REGIONAL AND LONG RANGE TRANSPORTED AEROSOLS DETECTED WITH A RAMAN LIDAR AND FILTER RADIOMETER MEASUREMENTS

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ABSTRACT

A Raman lidar system performed routine measurements of suspended aerosols particles in the Planetary Boundary Layer and the free troposphere (0-5 km) over Thessaloniki (40.5°N, 22.9°E) in the frame of the EU funded EARLINET project, since mid-2000. The measurement of the elastic-backscatter signal at 355 nm and of the nitrogen Raman (inelastic)-backscatter signal at 387 nm permits the determination of the extinction and backscatter coefficients independently of each other and, thus, of the extinction-to-backscatter ratio (lidar ratio). In certain cases the measured aerosol extinction and lidar ratio profiles, along with trajectory analysis, illustrate events with distinct aerosol layers above the mixing height, which possibly originate from the North Sea, Bulgaria, Sahara, or NW Greece. In addition, measurements of the aerosol optical depth at 4 wavelengths in the visible part of the spectrum and the corresponding Angstrom exponent were measured at Thessaloniki and at a rural site 100 km west of the city using a multi filter shadow band radiometer. The comparison of the measurements of the two radiometers distinguishes between events when regional or long-range transport of aerosols might have occurred and events of local pollution.

Figure 1. Sectors used for the analysis of lidar data

INSTRUMENTATION

The lidar system of the Laboratory of Atmospheric Physics (LAP) was designed to perform continuous measurements of suspended aerosols particles in the Planetary Boundary Layer and the lower free troposphere (Balis et al, 2000, Papayannis and Balis 1998). It is based on the second and third harmonic frequency of a compact, pulsed Nd:YAG laser. Using the methodology proposed by Ansmann et al. (1992) the measurement of the elastic-backscatter signal at 355 nm and of the nitrogen inelastic-backscatter signal at 387 nm permits the determination of the extinction and backscatter coefficients independently of each other and, thus, of the extinction-to-backscatter ratio often called as lidar ratio (LR). The height profile of the particle backscatter coefficient at 355 nm is determined from the ratio of the elastic to the inelastic nitrogen Raman signal and the extinction-to-backscatter ratio is then, calculated. The lidar system of LAP and the algorithms implemented were successfully intercompared with the other EARLINET groups (Matthias et al., 2002). In Thessaloniki near the lidar system and in the small town of Ouranoupolis, 100km south west of Thessaloniki, two multifilter rotating shadow band radiometer (MFR) (MFRSR-7, Yankee Environmental Systems, Turner Falls, Massachusetts) were used to measure the global (E_t) and diffuse (E_d) solar irradiance (1 min average) over five narrowband channels (415, 501, 615, 675, and 868 nm, 10 nm full width at half maximum (FWHM)) and one broadband channel (300–1100 nm)

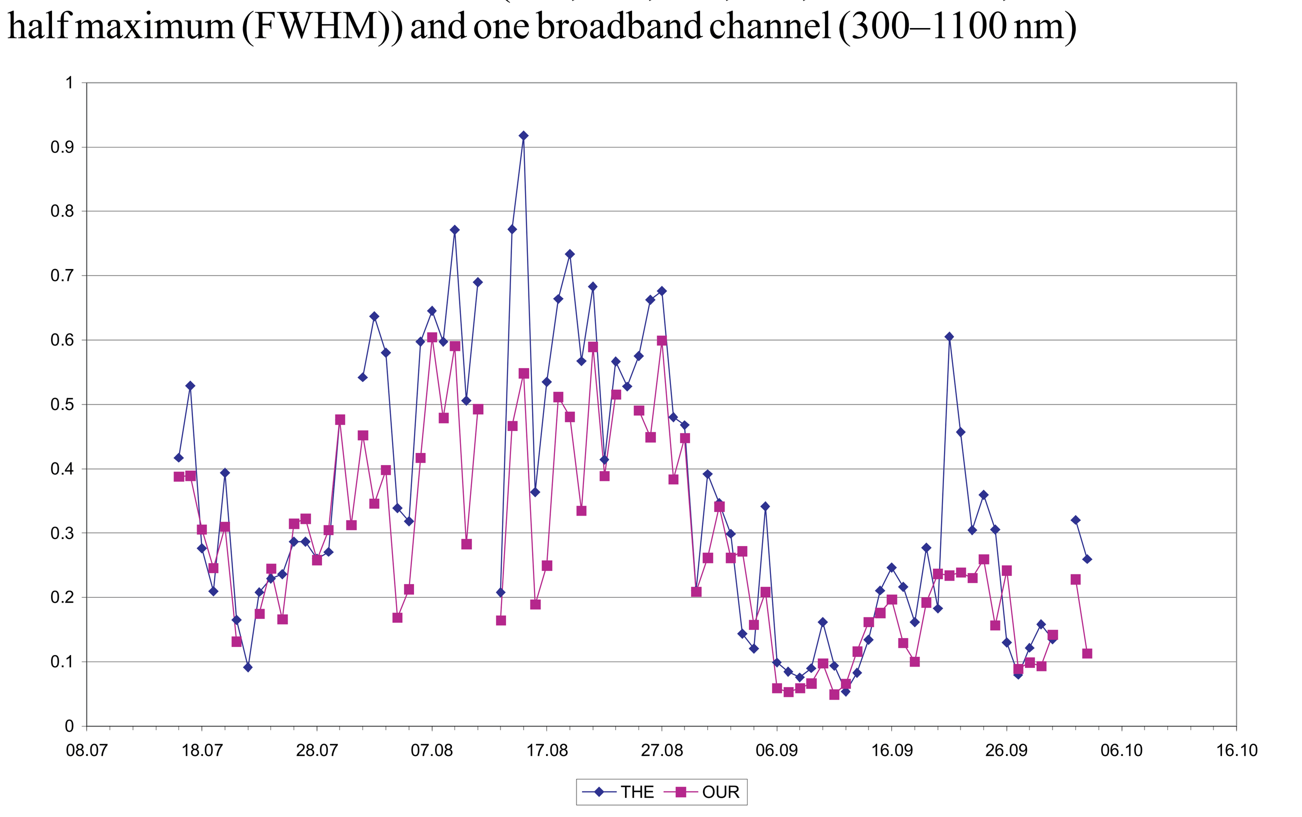
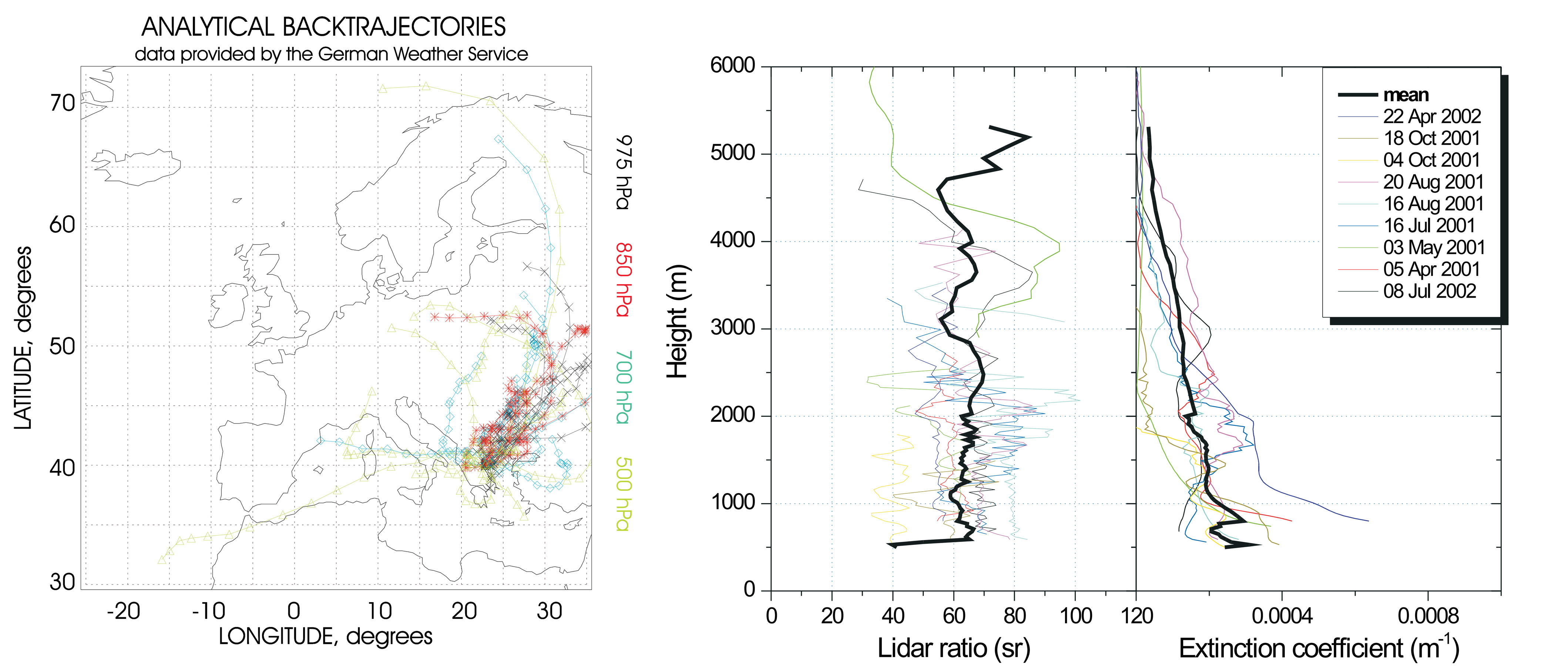
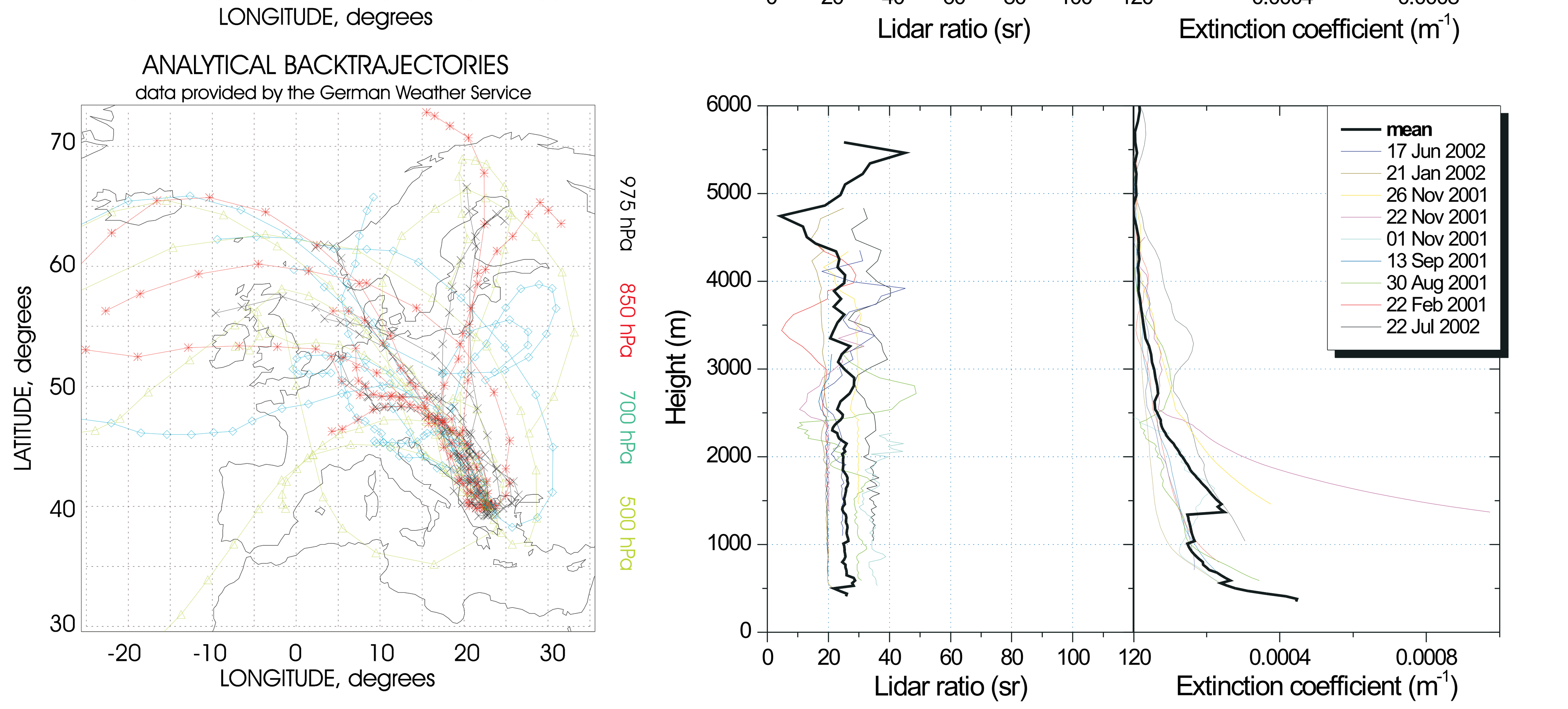
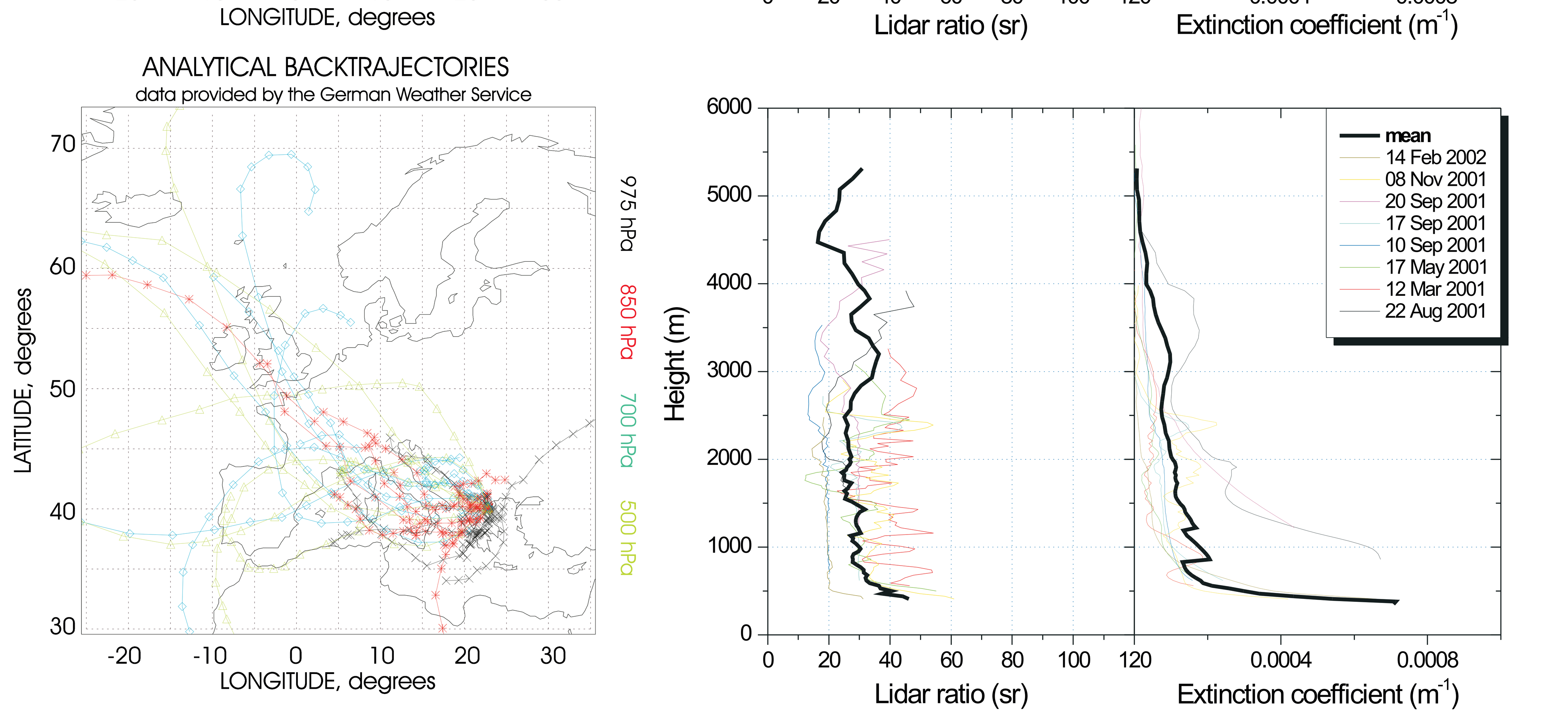
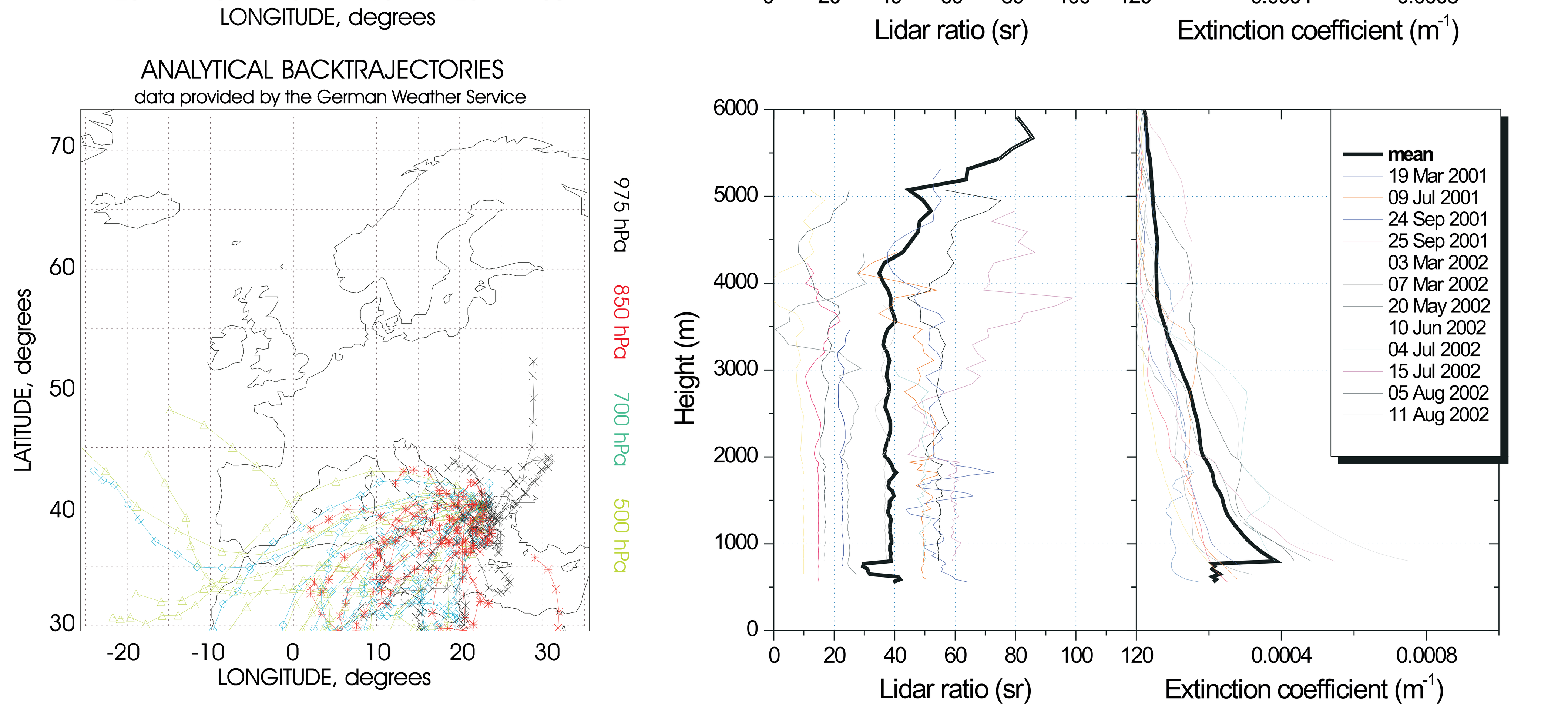


Figure 2. Aerosol optical depth at Thessaloniki and Ouranoupolis at 416 nm with a multi filter shadow band radiometer









CONCLUSIONS

- **North east directions showed transport of aerosols with lidar ratios between 40 and 80 sr.** In the case of Thessaloniki station, the NE flow transports air masses from regions with significant lignite-burning emissions (Bulgaria, Romania and former Yugoslavia). During summer 2001 several cases of aerosols from biomass-burning were also observed, originating from these regions. Maritime aerosols are also transported to Thessaloniki from Black Sea region. This maritime background is thought to be responsible for lower lidar ratios. Rare cases with small lidar ratio around 30sr were observed which corresponded with transport from Barents Sea.
- **Low values for the lidar ratio between 20 and 40 sr were found for the case of west and north-west winds.** Trajectories from northwest indicate the presence of anthropogenic particles. However air masses coming from these directions are heavily influenced from maritime aerosols from the North Atlantic.
- **Desert particles show lidar ratios between 10 and 80sr.** Possible reasons for the wide range of the lidar ratio values observed are the dependence of size distribution of dust particles on the wind velocity, the enhanced light absorption of particles in the UV and its sensitivity to large and potentially non-spherical particles.
- **Comparison of aerosol optical depth measurements between an urban (Thessaloniki) and a rural site (Ouranoupoli) show similar day-to-day variability but also help in distinguishing the contribution of local pollution in the total aerosol loading.**

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