Atlas of Absorption Lines From 0 to 17 900 cm⁻¹

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Atlas of Absorption Lines From 0 to 17 900 cm$^{-1}$

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DESCRIPTION OF THE ATLAS

This atlas is a pictorial representation of atmospheric absorption line parameters contained in the AFGL (Air Force Geophysics Laboratory) major-gas and trace-gas compilations currently available on magnetic tape (Rothman 1981, Rothman et al. 1981). It is a revised edition of the atlas previously published by Park (1977), which had been based on an earlier version of the AFGL major-gas compilation (McClatchey et al. 1973) and trace-gas line parameters collected at NASA Langley Research Center. This earlier publication has become very useful as a quick reference for researchers in the fields of molecular spectroscopy and atmospheric remote sensing. Since new, extensively revised versions of the AFGL line parameter compilations have recently been released, the authors felt that a new edition of the atlas was necessary.

In the atlas are presented plots of the logarithm (base 10) of absorption line strength (S in atm \(-1\) cm\(^{-2}\)) at 296 K versus wavenumber (in cm\(^{-1}\)) for atmospheric gases (see table I). The atlas covers the spectral range of the AFGL compilations.

**TABLE I.- LIST OF GASES SHOWN IN THE ATLAS**

<table>
<thead>
<tr>
<th>AFGL Gas Code</th>
<th>Gas name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>H(_2)O</td>
</tr>
<tr>
<td>2</td>
<td>CO(_2)</td>
</tr>
<tr>
<td>3</td>
<td>O(_3)</td>
</tr>
<tr>
<td>4</td>
<td>N(_2)O</td>
</tr>
<tr>
<td>5</td>
<td>CO</td>
</tr>
<tr>
<td>6</td>
<td>CH(_4)</td>
</tr>
<tr>
<td>7</td>
<td>O(_2)</td>
</tr>
<tr>
<td>8</td>
<td>NO</td>
</tr>
<tr>
<td>9</td>
<td>SO(_2)</td>
</tr>
<tr>
<td>10</td>
<td>NO(_2)</td>
</tr>
<tr>
<td>11</td>
<td>NH(_3)</td>
</tr>
<tr>
<td>12</td>
<td>HNO(_3)</td>
</tr>
<tr>
<td>13</td>
<td>OH</td>
</tr>
<tr>
<td>14</td>
<td>HF</td>
</tr>
<tr>
<td>15</td>
<td>HCl</td>
</tr>
<tr>
<td>16</td>
<td>HI</td>
</tr>
<tr>
<td>17</td>
<td>HI</td>
</tr>
<tr>
<td>18</td>
<td>ClO</td>
</tr>
<tr>
<td>19</td>
<td>OCS</td>
</tr>
<tr>
<td>20</td>
<td>H(_2)CO</td>
</tr>
<tr>
<td>(a)</td>
<td>N(_2)</td>
</tr>
<tr>
<td>(a)</td>
<td>CH(_3)Cl</td>
</tr>
<tr>
<td>(a)</td>
<td>Solar CO</td>
</tr>
</tbody>
</table>

*aIndicates data not in 1980 AFGL compilations. O\(_2\) quadrupole lines near 6.3 \(\mu\)m are also not included in the 1980 major-gas tape.
(0 to 17 900 cm\(^{-1}\)). Line parameters for all gases are taken from the 1980 versions of the AFGL major-gas and trace-gas compilations, and additional data are included for the electric quadrupole lines of \(\text{O}_2\) (Rothman and Goldman 1981) and of \(\text{N}_2\) (obtained from S. E. Keddy, Memorial University of Newfoundland, 1981) and for the \(\text{U}_4\) band of \(\text{CH}_3\text{Cl}\) (Margolis 1978). Solar CO lines at 6000 K, calculated by C. P. Rinsland in 1981, are also shown for the fundamental and first overtone sequences. The solar CO line strengths were calculated with the dipole moment function of Kirschner et al. (1977) following Tipping (1976) with terrestrial isotope ratios assumed. All isotopic bands contained in the AFGL compilation are included in this atlas, as well as the \(\text{U}_4\) bands of both \(\text{CH}_3\text{Cl}_{35}\) and \(\text{CH}_3\text{Cl}_{37}\) and the main isotopes of \(\text{O}_2\) and \(\text{N}_2\) for the quadrupole transitions. As in the AFGL compilation, intensities of all bands are scaled according to the terrestrial abundance of each isotopic species.

On each page of the atlas, the plots of \(\log (S)\) versus wavenumber for all gases having absorption lines in the same 50 cm\(^{-1}\) interval are presented in order of the integer gas codes given in table I. For the major gases (\(\text{H}_2\text{O}, \text{CO}_2, \text{O}_3, \text{N}_2\text{O}, \text{CO}, \text{CH}_4,\) and \(\text{O}_2\)), all lines having strengths within \(10^{-6}\) of the maximum value for that interval are shown; and for the trace gases, all lines having strengths within \(10^{-4}\) of the maximum are included, because the maximum and minimum line strengths are redetermined for each 50 cm\(^{-1}\) interval, sudden changes may appear in the line strength scale from one plot to another, and some weak lines on the AFGL tape are not plotted in this atlas. Isolated weak bands may also appear, at first glance, to be much stronger than expected. Since the number of gases appearing simultaneously in any single 50 cm\(^{-1}\) interval is significantly reduced at wavenumbers higher than 5000 cm\(^{-1}\), plots of \(\log (S)\) versus wavenumber for two consecutive intervals are presented on the same page from 5000 to 10 000 cm\(^{-1}\), and three consecutive intervals are plotted together from 10 000 to 17 900 cm\(^{-1}\).

At the bottom of each page for intervals from 0 to 5000 cm\(^{-1}\), also presented are plots of the lower-state energy values (\(E''\) in cm\(^{-1}\)) for lines of the strongly absorbing gases \(\text{H}_2\text{O}, \text{CO}_2, \text{O}_3,\) and \(\text{CH}_4\). These energy values are plotted as an aid to quickly judge the strength of atmospheric absorption by these gases at temperatures different from 296 K. Energy values greater than 1500 cm\(^{-1}\) are plotted as 1500 cm\(^{-1}\); in the few cases of unassigned transitions, where the energies are given as \(-1\) on the AFGL tape, they are plotted as 0 cm\(^{-1}\) in the atlas. At wavenumbers higher than 5000 cm\(^{-1}\), plots of \(E''\) versus wavenumber are omitted.

Updated versions of this atlas are planned when major revisions of the AFGL line parameter compilations are released.

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REFERENCES


The diagram shows the wavelength spectrum for different substances:

- **H₂O**
- **CO₂**
- **O₃**
- **SO₂**
- **NH₃**

The X-axis represents the wavelength (in μm) and the Y-axis represents the intensity of absorption bands. The wavelength range is from 10.000 to 9.524 μm.

The diagram also includes a detailed wave number spectrum from 1000 to 1050 cm⁻¹ with specific absorption peaks for each substance.
3.030 3.026 3.021 3.017 3.012 3.000 3.003 2.999 2.994 2.990 2.985 

WAVENUMBER

3.030 3.026 3.021 3.017 3.012 3.000 3.003 2.999 2.994 2.990 2.985 

μm

log(S)

H₂O

log(S)

CO₂

log(S)

N₂O

log(S)

OH

log(S)

CO SUN

WAVENUMBER

H₂O

CO₂

cm⁻¹
H₂O  N₂O  CO  HF  CO SUN

2.469  2.466  2.463  2.460  2.457  2.454  2.451  2.448  2.445  2.442  2.439 µm

log(S)

log(S)

log(S)

log(S)

log(S)  CO SUN

WAVENUMBER

H₂O cm⁻¹

1100  1050  1000  950  900  850  800  750  700  650  600  550

85
The diagram shows a spectrum analysis of various molecules over a range of wavelengths. From top to bottom, the molecules identified are:

1. **H₂O** (Water)
2. **N₂O** (Nitrous Oxide)
3. **CO** (Carbon Monoxide)
4. **HF** (Hydrogen Fluoride)
5. **HI** (Hydrogen Iodide)
6. **CO SUN**

The spectrum is plotted on a wavelength scale ranging from 2.326 to 2.299 μm and a wave number scale from 4350 to 4300 cm⁻¹. The spectrum lines indicate absorption peaks for each molecule at specific wavelengths.
2.208 2.205 2.203 2.200 2.198

log(s)

log(s)

\( \mu m \)

WAVENUMBER

H_2O

CO_2

H_2O

CO_2
\begin{align*}
\log(s) & \quad \text{\texttt{H}_2\text{O}} \\
\log(s) & \quad \text{\texttt{CO}_2} \\
\log(s) & \quad \text{\texttt{HBr}}
\end{align*}
H₂O

log(S)

log(S)

log(S)

WAVENUMBER

cm⁻¹

H₂O

CO₂

HCl

WAVENUMBER

cm⁻¹

H₂O

CO₂

CH₄

WAVENUMBER

cm⁻¹
\[ \mu m \]

**WAVENUMBER**

\[ cm^{-1} \]
WAVENUMBER

\[
\begin{array}{cccccccccccc}
1.250 & 1.249 & 1.248 & 1.247 & 1.246 & 1.245 & 1.244 & 1.243 & 1.242 \\
\times_{(S)} & -10^8 & -10^7 & -10^6 & -10^5 & -10^4 & -10^3 & -10^2 & -10^1 \\
\times_{(S)} & -10^8 & -10^7 & -10^6 & -10^5 & -10^4 & -10^3 & -10^2 & -10^1 \\
\times_{(S)} & -10^8 & -10^7 & -10^6 & -10^5 & -10^4 & -10^3 & -10^2 & -10^1 \\
\times_{(S)} & -10^8 & -10^7 & -10^6 & -10^5 & -10^4 & -10^3 & -10^2 & -10^1 \\
\end{array}
\]

WAVENUMBER
WAVENUMBER
1.163 1.162 1.161 1.160 1.159 1.159 1.158 1.157 1.157 1.156...

8600 8605 8610 8615 8620 8625 8630 8635 8640 8645 8650

Wavenumber

8650 8655 8660 8665 8670 8675 8680 8685 8690 8695 8700

Wavenumber
W A V E N U M B E R
The diagrams show the spectral distribution of water vapor ($H_2O$) and oxygen ($O_2$) in the wavelength range of 12850 to 13000 cm$^{-1}$ and their logarithmic intensity ($\log(S)$) at various points. The intensity ranges from $-12$ to $-6$. The diagrams illustrate the absorption bands of water and oxygen in the near-infrared region.
WAVENUMBER
Plots of absorption line strength versus line position for wavenumbers from 0 to 17,900 cm\(^{-1}\) are shown for the 20 atmospheric gases (H\(_2\)O, CO\(_2\), O\(_3\), N\(_2\)O, CO, CH\(_4\), O\(_2\), NO, SO\(_2\), NO\(_2\), NH\(_3\), HNO\(_3\), OH, HF, HCl, HBr, HI, ClO, OCS, H\(_2\)CO), which appear in the 1980 Air Force Geophysics Laboratory major-gas and trace-gas compilations, and for N\(_2\) and CH\(_3\)Cl at 296 K and solar CO at 6000 K. Also shown are similar plots of lower-state energy values for absorption lines for the strongly absorbing atmospheric gases (H\(_2\)O, CO\(_2\), O\(_3\), and CH\(_4\)) for wavenumbers from 0 to 5000 cm\(^{-1}\).