Abstract View

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On Spatial Scales and Lifetimes of SST Anomalies beneath a Diffusive Atmosphere

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ABSTRACT

The authors identify spatial and temporal scales in a one-dimensional linear, diffusive atmospheric energy balance model coupled everywhere to a slab mixed layer of fixed depth. Mathematically, the model is identical to a heat conducting rod, which over its entire length both radiates and is in contact with a large but finite“reservoir.” Three characteristic timescales mark, respectively, the atmosphere’s adjustment to a sea surface temperature (SST) anomaly, the decay of a pointwise SST anomaly, and the radiative decay of a large-scale SST anomaly. The first and the third of these timescales are associated with diffusive length scales characterizing, respectively, the distance over which heat is diffused in the atmosphere before being lost to the ocean beneath, and the distance over which heat is diffused in the coupled system before being radiated to space. For spatial scales between the two diffusive lengths, the SST anomaly does not decay exponentially but with the square root of time; this regime has not previously been identified. Apparent discrepancies between published discussions of diffusive length scales are reconciled.