New CORSIKA: Large Zenith Angles

Since the standard version of the air shower simulation code CORSIKA [He98] treats the shower development in a plane atmosphere (Figure 0.1 left), modifications have been performed for a complete simulation at large zenith angles. To avoid lengthy formulas for a treatment in a spherical coordinate system with corresponding long CPU times the description of particle transport is kept, but the horizontal step size is limited (see Figure 0.2). Longer transport distances are subdivided into appropriate segments to be treated in a local flat atmosphere. After each traversed segment the particle coordinates are transferred into the next local Cartesian coordinate system with its vertical axis pointing to the center of Earth. Thus the curved Earth's surface is approximated piece by piece by flat segments with limited horizontal extension (Figure 0.1 right).

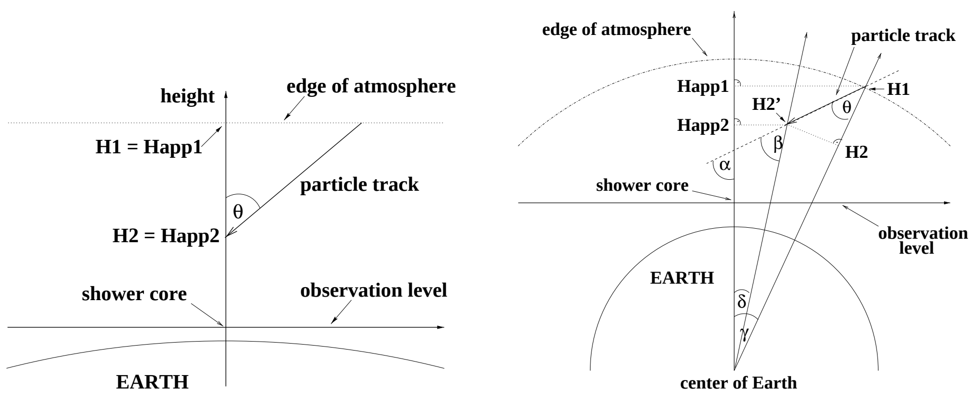

Abbildung 0.1: Left: CORSIKA geometry in the standard version. Right: Scheme of the new treatment of particles in the modified CORSIKA version. Heights and zenith angles: H1, H2, θ in the first local frame; H2', β in the next local frame; Happ1, Happ2, α in the 'detector frame'.

When transferring the coordinates into the next local flat system, the atmospheric thickness makes a jump due to the treatment in a local flat atmosphere. To keep this jump negligible (Δthickness/thickness $< 1\%$ and Δthickness $<$ 0.5 g/cm^2) a thickness dependent horizontal step size limitation is introduced.

Thus the step size limit varies exponentially between 20 km at the top of the atmosphere and 6 km at sea level. A similar treatment has been described by [Sc98] (see also [He99]). Additionally to the modified particle transport the Cherenkov photon tracks are corrected due to the atmospheric refraction using precalculated tables gained by numerical integration.

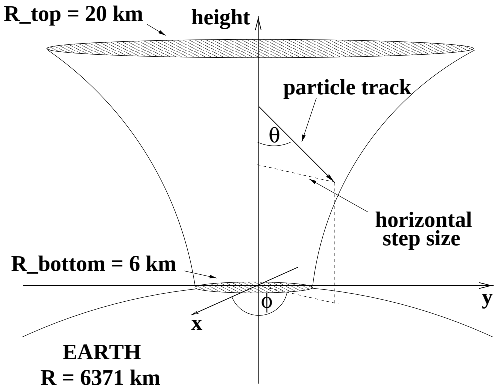

Abbildung 0.2: Condition for defining a local plane Cartesian coordinate system.

Literaturverzeichnis

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[Sc98] Sciutto, S., Auger technical note GAP-98-032 (1998)