C-N-H_2O fluxes observations in ChinaFLUX

Shuli Niu, Guirui Yu & ChinaFlux members

Institute of Geographical Sciences and Natural Resources Research, Chinese Academy of Sciences

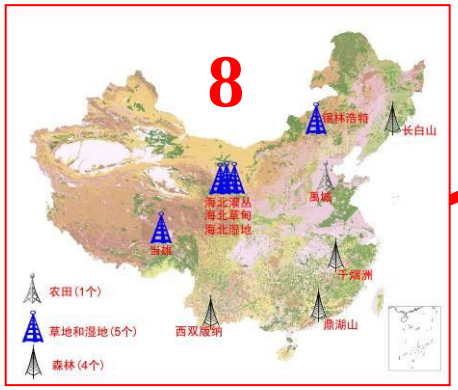
Outlines

1. C-N-H_2O fluxes observational systems
2. New progresses in C-N-H_2O fluxes studies
3. Future research opportunities

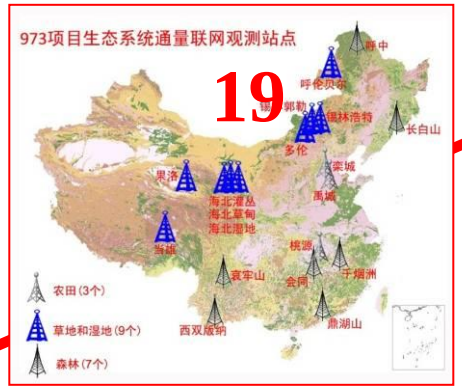
ChinaFLUX

- Knowledge Innovation Program of CAS
- National Program (973 Program)

Stage I 2001-2004



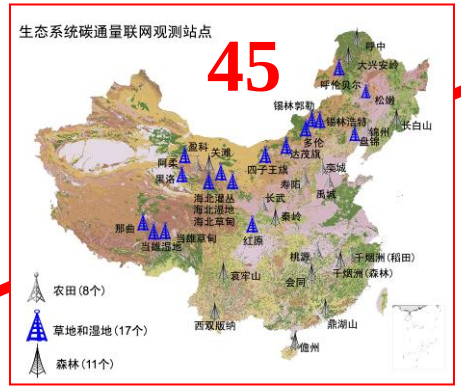
Stage II 2005-2009



- Program of CAS
- NSFC: Key Program
- NSFC Asia 3 Foresight Program

- 973 Program
- Program of CAS

Stage III 2010-2014



Stage IV 2015-2017

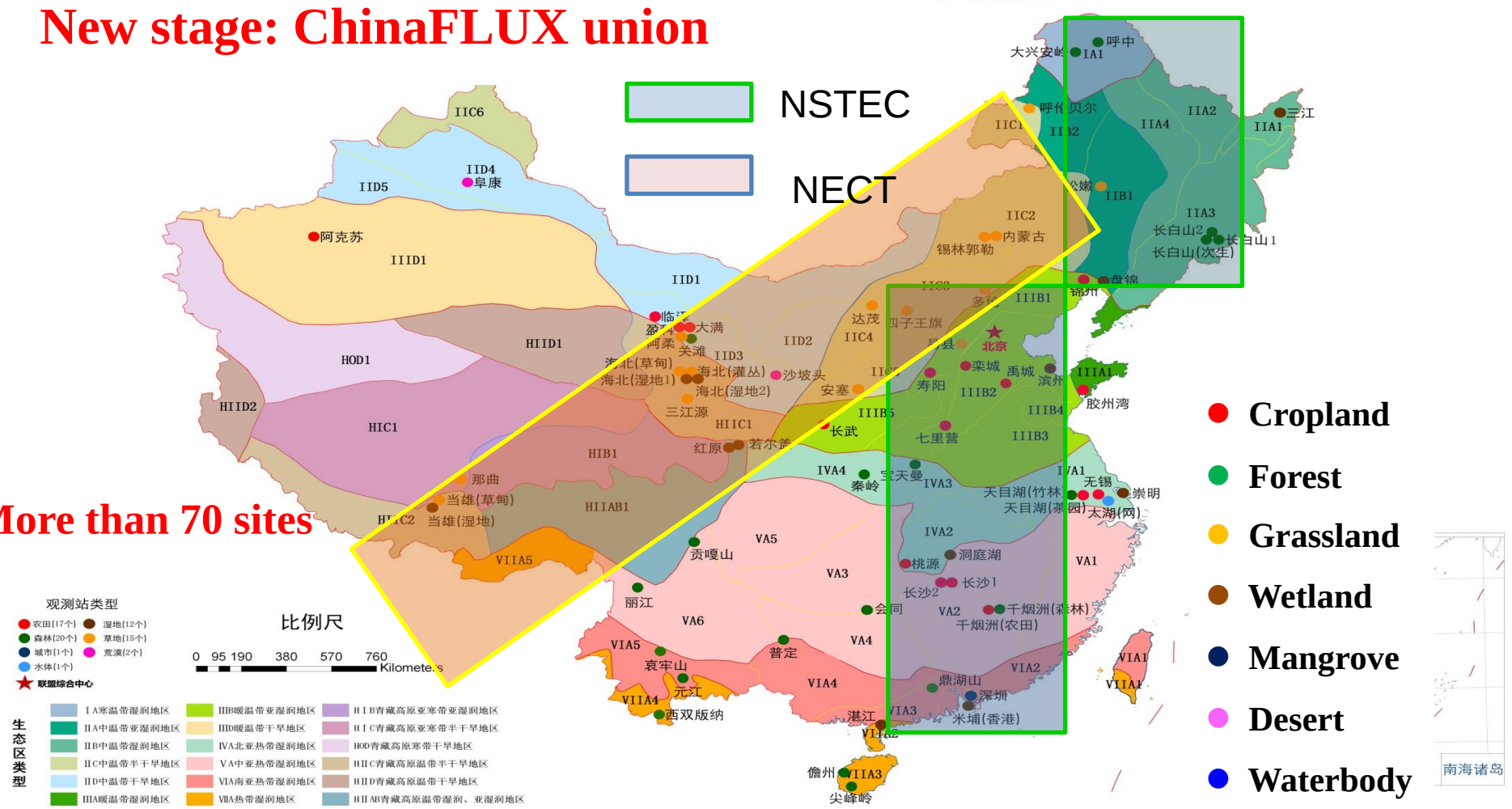
- NSFC: Key Program
- NSFC: Intercoop Program
- CERN Special program

ChinaFLUX

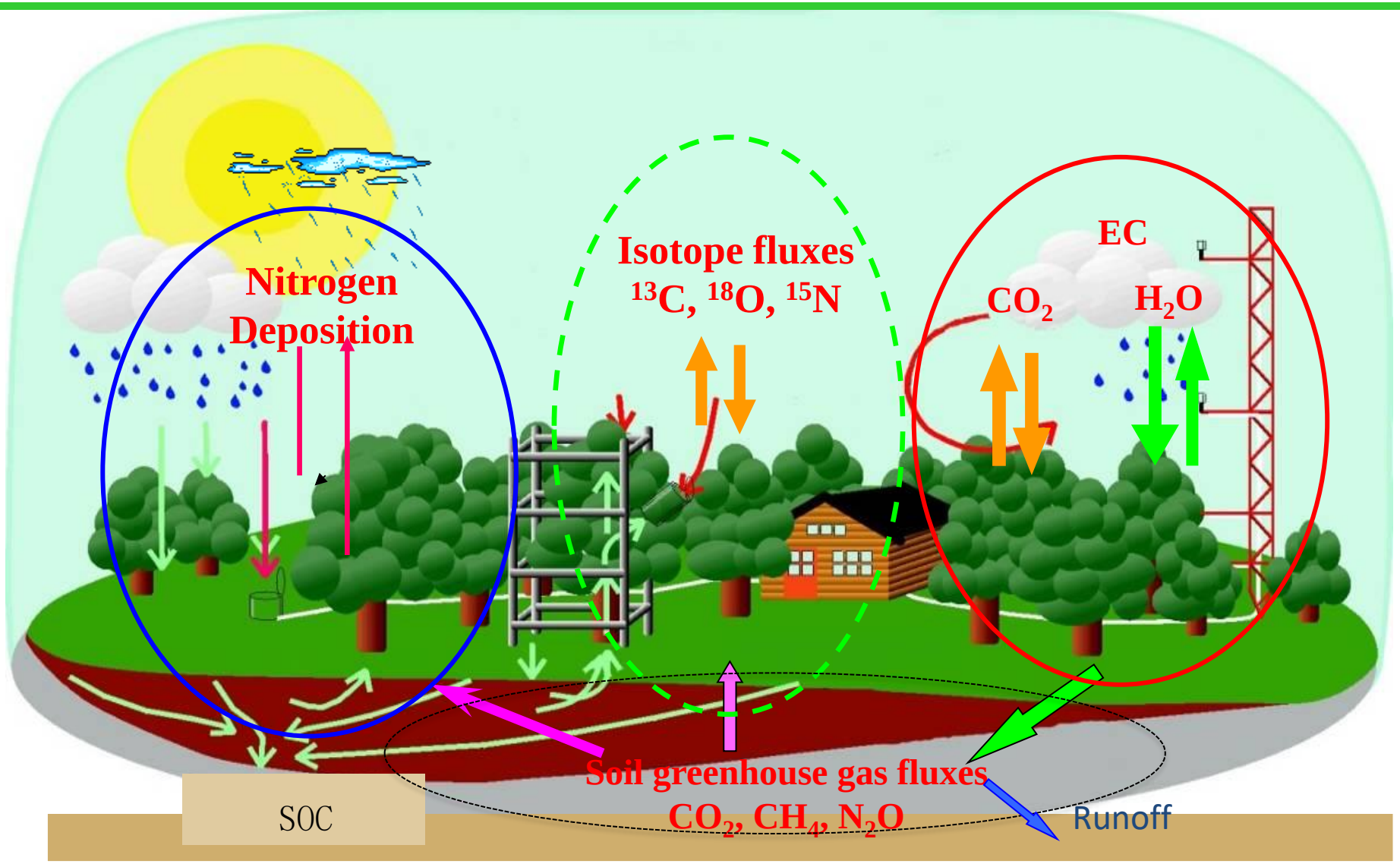
(http://www.chinaflux.org/enn/index.aspx)

New stage: ChinaFLUX union

More than 70 sites

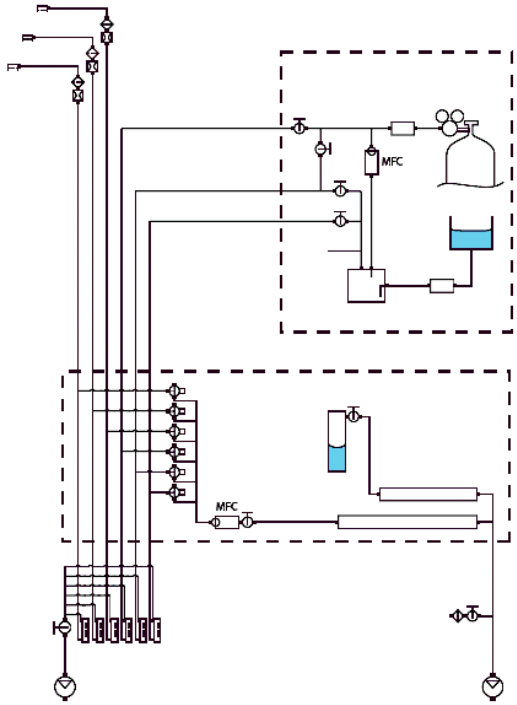


C-N-H_2O fluxes coordinated observation systems



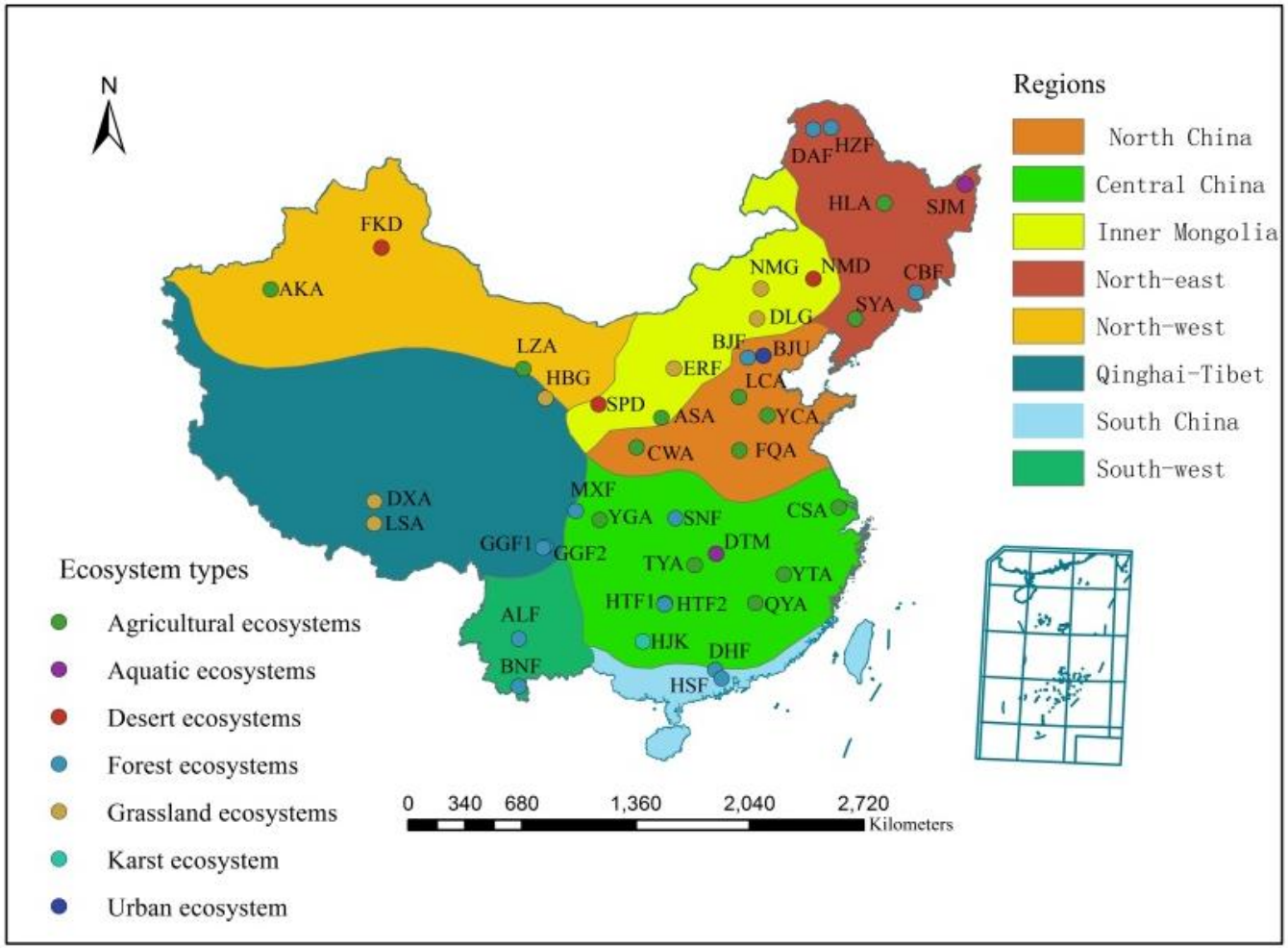
Continuous CO_2 and H_2O stable isotope fluxes measurement system

- **Isotope ratio infrared spectroscopy (IRIS)**
- **(δD, $\delta^{18}O$)-H_2O, ($\delta^{13}C$, $\delta^{18}O$)-CO_2 ratio and fluxes** automatic, synchronal and continuous measurement
- Success in capturing the **rapid change** of stable CO_2 and H_2O isotope fluxes



OA-ICOS WS-CRDS

Observation network for atmospheric wet N deposition

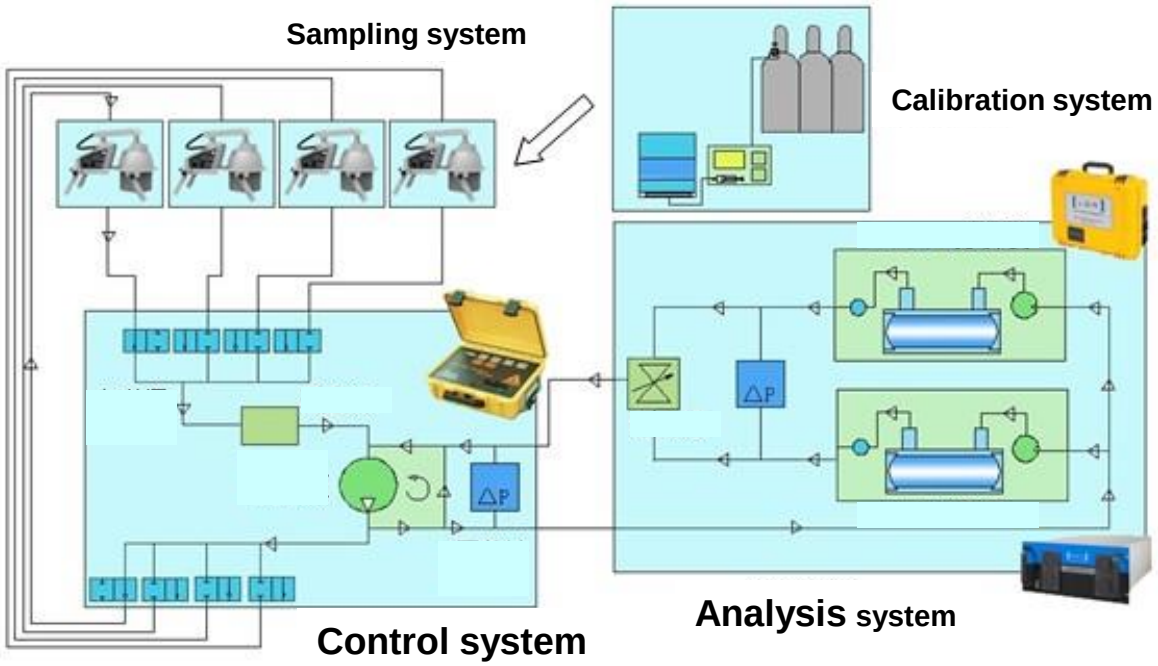


41 typical terrestrial ecosystems cover forest, grassland, desert, lake, marsh, karst and urban ecosystems.

22 provinces and 8 ecological regions

Automatic measurement systems for soil greenhouse gases

- **Laser technique**
- **Soil CO_2, CH_4, and N_2O fluxes** automatic and continuous measurement
- **High precision**: CO_2: 0.5umol m^{-2} s^{-1} (5umol m^{-2} s^{-1})
  CH_4: 2nmol m^{-2} s^{-1}(20nmol m^{-2} s^{-1}); N_2O: 0.5nmol m^{-2} s^{-1} (2nmol m^{-2} s^{-1})



Outlines

1. C-N-H_2O fluxes observational systems of ChinaFLUX

2. **New progresses in C-N-H_2O fluxes research of ChinaFLUX**
   - spatial patterns of C fluxes and biogeographic mechanisms
   - decadal variation of atmospheric N
   - spatial patterns of H_2O fluxes and water use efficiency

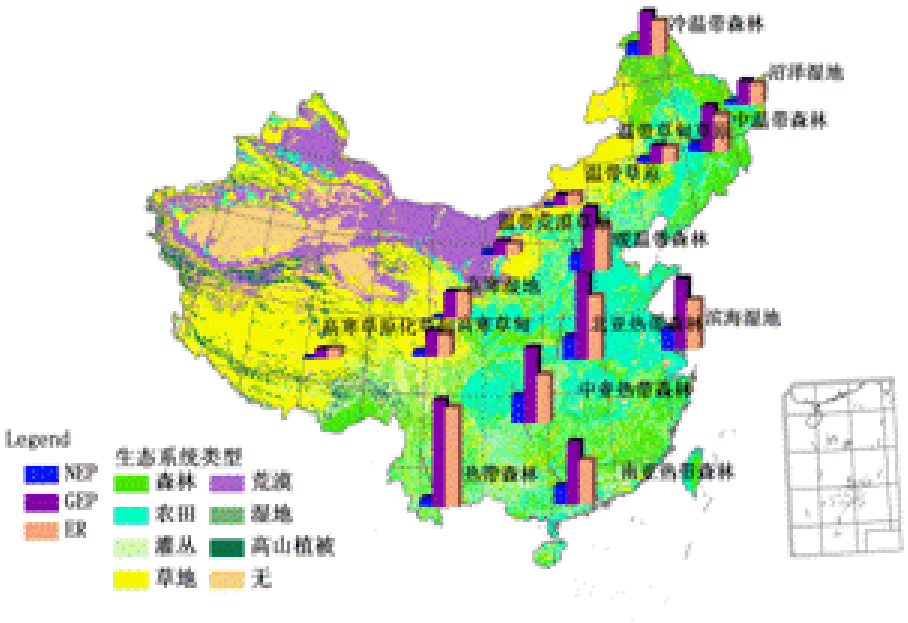
Geographic distribution of C fluxes in China

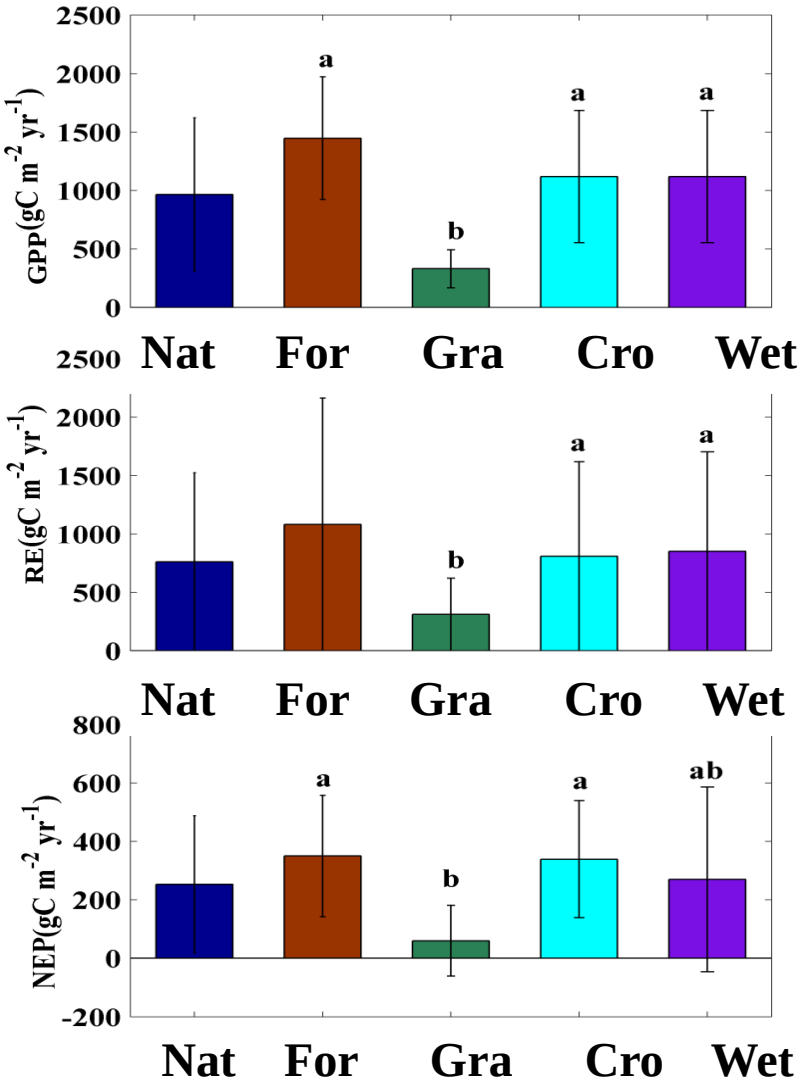
Mean values in China（g C m^{-2} yr^{-1}）

GPP：965.45 ± 665.53

RE： 760.84 ± 473.38

NEP：252.88 ± 234.23

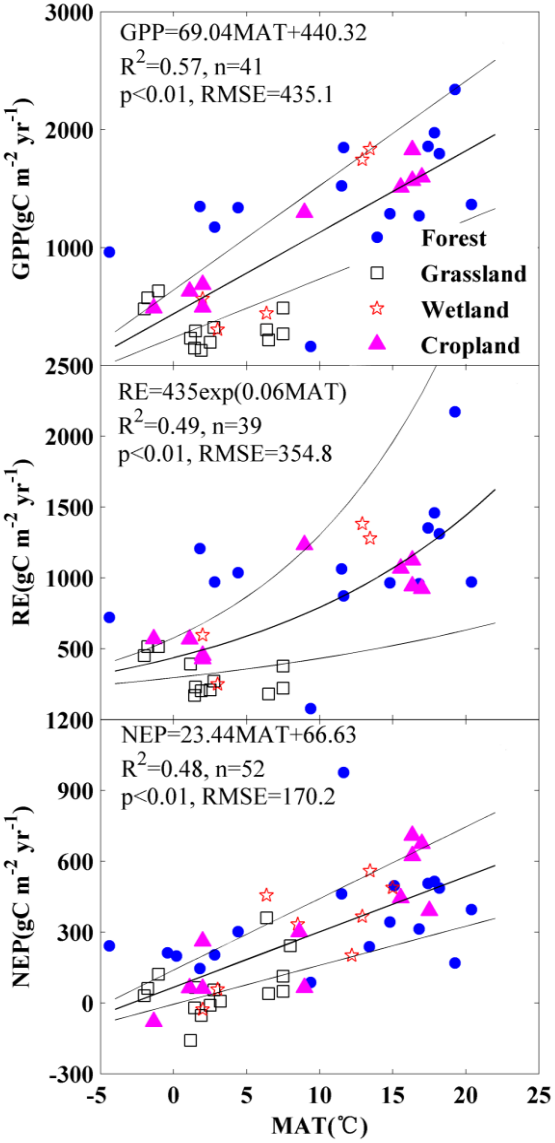


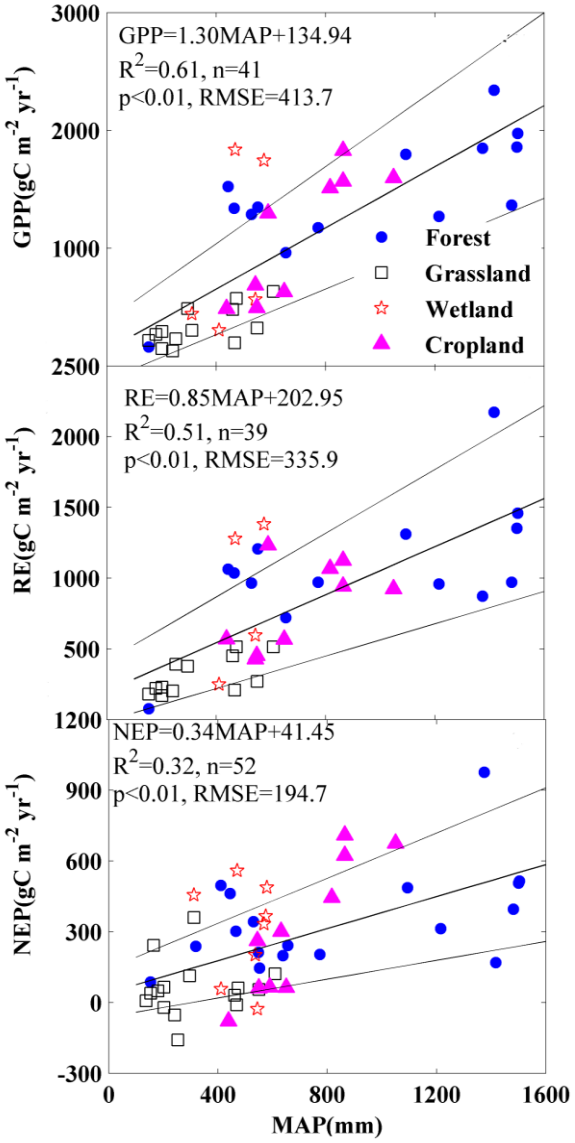


A strong C sink in China

Yu et al., 2013. Global Change Biology

Controlling climate factors: MAT & MAP





MAT and MAP together

GPP:79%

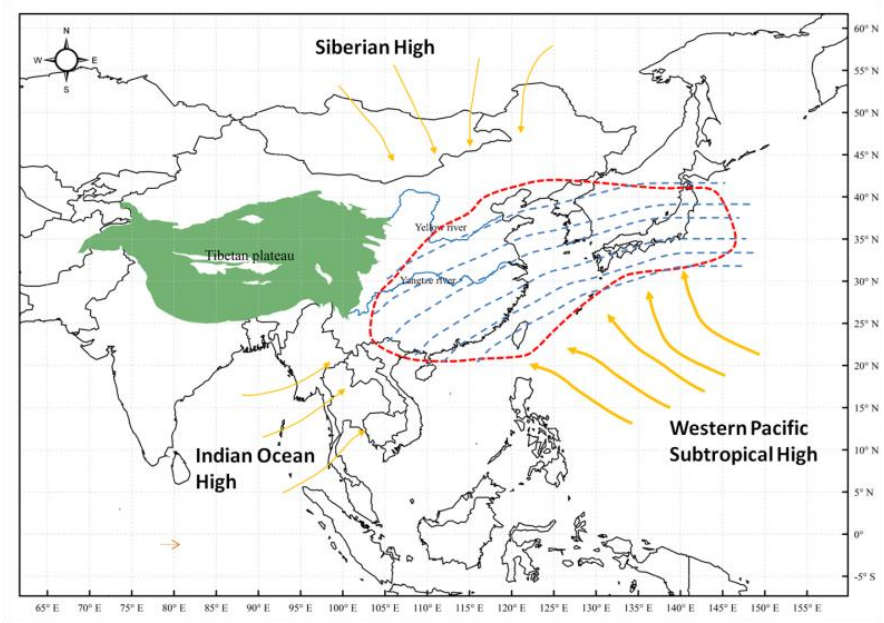
RE:62%

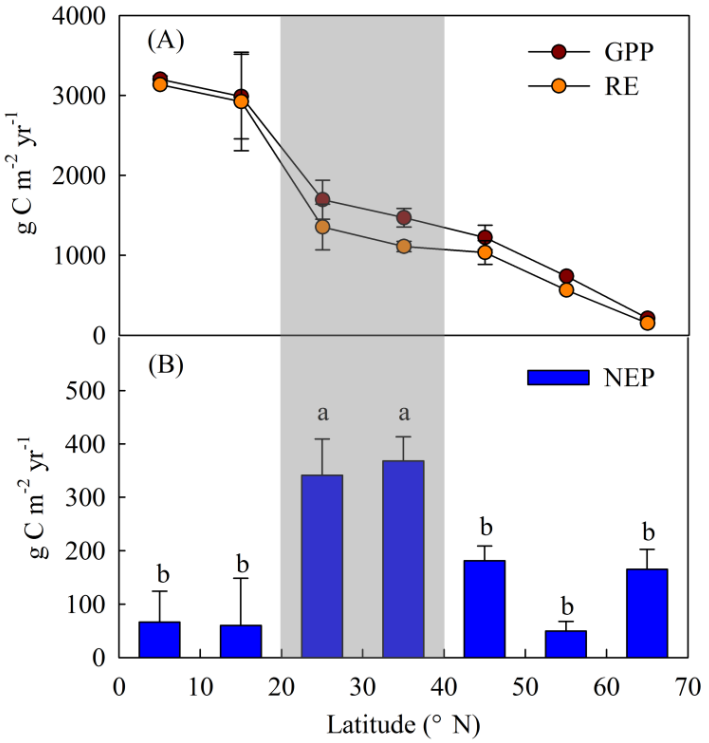
NEP:66%

The determinant role of MAT and MAP did not change with ecosystem types.

Yu et al., 2013. GCB

Large C uptake in subtropical forest ecosystems in the East Asian monsoon region



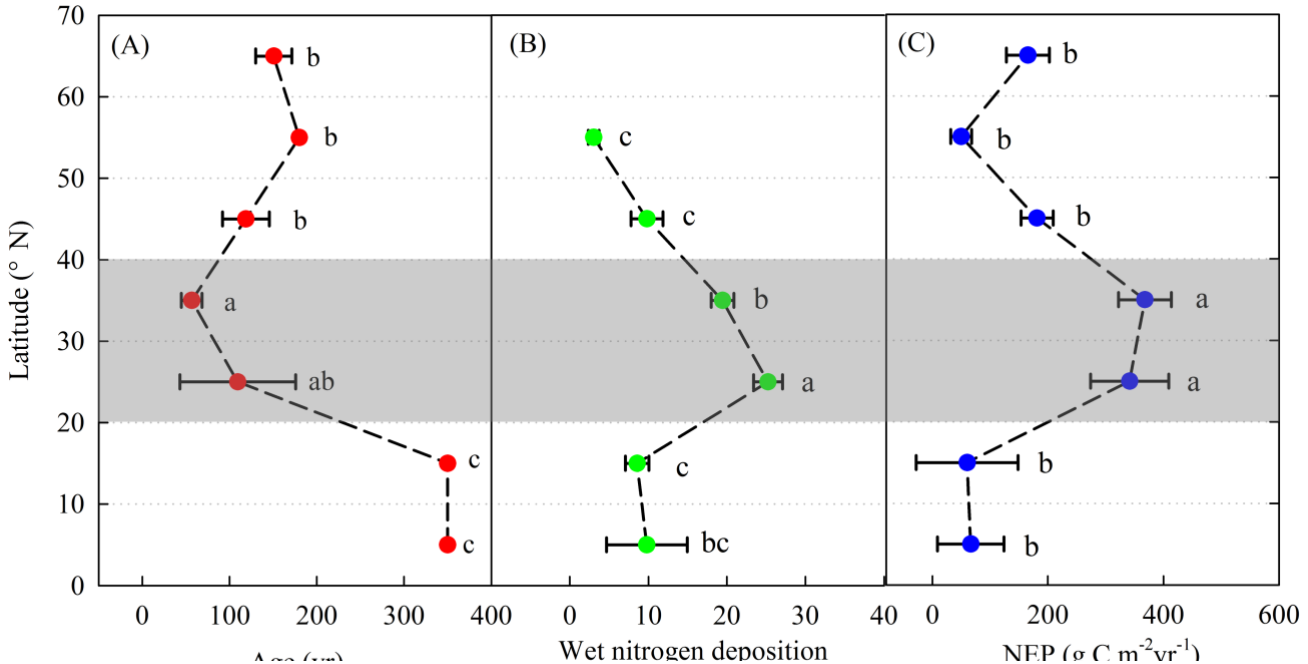


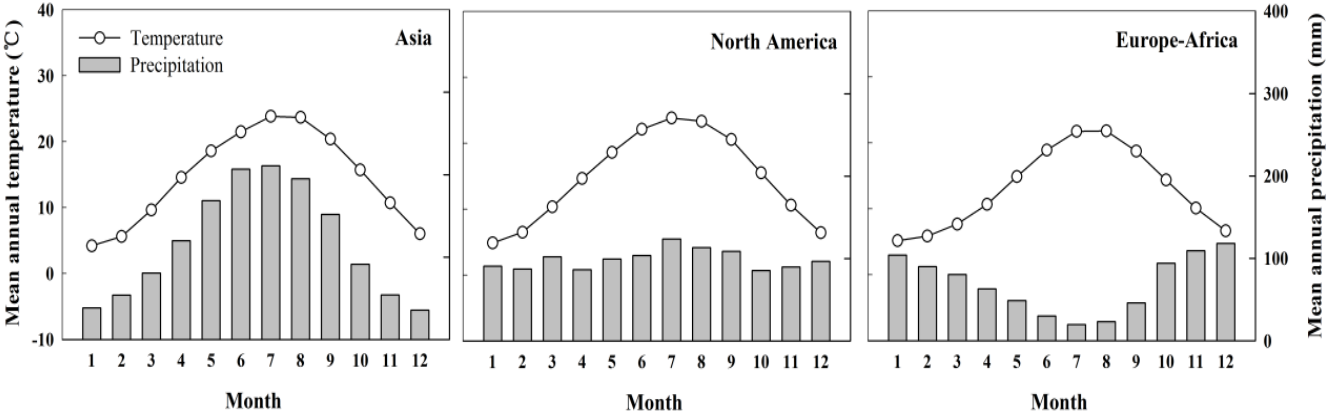
Net C uptake in subtropical forests in the East Asian monsoon region: **362±39 g C m^{-2} yr^{-1}** .

Total regional uptake of carbon: **0.72±0.08 Pg C yr^{-1},** 8% of the global forest NEP

Yu et al., 2014. PNAS

Large C uptake in subtropical forest ecosystems in the East Asian monsoon region

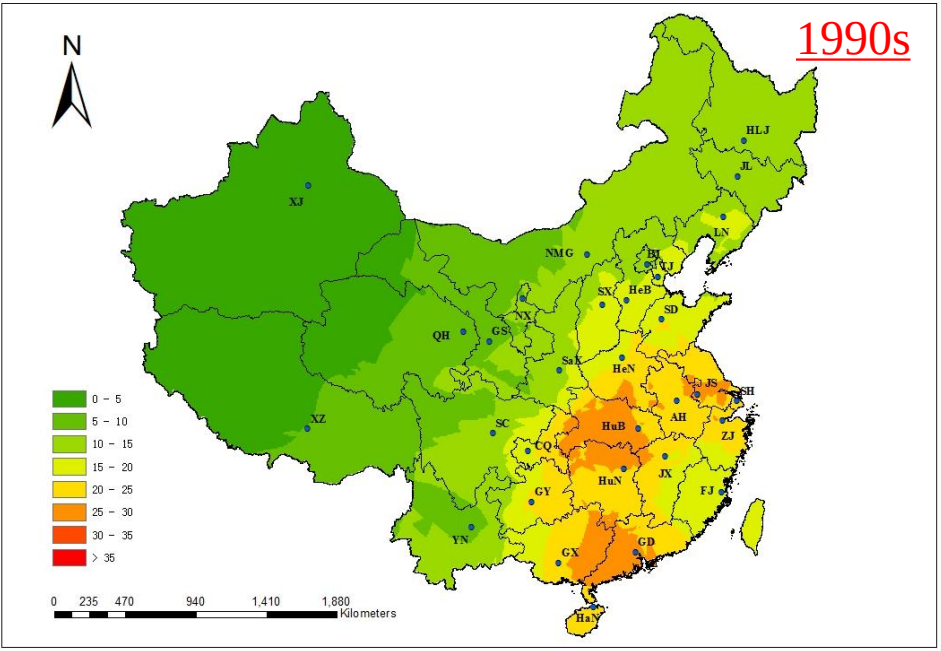


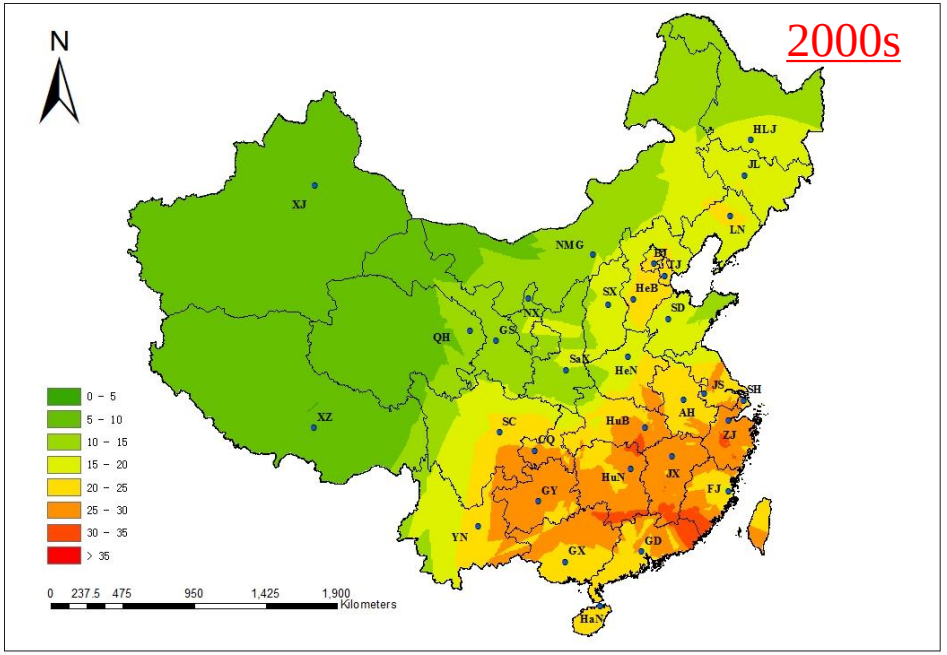


- N deposition,
- forest age,
- climate factors

Yu et al., 2014. PNAS

Spatial pattern of atmospheric wet N deposition in China

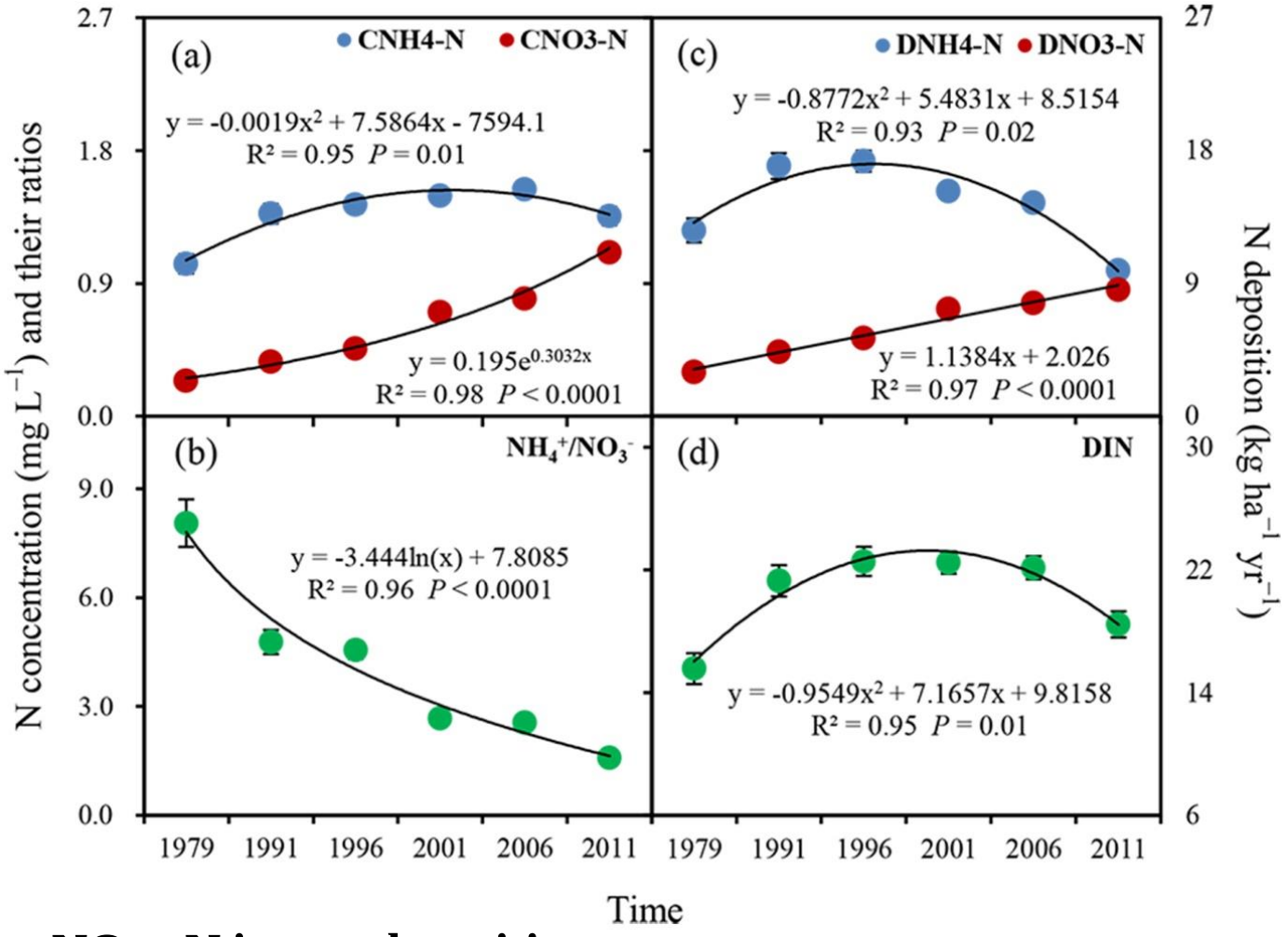




- Mean wet deposition: 11.11in the 1990s and 13.87 kg ha^{-1} a^{-1} in the 2000s
- High N deposition regions: Central China and South China

Zhu et al., 2015, Science of the Total Environment

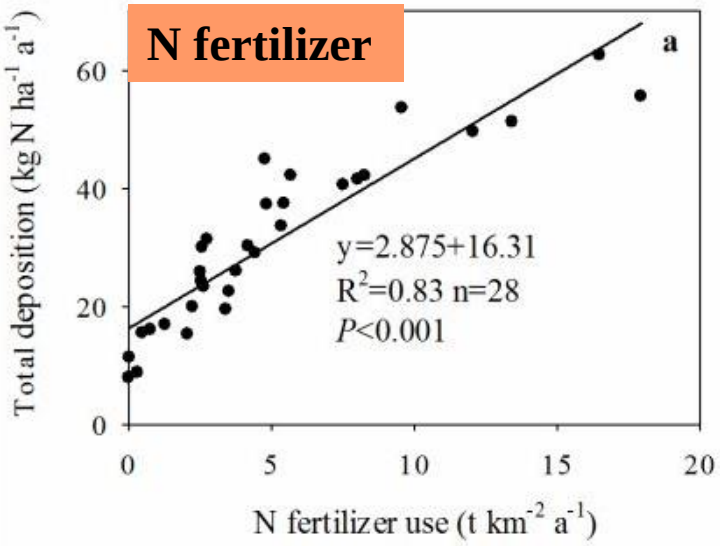
Temporal variation of atmospheric wet N deposition in China

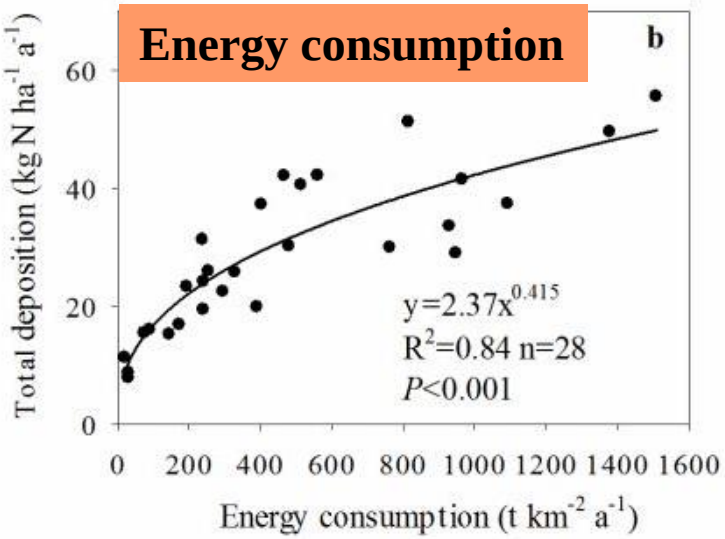


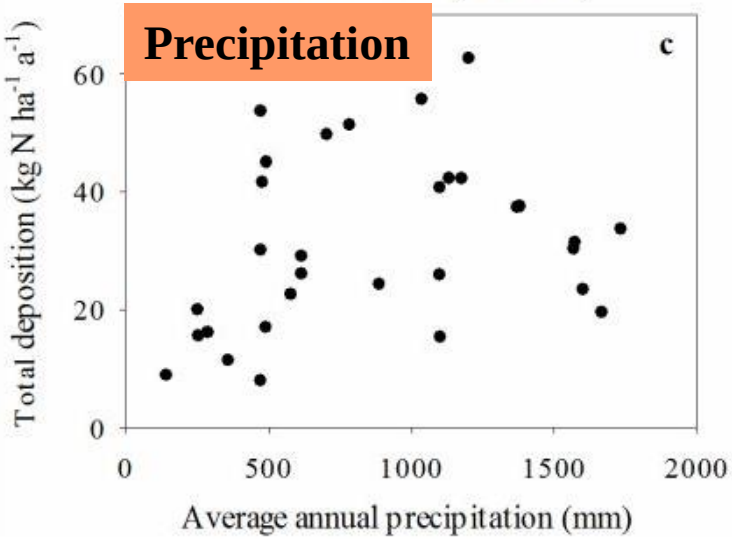
- NH_4^+–N > NO_3^-–N in wet deposition.
- NO_3^-–N kept increasing, 1.14 kg N ha^{-1} yr^{-1}
- NH_4^+–N deposition flux tended to decrease.

Zhu et al., 2016, JGR

Influencing factors of atmospheric N deposition in China





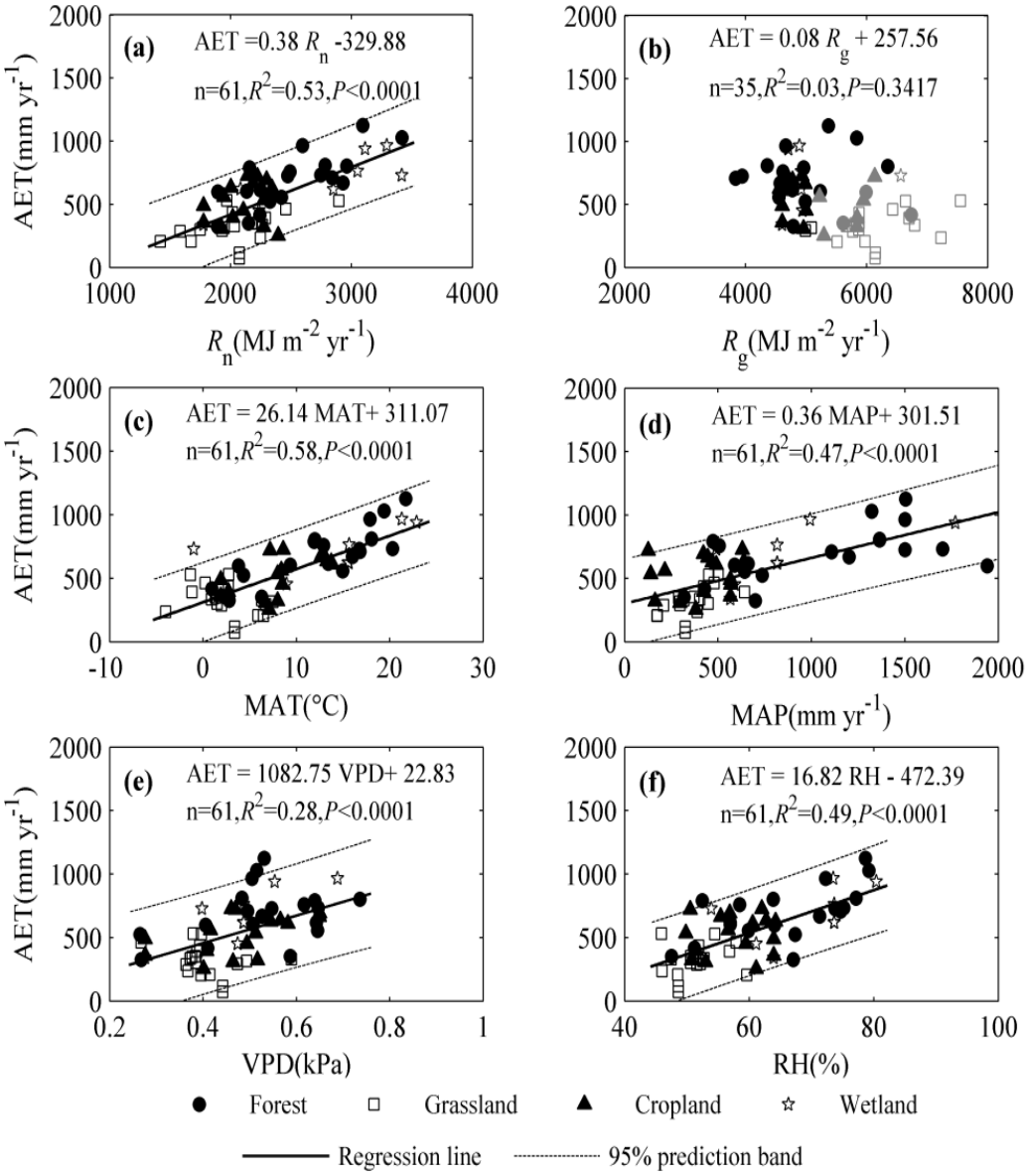


- **N fertilizers use and energy consumption are the main factors.**
- **The models including the two factors can explain ~88% of the spatial variation**

Jia et al., 2014, Scientific Reports

Prediction model: $N_{total} = 23.44 \times (F_N \times 18.5\% + E \times 0.24\%)^{0.4}$; $R^2=0.88$, $P<0.001$

Controlling climate factors for ET in China



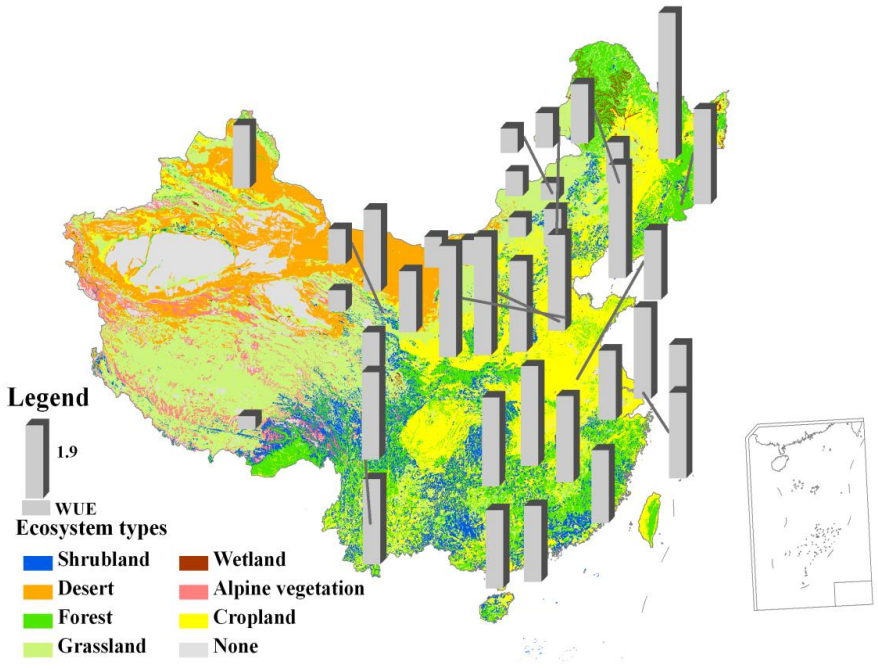
MAR, MAT and MAP are direct influence factors for the spatial pattern of AET.

AET=0.19MAP+0.21R_n+9.49MAT–191.123, R^2=0.84

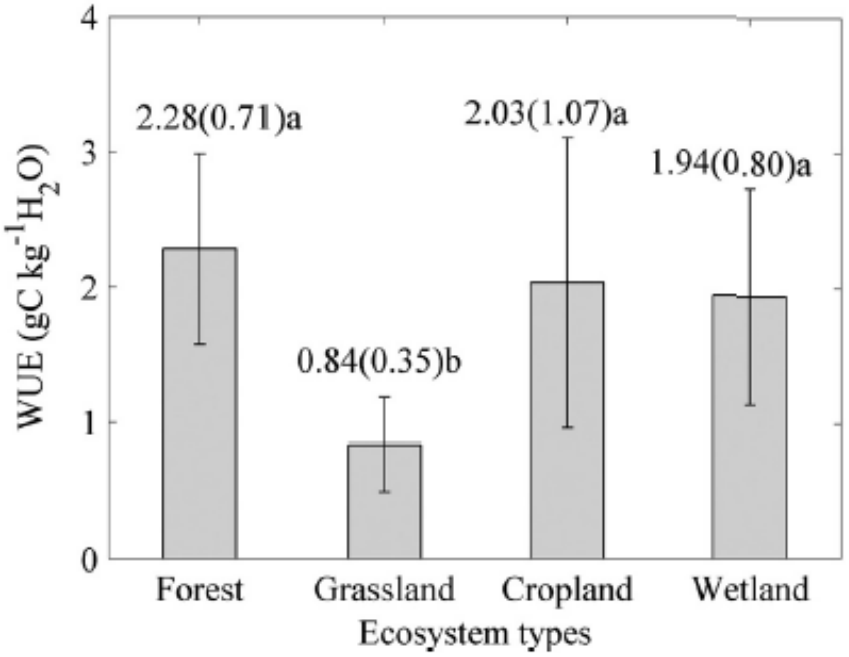
Zheng et al. 2016, Journal of Geographical Sciences

Spatial pattern of water use efficiency(WUE) in China

Typical ecosystems in China



- 37 sites over China
- Forests：13；Grasslands：12; Croplands：5; Wetlands：7
- Decreased from the East to West



- No difference of WUE between Forests, Croplands and Wetlands;
- Lower in Grasslands than other ecosystems.

Zhu et al., 2015, Global and Planetary Change

Water use efficiency for carbon sequestration in China

Agricultural and Forest Meteorology 195–196 (2014) 32–37

Contents lists available at ScienceDirect

Agricultural and Forest Meteorology

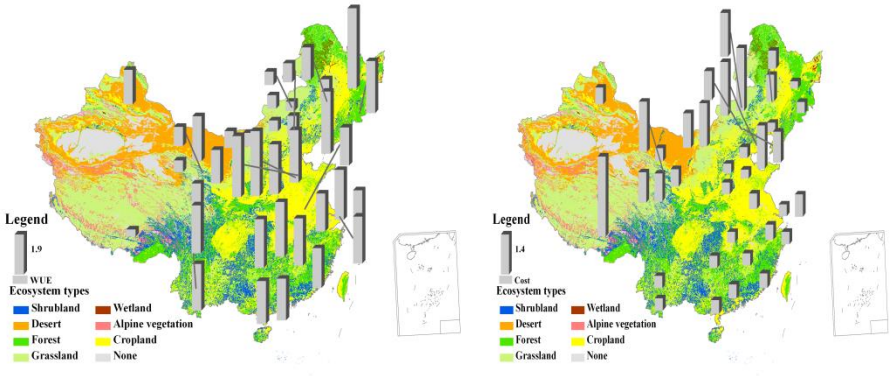
journal homepage: www.elsevier.com/locate/agrformet

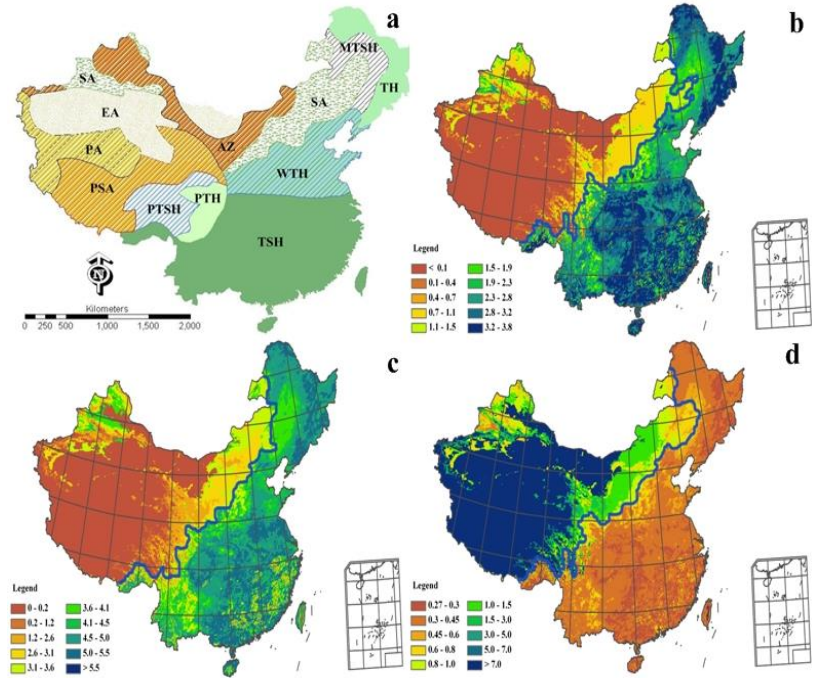
Water use efficiency threshold for terrestrial ecosystem carbon sequestration in China under afforestation

Yang Gao[a,b], Xianjin Zhu[a], Guirui Yu[a,*], Nianpeng He[a], Qiufeng Wang[a], Jing Tian[a]

[a] Key Laboratory of Ecosystem Network Observation and Modeling, Institute of Geographic Sciences and Natural Resources Research, CAS, Beijing 100101, China

[b] USDA-ARS, National Soil Erosion Research Laboratory, Purdue University, IN 47907, United States





400-500 mm precipitation is a water use efficiency threshold for ecosystem carbon sequestration

NATURE CLIMATE CHANGE | VOL 4 | JULY 2014

MITIGATION

Water costs of afforestation

Agric. Forest Meteorol. **195–196,** 32–37 (2014)

Afforestation is one way to sequester carbon dioxide from the atmosphere and mitigate climate change, but choosing the best location is not always straightforward.

Yang Gao from the Institute of Geographic Sciences and Natural Resources Research, China, and colleagues investigated the water consumption cost of carbon sequestration (WCCC) for afforestation projects in China. They find an abrupt change in ecosystem and plant water-use efficiency coincident with the 400–500 mm average annual precipitation isopleth, where the WCCC is 1 kg H_2O per g C. This threshold represents a boundary beyond which afforestation may lead to land degradation due to water depletion.

Unfortunately China's major afforestation programmes are mostly concentrated in relatively arid areas with a high WCCC to the west of the 400–500 mm precipitation isopleth. This illustrates the importance of considering water-use efficiency when selecting sites for afforestation.

AB

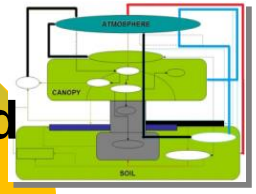
Gao et al., 2014, Agricultural and Forest Meteorology

Outlines

1. C-N-H_2O fluxes observational systems
2. New progresses in C-N-H_2O fluxes studies in ChinaFLUX
3. **Future research opportunities**

Big project-ChineTERN

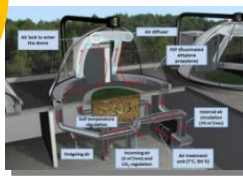
Data center and predictive systems

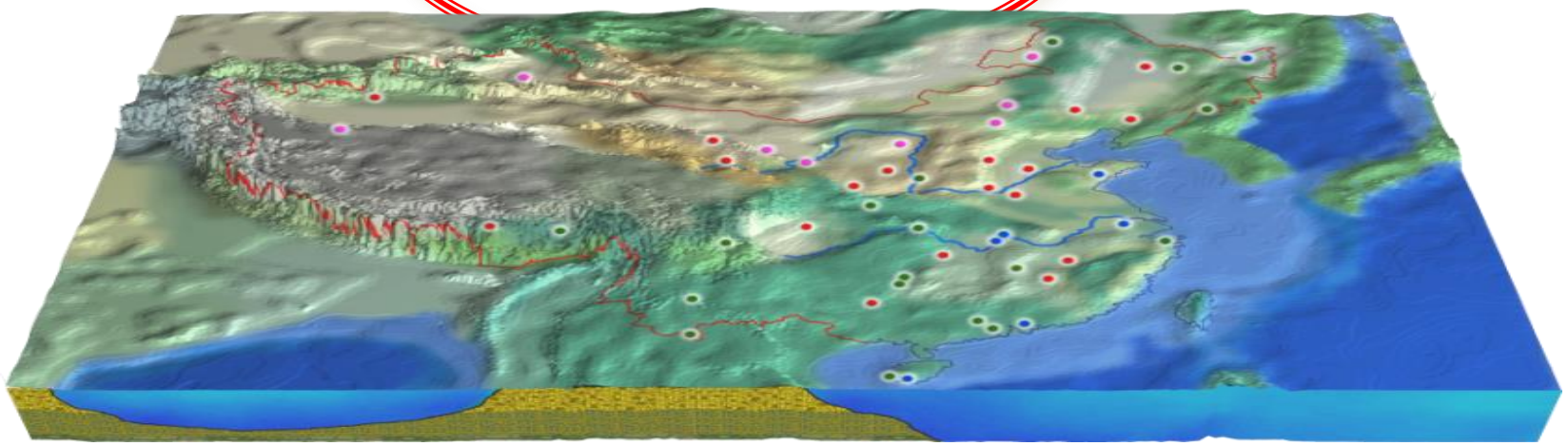


Distributed coordinated observation systems

Advanced infrastructure

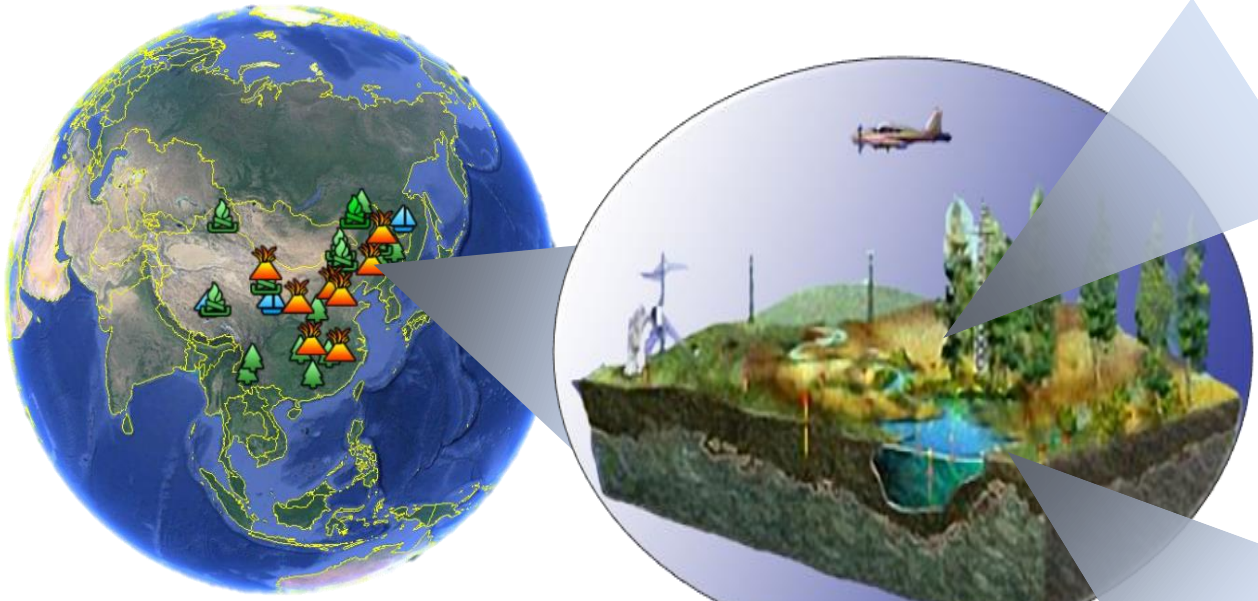
Standardized experiment systems

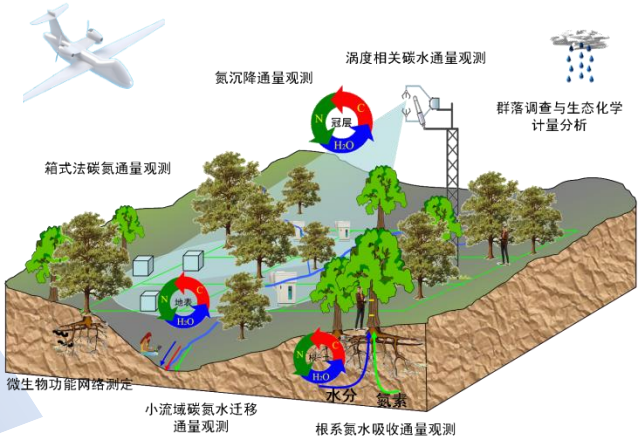




Advanced infrastructures for observation and experiment

28 super sites

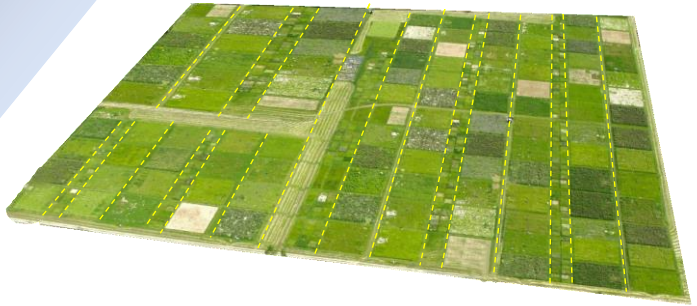




Integration of atmosphere and ground based observation

+

Standardized experiments



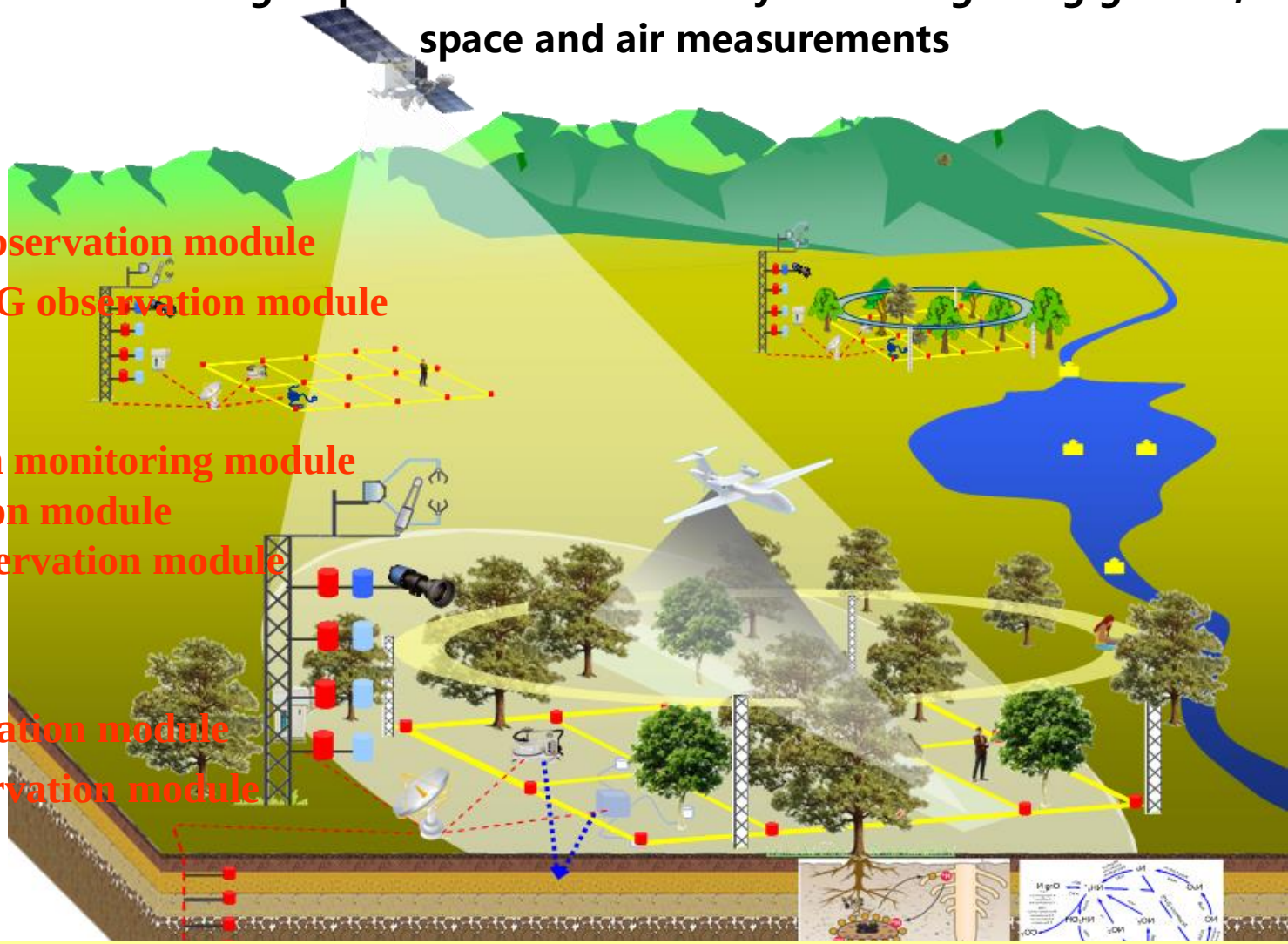
Vegetation types：

Forest 10，wetland 3、grassland 7

cropland 8

National observation system in ChinaTERN

Tower-group-based observation system integrating ground, space and air measurements



Atmosphere

- Environmental observation module
- Atmospheric GHG observation module

Vegetation

- vegetation growth monitoring module
- canopy observation module
- stable isotope observation module

Soil

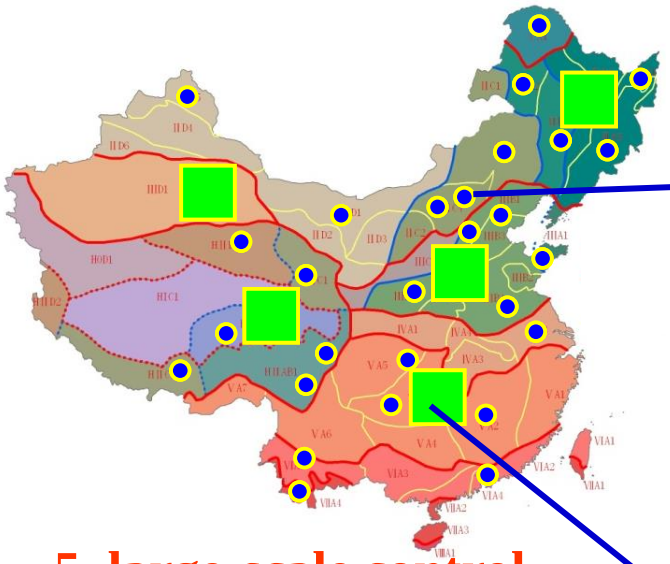
- Soil process observation module
- Soil trace gas observation module

Temporal resolution：Automatic observation on hourly and continuous basis

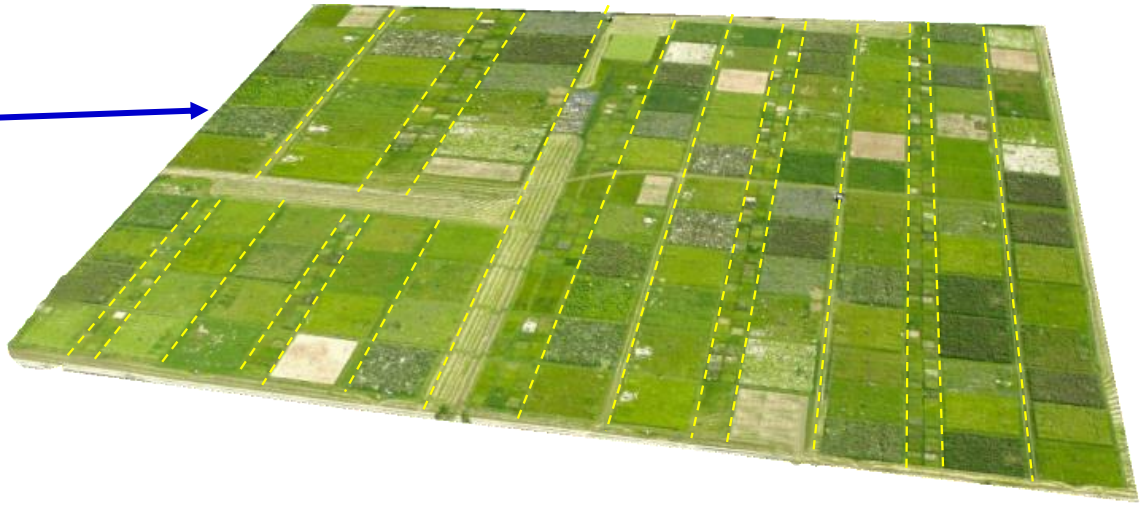
Spatial resolution：leaf→vegetation→ecosystem→landscape (100km^2)

Manipulative experiments in ChinaTERN

28 sites



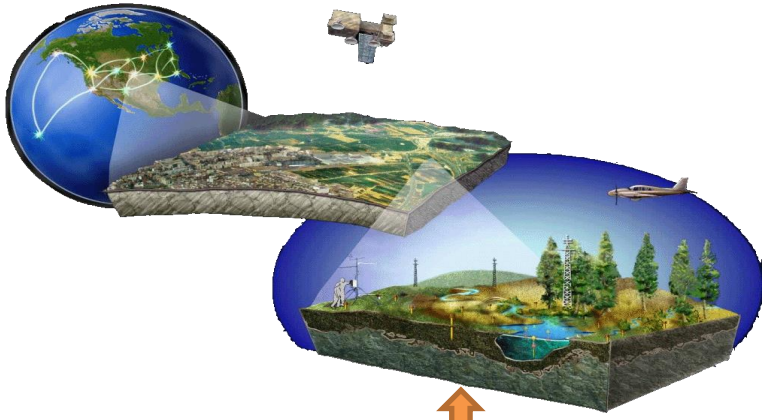
Standardized manipulative experiment network



5 large-scale control experiment facilities

Large-sized control experiment devices

Ecosystem modeling and prediction system in ChineTERN



Super computing

Speed： 12 PetaFlops
Storage ：5PB

Big data
Cloud storage

100PB volume

Interactively visible

Ecosystem modeling hardware system

Prediction of Chinese Ecosystems

The joint conference of AsiaFlux Workshop 2017 and the 15th Anniversary Celebration of ChinaFLUX to be held in Beijing, China, on August 17-19, 2017.

The tentative thesis of AsiaFlux Workshop 2017 is "Linking ecosystem flux measurements and carbon management to global change" . This workshop features will discuss the scientific challenges on flux measurement and monitoring, couplings cycles of carbon, water and nitrogen, upscaling approaches for regional carbon budget, as well as ecosystem carbon/water management.

As one of important partners of FLUXNET and AsiaFlux, ChinaFLUX will greet the coming 15th Anniversary since 2002. During this joint conference, a series of celebration will be organized for the 15th Anniversary of ChinaFLUX.

Date & Vanue

- Training Course: August 14-16, Institute of Institute of Geographic Sciences and Natural Resources Research
- AsiaFlux Workshop 2017: August 17, Beijing International Convention Center
- The 15th Anniversary Celebration of ChinaFLUX: August 18, Beijing International Convention Center
- Field Excursion: August 19, Yucheng site

Important Dates

- March 05, 2017: Open for Registration & Abstract submission
- June 30, 2017: Deadline for training course application
- July 20, 2017: Deadline for ONLINE registration & Abstract submission
- July 20, 2017: Deadline for field excursion

Organizers

AsiaFlux ChinaFLUX

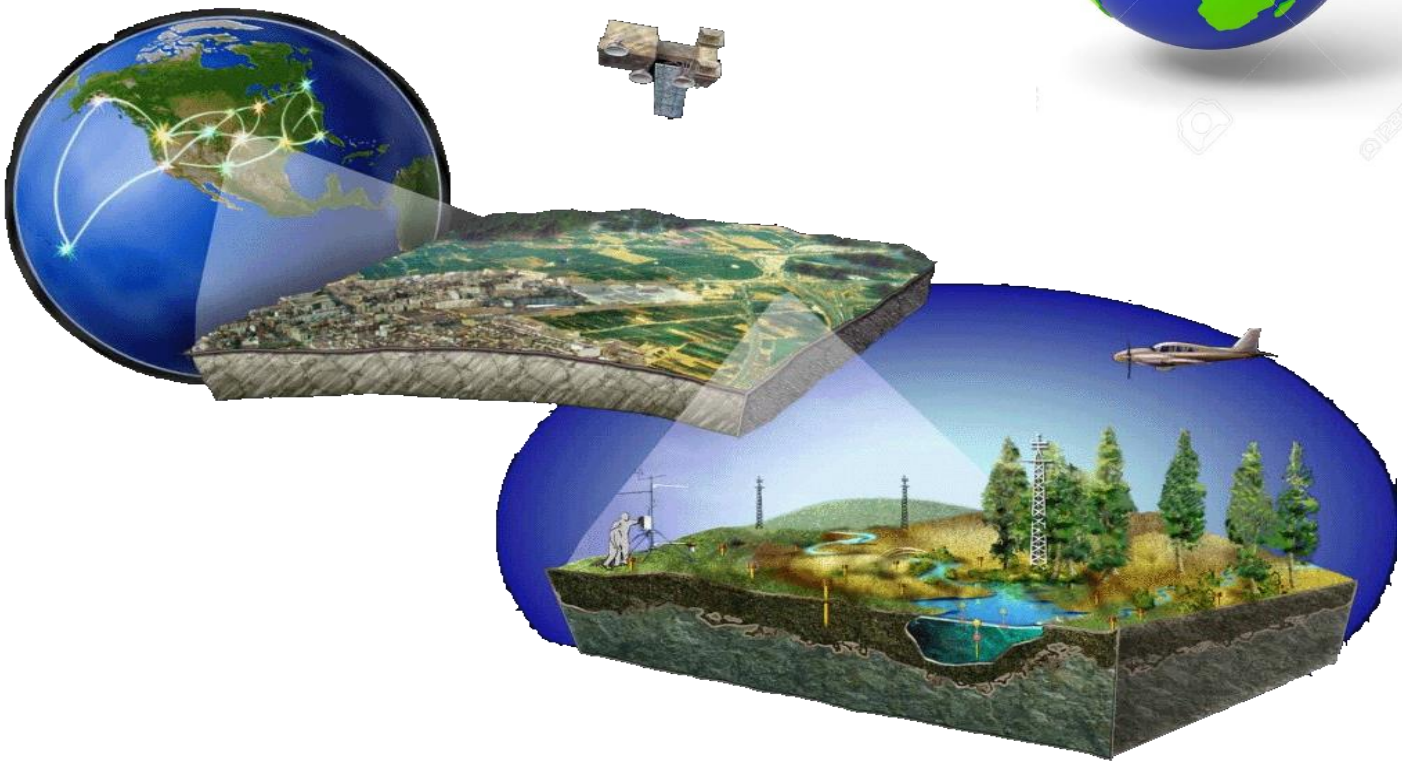
Co-organizers

CERN CNERN CFERN

Thanks for your attention!

Thank You !

ChinaTERN

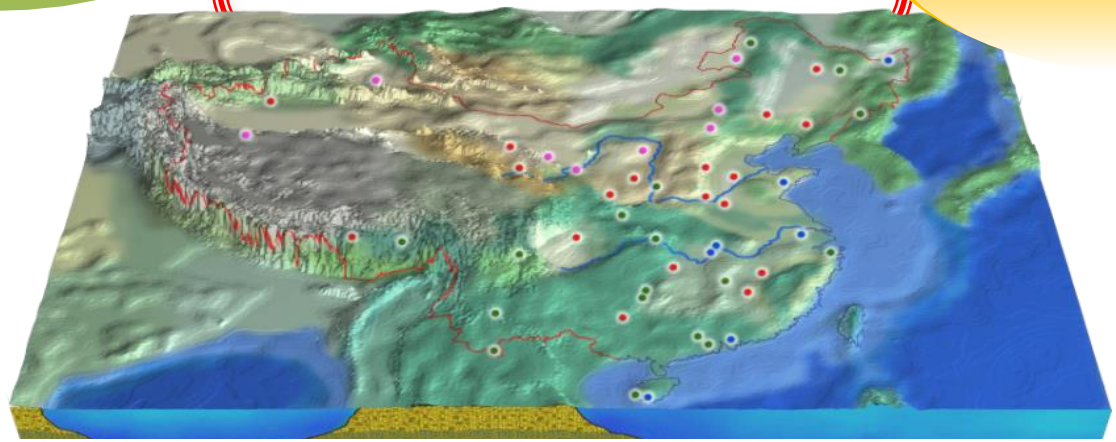


The way forward-ChineTERN

Data center and predictive systems

Distributed coordinated observation system

Standardized experiments



Integration of atmosphere and ground observation + manipulative experiment + model prediction