CONTRIBUTIONS FROM A DECIDUOUS FOREST AND SHRUB WETLAND TO REGIONAL CARBON FLUXES IN NORTHERN WISCONSIN

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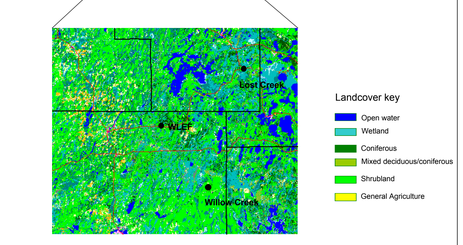
SUMMARY

Long-term observations of CO_2 exchange between terrestrial ecosystems and the atmosphere are currently being collected around the world using the eddy-covariance technique. Most of these studies, however, are limited to local-scale flux measurements within a single vegetation type. This study is unique because we have combined both stand-level and regional-scale eddy covariance measurements of CO_2 exchange within a localized area. We selected two distinctly different ecosystems, an upland deciduous forest and alder-willow wetland, which comprise a substantial portion of the landscape in the northern Great Lakes region and the area surrounding a 400 m eddy covariance tower near Park Falls, WI.

During the 2000 growing season, we found that the photosynthetic uptake of CO_2 for the region was substantially smaller and respiration slightly greater than the deciduous upland forest. Lower photosynthetic rates appear to be associated less productive areas such as shrub wetlands, and perhaps recently logged or thinned forests. There was not much variability in soil temperature among the sites, and lower respiration rates appeared to be associated with sites characterized by excessive soil moisture and elevated surface water. Differences in root growth and turnover, and disturbance caused by timber harvesting may also explain higher respiration in the region.

Stand-scale observations at this location demonstrate the wide range of variability that exists within the mosaic of ecosystems within the Great Lakes region. In this study, we observed annual ecosystem exchange (NEE) from an upland hardwood forest of -425 g C m^{-2} yr^{-1}, which was substantially less than 71 g C m^{-2} yr^{-1} for the region. In the future, we will continue to use these observations, our understanding of environmental processes controlling stand variability, and flux measurements contrasting re-growing, managed forests and old growth communities to upscale to regional observations.

FLUX TOWER SITES AND VEGETATION



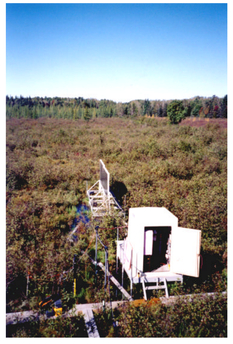
Forest Species at Flux Towers Sites

Species	WLEF	Willow Creek
	----- % of total basal area -----	
Trembling aspen	24	0
Balsam fir	13	0
Sugar maple	12	40
Red pine	12	0
Alder spp.	8	0
White cedar	8	0
Red maple	4	1
Tamarack	3	0
Basswood	3	36
Black spruce	2	0
White spruce	2	0
Paper birch	2	1
Yellow birch	1	< 1
Green ash	< 1	14
Red oak	< 1	7
Other spp.	< 6	< 1
	---------- m^2 ha^{-1} ----------	
Total basal area	18	28

REGIONAL OBSERVATIONS WLEF 450 m flux tower

STAND-SCALE FLUXES

Lost Creek Wetland
Alder-Willow-Sedge



Willow Creek Upland
Maple-Basswood-Ash

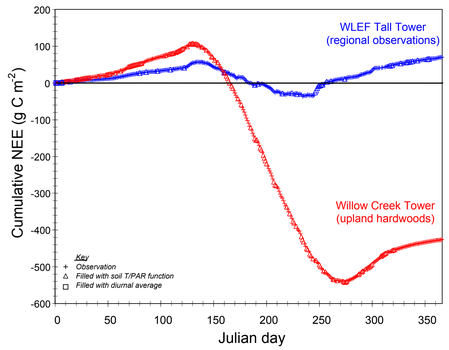
MICROMET STATIONS

Alder Wetland
Alder-Cedar-Sphagnum

Mixed Upland
Maple-Fir-Aspen

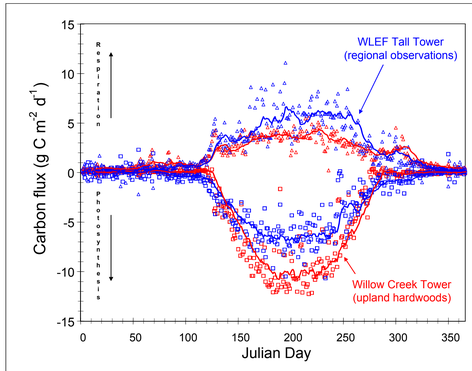
UPLAND FOREST CONTRIBUTION

WLEF and Willow Creek, 2000



Annual NEE observations:

- ***Region is a slight annual C source***
- ***Upland site is a large annual C sink***
- ***In winter, upland respiration rate is greater***

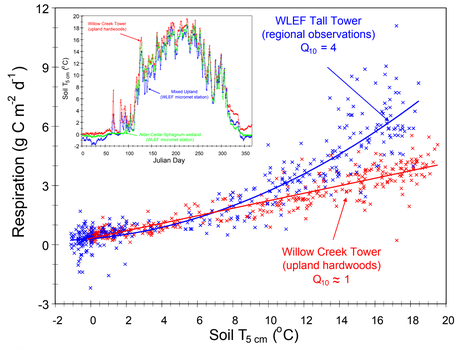


Apparent respiration/photosynthesis rates:

- ***Regional respiration is greater from May-Sept***
- ***Upland photosynthesis is substantially greater***

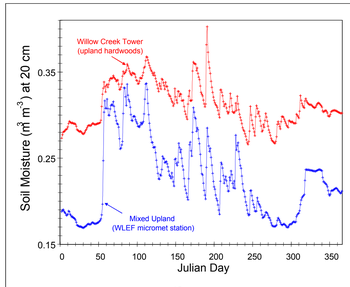
	Annual Carbon Flux (g C m^{-2} yr^{-1})	
	Willow Creek (upland hardwoods)	WLEF Tall Tower (regional observations)
Respiration	695	880
Photosynthesis	-1120	-809
Net Ecosystem Exchange	-425	71

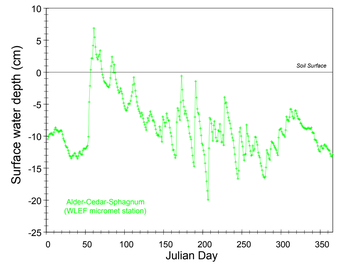
CONDITIONS CONTROLLING RESPIRATION



Soil temperature:

- ***Soil T variability between all sites was small***
- ***Regional respiration rates increased rapidly during the growing season***
- ***Respiration rates at Willow Creek were not stongly influenced by surface soil T***



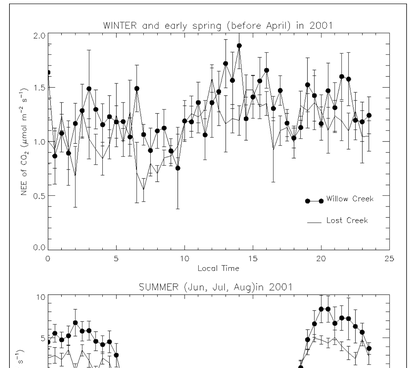


Soil moisture and surface water depth:

- ***Soil moisture retention was greater at Willow Creek than the upland site near WLEF***
- ***Soil moisture contents remained high all year at Willow Creek***
- ***Wetland surface water was lowest when both soil T and respiration were higher***

WETLAND vs. UPLAND FLUX

Lost Creek and Willow Creek, 2001



Wetland Fluxes:

- ***NEE during the winter was small and nearly identical at the sites***
- ***Nighttime NEE (respiration) rates were lower than the upland forest***
- ***Daytime NEE (photosynthesis) rates were lower than the upland forest***

FUTURE PLANS

To Resolve Scaling Issues

1) Additional field measurements:

- ***roving flux towers***
- ***additional soil measurements***

2) Analysis of WLEF observations:

- ***isolate distinct forest stands***
- ***compare respiration during drought periods***

3) Continue flux measurements to understand processes controlling stand-scale variability.

4) Contrast measurements from re-growing, managed forests and old growth communities.