What is new in HITRAN2024?

I. E. Gordon, R. J. Hargreaves, L. S. Rothman, F. M. Gomez, T. Bertin, M. O'Donnell, the HITRAN community worldwide

Division of Atomic and Molecular Physics, Center for Astrophysics | Harvard & Smithsonian, Cambridge, MA, USA

CENTER FOR ASTROPHYSICS HARVARD & SMITHSONIAN

Introduction

The new edition of the HITRAN database (HITRAN2024) and associated publication are being prepared and will be released in the Fall. This poster outlines the scope of the extensions and improvements, with just some of the characteristic selected examples presented. Also, note Fran Gomez's poster about improvements to the water vapor line list.

Line-by-line overview

Line-by-line portion for HITRAN2024

H_2O (7)	**NO (3)**	**HCl (4)**	N_2 (2)	COF_2 (2)	NO^+ (1)	**C_4H_2 (1)**	**SO (1)**	**CH_3 (1)**
CO_2 (12)	SO_2 (4)	HBr (4)	**HCN (3)**	**SF_6 (1)**	HOBr (2)	**HC_3N (1)**	**CH_3F (2)**	**S_2 (1)**
O_3 (5)	**NO_2 (3)**	HI (2)	CH_3Cl (2)	**H_2S (3)**	**C_2H_4 (2)**	**H_2 (2)**	GeH_4 (4)	**COFCl (2)**
N_2O (5)	**NH_3 (2)**	ClO (2)	**H_2O_2 (1)**	**HCOOH (2)**	**CH_3OH (1)**	**CS (4)**	**CS_2 (4)**	**HONO (1)**
CO (6+3*)	**HNO_3 (2)**	**OCS (6)**	**C_2H_2 (3)**	HO_2 (1)	CH_3Br (2)	SO_3 (1)	**CH_3I (1)**	**$ClNO_2$ (2)**
CH_4 (4)	**OH (3)**	**H_2CO (3)**	**C_2H_6 (3)**	O (1)	**CH_3CN (1)**	C_2N_2 (1)	NF_3 (1)	
O_2 (3)	HF (2)	**HOCl (2)**	**PH_3 (1)**	$ClONO_2$ (2)	CF_4 (1)	$COCl_2$ (2)	**H_3^+ (1)**	

Figure 1: Line-parameters updates and additions per molecule in HITRAN2024. **Molecules that are updated/extended with respect to HITRAN2020 are in bold text**. New molecules or additional isotopologues for existing molecules are highlighted in red

Methane updates

The line list of methane has been updated substantially as described in Bertin et al. (submitted). The most notable updates from the perspective of atmospheric retrievals are those in the pentad (around 3.3 μm), octad ($\sim$4.3 μm), and tetradecad ($\sim$1.66 μm) regions. These bands are important not only for methane retrievals but also to be able to detect trace species "hiding" underneath strong CH_4 bands. It is important to mention that speed-dependent Voigt parameters for air broadening are now provided for many lines in the tetradecad region. This region was a subject of coordinated effort at NIST, Grenoble, DLR, and Hefei.

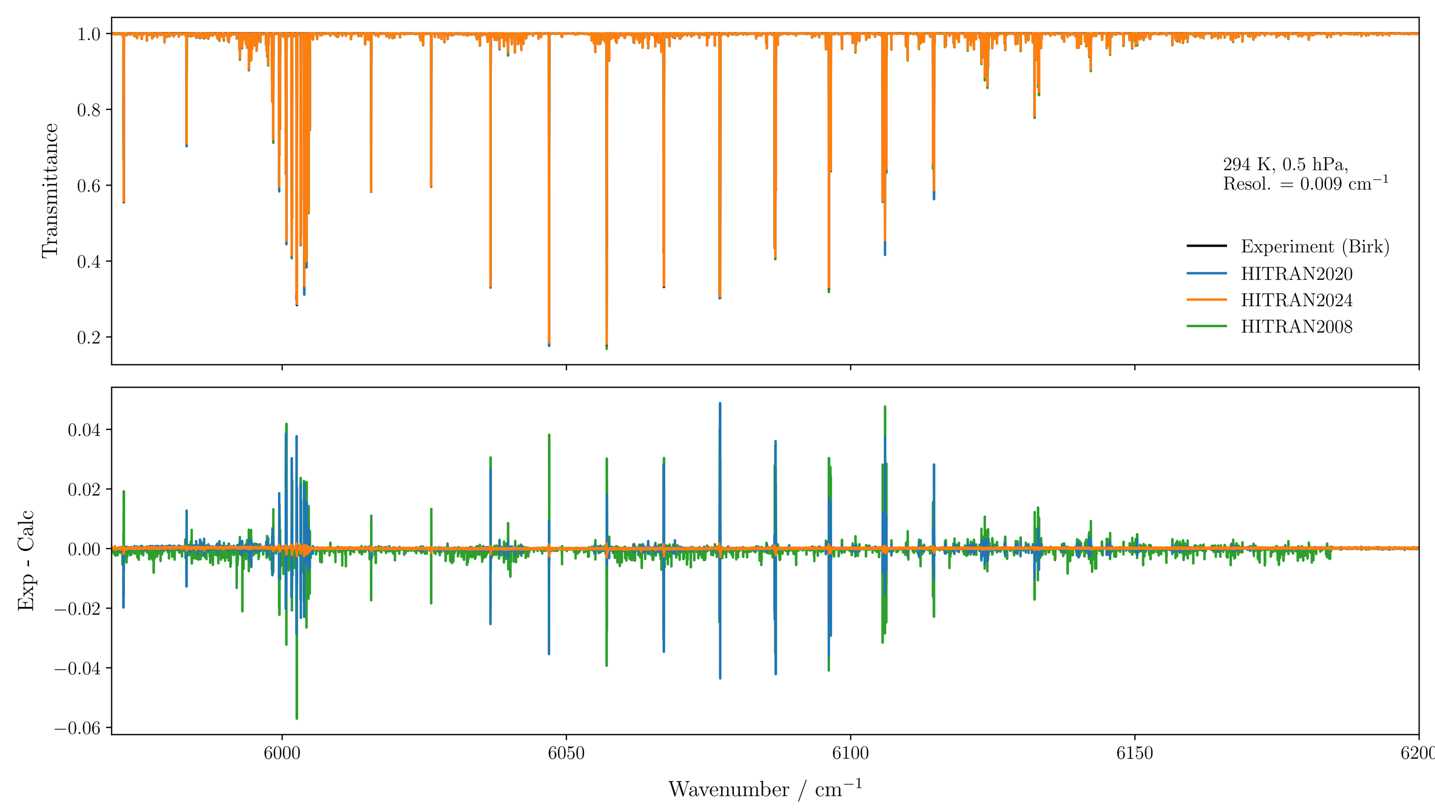

Figure 2: Methane tetradecad residuals obtained at 294 K and 0.5 hPa (low pressure) between the experiment from DLR and Voigt calculations from different versions of HITRAN.

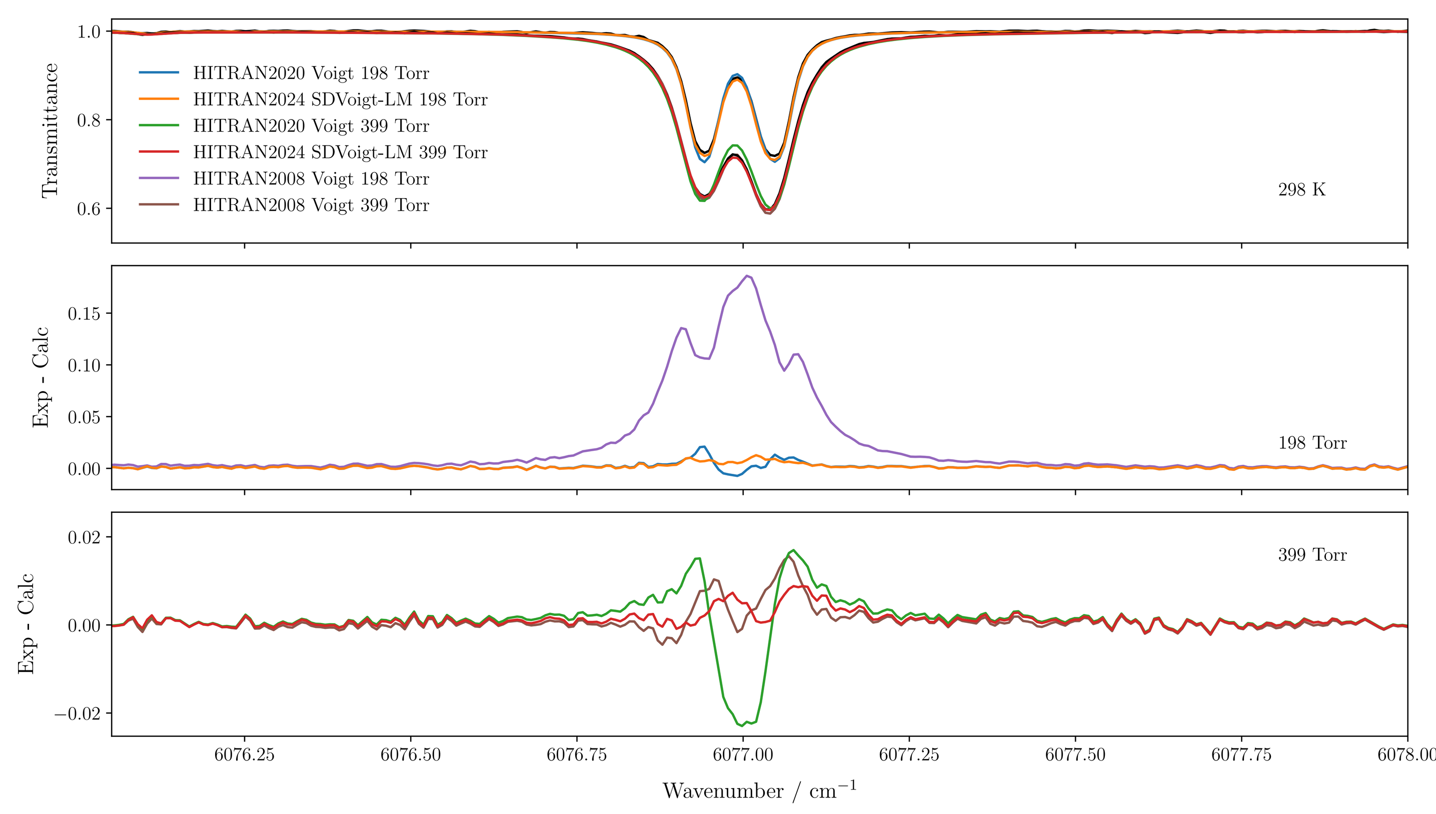

Figure 3: Methane tetradecad residuals at higher pressures using R(6) manifold as example. Comparison between experiments at JPL and calculations from different versions of HITRAN, and introducing the non-Voigt line shape effects.

Updated O_2 line list

Substantial improvements have been introduced to most of the oxygen bands in HITRAN, including the introduction of non-Voigt parameters. The figure below shows appreciable changes to the intensities of the A-band that the remote sensing community should note.

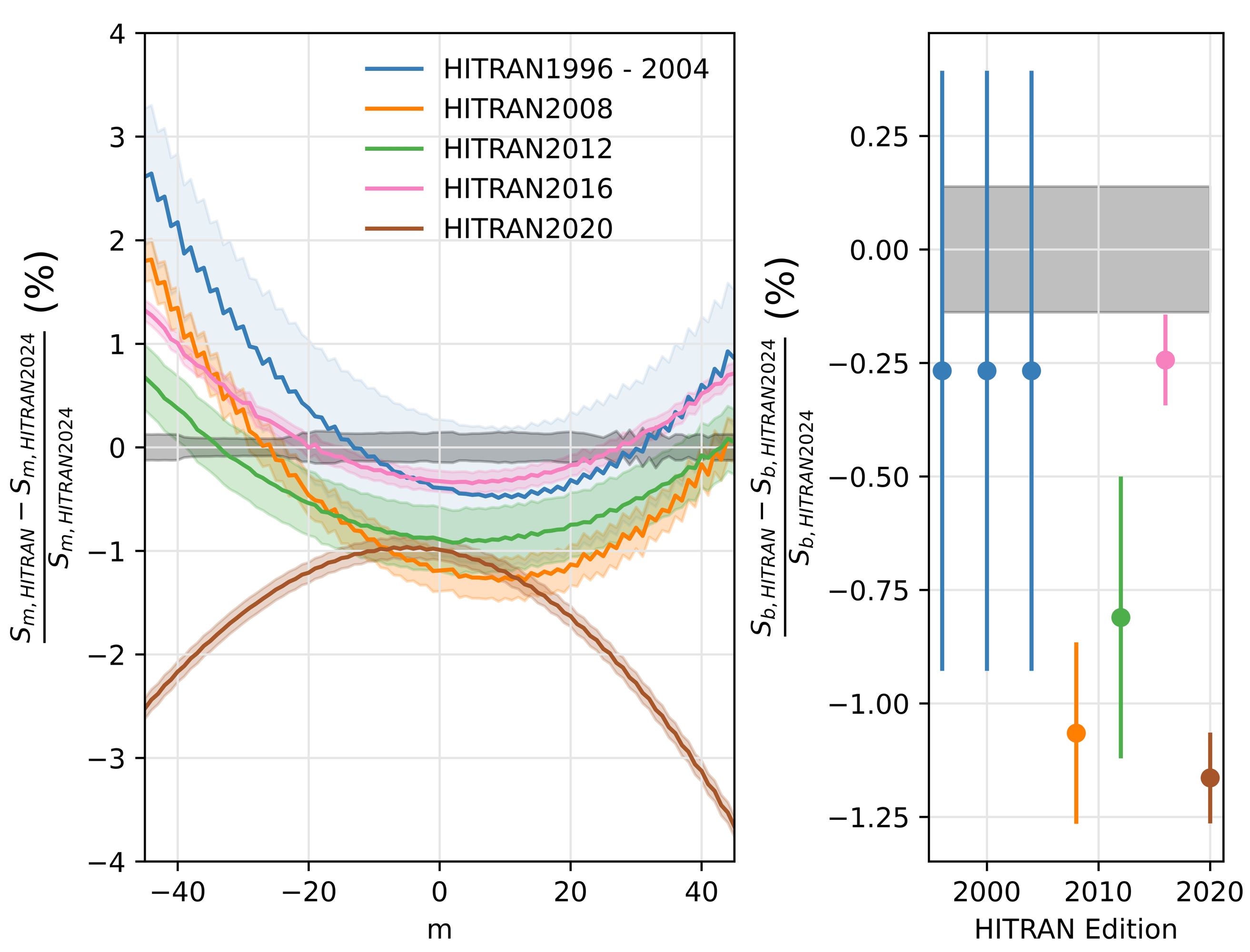

Figure 4: Intensities of the A-band of oxygen from the previous HITRAN versions compared to HITRAN2024. HITRAN2024 is based on an extensive measurement effort at NIST, from Adkins et al. (2025). Note that the new edition also features substantially improved line-shape parameters and their temperature dependencies in this and other oxygen bands.

Extending OCS and H_2CO line lists

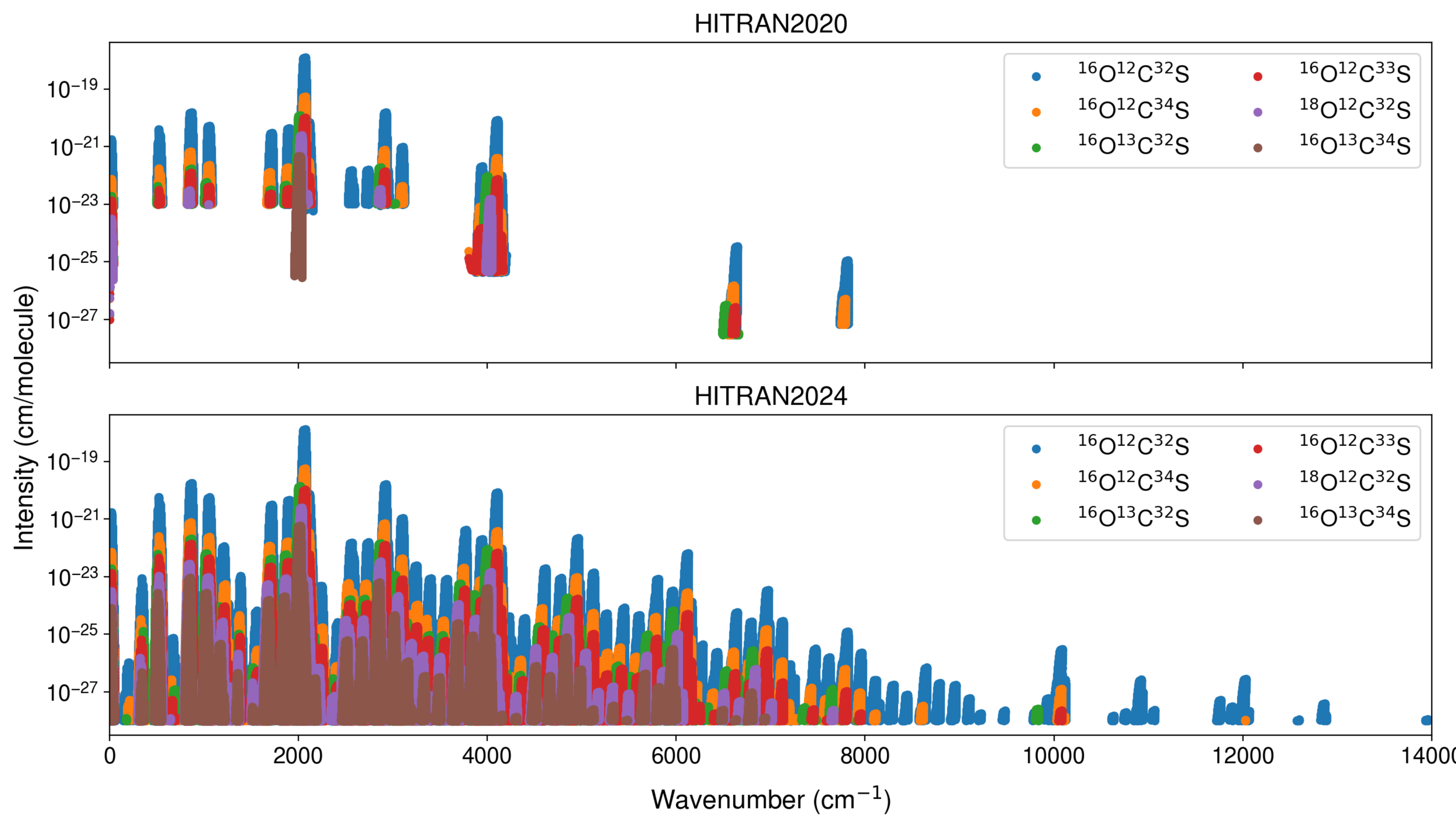

Figure 5: Line intensities of six isotopologues of carbonyl sulfide included in HITRAN2020 (upper panel) and HITRAN2024 (lower panel). The new line list is mostly from the semi-empirical work of Huang et al. (2024).

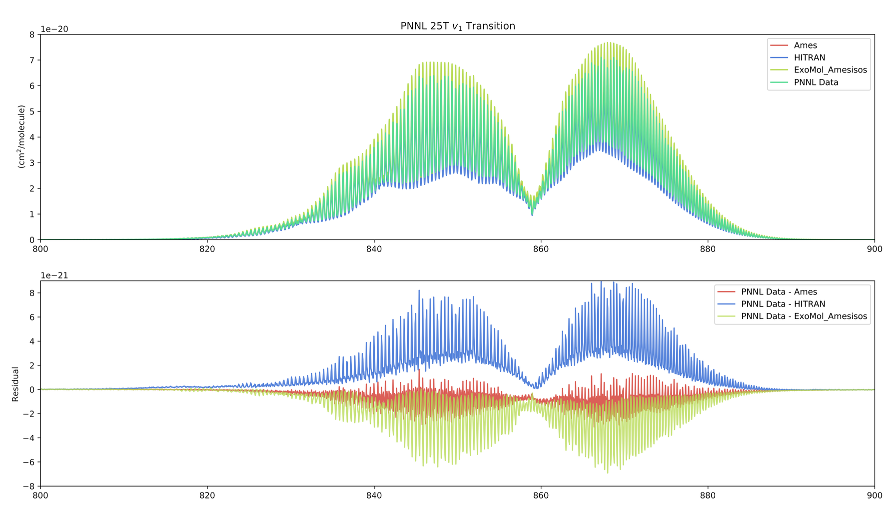

Figure 6: Residuals around the ν_1 band of OCS obtained with HITRAN, ExoMol, and the new (Ames) list

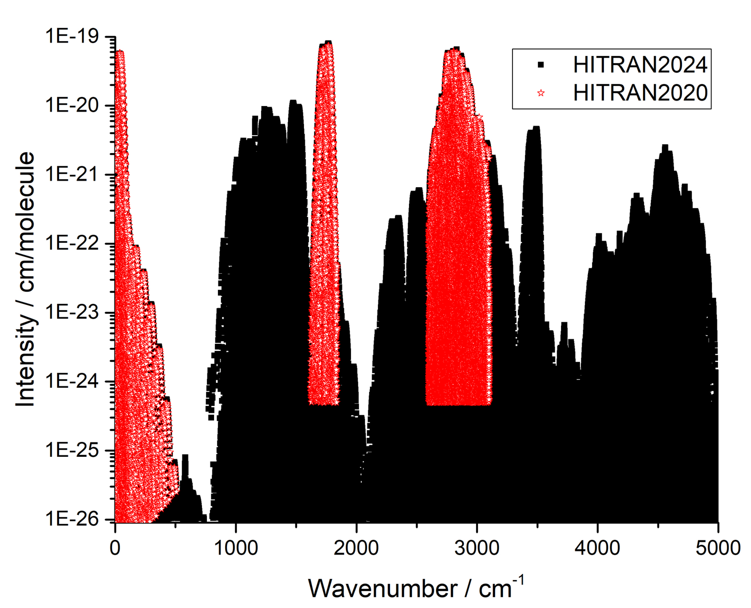

Figure 7: Extension of the formaldehyde line list

Absorption cross-sections

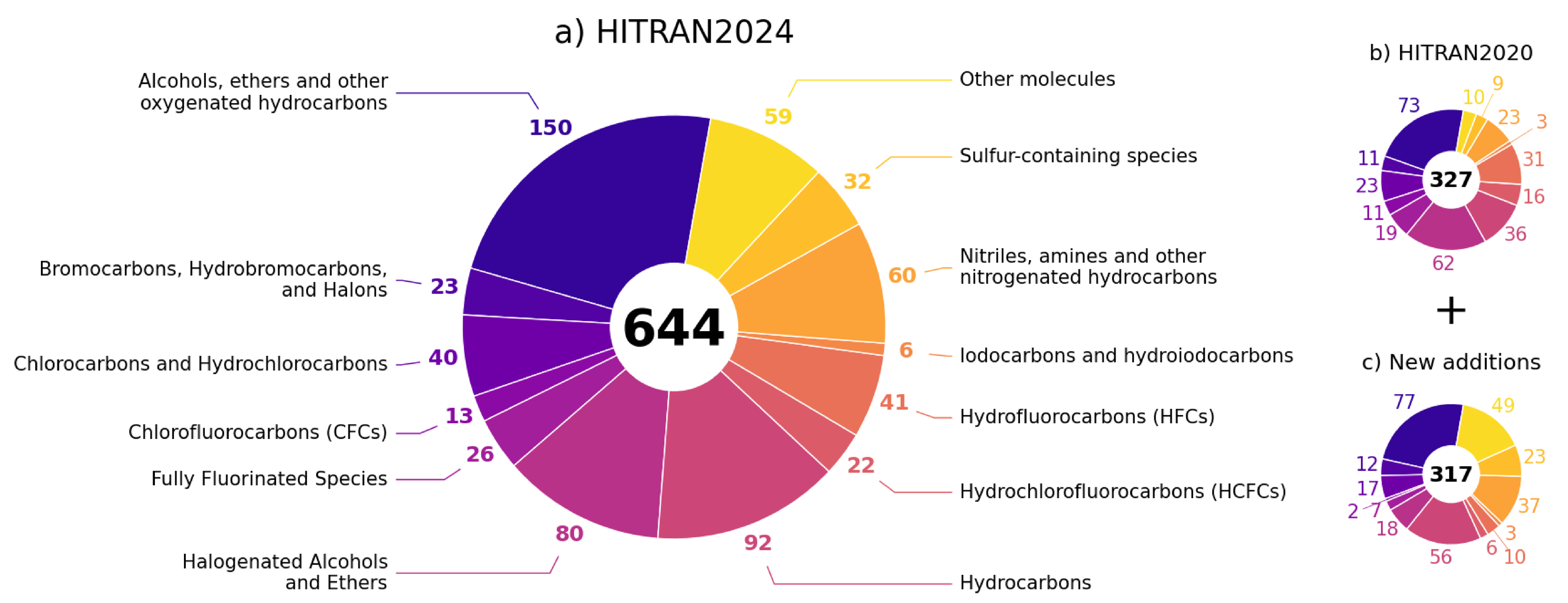

Figure 8: Experimental absorption cross-sections available in HITRAN2024 compared to HITRAN2020, demonstrating a very substantial expansion. Note that along with the increased number of new cross-sections, the quality of the existing ones has also increased. The species are grouped by their composition.

Water vapor continuum

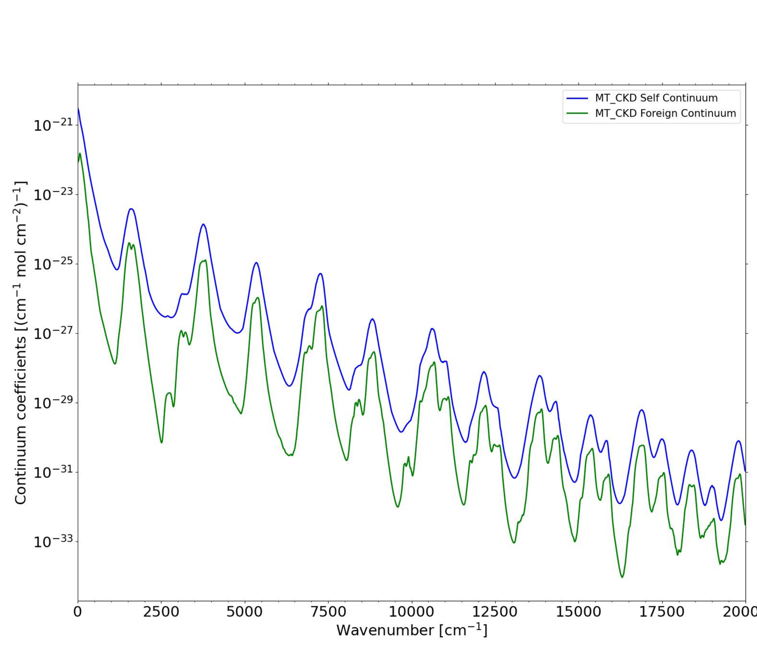

Figure 9: Mlawer-Tobin-Clough-Kneizys-Davies water vapor self and foreign continuum provided in HITRAN2024. Figure from E. Mlawer and J. Mascio (AER)

Collision-induced absorption

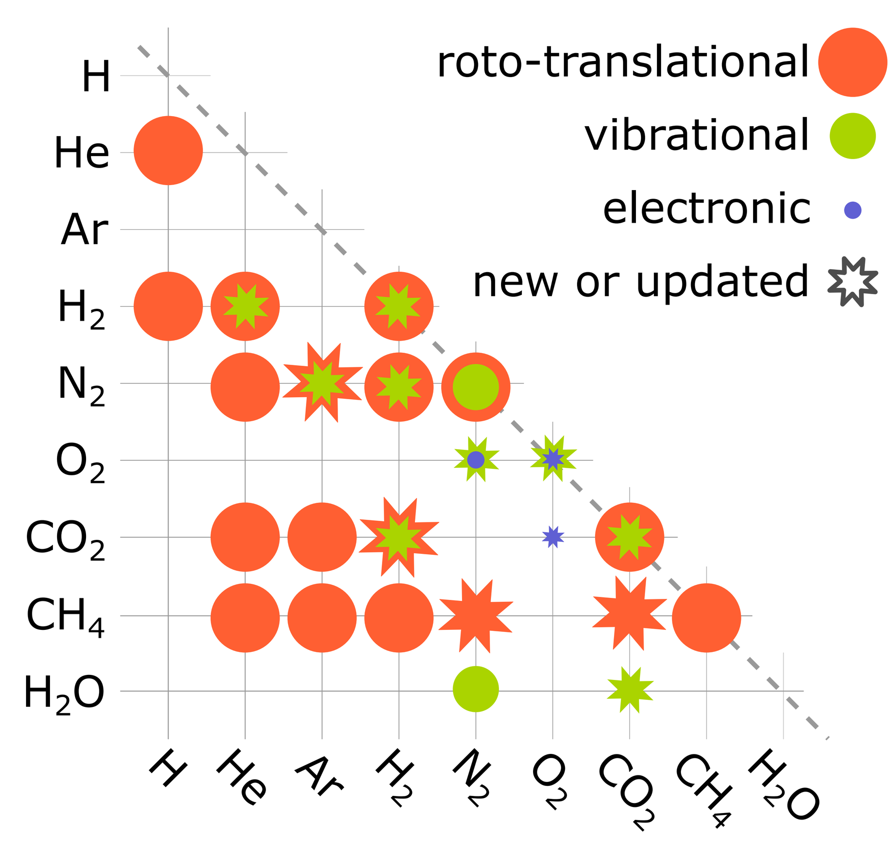

Figure 10: Overview of the previous and new collision-absorption by molecular pairs in HITRAN. From Terragni et al. (2025). One can see that relevant collision-induced absorption data have been expanded or updated.

References & Acknowledgments

The development of HITRAN2024 edition is funded through NASA grants 80NSSC23K1596, and 80NSSC24K0080. We thank HITRAN contributors from around the World as well as the users of the HITRAN data. Manfred Birk (DLR) and Keeyoon Sung (JPL) are thanked for providing the laboratory spectra used for validations of methane spectroscopy presented here.

Smithsonian