Relation of in situ Hyper-Spectral Radiometer Data with Phenomena Observed by Other Variables – Comparison of *in situ* data with MODIS images –

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1. Progress summary

In the one of activities in ABL team in YRiS (Hiyama et al., 2005), we installed in-situ type hyper-spectral radiometers in Changwu station, located on Loess Plateau, China. Observation started since May 2004, good quality of dataset was collected. We summarized the preliminary results derived from hyper-spectral radiometers and related variables as follows:

a. Seasonal variation in spectral radiance over the winter wheat represented well the seasonality of wheat phenology (stages of growth, mature, emergence, tillering and the end of wintering). In particular, red position moving to shorter wavelength (so-called blue shift of red edge) detected both years of 2005 and of 2006. Such phonological reaction of the winter wheat corresponded well the seasonality of NEP by eddy covariance variables.

b. Based on the time series of hyper-spectral radiometer's data, space-borne optical sensor's (e.g., NOAA/AVHRR, EOS/MODIS, Landsat/TM, ETM+) spectral reflectance could be simulated. We simulated each space-borne sensor's spectral reflectance and NDVI for the validation of NDVI obtained from different sensors. Intercomparisons of several NDVI did not show the significant differences based on spectral difference of each sensor, except AVHRR based NDVI (under-estimation compared with other NDVI). These results indicated that, at least NDVI based, observation wavelength differences among space-borne sensors are not critical than the effects of observation time (pre-noon or after-noon) and of bi-directional reflectance function, etc.

2. Comparison with MODIS

Based on previous our analysis, we focus on the spectral characteristics of MODIS. Usually, channels with spatial resolution of 250m and 500m (same as Landsat/ETM+) were used for the terrestrial studies (red lines in Fig. 1, blue, green, red and near-IR). MODIS is also sensible (more channels) in visible and near-IR wavelength (green lines in Fig. 1) with 1-km resolution for the target of ocean color and aerosol detection studies.

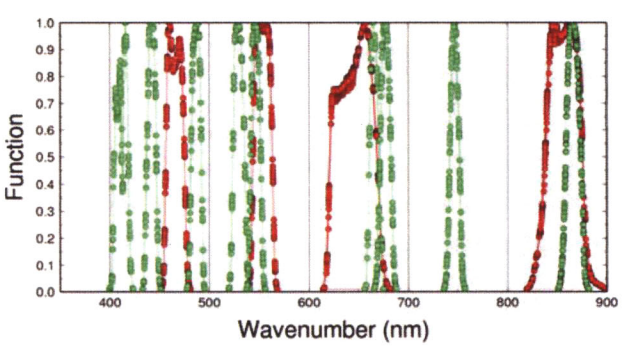

Fig.1 Weighting functions of Terra/MODIS in the wavelength of 350 – 900 nm. Red lines represent 250 & 500m res. Channels, green's are 1km res. Ch.

We simulated MODIS channels account for the weighting function of each channel from in situ

hyper-spectral data. Figure 2 shows seasonal variation in simulated MODIS Ch.13 (red1, 658 – 674 nm, a blue line), Ch. 14 (red2, 668 – 685 nm, a green line) and Ch.15 (near-IR, 739 – 754 nm, a red line) in 2005. Ch. 15's line in Fig. 2 had a peak around DOY120, decreased slightly until DOY150. However spectral radiance in Ch.15 was almost same during DOY150 to DOY 180.On the other hand, seasonal variation in Ch.13 and Ch. 14 (red) behaved quite similarly. To pay an attention of small difference in these two channels, Ch.14's value was slightly higher than that of Ch.13 during DOY150 to DOY180. Such small difference within the wavelength of red represents the phase change of winter wheat's phenology (blue shift of red edge). If MODIS's 1-km channel (Ch. 13 & 14) detectors measure correctly not only over the ocean also over the land, difference between Ch.13 and Ch.14 derived from in situ measurement is detectable (max. 7 W m^{-2} $microm^{-1}$). Thus we checked MODIS images during DOY150 to DOY160, particularly focus on 1-km resolution channels. Figure 3 shows examples of MODIS image including Changwu station (represented as star symbol). In the case of Ch. 8 (blue, 403 – 422 nm), images ware reflected day to day variance well (high spectral radiance captured clouds). Unfortunately, Ch.13's images (target channel) had almost same values over the whole of each image (both DOY153 and DOY158). Such responses imply that Ch.13 in MODIS could not capture the state of nature over the land. 1-km's red channels in MODIS specialized for monitoring ocean color, thus dynamic ranges in red are too narrow than that in other wavelength.

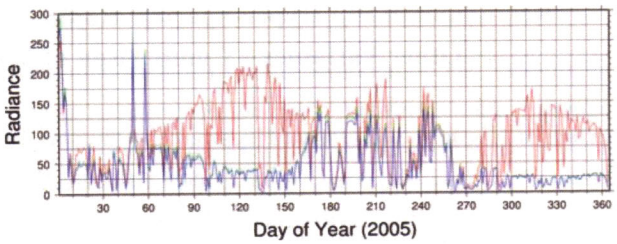

Fig. 2 Seasonal variation in estimated radiance of Terra/MODIS Ch.13 (blue line), Ch.14 (green line) and Ch. 15 (red line), derived from *in situ* hyper-spectral radiometer

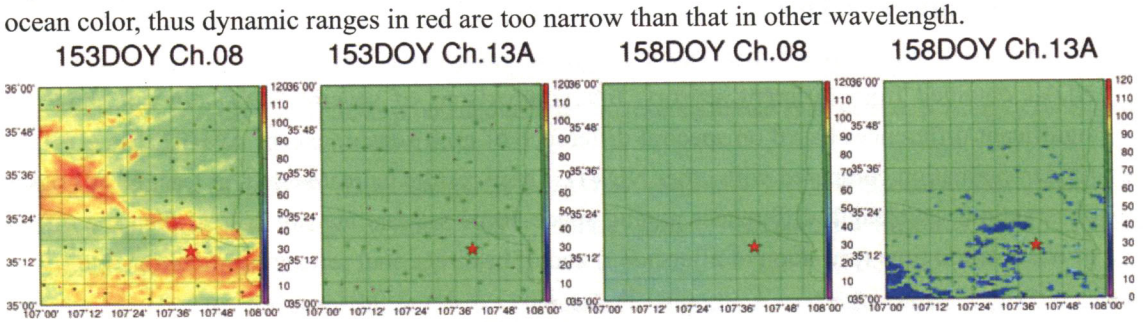

Fig. 3 Examples of Terra/MODIS images in Ch.08 (blue), Ch.13A (red) over Changwu station (marked red star symbol).

3. Concluding Remarks

Under the current situation, unfortunately, difference within red wavelength can not apply the space-borne sensor's study. In addition, next operational polar orbit satellites (NPOESS) plan only one channel will sensible within red. However, on the research objective bases, possibility of fine spectral observation on the visible wavelength are still remained. We need more efforts to recognize the efficiency of red channels by the accumulations of ground-based studies.

References

Hiyama, T., A. Takahashi, A. Higuchi, M. Nishikawa, W. Li, Y. Fukushima (2005): Atmospheric boundary layer (ABL) observations on the "Changwu Agro-Ecological Experimental Station" over the Loess Plateau, China, AsiaFlux Newsletter, No.16, 5-9.