

ChinaSpec: a network of spectral measurements to bridge flux measurements and remote sensing data

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8/20/2017

Outline



1. Background



2. The need to combine optical & flux measurements



3. International spec network



4. Current status of ChinaSpec

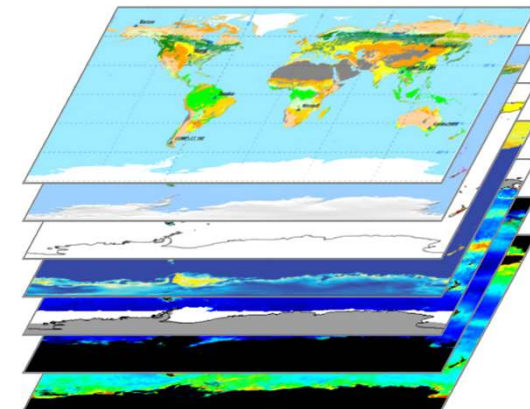
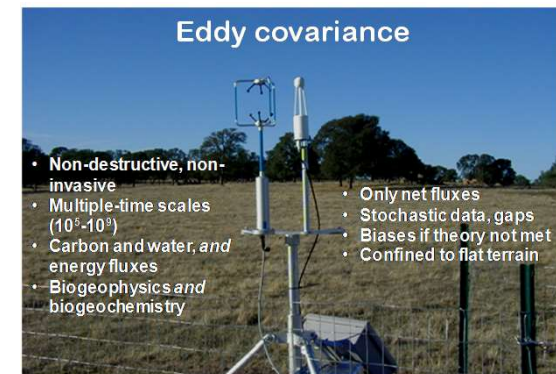


5. Future directions

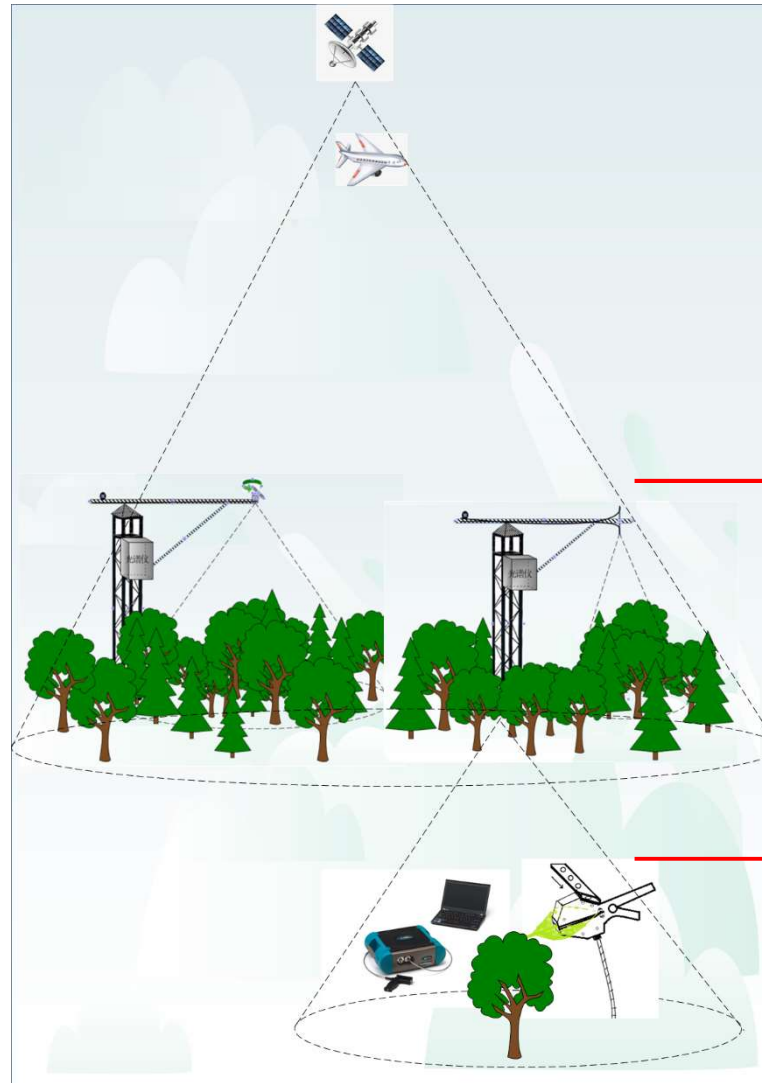
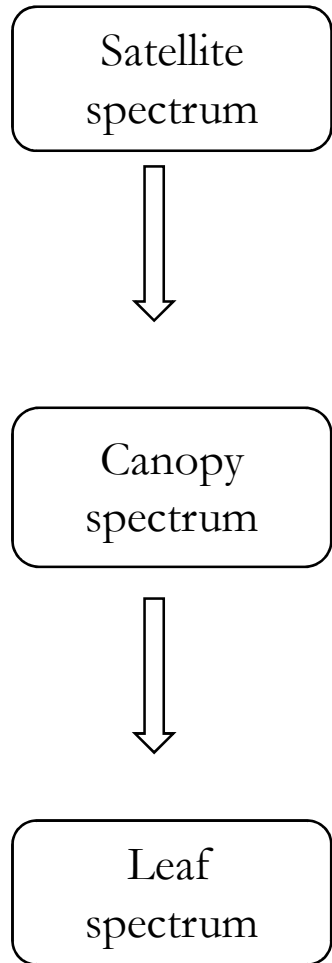
1. Background

The problem

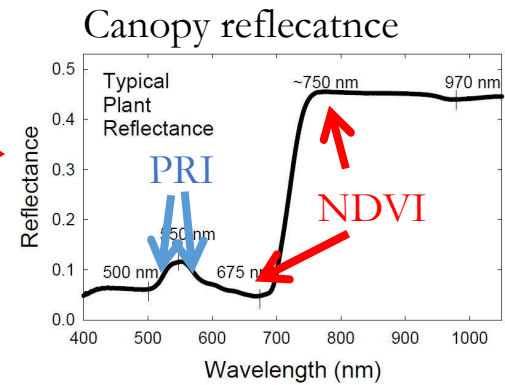
- Remote sensing is used to upscale the point eddy covariance (EC) measurements.
- However, **critical gaps** remain between the EC observations and coarse satellite data due to the **scale mismatch**.
- A network of *in situ* **optical observations** to bridge the scale-mismatch



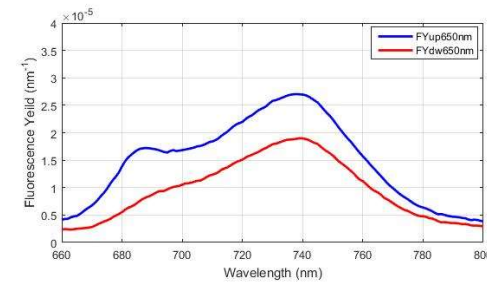
1. Background



Optical spectrum as proxy of vegetation information



Leaf chlorophyll fluorescence



2. The need to combine optical & flux measurements

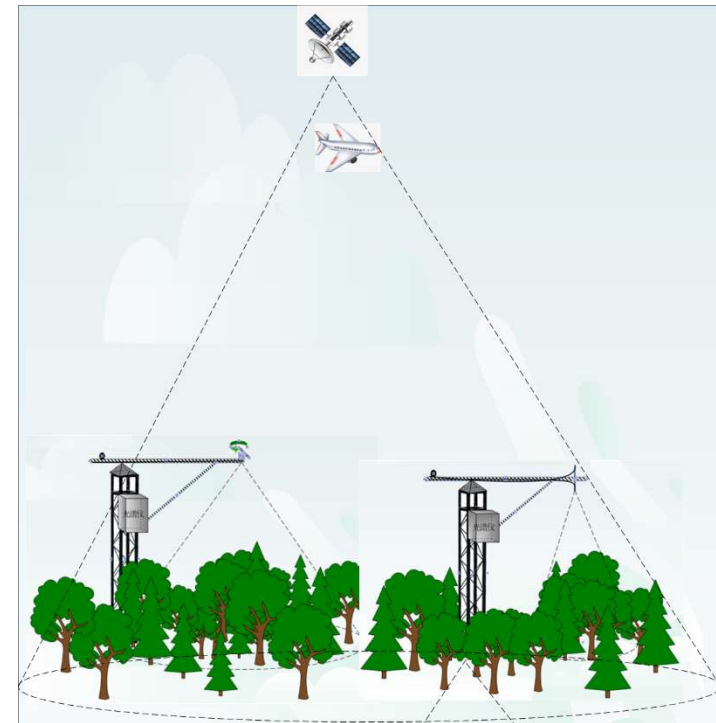
Linking Remote Sensing to Fluxes

Challenge:

Integrating spatial and temporal domains

Solution:

Ground optical sampling at the scale of the flux tower footprint.

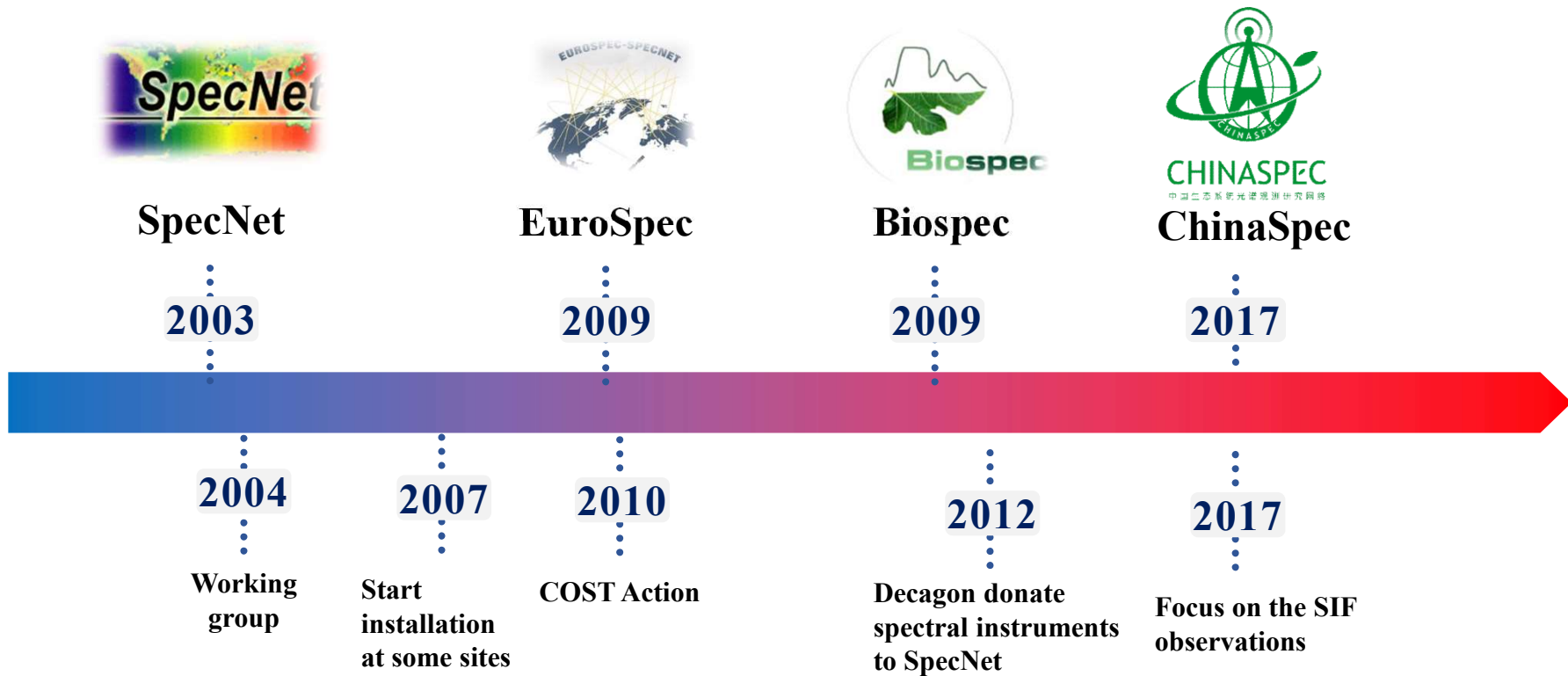


2. The need to combine optical & flux measurements

- Improve our understanding of fluxes
 - Matches the flux footprint
 - Linking respiration to recently fixed carbon
- Connects fluxes to remote sensing – helps with “scaling”
 - Upscaling – extrapolating from points to regions
 - Downscaling – calibration/validation of satellite models
- Improves understanding of flux controls & dynamics
 - Phenology
 - Disturbance
 - Identifies factors controlling fluxes
- Needed to “quantify carbon, water and energy fluxes Everywhere, and All of the Time.”

3. International spec network

Current status on the spec network internationally



4. Current status of ChinaSpec

Our focus

- Continuous outdoor canopy **spectrum measurements** together with EC observations
- In particular, mainly focus on the **canopy SIF measurements**
- Build a **network** across China mostly based on ChinaFlux: forest, cropland, grassland, and wetland
- Bridge the **gap** of satellite data and EC observations

4. Current status of ChinaSpec

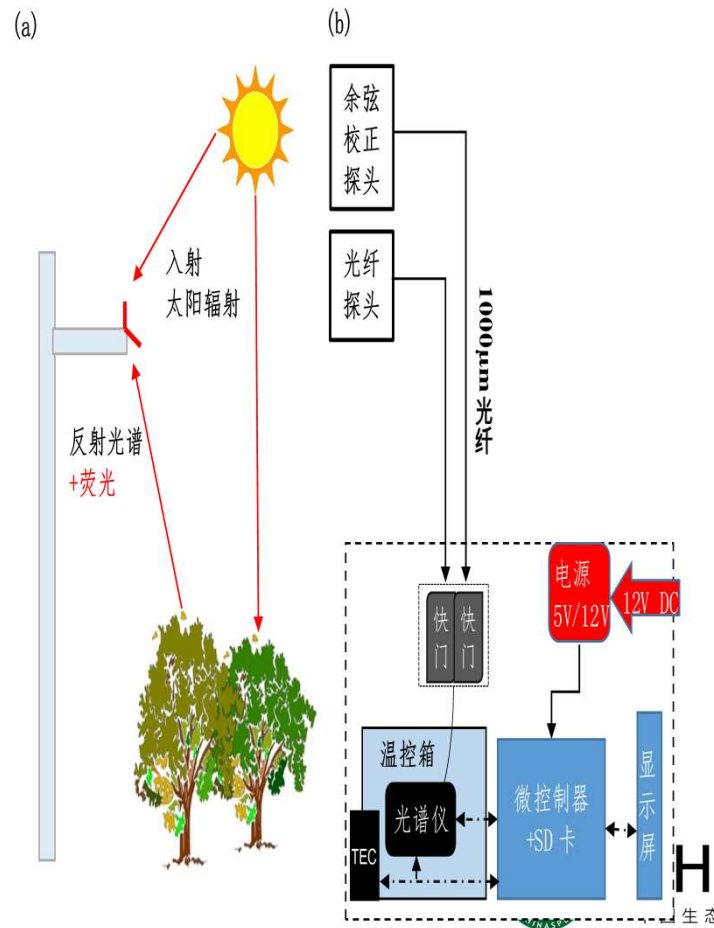
Standard protocol

- Same configurations on the instruments
 - Spectrometers (Ocean Optics: QEpro, HR2000+, etc) ;
 - Similar spectral resolution and SNR
 - Same radiometric and spectral calibration
- Same measurement mode
 - Single field of view (HEMISPHERICAL-CONICAL or BI-HEMISPHERICA)
- Same data process and algorithm of SIF retrievals

4. Current status of ChinaSpec

Instruments

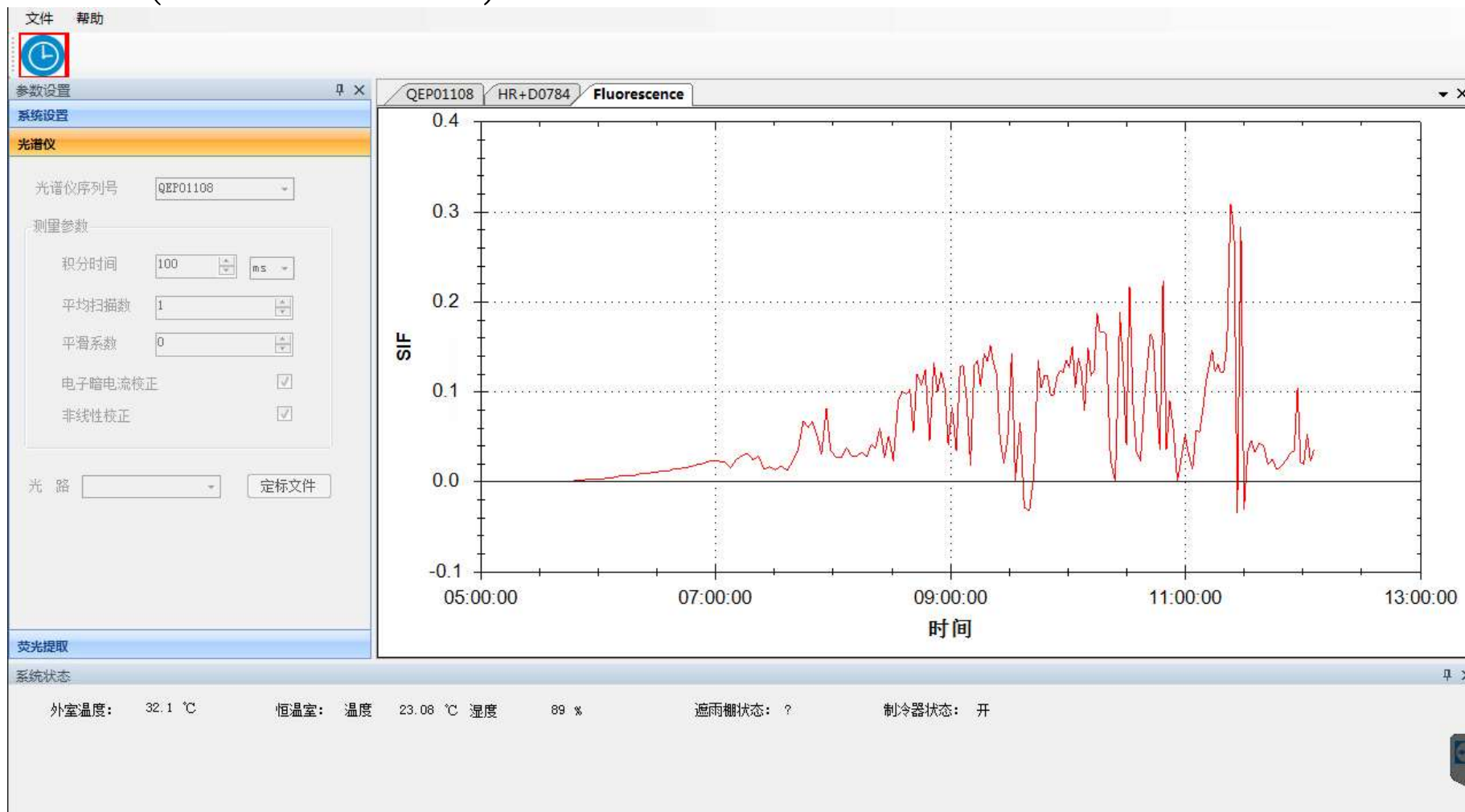
- Developed an auto SIF system (SIFspec) with a company (BERGSUN Inc.)



4. Current status of ChinaSpec

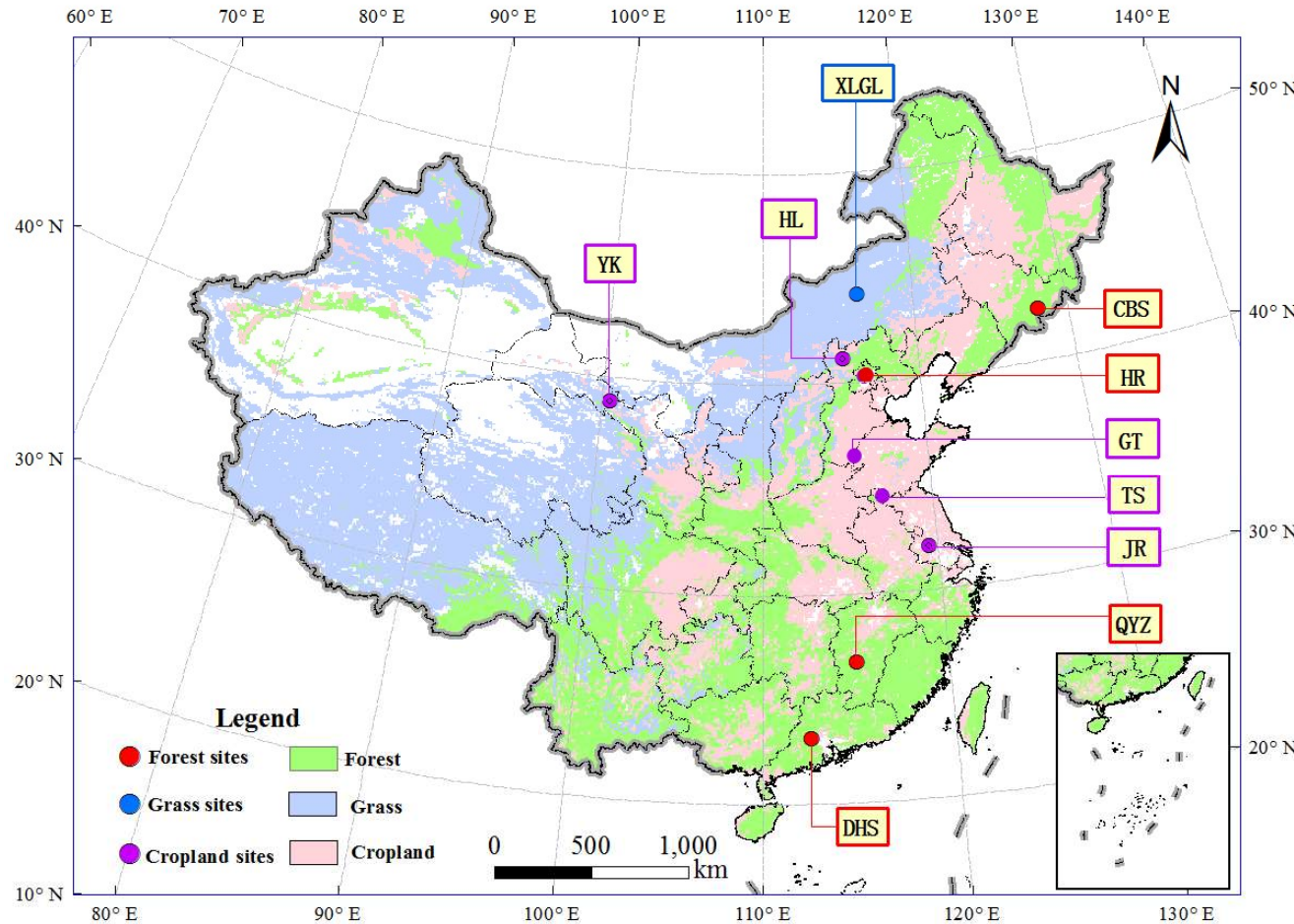
Instruments

- Developed an auto SIF system (SIFspec) with a company (BERGSUN Inc.)



4. Current status of ChinaSpec

Site Installation



Since 2014

SIFspec installed at
8 flux sites

2 forest sites,

1 grassland site,

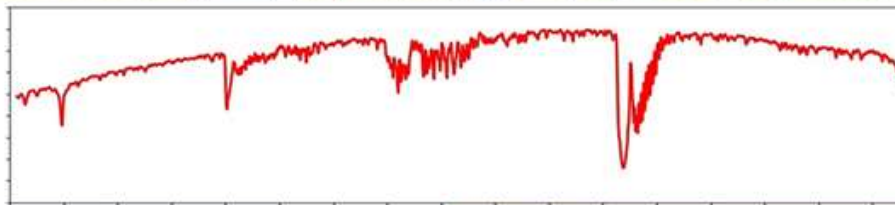
5 cropland sites



4. Current status of ChinaSpec

Site Installation

ENF



Rice



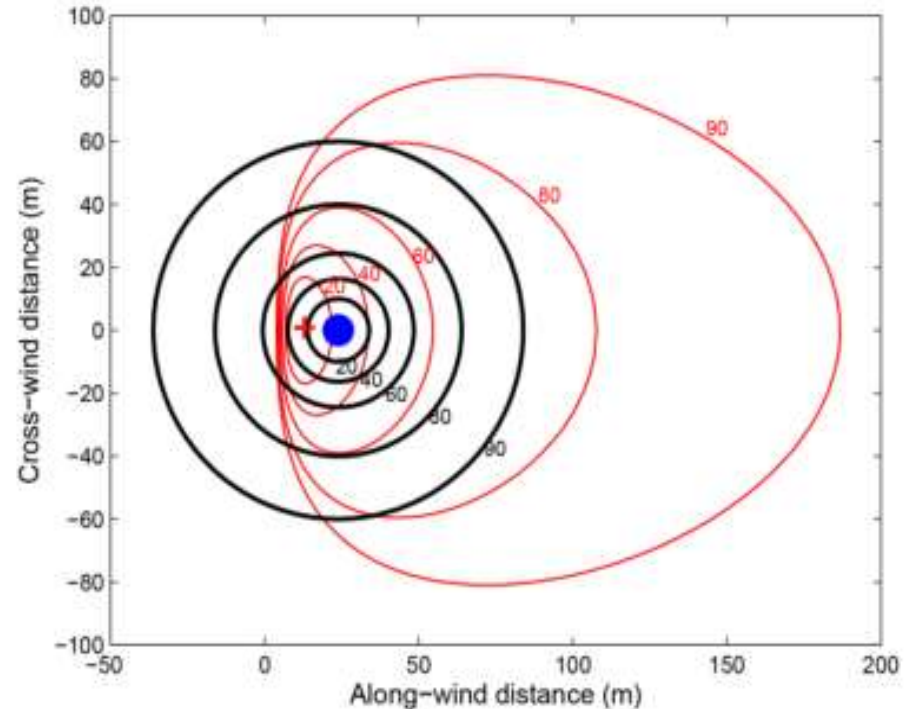
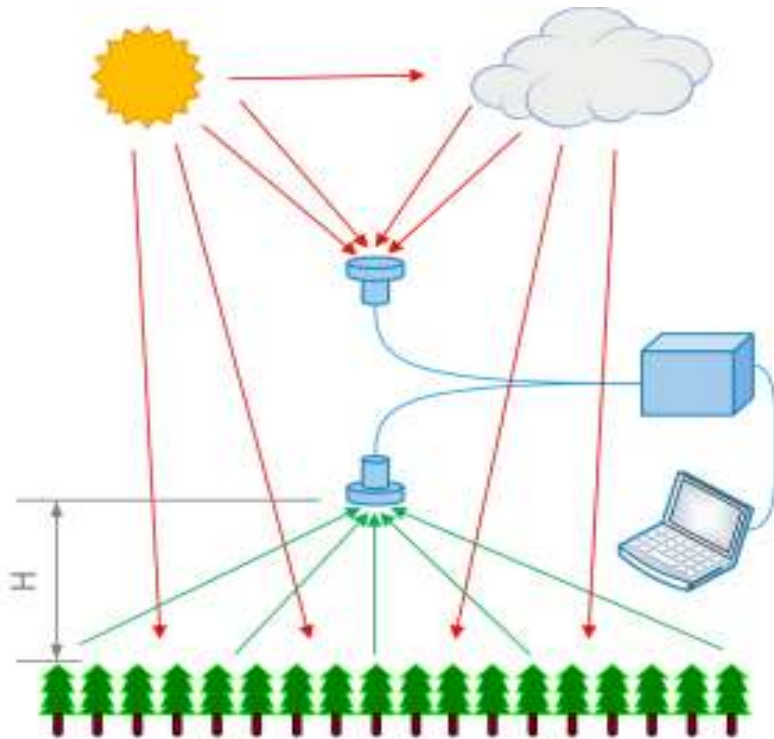
Grass



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4. Current status of ChinaSpec

Footprint and equivalent radiance transfer path(ERTW)



Bihemishperic measurement: 90% of the total radiation contribution comes from the FOV within 72° can cover 75.68% of the source area of flux measurement under convective condition with weak wind. ERTW is 2 times of tower height.

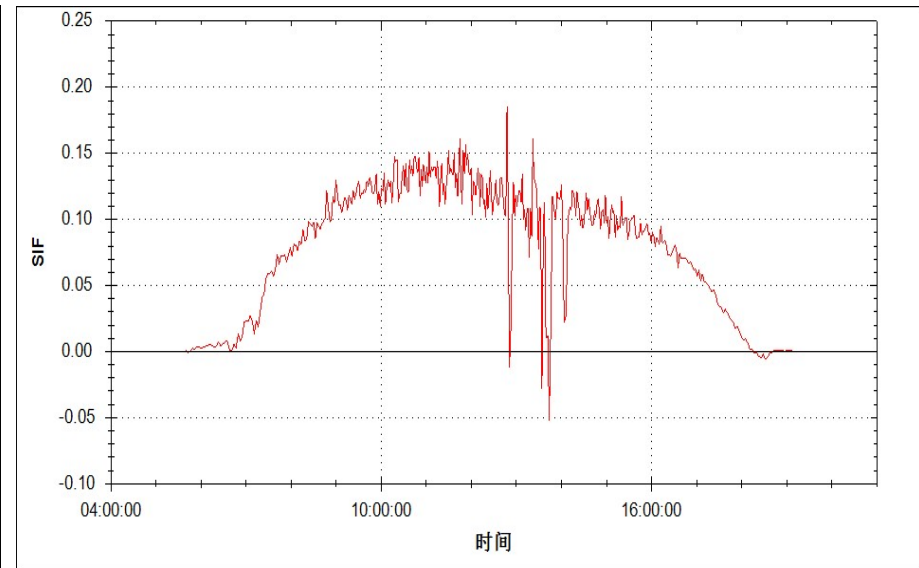
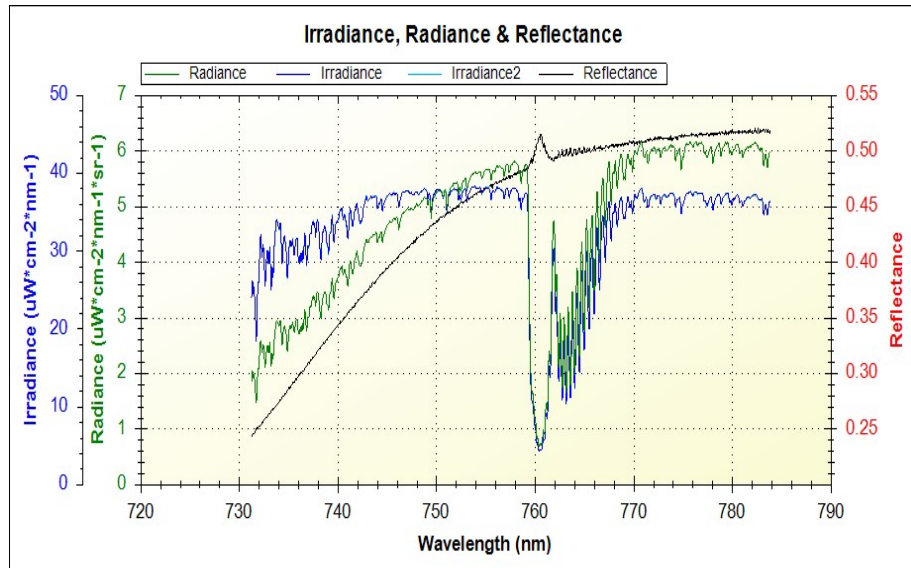
Hemishpere-conical measurement: only cover 1.93% of the flux footprint, ERWT is the tower height.

Liu, X., Liu, L., Hu, J., & Du, S. (2017). Modeling the Footprint and Equivalent Radiance Transfer Path Length for Tower-Based Hemispherical Observations of Chlorophyll Fluorescence. *Sensors*, 17(5), 1131.

4. Current status of ChinaSpec

Some examples

Shangqiu: Corn on Aug. 10, 2017



Clear peak apparent reflectance
at 760 nm

Diurnal cycle of SIF

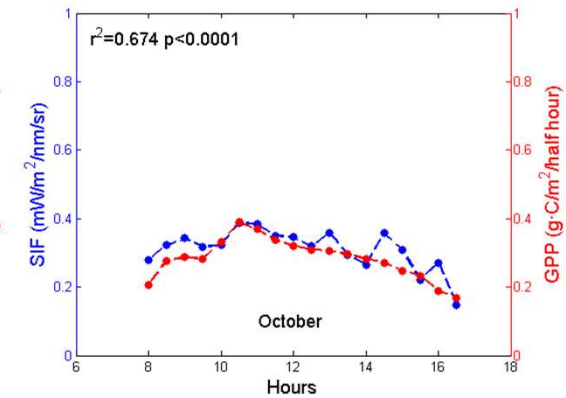
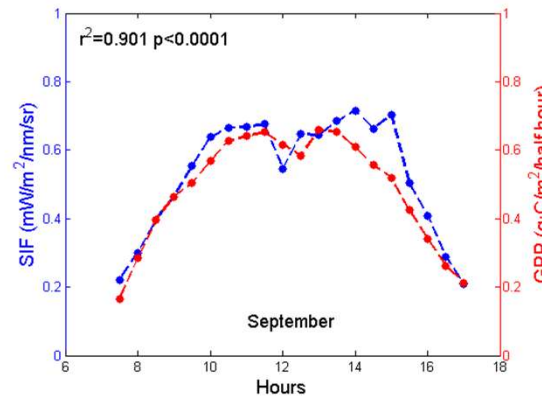
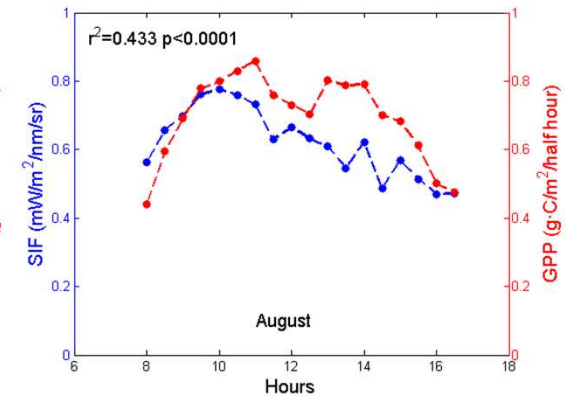
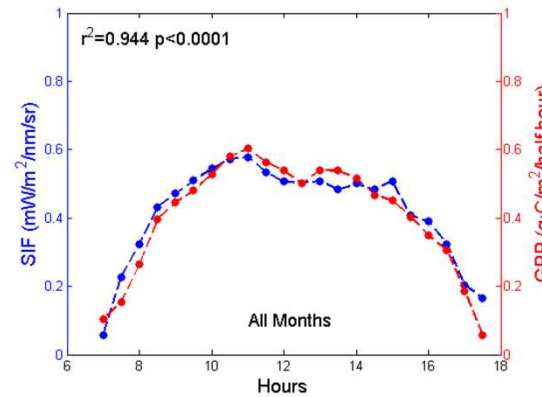


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4. Current status of ChinaSpec

Some examples

Diurnal cycle of SIF and GPP at the rice paddy field, Jurong



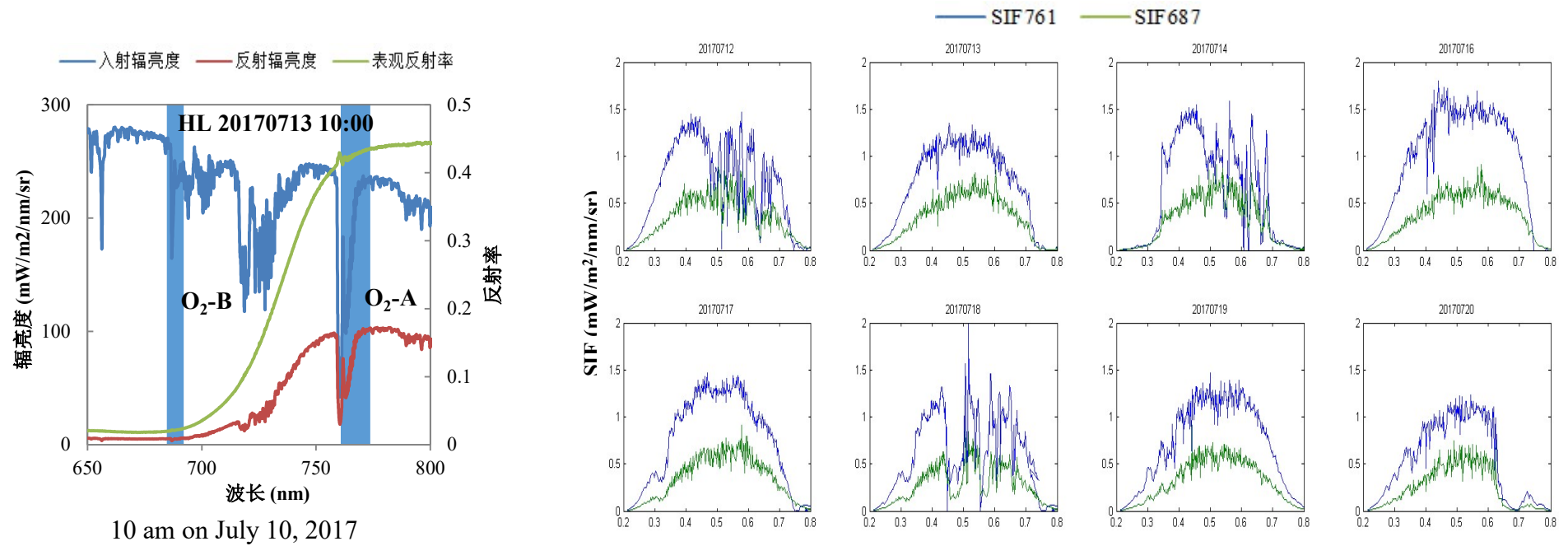
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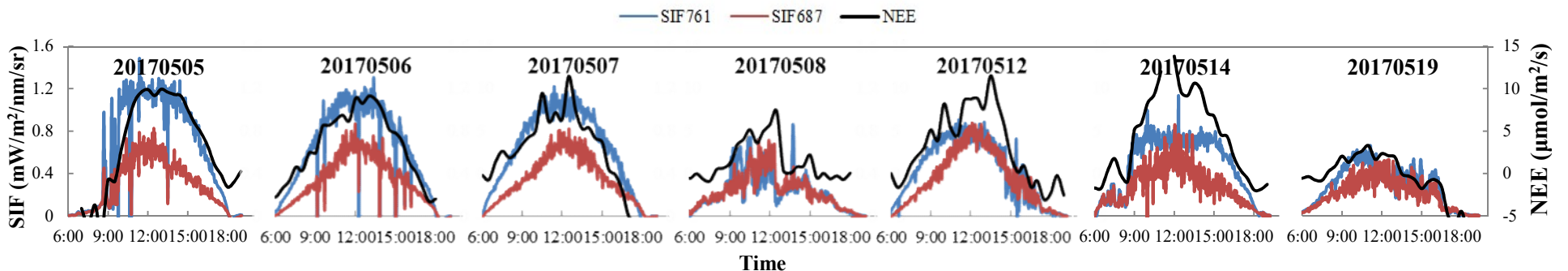
4. Current status of ChinaSpec

Some examples

Huailai: **Corn**



Daily SIF for both red and far-red bands



Xitangshan: **diurnal SIF vs NEE for wheat**

4. Current status of ChinaSpec

Some examples

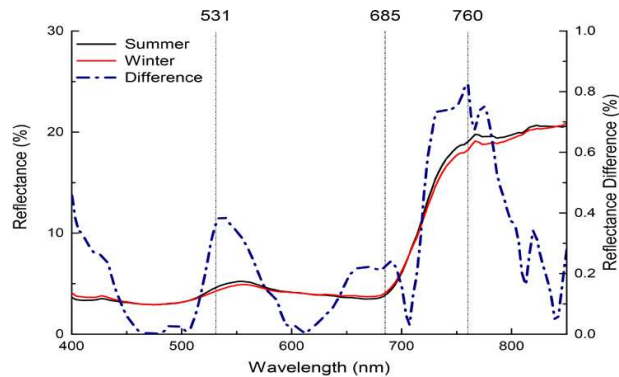


Fig. 1 Canopy reflectance spectra in Dinghu Mountain, Guangdong Province, China, at 12 o'clock in winter (red line, December 18, 2014) and summer (black line, July 23, 2014). Difference spectrum between winter and summer canopy reflectance measurements showing three peaks at 531nm, 685nm and 760nm.

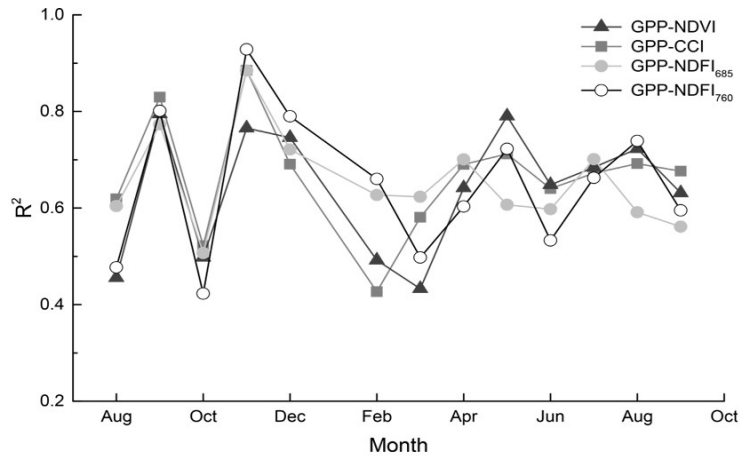
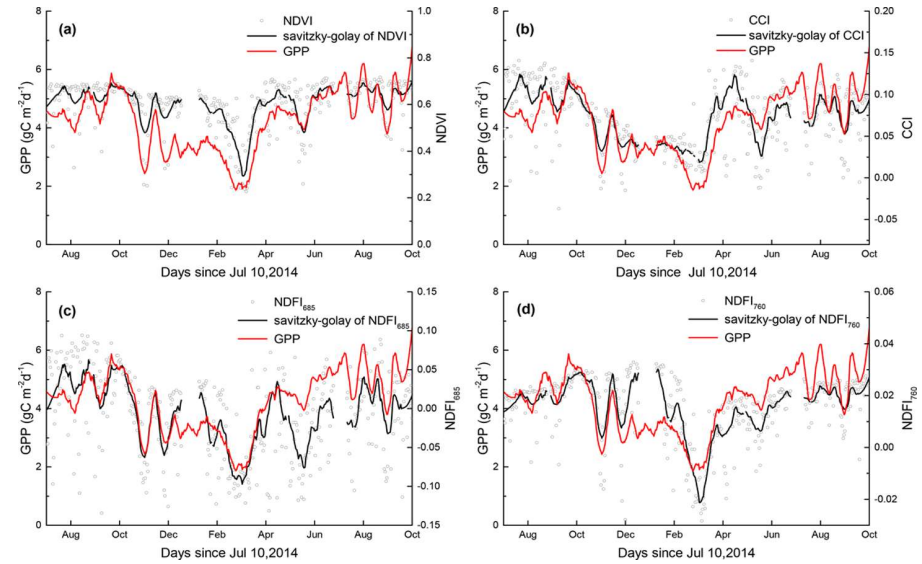


Fig.5 Correlation of NDVI, CCI, NDFI₆₈₅ and NDFI₇₆₀ with GPP monthly (from Jul 2014 to Sep 2015)

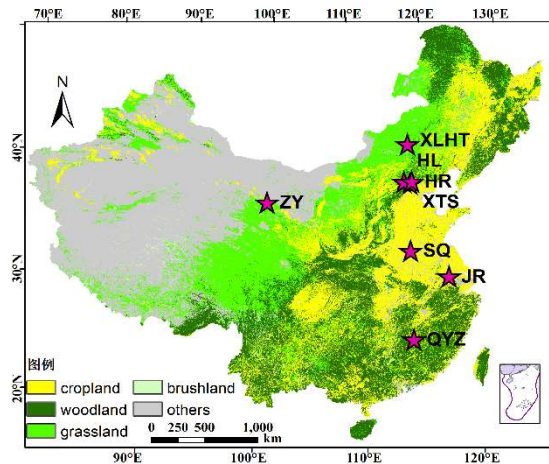


The flux site of Dinghushan

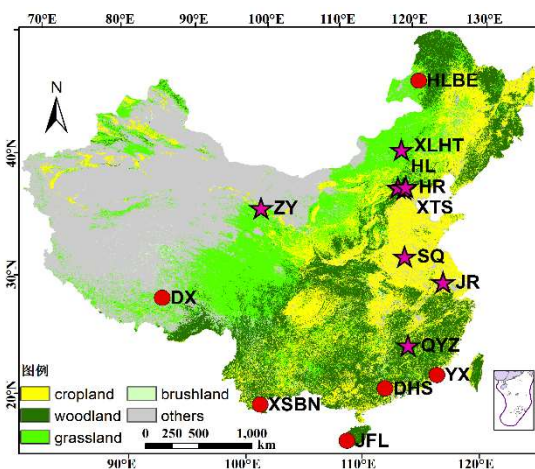
5. Future directions

Future plan

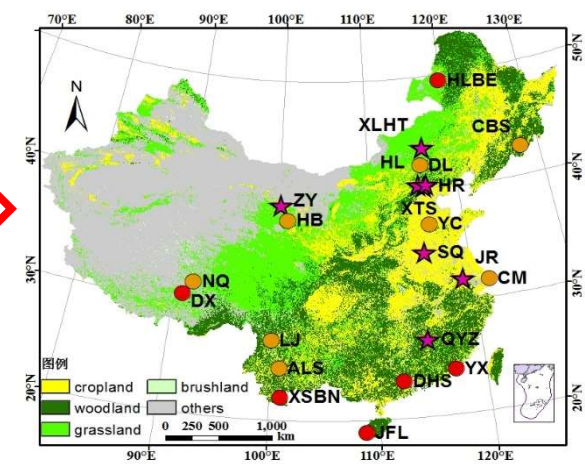
Stage 1:
2016-2017



Stage 2:
2017-2018



stage 3:
> 2018



- Based on ChinaFlux, SIFspec system will be installed more sites to expand ChinaSpec.
- We invite the PIs of flux sites to install the system to measure SIF and flux together.



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5. Future directions

Website is on the way...

The screenshot shows a web browser window displaying the CHINASPEC website. The browser title is "China ecosystem spectral observation network - Mozilla Firefox". The address bar shows the URL "221.226.218.150:1020/observation_station.html". The website header includes the CHINASPEC logo and the text "中国生态系统光谱观测研究网络". A navigation menu contains links for HOME, INFORMATION, OBSERVATION SITE, RESEARCH TRENDS, DATA DOWNLOAD, and CONTACT US. The main content area is titled "Observation Site" and includes a breadcrumb trail "Location: Home > Observation Site". Below this, there is an "Explain" section with two numbered points: "1.Data sources seeData Management Policy" and "2.click on the station to check the details of the site information". To the right of the text are two buttons labeled "List" and "Map". The "Map" button is highlighted. Below the text is a satellite map of China with several red location markers. The map interface includes a search bar at the top left with the text "地图 混合 卡拉干达".

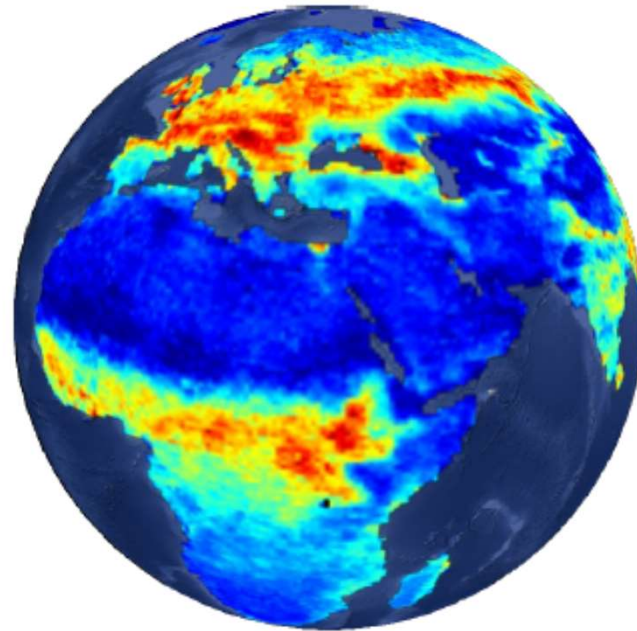
5. Future directions

The spectrum data will be publicly available

The screenshot shows the CHINASPEC website's 'Data Download' page. The page header includes the CHINASPEC logo and navigation menu. The main content area displays a table of observation sites. The table has the following columns: #, Subordinate System, Site Name, Province, City, longitude, and latitude. The table contains 10 rows of data. Below the table, there are 'Previous Page' and 'Next Page' buttons, with '1' indicating the current page.

#	Subordinate System	Site Name	Province	City	longitude	latitude
39	草地生态系统	呼伦贝尔站	内蒙古自治区	内蒙古	119.933	49.333
70	农田生态系统	句容农田生态系统	江苏省	镇江市	119.21726	31.8068
71	森林生态系统	千烟洲人工林通量观测站	江西省	吉安市	115.03292	26.44291
72	农田生态系统	商丘农田生态系统观测站	河南省	商丘市	115.5753	34.587
73	草地生态系统	锡林郭勒温性典型草原通量观测站	内蒙古自治区	锡林郭勒盟	116.6667	43.53333
74	农田生态系统	黑河农田生态系统观测站	甘肃省	张掖市	100.4069	38.8581
75	农田生态系统	怀来农田生态系统	河北省	张家口市	115.7833	40.3489
76	农田生态系统	小汤山农田生态系统观测站	北京市	昌平区	116.4433	40.1789
77	农田生态系统	怀柔森林生态系统观测站	北京市	怀柔区	116.6320	40.3163

Sun induced chlorophyll fluorescence is the future of vegetation remote sensing!



Thank you for your attention !

