Tropical Waves

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WMO Region IV
Tropical Cyclone Workshop
Outline

• Basic definition
• Schematic diagrams/Interactions
• Operational products/forecasts
• Tools for tracking
• Exercise
What are tropical waves?

* Perturbations / disturbances in the tropical easterlies that typically move from east to west.

* Often seen as inverted troughs of low pressure (inverted-V pattern in satellite imagery). Significant rain producers.

* Convection typically on the east side. Subsidence/clearing on the west side.

* Convection highly modulated by atmospheric moisture, upper level features, topography, etc.

* Develop into tropical cyclones.

* Around 60 tracked per year (little annual variability)
How/where they form

- Generated by an instability (baroclinic-barotropic) of the African easterly jet

- Jet arises as a result of reversed lower tropospheric temperature gradient over west-central north Africa due to extremely warm temperatures over the Sahara Desert and substantially cooler temperatures along the coast of Guinea.
Tropical waves/African easterly waves move westward within the trade wind flow south of the Bermuda-Azores high.
Tropical wave activity in terms of numbers is highest June-August
Schematic diagrams

Classic inverted V-shape near the eastern Caribbean
Schematic diagram

- Trough axis
- Convergence
- Divergence

Adapted from Robert Simmon, NASA GSFC
At what pressure level is the maximum amplitude?

(a) 700 mb
(b) 500 mb
(c) 200 mb
(d) surface
• Notice eastward slope will height
• Maximum amplitude is around 700 mb
* wavelength of about 2000 km
* period of 3 to 4 days.
* typically move westward at 10 to 15 kt
NO SHEAR

EASTERLY SHEAR

WESTERLY SHEAR
Waves in Westerly Shear

Clouds/rain displaced to the east of the wave axis
Waves in Easterly Shear

Clouds/rain displaced to the west of the wave axis
What happens when tropical waves interact with upper-level lows and troughs?

(a) Convection decreases
(b) Convection increases
(c) A tropical cyclone forms
Although interaction with upper-level lows are unfavorable for tropical cyclogenesis, it can often induce heavy rainfall.
Sea-breeze convergence, upslope flows, and afternoon heating can cause convection to become chaotic and difficult to predict.
Saharan Air Layer

Very dry/warm air in the low-mid levels of the atmosphere limits convection.
Tool to help track the strength and position of the SAL
NHC Products
TAFB products: Surface Analysis

Analyze current positions
Tropical Weather Discussion for North America...Central America...Gulf of Mexico...Caribbean Sea...Northern Sections of South America...and Atlantic Ocean to the African Coast from the Equator to 32N. The following information is based on satellite imagery...meteorological analysis...weather observations...and radar.

Based on 1800 UTC surface analysis and satellite imagery through 2315 UTC.

...Tropical Waves...

A tropical wave is along 32N S of 17N moving W near 13 kt. This wave coincides with a deep layer moisture maximum observed in total precipitable water imagery. Isolated moderate convection is from 13N-15N between 30W-34W.

A tropical wave is along 43N S of 14N moving W near 16 kt. This wave remains on the leading edge of dry Saharan air and dust inhibiting deep convection along the wave axis. However...scattered showers are from 10N-12N between 46W-50W.

A tropical wave is along 56W S of 18N moving W near 15 kt. This wave coincides with a deep layer moisture maximum that stretches NWD into the SW North Atlc due to an upper level low centered near 23N67W. Interactions between the tropical wave and upper level low are producing scattered showers and isolated moderate convection from 10N-19N between 60W-70W.

A tropical wave is along 82N S of 21N moving W near 15 kt. This wave lies in a broad area of deep layer moisture observed in total precipitable water imagery. This wave continues moving beneath a diffluent pattern aloft enhancing scattered moderate convection over the SW Caribbean S of 12N and across Panama and Costa Rica. Also scattered moderate/isolated strong convection is over the NW Caribbean N of 18N between 80W-85W...including portions of Wrn Cnta and the Yucatan Peninsula.
Predict future positions: 24h, 48h, and 72h
Approximately 70% of Atlantic tropical cyclones and 85% of major hurricanes originate from tropical waves.
What is more important for tropical cyclogenesis?

(a) the wave structure
(b) the environment
Developing vs. Non-developing

Very little different in structure between developing and non-developing waves

Hopsch, Thorncroft, and Tyle (2009)
Tools to track tropical waves
Satellite Hovmoller Diagrams

Aug 26
Aug 27
Aug 28
Aug 29
Aug 30
Aug 31
Sep 1
Surface Observations

Up to 4 mb pressure falls associated with a strong wave
Scatterometer

Note: 1) Times are GMT 2) Times correspond to 1°N at right swath edge - time is right swath for overlapping swaths at 1°N 3) Data buffer is 24 hrs for OB0802 4) Block barbs indicate possible rain contamination

NOAA/NESDIS/Office of Research and Applications
Total Precipitable Water

Morphed composite: 2007-08-03 00:00:00 UTC
The northern portion of the wave often fractures but the southern extension continues moving westward
Upper-Air Time Sections

Dakar

Sal
Models

Relative vorticity

Streamlines

Moisture fields

Sea Level Pressure
EXERCISE