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WE BELIEVE

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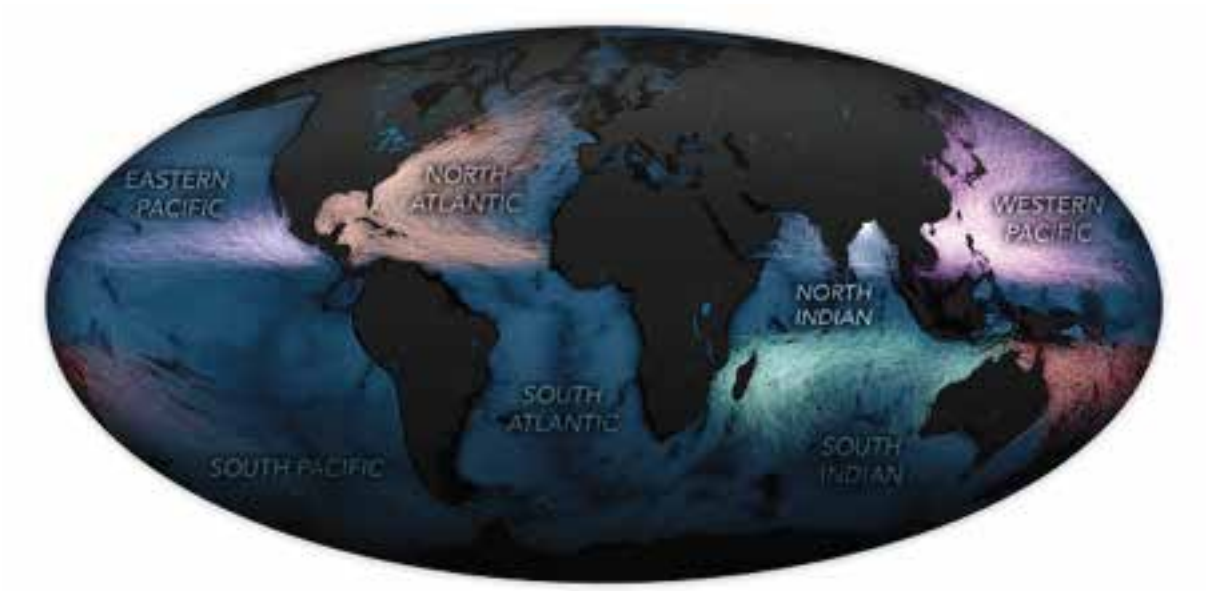
The Active North Indian Ocean Cyclone Season 2019

Tracks of Cyclone Maha

The year 2019 has been one of the most active cyclone seasons in the North Indian Ocean. Four cyclones have formed off the coast of India in the Arabian Sea – Vayu, Hikaa, Kyarr and Maha. While Vayu, Hikaa and Kyarr did not make landfall in India, the western coast from Kerala to Gujarat witnessed heavy rains and strong winds, affecting normal life in several areas.

The oceanic basin to the west of the Indian sub-continent, which usually sees low-intensity cyclonic activity, has suddenly turned into a hotspot of sorts, churning out severe cyclonic storms one after the other.

The North Indian Ocean Basin vs. Other Basins



Cyclone Activity in the world's major ocean basins between 1842- 2017 | Source: *NOAA*
Brighter areas indicate where a large number of storm tracks have overlapped.

The scarcity of storm tracks in the North Indian basin—particularly west of India—compared to other basins is noteworthy. On average, this North Indian region sees 4.8 storms per year that reach the strength of a "cyclonic storm" (tropical storm) or greater. Of those, just 1.5 reach the strength of "very severe cyclonic storm" (category 1 hurricane) or greater. For comparison, the northwestern Pacific—the busiest basin—sees an average of 26 tropical storms and 16.5 typhoons every year.

Most cyclones in this region tend to form before or after the monsoon season. It is also notable that four of these cyclones formed west of India over the Arabian Sea. In a typical year, most cyclones form east of India in the vicinity of the Bay of Bengal.

The 2019 Season

Not only is there growing formation of cyclones in the Arabian Sea, these storms have also been increasingly severe in intensity. The year 2019 has already seen four cyclones ranging from 'very severe cyclonic storm to super cyclone' developing in the Arabian Sea - a rather unusual phenomenon in the region which could be linked to global warming.

It began with Cyclone Vayu in June, which was classified as a 'very severe cyclonic storm' by the India Meteorological Department (IMD) with wind speeds of 150 kilo meter per hour (kmph). This was followed by Cyclone Hikaa in September, which again termed a 'very severe cyclonic storm' and moved in north-west to make landfall in Oman.

Cyclone Kyarr, was the first super cyclone with wind speed of 250 kmph formed in the Arabian Sea after a gap of 12 years. Kyarr, (Super Cyclonic Storm by the IMD / category 4 cyclone by NOAA, USA) and was only preceded by Super Cyclone Gonu in 2007, which ravaged the coast of Oman. However, it's not the formation of a super cyclone in the Arabian Sea that has triggered interest, but the simultaneous development of two big cyclones in the region. Extremely severe cyclonic storm Maha with wind speed of 185 kmph, developed over the Arabian Sea, even as Kyarr prevailed and made landfall near Gujarat coast as a depression.

For the meteorologists, this was for sure a rare occurrence. Two big cyclonic systems forming at the same time could also influence each other's wind systems and lead to pushing and pulling. This is usually known as the Fujiwhara effect - named after the Japanese Meteorologist Sakuhei Fujiwhara - when two nearby cyclone vortices orbit each other.

According to the NOAA Historical Hurricane Tracks database, only four other category 4 or stronger tropical cyclones besides Kyarr have been recorded in the Arabian Sea, where reliable satellite data extends back to 1998:

Name	**Wind speed (kmph)**
Gonu 2007	265
Phet 2010	230
Chapala 2015	240
Nilofar 2014	210

Prior to 2019, formation of four storms in the Arabian Sea was recorded in 1902. Further, the sea surface temperature was nearly 27 to 29 degrees Celsius, more than normal, which helped in formation of cyclones.

Kyarr was the second high-end category 4 cyclone observed this year in the North Indian Ocean. On May 2, Tropical Cyclone Fani, which formed in the Bay of Bengal off the east coast of India, peaked with 250 kmph winds. Fani made landfall on May 3 in eastern India with 240 kmph winds, and caused over US$8 billion economic loss and over US$ 500 million insured losses.

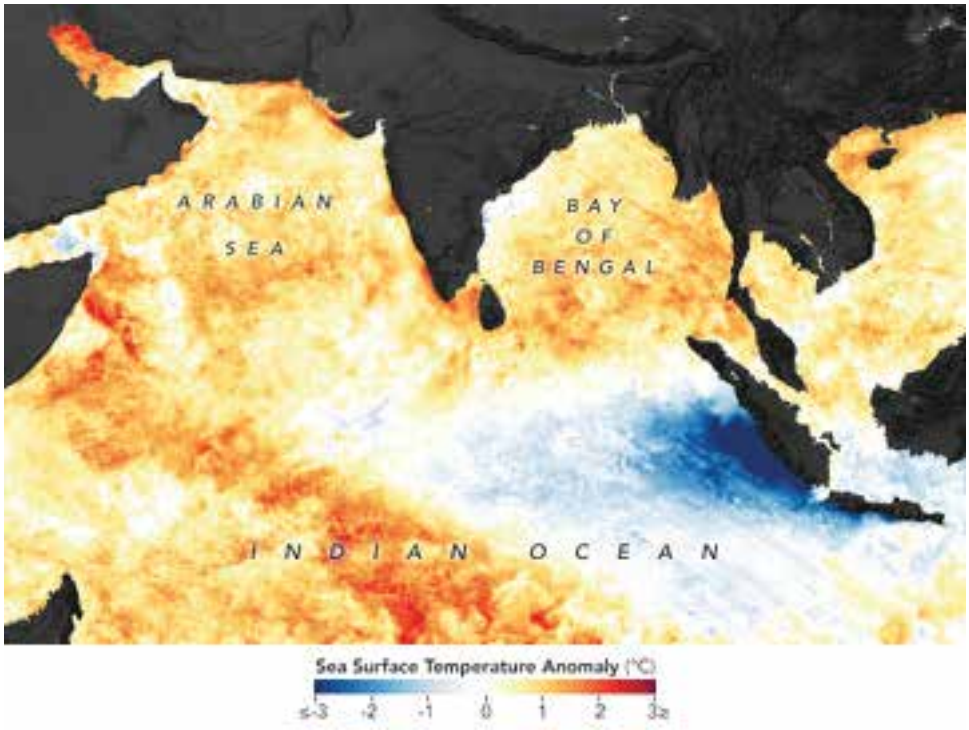
Climatologically, the Bay of Bengal sees about twice as many tropical cyclones as the Arabian Sea. For the 172 tropical cyclones that formed over North Indian Ocean during 1983–2015, 56 formed over Arabian Sea, and 116 formed over the Bay of Bengal.

The four Northern Indian Ocean tropical cyclones of 2019 have combined to produce the most active tropical cyclone season in recorded history for the basin, when measured by Accumulated Cyclone Energy (ACE). It measures the total destructive power of a hurricane/cyclone season, based on the number of days strong winds are observed. ACE for an individual storm is computed by squaring the maximum sustained winds of the storm at each 6-hourly advisory and summing up over the entire lifetime of the storm. Since 1998, the highest ACE for a North Indian Ocean season was 46.1 in 2007.However, the scientists the measured the value of ACE on October 31, 2019 as 65.2.

The Role of IOD

The surge of strong storms this year is likely related to a climate phenomenon known as the Indian Ocean Dipole (IOD). Similar to the way phases of the El Niño-Southern Oscillation shift sea surface temperatures (SST) in the Pacific Ocean, the IOD shifts temperatures in the Indian Ocean in ways that can affect seasonal weather patterns.

In a positive phase of the IOD, winds and ocean circulation cause warmer than usual waters in the basin's west side and cooler than usual waters to the east. This sets up a convection pattern those results in more rain and storms over the Arabian Sea.



The strong IOD is visible in the map above, which shows the SST anomalies on October 17, 2019. The map does not show absolute temperatures, but how much the surface layer was above or below that day's average temperature (measured between 2003 and 2014). The warmer than usual (red) water contrasts sharply with colder than usual (blue) water near Indonesia.

According to news reports, the current "positive" phase of the IOD started in June 2019 and strengthened quickly in September due to strong easterly winds. The same report notes that the IOD this year is the strongest it has been in at least 60 years.

Impact of an Active Season

More cyclones can cause damage through strong winds, rains and floods that can affect property, crop and lives. As the western states in India have more exposure, the frequent events can cause severe economic and insured losses.

Source: *IMD, India Today, NASA, NOAA*

Annexure

Classification of Cyclonic Storm by IMD and NOAA

IMD

System	Associated wind speed Knots (Kmph)
Low pressure area	<17(<31)
Depression	17-27 (31-49)
Deep Depression (DD)	28-33 (50-61)
Cyclonic Storm (CS)	34-47 (62-88)
Severe Cyclonic Storm (SCS)	48-63 (89-117)
Very Severe Cyclonic Storm (VSCS)	64-89 (118-166)
Extremely Severe Cyclonic Storm (ESCS)	90-119 (167-221)
Super Cyclonic Storm	≥ 120 (≥ 222)

NOAA

Category	Wind speeds	
	(for 1-minute maximum sustained winds)	
	knots (kn)	Kmph
Tropical depression	≤ 33 kn	≤ 62 kmph
Tropical Storm	34–63 kn	63–118 kmph
One	64–82 kn	119–153 kmph
Two	83–95 kn	154–177 kmph
Three	96–112 kn	178–208 kmph
Four	113–136 kn	209–251 kmph
Five	≥ 137 kn	≥ 252 kmph

Conversion: 1 knot = 1.852 kmph