ABSTRACT

Pacific Subtropical Cell Variability in Coupled Climate Model Simulations of the late 19th-20th Century

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Observed sea surface temperatures averaged over the tropical Pacific Ocean show a warming trend since the 1970’s (e.g. Levitus et al. 2000). Changes in sea surface temperatures (SSTs) in the tropical Pacific have a profound impact on the global climate (e.g. Trenberth et al. 1998). McPhaden and Zhang (2002) suggest that these changes are driven, in part, by transport variations in the Pacific Subtropical Cells (STCs), based on the observed correspondence between a decrease in transport convergence in the equatorial thermocline and an increase in tropical Pacific SSTs (their Figure 2). The STCs are shallow meridional circulation cells in which water flows out of the tropics within the surface layer, subducts in the subtropics, flows equatorward within the thermocline, and upwells in the eastern equatorial ocean (Bryan 1991, see his Figure 2; McCreary and Lu 1994; Liu et al. 1994; Blanke and Raynaud 1996; Rothstein et al. 1996; Lu et al. 1998). The STCs provide a pathway by which extratropical atmospheric variability can force tropical variability through the ocean by temperature anomalies, $T$, that subduct in the extratropics and upwell at the equator (the VT mechanism) (Gu and Philander 1997) or by transport anomalies, $V$, that change the amount of water that upwells at the equator (the VT mechanism) (Kleeman et al. 1999). In this research the PIs will access how well coupled climate model simulations of the late 19th-20th centuries simulate the observed climate mean and variability of Pacific STCs, as well as, the relationship between tropical Pacific SST and STCs. The VT mechanism will be evaluated by comparing off-equatorial meridional transports on isopycnal (density) surfaces, from both the North and South Pacific, to observations. The VT mechanism will be evaluated by comparing water mass properties of the equatorial thermocline to observations. The PIs will construct multi-model ensembles using all available model output in order to estimate confidence intervals of STC variability due to changes in external forcing. The observations used in this analysis will be the Simple Ocean Data Assimilation (Carton et al. 2000a,b). The PIs understand the concerns about using this dataset as observations given the errors based on comparisons with WOCE hydrographic sections (Carton et al. 2000b). However, they feel this dataset provides an adequate estimate of the state of the Pacific upper ocean by assimilating both temperature and salinity. The NCAR Oceanography Section and Dr. Tom Delworth at GFDL have agreed to act as unpaid consultants on this project.

This is a grant under the U.S. Climate Change Science Program’s CLImate VARiability and Predictability Program (CLIVAR).