NUMERICAL ERROR ESTIMATION IN FINITE VOLUME METHOD FOR RADIATIVE TRANSFER EQUATION FOR COLLIMATED IRRADIATION

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ABSTRACT. Collimated irradiance takes part as paramount importance in numerous engineering applications such as a source of primary energy input in solar energy applications - the radiation source is none but the collimated beams, optical measurement systems, significant in astrophysics and atmospheric science, remote sensing, laser manufacturing and many more. An improved understanding of collimated irradiance may result in improved system performance in the respective fields. The radiation energy transfer in a direction is governed by radiation transfer equation (RTE) which is a integro-differential equation. Many techniques have been developed to solve RTE, but mostly applicable for the diffuse radiation. However, only a few can be used for the collimated radiation with some limitations. Monte-Carlo ray tracing method-a statistical method, is being widely used to tackle the collimated problems. The statistical methods has its own advantages/disadvantages. Nevertheless, some continuum methods suitably adjusted to tackle the collimated beam radiation problem. The finite volume method for RTE (fvRTE) is advantageous as it offers flexibility in angular discretization and calculating the directional weights. The numerical methods like FVM, FDM, FEM always have some numerical errors due to discretization schemes, techniques, algorithms etc, and sometimes methods itself has some constraints to handle the particular problem. These problems could be systematically removed by clear understanding of the source of errors. In the present study, the numerical fvRTE has been modified to tackle the collimated irradiance problems. The errors arises due to methods and numerical techniques by fvDOM for collimated beam radiation have been evaluated by two test cases-two and three-dimensional enclosures. Each enclosure has a semitransparent window and a collimated beam irradiance is applied on the window in a certain direction. The walls and the medium inside the enclosure are cold (0K), the other walls except the semitransparent window are opaque and medium is non participating. The beam's target point of strike and profile improve with the increase of the angular/spatial discretization and numerical schemes.

References:

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