UNIVERSITY OF NAIROBI

College of Biological and Physical Sciences

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and

College of Education and External Studies

Faculty of External Studies

Bachelor of Science/Bachelor of Education (Science)/Postgraduate Diploma (Meteorology)

Course Unit:

TROPICAL METEOROLOGY II

(SMR 402/SMR 506)

Study Unit

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General Introduction

The role of weather/climate in the day-to-day activities engaged in by the human race has been of interest to physical scientists for a long time. Indeed, weather affects many aspects of, not only human and animal life, but also the type and distribution of vegetation over the globe. Where we make our home, what kind of house we leave in, the type of infrastructure we build, as well as what we wear are all affected by weather/climate in one way or another. Leisure travel (tourism), sports and games also depend on weather/climate conditions. Weather also affects agriculture and largely dictates the types of crops we grow, the farming practices we undertake, and the kind of animals we keep. Furthermore, weather/climate also influences both the occurrence and outcome of wars on the globe. Conflicts during prehistoric and medieval times, battles in biblical times, the great world wars of yesteryear, and the present day skirmishes and clashes have depended on the prevailing weather.

At this point, you, the learner, may be able to think of several ways in which weather/climate influences a number of other activities that humankind engages in. The fact that the weather/climate of a locality plays a crucial role in the cultural, societal, economic and military activities brings us to a very important aspect: Can we predict the weather/climate over various time scales in order to improve man's life style and avert the adverse consequences associated with extreme weather/climate events? The answer to this question is critical and forms the basis for the current course. Before one can predict the future weather/climate of a place, one must first attempt to understand the normal behaviour of the systems that influence the weather/climate, including studying the causes, intensity and general behaviour of these systems.

In the course *Tropical Meteorology I* (SMR 302), you learned that the term "the tropics" refers to the part of the world that lies between the lines separating the westerly winds and the easterly winds in the middle troposphere. About one-half of the earth's surface area lies between 30°N and 30°S. Studies of tropical phenomena are therefore important for at least two reasons: Firstly, from size considerations,

meteorological activities within the tropics influence the extra-tropical weather/climate systems. Secondly, and more importantly, approximately three-quarters of the world's population live in the tropics.

In the course unit alluded to above, you were introduced to the structure, space-time behaviour and the characteristics of some of the systems that influence the weather/climate in the tropical region. You studied the seasonal location, intensity and structure of the systems that control weather/climate over Africa with special reference to Eastern Africa. In the present unit, you shall study more about some of these systems at a more advanced level. The learner will also encounter some tropical systems not covered in SMR 302.

This study unit consists of nine lectures. The first lecture is a review of the observed temporal variability in the tropical atmosphere on various time scales, including aspects of the diurnal, seasonal, semi-annual and annual cycles of meteorological phenomena in some cases. In the second lecture of the unit, you shall study the role of static instability in tropical convection. Some of the dynamical instabilities that influence tropical weather systems are discussed in Lecture 3. The fourth lecture comprises a survey of some of the disturbances in the tropical atmosphere. This is followed in Lecture 5 by a study of tropical cyclones, their causes and observational aspects, and how they may be modelled and predicted. In Lecture 6, some of the zonal asymmetric features of the tropics are studied. Lecture 7 consists of processes that occur in the middle atmosphere, more specifically, the upper stratosphere and mesosphere. This is followed by a lecture on processes in the tropical boundary layer, as distinct from those in the extra tropics. The final lecture covers aspects of modelling and prediction of tropical weather/climate systems.

Study Unit Objectives

At the end of the course, you should be able to do the following:

1) Explain the observed temporal variability of meteorological elements and phenomena in the tropical atmosphere.
2) Describe the types of static instability and their role in convection processes in the tropical troposphere using relevant equations.

3)	Discuss the types of dynamical instability in the tropics.
4)	Distinguish among the characteristics of the disturbances found in the tropical atmosphere, including their causes, growth and development, and dissipation.
5)	Outline the properties of tropical cyclones and describe their prediction and modelling.
6)	Elucidate the distribution and controls of zonally asymmetric features of the tropics.
7)	Review the properties of the tropical stratosphere and mesosphere that influence tropical weather/climate.
8)	Describe the distinguishing properties of, and processes in, the tropical boundary layer.
9)	Review the techniques applied in modelling and prediction of the tropical weather/climate systems.

This study unit material is designed for students at University level who have some knowledge in synoptic and dynamic meteorology but who desire to enhance their knowledge in tropical meteorology. Aspects of tropical meteorology covered under SMR 302 are not repeated here per se, except for purposes of emphasis. You should therefore be familiar with this study unit. The discussion and treatment of the material in this lecture unit is simple (but certainly not simplistic). I wish, therefore, to welcome you to this course which, doubtless, you will find to be both very interesting and enjoyable, as well as relevant and applicable in your pursuit of understanding more about tropical weather/climate systems.

Lecture I:

The Observed Temporal Variability in the Tropics

General Objective:	At the end of the lecture, you should be able to explain the observed temporal variability of radiation, temperature, pressure, winds and precipitation in the tropics.
Scope:	To introduce you to the factors that influence the temporal variability of meteorological elements in the tropics.
Outline:	Introduction, radiation, temperature, pressure, winds, precipitation.
Prerequisite:	*Introduction to Meteorology I and II, Tropical Meteorology I, General Circulation and Climatology*.
Presentation:	Lecture notes.

1 Introduction

Let us begin our lecture by defining the word *meteorology* for reasons that will become clear in a short while. You might call to mind from earlier study units that *meteorology* is a name used for the weather science involving the scientific study of the Earth's atmosphere, especially regarding the patterns of climate and weather. What parameters define weather and climate? The meteorological parameters that define weather and climate include radiation, temperature, pressure, wind speed and direction, humidity, clouds, precipitation and visibility. We know, don't we, that these elements are neither constant in time nor in space. But what factors influence this variability? Before we can predict the weather and climate in the tropical regions, we need to have an accurate understanding of the behaviour of these parameters and the factors that influence their characteristics in time and space. We shall consider the variability of these parameters in space in the tropics in a later lecture.

In this lecture, we shall take some time to study the observed variability of meteorological parameters with time in the tropics, which we call *temporal variability*, and the factors that influence these variations.