Geophysical Research Abstracts
Vol. 14, EGU2012-9512, 2012
EGU General Assembly 2012
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A Montecarlo routine to simulate scattering in particulate media

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Analytic solutions of the radiative transfer equations are widely used as they are easy to handle and give a clear physical picture of the scattering processes at work. However they rely on some assumptions and approximations that are not always satisfied. For example, one of the major limitations in the analytic approach is in the treatment of multiple scattering, which can be performed in closed form only in the case of simple single particle phase function laws (Hapke,2002).
In real cases the single particle phase function can have complex formulations. For example in media whose "effective particles" are indeed aggregates of smaller grains (like the planetary rings) the photometric behavior of the single aggregate is the result of the single and multiple scattering processes (and of additional mechanisms like the opposition effect) in the regolith covering the surface. In this case the interaction of light between the aggregates, in particular for high albedo materials where inter-particle scattering is relevant, can be properly described only applying numerical methods.
Starting from these considerations, we have realized a simple Montecarlo routine (written in IDL language) with the aim to simulate the scattering in particulate media for any given formulation of the single particle phase function, in the limit of the geometric optics.
Preliminary tests performed to check the accuracy of the code, from the physical and computational point of view, are shown and discussed. In particular, using our routine, we have computed the transmission factor, the diffusive radiance and the average scattering number for a slab of isotropic scatterers and compared our results to theoretical calculations.
Simulations of remote sensing observations are performed with the purpose to retrieve the bidirectional reflectance of the medium. Moreover we have investigated the dependence of spectral signatures on the geometry of the observations, comparing the results with the analysis of real measurements obtained from space missions and laboratory activity.
This work is supported by an Italian Space Agency (ASI) grant.