

## Did COVID-19 lockdown brew “Amphan” into a super cyclone?

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The world witnessed one of the largest lockdowns in the history of mankind ever, spread over months in an attempt to contain the contact spreading of the novel coronavirus induced COVID-19. As billions around the world stood witness to the staggered lockdown measures, a storm brewed up in the urns of the rather hot Bay of Bengal (BoB) in the Indian Ocean realm. When Thailand proposed the name “Amphan” (pronounced as “Um-pun” meaning ‘the sky’), way back in 2004, little did they realize that it was the christening of the 1st super cyclone (Category-5 hurricane) of the century in this region and the strongest on the globe this year. At the peak, Amphan clocked wind speeds of 168 mph (Joint Typhoon Warning Center) with the pressure drop to 925 h.Pa. What started as a depression in the southeast BoB at 00 UTC on 16th May 2020 developed into a Super Cyclone in less than 48 hours and finally made landfall in the evening hours of 20th May 2020 through the Sundarbans between West Bengal and Bangladesh. Did the impact of the COVID-19 induced lockdown drive an otherwise typical pre-monsoon tropical depression into a super cyclone?

### Global Warming and Tropical Cyclones

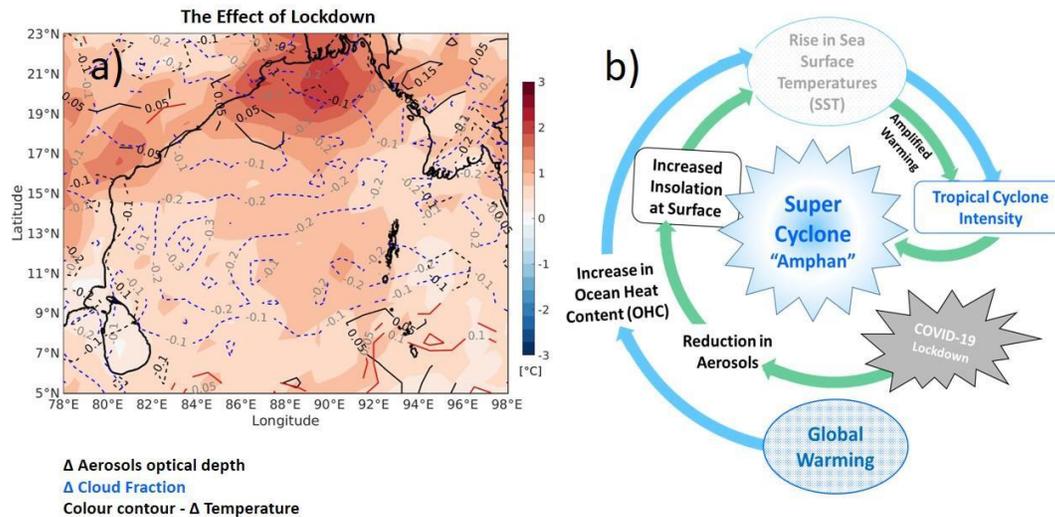
Tropical cyclones are primarily fueled by the heat released by the oceans. Climate change and associated global warming have enabled significant accumulation of ocean heat content (OHC) across the globe increasing the frequency of intense tropical cyclones. The oceans are known to have absorbed more than 90% of all the excess heat trapped by the anthropogenic Green House Gas (GHG) emissions thereby rapidly increasing ocean surface temperatures<sup>1,2,3</sup>, favouring the genesis and intensification of cyclones. In fact 36 cyclones have been reported world over in the last four months of 2020 alone. Overall, there is seemingly a preferential increase in category 4 & 5 cyclones<sup>4</sup> throughout the globe in recent years.

### Bay of Bengal: The cyclonic hotbed

The North Indian Ocean witnesses about 12% of the total number of global cyclones with an average of 5 to 6 of them forming in the BoB and the Arabian Sea (AS) every year<sup>5,6,7</sup>. With high population density, the coastal areas spread across India, Bangladesh and Myanmar are socially and economically vulnerable to damages owing to cyclones<sup>7</sup>. The Indo-Gangetic Plains (IGP) in South East Asia is among the most densely populated (with more than 60% of India’s population) and highly polluted regions in the world<sup>8,9,10</sup>. These pollutants or particulate matter or atmospheric aerosols that can both scatter and absorb surface-reaching solar radiation<sup>11</sup>, are increasing at a rate of 2 to 3 % per year<sup>12</sup>. The unique topography of the region, assisted by conducive wind patterns, transports most of these anthropogenic air pollutants into the BoB<sup>13</sup>. Therefore, heightened human activity leads to higher aerosol loading and hence cooling of the Bay.

In addition, these aerosols are also known to increase cloud fraction by acting as cloud condensation nuclei, thus modifying their spread<sup>14</sup>.

## The Pandemic and the Lockdown: A catalyst?



**Figure. 1.** a) The anomalies of sea surface temperature (color contour), aerosol optical depth (black line contour) and cloud fraction (blue line contour) during the lockdown and b) summary schematic on the possible mechanism of amplification of the strength of cyclone initiated by the lockdown.

The lockdown has rendered the atmosphere over the BoB relatively clean due to significant decline in anthropogenic activities and consequent aerosol loading and clouds by as much as 30% over the ocean (Table 1). Quite interestingly, the magnitude of this decline itself is much larger than the normal average aerosol loading over some of the developed nations. The combined decline of both aerosols and clouds could easily increase the sea surface temperature further compounding the climate change-related warming of the oceans (see also Table 1). The pre-existing high summer SST, climate change enhanced OHC, lockdown induced decline in aerosols & clouds, are all perfect ingredients for genesis potential and subsequent intensification of any cyclonic activity.

Comparing the super cyclone “Amphan” (16th to 20th May 2020, 168 mph, 925 hPa) (Category-5: > 156 mph) with a similar cyclone “Fani” (26th April to 5th May 2019, 155 mph, 932 hPa) (Category-4: 130-156 mph) that formed in the same region and season last year suggests that Fani could have intensified easily to Category-5 if only such a large scale lockdown transpired last year which is also supported by a recent study<sup>15</sup>. Thus, seemingly disparate extreme events may compound our vulnerability to unforeseen disasters (Fig. 1) over certain regions and times demanding heightened disaster preparedness and consistent climate actions. Even though reduction in air pollution seem to have intensified the cyclone, it should not be inferred that mitigation of pollution would enhance cyclonic activity. This could be a one off case where COVID-19 induced lockdown and reduced pollution in sync with various favourable compounding factors may have led to intensification of the cyclone under consideration. This may likely be a once-in-lifetime case to have witnessed a cyclone being modulated by reduced air pollution and subsequent short-term effects.

**Table 1.** The observed changes to the ocean and atmospheric parameters of relevance to cyclones over the Bay of Bengal due to global warming and COVID-19 lockdown (pre-lockdown minus lockdown of anomalies w.r.to climatology).

	Ocean		Atmosphere	
Parameter	Sea Surface Temperature (Skin) (°C)	*Ocean Heat Content <sub>700m</sub> (x 10 <sup>22</sup> J)	Aerosol Optical Depth*	Cloud Fraction* (%)
Change during Lockdown	+1 to 2	+0.1347	-0.1 (25 to 30%)	-30.0
Data Sources	AIRS	NOAA-NODC	MODIS Terra/Aqua	MODIS Terra/Aqua

\*absolute difference with respect to 2019

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