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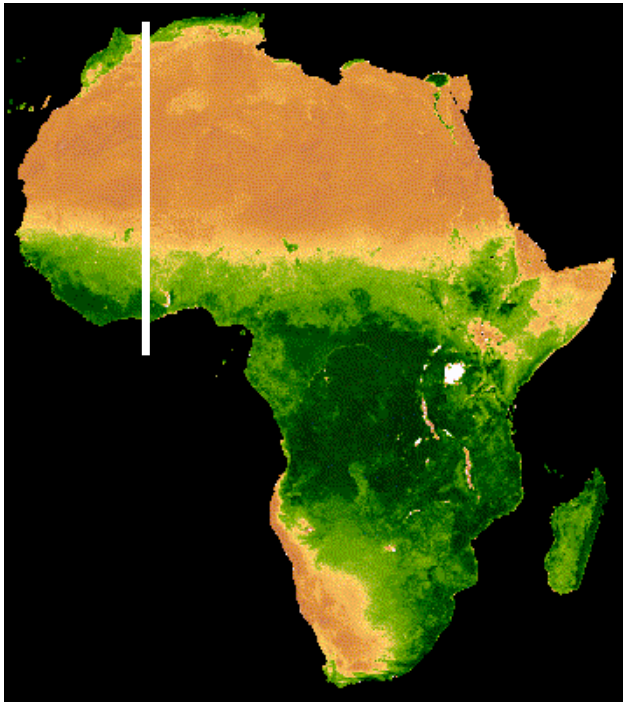
Understanding Changes in West African Monsoon Precipitation in Response to Increased CO_2

Mat Collins, **Harry Mutton**, et al.

West African Monsoon (WAM)



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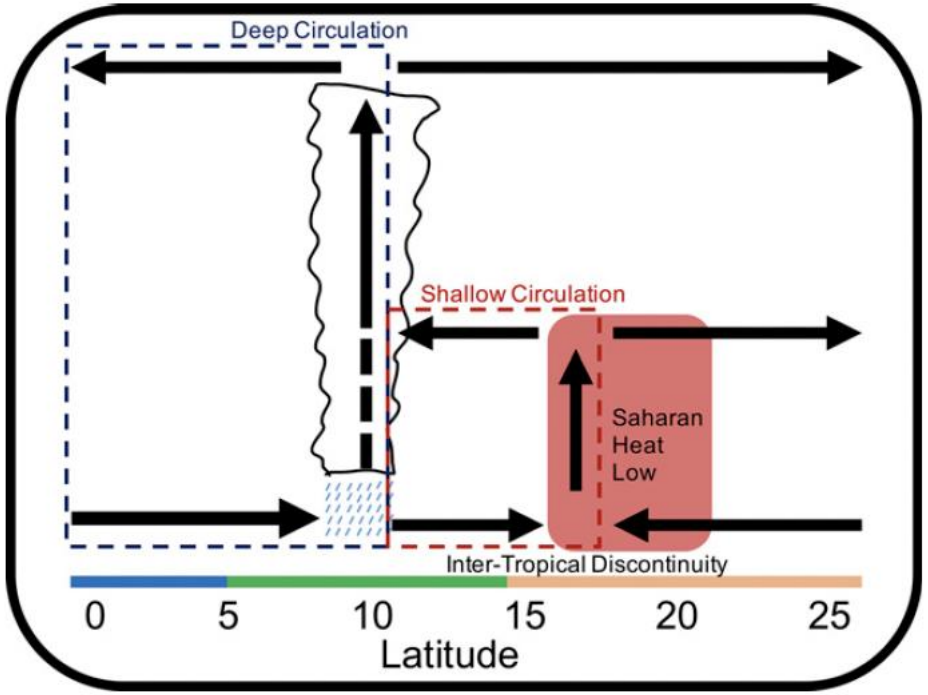

The Impact of the Direct Radiative Effect of Increased CO_2 on the West African Monsoon

HARRY MUTTON,[a] ROBIN CHADWICK,[b] MATTHEW COLLINS, F. HUGO LAMBERT,[a] RUTH GEEN,[a] ALEXANDER TODD,[a] AND CHRISTOPHER M. TAYLOR[c]

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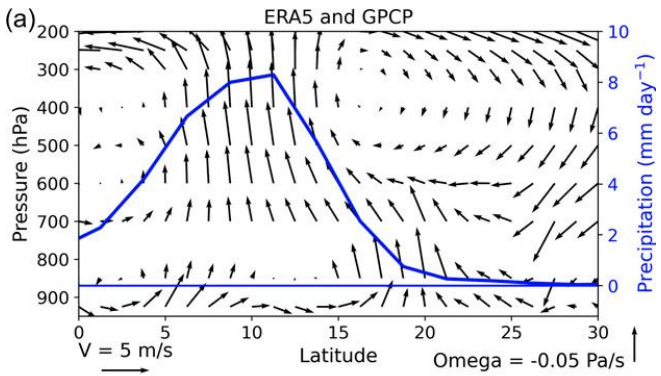

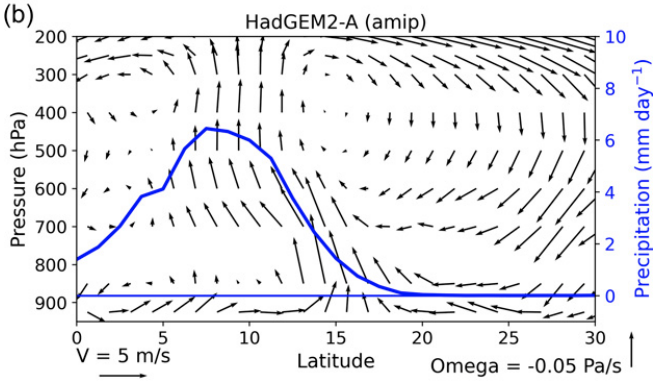

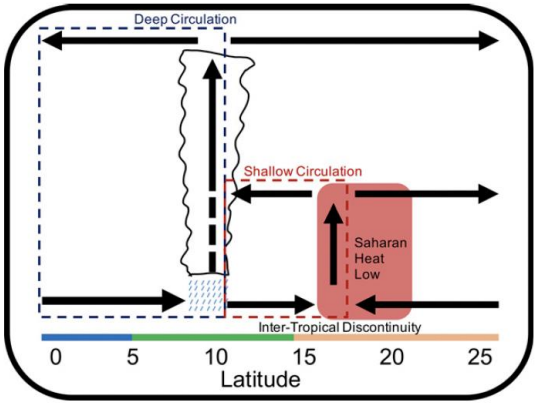

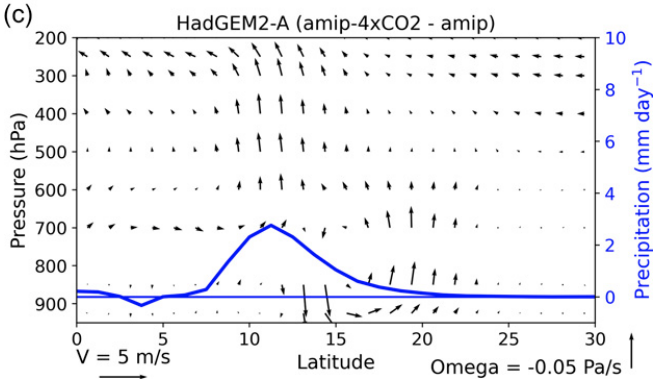

Direct effect of CO_2

J.Clim

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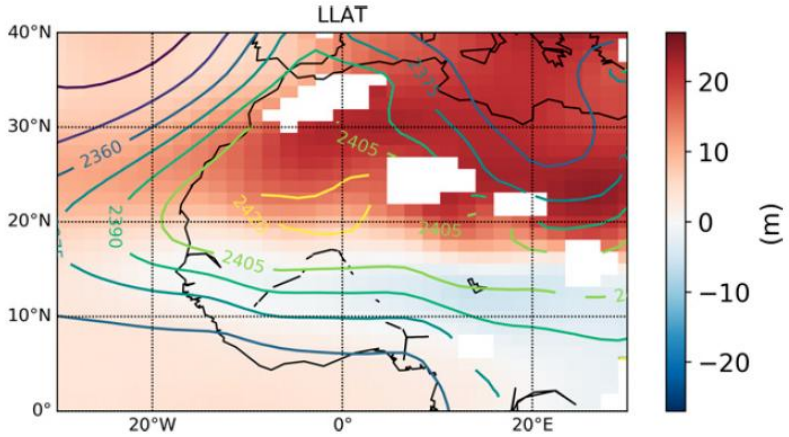

FIG. 9. August amip climatology (line contours) and amip-4xCO2 − amip anomalous (colors) low-level atmospheric thickness (LLAT; m). Areas of white are caused by topography masking the data.

- WAM precipitation increases due to a weakening of the shallow meridional circulation over N. Africa, advecting less dry air into the convective column associated with the monsoon
- Changes in the shallow circulation are associated with atmospheric and surface warming patterns over N. Africa, causing a northward shift in the Saharan heat low
- In response to increased precipitation in the Sahel, local soil moisture feedbacks play a role

The impact of a uniform ocean warming on the West African monsoon

Harry Mutton[1] · Robin Chadwick[2] · Matthew Collins[1] · F. Hugo Lambert[1] · Christopher M. Taylor[3,4] · Ruth Geen[5] · Alexander Todd[1]

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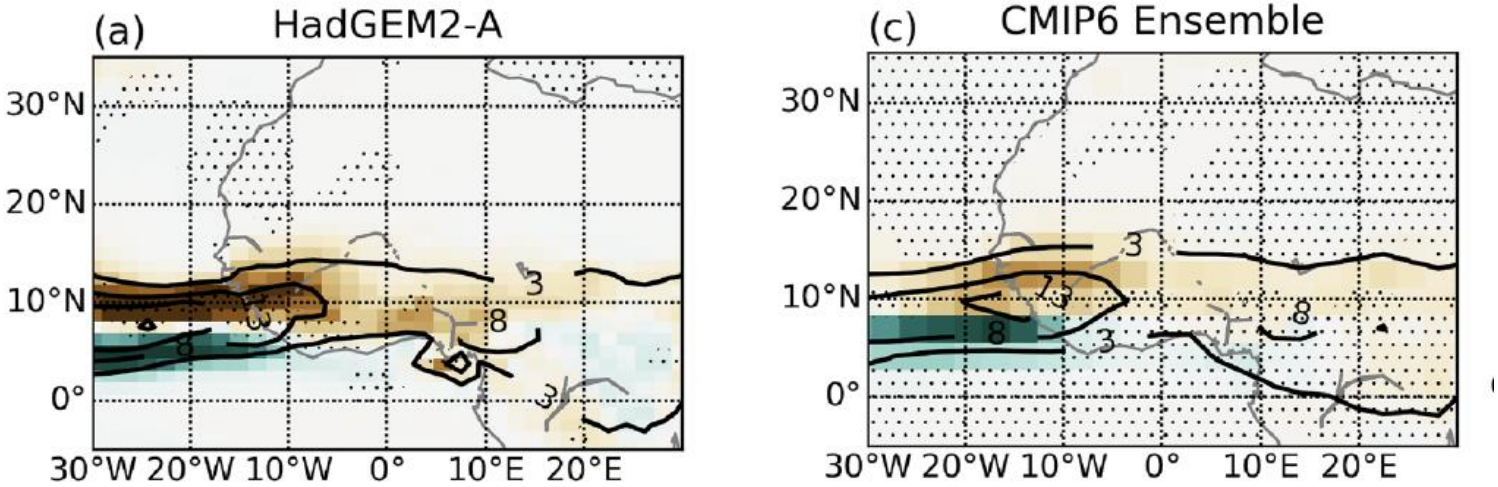

+4K Uniform Sea Surface Temperature Warming

Clim. Dyn

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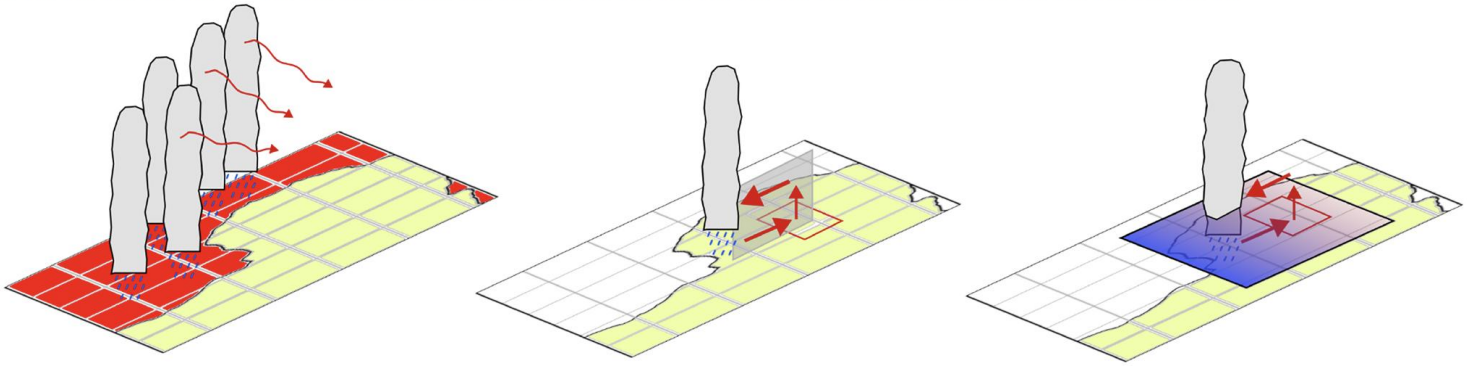

a) The initial decrease in WAM precipitation is caused by warming and enhanced convection over the ocean, stabilising the atmosphere inland and disrupting the monsoon inflow at low levels

b) Later in the response the WAM precipitation is reduced through a strengthening of the shallow circulation over West Africa, associated with changes in the large-scale temperature gradients and a local warming of the atmosphere related to a soil moisture feedback mechanism over the Sahel

c) Finally, the WAM precipitation is also reduced through changes in specific humidity gradients that lead to increased potency of dry air advection into the monsoon rainband

Understanding the Uncertainty in the West African Monsoon Precipitation Response to Increasing CO_2

Harry Mutton, [a] Robin Chadwick, [a,b] Matthew Collins, [b] F. Hugo Lambert, [b], Christopher M. Taylor, [c,d] Ruth Geen, [e] Hervé Douville, [f] Marion Saint-Lu [g]

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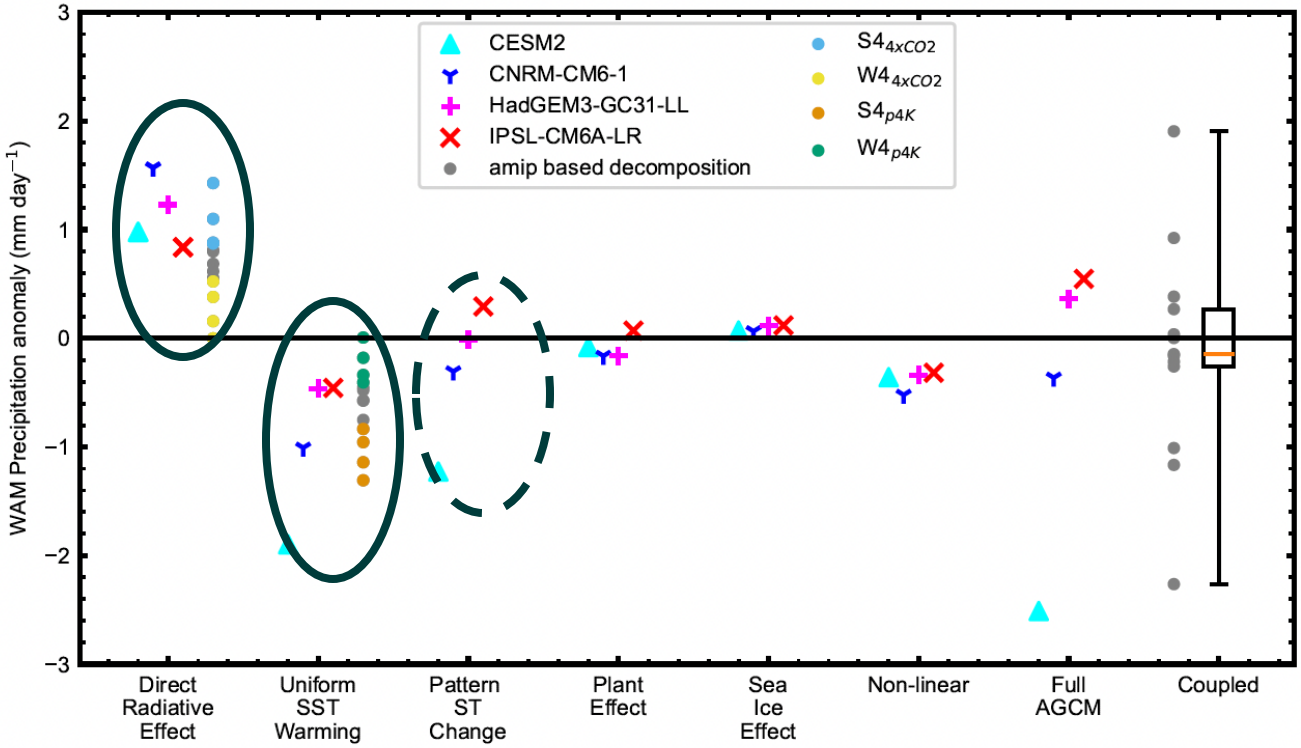

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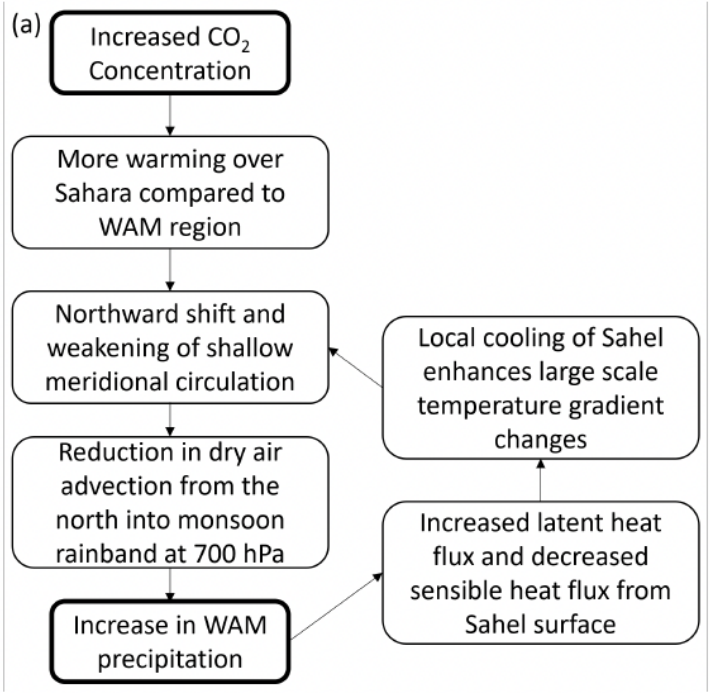

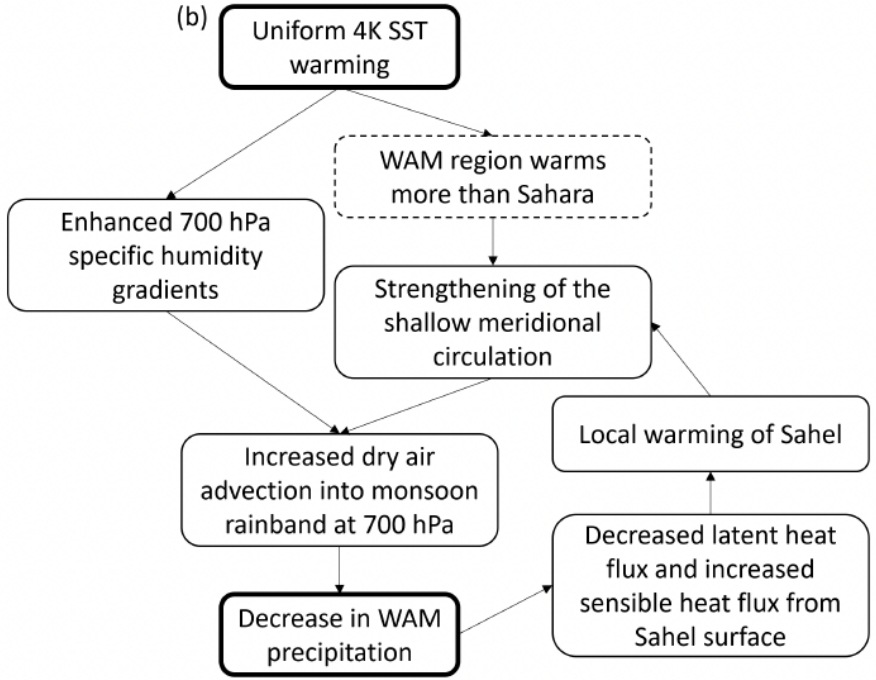

Summary

- Direct effect of CO_2 increases WAM precipitation
- Uniform warming of SSTs decreases WAM precipitation, but SST patterns also play a role
- Much of the uncertainty associated with the response to the direct radiative effect and uniform SST warming is shown to be related to differing changes in 700hPa moisture flux divergence associated with the shallow meridional circulation over West Africa…
- … as well as differences in a soil moisture - surface heat flux feedback over the Sahel

- For the SST-pattern effect, the difference between North Atlantic SSTs as well as inter-hemispheric gradients in surface temperatures are key drivers of intermodel spread