Supplementary Document: EGU 2025 Poster Presentation

Title: Human Thermal Indices and the Risk of Abrupt Population Disruption

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1. Introduction

This research investigates the future evolution of heat stress patterns using data from 37 climate models. The core objective is to identify potential "abrupt disruptions" in thermal conditions – rapid changes in the frequency, intensity, or duration of heatwaves – that could pose significant threats to populations. To provide a regionally specific analysis, the study area is divided into zones based on the Köppen-Geiger climate classification system. This zoning allows for a more detailed assessment of the timing of potential disruptions for populations in different climatic regions. The study employs a comprehensive suite of thermal index parameters to capture various facets of heat stress. Ultimately, the project aims to pinpoint high-risk areas, enabling the development of targeted intervention strategies.

2. Objectives

The primary objectives of this research are:

- To generate global thermal indices for the period 1985-2100 using data from 38 General Circulation Models (GCMs).
- To determine the timeline for abrupt heat stress disruptions for populations, referencing previously experienced extreme climate events as a baseline.
- To identify hotspots of future susceptible heat-stressed areas.

3. Materials and Methods

The research utilizes temperature, relative humidity, wind speed, and vapor pressure data at a coarse resolution (1° x 0.25°) to calculate a range of thermal indices. These indices include:

- Heat Index and Humidex
- Apparent Temperature (indoors and outdoors) and Discomfort Index
- Effective and Net Effective Temperature, Discomfort and Modified Discomfort Index
- Surface Air Temperature, Modified Discomfort Index and Net Effective Temperature
- Wind Chill Temperature, Simplified Wet-bulb Temperature and Wet-bulb Temperature

The study incorporates historical extremes of all indices using data from 37 General Circulation Models (GCMs). The methodology involves calculating thermal indices for both historical (1850-2015) and future (2015-2100) time periods. The timing of disruption is determined using the historical maximum values of all indices in conjunction with the Köppen-Geiger climate classification.

4. Results

The poster presents results focusing on apparent temperature (AT_Out) and discomfort index (DI) under different Shared Socioeconomic Pathways (SSPs). Key findings include:

- Global maps showing AT_Out and DI under SSPs 1-2.6, 2-4.5, and 5-8.5.
- Comparisons of temperature patterns between AT_Out and DI scenarios.
- Maps illustrating threshold exceedance for AT_In, evapotranspiration (ET), and surface air temperature (SAT) by 2100.
- Time series plots showing the percentage of global land area exceeding these thresholds.

5. Conclusions

The study yields several major conclusions:

- A substantial fraction of global land is projected to surpass critical thresholds for various thermal parameters by 2100.
- Higher emission scenarios exacerbate the severity and extent of threshold exceedance.
- Lower latitude regions are identified as particularly vulnerable to increased heat stress.
- Even with moderate emission mitigation, some level of impact is unavoidable.
- Uncertainty in projections increases over time, especially under high emission scenarios.

6. References

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2. Li, X., Lao, M., Zhao, Y., Zhang, H., Ge, E, Huang, Z. & Tang, Y. (2023). A daily high-resolution (1 km) human thermal index collection over the North China Plain from 2003 to 2020. Scientific Data, 10(1), 634.

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