Coupled Ocean-Atmospheric Dynamics of the ITCZ and its Variability over the Pacific and Atlantic

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The intertropical convergence zone (ITCZ) is the rising branch of the Hadley circulation and through the intense condensational heating that takes place there, drives the global atmospheric circulation. Despite an annual-mean solar radiation distribution that is symmetric about the equator, the ITCZ over the eastern Pacific and Atlantic is displaced in the Northern Hemisphere (NH), except for a brief period of March and April when it stays near the equator and occasionally move into the Southern Hemisphere. The collocation of the ITCZ with the meridional maximum of sea surface temperature (SST) suggests the importance of ocean-atmosphere interaction in keeping the Pacific and Atlantic ITCZ north of the equator. This paper reviews the progress made in the past decade in understanding the coupled dynamics of this northerly ITCZ.

A positive feedback between wind speed, evaporation at the sea surface and SST (WES) is at the center of developing equatorial asymmetry of oceanic ITCZ. Continental asymmetries, such as the land bulge of western North Africa and the tilted west coastal line of Americas, excite a coupled wave front that propagates westward and leaves behind a northward-displaced ITCZ. Challenges remain to model adequately the stratus cloud deck in the Southern Hemisphere and the narrow and steep mountains of the Andes. On geological timescales, continents experience large changes in their shape and relative location, likely with great consequences to the ITCZ and hence global circulation.

The meridional configuration of the ITCZ is a key factor influencing the time-space structure of climate variability. On the seasonal timescale, the northward displacement of the ITCZ is shown to trigger a pronounced annual cycle on the equator despite a lack of annual solar forcing there. On interannual timescales, the weakening of equatorial asymmetry in the mean ITCZ in boreal spring provides a time window for developing a meridional dipole of coupled ocean-atmospheric variability in the tropical Atlantic. There is evidence that the same WES feedback is at work in developing this tropical Atlantic variability, causing the ITCZ to vary its position from one year to another.