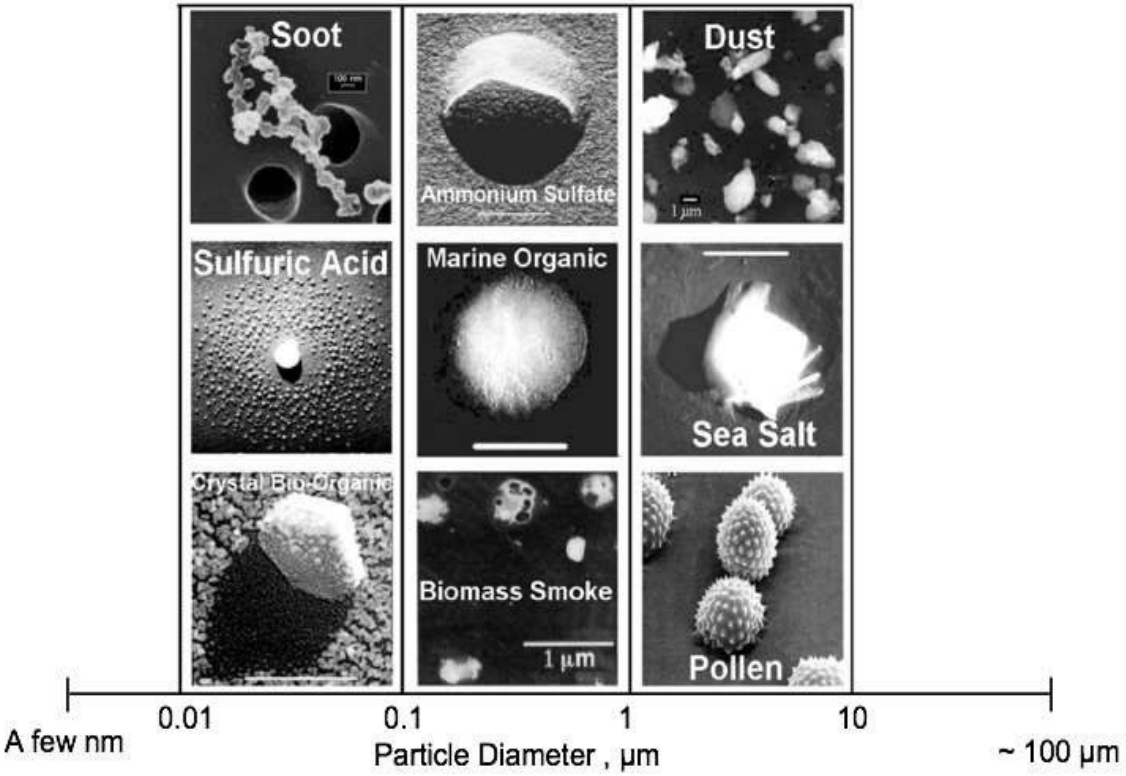
# Aerosols and Air Pollution



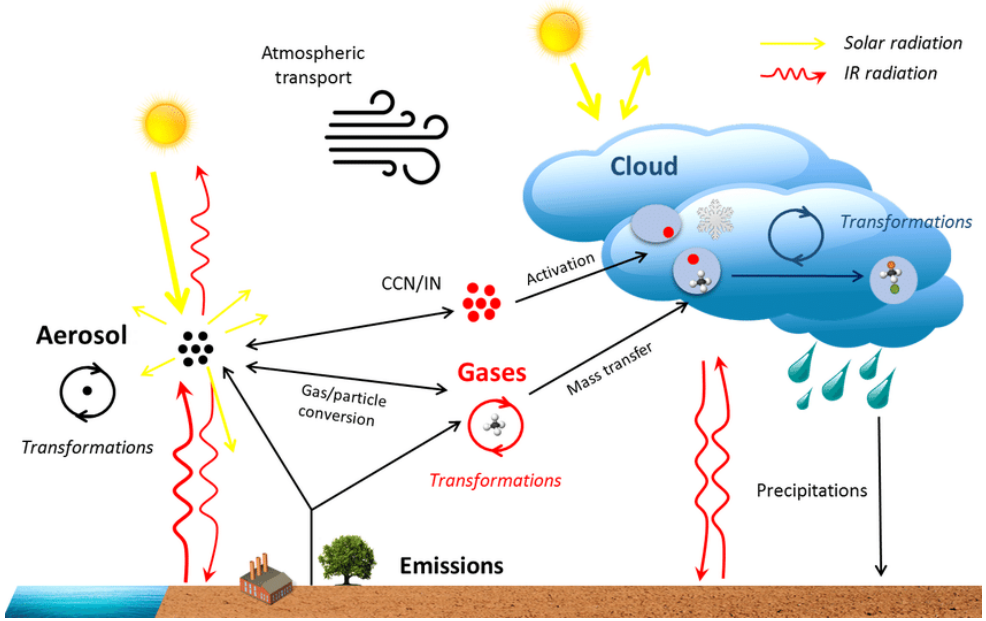

- Solid or liquid particles (in range of 0.002µm to 100µm) suspended in the air, both natural & anthropogenic are known as aerosols
- Aerosol particles vary greatly in size, source, chemical composition, amount and distribution in space and time

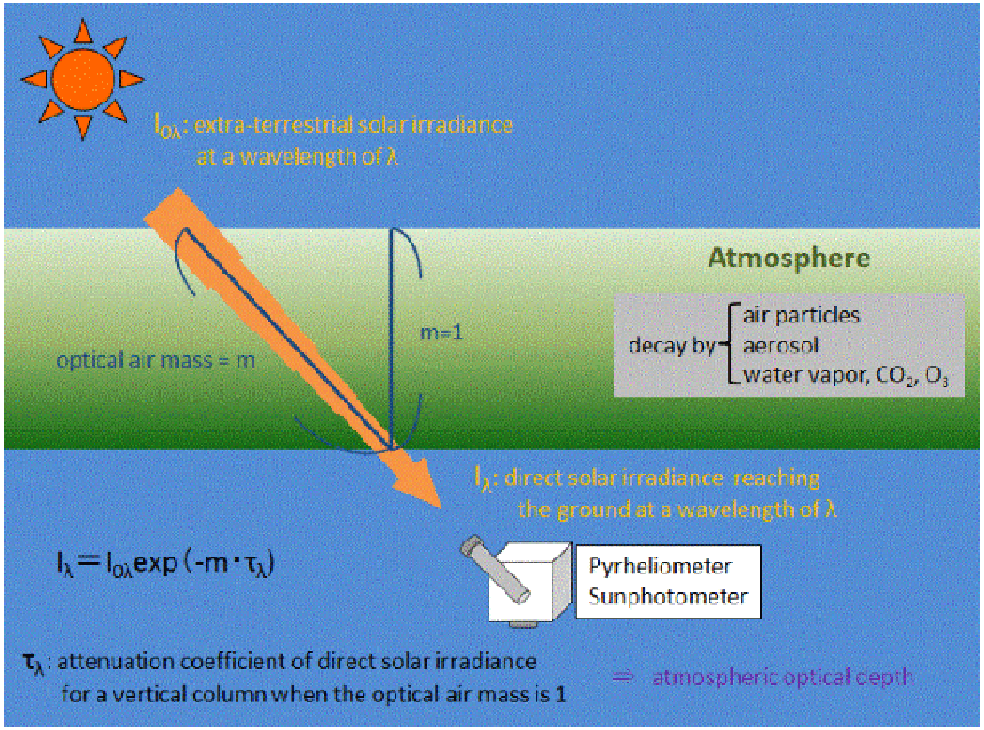
# Aerosol Optical Depth Data

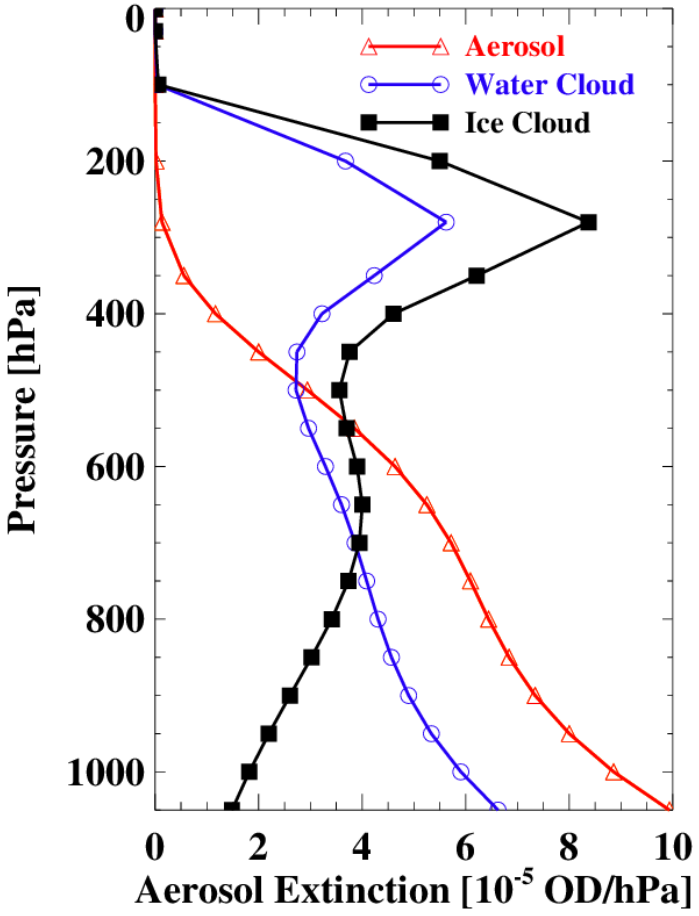
- AOD is the degree to which aerosol prevents transmission of light to earth by means of scattering & absorbing sunlight

- An AOD of less than 0.1 indicates clear sky with maximum visibility; whereas AOD value more than 1 indicates presence of aerosol & extinct solar radiation reaching ground surface by absorbing or scattering

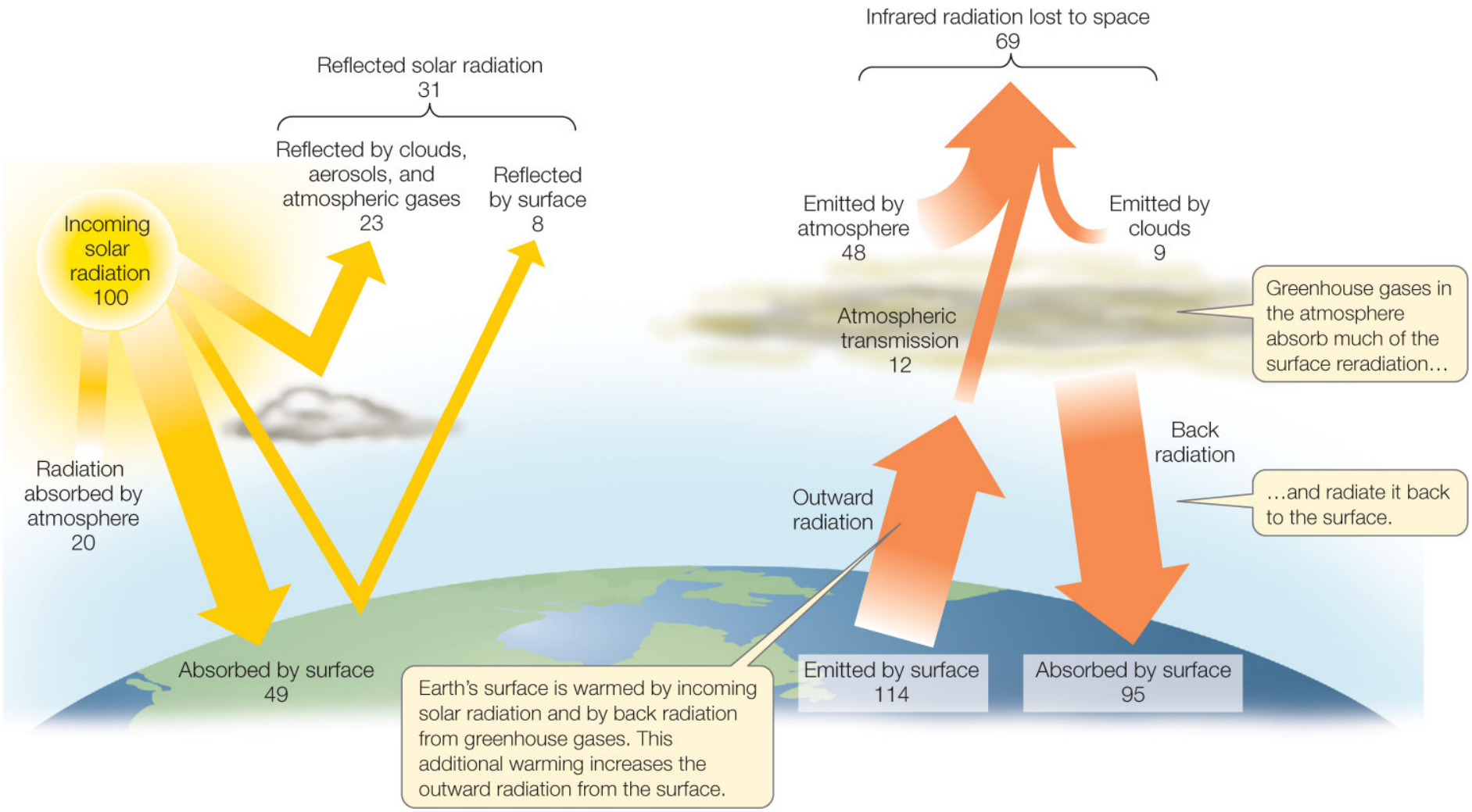
- Depending upon their size, type, location & source of emission, aerosols can either cool the surface (Sulfates & Nitrates), or warm it (Black Carbon)


Atmospheric transport
Solar radiation
IR radiation
Cloud
Transformations
CCN/IN
Activation
Aerosol
Gases
Gas/particle conversion
Mass transfer
Transformations
Transformations
Precipitations
Emissions


$I_{0\lambda}$: extra-terrestrial solar irradiance at a wavelength of λ
Atmosphere
m=1
optical air mass = m
decay by air particles, aerosol, water vapor, $CO_2$, $O_3$
$I_\lambda$: direct solar irradiance reaching the ground at a wavelength of λ
$I_\lambda = I_{0\lambda} \exp(-m \cdot \tau_\lambda)$
Pyrheliometer
Sunphotometer
$\tau_\lambda$: attenuation coefficient of direct solar irradiance for a vertical column when the optical air mass is 1
= atmospheric optical depth


Aerosol
Water Cloud
Ice Cloud
Pressure [hPa]
0
200
400
600
800
1000
0
2
4
6
8
10
Aerosol Extinction [$10^{-5}$ OD/hPa]

# Aerosol Optical Depth Data



# Retrieval of Aerosol Optical Depth Data

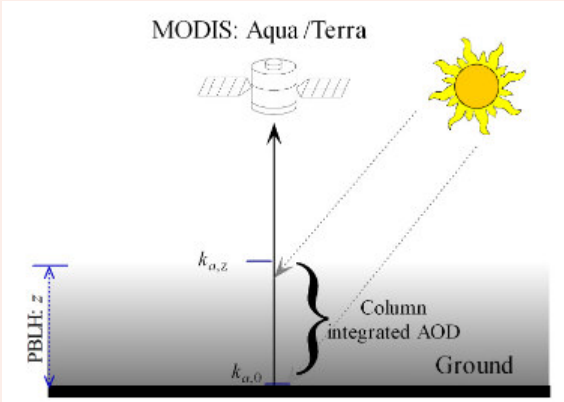
- AOD data can be retrieved by following means:
    i. **Ground based measurement**
    ii. **Satellite data & imagery**

- Ground based measurements can be carried out with:-
    i. Hand-held sunphotometers which measures AOD at 5 wavelengths (380,440,500,675 & 870 nm)

    ii. Sunphotometers installed by AERONET-NASA at selected sites

    iii. CIMEL Sun-sky Radiometers

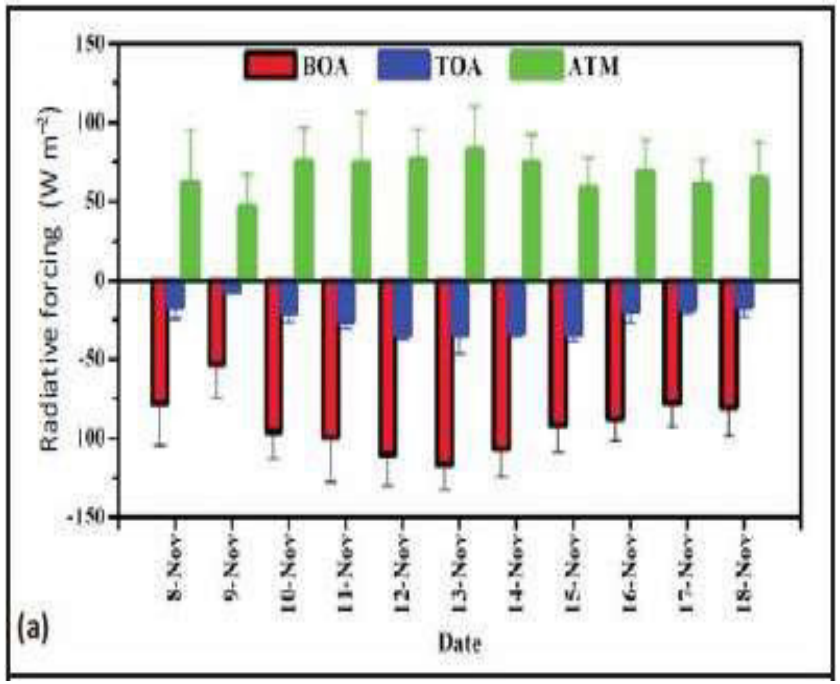
Satellite data can be retrieved from the sensors on-board to various satellites launched by NASA, which are named below:

| Sensor/Platform | Parameter | Spatial Coverage |
|---|---|---|
| AVHRR/NOAA-series | • Optical Depth,<br>• Angstrom exponent | Daily coverage of global ocean |
| TOMS/Nimbus, ADEOSI,EP | • Optical Depth | Daily coverage of Global land & ocean |
| POLDER,-1,-2 PARASOL | • Optical Depth, fine mode fraction,<br>• Angstrom Exponent,<br>• Non-spherical fraction |  |
| MODIS/Terra,Aqua | • Optical Depth<br>• Fine-mode fraction<br>• Angstrom exponent<br>• Effective radius | |
| MISR/Terra | • Optical depth<br>• Angstrom Exponent<br>• Small-medium-large fraction<br>• Non-spherical fraction | Weekly coverage of global land & ocean, including bright desert |

https://worldview.earthdata.nasa.gov/

## Aerosol Direct Radiative forcing

- The AODs and associated aerosol optical and microphysical parameters, obtained from the Sun–sky radiometer observations during the study period, along with other radiation and chemical parameters of aerosols prevailing over the experimental site in the **Optical Properties of Aerosols and Clouds(OPAC) model** have been used as input information to the **SantaBarbara DISORT Atmospheric Radiative Transfer (SBDART)model** to derive the aerosol direct radiative forcing (ADRF in $W/m^2$) at the:
    i. Bottom of the atmosphere (BOA)
    ii. In the atmosphere (ATM)
    iii. At top of the atmosphere (TOA)



# Spectral-Temporal variation & Influence of Meteorological parameter

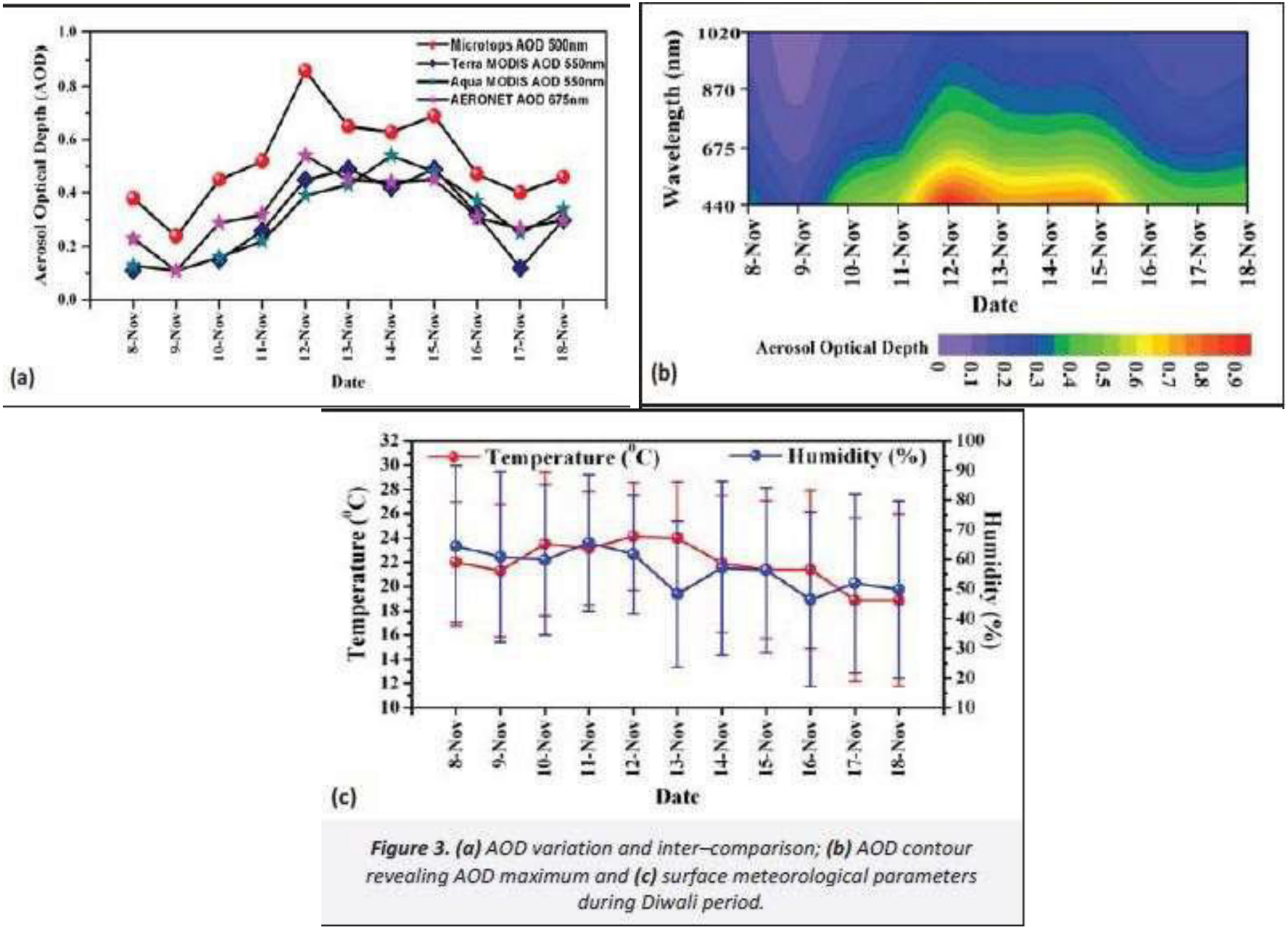



***Figure 3.*** ***(a)*** *AOD variation and inter–comparison;* ***(b)*** *AOD contour revealing AOD maximum and* ***(c)*** *surface meteorological parameters during Diwali period.*

# Long range transport & satellite images of fire/smoke aerosols

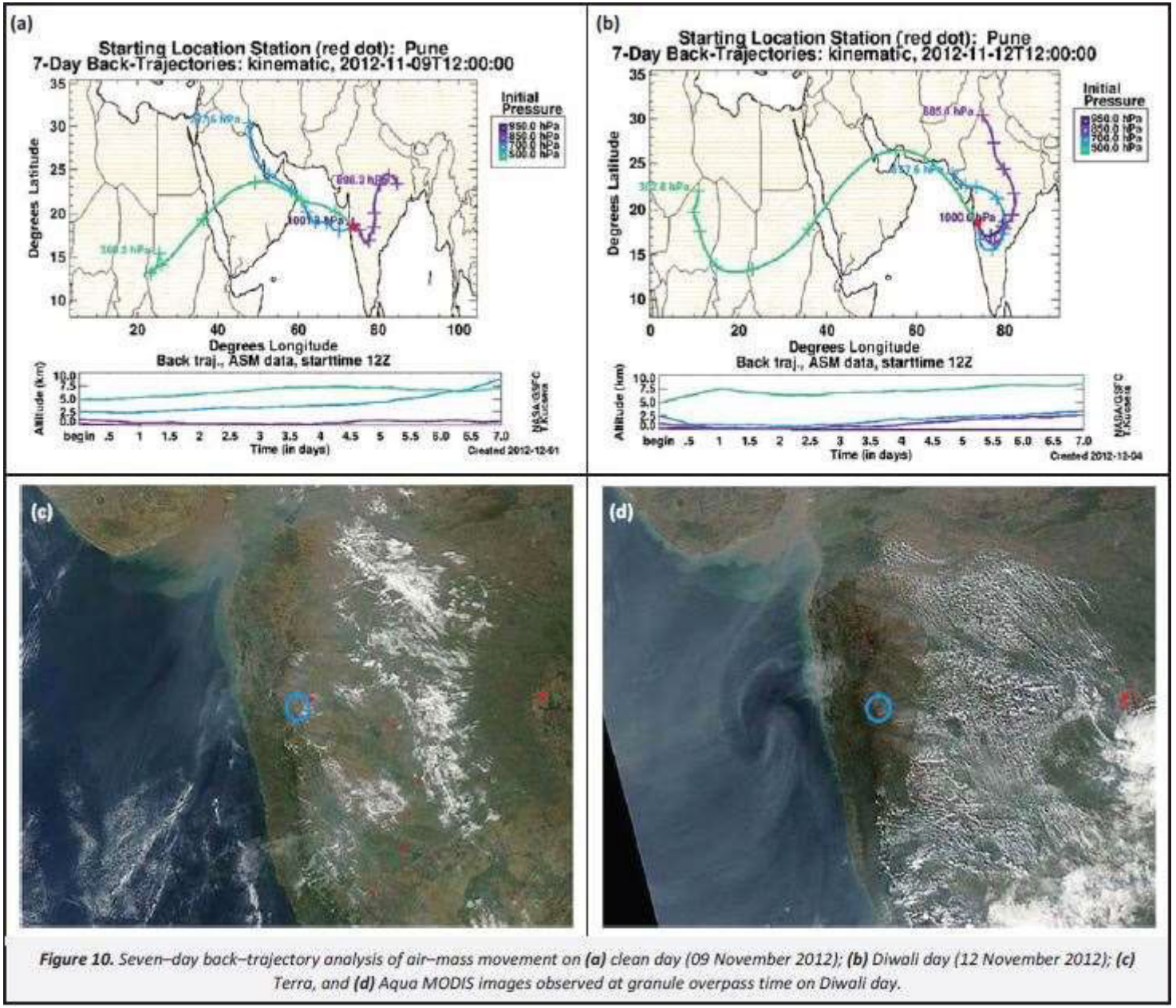



***Figure 10.*** *Seven–day back–trajectory analysis of air–mass movement on* ***(a)*** *clean day (09 November 2012);* ***(b)*** *Diwali day (12 November 2012);* ***(c)*** *Terra, and* ***(d)*** *Aqua MODIS images observed at granule overpass time on Diwali day.*