Simple three-state lattice model for water

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A simple three-states lattice model that incorporates two states for locally ordered and disordered forms of liquid water in addition to empty cells is introduced. The model is isomorphic to the Blume-Emery-Griffith model. The locally ordered (O) and disordered (D) forms of water are treated as two components, and we assume that the density of the D component is larger. The density of the sample is determined by the fraction of cells occupied by the O and D forms of water. Due to the larger density of the D state, the strength of the Van der Waals (vdW) interactions of the pairs O-O, O-D, and D-D increases. On the other hand, the H-bond interactions are assumed only for the O-O pairs. For the vdW and H-bond interaction parameters and the density ratio of the close-packed and ice forms of water compatible with experimentally known values we find liquid-vapour and liquid-liquid transitions and the corresponding critical points in good agreement with other approaches. All major water anomalies are correctly predicted within mean-field approximation on a qualitative level.