LIDAR and Atmosphere Remote Sensing

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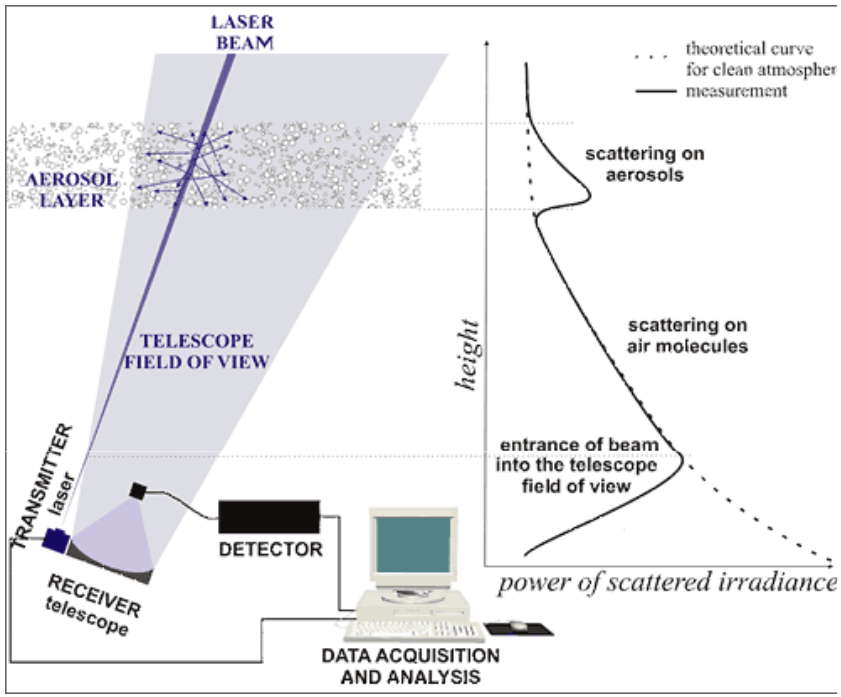
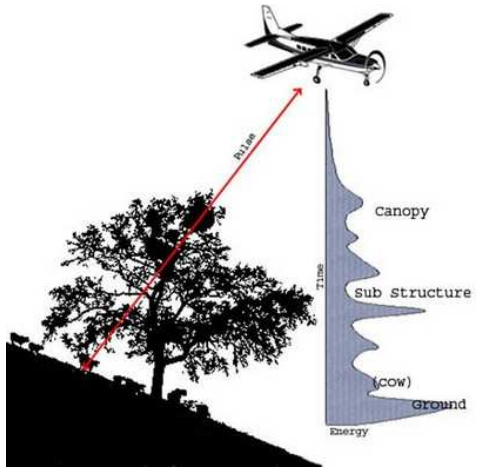
LIDAR Principle

- LIDAR (Light Detection and Ranging)
- LIDAR employs a laser as a source of pulsed energy
- Lasers are advantageous because –
  - ✓ Monochromatic
  - ✓ Highly coherent, high collimated
  - ✓ Short pulse duration, high pulse energy

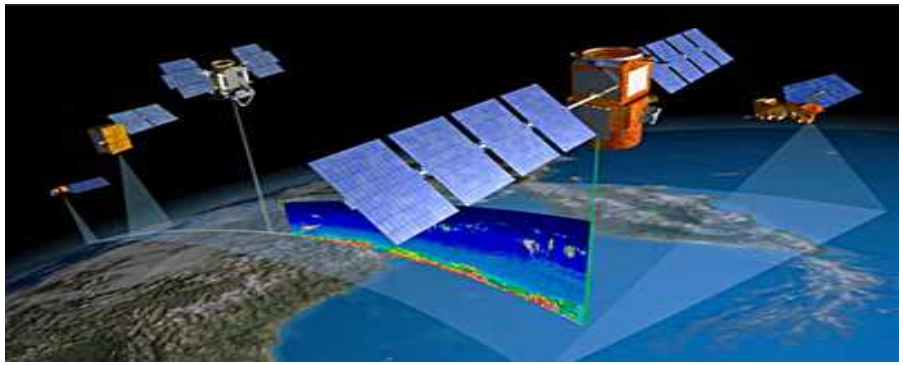


- Transmitted laser beam passing through the atmosphere causes scattering.
- Absorbtion by gases and particles attenuates the beam as it propagates
- Fraction of energy is backscattered in the direction of the LiDAR system and is available for detection.

LiDAR Platforms



Airborne

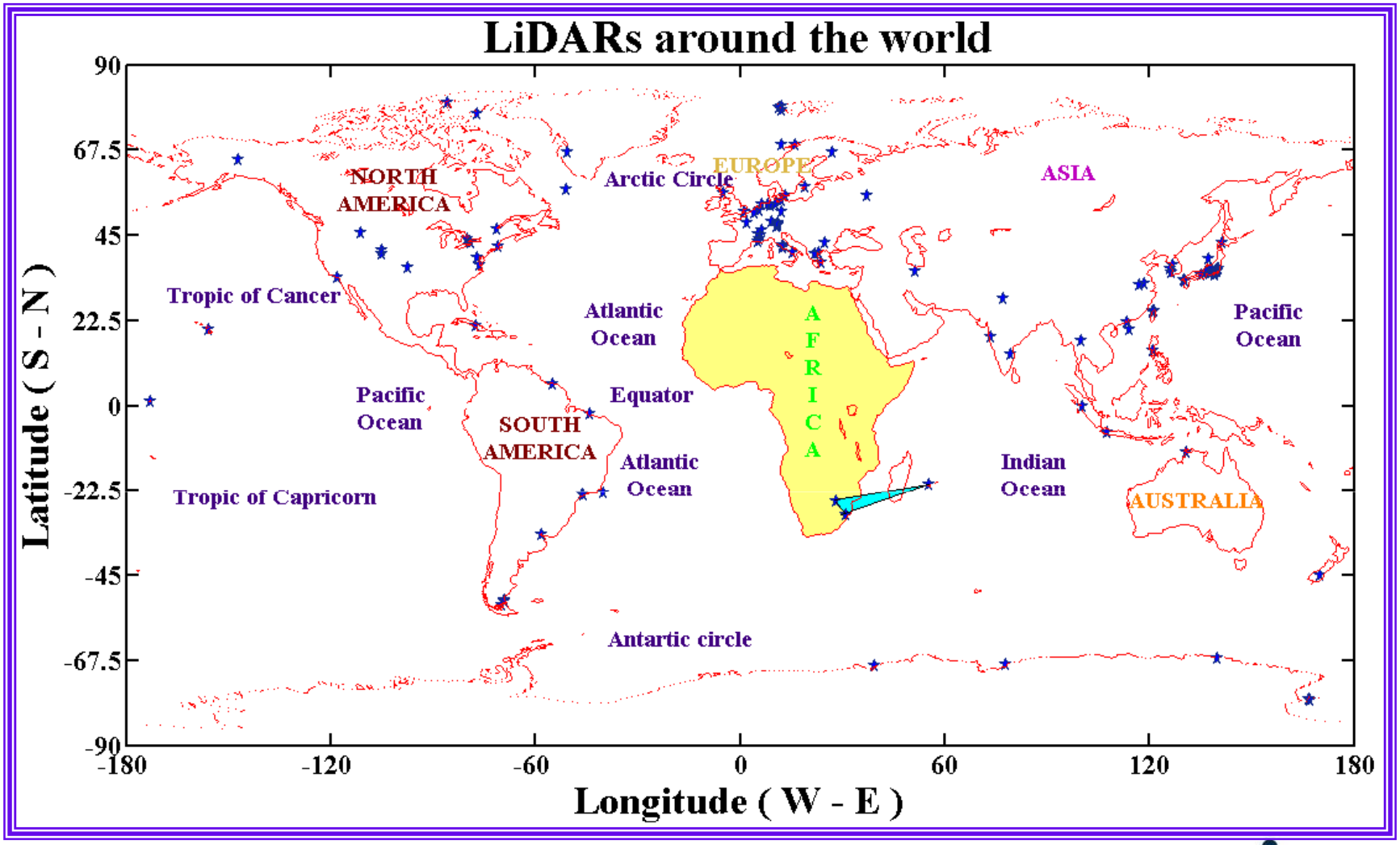


Satellite

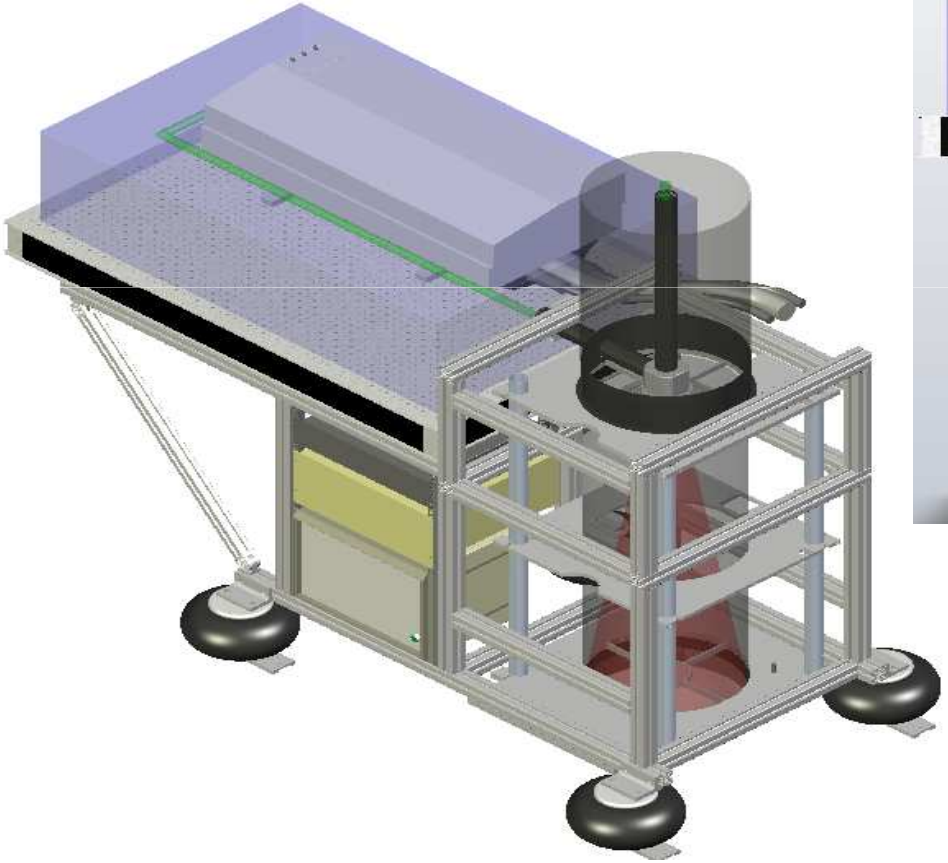
Mobile

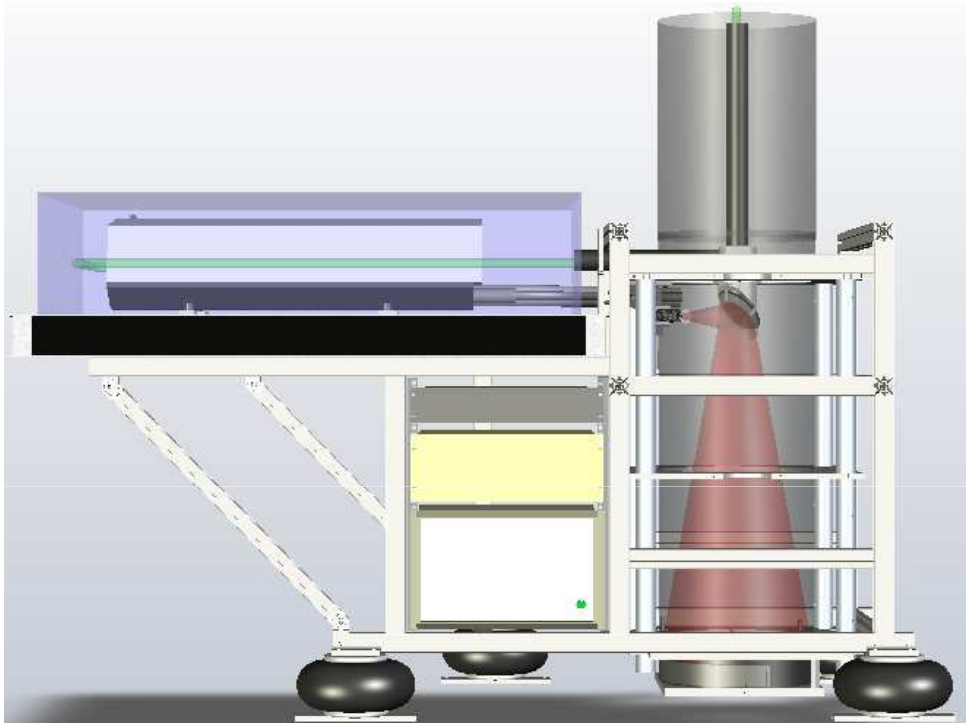
Ground-based

Phoenix Mars Mission

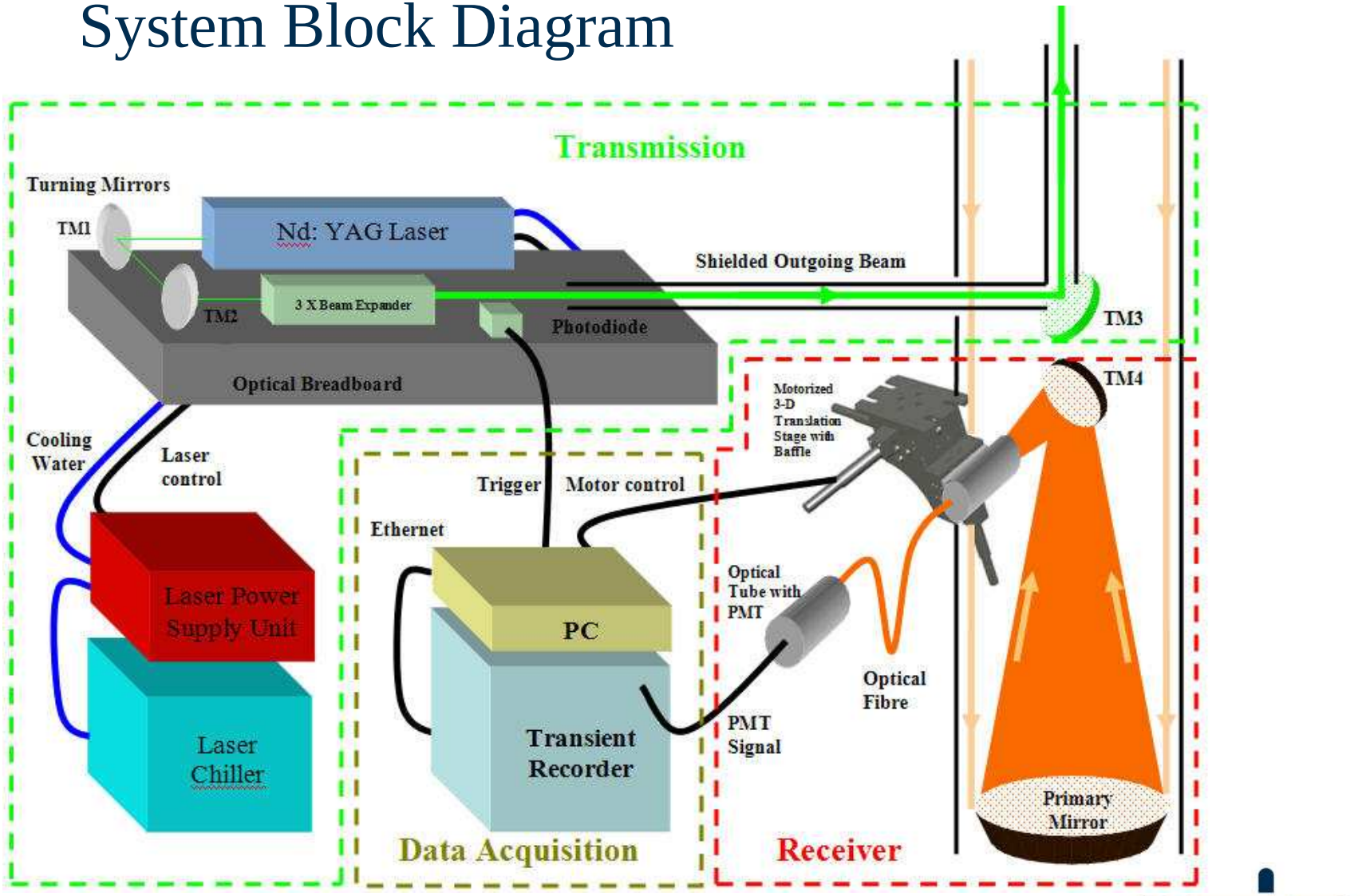


System 3-D View

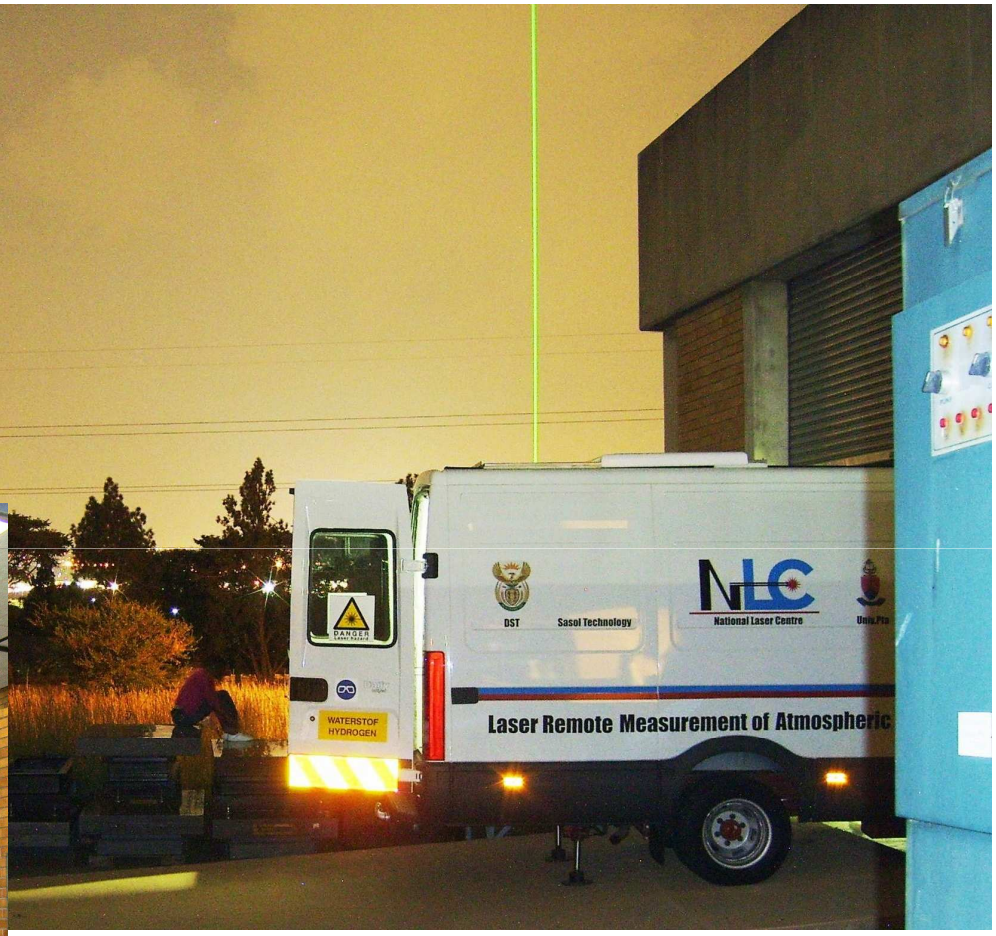




System Block Diagram

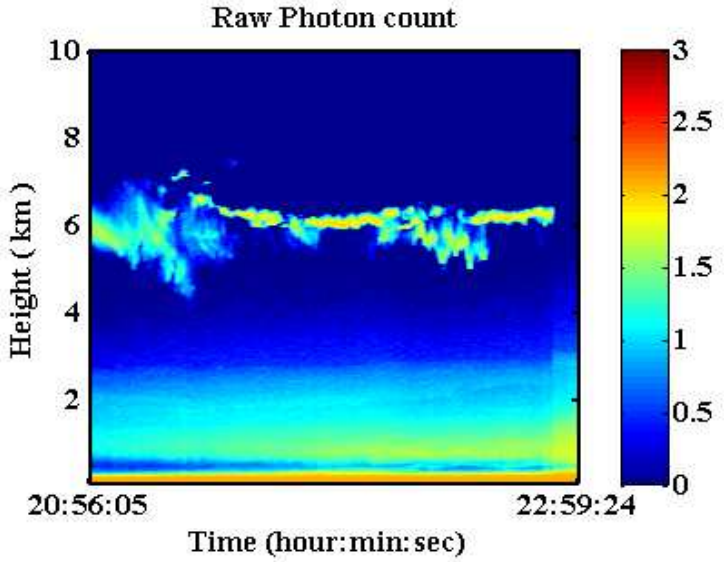


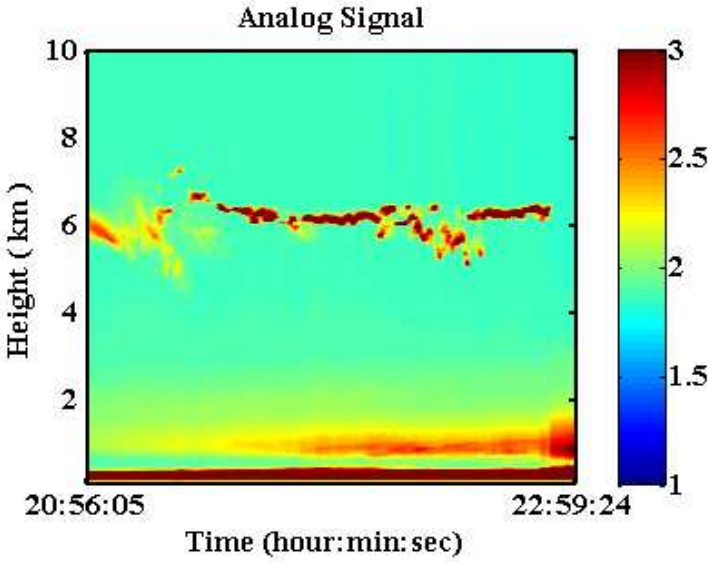
Initial Tests

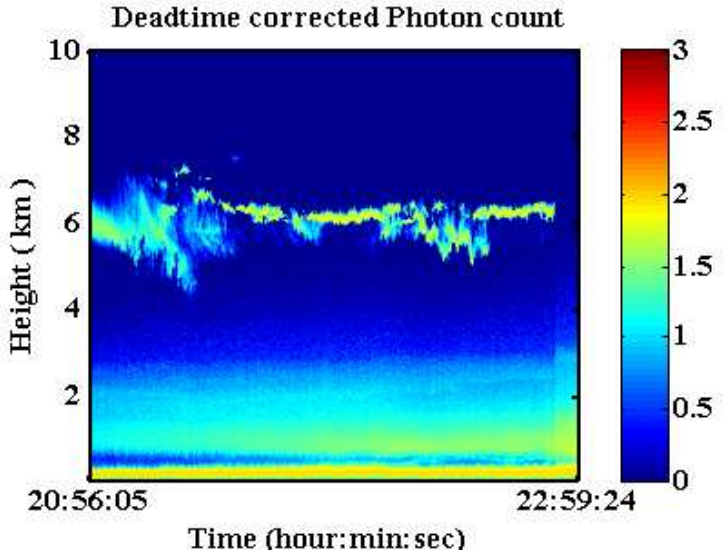


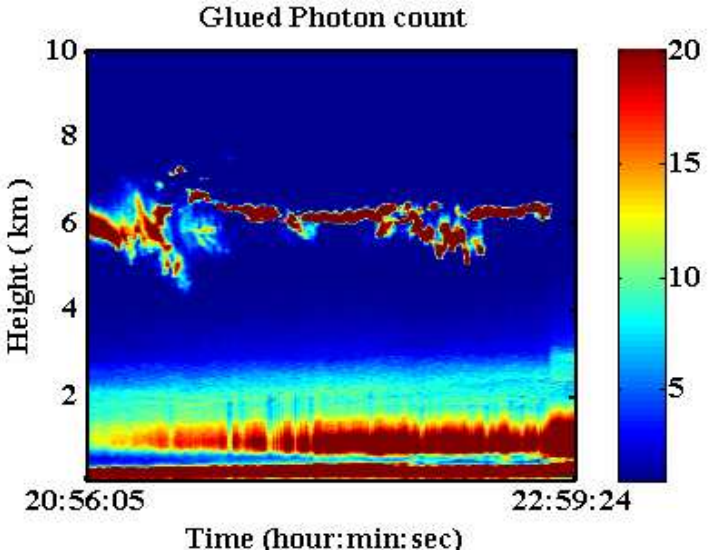
Preliminary Results

18 April 2008

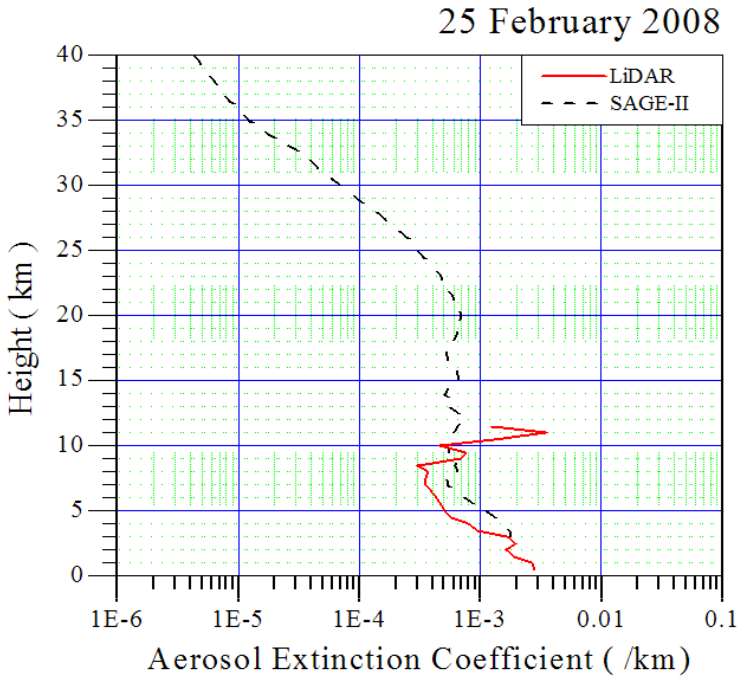


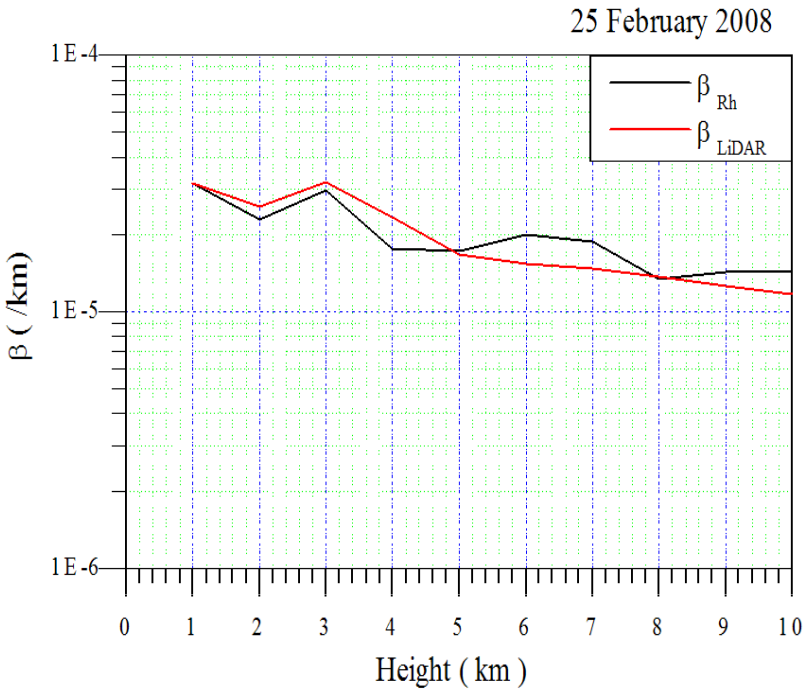


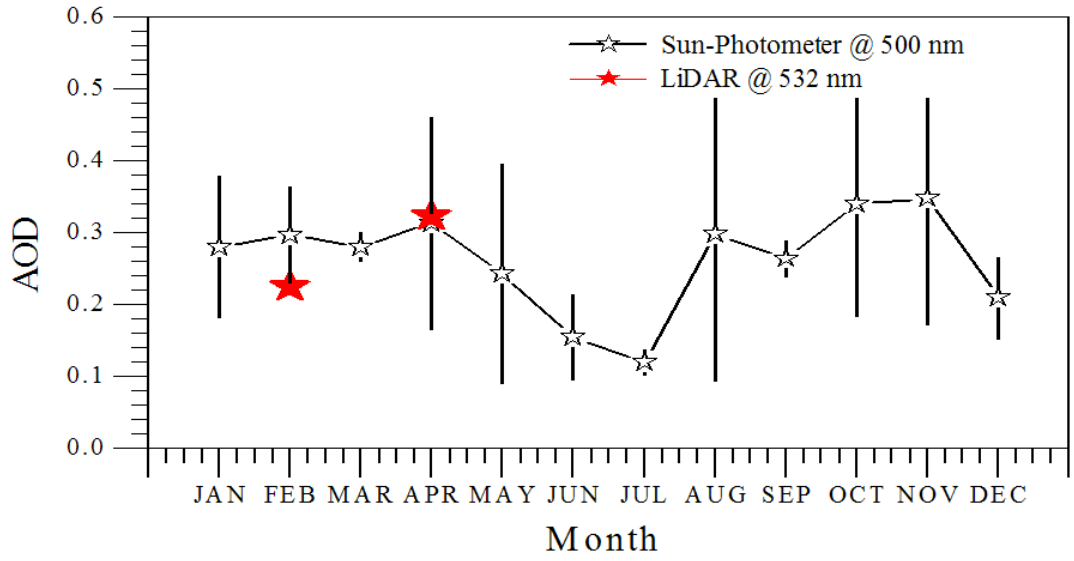




Validation/Comparison







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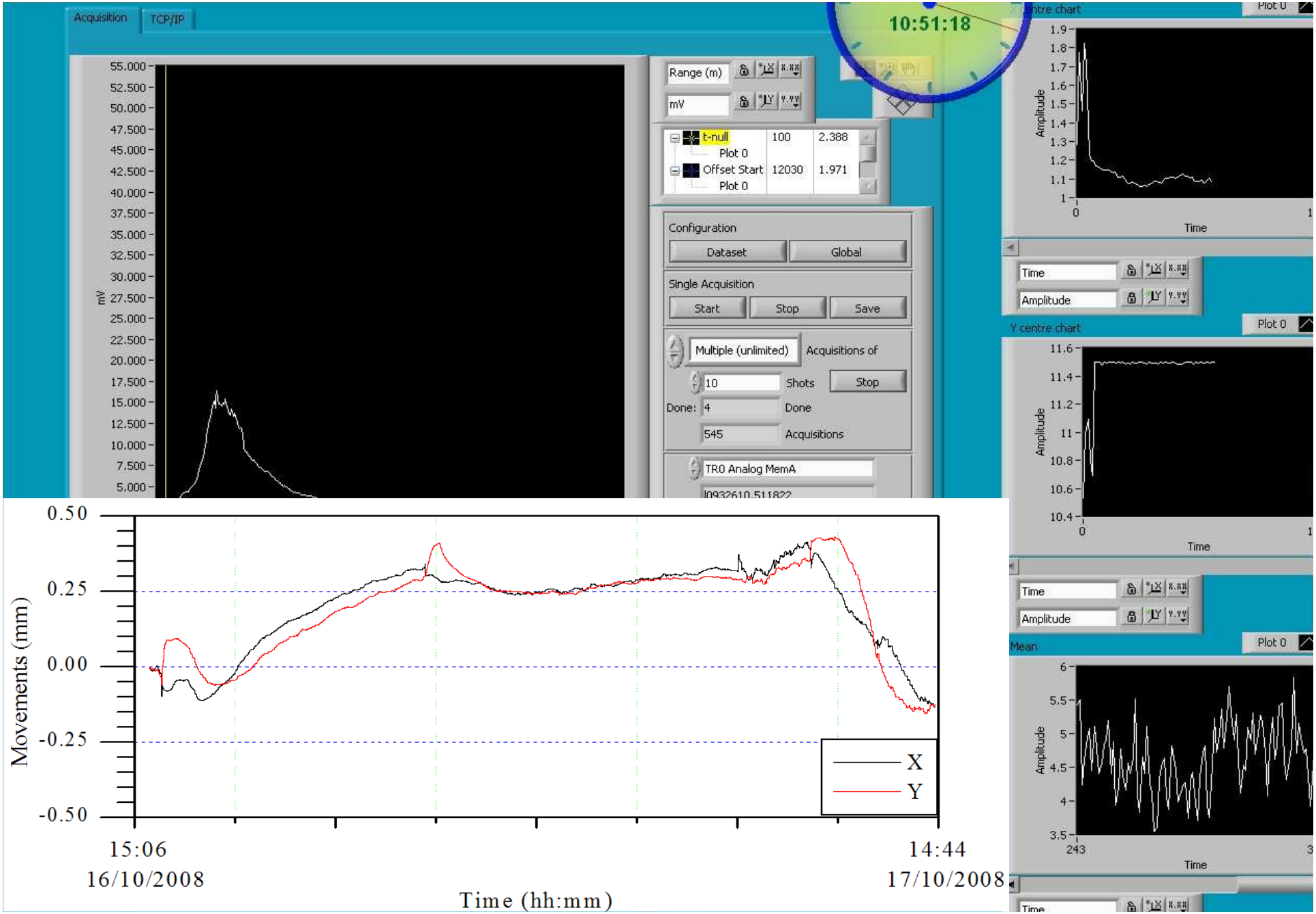
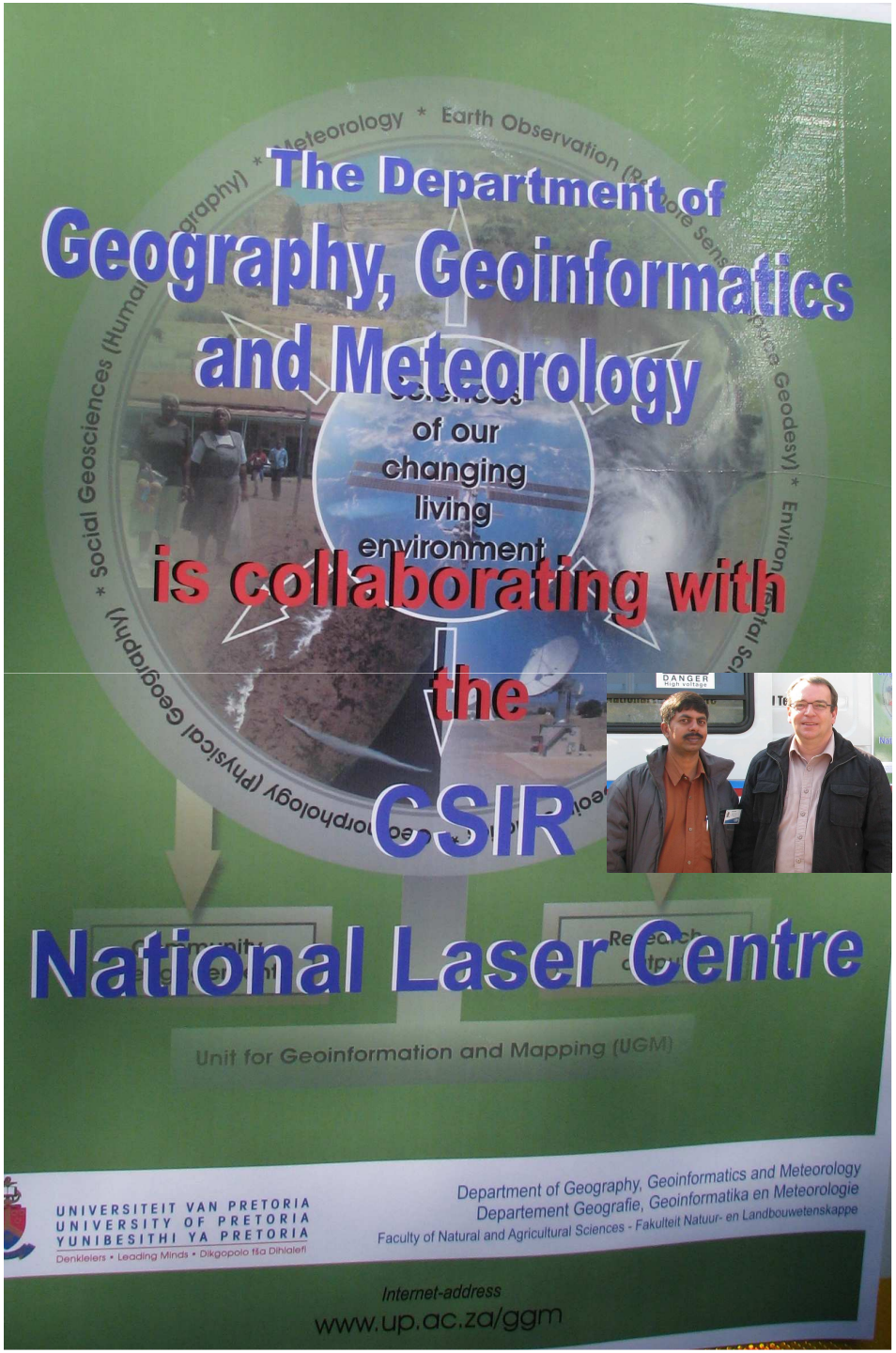
Fibre Auto-Alignment



SERA CSIR-UP

A combined research and academic training activity between the Council for Scientific and Industrial Research (CSIR) National Laser Centre (NLC) and the Department of Geography, Geoinformatics and Meteorology (GGM) at the University of Pretoria (UP)

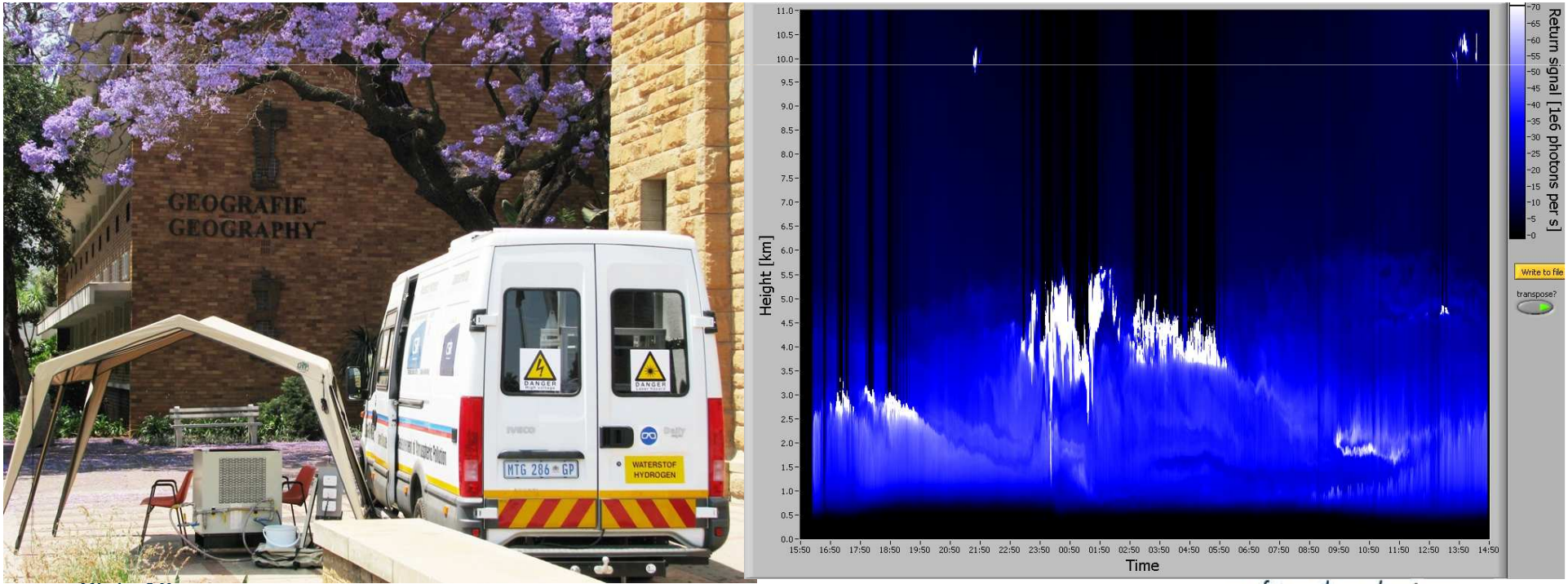
on ATMOSPHERIC REMOTE SENSING using state of the art Light Detection And Ranging (LiDAR) instrumentation and other active and passive remote sensing tools.

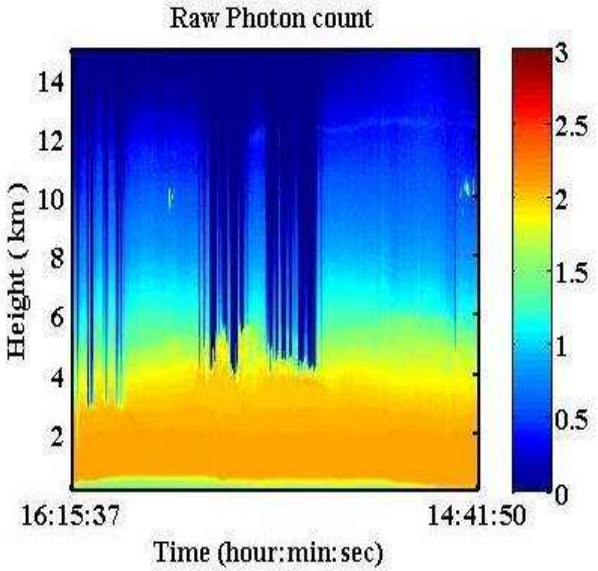


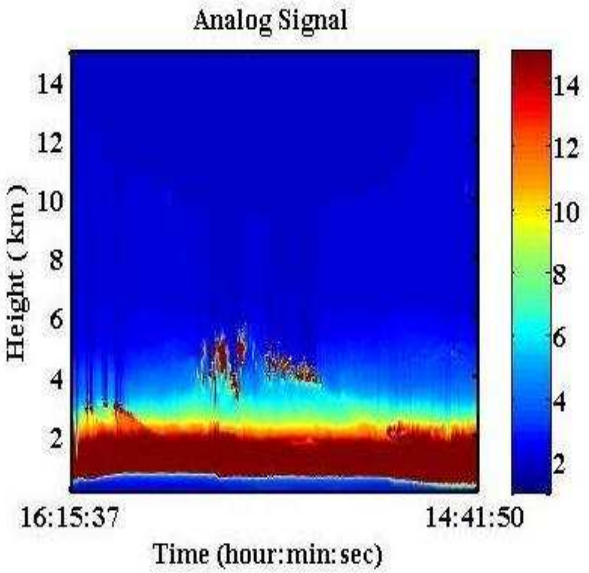
Last year, there were 35 students enrolled for bachelor degree programme and benefited.

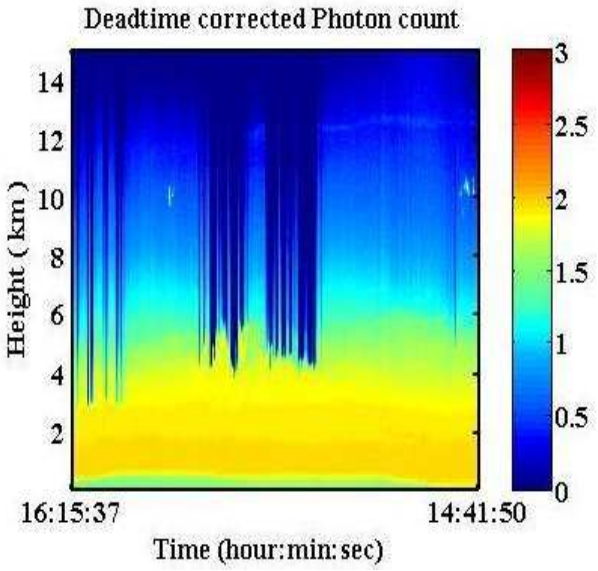
First "Lidar Field Campaign"

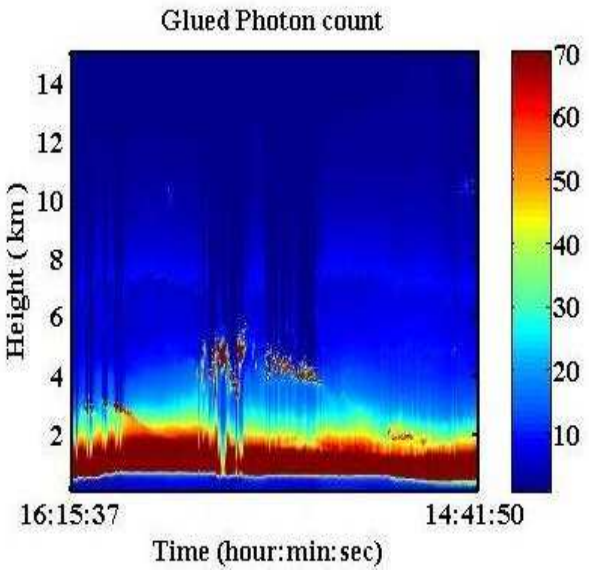
- 2-day measurement campaign at University of Pretoria
- First 23-hour continuous measurement

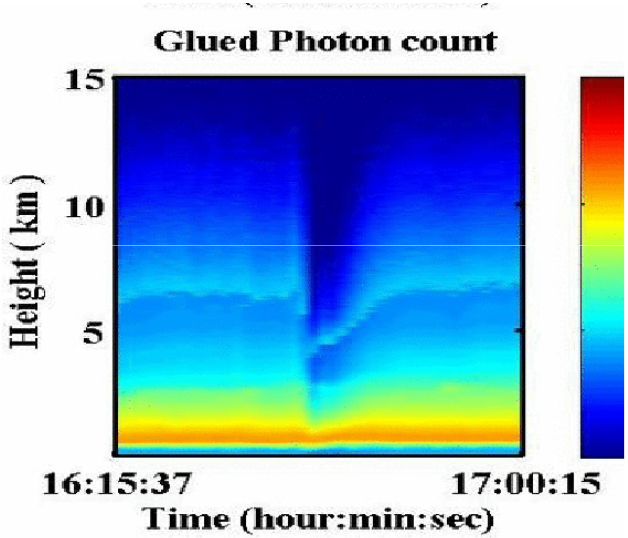












Remote Sensing Program at GGM

- Currently, remote sensing modules are offered at BSc level for:

    1. First year level:- Remote sensing (GGY 162)
    2. Second year level:- Remote sensing (GMA 220)
    3. Third year level:- Remote sensing (GMA 320)

- The remote sensing module at first year was designed as ‘a service course’ and a proposal has been put forward for it to be combined with cartography course

GMA 220

- To be called, Principles of remote sensing
- A semester course and to consist of theory and practical exercises
- Theory:

  Remote sensing process, Photogrammetry, introduction to multispectral, remote sensing systems, Thermal infra-red remote sensing, Active and passive remote sensing, LIDAR, Application of remotely sensed data (Atmosphere and Earth Observation)

- 7 Practical exercises :
  1. Principles of electromagnetic radiation
  2. Image interpretation and analysis
  3. Thermal IR image interpretation
  4. Analysis and interpretation of radar imagery
  5. Analysis and interpretation of LIDAR imagery
  6. Atmospheric remote sensing
  7. Remote sensing application for earth observation
- Schedule: 2*1-hr lectures, 1*1-hr study, 3-hr lab per week
- Practicals (~5 (best) *8= 40 %)+Semester test (60 %)+Exam (100%)

GMA 320

- This course mainly deals with digital image processing in remote sensing: Proposed name:- Digital image processing in Remote sensing
- Has theory and practical exercises
- Theory:

  Remote sensing & Digital image processing, Remote sensing data collection, Digital image processing hardware and hardware considerations, Image quality assessment, Display alternatives and scientific visualization, EM radiation principles and radiometric correction, Geometric correction, Image enlargement, Thematic Information extraction (image classification)
- Research task & 7 lab exercises:
  1. Remote sensing process (Research task)
  2. Introduction to (some) remote sensing software:- Image display & cursor operations
  3. Remote sensing data (sources & formats)
  4. Contrast stretching and density slicing operations
  5. Image statistics (using spatial modeler)
  6. Image annotation and map composition
  7. Radiometric and geometric correction
  8. Image classification
- Lectures: 1- hr lectures, 1-hr study, 1, 3-hr lab per week
  - Lab ex. (5 (best)*8= 40 %)+Semester test (60 %)+Exam (100%)

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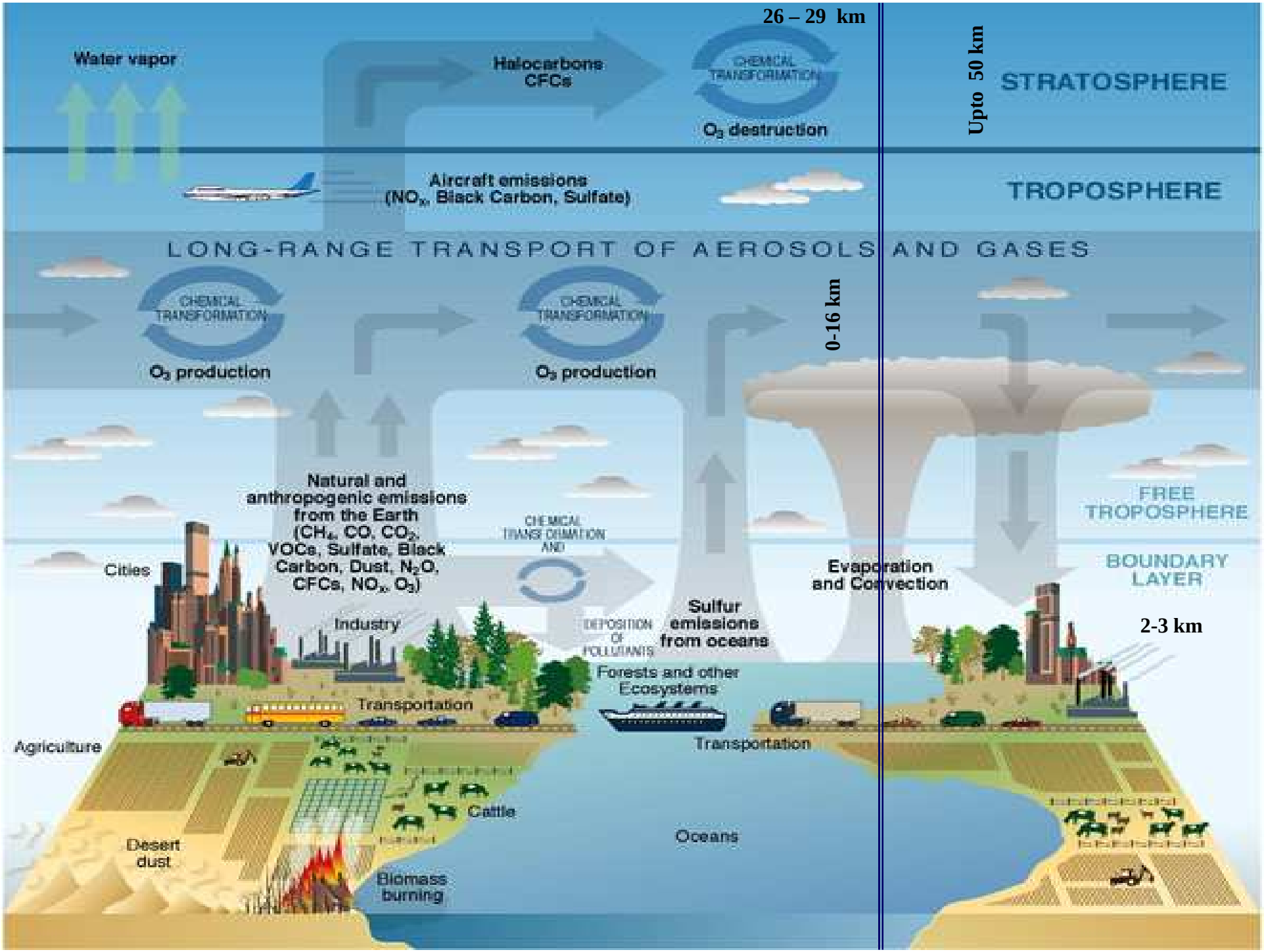
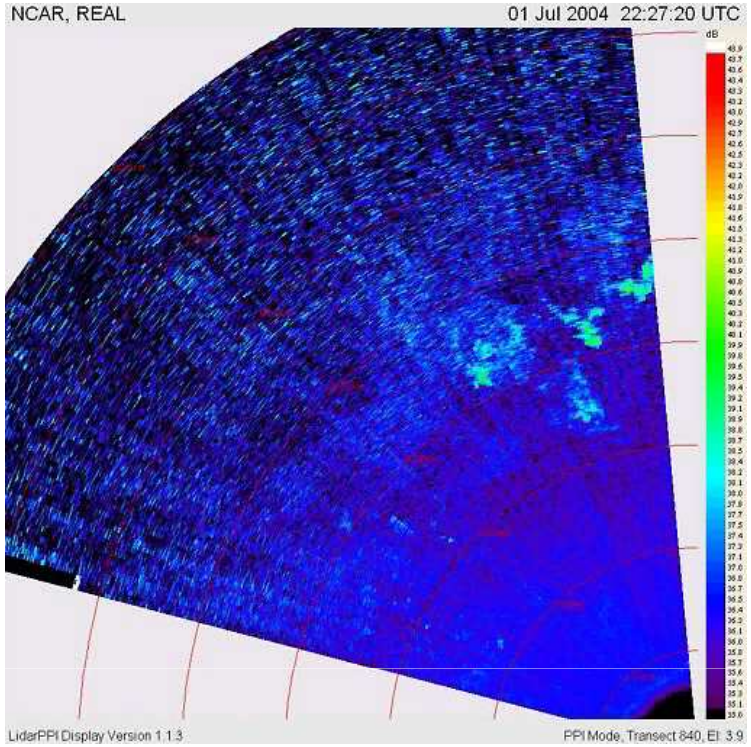
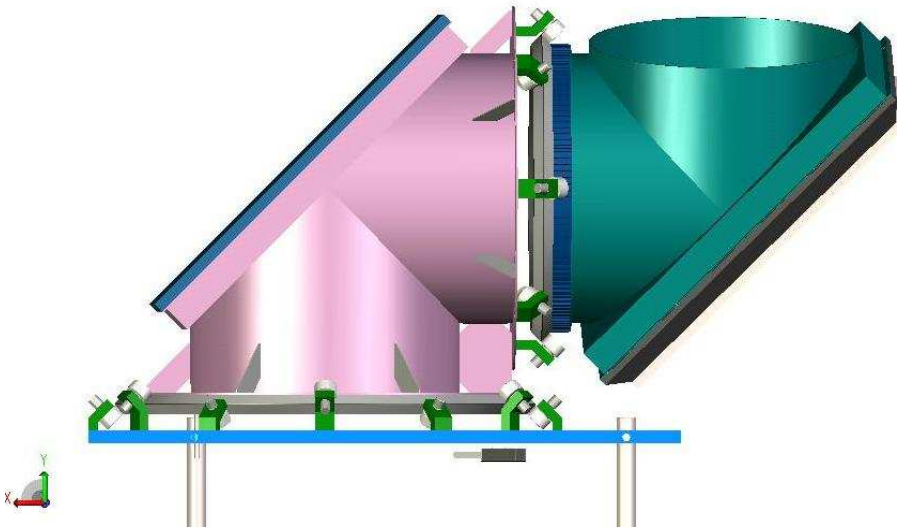

26 – 29 km
Upto 50 km
STRATOSPHERE
Water vapor
Halocarbons
CFCs
CHEMICAL TRANSFORMATION
O_3 destruction
Aircraft emissions
(NO_x, Black Carbon, Sulfate)
TROPOSPHERE
LONG-RANGE TRANSPORT OF AEROSOLS AND GASES
0-16 km
CHEMICAL TRANSFORMATION
O_3 production
CHEMICAL TRANSFORMATION
O_3 production
Natural and anthropogenic emissions from the Earth (CH_4, CO, CO_2, VOCs, Sulfate, Black Carbon, Dust, N_2O, CFCs, NO_x, O_3)
CHEMICAL TRANSFORMATION AND
DEPOSITION OF POLLUTANTS
Evaporation and Convection
FREE TROPOSPHERE
BOUNDARY LAYER
2-3 km
Cities
Industry
Sulfur emissions from oceans
Forests and other Ecosystems
Transportation
Transportation
Agriculture
Cattle
Oceans
Desert dust
Biomass burning

Where does it go ?

How does it impact ?





Adopted from NCAR site

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)

National Collaborators

Prof. Prince Ngobeni, Tshwane, University of Technology, Pretoria.

Prof. Hannes Rautenbach, University of Pretoria, Pretoria.

Prof. Stuart Piketh, University of Witwatersrand, Johannesburg.

Lidar Scientist…., University of KwaZulu Natal, Durban.

Dr. Mark Alexander Tadross, University of capetown, Capetown.

Dr. Sandile Malinga, Hermanus Magnetic Observatory, Capetown.

Dr Deon Terblanche, South African Weather Service Department

International Collaborators

Dr. Gizaw Mengistu, Addis Ababa University, Addis Ababa, Ethiopia.

Prof. Hassan Bencherif, CNRS-UMR 8105, Reunion University, Reunion, France.

Dr. Philippe Keckhut, Service d'Aéronomie, CNRS-UMR 7620, Paris, France.

Lidar for Atmospheric Research over Africa

(March 2007 – February 2010)

- **Mie scattering of particulate size (µm) matter in the atmosphere**
- **Aerosol measurements and cloud characteristics**
- Water vapour measurements in the lower troposphere region up to 8 km
- Ozone measurements in the troposphere regions up to 18 km

Project Leader

Prof. SIVAKUMAR VENKATARAMAN

(National Laser Centre - CSIR, Pretoria, SOUTH AFRICA)

Collaborators

Lidar Scientist / Prof. SADHA PILLAY

(University of KwaZulu-Natal, Durban, SOUTH AFRICA)

Dr. GIZAW MENGISTU

(Addis Ababa University, ETHOPIA)

Prof. HASSAN BENCHERIF

(Université de la Reunion, Laboratorie de l'atmosphere et des cyclones, CNRS - UMR-8105, Reunion, FRANCE)

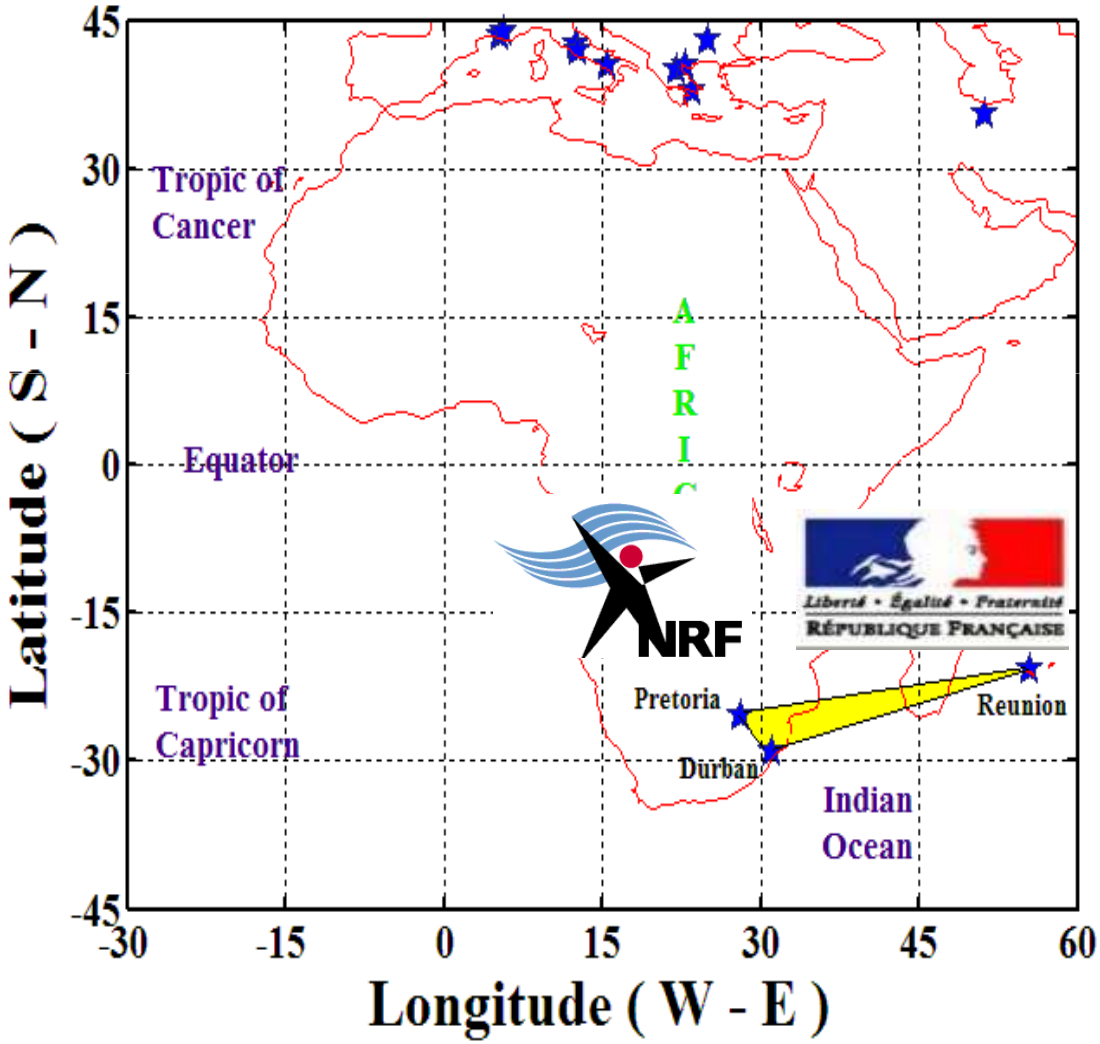
Dr. PHILIPPE KECKHUT

(Service d'aéronomie, CNRS - UMR-7620 Paris, FRANCE)

South-African French LiDAR (SAFiR) network for study of upper troposphere and lower stratosphere aerosol distributions and dynamics

(January 2009 – December 2010)

- Studies on upper troposphere and lower stratosphere (UTLS) aerosol
- Gravity wave influences on UTLS aerosol variations and size distributions
- Cirrus cloud morphology and dynamics.



Atmospheric Research in Southern Africa and Indian Ocean (ARSAIO)

Middle atmosphere dynamics and thermal structure: comparative studies from LIDAR datasets
Water vapour cycle study in the Upper Troposphere-Lower Stratosphere
Stratospheric ozone variability, transport and mixing processes in the southern tropics: a French-South African observation and research network
Ozone and UV radiation
Atmospheric pollution and Climate change in southern Africa
Tropospheric ozone and Regional Impact over the Indian Ocean Region
Tropospheric aerosol studies over Indian Ocean Region
Greenhouse gas measurements

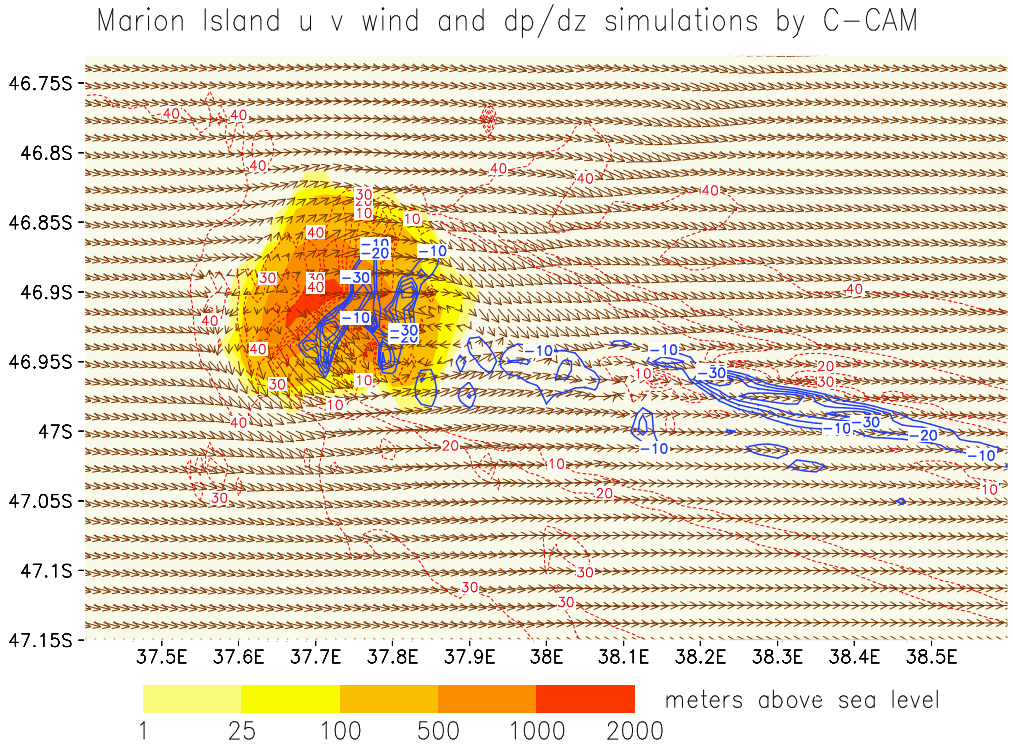
LiDAR Workshop

It has been organized during 21-22 November 2007 and the research community from South Africa, France and Ethiopia are benefited.

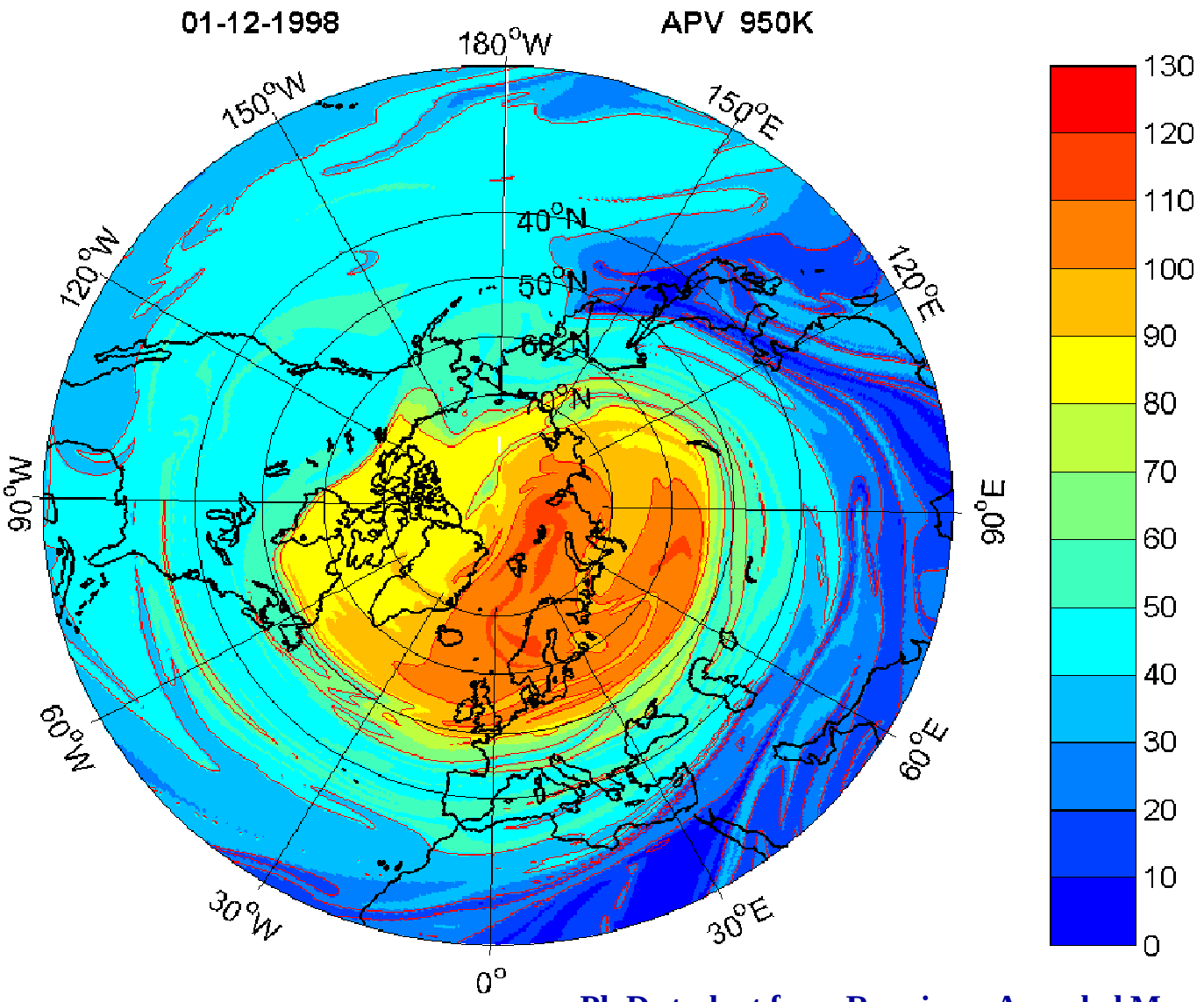
Total number of participants : 47 (7 from France, 3 from Ethiopia)

Miss. Elodie Feld,
Master degree in atmosphere science, Reunion University, Reunion
Carried out a project work entitled

"THE INFLUENCE OF MARION ISLAND TOPOGRAPHY ON GENERAL ATMOSPHERIC CIRCULATION"



Statistical and characteristics of sudden stratospheric warming over northern and southern hemisphere lidar stations

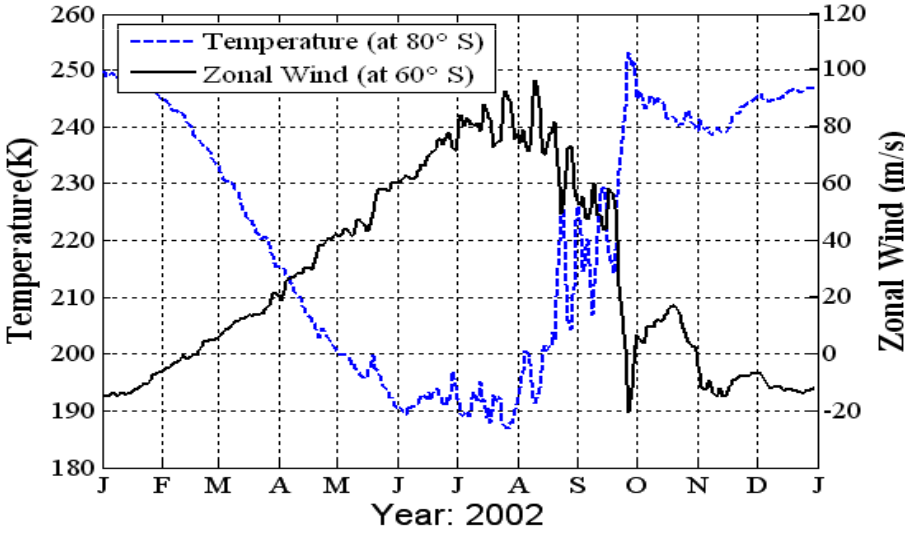


Ph.D student from Reunion – Awarded May, 2009.

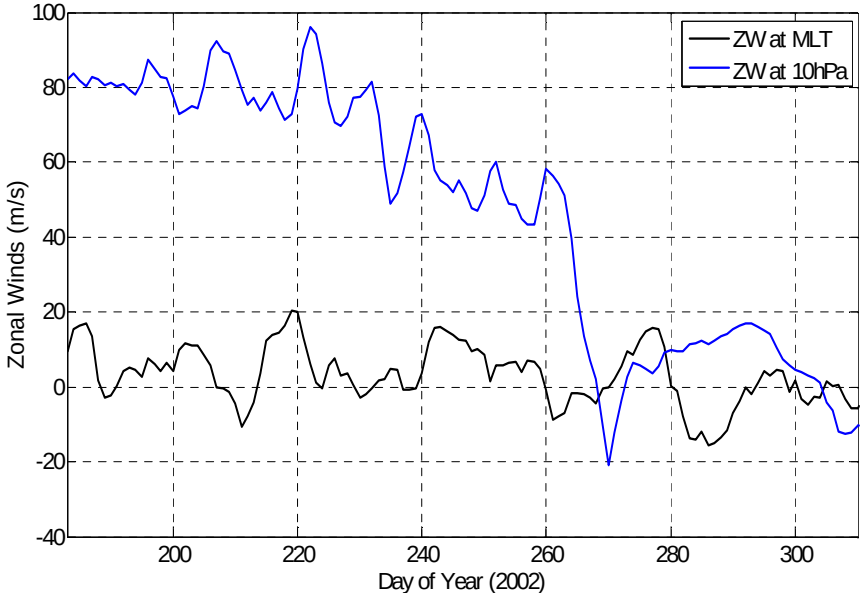
Mr.Nkanyiso Bongumusa Mbatha

Ph.D Student (Registered at University of Kwa-Zulu Natal)

Study on the effect of sudden stratospheric warming in the upper mesosphere-lower thermosphere region using satellite and HF radar



SSW recorded during 2002 by NCEP data



MLT wind reversal is observed ~ 6 days before the reversal at the stratosphere.


Thank You
Merci Beacouq
2008/12/29 11:31
2008/12/22 15:08
2008/12/06 18:54