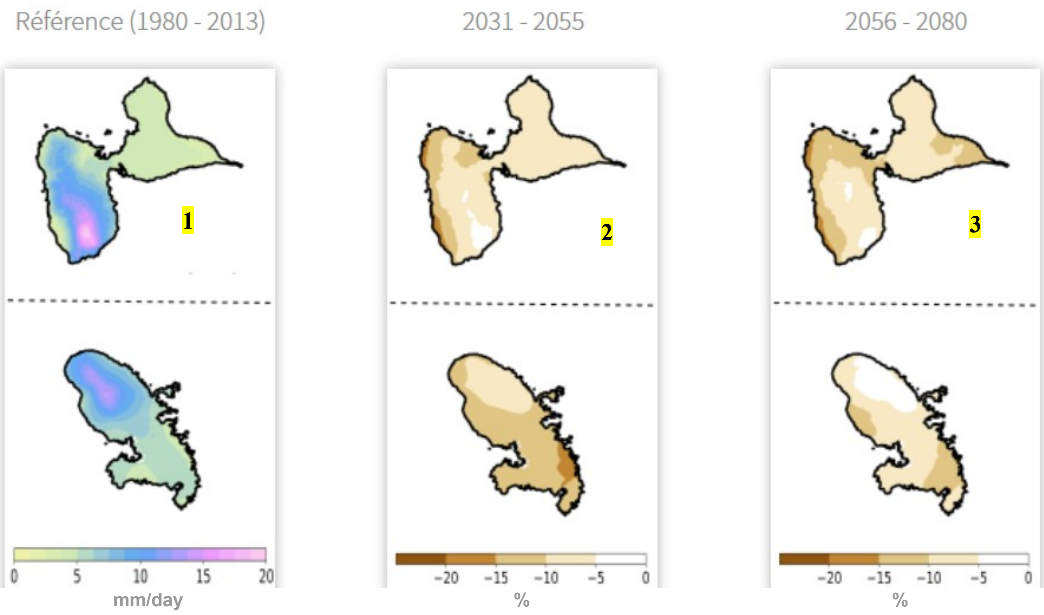
Evolution of annual/seasonal precipitation
Future climate – French West Indies

1. Graph reading aid

Annual rainfall amount: reference and deviation from it per time horizon
Climate simulations for climate evolution scenario RCP8.5



3 maps are presented on this page :

Map 1 :
Annual or seasonal mean daily precipitation simulated with the Arpege-Climat model (Météo-France), averaged over the 1980-2013 period (gridded data see §3. Data and methods). The map corresponds to the average among the ensemble of 5 members (see §3. Data and methods).

Map 2 :
Relative deviation from the 1980-2013 reference period of annual or seasonal mean daily precipitation simulated with the Arpege-Climat model (Météo-France) for the RCP 8.5 scenario over the 2031-2055 period (gridded data see §3. Data and methods). The map corresponds to the average among the ensemble of 5 members (see §3. Data and methods).

Map 3 :
Relative deviation from the 1980-2013 reference period of annual or seasonal mean daily precipitation simulated with the Arpege-Climat model (Météo-France) for the RCP 8.5 scenario over the 2056-2080 period (gridded data see §3. Data and methods). The map corresponds to the average among the ensemble of 5 members (see §3. Data and methods).

Each map can be enlarged by clicking on the corresponding thumbnail.

2. Définitions

Weather seasons :

- Wet season : July to November
- Dry season : February to April

Relative deviation of annual or seasonal mean daily precipitation from its reference value (1980-2013) : difference between the annual or seasonal mean (RRs) and the reference mean (Ref RRs), normalized by the reference mean

- Annual or seasonal mean precipitation (RRs) = average over the year or season of daily precipitation
- Daily precipitation = amount of water simulated between D-1 day at 8pm local time and D-day at 8pm local time
- Reference mean over the 1980-2013 period (Ref RRs) = average of the 34 RRs values. This average is computed for each of the 5 ensemble members (see §3. Data and methods).

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 17^{th} and 83^{rd} 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 precipitation 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 heavy rainfall.
Daily data from these members have been bias-corrected with the quantile-quantile method (performed at Météo-France), using an ensemble of 29 rain gauges in Martinique and 36 rain gauges in Guadeloupe, selected based on availability, quality and representativity criteria. The resulting data were then projected onto the locations of these stations (Cantet et al. 2021). Last, the annual/seasonal climatological means from these corrected data are gridded at a high resolution (90 m) with a so-called ‘‘kriging with external drift(s)’’ method. The latter, which uses geographical predictors mainly based on topography, is particularly well adapted to the French West Indies (Cantet 2017).

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

Cantet, P. Mapping the mean monthly precipitation of a small island using kriging with external drifts. Theoretical and Applied Climatology 127(1-2), 31–44 (2017). https://doi.org/10.1007/s00704-015-1610-z

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