CLIM-RUN Product Information Sheet: April 2014

Climate change projections of temperatures in high mountain areas

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Key words : Savoie, Tourism, High Mountains, Future Climate change, Temperature

Target groups

- **Outdoor activity operators and professional organisations**
- **Tourism institutions**
- **Regional authorities**

Relevance to the Case-Study Requirements

Increasing temperatures are a strong indicator of climate change for the Savoie tourism industry. Consequently, many actors have already underlined the importance of having access to projections differentiating between mid- and high-mountain areas. A product specifically developed for high-mountain areas would allow actors to better plan for the risks threatening some tourism activities such as mountain climbing, glacier trails and hiking. These risks (including falling blocks of ice and seracs), which have already been observed, could threaten traditional itineraries, increasing the level of difficulty of some trails. By better understanding future conditions, actors could adapt activities accordingly.

The Approach

Simulations of climate change over European mountainous regions have been carried out within the ANR/SCAMPEI project (http://www.cnrm.meteo.fr/scampei/presentation_scampei/index.php). The simulations were carried out by the LMD, LGGE and CNRM modelling groups at Météo France using high-resolution regional climate models at a 12 km horizontal resolution. Afterwards, statistical analysis was applied to take into account the complex orography in mountainous regions. The simulations were run over three different periods: the present period (1961-1990), the near future (2021-2050) and the far future (2071-2100) following an A1B greenhouse gas emissions scenario. As far as we know, these simulations are the only ones which have corrected the model bias with altitude. Thus they are the best available to explore climate changes over mountainous regions.

Using the SCAMPEI data base, the models output corresponding to specific user needs in terms of parameters (mean-max-min temperatures) are corrected for different altitude ranges. However, the horizontal resolution of the different models (12 km) does not allow good representation of the highest altitude (4800m for Mont Blanc). In the models, the highest grid cell has a maximum altitude of 3300m which is too low to give information about the evolution of the 0°C isotherm in the summer season. The 0°C level is above this altitude at this time of the year in both present and future climates. Thus to overcome this problem, we look at temperature projections for different altitude ranges: 1500-2500 meters and 2500-3300 meters. The temperature change obtained gives a quick comparative indication of the change of the freezing level since a change of 1°C corresponds approximatively to an increase in altitude of about 100 meters.

A major issue was to represent in a simple way not only the trend of future temperature change but also the range of uncertainty around this trend. Also, it appears relevant to represent model values (of mean, max and min temperature) for different future time periods in order to guide the decision making process. Although maps have been provided and can be a good way of communication with the wider public, graphs are most comprehensible for most stakeholders.

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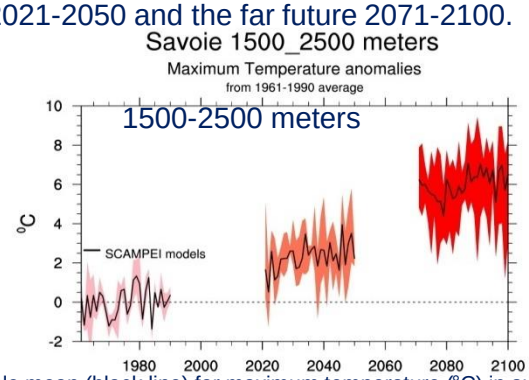
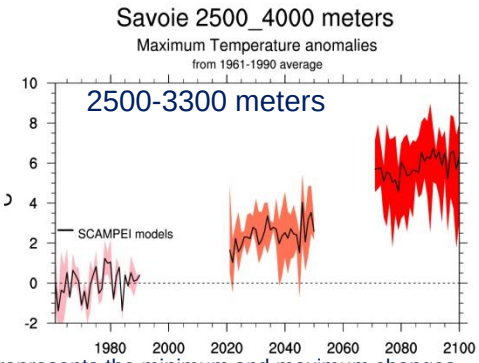
The product

Here, we present the change in maximum temperatures during the summer season in Savoie for two different altitude ranges: 1500-2500m and 2500-3300m. The reference period is 1961-1990. The near future is the period 2021-2050 and the far future 2071-2100.

°C	T_{min}	T_{mean}	T_{max}
2021 -2050	1.1	2.3	3.7
2071 -2100	3.8	6.0	7.7

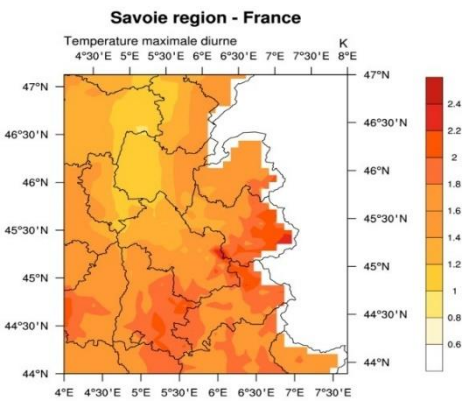


°C	T_{min}	T_{mean}	T_{max}
2021 -2050	1.3	2.4	3.6
2071 -2100	3.8	5.8	7.4

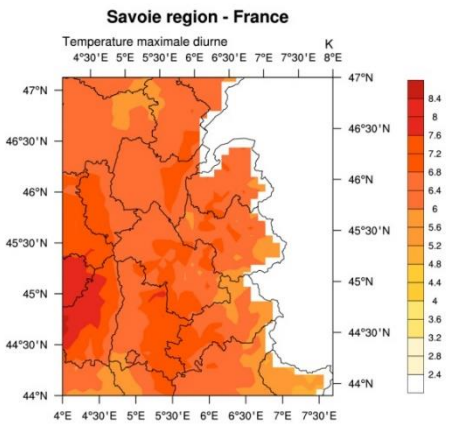


Model ensemble mean (black line) for maximum temperature (°C) in summer. The envelope represents the minimum and maximum changes from the different simulations.

Changes in near future



Changes in far future



Maximum temperature is projected to increase in the future for all altitude ranges and models. By the end of the century the mean projected increase of the models is around +6°C with a range of 4°C to 8°C. This information can be translated by the stakeholders who are familiar with the local climatic conditions. It is very important to provide information to stakeholders about the spread of the models not just the mean.

Making the product usable

This product could be integrated in the French climate service portal: DRIAS, where figures with the mean trend and the associated uncertainties are useful for stakeholders. (http://www.drias-climat.fr/) Recommendations will be addressed to them in terms of improvements of the representation of model outputs (graphs, means of the models for maps etc.).

This product will be useful in the hands of professional organizations in order to raise the awareness of the wider public especially those who are practicing outdoors activities. To make the product usable for the professional operators, it would be necessary to provide information on seasonal to decadal timescales.

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