Use of data and coupled modeling of ENSO to detect processes that are not detectable in forced models

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Several examples of processes are identified for having a key impact on the seasonal-to-interannual climate variations simulated by a coupled model of El Nino and a negligible impact when simulated by the model in ocean-forced or atmosphere-forced experiments. Thus, processes like the reflection of waves at the eastern or western boundaries of the ocean or like the driving of the ocean by the off-equatorial wind or by the meridional component of the wind have an impact on the 1980-to-2000 time series of the Nino3 index which is smaller than 0.5 Degree K in forced model simulations. By contrast, canceling any one of these processes during coupled simulations has an impact at least as large as 2 Degree K. Experiments are then designed to understand what role is played by each of these processes in reality. Thus, twenty-year long experiments are performed where the 1980-to-2000 variations of the so-far neglected process are prescribed while every other oceanic and atmospheric variable is being computed by the model equations. By contrast with the data-free fully coupled experiments that drift away from reality in a few months after the model initialization, the use of data to prescribe the so-far neglected process allows to simulate climate anomalies that are in good agreement with the reality observed during 1980-2000. These results illustrate that it is not because of model error growth that coupled simulations diverge from reality, but because the coupling between the ocean and the atmosphere allows processes of little importance in amplitude to play a role in setting up the phase of the system. This conclusion is also consistant with results in paleoclimate that show how the Milankovitch forcing found too weak to explain the drastic amplitude of past climate changes may have played a key role in the phasing of the climate shifts.