THE THREE PRINCIPLES

Most of the papers in this collection are based on three very basic premises or principles. These are:

THE FIRST PRINCIPLE

SENSORS INTERACT WITH THAT WHICH IS BEING SENSED

Let us postulate a portion of the free atmosphere. This portion can be a mixture of atmospheric gases, it can be entirely liquid (a cloud droplet), it can be entirely solid (a snowflake), or it can be composed of all three phases of atmospheric matter. The First Principle applies in every case. Let us further postulate an instrument (the sensor) that we hope to use to measure some property or characteristic of the free atmosphere by means of direct physical contact between the sensing surface of that sensor and the postulated portion of free atmosphere.

A moment's thought will convince us that that sensor can sense and measure the properties and characteristics only of those molecules of the free atmosphere with which it interacts. Molecules that do not interact with the sensing surface are not sensed, and their parameters are not included in the measurements based on that sensing. Those parameters may be calculated (in fact, we do so in these papers) but they cannot be measured. Measurement requires interaction.

A thermometer measures the kinetic energies only of those molecules that impact upon its sensing surface. (For many common thermometers, of course, the sensing surface is the entire surface of the thermometer.) A manometer measures the force transmitted to its sensing surface only of those molecules that impact on that surface.

It would be natural to assume that the characteristics of the population of molecules interacting with the sensing surface are the same as that of the other molecules in the system. Statistical mechanics, however, assures us that this is not the case. The two sub-populations have significantly different parameters of mean molecular mass and mean molecular speed. We will develop this concept at length in our treatments of these two basic parameters in the division devoted to basic parameters. In the meantime, this concept is the basis of the second principle. That is,

THE SECOND PRINCIPLE

INTERACTING POPULATIONS HAVE DIFFERENT PARAMETERS THAN DO NON-INTERACTING POPULATIONS

The two specified parameters (mass and speed) of those molecules that interact with an object of interest (sensing or otherwise) differ from those same two parameters in non-interacting molecules.

$$\bar{\boldsymbol{m}}_i < \bar{\boldsymbol{m}}_p \qquad \text{TTP01}$$

The mean interactive molecular mass ($\bar{\boldsymbol{m}}_i$) is always less than the mean passive (non-interacting) molecular mass ($\bar{\boldsymbol{m}}_p$). How much less depends upon the chemical, isotopic, and ionic composition of the system—especially the humidity (see **Molecular Masses**).

In **Molecular Speeds**, we discuss how the mean molecular speed of interacting molecules ($\bar{\boldsymbol{v}}_i$) is always greater than the mean molecular speeds of non-interacting (passive) molecules ($\bar{\boldsymbol{v}}_p$).

$$\bar{\boldsymbol{v}}_i = \tfrac{\pi}{2}\bar{\boldsymbol{v}}_p \qquad \text{TTP02}$$

THE THIRD PRINCIPLE

THE SENSOR ONLY SENSES PARAMETERS THAT ARE NORMAL TO ITS SENSING SURFACE

When a molecule impacts upon a sensing surface, only the parameter components that are normal to the surface are sensed and measured. This is, of course, basic physics; but it is worth emphasizing.

Both the free atmosphere and air samples in the laboratory are three-dimensional systems. It is only natural, therefore, for scientists to focus on three-dimensional parameters. These include such concepts as the mean kinetic energy of translation along the molecules' true paths, the mean velocity or speed along those same true paths, the mean molecular mass of all the molecules in the system, and so on.

While having both theoretical and practical interest, we will see that these three-dimensional parameters are irrelevant to most atmospheric phenomena. These phenomena include gas temperatures and pressures, the evaporation and condensation of water vapor, winds and currents, and many other atmospheric parameters.

This is a bold hypothesis indeed, but I hope that you will come to share it as you follow the arguments presented in the essays that follow.