Atmospheric Radiation Analysis
Laboratoire de Météorologie Dynamique/CNRS/IPSL

The GEISA spectroscopic database: a key tool for remote sensing applications

http://ara.abct.lmd.polytechnique.fr

N. Jacquinet

R. Armante, L.Crépeau, N.A. Scott , A. Chédin, C. Crevoisier, V.Capelle, C. Boutammine , A. Bouhdaoui

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

ITSC-19, Jeju Island, South Korea, 25 March – 1 April 2014

OUTLINE

1. General Presentation; IASI and IASI-NG molecules selection
2. Details of Updates (IASI and IASI-NG Spectral Range)
3. Evaluation
4. Distribution

GEISA SYSTEM GENERAL CONTEXT

- GEISA is a computer-accessible Spectroscopic Database designed for accurate forward atmospheric radiative transfer calculations using a line-by-line (atmospheric) layer-by-layer approach.

spectral range 10^{-6} – 35,877 cm^{-1}

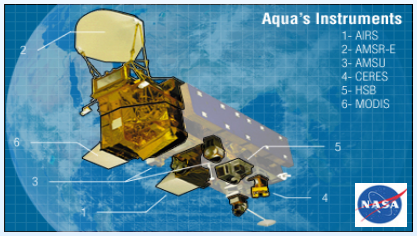
10^{10} – 0.28 µm

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

N. Jacquinet-Husson *et al.*, The 2009 edition of the GEISA spectroscopic database, *JQSRT* 112, 2395-2445, 2011

GEISA-11 SYSTEM GENERAL CONTEXT

Spectroscopy is at the root of modern planetology, enabling to determine the physical properties of planets remotely



(CASSINI-HUYGENS 29/01/06 TITAN)

EPS METOP

IASI

Computer-accessible Spectroscopic Database

GEISA

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

spectral range 10^{-6} - 35,877 cm^{-1}
10^{10} - 0.28 µm

MANAGEMENT SOFTWARES
For each Sub-database
http://www.pole-ether.fr

Line parameters sub-database
3,794,426 entries
50 molecules (111 isotopic species)

Absorption cross-sections sub-database
IR: 39 molecular species
UV/Visible : 17 molecular species

Microphysical and optical properties of atmospheric Aerosols sub-database

GEISA 2014 UPDATE

42 co-auteurs
16 laboratoires

Journal of Quantitative Spectroscopy & Radiative Transfer 95 (2005) 429–467

The 2003 edition of the GEISA/IASI spectr

N. Jacquinet-Husson[a,*], N.A. Scott[a], A. Chédin[a], K. Gar

53 co-auteurs
27 Laboratoires

Journal of Quantitative Spectroscopy & Radiative Transfer 109 (2008) 1043–1059

Journal of Quantitative Spectroscopy & Radiative Transfer

www.elsevier.com/locate/jqsrt

The GEISA spectroscopic database: Current and future archive for Earth and planetary atmosphere studies

N. Jacquinet-Husson[a,*], N.A. Scott[a], A. Chédin[a], L. Crépeau[a], R. Armante[a], V. Capelle[a], J. Orphal[b], A. Coustenis[c], C. Boonne[d], N. Poulet-Crovisier[d], A. Barbe[e], M. Birk[f], L.R. Brown[g], C. Camy-Peyret[h], C. Claveau[h], K. Chance[i], N. Christidis[j],

59 co-auteurs
26 laboratoires

Journal of Quantitative Spectroscopy & Radiative Transfer 112 (2011) 2395–2445

Contents lists available at ScienceDirect

Journal of Quantitative Spectroscopy & Radiative Transfer

journal homepage: www.elsevier.com/locate/jqsrt

UPDATED IN 2011

2014 UPDATE

The 2009 edition of the GEISA spectroscopic database

N. Jacquinet-Husson[a,*], L. Crepeau[a], R. Armante[a], C. Boutammine[a], A. Chédin[a], N.A. Scott[a], C. Crevoisier[a], V. Capelle[a], C. Boonne[d], N. Poulet-Crovisier[d], A. Barbe[c], A. Campargue[d], D. Chris Benner[e], Y. Benilan[r], B. Bézard[g], V. Boudon[n], L.R. Brown[i], L.H. Coudert[f], A. Coustenis[g], V. Dana[j], V.M. Devi[e], S. Fally[k], A. Fayt[l], J.-M. Flaud[f], A. Goldman[m], M. Herman[n], G.J. Harris[o], D. Jacquemart[p], A. Jolly[f], I. Kleiner[f], A. Kleinböhl[i], F. Kwabia-Tchana[p], N. Lavrentieva[q], N. Lacome[p], Li-Hong Xu[r], O.M. Lyulin[q], J.-Y. Mandin[j], A. Maki[s], S. Mikhailenko[q], C.E. Miller[i], T. Mishina[q], N. Moazzen-Ahmadi[t], H.S.P. Müller[u], A. Nikitin[q], J. Orphal[v], V. Perevalov[q], A. Perrin[f], D.T. Petkie[w], A. Predoi-Cross[x], C.P. Rinsland[y], J.J. Remedios[z], M. Rotger[c], M.A.H. Smith[y], K. Sung[i], S. Tashkun[q], J. Tennyson[o], R.A. Toth[i], A.-C. Vandaele[k], J. Vander Auwera[n]

GEISA-2014 System Overall Description

spectral range 10^{-6} - 35,877 cm^{-1} *(1010 - 0.28 µm)*

GEISA 2014 UPDATE

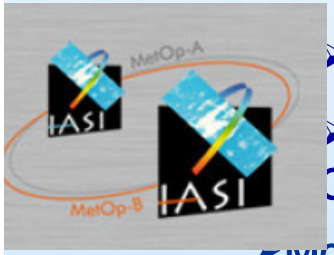
MANAGEMENT
SOFTWARES
and DISTRIBUTION
http://www.pole-ether.fr

Three SUB-DATABASES

- Line parameters sub-database

  52 molecules (113 isotopic species)

  About 4,800,000 entries in the spectral range10^{-6} and 35,877 cm^{-1}



- Major permanent constituants of EARTH atmosphere : O_2, H_2O, CO_2 …
- Trace molecules in EARTH atmosphere :
  CH_4, 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.:
  C_6H_6, CH_4, CH_3D, C_2H_2, C_2H_4, GeH_4, HCN, C_3H_8, C_3H_4

(CASSINI-HUYGENS
29/01/06 TITAN)

- Absorption cross-sections sub-database
  - IR and UV/Visible

- Microphysical and optical properties of atmospheric Aerosols sub-database

GEISA and IASI/IASI-NG Atmospheric Sounding

Extraction of GEISA in the spectral range 599 - 3001 cm^{-1}
Actual molecular species selection (possible extension)

❖Individual spectral lines spectroscopic parameters sub-database

23 molecules (66 isotopic species):

- 16 molecules (53 isotopic species) selected for operational meteorology)
H_2O, HDO, CO_2, O_3, N_2O, CO, CH_4, CH_3D, O_2, NO, SO_2, NO_2, HNO_3, OCS, C_2H_2, N_2

- 7 molecules (13 isotopic species) selected for IASI trace gas retrievals
HCN, HNC, NH_3, HCOOH, C_2H_4, CH_3OH, H_2CO

❖IR absorption cross-sections sub-database (mainly CFC's)

6 molecular species

- CFC-11, CFC-12, CFC-14, CCl_4,N_2O_5, HCFC-22;
- PAN (peroxyacetyl nitrate)

❖Microphysical and optical properties of Basic Atmospheric aerosol components sub-database

2014 GEISA line by line archive for IASI and IASI-NG Archive

645 – 3001 cm^{-1} spectral range (extraction of GEISA)
21 Molecular species

Operational Meteorology interest

H_2O	**updated**		
HDO	**updated**		
CO_2	**updated**		**Line shape parameters by R. Gamache**
O_3		*No update*	***on GEISA-IASI spectral range; update for GEISA***
N_2O		*No update*	
CO		*No update*	
CH_4	**updated**		V. Boudon's , A. Campargue's new line lists
CH_3D	**updated**		V. Boudon's , A. Campargue's new line lists
O_2	**updated**	New global approach by Shan Shan (JPL); revision of positions and ground level of HITRAN-12	
NO		*No update*	
SO_2			*Possible update (Ulenikov et al.; spectral interval 2600-2900 cm^{-1})*
NO_2		*No update*	
HNO_3	**updated**		A. Perrin, $H^{15}NO_3$ at 11µm. New isotopologue (code 156)
OCS		*No update*.	*Some verification to be made in the actual data base*
C_2H_2	**updated**		D. Jacquemart at 7.7 µm; spectral range:
N_2		*No update*	

Trace gazes potentially detectable by IASI and IASI-NG (non exhaustive list)

HCN	**updated**		J. Harris and J. Tennyson
HNC			
NH_3	**updated**		L.R. Brown
HCOOH		*No update*	
C_2H_4	**updated**		J.-M. Flaud
CH_3OH		*No update*	
H_2CO		*No update*	

Archived Spectroscopic Line Parameters

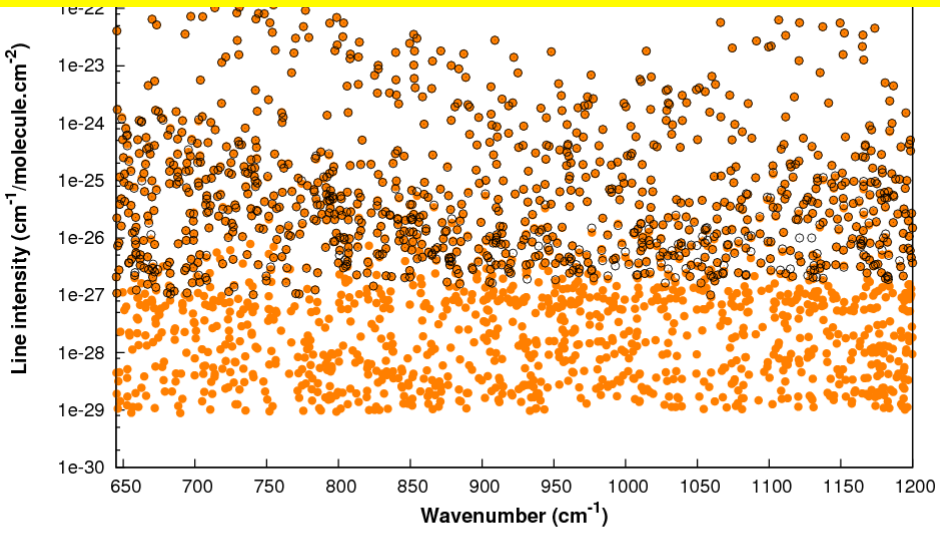
A Wavenumber (cm^{-1}) of the line
B Intensity of the line in (cm^{-1}/(molecule.cm^{-2})
C Air broadening pressure halfwidth (HWHM)(*) ($cm^{-1}atm^{-1}$)
D Energy of the lower transition level (cm^{-1})
E Transition quantum identifications for the lower and upper state of the transition
F Temperature dependence coefficient n of the air broadening HWHM
G Identification code for isotope as in GEISA
I Identification code for molecule as in GEISA
J Internal GEISA code for the data identification
K Molecule number in HITRAN
L Isotope number (1=most abundant. 2= second…etc) in HITRAN
M Einstein A-coefficient (s^{-1}).
N Self broadening pressure HWHM ($cm^{-1}atm^{-1}$)
O Air pressure shift of the line transition ($cm^{-1}atm^{-1}$)
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 HWHM ($cm^{-1}atm^{-1}$)
F' Estimated accuracy on the temperature dependence coefficient n of the air broadening HWHM
O' Estimated accuracy on the air pressure shift of the line transition ($cm^{-1}atm^{-1}$)
R' Estimated accuracy on the temperature dependence coefficient n of the air pressure shift
N' Estimated accuracy on the self HWHM
T Self pressure shift of the line transition ($cm^{-1}atm^{-1}$)
T' Estimated accuracy on the self pressure shift of the line transition ($cm^{-1}atm^{-1}$)
U Temperature dependence coefficient n of the self pressure shift
U' Estimated accuracy on the temperature dependence coefficient n of the self pressure shift broadened HWHM ($cm^{-1}atm^{-1}$)
S Temperature dependence coefficient n of the self broadening HWHM
S' Estimated accuracy on the temperature dependence coefficient n of the self- broadening

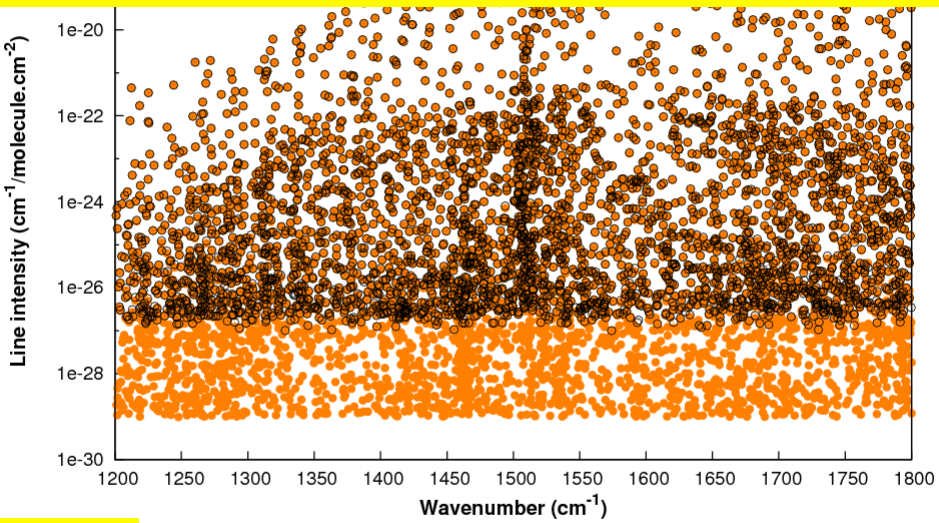
(*) HWHM: line half-width at half-maximum

NEW

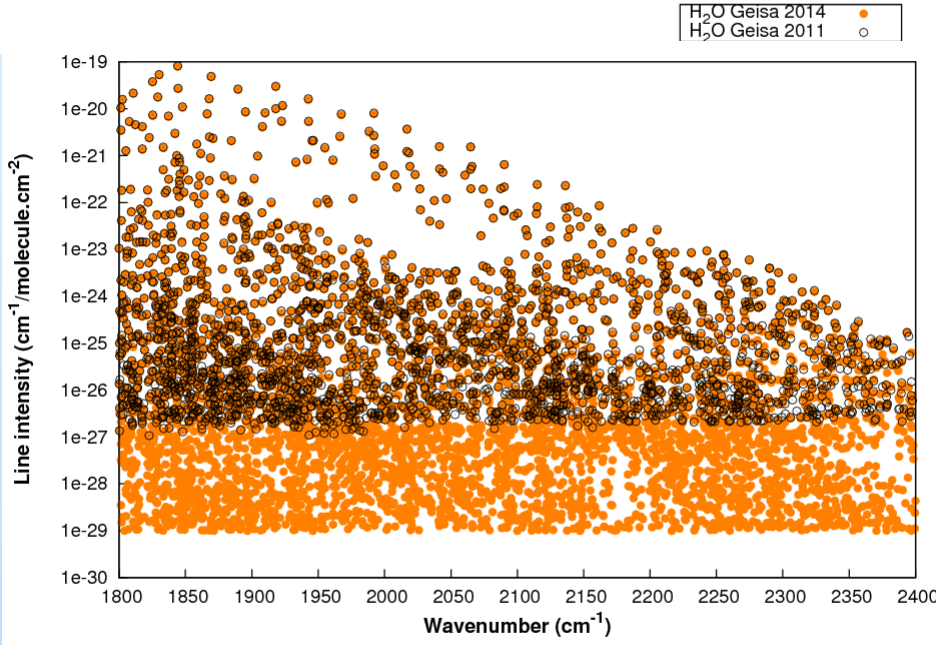
Since GEISA-09 Standardized parameter missing values

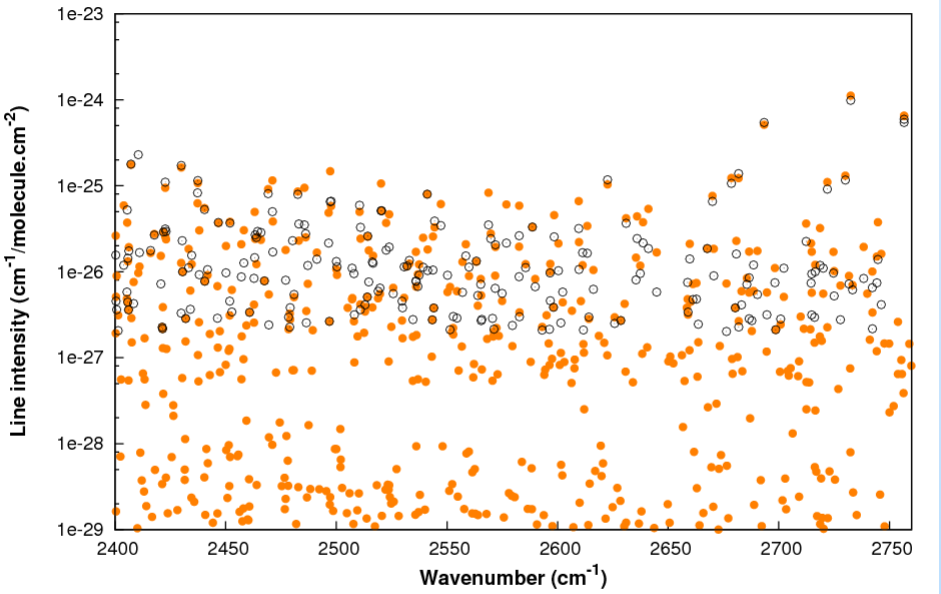
IMPORTANT: for GEISA 2014 edition HDO no more considered as an isotopologue of H_2O but as an idependent molecule (as for CH_4 and CH_3D)





H_2O





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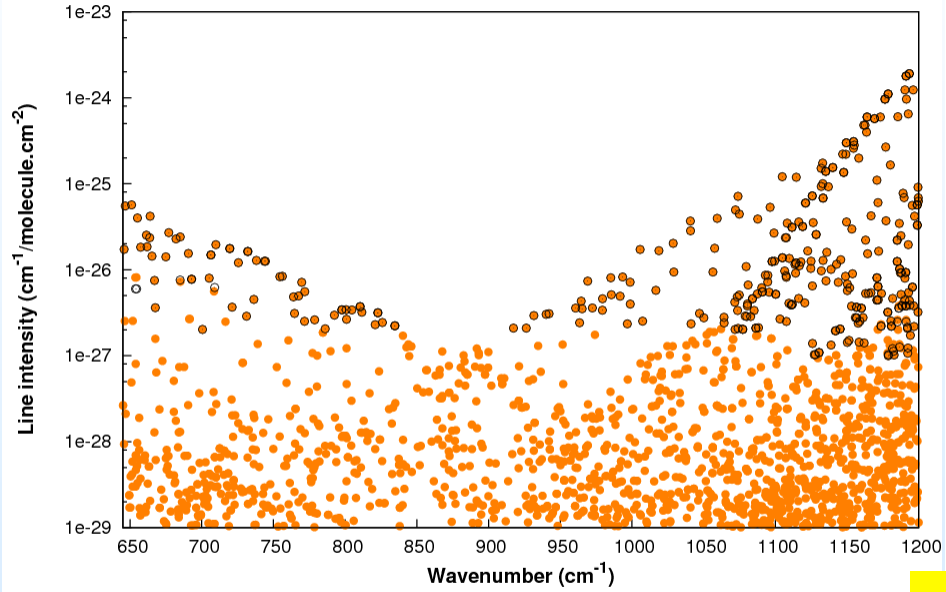
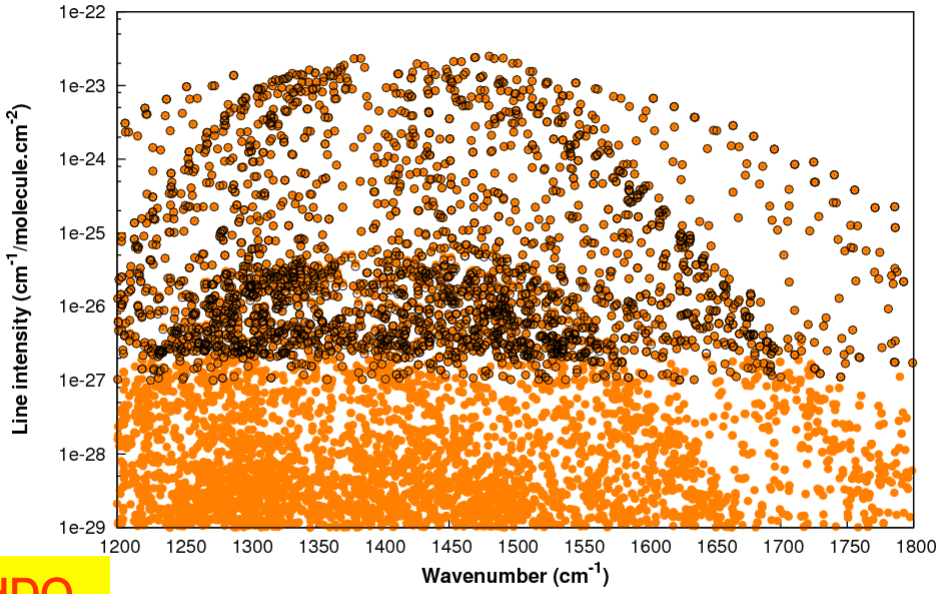
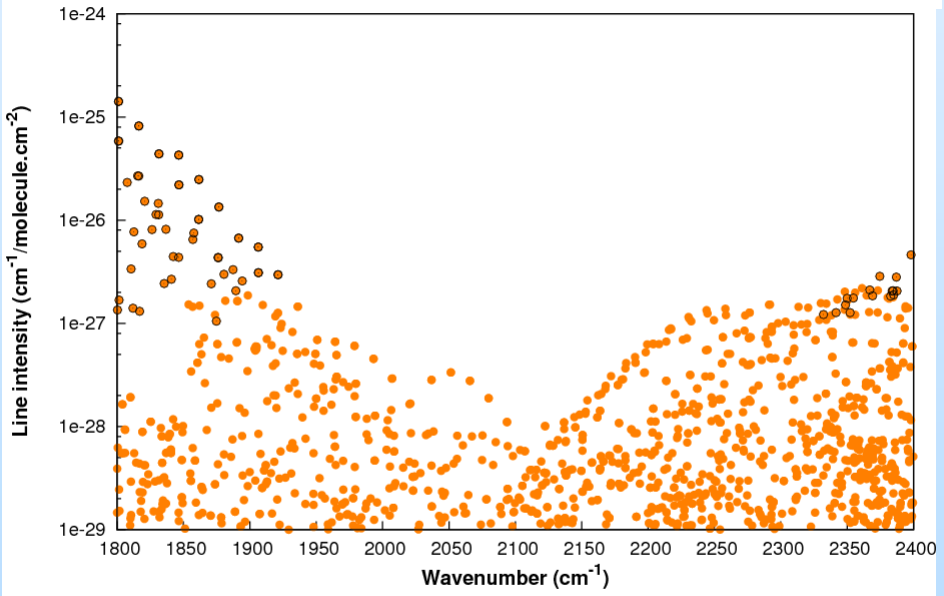
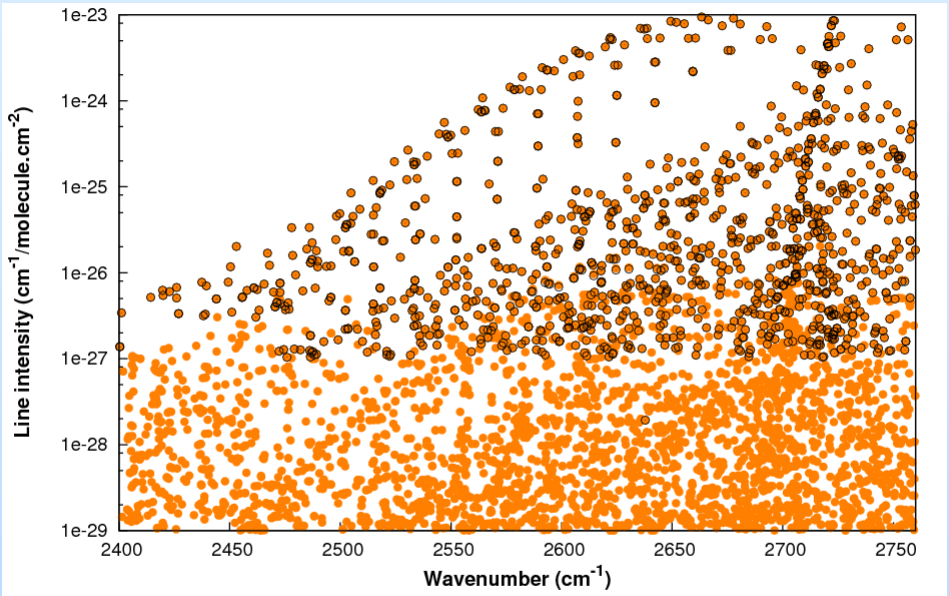
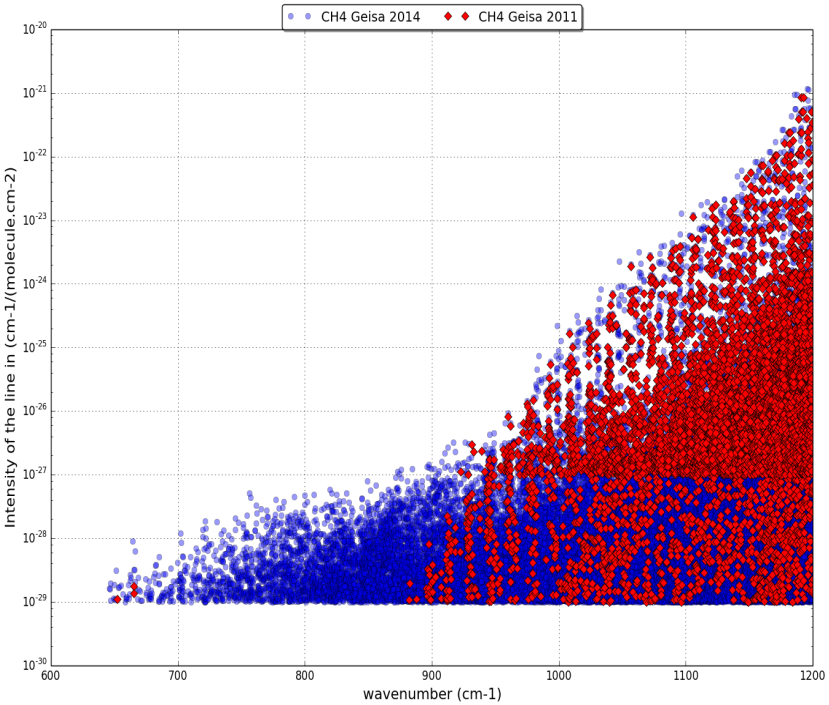


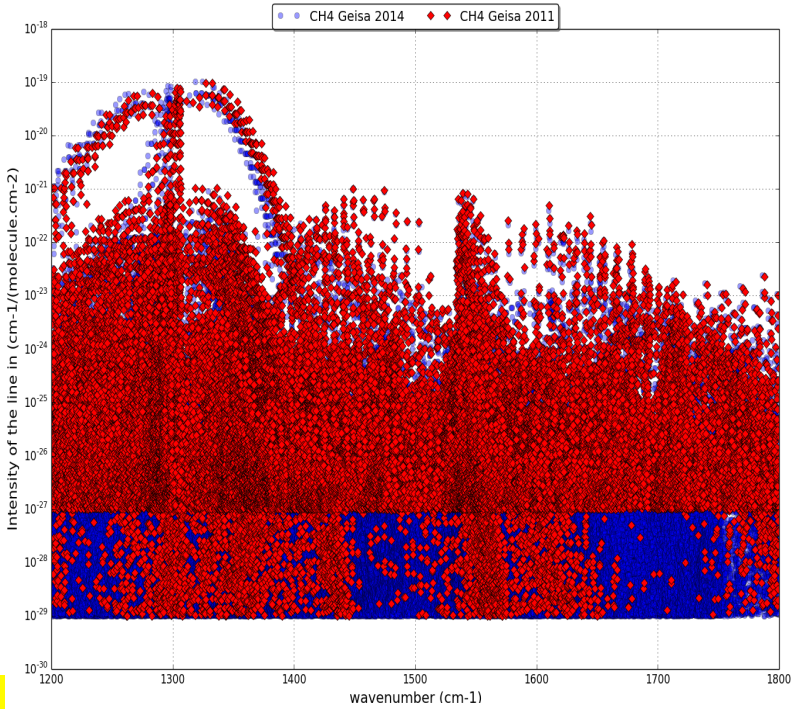


HDO

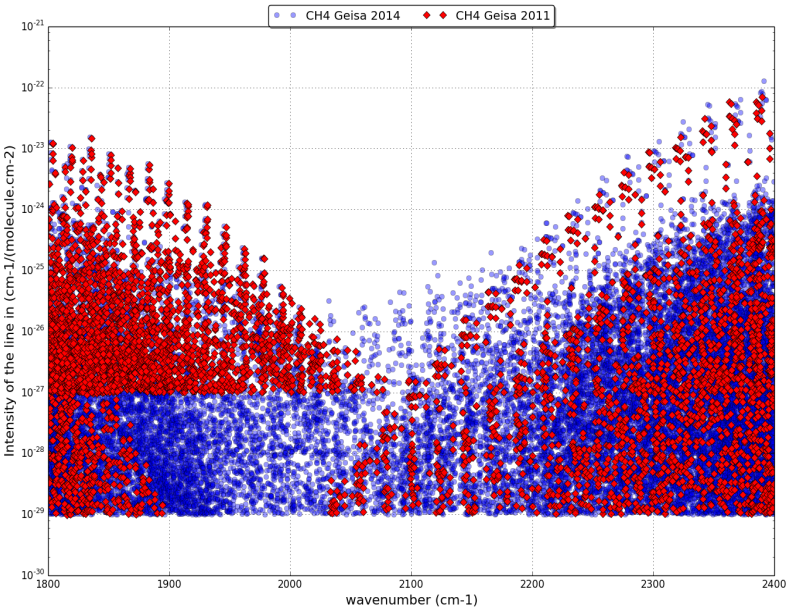


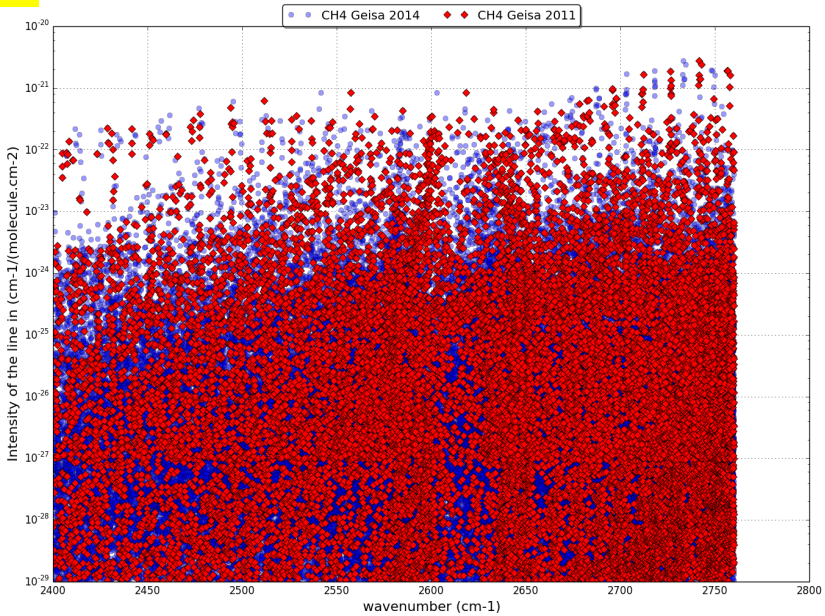


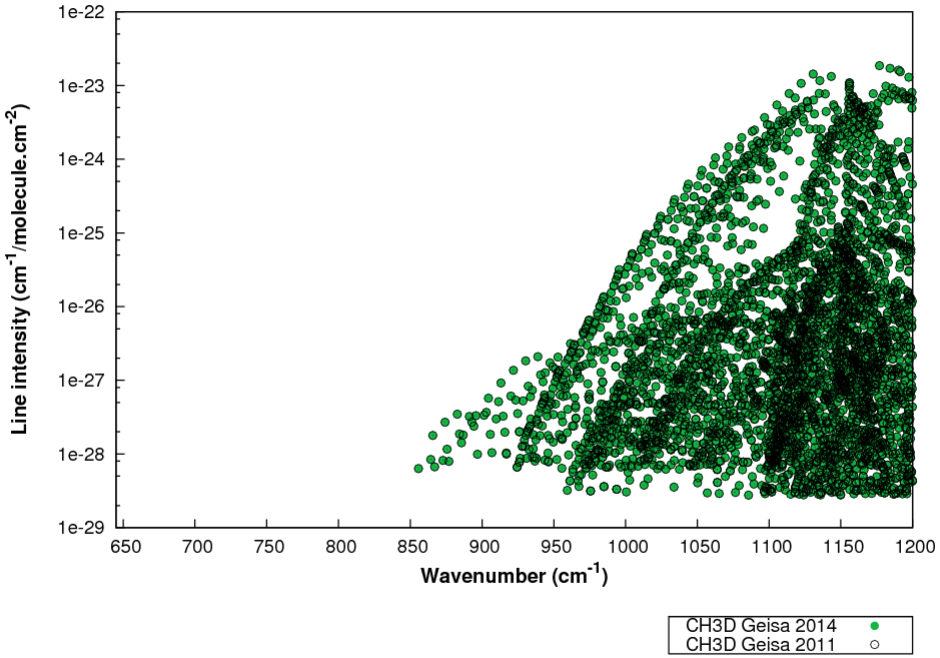

CH4 Geisa 2014
CH4 Geisa 2011
Intensity of the line in (cm-1/(molecule.cm-2)
wavenumber (cm-1)


CH4 Geisa 2014
CH4 Geisa 2011
Intensity of the line in (cm-1/(molecule.cm-2)
wavenumber (cm-1)

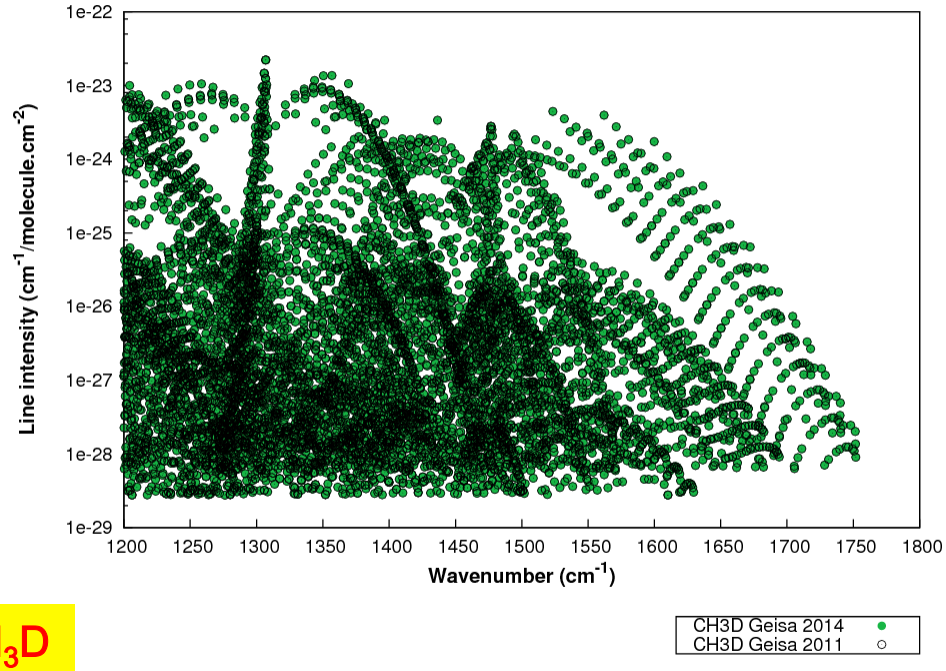
CH_4

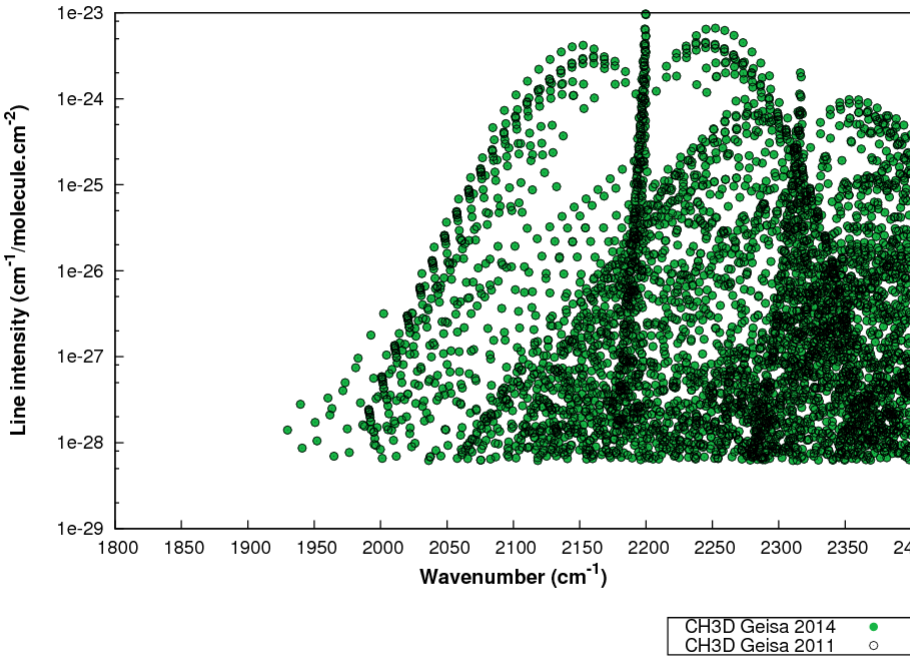

CH4 Geisa 2014
CH4 Geisa 2011
Intensity of the line in (cm-1/(molecule.cm-2)
wavenumber (cm-1)

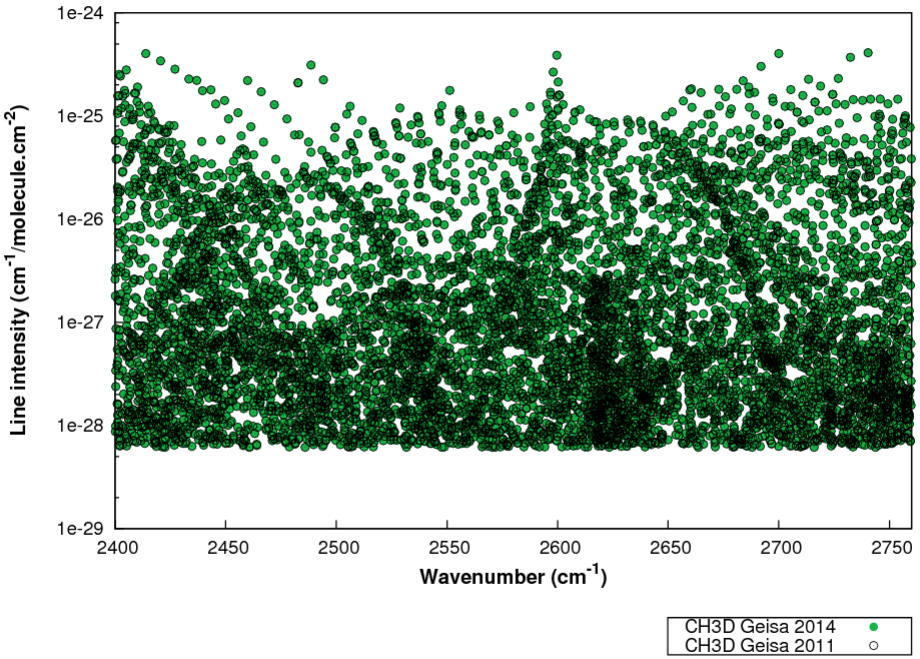

CH4 Geisa 2014
CH4 Geisa 2011
Intensity of the line in (cm-1/(molecule.cm-2)
wavenumber (cm-1)


Line intensity (cm-1/molecule.cm-2)
Wavenumber (cm-1)
CH3D Geisa 2014
CH3D Geisa 2011

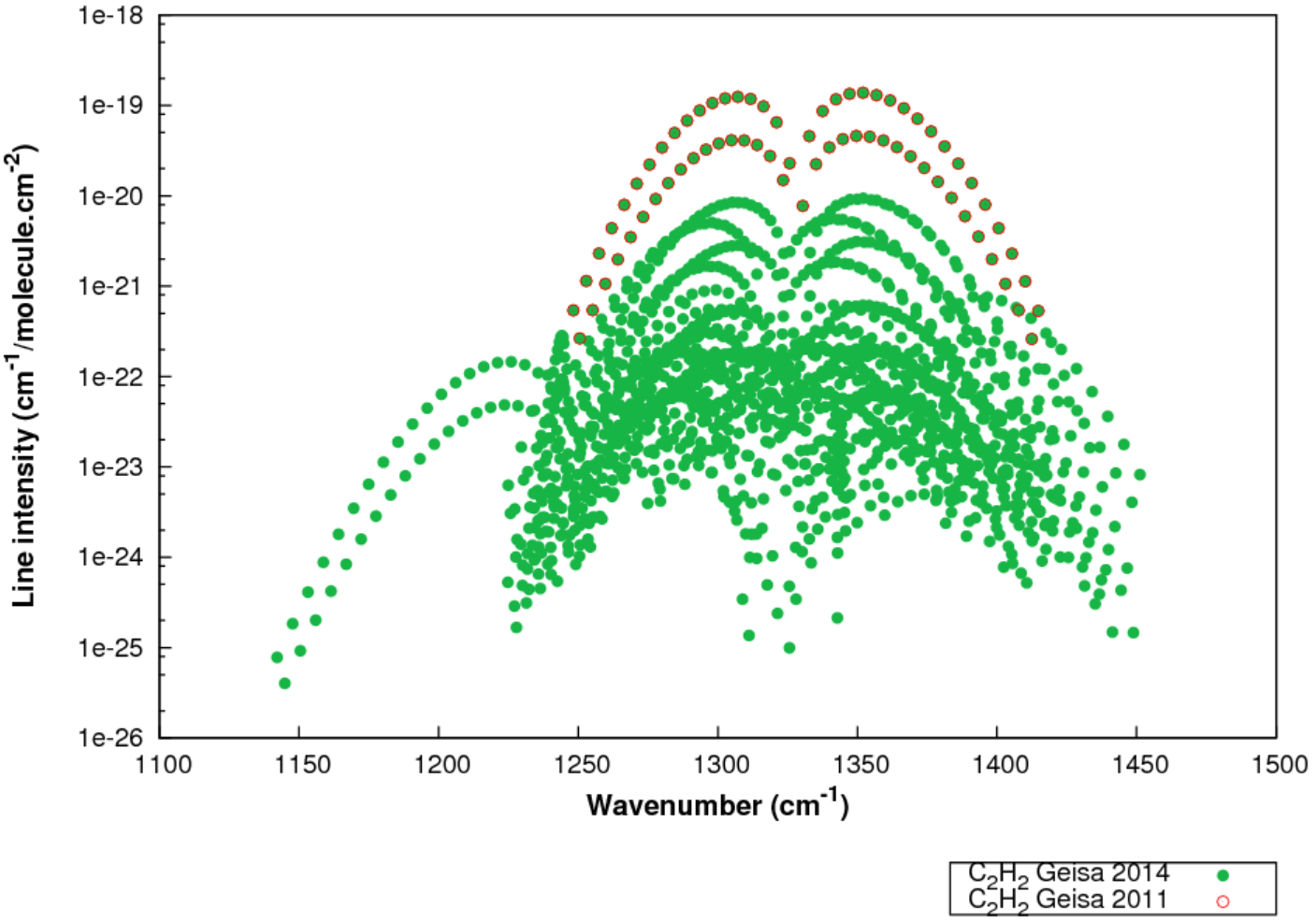
CH_3D


Line intensity (cm-1/molecule.cm-2)
Wavenumber (cm-1)
CH3D Geisa 2014
CH3D Geisa 2011

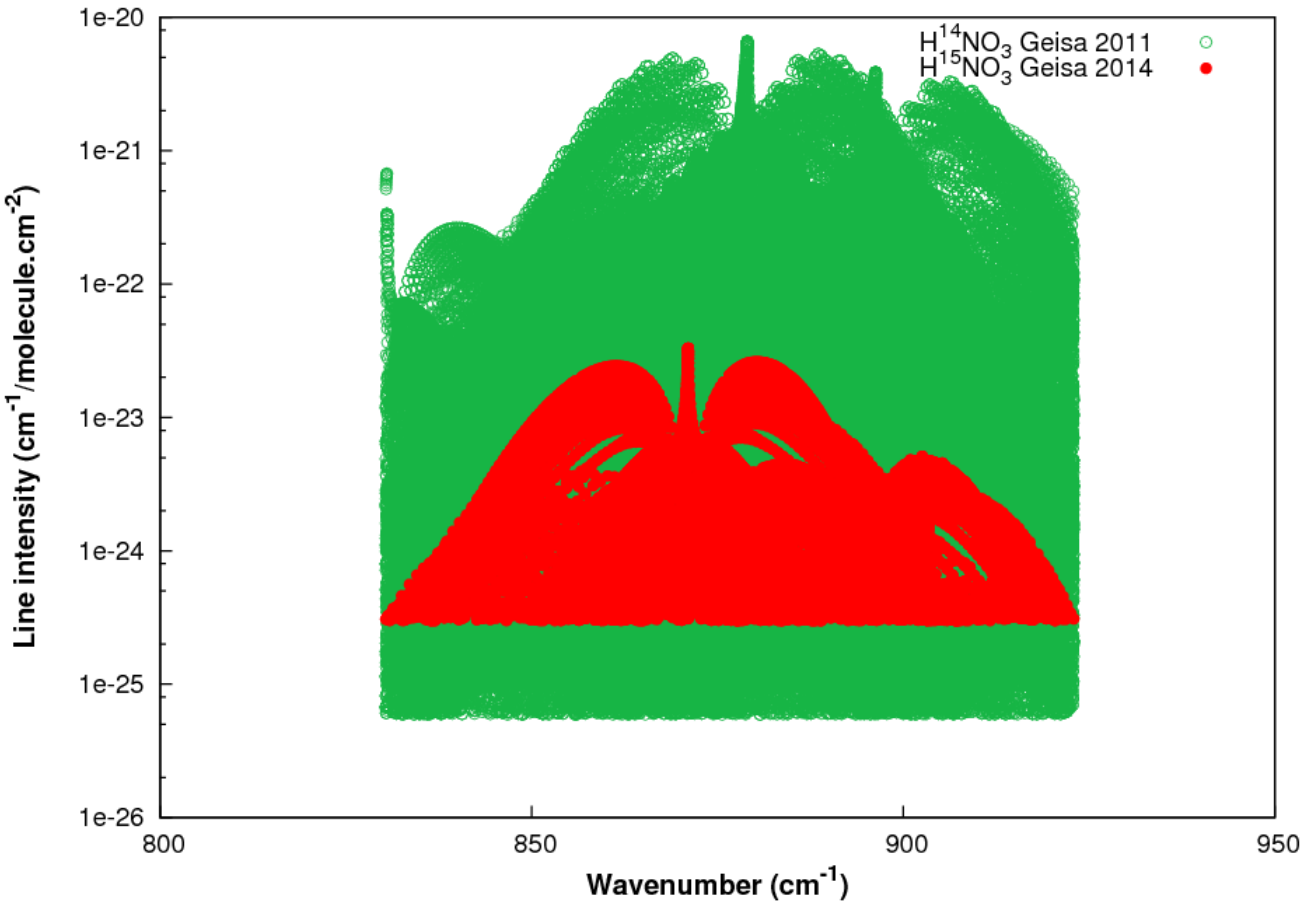

Line intensity (cm-1/molecule.cm-2)
Wavenumber (cm-1)
CH3D Geisa 2014
CH3D Geisa 2011


Line intensity (cm-1/molecule.cm-2)
Wavenumber (cm-1)
CH3D Geisa 2014
CH3D Geisa 2011

C_2H_2

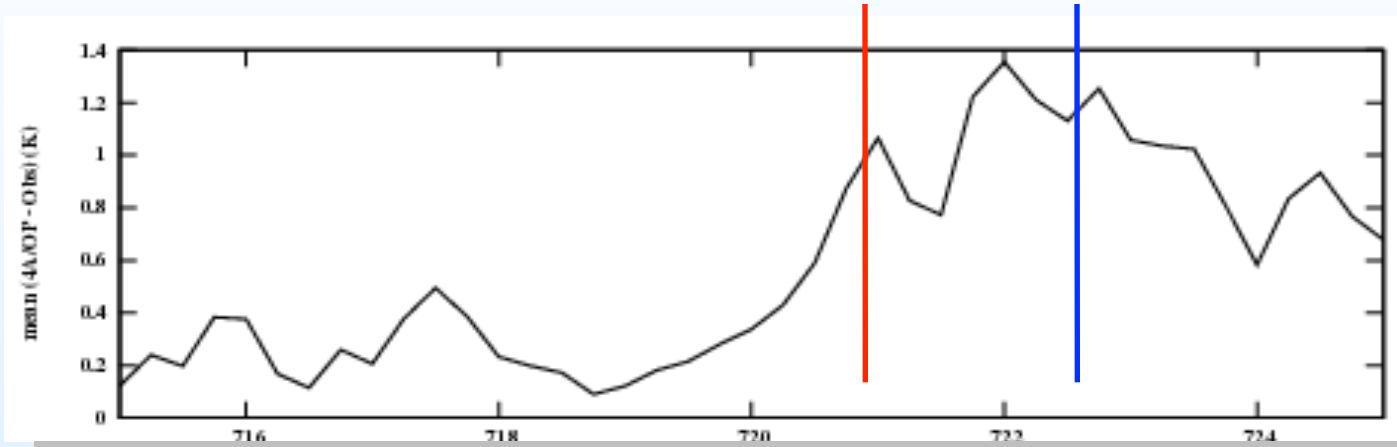

1e-18
1e-19
1e-20
1e-21
1e-22
1e-23
1e-24
1e-25
1e-26
Line intensity (cm-1/molecule.cm-2)
1100
1150
1200
1250
1300
1350
1400
1450
1500
Wavenumber (cm-1)
C2H2 Geisa 2014
C2H2 Geisa 2011

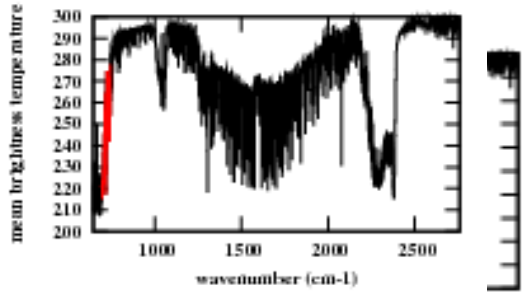
HNO_3

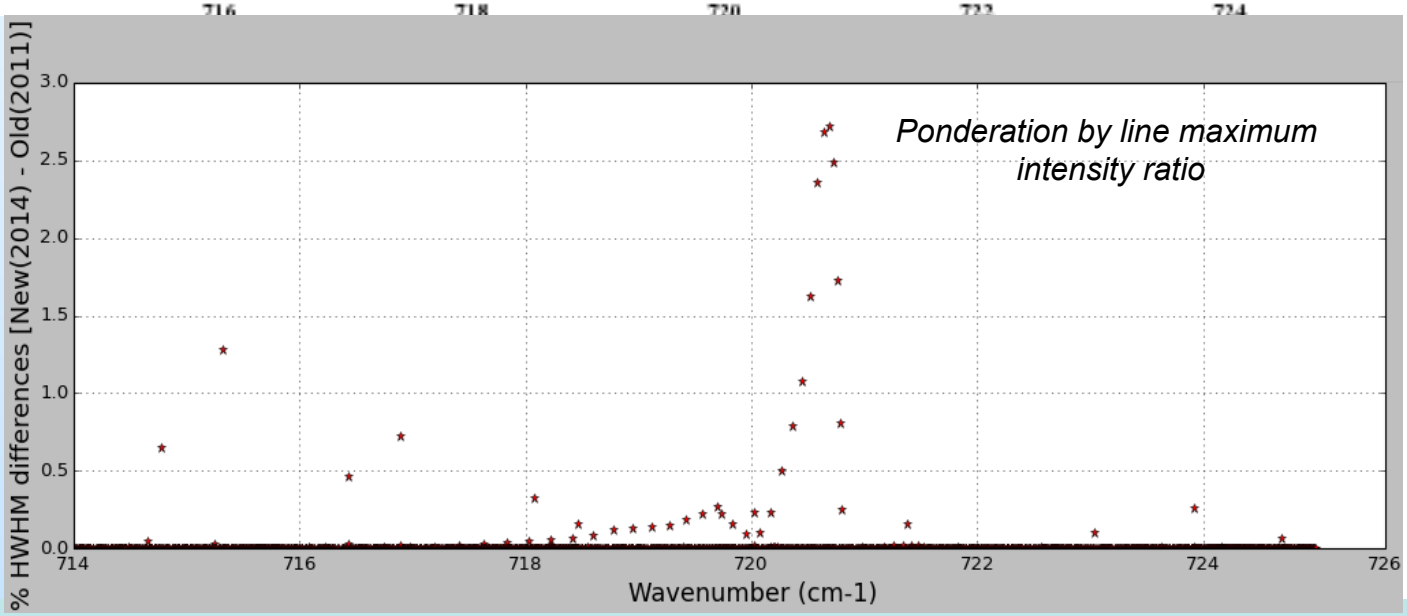

$H^{14}NO_3$ Geisa 2011
$H^{15}NO_3$ Geisa 2014
Line intensity (cm^{-1}/molecule.cm^{-2})
1e-20
1e-21
1e-22
1e-23
1e-24
1e-25
1e-26
800
850
900
950
Wavenumber (cm^{-1})

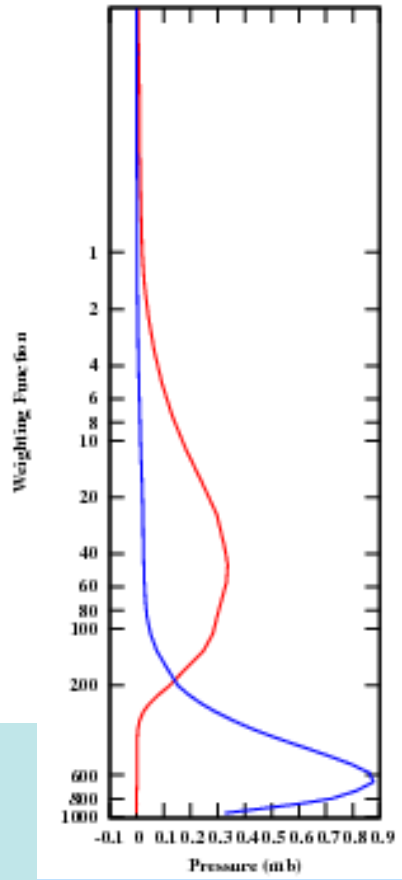
IASI Band B1 : 715 – 725 cm^{-1} spectral interval

See presentation #4.05 Scott et al









Work to be done at LMD:

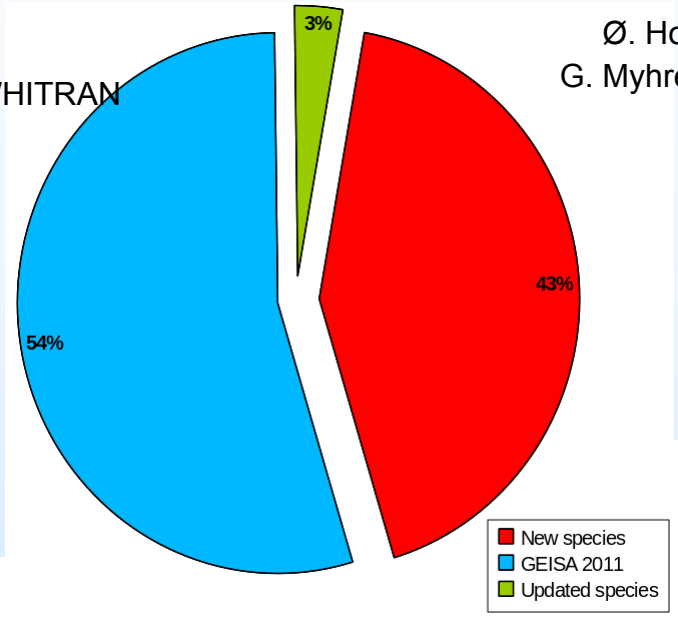
Update of the line mixing coefficients using new GEISA 2014 CO_2 HWHM by using :

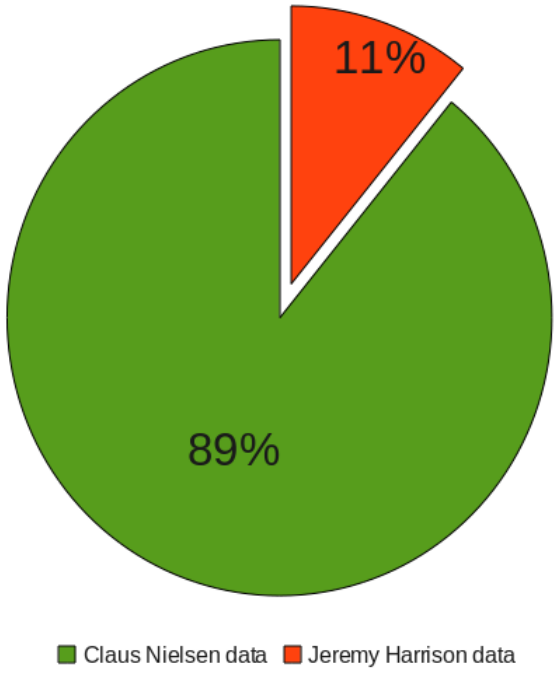
- ✓**Line mixing tools (J-M Hartmann)**
- ✓**Different Voigt profiles : classical or speed dependent (Ha Tran)**

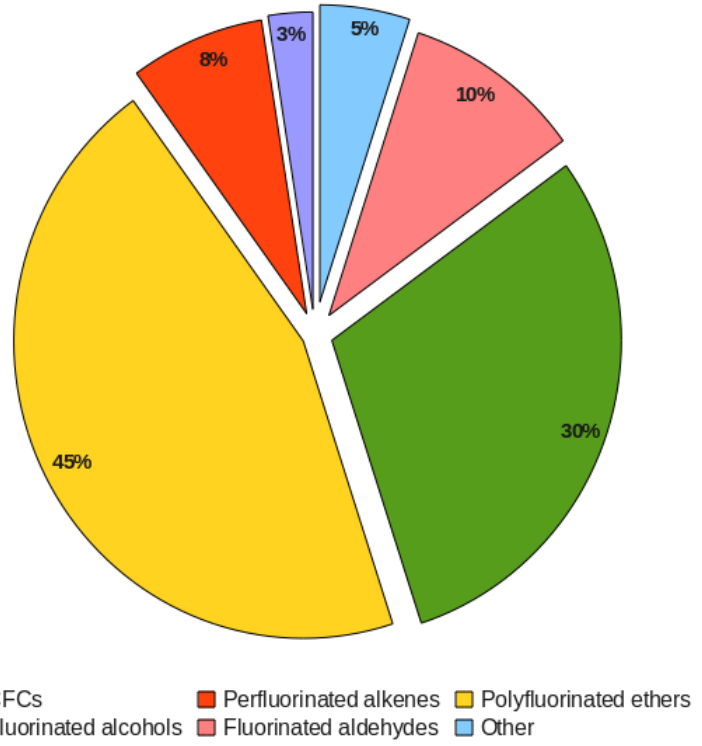
GEISA-2014 Cross-Sections Sub-database

J. Harrison et P. Bernath, ASA/HITRAN conference, Aug. 2012, Reims

Ø. Hodnebrog, M. Etminan, J.S.Fuglestvedt, G. Marston, G. Myhre, **C.J. Nielsen,** et al., Reviews of Geophysics, 2013

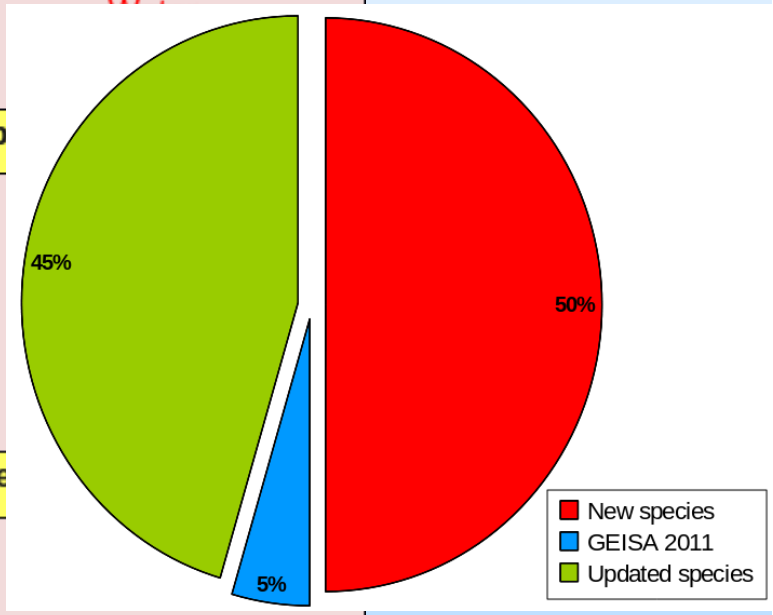






GEISA-2014 AEROSOLS SUB-DATABASE

Minerals		Organic acids
Clay Illite Kaolin Montrillite	Anhydrite Dolomite Hematite Illite Kaolinite Montmorillonite Olivine Olivine Fayalite Quartz Wustite	Ammonium sulphate $(NH_4)_2SO_4$ Benzoic acid $C_7H_6O_2$ Glutaric acid $C_3H_6(COOH)_2$ Hydroxymalonic $C_3H_4O_5$ Malonic acid $CH_2(COOH)_2$ Oxalic acid $H_2C_2O_4$ Phthalic acid $C_6H_4(CO_2H)_2$ Pinonic acid $C_{10}H_{16}O_3$ Pyruvic acid $CH_3COCOOH$ Succinic acid $C_4H_6O_4$
Acids		**Watern ice and sea-salts**
H_2SO_4 HNO_3 $H_2SO_4 + HNO_3$ Nitric acid dihydrate (NAD)		Supercooled Water Ice Ich Water
Dusts and sands		**Ashs, soots and b**
Saharan dust	Andesite Basalt Granite Limonite Obsidian Pumice Sand	Flame soot Ash volcanic Biomass aerosols Pyrolytic graphite Propane Organic-Based nonvolatile aerosols
Carbonaceous		**Othe**
Brown carbon spheres Amorphous carbon Different HULIS		Martian Dust Organic haze



GEISA SYSTEM COMPREHENSIVE DISTRIBUTION

Ether

Atmospheric Chemistry Data Centre

http://www.pole-ether.fr

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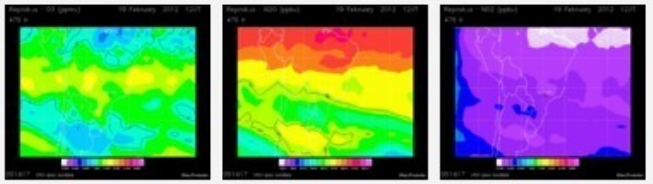
News

Project call

15, 16 october 2012 : Ether users committee meeting

26 november 2012 : Ether steering committee meeting



Reprobus map for the TRO-pico campaign 475K

Atmospheric Data

- Satellites - Balloons - NDACC - ECCAD - IASI - GOSAT - IAGOS

Satellites	Balloons	NDACC	ECCAD	IASI	GOSAT	IAGOS
		NDACC France	ECCAD			IAGOS

Field Campaigns

- TROpico - Megapoli - Enriched - StrapolEte

Daily Modelisation and Forecast

- Mimosa - Reprobus - Acomida

Spectroscopic data and Kinetics

- GEISA - Kinetics

GEISA	Kinetics
GEISA	

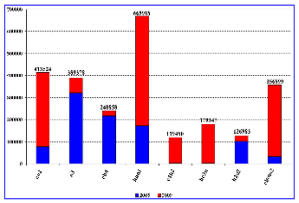
General content

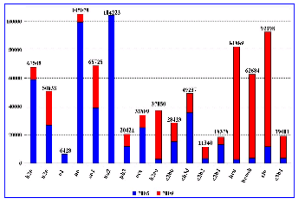
The GEISA-09 line transition parameters archive contains 3,794,488 lines in the spectral range 0.000001 - 35,877.030506 cm^{-1}.

Number of entries per molecule in GEISA-09 line transition parameters archive.
In red : Molecules updated in the GEISA-09 edition.

Molecules	Molecule codes	Isotope codes	Number of transitions
H_2O	1	162 161 171 181 182 172	67,509
CO_2	2	626 636 628 627 638 637 828 728 838	413,524
O_3	3	666 676 667 668 686	389,378
N_2O	4	446 447 448 456 458 546 548 556	50,633
CO	5	36 38 26 28 27 37	13,515
CH_4	6	211 311	240,858
O_2	7	66 67 68	6,428
NO	8	46 48 56	105,079
SO_2	9	626 646	68,728
NO_2	10	646	104,223
NH_3	11	411 511	29,082
PH_3	12	131	20,421
HNO_3	13	146	669,988
OH	14	61 62 81	42,866
HF	15	19	107
HCl	16	17 15	533
HBr	17	11 19	1,294

Lines evolution since GEISA-03 for GEISA-09 updated molecules





Format descriptor

Parameter	A	B	C	D	E1	E2	E3	E4	F	G	I	J
Field length	12	11	6	10	25	25	15	15	4	3	3	3
Fortran descriptor	F12.6	1PD11.4	0PF6.4	F10.4	A25	A25	A15	A15	F4.2	I3	I3	A3
Undefined values	-0.999999	-9.9999D-01	-.9999	-0.9999	*	*	*	*	-.99	-99	-99	*
Record counting	12	23	29	39	64	89	104	119	123	126	129	132

K	L	M	N	O	R	A'	B'	C'	F'
2	1	10	7	9	6	10	11	6	4
I2	I1	1PE10.3	0PF7.4	F9.6	F6.4	F10.6	1PD11.4	0PF6.4	F4.2
-9	0	-9.999E-01	-9.9999	0.000000	-.9999	-0.999999	-9.9999D-01	-.9999	-.99
134	135	145	152	161	167	177	188	194	198

O'	R'	N'	S	S'	T	T'	U	U'
9	6	7	4	4	8	8	4	4
F9.6	F6.4	F7.4	F4.2	F4.2	F8.6	F8.6	F4.2	F4.2
-9.999999	-.9999	-9.9999	-.99	-.99	-.999999	-.999999	-.99	-.99
207	213	220	224	228	236	244	248	252

A : wavenumber (cm^{-1}) of the line
B : intensity of the line in (cm^{-1}/(molecule.cm^{-2}) at 296K
C : Air broadening pressure halfwidth (HWHM) ($cm^{-1}atm^{-1}$) at 296K
D : Energy of the lower transition level (cm^{-1})
Ei (i=1,2,3,4) : Transition quantum identifications for the lower and upper state of the transition
E1 : upper state vibrational identification **E2** : lower state vibrational identification
E3 : upper state rotationnal identification **E4** : lower state rotationnal identification
F : temperature dependence coefficient n of the air broadening halfwidth
G : identification code for isotope as in GEISA

The included molecules are constituents of the atmospheres of Earth (major permanent and trace molecules) and of other Planets (such as: C_2H_4, GeH_4, C_3H_8, C_2N_2, C_4H_2, HC_3N, H_2S, HCOOH and C_3H_4, for the Giant Planets). Among the 31 spectroscopic parameters archived in GEISA, the most important for atmospheric radiat
wavenumber (cm^{-1}) of the line associated with a vibro-rotational transition, the intensity of
Lorentzian collision halfwidth (cm^{-1} atm^{-1} at 296 K), with associated self - pressure broa
lower level of the transition (cm^{-1}), the transition quantum identifications for the lower a
temperature dependence coefficient of the halfwidth, the database management ident
molecules.

- General content
- GEISA-09 format for line transition parameters
- Overall description of available vibrational transitions

Overall description

1) molecule : h2o quantum number : V1,V2,V3

1)h2o	/162	1466	!	000!	000!	0.007002	834.732620	1.2400-32	2.7000-22	1.1730-20	2.9090-01
2)h2o	/161	878	!	010!	010!	0.400700	1029.459965	1.0200-29	1.1430-21	2.2680-20	5.6230-01
3)h2o	/161	1765	!	000!	000!	0.401200	19752.369600	1.0100-32	2.6540-18	5.2320-17	1.2970+03
4)h2o	/171	651	!	000!	000!	6.471000	976.244660	2.0610-27	9.8300-22	1.9420-20	4.8160-01
5)h2o	/181	813	!	000!	000!	6.785000	1107.883620	2.0330-27	5.3900-21	1.0660-19	2.6430+00
6)h2o	/181	217	!	010!	010!	21.590000	674.017100	2.0490-27	2.3500-24	4.6390-23	1.1500-03
7)h2o	/171	121	!	010!	010!	21.759001	559.225800	2.0330-27	4.2300-25	7.9310-24	1.9670-04
8)h2o	/161	98	!	001!	001!	24.172295	368.217807	1.0040-27	3.1170-26	5.2950-25	1.3130-05
9)h2o	/161	237	!	020!	020!	25.868008	645.186994	1.0110-27	6.2540-25	1.1810-23	2.9260-04
10)h2o	/161	122	!	100!	100!	36.020567	411.814625	9.9830-28	4.3890-26	8.8460-25	2.1940-05
11)h2o	/161	13	!	001!	100!	90.366617	264.510396	1.0120-27	1.3020-26	5.1850-26	1.2850-06
12)h2o	/161	14	!	100!	001!	90.767560	287.807805	1.0070-27	7.6330-27	4.0110-26	9.9440-07
13)h2o	/161	2	!	020!	100!	153.928500	396.283478	2.0350-27	2.2440-27	4.2790-27	1.0610-07
14)h2o	/161	5	!	100!	020!	173.439138	428.086866	1.3390-27	7.4600-27	1.7460-26	4.3250-07
15)h2o	/161	1	!	001!	020!	357.516107	357.516107	9.2690-27	9.2690-27	9.2690-27	2.2960-07
16)h2o	/161	1	!	020!	001!	404.164670	404.164670	2.3330-27	2.3330-27	2.3330-27	5.7850-08
17)h2o	/161	1936	!	010!	000!	701.964360	2909.479980	1.0990-27	3.1930-19	1.1300-17	2.8020+02
18)h2o	/161	876	!	020!	010!	877.313718	2628.578500	1.5790-27	2.7360-22	9.3950-21	2.3290-01
19)h2o	/181	1031	!	010!	000!	893.551390	2310.511470	2.0330-27	6.0510-22	2.1700-20	5.3800-01
20)h2o	/162	1821	!	010!	000!	917.364820	1921.277910	1.0000-27	2.5050-23	2.7570-21	6.8360-02
21)h2o	/171	873	!	010!	000!	951.156494	2260.604500	1.4900-27	1.2100-22	4.2970-21	1.0650-01
22)h2o	/161	382	!	030!	020!	1122.160900	2698.566090	1.0080-27	1.2000-25	3.5760-24	8.8710-05
23)h2o	/162	582	!	020!	010!	1127.176510	1745.097410	1.0000-27	6.4950-26	6.3410-24	1.5720-04
24)h2o	/182	438	!	010!	000!	1173.772010	1684.226320	2.0330-27	5.0830-26	5.3470-24	1.3260-04
25)h2o	/181	303	!	020!	010!	1203.315770	2014.552120	2.0250-27	5.8500-25	1.9960-23	4.9490-04
26)h2o	/161	536	!	100!	010!	1221.410373	2611.664590	1.1740-27	3.8970-24	1.5290-22	3.7910-03
27)h2o	/162	33	!	100!	010!	1230.772520	1574.104220	2.0210-27	9.9210-27	9.1740-26	2.2750-06
28)h2o	/172	175	!	010!	000!	1234.234730	1598.765470	2.0330-27	9.3150-27	7.1310-25	1.7680-05

Atmospheric Radiation Analysis

Laboratoire de Météorologie Dynamique/CNRS/IPSL

2014 GEISA WORKSHOP

The purpose of the workshop is to assess the current spectroscopic Databases and reinforce the interactions between experts from various disciplines needed to meet the challenges and requirements of future space observation.

http://www.lmd.jussieu.fr/geisa2014/

Dead line for registration and submitting an Abstract March 28th

ITSC-19, Jeju Island, South Korea, 25 March – 1 April 2014

ACKNOWLEDGMENTS
to
CNES, CNRS/INSU and EUMETSAT
for their Encouragements and Supports

THANK YOU FOR YOUR ATTENTION