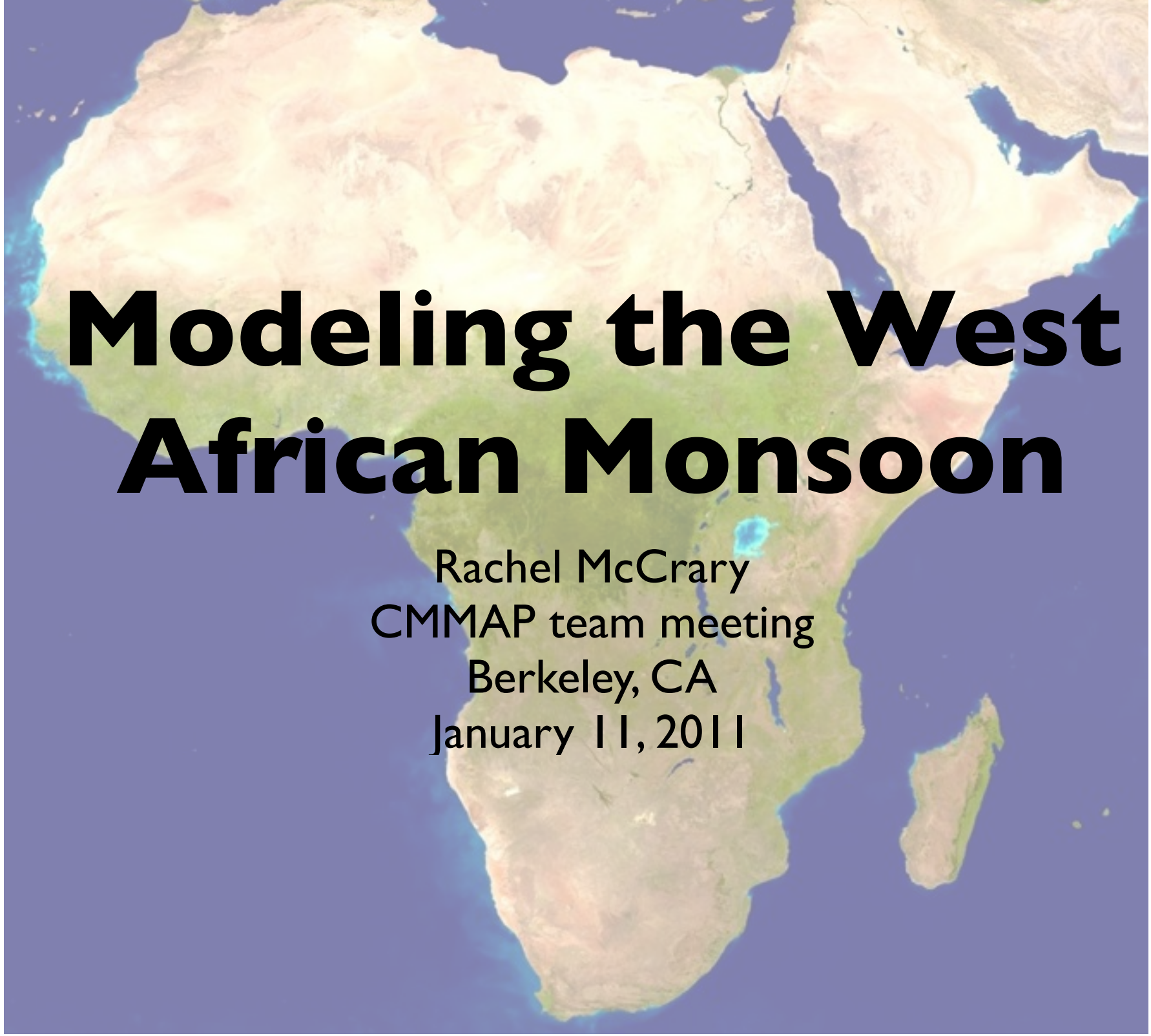


Modeling the West African Monsoon

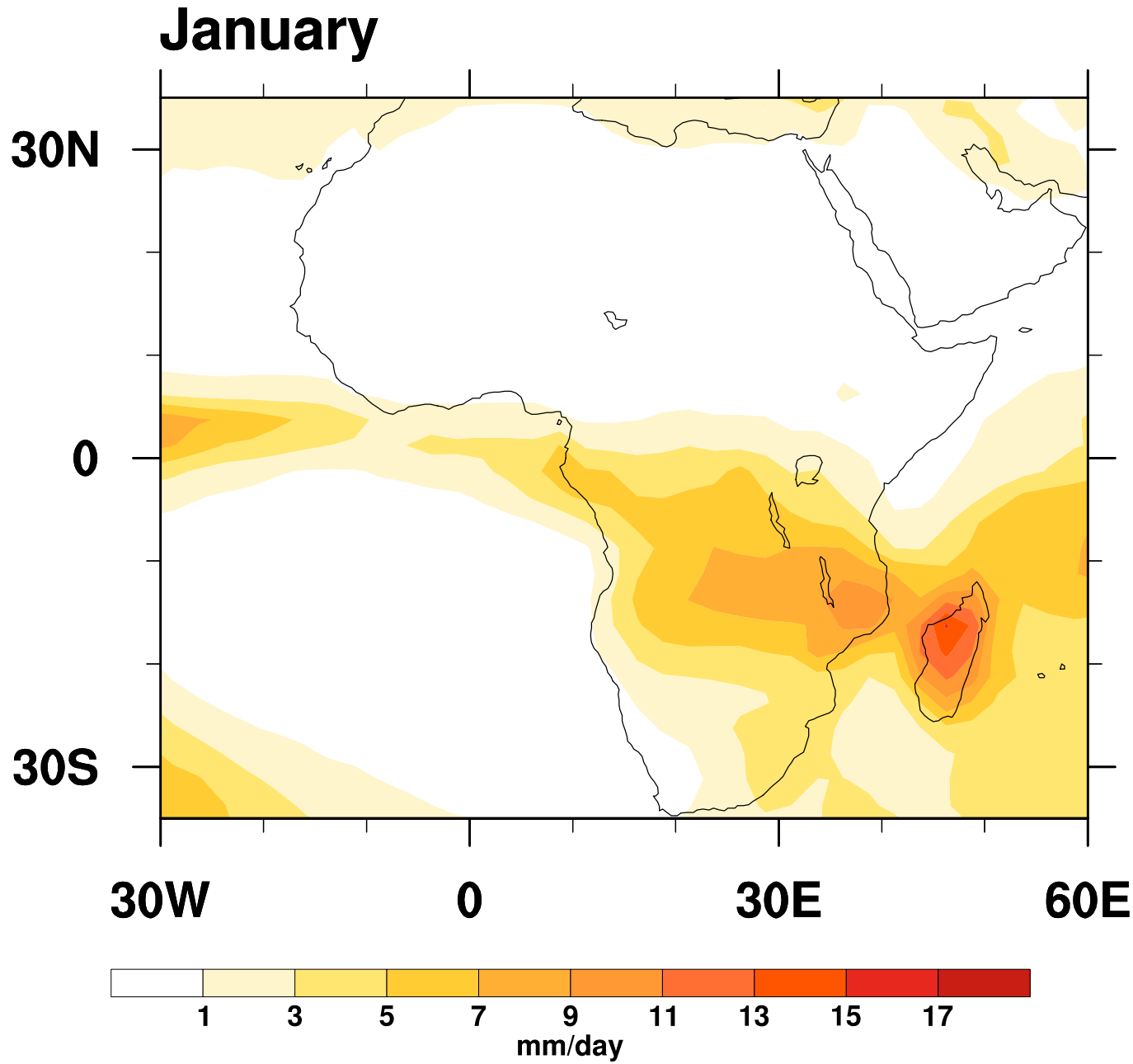
Rachel McCrary

CMMAP team meeting

Berkeley, CA

January 11, 2011

Seasonal Progression of Rain Over West Africa



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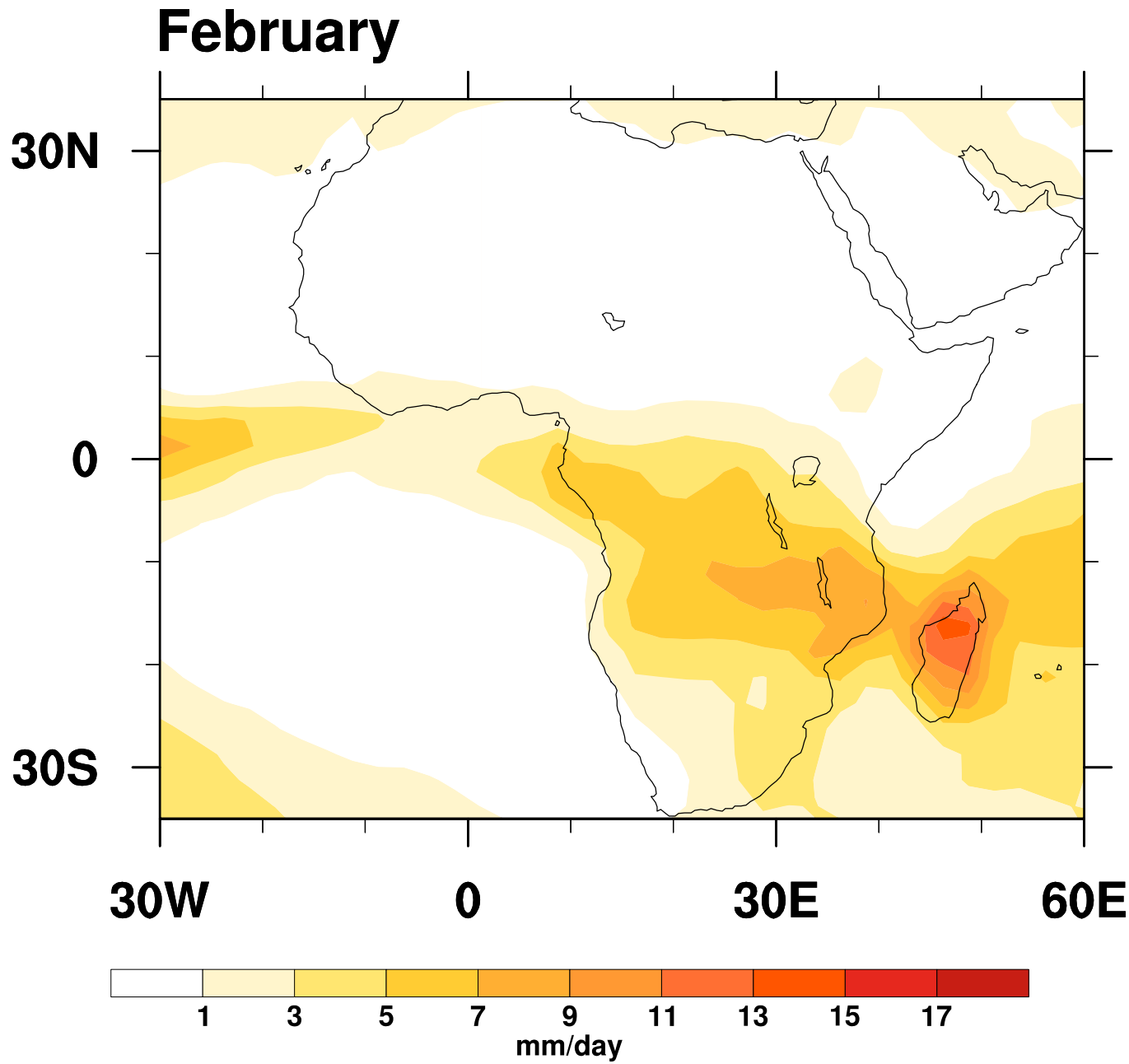

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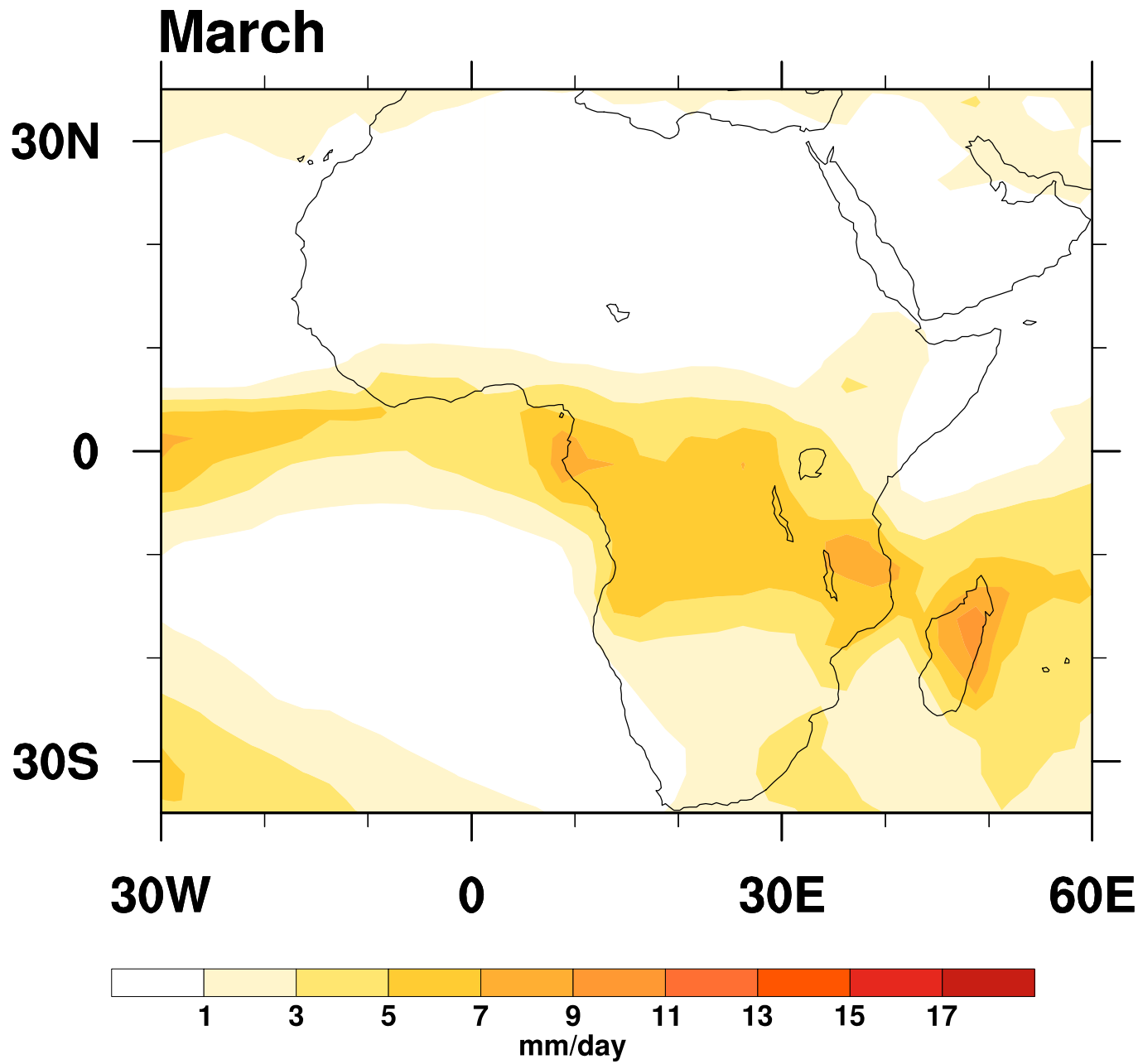

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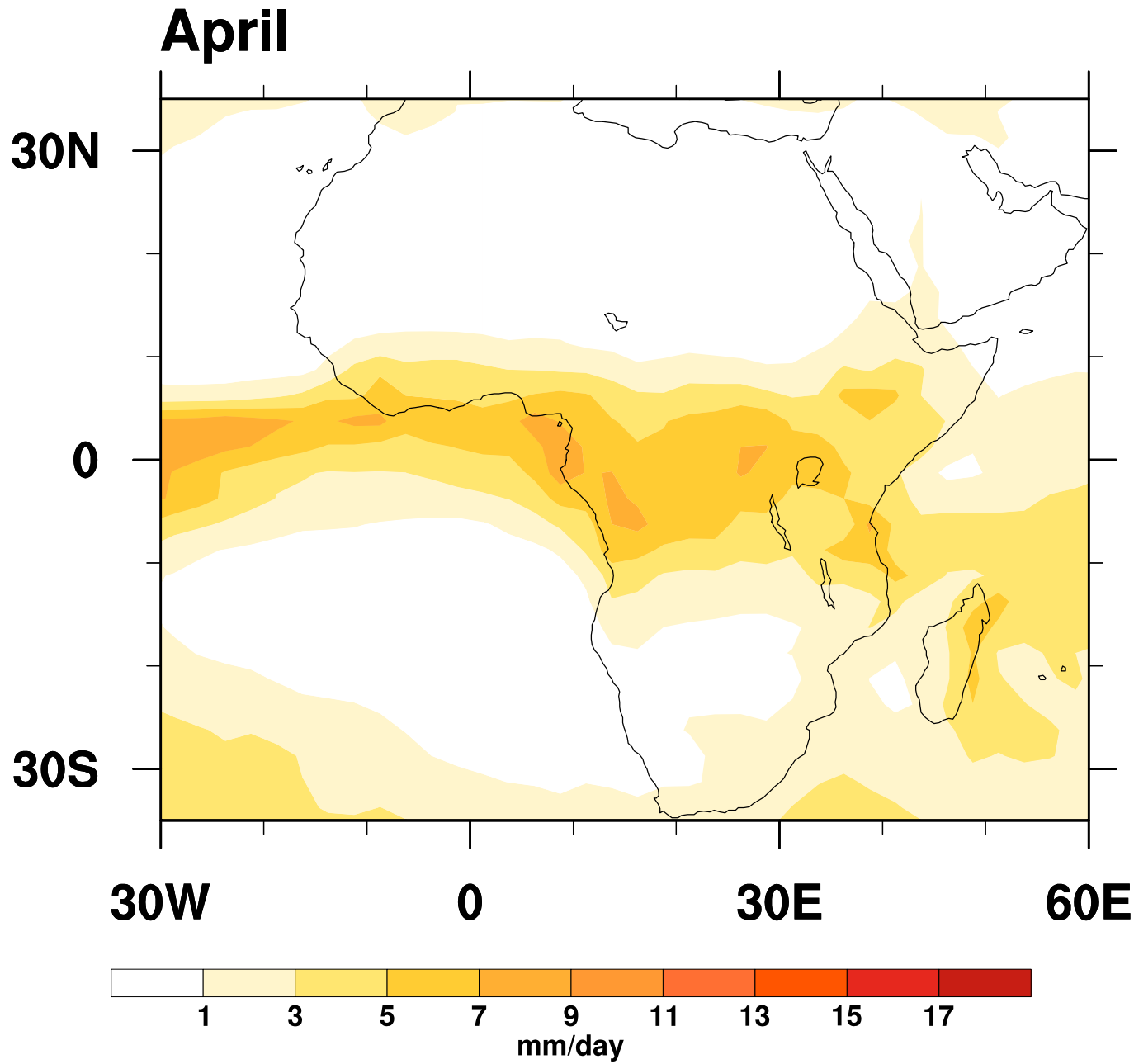

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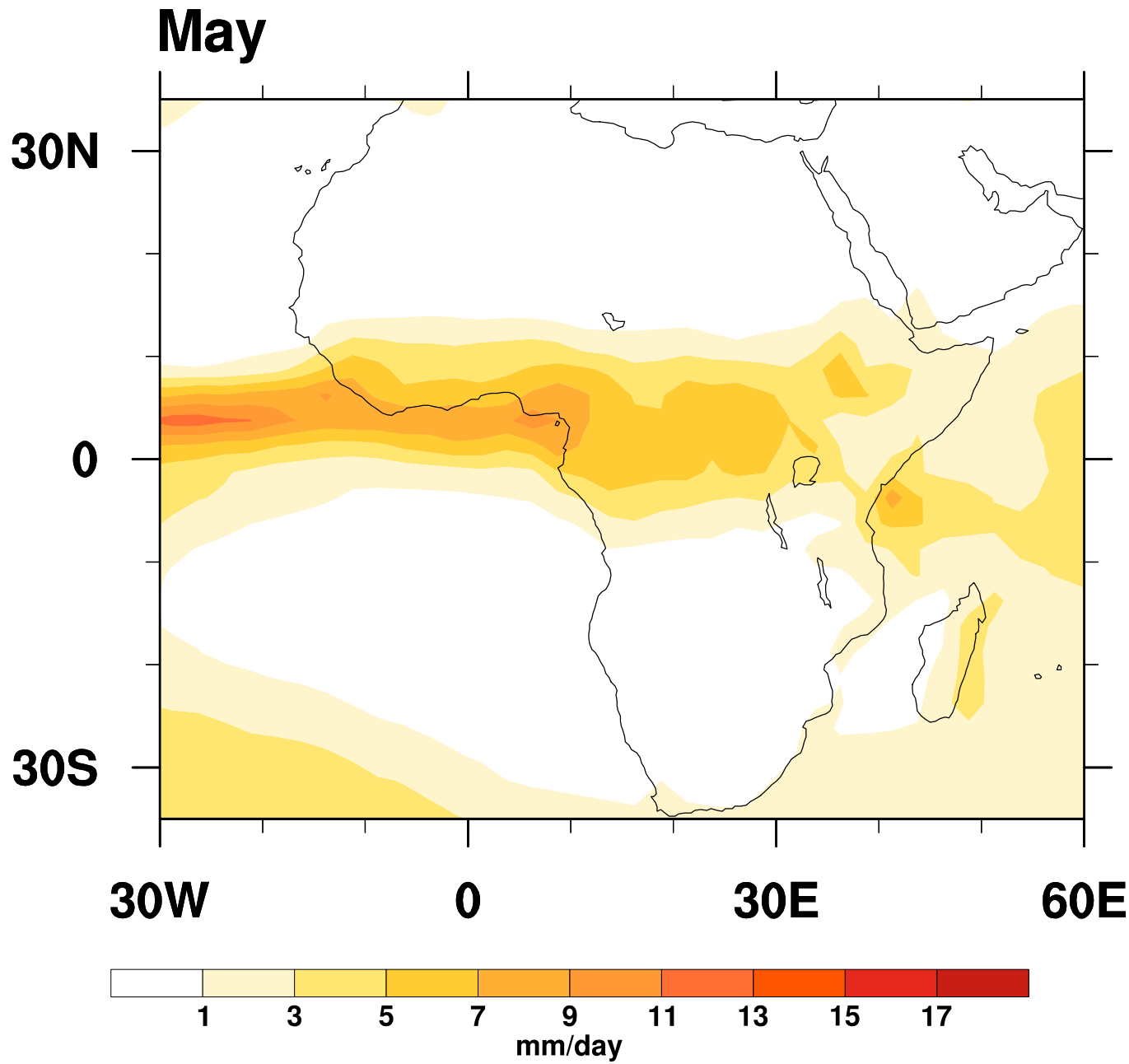

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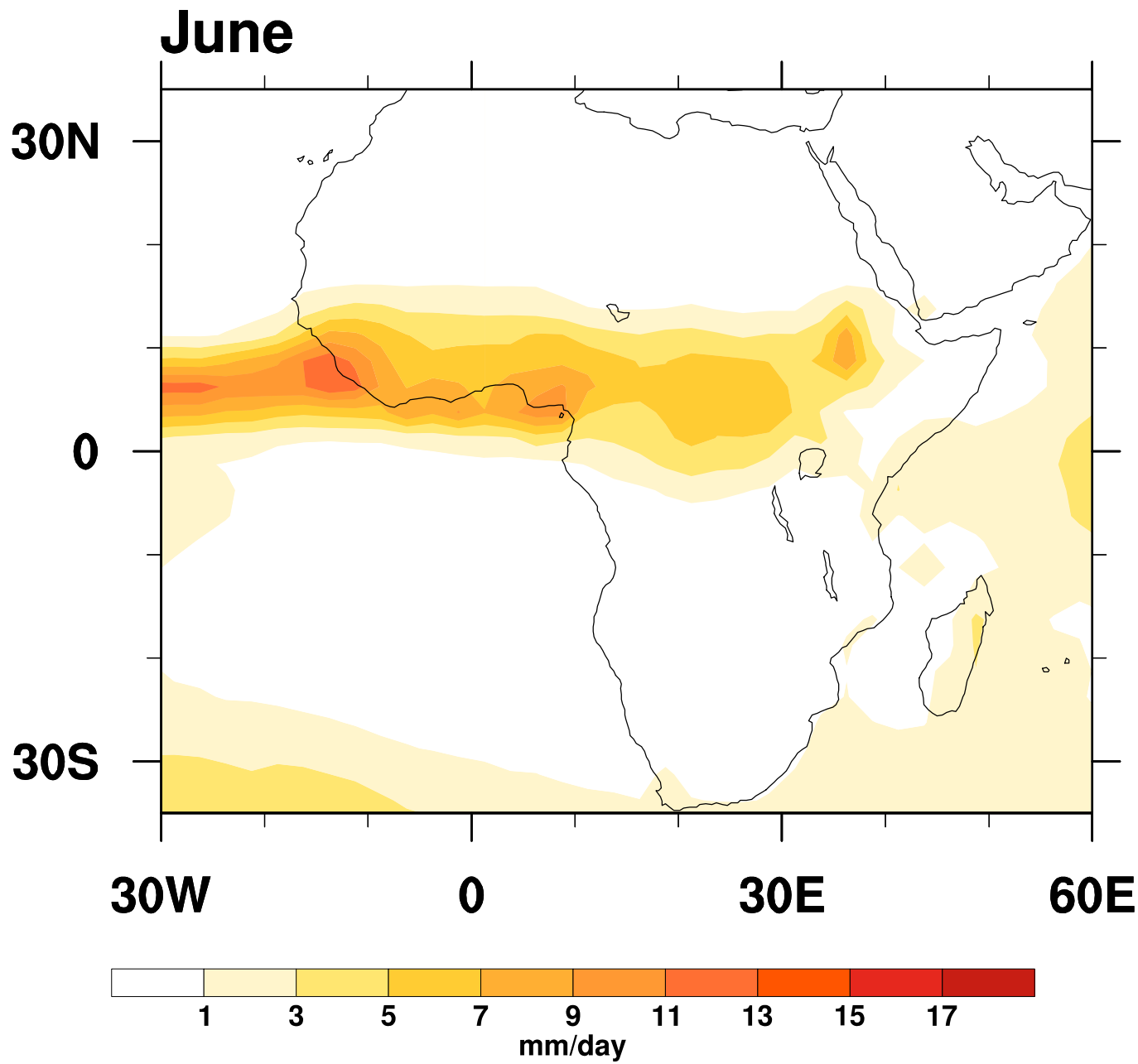

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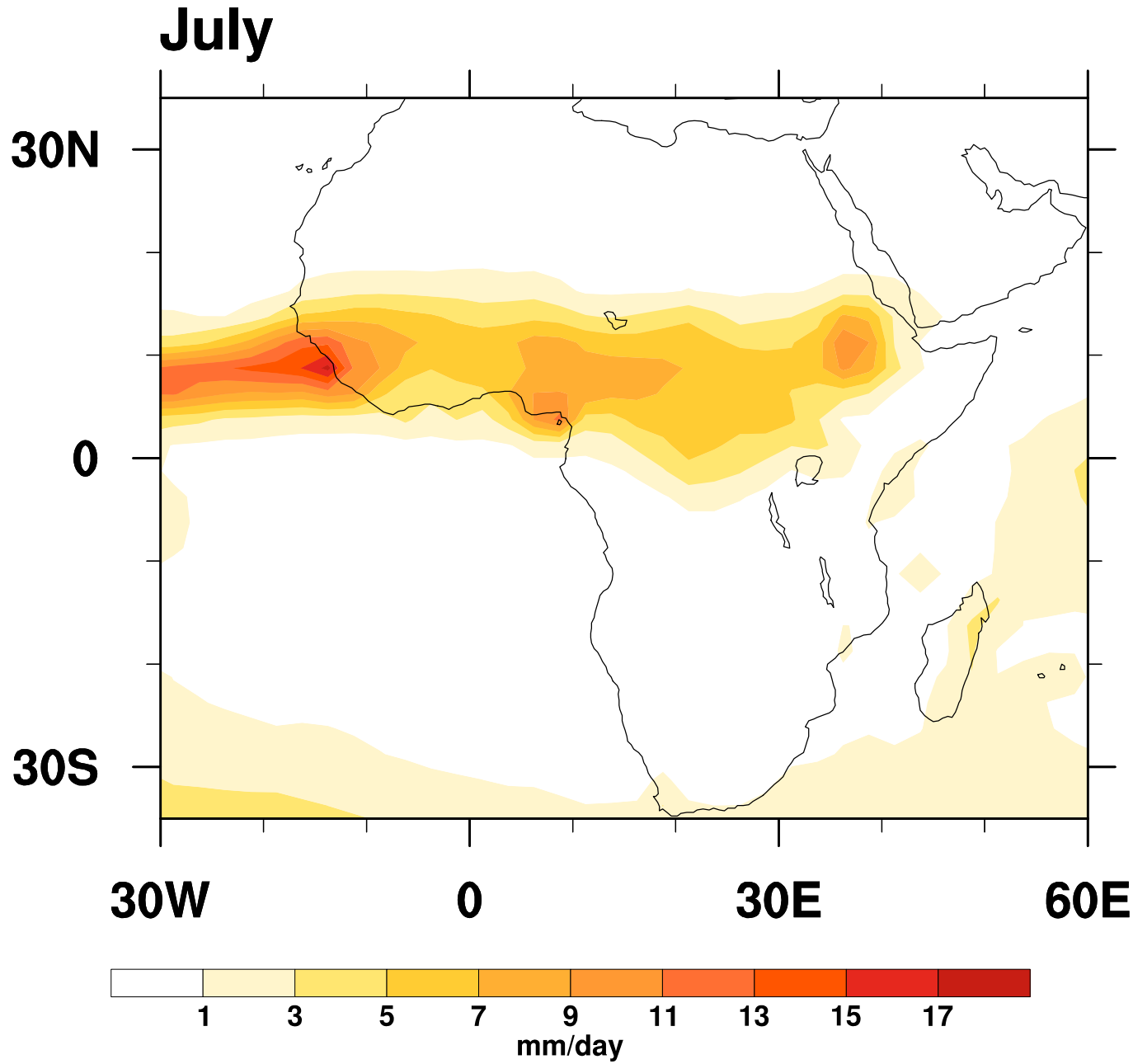

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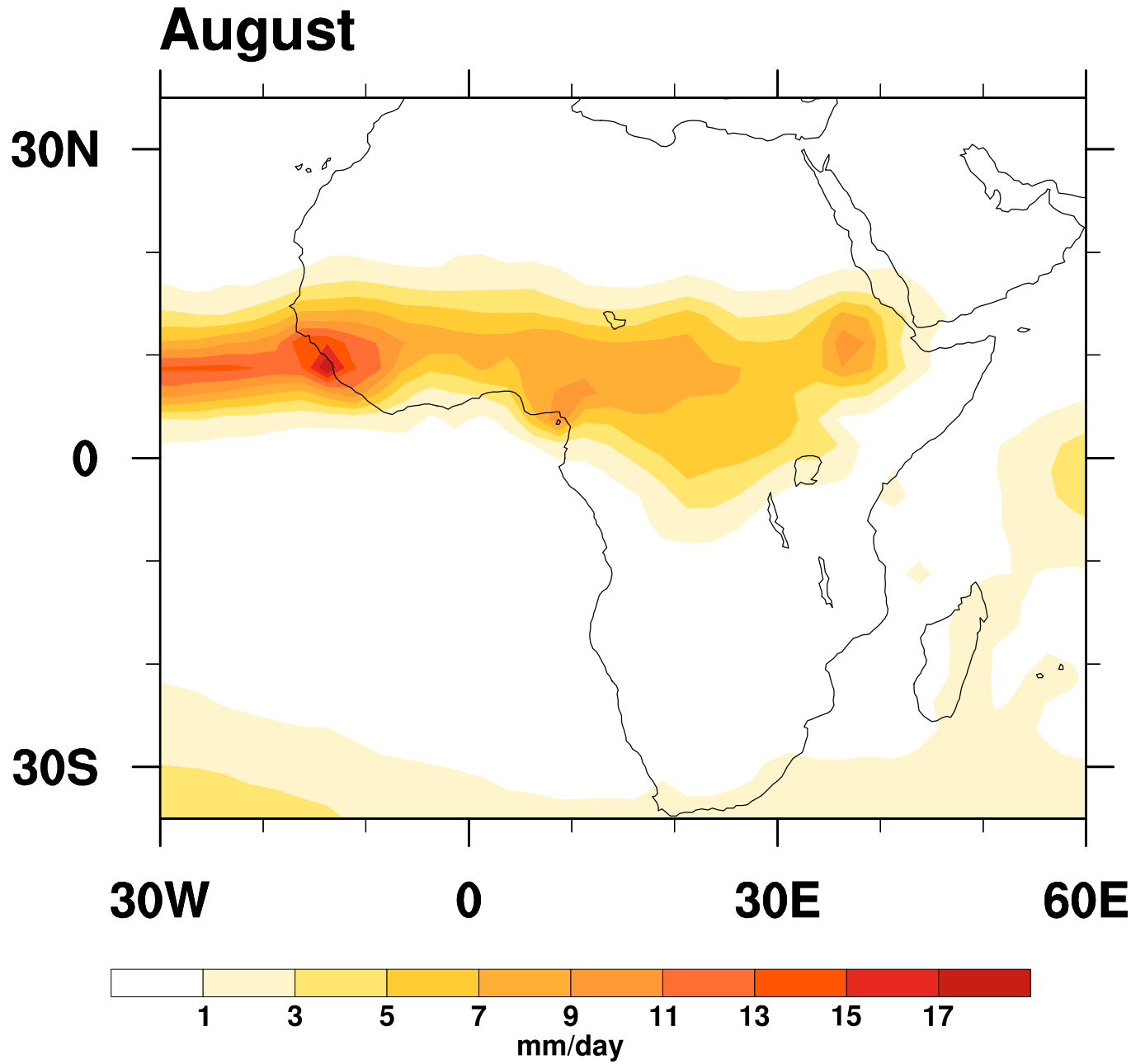

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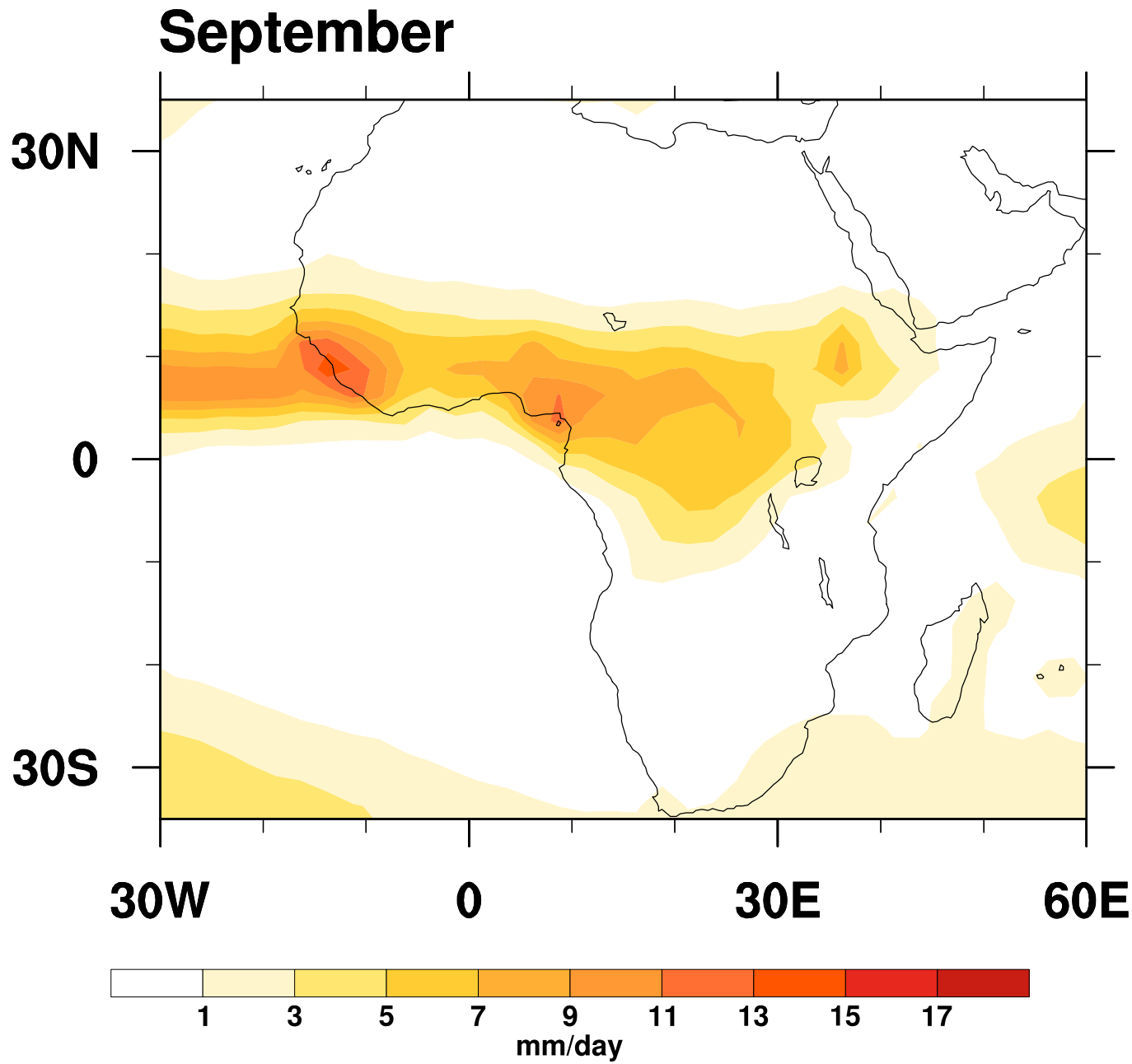

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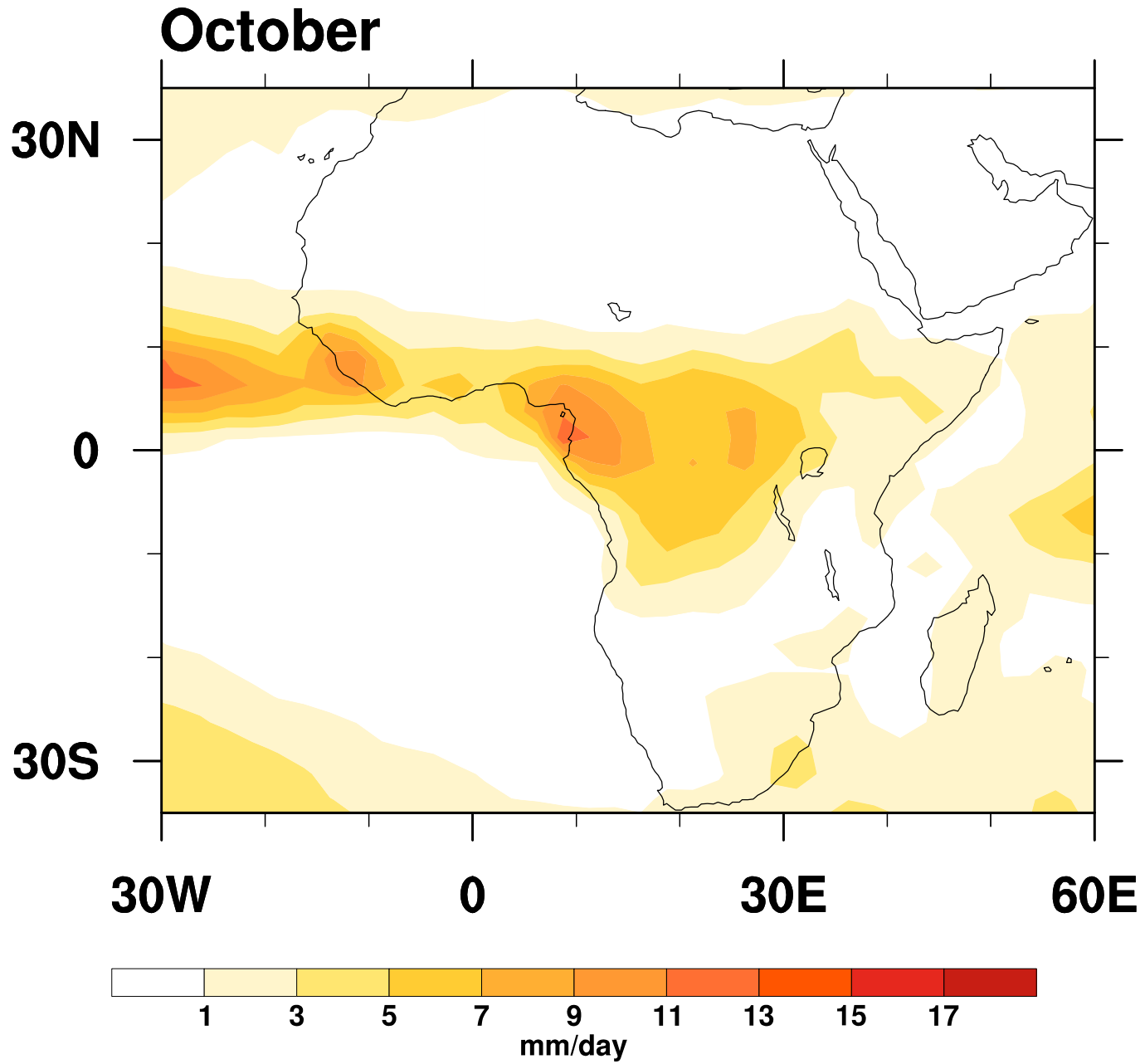

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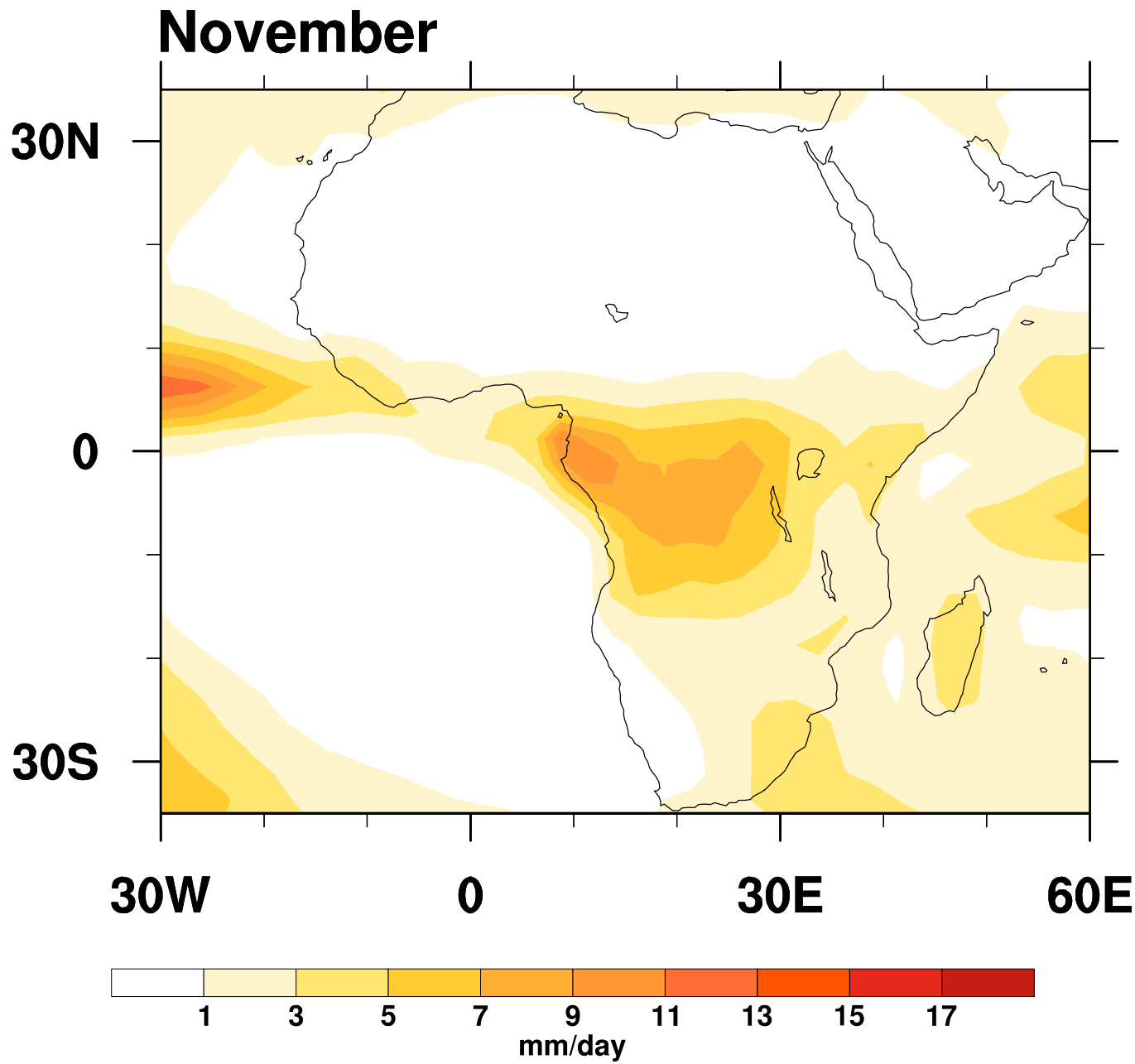

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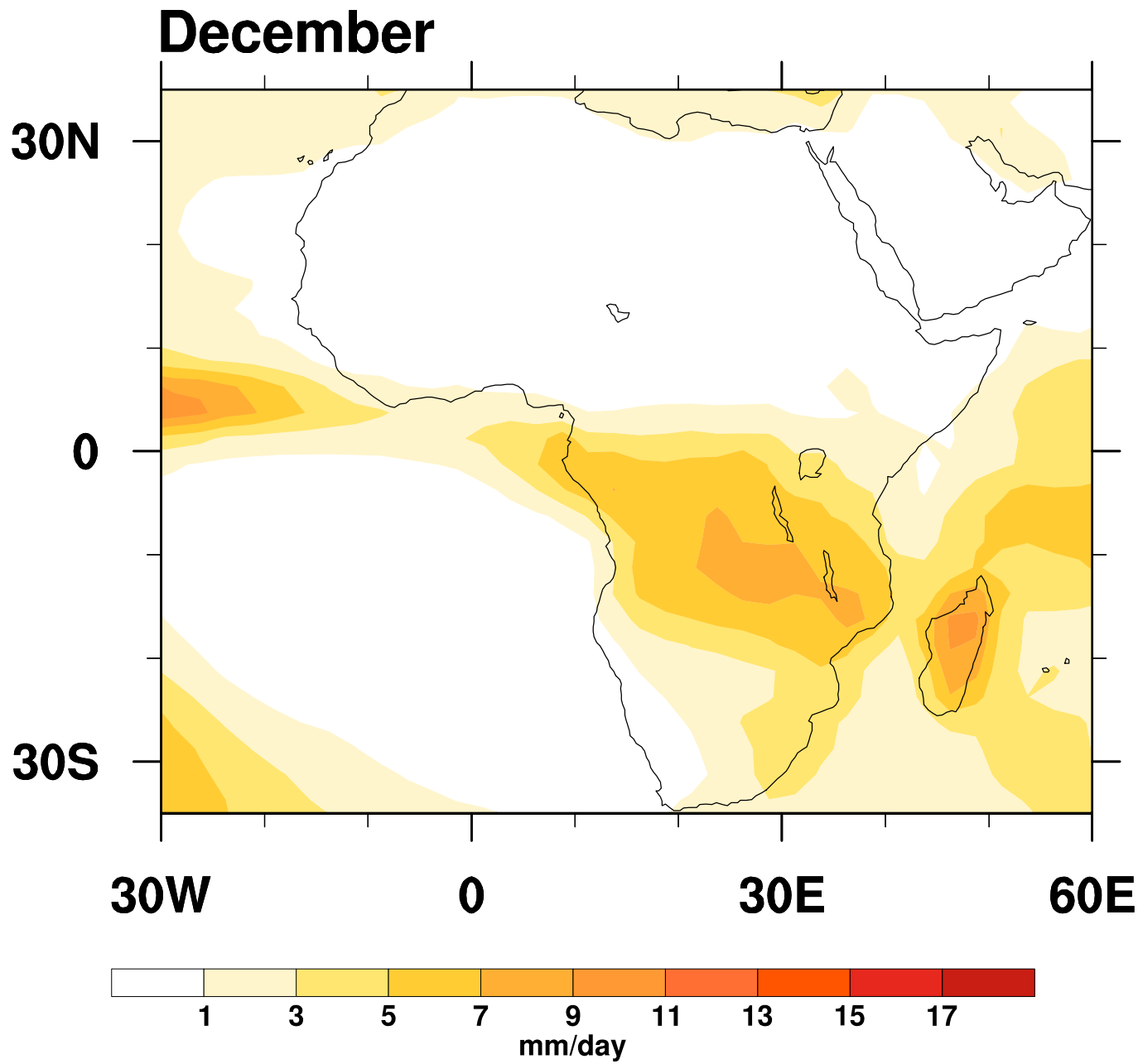
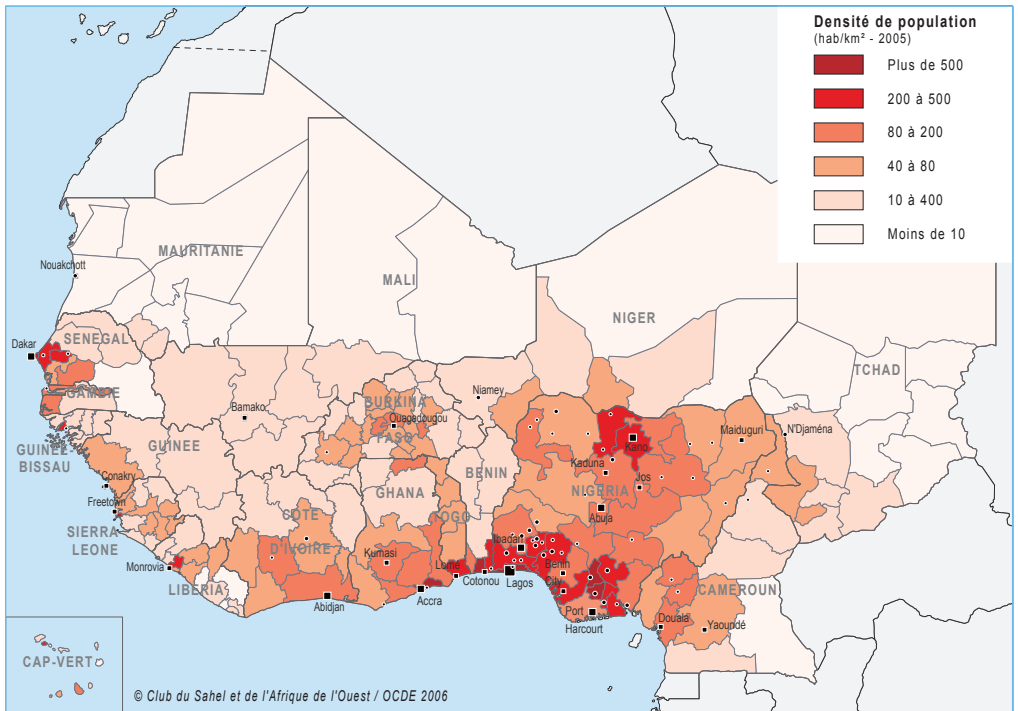


Why Study the Monsoon?

- Understand and predict the seasonal rains over West Africa.
- 300 million inhabitants (2006)
- Rainfed crop production is the main source of food and income in the Sahel.
- Irrigation, mechanization and fertilizers largely unavailable to farmers
- Currently experiencing a food deficit crisis due to rapidly going population and low food production over the past decades



Densité de population en Afrique de l'Ouest (2005)

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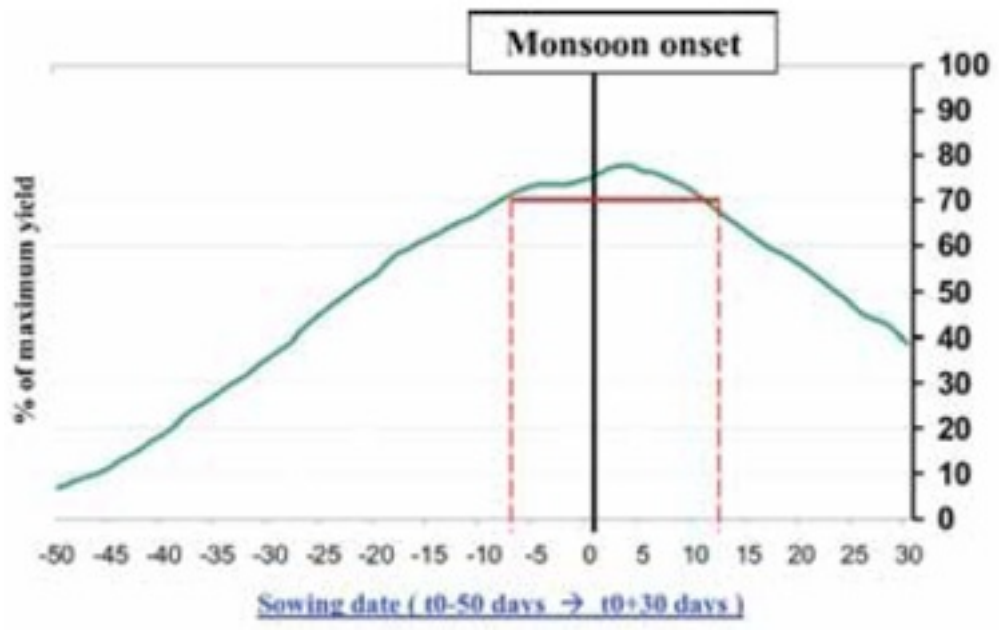

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- Multiscale interactions associated with the monsoon
  - atmosphere, ocean, land surface
  - large-scale circulation to individual rain events.
  - AJE, AEW, MCSs, monsoon flow etc.

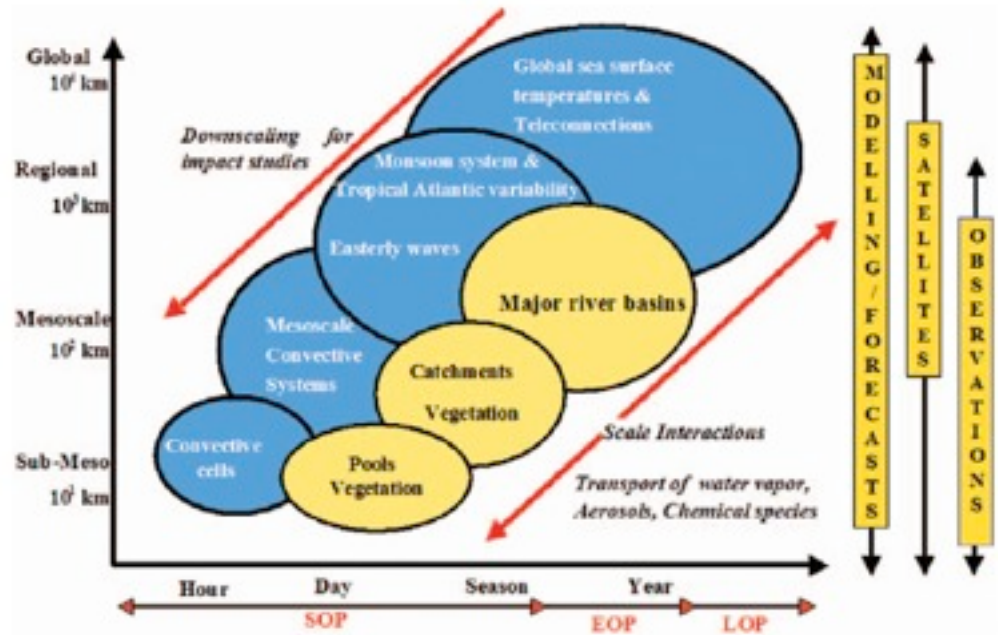

FIG. 1. Simplified schematic of key phenomena together with their associated space and time scales. The arrow is included to highlight the importance of scale interactions and transport processes in the WAM. SOP, EOP and LOP refer to the AMMA observing periods, Special Observing Period, Enhanced Observing Period and Long-term Observing Period respectively.

- Great test bed for the Multiscale Modeling Framework (MMF).

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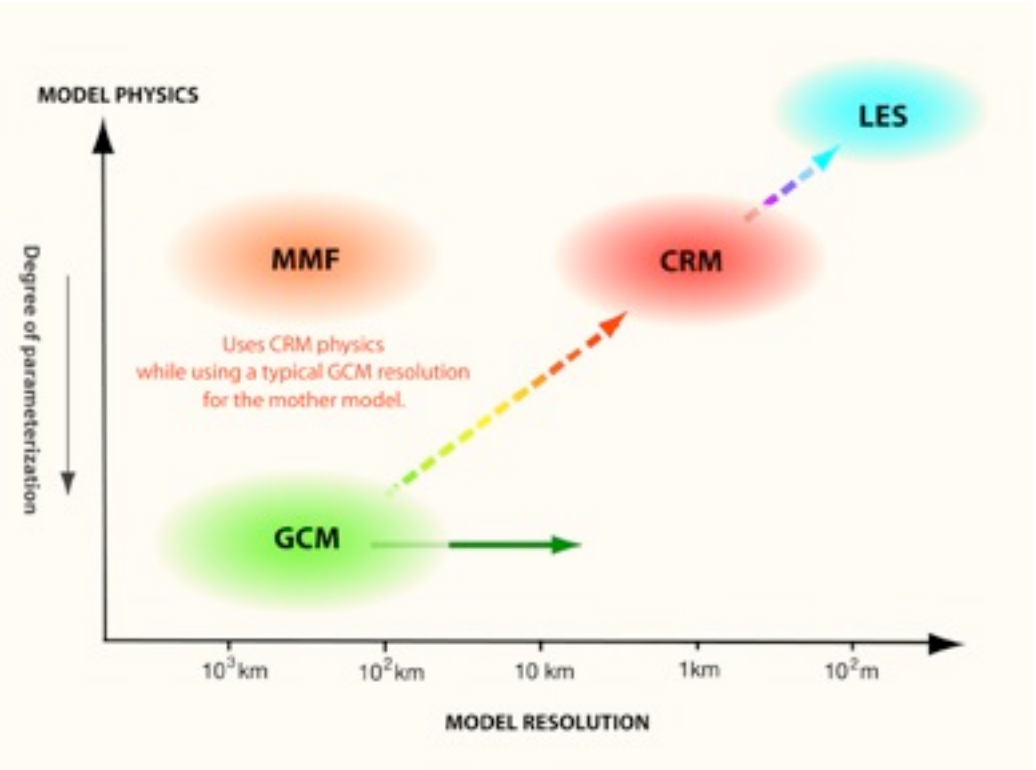
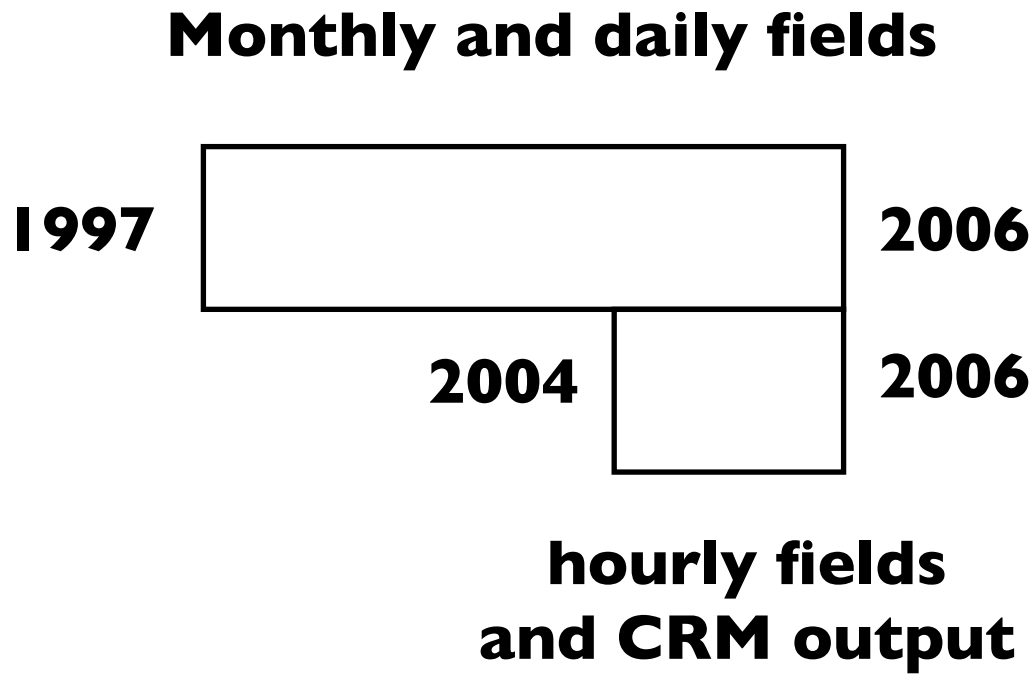


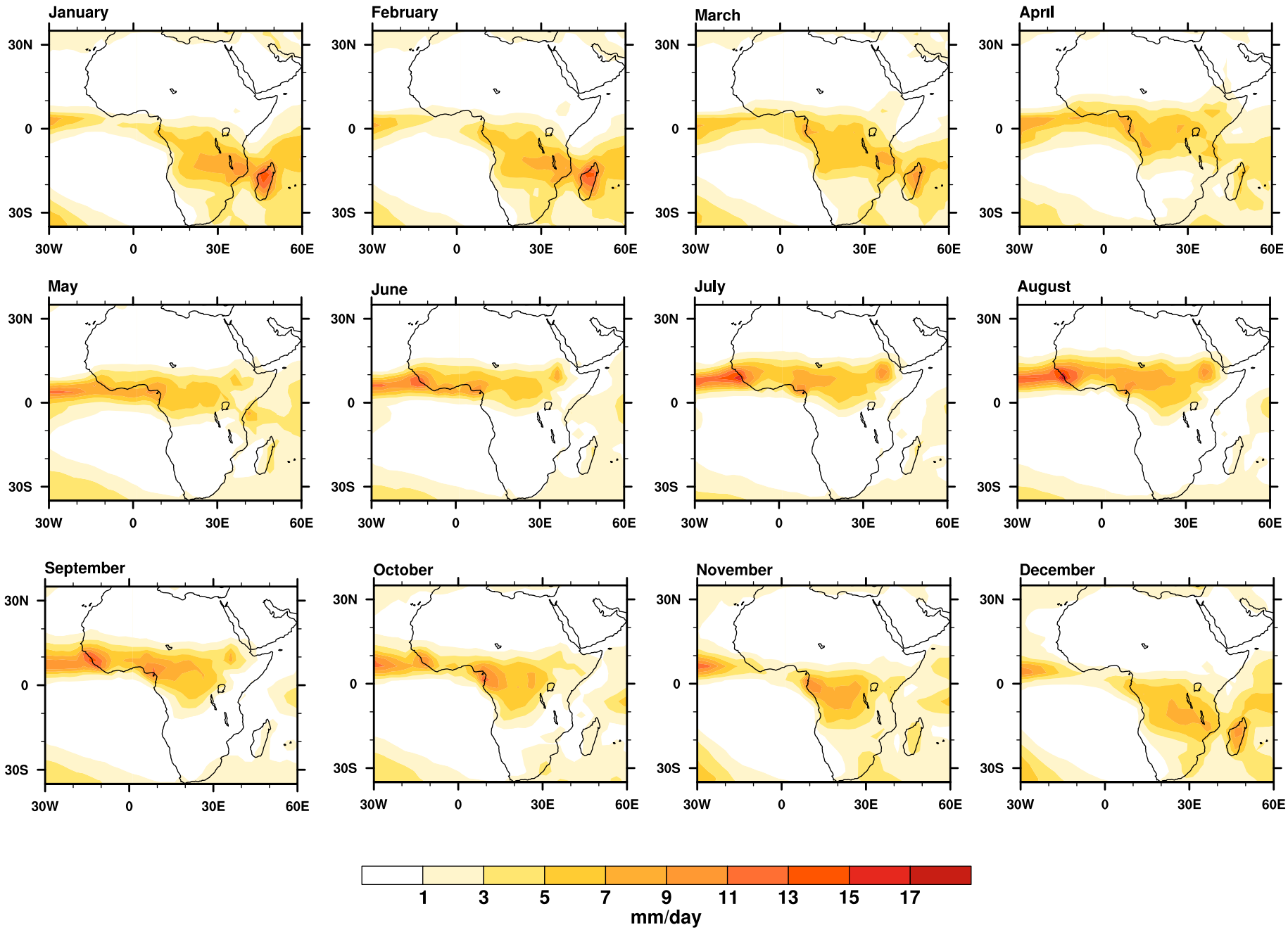
- Great test bed for the Multiscale Modeling Framework (MMF).

Model Runs

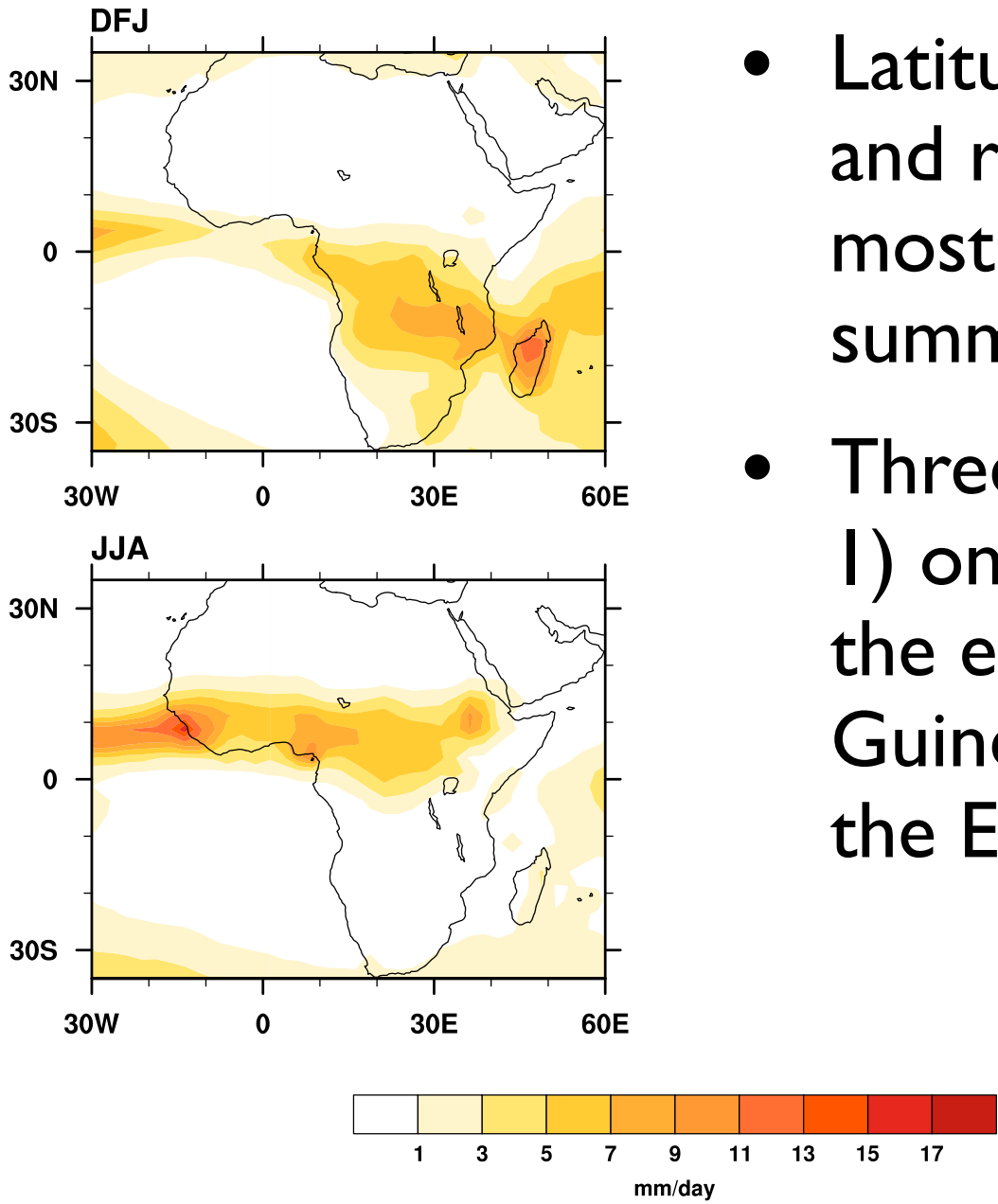
- Two AMIP style runs forced with observed SSTs from the HadISST dataset for the period 1997-2006.
- 1.9°lat x 2.5°lon, 30 levels
- Control run - Standard CAM version 3.5.
- SP-CAM version 3.5
  - CRM oriented in N-S direction.
- Will be available to CMMAP members via the SDSC (soon?)



Observed Precipitation (GPCP)

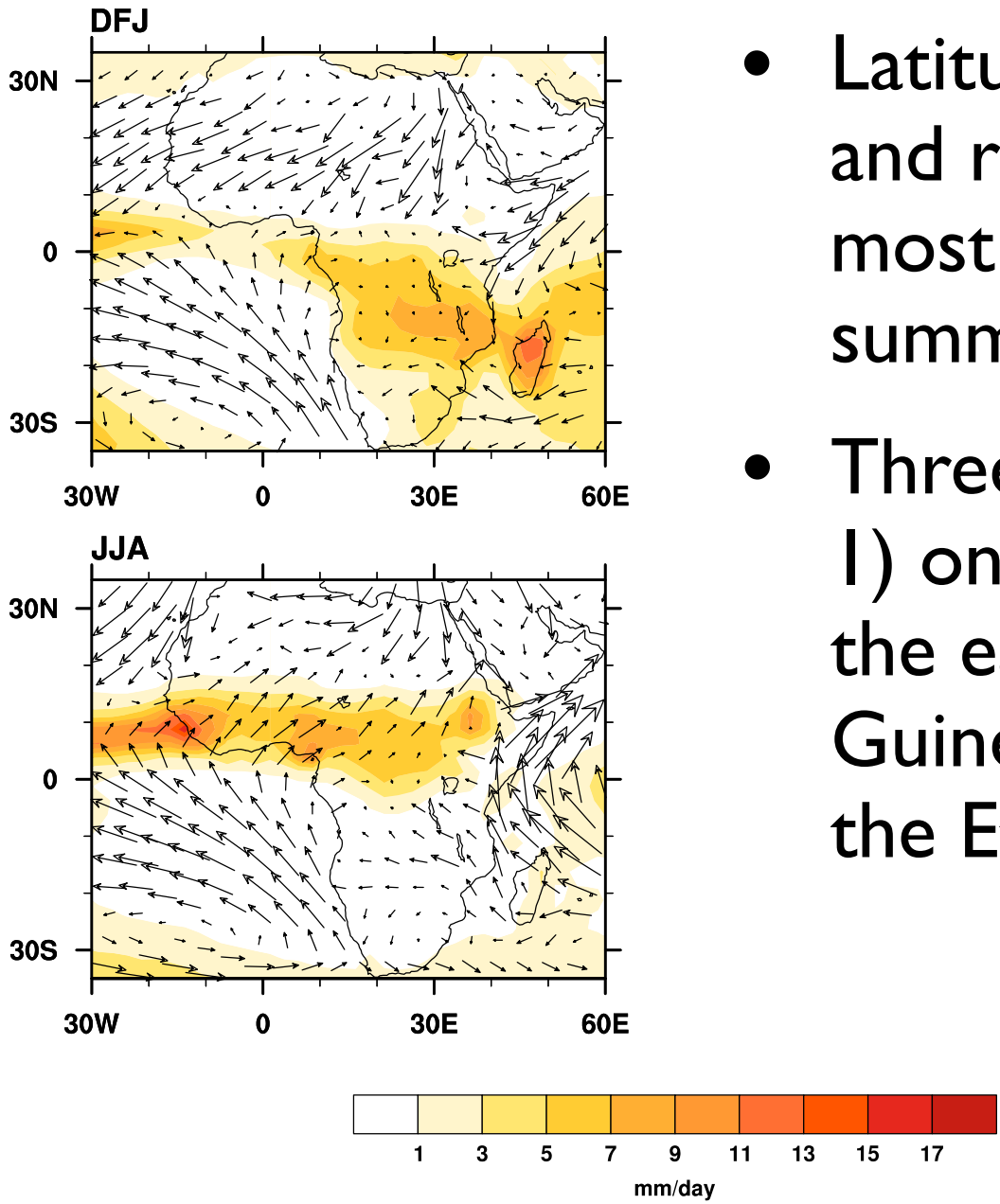


GPCP



- Latitudinal position of ITCZ and rain fall reaches northern most extent during boreal summer
- Three precipitation maxima - 1) on the west coast, 2) over the eastern portion of the Guinean coast, and 3) over the Ethiopian highlands

GPCP



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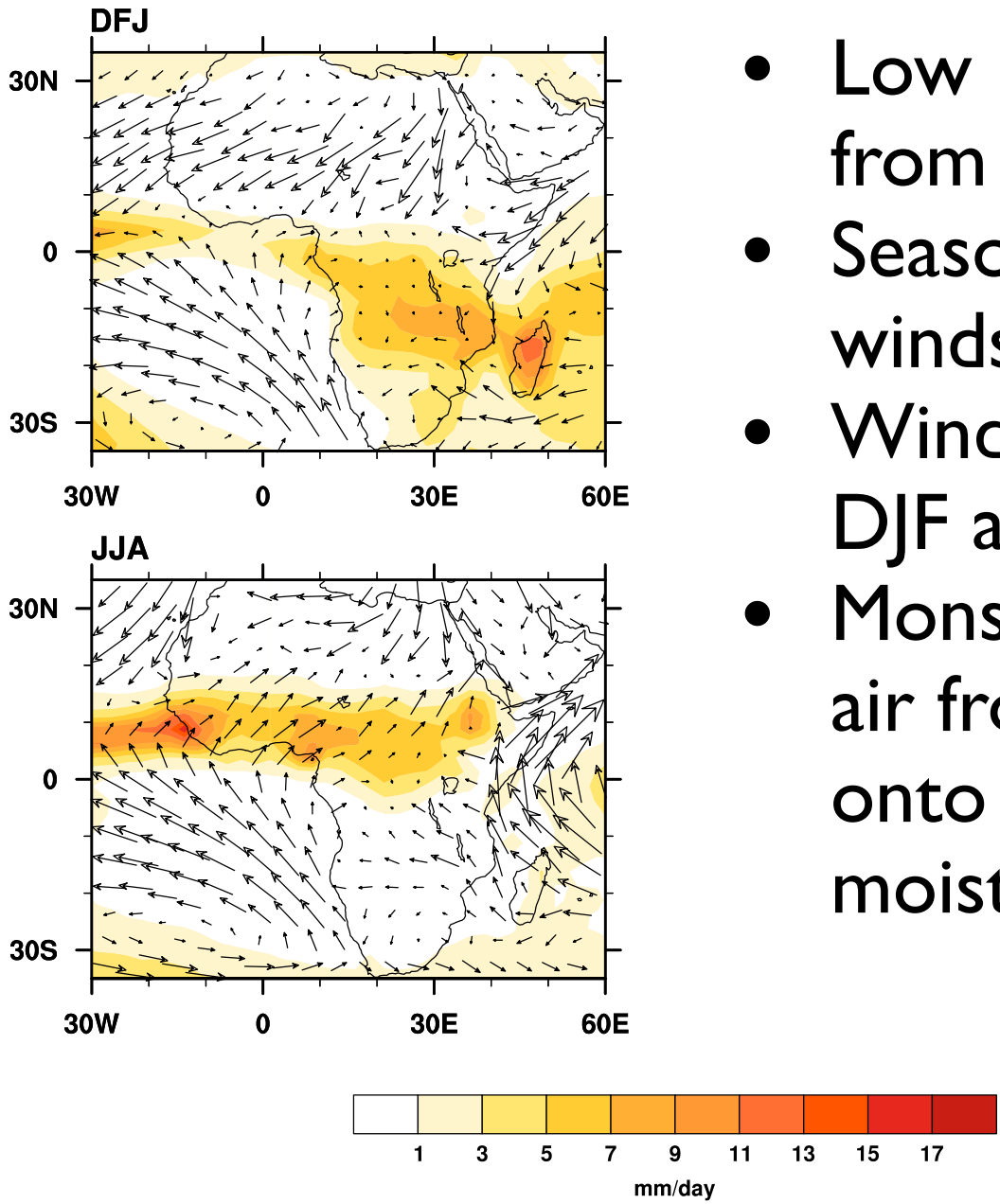
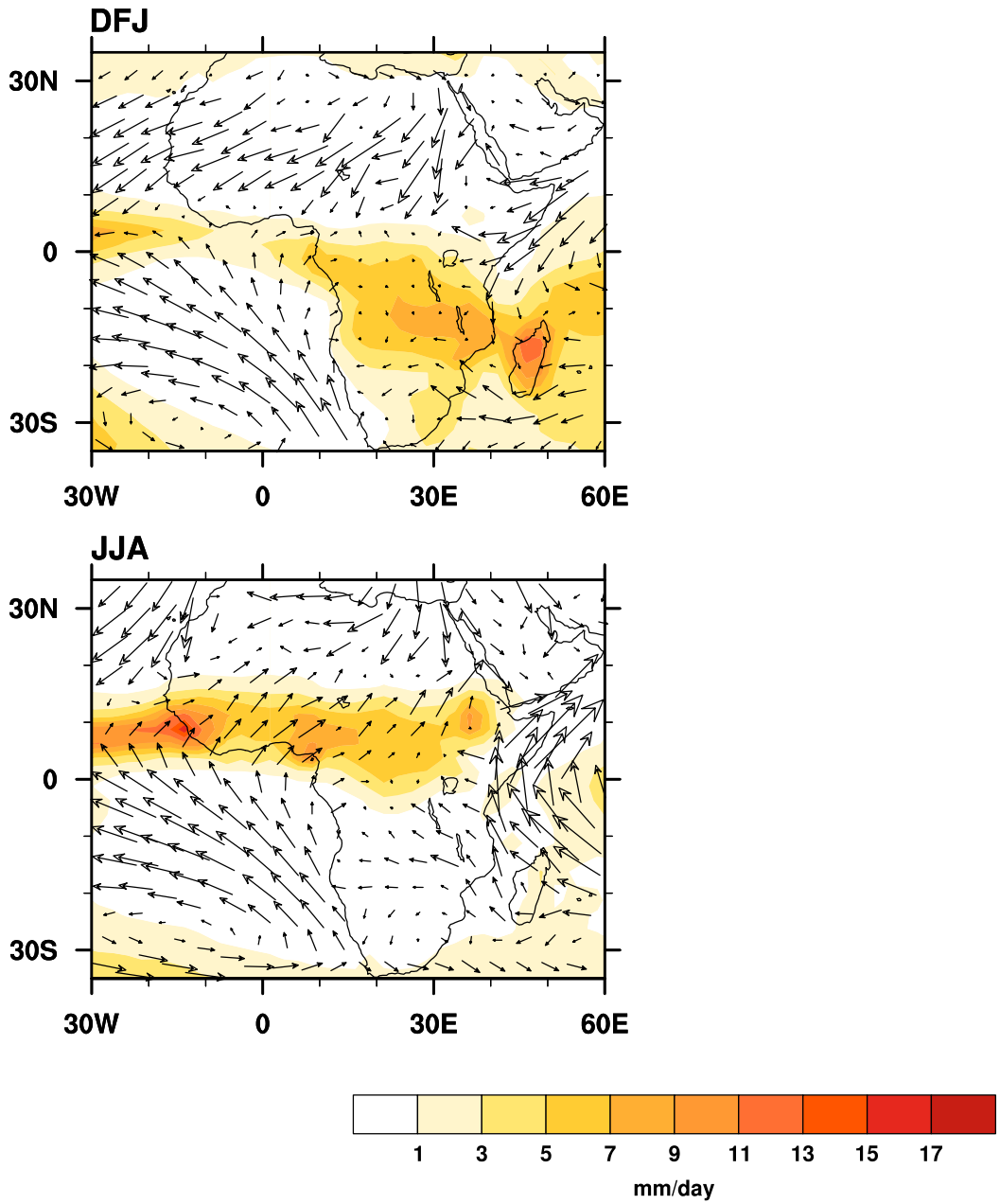


- Low level (925 hPa) winds from ERA-interim.
- Seasonal reversal of the winds.
- Winds are offshore during DJF and onshore during JJA.
- Monsoon winds bring moist air from the Gulf of Guinea onto land and help supply moisture for convection

GPCP



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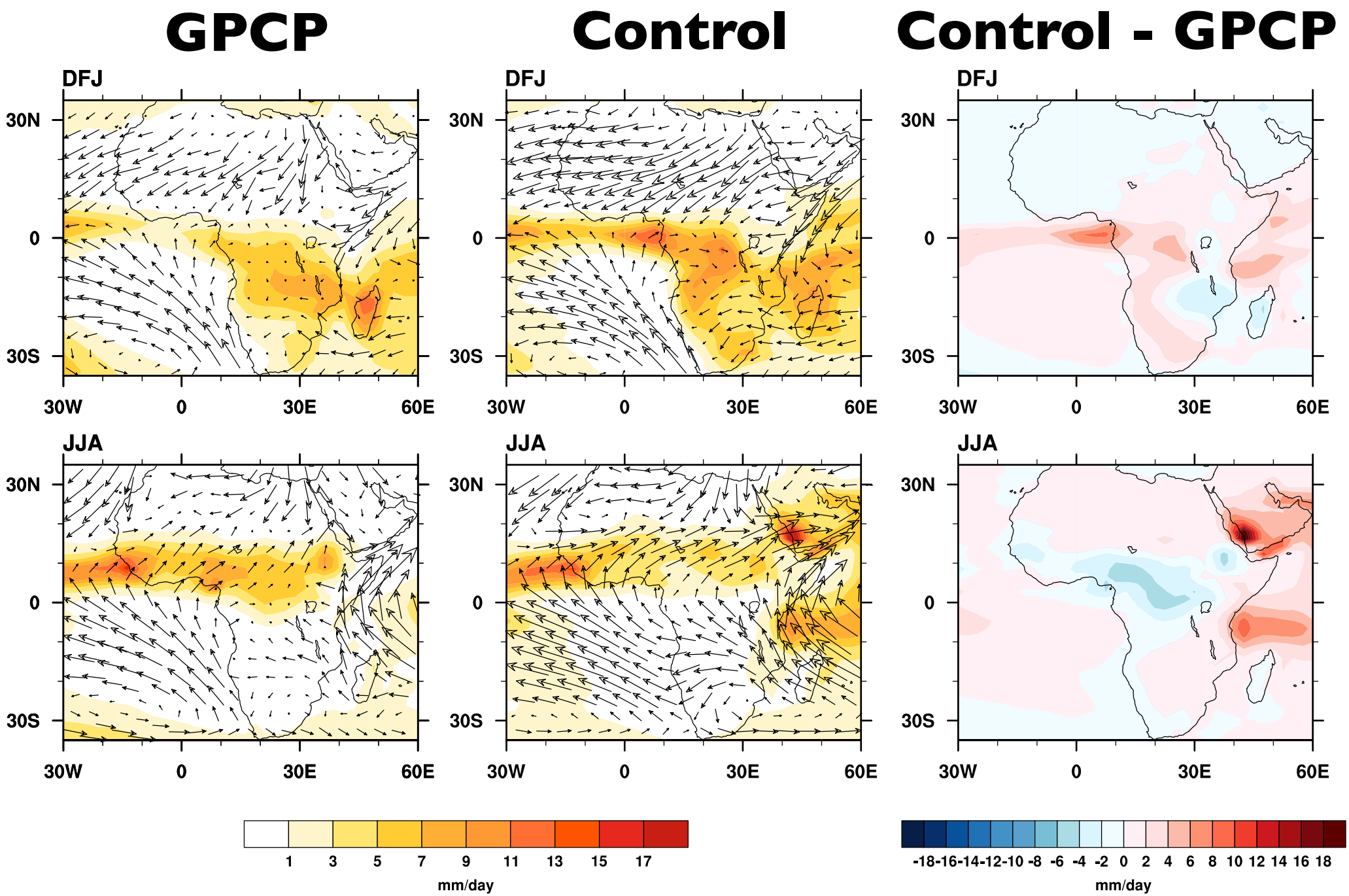

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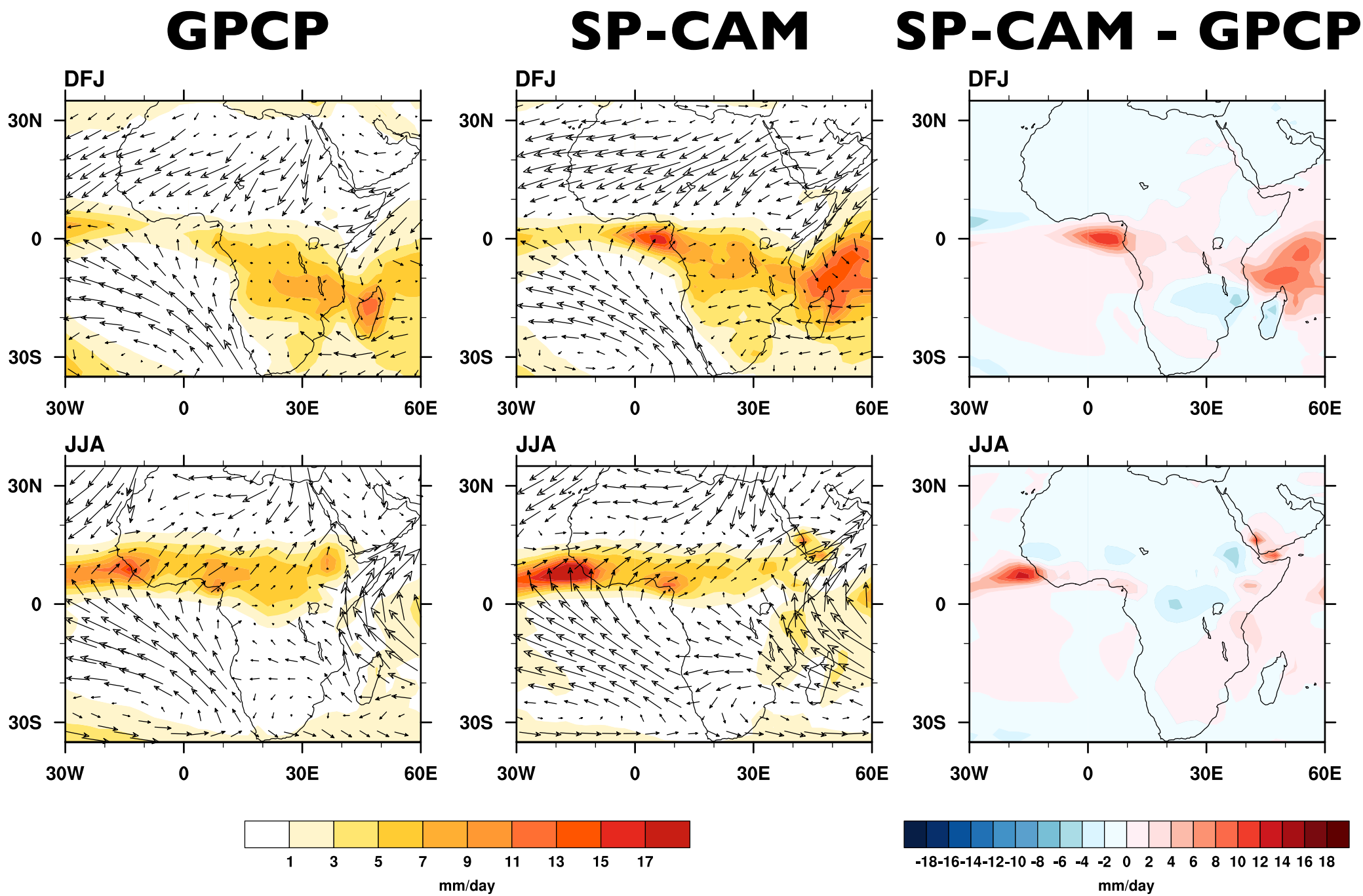
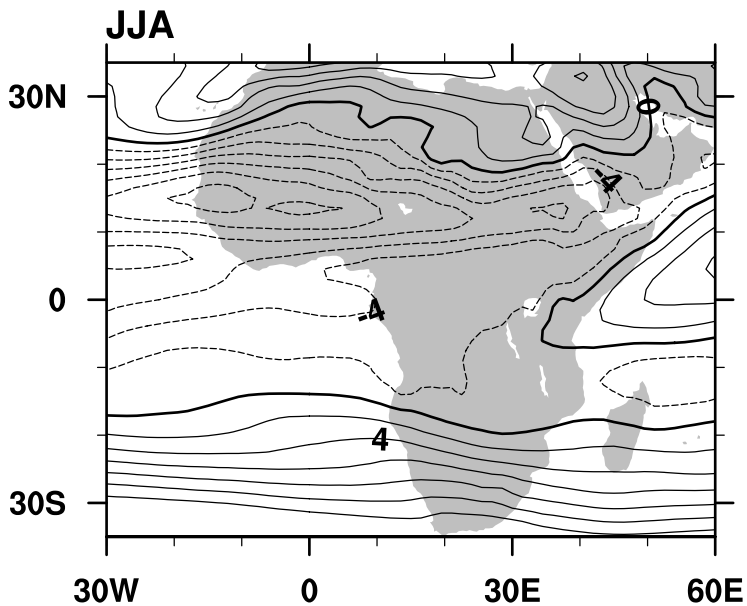

GPCP
SP-CAM
SP-CAM - GPCP
DFJ
JJA
30N
0
30S
30W
0
30E
60E
1 3 5 7 9 11 13 15 17
mm/day
-18-16-14-12-10 -8 -6 -4 -2 0 2 4 6 8 10 12 14 16 18
mm/day

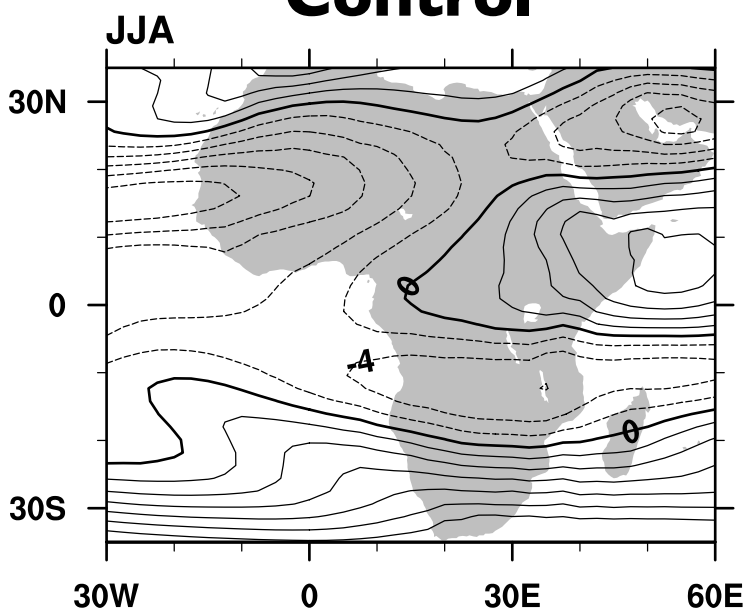
African Easterly Jet

ERA - Interim

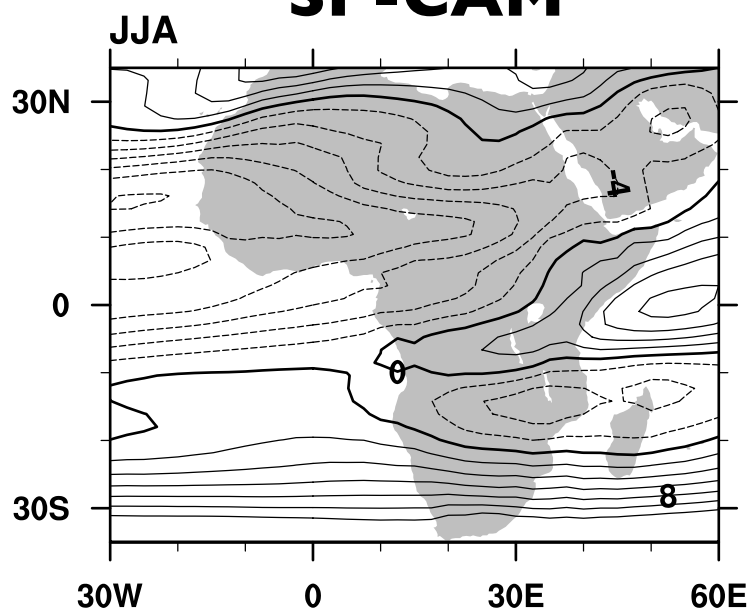


- 600 hPa average JJA zonal wind.
- Direct result of the temperature and moisture gradients that occur over west Africa during the boreal summer.
- Exhibits baratropic-baroclinic instability

Control

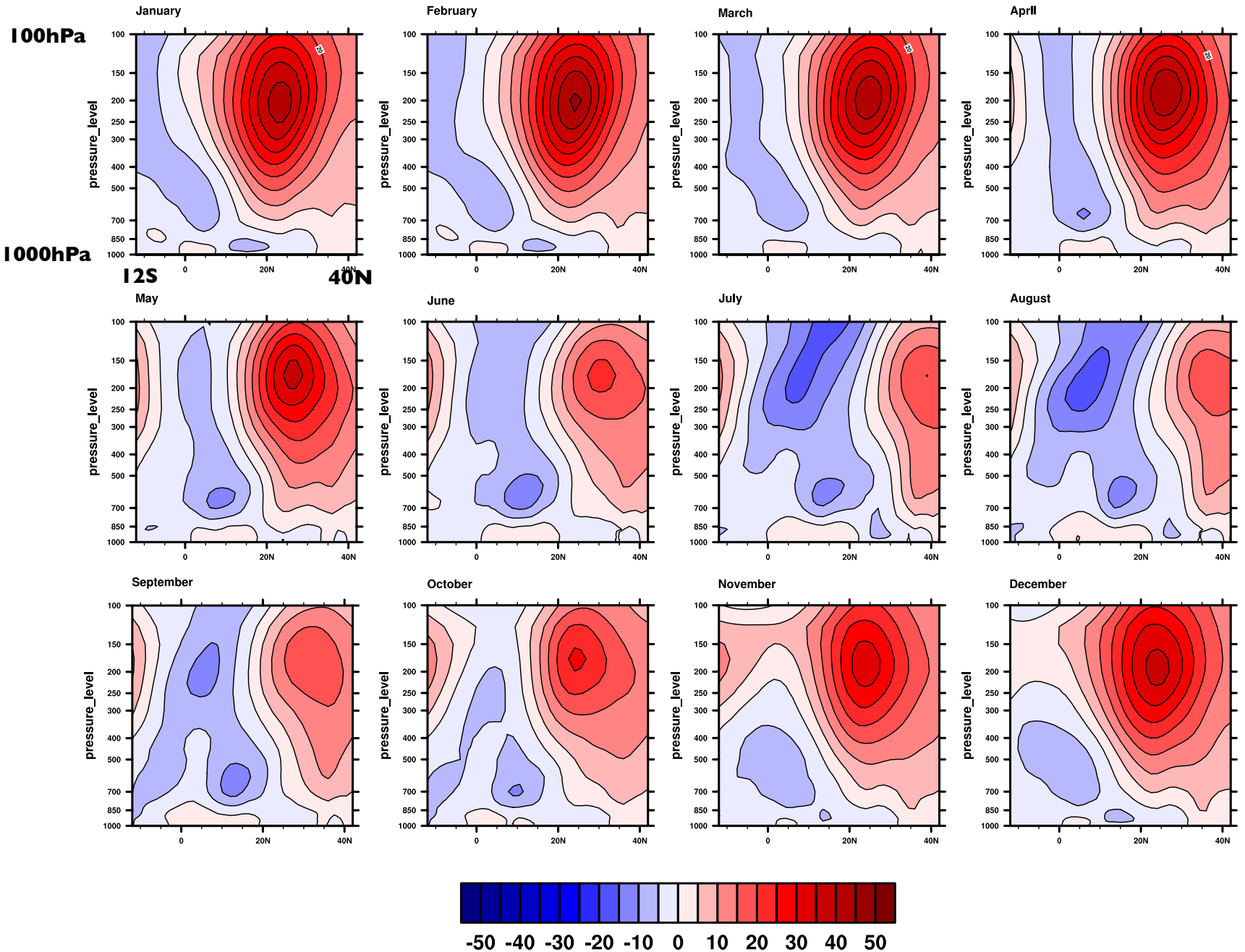


SP-CAM



African Easterly Jet

Cross section at 0ºW



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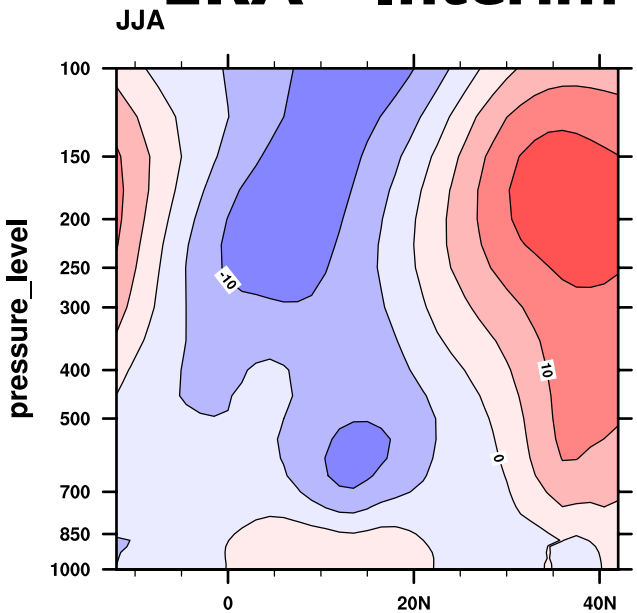
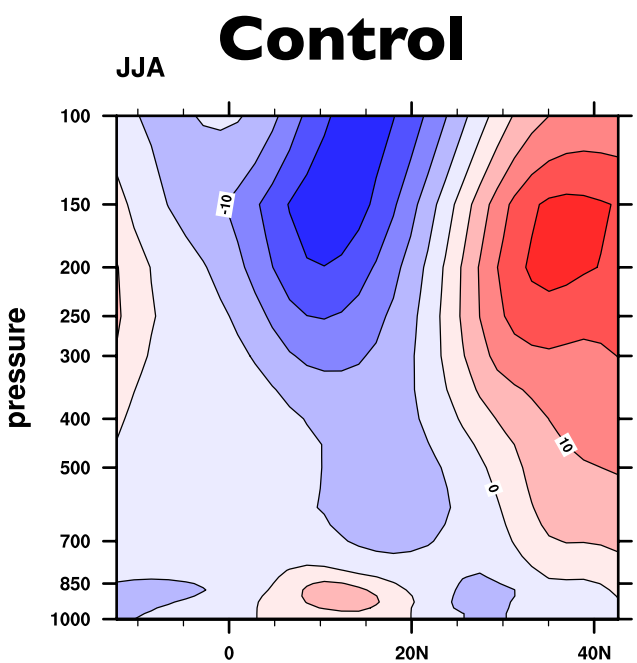
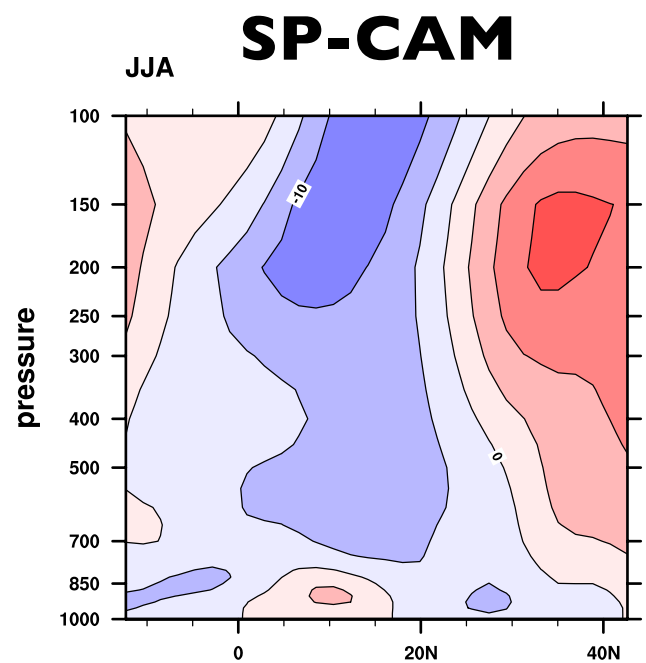
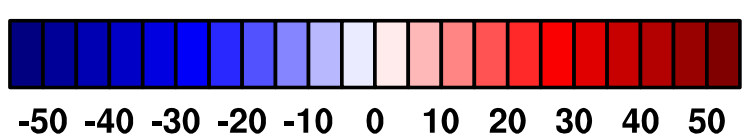
African Easterly Jet
Cross section at 0°W

- Intensity of AEJ is underestimated by both models.
- Surface westerlies larger in both models.

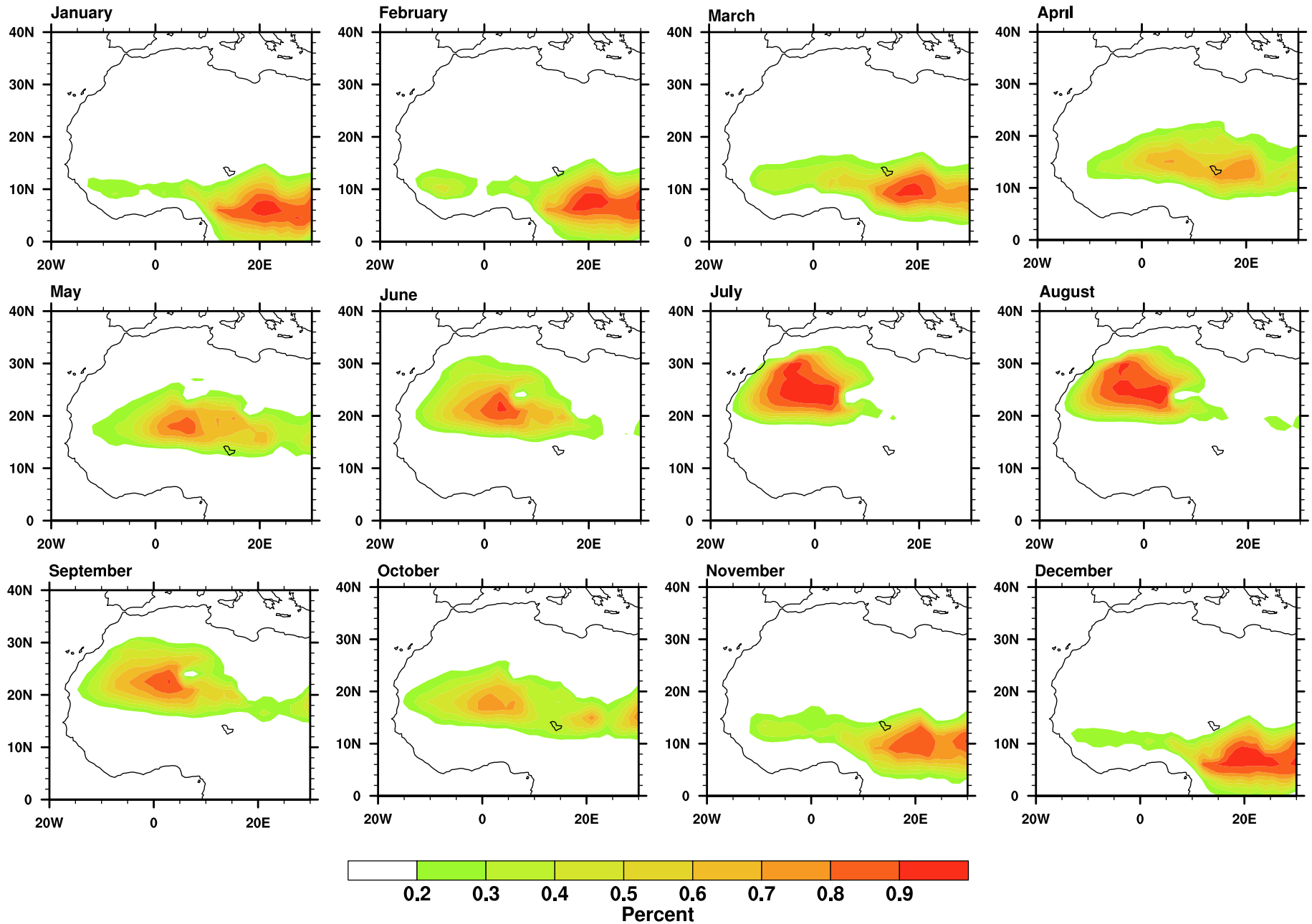


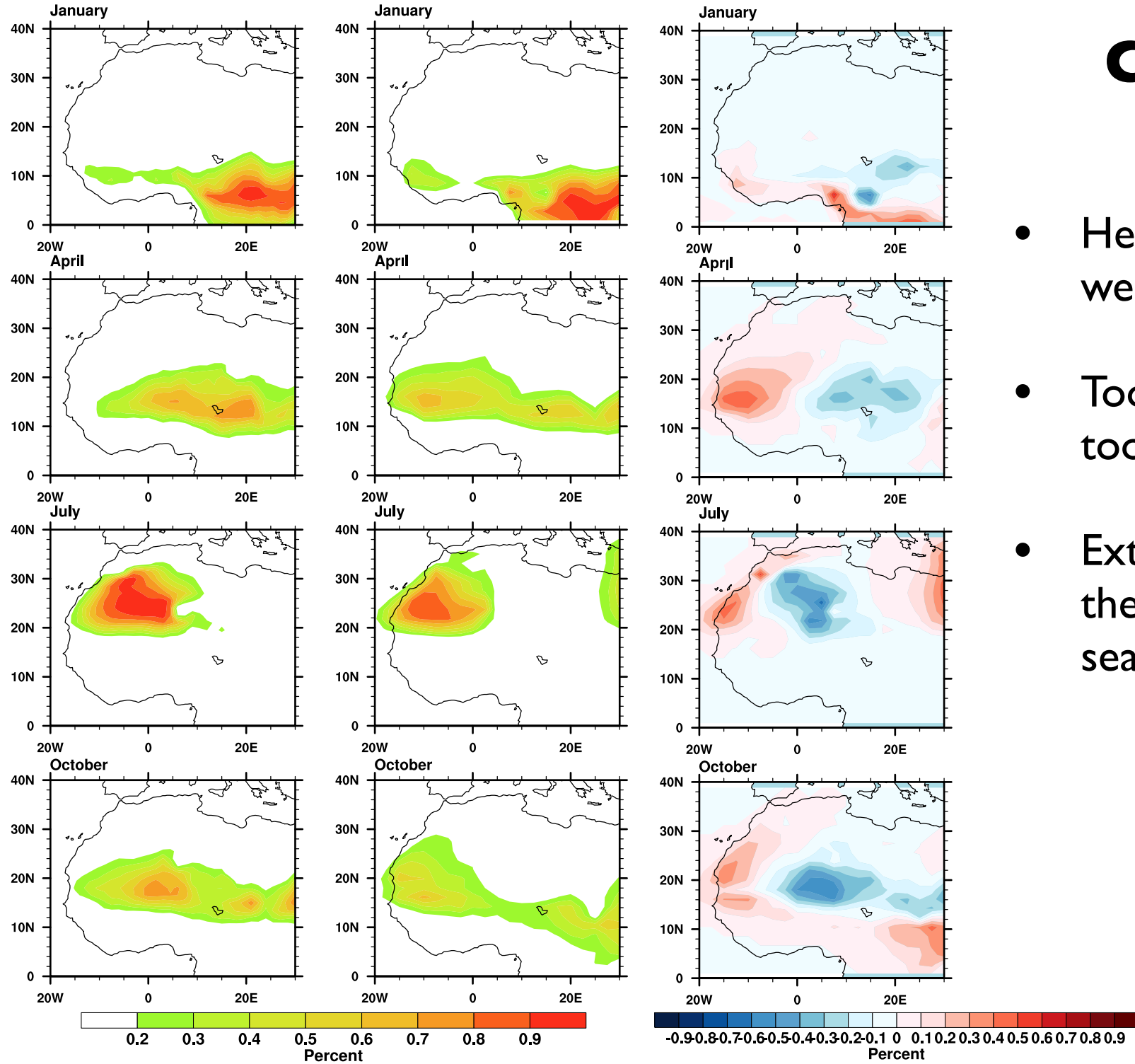






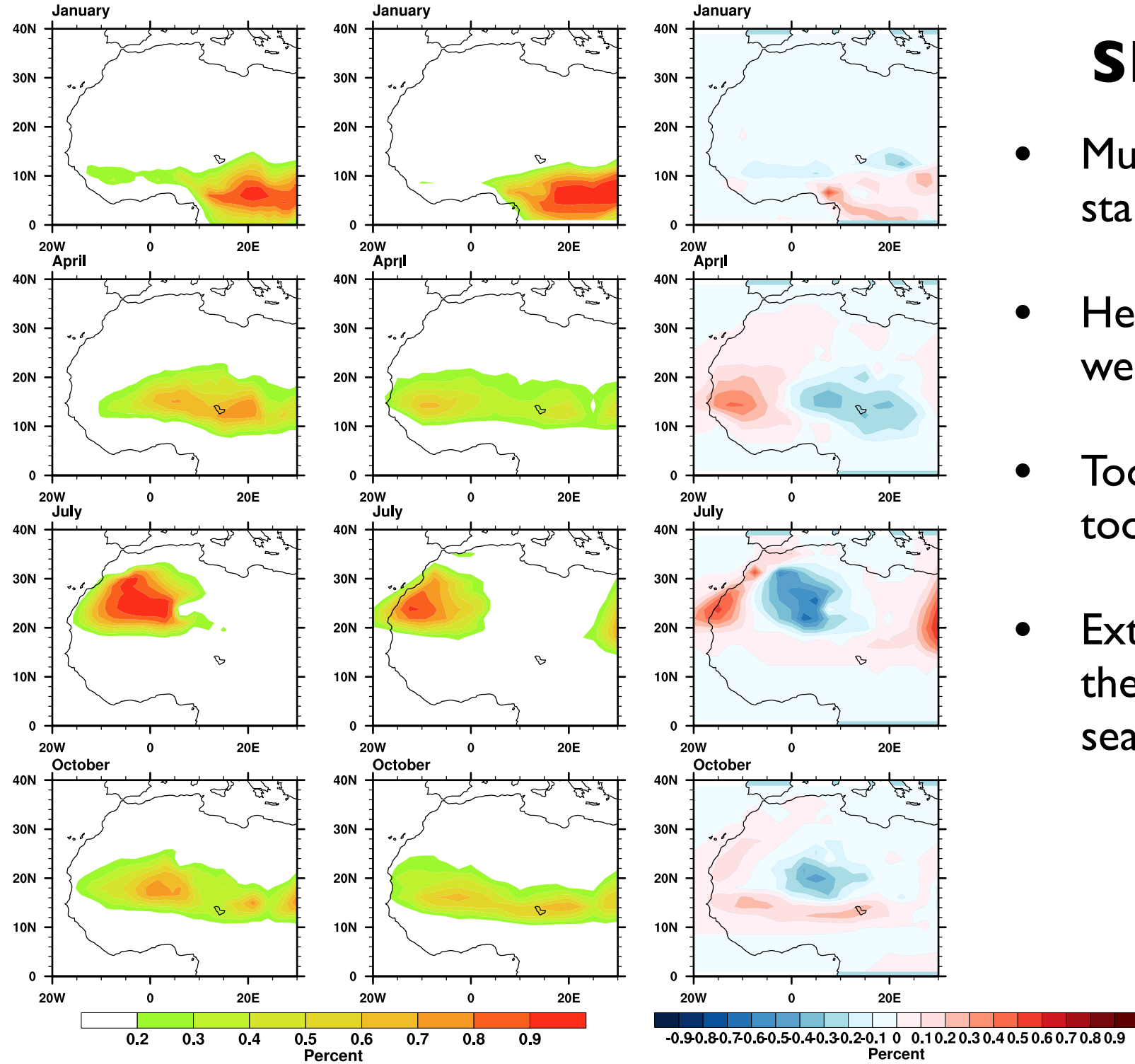
Saharan Heat Low





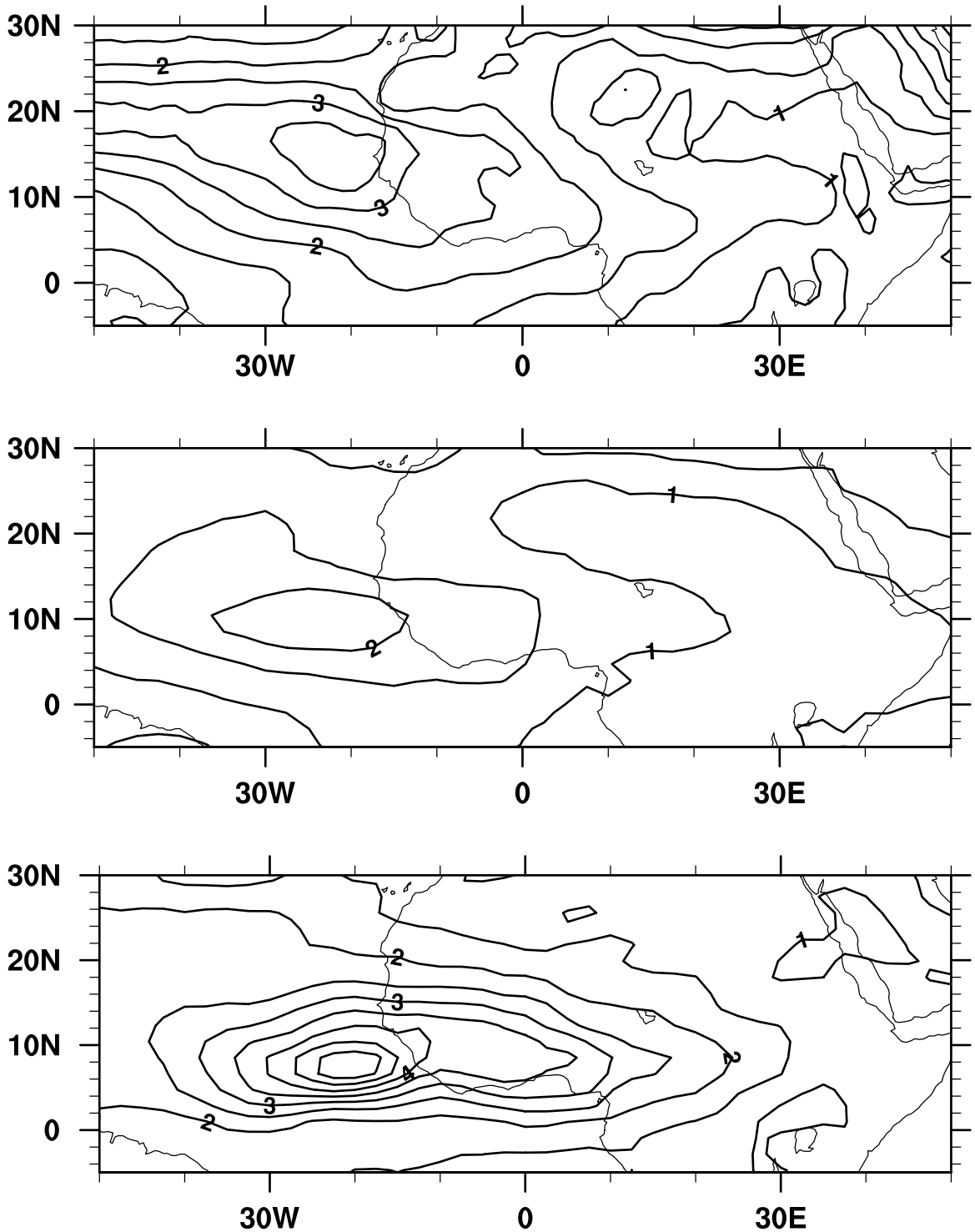
Control

- Heat low generally well represented.
- Too deep in winter too weak in sumer.
- Extends to far to the west in most seasons.



SP-CAM

- Much like the standard CAM...
- Heat low generally well represented.
- Too deep in winter too weak in sumer.
- Extends to far to the west in most seasons.



African Easterly Waves

- Average Eddy Kinetic Energy (EKE) for MJJAS.

$$\frac{u'^2 + v'^2}{2}$$

- Have applied a high-pass filter to u' and v'.
- CAM underestimates AEW activity
- SPCAM seems to overestimate.

Future Work

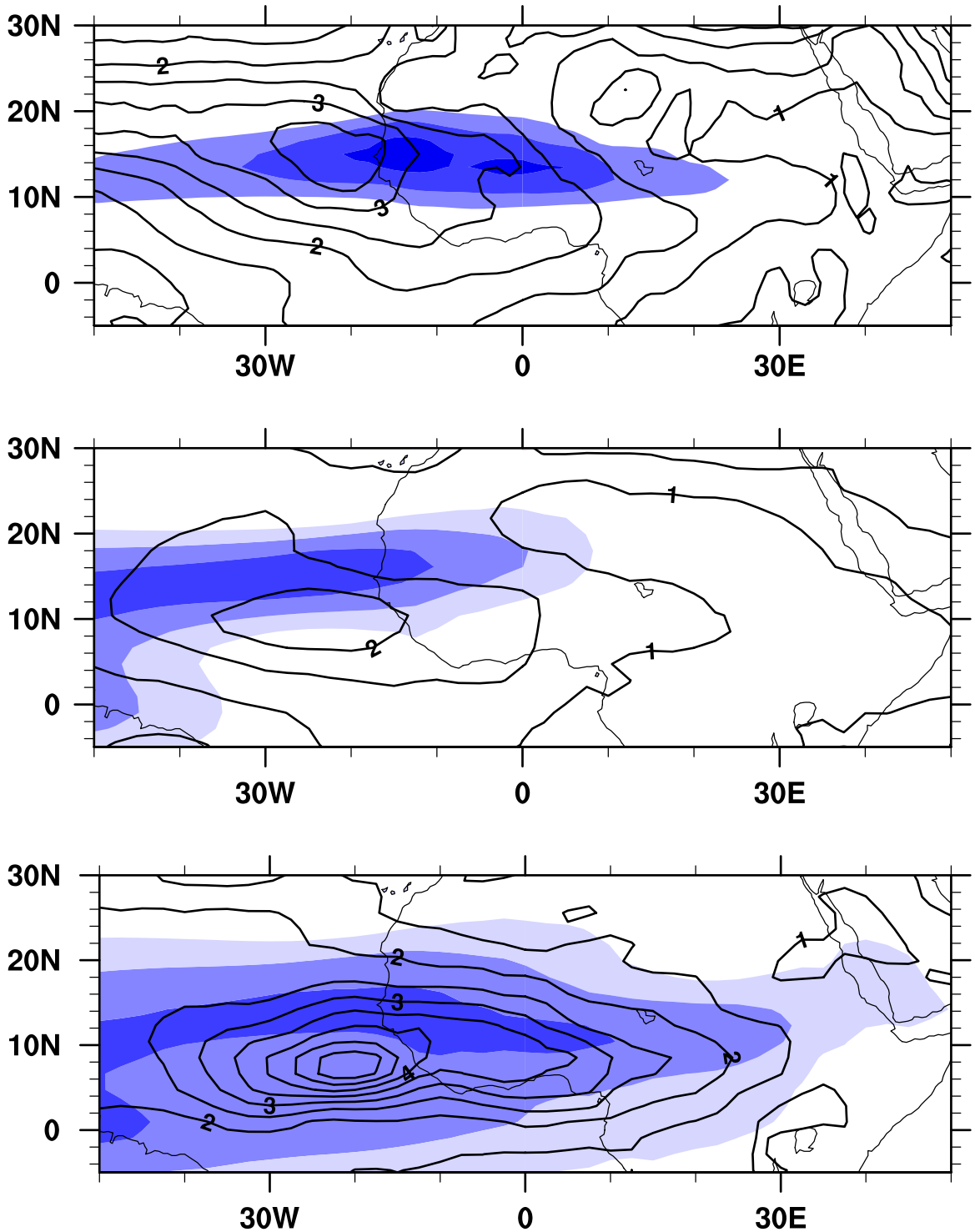
- Understand why three precipitation maxima occur in over west Africa. Why doesn't the standard CAM represent the maxima over the Guinean coast but SP-CAM does?

- Detailed analysis of structure of AEW in observations and the two models.

- Examine the dirunal cycle of convection over west Africa using the AMMA observations for comparison.

- Examine the importance of land surface conditions for the dynamics of the monsoon.

African Easterly Waves & the African Easterly Jet



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