A novel despiking method is presented for in-stationary wind lidar velocity measurements. A finite difference approach yields the upper and lower bounds for a valid velocity reading. The sole input to the algorithm is the velocity series and optionally a far-field reference to the temporal variation in the velocity. The new algorithm is benchmarked against common despiking algorithms using a dataset acquired by three synchronised lidars in the upstream area of a full-scale wind turbine rotor and an artificially created space-time series with controlled spike contamination. By accounting for variations in space and time, this approach yields improvements in spike detection for in-stationary lidar measurements of about 25% over other more established stationary methods. Furthermore it proofs to be robust even for large numbers of spikes.