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The tropical Pacific climate response to the changing forcing over the last glacial cycle

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The response of the tropical Pacific to orbital forcing is poorly understood. This is the result of the relative complexity of modelling the tropical climate which requires full complexity global models. Such full complexity models do not, however, lend themselves to long integrations over orbital time scales due to the vast computer resources needed. Some studies have shown how the mean state and interannual variability (ENSO) vary with changes in orbital forcing but the results are conflicting and the models used have serious short comings.

We present results from a series of integrations over the last 120 thousand years of a full complexity GCM, HadCM3, which contains all the processes that could change the mean state and ENSO on long and short timescales. These runs, the first of their kind using a full complexity model, overcome some of the flaws in the previous studies. We show results from a suite of model simulations, run as a series of snapshots over the last 120 thousand years that not only vary the orbital forcing but also greenhouse gas forcing and the presence of northern Hemisphere ice sheets. These are varied in three sets of simulations that vary the orbital forcing alone, the orbital and greenhouse gas forcing and all the forcings together. With these three sets of experiments we can unravel how the tropical Pacific climate varies over the glacial cycle.

We show that when the orbital forcing alone is varied, the annual mean temperature and ENSO vary on precessional timescales. Although this is in agreement with previous studies, we do not find that the previously proposed dynamical thermostat mechanism is responsible for the change in the full complexity model. We find that the effect of greenhouse gases on the annual mean temperature dwarves the effect of orbital variations but that ENSO variability is once again paced with the precessional cycle. The presence of ice sheets has little impact on the annual mean temperature in the tropics but causes a dramatic increase in the variability of ENSO.