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>
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<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>HBr</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 O$_2$ (Rothman and Goldman 1981) and of N$_2$ (obtained from S. F. Keddy, Memorial University of Newfoundland, 1981) and for the U$_4$ band of CH$_3$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 U$_4$ bands of both CH$_3$Cl$^{35}$ and CH$_3$Cl$^{37}$ and the main isotopes of O$_2$ and 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 (H$_2$O, CO$_2$, O$_3$, N$_2$O, CO, CH$_4$, and 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 H$_2$O, CO$_2$, O$_3$, and 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 image contains a graph with wave numbers on the x-axis and intensity on the y-axis. The graph shows various spectral lines for different gases, including H$_2$O, N$_2$O, CH$_4$, O$_2$, NO$_2$, and CO. The wave numbers range from 6.250 to 6.061 μm, and the spectral intensities are represented in a logarithmic scale. The graph is labeled with corresponding gas names for each spectral line.
<table>
<thead>
<tr>
<th>WAVENUMBER cm⁻¹</th>
<th>H₂O</th>
<th>CO₂</th>
<th>CH₄</th>
<th>HCl</th>
<th>HBr</th>
</tr>
</thead>
<tbody>
<tr>
<td>2650 - 2700</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.774 - 3.704 μm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wavenumber (cm^{-1})</td>
<td>H₂O</td>
<td>CO₂</td>
<td>N₂O</td>
<td>OH</td>
<td>HF</td>
</tr>
<tr>
<td>----------------------</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
<td>----</td>
<td>----</td>
</tr>
<tr>
<td>3350 - 3400</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
1.299 1.298 1.297 1.296 1.295
I 11
1.294 1.294 1.293 1.292 1.291 1.290
E 0
z -2
f
147

H₂O
CO₂
O₂
HF

1.285 1.284 1.283 1.282
μm
μm

WAVENUMBER
WAVENUMBER

7750 7755 7760 7765 7770 7775 7780 7785 7790 7795 7800
7750 7755 7760 7765 7770 7775 7780 7785 7790 7795 7800
WAVENUMBER
WAVENUMBER
WAVENUMBER

H₂O

WAVENUMBER

H₂O

WAVENUMBER

H₂O
W A V E N U M B E R

14800 14805 14810 14815 14820 14825 14830 14835 14840 14845 14850

W A V E N U M B E R

14900 14905 14910 14915 14920 14925 14930 14935 14940 14945 14950

W A V E N U M B E R

186
WAVENUMBER

WAVENUMBER

WAVENUMBER

WAVENUMBER
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\(^{-1}\).