

A Short Note on Composition and Thermal Structure of the Earth's Atmosphere

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Commentary

Received: 23-Feb-2023,
Manuscript No. JPAP-23-92599; **Editor assigned:** 27-Feb-2023, Pre QC No. JPAP-23-92599 (PQ); **Reviewed:** 10-Mar-2023, QC No. JPAP-23-92599; **Revised:** 17-Mar-2023, Manuscript No. JPAP-23-92599 (R); **Published:** 24-Mar-23-2023, DOI: 10.4172/2320-2459.11.1.005

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Citation: Prabhakar C, A Short Note on Composition and Thermal Structure of the Earth's Atmosphere. Res Rev J Pure Appl Phys. 2023; 11:005.

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ABOUT THE STUDY

The Earth's atmosphere is the layer of gases that surrounds the planet and extends up to several hundred kilometres from its surface. It is composed of approximately 78% nitrogen, 21% oxygen, and 1% other gases, such as argon, carbon dioxide, neon, and helium. The atmosphere is divided into several layers, including the troposphere, the stratosphere, the mesosphere, and the thermosphere. The atmosphere plays a vital role in supporting life on Earth by providing us with air to breathe, moderating the climate and temperatures, and shielding us from harmful radiation. The study of Earth's atmosphere is essential to understanding the planet's climate, weather patterns, and the effects of human activities on the environment.

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Composition of the earth's atmosphere

The world's current atmosphere is thought to be a secondary atmosphere developed from volatile substances contained inside the solid planetesimals that formed the earth. Any collected primary atmosphere had to be lost since the cosmic abundances, which make up the makeup of most stars, including the sun, which comprises around 90% H and 10% He by mass, had been severely depleted. The violent bombardment of the Earth halted at 3.8 billion years ago, and the atmosphere may have included CH₄ and NH₃. The post-heavy bombardment atmosphere was most likely dominated by CO₂ and N₂, with traces of CO and H₂O, but it lacked free O₂, resulting in a weakly reduced atmosphere associated with volcanic activity. On the earth's surface, liquid water is thought to have existed. A considerable amount of CO₂ or other greenhouse gases is thought to have evolved to compensate for the feeble young sun around 3.5-3.8 billion years ago. It has been proposed that the biota had an important role in managing atmospheric O₂ levels as they naturally rose. The biggest rise appears to have happened between around 1.9 and 2.2 billion years ago. The quantity of free O₂ is also thought to be related with the creation of the ozone layer, which served as an efficient shield against UV solar radiation. The area of the earth's atmosphere is defined and discussed in the following sections.

Thermal structure

To study the interaction of the Earth's atmosphere with solar radiation, we must first understand the composition and structure of the atmosphere. To define the area of the atmosphere involved with sunlight absorption and scattering, we first describe the typical atmosphere's vertical temperature profile. This profile depicts typical mid-latitude weather patterns. The vertical profile is separated into four different levels, according to the International Union of Geodesy and Geophysics (IUGG) standard nomenclature set in 1960. The troposphere, stratosphere, mesosphere, and thermosphere are the four layers of the atmosphere. The tops of these layers are known as the tropopause, stratopause, mesopause, and thermopause, in that order.

The troposphere is distinguished by a temperature reduction with height from a mean surface temperature of around 288 K to a temperature of approximately 220 K, with a normal lapse rate of 6.5 K km⁻¹. The temperature structure in this layer is caused by radiative balancing and convective energy transmission from the surface to the atmosphere. This layer contains almost all of the water vapor, clouds, and precipitation. The stratosphere is distinguished by an isothermal layer from the tropopause to approximately 20 km, above which the temperature rises to the stratopause, which has a temperature of around 270 K. Ozone is found mostly in the stratosphere. Moreover, small layers of aerosol have been reported to remain for an extended length of time inside particular stratospheric height ranges. The absorption of solar fluxes by ozone and the emission of infrared fluxes by carbon dioxide govern the status of the stratosphere. Temperatures in the mesosphere decline with height from approximately 50 to 85 km, similar to the troposphere. Above this height and continuing upward to several hundred kilometers lies the thermosphere, where temperatures range from 500 K to as high as 2000 K, depending on the

degree of solar activity. The exosphere is the uppermost portion of the atmosphere above the thermosphere. Traditionally, atmospheric nomenclature is taken from its temperature condition, as previously established. Yet, there is little physical difference between the stratosphere and the mesosphere. In recent years, the atmosphere has been classified into three layers: the lower atmosphere (troposphere), the middle atmosphere (stratosphere and mesosphere), and the high atmosphere. Moreover, the lowest 1 km or so of the atmosphere varies from the rest of the troposphere in that it has strong and important interactions with the surface. This is known as the planetary boundary layer.