

Modelling of Radiative Heat Transfer in Modelica with a Mobile Solar Radiation Model and a View Factor Model

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This paper presents a model to estimate the solar radiation under clear sky conditions over stationary surfaces like building façades or parked automobiles, moving surfaces like vehicles following a predefined path, as well as flying surfaces like aircraft during climb, cruise and descent. For the latter it is important to predict the peak solar irradiance under clear sky condition to calculate maximum possible solar thermal loading. Solar heating can contribute significantly to thermal loads of an aircraft, especially when flying at high altitudes. Solar radiation affects e.g. aircraft cockpits directly through the windshield and cabins through windows. Heat dissipated by internal heat sources and heating by direct solar radiation has an adverse effect on thermal comfort of passengers, cabin crew and pilots which requires considerable amount of cooling air in the cabin and in the cockpit. In this paper results of irradiation over surface on ground and over aircraft windows and windshields at cruise altitude are presented.

Another model implemented, calculates the view factor between two or more surfaces. Determination of the long-wave radiant heat exchange between two or more surfaces or heat exchange with a surface itself requires a view factor matrix. There are several analytical solutions available to calculate view factors for simple and known configurations. Many building simulation programs estimate the view factors in a simplified way, especially when complex geometries are involved. The simplified approach may result in high errors of surface temperatures, which can further cause error in energy balance and estimation of comfort level. The purpose of creating this model is to calculate view factors between complex geometries. The view factor matrices of an enclosed space and of a geometry with openings on its surfaces are presented in this paper. A sensitivity analysis of a view factor matrix is also presented.