Photosynthetically Active Radiation (PAR) Attenuation in the Atmosphere in North China

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Integrated observations of solar radiation and meteorological parameters at 4 stations in North China from September 2004 to October 2006 show that PAR and global radiation (Q) were influenced by water vapor and aerosol scattering factors. From these measurements, an empirical model of hourly PAR under all sky conditions for North China was developed. The annual average PAR at the Earth's surface in North China attenuated by the water vapor factor and its ratio to PAR were 7.99 Wm^{-2} and 4.24%, and PAR at the Earth's surface attenuated by the scattering factor and its ratio to PAR at the Earth's surface were 172.36 Wm^{-2} and 95.76%. PAR losses influenced by water vapor and scattering in the atmosphere are 15.33, 309.30 Wm^{-2} in North China, respectively. This energy loss displayed seasonal variations and regional differences. Sensitivity tests shows that PAR displayed different responses to different changing rates of the water vapor factor and the scattering factor; PAR is more sensitive to the change of the scattering factor than that of the water vapor factor. The relation of the water vapor factor and PAR indicated a close relation with water, the sum of direct absorption and indirect consumption (in the reactions of chemistry and photochemistry through hydroxyl radicals, including homogeneous and heterogeneous processes) and by various substances (including gases, liquid and solids) in the atmosphere. PAR at the top of the atmosphere was calculated by an empirical model, its error was -3.5%. The consumed energy in the atmosphere is related to water or water vapor and is not fully recognized at present, but, it influences almost all basic processes in the atmosphere, such as radiation transmission, atmospheric chemistry and photochemistry, biological process on the earth, local climate and global climate change. As such, it should be paid more attention in future studies, including laboratory, field experiments and models.

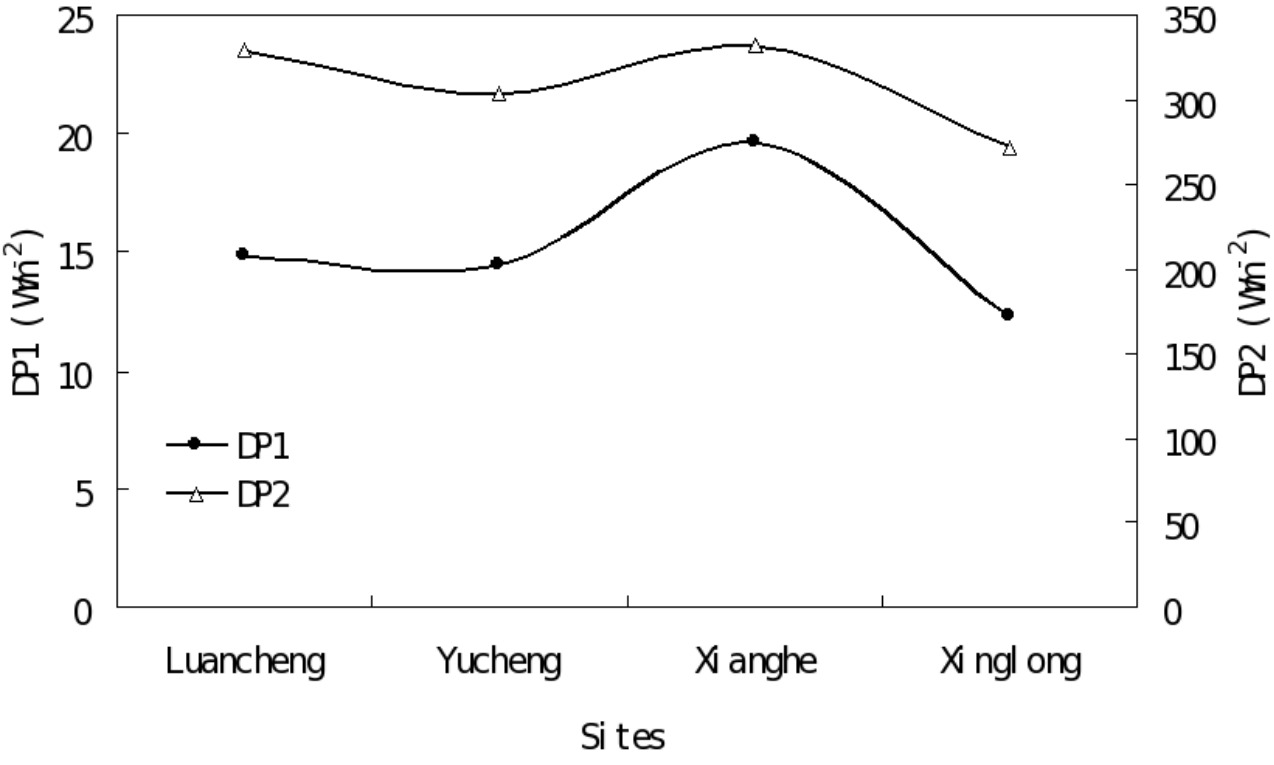

Figure 1. PAR losses in the atmosphere caused by the water vapor factor (DP1) and the scattering factor (DP2), respectively.