CoREAS simulations of inclined air showers predict refractive displacement of the radio-emission footprint

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What is this contribution about?

We observe a displacement of the radio core from the MC core in CoREAS simulations of inclined air showers (inclinations above 65°) for atmospheres with a changing refractive index, e.g. following the density gradient in the atmosphere.

Why is it relevant / interesting?

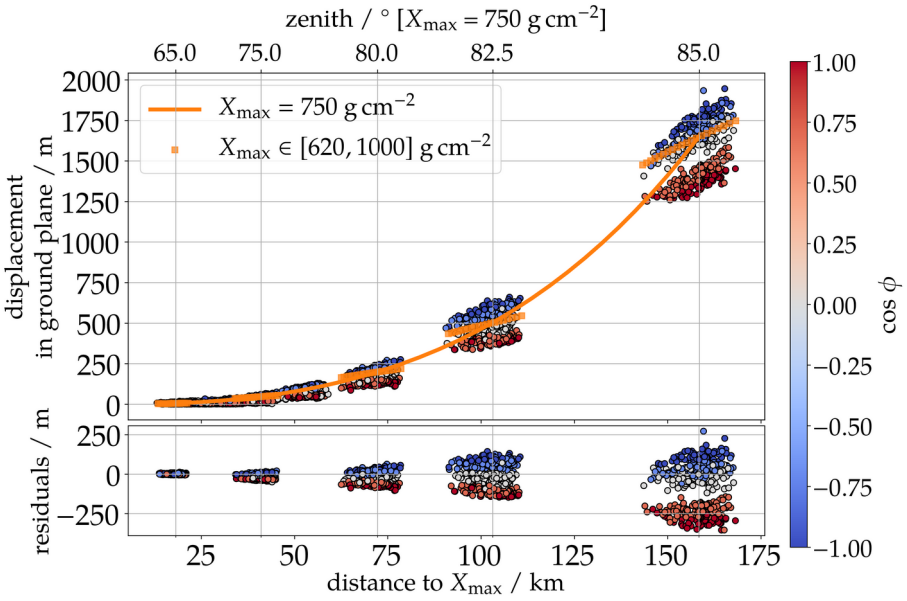
The displacement of the radio-emission is relevant for a) the development of new models of the lateral distribution of the radio emission as using the Monte-Carlo core will lead to a mismodelling of the lateral distribution; and b) for the interpretation of hybrid reconstruction, i.e. the shower cores reconstructed with particles and radio are expected to deviate.

What have we done?

We determined the core of the radio emission for 4185 CoREAS simulations without assuming a specific lateral distribution and found a displacement w.r.t. the MC core. The found displacement is compared with the prediction of a model that describes the propagation of an electromagnetic wave through a refractive atmosphere based on Snell's law.

What is the result?

The radio core is displaced by up to 1500 m at an inclination of 85° from the Monte-Carlo impact point which agrees with the prediction by our propagation model. Thus, we concluded that the displacement is due to refraction.



Comparison between model-predicted (orange) and CoREAS-derived (colored circles) displacement of the radio core in the ground plane. The residuals are shown in the bottom frame.