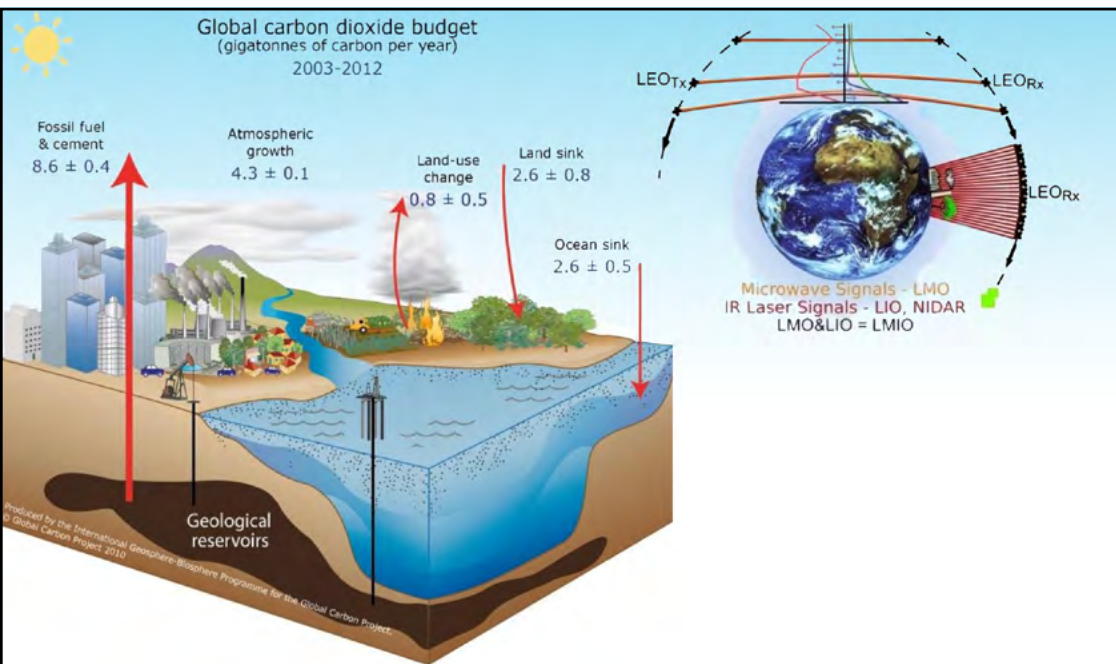


# EXPLORING GREENHOUSE GASES, WATER AND CLIMATE CHANGES BY LEO-LEO OCCULTATION

July 24-26, 2019



FORUM  
HANDBOOK

## CONTENTS

<b>ABOUT ISSI-BJ</b>	<b>3</b>
<b>ORGANIZERS</b>	<b>4</b>
Conveners	4
Sponsors	4
<b>FORUM OUTLINE AND PROGRAM</b>	<b>5</b>
Context and Objectives of the Forum	5
Main Themes of the Forum	6
Program	7
<b>PRACTICAL INFORMATION</b>	<b>10</b>
Venue	10
WIFI Access	10
Accommodation	11
Lunch	12
Coffee Breaks	12
Useful information	12
Emergency Contact Person in China	12
ISSI-BJ Dinner Location	13
CACES Dinner Location	14
<b>PARTICIPANTS</b>	<b>15</b>
<b>NOTES</b>	<b>17</b>

## ABOUT ISSI-BJ

The International Space Science Institute in Beijing (ISSI-BJ) was jointly established by the National Space Science Center (NSSC) and the International Space Science Institute (ISSI) with the support of the International Cooperation Bureau and the Space Science Strategic Project of the Chinese Academy of Sciences (CAS). ISSI-BJ is a close cooperation partner of ISSI in Bern. The two institutes share the same Scientific Program Committee, the same study tools, and other information of mutual relevance and interest. However, both use independent operational methods and different funding sources.

**ISSI-BJ is a non-profit research institute.** Our main mission is to **contribute to the achievement**

**of a deeper scientific and technological understanding of future space missions** as well as of the **scientific results** from current and past missions through **multidisciplinary research**, possibly involving, whenever felt appropriate, ground based observations, modelling, numerical simulation and laboratory experiments, using the same tools as ISSI, i.e. **Forums, International Teams, Workshops, Working Groups or individual Visiting Scientists.**

The Program of ISSI-BJ covers a widespread spectrum of space science disciplines, including astrophysics, solar and space physics, planetary science, astrobiology, microgravity science and Earth observation from space.

## ORGANIZERS

The Forum on “Exploring greenhouse gases, water and climate changes by LEO-LEO occultation” is organized by the International Space Science Institute - Beijing (ISSI-BJ).

### CONVENERS

- Maurizio Falanga, ISSI-BJ, China
- Quanlin Fan, NSSC, CAS, China
- Gottfried Kirchengast, WEGC, University of Graz, Austria
- Congliang Liu, NSSC, CAS, China
- Armin Loescher, ESA Future Missions & Instruments Division, The Netherlands
- Daren Lv, IAP, CAS, China
- Yueqiang Sun, NSSC, CAS, China
- Stig Syndergaard, DMI Copenhagen, Denmark
- Xin Wang, IAP, CAS, China

### SPONSORS



## FORUM OUTLINE AND PROGRAM

### CONTEXT AND OBJECTIVES OF THE FORUM

The atmospheric thermodynamic state variables (i.e., temperature, pressure, humidity, etc.) and greenhouse gases are essential climate variables (ECVs) and significant in physical/chemical processes of the atmosphere, which play very important roles in the earth system, ecosystem and human society. The responses and feedback of these ECVs to global change are one of the key questions in the earth science. However, the existing ground-based and satellite observations are still far from enough to function properly in atmospheric physics and global climate change research that requires long-term stable, global coverage, high spatial resolution and simultaneous measurement of these ECVs, to deliver atmosphere and climate benchmark data. The benchmark observations also helpful to understand the exchanges among the atmospheric water vapor, ice liquid water and ice crystals, under strong convection conditions.

The GNSS radio occultation (RO) has become a major method to observe the atmospheric

thermodynamic state variables, which demonstrated the occultation observations have the atmosphere and climate benchmark data features. However, the GNSS RO has temperature and humidity temperature-humidity ambiguity problem. Fortunately, as an advanced technique microwave occultation-using centimeter and millimeter wave signals between low Earth orbit satellites (LEO-LEO microwave occultation, LMO) can exploit both the refraction and absorption of the signals to solve the temperature-humidity ambiguity in the troposphere. Thus LMO enables to retrieve pressure, temperature, and humidity profiles without background information. Liquid water and rain rate profiles as well as turbulence and complementary 3D cloud information can be co-observed.

Additionally, the LEO-LEO infrared-laser occultation (LIO), using laser signals in the short-wave infrared band 2–2.5  $\mu\text{m}$  between LEO satellites, has been designed to accurately observe key trace gas species for chemistry and climate (i.e., greenhouse gases H<sub>2</sub>O, CO<sub>2</sub>,

CH<sub>4</sub>, N<sub>2</sub>O, O<sub>3</sub>, CO, etc.), line-of-sight wind speed, and also profiles of cloud layers and aerosols as by-products. LIO observes the absorption of the signals to retrieve volume mixing ratio (VMR) profiles of the greenhouse gases. In order to mitigate the effects of foreign species absorption, aerosol extinction, scintillation, and scattering on the retrieved trace species profiles, LIO uses the differential transmission principle between carefully selected pairs of absorption signals and reference signals. This enables accurate retrieval of the pure absorption profile due to the target species and hence accurate greenhouse gas profiles.

In the last decade, ESA and NASA have proposed several LMO and LIO missions for atmosphere and climate change, and done many pre-studies. In China,

an Climate and Atmospheric Components Exploring Satellites (CACES) mission concept has been proposed to the Strategic Priority Research Program of Chinese Academy Science (SPRPCAS). A mission for benchmark monitoring of the Earth's atmospheric thermodynamic state variables, greenhouse gases and climate change by microwave and infrared-laser crosslink occultation and 3D clouds imaging from low Earth orbits.

The aims of this ISSI-BJ FORUM are to discuss 1) the key scientific questions of responses and feedbacks of ECVs physical/chemical processes to global change; 2) the scientific objectives and observation requirements of CACES mission; 3) the LMO/LIO techniques in terms of principles, algorithms and payloads

## MAIN THEMES OF THE FORUM

1. Fundamental science questions and scientific objectives of CACES mission
2. Scientific objectives of the LEO-LEO occultation mission-CACES
3. The overall design and key technologies of the CACES mission
4. International collaborations

PROGRAM

Wednesday, July 24

	Subject	Contributor
	<b>Introduction</b>	<b>Chair: L. En</b>
8:30-9:00	<i>Registration</i>	
9:00-9:10	Welcome and introduction to ISSI-BJ	A. Yang
9:10-9:30	Brief introduction to NSSC and China Space Science Missions	Q. Fan
<b>Session 1</b>	<b>Overview to LEO-LEO occultation technique and review previous studies</b>	<b>Chair: G. Kirchengast &amp; W. Bai</b>
9:30-10:00	The LEO-LEO occultation technique and overall research objectives	G. Kirchengast
10:00-10:30	Overview of LEO-LEO occultation preparatory studies in Europe/ESA	A. Löscher
10:30-11:00	<i>Coffee Break</i>	
11:00-11:30	Overview of LEO-LEO occultation research and studies in China	Y. Sun, Q. Du & C. Liu
11:30-12:00	Discussion	
12:00-14:00	<i>Lunch Break</i>	
<b>Session 2</b>	<b>Mission overviews and scientific challenges</b>	<b>Chair: K. Cahoy &amp; A. Löscher</b>
14:00-14:30	Climate and Atmospheric Components Exploring Satellites (CACES) mission concept	D. Lv
14:30-15:00	Current performance and future perspective of FY-3 satellites atmospheric sounding	Z. Yang
15:00-15:30	<i>Coffee Break and Group Photo</i>	
15:30-16:00	Challenges in monitoring of atmospheric profiles by using the LEO-LEO microwave technique	S. Syndergaard

**Wednesday, July 24**

	Subject	Contributor
16:00-16:20	Scientific challenges in greenhouse gases, water and climate change studies	G. Kirchengast
16:20-17:00	Discussion	
18:30	<i>Dinner hosted by ISSI-BJ</i>	

**Thursday, July 25**

	Subject	Contributor
<b>Session 3</b>	<b>CACES mission design and payloads</b>	<b>Chair: A. Löscher &amp; J. Wickert</b>
9:00-9:30	Introduction to Climate and Atmospheric Components Exploring Satellites (CACES) mission design	W. Xin
9:30-10:00	Introduction to the X/K band microwave occultation sounder design	W. Bai
10:00-10:30	Introduction to the Infrared-laser occultation sounder design	D. Lei & L. Cheng
10:30-11:00	<i>Coffee Break</i>	
11:00-12:00	Discussion	
12:00-14:00	<i>Lunch Break</i>	
<b>Session 4</b>	<b>Synergies, complementary missions and international collaborations</b>	<b>Chair: S. Syndergaard &amp; C. Liu</b>
14:00-14:30	ESA technology and system studies in the context of MW and optical Leo-Leo occultation	A. Löscher



## Thursday, July 25

	Subject	Contributor
14:30-15:00	CubeSat-compatible LEO-LEO laser occultation atmospheric sounder for temperature-pressure and greenhouse gas profiling	K. Cahoy
15:00-15:30	GNSS sounding science and its synergies	J. Wickert
15:30-16:00	<i>Coffee Break</i>	

### Session 5

### Discussion and future plans

**Chair: G. Kirchengast & D. Lv**

16:00-17:00	Discussion <ul style="list-style-type: none"> <li>• Key science goals of CACES</li> <li>• Design, payloads, observing strategy, science data exploitation</li> <li>• International collaborations and their potential</li> <li>• Outline, structure, publication of the forum report</li> <li>• Action items</li> <li>• Summary of the Forum</li> </ul>
-------------	---

18:00 *Dinner hosted by CACES team*

## Friday, July 26

**Discussion by key scientists and engineers about the detailed techniques, forum results, and related paper work (internal mission science meeting)**

Meeting room: A0827

## PRACTICAL INFORMATION

### VENUE

The Forum will be held in the Saturn Hall, NSSC building A, 4<sup>th</sup> Floor.

#### Address

N°1 Nanertiao, Zhongguancun, Haidian District, Beijing, 100190  
北京市海淀区中关村南二条一号

#### ISSI-BJ Office

The ISSI-BJ office is located at NSSC, Building A, 4th Floor. It is equipped with computers (MS Windows) with CD/DVD drives and USB ports, connected to high-speed network and printer.

### WIFI ACCESS

Login via web: NSSC-guest

Username: issi-bj  
Password: issi-bj



## ACCOMMODATION

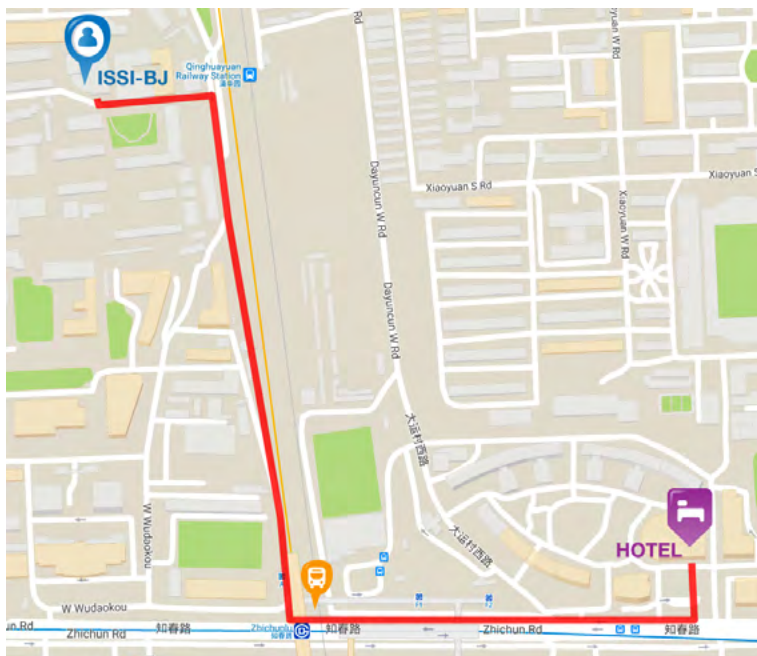
ISSI-BJ covers the cost of the accommodation and breakfast. Please kindly note that all the other expenses in hotel will be deducted from your check-in deposit.

### Park Plaza Hotel Beijing Science Park

No.25, Zhichun Road, Haidian District, 100083, Beijing China  
北京市海淀区知春路25号

**Directions:** Turn right on Zhichun Rd. (知春路) when going out of

the hotel. Climb the stairs to the entrance of the metro station ZhiChunLu (Exit A), turn left and walk straight for about two minutes. Then turn right on West Wudaokou (西五道口), following the northbound elevated subway. Walk for about 10 minutes, towards the direction of LiaoNing International Hotel (辽宁大厦) or the National Microgravity Laboratory Tower, finding NSSC (国家空间科学中心) on the left. The way is highlighted in red on the map.



## LUNCH

Lunch buffet for all participants of the ISSI-BJ Forum will be available

at the canteen on the -1 floor of the NSSC building A.

## COFFEE BREAKS

Coffee breaks will be provided in the ISSI-BJ Office, across from the

meeting room, see Program to check the coffee break times.

## USEFUL INFORMATION

**Credit Cards:** Credit and debit cards can be used in ATMs displaying the appropriate sign. Credit cards are increasingly becoming accepted in major shopping zones and high level restaurants but keep some cash handy just in case.

You can find two ATMs at the NSSC lobby of Building A.

**Currency:** Chinese Yuan Renminbi (RMB) (1 USD = approx. 6.6 RMB)  
(1 EUR = approx. 7.8 RMB)

**Drinking Water:** Avoid drinking tap water directly. Bottled water and mineral water can be found in convenience stores and drink stalls. The price is 2-10 yuan RMB per bottle.

**Electricity:** 220 volts AC

**Taxi:** Please contact Ms. Lijuan EN: +86-139-1139-7464 if you need to book a taxi.

**Time:** UTC/GMT +8 hours

## EMERGENCY CONTACT PERSON IN CHINA

Ms. Lijuan EN +86-139 1139 7464  
Ms. Anna YANG +86-185 1002 9307

## ISSI-BJ DINNER LOCATION

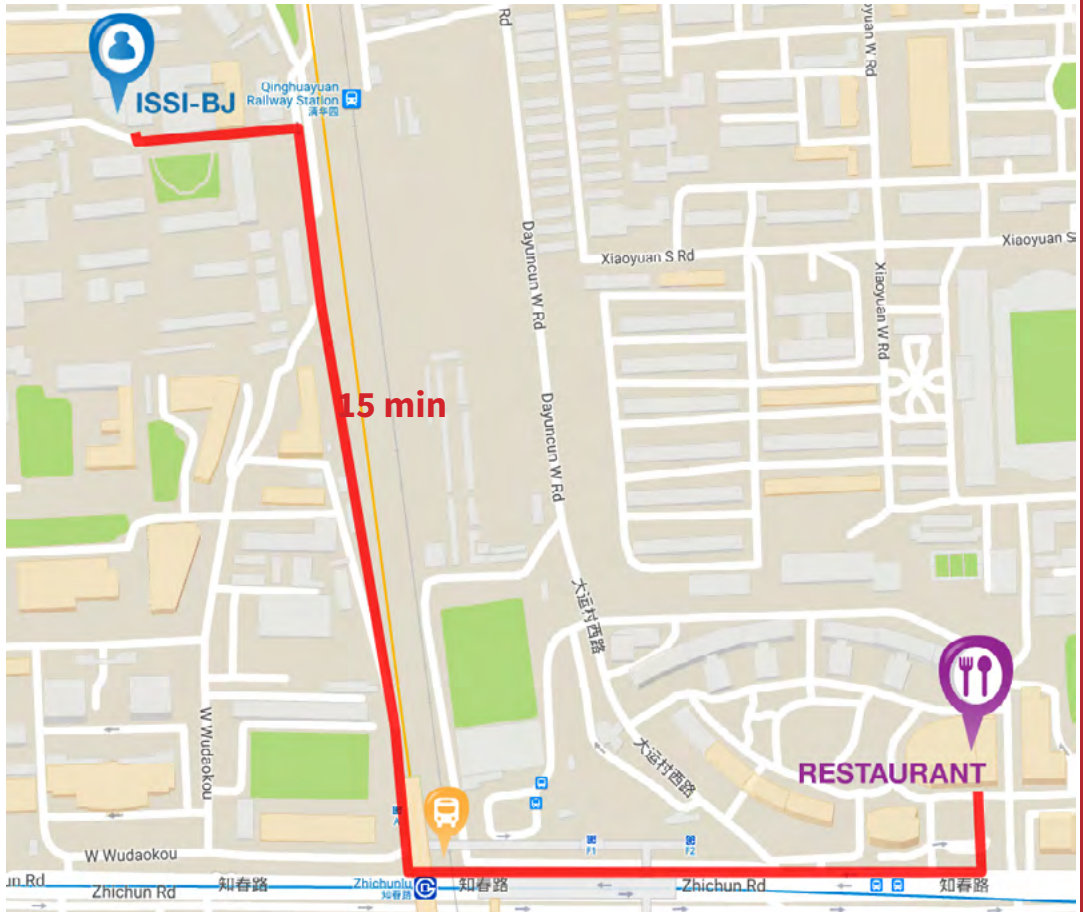
Dinner hosted by ISSI-BJ on  
**Wednesday, July 24 at 18:30.**

### Restaurant:

Amber 6, 2nd Floor of Park Plaza  
Beijing Science Park  
丽亭华苑酒店金辉6厅

### Address:

No. 25 Zhichun Rd. (知春路),  
Haidian District, Beijing  
北京市海淀区知春路25号



## CACES DINNER LOCATION

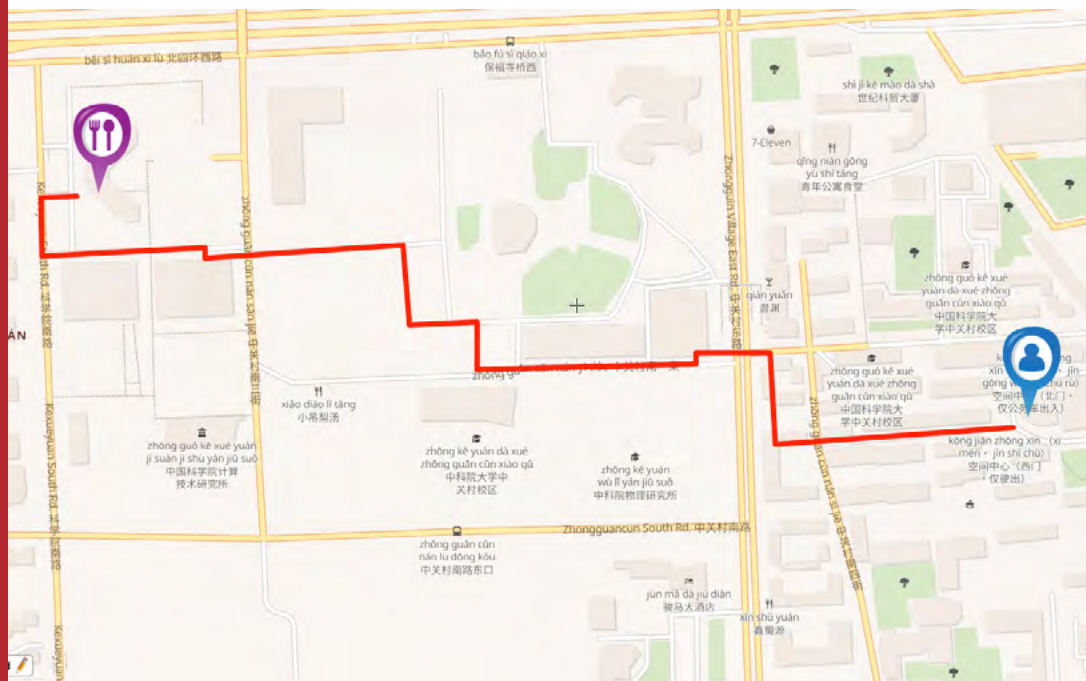
Dinner hosted by CACES on **Thursday, July 25 at 18:00.**

### Restaurant:

Hua Jia Yiyuan, 1st Floor of Raycom Infotech Park, Block A  
花家怡园, 融科资讯中心A座一层

### Address:

No. 2 Kexueyuan S Rd, Haidian District, Beijing  
北京市海淀区科学院南路2号



## PARTICIPANTS

No.	Name	Institution
<b>CONVENERS</b>		
1	Maurizio Falanga	ISSI-BJ, China
2	Quanlin Fan	NSSC, CAS, China
3	Gottfried Kirchengast	WEGC, University of Graz, Austria
4	Congliang Liu	NSSC, CAS, China
5	Armin Loescher	ESA Future Missions & Instruments Division, Netherlands
6	Daren Lv	IAP, CAS, China
7	Yueqiang Sun	NSSC, CAS, China
8	Stig Syndergaard	DMI Copenhagen, Denmark
9	Xin Wang	IAP, CAS, China
<b>PARTICIPANTS</b>		
10	Weihua Bai	NSSC, CAS, China
11	Kerri Cahoy	MIT, USA
12	Long Cheng	SITP, CAS, China
13	Lei Ding	SITP, CAS, China
14	Qifei Du	NSSC, CAS, China
15	Xiaoyong Du	Beijing Institute of Applied Meteorology, China
16	Xiuqing Hu	NSMC, CMA, China
17	Mi Liao	NSMC, CMA, China
18	Yan Liu	NSMC, CMA, China
19	Lijun Liu	NSSC, CAS, China
20	Xiangguang Meng	NSSC, CAS, China
21	Yufang Tian	IAP, CAS, China
22	Xianyi Wang	NSSC, CAS, China
23	Jens Wickert	GFZ, Germany

<b>No.</b>	<b>Name</b>	<b>Institution</b>
24	Junming Xia	NSSC, CAS, China
25	Guanglin Yang	NSMC, CMA, China
26	Zhongdong Yang	NSMC, CMA, China
27	Zhijia Zhang	IAP, CAS, China
28	Danyang Zhao	NSSC, CAS, China
29	Lijuan En	International Space Science Institute - Beijing (ISSI-BJ)
30	Anna Yang	International Space Science Institute - Beijing (ISSI-BJ)



## NOTES



Forum website:

<http://www.issibj.ac.cn/Program/Forums/ExploringByLEOLEO/>







Advancing Space Science Research  
by Worldwide Collaboration

International Space Science Institute - Beijing  
N°1 Nanertiao, Zhongguancun, Haidian District  
Beijing, China | Postcode: 100190  
Telephone: +86-10-62582811 | Email: [info@issibj.ac.cn](mailto:info@issibj.ac.cn)

