(1-1) Introduction

The purpose of this chapter is to provide an introductory overview of the essential meteorological mechanisms of atmosphere, as the wind, temperature, atmospheric pressure, atmospheric stability and some of physical factors, where, we will show the atmospheric air structure, atmospheric energy, atmospheric forces, atmospheric stability, atmospheric motions, atmospheric boundary layer, and stability classes.

(1-2) Atmospheric Layers

The atmosphere is made up of five main layers are listed in the following [50]:

1- Troposphere

This layer is the lowest layer of the atmosphere; it stretches about 10 – 16 km above the ground. Troposphere layer is sometimes called the weather layer, where it is the layer in which convection happens, warm air rises and cold air sinks to take its place. Clouds form in this layer too, bringing rain and snow. The clouds are trapped in the troposphere because the next layer up, stratosphere, is warmer and acts like a lid. The troposphere layer cools from an average temperature of 15° C at the Earth surface to -60° C at the tropopause (the top of the troposphere).

2- Stratosphere

Stratosphere layer stretches from the tropopause to about 50 km above the ground. The temperature in this layer warms from about -60° C at the bottom to just above freezing (10° C) at the top (stratopause). In addition, stratosphere layer contains Ozone layer.

3- Mesosphere

It stretches from the stratopause to about 80 km above the ground. Mesosphere layer is very cold, with temperature less than -100° C at the top (Mesopause) in spite of the bottom is warm.

4- Thermosphere

This layer stretches from the Mesopause to about 450 km above the Earth, it is the hottest layer, as the few air molecules absorb radiation coming from the sun. Temperature reaches as high as 2000° C at the top Thermopause. Thermosphere contains the Ionosphere layer, which is divided to two layers Heaviside layer (from 80 km to 100 km above the ground) and Appleton layer (from 100 km to 300 km above the ground), the ions are spreading in the ionosphere layer due to the ultraviolet radiation from the sun.

5- Exosphere

Exosphere layer is the external layer of the atmosphere; it stretches from the Thermopause to about 900 km above the Earth. The air is very thin and gas molecules are constantly as into space.

(1-3) Atmospheric Air Structure

The composition of the atmosphere is important in any understanding of the role, which the atmosphere plays in processes of atmospheric dispersion of the pollutants.

The atmosphere is largely a mixture of gases, some with constant concentrations, others that are variable in space and time. Table (1-1) shows the main constituents of the Atmosphere below 100 km [26].

Table (1-1)

Gas	Symbol	% by Volume	Gas	Symbol	% by Volume
Nitrogen	N2	78.08	Water vapor	H2O	0.1 – 4.0
Oxygen	O2	20.95	Carbon dioxide	CO2	0.0351
Argon	Ar	0.93	Methane	CH4	0.00017
Neon	Ne	0.0018	Carbon monoxide	CO	0.00002
Helium	He	0.00052	Ozone	O3	0.000004
Hydrogen	H2	0.00005	Sulfur dioxide	SO2	0.000001
Xenon	Xe	0.000009	Nitrogen dioxide	NO2	0.000001

In addition there are suspended particles (e.g. aerosol, smoke, ash etc.) and hydrometeors (e.g. cloud droplets, raindrops, snow, ice crystals, etc). About 99% of the mass of the air lies below an altitude of 30 km.

It is clear that Nitrogen, Oxygen and Argon account for about 99.99% of the permanent gases. Carbon dioxide can be somewhat variable in concentration on a localized basis at low levels. Water vapor content may vary from about 0 to 4%, and ozone concentrations vary markedly. In addition to these variable constituents, there are also aerosols and hydrometeors, which can vary widely in space and time [26].

(1-4) Atmospheric Energy

The Earth's atmosphere acts as a giant heat engine transforming available energy into the movement of huge masses of air. Practically all energy of this engine is supplied by the sun [4].
The contribution of all other sources (e.g. the Earth's interior) is smaller than 0.02%. Since the Earth's atmosphere is semi-transparent to incoming solar radiation, it obtains roughly 20% of its energy strictly by absorption. About 30% of solar radiation is reflected or scattered into space. The rest passes through the atmosphere and is absorbed by the Earth's surface [49].

The surface of the Earth has a considerable influence on air temperature. Differences in temperature near the ground are caused by the variation of thermal properties of the underlying surface [4].

Because water has an enormous specific heat, it takes far more heat to raise the temperature of water than it does to raise the temperature of rocks or soil. Besides, the heating energy is deposited only in a few decimeters of soil, while in the oceans it is mixed through the top few meters of water. Consequently, since water covers 61% of the Northern Hemisphere and 81% of the Southern Hemisphere [4], there are considerably smaller annual temperature variations in the water-dominated Southern Hemisphere, as compared to the Northern one.

(1-5) Atmospheric Forces

Atmospheric motion results from the action of atmospheric forces. Such forces may be classified into two categories body forces and surface forces. Body forces, such as gravity, act at a distance on the bulk of the air parcel (hence the word body). Surface forces, or stresses (forces per unit area), act through direct contact and are exerted directly on the surface of the air parcel. The surface forces can be divided into normal stresses and tangential (shear) stresses [50].
Surface forces reflect an interaction among air molecules or air parcels. If two layers of air flow with slightly different velocities, the random sidewise intrusions of some slower molecules into the faster stream tend to slow down the faster stream. The intrusion of faster molecules into the slower stream tends to speed up the slower stream [49]. The wandering of individual molecules introduces internal friction in the fluid, which is called viscosity.