

## THE GEISA DATABASE 2009 EDITION: Update Description and Assessment of Spectroscopic Parameters Through Hyperspectral Remote Sensing Applications



- [Presentation](#)
- [The Context](#)
- [Research themes](#)
- [Tools](#)
- [Geisa](#)
- [Get ARA data](#)
- [HFTP](#)
- [Publications](#)
- [Oral Publications](#)
- [Acronyms](#)
- [Contacts](#)
- [Links](#)
- [Jobs](#)
- [Intranet](#)

Last update: 18th May 2009

Copyright © 1995/2010  
ARA/LMD, All Rights Reserved.



### The ARA Group

The Atmospheric Radiation Analysis group is specialized in the study of the variability and evolution of the climate of the Earth from space borne observations made principally by vertical sounders, in the infrared and the microwave domains.

Its main research themes relate to the collection of a long term, global, climatology of the earth-atmosphere state: temperature and moisture; cloud characteristics, including their microphysical properties; greenhouse gases, mainly CO<sub>2</sub>, in relation with the carbon cycle; aerosols (volcanic, dust, smoke, etc.) infrared characteristics in relation with the earth radiative budget; continental surface infrared emissivities, in relation with the interaction between the surface and the atmosphere. The group is also deeply involved in statistical analysis of large spatio-temporal data bases (inverse problems, linear and non linear inference, neural networks, classification, pattern recognition, etc.).

The group has developed numerous tools in spectroscopy of the atmospheric gases, forward and inverse radiative transfer modelling, etc. In particular, the group develops and maintains the spectroscopic data base [GEISA](#) « Gestion et Etude des Informations Spectroscopiques Atmosphériques » (*Study and management of atmospheric spectroscopic information*).

The [Laboratoire de Météorologie Dynamique \(LMD\)](#) is a Laboratory of the French [Centre National de la Recherche Scientifique \(CNRS\)](#), of the [Ecole Polytechnique](#), of the [Ecole Normale Supérieure](#), of the [Université Pierre et Marie Curie \(Paris 6\)](#), and belongs to the [Institut Pierre-Simon Laplace \(IPSL\)](#). It is also one of the French space laboratories working in cooperation with the [Centre National d'Etudes Spatiales \(CNES\)](#).



<http://ara.lmd.polytechnique.fr>

Jacquinet-Husson N.,  
Crépeau L., Capelle V.,  
Scott N.A., Armante R.,  
Boutammine C.,  
Chédin A.

Laboratoire de **M**étéorologie **D**ynamique  
**A**tmospheric **R**adiation **A**nalysis Group  
Ecole Polytechnique  
91128 Palaiseau, France



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



## OUTLINE

### [1] GEISA-09 SYSTEM OVERVIEW

### [2] OVERALL DESCRIPTION

- ▶ Individual lines sub-database
- ▶ Cross-Sections subdatabase

### [3] GEISA/IASI SUMMARY

### [4] GEISA-09 UPDATE EVALUATION

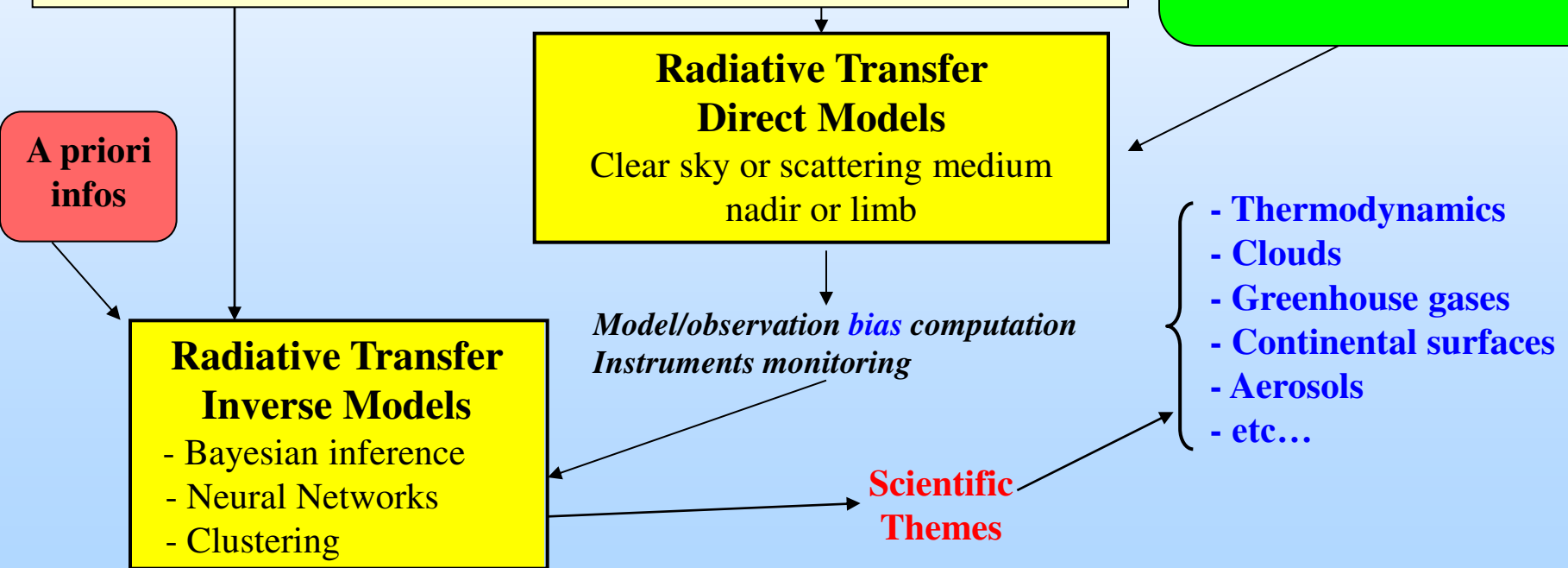
### [5] CONCLUDING COMMENTS

### [6] GEISA ETHER DISTRIBUTION

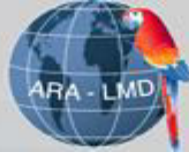
# [1] FROM SATELLITE OBSERVATIONS TO CLIMATE VARIABLES: a long process based on Radiative Transfer

The performance of the second generation vertical sounding, high-resolution, sophisticated infrared 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  
SPECTROSCOPIC  
DATABASE**

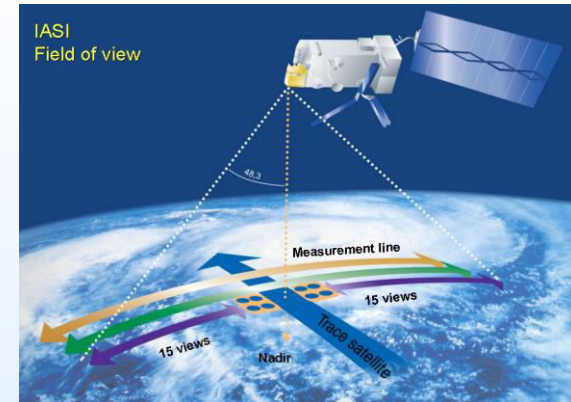


# [1] GEISA EFFECTIVE USE



**IASI (Infrared Atmospheric Sounding Interferometer) on METOP (October 19th 2006 launch)**

3 Bands  
[1] 645-1210  $\text{cm}^{-1}$   
[2] 1210-2000  $\text{cm}^{-1}$   
[3] 2000-2760  $\text{cm}^{-1}$



Related to  
**IASI Level 1 Cal/Val activities@ CNES**



- **GEISA (599-3001  $\text{cm}^{-1}$ )** used as the reference spectroscopic database
- **Validation achieved using 4A/OP 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)]



## [1] THE GEISA-2009 SYSTEM

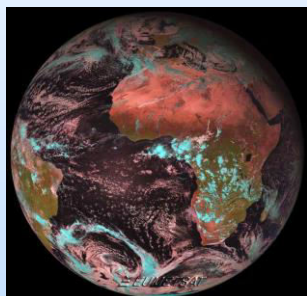
### Three SUB-DATABASES

#### ● Line transition parameters database

**50** molecules (**111** isotopic species)

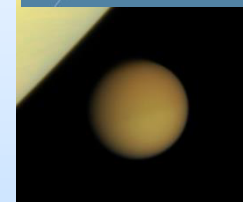
3,807,997 entries in the spectral range  $10^{-6}$  and  $35,877 \text{ cm}^{-1}$

- Major Permanent constituents of EARTH atmosphere :  $\text{O}_2, \text{H}_2\text{O}, \text{CO}_2 \dots$
- Trace molecules in the EARTH' atmosphere :  
 $\text{NO}, \text{SO}_2, \text{NO}_2, \text{NH}_3, \text{HNO}_3, \text{OH}, \text{HF}, \text{HCl}, \text{HBr}, \text{HI}, \text{ClO}, \text{OCS}, \text{H}_2\text{CO}, \text{PH}_3, \dots$
- Molecules in atmospheres of JUPITER, SATURN, URANUS, TITAN etc.:  
 $\text{CH}_6, \text{CH}_3\text{D}, \text{C}_2\text{H}_2, \text{C}_2\text{H}_4, \text{GeH}_4, \text{HCN}, \text{C}_3\text{H}_8, \text{C}_3\text{H}_4$



(MSG-2 25/01/06)

EARTH



(CASSINI-HUYGENS 29/01/06)

TITAN

#### ● Absorption cross-sections database

- IR: 43 molecular species (mainly CFC's)
- UV/Visible : 19 molecular species

#### ● Aerosol data archive and softwares

**MANAGEMENT  
SOFTWARES**  
For each Sub-database

# [1] GEISA-09 Line Transitions Records



252 characters Record

31 Parameters

Standardized parameter missing values in GEISA-09

- (A) Wavenumber ( $\text{cm}^{-1}$ ) of the line associated with the vibro-rotational transition.
- (B) Intensity of the line ( $\text{cm molecule}^{-1}$  at 296K).
- (C) Lorentzian collision halfwidth ( $\text{cm}^{-1} \text{atm}^{-1}$  at 296K).
- (D) Energy of the lower transition level ( $\text{cm}^{-1}$ ).
- (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.

Extended format length

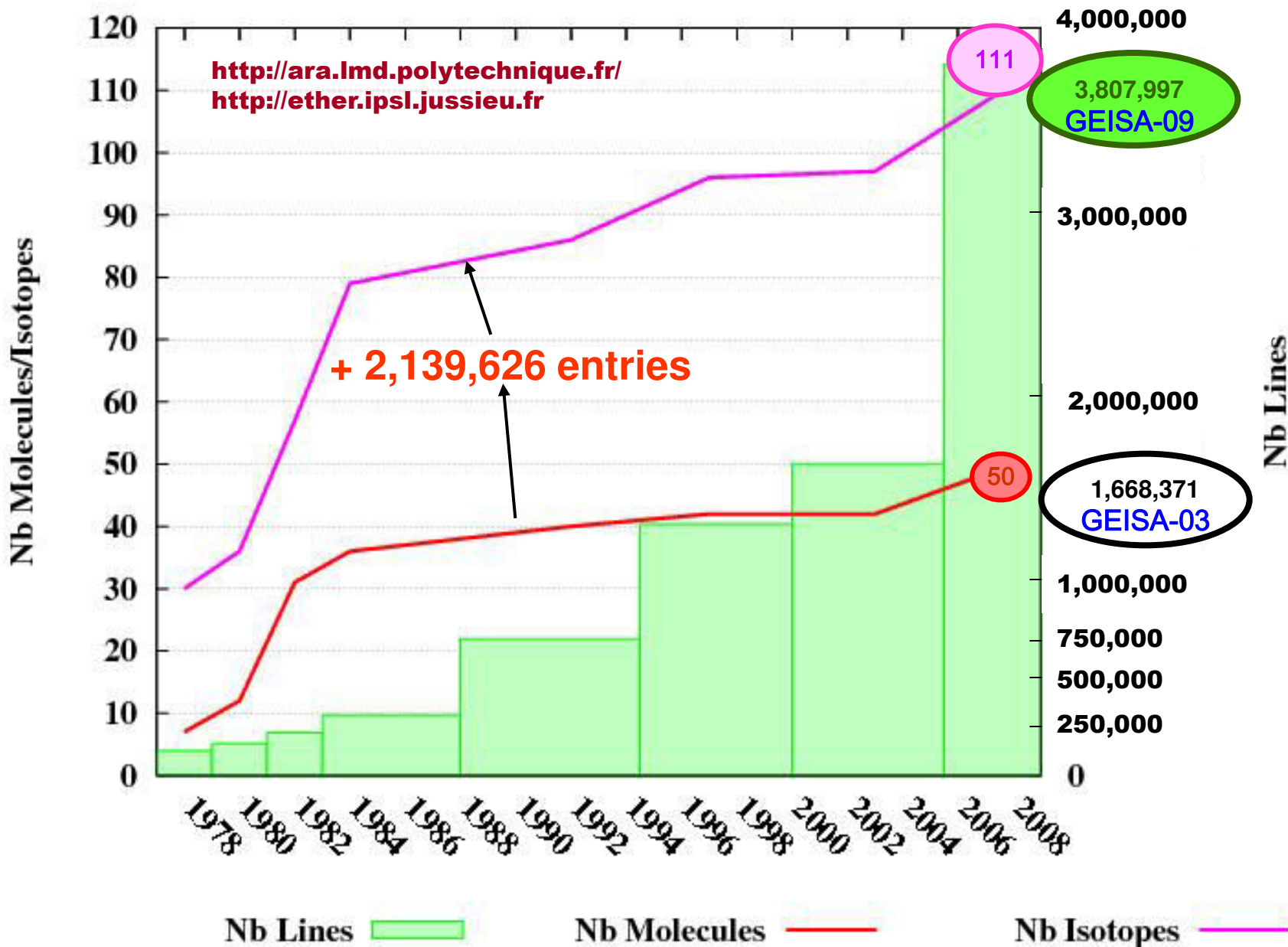
Parameter	A	B	C	D	E1	E2	E3	E4	F	G	I	J	K	L
Field length	12	11	6	10	25	25	15	15	4	3	3	3	2	1
Fortran descriptor	F12.6	1PD11.4	0PF6.4	F10.4	A25	A25	A15	A15	F4.2	I	I3	A3	I2	I1

M	N	O
10	5	8
1PE10.3	0PF7.4	F9.6

- (M) Einstein A-coefficient
- (N) Self broadening pressure halfwidth (HWHM) ( $\text{cm}^{-1} \text{atm}^{-1}$ ) at 296K
- (O) Air pressure shift of the line transition ( $\text{cm}^{-1} \text{atm}^{-1}$ ) at 296K

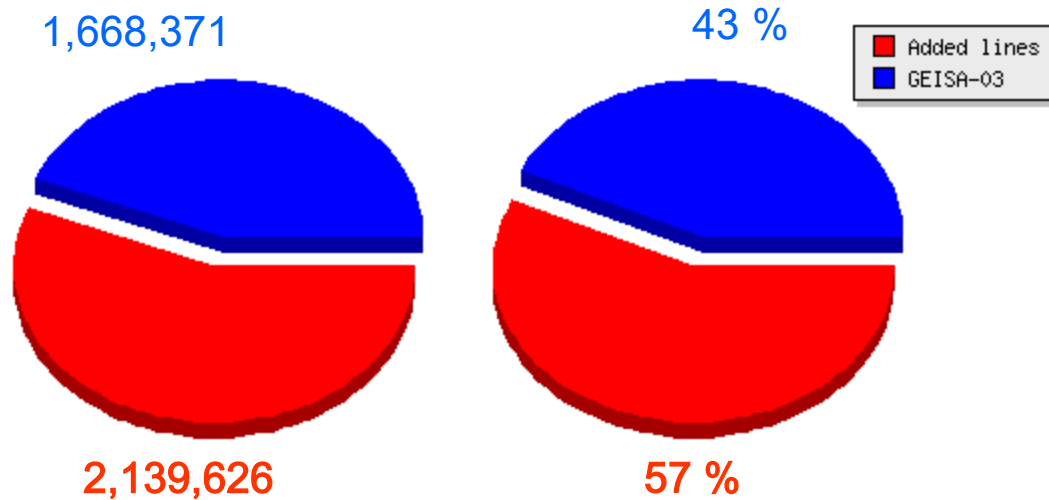
Extended format length

# [1] GEISA-09 LINE TRANSITION PARAMETERS SUB-DATABASE EVOLURION SINCE 1978



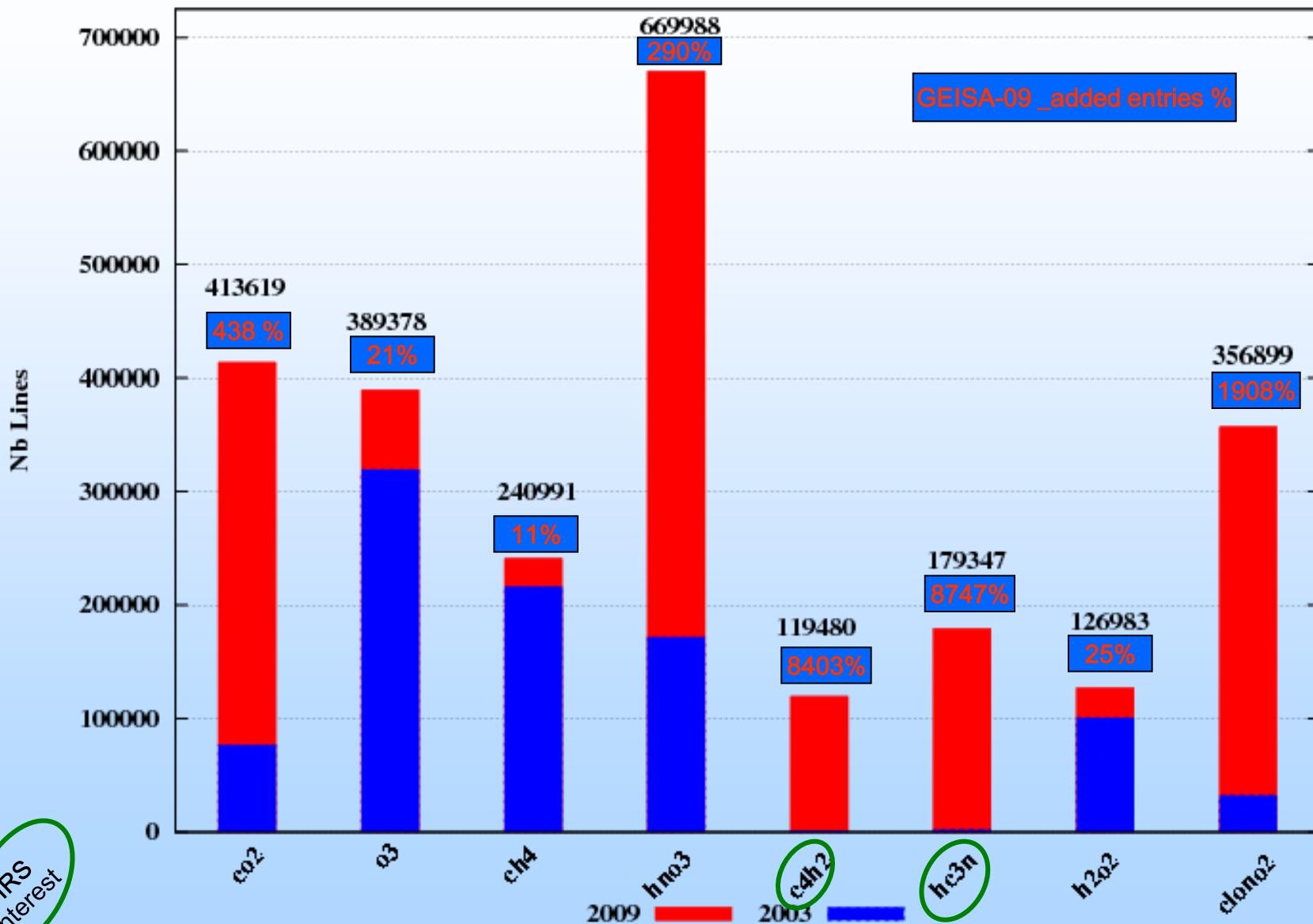
[1]

## GEISA-09 3,807,997 LINES





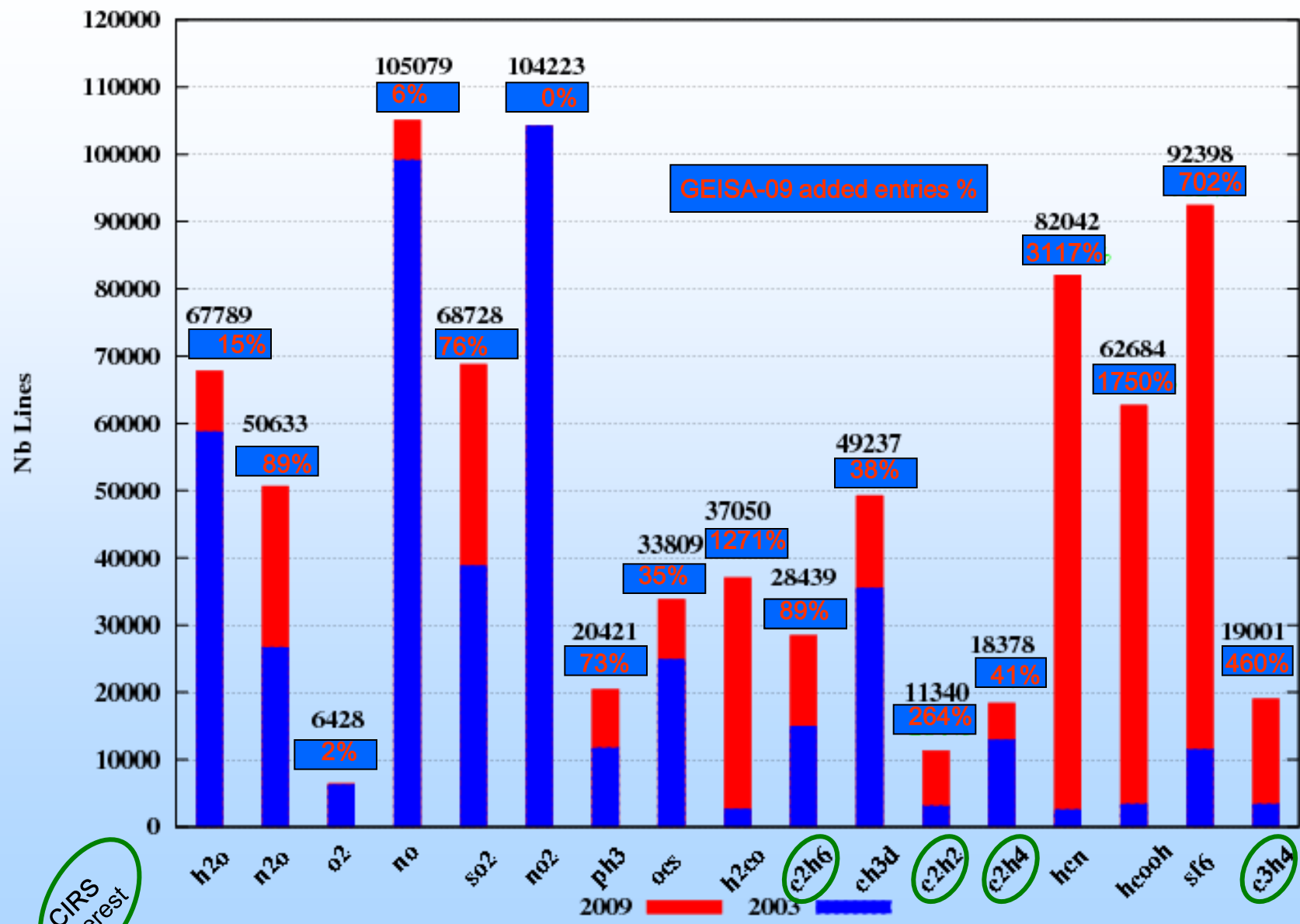
# [2] GEISA-09 # LINES EVOLUTION SINCE 2003 for UPDATED MOLECULES



CIRS interest

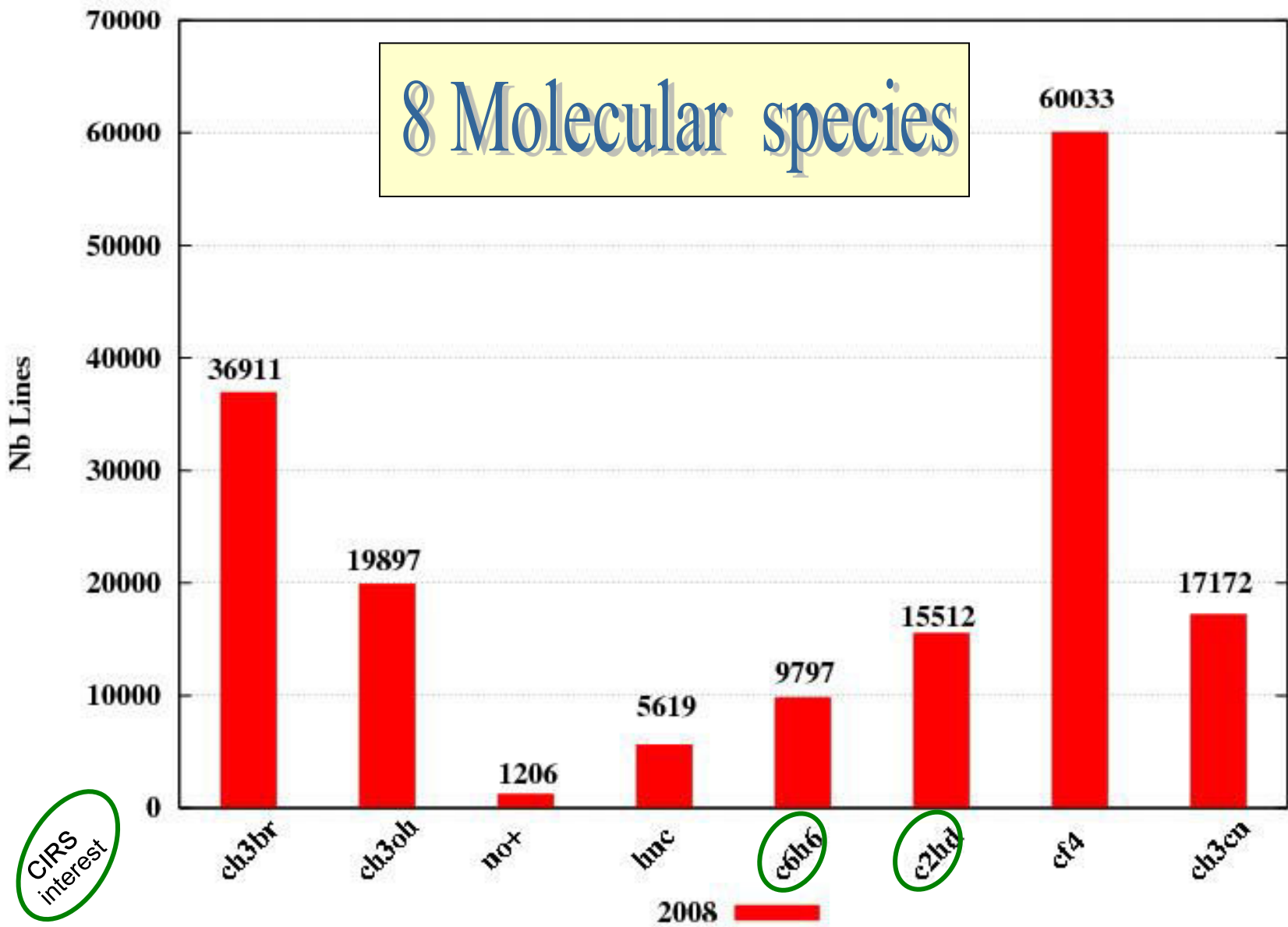
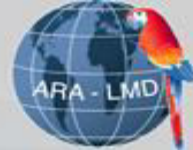


# [2] GEISA-09 # LINES EVOLUTION SINCE 2003 for UPDATED MOLECULES (following)



CIRS interest

# [2] NEW MOLECULAR SPECIES for GEISA-09



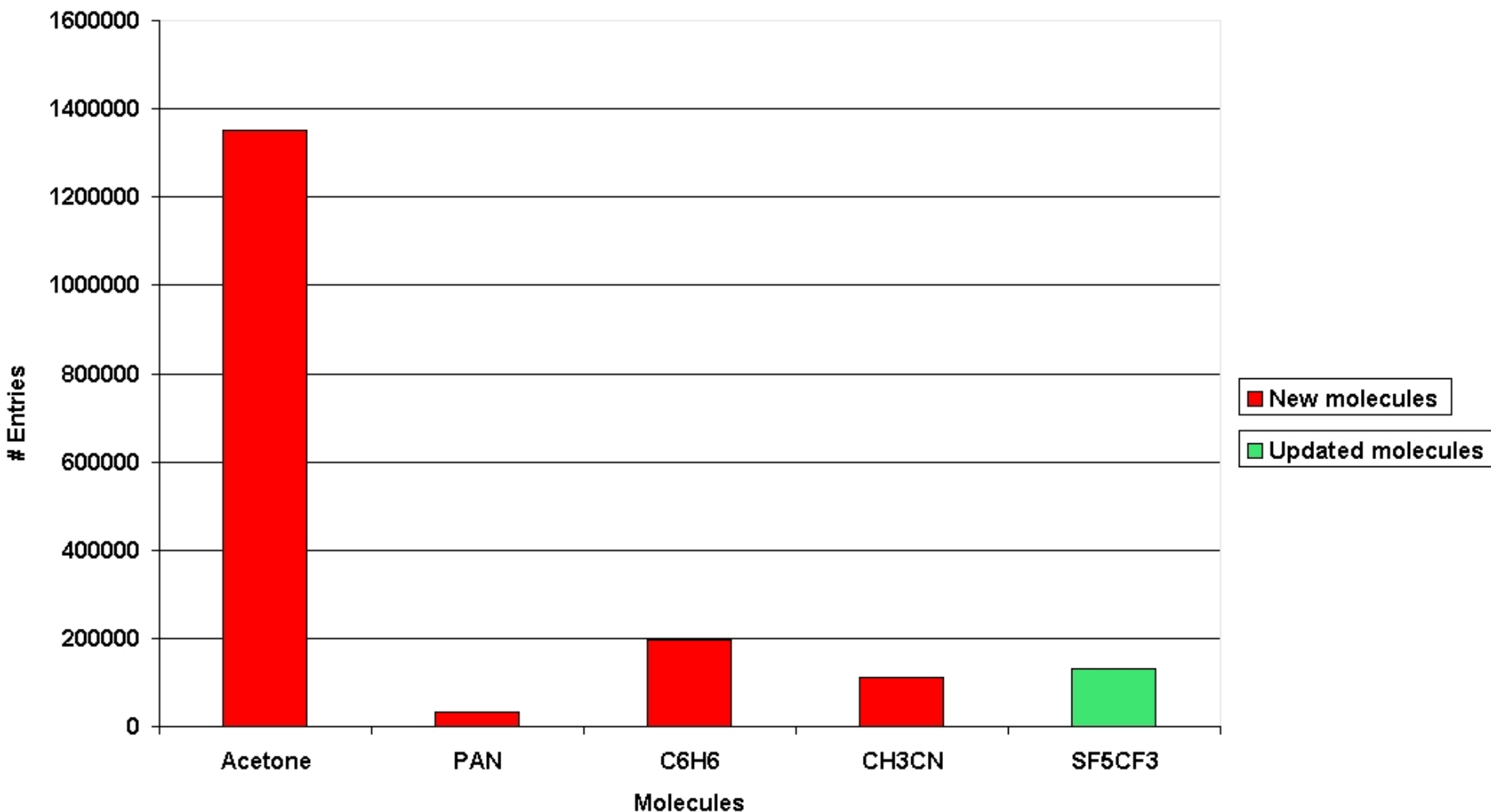
# [2] GEISA-09 IR CROSS-SECTIONS UPDATE

(molecular species update)



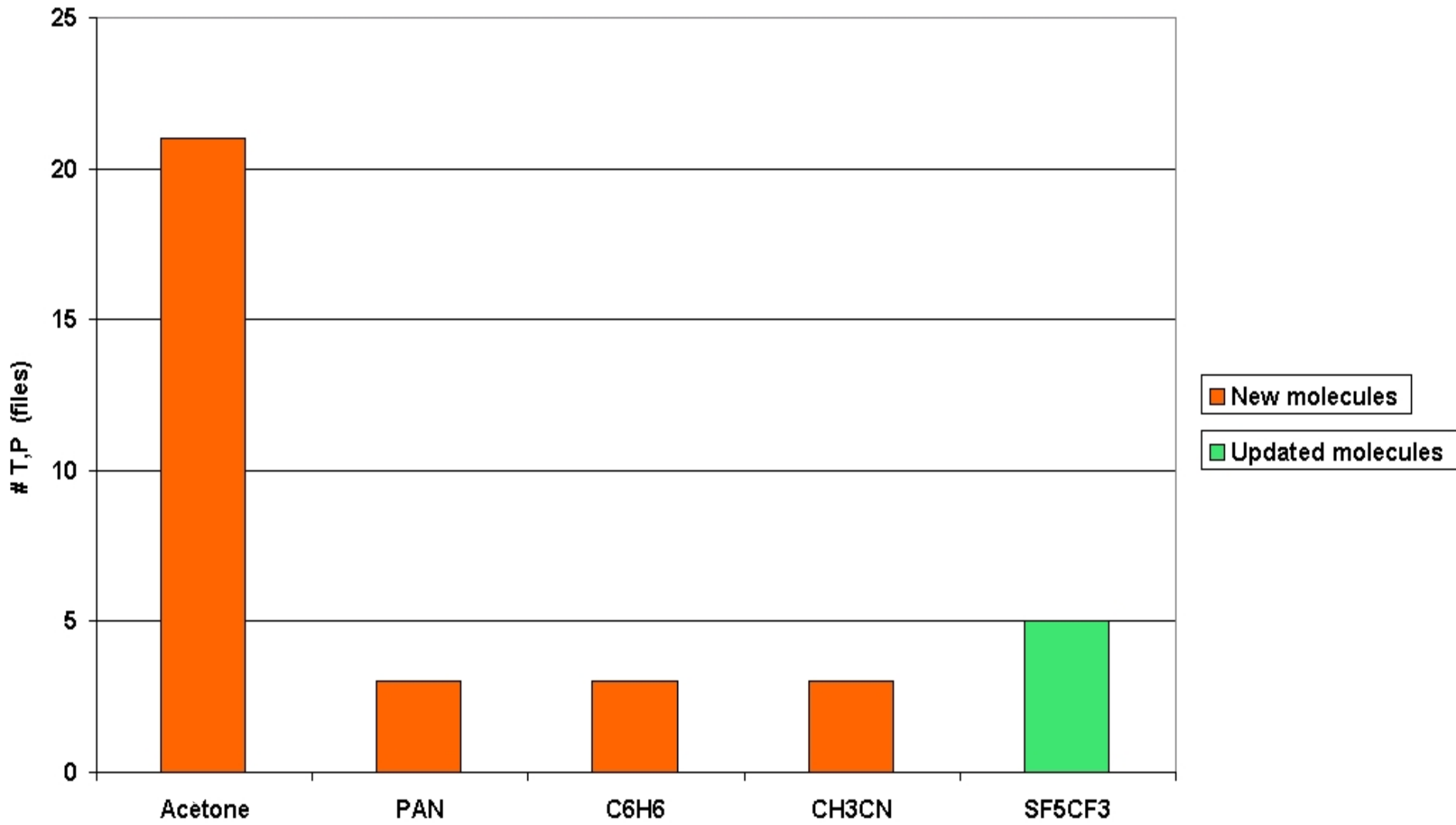
➤ 4 new molecular species: Acetone, PAN, C<sub>6</sub>H<sub>6</sub>, CH<sub>3</sub>CN

➤ 5 additives files for SF<sub>5</sub>CF<sub>3</sub>



# [2] GEISA-09 IR CROSS-SECTIONS UPDATE

(# new T,P couples)





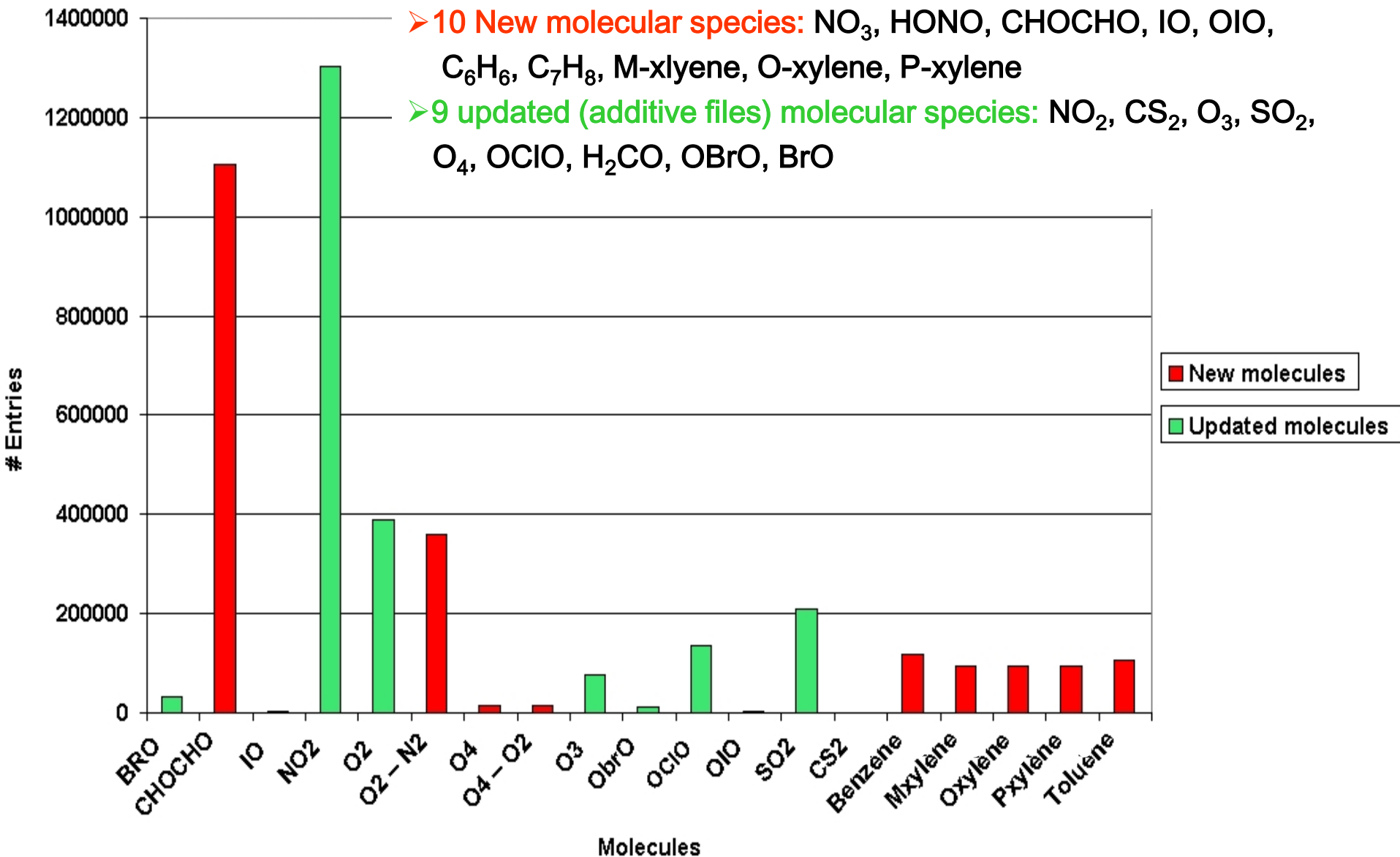
## ACKNOWLEDGMENTS

to

**CNES, CNRS/INSU and EUMETSAT  
for their Encouragements and Supports**

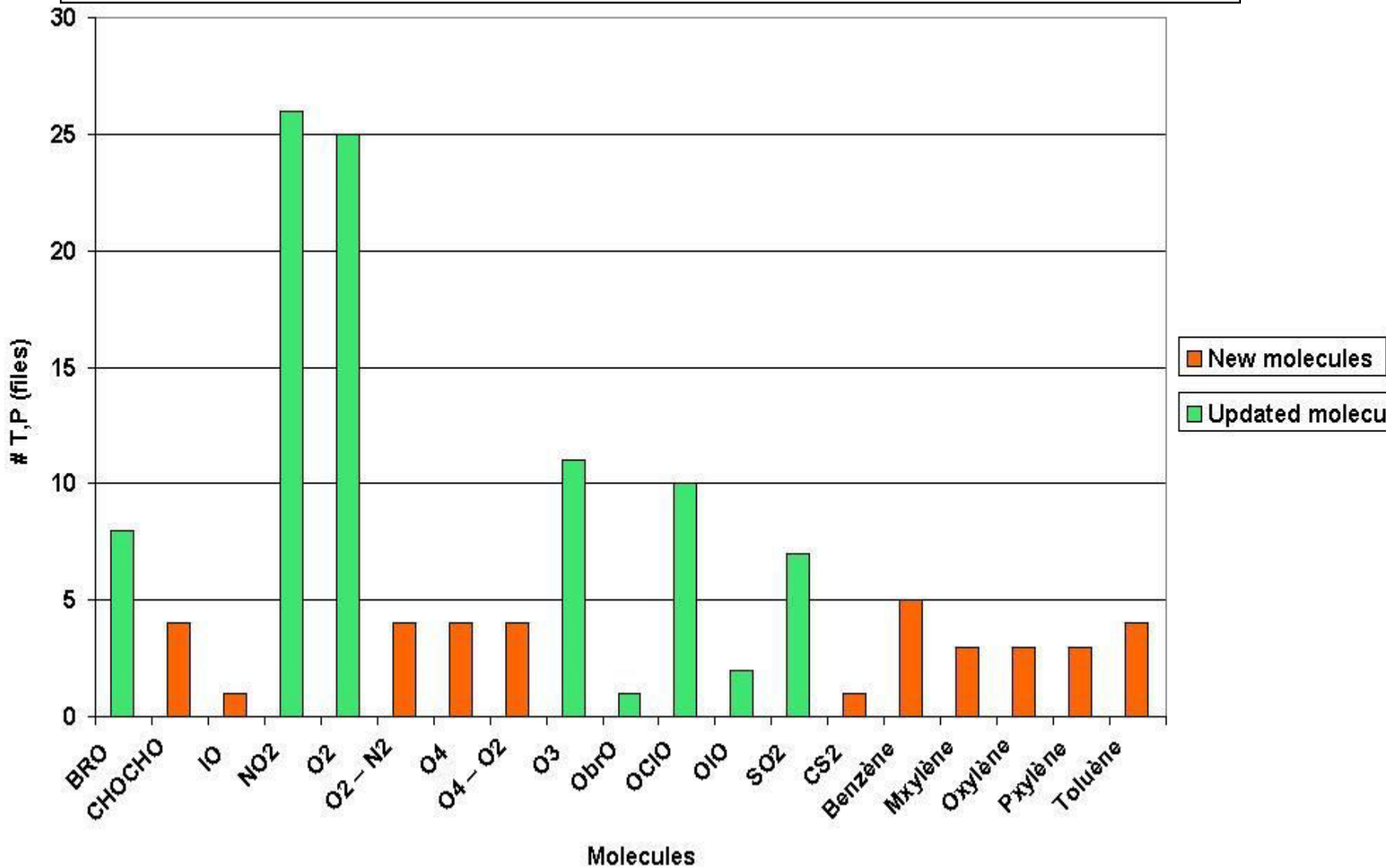
**THANK YOU FOR YOUR ATTENTION**

# [2] GEISA-09 UV/VIS CROSS-SECTIONS UPDATE (molecular species update)



# [2] GEISA-09 UV/VIS CROSS-SECTIONS UPDATE

## [# new (T,P) couples]





## [3] FROM GEISA-09 TO GEISA/IASI-09

### Individual spectral lines spectroscopic parameters sub-database

Extraction of GEISA-09 in the spectral range 599 & 3001  $\text{cm}^{-1}$

20 molecules (66 isotopic species):

$\text{H}_2\text{O}$ ,  $\text{CO}_2$ ,  $\text{O}_3$ ,  $\text{N}_2\text{O}$ ,  $\text{CO}$ ,  $\text{CH}_4$ ,  $\text{O}_2$ ,  $\text{NO}$ ,  $\text{SO}_2$ ,  $\text{NO}_2$ ,  $\text{HNO}_3$ ,  $\text{OCS}$ ,  $\text{C}_2\text{H}_2$ ,  $\text{N}_2$ ,  
 $\text{HCN}$ ,  $\text{NH}_3$ ,  $\text{HCOOH}$ ,  $\text{C}_2\text{H}_4$ ,  $\text{CH}_3\text{OH}$ ,  $\text{H}_2\text{CO}$

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

6 molecular species: CFC-11, CFC-12, CFC-14,  $\text{CCl}_4$ ,  $\text{N}_2\text{O}_5$ , HCFC-22

PAN (peroxyacetyl nitrate)

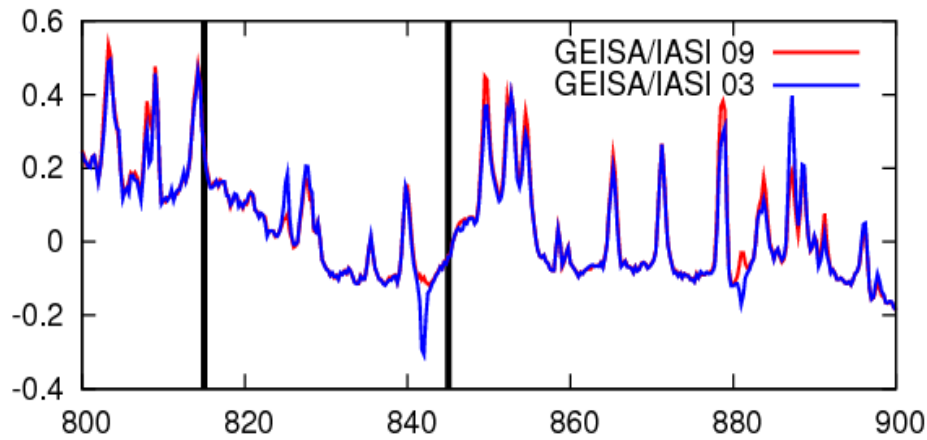
### Microphysical and optical properties of Basic Atmospheric aerosol components sub-database

### Continuous update

### Related with: IASI measurement capabilities assessment

*Associated interest for AIRS*

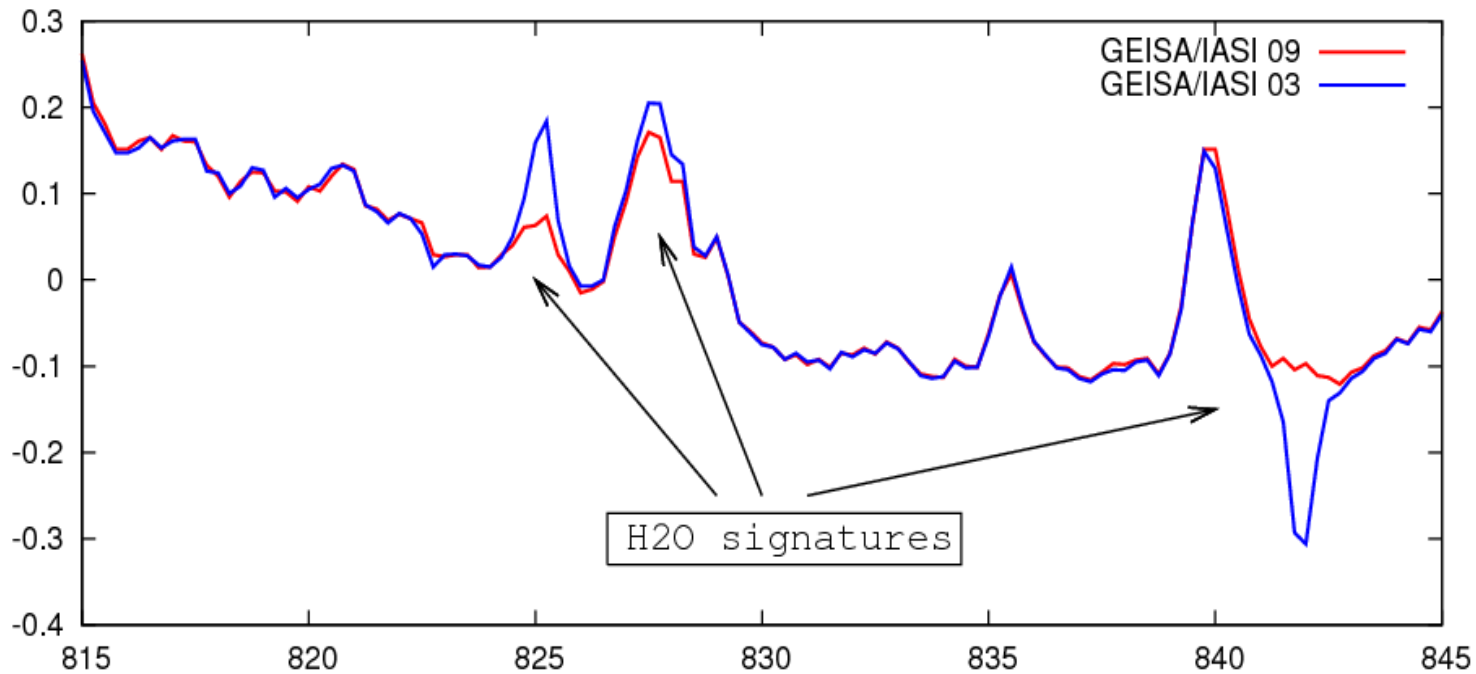
# [4] Use of IASI data and 4A/OP for the Validation of the New Spectroscopy of GEISA-09



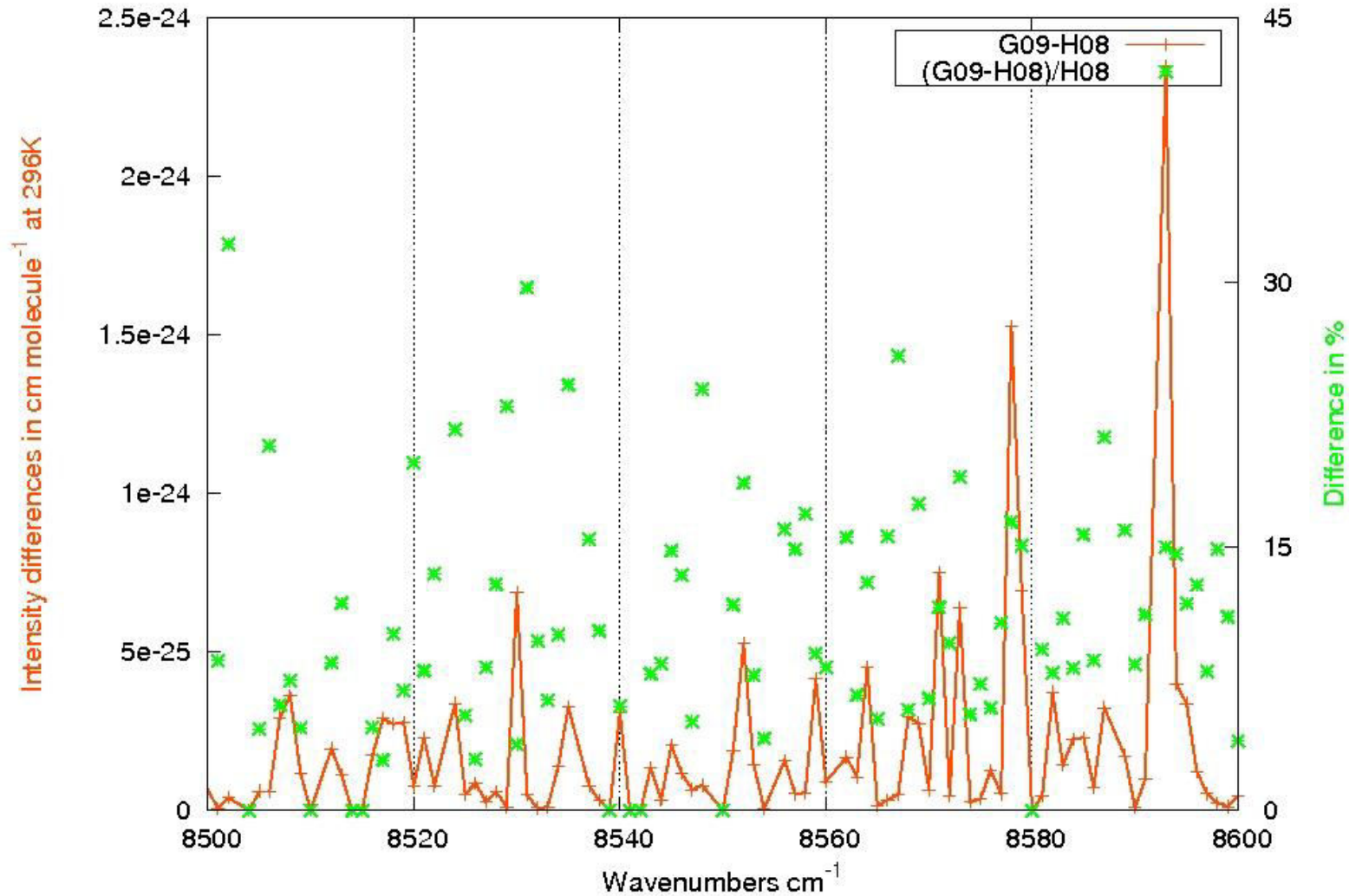
➤ Instrument : IASI (2007/07 → 2009/11)

➤ Collocations (300 km, 3 hours) of clear IASI observations with radiosoundings from the ARSA database

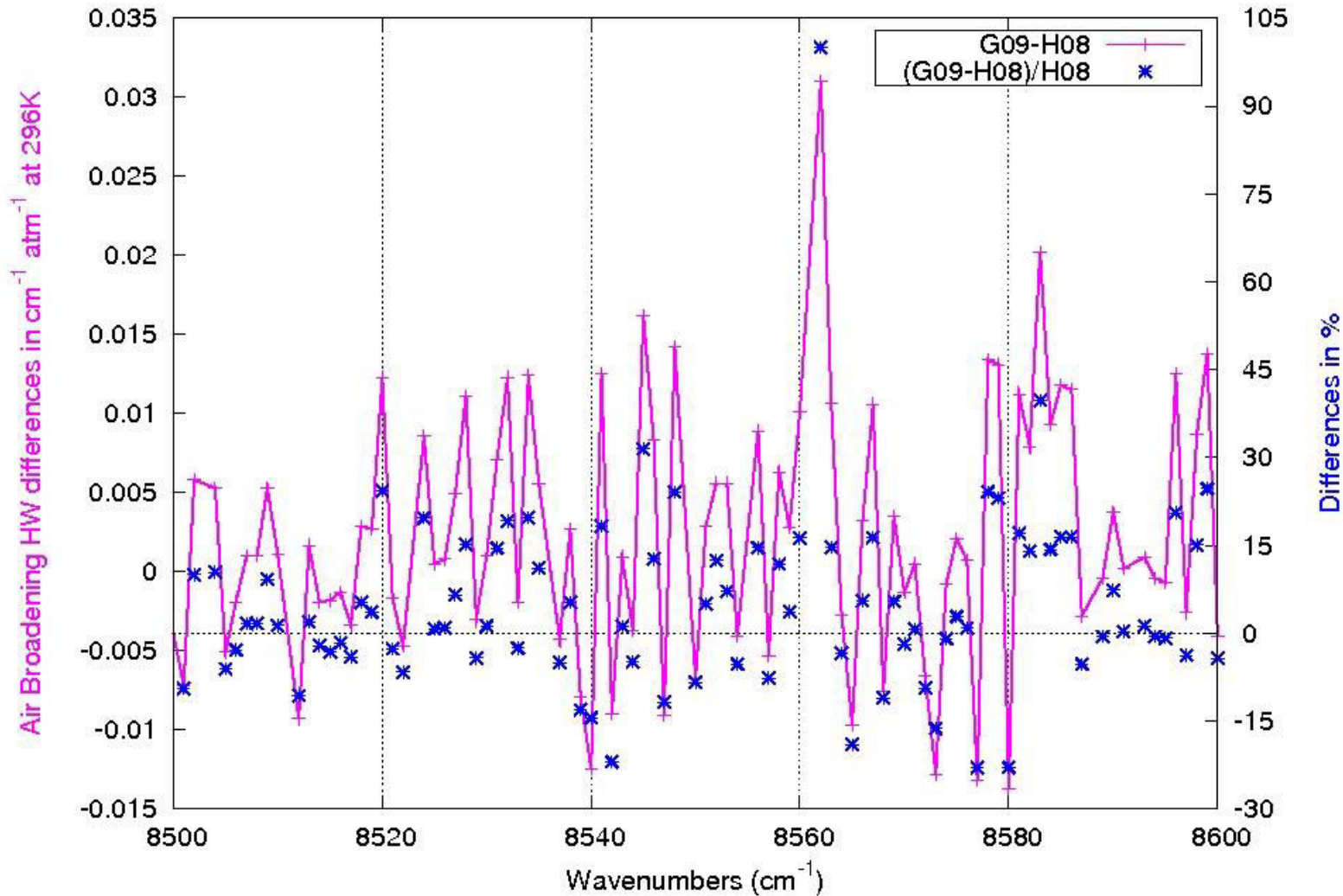
➤ Statistics for sea, night, tropical atmospheres of the differences « simulated vs observed »



## [4] HITRAN-08 VS GEISA-09 INTENSITY DIFFERENCES



## [4] HITRAN-08 VS GEISA-09 AIR-BROADENING HW DIFFERENCES



## [5] CONCLUSIONS FROM THE 2nd INTERNATIONAL IASI CONFERENCE, SEVRIER, France, 25-29 JANUARY 2010



### General Spectroscopic Requirement to achieve Forward Model accuracies required for retrievals from IASI and future sounders

Considering the still existing Spectroscopy issues, the following already ongoing specific actions have to be reinforced and maintained:

❖ **Necessary validation:** Assessment in GEISA/IASI of:

spectroscopic molecular species related to IASI trace gas retrievals:

HCN, NH<sub>3</sub>, HCOOH, C<sub>2</sub>H<sub>4</sub>, CH<sub>3</sub>OH, H<sub>2</sub>CO.

cross-sections: CFC-11, CFC-12, CFC-14, CCl<sub>4</sub>, N<sub>2</sub>O<sub>5</sub>, HCFC-22 and especially PAN.

❖ **The still outstanding general spectroscopy-related conclusions for public databases, from ISSWG -30, June-2 July 2008, CNES, Paris, France-, to be considered:**

Comparison with HITRAN and GEISA, in particular for water vapour, and real IASI spectra, compared to simulations with ECMWF provided radiosondes, lead to the conclusion that:

in particular water vapour needs to be validated, and the continuum reinvestigated.

IASI related spectroscopy problems with H<sub>2</sub>O and CO<sub>2</sub> as first priority

❖ **Line coupling/mixing modelling**, (which should be used in conjunction with the molecular parameters of the data base from which they have been derived) and **non-LTE** (Local Thermodynamic Equilibrium) effects are areas to be urgently investigated.



## Welcome to the Ether website

# [6] GEISA ETHER DISTRIBUTION

This website offers various products of French activities in  
 to the products (see "Login Request"). [More information ...](#)

### Image of the month



### Latest news

ETHER Newsletter  
 ADOMOCA Newsletter  
 2nd IASI conference

### New proposal activities

Appel\_a\_projet\_Ether.doc

### Useful information

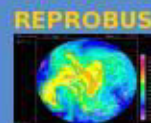
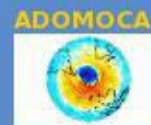
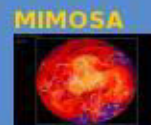
ECMWF website  
 Campus map

last modified : 2009-12-22

### Databases



### Data



### Services



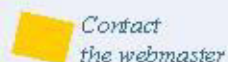
### Projects



## Ether Products and Services Centre Facilities

<http://ether.ipsl.jussieu.fr>

Ether Users : [LOGIN REQUEST](#) | [USER SPACE](#) | [ORDER TRACKING](#) | [USER RIGHTS](#)



[Website Policy](#)



Managed By



## ASSOCIATED Co-AUTHORS

A. Barbe  
 Y. Benilan  
 D.C. Benner  
 B. Bézard  
 V. Boudon  
 L.R. Brown  
 L.H. Coudert  
 A. Coustenis  
 V. Dana  
 S. Fally  
 A. Fayt  
 J.-M Flaud  
 A. Goldman  
 M. Herman  
 G. J. Harris  
 D. Jacquemart  
 A. Jolly,  
 I. Kleiner  
 A. Kleinböhl  
 F. Kwabia-Tchana  
 N. Lavrenjeva  
 N. Lacomme  
 J-Y. Mandin  
 A. Maki

A. Barbe  
 Y. Benilan  
 D.C. Benner  
 B. Bézard  
 V. Boudon  
 L.R. Brown  
 L.H. Coudert  
 A. Coustenis  
 V. Dana  
 S. Fally  
 A. Fayt  
 J.-M Flaud  
 A. Goldman  
 M. Herman  
 G. J. Harris  
 D. Jacquemart  
 A. Jolly,  
 I. Kleiner  
 A. Kleinböhl  
 F. Kwabia-Tchana  
 N. Lavrenjeva  
 N. Lacomme  
 J-Y. Mandin  
 A. Maki

V. Malathy Devi  
 S. Mikhailenko  
 C.E. Miller  
 N. Moazzen-Ahmadi  
 A. Nikitin  
 J. Orphal,  
 V. Perevalov  
 A. Perrin  
 D.T. Petkie  
 A. Predoi-Cross  
 J. Remedios  
 M. Rotger  
 K. Sung  
 S. Tashkun  
 J. Tennyson  
 R.A. Toth  
 A-C. Vandaele  
 J. Vander Auwera  
 C. P. Rinsland  
 L-H Xu

V. Malathy Devi  
 S. Mikhailenko  
 C.E. Miller  
 N. Moazzen-Ahmadi  
 A. Nikitin  
 J. Orphal,  
 V. Perevalov  
 A. Perrin  
 D.T. Petkie  
 A. Predoi-Cross  
 J. Remedios  
 M. Rotger  
 K. Sung  
 S. Tashkun  
 J. Tennyson  
 R.A. Toth  
 A-C. Vandaele  
 J. Vander Auwera  
 C. P. Rinsland  
 L-H Xu