Determination of the total ozone column based on multi-dimensional lookup tables

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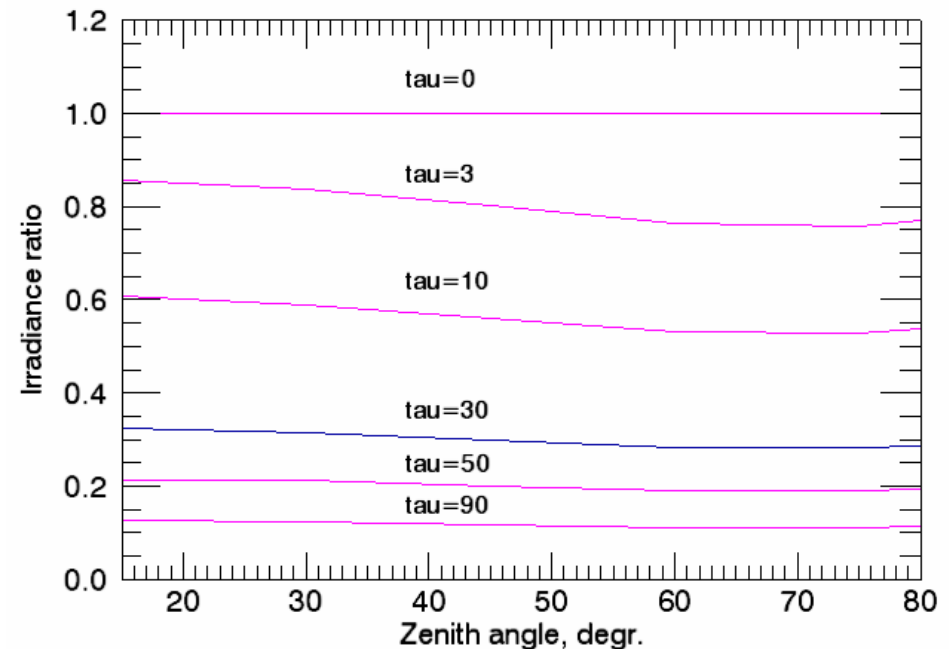[3] Polar Geophysical Institute (PGI), Apatity, Russia

Introduction

The method to retrieve TOC's using global UV irradiance measurements is based on a calculated 2D Lookup table (LUT), where the irradiance ratios are modelled as function of the zenith angle for different (TOC) (Stamnes, 1991). In a previously work the 2D LUT were calculated and the TOC were determined from irradiance ratios, whi czch were processed by data smoothing and for the ratios an upper envelope were calculated to reduced the influence of clouds on the irradiance rations. In satellite data processing widely are use LUT's for the retrieval of cloud properties and of the determination of the aerosol optical depth. Here we use a 3D LUT depending not only from zenith angle but additional from the cloud optical depth.

Main goal: The main goal of the presented here study consist by better consideration of the cloudiness to enhanced the TOC processing procedure.

1. Estimation of the cloud optical depth

The cloud optical depth (COD) is defined as ratio of the irradiance at the top of the atmosphere and the irradiance received at the Earth surface. The irradiances $I_0(\lambda,\ zenith)$ at the top of the atmosphere were estimated using the terms $(R/R_0)^2\cos(zenith)$, which were regressed against the measured irradiance at 380 nm for clear days. A LUT was calculated to found the COD for a given irradiance rations and zenith angles. As is to see in Fig.

Calculated by help of the Quick TUV program LUT for irradiance ratios at 380 nm for different COD tau and zenith angles.

the calculated irradiance rations depend only weekly from the zenith angle. Therefore we have estimated the COD tau from the irradiance ratios only by values for the zenith angle 50 deg.
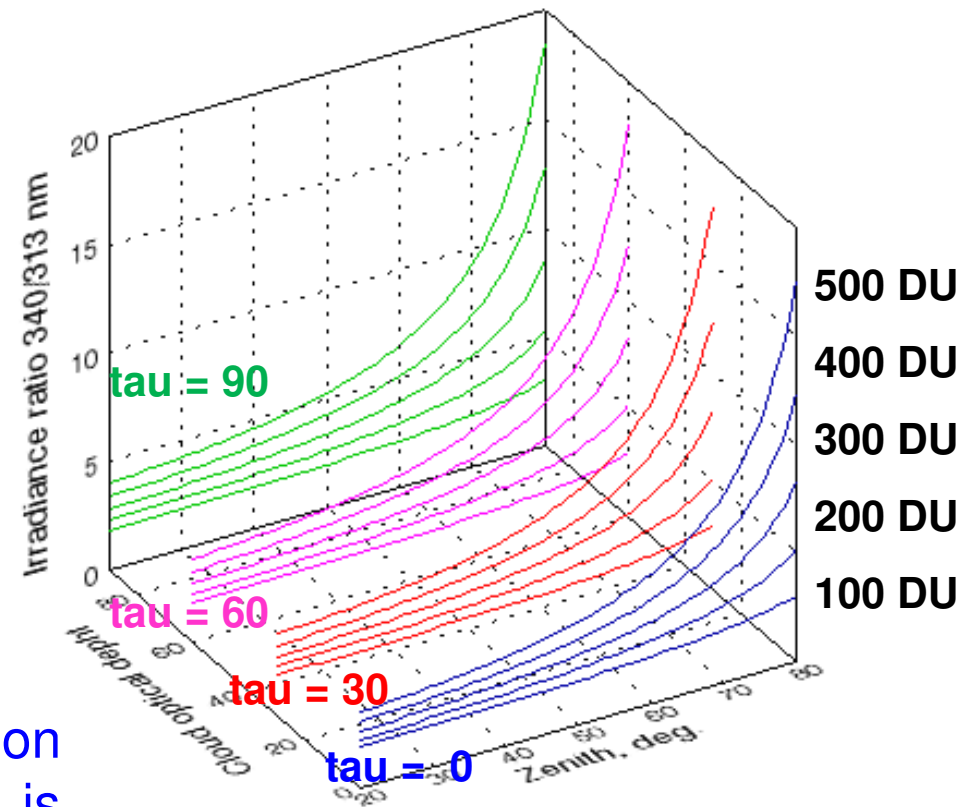
2. 3D Lookup table for the retrieval of TOC

From the observed irradiance ratios of 340 and 313 nm, estimated parameter tau and the actual zenith angle the TOC is retrieved by interpolation of the previously calculated LUT. The LUT was interpolated by cubic splines for better resolution.

The LUT for the determination of TOC is shown. The table is drawn for different values of TOC, tau and zenith angles.

Methodology of TCO determination

3D Lookup table for the retrieval of TOC

A part of the LUT for the illustration of the influence of tau on the TOC retrieval is shown. The red line displays the irradiance ratio value 3 for a zenith angle of 35 deg. The red circles marked the position for tau = 0 and tau = 90 with the TOC, which are approximately 340 DU and 300 DU correspondingly.
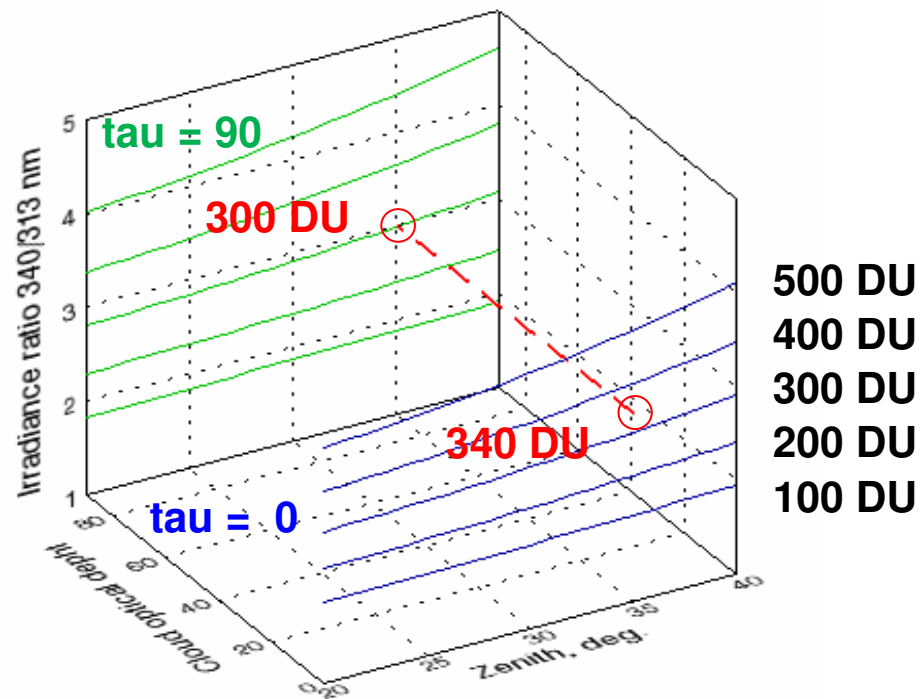
Results

The main results are shown at the following slides. The constructed TOC time series displays the typical seasonal cycle.
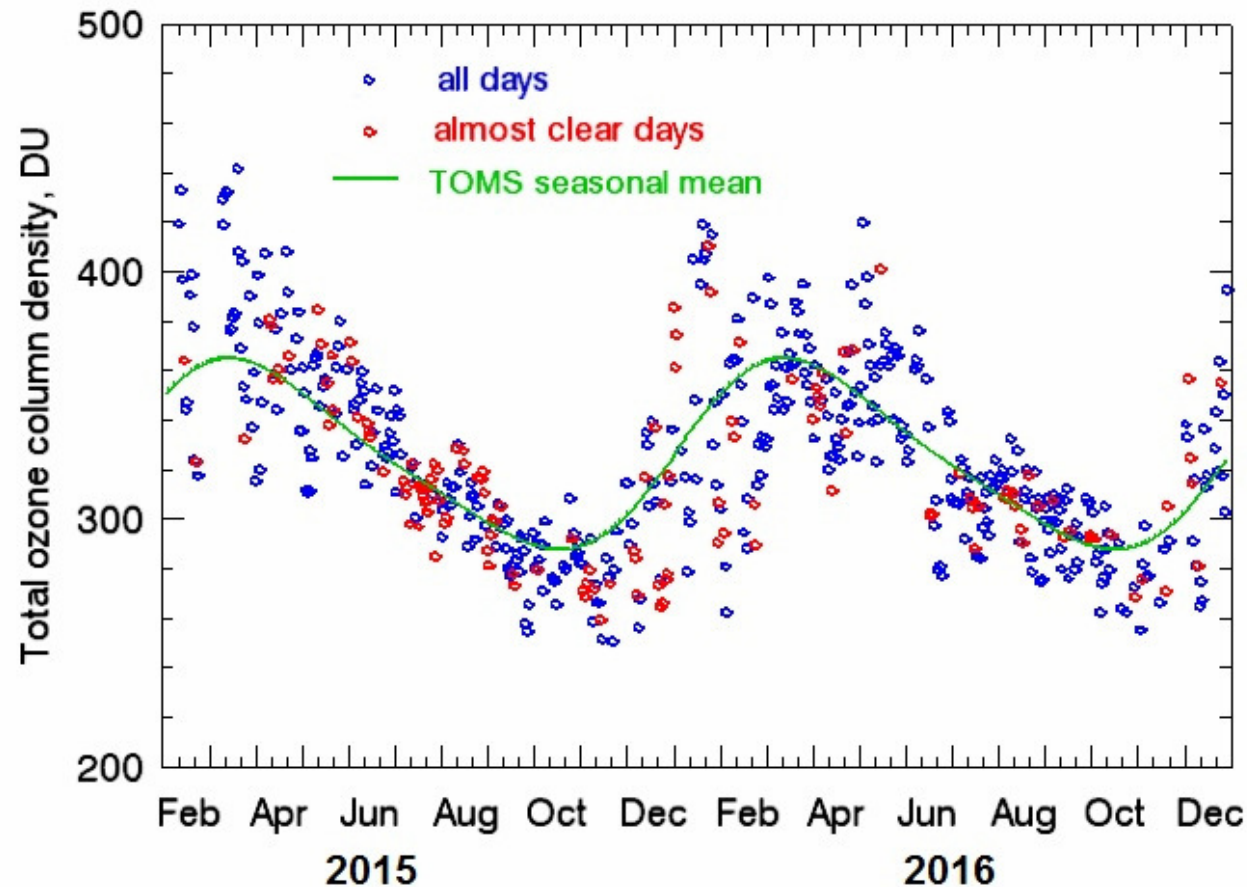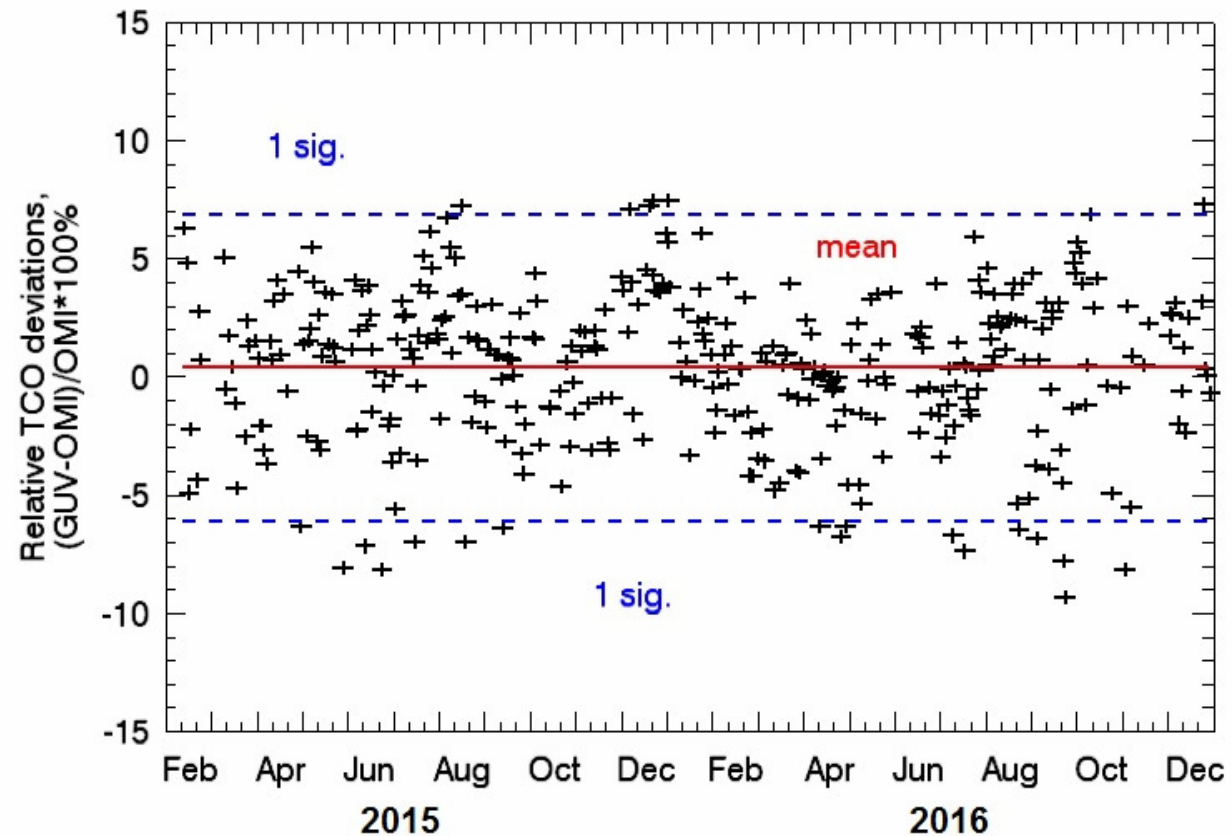

Time series of the retrieved TOC by the 3D LUT.

The 1 sig. relative deviations of the GUV and OMI TOC's are approximately 6.5%. The mean deviation is different from zero. The reason is the not exactly known position of the filter 313 nm wavelength.

Relatively devia-tions of the GUV TOC from the OMI satellite ones.

Results

The correlation coefficient of the regression of the GUV TOC against the OMI TOC both for the same days (Fig. 7) is about 0.961 and is not significantly different from the coefficient of 0.970 obtained by the 2D LUT algorithm (see the presentation http://ws-sozopol.stil.bas.bg/2016Sunny/Nessebar_Werner_3.pdf).
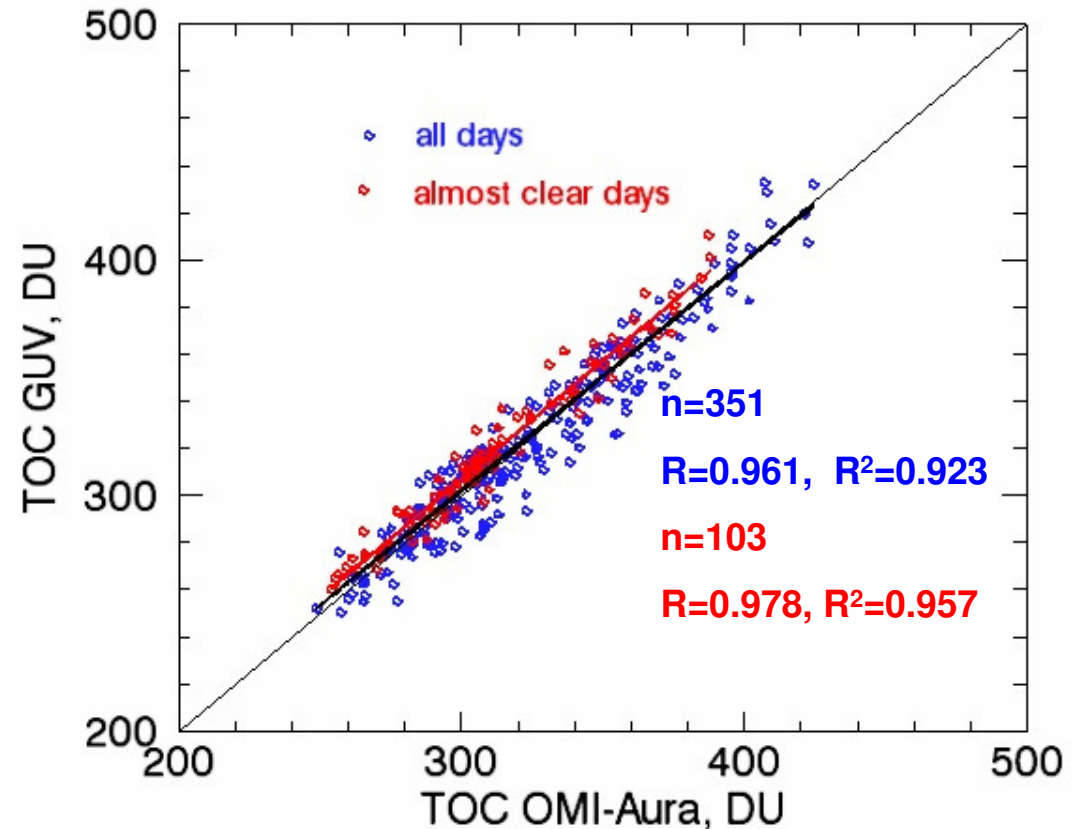
Regression of the here obtained TOC using the 3D LUT against the OMI TOC.

Results
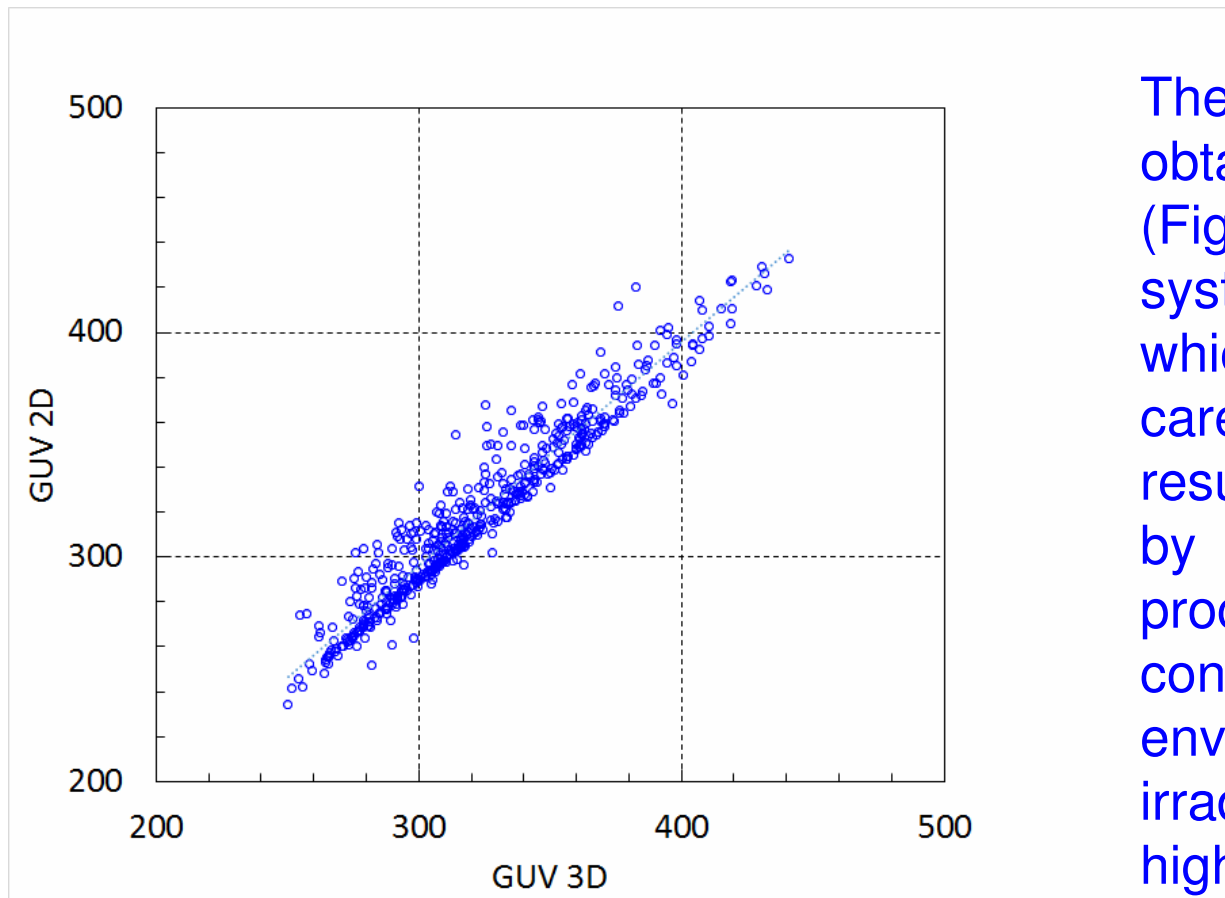
Comparison of the TOC obtained by the algorithm based on 2D LUT and the here used 3D LUT.

The plot of the TOC obtained by both algorithms (Fig. 8) indicates systematic deviations, which have to examine carefully. Probably better results would be archived by the combination of the processing algorithms – construction of a upper envelope to avoid effects of irradiance variations with high frequency and reducing of overestimations of TOC taking into account the cloud optical depth.

Conclusions and Acknowledgement

The results related to the TOC retrieval from the UV irradiance measurements obtained by the algorithm presented here and by the algorithm describe in a previously work are in good agreement. Neither of this is better. More detailed analyses are necessary to improve the quality of the TCO data.

Thank you

for

your attention