Comparison between Aerosol Optical Depth acquired from Sun Photometer and MODIS satellite data over Durban

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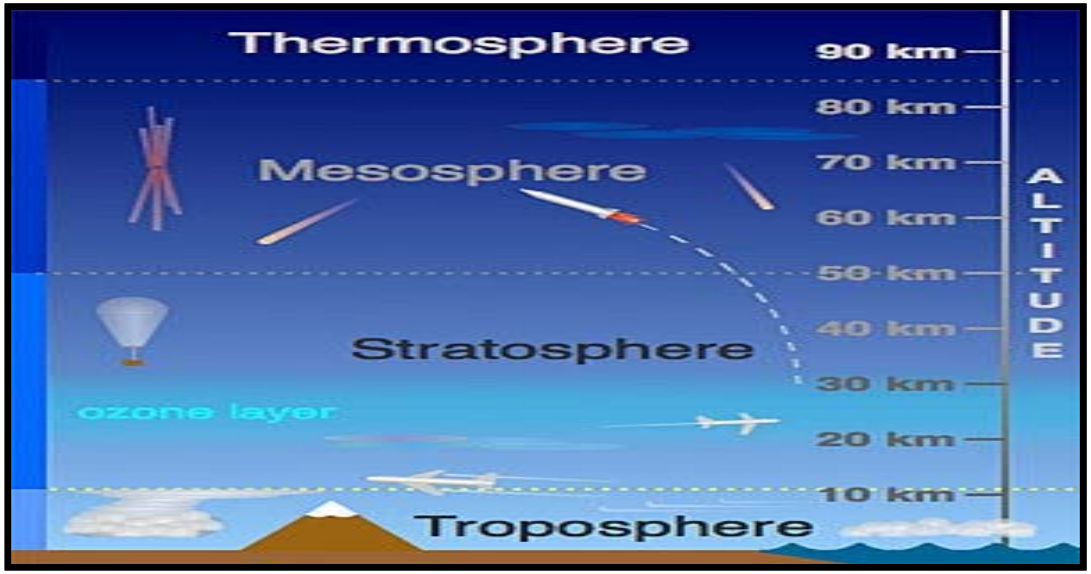
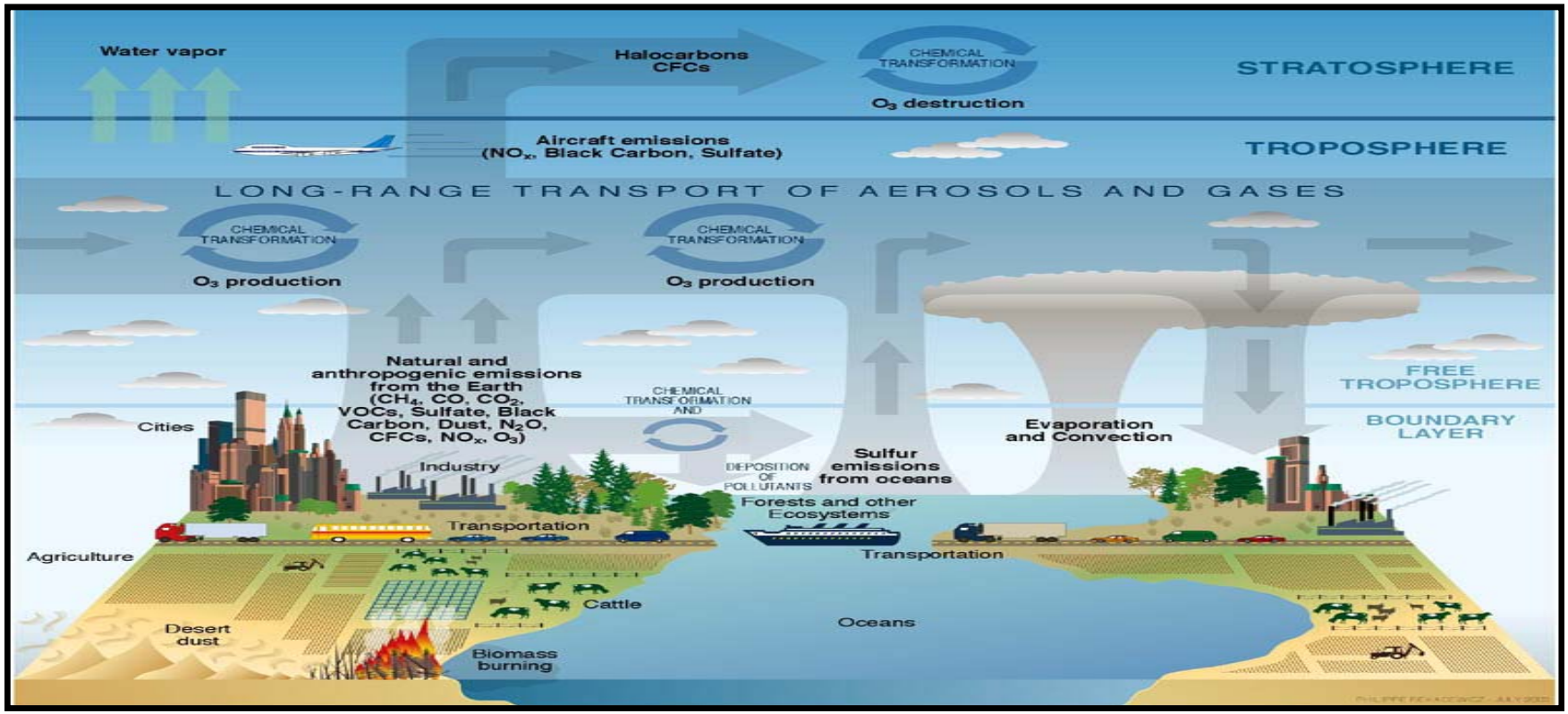
Introduction

- The atmosphere of Earth is made up of a layer of gases, commonly known as air.
- Surrounds the planet Earth and is retained by Earth's gravity.
- The atmosphere protects life on Earth by absorbing ultraviolet solar radiation, warming the surface through heat retention (GHGs)

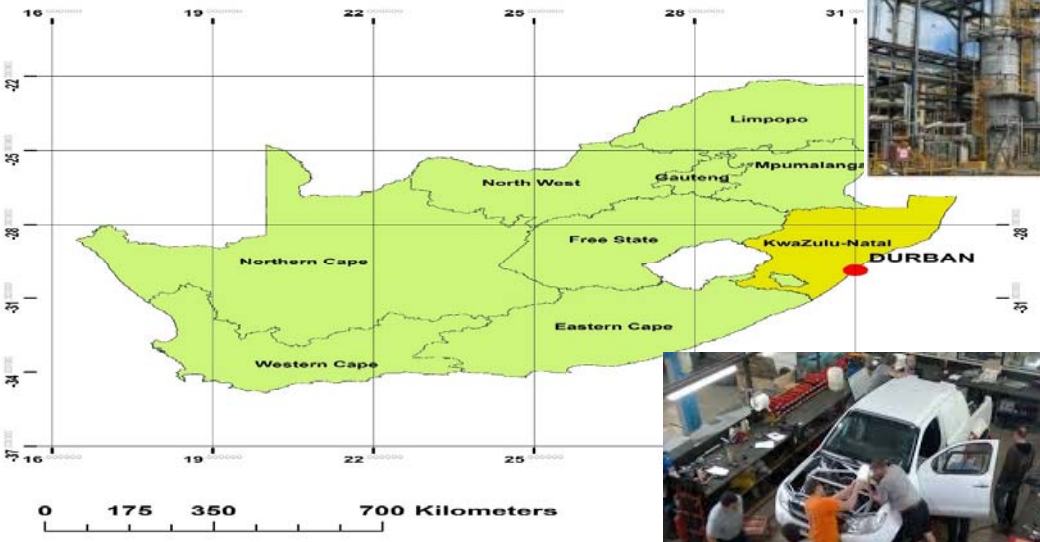


- Human activities release a mixture of pollutants into the atmosphere, that lead to the creation of aerosol particles.



- **Aerosols have the following characteristics:**
  - Aerosols are particles suspended within a liquid or solid medium.
  - They are both horizontally and vertically entrained in the atmosphere
  - Aerosols also have a diverse spatial and temporal distribution and wide side ranges
  - Aerosol's impact on climate is separated into **direct** and **indirect**
  - **Direct effect**: Aerosols scattering sunlight directly back to space
  - **Indirect effect**: Aerosols in the lower atmosphere changing the size of cloud particles

Study area: Durban



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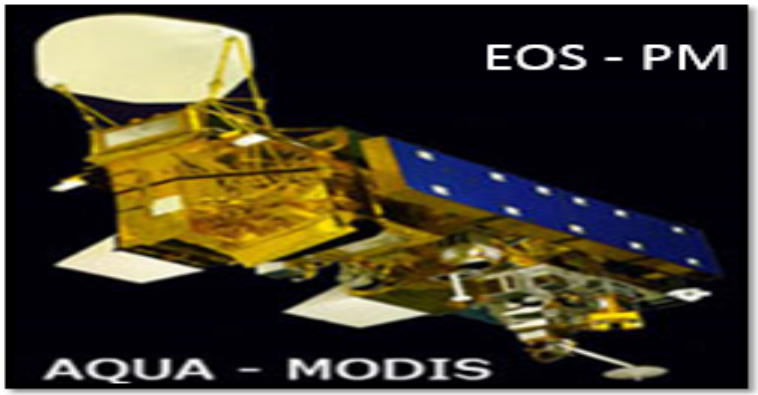
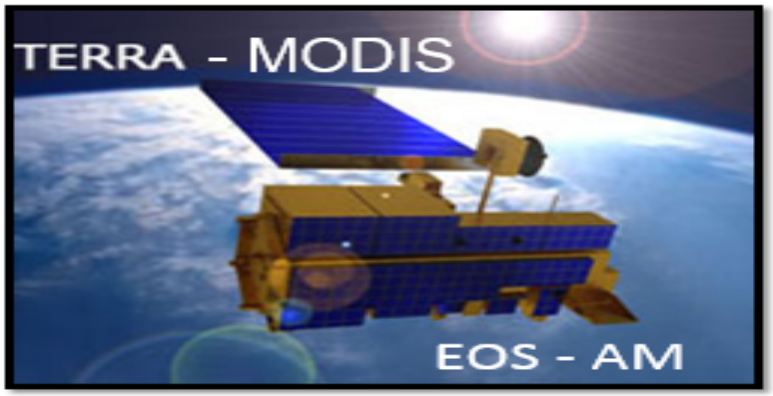
Motivation

- Recently there have been many studies comparing aerosol properties in South Africa using AERONET.
- However, there still exist inconsistencies in understanding aerosol properties in many parts of the world.
- Especially in Southern Africa due to the significant lack of ground-based monitoring stations.
- Durban sun photometer was installed in December 2013, first measurements are from Jan- Sep 2014.
- It is useful to compare AOD generated for ground based stations with AOD from satellite measurements to determine if satellite data can be a proxy for ground based measurements in the region.

Aim





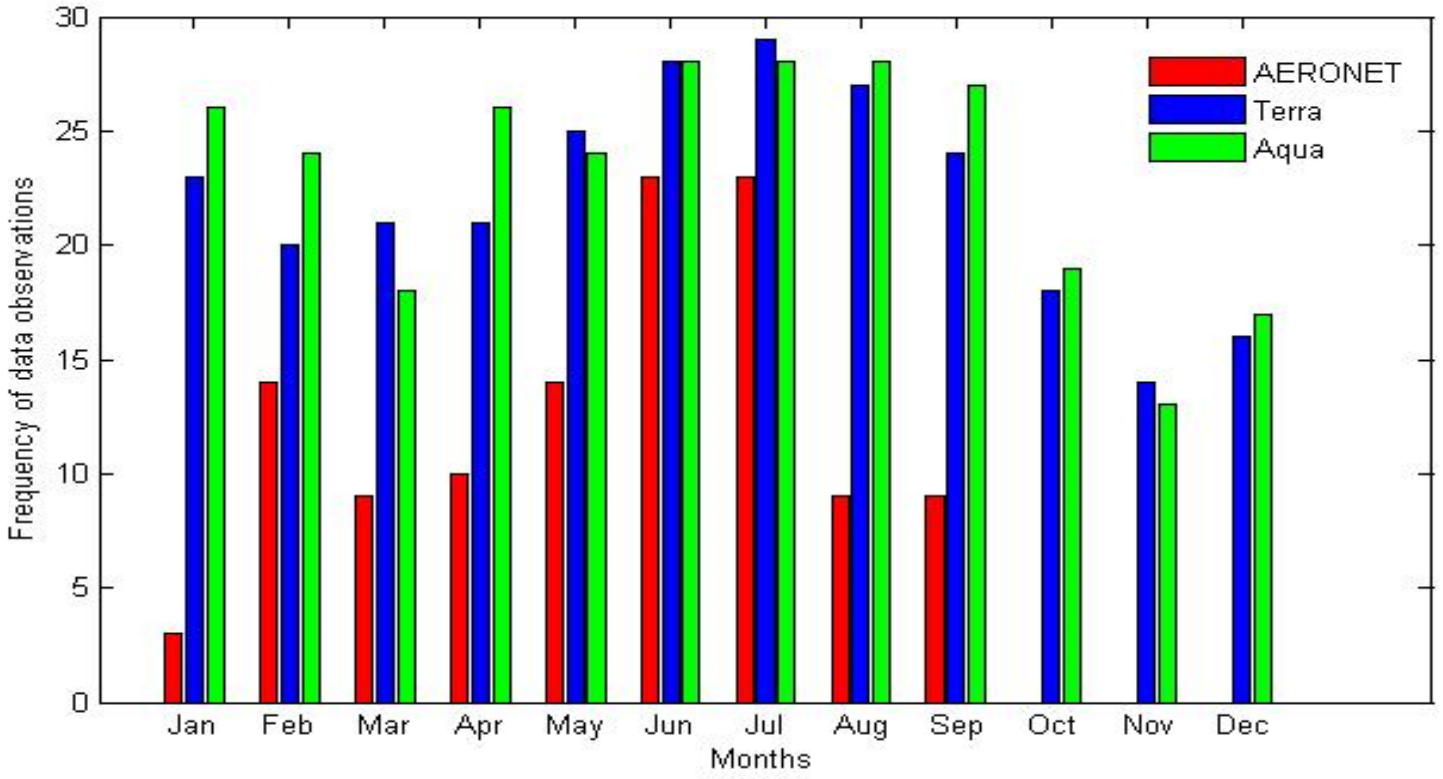
- The DT algorithm has specific algorithms for land and ocean and covers dark vegetated surfaces.
- The DB algorithm is a land retrieval only
- This study will compare AOD derived from the Moderate Resolution Imaging Spectroradiometer (MODIS) dark target (DT), deep blue (DB) retrieval algorithms and a merged (avg. DT & DB) with sun photometer derived AOD from January – September 2014, using regression statistical analysis.

Methods

- This study made use of area averaged MODIS, C6, level 3 data, at the 10 km spatial scale using MODIS Terra and MODIS Aqua for both algorithms.
- Area averaged MODIS AOD at 550nm was extracted from MODIS and daily average AOD at 500nm was downloaded from the Durban sun photometer located at the University of KwaZulu – Natal
- AOD values from each sensor to a common wavelength. The sun-photometer AOD wavelength was, therefore, converted to the MODIS AOD wavelength using the power law:

$$AOD_a = AOD_b \left(\frac{a}{b}\right)^{-AE}$$

- Where a = 550 nm for MODIS, b = 500 nm for AERONET, and AE is the Ångström exponent ($\alpha_{440–870}$)



- Only days where measurements were available for both instrumentation were included in the analysis.

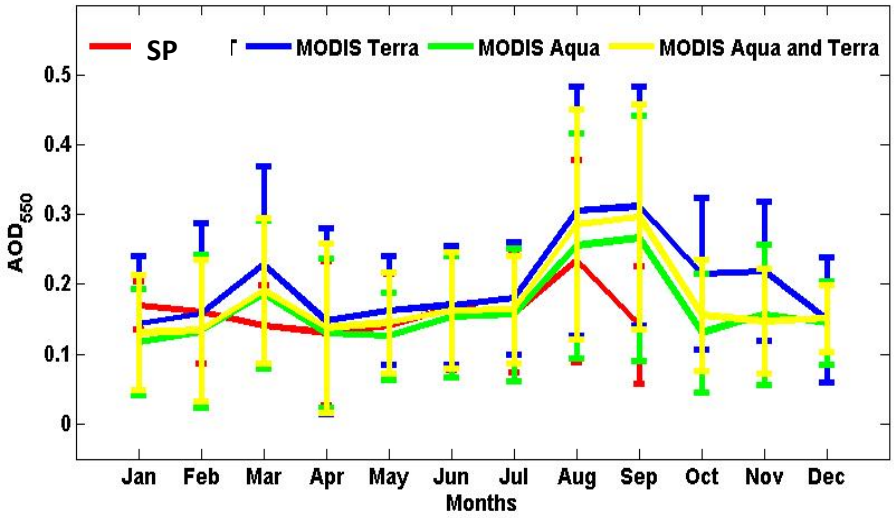

Claw
Collimator
Zenith
Motor
Casing
Sensor
head
Azimuth
Motor
Casing

Results

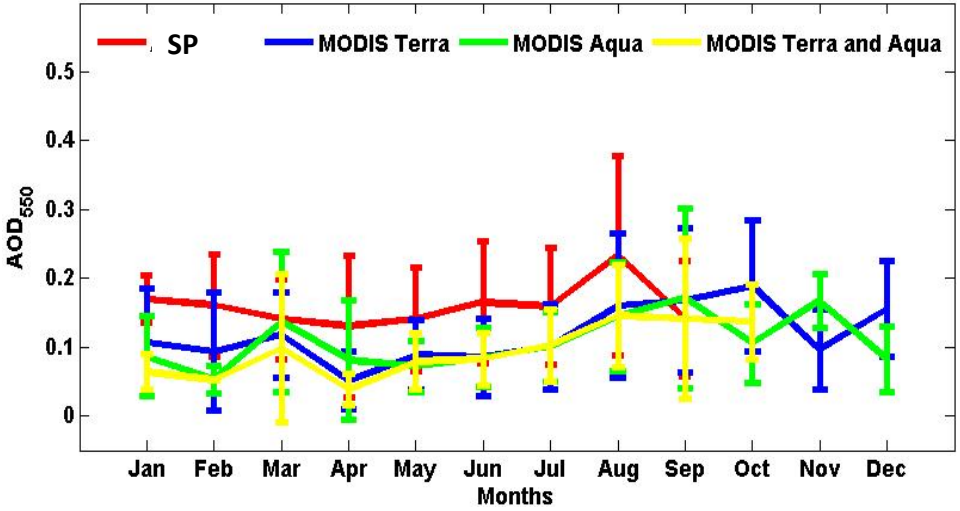
R^2 value obtained by linear interpolation for the different retrieval algorithms on common days from January – December 2014.			
Algorithm	Sun photometer vs. Terra	Sun photometer vs. Aqua	Terra and Aqua vs. Sun photometer
	R^2	R^2	R^2
Deep Blue	0.70	0.68	0.79
Dark Target	0.60	0.78	0.74

- Similar studies conducted by Sun, et al., (2008) and More, et al., (2013) attained similar results.

A.



B.



Monthly averaged AOD over Durban during the year 2014 retrieved from MODIS DT (A) and MODIS DB (B) and Durban sun photometer retrievals. The vertical lines represent the standard deviation of AOD for that month.

- The underestimation of AOD could be due:
  - sensor calibration error
  - an unsuitable assumption about the ground surface reflection
  - inconsistencies between the aerosol microphysical and optical properties
- Also inaccuracies occur due to point measurements from AERONET versus 10km area averaged MODIS retrievals.
- MODIS retrievals can be used as a subtle proxy for ground-based measurements in Durban, however, it depends on the time of year and further studies need to be done, using a larger dataset.

Summary

- This study made use of data from MODIS sensors and the sun photometer located in Durban.
- Moderate correlations can be observed when using both retrieval algorithms (DT and DB) during certain months.
- Low to moderate correlations, with higher seasonal correlations were found between MODIS and AERONET for various studies over India, China and Illinois and southern Africa
- Therefore, when using satellite measurements to obtain aerosol characteristics it is important to consider the **time of year**, **retrieval algorithms**, **instrument calibration**, **cloud screening**, **data availability** **and** **algorithm assumptions**.