Using Artificial Sky Glow to Retrieve Night Time Aerosol Optical Depth

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Outline

- Aerosol optical depth retrieval methods
- Goal and basic idea
- What is light pollution?
- Important variables involved
- Understanding by modelling
- AOD sky glow relationship (modelled)
- Light pollution detector
- AOD sky glow relationship (observed)
- First results
- Ongoing and future works

Aerosol optical depht (AOD) retrieval methods

Sunlight based retrieval methods:

- **Sunphotometers networks** (e.g. AERONET)
  sparse data but good temporal sampling

- **Dark targets inversion on satellite images**
  (e.g. sea surface, dense dark vegetation)
  better spatial sampling but low temporal frequency

Retrieval during night time

- **Starphotometers**
  - **requires relatively dark sites**
    i.e. Not suitable for urban sites
- **Moon photometry**
  - **possible only 6 month/year**
- **LIDAR**
  - **High cost system (difficulty to expand them in large networks)**

Our goal

Provide a new night time aerosol remote sensing method suitable for urban applications

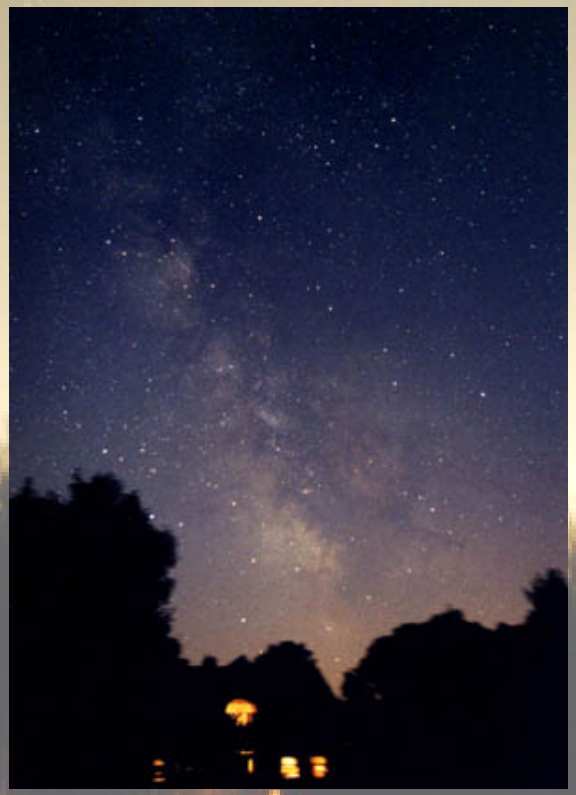
Basic idea

Use artificial sky glow (light pollution) to estimate the aerosol content of the atmosphere

What is light pollution?

1) Artificial light is directed toward the sky
(directly or after ground reflexion)

2) A part of this light is scattered back toward the ground
(by molecules and aerosols)

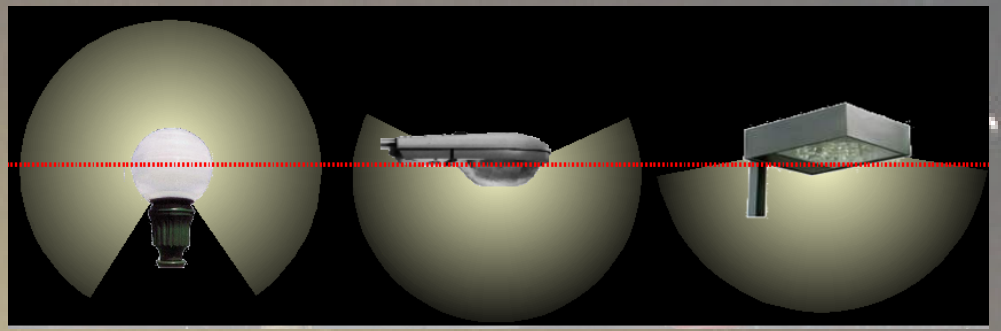


Fuji 800 ASA, 90 seconds

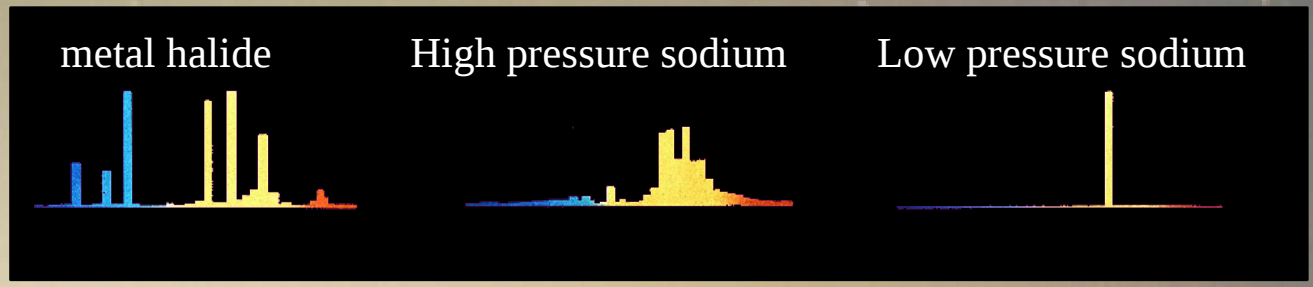
Fuji 800 ASA, 30 seconds

Important variable involved

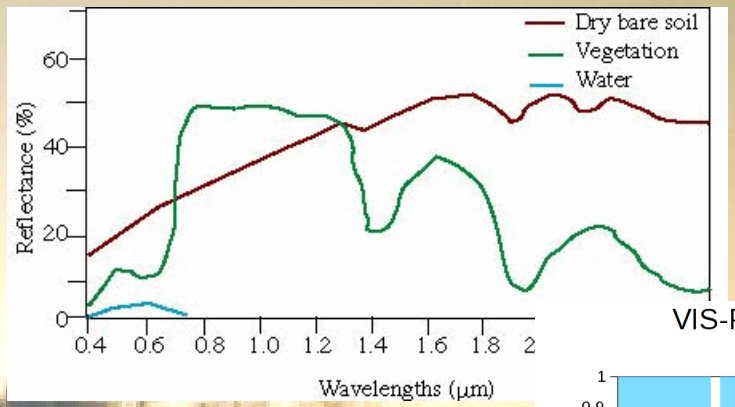
- Source angular photometry



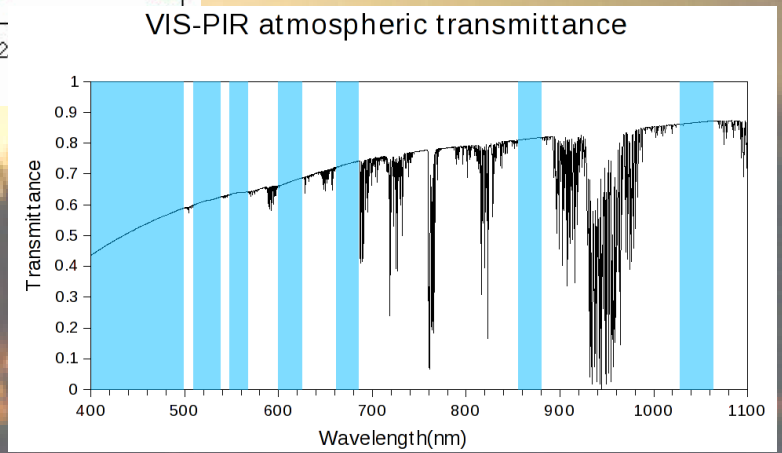
- Source spectral dependance



- Ground spectral reflectance



- Atmospheric optical properties

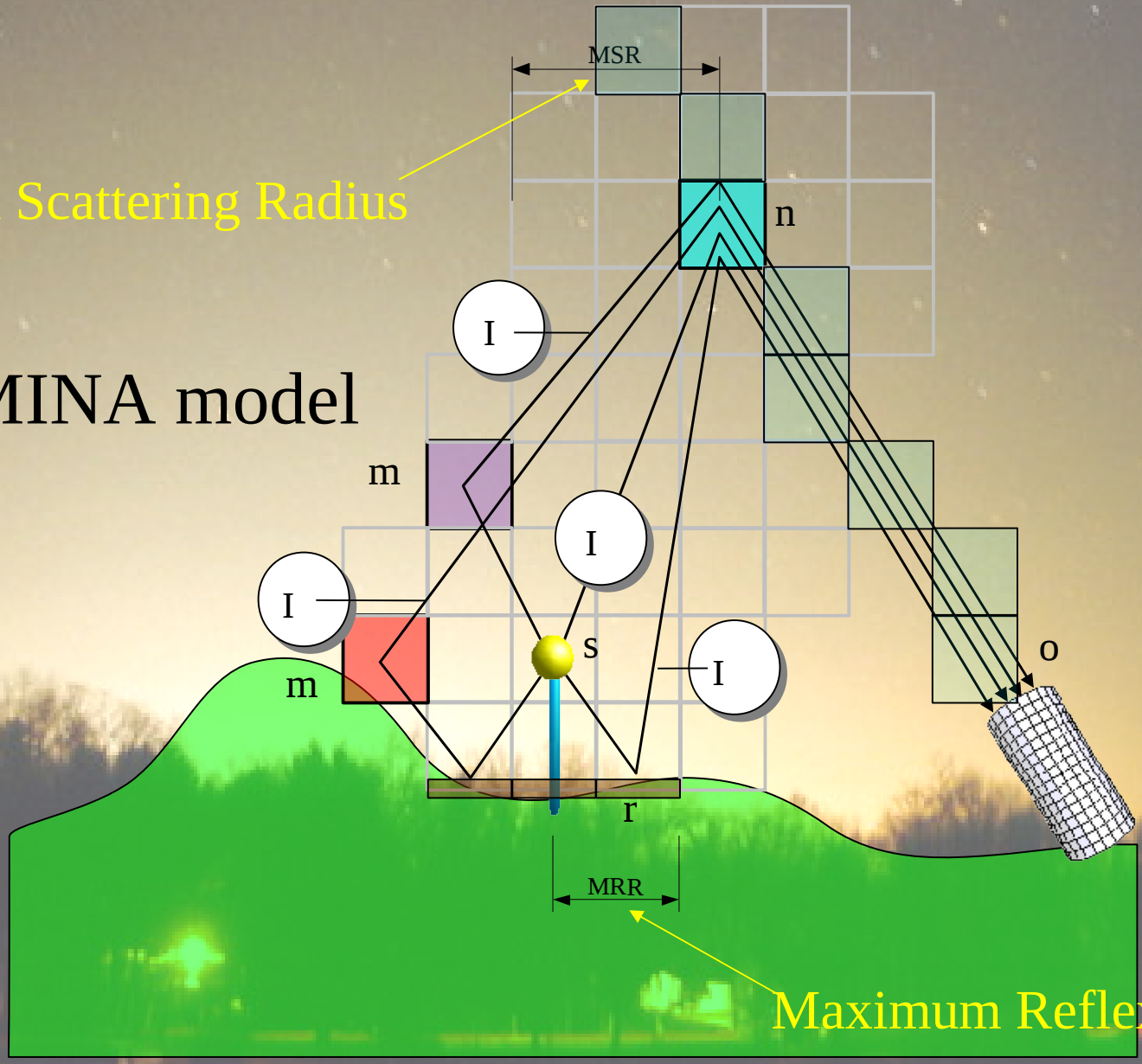


- Topography and obstacles (shadowing effects)

Using high level modelling to understand AOD-Sky glow relationship

Maximum Scattering Radius

The ILLUMINA model

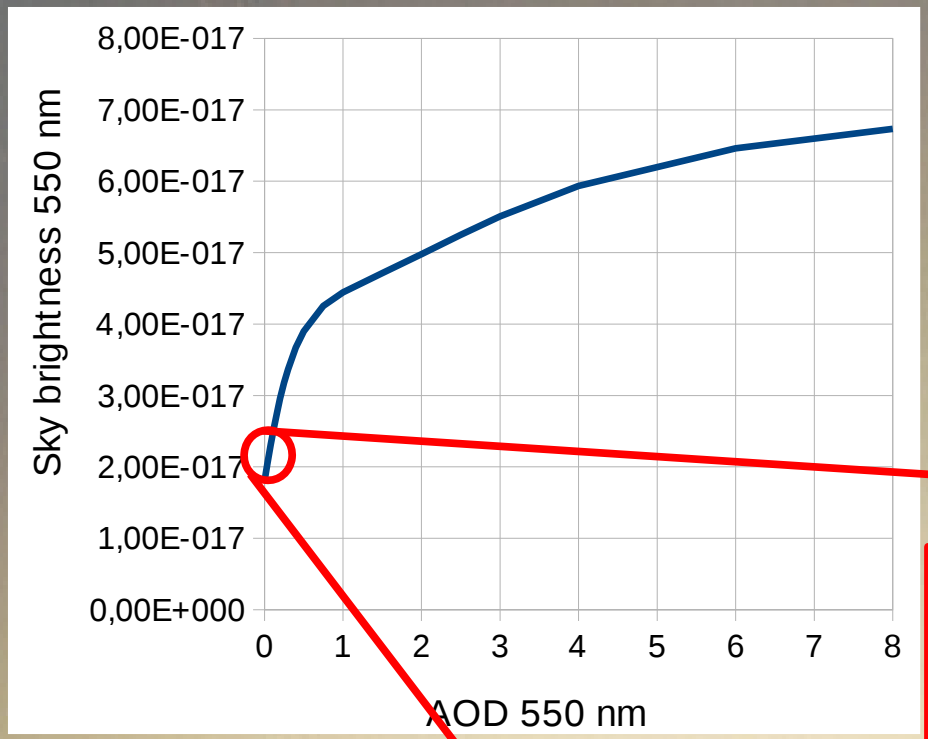


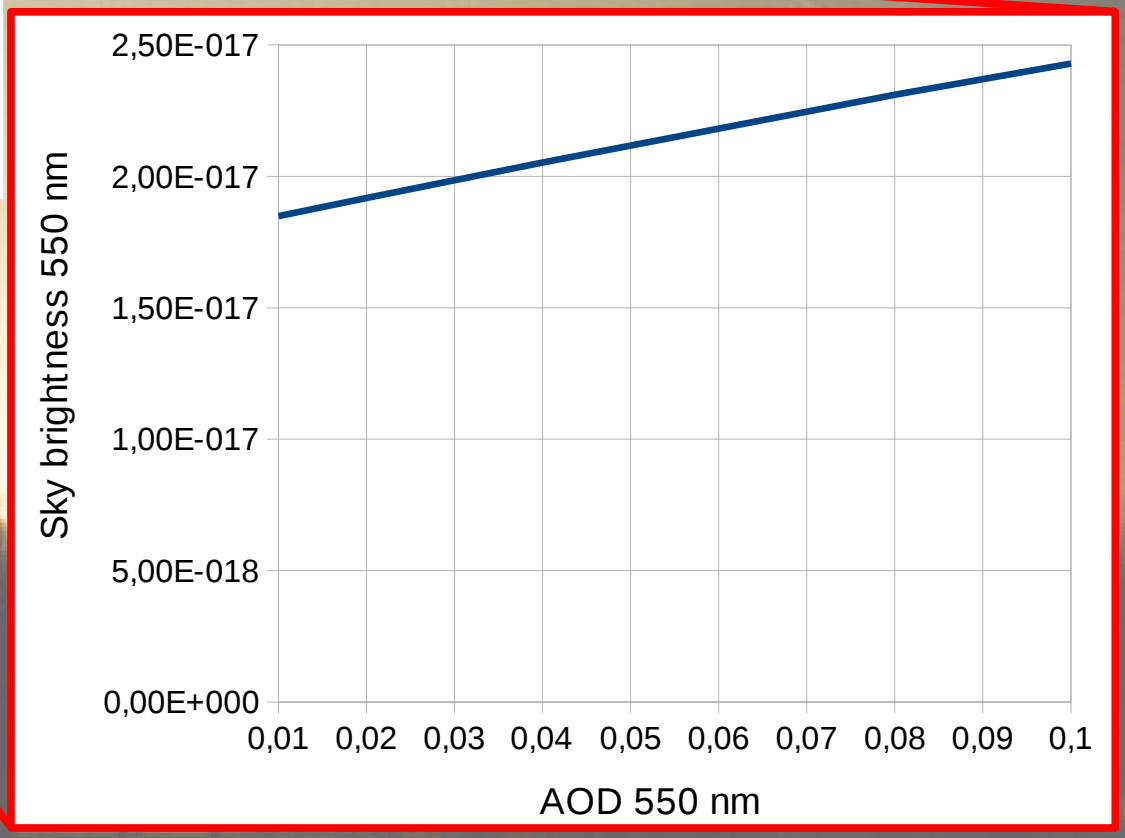
Maximum Reflexion Radius

ILLUMINA Model features

- **Heterogeneity of the environment (topography, ground reflectance, light sources geographical distribution)**
- **Spectral dependance**
- **Light source angular output pattern (horizontal isotropy is assumed)**
- **Molecule and aerosol optics:**
  - **molecules -> scattering**
  - **aerosols -> scattering & absorption**
  - **molecules and aerosols extinction along the light path**
- **Computation of shadows (including subgrid)**
- **Up to 9 source types per horizontal cell**
- **3D computation (1024 x 1024 x 50 levels)**
- **Logarithmic vertical scale which allow a better simulation near light sources where atmospheric concentration and light intensity are higher**

Modelled AOD-Sky glow relationship

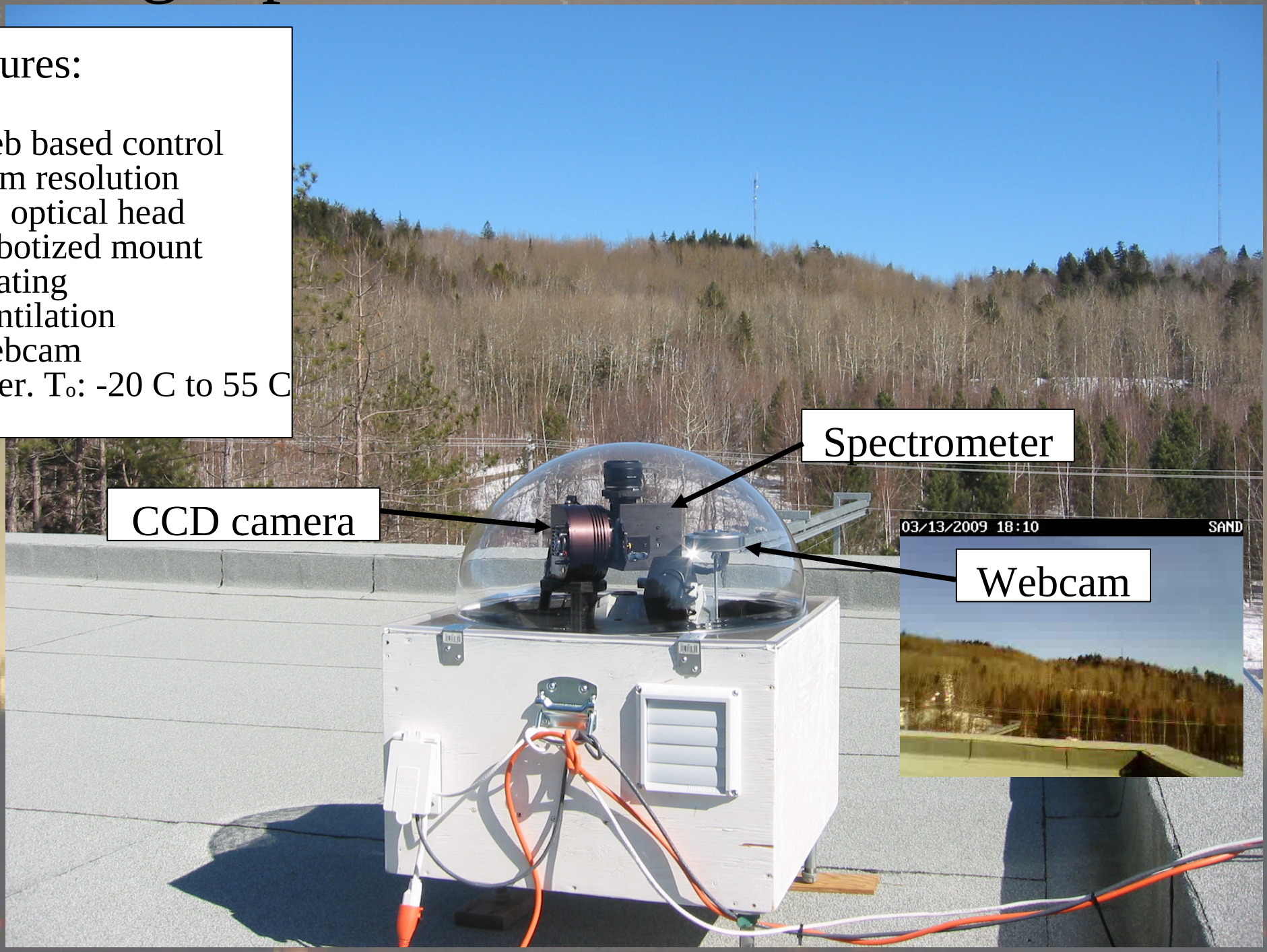




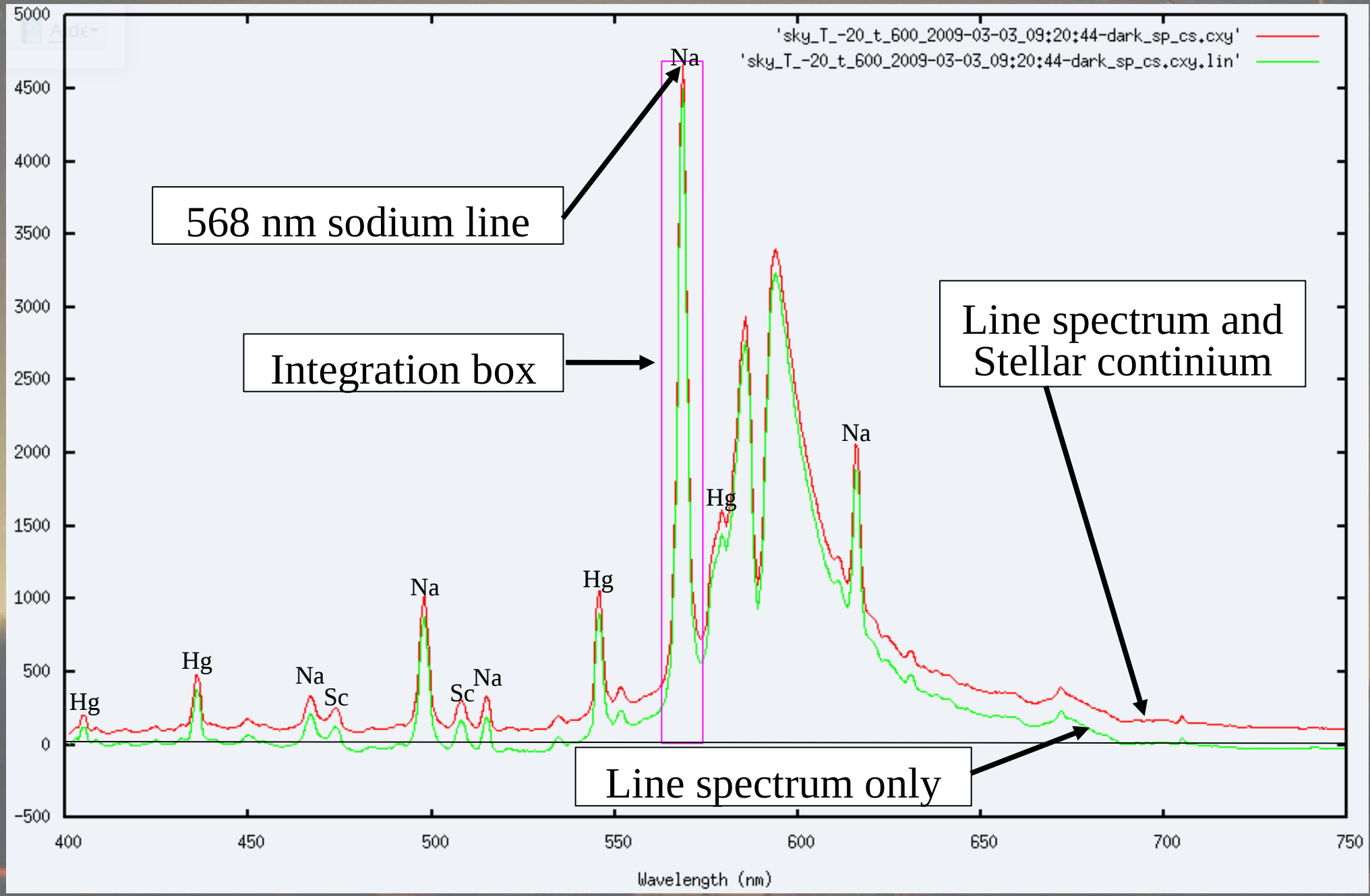
Light pollution detector: SAND

Features:

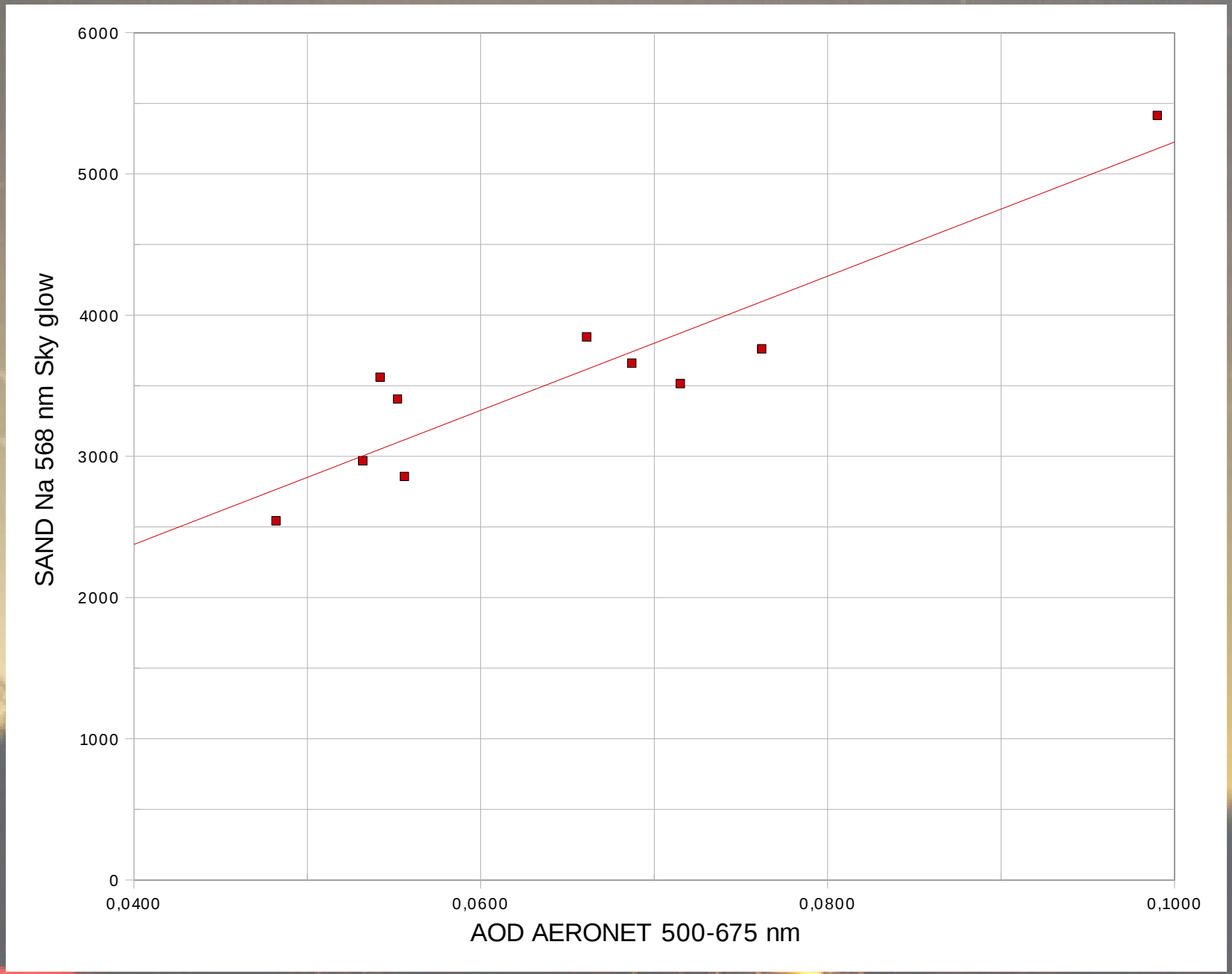
- Web based control
- 2 nm resolution
- F/2 optical head
- Robotized mount
- Heating
- Ventilation
- Webcam
- Oper. T_o: -20 C to 55 C



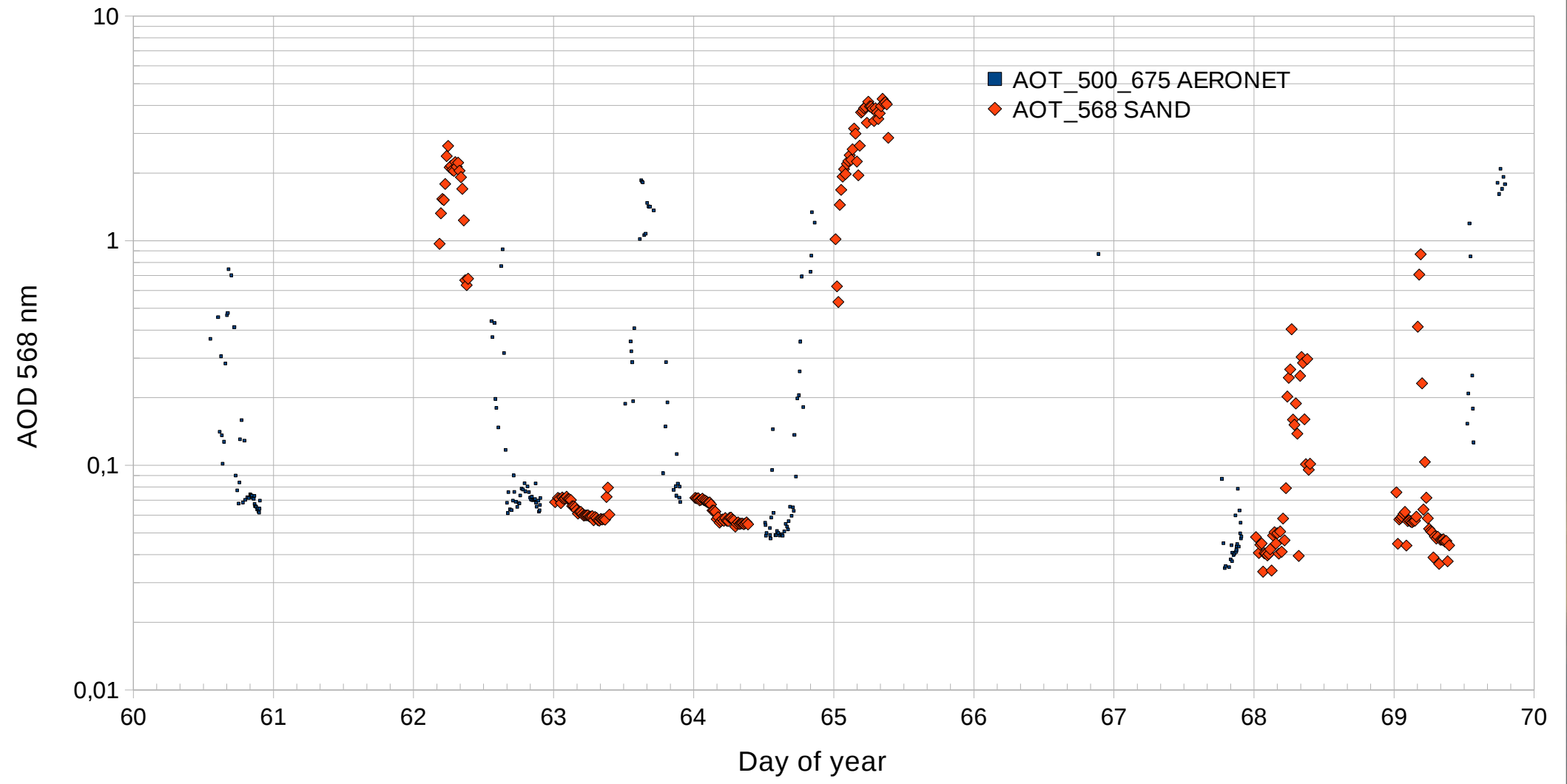
Light pollution detector: SAND



Observed AOD-Sky glow relationship



First results - march 2009



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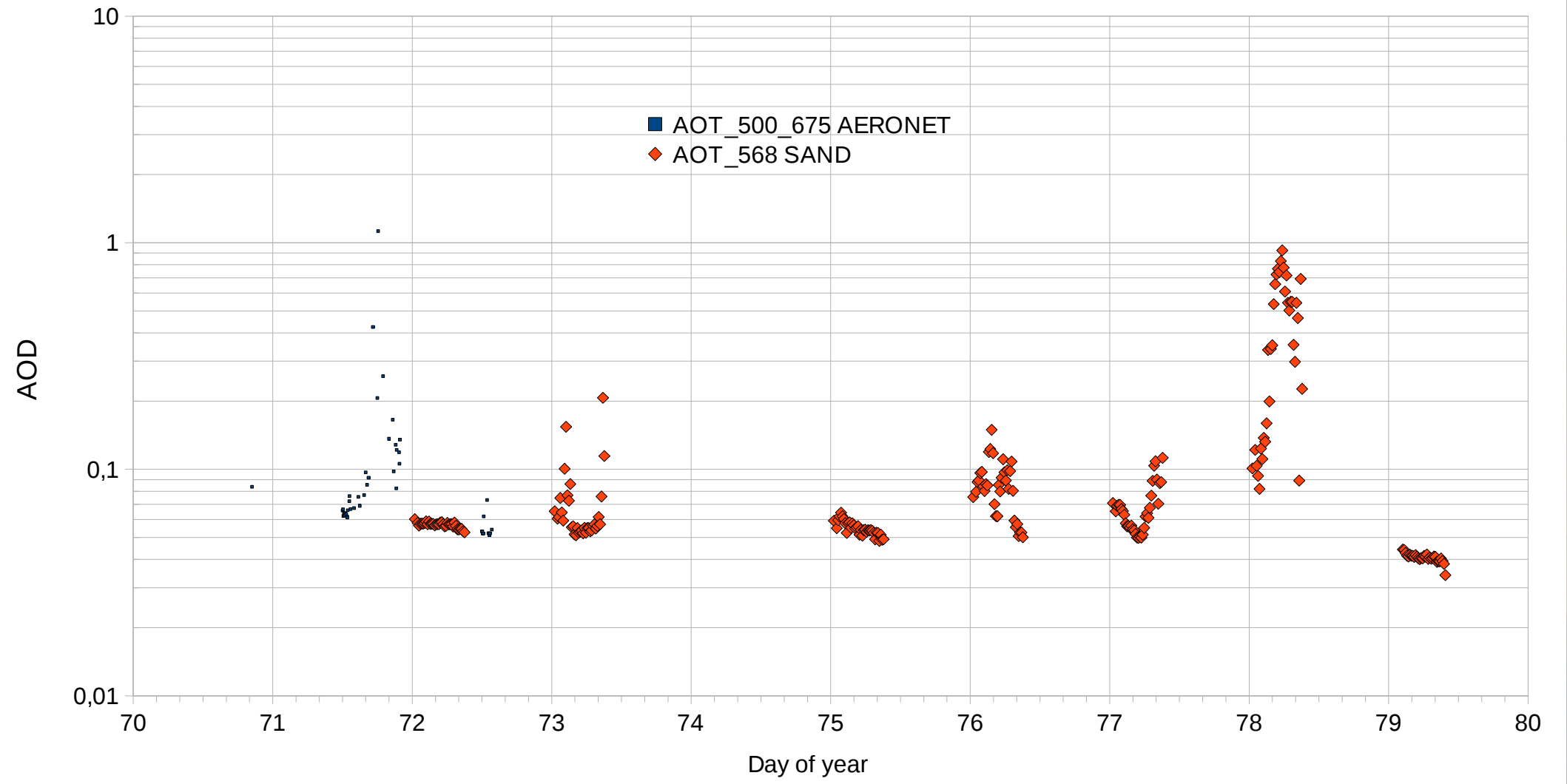

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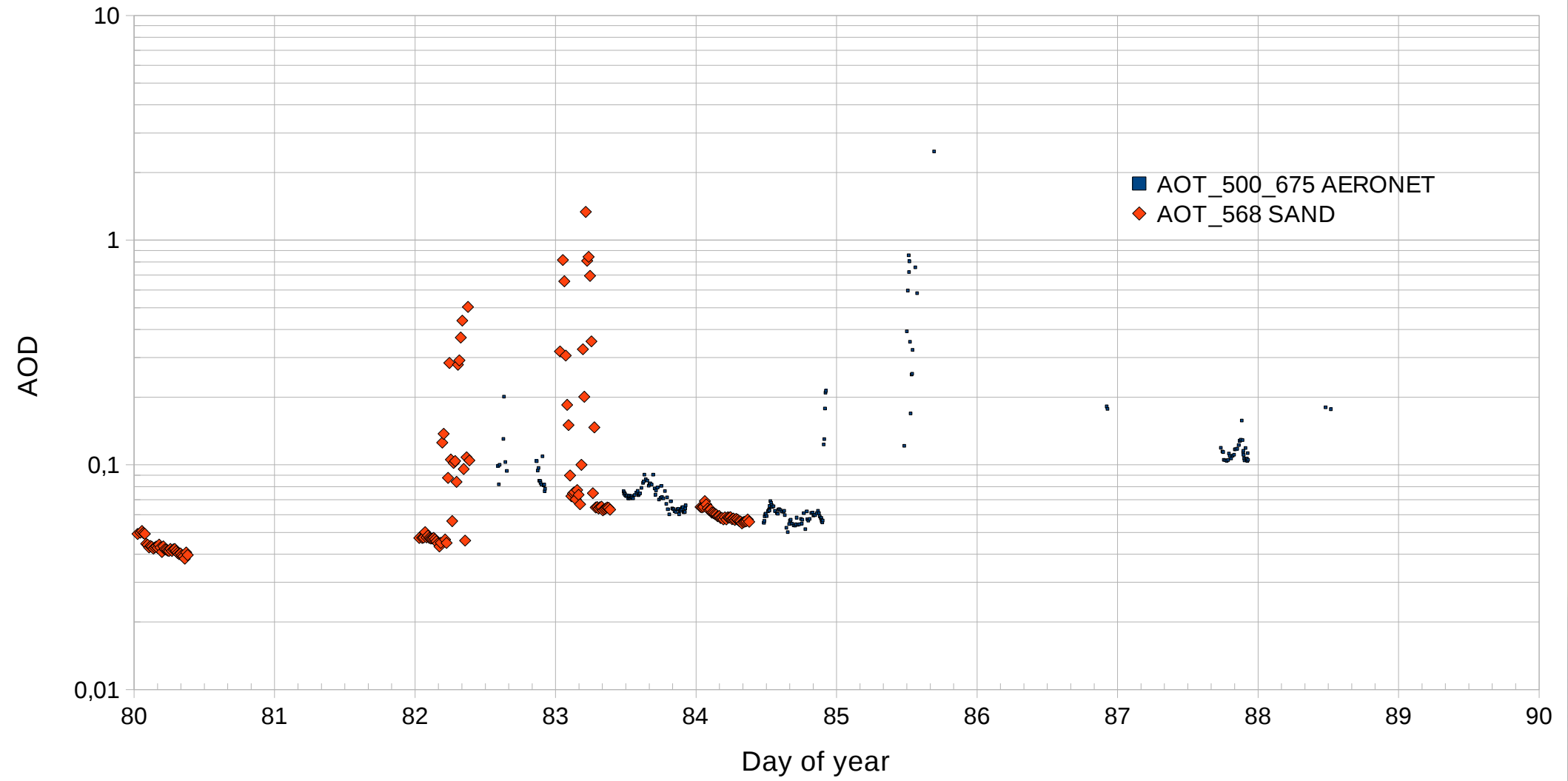

Ongoing and future works

- **Perform more AERONET – SAND comparison – validation Especially for AOD > 0.1**
- **Explore the effect of ground reflectance on this relationship Particularly the winter/summer difference**
- **Try to find an optimal observing direction for which Sky glow is more sensitive to AOD**
- **Implement a SAND network!**