

Dust characteristics in South East Asia

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International Workshop on Sand and Dust Storms, Istanbul (4-7 October, 2016)

Republic of Turkey
The Ministry of
Forestry and Water
Affairs



This Presentation covers

- ❖ Introduction
- ❖ Impacts of dust storm
- ❖ Motivation
- ❖ Study area
- ❖ Data & Methods
- ❖ Results & Discussion
- ❖ Conclusion



Dust storm????



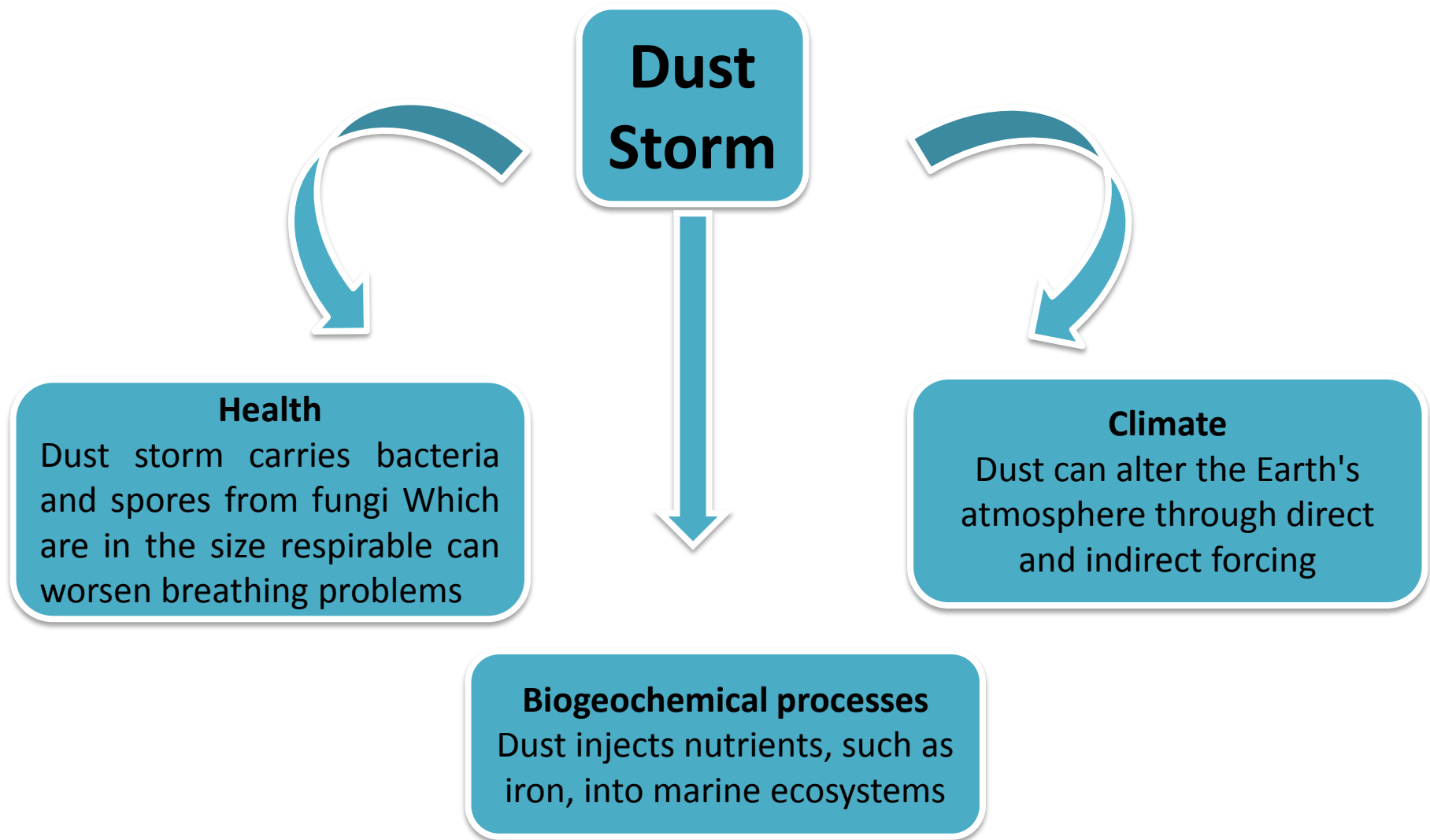
A **Dust Storm** (or Sand Storm) is a common meteorological phenomenon that is common in arid and semi-arid regions



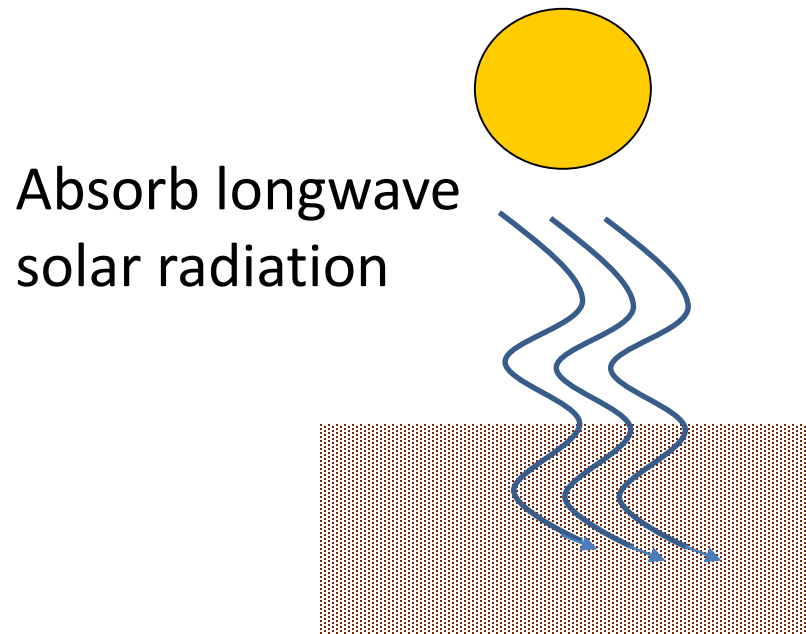
❖ World's Largest Deserts



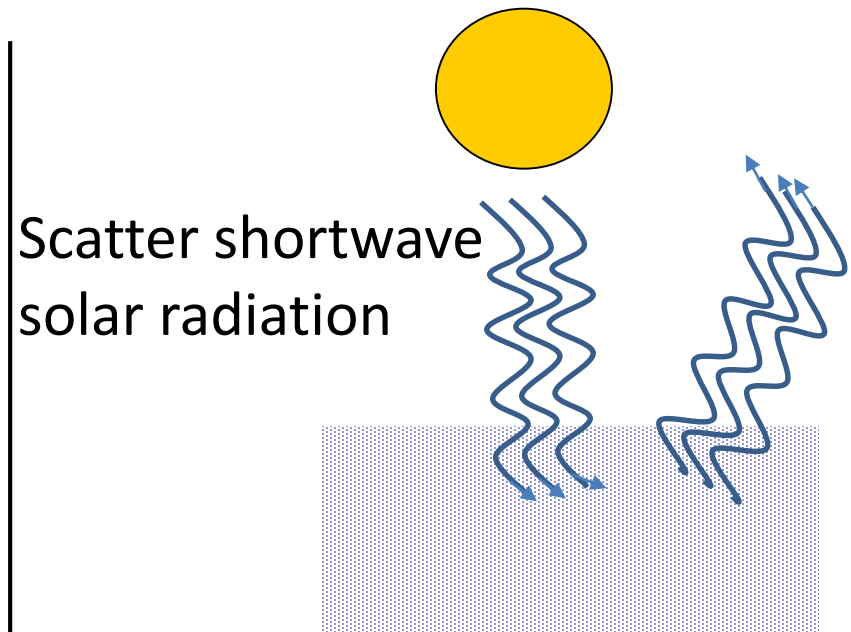
❖ Impacts of dust storm



Direct radiative forcing by dust aerosols (Direct effect)

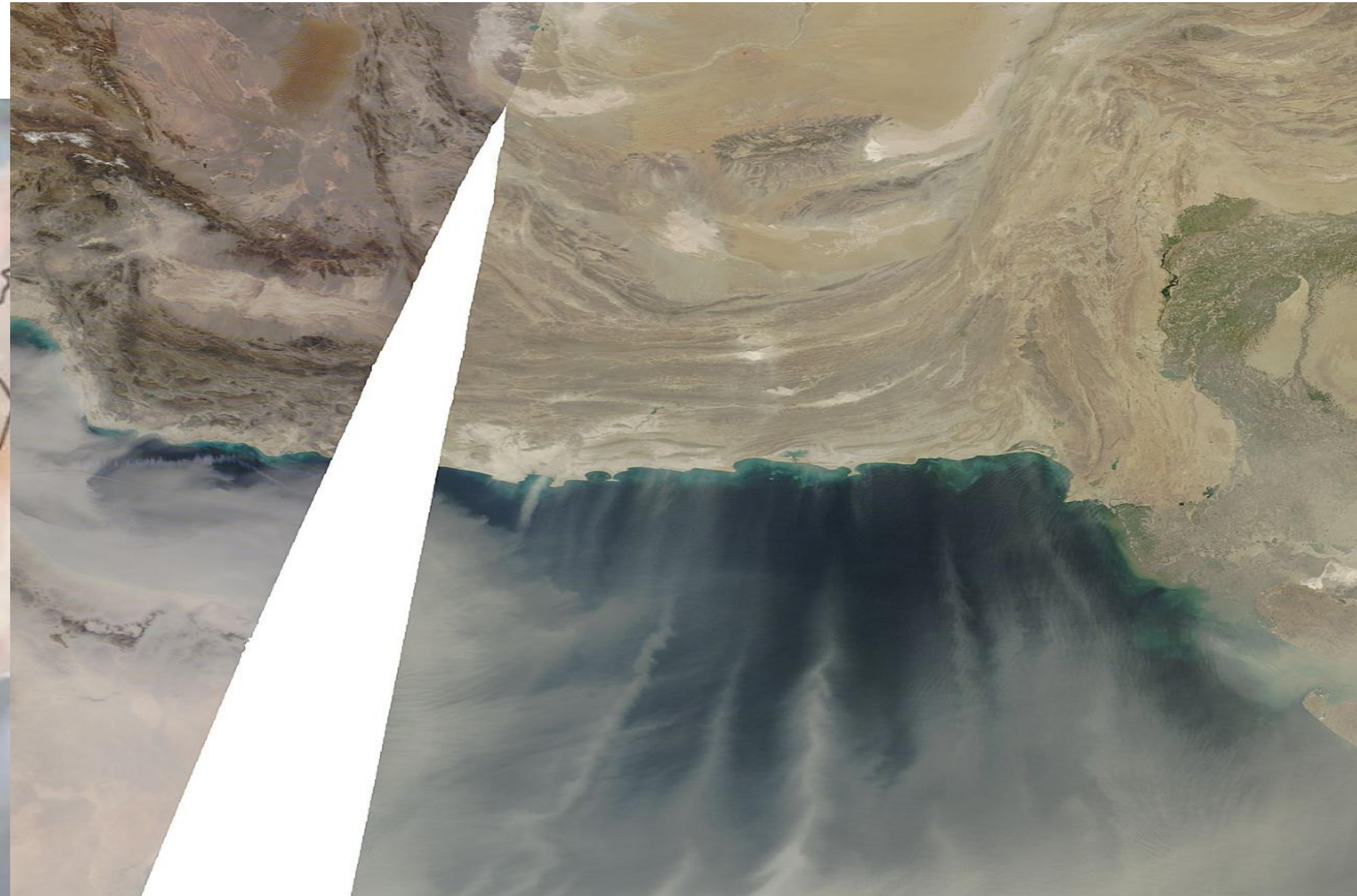


**Solar radiation absorbed
(Warming)**



**Solar radiation scattered to
space (Cooling)**

❖ Impacts of dust storm



❖ Introduction

Important Terminology

When a beam of light impinges on aerosol particles, it results scattering and absorption of the incident radiation, thereby diminishing the intensity of the beam. This process is called **extinction**.

The **extinction coefficient** represents the sum of the extinctions from gases and particles, each of which can in turn be divided into extinction due to absorption or scattering.

$$\begin{aligned}\beta_{\text{ext}} &= \beta_{\text{gas}} + \beta_{\text{particles}} \\ \beta_{\text{ext}} &= \beta_{\text{abs}} + \beta_{\text{scatt}}\end{aligned}$$

The integrated extinction coefficient over a vertical column of unit cross section is called **aerosol optical depth (AOD)**

$$AOD(\lambda) = \int_{S_1}^{S_2} \beta_{\text{ext}, \lambda}(h) dh$$

Important Terminology

Single scattering albedo (ω) is a measure of the fraction of aerosol extinction caused by scattering:

$$\omega = b_{\text{scatt}} / (b_{\text{abs}} + b_{\text{scatt}})$$

Angstrom exponent (α) is a measure of the aerosol size number distribution. High values of α indicate the dominance of fine particles and low values indicate the dominance of coarse particle

Atmospheric Forcing

- In order to understand how the Earth's climate is changing, it is critical to make sense of each mechanism that causes warming or cooling in the atmosphere
- Each process that changes the balance of radiation coming into and going out of the Earth-Atmosphere system is known as atmospheric forcing
- The long wave (LW) and shortwave (SW) radiative forcing at the surface are important components of the Earth's radiation balance

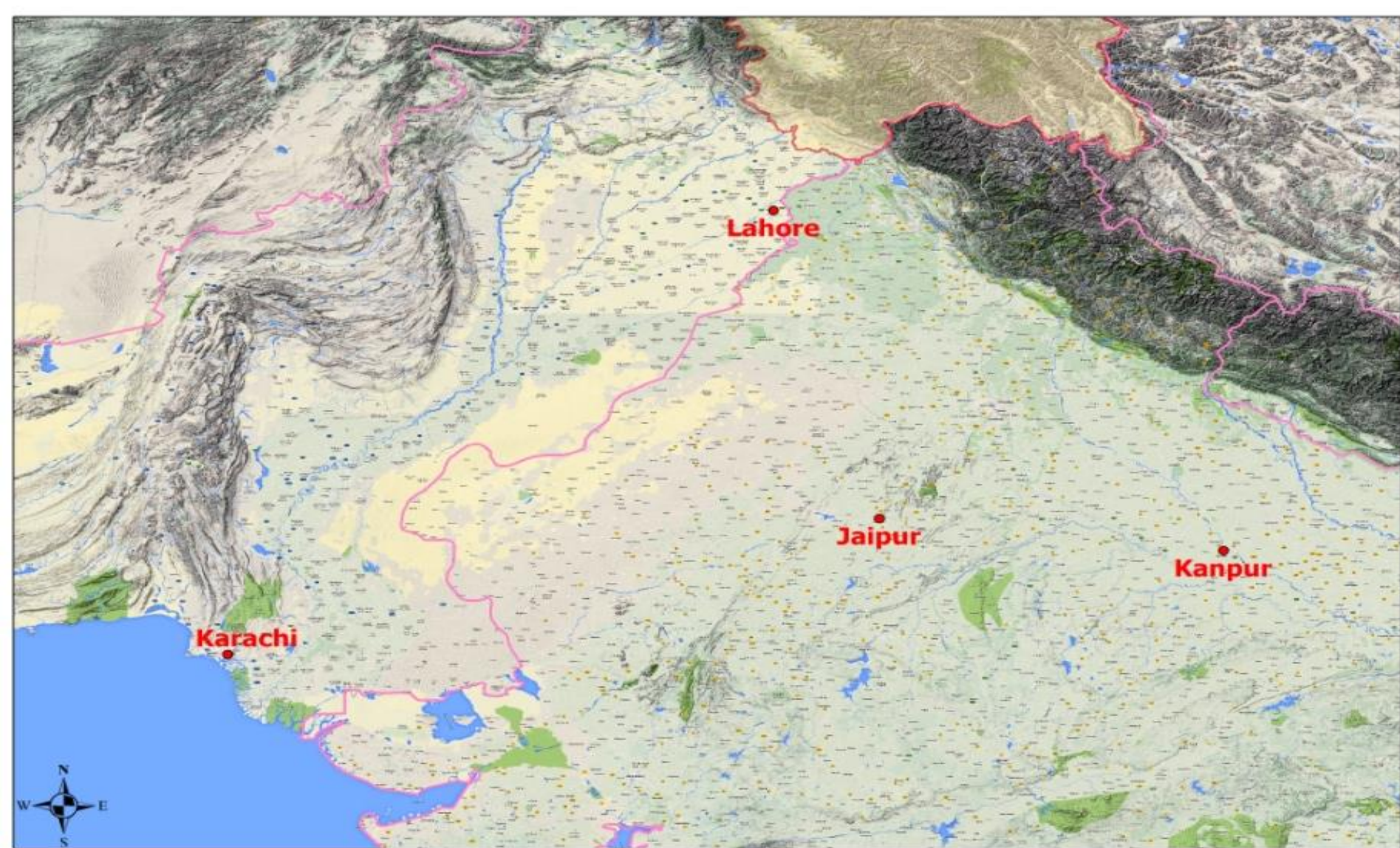
Aerosol Radiative Forcing

The difference in the net solar fluxes (down minus up) with and without aerosol

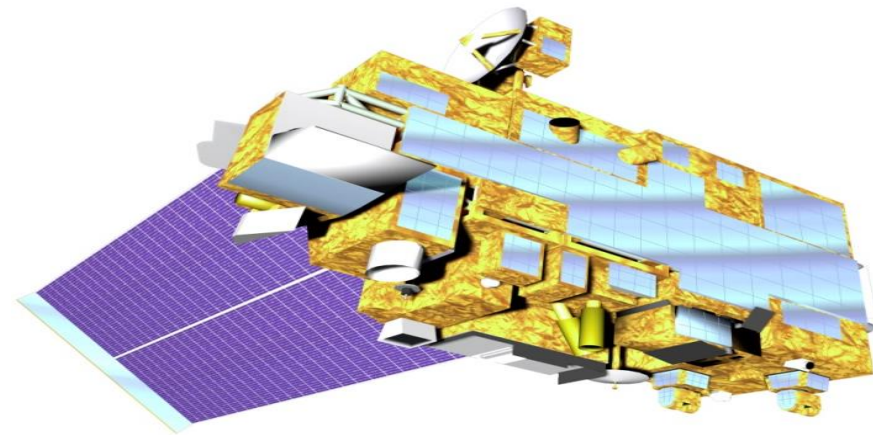
$$F_{net} = F^{down} - F^{up}$$

- In order to better understand the effects of dust on climate, we have analyzed aerosol optical and radiative properties during dust events using ground-based observations

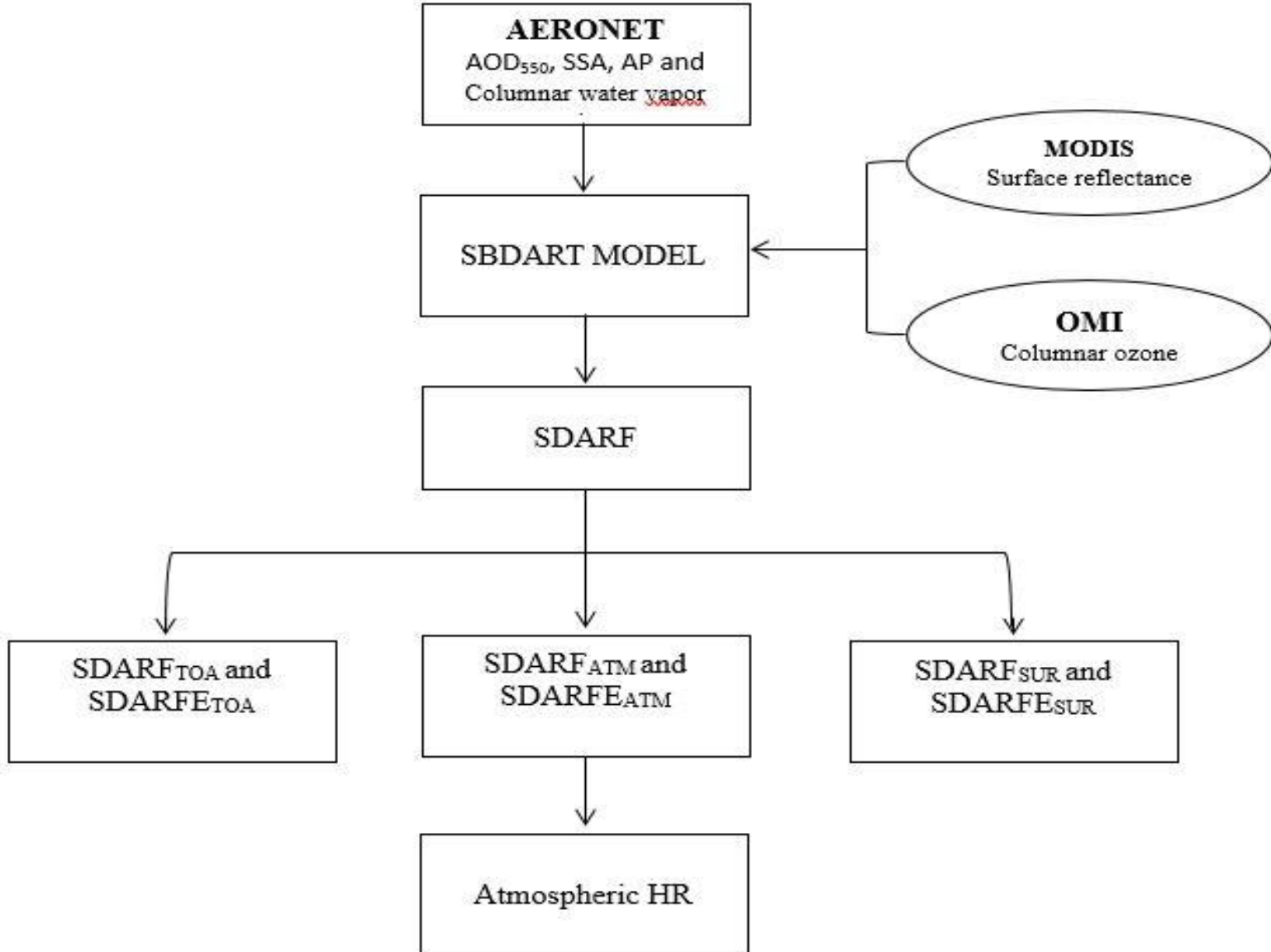
Indo-Gangetic Plains



- Aerosol Robotic Network (AERONET) .
- Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observation (CALIPSO)
- Hybrid single particle Lagrangian Integrated Trajectory (HYSPLIT) model
- Santa Barbara DISORT Atmospheric Radiative Transfer (SBDART) model
- Data were retrieved for dusty days during 2007-2013.

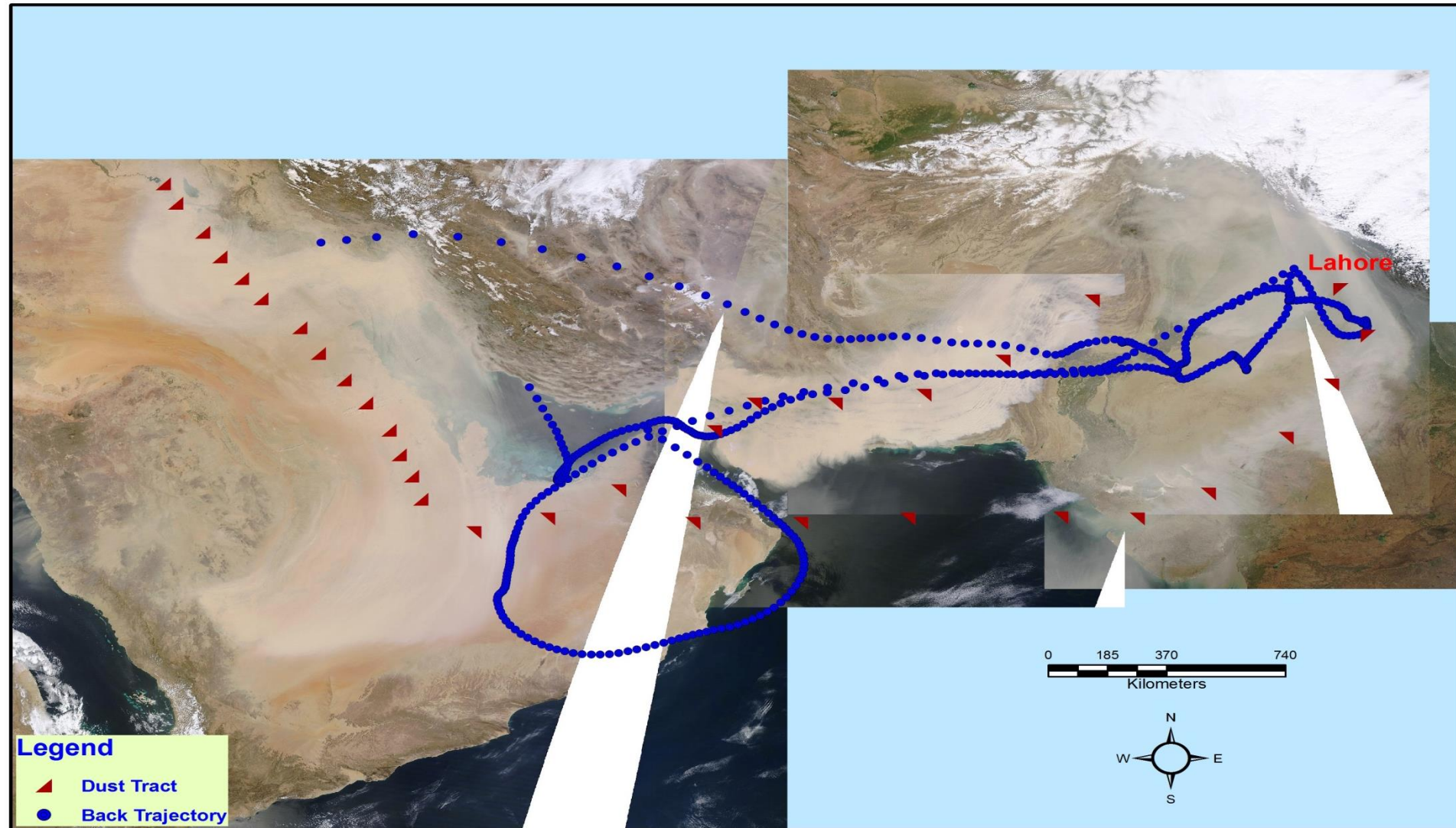


Model

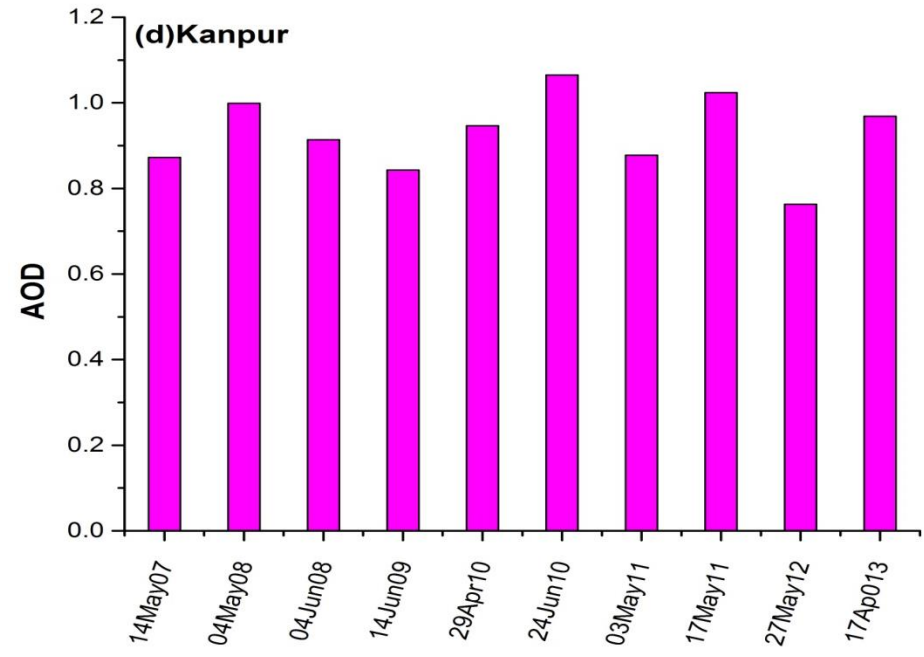
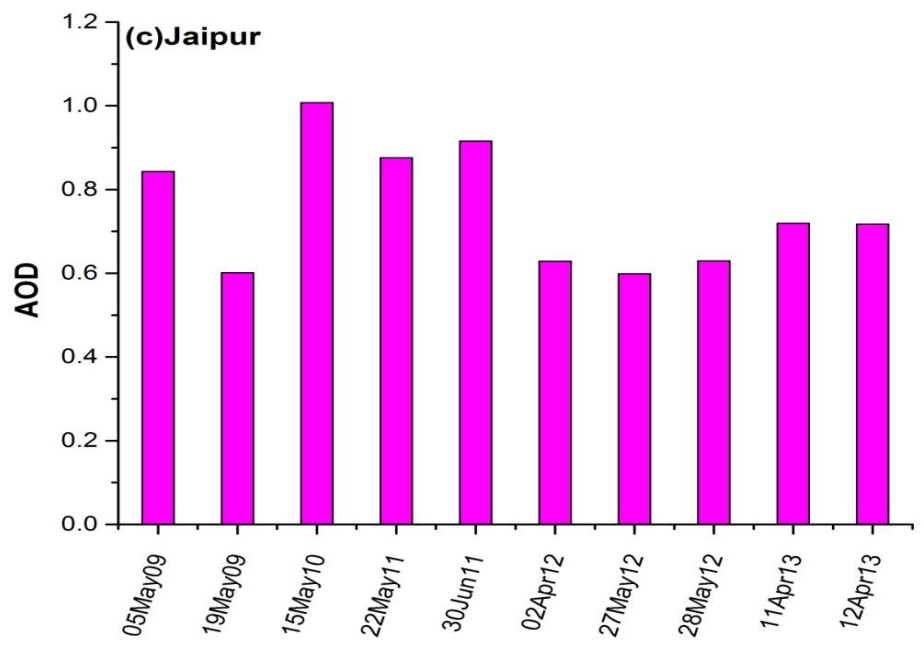
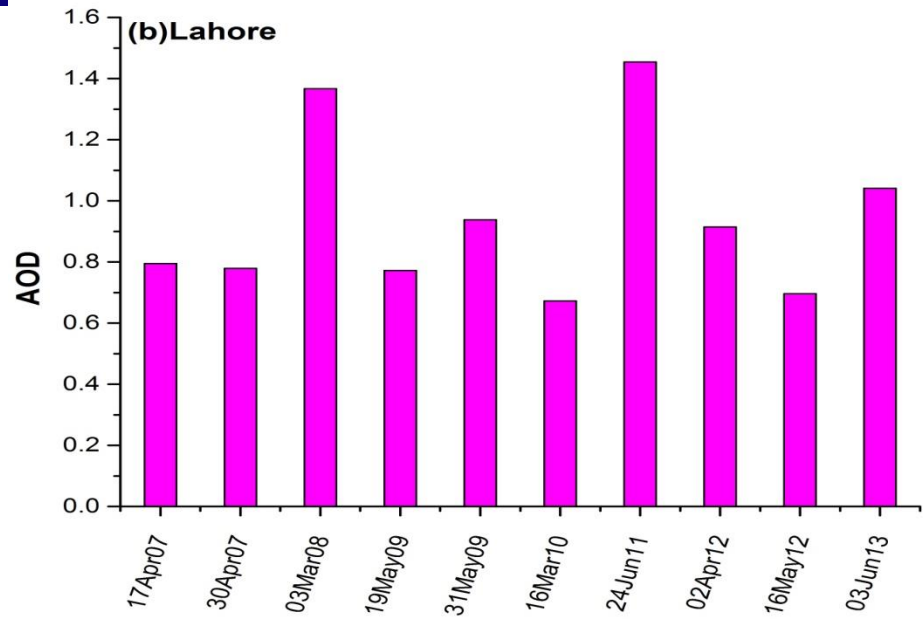
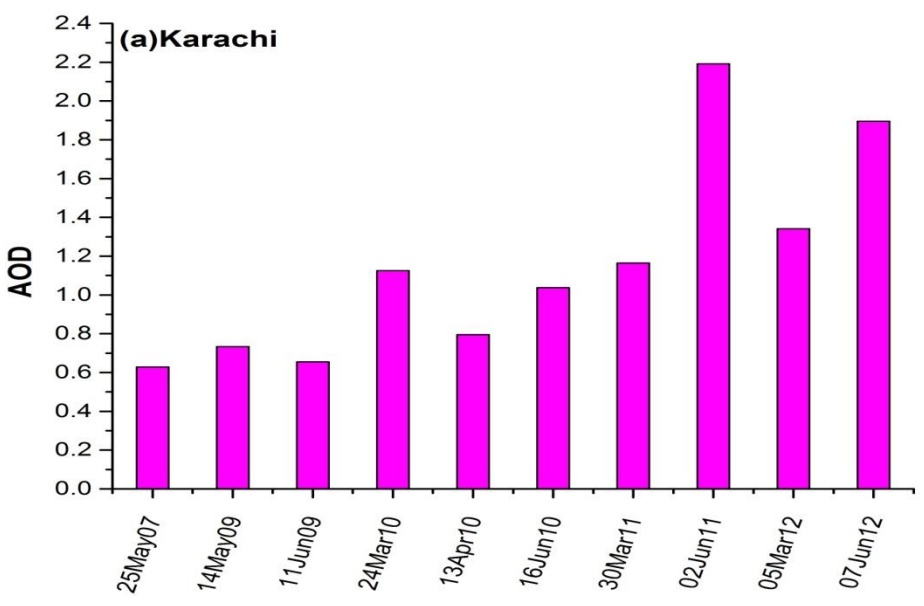


Dust Characteristics Based on Satellites & Ground based Datasets

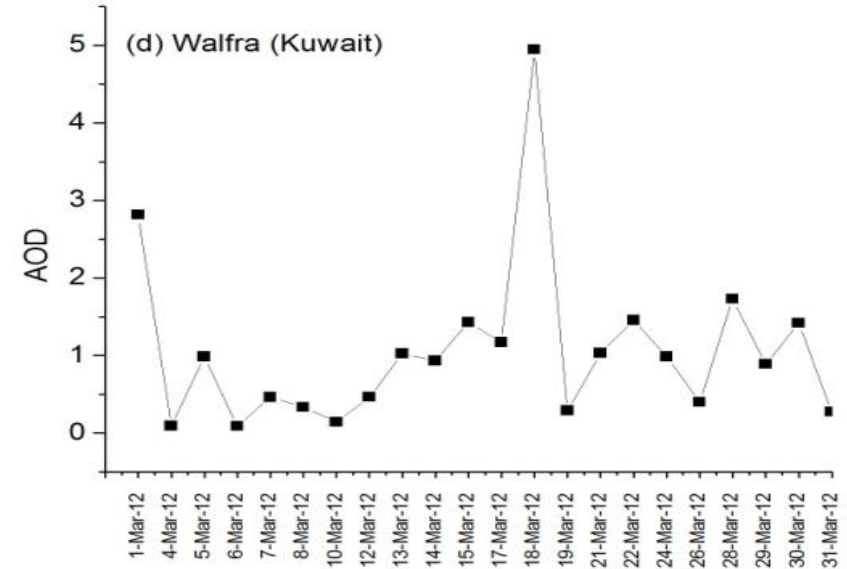
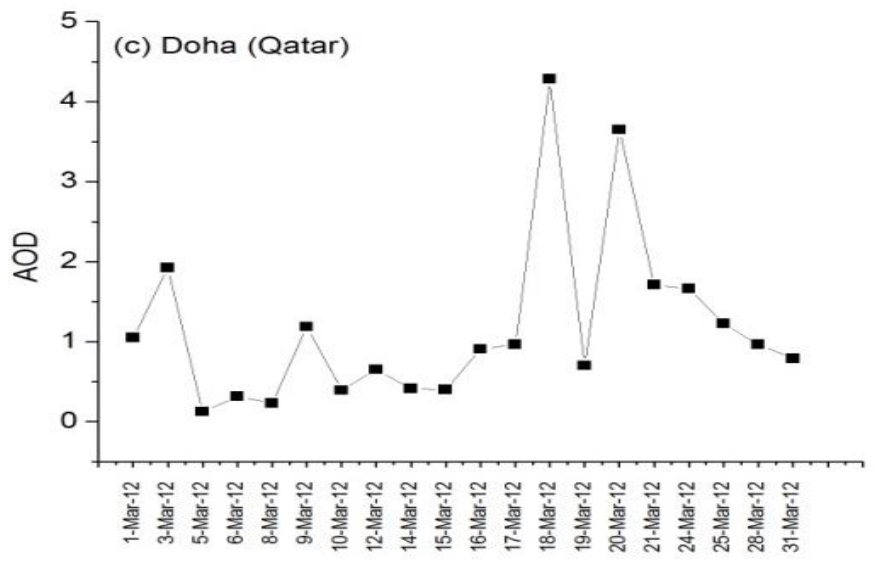
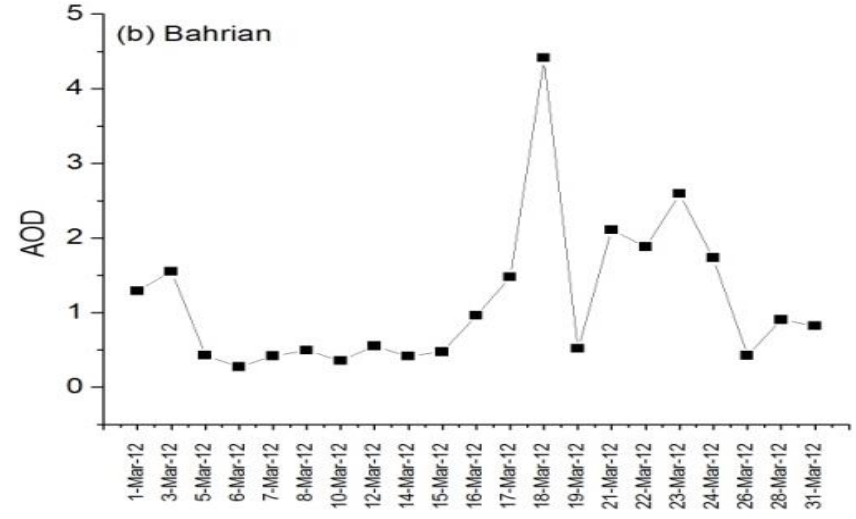
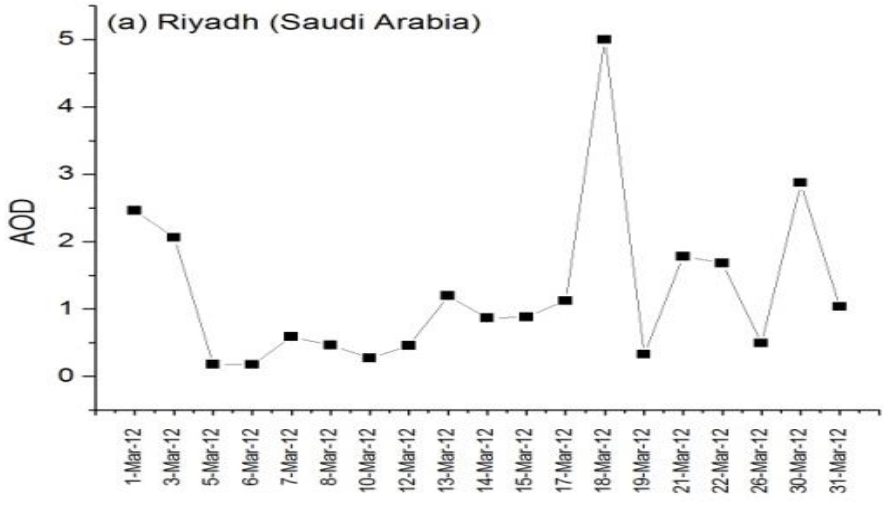
Formation of Dust events and Meteorological situation



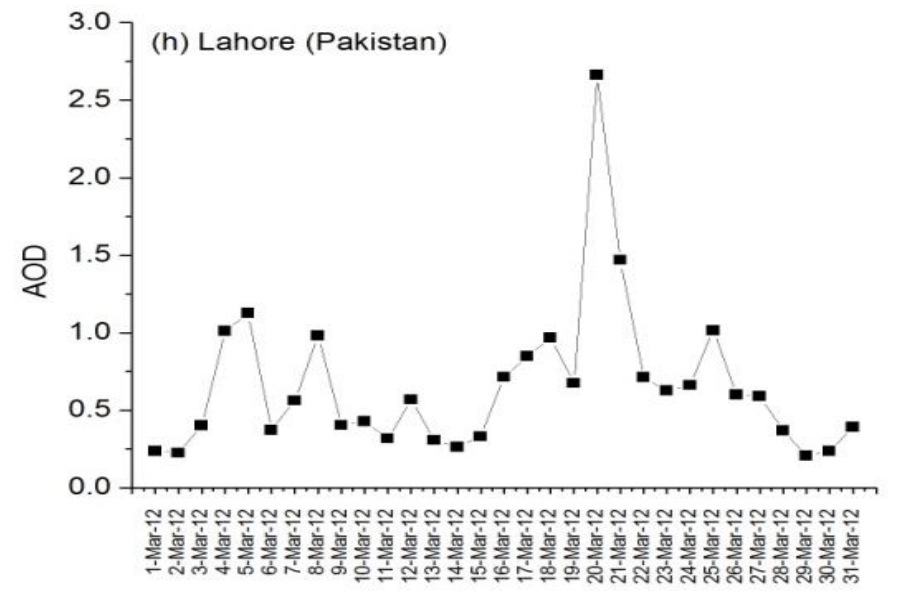
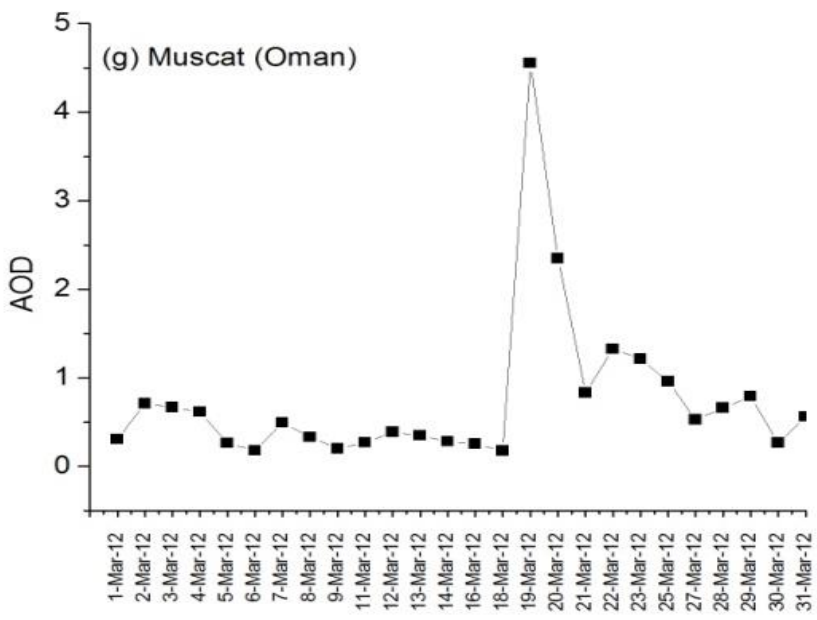
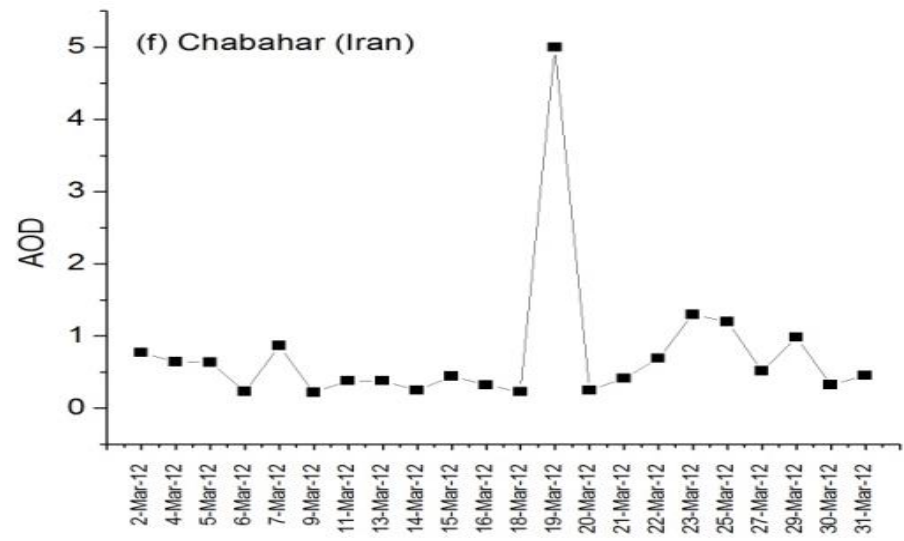
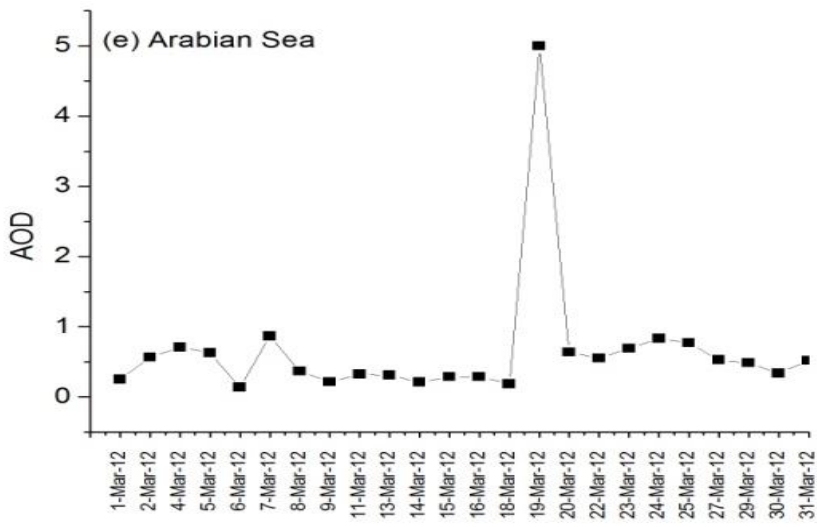
Results & Discussion: Aerosol Optical Depth Variations



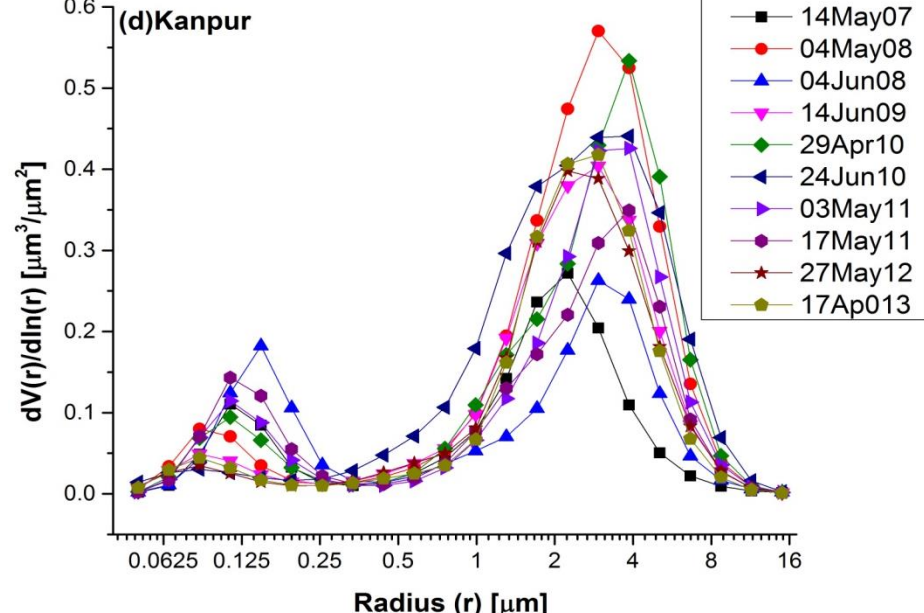
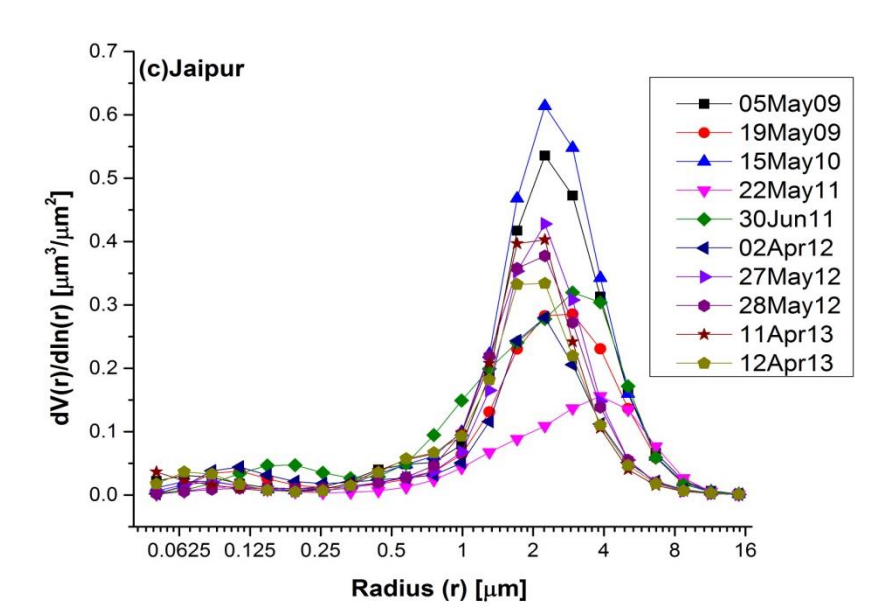
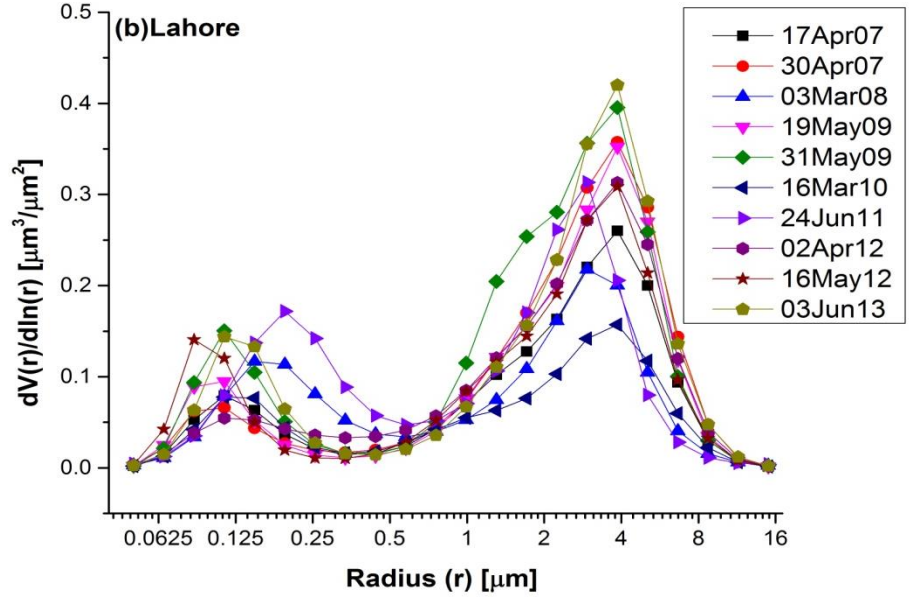
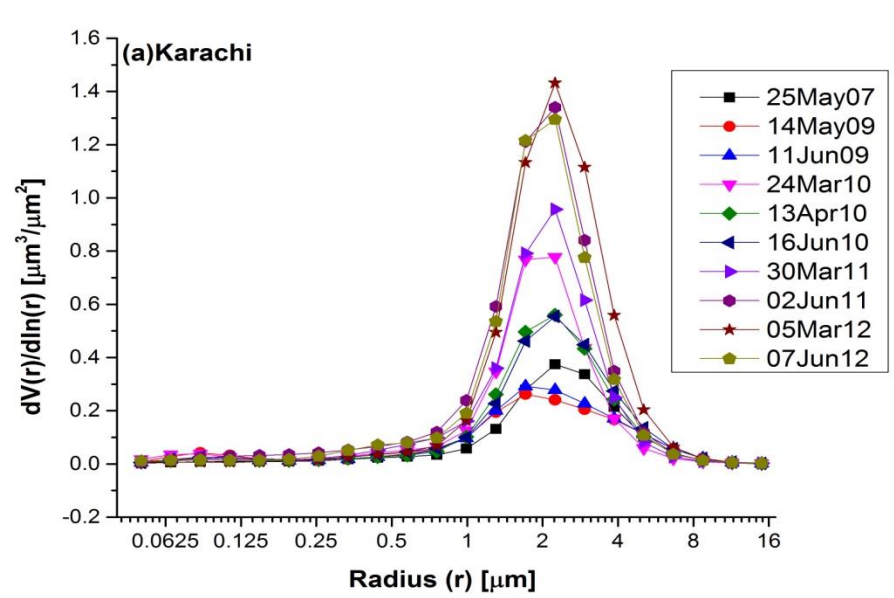
❖ Results & Discussion: Aerosol Optical Depth Variations



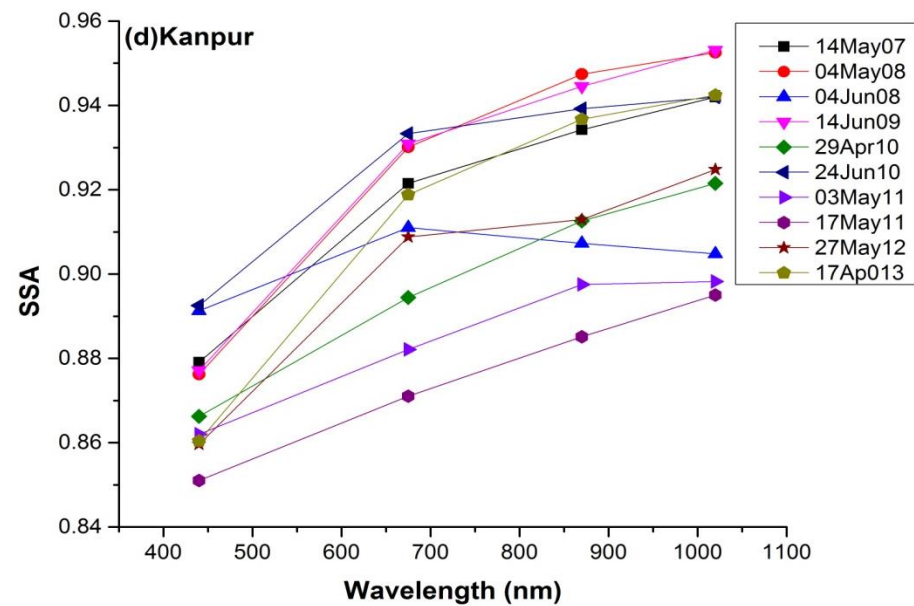
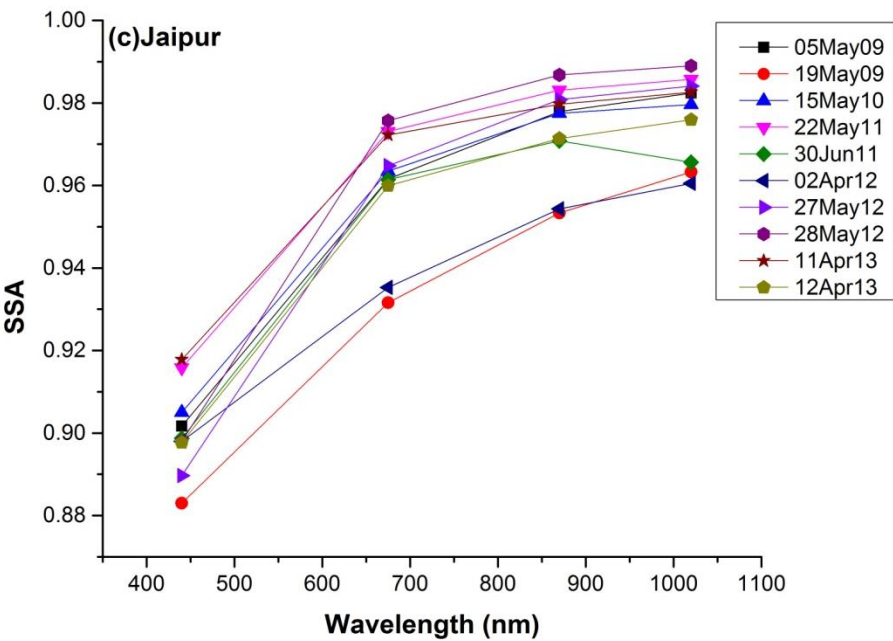
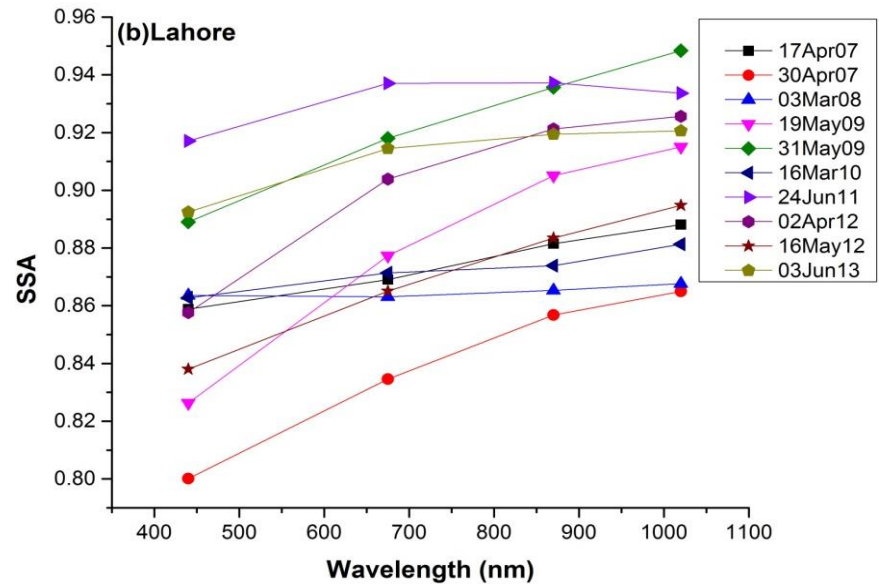
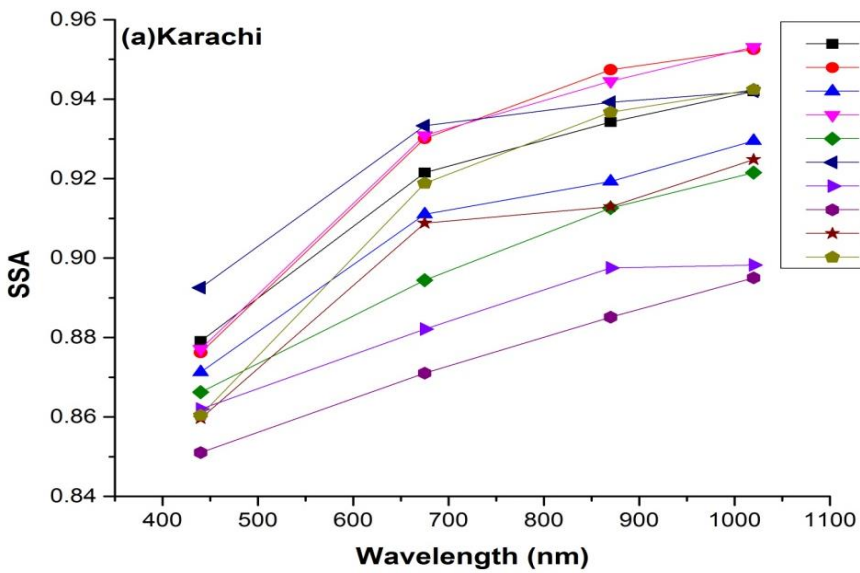
❖ Results & Discussion: Aerosol Optical depth variations



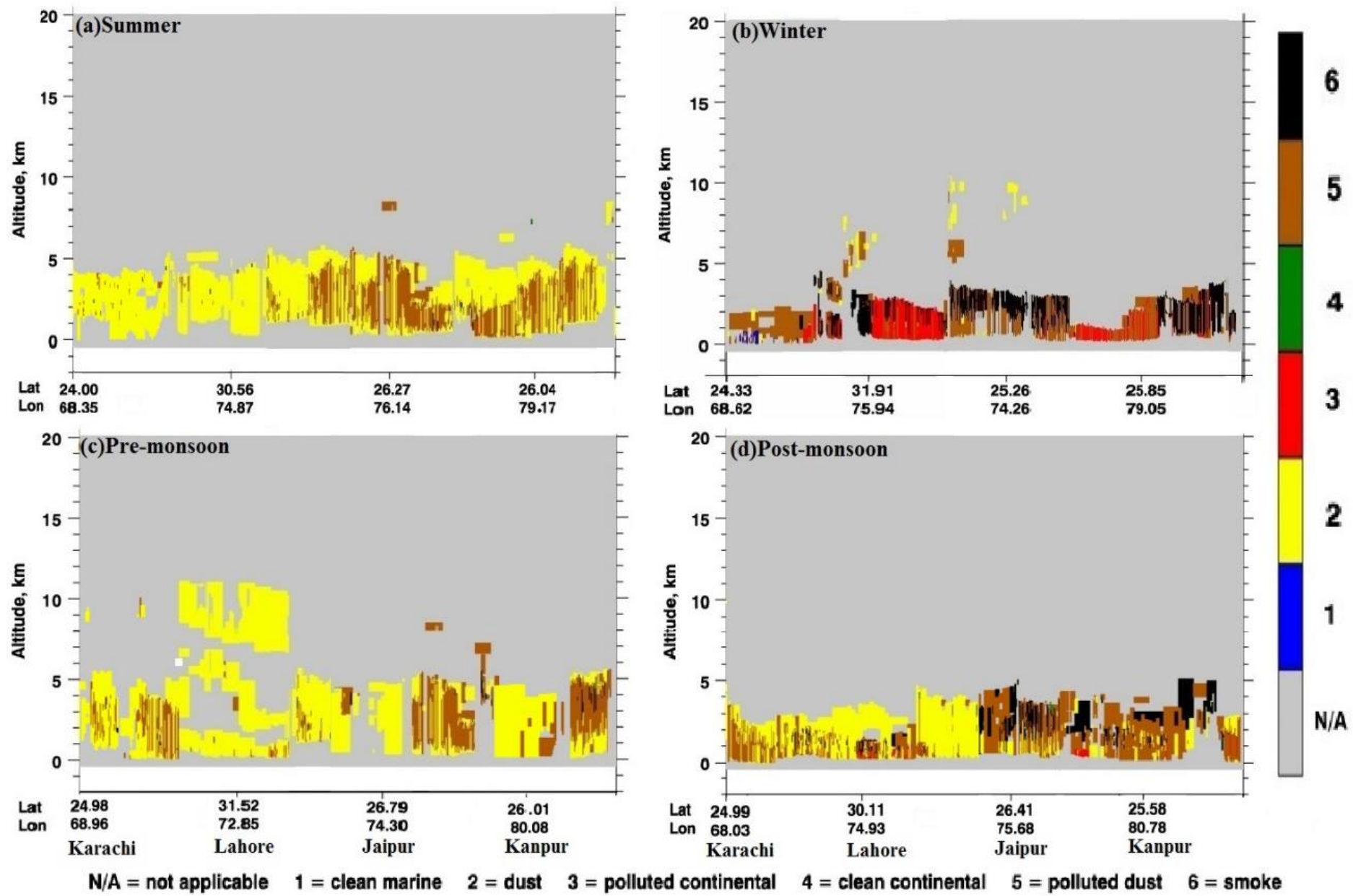
❖ Results & Discussion: Dust Properties



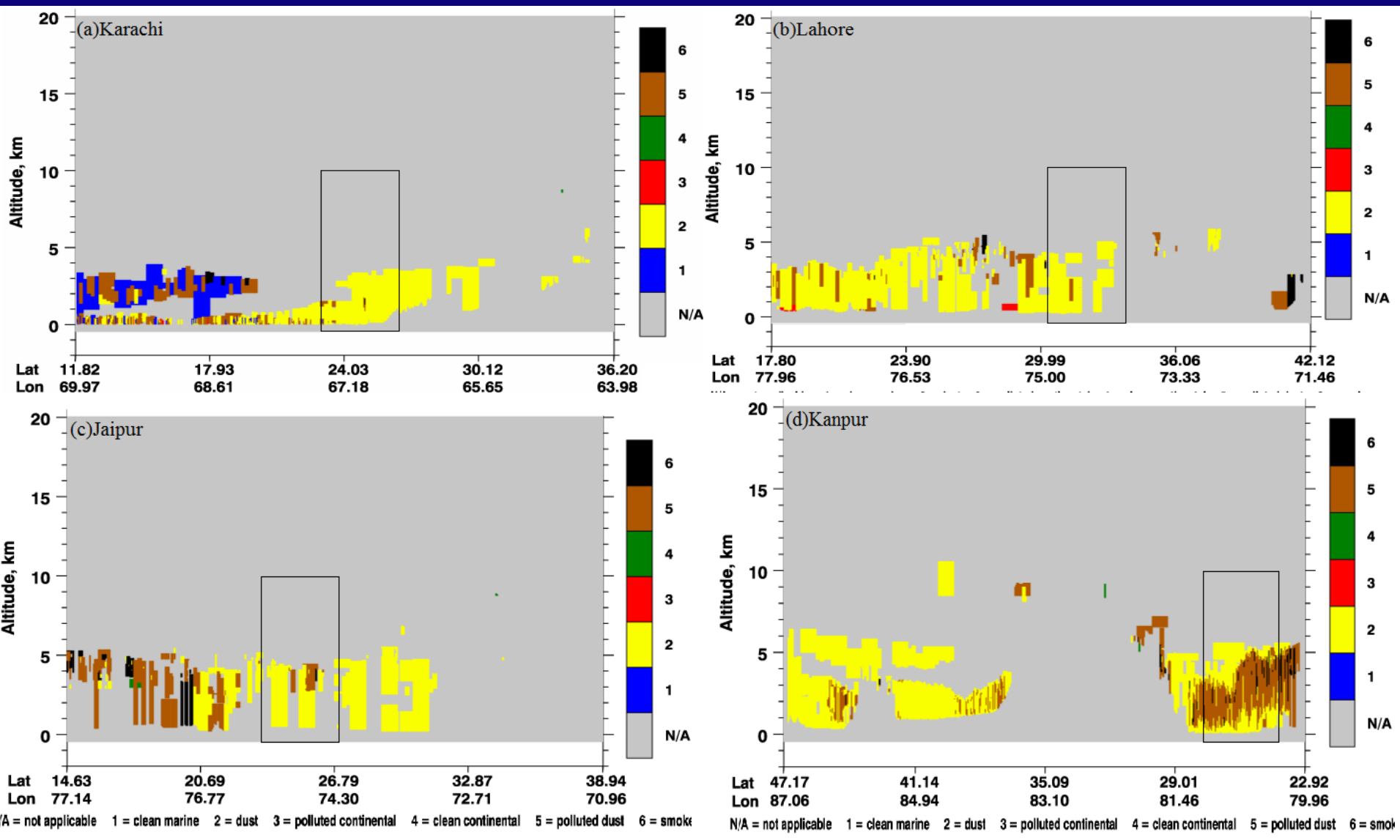
Results & Discussion: Dust Characteristics



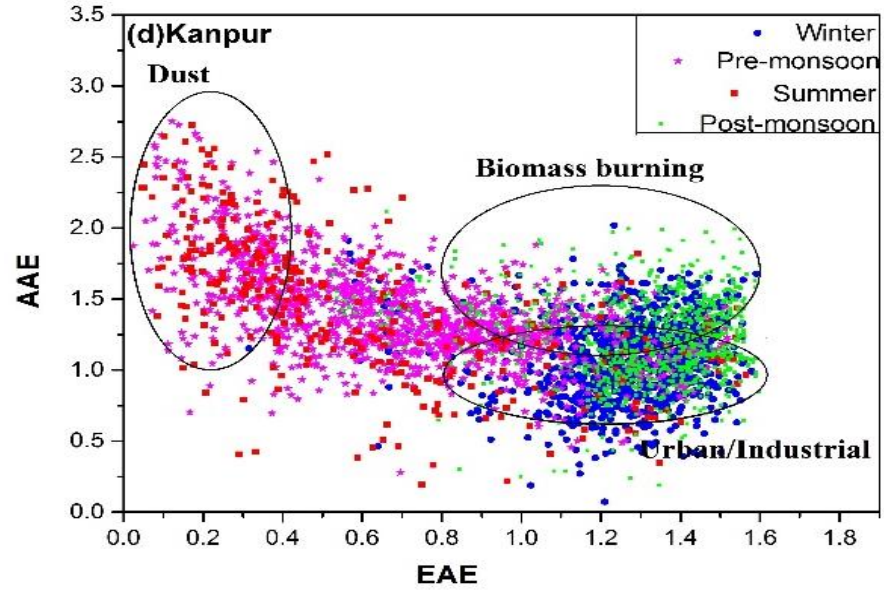
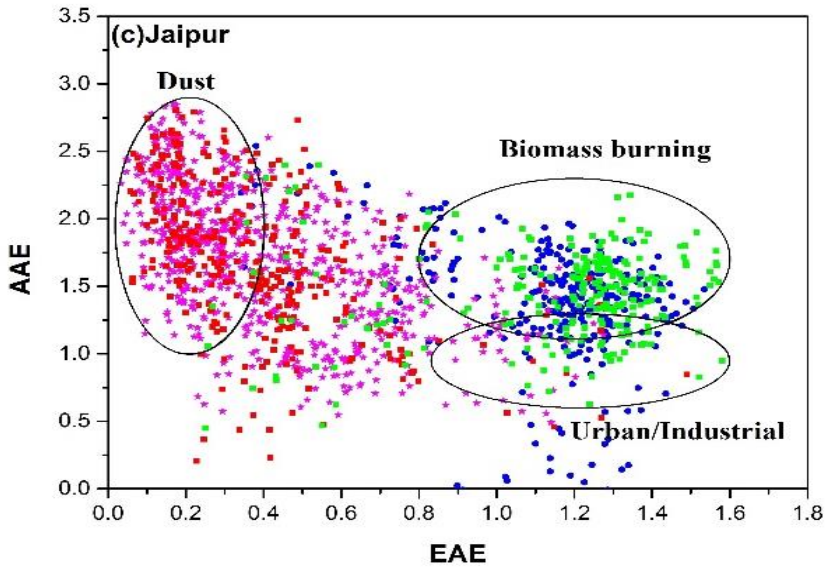
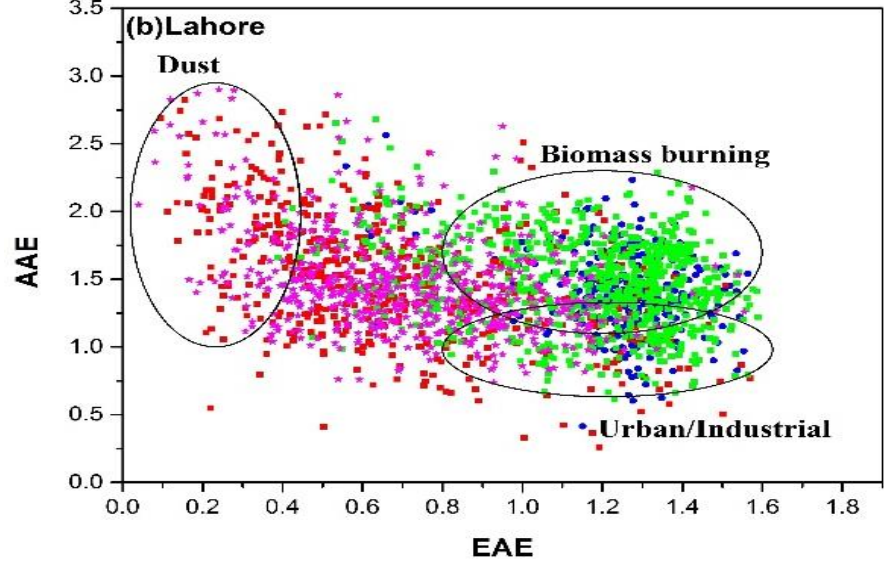
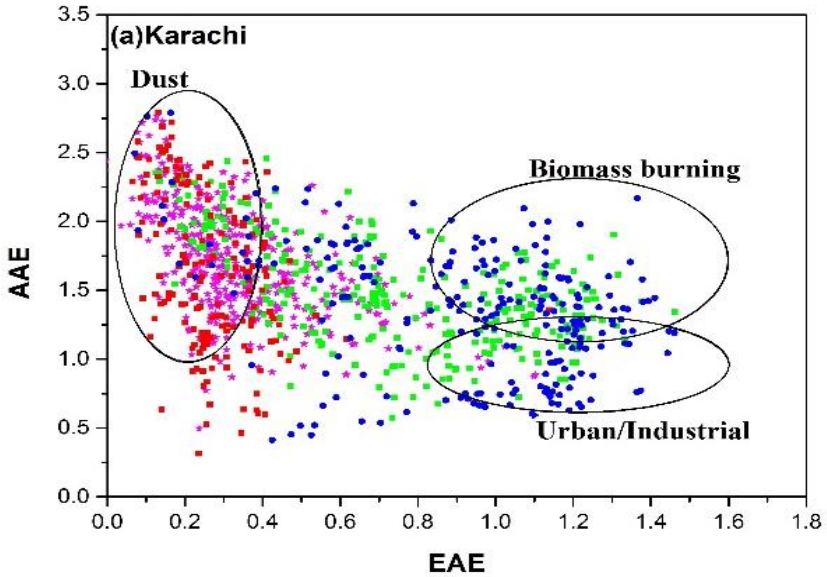
❖ Results & Discussion: Classification of Dust



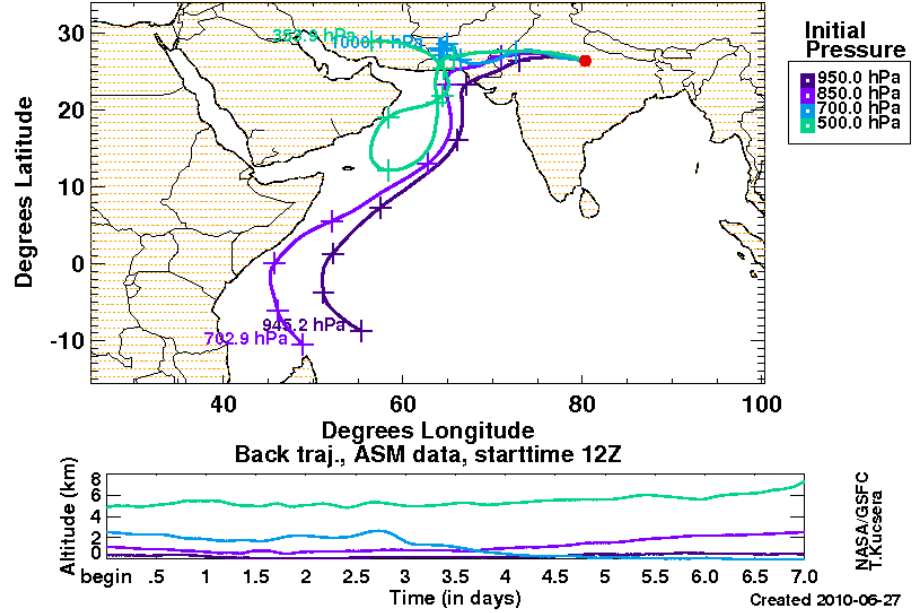
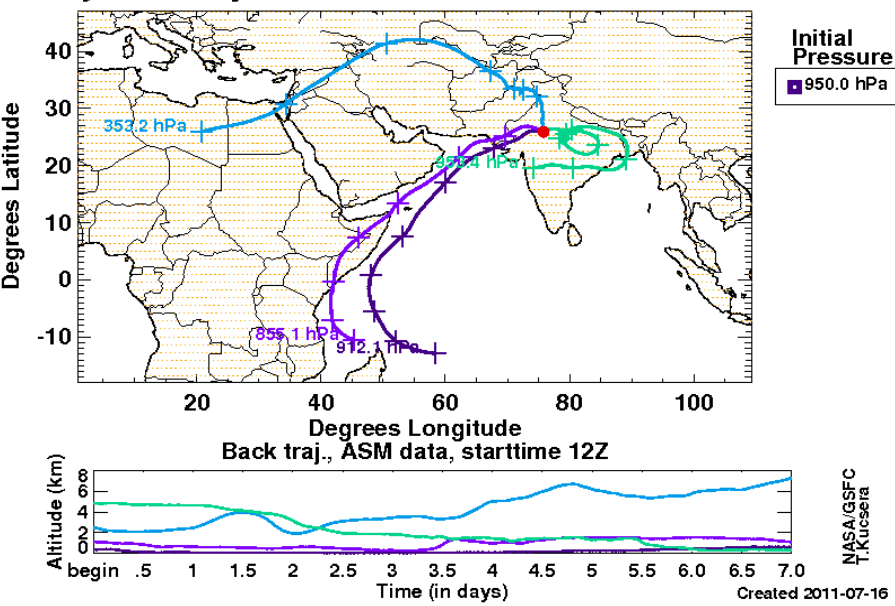
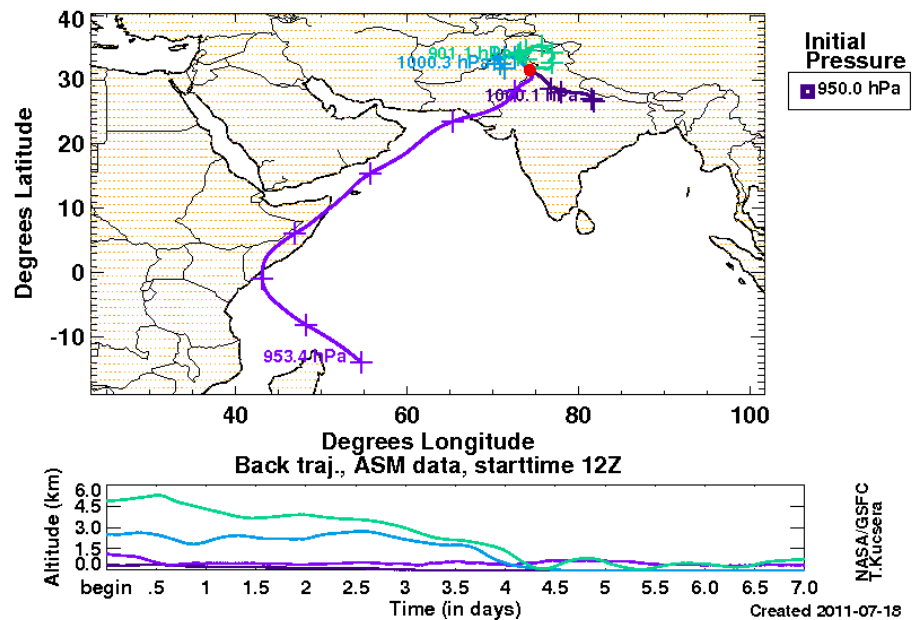
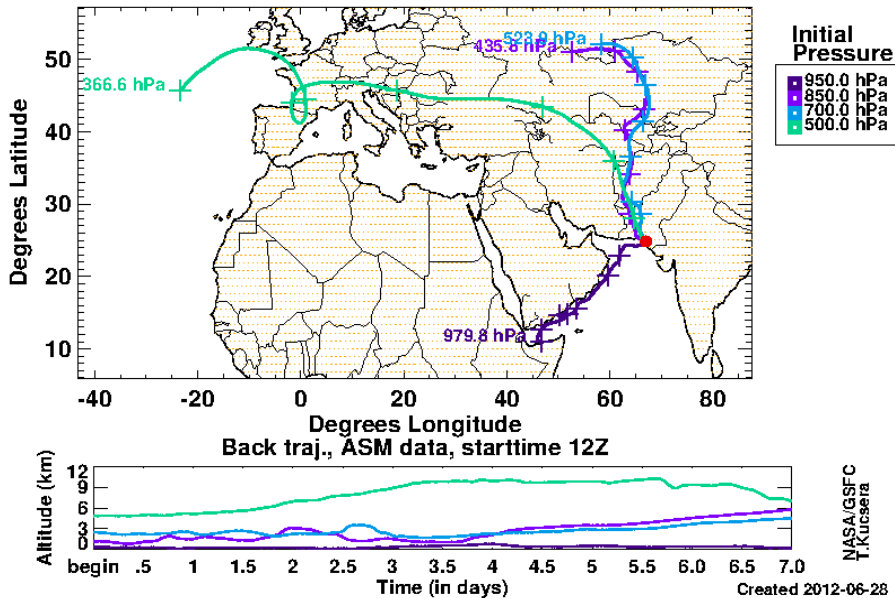
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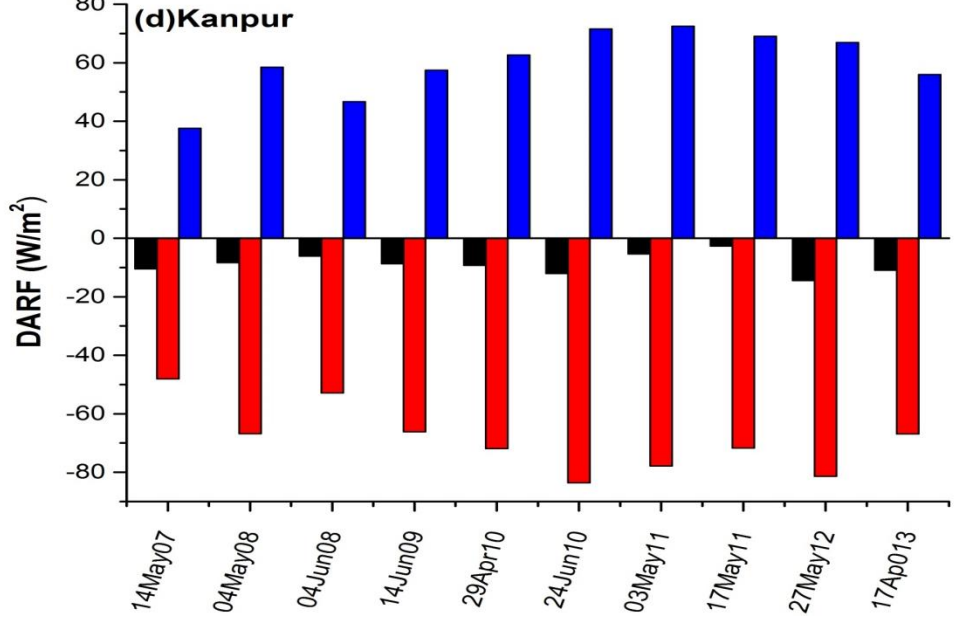
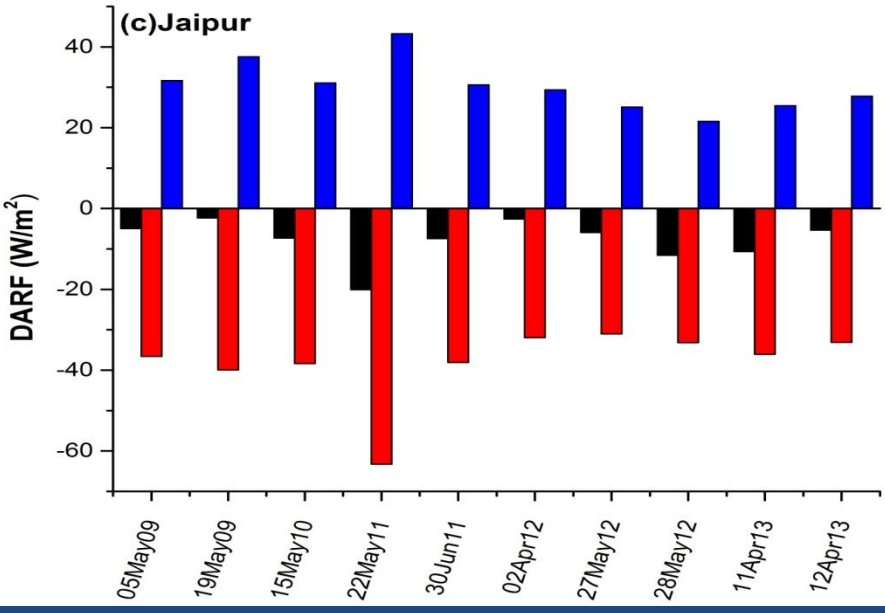
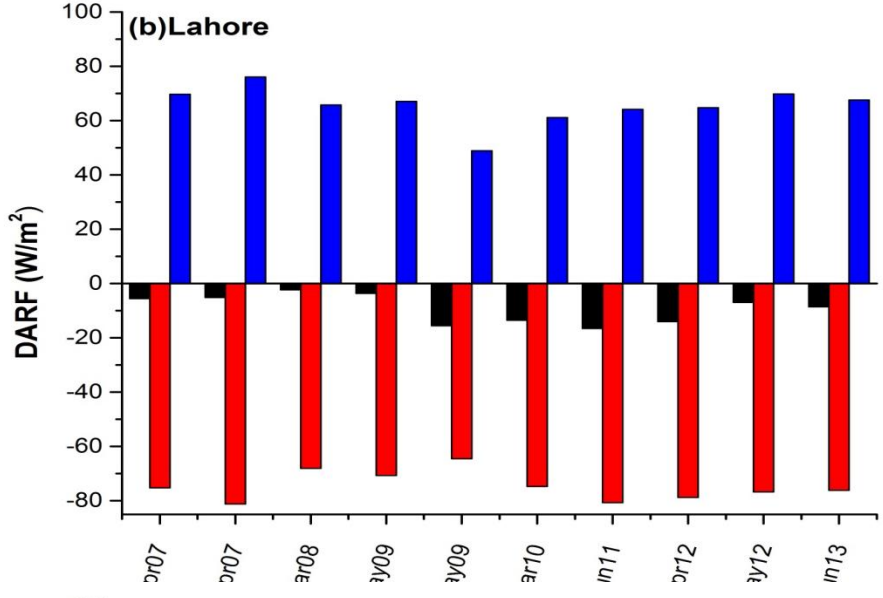
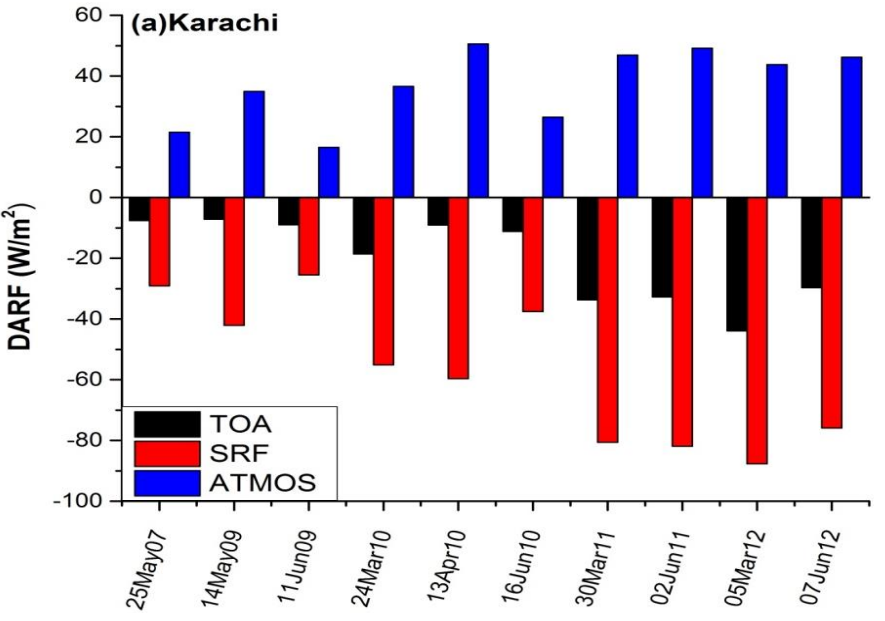
❖ Results & Discussion: Classification of Dust



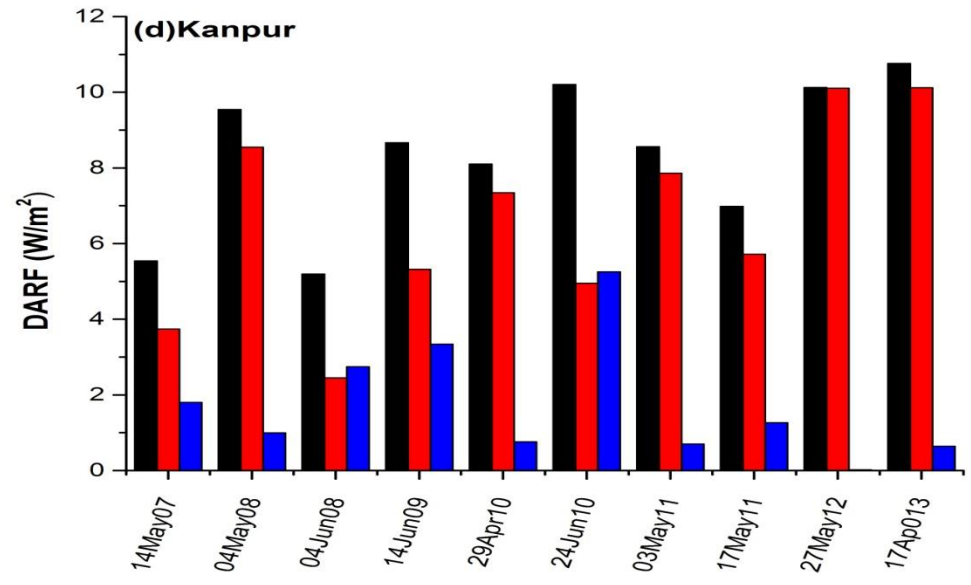
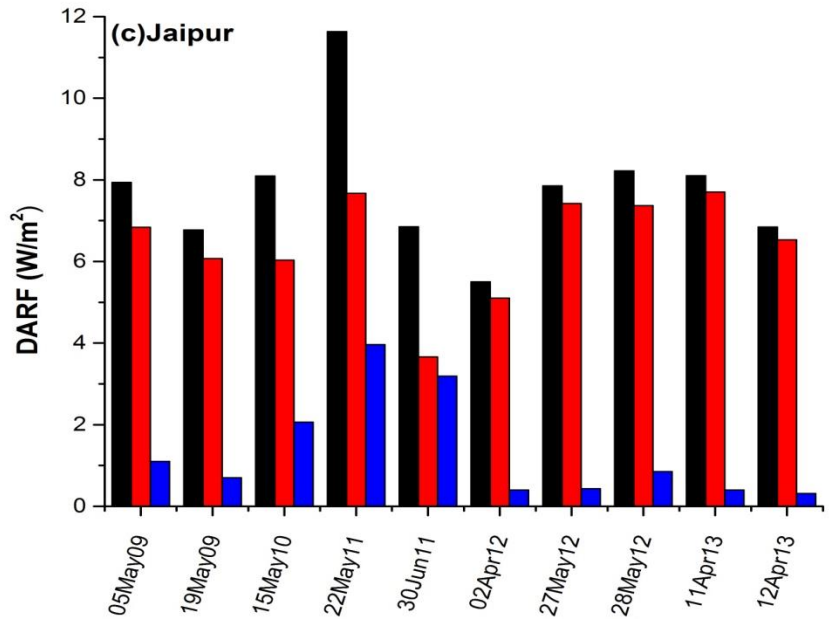
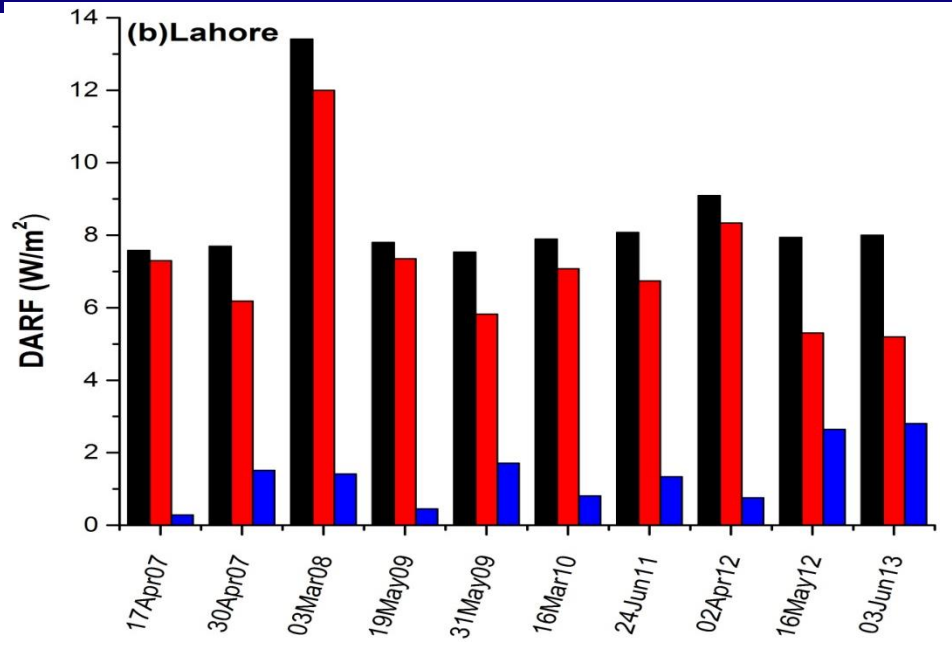
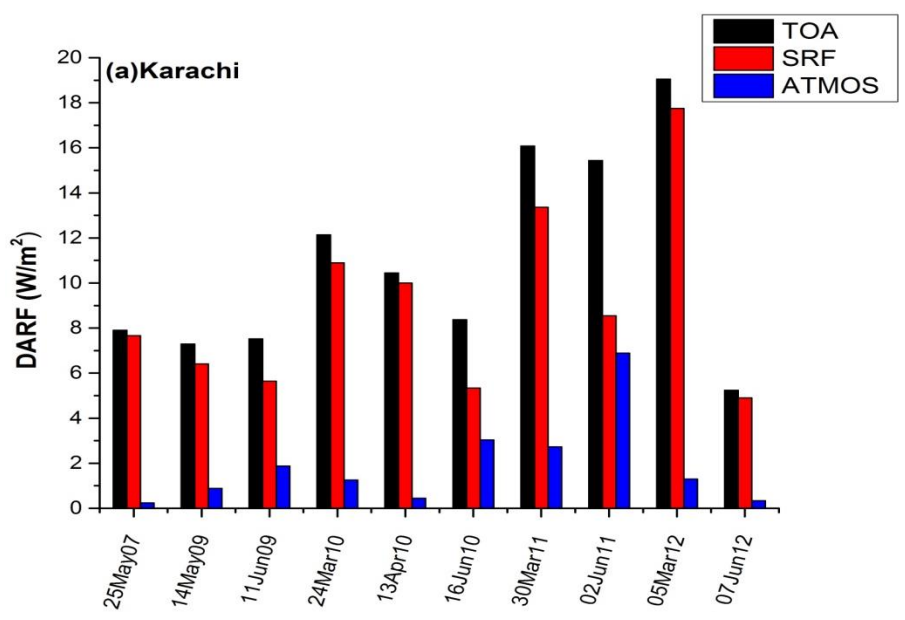
❖ Results & Discussion: Back Trajectories for Dusty days



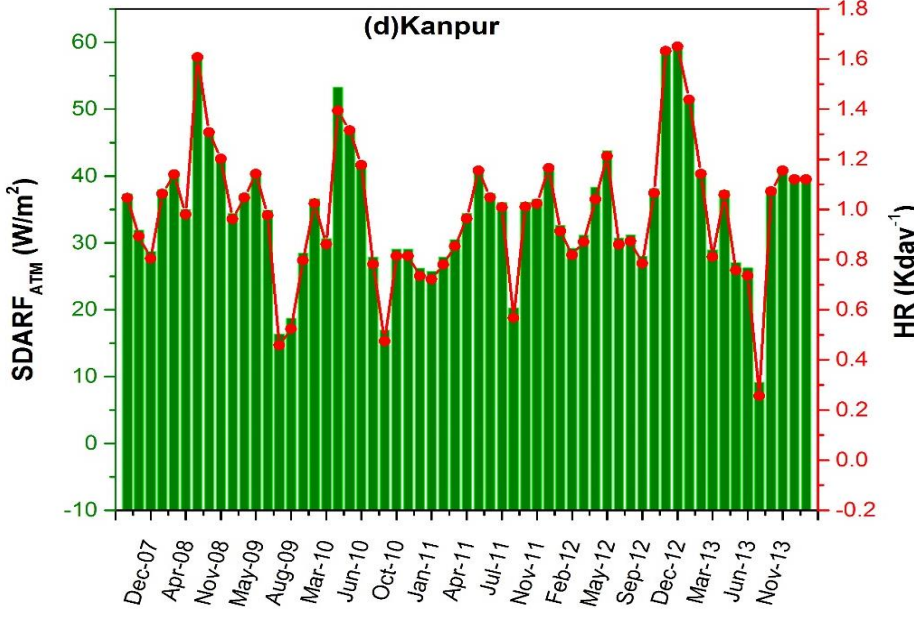
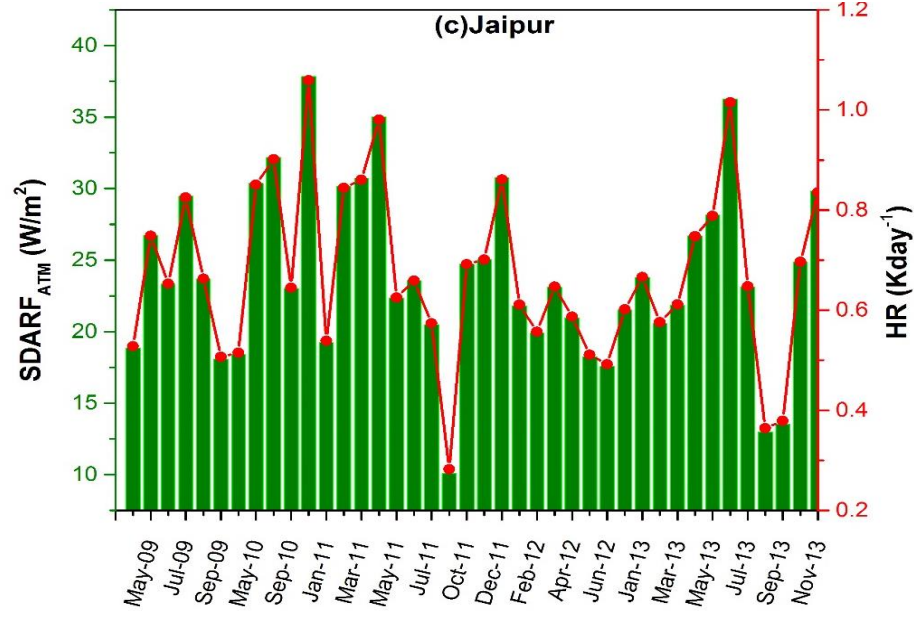
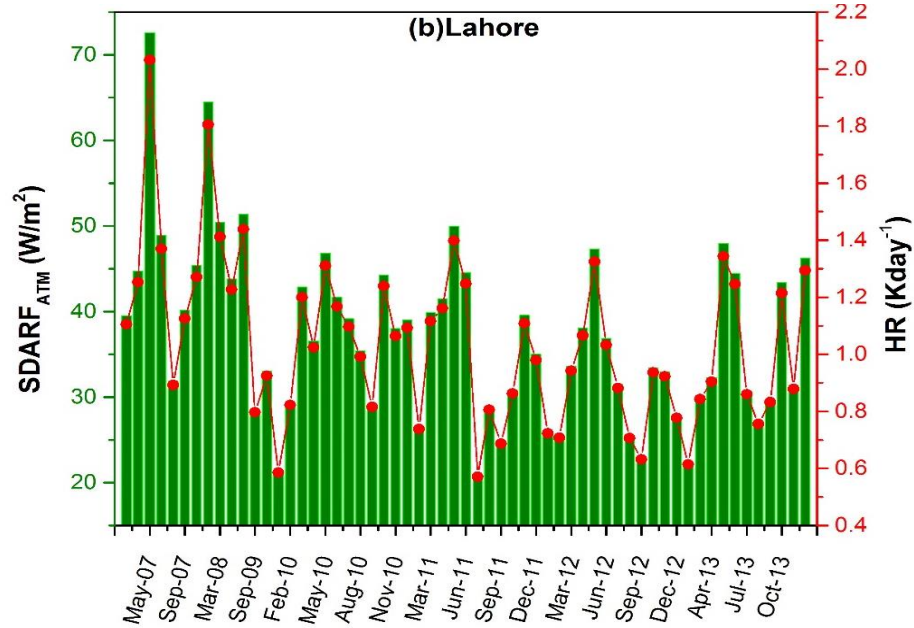
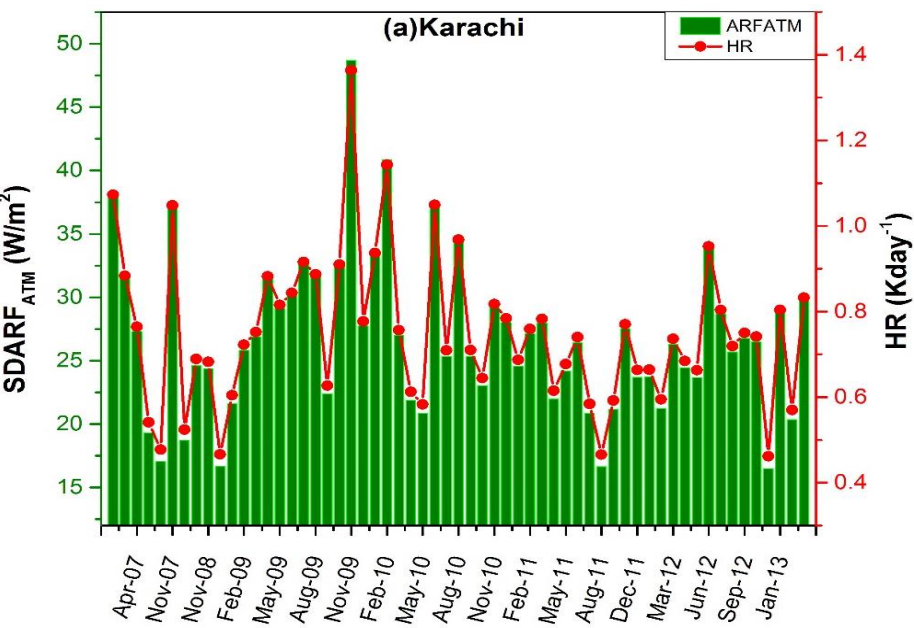
Results & Discussion: Short wave Radiative forcing



❖ Results & Discussion: Long wave Radiative forcing



❖ Results & Discussion: Atmospheric forcing and Heating rates



- The results revealed that VSD, SSA, ASY, and RI showed significant variations during dusty days.
- The VSD in coarse mode aerosols was high during dusty days and no significant variations was found in VSD fine mode.
- The SBDART model results showed that SW radiative forcing produce cooling effects both at the TOA and the earth's surface, whereas, LW produce heating both at the TOA and at the earth's surface.
- The HYSPLIT model revealed that air masses originated from Middle East, Africa, Arabian Sea and Saharan desert.

- Increased warming from high dust concentrations leads to reduction in surface pressure and strengthening of the pressure gradient over the Arabia Sea. This leads to increased monsoon winds, moisture convergence and precipitation over India and Pakistan.
- Resulting in severe casualties and huge agricultural and economic losses in the densely populated region.

I would like to thank you the Republic of Turkey, the Ministry of Forestry and Water Affairs, General Directorate of Desertification and Erosion to give me an opportunity to deliver an invited talk in this important workshop.



THANK YOU

