GEISA: Gestion et Etude des Informations Spectroscopiques Atmosphériques; Management and Study of Atmospheric Spectroscopic Information

THE GEISA DATABASE 2009 ARCHIVE: An assessment of Spectroscopic Parameters through IASI Hyperspectral Remote Sensing Applications

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GENERAL CONTEXT

➢**The performance of the second generation vertical sounding, high-resolution, sophisticated infrared hyperstral spectroscopic instruments, such as AIRS in the USA and IASI in Europe, highly depends on the accuracy in the spectroscopic parameters of the optically active atmospheric gases, since such data constitute an essential input in the forward models that are used to interpret the recorded spectral radiances.**

➢**GEISA-09 is a computer-accessible spectroscopic database, designed to facilitate accurate forward atmospheric radiative transfer calculations using a line-by-line and (atmospheric) layer-by-layer approach.**

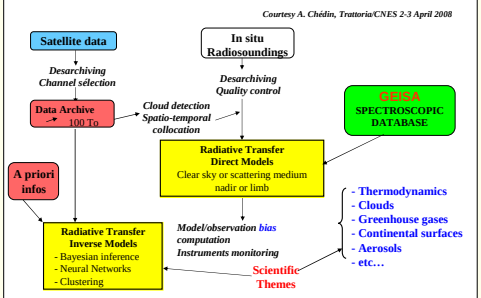
The current 2009 edition of GEISA (GEISA-09) is a system comprising three independent sub-databases, with associated management softwares and devoted respectively to:

- **Line transition parameters**
- **Absorption Cross-sections in the IR (39 molecular species) and in the UV/VIS (17 molecular species)**
- **Microphysical and Optical Properties of Atmospheric Aerosols.**

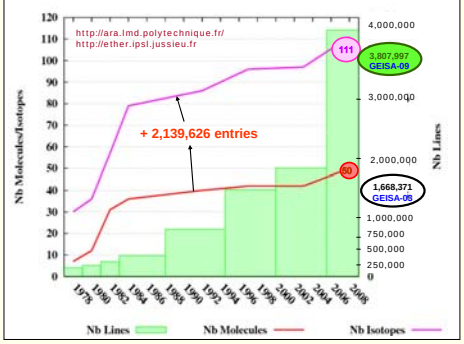
The development of GEISA was started in 1976 at Laboratoire de Météorologie Dynamique (LMD) in France and regularly updated.

➢**GEISA/IASI-09 derives from GEISA-09 for selected molecular species line transition parameters, in the IASI spectral range, 599 – 3001 cm^{-1}; 7 molecular species (CFC-11, CFC-12, CFC-14, CCl_4,N_2O_5, HCFC-22, PAN have been selected for inclusion in its IR absorption cross-sections sub-database; the Microphysical and Optical Properties of Atmospheric Aerosols archive is similar with the GEISA-09 one**

FROM SATELLITE OBSERVATIONS TO CLIMATE VARIABLES: a long process based on RadiativeTransfer



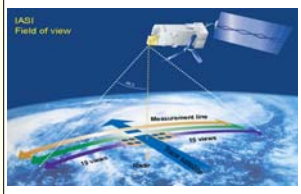
GEISA EVOLUTION SINCE 1978



GEISA EFFECTIVE USE

Related to IASI Level 1 Cal/Val activities@CNES

IASI ON METOP SINCE OCTOBER 19TH 2006 LAUNCH



GEISA/IASI used as the reference spectroscopic database [Jacquinet-Husson N. et al. JQSRT, 95, 429-67, 2005]
Validation achieved using 4A line by line Radiative Transfer Model [Scott & Chédin, J.Appl.Met (1981); 4A/LMD http://ara.lmd.polytechnique.fr 4A-OP co-developed by LMD and NOVELTIS with support of CNES]

GEISA DISTRIBUTION

GEISA implemented on the Ether (CNRS/CNES) Products and Services Centre (CPS)

http://ether.ipsl.jussieu.fr

GEISA-09 and GEISA/IASI-09 LINE TRANSITION ARCHIVES


(MSG-2 25/01/06)
EARTH

➢**Minor permanent constituents of the EARTH atmosphere : O_3,CH_4,N_2O,CO …**

➢**Major Permanent constituents of EARTH atmosphere : O_2,H_2O,CO_2 …**

➢**Trace molecules in the EARTH' atmosphere : NO, SO_2,NO_2,NH_3, HNO_3, OH,HF, HCl, HBr, HI, ClO, OCS, H_2CO, PH_3**

➢**Molecules in atmospheres of JUPITER, SATURN, URANUS,TITAN etc.: CH_6, CH_3D, C_2H_2, C_2H_4, GeH_4, HCN, C_3H_8, C_3H_4**


(CASSINI-HUYGENS 29/01/06)
TITAN

➢**14 molecules (53 isotopic species) selected for operational Meteorology:**
H_2O, CO_2, O_3, N_2O, CO, CH_4, O_2, NO, SO_2, NO_2, HNO_3, OCS, C_2H_2, N_2

➢**6 molecules (13 isotopic species) selected for IASI Trace Gas retrievals:**
NH_3, H_2CO, C_2H_4, HCN, HCOOH, CH_3OH

Related with: EPS Mission, IASI measurements capabilities, ISSWG, IASI-NG; Associated interest for AIRS

Mole	Spectral range (cm^{-1})	# lines	Mole	Spectral range (cm^{-1})	# lines	Mole	Spectral range (cm^{-1})	# lines
H_2O	0.007 – 25,232.004	67,789	HBr	16.232 – 9,758.564	1,294	N_2	1,992.628 – 2,625.497	120
CO_2	5.891 – 12,784.053	413,619	HI	12.509 – 8,487.305	806	CH_3Cl	674.143 – 3,172.927	18,344
O_3	0.0263 - 6395.379	389,373	ClO	0.015 – 1,207.639	7,230	H_2O_2	0.043 – 1,730.371	126,983
N_2O	0.838 – 7,796.633	50,633	OCS	0.381 – 4,199.671	33,809	H_2S	2.985 – 4,256.547	20,788
CO	3.414 – 8,464.882	13,515	H_2CO	0.000 – 3,099.958	37,050	HCOOH	10.018 – 1,889.334	62,681
CH_4	0.001 – 9,199.284	240,991	C_2H_6	706.601501 - 961.145	27,644	COF2	725.005 – 2,001.348	83,750
O_2	0.000 – 15,927.230	6,428	CH_3D	7.760 – 6,510.326	49,237	SF_6	588.488 - 975.788	92,398
NO	0.000 - 9273.214	105,079	C_2H_2	604.774 – 9,889.038	11,340	C_2H_4	288.913 - 673.479	19,001
SO_2	0.0174 – 4,092.948	68,726	C_2H_4	701.203 – 3,242.172	18,376	HO_2	0.173 – 3,675.819	38,804
NO_2	0.498 – 3,074.152	104,223	GeH4	1,937.371 – 2,224.570	824	$ClONO_2$	0.636 - 797.741	356,899
NH_3	0.058 – 5,294.501	29,082	HCN	0.000 – 17,581.010	82,042	CH_3Br	794.403 – 1,705.612	36,911
PH_3	17.805 - 3601.652	20,421	C_3H_8	700.015 - 799.930	8,983	CH_3OH	0.019 – 1,407.206	19,897
HNO_3	0.0119 – 1,769.982	669,988	C_3N_2	203.955 – 2,181.690	2,577	NO_+	1,634.831 – 2,530.462	1,206
OH	0.005 – 35,877.031	42,866	C_3H_2	191.635 - 730.235	119,480	HNC	0.217 – 4,814.904	5,619
HF	41.111 – 11,535.570	107	HC_3N	463.604 - 759.989	179,347	C_3H_8	642.427 - 705.262	9,797
HCl	20.240 – 13,457.841	533	HOCl	0.0236 – 3,799.682	17,862	C_3HD	416.785 – 3,421.864	15,512
						CF_4	594.581 – 1,312.648	60,033
						CH_3CN	890.052 – 1,650.000	17,172
						TOTAL # LINES	3,807,997	

50 Molecules 111 Isotopes

Molecules GEISA/IASI

ARCHIVED SPECTROSCOPIC LINE PARAMETERS

252 character Records 31Parameters

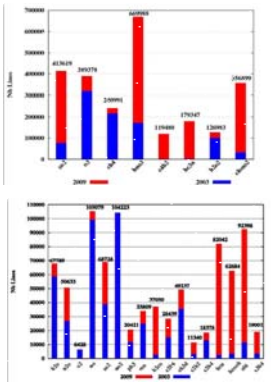
(A) Wavenumber (cm^{-1}) of the line associated with the vibro-rotational transition.
(B) Intensity of the line (cm molecule^{-1} at 296K).
(C) Lorentzian collision halfwidth (cm^{-1} atm^{-1} at 296K).
(D) Energy of the lower transition level (cm^{-1}).
(E) Transition quantum identifications for the lower and upper levels of the transition
(F) Temperature dependence coefficient *n* of the halfwidth
(G) Identification code for isotope.
(I) Identification code for molecule.
(J) Internal GEISA code for data identification.

(K) Molecule number as in HITRAN
(L) Isotope number as in HITRAN
(M Einstein A-coefficient

(N Self broadening pressure halfwidth (HWHM) (cm^{-1}atm^{-1}) at 296K
(O Air pressure shift of the line transition (cm^{-1}atm^{-1}) at 296K
(R) Temperature dependence coefficient n of the air pressure shift
(A') Estimated accuracy (cm-1) on the line position
(B') Estimated accuracy on the intensity of the line in (cm^{-1}/(molecule.cm^{-2})
(C') Estimated accuracy on the air collision halfwidth (HWHM) (cm^{-1}atm^{-1})
(F') Estimated accuracy on the temperature dependence coefficient n of the air broadening HW
(O') Estimated accuracy on the air pressure shift of the line transition (cm^{-1}atm^{-1}) at 296K
(R') Estimated accuracy on the temperature dependence coefficient n of the air pressure shift
(N') Estimated accuracy on the self broadened (HWHM) (cm^{-1}atm^{-1}) at 296K
(S) Temperature dependence coefficient n of the self broadening halfwidth
(S') Estimated accuracy on the temperature dependence coefficient n of the self broadening HW
(T) Self pressure shift of the line transition (cm^{-1}atm^{-1}) at 296K
(T') Estimated accuracy on the self pressure shift of the line transition (cm^{-1}atm^{-1}) at 296K
(U) Temperature dependence coefficient n of the self pressure shift
(U') Estimated accuracy on the temperature dependence coefficient n of the self pressure shift

Standardized parameter missing values in GEISA-09

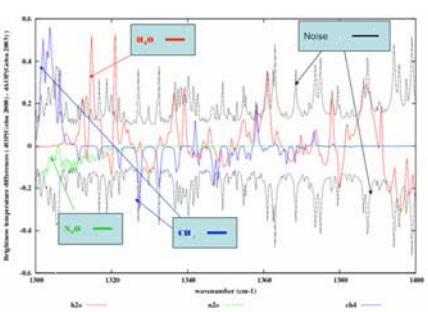
LINES EVOLUTION SINCE GEISA-03 FOR GEISA-09 UPDATED MOLECULES



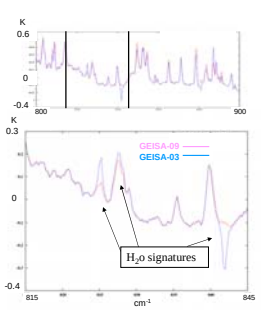
ASSESSMENT OF SPECTROSCOPY FOR IASI; GEISA/IASI-09 UPDATE EVALUATION

➢**Use of GEISA/IASI-03 and GEISA/IASI-09 in STRANSAC and 4A/OP for evaluation of Spectroscopy impact in IASI Brightness Temperatures (BT) modelizations and observations. Examples for H_2O, N_2O, CH_4**
➢**Conditions for evaluation against observations:**
IASI data: 2007/7 – 2009/11; Collocations (300 km, 3 hours) of clear IASI observations with radiosoundings from the ARSA database (ARA/LMD Analyzed RadioSoundings Archive ARA/LMD

BT TEMPERATURE DIFFERENCES (4AOP/GEISA-09 – 4AOP/GEISA-03)



STATISTICS FOR SEA, NIGHT, TROPICAL ATMOSPHERES OF DIFFERENCES « SIMULATED vs OBSEVED »; all spectral ranges of IASI currently studied



CONCLUSIONS FROM ISSWG 2.1, JULY 2008, CNES, PARIS

- water vapour needs to be validated, and the continuum reinvestigated (conclusion of comparisons of simulations with HITRAN or GEISA and ECMWF radiosoundings).
- Urgent areas to investigate were considered to be line coupling, (which should be independent of the data bases) and non LTE.
- IASI related spectroscopy problems with H_2O and CO_2 as first priority
- Assessment of Molecular species related with IASI Trace Gas Retrievals (HCN,NH_3,HCOOH, C_2H_4, CH_3OH)

NECESSARY VALIDATION

REFERENCES
Jacquinet-Husson N. et al. The 2003 edition of theGEISA/IASI spectroscopic database.JQSRT, 95, 429-67, 2005.
Jacquinet-Husson N. et al. The GEISA spectroscopic database: current and future archive for Earth & planetary atmosphere studies. JQSRT, 109, 1043 - 1059, 2008.

ASSOCIATED FRENCH INSTITUTIONS
CNES: Centre National d'Etudes Spatiales
CNRS: Centre National de la Recherche Scientique
INSU: institut National des Sciences de l'Univers
IPSL: Institut Pierre Simon Laplace des Sciences de l'Environnement

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