



## A Comparative Analysis of Dynamic and Statistical Downscaling Techniques to Bridge the Gap Between the Regional and the Local Scale: Case Study for Nicosia

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The Eastern Mediterranean and Middle East (EMME) region exhibits continuously accelerated warming, posing a significant threat to cities within this area and thus increasing their vulnerability to climate change. Regional Climate Models (RCMs) serve as valuable tools for climate simulations, but when the focus is given to the urban thermal environment the resolution of their output results is not sufficient. Downscaling techniques can be utilized to improve the spatial resolution of the RCMs and, hence, bridge this gap between the regional and the local scale. The downscaling techniques can be divided into two main categories, the dynamical (DD), and the empirical/statistical (ESD). While DD relies on physical schemes, its computational demands pose challenges for long-term simulations contrary to the ESD which is computationally inexpensive. In this study, both the DD and the ESD techniques are applied to downscale the 2m air temperature from the regional to the local scale for the city of Nicosia, the capital of Cyprus. Concerning the DD, the Weather Research and Forecasting (WRF) model is used to downscale the ERA5 re-analysis in three different domains, over the EMME region, Cyprus, and Nicosia, with a spatial horizontal resolution of 12km×12km, 4km×4km, 1km×1km respectively, over a 5-year historical period (2008-2012). Detailed information on the urban characteristics is incorporated into the WRF model through the coupling of the Single Layer Urban Canopy Model (SLUCM) as well as with the utilization of the state-of-the-art land use/land cover CGLC-MODIS-LCZ dataset. The ESD utilizes the generated database of the WRF model to establish statistical relationships between the regional and the local scale for the same period by employing advanced machine learning techniques, including Artificial Neural Networks (ANNs) and Multiple Linear Regression (MLR). A detailed comparative analysis between the two downscaling techniques as well as an evaluation of the simulation results against observation data from two meteorological stations are performed to assess their accuracy in estimating the air temperature over Nicosia.

**Key Words:** WRF model; dynamical downscaling; statistical downscaling; urban climate modeling; Local Climate Zones