Breakout Session on AMF-China

Aerosols and Climate in China:

Update on AMF-China Update of the AMF-China related researches and JGR special section papers (Z. Li, 15 min)

Status of the AMF-China related data sets (M. Cribb, 15 min)

Aerosol effects on climate in China: A review (Y. Qian, 15 min)

The Effect of Aerosols on the Onset of Precipitation (Kathryn Boyd, 15 min)

A Study of Asian Dust Plumes using Satellite, Surface, and Aircraft Measurements during the INTEX-B Field Experiment (X. Dong, 15 min)

Anthropogenic pollution near dust source regions matters: results from the AAF deployment over northwestern China in spring 2008 (C. Li, 15 min)

Increase in Wintertime Fog and Weakening of the Eastern Asian Monsoon:

Impacts of Global Warming and Aerosols in China (F. Niu, 15 min)

Aerosol Indirect Effects on Clouds and Precipitation: Case Studies During the

AMF-China Campaign (Jiwen Fan, 15 min)

2008 AMF/EAST-AIRE Campaign Sites

Anchored by the AMF in Shouxian, additional instrumented sites to the east and north provided a comprehensive atmospheric data set for studying aerosol effects in the region.

Nature (Sep 24) Feature Article on AMF-China Mission


NEWS FEATURE NATURE|Vol 461|24 September 2009

Cloudy, with a chance of science

When American and Chinese scientists agreed to measure pollution and dust over China, nobody foresaw how difficult it would be. **Jane Qiu** reports.

466


NATURE|Vol 461|24 September 2009 NEWS FEATURE

467

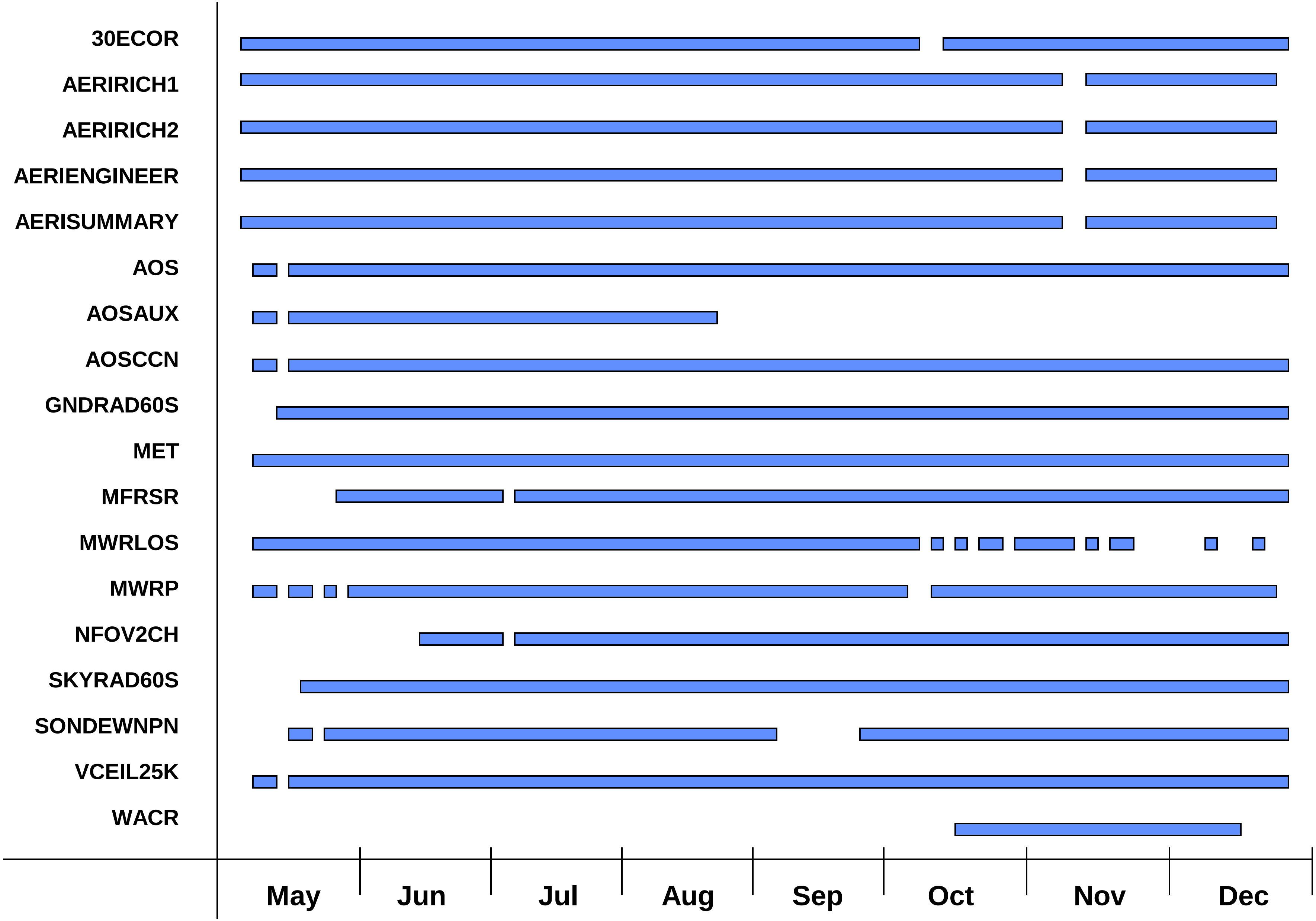

NEWS FEATURE NATURE|Vol 461|24 September 2009

"We now have cloud data from China nobody has ever had before." — Mark Miller

468

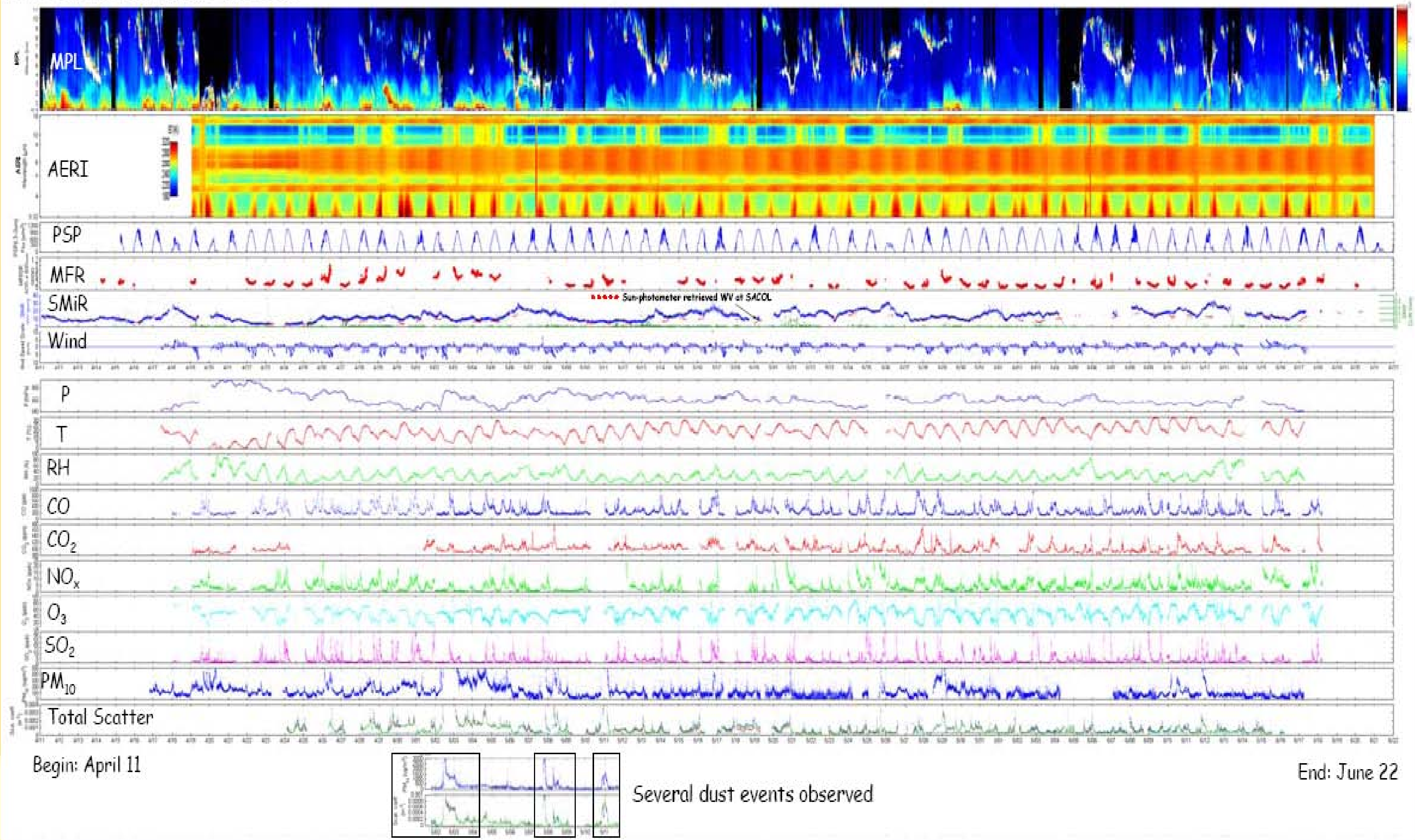

ARM Mobile Facility Deployment in Shouxian

HFE Summary of Completeness: May 1, 2008 – Dec. 31, 2008



Time Series of Data from AAF

3. Selected time series



Begin: April 11

End: June 22

Several dust events observed


Taihu Observator
Wuxi
Suzhou
Shanghai
Hangzhou

Xianghe Obervatory



Radiation Instruments


Aerosol Instruments

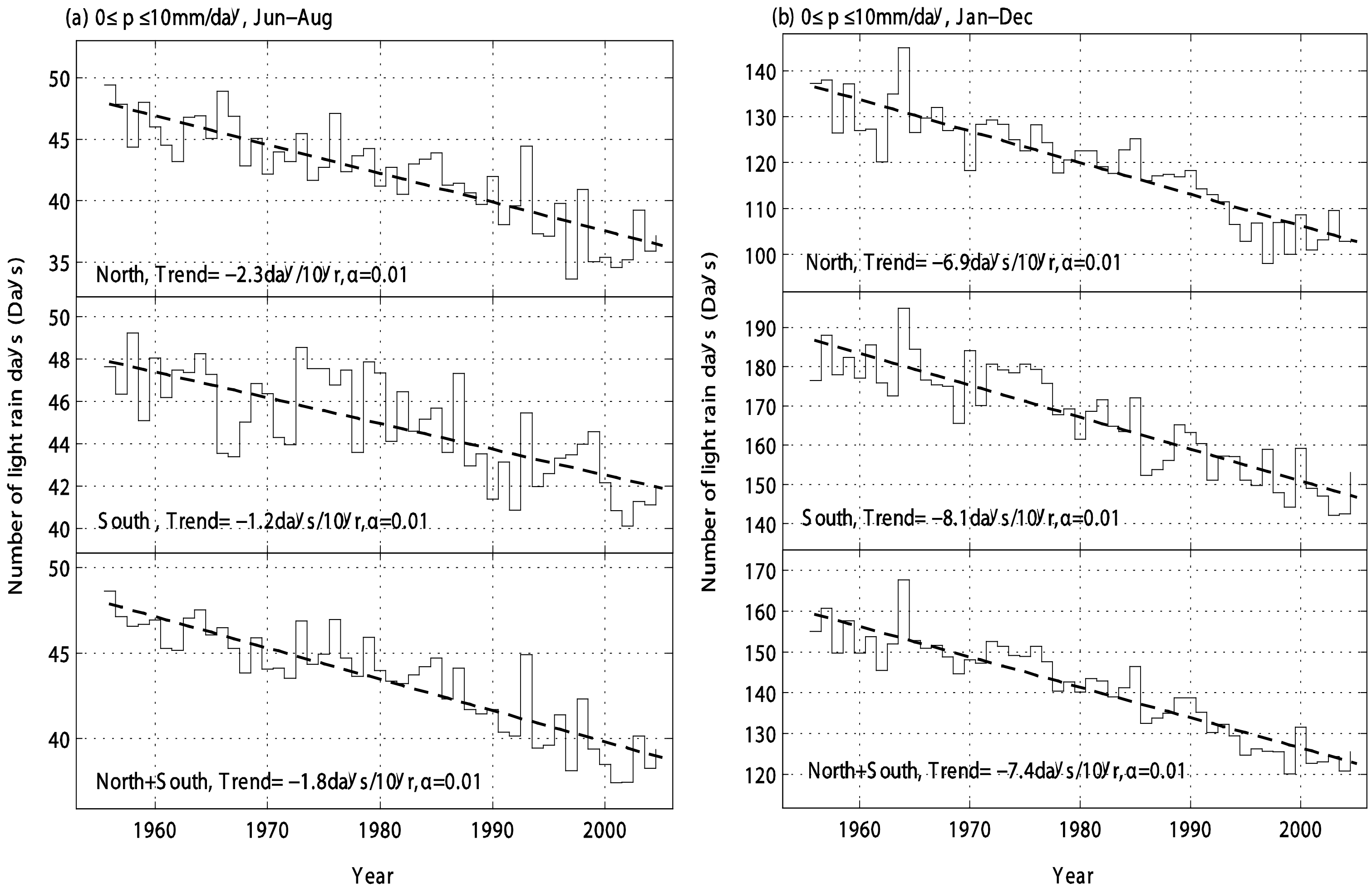


Cloud Instruments

Taihu Instrumentation List 2008

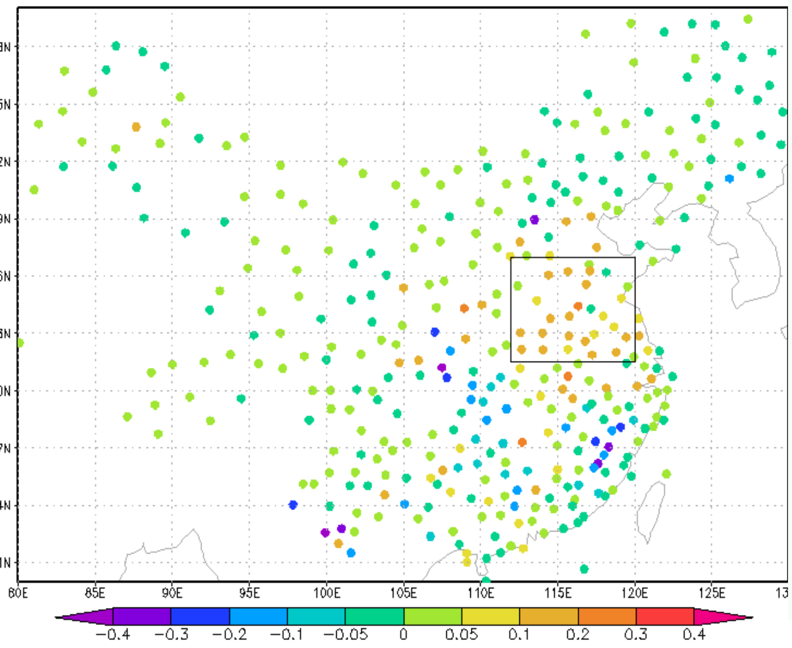
Instrument	Parameters	Units	Temporal Resolution	Time Period
Cimel sunphotometer	AOD; SSA; Angstrom exponent; size distribution;	none, none none $\mu m^3/\mu m^2$	15 minutes	Jan.1/08-Oct.2/08 (V2.0) Oct.7/08-Dec.31/08 (V1.5)
ASD spectroradiometer	solar spectral radiances (350-2500 nm, 1-nm resolution)	$W\ m^{-2}\ nm^{-1}\ sr^{-1}$	1 minute	2008: Apr. 25 – May 19 Jul. 19 – Dec. 31
MFRSR	broadband fluxes; spectral fluxes (414,495,613,671,867,939 nm)	$W\ m^{-2}$ $W\ m^{-2}\ nm^{-1}$	1 minute	Apr. 27/08 – Dec.31/08
B&W pyranometer **Norm. incid. pyrheliometer** **PIR pyrgeometer** **PAR Lite sensor**	diffuse solar fluxes ; direct solar fluxes ; longwave fluxes; photosynthetic photon flux	Wm^{-2} Wm^{-2} Wm^{-2} Wm^{-2}	1 minute	Jan.01/08 – May 23/08
Micro-pulse Lidar	total lidar attenuated backscatter profile; linear depolarization ratio		1 – 3 minutes	2008: Mar. 24 - May 3 May 16 – Aug. 4 Aug. 8 - 29
Microwave Radiometer time series of:	temperature profile; RH profile; vapor density profile; liquid water profile surface pressure ;RH ; surface T ;T (IR) ; cloud base height; precipitable water; liquid water; rain	K % $g\ m^{-3}$ $g\ m^{-3}$ mb,% K,K km cm mm, 0=no, 1=yes	1 minute	Apr. 25/08 – Dec. 31/08
Total Sky Imager	JPEG images of daytime sky		1 minute	Apr. 24/08 – Dec. 31/08
Weather Transmitter	air pressure; air temp. ; RH; wind speed/direction; rain accumulation	mb C, % $m\ s^{-1}$, degrees mm	1 second 1 second 3 seconds 1 second	Sep. 23/08 – Dec. 31/08

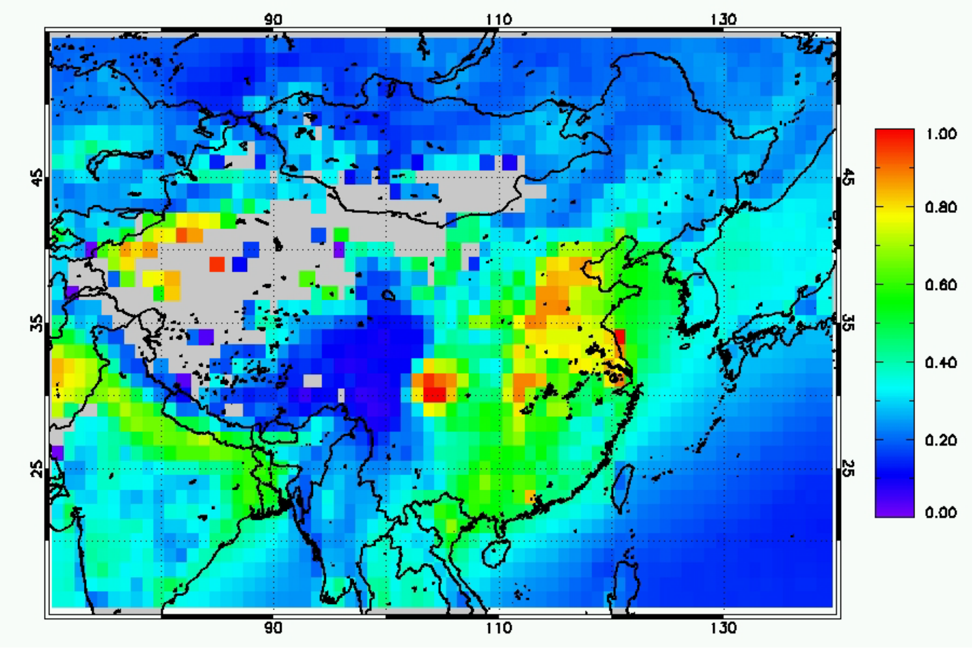
Time series of number of days for light rain (<10mm/day) from 1956-2005 (left: JJA; right: Jan-Dec)



Qian et al. (2009)

Annual Change Rate of Fog Occurrence 1976-2007

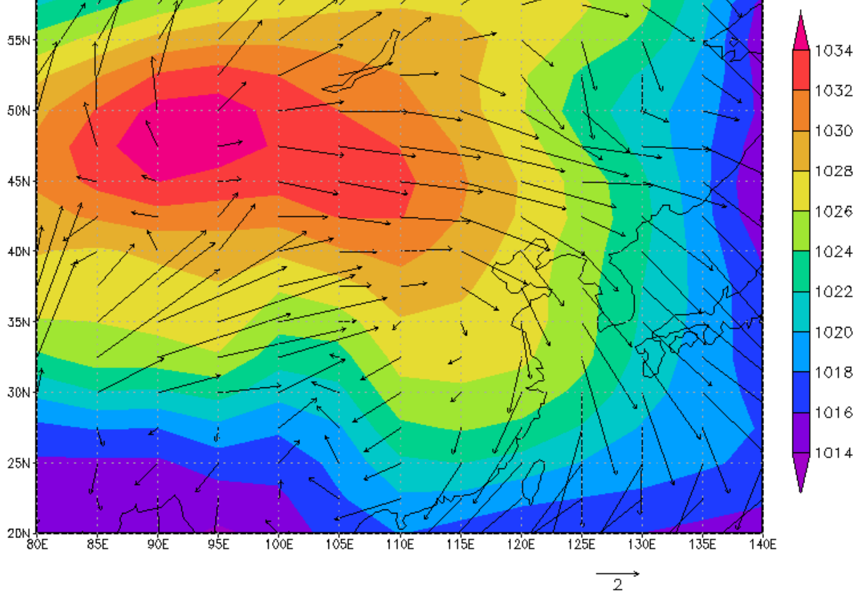




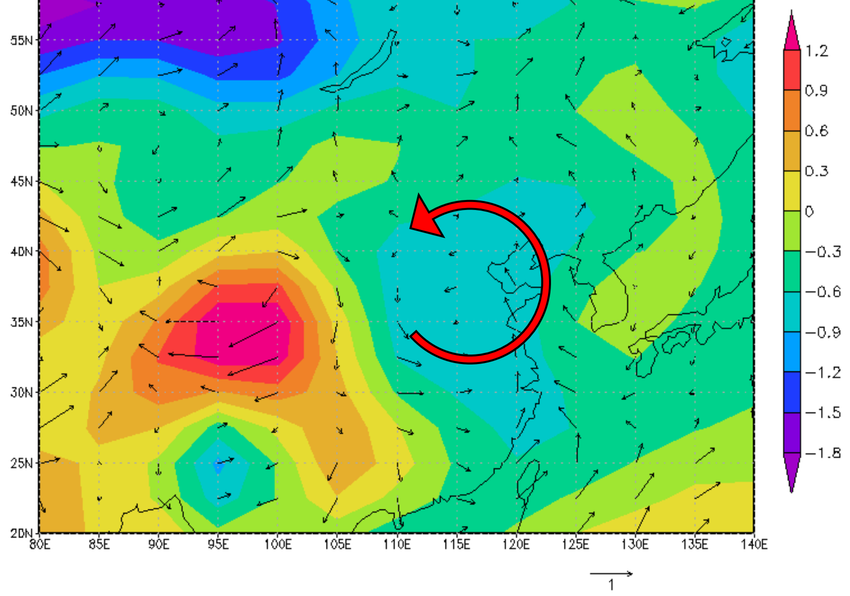
Niu et al. (2010)

Winter Sea Level and Wind (NOAA/NCAR Reanalysis)

(a) Mean Values

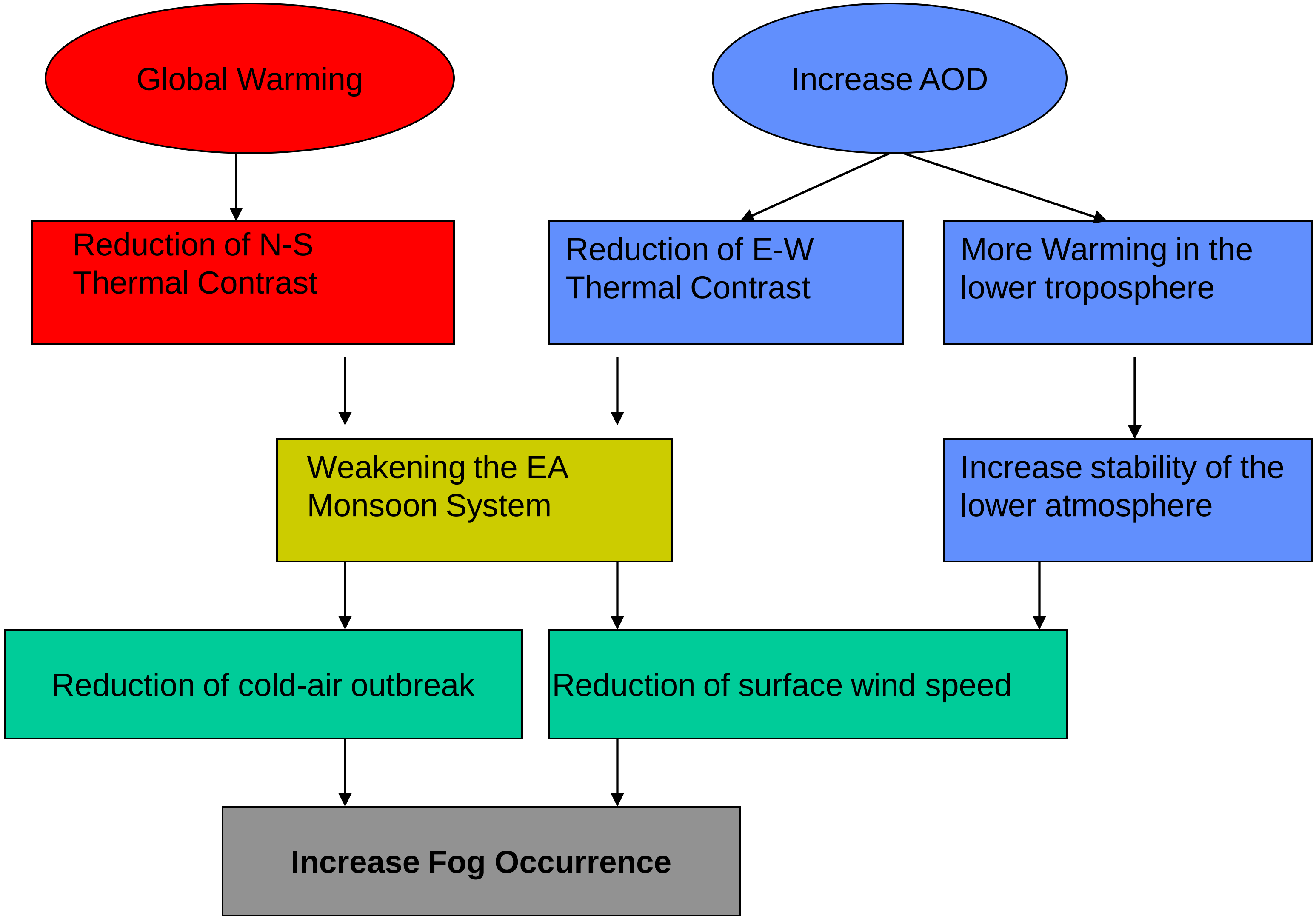


(b) Changes

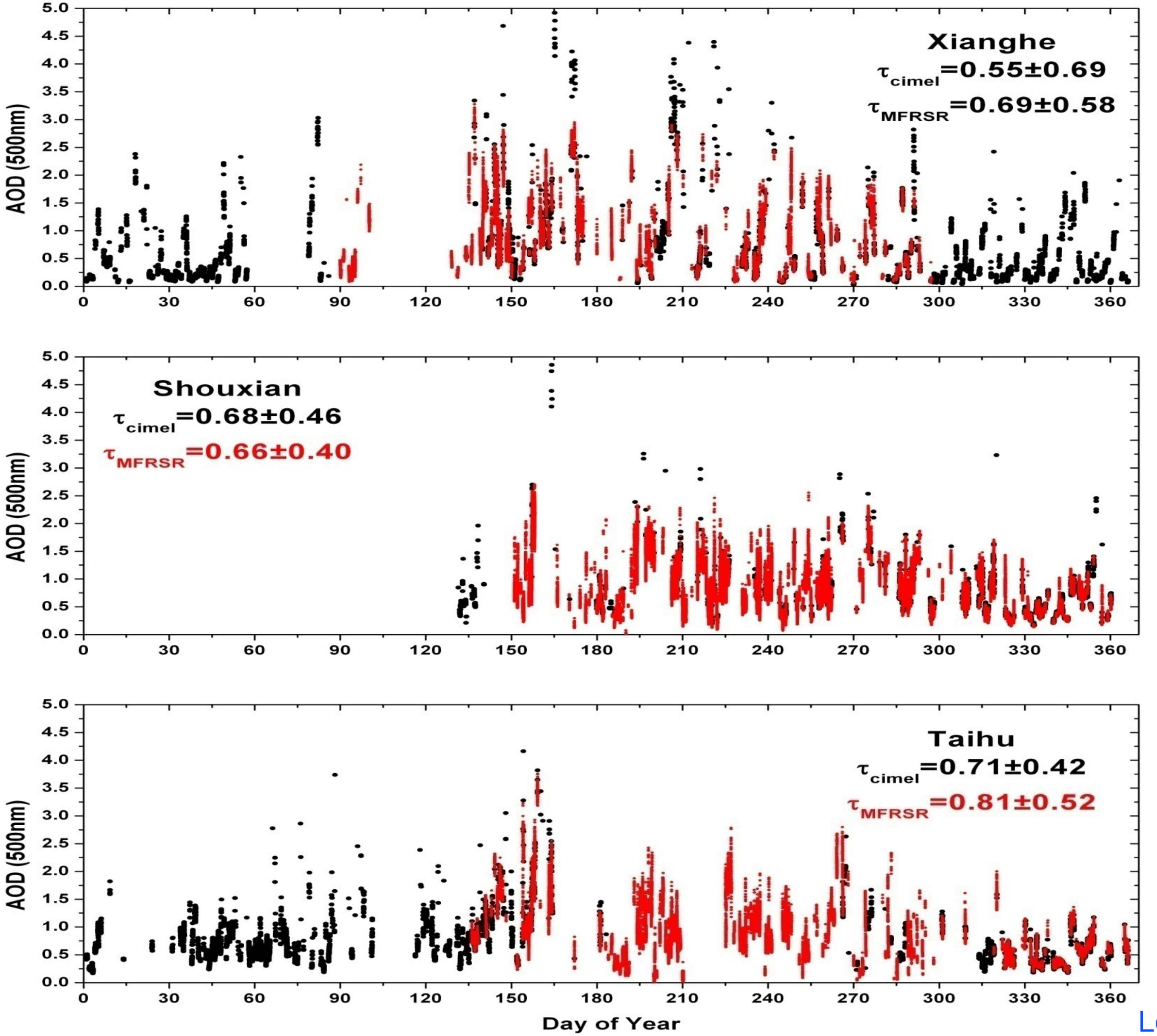


Niu et al (2010)

Aerosol-Monsoon Mechanisms



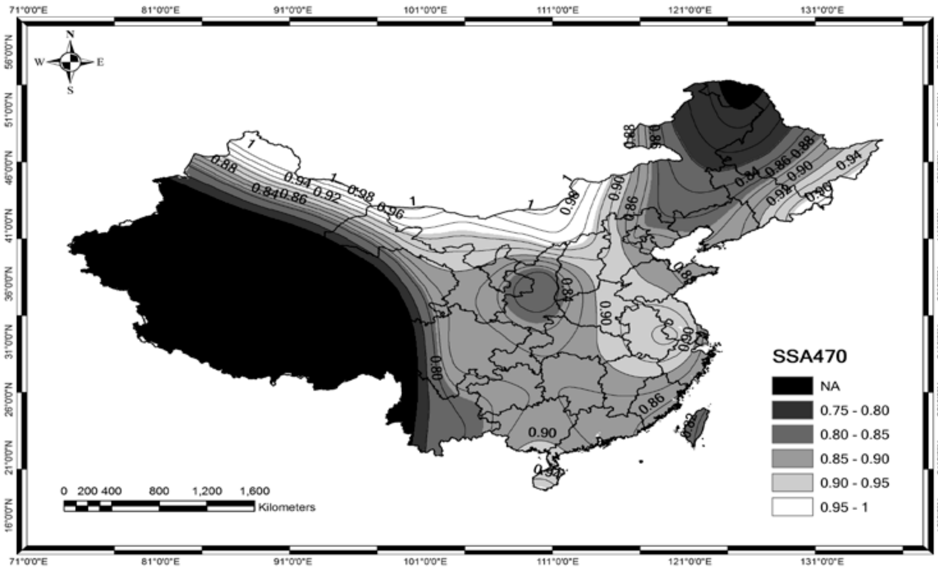
AOD records during 2008



Black: Cimel
Red: MFRSR

Lee et al. 2010

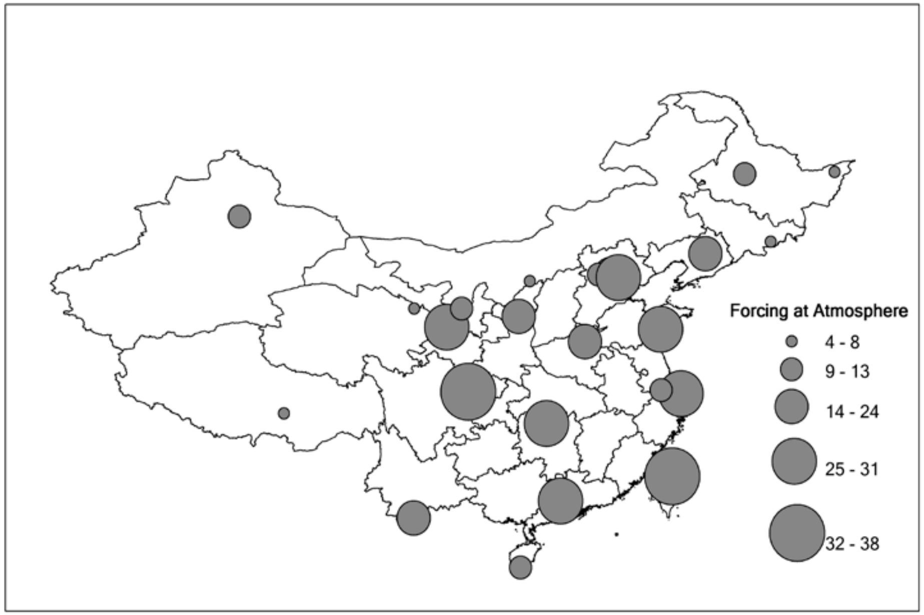
Aerosol single scattering albedo



A new method was proposed to estimate aerosol single scattering albedo by combing TOA reflectance with surface transmittance measurements at multiple wavelengths. The figure shows the results obtained over China

(Lee et al. 2007)

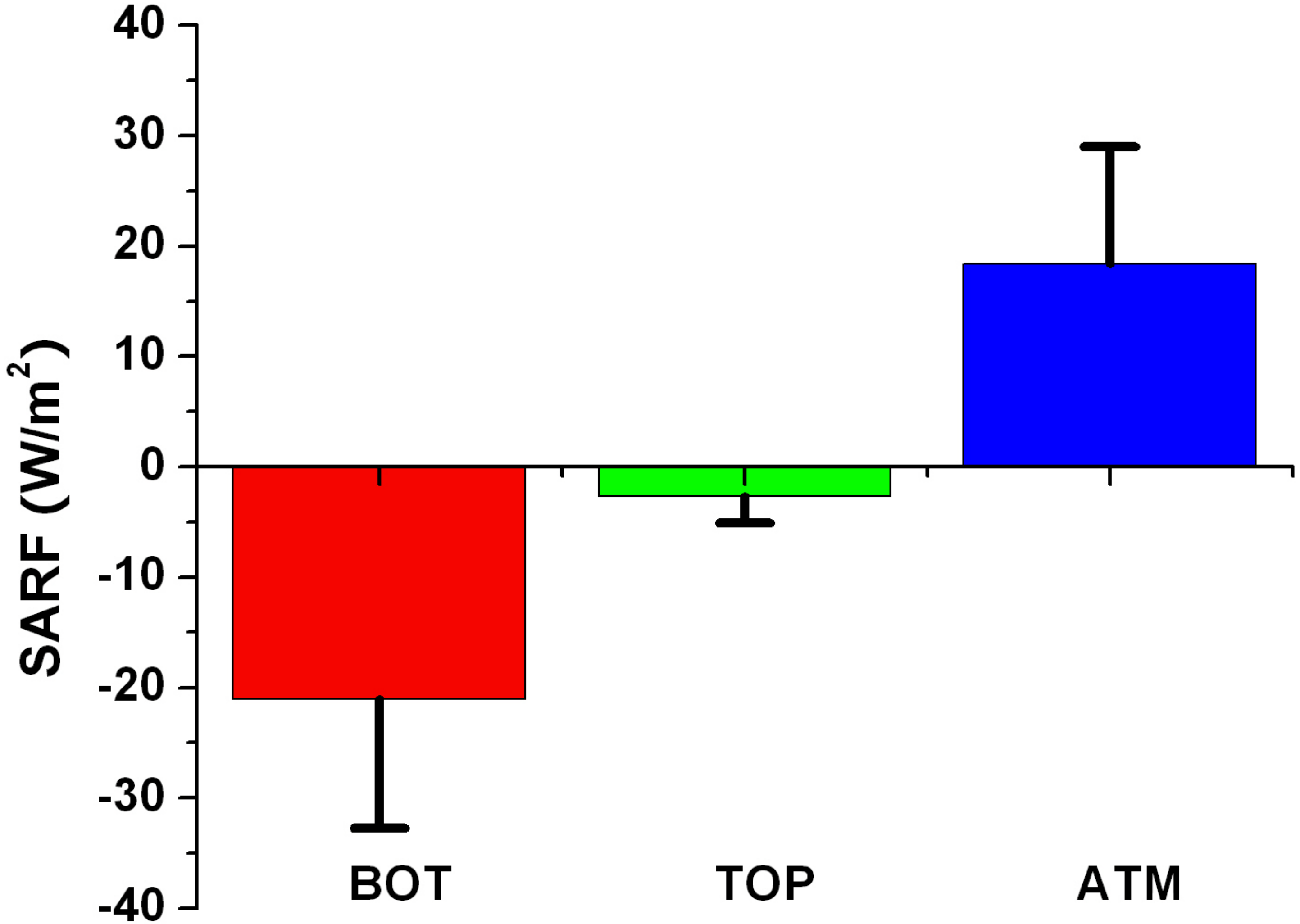
Aerosol radiative forcing in the atmosphere



By making use of ground-based measurements of aerosol optical depth and estimates of aerosol single scattering albedo, aerosol radiative forcing in the atmospheric column is computed across China for the first time, which show exceptionally strong warming effect

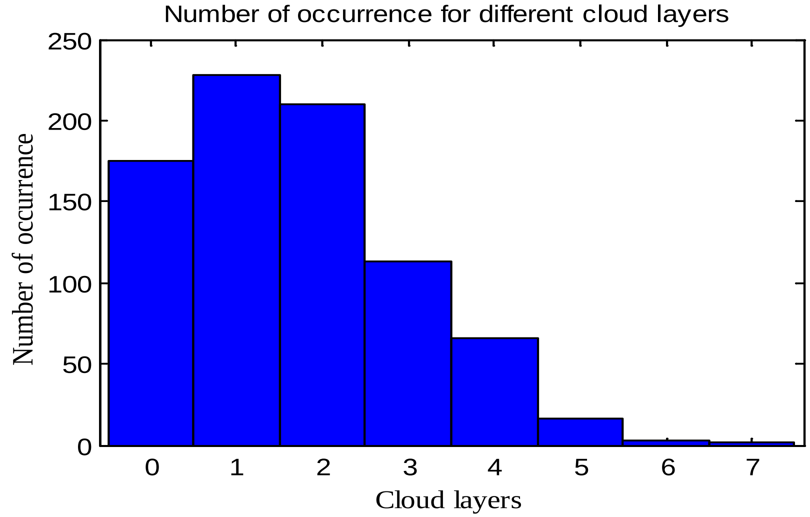
(Li et al. 2010)

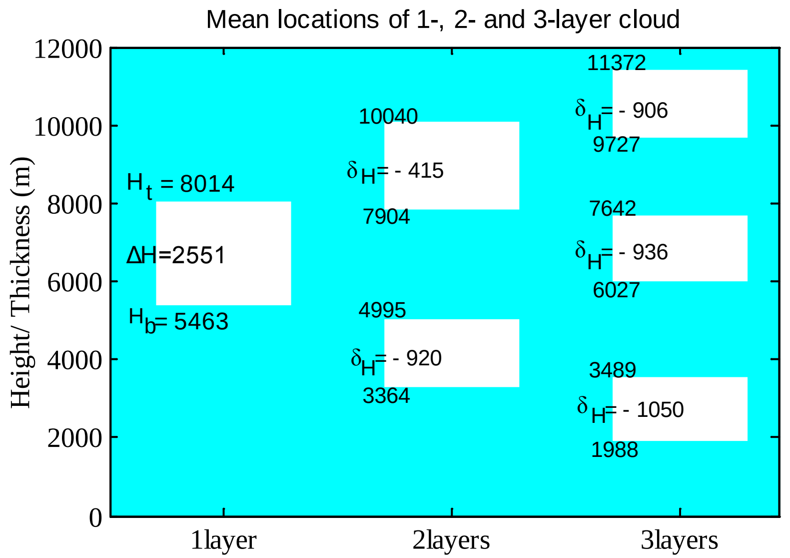
National Mean of Aerosol Radiative Forcing at the TOA, Surface and inside the Atmosphere

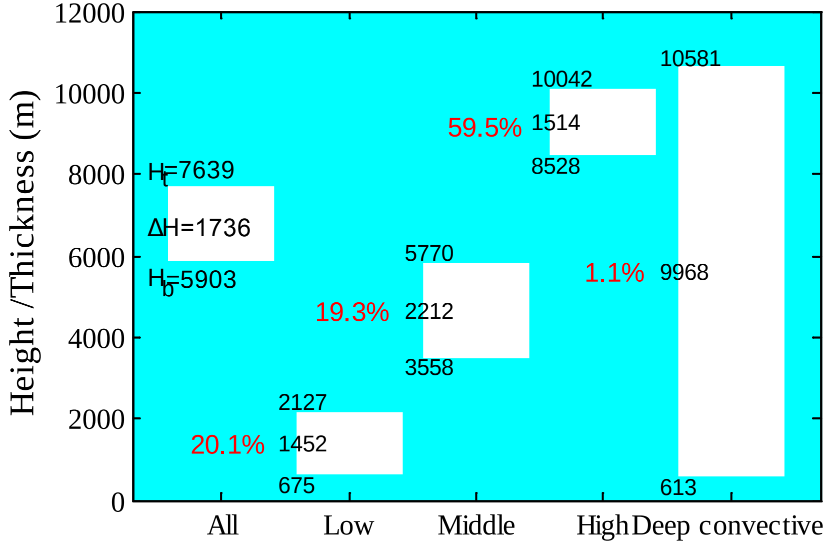


Li et al. (2010)

Cloud layer results determined by radiosonde



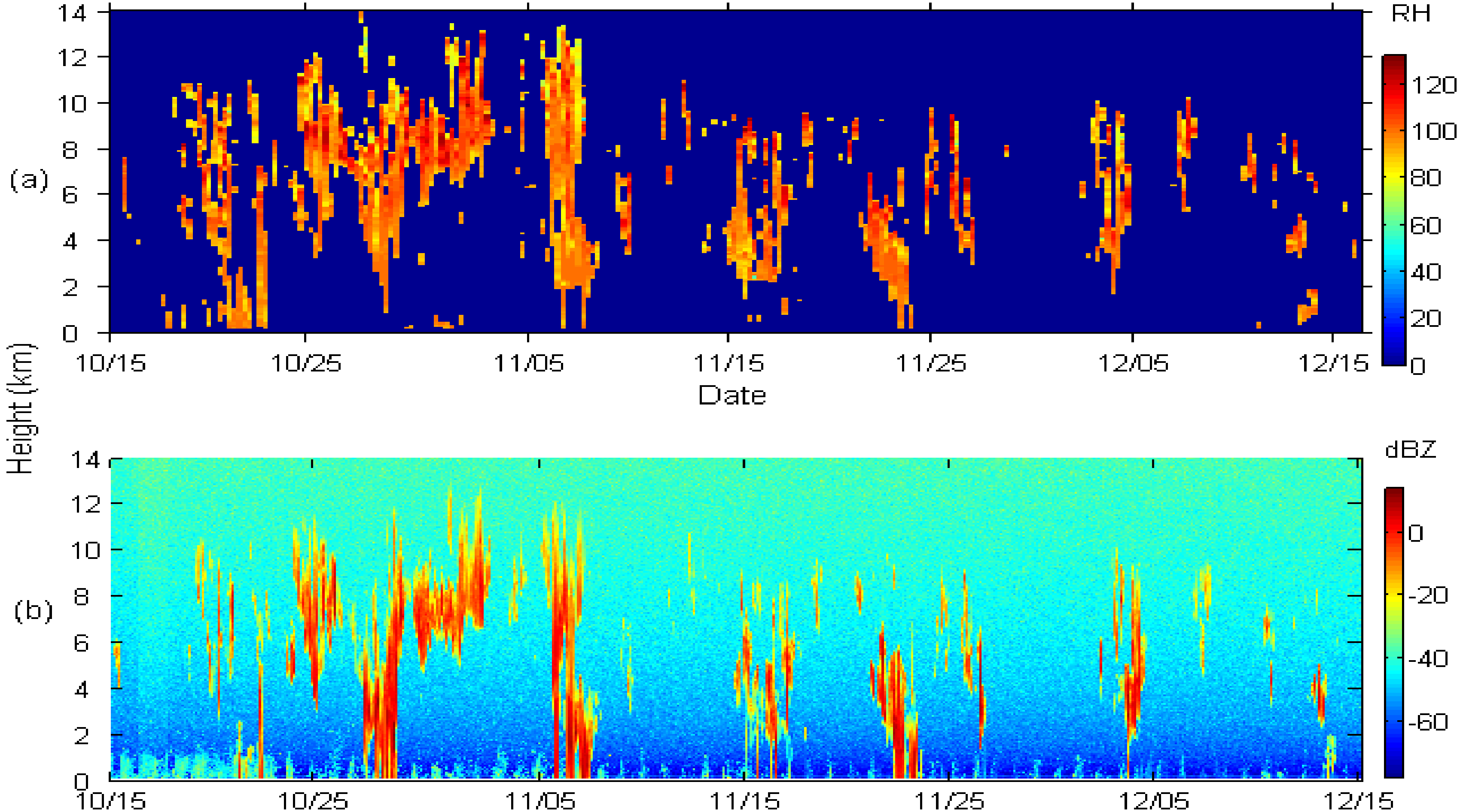




- Cloud-free cases and 1- to 3-cloud layers account for 21.5%, 28.0%, 25.8% and 13.9% of all cases, respectively.
- High clouds occurred most frequently.
- Single-layer clouds are thicker than multi-layer clouds with a mean difference of -867 m.

Zhang et al. (2010)

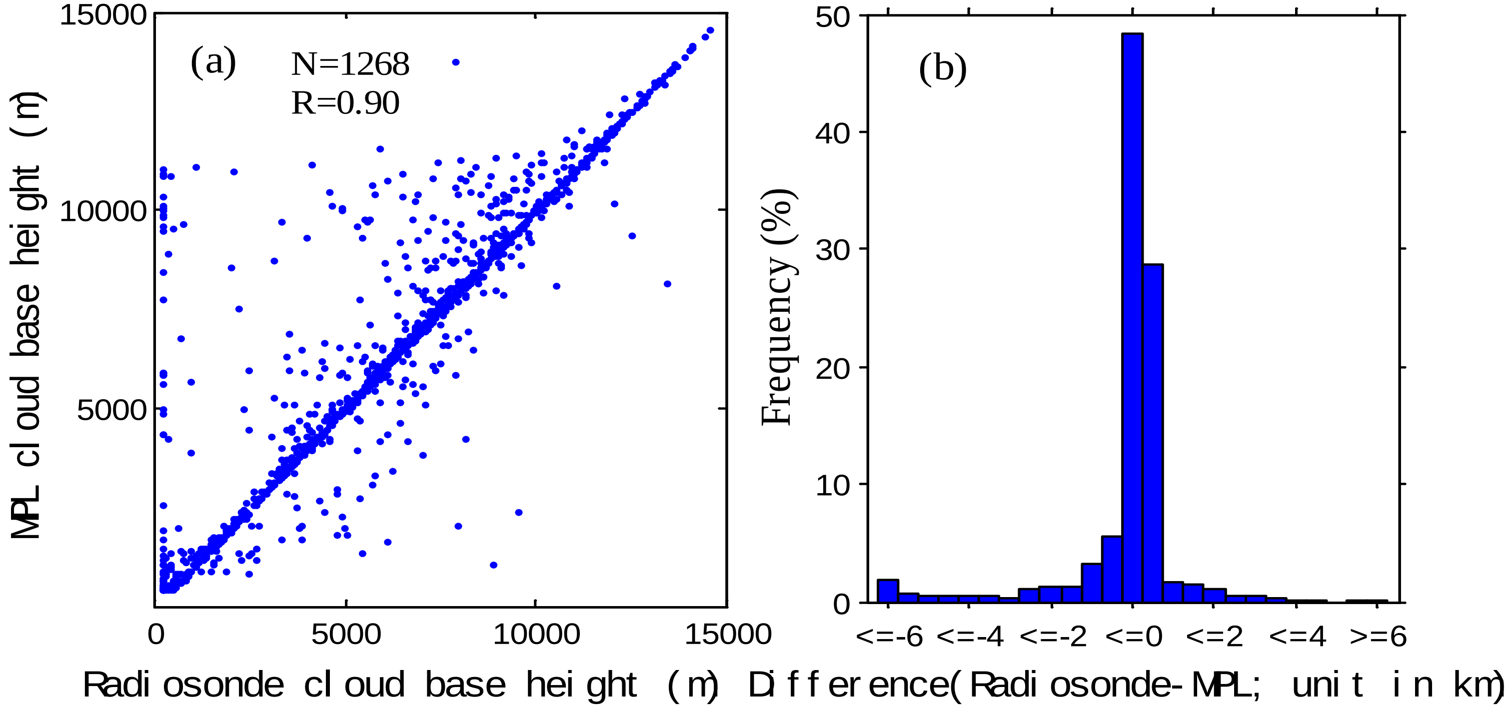
Comparisons between the radiosonde and the WACR



The two detections are very similar, but several thin clouds in the radiosonde observations which are not detected by the WACR.

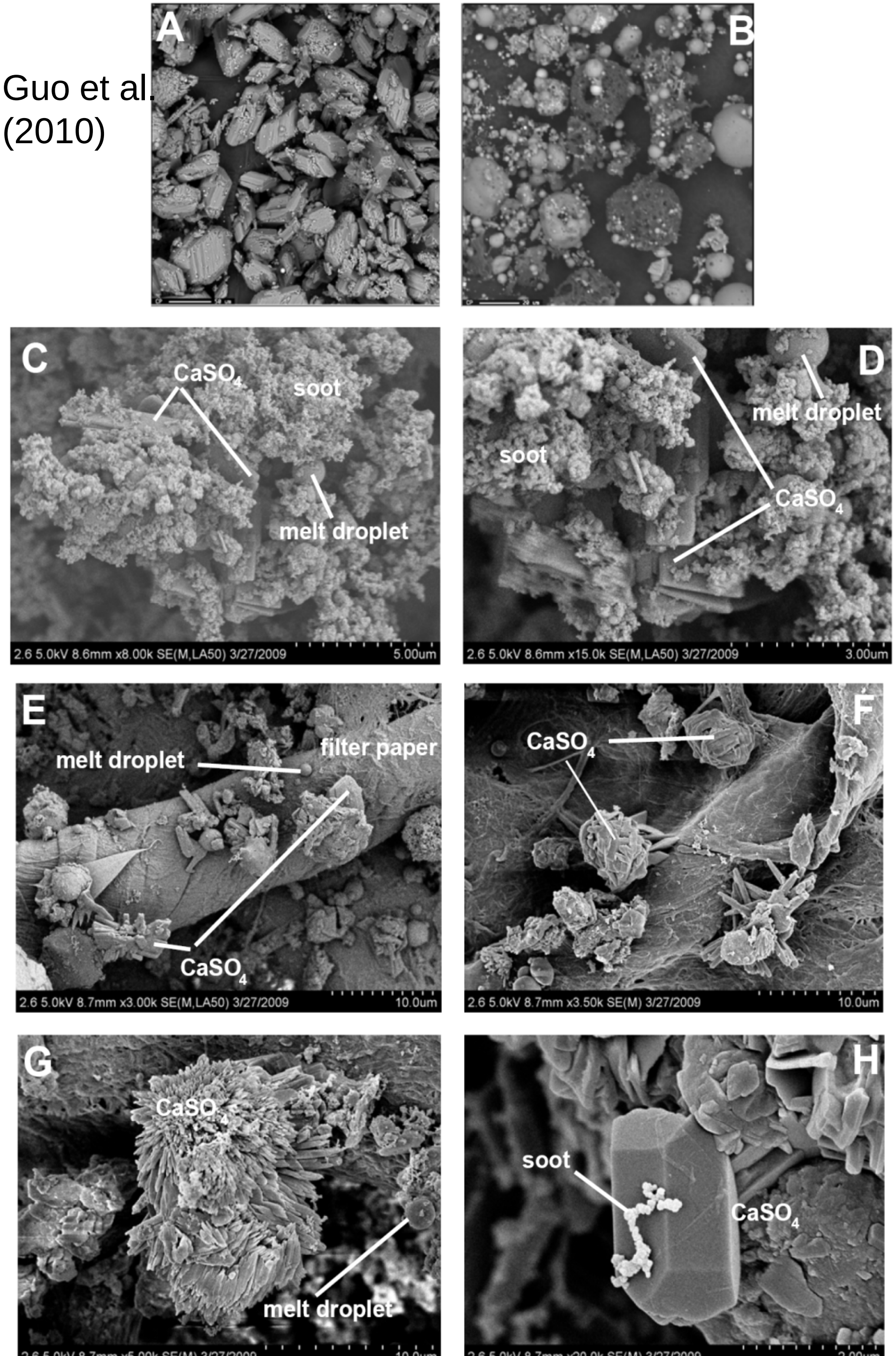
Zhang et al. (2010)

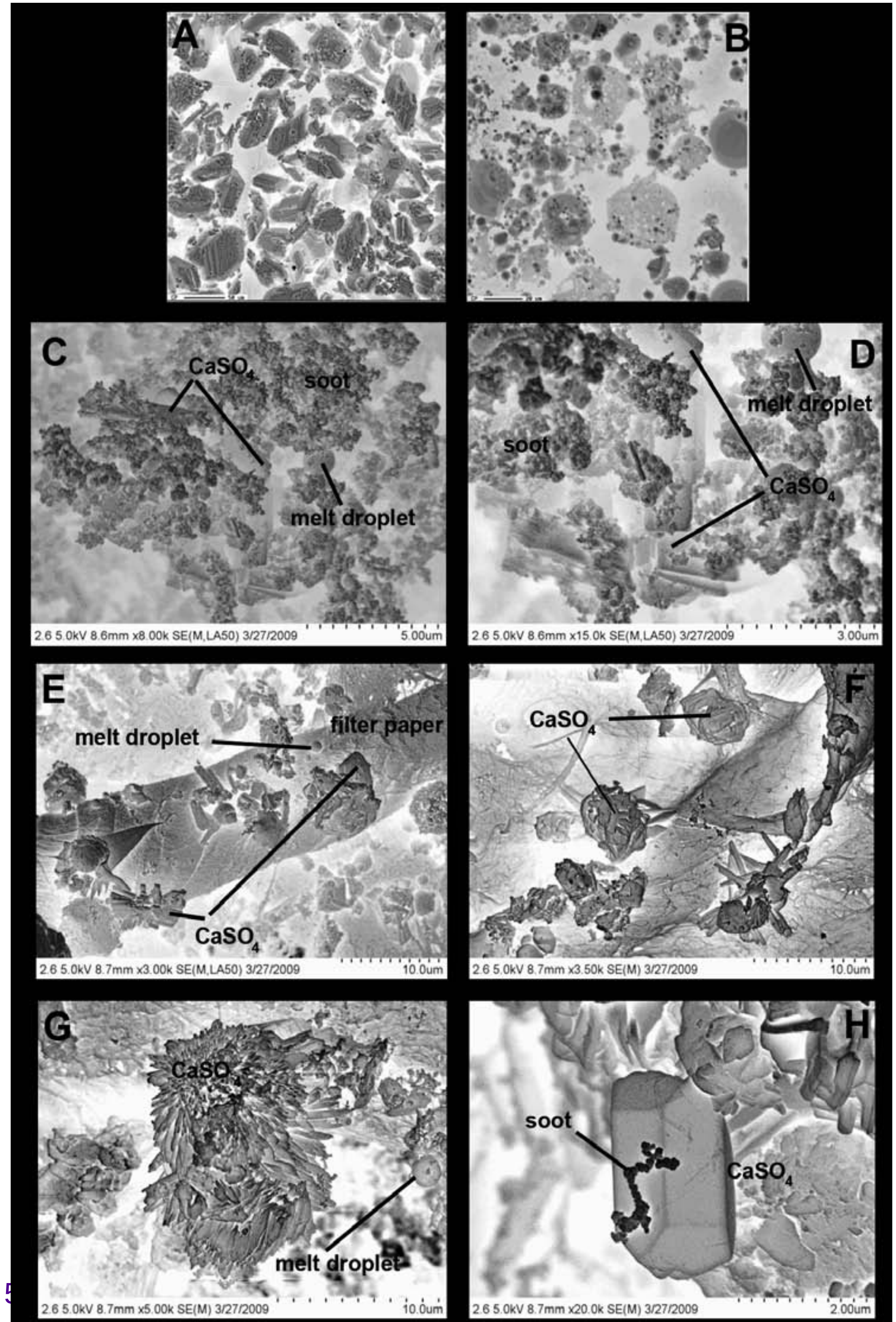
Cloud base detection comparisons between the radiosonde and MPL



- The absolute differences (ΔH) are less than 500 m for 77.1% .
- The average ΔH is 639m, and the average difference is -389 m.

Guo et al. (2010)





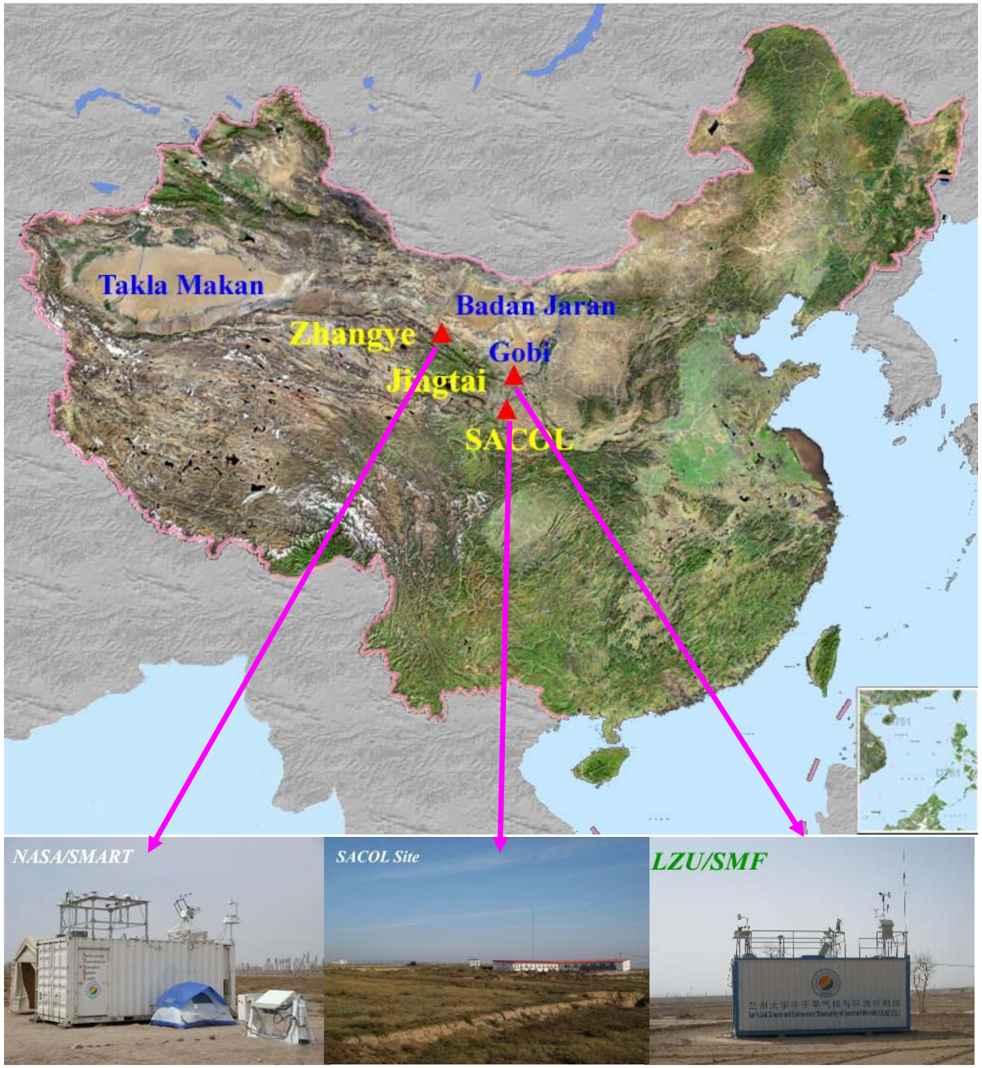
2008 China-US Joint Experimental

Jianping Huang et al.

College of Atmospheric Sciences

Lanzhou University

P.R. China



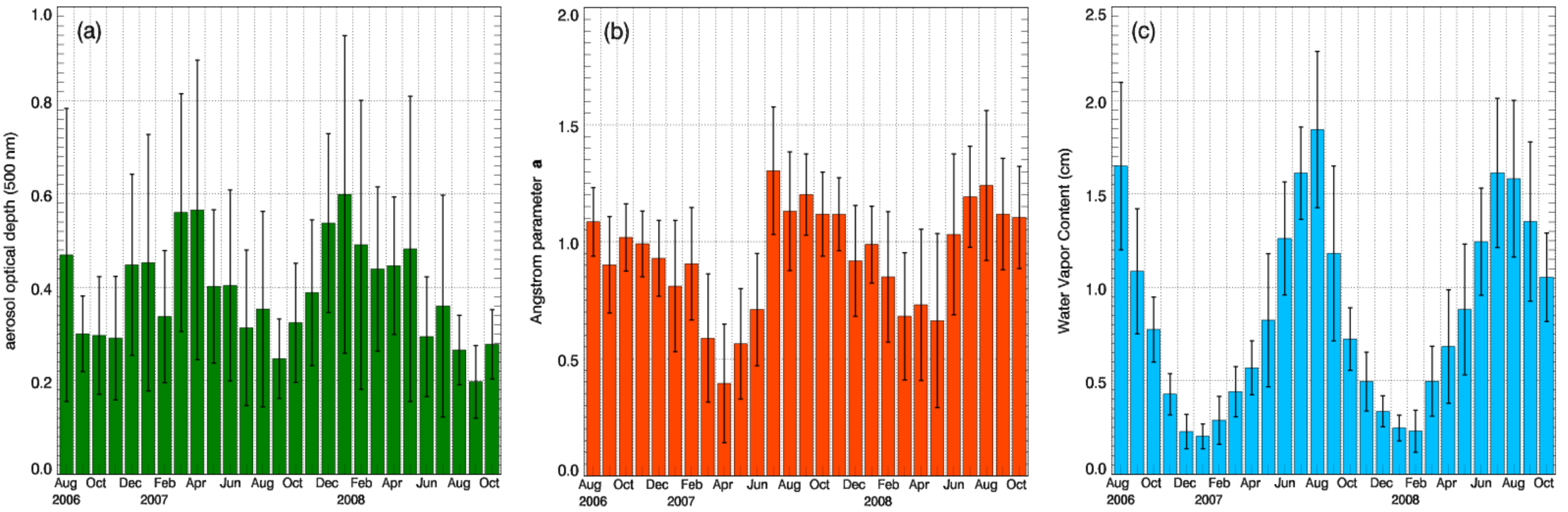
(a) 39.08ºN,100.28ºE,1460m (b) 35.95ºN,104.14ºE,1970m (c) 37.34ºN,104.14ºE,1592m

Map of three sites for 2008 Field Experiment

2008 China-US Joint Field Experiment & SACOL Observation

Jianping Huang et al.

College of Atmospheric Sciences, Lanzhou University, Lanzhou, 730000, PRC



Two-year average value (SACOL):

AOD at 500nm: 0.35±0.21

Ångström parameter: 0.93±0.34

WVC: 0.77±0.52cm

Fig 15. Mean monthly values of (a) AOD at 500 nm, (b) Ångström parameter, and (c) water vapor content at SACOL. The bars indicate one standard deviation.

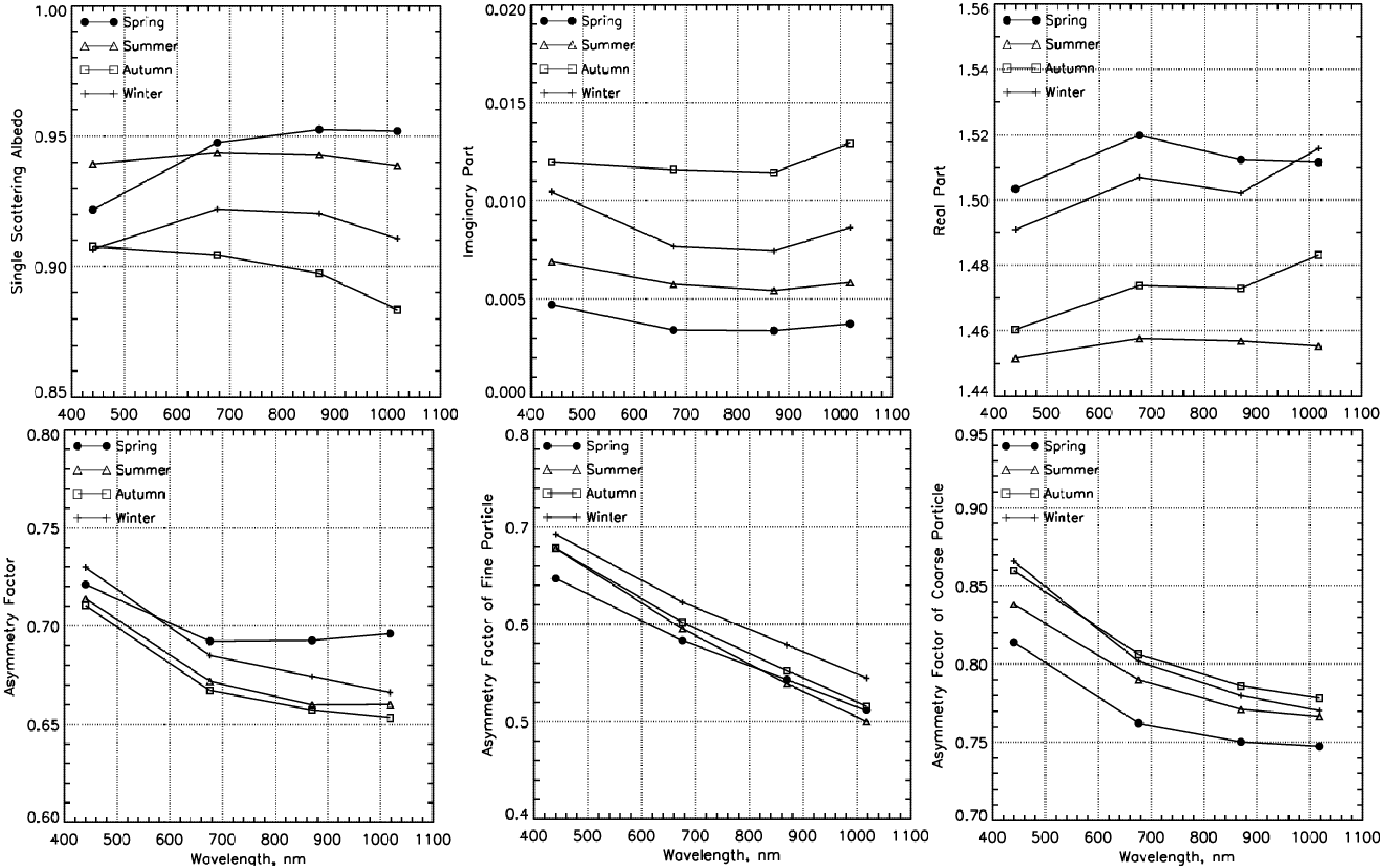
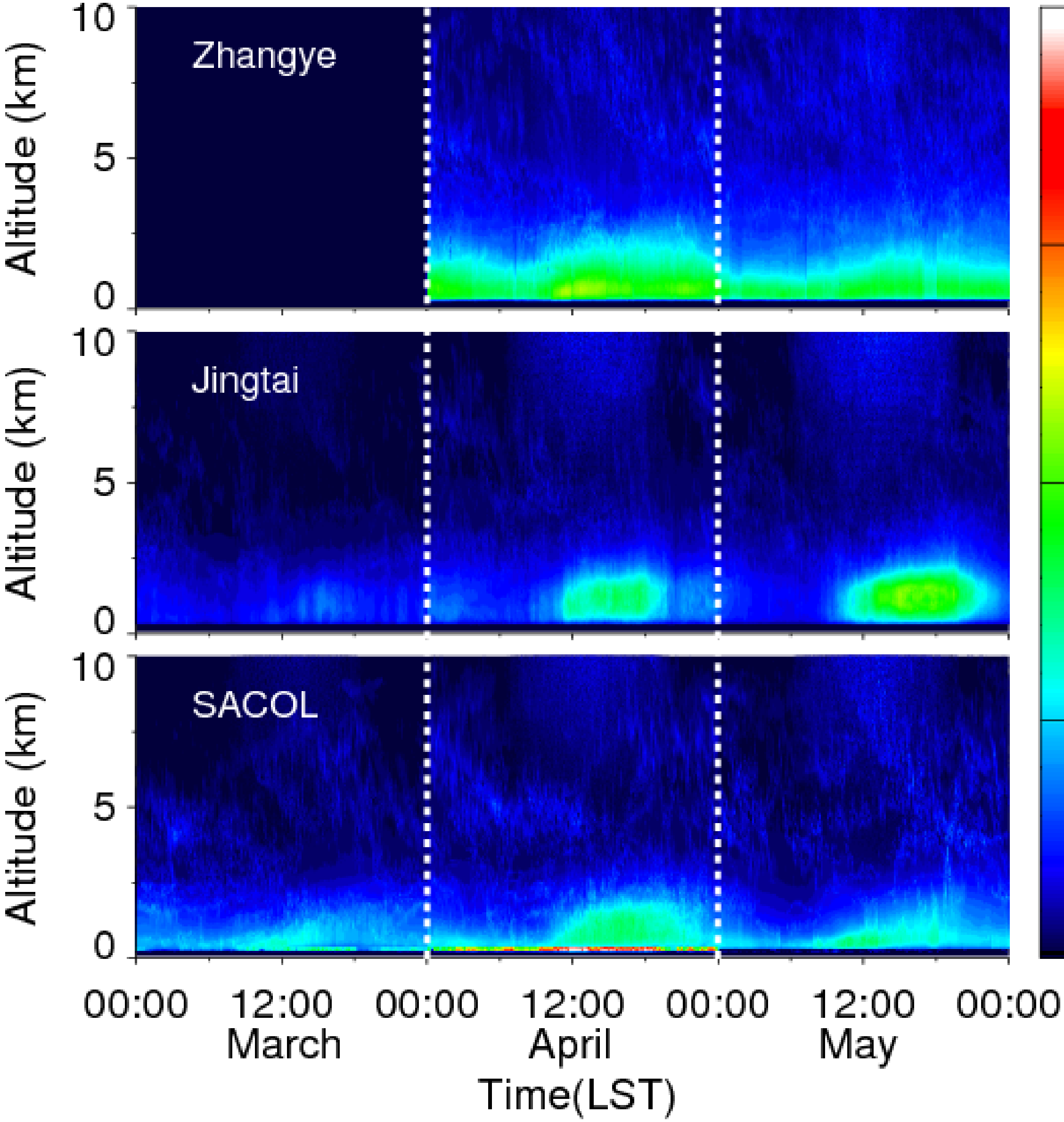


Fig 18. Seasonal spectral values of retrieved SSA, ASY, the real and imaginary parts of refractive indices, ASYs of fine and coarse particles at SACOL.



aerosol particle concentrations are much higher in the afternoon than in the morning!!

Fig 1. Diurnal cycle of monthly average aerosol vertical structure at Zhangye, Jingtai, and SACOL sites from Mar. to May 2008. [Huang et al., 2009]

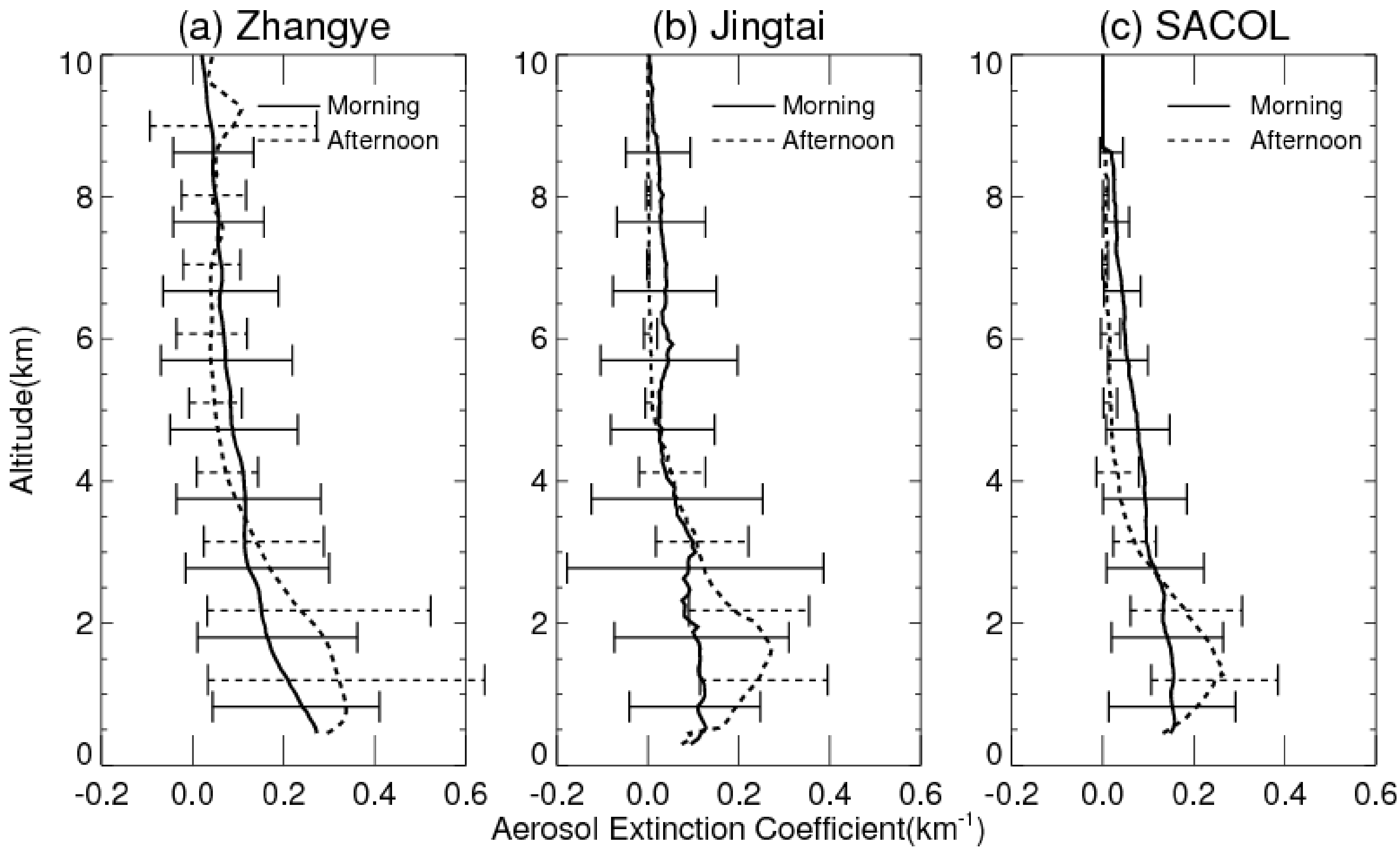
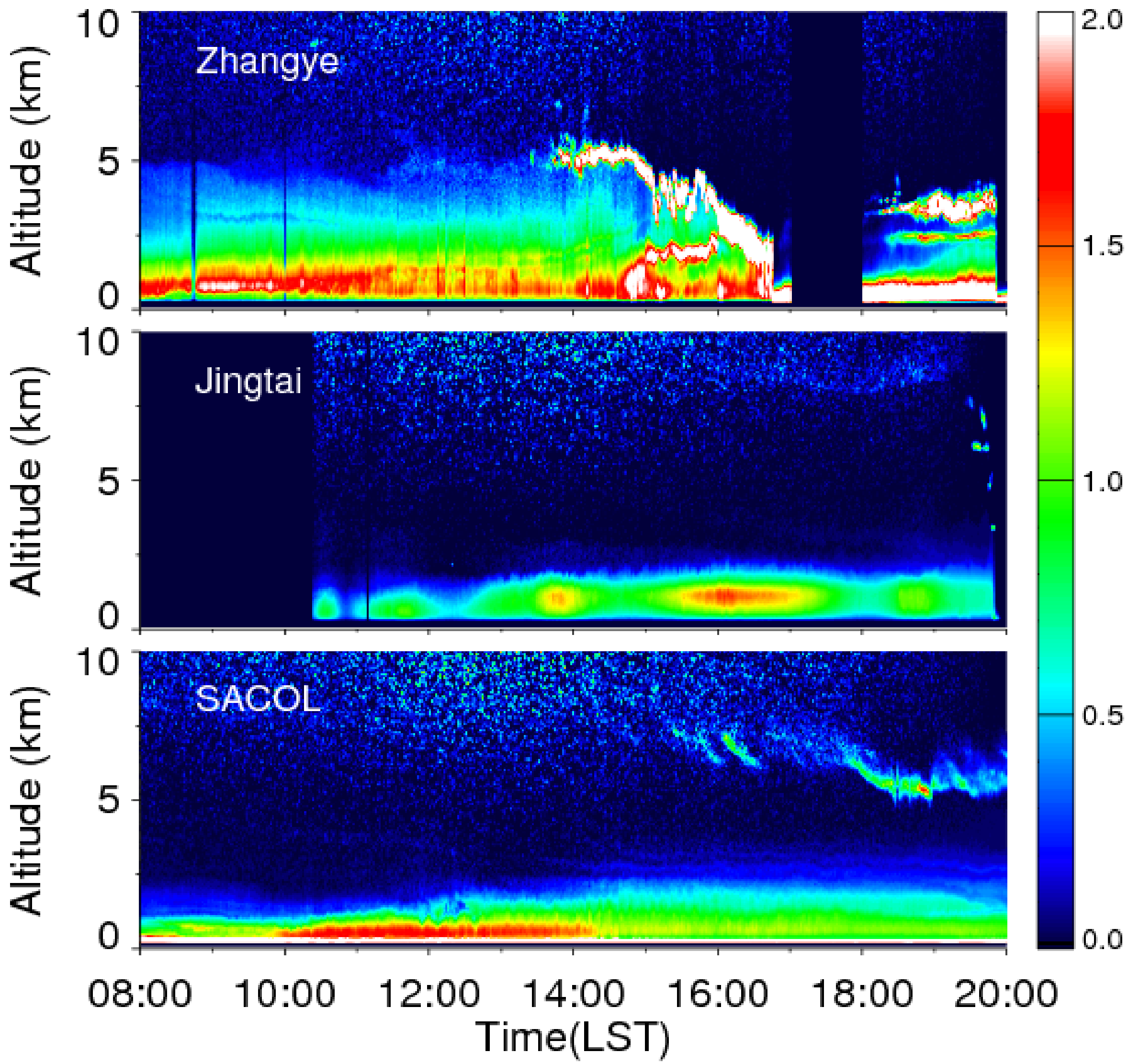


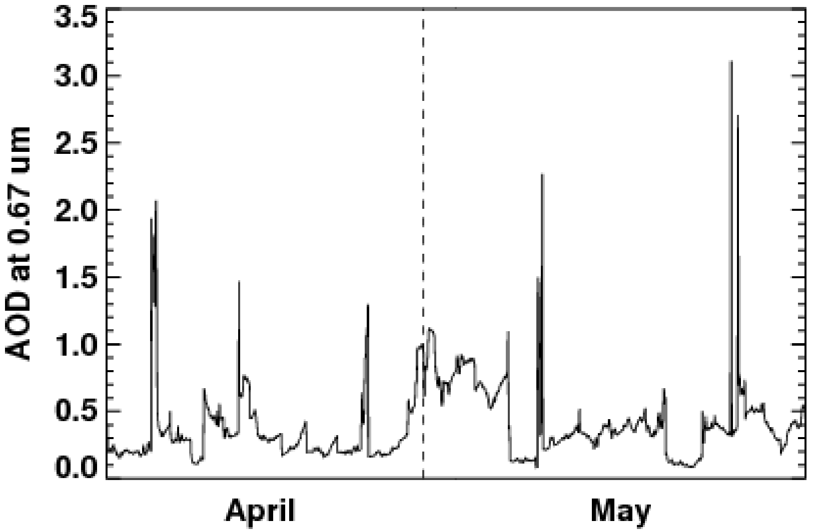
Fig 2. Seasonal average vertical profiles of aerosol extinction coefficients at three sites from Mar. to May 2008. Error bars are standard deviations computed from the vertical bins of each profile. [Huang et al., 2009]



Case Study:

A heavy dust event happens at three sites on May 2th 2008!

Fig 4. MPL normalized relative backscatter at Zhangye (39.08N, 100.27E), Jingtai (37.33N, 104.14E), and SACOL (35.95N, 104.14E) sites on May 2th 2008. [Huang et al.,2009]



AOD ranges from 0.08 ～ 3.1 at Zhangye site!

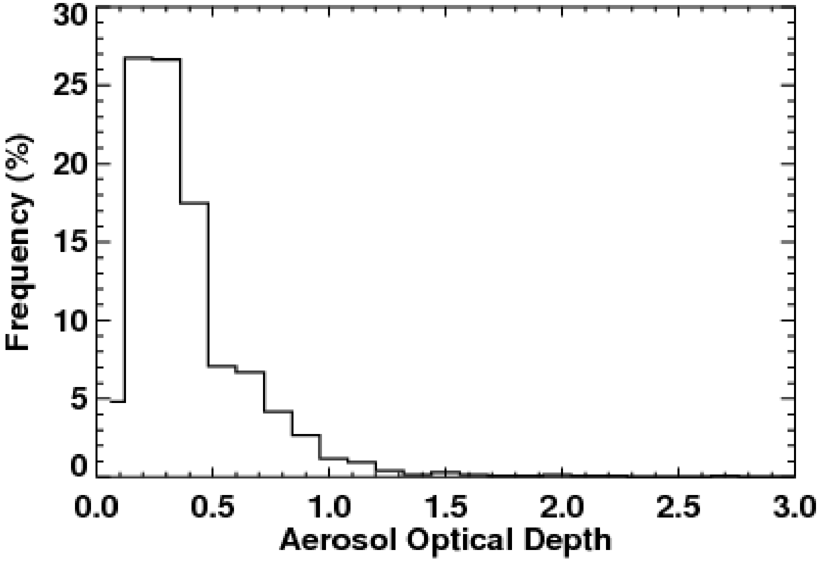
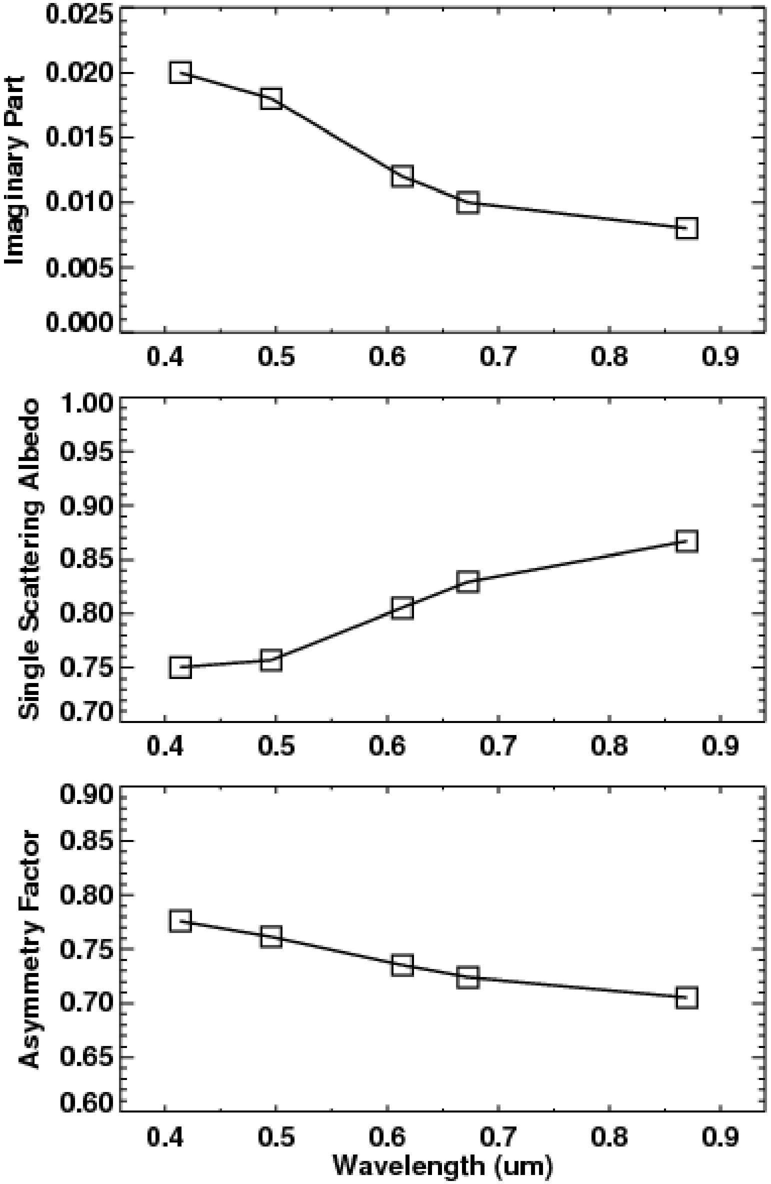
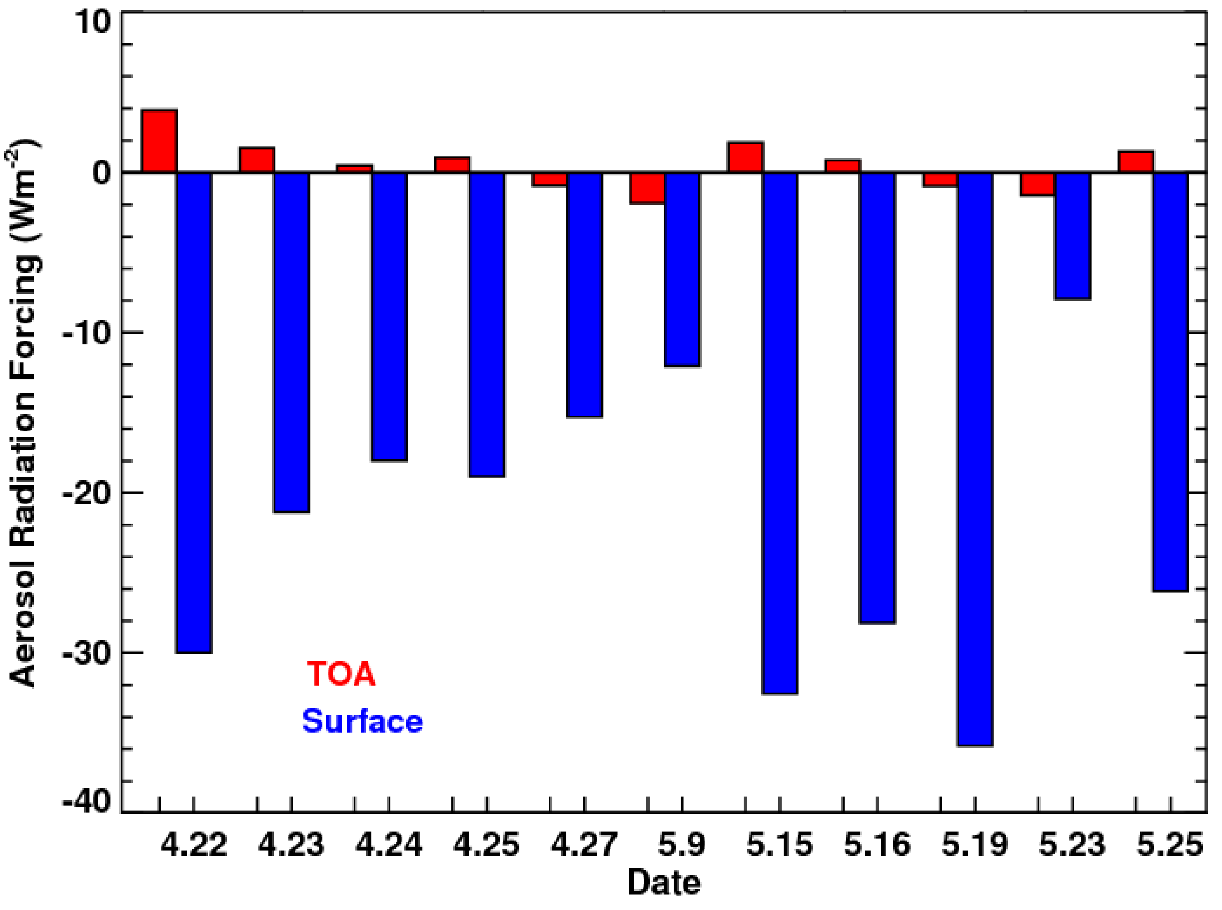


Fig 7. Time series of AOD at 0.67 μm and frequency distribution during the periods of April and May from CIMEL measurements at Zhangye site. [Ge et al., 2009]



Imaginary part:0.02～0.008
SSA: 0.75～0.87
ASY : 0.78 ～ 0.71
[From MFRSR]

Fig 11. Retrieved spectrally-dependent values of the imaginary part of refractive indices, SSA, and the ASY for the April 24 case at Zhangye site. [Ge et al., 2009]



ARF mean value:

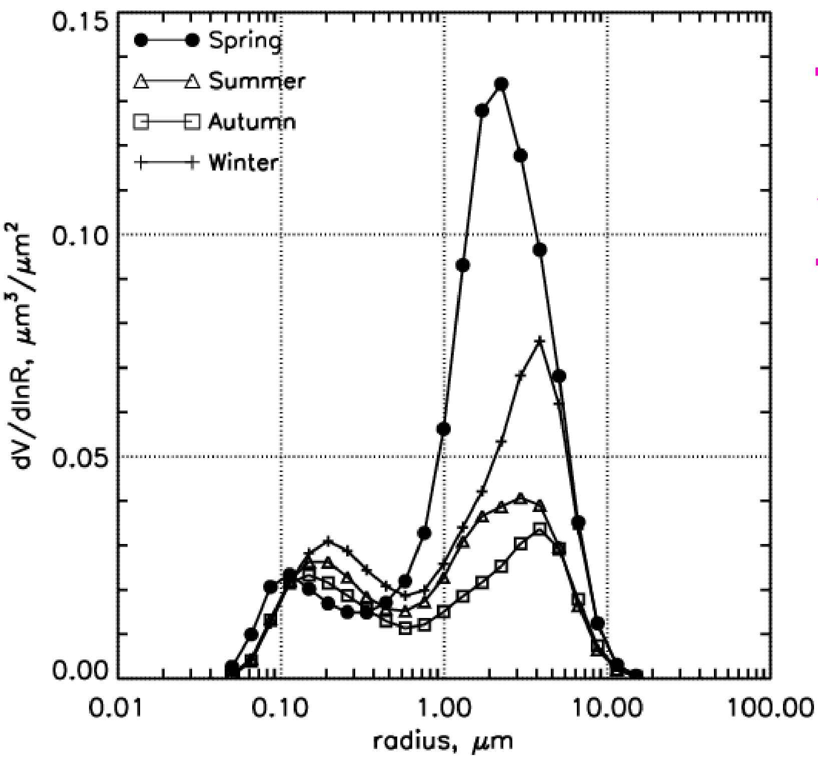
Surface:

-22.4±8.9 Wm^{-2}

TOA:

-2 ～ +4 Wm^{-2}

Fig 13. Daily-averaged direct aerosol radiative forcing at the surface (blue bars) and TOA (red bars) for the 11 cases. [Ge et al., 2009]



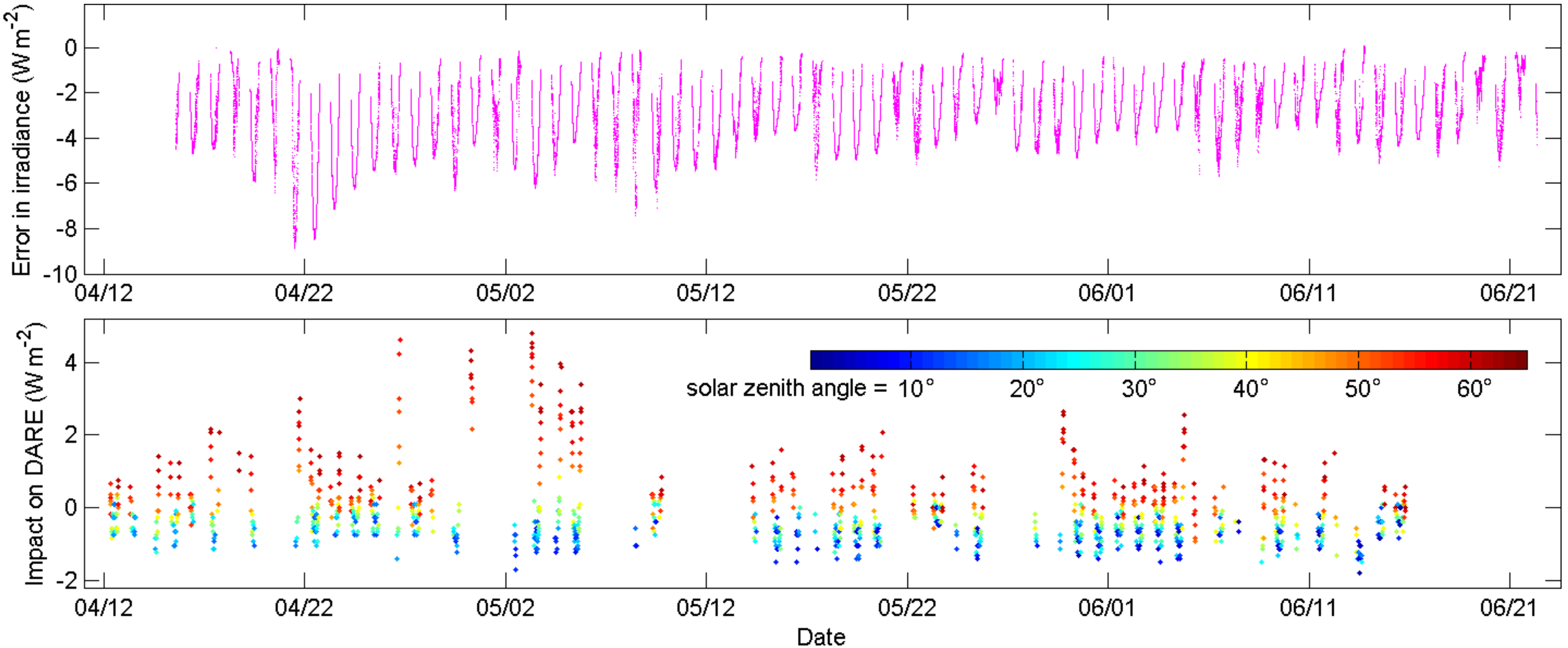
The fine mode shows relative stability, while the coarse fraction changes significantly in Spring!![due to dust events]

Fig 17. Seasonal aerosol volume size distributions in the total atmospheric column at SACOL.[from 2006 to 2008]

Studies done by S.-C. Tsay's Team

- **Pyranometer dome effect and impact on DARE**
- **MFRSR aerosol retrieval**
- **AERI cloud and dust retrieval**
- **In situ aerosol properties**
- **Satellite based study on transport and evolution of a plume (EAST-AIRE)**

Potential impact to direct aerosol radiative effect (DARE) by uncertainties in broadband solar irradiance measurements

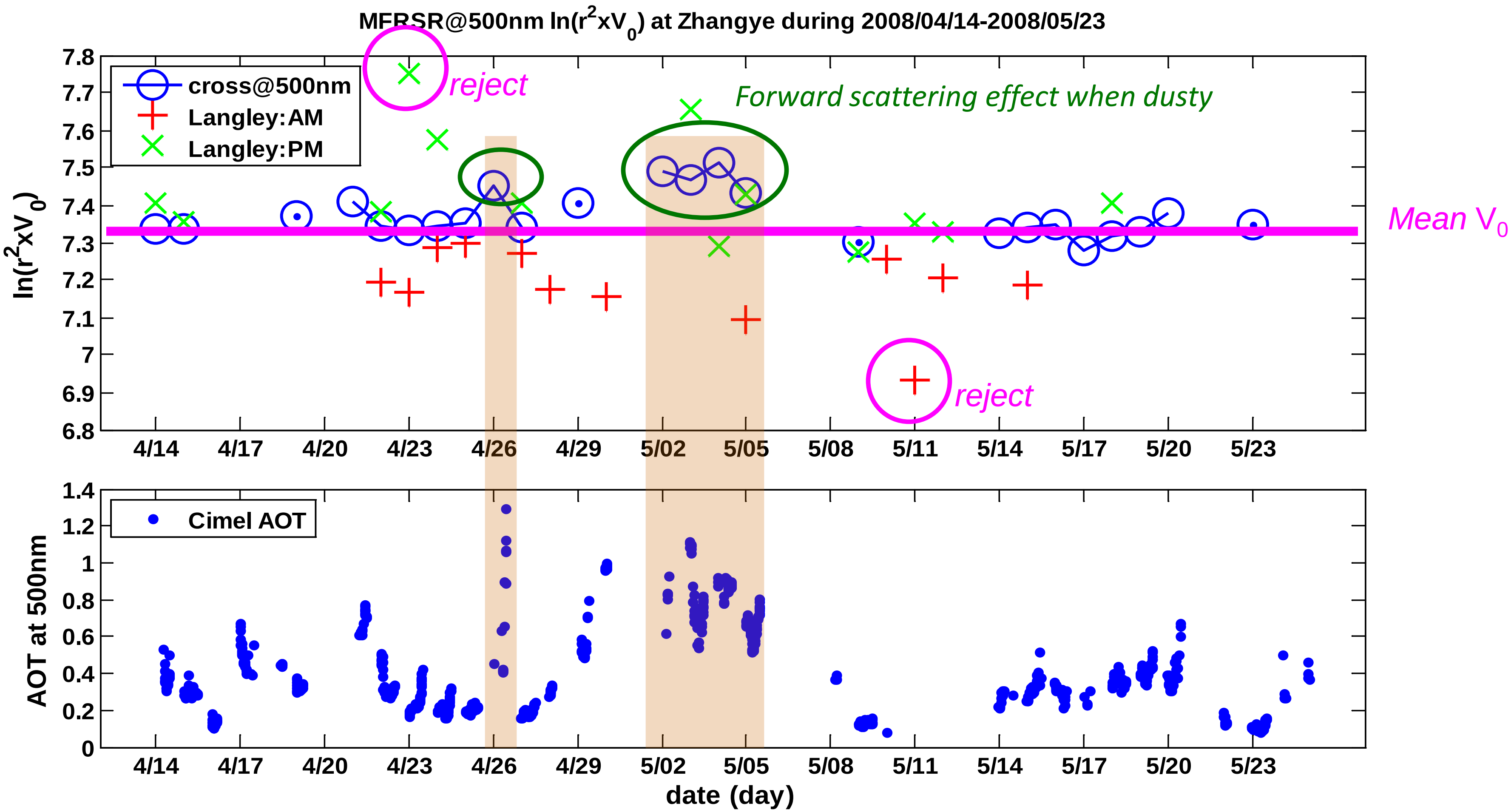


Upper: Error caused by ignoring the thermal dome effect (TDE) of a pyranometer, in Zhangye.

Lower: Resulting error in DARE; estimated with a sensitivity study based on Fu-Liou model calculations using the irradiance measurements as a constrain for selecting aerosol model.

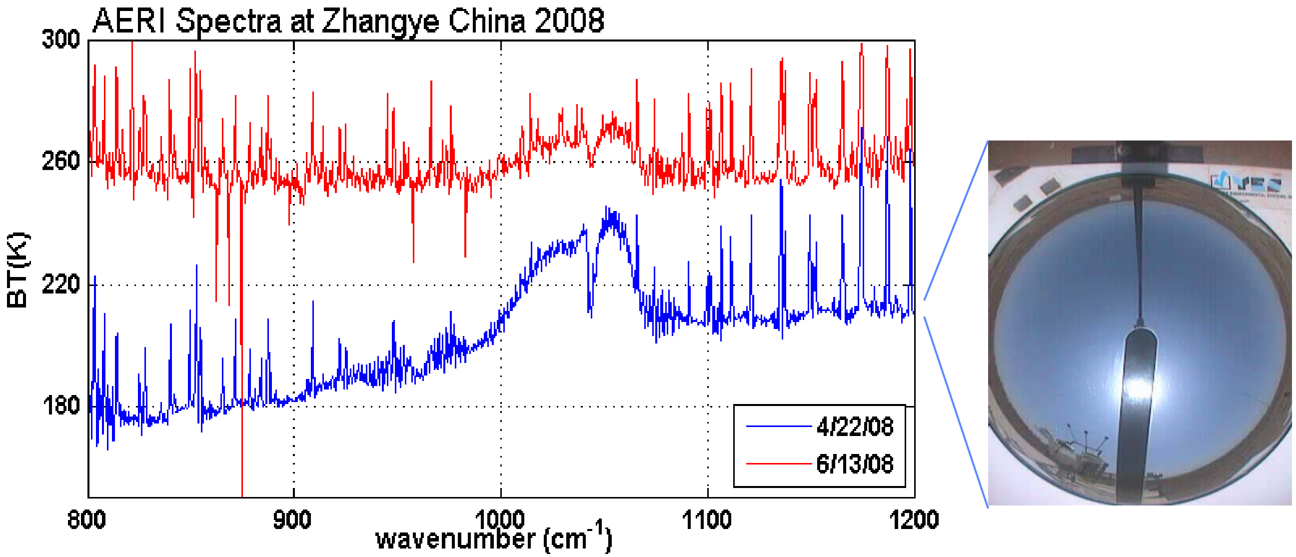
Summary: Without accounting for TDE, DARE can be underestimated by a couple of Wm^{-2} under small SZA, but overestimated by a few Wm^{-2} under larger SZA.
[*Ji & Tsay, JGR, 2009*, under review]

A method for improving MFRSR aerosol optical thickness retrieval

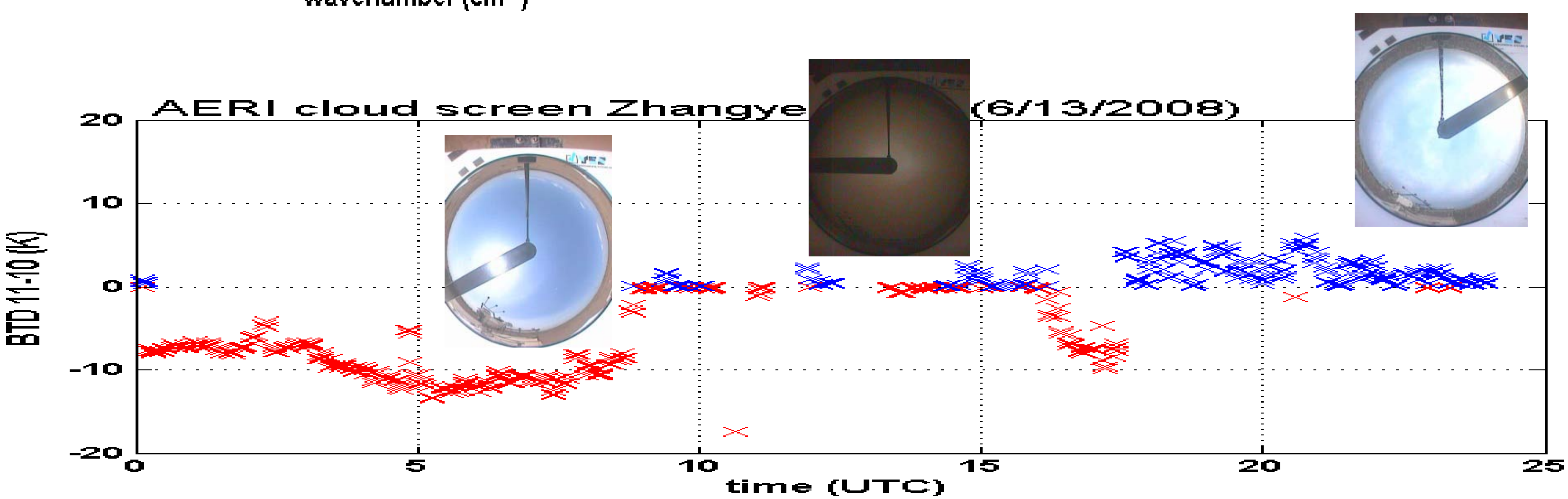


Summary: Using Cimel and MFR cross calibration, a reliable V_0 value for MFR can be determined, leading to a more accurate retrieval of AOT. Furthermore, the forward scattering from dust can also be estimated. [*S.-H. Wang et al., 2010*, in preparation]

Use AERI to Derive Cloud and Dust Properties

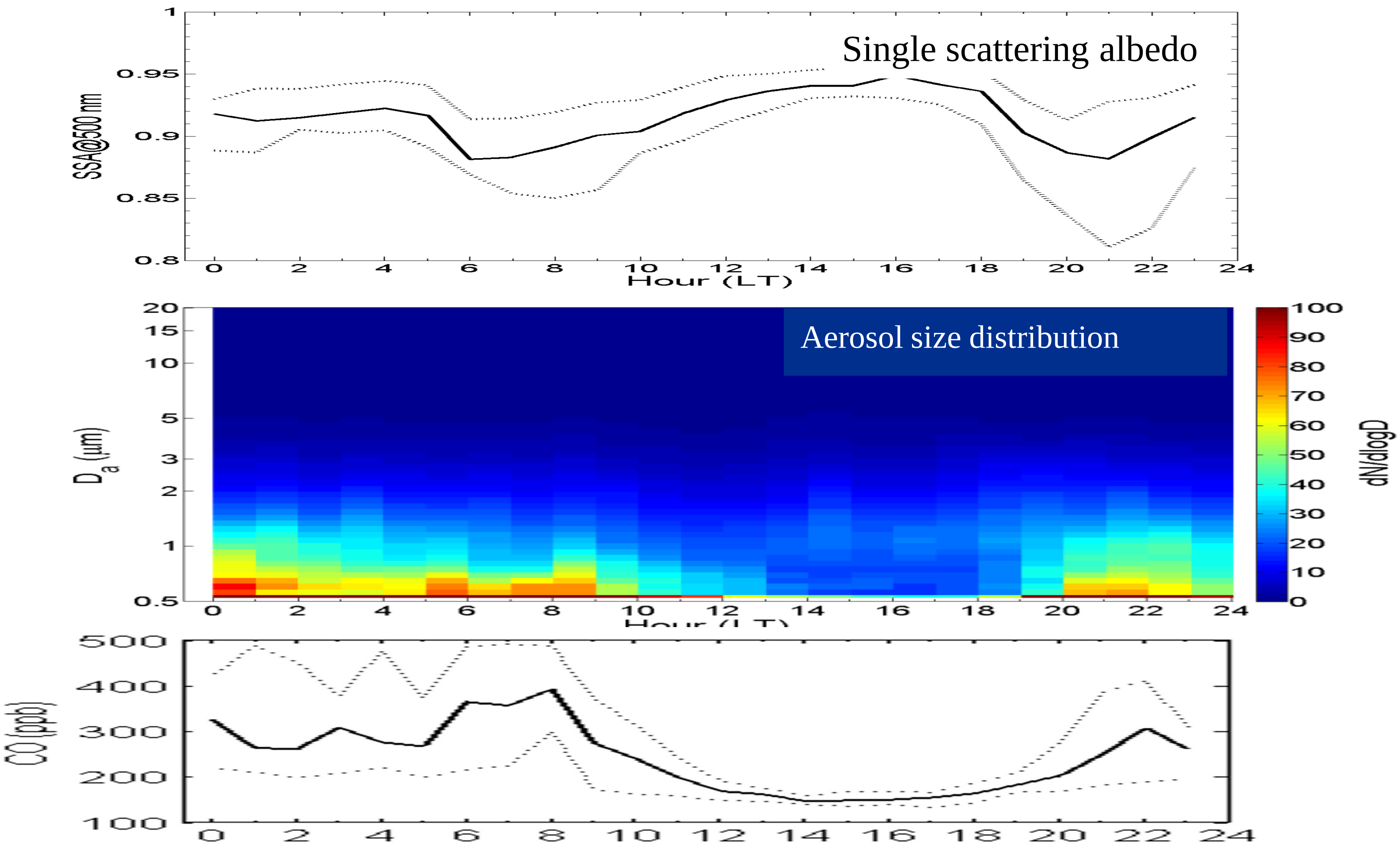


The differences in AERI spectra between 4/22 (blue, clear day) and 6/13 (red, dusty) indicate changes in both dust and cloud.



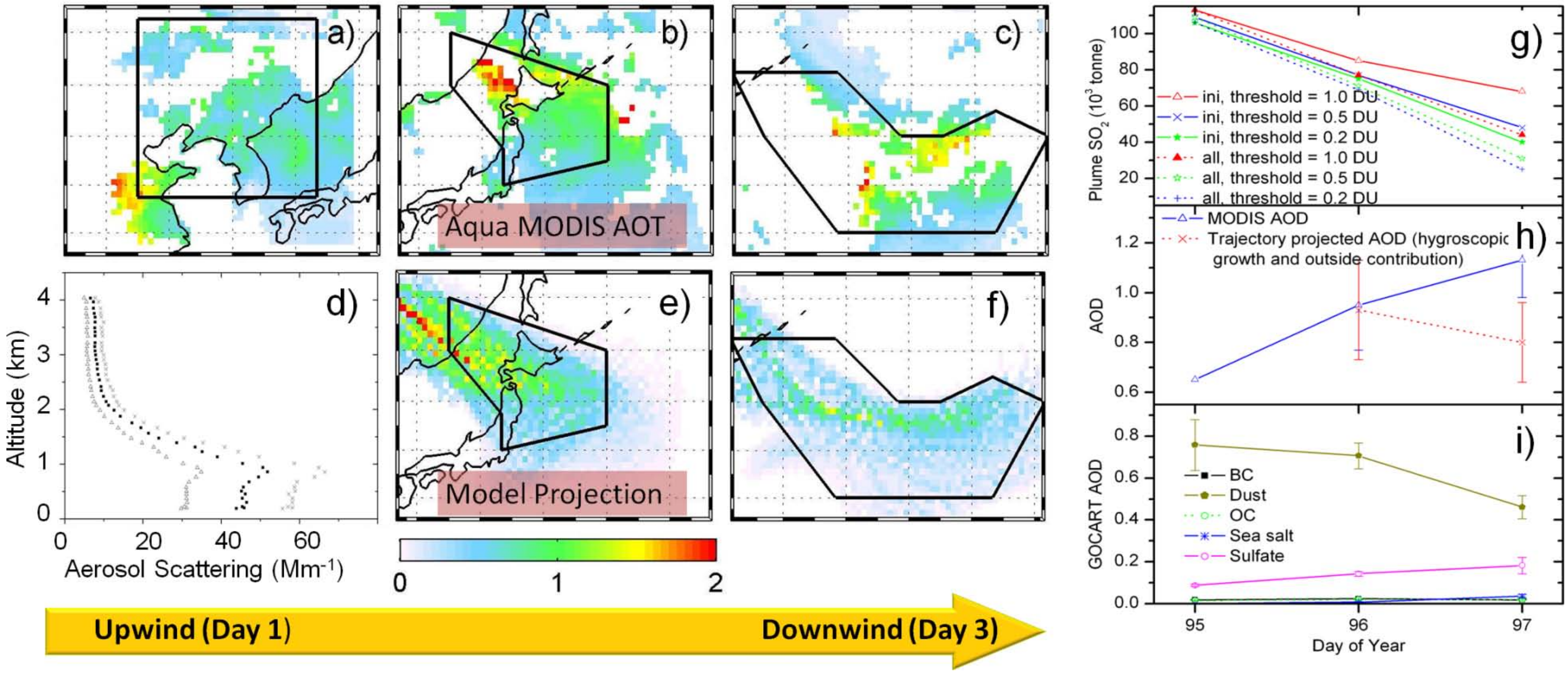
Summary: The AERI BTD 11-10 dust/cloud separation technique is robust for deriving cloud and dust properties.
[*Hansell et al., JGR, 2010*, in preparation]

Anthropogenic Pollution Observed in Zhangye, near an Important Dust Source Region in NW China



Summary: There was a diurnal change in pollution and aerosol composition and optical properties. Mixing between dust and pollutants were observed on a daily basis, and also during strong dust storms.
[*Li et al., JGR, 2010*, under revision]

Combine Multiple satellites, in situ measurements, and models to study the transport and evolution of aerosol plumes



Summary: **a)**, **b)**, and **c)** Aqua/MODIS-retrieved AOD used to track the propagation of a regional aerosol plume, from its source region over NE China to the NW Pacific (Day 1-3).

d) Aerosol vertical profiles from in-situ measurements over NE China on April 5.

e) and **f)** The projected aerosol plume, combined with (**b**, **c**) satellite data, can be used to characterize the evolution of the plume during transport.

g) The satellite-observed decrease in SO_2 and **h)** change in aerosol loading implies possible conversion from aerosol precursor to aerosol particles, and **i)** chemical transport modeling can provide aerosol species information to help interpret the above results.

[*Li et al.*, *JGR, 2010*]

Special Section Papers in J. Geophy. Res.

EASTAIRC1- East Asian Study of Tropospheric Aerosols and Impact on Regional Climate
(42 papers submitted**, 13** published & in press**; 7** revised or under revision**, 7** submitted, >20 rejected**)**

Papers published and in press (13)

Li, C., N. A. Krotkov, R. R. Dickerson, Z. Li, K. Yang, and M. Chin (2010), Transport and evolution of a pollution plume from northern China: A satellite-based case study.

Qian, Y., D. Gong, J. Fan, L. R. Leung, R. Bennartz, D. Chen, and W. Wang (2009), Heavy pollution suppresses light rain in China: Observations and modeling.

Guo, Z., Z. Li, J. Farquhar, A. J. Kaufman, N. Wu, C. Li, R. R. Dickerson, and P. Wang (2010), Identification of Sources and Formation Processes of Atmospheric Sulfate by Sulfur Isotope and SEM Measurements.

Lee, K. H., Z. Li, M.C. Cribb, J. Liu, L. Wang, Y. Zheng, X. Xia, H. Chen, and B. Li (2010), Aerosol optical depth measurements in Eastern China and a new calibration method.

Ge, J. M., J. Su, T.P. Ackerman, Q. Fu, J.P. Huang, and J.S. Shi (2010), Dust Aerosol Optical Properties Retrieval and Radiative Forcing over Northwestern China during the 2008 China-US Joint Field Experiment.

Huang, K., G. Zhuang, J. Li, Q. Wang, Y. Sun, Y. Lin, and J. S. Fu (2010), The mixing of Asian dust with pollution aerosol and the transformation of aerosol components during the dust storm over China in spring, 2007.

Zhuang. G. (corresponding author) et al., Relation between optical and chemical properties of dust aerosol over Beijing, China

Sun, Y., G. Zhuang, K. Huang, J. Li, Q. Wang, Y. Wang, Y. Lin, J. S. Fu, W. Zhang, A. Tang, and X. Zhao (2010), Asian dust over northern China and its impact on the downstream aerosol chemistry.

Liu, Y., D. Yang, W. Chen, and H. Zhang (2010), Measurements of Asian dust optical properties over the Yellow Sea of China by shipboard and ground-based photometers, along with Satellite remote sensing: a case study of the passage of a frontal system during April 2006.

Xiao, X. (2010), Spatiotemporal changes in sunshine duration and cloud amount as well as their relationship in China during 1954-2005.
Zhang, L., H. Liao, and J. Li (2010), Impacts of Asian summer monsoon on seasonal and interannual variations of aerosols over eastern China.
Zhang, Y., Q. Yu, W. Ma, and L. Chen (2010), Atmospheric deposition of inorganic nitrogen to the eastern China seas and its implication to marine biogeochemistry.

Manuscripts Revised & Under Revision (7)

Li, Z., K.-H. Lee, J. Xin, Y. Wang, W.-M. Hao, 2010, First observation-based estimates of aerosol radiative forcing at the top, bottom and inside of the atmosphere, J. Geophy. Res., revised.
Niu, F., Z. Li, C. Li, K. Lee, M. Wang, Increase in Wintertime Fog and Weakening of the Eastern Asian Monsoon: Potential Impacts of Global Warming and Aerosols in China.

Jeong, M., and Z. Li, Separating real and apparent effects of cloud, humidity, and dynamics on aerosol optical thickness near clouds. Under revision.
Li, C. et al., Anthropogenic Air Pollution Observed near Dust Source Regions in Northwestern China during Springtime 2008
Li, C., et al. Concentrations and Origins of Atmospheric Lead and Other Trace Species at a Rural Site in Northern China
Wang T. (corresponding author). et al., Semi-direct Radiative Forcing of Internal Mixed Black Carbon-Cloud Droplet and its Regional Climatic Effect over China, under revision.
Zhuang. G. (corresponding author) et al., The source, long-range transport, and characteristics of the highest-recorded dust pollution occurred at Shanghai, under revision.

Submitted

Zhang, J., H. Chen, Z. Li, X. Fan, L. Peng, Y. Yu, M. Cribb, Analysis of cloud layer structure in Shouxian, China using RS92 radiosonde and 95-GHz cloud radar data, *J. Geophy. Res*., submitted, 2010.

Logan, T., B. Xi, X. Dong, R. Obrecht, Z. Li, and M. Cribb, 2010, A Study of Asian Dust Plumes using Satellite, Surface, and Aircraft Measurements during the INTEX-B Field Experiment, submitted.

Wang, B., G. Shi, Long-term Trends of Atmospheric Absorbing and Scattering Optical Depths over China Region Estimated from the Routine Observation Data of Surface Solar Irradiances

Wang T. (corresponding author). et al., Investigations on direct and indirect effect of nitrate on temperature and precipitation in China using a regional climate chemistry modeling system

Huang, J. (corresponding author), Dust aerosol vertical structure measurements using three MPL lidars during 2008 China-US joint dust field experiment

Wang, X., et al., Surface Measurements of aerosol properties over Northwest China during ARM China-2008 deployment.

Ji, Q., S.-C. Chee, A novel non-intrusive method to resolve the thermal-dome-effect of pyranometers - Part I: Instrumentation and observational basis

Summary

- **Increasing loading of aerosols in China could have significantly altered the regional climate through their direct and indirect effects**
- **Understanding the mechanisms of aerosol interactions with the dynamic system requires extensive observation and modeling studies**
- **Field campaigns in China provide insights into these complex issues, but resolving them requires close collaboration between observers and modelers.**
- **To learn about the field observation programs and what we have learned to date, visit: www.atmos.umd.edu/~zli**

Ongoing and planned studies

- **Detection and quantification of aerosol-cloud-precipitation interaction**
- **Aerosol vertical distribution and heating profiles**
- **Aerosol and boundary-layer development and**
- **Aerosol and atmospheric vertical motion**
- **Aerosol and regional circulation**
- **Aerosol and the Asian monsoon system**
- **To learn about the field observation programs and what we have learned to date, visit: www.atmos.umd.edu/~zli**