Comparison of climate change projections for Patagonia viticultural regions generated by GCMs and a regional climate model PRECIS

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Background

Patagonia is a vulnerable region where the scientific community is facing challenges in estimating the timing and the magnitude of climate changes, and their environmental and socioeconomic impacts. The interactions between continental surfaces and atmospheric forcing are crucial drivers of its climate, and the variability of rainfall are key issues. However, the global climate models (GCMs) which traditionally provide useful climate projections at continental scale of several thousand kilometres, lack the regional scale details needed for adequate predictions of precipitation particularly in regions with significant topography. Regional climate models (RCMs) have shown promising performances in reproducing observed regional surface climate characteristics for many tropical regions. Here it is used in an extratropical region

Methodology

In this paper, the four main IPCC SRES emission scenarios have been compared and GCM outputs (low resolution) have been analyzed in order to project climate conditions for Patagonia, Argentina, for the 21st century. Furthermore, spatially more detailed projections (for the period 2071-2100) of climate parameters are provided by using the regional climate model PRECIS developed by the Hadley Centre, UK, (at 25 km horizontal resolution, 19 vertical levels). We present the comparison of climate scenarios simulating from the GCMs and the regional climate model PRECIS.

Advantages of a Regional Model

- General circulation models (GCMs)
  - large-scale patterns
  - large mainframe or cluster computers
  - no skill in extremes
- Regional climate models (RCMs)
  - local detail
  - run on a PC
  - realistic extreme events
  - represent small scale features

- Horizontal resolution: 0.22° x 0.22° (~25 km)
- grid spacing
- Vertical resolution: 19 hybrid levels, from ~50m to 0.5 hPa
- Time step: 5 minutes
- Duration: 10 years, 1960 to 1970
- Scenario A2

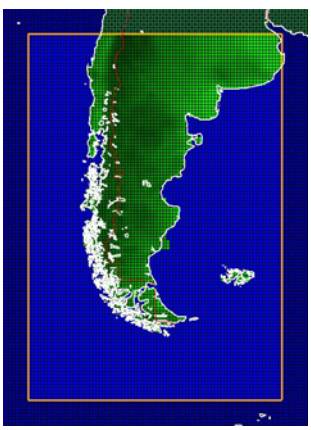


Figure. 1: *Model domain*

Results

Change in Temperature and Precipitation (GCMs)

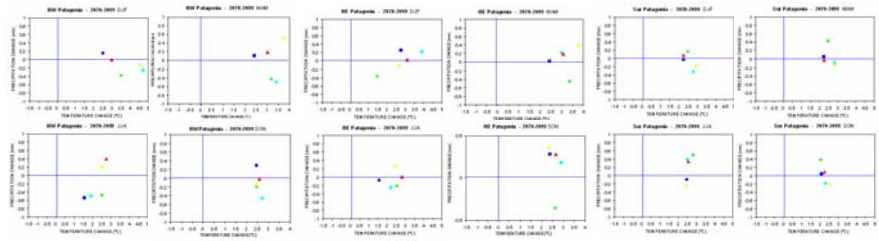


Figure 2: Projected climate change by 2070-2099 (relative to the baseline period (1961-1990) in the southern of Argentina country *IPCC Global Models SRES Scenario A2. Note: precipitation shown in mm/day*

Change in Temperature and Precipitation (RCM)

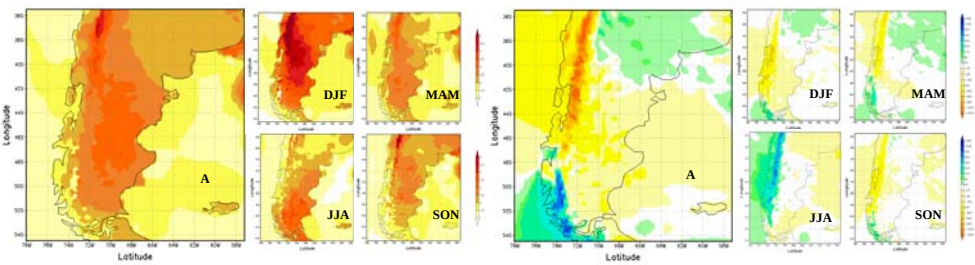


Figure 3: *Mean temperature change (2070-2080) relative to (1960-1970).*

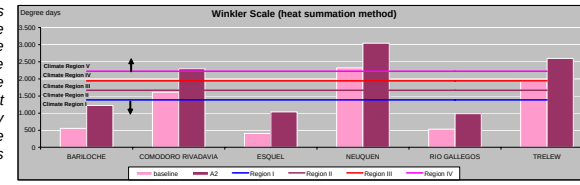
Figure 5: *Precipitation changes (2070-2080) relative to (1960-1970). Note: precipitation shown in mm/year and mm/season*

Change in climate aptitude for viticulture

Table 1: *System of heat summation by degree days and its relationship. This method for classifying wine climate regions was developed in the 1930s at the University of California Davis. Winkler and Amerine (1944) summed the degrees above 10 ºC (50ºF). The method is based on the theory that no wine shoot growth occurs below 10ºC and that each degree a day average above 10ºC is considered a degree day. The heat summation of a growing region determines its classification.*

Climate Region	Day Degrees	Traditional winemaking regions	Suggested varieties	Wine Style
I *(Is the coolest)*	*up to 1.389 degree days*	Regions like Champagne and Côte d'or in France, the Rhine in Germany, and Willamette Valley in Oregon	Cabernet Sauvignon, Chardonnay, Pinot Noir, Riesling and Sauvignon Blanc.	Best table wines, light to medium body and good balance
II	*from 1.391 to 1.666 degree days*	France's Bordeaux region Napa Valley	include those for Region I plus Merlot.	Best table wines, light to medium body and good balance
III	*from 1.667 to 1.945 degree days*	France's Rhône region. Uco Valley (Mendoza) in Argentina	Carignan, Ruby Cabernet, Sauvignon Blanc, Sémillon, and Zinfandel.	Full-bodied dry and sweet table wines lighter bodied dessert wines
IV	*from 1.946 to 2.222 degree days*	Southern Spain. Florence (Italy) Calchaquies Valley in Argentina	Barbera, Emerald Riesling Ruby Cabernet, and those used for port-style wines.	Dessert wines and low quality table wines
V *(Is the hottest)*	*more than 2.222 degree days*	North Africa. Chilecito-Nonogasta in Argentina	Is best suited to wines like Muscat (grape and wine) or varietals like Verdelho	Bulk wines and fortified wines. Fresh and dried grapes

Dates from Catania, et al. 1994; Taylor 2004; and Herbst.



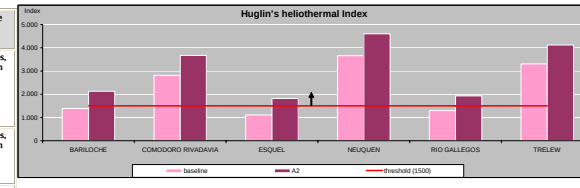


Figure 6: *Two systems for assessing climate in six provinces of the Patagonia with A2 and baseline scenarios.*
•Winkler Scale is divided into five climate regions based on temperature.
•Huglin´s heliothermal index puts more weight on maximum temperature and adds a parameter for latitude to reflect the effect of increasing hours of sunlight. The formula sums average temperature minus 10°C plus maximum temperature minus 10°C, multiplied by a coefficient for latitude that increases from 1.02 at 40° to 1.06 at 50°. The region with an index above 1.500 could be considered a potential viticulture area.

Conclusions and future plans

We observed that this model offers improved applicability and reliability concerning viticultural aspects and primarily aims at evaluating measures of adaptation rather than predictions. The results demonstrate the extent and effects of climate change on viticultural areas in south Argentina. In comparison to its parent GCM simulates mean precipitation better (and the evolution of seasonal anomalies due, in part, to its use of reanalysis boundary conditions).
Winkler scale: When the scenario is changed the increase in the heat summation modifies the Climate Region.
Huglin index: All provinces could be able to increase and became viticulture area when the scenario is changed.