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Tokyo Climate Center, Japan Meteorological Agency (TCC/JMA)

Contribution of an unprecedented marine heatwave to extremely hot summer conditions over northern Japan in 2023

Unusually high ocean temperatures (known as marine heatwaves, or MHWs) prevailing around northern Japan in association with prominent poleward meandering of the Kuroshio Extension are likely to have played a part in the unprecedentedly hot summer conditions of 2023 in the region. This MHW contributed to reduced amounts of low-level cloud and increased insolation, atmospheric heating due to the warm ocean, and anomalous evaporation and an enhanced greenhouse effect.

In recent years, unusually high ocean temperatures (known as marine heatwaves, or MHWs) have attracted focus because of their effects on marine ecosystems and fisheries. The frequency and intensity of MHWs are expected to increase in association with global warming (Intergovernmental Panel on Climate Change, 2021).

In 2023, the Japan Meteorological Agency (JMA) Advisory Panel on Extreme Climatic Events (comprised of prominent climate science academics and researchers) identified MHWs around northern Japan as a potential contributor to northern Japan's unprecedentedly hot summer in 2023 (Fig. 1) (Tokyo Climate Center, 2023; Takemura et al. 2024).

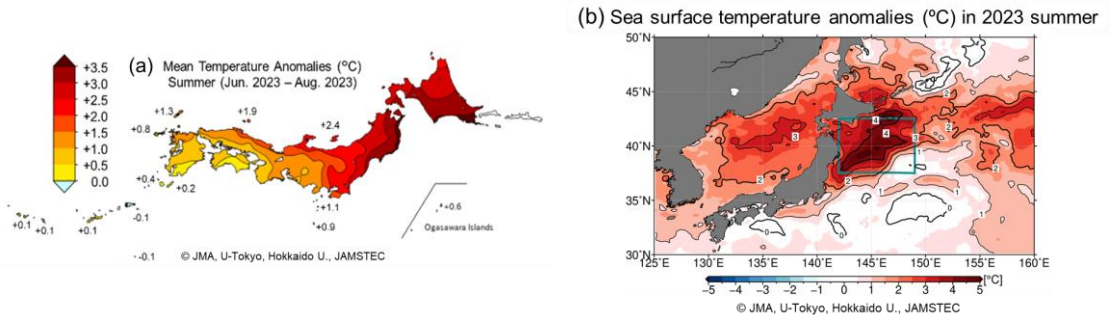

Fig. 1 Summer-mean surface air temperature anomalies over Japan in 2023. (b) As in (a), but for sea surface temperature anomalies. From Sato et al. (2024 Scientific Reports).

Further analysis by a joint research team (comprising TCC/JMA and advisory panel members Prof. Hisashi Nakamura from the Research Center for Advanced Science and Technology (RCAST) at the University of Tokyo, Prof. Youichi Tanimoto from Hokkaido University and Dr. Masami Nonaka from the Japan Agency for Marine-Earth Science and Technology (JAMSTEC)) indicated that the marine conditions contributed to reduced amounts of low-level cloud and increased insolation, atmospheric heating due to the warm ocean, and anomalous evaporation and an enhanced greenhouse effect (Fig. 2).

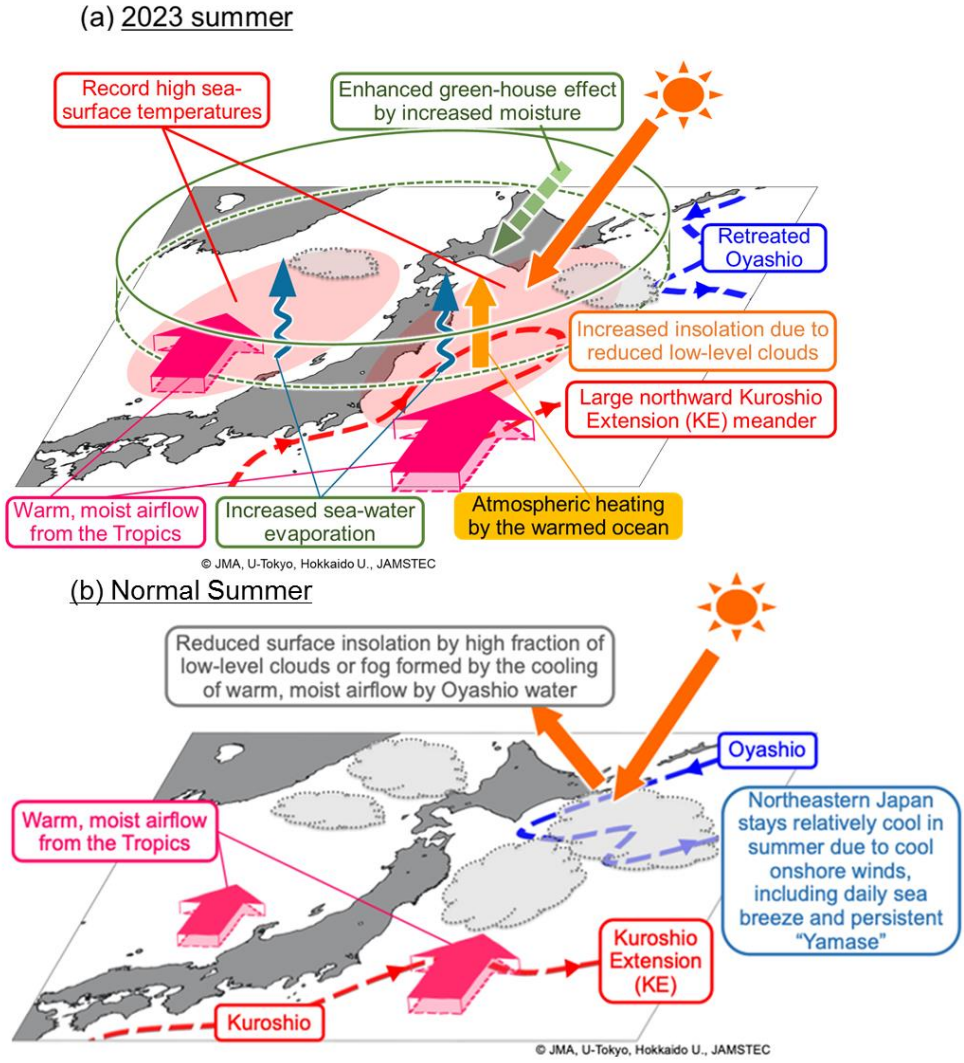

Fig. 2 (a) Schematic of processes involved in the impact of an unprecedented marine heatwave (MHW) on record-breaking hot summer in 2023 over northern Japan. (b) As in (a), but for atmospheric and oceanic processes that characterize climatological summertime situation around northern Japan. Based on Sato et al. (2024 Scientific Reports).

As the intensity and frequency of MHWs and high atmospheric temperatures are expected to increase further as global warming progresses, it is crucial to clarify and be able to predict how MHWs will raise atmospheric temperatures in surrounding regions, as well as determining the mechanisms of MHWs themselves. TCC/JMA remains committed to its analysis of extreme climate events for enhanced prediction to support mitigation of impact of climate change.

The results of this survey were published online in Scientific Reports on 19 July 2024. See also a related article by RCAST at The University of Tokyo: https://www.rcast.u-tokyo.ac.jp/en/news/report/page_00338.html.

Paper

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References

Intergovernmental Panel on Climate Change, 2021: Summary for Policymakers. In: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., et al. (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 3−32. https://doi.org/10.1017/9781009157896.001

Takemura et al. 2024: Preliminary Diagnosis of Primary Factors for an Unprecedented Heatwave over Japan in 2023 Summer. *SOLA*, **20**, 69-78. https://doi.org/10.2151/sola.2024-010

Tokyo Climate Center, 2023: *Climate characteristics and factors behind heavy rainfall during the Baiu season in 2023 and extremely high temperatures from mid-July onward* (press release) https://ds.data.jma.go.jp/tcc/data/news/press_20230928.pdf