Geophysical Research Abstracts
Vol. 21, EGU2019-6090, 2019
EGU General Assembly 2019

Tropical cyclone sensitivity to CO_2 doubling: impact of resolution and forcing

Gabriel Vecchi (1), Hiroyuki Murakami (2), Tom Delworth (2), Seth Underwood (2), Andrew Wittenberg (2), Fanrong Zeng (2), Wei Zhang (3), Jane Baldwin (4,5), William Cooke (2), Jie He (5,6), Sarah Kapnick (2), Tom Knutson (2), Gabriele Villarini (3), Karin van der Wiel (7), Whit Anderson (2), Venkatramani Balaji (2,5), Jan-Huey Chen (2), Keith Dixon (2), Rich Gugel (2), Lucas Harris (2), and the Team Working on HiFLOR and FLOR

(1) Princeton University, Department of Geoscience and Princeton Environmental Institute (gvecchi@princeton.edu), (2) NOAA/GFDL, (3) University of Iowa, (4) Princeton University, Princeton Environmental Institute, (5) Princeton University, Atmospheric and Oceanic Sciences Program, (6) Georgia Institute of Technology, (7) KNMI, (8) Princeton University, Department of Civil and Environmental Engineering

Idealized CO_2 perturbation experiments are performed with coupled global climate models (GCMs) across a range of horizontal atmospheric resolutions (2°, 0.5° and 0.25°), each with the same ocean and sea ice components (including resolution), in order to understand the response of tropical cyclone activity and its sensitivity to model resolution. The response of the inter-tropical convergence zone (ITCZ) differs across the models both globally and in the tropical Pacific, and largely reflects the mean biases in each model's zonal-mean precipitation. Global-mean temperature response differs across the models, largely due to differences in ocean heat uptake, and not to differences in radiative feedbacks/equilibrium climate sensitivity.

Further idealized perturbation experiments in which uniform warming, isolated CO_2 increase (with SST fixed), warming and CO_2 increased, and patterned warming and CO_2 increases, are performed with the models to further understand the sources of inter-model spread. Experiments with the same perturbation applied to modeled (biased) and observed SST climatology are performed to evaluate the "time-slice" framework, and explore the impact of SST biases on the response of tropical cyclones.

Doubling CO_2 and warming drive a substantial decrease in global TC frequency in the 0.5° model, but either no change or an increase in the 0.25° model (depending on whether or not that model's climatological SST biases are corrected). The response of global TC frequency arises due largely competing influences of the number of precursive disturbances ("TC seeds") and the large-scale favorability of the enviroment (e.g., shear, potential, intensity, humidity changes) - accounting for only one or the other fails to capture the modeled TC changes. The models show substantial heterogeneity in their regional TC response, mediated by biases in the simulated time-mean SST. The 0.25° model shows a substantial increase in both TC intensity and the occurrence of “Major” (Category 3-5) tropical cyclones. These responses arise from competing influences of CO_2 on the atmosphere and land, uniform ocean warming, and spatial patterns in that warming.