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Determining atmospheric electric fields from the cosmic-ray radio footprint

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We present measurements of radio emission from extensive air showers during thunderstorm conditions. Both intensity and polarization signatures of these events are very different from those measured during fair weather. The reason for this difference is due to the action of the atmospheric electric field. We have developed a procedure to extract from the radio footprint in intensity and polarization observables the structure of these atmospheric electric fields. This method can be regarded as a tomography of electric fields in (thunder)clouds using cosmic rays as probes.

We show that, in order to reconstruct these showers, atmospheric electric fields in thunderclouds generally are composed of at least three layers. We find that the electric fields extracted from these events have some similar characteristics. Large horizontal components of the electric fields are observed in the middle and the top layers. The height of the bottom layer depends on the season.

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