12th Annual Symposium on New Generation Operational Environmental Satellite Systems

The accuracy of aerosol satellites‘ AOD products over China

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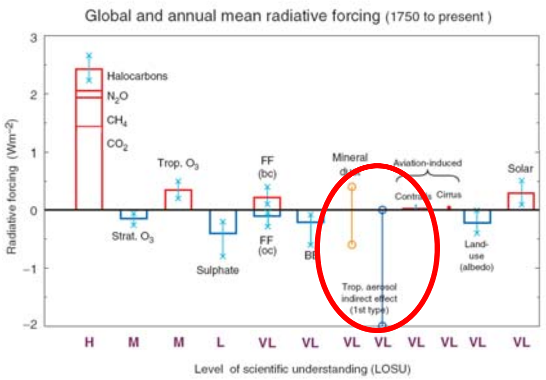
2016-01-10

Contents

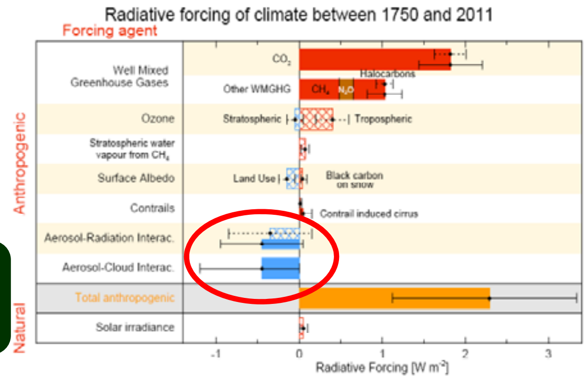
1. The research background



IPCC 2001

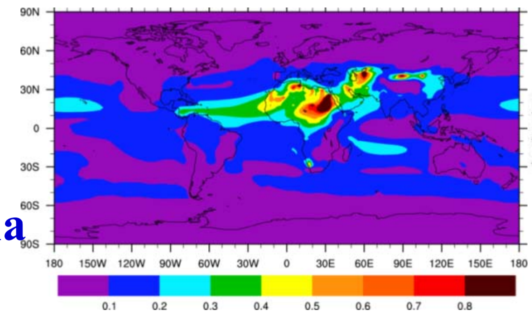
The effect of aerosol

Observation → **Modeling**

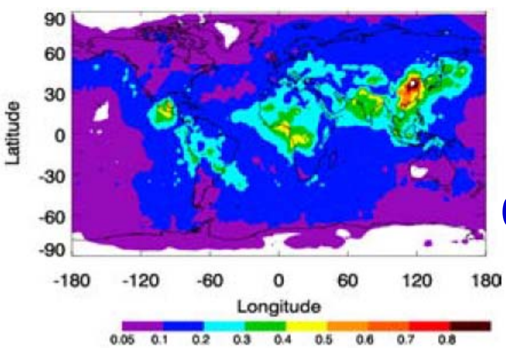


IPCC 2013

NCAR CESM



MISR+AERONET



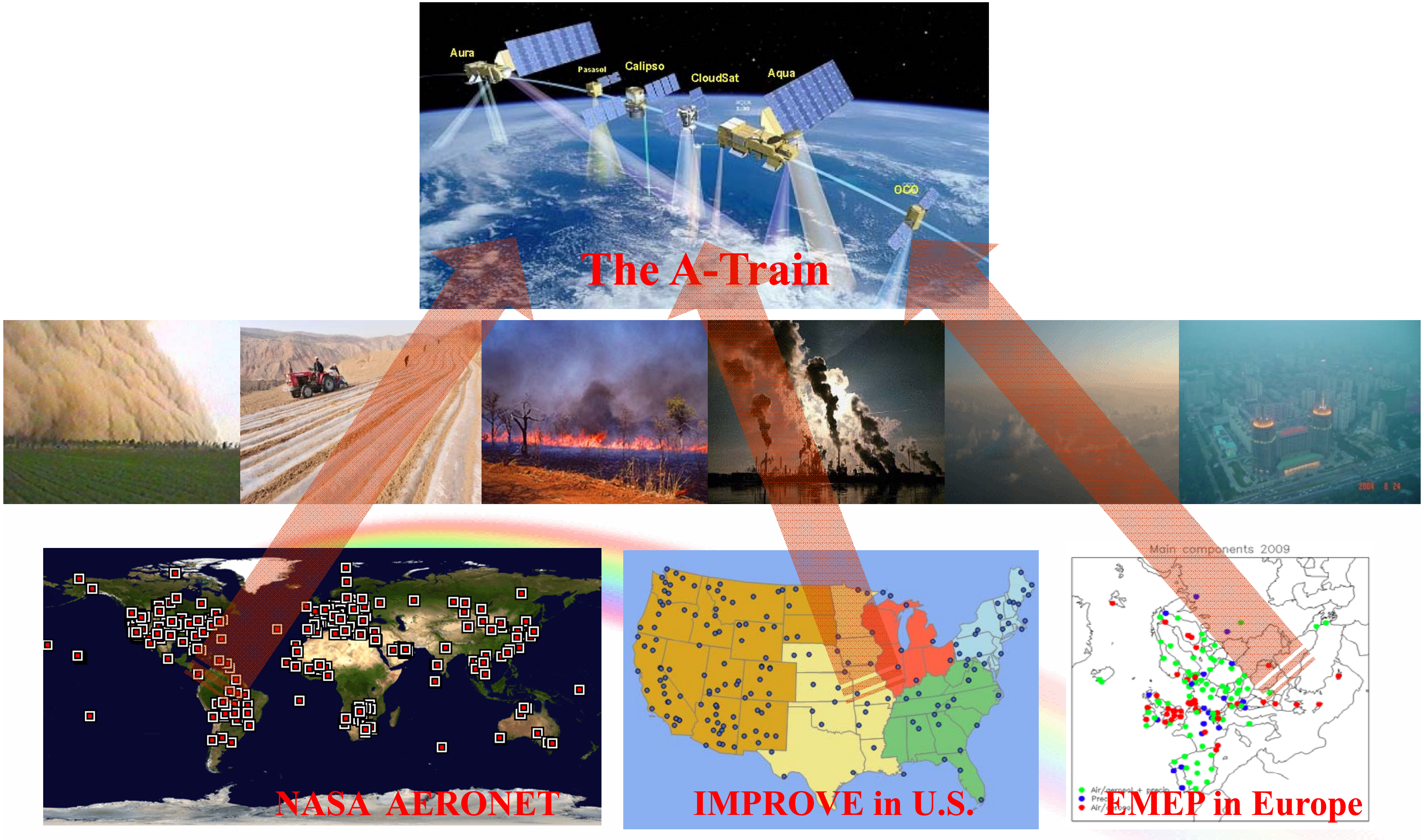
Simulated AOD: 0.2-0.3 in East China

Observed AOD: 0.4-0.8 in East China

NCAR CESM simulated and offered aerosol data in IPCC AR5.

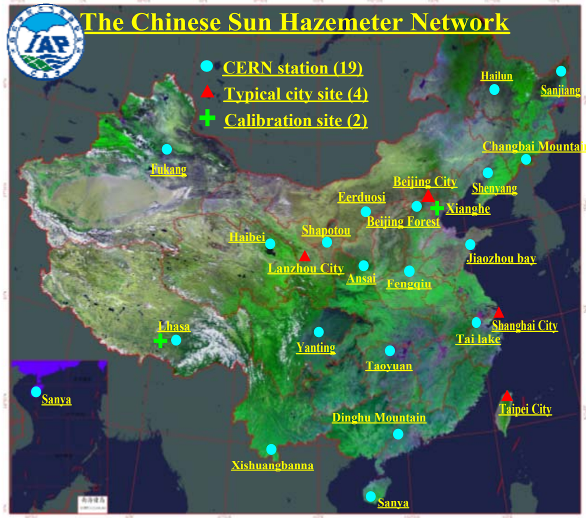
Y. Feng 2011, CESM NCAR, report

Aerosol optical parameters:
Bridging the ground observation, satellite, and model



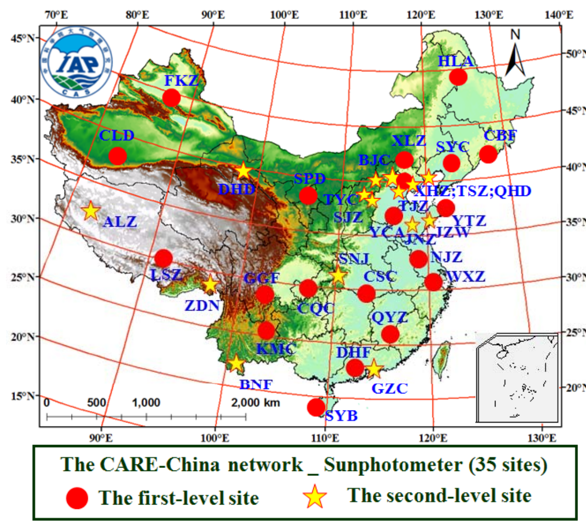
2. The observation network in China

- The Chinese Sun Hazemeter Network, 2004-2007
- The CARE-China Network_Sunphotometer, 2011-Now



The Chinese Sun Hazemeter Network
2004.08-2007.07 (23 sites)

The CARE-China Network _ Sunphotometer
2012.01-Now(36sites)



U.S. Forest Service

Solar Light Co.

The observing group of the network

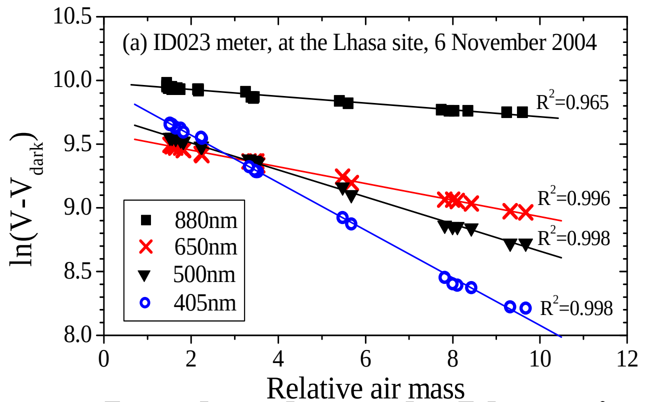
Calibration and Quality Control

- ✓ **To build the observation and instrument calibration standard**
- ✓ **To build the data quality control procedure for the network**

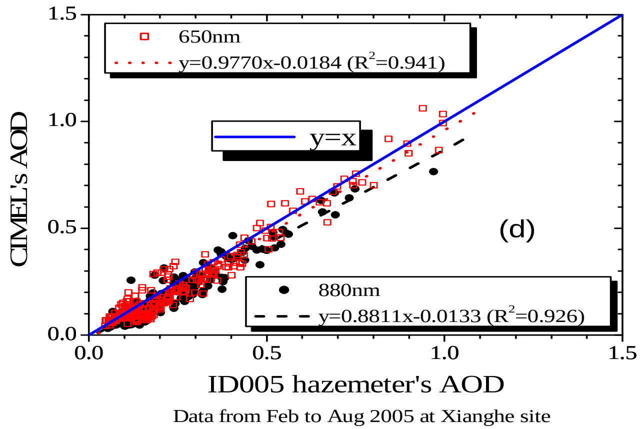
Langley plot
↓
CIMEL Com.
↓
Transfer Cal.
↓
Test Stability
↓
In Rotation

Calibration Process

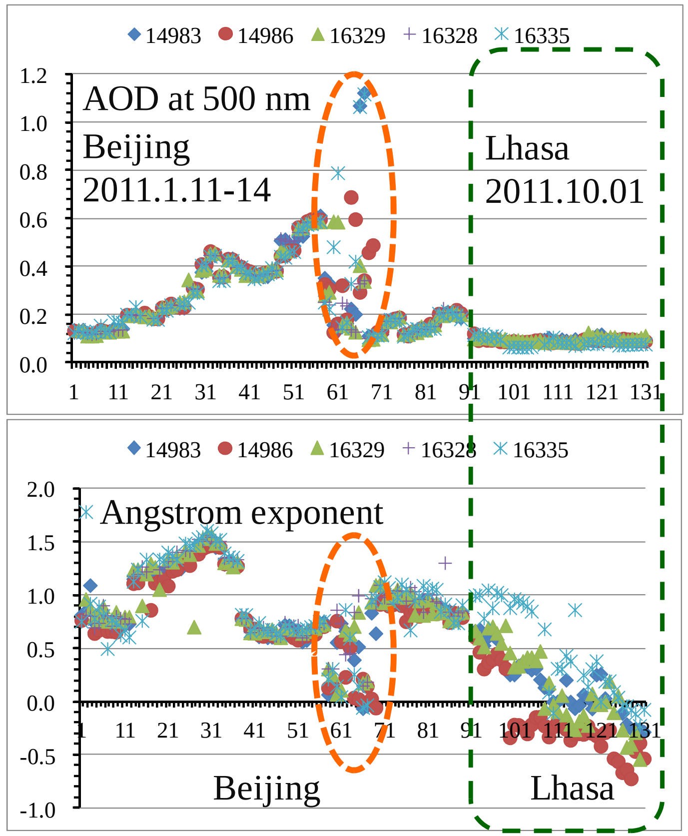
Xin et al. JGR, 2007



Langley plot at the Lhasa site



Comparison with AERONET site



Transfer calibration, test stability; deal with the cloud pollution

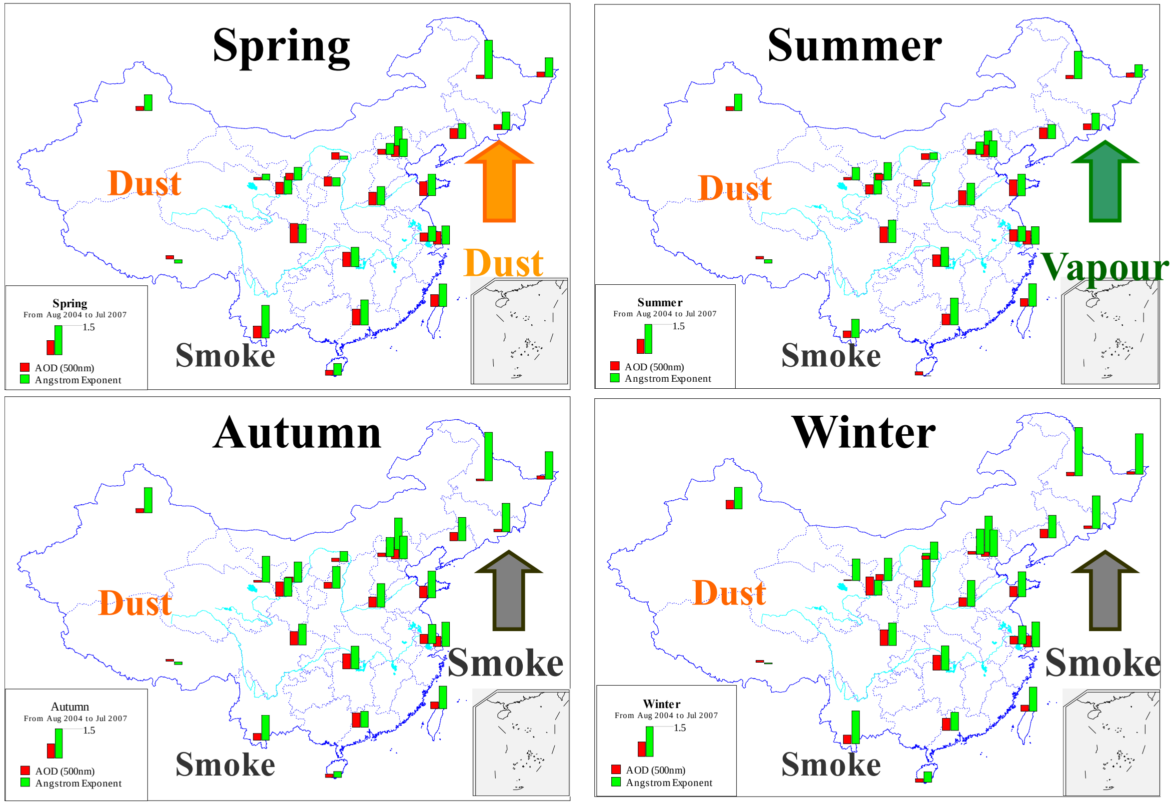
3. Research results and progress

- 3.1 The distribution of aerosol optical properties
- 3.2 The application to MODIS AOD upgrade in China
- 3.3 The accuracy of MODIS AOD C4, C5, C6 products
- 3.4 The accuracy of VIIRS IP AOD over east China
- 3.5 The accuracy of Chinese FY-3A and GF-1 AOD
- 3.6 To find the relationship between PM2.5 and AOD

3.1 The distribution of aerosol optical properties

- **There were similar monthly and seasonal variations of AODs and aerosol types over northern and southern China.**
- **Dust aerosol in spring, smoke and soot in autumn and winter. And dust over the Tibet Plateau, smoke and soot in Southeast Asia.**

The annual mean AOD at 500nm is 0.1-0.2 over the Tibet Plateau, remote northeast, and Hainan island. 2004.8-2007.7

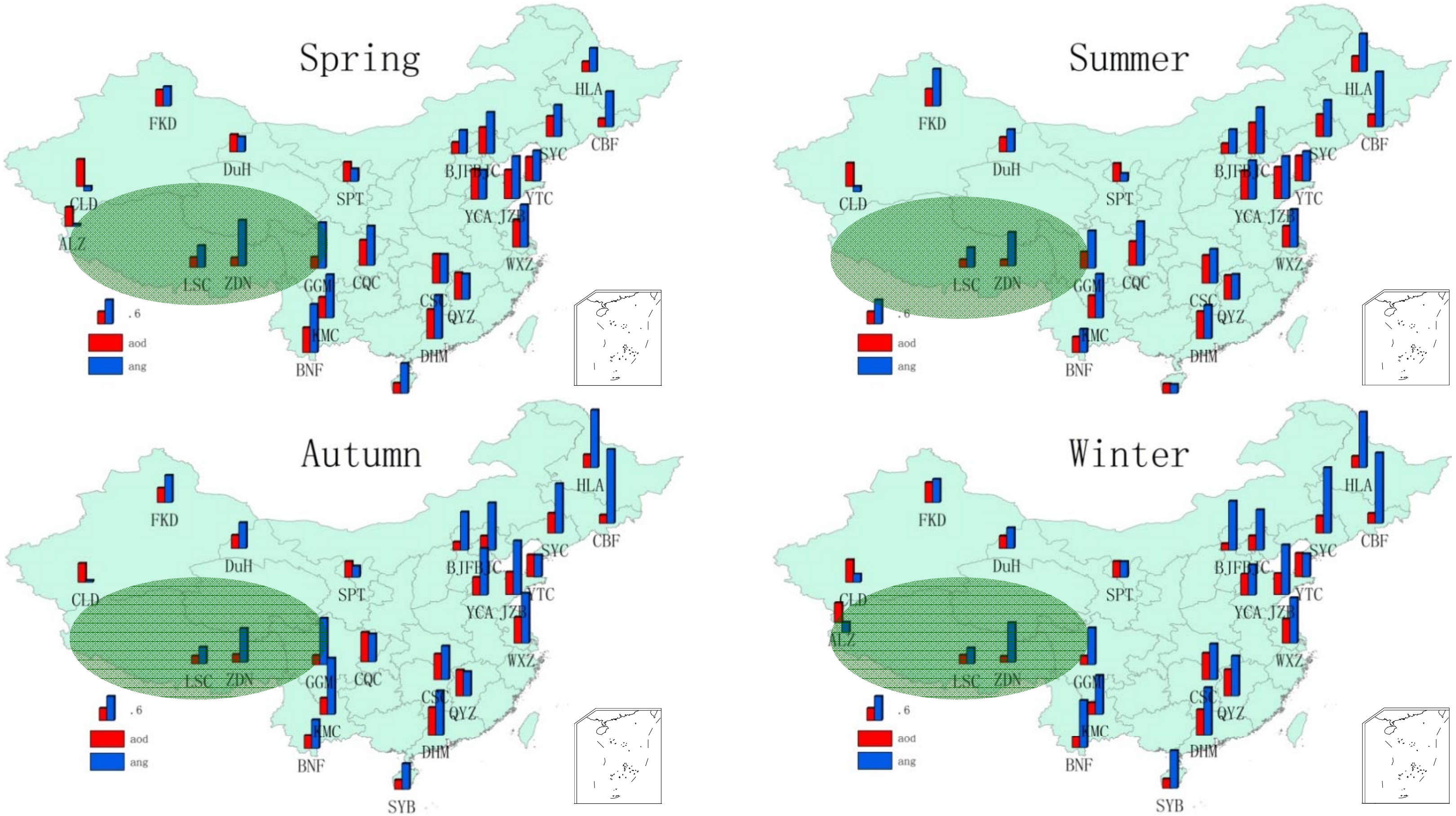


The annual mean AOD at 500nm is 0.5-0.9 over the central, eastern, southern and eastern coastal areas. 2004.8-2007.7

Xin et al. JGR, 2007, 2011; AE, 2008; AAS, 2010

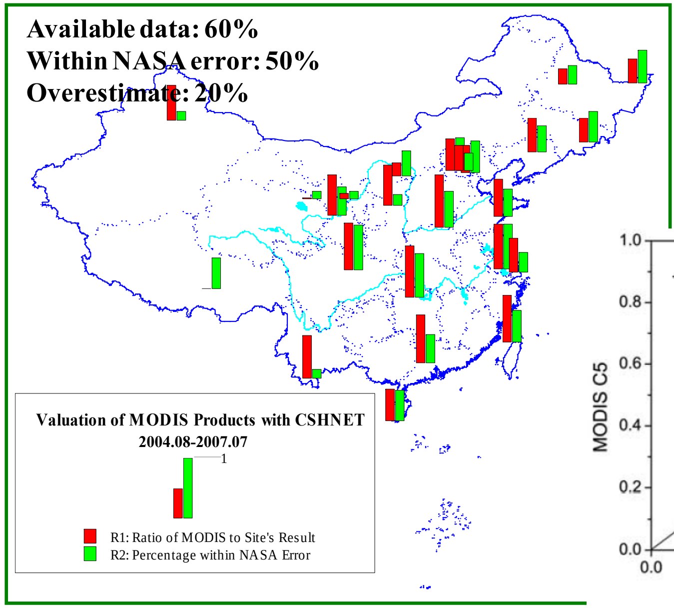
The spatial and temporal distribution in 2012

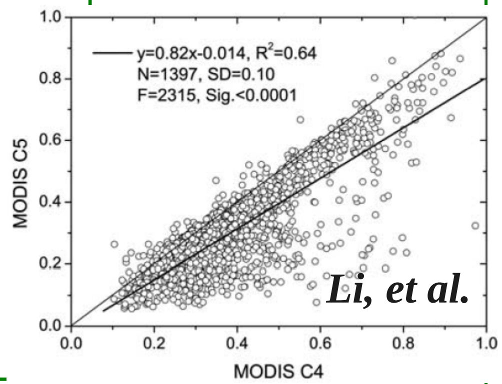
- **Comparing with 2004-2007, there was increasing of AOD in China except the Tibet Plateau, similar variation of aerosol types as before. But many sites had large changes in the remote areas.**

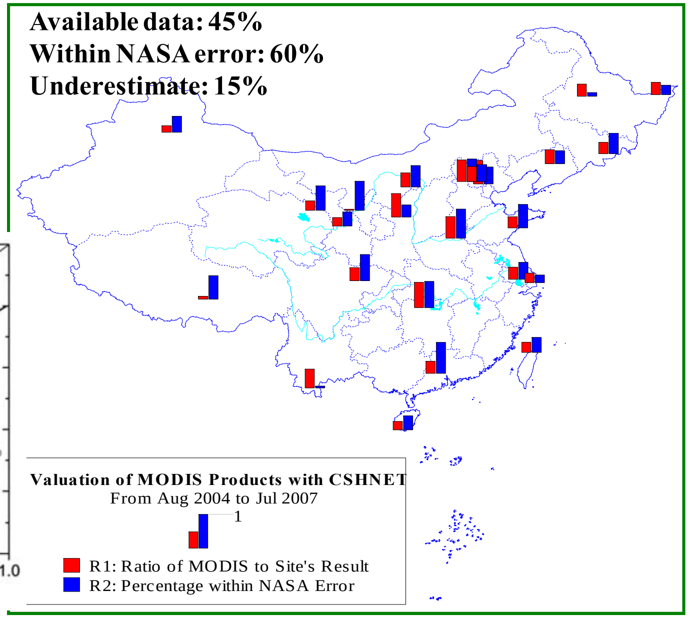


3.2 The application to MODIS AOD upgrade

- In collaboration with UMD and U.S. Forest Service, we traced to evaluate the accuracy of MODIS AOD from C4 to C5 products.
- The accuracy of MODIS C5 product increased by 10% on average in China, but the ratio of available data decreased by 15%.





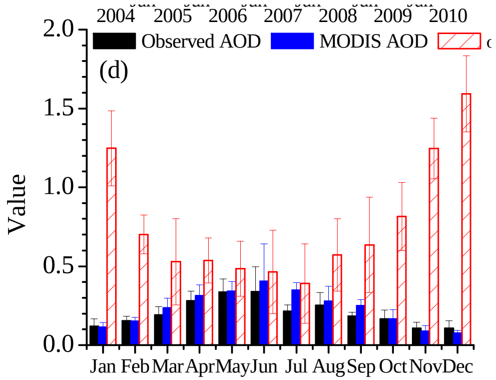


Evaluate MODIS C4 Product **Evaluate MODIS C5 Product**

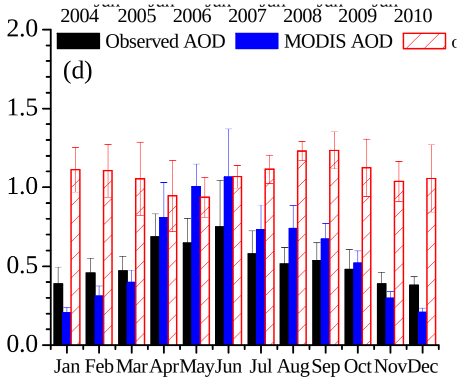
Wang, Xin, Li, et al., JGR, 2007; AE, 2007; CSB, 2007; GRL, 2008; AR, 2010

MODIS C5 AOD revised by the ground observation

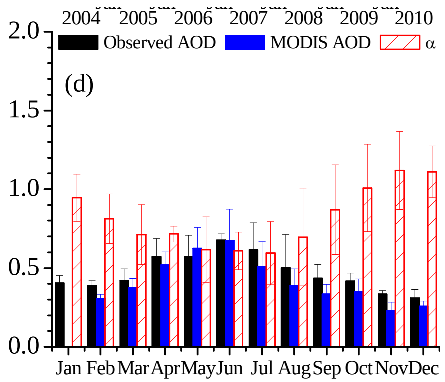
- MODIS C5 product also has large seasonal systematic errors in the urban region.
- Overestimate by 20% in summer and autumn; underestimate by 20% in spring and winter.



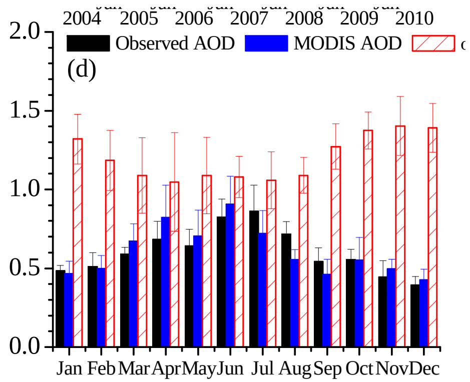
Background site



Beijing City



Shenyang Agr.

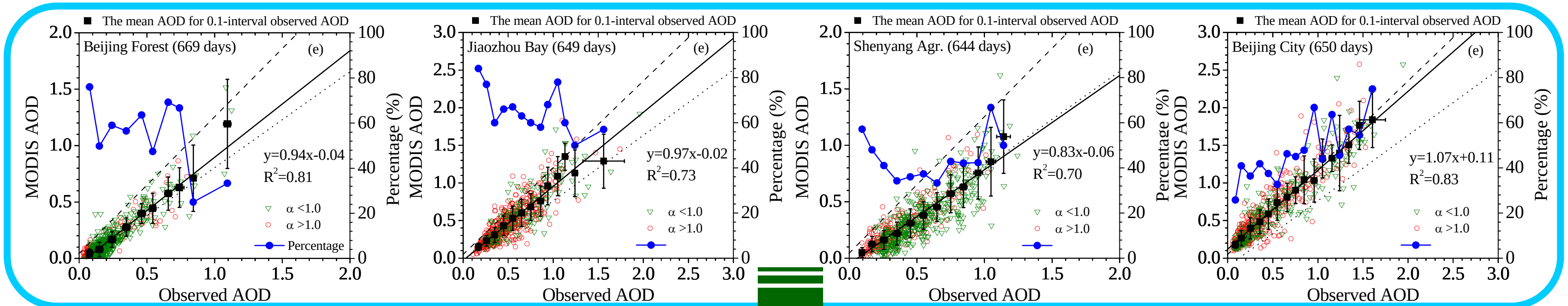


Jiaozhou Bay

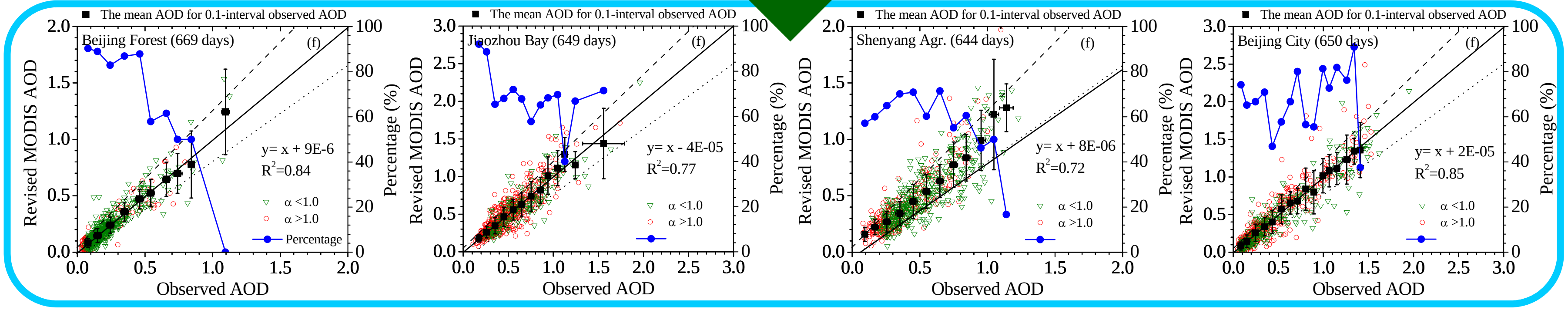
Xin et al., AE, 2011

MODIS C5 AOD revised by the ground observation

- The available ratio of the revised MODIS product reached 60-85%, raised by ~20% on average; the relative error declined to ~15%.
- The network was serviced to evaluate the Chinese satellites: HJ-1A , GF-1 and FY-3A. The GF-1 is getting close to MODIS.



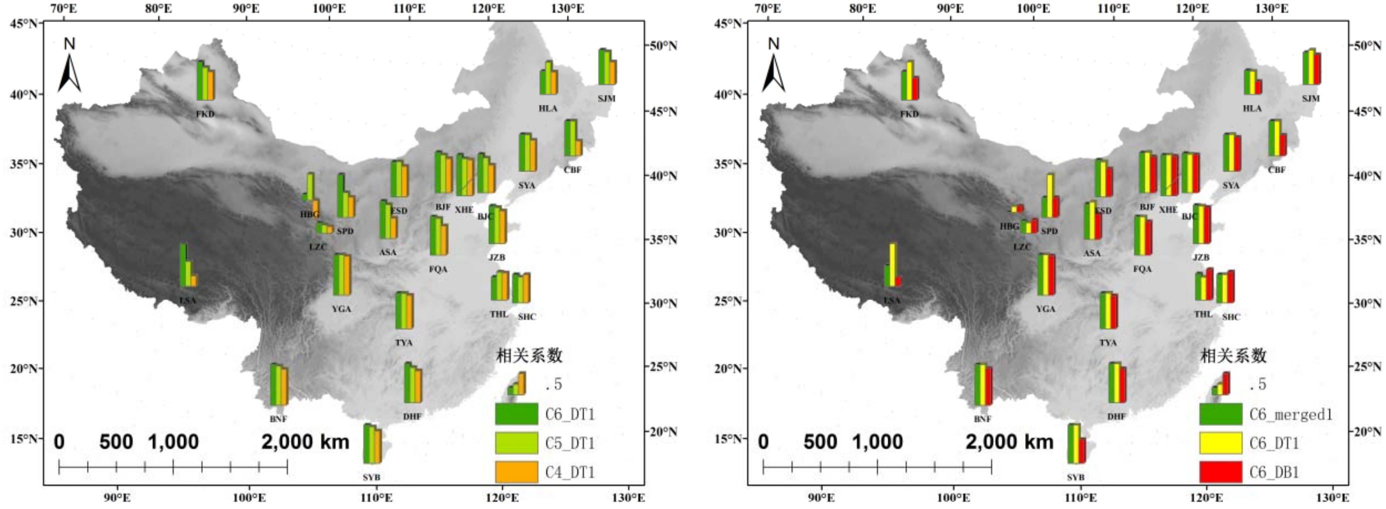
Comparison with MODIS C5 AOD in the urba



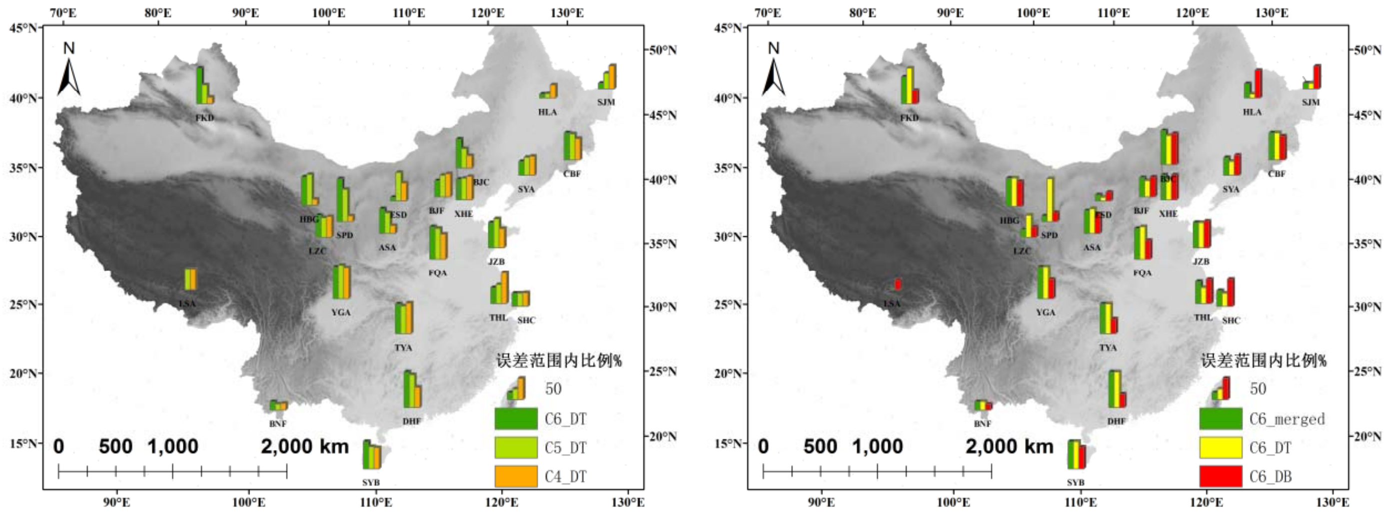
Comparison with the revised MODIS AOD

Xin et al., AE, 2011

3.3 The accuracy of MODIS C4, C5, C6 products



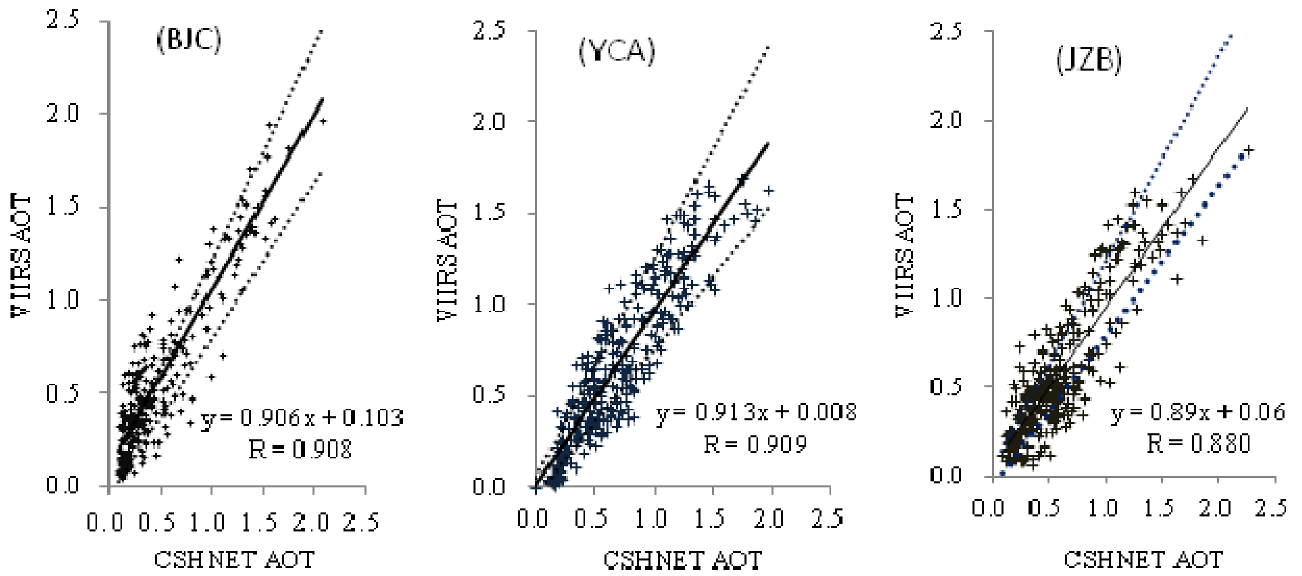
The correlation between MODIS-C6 AOD and observed AOD

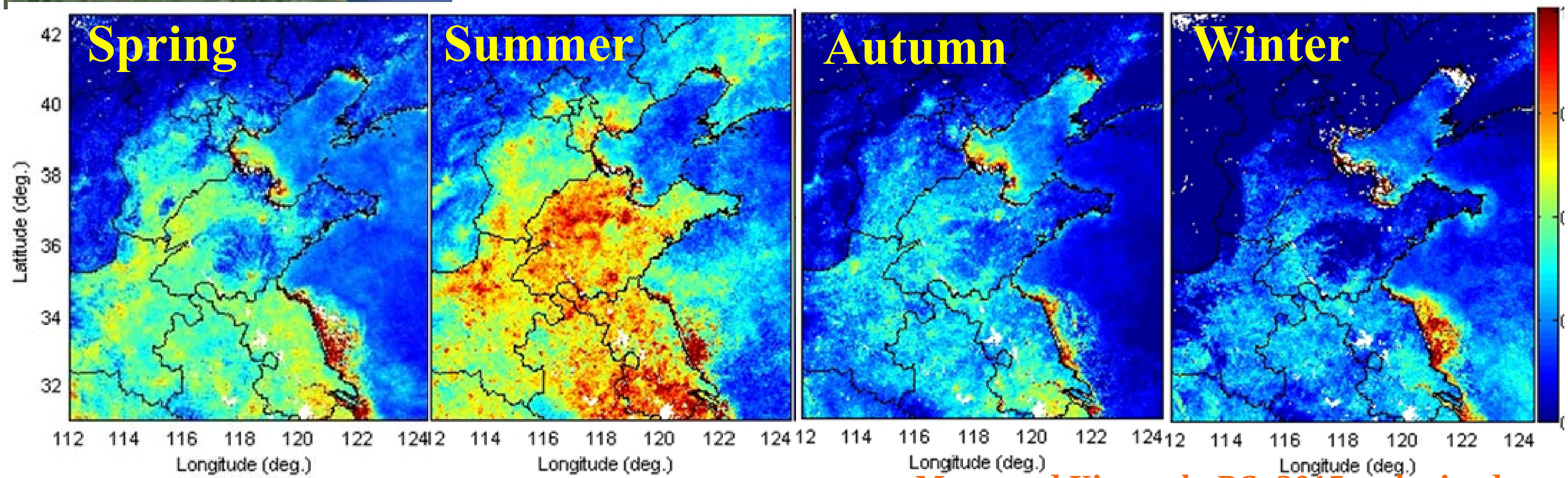


The rates of C6 products filling in the NASA errors

- 65% of C6 products filling in the NASA errors over China.
- But C6 products underestimated AOD by 20% (DB and the Merge) and 14% (DT).
- In the northeast, the northwestern desert and the Tibet Plateau, the accuracy of C6 DT was higher than C4 and C5 DT products.
- C6 DB was superior to DT and Merge in the northeast, the Beijing-Tianjin-Hebei and the Yangtze River delta. But DT and Merge were more superior to DB in other regions.

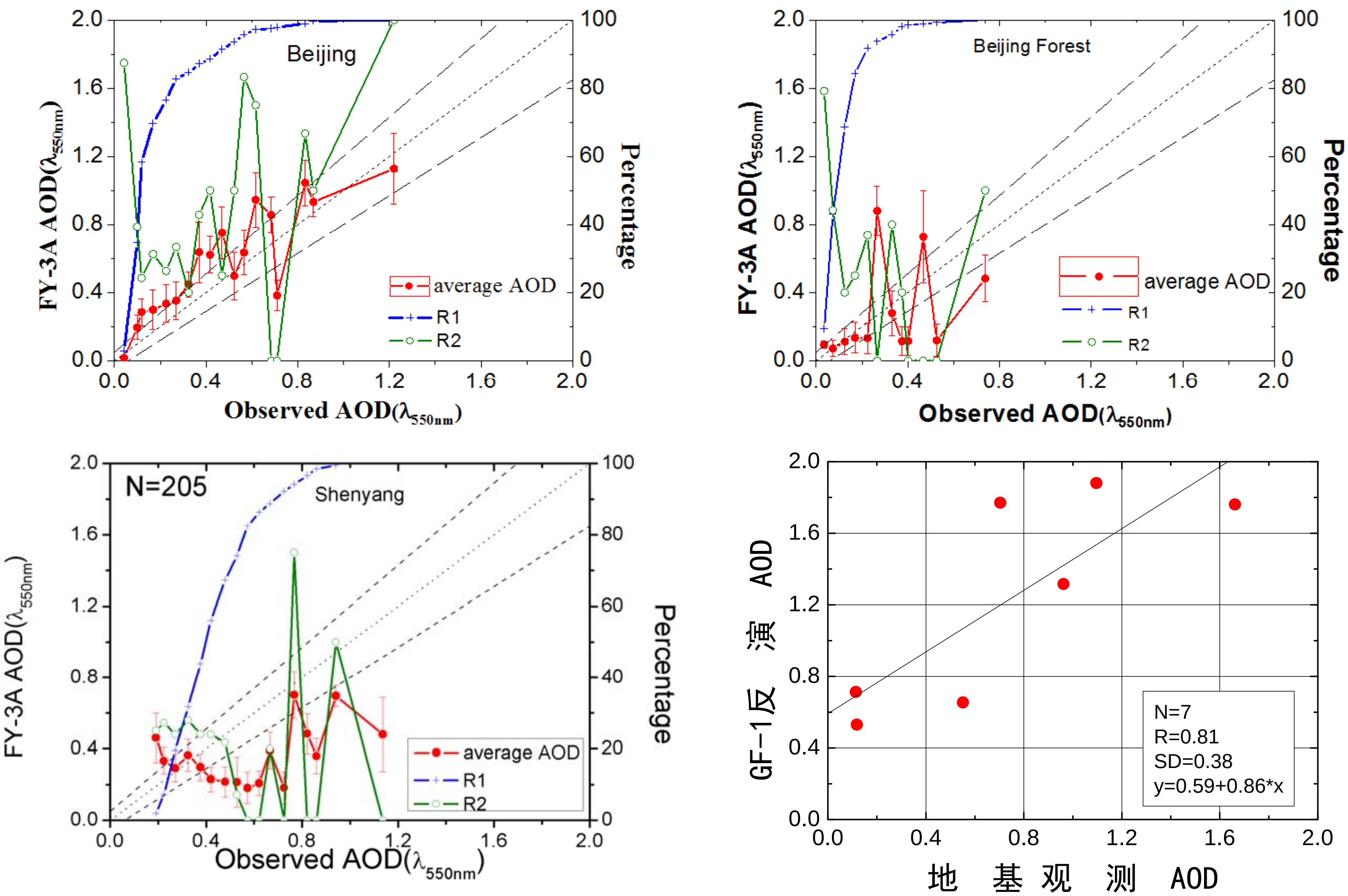
3.4 The accuracy of VIIRS IP AOD over east China





Meng and Xin et al., RS, 2015, submitted

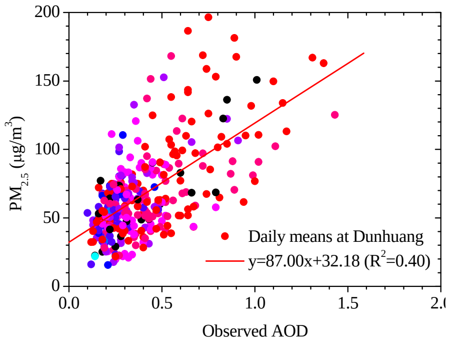
3.5 The accuracy of Chinese FY-3A and GF-1 AOD



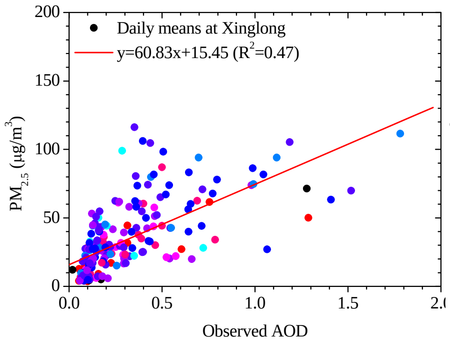
王中挺, 辛金元等, 遥感学报, 2015.

3.6 The relationship between $PM_{2.5}$ and AOD

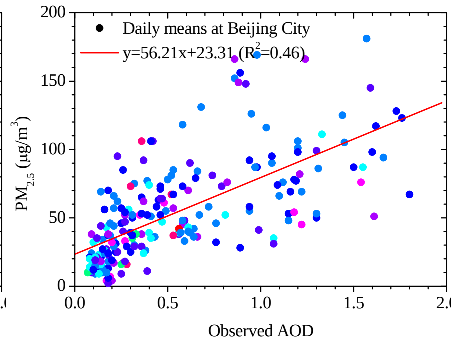
- There were certain correlations between PM2.5 and AOD.
- The correlations are different at different regions and among the four seasons due to the aerosol types, components and weather conditions.



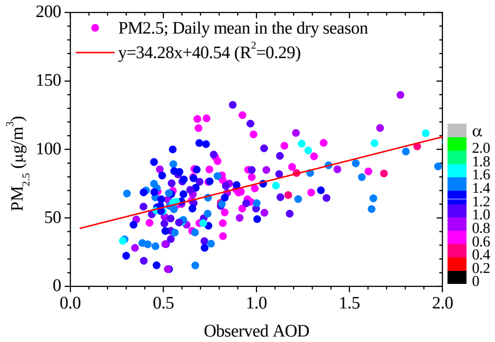
Dunhuang Desert



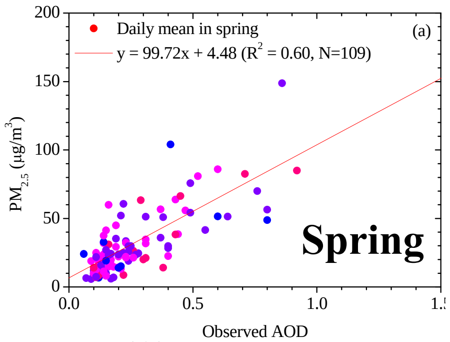
Xinglong Mt.

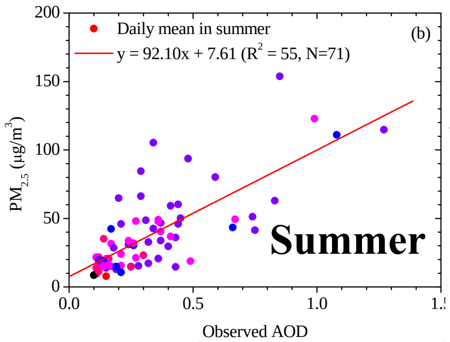


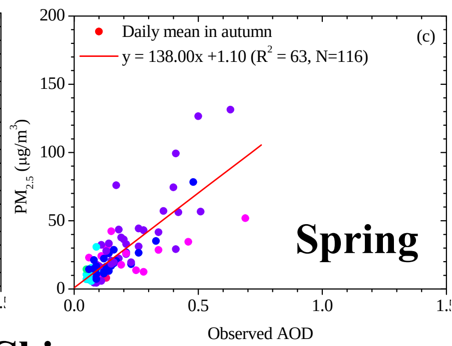
Beijing City

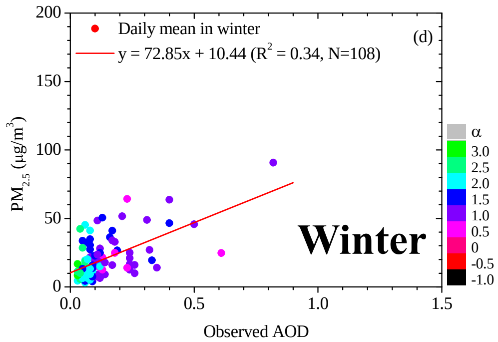


Dinghu Mt.





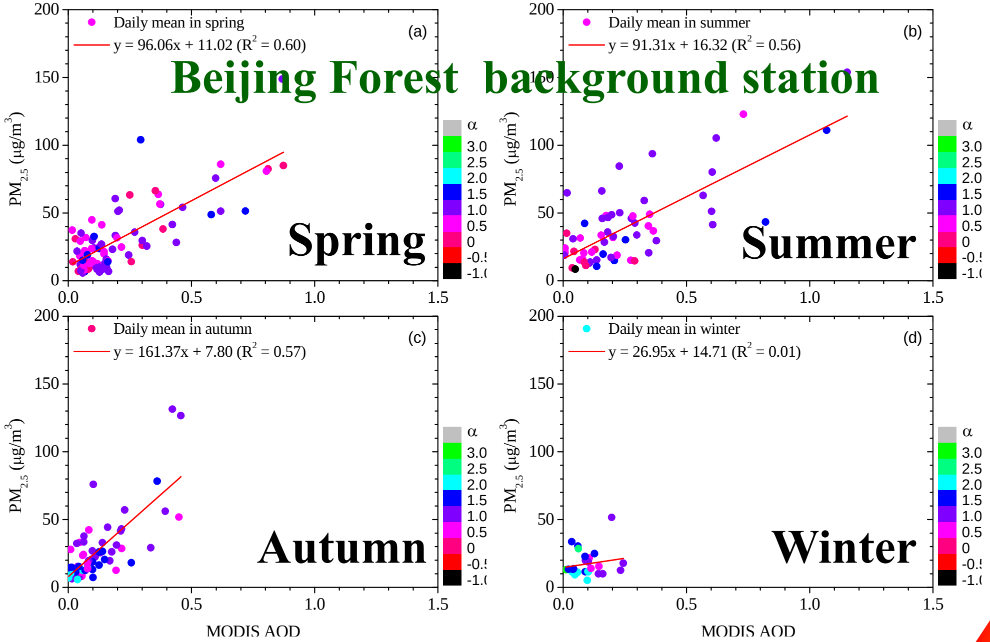




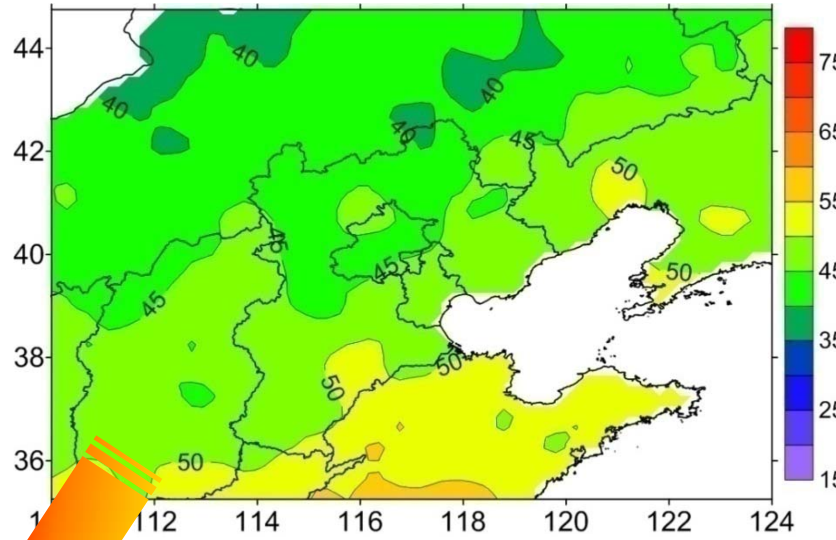
Beijing Forest background station in North China

Xin et al., Atmospheric Research, 2014

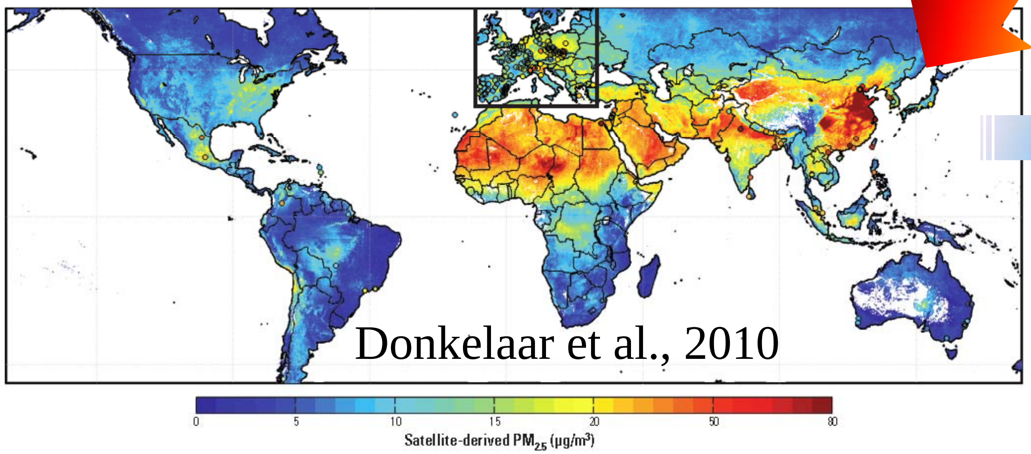
An example: PM2.5 retrieved from the satellite



The relationships between PM2.5 and MODIS AOD



The annual PM2.5 on sunny days (2009-2011): 40-55 μg/m³



The annual PM2.5 (2001-2006): 60-80 μg/m³

There may be large error, if without the local revisal.

Xin et al., Atmospheric Research, 2014

4. Summary

1. Since 2004, we began a network to investigate the spatial and temporal distribution of aerosol optical properties in China, and try to track the trends.
2. The network has been used to revise the satellite products, aerosol model results, and to obtain the relationship between PM2.5 and AOD.
3. The accuracy of MODIS AOD increased by 20% from C4 to C6 products. 65% of C6 product filled in the NASA errors over China, but the product underestimated AOD in China.
4. 60% of VIIRS IP products filled in the NASA errors over east China. Besides, Chinese FY and GF satellites' AOD products showed large errors in the region.

Thank you !

Any question?

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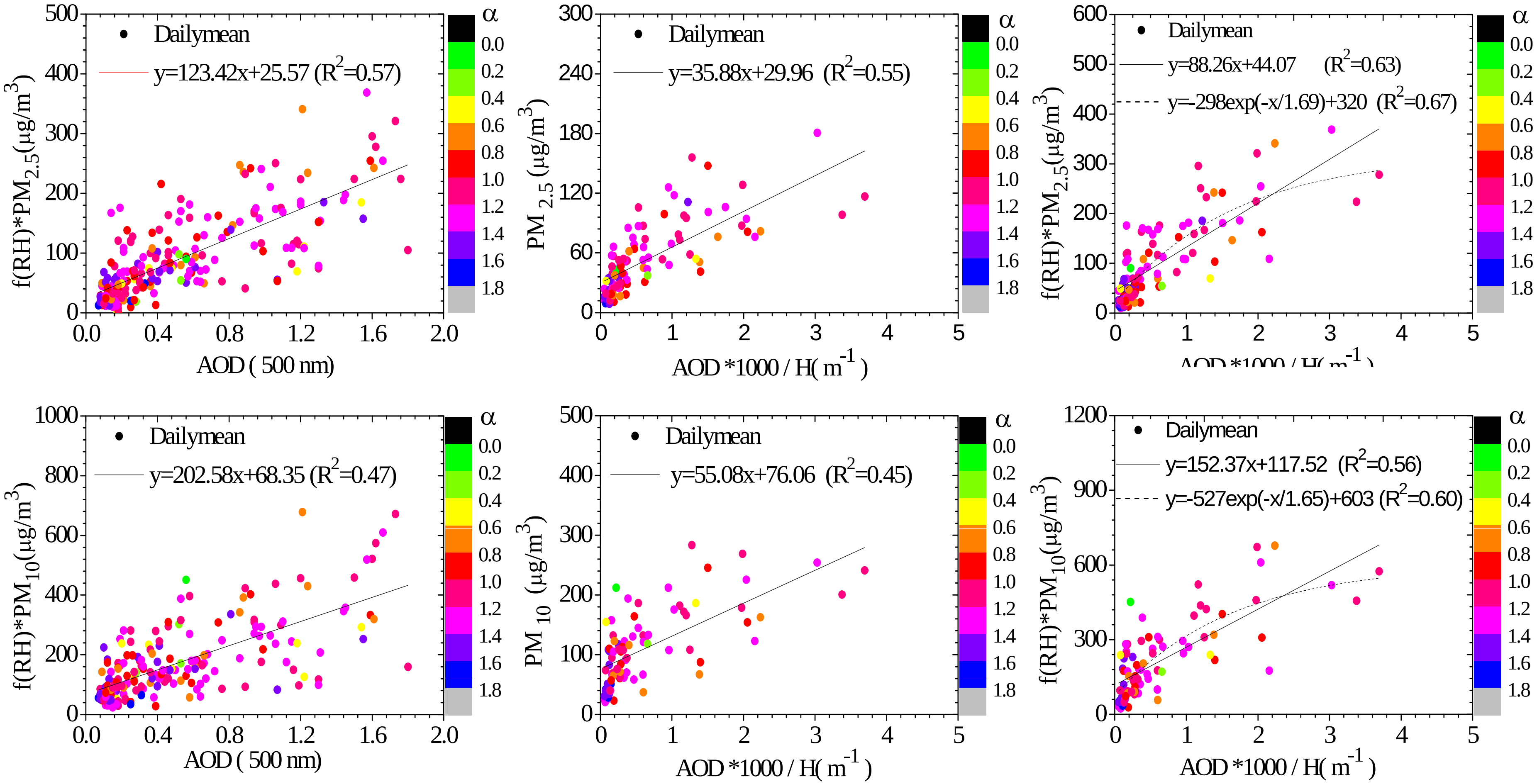
LAPC & CERN-SCAS, IAP-CAS

CV of Dr. Jinyuan Xin

Dr. JINYUAN XIN was born in 1975. He is an associate professor and a master tutor of the Institute of Atmospheric Physics, Chinese Academy of Sciences. He obtained the bachelor and master degrees in atmospheric physics and atmospheric environment, the doctorate degrees in meteorology in Lanzhou University in 1999, 2002 and 2007, respectively. The research field is in atmospheric physics and atmospheric environment. He has a deep research in the field of aerosol optical properties and air pollution. He has taken on 7 projects, including two NSFC projects, and 5 sub-projects from the 863 important plan, the key project of knowledge innovation of CAS, two strategic special projects of CAS and the 973 project.

He won six Chinese academic awards: the National Excellent Youth Scholar of NSFC in 2012, the "QIUSHI" Award in 2005, the "XUE DU FENG ZHENG" Award in 2006, the "National Hundred Outstanding PhD Thesis" Nomination Award in 2009, the Youth Meteorological Science and Technology Excellent Paper in 2014, Youth Meteorological Science and Technology Award in 2014. He has published 70s academic papers (40s SCI papers), which have been cited more than 1000 times.



*林海峰, 辛金元*等, 环境科学, 2013.*