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A simplified multiscale coupled atmosphere-ocean for El Niño

Ramirez Gutierrez Enver, Silva Dias Pedro, and Raupp Carlos
University of São Paulo, IAG, Meteorology, SP, Brazil (enver.ramirez@gmail.com)

A mathematically and physically consistent simplified coupled atmosphere-ocean model for the study of the El Niño variability is developed. We start with two coupled nonlinear shallow water equations in the Equatorial beta-plane. The model contains two sources of quadratic nonlinearity: internal which is associated with the advective terms and nonlinearity related to the coupling with the other medium. A simplified version of the models is obtained through the application of anysotropic spatial scalings, multi-time scale and asymptotic methods, these relatively simpler set evolves in three time scales: Equatorial Synoptic, Intraseasonal and Interanual. The set contains, as a particular case, the Matsuno-Gill coupled atmosphere-ocean model for El Niño, and with the inclusion of the thermodynamic equation, the model looks like to that used in Battisti (1988). The values for the scalings are typical values of the horizontal lengths scales, wave particle speed, and advective time scales observed in the tropical pacific region. The atmosphere evolves using the fastest two of these time scales, whereas the ocean follows the slowest two scales, this is in agreement with the intuition. Further application of asymptotic methods, allows us to obtain the slow evolution of the amplitudes or equivalently the energy of the Kelvin and Rossby waves, both paradigms of the El Niño development. Similarities and differences between the atmospheric and oceanic waves can be examined, thus with the parameterizations utilized, mass source forcing introduce dispersion in the atmospheric Kelvin and Rossby wave, whereas in the ocean no dispersion is found associated to physical parameterizations. Future works will seek for resonance conditions in these simplified model.