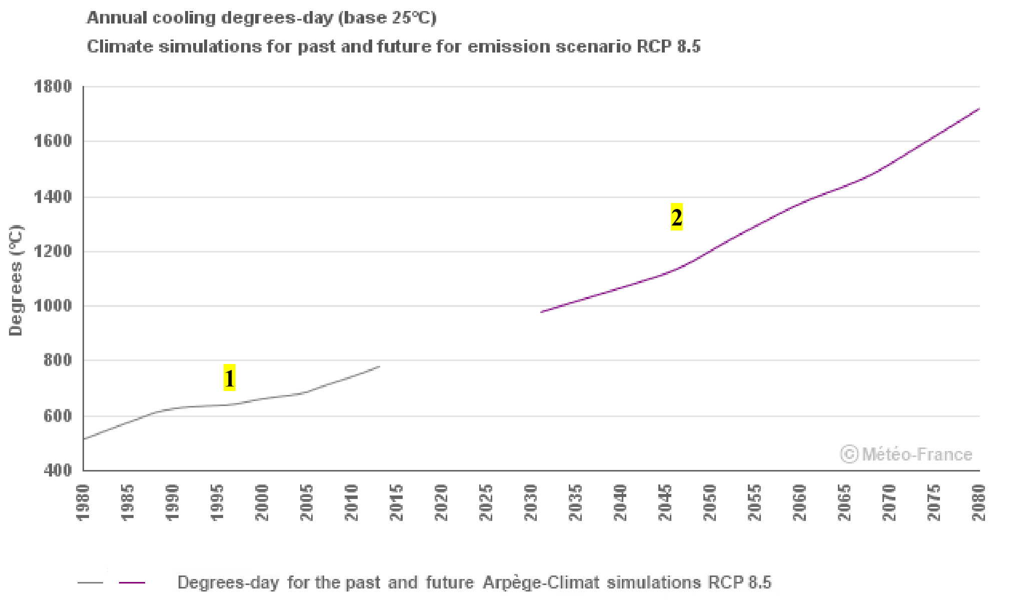
Evolution of cooling degree days
Future climate – French West Indies

1. Graph reading aid



2 series are represented on the graph :

Series 1 : represented in grey :
Cooling degree days allow evaluating the energy consumption associated with air conditioning. For each year, the accumulated cooling degree days over the year, computed with the air conditioning method (*see §2.2 Definition*) using data simulated with the Arpege-Climat model (Météo-France), over the 1980 – 2013 period (regional index, see §3. Data and methods), is represented here. The curve corresponds to the smoothed value of the median within the ensemble of 5 members (see §3. Data and methods).

Series 2 : represented in purple :
Yearly accumulated cooling degree days simulated with the Arpege-Climat model (Météo-France) for the RCP 8.5 scenario, 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

Cooling degree days with the air conditioning method : (TMq - 25) if TMq > 25°C
The 25°C threshold has been adapted for the French West Indies and Reunion Island. It is 18°C in continental France.

Daily mean temperature (TMq) : TMq = (TNq + TXq)/2

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

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 cooling degree-days 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 hot nights for instance.
TMq data from these members have been bias-corrected with the quantile-quantile method (performed at Météo-France), using one station with temperature records in Martinique (Lamentin) and another one in Guadeloupe (Raizet), selected based on availability, quality and representativity criteria. The resulting data were then projected onto the locations of these 2 stations (Cantet et al. 2021), before computing the annual time series of the corresponding accumulated cooling degree days (see §2. Definitions). Last, a regional index has been computed by averaging these 2 series.
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

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