Short-term variability of extinction by broadband stellar photometry

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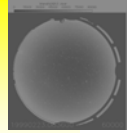
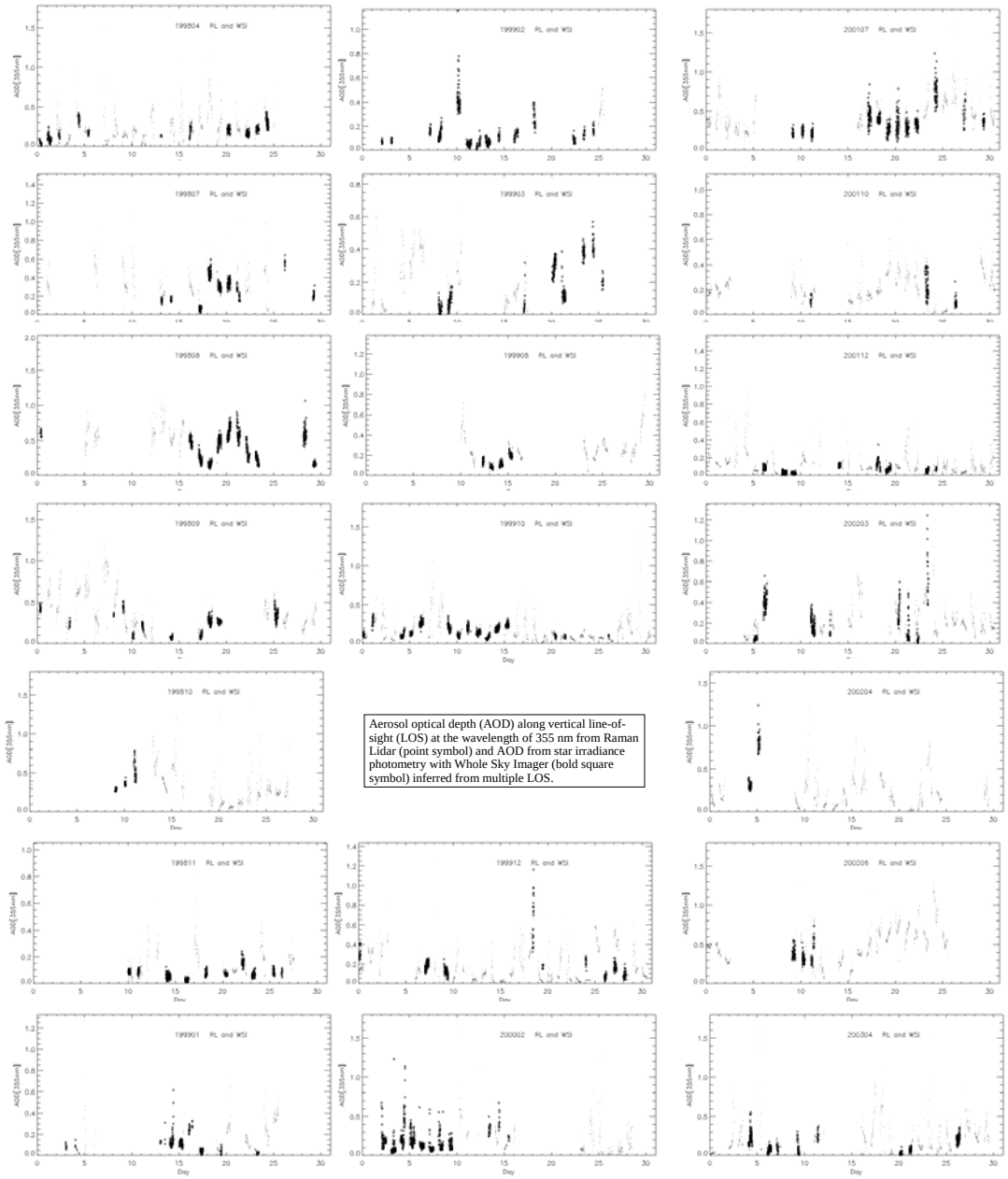


Abstract:

Aerosol optical depth over short-term intervals is determined from broadband observations of stars with a whole sky imager. The main difficulty in such measurements consists of accurately separating the star flux value from the non-stellar diffuse sky light. Using correction method to overcome this difficulty, the monochromatic extinction at the ground due to aerosols is extracted from heterochromatic measurements. A form of closure is achieved by comparison with simultaneous or temporally close measurements with other instruments, and the total error of the method, as a combination of random error of measurements and systematic error of calibration and model, is assessed as being between 2.6 and 3% rms.

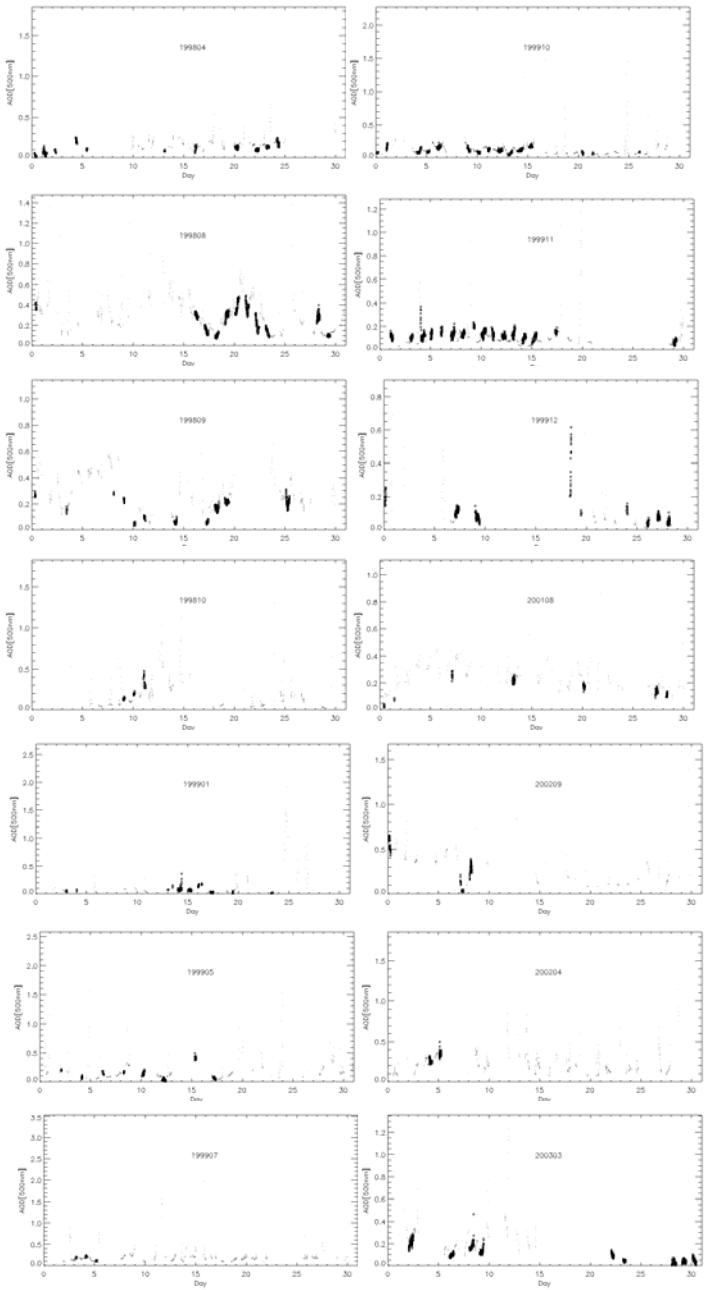
Aerosol optical depth from whole sky imager (WSI) star photometry:

- star irradiance photometry (broadband [400;900]nm) by aperture or profile fitting methods
- knowledge of spectral and luminosity classification for observed stars, and of the absolute photometry for a standard star;
- star irradiance from observations at high zenith angle: 1. correction for sky spectral brightness due to diffuse sources: airglow emission, zodiacal light and (non resolved stars')integrated starlight; 2. correction for atmospheric scattering of diffuse sources;
- removal of atmospheric gaseous absorption (LOWTRAN model): daily values for total columnar ozone, 3-horar values for total columnar precipitable water vapor and the climatologic concentration values for other ten molecular species.



Aerosol optical depth (AOD) along vertical line-of-sight (LOS) at the wavelength of 355 nm from Raman Lidar (point symbol) and AOD from star irradiance photometry with Whole Sky Imager (bold square symbol) inferred from multiple LOS.

Aerosol optical depth (AOD) during day time at the wavelength of 500 nm from Cimel sun photometer (point symbol) and AOD during night time from star irradiance photometry with Whole Sky Imager (bold square symbol):



Conclusion:

A statistically computed spatial coherence distance of 200 km for aerosol airmass was proposed (Anderson et al, 2003). When a 5 km height aerosol layer is observed by the WSI, the range on the layer measures at most 180 km from horizon to horizon, i.e. all lines of sight for aerosol layer are within the coherence limit. Thus, vertical and oblique lines of sight are conducive to same aerosol optical depth values.