Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

AHW027-19 Room:202 Time:May 23 14:45-15:00

A decade of studies at Mase paddy flux site: how long is long enough?

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It is the thirteenth year since the tower-flux measurement started at a rice paddy field in Mase, Tsukuba, Japan (Mase paddy flux site) in July 1999, and it is the tenth year since the organized system of long-term measurement got ready to work in 2002 after repeated trial and error at the beginning stage. Since lifetime of monitoring sites in agricultural fields in Asia is generally short as summarized by AsiaFlux (Mizoguchi et al., 2009), the decadal observation at the Mase site is probably longer than average. What is the significance of the long-term measurement in a rice paddy, where, unlike forest or grassland site, transplanting and harvesting are regularly repeated every year? This is the question always casted on us and also we ourselves are wondering to us. Sometimes the question has another form: how many years of observation is enough? The answer may depend on what we need, but I cannot find a good answer now. Here, I show some results on inter-annual variations of observed fluxes to discuss the issue.

At the Mase site, we are conducting the measurement placing the various instruments in a rice paddy, which was managed by the field owner who is a sideline farmer. We basically leave field management to the field owner. He cultivates Koshihikari, the most popular rice variety in Japan, and gets average crop yield in the prefecture. The coefficient of variation (CV) of crop yield in nine years from 2002 to 2010 was 7%, whereas the CV of the total solar radiation in the growing season was 9% and standard deviation of air temperature averaged over the growing season was 0.9 degree Centigrade. The CVs of the total net ecosystem CO2 exchange (NEE) and evapotranspiration were both 10%. The CV of gross primary production (GPP) estimated from observed NEE was 5%, but it was reduced to only 2% if we exclude GPP in the 2004 growing season, which had extraordinarily large GPP under conditions of high temperature and plenty of solar radiation. The small inter-seasonal variation in GPP reflects stable Japanese rice production, which is supported by excellent cultivation practices and moderate climate conditions. Since we cannot find long-term trends in the fluxes above, a period of ten years seems to be sufficient for understanding the current state of the fluxes. However, some fluxes showed obvious changes in last 10 years. For instance, methane emission decreased from the 2006 growing season. This is presumably caused by the change of rice straw management: until 2004, rice straw was plowed into soil after harvest, but in and after 2005, rice straw was partially burnt in the field before plowing. A probable scenario is that the burning of rice straw reduced soil organic matters which were used for methanogenesis in early stage of the next growing season. So we are now analyzing how the change in rice straw management affected CO2 efflux in the fallow season. Agricultural fields are strongly affected by human impacts through field management. Changes in field management as well as increase in temperature and CO2 concentration will affect CO2 flux and evapotranspiration. A 10-year period is not sufficient to detect those influences by field observation, but we may have another approach. We have recently decided to spend time to think about it by minimizing observation at the Mase site.

Keywords: flux, rice paddy, carbon dioxide, methane, evapotranspiration, AsiaFlux