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Weather regime characterisation of the atmospheric environment leading to the development of tropical cyclones in the Northern Tropical Atlantic

Marco Gaetani[1], Cyrille Flamant[2], Tanguy Jonville[2], Jean-Pierre Chaboureau[3], Christophe Lavaysse[4], Juan Cuesta[5], Laurent Menut[6], Natalia Castillo[1], and Formenti Formenti[5]

[1]IUSS Pavia, Italy (marco.gaetani@iusspavia.it)
[2]LATMOS, IPSL, CNRS, Paris, France
[3]Laboratoire d'Aerologie, CNRS, Université de Toulouse, France
[4]IRD, Grenoble, France
[5]LISA, IPSL, CNRS, Creteil, France
[6]LMD, IPSL, CNRS, Palaiseau, France

At the end of the monsoonal season in West Africa, tropical cyclones (TCs) start to develop in the Northern Tropical Atlantic off shore Senegal, south of Cape Verde. TCs generally develop from low pressure disturbances travelling westward from West Africa embedded in the African easterly waves (AEWs), characterised by organised convection and high specific humidity. Some of these TCs eventually evolve into tropical storms and hurricanes. However, whereas there is overall agreement concerning the main necessary conditions, involving sea surface temperature (SST) and vertical wind shear, for a TC to evolve into a tropical storm or a hurricane, the elements concurring to the formation of TCs from easterly depressions are still unclear. Indeed, the environment where the transition occurs is characterised by complex interactions involving atmospheric dynamics and aerosol-cloud-radiation interactions not fully understood yet.

The purpose of this study is to contribute to enlighten the mechanisms leading an easterly African depression to evolve (or not) into a TC in the Northern Tropical Atlantic, by characterising the atmospheric environment off shore Senegal and south of Cape Verde, where TCs start to develop. To this aim, a weather regime (WR) classification of the atmospheric variability is first performed on a climatological time scale in a region including West Africa and Northern Tropical Atlantic. The WR classification is then used to characterise the relevant atmospheric variables involved in the TC development. In particular, the role of major outbreaks of mineral aerosols from the adjacent Sahara Desert is investigated. Data from ERA5 and CAMS reanalysis products are analysed for the period 1991-2020.