

ESCI 344 – Tropical Meteorology
Lesson 4 – Seasonal-mean Wind Fields

References: *Forecaster's Guide to Tropical Meteorology* (updated), Ramage
Climate Dynamics of the Tropics, Hastenrath
Tropical Climatology (2nd ed), McGregor and Nieuwolt
Tropical Meteorology, Tarakanov
Climate and Weather in the Tropics, Riehl
General Circulation of the Tropical Atmosphere, Vol. II, Newell et al.

Reading: McGregor and Nieuwolt, Chapter 5 (e-reserve)
“Climatological Streamlines” (e-reserve)
“Climatological Streamlines (detailed)” (e-reserve)
“Tropical Cyclone Forecaster’s Reference Guide”, Chapter 2, Section 1.2 thru
1.5, (web resource) <http://www.nrlmry.navy.mil/~chu>

LOW-LEVEL WIND FIELD

- **January**
 - **Oceanic subtropical ridges merged with continental anticyclones.**
 - **Max easterly trade flow at about 10N.**
 - **Heat lows over Southern Africa.**
 - **In Atlantic and Eastern Pacific, trade-wind trough lies between 0 and 5N.**
 - **In Western Pacific and Indian Ocean, monsoon trough in SH, with northeast monsoon firmly in place over Asia**
- **April**
 - **Subtropical ridges close to January location.**
 - **African monsoon trough near 10N**
 - **In Atlantic and Eastern Pacific, trade-wind trough still lies between 0 and 5N.**
 - **Heat lows forming over China, Southern India, and Sahara Desert.**
 - **In Western Pacific and Indian Ocean, SH monsoon trough has moved toward Equator.**
 - **A nearly symmetric trough forms in North Indian Ocean, and begins the first of two tropical cyclone seasons in the Bay of Bengal and North Arabian Sea**
- **July**
 - **African monsoon trough near 20N**
 - **Heat lows over Saudi Arabia and Mexico**
 - **Eastern Pacific now has a monsoon trough, instead of a trade-wind trough.**

- Monsoon trough sets in over South China sea and Western Pacific, and is oriented northwest to southeast.
- South Asia firmly entrenched in southwest monsoon flow, with monsoon trough well inland.
- **October**
 - Monsoon trough over North Africa is weak and lies near 10N.
 - Trade wind trough in Eastern Pacific.
 - Heat lows over Asia are gone.
 - Monsoon trough over South China Sea moves southward.
 - Monsoon trough draped across North Arabian Sea and Bay of Bengal, leading to second tropical cyclone season in North Indian Ocean.

UPPER-LEVEL WIND FIELD

- **January**
 - West Pacific and Indian Ocean under long ridges in both hemispheres.
 - Eastern Pacific and Atlantic have westerly flow, broken by anticyclone over South America.
 - NH subtropical jet stream well developed, with strong maximum south of Japan.
- **April**
 - NH subtropical jet still present, but weaker.
 - SH subtropical jet moves toward Equator.
 - Ridges in both hemispheres have moved closer to equator.
 - Westerlies still dominate Eastern Pacific and Atlantic, but have pronounced dip into SH.
- **July**
 - Ridge over Asia has moved drastically northward.
 - NH subtropical jet has disappeared.
 - SH subtropical jet very strong near Australia.
 - *Tropical easterly jet* (TEJ) has formed over Asia.
 - Continuous ridge present in SH.

- Upper-level troughs, termed *tropical upper-tropospheric troughs* (TUTT) have formed in North Pacific and North Atlantic.
- Anticyclone established over Mexico.
- **October**
 - Anticyclone in Asia-Africa region moved back toward Equator.
 - NH subtropical jet reestablished.
 - Anticyclone that was over Mexico has moved south.
 - Variable westerlies reestablish over Atlantic and North Eastern Pacific.
 - SH subtropical jet weakens somewhat.

SUBTROPICAL JET STREAM

- The subtropical jet stream located in the upper troposphere above where the Hadley cell descends.
- In the SH the subtropical jet is present year-round.
- In the NH the subtropical jet disappears in summer.
- There are three speed maxima, over the Middle East, Asia, and America.
- The subtropical jet is often very close to the polar jet.
 - Forecasters often refer to the subtropical jet as the “southern branch” of the jet stream, though this is misleading as it implies that the subtropical jet is just an offshoot of the polar jet.
- The dynamics of the subtropical jet are very different than those of the polar jet.
- The origin and maintenance of the subtropical jet is complex, and not completely understood. Some significant factors are:
 - conservation of angular momentum as the air in the upper branch of the Hadley cell moves poleward.
 - meridional gradients in the surface heat budget
 - Central Asian topography
- Though there is no surface front or weather characteristics associated with the subtropical jet, there is an upper-tropospheric front associated with it. This is consistent with thermal wind balance.

- The gradients across the upper-tropospheric front are due in part to the upper air convergence in this region as the upper branch of the Hadley cell converges with the mid-latitude westerlies.
- Though there is no surface weather associated with the subtropical jet, it does interact with the midlatitudes and does play a role in midlatitude dynamics and influences midlatitude weather.

TROPICAL EASTERLY JET

- The tropical easterly jet (or TEJ) forms over Southern Asia and East Africa during the boreal summer.
- It exists because the mid-tropospheric thickness gradient is reversed due to the intense heating over the Tibetan Plateau.

WEST AFRICAN MID-TROPOSPHERIC JET

- The West African mid-tropospheric jet is found at about 600 mb, and extends from the Red Sea to the Atlantic Coast.
- Mean position is about 15N.
- Strongest in boreal summer (~10 m/s).
- Exists due to easterly thermal wind caused by heating over Sahara Desert contrasted with cooler, maritime air to South.

EAST AFRICAN LOW-LEVEL JET (SOMALI JET)

- Found near 850 mb
- Velocities 12-15 m/s.
- African highlands are important geographic feature for creation and maintenance of jet.
- Maximum speeds in early morning, with minimum in early afternoon.
 - Likely due to changes in boundary layer stability between morning and afternoon.
- Important for mass transport and water vapor transport across Equator during southwest monsoon.