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Oscillation tomography study of Earth's composition and density with atmospheric neutrinos

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Knowledge of the Earth's interior composition is highly relevant to many geophysical and geochemical problems. Neutrino oscillations are modified in a non-trivial way by the effects of matter. They can provide valuable and unique information not only on the density but also on the chemical and isotopic composition of the deep regions of the planet. In this paper, we re-examine the possibility of performing an oscillation tomography of the Earth with atmospheric neutrinos and antineutrinos to obtain information on the composition and density of the outer core and the mantle, complementary to that obtained by geophysical methods. Particular attention is paid to the D'' layer just above the core-mantle boundary and to the water (hydrogen) content in the mantle transition zone. Our analysis is based on a Monte-Carlo simulation of the energy and azimuthal angle distribution of μ-like events generated by neutrinos. Taking as reference a model of the Earth consisting of 55 concentric layers with constant densities determined from the PREM, we evaluate the effect on the number of events due to changes in the composition and density of the outer core and the mantle. The variations are implemented so that the constraint imposed by the Earth's total mass and its moment of inertia are verified.

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