Supplementary information

# Combining hazard, exposure and vulnerability data to predict historical North Atlantic hurricane damage

Alexander Frank Vessey[1], Alexander J. Baker[2, 3], Vernie Marcellin-Honore[2], and James Michelin[2]

[1]AXA XL, 20 Gracechurch Street, London, United Kingdom
[2]Department of Meteorology, University of Reading, Reading, United Kingdom
[3]National Centre for Atmospheric Science, University of Reading, Reading, United Kingdom

**Corresponding authors:**
Dr Alexander Frank Vessey (alexander.vessey@axaxl.com)
Dr Alexander J. Baker (alexander.baker@reading.ac.uk)

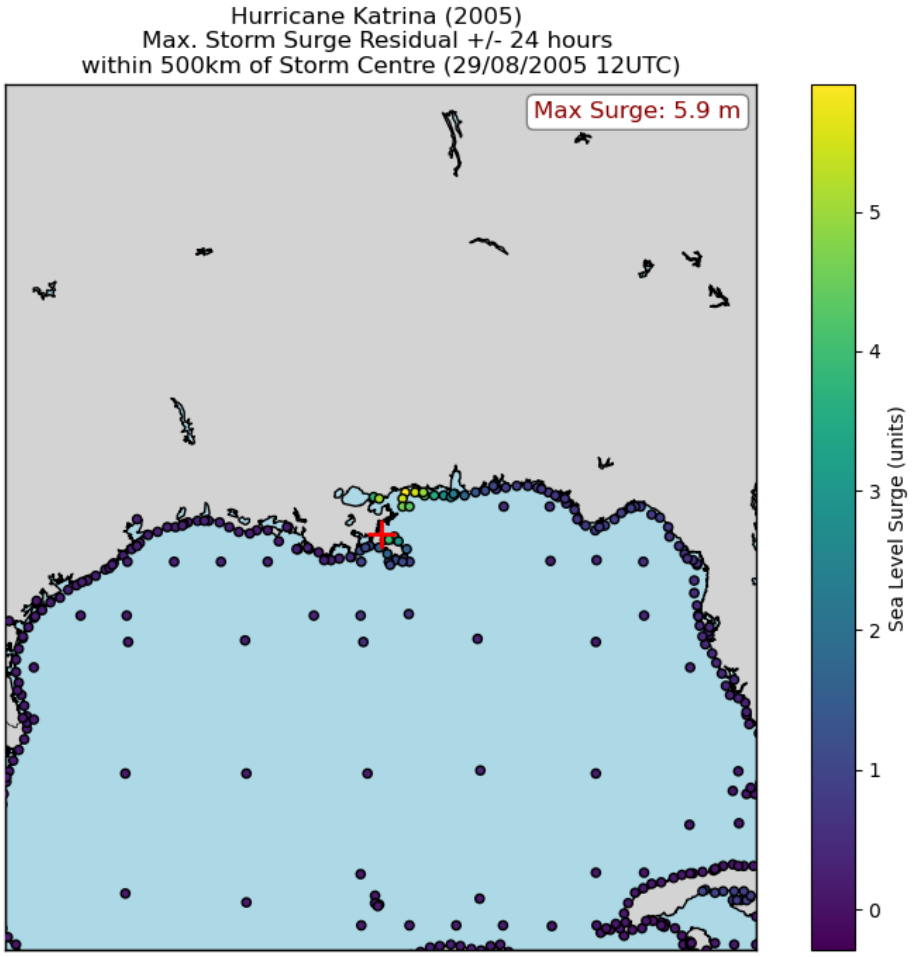


***Figure S1***. *Example ERA5-derived storm surge residual reconstruction for Hurricane Katrina (2005), which made landfall on the 28$^{th}$ of August, 2005, defined as maxima within 500km of the cyclone centre and ±24 hours of landfall. Unit is metres above reference height.*

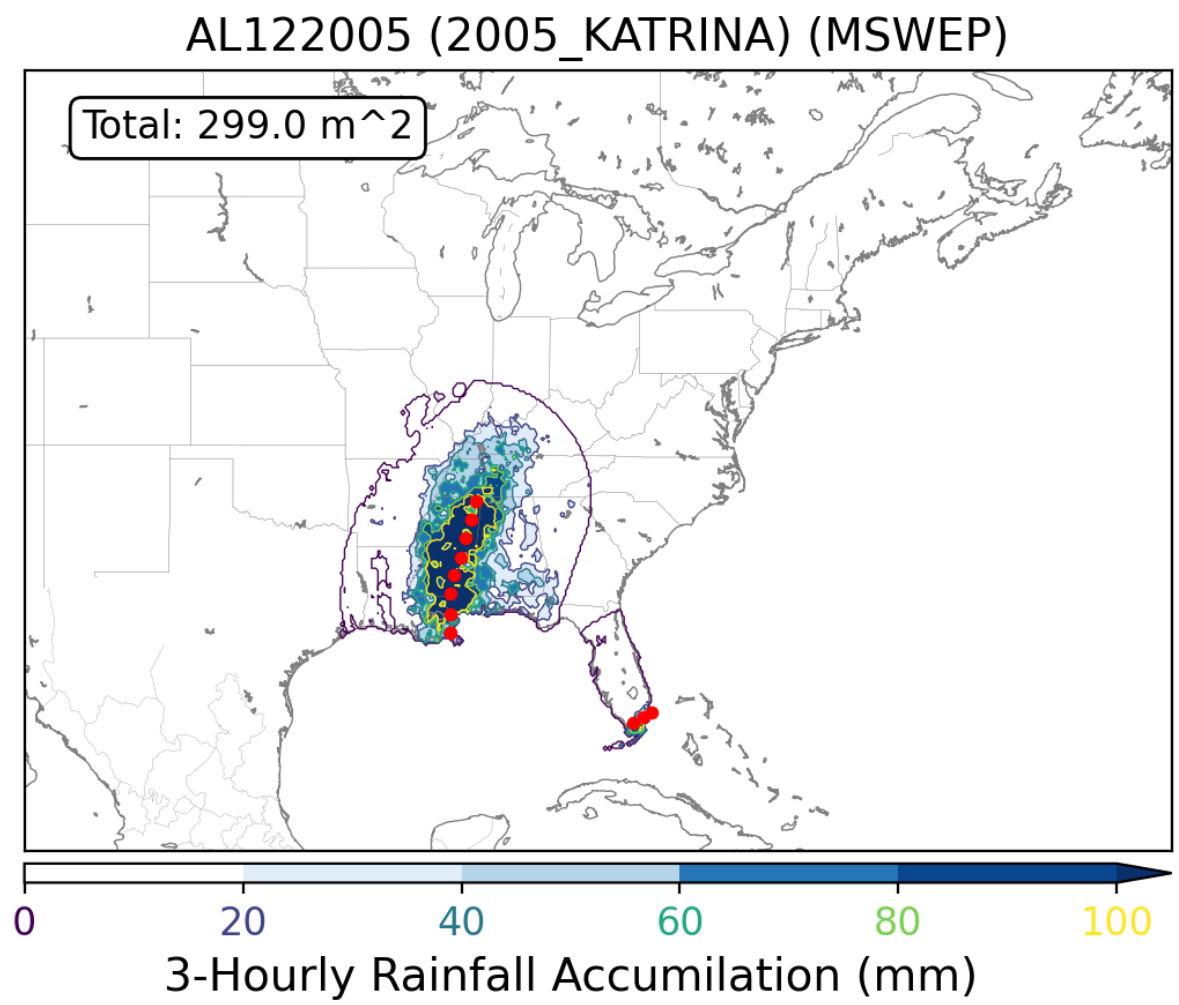


***Figure S2**. Example rainfall footprint for Hurricane Katrina (2005), determined by accumulating three-hourly MSWEP data along the track following landfall.*

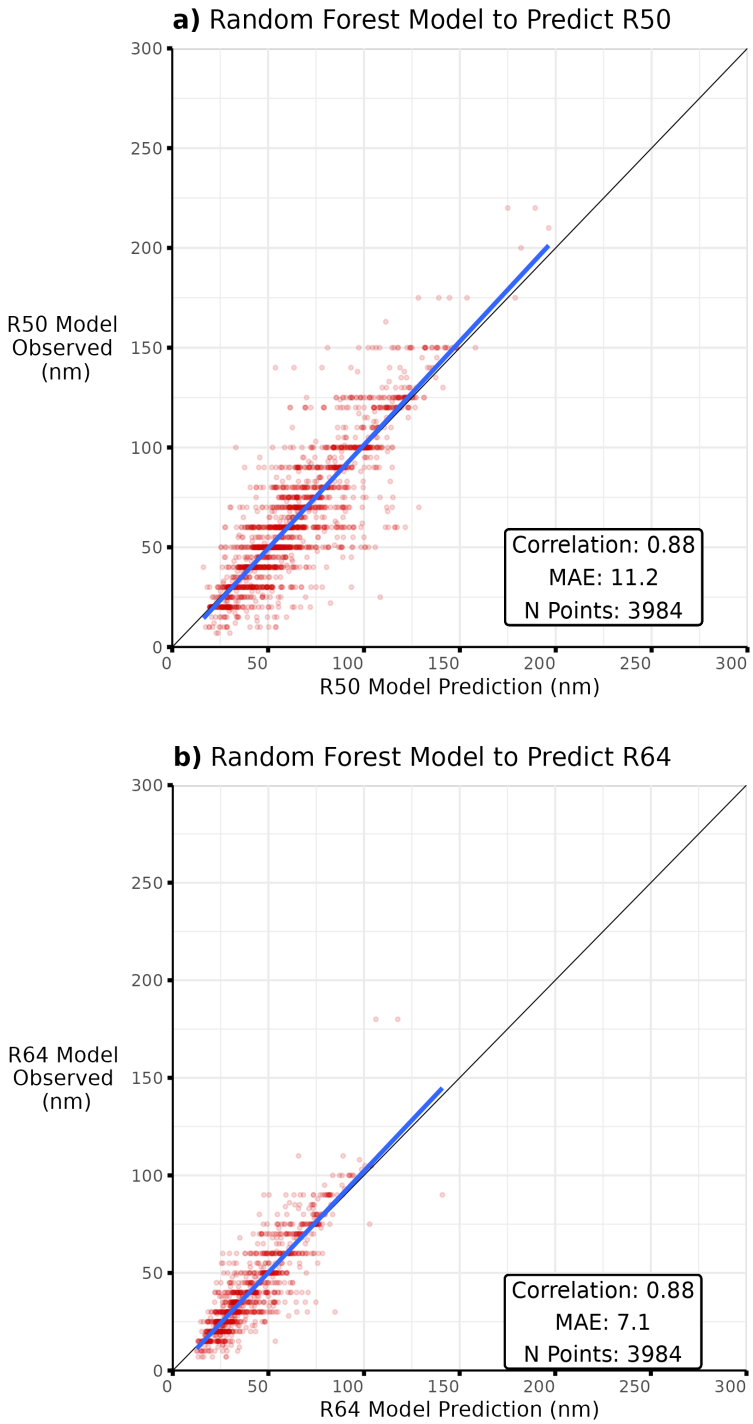


***Figure S3**. Comparison of estimated and observed hurricane **a)** R50 and **b)** R64 from 1979–2023, using a random forest statistical model based on $v_{max}$, RMW, $c_p$ and latitude as predictors.*

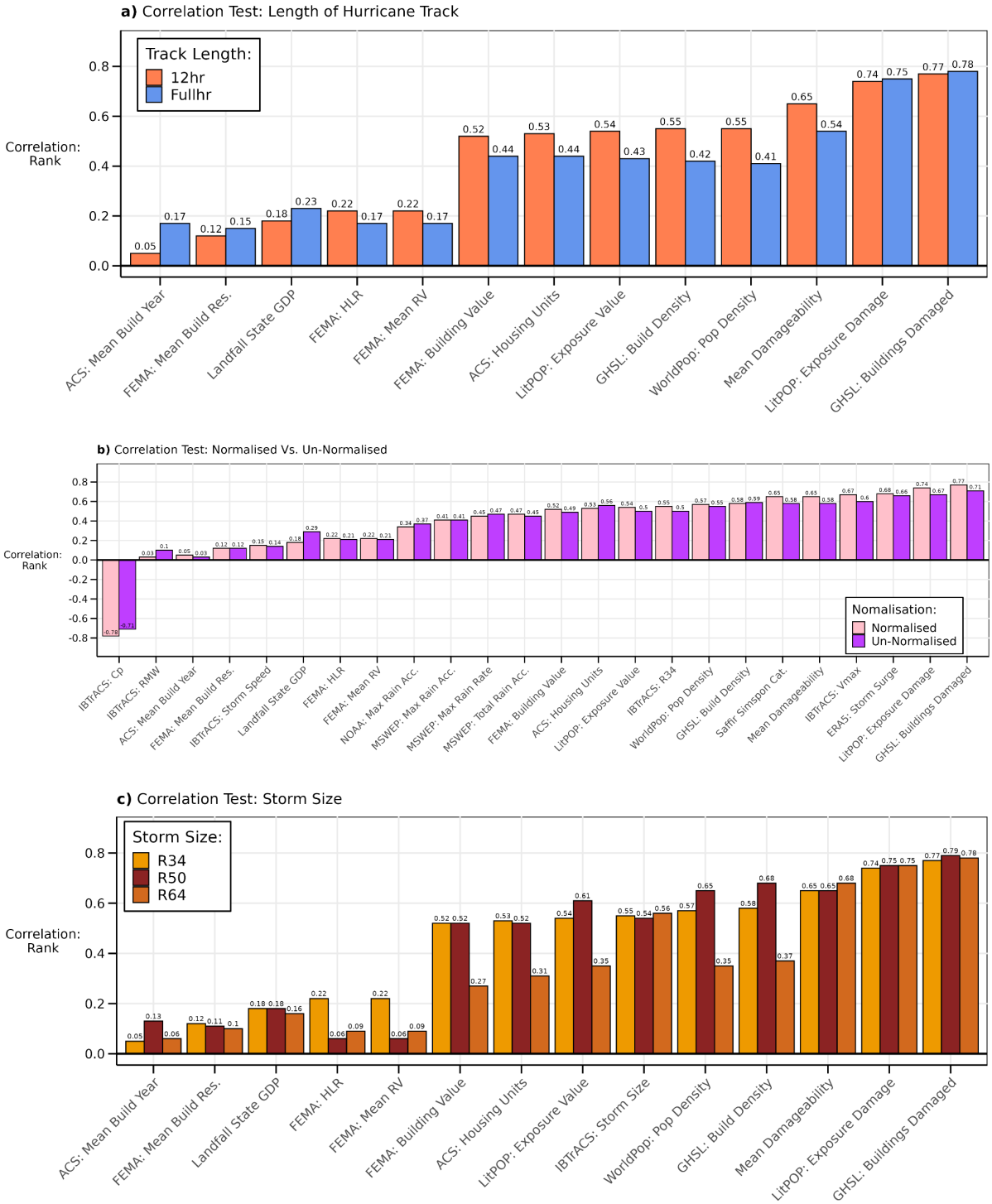


***Figure S4****. Uncertainty in Spearman coefficient for correlation with economic loss estimates when* ***a)*** *different track lengths are used to calculate exposure and vulnerability footprints (using 12 hours post-landfall versus the full track),* ***b)*** *using un-normalised and normalised economic loss, and* ***c)*** *using R34, R50 and R64 to define the hurricane exposure and vulnerability impact footprint radii. If un-normalised, past building density, population density and housing unit footprint data are used; if normalised, present-day building density, population density and housing unit footprint data are used for all historical storms.*

***Table S1.*** *Historical U.S. landfalling hurricanes* (1979–2023) *per Saffir–Simpson category and the thresholds in landfalling $c_p$ and loss rank required to reclassify historical hurricanes in our HDPS scale, maintaining the same proportions of events per category.*

| **Saffir–Simpson category** | **Percentage of historical U.S. landfalling hurricanes per Saffir–Simpson category** | **Saffir–Simson scale $v_{max}$ Threshold (knots)** | **$c_p$ threshold (hPa)** | **Loss (U.S.$ bn)** |
|---|---|---|---|---|
| **Cat 1** | 55.4% | <64 | <962.0 | <5.3 |
| **Cat 2** | 25.6% | 64 - 83 | 962.0 - 946.4 | 5.3 - 24.9 |
| **Cat 3** | 9.2% | 83 - 96 | 946.4 - 937.8 | 24.9 - 48.2 |
| **Cat 4** | 9.2% | 96 - 114 | 937.8 - 923.3 | 48.2 - 150.7 |
| **Cat 5** | 1.5% | 114 - 136 | 923.3+ | 150.7+ |