Linear theory of the spatial signatures of critical slowing down

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Critical slowing down is thought to be one of the main signs that a dynamical system is close to a tipping point. Therefore, early warning indicators have been developed to identify it, mainly tracking the temporal evolution of the system under investigation. It has been shown that critical slowing down displays also spatial signatures, such as an increase in the spatial correlation. However, these signatures are based only on heuristic observations and the analysis of numerical simulations. In this work, I will derive analytical expressions for typical spatial early warning indicators of critical transitions in spatially extended systems, such as spatial correlation, spatial variance, and spatial permutation entropy in the linearized limit. As a result, I will show that the common belief that the spatial correlation increases when a bifurcation is imminent is false. Other indicators, instead, might represent more robust substitutes, such as the spatial permutation entropy.