Geophysical Research Abstracts
Vol. 15, EGU2013-12262, 2013
EGU General Assembly 2013
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Water vapour in the Sarahan Heat Low : A new theory of interannual to decadal scale variability in the summertime circulation over West Africa

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The Saharan Heat Low (HL) is a region of summertime high surface and boundary layer temperature that is a key dynamical element of the West African monsoon system. Variations in the temperature and thickness of the boundary layer air over the HL region have been shown to modulate the characteristics of the monsoonal circulation, including the intensity and location of monsoon precipitation. Although the importance of the HL in shaping the intraseasonal variability of the monsoon has been established, no study has investigated the interannual to decadal scale variability of the HL, nor determined how such changes in the HL may have affected precipitation across West Africa on such time scales. Via analysis of observations, reanalysis data, coupled model output, and an idealized linear model, we suggest that the noted intraseasonal relationship between HL temperatures and monsoonal circulation holds on interannual to decadal time scales. In addition, the year-to-year variations in the intensity of the HL are radiatively forced by changes of water vapour within the HL region, and, as such, small changes in water vapour advected into the HL may alter the summertime circulation over West Africa. Based on these results we propose a new theory for explaining observed interannual to decadal-scale variability of the West African monsoon and summertime precipitation that is based on positive feedbacks between evaporation associated with vegetation changes in the Sahel, dust emission from West Africa, tropical Atlantic Ocean temperature anomalies, and the dynamics of the HL.