Natural Centennial Tropical Pacific Variability in Coupled GCMs

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Millennial Climate Model Simulations

Coupled Model Intercomparison Project Phase 5 (CMIP5)

21 Modeling Groups Performing “Long-Term Experiments”

10 Groups Performing (multiple) Last Millennium Experiments
Current Collection of Forced Transient Millennial Runs

CSM1.4 and CCSM3
ECHO-G: ERIK1 and 2
IPSL
MPI-ESM E1 and E2
CNRM

Gonzalez-Rouco et al., Medieval Climate Anomaly to Little Ice Age transition as simulated by current climate models, PAGES news, 19(1), 2011
Model Forcings Since 850

GHG Concentrations

Global Cropland/Pasture Area

Fig. 2. Well-mixed greenhouse gas concentration changes from 850 to 1850 CE.

Model Forcings Since 850
Volcanic Stratospheric Aerosols

Observed Trends in the SST Gradient

Observed Trends in SST and SLP Gradients

Modeled SST and SLP Climatology

Simulated Zonal SST and SLP Gradients (Control Runs)

ECHO–G Coupled Climate Model
ECHAM4 atmospheric & HOPE–G ocean models

Atm. Resolution: T30 (~3.75°) by 19 levels
Ocean Resolution: T42 (~2.8°; meridional resolution increasing to ~0.5° near the equator) by 20 levels

The ECHO–G applies a time-invariant flux adjustment (heat and freshwater fluxes) to avoid climate drift

Are Low-Frequency Oscillations Just ENSO Modulation?

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Composite Patterns

Conclusions

• If nature exhibits strong natural variability in tropical Pacific SSTs on centennial time scales, then the assumption that the observed centennial trend in the SST gradient is a response to radiative forcing is difficult to defend. Nevertheless, the natural variability could strengthen or weaken in the future as the natural variability evolves and combines (interacts?) with any forced response, clearly having implications for tropical Pacific and global climate.

• If the centennial variability in the models is spurious, it is nevertheless a component of the models and will continue to influence coupled GCM projections of future climate, as well as initialized decadal hindcasts and forecasts that are being conducted with these models. In both cases, the natural centennial variability must be properly phased at the beginning of the forecast or projection to isolate the forced change from the spurious modeled natural variability.

• Increasing numbers of millennial-length forced transient runs from fully coupled GCMs will become available over the next several years and should be an important resources for understanding these simulated periods of variability. These simulated periods of variability must also be validated against proxy evidence.