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Optical characterization of three Reference Dobsons in the ATMOZ Project– Verification of Prof. Dobson’s Original Specifications

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The Dobson spectrophotometer was developed by Prof. G.M.B. Dobson in Oxford 90 years ago for measuring the thickness of the ozone layer (Total Ozone Column TOC). As many as 100 instruments have been used in a global network since 1926 to monitor the ozone layer.

The instrument measures the relation of solar radiation intensities between defined wavelength pairs in the 300-340 nm range. To calculate TOC from the measurements on sunlight, laboratory derived ozone cross-sections are combined (convolution) with the instrument slit (transfer) functions, and extra-terrestrial constants (ETCs) derived using the Langley plot technique. The original goal was that all Dobson instruments would be aligned identically to published specifications, so all instruments have the same fixed slit functions and ETCs. As an attempt to achieve this goal, the optical alignment of all instruments have been checked and adjusted in numerous international calibration campaigns

Experience revealed this goal was not fully obtained. Thus the use of effective ozone absorption coefficients (EACs) convolving the ozone cross-section with the real slit functions should improve the Dobson data quality and its comparison with the modern Brewer spectrophotometer, where these EACs have already been applied.

With an intention of improving the TOC measurements and the consistency of data obtained by different instrument types, ENV59 ATMOZ (Traceability for the atmospheric total column ozone) project was started within the European Metrology Research Programme (EMRP) in 2014. One of the tasks in this project is dealing with the investigation of the slit functions of reference Dobsons at the Physikalisch-Technische Bundesanstalt (PTB, Braunschweig, Germany) and the Czech Metrological Institute (CMI, Prague, Czech Republic). Two Dobsons (regional reference No. 064, Germany and primary reference No. 083, NOAA/Boulder) were investigated at PTB, one instrument (regional reference No. 074, Czech Republic) at CMI.

The results are similar to the older investigations and show, that even the reference Dobsons, which belong to the group of “good = well aligned” Dobsons, do not match perfectly the handbook requirements. The application of the determined slit functions provides individual EACs for each examined Dobson. These coefficients together with the ETCs derived either using the absolute calibration (Langley Method) or the relative calibration towards the primary standard define a more realistic instrumental calibration. Additionally, the agreement with other TOC determining instruments (e.g. with reference Brewers, being similarly investigated at the Metrological Institutes), should improve. The methods of these Dobson investigations at PTB and CMI and their results are presented. These new sets of EACs will be applied to the measurements during the planned Dobson/Brewer campaign (Langley calibration and intercomparison) at the Izaña Observatory on Tenerife in September 2016. When new sets of ozone cross sections instead of the old Bass/Paur set will be introduced, the use of individual EACs for each instrument is recommended.