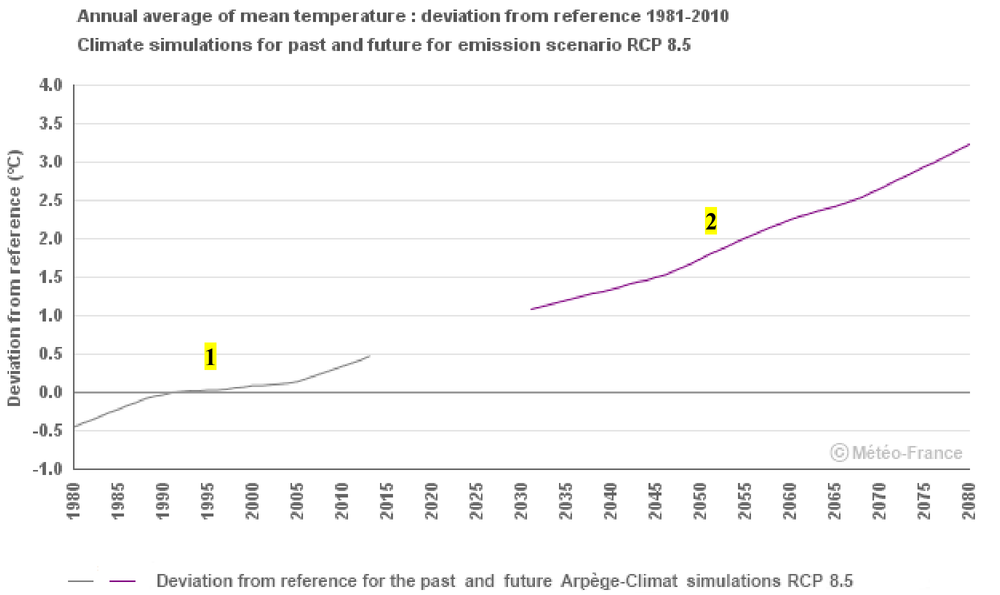
Evolution of annual/seasonal temperatures
Future climate – French West Indies

1. Graph reading aid



2 series are represented on the graph :

Series 1 : represented in grey :
Deviation of the annual/seasonal average of daily minimum/mean/maximum temperatures simulated with the Arpege-Climat model (Météo-France) from the reference value (1981-2010 average), over the 1980-2013 period (regional index, see §3. Data and methods).
The curve corresponds to the smoothed value of the median within the ensemble of 5 members (see §3. Data and methods).
Note that for the December-January season, the reference corresponds to the December 1981-January 1982 to December 2009-January 2010 period.

Series 2 : represented in purple :
Deviation of the annual/seasonal average of daily minimum/mean/maximum temperatures simulated with the Arpege-Climat model (Météo-France) for the RCP 8.5 scenario from the reference value (1981-2010 average), over the 2031-2080 period (regional index, see §3. Data and methods). The curve corresponds to the smoothed value of the median within the ensemble of 5 members (see §3. Data and methods).

2. Definitions

Weather seasons :

- Wet season : July to November
- May and June
- Dry season : February to April
- December and January

Minimum/maximum/mean temperatures :

- Daily minimum temperature (TNq) = minimum simulated temperature between D-1 day at 8pm local time and D-day at 8pm local time
- Daily maximum temperature (TXq) = maximum simulated temperature between D-1 day at 8pm local time and D day at 8pm local time
- Daily mean temperature (TMq) = (TNq + TXq)/2

Deviation of the annual/seasonal average of daily minimum/maximum temperatures from its reference value :

- Annual/seasonal average TNs (resp. TXs) of daily minimum (resp. maximum) temperatures = average over the year/season of daily minimum (resp. maximum) temperatures TNq (resp. TXq)
- Reference over the 1981-2010 period (Ref TNs or Ref TXs) = average of the 30 TNs or TXs values. This average is computed for each of the 5 ensemble members (see §3. Data and methods)
- Deviation from the reference = difference between the annual/seasonal mean (TNs or TXs) and the reference (Ref TNs ou Ref TXs)

Deviation of the annual/seasonal average of daily mean temperatures from its reference value :

- Annual/seasonal average TMs of daily mean temperatures = average over the year/season of daily mean temperatures TMq
- Reference over the 1981- 2010 period (Ref TMs) = average of the 30 TMs values. This average is computed for each of the 5 ensemble members (see §3. Data and methods)
- Deviation from the reference = difference between the annual/seasonal mean (TMs) and the reference (Ref TMs)

3. Data and methods

Climate modelling:

Climate simulations are created from general circulation models, which take different reference scenarios for the evolution of radiative forcing called RCP (Representative Concentration Pathway) into account. Compared to weather forecast models, an essential feature of climate models is that they do not need to be adjusted to observations. The simulated climate system evolves completely freely; it receives energy from solar radiation and loses energy through infrared radiation emitted into space. The simulated climate (temperature, precipitation, etc.) is the result of this adjustment between received and lost energy. Energy conservation, and more generally energy exchanges, are therefore fundamental for a climate model, and their modelling is the primary concern of climate scientists.
These models allow the development of climate projections that are representative of different possible scenarios for climate evolution.

RCP scenarios:

Only one RCP scenario is considered: RCP 8.5, corresponding to a scenario without climate policy (pessimistic scenario).
The number following the RCP acronym is the radiative forcing for year 2100 in Watts per square meter.

The climate projections being used:
The projections used to construct the index over the French West Indies are from the Arpege-Climat *global high-resolution* model (Météo-France). Such high resolution being essential in order to represent the local climate in these small island territories, it was not possible to proceed with a multi-model approach with percentile calculation to define uncertainty estimates and to represent the range of highest probability (between the 17th and 83rd percentiles), as has been done for metropolitan France for the RCP 4.5 and RCP 8.5 scenarios.
The Arpege-Climat global *high-resolution* model is close to the global *low-resolution* multi-model mean from the CMIP5 exercise, which gives good confidence in the evolution of temperatures proposed here under the RCP 8.5 scenario, despite the lack of range of highest probability that would account for the uncertainty related to the choice of model.
Besides, 5 so-called ensemble simulations, also named 'members', are available for this model and for both climate experiments (historical reference and RCP 8.5 scenario). These simulations are subject to the same forcings (sea surface temperatures from a CMIP5 model, that of Météo-France) and follow the same overall climate evolution, but differ in the exact sequence of meteorological events, thanks to slightly different initial conditions that lead to the propagation of these differences over the entire globe : this is the famous 'butterfly effect'. Using such an ensemble allows accounting for the sampling uncertainties, which is particularly critical to evaluate the future evolution of rare or extreme events such as hot days and nights or days of heavy rainfall.
Daily data from these members have been bias-corrected with the quantile-quantile method (performed at Météo-France), using an ensemble of 13 stations with temperature records in Martinique and 2 stations in Guadeloupe (selected based on quality and representativity criteria), and projected onto the locations of these stations (Cantet et al. 2021). Last, a regional index has been computed separately for the two islands by averaging the available station data (deviations from the reference, see §2. Definitions), before averaging the two indices for Guadeloupe and Martinique.
The data shown are smoothed with a LOWESS filter using 50% of the values in the series.

4. References

Drias, futures of climate
www.drias-climat.fr

Coupled Model Intercomparison Project : phase 5 (CMIP5)
https://www.wcrp-climate.org/wgcm-cmip/wgcm-cmip5

C3AF project (Climate Change and Consequences over the French West Indies – in French)
https://c3af.univ-montp3.fr/

Belmadani, A., Dalphinet, A., Chauvin, F., Pilon, R., Palany, P. Projected future changes in tropical cyclone-related wave climate in the North Atlantic. Clim Dyn 56, 3687–3708 (2021). https://doi.org/10.1007/s00382-021-05664-5

Cantet, P., Belmadani, A., Chauvin, F., Palany, P. Projections of tropical cyclone rainfall over land with an Eulerian approach: Case study of three islands in the West Indies. Int J Climatol 41(1), E1164–E1179 (2021). https://doi.org/10.1002/joc.6760

Chauvin, F., Pilon, R., Palany, P., Belmadani, A. Future changes in Atlantic hurricanes with the rotated-stretched ARPEGE-Climat at very high resolution. Clim Dyn 54, 947–972 (2020). https://doi.org/10.1007/s00382-019-05040-4

Chauvin, F., Pilon, R., Palany, P., Belmadani, A. Correction to : Future changes in Atlantic hurricanes with the rotated-stretched ARPEGE-Climat at very high resolution. Clim Dyn 56, 683–685 (2021). https://doi.org/10.1007/s00382-020-05564-0