

Coupled ocean-atmosphere manifestations of the Hadley Circulation in the monsoon system

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The original works of Halley and Hadley attempted to explain the observations made by mariner's of the tropical wind systems in the subtropics and tropics. Halley explained the seasonal reversal of the monsoon winds by noting the seasonal cycle of heating between the ocean and adjacent continents. Hadley explained the persistent trade winds as a result of the rotation of the planet. Together, their physical reasoning explains much of the variance of the monsoon circulations. By the latter half of the last century with the inclusion of moist processes, and an understanding of how heat is vertically mixed in the oceans it was thought that the strongest component of the planetary meridional circulations was completely understood. However, recent observations and analysis indicate that the oceans in the monsoon regions play a much more dynamic role than was previously thought.

Rather than being a simple atmospheric phenomenon responding to changes in surface fluxes associated with slowly changing SST distributions, it appears that the monsoon circulation is truly a coupled phenomenon with dynamic heat transports by the ocean acting as a negative feedback on the overall magnitude of the atmospheric circulation. In fact, the wind-driven ocean transports resemble cross-equatorial meridional circulations acting in the opposite sense to those found in the atmosphere and transporting large quantities of heat from the summer to the winter hemisphere. The appreciation that the monsoon is a coupled ocean-atmosphere system has allowed a greater understanding of the mechanisms that produce the mean structure of the monsoon as well as its intraseasonal and interannual variability. .