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Using spatial variations of surface radiation to constrain the global temperature sensitivity to surface radiative change

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Although climate models are able to simulate the effect of radiative changes on surface temperature there is a large model spread in the response to climate change which calls for observational constraints to improve model parameterizations and reduce the uncertainty for climate sensitivity. Here, we use the high information content of spatial variation in the surface radiation budget obtained by remote sensing and reanalysis to constrain how the surface energy partitioning responds to changes in surface radiation induced by climate change. While it is well known that temperature is strongly affected by the partitioning into radiative and turbulent cooling, we show here that surface temperature will respond much more to changes in the longwave than to changes in shortwave radiation. By using spatial variations of remote sensing (CERES-EBAF) and reanalysis (ERA-Interim) products we obtain observational constraints, which disentangle the sensitivity of surface temperature to changes in net shortwave and downwelling longwave radiation. There is a remarkable agreement between the spatial sensitivity derived from present day observations and the sensitivity of temperature to downwelling longwave radiative change derived from global scale climate change simulations. However, climate models show a large spread of their spatial sensitivity which is correlated to climate feedback and related to radiation transfer parameterizations. We conclude that spatial variation provides an observational constraint on how temperature responds to surface radiative change and may guide improvements in climate model parameterizations.