

CLIMATE MATTERS.

INTRODUCTION.

Climate is the weather cumulated over longer time, and explains rainfall or drought episodes. Note that drought is a weather phenomenon whereas famine results from poor administration. This short report exposes what the fate of the Ethiopian climate might be with the ongoing global climate warming. Basically the article suggests that Ethiopian farmers ought to be alerted on impending floods, as the monsoon rainfalls will be strong in this period of global warming.

FINDINGS AND DISCUSSION.

The sun is the source of heat for surface phenomena. The oceans and the atmosphere are dynamically linked into weather systems and distribute that heat received from the sun from the tropical regions to the poles. Three weather systems affect countries around the Indian Ocean: Monsoons, ENSO, and IOD. But first a reminder or background information!

The ocean and the land respond to the sun's heat differently. The sun's heat raises the temperature of the land surface, and such heat is commonly called sensible heat. In contrast, the sun's heat breaks up hydrogen bonds that bind water molecules instead of raising the temperature of the ocean. Such heat is called latent heat and it is said that the ocean has a high heat capacity. Water vapor rises from the oceans carrying latent heat with it. When the vapor condenses to form clouds the latent heat is released to the atmosphere. Thus atmospheric circulation distributes heat received from the oceans. Also the wind circulation initiates surface water circulation. Hence, the ocean atmosphere circulations are coupled.

The air pressure above a warm region is low while above a cooler region it is high. Wind blows from a high-pressure region (cooler) to a low-pressure region (warmer). The difference in the air pressures of two regions (pressure gradient) determines the strength and speed of the wind. A high pressure-gradient results in strong and fast flowing wind. Winds are named for the direction from which the winds blow. Thus, northeast trade winds blow from the northeast to the southwest.

On June 21 the sun is directly above $23 \frac{1}{2}^{\circ}$ North Latitude, while on December 21 it is directly above $23 \frac{1}{2}^{\circ}$ South Latitude. The heat equator and the rainfall belt move between these latitudes. In the tropics (regions within 30 north and south latitudes) northeast trade winds and southwest trade winds converge near the geographic equator. Where these tropical winds converge is the ITCZ (Inter Tropical Convergence Zone, Figure 1). At the ITCZ, warm vapor-laden air rises up, condenses to form clouds and rainfalls, and releases latent heat to the atmosphere. The ITCZ is also called the Heat Equator. The ITCZ is north of the geographic equator in the summer, "kremt" (Figure 2a), and lies south of the geographic equator in the winter, "bega" (Figure 2b).

1. Monsoons. In general, because of the high heat capacity of the oceans, the land gets hotter than the oceans in the summer, and the land gets colder than the land in the winter. Thus, around the Indian Ocean, summer winds blow from ocean to land (Figure 2a), and in the winter they blow from land to the ocean (Figure 2b). Such yearly alternating climate is called monsoon. Often the summer monsoons result in rainfalls ("ye krent znab"). Drought occurs when the summer monsoons fail to give rain.

2. ENSO. El Nino Southern Oscillatory. Often warm surface water is present near the Indonesian and Australian east coasts (Figure 4a). Occasionally, once in four to seven years, warm surface water sloshes toward Peru corresponds to an episode called El Nino (Figure 4b). Since the air pressure above warm water is low compared to that above cold water, the back and forth sloshing of warm water corresponds to an oscillation of air pressure. Gilbert Walker (British mathematician who headed the Indian Colony Weather Bureau from 1904-1924) gave the name Southern Oscillator (SO) to the changing air pressures between Darwin in Australia, and Tahiti in the eastern Pacific Ocean. A negative SO index corresponds to higher pressure at Darwin, and below normal low pressure at Tahiti, whereas a positive SO index corresponds to a high pressure at Tahiti. He noted that the Indian monsoons fail to give rain and Canadian winter become milder during a negative SO index. In 1910 Walker had shown positive correlation between monsoon rainfalls of India and flooding in the Nile Valley. We now know that a negative SO index corresponds to an El Nino episode; hence the name El Nino Southern Oscillator (ENSO).

An El Nino event occurs in December ("Bega"). The El Nino event could be strong or weak. There is also a decadal alternating season lasting from 17 to 20 years in which the El Nino events alternate from strong to weak events. This period corresponds to the Pacific Decadal Oscillator (PDO). The last warm phase PDO ranged from 1977 to 1999. From 200 to about 2010 will be a cold phase PDO with corresponding weaker El Nino events.

Walker's inference of a connection between a negative SO of the Pacific Ocean to the failure of the monsoon rains over India was quite profound. In the wake of warm surface water of the equatorial southern Pacific Ocean sloshing toward Peru, it has been suggested that during an El Nino event cooler water prevails not only on the east coastal waters of Indonesia and Australia but also on their west coastal waters. This is a case of ENSO pulling the ITCZ south of the equator, so that the summer monsoons will blow dry air.

However, subsequent work began to show that the ENSO might not be associated with failure of rain in the summer monsoons all the time, and particularly when the monsoons strengthen due to other global phenomena.

3. IOD. Indian Ocean Dipole first described in 1999 by Yamagata (Japanese oceanographer) and associates was based on computer modeling of weather phenomena. Positive IOD index results from warm water near Africa and cooler water near Indonesia and Australia, and brings rain to East Africa and India (Figure 4a), whereas negative IOD

index brings rain to Indonesia and Australia (Figure 4b). The IOD is also called Equatorial Indian Ocean Oscillator. After the discovery of the IOD a strong correlation was noted between it and the monsoons causing some to infer that the IOD is initiated by the monsoons, while others infer that the IOD is initiated by ENSO. To better understand the relationships among the three oscillators (monsoons, ENSO and IOD), researchers wanted to determine temperature recorded in coral reefs. The calcium carbonate (calcite) secreted by coral polyps of tropical shallow marine waters, of Indonesia as an example, has a signature of the climate with associated sea surface temperature and rainfall, which scientists can determine by measuring oxygen isotope and strontium/calcium ratios in calcite. The width of growth bands of calcite of similar chemical and isotopic signature would correspond to drought (ENSO and positive IOD) or to rainfalls (monsoon and positive IOD) in Indonesia.

Abrams (Australian paleoclimatologist) and associates (2007) measured oxygen isotopes and strontium/calcium ratios in drill cores of reefs in coastal Indonesia and found that ancient climate, 6500-to 4000 years ago, was colder and lasted longer in that region. They inferred that monsoons with associated rainfalls were stronger and the monsoons along with positive IOD lasted longer, with the latter triggering longer droughts in the region. Currently, global warming is increasing and the monsoons are strengthening which synergistically lengthen the positive IOD. The inference is that Indonesia and Australia may be set for longer lasting drought whereas India and eastern Africa may be bombarded with stronger tropical storms.

CONCLUSION.

Our knowledge on weather phenomena is increasing substantially. We have responsibilities to make farmers know about the climate on which they depend for their livelihood. The summer ("kremt") rainfalls or dry episodes result from the interaction of the different weather systems mentioned above. Global warming which should strengthen the monsoon winds will "trump" the effect of ENSO on the monsoons. Ethiopia should expect flooding during the summers in these days of Global warming. It is inferred that farmers should be encouraged to plant trees that would help reduce the floods and to construct basins for catching flood waters that would help them get water during the long dry months.

DISCLAIMER:

Prediction of weather and climate are fraught with difficulties because of their sensitive dependence on perturbations in the atmosphere or the ocean or both. Also, the climate of Ethiopia is not monsoonal in all regions or at all times. Moreover, oceanographers had indicated the occurrence of sea surface convergence zones, corresponding to zones of down welling of surface waters, on either side of the geographic equator. Recently, Liu (2007) and associates of NASA's Jet Propulsion Laboratory at Pasadena, California, based on infrared satellite imagery have reported year-round, double Inter Tropical Zones of Convergence (double ITCZs) are present one on each side of the equator at the

Atlantic and Pacific Oceans. They have encouraged climate modelers to use this new finding.

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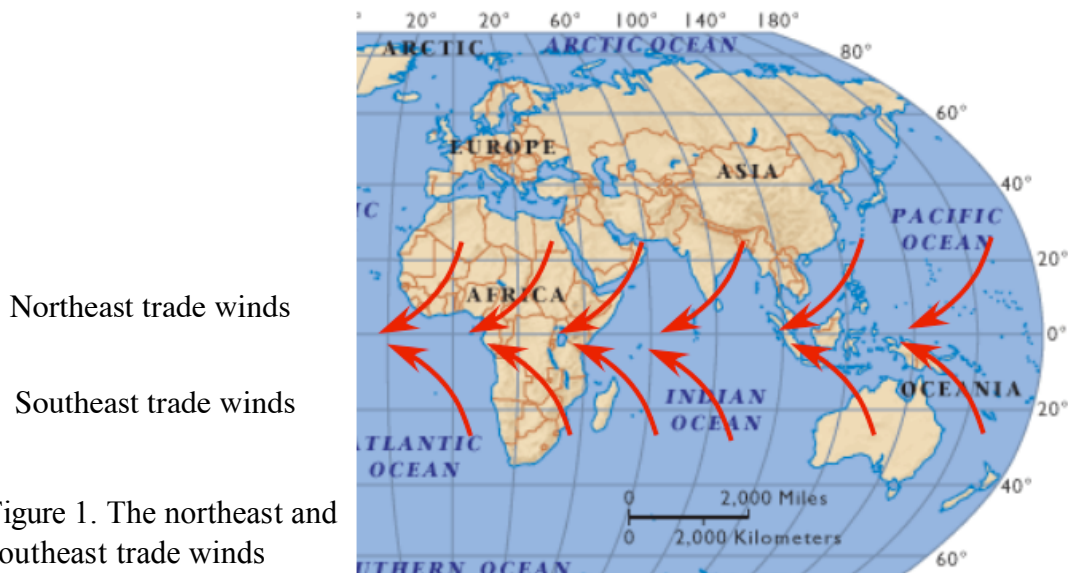


Figure 1. The northeast and southeast trade winds converge at the geographic equator when the sun is directly above the equator in March 21 and September 21. This Intertropical Convergent Zone (ITCZ) is also known as the heat equator and migrates north and south of the equator following the sun's location, see Figure 2.

Figure 2a. ITCZ in June.
 The Inter Tropical
 Convergent Zone (ITCZ)
 straddles the geographic
 equator, being in the northern
 hemisphere in the summer,
 and in the southern
 hemisphere in winter.

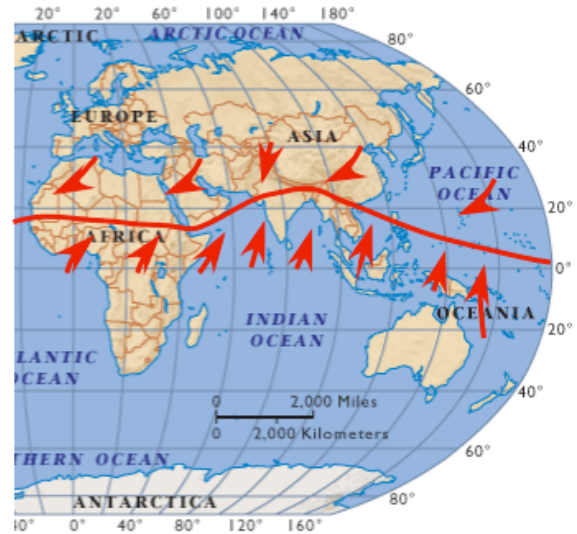


Figure 2b. ITCZ
 The Inter Tropical
 Convergent Zone (ITCZ)
 straddles the geographic
 equator, being in the northern
 hemisphere in the summer,
 and in the southern
 hemisphere in winter.

Figure shows the winter monsoons.

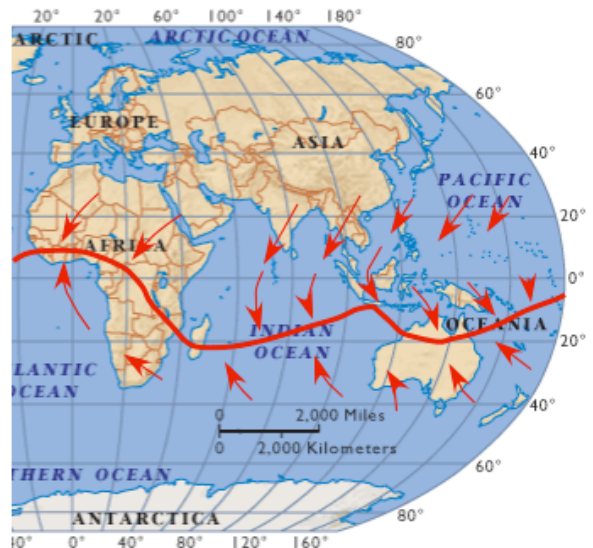




Figure. 3a. Normal event in the Pacific Equatorial. Warmest surface water in the region between Indonesia and South America shown by red color is closer to Australia. Coastal waters of South America and Central America are cooler, and sea level is lower.



Figure. 3b. El Nino event. Warmest surface water in the region between Indonesia and South America, shown by red color, has migrated toward Peru. Coastal waters of South America and Central America are warmer, and sea level is higher. The seesaw between normal event (Fig. 3a) an El Nino event occurs once in for to seven years.

Figure 4a. Positive IOD
(Indian Ocean Dipole)

Hot near east
Africa

Cooler near
Indonesia.

Winds blow
towards Africa
and India.



Figure 4b. Negative IOD
(Indian Ocean Dipole)

Hot near Indonesia.

Cooler near eastern Africa

Winds blow towards
Indonesia
and Australia

