Life and the solar UV environment on early Earth

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Studies of the solar UV environment on Earth 2.0 Gyr to 3.8 Gyr ago suggest that the terrestrial atmosphere was essentially anoxic, resulting in an ozone column abundance insufficient for protecting the planetary surface in the UV-B (280 nm - 315 nm) and the UV-C (200 nm - 280 nm) ranges. Since, short wavelength solar UV radiation in the UV-B and UV-C range penetrated through the atmosphere to the unprotected early Earth's surface, associated biological consequences may be expected. We discuss experimental data obtained as follows: Radiation sources applied were low pressure Mercury lamp and Xenon 2 kW lamp, the wavelength were adjusted by interference filters (200BP10, 210BP10, 220BP10, 230BP10, 240BP10, 250BP10, 260BP10, 270BP10, 280BP10, 290BP10, 300BP10, 310BP10, 320BP10) and the irradiances were measured by OL754 spectroradiometer. The photo-reverse effect depends highly on the wavelength of the exposed radiation. Shorter wavelength UV radiation of about 200 nm is strongly effective in monomerization, while the longer wavelengths prefer the dimerisation. In case of polychromatic light, like in space or on a planetary surface which is unprotected by an ozone layer the two processes run parallel. We could demonstrate experimentally, for the case of a uracil thin-layer that the photo-reaction process of the nucleotides can be both dimerization and the reverse process: monomerization. These results are important for the study of solar UV effects on organisms in the early terrestrial environment as well as for the search for life on Mars since we can show that biological harmful effects can also be reduced by shorter wavelength UV radiation, which is of importance in reducing DNA damages provoked by wavelengths longer than about 240 nm. Our earlier results showed that dimerization of the pyrimidin base uracil can be described by a first order kinetics, and this reaction gives the possibility to determine the dose of the UV source applied. This work is a theoretical and experimental approach to the relevant parameters of the first order kinetics.