

GLOBAL AVERAGE UPPER OCEAN TEMPERATURE RESPONSE TO CHANGING SOLAR IRRADIANCE: EXCITING THE INTERNAL DECADEAL MODE

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Global average upper ocean temperature anomalies of $\pm 0.05^\circ\text{K}$ fluctuate in fixed phase with decadal signals in the Sun's irradiance of ± 0.5 Watts m^{-2} over the past 100 years (White et al., 1997), but its amplitude is 2 to 3 times that expected from the transient Stefan-Boltzmann radiation balance (White et al., 1988). Examining global patterns of upper ocean temperature and lower troposphere winds, we find the internal interannual mode of variability in Earth's ocean-atmosphere-terrestrial system with global-average upper ocean temperature anomalies of $\pm 0.05^\circ\text{K}$ occurring naturally, independent of changing solar irradiance (White et al., 2000). Yet coherence and phase statistics indicate that the observed internal decadal mode in Earth's ocean-atmosphere-terrestrial system is excited by the decadal signal in the Sun's irradiance. To understand the thermodynamics of this association we conduct a global-average upper ocean heat budget utilizing upper ocean temperatures from the SIO reanalysis and air-sea heat and momentum fluxes from the COADS reanalysis, finding the source of decadal global warming to be the reduction in trade wind intensity across the tropics, decreasing global average latent heat flux out of the ocean. We demonstrate that this reduction in trade wind intensity in the Pacific Ocean is governed by a delayed action oscillator mechanism in the ocean-atmosphere system differing little from that used to explain the El Niño-Southern Oscillation (Graham and White, 1988). We operate an intermediate coupled model of this delayed action oscillator, normally driven by white noise, by superimposing the Stefan-Boltzmann upper ocean temperature response to decadal changes in the Sun's irradiance. We find the latter, with weak amplitude of $\pm 0.02^\circ\text{K}$ and non-random phase, is able to excite a decadal signal in this delayed action oscillator, yielding a damped resonance response of $\pm 0.1^\circ\text{K}$ in the equatorial Pacific Ocean, with dissipation provided by longwave radiation to space.

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