# Unit 2: Tropical Disturbances

## Topics and Resources

### Tropical waves

* 1. *African Easterly Waves*

<http://www.meted.ucar.edu/tropical/synoptic/Afr_E_Waves/>

This module describes characteristics of African easterly waves including horizontal and vertical structure, evolution, speed, frequency, methods of tracking, and their downstream transformation over the Atlantic, Caribbean, and East Pacific. Mechanisms for wave formation are presented. Also explored are differences between waves that develop into tropical cyclones and those that do not. Extratropical interactions are also examined.

* 1. Equatorial Waves

*Introduction to Tropical Meteorology, Section 4.1.2,*

<http://www.meted.ucar.edu/tropical/textbook_2nd_edition/navmenu.php?tab=5&page=1.2.0>

This section describes the space and time scales, speed, and cloud and precipitation patterns of equatorial waves. Examine Kelvin waves (Section 4.1.2.1), equatorial Rossby waves (Section 4.1.2.2), mixed Rossby-gravity waves (Section 4.1.2.3), areas where equatorial waves have greatest impact including on tropical cyclone genesis (Section 4.1.5.1), how to monitor and forecast equatorial waves (Section 4.1.5.2). An operational focus section has links to other examples of equatorial waves,

<http://www.meted.ucar.edu/tropical/textbook_2nd_edition/navmenu.php?tab=5&page=4.0.0>

* 1. Synoptic analysis of equatorial waves

*Introduction to Tropical Meteorology, Section 9.3.3*

<http://www.meted.ucar.edu/tropical/textbook_2nd_edition/navmenu.php?tab=10&page=3.3.0>

The second part of this section describes how to identify equatorial Rossby waves and mixed Rossby-gravity waves using 850 hPa synoptic charts and satellite images.

* 1. Madden Julian Oscillation (MJO)

*Introduction to Tropical Meteorology, Section 4.1.1*

Basic spatial and temporal structure of the MJO, Section 4.1.1.1, <http://www.meted.ucar.edu/tropical/textbook_2nd_edition/navmenu.php?tab=5&page=1.1.1>

Forecasting the MJO, Section 4.1.1.4, <http://www.meted.ucar.edu/tropical/textbook_2nd_edition/navmenu.php?tab=5&page=1.1.5>

* 1. MJO influence on tropical cyclone activity

*Introduction to Tropical Meteorology, Sections 4.1.1.3 and 8.6.2.1*

<http://www.meted.ucar.edu/tropical/textbook_2nd_edition/navmenu.php?tab=5&page=1.1.3>

<http://www.meted.ucar.edu/tropical/textbook_2nd_edition/navmenu.php?tab=9&page=6.4.1>

### Tropical Upper-Tropospheric Trough (TUTT)

*Topics in Tropical Meteorology*, *TUTT*

<http://www.meted.ucar.edu/tropical/met_topics/print.htm#s6>

This section includes definition and structure and climatology of TUTTs in the North Atlantic as well as their role in tropical cyclone formation and suppression.

### Subtropical Cyclones

*Introduction to Tropical Meteorology*, Section 9.3.4.1

<http://www.meted.ucar.edu/tropical/textbook_2nd_edition/navmenu.php?tab=10&page=3.4.1#subtropic_cyclone>

The subsection on subtropical cyclones describes their climatology, structure, and typical weather. Illustrations show the synoptic pattern through the lifecycle of a subtropical cyclone that affected Hawaii.

### Mesoscale convective systems: A brief introduction

* 1. *Severe Convection II, Squall Lines in the Tropics, Section 3.6*

<http://www.meted.ucar.edu/mesoprim/severe2/frameset.htm>

<http://www.meted.ucar.edu/mesoprim/severe2/print_version/_p_3.6SL-TropicalSquallLines.htm>

This section compares midlatitude and tropical squall lines including radar cross-section schematics and circulation patterns; table of lifting condensation levels, shear, and cold-pool strength; examples from South America; and maps of famous tropical squall line locations (on 3 pages).

* 1. Mesoscale Influences on Tropical Cyclogenesis

*Introduction to Tropical Meteorology*, *Section 8.3.3,*

<http://www.meted.ucar.edu/tropical/textbook_2nd_edition/navmenu.php?tab=9&page=3.4.0>

This section examines tropical cyclogenesis associated with African easterly waves, mesoscale convective systems, and subtropical storms.

### Tropical Cyclones

* 1. *Introduction to Tropical Meteorology, Chapter 8*

<http://www.meted.ucar.edu/tropical/textbook_2nd_edition/navmenu.php?tab=9&page=1.0.0>

A comprehensive treatment of tropical cyclones including monitoring (Section 8.1), structure (Section 8.2), genesis (Section 8.3, Box 8-2), intensity (Section 8.4), climatology (Section 8.5), motion (Section 8.7). For this course, students can bypass the theoretical sections and, unless regionally appropriate, extra-tropical transition.

* 1. *Introduction to Tropical Meteorology, Sections 9.5, 9.6*

<http://www.meted.ucar.edu/tropical/textbook_2nd_edition/navmenu.php?tab=10&page=5.0.0>

<http://www.meted.ucar.edu/tropical/textbook_2nd_edition/navmenu.php?tab=10&page=6.0.0>

This section provides an in-depth coverage of prediction of motion and intensity of tropical cyclones including statistical and dynamical models, ensemble techniques. Forecast verification techniques are also described.

* 1. Interviews with tropical forecasters

*Introduction to Tropical Meteorology, Chapter 9, Focus Section 2* <http://www.meted.ucar.edu/tropical/textbook_2nd_edition/navmenu.php?tab=10&page=7.2.0.1>

This section features interview with forecasters from the National Hurricane Center and Météo-France La Réunion. Lixion Avila’s interview is available in the Spanish version of the textbook and Anne Claire Fontan’s interview is also available in French.

### Monsoon phenomena

* 1. Monsoons

*Introduction to Tropical Meteorology, Section 3.5*

[http://deved.meted.ucar.edu/tropical/textbook\_2nd\_edition/navmenu.php?tab=4&page=5.0.0](http://www.meted.ucar.edu/tropical/textbook_2nd_edition/navmenu.php?tab=4&page=5.0.0)

This section describes the global monsoon systems including monsoon regions (Section 3.5.1), monsoon onset and evolution in Asia (Section 3.5.3), Australia-Maritime Continent (Section 3.5.4.1), West Africa (Section 3.5.4.2), Americas (Section 3.5.4.3), intra-seasonal variability or active/break monsoon (Section 3.5.5.5) and the following monsoon weather systems:

Mei-yu/Baiu front and weather systems

[http://www.meted.ucar.edu/tropical/textbook\_2nd\_edition/navmenu.php?tab=4&page=5.3.0#meiyu](http://deved.meted.ucar.edu/tropical/textbook_2nd_edition/navmenu.php?tab=4&page=5.3.0#meiyu)

Winter monsoon convection in East Asia, Section 3.5.3

[http://www.meted.ucar.edu/tropical/textbook\_2nd\_edition/navmenu.php?tab=4&page=5.3.0#winter\_monsoon\_weather](http://deved.meted.ucar.edu/tropical/textbook_2nd_edition/navmenu.php?tab=4&page=5.3.0#winter_monsoon_weather)

Maritime continent monsoon convection, Section 3.5.4.1

[http://www.meted.ucar.edu/tropical/textbook\_2nd\_edition/navmenu.php?tab=4&page=5.4.0](http://deved.meted.ucar.edu/tropical/textbook_2nd_edition/navmenu.php?tab=4&page=5.4.0)

Major systems of the West African Monsoon, Section 3.5.4.2

[http://www.meted.ucar.edu/tropical/textbook\_2nd\_edition/navmenu.php?tab=4&page=5.4.2#west\_africa\_systems](http://deved.meted.ucar.edu/tropical/textbook_2nd_edition/navmenu.php?tab=4&page=5.4.2#west_africa_systems)

* 1. Monsoon Depressions

*Introduction to Tropical Meteorology, Section 9.3.4.1*

[http://www.meted.ucar.edu/tropical/textbook\_2nd\_edition/navmenu.php?tab=10&page=3.4.1#monsoon\_dep](http://www.google.com/url?q=http%3A%2F%2Fwww.meted.ucar.edu%2Ftropical%2Ftextbook_2nd_edition%2Fnavmenu.php%3Ftab%3D10%26page%3D3.4.1%23monsoon_dep&sa=D&sntz=1&usg=AFQjCNGg1Qi4XN-qPq6KjTu2asQL3OS4Tw)

* 1. Australian-Maritime Continent Monsoon

*Introduction to Tropical Meteorology, Chapter 9, Focus Section 1*

<http://www.meted.ucar.edu/tropical/textbook_2nd_edition/navmenu.php?tab=10&page=7.1.0>

This section is an overview of the north Australia-Maritime Continent monsoon including typical synoptic conditions, soundings, and weather systems observed during the active monsoon (Section 9F1.2.2), break monsoon (Section 9F1.2.3), comparison of active and break monsoon (Section 9F1.2.4), and suppressed monsoon (Section 9F1.2.5). A concept map summarizes the different north Australian monsoon regimes, their primary drivers, and typical weather systems.

### Tropical-Temperate Trough (TTT)

*Introduction to Tropical Meteorology*, Section 9.3.4.1

<http://www.meted.ucar.edu/tropical/textbook_2nd_edition/navmenu.php?tab=10&page=3.4.1#TTT>

The subsection provides a brief description of TTTs, which link tropical convection with midlatitude transient systems over southern Africa and the southwest Indian Ocean.

### Ocean-atmosphere coupling

*For synoptic meteorology, this topic is covered only in the context of ocean-atmosphere coupling influences on weather (e.g., tropical cyclone activity and monsoon variability)*

* 1. Walker Circulation

*Introduction to Tropical Meteorology, Section 4.2.1.2*

<http://www.meted.ucar.edu/tropical/textbook_2nd_edition/navmenu.php?tab=5&page=2.1.1>

This page describes the Walker circulation and includes conceptual illustrations

* 1. Climate Impacts of ENSO

*Introduction to Tropical Meteorology, Section 4.2.1.7*

<http://www.meted.ucar.edu/tropical/textbook_2nd_edition/navmenu.php?tab=5&page=2.1.8>

This section provides examples of the impacts of El Nino and La Nina around the globe.

* 1. ENSO impact on tropical cyclone activity

*Introduction to Tropical Meteorology, Section 8.6.3.1*

<http://www.meted.ucar.edu/tropical/textbook_2nd_edition/navmenu.php?tab=9&page=6.5.1>

This page describes ENSO impacts on tropical cyclone activity in the Atlantic and Eastern Pacific.

* 1. Monsoon variability and ocean-atmosphere coupling

*Introduction to Tropical Meteorology, Section 3.5.5*

<http://www.meted.ucar.edu/tropical/textbook_2nd_edition/navmenu.php?tab=4&page=5.5.0>

This section describes ocean-atmosphere coupling related to strong or weak (wet or dry) Asian-Australia monsoons including the Tropospheric Biennial Oscillation (TBO), El Nino Southern Oscillation (ENSO), and Indian Ocean Dipole (IOD) mode.