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Qauntifying fine-scale pattern in satellite images for use in coarse-scale climate models

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Earth Observation data on land surface properties such as albedo is typically collected at a pixel resolution of 1 km or less. Global climate models, on the other hand, are constrained by current limits on computing power to run at a gridbox resolution of 10 km or more. This mismatch in spatial scales means that large amounts of pixel–scale information must be condensed into a small number of gridbox–scale summary statistics before they can be used in climate models. Subgridscale patterns in land surface properties may have a significant effect on climate models but the summary statistics currently in use – such as the gridbox mean and gridbox variance – are insensitive to the spatial arrangement of pixels. To address this gap in the information available to climate models we define here a new gridbox–scale summary statistic – the Laplacian pattern index – that is sensitive to the spatial arrangement of pixels. This dimensionless index is based on the mean–squared value of the Laplacian filter ∇^2 within the gridbox, and is motivated by the physics of diffusive heat transport. We investigate the value of the index in some simple cases and show that it can be interpreted as a measure of the local correlation structure within a gridbox. This allows us to generate random gridboxes in which the index takes (on average) a prescribed value. The Laplacian pattern index is designed to be a useful measure of subgridscale pattern in numerical climate models, but it could be used as a measure of pattern in any two–dimensional array of real–valued data.