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Links between West African Cloud Cover, Lightning Activity and the Intensity of Atlantic Hurricanes

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The majority of intense Atlantic Ocean hurricanes start as thunderstorms over tropical Africa, moving westward from Africa into the Atlantic Ocean. These thunderstorms are embedded in mesoscale convective systems (MSCs) that are part of large-scale African Easterly Waves (AEWs) that develop during the northern hemisphere summer season (May-October) every year. We have analyzed 6 years of cloud and lightning data (2005-2010) over Central and West Africa to: 1) understand the link between lightning and the temperature of cloud tops (T< 273 K) and their areal coverage, and 2) understand the link between cloud cover and the maximum intensity of Atlantic hurricanes.

The cloud data was obtained from the METEOSAT second generation (MSG) geostationary satellite that provides visible and infrared images of tropical Africa every 15 minutes. The lightning data was obtained from the World Wide Lightning Location Network (WWLLN) that detects primarily the intense cloud-to-ground (CG) flashes over Africa.

It was found that the daily WWLLN lightning activity was best correlated with the area coverage of clouds with cloud-top temperatures below 213 K (r=0.68), while the monthly lightning activity was best correlated with clouds colder than 203 K (r=0.8). Since the AEWs are associated with thunderstorms, that are associated with high cloud tops, it was not surprising that the number of AEWs per month was also well correlated with the monthly amount of clouds with tops below 223 K (r=0.82). We report a surprising link between the area coverage of cold clouds in West Africa, and the eventual maximum sustained winds in 63 tropical storms/hurricanes that developed from these AEWs. Low areal coverage of cold clouds in West African AEWs never resulted in major hurricanes (only tropical storms and Cat 1, 2 hurricanes), while high areal cloud coverage in West Africa always resulted in major hurricanes (maximum sustained winds > 96 knots, or category 3 and above).