post-cold settling from individual vineyard blocks. With 87% of Sauvignon blanc production in Marlborough (41^{o}31'00''S-174^{o}02'00''E), the majority of samples were from that region. A small number of samples was obtained from the North Island's East coast (39^{o}30'00''S - 176^{o}50'00''E), from Nelson (41^{o}20'00-173^{o}15'00''), and Central Otago (44^{o}58'00''-169^{o}16'00'') (Figure 1A).

A survey of each vineyard location and management practices was conducted. ArcGIS®, ArcMap™ 10 software was used to map the information that was collected. Soils data were taken from the New Zealand soils database (Figure 1B) to determine the different soil parameters, as well as meso-climate information from regional and local meteorological stations.

The frozen juices were analysed for following parameters: soluble solids (^{o}Brix), titratable acidity (TA), pH, the thiol pre-cursor 3-cysteinyl hexan-1-ol.

Each juice was micro-fermented at 15^{o}C using EC118 yeast and a standard winemaking protocol. The wines were analysed for: pH, alcohol, methoxy-pyrazines and the thiols 3-mercaptohexan-1-ol (3MH) and 3-mercaptohexyl acetate (3MHA).

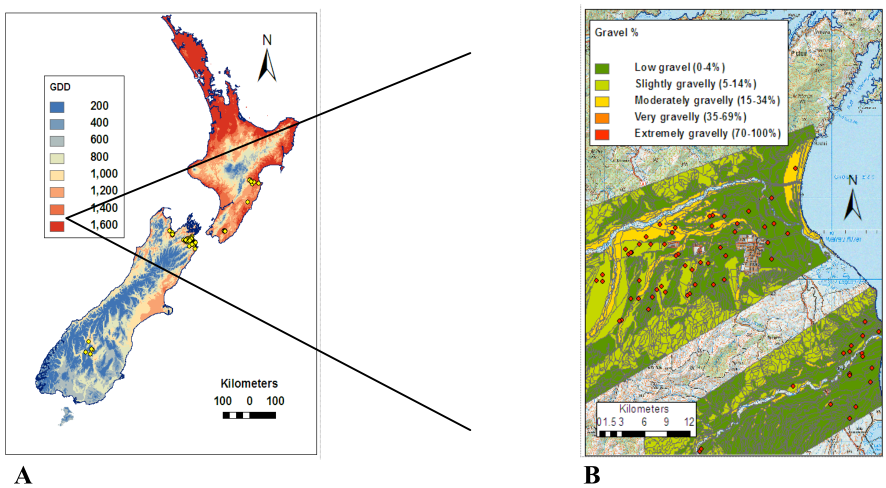

Figure 1. A) GDD (growing degree days base 10^{o}C,) for New Zealand. B) Gravel % for Marlborough soils with the vineyard blocks identified.

3 RESULTS AND DISCUSSION

To what extent does the sub-region of Marlborough affect the Sauvignon blanc wine style? What defines a typical Marlborough Sauvignon blanc and is it necessary to produce the fruit in Marlborough? On what scale does terroir actually work for Sauvignon blanc in New Zealand? Vaudour [23] already questioned the scale of the terroir concept but to be able to answer the above questions, it is essential to investigate how different juices and wines are and why they are different. Initially, geographic zones that were applied to the New Zealand wine regions reflected historic government administration areas and did not necessarily consider eco-physiological parameters important for wine production.

In general, the more northern regions of New Zealand have higher GDDs and earlier harvest dates. Differences in rainfall are not as important for determining terroir characteristics as in many 'Old World' regions, as irrigation is generally practiced in New Zealand.

It was found that the Hawke's Bay fruit from all six vineyard blocks were harvested at a lower soluble solids content, of 20.5 ^{o}Brix (Figure 2). This resulted in low alcohol wines after a very fast fermentation (12 days compared with 20-30 days in Marlborough).

The most important flavour and aroma compounds of New Zealand Sauvignon blanc (green, vegetal, fruity and tropical) are attributed to thiols and methoxypyrazines. The wines from the North Island wine regions in this study, Hawke's Bay and Martinborough, had the lowest concentrations of methoxypyrazines (Figure 2). In Hawke's Bay, despite the fact that juices were obtained from very different sub-regions, the overall variability was small. The most noticeable aspect of the Martinborough fruit was that they were harvested at high soluble solids of 22.2 ^{o}Brix, whereas Nelson wines were made from fruit harvested at a low average 19.7 ^{o}Brix (Figure 2). However, the lower soluble solids found for the Nelson and Hawke's Bay juices were presumably a harvesting decision by the winemaker rather than a climate-driven effect.

With most juices for this research obtained from Marlborough, high variability between wines was found, especially for isobutyl methoxy-pyrazine (IBMP) and thiols (Figure 2). That supports one of the initial hypotheses of the study: wines from the two main river valleys in the region, Awatere valley and the Wairau valley, are very distinct. But even within the main valleys there is high variability. Therefore, for this research the region is split up as follows: Wairau valley (Upper Wairau, Central Wairau, Lower Wairau, Rapaura, Renwick), Southern valleys (Brancott valley, Waihopai valley, Fairhall, Omaka) and Awatere valley (Blind River, Redwood Pass, Seaview, Upper Awatere). One example is from the Awatere valley Blind River area, where the lowest thiol pre-cursors in the juice were recorded, but the highest thiol concentrations in the wines, at up to eight times the value found in any of the other wines. In contrast, wines from the nearby Seaview area showed the lowest concentrations of thiols but very high amounts of methoxypyrazines (Figure 2).

From Central Otago we received only six juices; however, the variability within this region was very high compared with all the other regions. Despite this variability, the region scored the highest average °Brix value and the highest average thiol pre-cursors value.

In New Zealand, the lack of an AOC (controlled appellation of origin) equivalent results in the lack of uniformity of vine and vineyard management within a Terroir Unit (TU), as used by Deloire [5]. This makes the use of the concept of viticultural terroir unit (VTU), as proposed by Carbonneau [24], difficult to apply, as different canopy and yield management strategies are often used within the same vineyard. As was already mentioned [5], little work has been done on spatial modelling and terroir scale issues. Using GIS analysis will give us the opportunity to determine an appropriate scale for terroir zoning based on research outcomes.

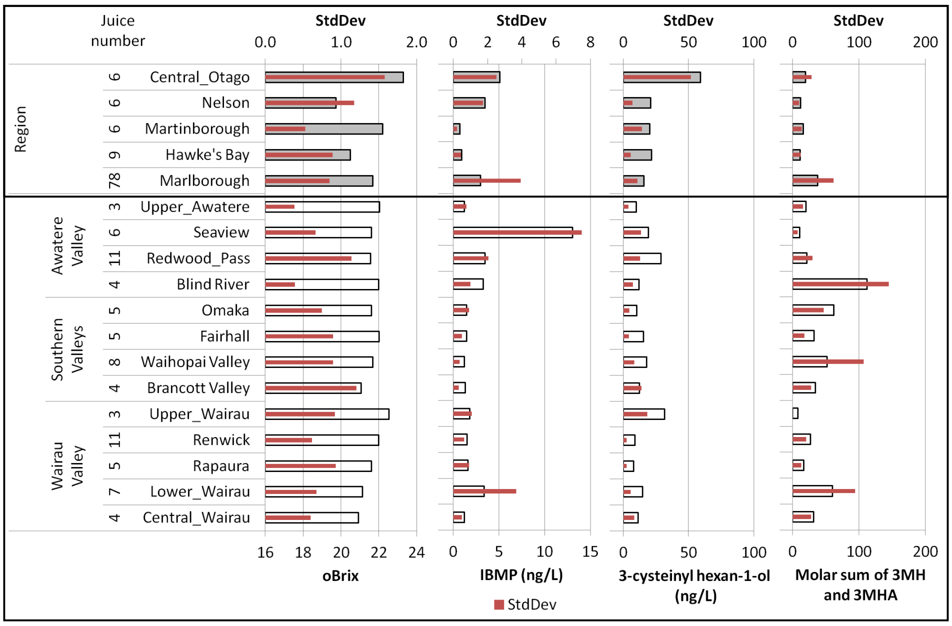

Figure 2. Averages (grey bars for New Zealand grape-growing regions and white bars for Marlborough sub-regions) and Standard Deviation within each (sub) region (red bars) for juice soluble solids (°Brix), 3-cysteinyl hexan-1-ol (thiol precursor of juice), molar sum of 3-mercaptohexan-1-ol (3MH) and 3-mercaptohexyl acetate (3MHA) thiols of wines and wine isobutyl methoxypyrazine (IBMP).

4 CONCLUSION

These preliminary results are from one year's research on a single grape variety, using a standardised winemaking technique. We used a combination of field differences and geographical differences to investigate the variation in juice and wine composition.

The trends found from this first year of data show that even over quite small geographic areas there are marked differences in juice and wine composition, some of which can be attributed to vineyard management. However, a few parameters, e.g. the IBMP concentration from the Seaview area and the thiol concentrations from the Blind River area in the Awatere valley, may reflect a distinct soil and/or climate influence often associated with terroir. So far, analyses have been made on a regional basis. No data have yet been analysed and related to climate, soils or management information.

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Meso-scale future climate modeling (5 km resolution): application over French wine regions under the SRES A2 scenario (2041-2050)

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ABSTRACT
In order to assess climate change at regional scales suitable to viticulture, the outputs of ARPEGE_Climat global model (resolution 0.5°) were downscaled using the Regional Atmospheric Modeling System (RAMS) and nested grids, providing downscaled datasets of 5 km resolution over France. Simulations were performed for two periods: 1991-2000, to assess the method against observations and quantify the large-scale induced biases; and 2041-2050 as near future climate projection under the SRES A2 scenario conditions. Results for July maximum temperatures, focussing on 6 wine regions, show RAMS contribution in reducing the large-scale bias, leading to a better assessment of climate change, yet with spatial differences.

Keywords: Mesoscale climate modeling, SRES A2 scenario, July maximum temperature, wine regions, France.

1 INTRODUCTION
Climate variability and trends are issues of growing concern at regional/local scales in the viticultural sector. The use of global climatic models (GCMs) ran under the different SRES emissions scenarios representing possible future evolution of greenhouse gases and aerosol precursor emissions during the 21st century (1), are necessary to simulate future climate. However, the outputs from GCMs are generally too broad-scale for viticultural purposes at regional scales (2, 3) and therefore downscaling methods (coarse to fine resolution) are necessary to translate changes at regional/local scales. Regional (or meso-scale) Climate Models (RCMs) driven by large-scale forcing generated by GCMs have been used for many years as a relevant downscaling tool (taking surface conditions and land-sea configuration into account, thus improving dynamical processes by means of nested grids (4) in order to study climate change at regional scales (5, 6). Many studies have shown the value of using different high-resolution three-dimensional atmospheric numerical models and increasing resolution to characterize the climate variability, potential and risks for viticultural environments (7-13). In this paper, the ARPEGE-Climat model of Météo-France (called ARPEGE thereafter) was used as the global driver for the Regional Atmospheric Modeling System (RAMS) and we show how RAMS contributed to deliver high resolution downscaled datasets (5 km) for recent past and near future climates, targeting some French wine regions.

2 DATA AND METHOD
The regional atmospheric modeling system RAMS (14) (v6.0) was initialized every 6 hours with the 3-D atmospheric fields of ARPEGE (4) (0.5° resolution), which simulated a succession of climatic conditions comparable to observations over Western Europe and reproduced the mean climatic characteristics of the 1971-2000 period (15). Two nested grids were used for downscaling (Fig. 1): Grid 1 corresponding to large scale forcing over the North Atlantic Ocean and Europe; Grid 2 with a 5 km resolution representing local circulations over France. The outputs of ARPEGE were downscaled for two periods of ten years in order to reduce computational costs (i.e. 1991-