International Conference on
Emergency & Personalized Medicine
December 05-06, 2022 | Dubai, UAE
contact@meetingsint.com | +65 3158 1626 | +65 3158 1626

International Journal of Cardiovascular Research

ISSN: 2324-8602
International Journal of Cardiovascular Research

Volume 10

Characteristics and Machine Learning Emulation of Heatwaves in Future Climate of New Jersey - Exploring Data From the CMIP6 Archive

Karthik V[1]

[1]The Wardlaw+Hartridge School



Abstract:

Statement of the Problem: Heatwaves have historically been one of the largest contributors to weather-related disasters across the world. Anthropogenic climate change increases the duration and intensity of heatwaves and densely populated states such as New Jersey are greatly susceptible to their effects. With a geographical focus on New Jersey, this research aims to quantify future heatwave events in order to explore underlying climate drivers and accordingly develop an optimal machine-learning based emulator to predict heatwaves.

Methodology and Theoretical Orientation: An initial analysis of the CMIP6 data archive from the Earth System Grid Federation (ESGF) was conducted and daily surface air temperature, annual carbon dioxide, and annual methane data were extracted from Shared Socioeconomic Pathways (SSPs) deployed in various climate models. Using heatwave detection methods from Hobday et al., heatwave characteristics such as duration and intensity were calculated for the time period of 2015-2100. Multiple machine learning models were developed and tested for their accuracy in emulating heatwave statistics based on carbon dioxide and methane data.

Findings: The results of this evaluation concluded that Random Forest and Ridge Regression models, trained on normalized CESM2-WACCM carbon dioxide data, achieved optimal performance especially in predicting the maximum duration of a heatwave event and the number of heatwave events in a given year. Additionally, the findings reveal the significant role of carbon dioxide as a strong climate driver of heatwaves, contrasting methane as a relatively weaker climate forcing agent.

Conclusion & Significance: The research validates the effectiveness of ML-based emulators in analyzing relationships between target climate events and climate drivers. The study also shows that the severity of heatwave metrics in New Jersey are projected to rise over time from 2015 to 2100, causing adverse implications on people's health and environment. The outcomes of this study offer valuable insight for future research and policy formation for climate change mitigation and adaptation.

Biography

Vinay Karthik is a high school junior and youth climate advocate at the Wardlaw+Hartridge School in New Jersey, USA, passionate about bringing climate solutions to his community. Vinay is part of the Global Coordination Team at YOUNGO, the Children and Youth constituency for UNFCCC, where he helps to organize international and national UN conferences. Vinay is also a National Youth Action Team Lead in Citizens' Climate Lobby where he has spearheaded several climate action campaigns, helped host multiple grassroots advocacy events, and lobbied local congressmen to pass important climate policies. Vinay has won several national advocacy awards and hosted many international climate workshops. He has also published multiple climate op-eds in newspapers and maintains a youth climate website and a popular youth climate blog. Vinay is interested in majoring in Environmental Engineering and Climate Policy.

Global Platform For
Science (Life Science, Medical, Clinical, Pharma), Technology, Engineering &
Management Professionals To Exchange Ideas,
Knowledge And Networking
At 300+ International Conferences

About Research Topic

A heatwave can be defined as an event of abnormal heat with temperatures rising above the 90th or 95th percentile for more than five days, based on a 30 year historical baseline period. The characteristics of a heatwave include duration, intensity, rate of evolution, and spatial extent, with duration and intensity having the most direct impact on how deadly a heatwave can be. Heatwaves have several detrimental effects on not only the health of humans, with more than 1,300 Americans dying every year due to extreme temperatures, but also the environment, with a massive loss of 75% of kelp cover near the United States between 1972 and 2018.

About Institution:

LAAS, The Wardlaw+Hartridge School is a top private and college prep school in Edison, New Jersey, which provide an independent, pioneering education experience at the early childhood, kindergarten, elementary, middle, and high school levels.

References:

1. Brown, S. J. (2020). Future changes in heatwave severity, duration and frequency due to climate change for the most populous cities. *Weather and Climate Extremes*, *30*, 100278. https://doi.org/10.1016/j.wace.2020.100278
2. Chen, H., Zhao, L., Cheng, L., Zhang, Y., Wang, H., Gu, K., Bao, J., Yang, J., Liu, Z., Huang, J., Chen, Y., Gao, X., Xu, Y., Wang, C., Cai, W., Gong, P., Luo, Y., Liang, W., & Huang, C. (2022). Projections of heatwave-attributable mortality under climate change and future population scenarios in China. *The Lancet Regional Health - Western Pacific*, *28*, 100582. https://doi.org/10.1016/j.lanwpc.2022.100582
3. Cowan, T., Undorf, S., Hegerl, G.C. *et al.* Present-day greenhouse gases could cause more frequent and longer Dust Bowl heatwaves. *Nat. Clim. Chang.* 10, 505–510 (2020). https://doi.org/10.1038/s41558-020-0771-7
4. Eyring, V., et al. "Overview of the Coupled Model Intercomparison Project Phase 6 (CMIP6) Experimental Design and Organization." Geoscientific Model Development, vol. 9, no. 5, 2016, pp. 1937–1958., https://doi.org/10.5194/gmd-9-1937-2016.
5. Fan, X., Duan, Q., Shen, C., Wu, Y., & Xing, C. (2020). Global surface air temperatures in CMIP6: Historical performance and future changes. *Environmental Research Letters*, *15*(10), 104056. https://doi.org/10.1088/1748-9326/abb051
6. Filbee-Dexter, K., Wernberg, T., Grace, S. P., Thormar, J., Fredriksen, S., Narvaez, C. N., Feehan, C. J., & Norderhaug, K. M. (2020). Marine heatwaves and the collapse of marginal North Atlantic kelp forests. *Scientific Reports*, *10*(1). https://doi.org/10.1038/s41598-020-70273-x
7. Hansen, J., Lacis, A., Ruedy, R., & Sato, M. (1992). Potential climate impact of Mount Pinatubo eruption. *Geophysical Research Letters*, *19*(2), 215–218. https://doi.org/10.1029/91gl02788
8. Hobday, A.J., et al. "A Hierarchical Approach to Defining Marine Heatwaves." Progress in Oceanography, vol. 141, 2016, pp. 227–238., https://doi.org/10.1016/j.pocean.2015.12.014.
9. I. Buo, V. Sagris and J. Jaagus, "Gap-Filling Satellite Land Surface Temperature Over Heatwave Periods With Machine Learning," in IEEE Geoscience and Remote Sensing Letters, vol. 19, pp. 1-5, 2022, Art no. 7001105, https://doi.org/10.1109/LGRS.2021.3068069.
10. Jordon, M. W., Smith, P., Long, P. R., Bürkner, P.-C., Petrokofsky, G., & Willis, K. J. (2022). Can regenerative agriculture increase national soil carbon stocks? simulated country-scale adoption of reduced tillage, cover cropping, and Ley-arable integration using ROTHC. *Science of The Total Environment*, *825*, 153955. https://doi.org/10.1016/j.scitotenv.2022.153955
11. Kim, DW., Deo, R.C., Chung, JH. *et al.* Projection of heat wave mortality related to climate change in Korea. *Nat Hazards* 80, 623–637 (2016). https://doi.org/10.1007/s11069-015-1987-0
12. Lessmann, M., Ros, G. H., Young, M. D., & Vries, W. (2021). Global variation in soil carbon sequestration potential through improved cropland management. *Global Change Biology*,

28(3), 1162–1177. https://doi.org/10.1111/gcb.15954.

13. Montzka, S., Dlugokencky, E. & Butler, J. Non-CO2 greenhouse gases and climate change. *Nature* 476, 43–50 (2011). https://doi.org/10.1038/nature10322
14. Nairn, J. R., & Fawcett, R. J. (2014). The excess heat factor: a metric for heatwave intensity and its use in classifying heatwave severity. International journal of environmental research and public health, 12(1), 227–253. https://doi.org/10.3390/ijerph120100227
15. New Jersey Department of Environmental Protection. 2020. New Jersey Scientific Report on Climate Change, Version 1.0. (Eds. R. Hill, M.M. Rutkowski, L.A. Lester, H. Genievich, N.A. Procopio). Trenton, NJ. 184 pp.
16. O'Neill, B.C., et al. "A New Scenario Framework for Climate Change Research: The Concept of Shared Socioeconomic Pathways." Climatic Change, vol. 122, no. 3, 2013, pp. 387–400., https://doi.org/10.1007/s10584-013-0905-2.
17. Patnaik, B., Swain, S. C., Rout, U. K., & Dash, R. K. (2022). A comparative analysis of solar PV forecast using SVM under CO2 Concentration. *WSEAS TRANSACTIONS ON POWER SYSTEMS*, *17*, 84–92. https://doi.org/10.37394/232016.2022.17.10
18. PCMDI. (2007, October 16). *IPCC standard output from coupled ocean-atmosphere GCMS*. Variable List. https://pcmdi.llnl.gov/mips/cmip3/variableList.html
19. Seitz, D., Fischer, L.M., Dechow, R. *et al.* The potential of cover crops to increase soil organic carbon storage in German croplands. *Plant Soil* (2022). https://doi.org/10.1007/s11104-022-05438-w
20. Smith, C. J., Forster, P. M., Allen, M., Leach, N., Millar, R. J., Passerello, G. A., and Regayre, L. A.: FAIR v1.3: a simple emissions-based impulse response and carbon cycle model, Geosci. Model Dev., 11, 2273–2297, https://doi.org/10.5194/gmd-11-2273-2018, 2018.
21. Thomson, C., & Harrison, G. (2015). Life Cycle Costs and Carbon Emissions of Offshore Wind Power. ClimateXChange. http://www.climatexchange.org.uk/files/4014/3325/2377/Main_Report_-_Life_Cycle_Costs_and_Carbon_Emissions_of_Offshore_Wind_Power.pdf
22. Wang, B., Waters, C., Anwar, M. R., Cowie, A., Liu, D. L., Summers, D., Paul, K., & Feng, P. (2022). Future climate impacts on forest growth and implications for carbon sequestration through reforestation in Southeast Australia. *Journal of Environmental Management*, *302*, 113964. https://doi.org/10.1016/j.jenvman.2021.113964
23. Watson-Parris, D., Williams, A., Deaconu, L., & Stier, P. (2021). Model Calibration Using ESEM V1.0.0 – an Open, Scalable Earth System Emulator. https://doi.org/10.5194/gmd-2021-267
24. Wu, T., et al.: The Beijing Climate Center Climate System Model (BCC-CSM): the main progress from CMIP5 to CMIP6 , Geosci. Model Dev., 12, 1573–1600, https://doi.org/10.5194/gmd-12-1573-2019, 2019.
25. Yukimoto, S., et al. The Meteorological Research Institute Earth System Model Version 2.0, MRI-ESM2.0: Description and Basic Evaluation of the Physical Component, Journal of the Meteorological Society of Japan. Ser. II, 2019, Volume 97, Issue 5, Pages 931-965, https://doi.org/10.2151/jmsj.2019-051.
26. Zacharias, S., et al. "Climate Change Effects on Heat Waves and Future Heat Wave-Associated IHD Mortality in Germany." *MDPI*, 26 Dec. 2014, www.mdpi.com/2225-1154/3/1/100.