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Comment on gmd-2021-384

Anonymous Referee #1

Referee comment on "Cyclone generation Algorithm including a THERmodynamic module for Integrated National damage Assessment (CATHERINA 1.0) compatible with Coupled Model Intercomparison Project (CMIP) climate data" by Théo Le Guenedal et al., Geosci. Model Dev. Discuss., <https://doi.org/10.5194/gmd-2021-384-RC1>, 2022

"Cyclone generation Algorithm including a THERmodynamic module for Integrated National damage Assessment (CATHERINA 1.0) compatible with CMIP climate data" describes CATHERINA which is a model that generates national tropical cyclone damages from monthly climate model data. CATHERINA takes the relative humidity, sea surface temperature, sea level pressure, and tropopause temperature from CMIP5 models. It then uses ERA5 reanalysis data to get more spatially refined estimates of these climate measures. The future estimates of each climate model are adjusted for the historic bias in the CMIP5 data. The model assumes the frequency of tropical cyclone origins does not change and the random path of tracks roughly conforms with past tracks. What changes is the power of each storm which is assumed to increase at an increasing rate with sea surface temperature depending on the ocean basin. They use data from Eberenz 2019 that uses night lights, population and national borders to measure how physical assets vary across space within a country. They then take a damage function from Eberenz 2020 that is calibrated to measure the tropical cyclone damage in each region. The result is an estimated annual damage cost for each country from tropical cyclones.

It is not clear that this tropical cyclone model leads to accurate forecasts of storms. Changes in wind patterns can have no effect in this model. Is the cyclone model in this paper as accurate as the models developed by Emanuel? Or is this model a step backwards?

The estimates of the effect of each hurricane are crude. The model assumes that all damage is from wind whereas only 40% of cyclone damage is wind related. Another 40% of cyclone damage is from storm surge. But storm surge strikes largely just the coastline. The remaining 20% of damage is from excess precipitation which often falls far from where the cyclone strikes land.

The model depends a great deal on the damage function. But it is not clear how this damage function was estimated.

The estimates of how national assets are distributed across space are crude. Light times population is not going to allocate national assets carefully. I am specifically concerned about how well they model the assets near the coast.

The model appears to assume the spatial distribution of assets are fixed within a country.

The paper does allow national assets to change over time, but they do not describe how this is done.

There is no effort to measure adaptation by the country being hit or how that might change over time.

The initial forecasts of windspeed from the climate models are very inaccurate. The corrections appear to matter a great deal. However, these corrections have been made on the historic data. So once they adjust historic data to actual historic outcomes, they do fine. But how well the model predicts future wind speeds is unclear.

Figure 19 suggests the model predicts a small probability of very large damage but an expected value that is quite small. What explains this large tail to the distribution of damage? Is this simply the probability of a large storm striking a large coastal city? What is the expected value of damage?

Why does going from historic (1980-2020) to RCP2.5 lead to more damage than going from RCP2.5 to RCP8.5? Going from historic temperature to RCP2.5 is a 1C increase whereas going from RCP2.5 to RCP8.5 is going from 2C to 5.4C? Given the assumption that wind speed increases more rapidly as sea surface temperature rises, this outcome is hard to understand.

How much confidence do the authors have that they understand the relative damage caused by tropical cyclones at the end of the century across countries? How much of this is simply assuming the same distribution as today?

It is not likely that anyone could design adaptation measures from this study given the crudeness of both the tropical cyclone predictions as well as the damage predictions. Is there any reliable prediction of a change in tropical cyclone outcomes from current outcomes other than they will get uniformly more powerful?