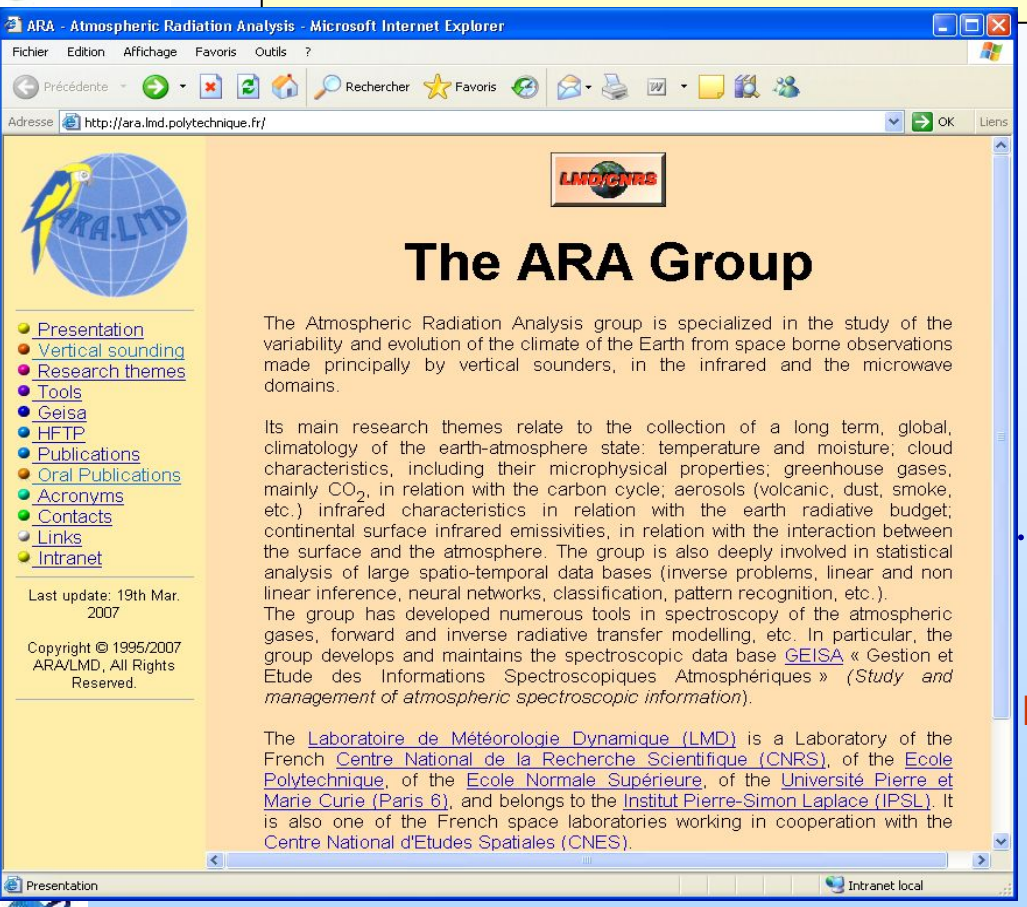
THE GEISA/IASI SPECTROSCOPIC DATABASE: Evaluation for IASI Flight data



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OUTLINE

- ***GEISA and GEISA/IASI System Overview***

- ***GEISA and GEISA/IASI Interactive Use***

  Implementation of the databases on the Ether Products and Data Center (CNES/CNRS)

- ***SPECTROSCOPIC ARCHIVE ISSUE***

  (Some examples)

- ***GEISA/IASI-2008 Archive in Preparation***

  (line transition parameter sub-database)

- ***Concluding Comments***

GEISA and GEISA/IASI System Overview

GEISA and GEISA/IASI System Overview

42 co-authors
16 Laboratories

ELSEVIER

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

Journal of Quantitative Spectroscopy & Radiative Transfer

www.elsevier.com/locate/jqsrt

The 2003 edition of the GEISA/IASI spectroscopic database

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Received 23 July 2004; accepted 15 December 2004

MORE RECENT REFERENCES

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Jacquinet-Husson N. et al. **A spectroscopic database system for the second generation vertical sounders radiance simulation.** *Proceedings of the 13th International TOVS Study Conference, Sainte-Adèle, Canada ; 28 October – 4 November 2003.*

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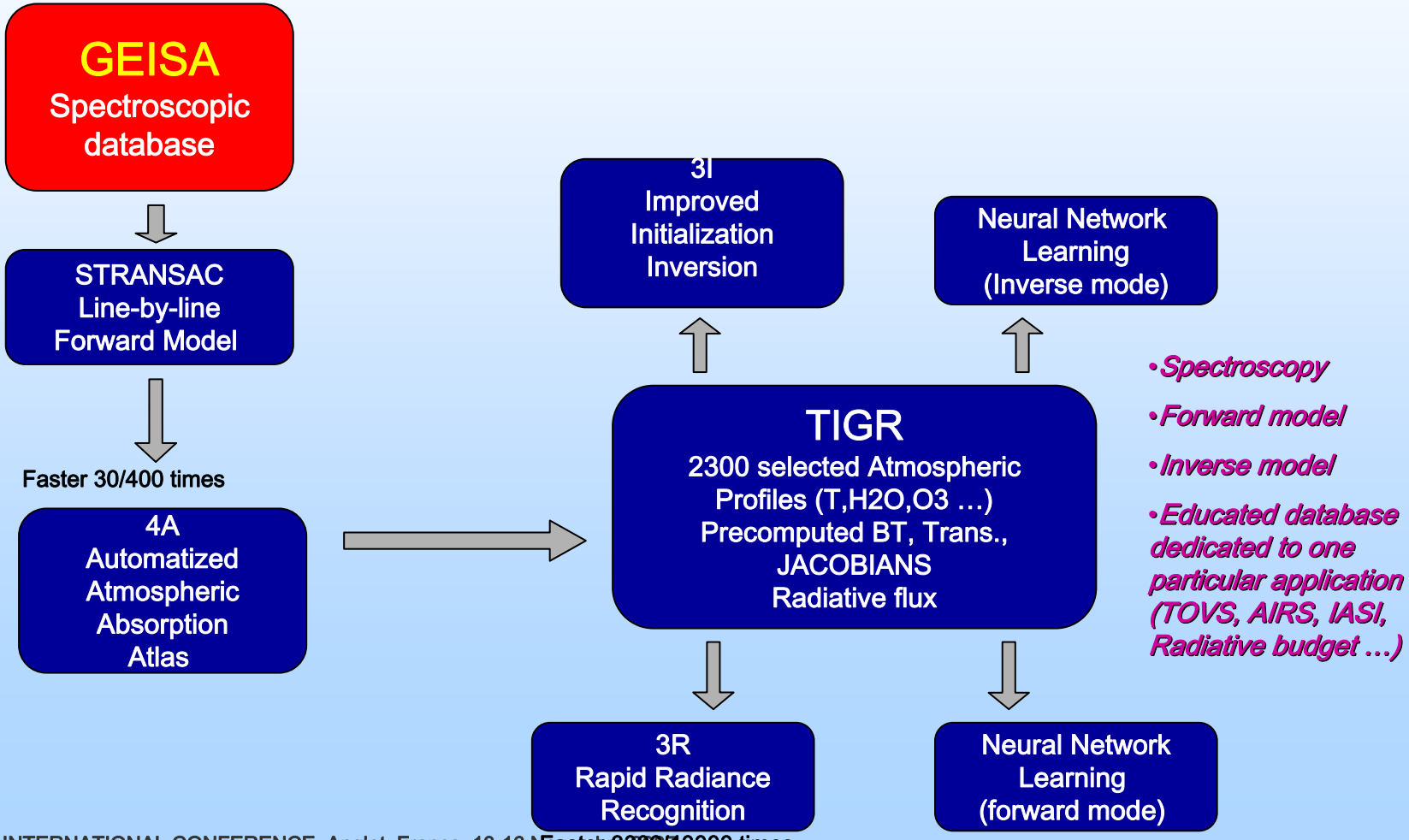
The GEISA spectroscopic database in the ARA/LMD tools

The ARA (Atmospheric Radiation Analysis group at LMD) has been engaged, during the past three decades, in the development of GEISA, a computer-accessible spectroscopic database, designed to facilitate accurate and fast forward calculations of atmospheric radiative transfer using a line-by-line and (atmospheric) layer-by-layer approach.



The GEISA-2003 system

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

Three SUB-DATABASES

- Line transition parameters database
  42 molecules (96 isotopic species)

  1 668 371 entries between 0 and 35 877 cm^{-1}
- Absorption cross-sections database
  - IR: 32 molecular species (mainly CFC's)
  - UV/Visible : 11 molecular species
- Aerosol data archive and softwares

ASSOCIATED MANAGEMENT SOFTWARES

(For each sub-database)

GEISA/IASI database general context

- **Extraction of GEISA-03 between 599 & 3001 cm^{-1}**
  - **Individual spectral lines spectroscopic parameters sub-database**
    14 molecules (53 isotopic species): **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**
  - **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**
  - **Microphysical and optical properties of Basic Atmospheric aerosol components sub-database** (similar with the GEISA-03 one)

Total # entries: 702550

- **Continuous update**

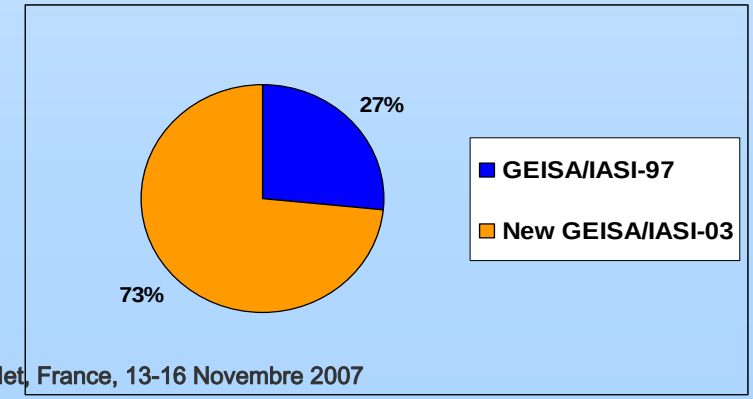
- **Related with:**
  - **CNES/EUMETSAT EPS mission**
  - **IASI measurement capabilities assessment**
  - **ISSWG**

Associated interest for AIRS

IASI : Infrared Atmospheric Sounder Interferometer
ISSWG : IASI Sounding Science Working Group
EUMETSAT : EUropean organization for the exploitation of METeorological SATellites
AIRS : Advanced InfraRed Sounder
CNES : Centre National d'Etudes Spatiales, France

GEISA/IASI-03 cross-sections sub-database

Molecule	Spectral range (cm-1)	Temperature range (K)	Pressure range (Pa)	Number of TP sets	References	Number of entries
CFC-11	599 - 2000	296	93325	1	Hurley(2003); Christidis(1997)	1,657,853
	500 - 1601	297	0	1	Heathfield (1998) ; Shine (2003)	
	810 - 880 1050 - 1120	190 - 296	1000 - 101325	55	Li & Varanasi (1994) Varanasi (2000)	
CFC-12 (CCl_2F_2)	850 - 1190	253 - 287	0	3	Clerbaux (1993)	2,199,538
	210 - 2000	296	93325	1	Hurley(2003)	
	850 - 950 1050 - 1120	190 - 296	1000 - 101392	57	Varanasi & Nemtchinov (1994) Varanasi (2000)	
CFC-14 (CF_4)	220 - 2000	296	93325	1	Hurley (2003)	411,228
	1250 - 1290	180 - 296	1005 - 101458	55	Nemtchinov & Varanasi (2003)	
HCFC-22 ($CHClF_2$)	700 - 1500	203 - 293	0 - 80000	8	Vander Auwera (2003)	2,019,054
	765 - 1380	253 - 287	0	3	Clerbaux (1993)	
	208 - 2000	296	93325	1	Pinnock (1995); Hurley (2003)	
	760 - 860 1070 - 1195	181 - 297	2666 - 101936	51	Varanasi (2001)	
N_2O_5	540 - 1380	205 - 293	0	5	Wagner & Birk (2003)	87,120
CCl_4	750 - 812	208 - 297	1070 - 101272	32	Nemtchinov & Varanasi (2003)	197,536
Total				274		6,572,329



⇦ 1 750 993 entries

⇦ 4 821 336 entries

GEISA/IASI cross-sections sub-database
Future evolution

■ Recent efforts have been deployed to supplement the previous infrared absorption cross-sections GEISA/IASI sub-database of CFC's and their variation with pressure and temperature (+ 275 %) .

■ **A simple archiving of numerous experimental (or calculated) Cross-Sections is no more fully suitable, especially for use in radiative transfer modelling algorithms.**

Main features of the future cross-sections database

- **Noise smoothing**

  Consequently: elimination of negative values

- **Elimination of redundant information**

  Consequently: important reduction of the actual database size.

  (6 572 329 entries)

GEISA and GEISA/IASI-03 aerosols sub-database

Data on microphysical and optical properties of basic aerosol components.

4 sub-databases included

- A database on refractive indices of basic atmospheric aerosol components:
  - Acids
  - Water ice
  - Water droplets
  - Water soluble components
  - Thin films
  - Solid Substances
- **A Database on atmospheric aerosols from LITMS (Rublev, 1994)**
- **The software package and database OPAC (Optical Properties of Aerosols and Clouds) (Hess et al., 1998)**
- **The Global Aerosol Data Set: GADS (Köpke et al., 1997)**

Proposed new organization of GEISA/IASI aerosols sub-database

- **Structure of files and directories** : to homogenize (in order to process automatically large amount of data)
- **Refractive index data** : to update and enlarge
- **For each aerosol kind, the range of possible size distributions** : to be settled (bibliographic study)
- **Optical data** : to compute with Mie theory for each refractive index spectrum and possible size distribution

GEISA and GEISA/IASI interactive Use

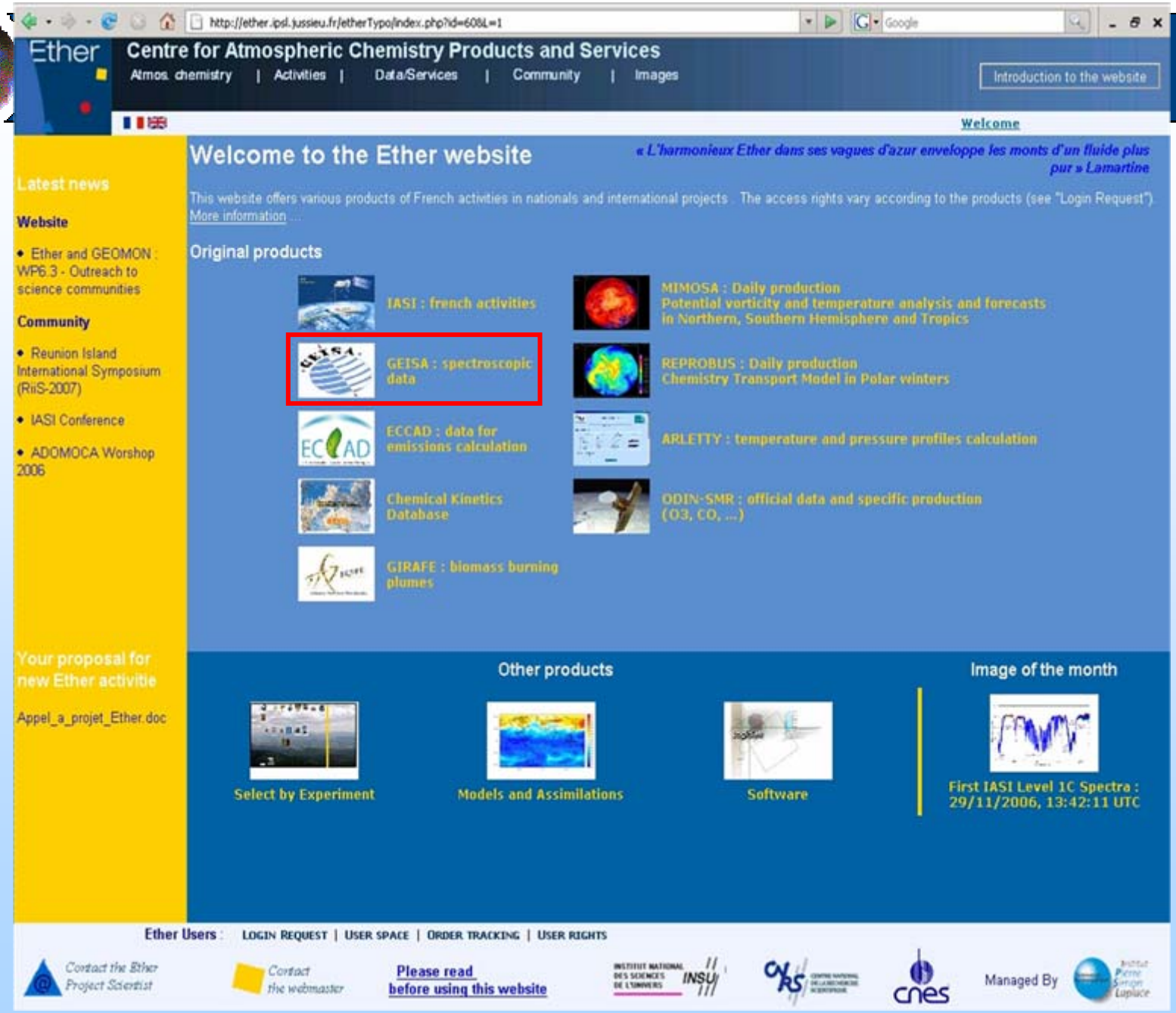
GEISA Actual Operational Use

GEISA and associated facilities are implemented on the **Ether (CNRS/IPSL)** Products and Services Centre (CPS)

Effective January 2007

Ether Products and Services Centre Facilities:

http://ether.ipsl.jussieu.fr


http://ether.ipsl.jussieu.fr/etherTypo/index.php?id=608&L=1
Ether
Centre for Atmospheric Chemistry Products and Services
Atmos. chemistry | Activities | Data/Services | Community | Images
Introduction to the website
Welcome
Welcome to the Ether website
« L'harmonieux Ether dans ses vagues d'azur enveloppe les monts d'un fluide plus pur » Lamartine
This website offers various products of French activities in nationals and international projects . The access rights vary according to the products (see "Login Request").
More information ...
Latest news
Website
Ether and GEOMON : WP6.3 - Outreach to science communities
Community
Reunion Island International Symposium (RiiS-2007)
IASI Conference
ADOMOCA Worshop 2006
Original products
IASI : french activities
GEISA : spectroscopic data
ECCAD : data for emissions calculation
Chemical Kinetics Database
GIRAFE : biomass burning plumes
MIMOSA : Daily production
Potential vorticity and temperature analysis and forecasts in Northern, Southern Hemisphere and Tropics
REPROBUS : Daily production
Chemistry Transport Model in Polar winters
ARLETTY : temperature and pressure profiles calculation
ODIN-SMR : official data and specific production (O3, CO, ...)
Your proposal for new Ether activitie
Appel_a_projet_Ether.doc
Other products
Select by Experiment
Models and Assimilations
Software
Image of the month
First IASI Level 1C Spectra : 29/11/2006, 13:42:11 UTC
Ether Users : LOGIN REQUEST | USER SPACE | ORDER TRACKING | USER RIGHTS
Contact the Ether Project Scientist
Contact the webmaster
Please read before using this website
Managed By

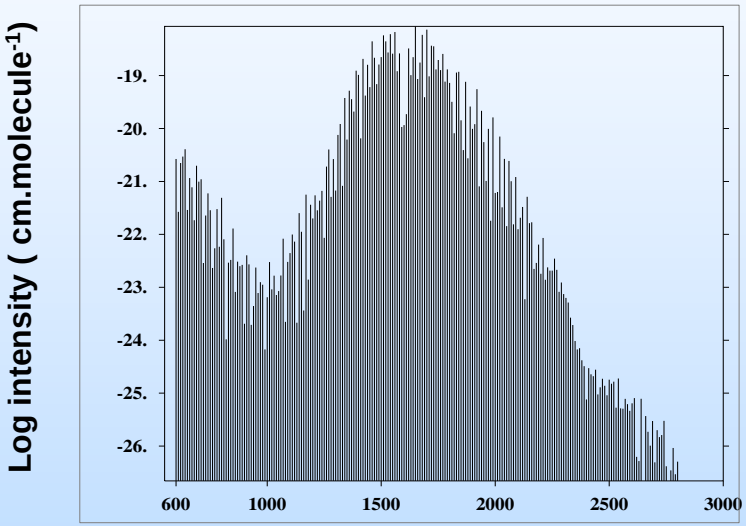
Spectroscopic Archive Issue

Some examples

H2O GEISA/IASI-03 updating and alternative archive

Toth's (2000, 2002)

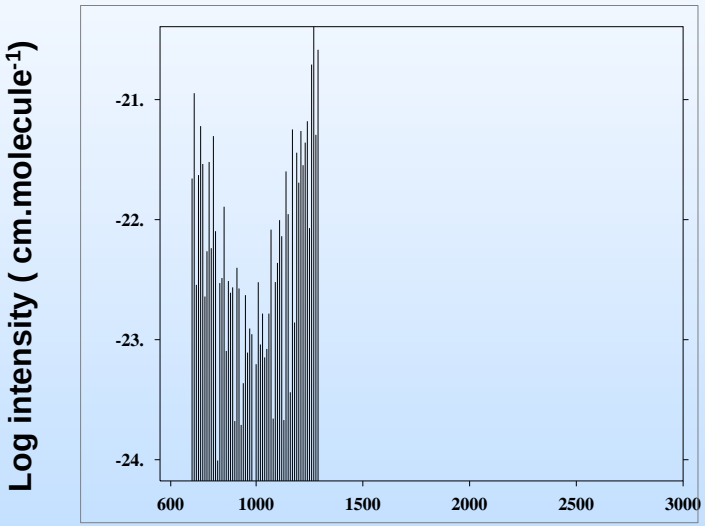
599.681 - 2819.848 cm^{-1}



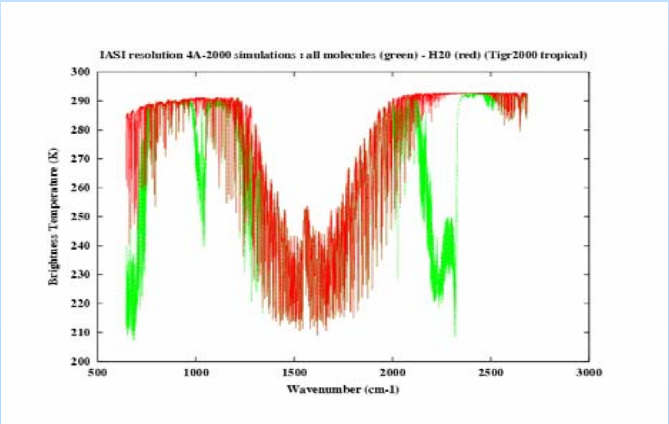
Choice for GEISA/IASI-03 update

RAL/ EUMETSAT

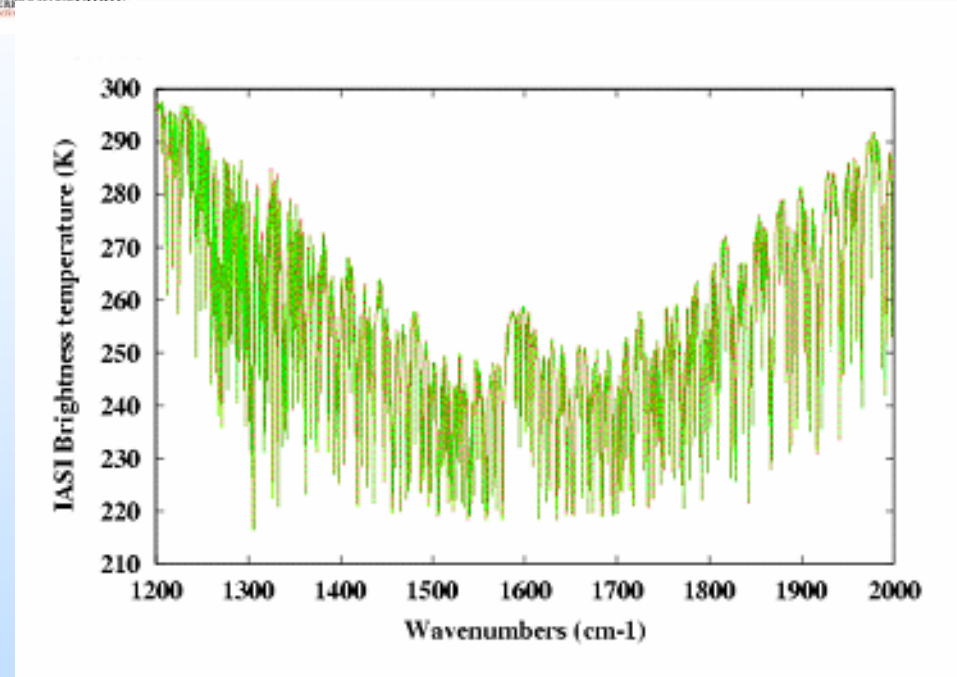
700.032 - 1299.980 cm^{-1}



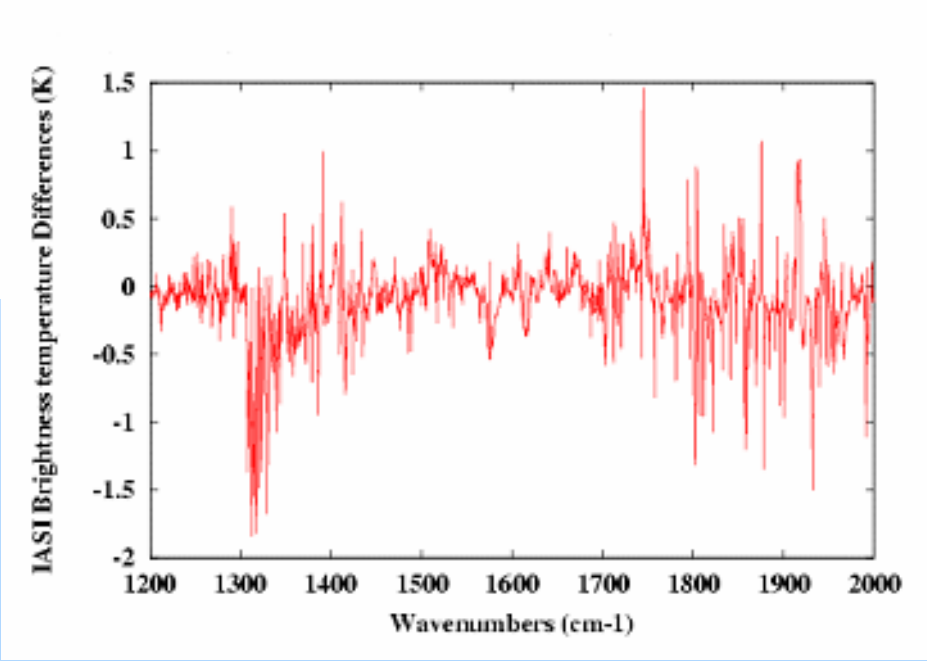
Alternative choice for GEISA/IASI-03 update



IASI Stransac-2000 simulations with RAL or TOTH's H_2O spectroscopy



Mc Clatchey Tropical



Stransac + Toth _____

Stransac + RaL _____

Comparisons with other Data bases

differences in contents and subsequent IASI radiative transfer modelling

- GEISA/IASI-03

  Jacquinet-Husson et al.J. Quant. Spectrosc. Radiat. Transfer 95 (2005) 429-467.

  599 – 3 001 cm^{-1}

- MIPAS Dedicated Spectroscopic Database Version PF 3.2

  Flaud et al. J. Atm. And Ocean Optics, 16 (2003) 172-182.

  597 – 2 503 cm^{-1}

- HITRAN-04 Rothman et al.J. Quant. Spectrosc. Radiat. Transfer 96 (2005) 139-204.

extractions in GEISA/IASI and MIPAS databases common spectral intervals

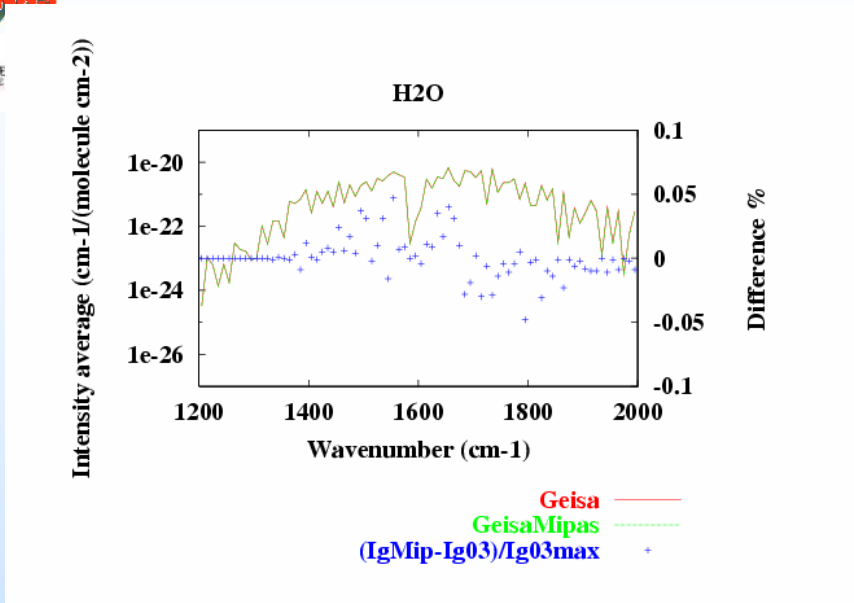
6 Molecular species selected for comparisons, i.e.:

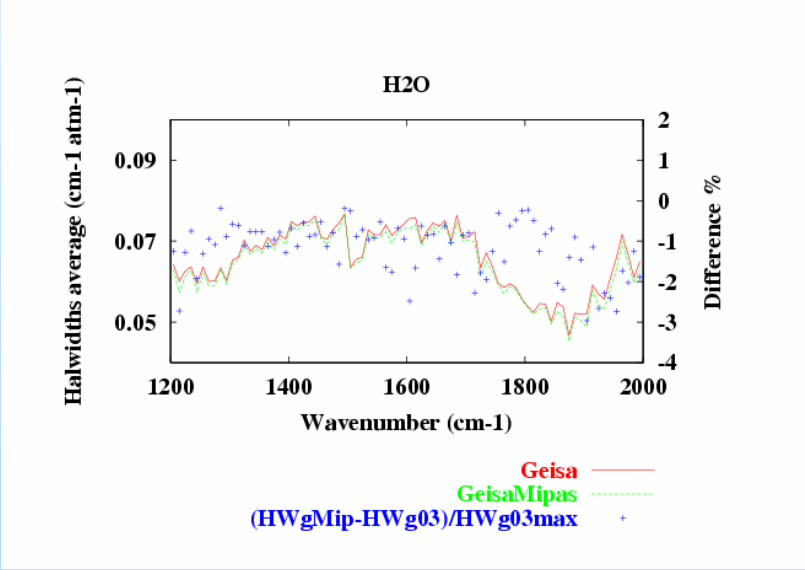
H_2O, CO_2, O_3, N_2O, CO, CH_4

DIFFERENCES BETWEEN GEISA/IASI-03 and MIPAS-03

(example of H_2O)

H_2O Collision Half-Width Differences





DIFFERENCES BETWEEN GEISA/IASI-03 and HITRAN-04

(example of H_2O)

H2O

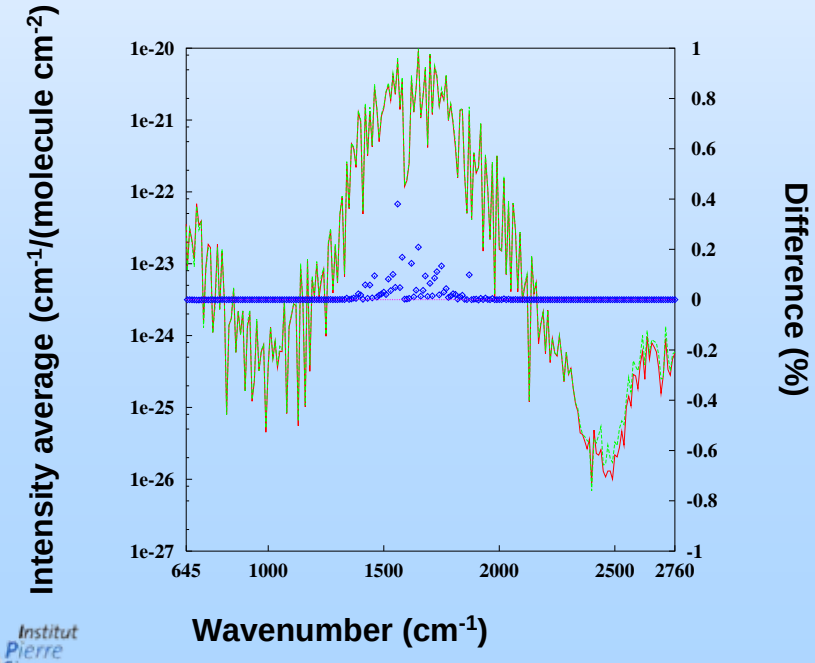
GEISA/IASI 03 *(Toth's data)* and HITRAN 04 comparisons for air-broadened half-widths (HW) and intensities (I)

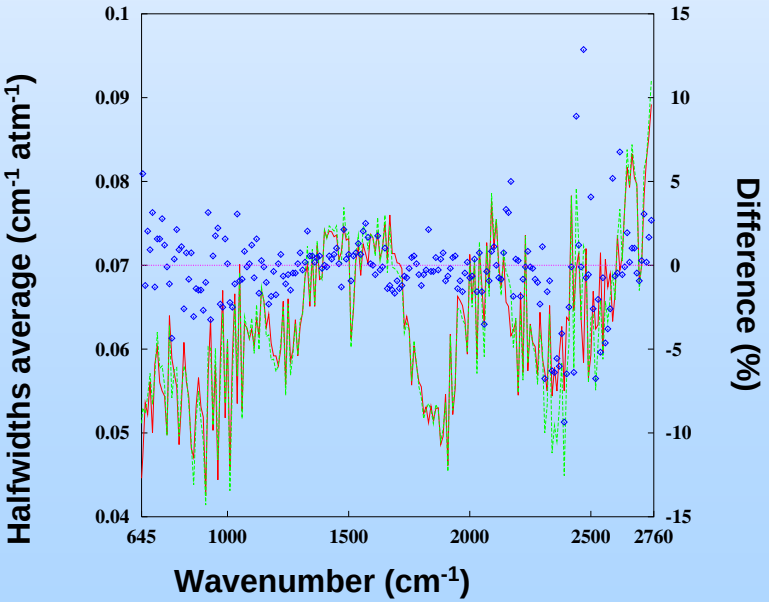
% 10 cm^{-1} Intensity Average difference

$$(I_{H04} - I_{G03}) / (I_{H04\,max} + I_{G03\,max}) \times 2 \times 100$$

% 10 cm^{-1} HW Average difference

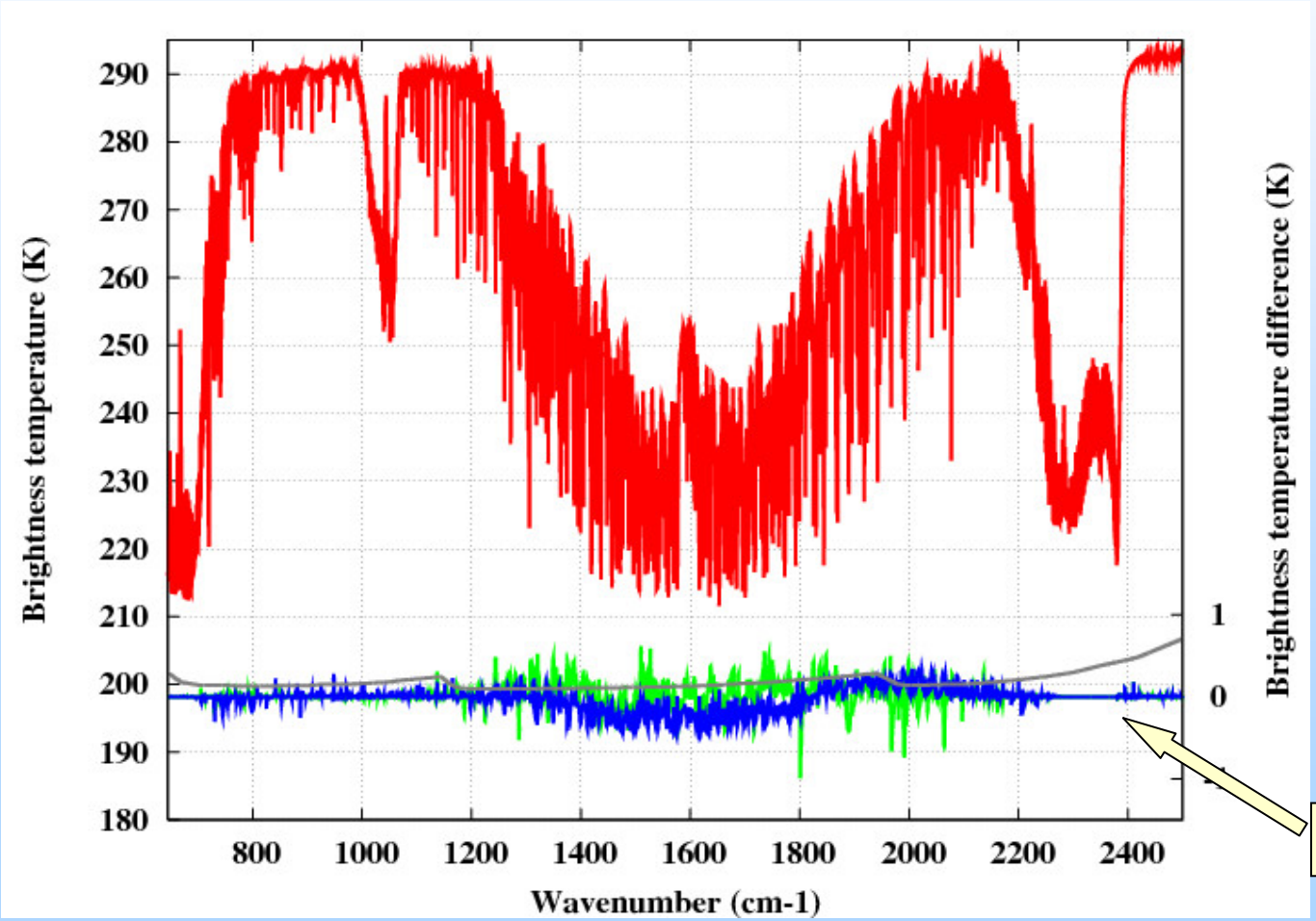
$$(HW_{H04} - HW_{G03}) / (HW_{H04\,max} + HW_{G03\,max}) \times 2 \times 100$$





H2O Spectroscopy differences illustration

- ❖IASI brightness temperature (K) simulation with GEISA-03 (upper curve);
- ❖Impact of replacement of **HITRAN-04** or **MIPAS PF3.2** **H_2O data** in GEISA-03
- ❖differences (K) in lower curves, with associated **IASI noise.**



Différences (K)

GEISA/IASI- 2008 Archive in Preparation:

line transition parameter sub-database

Updates for 2008 Edition of GEISA line transition parameters sub-database

Preliminary non exhaustive list

H_2O	500- 8000 cm^{-1}	LISA, JPL
CO_2	2200-7000 cm^{-1}	JPL, LTS
N_2O	1900-6800 cm^{-1}	JPL
CH_4	750-1350 cm^{-1}	ICB, JPL
	2850-3150 cm^{-1}	
SO_2	ν_1,ν_3	LISA
	$\nu_1+\nu_2-\nu_2$	GSMA
HNO_3	ν_5 ; $2\nu_9$	LISA
C_2H_2	604- 2254 cm^{-1}	LADIR

Molecular species related with IASI Trace Gas Retrievals to be added

HCN
NH_3
HCOOH
C_2H_4
CH_3OH

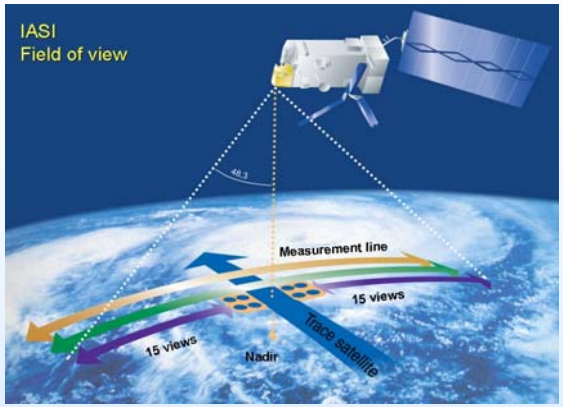
New PF 3.2 Version (courtesy of J.M. Flaud) to be considered

Comparison with actual GEISA/IASI-03 content

Concluding Comments

GEISA/IASI EFFECTIVE USE

IASI on METOP
since October 19th 2006 launch



- GEISA/IASI used as the reference spectroscopic database
- 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 the support of CNES (2006)]

Related to

IASI Level 1 Cal/Val activities@ CNES

Remaining spectroscopy related problems

Some conclusions of validation exercises, using e.g. : the 4A-00/LMD Model, in the case of IASI radiative transfer modelling

1. The water vapour spectroscopic parameters: still need to be validated;
2. The water vapour continuum: more tuning to be done when more validation data (especially with high water vapour content) become available;
3. The freons bands at 850 and 920 cm^{-1}: refine the temperature dependence;
4. O_3 in the 9.6 µm region: the spectroscopic parameters still need to be validated;
5. Some CO_2 – Q branches: further improvement/tuning of the line mixing (15 µm region especially)

STATUS OF MOLECULES FOR IASI RADIATIVE TRANSFER MODELLING

From ISSWG-14 (March 24-26 /2001) Conclusions

WHERE ARE WE NOW ?

MOLECULE	LINE POSITION	LINE INTENSITIES	LINE BROADENING	LINE MIXING	CONTINUUM	CROSS-SECTIONS
H_2O	1	1	1		1	
CO_2	Y	Y	2	1		
O_3	3	1?	1			
CH_4	2	2	1	1		
CO	Y	Y	Y			
N_2O	?	?	2	2		
HNO_3	Y	Y	3			
O_2 & N_2 collision induced spectrum					Y	
CFC's, HCFC's, N_2O_5						Y

Prepared by A. Perrin (GIDSC chairman)

GIDSC: GEISA/IASI Database Scientifiv Commitee

1: Parameters that need to be improved; 2 rd priority; 3 rd priority

Y no problem clearly identified; ? The databases have to be checked

ACKNOWLEDGMENTS

to

CNES, CNRS/INSU and EUMETSAT

for their encouragements and support