



## Indian Ocean Dipole

**For Prelims:** [Indian Ocean Dipole](#), [El Nino](#), [IMD](#), [Monsoon](#), [ENSO](#), [Pacific Ocean](#), [Indian Ocean](#).

**For Mains:** Indian Ocean Dipole and its impact on El Nino.

### Why in News?

The Indian [Monsoon](#) is expected to be influenced by the [El Nino phenomenon in 2023](#), there are also anticipations of a positive [Indian Ocean Dipole \(IOD\)](#) developing, which could potentially offset the **impact of El Nino**.

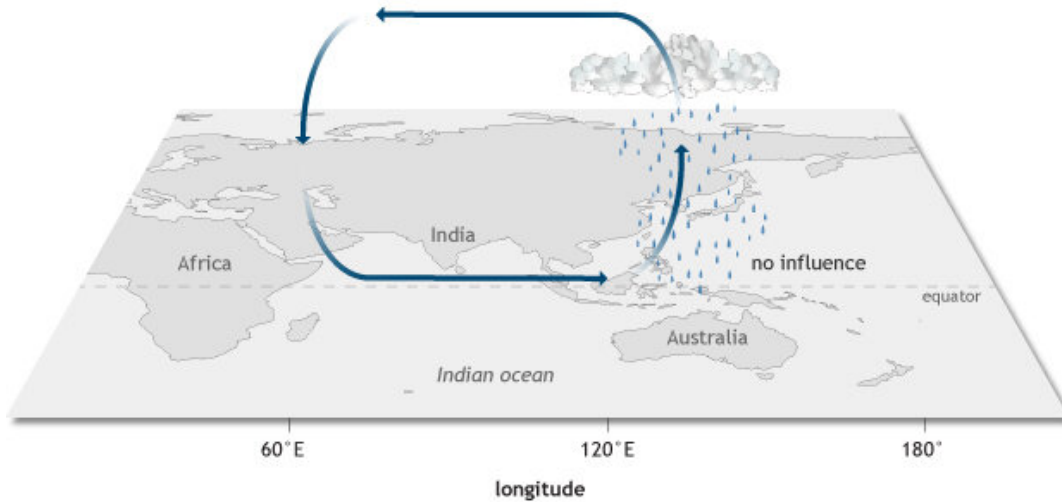
- According to the India Meteorological Department (IMD), there is about 80% probability for positive IOD conditions and 15% of a neutral IOD during June-August 2023 season.
- While the El Nino is already firmly established in the Pacific Ocean in 2023, the IOD is **still in the neutral phase** and may develop in the coming months.

### What is the Indian Ocean Dipole (IOD)?

- **IOD or Indian Nino:**
  - IOD, sometimes referred to as the **Indian Nino**, is similar to the **El Nino** phenomenon, **occurring in the relatively smaller area** of the Indian Ocean between the **Indonesian and Malaysian coastline in the east and the African coastline near Somalia** in the west.
  - **The El Nino** is the warmer-than-normal phase of the [El Nino Southern Oscillation \(ENSO\) phenomenon](#), during which there are generally warmer temperatures and less rainfall than normal in many regions of the world, including India.
  - One side of the ocean, along the equator, gets warmer than the other.
  - IOD is said to be positive when the western side of the Indian Ocean, near the **Somalia coast, becomes warmer** than the eastern Indian Ocean.
  - It is negative when the **western Indian Ocean is cooler**.
- **Mechanism:**
  - Negative IOD:
  - The air circulation in the Indian Ocean basin moves from **west to east**, that is from the **African coast towards the Indonesian islands**, near the surface, and in the opposite direction at the upper levels. That means the **surface waters in the Indian Ocean get pushed from west to east**.
    - In a normal year, **warmer waters in the western Pacific** near Indonesia cross over into the Indian Ocean and make that part of the Indian Ocean slightly warmer. That causes the air to rise and helps the prevailing air circulation.
  - In the years when the air circulation **becomes stronger, more warm surface waters from the African coast** are pushed towards the Indonesian islands, making that region warmer than usual. This causes hotter air to rise, and the **cycle reinforces itself**.
  - This is the **state of negative IOD**.

## INDIAN OCEAN DIPOLE

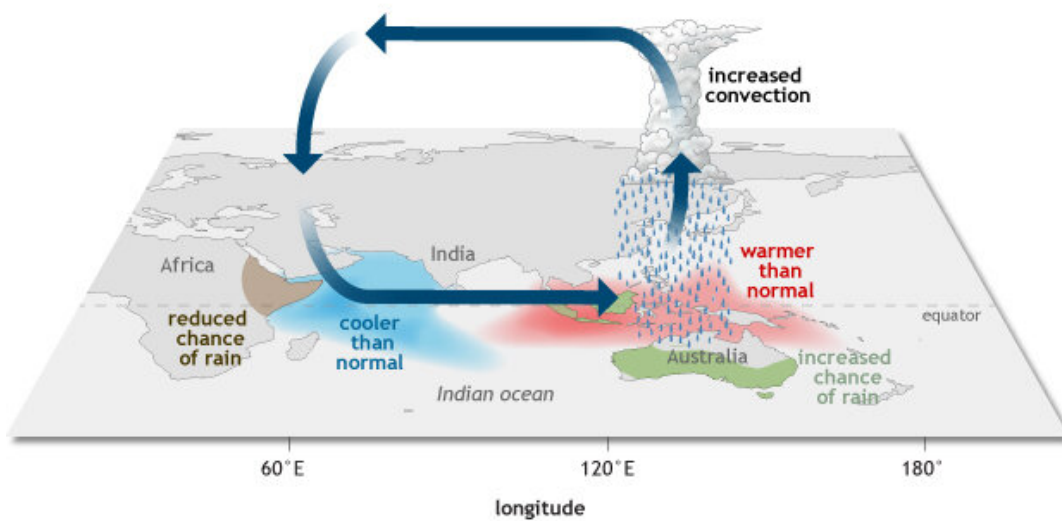
Neutral phase



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## INDIAN OCEAN DIPOLE

Negative phase



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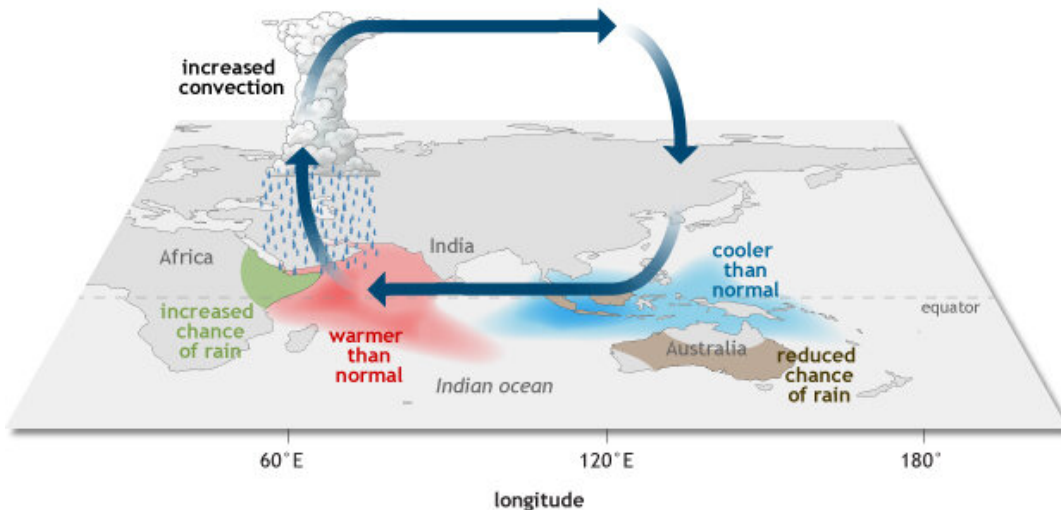
### Positive IOD:

- Air circulation becomes **slightly weaker** than normal. In some rare cases, the air circulation **even reverses direction**. The consequence is that the African coast **becomes warmer while the Indonesian coastline gets cooler**.
  - A positive IOD event is often seen developing at times of an **El Nino**, while a **negative IOD is sometimes associated with La Nina**.
- During El Nino, the Pacific side of Indonesia is cooler than normal because of which the Indian Ocean side also gets cooler. That **helps the development of a positive IOD**.



# INDIAN OCEAN DIPOLE

Positive phase



NOAA Climate.gov

## ▪ Impact of IOD:

- In the Indian Ocean, IOD exhibits **an ocean-atmosphere interaction** that closely resembles the fluctuations observed during El Niño events in the [Pacific Ocean](#). However, the IOD is considerably **less powerful compared to El Niño, resulting in relatively minimal impacts**.
- A positive IOD helps rainfall **along the African coastline and also over the Indian sub-continent** while suppressing rainfall over Indonesia, southeast Asia and Australia. The impacts are opposite during a negative IOD event.

## ▪ Past Events:

- In 2019 the IOD event developed during the late monsoon but was **so strong that it compensated for the deficit rainfall** during the first month of the monsoon season (June had 30% deficiency that year).
  - The deficit in June that year was also **attributed to a developing El Niño but that fizzled out later**.

## What is ENSO?

- In a normal year, the eastern side of the Pacific Ocean, near the **northwestern coast of South America**, is cooler than the western side near the islands of Philippines and Indonesia.
  - This happens because the **prevailing wind systems that move from east to west sweep the warmer surface** waters towards the Indonesian coast.
- The relatively **cooler waters from below come up** to replace the displaced water.
- An El Niño event is the **result of a weakening of wind systems that leads to lesser displacement** of warmer waters.
- This results in the **eastern side of the Pacific becoming warmer** than usual. During **La Niña, the opposite happens**.
- Both these conditions, together called [El Niño Southern Oscillation \(ENSO\)](#), affect weather **events across the world**.
- Over India, the El Niño has the **impact of suppressing monsoon rainfall**.

# El Niño and La Niña

## El Niño

- Warming of the ocean surface/ Above average sea surface temp. (SST)
- Easterly winds either weaken or start blowing in the opposite direction
- First noticed by Peruvian fishermen in the 1600s
- More frequent than La Niña

### Impacts

- Drastically higher rainfall in S. America (coastal flooding and erosion)
- Droughts in Indonesia and Australia; wildfires
- Weaker monsoons and even droughts in India and SE Asia
- Reduces the upwelling of cooler, nutrient-rich waters from the deep - along the west coast of South and Central America.

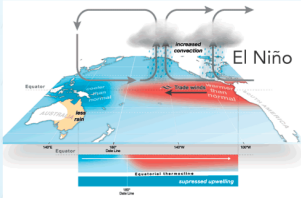


Fig. 1 - Depiction of El Niño Phenomenon

## La Niña

- Also called El Viejo, anti-El Niño, or simply "a cold event"
- Normal easterly winds along the equator become even stronger
- May last 1-3 years, unlike El Niño (which usually lasts no more than a year)

### Impacts

- Heavier rains in SE Africa, catastrophic floods in Australia
- Drier-than-normal conditions in S. America
- Summer Monsoon rainfall - greater than normal rainfall in India; beneficial for agriculture dependent Indian economy
- Off the west coast of the Americas, upwelling increases, bringing cold, nutrient-rich water to the surface.

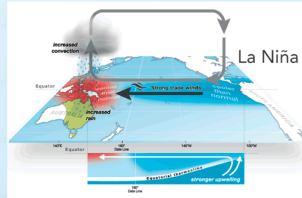


Fig. 2 - Depiction of La Niña Phenomenon

## Oceanic Niño Index (ONI)

- It is a measure of the departure from normal sea surface temperature in the east-central Pacific Ocean.
- It is the standard means by which each El Niño episode is determined, gauged, and forecast.



## UPSC Civil Services Examination, Previous Year Question (PYQ)

### Prelims:

**Q. With reference to 'Indian Ocean Dipole (IOD)' sometimes mentioned in the news while forecasting Indian monsoon, which of the following statements is/are correct? (2017)**

1. IOD phenomenon is characterised by a difference in sea surface temperature between tropical Western Indian Ocean and tropical Eastern Pacific Ocean.
2. An IOD phenomenon can influence an El Niño's impact on the monsoon.

**Select the correct answer using the code given below:**

- (a) 1 only
- (b) 2 only
- (c) Both 1 and 2
- (d) Neither 1 nor 2

**Ans: (b)**

### Mains:

**Question:** How far do you agree that the behaviour of the Indian monsoon has been changing due to humanizing landscape? Discuss. (2015)

PDF Refernece URL: <https://www.drishtias.com/printpdf/indian-ocean-dipole-1>

