Aerosol and Climate Change in China Overview of the 2008 Field Campaign Data And Preliminary Results

Zhanqing Li

Contributors and collaborator:

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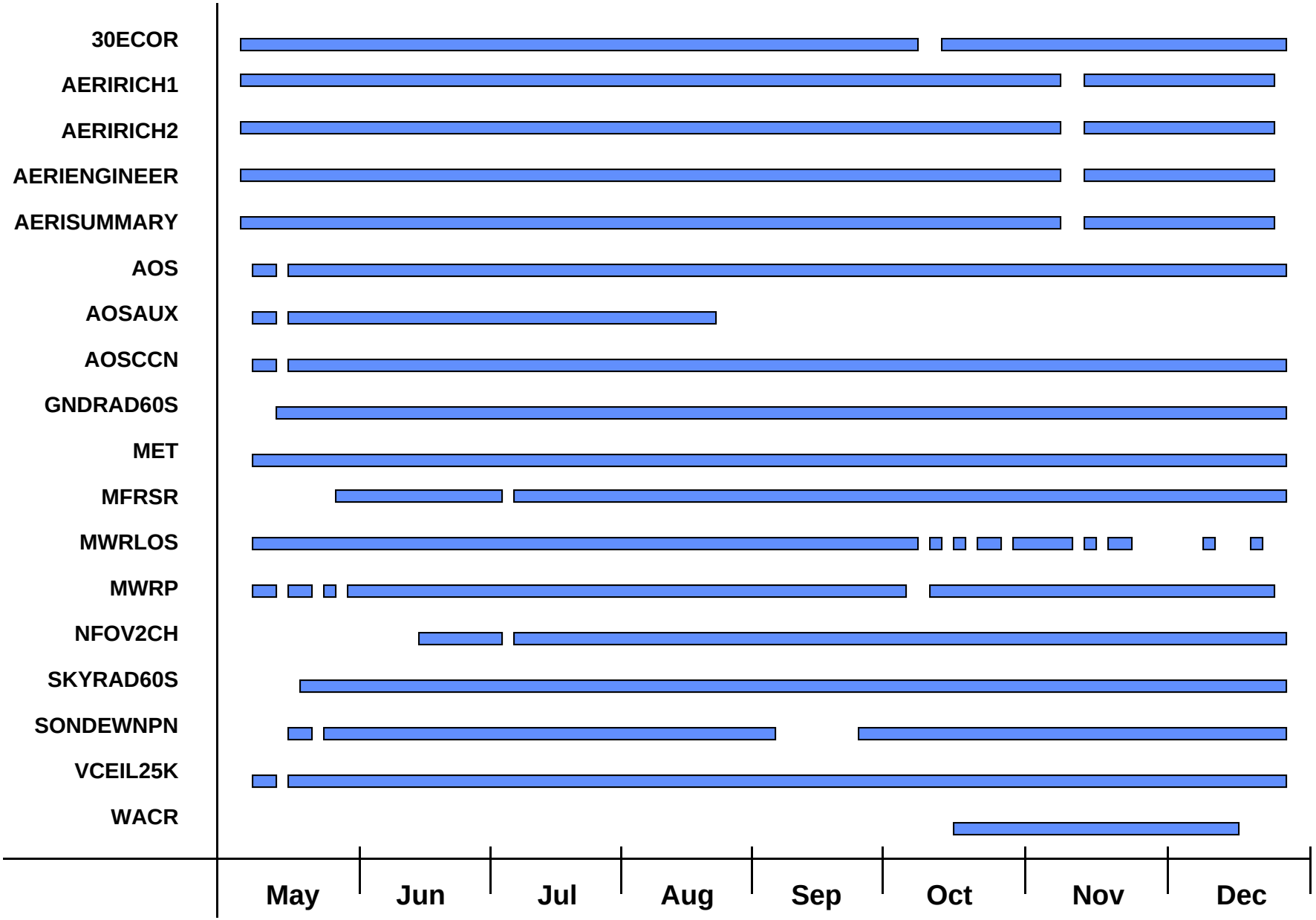
2008 AMF/EAST-AIRE Campaign Sites

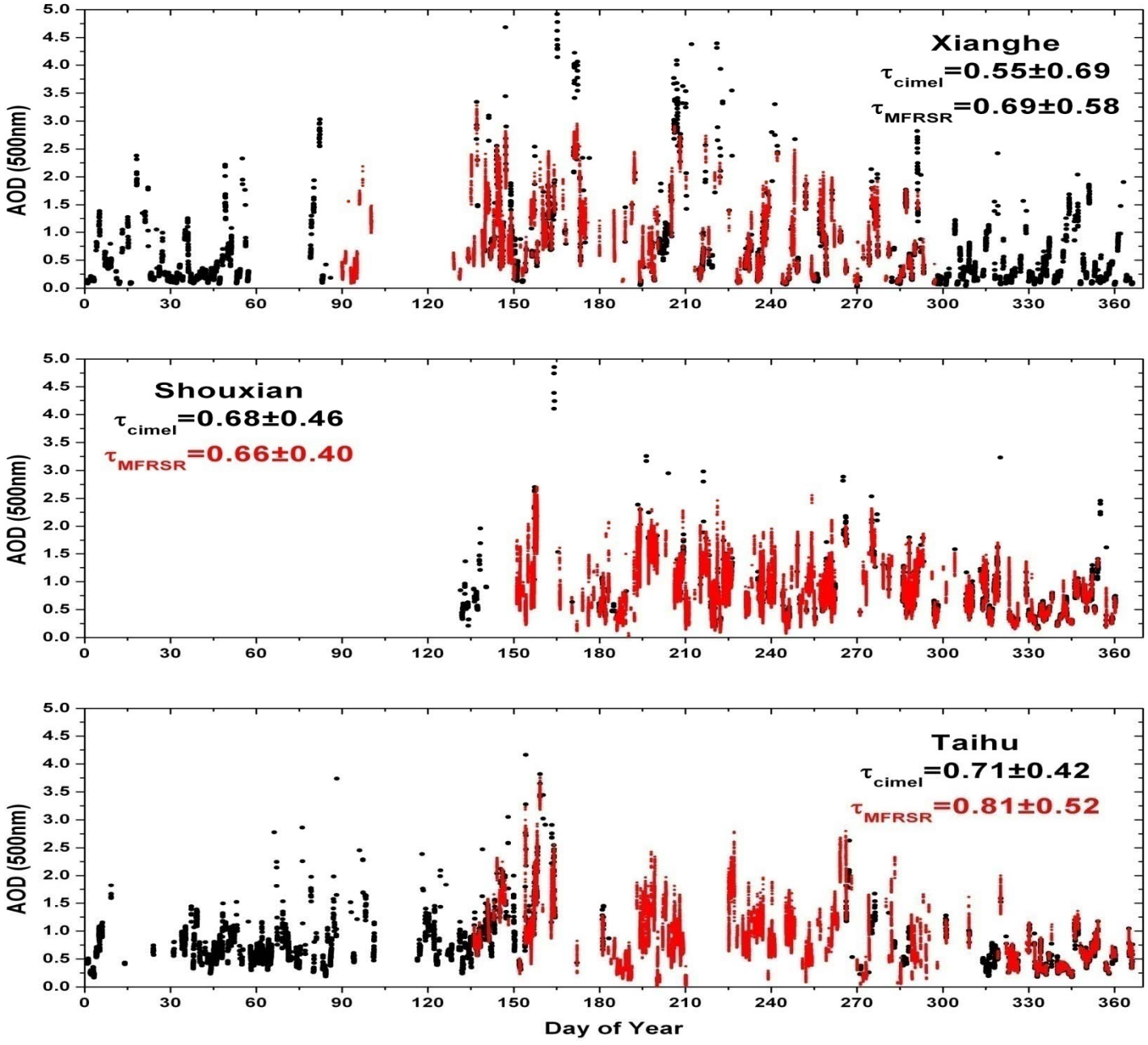
Anchored by the AMF in Shouxian, additional instrumented sites to the east and north provided a comprehensive atmospheric data set for studying aerosol effects in the region.

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



Shouxian
Aerosol and CCN

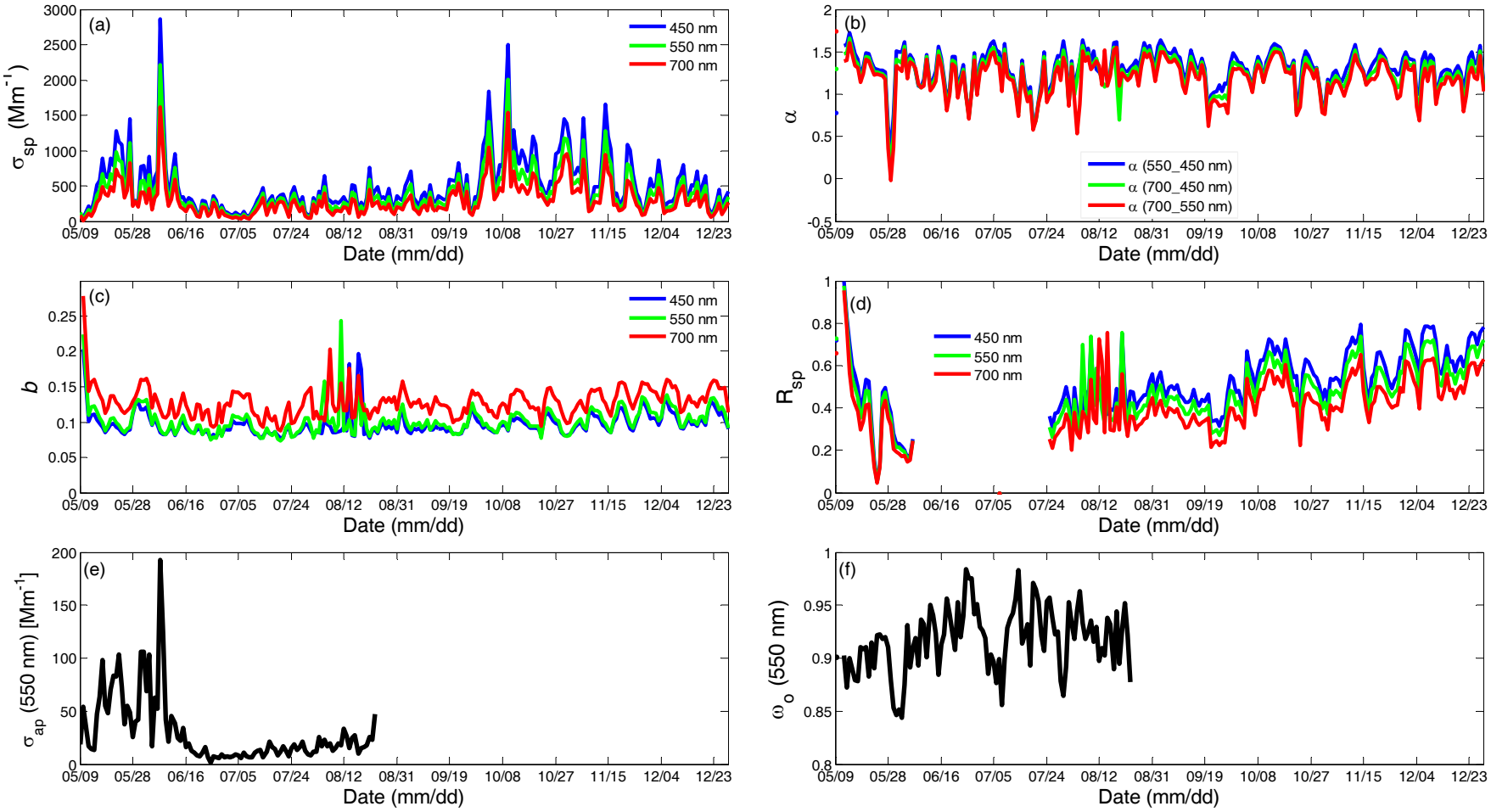
AOD records during 2008



Black: Cimel
Red: MFRSR

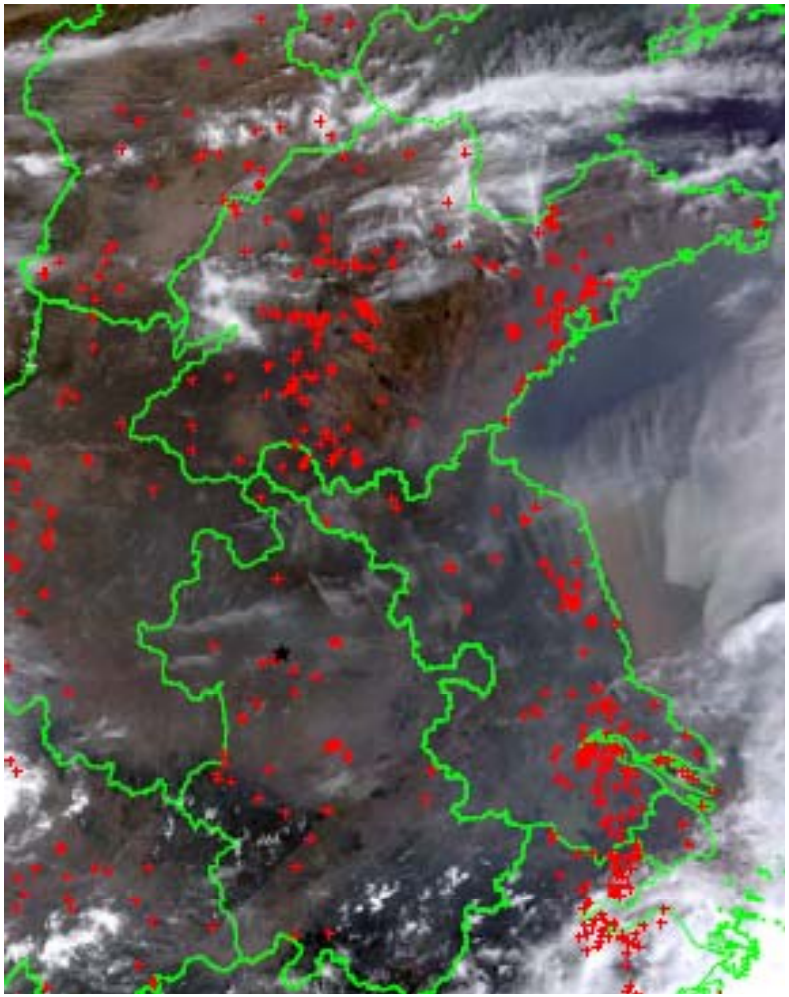
Lee et al. (2010)

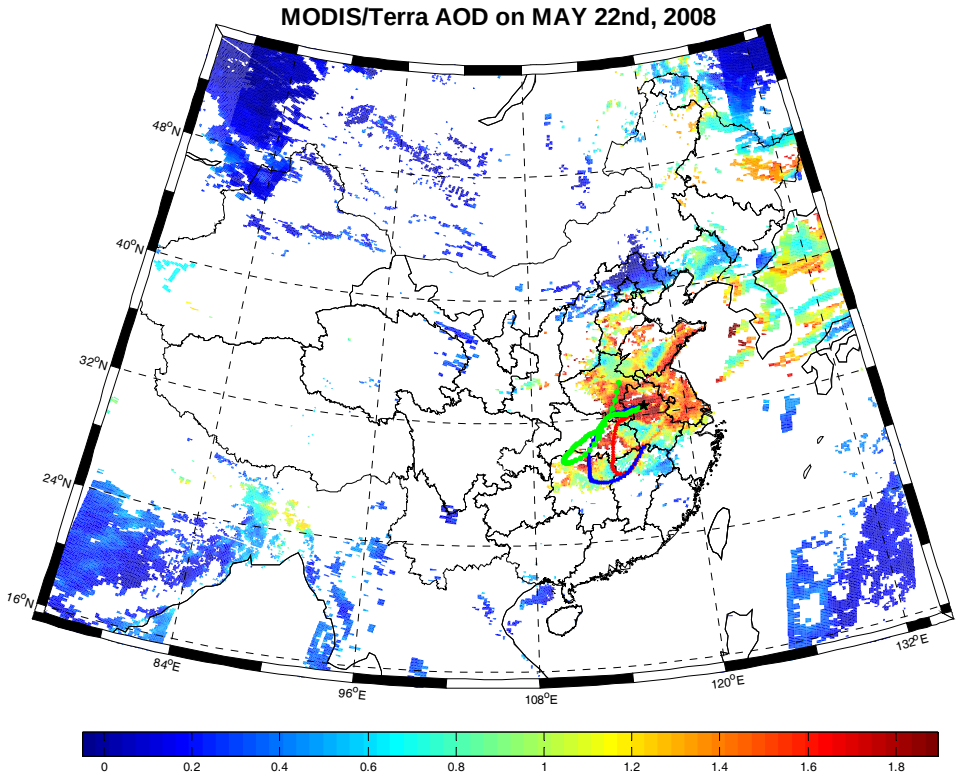
Time series of aerosol optical properties from the AOS



Fan et al. (2010)

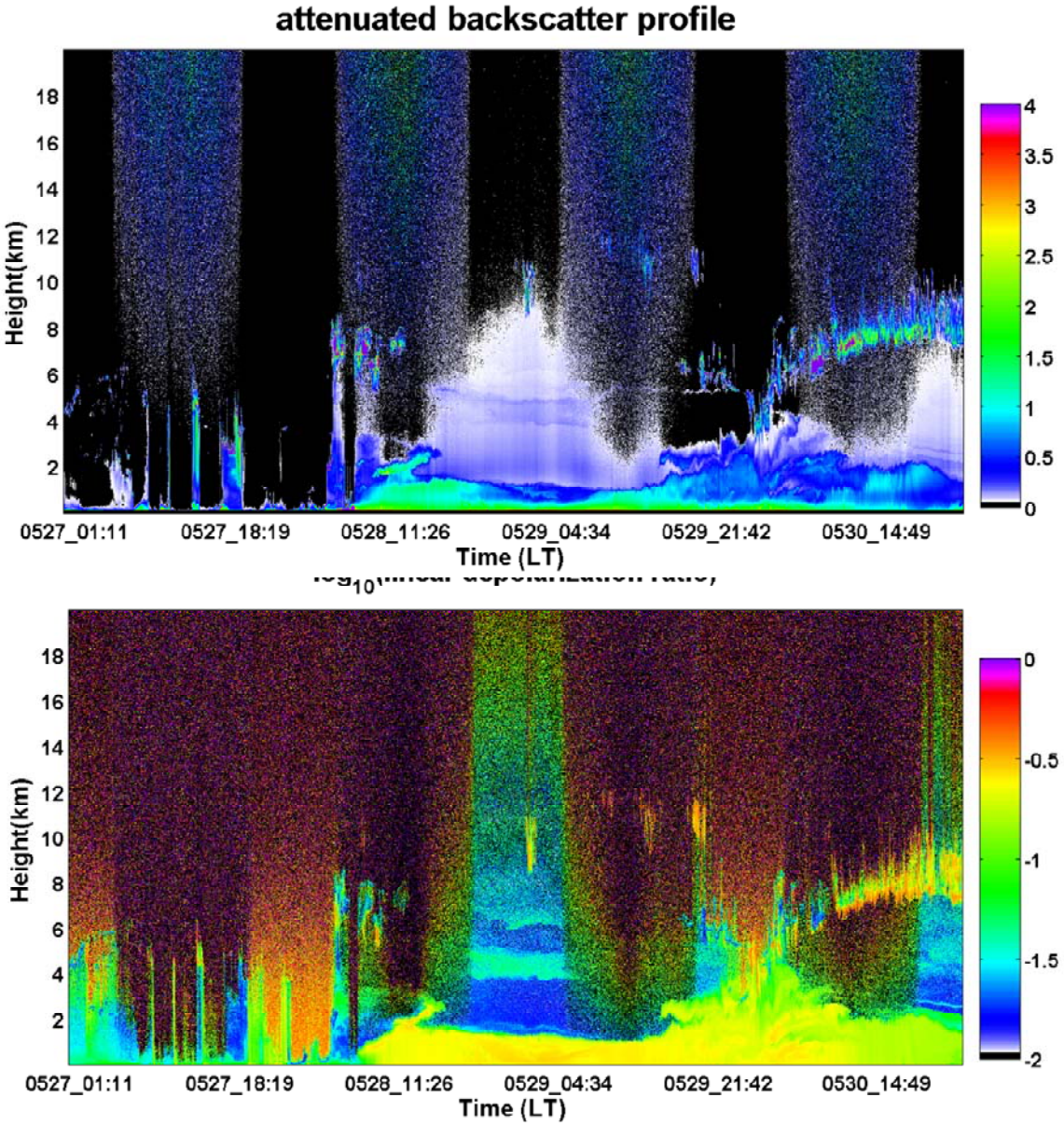
Smoke Episode on May 22, 2008

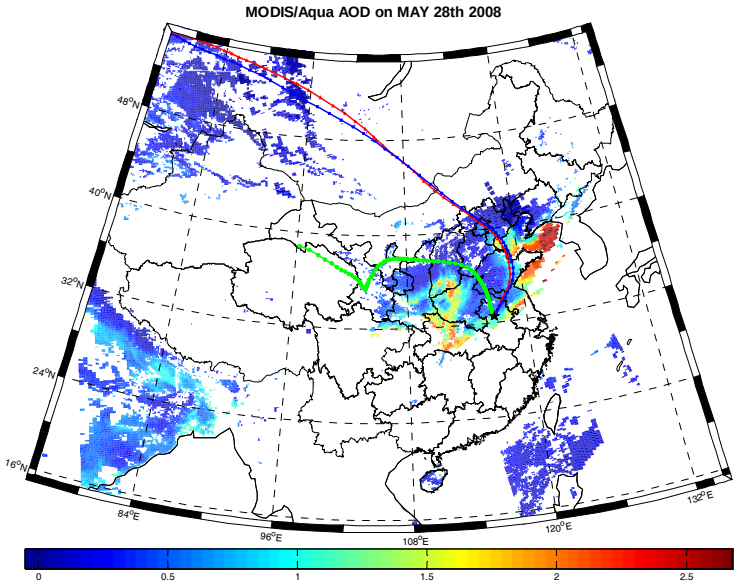




Fan et al. (2010)

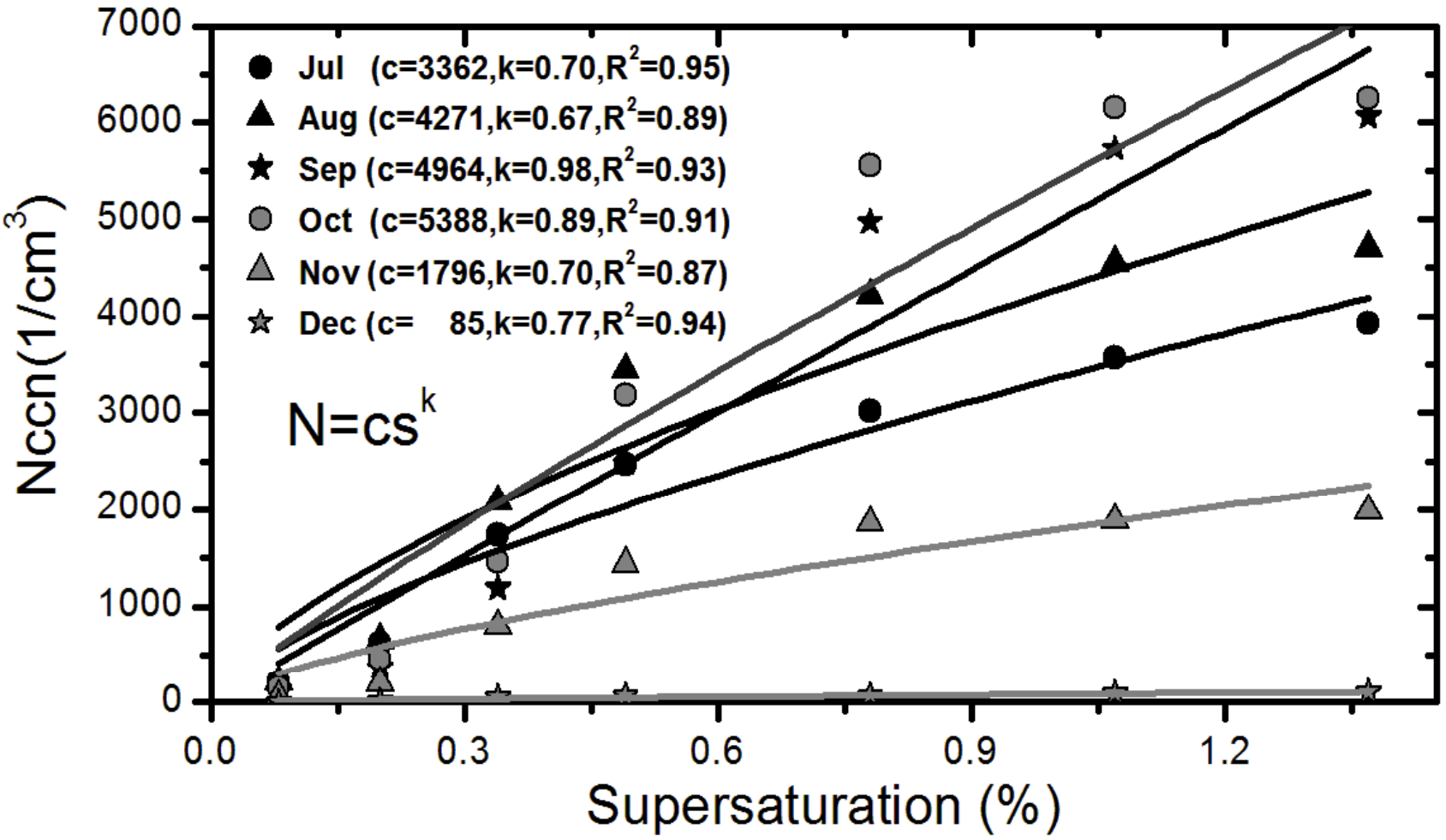
Dust Aerosol Episode on May 28





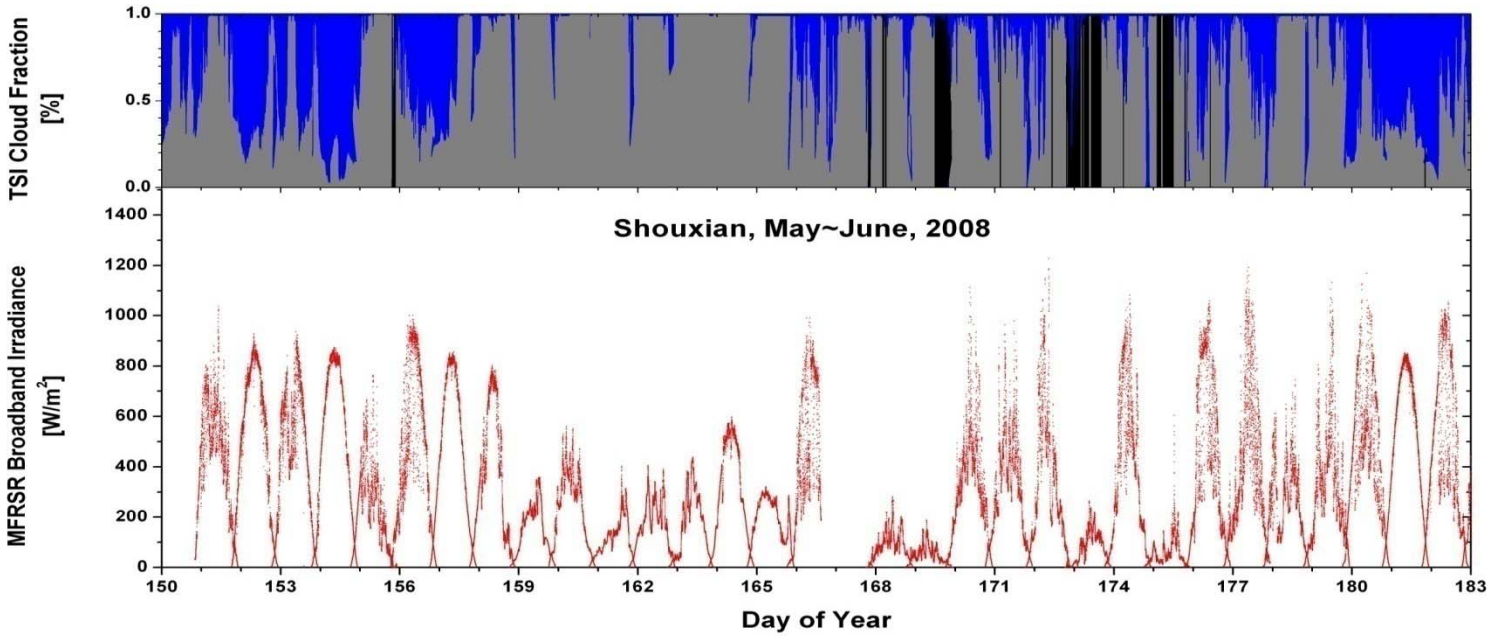
Fan et al. (2010)

CCN Spectra

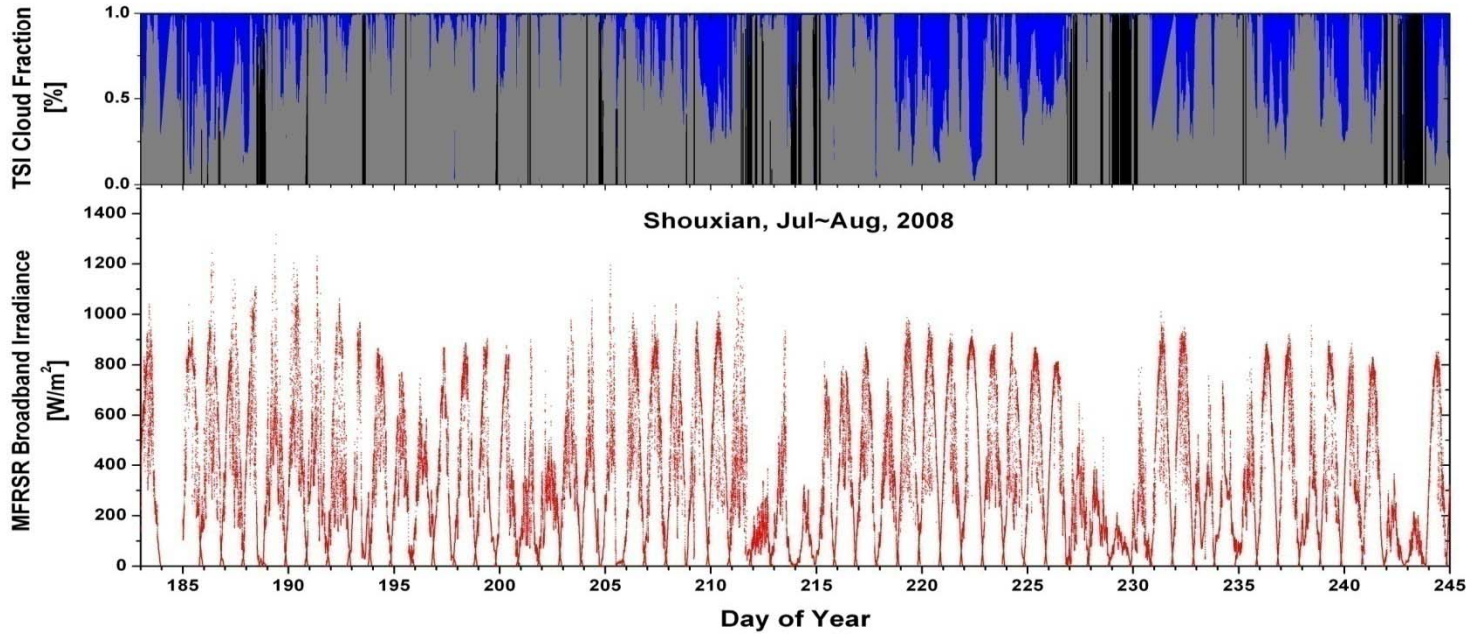

Jul (c=3362,k=0.70,R²=0.95)
Aug (c=4271,k=0.67,R²=0.89)
Sep (c=4964,k=0.98,R²=0.93)
Oct (c=5388,k=0.89,R²=0.91)
Nov (c=1796,k=0.70,R²=0.87)
Dec (c= 85,k=0.77,R²=0.94)
N=cs^k
Nccn(1/cm³)
Supersaturation (%)
0
1000
2000
3000
4000
5000
6000
7000
0.0
0.3
0.6
0.9
1.2

Shouxian
Cloud Properties

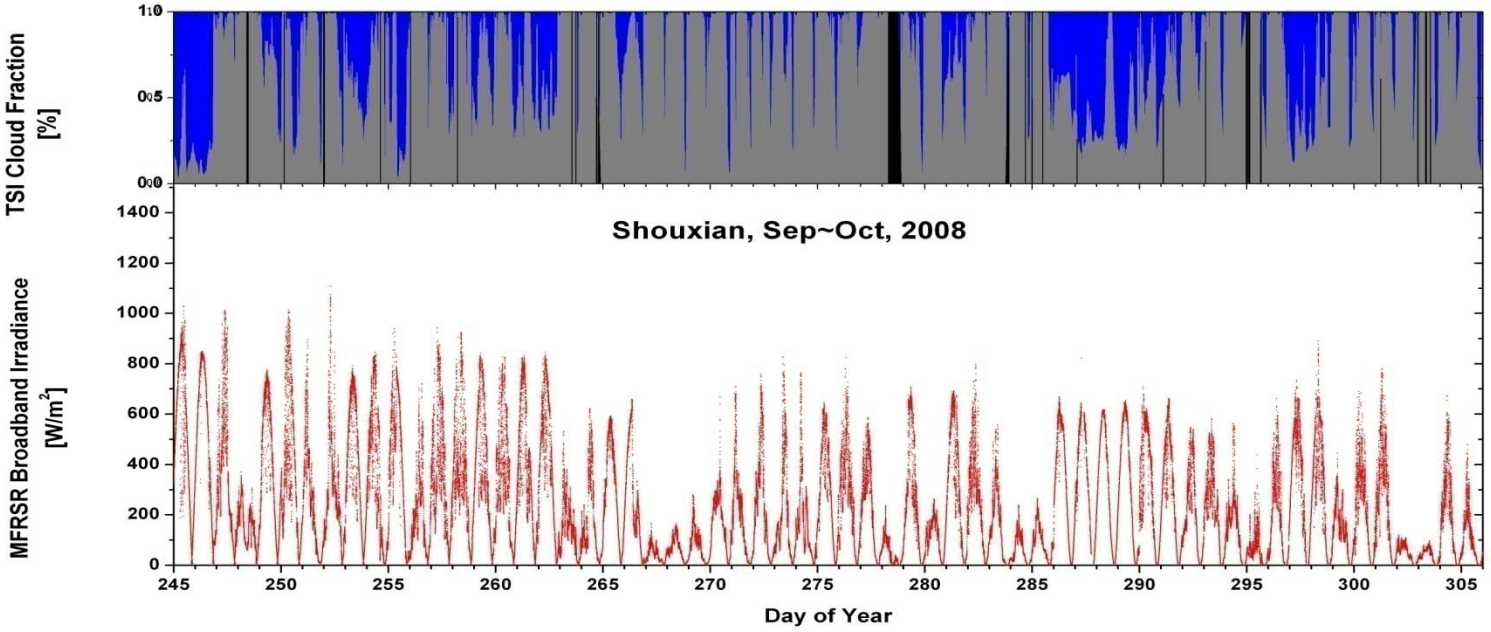
MFRSR broadband radiation &TSI cloud opaque (%)

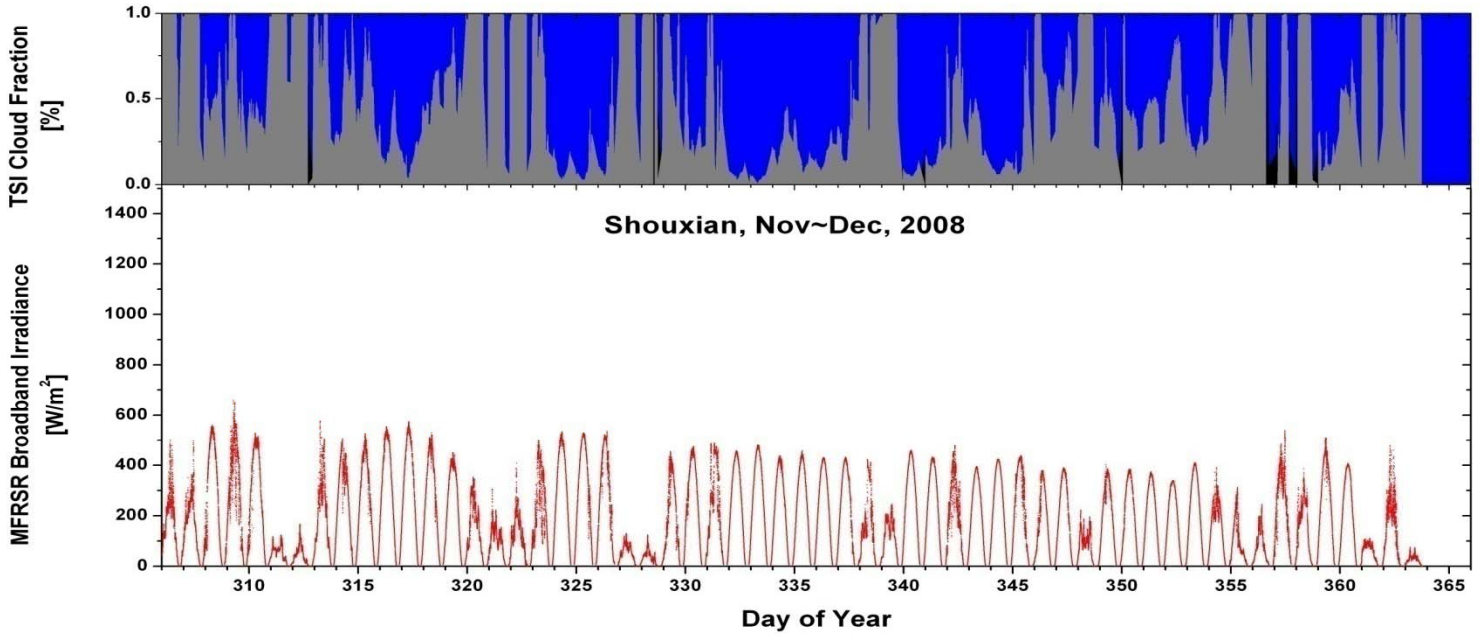


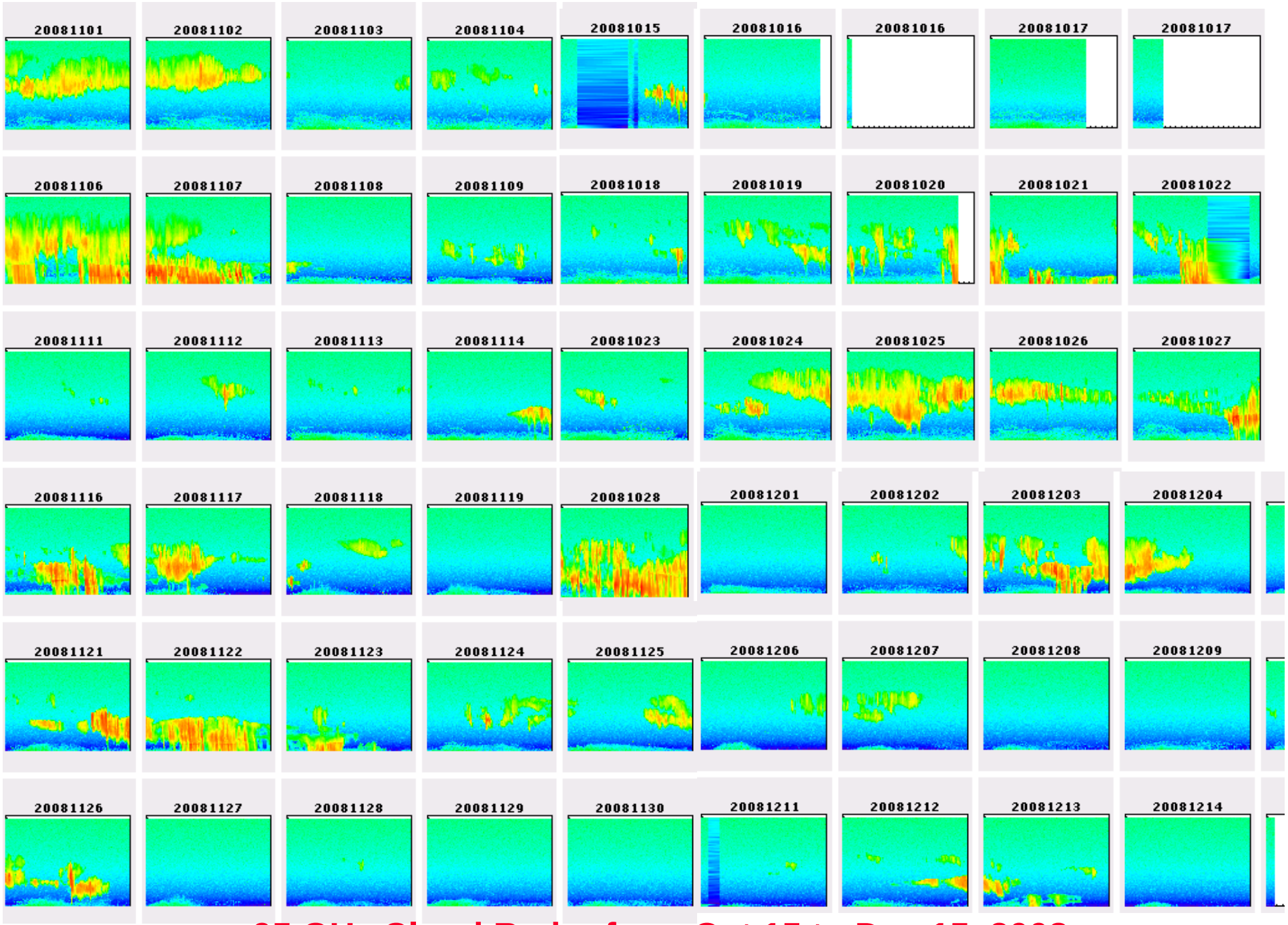
Black: Precipltati
Gray: Cloud
Blue: clear sky
Red: MFRSR



MFRSR broadband radiation &TSI cloud fraction (%)

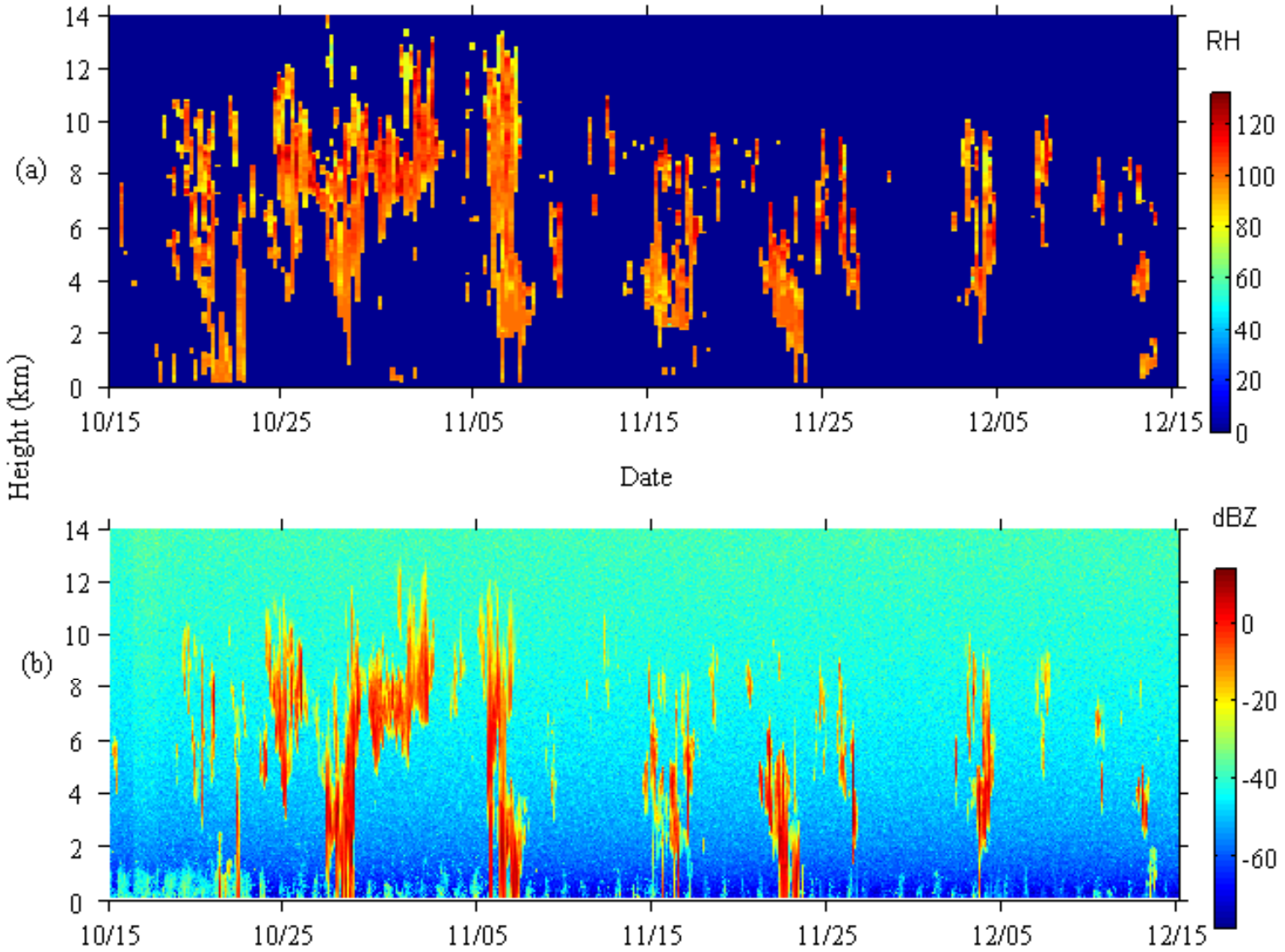






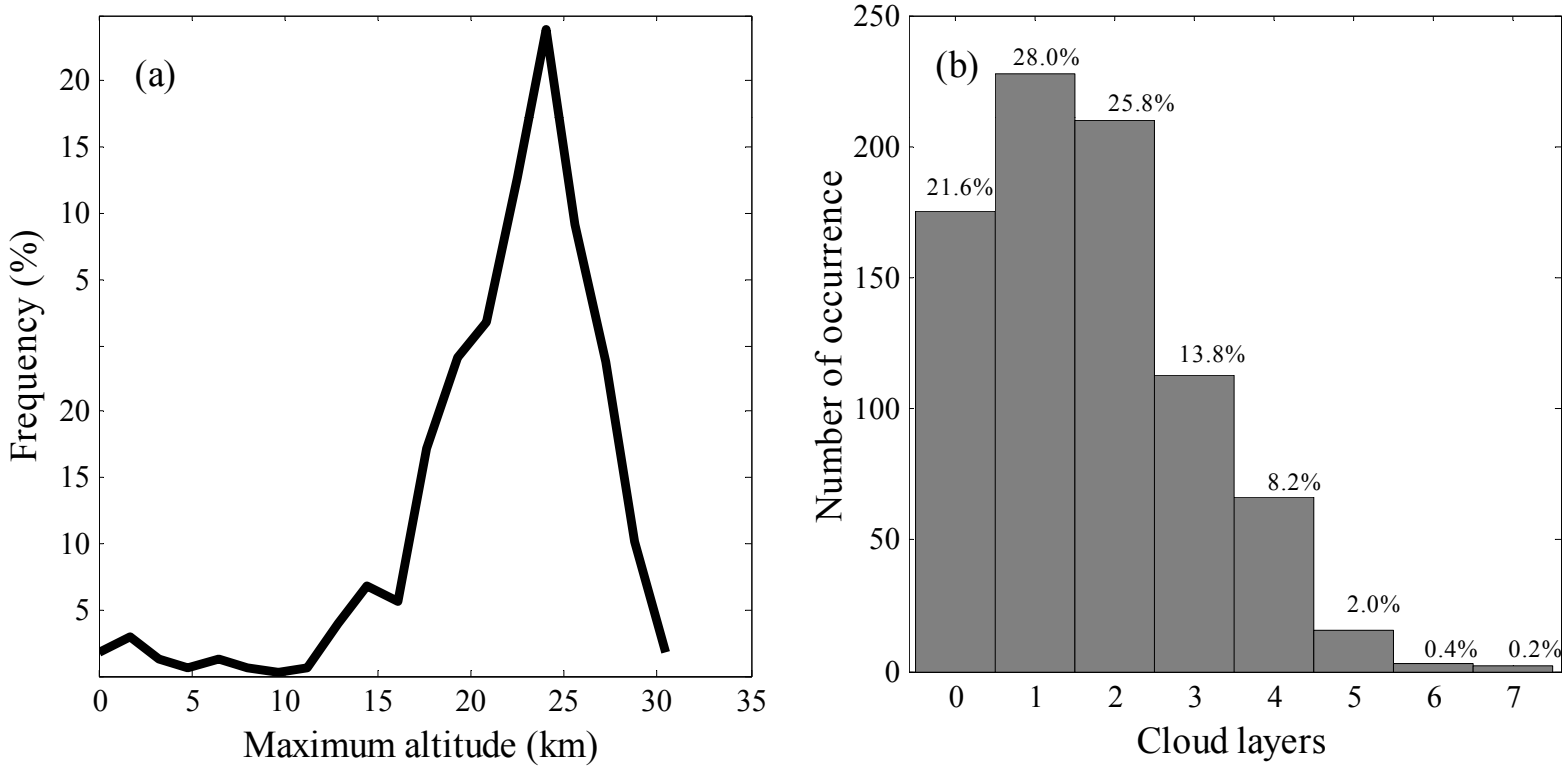
95 GHz Cloud Radar from Oct 15 to Dec 15, 2008

Comparison of cloud distributions determined by the radiosonde and reflectivity measured by the WACR.

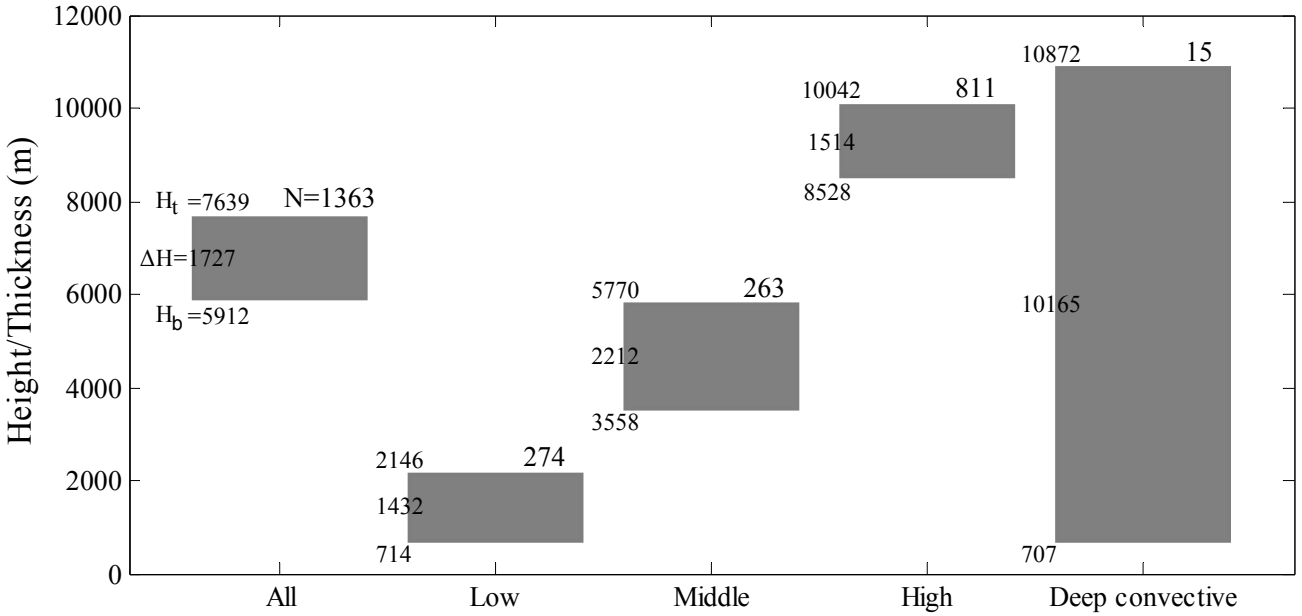


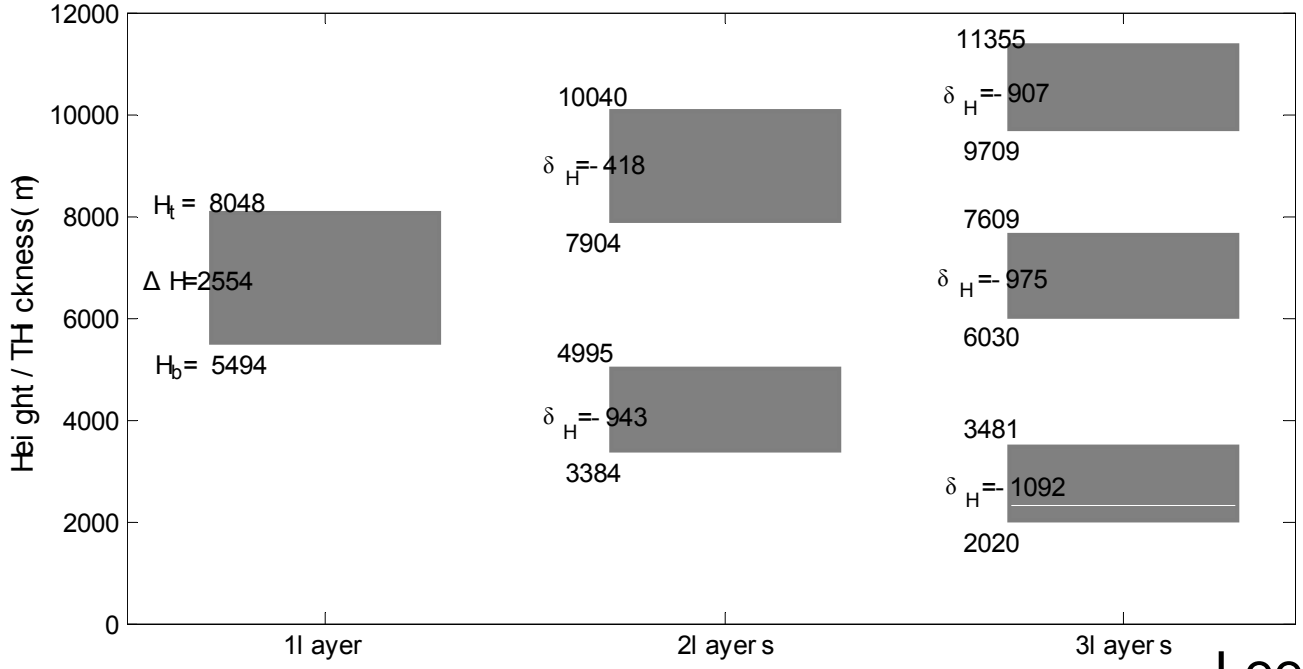
(a) The frequency distribution of maximum altitude of radiosonde observations.

(b) Number and frequency of occurrence for different cloud layers



Lee et al. (2010)

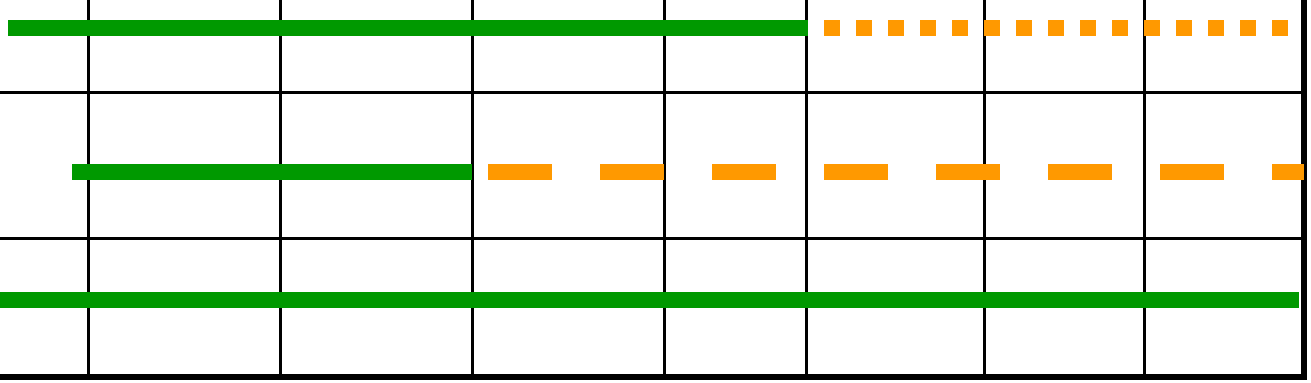




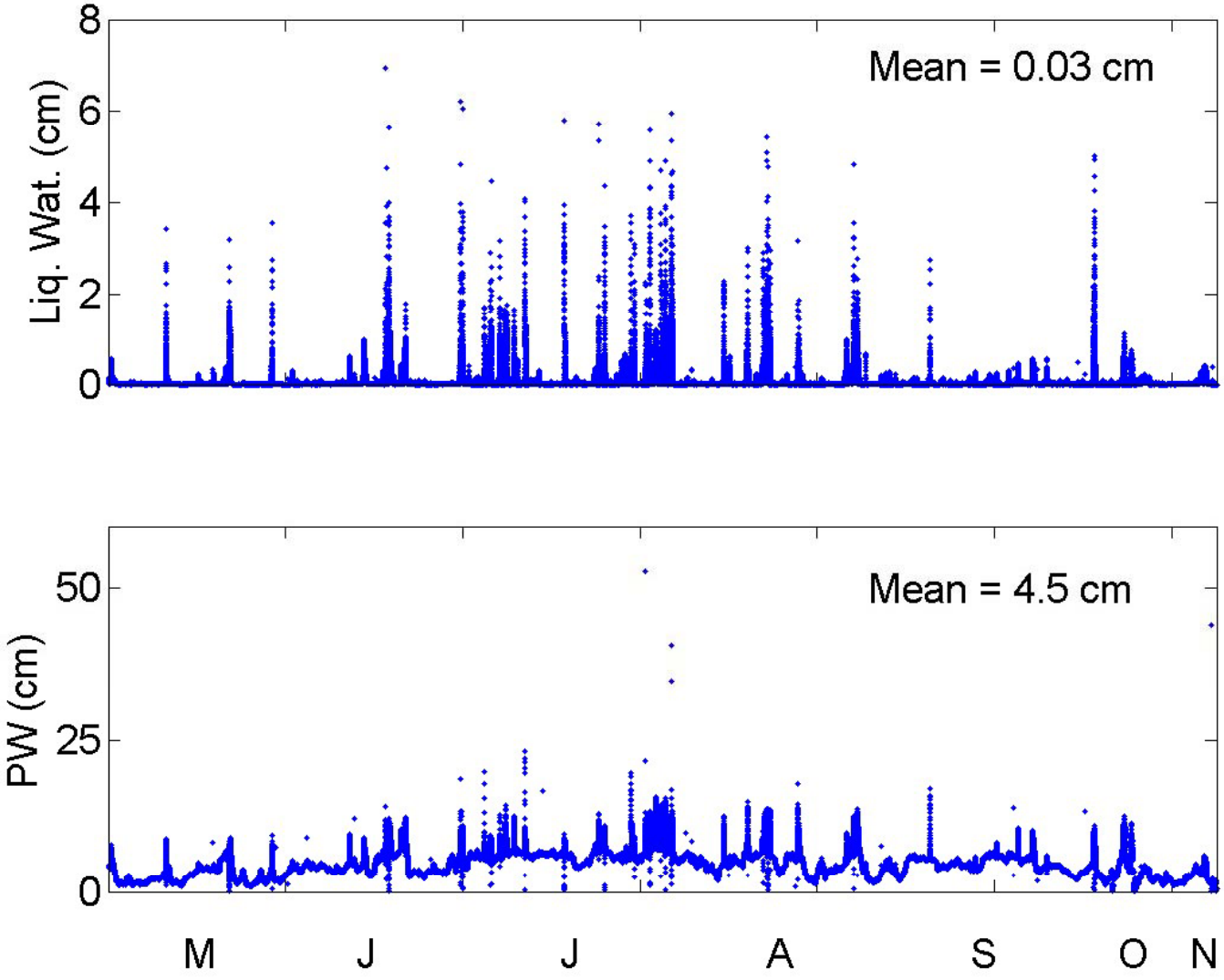
Lee et al. (2010)

Microwave Radiometer

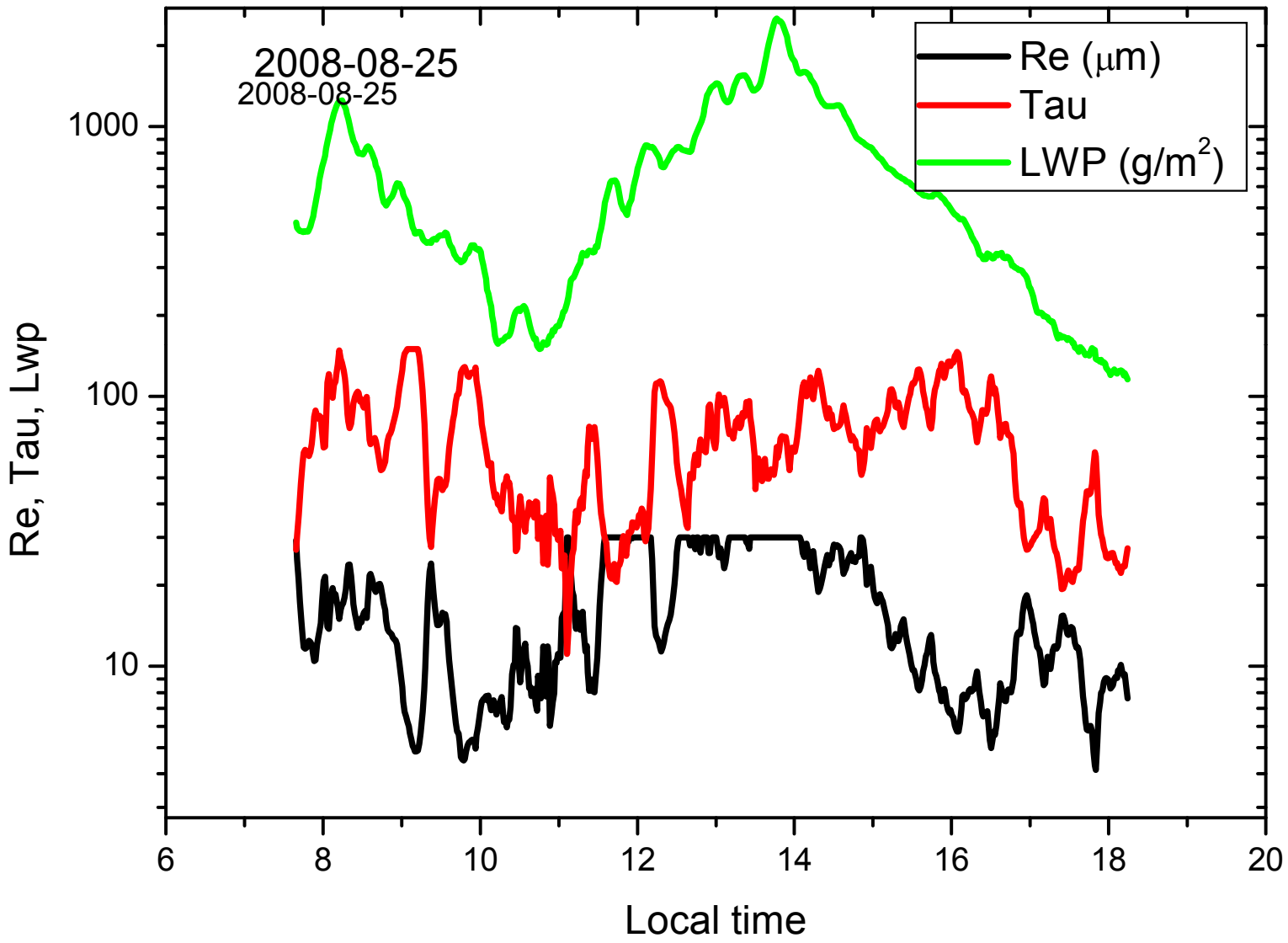
Instrument	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
MWRLOS (23.8/31.4 GHz)								
MWRHF (90/150 GHz)								
MWRP (22-30, 51-59 GHz)								

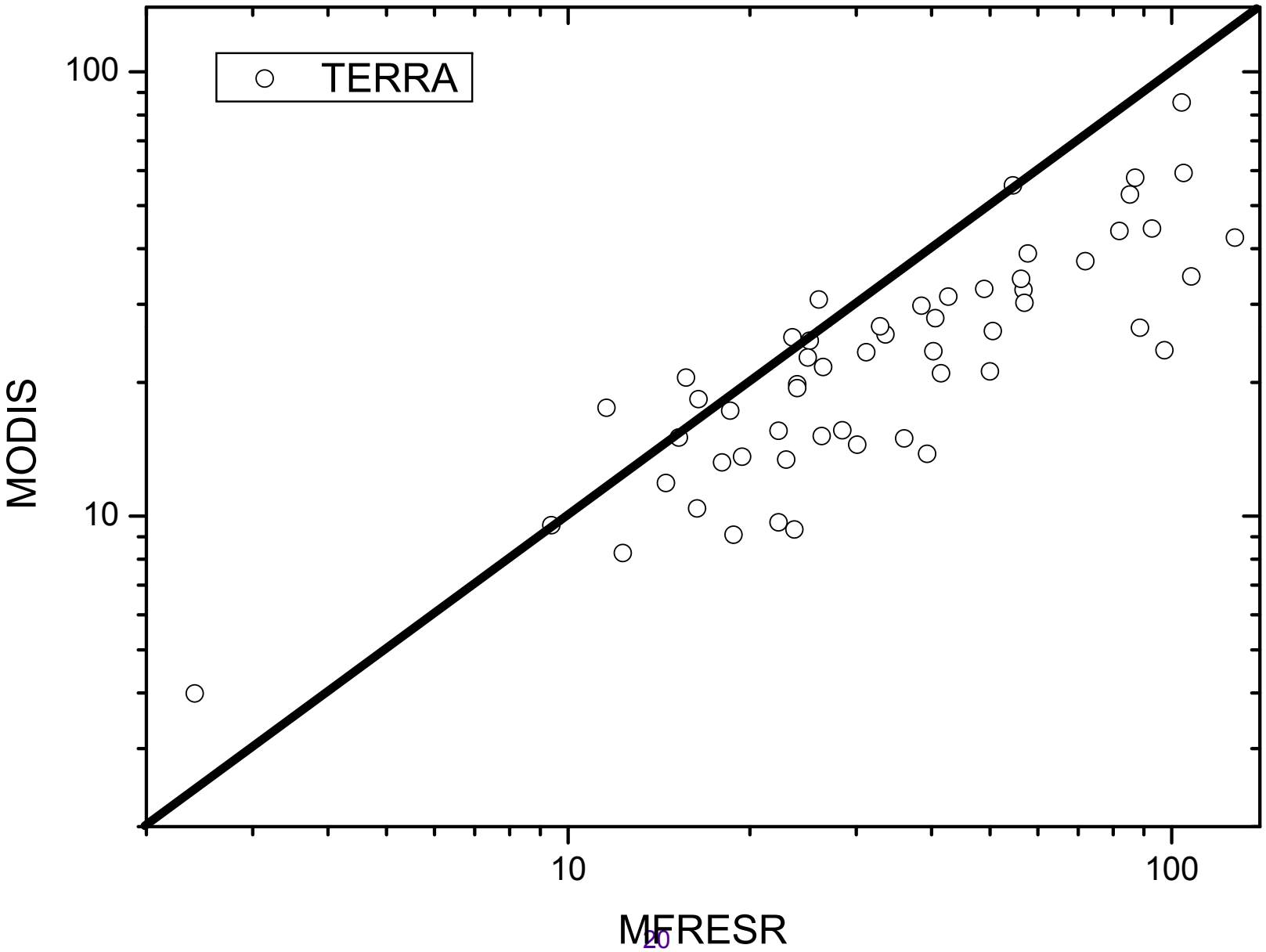


- **MWRLOS (line of sight): integrated vapor and liquid water along line-of-sight**
  - **periods of missing data from October onwards**
- **MWRHF (high frequency): sky brightness temperatures at 90 GHz and 150 GHz**
  - **data quality not okay; possible issues with instrument calibrations from tip curves, elevated noise in 150 GHz data (under review)**
- **MWRP (profiler): vertical profiles of atmospheric moisture, pressure, temperature, cloud liquid water content, cloud base height, integrated vapor and liquid water**



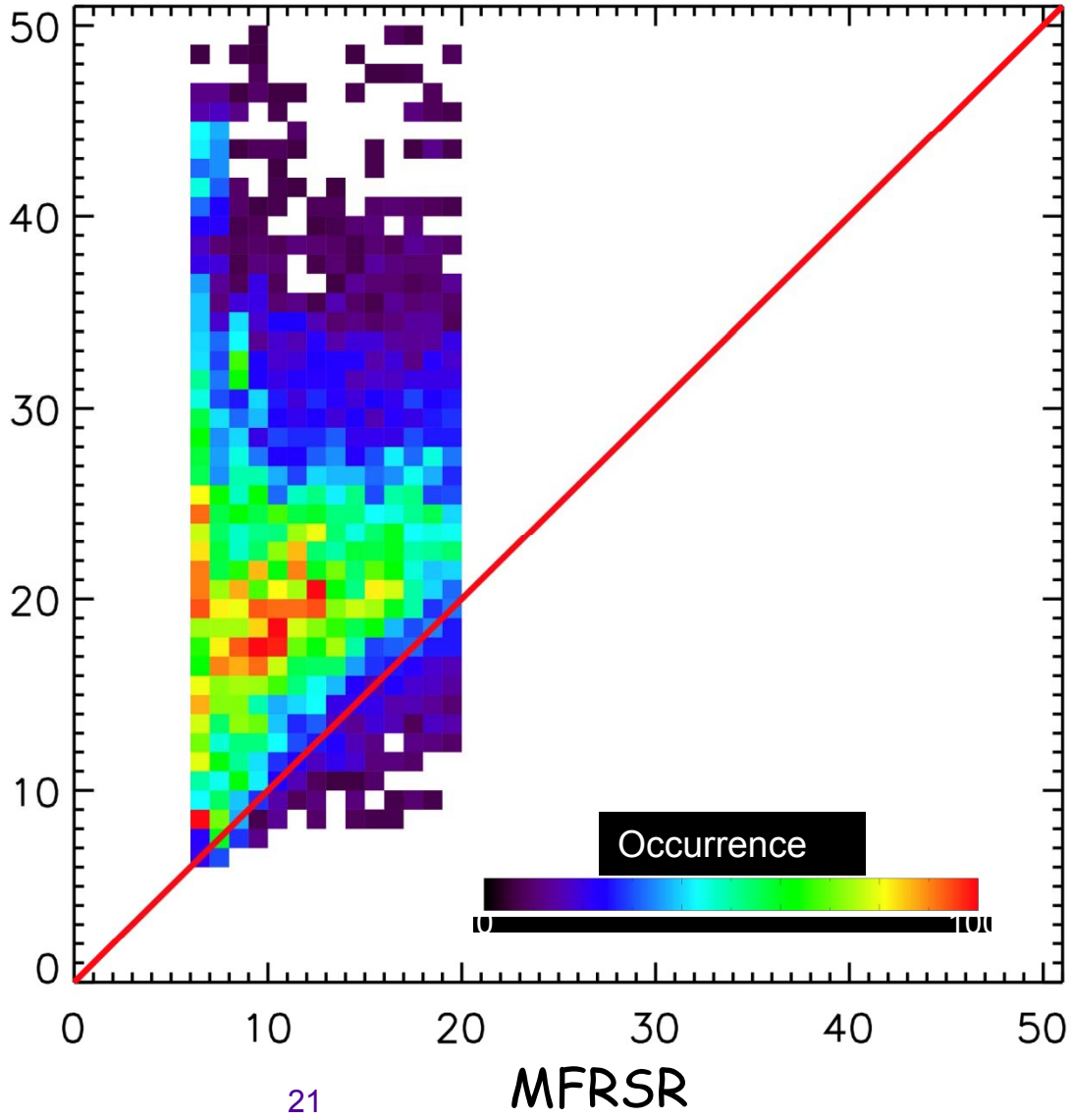
Time series of integrated liquid water amount (top panel) and precipitable water amount (bottom panel) along the line of sight path during the MWR deployment at Shouxian.


2008-08-25
2008-08-25
Re (μm)
Tau
LWP (g/m2)
Re, Tau, Lwp
1000
100
10
6
8
10
12
14
16
18
20
Local time


TERRA
100
10
MODIS
10
100
MERESR

Intercomparison between MFRSR and MPL (Solar background light) retrievals

Cloud optical depth from MPL



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Shouxian
Precipitation processes

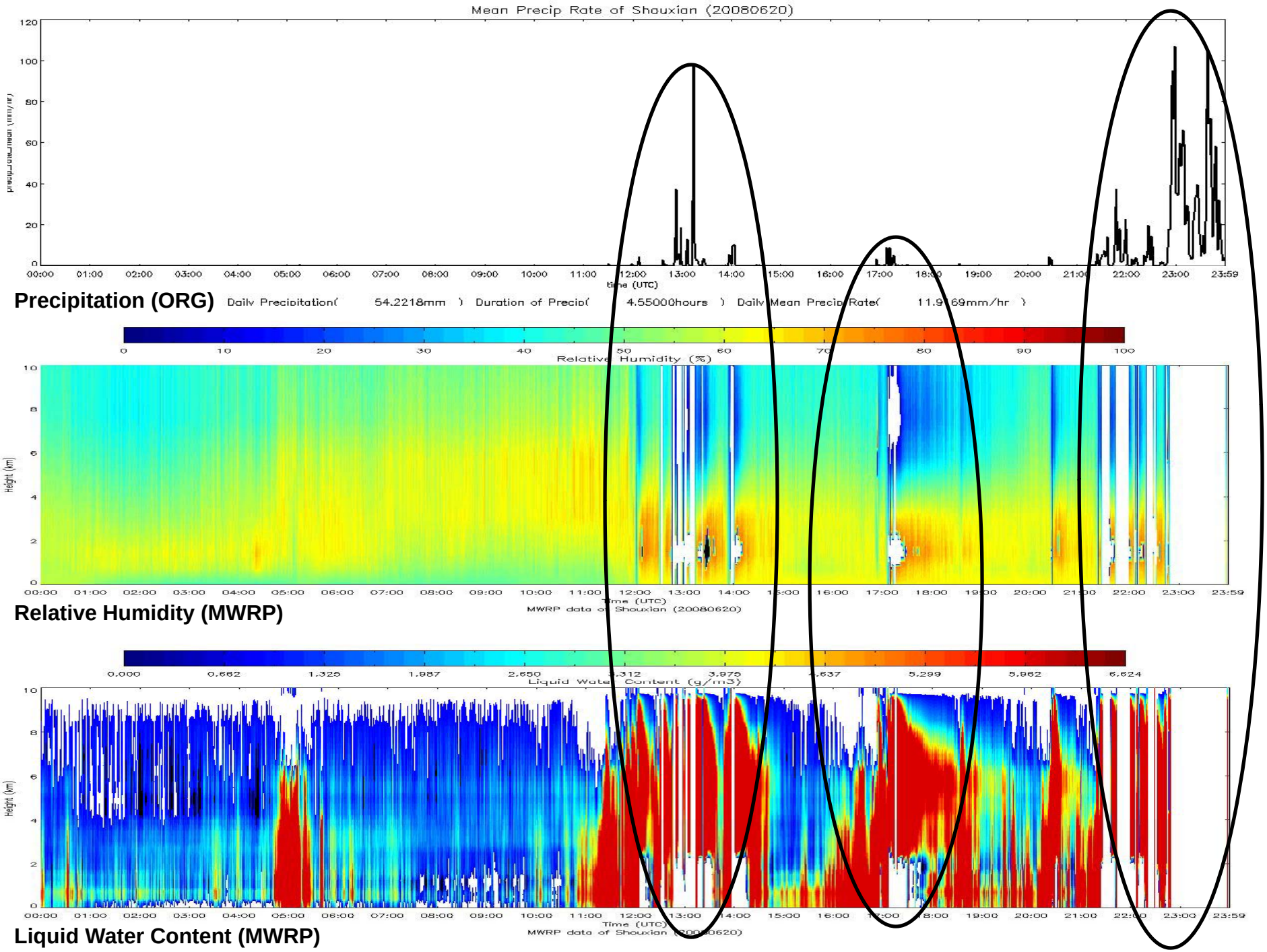
Surface Meteorological Instrumentation (MET)

Precipitation Measurements(05/09/2008-28/12/2008)

Optical Rain Gauge measurements: precipitation rate and accumulation

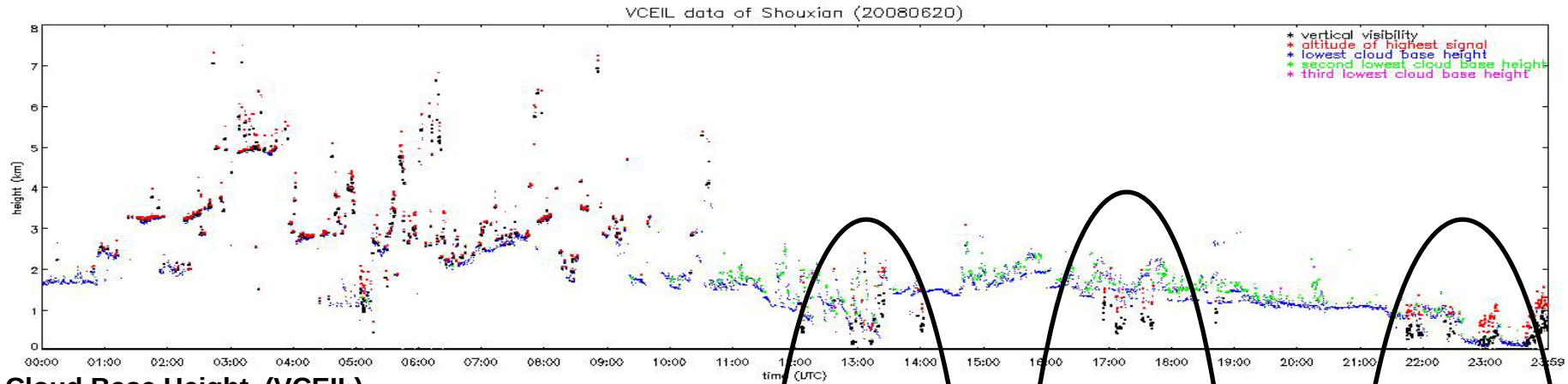
Daily rainfall (mm)	<0.1	0.1-10	10-25	25-50	50-100	100-200	>200
Category	Trace or No precipitation	Light rain	Moderate rain	Heavy rain	Rainstorm; heavy rain	Heavy rainstorm	Very heavy rain
Frequency of different types of precipitation	171	44	8	6	6	0	0

23

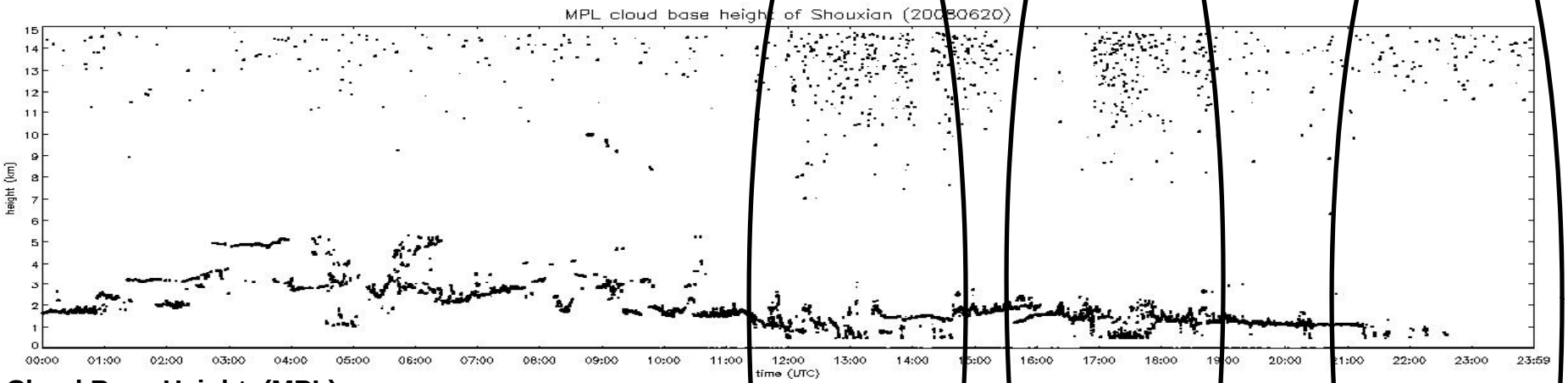


Relative Humidity (MWRP)

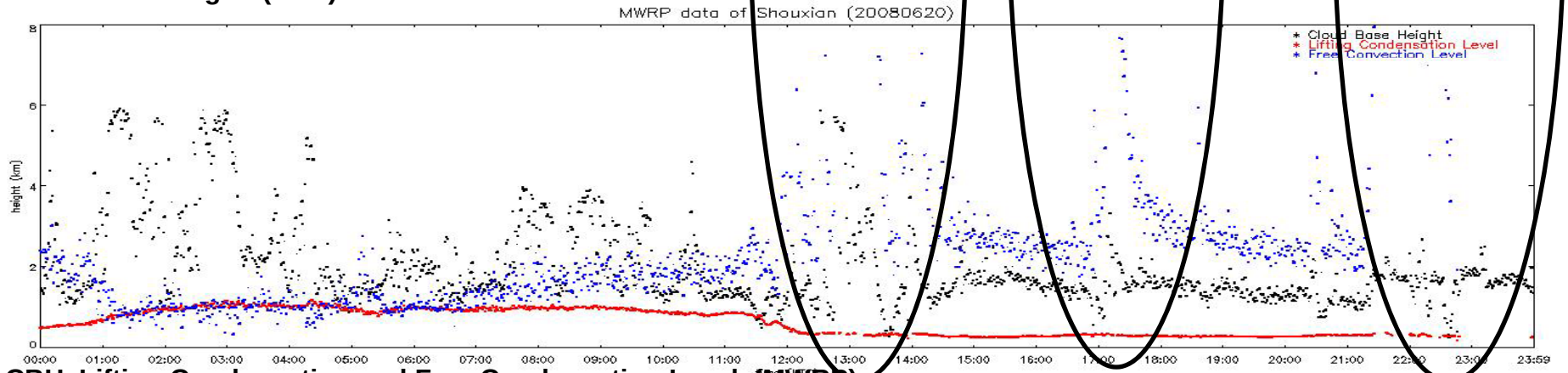
Liquid Water Content (MWRP)



Cloud Base Height (VCEIL)



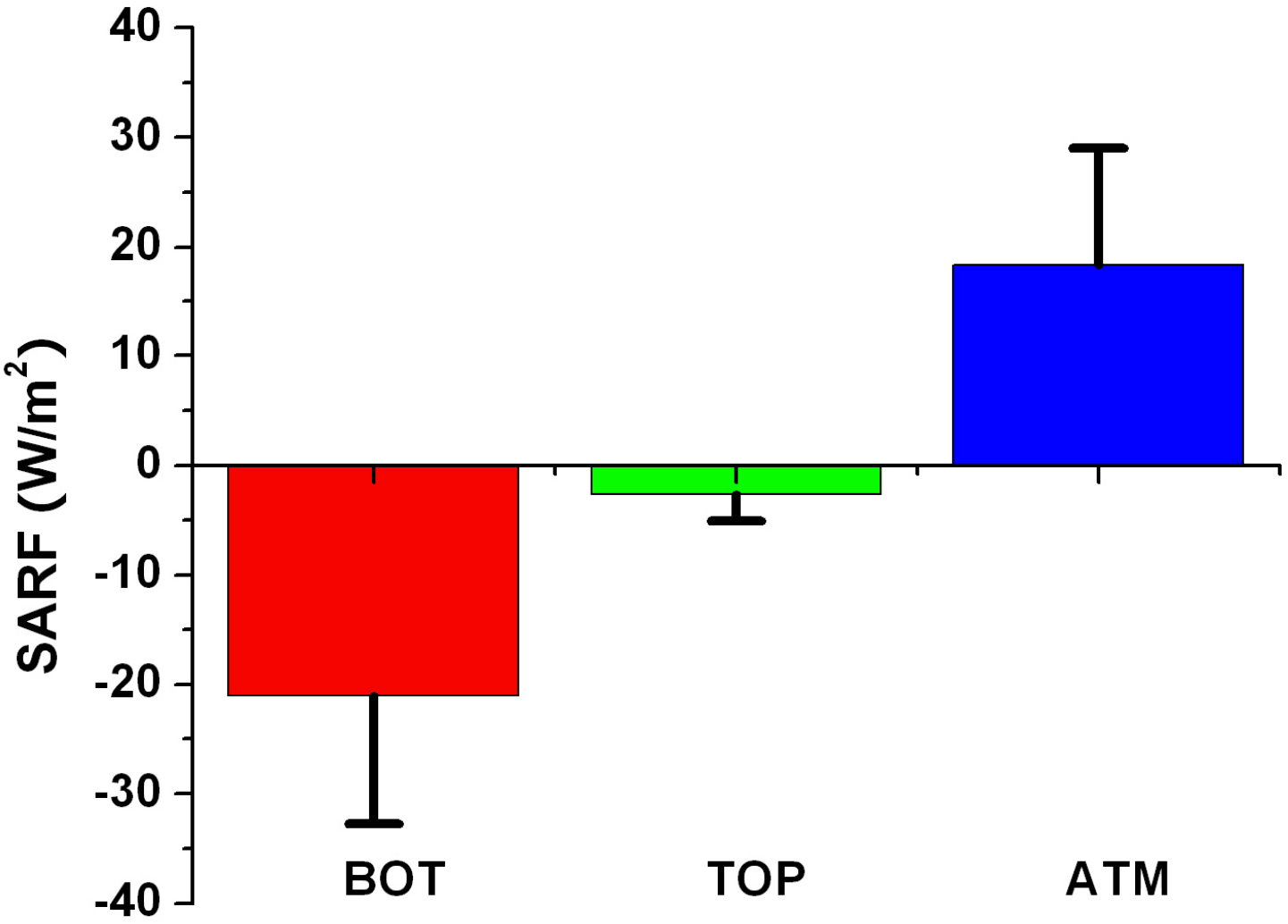
Cloud Base Height (MPL)



CBH, Lifting Condensation and Free Condensation Level (MWRP)

Aerosol radiative forcing and Atmospheric dynamics

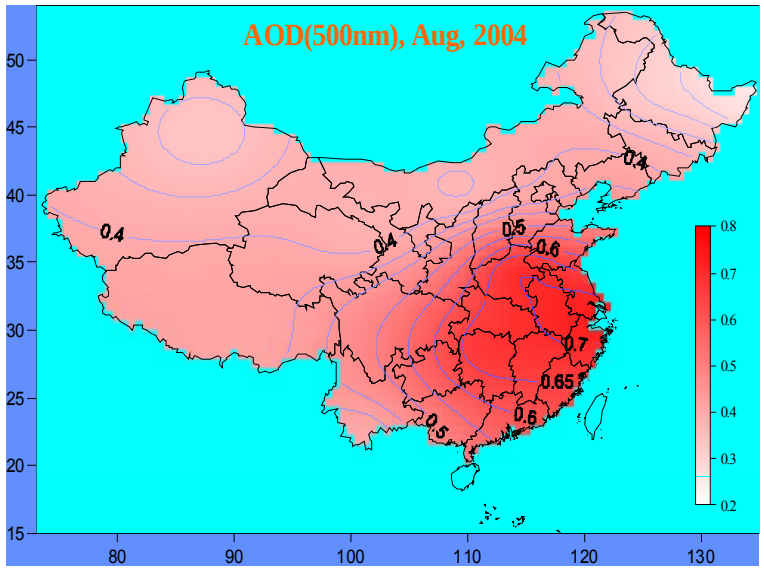
National Mean of Aerosol Radiative Forcing at the TOA, Surface and inside the Atmosphere



Li et al. (2010, JGR)

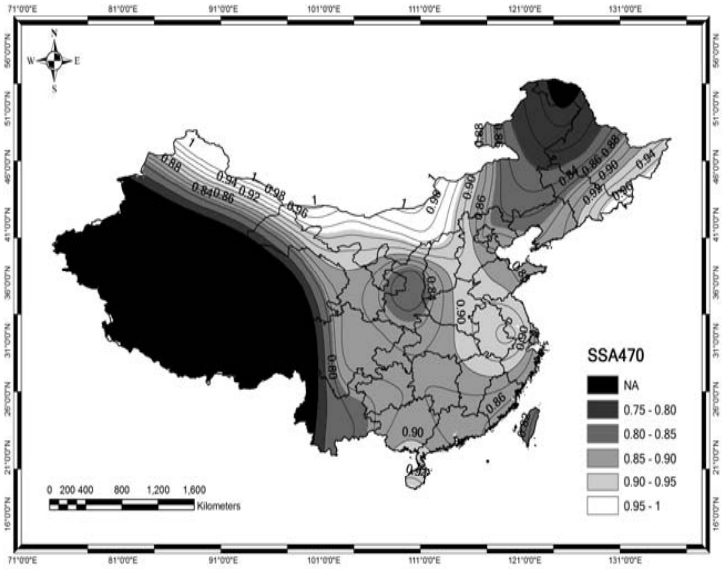
Aerosol Optical Dept

Xin et al. (2007)



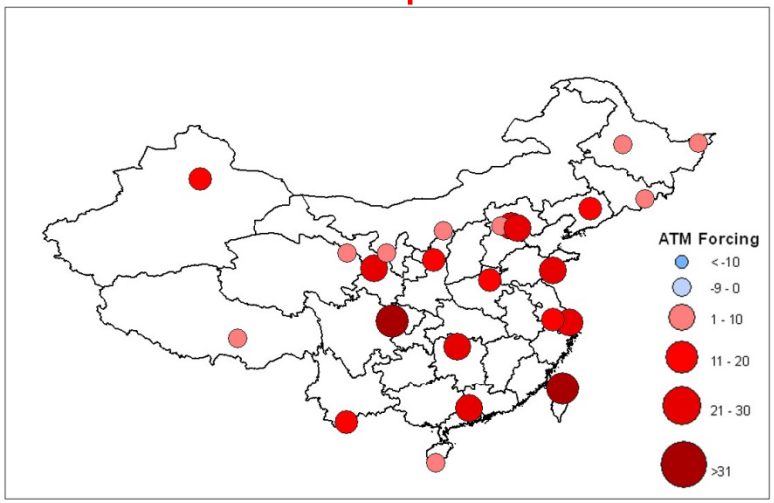
Single Scattering Albedo

Lee et al. (2007)

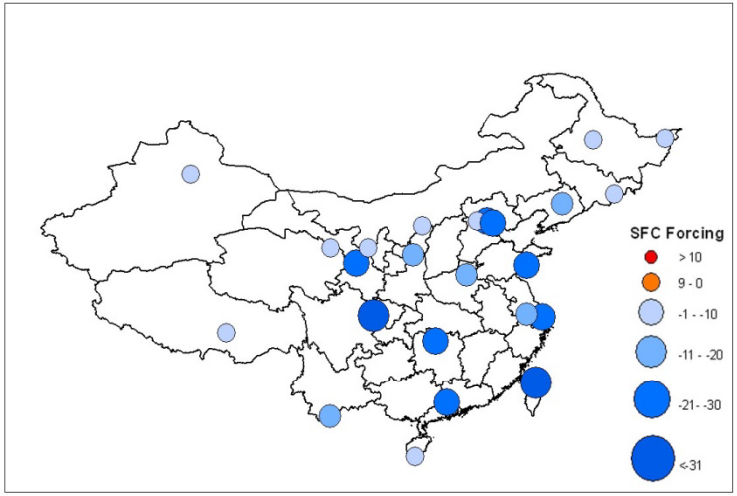


Aerosol Radiative Forcing

Atmosphere

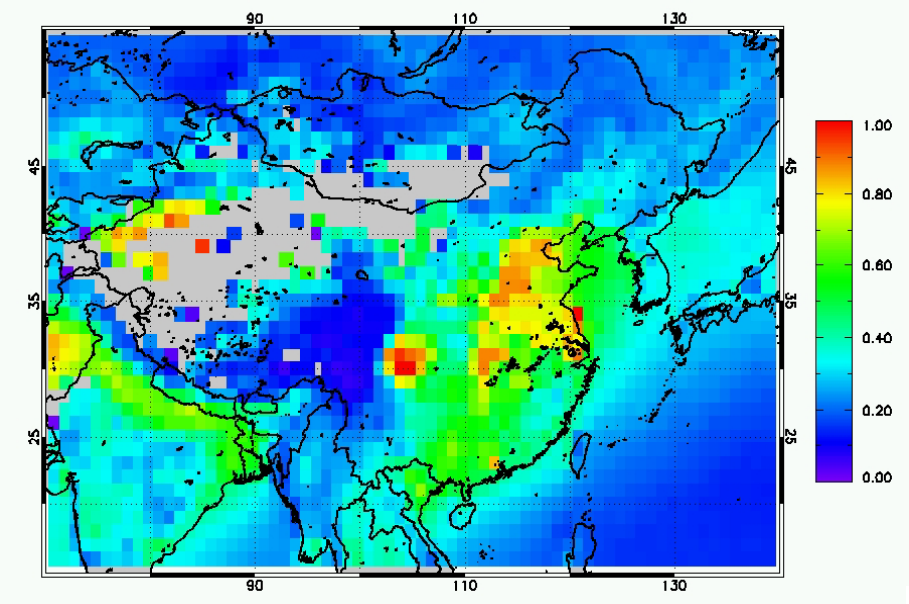


Surface

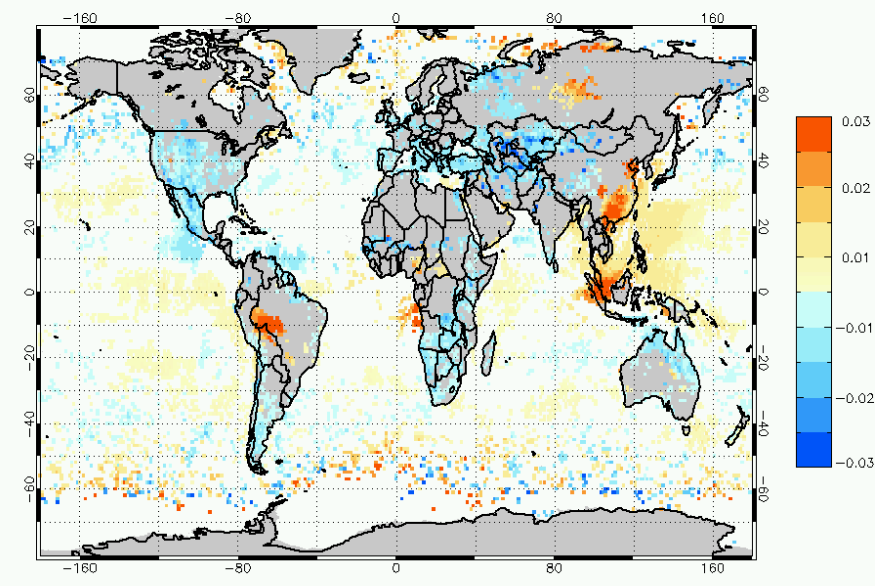


Li et al. (2010)

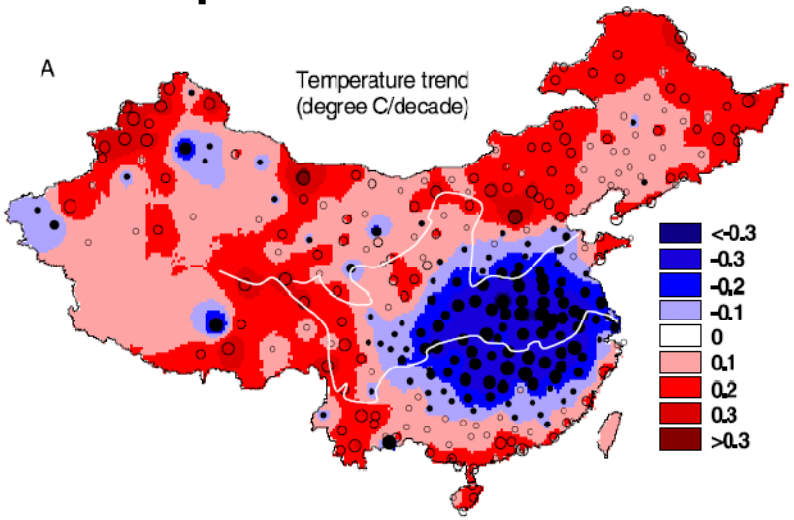
Mean MODIS AOT



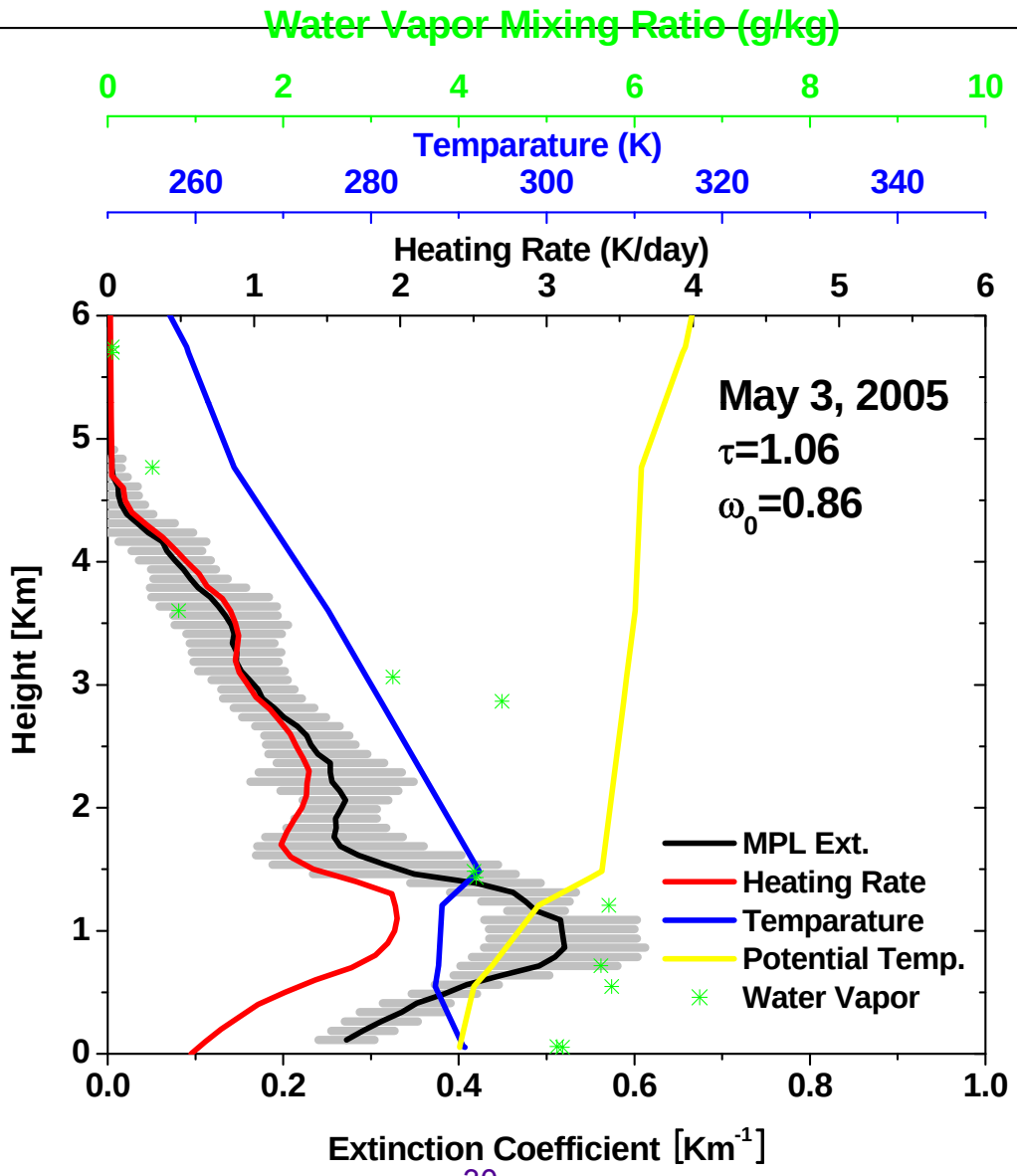
MODIS AOT Trend

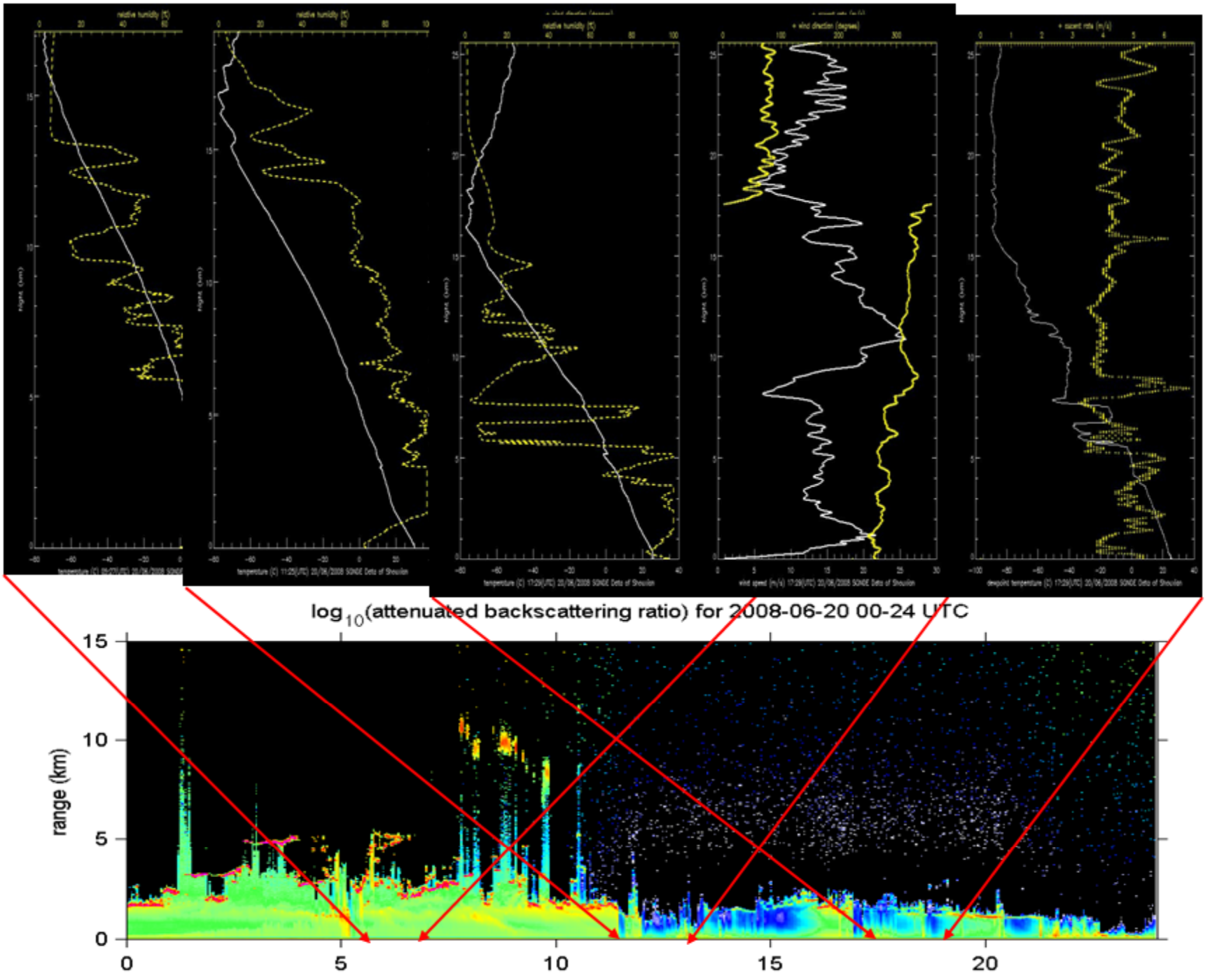


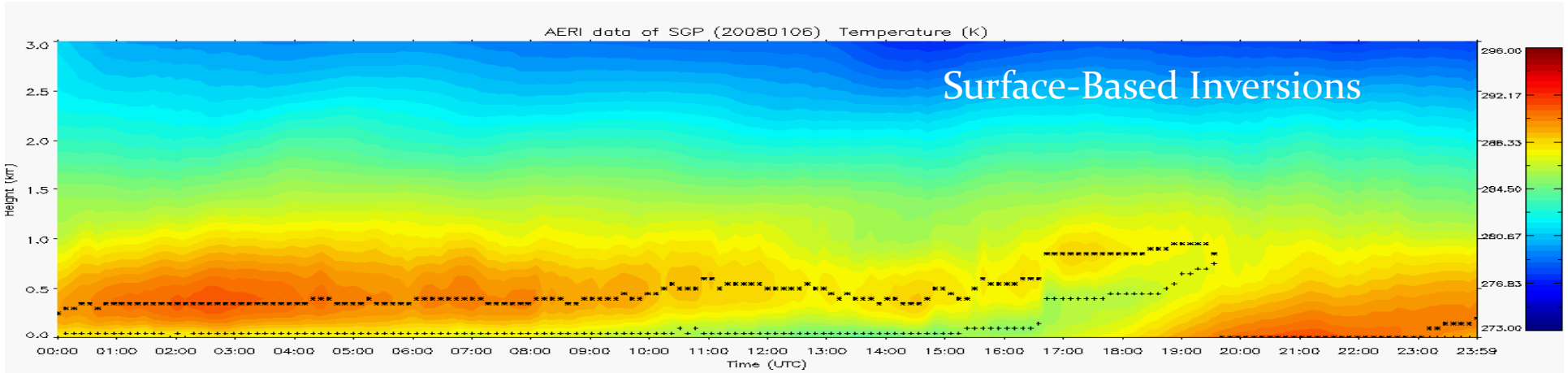
Temperature Trend

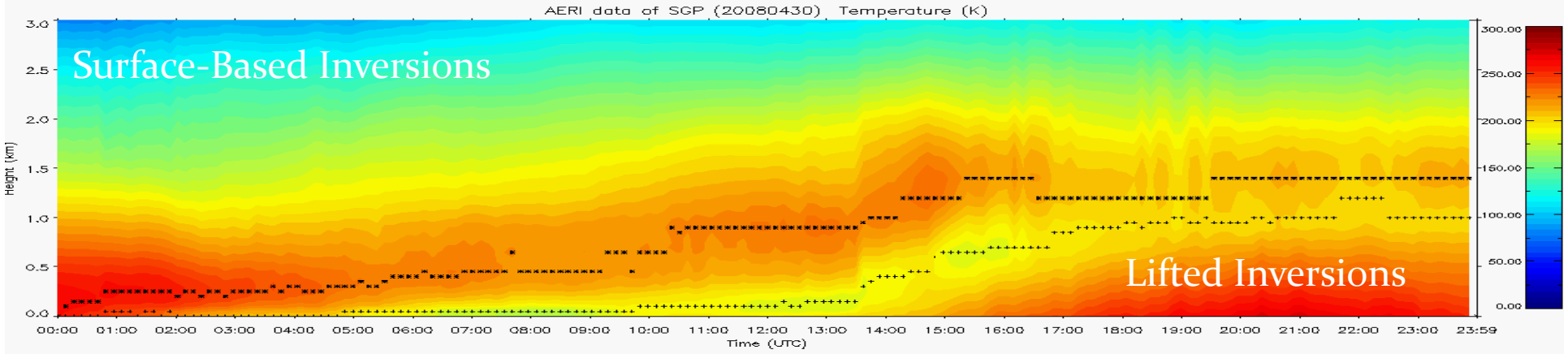


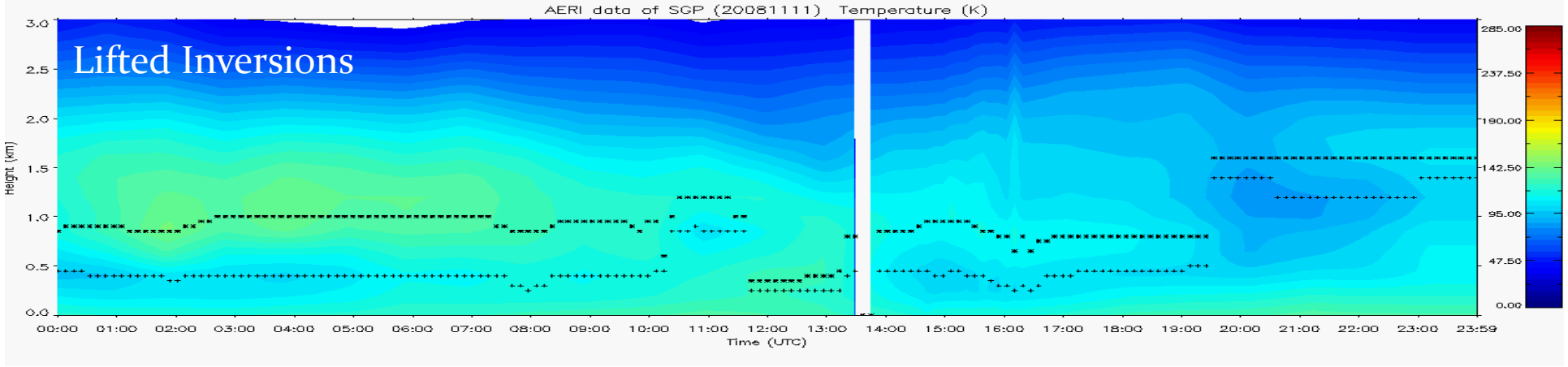
Atmospheric adiabatic heating rate




log10(attenuated backscattering ratio) for 2008-06-20 00-24 UTC
range (km)
0
5
10
15
20
4
4
3
3
2
2
1
1
0


AERI data of SGP (20080106) Temperature (K)
Surface-Based Inversions
Height (km)
Time (UTC)


AERI data of SGP (20080430) Temperature (K)
Surface-Based Inversions
Lifted Inversions
Height (km)
Time (UTC)


AERI data of SGP (20081111) Temperature (K)
Lifted Inversions
Height (km)
Time (UTC)

JGR Journal of Geophysical Research Atmospheres

East Asian Study of Tropospheric Aerosols and Impact on Regional Climate (EAST-AIRC)

Journal of Geophysical Research, vol. 115, no. , 2010

Guest Editor(s): Z. Li

Dwyer, J. G., J. R. Norris, and C. Ruckstuhl
Do climate models reproduce observed solar dimming and brightening over China and Japan?
J. Geophys. Res., 115, D00K08, doi:10.1029/2009JD012945
8 pages, 3 figures, 1 table
6 May 2010 [Abstract] [Dynamic Article] [Print PDF]

Fu, Q., G. Zhuang, J. Li, K. Huang, Q. Wang, R. Zhang, J. Fu, T. Lu, M. Chen, Q. Wang, Y. Chen, C. Xu, and B. Hou
Source, long-range transport, and characteristics of a heavy dust pollution event in Shanghai, 2007
J. Geophys. Res., doi:10.1029/2009JD013208, in press.
[PDF] (accepted 2 July 2010)

Ge, J. M., J. Su, T. P. Ackerman, Q. Fu, J. P. Huang, and J. S. Shi
Dust aerosol optical properties retrieval and radiative forcing over northwestern China during the 2008 China-U.S. joint field experiment
J. Geophys. Res., 115, D00K12, doi:10.1029/2009JD013263
11 pages, 10 figures, 4 tables
15 July 2010 [Abstract] [Dynamic Article] [Print PDF]

Gu, Y., K. N. Liou, W. Chen, and H. Liao
Direct climate effect of black carbon in China and its impact on dust storms
J. Geophys. Res., 115, D00K14, doi:10.1029/2009JD013427
12 pages, 7 figures
29 July 2010 [Abstract] [Dynamic Article] [Print PDF]

Guo, Z., Z. Li, J. Farquhar, A. J. Kaufman, N. Wu, C. Li, R. R. Dickerson, and P. Wang
Identification of sources and formation processes of atmospheric sulfate by sulfur isotope and scanning electron microscope measurements
J. Geophys. Res., 115, D00K07, doi:10.1029/2009JD012893
13 pages, 11 figures, 1 table
28 April 2010 [Abstract] [Dynamic Article] [Print PDF]

Huang, K., G. Zhuang, J. Li, Q. Wang, Y. Sun, Y. Lin, and J. S. Fu
Mixing of Asian dust with pollution aerosol and the transformation of aerosol components during the dust storm over China in spring 2007
J. Geophys. Res., 115, D00K13, doi:10.1029/2009JD013145
13 pages, 11 figures, 3 tables
21 July 2010 [Abstract] [Dynamic Article] [Print PDF]

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http://www.agu.org/journals/jd/special_sections.shtml?collectionCode=EASTAIRC1

- **Anthropogenic aerosols**
  - **Conversion from SO_2 into sulfate aerosol particles (Li et al.)**
  - **New formation mechanism of secondary sulfate aerosol (Guo et al)**
  - **Biomass burning aerosols from crop residues (Fan et al.)**
- **Dust aerosols**
  - **Vertical distributions at three desert regions (Huang et al.)**
  - **Chemical composition in Zhangye (Li et al.)**
  - **Tracking the origin of aerosols from downstream data (Wang et al)**
  - **Case studies in downsteam from coast (Liu et al) to Pacific (Logan et al)**
- **Aerosol optical properties and radiative forcing**
  - **Derivation of aerosol optical depths at all AMF sites (Lee et al)**
  - **Optical properties for 11 dust cases captured by AMF (Ge et al.)**
  - **First observation-based estimate of ARF across China (Li et al.)**
  - **A new correction method for accounting for the dome effect and influence estimation on radiation measurements (Ji et al.)**
- **Cloud properties**
- **Vertical distribution of cloud layers (Zhang et al.)**
- **The climate effect of aerosols**
  - **Direct effect of aerosols on temperature, pressure, wind, fog and circulation (Niu et al)**

Use of ARM Mobile Facility (AMF) Data to Study Aerosol Indirect Effects Future Work

- **Generation of VAP or HQ products for all variables needed to fulfill our objectives**
  - **Currently missing: T & q profiles from AERI, aerosol extinction from MPL, cloud particle size and phase, forcing data, satellite data**
- **Analysis and understanding of key processes**
  - ***Using VA/HQ from ALL sites, investigate if, how, and how much aerosols influence cloud, precipitation and regional climate in China;***
- **Modeling the effects of aerosols on cloud, precipitation & atmospheric circulation**
  - ***Incorporating a large volume of observed and inferred aerosol and meteorological quantities into a cloud resolving model to model the influence of aerosols on cloud, precipitation and regional climate and compare with observation-based findings***

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**