# Unit 1: General Review and Global Circulation Concepts

## Topics and Resources

Each is listed with common format: resource name, URL, instructions about length or scope of resource or sections within chapter.

### Space and time scales relevant to meteorology

* 1. Scales of atmospheric motion

*Introduction to Tropical Meteorology*, Section 3.1.4,

<http://www.meted.ucar.edu/tropical/textbook_2nd_edition/navmenu.php?tab=4&page=1.5.0>

This section starts with an illustration of space and time scales of atmospheric motion, which highlights phenomena at different scales (Fig. 3.1). The concept of dynamical scaling, the Rossby radius of deformation, is also presented (Fig. 3.5).

* 1. Three scales of climate drivers

*Introduction to Climatology,* Section 2*,*

<http://www.meted.ucar.edu/afwa/climo/intro/main.htm>

This section examines the drivers that combine to create the climate regions of the world, from mesoscale (local) level to synoptic-scale (continental) and global-scale levels. Examples and figures mostly focus on the midlatitude United States.

* 1. 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>

* 1. Challenges of Tropical Weather Forecasting

*Introduction to Tropical Meteorology,* Section 9.1*,*

<http://www.meted.ucar.edu/tropical/textbook_2nd_edition/navmenu.php?tab=10&page=1.0.0>

This section summarizes the challenges of tropical weather forecasting compared with midlatitude forecasting, including the role of mesoscale processes and the sparseness of station observations in the tropics.

### Review of fundamental dynamics: force balances, continuity, scale analysis

* 1. General Principles of Atmospheric Motion

*Introduction to Tropical Meteorology,* Section 3.1*,*

<http://www.meted.ucar.edu/tropical/textbook_2nd_edition/navmenu.php?tab=4&page=1.0.0>

This multi-page section reviews force balances at large-scale and the continuity principle (Section 3.1.1); hydrostatic balance and the thermal wind (Section 3.1.2); animations of 3-D flow in pressure systems (Section 3.1.3), scale analysis of horizontal motion and vertical structure for the midlatitudes and the tropics (Section 3.1.4); and divergence and vorticity expressed in kinematic analysis, using streamlines and isotachs (Section 3.1.5)

* 1. Wind processes

*S-290 Fire Weather, Unit 7: Section on Wind Processes*

<http://www.meted.ucar.edu/fire/s290/unit7/navmenu.php?tab=1&page=3.0.0>

This section is an introductory-level review of fundamental forces, large-scale flow, idealized general circulation of global surface winds, and divergent and convergent flow.

### Air masses and fronts

* 1. Tropical Air Masses

*Introduction to Tropical Meteorology,* Section 1.9*,*

<http://www.meted.ucar.edu/tropical/textbook_2nd_edition/navmenu.php?tab=2&page=9.0.0>

This section summarizes air masses formation and classification, and illustrates locations around the globe (Fig. 1.30).

* 1. Air Masses and Fronts: Examples for North America

*Introduction to Climatology,* Sections 4.1, 4.2, 4.4, 4.5

<http://www.meted.ucar.edu/afwa/climo/intro/main.htm> or

<http://www.meted.ucar.edu/afwa/climo/intro/print.htm#z4.1>

Sections 4.1 and 4.2 provide brief descriptions of air masses and examples from North America. Sections 4.4 and 4.5 define fronts and show examples of air masses, fronts, and jet streams over North America.

### Mid-latitude weather systems and cyclones

This material includes Norwegian cyclone model, conveyor belt conceptual models, and their limitations)

* 1. Midlatitude cyclone conceptual models and examples

*Mesoscale Banded Precipitation, Synoptic Setting, Section 3*

<http://www.meted.ucar.edu/mesoprim/bandedprecip/frameset.htm?3.htm>

*Norwegian cyclone model, Section 3.2.1 – 3.2.14*, <http://www.meted.ucar.edu/mesoprim/bandedprecip/print.htm#3.2>

This 14-page section describes types of fronts and the precipitation pattern associated with each type of front in the cyclone, it distinguishes anabatic and katabatic fronts; warm and cold occluded fronts. Each page shows a graphic or animation of fronts, airflow, and/or precipitation.

*Conveyor belt cyclone model, Section 3.3.1- 3.3.2*, <http://www.meted.ucar.edu/mesoprim/bandedprecip/print.htm#3.2>

Focus on the first two pages of this section, which include illustrations of the dry and cold air streams and their relationship to fronts. Examples are shown with satellite images, standard synoptic charts, and cross-sections.

### Differences between tropical, mid-latitude, and polar weather systems

* 1. Global semi-permanent surface pressure systems

*Introduction to Tropical Meteorology, Section 3.2.2,*

<http://www.meted.ucar.edu/tropical/textbook_2nd_edition/navmenu.php?tab=4&page=2.3.0>

This section describes the semi-permanent surface circulations systems from the tropics to the poles during winter and summer and includes maps.

* 1. Comparing the Tropics and Midlatitudes

*Introduction to Tropical Meteorology,* Section 3.2.3*,*

<http://www.meted.ucar.edu/tropical/textbook_2nd_edition/navmenu.php?tab=4&page=2.4.0>

This page summarizes key differences between the atmosphere in the tropics and in the midlatitudes including: baroclinic versus barotropic conditions, warm core versus cold core cyclones, and variability of the airflow (low frequency variability in the tropics, high frequency in the midlatitudes).

* 1. Arctic Climate, Synoptic Patterns

*Arctic Meteorology and Oceanography,*

<http://www.meted.ucar.edu/oceans/arctic_metoc/navmenu_pop.php?printname=lesson_3_climate.htm&page=1.2.0&type=text>

This section describes the mean synoptic patterns of the Arctic

*Arctic Climate, Tropopause*

<http://www.meted.ucar.edu/oceans/arctic_metoc/navmenu_pop.php?printname=lesson_3_climate.htm&page=1.4.0&type=text>

This section compares tropopause heights from soundings taken in the Arctic with soundings from the Caribbean.

### General circulation, the role of the tropics

* 1. Defining the Tropics

*Introduction to Tropical Meteorology,* Section 1.3*,*

<http://www.meted.ucar.edu/tropical/textbook_2nd_edition/navmenu.php?tab=2&page=3.0.0>

The tropics are defined by various methods including solar declination, surplus radiation, net upward motion, and predominance of easterly winds.

* 1. General Circulation of the Atmosphere and Ocean

*Introduction to Tropical Meteorology,* Sections 3.2.1, 3.3.1

<http://www.meted.ucar.edu/tropical/textbook_2nd_edition/navmenu.php?tab=4&page=2.0.0>

Section 3.2 describes the existing mean global atmospheric circulation and the contributing factors. It includes 3-D illustrations of the general circulation and animation of the formation of the subtropical jet stream. Section 3.3.1 describes the global ocean circulation.

*Tropical Circulation and Precipitation Distribution, Section 3.6,*

<http://www.meted.ucar.edu/tropical/textbook_2nd_edition/navmenu.php?tab=4&page=6.0.0>

This section describes and illustrates the relationship between tropical circulation systems and precipitation patterns.

*The role of the tropics in the general circulation,* Section 3.7

<http://www.meted.ucar.edu/tropical/textbook_2nd_edition/navmenu.php?tab=4&page=7.0.0>

This page illustrates and summarizes the role of tropical circulations in the global heat and momentum balance.

### Jet streams and jet streaks

* 1. *Jet Streams*

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

This module describes the general characteristics of upper-level jet streams (Polar Jet, Subtropical Jet, and Tropical Easterly Jet) and two major tropical low-level wind maxima (Somali Jet, African Easterly Jet). Included are discussions of their formation, maintenance, influence on synoptic weather, and role in the general circulation.

* 1. African Easterly Jet (AEJ) and Hurricanes

*Topics in Tropical Meteorology*, Section 1

<http://www.meted.ucar.edu/tropical/met_topics/print.htm#s1>

This section describes the AEJ, its formation mechanism, mean climatology and climatology during active or inactive Atlantic hurricane seasons.

* 1. *Jet Streak Circulations*

<https://www.meted.ucar.edu/norlat/jetstreaks/>

This webcast, by Dr. Jim Moore, is a very advanced review of many aspects of jet streak dynamics including convergence/divergence, ageostrophic winds, and coupled jets. This webcast is focused on the midlatitudes and applicable only where the polar jet extends far into the tropics (e.g., during cold surges over East Asia or South America).

### Spatial and temporal climatology of tropical circulation features

* 1. Roadmap to the tropics and subtropics

*Introduction to Tropical Meteorology,* Section 3.2.2*,*

<http://www.meted.ucar.edu/tropical/textbook_2nd_edition/navmenu.php?tab=4&page=2.3.0>

The winter and summer semi-permanent circulations at the surface and 200 hPa are presented.

* 1. Seasonal migration of precipitation

*Introduction to Tropical Meteorology,* Section 5.3.5,

<http://www.meted.ucar.edu/tropical/textbook_2nd_edition/navmenu.php?tab=6&page=3.5.0>

This section describes the seasonal migration of precipitation in the global tropics in response to seasonal heating and circulation changes. Included are monthly mean maps of surface pressure and winds and monthly mean precipitation.

* 1. The trade wind inversion

*Introduction to Tropical Meteorology,* Section 1.5.2*,*

<http://www.meted.ucar.edu/tropical/textbook_2nd_edition/navmenu.php?tab=2&page=5.2.0>

This page describes the formation of the trade wind inversion, a major feature of the tropics. Its relationship with mean surface circulation and its vertical structure from east to west are shown as a conceptual model.