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Changes in atmospheric composition discerned from long-term NDACC measurements: trends of direct greenhouse gases derived from infrared solar absorption spectra recorded at the Jungfraujoch station

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The University of LiËge (ULg) is operating -under clear sky conditions- two state-of-the-art Fourier Transform Infrared (FTIR) spectrometers at the high-altitude research station of the Jungfraujoch (Swiss Alps, 46.5oN, 3580m asl), within the framework of the Network for the Detection of Atmospheric Composition Changes (NDACC). Routine FTIR operation started in 1984. Since then, it has been continued without disruption, allowing collecting more than 45000 high-resolution broadband IR solar absorption spectra, between 2 and 16 µm, using either HgCdTe or InSb detectors as well as a suite of optical filters. Typically, the spectral resolutions achieved lie in the 0.003 to 0.009 cm-1 interval while signal-to-noise ratios of 1000 and more are reached. Numerous narrow-band IR spectra essentially recorded from 1976 to 1989 with grating instruments are also available. Their analyses with modern tools have recently started [Bader et al., 2011] and will be pursued to consistently extend our datasets back in the 1970s. Geophysical parameters are deduced from the ULg observational database either with the SFIT-1, SFIT-2 or PROFFIT-9 algorithm, allowing producing total column time series of the target gases. In addition, information on their vertical distributions with altitude can generally be derived when using SFIT-2 or PROFFIT-9 which both implement the Optimal Estimation Method of Rodgers [1990]. Presently, more than two dozen atmospheric species are systematically retrieved from the Jungfraujoch observations, allowing the monitoring of key constituents of the Earth's atmosphere which play important roles in stratospheric ozone depletion and/or in global warming. This communication will focus on the direct and major greenhouse gases available from our database, namely water vapor, CO2, CH4, N2O, tropospheric ozone, CFC-11, CFC-12, HCFC-22, CCl4, SF6, as well as CF4 which has recently been added to our targets list [Duchatelet et al., 2011]. Trends and associated uncertainties characterizing the available -and often multi-decadal- time series have been derived or updated with a statistical bootstrap resampling tool [Gardiner et al., 2008], they will be presented and critically compared with data available from the literature. Acknowledgments The ULg involvement has primarily been supported by the Belgian Federal Science Policy Office, and by the GAW-CH program. We thank the International Foundation High Altitude Research Stations Jungfraujoch and Gornergrat (HFSJG, Bern) for supporting the facilities needed to perform the observations. We are also grateful to the FRS-FNRS for recurrent support allowing maintaining and developing the Jungfraujoch laboratory and instrumentation. The CommunautÈ FranÁaise de Belgique is further acknowledged for covering staying costs at the Jungfraujoch. This communication is dedicated to our colleague and friend Curtis Rinsland who passed away in April 2011. We have enjoyed and benefited from a close and steady collaboration with him, over nearly 30 years for some of us, within the framework of the ATMOS, ACE and NDACC programs and missions. We will deeply miss him. References Bader, W. et al., Extension of the long-term total column time series of atmospheric methane above the Jungfraujoch station: analysis of grating infrared spectra between 1976 and 1989, Geophysical Research Abstracts, 13, EGU2011-3391-1, 2011. [http://hdl.handle.net/2268/88180] Duchatelet, P. et al., First retrievals of carbon tetrafluoride (CF4) from ground-based FTIR measurements: production and analysis of the two-decadal time series above the Jungfraujoch, Geophysical Research Abstracts, 13, EGU2011-6413, 2011. Gardiner, T. et al., Trend analysis of greenhouse gases over Europe measured by a network of ground-based remote

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