

The West African Monsoon as simulated by an ensemble of 10 RCMs

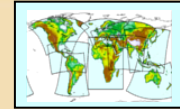
Grigory Nikulin & Colin Jones

Rosby Centre

Swedish Meteorological and Hydrological Institute

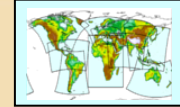
and

The CORDEX-Africa Team



many thanks to all RCM groups providing data:

HIRHAM5	(DMI, Denmark)
CCLM48	(CCLMcom consortium)
REMO	(MPI, Germany)
RACMO22	(KNMI, Netherlands)
ARPEGE51	(CNRM, France)
RegCM3	(ICTP, Italy)
PRECIS	(University of Cape Town, South Africa)
WRF311	(University of Cantabria, Spain)
MM5	(University of Murcia, Spain)
CRCM5	(Université du Québec à Montréal, Canada)
RCA35	(Rosby Centre, SMHI, Sweden)



main focus on West African Monsoon rainfall

RCM data:

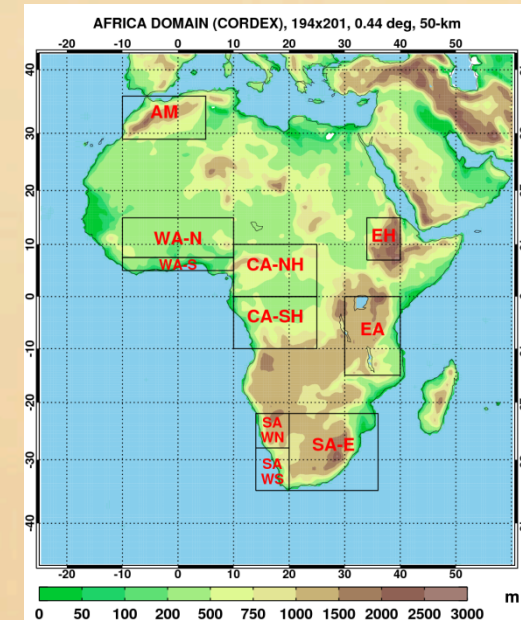
- ✓ driven by ERA-Interim
- ✓ ~50 km (1989-2008)
- ✓ 3-hourly precipitation

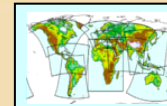
Gridded precipitation products:

- ✓ TRMM-3B42 (3-hr, 0.25°, 1998-2008)
- ✓ CMORPH (3-hr, 0.25°, 2003-2008)
- ✓ GPCP11 (daily, 1°, 1998-2008)
- ✓ GPCC5 (monthly, 0.5°, 1989-2008)
- ✓ CRU31 (monthly, 0.5°, 1989-2008)
- ✓ U. Delaware, UDEL, 2.01 (monthly, 0.5°, 1989-2008)
- ✓ ERA-Interim (3-hr, 0.75°, 1989-2008)

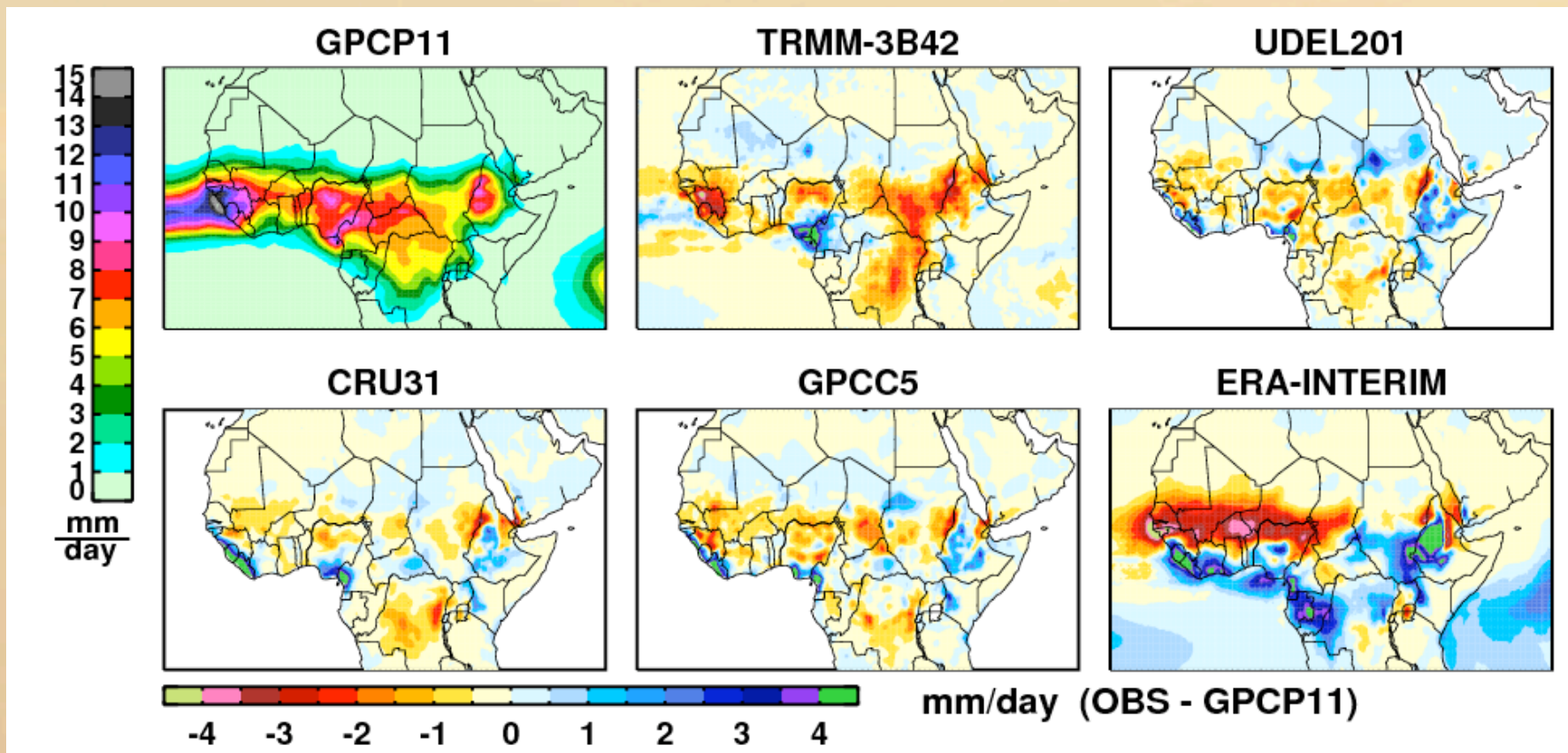
all different grids remapped onto the same 0.44° grid

CORDEX-Africa

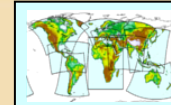




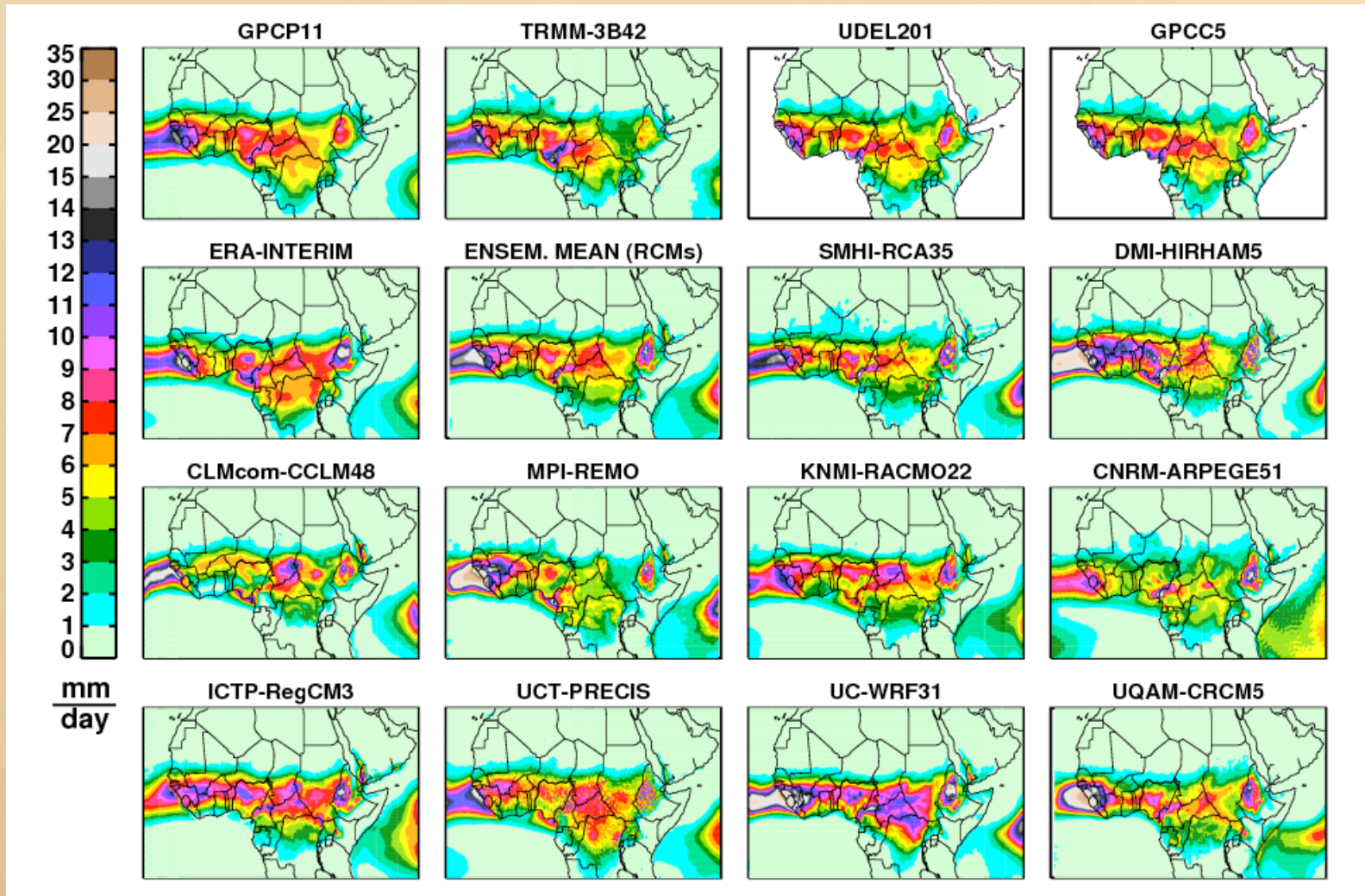
Precipitation bias relative to GPCP (JAS, 1998-2008)



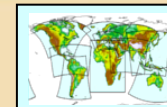
- large difference between GPCP and TRMM (adjusted to different gauge products)
- ERA-Interim has the largest biases (precipitation is not assimilated with obs.)



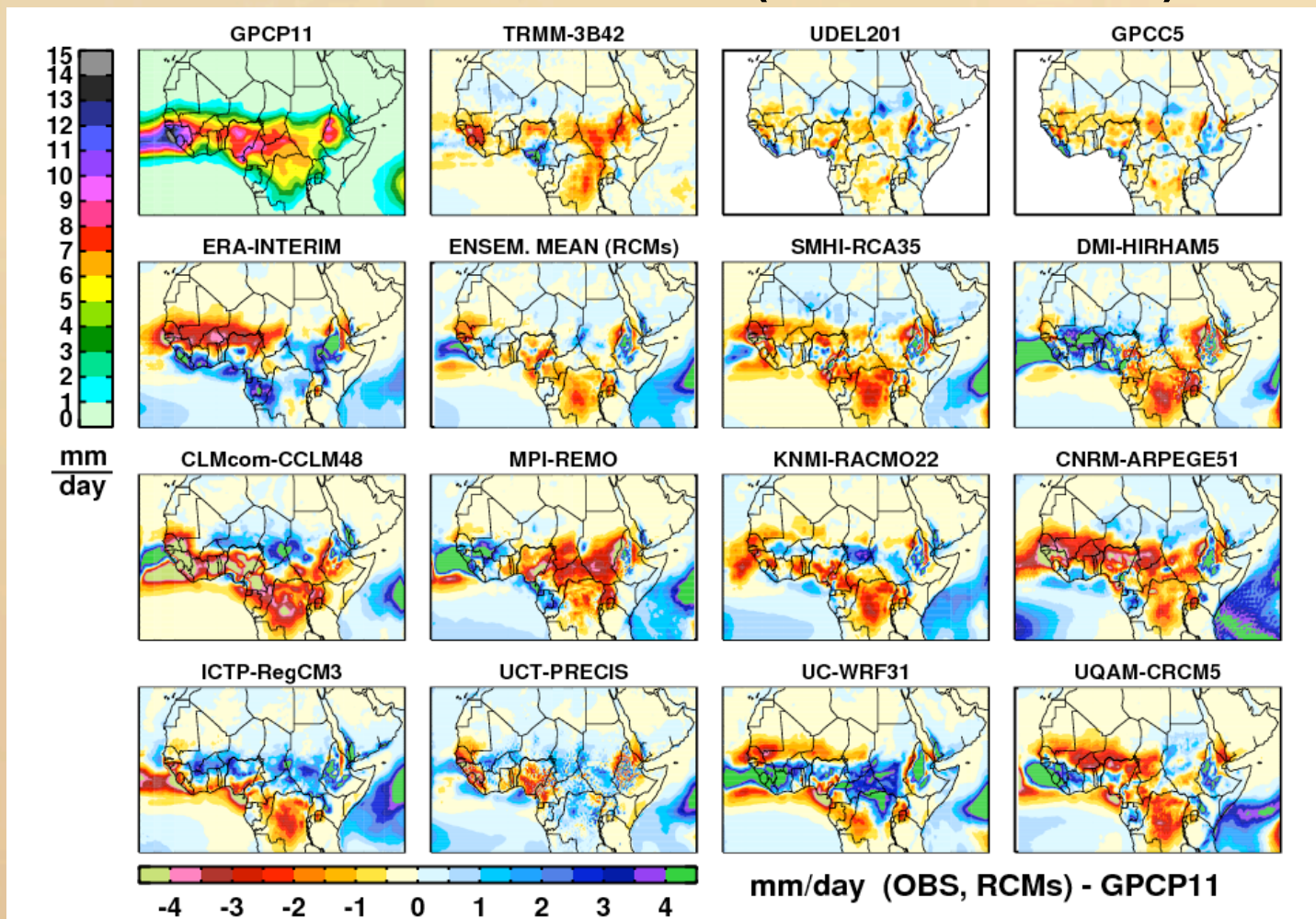
Total precipitation (JAS, 1998-2008)



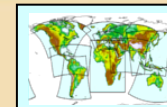
- RCMs capture the large-scale pattern of JAS precipitation (ITCZ rain belt)



Biases relative to GPCP (JAS, 1998-2008)



- RCMs have larger biases than the spread across observations
- many RCMs have more accurate precipitation than Era-Interim
- the ensemble average outperforms nearly all individual RCM (cancellation of biases)

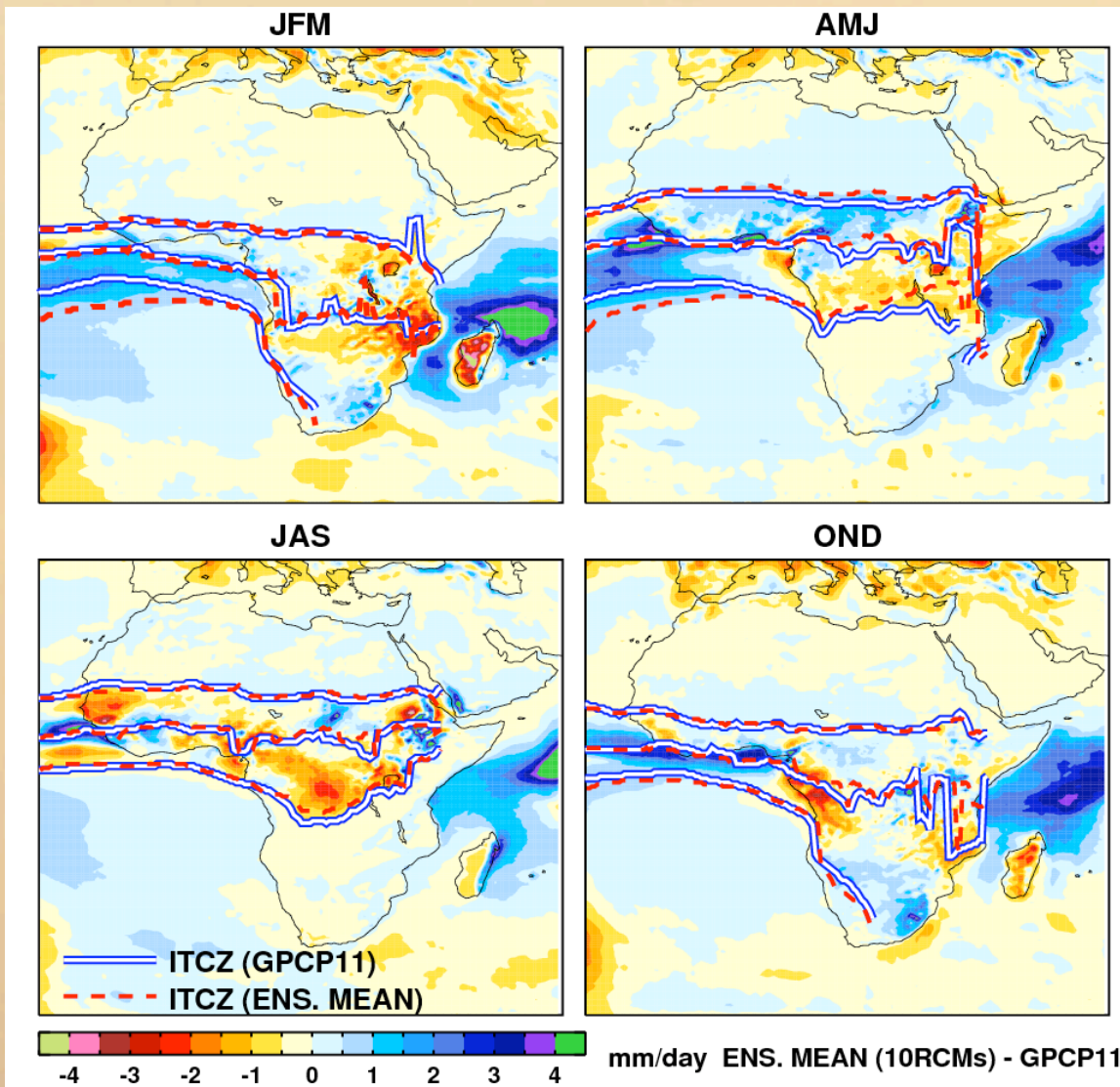


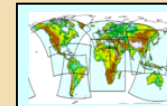
Ensemble mean bases wrt GPCP

ITCZ position:
 maximum precipitation in
 the centre of the rain belt
 and 1 mm/day on its flanks

Individual RCMs but not all
 have localized placement
 errors (not shown, noisy)

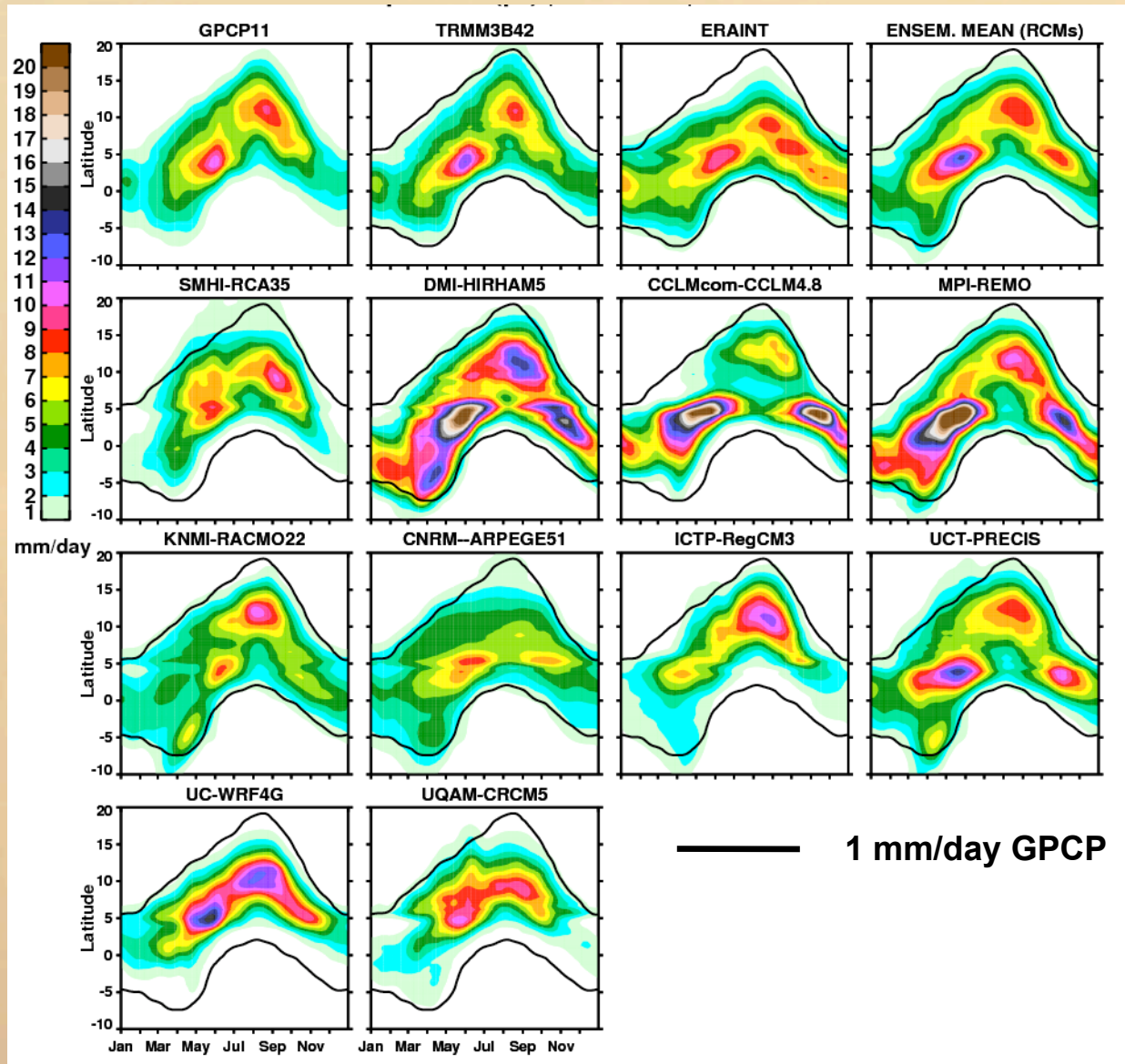
the RCM ensemble mean
 has extremely accurate of
 the location of the ITCZ
 through cancellation of
 these errors

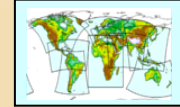




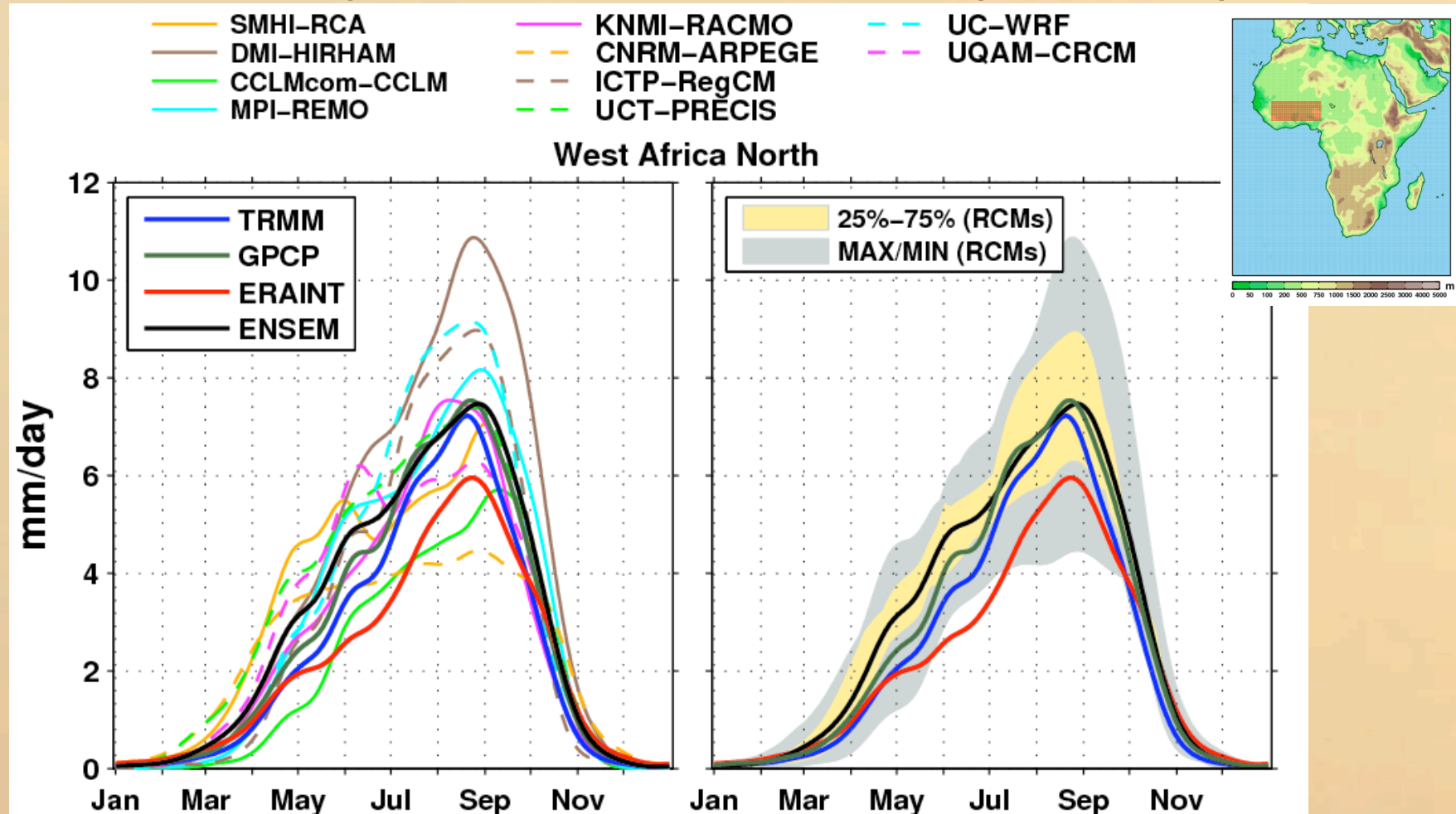
50-day low passed precipitation (10°W-10°E, 1998-2008)

- most RCMs capture the two rainfall maxima although the positioning, intensity and duration differ
- ERA-Interim and some RCMs fail to propagate precipitation far enough north
- the multi-model average smooths diverse biases and present the best simulated WAM rainfall

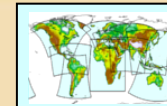




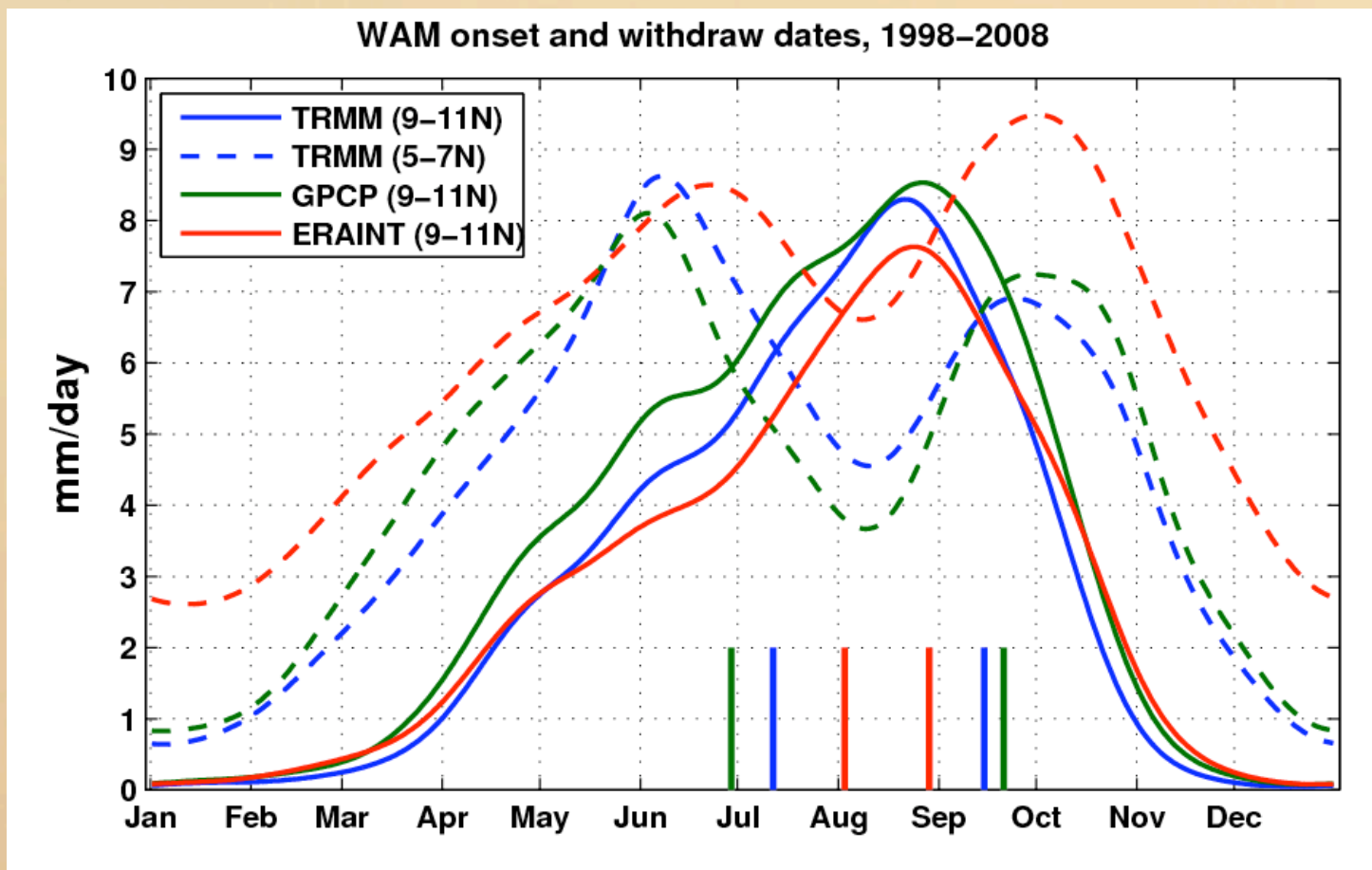
50-day low-passed precipitation (1998-2008)



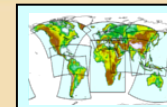
- RCMs show a wide spread around the observed annual cycle
- several RCMs and particularly the ensemble mean improve ERA-Interim
- ensemble mean accurately represents the observed annual cycle (bias cancellation)



Definition: rainfall averaged over 5°-7°N and 9°-11°N (10°W-10°E)
(the 50-day low-passed)



- WAM onset in TRMM is later than in GPCP and WAM season is shorter
- Era-Interim shows very late onset and short duration (doesn't propagate far north)
- in Era-Interim WAM onset cannot be defined for individual years



Onset and withdrawal dates (1998-2008)

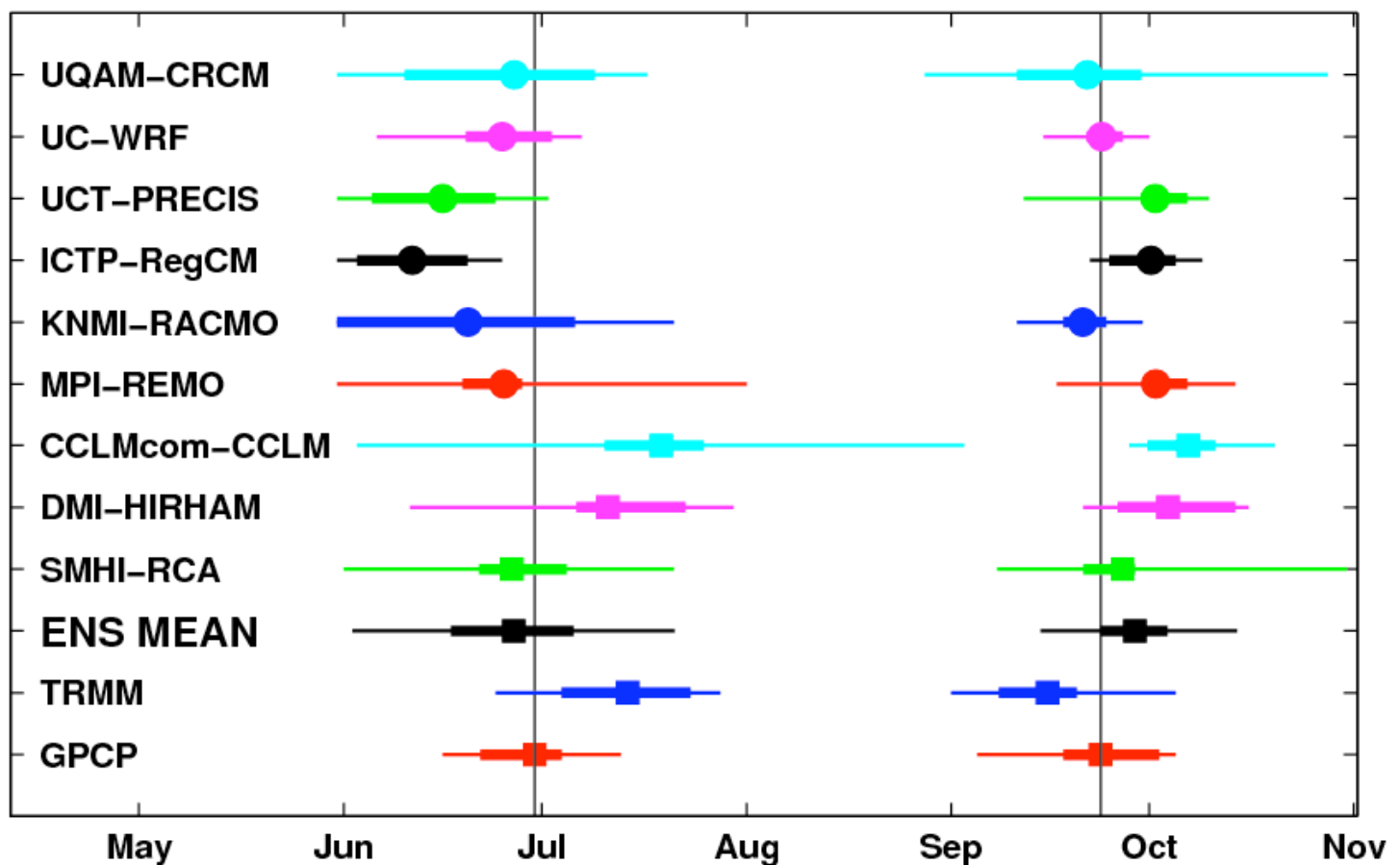
climatology



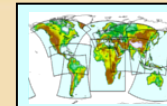
25-75%



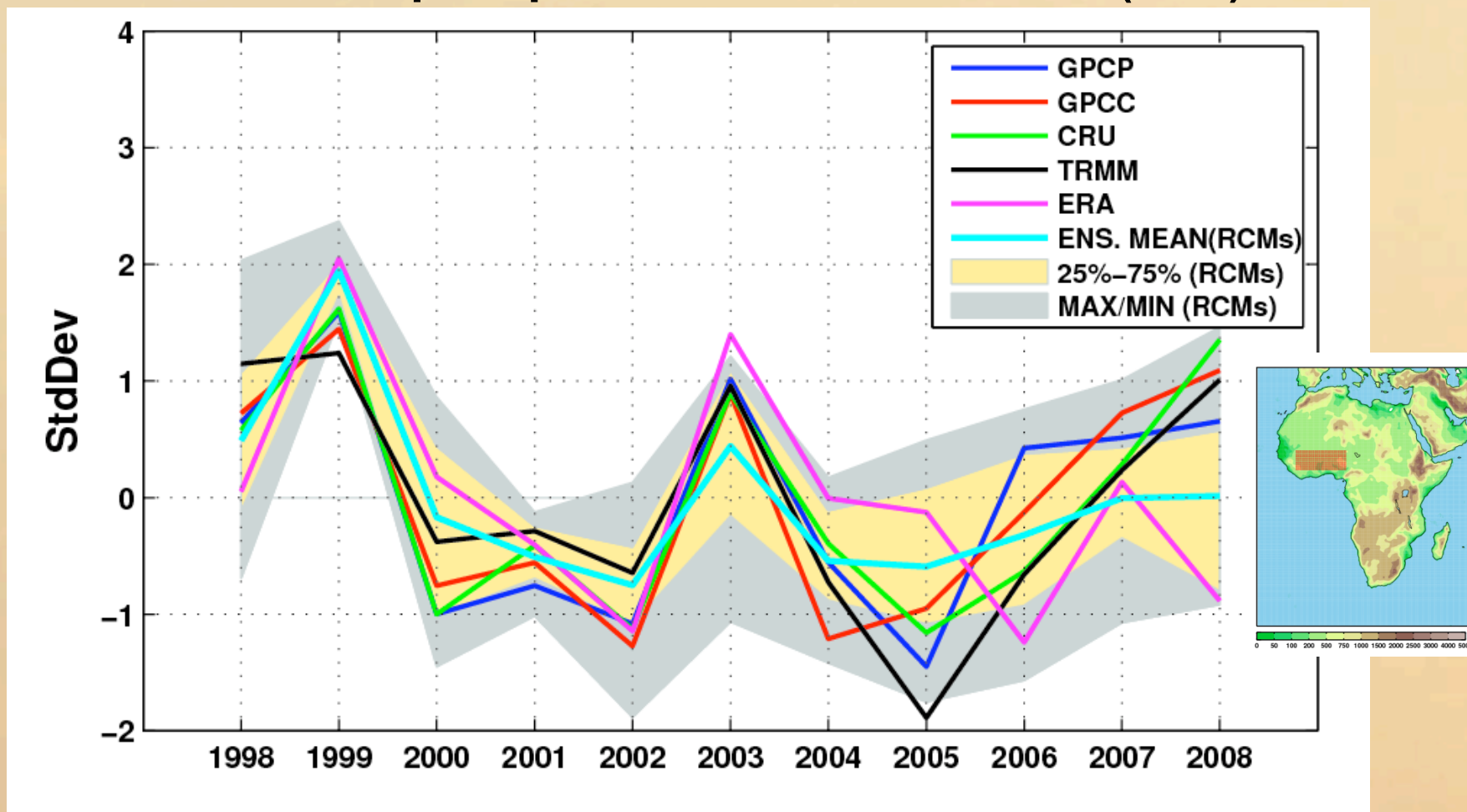
min/max



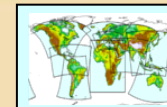
- RCMs: some tendency in early onset
- RCM onset date in a single year can strongly deviate from the climatology (min/max)
- several RCMs and the ensemble mean pretty accurately reproduce climatological onset and withdrawal dates



Normalized precipitation over West Africa (JAS)

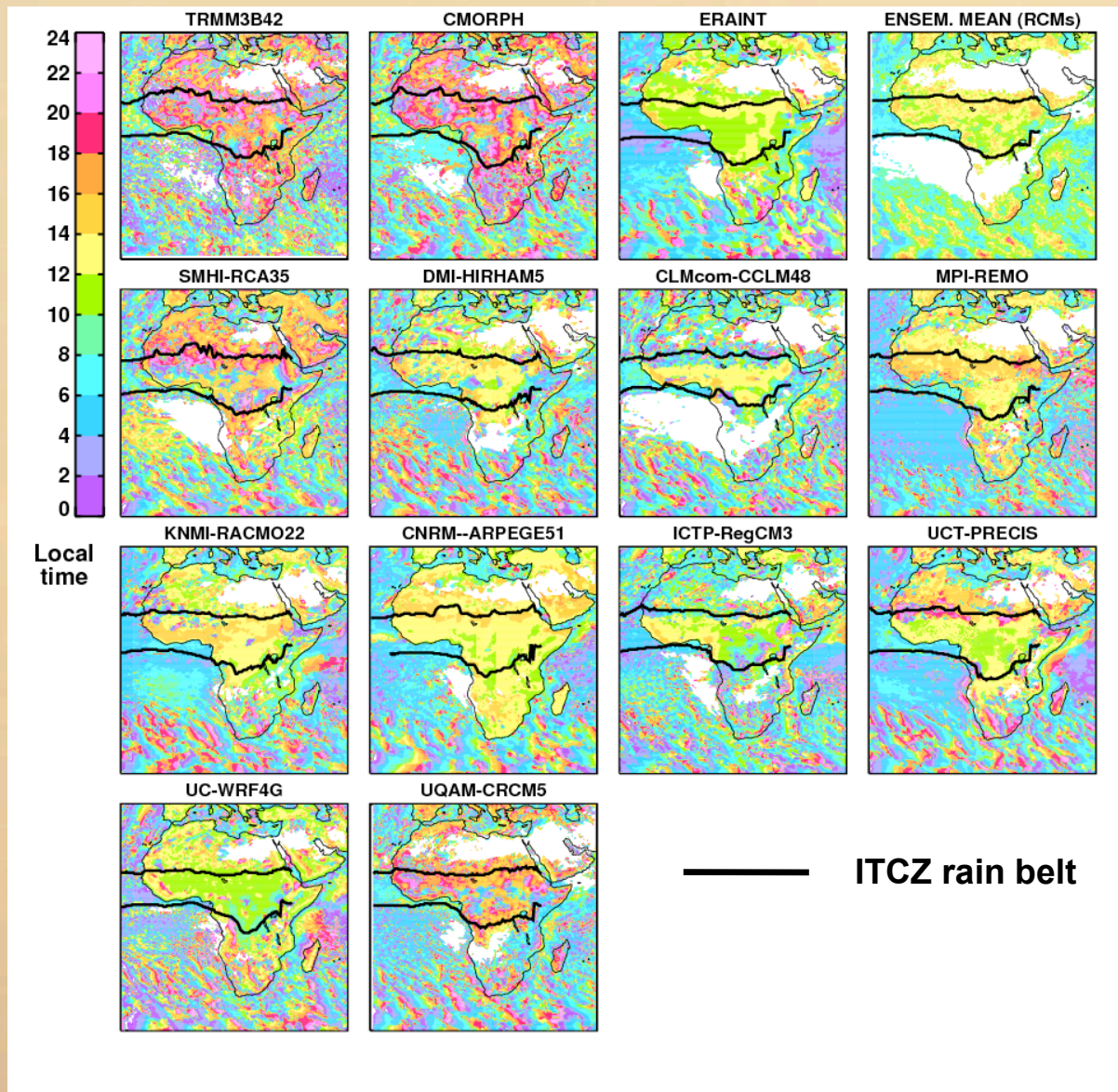


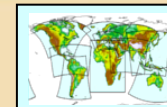
- ERA-Interim fails to reproduce some years: 2005, 2006 and 2008
- the ensemble mean reproduces interannual variability pretty well
- larger spread across RCMs in last several years (2004-2008)



JAS (2003-2008) only days > 1 mm/day

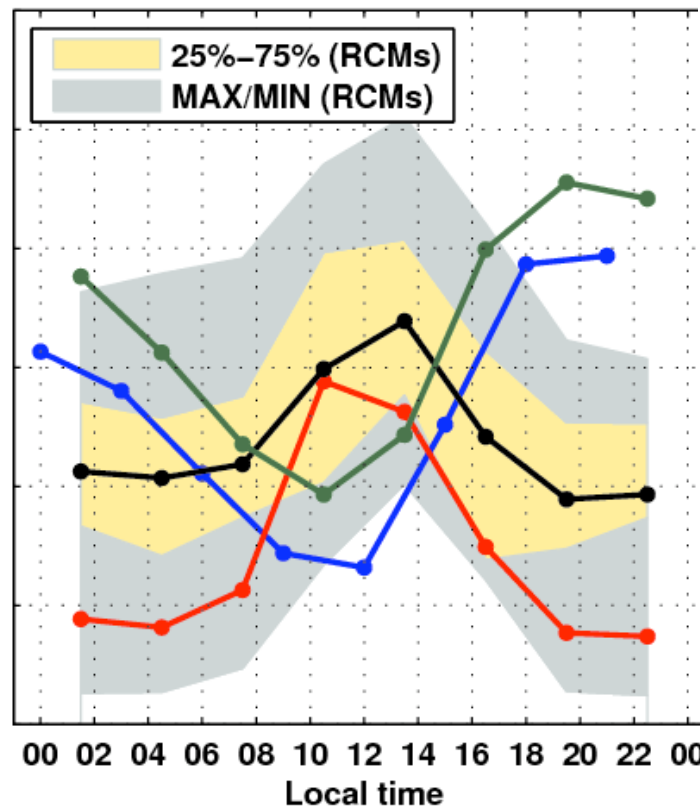
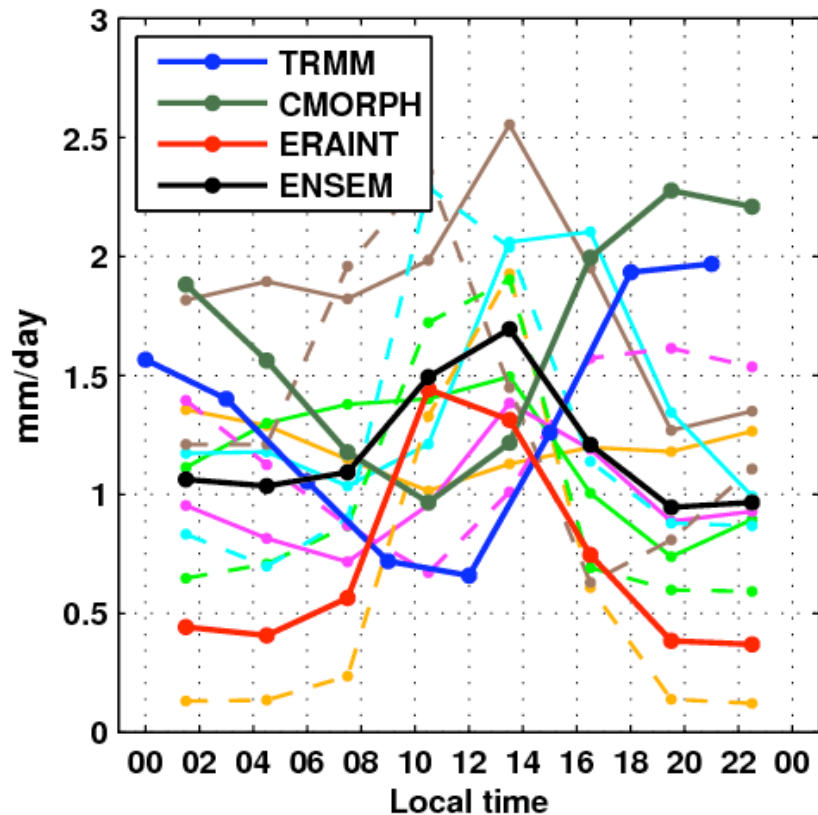
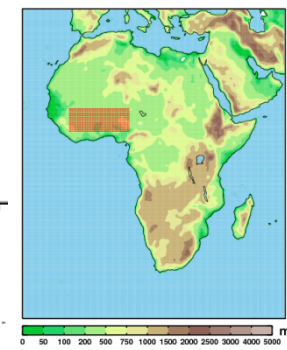
- TRMM/CMORPH maximum between late afternoon and midnight
- ERAINT and the majority of RCMs precipitates too early around the local noon
- RCA35 and CRCM5 capture to some degree the observed phase;
- both employ the Kain-Fritsch convective scheme, although WRF as well



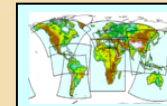


- SMHI-RCA
- KNMI-RACMO
- - - UC-WRF
- DMI-HIRHAM
- - - CNRM-ARPEGE
- - - UQAM-CRCM
- CCLMcom-CCLM
- - - ICTP-RegCM
- - - UCT-PRECIS
- MPI-REMO

West Africa North | JAS | 2003–2008



**RCA35 has a too flat diurnal cycle
 only CRCM5 captures diurnal cycle
 ensemble mean can partly correct the amplitude but not the phase**



- ✓ individual RCMs simulate West African Monsoon precipitation with differing level of accuracy
- ✓ most capture the WAM rainfall maxima (the Gulf of Guinea and the Sahel region) although the positioning, intensity and duration of these maxima differ across the models
- ✓ a number of RCMs show too early onset of the WAM
- ✓ the majority captures rapid northward progression into Sahel
- ✓ the multi-model average generally, but not always, outperforms any of the individual models
- ✓ such good performance of the ensemble mean is mostly a result of a cancelation of opposite signed biases
- ✓ nevertheless, many of RCMs do improve the WAM rainfall compared to their boundary - ERA-Interim → subset of RCMs can be used