Initiation of aeolian sediment transport is key to understanding the formation of dunes, emission of dust into the atmosphere, and landscape erosion. Previous models of the threshold wind speed required for saltation initiation have assumed that the particle bed is monodisperse and homogeneous in arrangement, thereby ignoring what is in reality a distribution of particle lifting thresholds, influenced by variability in soil particle sizes and bed geometry. To help overcome this problem, we present a numerical model that determines the distribution of threshold wind speeds required for particle lifting for a given soil size distribution. The model results are evaluated against high frequency wind speed and saltation data from a recent field campaign in Oceano Dunes in Southern California. The results give us insight into the range of lifting thresholds present during incipient sediment transport and the simplifications that are often made to characterize the process. In addition, this study provides a framework for moving beyond the ‘fluid threshold’ paradigm, which is known to be inaccurate, especially for near-threshold conditions.