Future change of tropical cyclone-induced waves in the Indian Ocean; An analysis based on super-high-resolution MRI-AGCM3.2 climate model

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Indian Ocean experiences intensive tropical cyclones in both northern and southern parts. The Northern Indian Ocean (NIO) includes 7% of the global tropical cyclones which results in generating severe wave climate during the extreme events. In this study, future change of tropical cyclone-induced waves due to climate change is assessed in terms of change in the spatial distribution patterns and magnitude. The cyclone seasons in NIO are divided by pre-monsoon (especially May) and northeast monsoon (October–December). Moreover, there are few cyclones form the southwest monsoon during June and September. Hence, the assessment of future change of intensity of tropical cyclones and the generated waves is necessary to be performed on a monthly scale. For this purpose, wind field obtained from super-high-resolution atmospheric global climate model MRI-AGCM3.2S of the Japan Meteorological Agency (JMA) -with horizontal spatial and temporal output resolutions of 20 km and 1 hr., respectively- was used to force a numerical wave model (SWAN) in historical (1979-2003) and future (2075-2099) periods (based on Representative Concentration Pathway (RCP) 8.5 scenario).
Spatial distribution of annual extreme events in the domain shows that the concentration of tropical cyclones is in the NIO and around Madagascar (located in the Southern Indian Ocean (SIO)) generating high waves of the magnitudes of around 20 m during the events. Spatial distribution of monthly maximum values of the historical and future wind speed (WS) and significant wave height (SWH) indicates that according to historical projection, intense cyclones happen during May and June in NIO, while they can be observed mostly during December to April in the SIO. The future monthly distribution of cyclone induced waves in SIO shows a similar pattern to the historical events, except for winter tropical cyclones (November and December), which are decreased in the future, while increasing in the intensity can be observed during October and April in NIO.
Monthly variation of maximum events in the domain was assessed in the NIO and SIO, separately. According to the past studies, due to the global warming, tropical cyclones of hurricane intensity -which currently occur only in the pre and post-monsoon seasons- will likely be formed even during the summer monsoon in NIO. Our results illustrate an increase in the intensity of cyclones in the future, not only during the summer monsoon (July) but also during the winter monsoon (September and October). Results show that the range of change in the highest SWH in NIO is between -27% (in February) and +26% (in October). In the northern part of SIO, the intensity of future tropical cyclones will increase during the southwestern inter-monsoon season (March and April), whereas it will decrease at the end of southwestern monsoon season (September). In the southern part of SIO, the intensity of tropical cyclones will increase around 20% during northeastern monsoon (February and March), which results in a future increase of 40% in maximum SWH in February. Generally, change in highest SWH in the future follows the pattern of WS except for the northern parts of SIO when the highest increase in maximum SWH (21%) occurs in March whereas the highest increase in maximum WS occurs in April (25%). There is a 20% increase in maximum WS during February in southern parts of SIO which can be a reason for the increase of SWH during March in northern parts. It can be concluded that the change in the intensity of future tropical cyclones in NIO is higher than SIO. The range of change in highest SWH in NIO is larger than SIO, except for February when the maximum wave height in southern parts of SIO will increase about 40% in

the future. Furthermore, the change in maximum SWH in northern parts of SIO seems to be affected by the change of tropical cyclones in southern parts of SIO.

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