Simulation of the West African Monsoon using the MIT Regional Climate Model

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RegCM3 Upgraded by MIT Eltahir Group

New Features	Key References
Coupling of Integrated Biosphere Simuylator (IBIS) Land Surface Scheme	Winter et al. (2009)
New surface albedo assignment	Marcella (2012), Marcella and Eltahir (2012)
New convective cloud scheme	Gianotti (2012), Gianotti and Eltahir (2013a)
New convective rainfall autoconversion scheme	Gianotti (2012), Gianotti and Eltahir (2013b)
Modified boundary layer height and boundary layer cloud scheme	Gianotti (2012), Gianotti and Eltahir (2013c)

Poster Session

- **Gianotti and Eltahir**: Improving simulation of the feedback between radiation, convective clouds and rainfall over the Maritime Continent
- **Eltahir et al**: Introducing the MIT Regional Climate Model (MRCM)

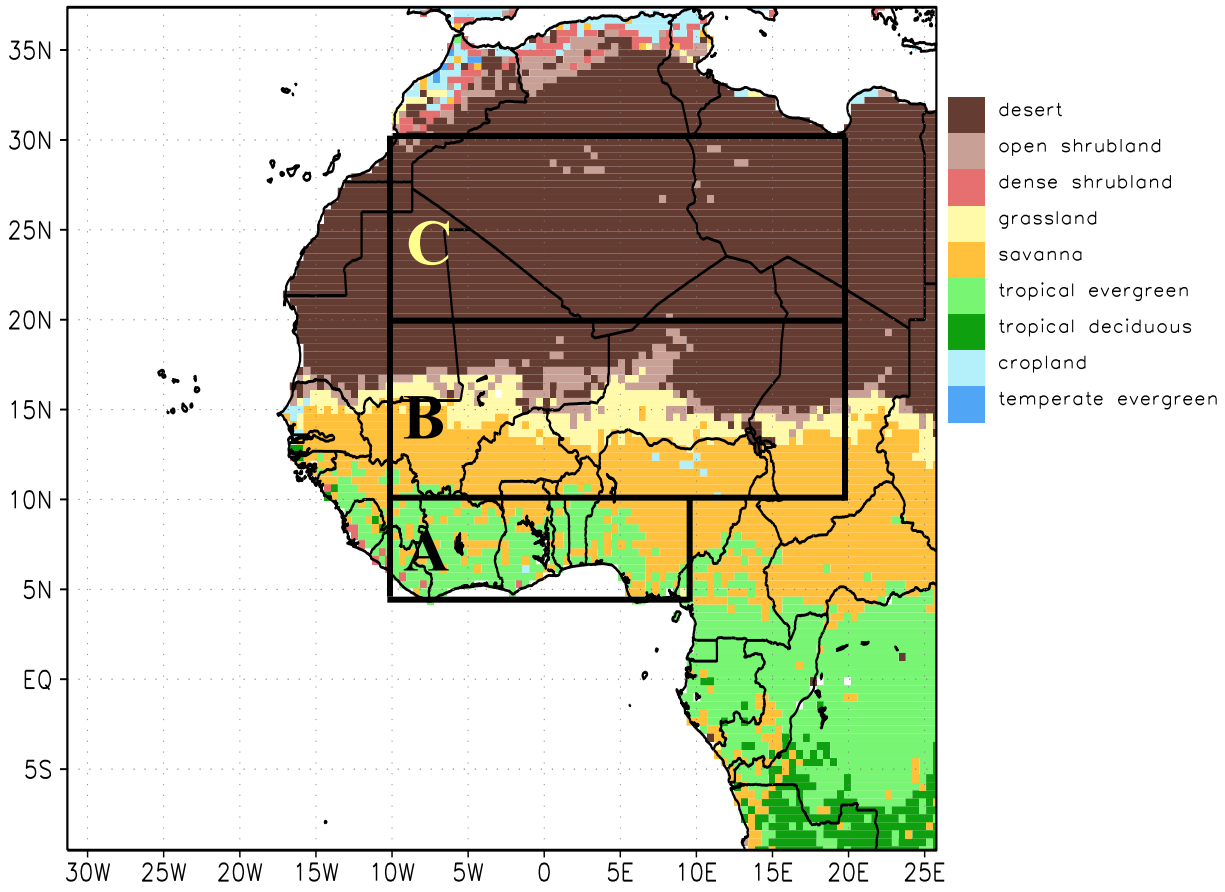
Experiments Design

	Land surface scheme	Convection scheme
IGF	IBIS	Grell FC
BSE	BATS	Standard Emanuel
ISE	IBIS	Standard Emanuel
IME	IBIS	Modified Emanuel

MIT Regional Climate Model (MRCM)

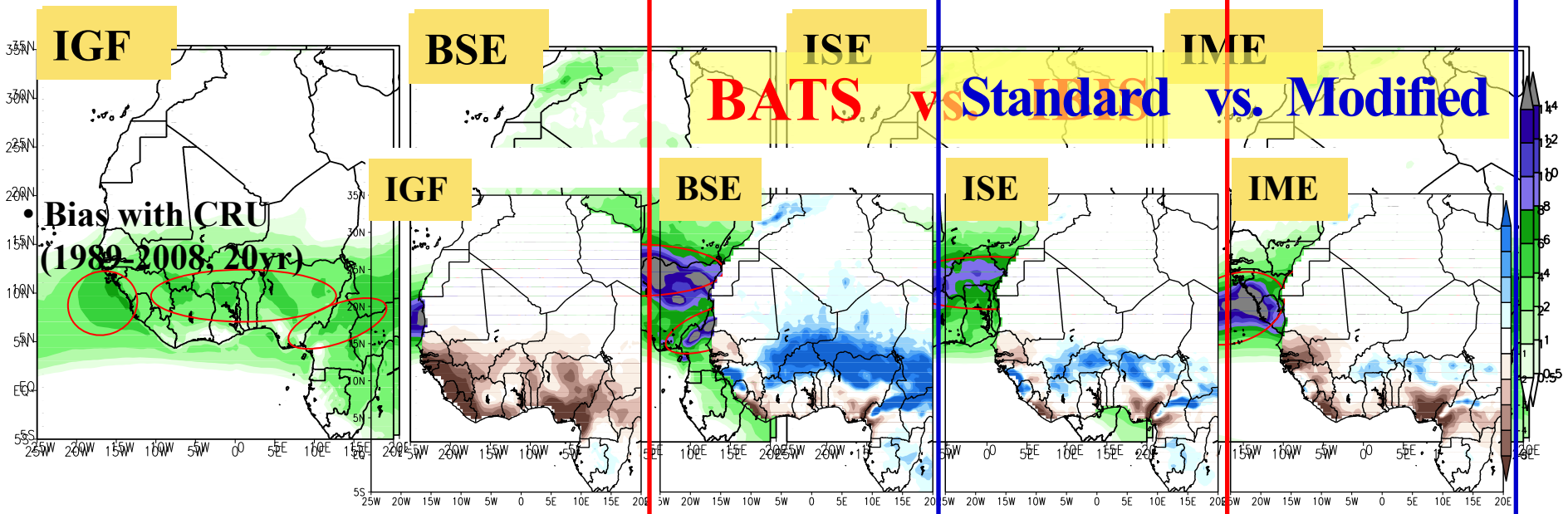
Model Configuration

- Resolution: 50km
- Integration Period: 1989-2008 (20yr)
- Initial & Boundary Condition: ERAInterim (1.5deg)
- Sub-domain for area-average validation
  - A: Guinea Coast
  - B: Sahel
  - C: Northern Africa



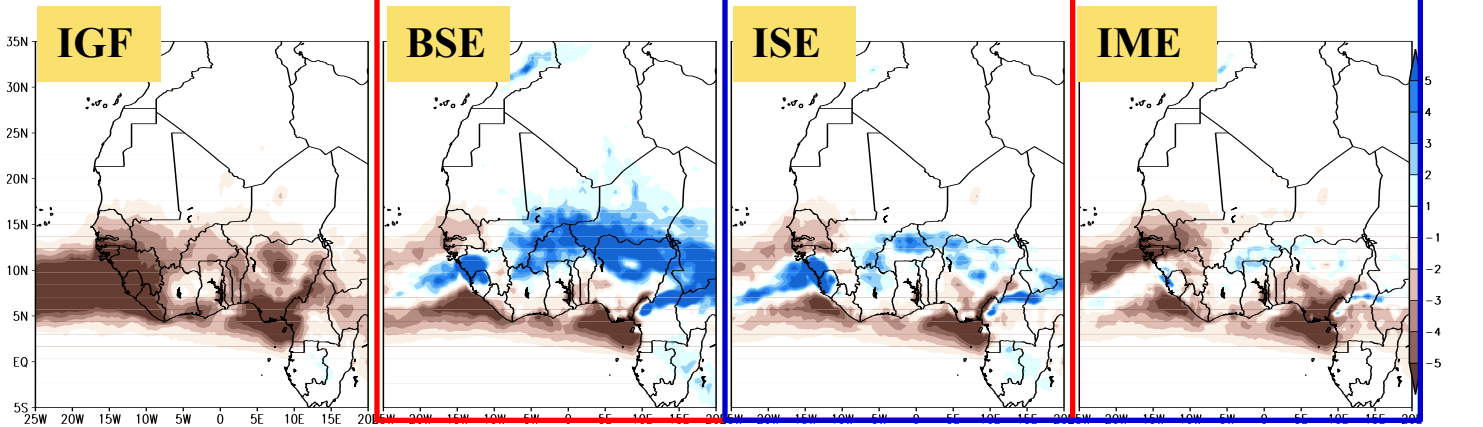
JJA Rainfall Spatial Pattern

- 20-YR Climatology (1989-2008)

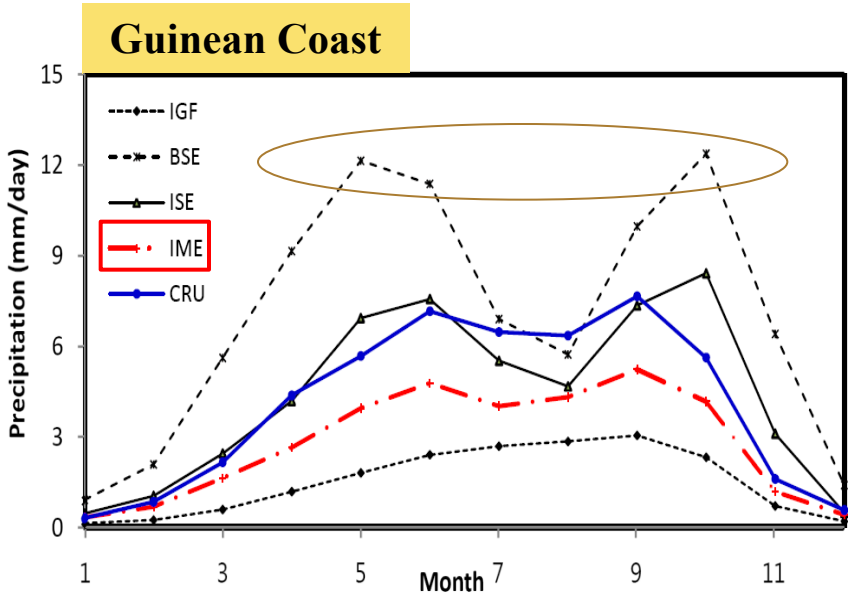


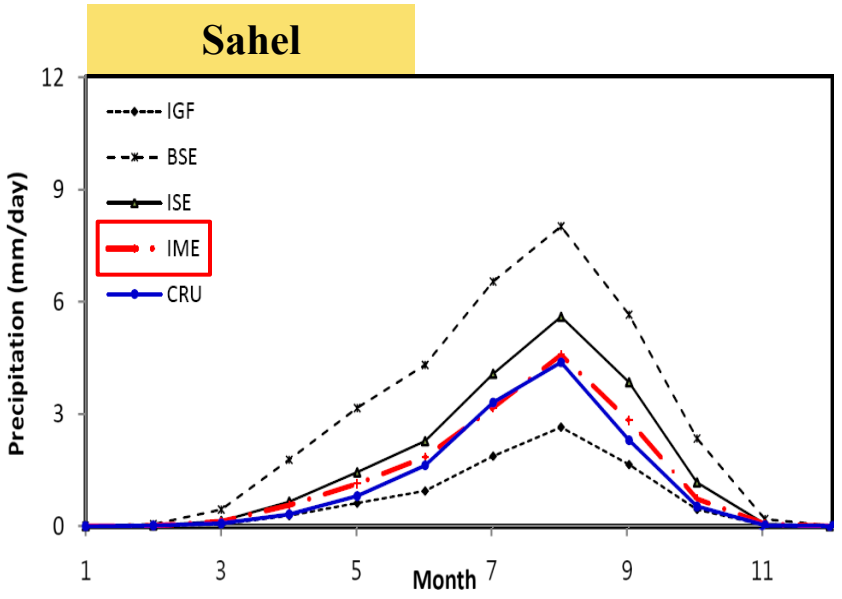
- Bias with CRU (1989-2008, 20yr)

- Bias with TRMM (1998-2008, 11yr)



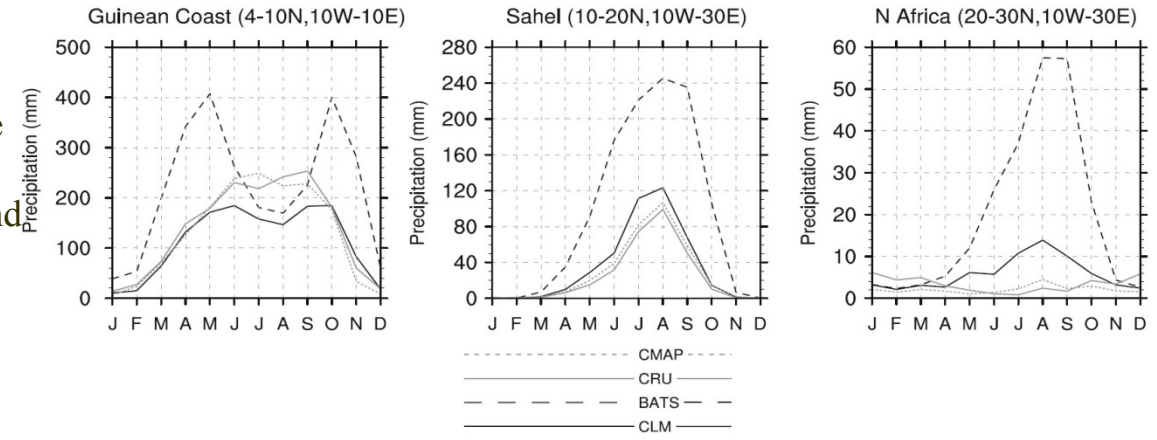
Rainfall Monthly Variation



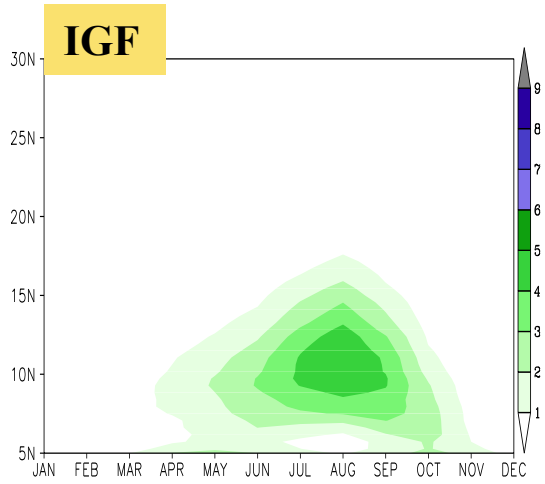


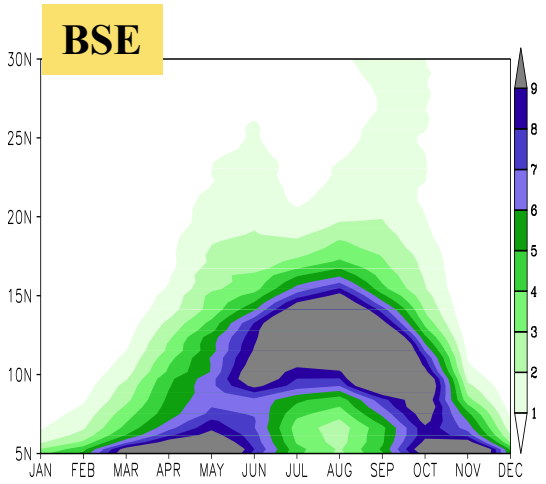
Steiner et al. (2009)

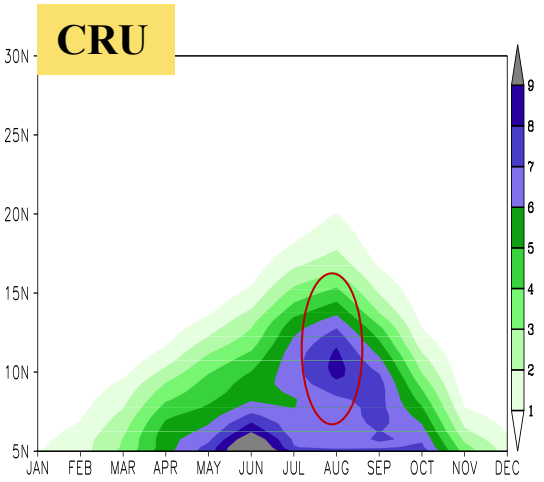
➔ This improvement is comparable with results using RegCM3 coupled with the Community Land Model Version 3 (CLM3).

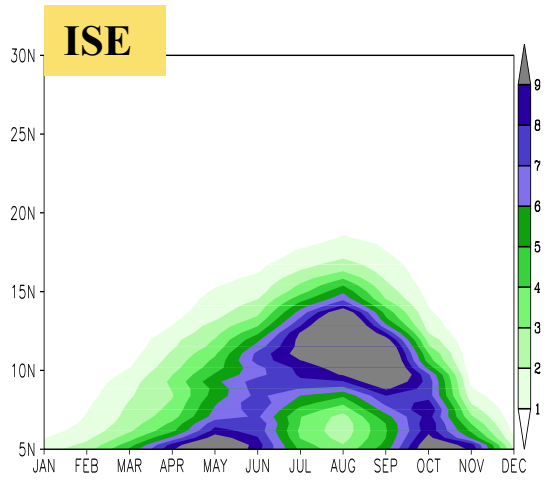


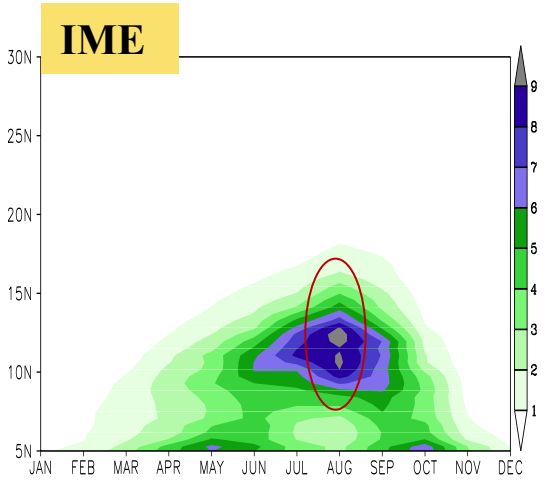
Latitude-Time Cross-section of Rainfall



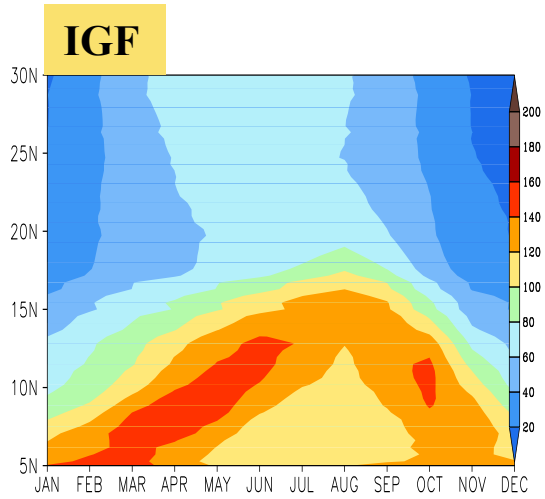


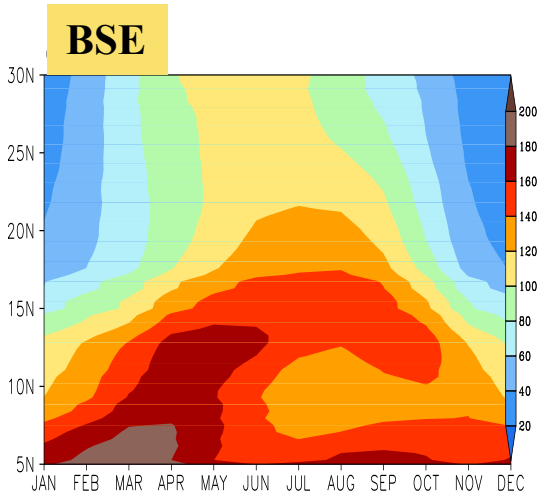


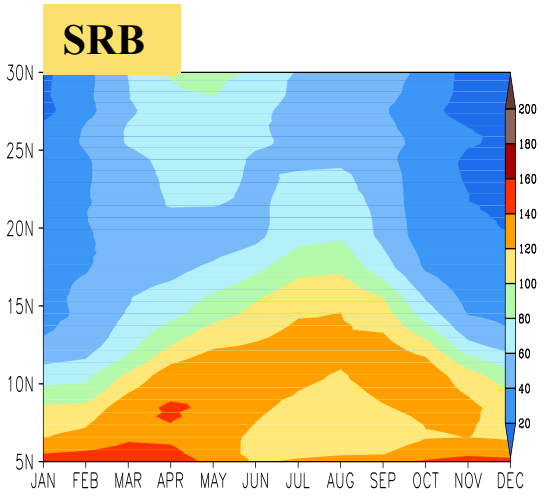


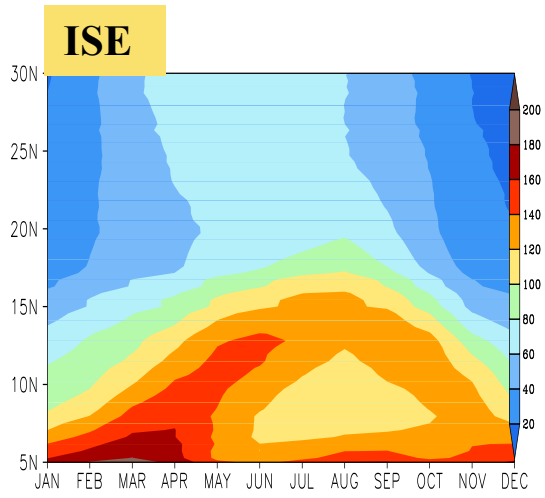


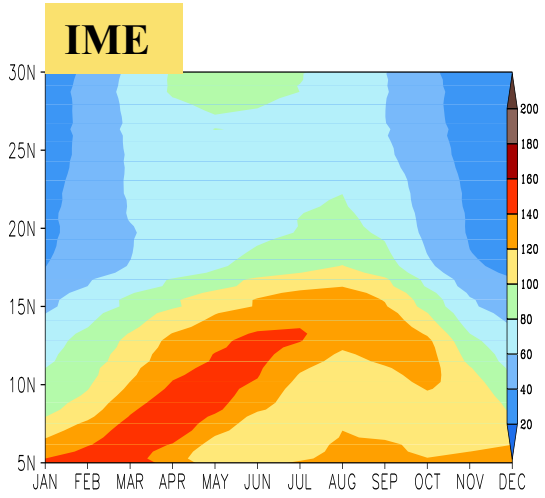
Latitude-Time Cross-section of Net Radiation



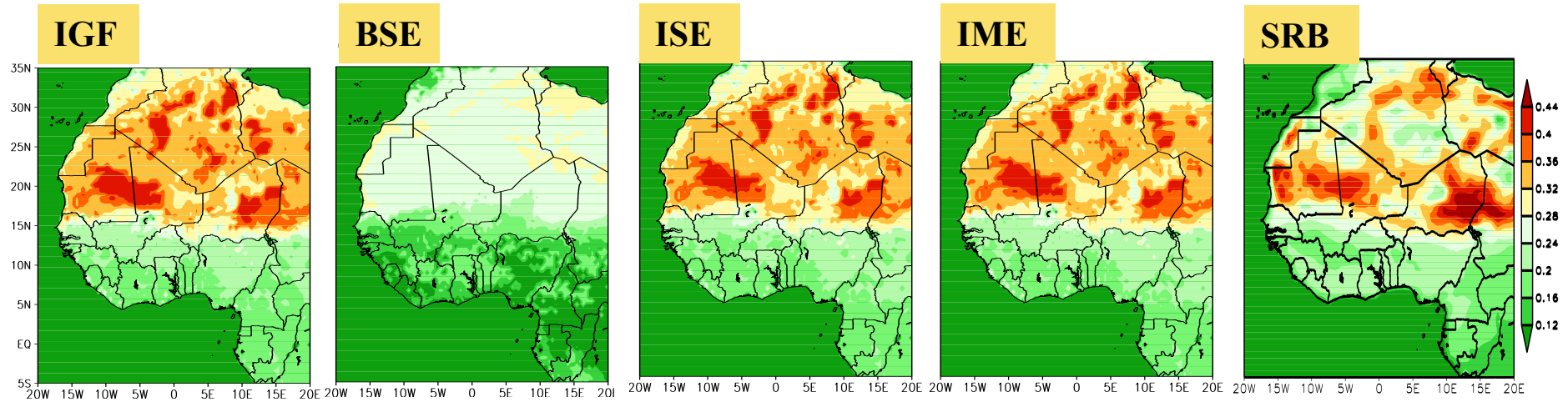








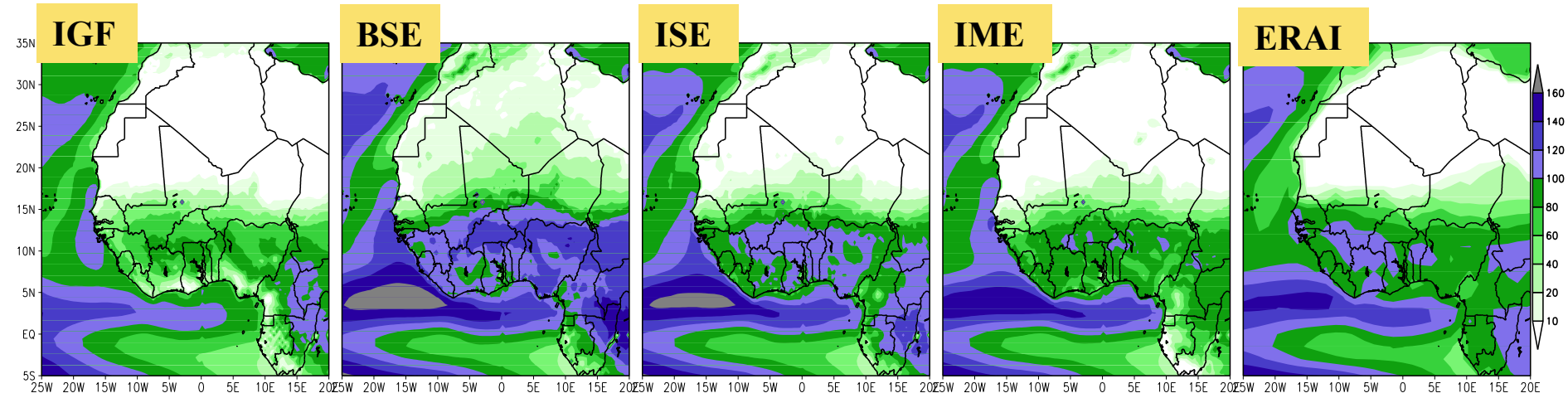
Surface Albedo



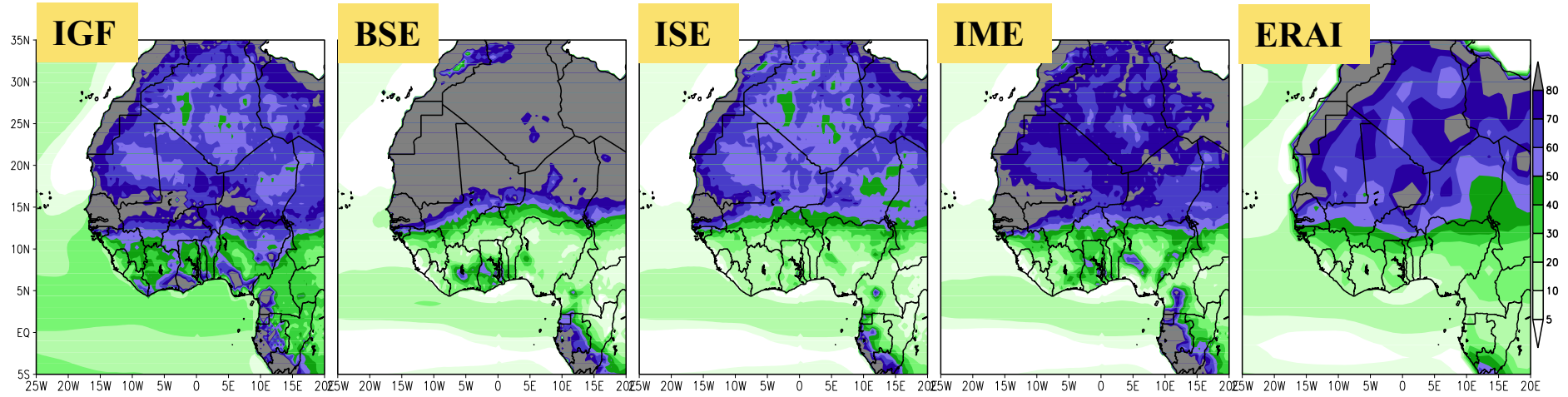
- **Steiner et al. (2009)** also noted that the surface albedo was too low in their simulation using BATS, and attributed this result to higher soil moisture. Since wetter soils further reduce the soil albedo, this can cause an enhanced feedback to absorbed solar radiation, leading to excessive net radiation.

Latent & Sensible Heat Flux

➢ Latent Heat Flux

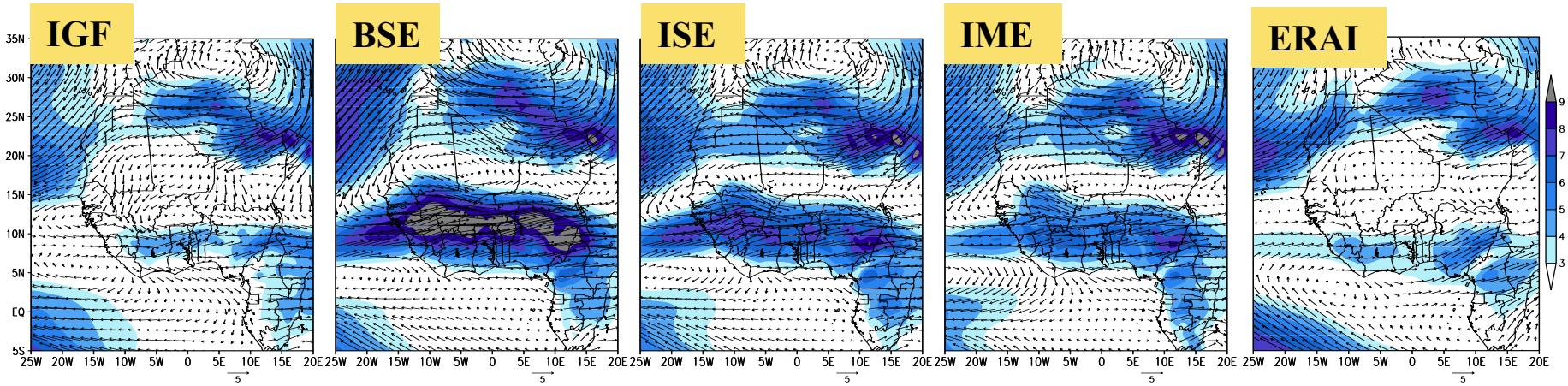


➢ Sensible Heat Flux

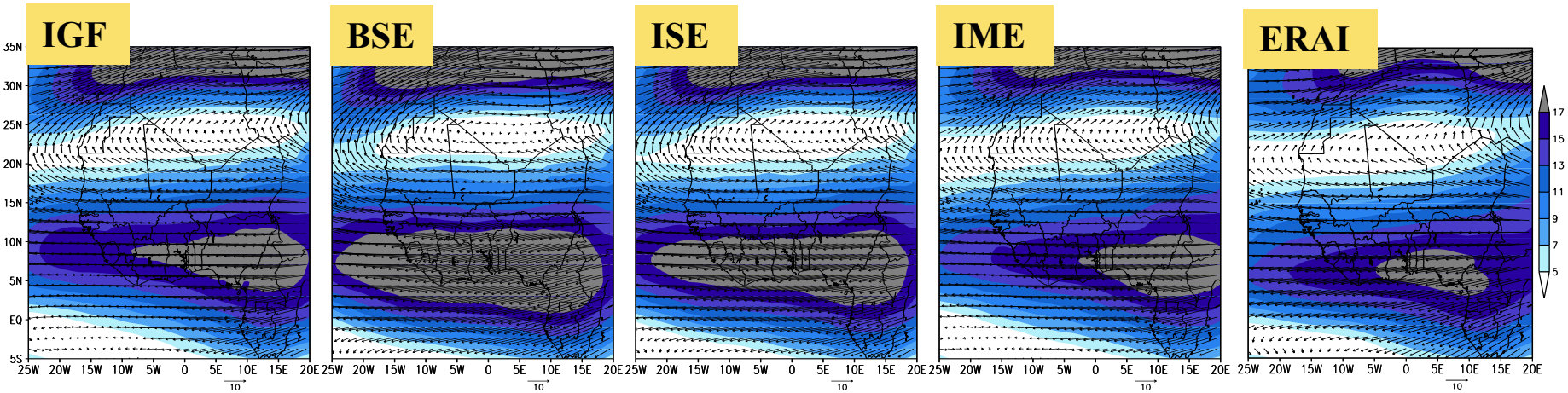


Wind Vector at 850 & 200 hPa

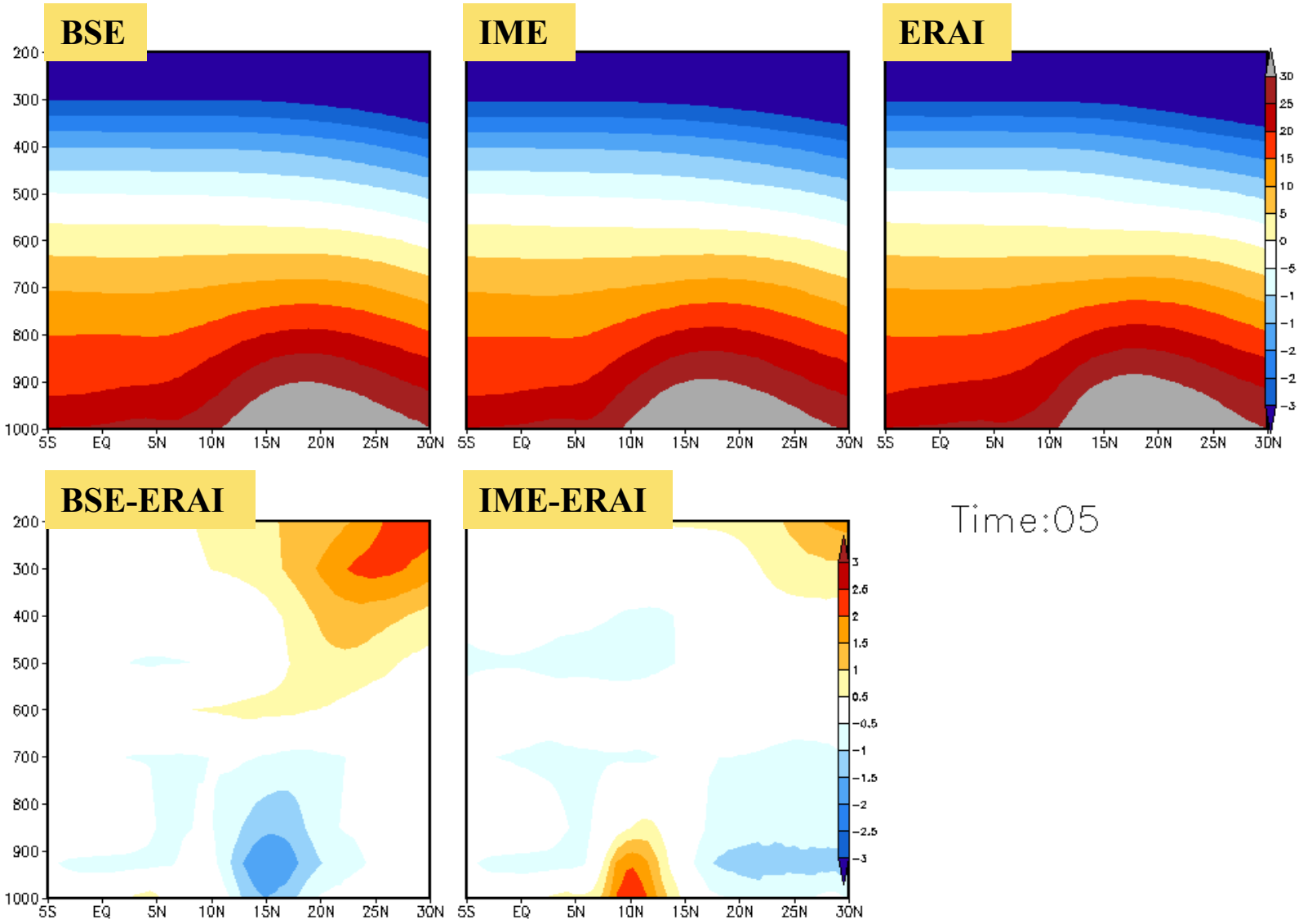
➢ 850 hPa Wind



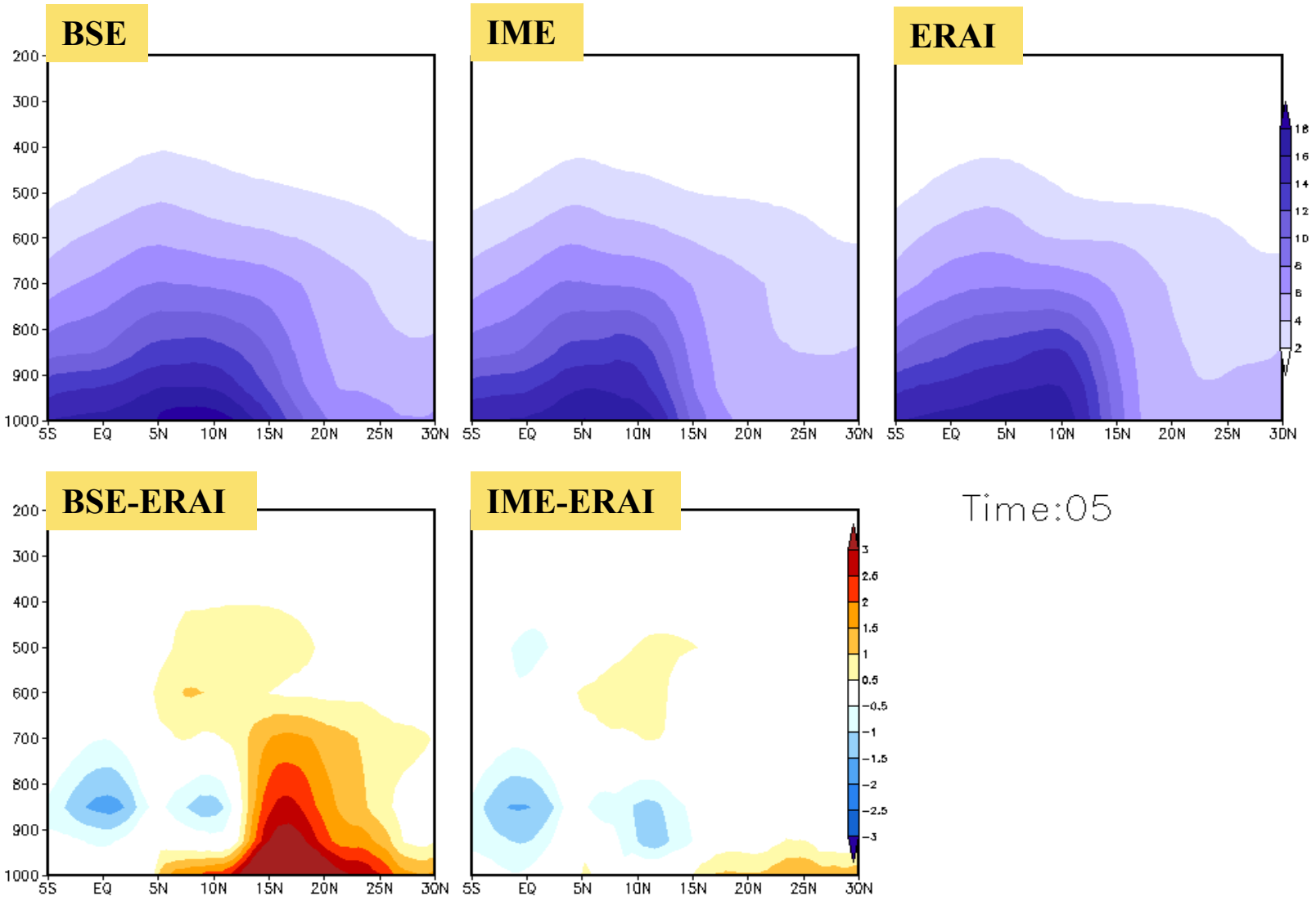
➢ 200 hPa Wind



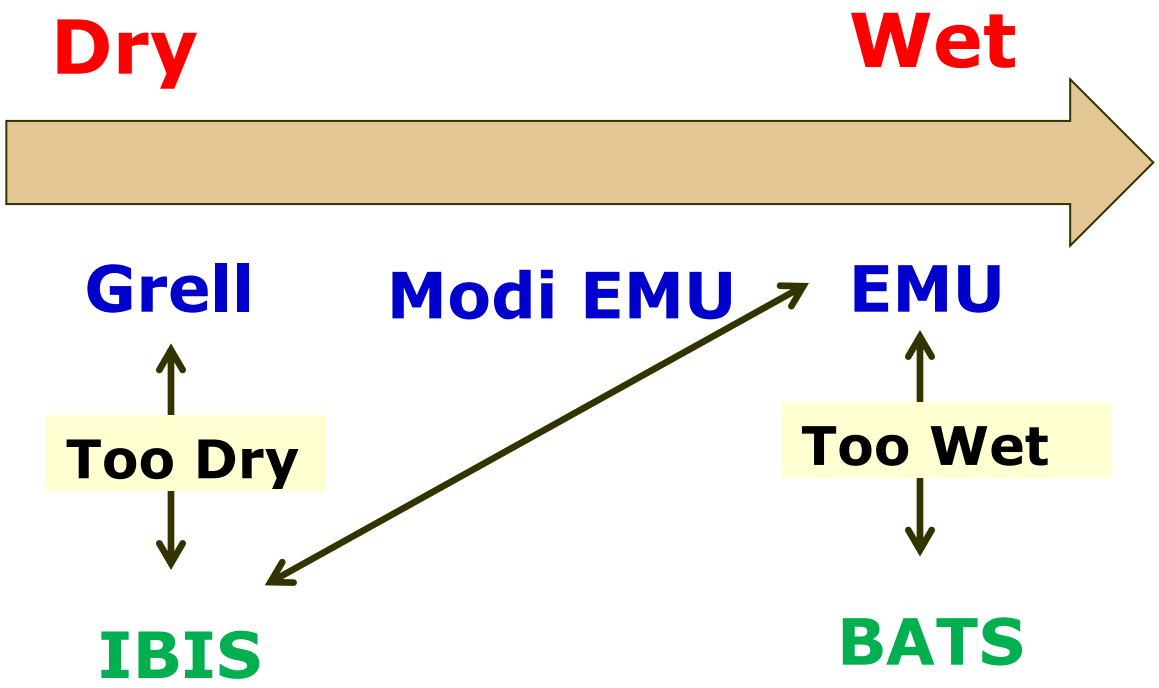
Temperature [10W-10E/May-Oct]



Specific Humidity [10W-10E/May-Oct]



General Tendency



Summary

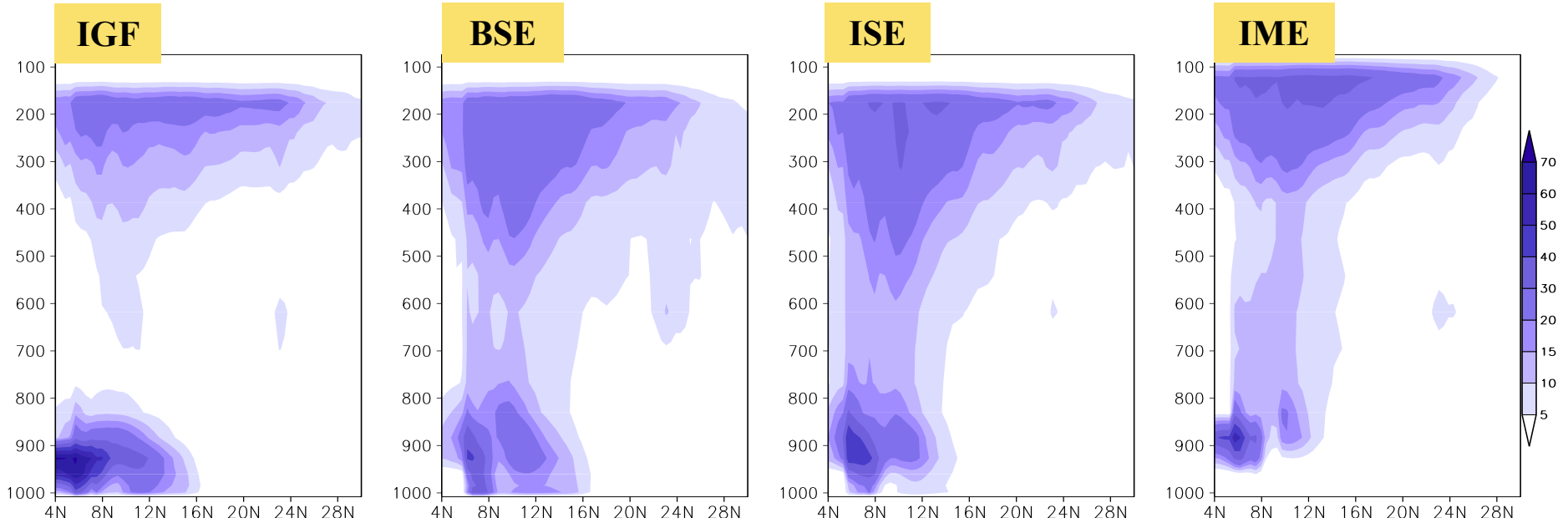
- The simulation of the WAM exhibits strong sensitivity to the choice of both land surface scheme and convection scheme.
- The improvement in the spatial and temporal distribution of rainfall in simulations using IBIS, rather than the default BATS scheme, is significant.
- In addition, the modifications incorporated within MRCM with respect to convective cloud cover, autoconversion and boundary layer characteristics significantly improved the simulation of rainfall.

⇨ **The MRCM represents a significant improvement over previous versions of this model that attempted to simulation the West African Monsoon.**

⇨ **The MRCM is capable of reproducing the major features of the rainfall and dynamics of the West African monsoon.**

Thank you for your attention!!

Vertical Structure of Cloud Fraction



- The IGF exhibits more extensive cloud cover in the lowest 100 mb of the atmosphere than the other simulations, but less cloud over throughout the rest of the vertical column. This reflects the weaker convective activity. The weak vertical transport results in little high cloud cover.
- In contrast, the simulations using the Emanuel scheme show less low-level cloud cover but more extensive cloud cover throughout the vertical column and especially at high altitudes. This results from the strong convective mass flux generated by this convection scheme, which transports large volumes of moisture vertically through the atmosphere and produces large anvil clouds aloft.
- The IME exhibits a cloud profile that appears shifted vertically compared to the other simulations, with very little cloud cover in the lowest 100 mb and more cloud cover within the top 100 mb. The representation of large-scale cloud cover within the PBL was modified such that cloud could only form within the mixed PBL if its entire depth was saturated. This was found to remove unrealistic dense cloud cover close to the surface over land and improve the model performance compared to the ISCCP observations

Zonal Wind & Omega [10W-10E/May-Oct]