C-N-H$_2$O fluxes observations in ChinaFLUX

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Outlines

1. C-N-H$_2$O fluxes observational systems
2. New progresses in C-N-H$_2$O fluxes studies
3. Future research opportunities
ChinaFLUX

- Knowledge Innovation Program of CAS
- National Program (973 Program)
  Stage I 2001-2004
- 973 Program
- Program of CAS
  Stage II 2005-2009
- NSFC: Key Program
- NSFC Asia 3 Foresight Program
- Stage III 2010-2014
- CERN Special Program
- Stage IV 2015-2017
New stage: ChinaFLUX union

More than 70 sites
C-N-H$_2$O fluxes coordinated observation systems

Nitrogen Deposition

Isotope fluxes $^{13}$C, $^{18}$O, $^{15}$N

Soil greenhouse gas fluxes CO$_2$, CH$_4$, N$_2$O

EC

H$_2$O

Runoff

SOC
Continuous CO$_2$ and H$_2$O stable isotope fluxes measurement system

- Isotope ratio infrared spectroscopy (IRIS)
  - (δD, δ$^{18}$O)-H$_2$O, (δ$^{13}$C, δ$^{18}$O)-CO$_2$ ratio and fluxes automatic, synchronal and continuous measurement
  - Success in capturing the rapid change of stable CO$_2$ and H$_2$O isotope fluxes
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 CO₂, CH₄, and N₂O fluxes** automatic and continuous measurement

- **High precision:** CO₂: 0.5umol m⁻² s⁻¹ (5umol m⁻² s⁻¹)  
  CH₄: 2nmol m⁻² s⁻¹ (20nmol m⁻² s⁻¹); N₂O: 0.5nmol m⁻² s⁻¹ (2nmol m⁻² s⁻¹)
Outlines

1. C-N-H$_2$O fluxes observational systems of ChinaFLUX

2. New progresses in C-N-H$_2$O fluxes research of ChinaFLUX
   - spatial patterns of C fluxes and biogeographic mechanisms
   - decadal variation of atmospheric N
   - spatial patterns of H$_2$O 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: $362 \pm 39$ g C m$^{-2}$ yr$^{-1}$. Total regional uptake of carbon: $0.72 \pm 0.08$ 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
Mean wet deposition: **11.11** in 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
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.

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

Jia et al., 2014, Scientific Reports
MAR, MAT and MAP are direct influence factors for the spatial pattern of AET.

\[ AET = 0.19 \text{MAP} + 0.21R_n + 9.49 MA - 191.123, \quad R^2 = 0.84 \]

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

Gao et al., 2014, Agricultural and Forest Meteorology
Outlines

1. C-N-H$_2$O fluxes observational systems

2. New progresses in C-N-H$_2$O fluxes studies in ChinaFLUX

3. Future research opportunities
Big project-ChineTERN

Data center and predictive systems

Distributed coordinated observation systems

Standardized experiment systems

Advanced infrastructure
Advanced infrastructures for observation and experiment

28 super sites

Vegetation types:
Forest 10, wetland 3, grassland 7, cropland 8

Integration of atmosphere and ground based observation

Standardized experiments
National observation system in China TERN

Temporal resolution: Automatic observation on hourly and continuous basis
Spatial resolution: leaf → vegetation → ecosystem → landscape (100km²)
Manipulative experiments in ChinaTERN

28 sites

Standardized manipulative experiment network

5 large-scale control experiment facilities

Large-sized control experiment devices

Control system hall
Ecosystem modeling and prediction system in ChineTERN

Big data
Cloud storage

Super computing
Speed: 12 PetaFlops
Storage: 5PB

100PB volume
Ecosystem modeling hardware system

Interactively visible

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 & Venue**

- 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
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