Ocean-atmosphere Coupling Observed from Space

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The ocean is forced at the surface largely through the exchanges of water, heat, and momentum. The exchanges drive the transport and change the storage of heat, water, and greenhouse gases, and thus moderate the world's climate. The ocean feedback to climate changes must be manifested through these exchanges, without which the Earth would be a more hostile habitat. Adequate observations at significant temporal and spatial scales can only be achieved from the vantage point of space. An overview of present spacebased sensors that contribute to the estimation of these exchanges will be presented. The manifestation of ocean-atmosphere coupling, as the correlation between two well-established spacebased measurements - sea surface temperature and surface wind, has long been studied. Two perspectives on the correlation will be presented - atmosphere or the ocean as the driving force.

Negative correlations are found between seasonal changes of curl of wind stress and sea surface temperature caused by monsoons, and at the wake of tropical cyclones, largely because of wind-driven Ekman pumping and vertical mixing in the ocean. Negative lag correlations have also been observed between wind-driven evaporative cooling and sea surface temperature in both annual and interannual time scales over global oceans. In these cases, atmosphere drives the ocean.

The case of ocean driving the atmosphere is best demonstrated in the two mechanisms that sustain the double intertropical convergence zones (ITCZ). The stronger ITCZ occurs when the northerly trade winds meet the southerly trade winds over water with sea surface temperature above threshold for deep convection. The weaker ITCZ occurs over cooler water and is caused by the deceleration of the surface winds as they approach the cold upwelling water near the equator. Decreases in vertical mixing and increases in vertical wind shear in the atmospheric boundary layer are suggested to be the causes of the deceleration of the trade winds as they move from warmer to colder water. This boundary instability mechanism is ubiquitous and may be a major mechanism for air-sea coupling when SST is below deep-convection threshold. The resultant positive contemporary correlation has been observed in tropical instability waves, in the cold wake of tropical cyclones, and in bathymetry induced and warm-current induced SST fronts.