Estimating weekly CO2 flux and light use efficiency of ecosystems from clear-days MODIS imagery

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Most polar orbiting Earth observing satellites provide, at best, a single daily snapshot of vegetation and, at worst, these snapshots may be separated by periods of many days when the ground was obscured by cloud cover. Since vegetation carbon exchange can be very dynamic on diurnal and day-to-day timescales, the limited temporal resolution of satellite data is a potential limitation in the use of these data to estimate integrated CO_2 exchange between vegetation and the atmosphere. Our objective in this study was to determine whether consistent relationships exist between midday carbon flux on clear days and daily or weekly mean values. CO_2 flux data were obtained from 8 sites, covering a wide range of vegetation types, which are part of the AmeriFlux system. We found that midday gross CO_2 exchange was highly correlated with both daily and weekly mean gross CO_2 exchange and these relationships were consistent across all the vegetation types. In addition, it did not make any difference whether the midday data were derived from the AM or PM satellite overpass times, indicating that midday depression of photosynthesis was not a significant factor in these relationships. Inclusion of cloudy days in the weekly means also did not affect the relationships relative to single clear days. Although there was a relationship between photosynthetic rates and photosynthetically active radiation (PAR) for half hour flux data, this relationship tended to saturate at PAR values less than half of full sun and for many of the sites the relationship between daily total photosynthesis and PAR was very weak. Consequently, cloudy conditions had less effect on daily gross CO_2 exchange than would have been expected. Conversely, the saturation of photosynthesis at moderate PAR values resulted in considerable variation in light use efficiency (LUE). LUE was higher for daily and weekly means than it was at midday on clear days and the correlation between midday and weekly mean LUE was relatively weak. Using a recently developed model for relating LUE with MODIS ocean-color band reflectance images and the above mentioned relationship between midday and weekly CO_2 exchange, we produced maps of weekly gross CO_2 fluxes for the 8 ecosystems we studied.