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Contributions of climate feedbacks and radiative forcings to surface temperature variability in an Energy Balance Model

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Understanding temperature variability is crucial because even a slight change in the mean climate can cause shifts in climate extremes. However, the underlying mechanisms governing this temperature variability remain limited, particularly regarding the roles of climate feedback and radiative forcings. To do so, we investigate these contributions using a simplified but conceptual physical framework of the Energy Balance Model (EBM). Radiative forcings are categorized into three components—external radiative, internal radiative, and non-radiative forcings—and reconstructed using outputs from 32 Coupled Model Intercomparison Project Phase 6 (CMIP6) models. For this reconstruction, we utilize both historical simulations and pre-industrial control runs. Surface temperature simulated by EBM, driven by CMIP6-derived inputs, is compared with CMIP6 values for each parameter. Our analysis shows that the variance of surface temperature is most strongly controlled by the climate feedback factor, highlighting its dominant role in modulating variability. These findings suggest that an EBM framework provides a useful and interpretable tool for disentangling how climate feedback and radiative forcings influence surface temperature variability.

Keywords: Energy Balance Model, Temperature Variability, CMIP6, Climate Feedback, Radiative Forcings

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