The Monsoon Trough

Monsoon trough

Monsoon Southwesterlies

NE Trades

ITCZ

SE Trades

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Hurricane Specialist Unit (HSU)
- TC forecasting
- Coordinate watches and warnings

Tropical Analysis and Forecast Branch (TAFB)
- Unified surface analysis
- Daily tracking of precursor disturbances
- Incorporate disturbances into our marine products - including precursor disturbances

***Unified surface analysis is the foundation on which our forecasts are built. During hurricane season, this product is used to depict regions which may be favorable for tropical cyclogenesis. With this in mind, TAFB started to include a depiction of the monsoon trough during the 2011 season***
NHC Definition of Monsoon

A large-scale, seasonally-reversing surface wind circulation in the tropics accompanied by large amplitude seasonal changes in precipitation.
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A large-scale, seasonally-reversing surface wind circulation in the tropics accompanied by large amplitude seasonal changes in precipitation.

“The primary cause is the much greater annual variation of temperature over large land areas compared with neighboring ocean surfaces, causing an excess of pressure over the continents in winter and a deficit in summer, but other factors such as the relief features of the land have a considerable effect. The monsoons are strongest on the southern and eastern sides of Asia, the largest landmass, but monsoons also occur on the coasts of tropical regions wherever the planetary circulation is not strong enough to inhibit them.” - WMO
Monsoon region based on Ramage (1971) definition. Hatched areas are monsoonal according to the surface wind criteria. Heavy line marks the northern limit of the region with low frequencies of surface cyclone-anticyclone passage in summer and winter. The rectangle encloses the monsoon region that satisfies all 4 criteria.
(a) Monsoon precipitation index, MPI (color shading) and the monsoon precipitation domain outlined by the black curves. The monsoon precipitation domain here is defined by MPI > 0.5 and the annual range of precipitation is greater than 300 mm. The data used are CMAP precipitation measurements.
(b) Monsoon westerly index, MWI (color shading) and the monsoon westerly domain outlined by the black curves. The monsoon westerly domain here is defined by MWI > 0.5. The wind data used are 850 hPa zonal wind component derived from NCEP2. The dashed rectangle indicates the monsoon domain defined by Ramage (1971). From Wang and Ding (2008).
Top: The spatial pattern of the first multi-variable EOF mode (which accounts for 71% of the variance) of the climatological monthly mean precipitation (shading, unit: mm/day) and the winds (vectors in units of m/s) at 850 hPa and:

Bottom: corresponding normalized principal component (Wang and Ding, 2008)
Top: The spatial pattern of the first multi-variable EOF mode of the climatological monthly mean precipitation (shading, unit: mm day⁻¹) and the winds (vectors in units of m s⁻¹) at 850 hPa.

Bottom: The spatial patterns of the first multi-variable EOF mode of the climatological monthly mean precipitation (shading, unit: mm day⁻¹) and the winds (vectors in units of m s⁻¹) at 850 hPa (Wang and Ding, 2008).
Asian-Australian monsoons


02 Jul

Data Sources: OLR – NESDIS/ORA, Winds – NCEP CDAS/ Reanalysis

Image from CPC
African monsoons

OLR, 200-hPa Streamlines and 850-hPa Wind Clim (1979-1995)

02Jul

Data Sources: OLR - NESDIS/ORA, Winds - NCEP CDAS/Reanalysis

Image from CPC
American monsoons


Data Sources: OLR – NESDIS/ORA, Winds – NCEP CDAS/ Reanalysis

Image from CPC
Data Sources: OLR - NESDIS/ORA, Winds - NCEP CDAS/Reanalysis
EPAC August
Surface Wind
Climatology
Wind Shift

> 150°
Atlantic
August
Surface Wind
Climatology
Surface Winds

Pacific

Climatological Feb-Aug wind shift > 150°

Atlantic
Locations of near-equatorial tradewind convergence (solid lines) and the monsoon troughs (dashed lines) (from Ramage, 1995 adapted from Atkinson and Sadler, 1970).
Intertropical Convergence Zone and Monsoon Trough Definitions used at NHC

- **Monsoon Trough** - A surface trough in association with a monsoon circulation. This is depicted by a line on a weather map showing the location of minimum sea level pressure coinciding with the maximum cyclonic turning of the surface winds, with southwesterly or northwesterly flow prevailing equatorward and northeasterly flow prevailing poleward of the typically zonally oriented trough axis.

- **Monsoon** - A large-scale, seasonally-reversing surface wind circulation in the tropics accompanied by large amplitude seasonal changes in precipitation.

- **Inter-Tropical Convergence Zone** - A zonally elongated axis of surface wind confluence typically of northeasterly and southeasterly trade winds in the tropics.
Impacts of monsoon trough

Heavy rain events over Central America and Southern Mexico as an active monsoon trough moves northward
Oct 08, 2011
00 UTC
Oct 16, 2011 00 UTC
### NUMBERS AT A GLANCE

<table>
<thead>
<tr>
<th>Country</th>
<th>Number Affected</th>
<th>Number Evacuated</th>
<th>Deaths</th>
<th>Source</th>
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</thead>
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<td>Guatemala</td>
<td>593,418</td>
<td>29,207</td>
<td>38</td>
<td>GoG¹ – October 19, 2011</td>
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<td>32</td>
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<td>Honduras</td>
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<td>1,000</td>
<td>Undetermined</td>
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Depicting the monsoon through and ITCZ on the Unified Surface Analysis