Mechanism and Forecast Potential of North Pacific Marine Heatwaves inferred from Adjoint Sensitivities

XIAOXUE WANG[1], ARMIN KÖHL[1], DETLEF STAMMER[1]

[1] *Institute of Oceanography, Center for Earth System Research and Sustainability (CEN), University of Hamburg (UHH), Hamburg 20146, Germany*

The increasing frequency and intensity of heatwave events have led to a significant rise in heat-related threads on land and in the ocean during recent years. A classic example of a marine heat wave (MHW) is the 2014 – 2016 warm event that spread across the north-eastern Pacific (NEP) Ocean—an event that researchers coined "the blob". Here we use an adjoint sensitivity approach to shed new light on potential causes for reoccurring NEP marine heatwaves events in the region of the NEP. The study is based on the Massachusetts Institute of Technology general circulation model (MITgcm) and its adjoint, for which the mean sea surface temperature (SST) of different target regions (region 1: 145°- 160°W, 48°- 56°N; region 2: 130°- 145°W, 40°- 48°N) and different target years (e.g. year 2014) was set as objective function. The adjoint sensitivities show that during the year of emergence, air-sea turbulent surface heat flux is the dominant atmospheric driver whatever the intensity of the MHW events. Air temperature and specific humidity contribute up to 80% to the temperature of NEP in MHW years and only about 60% in other years. When wind contributes more than the turbulent flux to the temperature of NEP region, there are typically no MHW occurrence. The horizontal temperature advection, i.e., the impact of the basin-wide ocean circulation, is found to be less important, but might act as a preconditioning of MHW through climate oscillations (e.g. NPGO). Because atmospheric forcing anomalies occurring within the 18 months prior to the MHW event play a particularly critical role in driving the overall response locally through air-sea interactions, the leading 18-month atmospheric conditions in the central North Pacific can be considered as predictive signals for later marine heatwave events. Based on our preliminary findings, it can be concluded that 2024 may not be a heatwave year for NEP region in a moderate confidence level.