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Intercomparison of OMI NO_2 and HCHO air mass factor calculations: recommendations and best practices for retrievals

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We present a detailed comparison of the air mass factor (AMF) calculation process used by various research groups for OMI satellite retrievals of NO_2 and HCHO. Although satellite retrievals have strongly improved over the last decades, there is still a need to better understand and reduce the uncertainties associated with every retrieval step of satellite data products, such as the AMF calculation. Here we compare and evaluate the different approaches used to calculate AMFs by several scientific groups (KNMI (WUR), IASB-BIRA, IUP-UNI. BREMEN, MPI-C, NASA GSFC, LEICESTER UNI. and PEKING UNI.). Each group calculated altitude dependent (box-) AMFs and clear sky and total tropospheric AMFs for several OMI orbits. First, European groups computed AMFs for one OMI orbit using common settings for the choice of surface albedo data, terrain height, cloud treatment and a priori vertical profile. Second, every group computed AMFs for two complete days in different seasons using preferred settings for the ancillary data and cloud treatment as a part of a Round Robin exercise. Box-AMFs comparison showed good consistency and underlined the importance of a correct treatment of the physical processes affecting the effective light path and the vertical discretization of the atmosphere. Using common settings, tropospheric NO_2 AMFs in polluted pixels on average agreed within 4.7% whereas in remote pixels agreed within 3.5%. Using preferred settings relative differences between AMFs increase up to 15-30%. This increase is traced back to the different choices and assumptions made throughout the AMF calculation, which affect the final AMF values and thus the uncertainty in the AMF calculation. Differences between state of the art cloud treatment approaches highlight the importance of an accurate cloud correction: total and clear sky AMFs in polluted conditions differ by up to 40% depending on the retrieval scenario. Based on the comparison results, specific recommendations on best practices are given and they will be used in QA4ECV community effort retrieval algorithm to be applied in past and future UV/Vis instrumentation for generating quality assured multi decadal NO_2 and HCHO records.