Introduction

The Indian Ocean Dipole (IOD) is defined by the difference in the sea surface temperature between the two equatorial areas of the Indian Ocean – a western pole near the Arabian Sea (in western Indian Ocean) and an eastern pole closer to the Bay of Bengal (in eastern Indian Ocean). IOD is defined by the Dipole Mode Index (DMI) which is a measure of the anomalous sea surface temperature (SST) gradient between the western equatorial Indian Ocean (50E-70E and 10S-10N) and the southeastern equatorial Indian Ocean (90E-110E and 10S-0N).
The IOD affects the climate of Southeast Asia, Australia and other countries that surround the Indian Ocean Basin. The Indian Monsoon is invariably influenced by the IOD.

Characteristics of IOD:

- IOD is the difference between the temperature of eastern (Bay of Bengal) and the western Indian Ocean (Arabian Sea).
- IOD develops in the equatorial region of the Indian Ocean from April to May peaking in October.
- This temperature difference results in a pressure difference which results in flowing winds between eastern and western parts of the Indian Ocean.

Difference between El Nino and La Nina

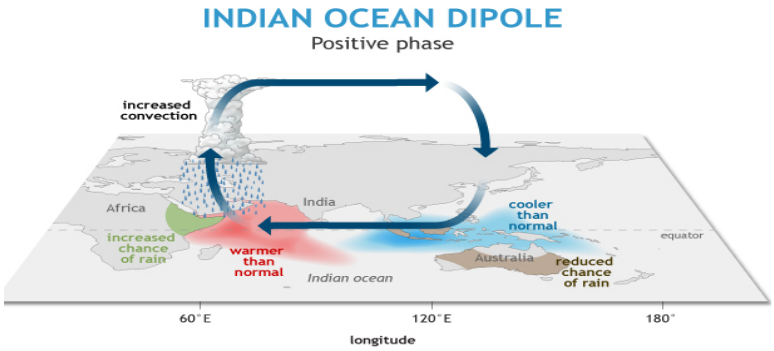
During normal conditions in the Pacific ocean, trade winds blow west along the equator, taking warm water from South America towards Asia. To replace that warm water, cold water rises from the depths — a process called upwelling. El Niño and La Niña are two opposing climate patterns that break these normal conditions. Scientists call these phenomena the El Niño-Southern Oscillation (ENSO) cycle. El Niño and La Niña can both have global impacts on weather, wildfires, ecosystems, and economies. Episodes of El Niño and La Niña typically last nine to 12 months, but can sometimes last for years. El Niño and La Niña events occur every two to seven years, on average, but they don't occur on a regular schedule. Generally, El Niño occurs more frequently than La Niña.

Impact of IOD (India)

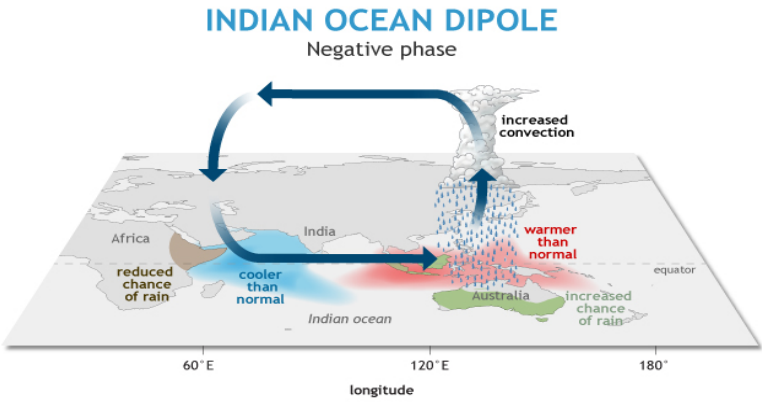
Type of IOD	Impact
Positive (+ve)	1. Flooding East Africa 2. Drier Indonesia & Australia 3. Monsoonal Rain increased.
Negative (-ve)	1. Wet Indonesia & Australia 2. Droughts in East Africa 3. Decrease Monsoonal rains.
Neutral	IOD has no impact.

What is the Indian Ocean Dipole – Positive Phase?

The positive phase of the IOD is driven by warmer than normal SSTs off the coast of Africa and cooler than normal SSTs to the west of Indonesia. This configuration of surface sea temperatures reverses the normal circulation with easterly winds setting up across the equatorial Pacific and warm water is pushed along.

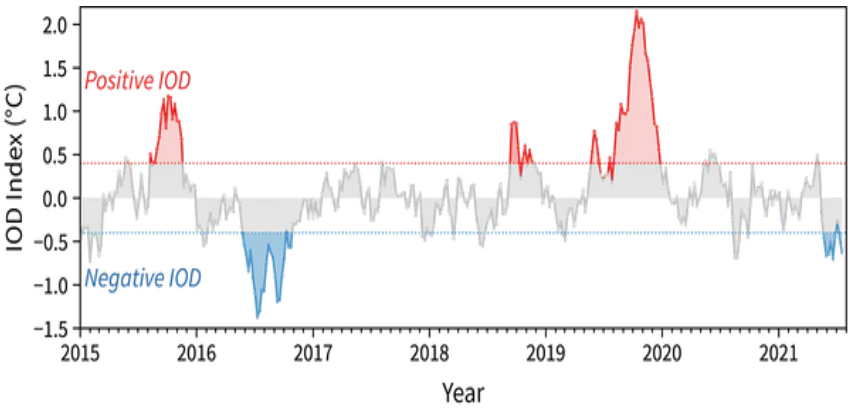


The reversed circulation suppresses convection over Indonesia, and leads to predominately dry weather and potential for drought. Over the Horn of Africa, convection is enhanced and rainfall is much more abundant than usual. This pattern is consistent with El Niño (positive phase of ENSO). It is characterized by warmer than normal SSTs in the eastern equatorial Indian Ocean and cooler than normal SSTs in the western tropical Indian Ocean.



The Indian Ocean Dipole and Long-Range Forecasting

The Indian Ocean Dipole typically remains in a given phase from a few weeks to many months. Thus, the IOD is very much a seasonal climate index (as opposed to a more short-lived subseasonal climate index such as the PNA (Pacific North American pattern). The IOD is generally well predicted by dynamical modeling and thus we can usually be fairly confident about which phase the IOD will favor in the coming months.



Observations:

1. Although El Nino Southern Oscillation [ENSO] was statistically effective in explaining several past droughts in India, in the recent decades the ENSO-Monsoon relationship seemed to weaken in the Indian subcontinent. For e.g. the 1997, strong ENSO failed to cause drought in India.
2. However, there is no established correlation between Indian summer monsoon rainfall and IOD.
3. Studies have shown that a positive IOD year sees more than normal rainfall over central India.
4. The indicated connection is between below-normal SST in the eastern Indian Ocean and above-normal rain over central India, and vice versa.
5. A negative IOD, on the other hand, complements El NiNo leading to severe drought.
6. At the same time, Positive IOD results in more cyclones than usual in the Arabian Sea.
7. Negative IOD results in stronger than usual cyclogenesis (Formation of Tropical Cyclones) in Bay of Bengal. Cyclogenesis in the Arabian Sea is suppressed during this time.
8. Study suggests that recently climate change will increase the frequency of extreme positive IOD.

When do the Indian and Pacific oceans work together ?

The El Niño–Southern Oscillation (ENSO) is the major climate driver in the Pacific Ocean and can have a strong impact on Australia's climate. El Niño years are typically warmer and drier over eastern Australia and La Niña years tend to be cooler and wetter over much of the country.

When El Niño coincides with a positive IOD, the two phenomena can reinforce their dry impacts. Likewise, when La Niña coincides with a negative IOD, the chance of above-average winter–spring rainfall typically increases.

2022 Predictions (NDTV)

It is said that while 2022 may experience a slight cooling influence from the ongoing La Niña, it will still be among our warmest years. To have an individual year as cool as those we experienced as recently as the 1990s is exceptionally unlikely due to our high greenhouse gas emissions.

Second, there will be more extreme heat events somewhere on Earth this year, because our influence on the climate has greatly increased the odds of record-breaking heat waves occurring.

Conclusion

The Indian Ocean Dipole is defined by the sea surface temperatures within the Indian Ocean, and can be thought of as the Indian Ocean branch of the Walker Cell. Phases of the Indian Ocean Dipole often persist for many months and are generally well predicted by dynamical modeling. The Indian Ocean Dipole is therefore a vitally important consideration in seasonal forecasting over both the tropics, and the mid-latitudes.

The Australian weather department says it has a neutral IOD for the upcoming months, which means water from the Pacific flows between the islands of Indonesia, keeping seas to Australia's northwest warm. Air rises above this area and falls over the western half of the Indian Ocean basin, blowing westerly winds along the equator.

Temperatures are close to normal across the tropical Indian Ocean, and hence the neutral IOD will result in little change to Australia's climate and this also has very little to no impact for the Indian climate which means India is expected to have a normal monsoonal rain this year and we can have a more clear view in the month of April.

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