

**WORKING PAPER NO: 732**

# **Mind the (Jensen) Gap: Climate and Health using Gridded Data**

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Year of Publication – March 2026

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### **Abstract**

High spatio-temporal resolution remotely sensed satellite imagery and gridded reanalysis /data are now being increasingly used to characterize the association between environmental variables and human health (for example, thermal stress or pollution exposure). Furthermore, the functions and models describing the relationship between climate variables and human health exhibit pronounced nonlinearities. Specifically, health outcomes observed under mean conditions differ substantially from the mean health outcomes calculated across the full spectrum of climatic variability. Jensen's inequality formalizes biases introduced by averaging nonlinear functions. In the climate-health context, threshold exceedances, nonlinear by definition, are especially critical. We investigate biases arising from nonlinear spatio-temporal averaging of reanalysis data by theoretically and empirically characterizing Jensen's inequality in the construction of the Universal Thermal Climate Index (UTCI), a widely used indicator of heat stress, and the associated threshold exceedances. We demonstrate that systematic and climate-zone sensitive biases are introduced by both coarse temporal (e.g., hourly or weekly climatology) and spatial (e.g., across counties, districts, and other political units) averaging of gridded climate data. Our framework for Jensen Gaps is general and can be applied to other fields and studies using remotely sensed or reanalysis data.

**Keywords:** Reanalysis Data; UTCI; Spatio-temporal Averaging