A COUPLED OCEAN-ATMOSPHERE REGIONAL SIMULATION OF THE TROPICAL ATLANTIC OCEAN : COMPARISON WITH OBSERVATIONS AND SENSITIVITY TO NUMERICAL CHOICES

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1. Introduction

Strong ocean-atmosphere coupling in the western tropical Atlantic Ocean :

- Due to the presence of warm waters (over 28°C)
- Development of deep-convection
- Heavy precipitations below the Inter-Tropical Convergence Zone (ITCZ)

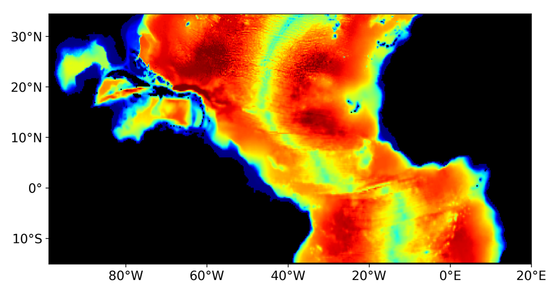

Fig. 1: Bathymetry [m] of the computational domain

To study this coupling : implementation of a high resolution (∼ 25 km) ocean-atmosphere coupled configuration of the tropical Atlantic basin (15°S to 35°N).
Models : NEMO 4.0 for ocean, WRF 3.7.1 for atmosphere, OASIS3-MCT 3.0 as coupler (NOW model, Samson *et al.*, 2014). Grid : Mercator projection.
Here, we present a sensitivity testing of WRF parameterizations and a comparison of the simulations with observations.

2. Method

Simulations between 2000 and 2003 (spin-up : 1 year)
Tests conducted only on the atmospheric model (the oceanic model parameters remained the same). Three main parameters were tested : the longwave (LW) and shortwave (SW) radiation schemes, and the Planetary Boundary Layer (PBL) scheme. The microphysics and convection schemes remained identical : we chose WSM6 for microphysics and Betts-Miller-Janjic for convection schemes (Meynadier *et al.*, 2014).

The table hereafter summarize the different tests :

Run	PBL	LW	SW
1	Yonsei University	New Goddard	New Goddard
2	Yonsei University	RRTMG	RRTMG
3	Yonsei University	RRTM	Goddard
4	Asymmetric Convective Model 2	New Goddard	New Goddard
5	Asymmetric Convective Model 2	RRTMG	RRTMG
6	Asymmetric Convective Model 2	RRTM	Goddard

Table 1: Description of the tested parameterizations

3. Results

Comparison of the different simulations for several variables (zonal and meridional sections) :

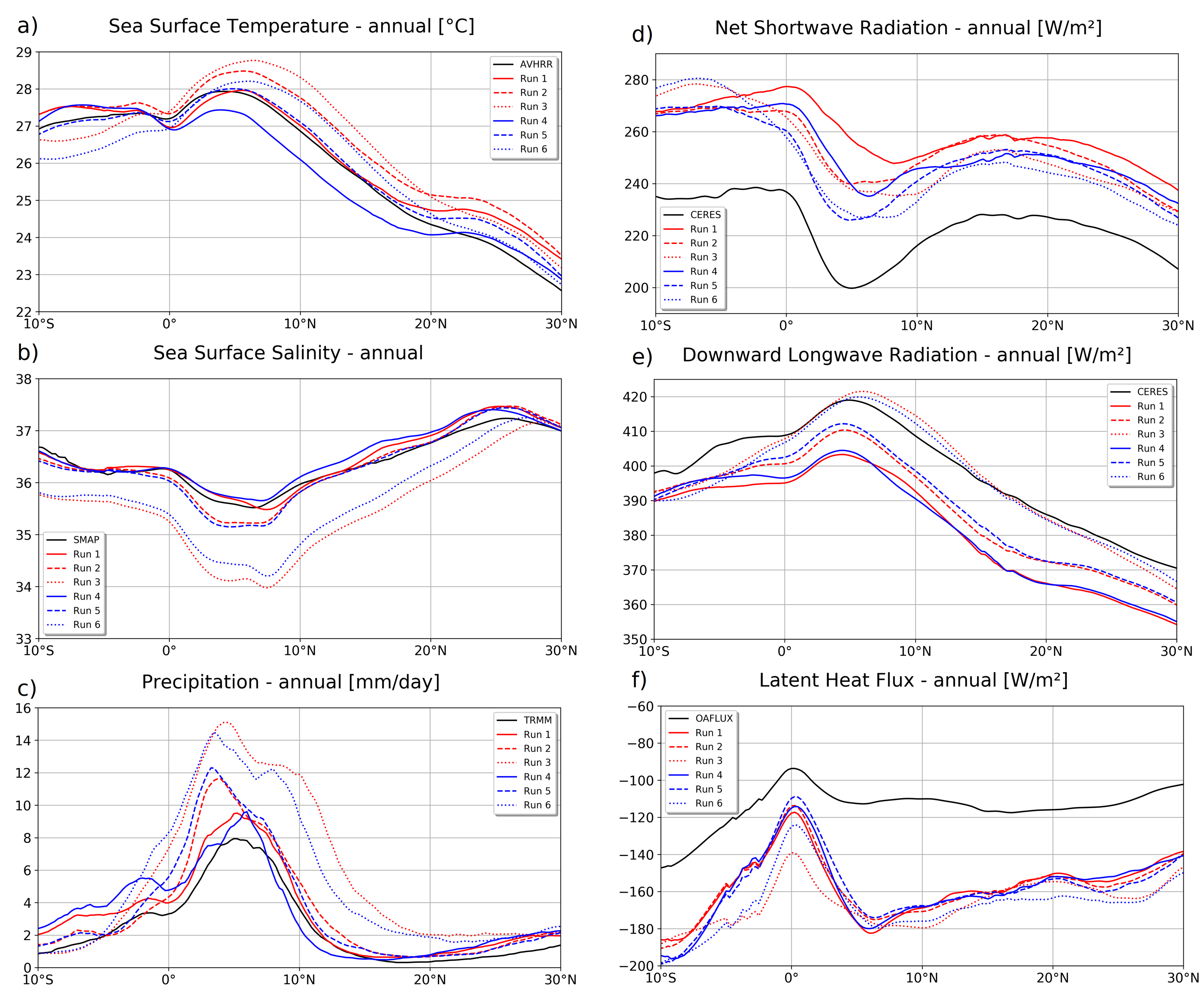

Fig. 2: South-North sections, mean between 20°W and 40°W of a) Sea Surface Temperature, b) Sea Surface Salinity, c) Precipitation, d) Net Shortwave Radiation, e) Downward Longwave Radiation and f) Latent Heat Flux

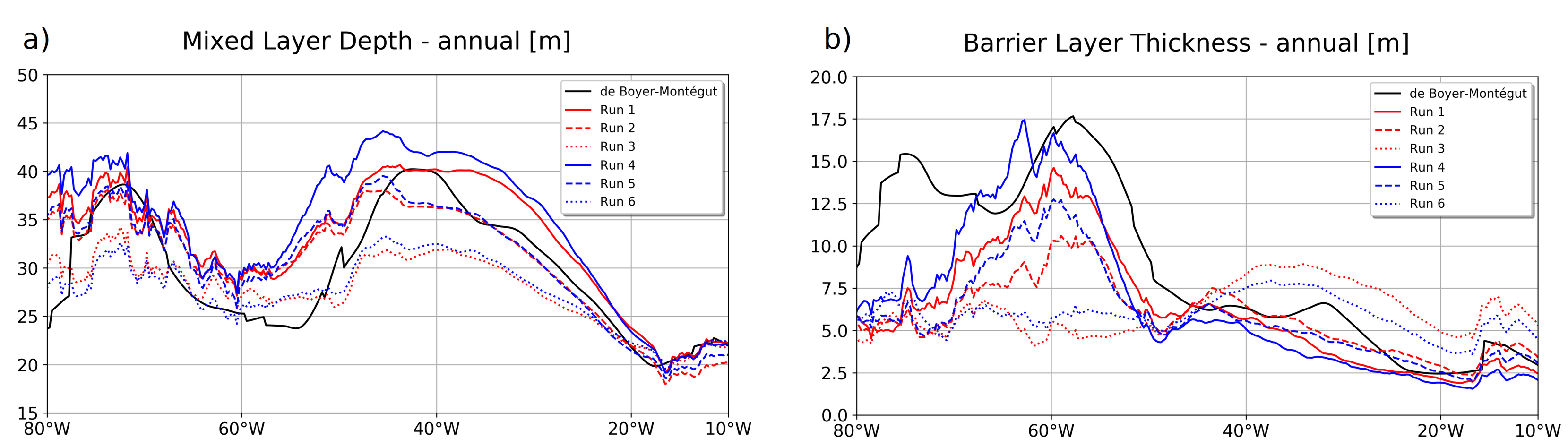

Fig. 3: West-East sections, mean between 0°N and 20°N of a) Mixed Layer Depth and b) Barrier Layer Thickness

Results (continuation)

Evaluation of the convective processes in the model :

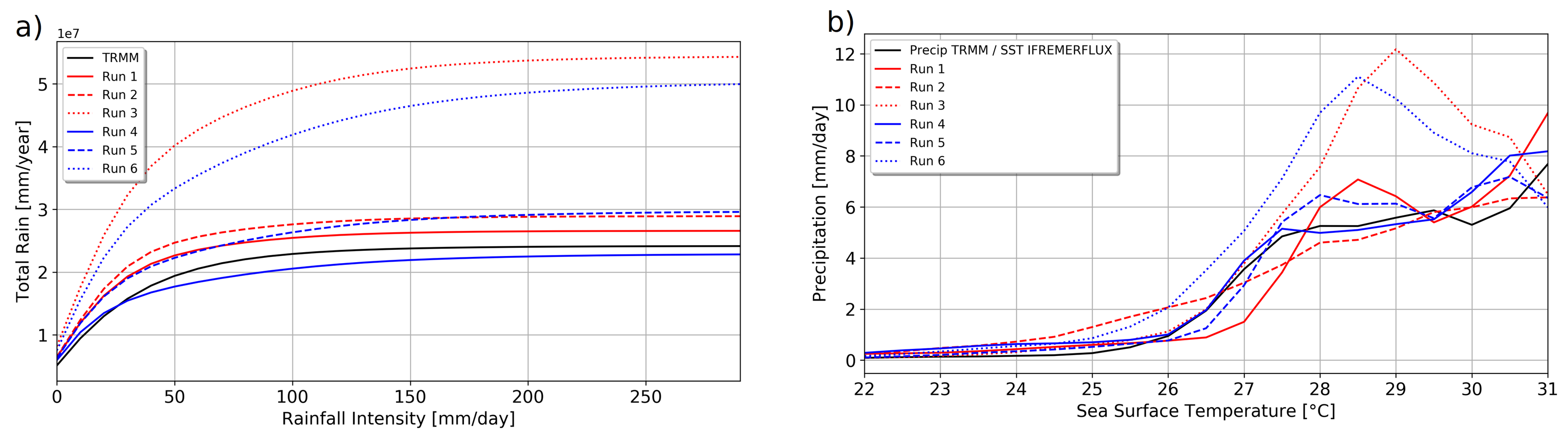

Fig. 4: a) Total rainfall as a function of rainfall intensity and b) Rainfall intensity as a function of Sea Surface Temperature

The Run n°4 seems to better represent the mean state of the western tropical Atlantic. We show here some maps of this simulation to evaluate spatial patterns :

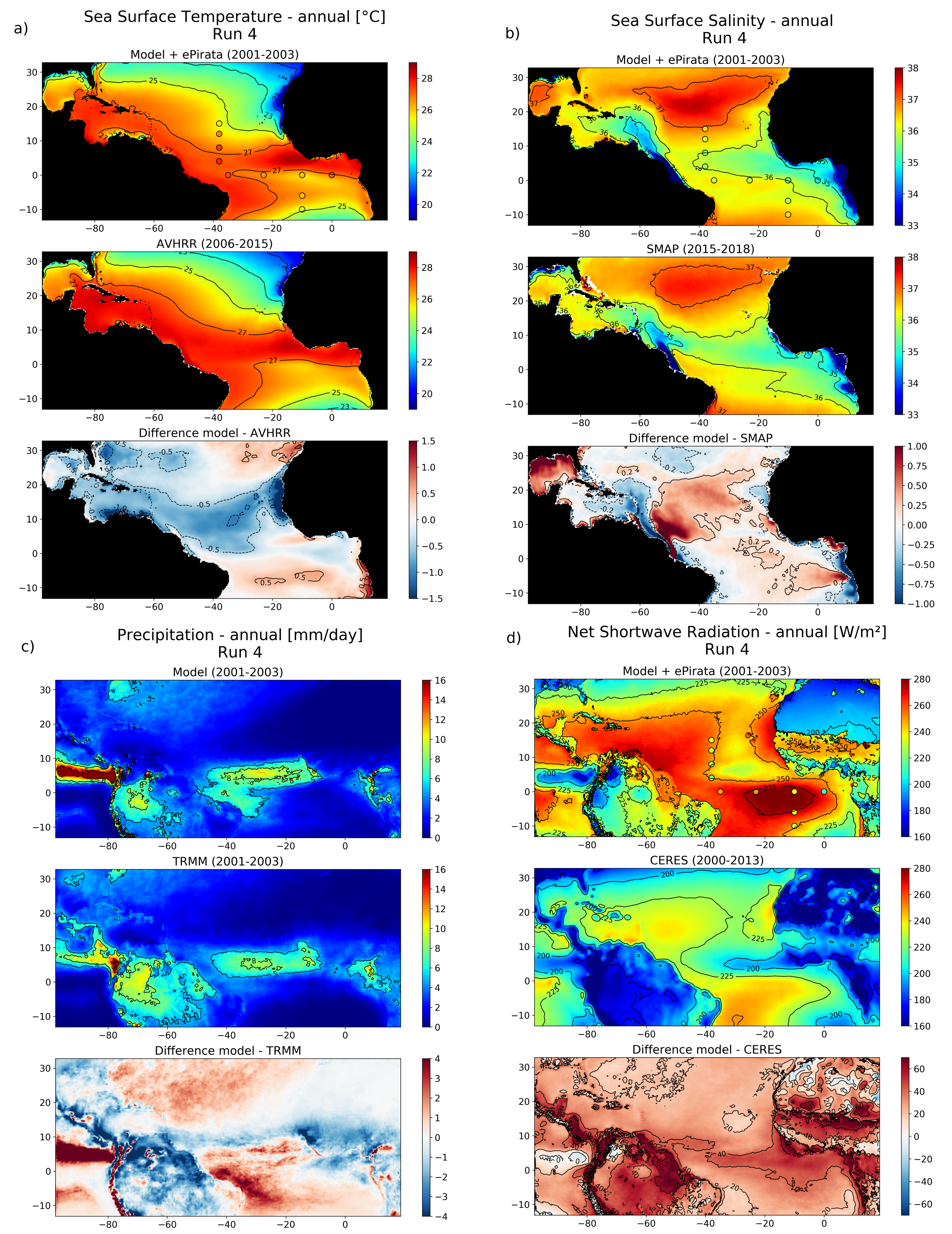

Fig. 5: Maps of a) Sea Surface Temperature, b) Sea Surface Salinity, c) Precipitation and d) Net Shortwave Radiation for the best simulation (Run 4). Map on top : model (+ PIRATA data when possible) ; in the middle : satellite observations ; below : difference between the two

4. Conclusion

Sensitivity testing of WRF parameterizations and comparison with observations show us :

- Good spatial representation of SST, SSS and precipitation, but heat fluxes not well represented (especially shortwave and latent heat fluxes)
- High sensitivity to the PBL and radiative schemes
- Need for further testing : consideration of parameterized clouds in the radiative scheme (test of a new WRF version)

Next step : use of this configuration to investigate the influence of salinity stratification on the air-sea interactions. Indeed, ITCZ + Amazon plume induce a very strong salinity stratification, with possible feedback on the SST, convection and precipitation (Krishnamohan *et al.*, 2019). This feedback loop has the potential to alter the climate of the whole Atlantic sector (Jahfer *et al.*, 2017).

References

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