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First retrievals of methane isotopologues from FTIR ground-based observations

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Atmospheric methane concentrations have reached a new high at 1845 $\pm$ 2 ppb, accounting for an increase of 256 % since pre-industrial times (WMO, 2016). In the last ten years, methane has been on the rise again at rates of $\sim$0.3%/year (e.g., Bader et al., 2016), after a period of stabilization of about 5 years. This recent increase is not fully understood due to remaining uncertainties in the methane budget, influenced by numerous anthropogenic and natural emission sources. In order to examine the cause(s) of this increase, we focus on the two main methane isotopologues, i.e. CH_3D and $^{13}CH_4$. Both CH_3D and $^{13}CH_4$ are emitted in the atmosphere with different ratio depending on the emission processes involved. As heavier isotopologues will react more slowly than $^{12}CH_4$, each isotopologue will be depleted from the atmosphere at a specific rate depending on the removal process. Methane isotopologues are therefore good tracers of the methane budget.

In this contribution, the first development and optimization of the retrieval strategy of CH_3D as well as the preliminary tests for $^{13}CH_4$ will be presented and discussed , using FTIR (Fourier Transform infrared) solar spectra collected at the Eureka (80.05 ˚N, -86.42 ˚E, 610 m a.s.l.) and Toronto (43.66˚N, -79.4˚E, 174 m a.s.l.) ground-based sites. Mixing ratio vertical profiles from a Whole Atmosphere Community Climate Model (WACCM v.4, Marsh et al., 2013) simulation developed by Buzan et al. (2016) are used as a priori inputs. A discussion on the type of regularization constraints used for the retrievals will be presented as well as an evaluation of available spectroscopy (primarily the different editions of the HITRAN database, see Rothman et al., 2013 and references therein). The uncertainties affecting the retrieved columns as well as information content evaluation will be discussed in order to assess the best strategy to be employed based on its altitude sensitivity range and complete error budget.

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References

Bader, W., Bovy, B., Conway, S., Strong, K., Smale, D., Turner, A. J., Blumenstock, T., Boone, C., Coulon, A., Garcia, O., Griffith, D. W. T., Hase, F., Hausmann, P., Jones, N., Krummel, P., Murata, I., Morino, I., Nakajima, H., O'Doherty, S., Paton-Walsh, C., Robinson, J., Sandrin, R., Schneider, M., Servais, C., Sussmann, R. and Mahieu, E.: Ten years of atmospheric methane from ground-based NDACC FTIR observations, Atmos. Chem. Phys. Discuss., 1–31, doi:10.5194/acp-2016-699, 2016.

Buzan, E. M., Beale, C. A., Boone, C. D. and Bernath, P. F.: Global stratospheric measurements of the isotopologues of methane from the Atmospheric Chemistry Experiment Fourier transform spectrometer, Atmos. Meas. Tech., 9(3), 1095–1111, doi:10.5194/amt-9-1095-2016, 2016.

Marsh, D. R., Mills, M. J., Kinnison, D. E., Lamarque, J.-F., Calvo, N. and Polvani, L. M.: Climate Change from 1850 to 2005 Simulated in CESM1(WACCM), J. Clim., 26(19), 7372–7391, doi:10.1175/JCLI-D-12-00558.1, 2013.

Rothman, L. S., Gordon, I. E., Babikov, Y., Barbe, A., Chris Benner, D., Bernath, P. F., Birk, M., Bizzocchi, L., Boudon, V., Brown, L. R., Campargue, A., Chance, K., Cohen, E. A., Coudert, L. H., Devi, V. M., Drouin, B. J., Fayt, A., Flaud, J.-M., Gamache, R. R., Harrison, J. J., Hartmann, J.-M., Hill, C., Hodges, J. T., Jacquemart, D., Jolly, A., Lamouroux, J., Le Roy, R. J., Li, G., Long, D. A., Lyulin, O. M., Mackie, C. J., Massie, S. T., Mikhailenko, S., Müller, H. S. P., Naumenko, O. V., Nikitin, A. V., Orphal, J., Perevalov, V., Perrin, A., Polovtseva,

E. R., Richard, C., Smith, M. A. H., Starikova, E., Sung, K., Tashkun, S., Tennyson, J., Toon, G. C., Tyuterev, V. G. and Wagner, G.: The HITRAN2012 molecular spectroscopic database, J. Quant. Spectrosc. Radiat. Transf., 130, 4–50, doi:10.1016/j.jqsrt.2013.07.002, 2013.

World Meteorological Organization, Greenhouse gas bulletin, N°12, October 2016.