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SHORT CONTRIBUTION

Total ozone on a European clear day

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ABSTRACT

Recent simultaneous measurements of total ozone made from two observatories only 10 km apart but with an altitude difference of 2.2 km on an apparently clear day are reported. A systematic difference of about 5% lower total ozone was observed from the mountain station and this is not simply attributable to the ozone found in the column between the two stations.

Lovill et al. (1978) recently showed that a statistically significant amount, namely 6.5%, less total ozone was observed from satellite retrieval measurements than measured by the ground based total ozone network. The purpose of this note is not to discuss a similar difference observed between total ozone amounts measured with the Dobson spectrophotometer and the New Zealand filter photometer (Matthews et al., 1974) as these have been mentioned in intercomparison data published elsewhere (Basher, 1978; Müller and Reiter, 1980). What is presented in this paper are recent data obtained during particularly stable conditions with two filter photometers, where after several days of simultaneous measurements at the Institute for Atmospheric Environmental Research at Garmisch Partenkirchen (altitude 740 m) one instrument was taken 10 kms away, up onto the summit of the Zugspitze (altitude 2963 m) where these simultaneous measurements were continued.

The raw data from the 9 April 1979 from one instrument are presented in Fig. 1 as a function of airmass representing 10 hours of measurement. The extreme linearity of these data gives a measure of the stability of the ozone column during the measurement period. Such a day or, even better, series of days come far too seldom as all users of the differential absorption technique are aware as such days can be used to calibrate an absorption spectrometer. Indeed, 9 April and 10 April were such days and this was confirmed by the Dobson data from Hohenpeissenberg 35 kms N and Arosa 140 kms SW (private communications) listed for comparison in Table 1.

The corresponding column abundances for Monday 9 April and the morning of 10 April are plotted as a function of time and are given in Fig. 2 where the expected constancy is displayed. In the afternoon of the 10 April measurements were made with one instrument from the Zugspitze while the other instrument continued to measure at Garmisch Partenkirchen a continuation of the constant value seen in the morning. The total ozone values measured by the second instrument, in the morning at Garmisch Partenkirchen, and in the afternoon on the Zugspitze are shown in Fig. 3. The important feature of these data is the 5% decrease in total ozone measured by lifting the observing platform by 2.2 kms. The airmass values pertaining specifically to each observatory have been used in these data evaluations. Tropospheric ozone concentrations monitored continuously over this period at the Zugspitze observatory and the I.A.E.R. gave an average concentration of 41 ppb which is typical for this time of the year (Fabian and Pruchniewicz, 1978). This concentration,

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Table. 1. *Daily average total ozone values for the days 9 and 10 April 1979 from three observatories. Arosa and Hohenpeissenberg data from Dobson spectrophotometers and Garmisch-Partenkirchen data from New Zealand filter photometers.*

Observatories:	Garmisch-Partenkirchen	Hohenpeissenberg	Arosa	
			D15	D101
Date	Total ozone [m. atm. cm]—(wavelength pair)			
9 April	379 (AD)	381	383	381
		387 (C)	379	374
10 April	372 (AD)	383	373	369
		388 (C)	372	368

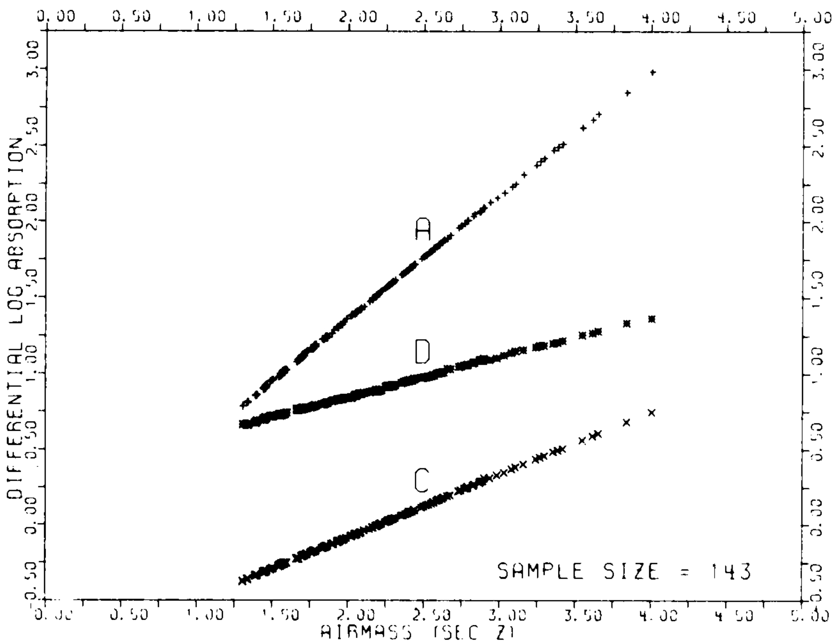

Fig. 1. Log intensity ratios versus airmass from New Zealand filter photometer on 9 April at Garmisch-Partenkrichen. A, C and D refer to standard wavelength pairs. Linearity gives a measure of the constancy of the ozone column abundance for the 10 hours of measurement.

integrated into a column the depth of which is the altitude difference of the two observatories, can be used to account for about 9 m. atm. cm of this 17 m. atm. cm difference. Lidar data of the scattering due to aerosols in the lower troposphere made on 10 April at Garmisch are presented in Fig. 4. This unaccounted-for difference must at least in part be attributed to the particulate scattering that one observes in the lidar data. Basher (1976) discussed how this particulate scattering effects the absolute value of total ozone, and Kulkarni (1973) attributes, in some trend analysis over several years, part of the observed change in total ozone to changes in haze. It must be emphasized however that the data set discussed here were made simultaneously in time and virtually from the same

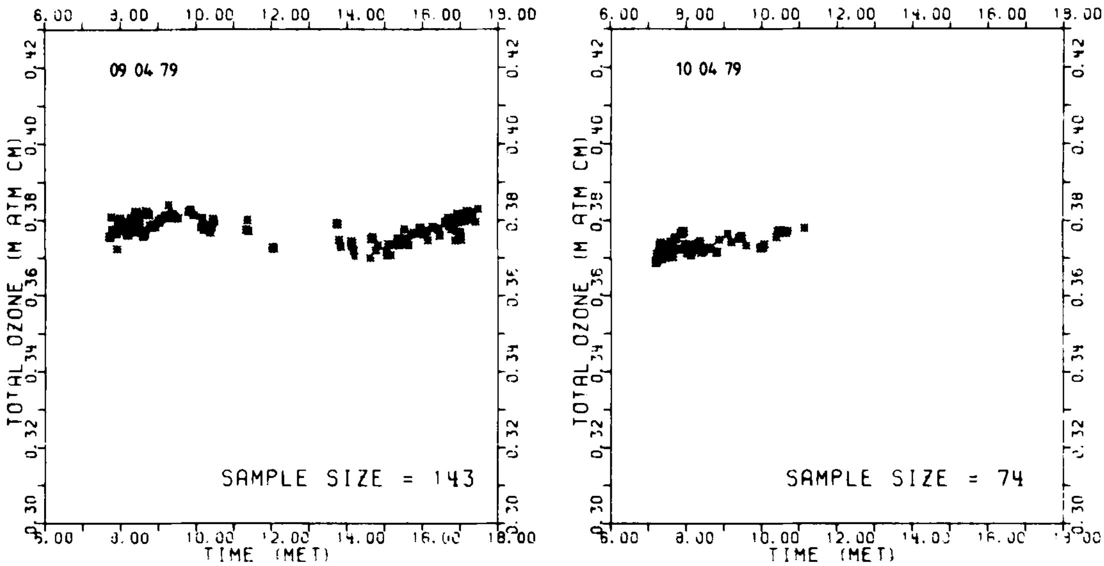

Fig. 2. Total ozone in (m. atm. cm) as a function of time at Garmisch-Partenkirchen on 9 and 10 April 1979.

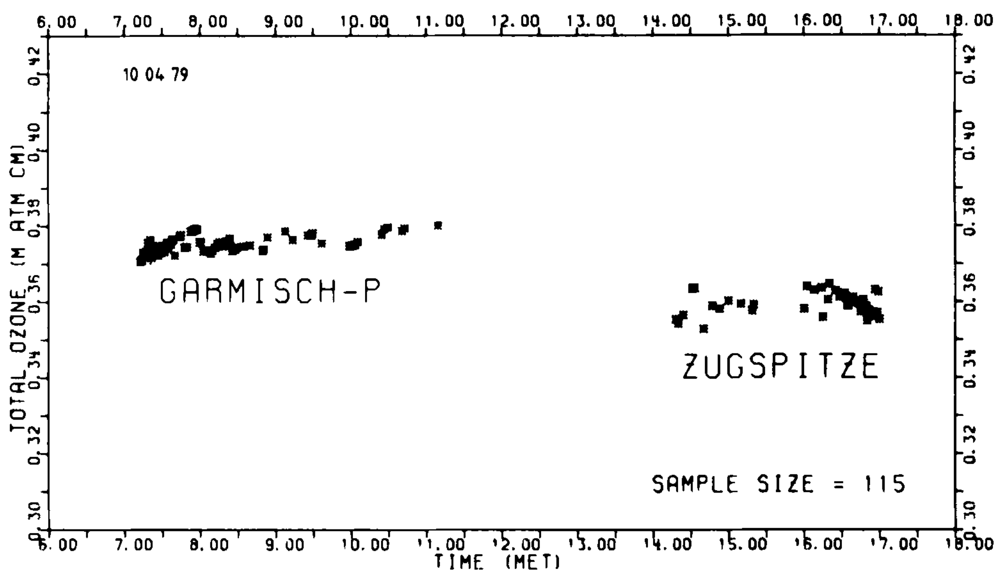

Fig. 3. Total ozone as a function of time on 10 April 1979 measured with the same instrument at Garmisch-Partenkirchen in the morning and on the Zugspitze in the afternoon.

geographic location, the only difference being in the altitude of the observing stations. Also, on both of these days, clear, apparently blue skies prevailed during the observing period. The interpretation of the difference between ground based data and satellite data is therefore difficult at least from European, North American and Japanese stations. This study suggests that part of the difference must be attributed to aerosol scattering and one could attribute the rest to the ozone absorption coefficients. How one apportions this division is, however, not clear.

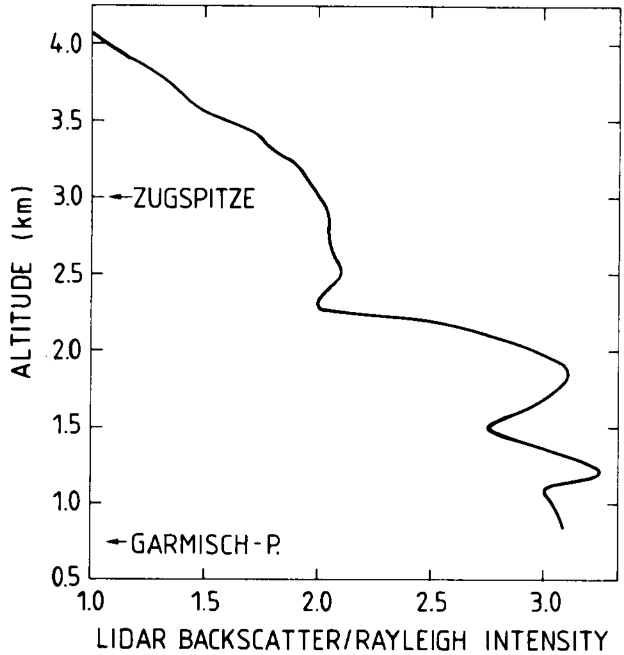

Fig. 4. Average ratio of backscattered 694 n.m. lidar intensity to Rayleigh scattering intensity as a function of altitude from Garmisch-Partenkirchen on the afternoon of 10 April.

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