Mechanisms of the seasonal intensification of the Somali jet

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Abstract

The intensification of the off-equatorial Somali jet which accompanies the onset of the South Asian monsoon is rapid compared to the seasonal evolution of the insolation forcing. We present a 27-year composite of the seasonal evolution of this jet based on reanalyzed winds, which shows that such rapid intensification occurs primarily over the off-equatorial Arabian Sea and to the east of the peak cross-equatorial flow. The intensification of the jet is accompanied by a large increase in low-level convergence north of the zero absolute vorticity contour as this contour shifts into the summer hemisphere, and also by a large increase in the surface enthalpy flux over the Arabian Sea that suggests a wind-evaporation feedback.

The mechanisms responsible for this behavior are examined in a simplified model of the tropical atmosphere. If the boundary layer entropy is assumed to adjust instantaneously to that of the underlying sea surface, nonlinear advection of zonal wind is required to produce strong low-level convergence north of the equator. If a thermodynamic disequilibrium is instead allowed to exist between boundary layer air and the sea surface, the dependence of surface entropy fluxes on wind speed produces strong low-level convergence north of the equator, even in the absence of nonlinear momentum advection. We show how the nonlinear advection of both zonal wind and boundary layer entropy can lead to the formation of fronts and a sharp off-equatorial convergence zone. The wind-evaporation mechanism explains the coherent

evolution of vorticity, low-level convergence, deep convection, and surface enthalpy fluxes seen in the composites of the Somali jet onset.