Report on the outcomes of a Virtual Mobility[1]

Action number: CA21119

Grantee name: Meritxell Garcia Suñer

Virtual Mobility Details

Title: Climatological study of AOD and total ozone at the Poprad-Gánovce station in Slovakia based on 30 years of measurements with a Brewer ozone spectrophotometer.

Start and end date: 23/09/2024 to 11/10/2024

Description of the work carried out during the VM

Description of the virtual collaboration and activities carried out during the VM, with focus on the work carried out by the grantee. Any deviations from the initial working plan shall also be described in this section. (max. 500 words)

During the period covered by the VM, the grantee has been sharing results, questions and ideas with Dr. Peter Hrabčák via e-mail and short reports. Dr. Hrabčák provided the grantee with data sets on optical depths and total ozone ranging from 18-08-1993 to 31-05-2024, which he obtained from Brewer spectrophotometer measurements. These data were employed to produce a climatology of the Poprad-Gánovce site. For the interpretation of these results in terms of site characteristics (recurrent wind directions, occurrence and origin of dust intrusions, orography, climate, local sources of aerosols, etc.), the grantee was guided by Dr. Hrabčák. In addition, he and Dr. Violeta Matos advised her on the analysis of temporal trends in AOD and total ozone. For the last part of the study, Dr. Hrabčák shared tropopause height data and some articles that helped the grantee in studying the relationship of total ozone measurements with changes in tropopause height. These outcomes will be reported in a future article. In addition, they motivate other studies of particular interest for the objectives of WG2. Specifically, a comparison of the Brewer spectrophotometer data with the measurements collected by a Cimel sun-photometer installed at the same station as the Brewer instrument is planned.

[1] This report is submitted by the grantee to the Action MC for approval and for claiming payment of the awarded grant. The Grant Awarding Coordinator coordinates the evaluation of this report on behalf of the Action MC and instructs the GH for payment of the Grant.

Description of the VM main achievements and planned follow-up activities

Description and assessment of whether the VM achieved its planned goals and expected outcomes, including specific contribution to Action objective and deliverables, or publications resulting from the VM. Agreed plans for future follow-up collaborations shall also be described in this section. *(max. 500 words)*

Overall, the activities carried out during the VM were successful in achieving the proposed objectives. The main findings are:

a) Obtain the climatology for total ozone and AOD at Poprad-Gánovce using the 30 years of data available for the Poprad-Gánovce station. In particular, the following analyses were carried out:
   - Representation of daily, monthly and annual means of AOD and total O_3. These plots allowed identifying annual patterns for both magnitudes. Hence, regarding AOD, the behaviour shown was satisfactorily explained based on climate (influence of air masses, dust events, solar irradiation and atmospheric dynamics) and site location (considering orography and local/far aerosol sources). For O_3, variations can be partly explained based on solar irradiance. However, the dominating effect on the amount of total ozone in the atmosphere has been found to be the Brewer-Dobson circulation.
   - Intra-annual variation of AOD and total ozone. This analysis confirmed the conclusions of the previous one, thus reinforcing the importance of atmospheric dynamics and large-scale processes in explaining the measurements of total ozone and AOD at a given location.

b) Study of the temporal evolution of AOD. Due to the size of the dataset, the study of the evolution of AOD measurements over the years is particularly appealing. Thus, it has been found that AOD tends to decrease significantly over time, in agreement with previous studies (Li et al. 2014).

c) Assessment of the dependence of total ozone on tropopause height. For this section, several points were explored:
   - The occurrence frequency of tropopause height values was analysed for two different periods: “summer” (May, June, July) and “winter” (November, December, January), where some variations between periods were noticed.
   - Exploration of the anti-correlation between tropopause height and total ozone data. This has been quantified from a linear regression analysis. The results obtained are in good agreement with studies conducted in the Northern Hemisphere (Steinbrecht et al. 1998; Varotsos et al. 2004, Coldewey-Egbers et al. 2022).
   - Quantification of the evolution of tropopause height and total ozone values over the years. This analysis allowed to estimate the extent to which changes in total ozone concentrations are associated with changes in tropopause height. The results obtained are similar to those reported by Steinbrecht et al. 1998 and Varotsos et al. 2004.

The outcomes summarized above are planned to be included in an article for the Quadrennial Ozone Symposium’s special issue. Furthermore, these have set the foundations for further studies. Two investigations are planned:

a) Compare the climatology results with 10 years (2014-2024) of AOD measurements from AERONET’s Cimel sun photometer, which is co-located with the Brewer spectrophotometer. The conclusions drawn will be promising for the research line focusing on AOD measurements in the UV.

b) Improve the study of temporal trends of the magnitudes taking into account the seasonality of the data. Temporal trends can be evaluated using Cimel measurements, and then compared with the trends obtained from the Brewer spectrophotometer to determine whether they are consistent.

The objectives and results obtained in this project are within the scope of WG2, which aims to establish a cooperation network working towards aerosol measurement improvement. One of the tasks of this group is to analyse aerosol data and interpret the corresponding results, to which the climatological and time evolution analyses of the Poprad-Gánovce site can contribute. Furthermore, the total ozone data collected by the Brewer ozone spectrophotometer can be used to improve the calibration methods of sun-photometers. Finally, as previously mentioned, a future study on the comparison of AOD measurements obtained by Brewer and Cimel at the Poprad-Gánovce site may be especially enlightening for exploring AOD measurements in the UV region, apart from the fact that this is another objective of WG2 (comparison of retrievals from co-located instruments giving the same magnitudes but using different equipment and methods of analysis). For these reasons, the analyses described above have helped in the elaboration of deliverable D2.2 of WG2.

References:

- Coldewey-Egbers, M., Loyola, D. G., Lerot, C., and Van Roozendael, M.: Global, regional and seasonal analysis of total ozone trends derived from the 1995–2020 GTO-ECV climate data record (2022). Atmos. Chem. Phys., 22, 6861–6878, https://doi.org/10.5194/acp-22-6861-2022

- Li, J., Carlson, B. E., Dubovik, O., and Lacis, A. A.: Recent trends in aerosol optical properties derived from AERONET measurements (2014), Atmos. Chem. Phys., 14, 12271–12289, https://doi.org/10.5194/acp-14-12271-2014

- Steinbrecht, W., Claude, H., Köhler, U., Hoinka, K.P. Correlations Between Tropopause Height and Total Ozone: Implications for Long-Term Changes. Journal of Geophysical Research (1998). 103. 19183-19192. 10.1029/98JD01929.

- Varotsos, C., C. Cartalis, A. Vlamakis, C. Tzanis, and I. Keramitsoglou. The Long-Term Coupling between Column Ozone and Tropopause Properties (2004). J. Climate, 17, 3843–3854, https://doi.org/10.1175/1520-0442