
Objectives:

- To introduce Dynamics I and establish procedures and standards
- To introduce basic SI units
- To describe the scales of atmospheric motions

Assignment: Review the syllabus and read pp. 1-8 in *Holton & Hakim.*

FOR NEXT TIME: Read pp. 4-20 in *Holton* & *Hakim*

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Time and location: Lecture: MWF, 1:00-1:50 PM, AHC5 357

Office Hours: Mon. 10:00-11:00 AM, Tue. 1:00-2:00PM, Wed 2:00-3:00 PM, or by appointment

Prerequisites: Physics with Calculus.

Text: ***An Introduction to Dynamic Meteorology, 5th Edition*** by James R. Holton and Gregory J, Hakim, Elsevier, 2012, 532 pp.

Grading:

Components of Your Grade	
Participation & Problems	30%
Exam #1	20%
Exam #2	20%
Final	30%
Total	100%

Grading Scale	
100-90	A
89-80	B
79-70	C
69-60	D
below 60	F

This is a mathematical course that focuses on solving problems.

Attendance is mandatory. Read the assignment before you come to class and do the problems before they are due.

Be sure that all of your work is your own.

Units of measurement:

Basic SI Units		
Property	Name	Symbol
Length	Meter	m
Mass	Kilogram	kg
Time	Second	s
Temperature	Kelvin	K

Derived SI Units		
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 = kg m^2 s^{-2})
Power	Watt	J (J s^{-1} = kg m^2 s^{-3})

Notes:

The unit of frequency is Hertz (Hz) = s^{-1} = cycles per second, not radians.

The meteorological unit of pressure mb (millibar) = hPa (hectoPascal) = 100 Pa = 100 N m^{-2} = 100 kg $m^{-1}s^{-2}$

Often temperature is measured on the Celsius scale $T_C = T_K - 273.15$. The units for the Celsius scale are degrees Celsius (^oC); whereas the unit of thermodynamic temperature is Kelvin (not "degrees K").

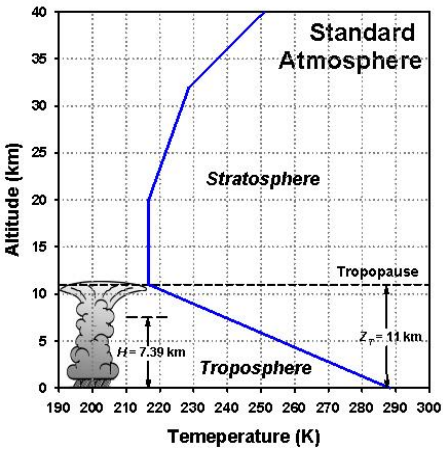
A day, 24 h = 24*3600 = 86400 ~ 10^5 s

SI Prefixes and Decimal Multipliers		
Multiplier	Prefix	Symbol
10^6	Mega	M
10^3	Kilo	k
10^2	Hecto	h
10^1	Deka	da
10^{-1}	Deci	d
10^{-2}	Centi	c
10^{-3}	Milli	m
10^{-6}	Micro	μ
10^{-9}	Nano	n

What do we mean by "***Dynamics***"? In general discussions dynamics is the science of motion in response to forces acting on objects or on parts of a continuum. In meteorology it means the study air motion in response to changes in pressure and temperature. We separate "Dynamics" from "***The Physics***" which

encompasses things like condensation, radiation, friction, etc. This isn't the way everybody else uses these words.

<u>Scales in the Atmosphere</u>:

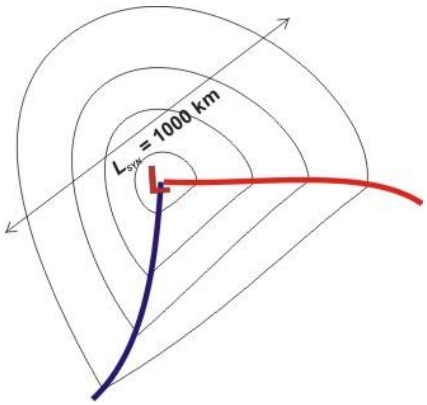


Two Vertical Spatial Scales:

- Depth of the Troposphere = 11 km
- Pressure scale height = H = 7.39 km for T = 252.4 K. This is the height over which the pressure decreases by a factor of e^{-1} = 0.3679 in an isothermal atmosphere.

Many horizontal scales:

- Cumulus clouds: ~H = 7-8 km
- Frontal Cyclones, Rossby Radius = R_R =1000-2000 km
- Radius of the planet = 6371 km (Circumference = $4x10^4$ km)



Also many time scales, for example:

- Cumulus cloud: ½ hour T_{CB} = 1800 s ~ 2 x 10^3 s
- Fontal cyclone: T_{SYN} = 1 day ~ 10^5 s

Typical velocity sale V = 10 m s^{-1} is about the same in both systems

Thus typical accelerations are much different between cumulus clouds and frontal cyclones.

Cumulus cloud acceleration = V/T_{CB} = 10/2000 = 5 x 10^{-3} m s^{-1}

Frontal cyclone acceleration = V/T_{SYN} = V/T_{SYN} = $10/10^5$ = 10^{-4} m s^{-1}

Thus, frontal cyclones are 135 times bigger than cumulus clouds. They last > 50 times as long, but the accelerations of their winds are 2% as strong. These relationships are an example of a ***Scale Separation***.

In MET 4301, we will focus on middle latitude, synoptic-scale motions that are forced primarily by the maintained horizontal temperature difference between the tropics and the arctic. That, said we will also deal with some non-middle latitude motions.