In austral summer 2011, an unprecedented Ningaloo Niño event occurred with sea surface temperature anomalies reaching 5°C off the west coast of Australia, with significant impacts on marine ecosystems. In this study, a high resolution (~2 km) hydrodynamic model (Regional Ocean Modelling System) is used to analyse the variations in the near-surface temperature from 2009 through mid-2011. The model is evaluated against Integrated Marine Observing System (IMOS) mooring data at the Two Rocks transect, demonstrating that the model achieves the timing of the local Leeuwin Current intensification and the temperature peak.

Model results indicate that the peak temperatures in the broad mid-West coast of Australia during the marine heat wave are predominantly due to poleward advection of warmer, tropical water (≈ 2/3 contribution). However, positive air-sea heat flux into the ocean also contributes (≈ 1/3 contribution) to the rise in temperature. The anomalous advection of warm water is caused by changes in the poleward flowing Leeuwin Current due to both local and remote wind forcing.

In early 2011, the Leeuwin Current intensified owing to remote forcing associated with the 2010-2011 La Niña. In addition, the southerly winds off the west coast of Australia weakened, allowing the Leeuwin Current to further intensify in speed at the peak of the event. Concurrently, the inshore, equatorward Capes Current was suppressed and reversed direction. The poleward flow over the shelf contributed to near-shore warming, in contrast to cooling by equatorward advection from the Capes Current in previous years. In addition to capturing the warming event, model results indicate notable freshwater anomalies along the coast, a topic for further investigation. Long-term thermal structure monitoring need to be continued, and it is desirable to have air-flux measurements off the coast.