Aerosol optical depth measurements during the EAST-AIRE and the AMF deployment in China

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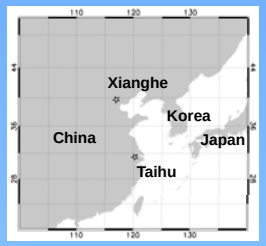
Introduction

• *Dataset*



Locations of MFRSR measurement sites

- MFRSR
  - Xianghe (2005~2008)
  - Taihu (2008~present)
- Micro pulse Lidar (MPL)
  - Taihu (2008~present)
- Cimel Sunphotometer
  - Xianghe (2001~present)
  - Taihu (2005~present)

See more details in JGR East-Aire Special Section, 112 (D22), 2007 and web (http://www.atmos.umd.edu/zli/EAST-AIRE)

• *Objectives*

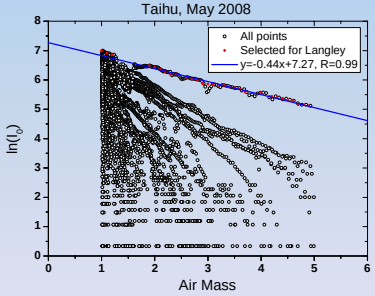
Development
- MFRSR calibration
- MPL extinction inversion

Analysis
- Aerosol Optical Properties (AOP) variations
- Aerosol vertical structure

Evaluation
- Aerosol Radiative Effect (ARE)
- AOP sensitivity of ARE

MFRSR

• *MFRSR calibration*

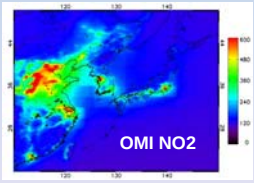


An example of proposed method for Langley plot

Beer's law,

$$I = I_0 \exp(-\tau_{tot} m)$$

$$\tau_{tot} = \tau_{ray} + \tau_{no2} + \tau_{o3} + \tau_{aer}$$

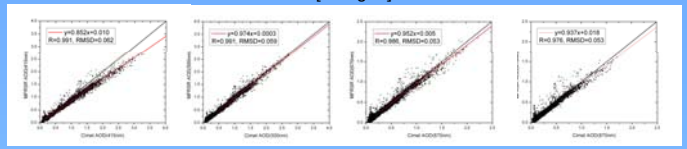


Determination of I_0

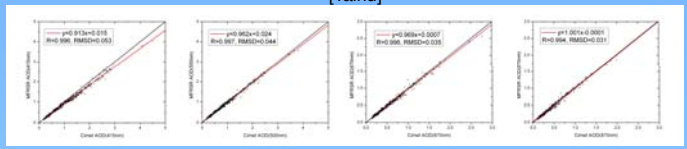
- Aerosol loadings at both sites are massive and highly variable during a day.
- To overcome disadvantage of the typical Langley plot method, the highest values at a given air mass during a period were used here.
- Those highest values can represent the clear-sky and relatively low aerosol loading condition.

• *MFRSR vs. Cimel AOD*

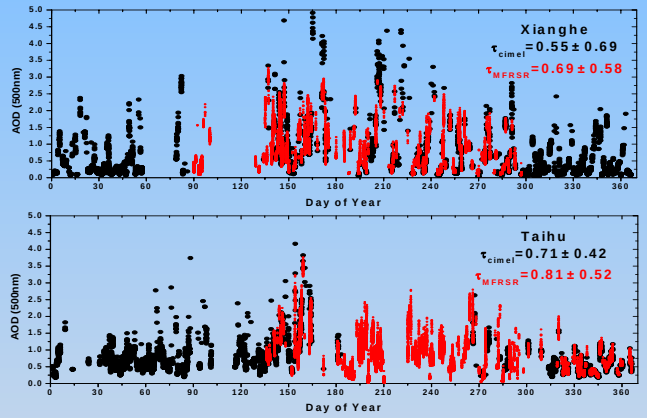
[Xianghe]



[Taihu]



Comparison of AOD derived by MFRSR and Cimel sunphotometer. 1:1 line (black) and liner regression line(red) are also plotted.

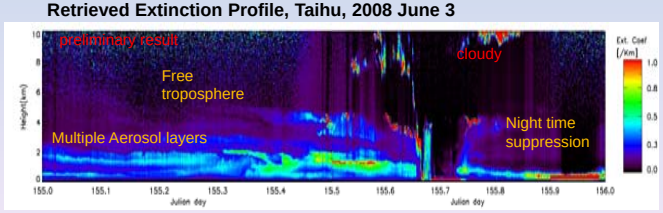


Time series of MFRSR and Cimel AOD during 2008

Micro Pulse Lidar

• *Aerosol extinction profile inversion*

Retrieved Extinction Profile, Taihu, 2008 June 3



Extinction can be solved numerically,

$$\beta_{aer}(z) = \frac{P(z)Z^2 \exp\left[-2\left(S_{aer}-S_{ray}\right)\int_0^z \beta_{ray}(z)dz\right]}{CE - 2S_{aer}\int_0^z P(z)Z^2 \exp\left[-2\left(S_{aer}-S_{ray}\right)\int_0^z \beta_{ray}(z')dz'\right]dz} - \beta_{ray}(z)$$

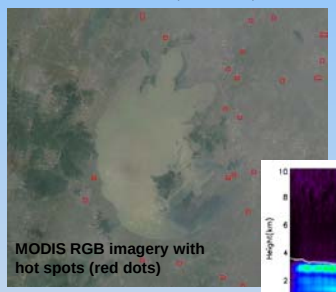
Continuous MPL observations provide vertical structure & PBL evolution.

Summary

- We developed a new method to retrieve the MFRSR AOD using the modified Langley calibration for hazy atmospheric conditions.
  - ✓ Retrieved MFRSR AODs are in good agreement with Cimel AODs with liner correlation slope>0.9, R>0.99, and RMSD<0.06.
- Statistics shows that the MFRSR AODs range from 0.57±0.49 in Xianghe to 0.81±0.52 in Taihu.
- The aerosol extinction profiles show multiple aerosol layer structure with high extinction of 0.5~0.8/ km under 4km altitude.
- Further investigation is needed to estimate aerosol effects on radiation budget or local climate.

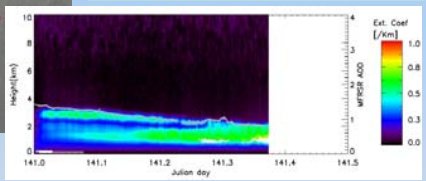
• *Case for hazy day*

Satellite, MFRSR, MPL results (May 20, 2008)



MODIS RGB imagery with hot spots (red dots)

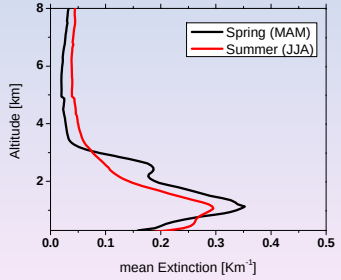
MFRSR : AOD: ~1.8
Lidar : thick haze+smoke layer under 4km
MODIS color image: shows hazy, many hot spots near the lake,small cloud sells are producing



MPL extinction profile with MFRSR AOD (gray dots)

• *Mean Aerosol Extinction Profile*

MPL [Taihu]



Aerosol layers are mainly located under 3.5km
→ can Increase radiative heating in the atmosphere + surface cooling
→ also can increase atmospheric stability and thus suppressed convection during the hazy and dusty days.

Seasonal mean aerosol extinction profiles