Changes in Temperature Persistence Under Climate Change

Benedikt Farag

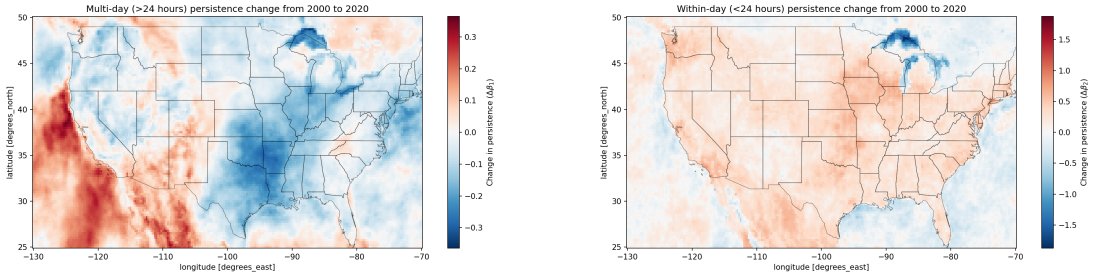
Executive Summary

While climate change has primarily focused on rising average temperatures, changes in temperature persistence (i.e. how long temperature pattens exist), time can also have significant effects on ecosystems, agriculture and public health. Temperature persistence (also known as *temporal autocorrelation*) determines whether temperatures sustain for hours, days, or weeks, which affects the duration of heat waves and cold spells.

We investigated these changes across the United States from 2000 to 2020 using hourly temperature measurements from the ERA5 reanalysis database. The data was processed to isolate the temperature persistence signal from regular daily cycles. The temperature persistence was quantified for two timescales: At low-frequency (β_1, variations longer than one day) and high-frequency (β_2, variations within each day), where greater values β indicate more persistence.

Figure 1 shows fundamental changes in temperature persistence across the 20 year period. For timescales longer than one day (Fig. 1a), the major inland regions including the Pacific Northwest, Midwest and Southern US exhibit decreased persistence, meaning that multi-day temperature patterns are less stable. In contrast, the North Pacific Ocean expressed an increased persistence, which might be linked to ocean warming.

For within-day timescales (Fig. 1b), the majority of the continental US exhibited an increased persistence, meaning that hourly temperature fluctuations have became more stable and temperature variance has shifted towards daily-cycles. This behavior suggests that once extreme temperature events do occur, they are more likely to be sustained which causes heat waves and cold spells to have a longer duration.



(a) Multi-day persistence (> 24 hours) (b) Within-day persistence (< 24 hours)

Figure 1: Difference in temperature persistence from 2000 until 2020: Blue regions indicate decreased persistence while red indicates increased persistence

These findings demonstrate that climate change is affecting not only average temperatures, but also the temporal structure of temperature variability. This directly affects extreme temperature duration and ecosystem stability.