SPECTROSCOPY FOR IASI: present and future of the GEISA/IASI database


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 CO₂, 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 atmospheric gases, forward and inverse radiative transfer modeling, etc. In particular, the group develops and maintains the spectroscopic data base GEISA (Gestion et Étude 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 Superieure, of the Universite 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).

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)

GEISA/IASI-2008 Archive in Preparation:

line transition parameter sub-database

Concluding Comments
GEISA and GEISA/IASI
System Overview
The 2003 edition of the GEISA/IASI spectroscopic database


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3Remote Sensing Technology Institute, German Aerospace Center (DLR), Oberpfaffenhofen, D-82234 Wessling, Germany
4Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA 91106, USA
5Laboratoire de Physique Moléculaire et Applications, Université Pierre et Marie Curie, 75252 Paris, France
6Service d’Astronomie, Institut Pierre Simon Laplace, Université Pierre et Marie Curie, 75252 Paris, France
7Service de Chimie Quantique et Photophysique, Université Libre de Bruxelles, C.P. 160/09, B-1050 Brussels, Belgium
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10National Center for Atmospheric Research, Boulder, CO 80307, USA
11State University of New York at Stony Brook, Stony Brook, NY 11794, USA
12Rutherford Appleton Laboratory, Chilton, Didcot, Oxon, OX11 0QX, UK
13Institute of Molecular Physics at Russian Research Center Kurchatov Institute, Moscow 123185, Russian Federation
14Max-Planck-Institut für Meteorologie, D-20355 Hamburg, Germany

Received 23 July 2004; accepted 15 December 2004

MORE RECENT REFERENCES

Atmospheric and Oceanic Optics. 16, No.3, 256-82, 2003.


The GEISA spectroscopic database in the ARA/LMD tools

The ARA \textit{(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.

**GEISA**

Spectroscopic database

\rightarrow

**STRANSAC**

Line-by-line Forward Model

\rightarrow

Faster 30/400 times

**4A**

Automatized Atmospheric Absorption Atlas

\rightarrow

**3I**

Improved Initialization Inversion

\rightarrow

Neural Network Learning (Inverse mode)

**TIGR**

2300 selected Atmospheric Profiles (T,H2O,O3 ...) Precomputed BT, Trans., JACOBIANS Radiative flux

\rightarrow

3R

Rapid Radiance Recognition

\rightarrow

Neural Network Learning (forward mode)

\rightarrow

\rightarrow

\rightarrow

\rightarrow

\rightarrow

Faster 3000/40000 times

\rightarrow

**• Spectroscopy**

**• Forward model**

**• Inverse model**

**• Educated database dedicated to one particular application (TOVS, AIRS, IASI, Radiative budget ...)**

ASSFTS13 Toulouse, 7-9 November 2007
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)
Extraction of GEISA-03 between 599 & 3001 cm\(^{-1}\)

- Individual spectral lines spectroscopic parameters sub-database
  - 14 molecules (53 isotopic species): H\(_2\)O, CO\(_2\), O\(_3\), N\(_2\)O, CO, CH\(_4\), O\(_2\), NO, SO\(_2\), NO\(_2\), HNO\(_3\), OCS, C\(_2\)H\(_2\), N\(_2\)

- IR absorption cross-sections sub-database (mainly CFC’s)
  - 6 molecular species: CFC-11, CFC-12, CFC-14, CCl\(_4\), N\(_2\)O\(_5\), HCFC-22

- Microphysical and optical properties of Basic Atmospheric aerosol components sub-database (similar with the GEISA-03 one)

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

Total # entries: 702,550
GEISA/IASI-03 line transition parameters sub-database
<table>
<thead>
<tr>
<th>Molecule</th>
<th>Code</th>
<th>Isotopes</th>
<th># Transitions</th>
</tr>
</thead>
<tbody>
<tr>
<td>h2o</td>
<td>1</td>
<td>161-162-171-181-182</td>
<td>13278</td>
</tr>
<tr>
<td>co2</td>
<td>2</td>
<td>626-627-628-636-637-638-728-828-838</td>
<td>50840</td>
</tr>
<tr>
<td>o3</td>
<td>3</td>
<td>666-668-686-667-676</td>
<td>195102</td>
</tr>
<tr>
<td>n2o</td>
<td>4</td>
<td>446-447-448-456-546</td>
<td>18966</td>
</tr>
<tr>
<td>co</td>
<td>5</td>
<td>26-36-28-27-38-37</td>
<td>3674</td>
</tr>
<tr>
<td>ch4</td>
<td>6</td>
<td>211-311-212 ( (ch3d) )</td>
<td>121281</td>
</tr>
<tr>
<td>o2</td>
<td>7</td>
<td>66-67-68</td>
<td>435</td>
</tr>
<tr>
<td>no</td>
<td>8</td>
<td>46-48-56</td>
<td>29608</td>
</tr>
<tr>
<td>so2</td>
<td>9</td>
<td>626-646</td>
<td>22301</td>
</tr>
<tr>
<td>no2</td>
<td>10</td>
<td>646</td>
<td>71687</td>
</tr>
<tr>
<td>hno3</td>
<td>13</td>
<td>146</td>
<td>152586</td>
</tr>
<tr>
<td>ocs</td>
<td>20</td>
<td>622-624-632-623-822-634-722</td>
<td>19768</td>
</tr>
<tr>
<td>c2h2</td>
<td>24</td>
<td>221-231</td>
<td>2904</td>
</tr>
<tr>
<td>n2</td>
<td>33</td>
<td>44</td>
<td>120</td>
</tr>
</tbody>
</table>

Spectral range: \( 599 – 3001 \) cm\(^{-1} \)  
Total: 702,550

**GIDSC Selection**  
14 molecules (53 isotopic species)
## GEISA and GEISA/IASI-03 Line Transitions Records

### A-J fields
Mainly specific of GEISA management software

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

### K-Q fields in the GEISA format
Mainly HITRAN-01 format inter-compatibility related

<table>
<thead>
<tr>
<th>Field</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>K</td>
<td>Molecule number as in HITRAN</td>
</tr>
<tr>
<td>L</td>
<td>Isotope number as in HITRAN</td>
</tr>
<tr>
<td>M</td>
<td>Transition probability (in debye(^2))</td>
</tr>
<tr>
<td>N</td>
<td>Self broadening pressure halfwidth (HWHM) (cm(^{-1}) atm(^{-1})) at 296K (for water)</td>
</tr>
<tr>
<td>O</td>
<td>Air pressure shift of the line transition (cm(^{-1}) atm(^{-1})) at 296K</td>
</tr>
<tr>
<td>P</td>
<td>Accuracy indices for wavenumber, intensity and halfwidth</td>
</tr>
<tr>
<td>Q</td>
<td>Indices for lookup of references for wavenumber, intensity and halfwidth</td>
</tr>
</tbody>
</table>
GEISA-03 Line Transitions Records (following)

R-U' fields in the GEISA format

(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.cm²))
(C') Estimated accuracy on the air collision halfwidth (HWHM) (cm⁻¹atm⁻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⁻¹atm⁻¹) @296K
(R') Estimated accuracy on the temperature dependence coefficient n of the air pressure shift

Water specific

(N') Estimated accuracy on the self broadened (HWHM) (cm⁻¹atm⁻¹) @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⁻¹atm⁻¹) @296K
(T') Estimated accuracy on the self pressure shift of the line transition (cm⁻¹atm⁻¹) @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)
GEISAIASI-03 cross-sections sub-database
## GEISA/IASI-03 cross-sections sub-database

<table>
<thead>
<tr>
<th>Molecule</th>
<th>Spectral range (cm⁻¹)</th>
<th>Temperature range (K)</th>
<th>Pressure range (Pa)</th>
<th>Number of TP sets</th>
<th>References</th>
<th>Number of entries</th>
</tr>
</thead>
<tbody>
<tr>
<td>CFC-11</td>
<td>599 - 2000</td>
<td>296</td>
<td>93325</td>
<td>1</td>
<td>Hurley (2003); Christidis (1997)</td>
<td>1,657,853</td>
</tr>
<tr>
<td></td>
<td>500 - 1601</td>
<td>297</td>
<td>0</td>
<td>1</td>
<td>Heathfield (1998); Shine (2003)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>810 - 880</td>
<td>190 - 296</td>
<td>1000 - 101325</td>
<td>55</td>
<td>Li &amp; Varanasi (1994)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1050 - 1120</td>
<td></td>
<td></td>
<td></td>
<td>Varanasi (2000)</td>
<td></td>
</tr>
<tr>
<td>CFC-12</td>
<td>850 - 1190</td>
<td>253 - 287</td>
<td>0</td>
<td>3</td>
<td>Clerbaux (1993)</td>
<td>2,199,538</td>
</tr>
<tr>
<td>(CCl₂F₂)</td>
<td>210 - 2000</td>
<td>296</td>
<td>93325</td>
<td>1</td>
<td>Hurley (2003)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1050 - 1120</td>
<td></td>
<td></td>
<td></td>
<td>Varanasi (2000)</td>
<td></td>
</tr>
<tr>
<td>CFC-14</td>
<td>220 - 2000</td>
<td>296</td>
<td>93325</td>
<td>1</td>
<td>Hurley (2003)</td>
<td>411,228</td>
</tr>
<tr>
<td>HCFC-22</td>
<td>700 - 1500</td>
<td>203 - 293</td>
<td>0 - 80000</td>
<td>8</td>
<td>Vander Auwera (2003)</td>
<td>2,019,054</td>
</tr>
<tr>
<td>(CHClF₂)</td>
<td>765 - 1380</td>
<td>253 - 287</td>
<td>0</td>
<td>3</td>
<td>Clerbaux (1993)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>760 - 860</td>
<td>181 - 297</td>
<td>2666 - 101936</td>
<td>51</td>
<td>Varanasi (2001)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1070 - 1195</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N₂O₅</td>
<td>540 - 1380</td>
<td>205 - 293</td>
<td>0</td>
<td>5</td>
<td>Wagner &amp; Birk (2003)</td>
<td>87,120</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td>274</td>
<td></td>
<td>6,572,329</td>
</tr>
</tbody>
</table>

- **GEISA/IASI-97**: 1,750,993 entries
- **New GEISA/IASI-03**: 4,821,336 entries
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-03 and GEISA/IASI common 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 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
Welcome to the Ether website

This website offers various products of French activities in national and international projects. The access rights vary according to the products (see "Login Request").

Original products

- IASI: French activities
- GEISA: spectroscopic data
- Eccad: data for emissions calculation
- Chemical Kinetics Database
- Girafe: biomass burning plumes
- Mimosas: daily production potential vorticity and temperature analysis and forecasts in Northern, Southern Hemisphere and Tropics
- Reprobis: daily production chemistry transport model in polar winters
- Ablettv: temperature and pressure profiles calculation
- Odin-smr: official data and specific products (CO, CO2, ...)

Other products

- Select by experiment
- Models and assimilations
- Software

Image of the month

First IASI level 1C spectrum: 24/3/2008, 12:39 UTC
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**

<table>
<thead>
<tr>
<th>Species</th>
<th>Wavenumber Range</th>
<th>Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>H2O</td>
<td>500-8000 cm⁻¹</td>
<td>LISA, JPL</td>
</tr>
<tr>
<td>CO2</td>
<td>2200-7000 cm⁻¹</td>
<td>JPL, LTS</td>
</tr>
<tr>
<td>N2O</td>
<td>1900-6800 cm⁻¹</td>
<td>JPL</td>
</tr>
<tr>
<td>CH4</td>
<td>750-1350 cm⁻¹</td>
<td>ICB, JPL, LISA, LPMAA</td>
</tr>
<tr>
<td></td>
<td>2850-3150 cm⁻¹</td>
<td></td>
</tr>
<tr>
<td>SO2</td>
<td>V1,V3</td>
<td>LISA</td>
</tr>
<tr>
<td></td>
<td>V1+V2–V2</td>
<td>GSMA</td>
</tr>
<tr>
<td>HNO3</td>
<td>V5 ; 2V9</td>
<td>LISA</td>
</tr>
<tr>
<td>C2H2</td>
<td>604-2254 cm⁻¹</td>
<td>LADIR</td>
</tr>
</tbody>
</table>
Updates for 2007 Edition of GEISA line transition parameters sub-database (Following)

The MIPAS data base in the spectral range
597.046462 – 2502.957500 cm\(^{-1}\)


- MIPAS (Michelson Interferometer for Passive Atmospheric Sounding) experiment operating on board the ENVISAT satellite since March 2002, recording emission limb sounding spectra at 0.025 cm\(^{-1}\) (unapodized) in the spectral range 685-2410 cm\(^{-1}\)

- Starting from HITRAN-96 and GEISA-97, and updated in 2001 and 2003 with specific spectroscopic studies or from spectroscopic studies prior to their publications. Validation through ATMOS and MIPAS recorded spectra

- 31 molecules (O, NO+, HOBr, C\(_2\)H\(_4\), CH\(_3\)OH, H\(_2\)CO, H2CO, SF6 discarded)

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

- Comparison with GEISA content
- Assessment of updates to be made in GEISA

ASSFTS13 Toulouse, 7-9 November 2007
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
   4A/OP co-developed by LMD and Noveltis with the support of CNES (2006)]

Related to:
IASI Level 1 Cal/Val activities@ CNES
Toth’s (2000, 2002)
599.681 - 2819.848 cm\(^{-1}\)

RAL/ EUMETSAT
700.032 - 1299.980 cm\(^{-1}\)

<table>
<thead>
<tr>
<th>Wavenumber (cm(^{-1}))</th>
<th>Log intensity (cm.molecule(^{-1}))</th>
</tr>
</thead>
<tbody>
<tr>
<td>600 - 3000</td>
<td></td>
</tr>
</tbody>
</table>

Alternative choice for GEISA/IASI-03 update

Choice for GEISA/IASI-03 update

RSF13 Toulouse, 7-9 November 2007
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 vapor content) become available;
3. The freons bands at 850 and 920 cm\(^{-1}\): refine the temperature dependence;
4. \(\text{O}_3\) in the 9.6 micron region: the spectroscopic parameters still need to be validated;
5. Some CO2 – Q branches: further improvement/tuning of the line mixing
## Status of Molecules for IASI Radiative Transfer Modelling

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

**Where are we now?**

<table>
<thead>
<tr>
<th>MOLECULE</th>
<th>LINE POSITION</th>
<th>LINE INTENSITIES</th>
<th>LINE BROADENING</th>
<th>LINE MIXING</th>
<th>CONTINUUM</th>
<th>CROSS-SECTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>H2O</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>Y</td>
<td>Y</td>
<td>2</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>O3</td>
<td>3</td>
<td>1?</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CH4</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO</td>
<td>Y</td>
<td>Y</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N2O</td>
<td>?</td>
<td>?</td>
<td>2</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HNO3</td>
<td>Y</td>
<td>Y</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>O2 &amp; N2 collision induced spectrum</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td>CFC’s, HCFC’s, N2O5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Y</td>
</tr>
</tbody>
</table>

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

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

Prepared by A. Perrin (GIDSC chairman)

GIDSC: GEISA/IASI Database Scientific Committee
Spectroscopic data involved in comparisons

**GEISA/IASI-03**  
599 - 3,001 cm$^{-1}$

14 molecules: $\text{H}_2\text{O}$, $\text{CO}_2$, $\text{O}_3$, $\text{N}_2\text{O}$, $\text{CO}$, $\text{CH}_4$, $\text{O}_2$, $\text{NO}$, $\text{SO}_2$, $\text{NO}_2$, $\text{HNO}_3$, $\text{OCS}$, $\text{C}_2\text{H}_2$, $\text{N}_2$

**MIPAS database**  
597 – 2,503 cm$^{-1}$

Version pf3.2

**HITRAN-04**  
extractions in GEISA/IASI and MIPAS databases common spectral intervals

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

$\text{H}_2\text{O}$, $\text{CO}_2$, $\text{O}_3$, $\text{N}_2\text{O}$, $\text{CO}$, $\text{CH}_4$
H2O Spectroscopy differences illustration

- IASI brightness temperature (K) simulation with GEISA-03 (upper curve);
- Impact of replacement of HITRAN-04 or MIPAS PF3.2 H2O data in GEISA-03
- Differences (K) in lower curves, with associated IASI noise.
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