INTRODUCTION

What do the molecules of the atmosphere do when the wind is blowing that they don't do when the air is still? When a barometer or manometer measures atmospheric pressure, what interactions are taking place between the sensing surface of the instrument and the molecules of the air? And, how are these interactions different from the interactions that take place when a thermometer measures air temperatures?

When evaporation occurs, some liquid or solid water molecules escape into the vapor phase while others do not. When condensation occurs, some vapor molecules condense into the liquid or solid phases and some do not. How are these selections made? And why does this condensation process that removes enthalpy from the gaseous phase of the atmosphere cause the temperature of the remaining gaseous phase to increase?

Why does rising air cool and why does sinking air warm? Since air temperatures measure an aspect of mean molecular speeds, what causes the molecules to either speed up or slow down?

These are fascinating questions, and the textbooks on meteorology that I have used over my teaching career have never answered them to my satisfaction.

Yes, there would be a token section in which kinetic gas theory was introduced. The books would admit (somewhat reluctantly, I felt) that the atmosphere was composed of an exceedingly large number of exceedingly small particles called molecules.

These textbooks would agree that—far from being continuous—the atmosphere was discrete, with the empty space between these molecules being many times their effective diameters. Moreover, these molecules dashed about from hither to yon at a wide variety of speeds, colliding with one another and anything else around some billions of times each second.

What was never made clear was how the macroscopic properties of the atmosphere: heat, temperature, pressure, density, humidity, wind velocity, evaporation, condensation, electrical discharges and the like were related to these curious particles called molecules.

What we would get instead was a bland statement to the effect that the integration and amalgamation of kinetic gas theory with macroscopic thermodynamics and fluid mechanics was one of the great accomplishments of twentieth-century physics. This statement was always unaccompanied by any sort of attribution or citation.

The authors of the texts would then abandon kinetic gas theory with what appeared to be unseemly haste and dash back to the familiar comforts of fluid mechanics and classical thermodynamics. The interesting questions in the first few paragraphs of this introduction would go unanswered. Only rarely, would molecules ever be mentioned again in describing meteorological phenomena.

This collection of papers is intended to remedy that situation. I hope to explain as many of the common atmospheric parameters, characteristics and phenomena in molecular terms as I am able. I have found this approach to be immensely rewarding, and I hope that you shall find that your time and effort is not wasted.

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