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The impacts of Sahara greening and reduced dust emissions on tropical cyclone activity during the mid-Holocene

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Future changes in hurricane intensity and frequency have been one of the major subjects of debate. Billions of dollars are indeed wasted every year in damages made by these atmospheric phenomena. With the increase in population along the American coastlines as well as in the values and amount of properties, it became more crucial than ever to investigate how future global warming and changes in climate variability will affect tropical cyclone (TC) activity in the North Atlantic. The lack of historical records and the sparse distribution of paleo climatic data over long temporal scales and geographical places hampers the possibility of characterizing such changes. Hence, we turn to the latest version of the Global Environmental Multiscale Model version 4.8 (GEM4.8) with high horizontal resolution (24 km and 12 km) to investigate the changes in Atlantic TC activity during a warm climate state (mid-Holocene, MH: 6,000 yr BP). This period was characterized by increased boreal summer insolation, a vegetated Sahara, and reduced dust emissions. We analyze a set of sensitivity experiments in which not only solar insolation changes are varied but also vegetation and dust concentrations. Given the large cold bias in sea surface temperature (SST) in the Atlantic in the pre-industrial experiment, we have applied a fix correction to the North Atlantic SST in all simulations. Our results show that while the greening of the Sahara and reduced dust loadings (MH_{GS+RD}experiment) lead to more favourable environmental conditions to the development of hurricanes, the total count is actually reduced compared to the pre-industrial climate and the orbital forcing alone. In particular, our simulations show a notable decrease in TC activity in MH_{GS+RD}experiment during the peak of present-day hurricane season (July to September), whereas the TC activity increases in the shoulder season (October-November) relative to the pre-industrial climate simulation. The same behaviour as in the MHGS+RD is simulated when considering the MH orbital forcing alone, but the variations are weaker. These results are in ostensible disagreement with the previous study made by Pausata et al., 2017 where a statistical thermodynamic model was used to simulate tropical cyclones. The reason of this disagreement could stem either from the fact that the statistical thermodynamical model used in Pausata et al., 2017 uses random seeding for the generation of TC, not accounting for changes in the African Easterly Waves (AEW) variability or because in our simulations we use bias-corrected SST. This study highlights the importance of fully considering the changes in atmospheric dynamics when investigate TC activity under a different climate state.