Examining Teleconnections Generated By Indian Ocean Convection By Modifying Diabatic Heating in a GCM

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Similar to classic linear modeling experiments, a full atmospheric GCM can be used to examine the teleconnections generated by tropical and subtropical heating, through modification of the GCM's calculation of diabiatc heating. The diabatic heating can be enhanced or suppressed in a specific region and left unchanged everywhere else; comparison with completely unmodified runs shows the response to the change in heating. This extends the results of linear modeling because the GCM response can be fully nonlinear and interacts directly with explicitly resolved moist processes and precipitation.

This approach is used to examine the influence of the teleconnections generated by tropical Indian Ocean convection on both Central-Southwest Asia (Barlow et al. 2007) and on Africa (Funk et al. 2008). Over Central Asia, observational analysis suggests that a Gill-like Rossby response to the tropical convection intersects the westerlies, resulting in thermodynamically-forced subsidence and reduced precipitation over Central-Southwest Asia, similar to the Rodwell-Hoskins desert monsoon hypothesis. All stages of this mechanism are reproduced in the GCM when deep diabatic heating is enhanced over tropical eastern Indian Ocean. Over Africa, observations again suggest a Gill-like response to tropical Indian Ocean convection, but the influence on continental precipitation appears to be primarily in terms of changes to moisture transport in this case. This teleconnection and its influence on moisture transport and precipitation is also reproduced well in modified GCM experiments.

These two analyses increase our understanding of the teleconnections generated by tropical Indian Ocean convection and suggest that GCM experiments with modified heating may have considerable utility in investigating climate variability.

Barlow, M., A. Hoell, and F. Colby, 2007: Examining the wintertime response to tropical convection over the Indian Ocean by modifying convective heating in a full atmospheric model, Geophys. Res. Lett., 34, L19702, doi:10.1029/2007GL030043.

Funk, C., M. Dettinger, J. Michaelsen, J. Verdin, M. Brown, M. Barlow, and A. Hoell, 2008: Warming of the Indian Ocean threatens eastern and southern Africa, but could be mitigated by agricultural development. Proc. Nat. Acad. Sci., in press.