

Climate projections for the XXI century over the Republic of Mauritius with COSMO-CLM

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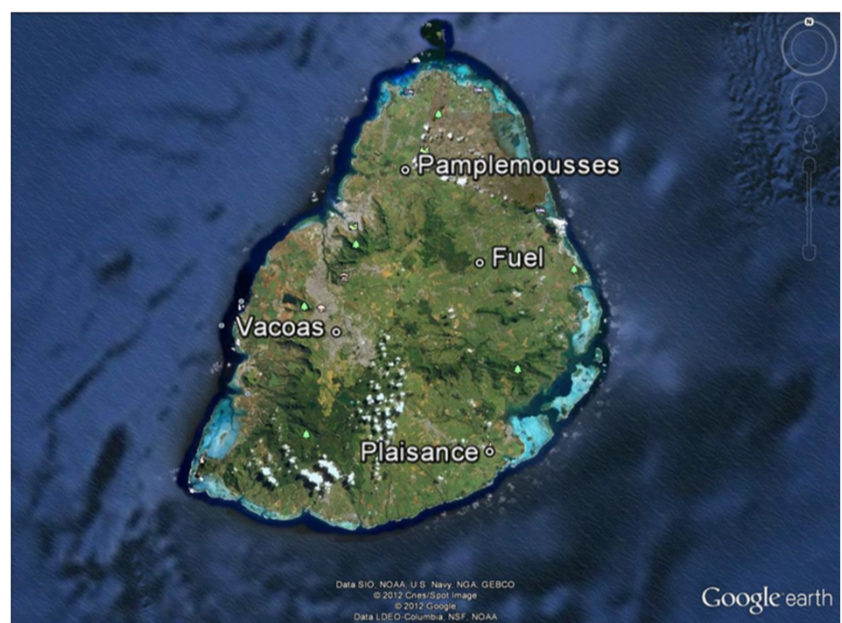
The climate of Mauritius

The main aim of this work is the production of downscaled regional climate projections at high resolution (0.0715°), using the IPCC scenarios RCP4.5 and RCP8.5 over a domain including the island of Mauritius and Rodriguez.

The Republic of Mauritius is situated in the southern edge of the tropical belt, enjoying a pleasant and mild maritime climate.

The island of Mauritius is characterized by a main hill with a central plateau. The mean summer temperature is 24.7° C, the mean winter one is 20.4° C. Despite its small area, there are substantial variations in the climate inside the island. Different behaviours may arise across the island, due to the differences in elevation or location, for instance the proximity of the coast.

The island of Rodriguez enjoys a mild tropical maritime climate with a mean summer temperature of 25.9° C and a mean winter temperature of 22.3° C. Persistent trade winds blow throughout the year. Long term annual mean rainfall (1971-2000) over the island is 1105 mm.

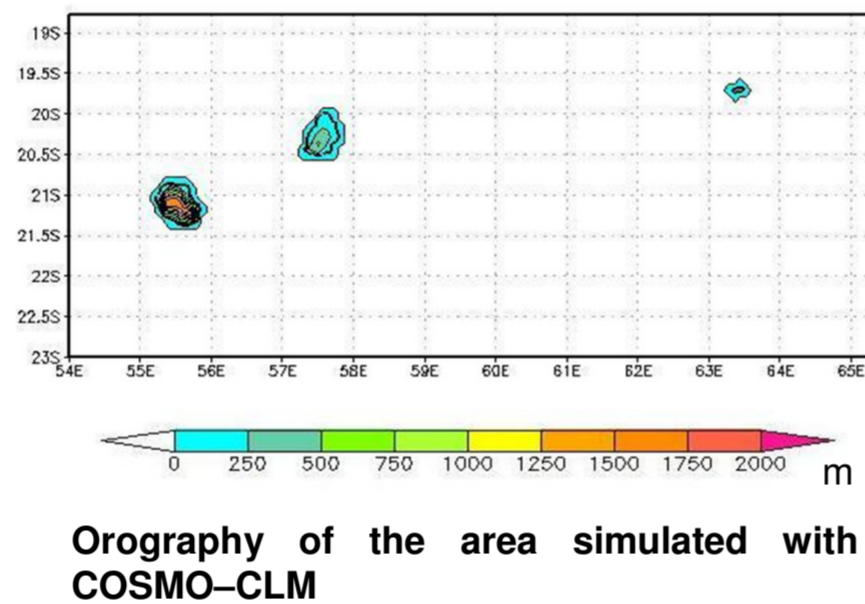


Set up of COSMO-CLM

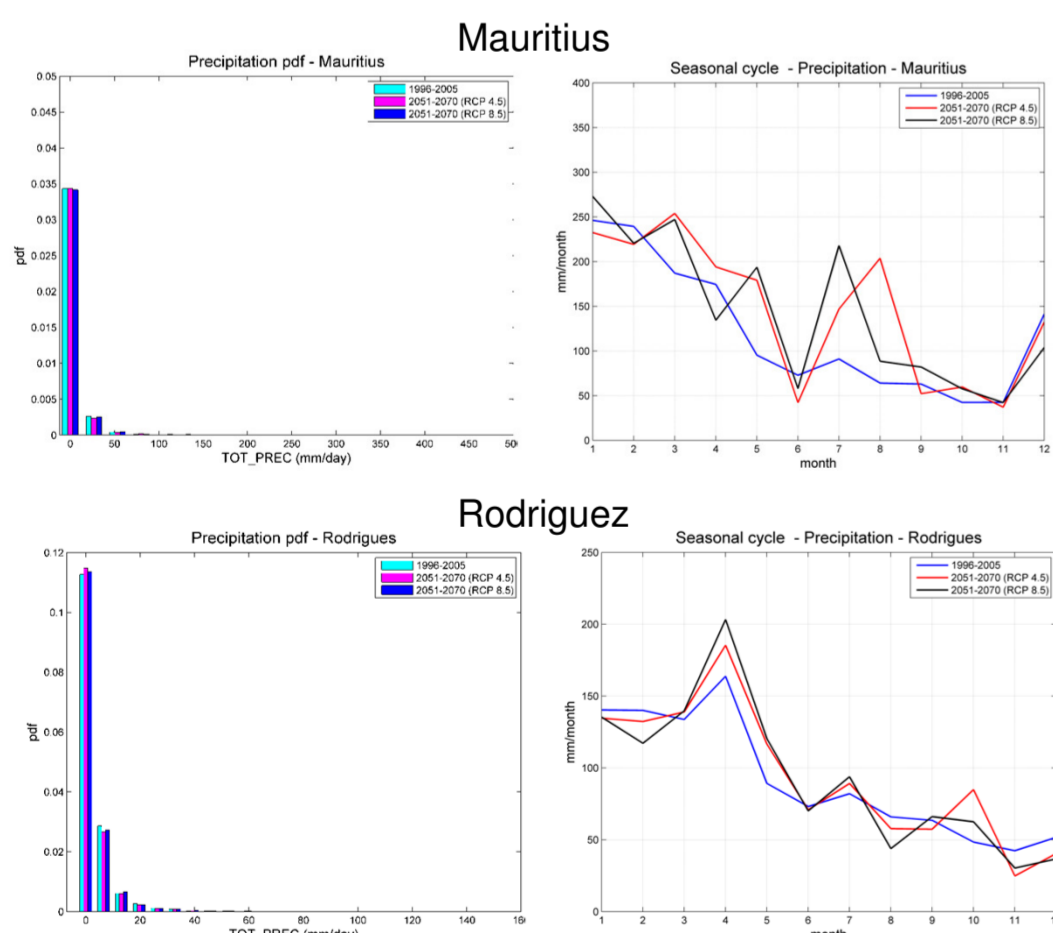
The domain of integration ranges from the latitude of 22.5° S to 18.99° S and from the longitude of 54.5° E to 65.15° E (1300 x 500 km). The period simulated is 1996-2070.

- Spatial resolution: 0.0715°
- Computational grid: 160 x 60 horizontal grid points; 40 vertical levels and 4 soil levels plus the climatological layer.
- Driving data:
 - CMCC-MED (ECHAM5 T159) (~ 80 km resolution, 6 h time resolution)
 - ERA40 reanalysis (only for the sensitivity activity)
- Time step: 50 sec.
- Numerical scheme: Runge-Kutta 2-time level HE-VI integration
- Convection scheme: Tiedtke

Climate projections have been performed by using the IPCC-RCP4.5 and RCP8.5 scenarios.

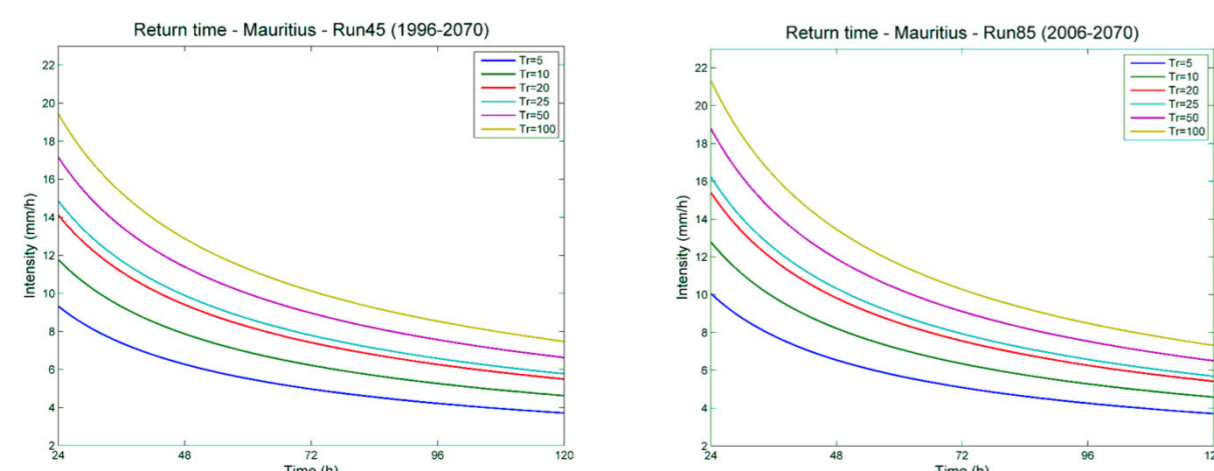


Climate projections: precipitations



The PDF for the scenarios RCP4.5 and RCP8.5 do not show a significant variation with respect to the present climate. Nevertheless the precipitation seasonal cycles show a different shape, especially over Mauritius island for the period from June to October.

These figures show the Rainfall Intensity - duration curves for Mauritius island for RCP4.5 scenario (left) and RCP8.5 scenario (right). The curves are evaluated using COSMO-CLM results over the period 2006-2070 after the application of a bias correction algorithm.



Acknowledgements

- The authors thank Burkhardt Rockel (HZG) for the support provided.
- This work has been funded by the Government of Republic of Mauritius, in the frame of the project "Consultancy Study for the Development of an Inundation, Flooding and Landslide National Risk Profile, Maps, Strategy Framework and Action Plans for Disaster Risk Management for the Republic of Mauritius".
- The authors thank also Studio Galli Ingegneria (Italy) for providing the opportunity to participate in this project.

Observational datasets

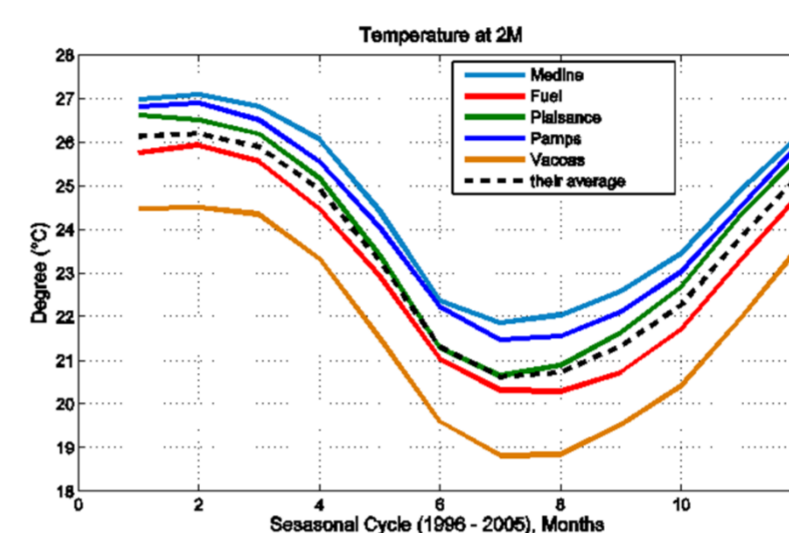
Observations have been provided by the Mauritius Meteorological Service.

They consist of 5 observations stations located at the islands of Mauritius and Rodriguez.

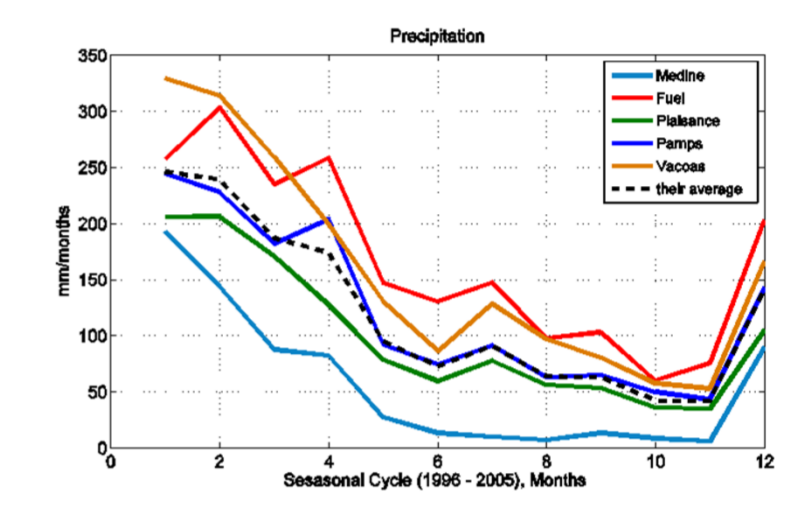
The collected variables (for the period 1996-2005) consist of:

- daily 2-metre temperature (°C)
- daily cumulated rainfall (mm/day).

Name of the station:	Location:
Vacoas	Island of Mauritius
Plaisance	Island of Mauritius
Fuel	Island of Mauritius
Pamplemousses	Island of Mauritius
Pointe Canon	Island of Rodriguez



Seasonal cycle of the 2-metre temperature for the 5 stations of observations (coloured lines), and their averaged (dashed line).



Seasonal cycle of the cumulated rainfall values (mm/year) for the 5 stations of observations (coloured lines), and their average value (dashed line).

Sensitivity analysis

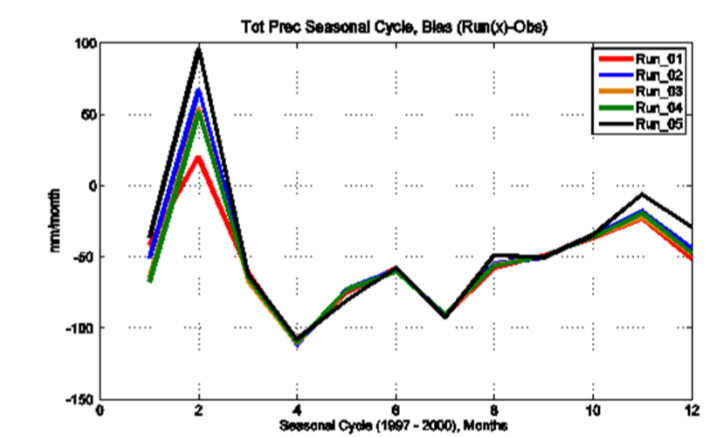
Five different configurations have been obtained starting from the basic one, by varying one or more key parameters, in order to analyse the response of the model to such changes.

Period considered: 1996-2000

The best configuration is the same adopted for the north-west region of Africa in the context of the CLUVA (CLimate change and Urban Vulnerability in Africa, <http://www.cluva.eu/>) project, whose overall aim is to develop methods and knowledge to be applied to African cities to manage climate risks.

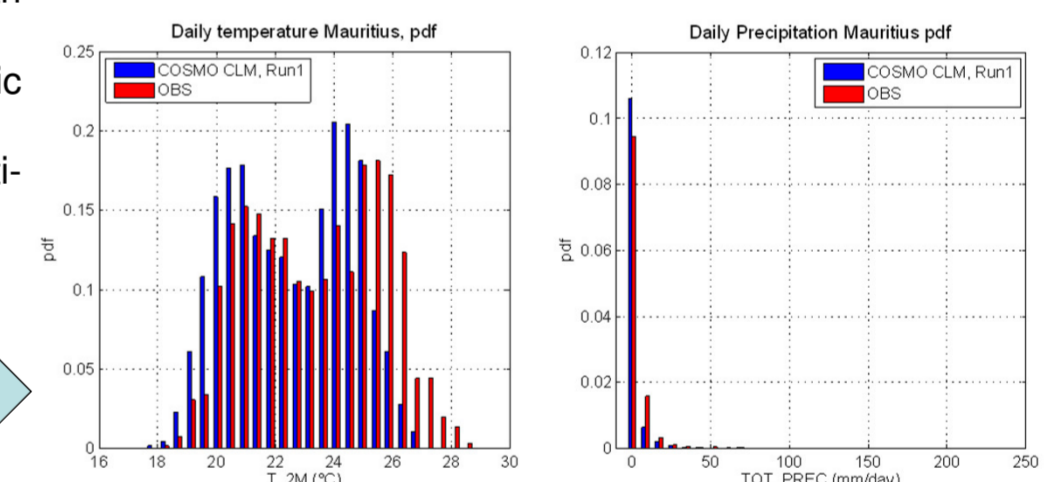
Main features of the selected configuration:

- boundary update frequency is 12 hours.
- a grid-scale precipitation scheme is adopted, with a Kessler-type warm parameterization scheme with cloud water and cloud ice.
- prognostic TKE-based scheme for the specific vertical turbulent diffusion parameterization.
- Soil processes are included by running the multi-layer soil model TERRA_ML.

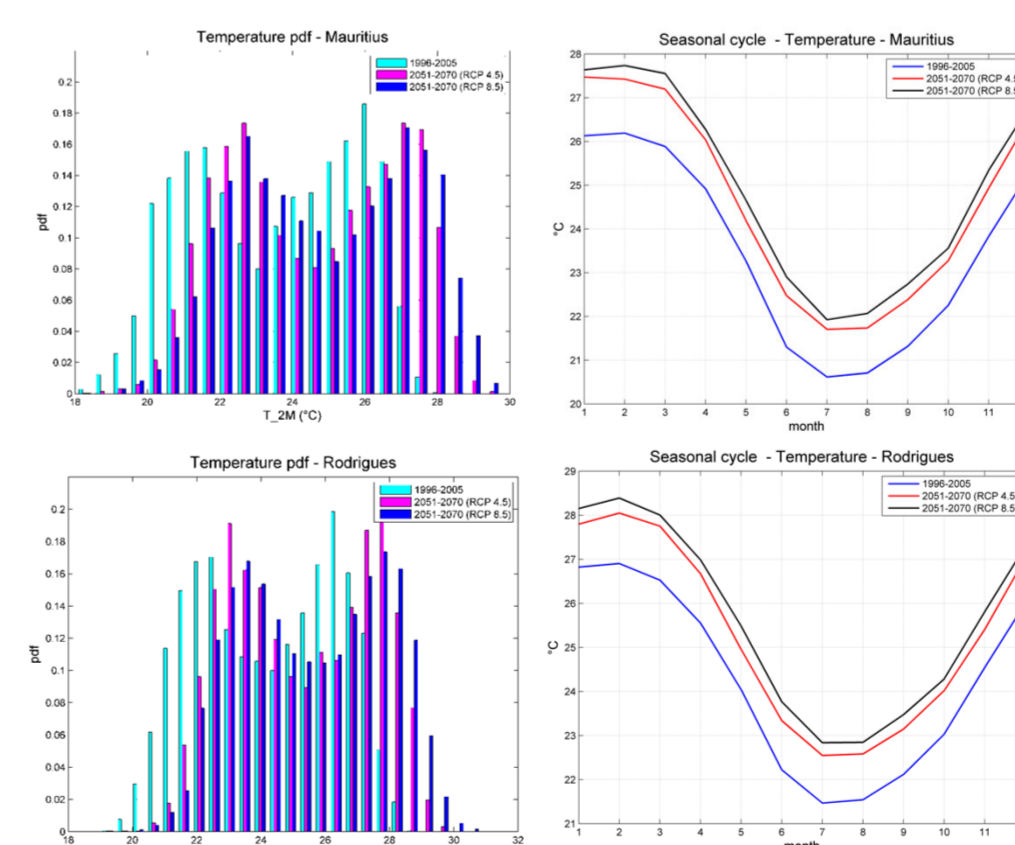


Seasonal cycle of bias of precipitation for different configurations.

PDF of precipitation and 2-metre temperature for CLM output (selected configuration) and observations.



Climate projections: temperature



An increase of temperature is observed comparing the period 2051-2070 with the period 1996-2005, for the 2 scenarios and for both the islands. The increase of temperature is in the range 1 - 2 °C and is more pronounced, as expected, for the scenario RCP8.5.

A significant growth of the number of very hot days is also projected.

Conclusions

A research activity with the aim of investigating the climate change expected has been performed using high resolution climate simulations over the Republic of Mauritius. Climate projections for the XXI century have been evaluated in terms of intensity and frequency of precipitations events, as well as temperature conditions.

A preliminary sensitivity analysis has been executed to determine an optimal configuration of COSMO-CLM for this particular area, making a comparison with observed data of 5 stations (1996-2005). The selected configuration provides satisfactory performances, with a bias of temperature that never exceeds 1.1° C (absolute value) and a bias of precipitation generally around 50 mm/month. Moreover, the model reveals a discrete capability in simulating the extreme events.

Climate projections highlight an increase of temperature of about 1-2° C in the period 2051-2070 with respect to the present climate and an increase of precipitations particularly evident over Mauritius, while they are generally unchanged over Rodriguez.