

The Intercomparison of Brewer and Dobson Spectrophotometers Total Ozone Measurements at the Marambio Base, Antarctica



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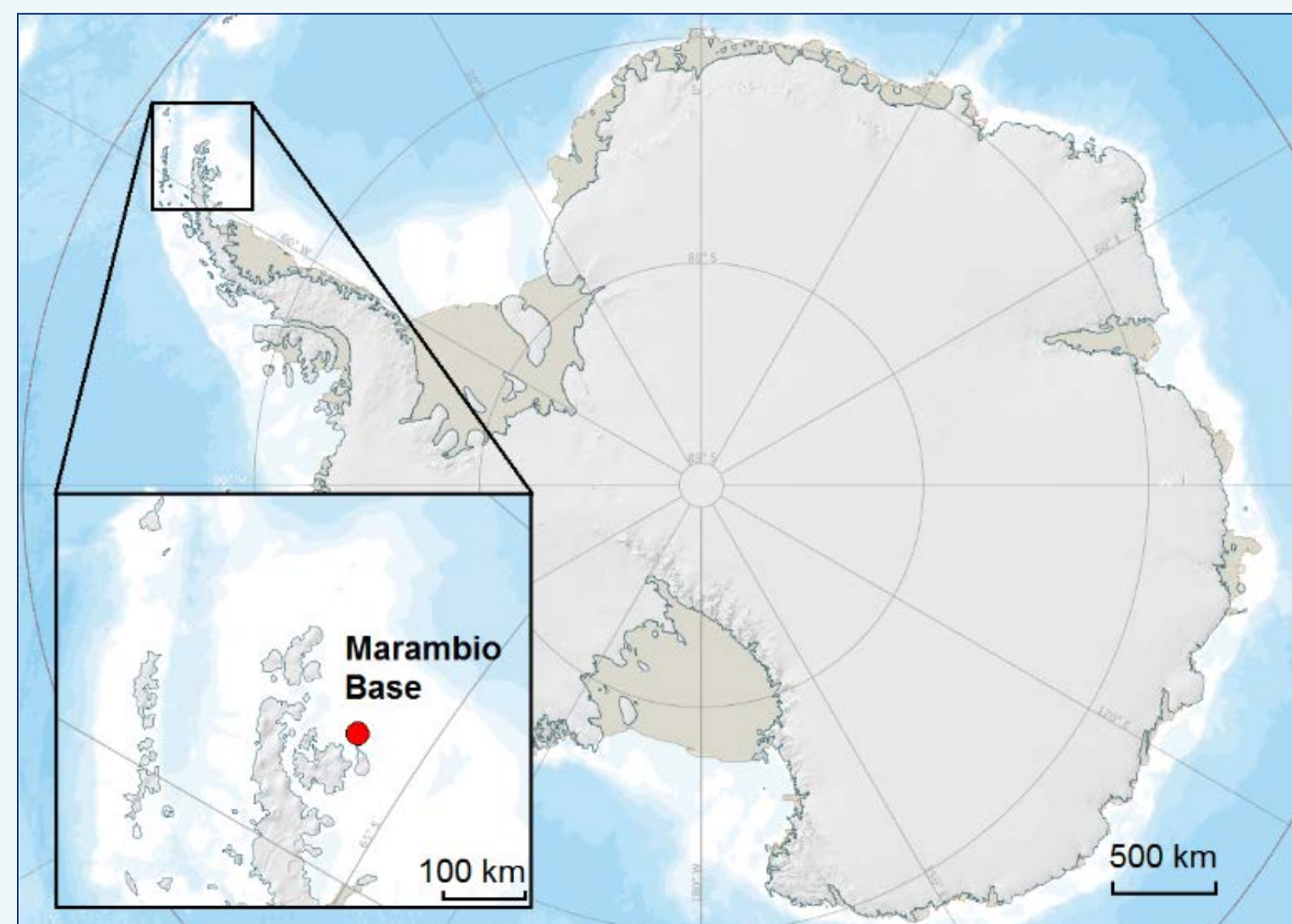


Fig. 1. The localization of the Marambio Base, Eastern Antarctic Peninsula.

Study Site

The Marambio Base is located at the Seymour Island, Graham Land, Antarctic Peninsula Region (64.241°S, 56.624°W, Fig. 1). It is a permanent Argentine research station that was founded in 1969. At the Marambio Base, various scientific activities are carried on, including stratospheric ozone monitoring and atmosphere radio-sounding.

Data and Methods

The data were collected by two collocated high-quality total ozone monitoring instruments:

Brewer spectrophotometer MkIII B199

This instrument was installed in 2010 and it is operated by the Czech Hydrometeorological Institute.

Dobson spectrophotometer D099

The Dobson spectrophotometer was installed in 1987 and it is operated by the National Meteorological Service of Argentina.

Due to the solar zenith angle, both instruments can only make observations since mid-August to the end of April. For the intercomparison, daily mean total ozone was used. Between January 2011 and December 2013, there were in total 577 days for which there existed valid data. For each day, a Brewer/Dobson ratio was calculated (BRE/DOB).

Both instruments allow making Direct Sun (DS) and Zenith Sky (ZS) observations, which were, together with daily mean total ozone column, number of observations and their standard deviation, taken in account when performing the intercomparison.

In order to assess the differences between daily mean total ozone column obtained by the Brewer and Dobson spectrophotometers, basic statistical methods (t-test, Spearman correlation, Kruskal-Wallis non-parametric ANOVA) were used.

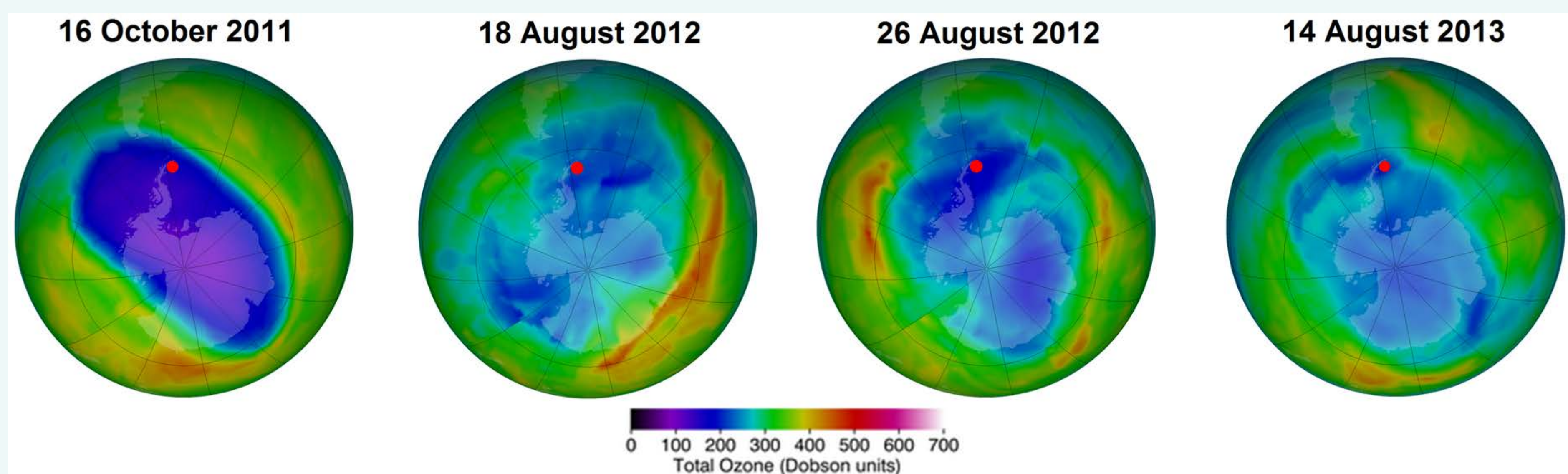


Fig. 5. Total ozone over the South Pole in four days with the most extreme BRE/DOB ratio, the red dot marks the location of the Marambio Base. The table above the figure gives the BRE/DOB ratio and other relevant characteristics for corresponding days. It can be seen that in these days, the total ozone was changeable and that the Brewer spectrophotometer performed Direct Sun observations, whereas the Dobson Spectrophotometer measured Zenith Sky. Therefore, depending on the type of measurement, the difference of observed total ozone column may exceed 30%.

Acknowledgement

The research was supported by the project of the Czech Hydrometeorological Institute No. 03461022 'Monitoring of the ozone layer and UV radiation in Antarctica', which is funded by the State Environmental Fund of the Czech Republic, by the project of Masaryk University MUNI/A/1315/2015 'Integrated research of environmental changes in the landscape sphere' and by the project LM2015078 'Czech Polar Research Infrastructure' funded by the Ministry of Education, Youth and Sports of the Czech Republic. The data used in this study were obtained from the Czech Hydrometeorological Institute, World Ozone and Ultraviolet Radiation Data Center and from the OMI instrument (NASA). The map used in Fig. 1 was adapted from British Antarctic Survey.

Introduction

There are various ways to measure total ozone, one of which is the use of spectrophotometers. At the Marambio Base, Antarctica, two different types of spectrophotometers are in operation, the Brewer and the Dobson spectrophotometers. The aim of this study is to provide a basic assessment of the instruments' observations, with regards to total ozone column, number of observations per day and the type of total ozone measurement, including the assessment of extreme values.

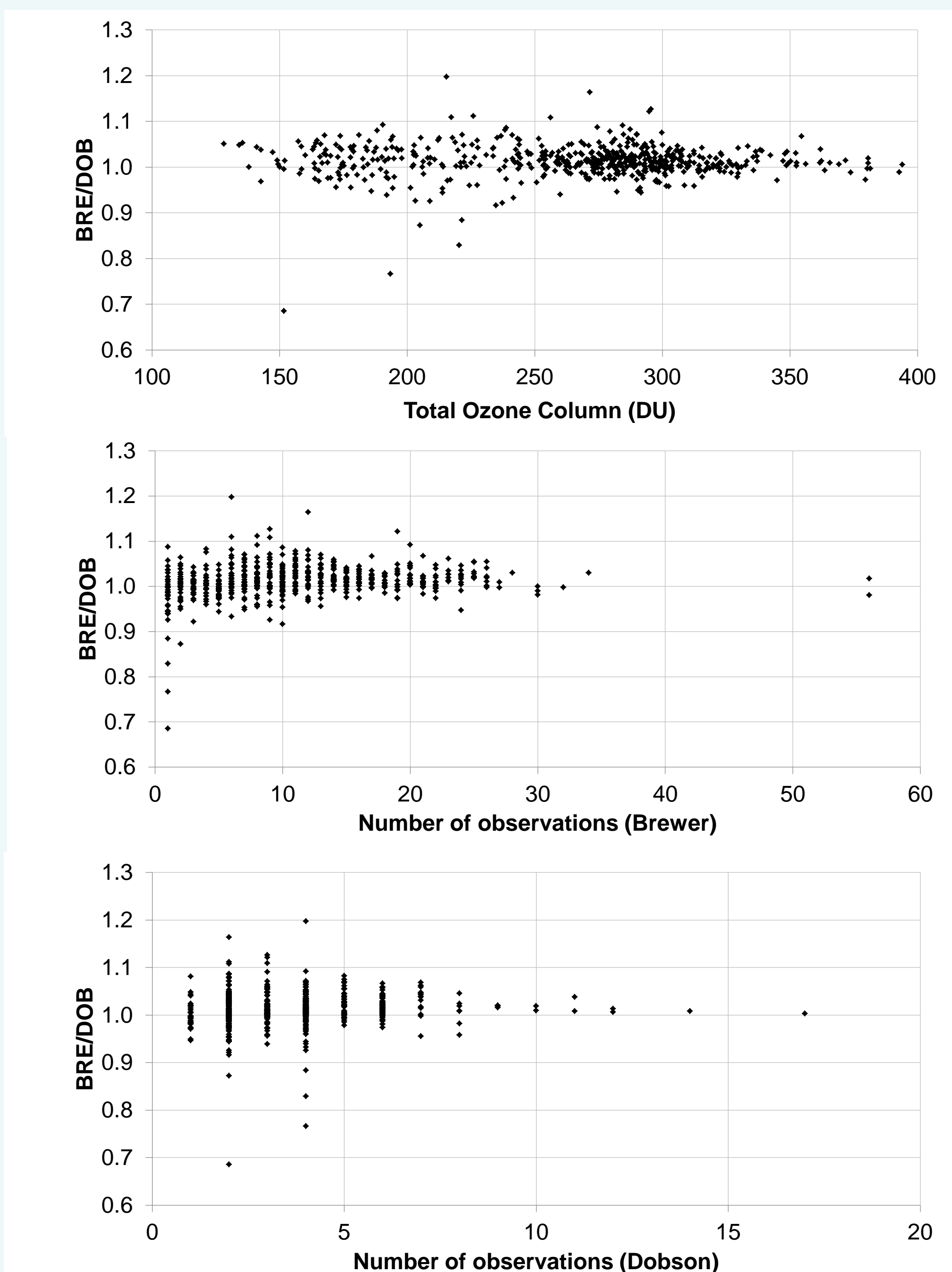


Fig. 3. The relationship between the BRE/DOB ratio and the mean daily total ozone column, the number of observations by the Brewer spectrophotometer and the number of observations by the Dobson spectrophotometer.

DATE (DMR)	16-10-2011	18-8-2012	26-8-2012	14-8-2013
BRE/DOB	0.69	0.83	0.77	1.20
Mean daily total ozone column	152	220	193	215
Number of observations (Brewer)	1	1	1	6
Number of observations (Dobson)	2	4	4	4
Type of ozone observation	B-DS;D-ZS	B-DS;D-ZS	B-DS;D-ZS	B-DS;D-ZS

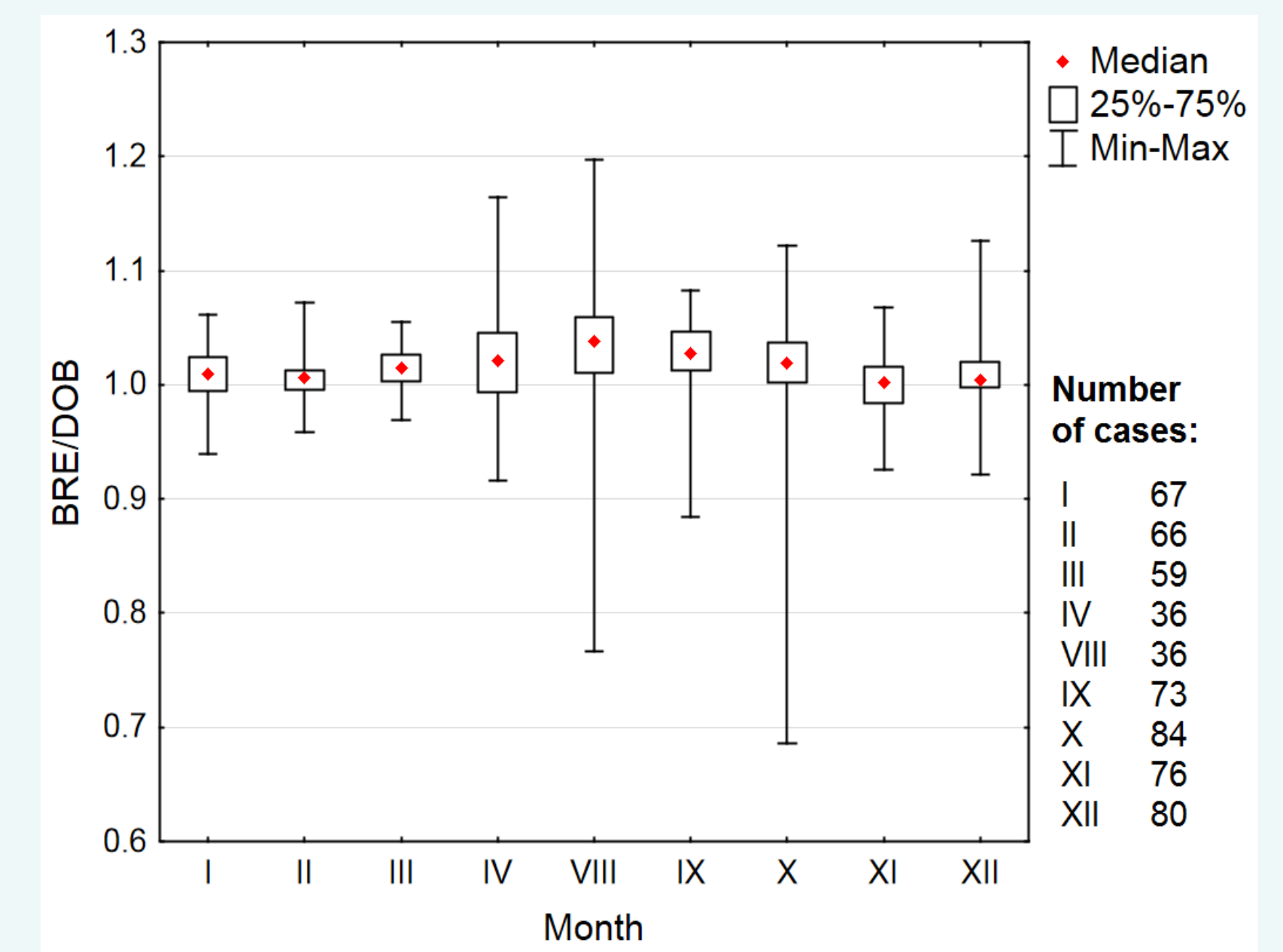


Fig. 2. Basic statistical characteristics of the BRE/DOB ratio for each month and the number of days with valid data. The very high range of the BRE/DOB ratio in October can be explained by the presence of one extremely low value (16th October 2011).

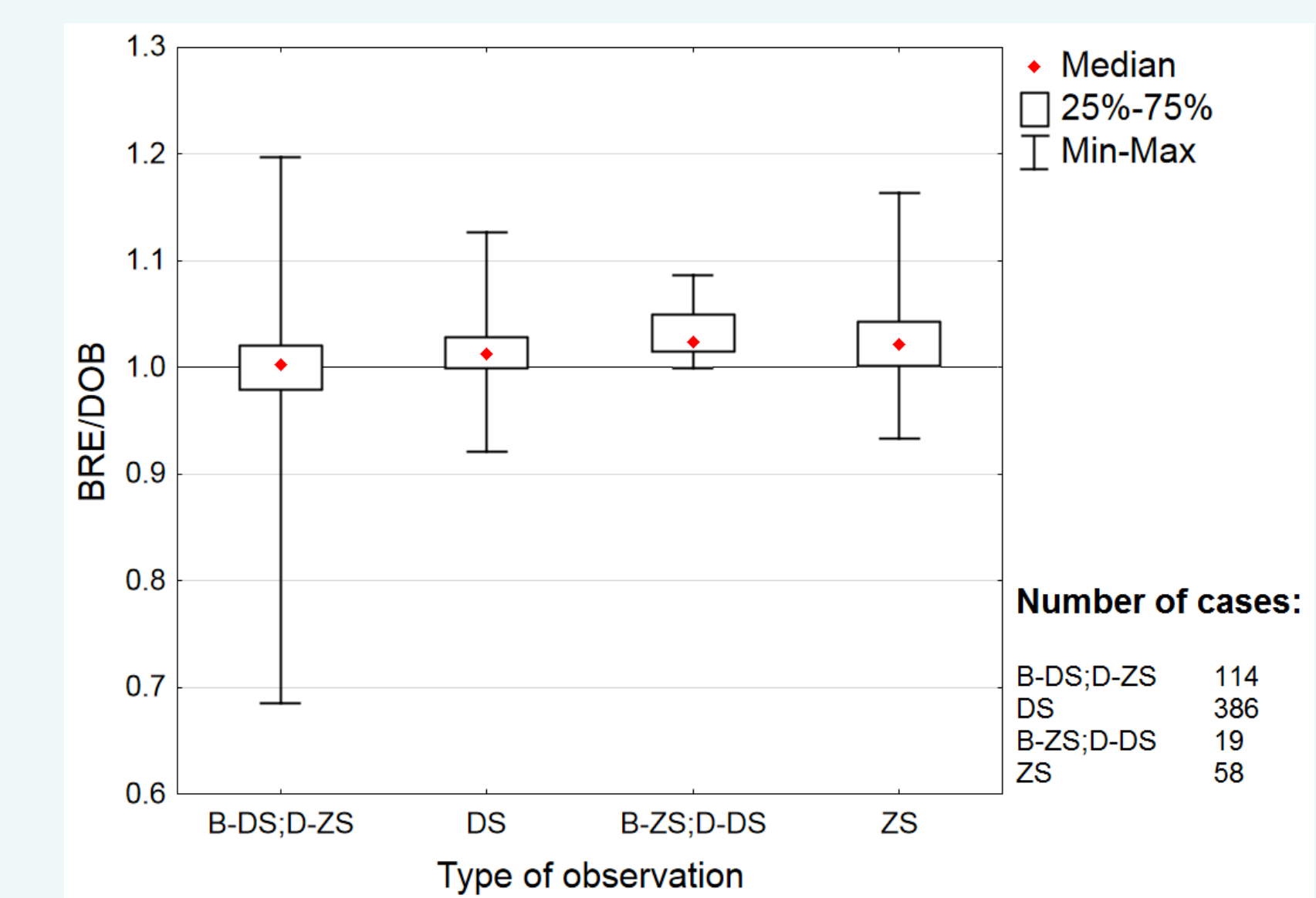


Fig. 4. Basic statistical characteristics of the BRE/DOB ratio according to the spectrophotometers' measurement types (B - Brewer, D - Dobson, DS - Direct Sun, ZS - Zenith Sky) and the number of observations in each group.

Results and Summary

- Daily mean total ozone column measured by the Brewer Spectrophotometer was in average 1.3% higher than the one measured by the Dobson spectrophotometer
- The BRE/DOB ratio was significantly (level of significance 0.05) higher than 1 in all months except XI (Fig. 2), the mean was highest in the months with lowest solar zenith angle (1.03 in VII)
- No strong relationships (correlation coefficient over 0.5) were observed between the BRE/DOB ratio and the mean total ozone column, number of observations and the standard deviation of observations
- With increasing mean total ozone column and number of observations by the Brewer and by the Dobson spectrophotometers the variability of the BRE/DOB ratio decreased (Fig. 3)
- Compared to other groups of measurement types, the BRE/DOB ratio was significantly lower when the Brewer - DS and Dobson - ZS measurement types were applied (mean = 1.0), there was also a significant difference between the DS and B-ZS;D-ZS groups (Fig. 4)
- Extreme values of the BRE/DOB ratio were observed mostly when total ozone column was low (up to 220 DU), there was a low solar zenith angle, low number of individual observations and the type of total ozone observation was B-DS;D-ZS (Fig. 3, 4 and 5)

