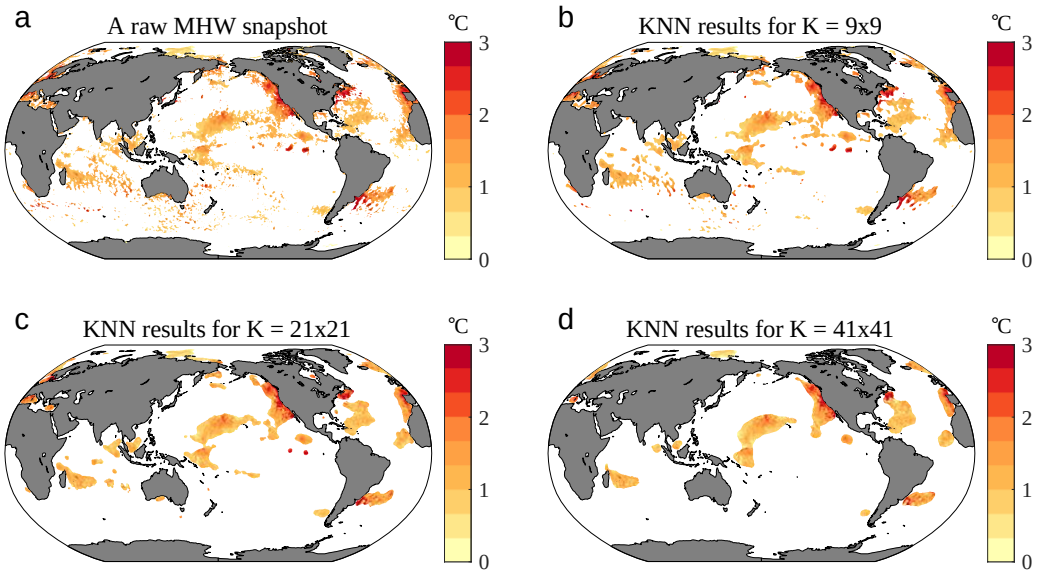


Fig. S1 Sensitivity tests for the *K*-parameter in the KNN. (a) A raw MHW snapshot on October 30, 2014 with MHWs identified point by point following Hobday et al. (2016) and (b-d) the post-processed snapshots by the KNN using different values for the *K*-parameter. The colorbar denotes SSTA referenced to a baseline climatology with no-MHW region masked by white.

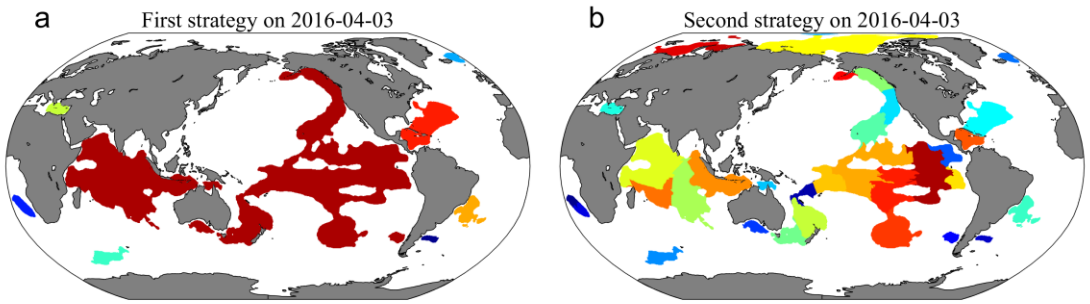


Fig. S2 The MHW events identified using the (a) first strategy (i.e., gather the connected domain as a mega MHW event) and (b) second strategy (i.e., treat the connected domain as multiple MHW events) on April 3, 2016 to handle the MHW merging. Domains occupied by different MHW events under the spatio-temporal framework are filled in different colors.

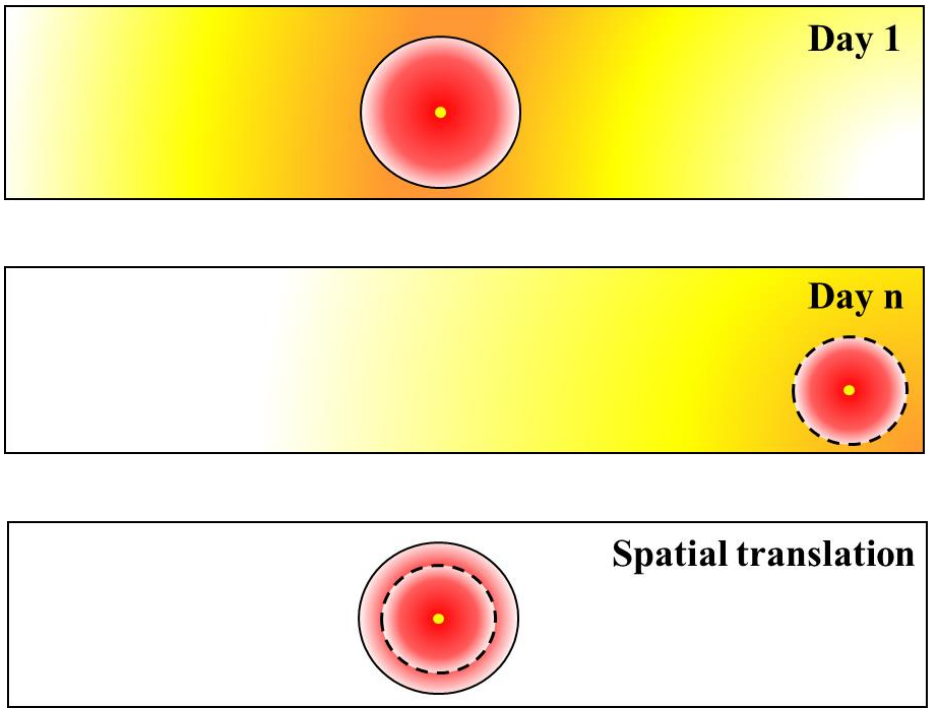


Fig. S3 The schematic of spatial translation in the definition of deformation rate. The yellow point represents the geometric center of MHW events.

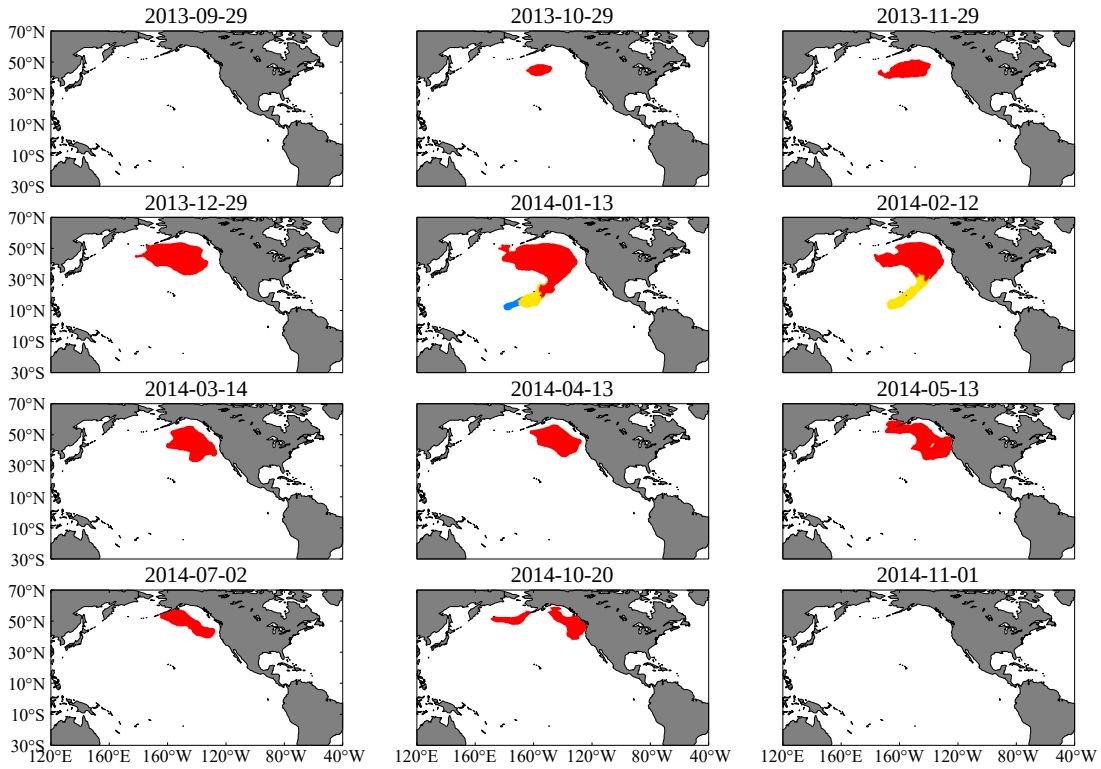


Fig. S4 Evolution of the three MHW events constituting the GOA-like MHW in the Northeast Pacific. A movie showing more details is available through https://github.com/cindyisok/MHWTracking/blob/main/video/NEP_MHW_evolution_2014_01_16.gif.

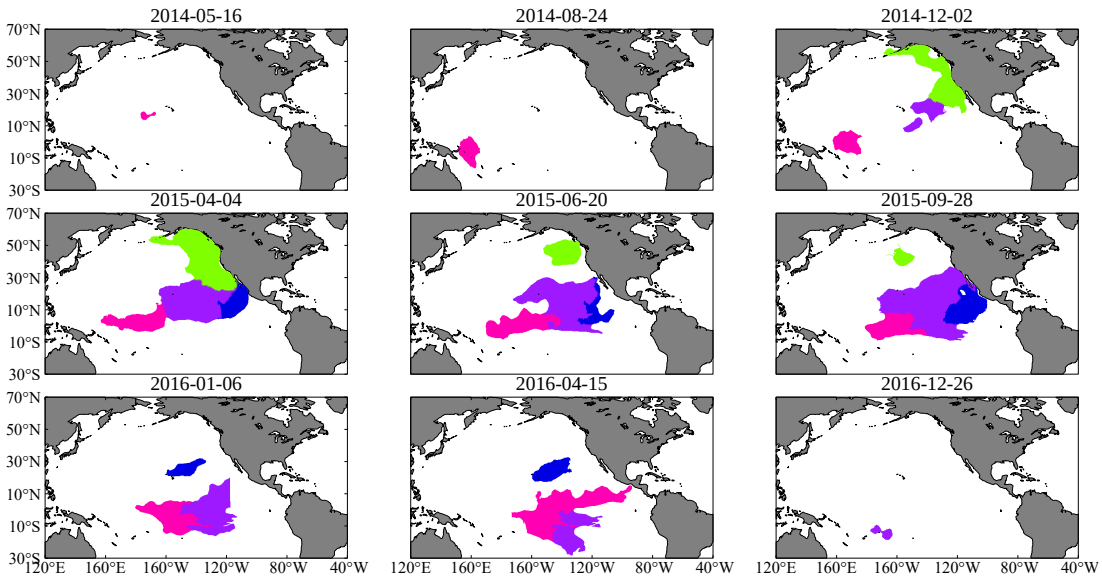


Fig. S5 Evolution of the four MHW events constituting the “ARC”-like MHW in the Northeast Pacific. A movie showing more details is available through https://github.com/cindyisok/MHWTracking/blob/main/video/NEP_MHW_evolution_2015_04_04.gif.

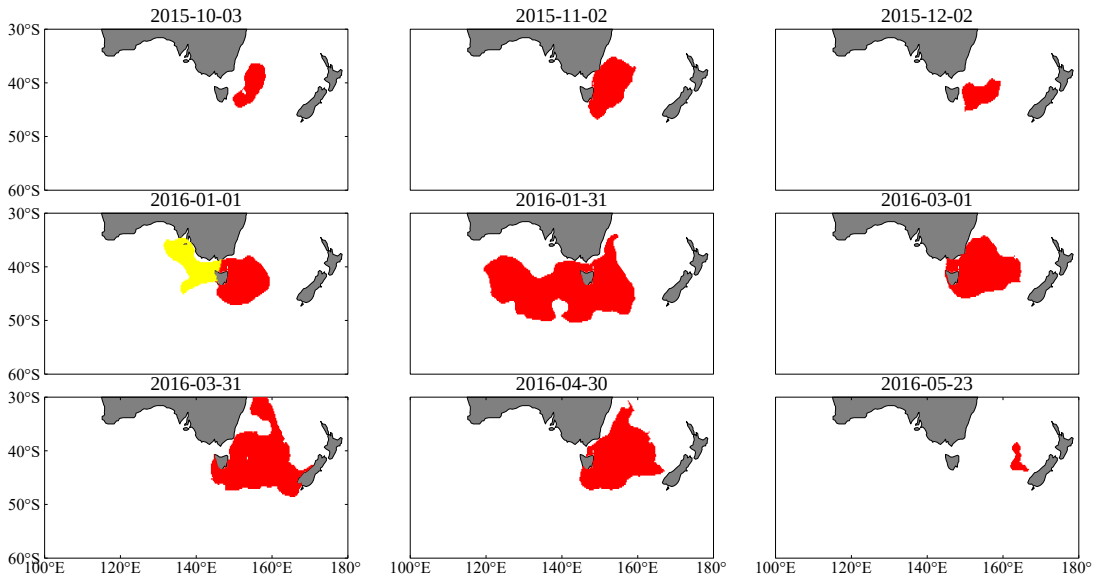


Fig. S6 Evolution of the two MHW events constituting the Tas. MHW. A movie showing more details is available through https://github.com/cindyisok/MHWTracking/blob/main/video/Tas_MHW_evolution_2015_12_29.gif.

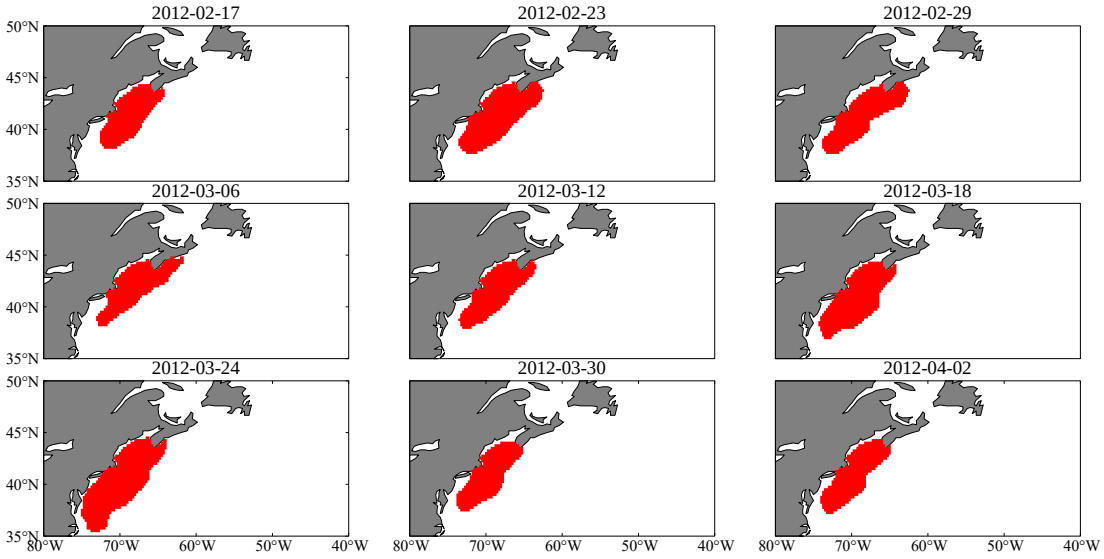


Fig. S7 Evolution of the MHW event corresponding to the NWA MHW. A movie showing more details is available through https://github.com/cindyisok/MHWTracking/blob/main/video/NWA_MHW_evolution_2012_03_20.gif.

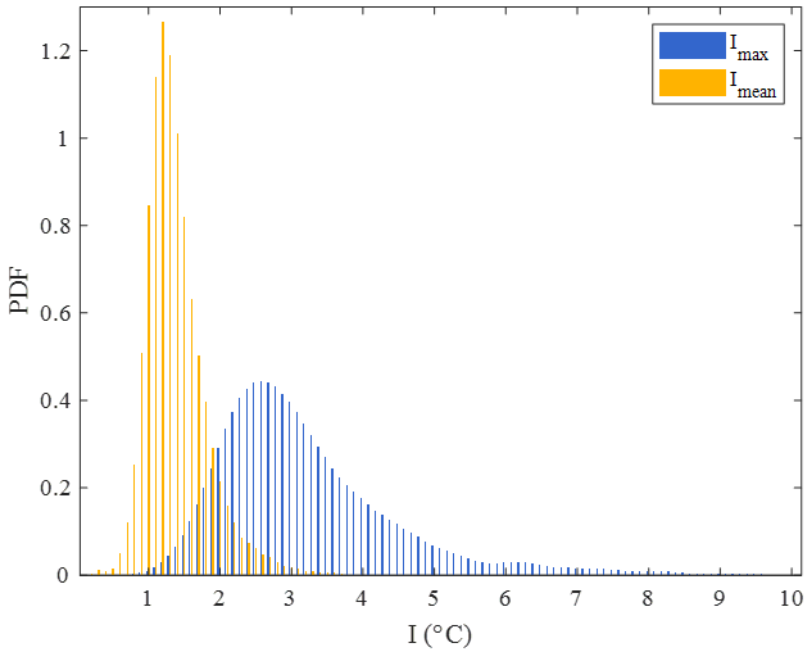


Fig. S8 PDFs of $I_{\max}$ and $I_{\text{mean}}$ after excluding MHW events poleward of 60°.

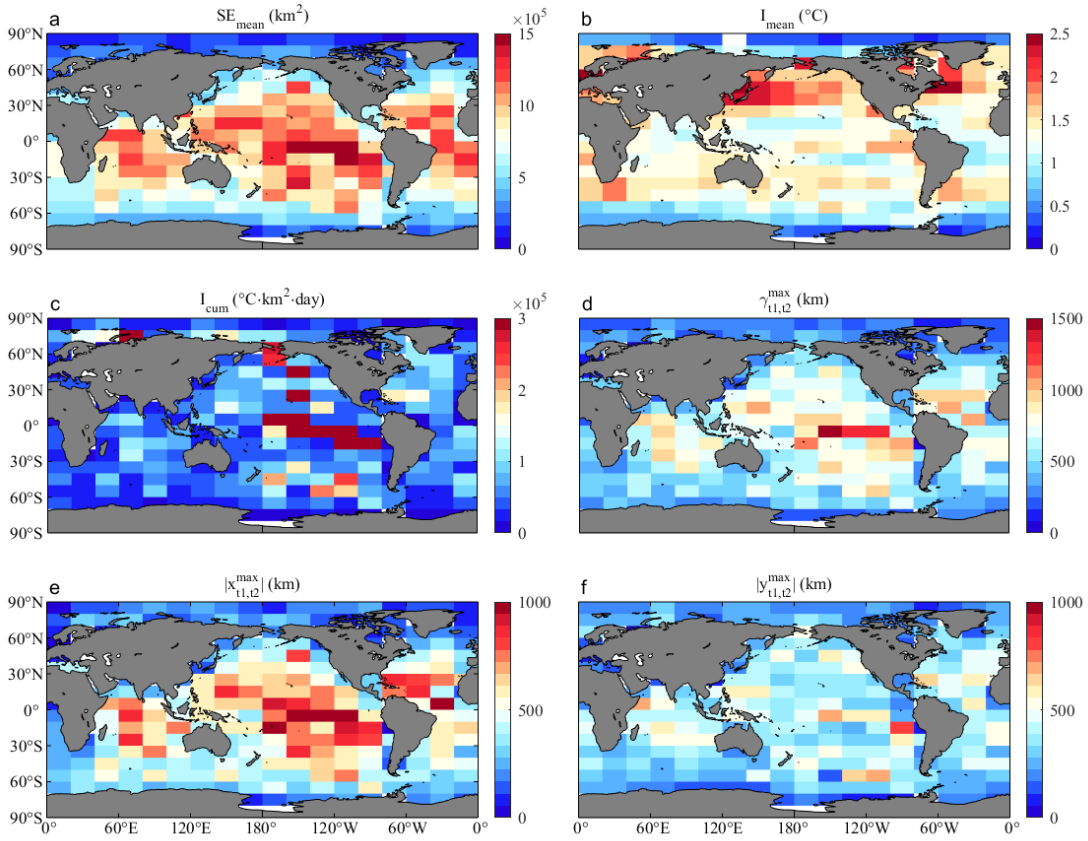


Fig. S9 Similar to Fig. 12 but for (a) $SE_{mean}$, (b) $I_{mean}$, (c) $I_{cum}$, (d) $\gamma^{\max}_{t_1,t_2}$, (e) $|x^{\max}_{t_1,t_2}|$ and (f) $|y^{\max}_{t_1,t_2}|$.

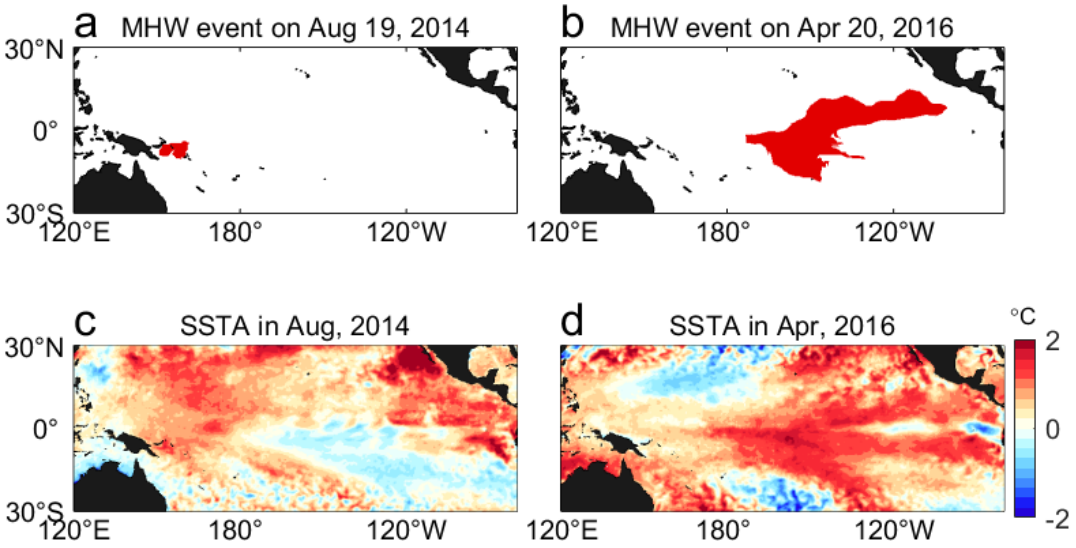


Fig. S10 (a) and (b) Snapshots of the MHW event on Aug 19, 2014 and Apr 20, 2016.

(c) and (d) Monthly mean SSTA in Aug 2019 and Apr 2016.

Table. S1 The number of MHW events under the spatio-temporal framework computed from the OISST with different grid sizes.

| resolution | 0.25°×0.25° | 0.5°×0.5° | 1°×1° | 2°×2° |
|---|---|---|---|---|
| *K*-parameter | 21×21 | 11×11 | 5×5 | 3×3 |
| $\alpha$ | 0.5 | 0.5 | 0.5 | 0.5 |
| MHW events | 8642 | 8546 | 10292 | 8028 |