# Organ specific averaged SAR for the central nervous system

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The organ or tissue specific averaged SAR ($SAR_{osa}$) provides information about the localization of the absorption of electromagnetic fields. The $SAR_{osa}$ is thus an important quantity for epidemiological research and radio frequency (RF) safety studies. It has already been assessed during mobile phone usage [1, 2] and near base station antennas [3]. In reality multiple sources are present in a varying environment. These realistic environments should normally be studied using a large number of time-consuming finite-difference time-domain (FDTD) simulations. A fast method to determine $SAR_{osa}$ in realistic far-field environments based on a small number of FDTD simulations has been demonstrated at 950 MHz [4] for the virtual family boy (vfb) [5]. This method is now expanded to higher frequencies in order to study the frequency dependence of $SAR_{osa}$ and cumulative exposure.

In a realistic electromagnetic environment the exposure is generally complex and multiple frequencies are present. Every realistic far-field electromagnetic environment is characterized by statistical parameters that describe the probability for a certain exposure scenario to occur [6]. The proposed method is based upon a set of electric fields inside a phantom's organs induced by incident plane-waves. These fields are determined using finite-difference time-domain simulations. An algorithm uses this set of fields to approximate realistic exposure scenarios accurately and thus determine the $SAR_{osa}$ in realistic environments. The method is demonstrated for the vfb, with the dielectric properties of its tissues obtained from the Gabriel database [7]. The tissues under consideration are those of the vfb's central nervous system, under both single and multiple frequency exposure.

The $SAR_{osa}$ is accurately (relative errors < 2 %) determined for any far-field exposure condition. There is a dependence of $SAR_{osa}$ on the studied tissue and the considered environment. More variation exists between different organs in the same environment (there can be up to 10 dB difference between the $SAR_{osa}$ of different brain regions) than between the $SAR_{osa}$ values of one organ in different environments (relative differences < 30 %). The $SAR_{osa}$ values are on average smaller at higher frequencies, since the penetration depth of RF radiation decreases at higher frequencies. The outer tissues of the phantom can on average have higher $SAR_{osa}$ values.

The $SAR_{osa}$ can be determined accurately in realistic environments using the proposed method. There is a dependence of the $SAR_{osa}$ on the frequency and the environment. Differences in $SAR_{osa}$ also exist between the different tissues.

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