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Internal variability in the West African Monsoon on a 7-10 day time-scale linked to the African Easterly Jet-African Easterly Wave System

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Title
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Summary
A crucially important component of the West African Monsoon (WAM) and its associated rainfall variability, is the African Easterly Jet-African Easterly Wave (AEJ-AEW) system. Its structural characteristics and dependencies have been explored in a moist idealised model. Prescribed zonally symmetric surface temperature and moisture profiles determine the AEJ which becomes established through meridional contrasts in dry and moist convection.

As in previous studies, a realistic AEJ developed with only dry convection. Including moist processes, increased its development rate, but reduced its speed and meridional extent. AEWs grew through barotropic-baroclinic conversions. Negative meridional PV gradients arose in the zonally symmetric state through the intrusion of the low PV Saharan boundary layer. Moist processes strengthened this significantly through diabatically-generated PV in the ITCZ, resulting in moist AEWs three times the magnitude of the dry AEWs. Larger barotropic conversions and faster AEJ development, increased the moist wave growth-rate. Jet-level and northerly low-level amplitudes grew, but in the moist case the low-level amplitudes weakened as the AEW interacted with convection, consistent with their absence from observations during the peak monsoon.

Importantly and in contrast to the dry AEWs, moist AEWs were characterized by intermittent periods of growth and decay, with growth preceded by increased mean rainfall, and subsequently weakening AEJs. Interestingly, the rainfall appeared to slightly lead the evolution of the EKE most of the time implying that moist convection was needed to strengthen the meridional PV gradient sufficiently to trigger/re-invigorate moist AEWs. This may be especially true following a period of growth that leaves the moist jet considerably weaker. These dependencies established an internal 7-10 day variability, consistent with intra-seasonal observations of 9-day rainy sequences. The observed 7-10 day cycle of rainy sequences related to the natural life cycle of the moist AEW and its interaction with the AEJ, the upper levels and the precipitation. This is a significant result from the moist life cycle as it offers a new view of the moist AEW life cycle and provides an alternative explanation for the observed intra-seasonal variability of the precipitation over NW Africa during the monsoon months.