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Supplement of

Effects on early monsoon rainfall in West Africa due to recent deforestation in a convection-permitting ensemble

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Rainfall Comparison with Observations (CMORPH)

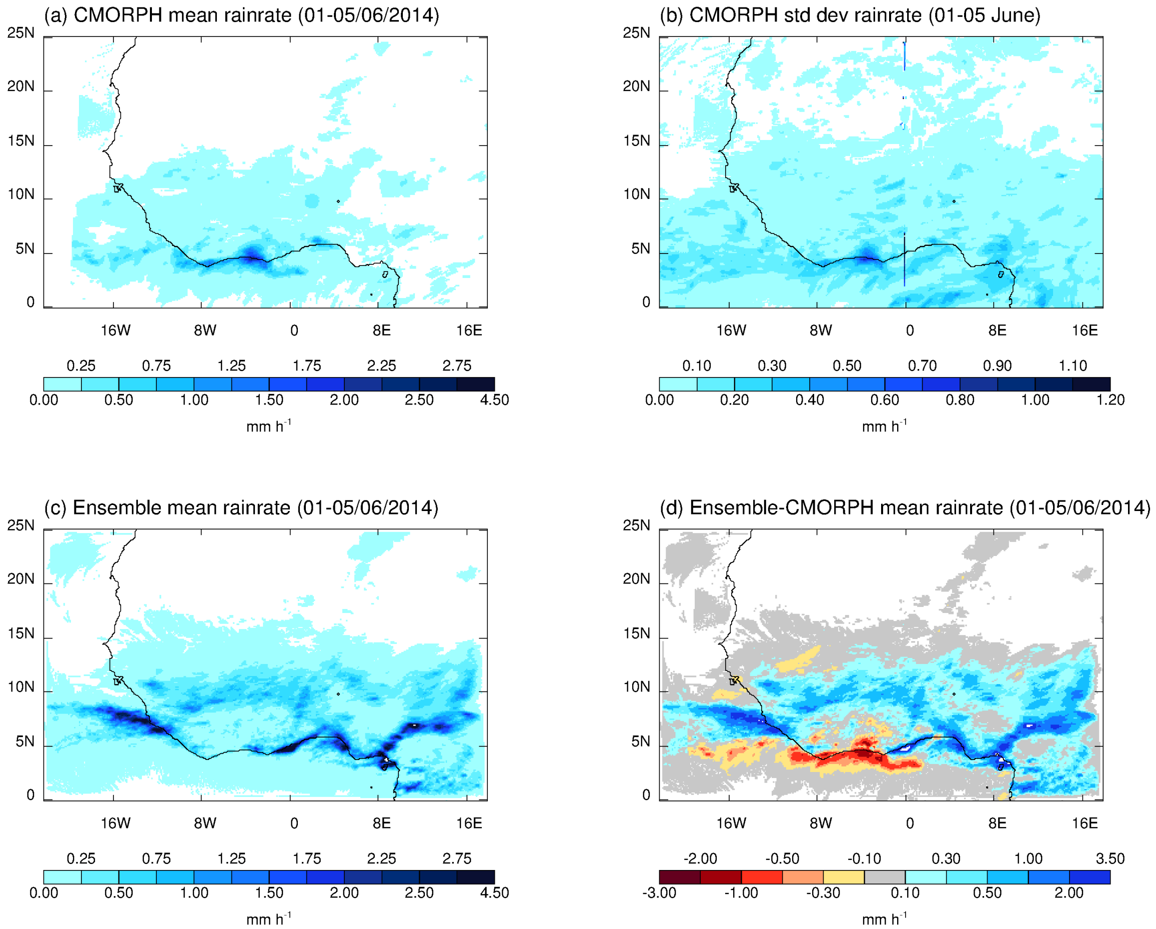

Figure S1: Mean rain rate over 1-5 June (a) from CMORPH 2014, (b) standard deviation from 9 years of CMORPH, (c) from Ensemble mean 2014, and (d) the difference Ensemble mean minus CMORPH 2014.

Vegetation Properties

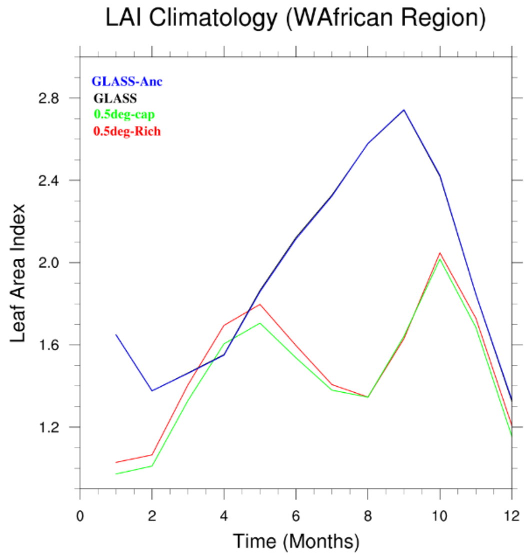

Figure S2: comparison of LAI (from MODIS 15) as it used to be in the model (green) with the GLASS product (black) and combined plant functional type LAIs as now used in the mode (blue) calculated from GLASS.

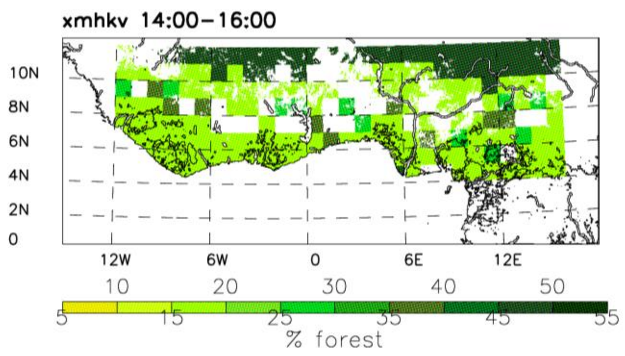

Figure S3: % forest cover at which latent heat becomes greater than sensible heat measured over 1°x1° boxes in current vegetation scenario. Only time steps with no rain in previous 24 hours were used.

Specific humidity changes

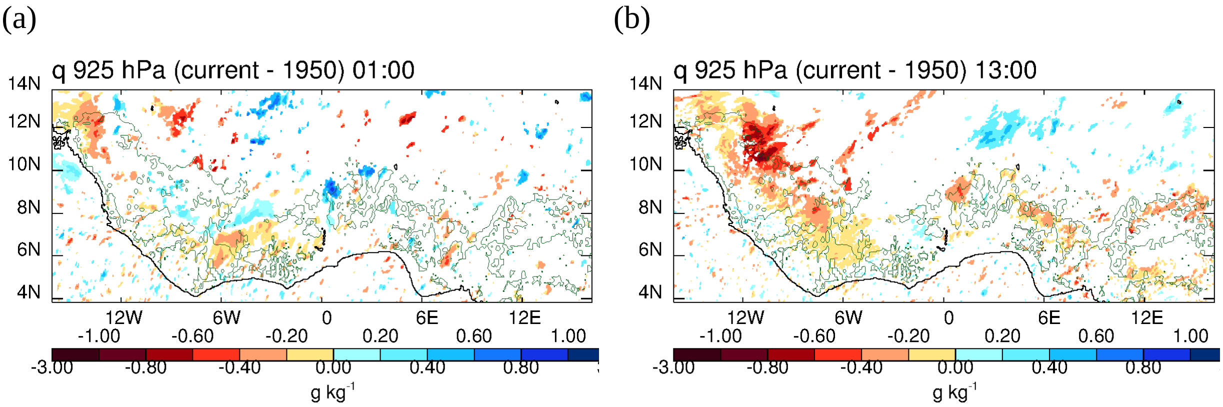

Figure S4: 925 hPa specific humidity changes at (a) 1:00 UTC and (b) 13:00 UTC. Insignificant changes at the individual pixels level are shown in white.

Understanding changes in winds:

Winds are driven by pressure gradients and affected by surface friction. The wind u at height z is related to the roughness length z_0 in a neutral surface layer by

$$u = \frac{u^*}{k} \ln\left(\frac{z}{z_0}\right) \tag{2}$$

where $u*$ is the friction velocity and k the Von Karman constant.

Where there is deforestation the reduced roughness length causes increases in wind speed for a fixed outer-layer wind speed. This increase would be enhanced further if the outer-layer wind speed increased. If the pressure gradient doesn't change much between 1950 and current as is the case over much of the deforested area at night and the outer-layer wind speed doesn't change, then we would expect changes in wind to be primarily due to roughness length changes, i.e.

$$u_{current} = u_{1950} \frac{\ln\left(\frac{z}{z_{0,current}}\right)}{\ln\left(\frac{z}{z_{0,1950}}\right)} \tag{3}$$

Figure S5 b and c show that the fractional change in the night time wind (U10m and V10m respectively) is strongly correlated with the roughness length scaling factor (Fig S4a) in equation (3) as expected for grid cells with small Coriolis parameters and insignificant changes in pressure indicating that a large part of the change (current – 1950) at night is due to roughness length changes.

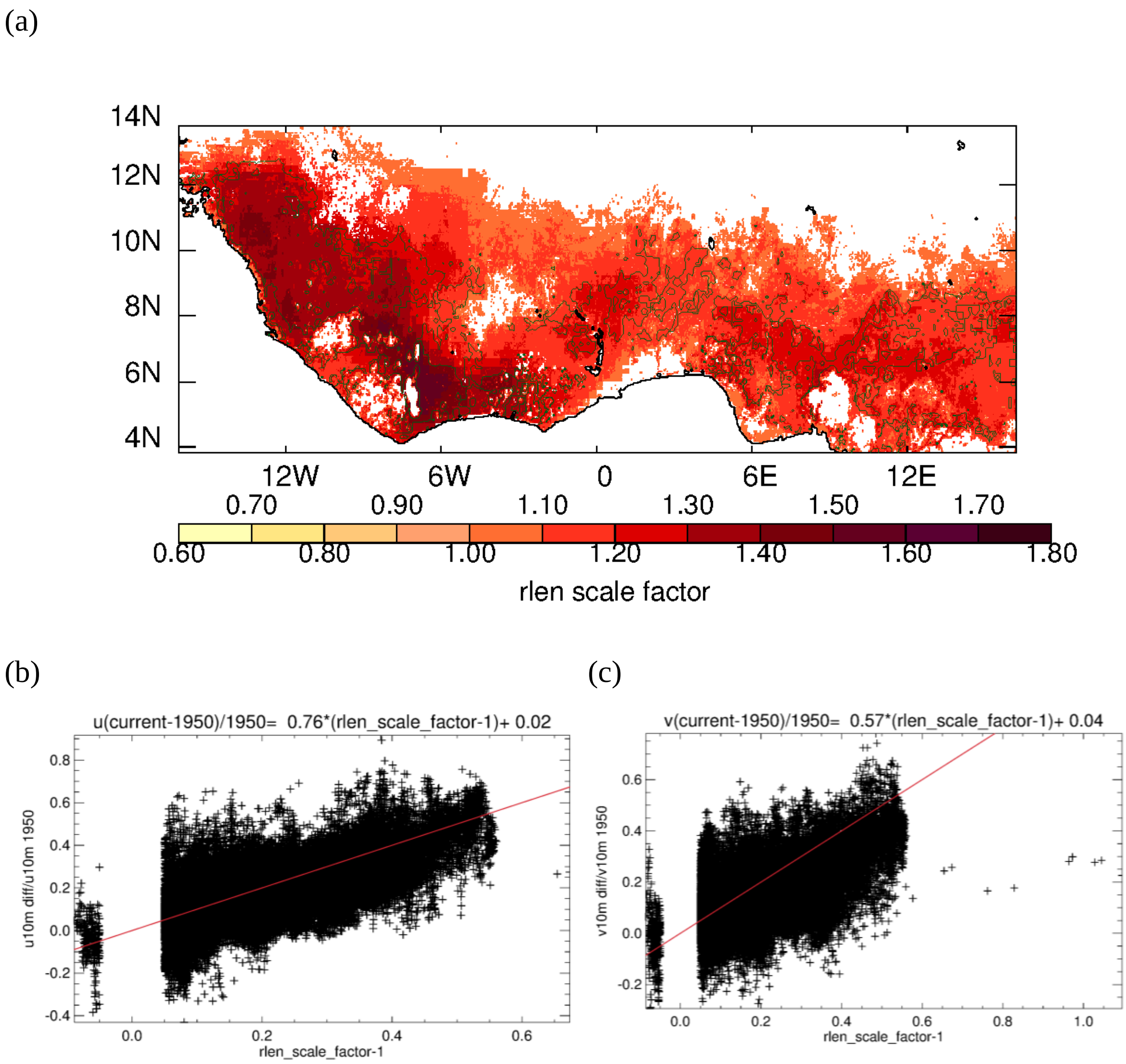

Figure S5: (a) roughness length scaling factor (white areas indicate no change in roughness length). Night time scatter plots of fractional differences (current-1950)/1950 vs roughness length scaling factor-1 for (a) u 10m, (b) v 10m, Only points south of 15N where the roughness length scaling factor > 1.05 or <0.95 and the pressure change has been insignificant are included. The red lines indicate the 1:1 relationship.

Analysis of subregions

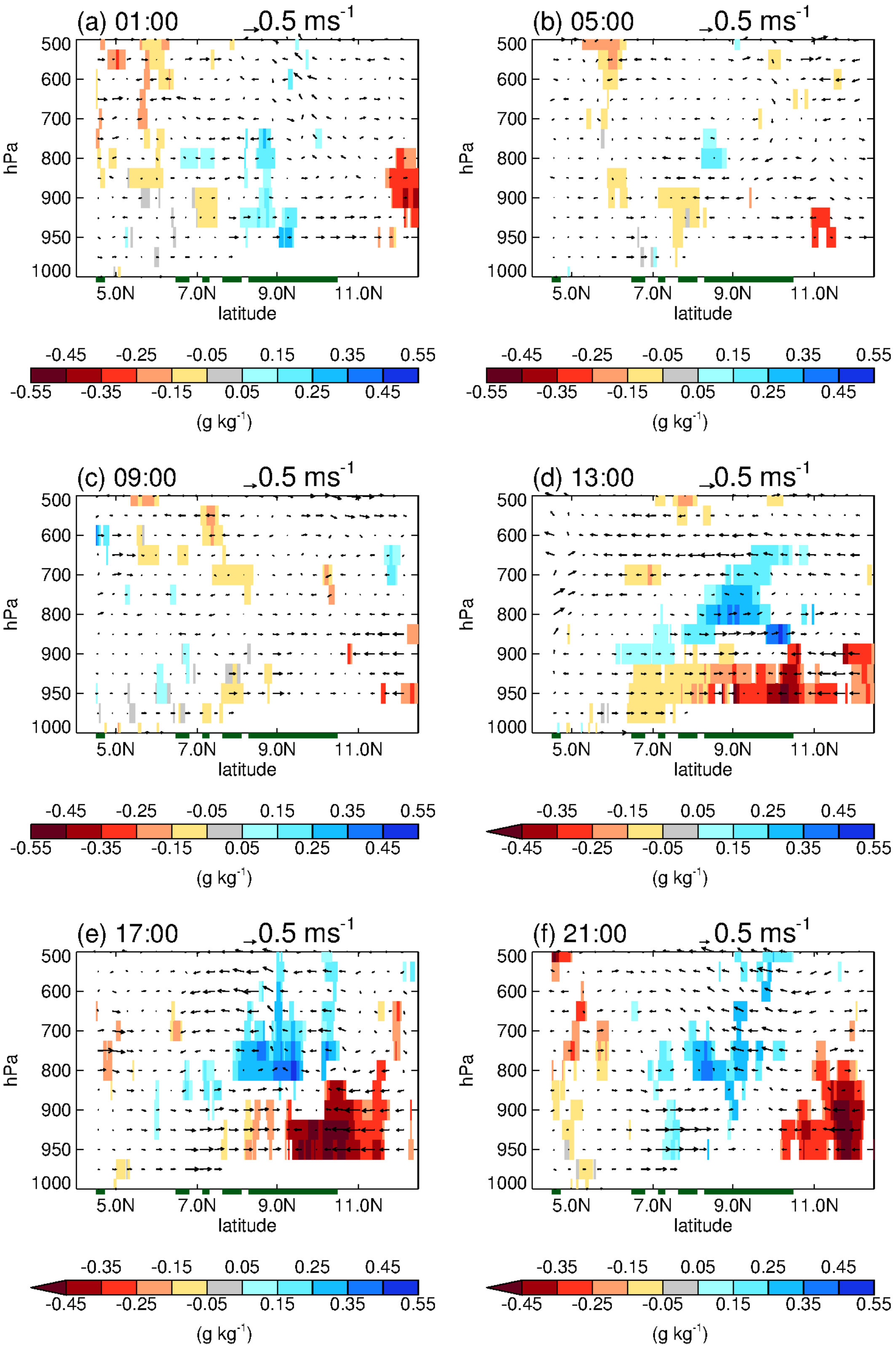

Figure S6: North-south vertical cross sections averaged over 10W to 8W over land. Changes in specific humidity profiles (shading) and meridional and vertical wind vectors. Green bars indicate where there has been deforestation. Insignificant changes are shown in white.

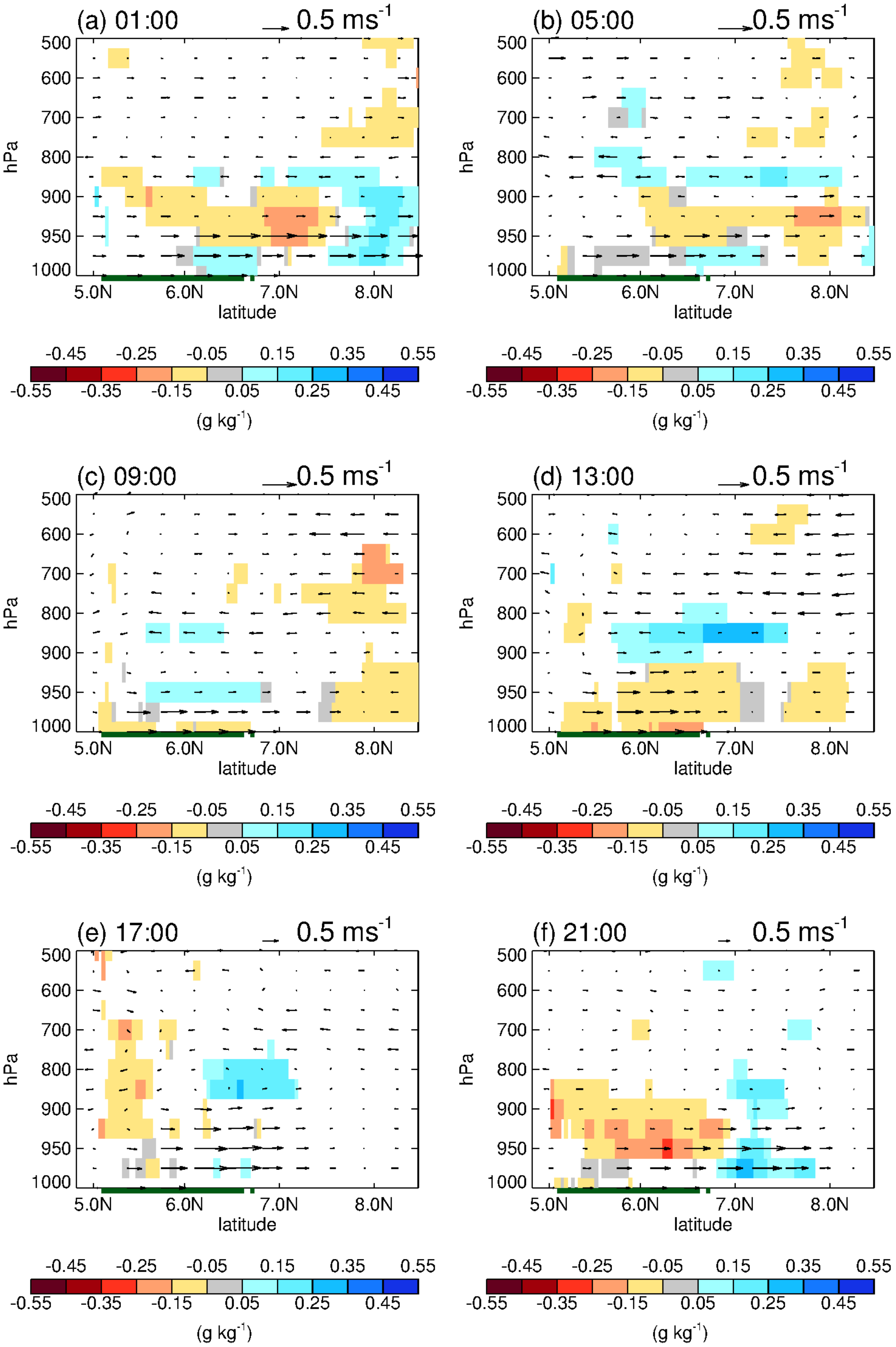

Figure S7: As for Fig S6 but for north-south vertical cross sections averaged over 6W to 3W over land.

Figures S6 and S7 indicate that 925 hPa is an appropriate low level to use for measure of CAPE.

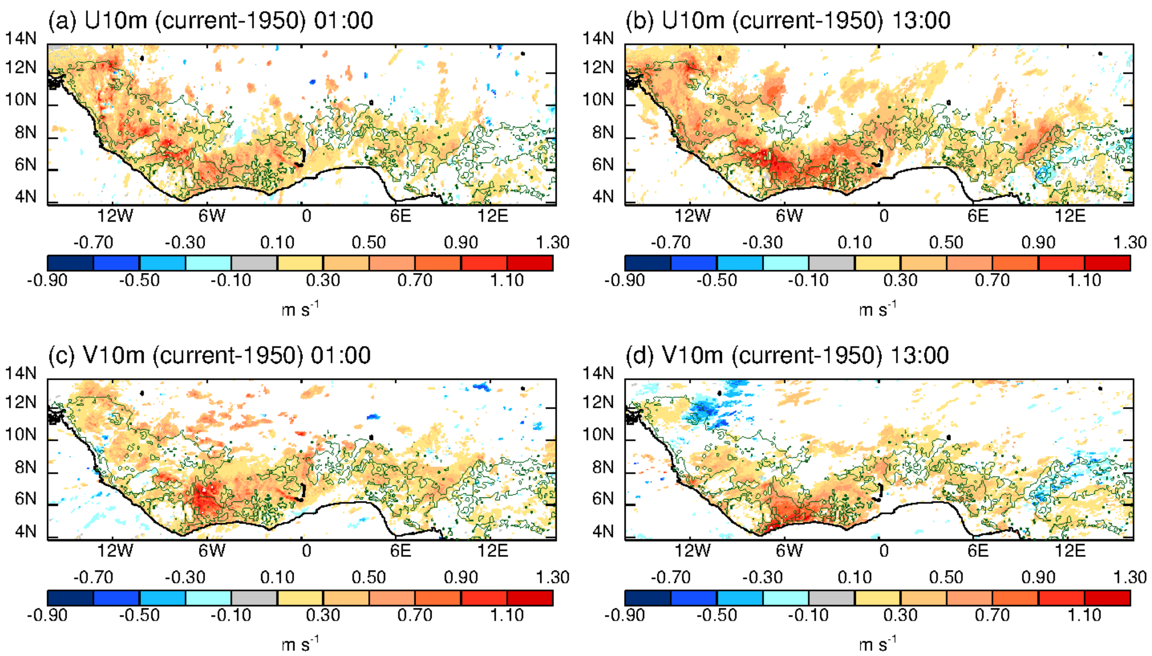

Figure S8: Changes in components of 10m winds. Insignificant changes using FDR correction are shown in white.