Geophysical Research Abstracts
Vol. 19, EGU2017-19208, 2017
EGU General Assembly 2017

The relationship between African easterly waves and equatorial waves and the influence from the Southern Hemisphere

John Methven (1), Yang Guiying (2), Kevin Hodges (2), and Steve Woolnough (2)
(1) Department of Meteorology, University of Reading, UK, (2) NCAS-Climate, University of Reading, UK

There is strong intraseasonal and interannual variability in African easterly waves (AEWs). AEWs are crucial to precipitation across West Africa, but also generate positive vorticity centres that sometimes develop into tropical storms which can in turn spin-up into hurricanes in the easterlies across the North Atlantic. In this paper we show that there are connections between African easterly waves (AEWs), equatorial Rossby (R1 and R2) waves and westward-moving mixed Rossby gravity (WMRG) waves and that the conditions for propagation of equatorial waves may have a major influence on AEW and hence tropical cyclone variability.

Two analysis approaches are taken using ERA-Interim data from 1979-2010: i) positive vorticity centres within AEWs are tracked at 600 hPa over West Africa to the Atlantic region and ii) the re-analysis data is filtered using a broad frequency and zonal wavenumber band and the filtered meridional wind is projected onto the horizontal structure functions derived from equatorial wave theory.

The tracked vorticity centres are part of AEWs and are found to move along with features in the meridional wind projecting onto R1 and R2 waves. In contrast, the structures projecting onto WMRG waves move westwards at a faster rate. The projection is calculated independently on each pressure level to create composite cross-sections of each wave mode in the zonal-height plane, shown relative to the 600 hPa vorticity centres. The R2 waves tilt in the sense necessary for baroclinic growth and amplify from east to west, indicating that R2 horizontal structure captures the baroclinic wave component of AEWs.

The composites show that the R2 structures have a wavelength matching the spacing between vorticity centres, while R1 and WMRG waves are longer. Intriguingly, the WMRG component has very strong cross-equatorial flow immediately to the east of positive vorticity centres developing on the AEJ. Although the WMRG propagates faster to the west and gets ahead of the original vorticity centre, the next AEW vorticity centre to the east develops with cross-equatorial flow in the same phase. This flow brings moist air from the southern hemisphere at low levels on the eastern flank of the vorticity centre, while there is an upper tropospheric "return flow" into the southern hemisphere above. Thus, there is a strong cross-equatorial component to the developing tropical storm outflow.

WMRG waves may aid the initiation and development of AEW vorticity centres. Over West Africa, regressions show that the eastward group propagation of a WMRG packet precedes the genesis of vorticity centres

on the AEJ. In years with stronger AEW activity, the upper tropospheric easterlies are stronger at the equator and extend further into the southern hemisphere. It is shown that stronger easterlies provide a waveguide for SH westward-moving Rossby waves in the upper troposphere to penetrate into the tropics, exciting equatorial WMRG waves and hence stronger AEW activity via the lower tropospheric cross-equatorial flow associated with WMRG waves.