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Development and application of a low-cost, portable DOAS system for stratospheric composition monitoring over the Argentinean Patagonia and Antarctic stations.

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A significant fraction of the Argentinean population is seasonally exposed to elevated UV radiation, particularly during severe stratospheric ozone destruction episodes in Antarctica. In order to provide early alert, global monitoring and to improve our understanding of these phenomena, various Argentinean and international organizations maintain stratospheric composition remote sensing sites from the southern tip of Argentina (Patagonia) to Antarctica. The understating of the ozone destruction dynamics will be significantly improved if more sites were available. For instance, the Laser and Applications Research Center, CEILAP (CITEFA-CONICET, Argentina) carries out systematic measurements of stratospheric ozone and tropospheric water vapor profiles at Rio Gallego (51º 36' S, 69º 19' W, 15 m asl) by means of LIDAR systems. Besides the active systems, the site possesses different passive instruments (GUV-541, UV-B and UV-A radiometers, SAOZ spectrometer, CIMEL sunphotometer) all of them working in synergy. The goal of this work is to present the design and development of a new compact atmospheric remote sensing system, able to determine the vertical column concentration in column (VCD) of multiple trace gases. We have developed a low-cost, portable passive DOAS system, ERO-DOAS, wich circumvents the cost limitations associated with new fixed monitoring sites. It is composed of commercial spectrophotometer (HR4000, Ocean Optics), a 400-μm core, 6-m long optic fiber, and a home-made automatic external shutter. We have developed a LabVIEW® based software for spectrometer/shutter control and data acquisition, and a MATLAB® based software for spectral data reduction. In the work we highlight the main characteristics of the system's components and we describe the visual interface implemented to controls the operation of the whole system, and the calculation algorithms to process the measured zenithal spectra, postulating the strategies implemented to solve the challenge. Also, we present measurements carry out at the Marambio Antarctic Base (64° 14' S; 56° 37' W, 197 m asl) during the months of January - February of 2008, using the ERO-DOAS. The NO_2 and O_3 VCD are derived from solar spectra acquired during the twilights (zenithal angles between 87° - 92°), using the DOAS (Differential Optical Absorption Spectroscopy) technique. The biggest contribution to these spectra comes from the stratosphere, atmosphere layer that we want to study. The analysis is carried out by solving the Beer-Lambert-Bouger (BLB) law for all the atmospheric absorbers and a quasi-continuous wavelength range. The algorithm minimizes the fitting residuals to the BLB law, having as unknown the slant column density of the species to determine. The effects of Rayleigh and Mie scattering, fluorescence and most of the Raman scattering are accounted for and subtracted out using a high-pass polynomial filter. We compare the data acquired by our DOAS system with co-located measurements performed with EVA, a visible absorption spectrometer operated by the Instituto Nacional de Técnica Aeroespacial (INTA), Spain. Additionally, a comparative study is presented among the ground-based signals and those obtained by the instrument OMI (AURA satellite). The bigger mistake sources associated with the comparison between AURA satellite observations and those carried out from earth are: a) NO_x daily cycle, b) NO_2 natural variability, and c) NO_2 tropospheric sensibility. In the case of Marambio, it hasn't relevance since it is non polluted places and the tropospheric NO_2 level is very low. We observe that the NO_2 has a strong photochemical variability during the day. This variability is associated with the solar cycle, the NO_x vertical distribution, the temperature in the high layers of the atmosphere and sometimes (in high latitudes) of other active species.