Climatological Variations In Aerosol Properties And Discrimination Of Aerosol Types With Their Frequency Distributions Based On Satellite Remote Sensing Data In The Yangtze River Delta, China

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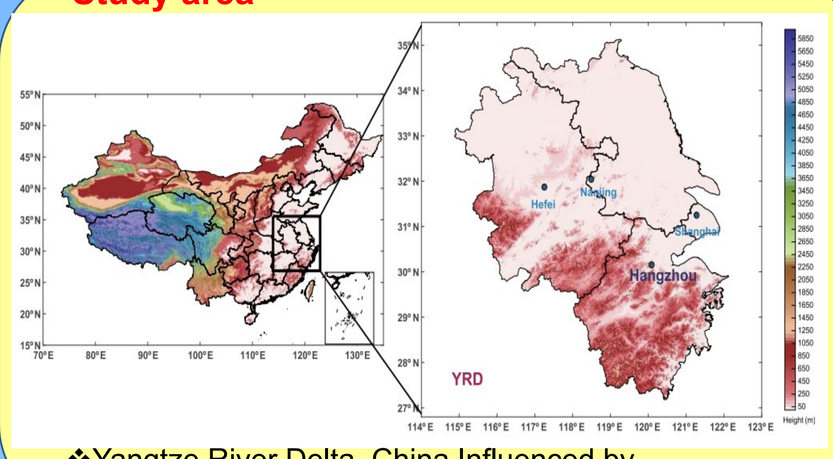
Abstract

The Collection 5.1 Level-2 data obtained from the MODIS sensor onboard Terra and Aqua satellites, the MISR, and the OMI for the period between 2002 and 2015 have been analyzed. The seasonal mean AOD_{550} ($AE_{470-660}$) was found to be maximum with 0.97 ± 0.48 during summer (summer) (1.16 ± 0.33) and a minimum of 0.61 ± 0.28 during the winter (spring) season (0.80 ± 0.28). $AE_{470-660}$ found higher in summer indicates relative abundance of fine mode aerosols over the coarse mode. Annual mean Terra AOD_{550} showed a strong decreasing trend (–0.70% $year^{-1}$), while the Aqua exhibited a slight increasing trend (+0.01 $year^{-1}$) during the study period. We also used the HYSPLIT model for presenting cluster trajectory analysis which revealed that the air masses from different source regions contributed greatly to aerosol loading. Using the AOD-AE-FMF methods, five major aerosol types were identified. In all the seasons, the mixed (MX) type of aerosol is dominant followed by the biomass burning/urban-industrial (BU) and desert dust (DD) aerosol types during summer and spring seasons, respectively. Further, the sub-classification of aerosol types was carried out considering into account of the characteristics of absorbing aerosol index (AAI). The two clustering techniques showed reasonable consistency in the obtained results.

Introduction

❖Atmospheric aerosols are among the major climate forcing agents recognized globally (IPCC, 2013).
❖ The biggest uncertainty in climate change, even by the best available models is due to uncertainties in aerosol radiative forcing (IPCC, 2013).
❖Uncertainties arise due to poor understanding of aerosols spatiotemporal distribution.
❖Over the last decade, various satellite remote sensing techniques were improved significantly in retrieving the global aerosol products such as the MODIS, MISR, and OMI which forms the basis for this study.

Study area



❖Yangtze River Delta, China Influenced by anthropogenic and natural aerosols

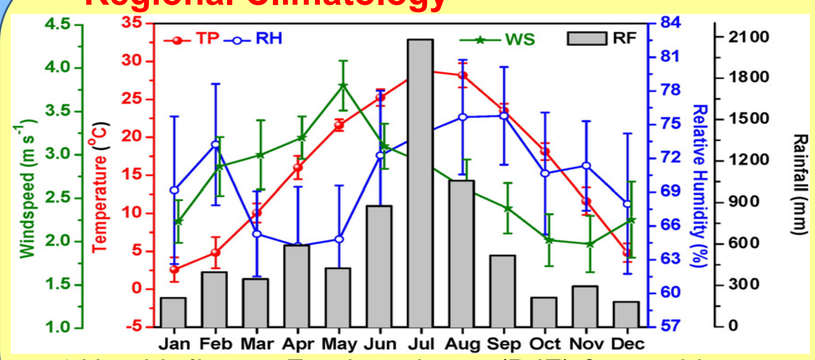
Objectives, Data & Methods

Objectives
❖Analysis of Aerosol Properties
❖Discrimination of Aerosol Types
❖FD in Aerosol Properties

Data
❖MODIS AOD & FMF
❖MISR AOD
❖OMI AAI
❖AERONET AOD

Methods
❖ Techniques to identify aerosol types
❖Air mass back trajectory analysis

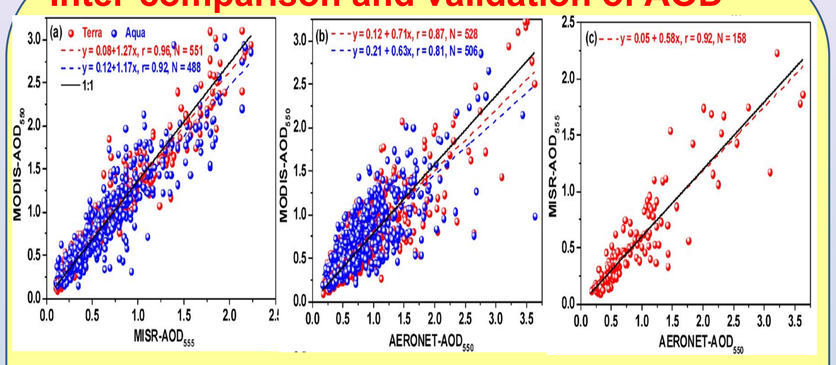
Regional Climatology



❖Humid climate, Freeing winters (DJF) & scorching summers (JJA). Westerly Winds during during late winter

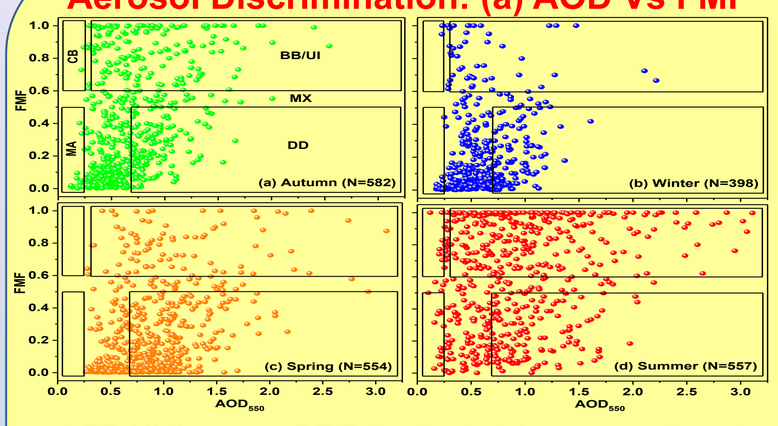
Results & Discussion

Inter-comparison and validation of AOD



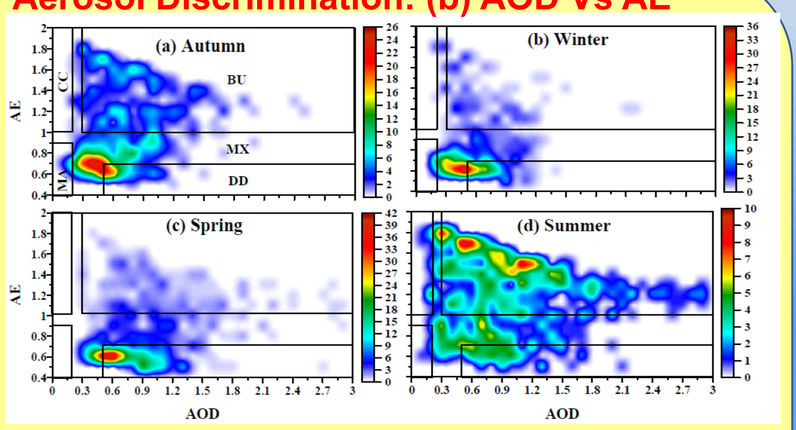
❖Strong positive correlations between MODIS & MISR at Nanjing
❖Overestimation of MODIS compared to the MISR relative to AERONET

Aerosol Discrimination: (a) AOD Vs FMF



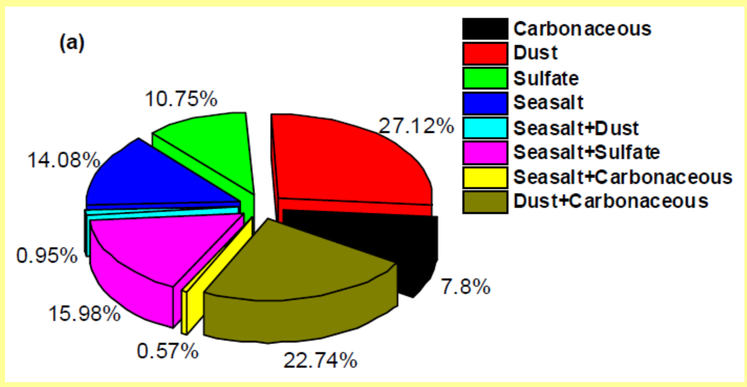
❖BB/UI & coarse DDT dominated in summer & spring
❖MX dominated in all seasons, except summer.

Aerosol Discrimination: (b) AOD Vs AE



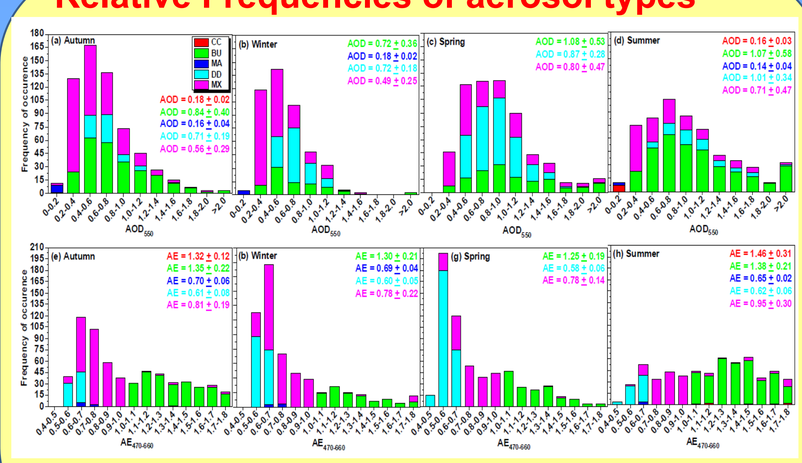
❖DDT due to long-range transported coarse aerosols from natural desert surfaces
❖CC and MA absent during types in spring

Aerosol Discrimination: (c) AOD, AE Vs AAI



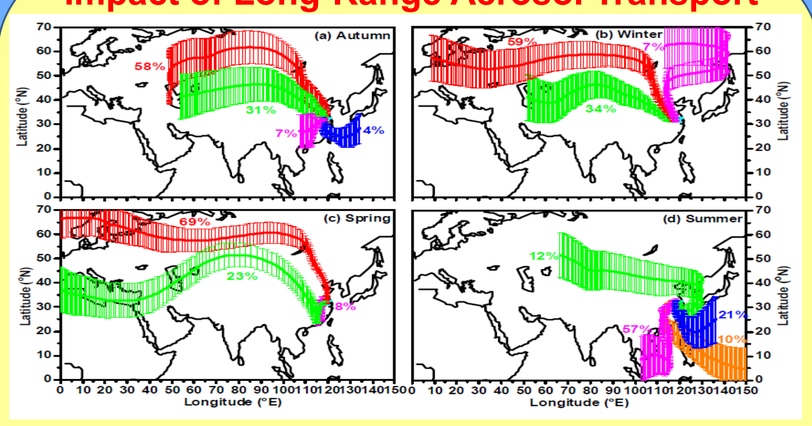
❖Dust & dust+carbonaceous type aerosols dominated
❖Low seasalt+dust & seasalt+carbonaceous aerosols at Nanjing

Relative Frequencies of aerosol types



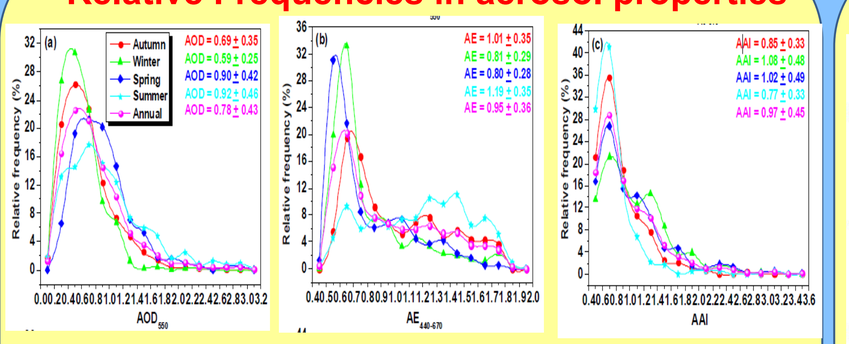
❖DD aerosol types at high AOD (0.5–1.2)
❖Predominance of BU at higher AOD (>1.0)

Impact of Long-Range Aerosol Transport



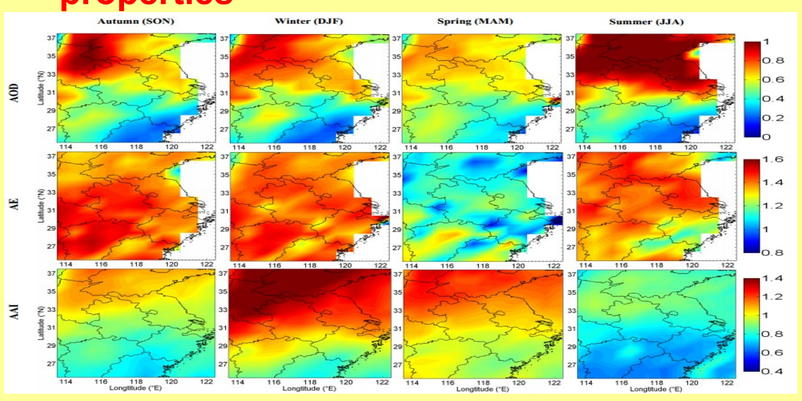
❖North, East, & South of China
❖Mongolia & Taklimakan Deserts
❖Russia & Kazakhstan

Relative Frequencies in aerosol properties



❖A unimodal distribution for AOD_{550} & AAI was observed for all seasons except in winter
❖Large seasonal heterogeneity in $AE_{470-660}$ observed suggesting strong variability in the aerosol particle size

Spatiotemporal distributions in aerosol properties



❖Higher (lower) in AOD & lower (higher) $AE_{470-660}$ appear in the northern and eastern parts in of East China

Conclusions

❖High aerosol loadings (>1.0) (high AE and low AAI) found over economically (highly urbanized) and industrially developed areas of northern and eastern parts of East China.
❖Low aerosol loadings (<0.2) (high AE and low AAI) observed in the rural and less-developed areas of southern regions of East China
❖The MX type aerosols contributed much influence on the aerosol loading in all
❖Complexity of aerosol types and sources existed over Nanjing, YRD with reasonable consistency among the different methods based on satellite data.

References

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❖Luo Y, Zheng X, Zhao T, Chen J. 2014. A Climatology of Aerosol Optical Depth over China from recent 10 Years of MODIS Remote Sensing Data. Int J Climatol. 34: 863-870. doi.org/10.1002/joc.3728