



# From GEISA-2015 to GEISA-2018

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**GEISA [Gestion et Etude des Informations Spectroscopiques Atmosphériques; Management and Study of Atmospheric Spectroscopic Information]** is a **computer-accessible Spectroscopic Database with associated management software**, designed for the interpretation of various atmospheric remote sensing observations; it is especially efficient for high spectral resolved Radiative Transfer simulations.

Spectroscopy is at the root of modern planetology, enabling us to determine the physical properties of planets remotely. As a result, standardized spectroscopic databases, were initiated in the early 1970's, such as, GEISA (Gestion et Etude des Informations Spectroscopiques Atmosphériques: Management and Study of Atmospheric Spectroscopic Information), at LMD, in France.

The 2015 release of GEISA [Jacquinet et al., 2016 and references herein], will be presented including significant updates and additions implemented in the three independent sub-databases of GEISA-2015:- the "fine parameters database" contains 52 molecular species (113 isotopologues) (spectral range from 10<sup>-6</sup> to 35,877,031 cm<sup>-1</sup>). A new molecule (SO<sub>2</sub>) has been added. HDO, isotopologue of H<sub>2</sub>O, is now identified as an independent molecular species. -the "cross section sub-database" has been updated and enriched by the addition of 43 new molecular species in its infrared part. A new section is added, in the near-infrared spectral region, involving 7 molecular species: CH<sub>3</sub>CN, CH<sub>3</sub>I, CH<sub>3</sub>O<sub>2</sub>, H<sub>2</sub>CO, HO<sub>2</sub>, HONO, NH<sub>3</sub>;-the "microphysical and optical properties of atmospheric aerosols sub-database" has been significantly enriched. It contains more than 40 species originating from NCAR and 20 from the ARIA archive of Oxford University.

Since the time of its creation GEISA has entered a new phase with the advent of high precision spectroscopy, coupling important developments in spectroscopic databases and radiative transfer modelling, to meet the needs of the international space agencies for the exploitation of these remote sensing data. Consequently, GEISA is constantly evolving, taking into account the best available spectroscopic data which are validated using the original and powerful approach of the SPARTE chain [Armante et al., 2016] developed at LMD.

The need to improve and consolidate the spectroscopic parameters is becoming a priority in order to exploit the increased spectral resolution and radiometric accuracy of new atmospheric instruments. In this context, spectroscopic parameters of targeted molecular species will be updated in GEISA-2018, associated with space missions such as: -IASI-NG (H<sub>2</sub>O, HDO, CO<sub>2</sub>, O<sub>3</sub>, N<sub>2</sub>O, CO, CH<sub>4</sub>, HNO<sub>3</sub>, OCS, CFC11, CFC12, CCl<sub>4</sub>, aerosols, ...), OCO-2 (CO<sub>2</sub>, O<sub>2</sub>, H<sub>2</sub>O), MicroCarb (O<sub>2</sub>, CO<sub>2</sub>, H<sub>2</sub>O), MERLIN (CH<sub>4</sub>, H<sub>2</sub>O), TROPOMI (CH<sub>4</sub>, CO, NO<sub>2</sub>, SO<sub>2</sub>, aerosols, ...)

GEISA and associated management software facilities are implemented and freely accessible on the AERIS/ESPRI atmospheric chemistry data center website. It is used on-line by more than 300 laboratories working in various domains like atmospheric physics, planetology, astronomy, astrophysics. GEISA line parameter database is the reference for current or planned TIR/SWIR space missions and it is associated with the work in progress in the frame of the ISSWG scientific group for IASI and its future IASI-NG.

### GEISA and RELATIONS TO SPACE MISSIONS (examples)

Atmospheric sounding for scientific study: Meteorology, Climatology, Air quality, Chemistry, astrophysics, ...

Current missions: IASI [on Metop-A (2006), Metop-B (2012), Metop C (2018)]

GEISA reference basis for IASI Level 1 Cal/Val activities @cnes and @lmd

MicroCarb Column concentration of CO<sub>2</sub>

Future missions: IASI-NG, MERLIN, MICROCARB, FLX

Requirements:

- remote sensing of the atmosphere at high spectral resolution FT spectrometers (IASI, IASI-NG) Grating spectrometers (MICROCARB) Lidars (MERLIN)
- evaluations of the performances for: Missions under exploitation Missions under development

### CURRENT GEISA SYSTEM (created in 1974) Contents and Organization

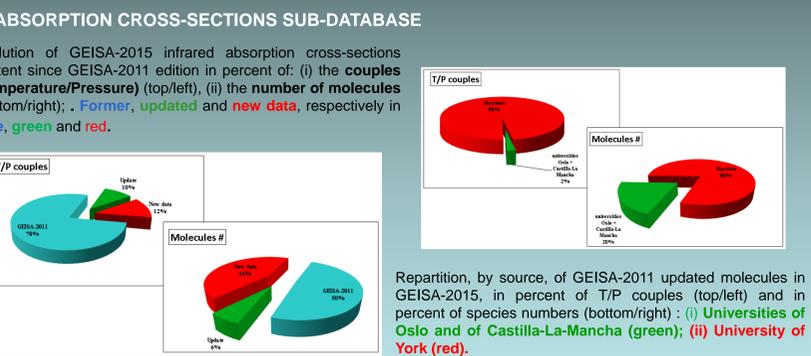
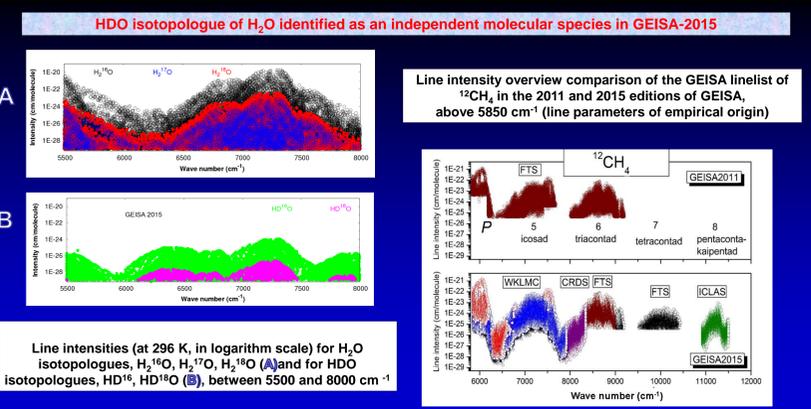
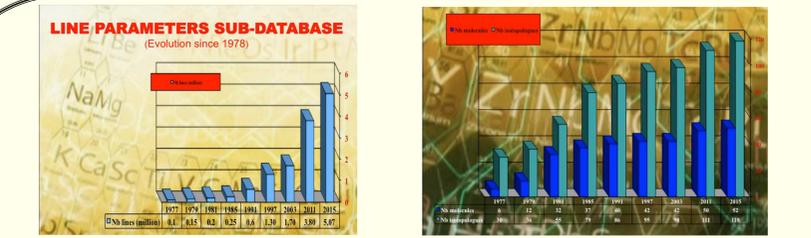
THREE INDEPENDENT SUB-DATABASES (associated management softwares)

- LINE PARAMETERS: wavenumber, intensity, air broadening pressure half-width (HWHM), energy of the lower transition, quantum identification, temperature dependence of coefficient for HWHM, .....
- ABSORPTION CROSS-SECTIONS: - in the IR (40 molecular species); - in the UV/VIS (17 molecular species)
- MICROPHYSICAL and OPTICAL PROPERTIES of ATMOSPHERIC AEROSOLS

- > Minor permanent constituents of the EARTH atmosphere O<sub>3</sub>, CH<sub>4</sub>, N<sub>2</sub>O, CO, ...
- > Major Permanent constituents of EARTH atmosphere O<sub>2</sub>, H<sub>2</sub>O, CO<sub>2</sub>, ...
- > Trace molecules in the EARTH atmosphere NO, SO<sub>2</sub>, NO<sub>2</sub>, NH<sub>3</sub>, HNO<sub>3</sub>, OH, HF, HCl, HBr, HI, ClO, OCS, H<sub>2</sub>CO, PH<sub>3</sub>
- > Molecules in atmospheres of JUPITER, SATURN, URANUS, TITAN, etc.: CH<sub>4</sub>, C<sub>2</sub>H<sub>2</sub>, C<sub>2</sub>H<sub>4</sub>, C<sub>2</sub>H<sub>6</sub>, GeH<sub>4</sub>, HCN, C<sub>3</sub>H<sub>2</sub>, C<sub>3</sub>H<sub>4</sub>

### Distribution Visualization and Tools

GEISA-2015 and associated management software facilities are implemented on AERIS and distributed by its ESPRI data center <http://www.pole-ether.fr/ether/Typo/index.php?id=1450&L=1>



### GEISA-2015 line transition parameters archive

In red : New or updated molecules since the GEISA-2011 edition

Molecular species	ID	Contributors	Number of transitions
H <sub>2</sub> O	1	L. Coudert, J. Tennyson, A. Campargue, S. Mikhailenko, O.V. Naumenko, J. Orphal, A. Ruth, R.R. Gamache	119,885
CO <sub>2</sub>	2	V.I. Perevalov, S. Tashkun, R.R. Gamache	534,227
O <sub>3</sub>	3	A. Barbe, S. Mikhailenko, V.G. Tyuterev	405,919
NO	4		50,633
CO	5		13,515
CH <sub>4</sub>	6	V. Boudon, L.R. Brown, A. Campargue, D.C. Benner, S. Yu, B. Drouin	439,385
O <sub>2</sub>	7		16,197
NO	8		105,079
SO <sub>2</sub>	9	D. Jacquemart, H.S.P. Müller	83,668
NO <sub>2</sub>	10		104,223
NH <sub>3</sub>	11	M. Down, J. Tennyson, L.R. Brown	46,414
Phb	12		20,364
HNO	13	A. Perrin	691,161
OH	14		42,866
HF	15		107
HCl	16		533
HBr	17		1,293
HI	18		806
ClO	19		7,230
OCS	20		33,809
H <sub>2</sub> CO	21	D. Jacquemart, H.S.P. Müller, L.R. Brown, K.Y. Sung	44,611
C <sub>2</sub> H <sub>4</sub>	22	L.R. Brown, K.Y. Sung	53,803
CH <sub>2</sub> O	23	L.R. Brown, A. Campargue	58,763
CH <sub>2</sub>	24	D. Jacquemart	12,969
C <sub>2</sub> H <sub>2</sub>	25	J.-M. Flaud	53,227
GeH <sub>4</sub>	26		824
HCN	27	J. Tennyson	138,103
C <sub>2</sub> H <sub>6</sub>	28		8,983
C <sub>2</sub> N <sub>2</sub>	29	A. Jolly, A. Fayt	71,954
C <sub>2</sub> H <sub>6</sub>	30	A. Jolly, A. Fayt	417,540
HCN	31		179,347
HOCI	32		17,862
N <sub>2</sub>	33		120
CH <sub>3</sub> Cl	34	D. Jacquemart, A. Nikitin, J. Buldyreva, N. Lavrentieva	83,043
H <sub>2</sub> O <sub>2</sub>	35		126,983
H <sub>2</sub> S	36	O.V. Naumenko, L.R. Brown	58,650
HCOOH	37		62,684
COF <sub>2</sub>	38		70,904
SF <sub>6</sub>	39		92,398
CaH <sub>4</sub>	40		19,001
HO <sub>2</sub>	41		38,804
ClONO <sub>2</sub>	42		356,899
CH <sub>3</sub> Br	43	D. Jacquemart	36,911
CH <sub>3</sub> OH	44		19,897
NO <sup>+</sup>	45		1,208
HNC	46	J. Tennyson	75,554
CaH <sub>2</sub>	47		9,797
C <sub>2</sub> HD	48		15,512
CF <sub>4</sub>	49		60,033
CH <sub>3</sub> CN	50		17,172
HDO (NEW)	51	A. Campargue, S. Mikhailenko, O.V. Naumenko, R.R. Gamache	63,641
SO <sub>2</sub> (NEW)	52	J. Tennyson, D.S. Underwood	10,881
Total number of lines			5,067,351

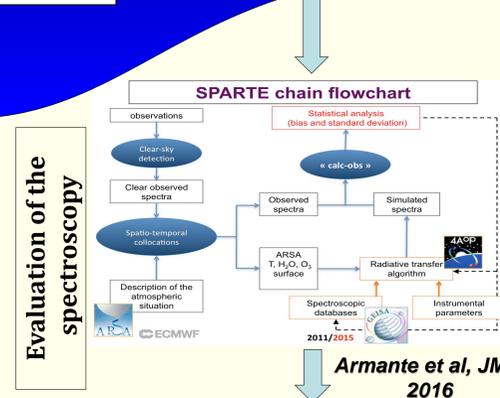
Jacquinet et al, JMS, 2016

**Aerosols** (NON EXHAUSTIVE LIST)  
African mineral dust: C. Di Biagio et al. Atmos. Chem. Phys., 14, 11093-11116, 2014 <https://doi.org/10.5194/acp-14-11093-2014>

**Cross-sections** (NON EXHAUSTIVE LIST)  
cyc-CF<sub>2</sub>CF<sub>2</sub>CF<sub>2</sub>CF=CH: Dongpeng Liu The Journal of Physical Chemistry A, DOI: 10.1021/acs.jpca.6b10348  
HCFC-22: Jeremy J. Harrison. Atmos. Meas. Tech., 9, 2593-2601, 2016 <https://doi.org/10.5194/amt-9-2593-2016>  
GPCOS LISA cross-sections database to be considered <http://www.lisa.u-pec.fr/GPCOS/SCOOPweb/>

### Lines

MOLECULES	ID	CONTRIBUTION REFERENCES (Non exhaustive preliminary list)	MOLECULES	ID	CONTRIBUTION REFERENCES (Non exhaustive preliminary list)
H <sub>2</sub> O	1	Tennyson et al. UCL Continuous update, (IUPAC)	HCl	16	Hebert et al. PTB
CO <sub>2</sub>	2	Perevalov et al. IAO Tennyson et al. UCL	OCS	20	Gobeliowski et al. ULB
O <sub>3</sub>	3	Tyuterev et al. GSMA Mikhailenko et al. IAO	C <sub>2</sub> H <sub>6</sub>	22	Moazzen-Ahmadi et al. U. Calgary
N <sub>2</sub> O	4	Tashkun et al. IAO Loos et al. PTB Hebert et al. IAO	CH <sub>3</sub> D	23	Boudon et al. ICB
CO	5	Li et al. CFA	C <sub>2</sub> H <sub>2</sub>	24	Jacquemart et al. UPMC Campargue et al. LIPhy
CH <sub>4</sub>	6	Boudon et al. ICB Nikitin et al. Campargue et al. LIPhy, GSMA	C <sub>2</sub> H <sub>4</sub>	25	Alkadrou et al. GSMA ULB
O <sub>2</sub>	7	Yu et al. Drouin et al. JPL	GeH <sub>4</sub>	26	Ulenikov et al. IAO
NO	8	Endres et al. Müller et al. CDMS ExoMol database	C <sub>2</sub> H <sub>6</sub>	28	Perrin et al. LMD
NO <sub>2</sub>	10	Perrin et al. LMD	HOCI	32	Auwers et al. ULB
NH <sub>3</sub>	11	Tennyson et al. ExoMol database	CH <sub>2</sub> Cl	34	Nikitin et al. IAO
PH <sub>3</sub>	12	Sousa-Silva et al. SAYTI line list	H <sub>2</sub> S	36	Naumenko et al. IAO Ulenikov et al. IAO
			HDO	51	Naumenko et al. IAO Mikhailenko et al. IAO
New molecular species (non exhaustive list)					
MeCN		Müller et al. (CDMS database)			
COFCI		Perrin et al. LMD			



FROM GEISA-2015



GEISA-2018