

On the Seasonality of the Hadley Cell

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Abstract

The classical ‘Hadley cell’ characterized by rising motion on the equator and sinking motion in the subtropics of both hemispheres is clearly apparent only in monthly cross sections of the zonally averaged streamfunction field for April and November. The fact that cross sections for all other months are marked by strong equatorial asymmetries, with a prevalence of rising motion in the summer hemisphere and sinking in the winter hemisphere has given rise to the notion that the tropical mean meridional circulations are dominated by an equatorially asymmetric ‘solstitial’ cell, which is strong year round, apart from brief post-equinoctial transition seasons in which it reverses direction.

Here it is shown that the equatorially symmetric and asymmetric components of the mean meridional circulation are, in fact, quite comparable in strength, and that the solstitial cell exhibits a smooth, sinusoidal seasonal evolution, provided that one takes into account its amplitude, as well as its polarity.

The residual derived by subtracting the solstitial component from the total field reveals a pattern that strongly resembles the annual-mean component in all calendar months. Hence the classical, nearly equatorially symmetric ‘Hadley cell’ is not an ephemeral equinoctial feature of the general circulation but it is robust and present year round.

We also present circumstantial evidence in support of the traditional interpretation of the solstitial cell as to be, to a large extent, a reflection of the monsoons.