# Coupled Hydrodynamic Ocean and Atmospheric Simulation of El Niño

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This project investigates the El Niño-Southern Oscillation (ENSO) and determines the effects it has on: rainfall rates, sea surface temperatures (SST), and wind stress on the ocean using a simple hydrodynamic model. A stacked and coupled 2D ocean and atmospheric mesh are used to solve balanced flow (equilibrium) hydrodynamics in the Pacific Ocean region. A wind-shear stress, Ekman pumping, evaporation, and condensation models were developed to provide coupling between the ocean and atmosphere. I wrote a multi-threaded C++ code from scratch to create my simulations. The initial ocean and atmospheric pressures were set by fitting Gaussian functions to observed yearly average values (nominal case). To model El Niño (La Niña), a low (high) pressure system is placed near Tahiti. For El Niño (La Niña), my simulation results show warmer (cooler) ocean surface temperatures and more (less) rainfall accumulated along the equatorial region. My simulation results are in good agreement with the NOAA data and seven professional models. The effects of global warming on ENSO were also studied by increasing the global SST in 0.5 degree steps up to 5 °C above the normal SST. A stochastic approach was used to model random atmospheric fluctuations including feedback from the SST and reflections of the thermocline "waves" off the west Pacific coastline. My simulation results predict that global warming will increase the ENSO intensity and rainfall along the equatorial region. These results were compared to a NOAA climate model and are consistent with a recently published analysis of several professional models.

**Awards Won:**

Society of Exploration Geophysicists: First Award of $1,000