

A wide-angle photograph of a savanna landscape. A dirt road with two tracks winds from the foreground towards the middle ground. The terrain is covered in dry, brownish-yellow grass and scattered acacia trees. In the background, there are rolling hills and a range of mountains under a blue sky with light, wispy clouds. The overall scene is bright and clear, suggesting a sunny day.

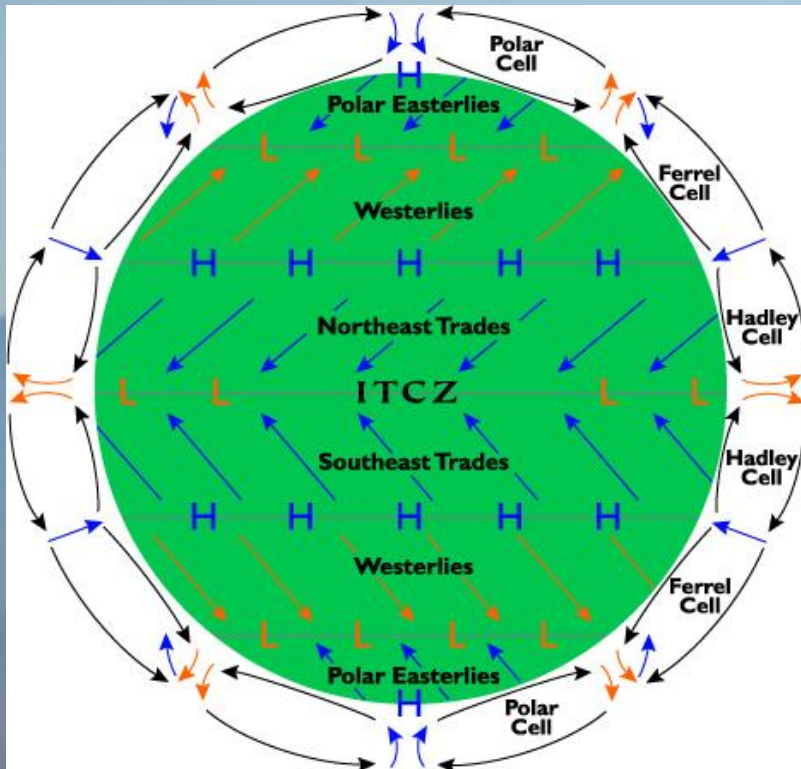
# The Climate of Northern Tanzania

Daniel Pollak

# Examining the Climate

- To understand and examine the processes that make up the Tanzanian climate we must first talk a great deal about the large-scale processes which make the African Climate what it is.
- The two main factors that drive the climate of Northern Tanzania are
  - ITCZ
  - Topography

# Global Pressure Belts and Winds

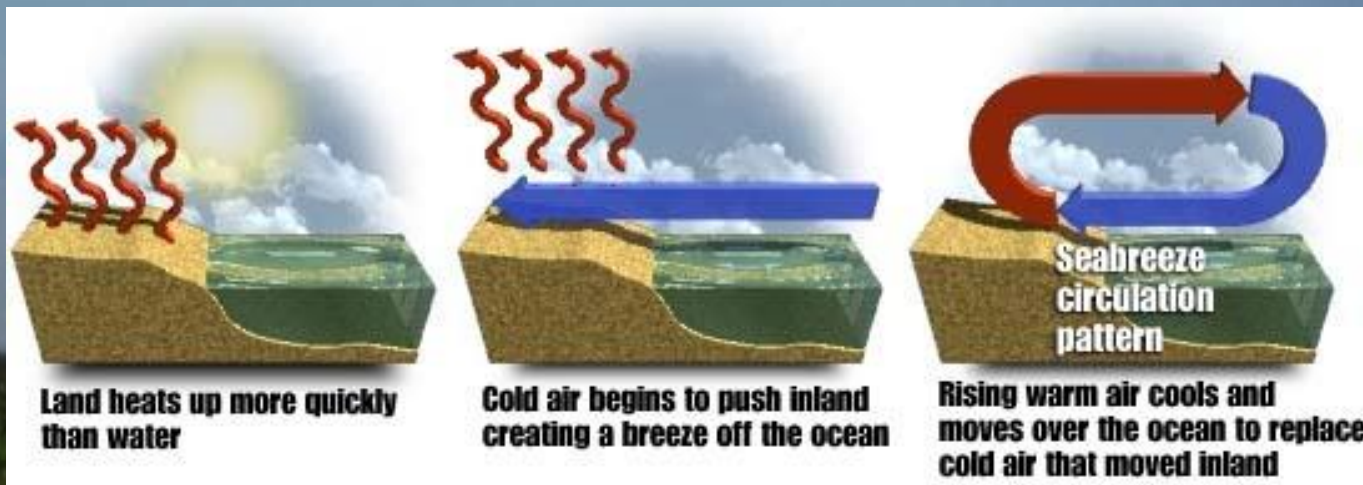


## What causes pressure belts & winds?

- The uneven heating of the Earth's surface.
  - Insolation, land type.
- The rotation of the Earth causes centrifugal and Coriolis forces and accelerations.

# Air Masses and Circulation

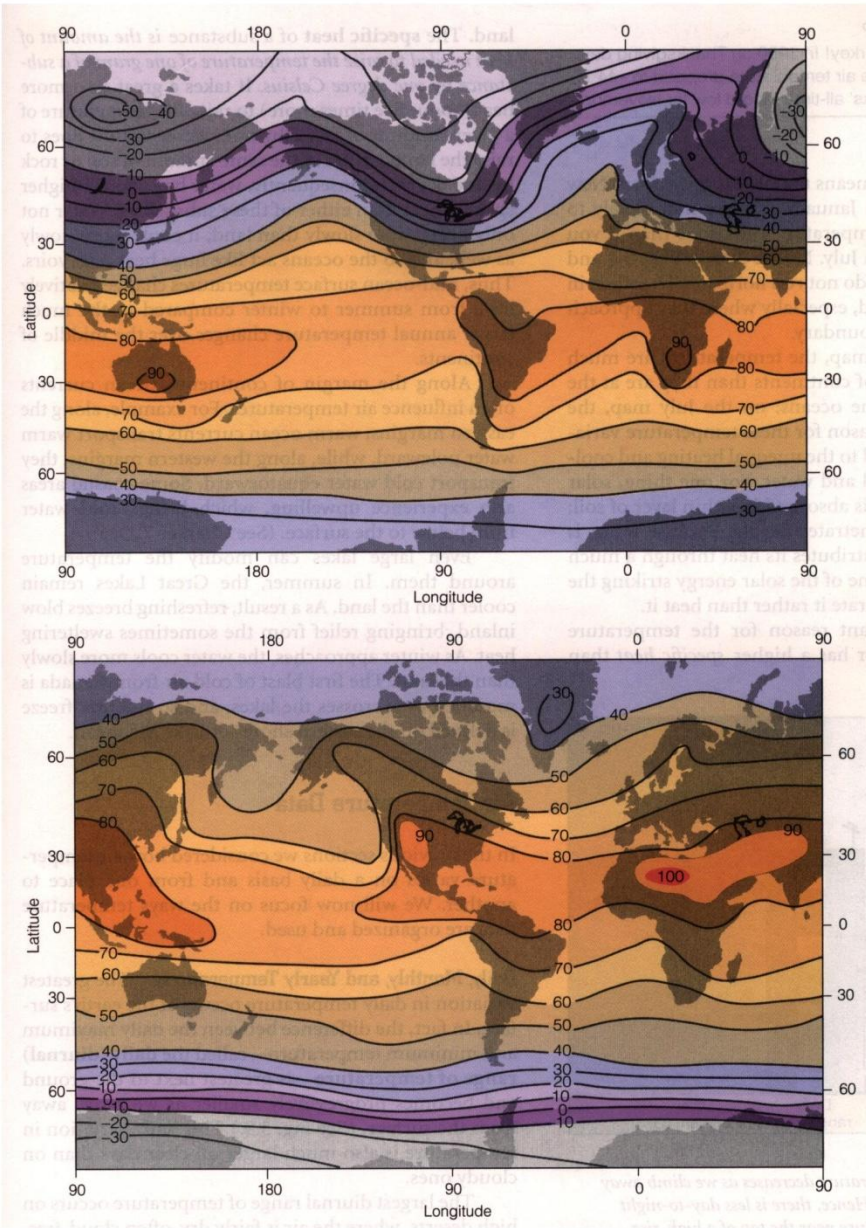
- An air mass is a body of air that possesses relatively uniform characteristics of temperature and humidity based on the characteristics of the source area.
- The movement of these air masses is predominantly caused by the differential heating of land and ocean.
  - Land: shallower, lower heat storing capacity.
  - Oceans: greater depth, mixing/distribution, high heat storing capacity.



Increase of local atmospheric height over the land

LAND: upper air divergence → lower level convergence (Low)

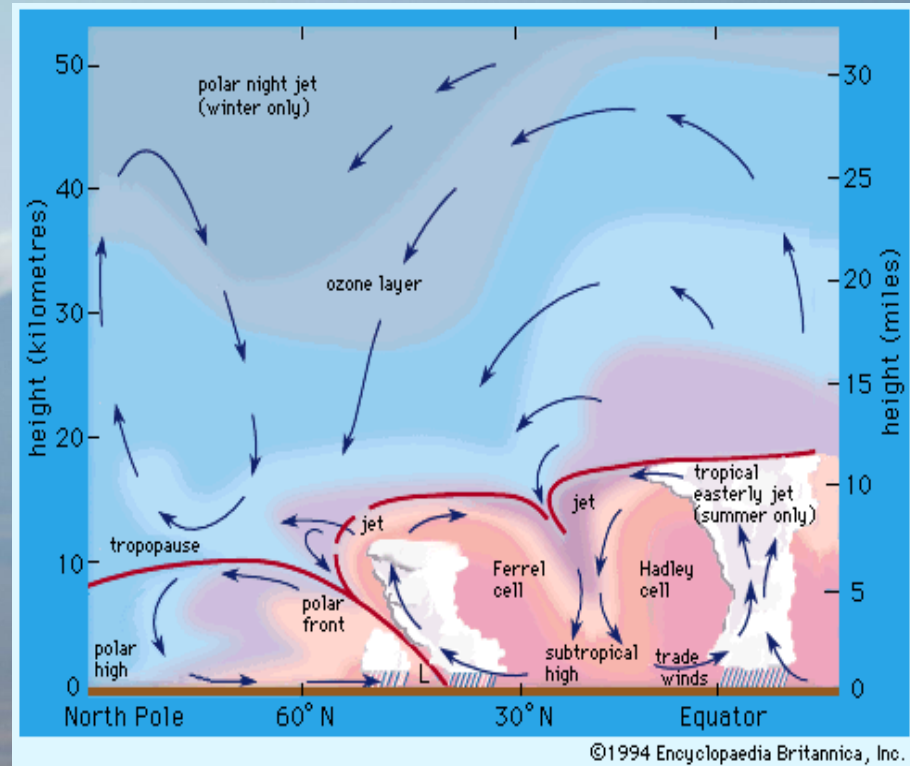
Ocean: opposite (High)



- Local pressures over the oceans stay relatively uniform; contrary to the land.
- Pressure gradients form in order to try to reach an equilibrium.
- These pressure gradients drive air circulation.
- A seasonal wind that reverses direction seasonally due to reversal of pressure over a large land mass is a Monsoon.

# ITCZ- Inter-tropical Convergence Zone

- Located where both Hadley cells meet along the equator and where the trade winds converge.
- Occurs in the equatorial region where temperatures are highest.
- Strong updrafts cause upper air divergence which causes low-level convergence.



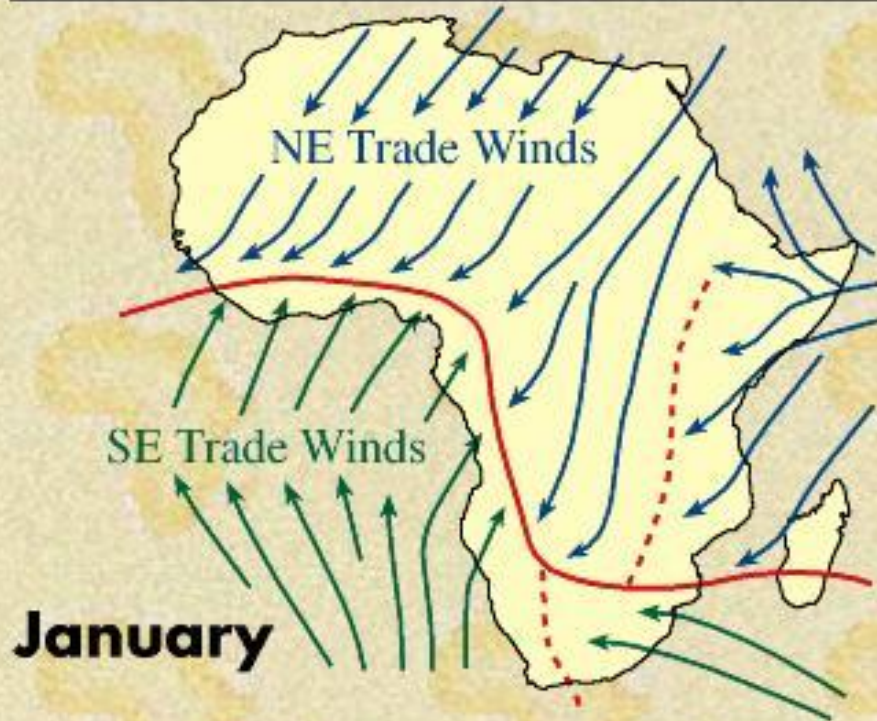
# ITCZ- Inter-tropical Convergence Zone

- Since the earth is tilted 23.5 degrees, the latitude of maximum differential heating changes as the Earth travels around the sun.
- This annual migration of the ITCZ follows the 90 degree sunlight angle latitude but at a 6-8 week delay.
- Other Limits of the ITCZ:
  - Diurnal motion shifts South in morning, and North in Afternoon (when in NH).
  - The position of the ITCZ varies considerably from year to year depending on how strong the air masses are in comparison to each other, which meet at the ITCZ.
  - The ITCZ plays a large role in determining precipitation amounts.
  - Uncertainty in ITCZ locations annually.

# Intertropical Convergence Zone

## Definition

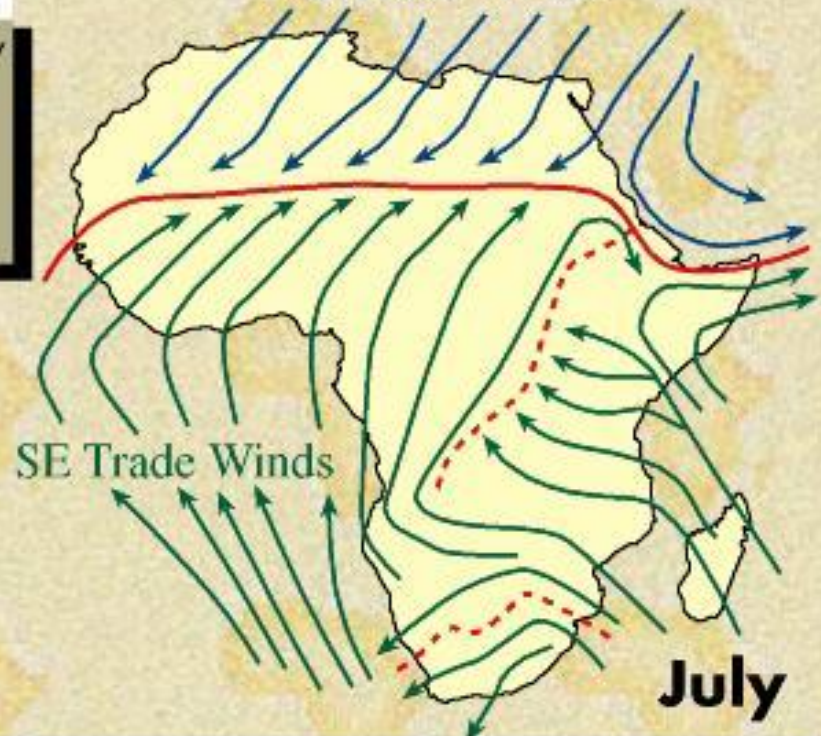
The Intertropical Convergence Zone (ITCZ) is an area of low pressure where the trade winds converge. Changes in air pressure over land cause a seasonal shift in the location of the ITCZ. Occasionally, the ITCZ stagnates over the ocean near the Equator. When this occurs, some refer to the lack of movement in the air mass as "The Doldrums."



**January**

- ITCZ
- - - Other Zones of Convergence
- Wind Currents

## NE Trade Winds



**July**

## Points of Interest

- The ITCZ shifts significantly from January to July.
- The ITCZ is one of Africa's principal rainmaking mechanisms.
- The movement of the ITCZ causes wet and dry seasons across Africa.
- Farmers plan their planting and harvesting according to the rain from the ITCZ.
- When the ITCZ does not follow its normal schedule, it affects the farming and pastoral life, causing both droughts and floods.



# TEJ = Tropical Easterly Jet

## AEJ = African Easterly Jet

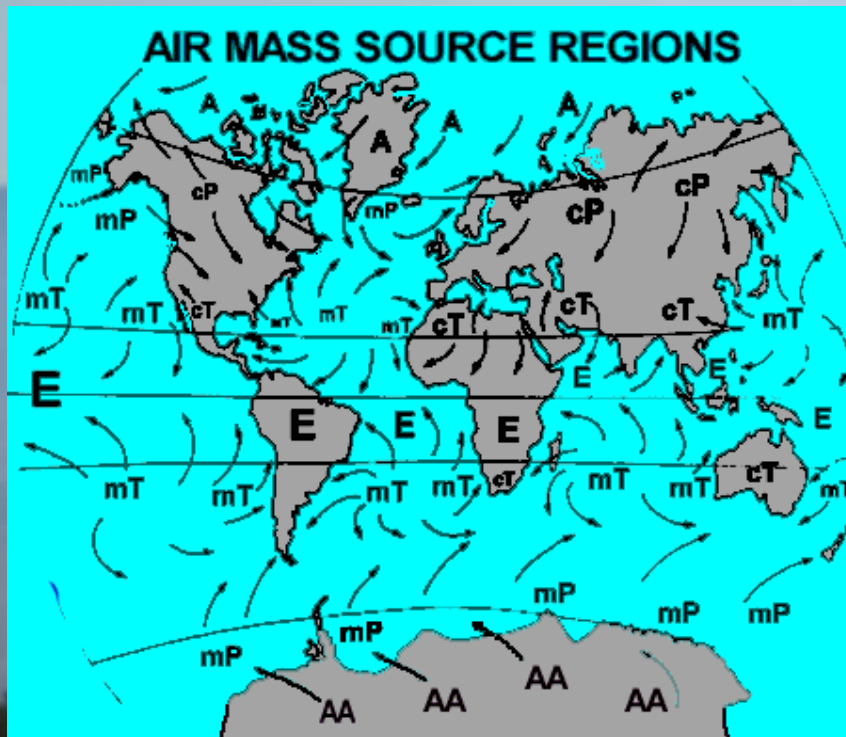
- The TEJ is the bound of the N/S Hadley cells @ 200 mb. It originates in the Tibetan plateau.
  - Most pronounced in the summer when the temperature gradient is the largest.
  - Associated with high pressure.
- The AEJ is a region (650-700mb) over West Africa where the seasonal wind speed is maximum and easterly.
  - The jet develops from the heating of the West African land mass during NH summer and creates a temperature and moisture gradient between the Sahara and Gulf of Guinea.

# Air Masses Influencing Africa

- cT = continental tropical
  - Subsiding air aloft; generally stable
  - Very dry, hot conditions
    - Sahara, Kalahari deserts
- mT = maritime tropical
  - Subsiding air; fairly stable but some instability on western sides of oceans
  - Warm, humid conditions
    - Azores, South Atlantic Anticyclone, Indian Anticyclone
- mE = maritime equatorial
  - Forms when mT air passes over oceans, gathers moisture & becomes unstable.
  - Ascending air, very high moisture content
  - Warm, very humid, unstable.
    - Equatorial Oceans

# Fronts & Climatic Regions

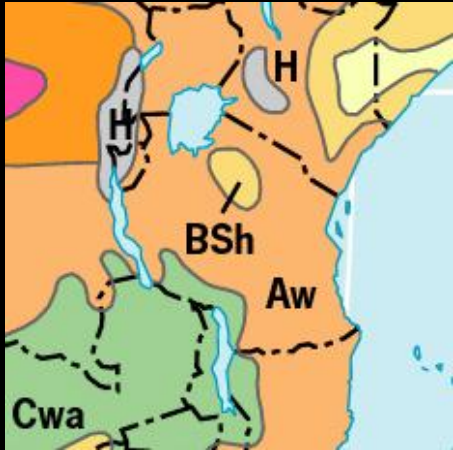
Front: where two air masses meet/converge.



<http://www.islandnet.com/~see/weather/graphics/photos/airmass-1c.gif>

- The ITCZ is essentially a front because two very different air masses meet there causing intense convergence.
- Besides the ITCZ there are a couple other prevalent locations where fronts often form in Africa.
- Positions of these fronts vary considerably from year to year
- The average locations of these air masses divide the land up into different climate regions.

# Climate Regions of Tanzania

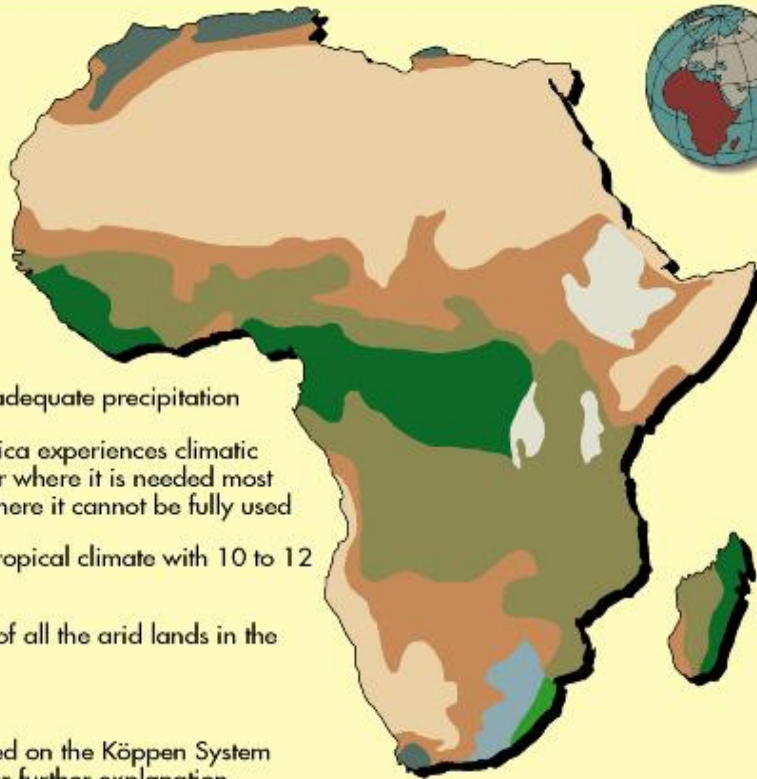


- Aw = Tropical Savanna (tropical wet & dry)
  - Monthly mean temperatures above 18 °C
  - Pronounced dry and wet season.
  - BSh = Semiarid Steppe Climate

# Climate Regions of Tanzania

## Climates\*

- Tropical Rainforest
- Humid Subtropical
- Mediterranean
- Savanna
- Steppe
- Desert
- Highland
- Marine



- Over 50% of Africa has inadequate precipitation
- 92% of the continent of Africa experiences climatic contrasts; shortage of water where it is needed most and oversupply of water where it cannot be fully used
- About 8% of Africa has a tropical climate with 10 to 12 months of rainfall
- Africa has about one-third of all the arid lands in the world

\* Climate definitions are based on the Köppen System  
Click on Köppen Symbol for further explanation

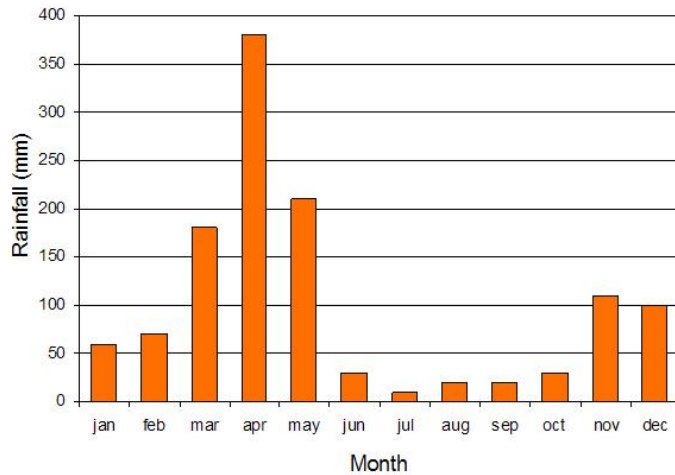
- H= highland climate.
  - Similar to surrounding climate but rise in altitude causes a decrease in temperatures; even snow is possible.
  - Rainfall similar to that of adjacent lowland areas.
  - Main cause of special microclimate in Northern Tanzania

# Climate of Northern Tanzania

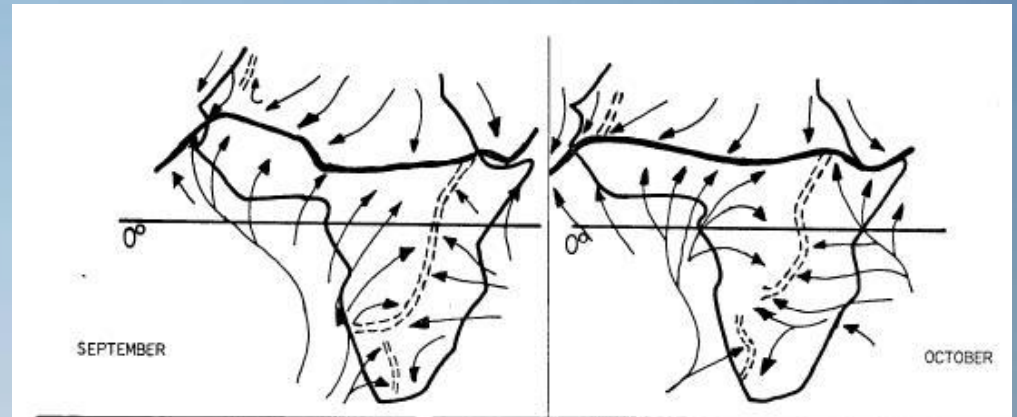
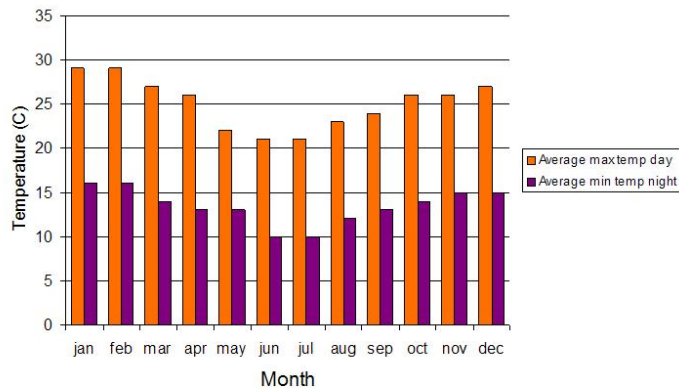
- Northern Tanzania has a savanna climate which is modified by altitude.
  - There are two distinct wet seasons:
    - Short wet season: November – December
    - Long wet season: March – May
  - These wet seasons are caused by the passage of the ITCZ through Tanzania. Can be variable.
  - Other than the distinct wet seasons, the mountains can provide for orographic precipitation to occur when the moist air masses cross the ocean and lift onto the plateaus and mountains of East Africa
- **ITCZ**
  - **Topography**

# ITCZ and Northern Tanzania Climate

Average rainfall Arusha



Average temperature Arusha



## September:

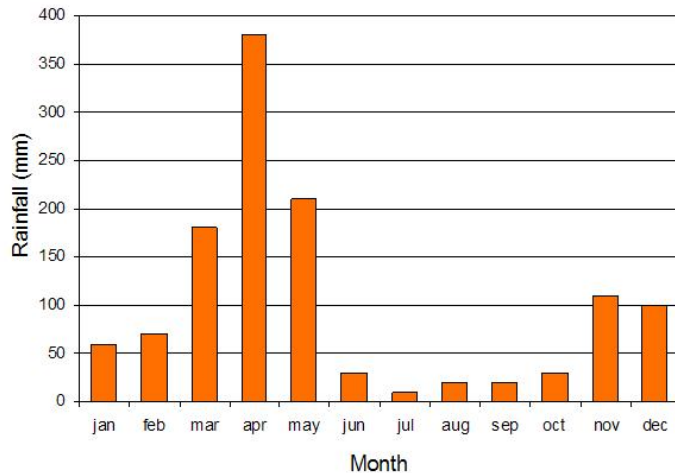
- starts pulling southward
- peak insolation at equator
- stable mT air mass in place

## October:

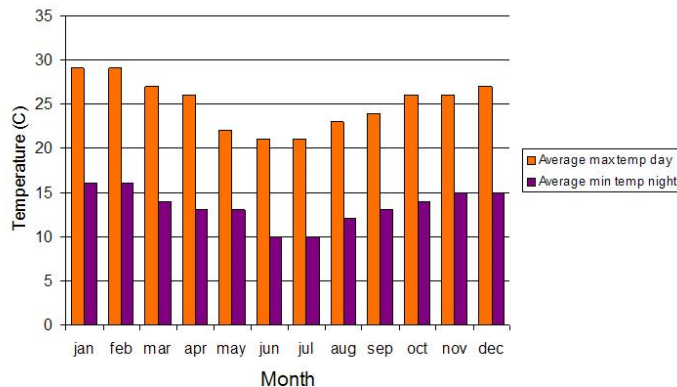
- Continues to pull southward
- maximum heating now in SH
- stable mT air mass in place

# ITCZ and Northern Tanzania Climate

Average rainfall Arusha



Average temperature Arusha

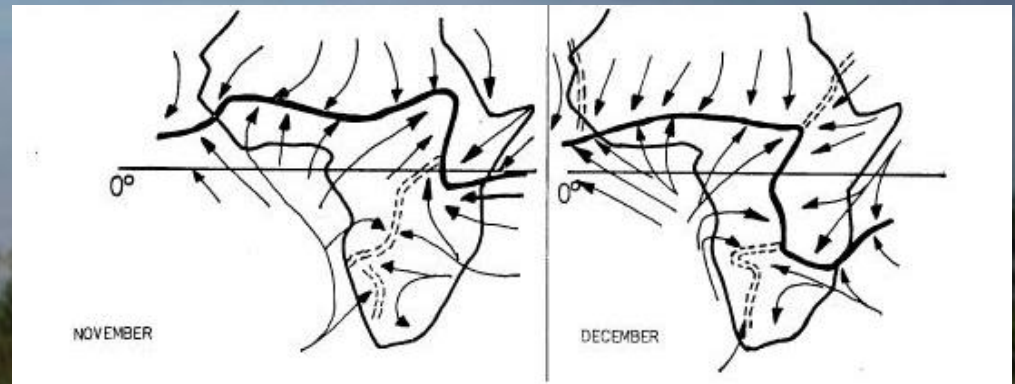


## November:

- max heating in SH
- ITCZ has large dip over Eastern Africa due to the Africa portion in SH
- ITCZ overhead- convergence and precipitation
- Change in prevailing wind

## December:

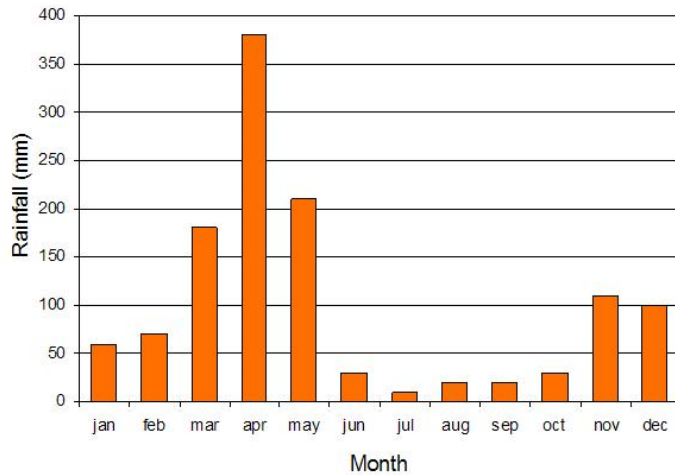
- ITCZ pulls slightly to south of N. Tanzania
- maximum insolation at furthest point south in SH.
- ITCZ nearby with low-level convergence



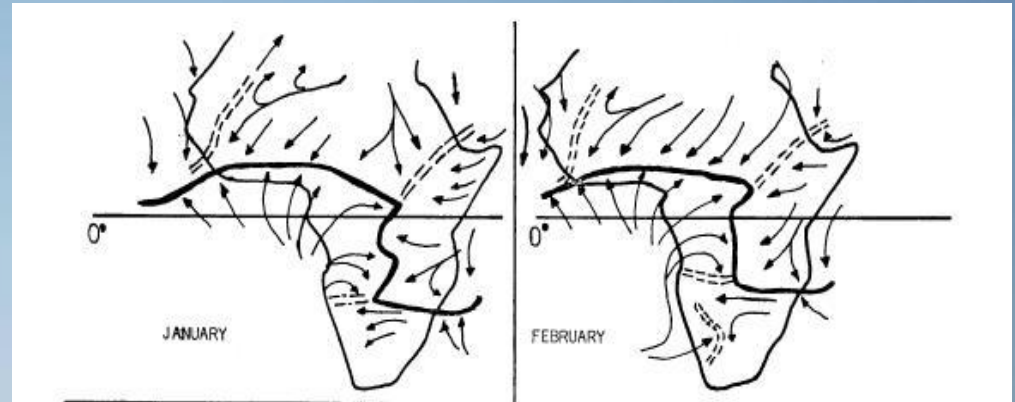
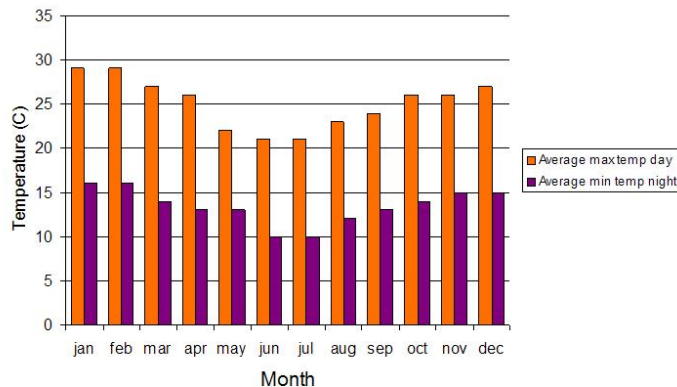


# ITCZ and Northern Tanzania Climate

Average rainfall Arusha



Average temperature Arusha

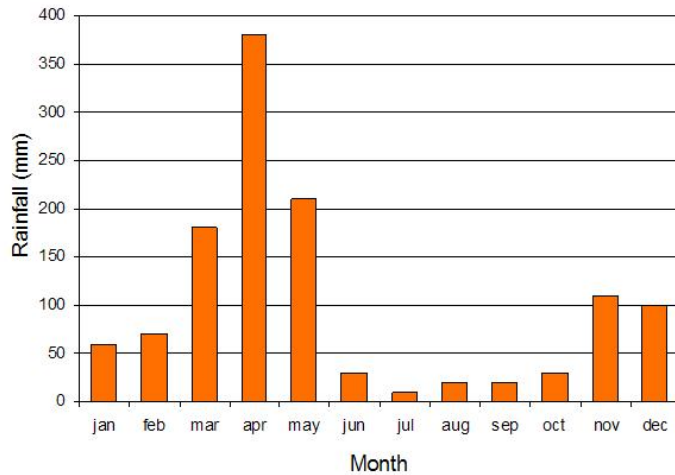


## January & February:

- ITCZ pulls further south into SH but cannot make push through mountains.
- Harmattan trade winds have enough strength to limit precipitation in parts of extreme Northern Tanzania.
- ITCZ overhead- convergence and precipitation
- February represents the furthest south the ITCZ will get into the Southern Hemisphere.

# ITCZ and Northern Tanzania Climate

Average rainfall Arusha



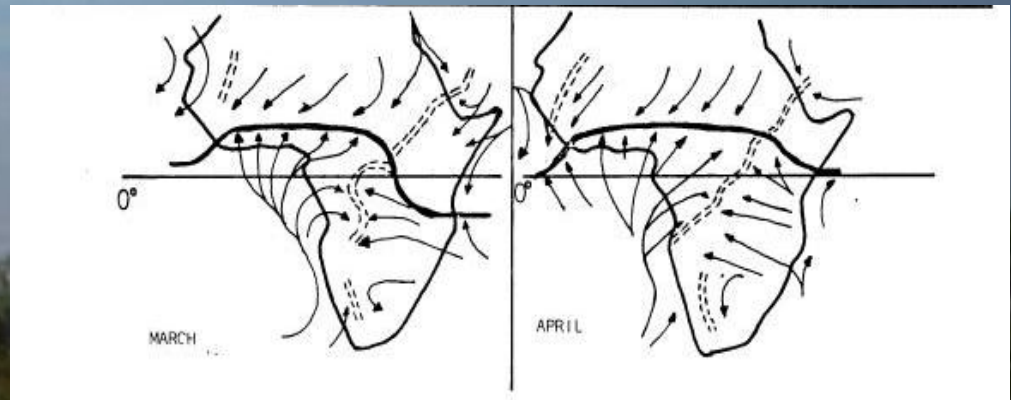
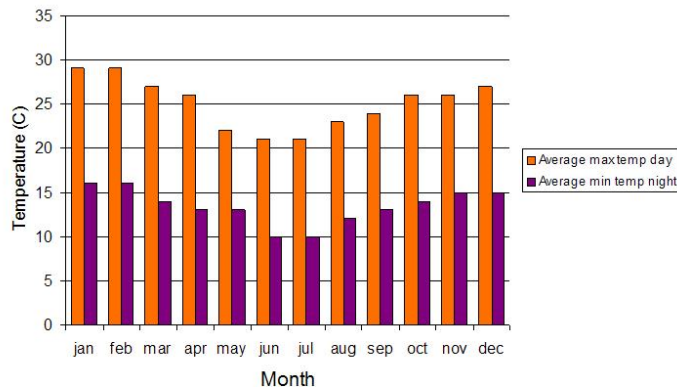
## March:

- ITCZ starts pulling northward as max insolation location is at equator again.
- ITCZ overhead- convergence of warm, moist air from south and hot, dry air from north.

## April:

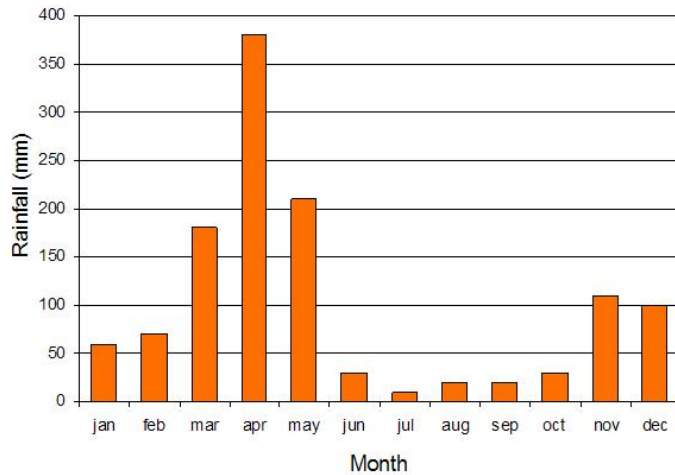
- ITCZ just to north of Tanzania.
- Precipitation on the south side abounds.

Average temperature Arusha

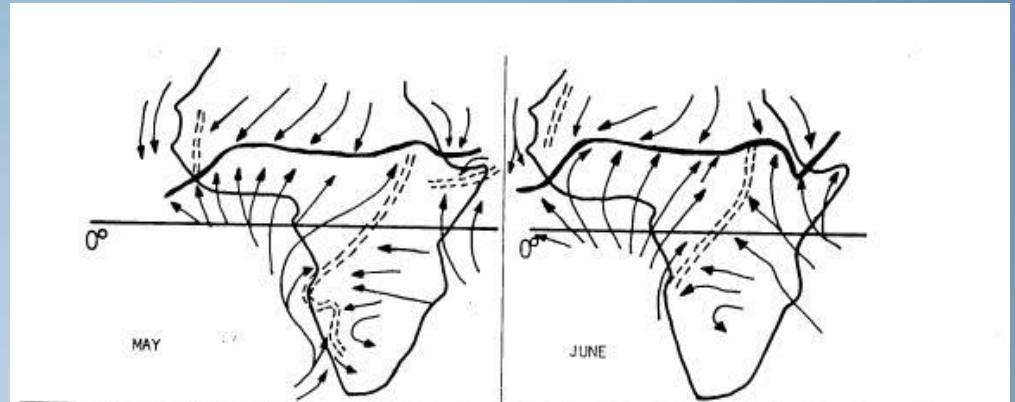
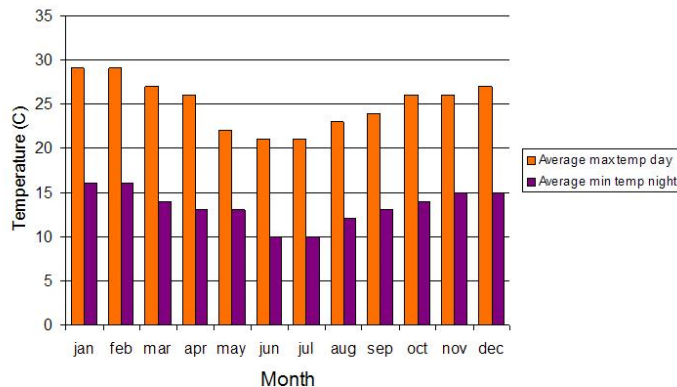


# ITCZ and Northern Tanzania Climate

Average rainfall Arusha



Average temperature Arusha



## May:

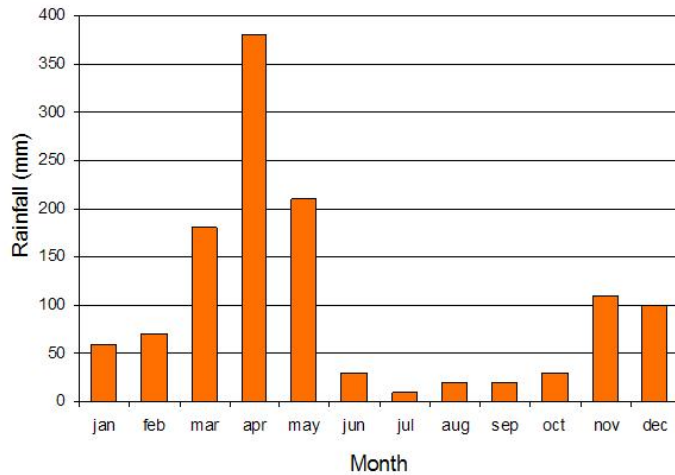
- SE trade wind flow returns later in month, becoming dryer
- Air becomes more stable as mT begins to dominate

## June:

- ITCZ well to the north. High pressure dominates.
- The max sun radiation hits furthest parts of Northern Hemisphere.

# ITCZ and Northern Tanzania Climate

Average rainfall Arusha



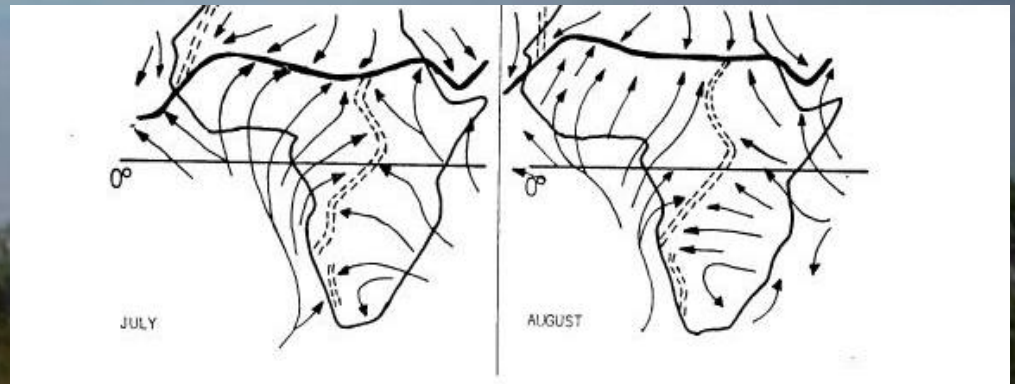
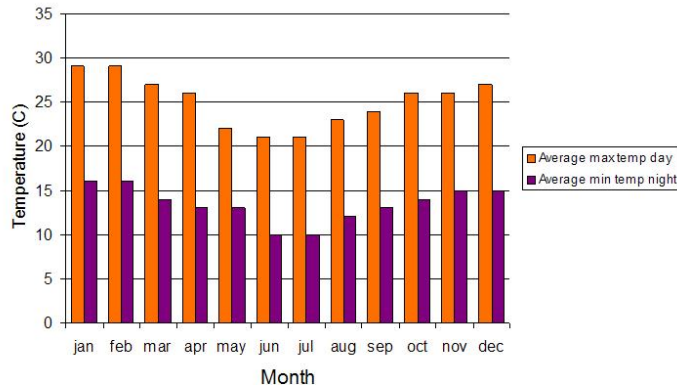
## July:

- Strong southeasterly trade wind keeps air stable and dry.

## August:

- ITCZ well into the Sahara Desert in North Africa.
- ITCZ at furthest north part of Africa.

Average temperature Arusha



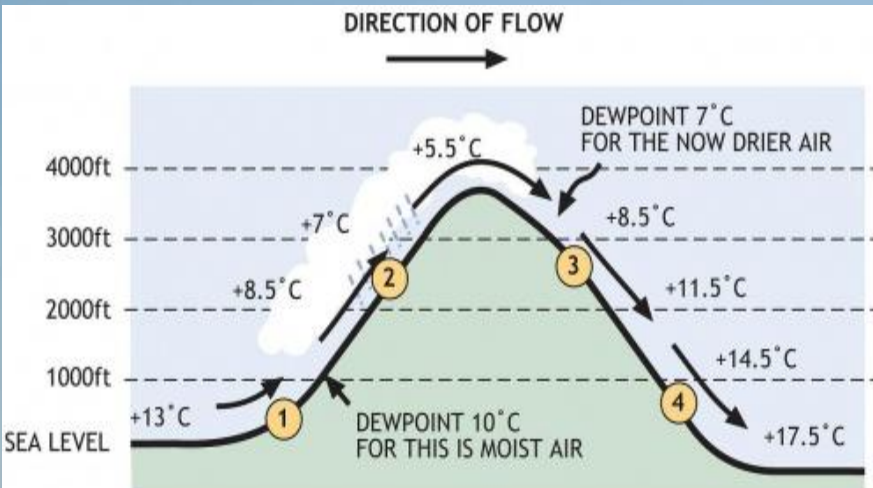
# Topography and Orographic Precipitation

- The other main influence → Topography
- As you head up a mountain, the temperature decreases at the environmental lapse rate of 6.5 degrees per 1km.
  - This decrease in temperature changes what plants and creatures can live/grow in the highlands.
- These mountains also cause roadblocks for the movement of air masses. To move, the air mass must rise over the mountains, often causing orographic precipitation.
  - This precipitation leads to smaller and unique micro climates on opposite sides of mountains.

# Orographic Precipitation

- **Orographic Precipitation:** precipitation resulting when large portions of the atmosphere must rise (and thus cool, expand, condense) in order to pass over a land barrier (mountain, escarpment)
  - Land barrier acts as lifting mechanism.
- When the air surpasses the top of the mountain, it begins to descend and condensation ceases.
  - Temperatures warm at the dry-adiabatic lapse rate often making the air-mass hot and dry.
- Windward: side of mountain which prevailing winds overcome.
- Leeward: side of mountain opposite flow of prevailing winds.
  - → Rain Shadow

# Orographic Precipitation



1. Air cools at 3°C/1000 ft until saturated, then cools at 1.5°C/1000ft until the top of the mountain is reached.
2. Precipitation removes moisture from the air.
3. Air warms, quickly becoming unsaturated, at a rate of 3°C/1000ft.
4. Air on lee side of mountain is drier than the windward side and has a lower dew point.

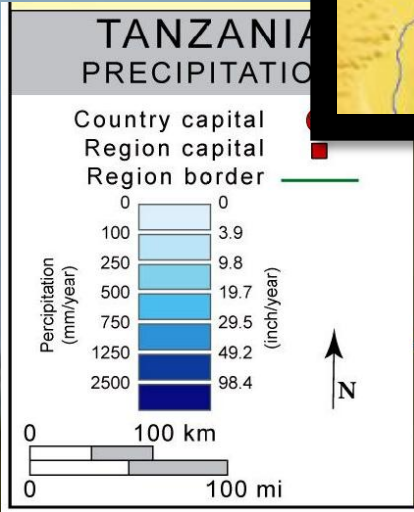
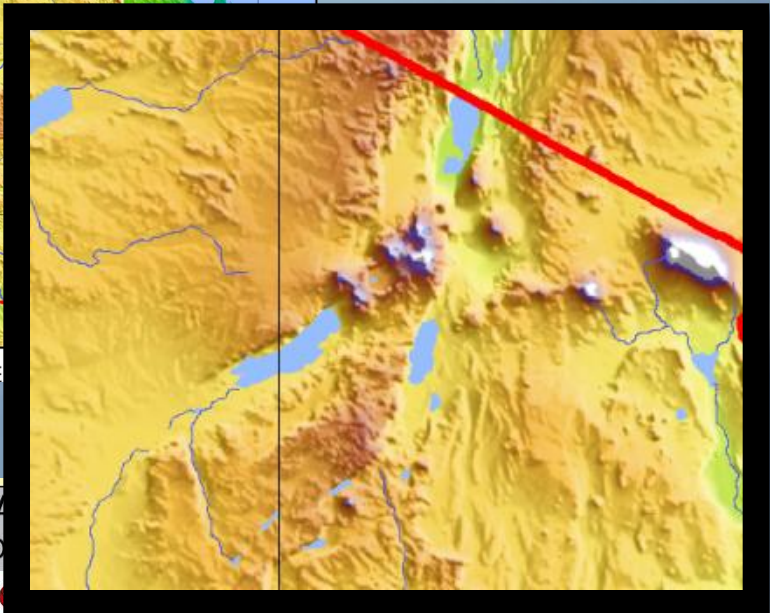
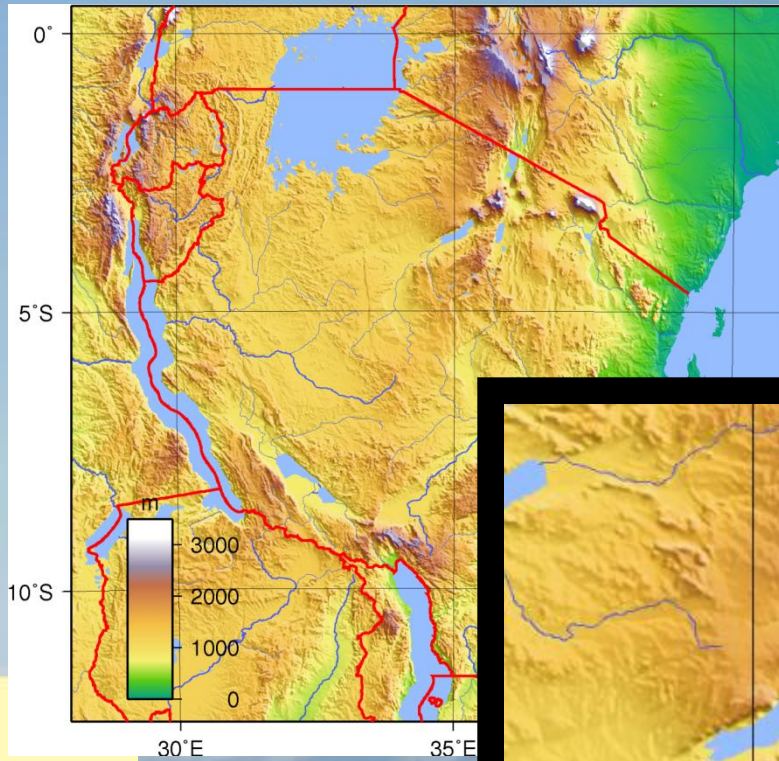


<http://www.skybrary.aero/images/thumb/Fohn.jpg/500px-Fohn.jpg>

Olduvai Gorge is one of the driest portions of the region because it lies in the rain shadow of the Ngorongoro highlands.



<http://www.addictedtotravel.com/travel-guides/countries/tanzania-travel-guide>



[http://upload.wikimedia.org/wikipedia/commons/8/87/Tanzania\\_Topography.png](http://upload.wikimedia.org/wikipedia/commons/8/87/Tanzania_Topography.png)

[http://www.stockmapagency.com/media/Country/Modern/T\\_Tanzan\\_Precip.jpg](http://www.stockmapagency.com/media/Country/Modern/T_Tanzan_Precip.jpg)





# Ol Doinyo Lengai



June 21<sup>st</sup>, 2008

# Wide Variety of Weather / Climates

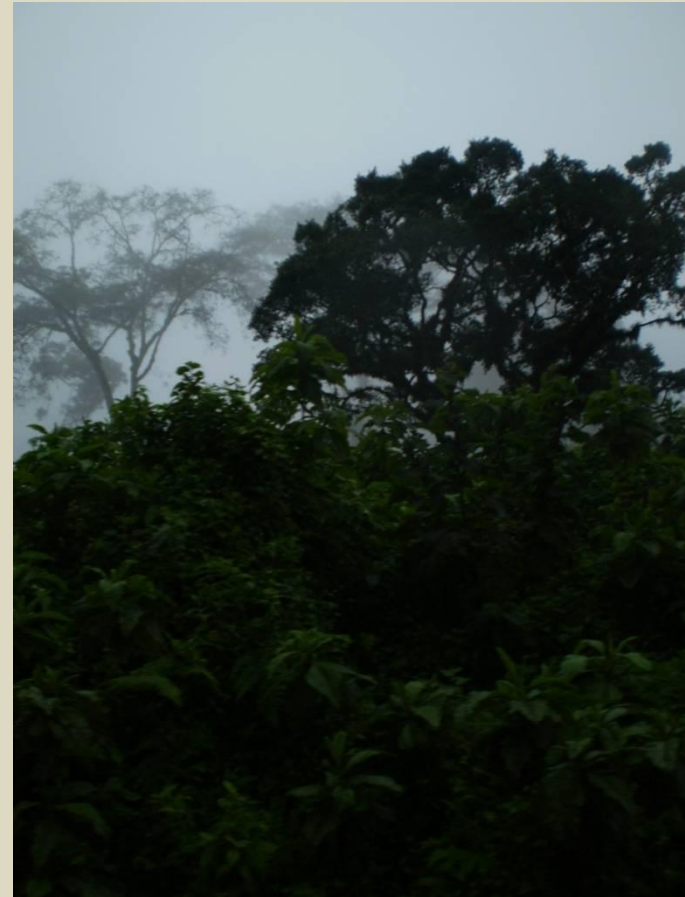
June 24<sup>th</sup>, 2008

Travel from Mto-Wa-Mbu --> Olduvai Gorge

via Ngorongoro



Heading into the  
Northern Highlands on  
windward side of  
Ngorongoro



Half clouds,  
half sun in  
Mto-Wa-  
Mbu





Viewing  
Ngorongoro  
from the  
leeward side  
of the crater  
(looking at  
windward)



Approaching  
the leeward  
side of the  
Ngorongoro  
crater rim.



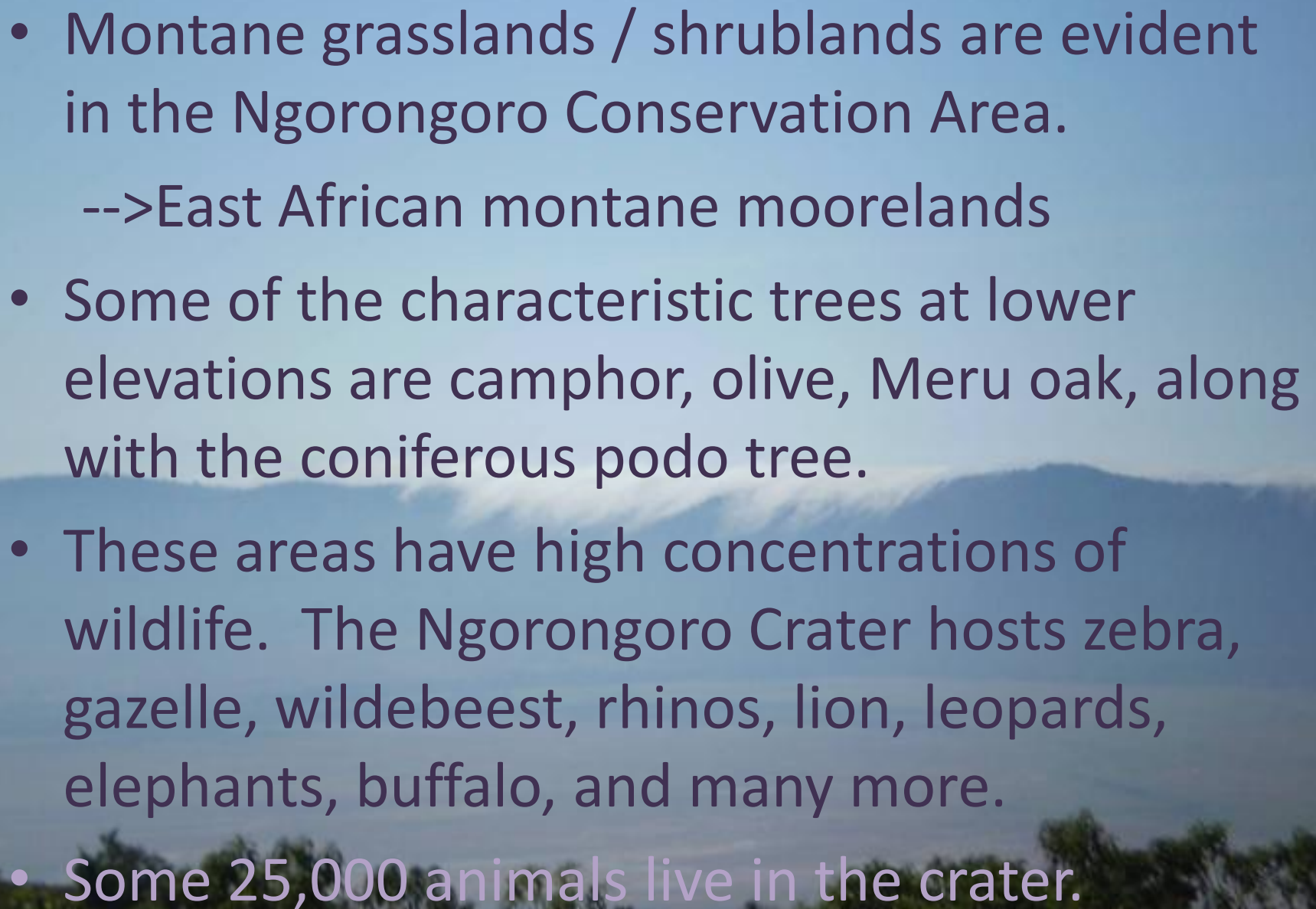
View from campsite at Olduvai Gorge



Driving in the plains to the  
west of Ngorongoro Crater

# Microclimates

- Looking at the previous pictures we can see that the highlands offer many unique microclimates.
- In the Northern Tanzanian highlands, both montane grasslands & montane forests are visible.
- The variety of climates promotes large biodiversity.

- 
- Montane grasslands / shrublands are evident in the Ngorongoro Conservation Area.
    - >East African montane moorelands
  - Some of the characteristic trees at lower elevations are camphor, olive, Meru oak, along with the coniferous podocarp tree.
  - These areas have high concentrations of wildlife. The Ngorongoro Crater hosts zebra, gazelle, wildebeest, rhinos, lion, leopards, elephants, buffalo, and many more.
  - Some 25,000 animals live in the crater.

# Key Sources

## Crucial Sources:

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<http://www.skybrary.aero/images/thumb/Fohn.jpg/500px-Fohn.jpg>

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[http://upload.wikimedia.org/wikipedia/commons/8/87/Tanzania\\_Topography.png](http://upload.wikimedia.org/wikipedia/commons/8/87/Tanzania_Topography.png)