Analysis of Electric field spatial variability in simulations of electromagnetic waves exposure to mobile telephony base stations

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Numerical simulation is now widely used for modeling of exposure to electromagnetic fields in urban areas, especially in the case of mobile telephony base stations exposure. This is due to the ever-increasing power of computation tools and to the quantity and the quality of available topographic data. The results of such simulations have more and more weight as they allow consultation between the public, mobile telephony companies, associations and local communities. They also help to define regulatory methods and are a support to public decision. Nevertheless the high spatial variability of electric field both on a local (around a given exposure point) and a global (in a whole urban area) point of view demands a complete scientific body of work on the presentation of results. Characterizing spatial variability is a major challenge in order to find better indicators of electromagnetic waves exposure.

In this paper we first focus on local spatial variability in three different areas of exposure (*cf.* figure 1), depending on emitting and receiving antennas positions, identified on a purely geometric criterion during ray-tracing computation.

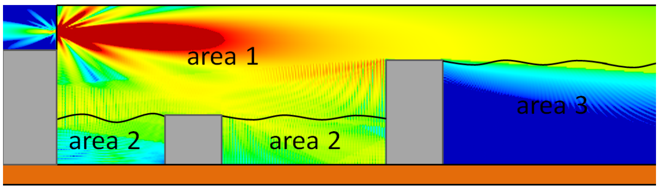

Figure 1: Illustration of the three characteristics areas

Area 1, 2 and 3 correspond respectively to locations where exists the direct path, reflected paths without the direct path and diffracted paths without direct or reflected paths. We need to understand how the electric field varies in each of these areas and at which distance this variation becomes significant. We will answer to these questions using spatial autocorrelation analysis with Moran's index (A.D Cliff and J.K Ord, "Spatial Autocorrelation", 1973, Londres, Pion). We will show that the spatial dependency of the electric field in direct (Area 1) and reflected (Area 2) areas lies within a sphere of 4λ radius. Whether for diffracted area (Area 3) the dependency is larger, and all electric field values of receivers are very close.

Then we will analyze the overall behavior of the electric field in a whole urban area by trying to identify statistical laws that effectively accounts for this behavior in the three different areas of exposure. This analysis will be performed on several representative French cities. Electric field is computed 1.5m above the ground and on frontages of buildings. The global exposure is studied by computing the cumulative density function (CDF) of electric field according to each emitter and each of the characteristic exposure areas (full environment, areas 1, 2 and 3). Technologies taken into account are GSM900, GSM1800 and UMTS. We will show in the full paper that the overall behavior of electric field enforces the Generalized Extreme Value law, whatever the exposure area and the city are. Furthermore the parameters of the laws are rather similar according to each city, for ground and frontages exposure.