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Disagreements between Moisture Distribution in (Re)Analysis Products associated with Surges of the West African Monsoon

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Reanalysis and operational analysis products are routinely used as the best estimates of the atmospheric state for climatological studies, to initialise operational forecasts or simulations for research, or to drive chemistry transport models. Differences between the models employed, assimilation methods and assimilated datasets can lead to substantial differences between (re)analysis products. Here we analyse such differences in the distribution of low-level water vapour to estimate the zonal mean position of the leading edge of the West African Monsoon (the Intertropical Discontinuity, ITDΦ). We do this for 11 monsoon seasons (April–September, 2000–2010) in 7 (re)analysis products: (1) NCEP-NCAR, (2) NCEP-DOE, (3) MERRA, (4) CFSR, (5) ERA-Interim, (6) GFS operational analysis and (7) ECMWF operational analysis.

Long-term biases and inter-annual and seasonal patterns of disagreement between the different (re)analysis products are identified, together with particular periods with extreme disagreement . Composites of the extreme disagreement events show that they coincide with northward excursions of the ITDΦ and the production of rainfall in the Sahel and Sahara. Tropical Rainfall Measuring Mission (TRMM) 3B42 V7 rainfall retrievals are used to illustrate the presence of precipitating clouds north of the ITDΦ one to four days before peak disagreement. TRMM retrievals are compared with outgoing longwave radiation (OLR) from the products which produce the greatest and smallest range of movement of ITDΦ. The product with the greatest range which also stays north longest compares well with TRMM and has a much greater coverage of cold cloud compared to the product which produces the smallest and shortest lived northward surge. The largest disagreement occurs during the retreat of the ITDΦ.

The sparse nature of observations over much of West Africa mean that the ITD in (re)analysis products is poorly constrained, particularly if ITDΦ is far north. Therefore, it is possible that much of the (re)analysis is directly attributable to the model first guess. The relatively coarse resolution used by global models means that features such as meso-scale convective systems have to be parameterised. This represents a problem because it is possible for meso-scale processes such as convective cold pools to significantly impact synoptic-scale meteorology. An example of the importance of observations is the large reduction in disagreement that is seen during 2006, when enhanced upper air observations took place during the Afican Monsoon Multidisciplinary Analysis (AMMA) field campaign.

It is important to note that agreement between products does not imply that they are correct. Nevertheless, it is hoped that this work will (1) inform the community that caution should be taken when using a (re)analysis product in isolation especially during times of northward surges of the ITD and (2) instigate further work to improve the quality of (re)analyses over West Africa.