# Learning Activity: Remote Sensing of Tropical Cyclones

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In support of Unit 2 Tropical Disturbances

## Objectives

At the end of this exercise students should be able to

* Interpret satellite images, including use of common wavelengths (infrared, visible) and enhancements and animated imagery, to identify synoptic systems
  + Specifically, features of tropical cyclone such as the eye, eyewall, rainbands, and inflow/outflow
* Interpret satellite images to identify relative intensity of tropical cyclones

## Instructions

* Assign students to finish the second chapter of the following COMET module prior to completing this assignment:
  + *Remote Sensing using Satellites, 2nd Edition*:
    - <http://www.meted.ucar.edu/satmet/remote_sensing/navmenu.php?tab=2>
* Pick a recent tropical cyclone from your region of choice (2006-present).
  + You can get imagery/animations from that cyclone from the websites listed in the Tools section
    - Find a cyclone that has the three typical satellite channels (VIS, WV, and IR) and the IR “BD-Curve” enhancement.
    - Find shear/shear tendency maps corresponding to the dates of your case from <http://tropic.ssec.wisc.edu/archive/>
    - Find the SST maps corresponding to the dates of your case from SST websites in the Tools section.
* Questions based on these imagery:
  + Of the four tropical cyclone features mentioned in the Remote Sensing Using Satellites module, order the timing of each feature on a timeline from tropical cyclogenesis to decay, noting the emergence and decay of each feature.
    - Discuss the physical implications of each feature’s occurrence in time (*i.e.*, you need long-lived inflow/outflow to get rotation throughout the column to get spiral rainbands to get an eye and eyewall.)
    - If you want to extend this further, plot the intensity and SSTs of the system on this timeline.
      * Note the lag between intensity and SST.
      * Note the eyewall replacement cycles if any. Also note their timing (day or night, period).
  + Eye:
    - Find the first instance of an eye using the imagery of your choice.
    - Find the last instance of an eye using the imagery of your choice.
    - Which imagery did you find was easiest to use to find the eye?
  + Repeat the above question set with each feature (eyewall, rainband, inflow/outflow).
  + Based on the Dvorak Technique T Number, has this storm intensified, weakened, or maintained its strength over the last day?
  + What do you expect to happen to tropical cyclone features upon landfall on a small island versus on a major continent? Compare and contrast using examples from these archives.
  + Aside from easterly flow regimes in the tropics, why do you expect tropical cyclones to NOT make landfall on the eastern side of a major ocean basin?
    - Are there any records of tropical cyclones making landfall on the eastern side of a major ocean basin?
    - If it is possible to go back and look at archived data for that event, ask students to compare and contrast this situation with the “normal” situation.

## Tools

* + - **Satellite Imagery and Overlays:**
  + <http://rammb.cira.colostate.edu/products/tc_realtime/index.asp>
    - You can navigate to your year of choice using the left-hand navigation menu.
  + <http://tropic.ssec.wisc.edu/archive/>
    - You can either navigate to the storm by name or the range of dates covered by that storm.
    - **Historical Hurricane Tracks:**
  + <http://www.atmos.uiuc.edu/iswecs/Google.Earth/Tropical/Hurrtracks/Hurrtracks.kmz>
    - Tropical cyclone tracks for all basins (not including current year in all basins)
      * File requires Google Earth or other .kmz/.kml compliant viewer
  + <http://www.nrlmry.navy.mil/tc-bin/tc_home2.cgi?SIZE=thumb&AGE=Latest&ARCHIVE=all&MO=SEP&YEAR=2012&STYLE=frames>
    - Tropical cyclone tracks and satellite images for all basins, choose year.
    - **SSTs:**
  + <http://www7320.nrlssc.navy.mil/altimetry/>
    - 3-day SSTs (interpolated) back to 1993
  + <http://www.ssec.wisc.edu/data/sst/archive/>
    - Daily SSTs rolling 1-year archive
  + Navy Coastal Ocean Model: <http://www7320.nrlssc.navy.mil/global_ncom/glb8_3b/html/index.html>
    - Daily SSHs and SSTs 2002-Present
  + Navy Layered Ocean Model: <http://www7320.nrlssc.navy.mil/global_nlom/>
    - Daily SSHs and SSTs 2002-Present
  + Navy Hybrid Coordinate Ocean Model: <http://www7320.nrlssc.navy.mil/GLBhycom1-12/skill.html>
    - Daily SSHs and SSTs 2007-Present
    - Snapshot archives can be found once you get to the regional level.
  + <http://weather.unisys.com/archive/sst/>
    - Weekly SSTs and SST Anomalies back to 1998
    - **Useful Tropical Cyclone Examples:**
* Atlantic:
  + Katia (2011)
  + Irene (2011; Landfalling [US])
  + Paula (2010; Landfalling [Cuba])
  + Gustav (2008; Landfalling [Jamaica])
* Eastern Pacific:
  + Adrian (2011)
  + Dora (2011)
  + Jova (2011; Landfalling [Mexico])
* Central Pacific:
  + Neki (2009)
* Western Pacific:
  + Nanmadol (2011; Landfalling [Taiwan, China])
  + Nesat (2011; Landfalling [Phillipines, China, Vietnam])
  + Merbok (2011)
* North Indian Ocean:
  + Thane (2011; Landfalling [India])
  + Five (2011)
* Southern Hemisphere:
  + Yasi (2011; Landfalling [Australia])
  + Bianca (2011)
  + Bingiza (2011; Landfalling [Madagascar])

## Submission Method

Students can submit powerpoint presentations or word documents with the relevant images and explanations.