SELF BROADENING COEFFICIENTS AND IMPROVED LINE
INTENSITIES FOR THE $v_7$ BAND OF $^{12}$C$_2$H$_4$ NEAR 10.5 $\mu$m, AND IMPACT
ON ETHYLENE RETRIEVALS FROM JUNGFRAUJOCH SOLAR SPECTRA

J. Vander Auwera, 1 A. Fayt, 2 M. Tudorie, 1 M. Rotger, 3 V. Boudon, 4 B. Franco, 5 E. Mahieu 5

1 Service de Chimie Quantique et Photophysique, C.P. 160/09, Université Libre de Bruxelles,
50 avenue F.D. Roosevelt, B-1050 Brussels, Belgium
2 Laboratoire de Spectroscopie Moléculaire, Université Catholique de Louvain,
Chemin du cyclotron 2, boîte L7.01.07, B-1348 Louvain-la-Neuve, Belgium
3 Groupe de Spectrométrie Moléculaire et Atmosphérique, UMR 7331 CNRS-Université de Reims
   Champagne-Ardenne, Moulin de la Housse, BP 1039, Cases 16-17, F-51687 Reims Cedex, France
4 Laboratoire Interdisciplinaire Carnot de Bourgogne, UMR 6303 CNRS-Université de Bourgogne,
   9 avenue Alain Savary, BP 47870, F-21078 Dijon Cedex, France
5 Institute of Astrophysics and Geophysics, Université de Liège, 17 Allée du 6 Août (B5a),
   B-4000 Liège (Sart-Tilman), Belgium

Ethylene is a tropospheric pollutant on the Earth, also present as a by-product of methane
photochemistry in the atmosphere of outer solar system bodies. Remote sensing of ethylene in the
infrared range relies on the 10 $\mu$m region. This spectral range corresponds to the excitation of 7
modes of vibration of $^{12}$C$_2$H$_4$, 4 of which being infrared active (see Fig. 1 of [1]). The
corresponding $v_{10}$, $v_7$, $v_4$ and $v_{12}$ bands are located near 826, 949, 1026 and 1442 cm$^{-1}$, respectively
[1]. Among these, the $v_7$ band is the strongest, indeed used for remote sensing measurements of
ethylene.

Relying on high-resolution Fourier transform infrared (FTIR) spectra recorded in Brussels, the
present work involved extensive measurements of individual line intensities and self broadening
coefficients for the $v_7$ band of $^{12}$C$_2$H$_4$. Compared to the corresponding information available in the
latest edition of the HITRAN spectroscopic database (HITRAN 2012 [2]), the measured line
intensities were found to be higher by about 10 % for high J lines in the P branch and lower by
about 5 % for high J lines of the R branch, varying between these two limits roughly linearly with
the line positions. Test calculations performed in this work indicated that these discrepancies could
result from the relative values of the transition moments of the $v_{10}$, $v_7$ and $v_{12}$ bands used when the
information provided in HITRAN was generated (the transition moment of the $v_4$ band was set to
zero). The measured self broadening coefficients exhibit a dependence on both J and K$_a$, which was
modeled empirically. The spectroscopic information for ethylene available in HITRAN 2012 was
modified to match the present observations. The impact of these modifications on retrievals of
atmospheric ethylene was then evaluated via FTIR retrievals in the 949.0–952.0 cm$^{-1}$ microwindow,
from a subset of ground-based high-resolution FTIR solar spectra recorded at the Jungfraujoch
station. The new line intensities were found to lead to a reduction of the measured total columns of
ethylene by $-4.1 \pm 0.1$ %, compared to the use of HITRAN 2012.

References