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A process-oriented approach for mining marine heatwaves with a time series of raster formatted products

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A marine heatwave (MHW) is defined as a coherent area of extreme warm sea surface temperature that persists for days to months, which has a property of evolution from production through development to death in space and time. MHWs usually relates to climatic extremes that can have devastating and long-term impacts on ecosystems, with subsequent socioeconomic consequences. Long term remote sensing products make it possible for mining successive MHWs at global scale. However, more literatures focus on a spatial distribution at a fixed time snapshot or a temporal statistic at a fixed grid cell of MHWs. As few considering the temporal evolution of MHWs, it is greater challenge to mining their dynamic changes of spatial structure. Thus, this manuscript proposes a process-oriented approach for identifying and tracking MHWs, named as PoAITM. The PoAITM considers a dynamic evolution of a MHW, which consists of three steps. The first step uses the threshold-based algorithm to identifying the time series of grid pixels which meets the MHW definition, called as MHW pixels; the second adopts the spatial proximities to connect the MHW pixels at the snapshots, and transforms them spatial objects, called as MHW objects; the third combines the dynamic characteristics and spatiotemporal topologies of MHW objects between the previous and next snapshots to identify and track them belonging to the same ones. The final extract MHW with a property from production through development to death is defined as a MHW process. Comparison with the prevail methods of tracking MHWs, The PoAITM has three advantages. Firstly, PoAITM combines the spatial distribution and temporal evolution of MHW to identify and track the MHW objects. The second considers not only the spatial structure of MHW at current snapshot, also the previous and next ones, to track the MHW process, which ensures the MHW completeness in a temporal domain. The third is the dynamic behaviors of MHW, e.g. developing, merging, splitting, are also found between the successive MHW objects. Finally, we address the global MHWs exploring from the sea surface temperature products during the period of January 1982 to December 2018. The results not only show well-known knowledge, but also some new findings about evolution characteristics of MHWs, which may provide new references for further study on global climate change.