Seasonal Characteristics of Mesoscale Coupling between the Sea Surface Temperature and Wind Speed in the South China Sea

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ABSTRACT

The seasonal characteristics of the mesoscale coupling between sea surface temperature (SST) and wind speed in the South China Sea (SCS) are investigated using satellite observations. The correlation between mesoscale SST and wind speed is highest in winter. The region of high correlation is located in the central SCS in the early stage of the winter monsoon. It then gradually shifts northward in the following months and is located in the northern SCS in the late stage of the winter monsoon. In summer, the region of high correlation is located to the east of the Vietnam coast. Two controlling factors are crucial in mesoscale SST–wind speed coupling: the mesoscale SST gradient and the wind speed steadiness. The mesoscale SST gradient is fundamental in mesoscale coupling, but a steady wind speed also plays an important role. The development of significant coupling depends on the relative contribution of these two factors. For regions where the mesoscale SST gradient is relatively weak, a very steady wind field is required for detectable mesoscale coupling to occur, whereas in regions where the wind speed is less steady, a stronger mesoscale SST gradient must exist for coupling to develop. Variations in wind speed steadiness can well explain the inconsistency between the spatial patterns of the mesoscale SST gradient and the intensity of coupling. The wind speed steadiness is a good factor with which to evaluate the constraining effect of the background wind field variability on the development of mesoscale coupling in the SCS.

1. Introduction

High-resolution satellite observations have shown that sea surface temperature (SST) and wind speed are positively correlated on oceanic mesoscales in both the tropics and extratropics. (Chelton et al. 2001; Xie 2004; Small et al. 2008). Such a positive SST–wind relationship is mainly due to the SST's modification of stability and vertical mixing in the atmospheric boundary layer. Cold water stabilizes the atmosphere boundary layer and thus decouples the winds at the sea surface from those at a greater height, whereas heating over warm water deepens and destabilizes the atmospheric boundary layer, decreasing the wind vertical shear (Hayes et al. 1989; Wallace et al. 1989; Hashizume et al. 2001; Xie et al. 2001). Other key mechanisms have also been proposed as underlying this positive relationship, including secondary circulation in the boundary layer driven by pressure gradients across SST fronts (Lindzen and Nigam 1987; Wai and Stage 1989) and wind stress change associated with fronts and eddy currents, which can impact the relative motion of the air and ocean (Cornillon and Park 2001; Kelly et al. 2001). The positive correlation between SST and wind speed is most significant in regions where there are prominent oceanic fronts, such as the Kuroshio and its extension (Nonaka and Xie 2003), the Southern Ocean (O'Neill et al. 2003; Perlin et al. 2014), the eastern tropical Pacific (Chelton et al. 2001), and the Gulf Stream rings (Park and Cornillon 2002).

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