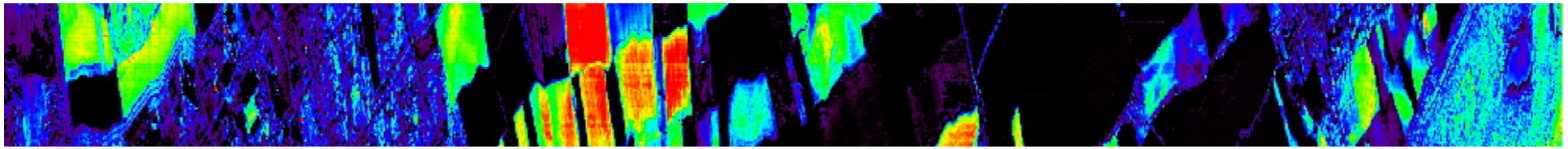

ChinaSpec: a network of spectral measurements to bridge flux measurements and remote sensing data

Shaoqiang Wang[1], Yongguang Zhang[2], Liangyun Liu[3], Weimin Ju[2], Guirui Yu[1], Zhigang Liu[3], Leigang Sun[4], Xudong Zhu[5], …

1. Institute of Geographical Sciences and Natural Resources Research, Chinese Academy of Sciences
2. International Institute of Earth System Science, Nanjing University
3. Institute of Remote Sensing and Digital Earth, Chinese Academy of Sciences
4. Remote Sensing College, Beijing Normal University
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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

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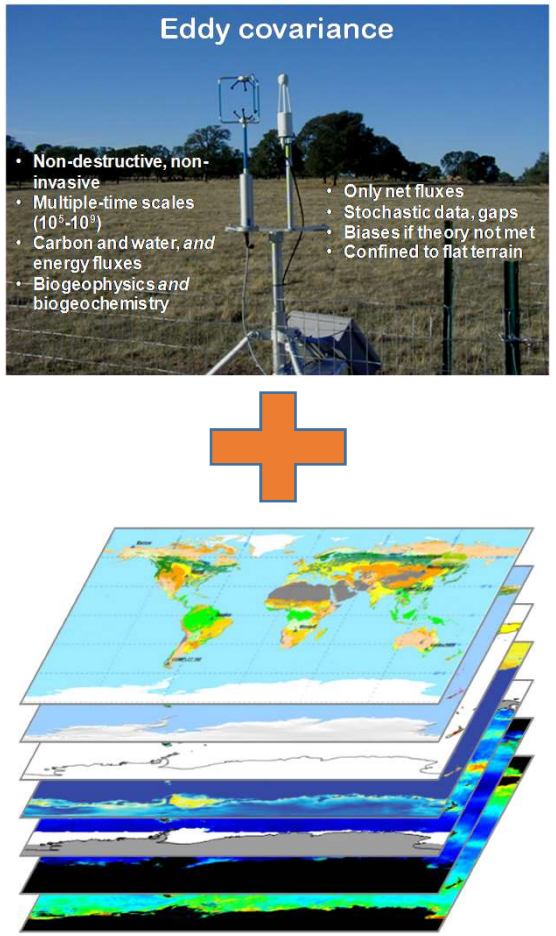
The problem

- 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



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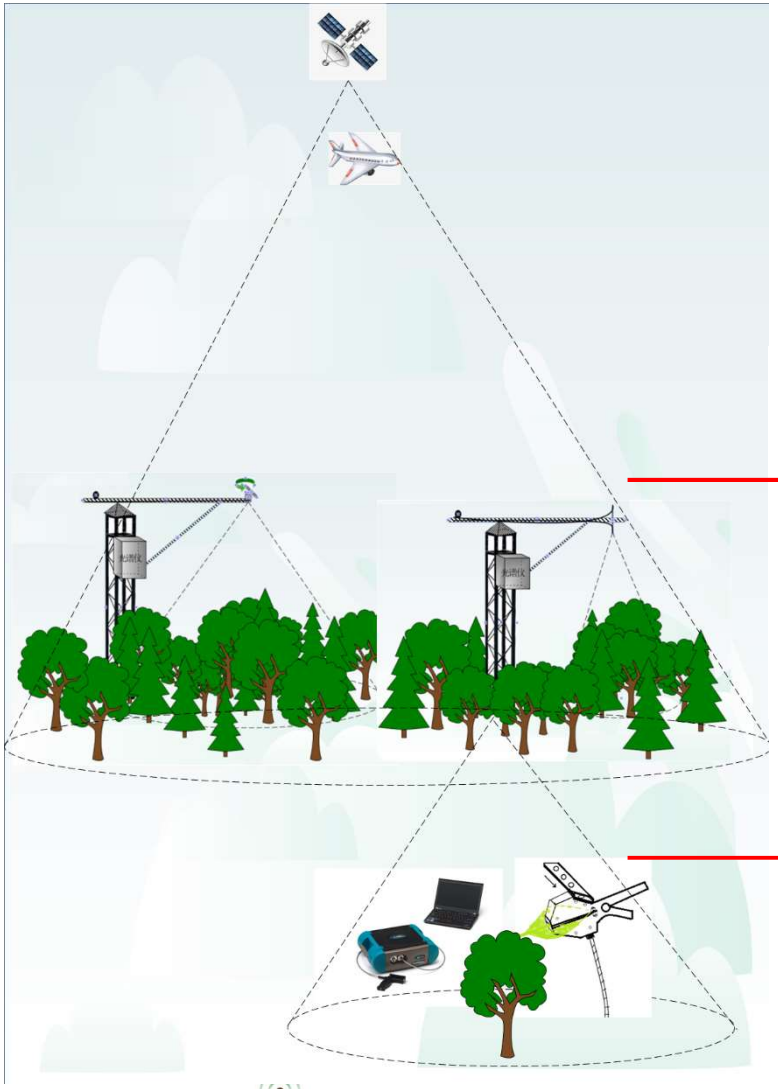
1. Background

Satellite spectrum

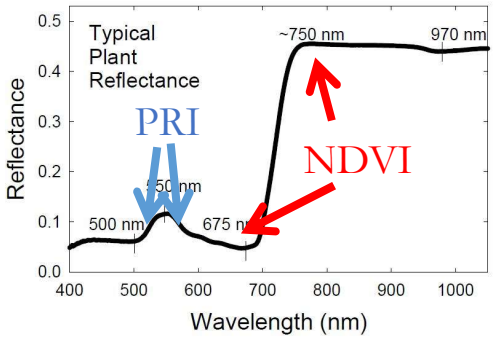
Canopy spectrum

Leaf spectrum

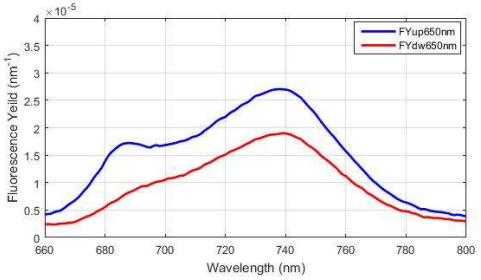


Optical spectrum as proxy of vegetation information

Canopy reflecatnce



Leaf chlorophyll fluorescence



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2. The need to combine optical & flux measurements

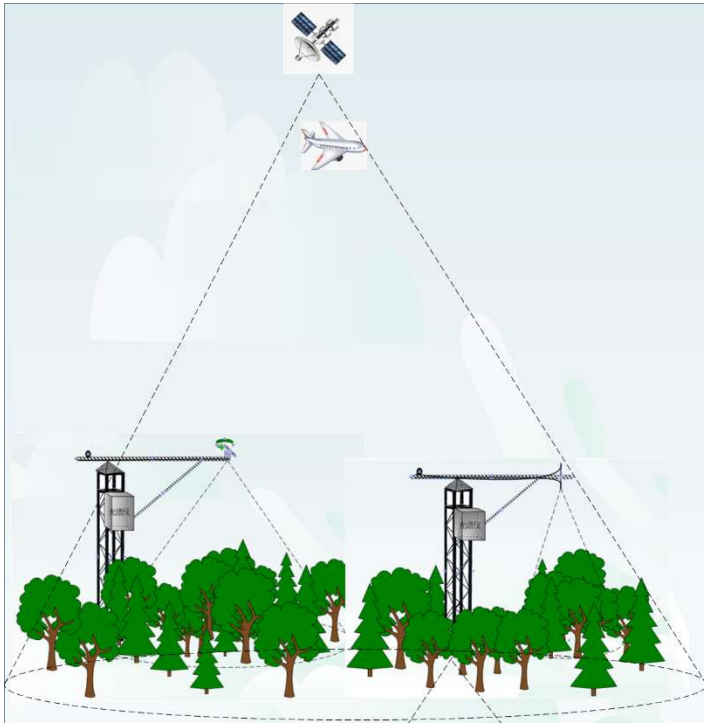
Linking Remote Sensing to Fluxes

Challenge:

Integrating spatial and temporal domains

Solution:

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



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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."

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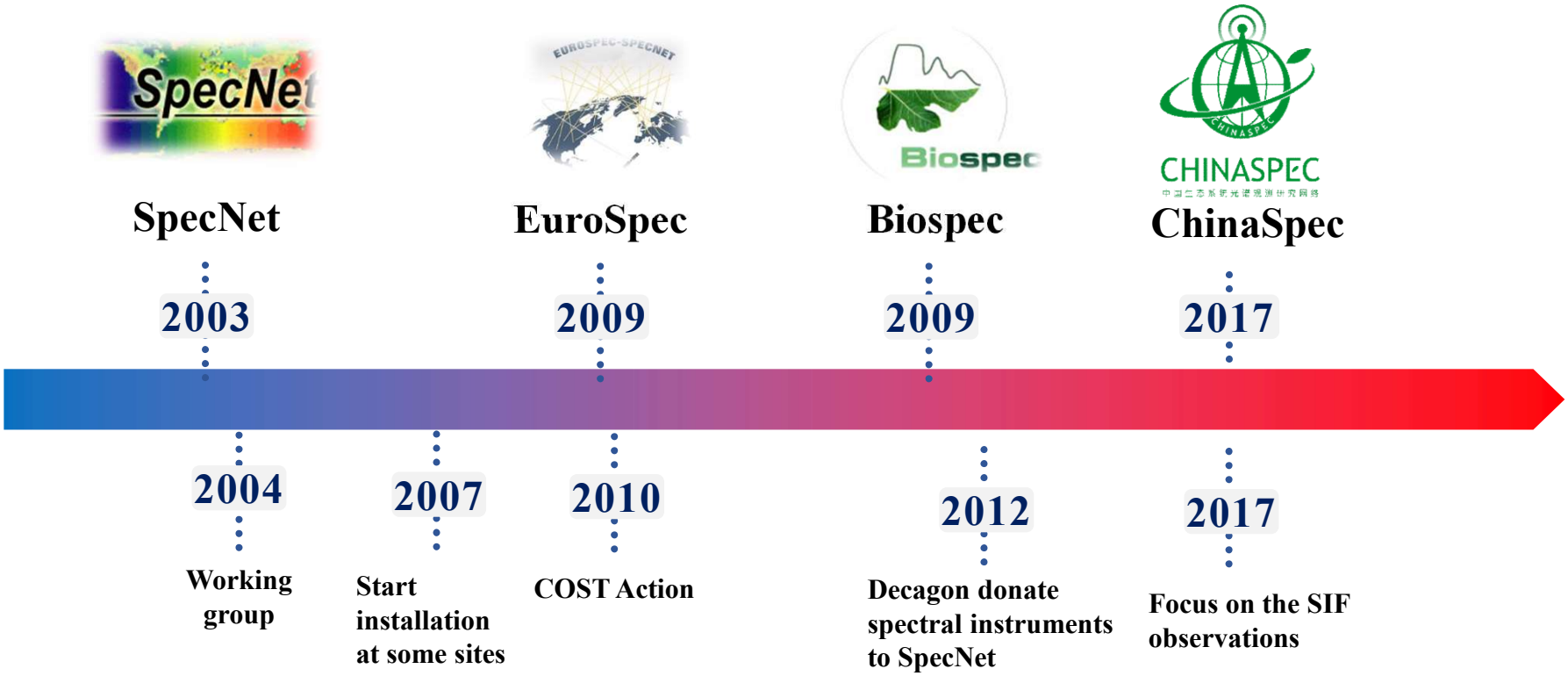
3. International spec network

Current status on the spec network internationally



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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

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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

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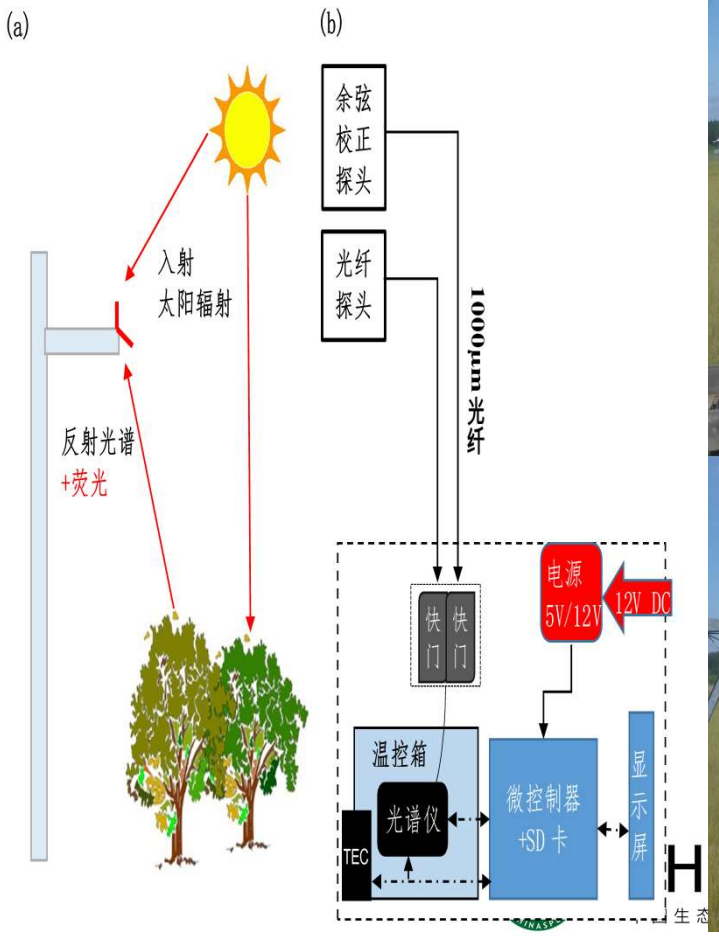
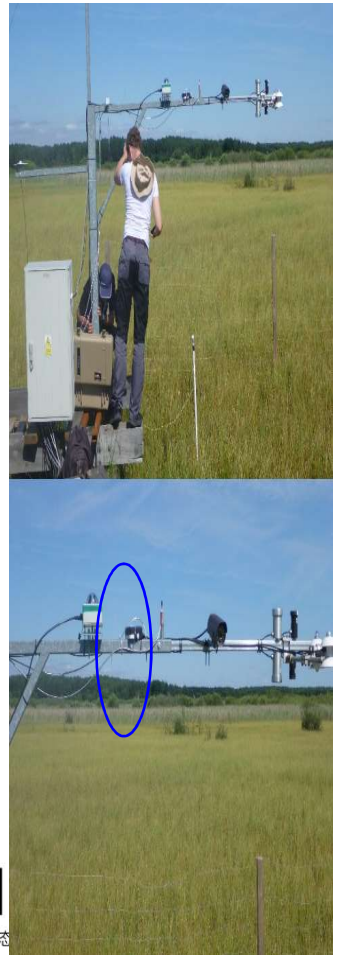
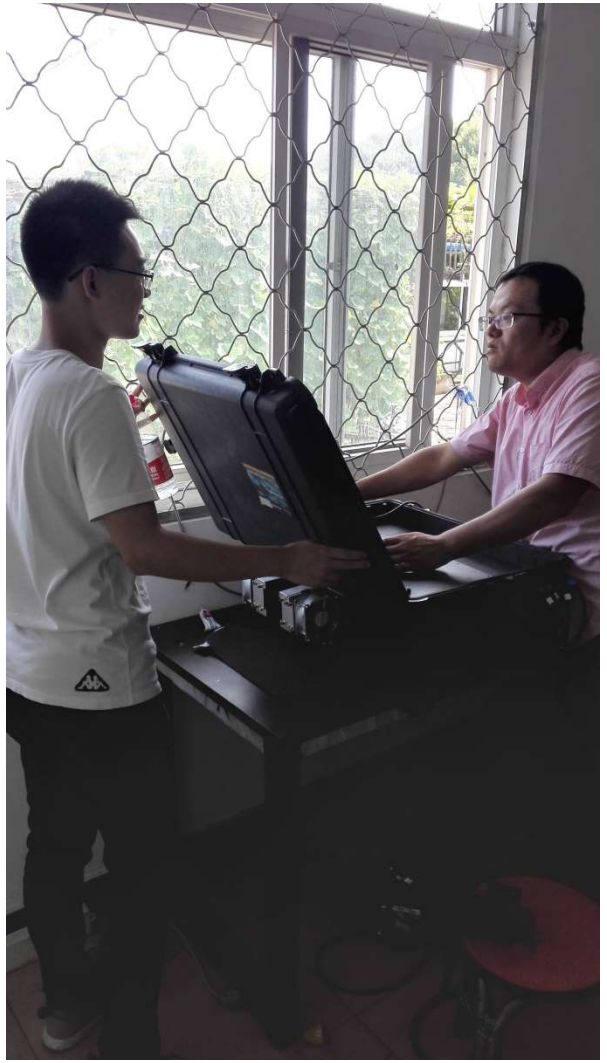
4. Current status of ChinaSpec

Instruments

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







4. Current status of ChinaSpec

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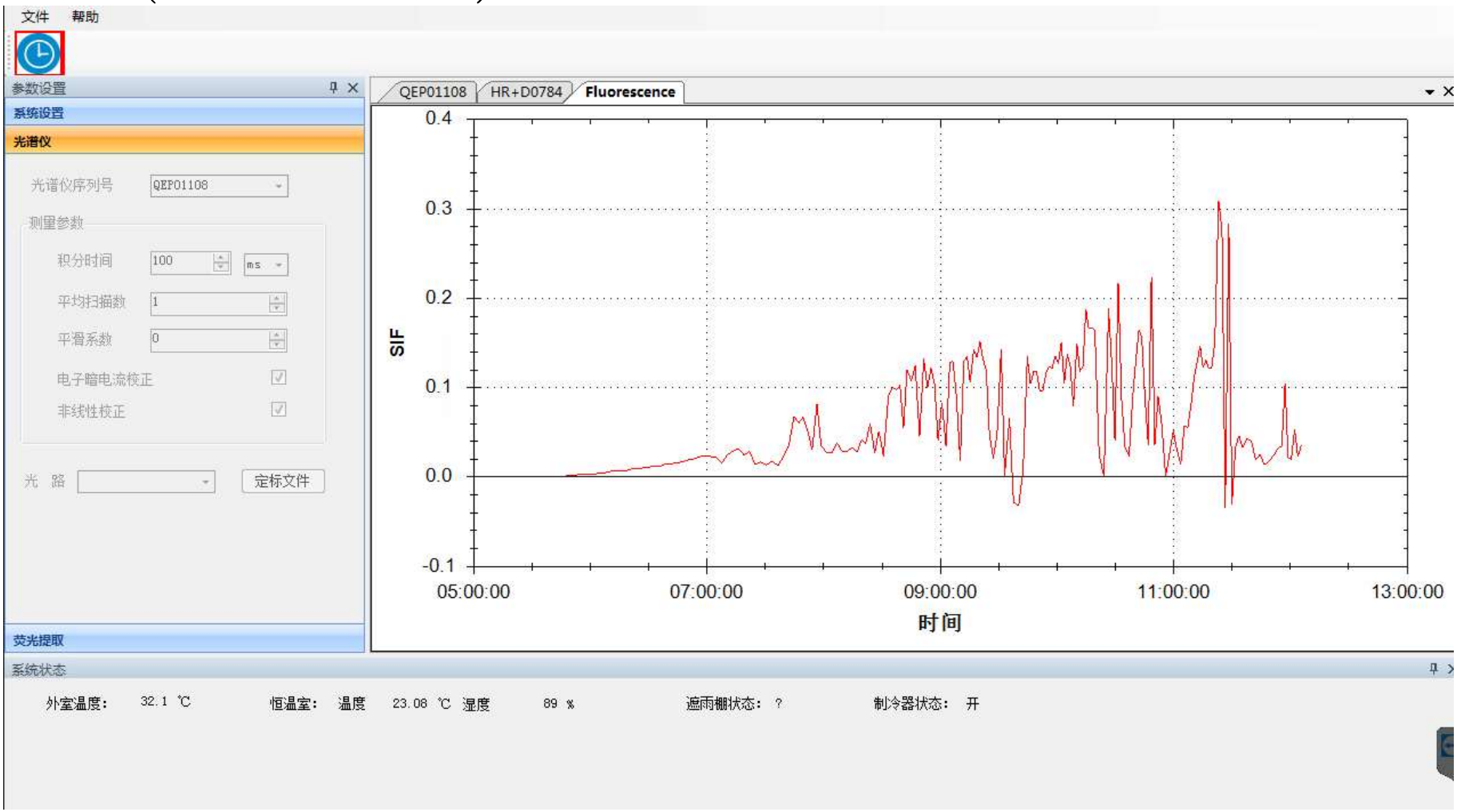
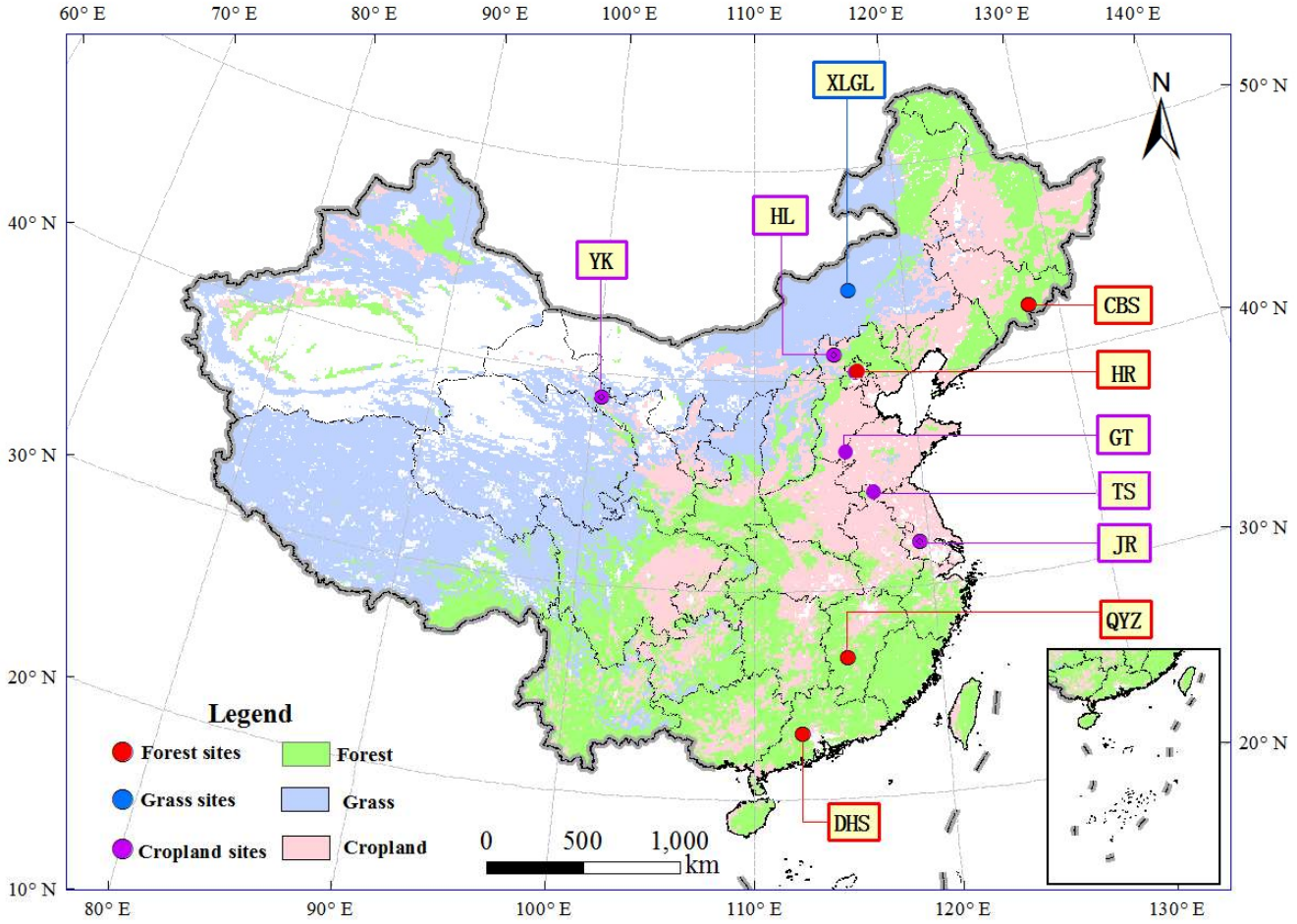


4. Current status of ChinaSpec

Site Installation



Since 2014

SIFspec installed at 8 flux sites

2 forest sites,

1 grassland site,

5 cropland sites

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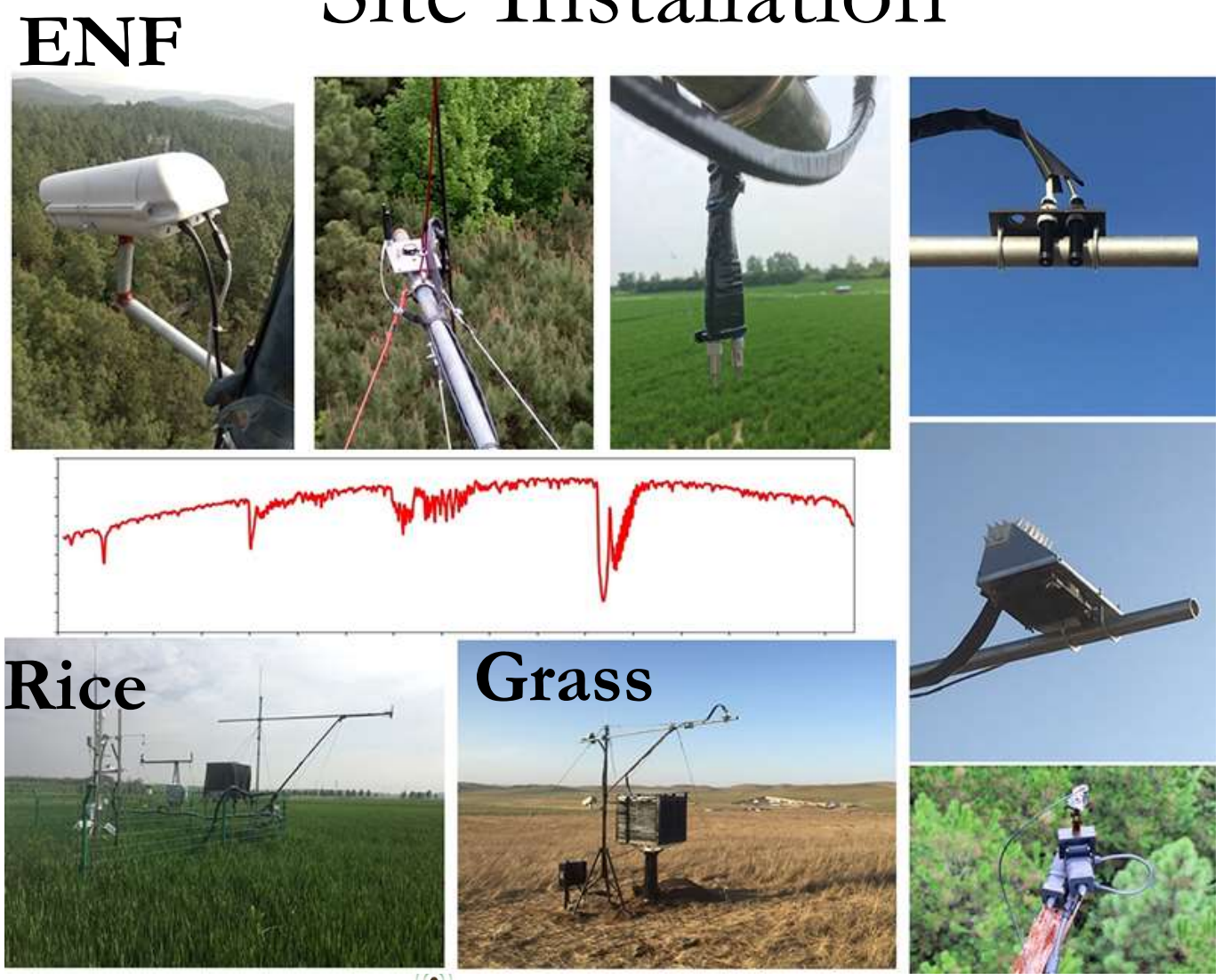
4. Current status of ChinaSpec

Site Installation



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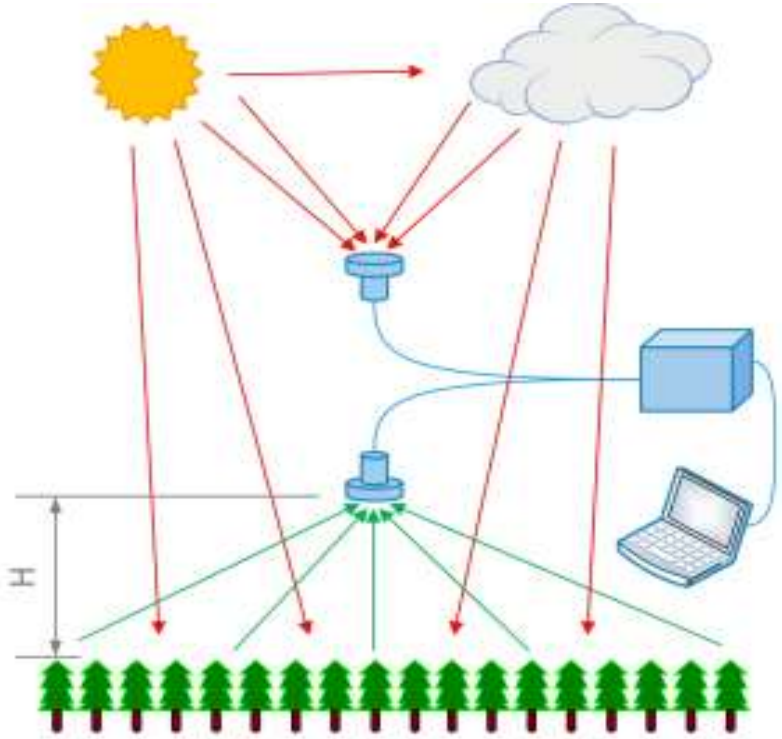
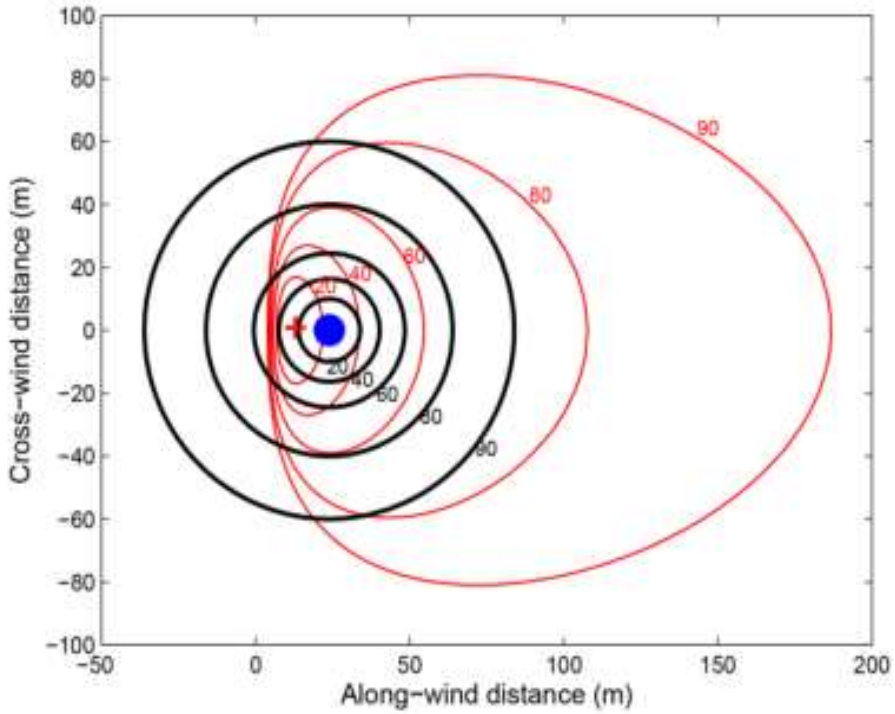
4. Current status of ChinaSpec

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.

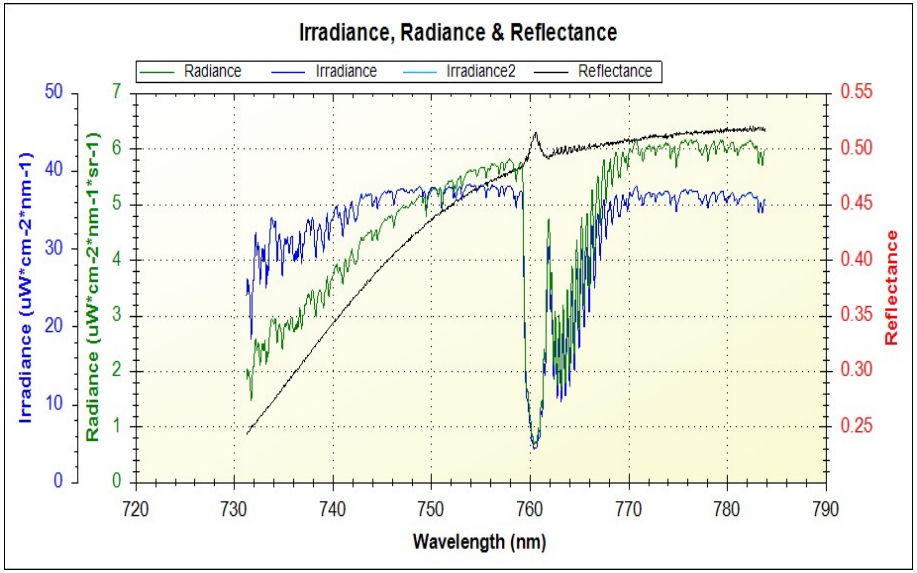
Hemishpere-conical measurement: only cover 1.93% of the flux footprint, ERWT is the tower height.

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.

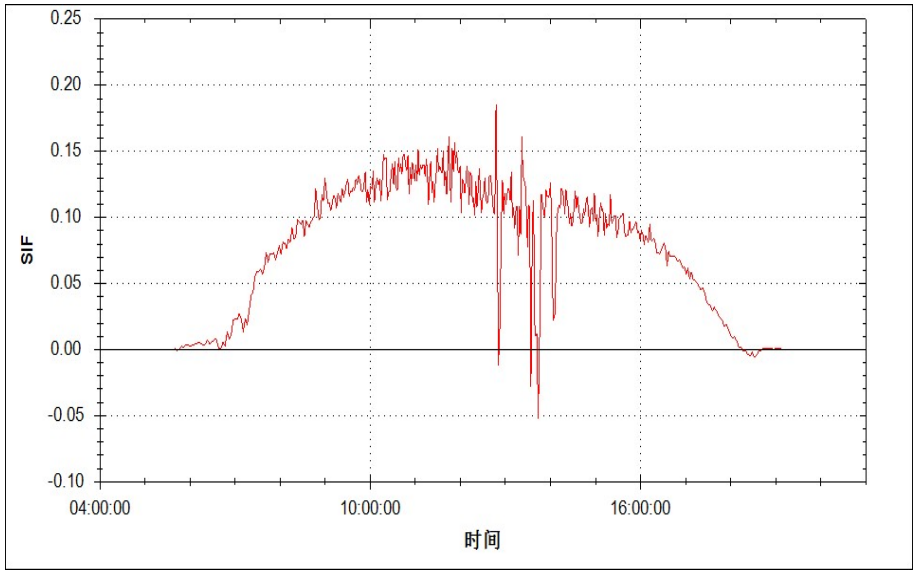
4. Current status of ChinaSpec

Some examples

Shangqiu: Corn on Aug. 10, 2017



Clear peak apparent reflectance at 760 nm



Diurnal cycle of SIF

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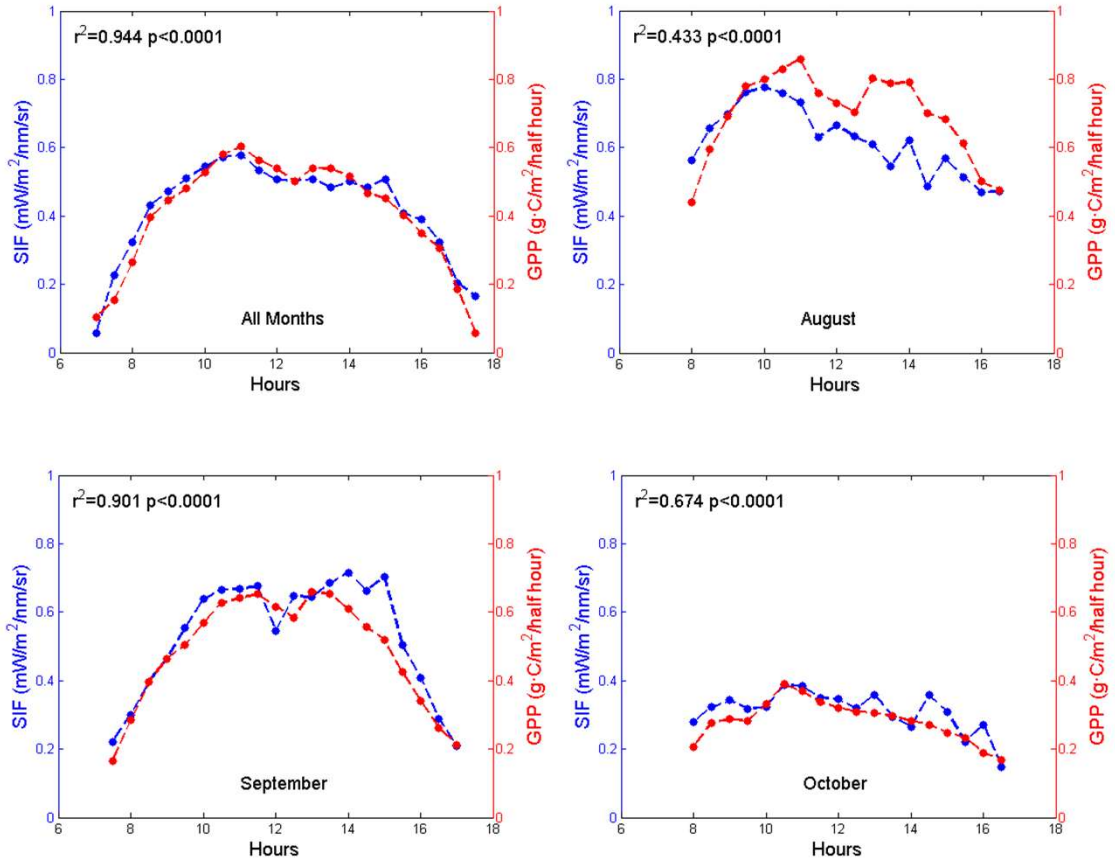
4. Current status of ChinaSpec

Some examples

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



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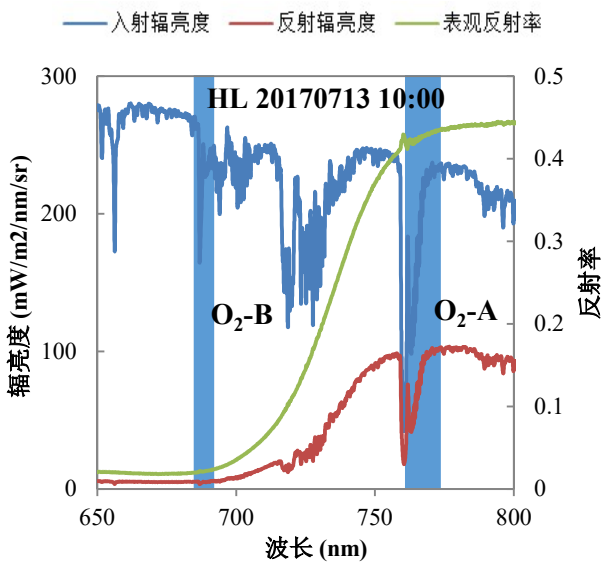
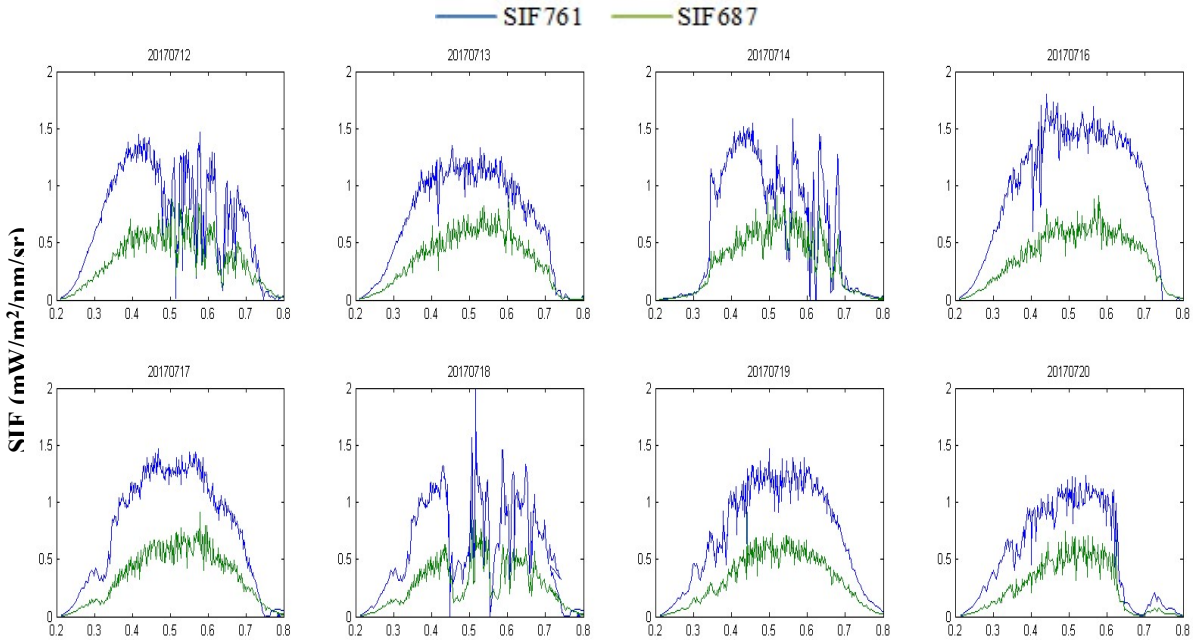
4. Current status of ChinaSpec

Some examples

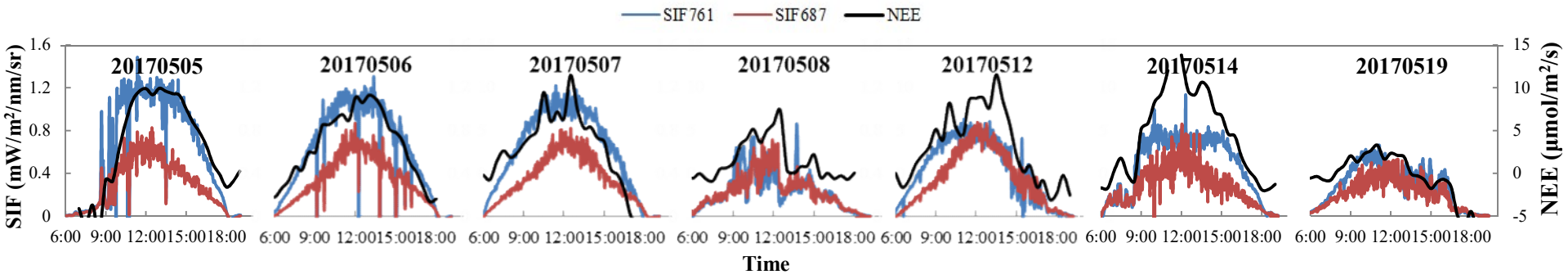
Huailai: Corn



10 am on July 10, 2017



Daily SIF for both red and far-red bands



Xitangshan: diurnal SIF vs NEE for wheat

4. Current status of ChinaSpec

Some examples

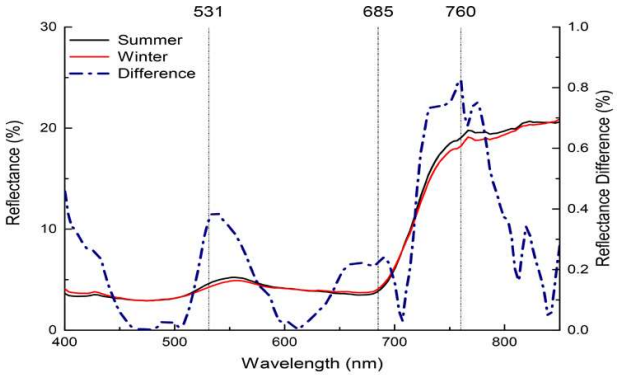


Fig. 1 Canopy reflectance spectra in Dinghu Mountain, Guangdong Province, China, at 12 o'clock in winter (red line, December 18, 2014) and summer (black line, July 23, 2014). Difference spectrum between winter and summer can opy reflectance measurements showing three peaks at 531nm, 685nm and 760nm.

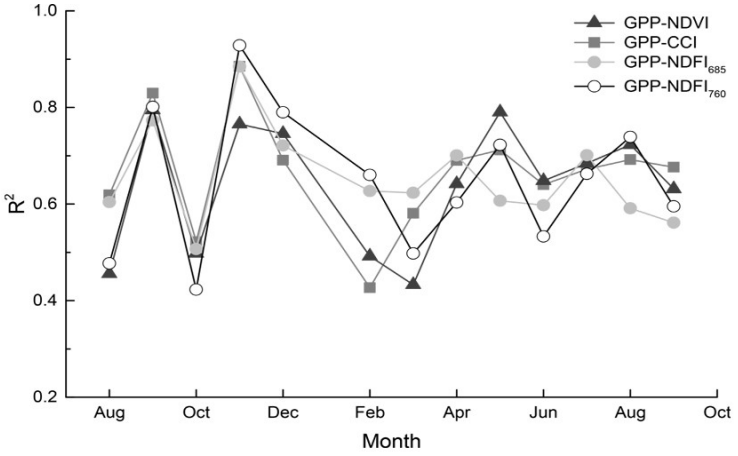
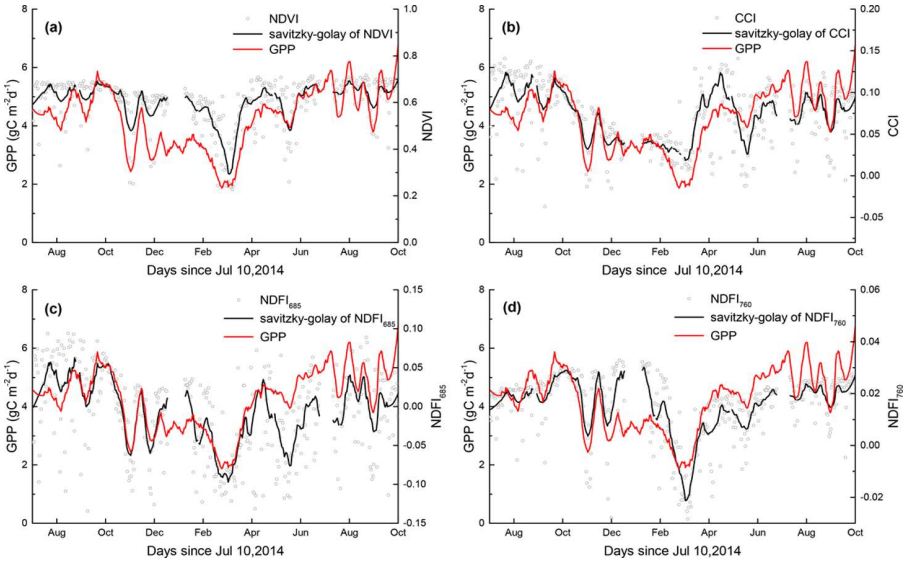


Fig.5 Correlation of NDVI, CCI, $NDFI_{685}$ and $NDFI_{760}$ with GPP monthly（from Jul 2014 to Sep 2015）

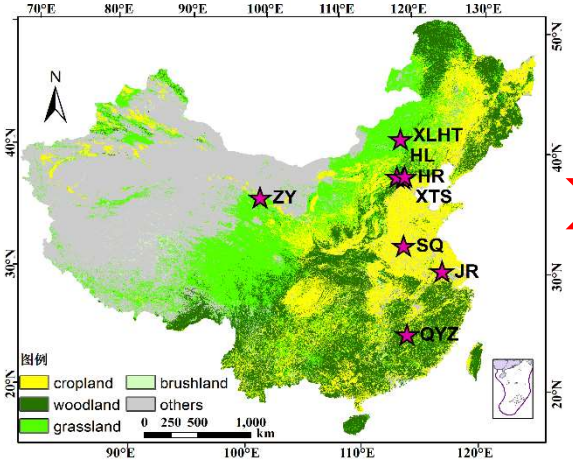


The flux site of Dinghushan

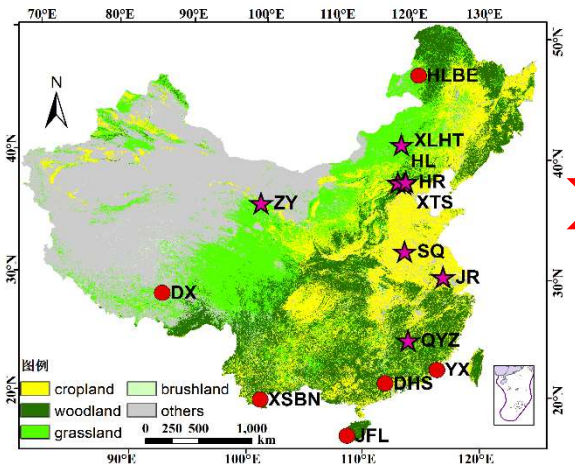
5. Future directions

Future plan

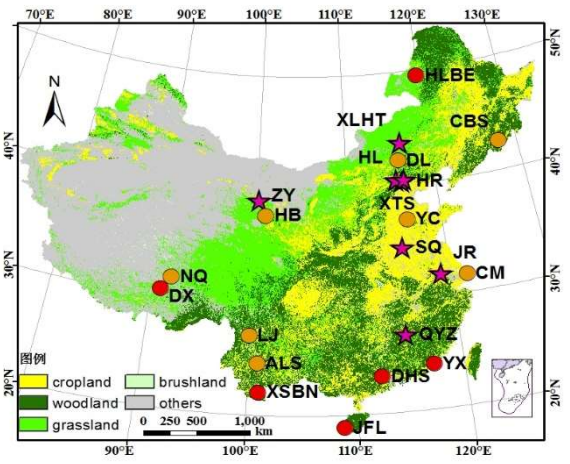
Stage 1:
2016-2017



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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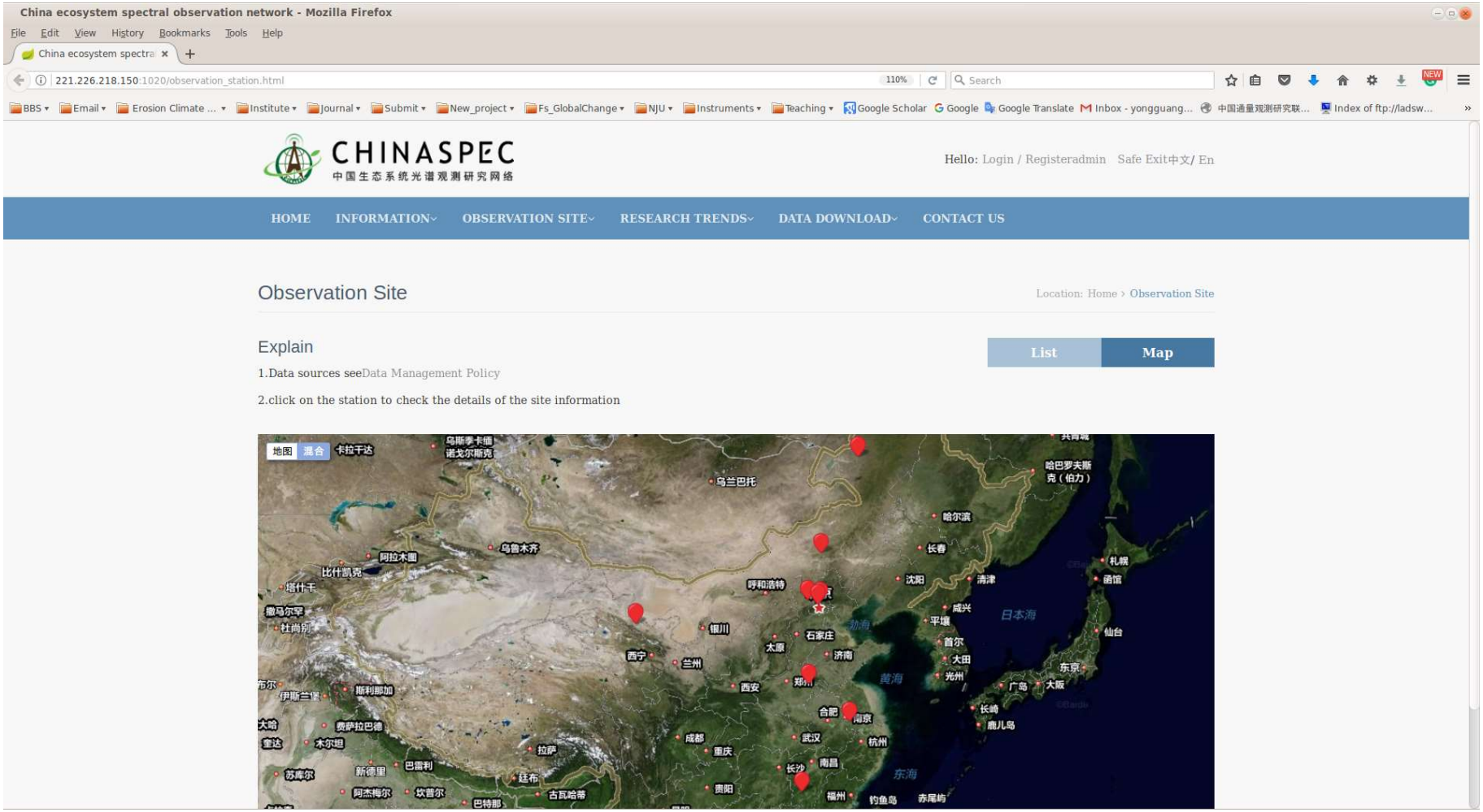
5. Future directions

Website is on the way…



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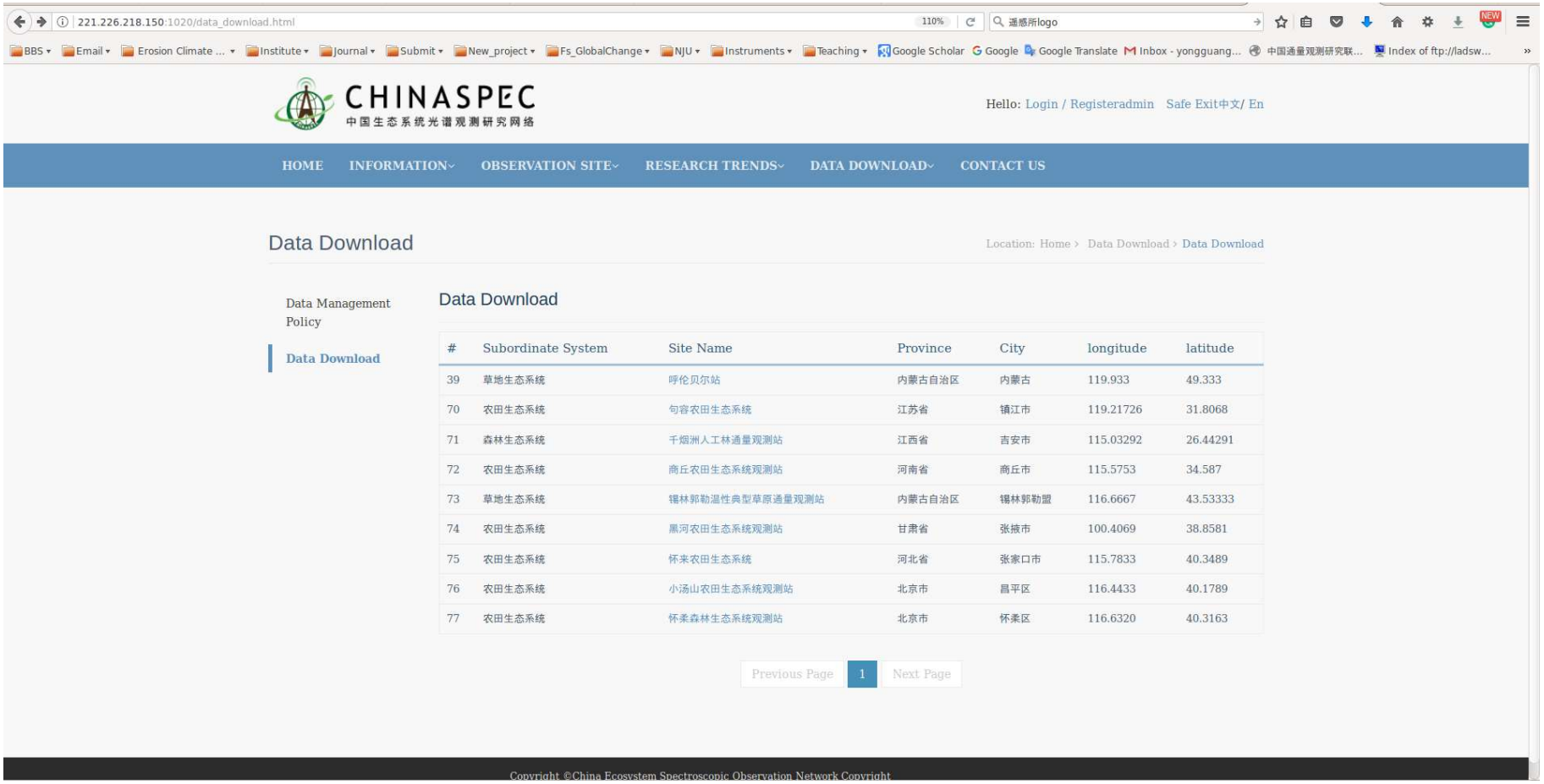
5. Future directions

The spectrum data will be publicly available



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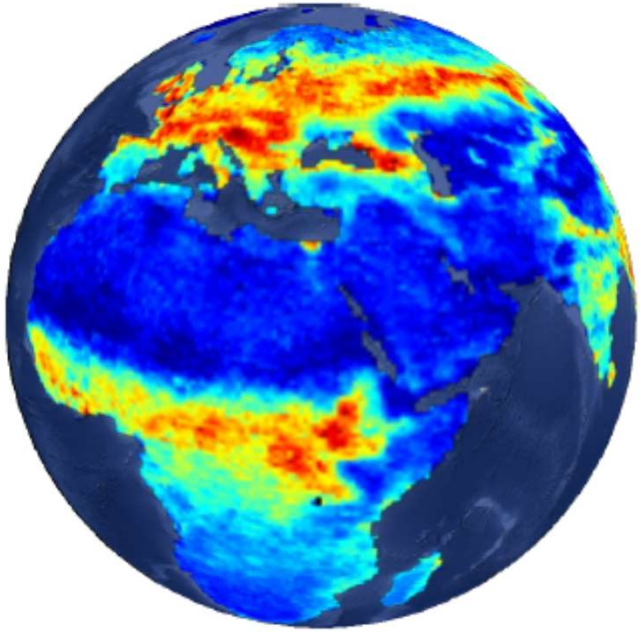
Sun induced chlorophyll fluorescence is the future of vegetation remote sensing!



Thank you for your attention !