

Effect of Aerosol on Photosynthetically Active Radiation

Panyawut Viriyathananont¹, Boossarasiri Thana¹ and Akkaneewut Chabangborn^{1*}

¹Department of Geology, Faculty of Science, Chulalongkorn University, Bangkok 10330, Thailand
*e-mail: akkane@geo.sc.chula.ac.th

Abstract

The effects of aerosol on radiation which plants use for photosynthesis or Photosynthetically Active Radiation (PAR) have been investigated. PAR, part of short-wave radiation (SR) with 400-700 nm in wavelengths is measured by a photosynthetically active radiometer (model MFR-7). The quantity of aerosols in atmosphere is measured as Aerosol Optical Depth (AOD). In addition, data of Light Intensity (LI) are collected for analysis with PAR and AOD. The instrument used in aerosol measurement is a sky-radiometer (POM-I). The solar radiation is measured by pyranometer. PAR, AOD and pyranometer data (May 2003 – April 2004) at Observatory for Atmospheric Radiation Research, Amphoe Sri Samrong, Sukhothai Province have been collected. PAR parameters are total, diffuse and direct which were observed during sunrise. Data were then analyzed by a spread sheet program.

Keywords: Photosynthetically Active Radiation (PAR); Aerosol Optical Depth (AOD); Light Intensity (LI), Aerosol

1. Introduction

Sunlight that travels through space and shines on the Earth is termed solar radiation (0.3-2.8 μm). Radiation is the emission and transmission of energy through space or through a material medium. Radiation includes an infinite array of radiowave, microwave, infrared, visible-light, ultraviolet, X-ray, and gamma-ray emissions. The un-attenuated path of radiation to the Earth's surface is called transmission or shortwave radiation (SR). The Earth's atmosphere will affect the solar radiation at various wavelengths. As solar radiation travels through our atmosphere, it can be absorbed, scattered, or reflected. The solar radiation reaches the Earth's surface by direct transmission as well as indirect transmission from scattering by particulates. Radiation that is not absorbed or scattered in the atmosphere will interact with the Earth's surface. The SR has a part of wavelength which plants use for photosynthesis that is known as Photosynthetically Active Radiation (PAR). Therefore we can say that PAR is a part of SR. This project investigates Photosynthetically Active Radiation or PAR

which has wavelengths between 0.4 and 0.7 μm (Dye, 2007). The analysis uses Aerosol Optical Depth (AOD) in finding correlation between PAR and aerosol. The instrument used for aerosol measurement is a skyradiometer (POM-I) and solar radiation is measured by pyranometer. PAR is measured by photosynthetically active radiometer (model MFR-7).

2. Experimental Results and Discussion

Data are calculated into hourly, daily and monthly averages and are classified by sky conditions (clear or cloudy condition). Hourly averages of total PAR radiation (Total PAR, Diffuse PAR and Direct PAR are components of PAR radiation) are shown in Figure 1 (clear condition). PAR radiation data are plotted every five days for classified sky conditions. Cloudy sky condition is indicated if one of the components of PAR radiation is not bell shaped; otherwise it indicates a clear condition. PAR distribution in a day shows that the quantity of PAR radiation slowly increases until noon (maximum radiation peak is about noon) after which it slowly decreases until sunset (bell shaped). Figure 2 shows AOD, classified by index values (case clean or case pollutes). AOD

index higher than 0.2 is chosen as a polluted indicate aerosols that reduce quantity of PAR decrease. From the selected data, both clean air and polluted air cases cover only three months each. The missing or cloudy condition data are rejected. The selected ratio between PAR and global radiation (from pyranometer) are shown in Table 1. In addition all data are used in hypothesis testing (by test parameter method of the probability theory) for checking values that agree or disagree. Final results of the experiment indicate that aerosols have effects on PAR radiation.

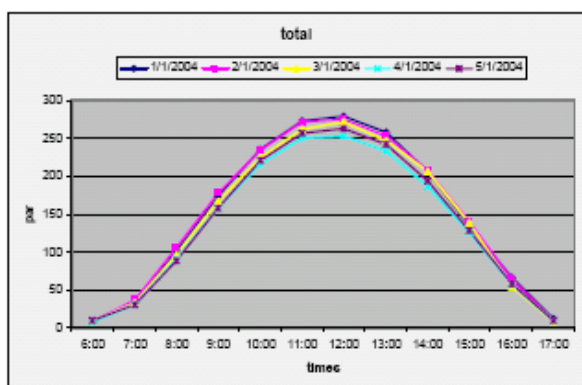


Figure 1: Hourly average of Total PAR during 1-5 January, 2004

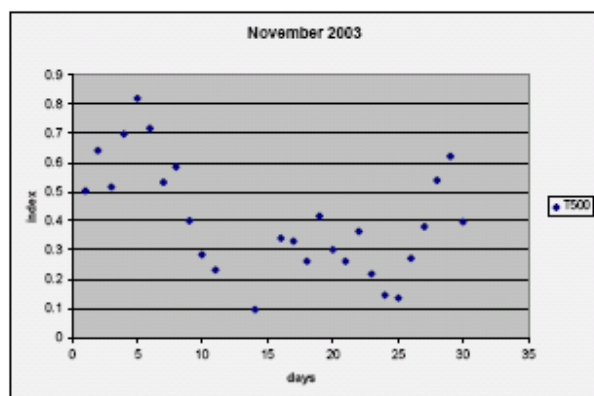


Figure 2: Index of AOD (T500) in November 2003

Table 1: Ratio of clean PAR / clean pyranometer and pollute PAR / pollute pyranometer

Ratio	clean PAR / clean pyranometer			pollute PAR / pollute pyranometer		
	Total	Diffuse	Direct	Total	Diffuse	Direct
November 03	0.33	0.85	0.18	-	-	-
January 04	-	-	-	0.30	0.62	0.13
March 04	-	-	-	0.29	0.41	0.19

3. Conclusions

Aerosols have effects on Photosynthetically Active Radiation (PAR). The PAR is reduced by about three percent in the polluted conditions.

Acknowledgement

The data on PAR, AOD and pyranometer (May 2003 – April 2004) was obtained at the Observatory for Atmospheric Radiation Research, Amphoe Sri Samrong, Sukhothai Province under collaboration between Geology Department and CCSR/University of Tokyo.

References

Dye, D.G., 2007, MODIS based strategy for global monitoring of photosynthetically active radiation to support ecosystem modeling. 3rd MODIS Workshop on Monitoring and Modeling of Environment and Disaster in Asia January 15-16.