

# **HABITABLE ZONES WITHIN SEDIMENT BEDS: A RADIATIVE TRANSFER MODELING APPROACH.** T. E. Murphy and L. Prufert-Bebout, NASA Ames Research Center (thomas.e.murphy@nasa.gov).

**Abstract:** Inhabited and uninhabited sediment beds – for example sand, soil, clay, microbial mats, and extraterrestrial regolith – have spectrally dependent radiative properties which significantly alter the spectrum of the incident irradiance over depths of millimeters to centimeters within those mineral or mineral-microbe matrices. In many cases these subsurface environments can provide habitable zones below a surface exposed to irradiances that are hostile (for example with respect to ultraviolet flux) [1,2]. Several studies have reported experimental measurement of light attenuation as a function of wavelength in sediments [3,4]. Most of these studies report attenuation coefficients of scalar irradiance, which is the radiance integrated over all directions and is of primary importance to microbes [5]. However, these studies have been limited to examine a rather narrow range of experimental parameters, namely, beam incidence angle, beam geometry, and particle size, shape, spacing, and mineral type. Relatively few studies have focused on modeling radiative transport in these environments, which can aid in answering a wide variety of questions. For example, due to logistics challenges, attenuation of scalar irradiance has often been experimentally measured under a normally incident, collimated beam [6,7]. How does the depth of and spectrum within the photic zone change when the incident light is instead a combination of a solar beam with a time dependent incidence angle and diffuse irradiation from a blue sky?

This talk will introduce a radiative transfer model for use in sediment beds defined by the user-specified particle complex index of refraction, size, shape, and spacing. A methodology will be described whereby the model can be used to identify zones within sediments that are enriched in light in wavebands in the ultraviolet, visible, and infrared regions, in an effort to aid the search for micro-habitable zones beneath the surface. In combination with eco-physiological information on various sediment inhabiting micro-organisms (absorption and action spectra, motility and growth rates) predictive distribution scenarios for various terrestrial environments can be produced and tested. Such a model would also be adaptable for use with incident radiation and sediment data for Mars or other Earth-like planets.

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