Estimating the impacts of 2021 heatwaves in the western United States

Annual Conference: Science for Solutions

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Abstract:

Increasing dryness in recent years causes more heatwaves with higher intensity around the world, resulting in abnormally high temperatures and additional heat stress to human health. Fast urbanization increases impervious areas and changes microscale climate conditions in urban areas, which is conducive to storing heat energy, leading to intensive urban heat island (UHI) effect. It was revealed that a heatwave in 2012 caused larger increases in the rural temperatures compared to the urban temperatures in Chicago from our previous study. In this study, we propose to expand our findings to investigate the coordinated effects of heatwaves and UHI in the western U.S. during the extreme heat event that occurred in late June to mid-July were due to an unusually strong and long-lasting ridge over the western US and Canada. The Weather Research and Forecasting (WRF) model is used to quantify the intensity of heatwaves and UHI in eight major western cities (Seattle, Portland, Boise, Salt Lake City, Las Vegas, San Francisco, Sacramento, and Los Angeles). Model performances are evaluated and the results indicate simulated temperatures are reliable in both coarse and finer domain, with statistical metrics of gross error (GE) and mean bias (MB) lower than suggested criteria of 2 and ±0.5 ºC. Spatiotemporal heatwave impacts are also quantified. Significant heatwaves occurred in early Montana, Wyoming, Utah, Nevada (early June), southern California, western Arizona (middle June), and Washington, Oregon (Late June) causing more than 8 ºC temperature increases. It is noted that heatwaves have stronger impacts during nighttime, it caused more than 10 ºC increases at night with the increasement were around 5 ºC during daytime. UHI intensity and associated impacts from heatwaves in eight cities will be investigated using regression functions combined with urban fraction index. Results from this work will provide supportive data for future studies related to urban development and epidemiological studies of heat impacts on human health.