

Dedicated to the 50th anniversary celebration of the Chinese academy of Forestry

*Measurement of poplar carbon flux in Eastern China:
Recent example using eddy covariance method*

ZHANG Xudong, WEI Yuan^{1,2}

1.Department of Ecological Engineering
Research Institute of Forestry
Chinese Academy of Forestry

2.Key lab of Silviculture
State Forestry Administration

FAO-IPC, Oct 29 Beijing



outline

- Background and objectives
- Introduction to study area
- Method and equipment
- First Data & Result
- Summary and conclusions

Background and objectives

■ Background

- Carbon Source/Sink of terrestrial ecosystem has become an important issue in ecological research concerning about the climate change and global warming.
- Compare with other ecosystem, forest carbon storage play a dominant role in the terrestrial carbon cycle and therefore many research are currently focusing on carbon sequestration and mechanisms of environmental control to this process.
- Currently, China's plantation area is $5.4 \times 10^7 \text{hm}^2$. Poplar plantation distributes widely in China because of its fast growth and strongly adaptive ability to ecological environment.
- The poplar plantation occupies $7 \times 10^6 \text{hm}^2$ which is 13% of the total plantation area, so the carbon sink of the poplar plantation is very important for carbon sink in China.
- USCCC :USCCC was established on December 16, 2003 in Beijing, P.R. China as a collaborative consortium between American and Chinese institutions that have interests in studying the role of managed ecosystems in the global carbon and water cycles.

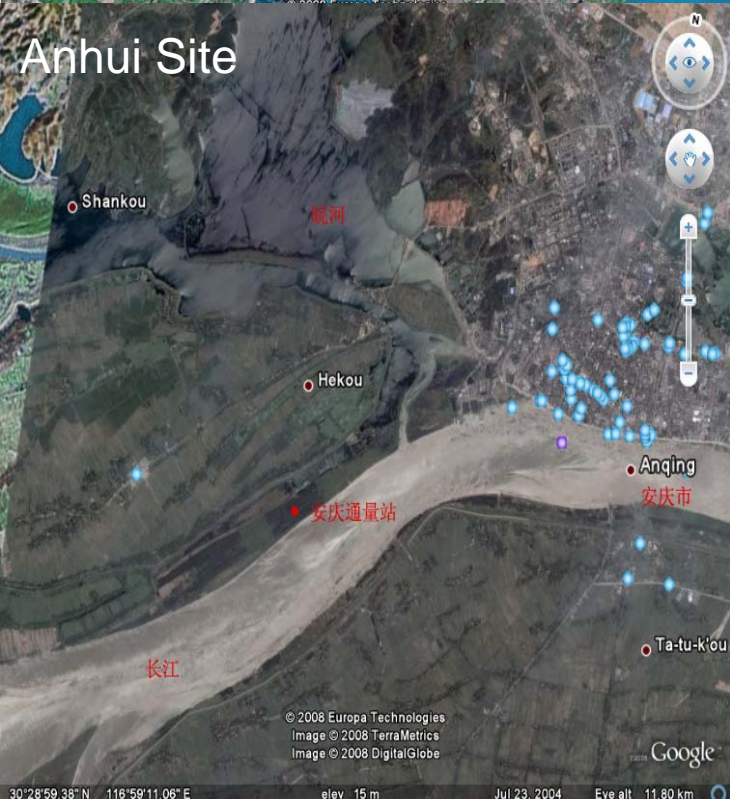
Objectives

- Quantify CO₂ exchange in poplar ecosystems: daily ,seasonal variability and annual budget
- Improve our basic understanding of biophysical processes that govern CO₂ exchange in *poplar* ecosystems. What environmental control the carbon exchange)

Introduction to study area

- The two sites were located along the Yangtze River.
- Climate at both sites was generally wet monsoon climate with gentle summer-winter gradients in temperature.



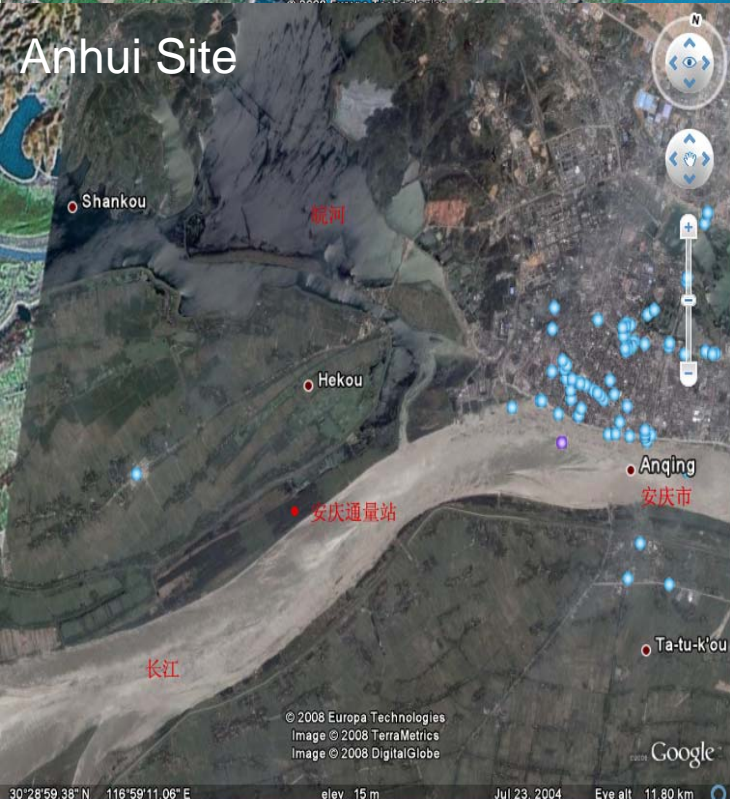


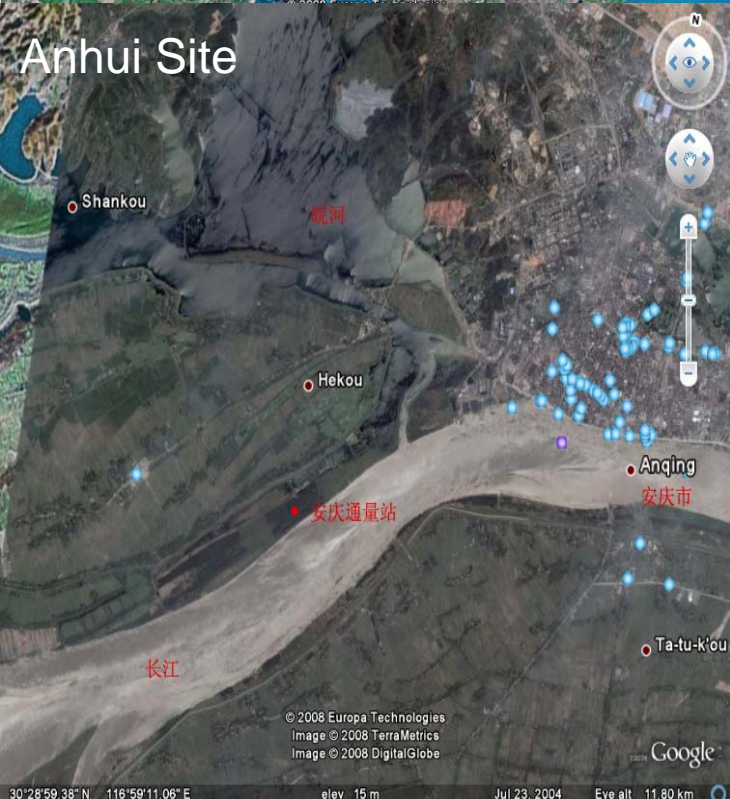
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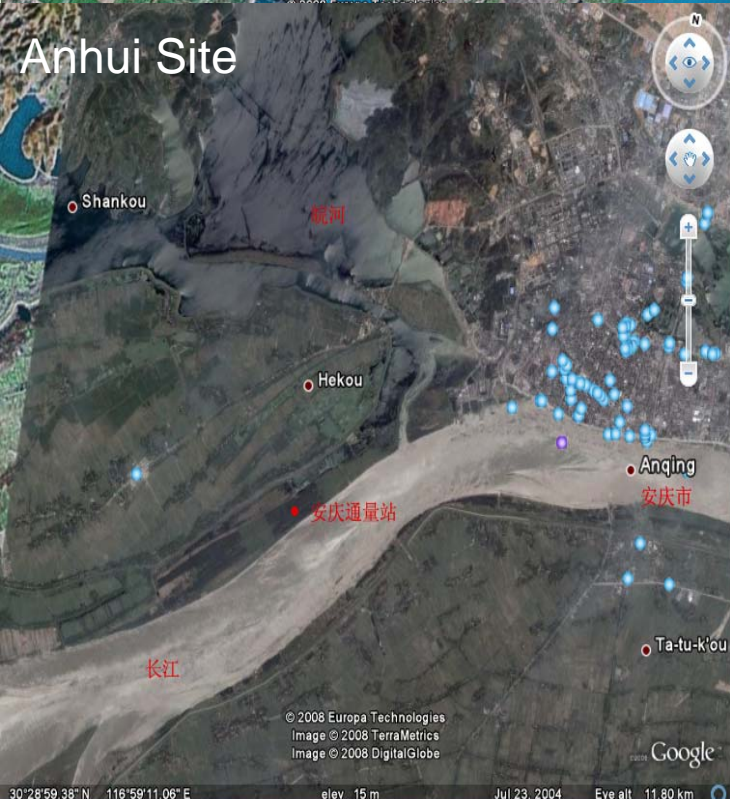




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4. The climate is characterized by annual rainfall of about 1200.7—1414.6mm (Anhui is about 1500mm), mean annual temperature of about 16.5~17.0°C (Anhui is about 16.7) and high relative humidity (80% on average),

Method

- What is eddy covariance?
- A measurement technique for surface atmosphere exchange that makes use of turbulence and concentration measurements

$$\text{Flux}_{\text{CO}_2} = \overline{w' \text{CO}_2'}$$

w' = vertical wind

$$\text{CO}_2 = (\text{CO}_2 + \text{CO}_2')$$

- Continuous Measurements
- Long-term
- Ecosystem scale/landscape level

equipment

- In order to evaluate the carbon sequestration in a typical poplar plantation, an eddy covariance unit was installed at a 23 meter tower (Anhui Site is 30m), to measure turbulent fluxes of mass and energy.
- The eddy covariance unit comprised one three-dimensional ultrasonic anemometer((CAST3, Campbell, USA) and one open path gas analyzer IRGA Li-7500. Measurements of CO₂ and H₂O fluxes in the constant flux layer were made continuously since February 2004. Both instruments were sampled at 10 Hz. Half-hourly fluxes are calculated on-line and collected by a CR5000 data logger (Campbell Scientific, USA).



equipment

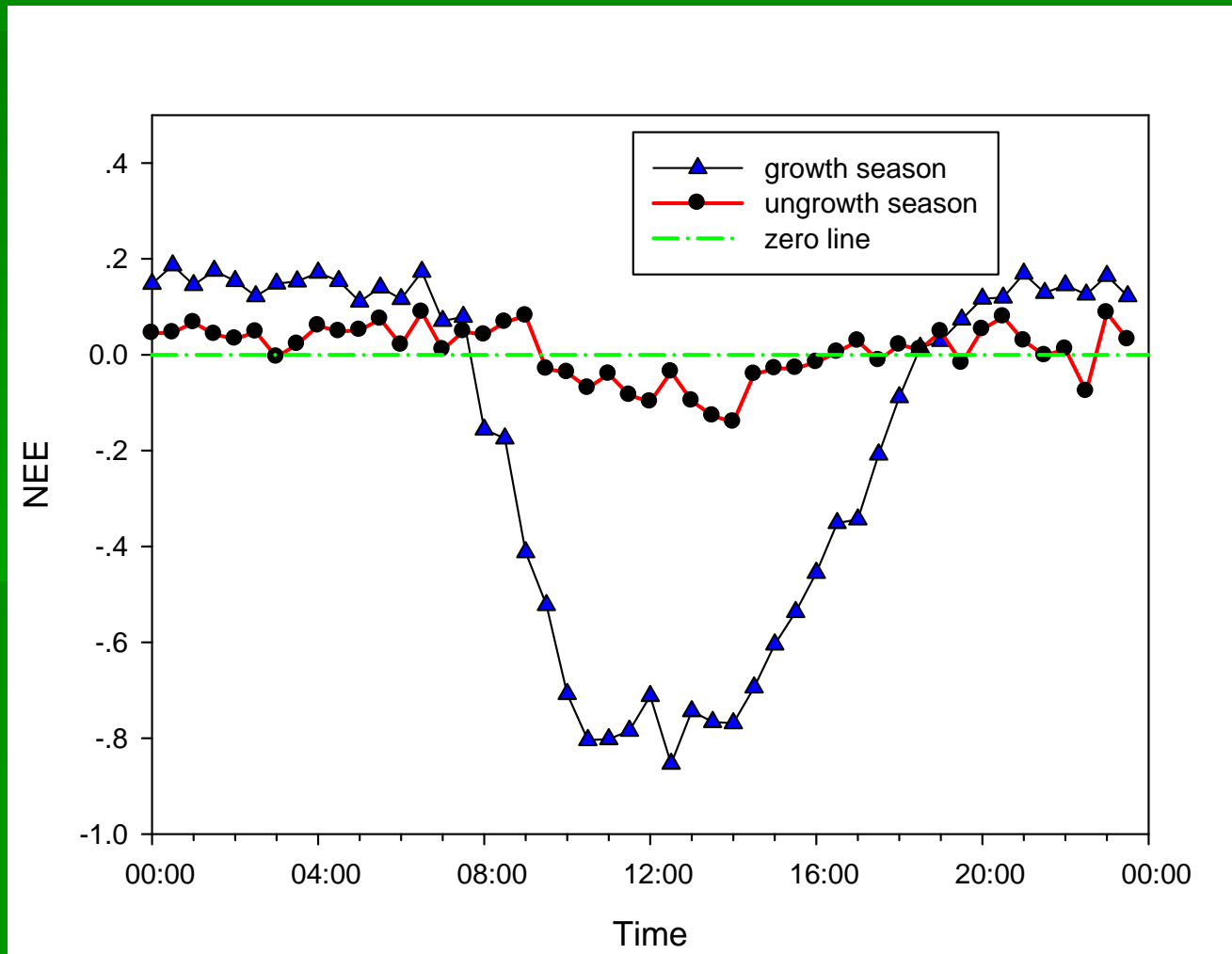
- A 4-level CO₂ profile (20m、14m、8m、2m)(Anhui is 2m、8m、16m、22m) was measured by a CR23X (Campbell, USA) controlled multi-port system connected to a Li840 gas analyzer.
- Meteorological variables were also sampled at 10Hz and calculated as half-hour statistics (CR23X, Campbell, USA). Meteorological measurements was implemented at 4-level(18m、14m、11m、4 m)(Anhui is 6m、15m、23m、28m) of the tower include air temperature and relative humidity (HMP45C, Vaisala, Finland)
- downward/upward solar radiation and net radiation (CNR1, Kipp & Zonen, the Netherlands), QPPFD (Li190SB, Li-Cor, USA)
- precipitation (TE525, Young, USA) are measured at 23 m(Anhui is 29m).
- One plates (HFP01, Hukseflux, the Netherlands) measure the heat flux at 2 cm under the soil surface.
- Soil water content is characterized by TDR probes (CS616, Campbell, USA).



First Data and Result

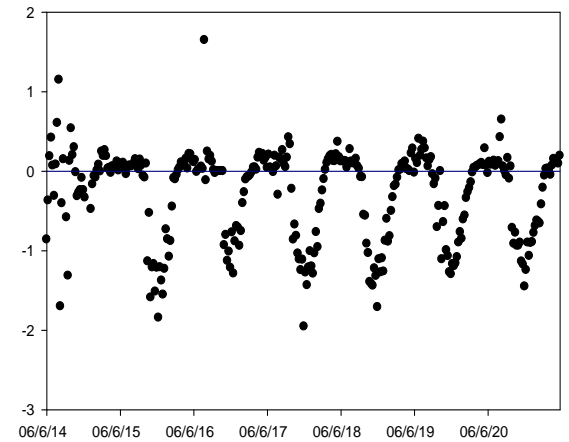
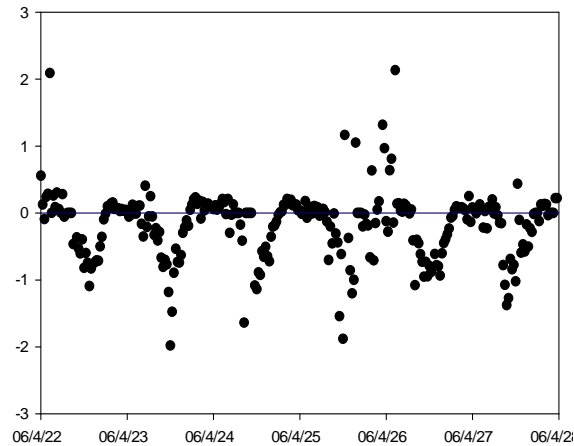
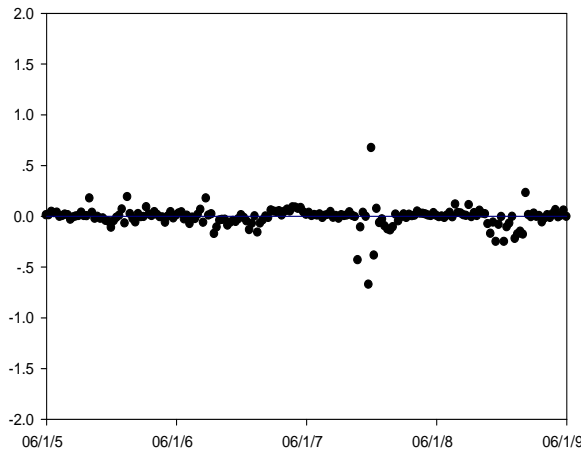
- NEE
- $NEE = F_c + F_s = NPP - R_e$

Monthly average diurnal variation of NEE during growing season and non-growing season Y-Axis unit is $\text{mgCO}_2/\text{m}^2\text{s}^1$



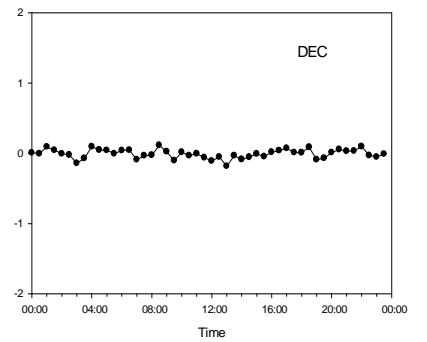
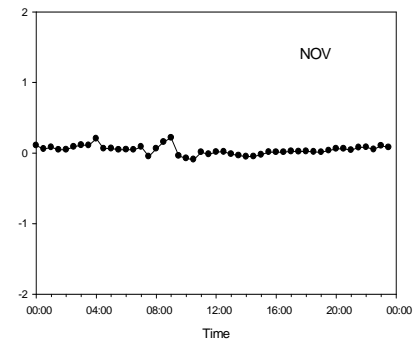
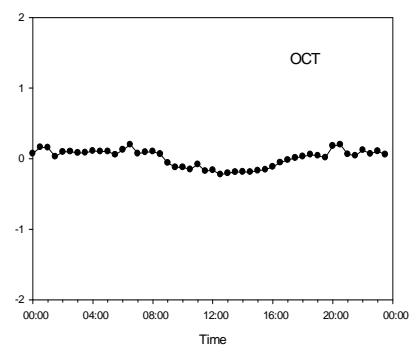
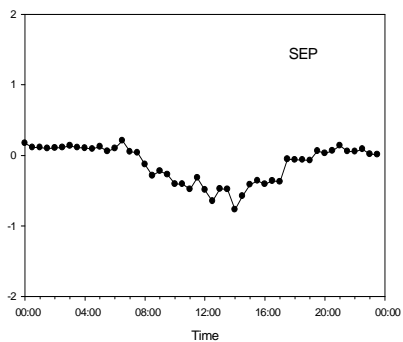
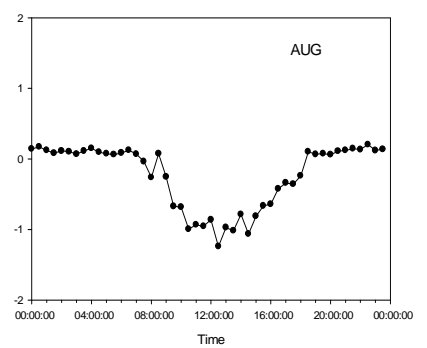
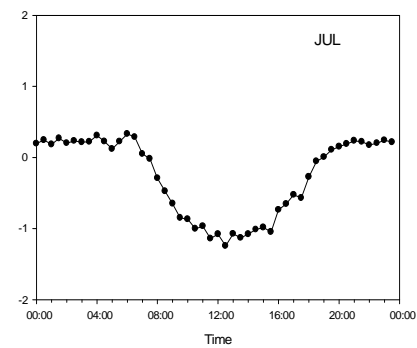
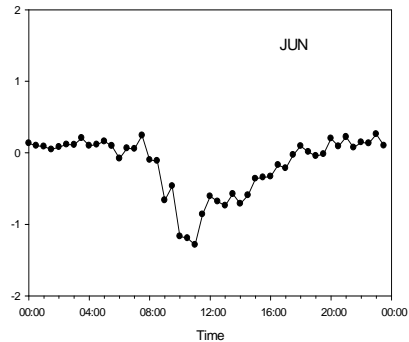
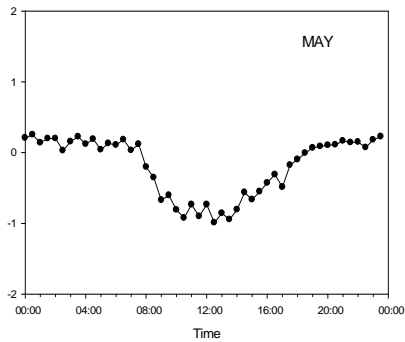
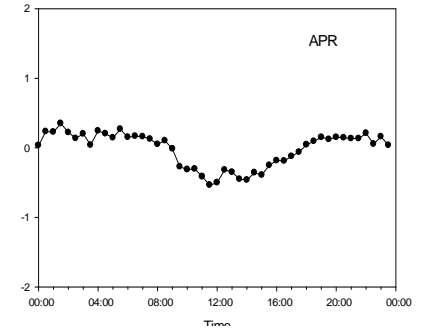
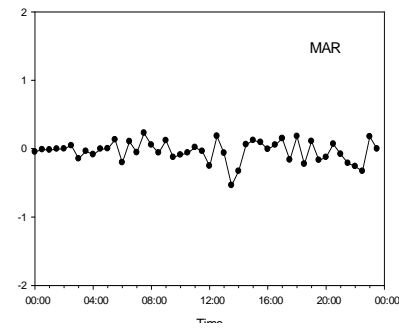
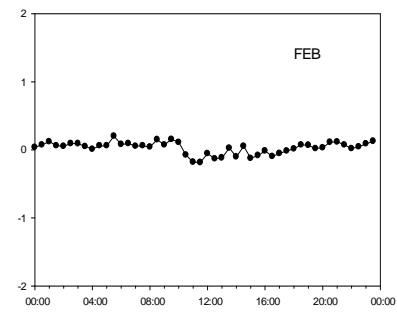
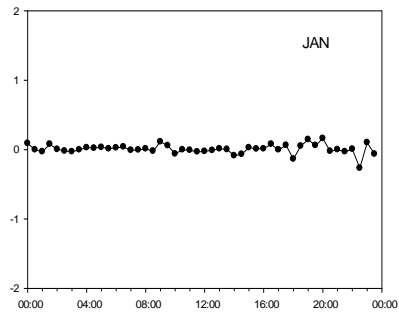
Classical daily variations of NEE during different months

Y-Axis unit is $\text{mgCO}_2/\text{m}^2\text{s}^1$

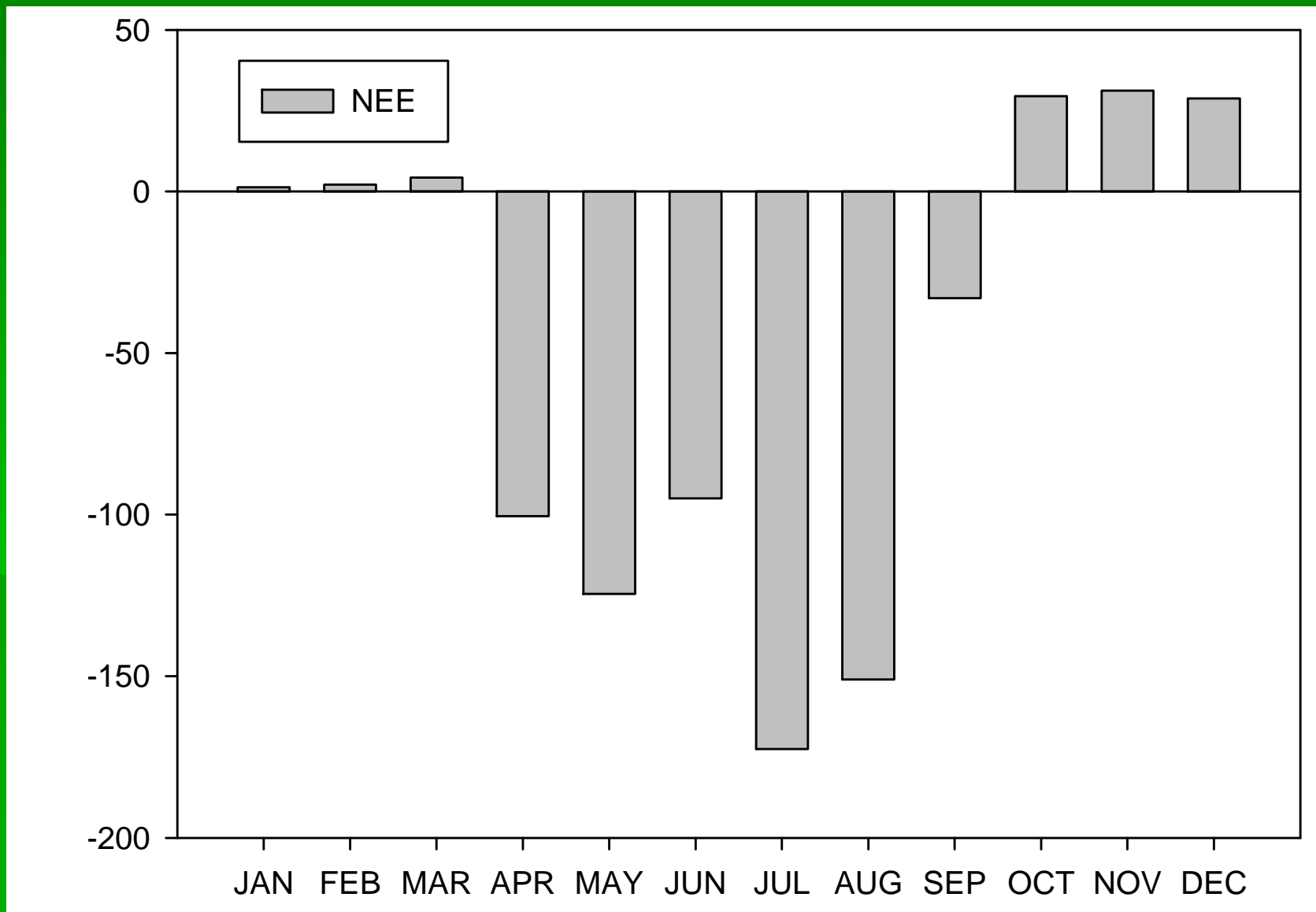


Mean averaged daily dynamic of NEE in different month

Y-Axis unit is $\text{mgCO}_2/\text{m}^2\text{s}^1$



Seasonal variation of gross monthly of NEE Y-Axis unit is gC/mon



Some NEE values

Opportunities for Carbon Sequestration in poplar plantation

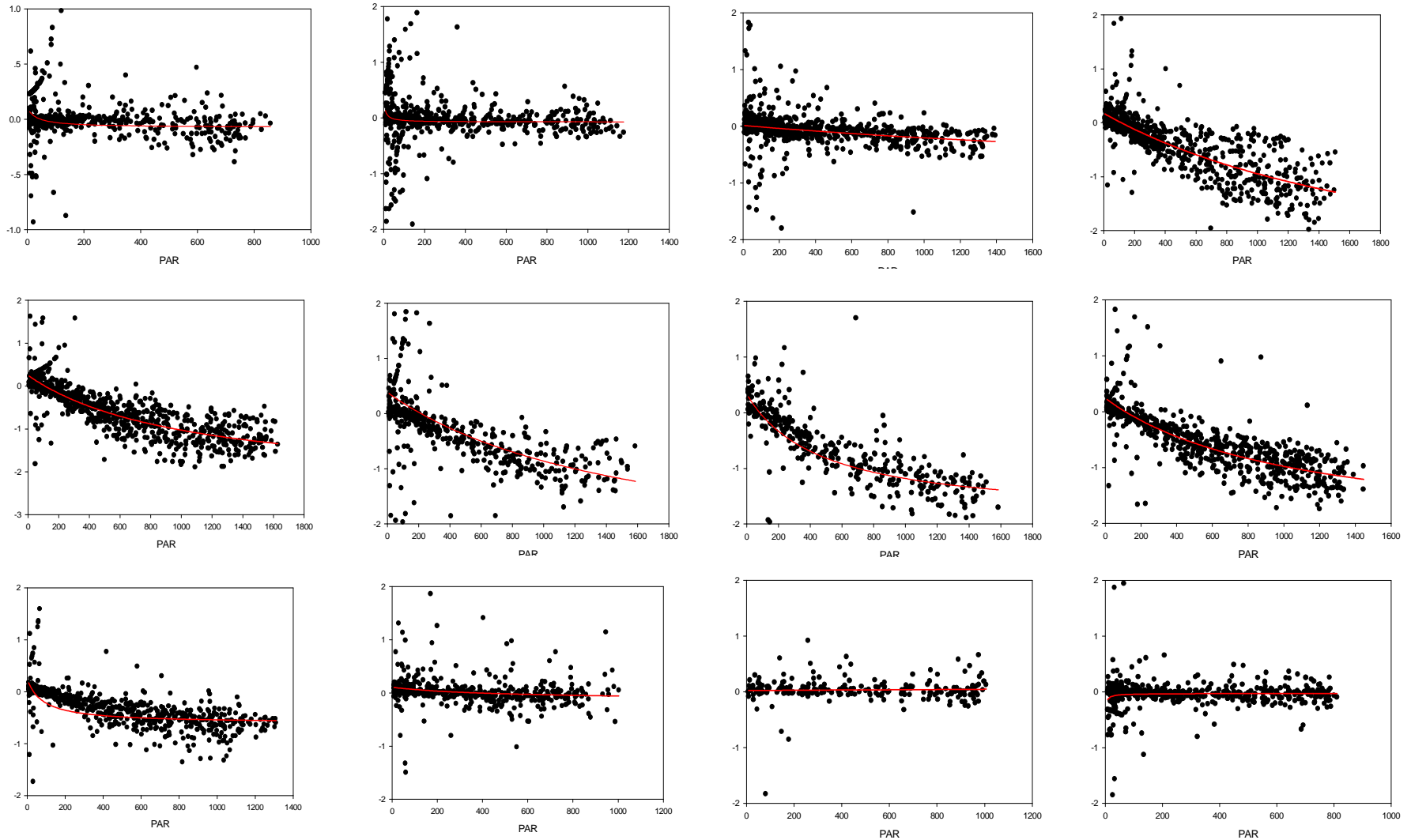
	location	Type of land	NEE [gC/m ² yr]
1	Bayreuth, GER	Evergreen needle forest	76.3
2	Yucheng, CHN	Farmland	198
3	Harvard forest,US	Mixed forest	120 to 303
4	DHS, CHN	Broad leaf forest	435.9
5	IM, CHN	Grassland	-109.9
6	Our site	Poplar plantation	579

NEE_{Daily} & PAR

- Michaelis-Menten Equation

$$NEE_{day} = \frac{\alpha \times PAR \times P_{max}}{\alpha \times PAR + P_{max}} + R_d$$

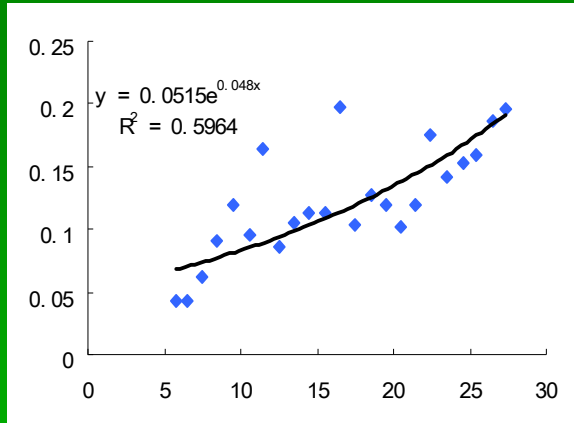
Light response for ecosystem photosynthesis in 2006



The output of michaelis-menten model

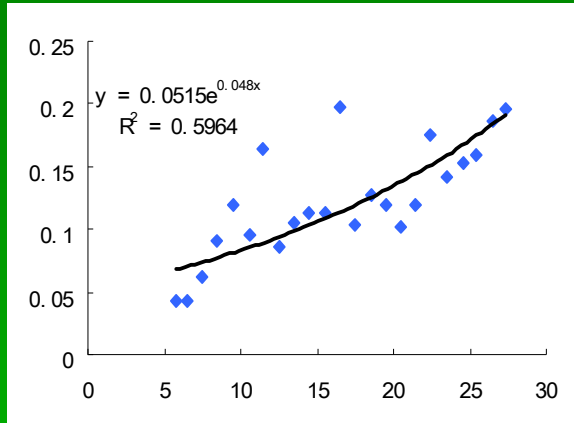
月份	α	P_{\max} (mg/m ² .s)	R_d (mg/m ² .s)
2006-04	-0.0016	-3.59	0.156
2006-05	-0.0023	-2.62	0.185
2006-06	-0.0013	-3.02	0.221
2006-07	-0.0026	-3.04	0.260
2006-08	-0.0017	-2.91	0.118
2006-09	-0.0011	-1.49	0.117
2006-10	-0.0009	-0.475	0.059

NEE_{night} & Soil temperature

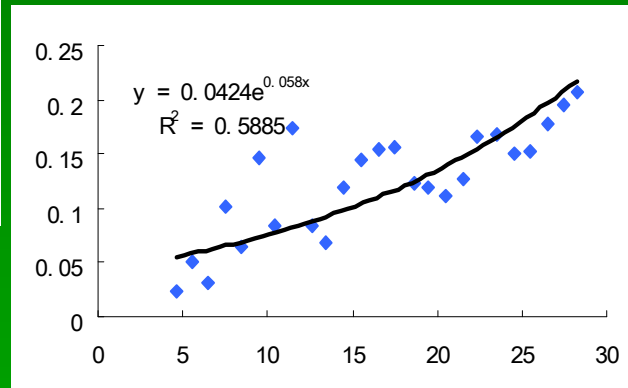


5cm

NEE_{night} & Soil temperature

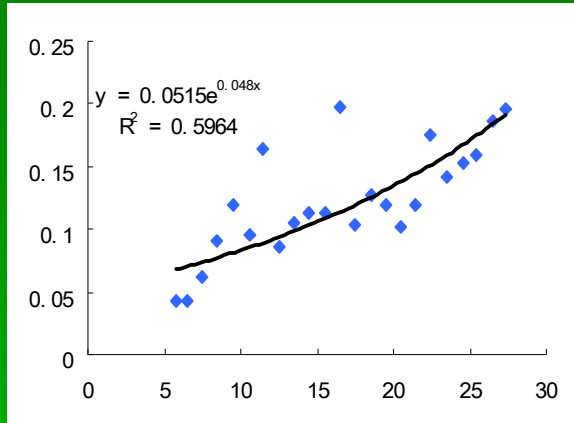


5cm

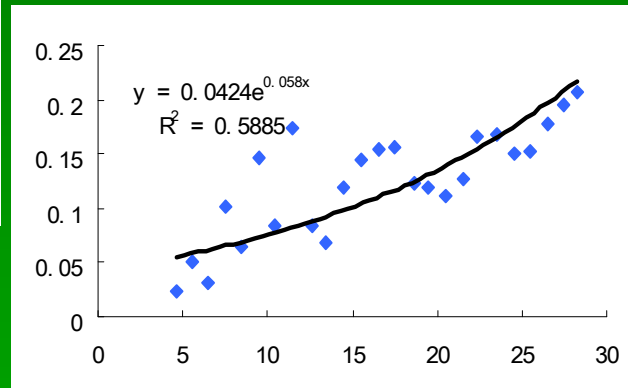


10cm

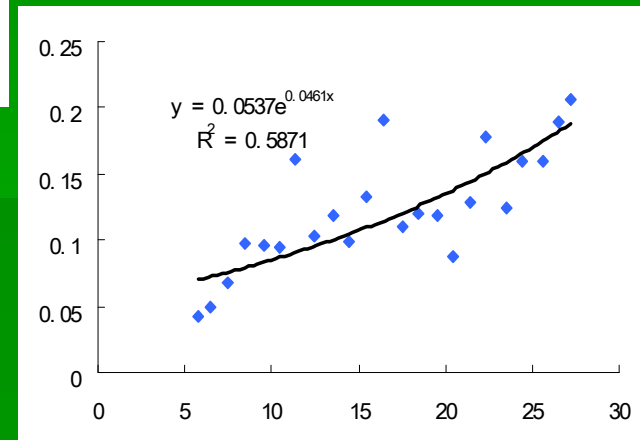
NEE_{night} & Soil temperature



5cm



10cm



20cm

Summary and discussion

- Big Carbon Sink
- PAR and Ts is key factor, maybe SWC?
- Water issue (WUE)

For further information

WEI Yuan



weiyuan_caf@126.com

TEL:86-10-62888401

Work funded by
Chinese Academy of Forestry

Thank you