

# MODELLING THE IMPACTS OF REFORESTATION ON FUTURE CLIMATE IN WEST AFRICA

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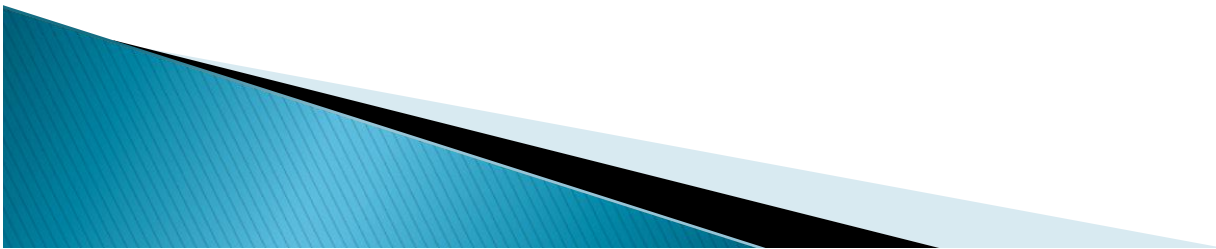
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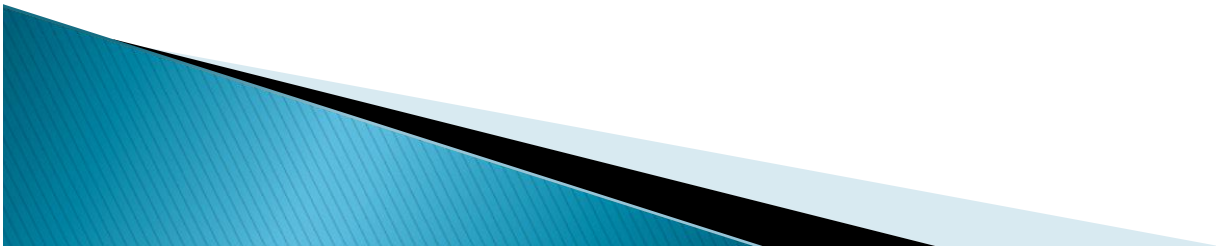
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Modelling the Impacts of Reforestation on Future Climate in West Africa. Theor  
Appl Climatol DOI: 10.1007/s00704-012-0614-1

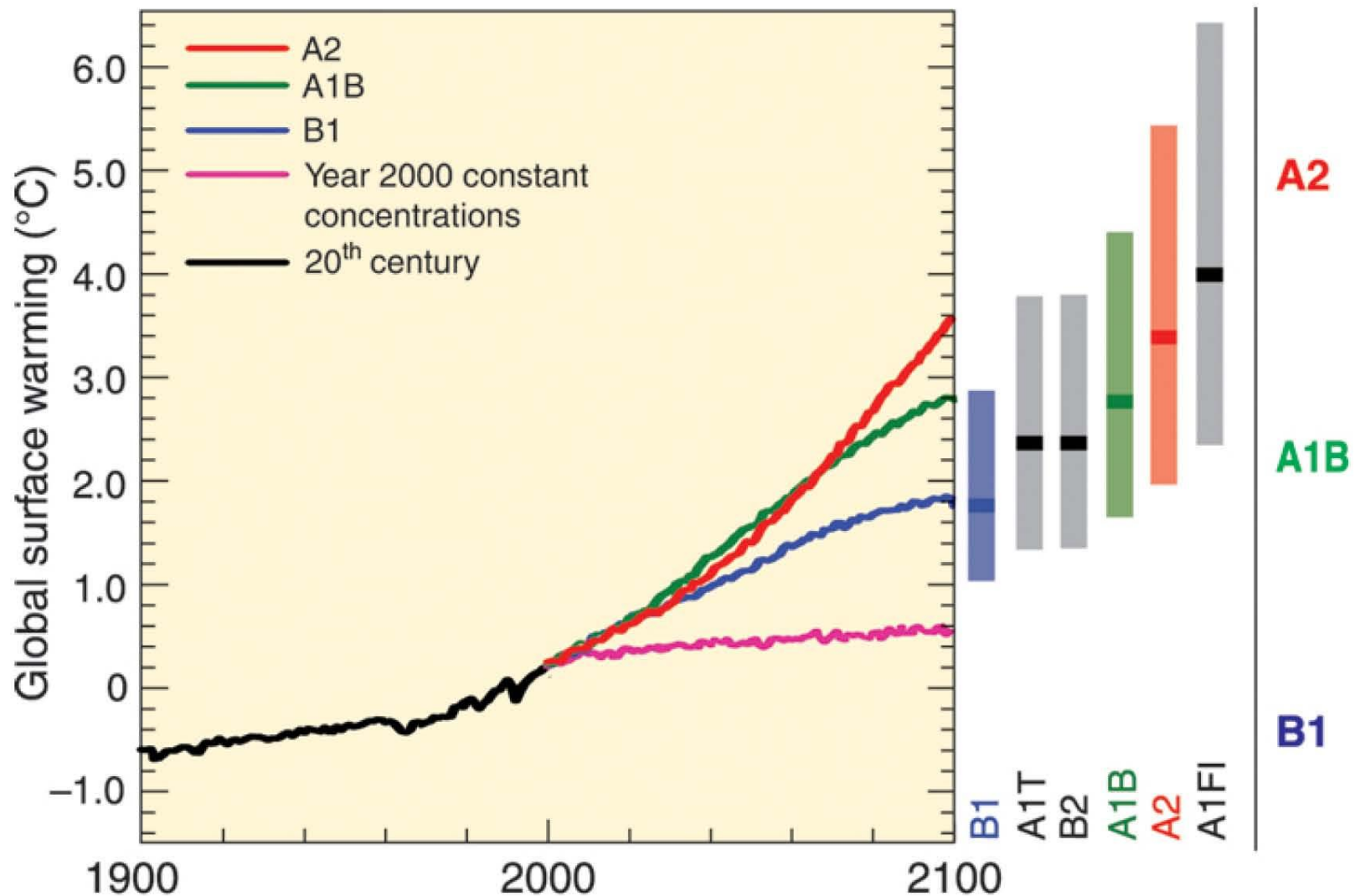
# Acknowledgment

- ▶ This study was supported by the following institutions:
  - National Research Foundation (NRF, South Africa)
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  - Centre for High Performance Computing (CHPC, South Africa)
  - Ecological Fund Office (EFO, Nigeria)
  - START (USA)
  - ICTP (Italy)



# Motivation

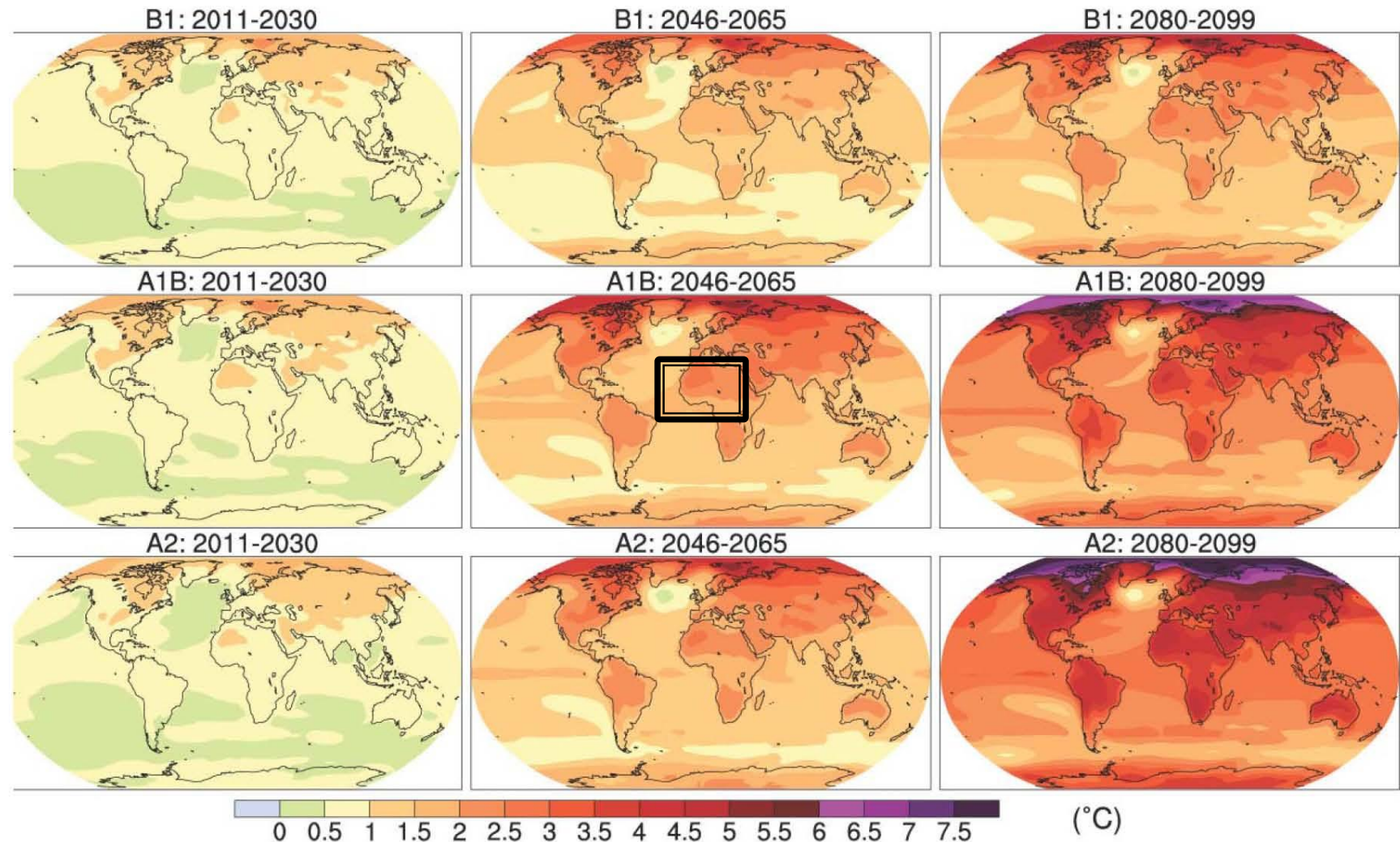




**Figure 3.2. Solid lines are multi-model global averages of surface warming (relative to 1980-1999) for the SRES scenarios A2, A1B and B1, shown as continuations of the 20th century simulations. The bars in the middle of the figure indicate the likely range assessed for the six SRES marker scenarios at 2090-2099 relative to 1980-1999 from all AOGCMs. AR4, Synthesis Report**



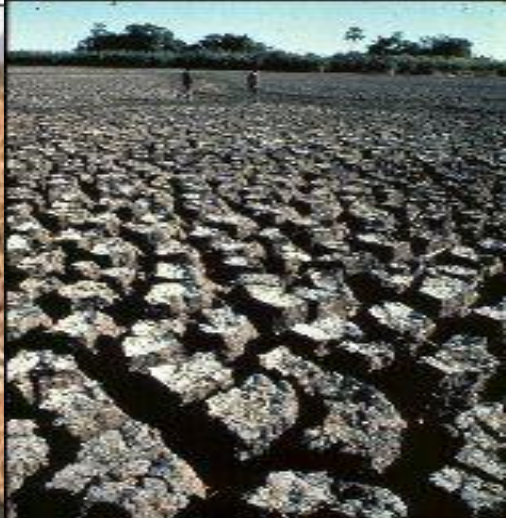
**Figure 10.8. Multi-model mean of annual mean surface warming (surface air temperature change, °C) for the scenarios B1 (top), A1B (middle) and A2 (bottom), and three Anomalies are relative to the average of the period 1980 to 1999.**



In each case, greater warming over most land areas is evident. Over the ocean, warming is relatively large in the Arctic and along the equator in the eastern Pacific with less warming over the North Atlantic and the Southern Ocean



# Impacts of Climate Change in West Africa



# Mitigation Strategies

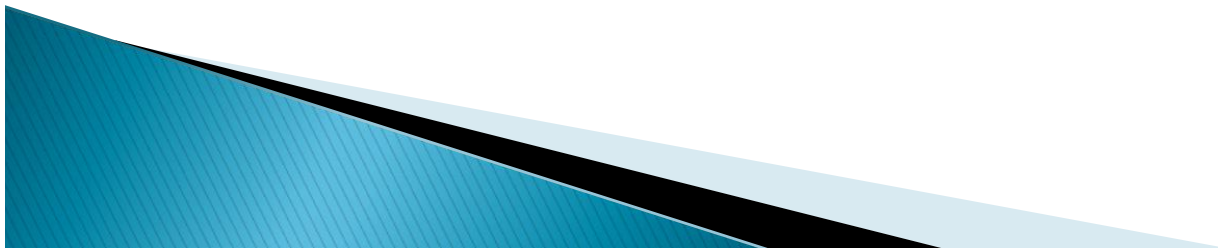
- ▶ Reducing GHG emissions into the atmosphere
  - Greenhouse gasses: CO<sub>2</sub>, Methane
  - Sources: Transports, Energy, Waste product
- ▶ Removing GHG from the atmosphere
  - Reforestation [Geo-engineering]
  - ...and others
- ▶ Decreasing the shortwave radiation absorbed at earth surface. [Geo-engineering]



GHG: Greenhouse gasses

# Questions on Geo-engineering approach of Mitigation

- ▶ Can these options work?
- ▶ Can they be carried out with reasonable costs?
- ▶ What are the side effects of implementing them?





# Reforestation as a mitigation option in West Africa: Not a new idea!

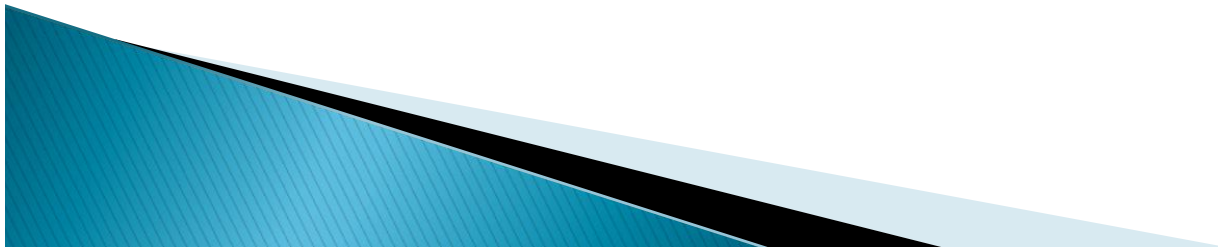
- ▶ Brook (1928)
  - Binding the blowing sand
  - Local increase (1% –2%) in precipitation
- ▶ Otterma (1974, 1977)
  - controlling influence convective precipitation
- ▶ Enger and Tjernstron (1991)
  - forest planting in semiarid, initially irrigated with aquifer water, may increase the precipitation so much that it would ultimately eliminate the need for further irrigations
- ‘Greening’ the Sahel
- Nigeria government plans to allocate 60% percent of Ecological Fund to plant more than one billion trees across the country



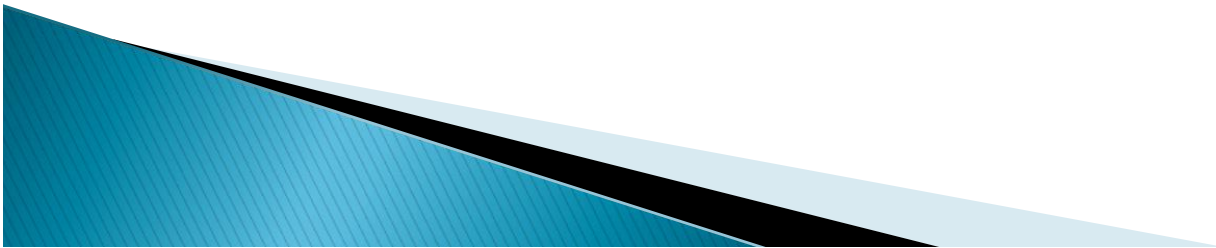
# Reforestation as a mitigation option in West Africa: Not a new idea!

How will the reforestation affect the dynamics of West African Monsoon system and the regional climate in future?

Where are the best locations for reforestation in West Africa?



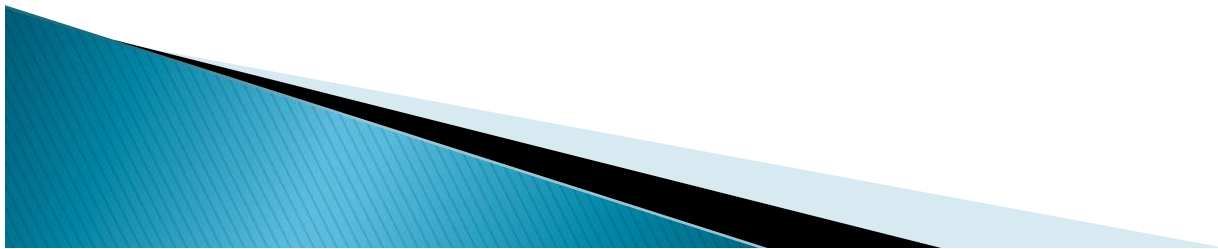
# Research Method: Numerical Experiments





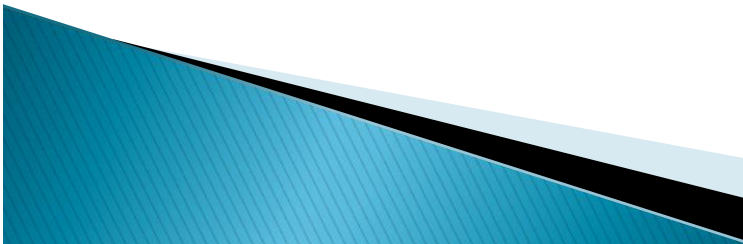
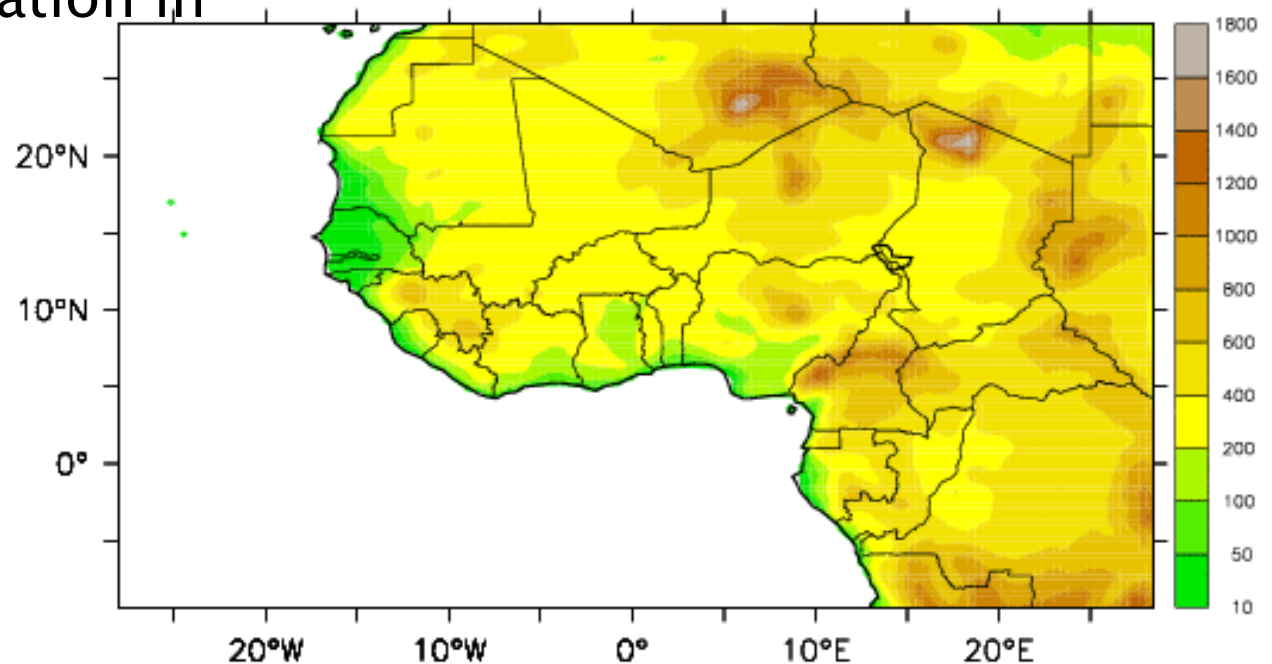
# Climate Modelling Experiments:

**“It gives planners a chance to make mistakes on the computer, thus avoid making mistakes in real life..” Enger and Tjernstrom (1990)**

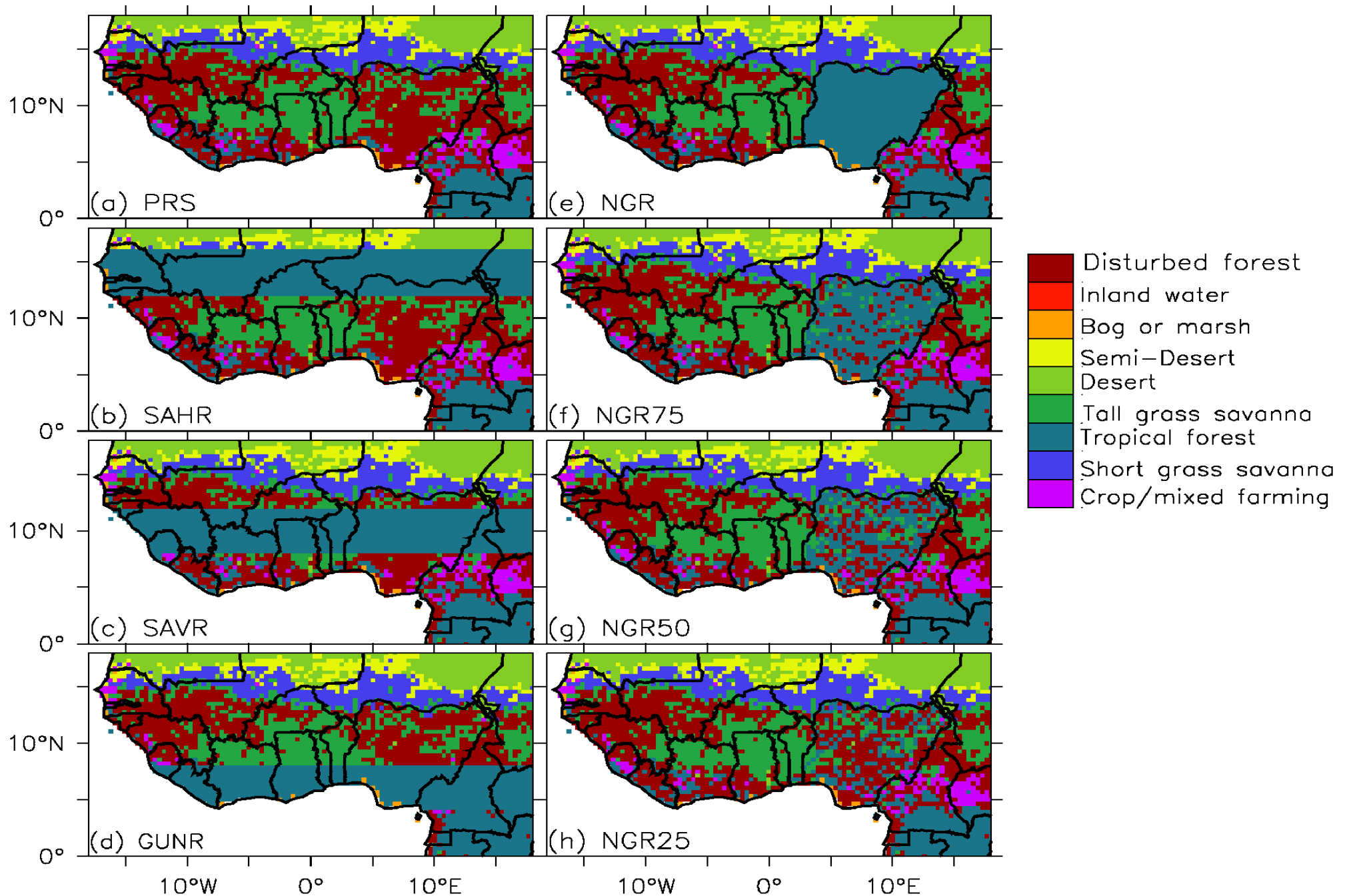


# Experiments: RegCM3

- Regional Climate Model (RegCM3, ICTP)
- Domain: (28°W–28°E; 3°S–27°N)
- Resolution: 40 km
- Physics: BATS; Grell Scheme with FC closure
- ECHAM5 simulation (data) for initial and boundary conditions
- Two control Experiments
  - Present climate (1981–2000)
  - Future climate (2031–2050)
- Seven reforestation experiments with future climate
  - 3–Zonal reforestation
  - 4–Random reforestation in Nigeria

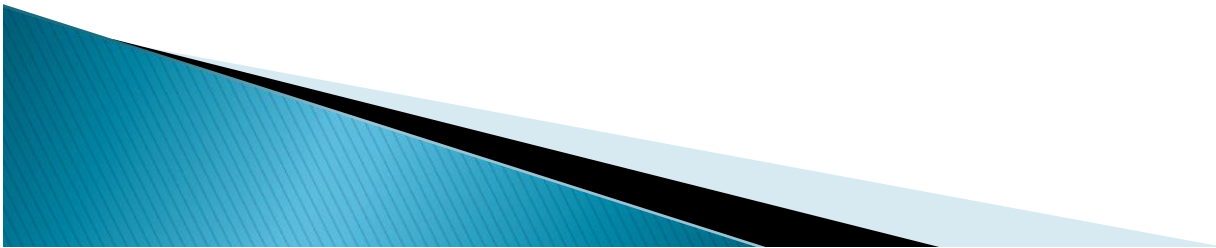


# Reforestation experiments with future climate

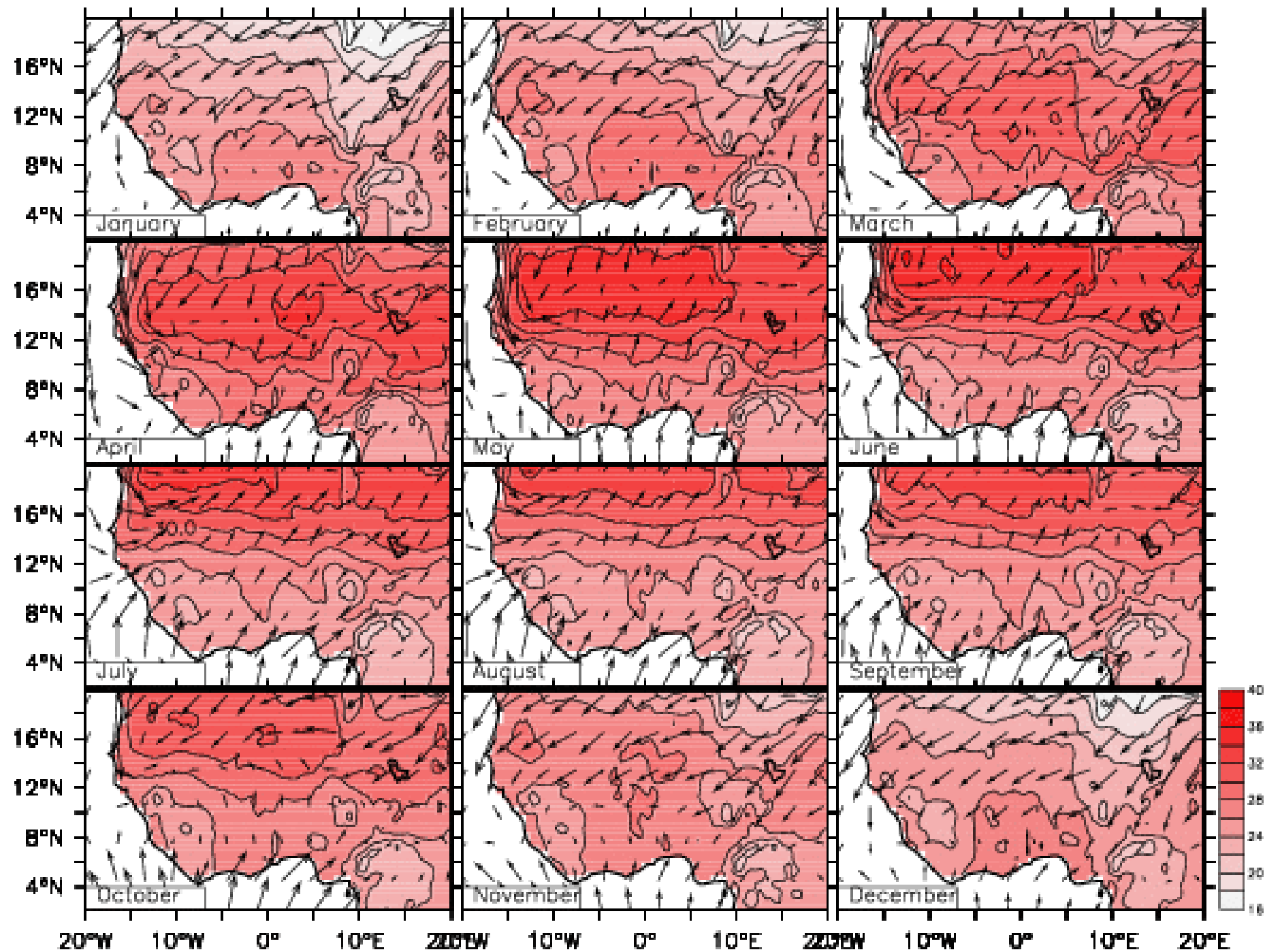




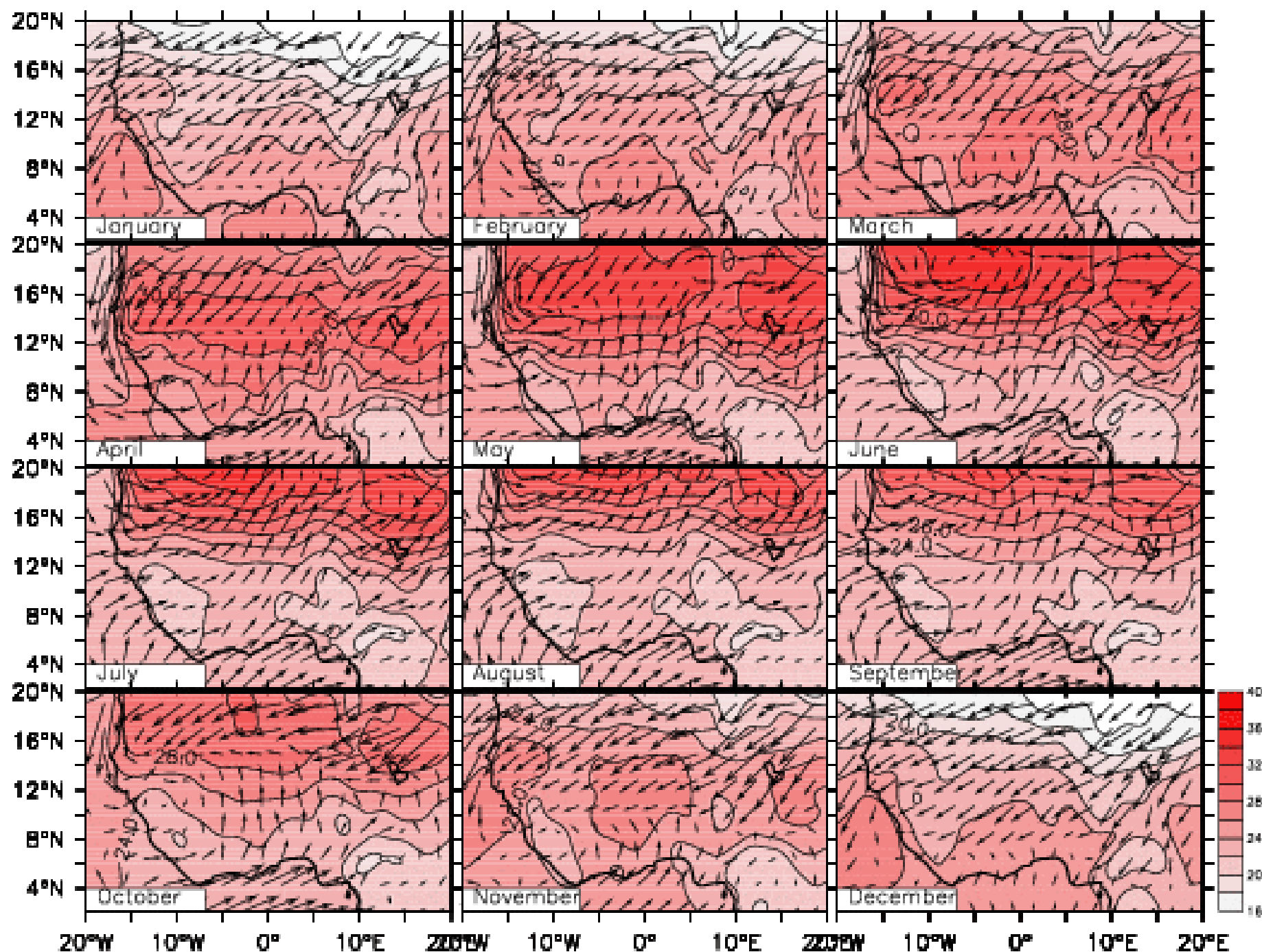
# Model Validation



# CRU: Observed Temperature ( $^{\circ}\text{C}$ ) Patterns (1981–2000)

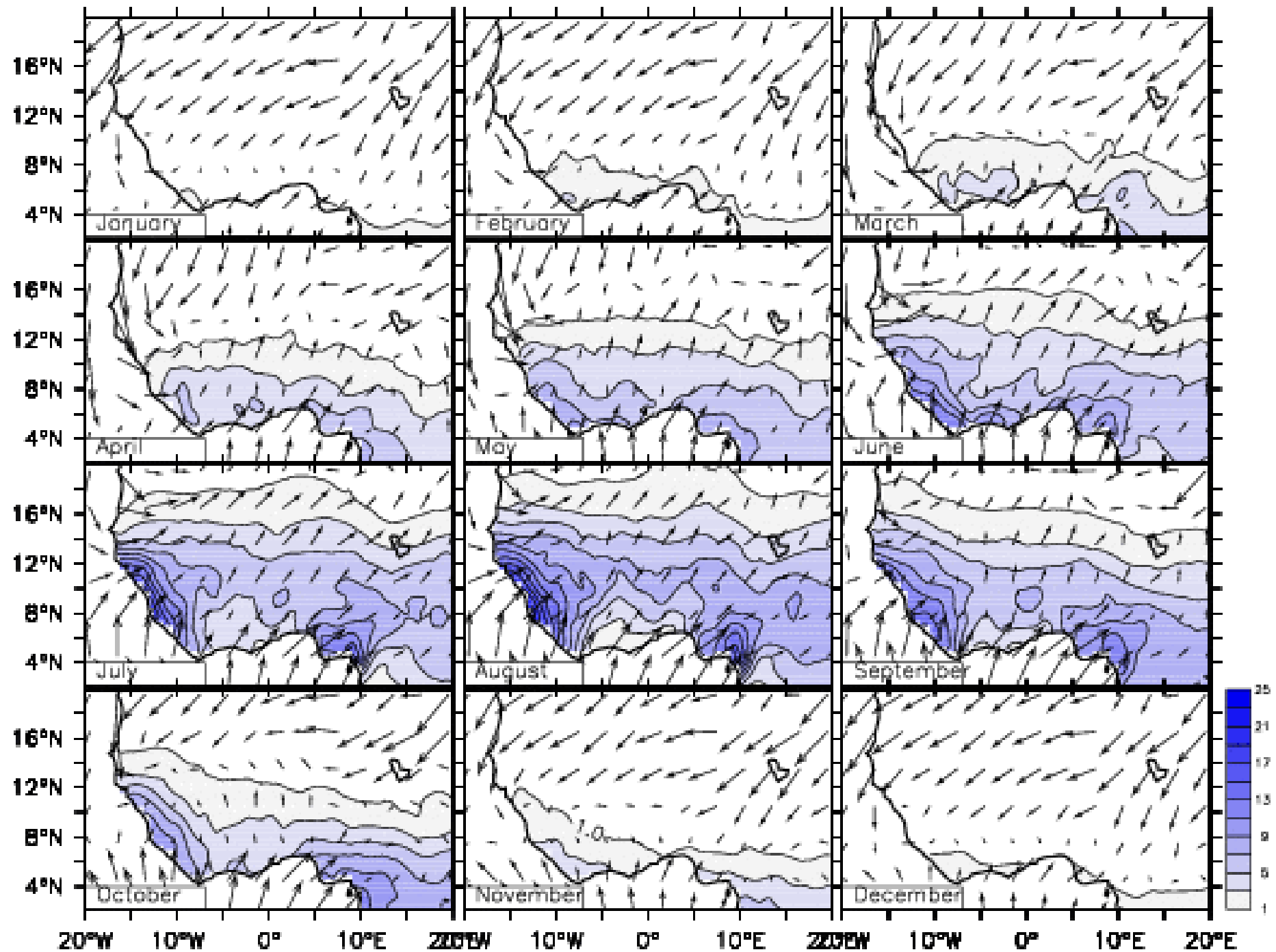


# RegCM3: Simulated Temperature ( $^{\circ}\text{C}$ ) Patterns (1981–2000)

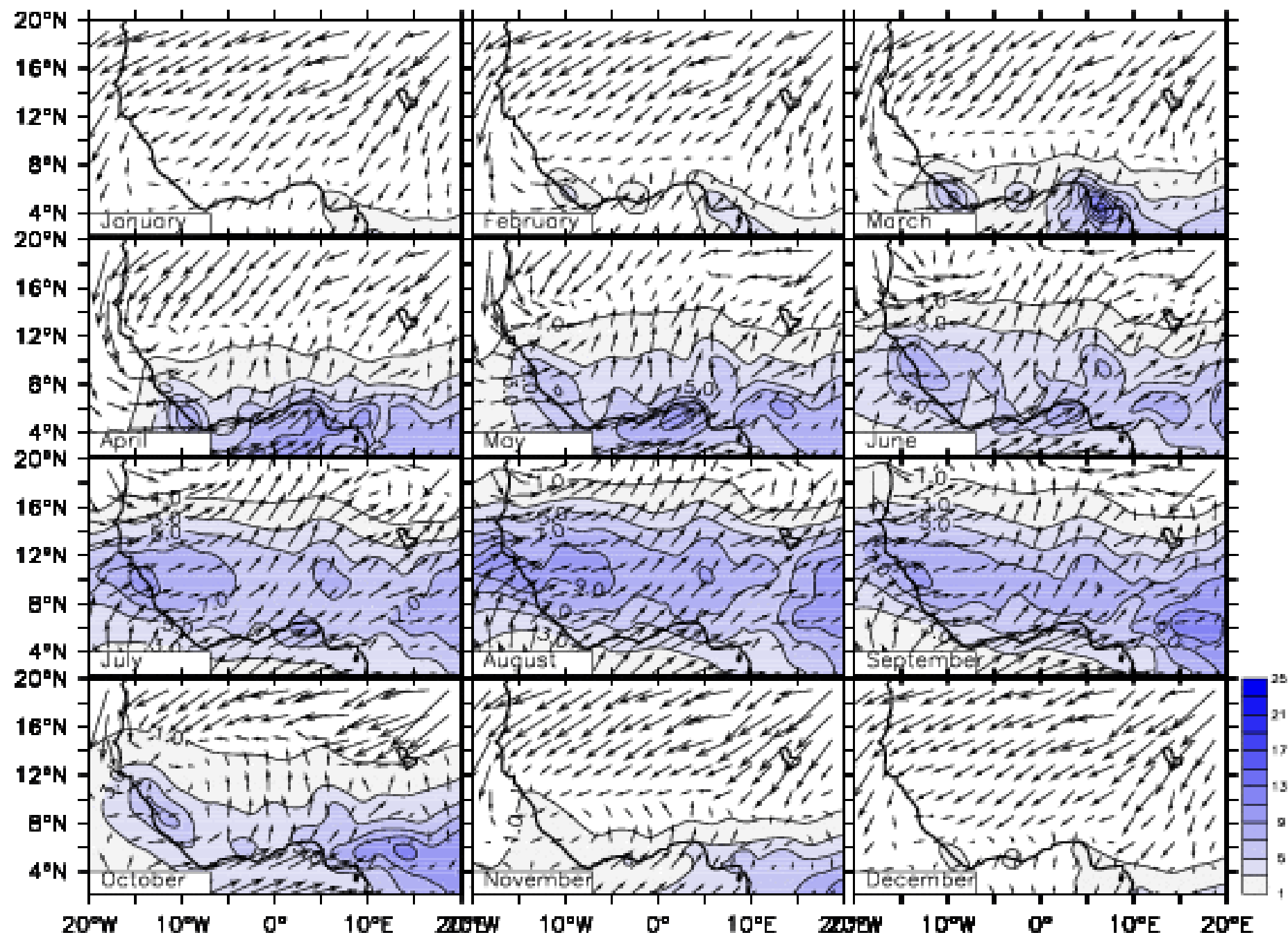




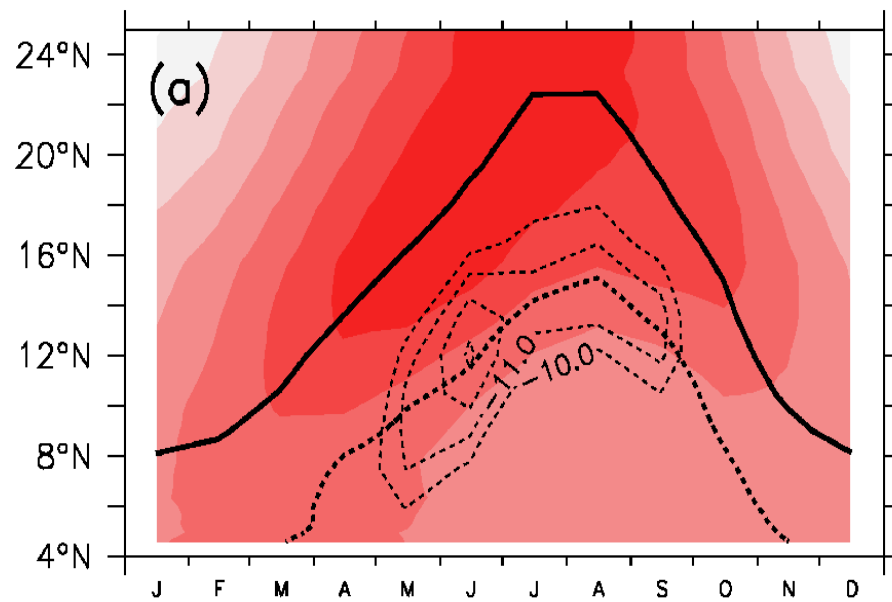
# CRU: Observed Rainfall (mm/day) Patterns (1981–2000)



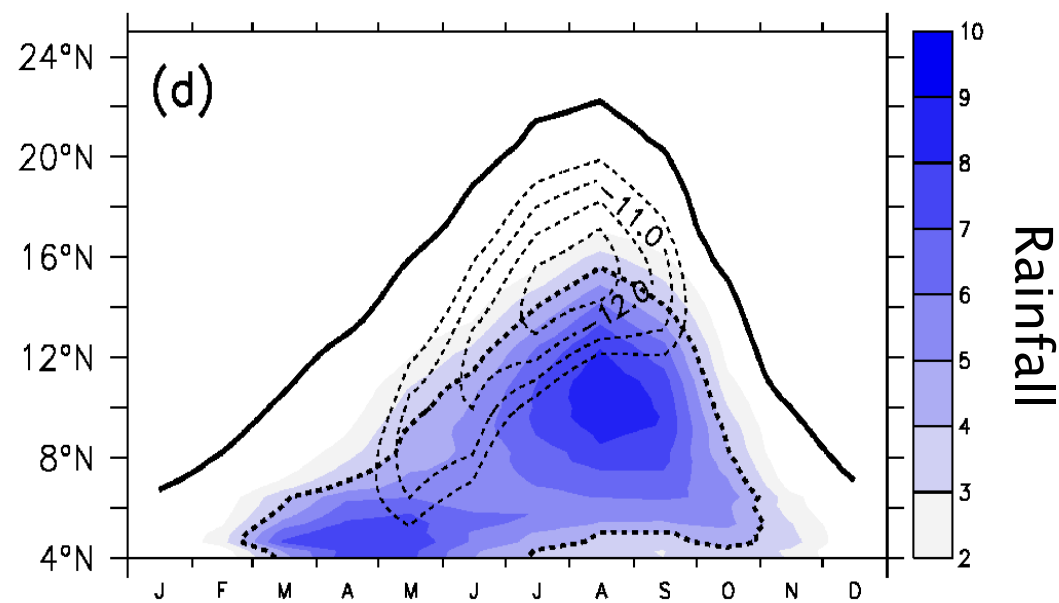
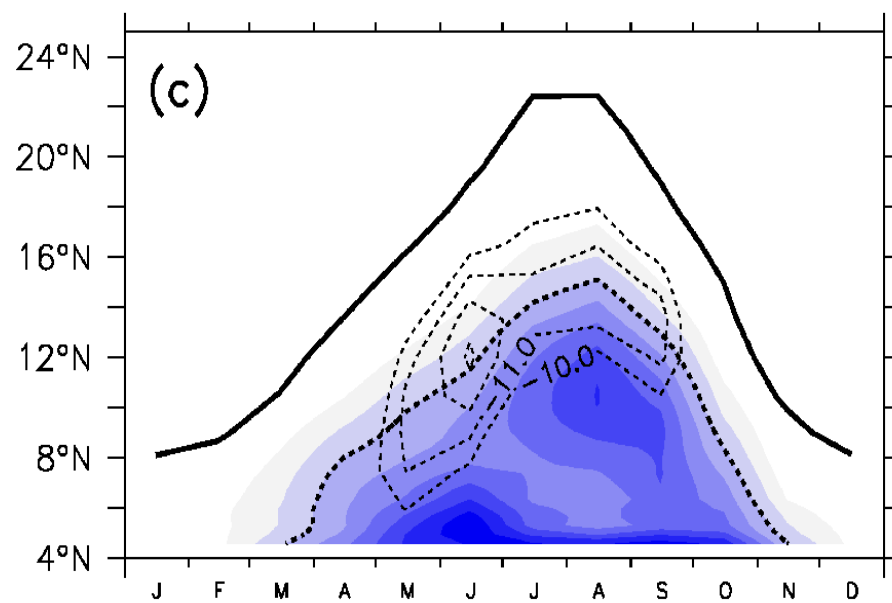
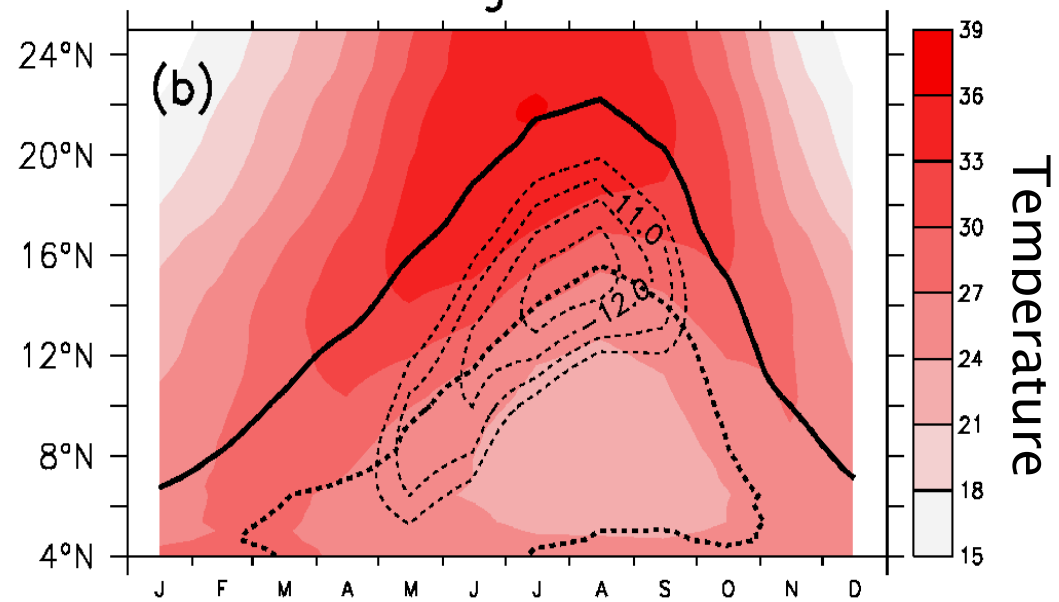
# RegCM3: Simulated Rainfall (mm/day) Patterns (1981–2000)



CRU & ERAIM

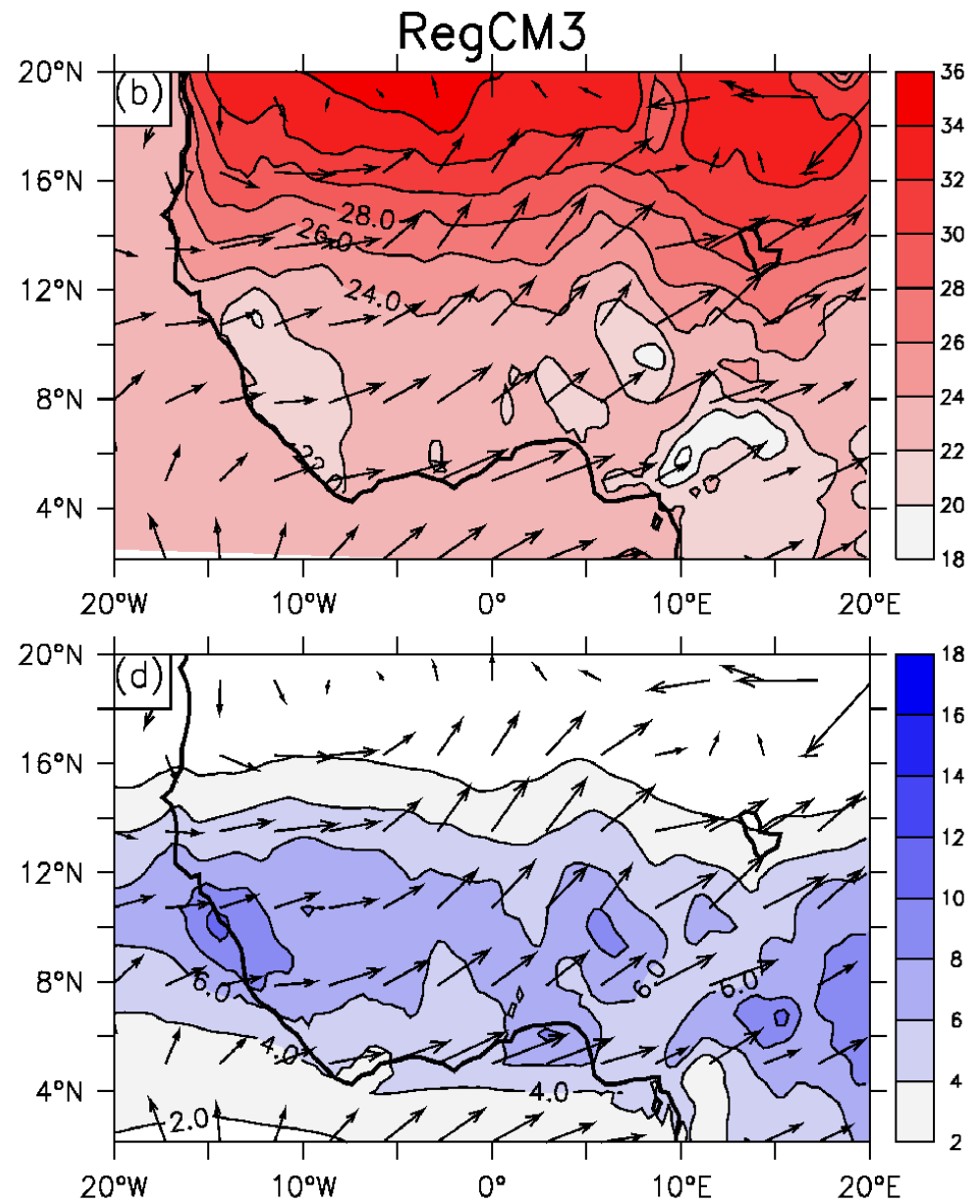
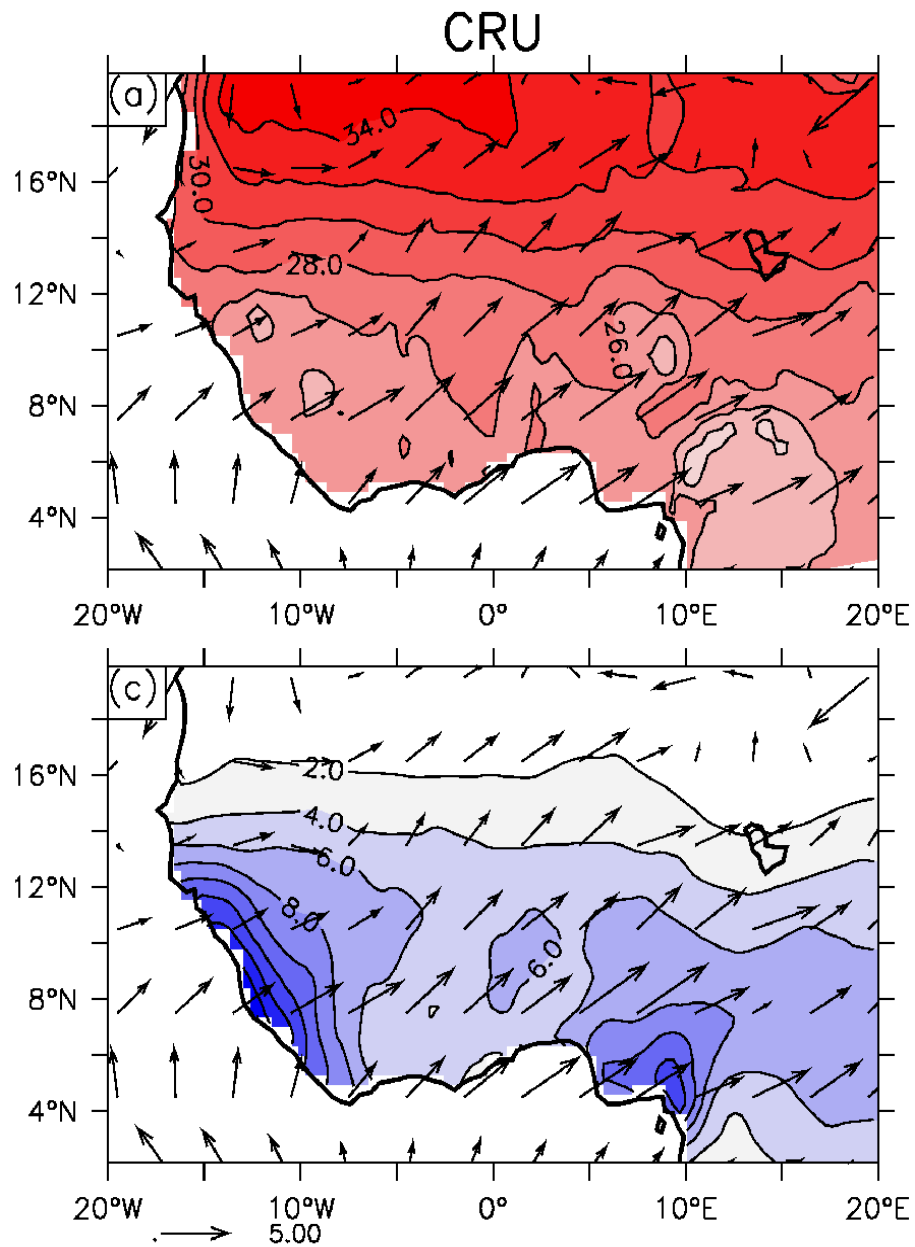


RegCM3

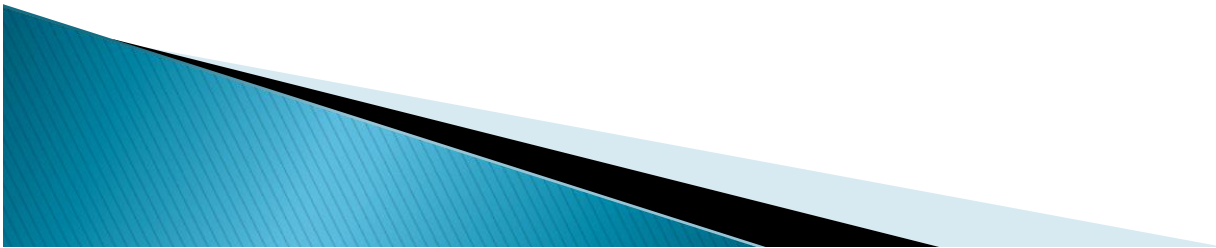




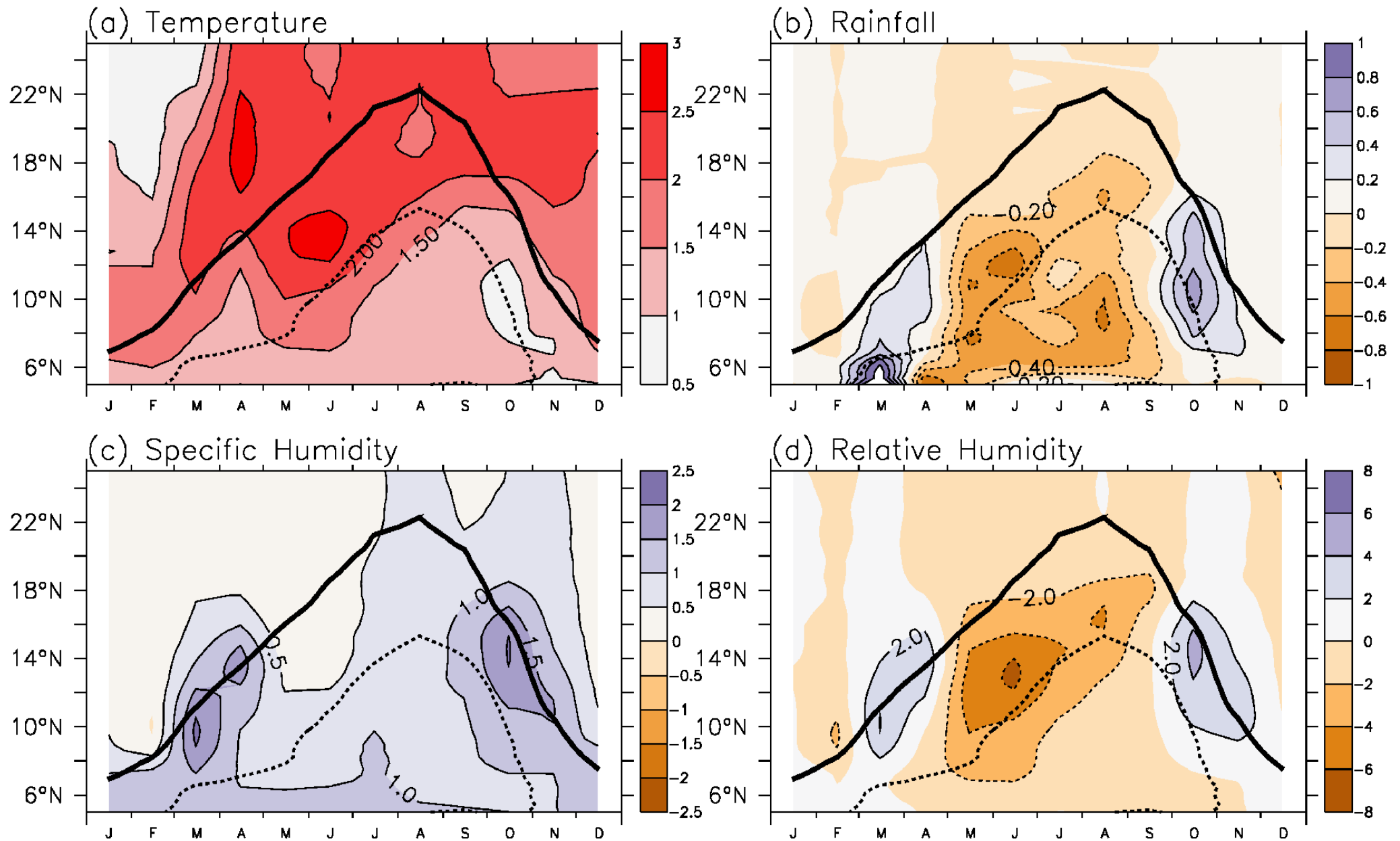
# Annual mean Temperature and Rainfall (June–August, 1981–2000)



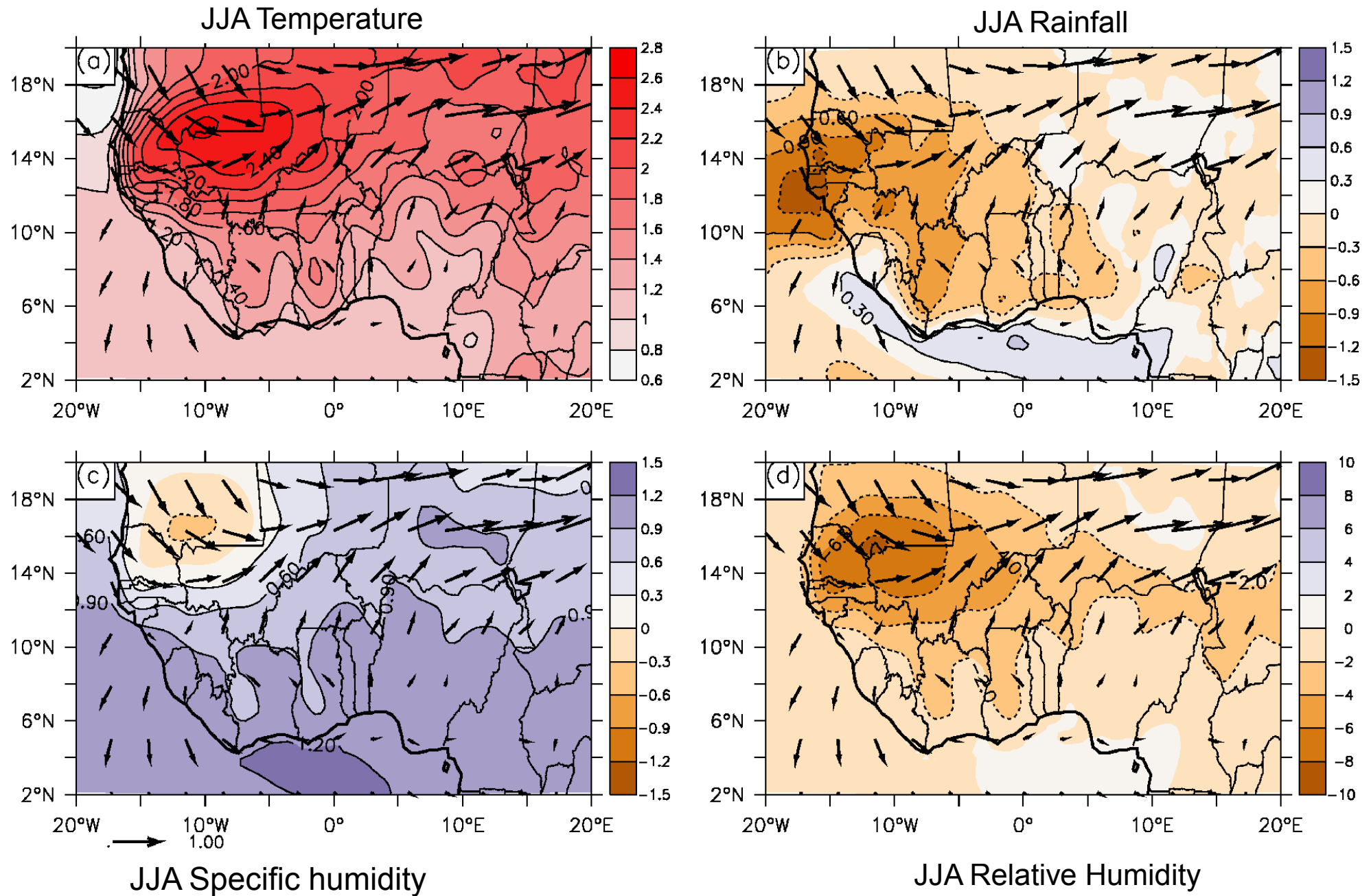
# Impacts of Global Warming on Future Climate



# Future Climate Changes by 2031–2050 under A1B scenario

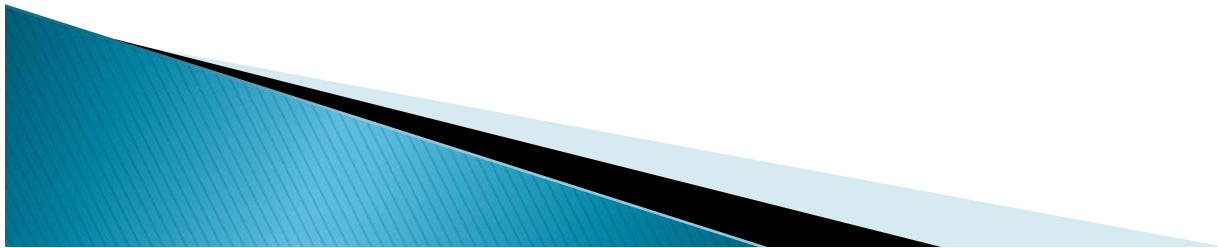


# Future Climate Changes by 2031–2050 under A1B scenario

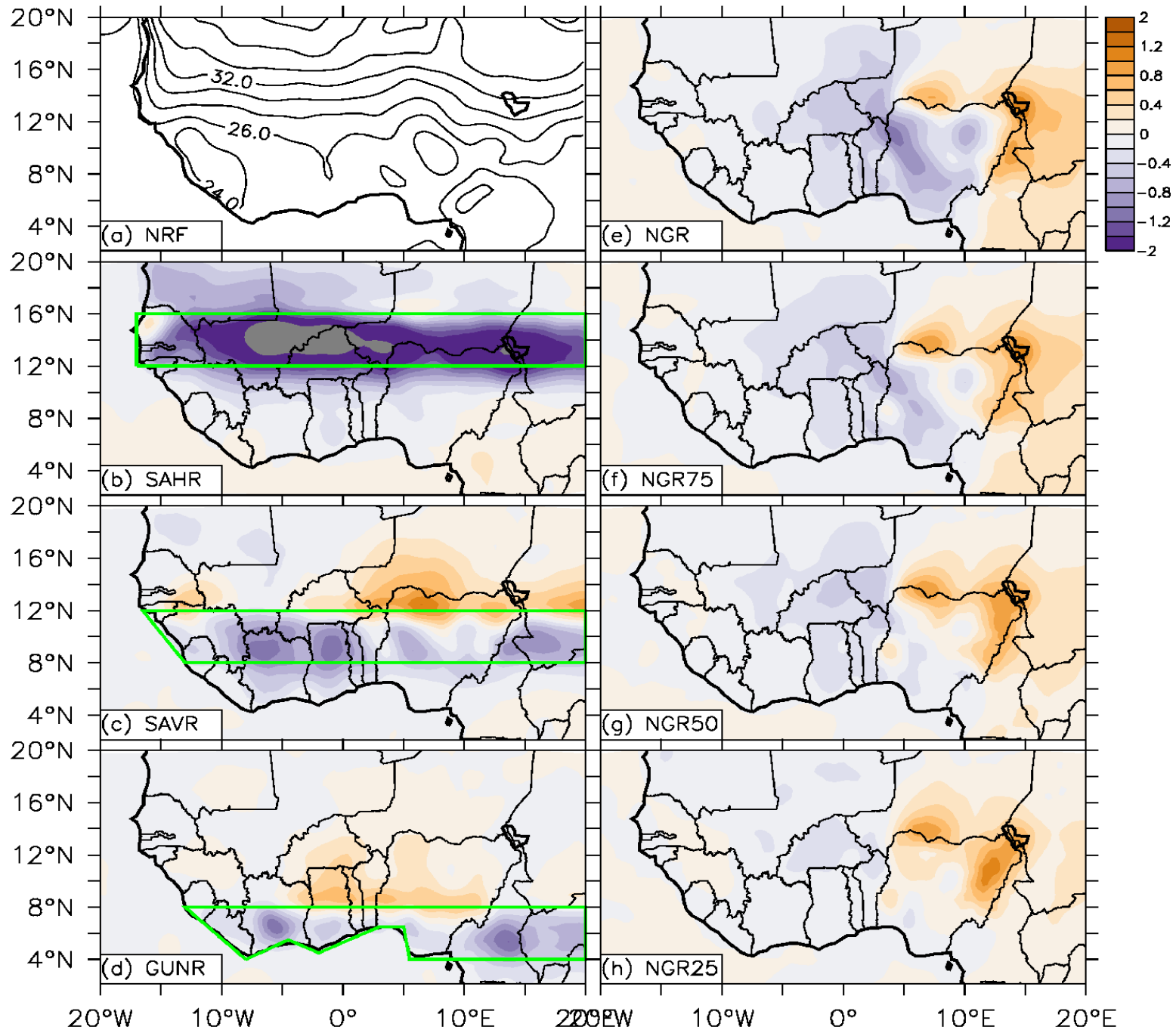




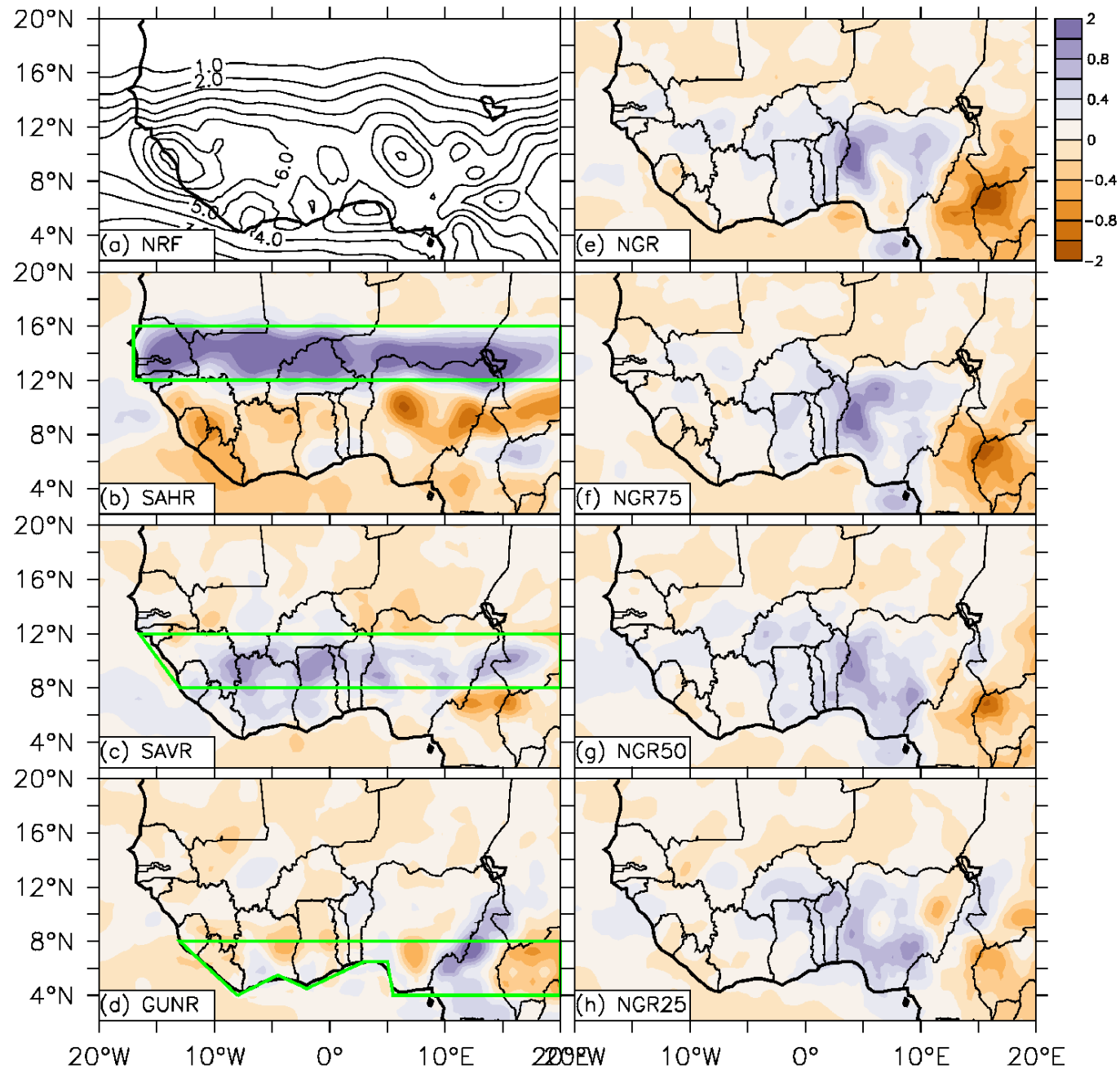
# Impacts of Reforestation on Future Climate



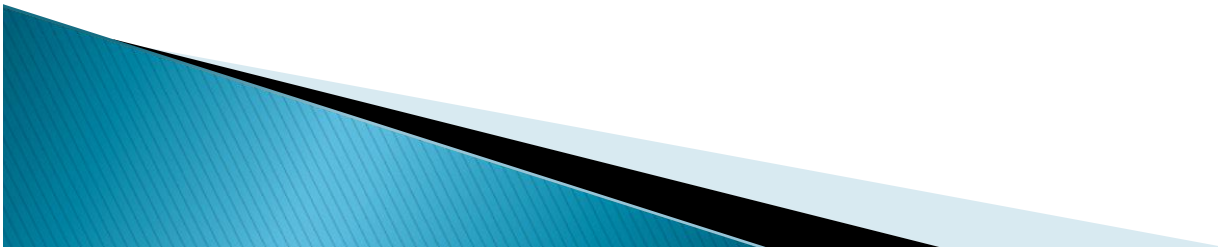
# Impacts of reforestation Temperature



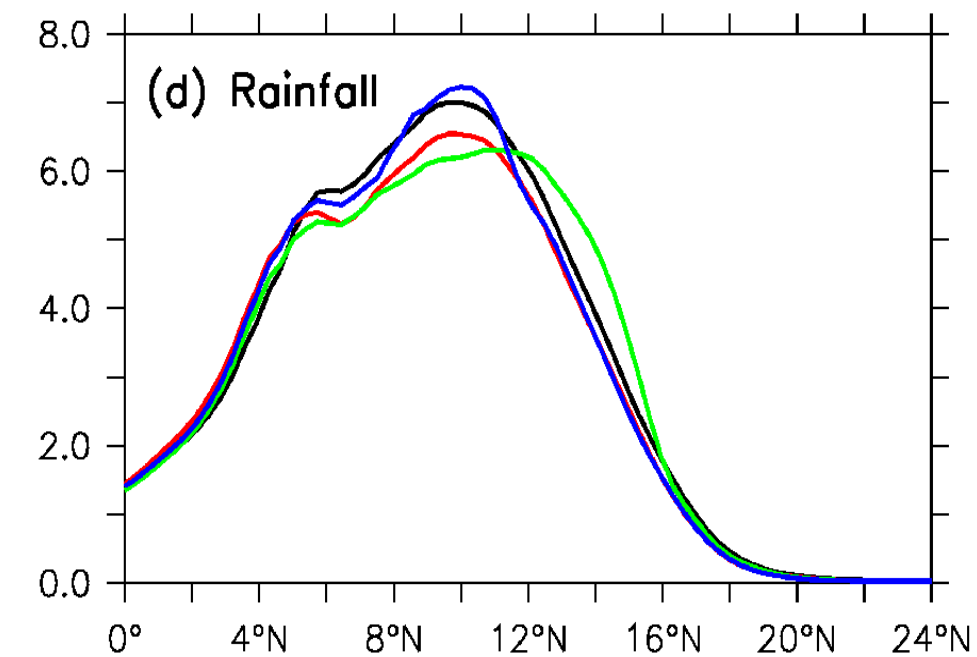
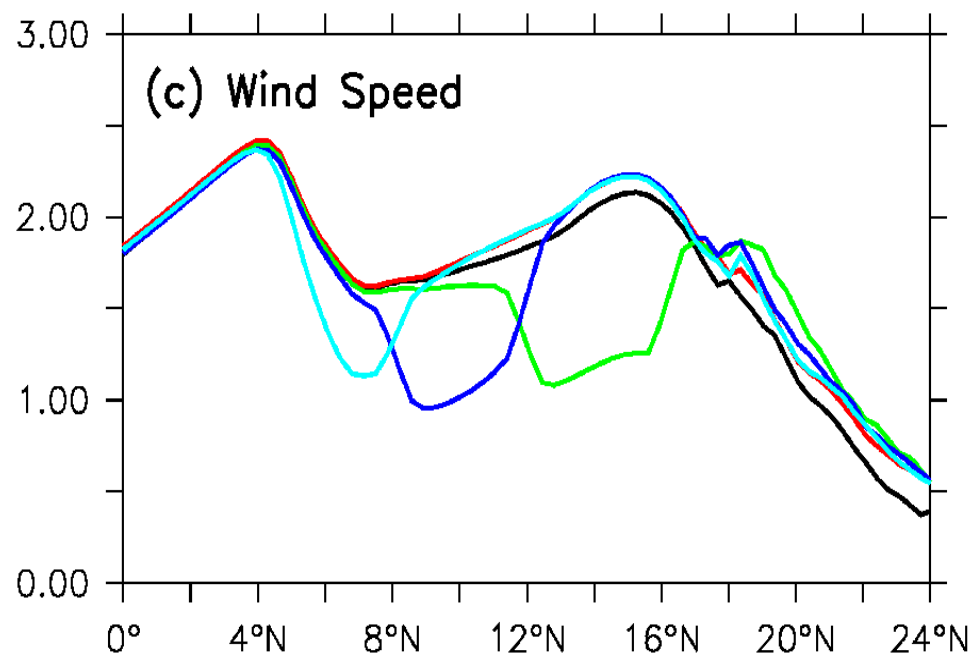
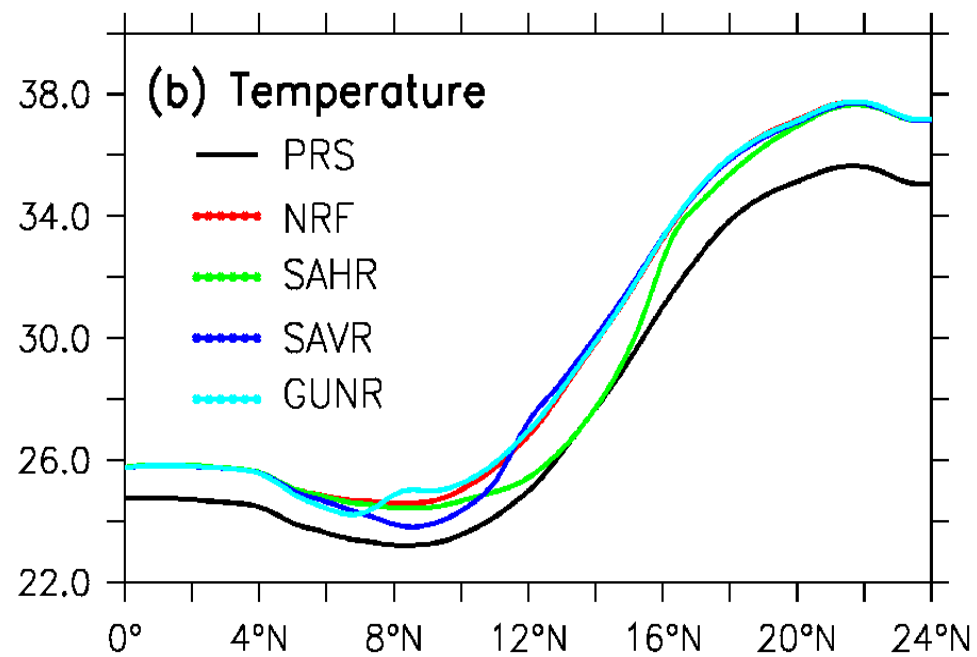
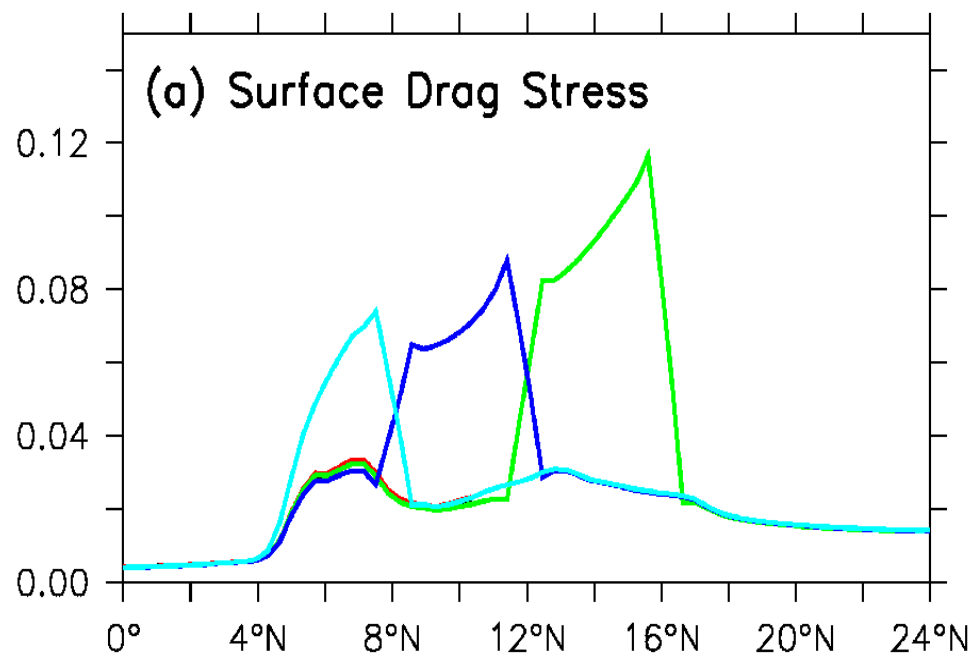
# Impacts of reforestation on Rainfall (JJA)



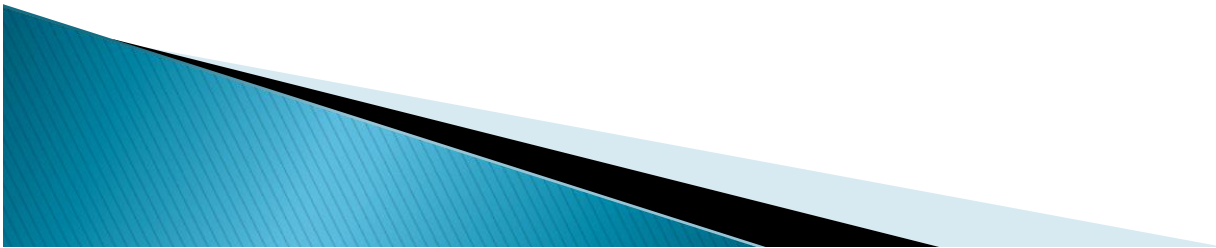
**Why?**



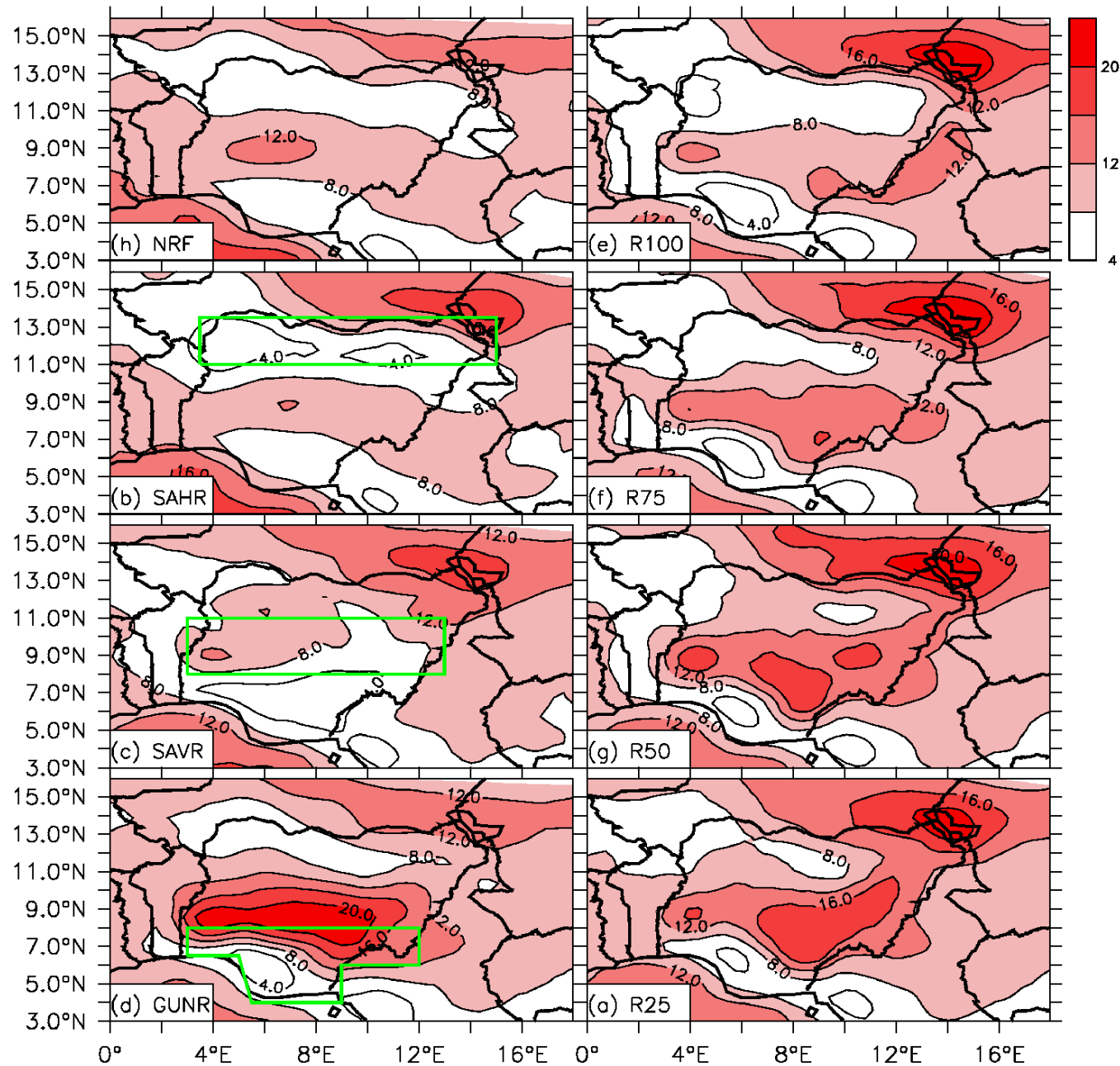




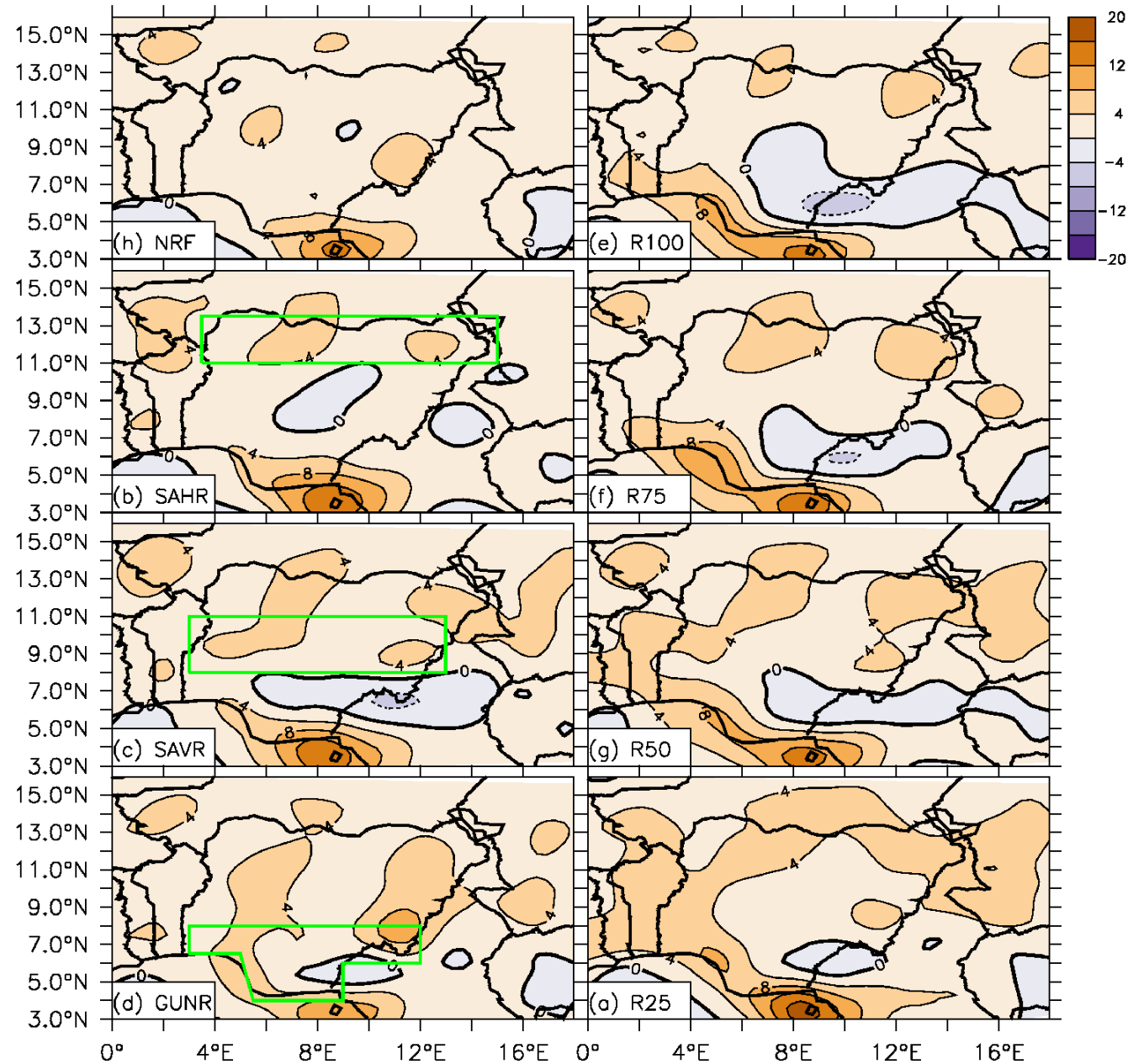
# Potential Impacts of Reforestation in Nigeria



# Changes in Heat waves (events/decade)

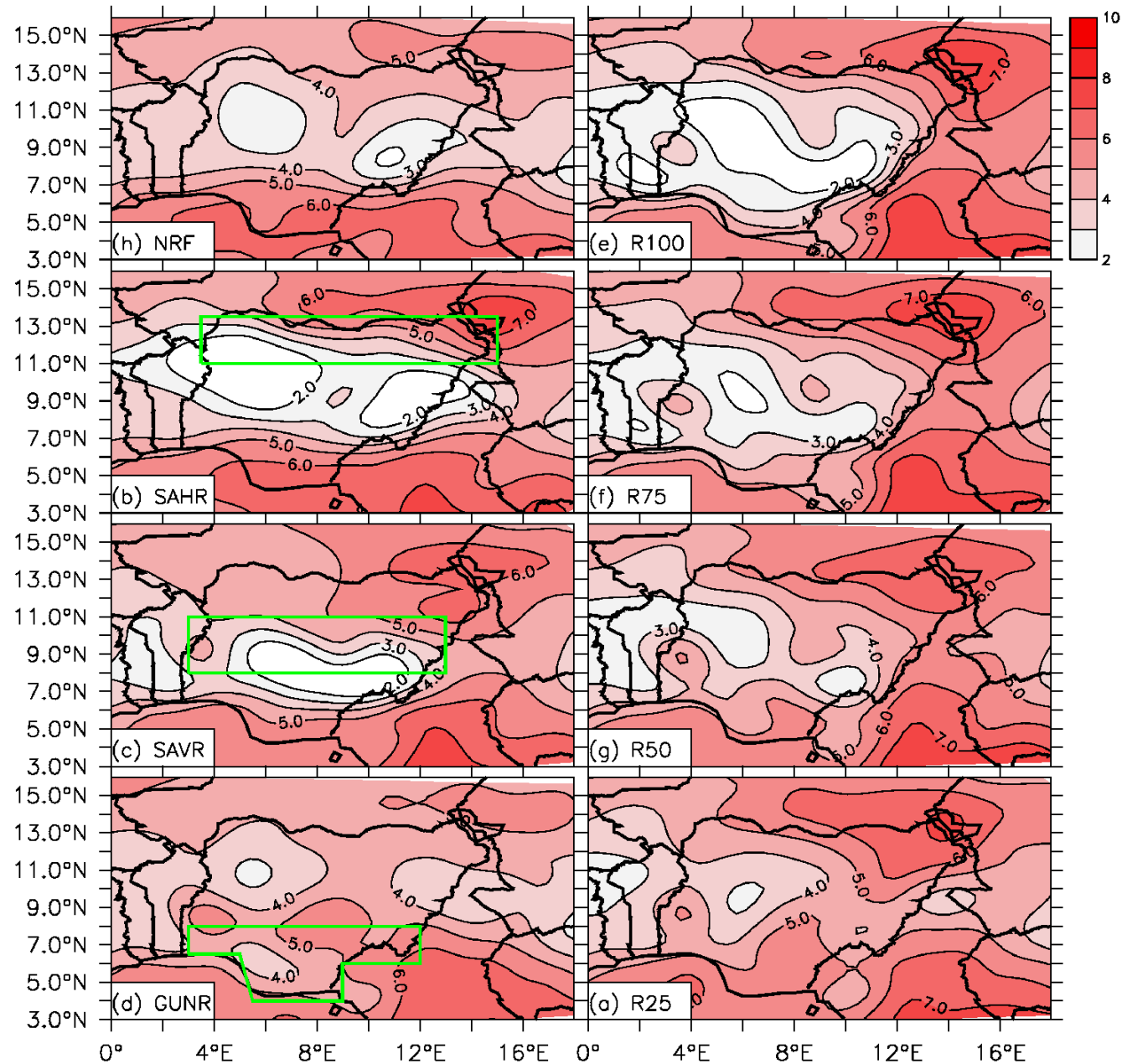


# Changes in Extreme Rainfall (events/decade)





# Changes in Drought Index (SPEI) (events/decade)



# Conclusion

- ▶ Reforestation is usually thought as a good approach to mitigate impacts of global warming over West Africa. This study shows that the reforestation may have bigger impacts than originally thought.
- ▶ While the reforestation could lower the warming over some areas, it could also enhance the warming over other areas.
- ▶ Hence, the reforestation requires a mutual agreement among the West African countries, because the impacts of the reforestation do not recognize political boundaries.

**Thank you!!!**

