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Research Article

ATMOSPHERIC PHYSICS

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ABSTRACT

Atmospheric physics is the discipline concerned with the physical processes that occur in the Atmosphere, the gaseous or vaporous shell that surrounds the earth. When early man first sought to understand his physics environment, his greatest awe surely concerned the sun, moon, planets, and stars (which became the basis of the science of astronomy or astrophysics), and next he wondered at the winds and storms, rain and snom,ironment, his greatest awe surely concerned the sun, moon, planets, and stars (which became the basis of the science of astronomy or astrophysics), and next he wondered at the winds and storms, rain and snow, clouds, lighting, and thunder that collectively made up his weather. The Greek root atmos, meaning air or vapor, originally derived from the word for winds. The first impetus to meteorological theory was given by the puzzling behavior of the barometer in relation to the weather, but it remained for Vilhelm Bjerknes, a physics professor at Bergen, Norway, around 1900 to formulate weather systems mathematically in terms of high- and low-pressure areas, warm fronts, and cold fronts. In England, Napier Shaw began scientific research on atmospheric processes in 1885 at the Cavendish Laboratory, by 1918 weather forecasting had become a science, much as we know it today. Soon As well as the seasonal changes from summer to winter. The prevailing weather at a given location is called its climate, and climate varies with geographical latitude, terrain features, and altitude.

INTRODUCTION

Atospheric circulation

Two major processes drive atmospheric weather systems: the rotation of the earth and uneven heating by solar radiation. Inaddition, the $23\frac{1}{2}$tilt of the earth's axis to the plane of its orbit and earth's elliptical orbit about the sun add winter and summer seasonal changes to the solar radiation received. These radiation processes are further altered by variable cloud cover, which reflects radiation that would otherwise warm the surface, and by the heat absorbed in the vaporizing of water or released by the condensation of water vapor into rain or snow. The earth's surface receives more solar radiation in the equatorial regions than at higher latitudes Air warmed near the surface rises and creates a convective circulation pattern in the upper atmosphere from the equator toward the poles. However, because the earth (and its atmosphere) is also rotating, the rate of eastward rotation is s function of latitude, being about 0.7 of the equatorial velocity at latitude 45" (and 0.5 at latitude 60").

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This motion superposes a shift to the right on the wind pattern in the Northern Hemisphere (and to the left in the Southern Hemisphere). The general circulation of the atmosphere is further modified by uneven local heating and by differences in neat absorption of oceans and land. There are general regions of prevailing winds, in the Northern Hemisphere (and, in reversed direction, in the Southern Hemisphere).Near the equator the creates a region of equatorial calms or doldrums. Between the equator and latitude 30 N is a region of prevailing northeast trade winds. Between latitude 30^0 and 60^0 is a region of prevailing westerly winds. Between these two regions are the so-called horse latitudes, another region of calm, where the air is sinking and warmed adiabatically. Above latitude $60^0$is a region of polar easterlies. At the surface, the moving air forms into whirling masses of high-pres –sure cells, called highs, or anticyclones (which circulate clockwise in the Northern Hemisphere); and low- pressure cells, called lows or cyclones (which circulate counter clock wise). Highs generally bring fair weather and lows unsettled weather. Although weather phenomena are atmospheric processes, the field of physical meteorology is now developed to the point that it is considered separate from atmosphere physics, which is ordinarily restricted to those phenomena other than weather.

Atmospheric Composition

The earth's atmosphere is the remainder of the primordial gaseous matter, parts of which cooled down to form the earth and sea. The natural atmosphere consists of about 21% oxygen, 78% nitrogen, 1% argon and other gases, and a slight trace of carbon dioxide. Another variable constituent is water vapor, which may be present up to about 3%. Living animals breathe in oxygen and use it to oxidize their food, breathing out carbon dioxide. Plant life containing chlorophyll consumes carbon dioxide in the presence of sunlight to build plant tissues and return oxygen to the atmosphere. In this way the biosphere maintains a balance between oxygen and carbon dioxide. Cosmologists such as Lloyd Berkner and Harold Urey have projected the composition or the atmosphere from earliest prehistory (before the water vapor condensed into the oceans and before life was possible).

Atmospheric structure and temperature

Atmospheric composition is essentially constant up to 90 km. above which the molecular weight of air begins to vary because of molecular dissociation. Pressure and density decrease approximately with height. Water vapor decreases more rapidly with height than the permanent constituents. Temperature variation with height is the most pronounced feature of the atmosphere, and layers and shells are described most easily by temperature. Usually temperature decreases with increasing height in the lowermost several kilometers; any increase of temperature with height in this region is called an inversion. The lapse rate is destined as – *dqldz*, the rate of decrease with height z of any atmospheric variable q. Except for the first 2 km above the earth's surface, the normal lapse rate is about 6.5 C km^{-1}in the troposphere, which extends from the surface (about 300 k) to the tropopause (at about 220 k). The tropopause is the atmospheric surface at which either the temperature decrease stops abruptly or the lapse rate becomes very low. The height. of the tropopause varies with latitude, season, and weather; in general, it is lowest (8-10km) in arctic regions in winter and highest (16-18km) in tropical and equatorial regions. Above the tropopause, temperatueres usually increase with height slowly at-first, then more rapidly up to about 50 km, where the average temperature is again close to the freezing poin (0^0C). The region between the stratopause and the tropopause is called the stratosphere. Above the stratosphere there is another region, called the mesosphere, in which temperature again decreases with height. This region ends at the mesopause, at 80 -90 km, where the lowest temperatures the atmosphere are found (about – 90 ^{0}C).

Above the mest pause is another region, called the thermosphere, who supper limit is undefined and in which temperature again increases with height up to about 200 km. Above this level the temperature varies widely according to the degree of solar activity; it is about600 ^{0}C when the sun is quiet and possible 2000 ^{o}C duringsunspot maxima. The exosphere (bout 55km) is the region where the mean free path is so great the particles escape from the atmosphere. In this region the temperature can no longer be defined in the usual way.

Atmospheric density

Except for highly variable aerosol and water- vapor content, the lower atmosphere behaves as a homogeneous mature of the constituents indicated in Table I, and its press directly proportional to the absolute temperature (Charles's lave and directly proportional to the sum obtained by adding. "Effective. Gether the molecular weights of the constituents, each multiplied the ratio of its partial pressure to the total pressure (Avogadro's law). The average atmospheric pressure at sea level is about 101.3 kPa and the density 1.2 kg m^{-3}both decrease exponentially with height, and by several earth radii the density can be said to that of interplanetary space. Drag effects due to atmospheric density can generally be neglected for rockets and spacecraft more than 200 km above the surface; satellites in such orbits have lifetimes of several years.

Atmosphere radiation

The sunis a huge gaseous sphere (about $1.39x10^5$km in diameter) whose temperature at the radiation surface is about 6000 k. The radiant solar energy incident on the earth outside the atmosphere is about 1390 Wm^{-2}(with an annual variation of $\pm$ 3.5% because of the ellipticity of the earth's orbit). If the earth had no atmosphere, but were a rotating sphere with an overall reflectivity similar to that of the moon, it would absorb this solar radiation until it had warmed up to an average temperature of just over 200 k, for then it would be radiating blackbody radiation to the 4π sphere of free space at about the same rate radiation is received from the sun. The atmosphere provides a warm thermal blanket around the earth, because it is largely transparent to the incoming 6000 –k blackbody radiation, which is mostly at wavelengths stituents ozone, carbon dioxide, and water have strong wavelength infrared radiation emitted by the earth. As a result, the surface temperature of the earth in the temperate regions warms to about 300k. Some of the oxygen molecules of the lower atmosphere diffuse upward but are then dissociated into atomic oxygen by incident solar ultraviolet radiation.

Table1, Mass of the atmosphere and its constituents

Substance	Volume percentage dry air	Molecular weight	Total mass (ka×10")
Total atmosphere			51 300 000
Dry air	100.00	28.97"	51 170 000
Nitrogen	78.09	28.02	38 648 000
Oxygen	20.95	32.00	11 841 000
Argon	0.93	39.88	655 100
Water Vapor		18.02	130 000
Carbon dioxide	0.03	44.00	23 320
Neon	0.0018	20.0	636
Krypton	0.0001	82.9	146
Helium	0.00053	4.00	37
Ozone		48.00	30
Xenon	0.000008	130.2	18
Hydrogen	0.00005	2.02	2

Atomic oxygen strongly absorbs all solar radiation shorter than 1850 A. There is a region about 30 km above the earth's surface where the up-ward-diffusing molecular oxygen and the downward-diffusing atomic oxygen react to form a tenuous layer of ozone. The ozone molecule strongly absorbs all radiation below about 3150 A, thereby screening out solar ultraviolet radiation that would otherwise be lethal to the surface. The absorption of radiation by ozone at 30 km and by atomic oxygen and nitrogen higher in the atmosphere is the mechanism responsible for the thermal structure of the atmosphere.

Atmosphere optics

The most important optical effects of the atmosphere are the screening out of lethal ultraviolet solar radiation and the raising of the radiation temperature of the earth by trapping infrared thermal radiation. In addition there are awide variety of curious optical effects that are interesting physics, but not of practical importance or dangerous to life: such phenomena as mirages, rainbows, halos, sun dogs, glories, and heiligenschein. These are caused by temperature inversions, scattering by aerosols, fog or ice crystals, and so on phenomena; today many of these effects can be seen by airplane travelers. M. Minneart and W.J Humphreys treat the physics of these phenomena.

The ionosphere

The bombardment of the atmosphere by ultraviolet radiation an energetic particles from the causes dissection and ionization of atmosphere that is the ionosphere. The ionosphere itself is classified into regions at difference altitudes, each due to differing atmosphere constituents. Above 150 km is the F region (N^+ and O^+). The E region occurs between 85 km and 150km, and is largely due to O_2^+ and NO^+. A weaker D region, between 50 and 85 km, is largely due to hydrated ions. These ionized layers can strongly affect radio communication, reflecting the wavelengths shorter than about 30 MHz. The ionosphere has seasonal and diurnal variations. Is strongly latitude dependent, and is also a function of the amount of sunspot activity. The airglow and aurora result and aurora result from emission by ionized constituents of the upper atmosphere.

The magetospere

In addition to its atmosphere, the earth is surrounded by a magnetic field. The main field originates the earth. The magnetic axis is inclined at an angle of about 11^0 to the axis of rotation. The field strength at the surface is about 0.6 G in the polar regions and 0.3 G in the equatorial region. Field originating outside the earth are much more variable and are weaker; in general, they last a few days or less. These field are caused by electric-current systems in the lower ionosphere. During magnetic storms these fields may have fluctuations of 5% of the main field in auroral zones. At altitudes of several earth interaction between the main field and corpuscular radiation from the sun (the solar wind) become more important. Magnetic disturbances can interrupt communications and affect the behavior of spacecraft; theare also linkedto the phenomenon of auroras in the high-altitude ionosphere.

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