



Drizzle Bias adjustment in climate models: A simple two-step downscaling approach

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Precipitation is a key variable for assessing the impacts of climate change across diverse sectors, from hydrology to ecology. However, climate models frequently overestimate the occurrence of light precipitation events—days or hours that should be dry are instead assigned a low rainfall rate. This pervasive issue, known as the “drizzle bias” or “drizzle problem” in climate science, undermines the reliability of climate impact assessments.

Traditional bias correction methods, such as linear scaling or empirical quantile mapping, address overall precipitation distributions but often fail to properly account for the frequency and duration of wet and dry periods. As a result, these methods may improve precipitation totals but fail to correct the skewed distribution of rainy events.

In this study, we propose a simple yet effective two-step statistical downscaling approach to address the drizzle bias. The first step aligns the frequency of wet and dry periods by assuming equivalence between observed and simulated rain frequencies. The second step corrects the precipitation distribution exclusively for wet samples.

We apply this methodology to a range of climate data products, including ERA5 Land reanalyses, as well as simulations from global circulation models (GCMs), regional circulation models (RCMs), and convection-permitting models (CPMs). Our analysis focuses on multiple measurement stations in Northern Italy, encompassing urban contexts such as Milan and mountainous contexts in the Italian Alps. Results reveal that drizzle bias is a widespread issue across these datasets, regardless of the modeling framework.

The findings demonstrate that our two-step downscaling approach effectively adjusts for drizzle bias, significantly improving the statistical fidelity of precipitation projections. This approach offers a straightforward and practical solution for enhancing the reliability of climate model outputs, enabling more robust assessments of climate change impacts across sectors sensitive to precipitation variability.