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Spatial validation of large scale land surface models against monthly land surface temperature patterns using innovative performance metrics.

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Land surface models (LSMs) are a key tool to enhance process understanding and to provide predictions of the terrestrial hydrosphere and its atmospheric coupling. Distributed LSMs predict hydrological states and fluxes, such as land surface temperature (LST) or actual evapotranspiration (aET), at each grid cell. LST observations are widely available through satellite remote sensing platforms that enable comprehensive spatial validations of LSMs. In spite of the availability of LST data, most validation studies rely on simple cell to cell comparisons and thus do not regard true spatial pattern information. This study features two innovative spatial performance metrics, namely EOF- and connectivity-analysis, to validate predicted LST patterns by three LSMs (Mosaic, Noah, VIC) over the contiguous USA. The LST validation dataset is derived from global High-Resolution-Infrared-Radiometric-Sounder (HIRS) retrievals for a 30 year period. The metrics are bias insensitive, which is an important feature in order to truly validate spatial patterns. The EOF analysis evaluates the spatial variability and pattern seasonality, and attests better performance to VIC in the warm months and to Mosaic and Noah in the cold months. Further, more than 75% of the LST variability can be captured by a single pattern that is strongly driven by air temperature. The connectivity analysis assesses the homogeneity and smoothness of patterns. The LSMs are most reliable at predicting cold LST patterns in the warm months and vice versa. Lastly, the coupling between aET and LST is investigated at flux tower sites and compared against LSMs to explain the identified LST shortcomings.