Characterisation of the UV environment of the Beagle 2 landing site

Conference or Workshop Item

CHARACTERISATION OF THE UV ENVIRONMENT OF THE BEAGLE 2 LANDING SITE M.R. Patel and J.C. Zarnecki, Planetary and Space Sciences Research Institute, The Open University, Walton Hall, Milton Keynes, MK7 6AA, UK (m.r.patel@open.ac.uk).

Introduction: Presented here is an analysis of the UV environmental conditions expected for the Beagle 2 landing site throughout the mission lifetime. Beagle 2 is an exobiology orientated mission, looking for signs of past life at or near the martian surface through an array of geochemical instrumentation. It will reach the surface of Mars on 26th December 2003, and begin its nominal 180 sol mission. Forming part of the Environmental Sensor Suite (ESS) to monitor the local meteorological environment is a UV sensor designed to monitor the previously unmeasured ultraviolet flux (200-400nm) at the martian surface [1]. The sensor will monitor bands of specific interest at intervals within this range centered at 210, 230, 250, 300 and 350nm, as well as the full 200-400nm flux. For the first time, in situ measurements of the surface flux and its variation with time will be available for study, helping to quantify the possibility of survival of organics and possible micro-organisms at or near the martian surface. To aid in the interpretation of this data upon arrival, the UV environment throughout the mission lifetime for a variety of events has been modeled.

Model Description: A model employing a two stream delta-Eddington approximation [2] for radiative transfer is used to calculate the UV surface flux between 200-400nm through the dust laden martian atmosphere, described further in [3]. Fluxes are calculated in terms of both direct and diffuse components. Model input constraints (pressure, latitude, time of day, areocentric longitude and reference optical depth) are set by the mission parameters. The Beagle 2 landing site is in the Isidis basin located at 10^{o}N, with touch down expected to occur at an areocentric longitude (L_s) of 322^{o} (northern mid-winter) continuing through to $L_s = 53^{o}$ (northern mid-spring). The model accounts for absorption and scattering of solar UV by relevant martian atmospheric gases, as well as interaction with suspended dust particles.

Results: The nominal UV spectrum expected after landing is shown in Figure 1 for a local time of midday. The optical depth of the suspended dust background haze is taken as 0.5, consistent with typical values for this season observed by Viking 1 and 2 [4]. The flux curve shows the characteristic 200nm cut off formed by the large CO_2 abundance seen in all modeled martian UV spectra, while the background dust haze has the effect of partially attenuating the input solar UV flux. Also investigated was the diurnal variation in direct, diffuse and total flux. As intuitively expected, the peak irradiation occurs at local noon and diffuse flux dominates close to sunrise and sunset due to the large airmass effects involved at high zenith angles.

The variation of midday flux throughout the mission lifetime is also investigated. Flux levels are seen to gradually decrease towards the end of the mission, ascribed to the orbital progress to aphelion.

The possibility of a dust storm occurring during the mission is low to moderate. The mission begins as Mars is passing out of its period of high dust activity when global dust storms can occur. Such storms can reach optical depths in excess of 3 [4], and should therefore be considered when addressing mission data. These storms have the effect of attenuating significantly the direct flux, increasing the relative contribution from the diffuse component. These results are shown in Figure 2, for a local storm of optical depth 2.

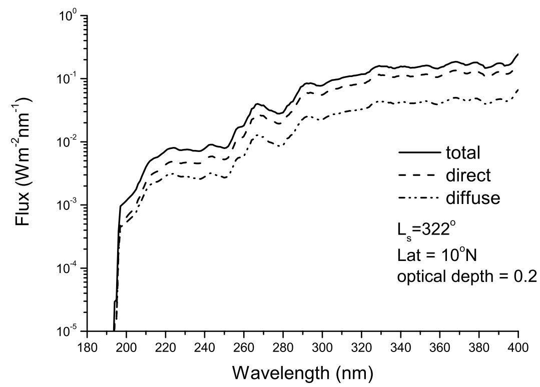

Figure 1

The effect of transient phenomena such as dust

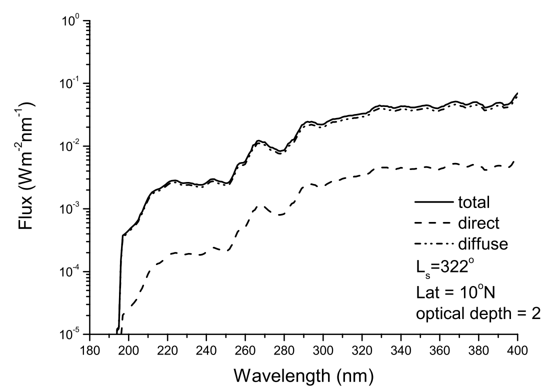

Figure 1

devil passage across the probe during the mission will also have a noticeable effect. These vortical columns of air contain appreciable amounts of dust, and passage of these columns through the line of sight of the sensor will result in a short term highly localized modification of the UV flux. The presence of such phenomena can be simulated by assuming a step-wise increase in optical depth (related to the dust loading of the dust devil in question) during transit time. The same effect as in Figure 2 but on a much shorter timescale is thus observed.

All spectra can then be interpreted from a biological viewpoint via the application of biological weighting factors to the flux values as a function of wavelength. The resulting spectra show that the UV environment of the Beagle 2 landing site will be extremely damaging to micro-organisms due to the significant presence of UV-C (<285nm) radiation. Significant protection is offered by the presence of dust in the atmosphere (i.e. any local or global dust storms) which reduce the flux levels significantly.

References: [1] Towner et al., 31st Lunar and Planetary Science Conference, March 13-17, Houston, Texas, abstract no. 1028. [2] Joseph, J.H. et al (1976) *J. Atmos. Sci., 33,* 2452-2459. [3] Patel, M.R. et al. (2002) *Plan. Space. Sci.*, submitted. [4] Pollack et al., (1979) *J. Geo. Res.*, 82 (28), 4479-4496.