Aerosol measurements over Southern Africa using LIDAR, Satellite and Sun-Photometer

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Aerosol Classification

Spherical

Anthropogenic

Composition and classification

Natural Particles

Dust

Sea Salt

Giant nuclei
Aerosol Formation and processes

Chemical condensables: SOA, H₂SO₄, HNO₃ ...

Condensation

Chemical Transformation

Primary Aerosols, BC, OC, Marine Salts, Natural resources

Nucleation

Humidity and deposition of particles

Emissions from Industries, vehicle and urban

Solar Radiation

CCN

Health

Clouds

Radiation Impact

Volatile Components

SO₂, NOₓ, NH₃, VOC

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Data

- **LIDAR (Light Detection and Ranging)**
  - Pretoria (25.45 S; 28.16 E)

- **HYPLIT**
  - NASA

- **AERONET**
  - University of Wits (26 S; 28 E) 2002 to 2008
  - Skukuza (24 S; 31 E) 1998 to 2008
  - Bethlehem (28 S; 28 E) 1996 to 2001

- **SAGE-II (Stratosphere Aerosol Gas Experiment – II)**
  - Southern Africa (15 S; 10 E to 40 S; 40 E)

- **Model simulation study**
  - In-house
...LiDAR Principle

Centre for Atmospheric Research, University of Nova Gorica
LiDARs around the world
Initial Tests
Signal to Noise Performance

Slide 10

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Preliminary Results

23 Feb 2008

Raw Photon count

Analog Signal

Deadtime corrected Photon count

Glued Photon count
Retrieved aerosol properties: Backscattering and Extinction profile
Back Trajectory Analysis (BTA)

NOAA HYSPLIT MODEL
Backward trajectories ending at 2100 UTC 23 Feb 08
GDAS Meteorological Data

Source ★ at 25.42° S 26.13° E

Meters AGL

Relative humidity(RH) %

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For Apr. 18; 2008,

Morphological classification

1 – 3.5 km  13.1 % \{ "troposphere loaded from the bottom".
3.5 – 7.5km  80.3 %
7.5 – 12km  5.6 %.
Validation / Comparison

Comparison with AErosol RObatic NETwork (AERONET) : Sun-Photometer Optical Depth measurements at 500 nm
Validation / Comparison

Comparison with Stratosphere Aerosol Gas Experiment (SAGE)-II: Aerosol extinction measurements at 520 nm

25 February 2008

Aerosol Extinction Coefficient ( /km)

Height (km)
SAGE – II – AEROSOL EXTINCTION 525 nm OVER SOUTHERN AFRICA

MONTHLY VARIATION

/ km
(*1000.0)

Altitude (km)

Month

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SAGE – II – AEROSOL EXTINCTION 525 nm OVER SOUTHERN AFRICA

Temporal variation of Aerosol Extinction coefficient at 525 nm

Extinction Coefficient (/km) *10000, 0

0 0.5 1 1.5 2 2.5 3

12 24 36 48 60 72 84 96 108 120 132 144 156 168 180 192 204 216 228 240 252 264

Month
Validation / Comparison

Aerosol backscatter co-efficient measured by LIDAR and Radiosonde

Method  Based on hygroscopic properties of Aerosol

\[
\frac{\beta^a(\lambda, r)}{\beta^a_{Rh}(\lambda, r)} = a \left(1 - \frac{Rh}{100}\right)^{-b}
\]

\[\beta^a_{Rh}(\lambda, r)\]  the reference backscatter co-efficient for relative humidity of 70 % = 0.0005 (km-sr)^{-1}

a=0.43 and b=0.3, for the regression co-efficient \((R^2) = 0.85\)
Water vapor doesn’t exist after or near 0°C. The non-spherical and non-hygroscopic nature of aerosol particle may causes a considerable deviation from the real Rh value.
- 2-day measurement campaign at University of Pretoria
- First 23-hour continuous measurement
Fibre Auto-Alignment
Where does it go?
How does it impact?
Based on our earlier survey, there are no multi-channel LIDAR systems employed for atmosphere research in South Africa and African countries and X-Y dimensional mapping of the atmosphere have not been explored (except few countries around the world)
Beautiful but dangerous....

Thanks for your attention