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Choose Your Model Wisely: Navigating Uncertainties in Future Global Tropical Cyclone Risks

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Future tropical cyclone risks will evolve depending on climate change and socio-economic development, entailing significant uncertainties. A comprehensive uncertainty and sensitivity analysis of future tropical cyclone risk changes is thus vital for robust decision-making not least in the context of physical climate risk disclosure. However, the outcomes of such uncertainty and sensitivity analyses are closely tied to the chosen model setup, warranting caution in interpretation and extrapolation. Our study investigates how four distinct tropical cyclone hazard models as well as alternate representations of socio-economic development influence future tropical cyclone risks. We find that average tropical cyclone risk increases 1-5% by 2050 across all models and global study region. But the estimated maximum risk increases by the end of the century range from 10-400% depending on the hazard model choice. Such diverging results are critically relevant for climate risk assessment in the financial and insurance sectors where usually model choices are made a priori and uncertainties are not quantified systematically. Additionally, socio-economic factors drive risk increase more strongly across all models, while the uncertainty in these risk drivers is hazard model-specific. For instance, the MIT model-based results are sensitive to the choice of global climate model, while estimates from CHAZ, STORM, and climate-conditioned IBTrACS are mainly influenced by exposure scaling based on Shared Socio-economic Pathways. Finally, we assert that quantitative estimates of uncertainty and sensitivity to model parameters greatly enhance the value and depth of climate risk assessments, which are essential for robust decision-making in the financial and insurance sector.