Atmosphere Aloft:
Locating the Tropopause

by Carol Hildreth

Problem:
How can the height of the tropopause be determined and how does it vary with latitude?

Materials:
1. Blank Stuve diagram (or one per student or group of students). For more advanced work, and to see what the temperature curves in the atmosphere with altitude are compared to, here is a blank Stuve diagram with all the lines.
2. Data listed below.
3. Earth Science Reference Tables.
4. Colored pencils (optional).

Procedure:
1. Discuss Atmosphere Aloft background information:

   OBSERVING THE ATMOSPHERE ALOFT:

   Sonde = Messenger.

   Radiosonde = FM radio transmitter on a balloon that measures temperature, humidity and air pressure. These are the size of shoebox. The military has a more compact unit and a smaller balloon.

   Rawinsonde = A complete information system. Ground-based radio direction finders track the motion of the radiosonde so that wind speed and wind direction at various levels can be determined.

   The weather balloons are launched at 12 hour intervals at 00Z and 12Z (midnight and noon, Greenwich Mean Time) from hundreds of ground stations around the world. Eastern Standard Time is Z-5 hours, and Eastern Daylight Time is Z-4 hours). The balloons burst at an average altitude of 20 to 30 km and the instrument package descends by parachute. About 20% are recovered, refurbished and reused.

   Dropwindsonde = A sonde dropped from an aircraft over oceans that descends on a parachute at about 18 km per hour (11 mph).

   ANALYZING THE ATMOSPHERE ALOFT:
Stuve Diagram = Shows the profile of the atmosphere aloft: temperature, dew point, wind direction, wind speed.

Tropopause = Boundary between the troposphere (lower atmosphere) and the stratosphere. It is observed as the lowest point in the temperature profile, a temperature inversion, or the beginning of isothermal temperatures near the 200-300 mb level (~10 km for our latitude; ~6 km in polar regions; ~16 km in the tropics).

2. On the blank stuve diagram draw the Standard Atmosphere Temperature Profile using the data in the table below. Plot points and connect them with a solid line (colored line optional).

<table>
<thead>
<tr>
<th>Air pressure</th>
<th>Altitude, km</th>
<th>Temp. ºC</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000</td>
<td>0</td>
<td>+15.0</td>
</tr>
<tr>
<td>~230</td>
<td>11</td>
<td>-56.5</td>
</tr>
<tr>
<td>~100</td>
<td>16</td>
<td>-56.0</td>
</tr>
</tbody>
</table>

3. The U.S. Standard Atmosphere describes the representative or average conditions of the atmosphere with height. The decreasing temperature line depicts the troposphere up to about 11 km. The isothermal region above 11 km, where temperatures remain steady, represents the lower portion of the stratosphere. Draw a horizontal line at the beginning of the isothermal layer and label it Standard Atmosphere Tropopause. Also label the troposphere and stratosphere. Refer to Earth Science Reference Tables, page 15, Selected Properties of Earth’s Atmosphere. How does your graph compare?

4. The tropospheric temperature decrease with altitude in the Standard Atmosphere is how many ºC per km?

5. Plot the temperature profile for Albany, NY on the graph and connect with a dashed (or colored) line.

   Use current upper air data

   OR

Use the edited data table below: [level heights next to corresponding pressures on vertical axis]

| Date: 1200z 25 FEB 97 (7amEST) [**specially selected levels of radiosonde data] |
|-------------------------------|---------------------|-----------------|-----------------|
| Station: ALB WMO ident: 72518                                        |
| Latitude: 42.75, Longitude: -73.80, Elevation: 89.00                  |

<table>
<thead>
<tr>
<th>Level**</th>
<th>Pressure, mb</th>
<th>Height, m</th>
<th>Temp. ºC</th>
</tr>
</thead>
<tbody>
<tr>
<td>SFC</td>
<td>1020</td>
<td>89</td>
<td>-13.1</td>
</tr>
<tr>
<td>2</td>
<td>1000</td>
<td>235</td>
<td>-14.3</td>
</tr>
<tr>
<td>5</td>
<td>893</td>
<td>1081</td>
<td>-20.1</td>
</tr>
</tbody>
</table>
6. Locate the tropopause at the beginning of the temperature inversion at ~8.2 km on 2/25/97. Draw a horizontal line and label tropopause with date, elevation, and surface temperature. How does this line compare with the Standard Atmosphere Profile?

7. Compare current Stuve diagrams for Albany and Miami. In each case the tropopause pressure is given in top right corner, labeled TP. Stuve diagrams for other US Cities may also be used for comparison. Discuss reasons for the differences in tropopause height and pressure. Refer to the Earth Science Reference Tables, page 15, Selected Properties of Earth’s Atmosphere.

Conclusion:

In a paragraph, answer the question in the problem, giving specific examples from this lab exercise.

Suggestion:

Copy this lab for student use. Make a class set of the latest Stuve diagrams of Albany and Miami for comparison. If Internet access is available to students, give them this address and have them get the Stuve diagrams (DataStreme Project).

Science labs web page
Pedagogy web page

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