# Unit 3: General Mesoscale Phenomena

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## Topics and Resources

### Thunderstorms

* 1. *Principles of Convection I: Buoyancy and CAPE,*

<http://www.meted.ucar.edu/mesoprim/cape/>

This module presents an overview of buoyancy and CAPE including use of soundings to diagnose buoyant energy from CAPE and the Lifted Index.

* 1. *Tropical Severe Local Storms*

[http://www.meted.ucar.edu/tropical/synoptic/local\_storms](http://www.meted.ucar.edu/tropical/synoptic/local_storms/)/

This module provides a brief overview of severe local storms in the tropics. Basic ingredients for thunderstorms and diagnosis from soundings are described. Properties and hazards of ordinary, multicellular, and supercells thunderstorms are reviewed. Supercell environments and methods of identifying them in radar and satellite images are presented. Non-supercell tornadoes properties are described and compared with supercell tornadoes. Finally, tornadoes, waterspouts, and dust devils properties are compared.

* 1. *Principles of Convection III: Shear and Convective Storms,*

<http://www.meted.ucar.edu/mesoprim/shear/index.htm>

This module describes the lifecycle of ordinary thunderstorms, multicellular storms, and the impact of shear on storm evolution.

* 1. Pulse and multi-cell thunderstorms

*Radar signatures for severe convective storms,*

<http://www.meted.ucar.edu/radar/severe_signatures/navmenu.php?printname=print_pulse_and_multicell.htm&page=1.0.0>

This module section describes structure, environment, and hazards of pulse and multi-cellular thunderstorms. Examples are from Australia.

### Mesoscale convective systems

* 1. *Tropical Mesoscale Convective Systems*

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

This module describes various types of tropical MCSs, their structure, lifecycle, environments, and hazards. Examples are presented from many different regions of the tropics.

Classification of the mesoscale

*Definition of the Mesoscale, Page 5,*

<http://www.meted.ucar.edu/mesoprim/mesodefn/navmenu.php?tab=1&page=5.0.0>

On Pages 6-8 are the forecast funnel and time pyramid for forecasting at different scales, hydrostatic equilibrium and reasons why non-hydrostatic processes are critical to mesoscale meteorology:

<http://www.meted.ucar.edu/mesoprim/mesodefn/navmenu.php?tab=1&page=6.0.0>

<http://www.meted.ucar.edu/mesoprim/mesodefn/navmenu.php?tab=1&page=7.0.0>

<http://www.meted.ucar.edu/mesoprim/mesodefn/navmenu.php?tab=1&page=8.0.0>

* 1. *Introduction to Tropical Meteorology*, Box 5-4,

<http://www.meted.ucar.edu/tropical/textbook_2nd_edition/navmenu.php?tab=6&page=3.3.1>

This section presents the typical lifecycle of a tropical squall line including animation of vertical cross-section of radar, cloud signature, and storm relative flow. Also included are radar images of a West African MCS.

* 1. Classification of precipitation in tropical MCSs

*Introduction to Tropical Meteorology,* Section 5.3.3,

<http://www.meted.ucar.edu/tropical/textbook_2nd_edition/navmenu.php?tab=6&page=3.3.0>

This section includes a conceptual model of an MCS with convective and stratiform regions and an example radar image.

* 1. *Introduction to Tropical Meteorology,* Chapter 9, Section 9F1.3,

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

This section describes mesoscale storm types of the north Australian monsoon (Section 9F1.3) such as wet and dry microbursts, continental squall lines, and monsoon squalls; phenomena are described using satellite, radar, soundings, and conceptual models. Critical thinking questions about how to analyze and forecast these systems are interspersed throughout.

* 1. MCS radar signatures,

<http://www.meted.ucar.edu/radar/severe_signatures/navmenu.php?printname=print_mcs.htm&page=1.0.0>

This module section provides conceptual models of different types of MCS, their lifecycle based on radar observation, and propagation characteristics. Some examples are presented with a southern hemispheric perspective as this module was created for training at the Australian Bureau of Meteorology.

### Orographic phenomena

* 1. *Thermally-forced Circulation II: Mountain/Valley Breezes* <http://www.meted.ucar.edu/mesoprim/mtnval/>
  2. *Mountain waves and Downslope winds,*

<http://www.meted.ucar.edu/mesoprim/mtnwave/>

This module includes many conceptual models of mountain waves, gravity waves, and downslope winds. The real examples are from the midlatitudes but the concepts are still applicable for the tropics.

* 1. Mesoscale Orographic Climate Drivers

*Introduction to Climatology,* Section 3

Downslope wind, <http://www.meted.ucar.edu/afwa/climo/intro/print.htm#z3.3>

Upslope wind, <http://www.meted.ucar.edu/afwa/climo/intro/print.htm#z3.5>

### Local scale weather influences

* 1. *Tropical Mesoscale and Local Circulations* <http://www.meted.ucar.edu/tropical/synoptic/trop_meso_circ/>

This module describes various terrain-induced mesoscale and local-scale circulation in the tropics including their formation, modifying influences, and associated weather. It also covers the interaction of thermally-forced circulations, such as sea breezes, with monsoonal and trade wind flows. A case study focuses on Lake Victoria, where local weather is influenced by complex lake/land and mountain/valley circulations and the synoptic-scale flow.

### Multi-scale analysis and forecasting

* 1. *Introduction to Tropical Meteorology,* Section 9.3.5.1

<http://www.meted.ucar.edu/tropical/textbook_2nd_edition/navmenu.php?tab=10&page=3.5.1>

This section provides an example of multiscale analysis that goes from the synoptic-scale analysis to mesoscale and local scale analysis. Individual instructors may develop their own hypothetical forecast exercise; where the forecast process is introduced, from "basic observations", to analysis, and forecasting with the use of the forecast funnel concept.

b. The forecast funnel and time pyramid for forecasting at different scales

*Definition of the Mesoscale,* Pages 5-8

<http://www.meted.ucar.edu/mesoprim/mesodefn/navmenu.php?tab=1&page=4.0.0>

<http://www.meted.ucar.edu/mesoprim/mesodefn/navmenu.php?tab=1&page=6.0.0>

<http://www.meted.ucar.edu/mesoprim/mesodefn/navmenu.php?tab=1&page=7.0.0>

<http://www.meted.ucar.edu/mesoprim/mesodefn/navmenu.php?tab=1&page=8.0.0>

These module pages describe how mesoscale forecasting is different from synoptic forecasting, the forecast funnel and time pyramid for forecasting at different scales, hydrostatic equilibrium and reasons why non-hydrostatic processes are critical to mesoscale meteorology.