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Long-term trend analysis of aerosol parameters at the Jungfraujoch

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Continuous measurements of aerosol parameters have been performed since 1995 at the high alpine research station Jungfraujoch (JFJ) situated at 3580 m asl, so that a first long-term trend analysis can be performed on this 10-year dataset. The JFJ is prevalently situated in the free troposphere, but is often influenced by thermal convection of planetary boundary layer (PBL) air during warm months. Consequently all measured aerosol parameters show a clear annual cycle with maximum values between June and August and minimum values in December-January.

Since the aerosol parameters are approximately lognormal distributed, a non-parametric test, the seasonal Kendall test, and a non-parametric slope estimator, the Sen's slope estimator, were applied to detect the long-term trends and their magnitudes for each month and for meteorological seasons. The global trend was estimated by a least-mean square fit of the data and the number of years necessary to detect the estimated trend was also calculated. With these statistical tools, a global image of the aerosol long-term variability can be obtained for the lower free troposphere.

The most significant trend is the increase (2-4% per year) of the aerosol light scattering coefficients at 450, 550 and 700 nm during the September to December period. The backscattering and absorption coefficients, and to a lesser extent the condensation nuclei concentration, also have significant positive trends in autumn. This autumn increase can be explained by a greater background aerosol load, which relates to long-range transport of air masses, and can be compared to the similar increase of background ozone concentration in autumn and winter at high elevation sites (Or-

dòñez et al., 2006). In general, the summer months, which are strongly influenced by the PBL, do not show any significant long-term trend. It seems therefore that the measured decrease of anthropogenic aerosol emissions in Europe is not yet perceptible in the summer mixed air masses found at the JFJ in summer. The backscattering fraction (backscattering coefficient/scattering coefficient) shows a significant negative trend for all the months except for July and August. Since a lower backscattering fractions indicate a smaller particle size, its decrease is a clear sign of a greater impact of the polluted air masses at the JFJ during the whole transition period from a PBL influenced period to FT conditions.

Most of the described trends are significant at 95% confidence level for both statistical methods. The number of years necessary to detect the estimated trend is usually found to be as long as or smaller than the measurement periods. We can therefore conclude that, due to the large magnitude of the detected long-term trends, our dataset is long enough to estimate the aerosol variability in the lower free troposphere.

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