Micrometeorological Measurements During the Transition of Perennial Biomass Feedstocks

Carl J Bernacchi, Andy VanLoocke, Mir Zaman Hussain, Marcelo Zeri
Carbon Cycle

Herbivory

Production (GPP)

VOC

Labile Organic C

Decomp

NPP

Ecosystem Respiration ($R_e$)

Heterotroph Respiration ($R_h$)

Plant Respiration ($R_a$)

DOC

Leaching

C STORAGE (NEP)
From B. Hungate
Life Cycle Analyses

Davis et al. (2009) Trends in Plant Science Vol.14 No.3
Climate Regulation

Anderson-Teixeira et al., Nature Climate Change DOI:10.1038/NCLIMATE1346
Climate Coupling

Fig. 1. Simulated time mean (APR–OCT) difference in (A) 2-m temperature [°C] (Perennials minus Annuals); (B) as (A) but perennial crop representation does not include albedo modification; (C) as (A) but perennial crop representation includes rooting depth of 2 m.

Georgescu et al., PNAS
Eddy Covariance
Eddy Covariance Data

Cumulative NEE (metric tons ha\(^{-1}\))

-0.25 -0.20 -0.15 -0.10 -0.05 0.00 0.05 0.10

Year


Corn Soy Corn Soy Corn Soy Corn Soy Corn Soy

Air flow can be imagined as a horizontal flow of numerous rotating eddies
Each eddy has 3D components, including a vertical wind component
The diagram looks chaotic but components can be measured from the tower
Interannual Variability: existing crops

Cumulative NEE (metric tons ha$^{-1}$)

Maize

Soybean

Day of Year
Net biome productivity: existing crops

Is the NBP positive or negative during establishment phase of growth?
How variable are fluxes of perennial grasses?
NWB = Precipitation - Evapotranspiration
Carbon fluxes during complete growing period in 2009-2011.
Carbon fluxes during July-Aug periods in 2008-2011
Net Ecosystem Carbon Balance: Establishment years
Water use efficiency

(a) NEP water use efficiency (ΣNEP/ΣTWU)

(b) Aboveground biomass water use efficiency (AGB/ΣTWU)

Maize/Soybean: grain only
Conclusions

• The perennial ecosystems are carbon sinks during transition

• The water and carbon dynamics differ between maize and perennials
  – Differences appear greater in response to stress events with perennial biofuels showing resistance to drought

• Biophysical components of these ecosystems differ
  – Differences are not limited to growing season length
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