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Asymmetries in the lateral distributions of signals measured by surface-detector arrays

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Surface detector arrays sample the distribution of particles from extensive air showers arriving at the ground. For a shower arriving from the zenith and for a flat array, this distribution is effectively radially symmetric. For inclined showers, however, detectors sample the shower at different stages in its development. Together with related attenuative and geometric effects, this results in radial asymmetries which differ between the various components of air showers. Left unaccounted for, these asymmetries may induce biases in the reconstructed position of a shower's core and in the reconstructed arrival direction of its primary. We present a parameterized model of these asymmetries as they manifest in the signals of two types of detectors commonly used to measure extensive air showers, namely scintillator and water-Cherenkov detectors. Additionally, we demonstrate the impact of taking these asymmetries into account during reconstruction. The results presented here are based on air showers simulated for proton and iron primaries with energies at and above $10^{18.5}$ eV and subsequent simulations of detector responses.

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