

# THINK ALOUD: COMPARISON AND GENERALIZATIONS

A Short History of Nearly Everything

by Bill Bryson

## 17 INTO THE TROPOSPHERE

**THANK GOODNESS FOR the atmosphere.** It keeps us warm.

Without it, Earth would be a lifeless ball of ice with an average temperature of minus 60 degrees Fahrenheit. In addition, the atmosphere absorbs or deflects incoming swarms of cosmic rays, charged particles, ultraviolet rays, and the like.

Altogether, the gaseous padding of the atmosphere is equivalent to a fifteen-foot thickness of protective concrete, and without it these invisible visitors from space would slice through us like tiny daggers. **Even raindrops would pound us senseless if it weren't for the atmosphere's slowing drag.**

The most striking thing about our atmosphere is that there isn't very much of it. It extends upward for about 120 miles, which might seem reasonably bounteous when viewed from

1. Call to Attention: Title
2. Direct statement – of author/RR
3. Comparison – call to attention
4. List- additional points – call to attn
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8. comparison – call to attention
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10. Direct statement + call to attention
11. call to attention: readers rule of N

Overall meaning and effect thus far:  
the atmosphere keeps us warm and protects us from all kinds of energy coming from outer space. As far as topic, this is about the atmosphere so I guess we will get more specifically at the troposphere in the next section.  
This is organized from more general

ground level, but if you shrank the Earth to the size of a standard desktop globe it would only be about the thickness of a couple of coats of varnish.

For scientific convenience, the atmosphere is divided into four unequal layers: troposphere, stratosphere, mesosphere, and ionosphere (now often called the thermosphere). The troposphere is the part that's dear to us. It alone contains enough warmth and oxygen to allow us to function, though even it swiftly becomes uncongenial to life as you climb up through it. From ground level to its highest point, the troposphere (or "turning sphere") is about ten miles thick at the equator and no more than six or seven miles high in the temperate latitudes where most of us live. Eighty percent of the atmosphere's mass, virtually all the water, and thus virtually all the weather are contained within this thin and wispy layer. There really isn't much between you and oblivion.

Beyond the troposphere is the stratosphere. When you see the top of a storm cloud flattening out into the classic anvil shape, you are looking at the boundary between the troposphere and

to more specific parts of the atmosphere.

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stratosphere. The invisible ceiling is known as the tropopause and was discovered in 1902 by a Frenchman in a balloon, Leon-Philippe Teisserenc de Bort. *Pause* in this sense doesn't mean to stop momentarily but to cease altogether; it's from the same Greek root as *menopause*. Even at its greatest extent, the tropopause is not very distant. A fast elevator of the sort used in modern skyscrapers could get you there in about twenty minutes, though you would be well advised not to make the trip. Such a rapid ascent without pressurization would, at the very least, result in severe cerebral and pulmonary edemas, a dangerous excess of fluids in the body's tissues. When the doors opened at the viewing platform, anyone inside would almost certainly be dead or dying. Even a more measured ascent would be accompanied by a great deal of discomfort. The temperature six miles up can be -70 degrees Fahrenheit, and you would need, or at least very much appreciate, supplementary oxygen.

After you have left the troposphere the temperature soon warms up again, to about 40 degrees Fahrenheit, thanks to the absorptive effects of ozone (something else de Bort discovered

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on his daring 1902 ascent). It then plunges to as low as -130 degrees Fahrenheit in the mesosphere before skyrocketing to 2,700 degrees Fahrenheit or more in the aptly named but very erratic thermosphere, where temperatures can vary by a thousand degrees from day to night-though it must be said that “temperature” at such a height becomes a somewhat notional concept. Temperature is really just a measure of the activity of molecules. At sea level, air molecules are so thick that one molecule can move only the tiniest distance-about three-millionths of an inch, to be precise-before banging into another. Because trillions of molecules are constantly colliding, a lot of heat gets exchanged. But at the height of the thermosphere, at fifty miles or more, the air is so thin that any two molecules will be miles apart and hardly ever come in contact. So although each molecule is very warm, there are few interactions between them and thus little heat transference. This is good news for satellites and spaceships because if the exchange of heat were more efficient any man-made object orbiting at that level would burst into flames.

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