Future Climate Projections in the French West Indies

Regional Climate, Tropical Cyclones, and Storm Waves

Ali Belmadani – Météo-France, Martinique

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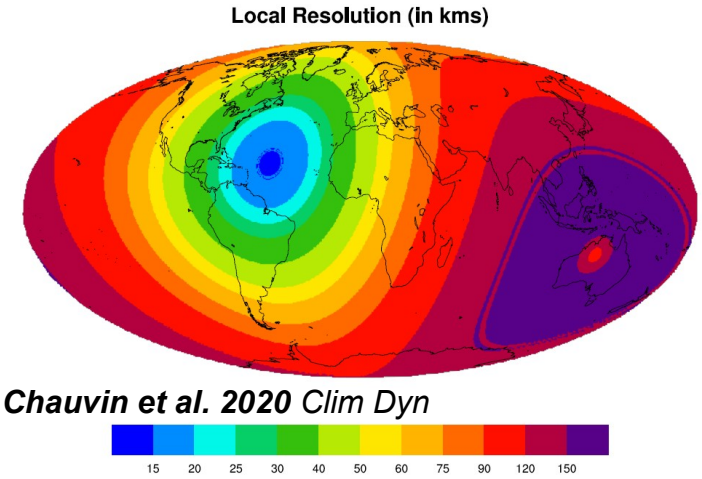
33rd Conference on Climate Variability and Change, paper J41.1, Boston, MA, January 15 2020

Modelling Framework

Multi-scale atmospheric & wave models

Very High Resolution Atmospheric GCM



Chauvin et al. 2020 *Clim Dyn*

ARPEGE-Climat

- 5-member ensemble runs
- RCP8.5 *2031-2080* vs. *1965-2013*
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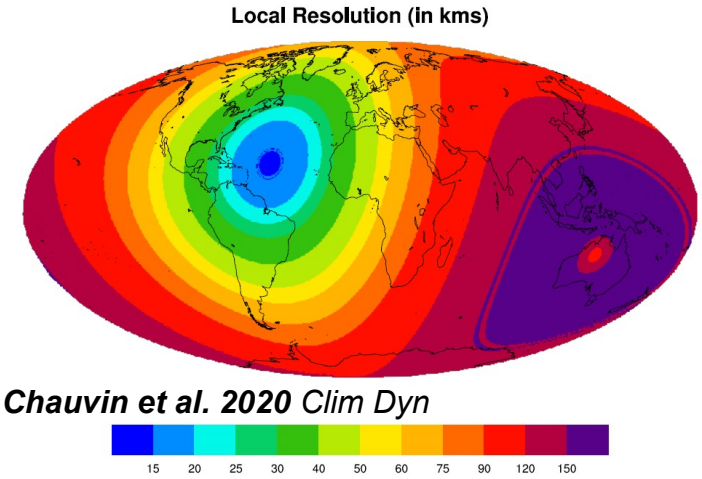

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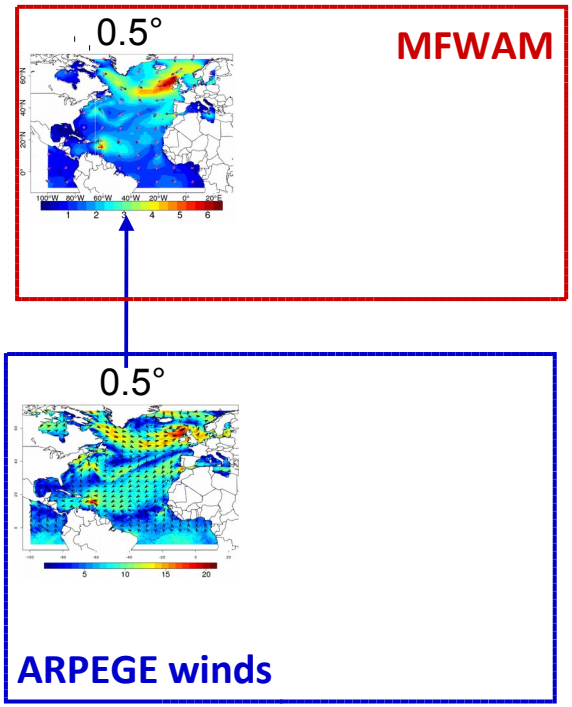

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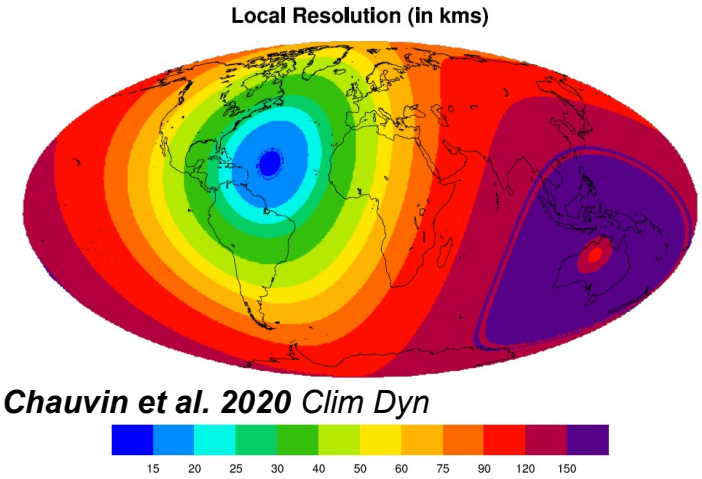

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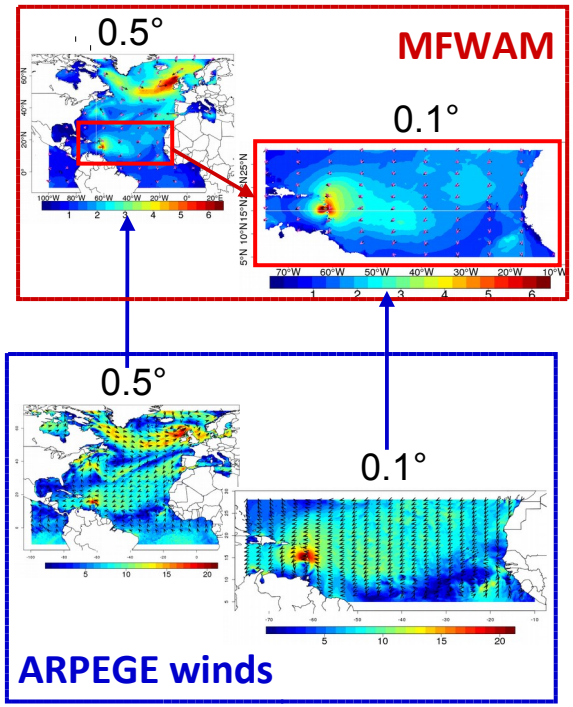

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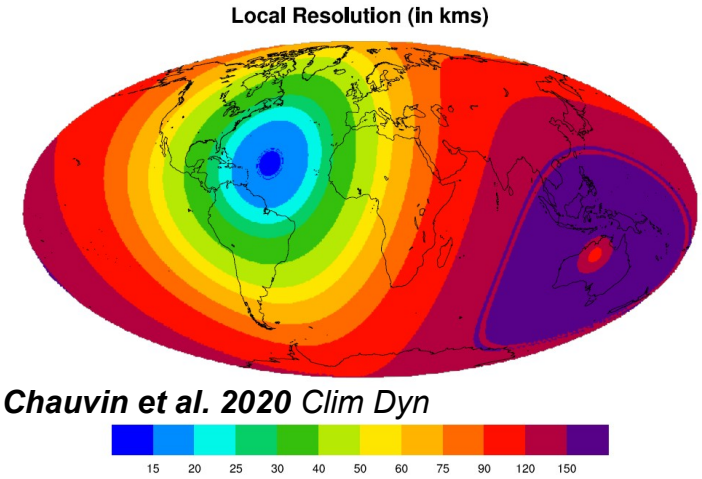

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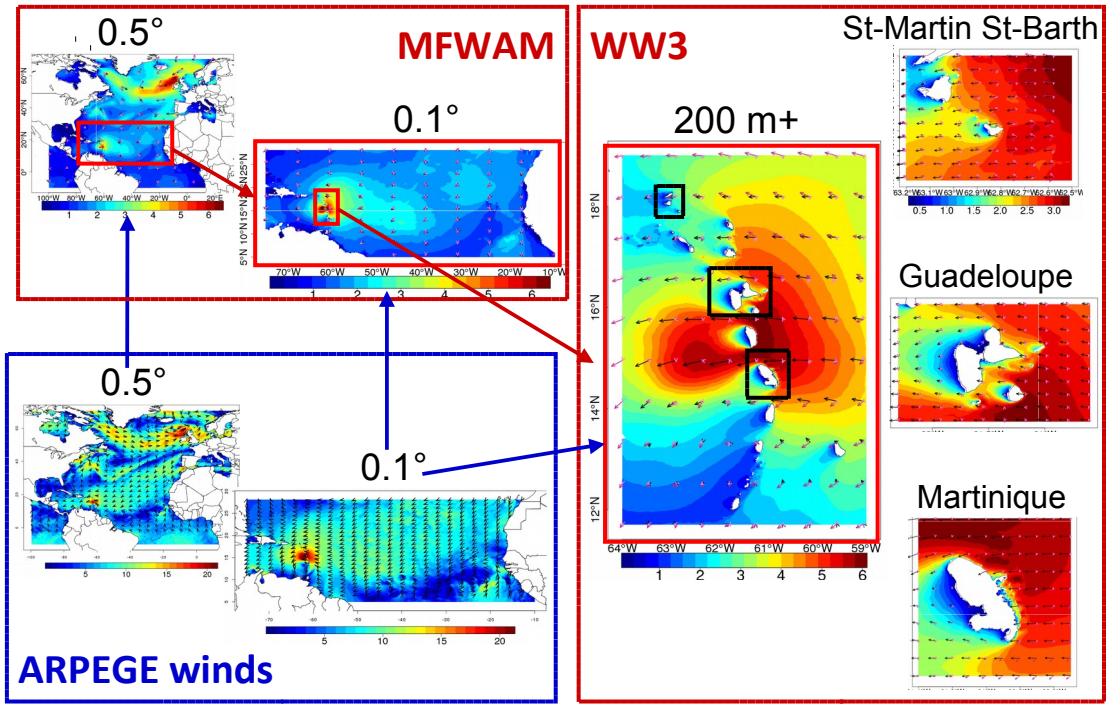

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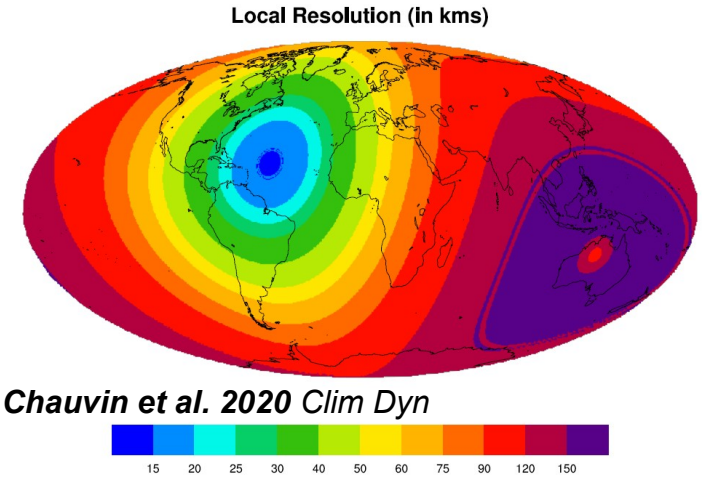

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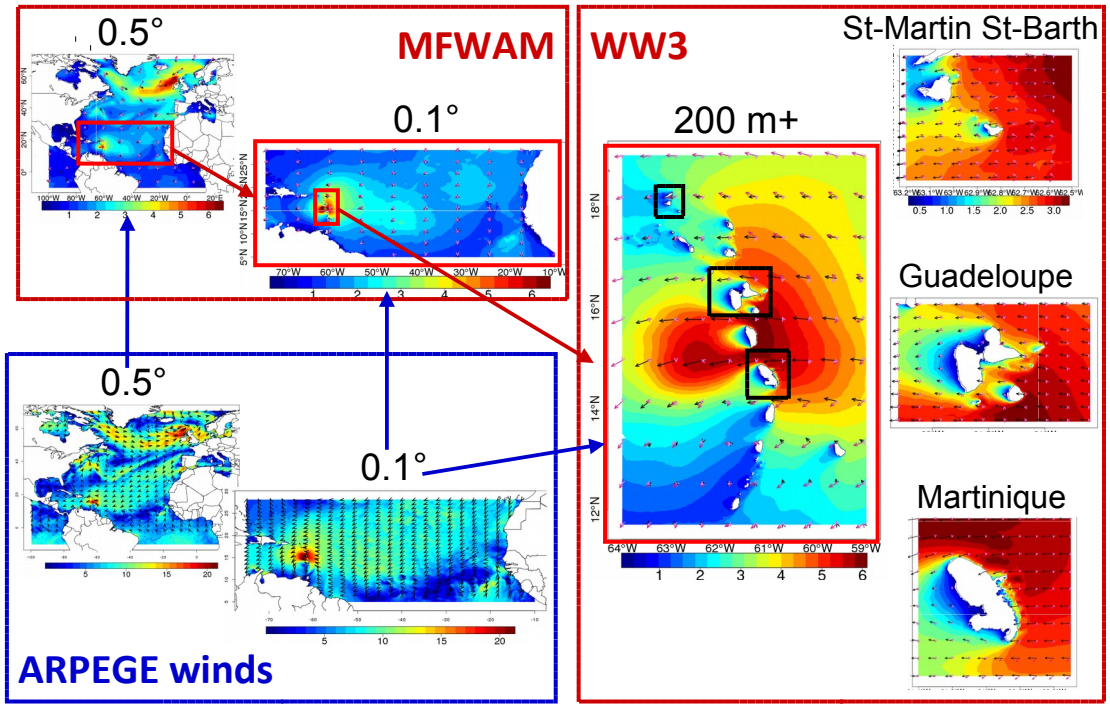

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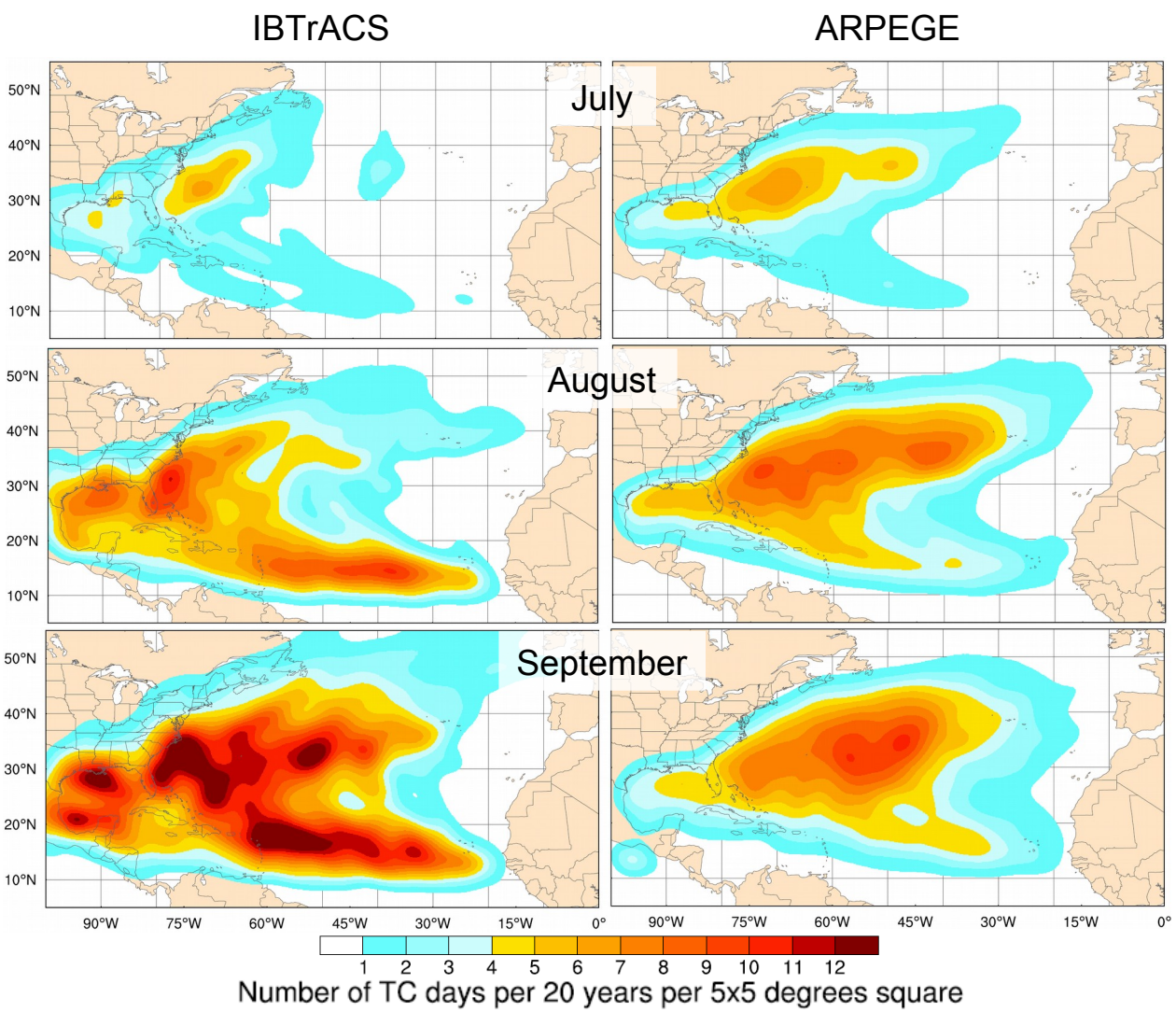
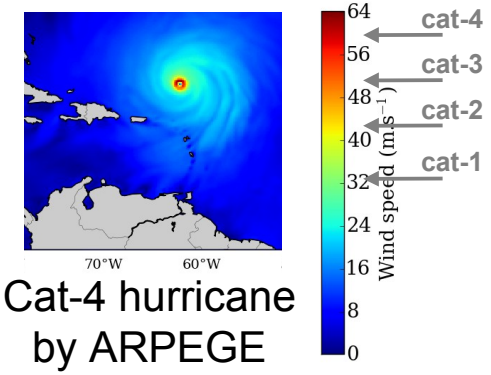
- MFWAM runs over *hurricane season* ~Mid-Jul to Early Nov
- WW3 runs over *season peak phase* ~Mid-Aug to Mid-Sep

Tropical Cyclones

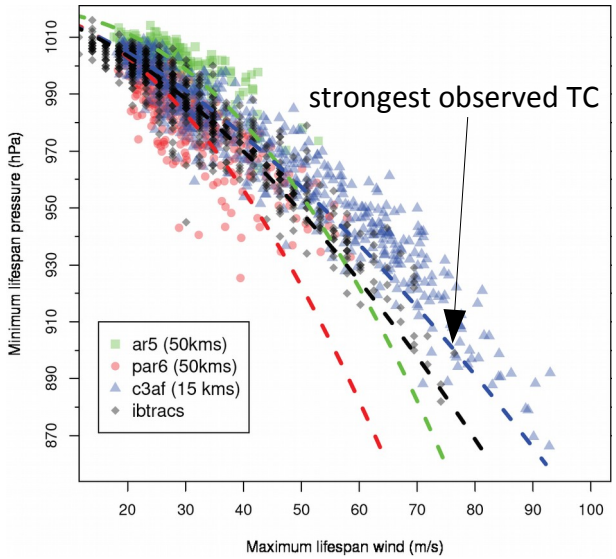
Modelling Atlantic TC activity

Chauvin et al. 2020 *Clim Dyn*





Cat-4 hurricane by ARPEGE



Tropical Cyclones

Future changes in Atlantic TCs

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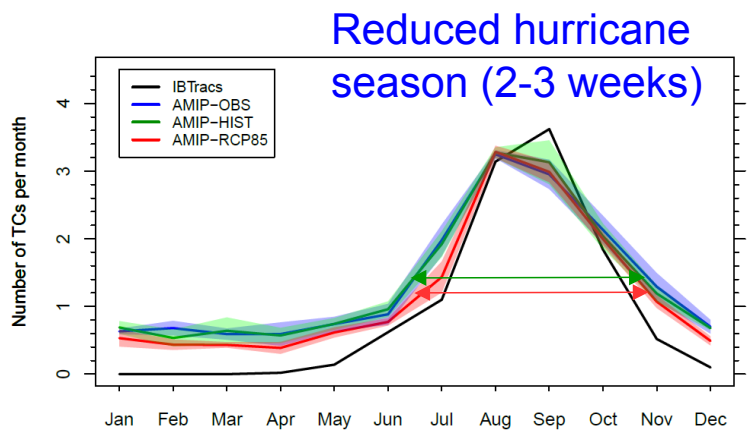
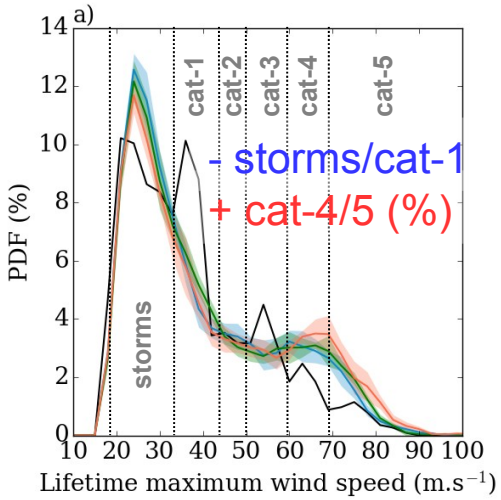
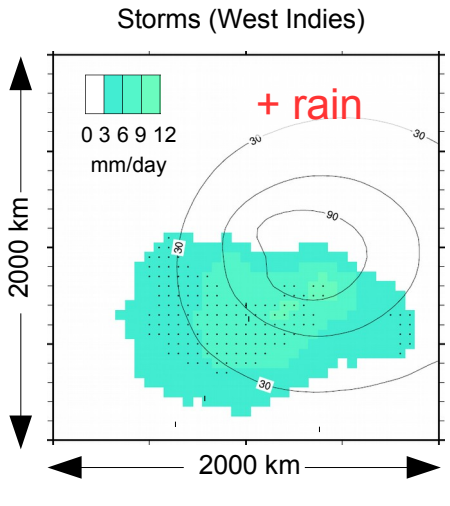
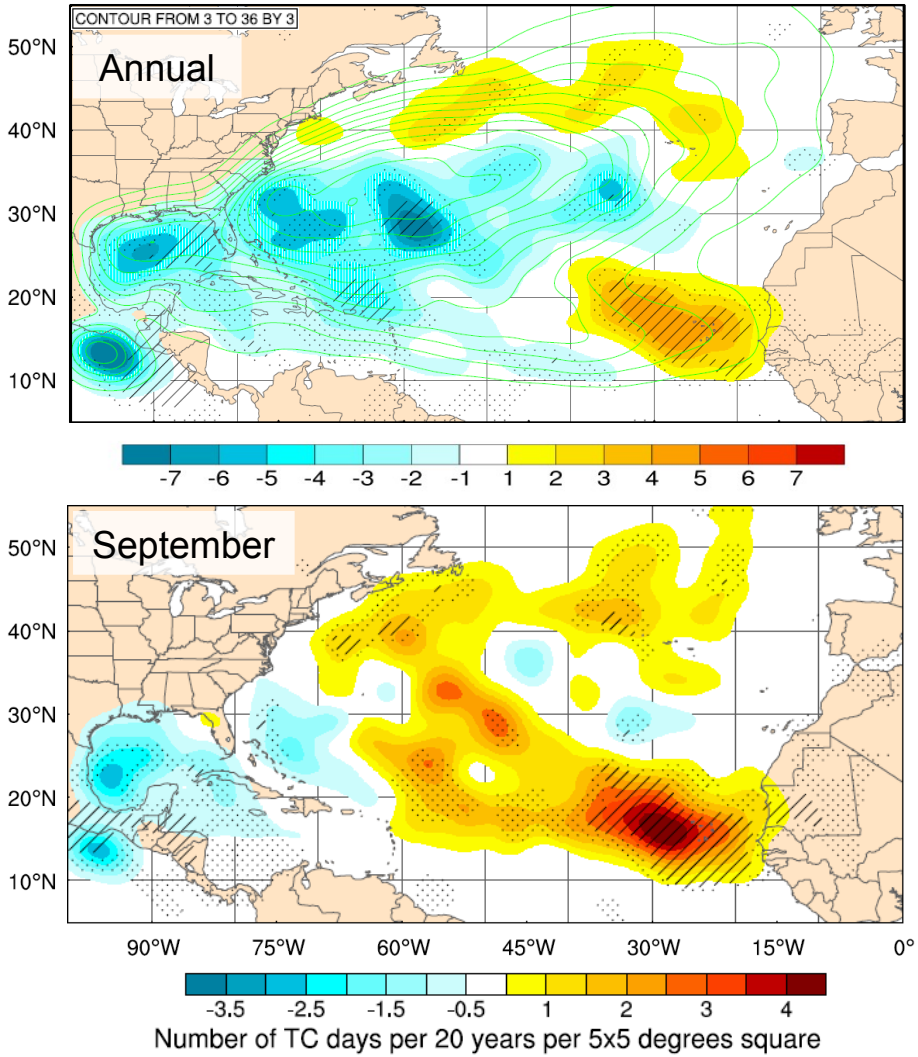






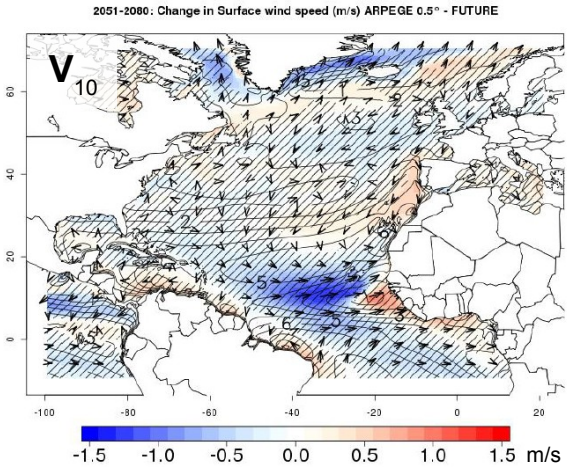


Storm Waves

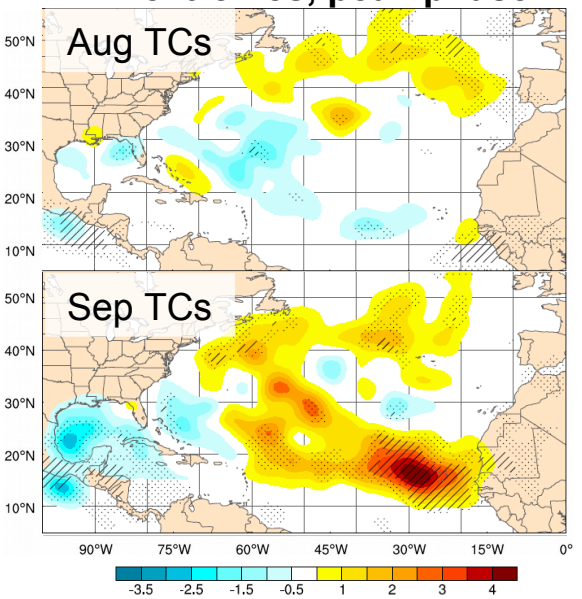
Future changes in N Atlantic wave climate

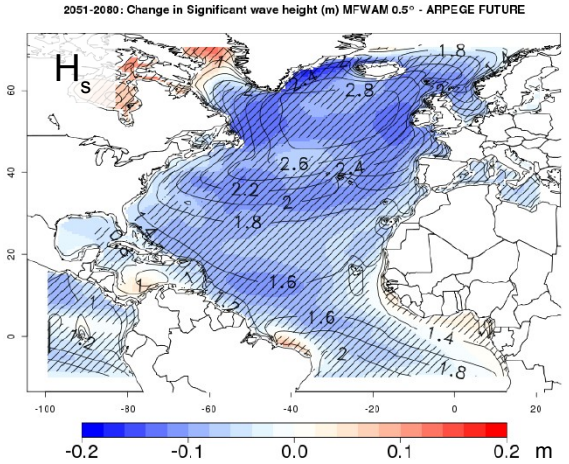
Belmadani et al. *submitted Clim Dyn*

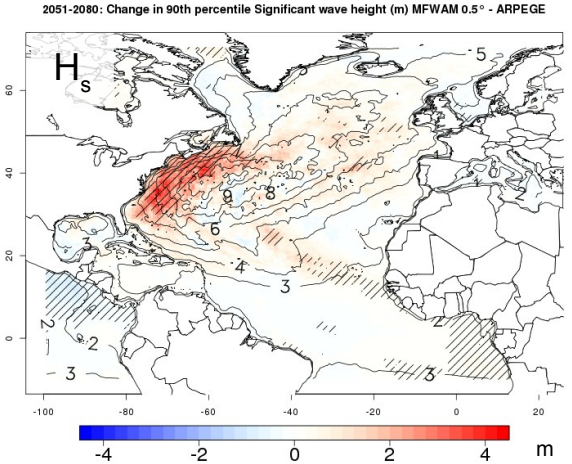
Hurricane-season mean



TC extremes, peak phase







Storm Waves

Downscaled projections for the West Indies

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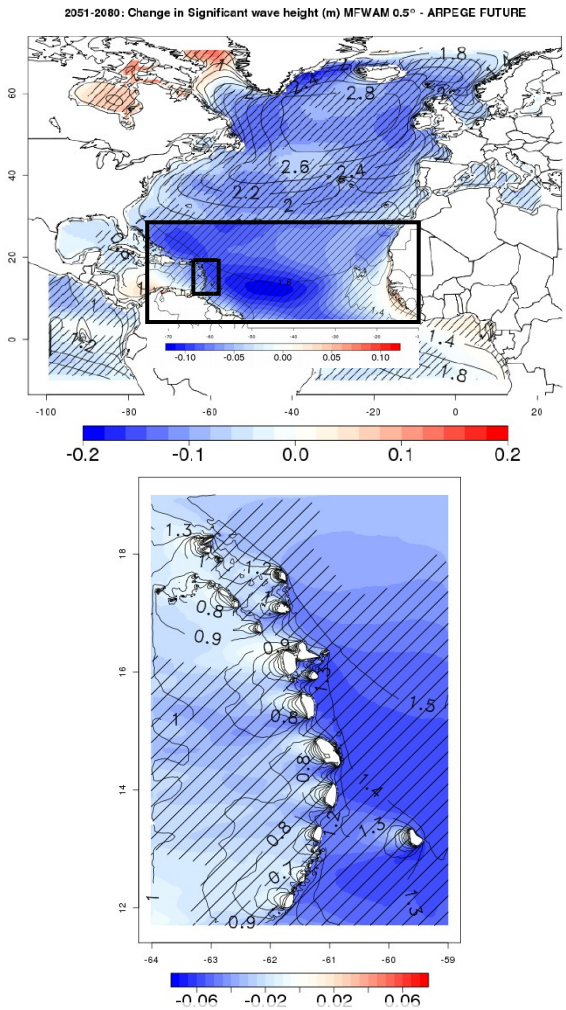
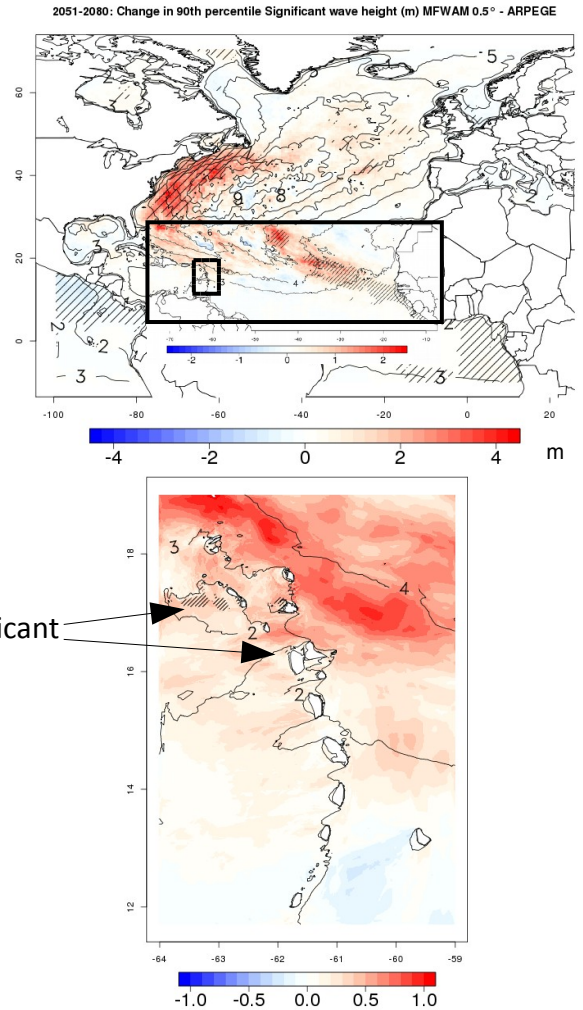
Hurricane-season mean



peak phase

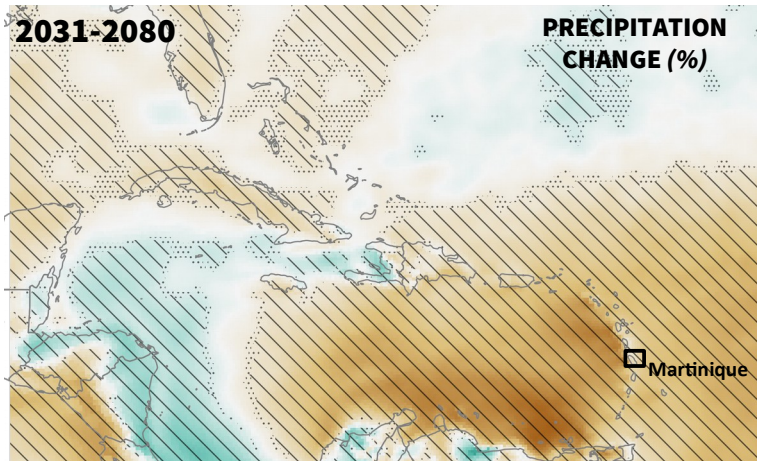
TC extremes, peak phase

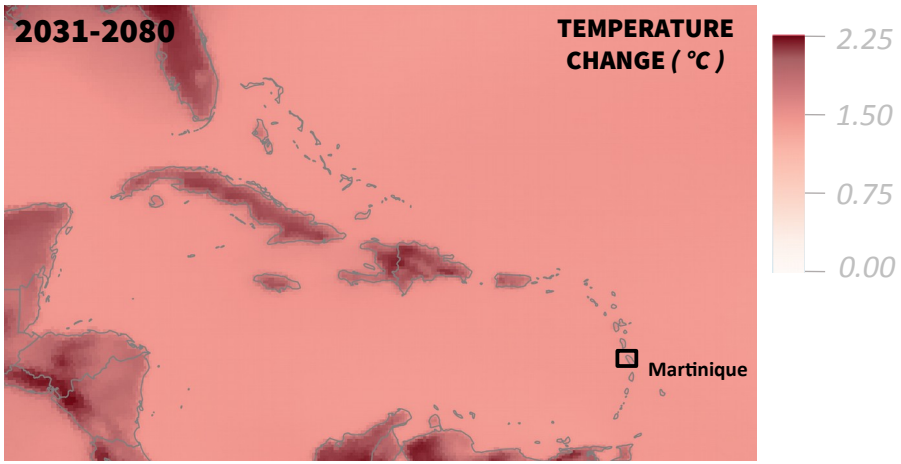


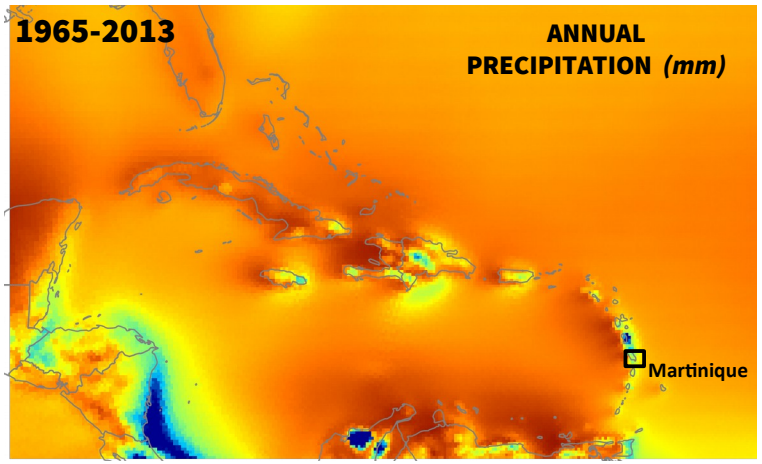
peak phase

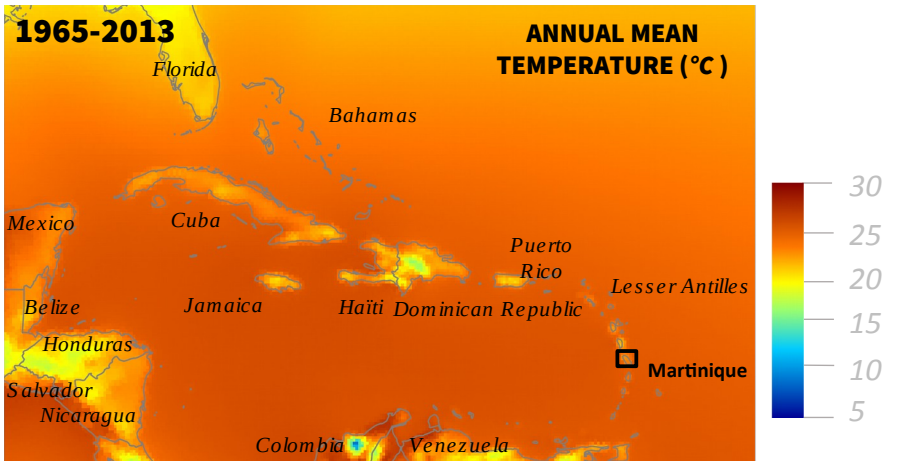
Regional Climate

Projections of Caribbean temperature & precipitation









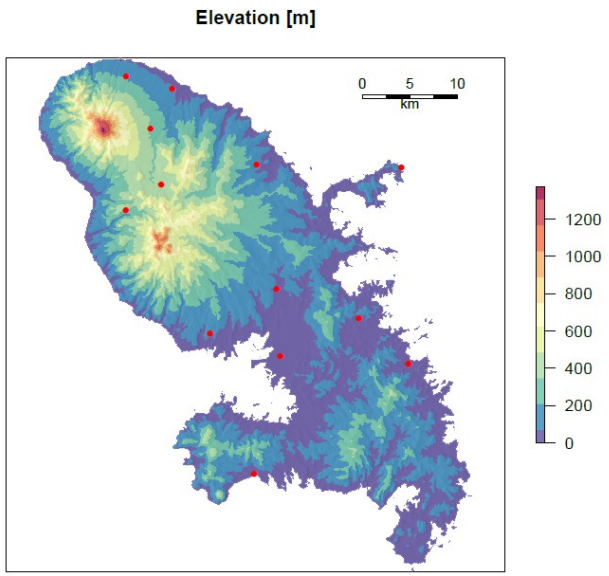
=> Regional **warming** & drying

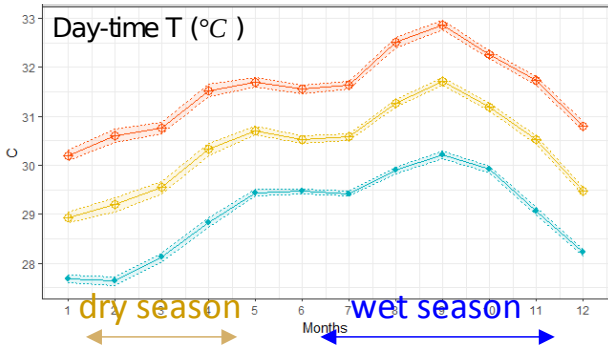
Regional Climate

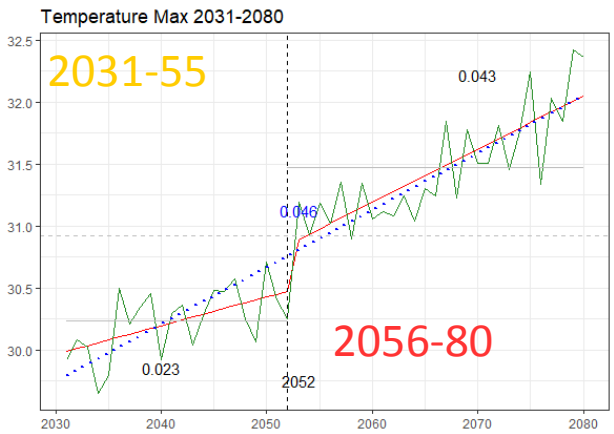
Temperature projections for Martinique

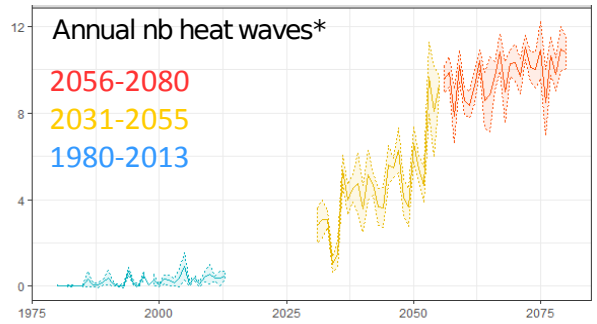
* 3+ consecutive warm days (32°C+) & nights (25°C+)

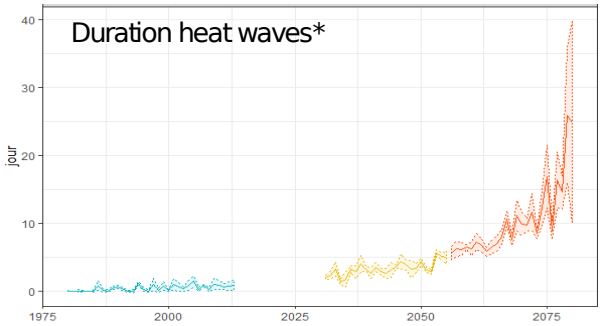
Cantet et al. 2014 *Tellus A* => quantile-quantile corrections with long station data











year-round **warming** everywhere

stronger & faster after ~2055

stronger @night in wet season

+ frequent & longer **heat waves**

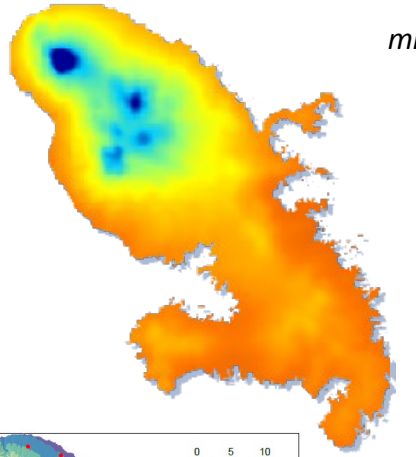
Regional Climate

Rainfall projections for Martinique

Cantet et al. 2014 *Tellus A* => quantile-quantile corrections with long station data

1980-2013 2056-80 change

Wet season RR



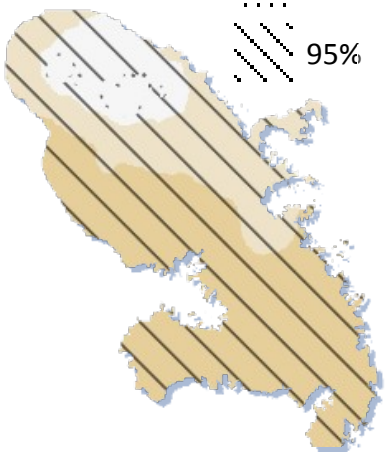
mm/day

20 15 10 5 0

SIGNIF.

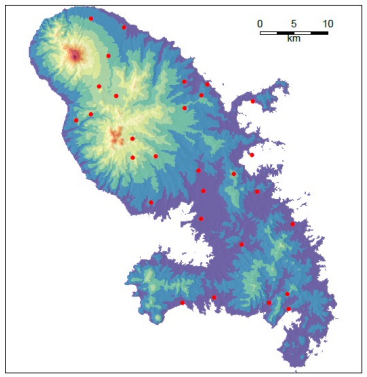
90%

95%



%

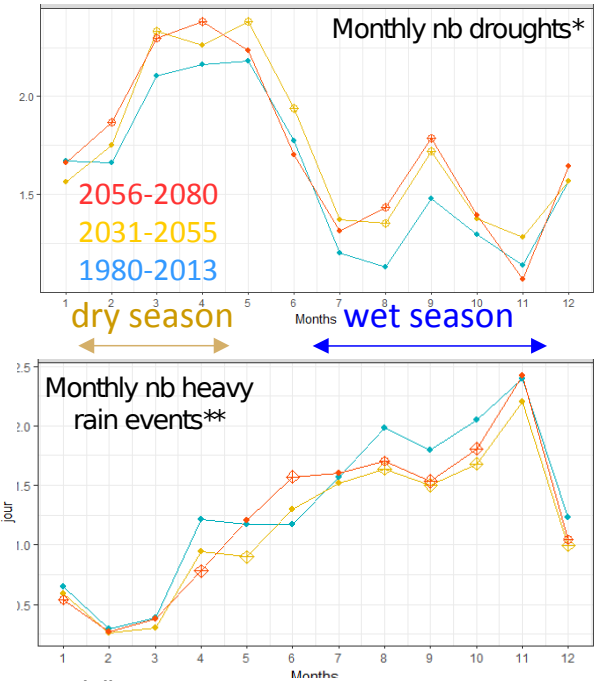
0 -10 -20 -30



1200 1000 800 600 400 200 0

Cantet 2015 *Theor Appl Clim*

* 3+ consecutive days with RR<1 mm



** daily RR >30 mm

wet-season **drying** everywhere

delayed wet season

no clear trend over 2031-2080

+ frequent **droughts** FMAM & AS

- frequent heavy rain ASO & Dec

Conclusion

- *Regional Climate*: **strong year-round warming** & **significant wet-season drying** over the French West Indies.
  + frequent heat waves & droughts but **– frequent heavy rain events**.
  => challenges for e.g. water resource management & agriculture.

- *Tropical Cyclones*: **increased proportion of major hurricanes** & **TC rainfall** in the Atlantic but **reduced hurricane season** & **shifted activity towards the mid-latitudes & Cape-Verde** (esp. in Sep).

- *Storm Waves*: **reduced basin-wide hurricane-season mean wave heights** but **increased TC-induced extreme wave heights** from Main Development Region to US East Coast.

  Eastern Caribbean: **+ exposed northern half**, **protected leeward sides**.

- *Future Research*: projections need to be confirmed with **other CMIP GCMs** to drive ARPEGE => increase confidence & better quantify uncertainties. Ongoing work: downscaled wave projections including **remote swells from mid-latitudes**, **dynamics of regional climate change** & **TC rainfall over the French West Indies**.

Thanks for your attention!

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Tropical Cyclones

Future changes in Atlantic TC rainfall

Chauvin et al. 2020 *Clim Dyn*