Landscape level carbon, water balances and agricultural production in mountainous terrain of the Haean Basin, South Korea

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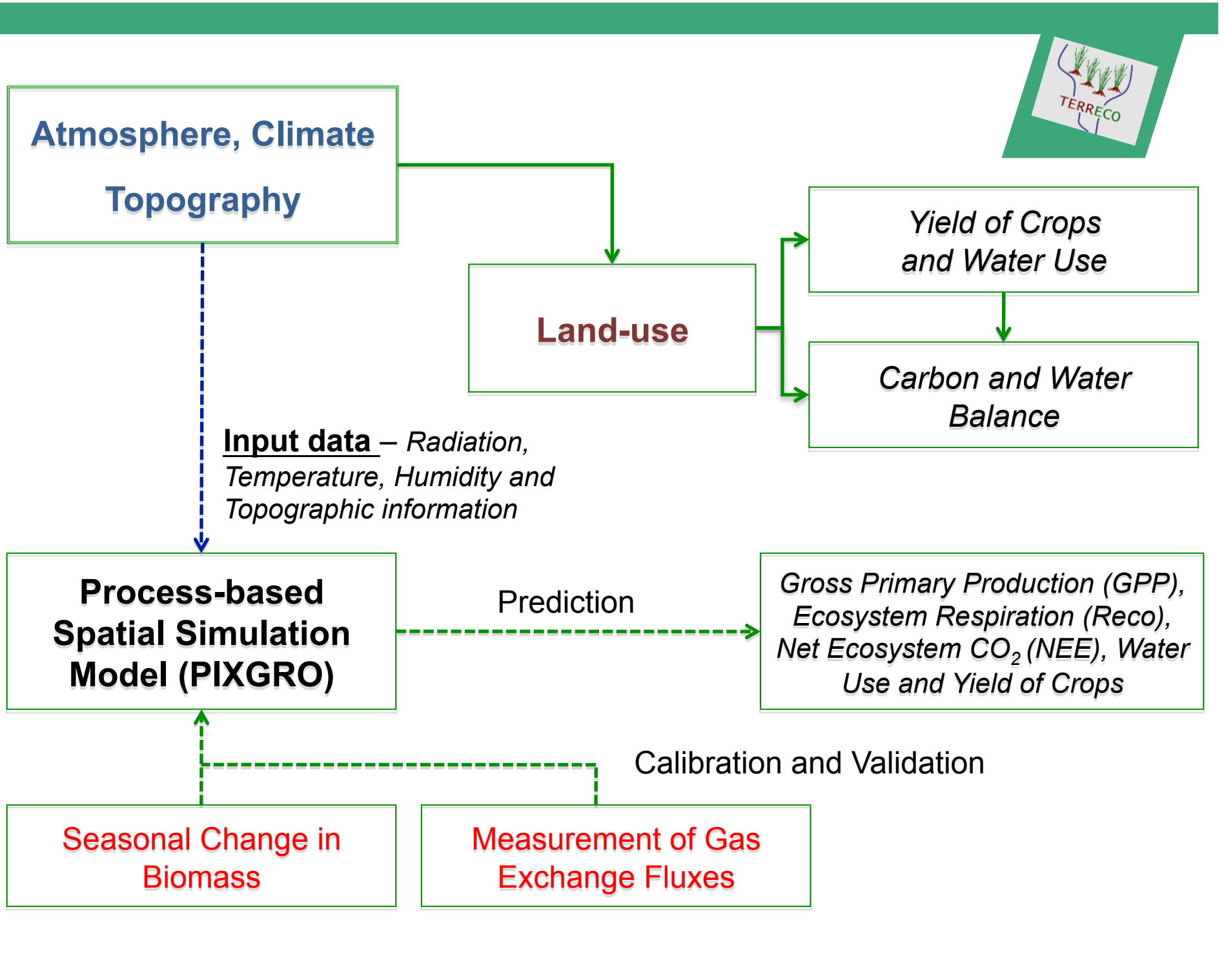
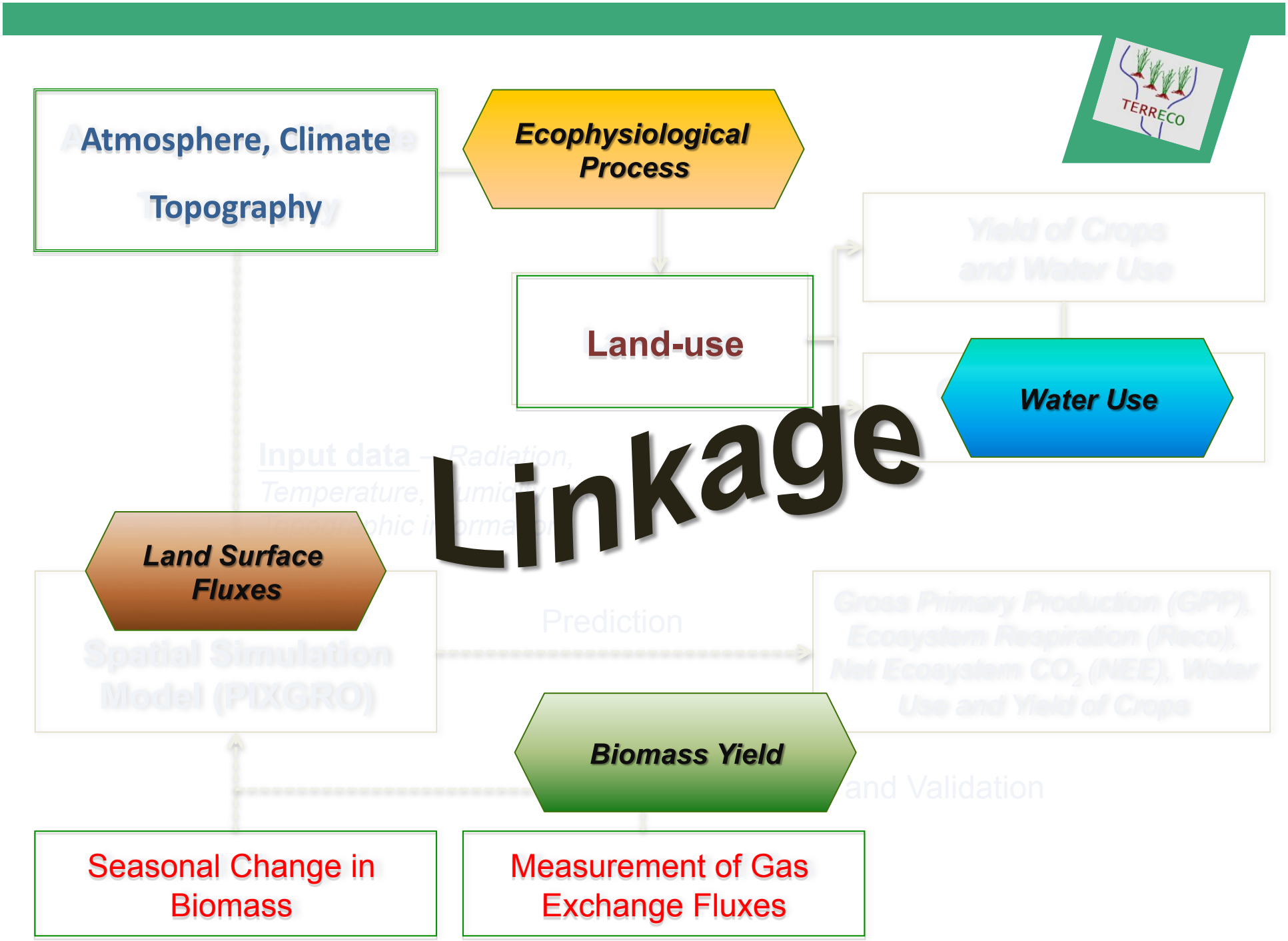
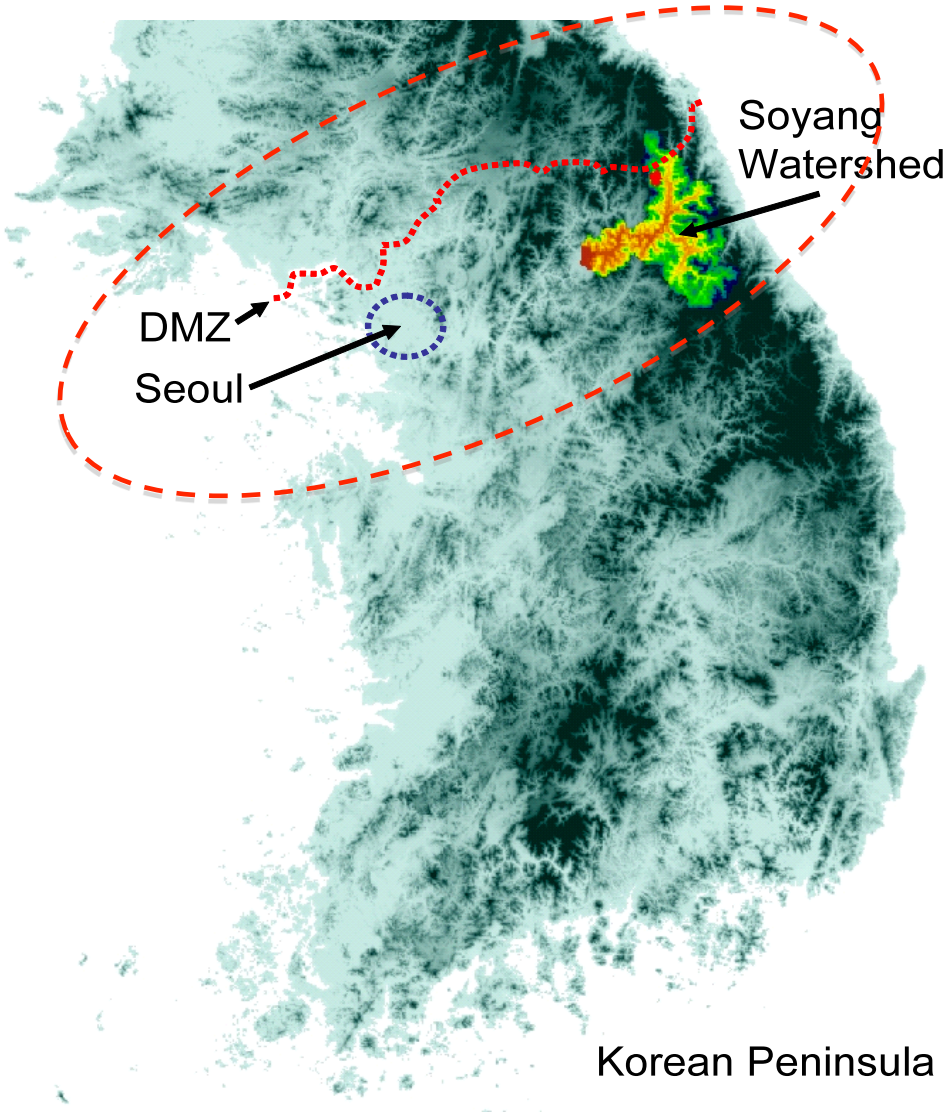
Introduction


Atmosphere, Climate
Topography
Land-use
Yield of Crops and Water Use
Carbon and Water Balance
Input data – Radiation, Temperature, Humidity and Topographic information
Process-based Spatial Simulation Model (PIXGRO)
Prediction
Gross Primary Production (GPP), Ecosystem Respiration (Reco), Net Ecosystem CO_2 (NEE), Water Use and Yield of Crops
Calibration and Validation
Seasonal Change in Biomass
Measurement of Gas Exchange Fluxes


Atmosphere, Climate
Topography
Ecophysiological Process
Land-use
Water Use
Linkage
Land Surface Fluxes
Biomass Yield
Seasonal Change in Biomass
Measurement of Gas Exchange Fluxes

Materials and Methods

Site Description



Simulation Model PIXGRO

Input

Meteorological drivers (Hourly)
- Radiation
- Temperature
- Precipitation
- CO_2

Land and Soil
- Soil Data Base
- DEM
- Land Cover
- Fertilizer Use

- MODIS 250m

$PROXEL_{NEE}$
Canopy processes

- Leaf Energy Balance
- Gross Primary Production (GPP)
- Canopy Conductance
- Transpiration Rate, ET

LAI

Fluxes

Fluxes

CGRO
Growth & Development
(Grass, Tundra Wetlands, Crops)

- Carbon Uptake
- Whole Plant Respiration
- Growth Allocation
- Nutrient Uptake
- Phenology & Development

Flux Summary
(Woody Vegetation)

- Carbon Uptake
- Leaf Respiration
- Microbial plus Wood and Root Respiration
- Soil CO_2 Efflux
- ET

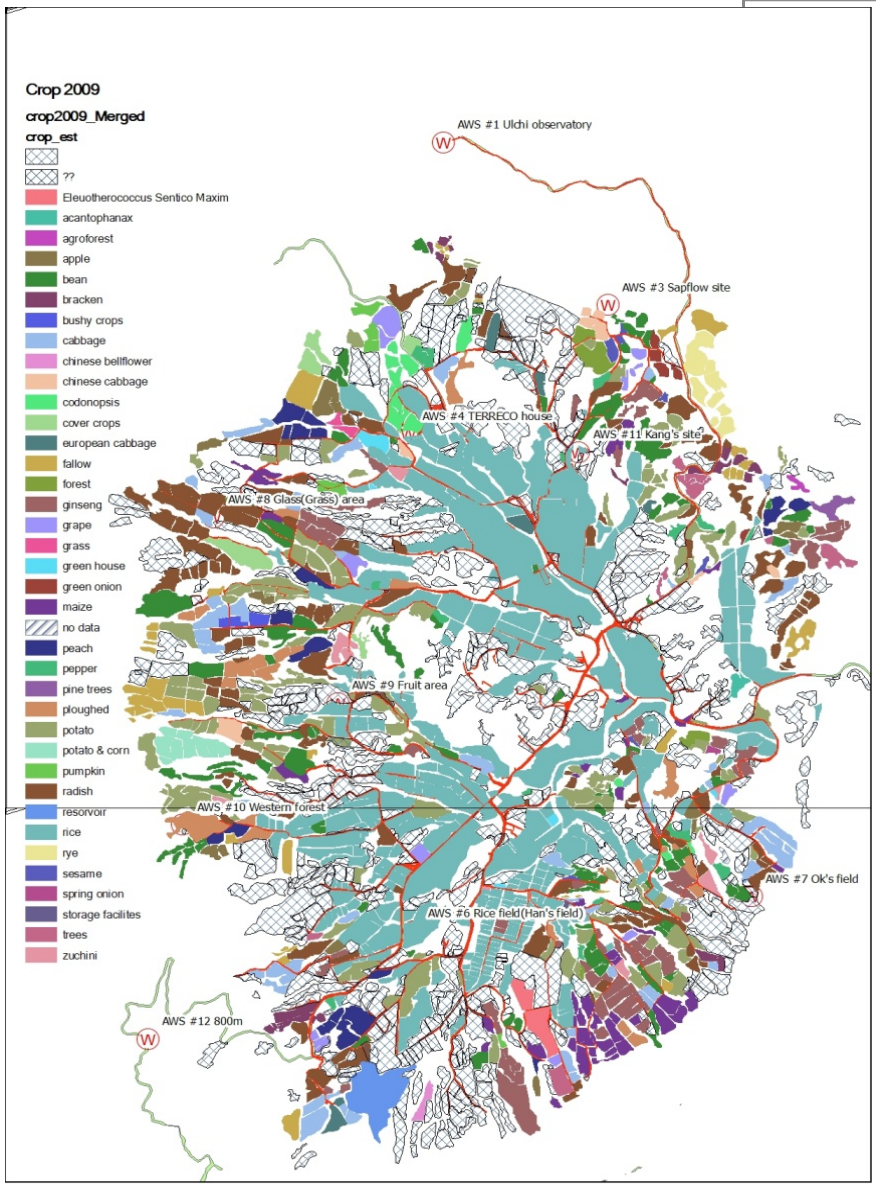
Water stress factor

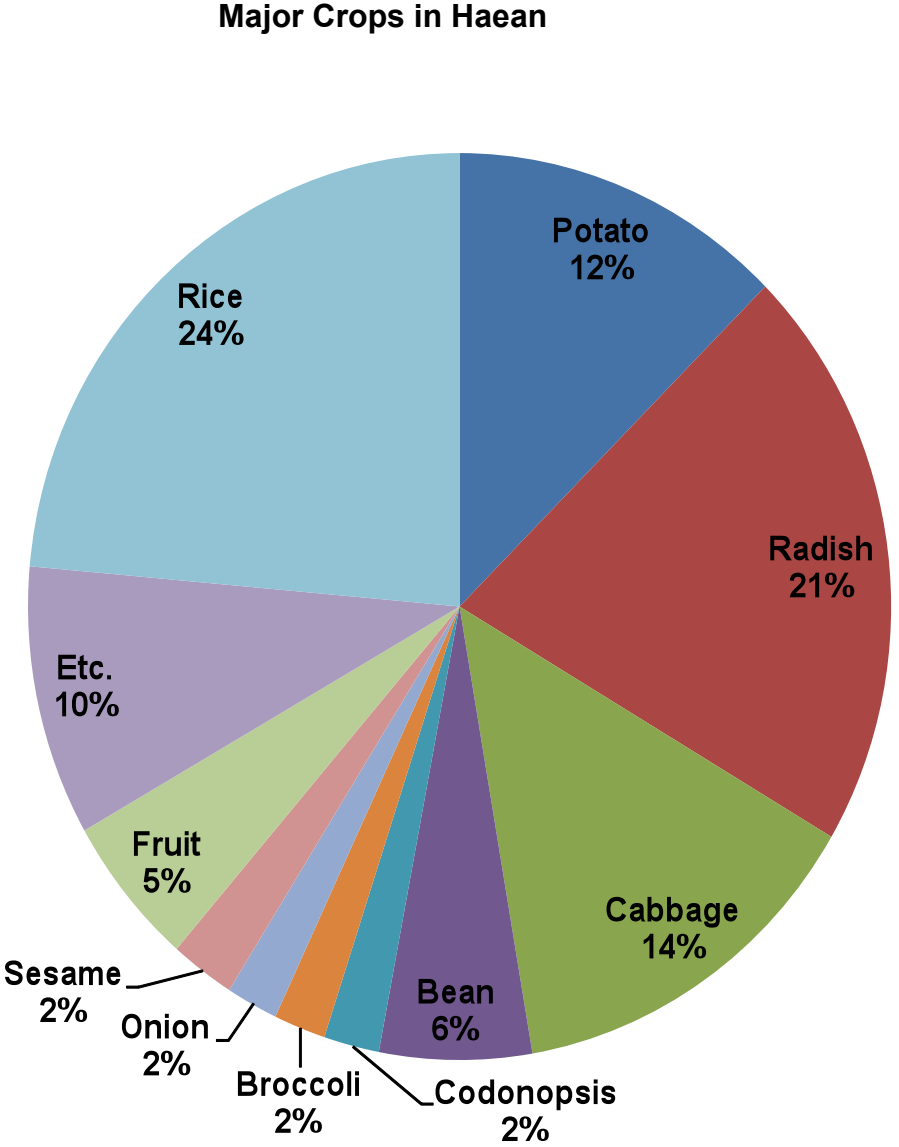
Soil Stores

Output

- Total Biomass
- Leaf Weight
- Stem Weight
- Root Weight
- Grain Weight
- Transpiration
- Crop Stage
- WUE, NUE

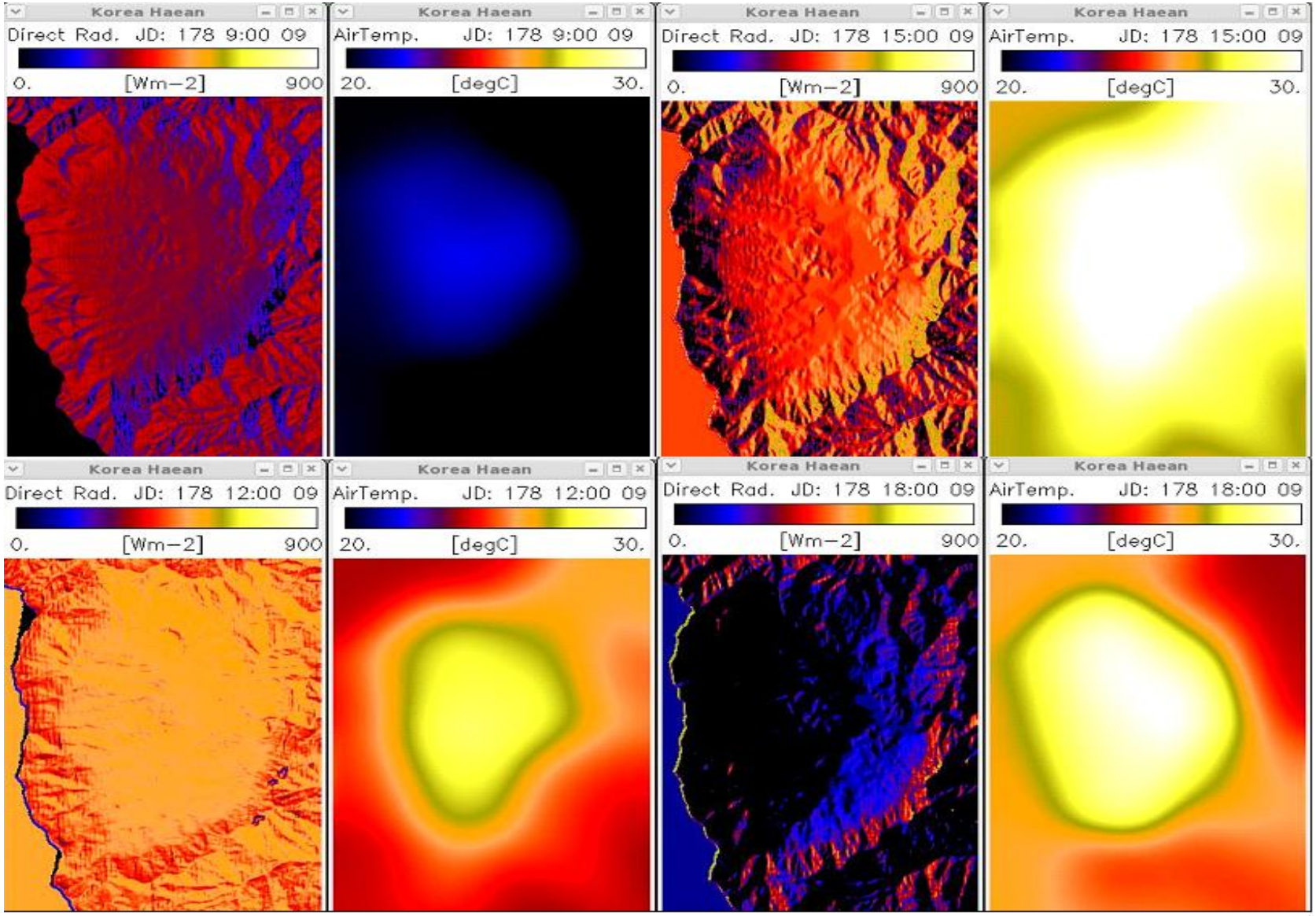
- Photosynthesis (GPP)
- Respiration (Reco)
- NEE
- Water Use and Soil Water Status



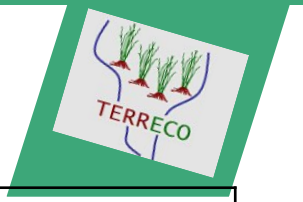


2009: CO_2 chamber measurement and yield survey were processed for 5 dominating crops, e.g., rice, potato, radish, cabbage and bean.

Spatial Framework

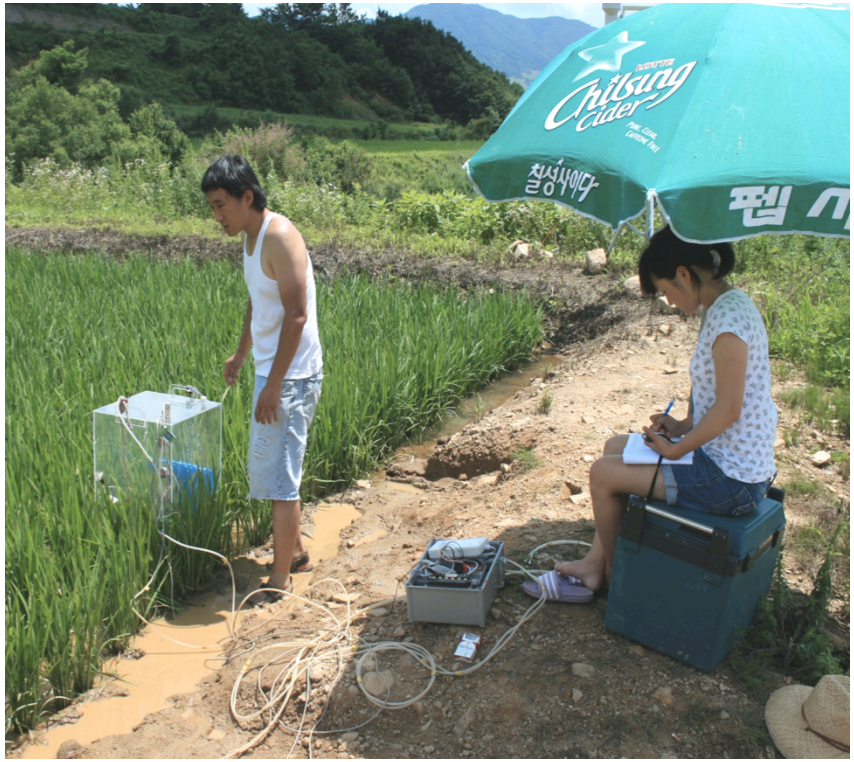


Needed Key Parameters of PIXGRO

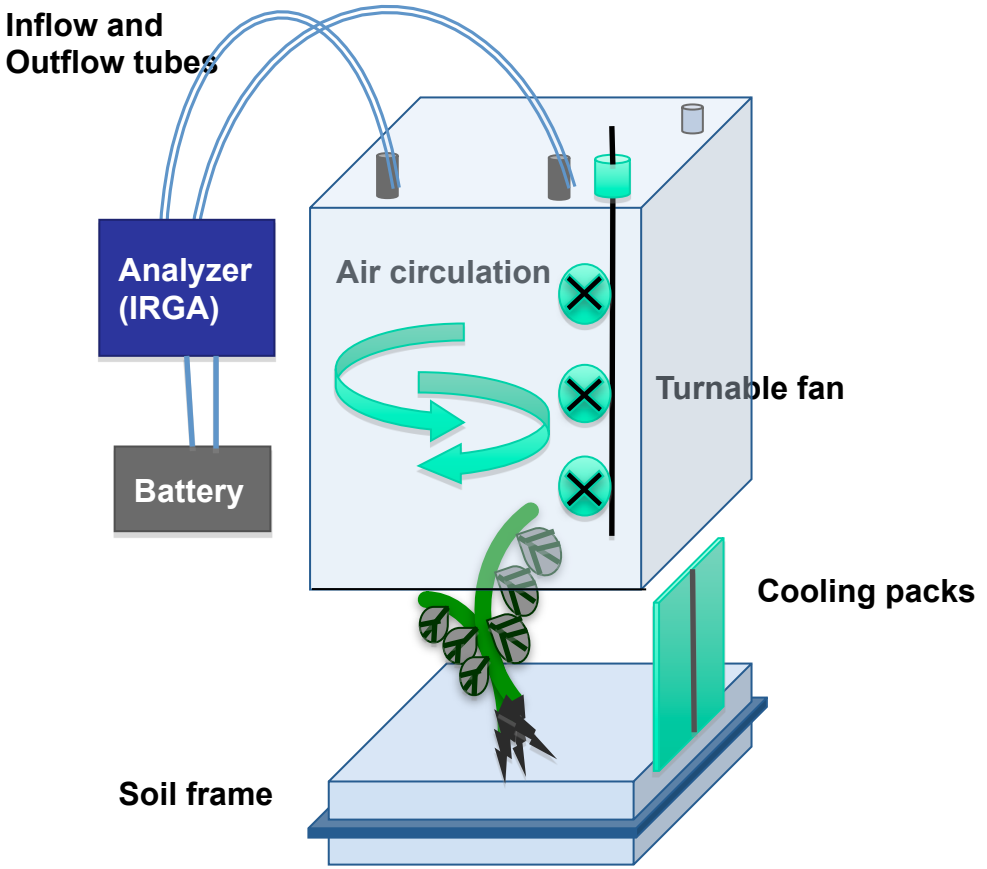


Parameter	Definition	Value	Unit
J_{max}	Electron transport capacity at 25 °C	21.7	µmol m^{-2} s^{-1}
Vc_{max}	Carboxylation capacity at 25 °C		µmol m^{-2} s^{-1}
Rd	Respiratory capacity at 25 °C	2.1	µmol m^{-2} s^{-1}
E	Growth respiration/conversion factor	0.7	g (tissue) /g (CH_2O)
K_m	Maintenance respiration constant	0.0006	g CH_2O / g tissue-h
B	Maintenance respiration coefficient	0.0693	$°C^{-1}$
SLA	Specific leaf area	200	cm2/g
V	Leaf area senescence factor	0.0005	cm2/hr
Phenophase threshold	Planting		°C day above 0 °C
	Flowering		°C day above 0 °C
	Graining		°C day above 0 °C
	Dormancy		°C day above 0 °C
Partitioning coefficients	Biomass partitioning coefficients of leaves, stems, roots and grain		

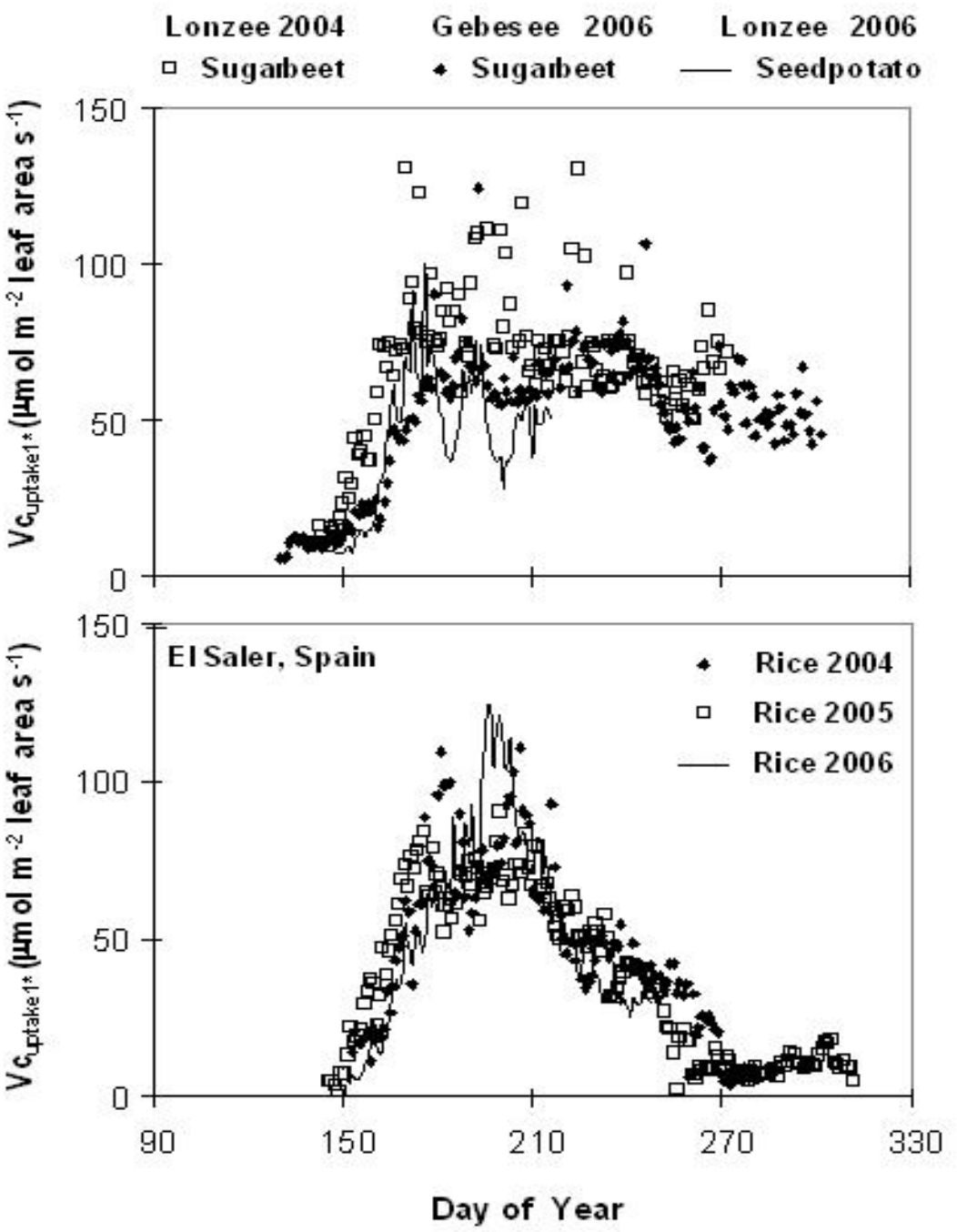
Measurement of Gas Exchange Fluxes



Validation via chamber and (in development) eddy covariance flux measurements



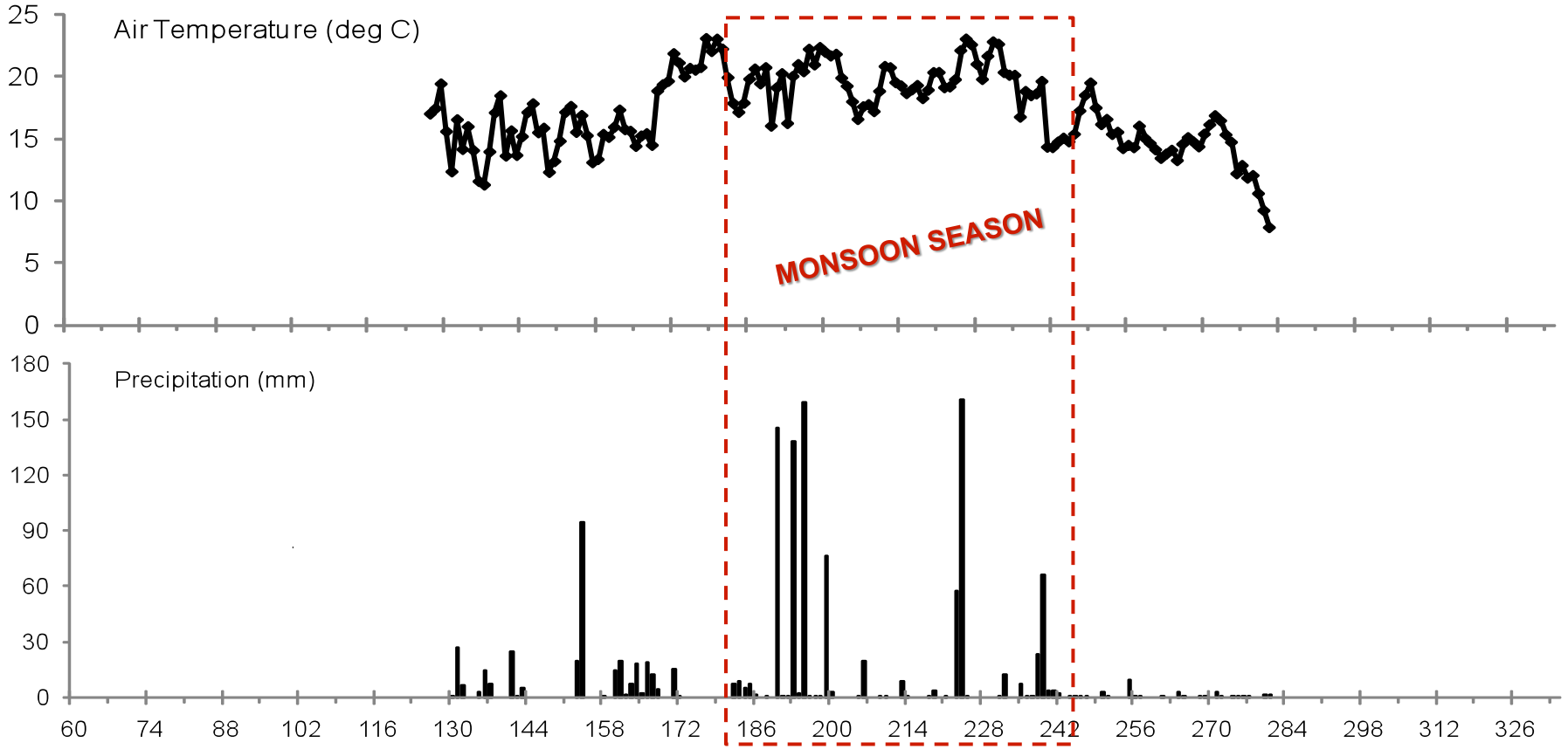
Chamber components



Hypothesized seasonal change in the physiological parameter, Vc_{uptake} based on flux measurements at other sites (CARBOEUROPE)

Key parameter for the PROXEL sub-model of PIXGRO for root crops and rice

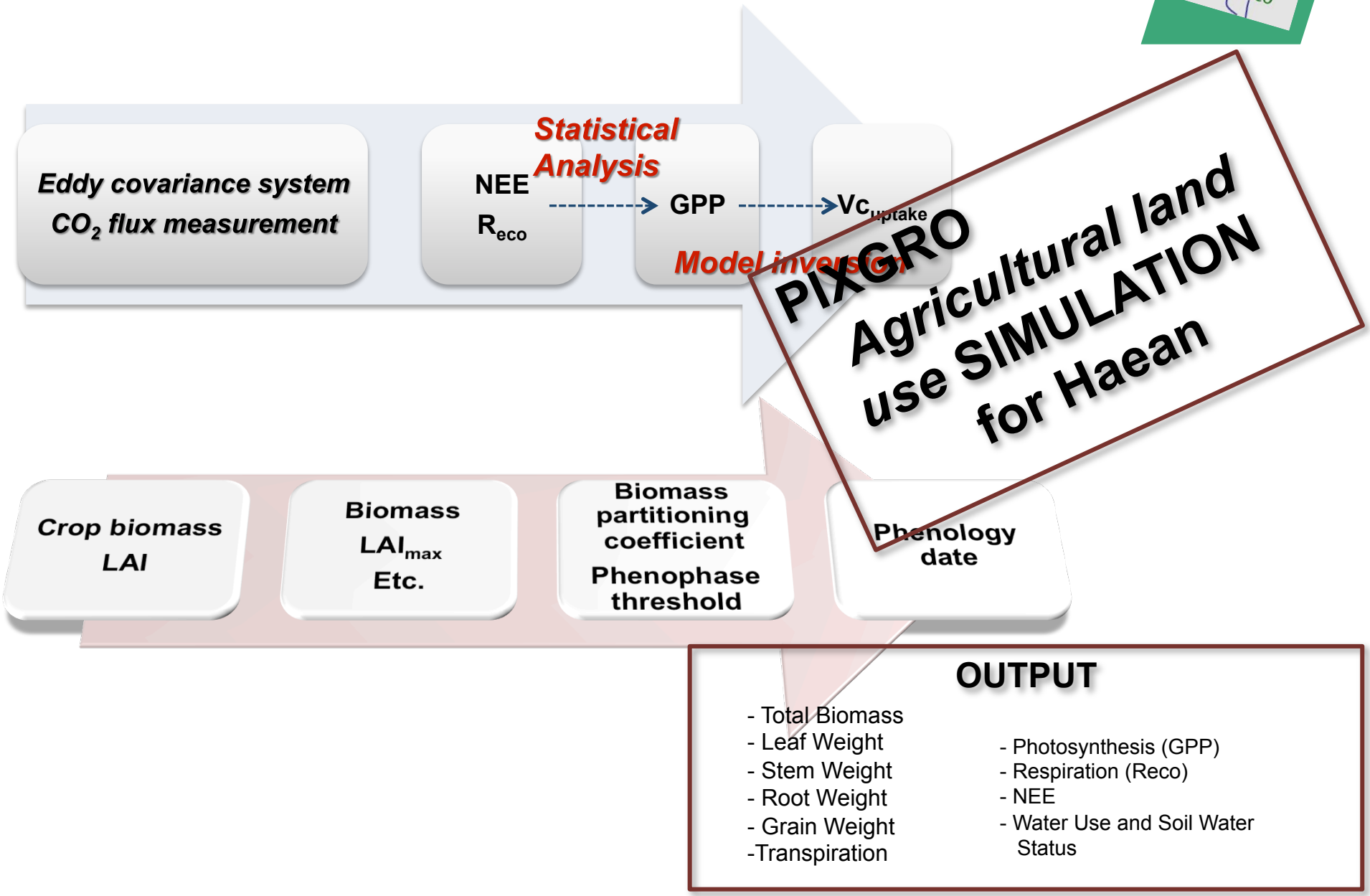
Methods can be applied to all crops and ecosystem types



Crop	March	April	May	June	July	August	September	October	November
Bean				27.5 (147)				31.10 (304)	
Cabbage				20.5 (140)		20.7 (201)			
Potato				30.4 (120)			31.8 (243)		
Radish				2.6 (153)			23.8 (235)		
Rice				17.6 (137)				10.10 (283)	

Planting date
Harvest date
Date of basal application of fertilizer
7 to 10 days
Chamber measured

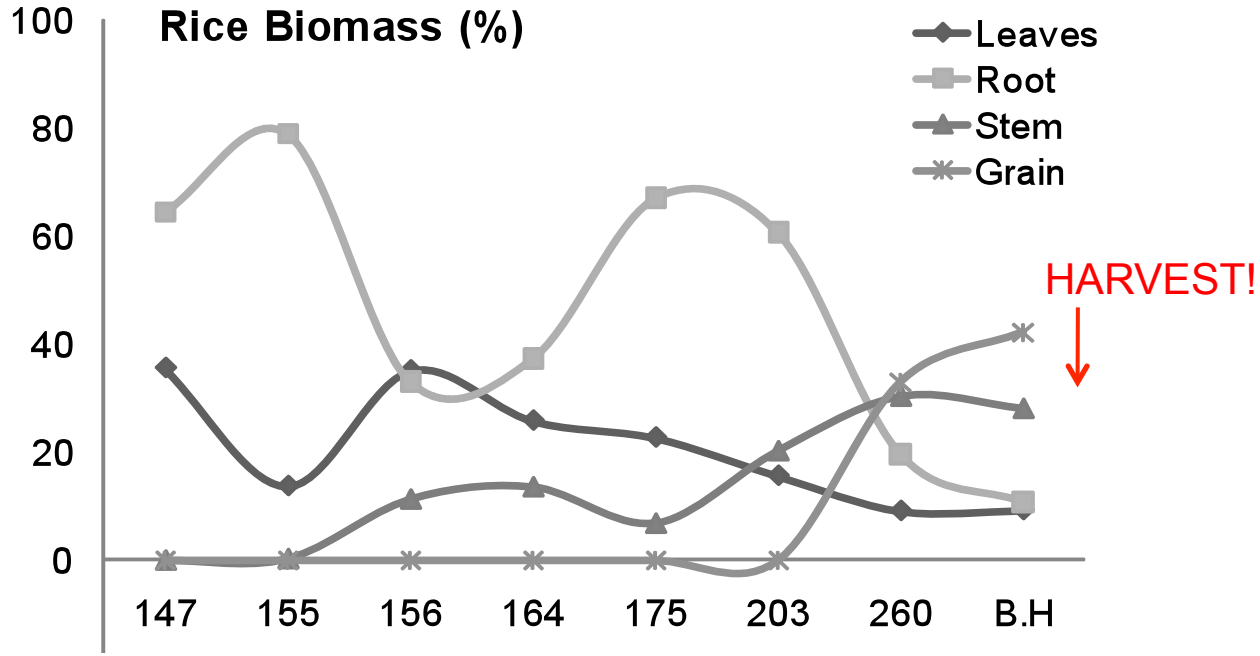
Application of Measurement

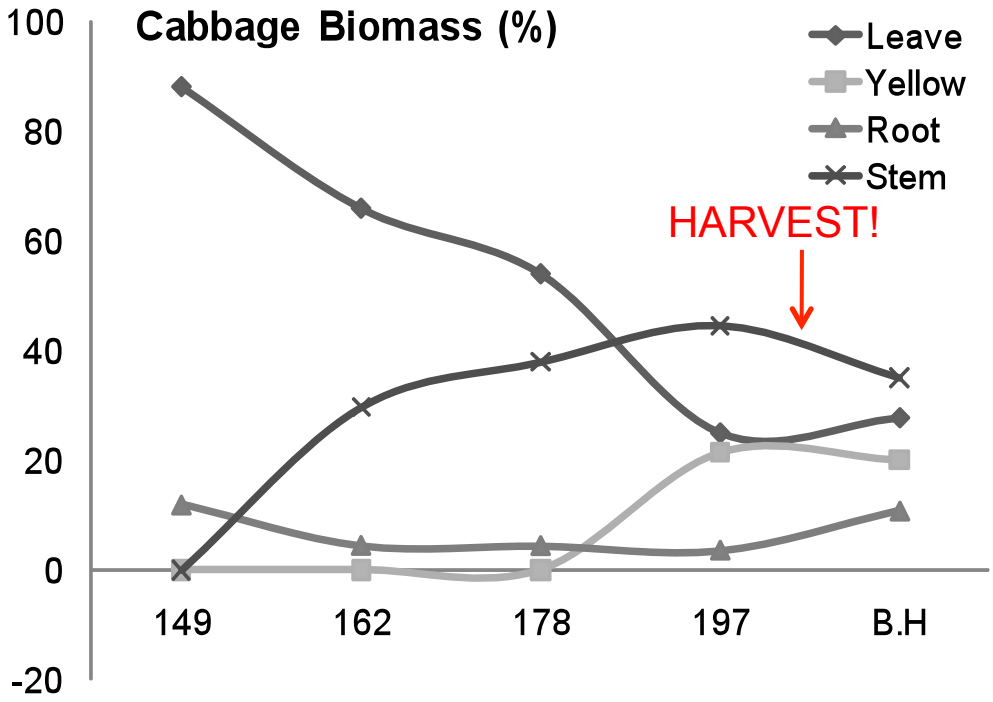


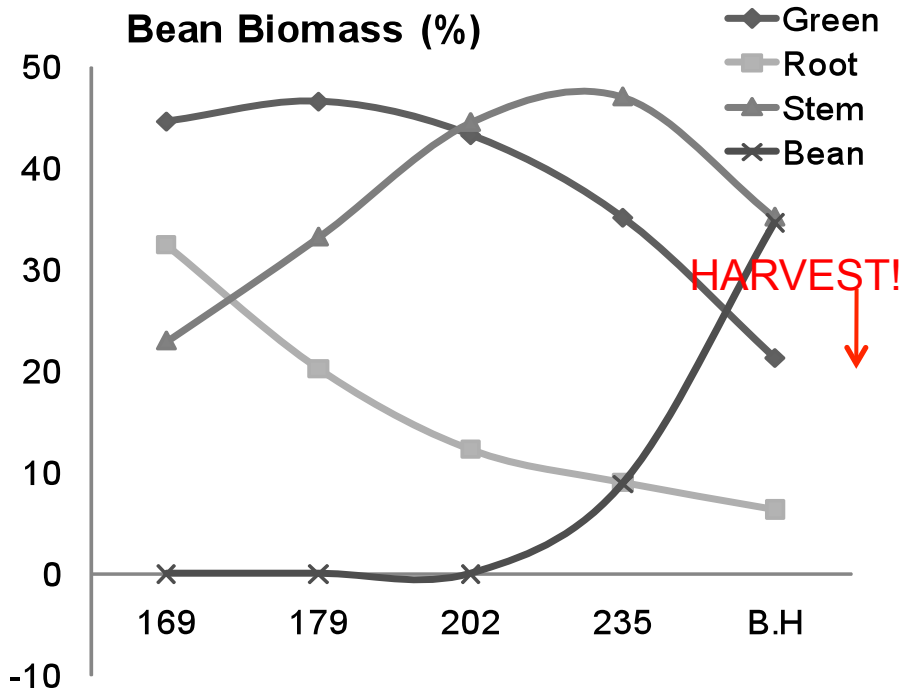
Results

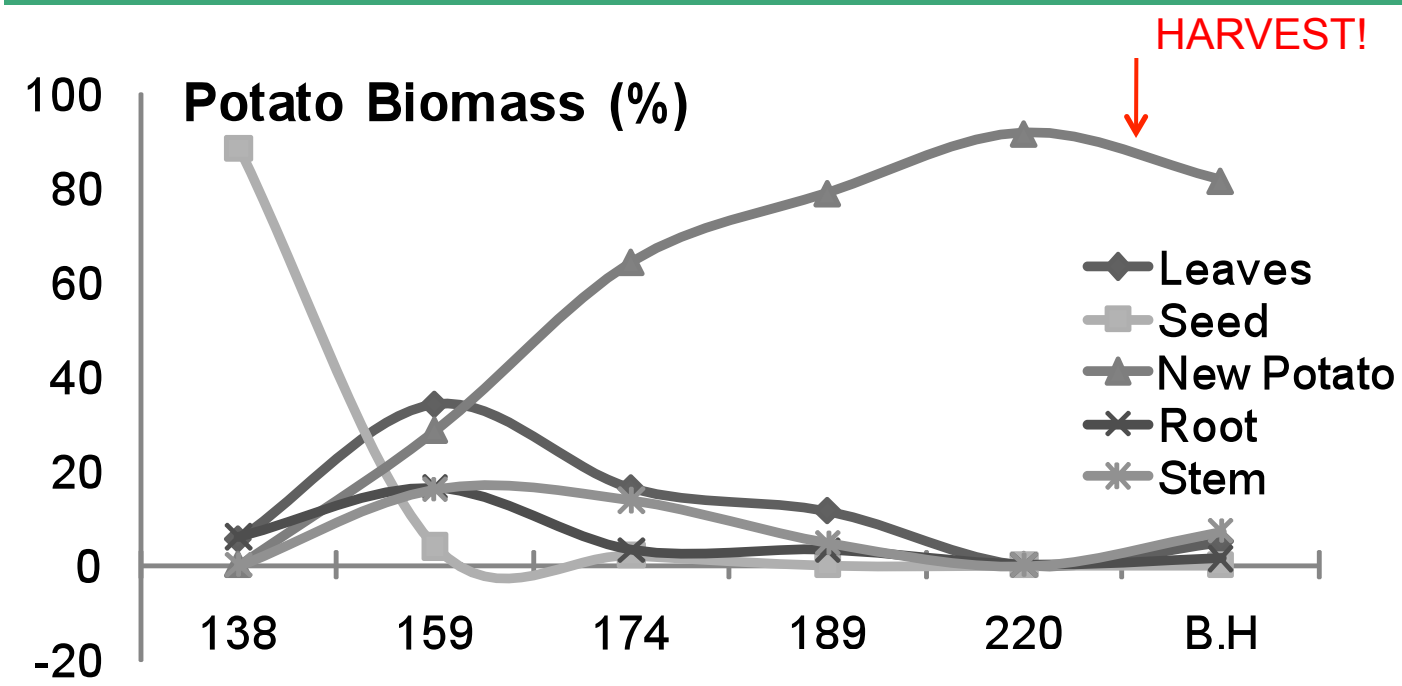
Crop Biomass

Max LAI	
Rice	2.83
Cabbage	7.21
Bean	5.99







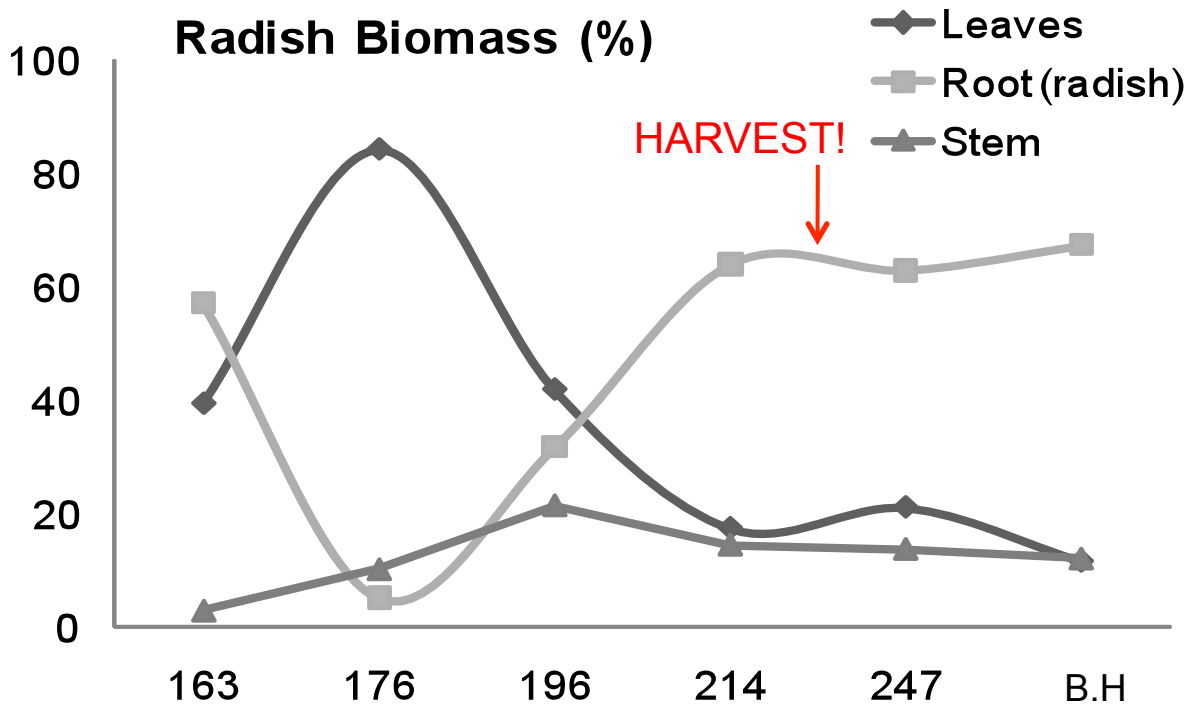


Root Crop

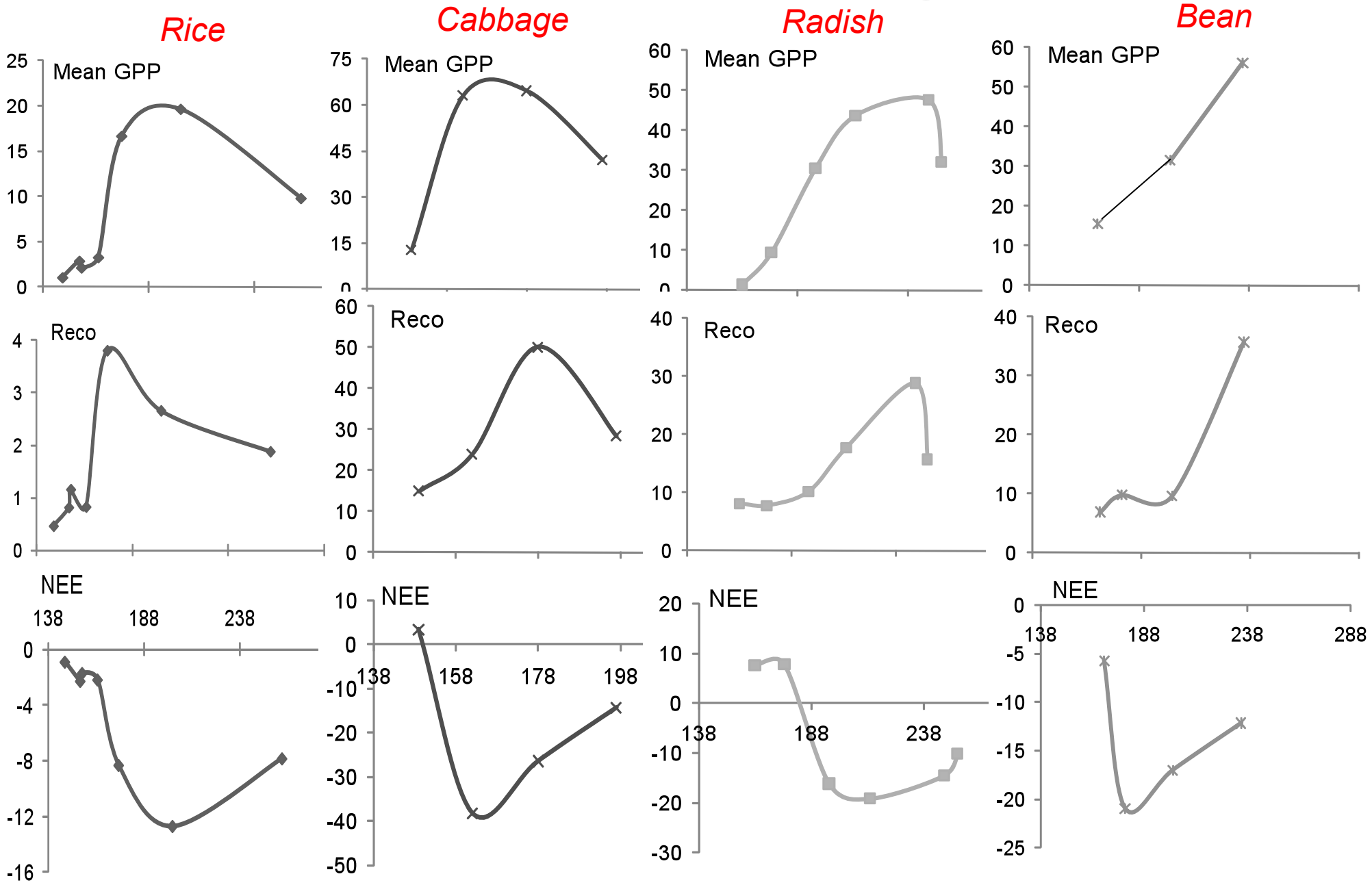
Max LAI

Potato 2.31

Radish 4.29



Seasonal course in maximum exchange rates

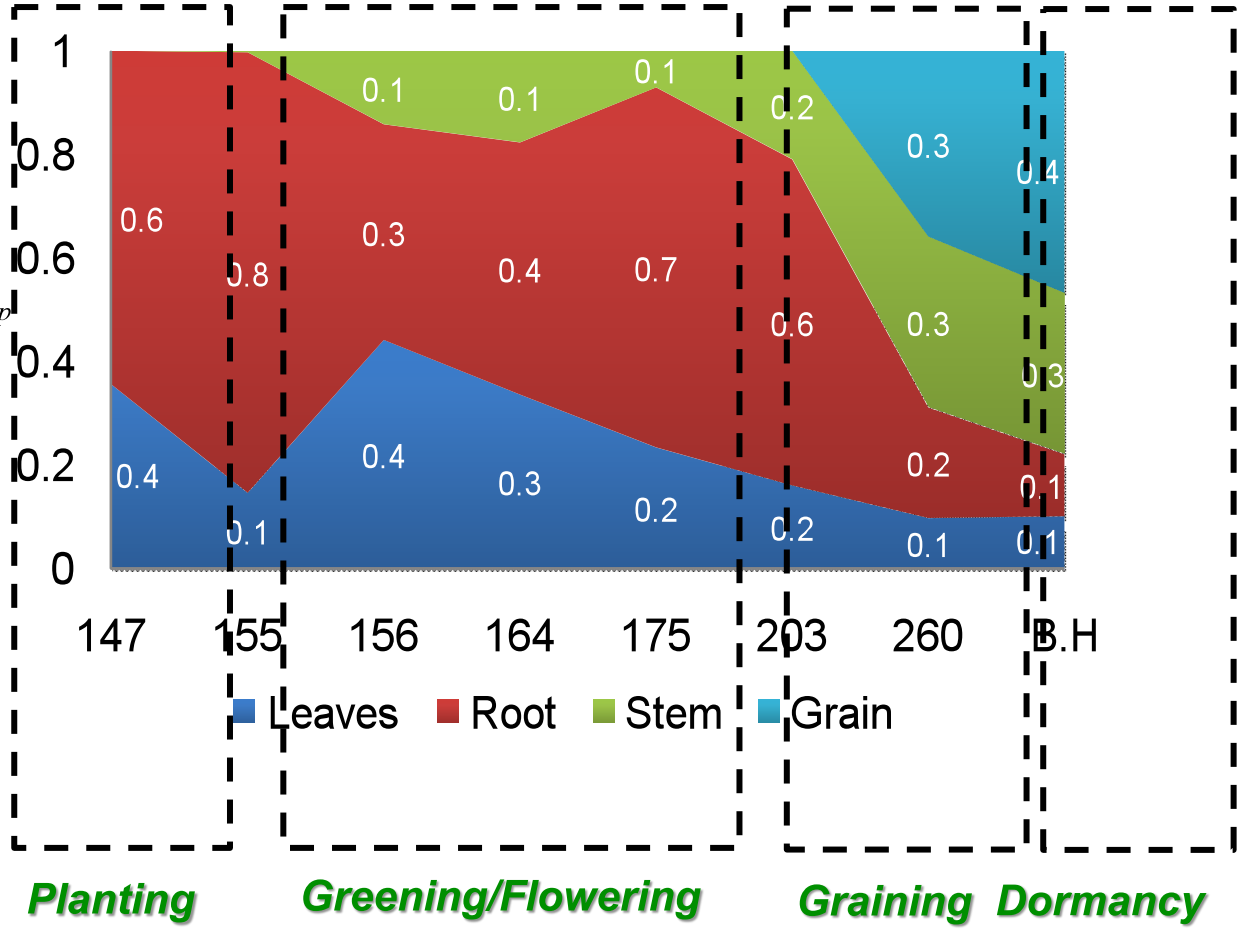


Measured data of Biomass Partitioning

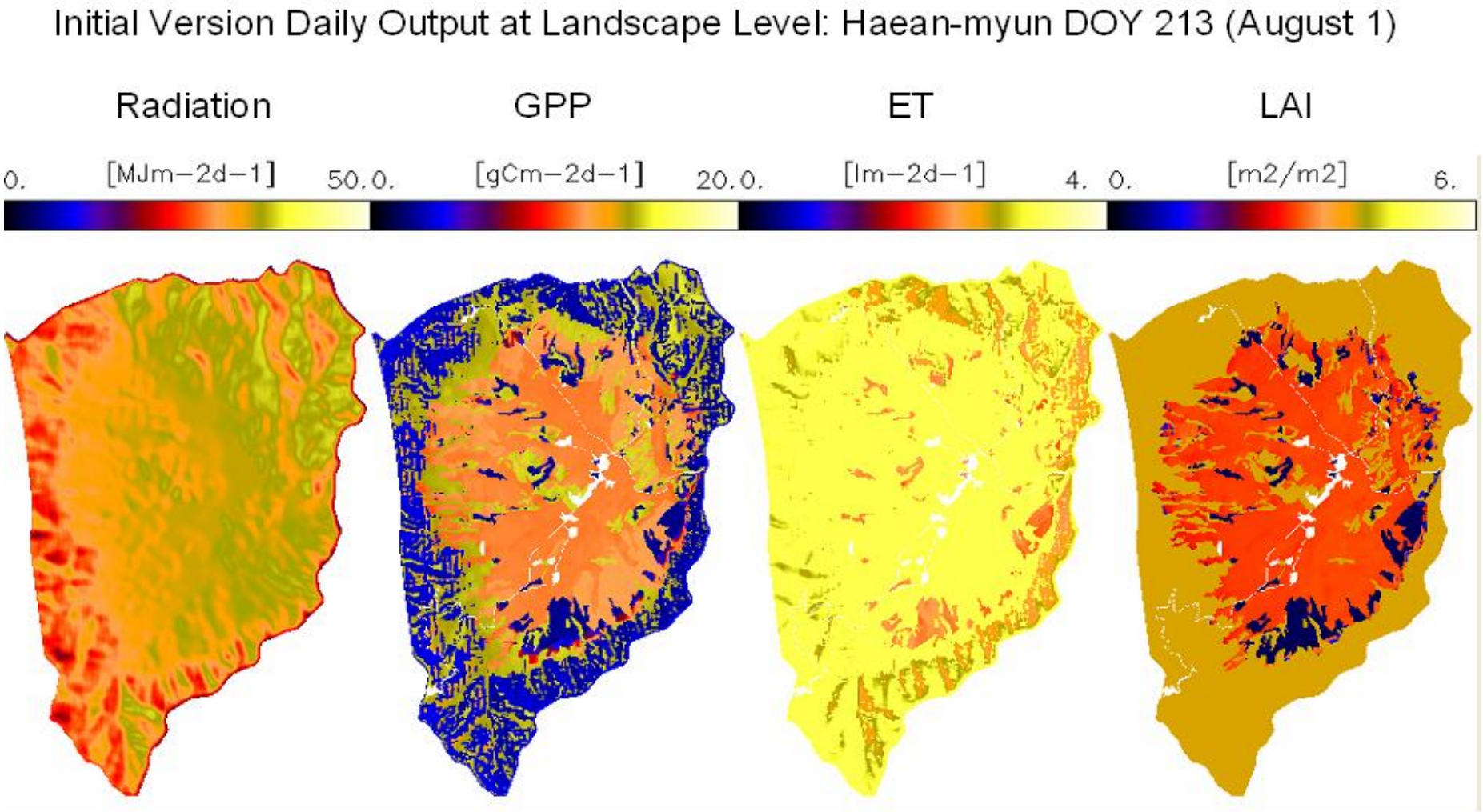
$$\frac{dW_{p_i}}{dt} = \eta_{p_i} \frac{dW}{dt}$$

η_p the partition coefficient

i 5 crops (bean, cabbage, potato, radish and rice)



Daily Outputs for Haean



Conclusions and Ongoing Work

- **Field Experiment provides**
  - crop yield, biomass, LAI
  - agricultural land surface fluxes
  - database of model parameters

Ecosystem response

- **PIXGRO provides**
  - a useful landscape level tool
  - a simple mechanistically-based approach
  - opportunities for validation of process interactions at several scales

- **Ongoing work**
  - To extend the spatially explicit simulation of yield to include many crops
  - To estimate services derived from at least 10 land use types
  - To include influences with respect to management
  - To derive key parameters using model inversion
  - To calculate spatial parameters through remote sensing
  - To develop and evaluate scenarios of expected global change in the Haean basin

Thank you