# Modeling the West African Monsoon and the Formation of African Easterly Waves

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## INTRODUCTION

The West African Monsoon brings seasonal rains to the Sahel region during the summer months of May to October. During this season, the African Easterly Jet (AEJ) is most strongly developed as a result of temperature and moisture gradients that span the region from the Gulf of Guinea to the Saharan desert. African easterly waves (AEWs) form in association with this jet. It is important to study AEW development and maintenance since AEWs propagate westward over the Atlantic and can foster development of hurricanes, as well as provide beneficial rainfall to west Africa during the summertime.

## MODEL SPECIFICATIONS

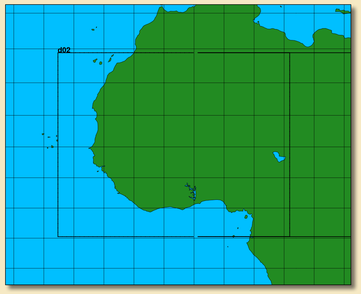


Figure 1. Example of model domains used in WRF simulation. Outer box represents the coarse dimension, inner box labeled d02 represents the finer domain.

- Weather Research and Forecasting (WRF ARW) Model version 3.3
- Fully compressible, non-hydrostatic
- Time step of 240 seconds
- 2 Nested domains, each with 28 vertical levels:

*Domain 1* - 78km resolution (3.130°S to 33.46°N 26.8°W to 22.8°E)

*Domain 2* - 26km resolution (1.7°N to 29.31751°N, 21.9°W to 17.2°E)

## MONSOON WINDS

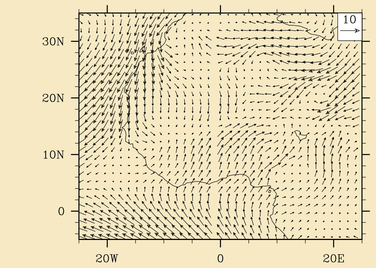


Figure 2. Average May 2006 wind vector field (m/s) at 925 mb using ERA-Interim reanalysis data.

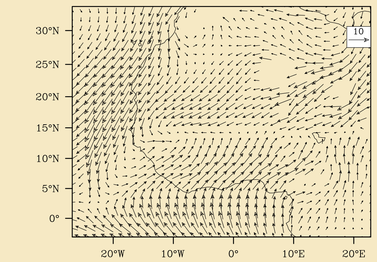


Figure 3. Average May 2006 wind vector field (m/s) at 925 mb using WRF model data.

## EDDY KINETIC ENERGY

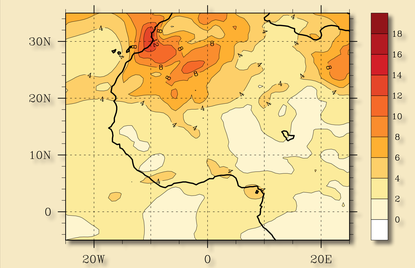


Figure 4. Average May 2006 eddy kinetic energy ($m^2/s^2$) at 700 mb using ERA-Interim reanalysis data.

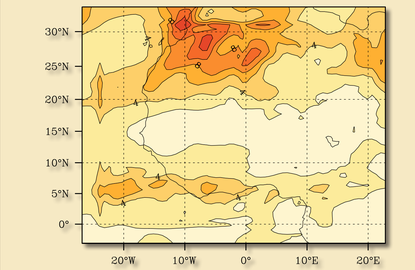


Figure 5. Average May 2006 eddy kinetic energy ($m^2/s^2$) at 700 mb using WRF model data.

## TEMPERATURE

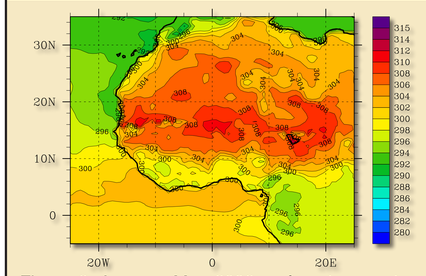


Figure 6. Average May 2006 surface temperature (K) using ERA-Interim reanalysis data.

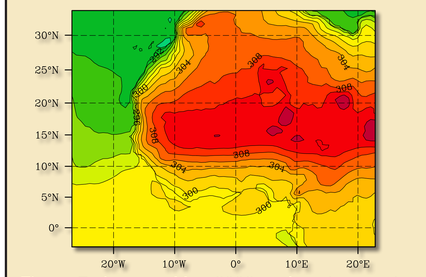


Figure 7. Average May 2006 surface temperature (K) using WRF model data.

## PRECIPITATION

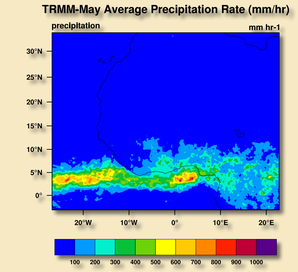


Figure 8. Average May 2006 precipitation (mm/hr) using TRMM data. TRMM was chosen over ERA-Interim to avoid the inherent errors in ERA-I precip data.

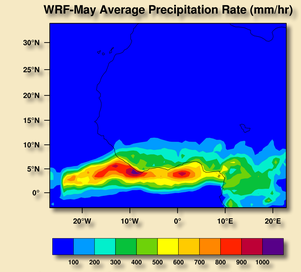


Figure 9. Average May 2006 precipitation (mm/hr) using WRF model data.

## AFRICAN EASTERLY JET

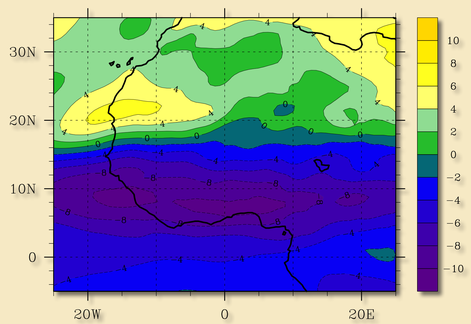


Figure 10. Average May 2006 700 mb U-winds (m/s) using ERA-Interim reanalysis data.

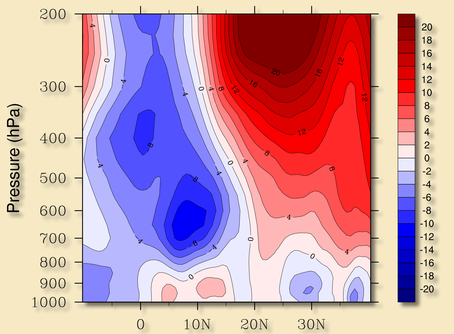


Figure12. Average May 2006 cross section of U-winds (m/s) at 0-East using ERA-Interim reanalysis data.

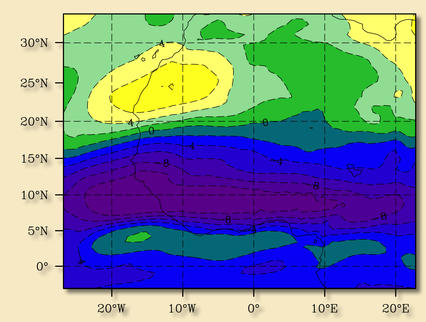


Figure 11. Average May 2006 700 mb U-winds (m/s) using WRF model data.

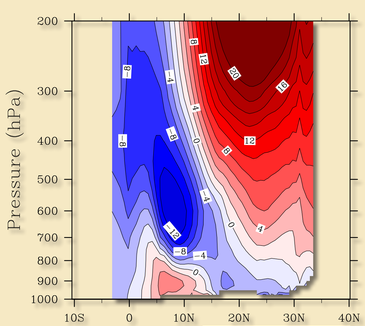


Figure13. Average May 2006 cross section of U-winds (m/s) at 0-East using WRF model data.

## AFRICAN EASTERLY WAVES

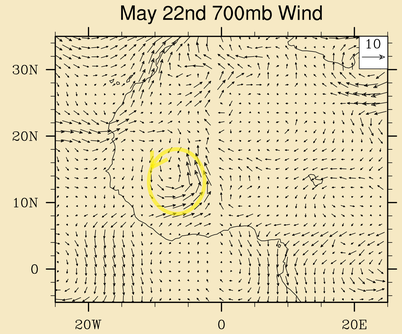


Figure 14. Average 700 mb $u^1$ & $v^1$ vector snapshot on May 22, 2006 using ERA-Interim reanalysis data. (Primes calculated as deviations from the 5-day mean)

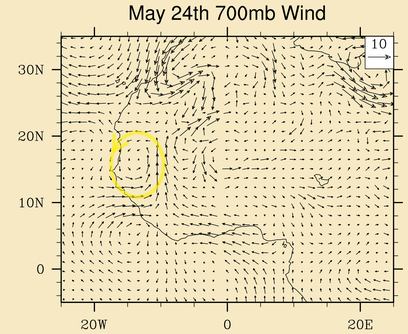


Figure 15. Average 700 mb $u^1$ & $v^1$ vector snapshot on May 24, 2006 using ERA-Interim reanalysis data.

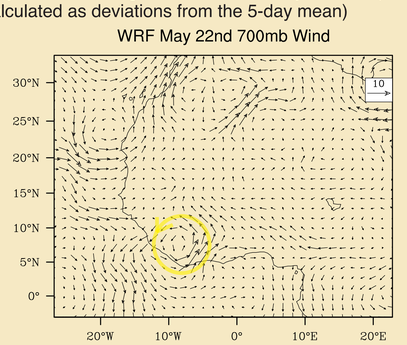


Figure 16. Average 700 mb $u^1$ & $v^1$ vector snapshot on May 22, 2006 using WRF model data.

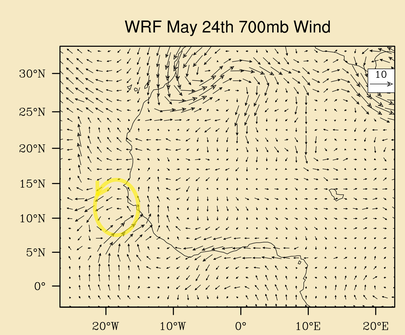


Figure 17. Average 700 mb $u^1$ & $v^1$ vector snapshot on May 24, 2006 using WRF model data.

## CONCLUSIONS

- WRF model has evident flaws when compared to observed data, but overall it's not bad
- Higher vertical resolution model approximately 8x more expensive in terms of computing time
- Unless high res model proves to be significantly better, current WRF model will be used for future research

## FUTURE WORK

- Extend WRF model run through September
- Determine the conditions that cause variations in the strength of easterly waves
- Try to understand the influence these waves have on convection over the region
- Complete a series of runs filtering out AEW information from the ERA-I input data to see how this may change the characteristics of convection over the region
- Extend model domain west over the Atlantic
- Assess the implication of AEWs and their variability for tropical cyclone formation
- Examine how cyclogenesis statistics change when easterly waves are suppressed

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