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How does the "too frequent, too light" precipitation bias in climate models affect the precipitation response to future warming?

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Longstanding biases in climate model precipitation cast doubt on predictions of future precipitation change. Precipitation is too frequent and too light in many climate models. Errors in the intensity and frequency of precipitation have an impact on cloud evolution and latent heat distribution within the atmosphere and therefore have a potentially important impact on a model's climate and predictions of future climate change. Past studies have suggested that the too frequent/too light bias affects models' ability to achieve extreme precipitation rates by inhibiting the buildup of moisture and instability and suppressing convective organization in climate models. In this study, we characterize more precisely the conditions under which these frequent, light rain events occur and investigate how a simple modification to a prototype model of the Department of Energy's Accelerated Climate Model for Energy, which alleviates the frequent and light precipitation, impacts the model's precipitation response to warming.

We find that light precipitation occurs globally, but primarily in oceanic trade cumulus regions, where daily 'drizzle' frequencies can exceed 90%. About 80% of this drizzle comes from the convective scheme. As expected, drizzle falls primarily from clouds in subsiding regions with modest precipitable water. With the original and a modified model where the light rain is suppressed, we examine the dynamic and thermodynamic response of the climate to reduced drizzle to test whether suppressing convective drizzle leads to changes in the precipitation response to a simple 4K increase in sea surface temperatures. We test whether the suppression of the light precipitation affects how and whether precipitation events become more organized with warming and hence affect changes in extreme rainfall rates.

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