生态系统研究方法

Ecosystem Research Methodology

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Outline

- Ecosystems: definition and classification
- Methodology in ecosystem research
  - Observations
  - Experimentations
  - Modeling
- Stale isotope technique for ecosystem studies
- Conclusions

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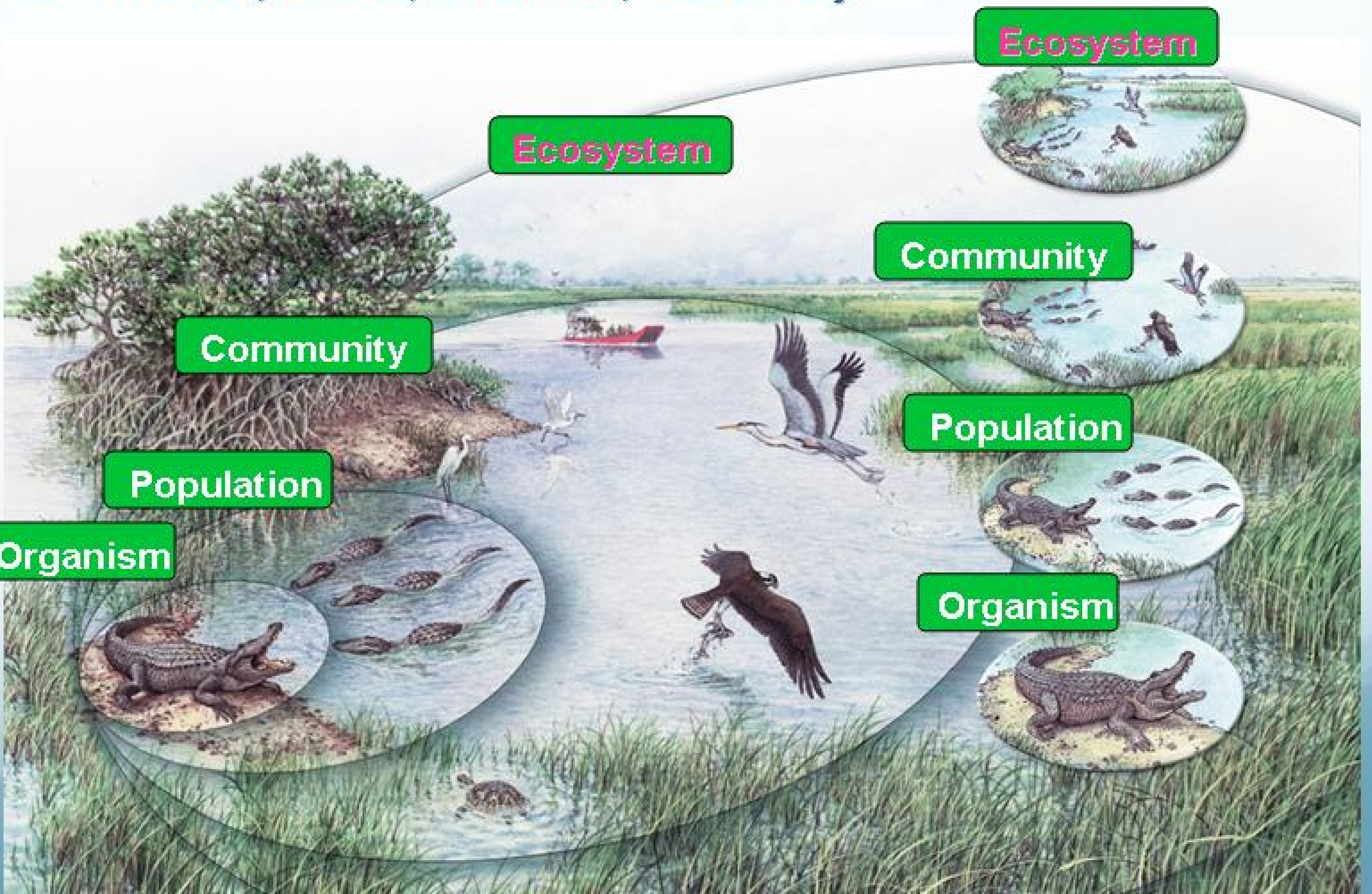
Ecology is the study of the relationships among organisms and their environment.

生态系统的含义

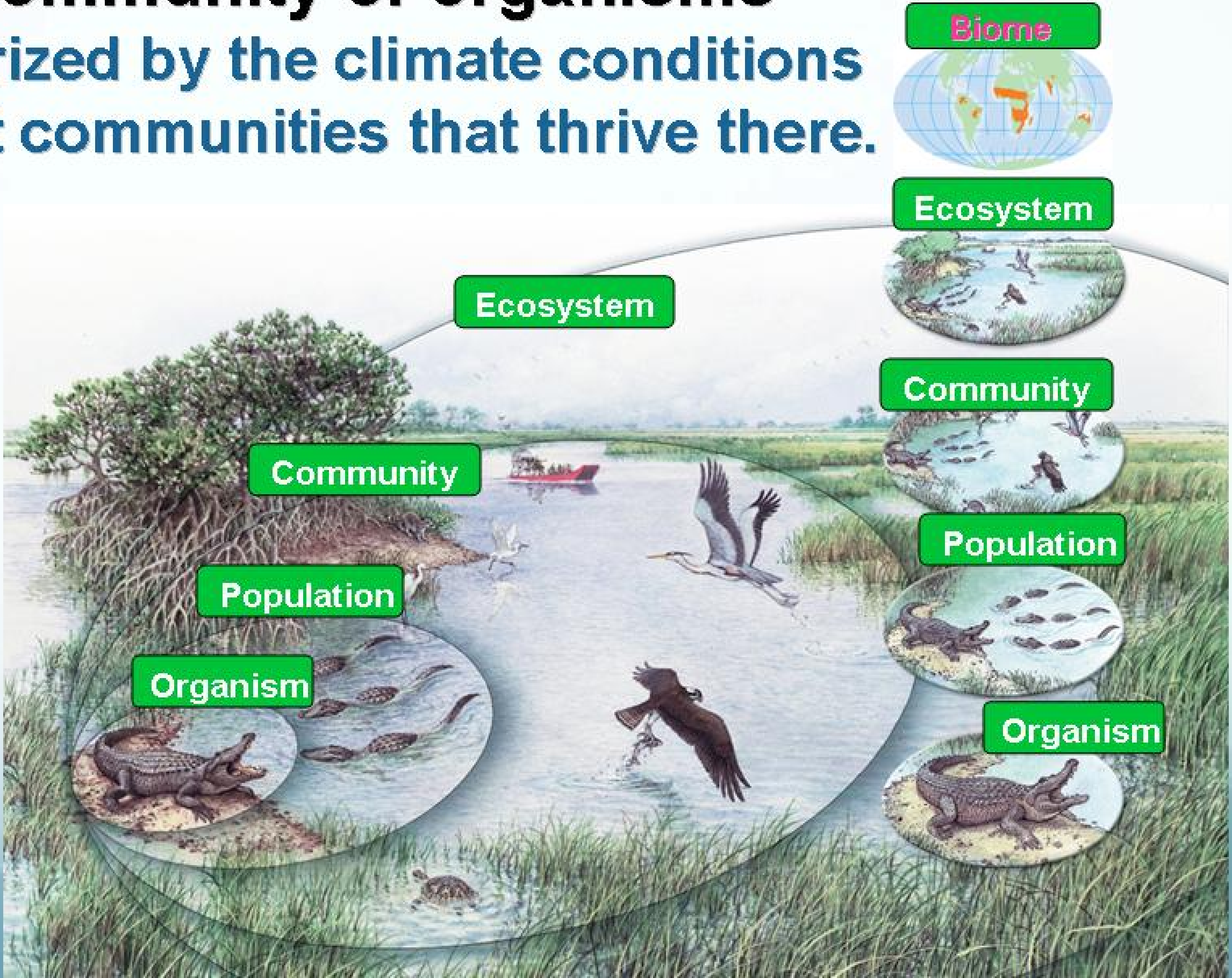
生态系统是在一定时间、空间范围内，生物与生存环境、生物与生物之间密切联系，相互作用，通过能量流动、物质循环、信息传递构成的具有一定结构的功能整体。

An ecosystem includes all of the organisms as well as the other nonliving things in a given area.

(such as climate, soil, water, rocks)



A biome is a major regional or global community of organisms characterized by the climate conditions and plant communities that thrive there.



生态系统的一般特征

1 生态系统的组成成分

2 生态系统的一般结构

3 生态系统的基本功能及过程

4 生态系统的特点

生态系统的组成成分

1. 生产者

指能利用无机物制造有机物的自养生物，主要是绿色植物，也包括一些蓝绿藻、光和细菌及化能合成细菌。

生产者完成有机物的合成过程，是生物圈生命活动能量的源头。

深海的生产者—化能自养硫化细菌

Tropical rainforests



Desert: Sparse rainfall (< 30 cm per year), plants and animals adapted for water storage and conservation. Can be either very, very hot, or very cold (e.g. Antarctica)

2. 消费者

是指直接或间接利用绿色植物有机物作为食物源的异养生物。

主要是指动物（草食动物、肉食动物、腐生动物、杂食动物）和寄生性生物。

Tundra: Permafrost (Permanent frozen ground), bitter cold, high winds and thus no trees. Has 20% of land surface on earth.

Yunxiao, Fujian

3. 分解者

又称还原者，主要指细菌、真菌等微生物，也包括某些营腐生生活的原生动物。

分解者的生态作用：

- 通过动、植物残体有机物质的分解，使营养物质得到再循环，微生物种群得到恢复和繁衍。
- 为碎屑食物链的各级生物提供了食物和物质基础。
- 产生有调控作用的“环境激素”，对生态系统中其他生物的生长产生重大影响。
- 改造地球表面的惰性物质。

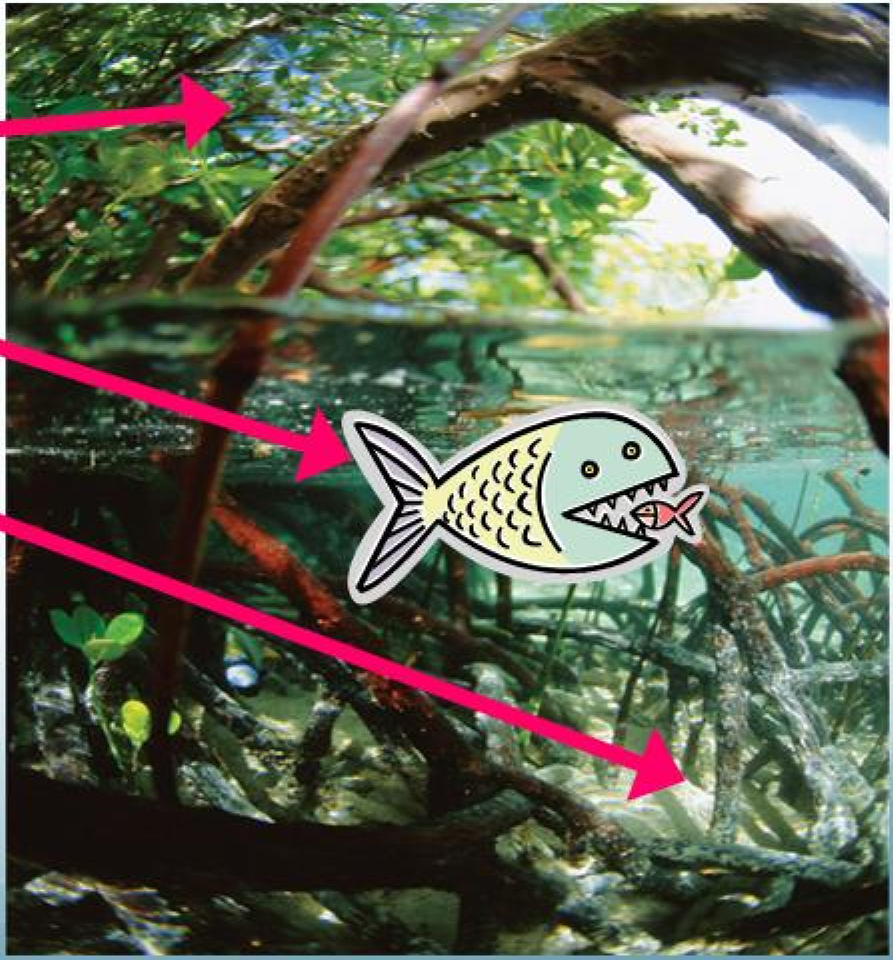
4. 无机环境

- **原料部分**：光、氧、二氧化碳、水、无机盐类以及非生命的有机物质等；
- **代谢过程的媒介部分**：水、土壤、温度和风等；
- **基层部分**：岩石和土壤等。

Elements in an Ecosystem (Mangrove wetland)

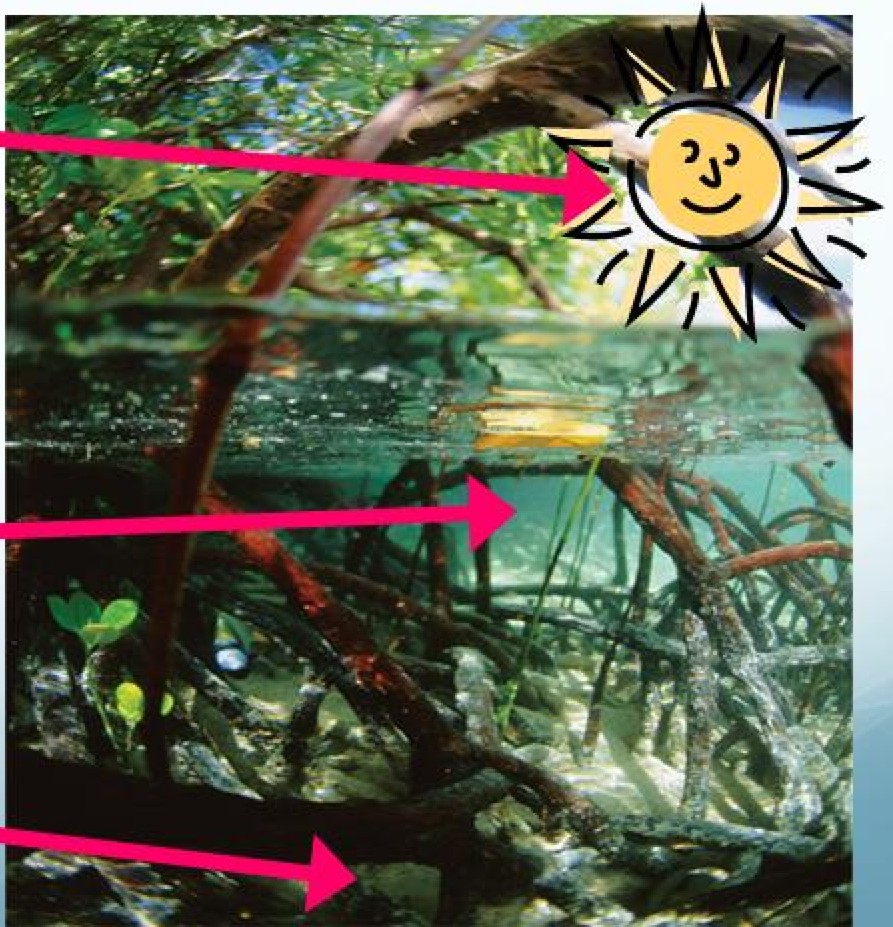
1. Biotic factors are living things.

   a. plants
   b. animals
   c. fungi
   d. bacteria



2. Abiotic factors are nonliving things

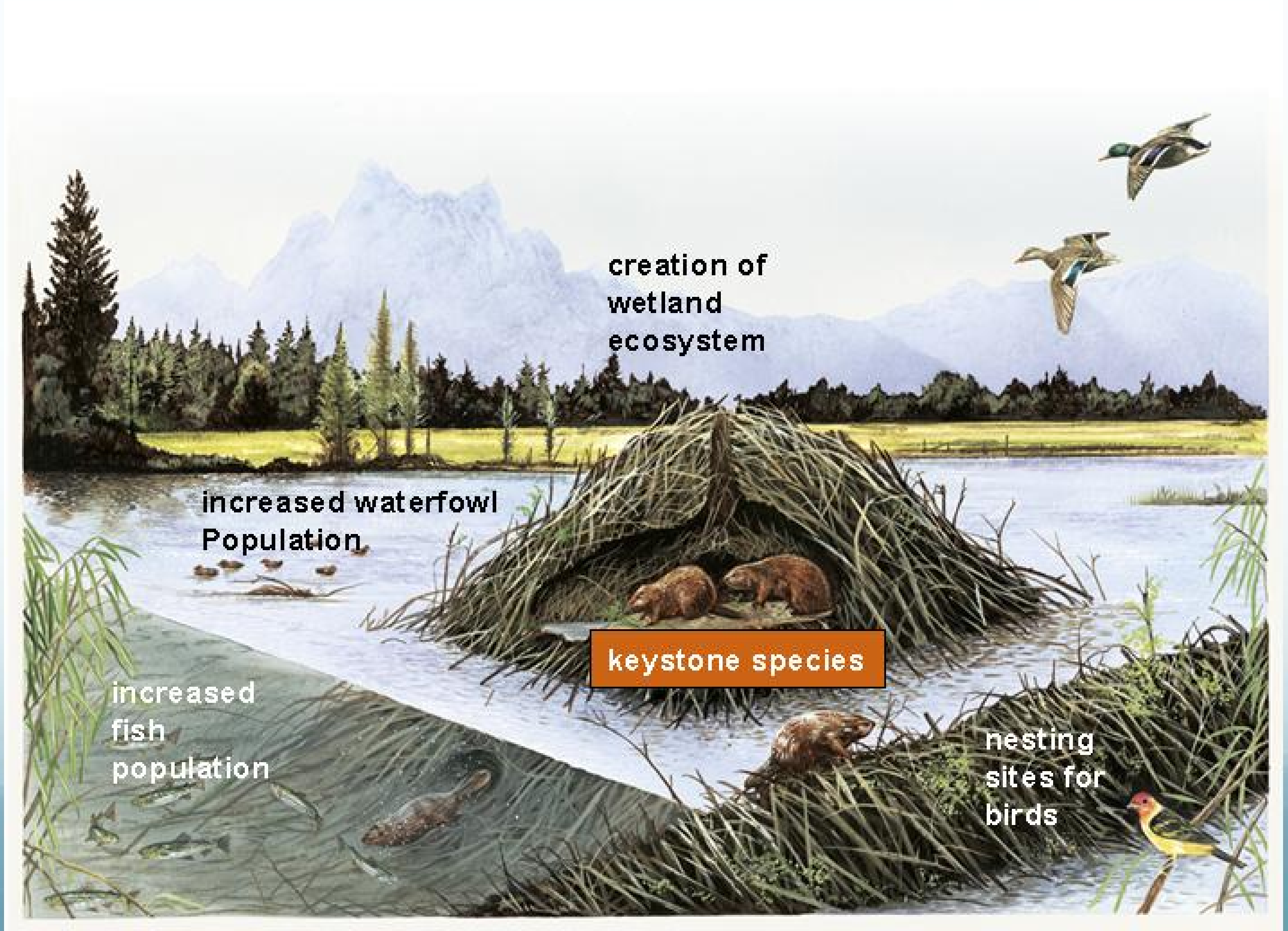
a. sunlight
b. temperature
c. wind
d. Moisture
   i. Water, rain, clouds
e. soil



3. Changing one factor in an ecosystem can affect *many* other factors.

4. A keystone species is a species that has an unusually large effect on its ecosystem.

5. Keystone species form and maintain a complex web of life.



生态系统的三个基本功能

能量流动

物质循环

信息传递

生态系统的特点

- 具有生命成分
- 具有空间结构
- 具有时间变化
- 具有自动调控功能
- 是开放系统

生态系统的类型

水域生态系统

湿地生态系统

陆地生态系统

农业生态系统

城市生态系统

按环境性质划分

水生生态系统		陆地生态系统
海洋生态系统	淡水生态系统	荒漠
海岸带	流水	冻原
浅海带		极地
上涌带		高山
珊瑚礁	静水	草原
远洋带		森林

按人类对生态系统的影响程度分

- 自然生态系统：凡是未受人类干扰和扶持，在一定空间和时间范围内，依靠生物和环境自身的自我调节能力来维持相对稳定的生态系统。
- 人工生态系统：按人类的需求，由人类设计制造建立起来，并受人类活动强烈干预的生态系统。
- 半自然生态系统：在自然生态系统的基础上，通过人工堆生态系统进行调节管理，使其更好地为人类服务的生态系统。

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Three basic methods of ecosystem research

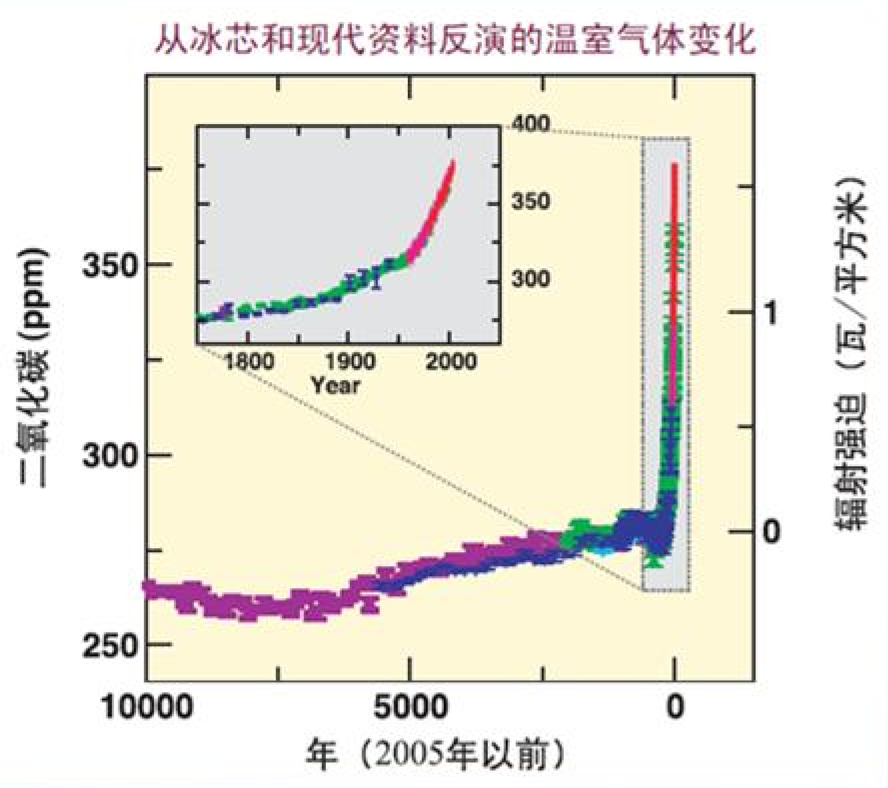
Observation: often the first step in asking ecological questions;

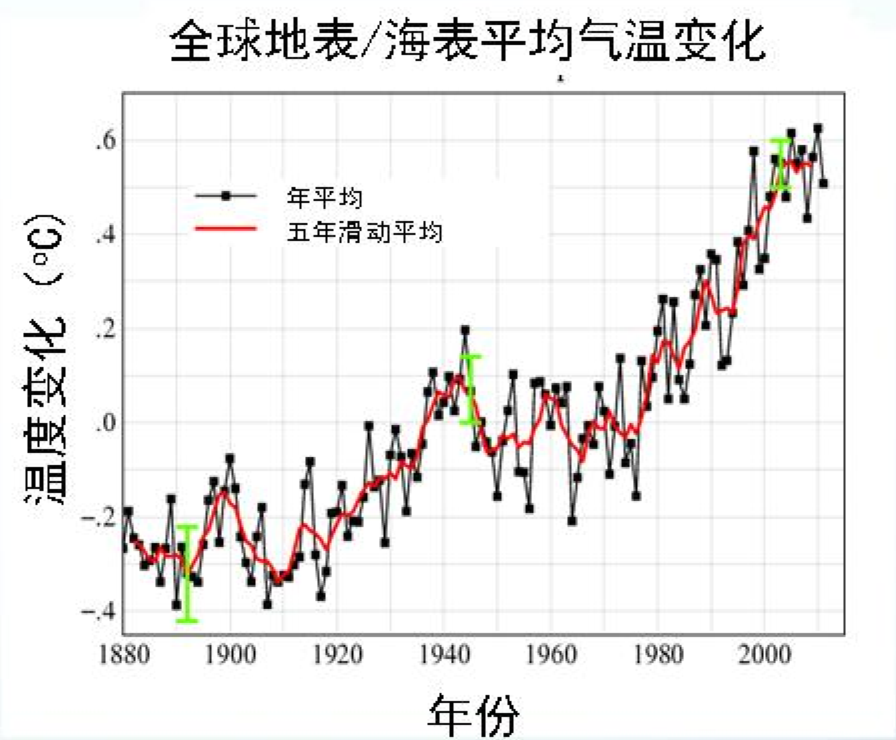
Experimentation: to test the hypothesis;

Modeling: to gain insight into complex phenomena such as the effects of global warming on ecosystems.

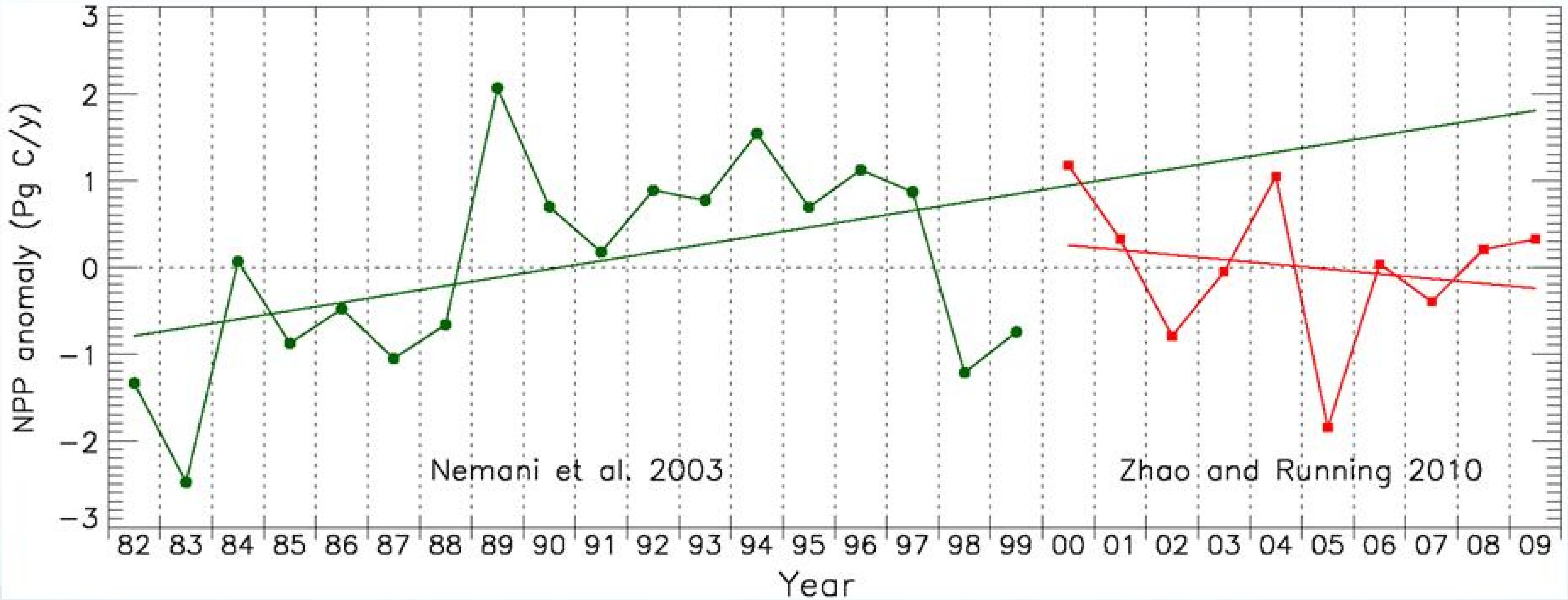
Observation is the act of carefully watching something over time.

Long term observation is a key!



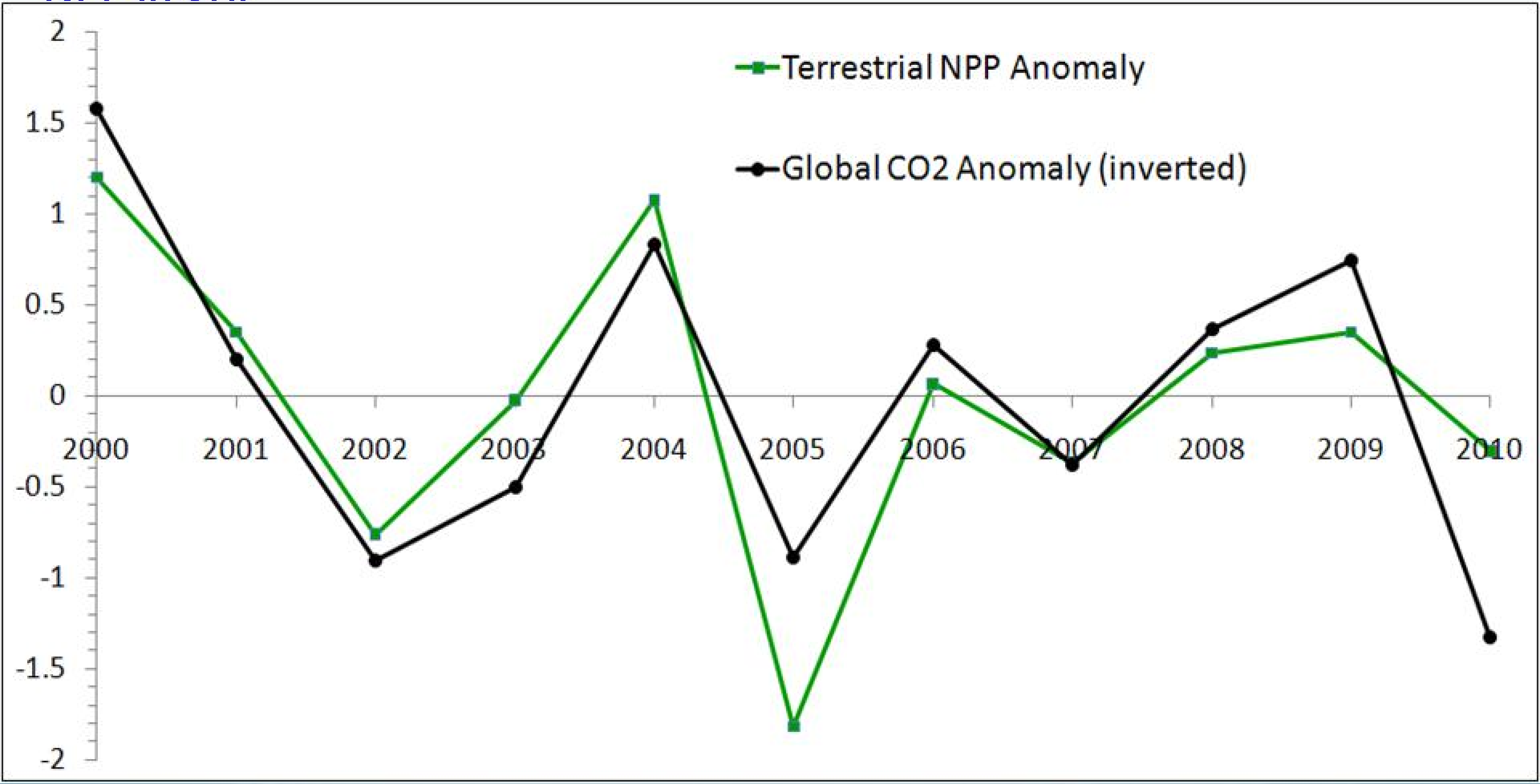


Remotely Sensed NPP change (1982-2009)



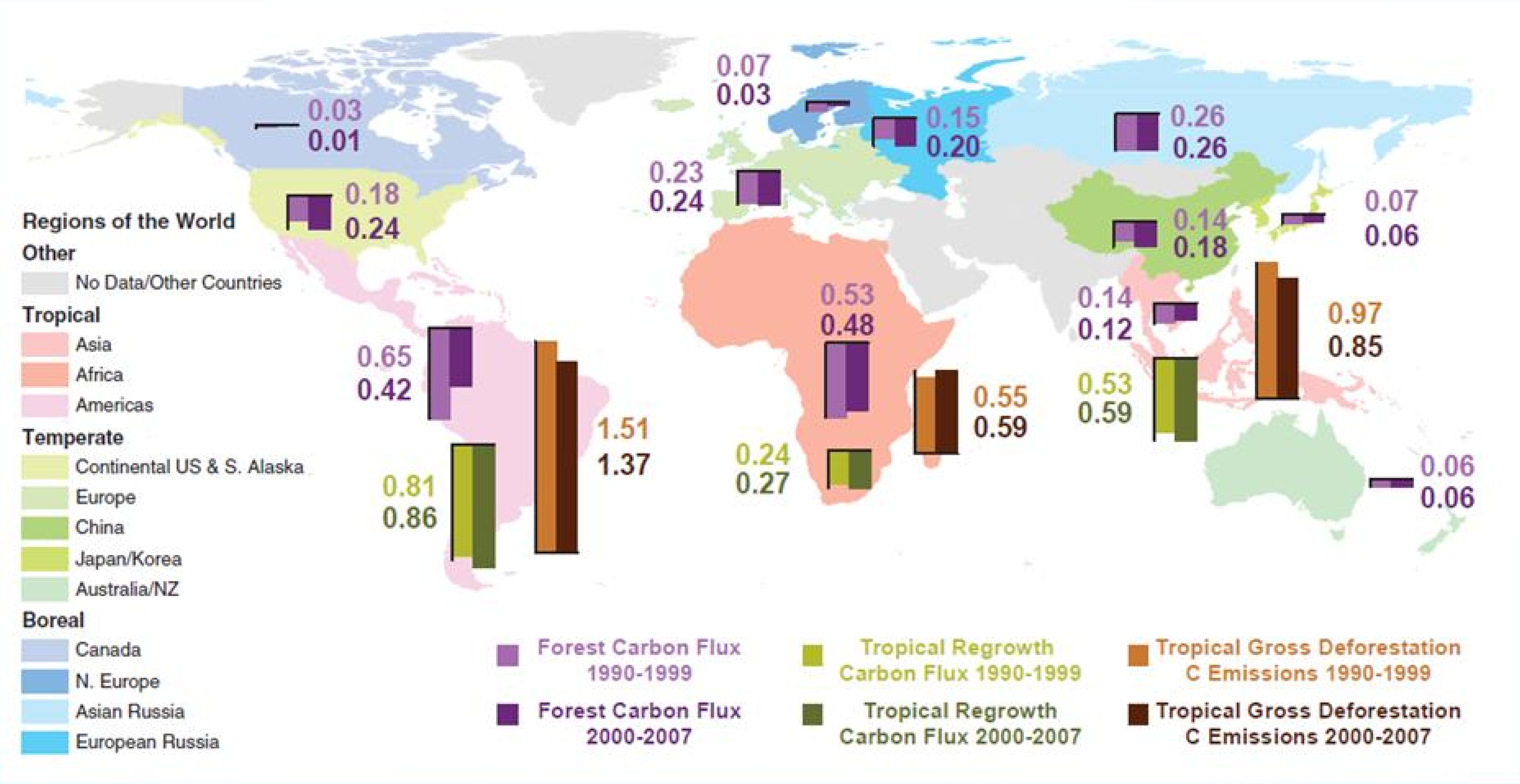
Zhao & Running (2010). Science

Global NPP decreased from 2000 to 2009, with NPP over North Hemisphere continued increasing (winner) and over South Hemisphere decreased; Recent drying trend caused the reduction in NPP in SH.

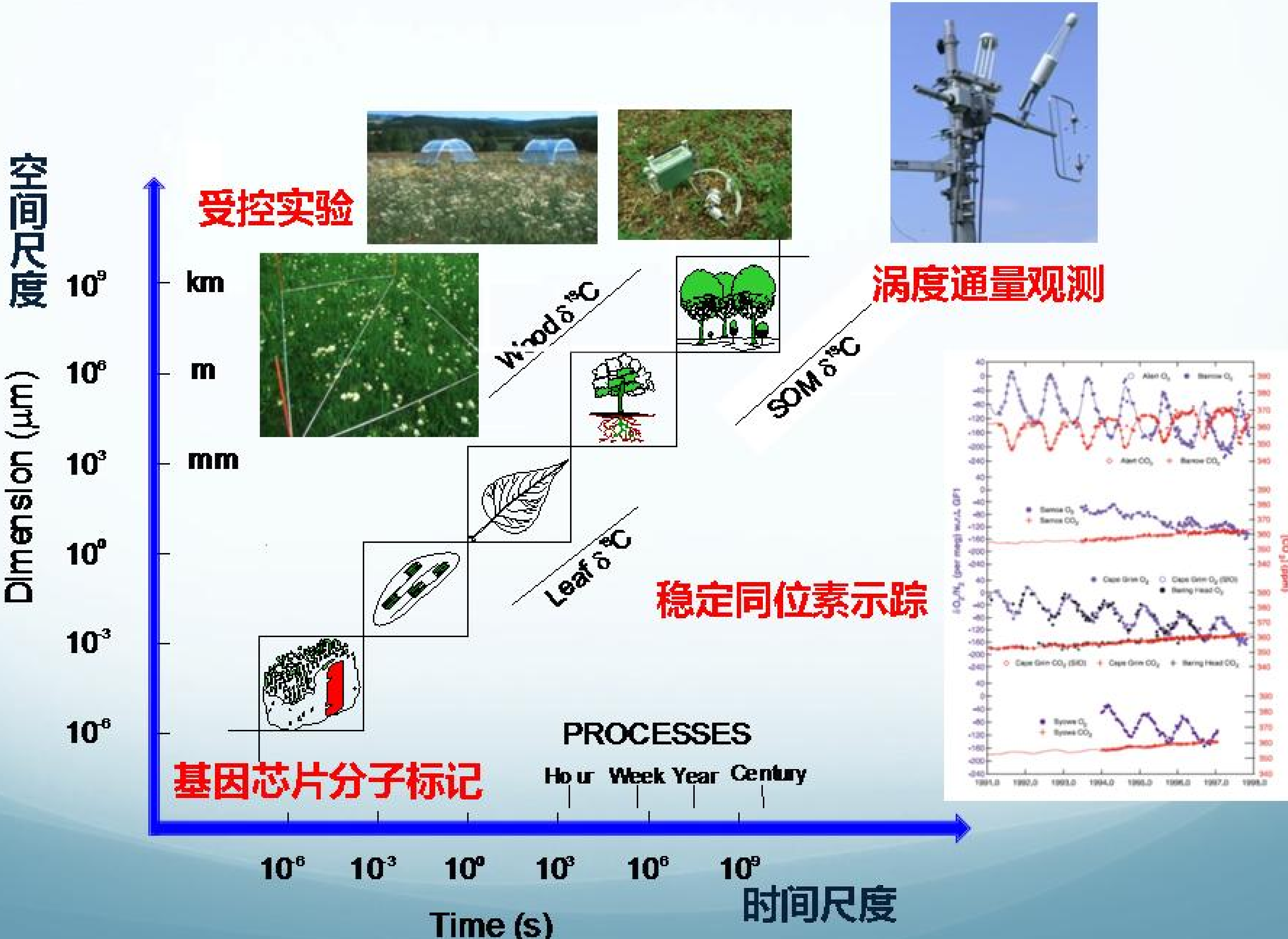


Zhao & Running (2010). Science

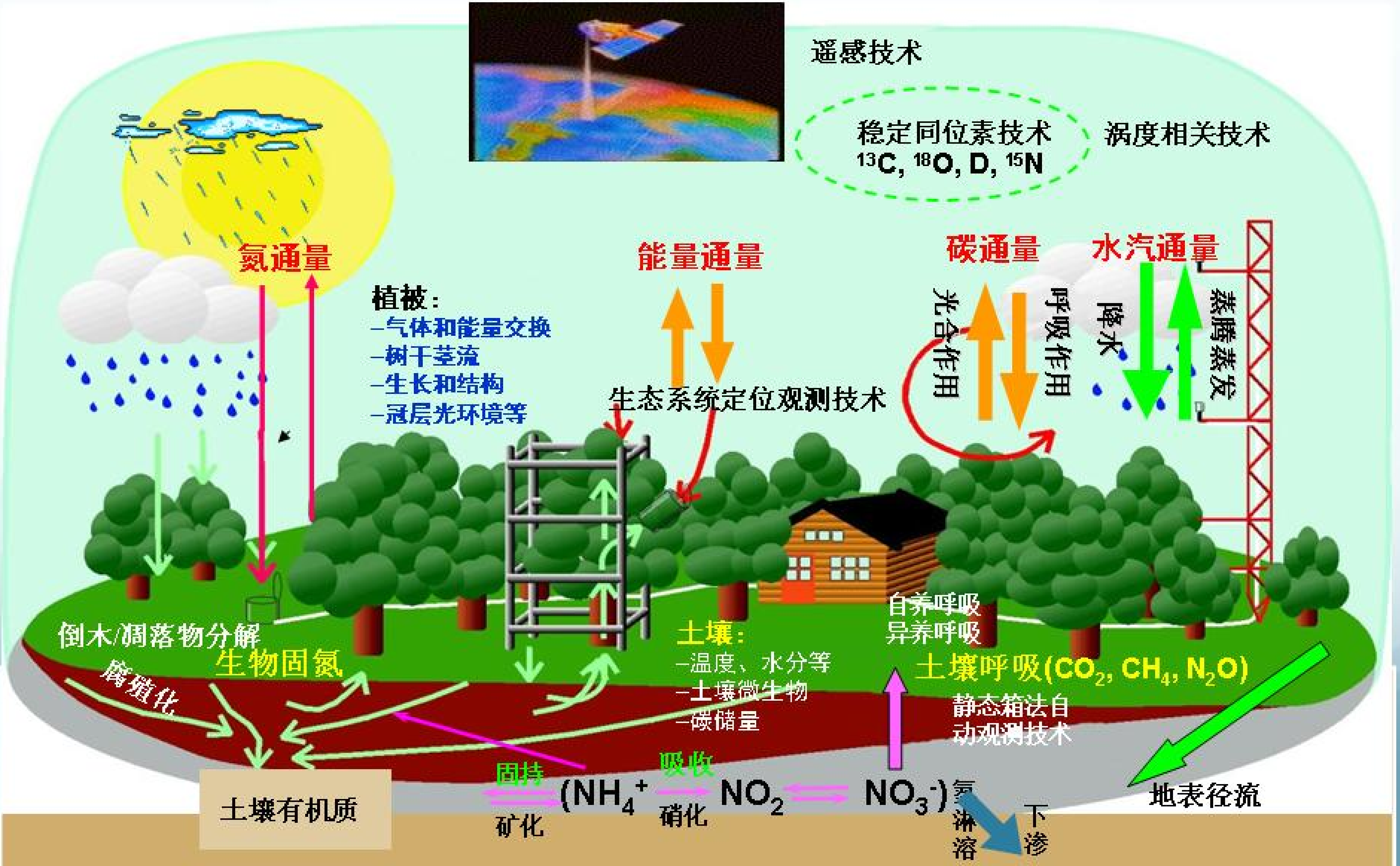
Carbon Sinks and Sources (Pg C yr^{-1}) in the World's Forests



Pan *et al.* (2011) *Science*


空间尺度
Dimension (μm)
10⁹
10⁶
10³
10⁰
10⁻³
10⁻⁶
km
m
mm
受控实验
涡度通量观测
Wood δ¹³C
SOM δ¹³C
Leaf δ¹³C
稳定同位素示踪
基因芯片分子标记
PROCESSES
Hour
Week
Year
Century
10⁻⁶
10⁻³
10⁰
10³
10⁶
10⁹
Time (s)
时间尺度

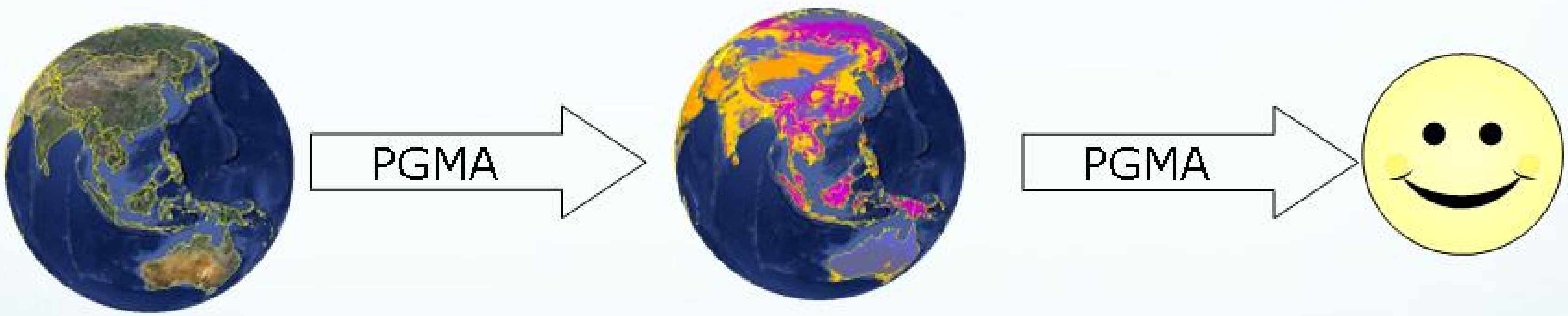
综合观测的内容和技术



遥感技术
稳定同位素技术
^{13}C, ^{18}O, D, ^{15}N
涡度相关技术
氮通量
能量通量
碳通量
水汽通量
植被：
–气体和能量交换
–树干茎流
–生长和结构
–冠层光环境等
生态系统定位观测技术
光合作用
呼吸作用
降水
蒸腾蒸发
倒木/凋落物分解
腐殖化
生物固氮
土壤：
–温度、水分等
–土壤微生物
–碳储量
自养呼吸
异养呼吸
土壤呼吸(CO_2, CH_4, N_2O)
静态箱法自动观测技术
地表径流
土壤有机质
固持
矿化
$(NH_4^+$
吸收
硝化
NO_2
$NO_3^-)$
氮淋溶
下渗

What is needed

- A systematic platform for global mapping and analysis (PGMA)



Global/Region
al
Images

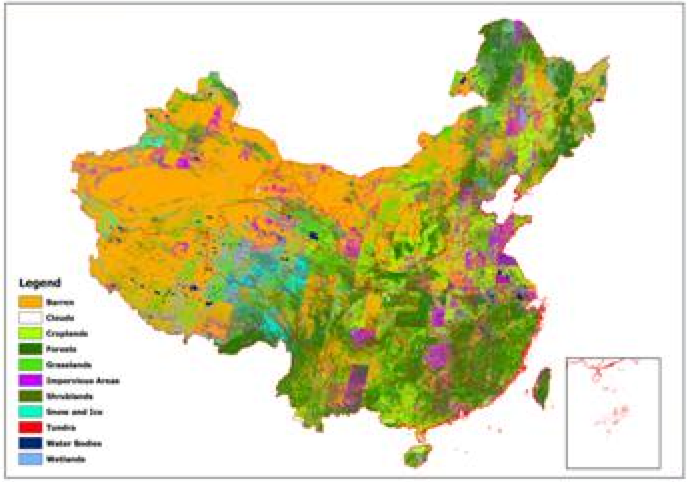
Global/Regional
mapping
productions
(maps)

Global/Regiona
l
Applications
(government,
group,
personal)

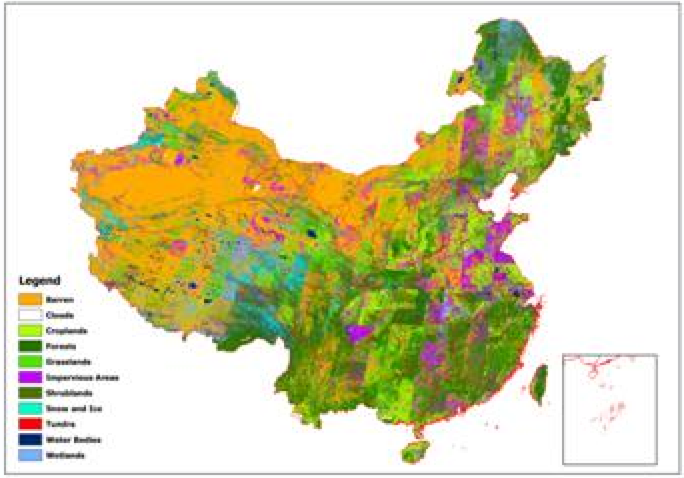
With the help of global browser as Google Earth
and global image processing system as ENVI

Global land cover mapping with 30 m resolution – China's case

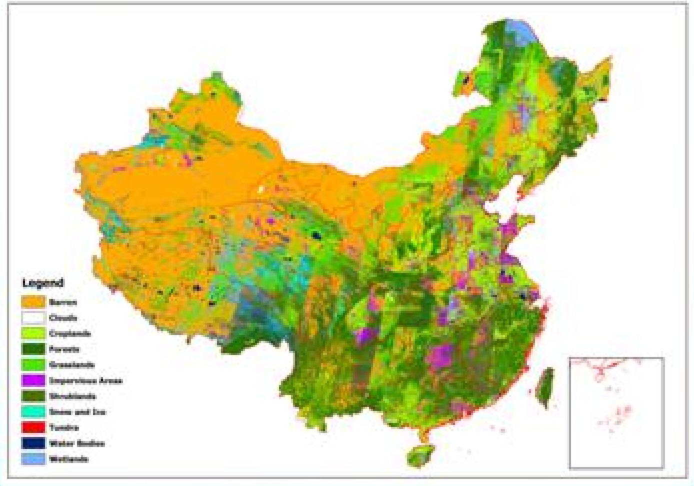
MLC



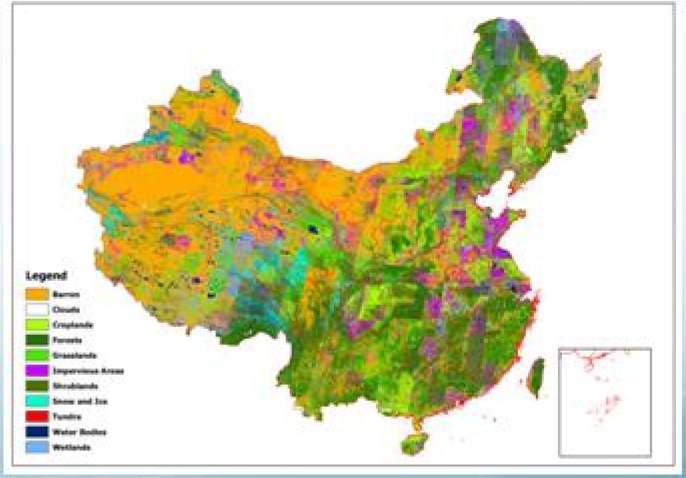
Random Forest



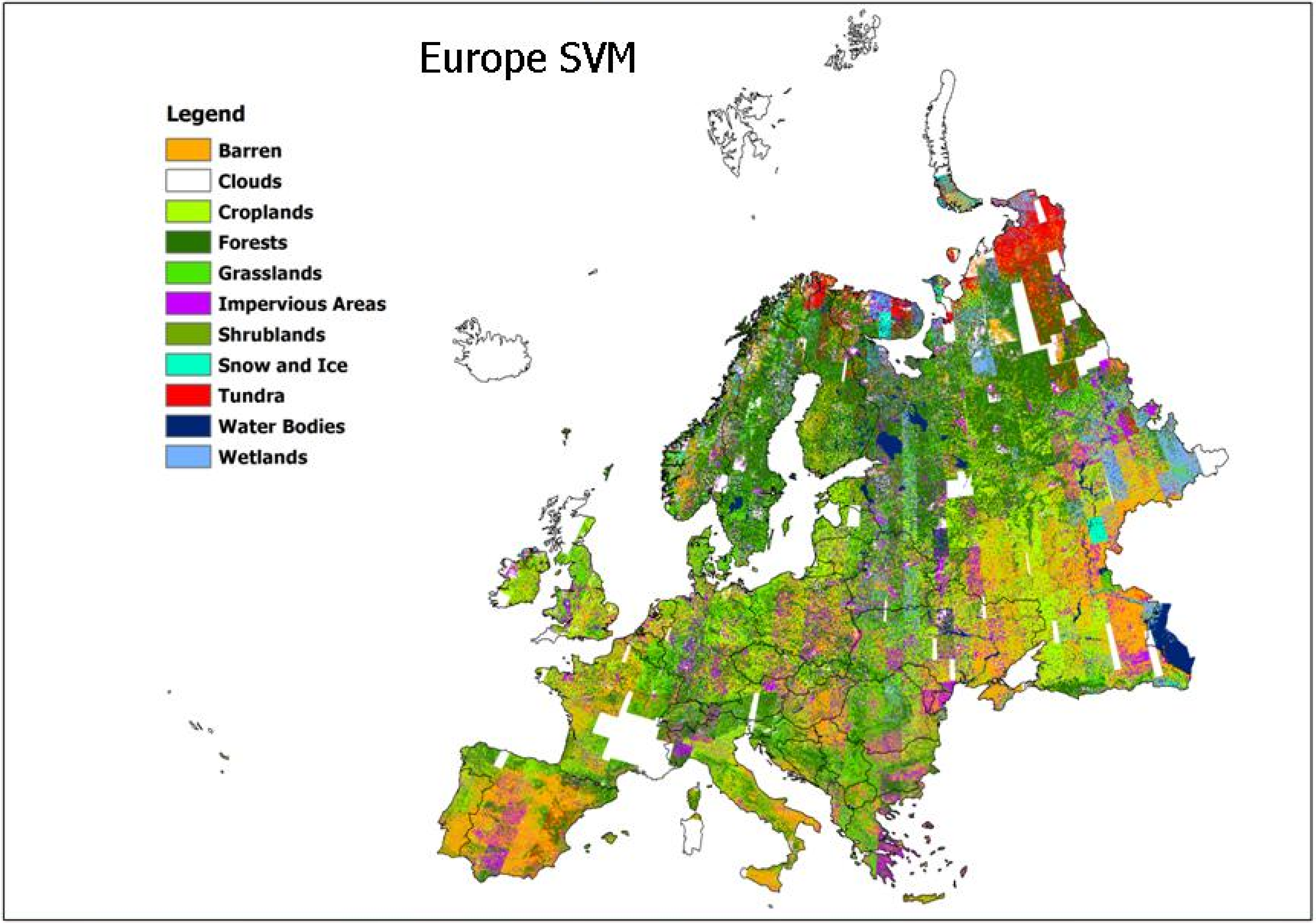
SVM



J48

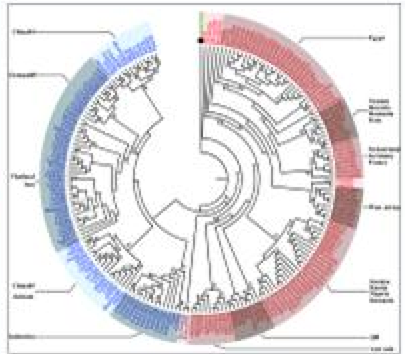


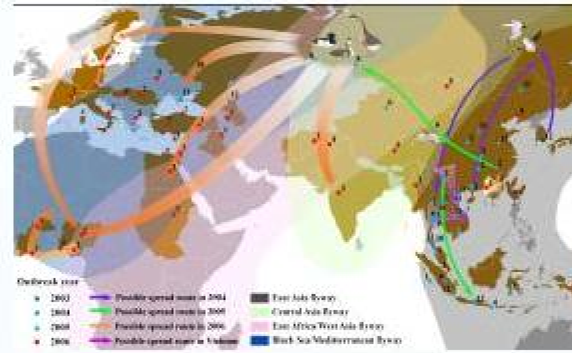
Global land cover mapping for Europe



Application examples

Liang et al., 2010, PLOS One

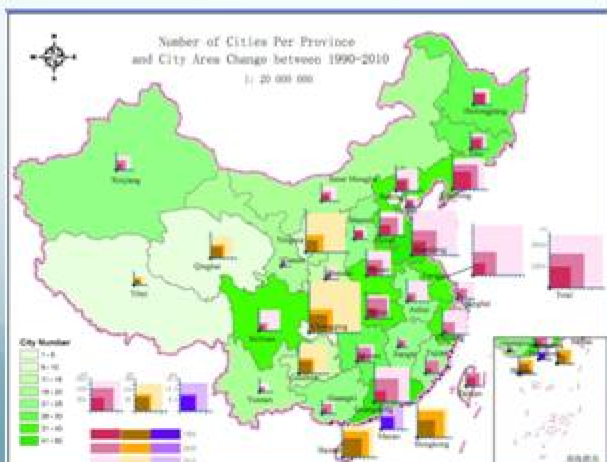




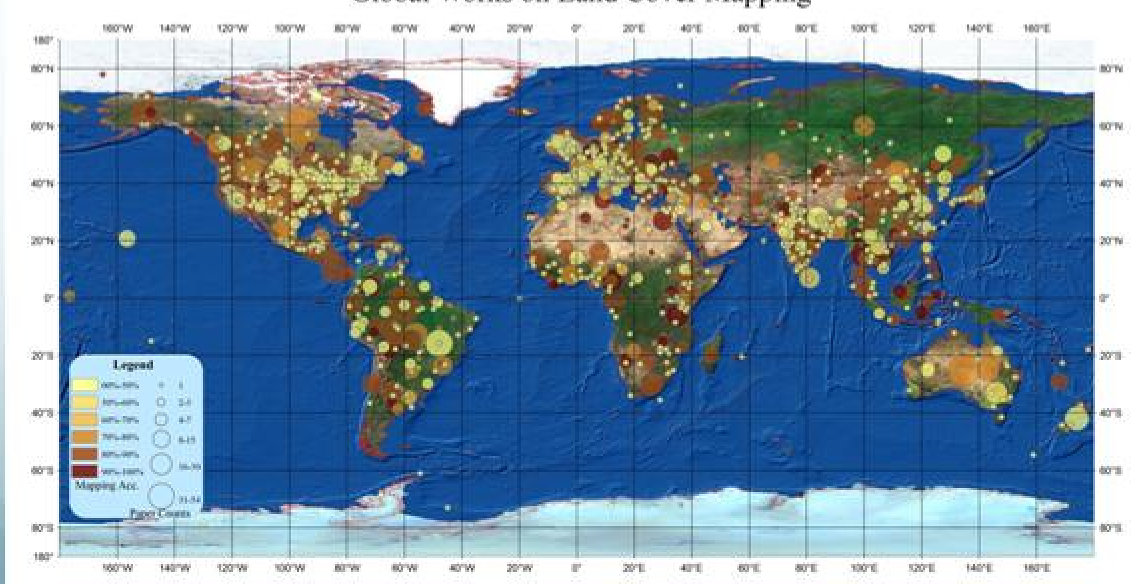
Develop analysis technology based on spherical coord

Combine with bioinformatics

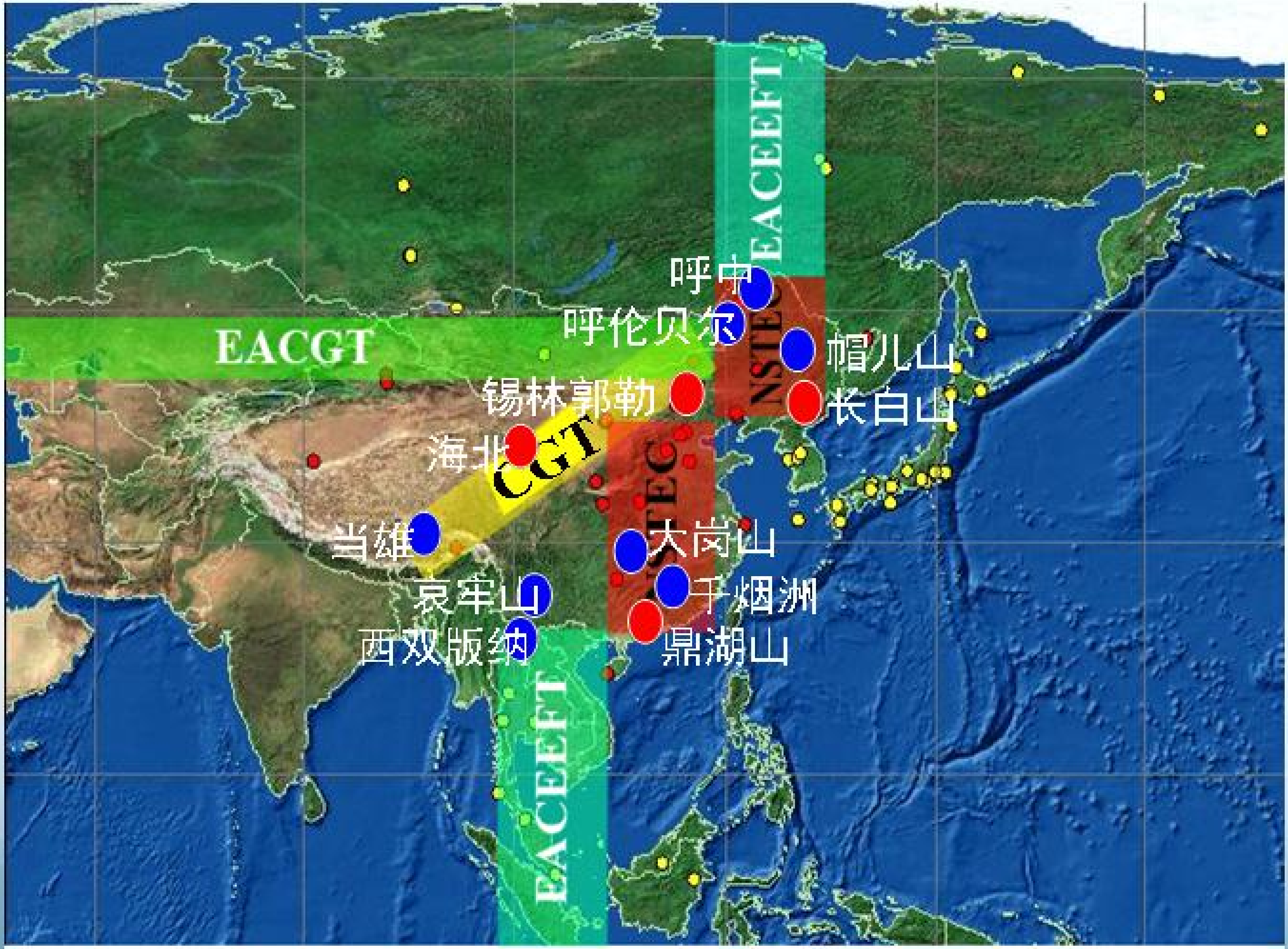
Form new understanding



Global Works on Land Cover Mapping



碳、氮、水通量的联网综合观测



样带：NSTEC和CGT；观测站：4个超级站；8个重点站

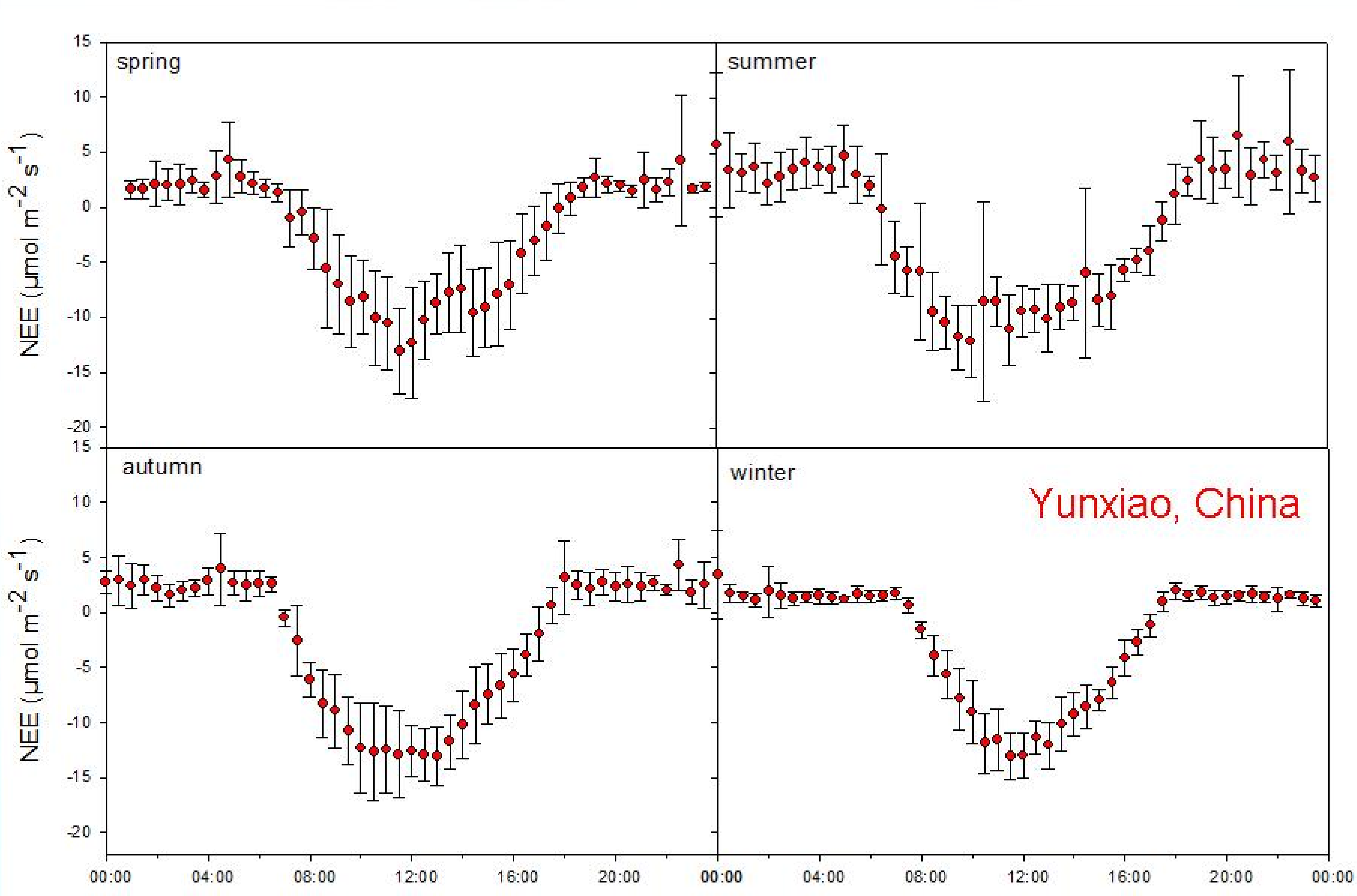
定位观测

涡度相关技术

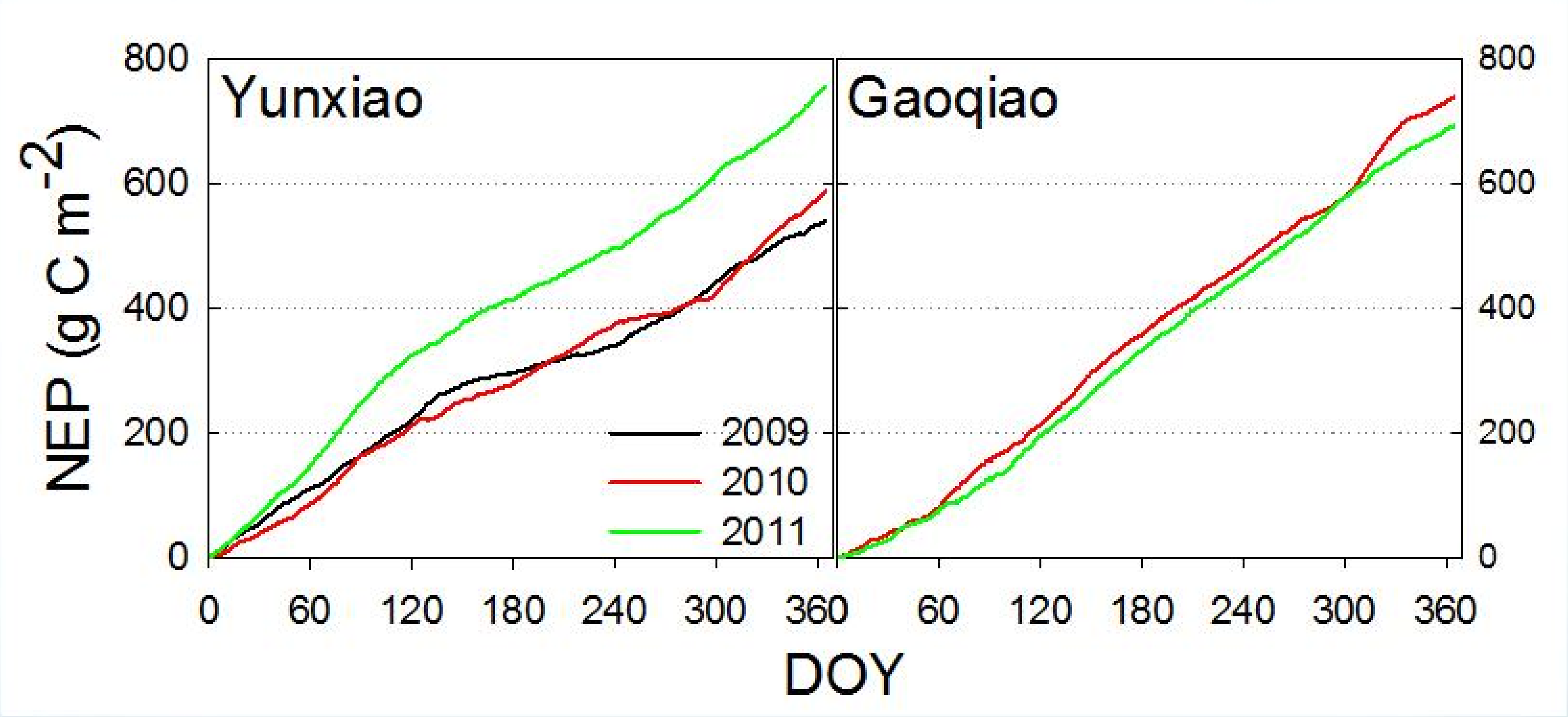
稳定性同位素技术

Gaoqiao Site, Guangdong

Diurnal patterns of net ecosystem exchange of CO_2 (NEE)



Net Ecosystem Productivity (NEP)



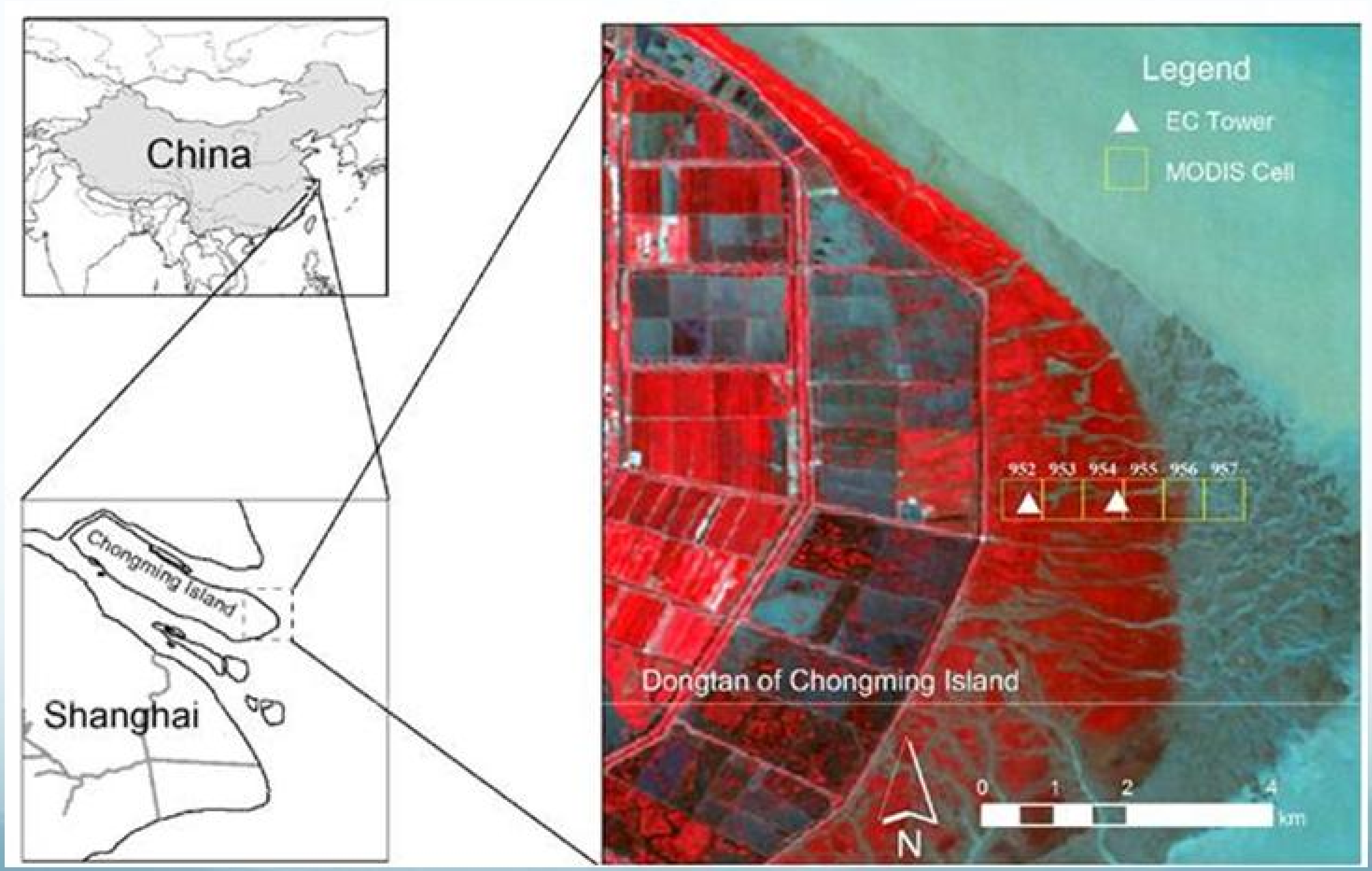
5.4-7.6 Mg C/ha/yr, but varied among years!

Comparisons between Chinese and USA mangroves

Annual C fluxes (g C m^{-2} yr^{-1})

	China Yunxiao			China Gaoqiao		USA (Miami)	
	2009	2010	2011	2010	2011	2009	2010
NEP	**540**	**588**	**756**	**738**	**617**	**926**	**796**
R_E	1238	1337	1297	1215	959	1176	1094
GEP	1763	1875	1928	1890	1557	2102	1890
R_E/GEP	0.70	0.71	0.67	0.64	0.62	0.56	0.58

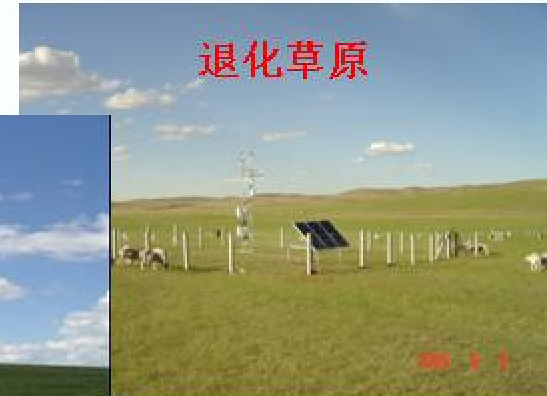
Coastal Shanghai: Tidal effects on production in *Spartina* wetlands. NEEc was more sensitive to tides at the low-elevation than at the high elevation; The amplitudes of diurnal Fc during tidal periods were larger than those reported for other wetland.



Chen et al. (2009); Guo et al. (2010); Yan et al. (2008; 2010)


LEES Lab
http://research.eeescience.utoledo.edu/lees/index.html

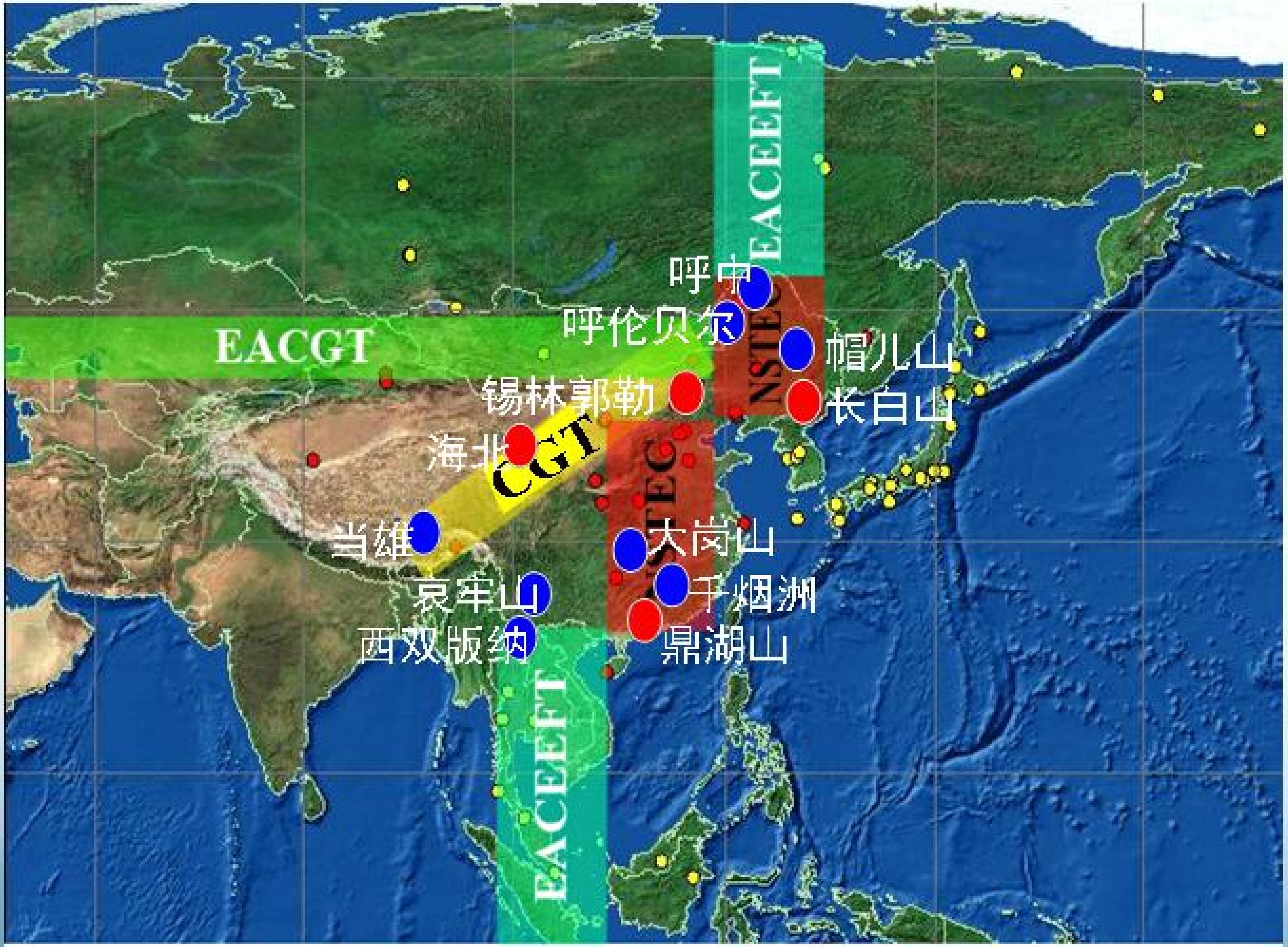
内蒙古草原涡度相关系统观测网络（三地六套）



库布齐沙漠

多伦（农牧交错区）

碳、氮、水通量的联网综合观测



样带：NSTEC和CGT；观测站：4个超级站；8个重点站

定位观测

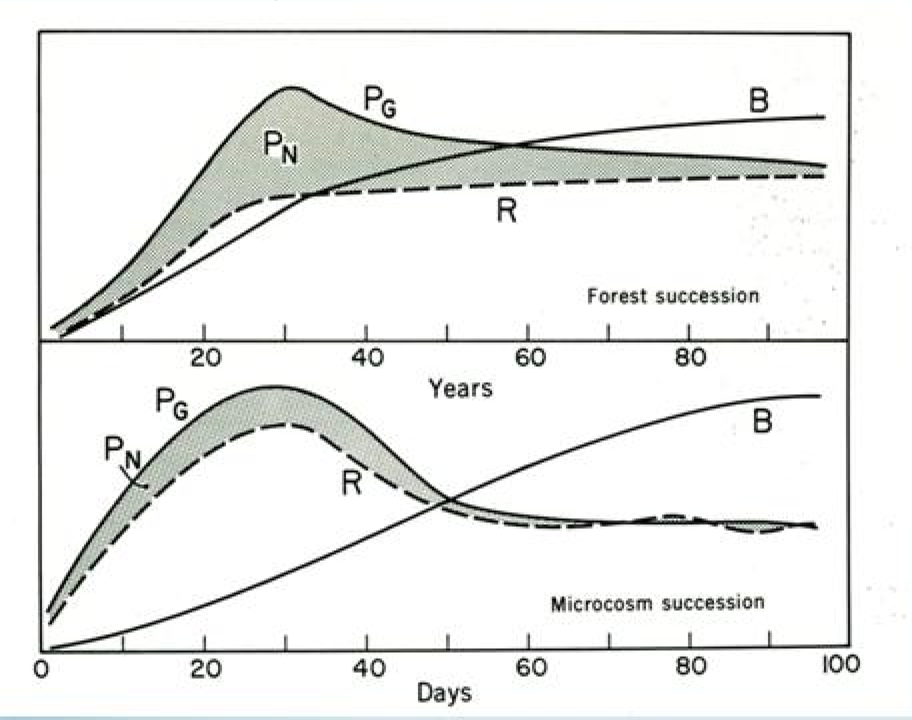
涡度相关技术

稳定性同位素技术

Ecosystem CO_2 Fluxes After Disturbance in Forests of N. America

B.D. Amiro, A.G. Barr, J.G. Barr, T.A. Black, R. Bracho, M. Brown, J. Chen, K.L. Clark, K.J. Davis, A.R. Desai, S. Dore, V. Engel, J.D. Fuentes, A.H. Goldstein, M.L. Goulden, T.E. Kolb, M.B. Lavigne, B.E. Law, H.A. Margolis, T. Martin, J.H. McCaughey, L. Misson, M. Montes-Helu, A. Noormets, J.T. Randerson, G. Starr, and J. Xiao

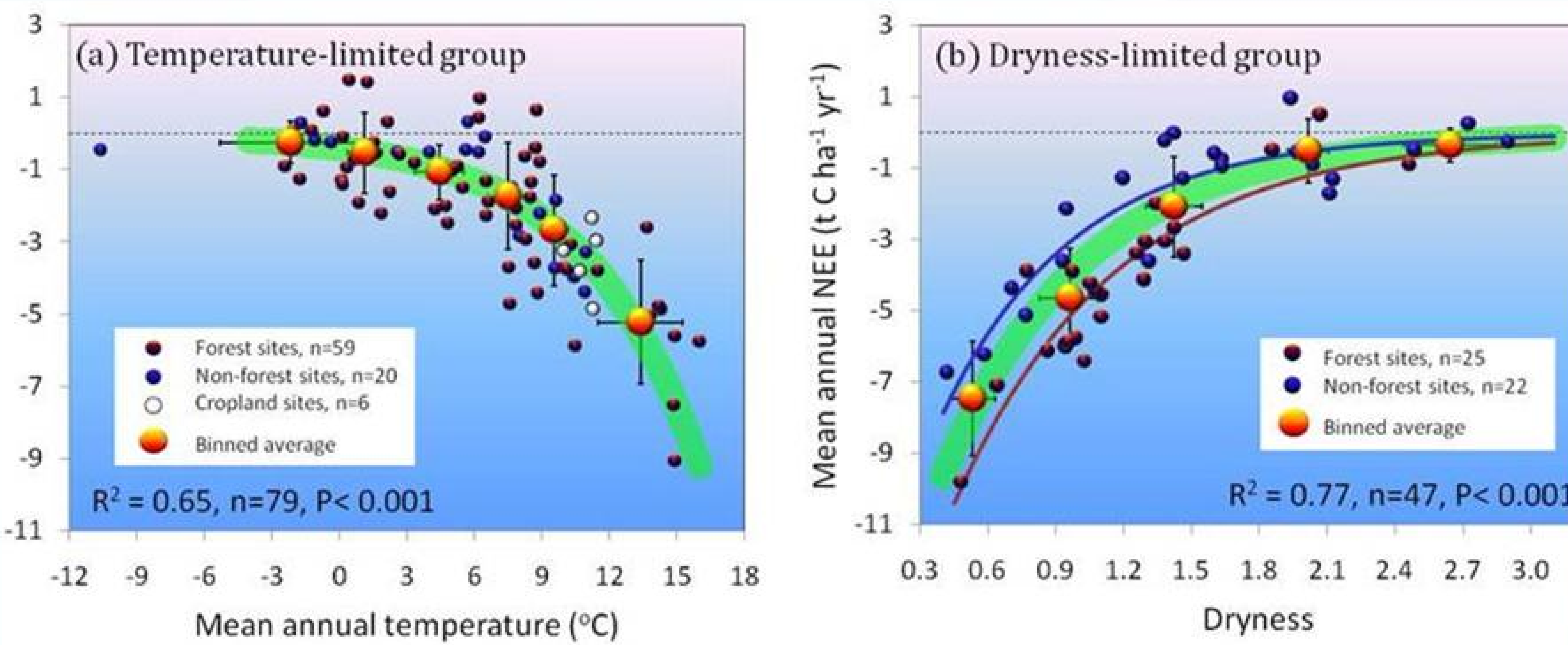
NEP vs Age



A Core Element of the U.S. Global Change Research Program
North American Carbon Program
Continental Carbon Budgets, Dynamics, Processes, and Management

featured article, JGR-Biogeosciences

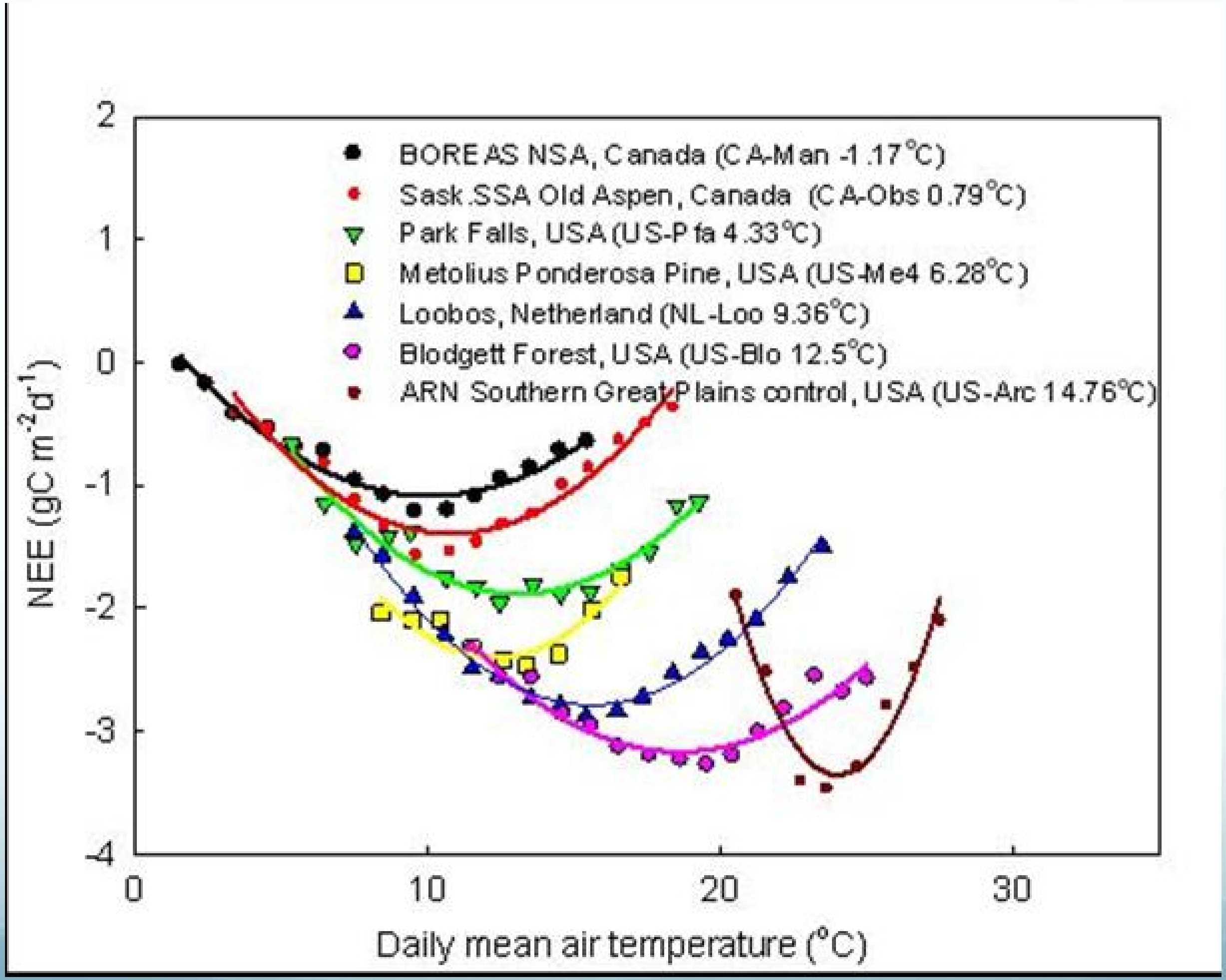
NEE observed at eddy covariance sites is: (1) a strong function of mean annual temperature at mid- and high-latitudes, (2) a strong function of dryness at mid- and low-latitudes, and (3) a function of both temperature and dryness around the mid-latitudinal belt (45°N).



Yi et al. ERL, 2010

Thermal Optimality of Net Ecosystem Exchange of Carbon Dioxide

The ecosystem-level thermal optimality is a new emergent property with its mechanisms yet to be further understood but has implications for modeling analysis of ecosystem-climate feedbacks.

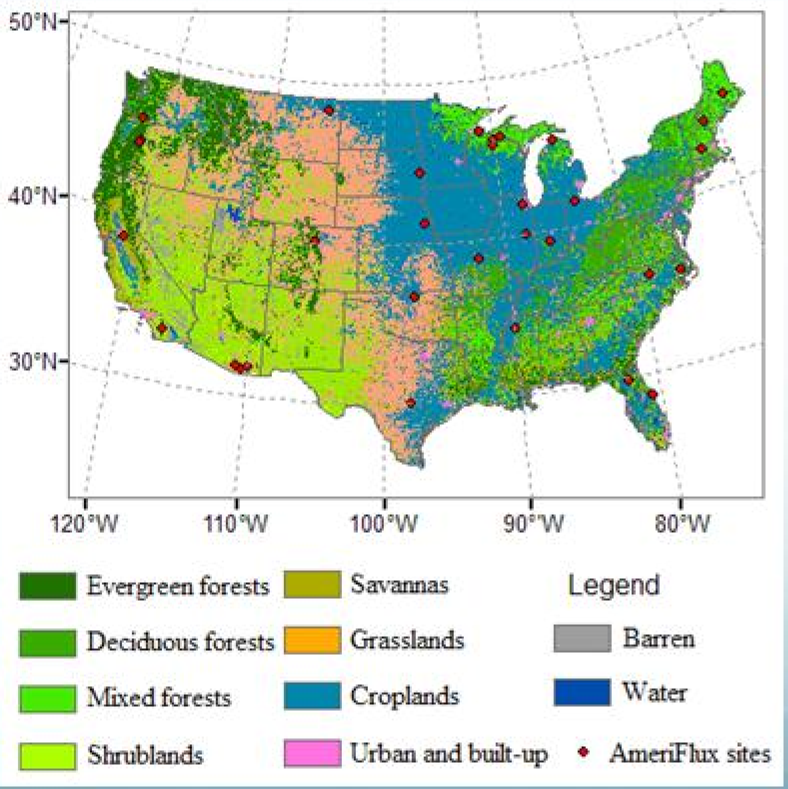


Niu et al. 2012

Cross-Lab Syntheses:

A CORE ELEMENT OF THE U.S. GLOBAL CHANGE RESEARCH PROGRAM
North American Carbon Program
CONTINENTAL CARBON BUDGETS, DYNAMICS, PROCESSES, AND MANAGEMENT

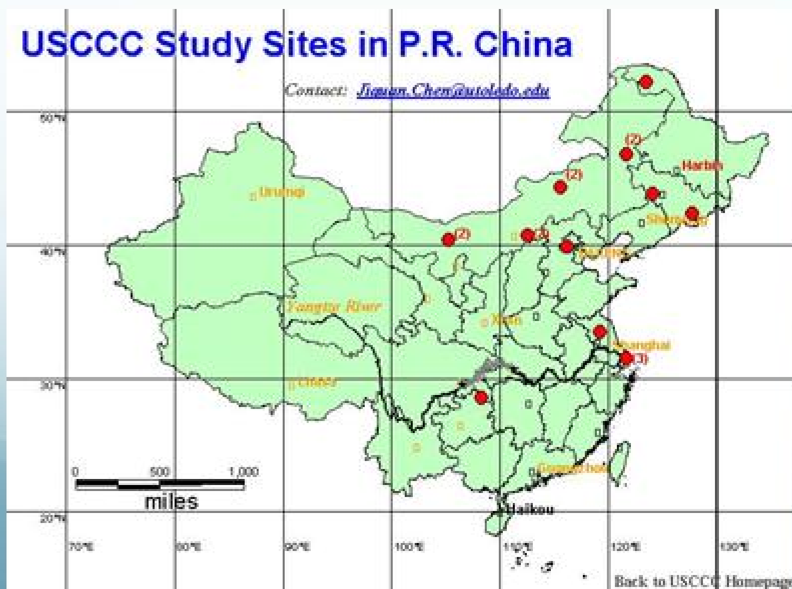
- Combined MODIS and AmeriFlux data for representative U.S. ecosystems to develop a predictive NEE model
- a gross carbon uptake between 6.91 and 7.33 Pg C yr^{-1} for the conterminous U.S. Drought, fires, and hurricanes reduced annual GPP at regional scales and could have a significant impact on the U.S. net ecosystem carbon exchange.
- The sources of the interannual variability of U.S. GPP were dominated by these extreme climate events and disturbances.

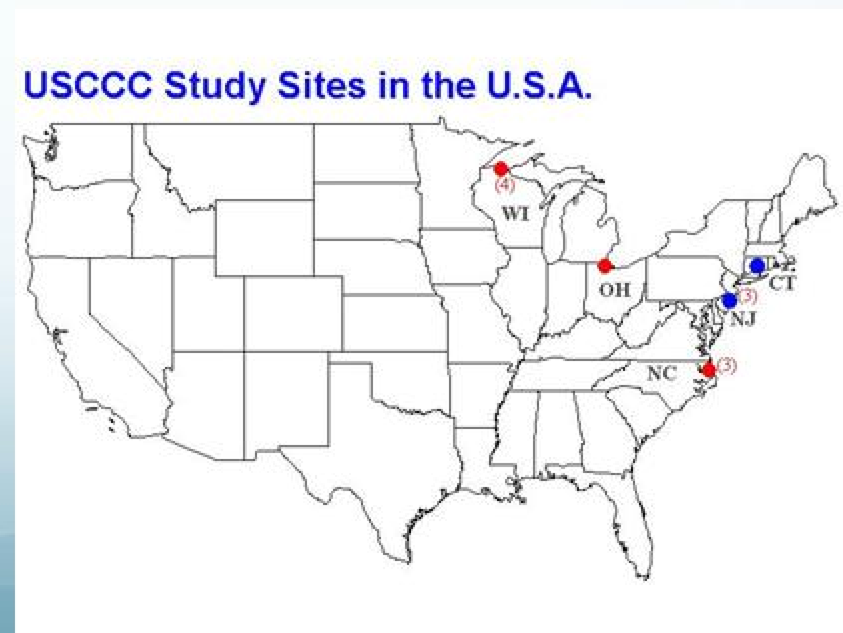


Xiao et al. (2008, 2010, 2011)

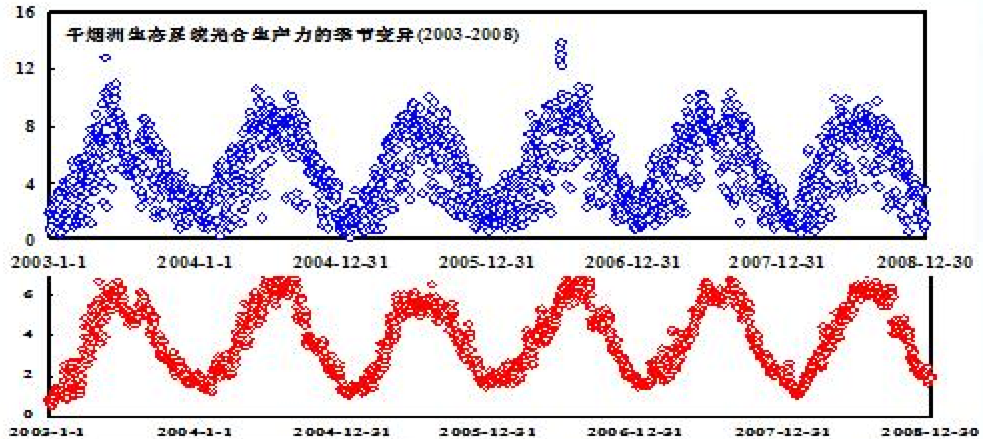
The LaHuile Synthesis: Almost three years ago the first global FLUXNET standardized dataset has been created (aka LaThuile dataset) with about 250 sites from all the networks and 1000 years with data, which have been shared among contributors to the dataset for join scientific analysis (The Synthesis Committee). The data available in this database have been provided by PIs and Regional networks with the aim to build a global standardized database of eddy covariance measurements to be used for global synthesis activities. www.fluxdata.org

The US-China Carbon Consortium (USCCC)

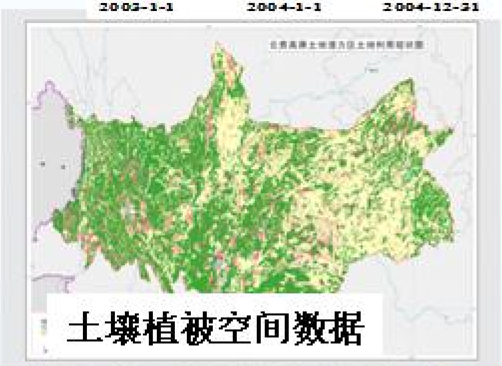




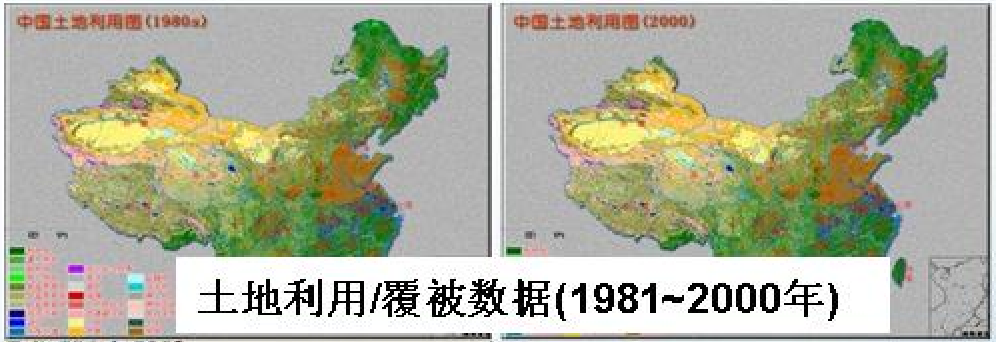
长期的数据积累



全国空间化的数据资源



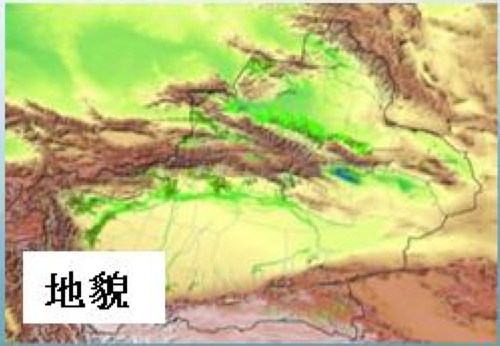
土壤植被空间数据



土地利用/覆被数据(1981~2000年)

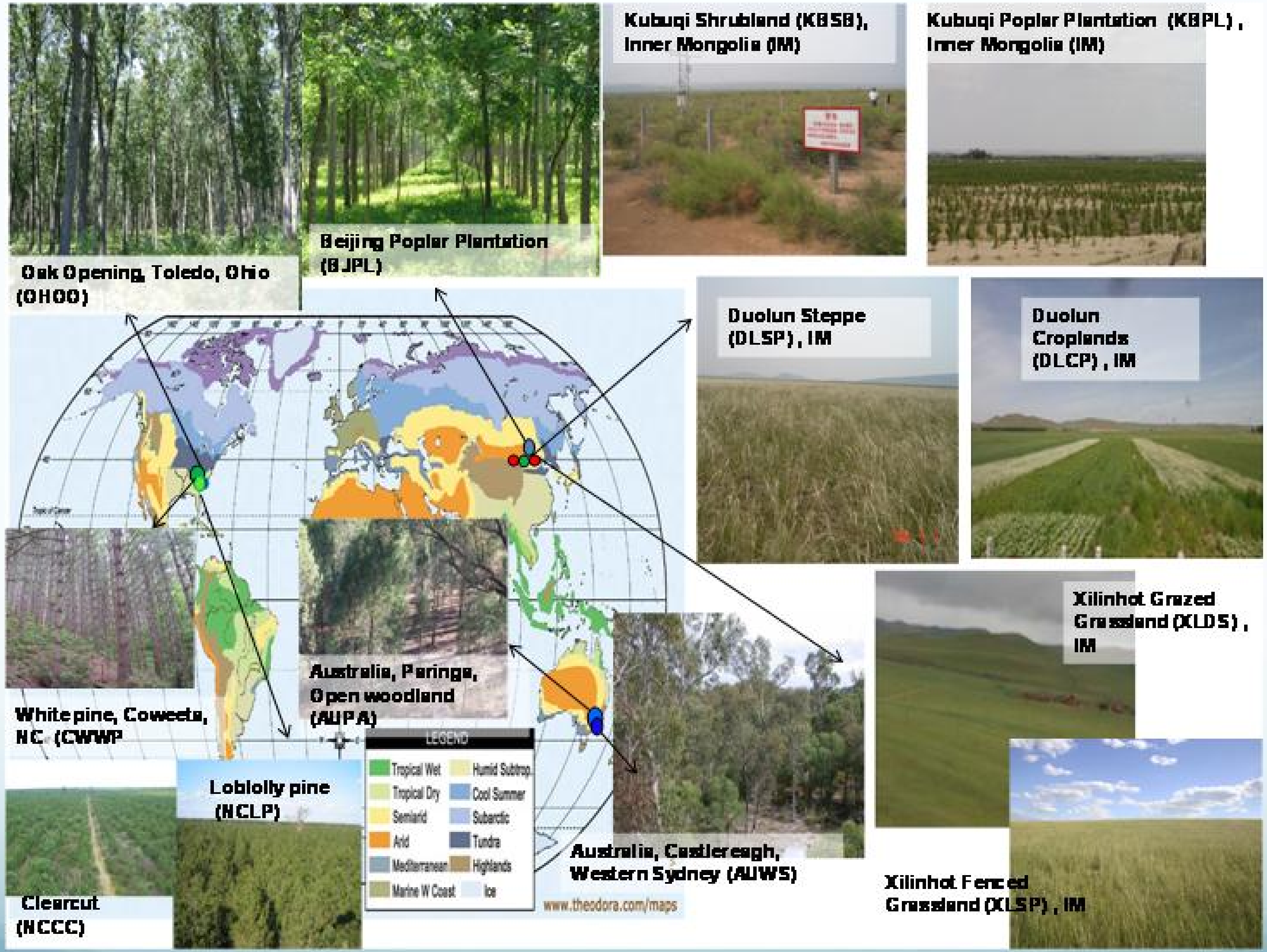
气象要素空间数据(1971~2008年)

蒸发散



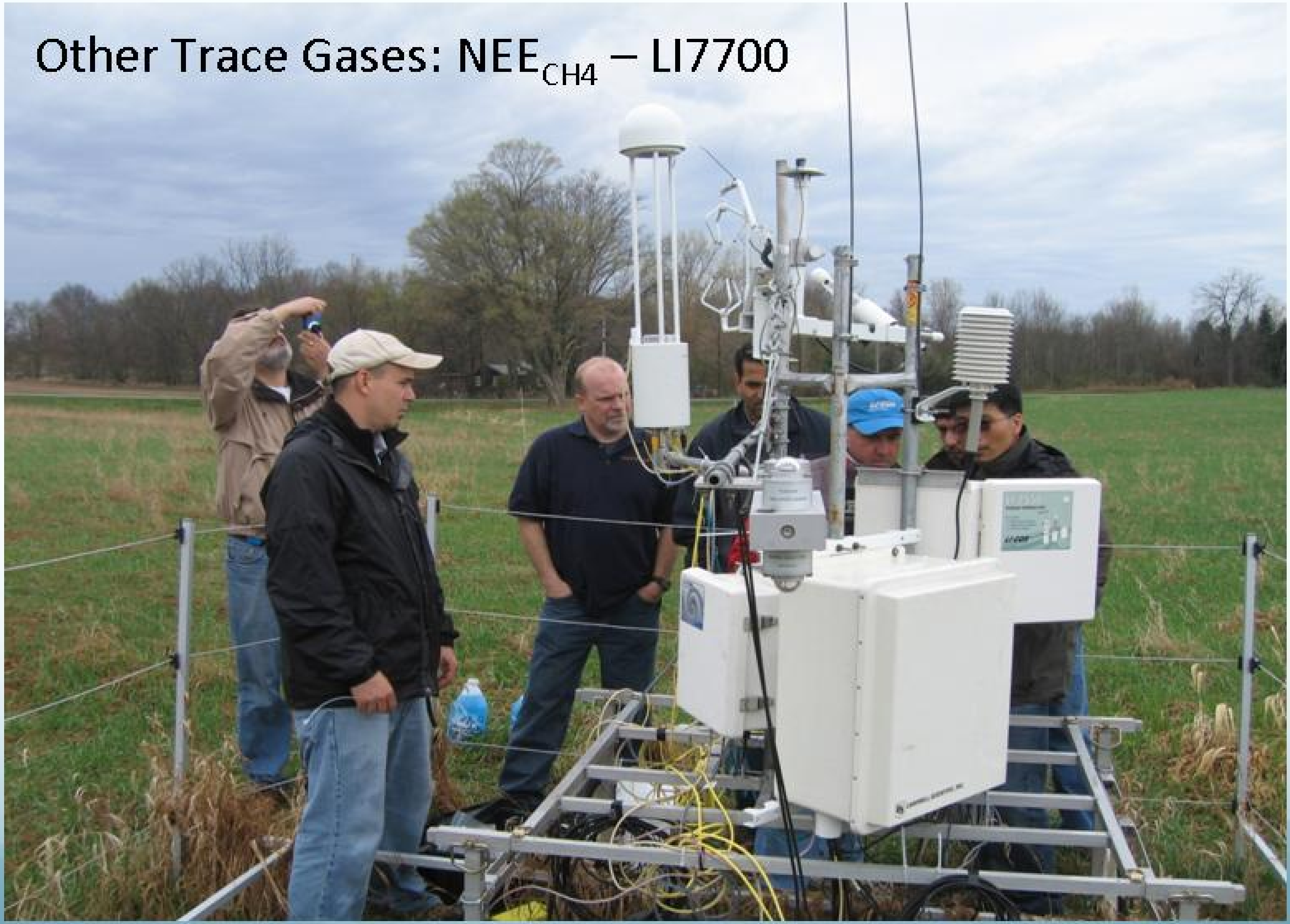
地貌

A General predictive model for estimating monthly ecosystem ET



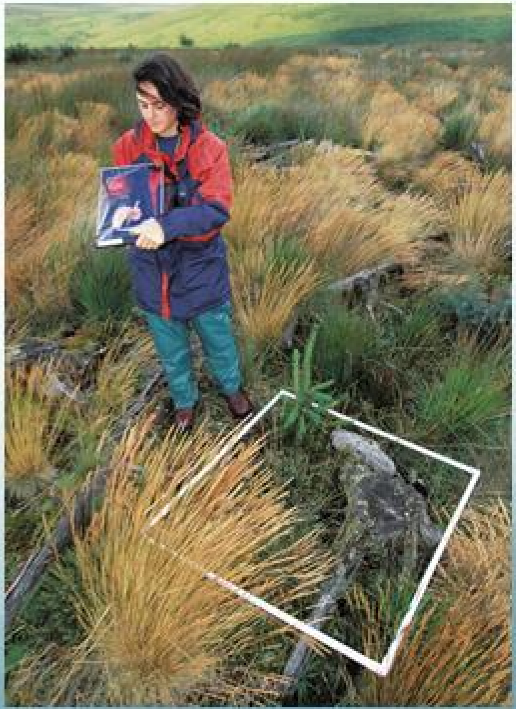
Sun et al. (2011) Ecohydrology

Frontier 4: Coupled biogeochemical cycles (see Front Ecol & Environ)



Experiments are performed in the lab or in the field.

- Lab experiments give researchers more control but are not reflective of the complex interactions in nature.
- Field experiments give a more accurate picture of natural interactions.




Yunxiao, Fujian
Mangroves
Cordgrasses

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Zhang, Yihui, Guanmin Huang, Wenqing Wang, Luzhen Chen, and Guanghui Lin. *In press.* Interactions between mangroves and exotic Spartina in an anthropogenically-disturbed estuary in southern China. Ecology. [doi:10.1890/11-1302.1]

Interactions between mangroves and exotic Spartina in an anthropogenically-disturbed estuary in southern China

Yihui Zhang[1,*], Guanmin Huang[2], Wenqing Wang[3], Luzhen Chen[4], and Guanghui Lin[5]

[1]Key Laboratory of the Ministry of Education for Coastal and Wetland Ecosystems, Xiamen University, School of Life Sciences

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俄克拉荷马大学

全球变暖与北美高草草原

全球变化与弃耕草地（二氧化碳、温度和水分）

夜间增温与物种组成

Alward et al. 1999. Science 283: 229-231.

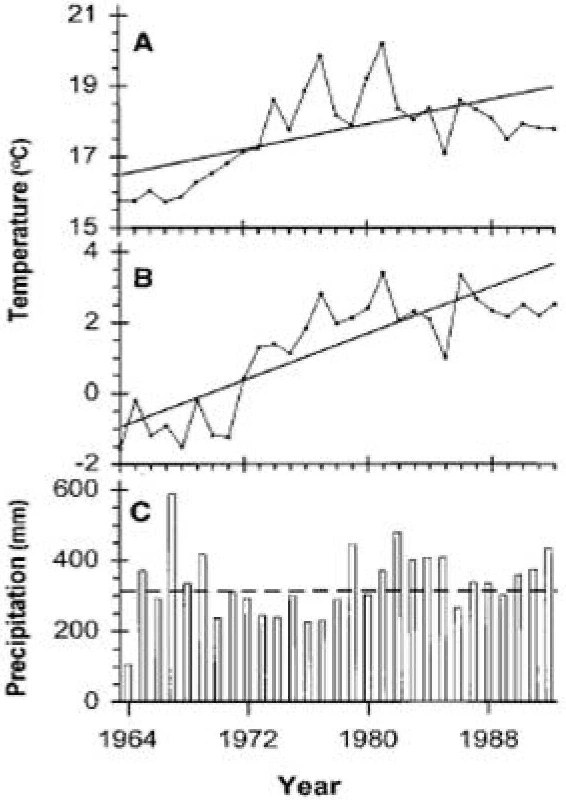


Fig. 1. Summary of climate data for the Central Plains Experimental Range site. (**A**) Average annual T_{MAX}. The heavy line is the significant linear trend in T_{MAX} [T_{MAX} = −150 + 0.085 (year); P = 0.001; R^2 = 0.36]. (**B**) Average annual T_{MIN}. The heavy line is the significant linear trend in T_{MIN} [T_{MIN} = −299 + 0.15 (year); P = 3.3 × 10^{-8}; R^2 = 0.68]. (**C**) Total annual precipitation. The horizontal dashed line identifies the average annual precipitation (323 mm) at this site since 1939.

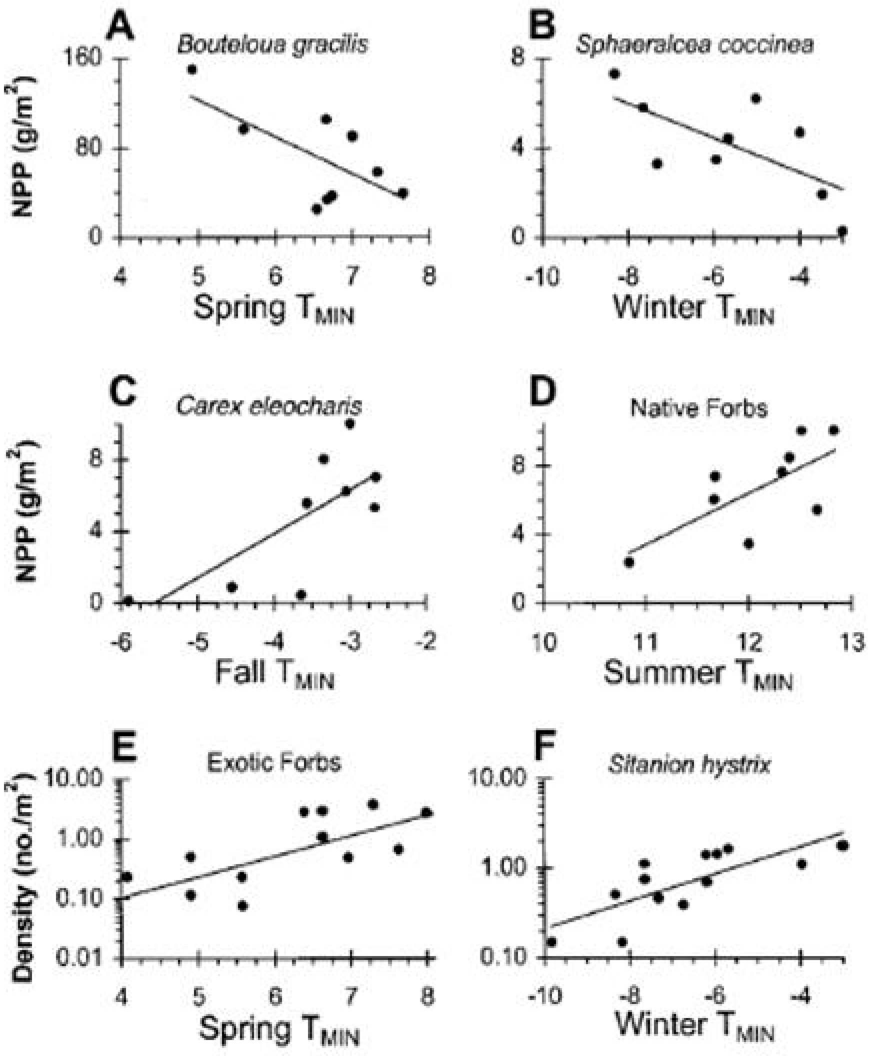
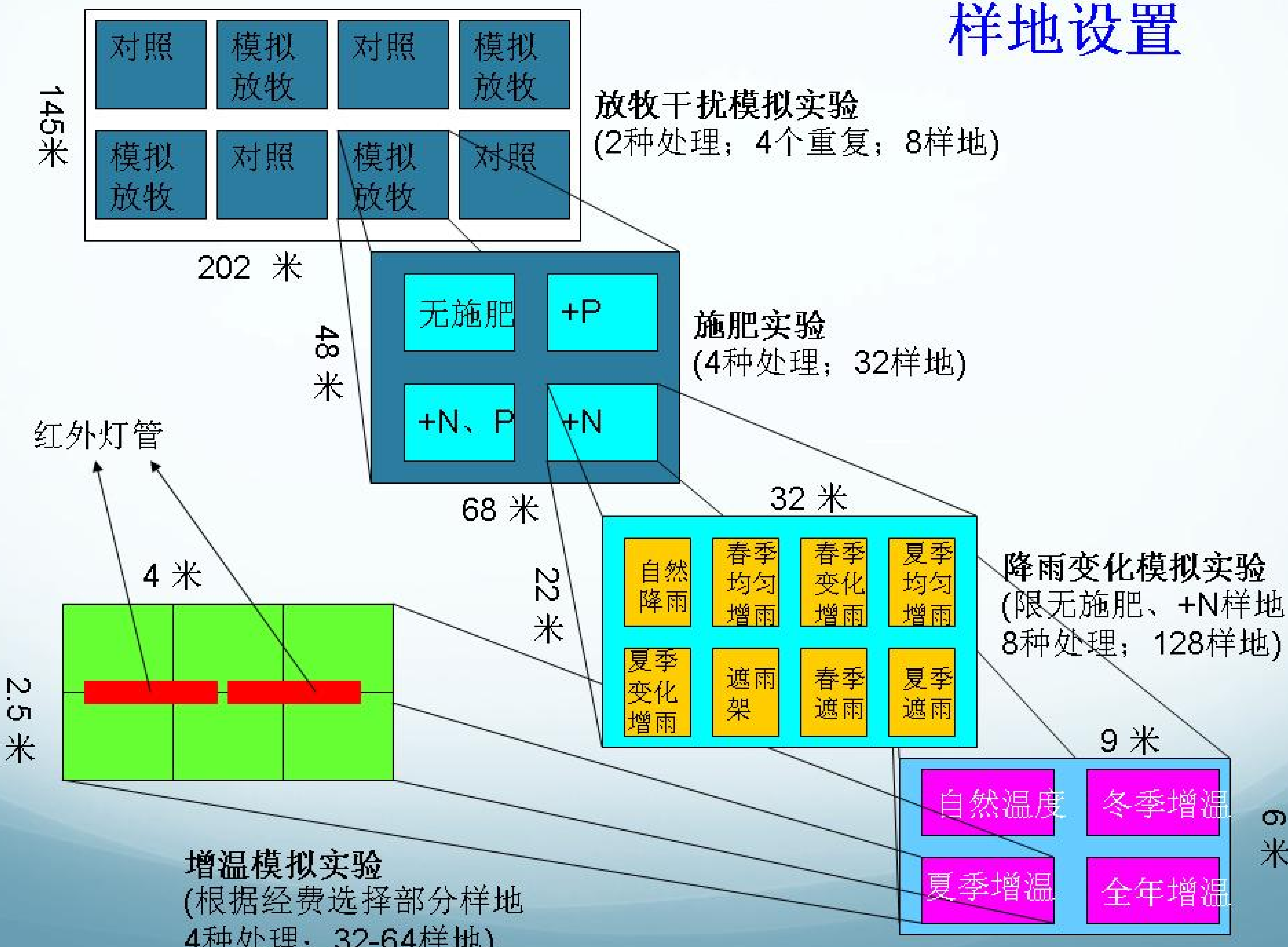


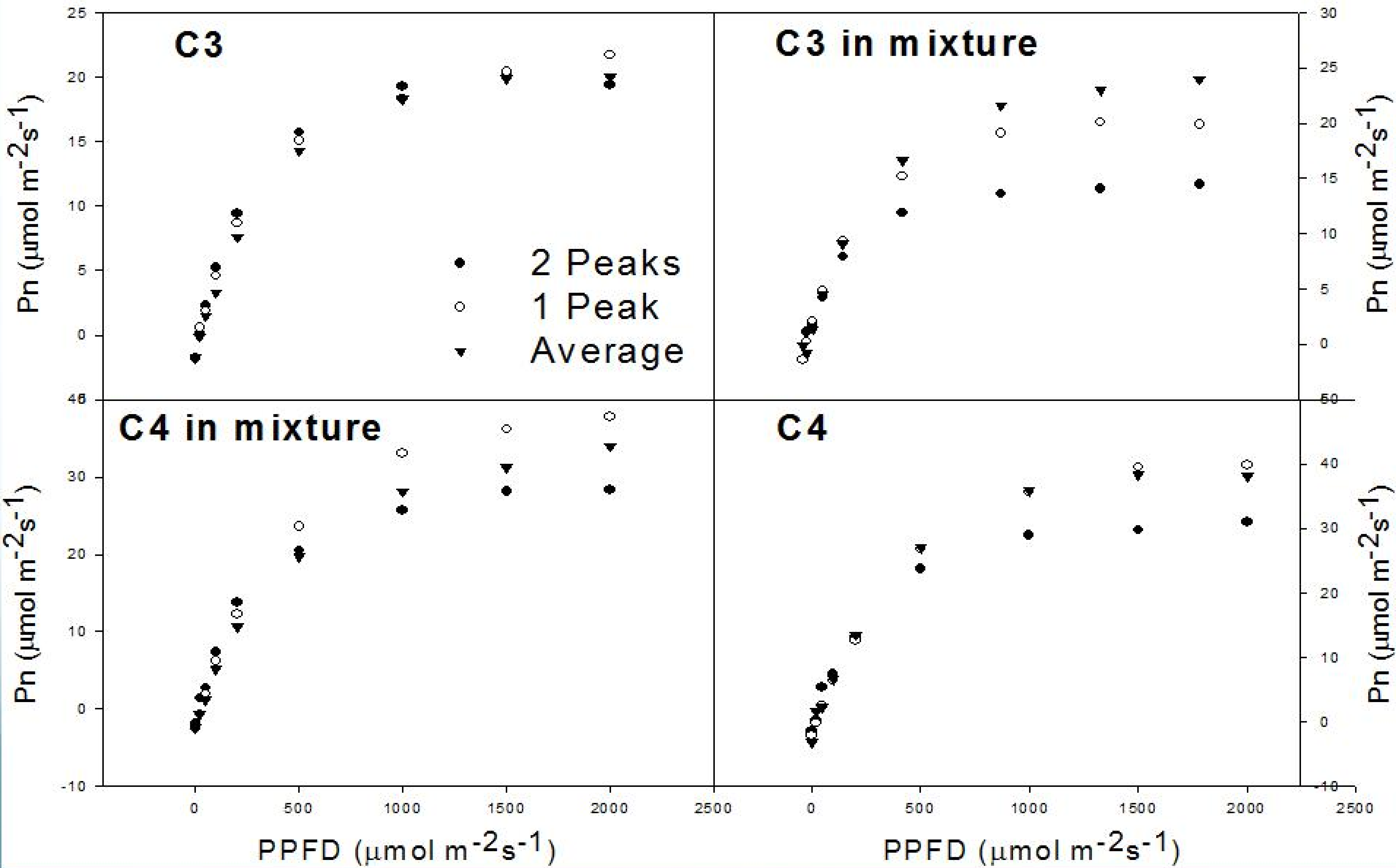
Fig. 2. Vegetation correlations with seasonal average T_{MIN}. (**A**) *Bouteloua gracilis* and spring T_{MIN} [ANPP = 288 – 33.1 (T_{MIN}); P = 0.039; R^2 = 0.48]. (**B**) *Sphaeralcea coccinea* and winter T_{MIN} [ANPP = 0.149 – 0.77 (T_{MIN}); P = 0.038; R^2 = 0.48]. (**C**) *Carex eleocharis* and fall T_{MIN} [ANPP = 13.6 + 2.44 (T_{MIN}); P = 0.019; R^2 = 0.56]. (**D**) Native forb (herbaceous dicots) and summer T_{MIN} [ANPP = –29.5 + 2.99 (T_{MIN}); P = 0.028; R^2 = 0.52]. (**E**) Exotic (nonnative) forb density and spring T_{MIN} [density = $0.008e^{0.71(T_{MIN})}$; P = 0.014; R^2 = 0.46]. (**F**) *Sitanion hystrix* density and winter T_{MIN} [density = $6.4e^{0.33(T_{MIN})}$; P = 0.002; R^2 = 0.57]. Methods for obtaining density and ANPP data are described in (*11*, *12*).

样地设置

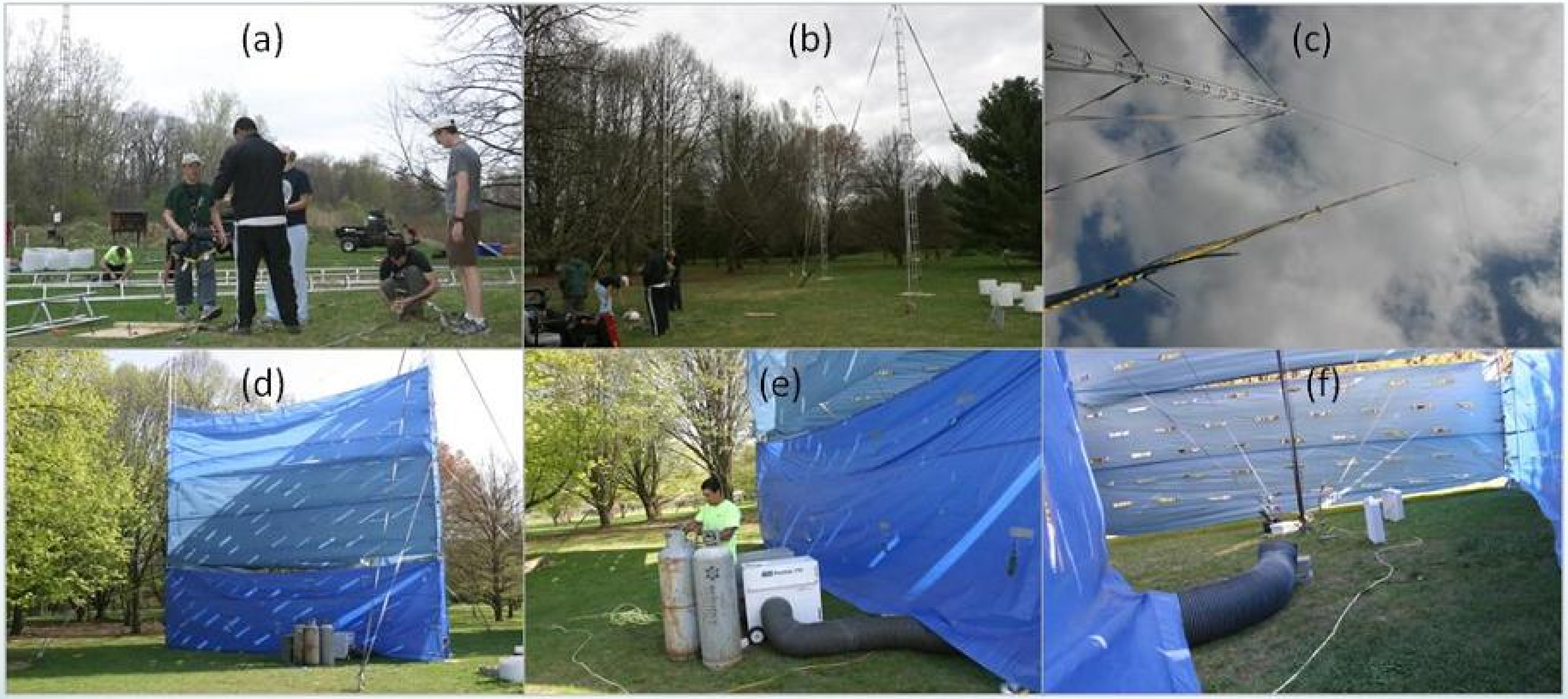


对照
模拟放牧
对照
模拟放牧
模拟放牧
对照
模拟放牧
对照
145米
202 米
放牧干扰模拟实验
(2种处理；4个重复；8样地)
无施肥
+P
+N、P
+N
48米
68 米
施肥实验
(4种处理；32样地)
32 米
22米
自然降雨
春季均匀增雨
春季变化增雨
夏季均匀增雨
夏季变化增雨
遮雨架
春季遮雨
夏季遮雨
降雨变化模拟实验
(限无施肥、+N样地
8种处理；128样地)
红外灯管
4 米
2.5米
9 米
6米
自然温度
冬季增温
夏季增温
全年增温
增温模拟实验
(根据经费选择部分样地
4种处理；32-64样地)

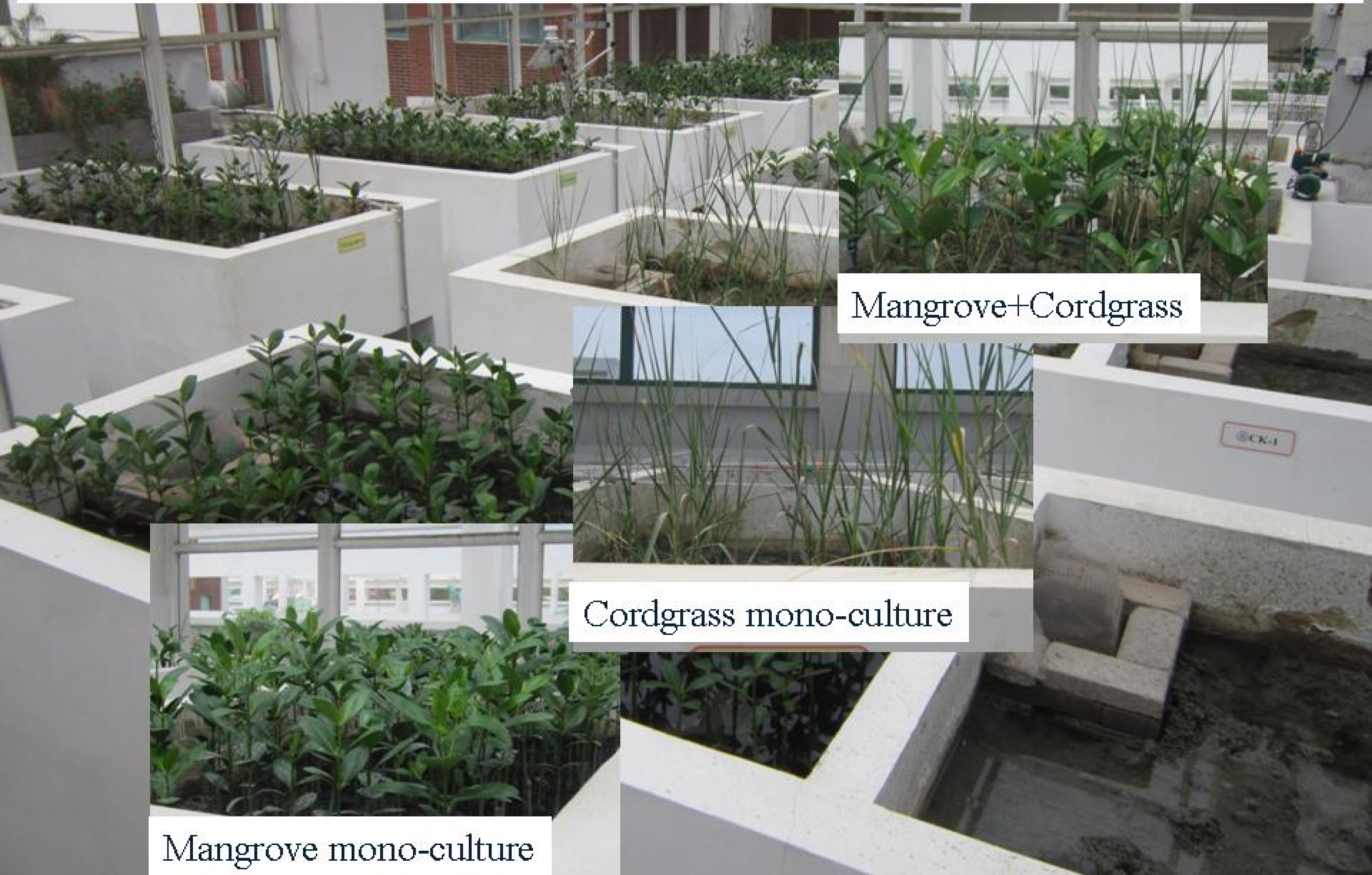
7月下旬 C_3与C_4植物在不同降雨模式下的A-PPFD曲线

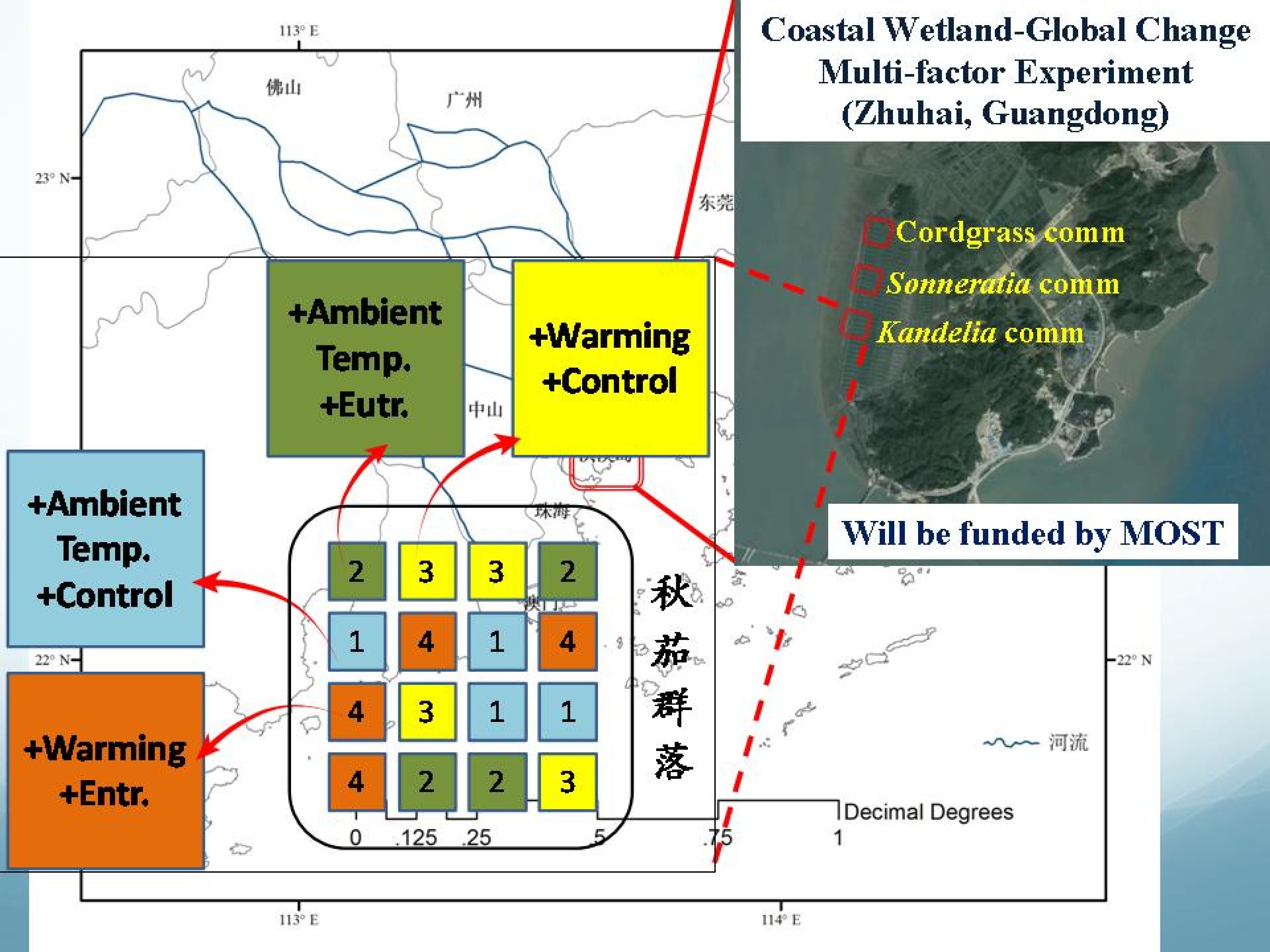


Field photos of a 40-ft tall pilot chamber for simulating heat waves, precipitation, and other drivers using large chambers.

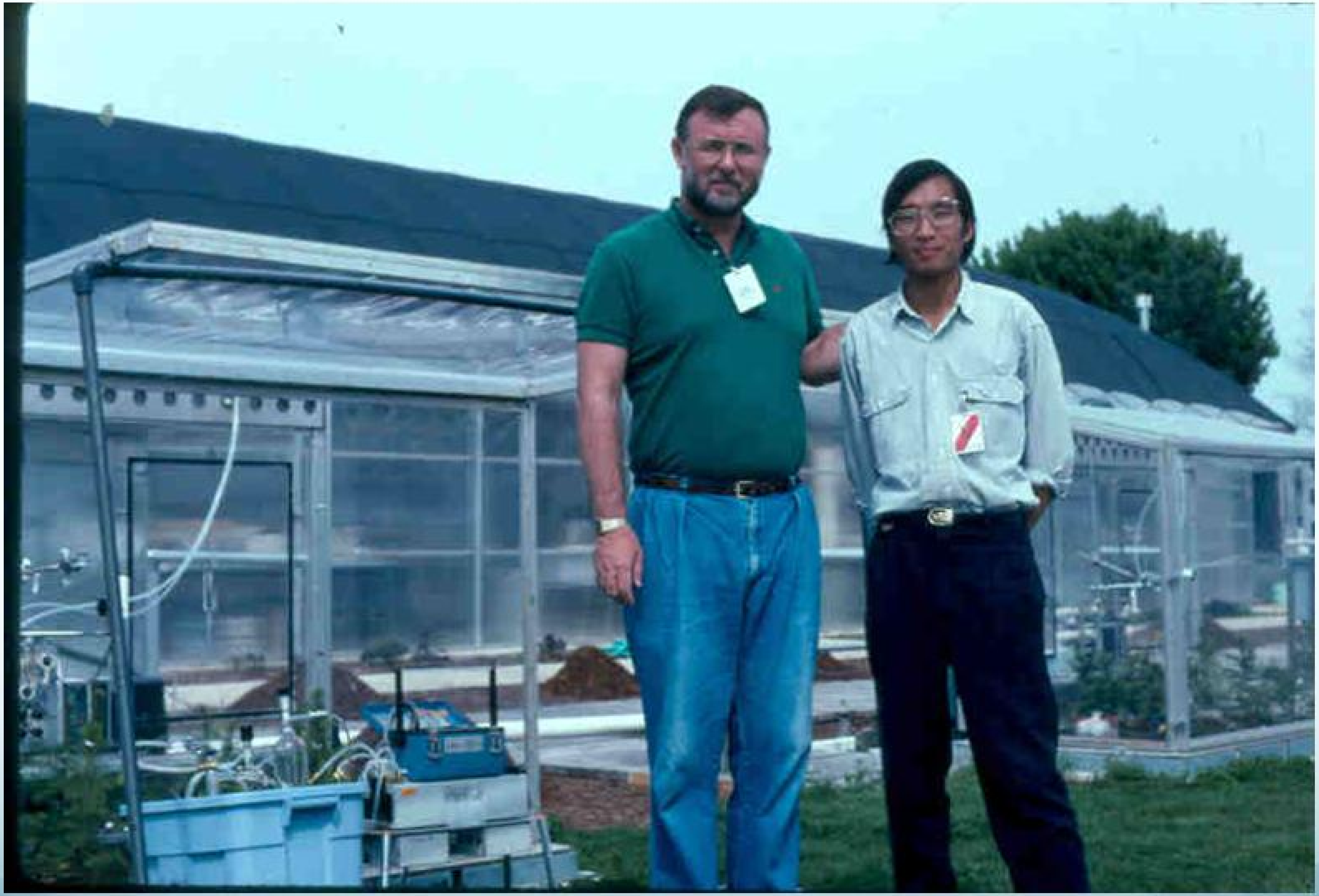


Controlled experiments with coastal wetlands (Shenzhen)
Funded by NSFC

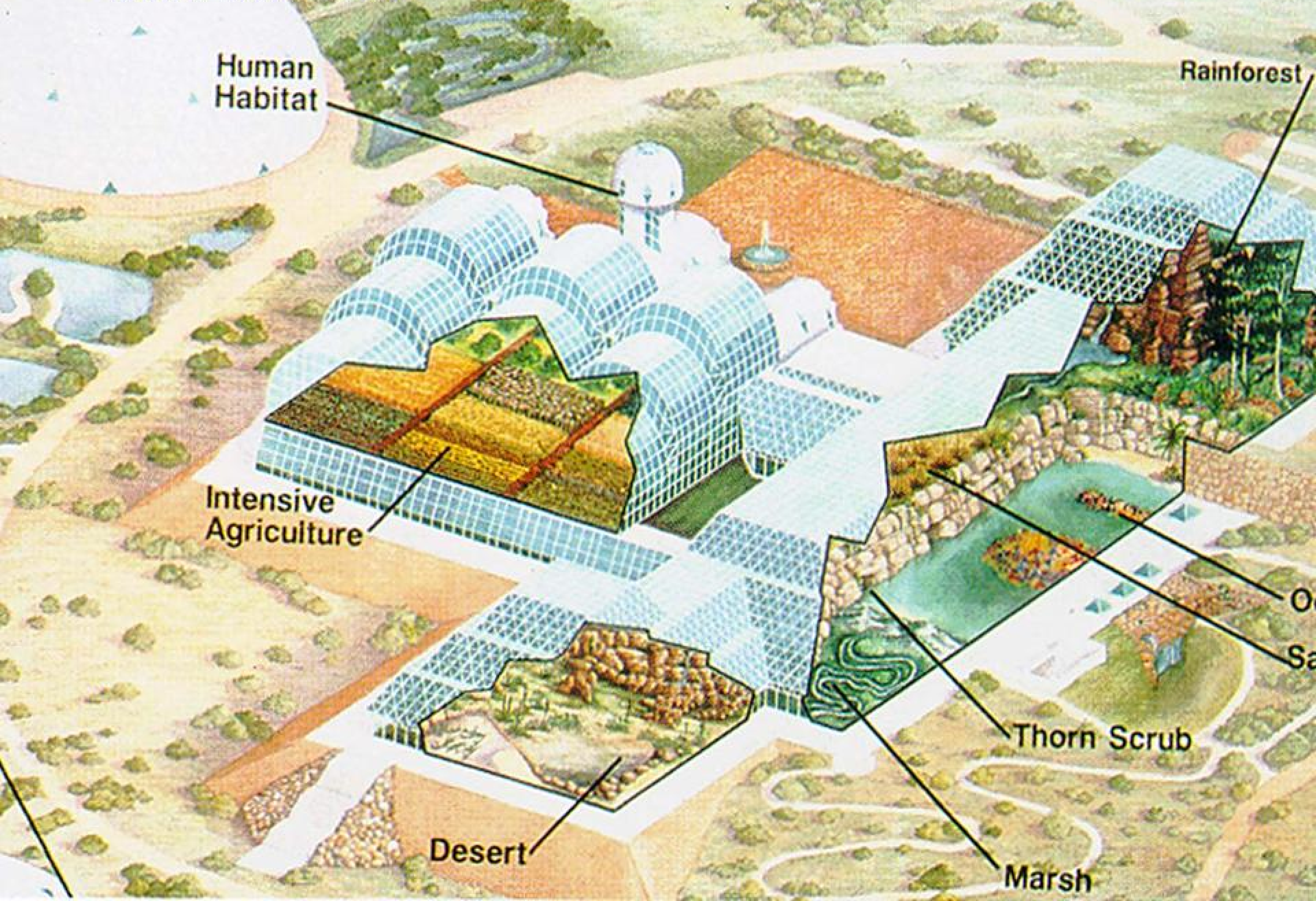


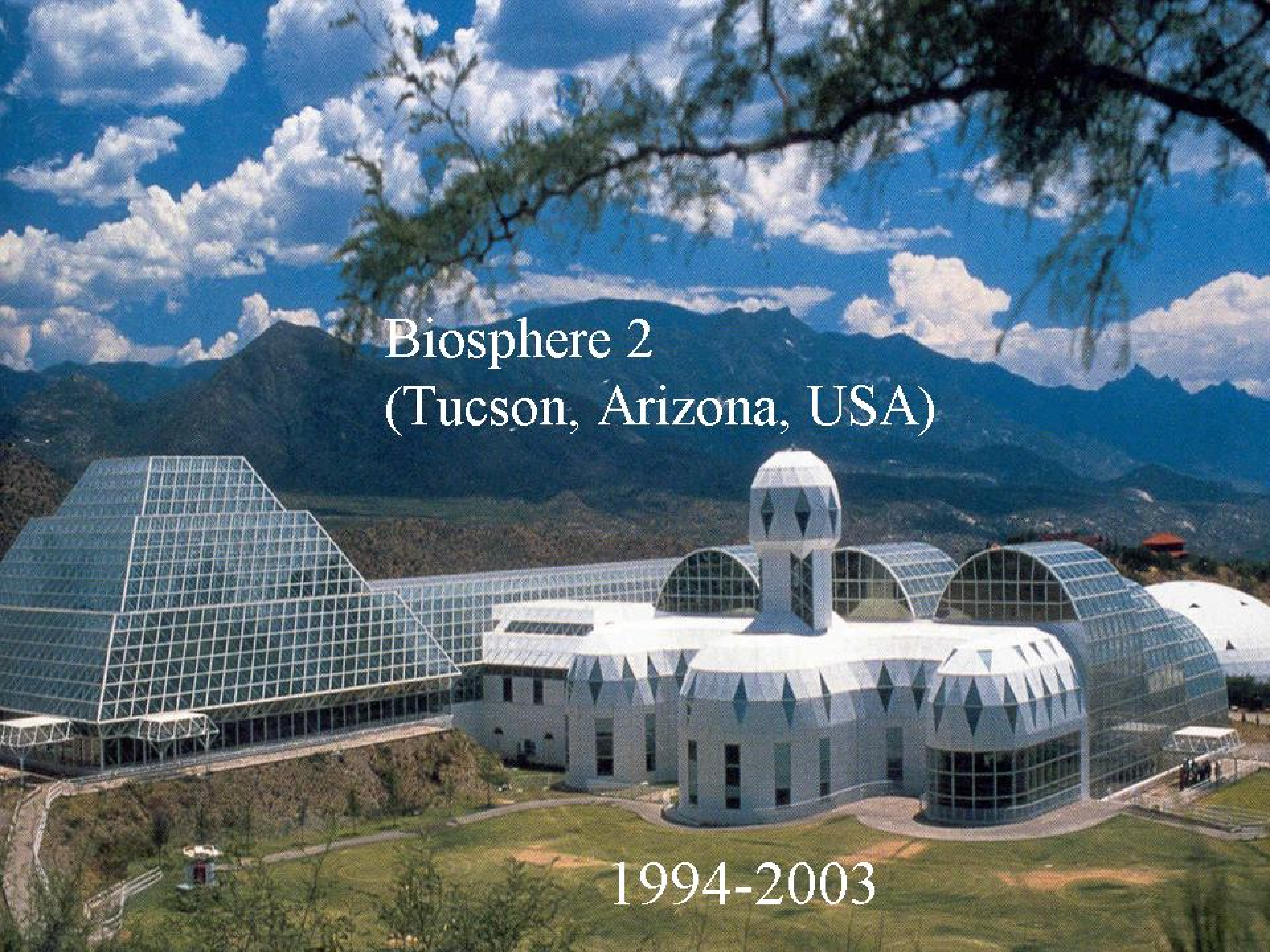

Coastal Wetland-Global Change
Multi-factor Experiment
(Zhuhai, Guangdong)
Cordgrass comm
Sonneratia comm
Kandelia comm
Will be funded by MOST
+Ambient Temp. +Eutr.
+Warming +Control
+Ambient Temp. +Control
+Warming +Entr.
2 3 3 2
1 4 1 4
4 3 1 1
4 2 2 3
秋茄群落
113° E
114° E
23° N
22° N
佛山
广州
东莞
中山
珠海
澳门
河流
0
.125
.25
.5
.75
1
Decimal Degrees

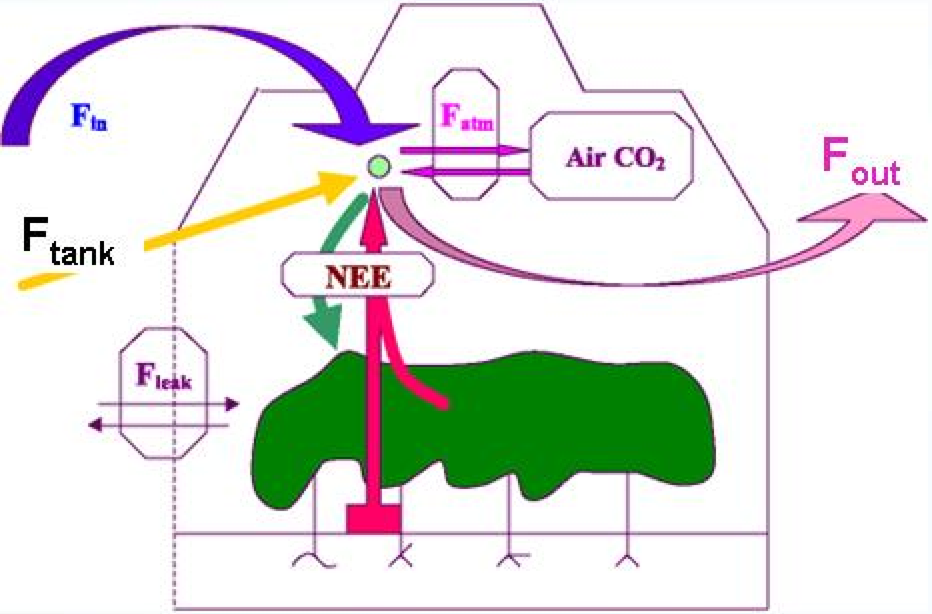
Terracosms



为了尽量贴近自然环境，该圈中的土壤、草皮、海水、淡水均取自外界的不同地理区间
一定的人工处理再利用




Biosphere 2
(Tucson, Arizona, USA)
1994-2003

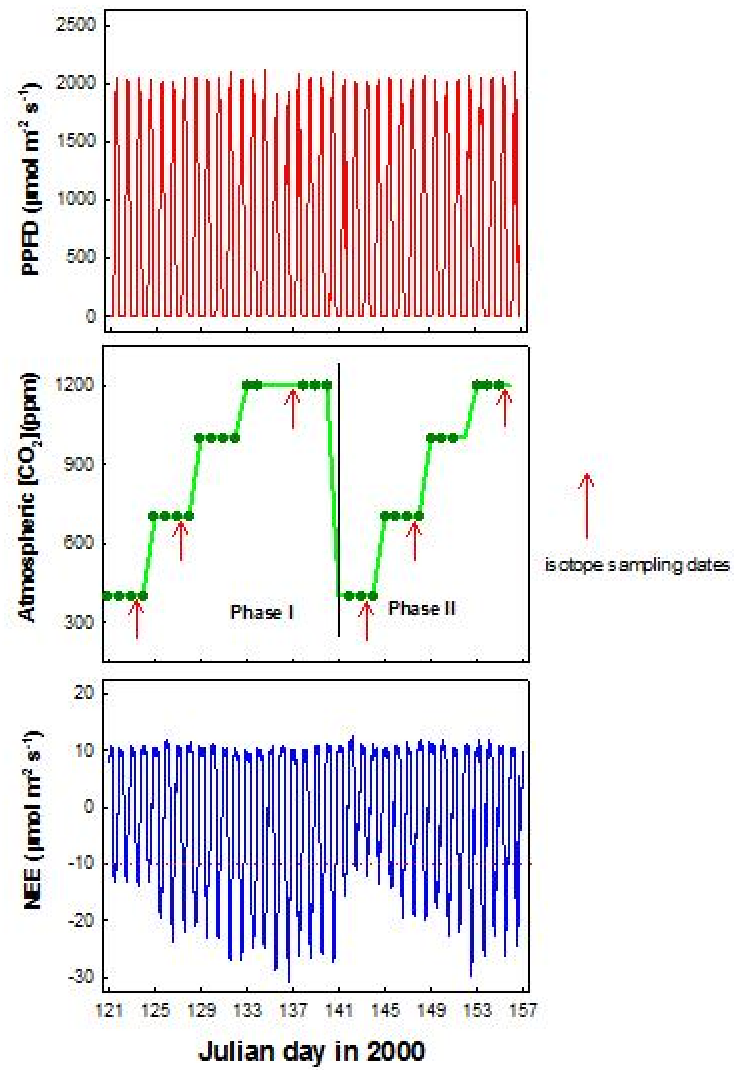


$$NEE = F_{in} + F_{tank} - F_{out} - F_{leak} - F_{atm}$$

NEE: Net ecosystem exchange of CO_2 by the rainforest
F_{in}: CO_2 flow into the rainforest from outside air
F_{out}: CO_2 flow out from the rainforest
F_{leak}: Net CO_2 leak across the partition curtain
F_{tank}: CO_2 added from the tank
F_{atm}: Net CO_2 accumulated in the inside atmosphere

$$GPP = NEE + R_{eco}$$

GPP: Gross photosynthetic productivity
R_{eco}: Ecosystem respiration rate

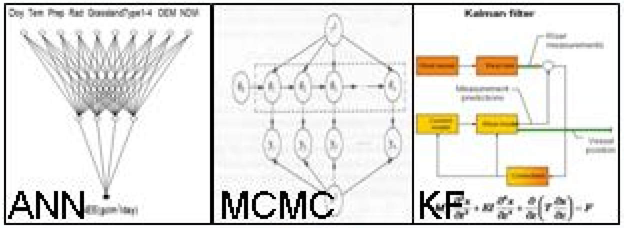


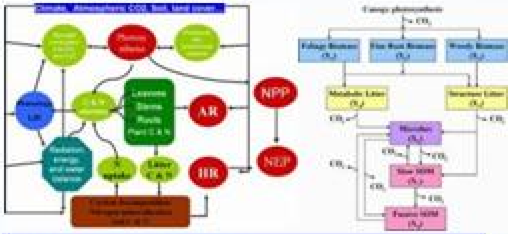
Lin et al. 1998, 1999, Osmond et al., 1999

- Modeling allows scientists to learn about organisms or ecosystems in ways that would not be possible in a natural or lab setting.

Ecologists use data transmitted by GPS receivers worn by elephants to develop computer models of the animal's movements.

数据–模型融合系统





生态系统碳循环数据
- 数据置信度明确
- 数据不完整，观测误差

融合

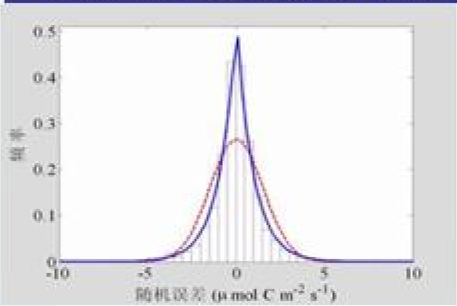
生态系统模型
- 理解机理，进行预测
- 结构不完善，参数不准确

综合分析
- 置信度明确，预测未来

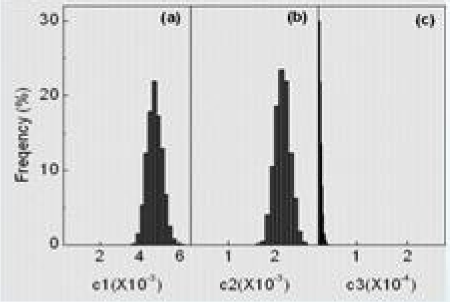
站点尺度

站点尺度

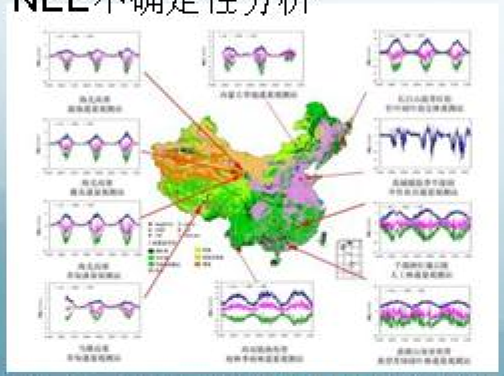
区域/全国尺度



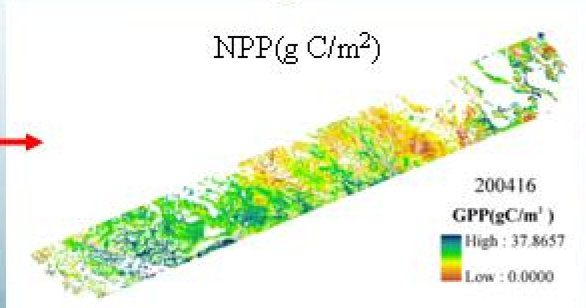
NEE不确定性分析



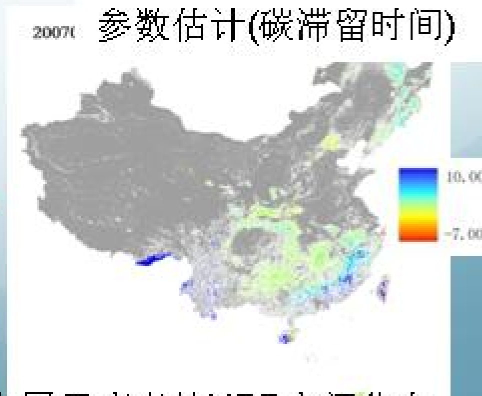
参数估计(碳滞留时间)



站点尺度GPP/RE/NEP动态系列



样带尺度GPP空间分布



全国尺度森林NPP空间分布

TRIPLEX, TRIPLEX-GHG 模式

彭长辉: 11月23, 26讲座

ELSEVIER

Ecological Modelling 153 (2002) 109–130

ECOLOGICAL MODELLING

www.elsevier.com/locate/ecolmodel

TRIPLEX: a generic hybrid model for predicting forest growth and carbon and nitrogen dynamics

Changhui Peng [a,b,*], Jinxun Liu [b], Qinglai Dang [b], Michael J. Apps [b,c],

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Global and Planetary Change

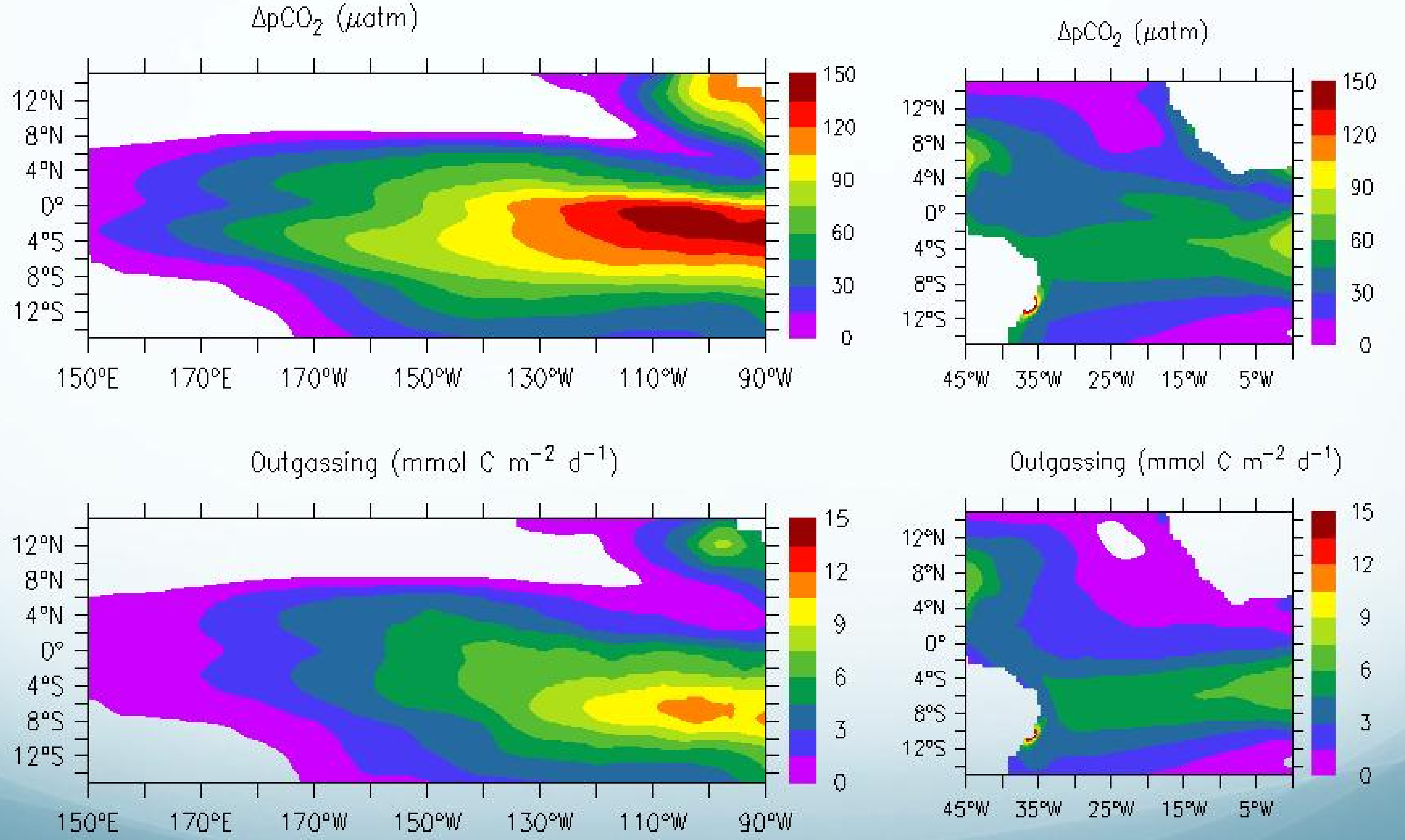
journal homepage: www.elsevier.com/locate/gloplacha

ELSEVIER

Quantifying the response of forest carbon balance to future climate change in Northeastern China: Model validation and prediction

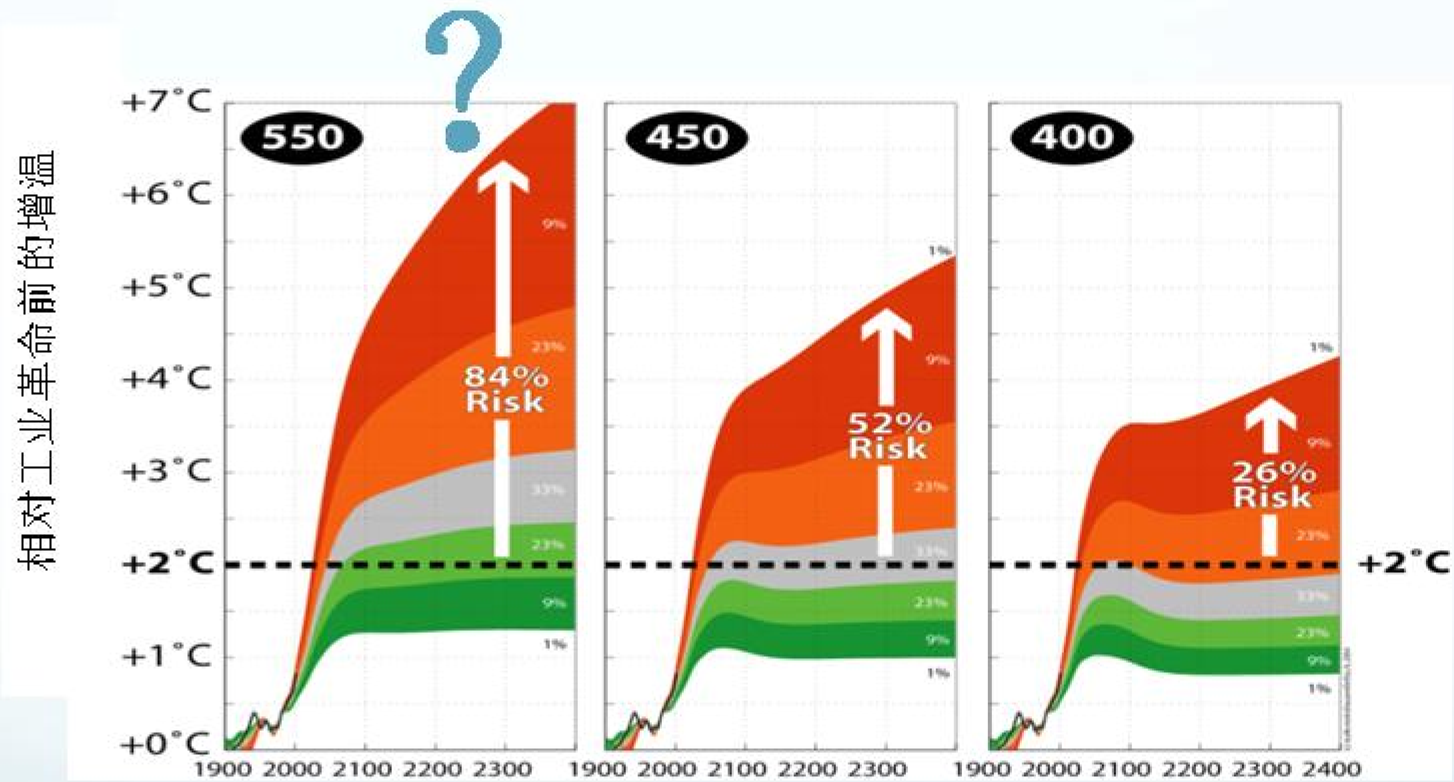
Changhui Peng [a,c,*], Xiaolu Zhou [a], Shuqing Zhao [a,b], Xiangping Wang [b], Biao Zhu [b], Shilong Piao [b], Jingyun Fang [b]

动态海洋生态-碳（DMEC）模型



Wang et al. (2006, 2008, 2009)

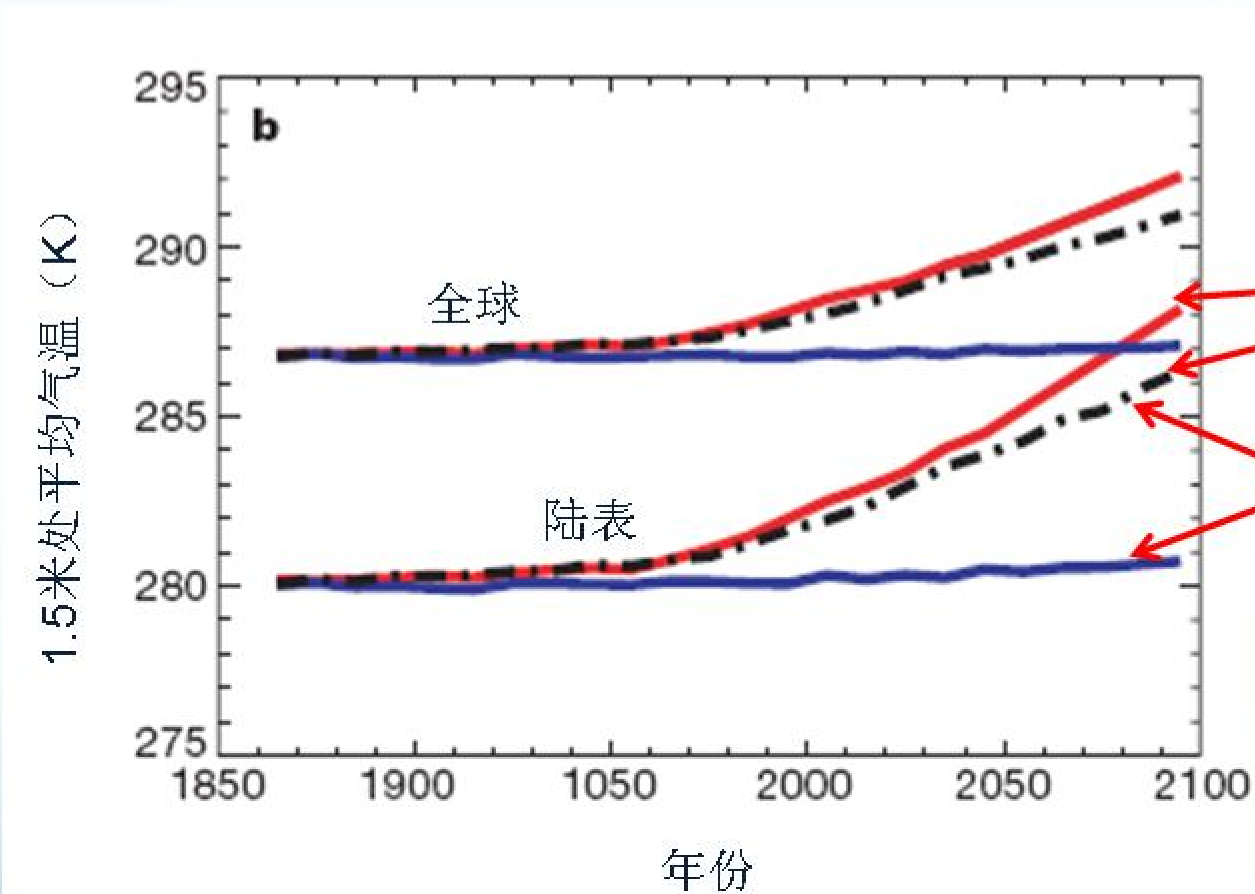
CO_2稳定目标浓度争论-2°C阈值问题



Meinshausen (2005)

Meinshausen et al. (2009) Nature； Fredlingstein et al. (2011) Nature climate change

碳循环与气候耦合的不确定性



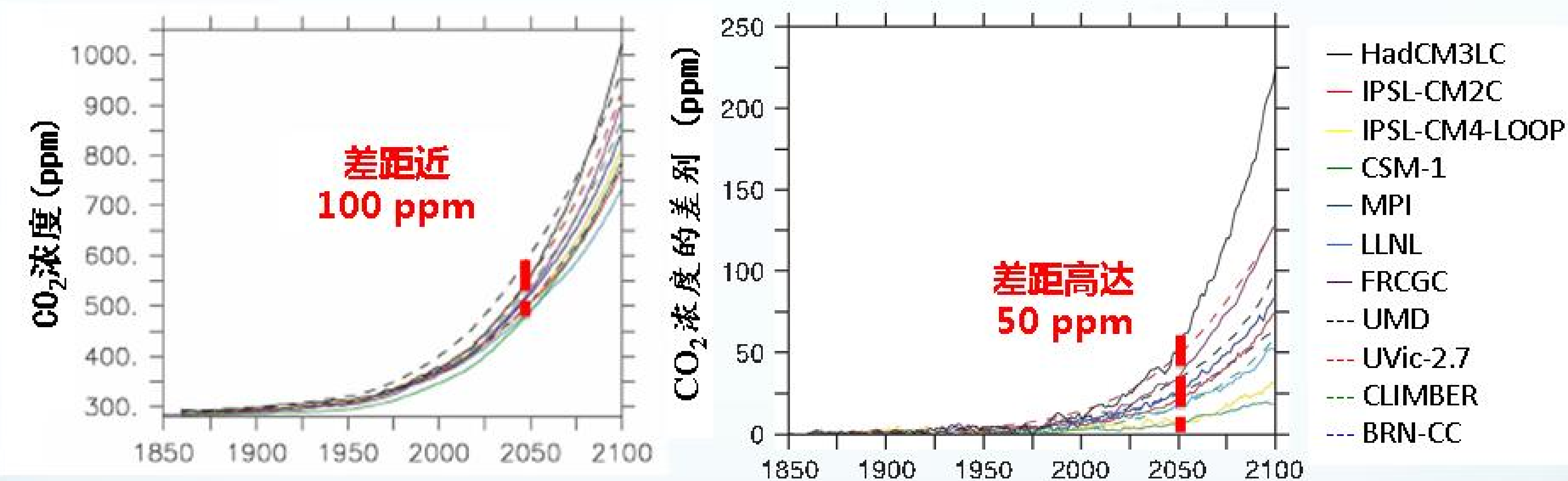
考虑动态

差高达5度

Cox et al. 2000 Nature

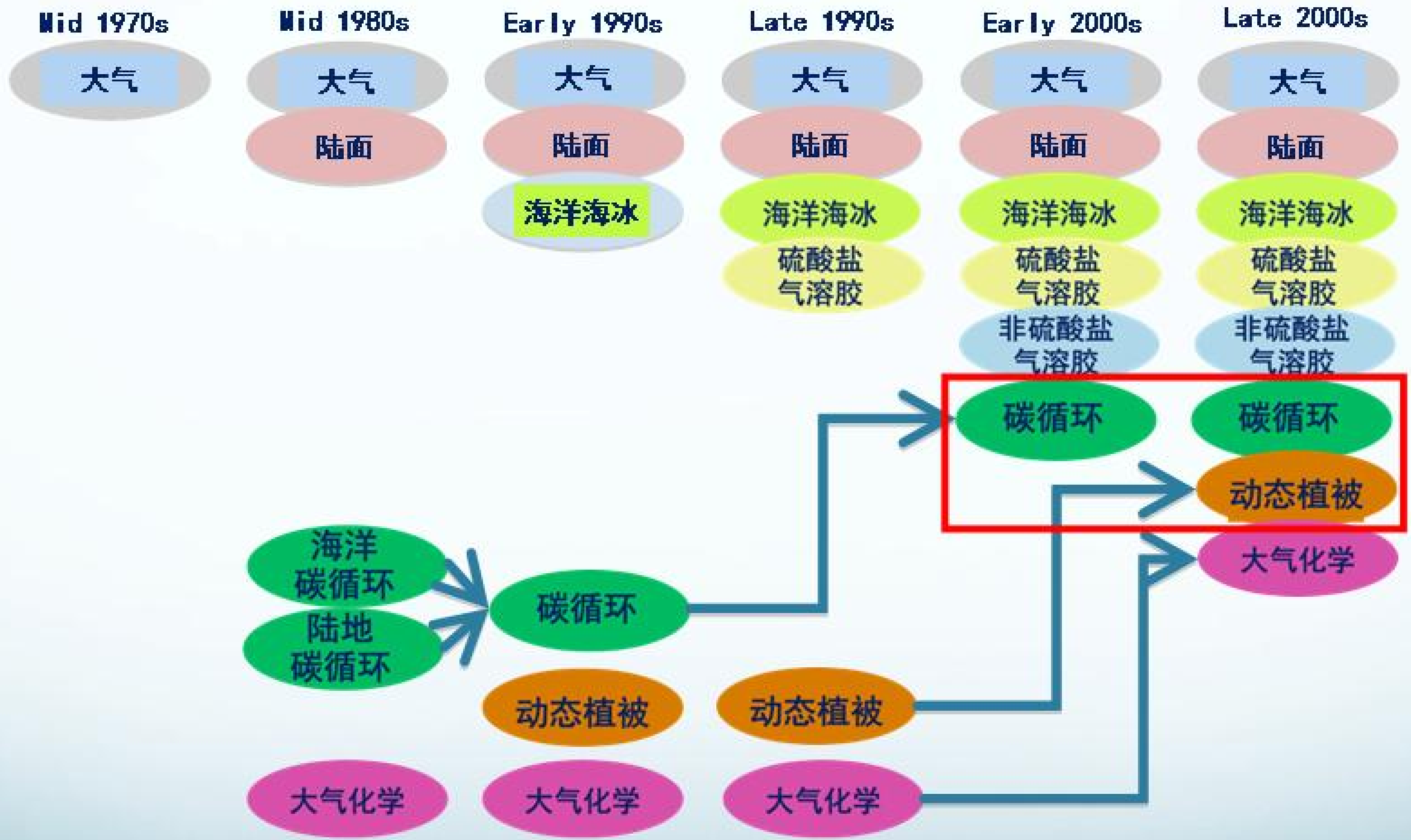
碳循环与气候耦合的不确定性

Fredlingstein et al. 2006



11个气候模式对未来CO_2浓度变化的预测差别甚大，耦合碳循环的效果也明显不同！

碳循环与气候模式的耦合



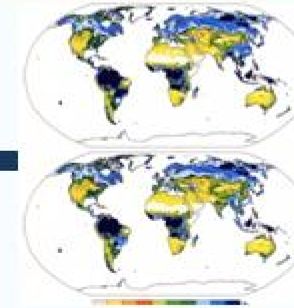
碳循环与气候的耦合成为地球系统模式发展的必然趋势

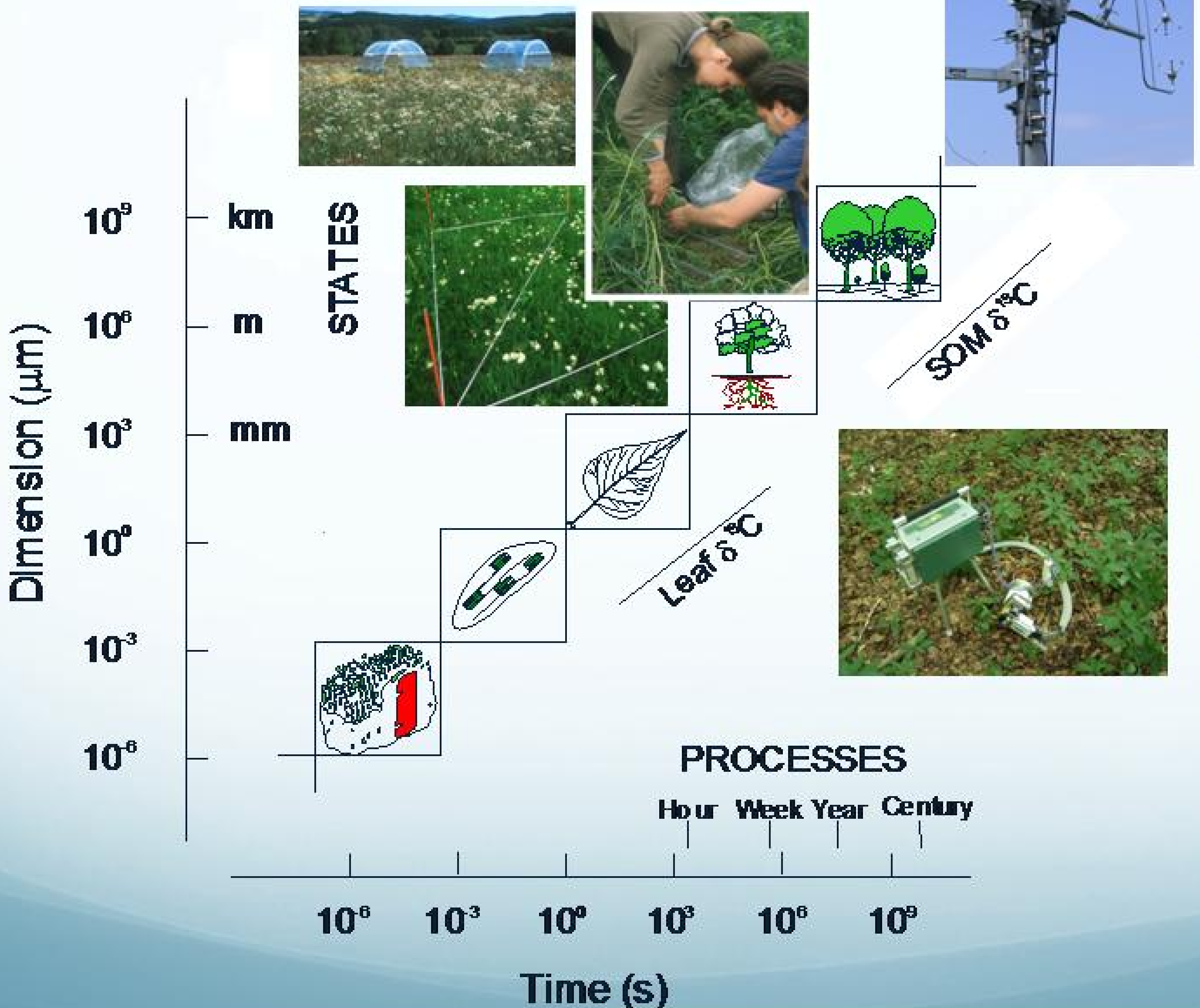
AR4：23个模式中无碳反馈 -> AR5：40个模式中的19个

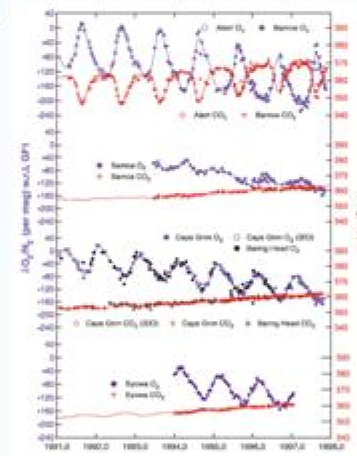
Outline

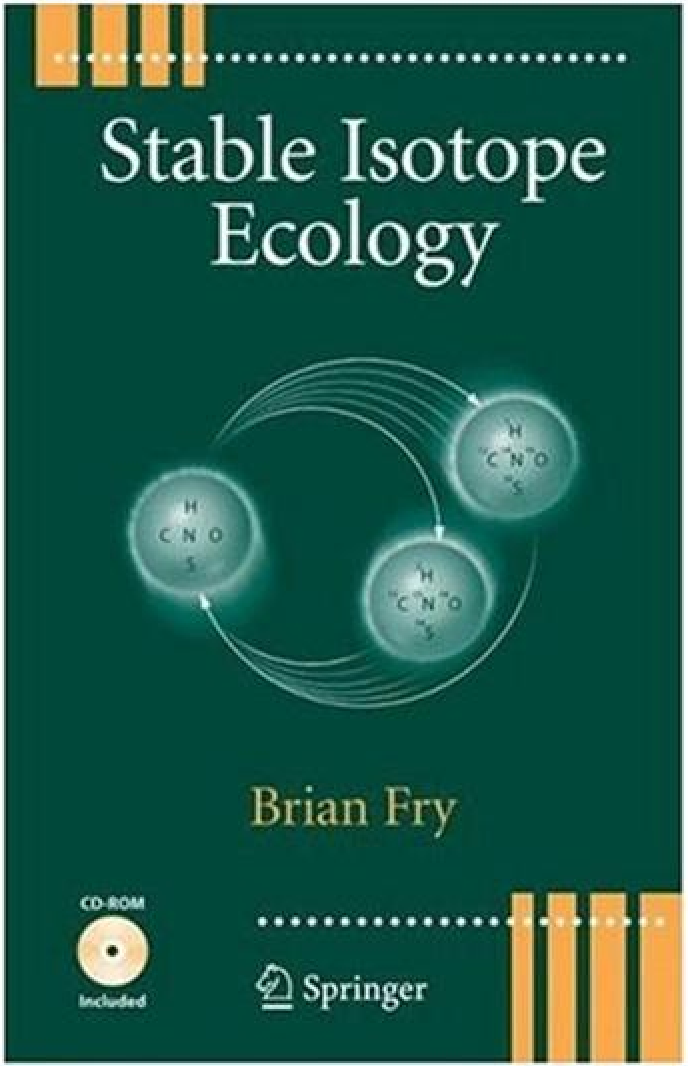
- Ecosystems: definition and classification
- Methodology in ecosystem research
  - Observations
  - Experimentations
  - Modeling
- Stale isotope technique for ecosystem studies
- Conclusions

Ecology need new methods









植物生态学报 2010, 34 (2): 119–122
Chinese Journal of Plant Ecology
doi: 10.3773/j.issn.1005-264x.2010.02.001
http://www.plant-ecology.com

稳定同位素生态学：先进技术推动的生态学新分支

林光辉[1,2]*
[1]滨海湿地生态系统教育部重点实验室(厦门大学), 福建厦门 361005; [2]中国科学院植物研究所植被与环境变化国家重点实验室, 北京 100093

Stable isotope ecology: a new branch of ecology resulted from technology advances

LIN Guang-Hui[1,2]*
[1]Key Laboratory of the Ministry of Education for Coastal and Wetland Ecosystems (Xiamen University), Xiamen, Fujian 361005, China; and [2]State Key Laboratory of Vegetation and Environmental Change, Institute of Botany, Chinese Academy of Sciences, Beijing 100093, China

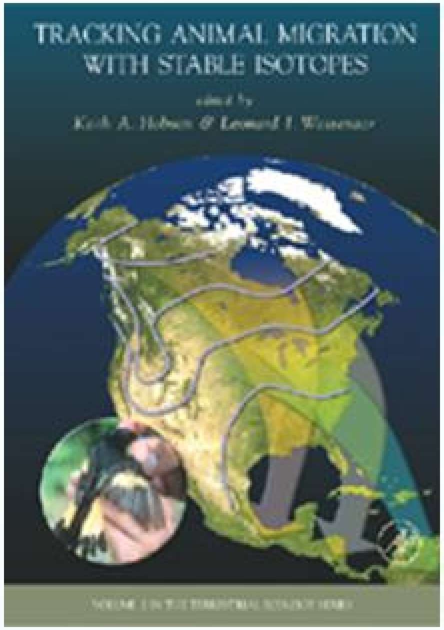
稳定同位素技术因具有示踪(tracers)、整合(integration)和指示(indicators)等多项功能，以及检测快速、结果准确等特点，在生态学研究中日益显示出广阔的应用前景。近年来，由于生态学研究问题更趋复杂化和全球化，多学科的交叉综合研究已成为本学科发展的新的生长点。以稳定同位素作为示踪剂研究生态系统中生物要素的循环及其与环境的关系，利用稳定同位素技术的时空整合能力研究不同时间和空间尺度生态过程与机制，以及利用稳定同位素技术的指示功能揭示生态系统功能的变化规律，已成为了解生态系统功能动态变化的重要研究手段之一。稳定同位素技术逐渐成为进一步了解生物与其生存环境相互关系的强有力的工具，使现代生态学家能够解决用其他方法难以解决的生态学问题(Rundel *et al.*, 1989; Ehleringer *et al.*, 1993; Yakir & Sternberg, 2000; Dawson *et al.*, 2002; Maguas & Griffiths, 2003; Fry, 2007)。例如，在植物生理生态学方面，稳定同位素技术使我们能从新的角度探讨植物光合途径、植物对生源元素吸收、水分来源、水分平衡和利用效率等问题。生态系统生态学家则利用稳定同位素技术研究生态系统的气体交换机制、生态系统功能动态变化及其对全球变化的响应模式等。在动物生态学方面，稳定同位素也已广泛地应用于区分动物的食物来源、食物链、食物网和群落结构，以及动物的迁移活动等方面的研究。总之，稳定同位素技术在生态学中的应用已引起了生态学家广泛的注意，逐渐成为现代生态和环境科学研究中最有效的研究方法之一。

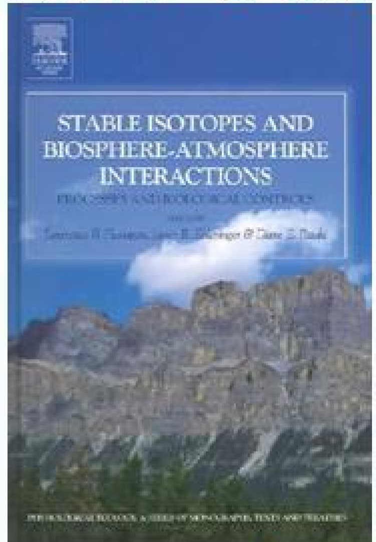
物学领域的发展所产生的重大影响一样，稳定性同位素技术已对现代生态学的发展产生积极的影响。稳定同位素信息使我们能够洞悉不同空间尺度上(从细胞到植物群落、生态系统或某一区域)和时间尺度上(从数秒到几个世纪)的生态学过程及其对全球变化的响应(Ciais *et al.*, 1995; Zanden *et al.*, 1999; Lin *et al.*, 1999; Battle *et al.*, 2000; Bowling *et al.*, 2001; Yepez *et al.*, 2003; Bukata & Kyser, 2007; Kosiba *et al.*, 2007)。由于众多同位素化学家和地球化学家前期的开拓性研究工作，我们已经对稳定性同位素在生态系统和生物地球化学循环中的特性有了深入的了解(Farquhar *et al.*, 1989)。随着同位素研究技术与方法的日趋完善，稳定同位素技术在那些需要深入研究的现代生态学领域中的应用前景将更加广阔。例如，通过稳定同位素的分析，不仅可以追踪重要元素如碳、氮和水等的地球化学循环过程，还可诊断病人的代谢变化及其原因，估测农作物施肥的最佳配方和时间，研究动植物对环境胁迫的反应及相互关系，追踪污染物的来源与去向，推断古气候和古生态过程，甚至还可用来了解农、林产品的组成成分、原产地及掺假可能性等等(Yakir & Sternberg, 2000; Dawson *et al.*, 2002; Maguas & Griffiths, 2003)。总之，稳定同位素技术的应用所提供的信息，大大加深了我们对自然环境下生物及其生态系统对全球变化的响应与反馈作用等方面的认识，拓展了生态学研究和应用的发展空间。美国Brian Fry专著《*Stable Isotope Ecology*》在2007年的正式出版，标志着稳定同位素生态学作为

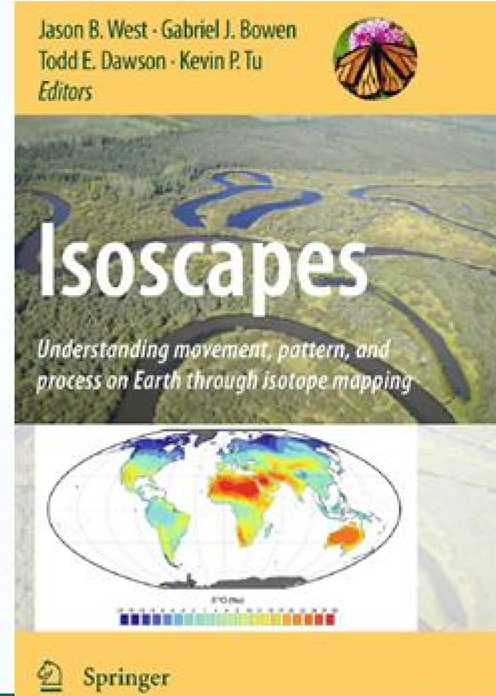
2007

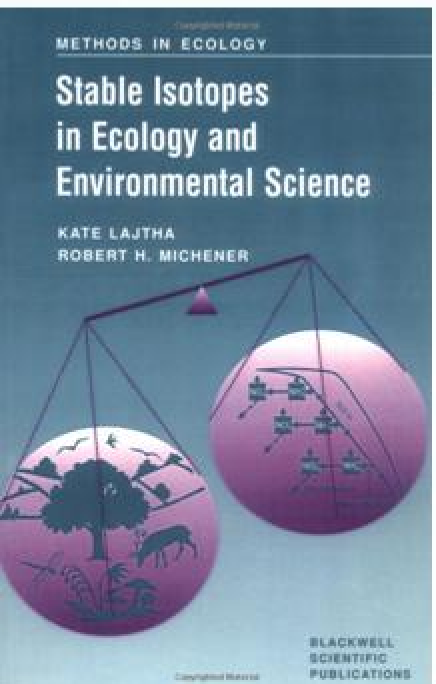
2010

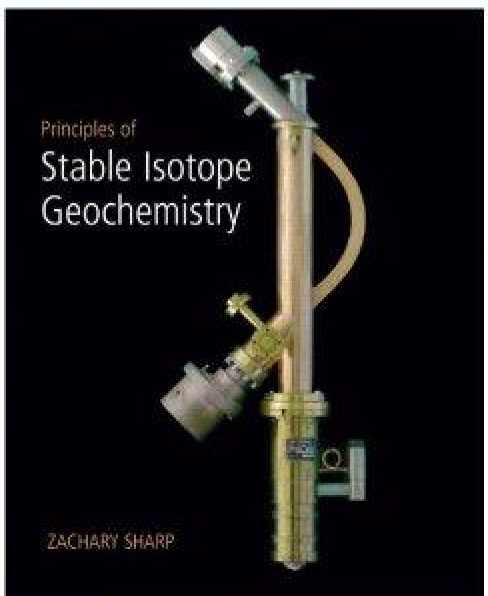
New books

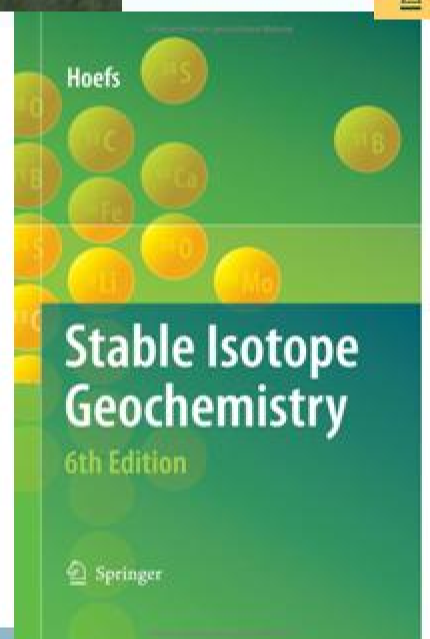

TRACKING ANIMAL MIGRATION
WITH STABLE ISOTOPES

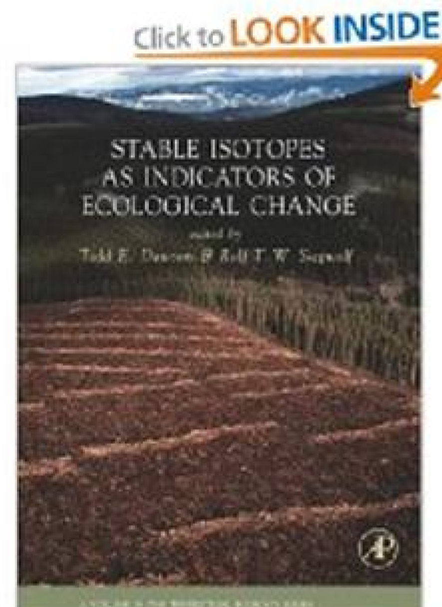

STABLE ISOTOPES AND
BIOSPHERE-ATMOSPHERE
INTERACTIONS


Jason B. West · Gabriel J. Bowen
Todd E. Dawson · Kevin P. Tu
Editors
Isoscapes
Understanding movement, pattern, and
process on Earth through isotope mapping
Springer


METHODS IN ECOLOGY
Stable Isotopes
in Ecology and
Environmental Science
KATE LAJTHA
ROBERT H. MICHENER
BLACKWELL
SCIENTIFIC
PUBLICATIONS


Principles of
Stable Isotope
Geochemistry
ZACHARY SHARP


Hoefs
Stable Isotope
Geochemistry
6th Edition
Springer


Click to LOOK INSIDE!
STABLE ISOTOPES
AS INDICATORS OF
ECOLOGICAL CHANGE

Some networks and associations

BASIN
Biogeosphere-Atmosphere Stable Isotope Network

neon
NATIONAL ECOLOGICAL OBSERVATORY NETWORK

CARBO EUROPE

IAEA - MIBA
MOISTURE ISOTOPES IN THE BIOSPHERE AND ATMOSPHERE

FIRMS

isotope
PILIPS

SIBAE

Important meetings

AGU Chapman
Sun Valley, Idaho,
USA on October 5-9, 2009

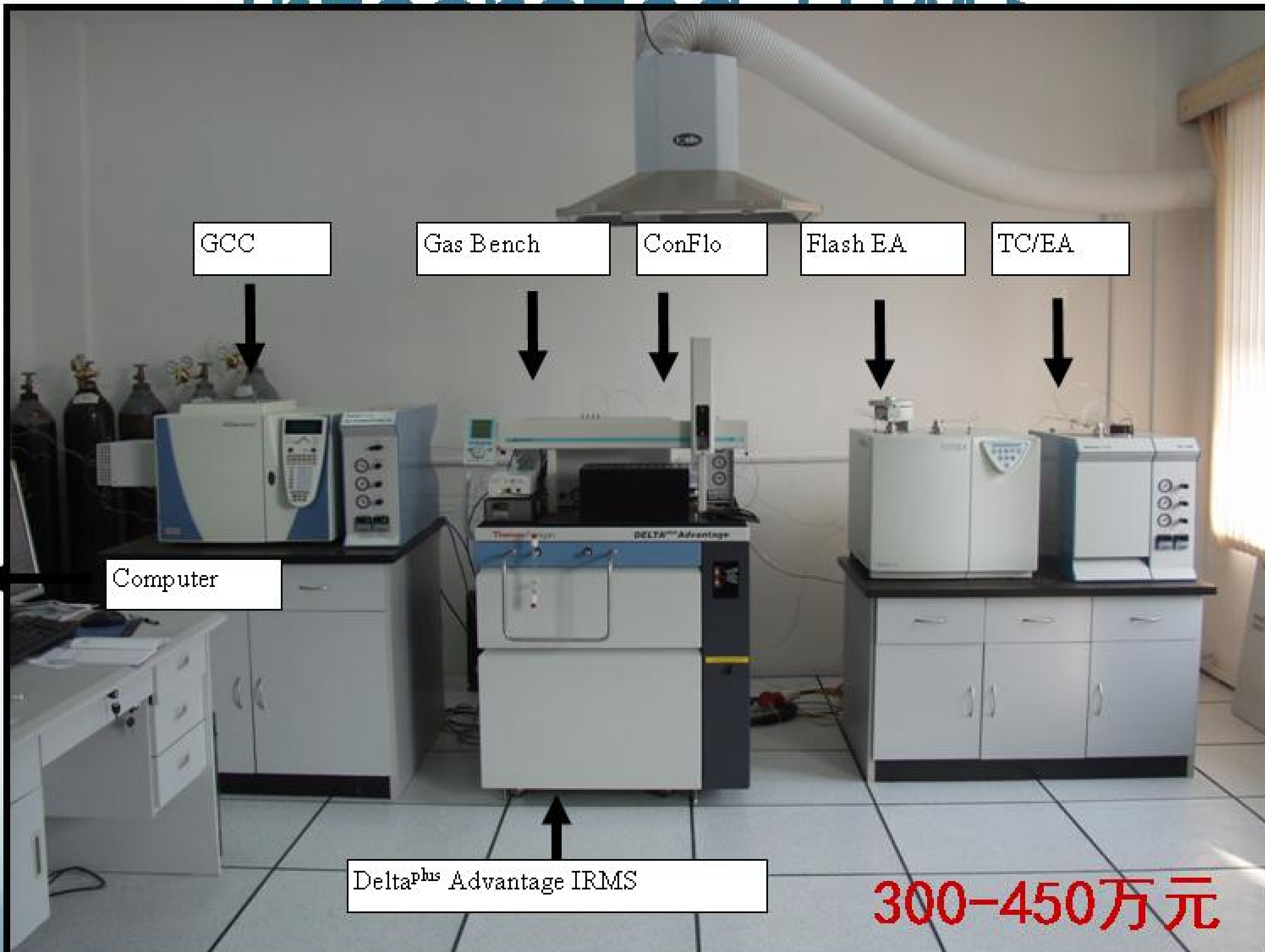
ISO ^{13}C OMP^{18}O U^{15}N D
ecology ecosystem earth sciences

IsoCompound 2009 Meeting
June 1-5 2009， Potsdam, Germany

IsoEcol Conference VI
Honolulu, Hawaii
25-29 August 2008

2008 AGU Fall Meeting
San Francisco, California, 15-19 December
http://basinisotopes.org/2008AGUMeeting

More automatic and integrated IRMS



New types of instruments

Tunable Diode Laser system

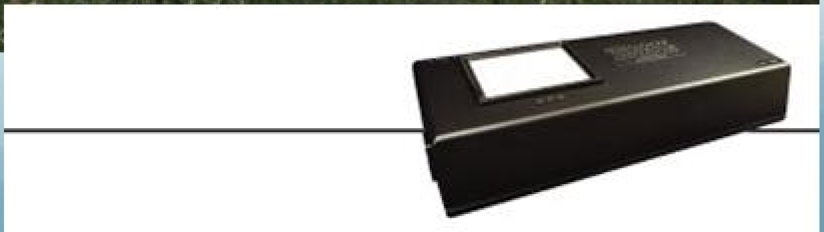
Campbell Scientific, Inc.
US$100,000-120,000

Fourier Transform Infrared (FTIR) spectroscopy

Vertex
US$75,000

Cavity Ring Down lasers (CRD) or Integrated-Cavity Output Spectroscopy (ICOS)

- LGR, US$40,000-65,000

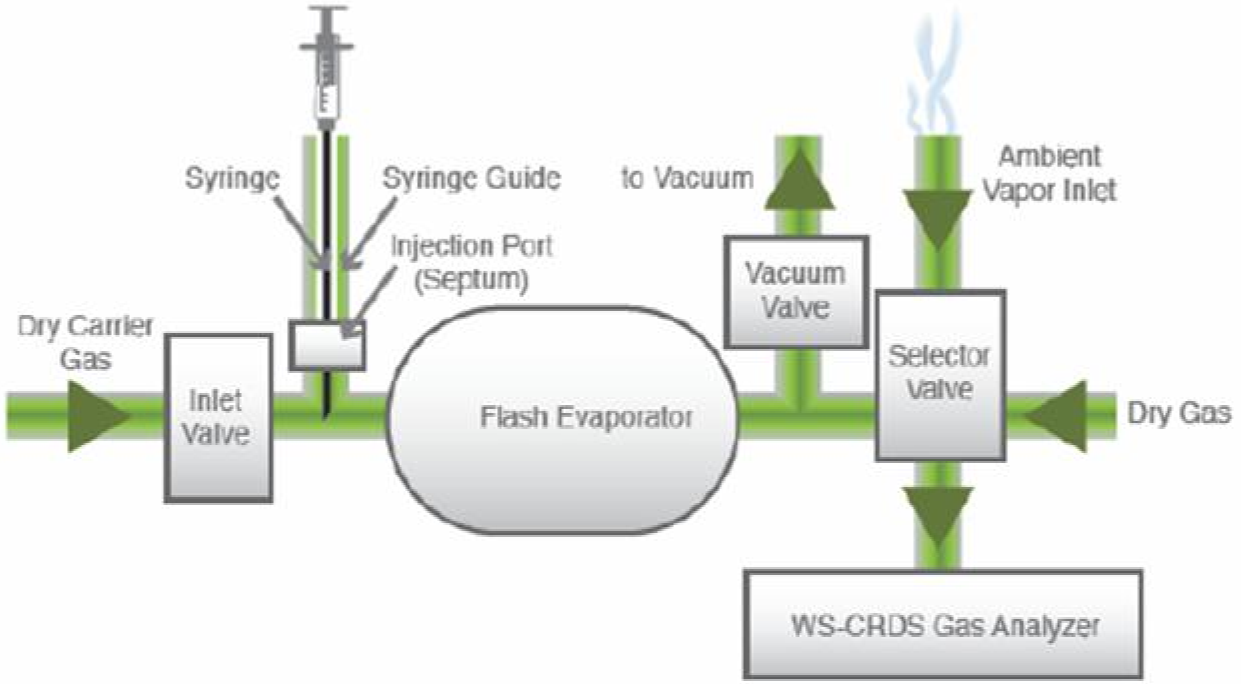
Laser Isotope Analyzers

Instrument foot print:
54 cm x 60 cm

Instrument weight:
~ 40 Kg

Power consumption:
300 watts @ 110V

Analyzer can accept either liquid or vapor samples or alternate between them



Whole assembly is maintained at a constant 140 °C

But

RAPID COMMUNICATIONS IN MASS SPECTROMETRY
Rapid Commun. Mass Spectrom. 2010; **24**: 1948–1954
Published online in Wiley InterScience (www.interscience.wiley.com) DOI: 10.1002/rcm.4597

RCM

Discrepancies between isotope ratio infrared spectroscopy and isotope ratio mass spectrometry for the stable isotope analysis of plant and soil waters

Adam G. West[1,2*], Gregory R. Goldsmith[1], Paul D. Brooks[3] and Todd E. Dawson[1,3]
[1]Department of Integrative Biology, University of California, Berkeley, Berkeley, CA 94720, USA
[2]Botany Department, University of Cape Town, Rondebosch, 7701, South Africa
[3]Center for Stable Isotope Biogeochemistry, University of California, Berkeley, Berkeley, CA 94720, USA

Received 7 April 2010; Revised 24 April 2010; Accepted 24 April 2010

The use of isotope ratio infrared spectroscopy (IRIS) for the stable hydrogen and oxygen isotope analysis of water is increasing. While IRIS has many advantages over traditional isotope ratio mass spectrometry (IRMS), it may also be prone to errors that do not impact upon IRMS analyses. Of particular concern is the potential for contaminants in the water sample to interfere with the spectroscopy, thus leading to erroneous stable isotope data. Water extracted from plant and soil samples may often contain organic contaminants. The extent to which contaminants may interfere with IRIS and thus impact upon data quality is presently unknown. We tested the performance of IRIS relative to IRMS for water extracted from 11 plant species and one organic soil horizon. IRIS deviated considerably from IRMS for over half of the samples tested, with deviations as large as 46‰ (δ^2H) and 15.4‰ ($\delta^{18}O$) being measured. This effect was reduced somewhat by using activated

Expanding research areas and applications

Plant ^{13}C: C_3/C_4+WUE => Ecosystem & global C cycles

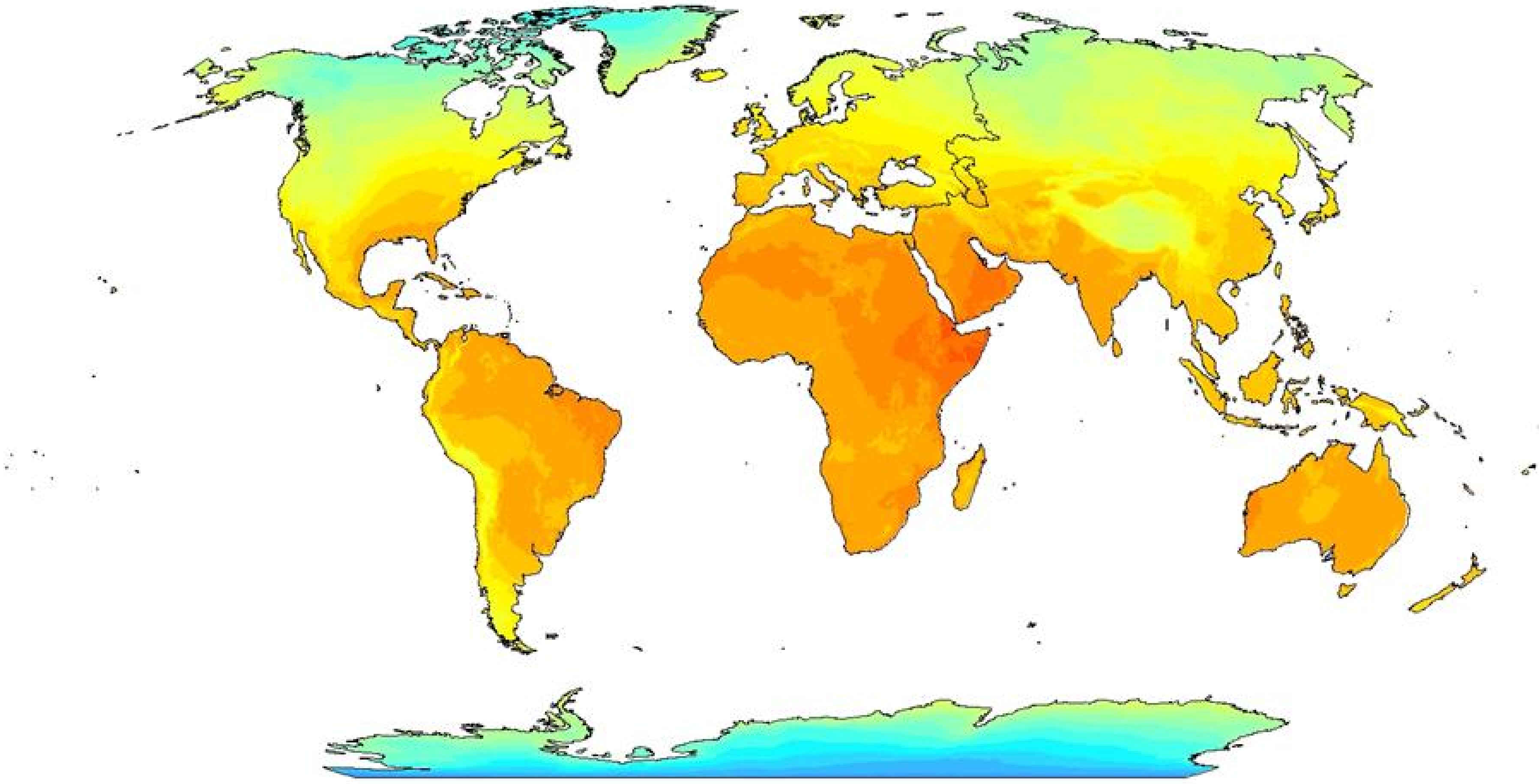
Water D & ^{18}O: Water source => Regional water cycles

Animal isotopes: Foodweb => Migration and movements

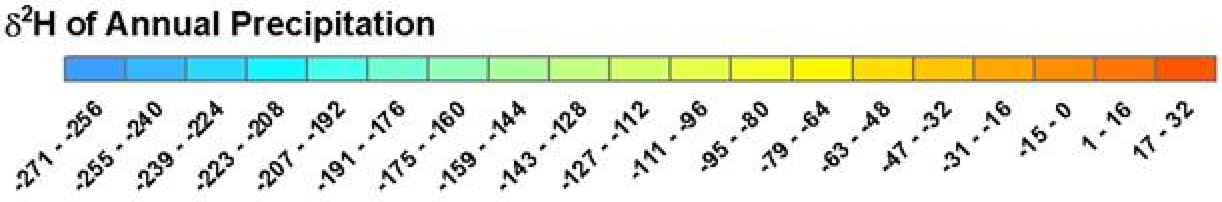
Food isotopes: Food quality => food sourcing +forensics

Isoscapes: Large scale movements, patterns and processes

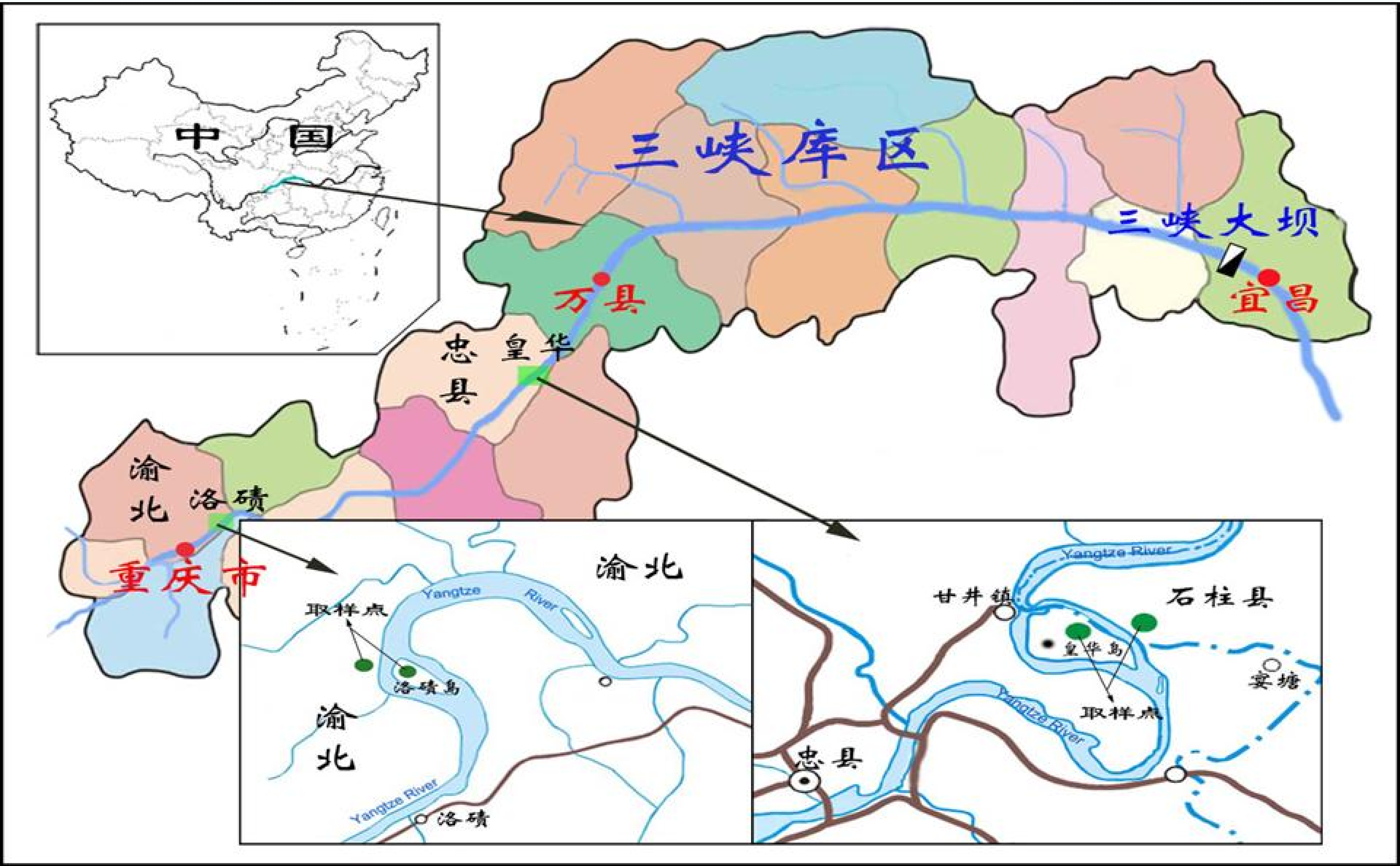
……

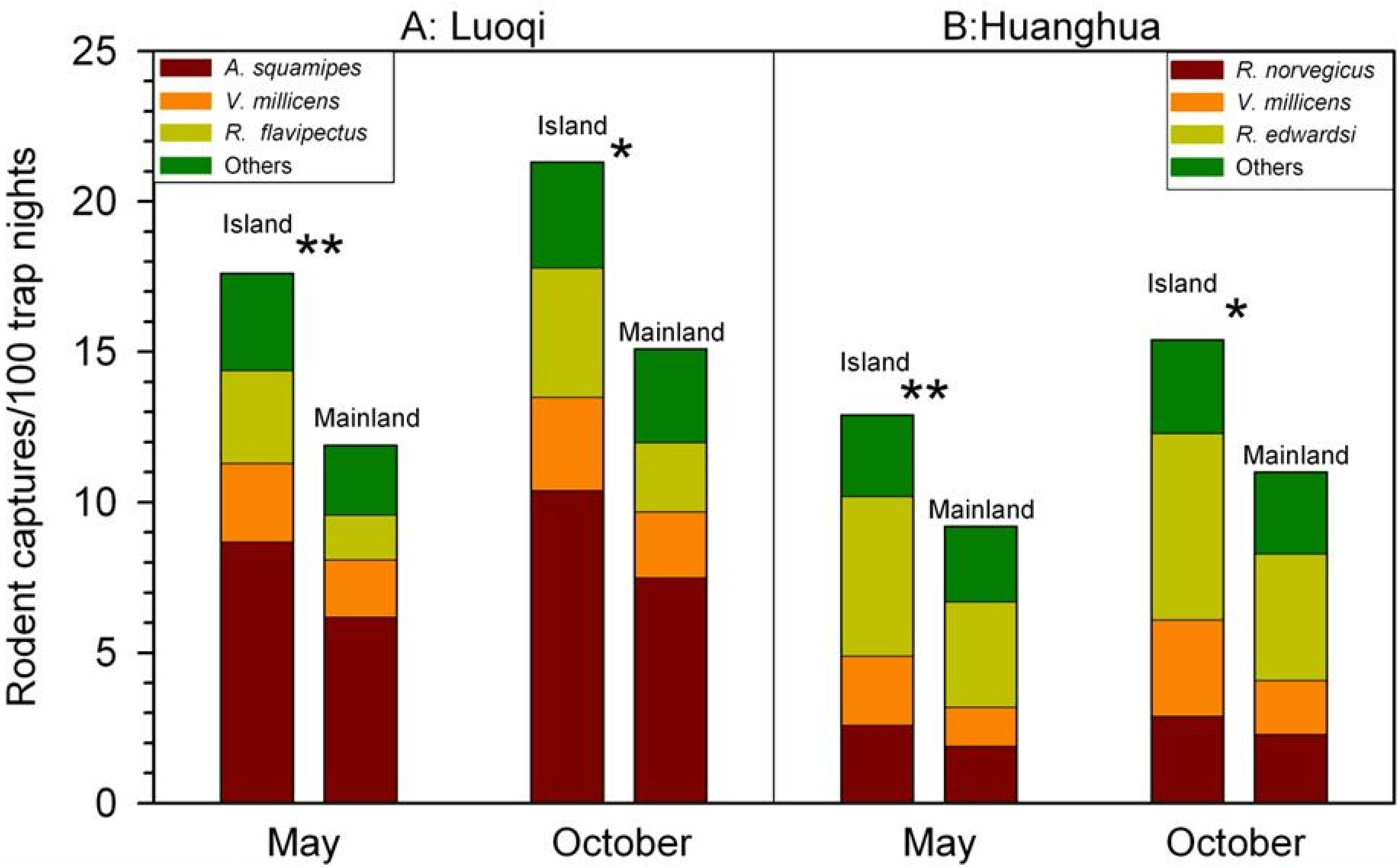


World Isoscape of Precipitation



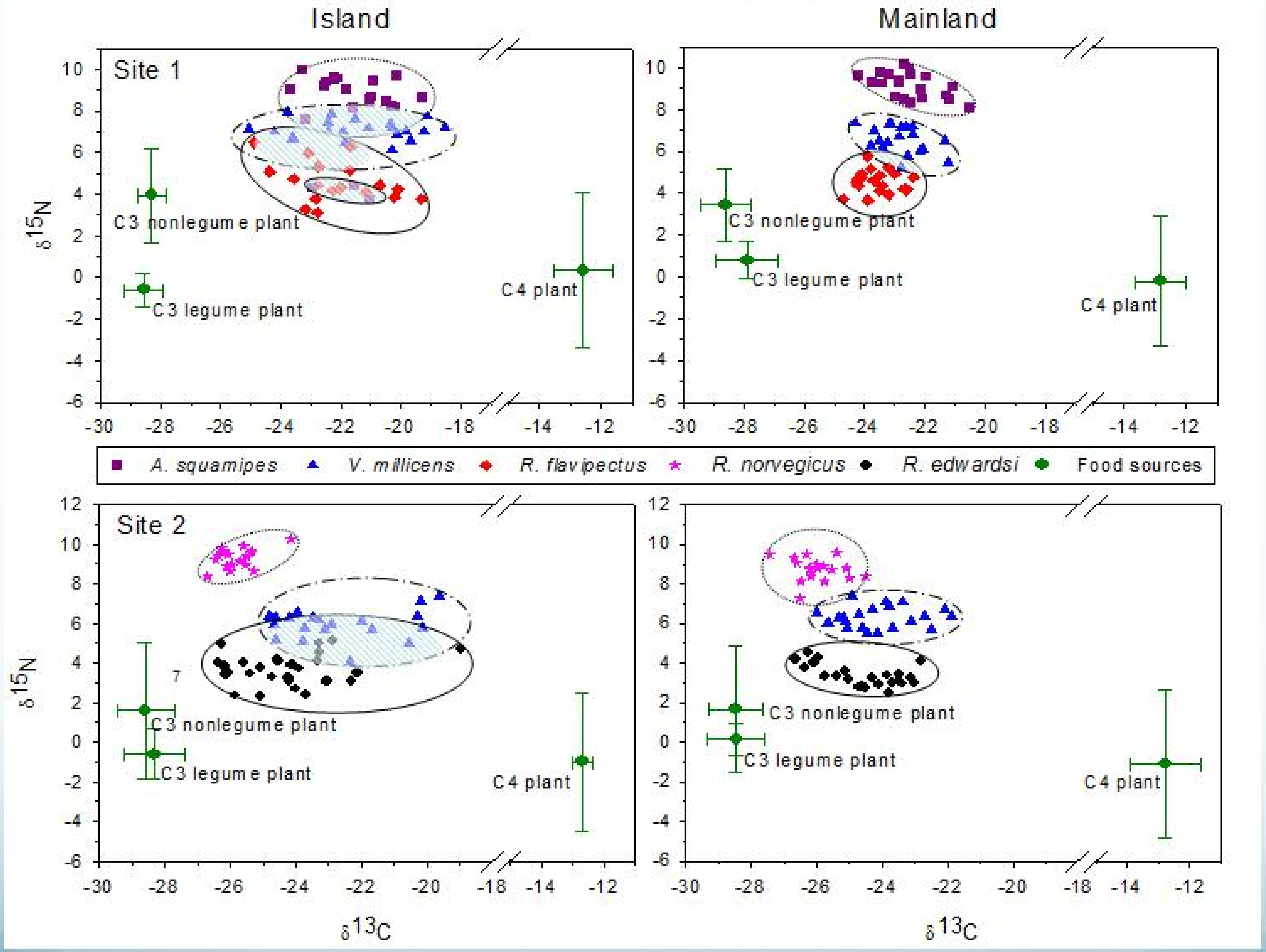
岛屿化过程对啮齿动物种群的影响





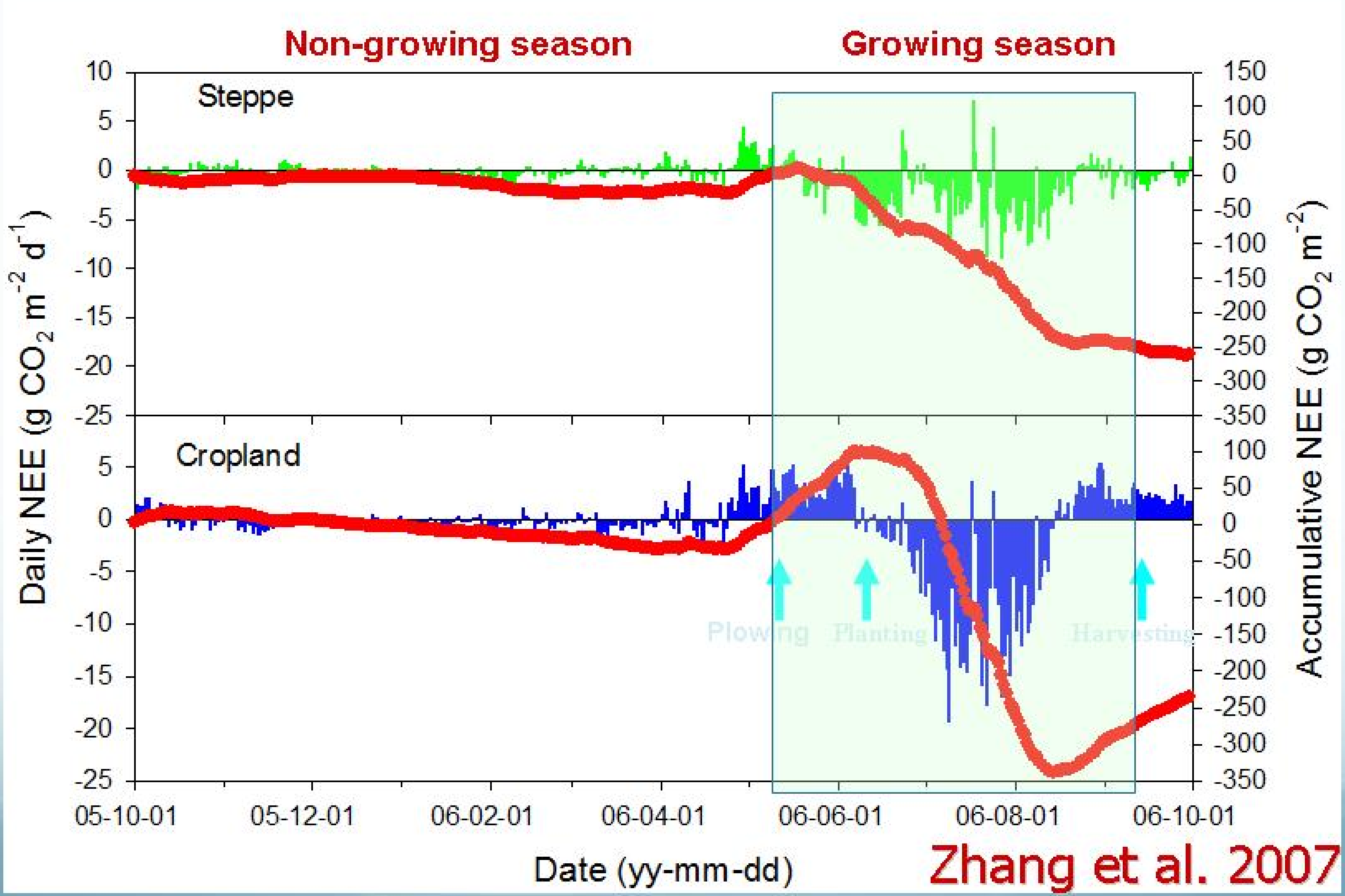
Wang et al., 2009 *Frontiers in Ecology and the Environment*

洛碛(Site 1)、皇华岛(Site 2) 及对岸啮齿动物稳定同位素值



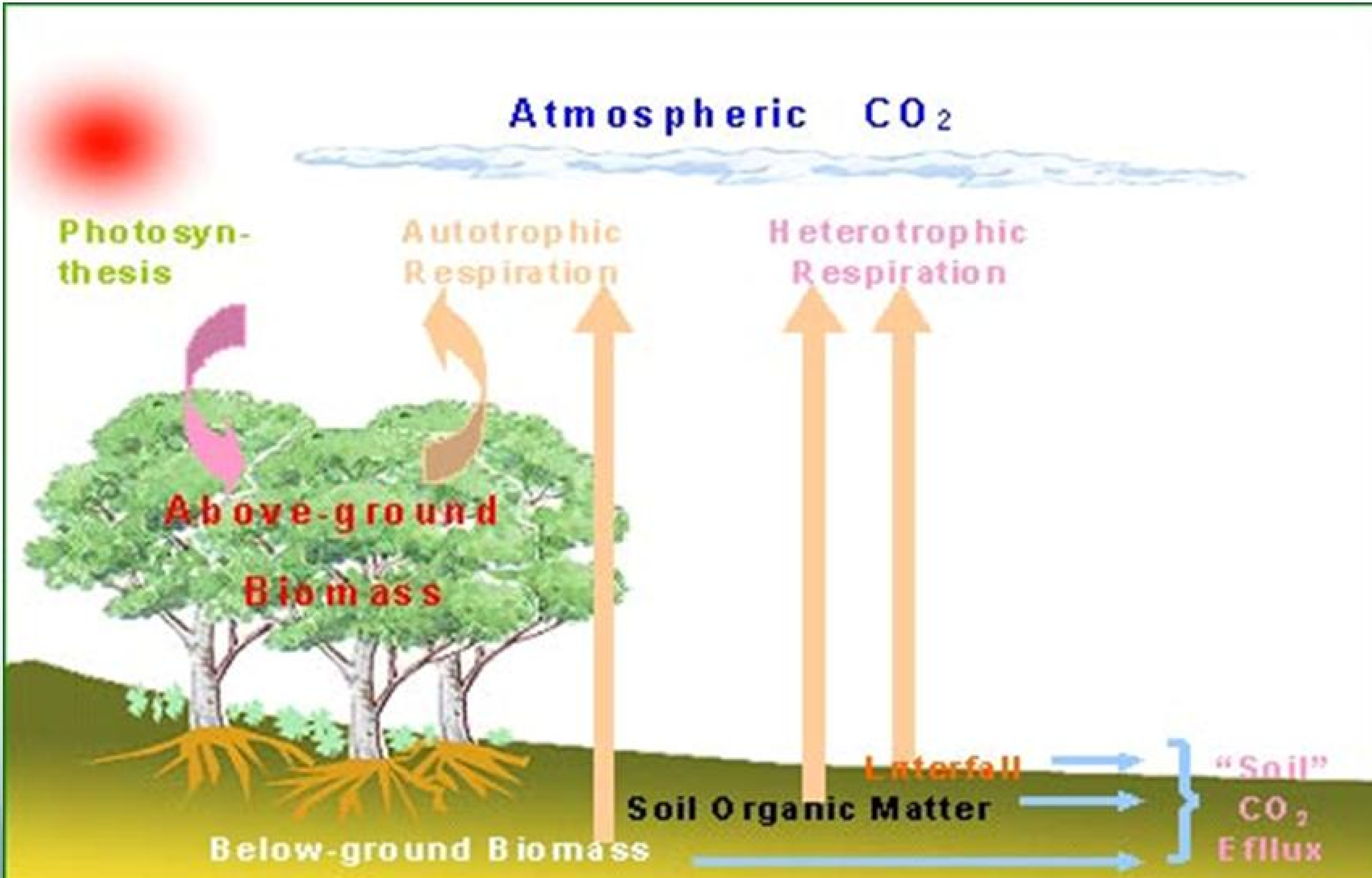
Wang et al., 2009 *Frontiers in Ecology and the Environment*

NEE comparison (Oct 05-Sept 06, Duolun)



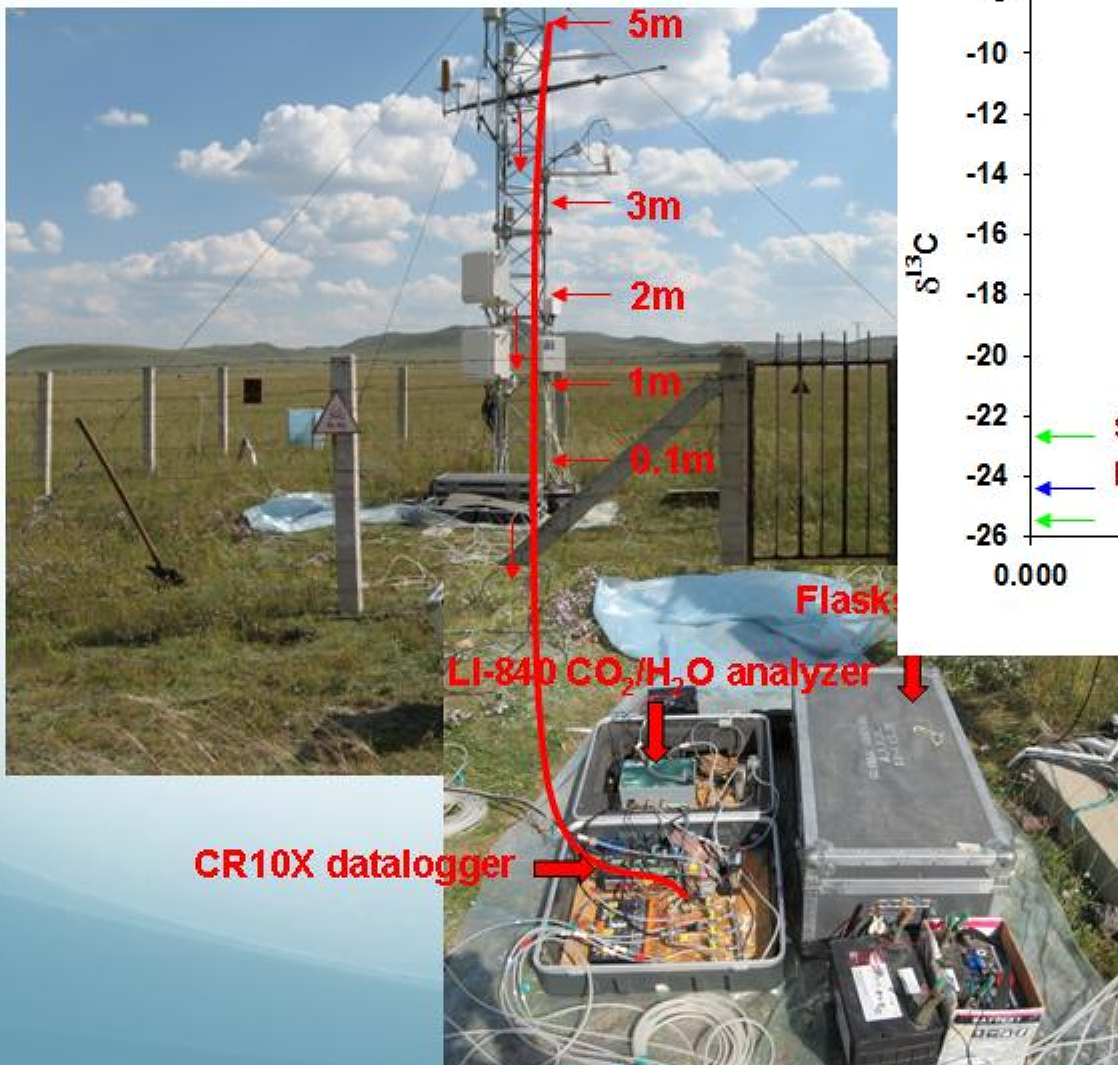
Zhang et al. 2007 AFM

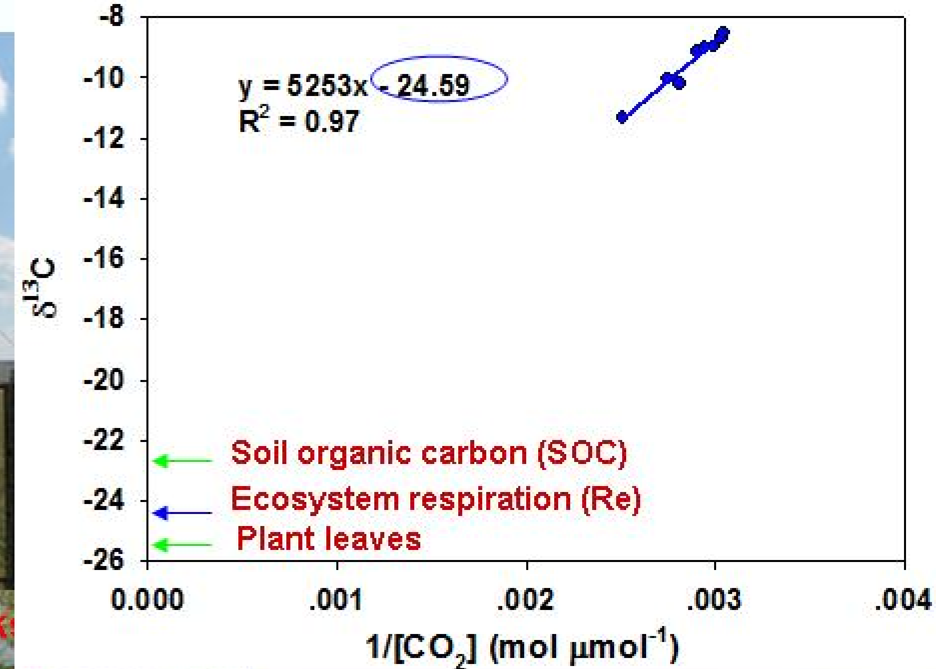
Ecosystem CO_2 Fluxes and their components



Partitioning of ecosystem carbon exchange

— Stable isotope (Keeling plot) method



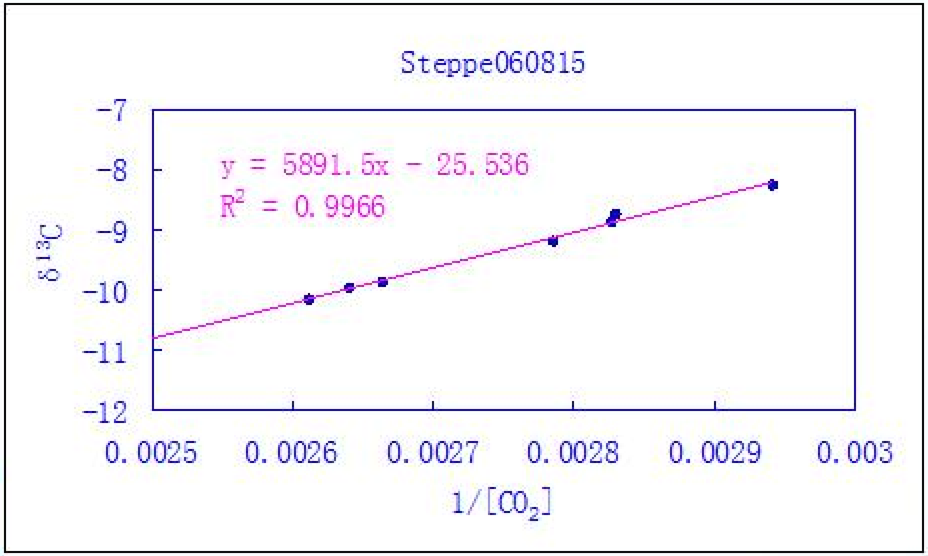


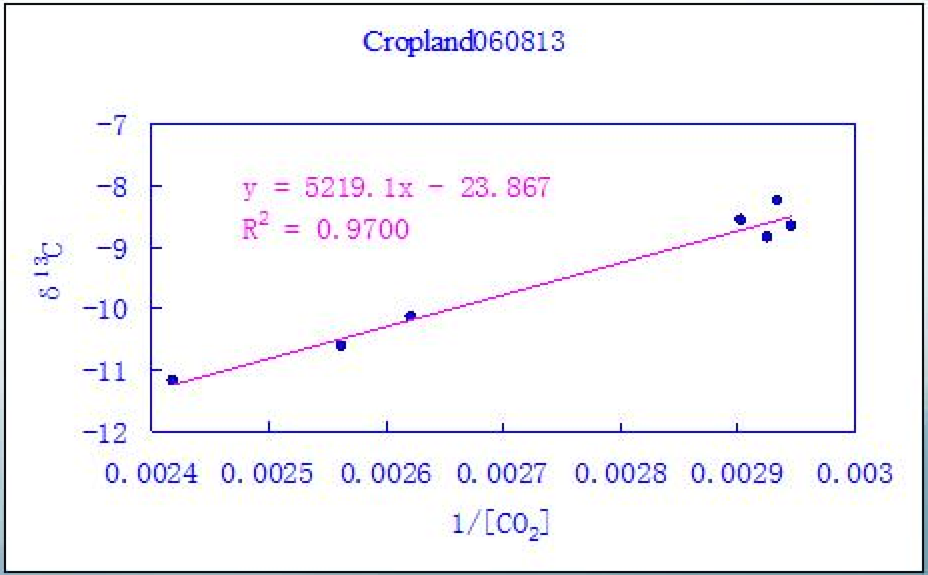
Ecosystem respiration

↓ **Heterotrophic respiration (Rh)**

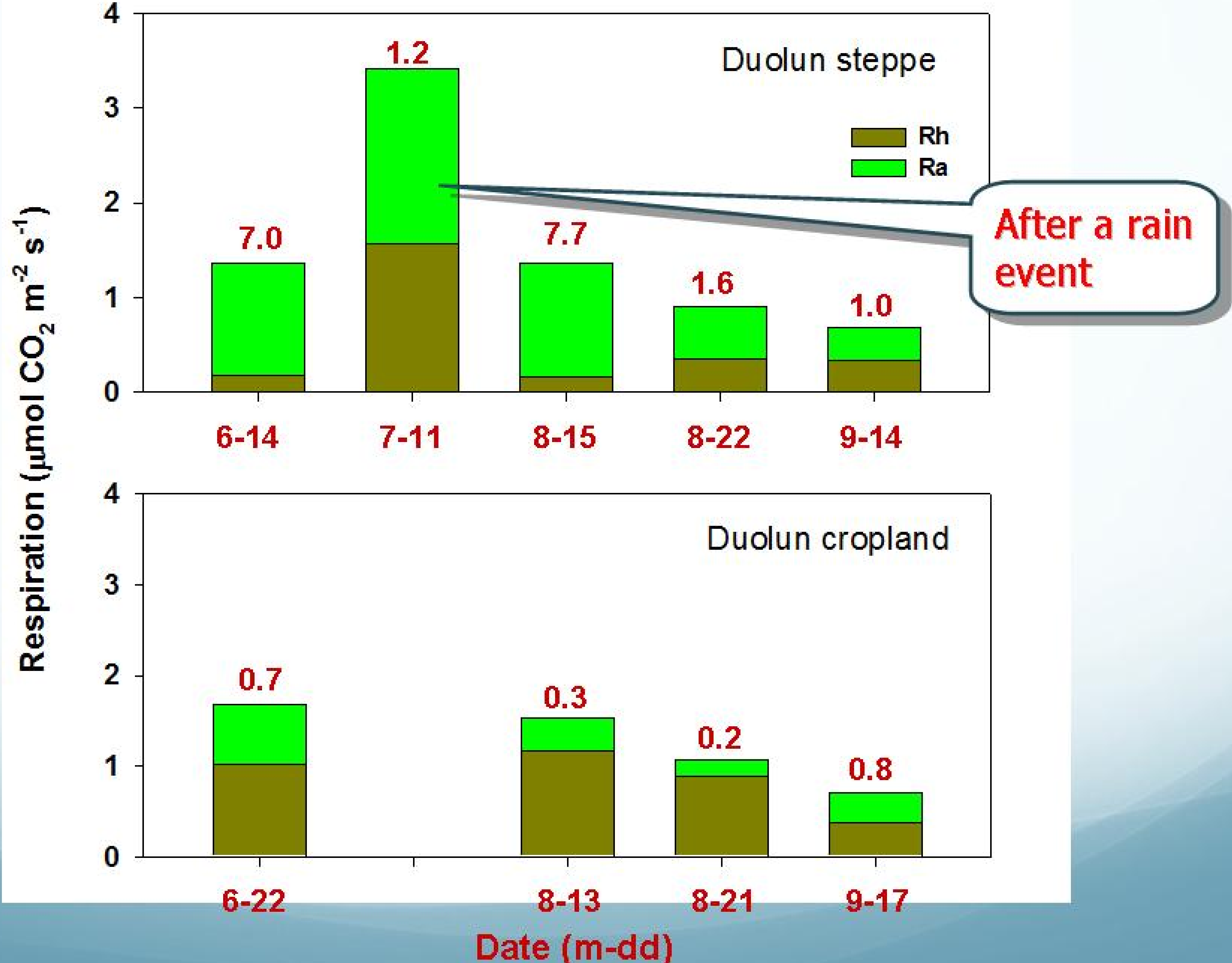
↓ **Autotrophic respiration (Ra)**

CO_2 Keeling Plots



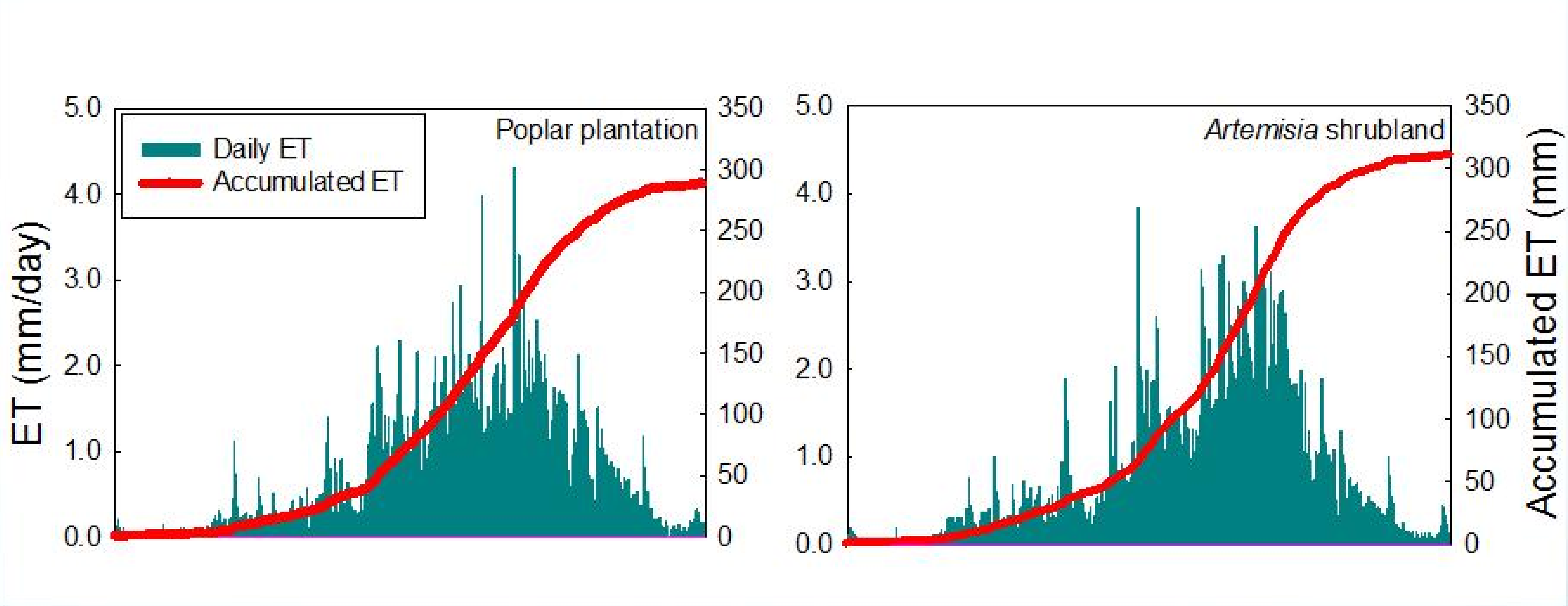


Partitioning of nighttime NEE (2006)



Kubuqi desert

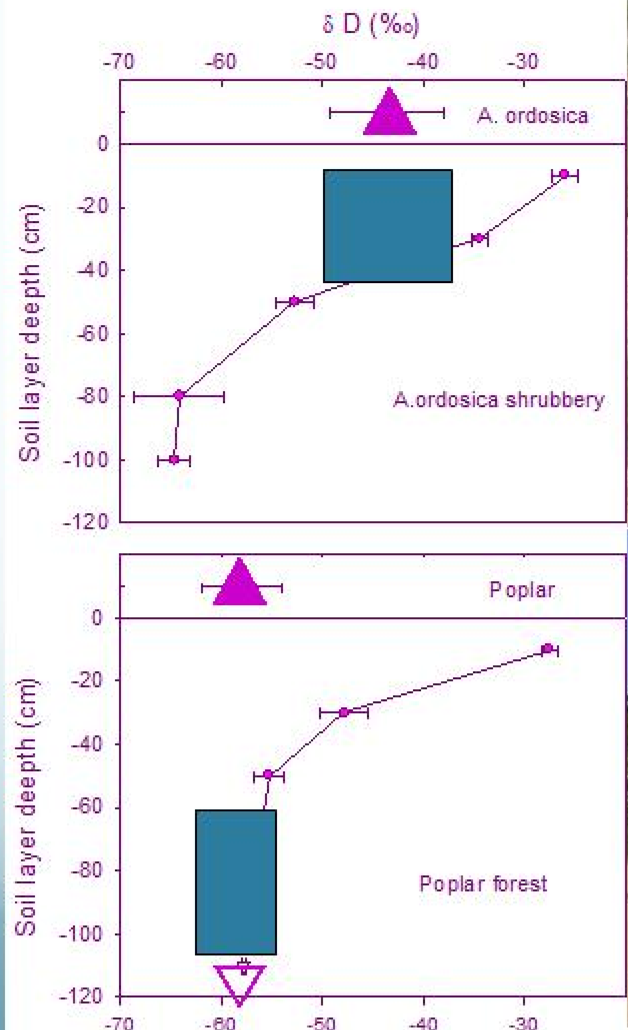
ET comparison (2005)



Accumulated ET

Miao, Lin et al. 2009

Plant water sources

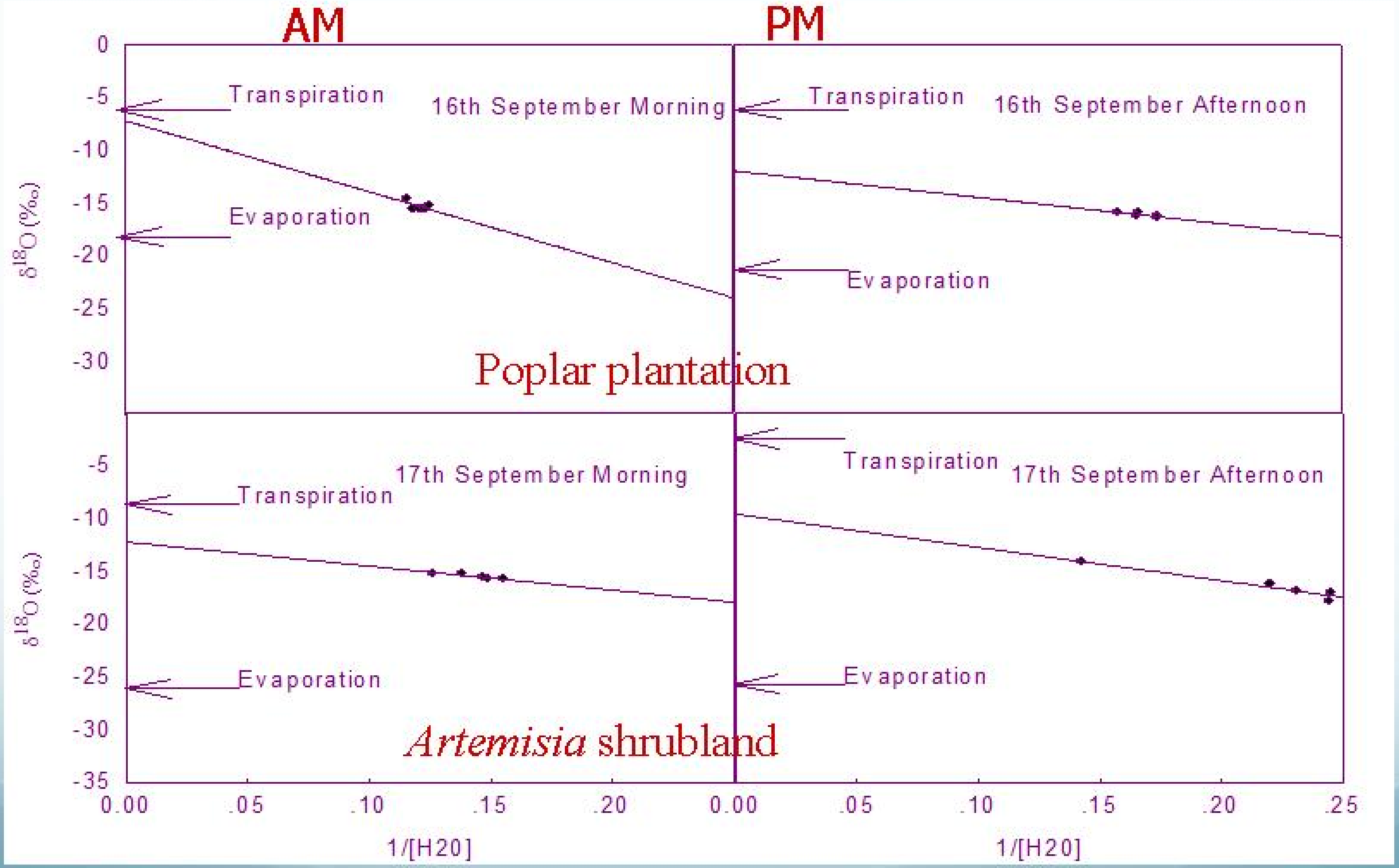


A. erdosica

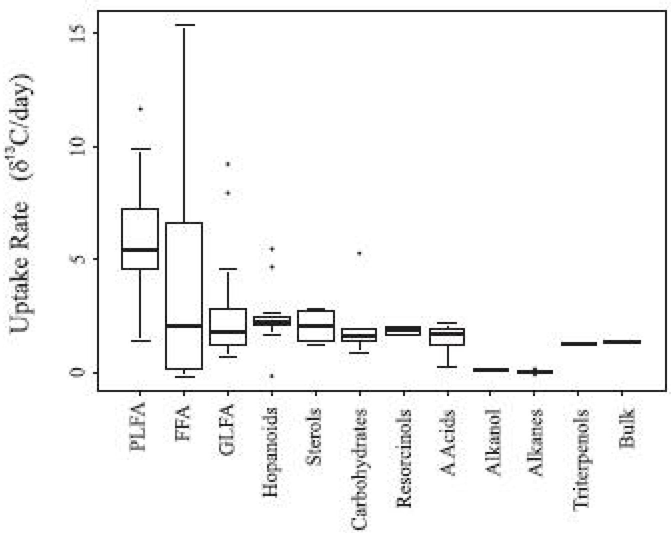
Populus

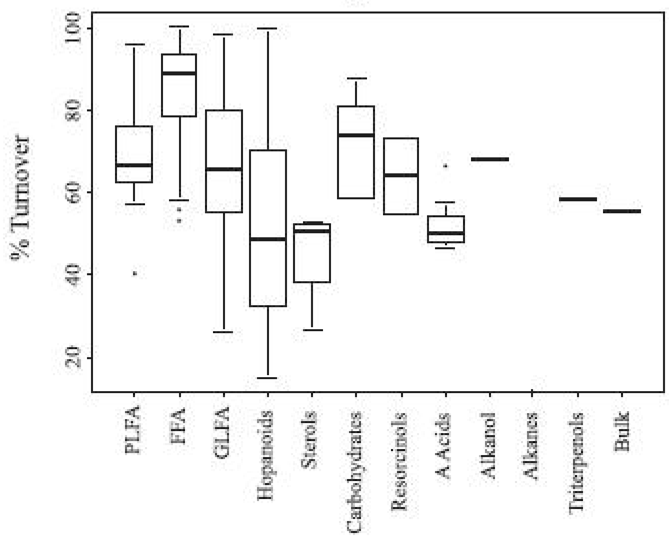
Stem water
Soil water
Groundwater

Keeling plot



稳定同位素与分子标记技术研究土壤碳循环与转化原理





Research Article

Rapid Communications in Mass Spectrometry

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(wileyonlinelibrary.com) DOI: 10.1002/rcm.6172

Stable isotope switching (SIS): a new stable isotope probing (SIP) approach to determine carbon flow in the soil food web and dynamics in organic matter pools

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[2]School of Earth Sciences, Bristol Biogeochemistry Research Centre and The Cabot Institute, University of Bristol, Wills Memorial Building, Queen's Road, Bristol BS8 1RJ, UK
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The ISME Journal (2008) 2, 602–614

www.nature.com/ismej

ORIGINAL ARTICLE

Applying stable isotope probing of phospholipid fatty acids and rRNA in a Chinese rice field to study activity and composition of the methanotrophic bacterial communities *in situ*

Qiongfen Qiu[1,2], Matthias Noll[2,3], Wolf-Rainer Abraham[4], Yahai Lu[1] and Ralf Conrad[2]
[1]*College of Resources and Environmental Sciences, China Agricultural University, Beijing, China;* [2]*Max Planck Institute for Terrestrial Microbiology, Marburg, Germany;* [3]*Federal Institute for Materials Research and Testing, FG IV.1, Berlin, Germany and* [4]*Helmhotz Center for Infection Research, Chemical Microbiology, Braunschweig, Germany*