The Physics of Extreme Weather

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Quick Quiz

Rank Causes of Death Per Million in USA*

1. Alcohol Use
2. Drug Use
3. Firearm accidents
4. Mibrobial Agents
5. Motor Vehicle Crashes
6. Obesity
7. Terrorist acts
8. Tobacco Use
9. Weather related disaster
**Quick Quiz**

**Rank Causes of Death Per Million in USA**

1. Alcohol Use  
2. Drug Use  
3. Firearm accidents  
4. Microbiological Agents  
5. Motor Vehicle Crashes  
6. Obesity  
7. Terrorist acts  
8. Tobacco Use  
9. Weather related disaster

<table>
<thead>
<tr>
<th>Rank</th>
<th>Cause</th>
<th>Death Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Alcohol Use</td>
<td>1450</td>
</tr>
<tr>
<td>2</td>
<td>Drug Use</td>
<td>1333</td>
</tr>
<tr>
<td>3</td>
<td>Firearm accidents</td>
<td>283</td>
</tr>
<tr>
<td>4</td>
<td>Microbiological Agents</td>
<td>250</td>
</tr>
<tr>
<td>5</td>
<td>Motor Vehicle Crashes</td>
<td>143</td>
</tr>
<tr>
<td>6</td>
<td>Obesity</td>
<td>97</td>
</tr>
<tr>
<td>7</td>
<td>Terrorist acts</td>
<td>57</td>
</tr>
<tr>
<td>8</td>
<td>Tobacco Use</td>
<td>2</td>
</tr>
<tr>
<td>9</td>
<td>Weather related disaster</td>
<td>0.00001</td>
</tr>
</tbody>
</table>
Quick Quiz II

Rank Causes of Death By Weather Events

1. Cold
2. Flood
3. Hail
4. Heat
5. Hurricane
6. Lightning
7. Thunderstorms
8. Tornado
9. Winter/Cold
Quick Quiz II

Rank Causes of Death By Weather Events

1. Cold
2. Flood
3. Hail
4. Heat
5. Hurricane
6. Lightning
7. Thunderstorms
8. Tornado
9. Winter

- Cold: 43%
- Flood: 15%
- Hail: 11%
- Heat: 8%
- Hurricane: 5%
- Lightning: 3%
- Thunderstorms: 10%
- Tornadoes: 5%
- Winter: 5%
<table>
<thead>
<tr>
<th>Country</th>
<th>Number of Fatalities</th>
<th>Other Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>France</td>
<td>14,802</td>
<td>Temperatures soared to 104 degrees Fahrenheit in parts of the country; temperatures in Paris were the highest since record-keeping began in 1873.</td>
</tr>
<tr>
<td>Germany</td>
<td>7,000</td>
<td>High temperatures of up to 105.4 degrees Fahrenheit, the hottest since records began in 1901, raised mortality some 10 percent above average.</td>
</tr>
<tr>
<td>Spain</td>
<td>4,230</td>
<td>High temperatures coupled with elevated ground-level ozone concentrations exceeding the European Union's health-risk threshold.</td>
</tr>
<tr>
<td>Italy</td>
<td>4,175</td>
<td>Temperatures in parts of the country averaged 16 degrees Fahrenheit higher than previous year.</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>2,045</td>
<td>The first triple digit (Fahrenheit) temperatures were recorded in London.</td>
</tr>
<tr>
<td>Netherlands</td>
<td>1,400</td>
<td>Temperatures ranged some 14 degrees Fahrenheit warmer than normal.</td>
</tr>
<tr>
<td>Portugal</td>
<td>1,316</td>
<td>Temperatures were above 104 degrees Fahrenheit throughout much of the country.</td>
</tr>
<tr>
<td>Belgium</td>
<td>150</td>
<td>Temperatures exceeded any in the Royal Meteorological Society's records dating back to 1833.</td>
</tr>
<tr>
<td><strong>TOTAL OF ABOVE COUNTRIES</strong></td>
<td><strong>35,118</strong></td>
<td>**</td>
</tr>
</tbody>
</table>
Number of deaths by selected characteristics
(Rome, Italy, June-August 2003)

<table>
<thead>
<tr>
<th>Characteristic</th>
<th># deaths reported</th>
<th># deaths expected</th>
<th>Excess deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age Group</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0-64</td>
<td>840</td>
<td>870</td>
<td>-30</td>
</tr>
<tr>
<td>65-74</td>
<td>1,150</td>
<td>1,084</td>
<td>66</td>
</tr>
<tr>
<td>75-84</td>
<td>1,919</td>
<td>1,484</td>
<td>435</td>
</tr>
<tr>
<td>≥85</td>
<td>1,985</td>
<td>1,362</td>
<td><strong>623</strong></td>
</tr>
<tr>
<td><strong>Sex</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>2,689</td>
<td>2,379</td>
<td>310</td>
</tr>
<tr>
<td>Female</td>
<td>3,205</td>
<td>2,421</td>
<td><strong>784</strong></td>
</tr>
<tr>
<td><strong>Location of death</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>In hospital</td>
<td>2,223</td>
<td>2,088</td>
<td>135</td>
</tr>
<tr>
<td>Out of hospital</td>
<td>1,170</td>
<td>954</td>
<td><strong>216</strong></td>
</tr>
<tr>
<td><strong>Socioeconomic level</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High</td>
<td>824</td>
<td>778</td>
<td>46</td>
</tr>
<tr>
<td>Medium High</td>
<td>1,227</td>
<td>11,195</td>
<td>32</td>
</tr>
<tr>
<td>Medium Low</td>
<td>1,144</td>
<td>1,016</td>
<td><strong>128</strong></td>
</tr>
<tr>
<td>Low</td>
<td>789</td>
<td>670</td>
<td><strong>119</strong></td>
</tr>
</tbody>
</table>
Albedo = 30/100
Albedo = 30/100

Shortwave

- Convection: -7
- Evaporation: -23
- Infrared Lost: -117
- Infrared Gained: -96

Longwave

- Convection: +6
- Evaporation: +23
- Infrared Lost: +111
- Infrared Gained: +64
The **specific heat capacity** of a solid or liquid is defined as the heat required to raise unit mass of substance by one degree of temperature.

\[
\text{Heat supplied} = \text{mass} \times \text{specific heat capacity} \times \text{change in temperature}
\]

\[\Delta Q = m \cdot c \cdot \Delta T\]
Snowstorms, Blizzards, Nor’easters, Squall Lines
Pressure Gradient Force

Air Column 1

City 1
Same Pressure

Air Column 2

City 2
Same Pressure

COLD

WARM

Low

High
Coriolis Force

Northern Hemisphere

departure point
North Pole
South Pole

destination
City Name

line key
- apparent path
- actual path

fly QUIT
Coriolis Force
1. Draw Isoheights

- 300 mb
- 500 mb
- 700 mb
- 850 mb

Pressure levels:
- 55°F
- 1000 mb
2. Draw Isoheights

300 mb
500 mb
700 mb
850 mb

30°F  40°F  50°F  60°F  70°F  80°F

SSM  DTW  CIN  ASH  SUV  MIA

1000 mb
3. Draw Isoheights
THUNDERSTORMS

http://www.youtube.com/watch?v=cl0aw87LqA
GOES-9

Rapid-scan test
8 am - 8 pm EDT
July 2, 1995

South Florida

July 13th edition

1995 Jul 2 12:11 UTC
Evaporative Cooling

- 2000 m: $T = 12°C$
- 1500 m: $T = 17°C$
- 1000 m: $T = 22°C$
- 500 m: $T = 27°C$
- $500 m$: $T = 32°C$

$T = 26°C$

$T = 21°C$

$T = 18°C$

$T = 15°C$

Virga

$T = 12°C$

$T = 17°C$

$T = 22°C$

$T = 27°C$
TORNADOES

Summer Vacation

Manitoba F5
Tornadoes

Number of Tornado Deaths per Month

- January (JAN)
- February (FEB)
- March (MAR)
- April (APR)
- May (MAY)
- June (JUN)
- July (JUL)
- August (AUG)
- September (SEP)
- October (OCT)
- November (NOV)
- December (DEC)
Tornadoes

- Annual
- 10 Year Average
Tornadoes

**Conditions**

1. Convective Instability
2. Wind Shear
3. Trigger