ESTIMATING LAI FROM ONSITE MEASUREMENTS OF RADIATION at NOAA-GAPP Reference Sites

T.P. Meyers[1] and Tim Wilson

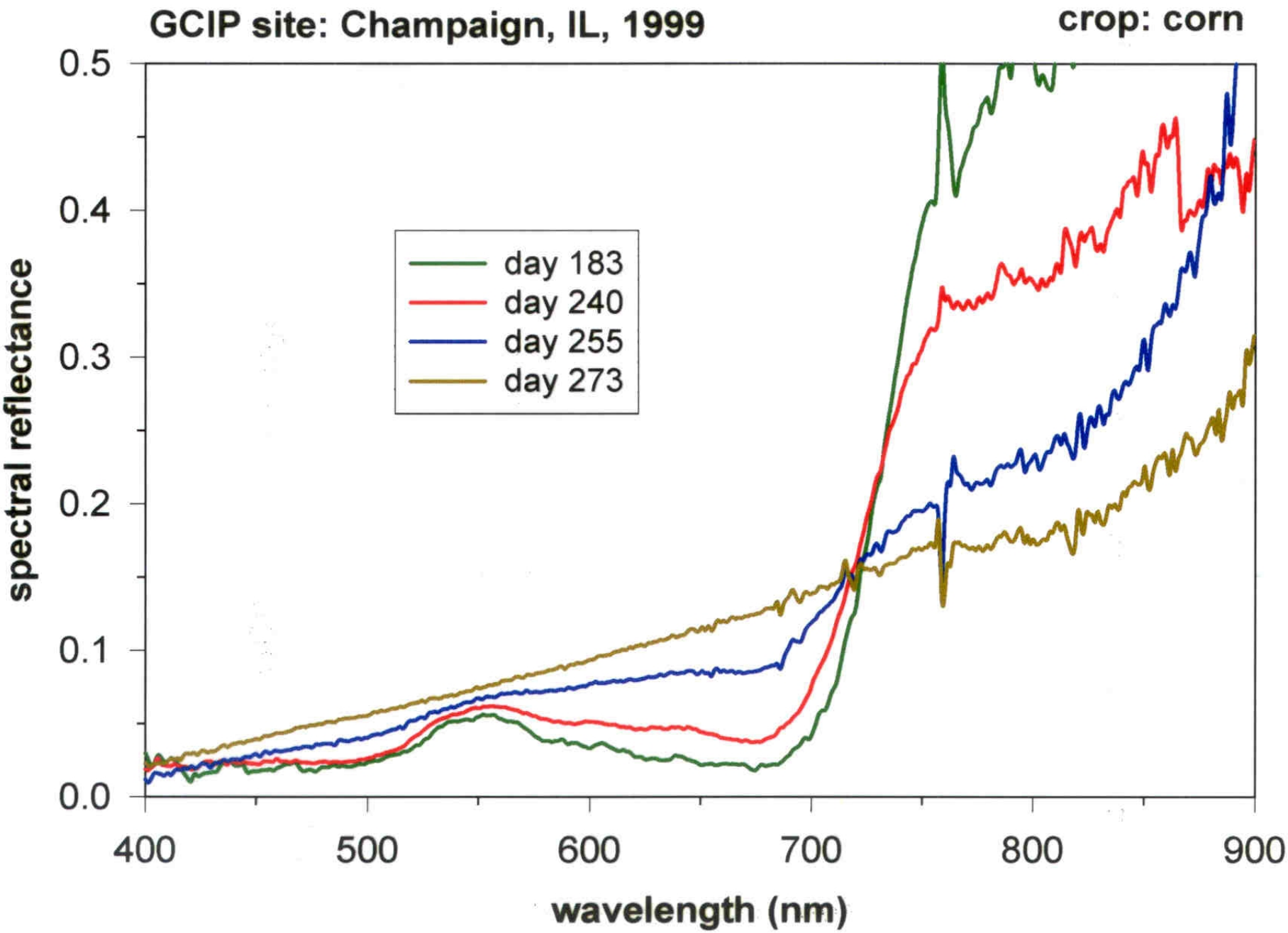
[1-]NOAA-ATDD

ORAU-Oak Ridge

OBJECTIVE

Use spectral signatures derived from radiation flux measurements to determine the seasonal variation of plant canopy cover needed to model site-specific energy and co_2 fluxes within soil-plant-atmosphere system in crops, grasses, and forests across the U.S.

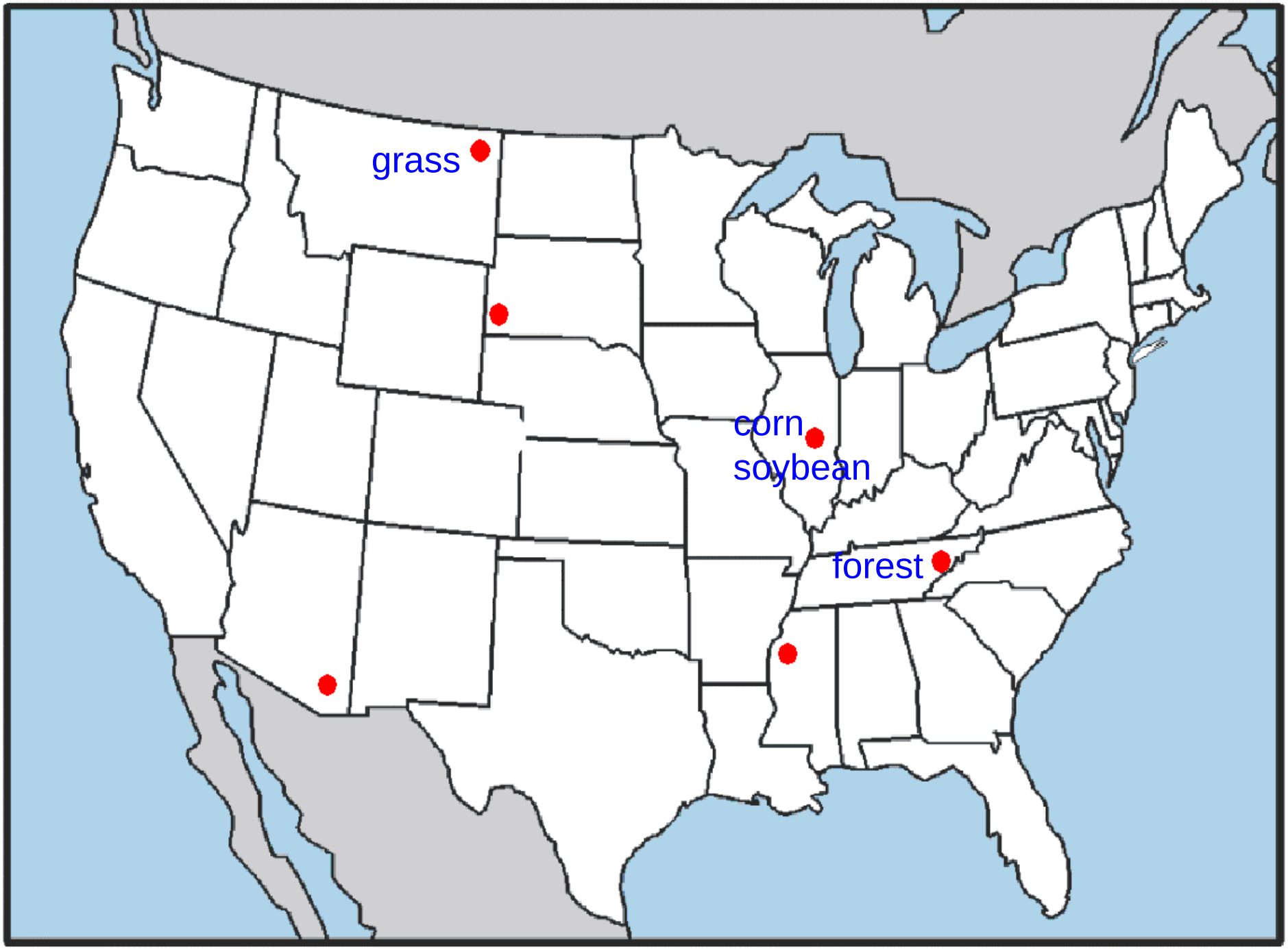
Calculate LAI as a linear function of NDVI derived from hourly measurements of PAR and global solar radiation.


GCIP site: Champaign, IL, 1999
crop: corn
spectral reflectance
0.5
0.4
0.3
0.2
0.1
0.0
day 183
day 240
day 255
day 273
400
500
600
700
800
900
wavelength (nm)

DATA SETS

Use LAI and radiation data measured at the NOAA-GEWEX monitoring sites: corn/soybean in Illinois, grass in Montana, and oak forest in Tennessee.

GEWEX Sites	Data
Corn/soybean, IL	LAI, PAR, Solar & NDVI
Grass, MT	PAR & Solar
Forest, TN	PAR & Solar


grass
corn
soybean
forest

ESTIMATING NDVI

$$NDVI = (r_n - r_v)/(r_n + r_v)$$

Where r_n – reflectance of near infrared

r_v – reflectance of visible

ESTIMATING r_v

$$r_v = PAR_{out}/PAR_{in}$$

Where PAR_{out} – outgoing PAR

PAR_{in} – incoming PAR

ESTIMATING r_n

$$r_n = NIR_{out}/NIR_{in}$$

Where NIR_{out} – outgoing near infrared

NIR_{in} – incoming near infrared

ESTIMATING NIR_{in} and NIR_{out}

$$NIR_{in} = 0.55RAD_{in}$$

$$NIR_{out} = RAD_{out} - r_{v*}(0.45RAD_{in})$$

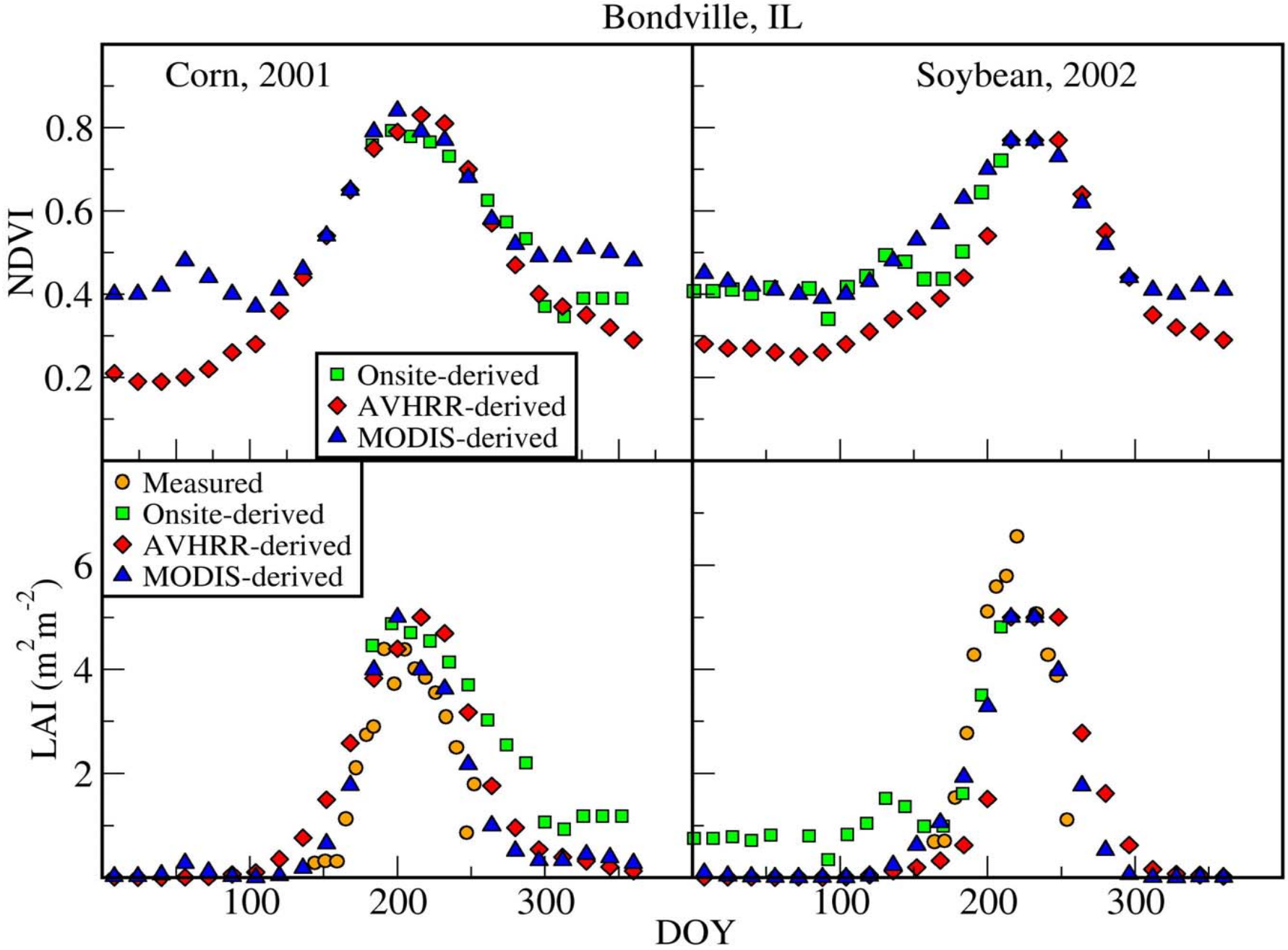
Where RAD – incoming & outgoing global solar

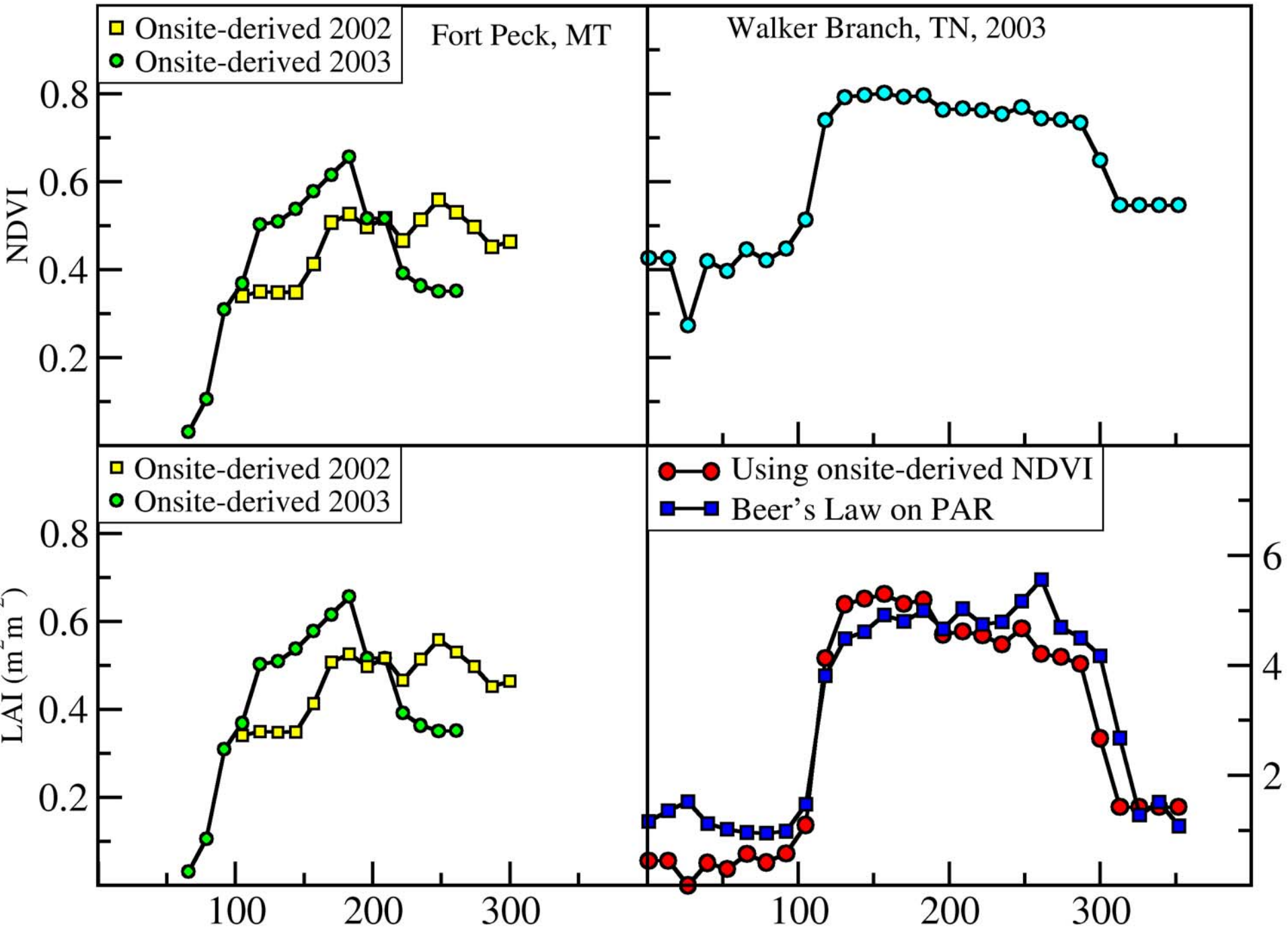
ESTIMATING LAI

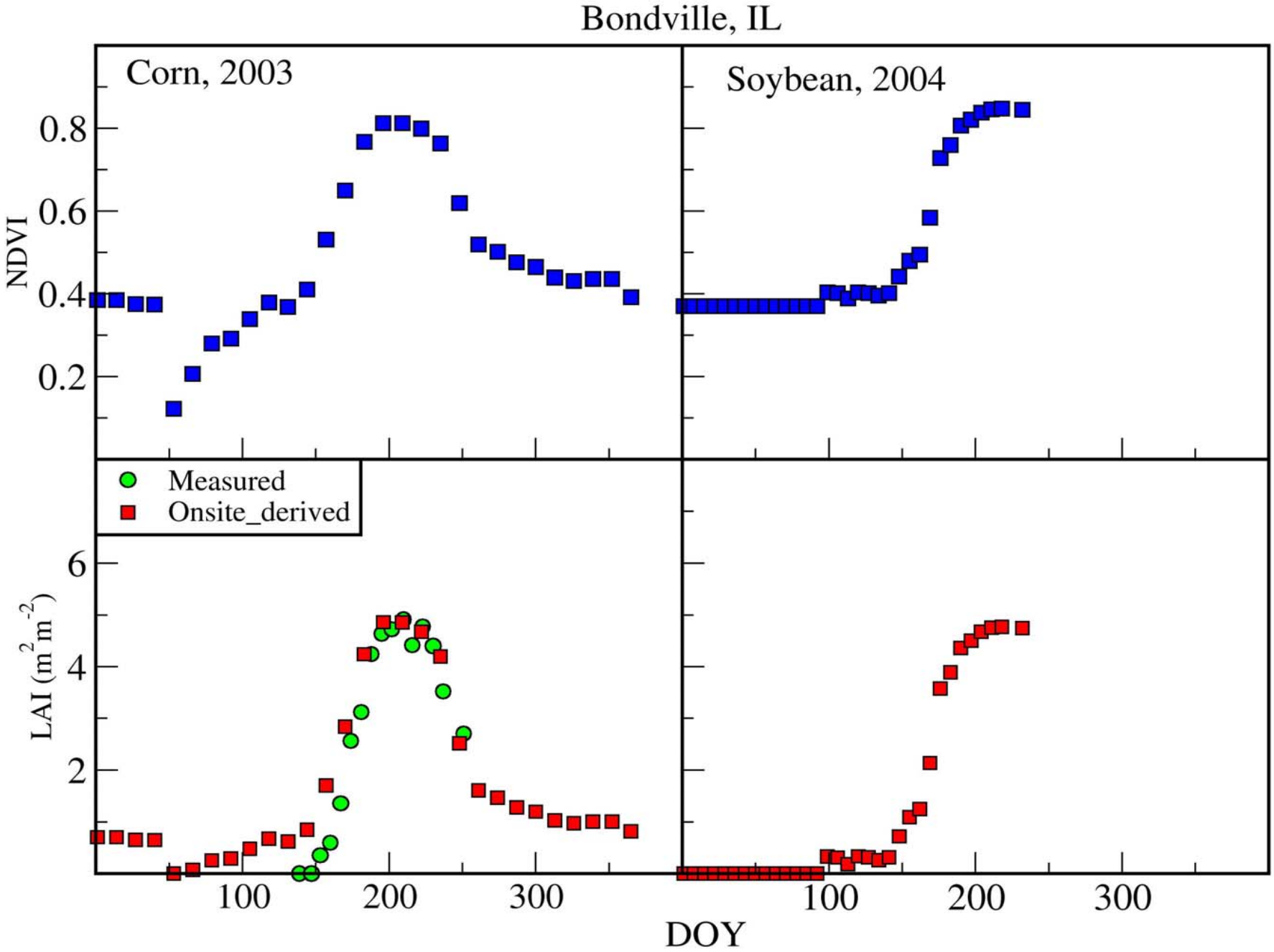
The value of LAI is estimated using linear function of NDVI as:

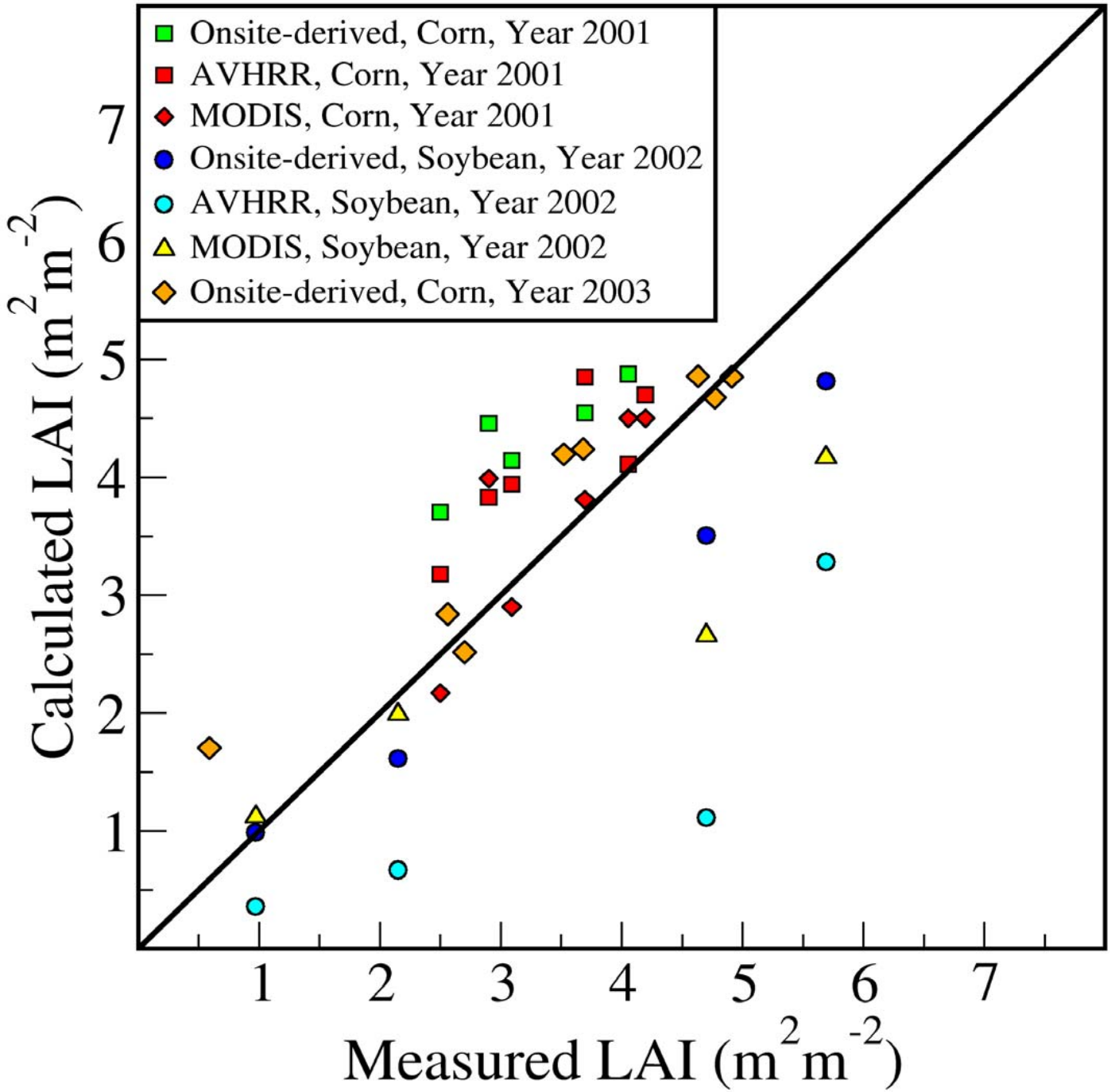
$$LAI = slope*(NDVI - NDVI_{min})$$

Where $NDVI_{min}$ is minimum NDVI for LAI = 0


Bondville, IL
Corn, 2001
Soybean, 2002
NDVI
0.8
0.6
0.4
0.2
Onsite-derived
AVHRR-derived
MODIS-derived
Measured
Onsite-derived
AVHRR-derived
MODIS-derived
LAI (m2m-2)
6
4
2
100
200
300
DOY


Onsite-derived 2002
Onsite-derived 2003
Fort Peck, MT
Walker Branch, TN, 2003
NDVI
0.8
0.6
0.4
0.2
Onsite-derived 2002
Onsite-derived 2003
Using onsite-derived NDVI
Beer's Law on PAR
LAI (m² m⁻²)
0.8
0.6
0.4
0.2
6
4
2
100
200
300
100
200
300


Bondville, IL
Corn, 2003
Soybean, 2004
NDVI
0.8
0.6
0.4
0.2
Measured
Onsite_derived
LAI (m^2 m^{-2})
6
4
2
100
200
300
DOY


Onsite-derived, Corn, Year 2001
AVHRR, Corn, Year 2001
MODIS, Corn, Year 2001
Onsite-derived, Soybean, Year 2002
AVHRR, Soybean, Year 2002
MODIS, Soybean, Year 2002
Onsite-derived, Corn, Year 2003
Calculated LAI (m2 m-2)
Measured LAI (m2 m-2)
1
2
3
4
5
6
7

CONCLUSIONS:

The suitability of NDVI derived from radiation flux measurements in estimating LAI is very encouraging considering that PAR and global solar radiation were the only inputs and LAI was not measured for all sites.

This initial result illustrates the importance of radiation interaction with the soil-canopy surface. However, quantifying LAI in terms of radiation measurements is limited, and we are only in the initial stages of using such approach to estimate LAI during the growing season. Our effort will have to include the integration of weather, physiological, and morphological factors of plant canopies that can be used as predictors for LAI.