EGU2020-7850
https://doi.org/10.5194/egusphere-egu2020-7850
EGU General Assembly 2020

Augmenting Catastrophe Models to Quantify Financial Losses Under Prescribed Climate Scenarios

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In 2019, the Bank of England, through the Prudential Regulation Authority (PRA), became the first regulator to ask insurers how financial losses could change under prescribed climate scenarios. Insurers readily use catastrophe models to quantify the likelihood and severity of financial losses based on at least 40 years of past climate data. However, they cannot readily use these models to answer the climate scenarios posed by the PRA.

We present four novel methods for how to use existing catastrophe models to answer what-if climate scenario questions. The methods make use of sampling algorithms, quantile mapping, and adjustments to model parameters, to represent different climate scenarios.

Using AIR's Hurricane model for the United States (US), Inland Flood model for Great Britain, and Coastal Flood model for Great Britain, we quantify the sensitivity of the Average Annual Loss (AAL) and the 100-year exceedance probability aggregate loss (100-year loss) to four environmental variables under three climate scenarios. The environmental variables include the (i) frequency and (ii) severity of major US landfalling hurricanes; (iii) the mean sea level along the coast of the US and Great Britain; and (iv) the surface run-off from extreme precipitation events in Great Britain. Each of these variables are increased in turn by low, medium and high amounts as prescribed by the PRA.

We compare each variable and rank their influence on loss. We find that the AAL and 100-year loss are more sensitive to changes in the severity of major US hurricanes than changes in the frequency. We will show whether sea level rise has a greater influence on coastal flooding losses in the US or in Great Britain, and we show how sensitive inland flooding losses are to surface run-off.

The methods yield approximate results but are quicker and easier to implement than running Global Circulation Models. The methods and results will interest those in insurance, the public sector, and academia, who are working to understand how society best adapts to climate change.