بسم الله الرحمن الرحيم

ATMOSPHERIC DYNAMICS 1

Third stage

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"BE A GOOD PERSON BUT DON'T WASTE TIME TO PROVE IT."

THISISLOVELIFEQUOTES.NET

Introduction

Dynamic meteorology is the study of air motion in the Earth's atmosphere that is associated with weather and climate. These motions organize into coherent circulation features that affect human activity primarily through wind, temperature, clouds, and precipitation patterns. Short-lived features, lasting from a few minutes to a few days, are related to weather, and some familiar weather examples that we will examine in this book include tropical and extratropical cyclones, organized thunderstorms, and local wind patterns such as those that occur near mountains. Figure 1.1 illustrates the mixing effect of larger weather patterns in the atmosphere, from large areas of convective cloud in the tropics to extratropical cyclones in the higher latitudes of the Northern and Southern Hemispheres.

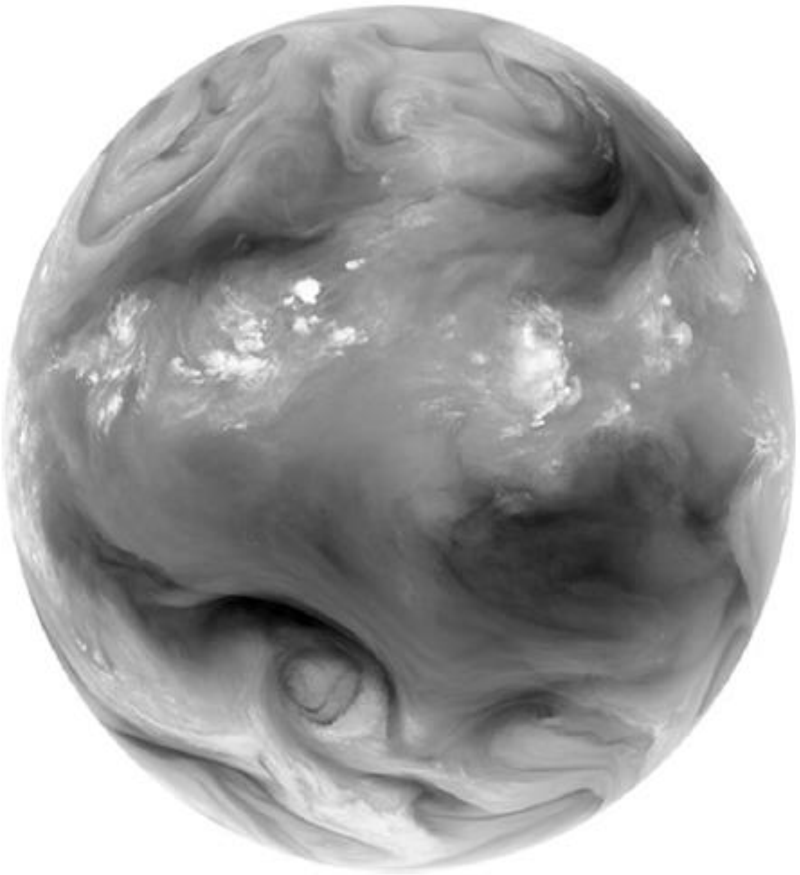
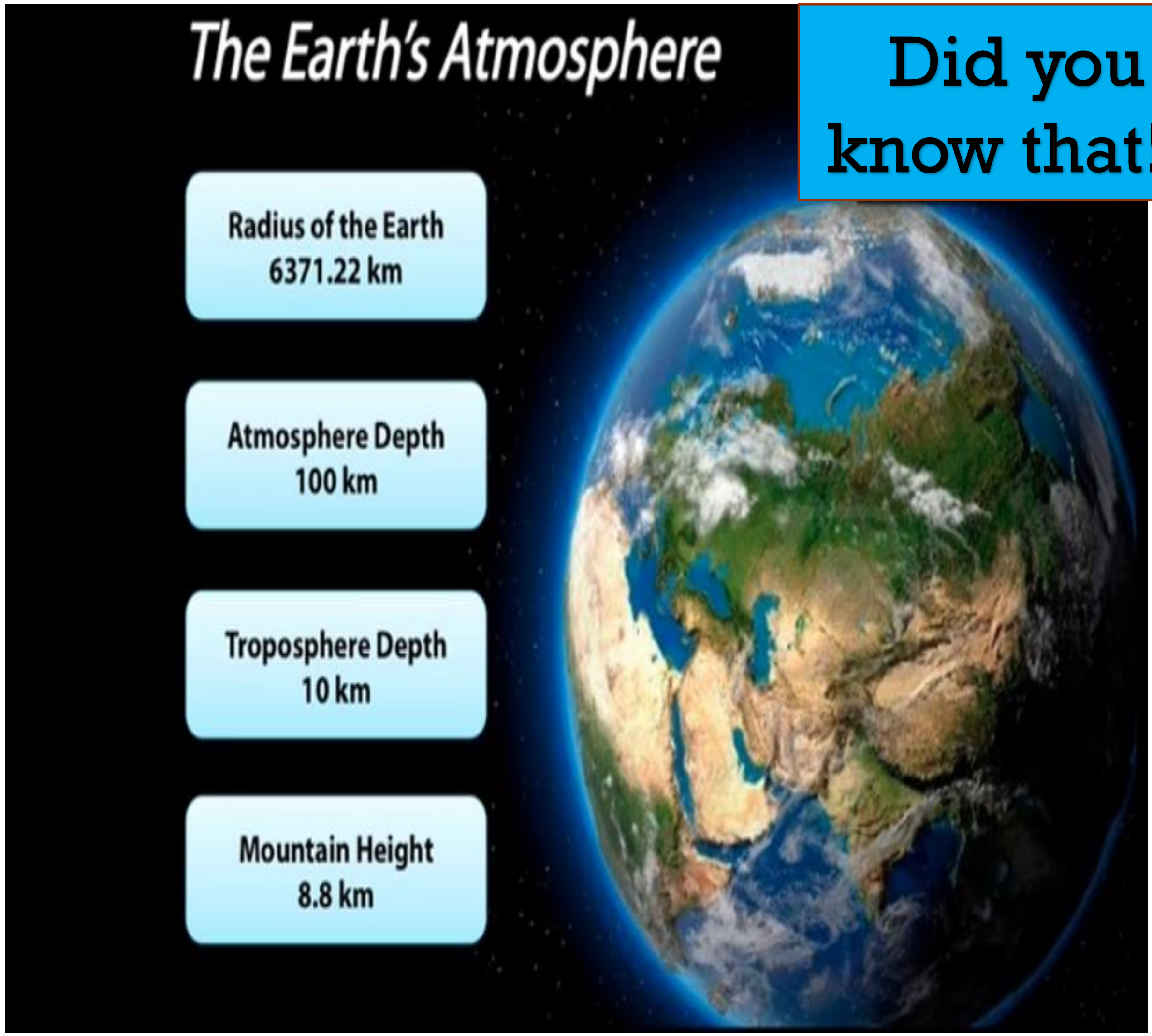


FIGURE 1.1 Infrared satellite image near a wavelength of 6.7 μm, which is known as the "water vapor" channel since it captures the distribution of that field in a layer roughly 5 to 10 km above Earth's surface. Because water vapor is continuously distributed, in contrast to clouds, atmospheric motion is especially well captured. Here we see the convective clouds in the tropics and the mixing effects of eddies at higher latitude. (*Source: NASA.*)

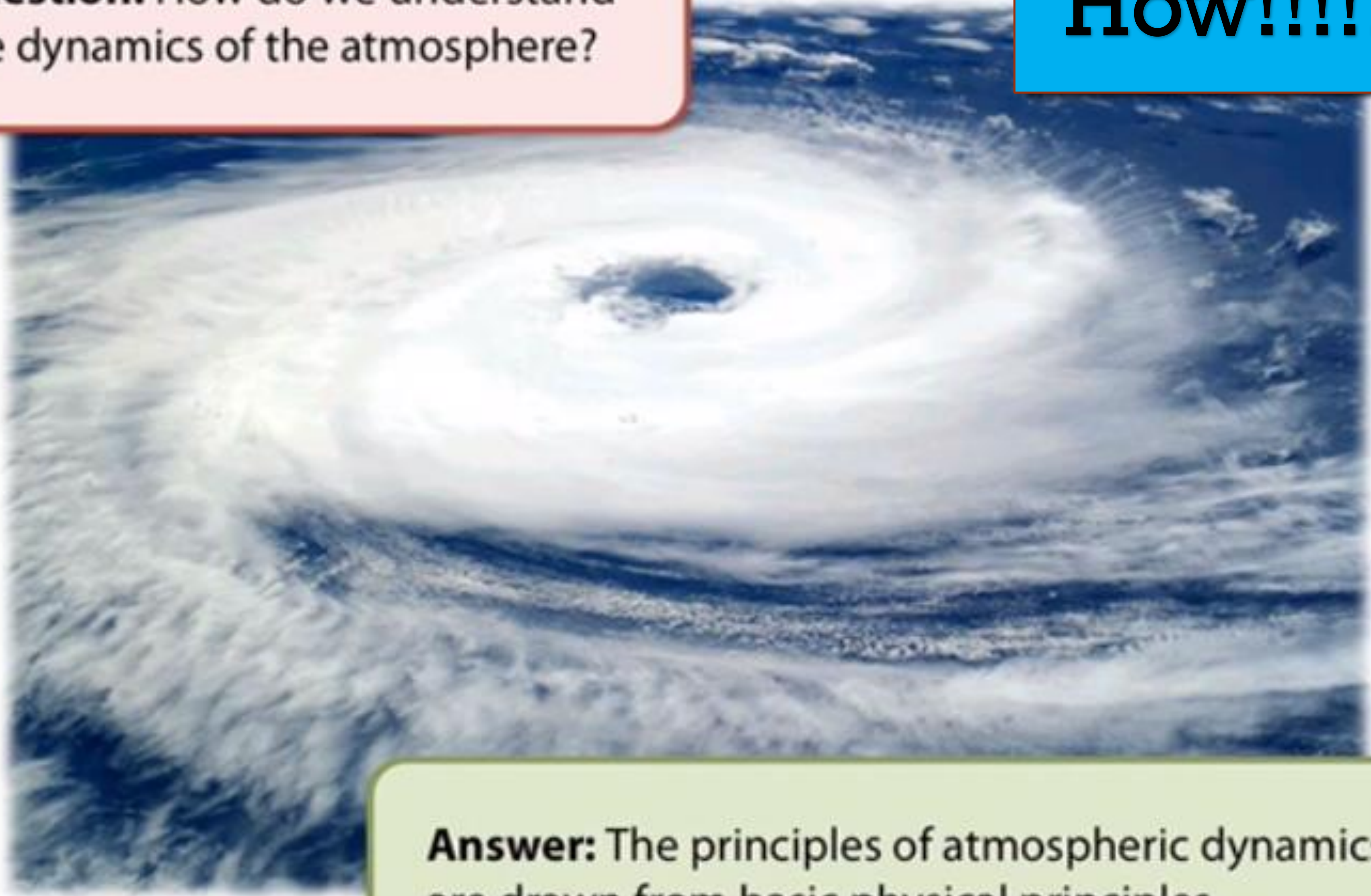
These weather elements occur in the troposphere, which is the portion of the atmosphere in contact with the surface. The troposphere normally exhibits a drop in temperature with elevation and contains most of the water vapor, clouds, and precipitation found in the atmosphere. On average, the troposphere extends vertically about 10 kilometers, where the tropopause is located. Above the tropopause is the stratosphere, where the temperature increases with elevation due to heating of the air by absorption of ultraviolet radiation by ozone. Most of the topics addressed in this book concern the dynamics of the troposphere and stratosphere.

Did you know that!!!



Question: How do we understand the dynamics of the atmosphere?

How!!!!!!



Answer: The principles of atmospheric dynamics are drawn from basic physical principles.

Week	Topics Covered		
1	Lecture 1: Review of vector analysis.	2 hours	A 9/12
2	Lecture 2: Fixed and rotating coordinates	2 hours	A 16/12
3	Lecture 3: Fundamental forces.	2 hours	A 23/12
4	Lecture 4: Real forces and apparent forces.	2 hours	A 30/12
5	Lecture 5: Momentum equation in rotating coordinates.	2 hours	A 13/1
6	Lecture 6: Order of magnitude.	2 hours	A 20/1
7	Lecture 7: Hydrostatic equation.	2 hours	A 27/1
8	Lecture 8: First Exam	2 hours	A 3/2
9	Lecture 9: Thermodynamic energy equation.	2 hours	A 10/2
10	Lecture 10: Continuity equation.	2 hours	A 17/2
11	Lecture 11: Homogenous atmosphere	2 hours	A 24/2
12	Lecture 12: Isothermal atmosphere	2 hours	A 3/3
13	Lecture 13: Adiabatic atmosphere	2 hours	A 10/3
14	Lecture 14: Hypsometric equation and thickness.	2 hours	A 17/3
15	Lecture 15: Second Exam	2 hours	A 20/3

Before we set off to explore the landscape of dynamic meteorology, we devote this first chapter to introducing fundamental concepts that will guide the journey.

- First, note that the laws that govern atmospheric motion satisfy the principle of dimensional homogeneity, which means that all terms in the equations expressing these laws must have the same physical dimensions.
- These dimensions can be expressed in terms of **multiples and ratios** of four dimensionally ndependent properties: length, time, mass, and thermodynamic temperature.
- To measure and compare the scales of terms in the laws of motion, a set of units of measure must be defined for these four fundamental properties.
- In this text the international system of units (SI) will be used almost exclusively. The four fundamental properties are measured in terms of the SI base units shown in
- Table 1.1. All other properties are measured in terms of SI derived units, which are units formed from products or ratios of the base units. For example, velocity has the derived units of meter per second (m s-1/.

TABLE 1.1 SI Base Units

Property	Name	Symbol
Length	Meter (meter)	m
Mass	Kilogram	kg
Time	Second	s
Temperature	Kelvin	K

TABLE 1.2 SI Derived Units with Special Names

Property	Name	Symbol
Frequency	Hertz	Hz(s^{-1})
Force	Newton	N(kg m s^{-2})
Pressure	Pascal	Pa(N m^{-2})
Energy	Joule	J (N m)
Power	Watt	W(J s^{-1})

A number of important derived units have special names and symbols. Those that are commonly used in dynamic meteorology are indicated in Table 1.2.

In addition, the supplementary unit designating a plane angle, the radian (rad), is required for expressing angular velocity (rad s-1/ in the SI system.1

Finally, Table 1.3 lists the symbols frequently used in this book for some of the basic physical quantities. Note that the full three-dimensional velocity vector, U, is related to the horizontal velocity vector, V, by U D .V;w/ and U D .V; !/ in height and pressure vertical coordinates, respectively.

We shall use the **term "zonal" to refer to the East–West direction** and **"meridional" to refer to the North–South direction.**

TABLE 1.2 SI Derived Units with Special Names

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TABLE 1.3 Symbols and Units of Basic Physical Quantities

Quantity	Symbol	Units
Three-dimensional velocity vector	$\mathbf{U}$	m s^{-1}
Horizontal velocity vector	$\mathbf{V}$	m s^{-1}
Eastward component of velocity	u	m s^{-1}
Northward component of velocity	v	m s^{-1}
Upward component of velocity	w (ω)	m s^{-1} (Pa s^{-1})
Pressure	P	N m^{-2}
Density	ρ	kg m^{-3}
Temperature	T	K (or °C)