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Response of seasonal cycle and interannual variability of SST in the eastern equatorial Pacific to orbital forcing during the Holocene and Eemian from model simulations

Vyacheslav Khon (1,2), Birgit Schneider (1), Mojib Latif (3), and Wonsun Park (3)

(1) Institute of Geosciences, Kiel University, Marine Climate Research, Kiel, Germany (vyacheslav.khon@ifg.uni-kiel.de), (2) A.M. Obukhov Institute of Atmospheric Physics, Russian Academy of Sciences, Moscow, Russia, (3) GEOMAR Helmholtz Centre for Ocean Research Kiel, Kiel, Germany

Although the Sun crosses the equator twice a year, the sea surface temperature (SST) in the eastern equatorial Pacific (EEP) exhibits a distinct annual cycle. Therefore, in addition to the direct solar forcing, coupled ocean-atmosphere processes must also be taken into consideration to explain the observed annual cycle of the EEP SST. The annual cycle is also an important factor for the seasonal phase locking of the El Niño/Southern Oscillation (ENSO). The aim of this study is to identify dominant factors affecting the annual cycle and interannual variability in the EEP on geological time scales. For this purpose we analyze transient climate simulations of the last two interglacials, the Holocene (9.5 ka-0 BP) and the Eemian (126 ka-115 ka BP). We find that both ENSO variability and the annual cycle of SST in the EEP tend to increase from the early to late interglacials. The weaker EEP sea surface temperature annual cycle during the early interglacials is mainly a result of insolation-forced cooling during its warm phase and dynamically induced warming during its cold phase. On the other hand, enhanced convection over northern South America weakens northeasterlies in the EEP leading to weaker equatorial upwelling, deeper thermocline and subsequent warming in this region. We show that a negative ENSO modulation of the annual cycle operates only on short timescales and does not affect their evolutions on orbital time scales where both ENSO and annual cycle show similar tendencies to increase. Our model results show that ENSO phase locking to boreal winter was stronger in the late interglacials in contrast to the early interglacials where El Niño demonstrates wide spread of its peak timings.