Do you still use the constant ratio of PAR to solar radiation for global studies?

*Tomoko Akitsu[1], Kenlo Nishida Nasahara[1], Atsushi Kume[2], Yasuo Hirose[3], Osamu Ijima[4], Kentaro Takagi[5], Reiko Ide[3]

1. University of Tsukuba, 2. Kyusyu University, 3. National Institute for Environmental Studies, 4. Japan Meteorological Agency, 5. Hokkaido University

Photosynthetically active radiation (PAR) is an essential source to drive photosynthesis. Therefore, PAR datasets are required to predict gross primary production (GPP) of ecosystem. In particular, global studies of plant productivity and carbon cycle require global wall-to-wall long-term datasets of PAR. However, such datasets to satisfy the requirements for the global studies are seldom available. Accordingly, in such global studies, PAR has been generally estimated using solar radiation (SR) datasets and the constant ratio of PAR to SR, which is around 0.45.

However, the ratio is not constant. In fact, many researchers have indicated that the observed ratio depends on the site, season, local time, and weather conditions. Nevertheless, the ratio remains incompletely understood as to how it depends on climatic factors. Accordingly, a general estimation model for the ratio of PAR to SR had not been well established.

Thus, the objective of our research is to establish a simple and general estimation model for the ratio of PAR to SR. To establish such a model, accurate measurements of both PAR and SR are needed. SR was measured by the direct and diffuse separation method. This method has been recommended for its accurate measurement by *WCRP/WMO* [1986]. PAR was measured using spectroradiometers and by a direct and diffuse separation method. Because it is well known that quantum sensors commonly used for PAR measurement have problems such as cosine errors, spectral errors, and the lack of a standard absolute PAR value. Our PAR measurement system could minimize such errors [*Akitsu et al.*, 2015].

Using the accurately measured data, we made the simple estimation model using water vapor pressure. The model was validated at specific sites in Japan. Furthermore, the monthly and annual global estimation was conducted using ERA-interim daily dewpoint temperature. On a global scale, the ratio has regional variability. Moreover, it has seasonal and annual variability. If this variable ratio was adopted for the global studies of plant productivity and carbon cycle, existing estimations of GPP might change within 15% of GPP.

Keywords: Photosynthetically active radiation, Ratio of PAR to solar radiation, Simple estimation model, Accurate PAR measurement

