Geophysical Research Abstracts, Vol. 7, 06576, 2005 SRef-ID: 1607-7962/gra/EGU05-A-06576 © European Geosciences Union 2005



## Gross primary productivity in grasslands better correlates with NDVI than net $\mathbf{CO}_2$ flux

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Tower CO<sub>2</sub>-flux measurements (Fc) in grassland ecosystems in North America and Europe belonging to AgriFlux, AmeriFlux, and GreenGrass networks representing environmental gradient from northern mixed prairies and dry steppes to tallgrass prairies were partitioned into gross primary productivity (Pg) and ecosystem respiration (Re) components using the light-response functions method (Gilmanov et al., 2003a,b, 2004, 2005). Analysis of the relationships between these CO<sub>2</sub>-flux components aggregated for corresponding time intervals (8, 10 or 16 days) and remotely sensed composites of the Normalized Difference Vegetation Index (NDVI) from MODIS 8day, SPOT-VEGETATION 10-day, or MODIS 16-day data sets in most cases demonstrated statistically significant higher correlation between gross primary productivity and NDVI than between net daytime CO<sub>2</sub> flux and NDVI (Table 1).

Table 1.  $\mathbb{R}^2$  values of the statistical relationships between gross primary productivity (Pg), net daytime CO<sub>2</sub> flux total (Fc), and the normalized difference vegetation index (NDVI) for various grassland ecosystems.

Site, ecosystem	Pg	Fc	_Time step (days)
Bugacpuszta, Hungary, dry steppe	0.88	0.86	16
Lethbridge, Alberta, Canada	0.65	0.45_	10
northern mixed shortgrass prairie			
Fort Peck, Montana, USA	0.46	0.05	10
northern mixed prairie			
Miles City, Montana, USA	0.77	0.20	10
northern mixed prairie			
Mandan, North Dakota, USA, mixed prairie_	0.73	0.53_	10
Cheyenne, Wyoming, USA, mixed prairie	0.62	0.45_	10
Little Washita, Oklahoma, USA	0.95	0.89_	10
grazed mixed/tallgrass prairie			
Brookings, South Dakota, USA	0.87	0.73_	8
pasture in northern tallgrass prairie			
Rannels Ranch, Kansas, USA	0.84	0.71_	10
ungrazed tallgrass prairie			
Walnut River, Kansas, USA	0.93	0.89_	10
grazed tallgrass prairie			
Shidler, Oklahoma, USA	0.80	0.71	10
ungrazed tallgrass prairie			
Temple, Texas, USA	0.66	0.68_	10
ungrazed tallgrass prairie			

Incorporation of additional factors-predictors (photosynthetically active radiation, precipitation, soil moisture, ...) leads to further increase of the predictive power of multivariate equations Pg(NDVI,  $X_1, X_2, ..., X_m$ ), Re(NDVI,  $Y_1, Y_2, ..., Y_n$ ) relating gross primary productivity and ecosystem respiration to NDVI and other variables, indicating possibilities to scale-up tower-based CO<sub>2</sub> fluxes to other ecologically similar territories (Wylie et al., 2003, 2004; Gilmanov et al., 2005).

Results of the study demonstrate that partitioning of the original net  $CO_2$  exchange data directly provided by tower flux measurements into gross primary productivity and ecosystem respiration components is an important step in data analysis and synthesis leading to construction of predictive models for scaling-up tower-based  $CO_2$  fluxes.

## References

Gilmanov, T.G., Johnson, D.A., Saliendra, N.Z. (2003a). Growing season  $CO_2$  fluxes in a sagebrush-steppe ecosystem in Idaho: Bowen ratio/energy balance measurements and modeling. *Basic & Applied Ecology*, **4**, 167-183.

Gilmanov, T.G., Johnson, D.A., Saliendra, N.Z., Akshalov, K., Wylie, B.K. (2004). Gross primary productivity of the true steppe in Central Asia in relation to NDVI. *Environmental Management*, vol. 33, Supplement 1, pp. S492-S508 (DOI: 10.1007/s00267-003-9157-7).

Gilmanov, T.G., Tieszen, L.L., Wylie, B.K., Flanagan, L. B., Frank, A.B., Haferkamp, M.R., Meyers, T.P., Morgan, J.A. (2005). Integration of CO<sub>2</sub> flux and remotely sensed data for primary production and ecosystem respiration analyses in the Northern Great Plains: Potential for quantitative spatial extrapolation. *Global Ecology and Biogeography* (in press).

Gilmanov, T.G., Verma, S.B., Sims, P.L., Meyers, T.P., Bradford, J.A., Burba, G.G., Suyker, A.E. (2003b). Gross primary production and light response parameters of four Southern Plains ecosystems estimated using long-term CO<sub>2</sub>-flux tower measurements - art. no. 1071. *Global Biogeochemical Cycles*, 17(2), art. No. 1071, doi: 10.1029/2002GB002023, 2003.

Wylie, B.K., Gilmanov, T.G., Johnson, D.A., Saliendra, N.Z., Akshalov, K., Tieszen, L.L., Reed, B.C., Laca, E. (2004). Intra-Seasonal Mapping of CO<sub>2</sub> Flux in Rangelands of Northern Kazakhstan at One-Kilometer Resolution. *Environmental Management*, vol. 33, Supplement 1, pp. S482-S491 (DOI: 10.1007/s00267-003-9156-8).

Wylie, B.K., Johnson, D.A., Laca, E., Saliendra, N.Z. Gilmanov, T.G., Reed, B.C., Tieszen, L. L., Worstell, B.B. (2003). Calibration of remotely sensed, coarse resolu-

tion NDVI to  $CO_2$  fluxes in a sagebrush-steppe ecosystem. *Remote Sensing of Environment*, **85**, 243-255.