# FIRST LOOKS AT MODIS TERRESTRIAL NET PRIMARY PRODUCTION
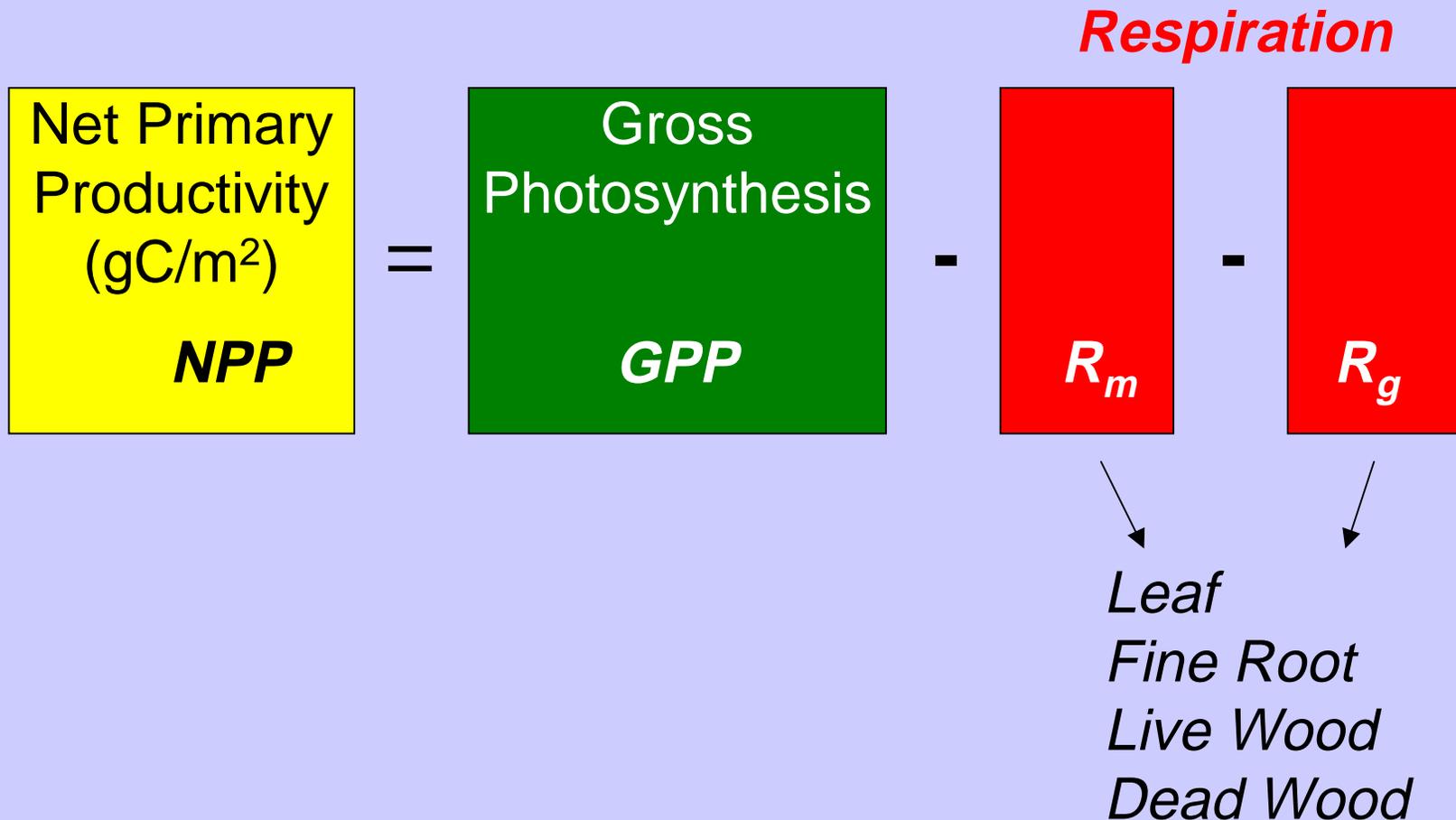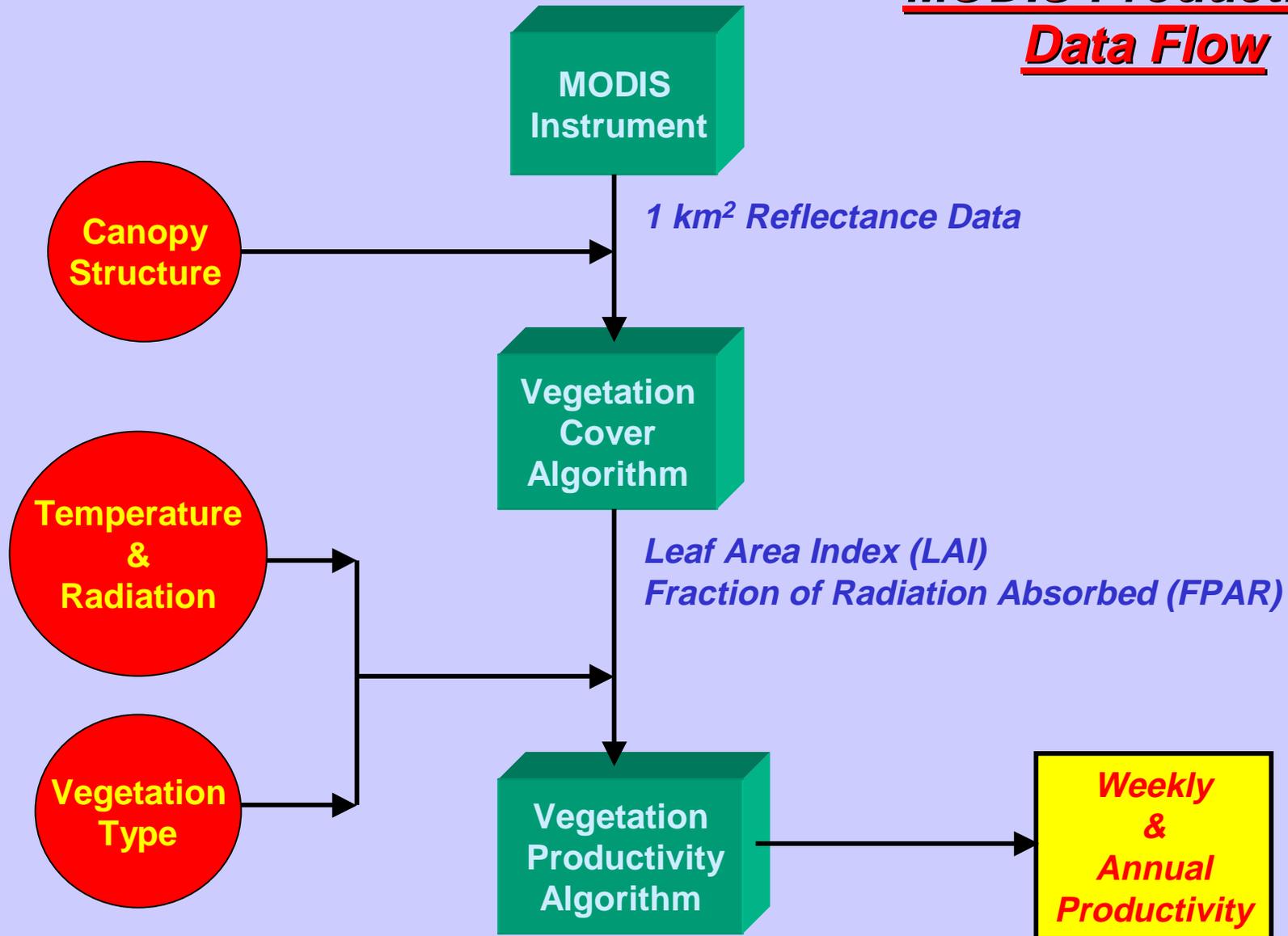
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MODIS SCIENCE TEAM MTG.
8 JUNE 2000

# *Vegetation Productivity*

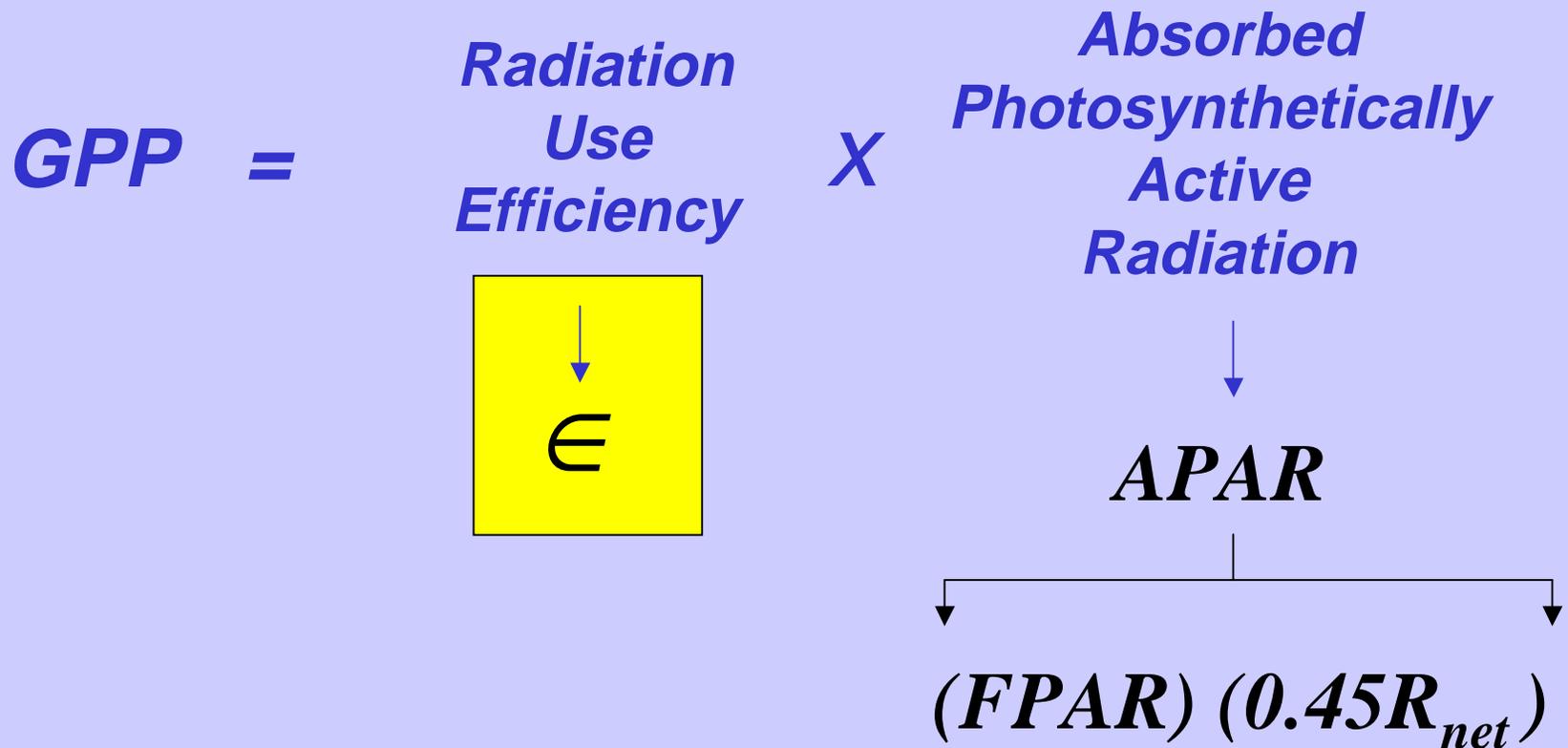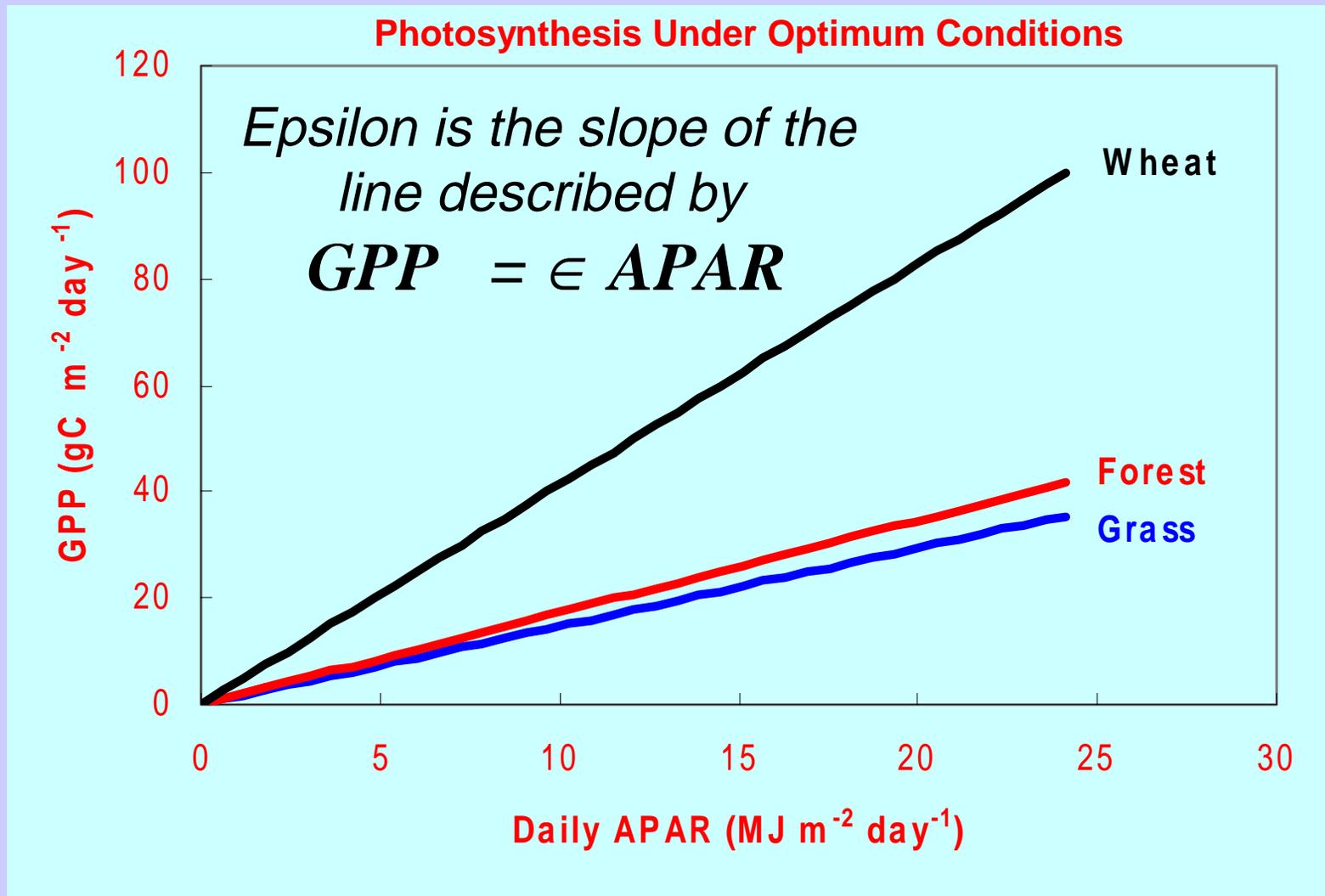**Respiration**

| Net Primary Productivity $(gC/m^2)$ **NPP** | = | Gross Photosynthesis **GPP** | - | $R_m$ | - | $R_g$ |

Leaf
Fine Root
Live Wood
Dead Wood

**MODIS Productivity Data Flow**

MODIS Instrument

Canopy Structure

*1 km² Reflectance Data*

Vegetation Cover Algorithm

Temperature & Radiation

*Leaf Area Index (LAI)*
*Fraction of Radiation Absorbed (FPAR)*

Vegetation Type

Vegetation Productivity Algorithm

*Weekly & Annual Productivity*

# MODIS Photosynthesis

*The Monteith equation….*

**GPP = Radiation Use Efficiency X Absorbed Photosynthetically Active Radiation**

$$\in$$

$$APAR$$

$$(FPAR)\,(0.45R_{net})$$

# MODIS Photosynthesis

## Photosynthesis Under Optimum Conditions

*Epsilon is the slope of the line described by*

$$GPP = \in APAR$$

Wheat

Forest

Grass

GPP (gC m$^{-2}$ day$^{-1}$)

Daily APAR (MJ m$^{-2}$ day$^{-1}$)

# *Radiation Use Efficiency*

Maximum
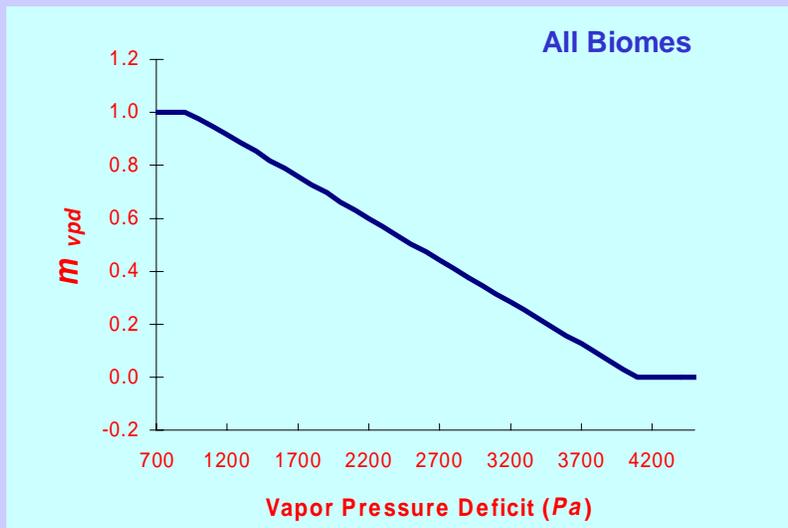Radiation Use Efficiency
under ideal conditions
for each biome

Vapor Pressure Deficit
Coefficient

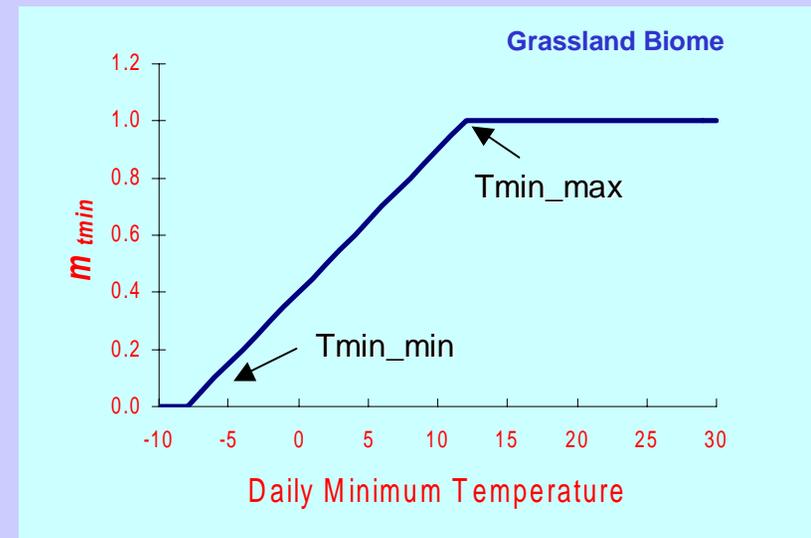$$\epsilon = \epsilon_{max} [m_{tmin}][m_{vpd}]$$

Temperature Coefficient for each biome

*The coefficients are calculated from daily minimum and maximum air temperature which are therefore necessary inputs to the model*
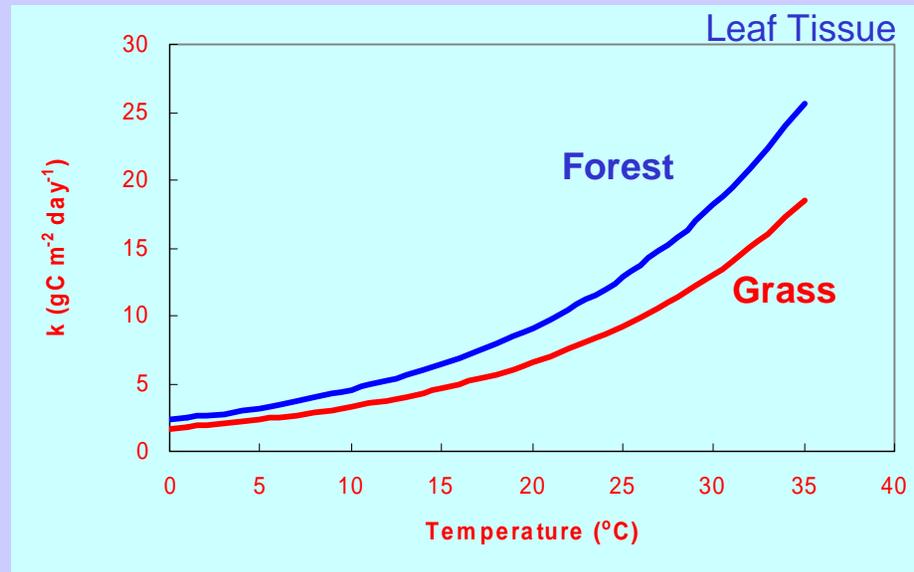
# VPD & Tmin Coefficients



**VPD**

**Tmin**

Tmin_max & Tmin_min are Tabulated by biome

# *Maintenance Respiration*



$$R_{m\_tissue} = k \text{ (mass of tissue )}$$

*Live wood maintenance respiration not included in weekly MODIS productivity*
*It is included in the annual estimate*

# Growth Respiration

$R_{g\_leaf}$ = ( leaf mass$_{max}$ )(turnover)(constant)

$$\left.\begin{array}{l} R_{g\_fine\ root} \\ \\ R_{g\_live\ wood} \\ \\ R_{g\_live\ wood} \end{array}\right] = (R_{g\_leaf})(constant)$$

*The amount of growth in each part of the vegetation varies over the growing season. Therefore growth respiration is not included in the weekly estimates of vegetation production*

# *MODIS Productivity*

**Weekly = GPP - R $_{m\_leaf}$ - R $_{m\_fine\ root}$**
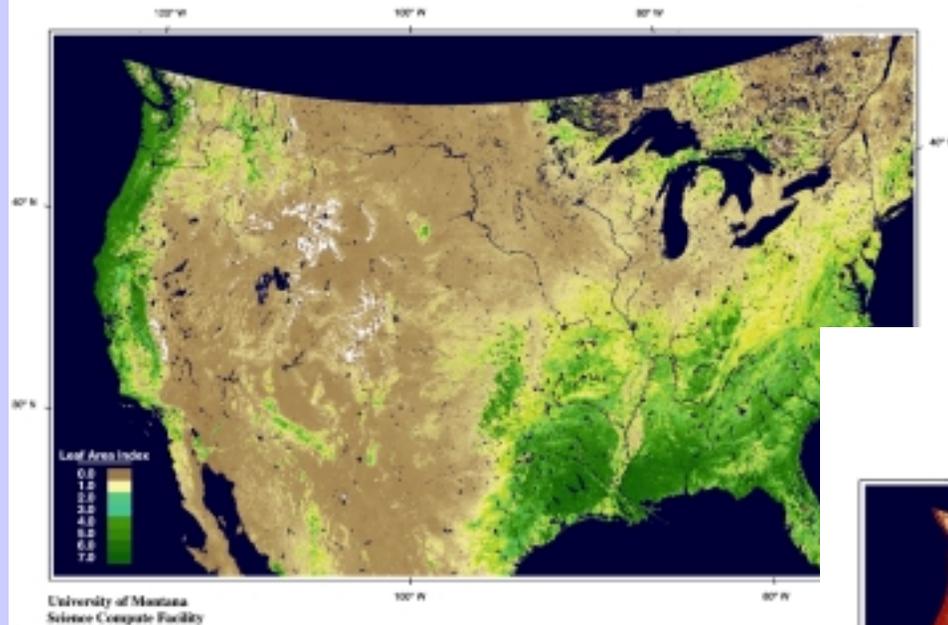
**Annual = $\sum$ (Weekly) - R $_{m\_live\ wood}$ - R $_g$**

$$GPP \ = \ \in_{max} (m_{tmin})(m_{vpd}) \ (FPAR)(0.45R_{net})$$
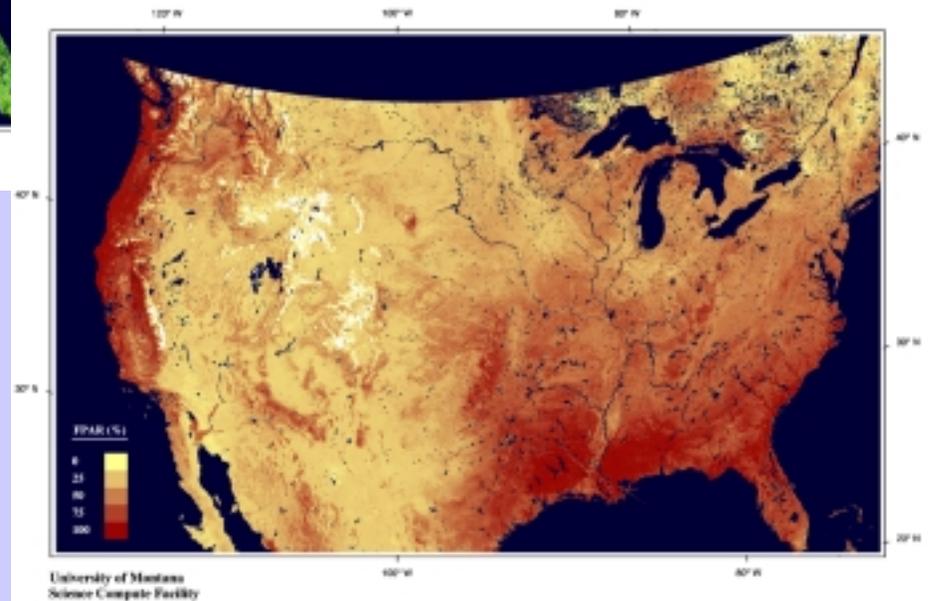
# MODIS INPUTS TO PSN/NPP ALGORITHM

MODIS Land Gross Primary Production  (MOD17)

16-day total GPP (gC m$^{-2}$)

0    20    40    60

16 days in Spring, 2000
March 26 - April 10
(two 8-day reporting periods)

U. Montana
MODIS-SCF/NTS

# Western Montana and Idaho
## MODIS Land Gross Primary Production
### 16 day total, March 26 - April 10, 2000
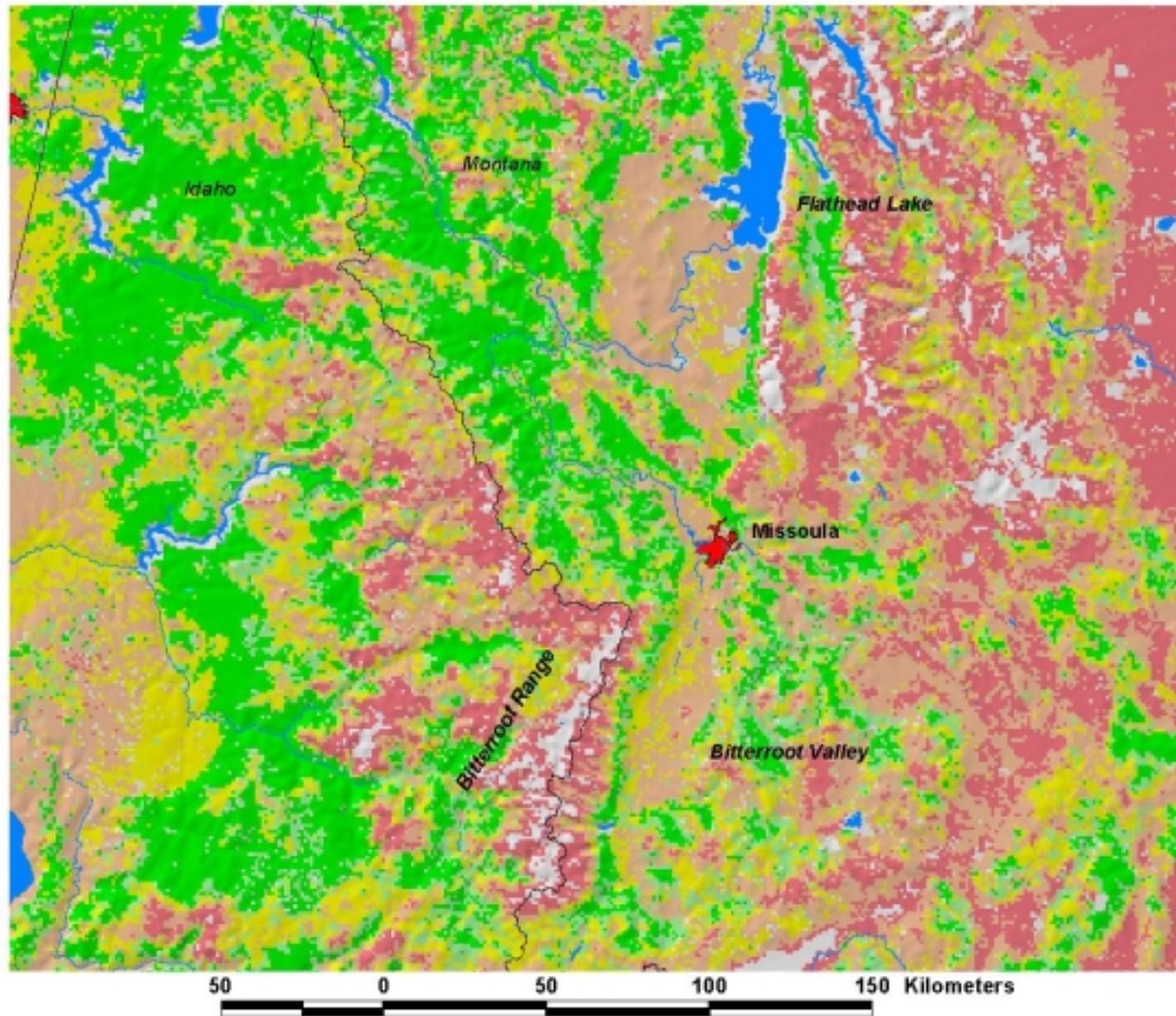
Urbanized areas

Fresh Water

16 day total GPP
(gC / m²)

| | |
|---|---|
| | 0 |
| | 0.1 - 4.5 |
| | 4.6 - 8.6 |
| | 8.7 - 12.6 |
| | 12.7 - 16.7 |
| | 16.8 - 20.8 |
| | 20.9 - 24.8 |
| | 24.9 - 28.9 |
| | 29.0 - 32.9 |
| | > 33.0 |

Idaho

Montana

Flathead Lake

Missoula

Bitterroot Range

Bitterroot Valley

50    0    50    100    150   Kilometers

University of Montana
MODIS-SCF / NTSG

# Chesapeake Bay Region
## MODIS Land Gross Primary Production
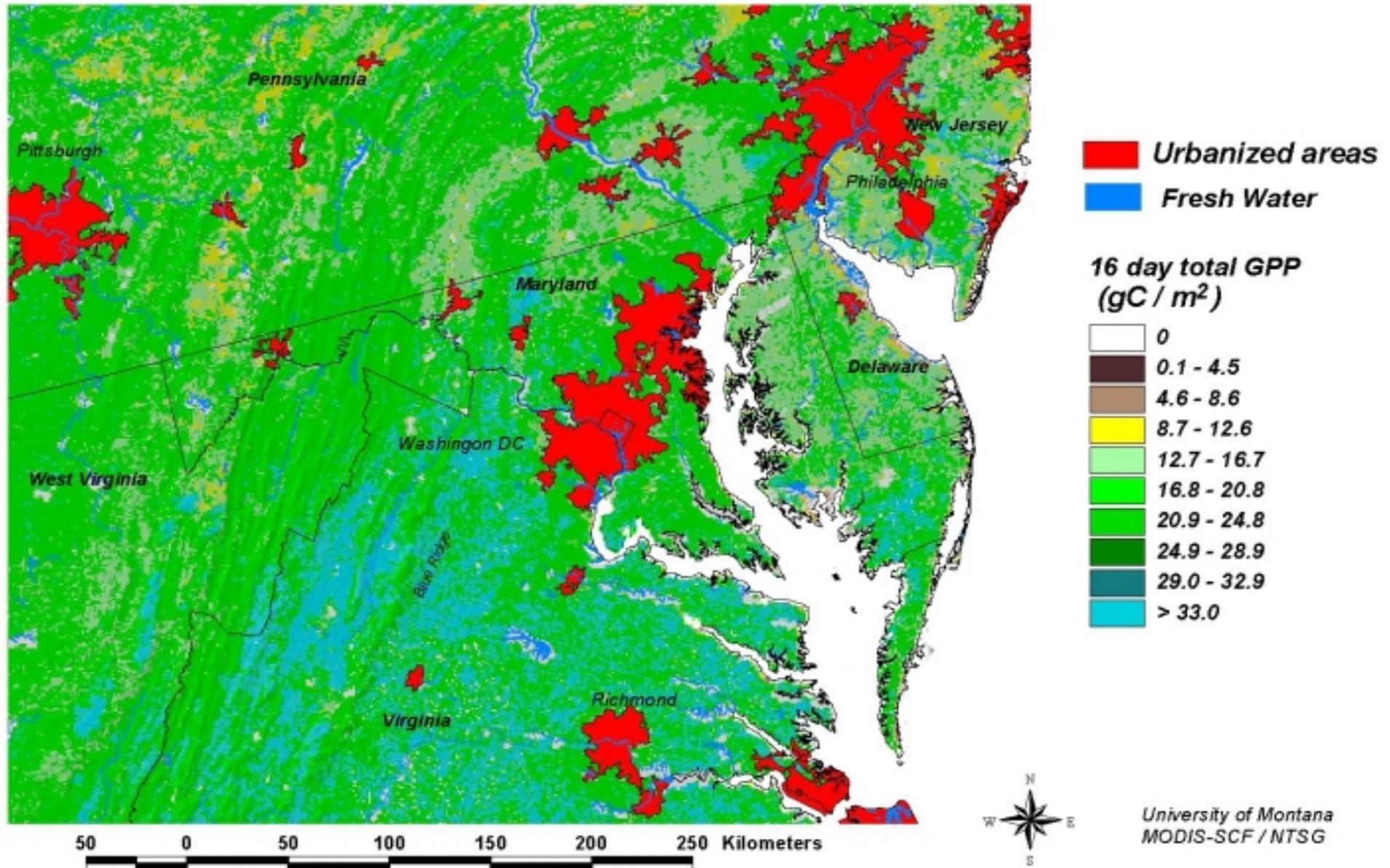## 16 day total, March 26 - April 10, 2000
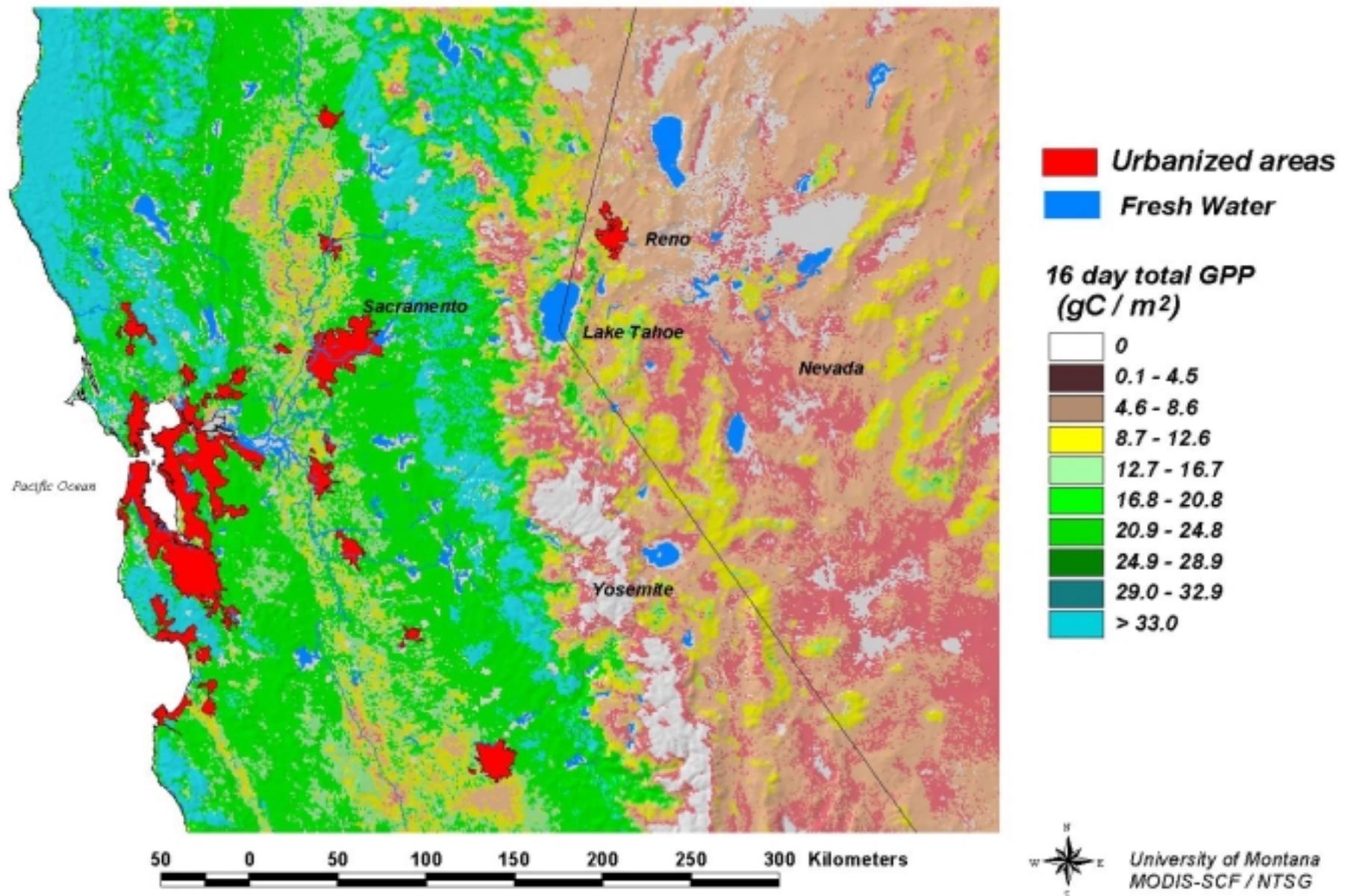
**Urbanized areas**

**Fresh Water**

**16 day total GPP (gC / m²)**

- 0
- 0.1 - 4.5
- 4.6 - 8.6
- 8.7 - 12.6
- 12.7 - 16.7
- 16.8 - 20.8
- 20.9 - 24.8
- 24.9 - 28.9
- 29.0 - 32.9
- > 33.0

*University of Montana*
*MODIS-SCF / NTSG*

Pennsylvania

Pittsburgh

New Jersey

Philadelphia

Maryland

Delaware

Washingon DC

West Virginia

Blue Ridge

Virginia

Richmond

50   0   50   100   150   200   250   Kilometers

# Northern California and Nevada
## MODIS Land Gross Primary Production
## 16 day total, March 26 - April 10, 2000



**Urbanized areas**

**Fresh Water**

**16 day total GPP
(gC / m²)**

| | |
|---|---|
| | 0 |
| | 0.1 - 4.5 |
| | 4.6 - 8.6 |
| | 8.7 - 12.6 |
| | 12.7 - 16.7 |
| | 16.8 - 20.8 |
| | 20.9 - 24.8 |
| | 24.9 - 28.9 |
| | 29.0 - 32.9 |
| | > 33.0 |

Reno

Sacramento

Lake Tahoe

Nevada

Pacific Ocean

Yosemite

50    0    50    100    150    200    250    300   Kilometers

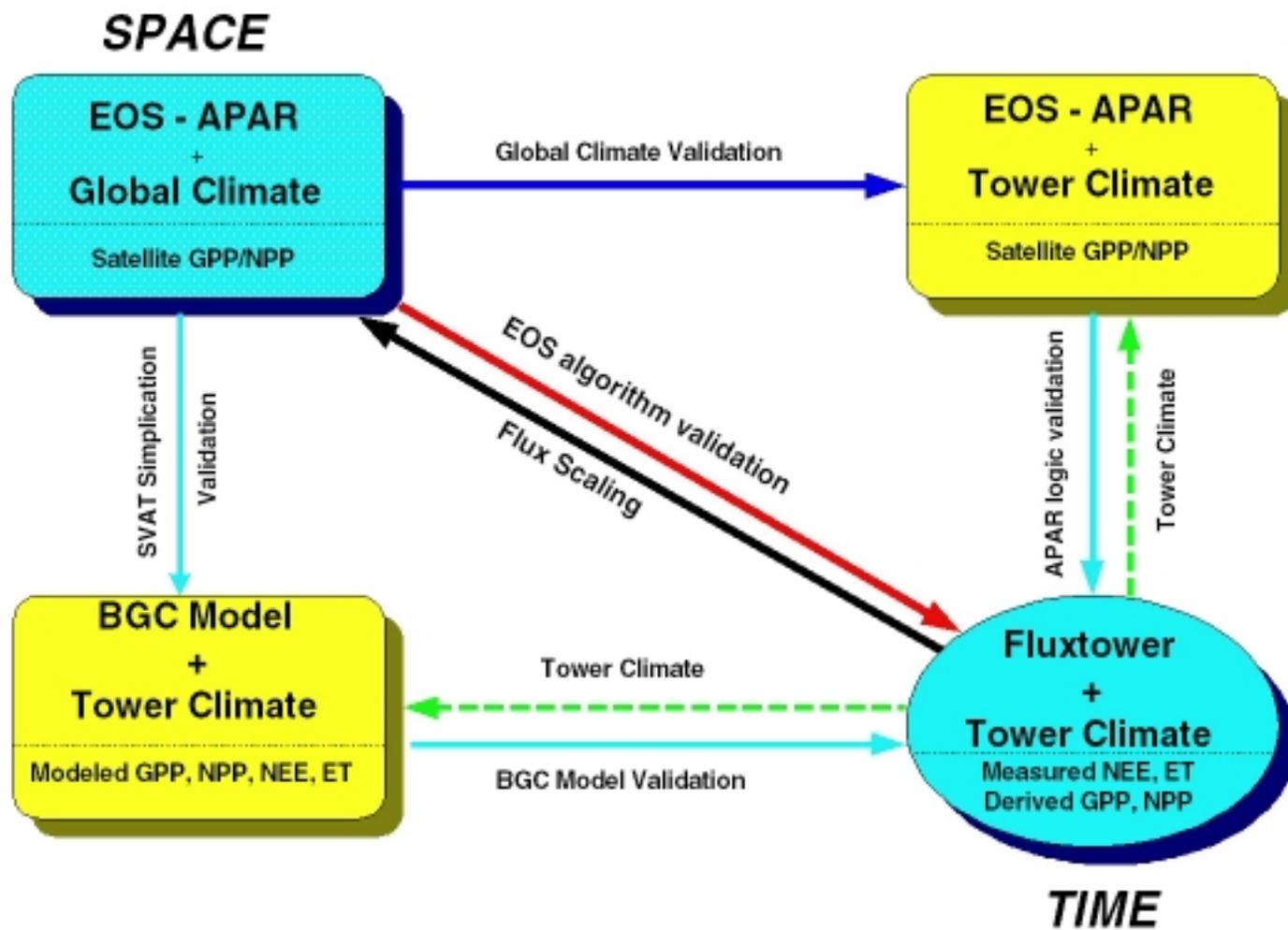*University of Montana
MODIS-SCF / NTSG*
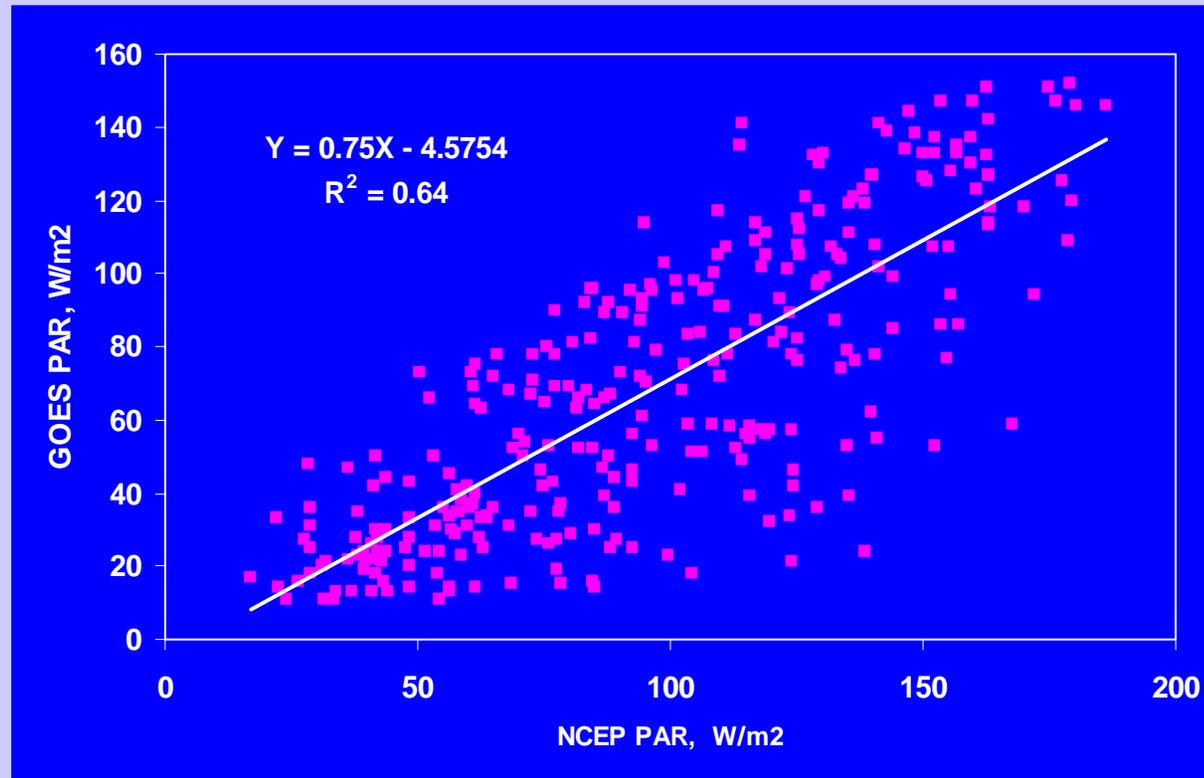
**VALIDATION OF MODIS PSN/NPP**

FLUXNET Sites
AmeriFlux(•), EUROFLUX(•), Medeflu(•),
JapanNet(•), LBA(•), others(•)
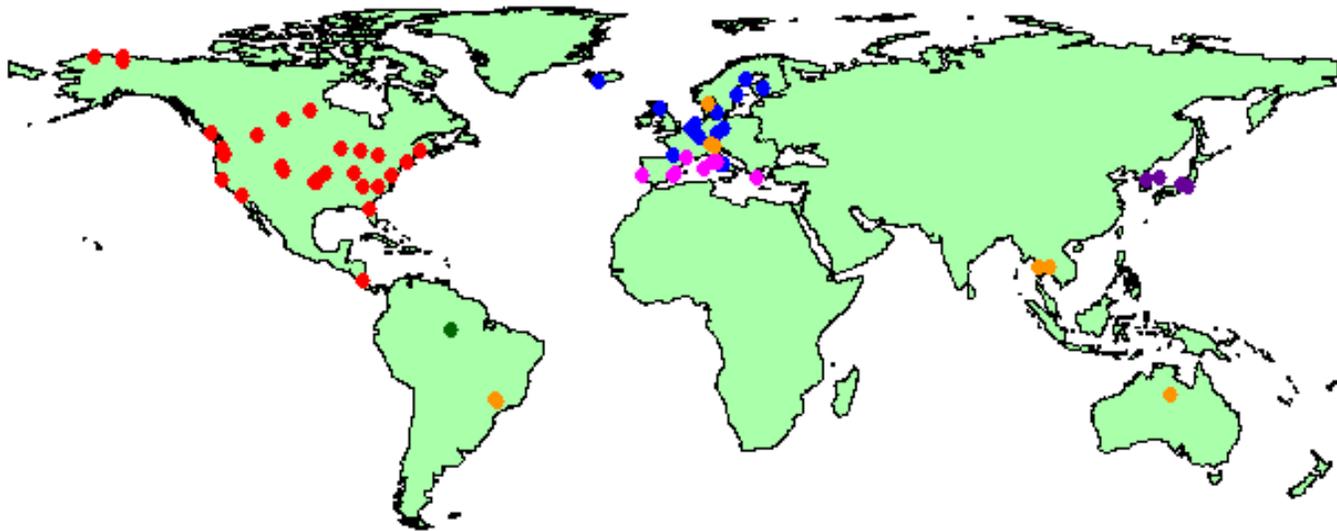
FLUX TOWER BASED VALIDATION FOR MODIS GPP/NPP

# Testing the accuracy of incident PAR input to MOD17 algorithm using GOES derived PAR over the continental U.S

# VALIDATION OF SATELLITE DERIVED GPP WITH FLUX TOWER OBSERVATIONS



Harvard Forest 1996 Tower vs MODISlike GPP

MOD17 = 0.62*Tower - 0.72
R2 = 0.72