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Supporting Information for

Deep-learning climate emulator ACE2 reveals a global decrease in tropical cyclone frequency in the 15th Century under an El Niño-like sea surface temperature trend

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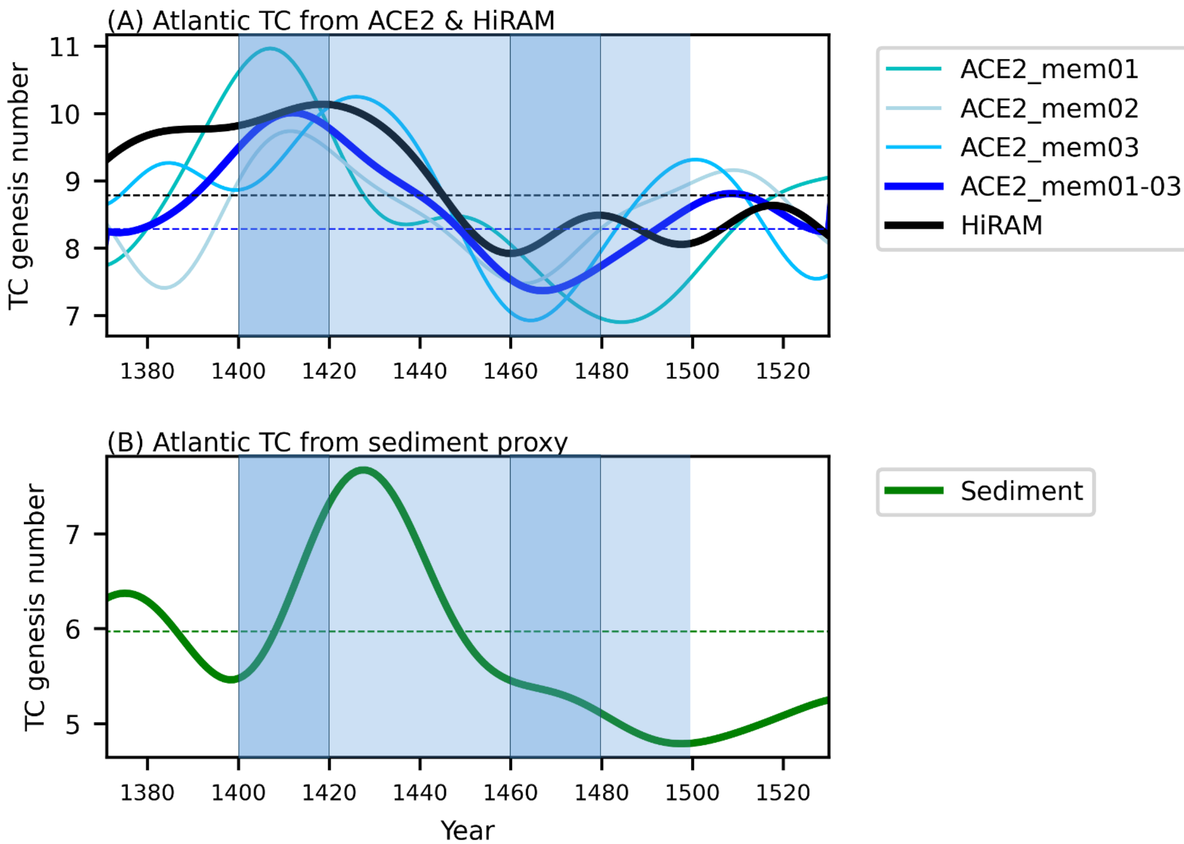

Fig. S1.
The time series of the 40-year low-pass filtered Atlantic TC number from 1371 to 1530 AD. This is similar to Fig. 2 but covers the entire simulated period. Note that the first and last 20 years (1351-1370, 1531-1550) are not shown because the 40-year low-pass filter is not applicable at the beginning and end of the simulation. The light-blue shading represents 1401-1500 AD, and the darker-blue shading represents the High and Low periods of global TCs as in Fig. 1A.

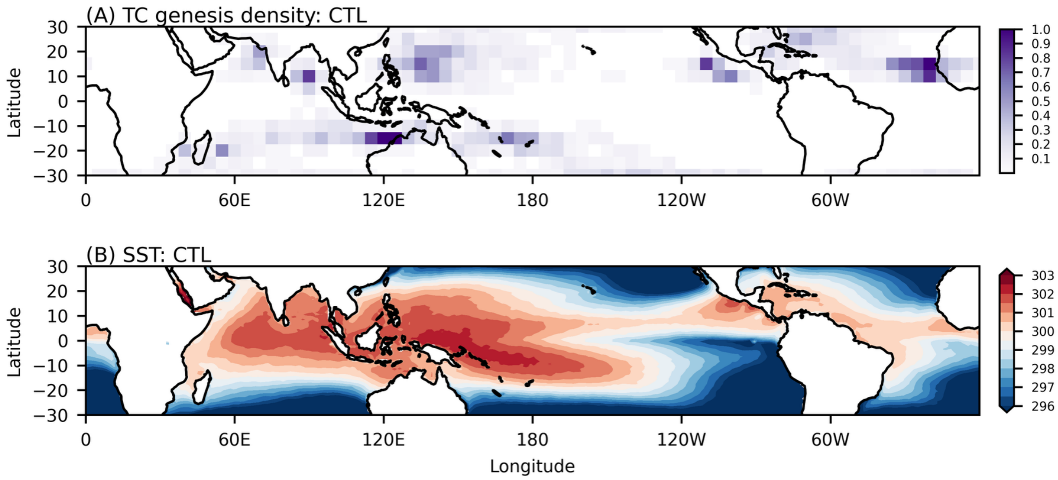

Fig. S2.

(A) TC genesis density map in 1401-1420 AD and (B) sea surface temperature map in 1401-1420 AD.

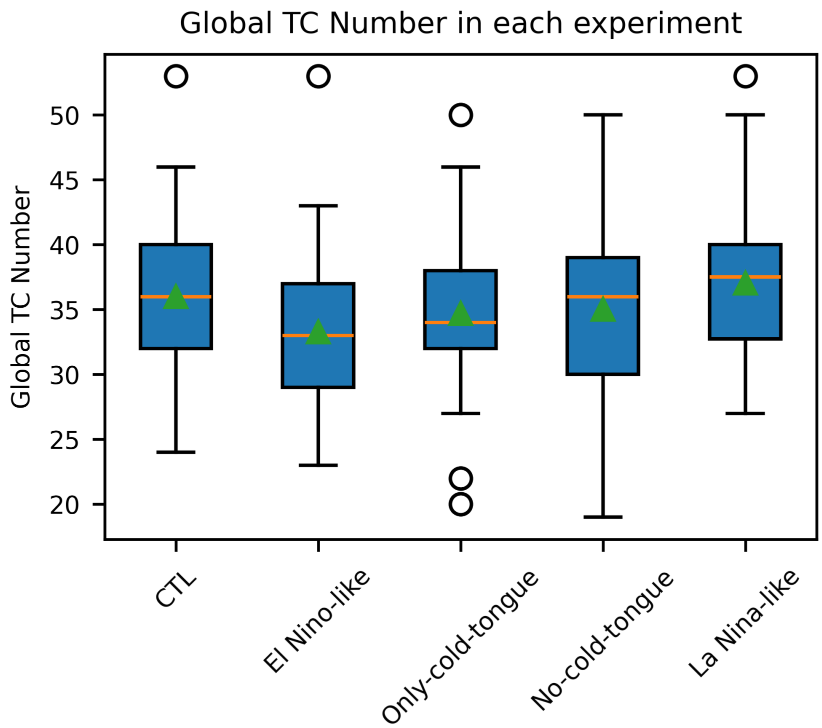

Fig. S3.

Box-and-whisker plot of TC number in each experiment for 80 ensemble members in the control run and 40 ensemble members for the other experiment. The box represents the 25th percentile and the 75th percentile, while the orange line represents the median (50th percentile). The upper and lower whiskers represent 1.5 times the interquartile range between the 25th percentile and the 75th percentile. Outliers are indicated in individual dots.

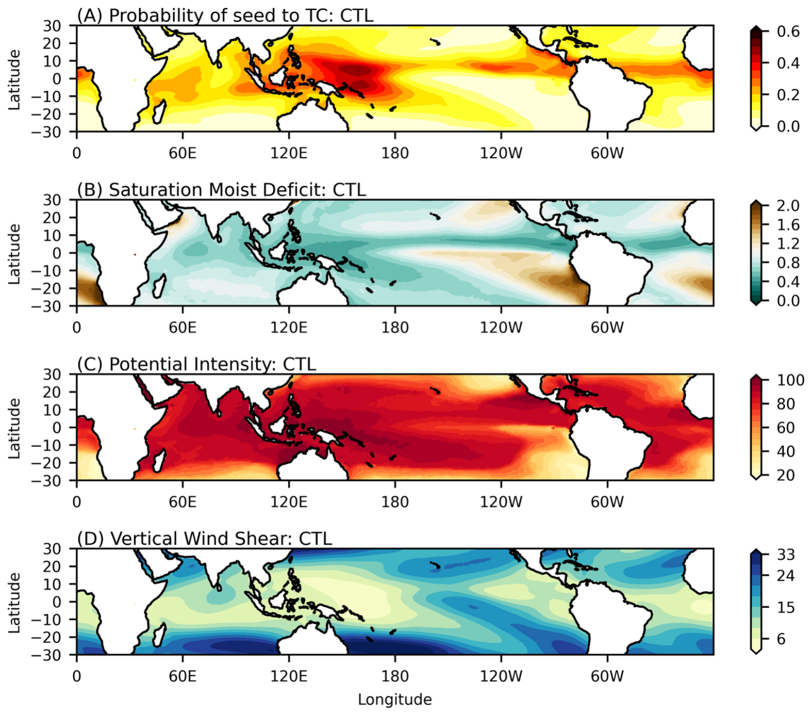

Fig. S4.

(A) Estimated transition probability from seeds to tropical cyclones based on environmental factors of the control run, including (B) saturation moisture deficit, (C) potential intensity, and (D) vertical wind shear.

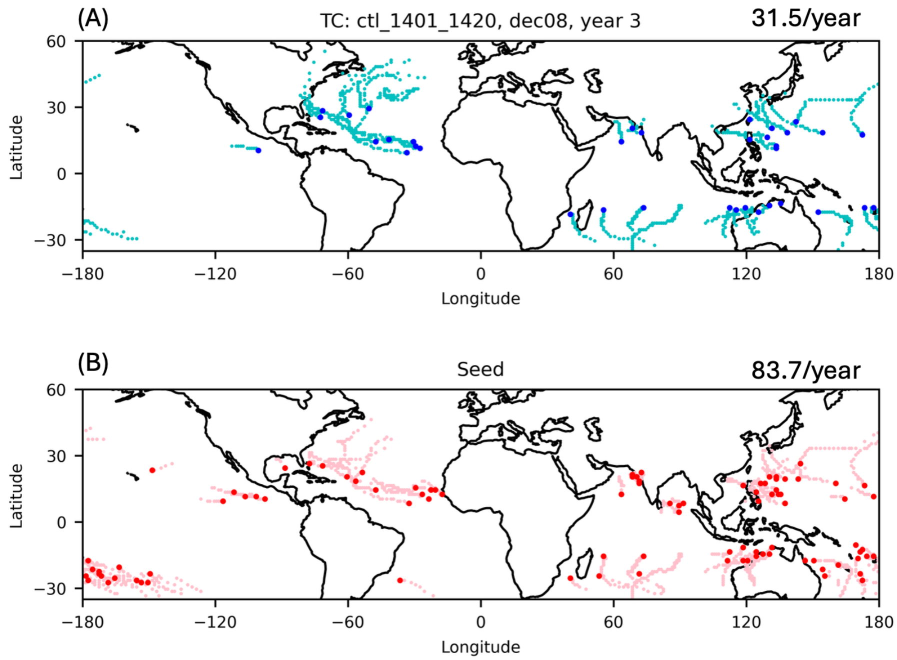

Fig. S5.
An example of geographic distribution of tropical cyclones and seed disturbances from the 73rd ensemble members of Experiment 1. (A) Tropical cyclone track (light blue) and genesis (dark blue), and (B) tropical seed disturbance track (pink) and genesis (red). The average TC number and seed number in 80 ensemble members in the control run are shown on top right of each panel.

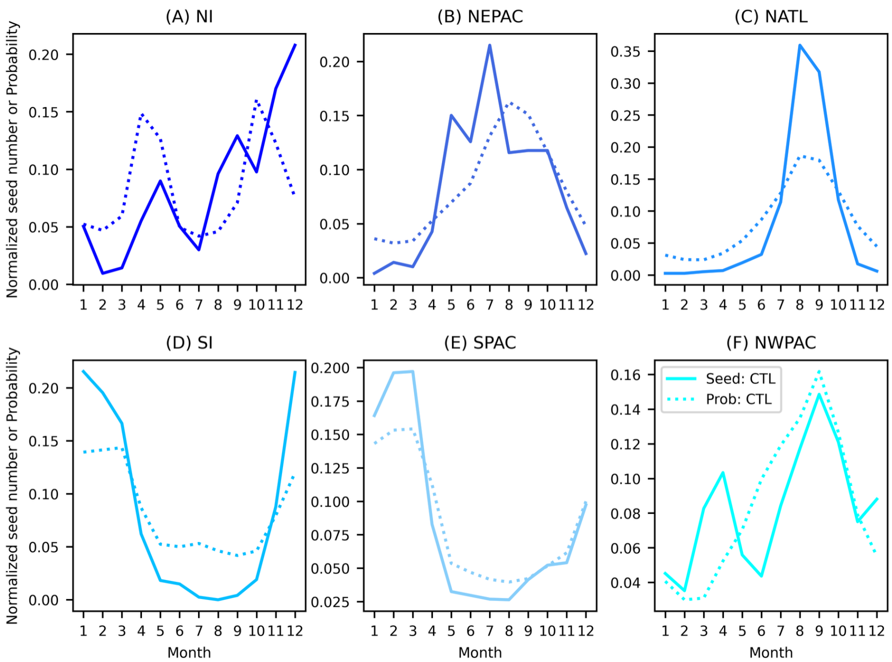

Fig. S6.
The annual cycle of seed disturbance (solid lines) and transition probability (dotted lines) in each basin from the control simulation.

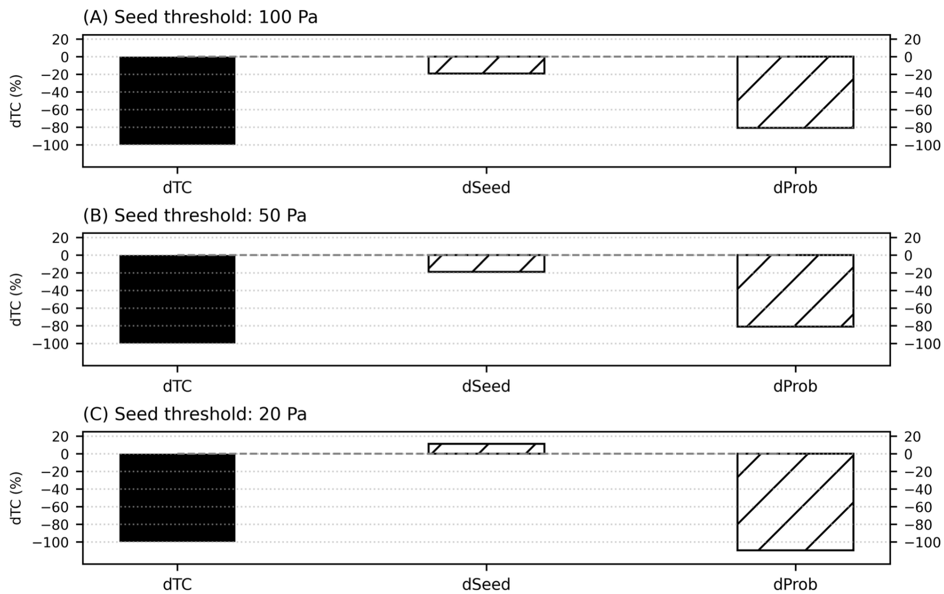

Fig. S7.

Probability change of global TC frequency due to seed or probability. Similar to Fig. 5O, but using different seed definitions: (A) Same as in Fig. 5O, using a sea level pressure threshold of 100 Pa, (B) sea level pressure threshold of 50 Pa, and (C) sea level pressure threshold of 20 Pa.

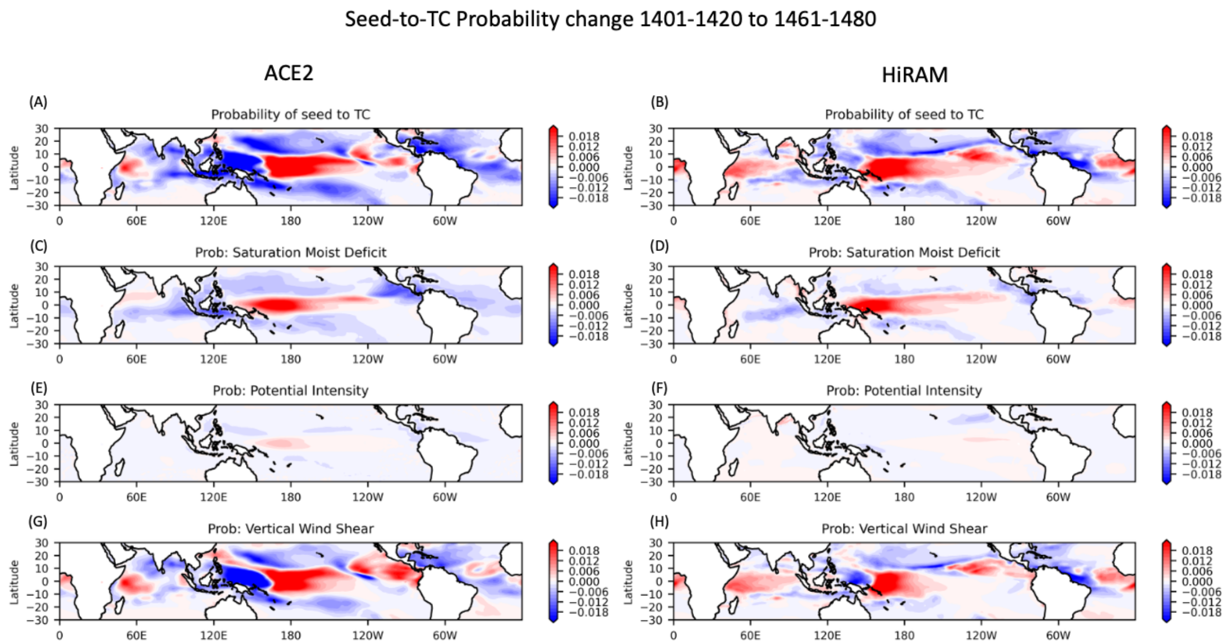

Fig. S8.

Probability change from the control simulation to Experiment 1 based on (A-B) all factors, (C-D) saturation moisture deficit, (E-F) potential intensity, and (G-H) vertical wind shear. The left column (A, C, E, G) presents ACE2-ERA5 results, and the right column (B, D, F, H) presents HiRAM results.

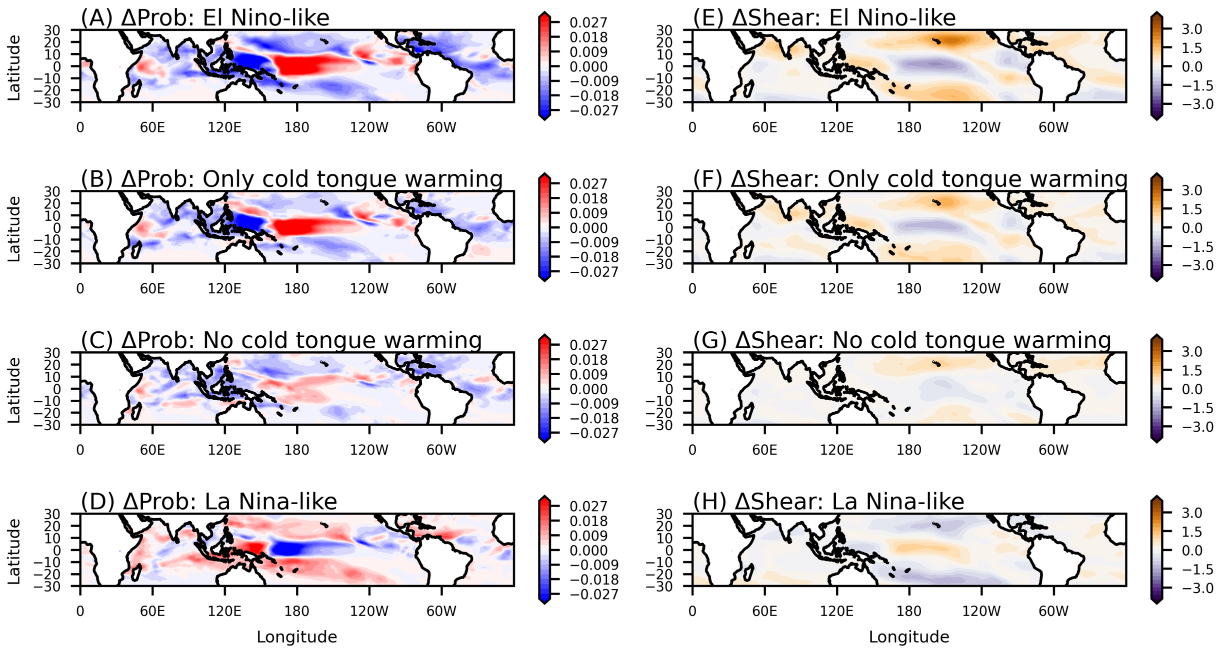

Fig. S9.

(A-D) Change in transition probability in each experiment. (E-H) Change in vertical wind shear in each experiment.

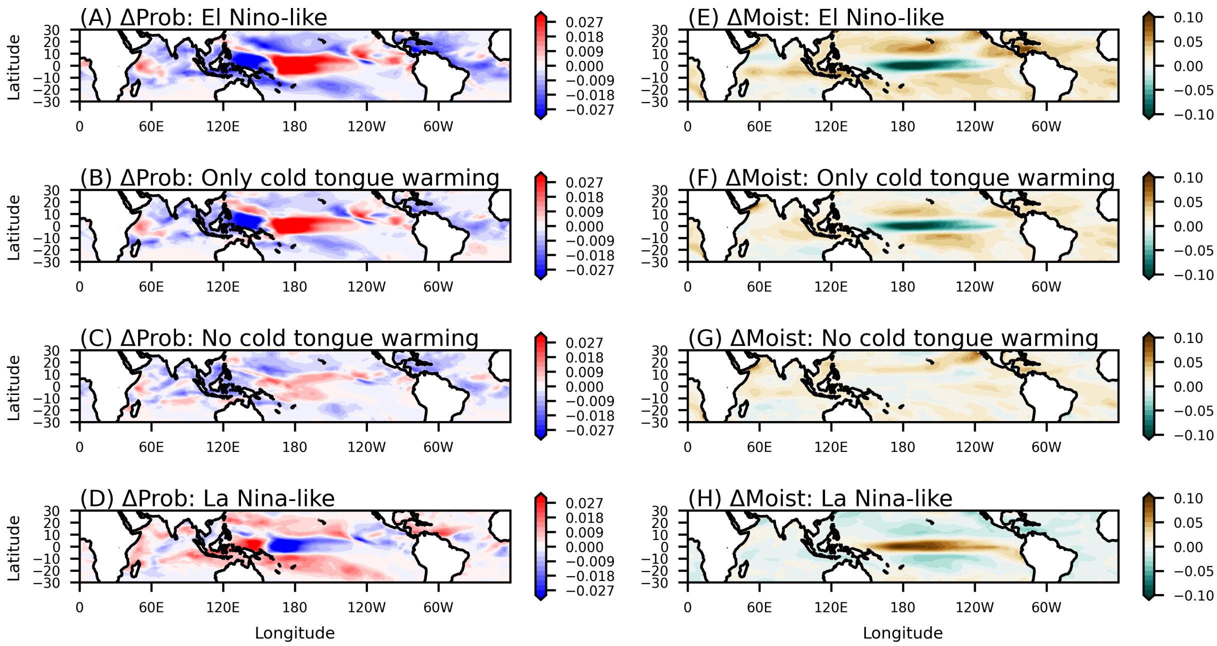

Fig. S10.

(A-D) Change in transition probability in each experiment. (E-H) Change in saturation moisture deficit in each experiment.