Multichannel Heterodyne Spectroradiometer for Atmospheric Greenhouse Gas Measurements

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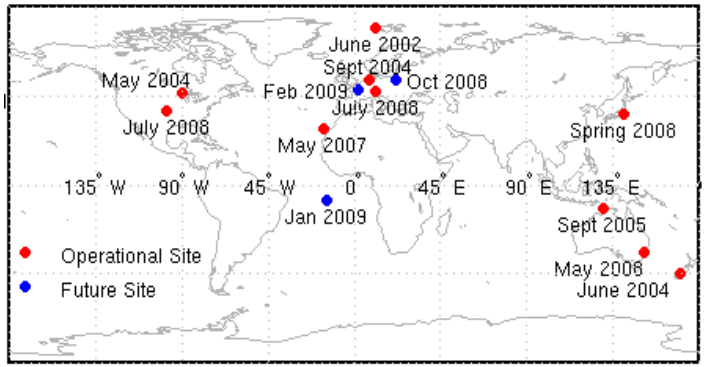
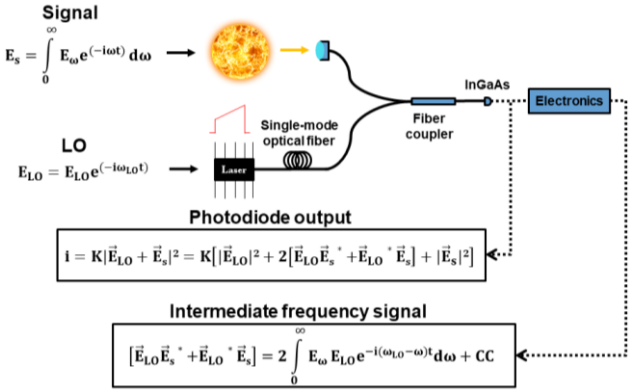
Remote sensing in the NIR

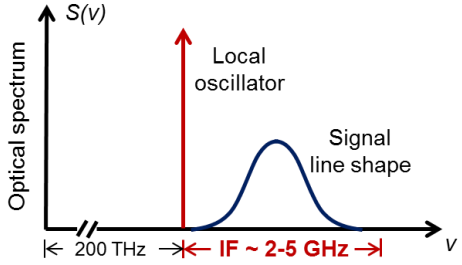


TCCON cites map and typical station

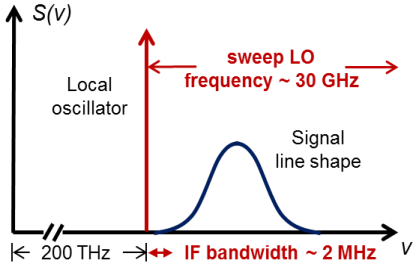
Principle of optical heterodyning



Some specific of the method implementing in the NIR

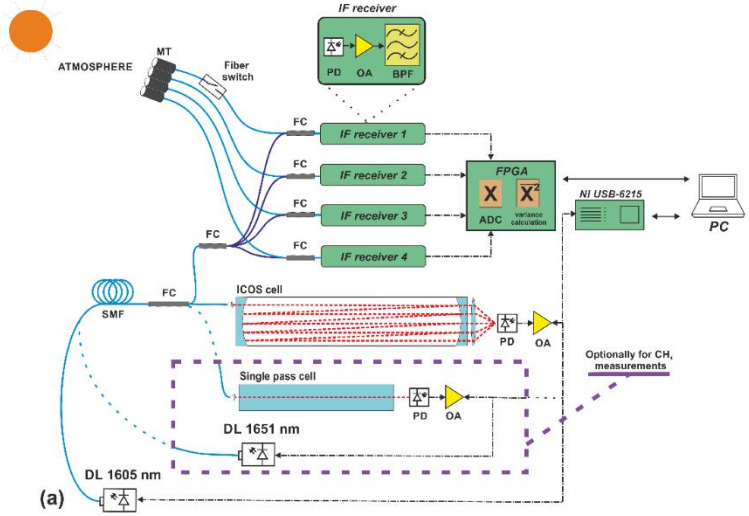


Standard approach

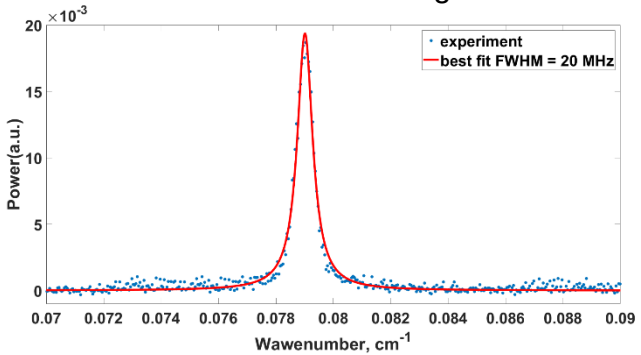


Our approach

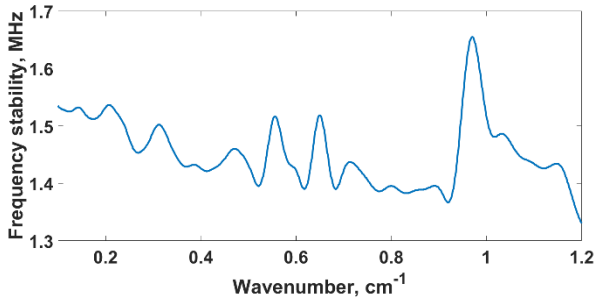
Ground-based prototype of MLHS



Principle scheme of MLHS and its view during field measurements. MLHS is Multichannel Laser Heterodyne Spectroradiometer

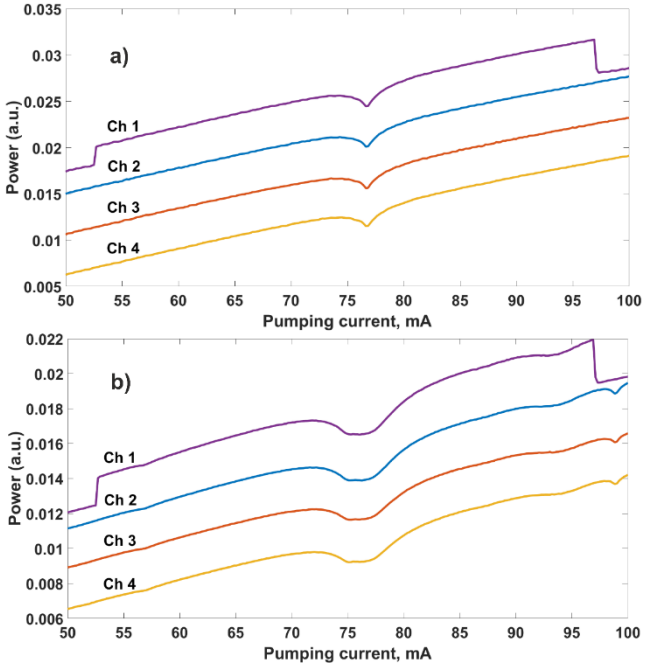


Spectral resolution of MLHS is 40 MHz or 0.0013 cm^{-1}

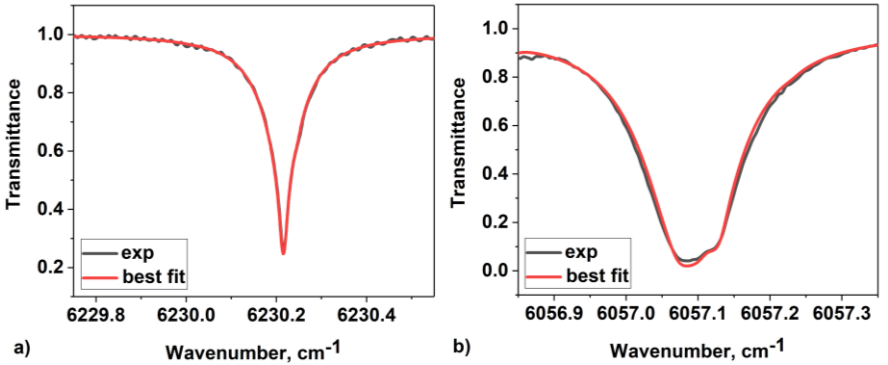


DL frequency stabilization is about 1.5 MHz

Ground-based prototype of MLHS: results



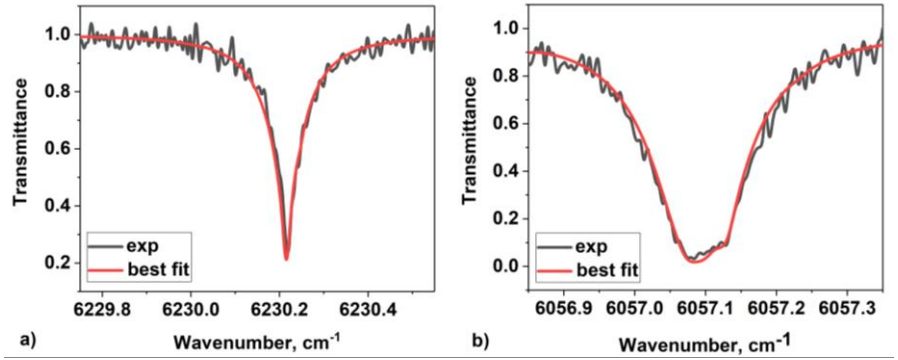
Raw data of 4 IF receivers of the MLHS at CO_2 and CH_4 measurements



2 minutes

SNR 500

Experimental results (a) CO_2 at 1605 nm, (b) CH_4 at 1651 nm.

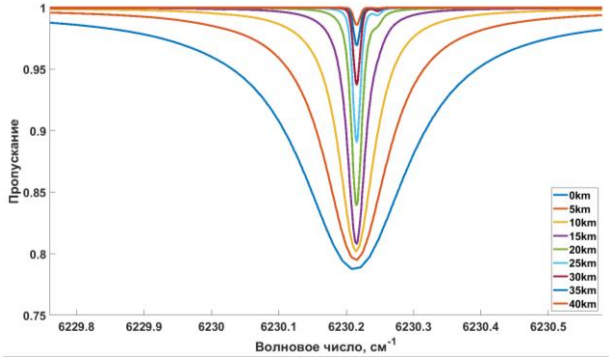


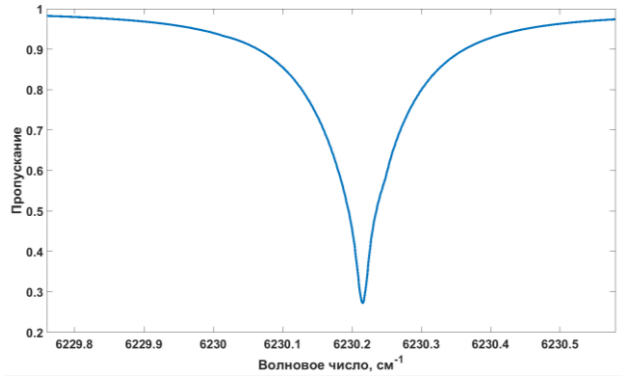
1 second

SNR 50

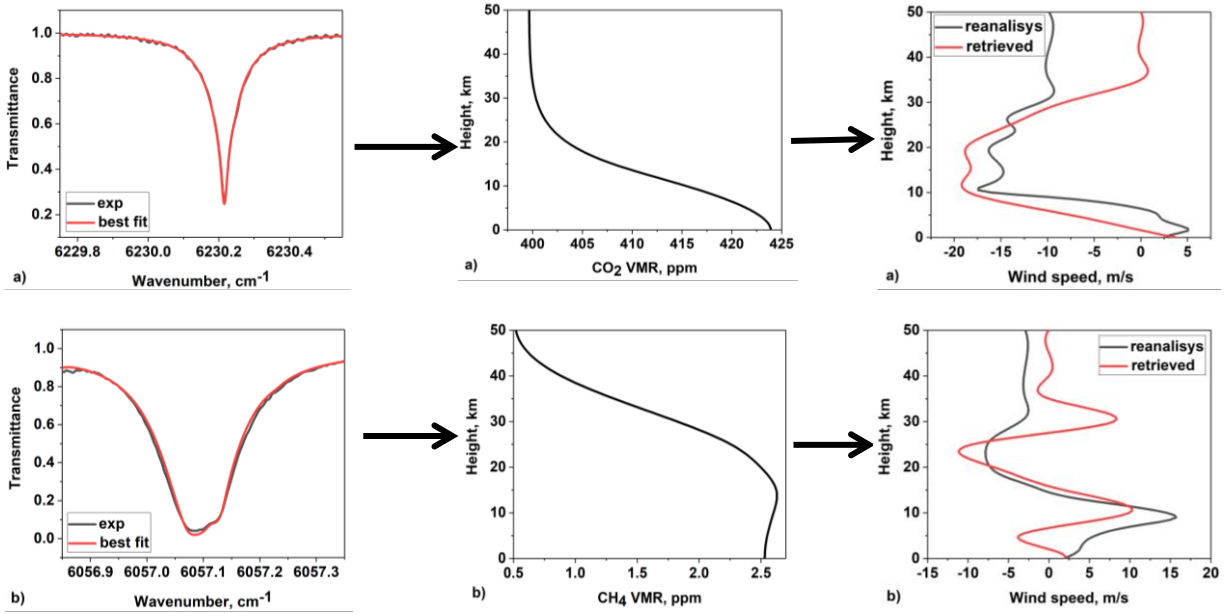
Ground-based prototype of MLHS: retrievals

Resolved individual atmospheric CO_2 absorption line analysis





Atmospheric structure and dynamics retrievals



List of relevant papers

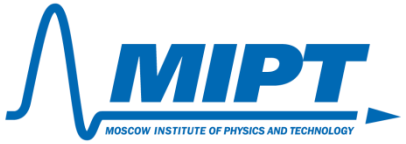
2012 – Klimchuk, A.Yu.; Nadezhdinskii, A.I.; Ponurovskii, Ya.Ya.; Shapovalov, Yu.P.; Rodin, A.V. On the possibility of designing a high-resolution heterodyne spectrometer for near-IR range on the basis of a tunable diode laser. Quant. Elect. 2012, 42, 244-249. https://doi.org/10.1070/QE2012v042n03ABEH014759

2014 – Rodin, A.; Klimchuk, A.; Nadezhdinskiy, A.; Churbanov, D.; Spiridonov, M. High resolution heterodyne spectroscopy of the atmospheric methane NIR absorption. Opt. Express 2014, 22, 13825-13834. https://doi.org/10.1364/OE.22.013825;

2019 – Zenevich, S.G.; Klimchuk, A.Yu.; Semenov, V.M.; Spiridonov, M.V.; Rodin, A.V. Measurements of a fully resolved contour of the carbon dioxide absorption line in a band at l = 1.605 mm in the atmospheric column using high-resolution heterodyne spectroradiometry. Quant. Elect. 2020, 49, 604-611. http://dx.doi.org/10.1070/QEL16859;

2020 – Rodin, A.V.; Churbanov, D.V.; Zenevich, S.G.; Klimchuk, A.Y.; Semenov, V.M.; Spiridonov, M.V.; Gazizov, I.S. Vertical wind profiling from the troposphere to the lower mesosphere based on high-resolution heterodyne near-infrared spectroradiometry. Atmos. Meas. Tech. 2020, 13, 2299–2308. https://doi.org/10.5194/amt-13-2299-2020;

2020 – Zenevich, S.; Gazizov, I.; Churbanov, D.; Spiridonov, M.; Rodin, A. Improvement of dark signal evaluation and signal-to-noise ratio of multichannel receivers in NIR heterodyne spectroscopy application for simultaneous CO2 and CH4 atmospheric measurements. OSA Cont. 2020, 3, 1801-1810. https://doi.org/10.1364/OSAC.395094.



Thank you for your attention

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