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Information obtained from observable meteorological state variables about transitions in the stably stratified nocturnal boundary layer

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The stably stratified nocturnal boundary layer (SBL) can be classified into two distinct states: one with moderate to strong winds, weak stratification and mechanically sustained turbulence and the other one with moderate to weak wind conditions, strong stratification and collapsed turbulence. We will show that with a hidden Markov model (HMM) analysis of the three dimensional state variable space of stratification, mean wind speeds, and wind shear we are able to classify these states accurately in both the Reynolds-averaged as well as turbulence state variables. The features of the two-state SBL are a generic structure at different tower sites around the world independent of their underlying surface types, the meteorological setting, or the complexity of the surrounding. Sensitivity analysis indicate that essential information about transitions between the states are present in both the shear and the stratification as these properties describe turbulent kinetic energy production and consumption, respectively. However, results are presented demonstrating that surface winds are already a good proxy in order to obtain some information on transitions in the SBL and therefore a global analysis of these transitions is potentially possible.