Looking at Grassland Carbon Storage: How Can Remote Sensing Help?

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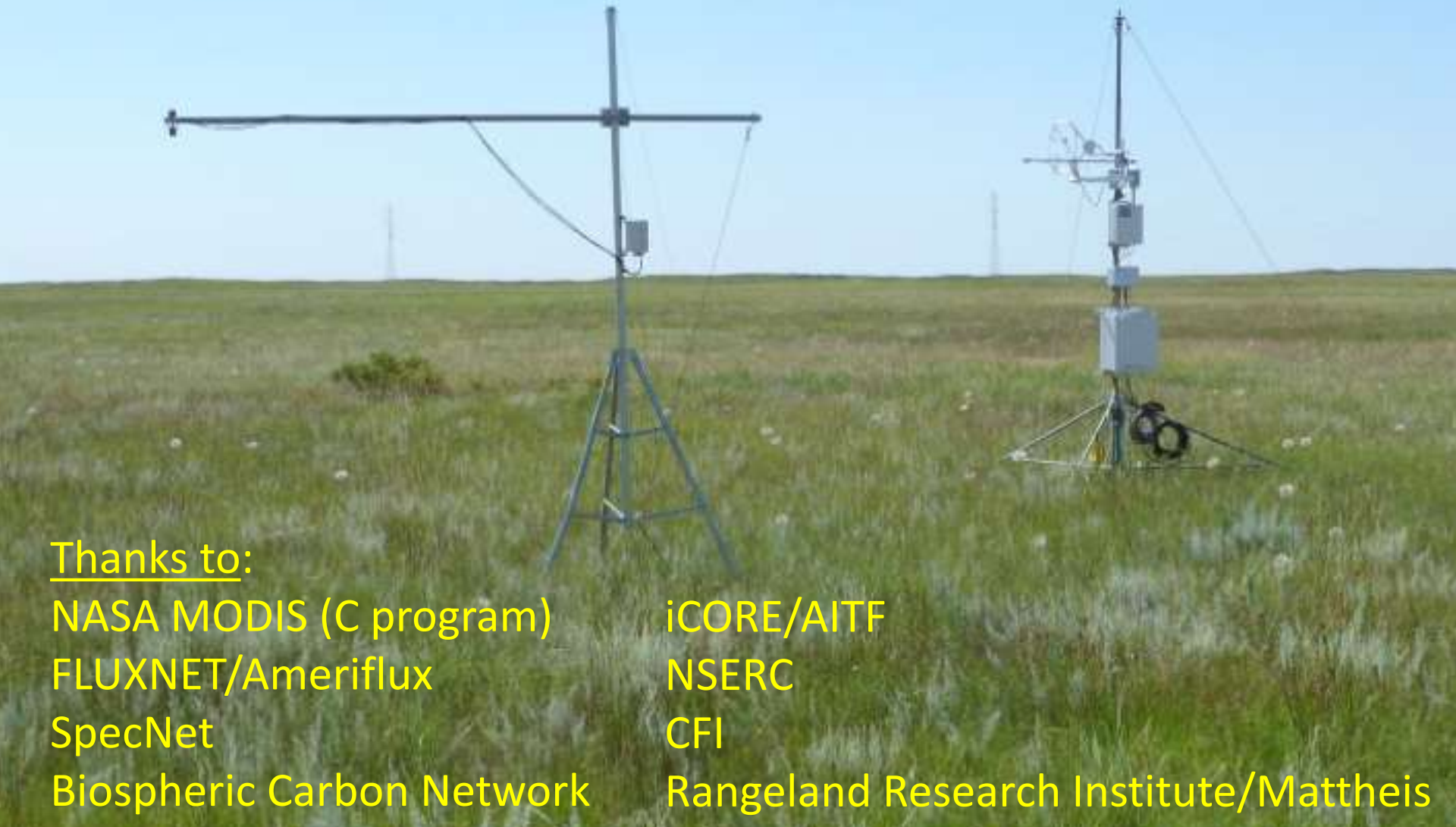


Thanks to:
NASA MODIS (C program)
FLUXNET/Ameriflux
SpecNet
Biospheric Carbon Network
iCORE/AITF
NSERC
CFI
Rangeland Research Institute/Mattheis

Carbon Sequestration

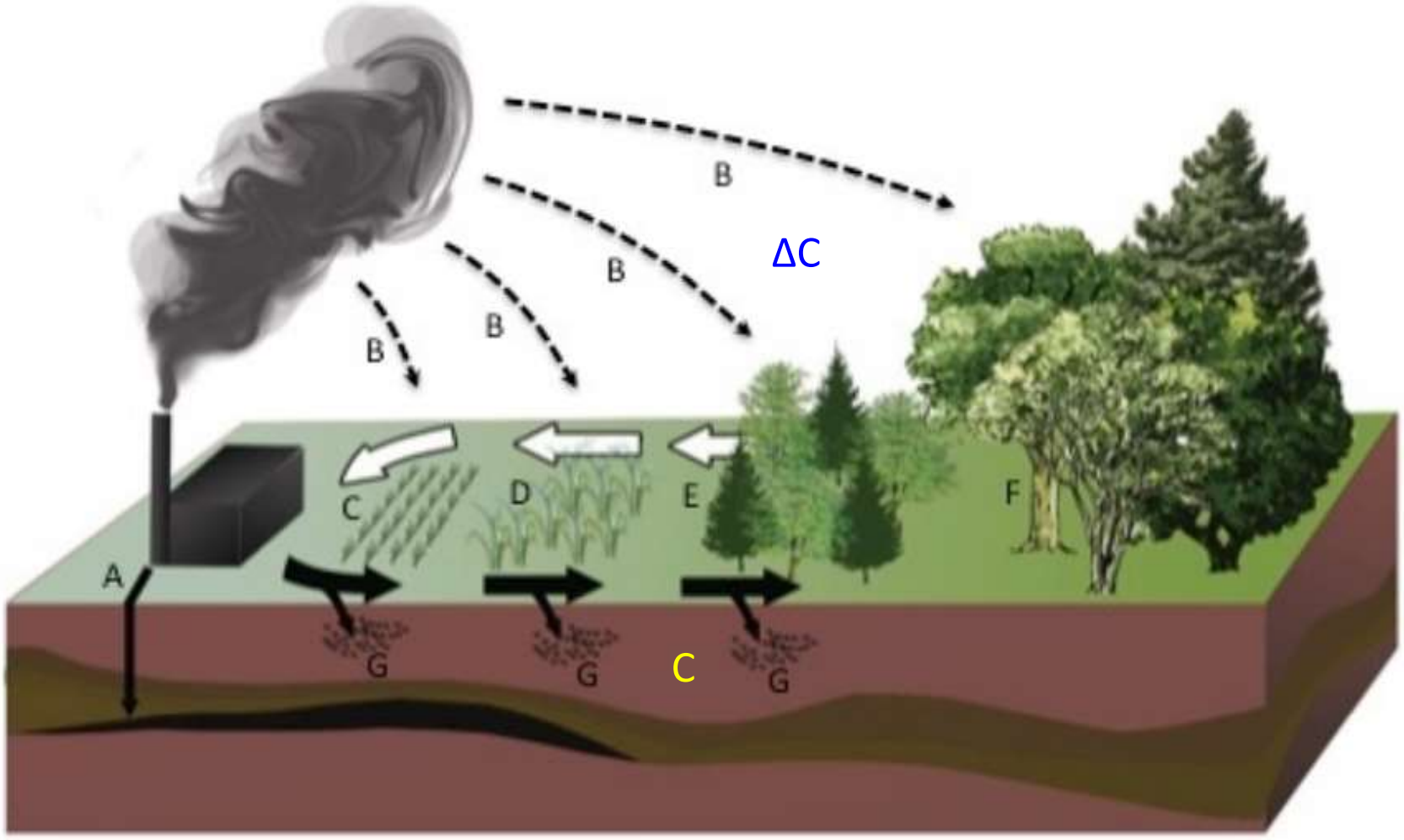
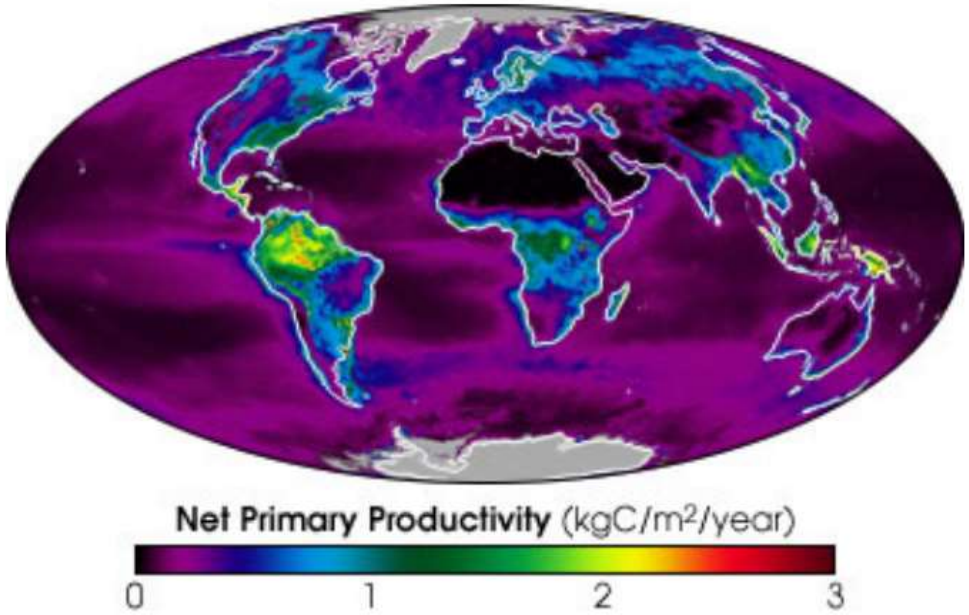


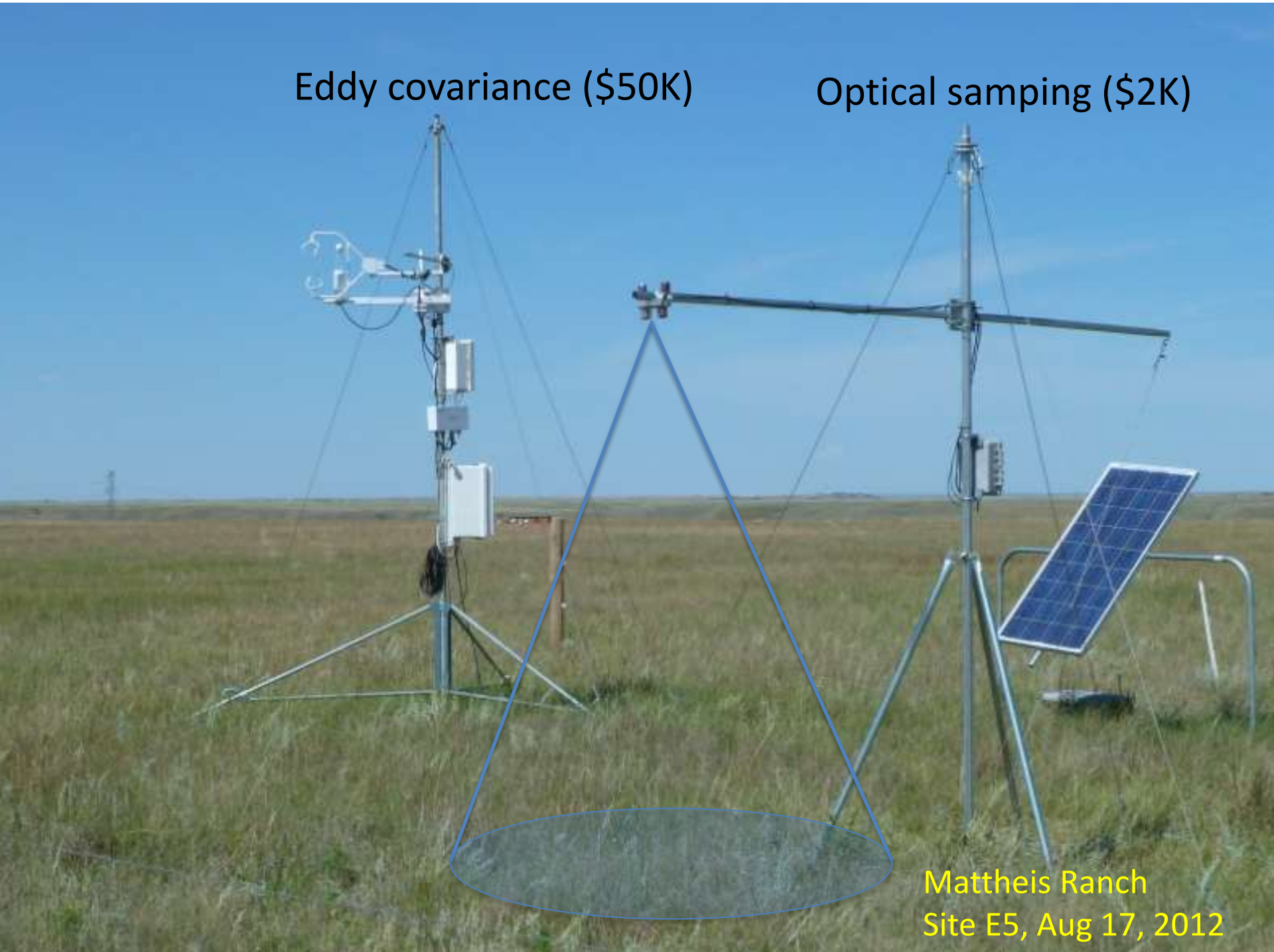
Figure 2: Geologic and Biospheric Carbon Sequestration

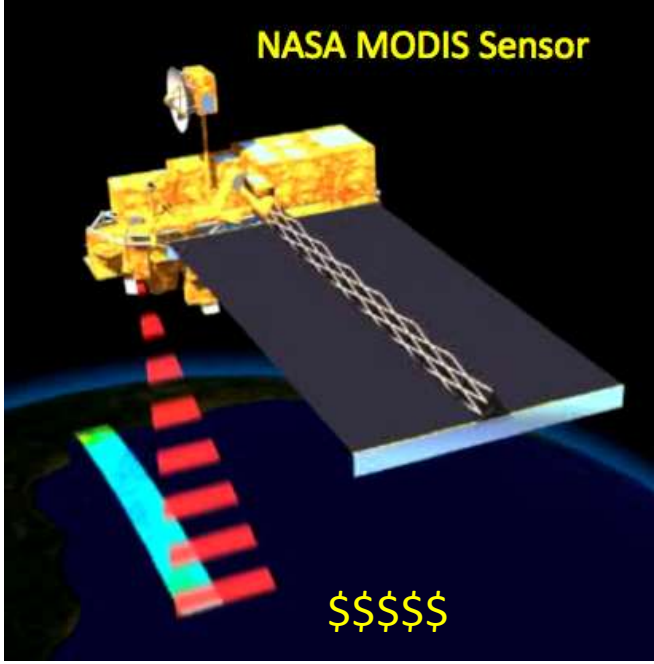
http://biosphericcarbonnetwork.org/

Global Carbon Monitoring

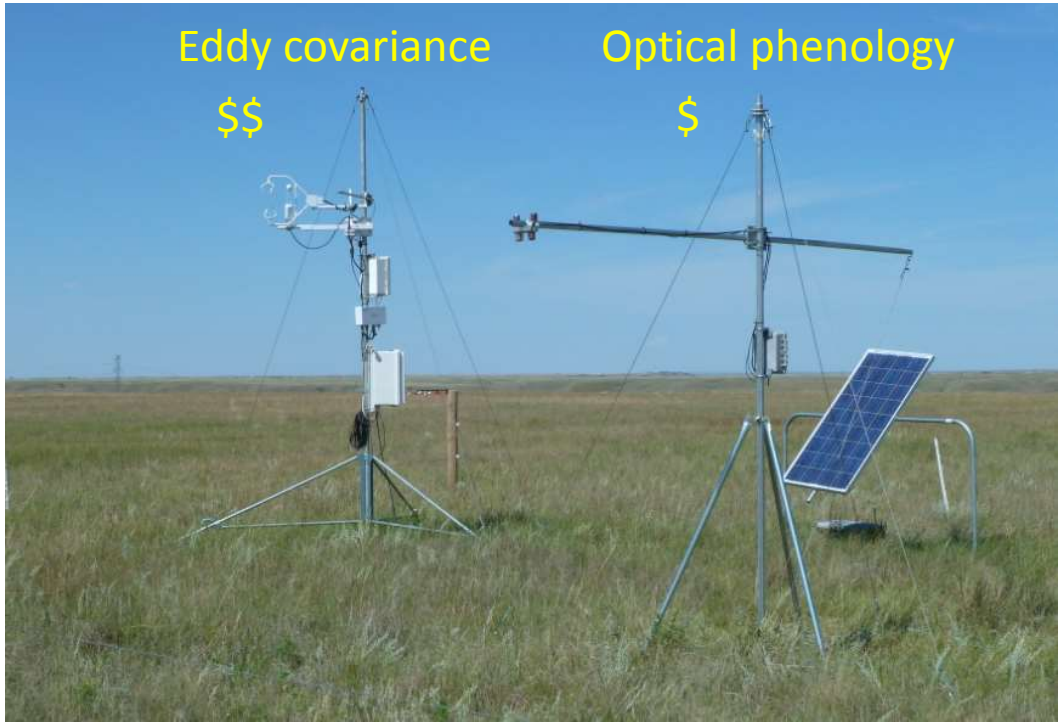


Global Net Primary Productivity (NPP)
derived from MODIS. I3mage released April 2003
(courtesy NASA Earth Observatory)

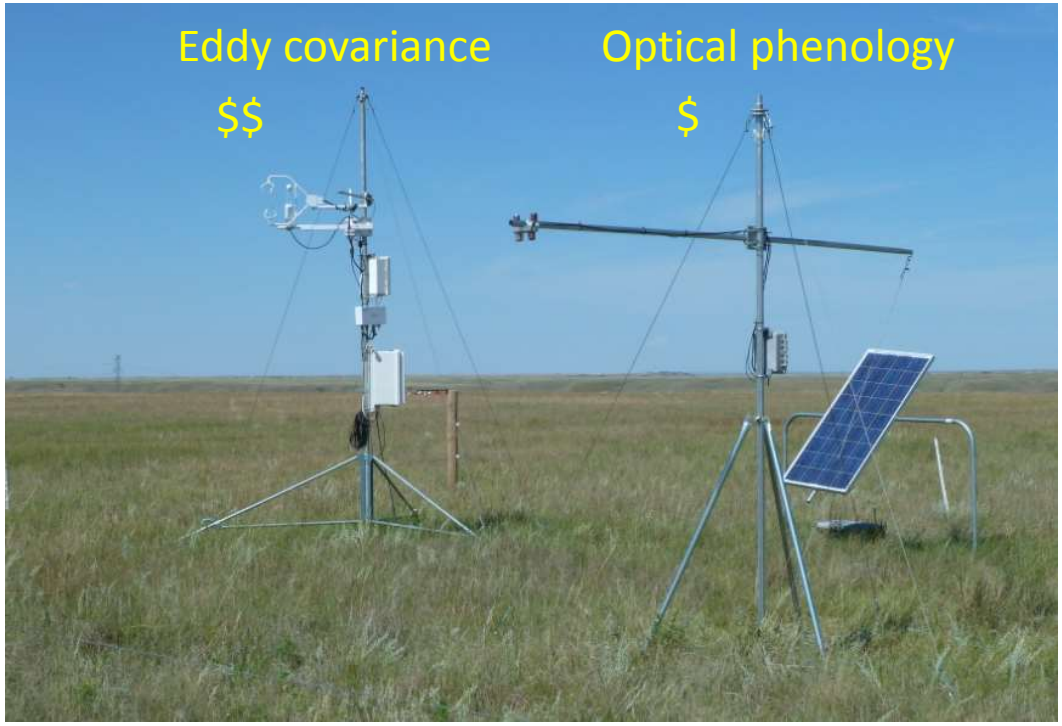

Eddy covariance ($50K)
Optical samping ($2K)
Mattheis Ranch
Site E5, Aug 17, 2012



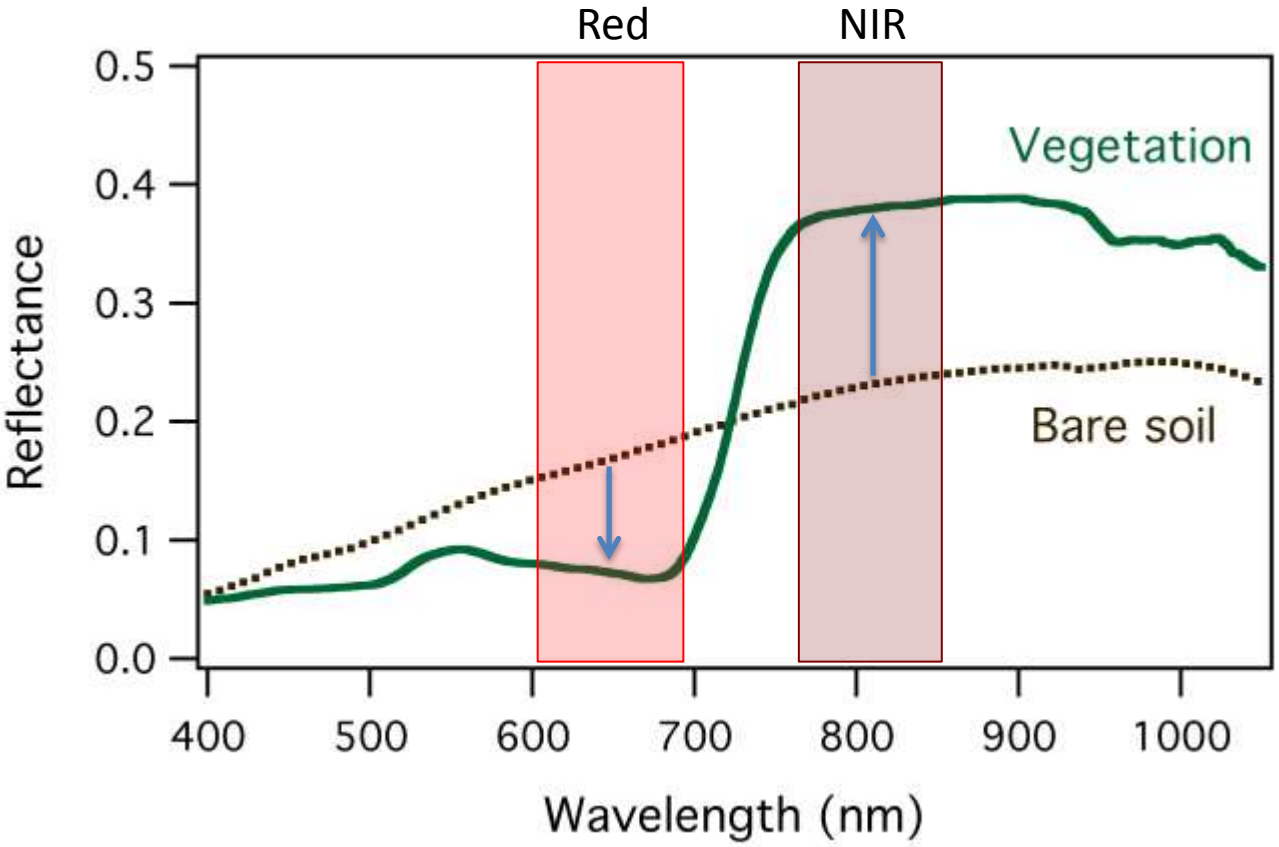
Multi-scale sampling



Multi-scale sampling



Measuring Canopy Greenness: Normalized Difference Vegetation Index (NDVI)



Barley canopy

$$NDVI = \frac{NIR-Red}{NIR+Red}$$

Linking Remote Sensing (NDVI) to Carbon Flux & Stocks

NDVI

↓

C Flux

GEE* = ***Absorbed radiation*** x *Efficiency*

↓

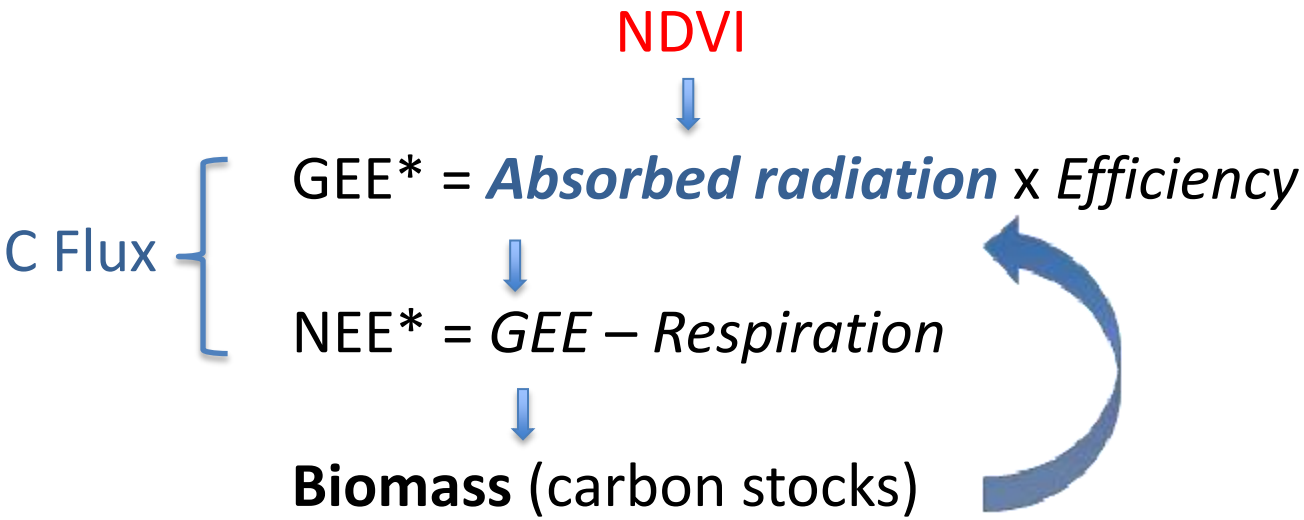
NEE* = *GEE – Respiration*

↓

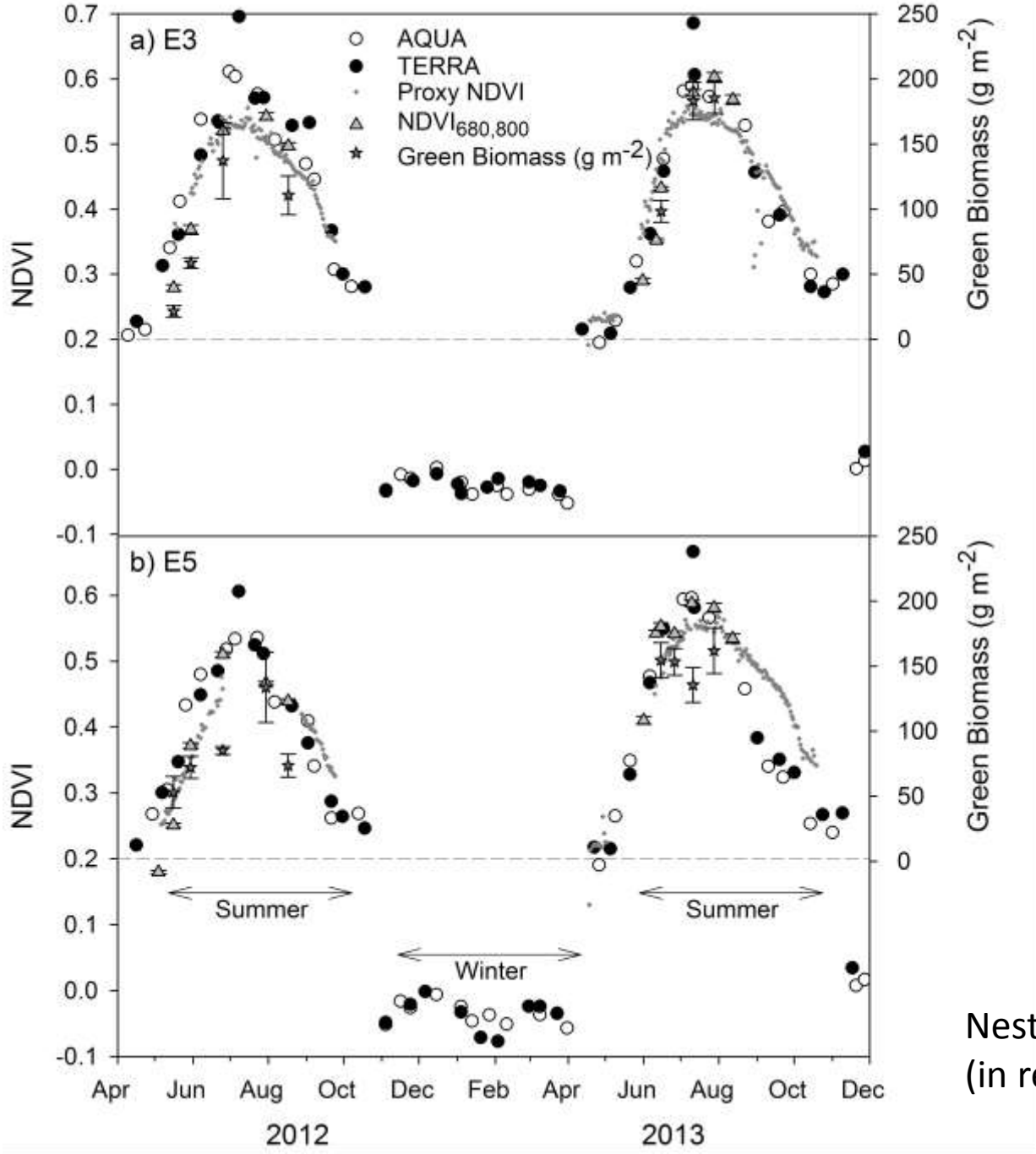
Biomass (carbon stocks)

*Gross Ecosystem Exchange
Net Ecosystem Exchange

Linking Remote Sensing (NDVI) to Carbon Flux & Stocks

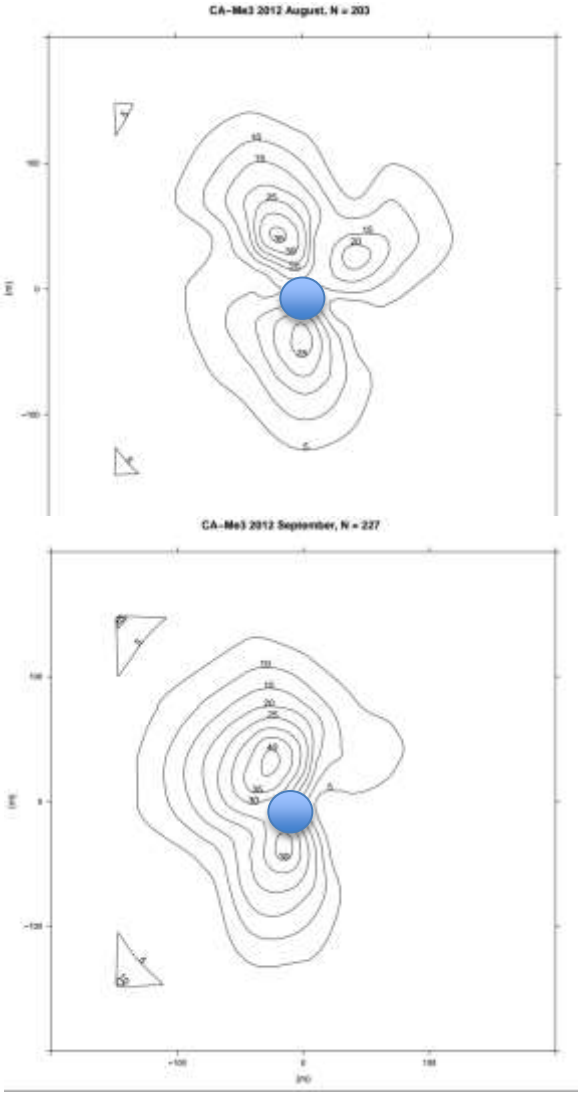


*Gross Ecosystem Exchange
Net Ecosystem Exchange

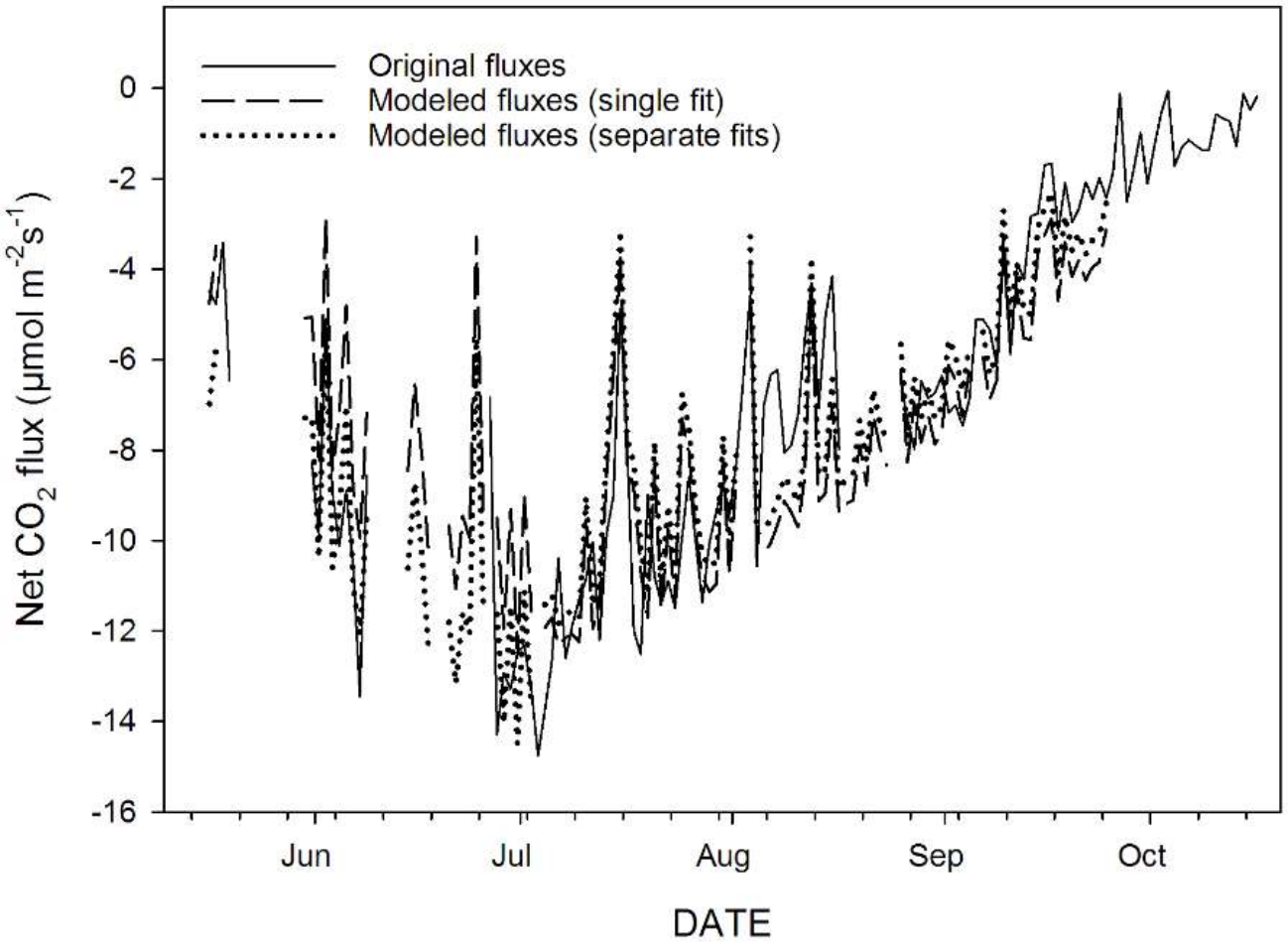


Nestola et al.
(in review)

Footprint analysis

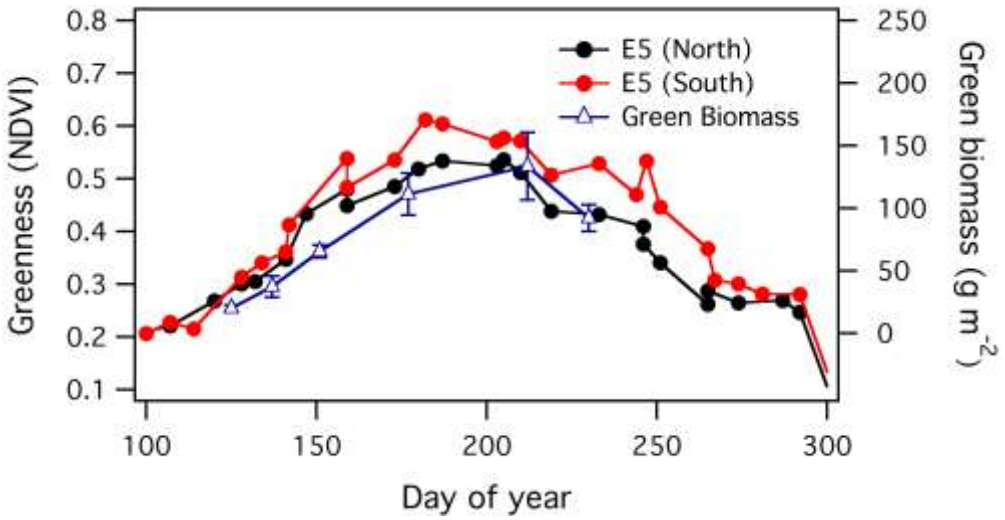


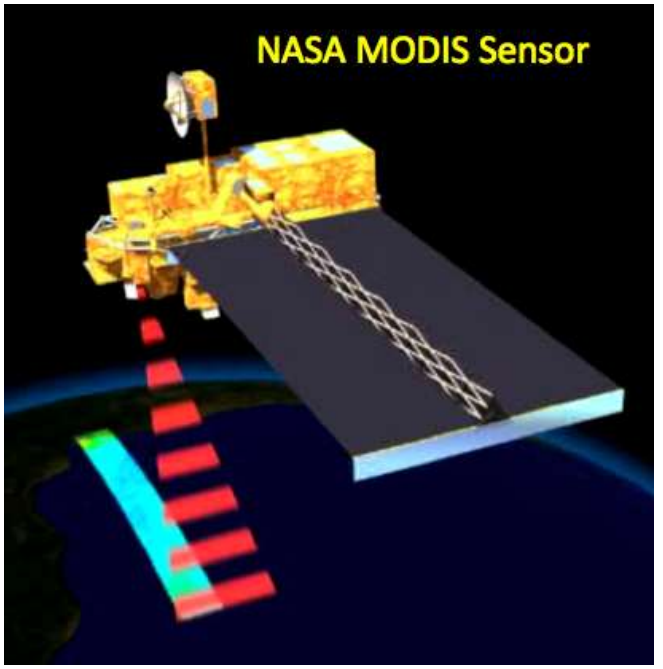
Modeled vs. Measured Fluxes (ΔC)

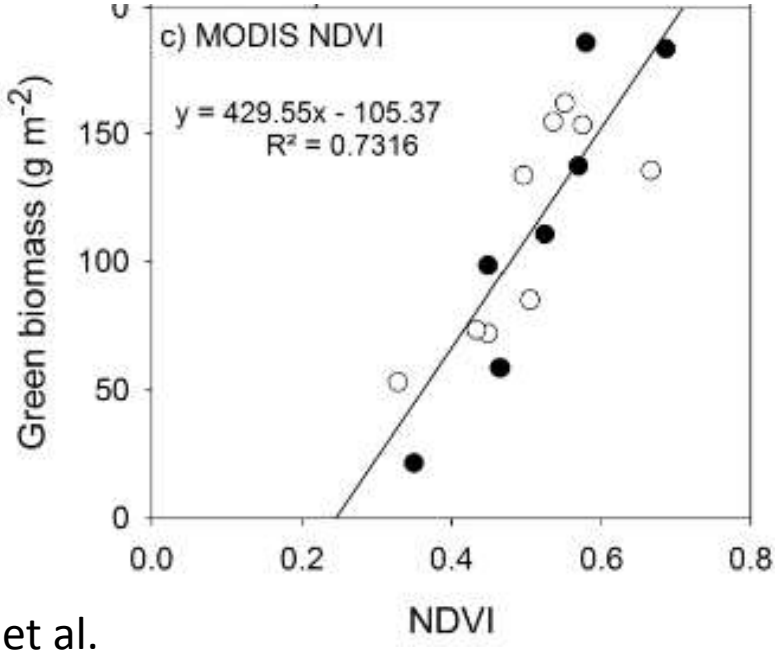


Nestola et al.
(in review)

NDVI vs. biomass







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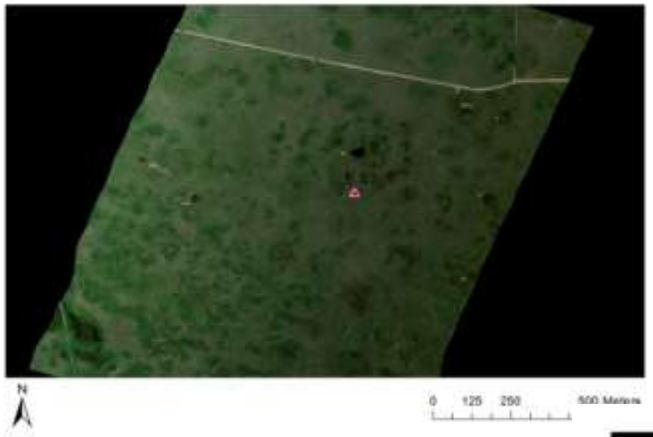
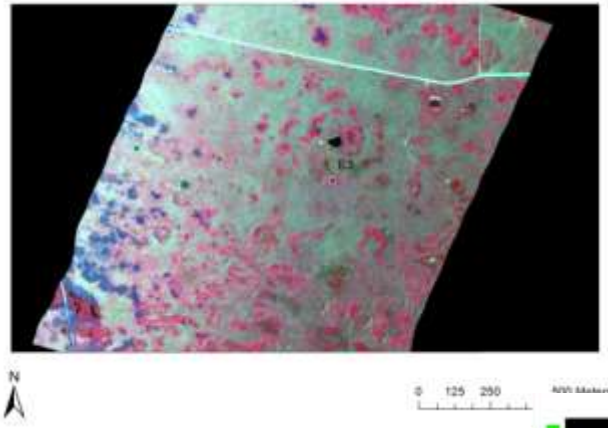


Extrapolating to the region with airborne spectrometry



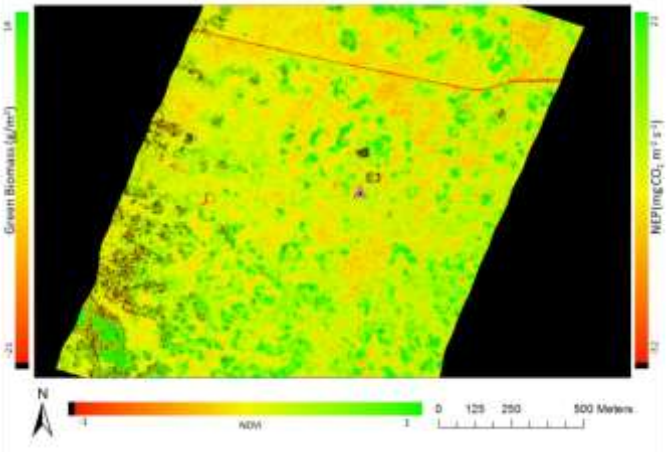
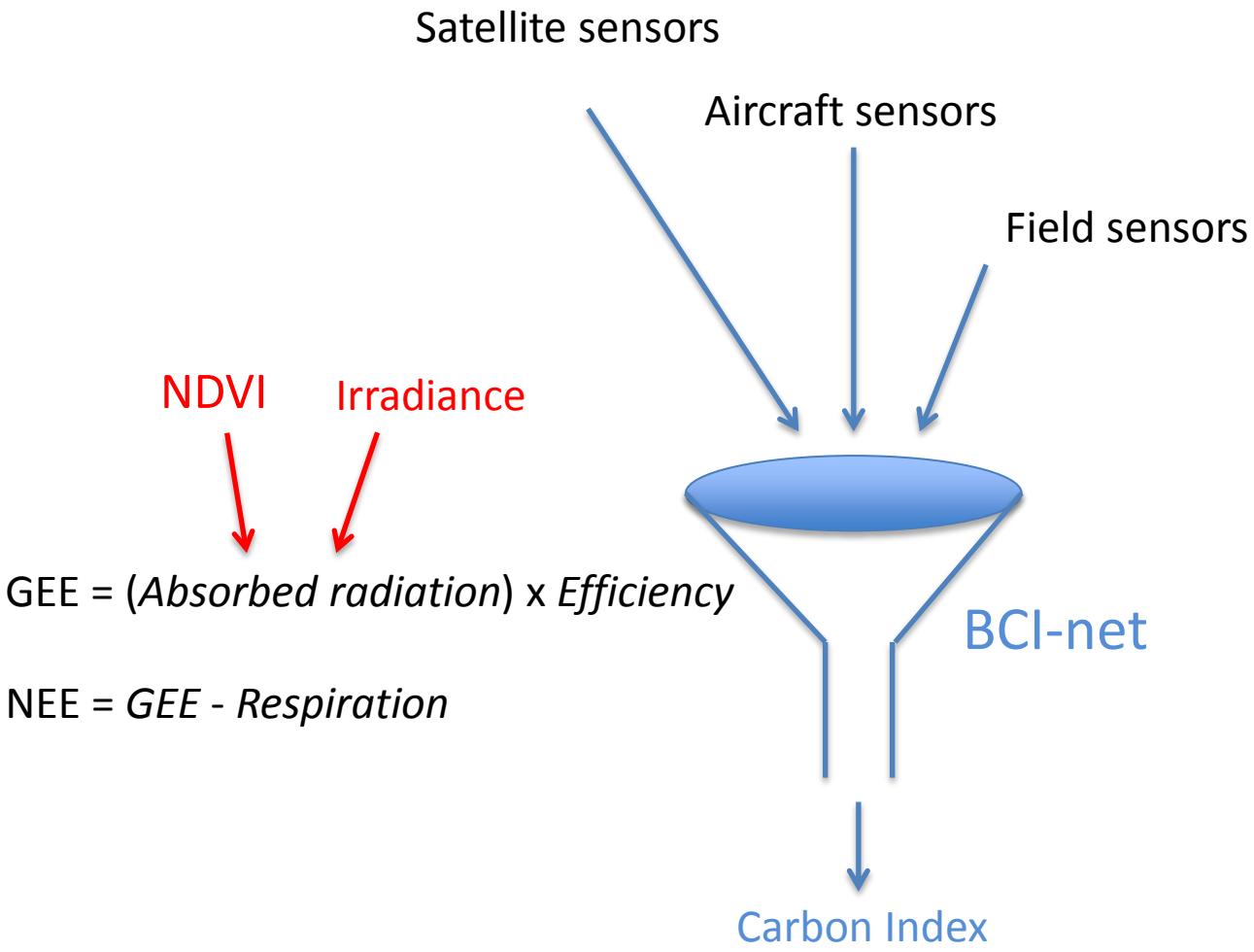


Table 1. Distribution of vegetation and NDVI within 200 meters radius from the flux towers

Flux Tower	Species Richness	Shannon Index	NDVI Mean	NDVI STD
E3	9	0.9060	0.4746	0.1586
E5	3	0.1547	0.3823	0.0927

Wang et al. (in prep.)

Integrating carbon data from multiple sources



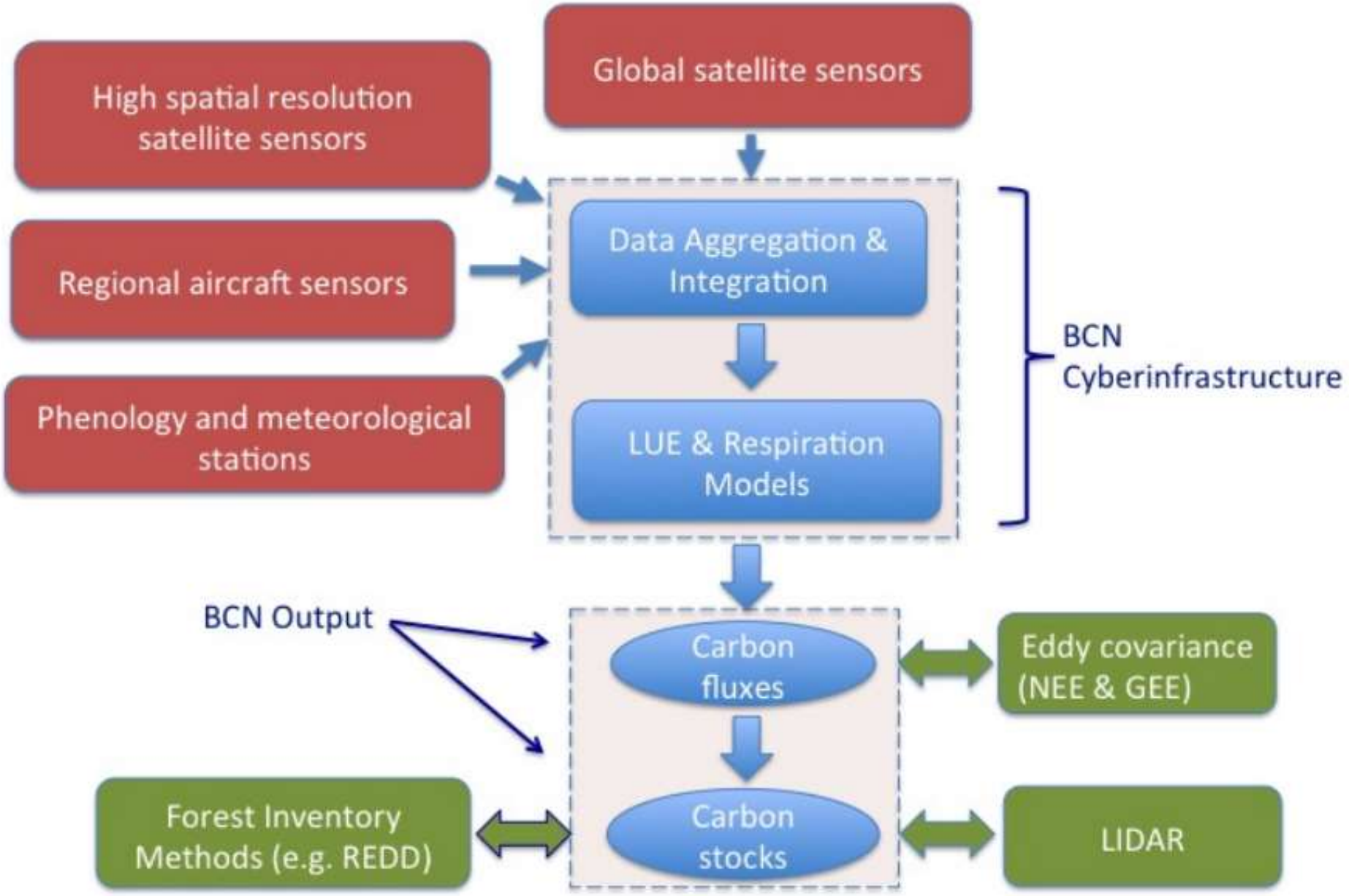


Figure 9: Schematic of Biospheric Carbon Network (BCN)

http://biosphericcarbonnetwork.org/

Challenges & Opportunities:

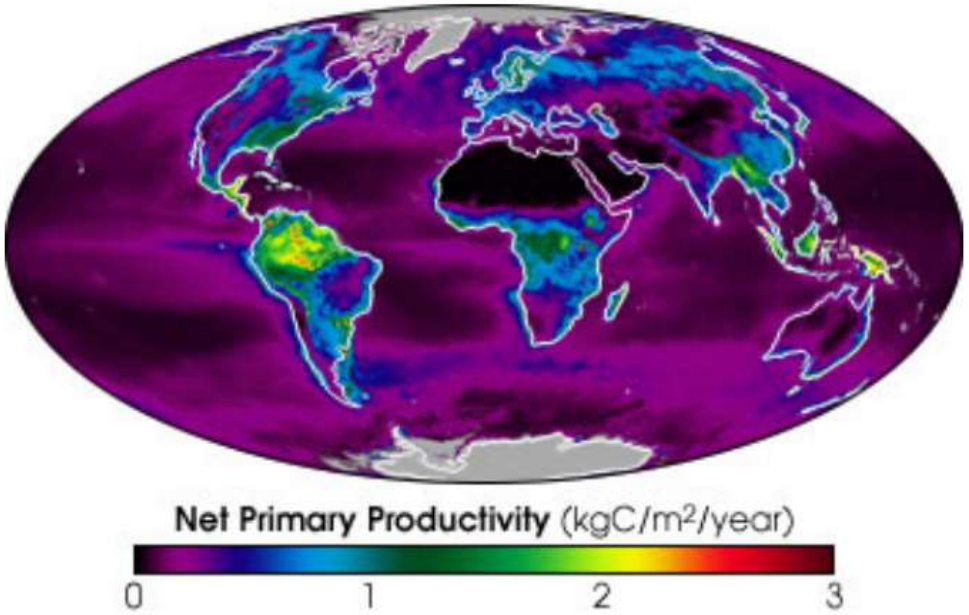
Putting a Price on Carbon C = $

Linking C fluxes to stocks (including soil stocks) C vs. ΔC

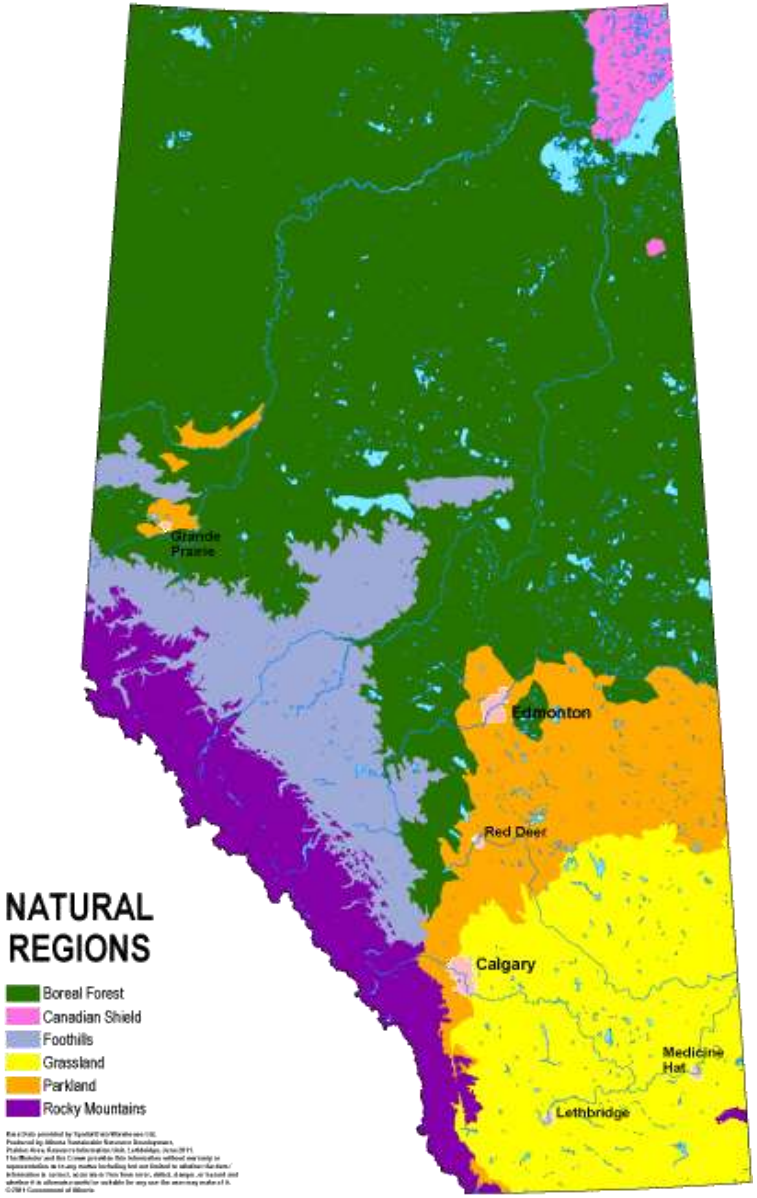
Solutions: Informatics (Biospheric Carbon Index)

Benefits of a Biospheric Carbon Index & Network

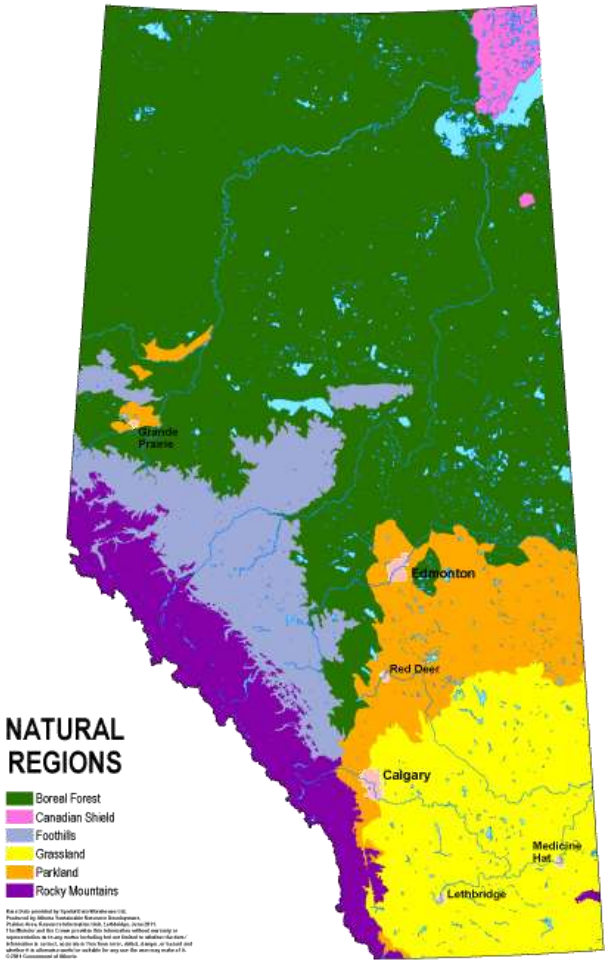
- Demonstrate C sequestration ($)
- Drive effective carbon policy
- Enhance ecosystem goods & services
  - Productivity
  - Biodiversity
- Diverse economic opportunities



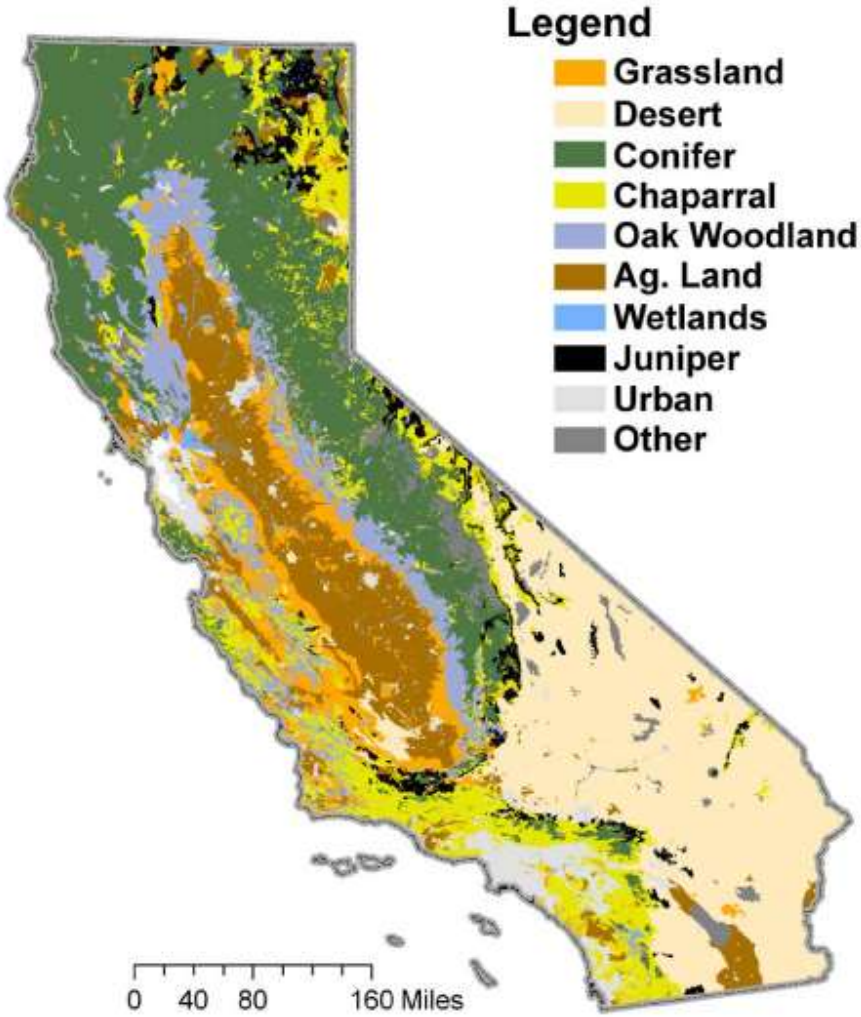
Global Net Primary Productivity (NPP)
derived from MODIS. I19mage released April 2003
(courtesy NASA Earth Observatory)



http://www.albertapcf.org/about-prairies/alberta-natural-areas



VS.



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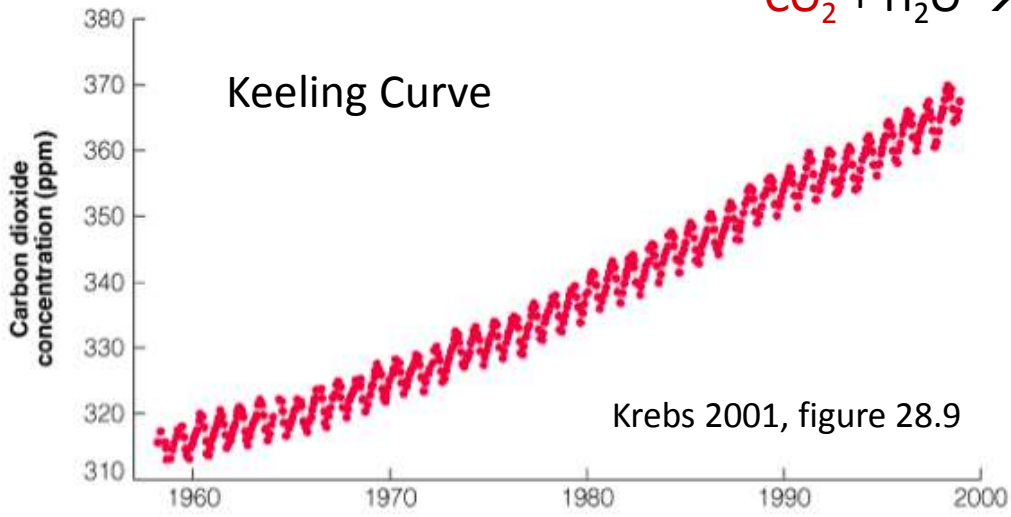
California Soil Resources Lab
(UC Davis)

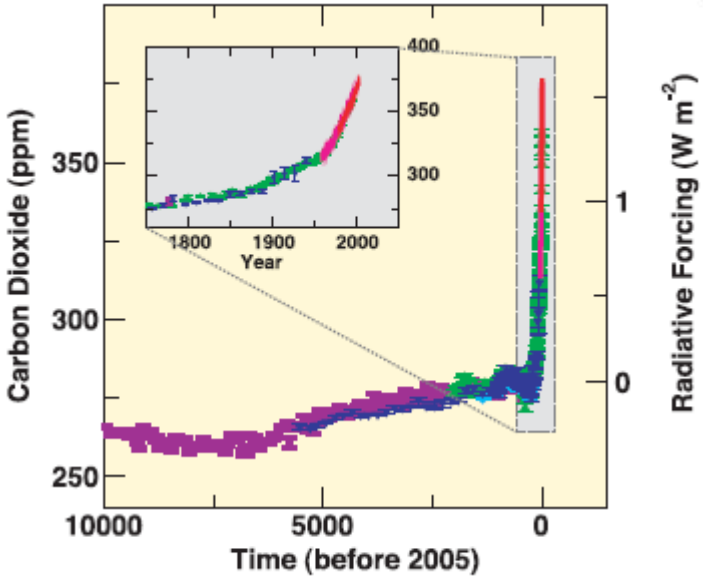
$CO_2 + H_2O \rightarrow CH_2O + O_2$

Biological fluxes

Keeling Curve

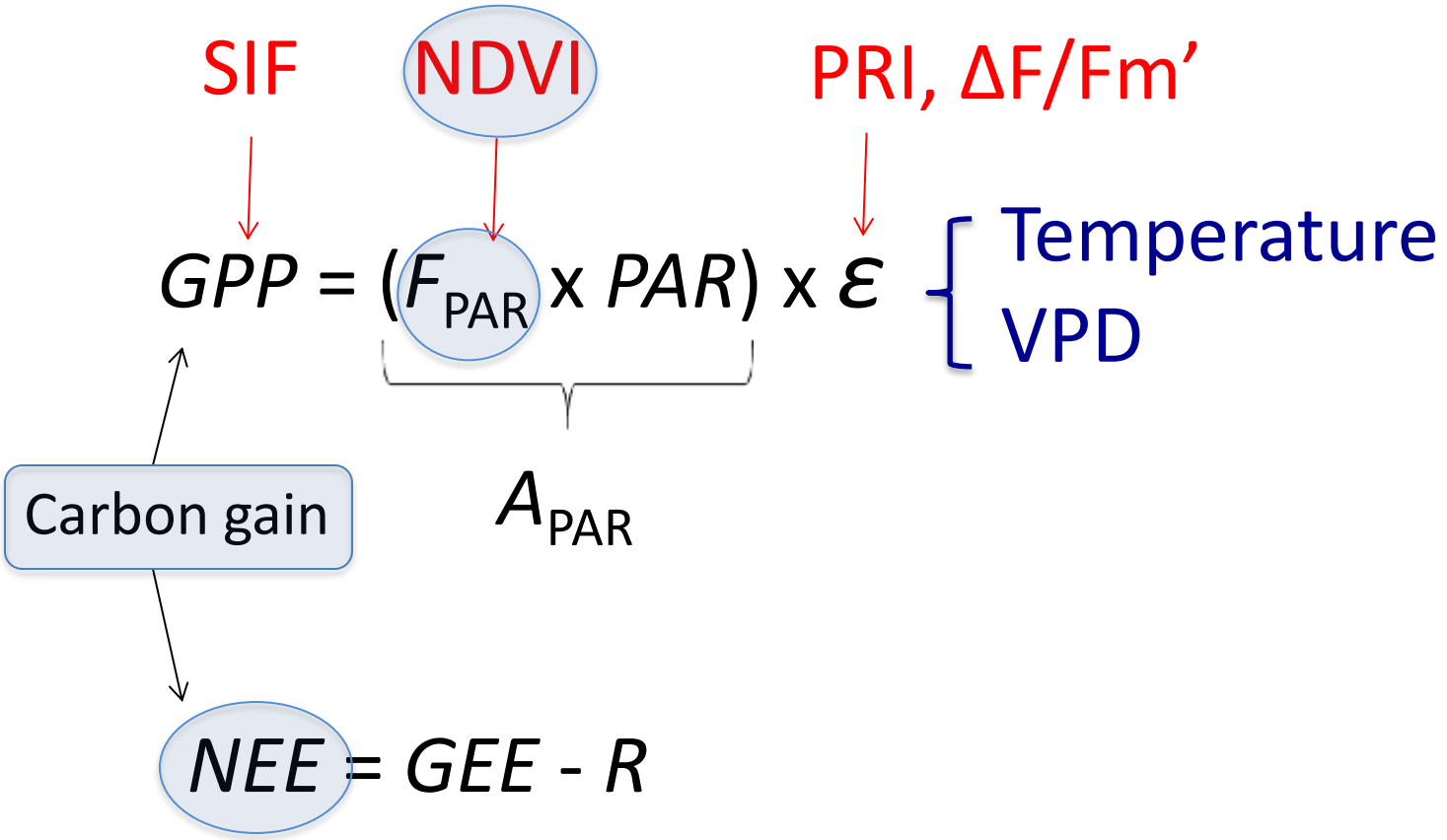


Krebs 2001, figure 28.9

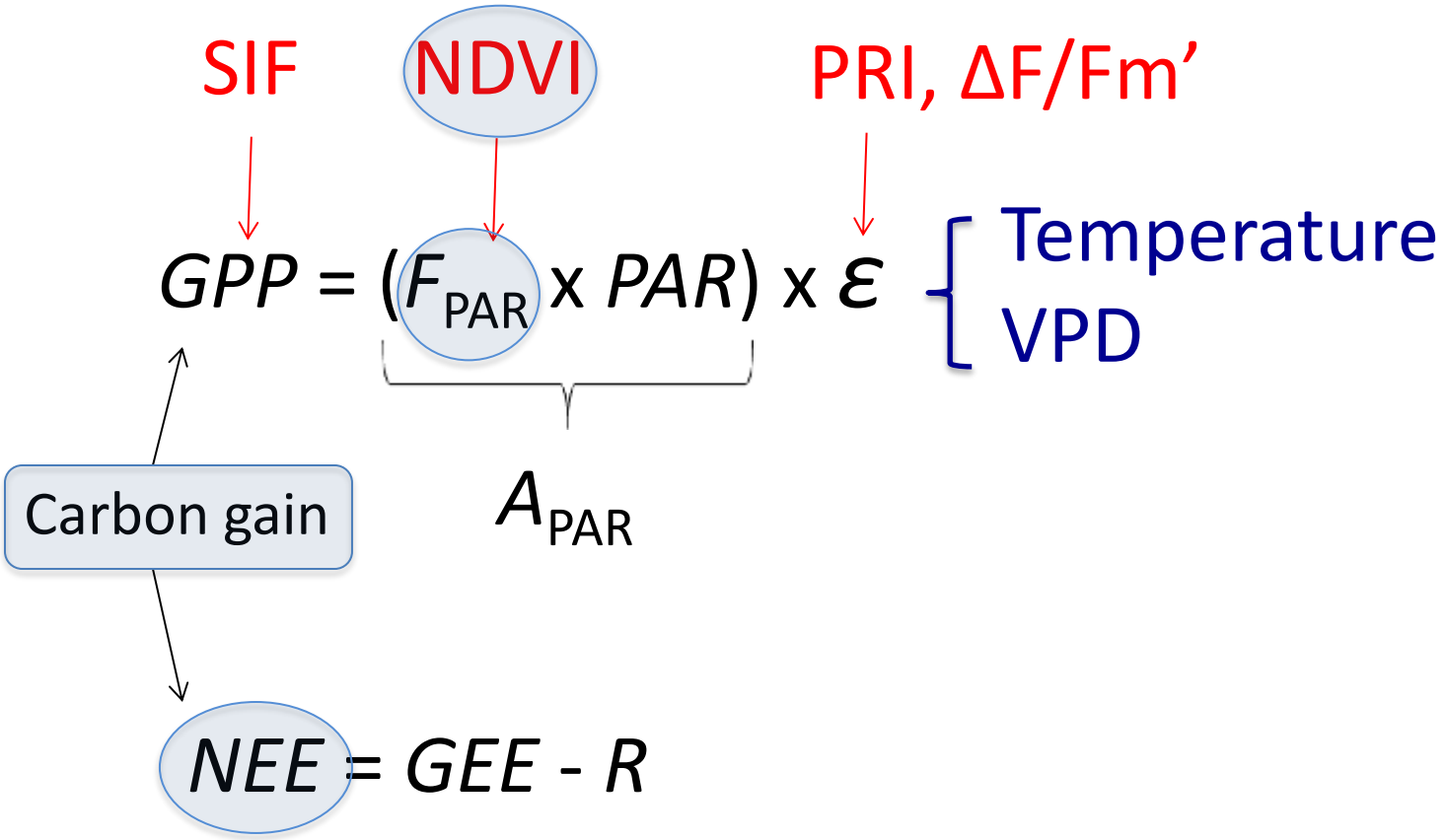


IPCC 2007

→ Using carbon *flux* to determine changing stocks



Gamon (2015) Biogeosciences Discussions

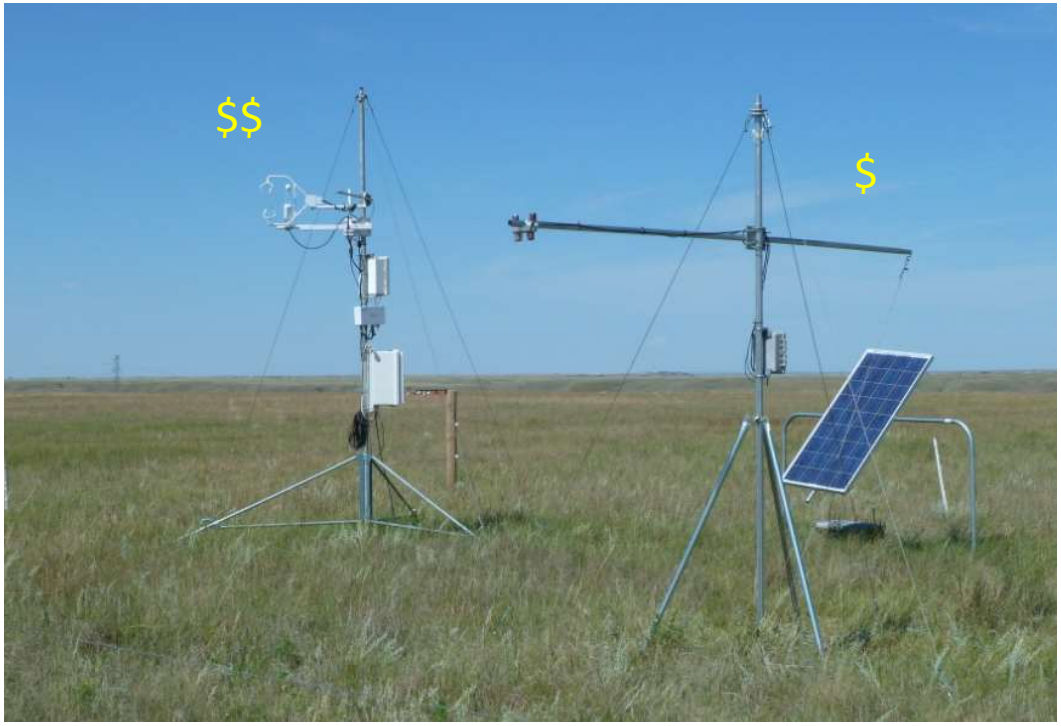


Gamon (2015) Biogeosciences Discussions

$$$

NASA MODIS Sensor
$$$$$ = FREE!

$$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