SIMPLIFIED APPROACHES TO RADIATIVE TRANSFER SIMULATIONS IN LASER-INDUCED HYPERTHERMIA OF SUPERFICIAL TUMORS

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ABSTRACT. A promising approach to the treatment of superficial human cancer is laser induced hyperthermia. A correct choice of the parameters used for the treatment planning should be based on modeling of both radiative transfer and transient heating of human tissues which will allow to predict the thermal conversions in the tumor. In this paper, we focus on the radiative transfer modeling which should be as simple as possible to be implemented in the combined heat transfer model. In general, the well-known $P1$ approximation is known to be sufficiently accurate in calculations of the absorbed radiation power distribution. At the same time, the error of this approximation may increase in the case of external irradiation, and thus needs to be examined by the comparison with the direct Monte Carlo simulation. The computational study with realistic geometrical and optical parameters of the problem undertaken in this work showed that the P1 approximation considerably underestimates the intense absorption near the body surface in comparison with the direct Monte Carlo solution. At the same time, it has been shown that a 1-D solution for radiative transfer can be used as a valid approach due to intense scattering of radiation by tissues. As a result, the modified two-flux approximation is recommended as a component of the multidimensional combined heat transfer model for soft thermal treatment of superficial tumors.