# Unit 2: Tropical Disturbances

## Learning Activities and Assignments

Included

* [Remote Sensing of Tropical Cyclones](https://docs.google.com/a/comet.ucar.edu/document/d/1xa2sLfLYACme0xL3jrSQBlvdlbaRDCOuI0o07hSgWRU/edit#)

Students learn about remote sensing and use satellite images to explore the lifecycle of three tropical cyclones. First, students take a COMET module then an exercise that explores more satellite remote sensing of tropical cyclones.

Suggestions

* Use the EUMETRAIN ePort South Africa website, <http://www.eumetrain.org/eport/archive_saws.html?width=1280&height=1024>, to analyze weather over southern Africa, Madagascar, and vicinity. It is an archive (from 2010- present) of Meteosat images and UK Met Office model analysis at 00, 06, 12, 18 UTC. Various fields can be overlaid on different image products.
* Use the EUMETRAIN ePort Atlantic website, <http://www.eumetrain.org/eport/archive_atlantic.html?width=1680&height=1050>, to analyze synoptic weather over all of Africa, the Atlantic Ocean, and eastern South America, including African easterly waves, tropical cyclones (hurricanes), South American Convergence Zone, and midlatitude waves that extend into the tropics. The archives are from 2012 to present and include Meteosat products, Jason altimetry, ASCAT ocean surface wind velocity, surface synoptic observations, and a few ECMWF model fields. Model fields and station plots can be overlaid on satellite products.
* Track tropical synoptic features including easterly waves in real-time using analyses and objective techniques on the University at Albany website, <http://www.atmos.albany.edu/student/janiga/web/regional_maps.htm>

Scroll to region of interest and link to horizontal analysis of waves, jet streams, and other synoptic tropical disturbances.

* Use the CIMSS Tropical Cyclone Page, <http://tropic.ssec.wisc.edu/>, to explore the lifecycle of current tropical cyclones using images and critical environmental variables such as low-level convergence, low-level vorticity, shear, and upper-level divergence. Request for several days of data can be made through their archive page, <http://tropic.ssec.wisc.edu/archive/>
* Explore the mesoscale structure and inner-core structure of tropical cyclones from archived and real-time cases linked from tropical cyclone website of the US Naval Research Laboratory, <http://www.nrlmry.navy.mil/tc_pages/tc_home.html>
* Interview tropical forecasters in your region to find out about their forecast procedures and forecast challenges. See example questions in the tropical meteorology textbook, Chapter 9, Focus Section 2, Tropical forecasters’ Perspective, <http://www.meted.ucar.edu/tropical/textbook_2nd_edition/navmenu.php?tab=10&page=7.2.0>. These interviews are also available in Spanish, <http://www.meted.ucar.edu/tropical/textbook_2nd_edition_es/navmenu.php?tab=10&page=7.2.0.1,> and French (Dr. Anne Claire-Fontan).

* Use the NOAA CPC and Australian BOM websites to track the MJO and equatorial waves in real-time

<http://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/mjo.shtml>

<http://www.bom.gov.au/climate/mjo/>

<http://cawcr.gov.au/staff/mwheeler/maproom/OLR_modes/>

* Tropical Cyclone Forecasting (critical thinking activity for a group)

Guidelines for activity

Make four groups where student can chat and discuss and come to a consensus on how to match the trough/TC interaction to the right outcome and forecast. Give each group a document with the options. Each will submit a final document with the correct outcome, track and their explanation for their answer. At the end, the group can discuss the results in an online discussion.

A midlatitude trough is approaching a tropical cyclone. Consider the following four characteristics of the trough in deciding on your forecasts for the tropical cyclone track and intensity change:

1. it has small spatial scale and is centered just north of the TC latitude
2. it has large spatial scale and is centered just north of the TC latitude
3. it is extending equatorward, but is centered far poleward and moving eastwards
4. it is small and far poleward, moving due east

For each situation, identify which of the following outcomes you would expect in formulating track and intensity forecasts:

1. The trough and the tropical cyclone will interact briefly. Vertical wind shear associated with the trough is 5 m s-1 over the 850-200 hPa layer.
2. The trough and the tropical cyclone will interact for a period of a day or more. Vertical wind shear associated with the trough is 5 m s-1 over the 850-200 hPa layer
3. The trough will move to the east and there will be no interaction
4. The trough and the tropical cyclone will interact briefly. Vertical wind shear associated with the trough is 15 m s-1 over the 850-200 hPa layer
5. The trough and the tropical cyclone will interact for a period of a day or more. Vertical wind shear associated with the trough is 15 m s-1 over 850-200 hPa.

Based on the outcome you have just selected for each of the four situations, identify the most logical track and intensity change forecasts for the tropical cyclone assuming no change in ocean temperatures or any other environmental factors:

1. The TC will not be impacted by the trough and will continue to evolve as before
2. The TC will move poleward briefly and either slow in intensification or weaken for a period of time before continuing westwards
3. The TC will begin recurvature and either slow in intensification or weaken for a period of time
4. The TC will begin recurvature and weaken for a period of time and possibly undergoing extratropical transition
5. The TC will recurve, weakening and possibly undergoing extratropical transition
6. The TC will recurve, weakening and eventually decay.

**Answers expected:**

**Available to registered instructors.**

* Identify and track different synoptic weather systems (such as tropical waves, inverted troughs, fronts) in the tropical Atlantic and tropical Pacific using:

* + - 1. Unified surface analysis charts at <http://www.opc.ncep.noaa.gov/index.shtml>

Loops of unified analysis available for 3, 7, and 14 days (choose Tropical Pacific or Tropical Atlantic) at <http://www.opc.ncep.noaa.gov/Loops/>

* + - 1. Analysis of the tropical Pacific, <http://www.prh.noaa.gov/hnl/pages/analyses.php> including surface streamline analysis of tropical synoptic features for the sector (30S-30N and 150E-120W.

Describe the weather changes at a single observation affected by the passage of the specified synoptic weather system or choose a series of stations at different locations within the system for a single time and describe the observed weather at the stations.

Describe how the observed weather compares with the conceptual models or examples in the text or modules.

Guidelines for activity

Students submit power point of their analysis with embedded data and descriptions

* Find out the current phase of ENSO from the observations displayed at the tropical buoy array sites (TAO-TRITON, <http://www.pmel.noaa.gov/tao/realtime.html>).

See also the Climate Prediction Center ENSO website, <http://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/enso.shtml>

Describe the expected impact (if any) on weather in your location.

Guidelines for activity

Students submit power point with graphics showing the current ENSO phase and forecast along with the synoptic climatology for their region (e.g., jet stream location shift, more/less cyclones)

* Explore the NOAA CPC and Australian BOM websites for real-time observations and forecasts of the MJO:

Current conditions and Expert Discussions, <http://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/mjo.shtml>

MJO forecasts, <http://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CLIVAR/clivar_wh.shtml>

Australian BOM MJO site, <http://www.bom.gov.au/climate/mjo/>

<http://cawcr.gov.au/staff/mwheeler/maproom/OLR_modes/>

Describe the impact (if any) that the MJO will have on weather in your area in the coming 1-2 weeks.

Guidelines for activity

Students submit power point with graphics showing the MJO (if any) and forecast along with the impact on synoptic weather for their region (e.g., anomalously wet/dry conditions)

* Observe equatorial waves and forecast movement on the Australian CACWR website,

<http://cawcr.gov.au/staff/mwheeler/maproom/OLR_modes/>

Describe the impact that equatorial waves (if any) on weather in your area for the next 1-3 days.

Guidelines for activity

Students submit power point with graphics showing equatorial waves and forecast along with the impact on synoptic weather for their region (e.g., anomalously wet/dry conditions, tropical cyclone formation)

* If high impact weather has occurred in your area recently (TC formation, heavy rain, dry period in the middle of the rainy season), use the archived animations of MJO and equatorial waves, from Australian BOM <http://cawcr.gov.au/staff/mwheeler/maproom/OLR_modes/>, or NOAA CPC, <http://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/mjo.shtml>, to see whether your local area had been affected by equatorial waves or the MJO. Try to identify the phase of the MJO or equatorial wave that had the most dramatic impact on your local weather.

Guidelines for activity

Students submit power point with graphics and discussion of the high impact weather in their area. This can include synoptic analysis at surface, 850 and 200 hPa, meteograms, or text listing of surface observations. They should also present graphics showing the MJO or equatorial wave activity and explain how the large-scale tropical circulations may have affected their area.

* Use time-height plots from the National Hurricane Center, <http://www.nhc.noaa.gov/index_station.shtml>, to monitor easterly waves moving from Africa to the Caribbean over several days.

Guidelines for activity

Instructor provides powerpoint with the plots of the station data. Formulate four questions for students to answer to demonstrate that they have reviewed the images and understand how they relate to their understanding of easterly wave structure.

Students submit power point with graphics and discussion. The lesson can also be expanded to review these plots in real-time.

Describe the changes in the vertical structure of the wind velocity, relative humidity, and equivalent potential temperature as an African easterly wave that moves from Niamey, Niger, to Dakar, Senegal, then to the Eastern Caribbean and Western Caribbean.

Niamey, Niger, <http://www.nhc.noaa.gov/stations/61052.shtml>

Bamako, Mali, <http://www.nhc.noaa.gov/stations/61291.shtml>

Dakar, Senegal, <http://www.nhc.noaa.gov/stations/61641.shtml>

Grantley Adams, Barbados, <http://www.nhc.noaa.gov/stations/78954.shtml>

La Raizet, Guadeloupe, <http://www.nhc.noaa.gov/stations/78897.shtml>

Saint Maarten, Netherlands Antilles, <http://www.nhc.noaa.gov/stations/78866.shtml>

Piarco, Trinidad and Tobago, <http://www.nhc.noaa.gov/stations/78970.shtml>

San Juan, Puerto Rico, <http://www.nhc.noaa.gov/stations/78526.shtml>

Curacao, Netherlands Antilles, <http://www.nhc.noaa.gov/stations/78988.shtml>

Kingston, Jamaica, <http://www.nhc.noaa.gov/stations/78397.shtml>