Abstract View

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Warm Water Mass Formation

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ABSTRACT

Poleward heat transport by the own implies warm Water mass formation, i.e., the retention by the tropical and subtropical ocean of some of its net radiant heat gain. Under what condition net heat retention becomes comparable to latent heat transfer to the atmosphere depends on the relative efficiency of transfer processes across the air-sea interface, the top of the atmospheric mixed layer, and the floor of the oceanic mixed layer. A thermodynamic model of the interacting atmospheric and oceanic mixed layers with the top of the atmospheric layer taken to be at cloud base, shows that net oceanic heat retention is significant under the following circumstances.

1) Seasonal heat storage, amplitude of order 100 W m^{-2}. This is a fairly straightforward consequence of the large heat capacity of the oceanic mixed layer and leads the seasonal forcing by about a month.

2) Massive upwelling (vertical velocity of order 10^{-5} m s^{-1}), mostly along equatorial cool tongues with net heat retention of order 100 W m^{-2}. The upwelling cooler water is heated and transported away mainly by the divergence of surface layer flow (less by the increasing temperature in the direction of the flow).

3) Cold water advection, mostly within the subtropical gyres net heat retention of order 30 W m^{-2}. The latitudinal variation of radiant heating and generally equatorward surface flow in the northern portions of subtropical gyres leads to a moderate rate of warming of the water column a it moves along i.e., to net heat retention of the above order.

A comparison of model results with observation shows that, over the subtropical gyres, observed temperature and humidity relationships can be simulated realistically only if cold water advection is taken into account. In addition, it is necessary to suppose that the transfer coefficient at the top of the atmospheric mixed layer (at cloud base) is about as large as at the sea surface, while the transfer coefficient at the oceanic mixed layer door is negligible, except in regions of massive upwelling. The general dominance of latent heal transfer arises from the large value of a nondimensional latent heat coefficient (a material property) and from the rapid drop of saturation specific humidity with height in the atmosphere.

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