EGU25-18397, updated on 16 May 2025
https://doi.org/10.5194/egusphere-egu25-18397
EGU General Assembly 2025

Assessing the added value of statistical downscaling to the predictive skill of global subseasonal temperature forecasts during the Paris 2024 Olympics

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Global warming is increasing the frequency and intensity of extreme temperature events, posing significant risks to human health during major outdoor events such as the Summer Olympics. Providing decision-makers with robust, high-resolution extreme temperature forecasts well in advance is crucial to anticipate risks on the health of both athletes and spectators. Global subseasonal forecasts can play a key role in addressing this challenge because they offer data with relatively high temporal resolution (i.e., weekly) several weeks ahead. However, the coarse spatial resolution of these forecasts limits their utility for the types of localized decision-making required for major events, necessitating the use of downscaling methods to improve resolution.

Although numerous downscaling approaches exist, their ability to skillfully downscale subseasonal data has not been systematically evaluated. To address this gap, this study assesses the performance of 27 statistical downscaling methods – including bias correction, linear regression, logistic regression, and analogs – in enhancing the spatial resolution of subseasonal temperature hindcasts. We use Climate Prediction System version 2 (CFSv2) data at 100 km resolution as the raw hindcast product and downscale these hindcasts to a 5 km resolution. The process is conducted separately for temperature hindcasts from models initiated 1, 2, 3, and 4 weeks prior to the three target weeks of the Paris 2024 Olympics (starting from 22 July, 29 July and 5 August). In addition to using CFSv2 temperature outputs as predictors, we explore the added value of incorporating atmospheric patterns into the downscaling process. Models are constructed using both daily and weekly data, enabling a comparative analysis of performance across two temporal scales.

The results show that downscaling methods can successfully transfer the predictive skill of CFSv2 to the 5 km resolution. However, the choice of downscaling method is crucial to the performance, as some methods degrade the predictive skill of CFSv2, while others enhance it. Notably, methods that incorporate atmospheric patterns show promise in improving forecasts with longer lead times. Additionally, daily data models using analogs outperform their weekly counterparts, while regression-based methods perform better with weekly data.

In summary, this study demonstrates the potential of statistical downscaling to enhance coarse-

resolution subseasonal temperature forecasts. However, it also highlights the significant variability in forecast skill depending on the choice of predictors and methods, which can either improve or degrade performance.