This study presents the simulated decadal variability of climate from an extended control run of a coupled global climate model (GCM) FGOALS-g2.0 developed at LASG/IAP. The physical mechanisms for these decadal variations are discussed and compared with observational data. The coupled GCM reproduces the similar spatial-temporal structures of sea surface temperature (SST) as observed PDO, with a significant period about 14-year. Correspondingly, the atmospheric circulation is closely related with the simulated SST anomalies associated with PDO. Response of the upper ocean temperature anomalies to the PDO PC time series matches well between the observation and the simulation. Further analysis show that the tropical Pacific variability of the upper-ocean heat budget is in accordance with the cycle of SST anomalies associated with PDO variations. The present results suggest that the heat exchanges in the upper ocean between the equatorial and off-equatorial Pacific Ocean that is associated with coupled system transit acts as a major mechanism responsible for the tropical Pacific decadal variations. Based on diagnosis above, a decadal prediction experiment with the coupled model is also carried out and evaluated.